Policy and Management for Headwater Streams in the Pacific Northwest: Synthesis and Reflection

Paul W. Adams

Abstract: The primary policy and management concern for headwater streams in the Pacific Northwest has been their potential influence on downstream water quality and fish habitat; and on federal lands, riparian wildlife habitat also has been a significant consideration. Regulations have been the primary policy tool used by state and federal agencies in the region to promote desired management for these areas, and to comply with federal laws for water quality and species protection. Management directives initially were relatively minor for headwater areas, but in recent years increased science assessments, research, and legal issues resulted in some notable policy proposals and changes for public and private lands. These measures focus on greater retention of riparian trees and other vegetation, an approach that for fish and wildlife habitat assumes significant ecological functions and benefits will follow over extended spatial and temporal intervals. Research continues to clarify ecological features and functions of headwater areas, but policy and management remain challenging because of highly variable observations downstream and because socioeconomic concerns are inconsistently addressed. Given these limitations, our policies may continue to confound decisionmakers and discourage many forest owners and managers, while also adding to an array of unintended local and global environmental consequences. FOR. SCI. 53(2):104–118.

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POLICIES AND MANAGEMENT for headwater streams represent a relatively new frontier for aquatic resource protection, and their nature and potential scope are generating considerable attention among forestland owners and managers in the Pacific Northwest. Until the last decade or so, the attention of both policymakers and resource managers in the region has focused almost exclusively on larger, perennial fish-bearing forest streams and their adjacent riparian areas. Although maintaining or enhancing freshwater habitat for anadromous and other fish species remains a top priority, in recent years headwater streams have been much more widely recognized for their potential influence on downstream habitat conditions. This is clearly reflected in the many papers and diverse research collected and discussed in this special issue of *Forest Science*.

A recent compilation (Moore 2005) and nearly all the papers in this special issue discuss research studies on the physical, chemical, and biological characteristics of headwater streams, riparian areas, and related resources. Some investigate the effects of specific management activities and prescriptions. Undoubtedly, the findings from these studies and other similar research will have an important influence on the further evolution of policies and management strategies for headwater areas. Even as this newer research is emerging, the policy and management of headwater streams provides a rich topic for review and discussion, although published literature specifically on this topic remains scarce.

Thus, under the themes of synthesis and reflection, I examine and discuss here both historic and contemporary dimensions of key aspects of forest headwater stream policies and management in the Pacific Northwest. These themes provide some latitude for individual interpretation and even some criticism, as suggested by the dictionary definitions of these terms (see, e.g., Merriam-Webster Online). Primary emphasis is given to policies for headwater stream channels and riparian areas, as these act as some of the most significant constraints for management of areas that otherwise often closely resemble the adjacent forest uplands. Headwater streams have been defined as having an annual streamflow of less than 2 cubic feet per second, and typically do not support fish populations (Oregon Headwaters Research Cooperative 2005a). Although my discussion is regional in nature, a number of examples and experiences from Oregon are used to highlight key points.

Policy Foundation and Focus

The federal "Clean Water Act" (CWA, or more specifically, the Federal Water Pollution Control Act as amended in 1972) provided much of the initial stimulus for forest stream protection programs throughout the United States. This law directed states to identify major water pollution sources and develop plans to control such problems so that water quality would be maintained or improved. Reflecting a form of "cooperative federalism" (Fischman 2006), the CWA allowed states some discretion in the use of either

Paul W. Adams, Forest Engineering Department, College of Forestry, Oregon State University, 204 Peavy Hall, Corvallis, OR 97333—Fax: (541) 737-4316; paul.adams@oregonstate.edu.

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nonregulatory or regulatory control programs, including those for nonpoint source pollution (NPS) from forest practices ("silviculture"). Subsequent amendments (e.g., the Clean Water Act of 1977 and the Water Quality Act of 1987) and related federal regulations expanded the concepts and tools to further focus and implement policies for water resource restoration and protection.

These updates included requirements for determining "beneficial uses" of specific water bodies, establishing water quality standards for these uses, and conducting periodic assessments to help identify "water quality limited" conditions and related pollution sources. Best management practice (BMP) programs were emphasized to control nonpoint pollution (Ice 2004, Seyedbagheri 1996), although the later CWA amendments resulted in a shift in attention toward an approach designed originally for point source control, i.e., total maximum daily load (TMDL) allowances. Sections of the law that describe these and other key requirements for water quality assessment and protection from nonpoint pollution include 208, 303(d), and 319, with further details found in the Code of Federal Regulations (e.g., Title 40, Parts 130 and 131). O'Laughlin (1996) provides an effective narrative summary of the key components of the CWA.

The objective of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," including "an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for the recreation in and on the water be achieved by July 1, 1983." This emphasis on fish and other biological values was readily adopted in the region and later increased significantly as aquatic species were considered for listing as Threatened or Endangered under the Endangered Species Act of 1973 (ESA).

Oregon, Washington, Idaho, and California responded relatively quickly to the federal mandates of the CWA, with each state implementing a regulatory BMP water protection program by the mid-1970s. In fact, the Oregon Forest Practices Act of 1971 that authorized and shaped the state's regulatory program was passed by the Oregon legislature before the CWA itself became federal law. Oregon's program also served as a pioneer in its emphasis on controlling the impacts of forest practices on fish, which was shaped in part by research findings from the Alsea Watershed Study that encompassed both fish-bearing and headwater streams (Ice et al. 2004a).

In the 1980s emphasis on freshwater fish habitat was strengthened further as agency assessments (e.g., Carleson and Wilson 1985, Yee 2003) and public agreements (e.g., Washington's Timber, Fish and Wildlife Agreement) brought primary attention to habitat concerns. A growing body of ecological research in the region played a role also, particularly in expanding the view of riparian functions from a relatively simple buffer providing shade and a pollutant barrier to a complex, dynamic source of food for aquatic organisms and large woody debris for habitat structure. Much of this research was summarized in a key 1986 conference titled "The Streamside Management Symposium: Forestry and Fisheries Interactions," with a detailed proceedings issued the following year (Salo and Cundy 1987).

Other resource values of forest streams and riparian areas also were recognized and better understood during this period. Some of the aforementioned ecological research, for example, clarified important features and functions of stream riparian areas for wildlife habitat (e.g., Brown 1985, Raedeke 1988). Such diverse ecological functions beyond water quality protection help explain why the choice of buffer widths is a key policy variable (O'Laughlin and Belt 1995). In addition, there has been an extended history of interest and research in forest management effects on water quality stemming from the importance of forest watersheds as a primary source of drinking water supplies in the region (e.g., Adams and Taratoot 2001, Brown et al. 1973, Taylor and Adams 1986).

In this context, major revisions to the state forest practice regulations for riparian areas were adopted in Oregon and Washington in the late 1980s (Adams et al. 1988). These policy changes clearly gave primary attention to fish habitat concerns, although wildlife habitat and drinking water considerations were integrated to some degree. Earlier regulations required little or no protection of headwater streams, but the late 1980s revisions reflected a modest increase in awareness of the potential for small, non-fish-bearing streams to influence downstream habitat and water quality. Although the CWA only refers once to "cumulative effects" (Section 208), the National Environmental Policy Act of 1969 (NEPA) requires their consideration when planning major federal management actions. This undoubtedly contributed to a growing number of policy-related discussions of this concept through the 1980s and early 1990s (e.g., Geppert et al. 1984, Munn 1987, Yee 2003) and an increasing interest in measures to protect headwater streams.

Oregon's Forest Practices Act, for example, was amended in 1991 to include "Class II Special Protection Waters," which were defined as streams with a significant summertime cooling influence on downstream Class I waters at or near a temperature that limits anadromous fish production. Forest operations along these streams were required to maintain at least 75% of the original shade, the same level needed for Class I streams. These were interim directives, with the amending legislation also mandating a review of stream classification and protection to support subsequent rulemaking; this process created a classification and analytical framework that would facilitate future consideration of "small Type N" steam protections. By the early 1990s, California and Idaho also adopted new stream protection regulations for forest lands (Belt et al. 1992, Yee 2003), although generally the protection measures for headwater streams remained relatively limited throughout the region (Table 1).

Expanding Influences and Scope

Several developments in the 1990s strongly influenced a number of policy initiatives that not only gave even greater attention to riparian forests and fish habitat in the region, they also significantly expanded the scope of concern within watersheds to more often include headwater streams. Arguably the most significant was the observed decline in wild salmon populations, which were widely highlighted in the

Table 1. Primary protection requirements for headwater forest streams in four Pacific Northwest states in the early 1990s (adapted from Belt et al. 1992). Specific stream class definitions vary among the states, but classes shown typically reflect small perennial or seasonal non-fish-bearing streams

State and stream class	Riparian width (ft)	Required measures
Idaho—Class II	5	No soil disturbance
Washington—Type 4	Not specified	Retain 25 trees >6 in. dbh per 1,000 ft
California—Class III	Not specified	Retain 50% of understory
Oregon—Class IIsp	Not specified	Retain 75% of existing shade

professional literature (e.g., Nehlsen et al. 1991, Williams et al. 1989) as well as the news media. Although limitations in establishing cause and effect relationships between these declines and contemporary land use practices were noted during this general period (e.g., Adams 1995a, Platts and Nelson 1988), such concerns did not dampen interest in expanded regulation of riparian forest management.

The 1990s saw an unprecedented level of influential federal reviews, decisions and policy-oriented input from scientists that related to important watershed, aquatic resource, and riparian forest issues. An EPA Region 10 review of streamside protection policies, for example, concluded that "the main impacts to riparian areas . . . stem from timber-harvesting and livestock-grazing" and that policies that support some "controversial steps" may be needed to improve and protect these areas (Goldberg 1991). ESA-based court decisions concerning the population status ("Threatened") of spotted owls and management-related changes in their habitat (e.g., Babbitt versus Sweet Home) prompted decisionmakers to favor a precautionary policy and management approach on federal lands (Mealey et al. 2005, Thomas 2002). Federal land management also became a focal point for several policy-oriented science assessments by selected groups of experts, such as the "Gang of Four" (Johnson et al. 1991) and FEMAT (1993) reports.

Although the federal science assessments were prompted primarily by the spotted owl issue, concurrent concerns about declining wild salmon populations as well as a wider array of forest species and ecological values led to discussions of much broader policy and management alternatives and strategies (Thomas 2002). These assessments thus evolved into the Northwest Forest Plan (NWFP), which included interim aquatic and riparian habitat protection directives (Table 2) for forests throughout much of the region (USDA and USDI 1994a, b), including headwater areas that previously had received limited attention. In fact, the Aquatic Conservation Strategy (ACS) that established the foundation and framework for the federal stream and riparian directives contains a section that specifically discusses intermittent streams, and includes an analysis of riparian protection widths needed "to protect the ecological integrity of intermittent streams" (Figure 1). The ACS's influence also was expanded geographically to most other federal forest lands in the region through the PACFISH decision (USDA and USDI 1995), which incorporated very similar riparian protection directives (Adams 1995a).

An estimated 2,627,500 acres of "Riparian Reserves" were expected from the initial implementation of the ACS on the federal "Matrix" lands where late-successional and old-growth habitat was not emphasized (USDA and USDI 1994a, b). The ACS directives also applied to the other land allocations within the Northwest Forest Plan (e.g., 9,054,800 acres in Late Successional Reserves, Managed Late Successional Areas, and Adaptive Management Areas), where about 40% of those lands were expected to become Riparian Reserves. It is important to note that the substantial areas allocated to Riparian Reserves stemmed largely from the initial, default directives that were very conservative compared to existing stream protection requirements for nonfederal lands (e.g., Tables 1 and 2). The default directives were designed as a precautionary starting point that allowed for adjustments to the basic buffer widths and management restrictions, with the flexibility given after completing the key prerequisite of a local, comprehensive watershed analysis.

Undoubtedly, the substantial protection given to headwater streams (Table 2), particularly in high rainfall, dissected terrain with a high density of these streams (e.g., the Siuslaw National Forest), was a major factor contributing to the large areas in the default Riparian Reserves. In addition, three unique and important aspects of the science assessments and related policies that influenced both the large areas and the precautionary nature of federal riparian protection were (1) the integration of habitat conservation for amphibians and other forest-dependent species, (2) the belief that a large-scale strategy was needed to effectively protect and recover habitat, and (3) the assumption of analysts and decisionmakers that, given their authority only for

Table 2. Interim widths and major protection measures for "Riparian Reserves" on USDA Forest Service and USDI Bureau of Land Management forest lands within the range of the Northern Spotted Owl (adapted from USDA and USDI 1994b)

	Fish-bearing streams	Perennial non-fish-bearing streams	Seasonal or intermittent streams
Width of Riparian Reserve	Two site-potential tree heights or 300 ft, whichever is greater	One site-potential tree height or 150 ft, whichever is greater	One site-potential tree height or 100 ft, whichever is greater
Major protection measures in Reserve	No timber harvest or new roads or landings except after watershed and site-specific analyses; changes in reserve width require similar analyses.		

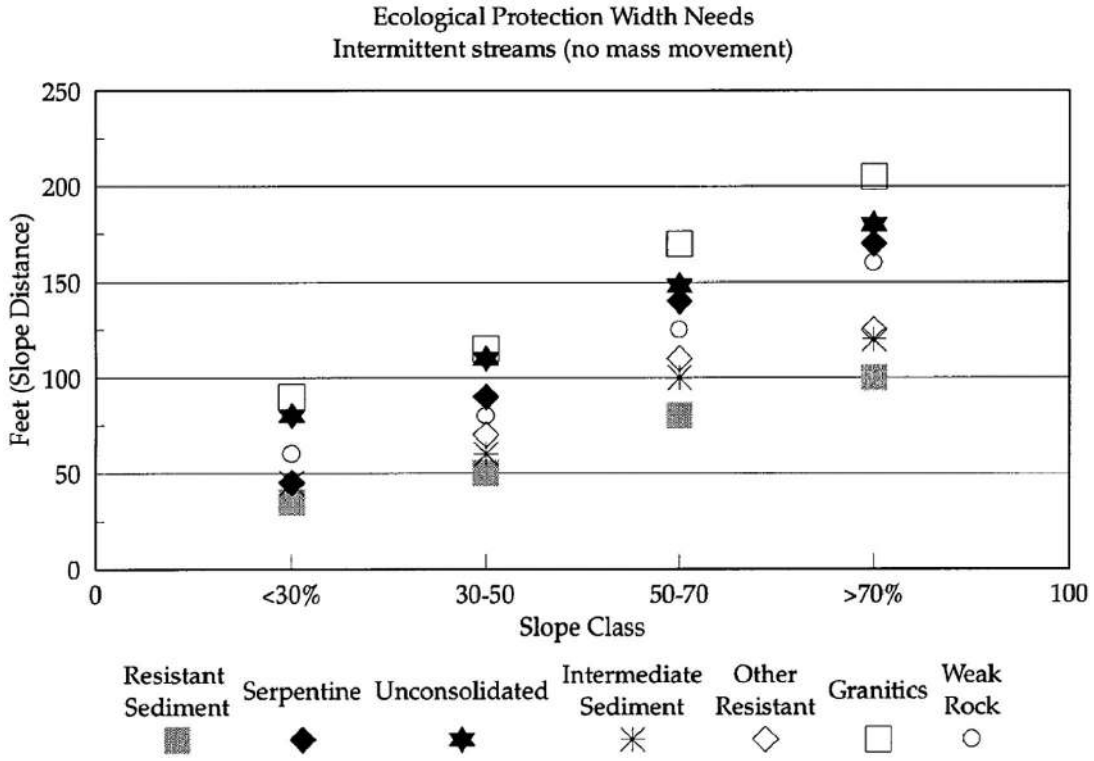

Figure 1. Widths of "Riparian Reserves" needed for intermittent streams, by slope class and rock type, on USDA Forest Service and USDI Bureau of Land Management forest lands within the range of the northern spotted owl (adapted from USDA and USDI 1994b). Values shown represent ecological protection needs other than slope stability and reflect estimates based on professional judgment and experience of an interagency team of scientists.

federal lands, primary habitat needs should be met on those lands (Reeves 2006, Reeves et al. 2006).

Policy-oriented science assessments and agency analyses also became more common at the state level. For example, as decisionmakers considered major revisions to the riparian protection measures required in the Oregon Forest Practice Rules, the State Forester requested a summary of relevant research from the dean of the OSU College of Forestry (Brown 1992). In California and Idaho, similar requests from agency and policy leaders generated various reviews and reports (Belt et al. 1992, Yee 2003). Interest in the technical basis for Oregon's policy revisions grew further, in part due to directives from the 1991 Oregon legislature (SB 1125), and thus the Oregon Department of Forestry (ODF) documented the science and policy considerations in the regulatory changes that were subsequently implemented (Lorensen et al. 1994). In a similar but broader and more detailed effort, the ODF, on behalf of the state's policymaking Board of Forestry, commissioned an independent assessment (Botkin et al. 1994) of the fisheries and forest practices issue.

Another notable development during this period was the growth of policy activism among scientists, as reflected by unsolicited input to public agencies and decisionmakers who were dealing with fish habitat and riparian forest issues in the region. For example, a letter from 12 university and agency scientists was sent to the ODF (Beschta et al. 1992), with recommendations that included rule requirements for a no-harvest buffer along all fish-bearing streams and retention of nonconiferous trees and shrubs along headwater (i.e., non-fish-bearing) streams. Similarly, as the FEMAT analysis was being completed and agencies were about to begin work on the Northwest Forest Plan, 125 scientists and other resource professionals sent a letter to President Clinton that urged substantial watershed and riparian protection and restoration on federal lands. *The Oregonian* newspaper also published a major article about the letter under the headline "Scientists Want Timber Solution to Protect Fish" (Adams 1995b).

Aside from applicable constraints of employer policies and professional ethics, such scientists clearly had the right to speak out as concerned citizens (Adams 1995b). In addition, there is no consensus among scientists as to whether such activism is inappropriate or essential to the well-being of society and nature (Kaiser 2000). Regardless of how scientists become involved in policy and decisionmaking, their input may be less effective and useful if they blur the lines among facts, values, and opinions. For example, the Chair of the Oregon Board of Forestry at the time the 1994 riparian rules were developed noted such problems in the aforementioned letter (Beschta et al. 1992) to ODF and contrasted it with the OSU Forestry Dean's input (Brown 1992), referring to the latter as "very powerful . . . its power derives not from passion but from the disinterested presentation of relevant facts" (McLennan 1992). Similar strengths and weaknesses were seen in other solicited and unsolicited input from scientists to decisionmakers involved with fish and wildlife protection issues in the 1990s, and contributed to various discussions and guidance (e.g., Adams and Hairston 1994, 1996, Cleaves 1994, Garland 1997, O'Laughlin and Cook 2002, Smith 2005). But despite growing awareness, it is noteworthy that during this period many,

if not most, of the influential policy-oriented science assessments in the region were not subjected to a formal (i.e., refereed) peer review process.

Greater activism by scientists paralleled a growing division among interest groups about forest resource protection policies on private lands in the region. To address these disparate views as well as increasing concerns about ESA-based species listings, policymakers expanded the use of negotiation processes in which interest group representatives collectively reviewed relevant science and worked toward some consensus about resource protection needs and responses. For example, in Oregon the Forest Practices Advisory Committee (FPAC) worked for 2 years to develop a set of stream protection recommendations, including approaches for headwater areas to address downstream concerns such as water temperature and the role of small streams in delivering desirable large wood via debris torrents. In Washington, new legislation and regulations evolved from a negotiation process know as Forests and Fish. However, in both states some parties initially engaged in the negotiation processes left the table and some subsequently engaged in litigation to promote their views and objectives. For example, although later dismissed in court, a lawsuit was filed against Oregon's State Forester (Pacific Rivers Council versus Brown) for "authorizing forest practices that harm [ESA] listed coho salmon."

Other unique policy approaches for stream protection on private forest lands evolved during the 1990s. For example, the 1994 revisions to the Oregon stream protection rules included an "active management" option that allowed landowners in some cases to remove more riparian timber than the rules normally allowed, in exchange for implementing approved stream habitat enhancement projects. Although often inaccurately referred to as an "incentive" approach, particularly given the inherent cost of such projects (e.g., Kellogg et al. 1993), it did show that policymakers were mindful of the regulatory costs of riparian protection to forest landowners and that active efforts to restore or improve fish habitat were desirable. These themes were expanded dramatically in Oregon when Governor Kitzhaber, in cooperation with the state's agencies, legislature, and forest products industry, established the "Oregon Plan for Salmon and Watersheds" as the state's primary response to the issue of declining salmon runs. However, its emphasis on nonregulatory (i.e., unenforceable) measures by private landowners prompted an ESA-based legal challenge (ONRC versus Daley) that was affirmed in a 1998 federal court decision.

Questions about the effectiveness of the Oregon Plan arose even before the 1998 court decision, particularly among the federal agencies responsible for species and habitat protection under the ESA and CWA. Adding to the issue during this period was the relative disparity in forest stream and riparian protection requirements between Oregon and California and Washington, the latter two states having "raised the bar" by adopting some stricter measures in response to the fish population and species listing concerns. Under this backdrop, the National Marine Fisheries Service (NMFS 1998) proposed that Oregon adopt significantly greater Forest Practice Rule restrictions on timber harvest and other practices in western Oregon riparian areas, including headwater streams (Table 3). The NMFS proposal met significant resistance by landowner and other interests, and the Oregon Board of Forestry declined to act on it due to questions about its technical and policy bases. However, the issue did reveal the high level of federal agency concern as well as the nature and scope of the favored riparian forest protection policies.

Unusually large storms in the region during the winter of 1996 (see, e.g., Laenen 1997) and fall-winter 1996–97 provided a sobering and instructive reminder of the power and influence of infrequent natural events on riparian and aquatic areas. The resource and human effects of related flooding and landslides caught the attention of scientists, resource managers, and policymakers alike, although not necessarily for the same reasons. For example, in Oregon numerous landslides (including one that originated in a clearcut and caused several deaths) prompted some agency analyses and policy-oriented science assessments (e.g., Pyles et al. 1998, Robison et al. 1999), as well as legislation (e.g., SB 1211) and Forest Practices Act changes that affected riparian management (including some headwater locations) in landslide-prone areas.

Although human property and safety concerns caught much of the public spotlight, the 1996 floods also provided a strong stimulus for further thinking about the broader ideas and management strategies for dynamic forest and aquatic ecosystems in the region. A number of studies and

Table 3. Draft Forest Practice Rule riparian management zones (RMZ) and protection measures proposed for western Oregon by the Northwest Region of the National Marine Fisheries Service (adapted from NMFS 1998)

	Perennial fish-bearing streams	Perennial non-fish-bearing streams	Seasonal (intermittent) streams
Total RMZ—width	1 site-potential tree (150–200 ft)	2/3 site-potential tree (100–150 ft)	1/2 site-potential tree (75–100 ft)
Inner RMZ—width	30 ft	30 ft	Slopes <30%—0 ft Slopes >30%—30 ft
Measures—inner RMZ	Light thinning only, without ground-based equipment, retain relative density ≥50	Light thinning only, without ground-based equipment, retain relative density ≥50	Slopes <30%, thinning only Slopes >30%, total tree retention
Measures—outer RMZ	Retain largest trees and relative density ≥30	Retain largest trees and relative density ≥30	Retain mature trees and relative density ≥30
Measures—total RMZ	Need written plan for harvest when mature	Need written plan for harvest when mature	Selective harvest OK when mature

discussions already had presented various evidence and conceptual models that suggested that periodic natural disturbances and dynamic stream conditions played some key roles in providing valuable fish and wildlife habitat features (e.g., Naiman et al. 1992, Reeves et al. 1995). The 1996 floods renewed interest in the issue, and undoubtedly influenced research and writings on the subject in the region in the late 1990s and beyond (e.g., Naiman and Bilby 1998, Hassan et al. 2005).

Another development in the 1990s, closely related to the fish population issue, was a significant expansion of CWA-based assessments and listings of "water quality impaired" (Section 303(d)) streams in the region. Excess sediment was the basis for many of the initial listings (O'Laughlin 1996), particularly in Idaho and Northern California. However, in recent years many stream listings have been due to impaired temperatures, and those in Oregon, Washington, and Idaho have represented a very high portion of the temperature-based listings nationwide (Ice et al. 2004b). The number of stream listings increased significantly after states revised their water quality standards for temperature in response to fish population concerns and policy-oriented science assessments of the water temperature issue (e.g., Technical Advisory Committee et al. 1995, Boyd and Sturdevant 1997). The impaired stream listings also undoubtedly contributed to continued concerns in the region about policies and management of forest streams and riparian areas as the 1990s drew to a close (e.g., ODF and DEQ 1998, Independent Multidisciplinary Science Team 1999, Ligon et al. 1999).

Policies and Management in the 2000s

It should be clear from the previous discussion that the policies and management for both large and headwater streams and riparian areas on forest lands in the Pacific Northwest have seen many influences and substantial changes from the 1970s through the end of the 20th century. Recognizing that a substantial level of flux is likely to continue, the remaining discussion will focus on policies and management current as of this writing (2006), and on a number of ongoing or emerging influences that could contribute to further issues and changes over the next decade or so. Although some common themes exist among major landownership groups, the policy and management considerations on federal, state, and private forest lands are different enough to merit some separate discussion.

Federal Lands

The ACS- and PACFISH-based policies for stream and riparian areas of federal forest lands in the Pacific Northwest have been in place for over 10 years, and their influence has expanded in Idaho and Montana through the similar INFISH policy. Reflecting on the first decade of experience with the ACS, two articles (Reeves 2006, Reeves et al. 2006) discuss its initial evolution as well as its subsequent implementation and results. These discussions provide much enlightening information and context for understanding the conceptual basis and notable outcomes of the ACS and related federal policies, although references by other observers also are recommended (e.g., Mealey et al. 2005, Thomas 2002) to provide a more complete and critical view of the strong social and political factors that have influenced these policies and outcomes.

The reviews by Reeves (2006) and Reeves et al. (2006) confirm the large area (2.6 million acres) currently allocated to Riparian Reserves on federal lands from the application of the standards listed in Table 2, and also acknowledges that protection to headwater (i.e., intermittent) streams was the greatest contributor to the increased riparian protection area over previous policies. Data presented in one of these reviews (Table 4) further indicate that although some active management within the Reserves has occurred, on an annual basis this has represented about 0.2% of the total area in Reserves. After a decade of this largely passive riparian management approach on federal lands, Reeves et al. (2006) state that although limited monitoring data preclude a quantitative assessment, the policies "appear to have prevented further degradation of watersheds that would have been likely under previous forest plans" and that "conditions of watersheds in the NWFP have improved at least somewhat since the NWFP was implemented. . . ."

Reeves (2006) and Reeves et al.'s (2006) observations also confirm the continued "ecological functional" nature of the federal strategies and policies, and add further clarification and discussion of key concepts that may help provide some near-term expectations for the policies and management of headwater streams and riparian areas on federal lands. For example, an extended discussion of headwater streams in Reeves (2006) emphasizes their dynamic nature and important ecological functions, particularly as a source of large woody debris for beneficial sediment processes and downstream fish habitat. This discussion acknowledges that the ability of upslope areas near headwater streams to contribute woody debris to fish-bearing streams can vary

Table 4. Estimated acres within federal Riparian Reserves where silvicultural activities occurred within the first 10 years of the Northwest Forest Plan (adapted from Reeves et al. 2006)

Area and administration	Thinning	Regeneration harvest	Total
Region 6, USDA Forest Service	29,359	3,116	33,675*
Region 5, USDA Forest Service	9,595	1,814	11,409
Oregon Districts, USDI Bureau of Land Management	unspecified	unspecified	6,089
California Districts, USDI Bureau of Land Management	84	0	84
Total	—	—	51,257

*Includes 1,201 acres not specified as either thinned or regeneration harvested.

widely, but also generally suggests that a policy and management emphasis on significant tree retention in headwater areas remains necessary, at least in steep terrain prone to mass soil movement.

Also notable are Reeves (2006) and Reeves et al.'s (2006) strong emphasis on landscape-level processes and conditions, which apparently were fundamental in the ACS but sometimes misinterpreted by federal managers and others concerned about policy and legal responsibilities and compliance. This misinterpretation resulted in managers attempting to meet all of the ACS objectives for any individual federal action or, failing to do this, in challenges by regulatory agencies or other interested parties. In fact, Reeves earlier (1999) made a declaration in federal court to call attention to this misinterpretation, and a recent decision (USDA and USDI 2004) resulted in a revision of the ACS policy document itself to provide formal clarification of the landscape-level nature of the ACS objectives. This emphasis is consistent with the watershed analysis component of the ACS mentioned above and provides a path for significant management flexibility. However, initial experience with these analyses has shown some significant challenges and limitations (Ice and Reiter 2003), such as key data gaps and the treatment of risks, which to date appear to have contributed to relatively limited management of Riparian Reserves.

State Forest Lands—Oregon Example

The Northwest Oregon State Forests Management Plan (NWOSFMP), developed by the Oregon Department of Forestry and adopted in 2001 by the Oregon Board of Forestry, provides an example (Table 5) of current protection policies for headwater areas on some state forest lands in the region. The policies and these lands are noteworthy not only because of the large area they encompass (i.e., 615,000 acres), but also due to their strategic location in a subregion where public forest lands are otherwise limited and the quality and quantity of mature forest habitat for fish and wildlife are a major concern for state managers. This situation and a specific policy directive to manage state forest lands to help maintain and restore aquatic habitats ("Greatest Permanent Value," Oregon Administrative Rule 629-035-0020) led to stream and riparian protection measures that significantly exceed those required under the Oregon Forest Practices Act and Rules. Although these default measures resemble the federal directives under the ACS (e.g., Table 2), particularly for headwater streams, there are more limited process requirements and considerable flexibility for modifications and exceptions.

The NWOSFMP is based on a concept called "structure-based management" that is intended to emulate natural landscape patterns and processes to provide desirable wildlife and aquatic habitat features like those found in older natural forests, but in fewer years. Thus, the discussion of aquatic and riparian strategies that provide the basis for the protection measures in the NWOSFMP (Chapter 4 in ODF 2001) echoes a number of themes of the federal ACS, including a landscape-scale approach, watershed analysis, and development of forest conditions that support natural ecological processes favorable to aquatic habitat complexity. However, the broad legal and policy mandates affecting the NWOSFMP (Appendix D in ODF 2001) include not only fish and wildlife protection, but also the primary objective of timber production to provide substantial revenues for local governments. Thus, relative to the federal ACS, the aquatic and riparian strategies and protection measures of the NWOSFMP provide a significant degree of allowance and flexibility for active management. For example, the "75% of stream reach" restrictions for perennial and seasonal non-fish-bearing streams (Table 5) allows for an extended rotation approach to timber harvesting in many headwater areas.

Although the aquatic and riparian strategies and directives in the NWOSFMP represent a significant level of protection for fish and wildlife habitats, discussion and debate have continued on the question of whether even greater management restrictions are desirable or necessary on state forest lands. For example, the implementation plan for the NWOSFMP included a "Salmon Anchor Habitat Strategy" (SAHS) that targeted 17 specific watersheds as core recovery areas where increased stream and riparian protection measures would be applied. For headwater areas, this included expanding the no-harvest zone from 25 to 50

Table 5. Riparian management areas (RMA) and related major protection requirements for small streams on State Forest lands in northwest Oregon (Adapted from Appendix J in ODF 2001)

	Small fish-bearing (Type F) streams	Perennial non-fish-bearing streams[1]	Seasonal non-fish-bearing streams[1]
Stream Bank Zone—0–25 ft	No timber harvest or ground operations	No timber harvest or ground operations	No timber harvest[2] or ground operations
Inner RMA—25–100 ft	Manage for mature forest, no management thereafter; retain $\geq$ 50 trees per acre and conifer density $\geq$ 25% SDI	Retain $\geq$ 15–25 conifers and snags per acre; within 500 ft of Type F, retain trees needed for 80% shade	Retain $\geq$ 15–25[2] or $\geq$ 10 conifers and snags per acre
Outer RMA—100–170 ft	Retain $\geq$ 10–45 conifers and snags per acre	Retain 0–10 conifers and snags per acre	Retain some or all snags
Total RMA—0–170 ft	Retain all snags and down wood; limit ground disturbance	Retain all snags	Retain some or all snags

[1] Requirements to be applied on $\geq$ 75% of stream reach.
[2] Requirement applies to high-energy or potential debris flow track reaches only.

ft along seasonal non-fish-bearing stream reaches classified as high energy or debris torrent prone (ODF 2003). Concerns about the increased restrictions among Oregon legislators prompted both an unsuccessful bill (HB 3632) that would have greatly relaxed the restrictions, and a successful budget note that directed a constituent review of the SAHS (INR 2004). The appointed group found little consensus in their views of the SAHS, however, and thus provided only limited direction to the Board of Forestry and ODF as they continued to evaluate and implement the NWOSFMP.

Private Lands

Stream protection regulations for private forest lands in the Pacific Northwest have become relatively detailed and complex, and thus the summary provided here focuses on some major similarities and differences among Oregon, Washington, Idaho, and California. Individuals dealing directly with these policies or interested in the details should review the latest version of the regulations from the appropriate state agency (Table 6), giving particular attention to definitions and other specific language and requirements. Major stream protection requirements for small forest streams in the region are summarized in Table 7. Measures for headwater streams generally match those listed in the right column (i.e., Non-Fish-Bearing Streams), with requirements for small (if specified), fish-bearing streams provided for comparison in the left column.

Downstream water quality and fish habitat protection clearly are the primary goals of the measures for headwater stream and riparian areas in all states, as shown by the emphasis on tree or understory retention and on limiting ground disturbance (Table 7). Definitions and other language in the specific rules themselves provide further evidence of these goals, including references to canopy cover, conifer retention, and the downstream proximity of fish-bearing streams. Key ecosystem functions explicitly or implicitly related to the headwater protection measures include shade and large woody debris supply, and soil infiltration. The rules also suggest some recognition of the large-scale functional role of steep, headwater areas in downstream delivery of woody debris and sediment, but not as pointedly or for other reasons as the federal and state lands policies discussed above. Oregon, for example, has a specific set of requirements for tree retention and limiting disturbance in steep, headwater areas on private lands primarily to protect public safety.

Of the four states reviewed here, Washington and California have the greatest restrictions on forest practices near headwater streams, particularly for situations where these streams drain directly into fish-bearing streams (Table 7). The 50-foot no-harvest area for such streams in Washington initially appears most restrictive, but the greater length (i.e., 1,000 ft upstream) and width (i.e., 100 ft for some slope and equipment combinations) of California's RMZs could result in similar or greater tree retention along headwater streams in that state. Although focused on fish-bearing streams, California also has provisions for greater protection measures within a relatively large area of watersheds with anadromous salmonids that are listed or candidates for Threatened or Endangered status under the state or federal ESA (i.e., the Threatened or Impaired Watershed Regulations).

Idaho's "Supplemental Measures" are among the most unique headwater protection provisions listed in Table 7, at least in terms of their direct connection between private land practices and federal law. They resulted from a formal agreement between the State of Idaho and the federal agencies primarily responsible for administration of the ESA, and apply to specific watersheds where threatened and endangered fish species have been a particular concern, i.e., the Salmon and Clearwater River drainages in Central Idaho. Although application of the measures is voluntary, landowners who do so receive an allowance for an "incidental take" of the local listed fish species, which avoids potential liability for species "takings" violations of the ESA.

The relatively limited measures required for headwater streams on private lands in Oregon (Table 7) have been the subject of considerable discussion and debate in recent years. For example, although the CWA generally allows state policies to prevail, recent comments from federal agency officials to the Oregon Board of Forestry (OBF) stated that ". . . improvements to management of small non-fish streams, landslide prone areas, and cumulative watershed effects would be necessary to argue convincingly that forest practices meet the [water quality] standards and TMDLs" (Markle 2004), and ". . . we are not confident that [the rule-making and voluntary measures proposed by the Board] can be relied on to meet Oregon's water quality standards . . . we believe additional improvements to the rules are needed" (Gearhard 2004). This input, while simply advisory in nature, came after the OBF had deferred action on draft rule changes to increase protection of small non-fish-bearing streams, although they had also initiated rule-making for increased protection of headwater woody debris

Table 6. Primary state boards and agencies that adopt and administer regulations to protect small streams on private forest lands in western Oregon, western Washington, Idaho, and California

Board and agency	Internet source for information and regulations
Oregon Board of Forestry	egov.oregon.gov/ODF/BOARD/index.shtml
Oregon Dept. of Forestry	egov.oregon.gov/ODF/PRIVATE_FORESTS/private_forests.shtml
Washington Forest Practices Board	www.dnr.wa.gov/forestpractices/board/
Washington Dept. Natural Resources	www.dnr.wa.gov/forestpractices/rules/
Idaho Board of Land Commissioners	www2.state.id.us/lands/landboard.htm
Idaho Dept. of Lands	www2.state.id.us/lands/bureau/forasst.htm
California Board of Forestry and Fire Protection	www.bof.fire.ca.gov/
California Dept. of Forestry and Fire Protection	www.fire.ca.gov/php/rsrc-mgt_forestpractice.php

Table 7. Riparian management zones (RMZ) and related major protection requirements for small streams on private forest lands in western Oregon, western Washington, Idaho, and California. Differences in specific stream and riparian classification criteria and other details allow only approximate comparisons between states using this simplified table

Perennial fish-bearing streams	Non-fish-bearing streams
Oregon	
Small, Type F—western OR	*Small, Type N* (no anadromous or game fish)
RMZ = 50 ft	RMZ = 10 ft, except 0 in Coast and Cascade Ranges
Retain all trees within 20 ft	Retain understory vegetation and conifers ≥ 6 in. dbh in RMZ; generally protect streams and water quality
Retain >40–50 ft^2 conifer basal area per 1,000 ft of stream; these basal areas may be reduced in exchange for approved in-stream habitat projects	Further tree retention may be required in unstable areas and/or along debris torrent-prone streams
Washington	
Type F—western WA	*Type Np* (perennial, no fish)—western WA
RMZ = 90–200 ft, depending on site class	RMZ = 50 ft, for 300–500 ft upstream of Type F; ≥ 50% of stream must have RMZ on both sides
Core RMZ = 50 ft, inner and outer RMZ vary	No timber harvest in RMZ and on alluvial fans
No timber harvest in core RMZ	No timber harvest 50 ft around headwalls and seeps
Retain trees in inner RMZ for shade and to promote mature forest conditions	Equipment use normally prohibited within 30 ft
Retain 20 trees per acre, ≥ 12 in. dbh in outer RMZ; these tree numbers may be reduced in exchange for approved in-stream habitat improvement projects	*Type Ns* (seasonal, no fish)—western WA
	Equipment use normally prohibited within 30 ft
Idaho	
Class I—streams under 10 ft wide	*Class II flowing into Class I* (few or no fish)
RMZ = 75 ft	RMZ = 30 ft
Retain ≥ 42 trees 8–11.9 in. dbh and ≥ 200 trees 3–7.9 in. dbh per 1,000 ft of stream	Retain ≥ 140 trees 3–7.9 in. dbh per 1,000 ft of stream
Retain 75% of current shade	*Class II not flowing directly into Class I*
Class I—Suppl. measures*	RMZ = 5 ft or wider if needed for protection
RMZ = 75 ft	No soil disturbance in RMZ
No timber harvest within 25 ft of stream	*Class II flowing into Class I*—Suppl. measures*
Retain ≥ 88 trees ≥ 8 in. dbh per acre in rest of RMZ	RMZ = 50 ft, 500–1,000 ft upstream of confluence
Retain trees ≤ 8 in. dbh and all shrubs in rest of RMZ	Retain >35 trees >8 in. dbh in RMZ
*Voluntary measures in central Idaho that allow for "incidental take" of local species listed under ESA	
California	
Class I	*Class II* (fish 1,000 ft downstream or aquatic life)
RMZ = 75–150 ft, depending on slope and equipment	RMZ = 50–100 ft, depending on slope and equipment
Retain ≥ 50% of total canopy, well-distributed	Retain ≥ 50% of total canopy, well-distributed
Retain ≥ 50% of understory canopy	Retain ≥ 2 conifers (16 in. dbh) per acre within 50 ft
Retain ≥ 2 conifers (16 in. dbh) per acre within 50 ft	Retain ≥ 25% of pre-harvest overstory conifers
Retain ≥ 25% of pre-harvest overstory conifers	*Class III* (no aquatic life; Class I or II connectivity)
*Class I—threatened or impaired watersheds**	RMZ = varies—determined on site-specific basis
RMZ = 150 ft	
Retain ≥ 65–85% of overstory canopy	
Retain ≥ 10 largest conifers (live or dead) per 330 ft of stream, within 50 ft	
Retain ≥ 75% undisturbed surface cover. Heavy equipment use normally prohibited	
*Watersheds with state or federal T&E listed or candidate anadromous salmonids	

source areas in unstable terrain as well as higher basal area retention along small fish-bearing streams in Western Oregon. As of early fall 2006, the OBF had approved new rules to locate wildlife leave trees in headwater areas prone to landslides, whereas the latter changes remained under discussion.

This recent Oregon example points out the range of water resource concerns and perspectives that remain about headwater stream protection on forest lands. While the OBF actions reflect an interest in increasing natural sources and beneficial functions of large woody debris in streams, at the heart of the comments from the federal personnel are specific concerns about compliance with water quality standards. As noted earlier, stream temperature criteria have been a primary focus, with a 2002 EPA database showing that 86% of the US listings of temperature-based, water quality-limited streams were found in three states in the region (Ice et al. 2004b). The stream temperature issue is unlikely to be resolved very soon, as serious questions persist about the suitability and effectiveness of the current standards (Ice et al. 2004b) as well as the complex nature and roles of channel conditions, riparian canopies, and sunlight (see, e.g., Johnson 2003, 2004, Wilzbach et al. 2005) in promoting a desirable balance of water quality and aquatic productivity. However, some newer watershed research initiatives (e.g., WRC 2006) have been specifically designed to help address important knowledge gaps and complexities concerning small streams in managed forests.

As discussed earlier, legal challenges and court rulings have played an important role in the evolving interpretation and administration of policies that affect stream and riparian protection on forest lands in the region. Thus, issues such as the large number of listed water quality-limited streams could quickly grow in significance if they become the basis for a major appeal or lawsuit by an individual or interest group. This is more than a remote possibility, as suggested

by a review of some recent court cases (Morford and Corbin 2003) involving other water resource issues related to policies and management for forest streams in the region. Two rulings in federal court (League of Wilderness Defenders versus Forsgren, Environmental Protection Information Center versus Pacific Lumber Company) in October 2003, for example, showed how the nonpoint-source exemption of silvicultural practices under the CWA could be successfully challenged, and have the potential to encourage further CWA-based challenges of practices such as aerial pesticide spraying and road drainage features in upland areas of private forest lands (Morford and Corbin 2003).

Economic and Social Dimensions

Like the content of this special issue, the environmental features and functions of forest streams and riparian areas have been the focus of most discussions among scientists and resource specialists that relate to the policies and management of these areas in the Pacific Northwest. The steady expansion and eventual dominance of technical, regulations-based management approaches in the region over the past three decades likely has further encouraged this tendency. Although presented in a broader geographic and historical context, Ellefson (2000) discusses the "culture of regulation" that has evolved in the United States. It is important to emphasize, however, that policy alternatives other than regulations exist and that much more than technical feasibility often is needed to promote the desired on-the-ground actions and environmental results that water resource protection policies are intended to achieve (Adams 1993, Garland 1987). The remaining discussion will thus focus on the uniquely human dimensions of the policy and management for headwater streams on forest lands in the region, giving particular emphasis to some key economic and social considerations.

When stream and riparian protection policies were relatively limited in the scope of physical area and practices affected, forest owners and managers were much less concerned about the specific costs and benefits of the policies. However, this issue has grown considerably as restrictions on timber harvesting and other major practices have expanded, and the recent adoption or prospect of further constraints for headwater areas now present some relatively serious economic and social implications. Earlier research showed how previous levels of riparian forest protection could significantly affect the design and costs of adjacent logging operations, including planning and equipment requirements, landing and road construction needs, and timber values foregone (Adams et al. 1988, Dykstra and Froehlich 1976, Olsen et al. 1987). The fact that, in the western portion of the region, headwater stream protection areas can represent such a significant added acreage (e.g., Ice et al. 2006, Reeves 2006, Reeves et al. 2006) clearly supports the importance of current questions about policy costs and benefits.

Even before the issue of headwater protection extended to private lands, however, significant concerns were expressed about stream protection regulations in the region. For example, in a survey of Oregon forest owners, managers, and operators who had filed notices for operations near streams, respondents were about equally divided between the view that the 1994 riparian rule changes went "too far" and the view that they were "about right" (Hairston and Adams 1996). Those surveyed also preferred economic relief (i.e., tax credits, compensation, capital gains benefits) over regulations and other policy tools to promote public values on private lands. A basis for landowner economic concerns is reflected in the volume of conifer timber found in a sample of 21 riparian buffers (8.5–10.2 thousand board feet (mbf)) left under the 1994-enacted rules (Hairston-Strang and Adams 1998), which represents about $3,000–4,000 per acre of buffer (assumed stumpage value = $350–400 per mbf). In part reflecting landowner concerns about the costs of the 1994 stream protection rule changes, the 1996 Oregon legislature amended the Forest Practices Act to require "a comprehensive analysis of the economic impacts" of proposed revisions as well as pointed consideration of the "least burdensome" rule alternatives (Oregon Revised Statutes 527.714).

In addition to the direct effects, there is evidence of some notable unintended consequences when costly changes in stream protection restrictions are expected and landowners have time to act in the interim. For example, a survey of both Washington and Oregon nonindustrial forest owners showed a significant number (35%) that said they would harvest sooner if increased riparian harvest restrictions were enacted and a similar number (36%) that said they were unwilling to make long-term investments in forest management on their property due to concerns about further government restrictions (Johnson et al. 1999). In 2000, Washington initiated a tax credit for forest owners affected by its stream protection regulations, although a study of 115 different harvests showed that the value of riparian leave trees was 5 to 23 times greater than the tax credits provided (Reeves 2004). More recently, two other landowner compensation programs were adopted for riparian protection in Washington (Forestry Riparian Easement Program, Riparian Open Space Program), but they have not yet been evaluated in detail.

It is important to acknowledge that both mandatory and voluntary stream protection measures, including those for headwater streams, may have some positive consequences for forest landowners. The major forest certification systems (i.e., Forest Stewardship Council (FSC) and Sustainable Forestry Initiative (SFI)), for example, require or favorably consider such measures, and thus they may help landowners in the region to qualify for the unique markets for certified forest products with less effort than their counterparts in other parts of the United States (Fletcher et al. 2001). Similarly, recent survey research has shown that the broad public has a significant level of awareness of resource protection measures required or otherwise undertaken by forest landowners, which may be critical in maintaining the "social license" to actively manage private forest lands in the region (Murray and Nelson 2005).

Evidence for economic rewards sufficient to offset the costs of stream protection remains sparse, however, and the costs of stream protection regulations are not the only concern of forest owners, managers, and operators in the

region. In the aforementioned Oregon survey, only 7% used the "active management" option of the stream protection regulations, and the much larger number that did not indicated that the lack of sufficient conifer timber or the effort and time required to prepare the needed plans were major factors in their decision not to use this option (Hairston 1996). A survey of nonindustrial forest owners in Washington suggests that concerns about property rights may be comparable to the economic issues of restrictive regulations: ". . . respondents expressed concern over the limits placed on their ability to manage their lands as they see fit. This sentiment does not seem to arise purely from the potential for economic loss, because timber does not appear to be an important component of respondent incomes. Rather, the loss of management control and government restrictions placed on private property rights may be more significant" (Creighton and Baumgartner 2005). The passage of a 2004 property rights and compensation initiative (Ballot Measure 37) by a substantial majority (61%) in Oregon also suggests that the broader public is sympathetic to landowner concerns about restrictive regulations.

In addition to the concerns of individual forest owners and managers about stream protection regulations, the cumulative economic effects of significant restrictions on timber harvest near streams has become an important public policy issue in the Pacific Northwest. For example, Lippke et al. (2005) estimated that increased stream protection requirements in western Washington had a total cost in deferred timber value of $1.27 billion ($63 million annually), of which 37% was attributable to headwater areas (i.e., Np streams in Table 7). At such levels of economic impact, alternative land uses become much more competitive and may contribute to high rates of forestland conversion in the region (Nowak and Walton 2005, Thompson and Dicus 2005). Adams et al. (2002) estimated how increased stream protection requirements could affect total timber harvest levels in western Oregon, with a 14 to 18% reduction over four decades under a regulatory scenario of a 50-foot, no-conifer harvest riparian buffer and a 50- to 100-foot partial cut buffer along all (including non-fish and intermittent) streams.

Although private forest lands are often the focus of economic and social issues of the policies for headwater stream protection, they extend to public lands as well, albeit in broader ways. Although developed for private lands, the estimated 24 to 25% reduction in total timber harvest under a scenario of a 100-foot no-harvest buffer on all streams in western Oregon (Adams et al. 2002) provides some indication of the magnitude of the effect of the ACS protection measures for small streams on federal lands in the region, at least for its first decade of application, when active management was very limited. Similarly, given that Riparian Reserves represent about 6.25 million acres (or about 40%) of the Non-Wilderness/Withdrawn acres under the ACS and Northwest Forest Plan, the economic and social effects of federal forest policy in the region appear nearly as much a stream and riparian protection issue as a late-successional forest and wildlife habitat issue. Furthermore, the scale of management changes on federal lands has had such broad regional, national, and global implications (e.g., from increased wildfire hazards to increased forest products imports) that the debate about forest resource "protection" is now exceedingly complex.

Observers of both federal and state policies in the region and beyond have reviewed such complexities (e.g., CDF 2003, Haynes 2003, Mealey et al. 2005, Perez-Garcia 2003, Salwasser and Wells 2004, Shifley 2006), which suggests that more pointed analysis and consideration of both environmental and social risks and outcomes of policies that greatly restrict management could significantly elevate the quality of the discussion. Mealey et al. (2005), for example, argue that "comparative ecological risk assessments" show promise as a decisionmaking tool for forest resource policy and management. They note the need for broad analysis of the short- and long-term consequences of both passive and active management strategies, a risk assessment approach that is especially important with fire-adapted forests (O'Laughlin 2005). And, more generally, serious issues about sustainability are raised when a heavily forested state such as California recently has been importing about three-quarters of its wood and paper products (CDF 2003).

More specific to stream protection, Ice (2005) discusses how environmental and economic analyses might be blended to optimize the benefits to costs of riparian buffers, including the possibility of reducing some buffers by targeting other critical areas or conditions that contribute more to the desired functions and resource benefits. Given recent comments about the cost-effectiveness of proposed changes in riparian regulations from the forest landowner community (OSWA 2006), such an approach could find some support among private forest owners. More holistic analysis of environmental and other trade-offs also seems consistent with evolving thinking about resource protection policies in the context of dynamic ecosystems (e.g., Lorensen 2003, Washington DNR 2006).

One other major issue that deserves recognition, given its potential impact on stream and riparian protection policies, is the philosophical differences that exist among some scientists and other key groups about the underlying basis and approach for forest resource management. This issue centers on the contrasting views about the relative importance and role of natural conditions and processes versus active management to achieve desired objectives for forest resources. In many discussions (e.g., Thomas et al. 1993, Reeves 2006, Reeves et al. 2006) this appears to be simply a matter of science, but a philosophical basis is suggested by the strong focus on relatively data-scarce conceptual models (e.g., "Historic Range of Variation") and a clear preference for natural conditions and disturbances (even those that have significant negative resource effects) over those from active management strongly suggest a philosophical basis. Similarly, the view that an exclusively active, utilitarian approach to forest resource management can serve as a complete substitute for complex natural conditions and processes also seems based largely in philosophy. Such philosophical contrasts parallel those that have been examined more broadly in forest resource management (Brown and Harris 1998) and perhaps explain some of the widely variable responses to headwater stream protection seen in the region.

Philosophy also is likely to play a greater role with issues with higher levels of uncertainty, which aptly describes the current situation for headwater stream management and policies. Despite some concerted efforts, recent research results show that headwater management influences on downstream resource conditions are difficult to detect and where apparent they are highly variable and challenging to assess qualitatively (Oregon Headwaters Research Cooperative 2005b). Given such key gaps and uncertainties in the knowledge base, policy and decision making about headwater stream protection can be strongly influenced by perceptions or assessments of resource risks. Because the approaches used for such risk assessments and related decisionmaking remain similarly variable, individual or collective philosophies (e.g., within groups of scientists, public agencies, or stakeholders) are increasingly likely to influence the interpretation of both the knowledge base and acceptable levels of resource risks.

Although a diversity of views exists within the environmental community, a number of groups that have publicly commented on stream protection policies in the region share some similar philosophical views. Illustrative is a report released by the Pacific Rivers Council (PRC 1999) that includes detailed directives that are recommended for private forest lands in much of the Pacific Northwest. The recommendations focus heavily on a refuge-based strategy with relatively wide riparian areas where timber harvest would be prohibited or significantly restricted. These features and related discussion reveal a strong philosophical preference for natural conditions and processes, as well as high concerns about resource risks, particularly given that benefits of federal forest policies are acknowledged. Although specific policy mechanisms are not offered, the discussion also suggests a philosophical view of human behavior that contributes to skepticism about nonregulatory approaches and an interest in retaining legal authority to influence landowner actions.

Overall, a significant reliance on philosophy is not necessarily a problem in itself, as it will always be a primary influence in both public (e.g., politics) and private (e.g., personal preferences) decisionmaking. However, serious concerns can arise when science-like "information is developed, presented, or interpreted based on an assumed, usually unstated, preference for a particular policy or class of policy choices" (Lackey 2004). Thus, more open acknowledgment and explicit identification of matters of science versus philosophy have the potential to promote higher-quality discussions and decisions on the protection of headwater streams and other resources. Similarly, decisionmaking approaches such as risk assessments that can incorporate diverse values in a decision support framework (e.g., O'Laughlin 2005) deserve further attention and refinement.

Conclusion

Headwater forest steams and riparian areas clearly have some important functions and values for fish and wildlife habitat and water quality in the Pacific Northwest. What is much less clear, however, is whether the current and proposed policies that restrict management activities in these areas show a favorable balance among local and broad-scale costs and benefits over both short- and long-term time scales, and whether there are ways to more effectively promote this balance across diverse landscapes and forest ownerships. This is a critical area for future research and information development, as there is significant evidence that current stream protection policies already are having some important unintended environmental and socioeconomic consequences (e.g., increased wildfire hazards, land use competition, resistance to regulation), and even greater levels of protection to headwater and other streams could simply exacerbate these less desirable outcomes.

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