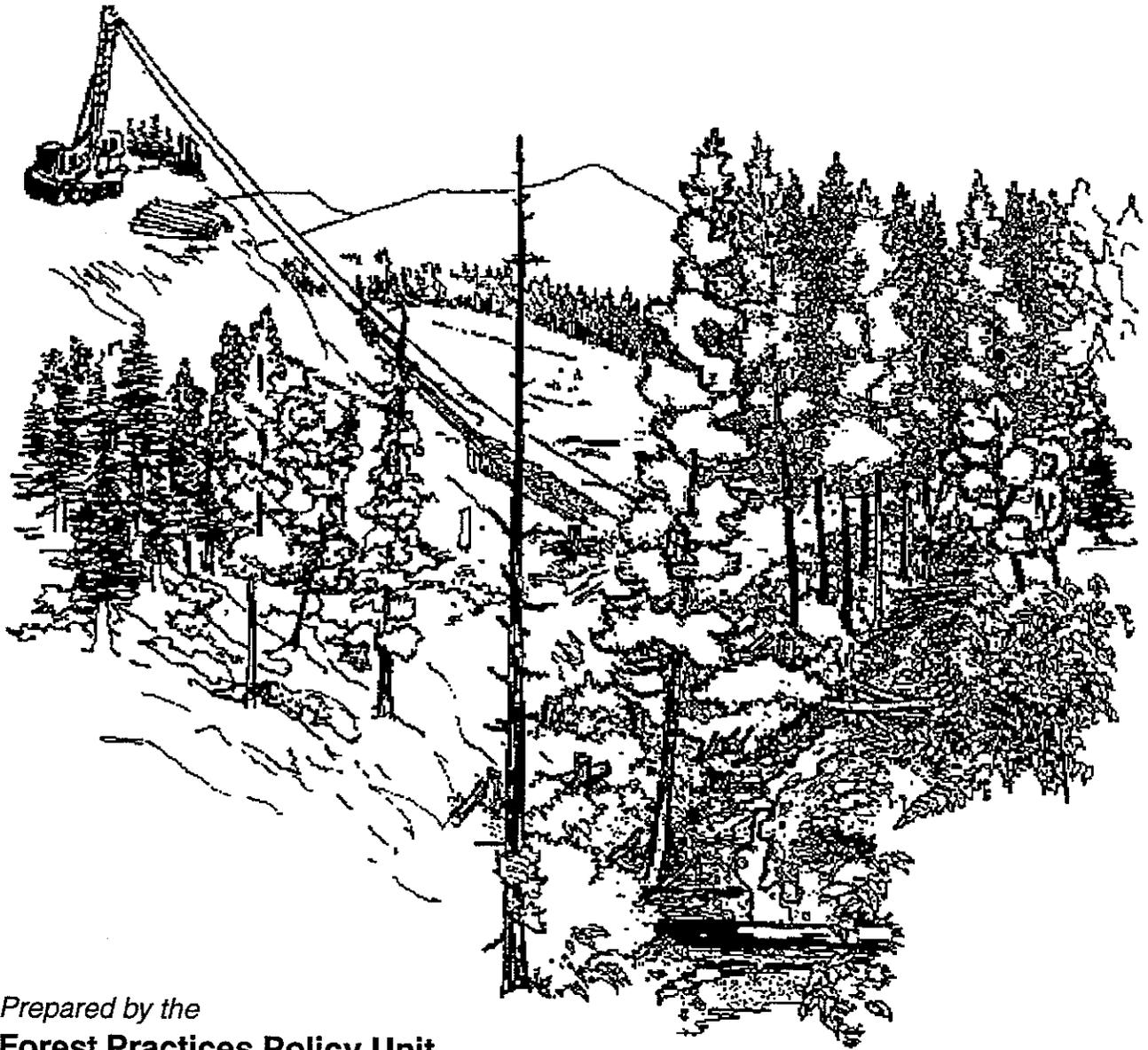


The Oregon Forest Practices Act Water Protection Rules

Scientific and policy considerations

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Introduction

The purpose of this report is to outline the science and policy considerations that shape the recently adopted water classification and protection rules.

As part of the rule development process, the Department of Forestry (Department) analyzed hundreds of research documents and reviewed the Department's riparian monitoring information. The synthesis of the research and monitoring information was included in a report, "Water Classification and Protection Project Draft Report," presented to the Board of Forestry (Board) in April 1992. This report was circulated for review and comment from interest groups, scientists, regional forest practices committees, state agencies, and the public. The overall response was favorable. This report, along with the "Riparian Rule Effectiveness Study Report" (ODF 1993) and "Report on the Analysis of Proposed Water Classification and Protection Rules" (ODF 1993), provides the detailed scientific and technical basis for the rules. Specific scientific references (except certain key issues or references) generally are not included in this report. The other documents referenced above should be reviewed for scientific detail and references.

Throughout the rule development effort, we addressed a number of key issues during a series of technical meetings, in the "Water Classification and Protection Project Draft Report," and through the riparian monitoring project. Issues were further analyzed through field work and consultation with experts. However, since the beginning of the project, the key points of debate ultimately have not been about science but rather about the *level* of water protection that should be provided on private forest lands.

The two primary reasons for reviewing and considering changes to the 1987 water protection rules were to:

- Meet the policy guidance about protection of state waters provided by the Board of Forestry to the Department as a result of a public forum conducted in Portland in December 1990
- Meet the requirements of Senate Bill 1125 passed in 1991.

Public Forum

Due to public concern, in December 1990 the Board conducted a forum about forest practices issues. The forum identified several key concerns of the Department of Fish and Wildlife and other interested parties relating to stream protection in forest operations. These concerns included:

- The current classification of waters was not adequate to match appropriate protection measures to beneficial uses and physical characteristics of the waters
- Water temperature was excessive in some streams

Reasons for change

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- Large woody structure was being depleted in many stream systems
 - Sedimentation may be reducing spawning success in some streams
 - Juvenile fish were unable to pass certain stream-crossing structures

The Board concluded that changes in the stream classification system and protection rules might be needed and directed the Department to review the water classification and protection rules.

Senate Bill 1125

Before the Board's direction could be implemented, the 1991 Legislature passed Section 9, Senate Bill (SB) 1125 requiring the Board to:

- Review its classification of waters of the state, create at least three classifications, and establish rules related to each classification
- Give particular consideration to perennial streams not currently classified as Class I (Class I streams included significant fish-bearing and domestic-use streams) that have an average gradient of not more than 8 percent and that are important to water quality and fish needs in downstream Class I streams
- Consider requirements for vegetative buffers along such streams consistent with the health of the forest and the protection of fish and wildlife. Also, the Board was to consider whether additional classifications should be subject to the requirements of ORS 527.670 (written plan requirement)
- Review current Class I streams and associated riparian protection rules and, where appropriate, improve protection of soil, air, water, fish, and wildlife resources, which include but are not limited to fish and wildlife habitat, species biodiversity, and stream morphology.

In addition, SB 1125 established a new and clear target for water quality standard achievement that needed to be considered in the review of existing practices and in the development of new "best management practices." This explicit target for the protection of water quality was a significant change and represents a higher standard of protection. Water quality standards include standards for temperature, turbidity, and antidegradation, all of which were to be considered in developing new forest practices rules.

Overview of the new rules

Key components of the new rules are as follows.

A new water classification system has been developed that is much different than the old two-class system. The new system identifies seven geographic regions; distinguishes among streams, lakes, and wetlands and further distinguishes each by size; distinguishes among those streams that have fish or domestic use, or neither, and in each case describes the stream as large, medium, or small based on average annual flow.

All fish-bearing streams will have a riparian management area (RMA) that includes a vegetation retention standard. Previously, a standard of vegetation retention applied only to those streams with "significant" fish use. The rules commit the Department (with the help of the Department of Fish and Wildlife) to a comprehensive fish-use survey of forest streams. Based on surveys completed last summer, this might increase by as much as 30 percent 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 natural barrier to fish migration.

The Board now has a process for adopting additional basin-specific protection rules for water-quality-limited streams or for streams with threatened and endangered aquatic species.

Rather than using a distinct "shade" standard, water temperature will be maintained through standards for understory and live tree retention. The new approach also uses live conifer basal area instead of number of trees as the vegetation-retention measure. The volume of conifer that will be retained along fish-bearing streams, especially large fish-bearing streams, is substantially increased over the 1987 standards.

Generally, no tree harvesting is allowed within 20 feet of all fish-bearing, all domestic-use and all other medium and large streams unless stand restoration is needed. In addition, all snags and downed wood must be retained in every riparian management area.

Provisions governing vegetation retention are designed to encourage conifer restoration on riparian forest land that is not currently in the desired conifer condition. Future supplies of conifer on these sites are necessary to support stream functions and to provide fish and wildlife habitat.

The rules provide incentives for landowners to place large woody debris in streams to immediately enhance fish habitat. Other alternatives are provided to address site-specific conditions and large-scale catastrophic events.

Rules for stream crossings and fish passage are strengthened considerably.

Fish passage will now be required for both juvenile and adult fish, up and down stream, during periods when fish passage would normally occur. Stream crossings will need to be designed for the 50-year storm event rather than for the previous standard, the 25-year storm event.

Rules related to harvest practices, site preparation, road construction, and skid trail location in riparian areas have been strengthened.

Policy background and considerations

Three key policy considerations helped shape the new rules.

Dealing with diversity

One of the key policy and technical issues in developing the rules was how to deal with the diversity of forests and ownerships.

Oregon has 30 million acres of forest land, which is half the state's land base. Fifty-eight percent is federally owned, 21 percent is owned by industrial private landowners, 5 percent is owned by state and local government, and 16 percent is owned by nonindustrial private landowners. Federal forest lands include a greater percentage of higher elevation and/or poorer quality forest lands than the private lands. The resources, both financial and technical, of private landowners to address forest management needs are highly variable and in the case of many nonindustrial owners quite limited.

Oregon's forests are biologically diverse. In the Coast Range, forests are primarily Douglas-fir, Sitka spruce, western hemlock, western red cedar, and red alder. On the west side of the Cascade Mountains, forest types are predominantly Douglas-fir, hemlock, and true firs. In the Siskiyou Mountains of southwest Oregon, a Mediterranean climate produces a mix of hardwood species, Douglas-fir, ponderosa pine, incense cedar, and true firs. On the east side of the Cascades, Douglas-fir, true firs, ponderosa pine, Engelmann spruce, larch, and lodgepole pine predominate. Annual rainfall on Oregon's forests ranges from nearly 200 inches along the summit of the Coast Range to less than 12 inches where the forests fade into sagebrush and juniper desert in eastern Oregon.

Levels of protection

Oregon passed the first comprehensive Forest Practices Act in the United States. The Act includes a clear objective and a framework for rule-making to develop practices to achieve the objective. The objective is to provide for the continuous growing and harvesting of forest tree species as a priority on private lands, while providing protection for water, air, soil, and fish and wildlife.

Forest practices rules must meet the requirements of the federal Clean Water Act. This is to be done by developing "best management practices" that meet, to the "maximum extent practicable," the state water quality standards.

The rules also must provide for the “overall maintenance” of fish and wildlife. While the protection requirement for water quality standards is specific, the objectives for fish and wildlife include a range of possible levels of protection from “minimum viable” to “maximum possible.” None of the possible levels of protection for fish and wildlife can be described in a quantitative, objective manner, and that level of uncertainty had to be dealt with in the process.

The Department worked with landowners, advocates for fish and wildlife, domestic water purveyors, and other agencies to draft the administrative rules. Collaboration was with the understanding that water quality standards must be achieved to the maximum extent practicable and that “good habitat” was to be maintained for fish and riparian dependent wildlife. “Good habitat” was negotiated based upon available science and on the recognition that the Act also encourages economically efficient forest practices. Also, policy direction from the Board was to provide habitat that would maintain fish populations well above at-risk levels and that would recover fish populations if other factors were not limiting.

The Department and the Board view riparian areas as places where the emphasis is on providing for water quality and fish and wildlife habitat first and where, to the extent that the goals for these values are met, timber management is encouraged. The interest groups often have very different points of view. Some believe that riparian areas should be managed only for nontimber values or left unmanaged, while some believe that all areas, including riparian areas, should be managed first and foremost for timber values.

In Oregon, riparian areas are in various states of ecological health for both natural and human-caused reasons. Historical logging practices, stream cleaning, channelization, flood control projects, navigation development, and other factors have resulted in simplified stream habitats often with much less large woody debris loading than the presumed “natural” condition. Particularly in western Oregon, hardwood tree species now dominate riparian areas that naturally supported conifer trees, so the future supply of durable large woody debris is also questionable.

There are no quick fixes or easy answers in drafting a set of regulations that will address these historical legacies. Indeed, it is very clear that protection measures alone will not result in the restoration of streams and streamside stands except over very long periods of time. Yet, in some cases, management may more quickly restore riparian areas or streams to meet needs for fish and wildlife habitat and clean water than would a no-management approach.

Landowner incentives and site-specific applications are needed for stream restoration efforts to be successful. For example, why would landowners

Dealing with historical legacies

reforest riparian areas to conifer if they know that none of the trees could ever be harvested? A restoration approach requires clear goals, trust and cooperation among agencies and landowners, and monitoring to know whether the goals are being achieved.

Key conclusions and underpinnings

The key conclusions and philosophical underpinnings of the rules are described in this section.

A holistic approach

Available data and the consensus of consulted experts was that riparian and aquatic habitat and water quality protection can be best provided by considering all the functions of riparian vegetation holistically. Accordingly, the rules focus on streamside vegetation condition rather than emphasizing only one or two discrete functions, such as large woody debris or shade.

Streamside vegetation provides a number of interrelated functions (Figure 1). Riparian vegetation's key functions are: aid in floodplain and channel development; provide nutrients; contribute root mass for bank stability; provide shade for temperature control; help dissipate energy associated with high flows; provide cover, large woody debris and other aquatic habitat components; and affect sediment movement. Focusing on only one of these at any one time may have unexpected consequences on other functions over time.

Stream Morphology ♦ Aquatic Shade ♦ Sedimentation
Bank Stability ♦ Nutrient Cycles ♦ Riparian-Dependent Wildlife Habitat
Migration Corridors ♦ Wildlife Snags ♦ Organic Matter Inputs
Source of Instream and Terrestrial Large Woody Debris (LWD)

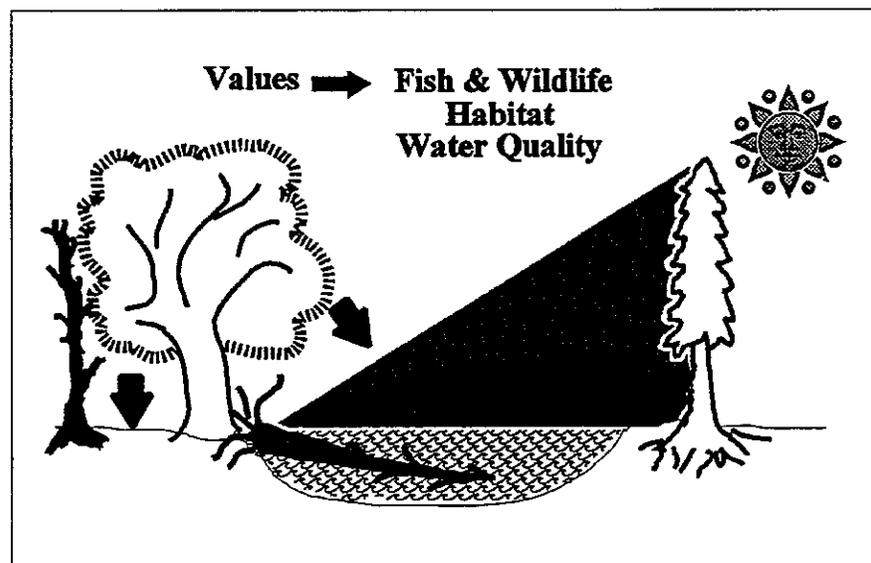


Figure 1. Key functions of the riparian system.

A holistic approach avoids the need to develop performance levels for shade, large woody debris, and other functions. Such performance levels were found unworkable because: (1) performance of vegetation with regard to shade, woody debris, etc. is highly variable, site-specific, and cannot be predicted consistently; (2) baseline data to establish performance levels are not available, and the “range of natural conditions” characteristically extends from zero to 100 percent for some factors such as shade; and (3) riparian areas have many functions that are interrelated, and so segregating levels of performance that emphasize some components may limit the system’s integrity. For example, field analysis found that levels of performance for shade are very difficult to administer and when achieved often are at odds with improving or maintaining other functions such as conifer trees that provide large woody debris.

One key reason the Act is effective is that, where possible, the rules are objective-based; that is, desired results are described in the rules so that a range of practices can be considered to best achieve the results. This objective-based approach allows flexibility in managing riparian systems. The new rules include a “desired future condition.” With this concept, many different management approaches can be considered so long as they achieve the desired conditions.

Objective-based and desired future condition

The rules describe desired future conditions based upon the characteristics of streamside stands. These rules are designed to achieve and maintain a desired future condition *similar to mature forests with an emphasis towards conifer species* along most fish-bearing streams.

This desired future condition will result in riparian areas with a considerable number of very large conifer trees near fish use streams that will, over time, provide a variety of functions. One of the most important functions is that of supplying large woody debris. Management that will achieve this desired future condition is encouraged within the riparian management area.

The desired future condition is to produce stands that function “similar to mature stands” along fish-bearing streams. The goal recognizes that management actions can produce stands that do not necessarily have the age but do have the functions of mature stands. Stands with characteristics similar to mature forests will provide the functional benefits needed to maintain water quality and fish and wildlife. The goal is in part described by the use of basal area — the cross-sectional area of a tree or stand measured approximately 4.5 feet from the ground.

The basal-area approach provides management incentive and flexibility. It allows an infinite combination of stocking levels and tree diameters that can measurably meet the target. The approach allows any number of silvicultural strategies, including both even-aged and uneven-aged silviculture.

Water classification

The technical and field review process verified that the 1987 classification of waters was not adequate to match appropriate protection measures to beneficial uses and physical characteristics of the waters.

A major support for this conclusion was a comprehensive survey of the presence of fish in streams in eight townships around the state. The survey found that many fish-bearing streams were not classified correctly as fish-use streams (previously referred to as Class I streams). The data on fish use are in Table 1. As indicated, the increase in fish-use stream densities varies considerably by region, with a maximum increase of 54 percent and an average increase of about 23 percent. This means stream protection will change significantly as a result of identifying and protecting all fish-use streams rather than only those streams with "significant" fish use.

Field analysis also indicated a number of large and medium streams that do not have fish but that do significantly affect downstream water temperatures and woody debris supply. On average for the eight townships, the density of medium and large streams without fish was 0.17 miles per square mile.

Table 1. Results of stream surveys: Average density of current Class 1 streams and all fish-bearing streams for eight townships.

Township	Stream Density (miles of stream per square mile of land)		
	Class I (A)	All Fish-Bearing (B)	Percent Change*
Lewis and Clark River <i>Clatsop County</i>	0.98	1.51	+54%
Yaquina River <i>Lincoln County</i>	1.34	1.67	+25%
Hunter Creed <i>Curry County</i>	0.57	0.77	+35%
Canyon Creek <i>Linn County</i>	0.42	0.37	-12%
Butte Creek <i>Jackson County</i>	0.88	1.07	+22%
Calapooya Creek <i>Douglas County</i>	0.68	0.81	+19%
Indian Creek <i>Union County</i>	0.88	0.94	+ 7%
Long Creek <i>Lake County</i>	0.47	0.62	+32%

* $[(B-A)/A] \times 100$

Analysis also indicated that small non-fish-bearing streams in the warmer and drier regions of the state needed protection from increases in stream temperature to meet water quality standards. Field analysis demonstrated that understory vegetation recovered within 1 to 2 years along most small streams in wetter portions of the state. Revegetation usually was slower in drier regions, including eastern Oregon and the Siskiyou, especially if grazing occurred. However, understory revegetation may not necessarily keep water as cool as did the original overstory vegetation. Also, data indicated that warmed water can cool when a stream enters a heavily shaded reach. The circumstances related to the warming and cooling of streams appear complex, due in part to the influx of cooling groundwater. Additional monitoring is needed for this issue.

Monitoring data, woody debris modeling, and consultation with experts indicated the amount and size of conifer woody debris resulting from the 1987 rules was not adequate to provide for long-term restoration and maintenance of instream large woody debris.

Additional large conifer trees

Large instream woody debris provides important fish habitat. Due to a number of factors, confirmed by recent stream surveys, many streams are deficient in large conifer woody debris. Trees must be large to provide functional woody debris, especially in larger streams. These large trees serve as key pieces for complex woody debris jams. As stream size increases, the rate that woody debris is moved downstream during high flows also increases. Smaller wood pieces are removed from the system more quickly than larger pieces.

The Department's monitoring data and other information show very few large conifer trees currently exist along fish-use streams on nonfederal forestlands to provide large woody debris. Undisturbed streamside conifer stands do not start producing much large instream conifer woody debris until the stand is 80 years old. Harvesting larger conifer trees from riparian areas truncates woody debris renewal processes. Under the 1987 rules, in some cases larger conifer trees were selectively harvested from riparian management areas. Thus, retained conifer were not the size and age needed to create functional large woody debris in a timely manner, particularly for large and medium streams.

For several reasons, the 1987 rules led to the conversion of some streamside conifer-dominated stands to more hardwood-dominated conditions. First, shade was the dominant target and could be achieved in many cases by leaving mostly hardwood trees. Second, the 1987 rules required only that conifer be left in the first half of the riparian management area closest to the stream. This was a significant constraint, since conifer trees often grow less frequently nearer streams, and often resulted in the retention of mostly hardwood trees. Finally, the rules provided no incentives for landowners to actively manage streamside stands to grow and maintain conifer trees.

Stream and streamside stand improvement

Many streamside stands, particularly in the Coast Range, are hardwood-dominated because of historical practices. Based upon limited research, some think the current frequency of alder along Coast Range streams is about double the "natural" level. Similarly, many streams have reduced woody debris loading from past events.

Field review confirmed that the rules need to provide incentives to encourage the management of streamside areas for restoration and enhancement of stands in "less than desirable condition," while maintaining the quality of streamside stands that are in "good condition." Relying upon a shade standard in the 1987 rules resulted in maintaining high levels of shade at the expense of maintaining or encouraging conifer reforestation and growth. Research has established that appropriate management practices may result in more timely conifer regeneration and growth than natural processes.

Analysis identified that a process was needed to allow for disturbance, when appropriate, within riparian management areas to create more desirable stand or stream conditions while also appropriately ensuring that water quality standards are maintained.

The new rules are designed to achieve conifer regeneration in riparian areas (especially in the Coast Range) where a healthy conifer condition is desired. Alternatives are provided to address site-specific conditions and large-scale catastrophic events. Practices that will result in streamside stands' meeting the desired future condition in a more timely manner are being promoted. Tradeoffs are allowed to promote immediate improvement in fish habitat.

The new rules provide incentives for landowners to place large woody debris in streams or to do other stream improvement work for fish habitat. There is no doubt that placement is an evolving science. However, there is such a significant and widespread lack of woody debris in streams that the consensus is a short-term fix is needed and, with application of sound judgment, will be effective. The short-term fix will be important while we wait for the riparian stands to mature. Guidance will be provided about what material can be placed and how. Credit for placement is given for only a limited portion of the required vegetation retention to ensure that the stand will be adequately stocked to provide for the long-term needs of the stream.

Other alternatives for stream enhancement work are included in the rules. Thus, in addition to placing logs, credit can be given for placing root wads or rocks, creating side channels, or other approved enhancement work including fencing. Temporal and spatial flexibility for improvement projects also are available because limiting placement to only the operation area and operation period may not result in the most effective and efficient results. These actions will allow additional innovation and improved timing for enhancement actions. For example, landowners can receive credit for placing logs in a stream reach where conditions are better suited to enhancing fish habitat even if this reach is outside the operation unit.

Research indicates that passage upstream for adult and juvenile fish is needed to ensure fish can migrate upstream to fully utilize available habitat for spawning and to avoid unfavorable stream conditions, especially warm water or flood flows. Consensus was that stream crossings designed for a 25-year storm event failed at too frequent a rate, which resulted in adverse effects. The 50-year peak flow design has become the standard for other states besides Oregon, such as Idaho and Washington.

Juvenile fish passage and structure failures

Field work in the summer of 1993 led to the conclusion that a shade standard cannot be reasonably implemented. As an alternative, under these revised rules water temperatures will be maintained through standards for understory and live tree retention. The choice to drop a shade standard has two positive outcomes. First, not having a shade standard will eliminate a barrier to the reforestation of shade-intolerant conifer species. Second, a better opportunity is created for landowners to fully lay out riparian management areas on their own since they will no longer need to achieve a shade standard that has been tough to implement in the field and as a result was routinely negotiated. Unlike "shade," the new requirements embody clear and measurable targets. The vegetation retention standards will be carefully monitored to verify that the water quality standards for temperature are being achieved.

No shade standard

The new protection standards were designed to be flexible and site-specific in achieving the desired future condition. The geographic region approach and the water classification system are designed so that protection measures can be applied with as much regional and site specificity as possible.

Flexibility and site-specificity

The desired future condition can be approached by three different avenues: a general prescription; an alternative prescription; or a site-specific prescription (Figure 2). This three-pronged approach allows management flexibility for achieving the desired results.

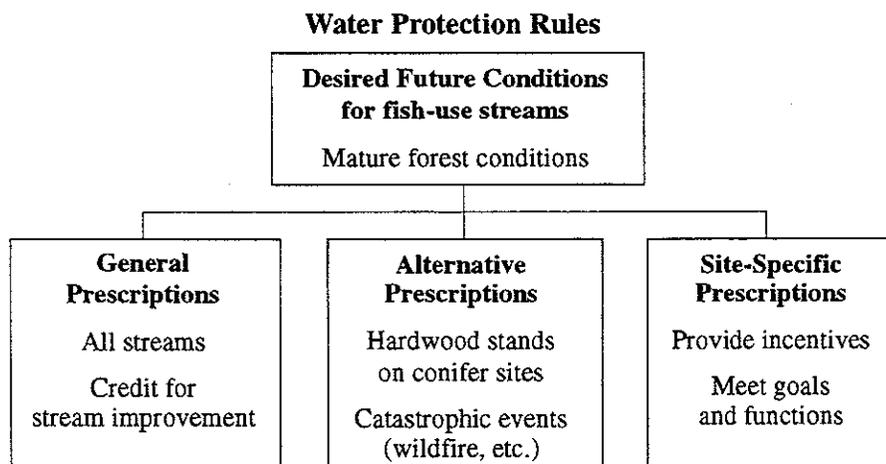


Figure 2. Alternative approaches for achieving the desired future condition.

General prescriptions are designed to be the baseline approach. They include both a standard target for vegetation retention and an “active management” target. The standard target is applied when the landowner is not interested in doing stream improvement work. The active management target is applied to those who are interested.

Alternate prescriptions may be applied in two particular circumstances: in hardwood-dominated riparian stands that are occupying conifer sites; and in catastrophic events such as fire or insect epidemics. In either case, the prescription allows disturbance so that the streamside stand can be restored in a timely manner.

Site-specific plans allow analysis of on-site conditions to form the basis for a prescription unique to the site but still consistent with the desired future condition.

The Board now has a process for adopting special protection rules for water-quality-limited streams and for streams with threatened and endangered aquatic species. This supplements the ability to meet obligations on water-quality-limited streams and provides a considered response should additional forest species be listed as either threatened or endangered at either the state or federal level. This process can provide for a watershed approach to resource management under these conditions. Additionally, in the interests of economically efficient forest practices, this approach avoids placing an undue burden on most forest landowners to address a unique, limited, or worst-case scenario that can best be addressed on a more limited scope.

Monitoring

A number of assumptions have been made to describe streamside stand conditions through the standard and active management targets. Monitoring will need to document whether these targets ultimately meet the various needs of the stream. Understanding the functions that riparian vegetation provide should help us encourage further understanding of what good stewardship requires for maintenance of water quality and fish habitat. The various interest groups very strongly agreed that monitoring should be appropriately supported, and the Board specifically directed that the rules provide for it.

Scientific and technical bases for rules

Research has established that riparian areas are critically important in maintaining and providing key ecological functions and processes. This section identifies and discusses the key scientific information and relationships considered during the rule development process. How the information and relationships were used to develop specific elements of rules are discussed further in subsequent sections.

Vegetation–Stream Interactions

A key relationship is the interaction between vegetation and the stream, which in turn is a function of distance of the vegetation from the channel edge. This relationship holds true for large woody debris as well as for litter inputs, shading, and bank stability. For example, relationships established by McDade (1987) show that the proportion of total loading of woody debris is a function of distance from the stream edge (Figure 3). Trees beyond 100 feet from a channel were found to contribute only about 10 to 15 percent of the total large woody debris loading, while trees within 25 feet of the channel contributed nearly 50 percent of the loading. Similar relationships have been established or extrapolated for other riparian vegetation functions, such as shade or litter inputs (Figure 4).

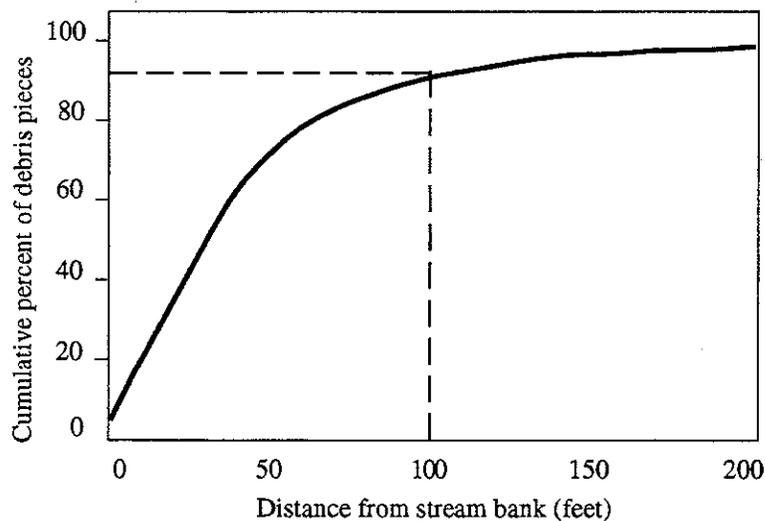


Figure 3. Proportion of total loading of woody debris from the riparian forest as a function of the distance from stream edge.¹

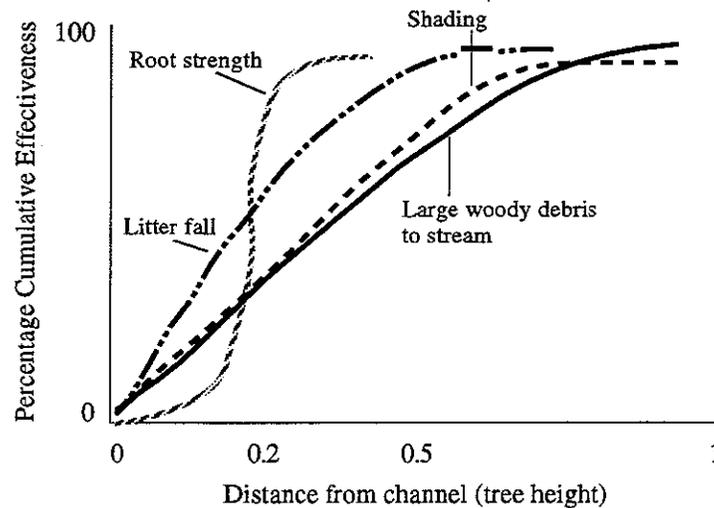


Figure 4. Proportion of riparian vegetation function in relation to distance from channel.²

Stream size also influences the role of vegetation as a function of distance. Generally, as stream size decreases, a relatively higher proportion of vegetative functions is provided by vegetation at relatively closer distance to the stream. For example, shade for larger streams may come from vegetation at some distance from the channel, while the majority of shade along very small streams originates from vegetation along the immediate bank.

Riparian Area Disturbances

Scientific information about the frequency, magnitude, and type of disturbances that normally occur within riparian areas indicate that throughout Oregon disturbance regimes are highly variable. Disturbance by fire can occur as frequently as every 15 years or as long as every 200 to 400 years. The consensus of consulted experts is that riparian areas are normally disturbed by fire at intervals twice as long as adjacent upland stands. Fire intensity often would be less in riparian areas than in upland stands.

Agee (1988) indicates that hydrologic disturbance will likely occur more frequently and to a wider extent on larger streams than on smaller streams.³ Conversely, fire has a much greater probability to disturb small, steeper streams than larger streams. Expected disturbance frequencies and intensities were considered in developing levels of protection and establishing appropriate levels for acceptable "temporary disturbance" (Figure 5). Fire control has reduced the frequency of wildfire disturbance to much less than the natural frequency. Therefore, management may be needed in place of natural fire disturbance on some sites to avoid succession to brush species and/or to maintain conifer growth and reforestation.

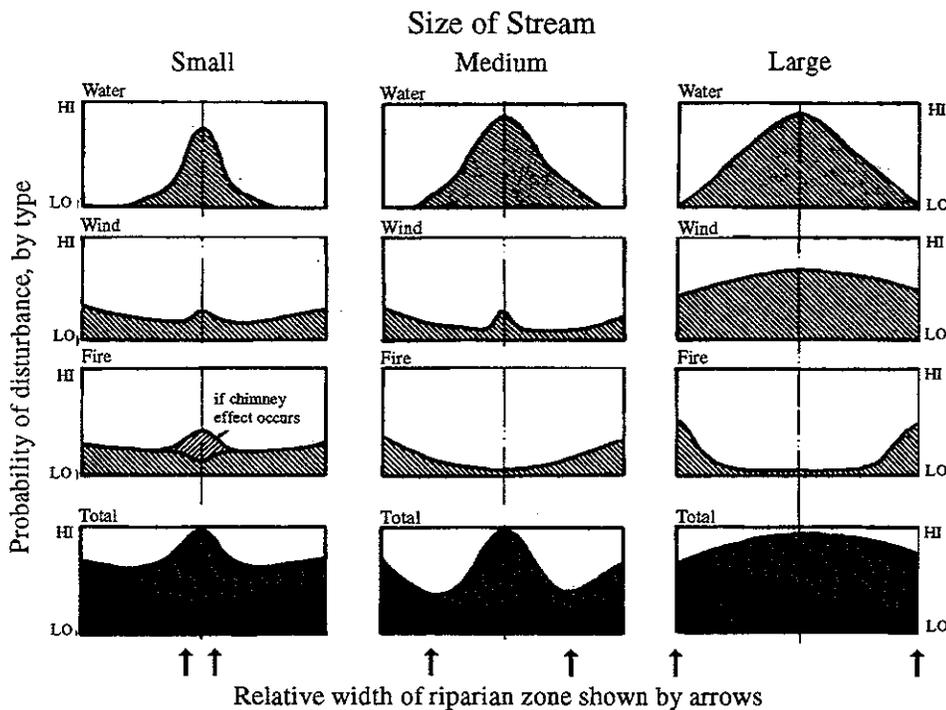


Figure 5. Models of probability of water, wind, and fire disturbance.³

Research has established that, of all the streamside functions, developing streamside stands capable of providing functional large woody debris inputs will take the longest to recover from disturbances. Shade, temperature, and organic nutrient inputs have been found to recover relatively rapidly after a disturbance event. Furthermore, while natural disturbance often greatly reduces such functions as shade, the same disturbance may cause a peak in large woody debris entry, despite the fact that the new stand developed after disturbance may not provide large woody debris for many years.

Finally, small streams move large woody debris downstream very infrequently, while larger streams displace woody debris fairly frequently.

Large Woody Debris and Stream Size

Another key relationship is how the “function” of large woody debris relates to stream size. Research (Bilby 1985) has found that length and diameter of stable woody debris in a stream is in part a function of channel width (Figure 6). Consistent with this, other research has found that large woody debris functions differently depending upon stream size and gradient. For example, most pools in small, low-gradient streams are step pools formed by individual pieces of wood; in larger streams, debris jams are common, and they form larger, scour-type pools.

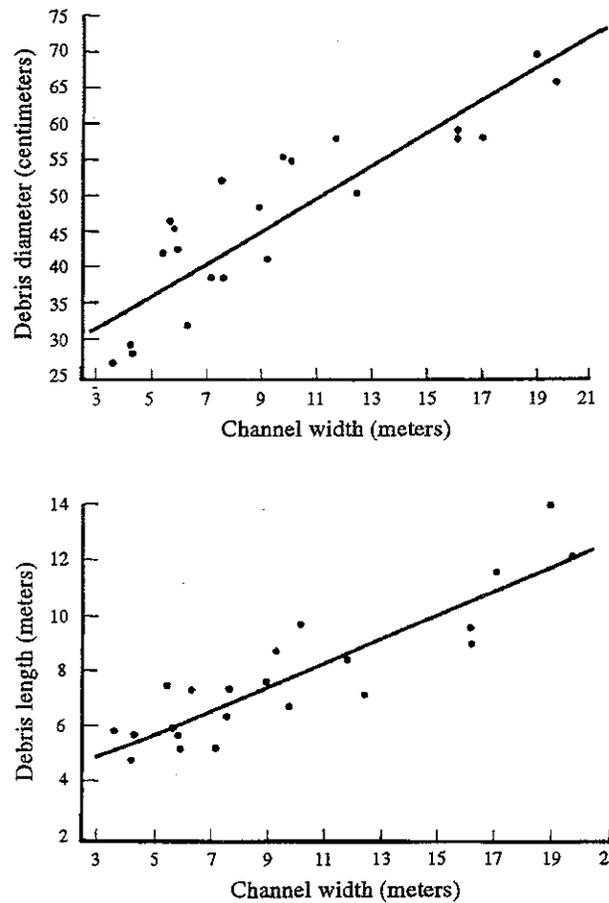


Figure 6. Relationship between the length and diameter of stable debris and channel width.⁴

Key debris pieces forming debris jams in these larger streams are often very large. The root wad appears to play a major role in holding the key piece in place. Along many streams on nonfederal lands, trees big enough to be key pieces are lacking. For small streams, much smaller pieces are functional, and the root wad appears less important. Also, the overall volume of wood required to create habitat features is less for small streams. These relationships are very consistent with the observation that larger streams are more hydrologically dynamic than smaller streams.

Riparian Stands' Growth Rate

Riparian stands do not grow on a stand basis as well as upland stands. Individually, riparian trees grow relatively fast, but due to higher mortality and other factors, riparian stands often are not stocked as densely with conifer as upland stands. As a result, riparian stands generally do not have as much conifer growth and volume as do upland stands.

Water Temperature

To examine water temperature issues, the Department collected shade information in the more arid portions of the state since there was more concern about how the water quality standards were to be met in these regions. Shade data for a variety of fish-bearing streams were collected in the Blue Mountains and Siskiyou geographic regions. A known relationship that was considered is that smaller streams gain and lose heat more rapidly than larger streams.

Data were also gathered to determine shade recovery rates and to evaluate the temperature patterns for small non-fish-bearing streams. Shade data were collected from 40 such streams within the Department's riparian monitoring sites and from within the eight townships.

Analysis of the data found that 55 percent of these small streams were at or above preharvest shade levels 1 to 2 years after harvest due to understory vegetation regrowth. The most rapid recovery was in the geographic regions with the higher precipitation levels. Because most of these streams had a bankfull width averaging less than 6 feet, most shade was provided by shrubs and grasses within 10 feet of the bank.

Evaluation of temperature patterns found that streams with elevated water temperatures did cool when they entered fully shaded downstream reaches. The mechanisms related to cooling appear complex, and it is not certain that understory shade alone may have the same cooling effects as a fully shaded reach with a tree canopy.

Based on the study and other relevant research, we concluded that:

- Maintaining shrubs and trees along only the lower portions of perennial small non-fish-bearing streams in a harvest unit for a distance of 1,000 to 1,500 feet will likely result in only minimal changes in the temperature of downstream fish-bearing channels and preserve cool water refuges (where they exist) at their confluences with fish-bearing waters. (It was estimated that temperatures would exceed current state water quality standards *within a portion* of the perennial non-fish-bearing stream but would not be more than 2° F above preharvest levels once the water reached downstream fish-bearing channels. This estimate was based upon the assumption that temperature increases in the portion of stream above the retained vegetation would not exceed 10° F.)
- Water temperature within portions of perennial non-fish-bearing streams without retained vegetation will be elevated and may temporarily exceed temperature tolerances for species such as tailed frogs and Olympic salamanders.

- Seasonality of flow (summer flow) was not well enough correlated to basin size to use basin size as a predictor of summer flow.

The rate at which harvesting occurs and vegetative shade recovers greatly influences whether warmed water within exposed perennial non-fish-bearing channels is likely to result in cumulative effects downstream. Since 1991, forest practice rules have required that clearcuts not exceed 120 acres and cannot be adjacent to another clearcut on the same ownership until the reforestation within the existing clearcut is 4 years old or 4 feet tall. For a majority of forest lands in Oregon, large expanses of land in a single watershed are not being harvested in a short time. However, this is occurring in some areas.

While the 120-acre limit on a single clearcut will not significantly influence harvest rates, it does have the effect of scattering the harvested area across a basin over time. This in combination with shade recovery along smaller non-fish-bearing streams, which was found to occur in a majority of cases within 2 years of harvest, should reduce possible cumulative effects. Monitoring is planned to analyze possible basin and cumulative temperature affects.

Water Volume and Stream Morphology

As stream size increases, water volume increases, channel morphology becomes more meandering and floodplains widen. As a result, the relative diversity of stream and riparian habitat and fish and wildlife populations also increases (Figure 7). This is not to say that small streams are unimportant but rather that relative diversity of the system increases with stream size.

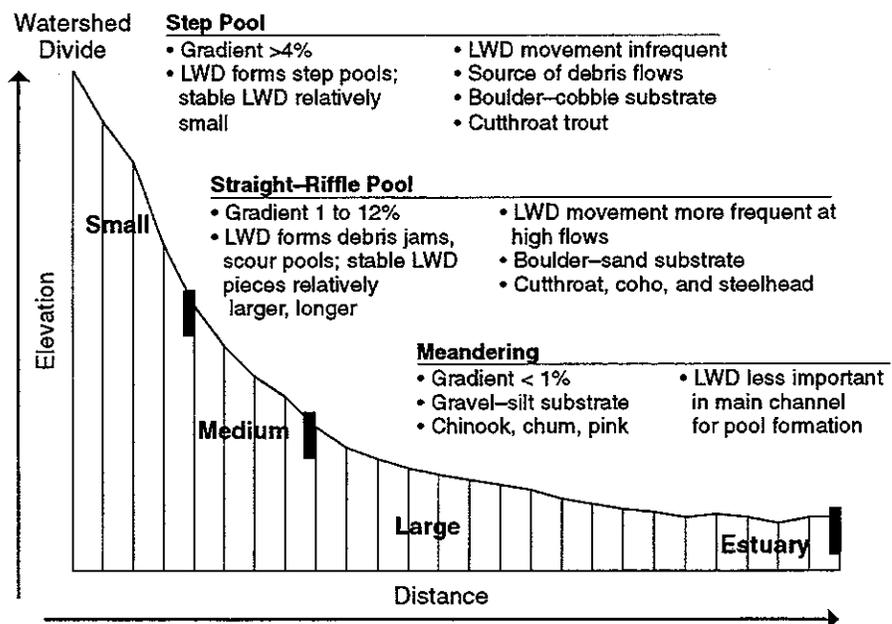


Figure 7. Patterns of channel morphology, movement and function of large woody debris (LWD), and fish use.⁵

Sediment Management

Streamside buffers have been found relatively unimportant in preventing or reducing sediment delivery to streams. Most sediment occurs in channelized flows, and “best management practices” that prevent such sources on roads and skid trails are the key to sediment management. Overland flow of sediment may be mitigated by buffers, but overland flow is relatively uncommon in the Pacific Northwest on forest soils.

Effects of Timber Operations

Several operational effects of protecting riparian vegetation were considered in developing the rules. Research suggests that as buffer requirements increase along small headwater streams, additional road building will occur. This is due to the high density of such small channels and to the fact that patches of timber become isolated from existing roads by the additional retained riparian vegetation. The additional road building is thought to have high potential for increased sedimentation since the roads often will be in steep terrain and require significant excavation. Other operational effects include development of more landings and additional safety problems as protection of riparian vegetation increases toward the headwaters.

The new water classification system is based upon type of water (stream, lake, or wetland), geographical region, beneficial use, and size. Separating waters by geographical region provides an appropriate mechanism to address the biological diversity of Oregon’s forest. The seven geographical regions that were developed represent common areas of climate, geology, and plant species associations. These regions were based upon the U.S. Environmental Protection Agency ecoregions. Figure 8 illustrates the general boundaries of the geographic regions.

Water classification

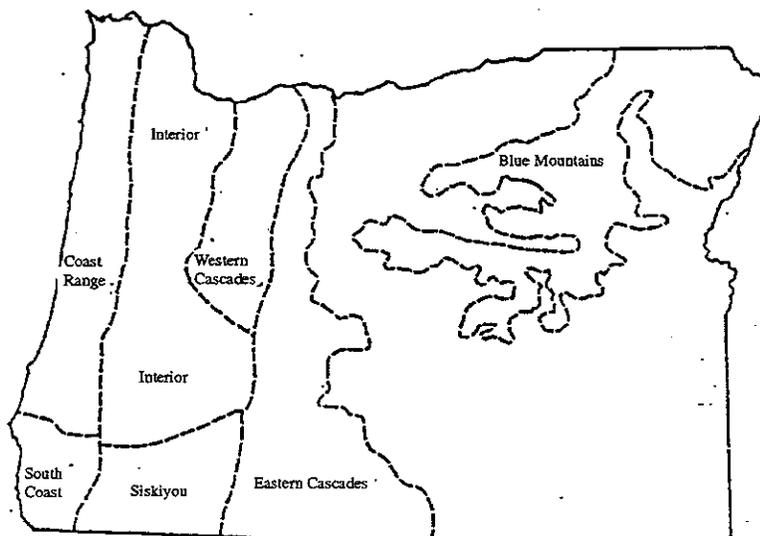


Figure 8. Geographic region boundaries.

Streams

Streams are segregated by beneficial use and size in order to match the physical characteristics and beneficial uses of a stream with appropriate protection measures. Based upon this system, in addition to the seven geographic regions there are nine possible combinations of uses and sizes (see Table 2, page 22).

Utilizing stream size in the classification system allows protection to be scaled to known physical relationships and adjusted based upon the relative importance of streams to beneficial uses. More specifically, this provides a means of segregating streams based upon their water power, fish usage, and other protection needs. For example, as described earlier, because a large stream has more water and water power, a greater proportion of the streamside forest needs to be retained so that there will be enough woody debris provided by the streamside stand to form fish habitat. Less of the streamside forest along a small stream needs to be retained to form an equivalent level of fish habitat. Similarly, more trees in a wider buffer are needed along a large stream to shade the channel than are needed to shade a small stream.

Stream size is based upon average annual flow. Small streams have an average annual flow of 2 cubic feet per second (cfs) or less. Medium streams have an average annual flow greater than 2 cfs but less than 10 cfs. Large streams have an average annual flow of 10 cfs or greater.

Small streams include streams that cannot normally move woody debris, that are dominantly used by resident fish species, and in which woody debris normally functions in step-pool formation and small trees can provide both stable and functional size debris. Based upon available data relating stream size to stable woody debris piece size, an average annual flow of 1.5 cfs was initially selected as the criterion. However, field observations indicated that 2 cfs was better correlated to changes in the functions listed. The break point between medium and large streams also reflects the difference in ability to move woody debris. A detailed description of the technical applications in sizing streams is included in Appendix B.

The stream size classes are based on the upstream drainage area and annual precipitation. However, actual measurements of average annual flow may be substituted for the calculated flows when it is obvious that the calculated flow is erroneous.

Notwithstanding precipitation amount, the drainage area that separates small from medium streams is never less than 200 acres. That limit is to minimize problems associated with possible inaccuracies and uncertainty of the location of stream channels on U.S. Geological Survey maps. The possible effects of this limit were not considered consequential, because the limit affected only very small portions of the state with very high precipitation levels.

In indexing streams by size, both stream order and bankfull width were considered as approaches. However, in practice, both these approaches have a number of pitfalls that the selected method does not. When stream ordering is based upon maps, the scale and accuracy of the map greatly determines where first- and subsequent-order streams occur. In the field, the decision where to begin counting order often depends upon personal interpretation. A field-based approach would be much more accurate than a map approach, but it would also be much more costly to implement.

Also, the order assigned may indicate little about the physical characteristics associated with a channel or its relative importance to beneficial uses. Research does indicate a general decrease in stream gradient and increase in stream width as order increases. However, these relationships change according to the underlying geology and terrain steepness. For example, Boehne and House (1983) showed that fish use of second- and third-order channels was considerably greater in the Coast Range than in the Cascades.⁶ Third-order channels generally are steeper in the Cascades. Channels in steeper terrain are more likely to be narrower and to have less beaver activity than similar order channels in gentle terrain. Bankfull width was found to have similar variability. Therefore, providing consistent classification was not possible with either of these other approaches.

Establishing beneficial use categories allows protection measures to be scaled to specific needs of a beneficial use. For example, the protection measures for fish-use streams and domestic-use-only streams are not always the same. Furthermore, the public recognizes distinctions between streams that directly provide beneficial uses and those that indirectly support beneficial uses.

Wetlands

Rules identify three major types of wetlands, which in some cases are further differentiated by size.

Significant wetlands Those wetlands greater than 8 acres: estuaries, bogs, and important springs in eastern Oregon.

Stream-associated wetlands that are not significant wetlands Those wetlands that occur immediately adjacent to stream channels and are not significant wetlands. A stream-associated wetland is considered part of the stream and is subject to the protection measures that apply to the stream. The width of the riparian management area may be greater where a stream-associated wetland occurs.

Other wetlands Those wetlands that are not stream-associated or significant wetlands. Other wetlands come in two sizes: greater than or equal to one-quarter acre; and less than one-quarter acre.

Lakes

A lake is defined as a body of year-round standing open water. There are only two types: large lakes, which have more than 8 acres; and other lakes, which are 8 acres or smaller. The logic for classifying wetlands and lakes by size is that size is an index for the relative overall habitat and hydrologic function values of a wetland or lake. Significant wetlands and lakes often occur side by side and can be indistinguishable from each other as water levels rise and fall during the seasons. For this reason, the protection measures are the same for lakes and significant wetlands greater than 8 acres.

Riparian management area widths

A riparian management area (RMA) is simply the ground next to specified streams, lakes, or wetlands where special management practices are required to protect water quality, hydrologic functions, or fish and wildlife habitat. In the new rules, every type of water has a riparian management area except small Type-N streams, "other wetlands," and "other lakes" without fish that are 0.5 acre or less.

The beds and banks of water types without riparian management areas must always be protected, and sensitive practices must be used that prevent negative impact on water quality. The riparian management area width along a stream varies according to its size and uses, as shown in Table 2.

Table 2. Riparian management area (RMA) widths for small, medium, and large streams.

Stream Size	Fish-Use or Fish and Domestic Use Together Type F	Domestic Use Only Type D	No Fish or Domestic Use Type N
Large	100 feet	70 feet	70 feet
Medium	70 feet	50 feet	50 feet
Small	50 feet	20 feet	none*

* For all small Type-N streams, water quality protection is provided through "best management practices" required during harvesting, road construction, site preparation, etc. For some Type-N streams, there is an additional requirement that understory and nonmerchantable conifer be retained within 10 feet of the stream.

Riparian management area widths were based upon analysis of where streamside vegetation functions and inputs come from. As discussed earlier, most riparian functions and inputs come from vegetation within 100 feet or less of the stream. For example, to get nearly 100 percent of potential large woody debris recruitment requires a riparian management area width of 200 feet, while over 80 percent of the large woody debris input would be provided from vegetation retained within 100 feet. Other inputs and functions, such as litter fall and shade, generally are provided by vegetation within 20 to 50 feet of a channel. To ensure that high levels of shade were provided along streams with riparian management areas, the first 20 feet were identified as being predominantly a no-harvest area.

Riparian management area widths also were based upon the assumption that the size and volume of woody debris required to maintain good habitat diminishes as stream size diminishes. There was also an assumption that the stand newly established after a harvest was likely to provide significant functional large woody debris to smaller streams.

Riparian management area widths were selected to meet the water quality standards and to provide for good fish habitat, not maximum fish habitat. This is consistent with the decision-making authority of the Board. The widths selected will maintain "good" habitat (based upon a high portion of all potential functions and inputs being provided) in an efficient manner.

Where a stream-associated wetland occurs, the riparian management area width is *at least* that shown in Table 2. This width is expanded to include the entire stream-associated wetland plus at least 25 feet on the outer edge of the wetland. Side channels of a stream are handled in the same way. This approach includes all components of the floodplain and stream, below the high water level, that are important hydrologically to water quality within either the defined riparian management area or stream so that they would be protected, plus providing at least 25 feet of riparian management area beyond the outermost feature. Thus, in the case of nonconstrained streams, the area between the outermost side channels will be protected as either riparian management area or stream.

Riparian management area width for significant wetlands, other wetlands, and lakes are shown in Table 3 (page 24).

For streams, the riparian management area is measured from the *high water level* of a main channel. If there is more than one main channel, the riparian management area is measured from the high water level of the outermost channel. As mentioned above, where a stream-associated wetland or side channel occurs along the stream, the riparian management area width is expanded to include the entire stream-associated wetland or side channel plus at least 25 feet on the outer edge. This may result in widths substantially greater than those specified in Table 2.

Table 3. Riparian Management Area (RMA) widths for significant wetlands, other wetlands, and lakes.

Water Type	RMA Width
Significant Wetlands	
Estuaries	100 to 200 feet
Bogs	50 to 100 feet
Important springs in eastern Oregon	50 to 100 feet
Wetlands greater than 8 acres	100 feet
Other Wetlands	none
Lakes Greater Than 8 Acres	100 feet
Other Lakes (8 Acres or Less)	
With fish	50 feet
Without fish and 0.5 acre or more	50 feet
Without fish and less than 0.5 acre	none

For wetlands that are not stream-associated, the riparian management area is measured from the edge of the wetland. For lakes, the riparian management area is measured from the high water level of the lake.

The riparian management area usually is measured as a slope distance. However, where the slope adjacent to a stream is steep exposed rock, soil, or talus slope, the riparian management area is measured as a horizontal distance to the top of the steep section and as a slope distance from there on. Using slope distance eases administration. Field evaluation and analysis of monitoring data found little impact to achieving the vegetation retention goals by using slope distance as compared to horizontal distance.

Goals for managing vegetation in streamside areas

Research has shown that the streamside stand is the source of a number of functions and inputs that maintain water quality and keep streams and their adjacent areas productive for fish and wildlife.

- When trees topple into the channel, they create pools, areas of low water velocity, and cover for fish.
- The root masses of live trees nearest the channel maintain bank integrity and also may create pools, undercut banks, and backwater areas that are heavily used by fish.
- Live trees provide shade that maintains water temperatures and provides cover for fish and wildlife.
- Leaves, needles, and branches from trees add nutrients to a stream. These nutrients are processed by aquatic organisms and ultimately become part of the food supply of fish and amphibians.

-
- Snags, live trees, and downed wood in the streamside area are important dwelling and feeding areas for wildlife species found throughout the forest landscape.

Fish-Use Streams

The goal for managing streamside stands along fish-use streams is to grow and retain vegetation along streams so that, over time, average conditions across the landscape become similar to those of mature unmanaged streamside stands. This fundamental goal-setting decision was based upon the following considerations.

1. Mature streamside stands are able to provide most of the functions and inputs in greater quality and quantity than are young stands. A shortage of large, persistent woody debris is particularly noticeable in streams bordered by young stands. Conifer stands with large trees are the best suppliers of this large, persistent woody debris.
2. Historically, the forest landscape contained streamside stands of all ages ranging from early successional to old-growth. Wildfire, windstorms, floods, disease, and beaver activity guaranteed that streamside areas were disturbed periodically. Nevertheless, across the forest landscape and at any given time, a large proportion of streamside areas supported stands of mature age classes. In contrast, the streamside areas on private land are now predominantly in younger age classes — very little is left of the mature age classes.
3. Recommendations of several scientists including Stan Gregory of Oregon State University, Robert Bilby of Weyerhaeuser Co., and Tom Nickelson of the Oregon Department of Fish and Wildlife. They assisted the Department in developing a process to model woody debris inputs and outputs.

To achieve the desired conditions on private lands will require incentives. The primary incentive available is to allow harvest of a portion of trees that are a product of management efforts above and beyond what an unmanaged stand might provide.

Under the desired future condition, stands along fish-bearing streams will become more diverse and the average tree size and age in the stand will move toward what would be expected under natural-disturbance regimes.

Once the decision was made to use mature streamside stands as the target, the next step was to develop a suitable physical descriptor for mature stands. Mature conifer stands often develop within 80 to 200 years. But this can vary depending on climate and soil conditions. Where the site is incapable of growing conifers (because of a high water table or periodic flooding), a hardwood stand will usually develop, often maturing earlier than 80 to 200 years. The vegetation retention requirements found in the general prescription were developed by examining the conifer basal area that would be expected for an unmanaged streamside area at the age of 120 years. The use

of 120 years seemed appropriate because, while streamside stands do not grow as well as upland stands, the individual trees grow faster and attain mature characteristics at an earlier age than those in upland stands. Additionally, 120 years is more supportive of economically efficient forest practices than older ages, and 120 years is an appropriate limit for the interpolations required when using the process described below.

Live conifer basal area based upon unmanaged stands was chosen as the primary descriptor of the streamside stand for the following reasons.

1. Conifer stands are the desired condition along most forest streams.
2. It is a highly accurate measure of forest stands, it is correlated to stand age and tree size, and it is relatively easy to measure.
3. It can be correlated to streamside stand functions including potential production of large woody debris and amount of shade.
4. It provides incentive to leave larger trees in the riparian management area. This is because basal area increases exponentially as diameter increases. Since the economic value of a tree is similarly correlated to diameter, by choosing to retain larger trees the landowner receives appropriately larger value in meeting the overall retention requirements.
5. It provides incentive to landowners to actively promote reforestation and growth of trees so that they can over time harvest basal area grown above the retention requirement.

In developing the basal area targets, in most cases theoretical yield tables were used instead of actual stand data. Data characterizing mature riparian stands are very limited and were absent for some portions of the state. The limited amount of data available was mostly from old-growth sites rather than from mature stands. Thus, an alternative was needed to the use of actual stand data. Theoretical yield tables were a logical starting point so long as they could be appropriately adjusted to reflect the difference in performance between upland and riparian stands and the targeted stand age. Actual riparian stand data were adequate for the eastern Oregon geographic regions and were used instead of the "calculated" process.

In the "calculated" process, conifer basal area was examined for each geographic region in order to account for general differences in climate, soil, and plant species associations. The calculations are shown in Table 4 which illustrates the adjustment factors and provides an example of how the basal area was calculated for large fish-use streams under a clearcut harvest scenario. Other tables demonstrating the calculations and adjustments for other types of streams are included in Appendix A.

Basal area estimates (on a per-acre basis) initially were made using normal yield tables for fully stocked upland stands based upon the average site index for nonfederal lands in the geographic region (column A, Table 4).

Table 4. Calculation of standard target for large fish-bearing streams.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduced RMA ^c (% dec.)	Reduction for	Reduction for	Reduction for	Reduction for	Basal Area Target (Adjusted Yield) [E=A(B×C×D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=E×G/F] (sq ft/ac)	Adjusted Basal Area Target	Adjusted Basal Area Target (sq ft/1000 ft)						
100	119	332	0.80	0.80	0.80	0.75	159	1.59	1	100	230	230							
100	109	320	0.85	0.80	0.75	163	1.59	1	103	236	236								
100	111	322	0.90	0.80	0.80	185	1.59	1	117	268	268								
100	113	325	0.85	0.80	0.85	188	1.59	1	118	271	271								
100	81	280	0.85	0.80	0.80	152	1.59	1	96	220	220								
100	data from mature stands used to establish basal target area					116	1.59	1	73	168	168								
100	data from mature stands used to establish basal target area					116	1.59	1	73	168	168								

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

The yield tables used were developed by the Washington Department of Natural Resources (WDNR) for Douglas-fir. WDNR yield tables are commonly used across the Northwest and are considered adequate estimators of growth and yield for second-growth stands in this region. The selection of Douglas-fir as a generic representative for streamside conifers was logical because, for nonfederal lands, Douglas-fir is the predominant conifer species across nearly all of Oregon. While other conifer species may be dominant in local areas, it was not practical to describe stands based upon all potential tree associations or site indices.

Basal area first was calculated for a fully stocked 120-year-old conifer stand. (Yield table data go only to 100 years; basal area for 120 years was interpolated.) Adjustments for factors such as mortality, stocking, and hardwoods were then applied. For all streams, the basal area initially was reduced by 20 percent (column C). This was a general adjustment to recognize that natural stands rarely are fully stocked due to a variety of factors such as rocky or wet soils. A 20 percent reduction is commonly used to describe “normal” stocking versus “full” stocking for upland stands.

This basal area level was further reduced by up to 20 percent in recognition that the first 20 feet of riparian management area is a no-harvest area and as a result will be proportionately more hardwood-dominated than upland stands (column B). This adjustment factor varied by geographic region as hardwood frequency in riparian areas varies by geographic region. Actual adjustments were based upon field observations and monitoring site data.

The basal area was also reduced by mortality adjustments that varied by geographic region. Generally, wetter areas have higher mortality estimates due to such factors as higher assumed frequency of flood events, greater competition with understory brush, and beaver damage. Estimates were based upon professional judgment and comparisons with what are thought to be representative conditions in known sites.

This final amount of basal area — the “basal area target” — represents the desired future condition for the *average* riparian stand on a conifer site across the landscape (column E). Of course, the landscape comprises many riparian stands, all of which grow and change over time. Therefore, the basal area target was further adjusted (column I) so the conifer basal area retained — the “adjusted basal area target” — in the riparian management area at harvest would meet or exceed the basal area target halfway through the next rotation or entry period. It is assumed riparian stands will be entered for harvest at the same time as adjacent upland stands. During an even-aged rotation or uneven-aged entry cycle, all the individual riparian stands could be subject to harvest that reduces the basal area below the basal area target. That point would be followed by long periods when these stands grow to and above the target. The average landscape condition will be composed of riparian stands with a variety of conifer basal area levels less than, equal to, and greater than the basal area target but whose average equals the target.

For even-aged management applications, a harvest period of 50 years was used to calculate the adjusted basal area target. This adjustment used average stand growth rates to reflect how much basal area would need to be left in the stand at harvest so that the stand would grow to meet or exceed the basal area target in 25 years. From 25 to 50 years after harvest, the basal area would continue to grow above the basal area target. Thus, the aggregate of the individual stands would meet the average landscape condition through time (columns F through I). Figure 10 illustrates the relationship between the basal area at the beginning, midpoint, and end of each rotation period for an individual stand with the basal area target.

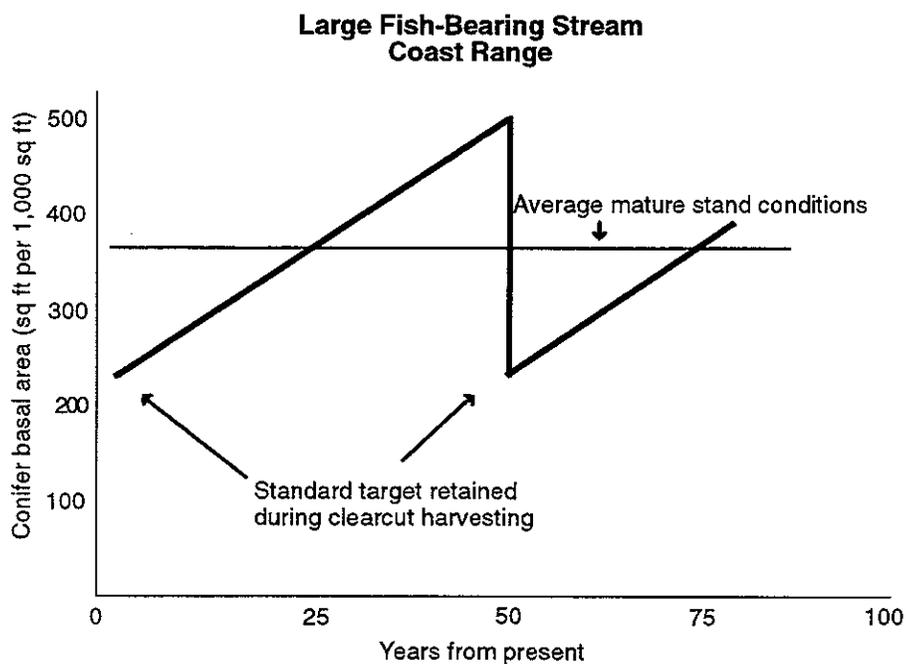


Figure 10. Conifer basal area at the beginning, midpoint, and end of each 50-year rotation for clearcut harvesting.

Similar calculations were made for partial harvest or uneven-aged applications based upon a 25-year entry cycle and a 12.5-year midpoint for the growth calculation. The adjusted basal area target for partial harvests is higher than the target for clearcuts because more frequent entries reduce the growth adjustment time period to the basal area target. Figure 11 (page 30) illustrates the relationship between the adjusted basal area target at the beginning, midpoint, and end of each entry period for an individual stand with the basal area target.

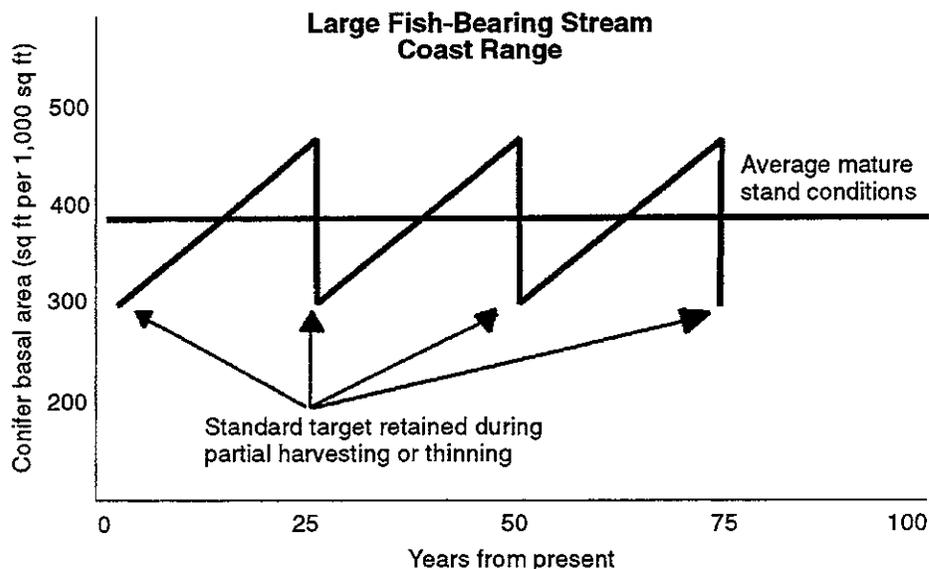


Figure 11. Conifer basal area at the beginning, midpoint, and end of each 25-year entry period for partial harvesting or thinning.

The average stand growth rates were derived from the stand model growth rates used in the Stand Projection System model (Arney 1985).⁷ This model was selected because it had the widest applicability for projecting growth in second-growth Douglas-fir stands in Oregon.

Growth projections for the conifer basal area do not include any adjustments for loss in basal area due to mortality factors such as windthrow that may be higher in riparian areas or that may increase due to creating an “edge” when leaving a buffer. Data to account for such factors were not available. Additionally, such losses have the effect of reducing harvest removals at the next rotation and, therefore, such losses may be compensated for.

When establishing the final retention target for large streams, it was assumed that “ingrowth” (basal area generated by reproduction during the next rotation period) would not contribute any basal area. For medium streams, it was assumed that ingrowth would provide up to 25 percent of the desired large woody debris. As a result, the conifer basal area target was reduced by 25 percent for medium streams. For small streams, a greater contribution for ingrowth was credited. For medium and small streams, the habitat features are more easily maintained by smaller sizes of woody debris; thus some functional large woody debris can be provided by ingrowth. These reductions were based on the assumption that inputs from the new stand growing alongside the older retained streamside conifers would contribute to habitat maintenance. For small streams, it was assumed that 75 percent of the desired instream large woody debris would be provided by the newly regenerated stand during the 50 years of stand growth following harvest.

As described above, the vegetation retention targets are in part a function of “average” conditions. Clearly there are consequences of selecting an average as the basis for rules. For example, using average site conditions for each geographic region imposes a higher retention requirement for sites with below-average productivity than for sites with above-average productivity. Similarly, using an average also will result in a lower proportion of potential biological function being provided on sites with above-average productivity and a higher proportion on below-average sites. However, these consequences appear to be supported by some known protection needs. For example, poorer sites often are that way because of environmental conditions such as dryness or instability. Thus it makes sense to retain a higher proportion of the potential stand to mitigate such factors. Nonetheless, as described later, the rules do allow consideration of site-specific plans to address the variability that could not be addressed by the standard rules. Thus, landowners with the technical resources to do appropriate analysis can propose alternative approaches to the standard requirements.

Domestic Use and Type-N Streams

The overall goal of the streamside vegetation retention rules along Type-N and Type-D streams is to grow and retain vegetation sufficient to:

- Support the functions and processes that are important to downstream waters that have fish;
- Maintain the quality of domestic water; and
- Supplement wildlife habitat across the landscape.

Reducing the basal area retention requirements for a Type-N or Type-D stream, compared to those of a Type-F stream of similar size, was judged appropriate since the amount of large woody debris entering these channels over time was not as important for maintaining fish populations within a watershed.

Hardwoods

Some provisions were added to allow large hardwood trees (except alder) to be included in the basal area targets. There is a need to promote a certain diversity in vegetation within streamside areas. Large hardwood trees often develop cavities that are used by birds and small mammals. In eastern Oregon, hardwoods including cottonwoods and aspens are particularly important and are preferred streamside stand components on some sites.

Certain provisions ensure that enough disturbance occurs within the riparian management area to regenerate new trees, including wherever trees have been harvested.

For streamside areas that are capable of supporting mostly hardwoods, but not conifers, the basal area targets found in the general prescription were developed along the following lines.

That portion of the hardwood stand closest to the stream would be retained and continue providing inputs to the stream through the next rotation. The harvested portions of the riparian management area would be regenerated to hardwoods, and these trees would someday supplement the older hardwoods left closest to the stream.

Because hardwood areas are often low-lying and flood periodically, natural events will also result in periodic disturbance and the reestablishment of the hardwood streamside stand.

A special emphasis is placed on retaining hardwoods along eastern Oregon streams. Hardwoods in eastern Oregon can play an important role in stream shading and providing wildlife habitat.

Snags, Dead Trees, and Downed Wood

In addition to the live vegetation retention requirements, all snags, downed wood, and dead trees generally must be retained in the entire riparian management area. This ensures that trees that die will be left through their full "life span" as habitat components. Provisions do allow some adjustments for operational or other specific reasons such as catastrophic events. However, any snags or dead trees that must be felled for operational reasons must be left where they fall. This avoids creating any incentive to cut snags.

Temperature protection

The Forest Practices Act requires stream protection rules to comply with state water quality standards. The water temperature standard is quite strict. Limited temperature increases are allowed as a result of timber harvest only if the preharvest stream temperature is less than an established threshold. No temperature increase is allowed if preharvest stream temperature is above the threshold.

The shade standard in the previous stream protection rules was always difficult to understand and enforce. Now, the general vegetation prescription rule requires that *all trees within 20 feet of the high water mark be retained*. The only exceptions are where yarding corridors or stream crossings are needed, where a hardwood stand is being converted to conifers (described later), along small streams that have no fish or domestic water use, or where a site-specific prescription is approved.

Field inspections and monitoring data indicate that this unharvested 20-foot-wide core area on each side of the high water mark, combined with other trees retained in the riparian management area to satisfy the basal area target, will result in overall compliance with the state water quality standard for water temperature. The validity of this assumption will be monitored closely during the next few years.

Temperatures in small Type-N streams in five of the seven geographic regions are protected by the requirement to retain nonmerchantable vegetation within 10 feet of bankfull level along perennial portions of those streams. The two geographic regions excepted are the Western Cascade and Coast Range regions — the two regions with the least known temperature problems and with the highest vegetative recovery rates.

There was considerable debate about how to specify a vegetation retention standard appropriate to meet the water quality standards “to the maximum extent practicable” for these streams. Information useful to developing prescriptions for these streams was limited. Nevertheless, the following factors were considered in developing the final approach.

- Most of the known temperature problems related to forest operations occur primarily in the five warmer and drier geographic regions, though documentation of actual detrimental temperature effects is poor.
- Smaller headwater streams are more likely to have higher rates of disturbance from fire than larger streams. The natural disturbance regimes likely resulted in more variable shade levels across the landscape for these streams than for larger streams.
- Many small Type-N streams do not have summer flows, and shade is not necessary to maintain stream temperatures along these streams. However, identifying which streams have summer flows is difficult. Basin size was not well enough correlated to summer flow to be adequately predictive.
- Vegetation regrowth along the majority of these streams provides shade near preharvest levels within 1 to 2 years of harvest.
- Shade for these streams is provided dominantly by understory vegetation within the first 10 feet of bankfull level.
- Small Type-N streams with summer flow and retained vegetation along their lower portions had lower water temperatures there than upstream where vegetation was not retained. About 1,000 to 1,500 feet of retained vegetation along the small Type-N stream is necessary to cool warmed water so that the water quality standards are met at the confluence with fish-use streams.
- Consensus is that practices that increase road densities (or that produce other detrimental environmental effects) should be avoided unless the environmental benefits of the practices exceed the environmental costs. As discussed earlier, additional buffers along small headwater streams will result in additional roads. Roads are a major source of stream sediment. Extending shade protection along these streams resulted in definite tradeoffs between environmental benefits (temperature) and environmental costs (sediment). The choice was to focus shade protection where it would do the most good.
- There was concern about negative cumulative temperature effects due to the level of shading provided along some of the small non-fish-bearing

streams. This issue was addressed by providing shade along such small streams when it was clearly warranted, as described above and where the operational effects did not counter the potential benefits. Since all other types of streams are provided high levels of shade, it is assumed that temperatures would be maintained overall and that any temperature increases along small non-fish-bearing streams would be short-lived and scattered over the basin with limited cumulative effects. Additionally, some argued that on the landscape level, the clearcut size and spacing limitations would reduce possible cumulative effects. Monitoring has been implemented to analyze basin-scale effects of small stream protection and possible effects of streamside stand conversion along fish-bearing streams.

Options for achieving the vegetation retention goals

Due to effects of past management practices on nonfederal forest lands, protection measures alone will not achieve desired restoration except for over very long periods of time. Thus, several options are available for operators to more quickly achieve the goals stated above and to provide incentives for stand and stream restoration. The options available depend on site conditions, existing stand conditions, and landowner interest. Figure 2 (page 11) illustrates the various options.

The amount of live conifer basal area growing within the riparian management area is the major factor controlling which vegetation retention options are possible. "Adequate conifer stocking" is a stand with enough conifer trees likely to produce the basal area of a 120-year-old conifer stand within the next rotation or entry period. It is assumed that stands with conifer stocking less than "adequate" can more quickly achieve the mature forest condition by the alternative prescription than by leaving the stand undisturbed. "Adequate conifer stocking" was determined to be half the value of the standard target defined under the general prescription for clearcut harvests.

1. If a streamside area currently has a stand with "adequate conifer stocking," the operator may choose to retain the amount of basal area specified in the *standard target* under the **general prescription**. Alternatively, if the operator chooses to conduct stream improvement work, a lesser amount of basal area (the *active management target*) may be retained in the riparian management area. (The active management targets were developed in the same manner as the standard targets, except that a more optimistic growth rate was assumed.)

If the basal area in the riparian management area exceeds the standard target, the operator may harvest any excess trees. If the basal area in the riparian management area is less than the standard target (yet has adequate conifer stocking), the operator must retain all conifers within the riparian management area unless active management is done.

2. Where a streamside area currently does not have a stand with “adequate conifer stocking” and the site is capable of growing conifers, the operator may choose the **alternative prescription**. The alternative prescription converts a portion of the hardwood stand to conifer while maintaining some of the shade and existing conifers.

3. Where a streamside stand has suffered a catastrophic event (such as windthrow, wildfire, disease mortality, or insect mortality) and the live conifer basal area is low, the operator may choose the **alternative prescription** that applies to his or her situation. This alternative prescription is designed to restore a portion of the damaged stand through conifer regeneration while maintaining a portion of the shade and existing conifers.

4. Where a streamside area does not support an adequate conifer stand and either the area is incapable of growing conifer or the operator does not choose to adopt an alternative prescription (or the alternative prescriptions are not applicable), then the operator may choose the default standard in the **general prescription**, which is to retain all conifer in the riparian management area.

5. The operator always has the option of developing a **site-specific prescription**. The site-specific prescription is an alternative plan that must be approved by the Department. The site-specific prescription is aimed at meeting the general protection goals through means that differ from the general prescription or alternative prescriptions.

These options ensure that the mature forest condition will be achieved. If the existing stand is likely to develop into the desired condition in a reasonable time, then the best option is to retain most of the conifer stand. Where this is not the case, or where stream restoration is needed, incentives are provided for management. Incentives include allowing more timber harvest, impacting less land base, and reducing constraints on other management activities or administrative requirements, or providing additional management flexibility. All three types of incentive are possible under the options developed.

The new rules provide a process to adopt additional rules for a specific watershed. These would be based upon a watershed analysis conducted by an interdisciplinary team. The process may begin when:

- The watershed contains aquatic species listed under the federal or state endangered species acts as threatened or endangered; or
- The Department of Environmental Quality has designated it a water-quality-limited watershed; and
- There is a demonstrated link between forest practices and either the water-quality-limiting factors or species maintenance.

Watershed-specific rules

The logic for limiting the scope of watershed-specific rule development is:

1. In most cases, the general rules will adequately address watershed scale concerns. For example, the riparian vegetation retention requirements should prevent deleterious cumulative temperature effects. Additionally, there are appropriate scale analyses already required in watersheds that have "high risk areas" and/or "high risk sites" (geologically unstable areas). Operations proposed in such areas can be allowed or disallowed based upon analysis of conditions.
2. Resources are limited to conduct watershed analysis. Thus, efforts should be focused on key problems where a link is established between forest practices and the problem.
3. Multiple ownerships make it expensive and difficult to conduct watershed-level analysis and planning.
4. Prescriptions to address some of the perceived problems are not well developed.

The Board is not restricted by this rule from considering the need for watershed analysis for other reasons. Additionally, statute directs the Board to consider watershed-scale planning if information about cumulative effects supports such action.

Developing good regulations requires a number of things including clarity, simplicity, and mechanisms to assure uniform and fair application. Clearly, it is not possible to impose the level of site-specific and/or landscape-level planning through regulation that some think is biologically or ecologically ideal. Nor is it possible to address all the known variability. The state and many forest landowners do not have the resources to do the type of analysis that the biological or ecological ideal might suggest. There are a number of other legal issues that regulation based upon larger scale "planning" raises.

Fish passage and design standards for stream crossings

The new rules require that stream-crossing structures be designed and maintained to pass both adult and juvenile fish, upstream and downstream. Previous rules required that only adult fish must be passed upstream, and there was no requirement that fish passage be maintained after installation.

The new rules do not require landowners to upgrade structures in place before September 1, 1994 to meet the new standards. This is because those structures were installed in good faith with the standards of the day. Correction of such structures should be through cooperative efforts. Nonetheless, the Oregon Department of Fish and Wildlife retains statutory authority to require correction of fish-passage structures, and this may be used in cases where cooperation does not result in acceptable solutions.

An abundance of scientific evidence established the need for juvenile fish to be able to move upstream (or into tributary streams) to avoid high flows or adverse temperatures. There was very little disagreement about this change. However, as a practical matter, implementing the change is going to require considerable work to identify effective stream-crossing structures.

The new rules increase the design standard for stream crossing. The previous design standard was based upon the 25-year storm; the new standard is based upon the 50-year storm. There was not a tremendous amount of information about the adequacy of the previous standard. Nevertheless, this new standard was adopted because overwhelming consensus among the interest groups was that the 25-year standard was not as prudent as the 50-year standard. Washington and Idaho already have adopted the higher standard.

As discussed in this report, a number of assumptions formed the basis for the rules. Thus it will be important to document that these assumptions were sound. It is equally important to document that the prescriptions developed achieve the desired results and that any negative consequences are identified. Thus the rules include clear direction for the Department, in cooperation with interest groups and other agencies, to develop and support an adequate monitoring program. To this end, the Department has developed a monitoring strategy that will form the basis for this effort. Concurrently, the Oregon Department of Fish and Wildlife has developed appropriate plans to provide for their cooperative support of this effort.

Monitoring

References

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- ⁶ Boehne, P.L. and R.A. House. 1983. Stream ordering: A tool for land managers to classify western Oregon streams. Technical Note T/N: OR-3. Bureau of Land Management, Salem, OR.
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Appendices

Appendix A

Calculations and adjustment factors used to develop vegetation-retention targets (shown by stream type and harvest method)

Clearcut harvest is based upon a 50-year harvest cycle and a 25-year midpoint for the growth calculation. Partial harvest or uneven-aged applications are based upon a 25-year entry cycle and a 12.5-year midpoint for the growth calculation.

Appendix B

Classification of types of waters found on forest lands (Oregon Department of Forestry *Forest Practices Technical Note FPI*, April 1994)

Large fish-bearing streams: Calculation of standard target for clearcut harvesting.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduction for RMA ^c (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^e (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B+C*D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=B*G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)									
100	119	332	0.80	0.80	0.75	159	1.59	1	100	230									
100	109	320	0.85	0.80	0.75	163	1.59	1	103	236									
100	111	322	0.90	0.80	0.80	185	1.59	1	117	268									
100	113	325	0.85	0.80	0.85	188	1.59	1	118	271									
100	81	280	0.85	0.80	0.80	152	1.59	1	96	220									
100	data from mature stands used to establish basal target area					116	1.59	1	73	168									
100	data from mature stands used to establish basal target area					116	1.59	1	73	168									

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Large fish-bearing streams: Calculation of active management target for clearcut harvesting.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduced RMA ^a (% dec.)	Reduction for RMA ^a (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^c (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B·C·D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=E·G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)								
100	119	332	0.80	0.80	0.80	0.75	159	2.1	1	76	174								
100	109	320	0.85	0.80	0.75	163	2.1	1	78	178									
100	111	322	0.90	0.80	0.80	185	2.1	1	88	203									
100	113	325	0.85	0.80	0.85	188	2.1	1	89	205									
100	81	280	0.85	0.80	0.80	152	2.1	1	73	167									
100	data from mature stands used to establish basal target area					116	2.1	1	55	127									
100	data from mature stands used to establish basal target area					116	2.1	1	55	127									

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Large fish-bearing streams: Calculation of standard target for partial harvesting and thinning.

	A	B	C	D	E	F	G	H	I	
RMA Width (ft)	Site Index ^a (base 50)	Normal Yield ^b (sq ft/ac)	Reduction for RMA ^c (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^e (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B * C * D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=E * G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)
100	119	332	0.80	0.80	0.75	159	1.59	1	100	230
100	109	320	0.85	0.80	0.75	163	1.59	1	103	236
100	111	322	0.90	0.80	0.80	185	1.59	1	117	268
100	113	325	0.85	0.80	0.85	188	1.59	1	118	271
100	81	280	0.85	0.80	0.80	152	1.59	1	96	220
100	data from mature stands used to establish basal target area					116	1.59	1	73	168
100	data from mature stands used to establish basal target area					116	1.59	1	73	168

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Large fish-bearing streams: Calculation of active management target for partial harvesting and thinning.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduced RMA ^c (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^e (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B×C×D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=E×G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)									
100	119	332	0.80	0.80	0.75	159	1.35	1	118	174									
100	109	320	0.85	0.80	0.75	163	1.35	1	78	178									
100	111	322	0.90	0.80	0.80	185	1.35	1	88	203									
100	113	325	0.85	0.80	0.85	188	1.35	1	89	205									
100	81	280	0.85	0.80	0.80	152	1.35	1	73	167									
100	data from mature stands used to establish basal target area					116	1.35	1	55	127									
100	data from mature stands used to establish basal target area					116	1.35	1	55	127									

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Medium fish-bearing streams: Calculation of standard target for clearcut harvesting.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduction for Reduced RMA ^c (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^e (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B × C × D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Basal Area Target [H=E × G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)										
70	119	332	0.80	0.80	0.75	159	1.59	0.75	75	121									
70	109	320	0.85	0.80	0.75	163	1.59	0.75	77	124									
70	111	322	0.90	0.80	0.80	185	1.59	0.75	87	141									
70	113	325	0.85	0.80	0.85	188	1.59	0.75	89	142									
70	81	280	0.85	0.80	0.80	152	1.59	0.75	72	115									
70	data from mature stands used to establish basal target area					116	1.59	0.75	55	88									
70	data from mature stands used to establish basal target area					116	1.59	0.75	55	88									

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Medium fish-bearing streams: Calculation of active management target for clearcut harvesting.

RMA Width (ft)	Site Index ^a (base 50)	A		B		C		D		E		F		G		H		I	
		Normal Yield ^b (sq ft/ac)	Reduced RMA ^c (% dec.)	Reduction for	Reduction for	Reduction for	Reduction for	Basal Area Target (Adjusted Yield) [E=A(B*C*D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Adjustment for Ingrowth	Adjusted Basal Area Target [H=E*G/F] (sq ft/ac)	Adjusted Basal Area Target (sq ft/1000 ft)							
70	119	332	0.80	0.80	0.80	0.75	159	2.1	0.75	57	91								
70	109	320	0.85	0.80	0.75	163	2.1	0.75	58	94									
70	111	322	0.90	0.80	0.80	185	2.1	0.75	66	106									
70	113	325	0.85	0.80	0.85	188	2.1	0.75	67	108									
70	81	280	0.85	0.80	0.80	152	2.1	0.75	54	87									
70	data from mature stands used to establish basal target area					116	2.1	0.75	41	66									
70	data from mature stands used to establish basal target area					116	2.1	0.75	41	66									

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Medium fish-bearing streams: Calculation of standard target for partial harvesting and thinning.

	RMA Width (ft)	A Site Index ^a (base 50)	B Normal Yield ^b (sq ft/ac)	C Reduction for Reduced RMA ^c (% dec.)	D Reduction for Stocking ^d (% dec.)	E Reduction for Mortality ^e (% dec.)	F Basal Area Target (Adjusted Yield) [E=A(B * C * D)] (sq ft/ac)	G Adjustment Ratio: Start of Rotation ^f	H Adjustment for Ingrowth	I Adjusted Basal Area Target [H=E * G/F] (sq ft/ac)	J Adjusted Basal Area Target (sq ft/1000 ft)
Coast Range	70	119	332	0.80	0.80	0.75	159	1.59	0.75	75	121
South Coast	70	109	320	0.85	0.80	0.75	163	1.59	0.75	77	124
Western Cascades	70	111	322	0.90	0.80	0.80	185	1.59	0.75	87	141
Interior	70	113	325	0.85	0.80	0.85	188	1.59	0.75	89	142
Siskiyou	70	81	280	0.85	0.80	0.80	152	1.59	0.75	72	115
Eastern Casades	70	data from mature stands used to establish basal target area					116	1.59	0.75	55	88
Blue Mountains	70	data from mature stands used to establish basal target area					116	1.59	0.75	55	88

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

Medium fish-bearing streams: Calculation of active management target for partial harvesting and thinning.

RMA Width (ft)	Site Index ^a (base 50)	Normal Yield ^b (sq ft/ac)	B		C		D		E		F		G		H		I	
			Reduction for RMA ^c (% dec.)	Reduction for Stocking ^d (% dec.)	Reduction for Mortality ^e (% dec.)	Basal Area Target (Adjusted Yield) [E=A(B+C+D)] (sq ft/ac)	Adjustment Ratio: Start of Rotation ^f	Basal Area Target [H=E+G/F] (sq ft/ac)	Adjustment for Ingrowth	Adjusted Basal Area Target								
70	119	332	0.80	0.80	0.80	0.75	159	2.1	0.75	57	91							
70	109	320	0.85	0.80	0.75	163	2.1	0.75	58	94								
70	111	322	0.90	0.80	0.80	185	2.1	0.75	66	106								
70	113	325	0.85	0.80	0.85	188	2.1	0.75	67	108								
70	81	280	0.85	0.80	0.80	152	2.1	0.75	54	87								
70	data from mature stands used to establish basal target area					116	2.1	0.75	41	66								
70	data from mature stands used to establish basal target area					116	2.1	0.75	41	66								

^a Estimated average Douglas-fir site index for upland areas.

^b Theoretical basal area yield for Douglas-fir at age 120 assuming full stocking. Values are from Washington Department of Natural Resources tables which were compiled from Washington stands.

^c The area up to 20 feet from the stream is a zone where all trees are retained. The effective RMA width is reduced proportionately by this amount because of this zone.

^d A reduction in expected basal area due to inability to attain full stocking.

^e Additional reductions in stocking due to factors unique to streamside areas. This includes soils with perched water tables, beaver damage, and increased competition from brush and hardwoods.

^f The basal area target is for the midpoint of the next 50-year rotation. Dividing by this ratio provides the basal area that needs to be retained at the beginning of the rotation to meet the target at midrotation.

*Oregon Department of Forestry
Forest Practices
Technical Note FP1
April 11, 1994*

Water Classification

The purpose of a water classification system is to match the physical characteristics and beneficial uses of a water body to some set of protection measures. The following water classification system was developed to meet this purpose and provide a relatively simple method for delineating the various types of waters found on forest lands.

For purposes of the Forest Practices Rules the waters of the state are classified as either streams, wetlands, or lakes. The various types of streams, wetlands, and lakes are described in detail below.

STREAMS

Streams are classified according to their size and according to one of the following beneficial use categories:

Streams that are used by fish, including fish-bearing streams that have domestic use, are classified as **Type F**.

Streams that have domestic water use but are not fish-bearing are classified as **Type D**.

All other streams are classified as **Type N**.

Fish use

A Type F stream is any stream used by anadromous fish, game fish, or fish listed as threatened or endangered under the federal or state endangered species acts. Fish use can be either seasonal or year-round.

A stream is not considered to be Type F if fish were introduced through a fish stocking permit and there is documentation showing that the stream had no fish prior to stocking.

The Department of Forestry, with assistance from the Department of Fish and Wildlife, will conduct a comprehensive field survey to identify all forest streams with fish use. The department may use reliable field survey information collected by others, such as landowners, state or federal agencies, or universities to supplement this field inventory.

This survey will take a number of years to complete. So, an interim process for identifying the extent of fish use in a watershed will be in effect until this comprehensive survey has been done for the watershed. This process is described below:

- The department will assume that streams have fish use if they were Class I under the previous classification system. Streams that were Class I solely because of a domestic water use are excluded.
- If streams within a proposed operation were not Class I under the previous classification system and fish use is unknown, then:

The department will conduct a field survey for fish use after a notification of operation is received by the department;

OR

The department will approximate the upstream extent of fish use in a watershed by considering the connection of the water with downstream waters where fish use is known. Fish use will be assumed to occur upstream of the known fish use until the first natural barrier to fish use is encountered.

Where fish use is unknown, an operator may request that the department conduct a field survey for fish use for reaches of a stream that will be included within an operation that is scheduled to start at least 12 months following the request. The operator shall limit such requests to operations that are part of a landowner's planned harvest schedule and will be conducted. The department, with assistance from the Oregon Department of Fish and Wildlife when needed, shall attempt to complete such surveys within 12 months following the request. If the survey cannot be conducted in the time indicated, the stream will be

considered to have no fish use. However, if the operation is not commenced within 6 months of the time originally indicated, the stream will again be considered to have unknown fish use.

The department may use other reliable fish survey information when determining whether or not a stream has fish use. This information could include surveys done by landowners, federal or state agencies, universities, or other persons or entities. The department will determine whether such information is reliable.

Domestic use

Type D streams do not contain fish and are located upstream of any domestic water intake for which a water use permit has been issued by the Oregon Water Resources Department.

The procedure for determining how far upstream from an intake that Type D classification applies depends on whether the intake is for a community water supply or not. This difference is explained below:

- If the domestic use is a community water system (has 15 or more service connections used by year-round residents, or which regularly serves 25 or more year-round residents) Type D classification shall initially apply to the length of stream that was designated Class I under the classification system that was in effect on April 22, 1994 (as shown on district water classification maps).
- If the domestic use is not a community water system, Type D classification shall initially be applied for the shortest of the following distances:

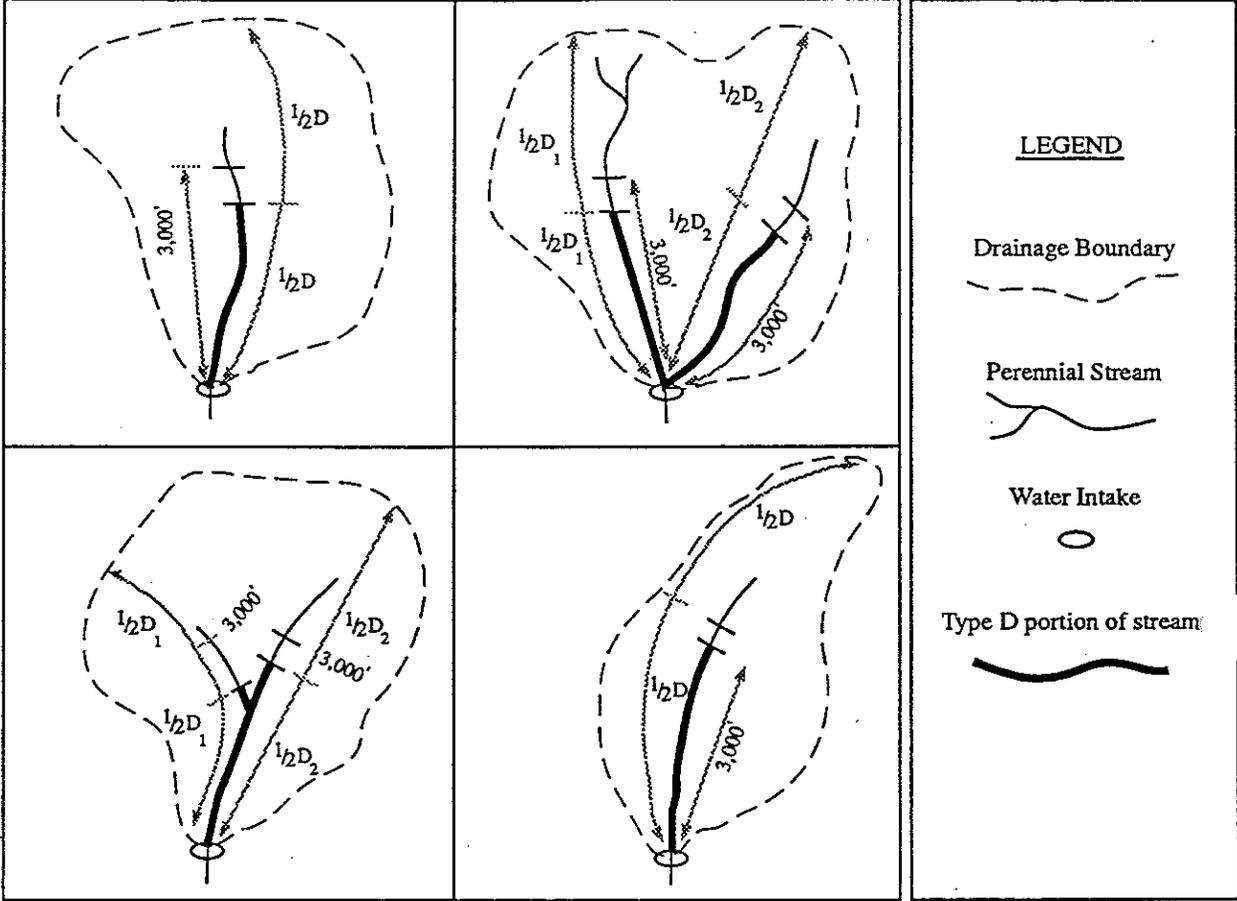
The distance upstream from the intake to the farthest upstream point of summer surface flow,

Half the distance from the intake to the drainage boundary, or

3000 feet upstream from the intake.

Type D classification shall apply also to tributaries off the main channel as long as the above conditions apply (see diagram on the next page).

Diagram showing the distance for Type D classification for domestic water uses that are not community water systems.



A representative of a community water system or other domestic use water permit holder may request that the department designate additional lengths of channels upstream from a domestic water intake or reservoir as Type D. The representative or permit holder must present evidence that the additional stream protection is needed.

The department will decide whether or not to extend Type D classification to these other channels based on evidence presented by the requesting party showing that protection measures associated with Type N classification would be insufficient to prevent adverse temperature increases, turbidity increases, or other water quality changes at the domestic water use intake or reservoir. This criteria also will be used to evaluate the extent of Type D classification for new community water systems. The department will decide whether or not to extend the length of Type D classification within 30 days of the presentation of evidence.

The domestic water use classification may be waived by the department at the request of the landowner where a landowner is the sole domestic water use permit holder for an intake and who owns all the land along upstream channels that would be affected by the classification related to that intake. The waiver is not intended to affect the classification related to downstream domestic water use intakes.

Stream size

For each of the three beneficial use categories (Type F, Type D, and Type N), streams are categorized further according to three size categories: **large, medium, and small.**

The combination of three beneficial use categories and three size categories creates a total of nine potential stream types as is shown below:

	FISH USE OR FISH AND DOMESTIC USE TOGETHER Type F	DOMESTIC USE ONLY Type D	NO FISH OR DOMESTIC USE Type N
LARGE			
MEDIUM			
SMALL			

The stream size categories are based on the average annual flow of a stream. Average annual flow is measured in cubic feet per second (cfs) and is simply the total volume of water (in cubic feet) transported by a stream during a normal year divided by the total seconds in a year.

Stream size categories were included in the classification system because they allow the tailoring of protection measures to fit site conditions. For example, fewer trees need to be retained along small streams than along large streams because the depletion of woody debris in a small stream is less during high flows and less debris volume is required to create the needed habitat in a channel.

Small streams have an average annual flow of 2 cfs or less. Medium streams have an average annual flow greater than 2 cfs but less than 10 cfs. Large streams have an average annual flow of 10 cfs or greater.

The average annual flow at any point along a stream is calculated using a relationship that is based on the upstream drainage area and annual precipitation. However, actual measurements of average annual flow may be substituted for the calculated flows. This may be necessary when it is obvious that the flow is unusually influenced by a spring or lava tube. An example of where the measured flow should be used is the Metolius River, which exits the ground as a large stream. Here, recent lava flows have obscured the actual drainage area and so the relationship between flow and drainage area would not apply.

Any stream with a drainage area less than 200 acres shall be assigned to the small stream category regardless of the calculated value.

The assignment of size categories to streams on forestland will be done by the department.

The equation that relates average annual flow to drainage area and average annual precipitation was developed using data from gauging stations on forested streams in eastern and western Oregon. Streams where gauge data were greatly influenced by water storage or withdrawals were not included in the analysis.

The relationship between flow and drainage area and precipitation were determined by multiple linear regression analysis. The independent variables in the data set (drainage area and precipitation) were transformed logarithmically (base e) to increase the linearity of the various relationships with the dependent variable. The dependent variable (flow) was assumed to be log-normally distributed. Analysis of the transformed data resulted in the following equation:

Western Oregon

$$\log_e(\text{FLOW}) = -11.972 + 0.990 * \log_e(\text{AREA}) + 1.593 * \log_e(\text{PRECIP})$$

n = 48; adjusted squared multiple R² = 0.96
standard error of estimate = 0.31

Eastern Oregon

$$\log_e(\text{FLOW}) = -15.712 + 1.176 * \log_e(\text{AREA}) + 2.061 * \log_e(\text{PRECIP})$$

n = 23; adjusted squared multiple R² = 0.83
standard error of estimate = 0.55

where: FLOW = average annual flow (cfs, cubic feet per second)
AREA = upstream drainage area (acres)
PRECIP = average annual precipitation (inches)

By rearranging the terms in the above equations, the relationships can be expressed as:

Western Oregon

$$\text{AREA} = 178600 * \text{FLOW}^{1.010} * \text{PRECIP}^{-1.609}$$

Eastern Oregon

$$\text{AREA} = 634300 * \text{FLOW}^{0.850} * \text{PRECIP}^{-1.753}$$

Using these last two equations, the drainage area corresponding to the division points between small and medium (2 cfs) and medium and large (10 cfs) streams can be calculated for various precipitation values, as shown in Table 1 and Table 2

Contour lines on topographic maps are used to define the boundaries of a basin and determine where the division points between small and medium and between medium and large streams occur. As shown in Figure 1, the line defining the boundary of a basin is always perpendicular to the contour lines.

The area enclosed by this boundary is the drainage area.

In this western Oregon example the annual precipitation is 65 inches so channels where the upstream drainage area is less than 440 acres are classified as small in size. The average annual precipitation for a location is obtained using the 1993 map produced by the Oregon Climate Service, Oregon State University.

The determination of stream size using watershed area and annual precipitation may underestimate the size of some spring-fed streams in eastern Oregon. In cases where the watershed area and annual precipitation relationship clearly does not estimate a stream's size, the alternative process of using direct measure of stream flow will be used. Spring-fed streams have relatively uniform flow throughout the year. Therefore, direct measurement of flow at any time of the year except during late summer and early fall or during spring runoff would provide a reasonable approximation of average annual flow.

Direct measurement of flow involves determining both the velocity and wetted cross-sectional area of the stream. Velocity is best measured using a flow meter, but a rough estimate of velocity can be made by measuring the time it takes for a wood chip to float a distance downstream and applying a correction factor. The wetted cross-sectional area is commonly measured using a level, level rod, and measuring tape. Figure 2 can be used to determine stream sizes for various combinations of velocity and wetted cross-sectional area.

Before this water classification goes into effect, the department will develop maps for all forest lands in Oregon, showing the size classes for all streams. Streams and their classification will be displayed on 1:24000 scale USGS topographic maps. Copies of these maps will be available at department field offices and master maps will be updated and maintained at the Salem office.

Table 1. Drainage areas that represent the break points between small and medium and between medium and large streams for western Oregon.

WESTERN OREGON

Average Annual Precipitation (inches)	DRAINAGE AREA (acres)	
	Small / Medium 2 cfs	Medium / Large 10 cfs
30 or less	1510	7680
35	1180	5990
40	950	4830
45	790	4000
50	660	3370
55	570	2890
60	500	2520
65	440	2210
70	390	1960
75	350	1760
80	310	1580
85	280	1440
90	260	1310
95	240	1200
100	220	1110
105	200	1020
110	200	950
115	200	880
120	200	830
125	200	770
130	200	730
135	200	680
140 or more	200	640

Table 2. Drainage areas that represent the break points between small and medium and between medium and large streams for eastern Oregon.

EASTERN OREGON

Average Annual Precipitation (inches)	DRAINAGE AREA (acres)	
	Small / Medium 2 cfs	Medium / Large 10 cfs
15 or less	9930	39000
20	6000	23600
25	4060	15900
30	2950	11600
35	2250	8840
40	1780	7000
45	1450	5690
50	1200	4730
55 or more	880	4000

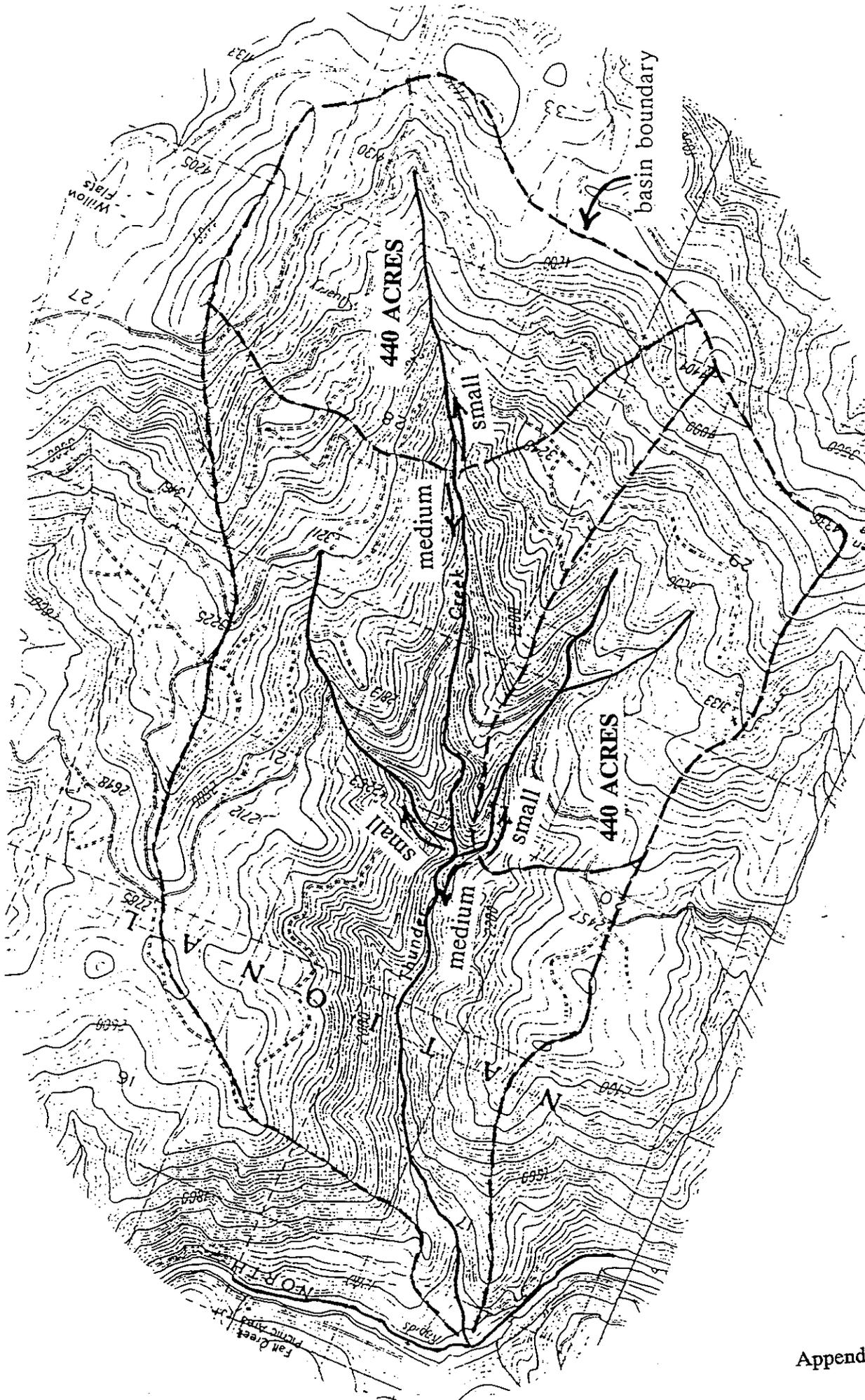


Fig 1. Example of basin boundaries that define small ar medium stream segments in a watershed. The average annual precipitation is 65 inches so stream segments draining less than 440 acres are considered small.

Relationship Between Velocity and Cross Sectional Area for Three Stream Sizes

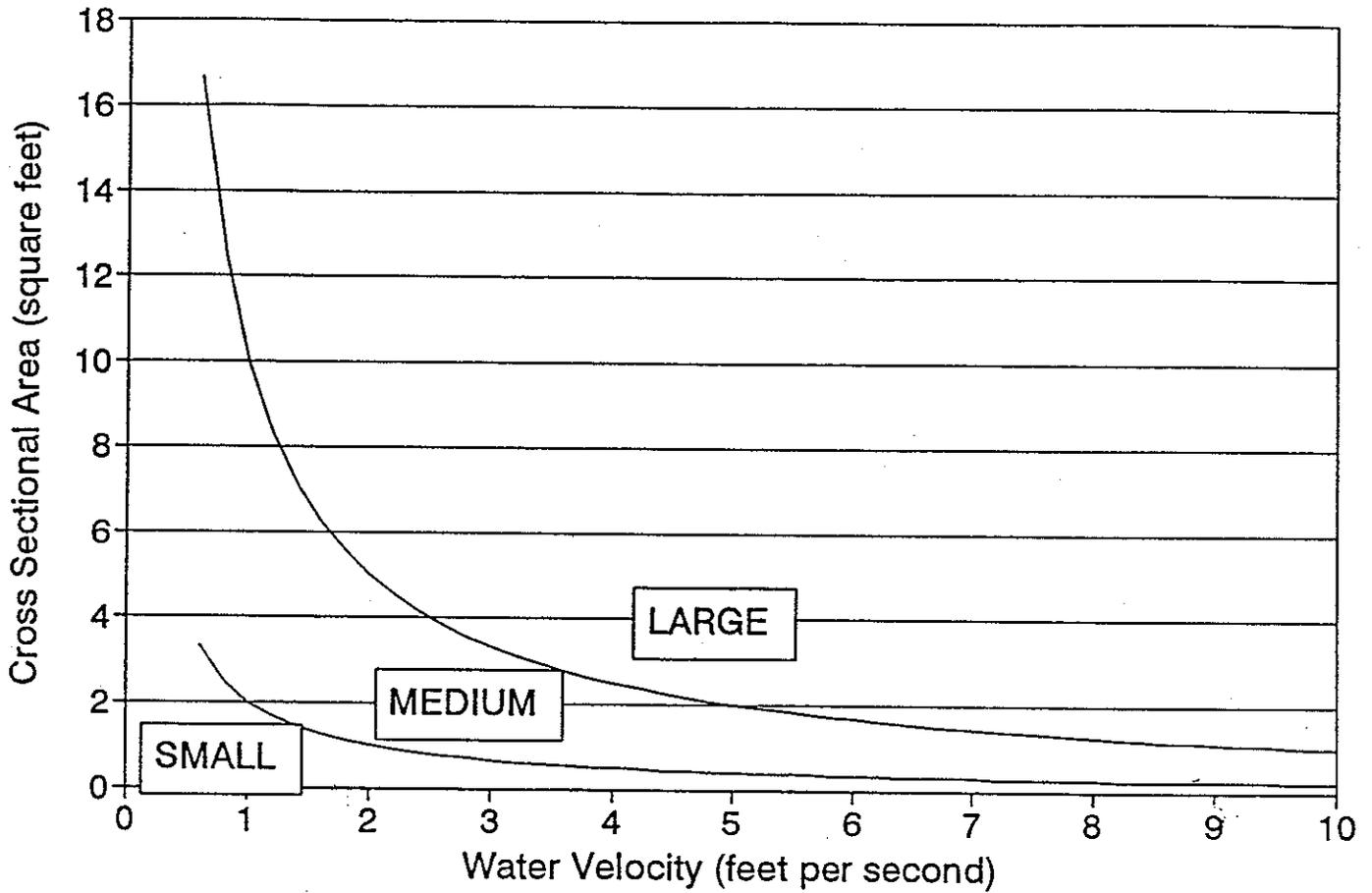


Figure 2. The relationship between stream velocity, wetted cross-sectional area, and stream size.

WETLANDS AND LAKES

Wetlands shall be classified further as indicated below:

The following types of wetlands are classified as "significant wetlands":

Wetlands that are larger than 8 acres;
Estuaries;
Bogs; and
Important springs in Eastern Oregon.

Stream-associated wetlands that are less than eight acres are considered to be part of the stream and are therefore classified according to the stream with which they are connected.

All other wetlands, including seeps and springs, are classified according to their size as either "other wetlands greater than one-quarter acre" or "other wetlands less than one-quarter acre."

Lakes shall be classified further as indicated below:

Lakes greater than eight acres are classified as "large lakes."

All other lakes are classified as "other lakes."

A lake is considered to have fish use if the lake is used by anadromous fish, game fish, or fish listed as threatened or endangered under the federal or state endangered species acts. Fish use can be either seasonal or year-round.

A lake is not considered to have fish use if fish were introduced through a fish stocking permit and there is documentation showing that the stream had no fish prior to stocking.