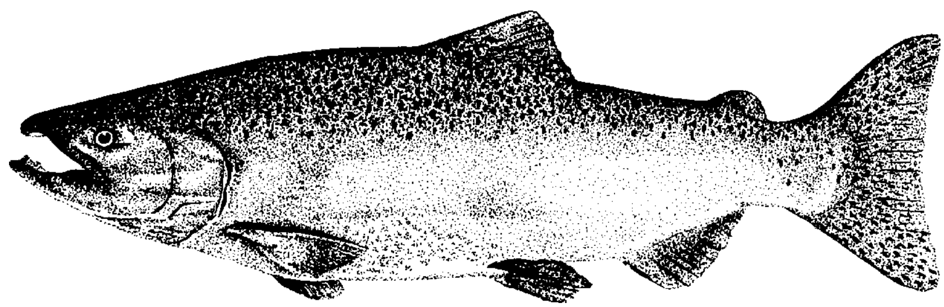
STATE OF WASHINGTON April 1997

Wild Salmonid Policy



Draft Environmental Impact Statement

April 15, 1997

Dear Reviewer:

We take pride in introducing, on behalf of our resource client — wild salmonids — this Draft Environmental Impact Statement for a Wild Salmonid Policy. We view this as an important step in the vigorous pursuit of healthy habitat conditions and wild salmonid fish populations.

Considerable work remains to be done on the policy and we need your help. This is a draft. We have identified and supported an agency recommended alternative but are not irretrievably wedded to its specific elements. Our minds remain open to more innovative approaches.

However, we do feel strongly that the deliberate overfishing of wild Pacific salmon populations must come to an end. While we concede relative inflexibility on this one point, better ways to get the job done may well come, via this process, from outside the Washington Department of Fish and Wildlife.

Get involved. Attend one of the 10 public meetings scheduled throughout the state.

Your interest in the resource is certainly appreciated. Your involvement in conservation of one of the Northwest's most unique resources is essential for future generations.

Sincerely,

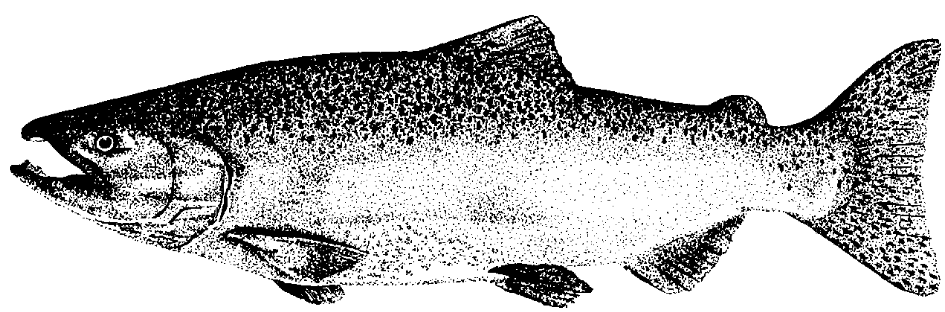
Bern Shanks, Ph.D.
Director

BS:SW:lsm

STATE OF WASHINGTON April 1997

Wild Salmonid Policy

Draft Environmental Impact Statement



Preferred Alternative Justification Statement

Recommended Alternative Justification Statement
Wild Salmonid Policy - Draft Environmental Impact Statement

Washington Department of Fish and Wildlife

1997

We conducted an examination of our ancestor agencies (WDW, WDF) in attempting to understand how we had become so integral a part of an acknowledged resource management failure. The resource management case histories of steelhead, sea-run cutthroat and resident trout evolved to relatively successful levels in the 1980s and these trends have carried over into the 1990s. Hatchery fish management zones never became a part of steelhead management because we correctly perceived the viable alternative of marking all hatchery fish. The ability of treaty Indian tribes to take their rightful share of the resource was not impaired by this change. Even the bull trout/Dolly Varden populations have shown improvements recently when managed under a strict conservation ethic.

The failure in resource management can be traced to Pacific salmon but even here the recent case histories of chum, pink and sockeye salmon show relative degrees of success. Management failure is deeply rooted in our chinook and coho salmon resources, the two species with huge hatchery programs and heavy fishery interceptions by other states and Canada.

It would be easy to join the popular 1990s trend of hatchery bashing, but the failure lies squarely in our inability to manage the mixtures of hatchery and wild fish. We did not have the foresight to perceive the viable alternative of marking all hatchery fish during a time frame when the change would have been relatively easy to implement.

Our federal government negotiated a poor treaty with Canada, based on our advice. We wanted it too badly. We knew from their annual management plans that the Canadians were willing to fish some of their own wild chinook and coho populations to extinction in order to get the type of treaty they wanted. We supported continued high Canadian catches of chinook and coho salmon despite warnings. Analysis at the time showed that the negotiated levels of catches could not be supported on a sustainable basis by the mixture of Washington fish and obviously depleted Canadian runs. We failed to realize that numerical catch limitations on Canadian and Alaskan fisheries also become catch guarantees to the same fishers. The normal year-to-year fluctuations in surplus production become accentuated in amplitude by the time Washington stocks become available for potential harvest by our own fisheries. The treaty should have been based upon percentage shares of annual surplus production.

We now know that achieving success in salmonid resource management will require major changes, especially for chinook and coho. We also know that to be successful overall, we will have to succeed in both fish habitat management and fish population management. We fully realize our lack of substantial authority in the first area. We attempted to identify the most critical elements which were mandatory for eventual success. Such elements simply have no viable compromise or fall-back positions. We believe that our recommended alternative best describes the recipe for success. No one in the agency wants to see their names added to the long list of personnel associated with resource management failures.

The Resource is Our Client

The documented case histories of fish resource management successes throughout the world share one common denominator. The people involved clearly recognized that the resource was their client. Alaskan salmon management has been an acknowledged success story under state management authority. Their primary objective is simple and the same for every fish population - put adequate numbers of viable wild fish on the spawning grounds.

It is no coincidence that the North Pacific Fishery Management Council has by far the best record of resource stewardship among all the regional councils. The basic conservation ethic established in managing foreign fisheries still carries over in today's domestic fishery management. These types of efforts also produce the best possible results for users of the fish resources. Having the resource as a manager's client is clearly in their best long-term interest.

When we examined case histories of management failures, there was also one common denominator. In each case, the officials responsible perceived something other than the resource to be their client. The federal government's classic failure of salmon management in Alaska was rooted in their capture by the fish processing industry. Potential production losses to this same group were of staggering proportions. In the Atlantic coast groundfish fishery, officials were far too anxious to immediately accommodate domestic fishermen recently freed from foreign competition pressures. The die was cast. The fish community changes now observed may well be irreversible. The less desirable species that were not heavily fished now dominate the ecosystem's biomass. The fishing industry may never quit paying for their unwarranted client status.

In our self-examination, we were forced to concede that the resource was not always our client in a myriad of past actions. In WDF, fisheries were often allowed to continue when we could not prove to someone's satisfaction that unwise use of the resource was occurring. We habitually cited benefits to certain user groups as reasons for our actions. For chinook and coho salmon, we have now failed to provide sustainable surplus fish production to these same groups.

We have failed to actively enforce long-standing fish passage and screening laws due to a perceived fear that the legislature would repeal the laws and/or eliminate our own budgets for these same services. In WDW, we often hypothesized that such actions would anger landowners. In retaliation, they would bar access to fishers/hunters and license sales would plummet. One example, the ever growing list of stream miles blocked to fish access by culverts (now nearly 3,000 miles), is ample testimony to the folly of our past actions.

We know that in order to be successful, the resource must be our exclusive client. Considerations such as loss of regulatory authority or budgets can no longer be factored into resource management decisions. We must also escape from our reactive behavior toward perceived threats such as the Endangered Species Act. Turf protection is not a character trait associated with competent natural resource managers. We can best serve future uses of salmonid fish populations - consumptive and non-consumptive - by having the resource as our client.

Eliminate Hatchery Fish Management Zones

Many wild chinook and coho salmon populations carry the nomenclature tag of "secondary protection." What this means in plain language is deliberate, planned overfishing designed to harvest co-mingled hatchery fish. The logical end point is genetic extinction of wild fish - the same result already achieved in fact for lower Columbia River coho salmon. In their case, heavy overfishing began in the early 1960s. Most of the other hatchery fish management zones in the state only date back to the mid- to late 1970s.

The so-called secondary protection is in fact non-existent in many cases or confined to fishing areas with only marginal attractiveness. Either way, nothing is in place to stop the inexorable push toward wild population extinction.

Agency employees cannot pursue successful fish habitat management in these same areas without compromising their professional integrity. Why should anyone incur tangible costs for protection of salmon habitat when fish population managers are not going to deliver viable wild fish to the same habitat?

We simply cannot afford to continue this transient practice of stop-gap origin that has outlived its usefulness and, on balance, now presents a preponderance of negatives.

Manage Hatchery Fish as Separate Species

It should be obvious to even the most casual observer that we cannot successfully manage any mixture of hatchery and wild salmonids as if they were a single homogeneous fish population. They really need to be managed by the same proven principles that you would use to manage separate species of fish. Steelhead and sea-run cutthroat have a better contemporary record of resource condition for one main reason - all hatchery-origin fish are marked by removal of their adipose fins. We must be able to clearly identify wild fish everywhere we observe them - on the spawning grounds, in catches, at hatchery racks, in fishways, and in juvenile populations. The steelhead/sea-run cutthroat prescription is the same one needed for chinook and coho salmon. Marking costs should be considered an essential component of hatchery production in the same manner as we treat feed, wages, repairs, maintenance, medicine, etc.

Killer Flood Flows

Salmonid managers see an emerging crisis at hand. More and more salmonid fish populations are showing cycle-to-cycle abundance fluctuations keyed to frequency and magnitude of peak flood flows. This includes many populations that were historically controlled by other environmental parameters. Where usable long-term records are available, streams are typically showing increasing trends in both frequency and magnitude of peak flood events.

Large woody debris that formerly created fish habitat now become destructive mobile battering rams. Thousands of formerly favorable egg incubation sites now have excessive bed load movements. In some cases, eggs are completely blown out of the gravel and lost. In others, bridging layers of fish redds are swept away, allowing fine sediments to clog the egg pockets. Juvenile fish are displaced from their normal winter refuge areas or eventually stranded away from the main stream channel. All of these types of calamities translate into considerably less fish after high flood flows. Populations are being forced to try and replace themselves on a sustainable basis under environmental conditions outside those of their evolutionary experience. We can only foresee these populations having greater difficulties in replacing themselves, much less continuing to produce surplus production for harvest. They will become our favorite cliche; i.e., “less productive.” This implies that the fish themselves are at fault.

The causes are obvious. In urban landscapes, where impervious surfaces continually proliferate, many streams now have several 100-year flood events each season. These streams will never have healthy salmonid fish resources, unless someone creates a prodigious new storm water retention capacity.

In the forested setting, many watersheds have too high a percentage of open canopy landscape, especially in rain-on-snow and unstable areas. Some of the problem can be traced to conversion of forest land to agricultural and residential use. These cleared areas essentially become permanent clear-cuts with respect to their effects on stream hydrology. When they constitute a significant percentage of any watershed, the chance to restore normal conditions is gone. However, a major source of flooding can still be traced to the forest itself. Is anyone willing to take a fresh, objective look at selective (uneven age) harvesting? Is the issue of spreading each watershed’s harvests out more equally from decade to decade still “off-the-table” in terms of even being considered by Timber, Fish and Wildlife? The thing we do know is that healthy salmonid fish populations and abnormally high peak flood flows will not occur in tandem.

Spawning Escapement Objectives

Every salmonid fish population has a definite correlation between parents and their progeny, commonly called a spawner-recruit relationship. Each has variability from year to year due to environmental factors and sometimes interactions with other species. Each is also limited in potential maximum population size by one or more environmental parameters. The fundamental approach on the Pacific coast is to try to take the maximum sustainable yield (MSY) that the relationship tells you will be available. Successful harvest management is attaining the proper balance between catch and escapement. Management is, by necessity, for a fixed numerical escapement objective since the environmental variation occurs after the escapement is made. It has a track record of success in many areas, especially Alaska and British Columbia.

However, we have often forgotten and/or ignored the basic scientific underpining of such relationships. The environmental variability that each population exhibits must have a trend line over time that is flat. If this is changing, then the population is moving toward or has reached a new relationship. The factors controlling maximum population size must also remain constant. If these change or are replaced by new limitations, then the original relationship is no longer valid. Finally, the spawner statistic must accurately reflect comparable egg potential values on a per fish basis. The next section will show that this is also changing over time for chinook and coho salmon.

All of the above leaves us with a great deal of uncertainty with respect to spawner-recruit relationships. One deviation from fixed escapement objectives (again for chinook and coho) was to use a range for escapements and sometimes a "floor." Proponents claimed that a range in data points would be generated, thus better defining the actual relationship. This was promoted under the "probing" element of adaptive management. Unfortunately, the details of this approach were ignored; i.e., the need for carefully planned, efficient fishery manipulation with a minimal loss of potential production during the acquisition of knowledge. In practice, efficient probing was subordinated to each succeeding year's perceived fishery needs. The accuracy of escapement numbers was also questionable. More recently, fishing rates became a new "solution" with some vague connection to acquisition of knowledge. It is significant to note that the "White Act" was a mid-course correction which failed to reverse the federal government's downward spiral in Alaska salmon stewardship. It mandated use of the fishing rate approach for management. In retrospect, these deviations were mistakes. We now have many more low escapements in population status records, with very little new insight into spawner-recruit relationships. In a conceptual sense, we have defaulted to more liberal fishing strategies when faced with higher levels of uncertainty. In the future, uncertainty and risk to the resource must be factored into the setting of escapement objectives. They must be more conservative (higher). This provides a positive incentive for gathering better information on each population. As uncertainty declines, harvest levels can be increased.

(**Note:** Recently the Department and the Western Washington Tribes have been moving toward a combination of fixed escapement goals coupled with fishing rates designed to meet wild population production capabilities. This approach, called “Comprehensive Coho” provides the benefit of a measurable escapement goal for streams where data are available, while the fishing rate would be chosen to provide escapement levels that provide ample escapement for other streams where the data are not available.)

Fishery Selectivity

Each salmonid species made many trade-offs during their evolutionary history. Chinook salmon went with the benefits of size and we have taken that away. Populations are younger, smaller and have a higher percentage of males than existed historically. Small three-year-old females were a minor component in the early 1900s when spawning and incubation flows were much more stable. The now abundant three-year-old females have an egg deposition depth capability that is about equal to the average scour depth in today’s rivers.

We know that hook and line gear as well as large mesh gill nets select the larger individuals from most chinook populations. When mixtures of mature and immature fish are present in marine waters, additional selectivity takes place since older fish are available for a longer period of exploitation.

Coho salmon are primarily three-year-old adults in the southern part of their range. Thus, the second type of selectivity does not occur. However, hook and line and gill net gear can continually select the larger individuals from coho populations. After decades of the same pressures, coho are right where you might expect; i.e., smaller, with less eggs and a reduced egg deposition capability. The problem of gear selectivity must be addressed in the future version of salmonid fish management.

Fishery Management Precision

A successful salmonid population harvest manager is best defined as someone who delivers the prescribed numbers of viable wild fish (or more) to the spawning grounds a high percentage of the time. The same manager will quickly detect situations when runs are markedly smaller then originally expected and close all fishing immediately. There is really no other meaningful quantitative criteria to separate success from failure in any harvest management track record. Alaska has many successful managers. They have field authority to enact fishing regulations and do not have to allocate fish between fishermen. Washington has its share of successful track records but these vary widely by time period, species and area. One contributor to the spotty record is placing the 50-50 catch allocation balance at a higher priority than achieving spawning escapement. Other causes of imprecision are not readily apparent. However, if spawning escapement is not accorded top priority and other sources of imprecision identified (and corrected) then management will have to become decidedly more conservative. The resource cannot continue to bear the risks of uncertainty. The risks must be shifted to the fisheries, beginning with lower harvests by those fisheries that are first in line. The risks from uncertainty must be carefully factored into each fish population management plan.

We resisted the temptation to list everything in our recommended alternative since this would imply that nothing is really essential for success. However, our short list is probably the most contentious selection possible. This was not done by deliberate intent, it just happens to be the truth. We do not honestly believe that salmonid resource management can be successful in the future without recognizing our true client, stopping deliberate overfishing, marking all hatchery-origin anadromous salmonids released in state waters, curbing high peak flood flows, establishing higher spawning escapement objectives, correcting fishery selectivity, and markedly improving our delivery of viable wild salmonids to the spawning grounds.

We must have a definitive wild salmonid policy <u>before</u> we can even begin to start sorting-out potential differences with the wide array of federal, state, tribal and local government entities which share salmonid resource management responsibility. We also need a policy to be able to interact effectively with our own Commission, resource user groups, private landowners, conservation organizations and the general public.

Many resident salmonid populations are not subject to shared population management responsibility or the sharing is with different entities than is the case for anadromous fish. Thousands of lakes, ponds and reservoirs have salmonid fish populations. For example, just the number of kokanee available for potential harvest in any given year probably exceeds the total for any one species of anadromous Pacific salmon. On a statewide basis, the total stream miles utilized by resident salmonids exceeds that used by anadromous fish. Two major anadromous fish production areas - the Columbia River basin below Bonneville Dam and Willapa Bay - do not have established treaty Indian fisheries. Two important anadromous fish resources - sea-run cutthroat and bull trout/Dolly Varden - do not support directed treaty Indian fisheries. The shared responsibility for steelhead is primarily between the WDFW and treaty Indian tribes. Pacific salmon shared responsibility includes the tribes but also managers from the federal government, Canada, Alaska, Oregon, California and Idaho.

When we get our own house in order, then we can begin dealing with everyone else on an honest, consistent basis.

FACT SHEET

Title and Description: Wild Salmonid Policy. The proposed Wild Salmonid Policy provides general policy guidance for the protection, management, and production of wild salmonid fishes (salmon, trout, char, grayling, and whitefish) in the state of Washington. It covers protection of salmonid habitats, protection and maintenance of population sizes, conservation of genetic resources, and other factors affecting the long-term survival and production of salmonids.

Proponent: Washington Department of Fish and Wildlife

Lead Agency: Washington Department of Fish and Wildlife

SEPA Responsible Official:
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Washington Department of Fish and Wildlife
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Permits and Licenses Required: None

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Issue Date: April 15, 1997

Date Comments are Due: May 30, 1997

Send Comments to:
Washington Department of Fish and Wildlife
Attn: Steve Phelps
600 Capital Way North
Olympia, WA 98501-1091
E-mail address: wildsal@dfw.wa.gov

Time and Place of Public Meetings or Workshops: Tentative schedule is provided in Table 2, page 7, of the DEIS.

Date Final Action is Planned: July 31, 1997
This date is subject to change based on the response to the DEIS

Background data materials referenced in this DEIS are available for review at:

Washington Department of Fish and Wildlife
Fish Management Program
Natural Resources Building, 6th Floor
1111 Washington Street SE
Olympia, WA

Cost: Copies of the DEIS are available to the public at no cost. For more information call (360) 902-2701.

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For additional information, if you have special accommodation needs, or require this document in an alternative format please contact: Steve Phelps at (360) 902-2701.

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Note: We have determined that, in order to curb excessive redundancy and improve clear presentation of alternatives and environmental analysis, a section specifically entitled "Summary" is not provided. Instead, we have fulfilled the same function and intent via utilization of the following:(1) providing an Introduction as Chapter I, (2) giving a narrative summary of the alternatives on pages 8 and 9 of Chapter II, and (3) showing comparisons of differences in the Alternative Summary Matrix, located at the end of the document for convenient reference.

LIST OF TABLES

LIST OF FIGURES

Background

The Problem

Do we want future generations to speak of salmon in the past tense or to be able to enjoy our salmonid runs as we and our parents have? Washington's salmon and trout populations are disappearing and the decline threatens the economic and social fabric of our Pacific Northwest society. Job losses, small business bankruptcies, and the resultant human effects are already occurring and more are anticipated. The quality of life to which our children have become accustomed and that attracts new business and growth to our economy is at risk. The ability of the state to meet treaty fishing rights is diminishing as harvests decline.

We are failing as stewards of our salmon and trout populations. A recent survey by state and tribal biologists found that less than half of Washington's salmon and steelhead stocks were healthy. Other recent reviews of the status of Washington salmon and steelhead stocks reinforce the finding that we are losing unique stocks of salmonids (Huntington et al. 1994 and Nehlsen et al.1991).

Some salmon populations, collectively symbol a quality of life in Washington, have been listed under the Endangered Species Act (ESA) and more stock listings are expected. The regulatory effects of the ESA for salmonid recovery are likely much greater than already felt for the spotted owl because of the larger geographic area involved. New businesses thinking about locating in Washington will have to consider the additional regulatory requirements and uncertainty arising from ESA listings before they make their decision.

Much of the available salmon habitat in Washington has been lost in the last 100 years. In a recent speech the Commissioner of Public Lands, Jennifer Belcher, noted that 4 - 5 million acres of land has been deforested in Washington; over 35% of natural forested areas in Puget Sound are gone. She also noted that we are losing 2,000 acres of wetlands each year. The Department of Fish and Wildlife estimates that at least 30,000 acres of fish and wildlife habitat are lost each year and another 100,000 acres of habitat is being degraded each year. Over 600 water bodies are listed on the Environmental Protection Agency 303(d) list as impaired or threatened compared to Clean Water Act standards. Needless to say it is a real challenge to reverse the trend of habitat loss given the projected population growth in Washington of an increase of 2.7 million people by the year 2020.

Coastal communities like Sekiu, Neah Bay, La Push, Westport and Ilwaco, some already hard hit by the decline in timber, have been struggling with the economic disasters caused by the fishery closures. In 1994, six counties in Washington were declared economic disaster areas from fishing closures; the estimated impact to the counties was over $50 million in one year. Slightly more than $15 million of federal disaster relief funds were made available. Small businesses such as fishing resorts, marinas, bait shops, commercial fishing operations, fish buyers, boat builders, and charter fishing offices are gone or in severe financial straits. Local governments that depend upon fishing industry related revenues are having to reduce services at the very time their residents need these services.

The causes of declining salmon and trout populations are many; habitat loss, overfishing, poor ocean survival conditions, unwise hatchery practices, institutional gridlock, lack of

The Wild Salmonid Policy and the Endangered Species Act

The Wild Salmonid Policy (WSP) Goal does not speak directly to the potential implications of the Endangered Species Act (ESA). Clearly the listings of several Snake River stocks, the proposed listing of steelhead in the Columbia River, the decision that listing of bull trout is warranted, and the current review of petitions for listings of other stocks and species suggest that the ESA has the potential to be an important factor. Several reviewers during the scoping process suggested that an important goal of the WSP ought to be avoiding listings under ESA. Avoiding listings under ESA will be an important result, because it means we have been successful in keeping stocks from the brink of extinction. However, avoiding ESA listings will not meet the broader goal of the WSP. The ESA is implemented when stocks or species are on the road to extinction, and the purpose is to keep them from becoming extinct. The goal of the WSP is much more than that. Our goal is not only to keep stocks from going to extinction, but to maintain them at healthy levels that can provide a variety of harvest, cultural, ecological and other benefits. The WSP goal avoids the ESA problem by maintaining stocks at levels well above ESA criteria.

Implementing the WSP guidelines for those stocks that are currently healthy will keep them from becoming part of the ESA process. The policy guidelines are designed to address the issues of abundance, survival, and productivity that have been raised in ESA reviews. At the same time we must develop recovery and restoration programs for those stocks that are currently at risk. Using the guidelines of the WSP we can rebuild stocks so that we exceed the criteria for ESA, and then go on to build healthy stocks that provide the variety of benefits that we desire.

coordination and accountability, unrealistic expectations of technology, and many others.

The Answer

Fortunately, salmon and trout are very adaptive and have incredible survival skills, and our efforts to protect them have been successful for many stocks. The goal of restoring salmonid populations to levels that not only ensure their perpetuation but allow for sustainable fisheries can be achieved if we commit to protecting existing healthy stocks and their habitats, and work to recover the other stocks and their habitats. Washington may look different than it did a hundred years ago, but we can restore healthy sustained salmonid runs if we can maintain healthy natural processes in our watersheds and marine environments.

A recent survey of public opinion indicates there is widespread public support for fish and wildlife in Washington. Approximately 85% of respondents said that wildlife related activities are an important part of their life and 75% said they would support an annual tax increase of up to $100. It is clear the public is willing to support salmonid protection.

State and tribal leaders anticipated the problem and in 1992 began the Wild Stock Restoration Initiative, a strategic plan to rebuild salmon and steelhead stocks. An inventory of salmon and steelhead stock health, the initial component of the strategic plan, was completed in 1992. An inventory of habitat status is scheduled for completion later this year.

Table 1. Salmonid fishes of Washington State.

Name	Scientific Name	Origin
Cutthroat Trout[1]	*Oncorhychus clarki* (Richardson, 1836)	Native
Rainbow Trout[1]	*Oncorhychus mykiss* (Walbaum, 1792)	Native
Bull Trout[1]	*Salvelinus confluentus* (Suckley, 1858)	Native
Dolly Varden[1]	*Salvelinus malma* (Walbaum, 1792)	Native
Chinook Salmon	*Oncorhynchus tshawytscha* (Walbaum, 1792)	Native
Chum Salmon	*Oncorhynchus keta* (Walbaum, 1792)	Native
Pink Salmon	*Oncorhynchus gorbuscha* (Walbaum, 1792)	Native
Coho Salmon	*Oncorhynchus kisutch* (Walbaum, 1792)	Native
Sockeye Salmon[1]	*Oncorhynchus nerka* (Walbaum, 1792)	Native
Atlantic Salmon	*Salmo salar* (Linnaeus, 1758)	Exotic
Brown Trout	*Salmo trutta* (Linnaeus, 1758)	Exotic
Golden Trout	*Oncorhynchus aguabonita* (Jordan, 1893)	Exotic
Brook Trout	*Salvelinus fontinalis* (Mitchill, 1814)	Exotic
Lake Trout	*Salvelinus namaycush* (Walbaum, 1792)	Exotic
Arctic Grayling	*Thymallus arcticus* (Pallas, 1776)	Exotic
Pygmy Whitefish	*Prosopium coulteri* (Eigenmann & Eigenmann, 1892)	Native
Mountain Whitefish	*Prosopium williamsoni* (Girard, 1856)	Native
Lake Whitefish	*Coregonus clupeaformis* (Mitchill, 1818)	Exotic

[1] Includes both freshwater and anadromous forms (e.g., rainbow trout, steelhead, and kokanee, sockeye.

A number of success stories already exist such as the White River spring chinook restoration program and numerous other stock recovery initiatives have been started. These range from family projects on local streams, to watershed or regional scale plans through the Timber, Fish and Wildlife forum. Participants have included people from across the state; while many of the projects have been successful, more is needed to achieve our goal.

A state wild salmonid policy that serves as a foundation for recovery is critical; one that has a strong scientific foundation, that identifies what wild salmonids need, and that establishes a balanced and flexible template upon which plans and actions can be based. This policy linked with the stock and habitat status information will form the foundation for the Wild Stock Restoration Initiative.

Scope of Policy

The different species of salmonids currently found in Washington State waters are listed in Table 1. It is very difficult to separate out just one group of fish without recognizing that they are part of a larger interconnected system. There can be a great deal of interaction between native and non-native species and stocks, between hatchery and wild fish of the same species, and even between salmonids, other fish species, and non-fish species including ourselves.

The wild salmonid policy will apply to all salmonids found in Washington State, regardless of origin and includes linkages to other non-salmonid and non-fish species. This policy establishes priorities for salmonids that must be balanced with priorities for other native fish and wildlife species.

Priorities

Priorities between salmonids, other non-salmonid fishes, and non-fish species are sometimes needed (see Appendix A).

General Policy Guidelines

- ➤ Protection of native stocks/species and their sustainable natural production will be emphasized, especially where conflicts with non-native species and stocks occur.
- ➤ Stocks that are threatened or endangered have a higher immediate priority than healthy stocks or species.
- ➤ Stocks or species with higher ecological, cultural, or economic value should generally have a higher priority than stocks or species of lower value provided both remain self-sustaining populations.

The question remains whether we should look at a general or more specific policy approach to these issues, particularly in those instances where habitat has been lost or is no longer useable.

We would like to hear your ideas. Some options are presented here:

- ➤ The maintenance of individual populations will have the highest priority. Where they are in danger of loss, all steps should be taken to protect them and maintain them at a level that insures basic survival needs at a minimum.
- ➤ No effort should be invested in those places where maintenance of wild salmonid populations is no longer possible due to changes in the habitat. We should concentrate on populations where the outlook is more positive.
- ➤ Little effort should be invested in places where all opportunity has been lost. Emphasis should be on those populations that have long-term potential to generate significant sustainable harvest and other benefits.

Treaty Fishing Rights And Cooperative Management

Washington's treaty tribes play a unique role in the management and protection of the wild salmonid resource. Salmonid fishes historically have played an important role in native culture and religion in the northwest. Important Treaty fishing rights include:

- ➤ the tribes have the right to take up to 50% of the harvestable fish;
- ➤ hatchery fish are included as part of the harvestable share;
- ➤ each party has the ability to decide how they want to use their share, provided it does not impair the other party's opportunity;
- ➤ the state cannot directly restrict treaty harvest except for conservation, including a need to constrain non-treaty fishing first.

Note: The treaties do not constitute a grant from our federal government, but are a reservation of rights not ceded to the federal government by the tribes when they ceded their land.

The courts have considered, but not determined, whether there is a treaty based obligation on the part of the state to protect the habitat necessary to maintain the fish runs. Several decisions, however, have noted that a treaty right to fish may have little meaning if there are no fish to catch.

Nothing in the Wild Salmonid policy is intended to diminish treaty fishing rights. In fact, one of the desirable outcomes of the policy will be to better meet treaty obligations by providing healthy future salmonid populations.

Policy Goal

The goal of the Wild Salmonid Policy is to protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries; non-consumptive fish benefits; and other related cultural and ecological values.

Policy Development Process

The 1993 Legislature affirmed the need for a wild salmonid policy by enacting Second Engrossed House Bill 1309 which states:

"By July 1, 1994 the departments of fisheries and wildlife jointly with the appropriate Indian tribes, shall each establish a wild salmonid policy. The policy shall ensure that department actions and programs are consistent with the goals of rebuilding wild stock populations to levels that permit commercial and recreational fishing opportunity".

The State Environmental Policy Act process is being used to ensure full public input into the policy development. Key steps in the policy development process have been:

- A scoping notice sent to more than 600 individuals and interested groups in 1993.
- A Draft Scoping Paper for A Wild Salmonid Policy in May 1994 that was distributed to 1,200 citizens and groups.
- Passage of Referendum 45 (and its implementation in July 1996) clearly empowered the Washington Fish and Wildlife Commission to, in part, develop a Wild Salmonid Policy.

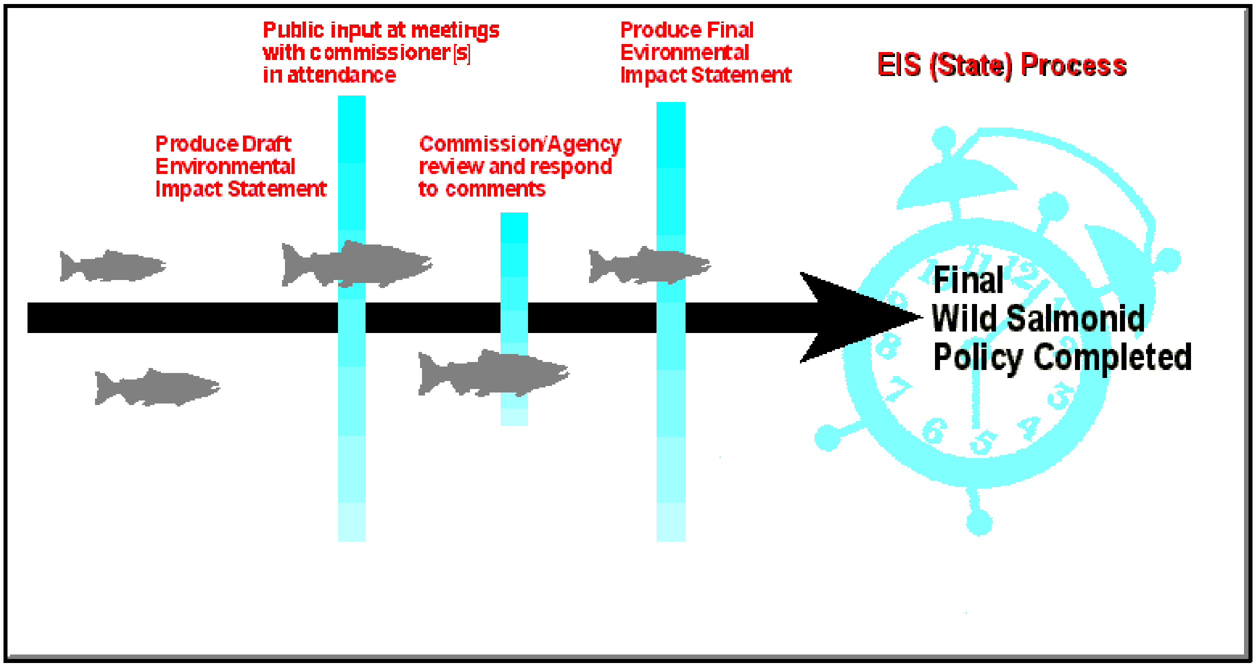
This document, the Draft Environmental Impact Statement, presents five options for public review that have been crafted from comments received from scoping. Public meetings throughout the state will be held in the presence of one or more Fish and Wildlife commissioners to hear citizen comments. Comments may also be provided in writing. Information from the public meetings and comments will be used to guide state policy leaders. Full implementation of the Wild Salmonid Policy will require the agreement and cooperation of tribal governments.

A final Environmental Impact Statement will be completed shortly after this DEIS is distributed.

Implementation Considerations

This DEIS is not an implementation document. It provides a range of alternatives for public comment. Where the resource is healthy, we need to protect it. Protecting the habitat and fish populations we have is much easier than rebuilding or recreating it once we have destroyed it. Where the wild salmonid resource has been lost or degraded, we need to restore and rebuild it so the important benefits of the salmonid resource will be available. Success will require both protection and restoration.

The lack of clear implementation prescriptions, guidelines, measurable objectives, and other planning tools is troubling to some reviewers. A number of reviewers requested detailed cost estimates, requirements for legislation, needed rule or regulation changes, and other detailed information be included in this DEIS. In general, we will not be able to provide this kind of



detailed information at this stage in the process. While we have made some specific attempts in past case studies to look at how the policy might be implemented, we can only guess at the full range of implementation approaches that might develop in specific watersheds. Until those strategies are developed, many of the specific cost estimates will not be available. We are striving to work within the framework of regulatory reform. Partnerships, local initiatives, voluntary approaches, and cooperative ventures are preferable to additional regulations in meeting the policy goals.

The other key feature is that implementation will be a process and not an endpoint. Implementation of some elements, in some watersheds, will occur immediately and with little fanfare. In many places the current approaches are making progress and meet most or all of the performance measures described in this report. In other places implementation will take much longer, requiring time, effort, and resources to answer the difficulties that some of our stocks currently face. As a result, it is difficult to predict all of the possible short-term outcomes along the way. In looking at the outcomes of the policy we focused on long-term outcomes of achieving the policy.

This framework policy will guide development of recovery plans required by the ESA, state and tribal fish management plans, local watershed plans, and even local land use plans.

Policy Exclusions

New ideas, scientific discoveries and data from monitoring and evaluation efforts are likely to suggest improvements.

What You Can Do

You can become involved by reviewing this DEIS and providing your ideas on the different options. There will be at least ten public meetings (see Table 2) around the state or the comments can be made in writing.

Citizens can also become volunteers; there are many volunteer opportunities through local and state governments, in addition to many other non-profit organizations or groups. For information on state volunteer programs please call Steve Jenks at (360) 902-2260 or Kent Dimmitt at (360) 902-2237. Another important way for citizens to become involved in salmonid protection and recovery is to be active in communicating with state and local government elected-officials and agency staff members. State legislators can be contacted at 1-800-562-6000.

Table 2. A list of locations and times for public input on the DEIS.

City	Location	Date Meeting Times - 7:00-9:00 p.m.
Eastside		
Spokane	Spokane Co. Public Health District Building Auditorium West 1101 College (south of County Courthouse)	Tuesday, April 29
Walla Walla	Walla Walla Community College Main Building Cafeteria 500 Tausick Way	Wednesday, April 30
Yakima	First Savings of Washington Meeting Room 502 W. Yakima Ave.	Thursday, May 1
Wenatchee	Chelan County Auditorium 400 Douglas Street (corner of Douglas & Washington across from county courthouse)	Tuesday, May 6
Westside		
Bellingham	Bellingham Public Library 210 Central Avenue	Wednesday, May 7
Port Angeles	Vern Burton Center 308 E. Fourth Street (corner of 4th and Peabody)	Tuesday, May 13
Tacoma	Tacoma Mountaineers 2302 North 30th	Wednesday, May 14
Vancouver	Clark Co. Public Utility Dept. Community Room 1200 Ft. Vancouver Way	Thursday, May 15
Tumwater	Dept. Labor and Industries 7273 Linderson Way SW	Tuesday, May 20
Seattle	Mountaineers 300 3rd Avenue West (6 blocks west of Space Needle off Elliot Ave.)	Wednesday, May 21

Please address written comments to:

Washington Department of Fish and Wildlife
Attn: Steve Phelps
600 Capital Way North
Olympia, Washington 98501-1091
E-mail address: wildsal@dfw.wa.gov

Comments must be received no later than May 30, 1997.

Five alternative policy approaches are presented for your consideration. Each includes a different combination of ideas for habitat, spawner abundance, genetic conservation, ecological interactions, harvest management and hatcheries to achieve healthy sustained salmonids stocks. Detailed technical information on each of the above key elements is presented in the Appendices. Readers are encouraged to carefully review the information presented in the appendices. These options may represent different levels of risk to stock health and harvest, or different implementation approaches (especially for habitat).

An alternative summary matrix is provided at the end of the document. It is possible to construct other alternatives using different arrangements of the options. A more protective approach from one element may be combined with a less protective approach from another. Reviewers may want to suggest different combinations of the options from those in the following alternatives:

A. Alternative 1 (Status Quo) - Currently wild salmonid management varies by species and location; generally wild stocks are managed individually or in aggregations (management units) for maximum sustained yield (MSY), or in a secondary status to hatchery or mixed-origin stocks. There is no formal policy to protect wild stock in secondary status. There are, with the exception of fish transfer guidelines and spawning protocols, no formal policies addressing genetic conservation, ecological interactions and supplementation. A patchwork of regulations, plans, and programs directly or indirectly provide salmonid habitat protection; some are statewide and some are limited to local jurisdictions.

B. Alternative 2 - This alternative places the greatest emphasis on protection of stock health. This alternative seeks to avoid negative impacts to stock and ecosystem health wherever possible. Harvest opportunity is clearly secondary to resource protection and would be very limited in mixed stock fisheries, but moderated somewhat by selective fishing methods. The use of hatchery fish would be strictly controlled. Habitat protection and restoration would occur through a fairly rigid, state-prescribed package of performance standards and action strategies.

C. **Alternative 3 is the agency's <u>recommended alternative</u>. The Fish and Wildlife Commission has not taken a position on its preferred alternative but did request the agency (Washington Department of Fish and Wildlife) to indicate which alternative it would recommend.**

   Alternative 3 -This alternative places slightly less emphasis on stock health. Harvest opportunity is still clearly secondary to stock and ecosystem health issues but would be greater than for Alternative 2. This alternative would accept some negative ecological impacts as long as they do not significantly impact stock or ecosystem health. There would be more flexibility in hatchery practices than Alternative 2. Habitat protection and restoration would occur through locally based watershed planning that would have the flexibility to adapt the performance measures and action strategies to local conditions with the implication of regulatory default.

D. Alternative 4 - Harvest opportunity takes on a greater role in Alternative 4. There is a clear commitment to long-term stock protection, but at levels of risk that are higher than Alternatives 2 and 3. This provides greater flexibility and opportunity for harvest and hatchery practices than Alternative 3. Habitat protection and restoration would be similar to that in Alternative 3 except that it would include performance <u>standards</u> as opposed to <u>measures</u>, and implementation would include a mix of regulations and locally-based plans.

E. Alternative 5 - Alternative 5 takes a less prescriptive approach, deferring the specifics of many management issues. This alternative accepts the largest negative impact on stock health; some individual stocks would be managed to levels immediately above the level of permanent harm. There is a much greater emphasis on flexibility to provide harvest and other opportunities, though there is a continuing commitment to stock protection. This alternative allows the greatest use of hatcheries as long as local stocks are used. Habitat protection and restoration would occur through existing and new forums using fairly general performance measures and optional action strategies.

Alternative 1 (Status Quo)

Alternative 1 is status quo. You will see that a wide number of approaches are used for different species, or in different places. These are approaches that have evolved over time in response to a variety of needs and issues. They continue to evolve and change in response to new information and ideas.

<u>Current Habitat Management Approaches</u>

A more detailed discussion of habitat is presented in Appendix C.

There are a myriad of laws and actions we can apply to solve our wild salmonid dilemma. Indeed, our actions have improved significantly over the last 20 years. Forest practices, for example, now employ "watershed analysis." This tool assesses salmonid habitat condition on state and private forest lands, determines the likely impact of proposed forest practices, and develops prescriptions designed to protect instream resources while allowing certain levels of forest practice activities. The Growth Management Act (GMA) couples land use and zoning with protection of critical areas including salmonid habitat. It has brought some improvement in habitat protection. These are important steps and should continue. However, without continued modification and significant improvement of the state's habitat management programs, salmonid habitat will continue to decline in productive capacity, leading to the loss of more wild salmonid populations.

A patchwork of government programs, regulations, and plans (see Table 3) affect land use that directly or indirectly protect salmonid habitat. There are also non-regulatory programs that provide technical assistance or financial assistance for stewardship practices. There is also a growing number of volunteer efforts to restore salmonid habitat.

These regulatory programs limit one or more aspect of the use of land or water. Any one project may be subject to a multitude of requirements from the listed programs. Some of the programs prescribe specific processes (e.g., SEPA, NEPA, GMA), others require specific permits, and some both (e.g. Shoreline Management Act). The permits frequently have different time requirements , sometimes even contradictions, and getting required permits can last several years for major projects. There are no

Table 3. Representative state, local and federal programs affecting land use in Washington.

Programs/Plans/Regulations	Geographic Scope
Local ordinances and zoning regulations	Limited to local jurisdictions
Shoreline Management Act	Statewide
State Environmental Policy Act	Statewide
Puget Sound Water Quality Plan	Broad, limited to Puget Sound
National Environmental Policy Act	Statewide
Planning under the Growth Management Act	Limited to high population cities and counties
Floodplain management plans	Limited to some local jurisdictions
Forest Practices Act	Statewide
Clean Water Act	Statewide
Federal Emergency Management Act	Statewide
Surface Mining Reclamation permit process	Statewide
Northwest Power Planning Act	Statewide but emphasis in Columbia River
Requirements under the National Pollution Discharge Elimination System (NPDES)that controls discharges of water into streams and rivers	Statewide
Hydraulic Project Approval Act, trust water right and water quality management programs	Statewide
Army Corps of Engineers requirements	Statewide
Federal Energy Regulatory Commission licensing and other hydropower approvals	Statewide
Local watershed plans	Some local watersheds

consistent, coordinated, statewide goals, performance measures or action strategies.

Current Management Approach for Spawner Abundance

A more detailed discussion of spawner abundance is presented in Appendix D.

Salmon and Steelhead

Salmon and steelhead management occurs through a variety of forums and has undergone substantial improvements over the last 20 years. Single species management has been replaced by separating species into populations or groups of populations (management units). For example, prior to the late 1970s ocean fisheries were allowed without assessing the fishery impacts on the management units used today. Annual negotiations with Canada and Alaska now occur through the Pacific Salmon Treaty process. The Pacific Fishery Management Council sets seasons and quotas for salmon in the ocean outside 3 miles. Washington is required to have comparable or more restrictive regulations in inside waters to complement the PFMC harvest scheme. Fisheries in the Columbia River are designed through the Columbia River Compact, a forum where the states of Washington and Oregon plan fisheries in concurrent waters of the Columbia River. Finally, there are many court orders and management plans that are used to design fishery plans by state and tribal fishery managers.

Most salmon and steelhead populations are managed for a fixed escapement goal intended to provide maximum sustained yield (MSY) to fisheries. In practice, the MSY level is usually unknown, and the desired escapement levels have been set by a wide variety of methods depending on the amount and types of information available.

Steelhead are managed on a river/stream basis, which may include either single or multiple stocks. Puget Sound, coastal, and Lower Columbia River desired spawner abundance levels were set for most streams using a habitat availability and optimal utilization approach developed in 1985 (Gibbons et al. 1985). The intent of this method was to provide for MSY level escapements. In smaller rivers and streams with limited habitat information, steelhead spawner abundance goals are set using historical average harvest rates or catches.

However, because the technique looks at total habitat availability, it includes both summer and winter steelhead where they occur in the same system. Ratios have been developed from harvest and escapement statistics and are used to design fisheries.

The Green River summer steelhead run is an exception to this wild escapement based approach because it is a naturalized hatchery run, and no wild goal has been set.

Escapement goals for steelhead spawning in the Columbia River above Bonneville Dam were established as part of the Columbia River Fish Management Plan. These goals are based on historical run levels and counts at various Columbia River dams.

Management plans that result in escapements above the goals are encouraged, consistent with treaty allocation requirements and recreational fishing needs.

While most steelhead runs are managed on a multi-stock basis, it is common to manage at the stock level. Where individual stocks are not going to meet their goals, the recreational fishery will often be limited to selective fishing directed at hatchery fish. In other cases, fishing on individual weak stocks will be closed completely.

Typically, only wild steelhead are counted towards meeting the escapement goal. In most areas hatchery fish spawn before the wild fish and are not included in escapement estimates. All hatchery steelhead are marked so that they can be identified, making the separation of hatchery and wild fish highly accurate.

Most steelhead populations are monitored for spawner abundance on a yearly basis. This is especially true of populations that are fished by both tribal and recreational fishermen. Smaller populations, and populations that are fished less heavily, are monitored less often.

Salmon management is currently organized around “management units.” Management units often include fish returning to a single river system, though in some areas a management unit includes several river systems (e.g., south Puget Sound coho, Hood Canal coho and chum, Nooksack/Samish chinook). Management units are split into either primary or secondary. Primary management units have an established escapement goal and an intent to meet it on an annual basis. Primary management units can be either hatchery fish or wild fish. Wild salmonid management units have an escapement goal based on the production needs of wild fish. Hatchery management units have escapement goals based on the needs of the hatchery production. Management units that are not primary units are called “secondary management units” and are discussed further below.

A variety of approaches were used to set salmon escapement goals. Some, like steelhead, are based on available habitat. Puget Sound wild coho escapement goals are based on the amount of rearing area at the time of late-summer low stream flow (Zillges 1977). The optimal smolt production potential of this habitat was calculated using appropriate data from the fisheries literature, since little work specific to Puget Sound streams was available. The number of adults needed to produce these smolts was based on MSY estimates from studies on Minter Creek, a tributary to south Puget Sound. A number of specific adjustments have been made as better information has become available, but the basic approach is the same.

The approach for coastal coho is similar, except there was less certainty about the optimal production rates for the habitat. In this case, a range of production rates is applied to the habitat. The result is an escapement range, rather than a single number. The range is expected to include the MSY level. For example, the escapement range for Hoh River coho is 2,000-5,000 adults. As a series of escapements occur throughout this range, it is hoped enough data will be collected so the range can either be narrowed or an MSY escapement selected. In the meantime, the range provides flexibility to fishery management.

Another approach to salmon escapement goals is historical utilization. In this case, a time period when escapements were felt to be appropriate was selected to represent proper escapement levels. This approach was used for Grays Harbor chinook; Willapa Bay and Grays Harbor chum; and a number of Puget Sound pink, chum, sockeye, and chinook salmon stocks. At this point, no attempt is made to relate these values to MSY or other standards. They simply represent a “reasonable” utilization of the available habitat.

The Puget Sound chum goals have been further refined to reflect the much lower numbers of chum that return and spawn in odd years, compared to those that return in even years. This is likely due to interactions with pink salmon, which spawn only in the odd years. Depending on the stock, the odd year escapement goal for Puget Sound chum ranges from 26% to 100% of the escapement goal in even years.

Another approach is used for north coastal chinook. Rather than setting an escapement number, a terminal harvest rate was chosen. This harvest rate is used unless the escapement will be below a floor value. The result is a sliding escapement goal that increases with increasing run sizes. The floor value was chosen to be near the lowest escapement the stock had experienced, with the presumption that the stock had already shown an ability to survive and recover from escapements at that level. One of the intended objectives of this approach was to generate information about a range of escapements that can be used to determine the optimal level. A harvest rate approach is now being actively discussed for future statewide coho management.

Hatchery escapement goals are based on the size of each planned hatchery program, information on the number of eggs per female, sex ratios, and typical survival rates.

All management units that are not managed as primary units are secondary management units. They have been given secondary status as a way of increasing benefits from primarily stocks in mixed-stock fisheries that contain populations of different productivity. There is no formal policy to address the needs of wild stocks in secondary status; these stocks can drop below minimum levels required for maintaining genetic diversity.

For example, the primary unit is most often a hatchery population and the secondary unit is a wild population. One example is south Puget Sound hatchery and wild coho. The wild coho population in south Puget Sound is relatively small compared to the much larger hatchery program. The hatchery fish can be harvested at a much higher rate due to the protection they receive while growing in the hatchery. Fishing at the lower rate required by the wild fish could result in an overall loss of catch. However, fishing at the higher rate allowed by the hatchery fish means the wild fish are typically depressed, placing them at greater risk of permanent harm. Other examples are Hood Canal hatchery and wild chum, Willapa Bay hatchery and wild coho and chinook, and lower Columbia River hatchery and wild coho and chinook. A slightly different example is wild Hood Canal coho as the primary management unit while wild Hood Canal summer chum are the secondary unit.

Managing for the wild stock usually means lower fishing rates and a greater likelihood of a healthy wild stock. It also results in surpluses at hatcheries. Examples include coho in Grays Harbor and the Quillayute and Skagit rivers, and summer/fall chinook in the Lake Washington and Duwamish River systems.

Secondary management units may or may not have defined escapement goals. Direct management actions for secondary stocks are typically limited, but there is an intent to achieve goals where possible. The actual escapement level that is achieved for secondary stocks depends on (1) the amount of fisheries overlap in time and space with primary management units, (2) susceptibility to the same types of gear (e.g., similar size for harvest in gill nets, tendency to bite on hook-and-line gear), (3) the level of harvest of the primary management unit, and (4) opportunities and concern for actions that will provide additional protection or harvest of the secondary run. These additional actions include specific area closures, supplementation, or reliance on hatchery straying to augment natural reproduction. For example, extra steps have been taken the last few years to reduce catches of summer chum during the Hood Canal coho fishery. Where the secondary units separate from the primary units in terminal areas, specific management actions are often taken.

In general any salmon spawning in the wild are counted towards meeting the escapement goal. Meeting numeric wild escapement goals may be a misleading indicator of management success if most of the naturally spawning fish are of hatchery origin. For example, a majority of the spawners in many hatchery managed systems had hatchery raised parents. Some examples are Willapa Bay, lower Columbia, and Green River chinook and coho. Only a small portion of the hatchery salmon have been marked, making identification of hatchery and wild fish more difficult.

Fishery managers currently make fishery decisions based on the status of slightly more than 100 primary management units for salmon and steelhead stocks.

Most salmon management units are monitored for spawner abundance every year. Individual stocks are monitored in some cases, depending on the specific estimation techniques used. Smaller independent tributaries may not be monitored. No formal accountability for meeting escapement goals is required except that the Pacific Fisheries Management Council does require a report on the causes for not meeting escapement goals for some key stocks that are consistently below goals.

Resident and Other Anadromous Salmonids

As with salmon, there are both hatchery and wild managed resident populations. In general, the escapement approach for wild managed populations is contained in *A Basic Fishery Management Strategy for Resident and Anadromous Trout in the Stream Habitats of the State of Washington* adopted in 1986 (WDG 1984). While it is informally called the "stream management strategy," the basic approach is also applied to some lake and reservoir systems. The goal of the strategy is to "allow a majority of females to spawn at least once before being subjected to a directed harvest." It is the general opinion of WDFW staff that this strategy results in spawning populations at or above the MSY level. This is supported by Johnson and Bjornn (1978). This approach is used for the vast majority of stream dwelling resident populations and in some of the larger lake systems that historically had native salmonids.

The widespread introduction of exotic species (e.g., carp, bass, bluegill, and pumpkinseed) in our lakes in the early 1900s is believed to have decimated many native resident populations. As a result, numerous other resident populations are managed on a hatchery basis. This applies primarily to lake and reservoir populations, some of which support self-sustaining wild populations and many that do not. This latter category includes many of the lowland lakes in western Washington and many of the lakes in eastern Washington that are man-made or have large populations of warmwater fishes. There are also limited instances where hatchery management is used in streams, typically in localized areas around campgrounds or where self-sustaining populations are limited. Management in the hatchery areas is based on providing maximum recreational harvest of hatchery fish.

There are exceptions to these two approaches, which are designed to provide higher levels of escapements. Two examples are the catch-and-release fisheries on the Yakima and Kettle rivers. The intent is to lower harvest mortality and provide higher population levels. These higher population levels result in higher than average catch rates and a higher level of satisfaction for a portion of the angling public.

Bull trout/Dolly Varden populations have been rated for stock health on a statewide basis. Fishing is allowed only on those populations that are healthy or at "low risk of extinction." No fishing is allowed on stocks at "some risk of extinction" or where the status of the stock is unknown due to a lack of data.

Other exceptions are kokanee and mountain whitefish for which no escapement policies have been established. The intent to maintain strong wild populations is the same. Due to a lack of data and a sense that current management approaches are providing sufficient spawners, no specific escapement methodology has been developed.

Except for Yale Reservoir, individual resident populations are rarely monitored for spawner abundance. Some index populations were established to track implementation of the stream management strategy. It is assumed that if those populations are responding as expected, then other populations managed with the same strategy will also.

<u>Genetic Conservation</u>

A more detailed discussion of genetic conservation is presented in Appendix E.

No explicit genetic priorities have been generally formulated for wild or hatchery salmonid populations in Washington. The Washington Fish and Wildlife Commission goals emphasize production of native game fish species and use of natural production within habitat capabilities. The Puget Sound Salmon Management Plan requires fishing across the timing of the run. Transfer guidelines that generally restrict movement of hatchery fish within certain boundaries are used.

Traditionally, Washington fisheries managers have developed escapement goals to provide harvest or utilize habitat. The number of spawners needed to maintain genetic diversity and other genetic issues has not typically been considered. Current policy is not always directed at ensuring adequate escapement. Stock abundance of populations that are managed as secondary units, or for hatchery production, can drop to very low levels under this secondary management, resulting in reductions in genetic diversity within stocks. This is also a problem where habitat loss has occurred.

Gene Flow

Historically, salmonid fishes have been transferred widely from area to area, with little regard to the origin of the fish. Transfer of fish has been increasingly limited in recent years; in large part for disease concerns. The transfer policy adopted for salmon limits the movement of fish, though some movement around Puget Sound still occurs, and movement of stocks around the lower Columbia River is common. Movement of steelhead and resident fish is more common and no formal policy is currently in place to control such movements.

There is currently no general policy that limits the number or percentage of hatchery offspring that contribute to naturally spawning populations. However, different strategies have been developed to reduce the likelihood of interbreeding between hatchery and wild fish:

A. Releases of hatchery resident salmonids into streams have been strictly limited in recent years.

B. Hatchery-wild interbreeding of steelhead is limited through:

   1. Reductions in releases in some areas.
   2. Creation of refuges where no planting is allowed.
   3. High harvest rates on hatchery fish, which reduce the hatchery population size in relation to wild spawners.
   4. Separation of hatchery and wild spawn timing through the use of stock(s) with different run timing.

   A Genetic Conservation Model (GCM) has been developed for steelhead, which estimates the loss of wild reproductive potential due to hatchery and wild interbreeding. It is designed to look at issues such as timing overlaps, differential harvest rates, and other factors to determine proper release strategies to achieve a given level of wild reproductive potential.

C. Many hatchery salmon stocks are derived from mixtures of introduced and local stocks. The approach at most salmon hatcheries is to use locally returning fish for hatchery broodstock, and to favor the similarity between the hatchery and wild broodstocks. The intent is to reduce the genetic effects of interbreeding since both hatchery and wild fish are drawn from a similar gene pool. However, domestication of the hatchery stock can take place, which can reduce the fitness of hatchery fish for survival in the wild. Further, if wild salmon collected for hatchery broodstock are not representative of the genetic variation present in the wild stock, the hatchery stock will differ from the local wild stock.

Fisheries Selectivity

Prevention of artificial selection on salmonids due to fishery practices is not generally a formal management intent. Managers usually agree on the need to distribute harvest across a population's return timing to reduce selection against any single timing part of the run. In fact, this is a requirement of the Puget Sound Salmon Management Plan. However, in practice, this even distribution may not be achieved. For example, it is often necessary to delay the opening of a fishery to protect a weak stock with earlier timing. This removes only the later-timed fish from the population, while the earlier timed fish return at greater levels. This, in effect, selects against the later timed characteristics in the population and can shift the run timing (Alexandersdottir 1987).

Much of salmon management depends on inseason updates to provide more current information on run status. When inseason information indicates the run is smaller than expected, the fishery is closed early, so that fishing occurs only on the early portion of the run. If both late opening and early closures occur, then selection against the central portion of the run increases.

To the extent males and females and different age classes enter fishing areas at different times during the run, management practices can select against a particular sex or age class as well as a timing component of the run. For example, South Puget Sound chum are generally dominated by 4-year-old fish early in the run. An early fishing pattern would not only select against early fish, but also older, larger fish.

Ecological Interactions

A more detailed discussion of ecological interactions is presented in Appendix F.

With the exception of limiting access to eagle feeding areas in the Skagit River, no formal policies have been developed or adopted that deal with the role of salmonid fishes in broader ecosystems. There is, however, a general intent to recognize the ecosystem impacts of current programs. Full exploration of this issue will occur through various landscape level planning processes such as Habitat Conservation Plans, integrated landscape plans, and other watershed/basin plans.

Harvest Management

A more detailed discussion of harvest management is presented in Appendix G.

The general harvest management intent is to protect salmonids through meeting the spawner escapement goals and provide for harvest opportunity (including meeting allocation requirements for treaty and non-treaty fisheries).

Incidental harvest limitations vary by species. No general guidelines have been established for salmon fisheries although incidental harvest impacts are included as part of the fishery plan, and accounted for as part of total mortality. They are annually negotiated based on the balance of stock health and harvest opportunity concerns in each situation.

Incidental impacts on steelhead are limited to 10% in Puget Sound and the coast. The Columbia River Fish Management Plan allows incidental harvests of 15-32% depending on the specific run.

Incidental harvests are usually not accounted for in resident fisheries.

There is no formal policy on selective fisheries, though a variety of techniques are commonly used. Currently all hatchery steelhead and sea-run cutthroat are marked by removing the adipose fin. This allows them to be readily identified by anglers. Wild fish release fisheries are commonly used in waters where wild fish need extra protection. Wild fish release is typically used at times when large numbers of hatchery fish are mixed in with wild fish. This approach is combined with specific tackle regulations to reduce handling mortality on the released fish.

Selective fisheries approaches for salmon combine a variety of time, area, and gear techniques to target the harvest on abundant stocks while minimizing impacts to weaker stocks. The specific technique used varies with the situation. Timing of fisheries is a common technique, particularly in more terminal areas. For example, hatchery coho returning to the Queets and Humptulips Rivers arrive earlier than the wild fish, so an early fishery takes mainly hatchery fish. Timing is an important element of controlling fishing impacts in the Buoy 10 sport fishery and many gillnet and purse seine fisheries.

The use of area closures is also common. For example, ocean coho fisheries are moved north or south in different years depending on which coho stocks are the weakest and where they are found in the ocean at different times of the year. Ocean troll and recreational fisheries can be moved inshore, where they catch mainly chinook, or offshore where they catch mainly coho, depending on which species needs protection. Fisheries are often moved around Puget Sound to take advantage of strong runs and protect weak runs.

Fishing gear can also be selective. Large mesh gillnets will catch chinook salmon while allowing smaller fish to pass on through. Purse seines are constructed with a panel of larger mesh near the top that allows smaller feeding chinook to pass through and escape the net. Various types of terminal troll gear of different sizes and colors can be used to selectively fish for different sizes of fish or different species.

Cultured Production/Hatcheries

A more detailed discussion of cultured production is presented in Appendix H.

Washington State has one of the largest salmonid artificial production systems in the world. WDFW currently operates 65 salmon and 30 trout rearing facilities. Five salmon species, steelhead, and sea-run cutthroat trout are included in anadromous hatchery production. Resident hatchery salmonids include rainbow, cutthroat, eastern brook, brown, lake, and golden trout; Arctic grayling; and kokanee. These facilities produced approximately 230 million anadromous and 20 million resident salmonids during 1992-93. In addition there are 12 federal and 17 tribal facilities that added another 50 million fish in 1992-93. There are also a large number of local volunteer fish culture programs operated by schools, clubs, community groups, and individuals. Hatchery programs have changed dramatically. For example, data indicating extremely low survival for fry plants plus concerns about ecological interactions with wild stocks have significantly reduced fry planting programs.

Salmonid culture programs typically address four key resource management needs: (1) *enhance* fishing opportunity, (2) mitigate for specific production losses, (3) *restore* depleted wild populations or *reintroduce* extirpated species, and (4) *research* to improve management and hatchery programs. A single facility may engage in several programs.

A. *Enhancement* programs are designed to increase the number of fish available for all forms of harvest. Enhancement programs are not designed to create more wild spawners, though this can occur.

B. *Mitigation* is used to offset losses. Most commonly mitigation is used to replace production from the construction of dams and reservoirs that destroy habitat or increase the mortality rate during some part of the life cycle. The Cowlitz and Lewis River hatcheries are examples of mitigation hatcheries.

C. *Restoration* is used to: (1) recover (supplement) populations that are having problems sustaining themselves and are not likely to recover naturally, (2) reintroduce wild stocks that have been lost from areas they historically inhabited, and (3) maintain stocks that face extreme risks. Restoration programs are designed to put more spawners on the spawning grounds.

D. *Research* at hatchery facilities has played a vital role in understanding the biology and management of salmonid populations. Hatchery fish can be studied directly, or used as indicators of how similar, neighboring wild populations may be behaving. Issues such as diseases, growth, physical changes before migrations, and ocean distribution and catch patterns are all studied using hatchery fish. In many cases similar work on wild fish is much more difficult due to smaller numbers and the difficulties in creating controlled conditions.

Hatchery programs have generally adopted fairly specific policies in some areas of genetic conservation. Spawning protocols are used to assure proper mating strategies in the hatcheries to combat selection and genetic drift. A statewide transfer policy for salmon is used to maintain among-stock diversity.

Specific fish management goals, including legislative and other legal requirements, determine how specific hatcheries are operated. The goals and operational procedures and policies for WDFW's anadromous facilities are defined in three regional volumes of the *WDFW Hatchery Operational Plan for Anadromous Fish Production Facilities*. These plans address fish health protection, genetic viability of stocks, ecological interactions of cultured and wild fish, and spawning protocols to ensure conservation of genetic diversity within cultured stocks. They outline the stock history for each hatchery, its physical structures, program objectives for production, practices to achieve objectives, protocols to maintain stock integrity and genetic diversity, environmental monitoring and reporting requirements, and record keeping requirements. Several important objectives listed in these operational plans include:

A. Minimize interactions with other fish populations.

B. Maintain stock integrity and genetic diversity of each unique stock.

C. Maximize survival at all life stages using disease control and prevention techniques, and prevent the introduction, spread, or amplification of fish pathogens.

D. Conduct environmental monitoring to ensure that hatchery operations comply with state and federal water quality standards.

D. Communicate effectively with other salmonid producers and managers in the region.

The hatchery operation plans outline performance standards for these objectives at each facility.

Currently budgets do not allow intensive monitoring of these objectives at each hatchery. Evaluation programs address key issues or needs at selected sites to improve understanding of culture operations and their outcomes.

Fish health concerns are managed under the *Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State.* This policy describes the various protocols for the prevention, detection, and control of fish diseases in the salmonid populations in Washington.

Except for the fish health policy, there are no overall guidelines or standards in Washington that direct management objectives for hatchery production or culture practices. However, there are a variety of informal policies that guide hatchery operations. These may be broad principles or they may apply only to a single facility. Some management plans, such as WDFW's *Basic Stream Management Strategy* (WDG 1984), define general management intent for hatchery fish.

Each year, the participants in state/tribal court-established processes such as U.S. vs. Washington, U.S. vs. Oregon, and Hoh vs. Baldrige develop a production plan for salmon and steelhead programs that defines fish culture objectives for each WDFW, tribal, federal, cooperative, and Regional Fisheries Enhancement Group facility. The production plan translates fish management objectives into a comprehensive action strategy for fish production. The production plan is reported in the *Future Brood Document*, which describes fish culture techniques, optimum production strategies, harvest management regimes, long-term planning, stock transfer guidelines, disease policy, gene conservation, and legal mandates. After considering all appropriate concerns and comments, the *Future Brood Document* is completed and adopted as the established set of annual production goals. At WDFW facilities, these goals and objectives are implemented via the hatchery operation plan for that facility.

Resident trout hatcheries do not have the same formal programming process, although one is being developed. Game fish have been programmed based on recreational needs, the use of historical release data, levels of fishing effort, mitigation agreements, and public input.

A new level of program planning has been required in recent years in those areas where hatchery programs might impact species listed as threatened or endangered under the Endangered Species Act. That process requires a series of permits and consultations with the federal government to show that the proposed programs will not jeopardize the future of the listed stock.

Mitigating Measures and Unavoidable Adverse Impacts

There are a large number of potential mitigating measures that could be used to reduce the impacts of the current approaches. Alternatives 2-5 represent mitigations for a number of the impacts to the natural environment. Many of the impacts to the built environment are shared by all four alternatives.

A. Reductions in Canadian fisheries would return more salmon to Washington and reduce the current impacts. Negotiations under the Pacific Salmon Treaty have been stalled. The Pacific Salmon Treaty process manages the interactions of Canadian and U.S. (including Alaskan) fisheries on each other's stocks. For resident salmonids and steelhead, Alaskan and Canadian interceptions are not an issue. However, for the five salmon species they are of critical importance. Canadian fisheries generally take over 50% of the catch of Puget Sound and coastal coho and chinook.

   The treaty is the focus of an ongoing series of negotiations and we certainly expect changes to occur. In 1995 and 1996, we have seen a shift to an abundance based approach for chinook and coho harvests off of Canada and some changes in U.S. harvests of sockeye. Each of these represents a potentially beneficial change in how we manage for healthy stocks.

B. Improved ocean survivals would also return more chinook, coho and steelhead; it appears that the hostile ocean survival conditions created by *El Nino* may have subsided. A resumption of *El Nino* would be an unavoidable impact.

C. Natural disasters such as volcanic eruptions and drought can cause unavoidable impacts to salmonids. The Mt. St. Helens volcanic eruption was devastating to salmonid stocks in the Green and Toutle River watershed.

D. The listing of more stocks of salmonids under the Endangered Species Act is probably unavoidable. One of the purposes for developing the Wild Salmonid Policy has been to strengthen the protection and recovery of wild salmonids and their habitats to maintain basic stock health. If successful, this removes the need and concern for ESA listings. Listings of Washington salmonid stocks are a continuing threat under Alternative 1. We assume the new alternatives are each sufficient to perpetuate stocks, and that ESA listings generally will not be necessary. As a result, the outcome analyses for the new approaches do not reflect any special recognition of ESA issues and potential impacts.

E. There is an major unavoidable short-term cost to making the required changes to have healthy sustainable salmonid populations. These costs are balanced by the long term benefits derived from healthy salmonid stocks.

Alternative 2

This alternative places the highest priority on protection of population and ecosystem health, and much less of a priority on harvest. This alternative proposes to avoid negative impacts to stock and ecosystem health wherever possible for habitat. It includes a fairly rigid, state-prescribed package of performance standards and action strategies. It is unlikely that such a package of regulations expanding state authority would be enacted by the current state legislature.

Habitat

Except for Alternative 1 (no action), each of the different alternatives proposed for habitat has the same potential outcome of providing sufficient amounts of quality salmonid habitat to achieve the overall goal of the policy. The differences between Alternatives 2 through 5 lie in their specificity, flexibility and regulatory emphasis. As a result they create different impacts on human activities that affect habitat.

Habitat Alternative 2 contains the components that would be also be addressed in Alternatives 2-5 and ultimately in a Wild Salmonid Policy. Each alternative has an overall goal followed by individual goals for basin hydrology and instream flows, water quality, sediment delivery and routing, stream channel complexity, riparian areas and wetlands, lakes and reservoirs, marine areas, fish access and passage, and habitat restoration. Each alternative has either quantitative or narrative standards or measures by component, and each has action strategies that would either be required, strongly suggested or provided as representative actions that could be taken. Collectively, a habitat section for any policy alternative would address salmonid habitat requirements at all life stages.

Alternative 2 is the most specific and most restrictive of the alternatives considered and is presented here in its entirety. The action strategies listed in Appendix C would be fully implemented through existing state and/or local government regulations or by new authorizing legislation and/or rule-making processes.

Note: The entire habitat section will not be repeated within the descriptions of Alternatives 3, 4 or 5. Instead we will describe their major differences contrasted with Alternative 2.

Overall Goal for Habitat

Maintain or increase the quality and quantity of habitat necessary to sustain and restore salmonid populations.

The ultimate performance standard for habitat is a level of productivity and production that will sustain robust fisheries while maintaining healthy adult spawning populations. However, relationships between habitat conditions and salmonid productivity have not been well defined (although efforts are currently under way to define them). Therefore, the approach used will be to define performance standards by the physical conditions within salmonid habitats that are expected to create good productivity. This is an indirect approach that must periodically be evaluated to ensure its applicability. The physical performance standards are described in the habitat components that follow. They are based on current knowledge of what is expected to provide good salmonid habitat and productivity and will be periodically updated as new or additional information becomes available.

Goal for Basin Hydrology

Maintain or restore the physical processes affecting natural basin hydrology. In addition, manage water use and allocation in a manner: that will optimize instream flows for salmonid spawning, incubation, rearing, adult residency and migration, that will address the need for channel-forming and maintenance flows, and that will address the impacts of water withdrawals on estuarine and marine habitats.

Basin Hydrology and Instream Flow Performance Standards

A. In streams or basins that provide useable wild salmonid habitat, and where instream flows have not been established by rule, the stream's flow trends, normalized to account for variations in precipitation, hold steady or increase (low flows) over time.

B. In streams or basins that provide useable wild salmonid habitat and where stream flows have been adopted or are being revised, the performance measure will be the instream flow as adopted by rule.

C. Physical indicators within a watershed will also be used as performance measures to assess or achieve the sub-goals for basin hydrology and instream flow. These performance measures are typically expressed as thresholds of change - if the thresholds are exceeded, habitat conditions including water quality and water quantity decline dramatically, and often irreversibly. Threshold management can help to maintain or restore natural basin hydrology and instream flow. Examples of thresholds include:

1. Percent effective impervious surfaces — These include road surfaces, rooftops, and parking lots. As percent effective impervious area exceeds a threshold of 8-10% in a watershed, instream conditions including the frequency and intensity of high flows and water quality begin to deteriorate. Groundwater recharge and summer low flows also usually decline, although the relationship is not always as predictable. The threshold could be applied to stream reaches or subbasins. This threshold could also be applicable to wetlands.
2. Forest harvest and road density — The seasonal timing of forest harvests and the density of roads in harvesting areas can have significant effects on streamflows. The percent of upland forests at hydrologic maturity and percent clearcut in rain-on-snow zones can be used as thresholds beyond which significant adverse impacts on basin hydrology and instream flow would be expected. The thresholds are basin specific, however some forest land managers feel that for western Washington watersheds a threshold of approximately 60% of standing timber at age 25 or more will begin to reflect hydrologic maturity. Road densities are even more basin specific and would require some form of analysis and discussion to arrive at a threshold number.
3. Threshold grazing standards could be set at the basin specific level. On state lands guidance is available in the HB1309 Ecosystem Standards for State-Owned Agricultural and Grazing Lands. This guidance may also have application on other ownerships as a reference document.

Physical indicators would be applied in conjunction with other actual instream flow measures whenever possible.

See required action strategies in Appendix C.

<u>Goals for Water Quality and Sediment Quality, Delivery and Transport</u>

A. **Provide for water and sediments of a quality that will support productive, harvestable, wild salmonid populations unimpaired by toxic or deleterious effects of environmental pollutants.**

B. **Manage watersheds, stream channels, wetlands and marine areas for natural**

rates of sediment erosion, deposition and routing to within the limits of salmonid life requirements.

Performance standards for this component include the following:

A. Maintain productive aquatic habitats for salmonids and their prey bases that contain a balanced, integrated community of organisms having species composition, abundance, diversity, structure, and organization comparable to that in unimpacted reference ecosystems of the region.

B. For factors such as temperature, dissolved oxygen, pH, turbidity and suspended solids levels, meet state surface water quality standards as established for waters supporting salmonids and prey base species.

C. For all relevant freshwater and marine areas, meet water and sediment quality criteria as established for toxic or deleterious pollutants that can affect the survival, growth or reproductive success of salmonids or prey species.

D. Consider gravel impaired in spawning areas if fine sediments (<.85mm) exceed 11%. If fine sediment levels naturally exceed 11% in spawning or rearing habitat, then sediment concentrations would not exceed natural levels.

See required action strategies in Appendix C.

<u>Goal for Stream Channel Complexity</u>

Maintain or restore natural stream channel characteristics for channel sinuosity, gravel quality and quantity, instream cover, large woody debris (LWD), pool depth and frequency, bank stability and side-channel and off-channel and flood plain connectivity and function.

<u>Performance Standards for Stream Channel Complexity</u>

A. Spawning gravel will be relatively stable, with a low potential for scour, throughout the nest building and incubation period of the wild salmonid species in the basin.

B. Adult salmonid holding pools will contain sufficient depth (depending on species and stream, but generally greater than one meter) and associated cover.

C. More than 90% of channel banks on streams will be stable, relative to natural rates of erosion in the basin. Stability, if needed, can be provided in a number of ways. If bank protection is necessary, bioengineering methods are preferred.

D. At a minimum, the performance measures relative to pools and large woody debris in forested and previously forested areas shall conform to those in the *Washington State Watershed Analysis Manual* (listed below) unless locally defined.

    1. In streams of any gradient, but less than 15 meters wide, the frequency of pools should not occur at intervals less than one pool for every two channel widths in length.
    2. The percent pools in a stream will not be impaired by the presence of sediments or the effects of human disturbances. For streams less than 15 meters wide, the percent pools should be greater than 55%, greater than 40%, and greater than 30% for streams with gradients of less than

2%, 2-5% and more than 5%, respectively.

3. The quantity and quality of "large woody debris" (LWD) in streams should not be impaired by human activities. For streams less than 20 meters wide, the number of pieces of LWD larger than 10 centimeters for every channel width should exceed two. The number of key LWD pieces per "bank full width" (BFW) should be greater than 0.3 pieces for streams less than 10 meters BFW and greater than 0.5 pieces for streams 10-20 meters BFW.

E. Side channels and other off-channel habitat, including wetlands, remain connected to the channel proper. Where feasible, dikes or levees that are constricting floodplains should be removed or modified to allow flood flow, storage, recharge, and release.

See required action strategies in Appendix C.

Goal for Riparian Areas and Wetlands

Functional riparian habitat and associated wetlands is protected and restored on all water bodies that support, or directly or indirectly impact salmonids and their habitat.

Performance Measures

A. There are no single agreed-upon, statewide numeric standards for riparian areas or wetlands. Regional or watershed specific standards may need to be applied based upon watershed analysis, the development of specific and detailed standards in individual watershed plans, or other assessments of site conditions and intensity of land use. It is also anticipated that in many instances existing encroachments in riparian areas or parcel size and configuration may preclude attainment of adequate riparian buffers.

1. Riparian Areas

The standards below are necessary to maintain riparian conditions which protect salmonid habitat:

a. For Water Types 1-3 (as defined and mapped in WAC 222-16-030) a buffer of 100 - 150 feet (measured horizontally) or the height of a site potential tree in a mature conifer stand (100 years), whichever is greater on each side of the stream.
b. For Type 4 streams, a buffer of at least 100 feet (each side)
c. For Type 5 streams, a buffer of at least 50 feet (each side).
d. For streams not administered directly or indirectly per WAC 222-26-030 apply a buffer of 100-150 feet each side on salmonid streams larger than 5 feet wide, a buffer of 100 feet (each side) on perennial streams and a buffer of 50 feet (each side) on all other streams.
e. The buffers may need to be expanded to accommodate anticipated channel migration, as an additional buffer against windthrow, or to address upslope instability or previous negative upslope impacts.
f. To the extent possible, buffers will be continuous along the stream channel. Tree removal shall occur only to improve the functional characteristics of the riparian area, or for road alignments, stream crossings or other corridors where no feasible alternative exists.
g. Plant community structural complexity (understory herbaceous

and woody overstory canopy) will approximate site potential for native plant species and native vegetation will be used for restoration.

h. Grazing will be managed to maintain or allow reestablishment of functional riparian vegetation.
i. Performance standards for Basin Hydrology and Instream Flow, and Water and Sediment Quality and Sediment Transport and Stream Channel Complexity will be met to ensure riparian functions would be meaningful and attainable.

2. Wetlands

a. Buffers for wetlands will be applied in accordance with the Department of Ecology Model Wetlands Ordinance - September 1990 and the updated 4-tier rating system (Pub #93-74 for western Washington and Pub. #91.58 for eastern Washington).
b. Wetlands replacement is highly discouraged because of the difficulty of providing adequate replacement of functions and values. Where replacement is unavoidable, the replacement ratio would be applied as provided in the Model Wetlands Ordinance. Wetlands mitigation banking is also an option which would be considered where on-site, in-kind mitigation would not be feasible or practicable.
c. Performance standards for Basin Hydrology and Instream Flow, and Water and Sediment Quality and Sediment Transport will be met, where applicable, to ensure wetlands extent and functions are meaningful and attainable.

See required action strategies in Appendix C.

<u>Goal for Lakes and Reservoirs</u>

Maintain or restore lake and reservoir habitats that are conducive to wild salmonid passage, rearing, adult residency and spawning.

<u>Performance Standards for Lakes and Reservoirs</u>

A. There are no statewide agreed-upon standards particular to all issues specific to lakes and reservoirs. However, performance standards for basin hydrology and instream flows, water and sediment quality, riparian areas and wetlands, and fish access and screening shall include factors relevant to lake and reservoir protection.

<u>Goals for Marine Areas</u>

A. **Provide nearshore marine, estuarine and tidally influenced marine ecosystems that contain productive, balanced, integrated communities of organisms having species composition, abundance, diversity, structure, and organization comparable to that of natural ecosystems of the region.**

B. **Ensure that functions and values of the following habitat types are maintained or increased: eelgrass habitats, herring spawning habitats, intertidal forage fish spawning habitats, intertidal wetlands, and safe and timely migratory pathways for salmonids in marine waters.**

C. **Allow natural rates of erosion and transport of sediments, nutrients, and large woody debris that affect habitat quality in tidally influenced estuarine and marine shorelines.**

Performance Standards for Marine Areas

A. Natural shoreline erosion, accretion to beaches, and transport processes are maintained or, where feasible, restored.

B. Ensure no net loss of eelgrass habitat, herring spawning habitat area or function, upper intertidal forage fish spawning habitat area or function, and intertidal wetland area or function.

C. Demonstrate successful establishment of functioning compensatory mitigation projects prior to final authorization of projects that adversely impact marine, estuarine and intertidal habitats.

D. Maintain or restore continuous shallow-water migration corridors along nearshore marine, estuarine, and tidally influenced areas.

Employ the required action strategies in Appendix C.

Goals for Fish Access and Passage

A. **Provide and maintain safe and timely pathways to all useable wild salmonid habitat in fresh and marine waters for salmonids at all life stages.**

B. **Ensure salmonids are protected from injury or mortality from diversion into artificial channels or conduits (irrigation ditches, turbines, etc.).**

C. **Ensure natural partial or complete fish passage barriers are maintained where necessary to maintain biodiversity among and within salmonid populations and other fish and wildlife.**

Performance Standards for Fish Access and Passage

A. Provide and maintain free and unobstructed passage for all wild salmonids according to state and federal screening and passage criteria and guidelines at all human-built structures.

B. Meet or exceed a 95% survival standard for fish passage through hydroelectric projects and fully mitigate for fish mortalities.

Employ the required action strategies in Appendix C.

Goal for Habitat Restoration

Restore usable wild salmonid habitat to levels of natural variability for watershed processes and habitats.

Performance Standards for Restoration

Restoration of salmonid habitat will be long-term, costly and contentious. It will involve a combination of active in-water work, extensive upslope work, and in large part, just providing the opportunity and time for watersheds and marine areas to mend themselves. Many of the performance standards and action strategies in the preceding components include reference to restoration of the physical processes and habitat types necessary for salmonids and they will not be repeated here.

A. Full habitat restoration within watersheds and marine areas will be ultimately achieved when the performance standards for the preceding components (i.e., basin hydrology and instream flow, water and sediment quality and sediment transport, etc.) are met.

Spawner Abundance Level and Unit

Alternative 2 (see Appendix D for a detailed discussion) calls for the full utilization of the habitat available to each salmonid stock. The intent of full utilization of the habitat is to:

A. Maximize the future population size of each stock to provide the greatest likelihood of future survival.

B. Maximize the potential number and distribution of locally adapted salmonid stocks.

C. Maximize the potential genetic diversity within stocks.

D. Maximize the contribution of wild salmonids to maintaining and supporting natural ecological processes.

E. Harvest opportunities may be provided where sustainable production above the level needed to fully utilize the habitat is available.

Spawner abundance goals for stocks would be established and managed for in all areas that have an existing or restorable habitat capacity to support naturally reproducing, self-sustaining populations, and would meet the following criteria:

A. Explicitly account for fishery management error, environmental variability, and other uncertainty.

B. Be based upon the best available scientific data and methods.

C. Be based upon a variety of information such as historical stock/recruit, historical escapement trends, habitat assessments, and population age structure, maturity rates, and density.

D. Can be defined in terms of fixed numerical goals, harvest rates, or surrogate approaches that result in meeting the full utilization goal for individual stocks.

E. Will be based on current population and habitat productivity and adjusted as productivity changes.

What Counts?

Only fish whose parents spawned in the wild would be counted towards meeting the spawner abundance goals, except in cases where a formal supplementation program has been established under the guidelines outlined in the Cultured Production/Hatcheries element under this alternative.

Monitoring

Under this alternative each salmonid stock would be monitored every two years to determine if the spawner abundance levels meet the criteria described above. It is expected that most salmon and steelhead stocks would continue to be monitored every year as part of routine management. This alternative provides a monitoring requirement for all salmonid stocks.

Accountability

If spawner abundance goals are not achieved for three consecutive years, or if the five-year moving average of spawner abundance falls below 80% of the goal, a management assessment would be completed within six months to determine the cause(s). Appropriate actions would be designed and implemented to return spawning levels to at or above the goal. Actions would include any necessary measures to ensure compliance.

Genetic Conservation

Under Alternative 2, conditions would be created that allow natural patterns of genetic diversity and local adaptation to occur and evolve. General requirements for genetic conservation in this element call for:

A. No stocks will go extinct as a result of human impacts, except in the unique circumstance where exotic species or stocks may be removed as part of a specific genetic or ecological conservation plan.

B. The biological characteristics and structure within and among populations, as monitored by such things as spawning and rearing distribution, life history traits, habitat associations and genetic traits and differences, will not change as a result of human influences.

C. The number and distribution of locally adapted populations will expand as a result of such management actions taken to: increase spawner abundance from previous wild generations, reduce numbers of hatchery strays, reduce genetic selection from fishing, and recoup access to lost spawning and rearing areas.

   In some areas the number and distinction of separate locally adapted populations will decrease as a result of successful habitat rehabilitation efforts to restore and connect damaged habitat; in such cases the total abundance of the "new" spawning population in its habitat will increase.

Minimum Spawner Abundance

This alternative requires that each individual stock maintain a minimum base level abundance of 3,000 fish. The 3,000 base level is for a population that spawns a single time and at a single age (e.g., pink salmon). Table 4 describes how this base level would be adjusted for other species and spawning types. Where the population at full habitat utilization is less than 3,000 (see Appendix D for details), steps to improve the amount or quality of the habitat should be taken to bring the population up to the minimum level.

Gene Flow

Under Alternative 2 there is no allowable level of human caused gene flow between species, major ancestral lineages, genetic diversity units, or stocks. There can be no transfer of fish across stock or other boundaries. This will require the development of local broodstocks for all hatchery and other enhancement programs. Where there is no supplementation program in place, the allowable percentage of the total wild spawning population that is made up of fish raised in a hatchery is given in Table 5. Other measures of potential gene flow may be used (e.g., migrants per generation), if they result in similar levels of potential gene flow. Similarity is described in detail in Appendix D. This alternative uses the stricter definition of similarity that compares the hatchery fish with an ideal locally adapted wild

Table 4. Minimum spawning populations needed to maintain genetic diversity and local adaptation for various spawning types and life histories.

Spawning Type	Life History	Typical Species	Rule for Calculating Desired Harmonic Mean Number of Spawners
1	No repeat spawning; Spawners a single age	Pink salmon	3,000 (no calculations involved)
2	No repeat spawning; Spawners multiple ages	Chinook, coho, chum, and sockeye salmon; steelhead[1]	3,000 divided by the average age of the spawners[2]
3	Repeat spawning; Spawners multiple ages.	Rainbow, cutthroat, Dolly Varden, Bull trout, and pygmy and mountain whitefish.	3,000 divided by the average age of the spawners[2] minus 1

1 Steelhead are technically repeat spawners, but repeat spawning in Washington is at a low level compared to type 3 spawners, so they are more appropriately included here.

2 Mean of the average age of the two sexes.

Table 5. Allowable percentages of hatchery fish on the spawning grounds.

Level of Similarity of Hatchery Fish	Maximum % of the Wild Spawning Population That Is of Hatchery Origin
High	5-10%
Intermediate	1-5%
Low	0-1%

fish. This maintains a higher level of local adaptation in populations that are already locally adapted, and increases the rate at which a hatchery influenced wild population becomes locally adapted. Similarity is determined based on the geographic origin, hatchery history, and hatchery practices that have affected the hatchery fish. In a hatchery population with high similarity, the hatchery fish would be of local wild stock origin and have few generations in the hatchery. There would be regular introductions of new wild broodstock into the hatchery population and the hatchery rearing conditions would be similar to wild conditions. Time spent in the hatchery would be limited and strict spawning guidelines would be followed.
A highly similar stock would need to pass all these tests. A low similarity hatchery population would have many generations in the hatchery. There may have been selection for timing or size and the population may have been at very low numbers at times. There are few introductions of wild fish or it may have been started with non-local fish. A low similarity stock would only have to meet one of these criteria. Intermediate

stocks exceed all the low criteria, but fail to meet at least one of the high criteria. It is expected that most current hatchery populations will be either low or medium similarity.

Hatchery fish spawning in the wild will be controlled so that the majority of stocks in a major watershed, river basin, or GDU do not have any hatchery gene flow, and so that the higher maximum percentages of hatchery fish on the wild spawning grounds noted are exceptions (i.e. occur infrequently and not in the most abundant or most unique components of the larger population groupings).

Fishery Selectivity

Under this alternative fishery selection will be avoided to insure that population characteristics such as adult size, timing and distribution of population migration and spawning, and age at maturity are the same between the fished and unfished portions of the population. This means that the population will not be changing over time as the result of harvest influences, and where changes have occurred in the past due to fishing pressure, the population should be changing back to a more natural pattern.

Habitat Loss and Fragmentation

Under this alternative habitat will be protected so that both the distribution and amount of habitat is sufficient to maintain local adaptation and genetic diversity. Genetic diversity will be measured both in terms of diversity at the level of gene composition and the maintenance of key life history characteristics. Key life history characteristics include such things as timing, age at maturity, upriver versus lower river distributions, how long an anadromous fish remains in freshwater, stream, river, and lake rearing characteristics of freshwater populations and other characteristics that provide for local adaptation and diversity.

Sanctuaries and Refuges

Sanctuaries, or refuges, will be established where populations can be protected from most of the effects of habitat, harvest and hatchery influences. It will not be possible to protect populations from all of these influences all the time, but it will be possible for some populations to be largely protected from many of these influences. These protected populations serve two important functions: (1) they provide a comparison for measuring the changes in unprotected populations so that we can see the impacts of our actions, and (2) a source of fish if a neighboring population is changed too much to recover naturally.

Ecological Interactions

Under Alternative 2, the goal of the ecological interactions element is to avoid adverse impacts to salmonid populations due to interactions with other parts of the ecosystem, and to support the health of the broader ecosystem by the presence of salmonids. Avoid as it is used here means to prevent, eliminate, or minimize. It is a strong term designed to provide a high protection level for salmonid and ecosystem health. There are four key parts to this:

A. Maintain diverse, abundant wild salmonid stocks at levels that naturally sustain ecosystem processes and diverse indigenous species and their habitats. This will primarily be done by meeting the spawning abundance goal.

B. Maintain healthy populations of indigenous species within levels that sustain or promote abundant wild salmonid populations and their habitats. A healthy, balanced ecosystem requires that all the parts be available in the right amounts. Where there is a lack of a species it may be necessary to increase populations by providing the proper habitat characteristics as described in Appendix C.

Alternatively, human caused changes to many ecosystems have created situations where there is an excess of predators. Healthy predator populations (e.g., marine mammals, birds, squawfish) may be controlled as necessary when they are an important factor in not achieving spawner abundance goals. This can only occur:

1. As part of a comprehensive recovery plan addressing all aspects of salmonid survival
2. As long as the predator population remains abundant.

C. Hatchery or other enhancement programs shall avoid negative impacts due to predation or competition on the health and abundance of wild salmonid or other indigenous non-salmonid populations. All hatchery and other fish culture programs will follow specific ecological risk assessments and management plans to avoid adverse impacts on wild populations.

Salmonids will not be introduced into areas where they did not historically or do not currently exist, except where an ecological risk assessment determines that there will be no negative impacts from the introductions.

Salmonid populations that currently exist outside their historical range will be reviewed and evaluated to determine if they pose an unacceptable risk to indigenous species and ecosystems. If they do, then steps will be taken to remove the risk.

D. Control the numbers, varieties, and distributions of non-indigenous species or stocks that compete with, prey on, or parasitize salmonids and other indigenous species. Introductions of fish populations will be managed to avoid negative effects on the diversity and productivity of native fish and wildlife populations, and in a way compatible with meeting other priority stewardship objectives for locally adapted populations. This alternative requires an ecological risk assessment of the current distribution

Harvest Management

Alternative 2 would require the fisheries to be managed to achieve the spawner abundance and genetic conservation criteria described above. Harvest management will be responsive to annual fluctuations in abundance of salmonids, and will be designed to meet any requirements for sharing of harvest opportunity. This is consistent across all the alternatives.

Incidental Harvest Limits

Where a population is not meeting its desired spawner abundance level the impact will be minimized, not to exceed 5% of the adult Washington population size. The limitation of the Washington population size mainly affects those salmon species that are caught in Oregon, California, Alaska, and Canada. The requirement is to affect only those fisheries that Washington managers can directly control. As a population moves further below the desired spawner abundance level, the 5% level may be adjusted downward to zero as necessary to maintain a stock.

Selective Fisheries

Where a population is not meeting its desired spawner abundance level, a priority will be given to those fisheries that can minimize their impacts on weak stocks and increase their harvest on healthy stocks by: (1) using gears that can selectively capture and release stocks with minimal mortality, or (2) avoid impacts by eliminating encounters with weak populations (proven time/area closures, gear types). This must be done consistent with meeting treaty harvest opportunity needs.

Cultured Production/Hatcheries

Meet criteria under genetic conservation and ecological interactions.

Meet criteria in *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State.*

Each hatchery program will be based on a complete operational plan that describes the specific operational components, measures to control risk, monitoring and evaluation, and performance audits.

Supplementation

Supplementation will be strictly limited to only where: (1) a stock is well below desired levels, (2) it cannot rebuild itself due to some cause other than overfishing, (3) it is being reintroduced to an area it formerly occupied, and (4) the risks of potential stock loss through extinction are greater than the genetic risks due to gene flow or the extinction risks due to the supplementation process itself. Supplementation will be primarily directed at efforts where the conditions causing the problem are being corrected so that the population will eventually become self-sustaining.

Gene Banking

Gene banking will only be allowed where the natural environment cannot sustain a population, and until these factors can be corrected.

Alternative 3

This alternative places slightly less emphasis on stock protection for harvest and hatchery issues, which in turn provides greater flexibility to provide long-term harvest opportunity. Major differences from Alternative 2 are in the lower level of spawner abundance, the higher allowable incidental harvest rate, and the level of negative impacts in ecological interactions. This is the alternative recommended by the Department of Fish and Wildlife; the Fish and Wildlife Commission has not taken a position on any of the alternatives.

Habitat

For habitat, Alternative 3 would provide a high degree of specificity and guidance about "what fish need." The performance "standards" listed in Alternative 2 would be listed as performance "measures" that should be met in order to be successful. The action strategies in Appendix C would be strongly encouraged. Alternative 3 would rely principally on locally-based planning efforts for specific implementation plans. This option would strongly encourage local problem solving; with state, local and federal agencies at the table. State agencies would provide technical support and would represent state's interests, but they would be at the table as partners, working collaboratively with local citizens to achieve Wild Salmonid Policy goals consistent with local needs. The habitat goals would be fairly rigid, but individual performance measures and action strategies within the habitat components could be revised or amended (or new ones could be added),

again consistent with local conditions. New or revised statutory or rule-making authority recommendations, if needed, would result from collaborative discussion by all interested parties. The state and local government regulatory framework would remain in place. Individual state agencies would review existing programs and make administrative adjustments as needed to implement the policy.

We envision a comprehensive watershed based approach that would stress the continuum that extends throughout the watershed, its estuary and near shore marine waters. No approaches have a solid track record of success to date, but our preferred alternative is similar to some recent good habitat efforts and has the best chance of being accepted by the many parties having habitat management responsibilities.

<u>Spawner Abundance Level and Unit</u>

Under this alternative spawner abundance goals will ensure that:

A. Available habitat will be abundantly utilized (as compared to full use in Alternative 2; see Appendix D for discussion of different levels of spawner abundance) by locally adapted stocks.

B. Numbers and distribution of locally adapted spawning populations will not decrease from current levels as a result of population management goals or actions.

C. Genetic diversity within populations will be maintained or increased.

D. Natural ecological processes will be maintained or restored.

E. Sustainable surplus production above that needed for population replacement will be generated to support fishing opportunities, harvest and other benefits.

Providing harvest opportunity is desirable and is a higher priority in Alternative 3 compared with Alternative 2. However, harvest opportunity is still clearly secondary to the stock and ecosystem health issues.

Management under this alternative will occur on a stock-by-stock basis similar to Alternative 2.

The actual work for salmon and steelhead will be firmly anchored in the proven scientific concept of MSY, which has a worldwide track record of sustainable success <u>when applied correctly</u>. The best possible data come from long time series of accurate spawner and recruit statistics for each population. In other words, the ideal situation is where the fish themselves tell you their precise relationship with no requirement for assumptions. In reality, two adjustments are essential for correct application. We will have varying degrees of uncertainty associated with each spawner-recruit relationship. This level of risk to the resource must be quantified and added to the point estimate of MSY. Alternatively, the managers should default to a different, more conservative fishing strategy. In addition, a second risk adjustment must be made for expected level of harvest management precision. The desired end result for each population is fully adequate (or greater) numbers of viable wild fish actually being delivered to the spawning grounds on a consistent basis. Note: The spawner-recruit relationship accounts for the value of nutrients brought into the ecosystem by adults spawners in terms of benefits to subsequent recruits. It does not directly account for any benefits to other components of the ecosystem.

For other resident and anadromous trout, fishery management measures will require approaches ranging from wild fish release to the following intent described by Wright (1992, p. 524): "The management approach that provides for some continued consumptive harvest is to set the minimum size limit at a level that will allow a full age-class of females to spawn at least once and thus ensure maintenance of a population's reproductive potential. For example, if only 20% of the females spawn at age 3 but a majority (over 50%) spawns by age 4 then the minimum size limit needs to be set a the upper end of the length-frequency distribution for age-4 females. Males typically mature when they are somewhat younger, thus any regulation geared to females will also produce adequate male spawners. This size distribution needs to be that which would be projected to occur at the end of the fishing season. Trout will be continually growing during a spring-to-fall fishing season and the effect of any minimum size limit will be continually shifting. In our planning, we elected to protect a full age-class of female spawners in order to reduce the potential for selective fishing pressure."

<u>Monitoring</u>

Under this alternative it will not be necessary to physically measure spawner abundance for each and every stock, though every stock will need to be covered by the inventory process. Index stocks that are typical of stocks within an area may be used to estimate abundance for the entire area. Surrogate measures such as standing stocks, random samples, stock composition or other measures may be substituted for actual measures of spawners. Evidence of the utility of such surrogates will need to be established for their use.

<u>Fishery Selectivity</u>

With respect to Pacific salmon, this alternative is the same as Alternative 2. For the remaining salmonids which have multiple spawning capabilities, the primary goal will be to prevent any significant shift to sexual maturity at a smaller size and/or age.

<u>Harvest Management</u>

Under Alternative 3 the incidental harvest impact will increase to 10% of the Washington stock abundance. This will allow greater opportunity to structure fisheries opportunity on more abundant and productive stocks. This 10% allowance is a maximum and will be adjusted downward to zero depending on how far a stock is below its spawner abundance goal.

<u>Ecological Interactions</u>

Under Alternative 3 the standard for ecological interactions is "no significant negative impact." This is less emphatic than the "avoid negative impacts" criteria in Alternative 2, but is still expected to be a risk adverse requirement. There would be greater flexibility in using hatchery programs; these programs would be used where they have no significant negative impact on wild populations.

Cultured Production/Hatcheries

All hatchery-origin juvenile anadromous fish will be marked by removal of their adipose fins prior to release in state waters. Specific exemptions may be granted on a case-by-case basis for (1) brood stock development or maintenance, (2) difficult treaty Indian allocation problems that cannot be resolved by other methods, or (3) valid wild stock supplementation programs.

In all other respects this alternative is the same as Alternative 2.

Alternative 4

Alternative 4 continues to shift the balance from stock protection to harvest opportunity. In Alternative 4 providing harvest opportunity becomes a more equal partner with maintaining stock and ecosystem health. Alternative 4 continues to require a high standard of survival for individual stocks, lower than under alternatives 2-3, but still not expected to materially change the extinction risk for populations. Some stocks under this alternative would be less robust.

Habitat

Alternative 4 would contain performance "standards" and action strategies as in Alternative 2 but, would place less emphasis on watershed planning as a primary habitat protection and restoration approach. Individual state agencies would review existing programs and make administrative adjustments as needed to implement the policy with a clear intent to more adequately enforce existing regulations. The performance standards would become a default where locally-based plans do not address the issue; or would be waived where the local plan provides equivalent protection given local conditions. For example, this alternative requires a 150' buffer along Types 1-3 streams as a performance standard to ensure a functional riparian area. If the local plan can demonstrate that due to local conditions a 100 foot buffer or a variable-width buffer would provide the functional characteristics necessary to protect the streams, that standard would apply. Otherwise the performance standard in the policy would apply as the default regulatory standard.

Spawner Abundance Level and Unit

Alternative 4 provides the opportunity to manage some stocks at a lower level of escapement in order to create more harvest opportunity on healthy stocks returning to many river systems. Overall management will be at the level of management units, the combination of stocks returning to a river system. Under this alternative, management units would be fairly narrowly defined. For anadromous populations they are the aggregate of stocks returning to a major river system that empties into saltwater, stocks returning to a significant tributary to the Columbia River, or the aggregate of smaller independent tributaries that empty into the same limited saltwater area (e.g., Hood Canal, South Puget Sound, Bellingham Bay). For resident species this would include the above definitions plus the aggregate of stocks in tributaries to a significant lake system (e.g., Ross Lake, Lake Chelan, Lake Roosevelt).

Alternative 4 calls for management units to be managed at spawner abundance levels that achieve MSY for wild production for the entire management unit, except where spawner abundance levels of greater than MSY are needed to meet specifically identified ecological requirements. Specifically identified ecological requirements are a response to a specific set of needs, rather than a general desire for more spawners to provide for general ecological health.

These might be to meet the needs of a specific eagle population, or to provide larger fish to control a population of smaller non-indigenous fish.

Individual stocks within the management unit may be managed at levels below MSY, provided that they remain above a level that provides a high probability of survival over a long time period. This lower management level would only be allowed where:

A. Significant benefits from mixed-stock harvests outweigh the costs of managing for a lower escapement level.

B. Approaches to separating stocks in time, place, or harvest approach are not feasible.

C. Deviation from the overall goal of MSY for stocks is the least amount necessary to achieve the desired benefits.

A practical guideline for the allowable level of stock survival is a greater than 99% probability of survival for 100 years.

If one or more stocks are managed for less than MSY, then other stocks in the management unit must be managed for above MSY in order for the entire management unit to be at or above MSY. This provides offsetting benefits to other stocks in the management unit, and will tend to limit the number of stocks that can be managed at the lower level.

Hatcheries

Increased flexibility for supplementation programs would be allowed under this alternative; they can be used to augment populations limited by habitat or overfishing constraints.

Monitoring

Under this alternative the monitoring requirements for spawner abundance change from every two years to every five years. Many populations are currently monitored every year, and this is expected to continue under any of these options.

Genetic Conservation

The main genetic conservation differences between this alternative and the previous ones are in the areas of minimum stock size and gene flow. The other pieces of the genetic conservation element remain the same as the previous alternative.

Minimum Stock Size

In this alternative the base level for minimum stock size is reduced to the greater of 2,000 fish or a stock size that results in a high probability of long-term survival as defined in the spawner abundance section. The 2,000 fish is minimum stock base adjusted for specific spawning types.

Gene Flow

In Alternative 4, the gene flow approach allows a greater interaction between hatchery and wild fish on the spawning grounds. Table 6 summarizes the allowable percentages of the total wild spawning escapement that can be of hatchery origin. This alternative maintains a fairly conservative approach for stocks that have low and intermediate similarity, but provides greater flexibility for use of stocks that have high similarity.

Fishery Selectivity

Table 6. Allowable percentages of the total wild spawning population that can be hatchery fish under Alternative 4.

Level of Similarity of Hatchery Fish	Maximum % of the Wild Spawning Population That Is of Hatchery Origin
High	10-30%
Intermediate	2-10%
Low	0-2%

The final difference in this alternative is in the criteria for fish selectivity. Under this alternative there is a lower standard for controlling fishery selectivity. Alternative 4 includes a requirement to manage fishery selectivity to maintain variation in population characteristics for distributions similar (as opposed to same in Alternative 2) to wild unfished populations. The specific measurement for a criteria such as size, age composition, or timing may be different between the fished and unfished populations as long as the unfished population maintains the same range of variation. Providing this same range of variation means that the population still has the same or similar capacity to respond to changing conditions and environments and become locally adapted.

Cultured Production/Hatcheries

More flexibility to supplement wild stocks with hatchery broodstocks would be allowed.

Alternative 5

Alternative 5 places the greatest emphasis on harvest opportunity of Alternatives 2-5. It provides a different approach and set of measures for evaluating genetic conservation issues. Changes also occur in the Harvest Management and Cultured Production/Hatcheries elements.

Habitat

Alternative 5, for habitat, would contain the habitat goals listed in Alternative 2 but would include suggested narrative performance “measures” and optional action strategies within a wild salmonid policy. The actual performance measures, which could include numerical standards, and action strategies, would be developed through a combination of state and local laws and ordinance revisions, and implementation of specific watershed plans. For example, there is agreement within the forest practices industry that current riparian standards for state and private forest lands must be reviewed for adequacy, given current scientific information. Under this alternative, the participants of the Timber, Fish and Wildlife group would develop recommendations for rule changes - as necessary, and consistent with the Wild Salmonid Policy’s general guidance - to the State Forest Practices Board. The board would then adopt what it considered an appropriate level of protection for riparian areas under its jurisdiction. State agencies would develop individual specific implementation plans with action strategies for their agency operations that would meet the general WSP goals and performance measures.

Spawner Abundance

Alternative 5 provides the opportunity to manage some entire management units at a lower level of escapement in order to create more harvest opportunity on the mixture of hatchery and wild populations returning to many river systems. Some individual stocks would be maintained slightly above the level of immediate risk of permanent harm.

Spawner Abundance Level and Unit

The definition of management unit under this alternative is less restrictive than Alternative 4. Management units may include adjacent major river systems (e.g., Nooksack and Samish, Humptulips and Chehalis) entering into salt water or the mainstem Columbia River (e.g., Lower Columbia River coho from Grays River to Bonneville Dam). For resident fish larger management units of multiple drainage systems or lakes would be allowed.

Under Alternative 5 complete management units will be managed for MSY for wild production except where:

A. Significant additional benefits from mixed-stock (e.g., hatchery-wild or wild-wild) harvests outweigh the costs of managing escapements to a lower level, and:

    1. Approaches to separating stocks in time, place, or with fishing gear are not feasible.
    2. Deviations below MSY escapements for wild production are the least amount necessary.
    3. All stocks are maintained above a level where the stock is at immediate risk of loss or long-term harm.

B. Larger escapements are necessary to respond to specifically identified ecological, harvest, or other needs. This standard of immediate risk is less protective than the stock protection level in Alternative 4, but is still designed to perpetuate the existence of individual stocks into the future.

What Counts?

Under this alternative all fish spawning in the wild will count towards meeting the desired spawner abundance level.

Genetic Conservation

The Genetic Conservation element in this alternative takes a different approach to achieving very similar goals as the previous alternatives. It relies more on monitoring and then responding to measurable changes in genetic criteria, rather than relying on prescriptions that either: (1) are designed to prevent changes that may not have occurred or (2) may not achieve the desired goal. It is expected that this alternative would require fewer changes and adjustments in the short term while the monitoring is underway. The level of future adjustments compared to the other alternatives will depend on how accurate the prescriptions in the other alternatives are, and how well we can measure changes.

Minimum Spawner Abundance

Alternative 5 uses the same base value of 2,000 found in the previous alternative, but sets the other criteria at a level that is above where the stock is at immediate risk of permanent harm. The minimum value will be the greater of the two criteria.

Gene Flow

Human caused gene flow between MALs, GDUs, and stocks would be allowed under this alternative, provided that the genetic relationships and magnitude of genetic differences between the

Table 7. Criteria for prioritizing assessments of gene flow.

Priority for Assessment	Surrogate measures of gene flow from non-native and native sources: Non-native sources: Migrants/ generation (based on genetic marks)	Non-native sources: % of total spawning population of hatchery origin	Native sources: Migrants/ generation (based on genetic marks)	Native sources: % of total spawning population of hatchery origin
High	100	5	1000	50
Moderate	10	2	100	25
Concerned	1	1	10	10

various units is maintained. Populations would be expected to change in response to natural environmental changes and other natural processes. Human caused hybridization between species, such as between bull trout and eastern brook trout, would not be allowed.

Gene flow between hatchery and wild fish would be treated somewhat similarly. The goal is to maintain genetic relationships between populations, prevent the genetic extinction of any populations or loss of life history forms, and allow populations to respond to natural conditions. The criteria in Table 7 will be used to prioritize stocks for monitoring these criteria. These criteria are thresholds. Once the evaluation of the stocks takes place, whatever steps are necessary will be taken to achieve the underlying goals. This may include more or less stringent requirements than are included in Alternatives 2-4.

The definition of similarity is less strict in this alternative. Here the comparison is directly between the existing hatchery and wild fish and not an ideal broodstock as was used in the previous alternatives. Generally any locally collected broodstock would be considered high similarity.

Ecological Interactions

Under this alternative if problems are found then steps will be taken to reduce or correct the problem. This applies to introductions of salmonids and non-indigenous species, and for ecological concerns about hatchery production.

Harvest Management

Incidental Harvests

Under this alternative there is not a fixed limit on incidental harvests when a population is not meeting its escapement goal. This will be determined on a case-by-case basis based on potential stock and harvest impacts.

Selective Fisheries

This alternative considers selective fishing approaches to be a tool that may be applied as necessary to increase potential benefits. It does not mandate specific priority for the more selective fisheries as is the case with Alternatives 2-4.

Cultured Production/Hatcheries

Supplementation

In this alternative hatchery programs will be designed to ensure that important populations are not lost. The additional spawners provided by hatchery fish would be a desired outcome of all hatchery programs that used a locally collected broodstock. This is consistent with including all spawners in the wild towards meeting the desired spawner abundance level, and the gene flow criteria with a higher threshold for concern. This approach to supplementation would be subject to the evaluation process for gene flow and future controls may need to be applied if impacts were discovered.

Some Factors Common to All Alternatives

The final policy will provide the road map for where we want to go -- clear direction and expected outcomes for meeting the goal of healthy stocks and sustainable benefits. As mentioned above, a number of planning approaches, strategies and actions will implement the policy's vision.

Monitoring and Evaluation

Evaluation Goal

Resource management goals, objectives, strategies and actions will be evaluated to ensure the goals of the Wild Salmonid Policy and related species or geographic plans are met.

The effectiveness of each of the alternatives depends on several key factors; monitoring and evaluation, enforcement, and education. Monitoring, evaluation and research will be the cornerstone for insuring the success of these various measures. Evaluation will be the ongoing foundation for implementation and related decision making, used to answer and act on such key performance questions as:

- Are we achieving the long-term policy goals - abundance, productivity and diversity of wild salmonids and their ecosystems; sustainable fishery and non-consumptive benefits; and maintaining other cultural and ecological values?

- Are we meeting policy guidelines and performance measures?

Enforcement

Enforcement is a key element in successful implementation of any regulatory policy.

Enforcement Goal

Provide an environment where people involved with wild salmonid habitat and harvest will voluntarily accomplish those steps necessary to achieve policy goals.

Education

"The real substance of conservation lies not in the physical projects of government, but in the mental processes of citizens." Aldo Leopold.

Education Goal

Give citizens the basic tools, understanding, and knowledge necessary to preserve, protect and restore wild salmonids.

Developing progressive, corrective management strategies, as detailed in this policy, is the first step toward maintaining and restoring wild salmon populations to healthy levels that provide desired benefits. The next step is the support and assistance of an educated human population. Paraphrasing Aldo Leopold, the real substance of wild salmon recovery is whether or not Washington's citizens will act to cause needed changes. For citizens to take positive actions, they must be informed. They must understand the problems, know the range of potential solutions, and be motivated to implement the appropriate changes. Central to this action is the need for a strong, effective and varied education program explaining the needs of wild salmonids.

Chapter III IMPACTS TO AFFECTED ENVIRONMENTS

This chapter describes the different impacts caused by each alternative on the natural environment (habitat, animal abundance and diversity, genetic conservation) and the built environment (land and shoreline uses, fishery and non-consumptive benefits, and cultural and historic preservation). It builds upon information described earlier.

As people begin to implement the preferred alternative, new and innovative solutions tailored to the local conditions will emerge that could substantially reduce the impacts.

Affected Environment

Habitat

Ecoregion Descriptions

This section provides a general description of the characteristics of watersheds across the state. There are several regional land classification systems used or being developed to describe the variability of watersheds across the Pacific Northwest (FEMAT 1993, Omernik and Gallant 1986, Cassidy 1992). For the purposes of this analysis, we will use the "ecoregions" system described by Omernik and used by The Environmental Protection Agency to describe the environments affected by this policy. The Pacific Northwest (in this case, Washington, Oregon, and Idaho) contains 15 ecoregions, 8 of which are found in Washington. The following general descriptions are derived primarily from that document. Other sources include Britton (1975), Wilson et al. (1994), GRP (1995) and Cassidy (1996).

A. Coast Range - This ecoregion includes the Pacific Coast Range and coastal valleys and terraces. Much of the region is highly dissected by perennial streams. Perennial streamflow can be generated in subbasins less than one square mile, with some of the larger streams draining greater than 300 square miles. In Washington the region abuts the Pacific Ocean on the west and the Puget Lowlands on the east. Lakes in the Washington portion of this ecoregion are sparse, formed by primarily by glacial drift or river meandering. The estuaries of Willapa and Grays Harbor are relatively shallow, containing extensive complexes of intertidal mud and sand flats which provide highly productive habitat for salmonid and salmonid prey species. The Columbia River estuary, comprised of a vast and variable mixture of tidelands, salt marshes, sand spits, uplands, and river channels also lies within this ecoregion. The physical features of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal range from the open ocean and pounding surf conditions occurring along the exposed

B. open coastline to less exposed shorelines of the strait and Hood Canal.

The Coast Range Ecoregion is characterized by elevations from sea level to higher local relief between 1,500-2,000 feet, with mountain tops generally below 4,000 feet. Precipitation is generally high and quite variable across the ecoregion, ranging from 55 to 125 inches annually depending upon maritime weather patterns and topographic relief. Precipitation is highest in the winter months and lowest in the summer months.

Forests are dominated by Douglas fir, western hemlock, Sitka spruce, and western red cedar; however lodgepole pine (shore pine) occurs along the ocean beach and estuary shorelines. Understory vegetation is characterized by salmonberry, rhododendron, willow, vine maple, salal, currant and evergreen huckleberry. Soils are developed mainly from sandstone, siltstone, shale and basalt rock sources and exhibit a wide range of characteristics.

Land use is characterized by urban and industrial development near marine harbors, grading to a variety of small communities, rural residences, agricultural lands, and forest lands with increasing distance from the harbor areas.

B. Puget Lowland - This region includes the open hills and tablelands of glacial and lacustrine deposits. The ecoregion is bordered by the Coast Range Ecoregion to the west, the Cascades Ecoregion to the east, and the Willamette Valley Ecoregion to the south. The northern portion of this ecoregion consists of low elevation (sea level to 500 feet) flats abutting Puget Sound and Hood Canal and interspersed high hills ranging to 2,000 feet. The southern and peripheral portions of this ecoregion consist of a greater concentration of hills and foothills, with peaks often exceeding 2,500 feet. Average annual precipitation is moderate (35-50 inches), due in large part to the rain-shadow effect of the Coast Range mountains. Stream density is less than in the Coast Range Ecoregion; most streams draining this ecoregion are perennial. The large rivers drain the slopes of the Cascades and portions of the Coast Range Ecoregion, while smaller, independent tributaries drain the Kitsap Peninsula and other Puget Lowland basins. Some streams in the southern portion of this ecoregion drain to the Coast Range ecoregion. Most lakes are derived from glacial processes, although numerous human-made lakes and reservoirs exist as well. Estuary conditions in Hood Canal, and Puget Sound vary from shallow bays and inlets to very abrupt and deep areas with exposed rocky or vegetated bluffs and with nearshore substrates ranging from mud to large cobble.

Most of the region is forested. Douglas fir predominates, followed by western hemlock. The lower-elevation forests are all characterized by widespread conversion to other uses. Remaining forests tend to be early seral and dominated by Douglas fir and red alder. Other vegetation includes prairie grasses and oak woodlands.

The majority of the soils in the northern portion are formed from glacial materials in association with coniferous forest communities. A combination of well-drained and poorly-drained soils derived from volcanic or sedimentary rock deposits in association with coniferous soils is found in the southern portion.

The region is characterized by dense urban commercial, industrial and residential development, most often near the marine shorelines. The land-use density generally declines with increasing distance and evaluation from Puget Sound. A variety of lower-density urban and rural residential development combined with agricultural and forest lands uses occur in the eastern portion of this region.

C. Willamette Valley - A small portion of this ecoregion exists in Washington, primarily in Clark County and approximately north to the Lewis River where it abuts the Puget Lowland Ecoregion. In Washington, this region is bounded by the foothills grading into the Coast Range Ecoregion on the west and by the Cascades Ecoregion on the east. Elevation of the valley floor varies from 100 to 300 feet and local changes in relief are gradual. Elevation of the foothills average 1,000 feet in the northern portion of this ecoregion. Annual precipitation averages 40 inches, with the northern portion receiving proportionately more moisture than portions to the south. The majority of the streams draining the northern end are perennial. The relatively few natural lakes in this ecoregion are mainly abandoned river meanders forming oxbow lakes on broad floodplains. Several miles of mainstem Columbia River exist in this ecoregion.

The natural forest vegetation of this ecoregion is comprised of Oregon white oak interspersed with Douglas fir, grand fir, and big leaf maple) and mixed stands of cedar, hemlock, and Douglas fir. Riparian area trees include willow and cottonwood. Remnant prairie grass communities exist in the ecoregion.

Land use in the Washington and the abutting Oregon portion of this ecoregion consists of mixed agriculture, forest lands, rural and urban residential development, combined with high urban densities and industrial development along the Columbia River and Willamette Rivers.

D. Cascades - In Washington, this ecoregion is comprised of the Cascades Mountain Range and the Olympic Mountains. The Cascades Range consists of two distinct physiographic regions: the High Cascades or eastern portion of the range and the geologically older, more dissected western portion of the range. Streams range from alpine rivulets to the upper reaches of major rivers. Lakes in this ecoregion are typically cirques and tarns derived from alpine glaciation. This ecoregion is characterized by high mountains and deeply dissected valleys. This region has a broad range of elevations, ranging from near sea level in the Columbia Gorge to greater than 10,000 feet for many of the High Cascades Peaks. However most of the region lies between 2000 and 7000 feet in elevation and local relief often exceeds 3000 feet. Average annual precipitation across the entire Cascades Ecoregion varies from 50 to 100 inches.

Most of the area is densely forested with typical stands of Douglas fir, noble fir, Pacific silver fir, and western white pine, with western hemlock and western red cedar providing climax forest cover. Mountain hemlock, subalpine fir, whitebark pine, and Englemann spruce grow at higher elevations. Understory vegetation is comprised of vine maple, huckleberry, salal, oceanspray, and Oregon grape. Forest floors and alpine meadows contain a variety of herbaceous vegetation.

Soils in this ecoregion are developed primarily from pyroclastic and igneous rock types, although soils developed on glacial till are also abundant. Most upper elevation areas of this ecoregion are in federal ownership (national forests, parks and wilderness areas). Most of the lower-elevation forested slopes on federal, state and private lands are utilized for timber harvest.

E. Eastern Cascades Slopes and Foothills

This ecoregion is a transition area between the moist rugged Cascades to the west and the drier areas to the east. In Washington, this ecoregion is located from the Columbia River north along the eastern Cascades to a point just north of Ellensburg, abutting the southern portion of the Columbia Basin Ecoregion. Elevation varies from near sea level along the Columbia River to over 7,000 feet across the ecoregion and local relief varies from 500 feet to more than 2,500 feet. The density of perennial streams varies widely. Natural lakes are common in areas of poor drainage such as tableland and basin flats.

Ponderosa pine forests predominate throughout the ecoregion, but stands of lodgepole pine are common. The understory contains grasses and a variety of brushy species such as manzanita, snowbrush ceanothus and bitterbrush. Sagebrush/wheatgrass steppe vegetation occurs in the foothills. Quaking aspen occurs in riparian areas and poorly drained wet areas.

Soils are generally immature; developed from volcanic material, interspersed with more advanced soils derived from bedrock and glacial deposits.

Timber harvest is the predominate land use, and livestock grazing is common as well.

F. Columbia Basin - The Columbia Basin Ecoregion is characterized by a high degree of variability. This ecoregion is surrounded by mountain ranges: the Cascades to the west, the Northern Rockies to the northeast, and in Washington, the Blue Mountains. Elevation ranges from less than 200 feet at the Columbia River to greater than 4,500 feet on some mountain peaks and local relief varies from less than 100 feet as much as 2,000 feet. The landscape is composed of irregular plains, tablelands with high relief, and low mountains. Precipitation is variable, ranging across the ecoregion from 9 to 25 inches annually. Large rivers course through the ecoregion from sources in the adjacent mountain ranges. Almost all the Columbia and Snake Rivers are impounded in reservoirs. The only exception is the Hanford Reach, the last free-flowing reach and an area heavily utilized as a spawning area by fall chinook salmon. Independent streams are often intermittent and ephemeral. Because of water withdrawals and evaporation losses, most perennial streams experience periods of very low or no flow in their lower reaches or portions. Lakes are uncommon, most often they are coulee lakes formed by glacial meltwater streams and catastrophic floods resulting from breakage of ice dams on glacial lakes.

The region naturally supports sagebrush/wheatgrass steppe and grasslands primarily of wheatgrass with smaller amounts of bluegrass and fescue. Virtually all soils have been formed under these vegetation types, but soil formation has also been influenced by parent rock materials and climatic variability. Loess deposits cover the basalt formations in Washington.

Agriculture is the primary land use in the ecoregion (dryland wheat, some irrigated farming), along with some cattle grazing.

G. Northern Rockies - This ecoregion is comprised of the northern portion of the Rocky Mountains. In Washington, this ecoregion primarily lies in the upper northeast counties of Ferry, Stevens, and Pend Oreille. Across the ecoregion, rugged, high mountains are the dominant feature.

Coniferous stands of western white pine, lodgepole pine, western larch, Douglas fir, subalpine fir, and Englemann spruce are common. Ponderosa pine is found in some areas. Forest understory is commonly grass and forbs. Prairie vegetation consists of wheatgrass, fescue and needlegrass.

Timber harvest is the main land use, with cattle grazing common in the lower elevation open forests. Small acreages in valleys produce forage, grain and peas.

H. Blue Mountains - This ecoregion occurs primarily in eastern Oregon, but ranges into southeast Washington, primarily in Columbia, Garfield and Asotin counties. Most streams are perennial. Lakes are formed from alpine glaciation. Reservoirs are found on a fair number of streams. Precipitation is highest in the Washington portion of the Blue Mountains Ecoregion which is characterized by a relatively cool, moist climate, and wide variations in topography.

The mountainous portions of the Washington portion of the ecoregion support forests of grand fir/Douglas-fir, ponderosa pine, and western spruce/fir. In the Blue Mountains, small amounts of western juniper commonly occur. Steppe vegetation includes shrubs (Nootka Rose, Wood Rose) forbs (balsamroot, cinquefoil) and grasses (Idaho fescue, wheatgrass).

Soils that have been formed under forest cover at moderate to high elevations are often derived from volcanic ash. Significant loess deposition has also occurred in the northern Blue Mountains.

Land use ranges from agriculture in the lower elevations to grazing and timber harvest at middle elevations and wilderness area at the higher elevations.

Current Status of Salmonid Habitat

The wild salmonid production has been significantly reduced due to direct and indirect alterations of Washington's freshwater, estuarine and marine habitats across the ecoregions of Washington. These alterations have led to loss of habitat, loss of access to habitat areas, adverse changes in physical habitat structure, and adverse changes in water quantity (higher flood flows and lower minimum flows) and water quality. Even hatchery production has been reduced by habitat degradation increasing sediment loads in water used for fish rearing.

Habitat loss, damage, or modification were listed as contributing factors for 86 of the 93 Washington salmonid stocks identified as either at “high” or “moderate risk of extinction,” or “of special concern” (Nehlsen et al. 1991). Another study reported that of the 97 Washington stocks identified as healthy or marginally healthy, the freshwater or estuarine habitat for 80% of these stocks was rated as either “fair” or “poor” (Huntington et al. 1994).

Prior to development, an estimated 4,550 stream miles of Columbia River Basin habitat *in Washington* were accessible to salmonids. Today, due primarily to blockage by dams, only 3,791 stream miles remain accessible (Palmisano et al. 1993). Much of the remaining accessible habitat has been degraded from other impacts. WDFW (1994) identified about 2,400 culverts at road crossings that blocked access to nearly 3,000 miles of stream habitat across the state.

Estuary development has reduced salmonid habitat as well. Many nearshore marine areas have been converted to industrial, commercial, and residential uses. Conversion of these areas usually results in fills or protective bulkheading, both of which affect juvenile salmonid feeding areas, migratory pathways and other factors.

Tideflats, swamps, and wetlands in the Columbia River estuary were reduced by 40% (33,000 acres) during 1870-1970 (Sherwood et al. 1990). In the Skagit River Basin, agricultural diking and drainage has resulted in the loss of 54% of the lower river slough habitat (Beechie et al. 1993). The British Columbia / Washington Marine Science Panel (1994) report identified nearshore estuarine wetland habitat losses as severely affected by human activities, primarily in urban areas and secondarily in suburban and rural areas. Destruction of wetlands in Puget Sound was estimated at 58 per cent, in urban bays losses have been as high as 99 and 100 per cent in the Duwamish and Puyallup estuaries, respectively.

Physical habitat structure has been simplified or altered in both freshwater and marine areas. The frequency of large pools in managed watersheds of the Columbia Basin has decreased 28% over the past 50 years (McIntosh 1994), primarily due to losses of instream woody debris. The loss of large pools is estimated at 30-70% on national forest lands in the Pacific Northwest (PACFISH Strategy 1993). More than half of Washington's streamside riparian vegetation has been lost or extensively degraded since the early 1800s.

Human activities also affect stream structure. Increases in channel forming flows, the periodic flood events that scour and define stream channels, are often found in timber harvest areas. Such flow increases, associated with logging-related hydrologic changes and sediment supply, can be particularly damaging to spawning habitat (Peterson et al. 1992) through such effects as destroying or damaging salmon nests. Surface water withdrawals can reduce streamflows below levels required for salmonids. This reduces available spawning, rearing, and migration habitat (Puget Sound Cooperative River Basin Team 1991, Palmisano et al. 1993). Bulkhead and other forms of bank stabilization reduce stream complexity and also affect salmonid habitat.

Changes in land use can significantly influence habitat conditions. Rural forest and agricultural lands are often converted to residential and commercial uses as urban areas expand and the demand for land for development increases. For example, population growth and urbanization from 1930-1980 resulted in the conversion of more than 4 million acres of forest lands to other uses, and between 1979-1989 another 170,000 acres were converted (DNR annual reports, DCD 1988). The majority of lands converted in Washington are low elevation and are the most productive habitat for salmonids.

Water quantity and quality are often impaired due to increases in impervious surfaces (i.e. parking lots, shopping malls, etc.) and storm water runoff resulting from urban expansion. Winter peak flows are significantly higher and of longer duration; summer flows are reduced or subsurface and salmonid habitat is degraded or lost (Lucchetti and Furstenburg 1993).

Impacts of the Alternatives

Recovery of salmonid habitat will be a daunting, time-consuming, expensive task (NRC 1996, Independent Scientific Group 1996). It will require recognition and understanding of the frequency, magnitude, and duration of natural and human disturbance. It will also require interpretation of what was (i.e. "natural" conditions), an understanding of the positive roles of disturbance, and agreement on what is or is not possible or feasible in a restoration strategy (Naiman 1992, Lichatowich et al. 1995, Stanford et al. 1996, Spence et al. 1996).

Although some fairly extensive habitat inventories have been made in selected areas (e.g. Columbia River basin sub-watersheds, Puget Sound marine waters), no completely accurate or quantified inventory of historical or existing habitat is available for comparison over time. Most of the extensive major losses of habitat have probably already occurred due to early settlement and development of our major cities, land and water transportation networks, port facilities, agricultural and commercial forest lands, and power generation facilities. It can be argued that since so much habitat has been lost already, the potential for losing habitat in the future should be less. Unfortunately this is probably not the case. The pace of change in Washington State continues and the pressure on our habitat base will continue. The probable differences between historical and future habitat loss and degradation will likely be in the type and distribution of land use and land activities which affect habitat and increasing demand for water and power.

Population growth and a changing economic structure will stimulate most of these changes. Our population has gone from about 1 million people in the early 1900s to over 5 million today, and is expected to reach 7 million by 2020. Power (1995) observed that Washington State's economy is changing from one dependent on timber and aerospace to one that is more balanced, diversified and resilient; the extraction of raw materials is no longer the driving force.

All the policy alternatives, including Alternative 1, will likely lead to some improved habitat protection and restoration.

However, all the habitat alternatives will likely result in additional habitat loss, degradation or fragmentation. Even under the best applied land-use scenarios, in order to accommodate the growth that is anticipated for our state, more forest and agricultural land will be converted. The state Growth Management Act (GMA) requires that most new growth locate in areas already characterized by urban densities. This will result in increased loss of habitat through such activities as increased culverting to accommodate roads, or habitat degradation directly through the cumulative impacts of stormwater run-off and other pervasive impacts on water quality due in large part to non-point sources., diminished riparian area function and extent, loss of LWD, and the frequent dredging and bank hardening projects that are typical in urban settings.

GMA also requires that forest and agricultural lands of long-term commercial significance be protected over the long term. Some counties have done a creditable job with this, others have not, still others have not completed the process. The pattern in the Puget Sound counties has been to reserve those forest lands that occur in areas of higher elevation, steeper terrain, not generally suitable for development (King County 1995, Pierce County 1996, Thurston County 1995). This puts increasing pressure on salmonid populations in the lower elevations, which will be developed for rural residential or urban densities. Unfortunately, the lower elevation areas, which contain some of the most productive forest land (Kitsap County 1996) also contain many of the most productive salmonid populations; particularly anadromous fish.

Through the Timber, Fish and Wildlife process, significant changes to forestry practices have been made to address salmonid needs. However, the effects of timber harvest rates and patterns in the 1970s and 1980s will continue to be realized for decades to come. Riparian area buffers requiring some trees to be left were not formalized into state forest practices rules until 1987. Prior to that most streams were logged down to the water's edge, or buffers which were left were alder-dominated. It will take many decades for these riparian areas to regain the vegetation composition and size necessary for healthy habitat; particularly for LWD recruitment. Streams channels that were scoured to bedrock may take hundreds of years to recover. It may also take decades for harvested basins to attain hydrologic maturity. Road systems, many of which were poorly located, constructed or maintained, will continue to contribute fine sediments to streams. Some will fail, causing massive impacts to stream channels. Others may become or develop barriers to fish passage because of culvert problems.

The state's expanding population will need water to drink, irrigate their lawns and agricultural crops, and provide electricity for homes, businesses and industries. The Department of Ecology has determined that about half the state's area now has insufficient water to support all the needs of people, plants and animals.

Without some significant changes, agricultural activities will continue to affect salmonid habitat. Most agricultural activities are exempt from riparian buffer requirements or other critical areas protections required under GMA. There will be a continuing effort to drain agricultural land through stream dredging and/or dike construction and maintenance. In many river basins, irrigation water withdrawals severely deplete stream flows. Agricultural runoff and farm waste disposal will also continue to be a problem for salmonid streams. State and federal programs administered by conservation districts have been providing technical and financial assistance for salmonid protection to many farmers. The Department of Ecology has a dairy-waste control program and has levied large fines in several instances.

Marine areas will continue to be affected through alterations such as navigational channel dredging, or indirectly through accumulations of contaminants within marine sediments. In Puget Sound, the majority of marine shorelines outside urban areas are held in private residential ownership. This places enormous pressure on inherently unstable marine shorelines and bluffs. One can anticipate increased slope failures as the remaining sites are built and expect increased efforts by landowners to protect their property. Often the protection is directed at the bottom of the slope in the form of bulkheads, although many of the failures are the result of bank and bluff failures, not erosion per se (Canning and Shipman, 1994). Significant bulkheading has already occurred. For example, Canning and Shipman report that a recent survey in Thurston County indicated that the number of shoreline parcels armored (bulkhead) increased by 78 per cent over the past 15 years.

Alternative 1

Under Alternative 1, the "No Action" alternative, the following specific impacts would generally be expected for the natural environment:

I. Basin Hydrology and Instream Flows - In the areas outside of Urban Growth Area (UGA) boundaries of individual cities and towns, basin hydrology and instream flow conditions in watersheds would probably remain the same or continue to worsen.

Timber harvest and agricultural practices, continued conversion of agricultural and forest land to rural residential uses, resistance to maintenance or reestablishment of floodplain connectivity and function, and failure to establish or actively enforce instream flow programs are the probable causes. Lake and marine processes could be affected because of altered hydrological conditions due to watershed condition and upstream withdrawals. Mainstem Columbia River flow conditions could improve independent of this policy because of other planning and implementation processes. Existing licensing agreements at most other large dams would probably preclude provision of adequate flow conditions for salmonids.

Some improvement in basin hydrology and instream flows would be expected, however, due to increased stewardship efforts by landowners and regulators. For example, the Timber, Fish and Wildlife Group is beginning an analysis of existing riparian area protection rules (including those affecting streamflow) for state and private lands. Habitat Conservation Plans are in place or continuing to be developed which in some cases would include stream and riparian area protection by addressing stream flows. The federal Northwest Forest Plan for westside forests will likely improve watershed hydrological conditions as well. Water conservation strategies are being developed by water users. Local governments are becoming more aggressive in addressing hydrology issues.

Within UGAs, basin hydrology and instream flows would probably continue to worsen. Protection measures have not been proven to be entirely successful at attenuating peak flows, and there is little evidence that maintenance of minimum summer flows is attainable with current stormwater management technology. Flood plain connectivity and function would continue to be severely compromised. Groundwater aquifer recharge would be restricted because of high percentages of impervious surfaces and concern about aquifer contamination by urban runoff. Restoration of suitable hydrologic conditions for salmonids in urban streams is problematic as it would require very expensive retrofitting of existing systems and stream restoration efforts.

B. Water Quality and Sediment Quality, Delivery and Transport - Water and sediment quality and sediment delivery and transport are related to basin hydrology and instream flow issues. Outside of UGAs, water quality and sediment delivery and transport processes would continue to be compromised by timber harvest activities, particularly due to road surface erosion and road failures. Some improvement would be expected through the Timber, Fish and Wildlife forum, the development of Habitat Conservation Plans, implementation of the Northwest Forest Plan, and local government planning.

Agricultural practices, including crop production and livestock grazing, would likely continue to impact existing water and sediment quality and transport processes, although significant efforts are underway or proposed to remediate existing conditions. Low flow conditions exacerbated by water withdrawals will continue to result in above- normal water temperatures and below-normal dissolved oxygen levels, particularly in the ecoregions of eastern Washington. Improvement on state lands are expected through the use of the Ecosystem Standards for State-Owned Agricultural and Grazing Lands.

It is unlikely that lowland lake water quality conditions will improve appreciably, given the high residential densities along the shorelines and dependence on septic systems. Marine water quality may be improved somewhat. In Puget Sound this would likely be due to efforts under the Puget Sound Water Quality Action Team Work Plan, however physical nearshore alterations (proliferation of bulkheading, increased vegetation removal and slope failures, navigation channel maintenance, etc) will likely continue to compromise natural shoreline processes affecting salmonids and their prey-base species.

High rural residential densities, particularly along stream corridors, lake and marine shorelines, will continue to impact water and sediment quality and transport issues. Water quality will be compromised by on-site septic systems, stormwater, and degradation of wetlands and riparian buffers. Sediment levels transport will usually be affected during site development. A predictable pattern of bank hardening, channel dredging, wetland drainage, large woody debris removal, and channel realignment invariably occurs after forest and agricultural lands are divided into smaller and smaller parcels for rural residential development.

Within UGAs, similar patterns of diminished water and sediment conditions will likely result, except that the impacts will be generally more severe, more frequent and more long-lasting. The difference is that in agricultural and forest lands the impacts have longer recurrence intervals and recovery is more likely. For example, at a forest rotation age of 45-60 years, many functions of riparian areas are reestablished and hydrological conditions are generally restored. Within urban areas, recovery to predisturbance conditions is not usually possible. Spills and other stream contamination due to point and non-point discharges will likely worsen.

C. Stream Channel Complexity - The combination of the physical processes of basin hydrology and sediment routing and how they affect water quality, coupled with riparian area condition, will continue to have an impact on stream channel complexity. Transportation systems, impoundments and operations for hydropower generation, water supply, flood control and recreational/residential developments, will continue to impact stream channel complexity. Both inside and outside of UGAs, stream channels will generally continue to lose complexity due to altered hydrology, to current patterns of timber harvest, agricultural practices, conversion of these lands to rural residential densities, and to the activities of both rural and urban residents. There may be some improvement related to new rules designed to protect riparian areas within commercial forest lands. However, mainstem rivers, particularly those near ports and urban areas, will likely remain channelized, disconnected from their floodplains, dredged for navigational purposes, and generally devoid of large woody debris. Riparian areas near most rural and urban residences will be impacted by loss or degradation of riparian corridors, channel realignments, road crossings, disconnection from floodplains by diking or channel downcutting, and removal of most instream woody debris from channels. Sedimentation will affect aquatic insect production, decrease substrate hiding cover and reduce pool volume; all affecting salmonid survival and growth.

As above, full or partial recovery of stream channel complexity is more assured when lands are less fragmented and when land use is forestry, agriculture or large lot rural residential. Some counties have done a creditable job under GMA to retain forest lands, and maintain or restore floodplain and riparian functions.

D. Riparian Areas and Wetlands - If the riparian area is intact, but basin hydrology, instream flows and sediment delivery and transport are not within levels of natural variability, the riparian area alone will not protect the stream. An intact riparian area is of little value (at least in the near term) if the stream has been scoured to bedrock, or if the channel has been overwhelmed by sediment. A riparian area will be degraded or lost if instream flows are too low, or if the channel has incised to a point below normal groundwater levels.

Existing riparian area conditions may improve somewhat due to implementation of critical areas ordinances and changes in forest practices on state, private and federal lands, and changes in grazing standards on state lands. Riparian conditions may improve slightly on private agricultural lands through incentive-based programs involving cost-sharing and technical support.

Wetlands protection and restoration has received considerable attention in Washington, and one can expect some improvement in wetlands extent and function under the no-action alternative. However, most wetlands programs are narrowly focused on mitigation for activities on existing or proposed land uses, not on fundamental avoidance by applying land use zoning. As with riparian areas, protection of wetlands function and extent requires basin-wide attention to hydrology, instream flows, sediment delivery and routing, and flood plain connectivity.

E. Lakes and Reservoirs - Most lowland lakes will continue to be subjected to incredible development pressure. Although significant attention has been directed towards lakes, most action has been related to improving the aesthetics and human safety problems as opposed to maintaining or improving salmonid habitat. Given the current pressures and attitudes towards these issues, it is unlikely habitat conditions will improve and they may be further degraded. Reservoir conditions in the Columbia and Snake Rivers may improve as a result of changing operations of the hydropower system.

F. Marine Areas - Most marine areas, particularly in Puget Sound, will continue to be subjected to incredible development pressure both within and outside UGAs.

Marine habitat will continue to be lost or degraded. Most planning and permitting agencies allow intense development along our marine shorelines, relying solely on mitigation techniques to lessen the habitat impacts. Most marine shorelines are inherently unstable; primarily due to upslope soils and steepness, secondarily because of toe erosion from waves or currents. Most relatively stable sites have been developed, yet construction permits are still being issued at a rapid rate. Slope failures will continue to affect shoreline habitat. Bulkheading, often ostensibly to prevent shoreline erosion, will continue to proliferate as property owners react to these physical processes.

Our expanding economy is likely to expand existing or create additional shipping facilities at the expense of salmonid habitat. Off-site, out-of-kind mitigation has been proposed for marine habitat loss although it is almost impossible to recreate these marine habitats that are critical for salmonids and their prey base species.

In other less developed marine and estuarine areas, particularly Grays Harbor, Willapa Harbor and the Columbia River, there may be opportunities to reclaim upper intertidal areas and wetlands by breaching or removal of agricultural dikes. Navigational dredging and water-quality issues due to contaminated sediments will continue to pose risks to salmonids.

H. Fish Access and Passage - Fish access and passage is affected by a myriad of human-related actions and activities such as: mainstem Columbia/Snake hydropower operations, impoundments on other medium-sized rivers, run-of the-river permanent and temporary diversions, flow control and lake level maintenance structures, stream crossings, tidegates, regulated flows and water diversions. There is considerable interdependence among these issues. For example, adult passage conditions made difficult by low summer flow volume may be further exacerbated by water withdrawal, by excessive sedimentation which creates multiple channels for the already reduced flow, by a difficult jump into a culvert with too little depth and too high a velocity, by water too high in temperature and too low in dissolved oxygen, etc.

Stranding of fish can occur in numerous ways; by flow reductions or increases, by diversion into irrigation ditches and water conduits (water supply, hydropower generation), by ship wakes, by channel shifting and abandonment, and by channel maintenance.

It is likely fish passage and access will continue to be a serious problem for the foreseeable future. At this time WDFW has identified over 3,000 miles of fish habitat currently inaccessible due to roadway culverts. On the positive side, the Department of Transportation works closely with the WDFW to address fish passage needs for new and existing roads. Also the WDFW has entered into agreements with cities and counties to correct these problems, but it is expected that this work may take decades given the available funding. The technology for designing, building, and maintaining culverts to ensure fish passage is available, yet we have not yet fully mobilized jurisdictions to address the problem or fully educated private landowners on the issue.

Fish screening at run-of the river diversions will improve under this alternative. Considerable funding has been provided, particularly for the Columbia Basin ecoregion, to construct juvenile bypass systems. Resolution of passage issues at other larger facilities in the state depend in large part upon federal licensing conditions.

Animal Abundance and Diversity

Stocks of salmonids are disappearing using the current approaches described earlier. Early European visitors remarked about the magnificent runs of salmon that seemed inexhaustible. Salmon and steelhead inhabited every accessible body of water in Washington State in numbers that are difficult to believe today. Estimates suggest that salmon returns to the Columbia River alone numbered 11-14 million fish, considerably more than the total run for the entire state in recent years. Many of these same groups of fish are still present today, but in much lower numbers. Much of the richness and diversity of those early salmon stocks has also been lost. We will never know how many different populations and stocks of fish existed, but it is clear that many are now extinct and will never return. As we consider the current salmon resource, it is very important to remember the resource that once existed, so we clearly understand the risk of not protecting wild stocks in the future.

Anadromous Salmonids - The Washington Salmon and Steelhead Stock Inventory (SASSI) (WDF et al.1993) identified 435 separate salmon and steelhead stocks (see Tables 8 and 9). The SASSI inventory classified each existing stock into one of four categories based primarily on trends in survival and population size: Healthy, Depressed, Critical, and Unknown. Healthy stocks are experiencing stable escapement, survival, and production levels, and do not display a pattern of chronically low numbers. Depressed stocks are experiencing difficulties that result in lower than expected numbers of returning fish. Depressed stocks met one of several negative performance criteria such as chronically low numbers, a long term declining trend, or a sudden sharp drop in numbers, but are above the level where permanent damage to the stock has occurred. Critical stocks have declined

Table 8. Regional and statewide salmon and steelhead stocks.

	Chinook	Chum	Coho	Pink	Sockeye	Steelhead
PUGET SOUND						
North Puget Sound	15	12	14	7	1	22
South Puget Sound	10	23	11	2	3	13
Hood Canal	1	12	9	3	-	11
Strait of Juan de Fuca	3	8	12	3	-	14
Totals	29	55	46	15	4	60
COASTAL						
North Coast	21	6	18	-	3	24
Grays Harbor	9	2	7	-	-	10
Willapa	2	6	1	-	-	6
Totals	32	14	26	-	3	40
COLUMBIA RIVER						
Lower Columbia	17	3	18	-	-	23
Upper Columbia	30	-	-	-	2	18
Totals	47	3	18	-	2	41
STATEWIDE TOTALS	108	72	90	15	9	141
435 TOTAL STOCKS						

Table 9. Summary of salmon and steelhead stock status by species.

	% of stocks			
	Healthy	Depressed	Critical	Unknown
Chinook	50.0	32.4	4.6	13.0
Coho	41.1	37.8	1.1	20.0
Chum	67.6	4.2	2.8	25.4
Pink	60.0	13.3	13.3	13.3
Sockeye	33.3	44.4	11.1	11.1
Steelhead	25.5	31.2	0.7	42.6

to a level where there is a significant risk of loss of within-stock diversity or extinction. Data are lacking to make a judgement about the Unknown stocks. It is likely that they will fall in all categories. Note: In retrospect, we now realize that use of the descriptive word “Healthy” was a poor choice. It implies to a reader that habitat supporting each stock is also healthy. This was definitely not the intention.

Of the total of 435 wild salmon and steelhead stocks; 187 (43%) were rated as Healthy, 122 (28%) were rated as Depressed, 12 (3%) were rated as Critical, and 113 (26%) were rated as Unknown. One stock identified at the beginning of the inventory was later determined to be extinct. Of the stocks of known status, 58% were rated as Healthy, 38% were rated as Depressed, and 4% were rated as Critical.

Chinook stocks were rated as 50% Healthy, 32% Depressed, 5% Critical, and 13% Unknown. The Healthy chinook stocks are distributed throughout the state, with the strongest showing on the Coast and in the Lower Columbia River. A majority of the Depressed stocks are found in the Upper Columbia River. The five Critical stocks are all spring or spring/summer type fish with four in Puget Sound and one in the Upper Columbia River.

Coho stocks were rated as: 41% Healthy, 38% Depressed, 1% Critical and 20% Unknown. The Healthy stocks are found in Puget Sound and the Coast, while the majority of the Depressed stocks were found in the Lower Columbia River and Puget Sound. The one Critical stock was identified in the Strait of Juan de Fuca.

Chum had the highest percentage of Healthy stocks, with 68%. Of the three Depressed stocks, one was located in Puget Sound and two in the Lower Columbia. The two Critical stocks are summer chum returning to Hood Canal and the Strait of Juan de Fuca. The overall abundance of chum salmon has increased over the last ten years.

Pink salmon had the second highest percentage of Healthy stocks, with 60%. The two (13%) Depressed and two (13%) Critical stocks were located in Hood Canal and the Strait of Juan de Fuca.

Depressed was the most common status (44%) for sockeye salmon. These were found in Lake Washington and Lake Ozette. Healthy stocks made up 33% of the total including one stock from the Coast and two from the Upper Columbia River. One Critical stock was identified from the Skagit River system, though this has shown some improvement recently.

Steelhead had the lowest percentage of Healthy stocks (26%), and the largest percentage of Unknown stocks (43%). The steelhead stocks in the inventory included a number of small populations for which data were not readily available. Only one steelhead stock was identified as Critical (<1%). Depressed stocks made up 31% of the total.

Other recent reviews of the status of Washington salmon and steelhead stocks include Huntington et al. (1994) and Nehlsen et al. (1991). The former concentrated on identifying healthy native populations. They identified a total of 74 healthy and 23 marginally healthy native stocks of salmon and steelhead. Chum and steelhead accounted for 62% of these. Nehlsen et al. (1991) identified 26 salmon or steelhead stocks from Puget Sound and the Washington Coast that were at high risk of extinction, 8 at moderate risk, and 7 of special concern.

Resident Salmonids - Like salmon and steelhead, there has been a general loss of resident populations over time. The Washington Department of Wildlife (WDW) evaluated the status of bull trout and Dolly Varden in 1992 (Mongillo 1993). The statewide status of other wild resident salmonids, although known for some local populations, has not been systematically evaluated. We can only speculate on the current status of most species.

The 1992 evaluation estimated that a minimum of 77 distinct bull trout/Dolly Varden populations still remain in Washington. Nine (12%) were rated at high risk of extinction, six (8%) were rated at moderate risk of extinction, 14 (18%) were rated at low risk of extinction, and six (8%) were rated at no immediate risk of extinction. There were insufficient data to assign a level of risk to 42 (54%) populations. Based on recent data, the status of some populations has improved since the 1992 status report was published (C. Kraemer, WDFW, personal communication). Habitat destruction, poaching, over-harvest, and the presence of non-indigenous fish species have adversely impacted bull trout and Dolly Varden. Increases in water temperature as the result of land use practices may be a significant contributor to the decline of bull trout and Dolly Varden. Interbreeding between resident populations of eastern brook and bull trout can lead to elimination of bull trout (Markle 1992).

Resident coastal and westslope cutthroat trout are considered to be moderately healthy. Environmental alterations, over-harvest, introduction of eastern brook trout, and hybridization with non-native cutthroat strains and rainbow trout have caused a decline from historic abundance. The range of westslope cutthroat in Washington has increased substantially as the result of introductions into previously barren alpine lakes.

The status of searun cutthroat populations is less clear. Coastal populations appear quite healthy. Populations in Hood Canal are depressed and there is concern about southern Puget Sound populations. A conservative management approach is used with lower Columbia River stocks because their status is unknown.

Wild rainbow trout, like cutthroat, can be characterized as moderately healthy. Historic abundance of wild rainbow has been reduced as the result of habitat destruction, hybridization with cutthroat trout and exotic strains of rainbow, introduction of a variety of exotic non-salmonid species, and over-harvest.

Kokanee populations are generally healthy, although the indigenous Lake Sammamish and Lake Washington populations are critically low. The range of kokanee has been greatly expanded as the result of hatchery introductions. There are currently about 40 wild populations and 40 hatchery maintained populations. Habitat destruction has caused kokanee population declines in localized areas, while construction of reservoirs has increased available habitat suitable for kokanee in others.

Mountain whitefish populations are healthy, although habitat alteration and introduction of non-native species has probably had a negative impact. In terms of weight, mountain whitefish are the most abundant species in several Central Washington streams and may be increasing in numbers. Western Washington populations are stable.

Several pygmy whitefish populations are extinct, while the status of others is unknown.

One of the most abundant wild resident salmonids in the state is the non-indigenous eastern brook trout. Eastern brook trout have displaced cutthroat and bull trout in a number of areas. They have the ability to out-compete cutthroat, and the capacity to reproduce in habitat that has become marginal for cutthroat and rainbow trout. The other non-native resident salmonids are locally healthy and generally have limited reproductive success. Exceptions are lake whitefish which are found in Lake Roosevelt and the mainstem Columbia River downstream to the

Tri-Cities, and lake trout which are successfully reproducing in a number of waters including Eightmile Lake, Loon Lake, and Isabel Lake.

The outlook for escapements and stock size under Alternative 1 is very specific to species and region:

A. The majority (greater than 90%) of stream resident fishes should continue to meet the goal of a majority of the females spawning once. Future populations should not be limited by spawning population levels. One possible exception is bull trout.

B. Steelhead stocks that are meeting escapement goals should not be spawning limited.

C. Salmon stocks such as many of our pink and chum salmon, and north coastal chinook and coho that are relatively consistently meeting escapement goals should continue to do well.

D. Those stocks that are currently depressed, due in part to high fishing pressure, will continue to be depressed and likely will continue to decline unless different harvest regimes are adopted. This includes Puget Sound coho, chinook, and many steelhead runs, Willapa Bay chinook and coho, Lower Columbia chinook and coho and resident stocks in the lakes managed with large numbers of hatchery releases.

Figures 1 and 2 show the recent average escapement levels of Puget Sound chum and coho runs by categories of greater than the escapement goal, 80-100% of the escapement goal, 60-80% of the escapement goal, and less than 60% the escapement goal. These data show that chum runs are typically above goal, but most coho runs are well below goal, in fact well below healthy levels. Worse yet, many of the coho spawners are actually hatchery fish that did not return to the hatchery and are spawning in the wild.

Table 10 shows the percentage of salmon and steelhead stocks in various categories of stock origin and production type. This information is based on the SASSI inventory (WDF et al. 1993). Origin has to do with whether the stocks are native. Non-native stocks include stocks from within and outside Washington. Mixed origin

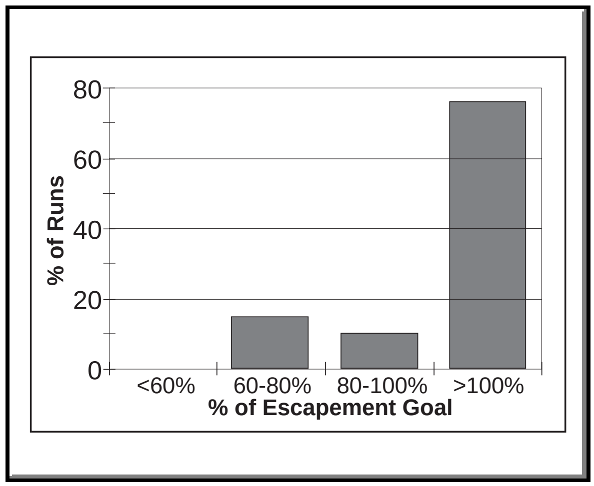


Figure 1. Recent year distribution of Puget Sound chum runs relative to escapement goals.

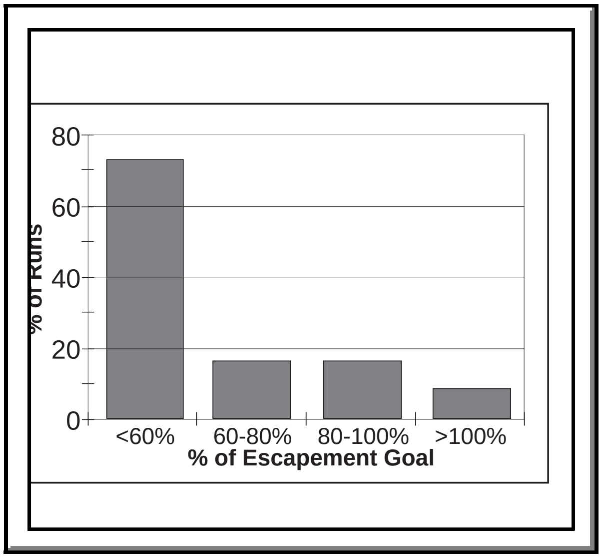


Figure 2. Recent year distribution of Puget Sound coho runs relative to escapement goals.

stocks are an intermediate group resulting from significant mixing of native and non-native fish. Production type describes the predominate source of the production: wild; composite which is a mixture of hatchery and wild; cultured; and unknown.

Currently less than 40% of the state's coho stocks are composed primarily of wild fish. Over 60% are a composite of hatchery and wild production. Even with the spawning of hatchery fish in the wild the coho escapements look poor. Under several of the proposed alternatives hatchery fish spawning in the wild would not be counted as part of the escapement of wild fish, so the escapement picture would look even worse. Other species show a varied pattern. Less than 60% of the chinook stocks are composed primarily of wild fish, but 71% of the chum, 100% of the pink stocks, 89% of the sockeye stocks, and 94% of the steelhead stocks are primarily composed of wild spawners. In the case of resident fish we would expect that most stream dwelling fish are wild. Lakes are probably a mixed bag, though many lakes with hatchery production in them do not support natural spawning so this is not an issue.

Genetic Diversity and Local Adaptation

If we continue the current approaches there will be a continued loss of genetic diversity and local adaptation due to small population sizes, gene flow, fisheries selectivity, and habitat loss and fragmentation. Exotic introductions are currently fairly limited. Stock transfers under current approaches may be a concern in some cases. The use of North Puget Sound coho stocks in the South Sound Net Pen complex, and the limited number of rainbow trout broodstocks used around the state are just two examples. Clearly there is significant gene flow between hatchery and wild spawners in many areas, particularly with salmon stocks. Nooksack, Lake Washington, Green River, Puyallup, and some of the South Sound coho stocks are areas where gene flow is a concern under the current approaches. This is also likely to be a problem for some Grays Harbor coho stocks, and coho stocks in Willapa Bay and the Lower Columbia River. This is certainly a concern for many Puget Sound chinook stocks, as well as in Willapa Bay and the Columbia River. Finally this may be a concern for the large number of off-station planting programs, particularly those using fry releases and remote-site-incubators. This high level of gene flow means that many of our wild stocks may not be achieving their full reproductive potential and are depressed below desirable levels.

Table 10 is a summary that gives an indication of the stock origin of our salmon and steelhead stocks statewide. Over 90% of our pink salmon stocks are considered native stocks; steelhead are at 80%, chum at 71%, chinook at 57% native and sockeye are at 56% (primarily because of the

Table 10. Percent of total stocks by stock origin and production type for Washington salmon and steelhead stocks (WDF et al 1993).

	Chinook	Coho	Chum	Pink	Sockeye	Steelhead	Total
Origin							
Native	57	17	71	93	56	80	318
Non-native	6	3	3		11	3	26
Mixed	31	77	19	7	11	13	158
Unknown	6	3	7		22	4	42
Production Type							
Wild	57	39	71	100	89	93	449
Composite	41	61	22			7	131
Cultured	2		3		11		16
Unknown			4				4

importation of sockeye stocks into the Lake Washington system many years ago). Only 17% of the coho stocks in Washington State are still considered native due to the high levels of gene flow that have occurred. The pattern for resident stocks is less well known. A number of exotic rainbow and cutthroat broodstocks have been used in Washington, and many areas of the state were extensively planted in the past. In recent years, the level of planting in streams has decreased dramatically, but the chance of significant gene flow in the past is very real. In lakes there continues to be a concern, since many continue to be regularly planted. The non-trout resident species have had less opportunity for gene flow. The possible exception is bull trout/Dolly Varden where there has been some interbreeding with eastern brook trout.

The current approaches are also at least partly responsible for the decline in individual fish size of many salmon stocks. Recent work has documented a 10% to 25% decline in coho weight over the last 35 years. This reduces the value of the fish for both recreational and commercial purposes. However, the most important impact may be that these smaller coho contain many fewer eggs. There has been a loss of nearly 1,000 eggs per female (approximately 40%) since 1960. This is a major reduction in productivity. It now takes nearly 1,700 females to lay as many eggs as 1,000 females did just 35 years ago. These 700 fish are not available to provide benefits to catches and they are not available to put extra eggs in the gravel to increase the population size. Also, since they are so much smaller, they do not provide as much of the needed ecological benefits. The smaller fish may not be able to spawn in some promising places, cannot bury their eggs as deep to escape scouring floods, and cannot defend their nests as well. Similar declines in size, due in part to fishing, have been identified for chinook.

The current approaches used for salmonid management carry some very real threats to the long-term health of salmonid populations. That risk increases the likelihood of listing of stocks under the Endangered Species Act.

Harvest Opportunity

Resident Fishes - Opportunities for harvest over the next 25 years should continue near current levels if habitat loss is prevented. Some currently depressed bull trout and Dolly Varden stocks should recover over the next 25 years due to the more restrictive fishing patterns of the last few years. This and increased use of selective fishing strategies may open the possibility of some expanded opportunity. Likewise, improved opportunity will occur when some of the many bull trout stocks of unknown status are determined to be healthy enough to support some level of fishing opportunity. Since many bull trout and Dolly Varden are susceptible to habitat damage, other populations will continue to be at risk of extinction and few opportunities will be available.

Most of the current resident fish catch comes from hatchery releases into lakes and reservoirs. This would continue.

Salmon and Steelhead - Fishery managers have reduced allowable harvest levels for salmon and steelhead in recent years in response to declining stock abundance. Mixed stock fisheries for salmon, especially in the ocean and Strait of Juan de Fuca, have been reduced dramatically or closed. Recreational and commercial harvest in the Columbia River for salmon has also been cut back significantly. Without major changes in the current human actions that impact salmonids, it is likely to expect more reductions in harvest opportunity, including elimination of some existing fisheries. Continued losses of opportunity for steelhead will result from losses of habitat productivity and capacity. Healthy steelhead stocks should continue to provide reasonable levels of utilization, provided the habitat base remains intact. Creative changes such as selective fishing can at least partially offset the decrease in fishing opportunity.

Salmon stocks that are managed for wild fish and are meeting escapement goals should continue to support harvest near current levels if habitat loss is prevented. The pattern of harvest may change with more harvest occurring in terminal areas and different harvesting gears being used. Most pink and chum stocks, along with a limited number of chinook and coho stocks, will continue to provide harvest benefits. However, these healthy stocks tend to be the most dependent on wild fish so there will likely be an overall decline in harvests due to habitat loss.

Current approaches for chinook and coho may provide the greatest opportunity for catch but these harvest levels are probably not sustainable. The low coho escapements seen in Figure 2 are a reflection of a general pattern of harvest rates that cannot be sustainable in the long run. The low stock sizes under the current approaches will be very productive due to the lack of competition etc., but they may also be more sensitive to environmental variation since they have less capacity to weather poor years and recover in the good years. There will also be more weak stocks needing protection that may limit mixed-stock fishing. Other concerns are that the high levels of gene flow may contribute to long term declines in stock productivity and harvest. Even if we have

Table 11. Proposed extinction risk assessments for Washington salmonid stocks resulting from NMFS preliminary West Coast ESA status review.

Species	ESU[1]	Extinction Risk
Chinook Salmon	Lower Columbia River Mid-Columbia River Spring-run Upper Columbia River Spring-run Upper Columbia R. Summer/Fall -run Snake River Falls Snake River Spring/Summer Washington Coast Puget Sound	"No majority conclusion" Listing not presently warranted "Likely to become endangered" Listing not presently warranted Listed as "Threatened" Listed as "Threatened" Listing not presently warranted "Likely to become endangered"
Steelhead Trout	Lower Columbia River Mid-Columbia River Upper Columbia River Snake River SW Washington Olympic Peninsula Puget Sound	"Threatened" "Candidate for listing" "Endangered" "Threatened" Listing not presently warranted Listing not presently warranted Listing not presently warranted
Coho Salmon	Lower Columbia River SW Washington Olympic Peninsula Puget Sound/Georgia Strait	Extirpated or endangered "Likely to become endangered" Status review re-opened Listing not presently warranted
Chum Salmon	Lower Columbia River Pacific Coast Puget Sound fall/summer/winter Hood Canal/Strait of Juan de Fuca summer	"In danger of extinction <u>or</u> likely to become so" Listing not presently warranted Listing not presently warranted "In danger of extinction"
Sockeye Salmon	Snake River Other basin populations (Columbia River) Lake Ozette All Puget Sound regional populations	Listed as "Endangered" Listing not presently warranted "Likely to become endangered" Listing not presently warranted
Sea-run Cutthroat Trout	Lower Columbia River Washington Coast Puget Sound	High potential for ESA-listing Listing not likely Listing not likely
Pink Salmon	Puget Sound	Listing not presently warranted

[1] Evolutionary significant unit
Note: listing of bull trout by USFWS is anticipated due to a recent court decision.

sufficient escapements, we should expect to see a decline in harvests due to habitat losses. Harvest rates will need to be reduced just to maintain the current escapement levels. The outlook for Puget Sound coho and chinook along with Willapa Bay and many Columbia River stocks is a decidedly poor situation. The outlook for hatchery contributions is one of declining survival rates and sustainability of the wild runs is a concern.

Other Benefits

Status quo provides the least benefits to non-consumptive, ecological, and cultural values. It produces the lowest population sizes of wild fish to help with nutrient cycling, food supply, and maintenance of ecological systems. Fewer fish are available to use the habitat and provide fish viewing and educational programs. Fewer fish can also mean a greater sensitivity to competition and predation. The problem with steelhead and sea lions at the Ballard Locks in Seattle is a function of a depressed run due to habitat declines, fishing pressure, and other productivity issues, combined with a situation where human changes have made an increased number of predators very effective. A nutrient enhancement program using hatchery carcasses to enrich the natural environment will increase the freshwater ecological benefits of the current approach.

Endangered Species Act Listings - The National Marine Fisheries Services has listed several evolutionary significant units (ESU's) of salmonids under the Endangered Species Act (see Table 11). Reviews of other species are underway and additional listings are expected. The geographic area likely to be affected by ESA implementation is presented in Figure 3 (excluding bull trout).

Land and Shoreline Use

As described earlier the existing patchwork of regulations and programs affect many land and shoreline use activities under Alternative 1.

Local ordinances that protect natural resources exist in different combinations in most, if not all cities and counties, at varying levels of protection. For example, King County has enacted a strong natural resource protection strategy into ordinances. There is a sensitive areas ordinance that is designed to protect critical habitats by requiring buffer widths in riparian areas, limiting or preventing development in and near wetlands , requiring stormwater restrictions, using incentives to prevent land conversion, zoning requirements, and many others. This can result in developers, commercial and residential, being required to downsize, redesign or delay their proposal, or in some cases not do the project. For example, a developer desiring to locate a new residential development along the Cedar River will have to include setbacks from the river that would eliminate a potential row of houses. They may have to redesign the plan to include stormwater controls. They may not be able to change or stabilize the river bank as desired, build roads or bridges as desired, or even may not be able to locate the development within the floodplain.

A farmland owner may be required to install fencing along each side of streams and wetlands to prevent or limit animal access. A residential landowner may not be able to add a garage on their property because the proposed site is a wetland. A sand and gravel operator may not be able to expand their gravel pit or even continue present operations.

Many other counties have a lower level of protection than King County, or in some cases, no protection at all. **The Growth Management Act** requires major cities and counties to develop

Figure 3. Potential ESA Listing for Washington State salmonid populations (excluding bull trout).

plans that include protecting natural resources; some have not completed these plans. Smaller jurisdictions are not required by state law to do this although some have done so. The **Shoreline Management Act**, administered by local governments, requires many development or activities that are located on the water or shoreline to be reviewed for environmental impacts.

The **NPDES** program is administered by the Washington Department of Ecology and requires compliance with standards for industrial water discharges through the **Clean Water Act**. New projects may not go forward if they are not expected to comply with the standards; existing industrial users are required to come into compliance within a specific time frame.

For examples, pulp and paper industries are being required to reduce the levels of toxics discharged in wastewater in order to continue operation; in many cases the companies are given lengthy periods to achieve the standards, frequently involving costly new designs and technologies. Fish hatcheries and aquaculture operations are required to have water discharges comply with permit requirements. Transportation systems are required to get NPDES permits, especially to assure stormwater does not reduce water quality. Sewage treatment plants and municipal water systems are also required to comply with the standards. Large livestock farmers are required to get a NPDES permit and be in compliance. In Columbia County, a rancher installs fencing and plants willows and alders along the stream banks using a mix of his own money and state funds through the local **Conservation District**. The **Forest Practices Act** is a state program and requires a permit for most timber harvesters that includes a harvest plan: road accesses, tree removal methods and timing, riparian management zones (buffers), chemical applications, land conversion planning links with local government, and many other aspects of timber operations are some of the issues covered by the permit. The Timber, Fish and Wildlife forum provides a process to address fish and wildlife issues in the forest.

The **FERC** relicensing process requires most hydropower dams to upgrade their facility to comply with state and local requirements for fish and wildlife before issuing a new license. Because these licenses last for long periods, up to 50 years, addressing the needs of salmonids at all dams will be a slow process. One of the longer, more complicated re-licensing efforts is the Cushman Project (Cushman and Kokanee Dams). Key issues include flow being diverted out of the north fork of the Skokomish River and fish passage needed for salmonids. The City of Tacoma, owner of the facility, has indicated that they may not be able to afford to continue operation and comply with fish protection needs.

The **Army Corps of Engineers** require permits for projects that require dredging , filling, or placing a structure in waters of the United States (includes wetlands, rivers, etc) For example, the siting and design of the Auburn Downs was limited by wetland considerations in the Army Corps Permit. A proposed garbage dump site for the City of Tacoma has been denied through this permitting process.

The **Hydraulic Project Approval** act requires that any activity that will use, divert, obstruct or change the natural flow or bed of any of the salt or freshwaters of the state will obtain a permit from the State Department of Fish and Wildlife to ensure protection of fish. For example, a citizen wishing to build a dock, bulkhead or boat ramp on a lake or marine shoreline is required to get a permit before construction. Construction along shorelines is not allowed during the peak juvenile salmonid migration. Another example is that gravel removal operations in or connected to waters of the state must receive a permit before removing any gravel. Marina development and expansion are subject to permit requirements. Bridges, culverts, sewer lines, and other water body crossing structures used by individual citizens or large municipalities are required to get a permit before proceeding.

The right to withdraw water is formalized by getting a **trust water right** from the Washington Department of Ecology. For example, a private landowner that wants to divert a portion of a stream out of the stream channel to irrigate should have a trust water right. There is a seniority to individual rights with those the most senior having precedence over younger ones. Likewise, large water withdrawals by irrigation districts, industrial users, aquaculture businesses, and municipal water systems are subject to the requirement of having a trust water right.

The range of impacts on land and shoreline uses include requiring design changes and site limitations for new projects, extending timelines for completion, denial of selected projects, requiring new technologies to continue to operate, and requiring operational changes that add costs and lower profits.

How come we have wild salmonids stocks being listed under the Endangered Species Act with all these programs? It is because they are a patchwork of programs with lots of holes. The effectiveness of many of the programs is constrained by lack of comprehensiveness, and staff and financial resources, (especially enforcement resources). In some programs many permit applications are analyzed without even visiting the site. Those sites that are visited seldom have a post-project completion visit. Many watersheds and marine shorelines are not covered by many of these programs.

Historical and Cultural Preservation

Meeting treaty Indian entitlements and the other historical and cultural aspects are at risk using status quo approaches. Salmon are a central element of tribal culture, woven throughout tribal economies and social and religious values.

Many coastal communities, small businesses and families have a historic and cultural reliance on salmonids. Many small businesses dependent on the fishing industry are gone or struggling; commercial fishers, marinas, ports, boat builders, fish buyers, charter offices, motels, resorts, bait shops, etc. Coastal communities like Sekiu, Neah Bay, Westport, LaPush, Ilwaco and others are being forced to adapt.

The opportunities provided by recreational fishing trips to pass values from one generation to another are declining.

Alternative 2

Habitat

This alternative, if fully accepted and applied, offers a high degree of habitat protection and recovery. However, given current emphasis on bottom-up planning and decision-making and other statewide collaborative processes, this alternative may not be well-received or implementable.

Animal Abundance and Diversity

Alternative 2 would provide the highest levels of stock abundance of any of the alternatives if fully implemented. Spawner numbers would be managed so that they fully utilize the available habitat. This means that we would expect to see the habitat producing the maximum number of fish that it can. Competition from exotic species would be avoided, as would competition and predation from hatchery salmonids. We would expect to see large increases in the abundance of wild stocks of chinook, coho, steelhead, and some of the resident species. Puget Sound coho escapements could increase from the current average of 211,000 fish per year to a range from 400,000 to 770,000 depending on the level of catches of Puget Sound coho in Canada, Alaska, and other non-Washington fisheries. Similar percentage increases might be expected in other wild coho populations around the state, as well as many chinook and steelhead populations.

Increases in other species, that tend to be meeting current escapement goals and have lower harvest rates, will be expected to increase as well, though perhaps not as dramatically. Chum and pink populations would be expected to increase. Increases in resident species will vary. Some relatively protected stream populations will not increase greatly. Other stream populations and some lake and reservoir systems may see much larger increases.

Stock abundances will likely be more stable, because the populations should be more robust and resilient in the face of a fluctuating environment.

Genetic Diversity and Local Adaptation

This alternative also provides a very aggressive and prescriptive approach to protect genetic diversity and allow development of locally adapted stocks. Stocks would be maintained at the highest levels. This would increase competition on the spawning grounds which would provide a broader distribution of the spawners and more likelihood of developing local adaptations. Stocks would be well above their minimum population levels so that diversity within stocks would be maintained. Stocks would be much less likely to disappear which would improve overall genetic diversity for the species. There would also be better connections for all of the units of the larger metapopulations, which would allow those habitats where stocks are lost to recover more quickly.

Gene flow would be greatly reduced over current approaches. No direct transfer of fish across stock or other boundaries would be allowed. This would reduce the movement and transfers of fish. It would have the least impact on pink, chum, and sockeye, less impact on chinook and coho in most areas, but would create the need for a series of new broodstocks for steelhead and resident fishes. Steelhead and resident fishes are often transferred long distances, which would not be allowed where it can impact wild salmonid populations. Gene flow between hatchery and wild fish would also be greatly reduced. This would require the development of new broodstocks and other programs to control the spawning of hatchery fish in the wild. This would require significant investments in facilities and man-power.

Harvest Opportunity

This alternative provides the lowest level of harvest opportunity of any of the proposed alternatives. As we described in Appendix C, full habitat utilization requires no harvest mortality for many salmonid species. Only a 5% incidental harvest opportunity would be provided for wild coho, steelhead, chinook and most resident species in order to allow the harvest of hatchery fish. This would require limited catch-and-release for all hook-and-line fisheries and very strict time and area restrictions on other fisheries. It may also require the development of very different gears and fishing locations to take advantage of returning hatchery fish. Hatchery production would be significantly reduced to comply with genetic conservation and ecological interaction limitations. Mixed stock fisheries and non-selective fisheries may be very limited or non-existent under this alternative.

Benefits

Resident fish - Under Alternative 2 we would expect all sport fisheries that catch resident wild salmonids to be catch-and-release. Any mortality on wild fish would be incidental. In most areas this would require the use of artificial lures or flies to reduce the handling mortality associated with using bait. As the populations grow, the success and quality of the catch-and-release fishing would go up. This will primarily affect streams and rivers and those lakes and reservoirs with self-sustaining wild populations. Populations that are not self-sustaining would see little impact from this.

Most of the current resident hatchery program is based on hatchery populations that would be rated as low similarity. As a result, any continuing hatchery programs will require new locally compatible broodstocks. This will likely impact some fishing as these new broodstocks are phased in over time.

The need to avoid any negative impacts on wild salmonids and other indigenous fish and wildlife will likely reduce the number of formerly barren waters that are planted. As a result, some fishing in alpine lakes that require periodic plantings may no longer be supported.

Steelhead - All steelhead fishing under this alternative would be wild fish release, except where complete closure was necessary to maintain the desired spawner levels. All mortality would occur as part of the catch-and-release process. Access to hatchery fish would be affected by this alternative as well. Meeting the genetic conservation criteria will likely require ending the early timed winter steelhead program that has been the main part of the hatchery steelhead program. This would require the development of new broodstocks from local sources and developing new facilities to hatch and rear them. In a few cases, this may not be economically feasible due to cold temperatures or the late timing of the wild fish that make it impossible to raise the young fish to release size in a single year.

Salmon - The Puget Sound coho harvest under this alternative will depend on the level of selective fishing, fishing in Canada and Alaska, and success in reducing hatchery fish spawning in the wild and increasing hatchery fish similarity. This would be typical of coho stocks on the coast and Columbia River and is indicative of harvest on other species.

Fishing opportunity on species such as chum, pink , and sockeye salmon would be expected to go down. Since they have a different shaped spawner-recruit curve (see Appendix B) some harvest may be available on these species, even at full habitat utilization. However, it will likely require lower harvests and lower harvest rates to achieve the desired spawner abundance level. One interesting issue is the possibility that current escapement levels for some chum and pink stocks are well below even the MSY escapement goal (J. Ames, WDFW, personal communication). Greatly increasing escapements to meet this alternative could result in higher catches if current goals are found to be low on the spawner-recruit curve.

Other Benefits

This alternative provides the greatest benefits to non-consumptive and ecological values. Wildlife viewing and the catch-and-release fisheries described above will benefit tremendously from the much larger populations of wild fish. Ecosystem health should be improved by the much larger numbers of spawning fish providing food and nutrient sources. Salmonids will not only be more abundant, but likely will be much better distributed across the habitat, so that the benefits are more widespread and accessible to more habitats.

Land and Shoreline Use

Strong enforcement of existing regulations and addition of new regulations would affect all of the land and shoreline uses described earlier. For example, many or all of the requirements described for King County's critical area ordinance would be applied statewide through new authority enacted by the state legislature or expanded rule making. Buffer zones along riparian areas and wetlands would be required statewide instead of only in those local governments that have ordinances that require them and the buffer widths would be the same size(s) throughout the state. This would mean that a farmer in Benton County would be subject to the same buffer zone and fencing requirements used in King County. Counties like King, Thurston, Pierce and others already have fairly strong resource protection ordinances. Landowners in counties that currently have limited resource protection ordinances (and those that do not have any) would be significantly impacted by statewide regulations. The potential impacts described in Alternative 1 would be more significant; affecting more land and shoreline uses in watersheds and along shorelines throughout the state. There would be impacts to some public services and jobs.

There would be statewide regulations on the use of aquatic weed chemical controls (e.g. copper sulfate), tougher requirements for construction of docks and bulkheads, less flexibility in development along rivers, wetlands, lakes, marine shorelines and connected uplands, additional controls on streambank stabilization projects, site limitation for new development, closer monitoring and regulation of septic systems, tougher regulation of surface and ground water use (instream flows for fish limiting irrigation, drinking water, etc.), and greater requirements for stormwater control systems.

There would greater controls on impervious surface construction (parking lots, roads, etc) , stormwater management, and water withdrawals (irrigation, municipal water systems, etc.). Residential and commercial development along rivers, wetlands, lakes, marine shorelines and connected uplands (including streambank stabilization) would be more limited. More limitation on gravel removal from floodplains, sewage treatment plant discharges, correcting failed culverts, streambank stabilization and diking would be required.

New or increased regulation of other industries would be required limiting impervious surface construction, increasing stormwater management requirements, limiting development along rivers, wetlands, lakes, marine shorelines and connected uplands (including streambank stabilization), controlling water withdrawals for industrial uses, controlling levels of chemicals in wastewater discharges, limiting gravel removal from floodplains, limiting streambank stabilization and diking options, and limiting dredging for navigation, docks, bulkhead construction, shoreline filling, and marine development, especially for eelgrass beds.

The consistency added by this statewide regulatory approach would make it easier for developers to be able to comply with regulations because there would be consistency throughout the state. Statewide application of buffer zones, stormwater requirements, wetland protection, etc. would have a major impact on land and water uses throughout Washington. Many landowners would view this as a loss of their property and some would not comply. Operational costs for many land uses would increase; some to the extent that profitability would disappear. Some specific projects would not be allowed at all.

Similarly, marine shoreline protection comparable to that used in Thurston County would be required statewide. Marine bluff development and septic system installation would be carefully regulated. In Thurston County, residential developments along sensitive marine shorelines are required to use septic systems that include sand filtration, and chlorination and dechlorination chemicals. The application of this level of protection statewide would greatly increase the cost of development along marine shorelines, and in some cases result in the land parcel not being useable for development.

Tougher standards would be required for hydropower and flood control dams for fish screens, and dam operations (flow control, etc.). Design improvements for fish passage and gas supersaturation controls, energy conservation and gravel supplementation programs would be required.

The statewide requirement of buffer protection zones presented as performance measures would have a major economic impact on the timber industry. Additional controls on forest practices such as changes in timber harvest, larger buffer strip requirements, longer harvest rotations, additional limitations on road construction, and requirements to decommission roads would increase the costs of doing business and reduce the available timber supply.

Agriculture would be affected by additional limits on water withdrawals for irrigation to comply with minimum instream flows. There would be limitation of grazing practices in riparian areas and in wetlands. Tougher standards for agricultural water discharges (such as irrigation outfalls and septic lagoons), fish screens and fish passage would be required.

Transportation systems would be significantly affected by new or increased regulation of road construction in riparian areas, wetlands and connected uplands. There would be additional requirements to address stormwater management, fish passage, bank stabilization, impervious surface construction, floodplain development, route limitations, wetland protection, bridge construction and maintenance, and dredging for navigation. These requirements would increase costs and timelines for project completion, and in some cases prevent specific projects from being completed. It is unlikely that state and local government officials would enact the proposed regulations into law due to the current concerns about existing environmental regulations.

Historical and Cultural Preservation

Those cultural values that are linked to harvest opportunity will not be well served by this alternative, especially for commercial use. There will be fewer fishermen to carry on traditional occupations for many tribal and non-tribal families. However, those cultural values that focus on the health of the natural world will find great benefits from larger numbers of fish and the ecological benefits from this alternative. This too is an important part of the tribal culture as well as many in the non-tribal community.

Businesses and coastal communities dependent on mixed stock fishery benefits would be affected significantly by this alternative.

Alternative 3

Habitat

This alternative offers a high likelihood for increased habitat protection and recovery. Locally-based problem solving is widely recognized as the planning tool of choice. But in contrast to being a fully open-ended and “bottom-up” approach developed only by local citizens, this alternative would also include governmental agencies as partners, and would provide a state template of performance measures and action strategies that could be applied locally. This alternative is recommended by the agency (WDFW). The Fish and Wildlife Commission has not taken a position on any of the alternatives as yet.

Animal Abundance and Diversity

Stock Abundance

This alternative provides levels of stock abundance that are generally less than Alternative 2. The primary spawner abundance criteria of abundant utilization of the habitat provides some flexibility to meet local needs, but still provide a relatively high level of spawners. In the Skagit River extra chum salmon could be specifically allowed to spawn to meet the needs of the local eagle population. Extra pink salmon could be allowed to spawn because of the information that says this improves coho salmon survival. In general more fish would be allocated for spawning as part of a general effort to meet

ecological needs. At these moderately higher levels of spawning, compared to Alternatives 4-5, we would expect overall abundance to be somewhat more stable.

There would also be a major improvement in the distribution of the escapements. Many of the current management units for coho are not consistently meeting their escapement goals, and some are well below. Under this alternative every stock within every management unit would be required to meet its escapement goal. Similar results would be expected for other coho stocks as well as chinook and steelhead.

Resident fish would also see an increase in spawner abundance. It is likely that some form of increased size limit would be necessary to achieve a lower overall harvest rate.

Genetic Diversity and Local Adaptation

The larger population sizes, better distributions, lower human-caused gene flow, lower fishery selectivity, and greater connection between populations would provide improvements in both diversity and local adaptation compared to the status quo.

Harvest Opportunity

The impact of this alternative on harvest opportunity will depend in large part on how flexible and creative we can be in developing new fishing strategies, gears, locations, hatchery release and rearing techniques, and broodstocks. If we are willing to be creative and adapt to some change then the impact to overall harvest opportunity will be much less.

Resident stocks - This alternative affects harvest opportunity on resident stocks. It will require lower overall harvest rates that will provide greater opportunity for spawning. Instead of setting up a fishing pattern so a majority of the females spawn once before they reach a size where they are available to the fishery, it may be necessary to set the size limit so some of the females spawn twice. There is also likely to be much greater use of selective fisheries and catch-and-release fisheries in order to lower harvest rates. Since the populations will be more abundant and contain larger fish, the quality of catch-and-release fishing will improve.

This alternative will likely not have a great impact on lowland lake and reservoir fishing where there is limited spawning area, or that cannot support wild fish. The need to avoid impacts on other indigenous species will probably reduce the number of alpine lakes that are stocked with resident species. It is likely that only those lakes that support populations without new plantings will continue to contain resident fish.

Steelhead - This alternative will likely reduce the overall harvest of wild steelhead due to the need for larger escapements in most streams. This will likely require greater use of selective and wild fish release strategies. Due to the larger population sizes these fisheries may be more effective than in the past. There will also be a large impact on the current hatchery programs. The early-timed hatchery fish used in most areas will likely be classified as having low similarity. The requirement that less than 1% of the spawners be low similarity hatchery fish will probably mean no longer using early timed hatchery fish. This can be compensated for by using local broodstocks and developing higher similarity stocks. This will require a significant investment in time, manpower, and

hatching facilities. It may not be possible in some areas. Other approaches of locating hatchery releases so that they are fished at higher rates or can be captured and removed as adults will continue to be necessary.

Salmon - The impact of this alternative on salmon harvests will vary by species. All the species will be affected by the need to provide additional spawners, so lower overall harvest rates are expected. Pink, chum, and sockeye stocks that are caught primarily in Washington waters, and that are typically meeting their escapement goals, will be affected the least. The possibility that the current escapement goals are lower than optimum will be tested in this approach, and there is a good chance that harvests could increase for many stocks.

Chinook and coho fisheries in Washington waters will likely be affected to a greater extent. First, much of the harvest of these fish occurs in Alaska and Canada. In the absence of new agreements, the initial need to improve escapements will come primarily from the Washington fisheries. With new agreements that provide additional protection to Washington stocks comes greater opportunity and flexibility for Washington fisheries.

The fisheries will likely change in location. Any directed fisheries on wild coho and chinook will likely occur in terminal areas. Stock-level management means that there are more populations that will need to be considered, and have the potential of limiting fisheries. This will require an ability to more clearly target the stronger stocks and protect the weaker ones. Traditional mixed-stock marine area fisheries will likely be selective fisheries only directed on hatchery fish or other species. The 10% incidental harvest limit will limit fisheries compared to current approaches.

There will also be a need to look for new harvest and production strategies that can do a better job of harvesting hatchery fish while protecting wild fish. For example, changes in release and recapture strategies so that hatchery fish are not spawning in the wild and new gears that can selectively and efficiently harvest hatchery fish while protecting wild fish will be needed.

Achieving higher catch levels on Puget Sound coho will require major investments in facilities and man-power to develop and raise new, higher similarity hatchery fish and provide alternative release locations. This same kind of impact would be expected for Puget Sound chinook and chinook and coho populations on the coast and Columbia River.

Protecting salmonid populations and other indigenous fish and wildlife populations may also impact harvest opportunities for hatchery salmonids and exotic fishes. The requirement that hatchery and exotic fish programs have no significant negative impacts on salmonids and other indigenous fish and wildlife species will almost certainly require changes in those programs over time.

Other Benefits

This alternative would also provide increased benefits to non-consumptive and ecological concerns compared to Alternative 1. The larger populations, better distribution of spawners, and more productive spawning populations would provide better viewing and better opportunity for low consumption uses like catch-and-release fisheries. The larger population sizes will provide more nutrients, larger food supplies, and generally provide

greater benefits to ecosystems that contain salmonids. Protecting some ecosystems may require that we stop planting lakes and streams that did not historically contain salmonids, and allow natural ecosystem relationships to redevelop. This is most likely to occur in alpine lakes and waters above anadromous blockages that now have anadromous fish. Protecting key salmonid populations will likely require significant changes in the use of exotic species, particularly warmwater competitors and predators that have taken over waters that used to contain self-reproducing populations of salmonid fishes. The requirement to have no significant impacts from either hatchery or exotic fisheries programs will require new efforts.

Land and Shoreline Use

The local watershed approach will require private and public land and water users to work with local watershed groups to develop and implement solutions, in some cases increasing costs and opening operating procedures to greater public review. It would affect many, if not all, of the land and shoreline uses described earlier but allow more flexibility in addressing conflicts between salmonid and human needs. Local groups would have the freedom to creatively address problems; incentives may be used instead of regulation, etc. It may reduce existing regulations and result in new ones. Land and shoreline uses would be affected differently in individual regions. It is expected that this approach will have less impact than Alternative 2 on land and shoreline users but the specific impacts cannot be specifically described.

Historical and Cultural Preservation

This alternative would require significant , although fewer than alternative 2, changes in the existing non-Indian culture of recreational and commercial use. Coastal communities dependent on mixed stock fishery benefits would be still be affected significantly by this alternative.

Alternative 4

Habitat

This alternative, if accepted and implemented, would yield habitat protection and results similar to Alternatives 2 and 3. However, the default regulatory standard may discourage acceptance of state agencies as collaborative partners in locally-based watershed planning. Loss of local initiative and problem solving may be the result.

Animal Abundance and Diversity

Stock Abundance

This alternative will continue to provide healthy stock abundance levels for most Washington salmonid stocks, since most management units, and likely most stocks, will be managed near the MSY level. However, in some cases, management units and stocks will be managed at less than MSY; perhaps as low as 50% of the MSY escapement level. This is a lower standard of protection than is currently afforded to most stream resident populations. Most stream populations are managed on a local population or stock basis and it is unlikely that many entire stream systems will be managed at this lower level. Where the low standard of protection is applied, there will be some reduction of overall population sizes compared to current levels.

Steelhead are also generally managed with a higher level of protection than is afforded under this alternative. Very few runs are managed with the intent of being less than the MSY level currently. Any expansion of this approach will result in lower stock abundance of steelhead runs and greater risk to long-term stock survival.

This alternative provides a higher level of protection than is currently applied to a number of salmon stocks. It will result in significant improvements in stock abundance and stock health for those chinook and coho stocks that are currently managed as secondary management units, but would now be managed for MSY. It would provide some increased protection for populations that are currently escaped below 50% of the MSY level. Figure 2 shows that 9 of 14 Puget Sound coho runs average escapements less than 60% of MSY. Overall, this alternative represents a small reduction in escapements compared to the 1986-91 average, but stocks with the lowest escapements will see marked improvements. The Snohomish and Skagit systems will drop from 66% of the total coho escapement to only 49%. This increase in stock abundance would also occur for many Lower Columbia and Willapa Bay chinook and coho stocks, and Puget Sound chinook. This will provide a greater level of protection of stock abundance against environmental variation and other problems.

Genetic Diversity and Local Adaptation

This alternative will provide significant improvements over the current approaches in the area of genetic diversity. The minimum stock abundance criteria will be most useful in this alternative where stocks will be managed at lower levels. The criteria for preventing genetic extinction due to human caused gene flow between stocks, GDUs, and MALs provides greater protection for many species, particularly steelhead and resident fish, than is found under the current approaches. The requirement to respond to areas of high gene flow between hatchery and wild fish to determine if the wild population is at risk is also an improvement for many salmon, steelhead, and resident populations. Finally, the requirement to maintain the full range of diversity in the unfished portion of the population will help maintain stock diversity and local adaptation.

Harvest Opportunity

This alternative provides more flexibility for management, bringing the potential for greater utilization opportunities when stocks of different productivities are in the same mixed-stock fisheries. Again the challenge for utilization is a willingness to adopt new approaches and strategies that take advantage of harvest opportunities on stronger wild runs and hatchery runs, while providing the necessary protection to wild fish.

Resident species - Most stream resident species will not be affected by this alternative. Since most resident stocks are managed on a stock by stock basis, there will be limited application for this alternative for either stream or lake resident populations. This does create the opportunity for limited scale hatchery based fisheries that could increase harvest opportunities in a targeted way.

Steelhead - Most steelhead runs would also be less likely to be affected by this approach, since they are most often managed similar to Alternative 3. This approach would provide some greater flexibility for management in a few situations.

Salmon - The harvest management aspects of this alternative are similar to management of many current salmon runs. However, the combination of the genetic conservation and harvest management options has some significant impacts on harvest, except at fairly high levels of selective fishing. This alternative will require some specific approaches to intensive selective fishing to maintain current levels of harvest opportunity.

Other Benefits

This alternative will provide some significant benefits to ecological and non-consumptive uses for some runs compared to current approaches. However, in most cases it will not represent a great improvement. If it can sustain fishing opportunities that might otherwise be lost, it will have positive benefits for some fishing communities and fishing dependent economies.

Land and Shoreline Use

The blend of local watershed decision making and new regulations will require previously described land and water users to work with local watershed groups to develop solutions and comply with new regulations. It would allow less flexibility than Alternative 3 and more than Alternative 2. Land and shoreline uses may be affected differently in individual regions and the specific impacts cannot be determined.

Historic and Cultural Preservation

This alternative would require some, although fewer than alternative 3, changes in the existing non-Indian culture of recreational and commercial use. Coastal communities dependent on mixed stock fishery benefits would be still be affected significantly by this alternative.

Alternative 5

Habitat

Habitat outcomes for this alternative are unclear. This approach most closely fits the definition of "bottom-up" and collaborative planning and is likely to be more readily accepted locally than Alternatives 2-4. However there is no method of evaluating whether performance measures or action strategies developed under this alternative will adequately protect or restore habitat.

Animal Abundance and Diversity

Assuming habitat is not a limiting factor, this alternative will continue to provide healthy stock abundance levels for most Washington salmonid stocks. However, in some cases, management units and stocks will be managed at less than MSY; perhaps as low as 50% of the MSY escapement level. This is a lower standard of protection than is currently afforded to most stream resident populations. Most stream populations are managed on a local population or stock basis and it is unlikely that many entire stream systems will be managed at this lower level. Where the low standard of protection is applied, there will be some reduction of overall population sizes compared to current levels.

Steelhead are also generally managed with a higher level of protection than is afforded under this alternative. Very few runs are managed with the intent of being less than the MSY level currently. Any expansion of this approach will result in lower stock abundance of steelhead runs and greater risk to long-term stock survival.

Fishing Benefits

This alternative provides the greatest flexibility for management, bringing the potential for greater utilization opportunities when stocks of different productivities are in the same mixed-stock fisheries. Again the challenge for utilization is a willingness to adopt new approaches and strategies that take advantage of harvest opportunities on stronger wild runs and hatchery runs, while providing the necessary protection to wild fish.

Resident species - Most stream resident species will not be affected by this alternative. Since most resident stocks are managed on a stock by stock basis, there will be limited application for this alternative for either stream or lake resident populations. This does create the opportunity for limited scale hatchery based fisheries that could increase harvest opportunities in a targeted way.

Steelhead - Most steelhead runs would also be less likely to be affected by this approach, since they are most often managed similar to Alternative 3. This approach would provide some greater flexibility for management in a few situations.

Salmon - The harvest management aspects of this alternative are similar to management of many current salmon runs. However, the combination of the minimum escapement level for all wild stocks, genetic conservation and harvest management options has some significant impacts on harvest, except at fairly high levels of selective fishing. This alternative will require some specific approaches to intensive selective fishing to maintain current levels of harvest opportunity.

Non-consumptive Benefits

This alternative will provide some significant benefits to ecological and non-consumptive uses for some runs compared to current approaches. However, in most cases it will not represent a great improvement. If it can sustain fishing opportunities that might otherwise be lost, it will have positive benefits for some tribal and fishing communities and fishing dependent economies.

Land and Shoreline Use

This alternative would impact most, if not all, land and shoreline uses described earlier but those impacts cannot be determined because the actions have not been determined yet. Land and shoreline users participating in existing processes like Timber, Fish and Wildlife would probably be affected initially. This is because some land and shoreline uses do not have ongoing forums to address natural resource issues. Agriculture is one example of a group of land users for which there is not a regional forum to bring natural resource concerns.

Historical and Cultural Preservation

This alternative requires the least amount of change for non-Indian fisheries compared to Alternatives 2-4.

APPENDIX A RESOLVING CONFLICTS BETWEEN AND WITHIN SPECIES AND STOCKS

We plan to resolve species and stock conflicts using guiding principles based on stock origin, stock status, and the relative value of different stocks.

Stock Origin Guiding Principles:

➤ The highest priority for management of wild fish is resource protection of native stocks.

➤ Locally adapted stocks are of a higher priority than newly introduced stocks.

➤ The priority for management of exotic species is primarily to provide fishery benefits, within the guidelines of sound management principles that also protect native species.

These principles result in the following stock priorities:

Highest Priority -Native stocks - populations that are relatively unchanged from before European settlement residing in their original habitat.

Second Highest Priority -Mixed origin stocks - populations originating from native and non-native stocks; or a previously native stock that has undergone substantial genetic alteration.

Third Highest Priority -Non-native stocks - populations from a native species that are outside their original habitat.

Fourth Highest Priority -Exotic stocks - stocks originating from outside Washington of species native to Washington.

Lowest Priority-Exotic species - species that are not native to Washington.

> Stock - the fish spawning in a particular lake or stream(s) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place at the same time, or in the same place at a different time.

Note: To date, the above definition has not always been applied consistently. For example, "stream(s)" was sometimes used to combine nearby but independent tributaries (to saltwater) into a single "stock." In addition, the application was not consistent between Pacific salmon and steelhead. These problems will need to be corrected if the final policy mandates stock-by-stock management.

Stock Status Guiding Principles:

➤ Critical and Endangered status stocks or species have the highest priority in terms of stock protection actions, to remedy the risk of extinction. It is recognized that it is also very important (especially more cost effective) to protect existing healthy stocks. Prioritization will involve balancing these two important issues.

➤ Depressed and Threatened status stocks or species have a high priority in terms of stock protection actions, to restore them to Healthy status. Stocks rated Unknown (SASSI) will be managed conservatively until their status is determined.

Relative Value Guiding Principle

➤ Higher priority will be given to those stocks that provide the greatest level of benefits or value. This includes the full range of economic, social, ecological, cultural, and other values provided that native stocks and established indigenous stocks are maintained at self-sustaining levels; and the recovery of Critical, Endangered, Depressed, and Threatened stocks or species is not impacted.

Application of Priority Criteria

Any management action directed at one species that has the potential to affect other salmonids should be examined using the three stock priority criteria. Examples of applications of these priorities:

<u>Examples of Applying Recommended Stock and Species Priorities</u>

The following are several hypothetical examples to show how we might apply the recommended policies in Chapter 3 under three different scenarios.

Example One

A coho salmon enhancement program is proposed for a group of streams that support chum, coho, cutthroat, and steelhead; all native stocks. The project involves the construction of coho rearing ponds to be stocked with coho fry hatched from eggs taken from the local coho stock. The intent of the new coho production is enhancement of regional sport, commercial, and tribal coho fisheries. Over the last decade, the chum stock has suffered a steep population decline because of the combined impacts of habitat degradation and over-harvest in commercial coho fisheries, and is currently rated as Critical status. Although the proposed coho enhancement would use the local, native coho as a brood stock, the result could be higher harvest rates on coho (and incidentally on chum) and the enhancement coho would impose increased biological impacts (competition and predation) on the chum. In this case, the proposed enhancement project would significantly impact a Critical stock and would not be authorized under this policy.

Example Two

A local community group wishes to restore chum salmon to a stream that supported strong runs in the recent past but, because of severe habitat degradation, chum have been absent from the stream for over a decade. Moderate numbers of coho and cutthroat trout currently inhabit the stream, particularly in its upper reaches. The group's proposal is to undertake a major habitat restoration effort, coupled with the reintroduction of chum salmon using egg incubation boxes for one to two cycles. The chum eggs would come from a local stock in an adjacent stream that typically has spawners in excess of its escapement goal. An evaluation of the proposal finds the numbers of chum likely to be produced by the stream would not generate increased commercial fishing pressure that would negatively impact the existing coho population. The habitat restoration would have positive effects on both the coho and cutthroat, and outmigrating chum fry would provide forage for both species. The positive values of the chum restoration (community involvement and contributions to various fisheries) coupled with the expected lack of negative biological interactions, would be strong reasons to approve this project.

Example Three

Construction of a fish ladder is proposed to allow introduction of steelhead above a barrier to the migration of anadromous fish. The stream has a self-sustaining population of resident cutthroat trout that were introduced to the area sometime in past years. These cutthroat are an indigenous species but are not native to the stream reach in question. An analysis of the potential interactions between the steelhead and cutthroat trout shows the steelhead would cause a substantial reduction in the abundance of cutthroat, but they would continue to exist at healthy, self-sustaining population levels. At this point the relative values of the steelhead and cutthroat production would be considered. The steelhead, once established, would contribute to various sport and tribal fisheries, while a diminished cutthroat population would provide a reduced opportunity for an established stream sport fishery focused on resident trout. Weighing the relative values of the two species, it would likely be decided the locally adapted cutthroat had the higher value because they provide a unique stream sport fishery for resident cutthroat trout, while there is extensive steelhead fishing opportunity within the region. The likely decision would be to forego the proposed steelhead production because of the high value placed on a unique, existing cutthroat sport fishery.

APPENDIX B DISCUSSION OF KEY ELEMENTS OF WILD SALMONID POLICY

The Wild Salmonid Policy addresses six elements; like the legs on a six-legged table, each of the policy elements is critical to achieving the goal of healthy stocks and sustainable benefits. Meeting some of the elements may slow the rate of decline, but will not change the ultimate result of more stocks in trouble and less benefits. This means a balanced approach is necessary. We need the participation and cooperation of everyone who impacts the salmonid resource. It cannot be just the harvesters or just the people who affect habitat. Everyone has a role in achieving the policy goal. The policy elements include:

A. **Habitat -** fish need a safe and productive environment to live in. The habitat must be capable of supporting populations large enough to sustain the resource and to provide the desired level of benefits.

B. **Spawner Abundance -** the right number of spawners are needed to sustain healthy salmonid populations, rebuild weak ones, and maintain overall ecosystem health.

C. **Genetic Conservation -** we need to sustain the basic productive capacity of stocks by protecting genetic diversity and allowing stocks to develop those traits that will make them successful in their local environment.

D. **Ecological Interactions -** salmonid fishes are part of complex ecosystems that must remain healthy if we are to be successful. Healthy ecosystems also require healthy salmonids as well.

E. **Harvest Management -** fisheries must be controlled to meet spawner abundance, genetic conservation and harvest objectives.

F. **Hatcheries -** hatcheries are important tools for providing harvest, mitigating for natural production losses from lost habitat, and rebuilding depressed runs.

In the following sections we discuss these elements and explain their importance to meeting the overall WSP goal. This is followed by a discussion of the policy issues and possible options for each element.

<u>A Model for Understanding Salmonid Populations</u>

In order to understand the implications of the various elements we need a picture, or model, of how the number of spawners relate to the number of offspring they produce. A model can allow us to compare how the elements affect fish populations. Figures 1 and 2 represent two typical pictures for salmonid fishes. Most typically the number of offspring is measured as the number of adult fish that become available, or recruit, to the fishery. Thus this model is called a spawner-recruit model.

Each species and stock of fish has its own unique spawner-recruit relationship. The shape of the curve in Figure 1 is descriptive of species that compete for rearing space or food in freshwater such as coho, steelhead, and most of the resident salmonids. Figure 2 reflects species that tend to spawn in large numbers and compete for spawning area. This would be typical of pink, chum, and sockeye populations. These models are a greatly simplified picture of how salmonid populations actually operate. However, they can be a useful tool for understanding what is happening.

In both figures the curved line represents the number of adult fish, or offspring, that are produced from different levels of spawner abundance. For example, if we had the number of spawners represented by the letter S on each figure we would get a number of adults equal to B on the curved line.

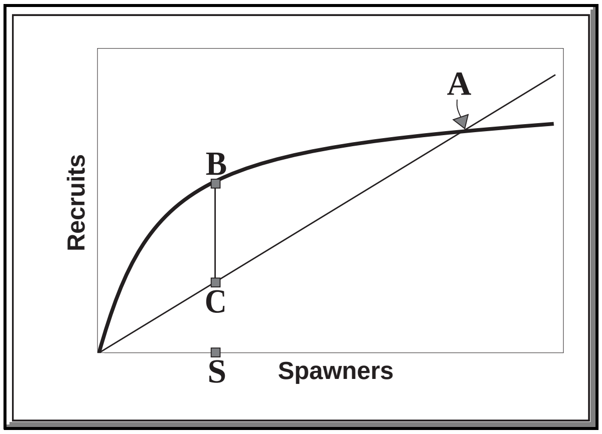


Figure 1. Spawner-recruit curve for species that compete for rearing space or food in freshwater.

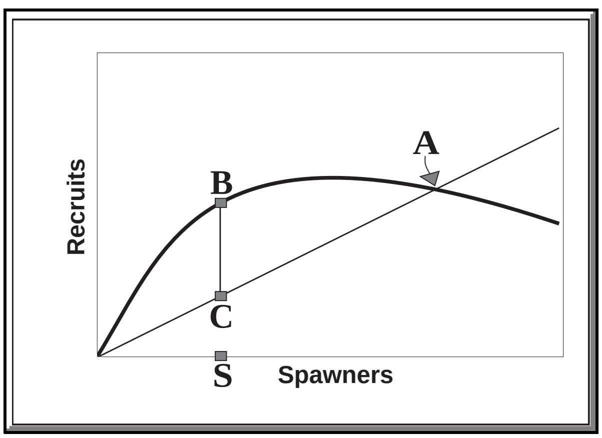


Figure 2. Spawner-recruit curve for species that tend to spawn in large numbers and compete for spawning area.

There are several key features of both figures:

A. As we add spawners from zero, the number of recruits increases. More spawners gives us more fish.

B. As we keep adding spawners, the curved line gets less and less steep. Each added spawner must compete with all the existing spawners for the best places to spawn, and their young must compete for places to feed or hide. Each new fish has to work a little bit harder and not all will survive. The number of new recruits we get for each new spawner goes down as the number of spawners increases.

C. Competition and other factors eventually increase to the point where adding more spawners does not appreciably increase the number of recruits. In Figure 1 this is where the curve nearly flattens out (between A and B on the curved line).

In Figure 2 the number of recruits actually decreases as you add spawners past a certain point. The cumulative effects of spawning, such things as competition, disease, later spawners digging up the nests of the earlier spawners, and attraction of predators, increase with larger and larger spawner abundance (escapement) levels to reduce the capacity of the system to produce recruits.

D. If we have S spawners and get B recruits, then we need to get S spawners for the next generation for the cycle to repeat itself. The straight line in each figure is called the replacement line. The point C on the replacement line is the number of recruits needed for spawning so the population will replace itself and keep the cycle going. From the figure it is shown that populations can sustain themselves at different levels, although there is a limit at the lower end required to maintain genetic diversity that stocks need to survive in their local environment. The distance between B and C is a measure of the number of fish you can harvest while providing enough spawners to sustain the run at the same level (S).

E. When there is no fishing the population will tend to grow to the point where the level of competition increases so much that the spawners just replace themselves. This is where the number of spawners is equal to the number of recruits. This is the point A on both figures. Point A is called the replacement point. Naturally spawning populations of salmonids cannot be sustained at escapement levels greater than the replacement point because they produce total run sizes that are less than the number of spawners that were started with.

The shape of the curve for any stock of fish will be unique. It will depend on the:

A. Species

B. The productivity of the environment and the stock. A very productive environment and stock will have a steeper, higher curved line and produce more recruits from each added spawner. Survivals will be higher and it will take fewer spawners to use the available habitat. A less productive environment will have a shallower curved line and produce fewer recruits from each added spawner. Productivity will be affected by habitat quality, ecological interactions such as competition and predation, and basic stock productivity. We discuss these factors in the sections on the *Habitat*, *Ecological Interactions*, and *Genetic Conservation* elements.

C. The capacity of the habitat to produce fish. The height of the curve is a measure of the capacity of the habitat to produce fish. This is affected primarily by habitat quantity and availability which are discussed in the *Habitat* element.

While the above factors control the shape of the curve, it is the number of spawners that determines how abundant the population will be (i.e. where a population will be found along the curve). The final piece of the picture, the effect of spawner numbers, is discussed in the *Spawner Abundance* element.

Figure 3 shows how changes in stock productivity and habitat capacity interact to affect the shape of the spawner-recruit model. The four curved lines model a population at different levels of productivity and capacity. If we have the same capacity, but lose productivity due to habitat degradation or loss of genetic characteristics, we can eventually produce the same run size when the spawner abundance gets large enough (at point X). At lower spawner abundance levels the numbers of offspring produced will be fewer (the difference between the current line and the loss of productivity line). However, the distance between the spawner-recruit line and the replacement line is much smaller for the population that has lost productivity, and the available harvests are much lower.

If the productivity is unchanged, but capacity is reduced (see Loss of Capacity line), the number of offspring and available harvests are less no matter how many spawners are there. When we lose both productivity and capacity, as we most typically do, the situation is similar (see Loss of Capacity and Productivity line). This reinforces the idea that addressing only one element of the policy will not be enough to meet our goal of healthy stocks and sustainable benefits. We need

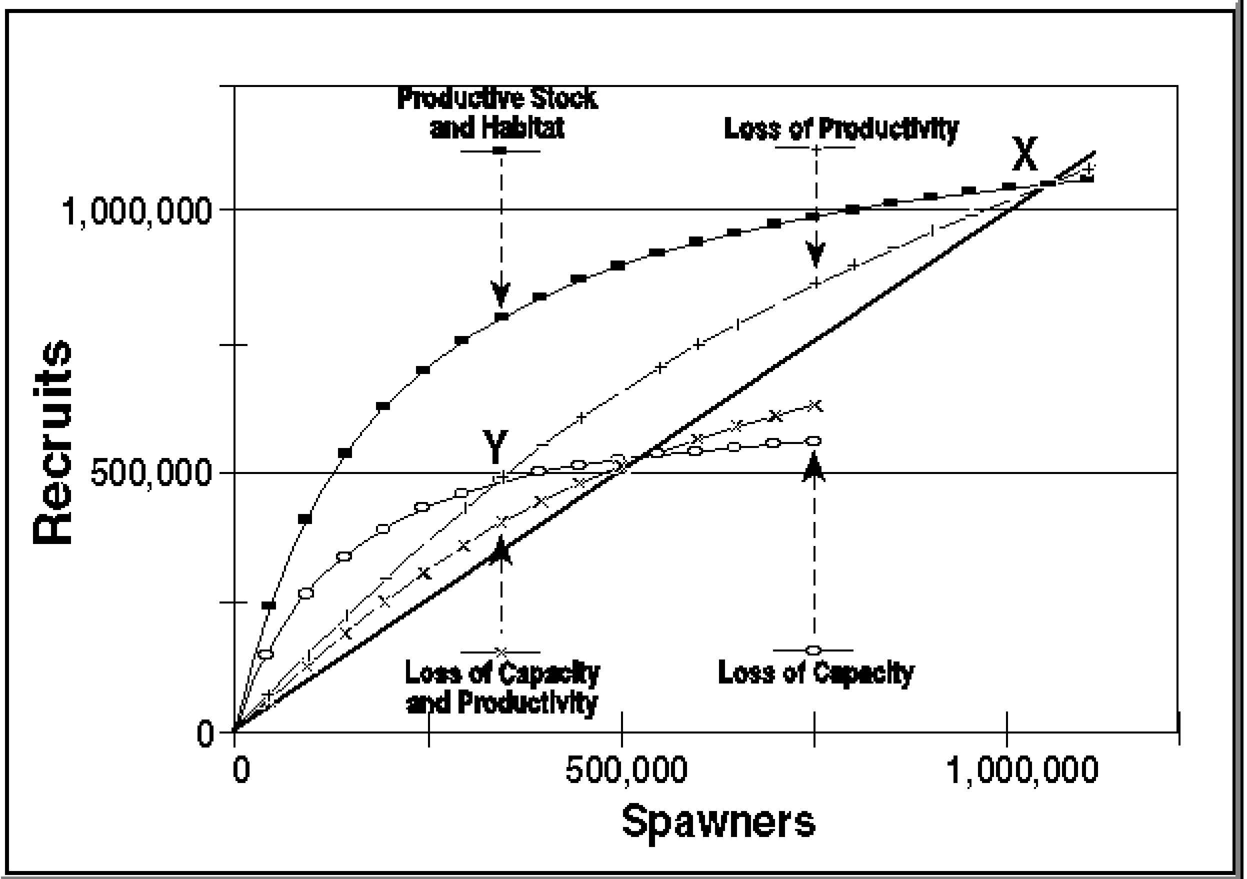


Figure 3. Changes in stock productivity and habitat capacity interact to affect the shape of the spawner-recruit model.

to protect both the productivity and capacity of our populations. As we look at the elements, we consider this model in more detail to see how the elements specifically affect the ability of populations to sustain themselves at healthy levels and produce the levels of benefits we desire.

__Uncertainty__

In an ideal world resource managers would have absolute knowledge about the full range of potential impacts and benefits of various interactions between habitat, harvest, genetic conservation and other issues. However, biology rarely provides absolute information and many of the guidelines established in the Wild Salmonid Policy will continue to reflect decisions based on considerable uncertainty. In some cases, we have had to suggest policy approaches in the absence of the complete level of information that we would like. These will not be the final answer, but represent the ends of a range of possibilities. However, to wait until we know all the details is to miss many opportunities to maintain the health and productivity of the resource.

This uncertainty carries with it an obligation to recognize what we don't know. We must manage the associated risk and opportunity, and more importantly monitor and evaluate the results. This new knowledge can lead to modifying and improving management policies and strategies in the future. This need is explicitly recognized in the monitoring and evaluation parts of the policy.

APPENDIX C DISCUSSION OF HABITAT ELEMENT

The *Habitat* element explains (1) salmonid requirements for survival, growth and reproduction; (2) how these requirements are influenced by natural physical processes and habitat conditions throughout the various salmonid life stages; (3) how human activities have affected these natural processes and habitats; (4) representative performance measures we could use to ensure success; and (5) examples of actions we can take to maintain or restore the processes and habitats vital to salmonid production.

Wild salmonid habitat includes all of the places where salmonids spawn, feed, grow, and migrate. In the broadest sense, maintaining and protecting salmonid habitat also protects the habitat of the prey species that make up the salmonid diet, and those upland areas that directly affect the waters where salmonids actually live. Salmonid habitat includes a wide range of geography and conditions. Streams, rivers, ponds, lakes, wetlands, estuaries, and the open ocean are all part of wild salmonid habitat. This habitat includes tiny, high-elevation streams and lakes that spend much of the year under ice and snow. It includes rivers, streams, and lakes, large and small, in arid areas of eastern Washington and the rain forests of the Olympic Peninsula. It includes streams that run through wilderness areas and national parks, commercial forests, agricultural land, suburban landscapes, and big cities. All of these must be considered when habitat is the issue.

Salmonid Habitat Requirements

Suitable habitat needs to provide for six key life requirements for salmonids to be productive and successful. Salmonids need an **adequate quantity** and **quality of water**. They need **food** for survival and growth. They need forms of **shelter** that provide protection from predators and allow them to minimize energy loss. Salmonids need to be **able to move within and between habitat types** to fulfill their life requirements. They need **clean and relatively stable gravel** areas to reproduce. These life requirements are affected by both natural processes and human influences on those natural processes. Many reviewers have summarized salmonid life histories, habitat requirements, and the effects of natural and human events and activities on salmonid survival and production. Palmisano et al. (1993), NRC (1996), Spence et al. (1996) and CRITFC (1996) all provide good summaries of these issues.

The life requirements for salmonids are influenced through a combination of interrelated physical processes and habitat conditions occurring over both short- and long-time scales, and across a variety of land forms. Many of these relationships are not well understood. Quite often it is very difficult, if not impossible, to draw quantitative relationships between habitat conditions and salmonid survival and production. Further, freshwater habitat/production relationships can be confounded by ocean survival conditions, inter- and intraspecific competition and predation relationships, and by a variety of fishery impacts. Nonetheless, salmonid life requirements appear to be affected by habitat conditions in the following manner:

A. Water quantity is affected primarily through basin hydrology, which is manifested as instream flows. Instream flows are affected by (1) natural climatic, geologic, and vegetative conditions; (2) land use activities; and (3) other in-and out-of-stream uses of water (hydropower, irrigation).

B. Water quality is affected in part by basin hydrology and instream flows. It is also influenced by (1) upslope events such as soil erosion and land slides; (2) by the condition and extent of riparian (near water) vegetation; (3) by the extent and function of wetlands; (4) by a variety of natural and chemical contaminants; (5) by stream channel and marine habitat stability and complexity; and (6) by in-water activities such as dredging.

C. Food supply and availability is affected by (1) instream flows; (2) sediment quality, delivery and routing; (3) water quality; (4) riparian, wetland, and marine vegetation; (5) stream, lake and marine habitat complexity; and (6) in many areas by the numbers of returning adult anadromous or resident spawning salmonids.

D. Shelter for rest and cover is influenced by hydrology, water quality, sediment quality, delivery and transport, and by the extent and condition of riparian vegetation. Stream channels which possess varied and complex habitat features such as large woody debris, rocks and boulders, and channel features such as overhanging banks, and a variety of water depths and velocities, provide abundant resting and hiding shelter.

E. Fish access and passage are affected by hydrology, water quality, sediment quality, delivery and routing, riparian and wetland condition and extent, and floodplain connectivity. Fish passage is further influenced by natural obstacles such as waterfalls and human structures such as dams, dikes, and culverts, and by some docks, breakwaters and piers in marine areas.

F. Reproduction is influenced by all the above, but primarily by instream flows, sediment transport, and water quality.

<u>Status of Wild Salmonid Habitat</u>

Wild salmonid production has been significantly reduced due to direct and indirect alterations of Washington's freshwater, estuarine and marine habitats. These alterations have led to loss of habitat, loss of access to habitat areas, adverse changes in physical habitat structure, and adverse changes in water quantity (higher flood flows and lower minimum flows) and water quality. Even hatchery production has been reduced by habitat degradation increasing sediment loads in water used for fish rearing.

Habitat loss, damage, or modification were listed as contributing factors for 86 of the 93 Washington salmonid stocks identified as either at “high” or “moderate risk of extinction,” or “of special concern” (Nehlsen et al. 1991). Of the 97 Washington stocks identified as healthy or marginally healthy, the freshwater or estuarine habitat for 80% of these stocks was rated as either “fair” or “poor” (Huntington et al. 1994).

Prior to development, an estimated 4,550 stream miles of Columbia River Basin habitat *in Washington* were accessible to salmonids. Today, due primarily to blockage by dams, only 3,791 stream miles remain (Palmisano et al. 1993). Much of the remaining accessible habitat has been degraded from other impacts. WDFW (1994) identified about 2,400 culverts at road crossings that blocked access to nearly 3,000 miles of stream habitat across the state.

Estuary development has reduced salmonid habitat as well. Many nearshore marine areas have been converted to industrial, commercial, and residential uses. Conversion of these areas usually results in fills or protective bulkheading, both of which affect juvenile salmonid feeding areas and migratory pathways.

Tideflats, swamps, and wetlands in the Columbia River estuary were reduced by 40% (33,000 acres) from 1870 to 1970 (Sherwood et al. 1990). In the Skagit River basin, agricultural diking and drainage has resulted in the loss of 54% of the lower river slough habitat (Beechie et al. 1993). The British Columbia / Washington Marine Science Panel (1994) report identified nearshore estuarine wetland habitat losses as severely affected by human activities, primarily in urban areas and secondarily in suburban and rural areas. Destruction of wetlands in Puget Sound was estimated at 58%. Losses are estimated to be as high as 99 and 100 per cent in the Duwamish and Puyallup estuaries, respectively.

Physical habitat structure has been simplified or altered in both freshwater and marine areas. The frequency of large pools in managed watersheds of the Columbia Basin has decreased 28% over the past 50 years (McIntosh 1994), primarily due to losses of instream woody debris. The loss of large pools is estimated at 30-70% on national forest lands in the Pacific Northwest (PACFISH Strategy 1993). More than half of Washington's streamside riparian vegetation has been lost or extensively degraded since the early 1800s.

Human activities also affect stream structure. Increases in channel-forming flows — the periodic flood events that scour and define stream channels — are often found in timber harvest areas. Such flow increases associated with logging-related hydrologic changes and sediment supply can be particularly damaging to spawning habitat (Peterson et al. 1992). Surface water withdrawals can reduce streamflows below levels required for salmonids which reduces available spawning, rearing, and migration habitat (Puget Sound Cooperative River Basin Team 1991, Palmisano et al. 1993). Bulkhead and other forms of bank stabilization reduce stream complexity and affect salmonid habitat.

Changes in land use can significantly influence habitat conditions. Rural forest and agricultural lands are often converted to residential and commercial uses as urban areas expand and the demand for land for development increases. The majority of lands converted in Washington are low-elevation, high-productivity sites, which also are the most productive habitat for salmonids because of low stream gradients, gentle topography, and for anadromous salmonids, access to marine waters.

Water quantity and quality are often impaired due to increases in impervious surfaces (i.e. parking lots, shopping malls, etc.) and storm-water runoff resulting from urban expansion. Winter peak flows are significantly higher and of longer duration; summer flows are reduced or non-existent and salmonid habitat is degraded or lost (Lucchetti and Furstenburg 1993).

Significant changes to wild salmonid habitat have occurred as a direct result of the human population expansion in Washington. The future promises to bring additional growth, and with it, the potential for further degradation of salmonid habitat. The Office of Financial Management predicts that an additional 2.7 million people will live in Washington by 2020. Such growth will place intense pressure on our natural resources, particularly fresh and marine waters, timber and agricultural lands, and fish and wildlife and their habitats. The Department of Natural Resources estimates that one acre of forest land is lost for each person added to the population.

Recovery of salmonid habitat will be a daunting, time-consuming, expensive task (NRC 1996, Independent Scientific Group 1996). It will require recognition and understanding of the frequency, magnitude, and duration of natural and human disturbance. It will also require interpretation of what was (i.e. “natural” conditions), an understanding of the positive roles of disturbance, and agreement on what is or is not possible or feasible in a restoration strategy (Naiman 1992, Lichatowich, et al. 1995, Stanford et al. 1996, Spence et al. 1996).

Components of Habitat Protection and Restoration

To sustain and recover wild salmonid populations, functional and accessible fish habitat is essential. This includes both existing salmonid habitat in its present condition, as well as degraded habitat in need of restoration. Wild salmonid recovery requires protection and restoration of the productive capacity of salmonid habitat. Areas used by salmonids to complete the full diversity of life history needs must be protected or restored, including instream, riparian, estuarine, and wetland ecosystems, and the uplands that affect them.

Protection of the existing habitat base should be the first priority for habitat actions. Such protection is usually the most cost-effective initial mechanism available to ensure wild salmonid sustainability. It is immediate, efficient, and can slow or stop the trend of habitat loss. It also retains current wild salmonid production capacity, and provides a foundation for future recovery and growth. Protection is also relatively inexpensive when compared to the cost of *restoring* salmonid habitat.

Restoration must also be initiated to be able to receive the benefits that salmonids provide. Restoration is a long-term activity. It may take many years to accomplish because of the cost and because often a period of natural watershed healing is needed . Habitat restoration is a relatively new and experimental science, and is more costly than protection. Restoration will be critical in those areas where the existing habitat base is insufficient to sustain a particular stock of fish, or where habitat degradation or loss is the key cause of stock decline. It will also be important for expanding the available habitat base and increasing long-term benefits provided by salmonids.

Protection and maintenance of salmonid habitat requires recognition of the continuum of aquatic and terrestrial physical and chemical processes, biological systems, and human influences on that continuum (Vannote et al. 1980). The stream continuum exists in a longitudinal fashion from the smallest rivulet, down through increasingly larger streams and rivers, into estuaries and eventually to the open ocean. Downstream processes are linked to upstream processes through routing of water, sediment, and organic matter. Salmonids evolved and adapted to this continuum of habitats and processes, each of which is interlinked and important to one or more life stages of wild salmonids (see Figure 1 on life cycle).

All options for the habitat element of a Wild Salmonid Policy are organized into the following components:

- Habitat Protection and Management Approach and Institutional Framework
- Basin Hydrology and Instream Flow
- Water and Sediment Quality and Sediment Transport
- Stream Channel Complexity
- Riparian Areas and Wetlands
- Lakes and Reservoirs
- Marine Areas
- Fish Passage and Access

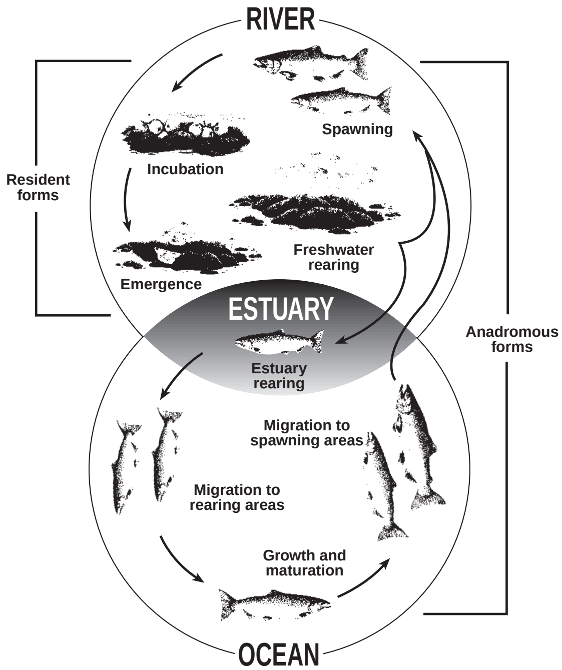


Figure 1. General life cycle of salmonids.

➤ Habitat Restoration

Each component would provide sub-goal(s), performance measures and action strategies that could address the issues specific to that component. Inadequate attention to one or more habitat components within the habitat chapter may reduce or eliminate the benefit of another. For example riparian buffers and stream channel complexity will be of reduced value to wild salmonids if instream flows are inadequate or fish access is precluded. For anadromous salmonids, production gained from freshwater rearing habitat may be lost if nearshore marine conditions for feeding and migration are inadequate.

Habitat quality is also related to all the other elements in the policy, particularly to spawner abundance and ecological interactions. Freshwater productivity can be heavily influenced by returning adult salmon whose carcasses provide a source of marine-derived nutrients (nitrogen, phosphorus and carbon) to the streams and riparian zones (Bilby et al.1996) and lakes (Kline et al. 1994). Spawning aggregations of some freshwater salmonids produce similar responses in streams isolated from the ocean (Richey et al.1975).

Habitat Protection and Management Approach and Institutional Framework

Habitat protection and management first require an overarching goal and philosophy to guide the policy implementation. They also require a number of institutional, housekeeping details to ensure efficiency of staff and budget for those involved or affected by this effort. This includes coordination of regulatory and proprietary efforts, up-to-date comprehensive information to guide habitat decisions, and sharing, interpretation and application of that information to habitat issues. Acquisition of key parcels or easements adjacent to salmonid habitat can be an effective way of partially protecting and restoring salmonid populations as well and should be a part of the overall habitat approach.

With this approach and framework in place, a habitat policy would address the issues of maintaining and restoring the physical and chemical processes necessary to meet salmonid life requirements, protecting and restoring key habitats and providing adequate migratory pathways between habitat types.

Subgoal

> **Maintain or increase the quality and quantity of habitat necessary to sustain and restore salmonid populations**

Performance Measures

The ultimate performance measure for habitat will be a level of productivity and production that will sustain robust fisheries while maintaining healthy adult spawning populations. The need for this type of performance standard will be clearly reflected in the goal statement of the WSP as well as in the policy on spawner abundance. However, relationships between habitat conditions and salmonid productivity have not been well defined (although efforts are currently under way to define them).

Therefore, the approach will be to define performance measures by the physical conditions within salmonid habitats that are expected to create good productivity. This is an indirect approach that must be periodically evaluated to ensure its applicability. The WSP will commit to developing a method to establish performance measures based directly on salmonid production, which will be added into the WSP and its implementation. The physical performance measures are described in the habitat components that follow. They are based on current knowledge of what is expected to provide good salmonid habitat and productivity and will be periodically updated as new or additional information becomes available.

The spawner abundance element of the policy will require an assessment of the reasons any stock or management unit fails to meet its prescribed spawning target levels, and could require that corrective actions be taken, including harvest and hatchery production adjustments. Whenever failure to meet the prescribed spawner objectives could be attributable, at least in part to habitat degradation or loss, an assessment will be made to determine if the performance measures in the following habitat components are being met. If they are not being met, then corrective measures could be implemented to ensure they are met. If the measures are being met, but minimum spawner abundance is still not attained, the habitat performance measures will be reassessed and modified as necessary to ensure the spawner abundance objectives are attained; and the goal of the WSP achieved.

Action Strategies

The following are examples of actions which will be taken to achieve the performance measures and meet the subgoal for this component.

A. While it would be the intent of the policy to avoid all habitat impacts, the policy recognizes that at times the needs of society will degrade habitat. Therefore, the policy will request that all human actions potentially affecting salmonid habitat would use the following hierarchy of approaches:

   1. Protect from human impacts all useable wild salmonid habitat in freshwater, estuarine, and marine environments that is important to migration, spawning, and rearing.
   2. Fully mitigate salmonid habitat impacts due to or anticipated from human activity.
   3. Seek full compensation for direct losses of salmonids and irreparable harm to salmonid habitat.
   4. Restore the wild salmonid habitat from its present condition up to its full productive capacity.

   This hierarchy will be applied to all planning activities and permit reviews. Avoidance would be the most preferred and most commonly used form of protection. Mitigation will be used only when no practicable or feasible alternative exists, and compensation would be infrequently considered - usually reserved for fish kills or habitat damage where restoration is impossible.

B. Conduct a coordinated, comprehensive inventory and assessment of freshwater/marine salmonid habitat, including aquatic biointegrity, with periodic updates:

1. Include all habitats necessary for maintaining life history stages of existing and historical salmonid populations, incorporating both physical habitat elements and biological monitoring parameters such as water chemistry and prey-base assemblages and densities.
2. Use the inventory to establish and evaluate watershed protection and restoration strategies.

C. Define and improve quantitative relationships between physical habitat conditions and salmonid productivity. Establish habitat performance measures based directly on salmonid production/productivity.

D. Routinely review and update physical habitat performance measures in the policy to reflect the best available science.

E. Develop a process to coordinate local, state, tribal, and federal regulatory and proprietary authority that ensures opportunities for public review and input and that ensures that all components of the habitat policy are adequately and efficiently implemented. This coordination process should include regularly reviewing and recommending revisions to regulations and/or reviewing and revising typical permit conditions as appropriate to protect salmonid habitat.

F. Develop a statewide, unified natural resource damage assessment and restoration strategy that will fully compensate the public for unauthorized activities that injure salmonids.

G. In collaboration with affected parties and in other forums addressing these issues, develop and propose rule changes or legislation changes to improve wild salmonid protection in four major areas: (1) forest practices (including WDFW representation on the Forest Practices Board); (2) growth management (addressing minimum standards for zoning, platting, and protection of critical areas, and more complete integration of watershed planning with GMA); (3) water allocation (addressing water rights and permitting, instream flows beneficial to wild salmonids, exemptions, water conservation), and (4); agriculture. New forums may need to be established to accomplish this objective.

H. Support a uniform state water-type classification system for use in protecting salmonid habitats.

I. Provide public access to the wild salmonid habitat information to maximize the effectiveness of habitat protection and restoration efforts.

J. Identify key parcels of wild salmonid habitat as a priority for state-funded land-acquisition programs.

1. Support a dedicated funding source for securing wild salmonid habitat.
2. Acquire key wild salmonid habitats using watershed inventories and analyses as a basis for identifying critical habitats. Acquisition priorities should be consistent with restoration priorities.
3. Increase efforts to seek opportunities for land trades that secure wild salmonid habitat.

Basin Hydrology and Instream Flows

The basic life need for all living organisms is water and, obviously, a fish out of water is in trouble. The amount and quality of the water, and its pattern of flow are among the key factors of critical importance to salmonids.

Salmonids occur in a variety of climatic regions within Washington, ranging from the very wet Olympic Mountains to the very dry Columbia Basin. The amount of water eventually available to salmonids as streamflow depends fundamentally on the basin (also referred to as catchment) hydrology — how local climates, geologic types and vegetation types affect the pattern of daily, seasonal, and yearly flows (or how water is routed and stored within a given

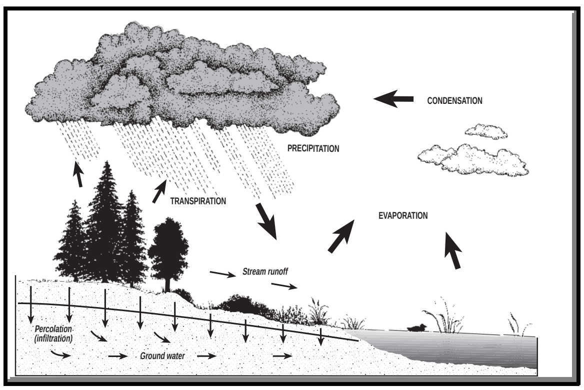


Figure 2. Hydrologic cycle.

watershed). This is referred to as the "hydrologic cycle" (Figure 2). Once the water reaches a stream or lake, its storage and routing are influenced by other physical processes such as sediment delivery and transport, and by riparian areas, wetlands, beaver ponds, and channel complexity.

Natural Hydrologic and Instream Flow Factors That Affect Salmonids

Streamflow is a major factor in controlling annual freshwater salmonid production by creating and maintaining salmonid habitat, preserving habitat function, and initiating movement or other behavioral changes. Streamflow also has an effect on the quantity and quality of estuarine and marine habitats for anadromous salmonids. The habitat and production of prey-base species for salmonids (e.g., aquatic insects and other fishes) are also dependent on streamflow. High flows help to maintain and/or create pools, flush fine sediments from spawning gravel, and transport and deposit gravel and large woody debris in the channel, estuaries, and marine areas. Many salmonid activities are stimulated or facilitated by natural hydrological changes. For example, adult upstream migration and spawning are triggered by fall/winter/spring rains (freshets), juvenile downstream migration is triggered by spring freshets, and fall freshets trigger movement by some species into off-channel refuge and rearing areas.

Peak winter flows and low summer flows are the primary hydrologic conditions affecting salmonid production in fresh water. These conditions are influenced by global and local climate, and by local geography, geology, and vegetation. Changes in the magnitude, frequency, and timing of high-flow events are of particular importance to salmonids. High peak flows can be a mixed blessing; sometimes simplifying channel form (reducing habitat productivity) or increasing channel form (increasing habitat productivity). Hydrologic changes can transform complex channels comprised of large woody debris and various types of pools, runs, and riffles into uniform riffle areas, limiting the habitat value to fewer and different salmonids. Streambanks can be eroded, causing a loss in bank stability and integrity that can increase siltation, and reduce the availability of salmonid hiding and resting cover. Peak flows can also displace juvenile fish downstream out of preferred rearing areas, delay migrations, and increase suspended solids that irritate gill tissues.

Instream flow is a critical limiting factor for spawning habitat. Instream flow can determine habitat accessibility for fish, whether appropriate water depth and velocity conditions exist for spawning, and the amount of habitat available for salmonid use. Each species has specific flow and depth requirements for spawning, and its spawning success can be limited by a variety of instream-flow events. For example, fish may be blocked from using high-quality habitat because of insufficient flow and forced to spawn in less productive mainstem areas. Eggs or alevins in the gravel can be dewatered and killed during incubation. Stream-side channels can become isolated or dewatered, stranding salmonids.

Survival of newly spawned eggs to the fry stage is dependent upon the stability of the streambed gravel that houses eggs and salmonid fry during their early development. High flows can physically disturb or scour the gravel, damaging or killing the eggs and alevins. Scour affects salmonids when they are most vulnerable — as immobile eggs and alevins (Peterson et al. 1992, Trip and Poulin 1985, Cederholm and Reid 1987). Some researchers have concluded that egg loss from gravel scour frequently exceeds losses attributable to fine sediment concentration, which tends to smother the eggs and alevins (D. Seiler, WDFW, personnel communication).

Like spawning habitat, rearing habitat is naturally influenced by instream flow (Smoker 1955). Natural low-flow periods (late summer/early fall) are particularly critical for rearing salmonids, especially for those species that have extended freshwater residence. In-channel and off-channel rearing space shrinks as flows recede. This increases competition for food and living space and exposes salmonids to increased predation. Portions of some streams may go below ground, restricting salmonid movement and interrupting the downstream transport of prey organisms.

Ponds formed by beavers play a significant role in creating and maintaining salmonid habitat and in maintaining summer low flows (Naiman et al. 1992). The relationship of the stream channel with its floodplain is also an important consideration for instream flows.

Low summer flows can affect water quality as well. Water temperature generally rises as flow falls, reducing dissolved oxygen content. Salmonid mortality is significant during low flows and can be exacerbated by extremely low flows.

Instream flow is such an influential factor that predictions for production of wild coho in Puget Sound are based largely on low summer stream flow conditions that existed when the wild coho were residing in freshwater. Steelhead production predictions are based, in part, on a combination of stream gradient and wetted stream width. Wetted stream width varies both yearly and seasonally and is the area of the stream containing water at any given time.

Human Activities That Affect Basin Hydrology and Instream Flows

Although the limiting conditions described above occur naturally, each can be affected by human activities. Agricultural activities that remove ground cover affect runoff. Livestock grazing, particularly in riparian areas, has the potential for soil compaction and increased runoff (Fleischner 1994). Certain forest practices, including forest roads and harvest in rain-on-snow zones, increase peak runoff and, for a time after harvest, increase summer low flows.

Flow regimes have also been changed by our activities. One dramatic example of modification of a river's flow regime is found in the Columbia Basin. Today, the Columbia River is virtually under human control through a series of water storage projects in Canada, Washington, Idaho, and Oregon. A large portion of the spring runoff can be captured behind dams and metered out through turbines to generate electricity. Where once the Columbia flowed at very high volumes during the spring, the river is now managed at much lower flows over a longer duration to accommodate the hydraulic capacity of the turbines at the various dams. In most years, it has become necessary to artificially simulate spring runoff by releasing water in an attempt to facilitate the downstream movement of salmonid smolts. Although this stimulates downstream movement, migration is still impaired where the smolts must traverse storage reservoirs with decreased flows and velocities.

Reduced flow levels at water storage dams can dewater, or dry up, spawning habitat, making it unavailable for salmonid use. If spawning has already occurred, low flows can dewater established redds.

The change in urbanized watersheds is more prevalent, but less dramatic, than in the Columbia Basin. Before development, many streams exhibited infrequent floods of low magnitude and summer low flows were usually sufficient to maintain high levels of salmonid production. Today, with development, these streams flood more frequently with greater magnitude and duration. The same surfaces that increase runoff in urban areas also affect summer low flows. The reduction in interception, storage, and release of ground water to streams during low flow conditions affects habitat availability and salmonid production, particularly for those species that have extended freshwater rearing requirements.

Changing hydrology, which is usually coupled with reductions in water quality, loss of fish passage, loss or simplification of streamside vegetation, reduction in flood plain extent and function, and reduction in channel complexity can severely reduce the potential of urbanized streams to produce salmonids (Lucchetti and Furstenberg 1993). These changes also affect wetland functions and values, and other instream resources.

Generally, instream functions and values begin to seriously deteriorate when the levels of impervious surfaces exceed 10% of a subbasin (Schueler 1994, Arnold and Gibbons 1996). Figure 3 is a stylized characterization of changes in habitat quality with increases in impervious surfaces. To put this in context, land uses that have an average residential lot size of one unit per acre result in 20% impervious surface while land uses comprised of commercial shopping areas would result in 95% impervious surface (Figure 4).

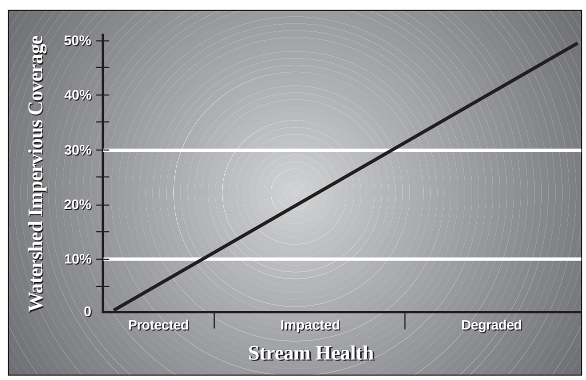


Figure 3. Relationship between the percent coverage of a watershed by impervious surfaces and stream health.

Society's demand for water for a variety of out-of-stream uses also has a profound impact on salmonids and their prey base. Many streams have water rights for diversion that far exceed normal low-flow volumes. Others are routinely

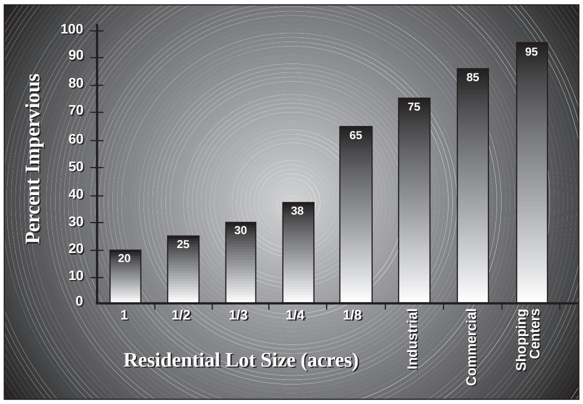


Figure 4. Relationship of percent impervious surfaces to land use zoning levels.

overused to the detriment of the salmonid ecosystem (e.g., Dungeness, Quilcene and Yakima rivers). Streamflow is also affected when ground water that is in continuity (connected) with surface water is withdrawn, and when surface or ground water is appropriated from one basin and transferred to another.

Basin Hydrology and Instream Flow Sub-goal

The policy will recognize that attainment of natural stream (basin) hydrology will be difficult in many cases and probably impossible in some urban areas. But there are numerous opportunities where either through land use allocation, land treatments, or water conservation, stored water releases, etc. we can prevent the situation from deteriorating or actually improve stream flows. Most policy options encourage locally-based watershed planning. This is where all activities affecting or likely to affect hydrology can be assessed and where specific actions can be developed and implemented. All actions would be tailored to meet the following goal:

> **Maintain or restore the physical processes affecting natural basin hydrology. In addition, manage water use and allocation in a manner that will optimize instream flows for salmonid spawning, incubation, rearing, adult residency and migration, that will address the need for channel-forming and maintenance flows and that will address the impacts of water withdrawals on estuarine and marine habitats.**

Basin Hydrology and Instream Flow Performance Measures

The following are suggested performance measures that would indicate success at meeting the basin hydrology and instream flow subgoal:

A. In streams or basins that provide useable wild salmonid habitat, and where instream flows have not been established by rule, the stream's flow trends, normalized to account for variations in precipitation, would hold steady or increase (low flows) over time.

B. In streams or basins that provide useable wild salmonid habitat and where stream flows have been adopted or are being revised, the performance measure would be the instream flow as adopted by rule.

C. Physical indicators within a watershed would also be used as performance measures to assess or achieve the sub-goals for basin hydrology and instream flow. These performance measures are typically expressed as thresholds of change - if the thresholds are exceeded, habitat conditions including water quality and water quantity decline dramatically, and often irreversibly. Threshold management can help to maintain or restore natural basin hydrology and instream flow. Examples of thresholds include:

   1. Percent effective impervious surfaces — These include road surfaces, rooftops, and

parking lots. As percent effective impervious area exceeds a threshold of 8-10 per cent in a watershed, instream conditions including the frequency and intensity of high flows and water quality begin to deteriorate. Groundwater recharge and summer low flows also usually decline, although the relationship is not always as predictable. The threshold could be applied to stream reaches or subbasins. This threshold could also be applicable to wetlands.

2. Forest harvest and road density — The seasonal timing of forest harvests and the density of roads in harvesting areas can have significant effects on streamflows. The percent of upland forests at hydrologic maturity and percent clearcut in rain-on-snow zones can be used as thresholds beyond which significant adverse impacts on basin hydrology and instream flow would be expected. The thresholds are basin specific, however some forest land managers feel that for western Washington watersheds a threshold of approximately 60% of standing timber at age 25 or more will begin to reflect hydrologic maturity. Road densities are even more basin-specific and would require some form of analysis and discussion to arrive at a threshold number.
3. Threshold grazing standards could be set at the basin-specific level. On state lands guidance is available in the HB1309 Ecosystem Standards for State-Owned Agricultural and Grazing Lands. This guidance may also have application on other ownerships as a reference document.

Physical indicators would be applied in conjunction with other actual instream flow measures whenever possible.

<u>Action Strategies for Basin Hydrology and Instream Flow</u>

The following are examples of action strategies that could help to meet the performance measures listed above:

A. Build consideration and development of water conservation guidelines and standards into regional and watershed-based water resources planning and implementation. Such guidelines could, as needed, be used to restore instream flows. Continue development and use of trust water rights as a means to achieve water conservation to benefit instream flows. If needed, request funding for development of statewide water conservation standards.

B. Ensure that maintenance or restoration of the hydrologic regimes necessary to protect or restore salmonid habitats and life history needs are an integral part of upland management plans and practices, growth management planning, and stored water management plans.

   1. Develop strategies to maintain, restore or emulate natural processes and land features that allow river basins to intercept, store, transfer, and release water so that instream flows are maintained and natural hydrologic regimes are attained.
   2. Develop means (including incentives, zoning, reaggregation of small parcels, clustering) to retain forest, agricultural, and rural lands in order to protect the extent and functions of aquifer recharge and discharge areas, wetlands, riparian zones, and frequently flooded areas.
   3. Develop mechanisms that limit the total effective impervious surface in a watershed subbasin to, or below, a threshold that prevents loss of habitat quality, habitat quantity, and salmonid

diversity. In watershed subbasins currently exceeding this threshold, employ best available technology to manage existing or anticipated stormwater runoff. These efforts could be coordinated with development and implementation of a statewide stormwater-management strategy.

4. Integrate water-resource planning for instream and potable uses with growth management planning. Determine adequate water supplies in a manner that accounts for the protection of instream flows.
   a. Identify and map known or potential aquifer recharge areas.
   b. Protect and restore groundwater recharge and discharge areas that are important for wild salmonids.

C. Protect (and restore where feasible) floodplain habitat of value for wild salmonids.

1. Employ low-density and low-intensity zoning and regulation.
2. Utilize floodplain management measures that provide retention, or reclamation of floodplain function and extent.
3. Require that new roads constructed in floodplains avoid increasing water surface levels and minimize the channeling effects that convert sheet flow to directed flow points (bridges, culverts) during flood events. Correct, to the extent possible, existing roads that function as dikes to reduce or eliminate their adverse hydrologic impacts.
4. Forest harvest planning could include harvest scheduling - including rotation ages that will prevent damaging changes in stream hydrology from rain-on-snow events and other hydrologic effects. Forest-road densities could be limited to thresholds which avoid damaging changes in stream hydrology.

D. Establish and maintain instream flows (minimum low flows, channel-forming and maintenance flows) that optimize habitat conditions for migration, spawning, incubation, and rearing for wild salmonids and their prey base.

E. Maintain instream flows by modifying stored water release strategies and addressing interbasin transfers of water.

F. Protect instream flows from impairment by groundwater withdrawals where groundwater is in hydraulic continuity with surface water. This protection includes minimizing the effects of single family exempt wells on stream flows.

G. Promote the use of best available irrigation practices that emphasize water and wild salmonid habitat conservation. State funding for new installation and upgrades of water delivery systems would be provided only where best available technology is used.

H. Where voluntary compliance has not been successful, attain and maintain instream flows through (1) increased enforcement of existing instream-flow regulations, (2) active pursuit of relinquishments, (3) elimination of waste, (4) increased water-use efficiency, (5) dedication of water from federal projects, (6) pursuit of trust water rights, and (7) denial of new consumptive water rights.

I. Institute specific wild-salmonid habitat protection criteria as part of the analysis to determine which flood control projects will be funded. These criteria would include channel-forming functions and values, bed character and quality, and overwintering habitat areas.

Water Quality and Sediment Quality, Delivery and Transport

Salmonids are dependent on abundant, clean, cool water for their survival. Several water quality components are important to, or regulate, salmonid habitat and resources: water temperature, dissolved oxygen, pH, total suspended solids (TSS), and specific toxic materials. The quality, delivery and transport of sediments throughout stream channels, lakes, and marine areas plays a significant role in salmonid survival and production.

Water Quality and Sediment Parameters That Affect Salmonids

Water temperature is a primary regulator in the aquatic environment because it affects chemical reaction rates, governs the physiological functions and processes that occur in water, and helps determine which aquatic species may be present. Low water temperatures will slow egg and alevin development in the gravel, promote formation of anchor ice in river beds that can destroy salmonid nests and desiccate incubating eggs, and retard growth of rearing salmonids. High water temperatures can stress salmonids, increasing their susceptibility to disease and even block access to movement.

Temperature affects all metabolic and reproductive activities of salmonids. The adverse effects of other environmental variables, such as pollution, predation, disease, and dissolved gases, are made worse by elevated temperature levels. Increased temperature can also be indicative of cumulative effects within a watershed on riparian structure and channel morphology. These general water-body changes can be detrimental to salmonids.

General temperature ranges for the various life history phases of salmonids are as follows.

Spawning Migration	38-68° F.
Spawning	39-57° F.
Incubation	36-52° F.

Fish diseases associated with elevated water temperatures become problematic in the 56-65° Fahrenheit range. Direct salmonid mortalities from elevated temperatures begin at 70° F. The fecundity and viability of eggs of spring chinook is reduced when pre-spawning stream temperatures exceed 54° F (Berman and Quinn 1991).

Dissolved oxygen (DO) is necessary in appropriate concentrations to keep aquatic organisms alive and to sustain reproduction, vigor, and population development (MacKenthun 1969). Severely reduced DO delays egg hatching, produces deformed alevins, interferes with food digestion, accelerates blood clotting, decreases tolerance to toxicants, reduces food conversion efficiency and growth, and reduces maximum sustained swimming speeds (WDF 1992). Salmonid growth, development, and activity can be limited by slight reductions in DO below saturation (Katz et al. 1968). Levels at or near oxygen saturation are desirable to maintain habitat function and fish health. Dissolved oxygen levels decrease as water temperatures increase.

The pH of water (acidity or alkalinity) and the rate of pH change directly affect salmonid use and survival. Near neutral conditions are most favorable, while changes in pH greater than 0.5 in 24 hours have resulted in both immediate and delayed salmonid loss in hatcheries (J. Shefler, WDFW, personal communication).

Total suspended solids (TSS) is a measure of the amount of sediment suspended in the water. Increases in TSS can contaminate salmonid spawning habitat with fine sediments, fill rearing pools, reduce instream productivity, damage or clog salmonid gill filaments, reduce feeding effectiveness, and interrupt spawning migration. The effects of TSS on salmonids are dependent on the size of fish, type of sediment, and the length of exposure.

A variety of elements affect spawning habitat quality and quantity. These include the abundance and size of gravel, the pattern and depth of flows, stream or lake structure, access, and distribution. The presence of suitable gravels can be limiting in many areas. Streams frequently lack a suitable gravel substrate. Streams with silt and sand substrates provide poor opportunities for spawning. Many lowland lakes in Washington do not have suitable spawning area in inlet or outlet streams, and as a result are not useable for spawning by wild salmonids.

Gravel substrates with a high concentration of fine materials will have poor wild salmonid survivals. Sediments smaller than 0.85 mm (0.0334 inches) in concentrations greater than 11% (by volume) have been found to decrease survival of eggs and alevins within gravels (Peterson et al. 1992). Fine sediment fills the spaces between gravels and inhibits the exchange of oxygen-bearing water, causing eggs to suffocate. A cap of compacted material cemented together by fine materials can form over the redd and trap the young fish after they hatch, confining them in the gravel. As a result, they starve.

Many elements and chemical compounds resulting from human activities have direct or indirect toxic impacts on salmonids. These chemicals range from naturally occurring metals and compounds to complex industrial effluents and synthetic pesticides. These are directly or indirectly introduced into the water from a myriad of industrial, agricultural, forest practices, urban development, and other activities. Lethal and sublethal impacts can result from both short-term, high-level exposure and chronic, low-level exposure.

For some chemicals, “no effect” levels — the level at which there is no adverse effect on the fish — are only slightly above natural background levels. Often these no effect levels are several orders of magnitude below levels that are acutely toxic. For instance, copper is both a naturally occurring element and an essential growth nutrient. At levels above those needed for metabolism, however, it becomes toxic. Lorz and McPherson (1976), for example, found that copper was acutely toxic to yearling coho salmon at 60-74 μg/L, but positively affected smoltification, migration, and survival at 5-30 μg/L.

Water quality standards and antidegradation requirements were designed, in part, to accommodate the biological needs of salmonids. When water quality standards are not met, the salmonids inhabiting those waters may be killed, forced to migrate to habitats having more suitable conditions (if any are available), or live in conditions that limit their ability to grow and reproduce. Substandard water quality conditions can limit or eliminate salmonid production.

Natural Factors That Affect Water Quality and Sediment Delivery, Transport and Quality

As with basin hydrology, water quality is affected by local climate, geography and geology, and vegetation, particularly riparian vegetation.

Water quality and water quantity are also inseparable as stated above. Seasonal variations in air temperature are reflected as seasonal variations in water temperature. Ground water temperature generally follows the average annual air temperature. The concentration of suspended solids within aquatic environments rises and falls with increases or decreases in streamflow, and is also well-associated with the geology and soils in a given basin. Sediments derived from bank erosion or upslope mass movements contribute to sediment levels within streams and streambeds. Riparian area vegetation regulates daily stream temperatures and contributes dissolved elements such as nitrogen and phosphorous to streams. Riparian vegetation also affects water quality through introductions of leaf litter, limbs, tree parts, and whole trees into aquatic environments, and by capturing or releasing upland or in-channel sediments.

Human Activities That Affect Water Quality and Sediment Delivery, Transport and Quality

Most land-use activities have some level of effect on water quality. Some of the more obvious impacts include removal of riparian vegetation, road building and timber harvest, agriculture and livestock grazing, stream and marine sediment dredging, sewage treatment effluent release, urban runoff, and a variety of industrial discharges.

Subgoals for Water Quality and Sediment Quality, Delivery and Transport

The performance measures and action strategies for this component are intended to meet the following subgoals:

A. **Provide for water and sediments of a quality that will support productive, harvestable, wild salmonid populations unimpaired by toxic or deleterious effects of environmental pollutants.**

B. **Manage watersheds, stream channels, wetlands and marine areas for natural rates of sediment erosion, deposition and routing to within the limits of salmonid life requirements.**

Performance Measures

Performance measures for this component would include the following:

A. Maintain productive aquatic habitats for salmonids and their prey bases that contain a balanced, integrated community of organisms having species composition, abundance, diversity, structure, and organization comparable to that in unimpacted reference ecosystems of the region.

B. For factors such as temperature, dissolved oxygen, pH, turbidity and suspended solids levels, meet state surface water quality standards as established for waters supporting salmonids and prey-base species.

C. For all relevant freshwater and marine areas, meet water- and sediment-quality criteria as established for toxic or deleterious pollutants that can affect the survival, growth or reproductive success of salmonids or prey species.

D. Consider gravel impaired in spawning areas if fine sediments (<0.85mm) exceed 11%. If fine sediment levels naturally exceed 11% in spawning or rearing habitat, then sediment concentrations would not exceed natural levels.

Action Strategies for Water Quality and Sediment Quality, Delivery and Transport

A. Require surface water runoff, water discharge, water conveyance systems and irrigation return flows to meet state, federal, and tribal water quality standards for a receiving stream channel or surface water.

B. Establish spawning and rearing habitat criteria (e.g., percent fine sediment) through the state water quality standards triennial review process.

C. Develop a statewide stormwater management strategy that illustrates how land use patterns affect impervious surfaces and stormwater runoff and how to use hydrologic modeling to develop land use options to avoid significant changes in basin hydrology and non-point source point pollution.

D. Develop a statewide, unified aquatic-sediments strategy to prioritize clean up of contaminated-sediment sites associated with salmonid production.

E. Continue to support a statewide, unified natural resource damage incident response, clean-up and assessment and restoration strategy to fully compensate the public for damages incurred due to releases of toxic substances.

F. Organize a forum to promote understanding and communication between the fish and wildlife management community and the agricultural community on issues of salmonid production and the production of agricultural crops and products. This could be modeled on the Timber Fish and Wildlife Agreement that was used to address the interactions of timber management activities and fish. Develop an improved regulatory framework including best management practices that assures agricultural activities will comply with federal and state water quality requirements.

G. Recommend “total maximum daily loading” (TMDL) for point and non-point pollution activities:
   1. Develop an improved version of watershed analysis or equivalent procedure to meet Clean Water Act requirements.
   2. Specify TMDLs that recognize the value of salmonid carcasses up to historical levels as a source of nutrients.

H. Develop interim approaches, including best management practices, for impaired water bodies or watersheds for which a TMDL has not been developed.

I. Seek to defer or condition activities or permits that will adversely affect state waters to ensure that no further degradation will occur.

J. Promote land-use practices that prevent significant changes in the delivery and transport of sediments. Priority consideration should be given to high-risk areas where potential for impacts are greatest, such as highly erodible areas.

K. Promote sediment control measures for activities that could introduce unnaturally high levels of fine sediments into streams and estuaries such as gravel or rock crushing/washing, road use in wet weather, and land clearing on erodible soils.

L. Advocate sediment control measures which protect all waters, including Type 4 and 5 streams (222-16 WAC) - especially in areas with steep headwall slopes, unstable slopes, and high mass-wasting potential - from sedimentation and pool filling, and to protect the integrity of downstream salmonid-bearing waters.

M. Manage watersheds to ensure that gravel and sediment delivery to streams is at levels that will maintain favorable substrate conditions for spawning and rearing salmonids.

N. Review designs of dams and water diversion structures to facilitate the normal downstream transport of sediment. Require gravel supplementation to mitigate gravel supply depletion.

O. Ensure gravel removal and dredging operations are evaluated and conducted in a manner that protects wild salmonid habitat, including instream, riparian, wetland, and marine resources.

Stream Channel Complexity

Salmonids have evolved and adapted to streams which possess a variety of in-channel features important to their survival, growth, migration, and reproduction. These features include pools , riffles and intermediate areas such as glides, cascades and waterfalls. Other features include substrate size and distribution (silt, sand, gravel boulders, etc.), sediment delivery and transport processes, water depth and velocity, undercut banks, side channels and instream large woody debris. These features collectively define the complexity - or simplicity - of a stream channel. On balance, complex channels are more productive for salmonids than simple channels.

In-channel Features That Affect Salmonids

Rearing habitats range from shallow, low-velocity stream margins and side-channel areas for recently-emerged salmonid fry to pools several feet deep for larger species (coho, steelhead, and spring chinook pre-smolts and resident trout). Plunge and scour pools with associated LWD are preferred habitat of rearing Dolly Varden and bull trout (Martin 1992, McPhail and Murray 1979). Higher velocity glides and riffles are used by several trout species and chinook. Steelhead, cutthroat, Dolly Varden and bull trout juveniles use spaces within the stream bed substrate as refuge during the winter.

Off-channel wetlands, lakes, and ponds and low-velocity tributary streams have been found to be particularly important over-wintering habitat for some coho populations (Cederholm and Scarlett 1982, Peterson 1982). Cutthroat and steelhead juveniles also use this habitat (D. King, WDFW, personal communication). These areas provide safe, stable, and productive rearing habitat that is buffered from winter flood events (Cederholm and Reid 1987). Smolt survival and growth rates in these areas often exceed those of smolts in other habitat (Cederholm and Scarlett 1982; Bustard and Narver 1978). Lakes and other impoundments provide rearing areas for sockeye, kokanee, coho, cutthroat, Dolly Varden, and bull trout. Small spring seeps and side-channels have recently been recognized as important early rearing areas for chinook fry in western Washington (P. Castle, WDFW, personal communication). Similarly, Fraley and Graham (1981) found a high abundance of bull trout in side channels and around rocks along stream margins.

Peterson et al. (1992) reviewed the available literature on pool habitat as part of a Timber, Fish and Wildlife (TFW) cooperative research effort and concluded that an appropriate target condition for the percentage of stream surface comprised of pools is 50% for streams with gradients <3%. In 1994, the Forest Practices Board adopted a watershed analysis manual that defined good habitat for streams less than 15 meters wide when:

Steam Gradient	% Pool Area
<2%	50
2-5%	30
>5%	40

Large woody debris is integral to the formation and maintenance of pools in most gravel stream channels and for the formation and maintenance of low-velocity side channels in large and small streams. LWD also functions to dissipate stream energy and trap sediment in smaller streams. LWD is important in forming channel structure in steep tributary streams (Maser and Sedell 1994). LWD is provided by the trees in or near the adjacent riparian zone. Most LWD (either whole trees or tree parts) comes from trees within 45 meters (150 ft) of the stream or wetland (McDade et al. 1994).

The Washington Forest Practices Board provides a description of adequate LWD loading in stream channels in its *Watershed Analysis Manual*. For streams less than 20 meters wide, the manual defines "good" LWD conditions when LWD pieces (>10 cm x 2 m length) exceed two (2) per channel width. If LWD were defined as "key pieces" in western Washington [stratified by piece length and diameter per bankfull width (BFW)], then the manual defines LWD conditions as "good" when key pieces exceed 0.3 per channel width when channel BFW is less than 10 m, and 0.5 per channel width when channel BFW is between 10 m and 20 m. (Key pieces are the large logs or rootwads that provide stream channel and bank stability in unison with the smaller pieces.)

Restated in less technical terms, small streams generally are served by smaller pieces of LWD, while large streams require larger LWD. Conifer species are generally more functional as LWD because of their larger diameter and resistance to decay after entering the channel.

Channel complexity is important for adult residents and anadromous spawners. Adult residents use a variety of instream habitat and cover types. Spawning salmonids also have a variety of reproductive strategies and use many different spawning habitats. This can range from brackish or freshwater areas of sloughs, rivers, streams and lakes where suitably-sized gravels accumulate, and where water flows over and between gravels. Eggs and alevins (young salmonids with the egg-sac still attached) incubate in this gravel habitat for several months. While in the gravel, the eggs and alevin are very susceptible to injury or suffocation, and are vulnerable to spawning habitat alterations because they are immobile.

Each species has its own set of spawning habitat needs. For example, different salmonid species require different size spawning gravel. Generally, concentrations of clean gravel mixtures four inches in diameter or less are considered viable spawning habitat, given appropriate water depth and velocities. Gravel accumulations must be large enough in an area to accommodate the spawning fish. For chinook, the largest salmonid, the recommended area for a spawning pair is 20 square meters. The recommended area for trout is 1.7 square meters (Bell 1991). The recommended size includes a defense area to prevent encroachment by other spawning pairs. Actual redd (nest area for laying eggs) size may be considerably smaller. Some salmonid species, like sockeye, pink and chum, often mass spawn. This occurs when large concentrations of fish spawn in close proximity, requiring large gravel beds.

Different species use different parts of the watershed. Some salmonid species spawn primarily in smaller tributary streams (coho, cutthroat, rainbow), while others use the mid- and upper reaches of larger, mainstem streams and larger tributaries (steelhead, pink, chinook). Sockeye and kokanee spawn in mainstem and tributary habitats that are linked to lakes, or on lakeshore gravels associated with ground water upwelling. Chum spawn in the lower mainstem of rivers, tributaries, and in associated sloughs and side channels. Dolly Varden and bull trout spawn in cold-water tributaries and upper mainstem streams (Brown 1992).

The variety of spawning areas provided by different stream reaches and complexity within stream reaches helps to limit inter-species competition for spawning and rearing habitats and to increase overall population survival and production.

Natural Processes that Affect Channel Complexity

Channel complexity depends on valley form, floodplain size and extent, riparian area vegetation types, sizes and extent, sediment routing and transport, and upon basin hydrology and instream flows. Spence et al. (1996) summarize the basic channel morphological units and the physical mechanisms affecting their characteristics. A stream channel is basically a manifestation of the interrelated processes of hydrology and sediment within a more or less defined channel. Stream channels can be described on several scales; an entire drainage network, a stream reach, or a channel unit. Generally, at the largest scale, averages of stream characteristics such as depth, velocity, width and channel form change in a downstream direction with increasing discharge and distance from their point of origin. However, stream reaches or segments (as used in *Watershed Analysis)* and channel units are more responsive to valley form, hydrology and sediment. Stream reaches, typically 1-10 kilometers long, possess relatively similar channel unit features such as pools, riffles, cascades, glides, stepped pools, and steps. Reach characteristics are determined in large part by local geology. Stream reaches within wide valley floors generally have unconstrained channels and are well-connected to broad flood plains, and possess a pool/riffle/glide/sequence with a variety of primary and secondary channels. Large woody debris, which enters the stream usually remains near to its point of entry, creates and maintains a variety of habitat types. Stream reaches characterized by narrow valleys, particularly within rocky non-erodible canyons, are usually deeper, swifter, and dominated by cascades, falls, and step-pool channel unit features. LWD and smaller sediments and spawning size gravels are usually transported through these reaches. Habitat features are more simple; cover is provided by larger rocks and boulders and water depth and turbulence. Depths and velocities are more uniform. In higher gradient reaches with well-developed riparian areas, wood plays an important role in creating and maintaining reach characteristics.

Natural disturbances such as landslides, debris flows and debris torrents affect stream channels. Hillslope material that enters steep and constrained stream channels during landslides, combined with already high streamflow, form a slurry of water, soil, rock and wood; which when mobilized can scour entire stream reaches to bedrock, changing what may have been a complex channel formed over millennia to a simple, exposed uniform reach in a matter of minutes.

Human Activities that Affect Channel Complexity

The most pervasive effect of human activity on stream channels has been a fundamental change from complex channels to simple channels. The channel unit and, in many cases entire reach characteristics, of most streams outside protected areas have been altered, often dramatically and permanently by land management activities. Both bank protection and diking limit off-channel rearing habitat by preventing channel migration and closing off side channels. Urbanization causes significant changes in stream morphology and water chemistry. These changes can cause a shift in the fish community, for example from coho (a pool-associated species) to cutthroat (a riffle-associated species) (Lucchetti and Fuerstenberg 1993). Logging and road building are associated with increased mass wasting events in watersheds, which cause scouring of pools in higher gradient areas and in low gradient areas cause pools to fill with sediments, resulting in a loss of channel complexity and rearing capacity. Recent habitat analysis indicates watersheds in Pacific Northwest National Forest lands have 30 to 70% fewer large pools today than in the past (PACFISH Strategy 1993).

Past logging practices, including removal of large conifers from riparian areas, clearing and snagging LWD from streams, and splash-damming streams to provide in-channel transport of timber to downstream mills, drastically reduced pool volume and channel stability. This was exacerbated by state and federal actions and mandates to clean out streams after logging (Cederholm and Reid 1987, Bisson et al. 1987). Agricultural drainage, flood control and navigation also caused LWD removal, as did the cutting of riparian zone trees in urban and agricultural areas (Sedell and Luchessa 1981).

Large and small dams interrupt or block normal migration and recruitment of gravel to streams. Gravel of all sizes has been trapped behind dams where it is unavailable for spawning. Below dams, smaller gravels are washed downstream and not replaced. This leaves only larger material that is unsuitable for many spawners.

Conversely, mass-wasting events also alter spawning habitat by contributing excess gravel and other sediments to the channel. This extra gravel is often unstable and subject to movement during moderate and high flows. Redds can be destroyed or disturbed by this sediment movement.

Removal of stream gravels for flood control and construction purposes has contributed to channel simplification. These activities are often coupled with dike construction, bank armoring, and channel straightening to accommodate roads and buildings, and channel obliteration through extensive culverting to prepare sites for construction.

<u>Stream Channel Complexity Subgoal</u>

The subgoal for stream channel complexity is:

> **Maintain or restore natural stream channel characteristics for channel sinuosity, gravel quality and quantity, instream cover, large woody debris, pool depth and frequency, bank stability and side-channel and off-channel and flood plain connectivity and function.**

<u>Performance Measures for Stream Channel Complexity</u>

Suggested performance measures for this habitat component include:

A. Spawning gravel will be relatively stable, with a low potential for scour, throughout the nest building and incubation period of the wild salmonid species in the basin.

B. Adult salmonid holding pools be of sufficient depth (depending on species and stream, but generally greater than one meter) and have associated cover.

C. More than 90% of channel banks on streams will be stable, relative to natural rates of erosion in the basin. Stability, if needed, can be provided in a number of ways. If bank protection is necessary, bioengineering methods are preferred.

D. At a minimum, the performance measures relative to pools and large woody debris in forested and previously forested areas should conform to those in the *Washington State*

Watershed Analysis Manual (listed below) unless locally defined.

1. In streams of any gradient, but less than 15 meters wide, the frequency of pools should not occur at intervals less than one pool for every two channel widths in length.
2. The percent pools in a stream will not be impaired by the presence of sediments or the effects of human disturbances. For streams less than 15 meters wide, the percent pools should be greater than 55%, greater than 40%, and greater than 30% for streams with gradients of less than 2%, 2-5% and more than 5%, respectively.
3. The quantity and quality of “large woody debris” (LWD) in streams should not be impaired by human activities. For streams less than 20 meters wide, the number of pieces of LWD larger than 10 centimeters for every channel width should exceed two. The number of key LWD pieces per “bank full width” (BFW) should be greater than 0.3 pieces for streams less than 10 meters BFW and greater than 0.5 pieces for streams 10-20 meters BFW.

E. Side channels and other off-channel habitat, including wetlands, should remain connected to the channel proper. Where feasible, dikes or levees that are constricting floodplains would be removed or modified to allow flood flow, storage, recharge, and release.

Action Strategies for Stream Channel Complexity

The following action strategies are suggested for stream channel complexity:

A. Allow river and stream channels to maintain or restore their natural meander patterns, channel complexity and floodplain connectivity. Where feasible restore these features.

B. Maintain or provide functional riparian corridors. See also action strategies under riparian areas and wetlands - next component.

C. Avoid or minimize channel relocations or encroachments. Where channel relocations are absolutely necessary, ensure the new channel design and construction will not result in a net loss of function or value. Where altered channels are being rebuilt or restored, the reconstruction design should conform to the performance measures identified in this component.

D. Restrict large woody debris removal from stream channels and floodways. Where LWD removal is warranted because of damage to property or capitol improvements relocate LWD to other areas within the channel. Discourage LWD removal for other purposes.

E. Develop performance measures, including channel complexity and sinuosity, for historically non-forested areas and intertidal lands of rivers and streams.

Riparian Areas and Wetlands

Riparian areas and associated wetlands perform the following functions, all of which have a direct or indirect affect on salmonid production:

- Stabilize streambanks and lake shores, and prevent erosion.
- Filter suspended solids, nutrients, and harmful toxic substances.
- Provide a distinct microclimate, usually cooler and more wind-free than the surrounding uplands.

- Help maintain cool water temperatures.
- Provide migration corridors.
- Dissipate stream energy and trap suspended sediments during overbank flows.
- Provide flood storage and ground water recharge.
- Provide quiet pools and off-channel habitat.
- Maintain undercut banks for hiding and rearing.
- Provide large woody debris (LWD) for channel stability, pool formation, and in-channel complexity/diversity.
- Moderate impacts of storm water runoff.
- Provide an energy source in the form of leaf litter and LWD.

Riparian and Wetland Functions That Affect Salmonids

All of the functions discussed above help to maintain habitat diversity and integrity (Cummins 1974, Meehan et al. 1977, Vannote et al. 1980). Riparian habitats create a multitude of niches that support fish and wildlife in higher abundance and diversity than any other habitat type. Invaluable to healthy aquatic ecosystems, riparian habitats also benefit about 90% of Washington's land-based invertebrates.

Functional riparian habitat contains a variety of vegetative communities usually composed of grasses, shrubs, and deciduous and conifer trees of various sizes. Forested wetlands provide refuge and high quality winter rearing habitat for wild salmonids. Riparian habitat must be relatively continuous along the stream corridor and fairly wide to provide the full range of functions described above (Naiman et al. 1992).

Riparian trees fall, or are washed, into the stream and provide large woody debris (LWD) for habitat formation and streambed stability. As water flows around LWD, it creates complex hydraulic patterns that form pools, falls and channel meanders, and cause physical variations within the stream. LWD can be very important for providing shelter for juvenile and adult fish in lakes, ponds, and wetlands. Most LWD is recruited from trees growing within the riparian zone of the stream or wetland. Cederholm (1994) reviewed recent literature describing recommended riparian buffer strip widths for LWD maintenance, and found that recommendations ranged from 100 feet to 200 feet (ave. 154 ft).

Large woody debris retains adult post-spawner salmon carcasses within the channel, allowing these carcasses to contribute to overall stream productivity. Large woody debris provides a substrate for colonization by aquatic invertebrates, which ultimately become prey for salmonids. The debris also dissipates stream energy as water flows over and around it, reducing erosion, sedimentation and gravel scour. Such instream obstructions also introduce oxygen to the stream as water tumbles over the LWD. The debris helps to retain leaf litter from adjacent riparian vegetation. This leaf litter is broken down by invertebrates in the quiet backwaters formed and maintained by LWD. Finally, large woody debris provides migration opportunities in steep gradient streams by providing low-velocity rest areas and “stair-stepping,” which reduces the local stream gradient.

A functional riparian zone does much more than provide LWD to the stream channel. Many of the elements that comprise good salmonid habitat (e.g., water temperature, bank stability, pool formation and persistence, stable spawning gravel, excess nutrient uptake, ground water recharge, etc.) are influenced by the riparian zone condition.

Stream water temperature is heavily influenced by riparian shading. To achieve adequate water temperature control, stream surfaces must have between 60% and 80% shade throughout the day. Cederholm (1994) found riparian buffers ranging from 35 ft to 125 ft provided that shading level. Mathews (1995) reported that a 100-foot "no harvest zone" is necessary for meeting shading requirements. Streamside shading was found to be less influential on streams greater than 50 ft wide.

Wetlands provide a variety of direct and indirect benefits to wild salmonids. Fully functional wetlands perform the following functions:

- Reduction of flood peak flows (including stormwater runoff), maintenance of low flows
- Shoreline stabilization (energy dissipation/velocity reduction)
- Groundwater recharge
- Water quality improvement, including sediment accretion and nutrient/toxicant removal/retention
- Food chain support (structural and species diversity components of habitat for plants and animals)
- Provide habitat for numerous fish and wildlife species including wild salmonids.

Natural Factors That Affect Riparian Areas and Wetlands

Riparian areas are defined as the interface between aquatic and terrestrial ecosystems. Riparian areas affect and are affected by the adjacent water source whether it is a stream, a wetland or a lake. There is a closely-linked relationship between riparian vegetation and ground water. Riparian and wetland vegetation is subject to natural disturbances such as fire, windthrow, landslides and floods. They are also subject to changes in global and local climatic conditions and to insect infestation.

Human Factors That Affect Riparian Areas and Wetlands

Past logging and stream clean-out practices, combined with shorter harvest rotations and conversion of forest lands to other uses, have removed much of the existing and potential LWD from the riparian zone. Riparian zone buffers were not generally required on Washington streams until 1988. As a result, in-channel LWD is less abundant now than in the past (Sedell and Luchessa 1982, Grette 1985, Bisson et al. 1987).

Freshwater and estuarine wetland habitat loss has been extensive in Washington state. Puget Sound and coastal wetland losses are estimated to be 40% and 70%, respectively, since European settlement. Diking, dredging, and urbanization have been the primary factors causing this wetland loss. Loss of wetland habitat has resulted in a significant reduction in available rearing and overwintering habitat for juvenile salmonids.

Subgoal for Riparian Areas and Wetlands

The following subgoal is suggested for riparian areas and wetlands:

Functional riparian habitat and associated wetlands is protected and restored on all water bodies that support, or directly or indirectly impact salmonids and their habitat.

__Performance Measures__

The policy will meet the riparian area and wetlands subgoal by achieving the following suggested performance measures:

A. There are no single agreed-upon, statewide numeric standards for riparian areas or wetlands. Regional or watershed specific standards may need to be applied based upon watershed analysis, the development of specific and detailed standards in individual watershed plans, or other assessments of site conditions and intensity of land use. It is also anticipated that in many instances existing encroachments in riparian areas or parcel size and configuration may preclude attainment of adequate riparian buffers.

1. Riparian Areas

The standards below will represent what would generally be necessary to maintain riparian conditions which protect salmonid habitat:

a. For Water Types 1-3 (as defined and mapped in WAC 222-16-030) a buffer of 100 - 150 feet (measured horizontally) or the height of a site potential tree in a mature conifer stand (100 years), whichever is greater on each side of the stream.
b. For Type 4 streams, a buffer of at least 100 feet (each side).
c. For Type 5 streams, a buffer of at least 50 feet (each side).
d. For streams not administered directly or indirectly per WAC 222-26-030 apply a buffer of 100-150 feet each side on salmonid streams larger than 5 feet wide, a buffer of 100 feet (each side) on perennial streams and a buffer of 50 feet (each side) on all other streams.
e. The buffers may need to be expanded to accommodate anticipated channel migration, as an additional buffer against windthrow, or to address upslope instability or previous negative upslope impacts.
f. To the extent possible, buffers will be continuous along the stream channel. Tree removal would occur only to improve the functional characteristics of the riparian area, or for road alignments, stream crossings or other corridors where no feasible alternative exists.
g. Plant community structural complexity (understory herbaceous and woody overstory canopy) would approximate site potential for native plant species and native vegetation would be used for restoration.
h. Grazing will be managed to maintain or allow reestablishment of functional riparian vegetation.
i. Performance standards for Basin Hydrology and Instream Flow, and Water and Sediment Quality and Sediment Transport and Stream Channel Complexity will need to be met to ensure riparian functions will be meaningful and attainable.

2. Wetlands

a. Buffers for wetlands will be applied in accordance with the Department of Ecology Model Wetlands Ordinance -

September 1990 and the updated 4-tier rating system (Pub #93-74 for western Washington and Pub. #91.58 for eastern Washington). The ordinance would be applied as guidance; it would not be a legally required state standard. It is not solely designed to meet the specific needs of salmonid habitat protection and recovery. In addition, the Model Wetlands Ordinance was designed as a regulatory tool and would be limited to standard categories that relate to development actions.

(Note: the Wild Salmonid Policy intent will be to encourage habitat protection through all means, not only through regulation. Generic application of the Model Wetlands Ordinance buffer widths and rating system for salmonid habitat protection in all cases could result in too much or too little protection of salmonid habitat in different site conditions. Use of the Model Wetlands Ordinance standards for the protection of salmonid habitat would be intended as interim guidance. There is a need to develop improved wetlands protection guidance that is specific to the salmonid habitat needs addressed in this policy).

b. Wetlands replacement will be highly discouraged because of the difficulty of providing adequate replacement of functions and values. Where replacement is unavoidable, the replacement ratio would be applied as provided in the Model Wetlands Ordinance. Wetlands mitigation banking is also an option which would be considered where on-site, in-kind mitigation would not be feasible or practicable.

c. Performance standards for Basin Hydrology and Instream Flow, and Water and Sediment Quality and Sediment Transport would need to be met, where applicable, to ensure wetlands extent and functions are meaningful and attainable.

Action Strategies for Riparian Areas and Wetlands

A. Develop wetland protection standards specific to the needs of wild salmonids.

B. Support a mechanism of wetlands inventory, tracking and characterization

C. Develop integrated strategies to include regulatory and non-regulatory approaches (e.g. incentives such as current-use taxation, conservation easements, awards/recognition, or land trusts or other forms of acquisition) to improve stewardship of riparian and wetland areas and buffers supporting wild salmonid habitat.

D. Ensure that land-use plans avoid the loss or degradation of riparian and wetland areas, fundamentally through land use allocation, secondarily through application of mitigation techniques.

E. Where wetlands alterations are unavoidable, support wetlands permitting programs to achieve no net loss of wetland acreage and function.

1. Provide for a mechanism to assess the effectiveness of wetlands mitigation to replicate wetlands functions and extent.
2. While avoidance of wetland impacts is preferable, there may be times when off-site mitigation is more practical, affordable and effective. A state

mitigation banking protocol should be followed when site specific wetland impacts are unavoidable and mitigation should occur within the same watershed. The protocol should ensure the needs of wild salmonids are met, including criteria for success and monitoring strategies.

F. Over the long term, seek to gain an increase in wetland base and functional characteristics.

G. Oppose new road construction or other encroachments in riparian areas and wetlands. Where construction, reconstruction, or upgrades are unavoidable, minimize encroachments in riparian areas and wetlands and mitigate for adverse impacts.

Lakes and Reservoirs

Lakes and reservoirs are significant and ever-changing features of the landscape of Washington. The over 8,000 lakes identified in the state vary widely in age and successional stage, origin, elevation, productivity, shape, hydrology and water quality, and in shoreline configuration and level of human development (Dion 1978). Some are nearly pristine and virtually unchanged physically. Others, typically low-elevation lakes such the Lake Washington/Sammamish system, have been extensively altered and developed with wholesale changes in inlet and outlet drainage systems. Many lakes have been manipulated in some fashion; usually for lake-level maintenance, flood control or hydroelectric power generation, and they are often equipped with control structures at their outlets.

The state also abounds with human-built reservoirs. Most have been converted from previously free-flowing stream reaches. They range from small impoundments to single large dam/reservoir structures up to entire river system impoundments such as the Columbia River system of hydroelectric dams. Some are designed to allow fish passage, while others completely obstruct passage or the passage facilities are inefficient or ineffective.

The Role of Lakes and Reservoirs in Salmonid Production

Lakes serve salmonids primarily as areas for feeding and growth, although they also provide spawning habitat as well. They also serve as migratory pathways between rearing and spawning habitats or as pathways between spawning and rearing areas. For example, adult steelhead trout and sockeye salmon migrate from Puget Sound through Lake Washington and into the Cedar River for spawning. The progeny of the sockeye spawners subsequently migrate as juveniles to the lake where they live a year or more prior to seaward migration, while the steelhead rear in the river and outmigrate as smolts from the river through Lake Washington to Puget Sound and the open ocean. Sockeye and kokanee use lakeshore beaches for spawning in areas where water upwells through the beach gravels or beaches where wave action provides oxygenated water to incubating eggs. In alpine lakes, cutthroat trout and others use inlet or outlet streams for spawning and short term-rearing prior to lake residence.

Reservoirs are used by salmonids in much the same ways as they use lakes, although they are usually not as hospitable or productive as are natural lakes for the reasons discussed below.

Natural Factors Affecting Lakes and Reservoirs

A natural lake is basically an accumulation of water in a basin or depression on the earth's surface. Lake basins originate in a variety of ways, and their distribution and function in large part is dictated by their origin. Most of Washington's lakes were formed by glaciation (outwash or erosion) or by the riverine processes of streambank and bed erosion and subsequent channel abandonment during meander development. Still others were formed by geologic processes such as landslides (Britton et al. 1975). Because they are formed in basins or depressions of the land, lakes are effective "sinks" for sediments and other nutrients from upland sources, from airborne particulates, and are subject to natural variations in hydrology and weather. As with streams, the water supply of a lake is governed by the hydrologic cycle. Lakes may gain water from precipitation, from surface inflows such as rivers and streams, and from the subsurface flow of groundwater through seeps and springs (Britton et al. 1975, Baker et al. 1993). Materials that enter a lake from tributaries or from the atmosphere may settle in the lake basin, be removed through the outlet, or remain in solution within the lake. Those that remain in solution and that are required for plant production may be incorporated into living tissue.

The physical, chemical and biological systems of lakes are complex and interrelated. For example, sunlight penetrating the water triggers the growth of phytoplankton (floating, one-celled plants). If conditions are favorable, the phytoplankton become so numerous that they reduce light penetration. Reduced light penetration may not only reduce the rate of phytoplankton production, but it may also influence the rate of warming of the lake water by the sun.

Physical characteristics affecting lakes include light penetration, temperature, suspended sediment (especially from inlet streams and shoreline areas) and morphological attributes such as flow-through or retention time, maximum depth, mean depth, shoreline length, stage (the lake elevation at a given time), volume, and watershed drainage area.

Chemical constituents include dissolved solids (such as calcium and magnesium), gases (such as oxygen and carbon dioxide) and organic compounds. These chemical characteristics are very important from the standpoint of water quality. Under natural conditions these chemicals are related primarily to minerals in the surrounding rocks. Most, if not all, of the major chemical constituents are essential for the growth of plants. A variety of other chemical constituents exist in minor concentrations, but may cause toxicity problems at higher concentrations.

Lakes support a great variety of bacteria, higher plants, insect and fish species that can be placed into three broad categories: plankton (primarily drifters), benthos (bottom-dwellers, and nekton (swimmers). The biological relationships and interactions among these various groups of organisms must be considered for successful management of salmonids.

The movement and mixing of waters within a lake or reservoir are key factors in its suitability for various fish species (Baker et al. 1993) Significant events affecting lake productivity for salmonids are the fall and spring overturns that occurs in lakes that are deep enough to maintain temperature stratification. Seasonally changing air temperature and wind are the primary energy sources that drive water movement and mixing.

At spring overturn, warmer air temperatures and increasing day lengths warm the lake's ice cover (alpine and some eastern Washington lower-elevation lakes) or the lake surface directly. The surface water is replaced by water from below. This circulation, aided by the stirring of the wind, eventually produces a water body of uniform temperature and density. As the water warms, it becomes less dense and no longer mixes with the underlying water, and as heating continues the resistance to mixing between layers increases.

The result during the summer months is stratification into identifiable temperature zones: an upper zone of uniformly warmer water (epilimnion), an intermediate zone of transition where temperature decreases rapidly with depth (metalimnion or thermocline) and a lower zone of uniformly cold water (hypolimnion).

During fall overturn, cooler air temperatures and decreased day lengths cool the upper layer of the lake. This cooled water, being more dense, settles and is replaced by warmer water from below. As cooling continues, the water approaches or reaches maximum density and sinks all the way to the bottom. This process of fall overturn again produces a water body of uniform temperature and density and a complete mixing of dissolved gases and chemicals that had accumulated in the warm and cold layers during the summer months.

There are many variations in the temperature cycle (Britton et al. 1975). In colder areas, the water freezes in the winter. Once the lake is frozen, circulation by wind action is prevented, and further loss of heat to the atmosphere is reduced. Many shallow lakes become stratified during periods of calm but may be completely mixed by moderate winds. This is particularly the case with shallow lakes of small surface area. Other lakes are continuously mixed and thermal stratification never occurs. In contrast, some larger deeper lakes with limited surface area and limited exposure to winds may mix once a year or not at all.

This temperature stratification allows adaptive use of the stratified layers by cool-water species such as salmonids and their prey base species. For example, lake temperature and temperature stratification affects the daily and seasonal feeding behavior and depth preferences of sockeye salmon in different lake environments, with both adults and juveniles residing at or near the thermocline (Burgner 1987). Brook trout and cutthroat trout occur most commonly in high elevation lakes and are relatively intolerant of warm water, seeking out cooler temperatures in the hypolimnion when surface waters heat up during the summer (Wydowski and Whitney 1979).

In addition, this pattern of fall and spring overturn and mixing of lake waters brings nutrients to the upper levels of the lake, stimulating growth and production of phytoplankton and zooplankton, many of which serve as prey for salmonids.

In a geologic sense, lakes are temporary fixtures of the landscape, subject to change due to the constant introduction of sediment and nutrients. Lakes fill with sediment and organic material, transitioning to wetlands and finally to upland forests or grasslands. This aging process is called eutrophication and is a useful way of categorizing lake productivity. Young, clear, nutrient-limited lakes are classified as oligotrophic, intermediate-successional lakes are considered mesotrophic; older, sediment- and nutrient-laden lakes are classified as eutrophic, and the lake in its final bog or wetland state is considered dystrophic. Since salmonids require cool temperature and high levels of dissolved oxygen they occur most often in oligotrophic or mesotrophic lakes.

<u>Human Factors Affecting Lakes and Reservoirs</u>

Human impacts on lakes can be short-term and dramatic or long-term and subtle. The most pervasive human effect on lakes is accelerated eutrophication due to increased sediment and nutrient delivery. Most lakeside residents are not served by public sewers and most have substituted ornamental shrubs and grasses for dense and abundant native vegetation. Fertilizers and septic systems add nutrients to the water body, particularly nitrogen and phosphorus, and can lead to explosive growth of aquatic weeds, phytoplankton and zooplankton. In addition, many exotic weeds such as Eurasian milfoil have been inadvertently introduced to our lowland lakes. These exotics displace native plants and where accumulations are so great they can foul boat motors, create unsafe swimming conditions and significant water quality concerns (especially low oxygen levels) as they die off. Some algae especially, the blue-green algae (Cyanobacteria) produce toxins that can affect the health of pets, wildlife and humans.

Secondary effects on lakes occur when lakefront property owners press for chemical treatment to control these nuisances. For example, copper sulfate, a commonly prescribed treatment chemical has been shown to affect salmon smoltification, migratory capability, and early marine survival (Wedemeyer et al. 1980). Further, the repeated treatment of many lowland lakes with chemicals, often over decades, leads to build-ups of these chemicals in lake sediments well beyond levels known to adversely affect salmonids and other aquatic biota.

Other lake-related issues affecting salmonids include unnaturally high or low flows in outlet streams due to lake level manipulations, outlet water quality problems due to excessive nutrient loads in the lake, inefficient or inadequate fish passage facilities at lake outlet structures, and sedimentation, filling or dock construction at nearshore upwelling spawning beaches used by salmonids. Sedimentation of spawning beaches in Lake Ozette has been identified as a principle cause of the near total loss of the beach-spawning population of sockeye salmon (McHenry et al. 1996). Alteration of groundwater quantity and quality due to upslope development may also affect these lakeside spawning habitats. Inlet streams may be affected as well. Loss of access to inlet spawning streams or degradation of spawning habitat may severely affect the production of salmonids in lakes.

Reservoirs are a mixed blessing. On the one hand they provide significant fishing opportunity, particularly for planted hatchery fish. But on the other hand, they present fish passage, water quality and quantity, predation, and habitat simplification problems for wild salmonids. In addition, reservoirs placed in formerly free-flowing reaches inundate and destroy spawning habitat. The reader is directed to several excellent summary documents for additional detail (Independent Scientific Group 1996, CRITFC 1996, Baker et al. 1993).

Subgoal for Lakes and Reservoirs

The subgoal for lakes and reservoirs is as follows:

> **Maintain or restore lake and reservoir habitats that are conducive to wild salmonid passage, rearing, adult residency and spawning.**

Performance Measures

A. There are no statewide agreed-upon standards particular to all issues specific to lakes and reservoirs. However, performance measures for basin hydrology and instream flows, water and sediment quality, riparian areas and wetlands, and fish access and screening should include factors relevant to lake habitats.

Action Strategies

A. Ensure that land-use plans and regulations take into account the particular sensitivity of lake habitats as identified in the lakes introduction.

B. Develop lake level manipulation operations plans that protect salmonid habitat.

C. Recommend: In areas of significant nearshore use by wild salmonids, minimize the size and numbers of docks, floats and ramps. Use community or shared/common structures where possible. Avoid the use of treated wood in these structures.

D. Develop strategies to address aquatic plant introduction and control issues.

E. Ensure that lake outlets afford free and unobstructed passage as necessary for anadromous and resident fish species.

Marine Areas

Washington State has approximately 100 diverse estuaries within 14 regions, exhibiting structural, hydrological and biological diversity (Simenstad et al 1982). As with freshwater habitat, salmonids have evolved their respective life histories around these patterns of estuarine development. Estuaries are critical transition areas where seaward-migrating smolts adapt to seawater and returning adults prepare to enter spawning streams.

The Role of Marine Areas in Maintaining Anadromous Salmonids

Anadromous salmonids pass through estuarine habitats during their migration to the marine environment. Intertidal and subtidal areas provide productive foraging areas, opportunities for physiological transition from fresh to marine water (Wedemeyer et al. 1980), and protection from predators. Fall chinook, chum, and pink salmon juveniles and anadromous cutthroat appear to make the most extensive use of nearshore shallow water estuarine habitat (i.e., the area from ordinary high water waterward to -10.0 feet- Mean Lower Low Water = 0.0 feet). Residence times for chinook and chum often exceed one month for individual fish, while cutthroat may spend several months in the estuary (Simenstad et al. 1982, Thorp 1994). Salmonid growth is especially rapid in the estuary. Pink and chum salmon juveniles can double their body size during their short stay in estuary rearing habitat.

In addition, this habitat comprises spawning habitat for many important species of marine fish, some of which serve as prey for salmonids.

Natural Factors Affecting Marine Areas

Estuaries are similar in many respects to lakes in that they are “sinks” for the variety of upland and riverine processes we described earlier. Estuaries are dependent upon natural rates of sediment and large woody transport and freshwater inflow to sustain conditions amenable to support salmonids and their prey bases. In addition, nearshore processes such as wave erosion and bluff failures at natural rates provide sediments to replenish those lost to nearshore sediment transport and provide an additional source of large woody debris to marine areas. As in freshwater, LWD plays an important role in providing structure and nutrients to marine habitats (Maser and Sedell 1994).

Human Factors Affecting Marine Areas

Estuarine rearing habitat has been lost or modified to accommodate development along rivers and bays. Palmisano et al. (1993) estimated that 39% of the coastal wetlands and 70% of the Puget Sound emergent wetlands have been lost, particularly in urban areas as a result of bulkheads, fills, and dredging. These alterations affect prey resource production, reduce the amount of habitat available to salmonids, and introduce toxic substances that kill prey organisms (Simenstad et al. 1982). In addition changes in flow timing, duration and magnitude affect estuarine salinities, which alter prey bases

(Columbia River example) and affect the timing of adult entry into streams. There is also a concern that reduced amounts of LWD may have an effect on marine productivity (Maser and Sedell 1994). The effect of accelerated or retarded sediment transport are also of concern. Tidal surge plains, those areas above salt water influenced by tides, have also been extensively altered by filling and diking. Most major river mouth habitats have been simplified and consolidated to accommodate navigation. This precludes development of functional riparian areas and access to off-channel sloughs and wetlands. Overwater structures such as piers and docks pose a risk to migrating juvenile salmonids, which in order to avoid the heavily shaded areas must move into deeper water where they are prone to increased predation.

Subgoals for Marine Areas

The performance measures and action strategies for marine areas would be intended to meet the following sub-goals:

A. Provide nearshore marine, estuarine and tidally influenced marine ecosystems that contain productive, balanced, integrated communities of organisms having species composition, abundance, diversity, structure, and organization comparable to that of natural ecosystems of the region.

B. Ensure that functions and values of the following habitat types are maintained or increased: eelgrass habitats, herring spawning habitats, intertidal forage fish spawning habitats, intertidal wetlands, and safe and timely migratory pathways for salmonids in marine waters.

C. Allow natural rates of erosion and transport of sediments, nutrients, and large woody debris that affect habitat quality in tidally influenced estuarine and marine shorelines.

Performance Measures

There are no statewide agreed-upon numeric standards for all issues specific to marine habitats. However, in general, wild salmonids will do best if the following narrative performance measures are met:

A. Natural shoreline erosion, accretion to beaches, and transport processes are maintained or, where feasible, restored.

B. Ensure no net loss of eelgrass habitat, herring spawning habitat area or function, upper intertidal forage fish spawning habitat area or function, and intertidal wetland area or function.

C. Demonstrate successful establishment of functioning compensatory mitigation projects prior to final authorization of projects that adversely impact marine, estuarine and intertidal habitats.

D. Maintain or restore continuous shallow-water migration corridors along nearshore marine, estuarine, and tidally influenced areas.

Action Strategies

Suggested action strategies for marine areas include:

A. Standards for basin hydrology and instream flows, water quality, stream channel complexity, and riparian areas and wetlands should be reviewed and modified to recognize and manage for functions necessary to maintain productive estuarine and nearshore marine habitats.

B. Ensure that maintenance or restoration of the natural marine shoreline processes necessary to sustain productive nearshore salmonid habitat are an integral part of upland and aquatic land-use planning.

C. Promote land-use planning that allows natural marine bluff and riverine erosion, sediment, nutrient, and large woody debris transport processes to create and maintain the productive marine habitats that salmonids depend upon.

D. Support mitigation sequencing (similar to habitat protection hierarchy) to fully mitigate for the potential impacts of proposed in-water or overwater structures on salmonid migratory pathways.

E. Include in watershed plans a program to restore diked, filled, and covered estuarine and tidally influenced habitats. Develop, promote, and seek funding for estuarine and tidally influenced habitat restoration.

F. Develop standards for aquatic lands to facilitate local planning to ensure salmonid productivity will be maintained or increased.

H. Develop a marine protected-areas strategy to include reserves for herring spawning habitat.

I. Develop integrated strategies to use regulatory and non-regulatory approaches to improve stewardship of estuarine wetlands through protection and restoration efforts.

J. Recognize the value of sediment transport to deltas and marine areas, and evaluate dredging and filling operations in a manner that protects nearshore marine, estuarine, and intertidal habitats and functions that wild salmonids depend upon.

K. Promote oil and hazardous substance spill prevention, contingency, and response planning to reduce risk, minimize exposures, remediate contaminated areas, and restore lost resource functions and services.

Fish Access and Passage

Physical barriers interrupt adult and juvenile salmonid migrations in many parts of the state. Persistent blockages deny access to critical spawning and rearing habitat. Loss of access to habitat will reduce overall salmonid productivity and may result in loss of salmonid populations. Fish passage is affected by and related to all the previous habitat components. Basin hydrology and instream flow are obvious fish passage parameters. Less obvious are the attributes of water quality and sediment delivery and transport, riparian areas, and lakes and marine shorelines. Fish passage, in the sense of the presence of adult salmonids, especially spawners, also affects water quality, aquatic productivity, riparian vegetation, and spawning gravel quality.

Fish Access and Passage Issues Affecting Salmonids

Most salmonid species use several different habitats during the freshwater phase of their life. Adults of anadromous species generally migrate from marine waters to pre-spawning holding habitats (usually low-energy areas like pools, LWD complexes, lakes), then on to the natal spawning streams and reaches. Resident salmonids may make similar spawning migrations within the freshwater system (e.g., from large streams and lakes into small tributaries for spawning). Access to spawning habitat can be an important limiting factor for salmonids that rear in freshwater. Young salmonids rear in areas they can reach as emergent fry with limited swimming ability. If salmonids are to occupy all available rearing habitat, some adults must spawn at the upper limits of the watershed. Thus, accessible, high-quality spawning habitat is required in the headwaters of watersheds for certain species.

Juvenile salmonids may make additional instream migrations during their freshwater residence. The migration may be directly back to marine waters after emergence from the gravel (pink and chum), up- or downstream to a lake for rearing (sockeye), or to habitats in the vicinity of the spawning reaches for additional rearing before embarking on further migration. Juveniles that have a long freshwater residence may migrate from one stream to another, from one habitat type to another (river to off-channel pond), or more typically, from a stream's upper reach to its lower reach.

Timely completion of these migrations is necessary for salmonids to survive critical stages of their life cycle. Migration patterns are usually a response to food supply, habitat condition and/or habitat availability, and have evolved to maximize the salmonid's opportunity for survival.

Fish passage requirements for salmonids are unique to the species present, the life history stage of the fish and site conditions. Chum salmon and grayling are generally unwilling to jump barriers. A relatively small elevation drop can block the upstream migration of these fish. For example, the desired drop between fishway pools is 1.0 ft for most adult salmon and trout, 0.75 ft for chum, and 0.25 ft for grayling (Bates 1992). There are a number of fishway facility types that provide adult fish passage, each with different applicability and design criteria. Upstream juvenile passage is important for anadromous and resident species that utilize several habitats while in freshwater; Dolly Varden/bull trout, coho, and spring chinook are good examples. Gradients of 7% or less and broken flow are needed for upstream juvenile passage, with hydraulic drops not greater than 0.7 ft for fry (45-65 mm) and 1.0 ft for fingerlings (80-100 mm) (Powers 1993).

Natural Factors Affecting Fish Access and Passage

Fish access and passage can be affected by a myriad of natural factors. Most obvious are natural physical barriers such as Snoqualmie Falls. However, velocity and height barriers at rapids and cascades or unbroken reaches of high gradient may preclude all but the most powerful swimmers from access. Other forms of migration barriers are low flows (at times exacerbated by high sediment deposition), some LWD jams, high temperatures, and high suspended sediment load. At times, what would present a barrier at one flow may provide passage opportunity at a higher or lower flow.

Human Factors Affecting Fish Access and Passage

Even the best salmonid habitat is of little value to fish if access is blocked. Impaired fish access is one of the more significant factors limiting current salmonid production in many watersheds. Today, in addition to major dams, most new fish blockages are caused by culverts, bridges, small dams, fords and other man-made instream features. The WDFW estimates that up to 3,000 miles of anadromous habitat are no longer accessible to salmonids due to impassable culverts at public and private road crossings alone.

Salmonid access to off-channel rearing habitats can be affected by land-management actions. Urbanization has blocked fish access in some areas to off-channel ponds and sloughs through public and private road construction and flood control projects. Significant off-channel habitat was filled or drained to create agricultural lands or urban building sites. Forest practices have destroyed off-channel habitats or blocked the access to them by road construction and timber harvest within the habitats. Passage into and out of many estuarine areas has been compromised or lost due to installation of tide gates or improperly installed culverts.

The productivity of spawning and rearing habitats, as well as specific stocks of salmonids, may be impaired or eliminated due to downstream migrant juvenile mortality. The most common sources of juvenile migrant mortality are diversions from the stream system due to unscreened or inadequately screened water withdrawal structures, and passage through water use structures such as hydroelectric turbines. Most major water withdrawal or diversion structures are now screened if they are used by anadromous salmonids.

Adequate screening of turbine intakes at hydroelectric dams, particularly on the mainstem Snake and Columbia Rivers, has not yet been completed despite more than two decades of research and development. Passage of controlled volumes of water through project spillways has been used to provide partial mitigation for inadequate turbine intake screening systems. Controlled spill programs have proven effective in safely passing those juvenile migrants which are able to use this passage route. Juvenile migrant passage survival in mainstem dam spillways is generally greater than or equal to 98%.

Irrigation diversion screens in the lower Columbia and Dungeness River basins are being upgraded to meet agency criteria where anadromous salmonids are present. This screen upgrading is being conducted through ongoing state, BPA, and federal programs. In basins where irrigation diversion screening requirements are not applicable (e.g., where water diversions were in-place before resident fish screening laws were enacted), significant loss of resident salmonids may still be occurring.

The practice of screening outlets at many lakes to retain planted fish for put-and-take trout fisheries, and ponding streams to promote wildlife use is also being reexamined. In addition to precluding adult or juvenile passage, the control structures on those lakes contribute to summer low flow problems in the outlet streams. In other cases outlet flow control for flood control or aesthetic purposes cause similar migration and water quality problems.

Fish Access and Passage Subgoals

We will be successful in addressing fish passage issues if the following subgoals are met:

A. Provide and maintain safe and timely pathways to all useable wild salmonid habitat in fresh and marine waters for salmonids at all life stages.

B. Ensure salmonids are protected from injury or mortality from diversion into artificial channels or conduits (irrigation ditches, turbines, etc.).

C. Ensure natural partial or complete fish passage barriers are maintained where necessary to maintain biodiversity among and within salmonid populations and other fish and wildlife.

Performance Measures

The following performance measures are suggested for meeting the subgoals for fish access and passage:

A. Provide and maintain free and unobstructed passage for all wild salmonids according to state and federal screening and passage criteria and guidelines at all human-built structures.

B. Meet or exceed a 95% survival standard for fish passage through hydroelectric projects and fully mitigate for fish mortalities.

Action Strategies

Suggested action strategies include:

A. Within three years, develop criteria, implementation processes, and compliance processes to identify, correct or remove existing human-caused fish passage problems in freshwater, floodplain and estuarine habitats.

B. Develop recommendations and coordinate with the U.S. Army Corps of Engineers (Corps) and federally licensed dam operators to implement, monitor, and evaluate controlled spill programs at dams, including dissolved gas abatement and other fish passage options, to maximize effectiveness for juvenile and adult salmonid passage.

C. Establish procedures for evaluating, adopting and implementing new fish passage technologies, including:

    1. Automation of spillway operational facilities.
    2. Development, testing and construction of surface attraction flow collectors.
    3. Minimization of juvenile migrant transportation as the primary means of dam passage.
    4. Construction of gas abatement structures and operation strategies to control gas supersaturation.

D. Promote land-use plans that prevent the impacts of road construction on fish passage. Associated components include:

    1. Reducing needs for new highways and streets via land use planning and transportation planning including such things as light rail, ride-sharing, etc.
    2. Reducing number of individual private roads for individual residences.
    3. Limiting most new growth to urban areas while retaining large blocks of habitat in rural areas.

E. Incorporate consistent state-wide criteria and guidelines for fish passage and screening into future design, construction, or alteration of instream structures, roads, and facilities.

F. Develop and expand programs to educate people regarding fish passage issues, and when stream crossings are unavoidable, assist them in the designing and constructing of instream structures which facilitate free passage.

G. Develop an equitable long-term funding mechanism and other incentives to share costs of passage restoration.

H. Develop and implement effective monitoring and maintenance programs, and compliance processes that assure fish passage and screening structures are safe and efficient.

Habitat Restoration

Any strategy designed to maintain or recover salmonid populations should have as a basic underpinning meaningful protection of existing habitat. But it should be no surprise to an informed citizen that we have lost significant habitat in our streams, lakes and estuaries. It may not be as clear to that person that much of our remaining habitat is in a degraded state. And it is even less clear to most citizens how difficult, if not impossible, and how expensive it is to recover or restore habitat. However, examples abound of the extreme cost of habitat restoration. Scientific journals and lay publications are replete with case studies and admonitions about the pitfalls of poorly planned habitat restoration projects. Continual restoration of unmitigated impacts to wild salmonid habitat is undesirable, often ineffective and the most costly means to achieving salmonid population recovery; in the long run salmonid populations are best protected by ensuring habitat protection.

That notwithstanding, given the current condition and diminished extent of salmonid habitat and since so many salmonid populations have been lost, it is clear that restoration of habitat should be a significant part of any population recovery strategy. Numerous reports and studies have addressed the recovery strategies. Some have worked, some have failed miserably, and some are yet to be evaluated.

However, there is fair agreement on guiding principles for successful recovery planning, implementation, monitoring and evaluation. They include the following:

A. Successful restoration requires competent analysis of watershed processes and identification of limiting factors.

B. Funding for restoration activities is limited; funding is enhanced where partnerships exist, where there is local support, where restoration is included in a larger project context (i.e., flood damage reduction plan, water storage and release strategies), where restoration is part of a completed overall land use and/or watershed plan, and where restoration of wild salmonid habitat contributes to improved wildlife habitat and other societal benefits, such as aquifer recharge for drinking water, flood damage reduction, improvement of soil fertility, and maintenance of rural economies.

C. Restoration is more likely where dedicated fund sources are sufficient and stable.

D. Restoration projects are facilitated by regulatory processes (permits) which are coordinated, timely, consistent and affordable.

E. Restoration is most successful when contemporary technical information and guidance is available to the public.

F. Active participation in or support of watershed restoration fosters an environmental ethic, improved land stewardship, support for habitat protection and increased support for additional restoration.

Subgoal

The habitat restoration subgoal is fairly succinct:

> **Restore usable wild salmonid habitat to levels of natural variability for watershed processes and habitats.**

Performance Measures

Restoration of salmonid habitat will be long-term, costly and contentious. It will involve a combination of active in-water work, extensive upslope work, and in large part, just providing the opportunity and time for watersheds and marine areas to mend themselves. Many of the performance measures and action strategies in the preceding components include reference to restoration of the physical processes and habitat types necessary for salmonids and they will not be repeated here. Therefore there is only one performance measure for the restoration component, simply:

Full habitat restoration within watersheds and marine areas will be ultimately achieved when the performance measures for the preceding components (i.e., basin hydrology and instream flow, water and sediment quality and sediment transport, etc.) are met.

Action Strategies

A. It is the legislature's intent to minimize expense and delay due to obtaining required permits for projects that preserve or restore native fish habitat (Chapter 378, Washington Laws). The law defines watershed restoration projects and provides that projects that have been reviewed under the State Environmental Policy Act shall be processed without charge and permit decisions shall be issued within 45 days of filing a completed application. The state agencies with permitting responsibilities relevant to watershed restoration should fully implement Chapter 378. They should continue to examine opportunities to increase their efficiency in processing project permits and to enhance the design and effectiveness of restoration projects.

B. Apply best available science and adaptive management to restoration strategies and activities:

   1. Where possible use some form of watershed analysis that identifies the physical, chemical and biological processes that may affect the success of the restoration strategy.
   2. Employ watershed restoration mechanisms and technology to restore and maintain habitats to optimum conditions for salmonid spawning, rearing, and migration.
   3. Use qualified experts to analyze, design, and construct specific projects and to evaluate the success of the strategy.
   4. Ensure that monitoring and contingency planning is included in project design.

C. Prioritize restoration activities. Considerations for priority would include:

   1. Salmonid stock status, if available
   2. Harvest management plan
   3. Population vulnerability
   4. Possible positive or negative risks or consequences to wildlife or capital improvements
   5. Community/landowner acceptance and/or support
   6. Feasibility and probability of long-term success
   7. Compliments existing completed restoration projects
   8. Level of funding, opportunity for partnerships
   9. Ability to obtain permits in a timely, affordable basis

D. Plan habitat restoration at multiple scales (subbasin, basin, watershed, state, region) to ensure efforts are consistent, coordinated, and effective.

E. Coordinate salmonid habitat recovery plans with other planning processes such as GMA, watershed planning, flood control planning, etc.

F. Support stable funding source(s) for salmonid habitat restoration in capitol budgets in order to provide time and predictability for planning, development, implementation and monitoring.

G. Establish criteria for salmonid habitat restoration to be incorporated into appropriate state grant funding program selection processes.

H. Where recovery of habitat is possible, pursue restoration measures to allow wild salmonids to recolonize areas they historically occupied.

I. Develop an education outreach program to local communities to foster environmental stewardship.

J. Work with local governments to assure the availability to landowners of incentive programs, such as current-use taxation, and to advocate land stewardship and recognition programs.

K. Develop a coordinated, statewide geographic information system - including mapped and tabular data - among federal, state and local governments for cataloging habitat extent, condition, and restoration needs. Data should be organized and accessed according to watershed and made available to all entities who are conducting watershed protection and restoration projects.

L. Use water conservation and water purchases to restore instream flows. This should include budget authorization to purchase water, water rights, or relinquished water rights and transfer them to the trust water rights program.

M. Pursue federal and state flood-control funds for restoration of wild salmonid habitat that has been damaged by flooding or flood-control activities. This could include non-structural solutions to flood damage reduction such as relocation of structures; removal of dikes and levees; and reconnection of sloughs, former side channels, oxbows and wetlands.

N. Provide technical support (engineering, biological assessments) to watershed groups.

APPENDIX D DISCUSSION OF SPAWNER ABUNDANCE

Allowing the proper number of fish to spawn is a key part of sustaining healthy salmonid stocks. Spawners are obviously needed to provide the eggs that will grow into the next generation of fish. This in turn affects the number of fish available for harvest. However, the number of spawners affects much more. Salmonid fishes are often described as "keystone" species in the ecosystems where they are found. They are a key species that support many other species. A variety of animals eat them. Even streamside plants are fertilized by decaying carcasses. These positive effects to the entire ecosystem can then affect the insects and other sources of food for growing salmon. Choosing the proper number of spawners is very important and affects the entire ecosystem.

The actual number of fish that spawn in any year is the result of what happens in the other five policy elements. The number of spawners is often called the "spawning escapement." Spawners are the fish that escaped the hardships of habitat in streams or lakes; escaped being eaten by birds, seals, or other fish; and escaped being caught by sport or commercial fishermen to finally have the chance to spawn. How we protect habitat, manage our fisheries and hatcheries, and maintain ecological processes determines the number of fish that will make it back to spawn. All these sources of mortality must be considered in our planning (ISG 1996).

The *Spawner Abundance* element is about choosing the desired number of spawners to meet the goal. How many spawners are needed to provide enough eggs to sustain the next generation, maintain a variety of genetic traits and behaviors, and provide carcasses to meet ecological needs? This section will consider a variety of ideas on this question.

Background

Fisheries managers generally agree that salmonid populations can be maintained across a broad range of spawner abundances. If this is true, what determines which level is the right one? The right level for a given situation will depend on: (1) keeping the population from going extinct, (2) the desired level of harvest opportunity, (3) issues of ecosystem health, and (4) non-consumptive use benefits. Some of these can be in competition with each other. Just keeping a stock from going extinct will not provide many fish for harvest, nor will meeting all the ecosystem health needs. High harvests may not provide fish for meeting ecosystem health needs or non-consumptive use benefits.

Underlying all these issues is the question of risk — risk to stock health, risk to harvest opportunity, and risk to other values. Different people may have very different responses to determining the proper escapement level, because they have different feelings about the balance of risk and potential benefits. These issues will be discussed in some detail in the next section.

An important issue for setting spawner abundance goals is environmental variation and management uncertainty. Figures 1 and 2 are drawn as if they occurred in a very stable environment and there was no error in measuring stock sizes or catches. The real world of salmonid management is very different. In the 1980s there was an eight-fold variation in the ocean survival of coho salmon in the Satsop River. So even if freshwater survival was stable, a given spawning could have numbers of recruits that were much higher or lower than expected. This variation in survival

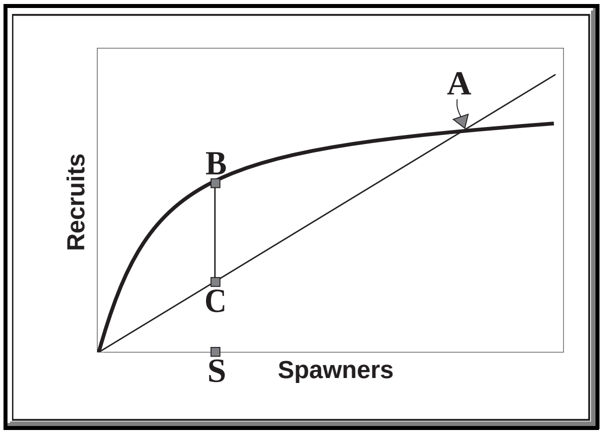


Figure 1. Spawner-recruit curve for species that compete for rearing space or food in freshwater.

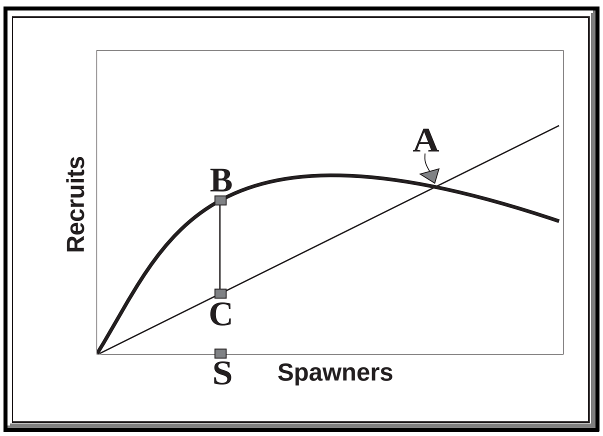


Figure 2. Spawner-recruit curve for species that tend to spawn in large numbers and compete for spawning area.

means that it is also very difficult to estimate run sizes and other management information. In setting spawner abundance levels it is important to incorporate these uncertainties.

Policy Issues

There are three key policy issues for spawner abundance: (1) the desired level of spawning, (2) the unit (stream reach, stock, watershed) that the spawning goal should be set for, and (3) what fish should count towards meeting the goal.

Spawner Abundance Level Approaches

As was discussed above, the desired level of spawner abundance relates to goals for stock health, ecosystem health, harvest opportunity, non-consumptive uses, and others. This discussion will consider a range of approaches:

A. **Full Utilization of Habitat -** full utilization of habitat has been suggested by a number of people as a good spawner abundance level. Full habitat utilization can be defined two ways: (1) the spawner level that produces the maximum number of adult offspring or (2) the point where adding one more spawner produces less than one more recruit. In Figure 1 both definitions are at point A on the curve. This is the number of recruits and the place where the population is just replacing itself. In Figure 2 the maximum recruits is where the curve reaches its highest point, while the point A is again where the population just replaces itself. The two types of curves give different results to the definitions. In Figure 1 both definitions provide no harvest opportunity, but maximize the number of fish produced and the maximum number of spawners on the spawning grounds. In Figure 2 definition 1 provides a significant harvest, the largest population size but fewer fish on the spawning grounds. Definition 2 provides no harvest opportunity, a lower total population, but provides the greatest number of spawners.

Full habitat utilization provides the greatest benefits to stock and ecosystem health:

1. Larger numbers of spawners can provide

protection against environmental problems such as floods.

2. Spawners are likely to have a greater distribution in multiple spawning areas so that a problem in one area is less likely to cause the loss of the entire population.
3. Many Northwest ecosystems evolved with large numbers of salmonids. Many animals, including bears, otters, and eagles use salmonids for food, and would likely benefit from increased numbers.
4. Spawning salmonids are an important source of nutrients for freshwater systems. Nitrogen is an important nutrient that often limits production in freshwater systems in the Northwest. Specific forms of nitrogen associated with salmon and steelhead carcasses are found in significant levels in stream vegetation and animals.
5. Periodic large escapements may improve spawning survival. Species such as pink, chum, and sockeye that spawn in high densities can clean the gravel during spawning. This improves the flow of water through the gravel and improves egg survival for all salmonid species.
6. Genetic fitness of salmonid stocks to the environment may also improve with large numbers. Salmonids generally evolved in the presence of large population sizes and high levels of competition. This competition for space and food helped maintain a high rate of natural selection for fitness to specific conditions. This competition is reduced at lower population levels. As a result, the level of genetic fitness may decline.
7. Larger populations of spawners may make salmonids more visible to people who live in the Northwest. This creates more incentive to protect habitat and meet other requirements that are important for long-term survival. Workers involved with habitat protection say the lack of visible evidence of salmonids in streams makes it more difficult to generate enthusiasm for stream protection.

Maintaining these larger populations has several costs. For pinks, chums, and sockeye, very large escapements may actually cause the population to decrease. There are indications that several Alaskan sockeye populations have been depressed following a series of large escapements, likely due to impacts to their food supply. Recent research on chum salmon in Kennedy Creek has shown dramatic increases in embryonic survival at escapements significantly above the current escapement goal.

It also has a cost in terms of catch. Under most of the definitions for full habitat utilization there is no sustainable harvest. At the extreme this would not even allow catch-and-release fishing since there is a harvest related mortality associated with it. In practice, some level of incidental harvest would likely be allowed to provide for selective fisheries on other stocks.

B. **Abundant Utilization of Habitat -** this level is an intermediate step between full habitat utilization and the focus on maximizing harvest opportunity in the next level. The intent here is to provide a strong focus on stock and ecosystem health, but provide the opportunity for some harvest. Spawner abundance levels would be set based on providing:

1. Two buffers will account for risk to the resource due to (1) uncertainty with respect to the exact spawner-recruit relationship; and (2) degree of harvest management precision - the ability to deliver fish to the spawning grounds. This makes it far less likely to overfish and depress the population. This is particularly important if there is uncertainty about the shape of the curve and where exactly different escapement levels fall. Managers would also have the option of defaulting to an alternative fishing strategy but only if it is clearly more conservative (less risk to the resource) than any MSY value calculated from the spawner-recruit relationship.
2. More stable fisheries and populations.
3. Larger total population sizes would make catch-and-release fisheries more successful, because the chance of encountering a fish goes up. The value of higher escapements will vary depending on the type of spawner-recruit relationship.
4. Levels of spawners that support good genetic diversity, and increase the number and distribution of wild stocks.
5. Levels of spawners that support natural ecosystem processes.

C. **Maximum Sustainable Yield (MSY) -** in Figures 1 and 2 there is a place (point B) where the distance between the replacement line and the spawner-recruit curve is the greatest. This is the place that provides the largest possible catch, or yield from the stock. If escapements are maintained at this level, this maximum yield or catch can theoretically be sustained. This is known as the point of maximum sustained yield (MSY). Conceptually MSY has many advantages. First, it maximizes harvest opportunity which is an important value for many people. It represents both recreational opportunity and economic benefits. Second, MSY is an objective standard for comparison with other approaches. It has a theoretical basis that has considerable support from actual observations.

Actually achieving MSY management can be a very difficult task. Determining MSY requires a large amount of accurate data, something that is available for only a very few stocks. There is some evidence that suggests that most data sets likely under estimate the level of spawners needed to achieve MSY (Hilborn and Walters 1992). However, fisheries managers have developed a number of approaches to approximate MSY. This uncertainty about the exact level of MSY increases the risk of overfishing, though salmonid populations that are actively and successfully managed for MSY type goals generally remain healthy. Also, variation in harvests may be greater than at higher spawning levels.

D. **Minimum Sustainable Escapement (MSE)** - the National Research Council (NRC 1996) recently developed a spawner abundance level that they called the minimum sustainable escapement. They suggest that this level be a floor, with all escapements above it. The MSE concept is designed to provide a long-term probability of survival of populations in the face of overfishing and random environmental and other variation. The concept also includes a recognition of the role salmonids play in ecosystem health, and the value of larger populations in maintaining genetic diversity and stock distribution, though they note that the need for this "is not well demonstrated with direct research." They propose using many of the same techniques currently used to develop MSY type goals for many Washington populations.

Their proposal suggests that this approach will result in escapements above the MSY level. However, under typical levels of environmental variation and management error for Washington coho stocks, high probabilities of long-term survival can be achieved at escapement levels substantially below MSY. It is not clear that MSE will result in higher long-term escapements. The unknown value here is the level of spawning necessary to meet some of the genetic and ecological considerations, which they have not detailed.

It appears there is a lower level of spawning below MSY which can provide a high probability of long-term survival. Managing at this lower level allows for higher fishing rates that allow more benefits. Many of our salmonid fisheries occur on a mixture of stocks to take advantage of fish quality, accessibility and opportunity for recreational and commercial harvesters, or historical precedence. Each stock within a mixed stock fishery has a unique spawner-recruit curve. Some stocks are more productive and can withstand greater levels of fishing. Less productive stocks need lower levels of fishing. If, for example, we are trying to maximize the harvest opportunity on the whole mixture of stocks, then some stocks will be managed above their MSY level and others below. One ideal solution is to allow stocks to separate before harvest, or use techniques which allow separation. For example, hatchery steelhead and cutthroat trout are all marked to be identified in the catch. Wild fish can then be released when necessary. This approach was recently mandated by the Washington State Legislature for coho and potentially chinook salmon.

In Washington State, this mixed stock dilemma is most apparent where there are mixtures of hatchery and wild fish in the same fishery. Hatchery stocks have much higher overall survival, since life in the hatchery protects them from much of the natural freshwater mortality that affects wild stocks. As a result, they need fewer spawners to maintain a stock and can withstand very high fishing rates, much higher than most wild stocks. With releases of many resident fish, a 100% harvest rate is desirable, since no future spawning is planned. In some areas mixtures of hatchery and wild fish are fished at high rates to take advantage of the hatchery production. This maximizes total catches, but results in wild stocks escaping at low levels. Examples of this include fall chinook and coho in the Nooksack River, Willapa Bay, and the Lower Columbia River, and trout in many lowland lakes.

The same condition occurs when wild stocks with different productivities are mixed in the same fishery. Examples include fisheries on wild summer chum and wild coho in Hood Canal and South Puget Sound, and on mixtures of resident trout species in lakes and streams.

There are three main issues with these lower escapements: 1) increased risk of stock loss, 2) loss of future production, and 3) loss of the ecological and stock benefits described previously. The extent of these concerns depends on the size of the stocks, stock productivity, and other factors. Lower escapements will reduce future production from the stock. Whether this is a concern depends on the harvest regime. Fishing a small, low productivity stock to a lower escapement to increase the harvest on a larger more productive stock will result in an increase in long-term harvests. Fishing a large stock to a lower level to take advantage of a smaller more productive stock may not. Each situation will be different, and normally more complex than these two stock examples.

E. **Stock Perpetuation -** it may be possible to manage populations at even lower levels where they are at no immediate risk of loss or permanent harm. As populations are managed at lower and lower spawner abundance levels, the risk of harm or extinction increases.

A flood or drought that may not be a insurmountable problem for a larger population may be devastating for a smaller population. Fish in smaller populations may have a more difficult time finding mates (Allee 1931, cited in Frederick and Peterman 1995); in a given area they may all be of the same sex. Some forms of competition among different fish species may become more of a problem as a fish population gets smaller (Gilpin and Case 1976). Smaller populations may also be in greater danger from certain predator populations (Peterman 1977). At smaller population sizes there is a much greater risk of loss of genetic diversity and local adaptation (see *Genetic Conservation*, Appendix E). This combination of impacts may make it difficult or impossible to recover a population under natural conditions. Even a relatively large population may be considered "functionally extinct" if it cannot recover due to a combination of such factors. Peterman (1977) and Frederick and Peterman (1995) describes some possible examples.

One place to manage spawner abundance is to stay above the place where the population becomes functionally extinct. At this point the population is probably at no immediate threat of extinction. This may be comparable to the boundary between threatened and endangered under the Endangered Species Act or the boundary between critical and depressed in the SASSI review. Frederick and Peterman (1995) used 5% of the unfished stock size (the unfished stock size is point A in Figures 1 and 2). While sustaining a population at this level for some time may be possible, the risk of extinction remains high.

The advantages of this approach are the opportunities that it yeilds to provide some protection for a weaker stock, while providing greater access to stronger, more abundant stocks capable of sustaining much larger harvests. The risks associated are the greater chance of stock loss and the lower ability to meet ecosystem health and other needs.

Units of Spawner Abundance for Management

Spawner abundance goals can be set for many different population groupings. Populations can be managed on the stream reach, stream, stock, river basin, or coast wide basis. For example, harvest management of salmon is based on over 100 individual units of spawner abundance. The SASSI report identifies 435 individual stocks. Managing on a finer scale provides a greater likelihood of meeting the needs of the individual populations, providing better distribution of spawners, and providing better utilization of the available habitat. Managing on a finer scale also requires more information, and a greater commitment to monitoring and evaluation. The information commitment is not only to how many spawners there are, but also to developing the management tools and data to predict run sizes and stock impacts. For the purposes of the WSP we have looked at two basic units: (1) individual stocks and (2) combinations of stocks called management units. Management units will typically be all the stocks of a species in a major drainage that empties into saltwater (e.g., Nooksack, Samish, Green/Duwamish, Queets), a major tributary of the Columbia River (Yakima, Cowlitz), or for resident stocks the tributaries to a major lake system (Ross Lake, Lake Chelan, Lake Roosevelt). Operating at finer than the stock scale was not considered because of the difficulty in collecting information and a sense that managing at the stock level would provide nearly all the benefits of finer scale mange. Operating at a broader scale was not considered because of the loss of information about the smaller populations.

What Counts?

A collection of local wild fish, hatchery fish that did not return to their hatchery, hatchery fish returning to a remote release site, and wild fish straying from other systems may all end up together on a spawning ground. When we are determining if the proper number of spawners is on the spawning grounds, what should be counted? There are several approaches:

A. Only wild (fish whose parents spawned in the wild) fish from the local stock - this provides the greatest incentive to put local wild fish on the spawning grounds. Since it is the local stock that is being managed, there is justification for measuring success based on that stock. This approach likely will provide the best distribution and habitat utilization over the long-term.

B. All wild fish no matter what their origin - in many cases it is very difficult to determine whether a wild fish is from the local stock or not. Since some level of straying from one stock to another is desirable, it is probably reasonable to include all wild fish.

C. All fish on the spawning grounds - this approach provides less incentive to meet the goal with the stock in question and poses some risk. All of the fish on the spawning grounds likely do contribute to future production, though there are some examples where the contribution is much less. Not counting the hatchery fish means there is an increment of spawners that increase competition and affect survival that are not being accounted for.

APPENDIX E DISCUSSION OF GENETIC CONSERVATION

Salmonids live in a highly variable and changing world. Their world changes over time due to the daily movement of the sun, changes in the seasons, and decade and longer climate patterns. It changes from river to river, or lake to lake, due to differences in soils, climate, orientation to the sun, elevation, and vegetation. The ability to adjust and adapt to this changing world around them is key to the long-term survival and productivity of salmonid populations. The *Genetic Conservation* element is concerned with maintaining the characteristics of fish populations that will allow them to be productive under the current and a range of future conditions.

Background

There are two key areas for genetic conservation: (1) *local adaptation* — a natural process that matches the characteristics of fish populations with their local environment, and (2) *genetic diversity* — the need to maintain a variety of characteristics in populations and species so they can respond to change.

Local Adaptation

Fish look and act the way they do largely because of traits they inherited from their parents. Traits such as a large body size for long upstream migrations or to spawn successfully in larger rivers, coloring that camouflages, the urge to migrate upstream or downstream at certain times, the ability to defend a feeding territory, smaller egg sizes that allow a population to survive in water with a lower oxygen content, an earlier spawn timing or shorter egg development period where the water is colder, and resistance to certain diseases are all traits that will help fish survive under certain conditions.

Traits are passed along from generation to generation on structures called “genes” which are contained in the sperm and eggs of the parents. Traits that help fish survive and reproduce are more likely to be passed on to the next generation, since the fish that have them are more likely to survive and reproduce. Traits that reduce survival and reproduction are less likely to be passed on. Over time a population will accumulate more of those traits that provide greater survival and productivity under local conditions. This process of accumulating positive traits is called local adaptation.

Maintaining this local adaptation is important for two reasons: (1) it increases population productivity, and (2) it helps the species live successfully in more places. Increased productivity means that more fish will be produced from each spawning pair. This makes the population more resilient and capable of dealing with its environment. It also increases potential benefits since more fish will be available for harvest, viewing, and ecosystem needs.

The ability to adapt to local conditions allows a species to live in more habitats and under a greater variety of conditions. For example, different populations of trout may have differing sensitivities to warm water. Each individual population may be limited by its own sensitivity to warm water, but the total species can live in more places because the various populations have a range of sensitivity.

Genetic Diversity

If all the fish in a stream have the exact same combination of traits, they will all react to a change in the world around them in the same way. For example, if all the fish in a population spawned at the same time, and conditions at that time were not right for spawning some year, the entire population would die. Luckily, all the fish in a population do not have exactly the same set of traits. A population of salmon or trout contains many similar, but not identical, individuals. Each individual fish will be slightly more successful in different conditions. Some will have an earlier spawning time, others a later one. This variability, known as genetic diversity, within a population allows the population to adjust to a changing environment. The differences allow the whole population to survive, even though some individuals may die.

The local adaptations of populations to different conditions provide a source of genetic diversity for the entire species. A species will be made up of a variety of sub-populations, each that are a little different. Each of these differences may be a valuable help in surviving under a certain set of conditions. This allows the entire species to survive even though a part of it is lost.

The diversity of traits exhibited by salmonid species is truly amazing. Salmonids show a variety of sizes, shapes, and life history patterns. They range in size from the large chinook salmon down to the much smaller size of a cutthroat trout or pygmy whitefish. Life histories range from the rigid two-year life of the pink salmon to the 22 different combinations of freshwater and ocean residence in some Alaska sockeye populations. Sockeye salmon, rainbow trout, cutthroat trout, and Dolly Varden all have both migratory (anadromous) and non-migratory (resident) forms. Some bull and cutthroat trout populations live their entire lives in small streams; other populations live in large streams but spawn in small streams. Still others live in lakes, but spawn in small streams. Populations often have very different patterns of return and spawning timing.

> Stock - the fish spawning in a particular lake or stream(s) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place at the same time, or in the same place at a different time.

These patterns of diversity have an order to them. At the lowest level is the stock. Stocks are the basic building block for genetic conservation in this policy. A stock is a population of fish that due to location or timing tend to largely spawn with each other rather than with some other population (see box for more detailed definition). This level of isolation from other populations allows the stock to become locally adapted and unique from other stocks. Depending on the species and habitat, a watershed may have a single stock or many stocks, and they may contain many fish or a few fish.

Stocks from a similar geographic area tend to be more similar than stocks from another area. These similar stocks can be grouped together into Genetic Diversity Units (GDUs). Similar GDUs can be grouped together into Major Ancestral Lineages (MALs). The MALs can then be grouped into species.

We can think of a species of salmon as a collection of populations, sometimes called a metapopulation. These populations are related because they are the same species, they may share a geographic area (e.g., chinook in the Columbia River, or several populations of steelhead using the mainstem of a river during migration), or they face similar climate conditions etc. There may also be some limited movement of spawners between the populations. One population may have been started by fish straying from another population so they share ancestors. It is the interaction of these populations that provides for the long-term survival of the entire species. Each of the stocks or GDUs provides diversity to the entire population. As conditions change, some part of the population will hopefully have the traits that will allow them to survive. If a population is wiped out by pollution or a landslide, it can be restarted by fish straying from nearby populations. If enough of the populations are maintained in a healthy condition, the species can remain healthy. So the survival of each stock is important to the overall survival of the species.

Policy Elements

There are four key components to the genetic conservation element: (1) minimum spawner abundance, (2) gene flow, (3) fishery selectivity, and (4) habitat fragmentation and loss.

Minimum Spawner Abundance

As populations get smaller the risk of loss of both local adaptation and genetic diversity increases. Smaller and less diverse populations are much more sensitive to environmental changes, predation, and other impacts and so the loss of the entire unique population is more likely. Also, in smaller populations some traits will only be carried by a few individuals. The loss of these few individuals before they can spawn means the complete loss of the traits in the population.

Minimum allowable spawner abundances can be set to protect against the potential loss of diversity. In general the population level needed to maintain diversity will be smaller than the minimum spawner abundance levels discussed in the *Spawner Abundance* element. To meet both the spawner abundance needs and the genetic conservation needs, the larger of the two requirements should be used. The minimum levels discussed here will be most useful when dealing with depressed or critical stocks, or with stocks that have historically small run sizes.

The scientific literature suggests that an effective (or genetically ideal) population of 500 individuals can generally maintain adequate diversity within the population over a long period of time. This genetically ideal population assumes that: (1) there are equal numbers of both sexes, (2) there is random mating, and (3) there is equal survival of all offspring. All of these assumptions are likely to be violated in a natural salmonid population. We have already discussed the idea that under any set of conditions some individuals will be more likely to survive and reproduce than others. As a result, it will be necessary to have more than 500 actual spawners in the population to have an effective population size of 500.

The effective population is also affected by the number of times the fish spawn (once, like salmon, or multiple times, like trout), and the average age of the spawners. For example, pink salmon spawn a single time and all at age 2. As a result, there is no mixing of the even and odd year pink salmon gene pools. Chinook salmon spawn only once, but may spawn at from 2 to 7 years of age. This means the offspring of fish spawning in one year may spawn with the offspring of fish spawning in several other years. When there is spawning overlap of cohorts, the rate of random genetic change is determined by the sum of the annual effective population sizes each generation. It takes fewer chinook salmon spawning each year to maintain diversity than it does pink salmon. Fish that spawn more than once have a greater impact on the future population and so tend to reduce diversity. This requires more fish to meet an effective population size. Details on how these factors interact with each other to determine the minimum spawner abundance are given in the Appendix D.

Gene Flow

Gene flow is the movement of genetic material from one population to another. A limited amount of gene flow occurs in nature. This natural gene flow is a good thing because it introduces some new genetic material into populations and helps increase diversity. However, too much gene flow can disrupt the traits that provide for local adaptation by introducing new traits that do not fit with local conditions. At high levels of gene flow from one population to another the populations will become basically the same so there is a loss of genetic diversity. When one population becomes just like another it is said to become “genetically extinct”. The result of this high gene flow is the loss of productivity and greater risk to the population.

Human impacts to gene flow usually result from: (1) transfers of stocks from one area to another, including the introduction of exotic species that are capable of interbreeding with local stocks, and (2) where there is widespread use of similar hatchery strains that reduce genetic diversity in the hatchery fish.

Fish adapt to living in the hatchery for all or part of their lives, similar to local adaptation by wild fish. From a hatchery production standpoint this domestication is positive. It increases the survival and productivity of the fish in the hatchery. Attributes that favor survival in the hatchery are not the same ones that favor survival in the wild. When wild and hatchery fish interbreed it reduces the local adaptation of the wild fish, because the domesticated traits are introduced into the wild population. Rainbow trout production is a good example of this concern.

This problem has been identified by a number of researchers. Reisenbichler and McIntyre (1977) showed that wild Deschutes River steelhead outperformed pure hatchery and hatchery- wild crossed fish in the wild. Leider et al. (1990) showed an 86% reduction in productive capacity comparing crosses of hatchery Washougal summer steelhead with wild summer steelhead in the Kalama River. Declines have also been found for winter steelhead (P. Hulett, WDFW, personal communication). Nicholson et al. (1986) followed survivals of hatchery coho releases from initial rearing through adult return and spawning. They found releases of hatchery fry increased juvenile and adult numbers immediately, but when the hatchery fish spawned the resulting populations were actually less than unplanted areas. Fleming and Gross (1992), Swain and Riddell (1990), and Berejikian (1995) described potential genetic differences in spawning behavior and juvenile behavior between hatchery and wild coho. The behaviors of the hatchery fish in their study appeared inappropriate for the wild environment and may have led to lower productivity. Doyle (1983) showed that even subtle differences in feeding patterns may select for different traits in the hatchery population.

Some investigators have suggested that these concerns can be alleviated by using locally derived stocks and changing hatchery practices. These changes occur even when the hatchery population was derived from a local stock. Ferguson et al. (1991) showed that even when great care was taken in the collection of broodstock, there were losses of genetic diversity and changes in population structure. The entire process of collecting broodstock and rearing in a different environment (i.e., a hatchery) can cause changes in a population. These concerns indicate guidelines are needed to control gene flow between hatchery and wild fish to ensure high productivity for the wild fish. However, the risk of loss of local adaption and diversity is the greatest when the hatchery and wild stocks are very different. More similar stocks have less potential impact since they will share many traits.

There is a special case of gene flow when applied to supplementation. Supplementation is the deliberate use of hatchery fish to increase wild spawning populations. It may be desirable to allow more gene flow in certain cases to rebuild stocks.

Fishery Selectivity

The harvest of fish is not usually a random removal of fish from a population and may not affect all segments of the populations equally. Particular fishing techniques tend to capture bigger fish or smaller fish, early or later migrating fish, fish in the shallows or fish that are deep. Fish with traits that make them more likely to be caught are removed from the population, and their traits are not passed along to the next generation. This causes the population to change, and become less locally adapted to natural conditions.

In both anadromous and resident species there are examples of populations where fish have become smaller as fisheries removed the larger fish. Ricker (1981) and Ricker and Wickett (1980), and others have described a lowering of size and age of spawning of chinook due to hook-and-line catches that tend to remove older, larger fish. This reduction in size makes these fish less effective spawners since they have fewer eggs, and they cannot bury their eggs as deep or spawn in the larger, more stable gravel that resists movement during floods.

Recent studies on coho salmon in Washington have found that the average size of fish harvested in many gill-net fisheries was significantly larger than the spawning population from the same stream or hatchery (S. Phelps and C. Knudsen, WDFW, personal communication). The studies also documented a significant decline in length since 1980 and a parallel decline in eggs per female since 1960. The number of eggs per female has declined by nearly 1,000 (about 40%). It now takes 1,700 spawners to produce the same number of eggs as 1,000 spawners did in 1960. This suggests that fishing may be one part of the cause of the decline in fish size. Other potential causes include environmental factors or hatchery programs.

Minimum size limits are used extensively to manage resident stocks. Faster growing fish or fish that mature at a larger size or older age are more likely to be removed from the population before they have a chance to spawn. This leaves the slower growing and early maturing fish to spawn and pass on their traits.

There are several examples of run timing changing due to fishing. Alexandersdottir (1987) found that pink salmon return timing in Sashin Creek Alaska was delayed a full month after a number of years of heavy fishing on the early portion of the run. This change was important since the early fish appeared to have been more productive than the later fish. The same number of fish were spawning, but fewer fish were being produced. On Kodiak Island, Alaska, heavy fishing during the middle portion of the Karluk Lake sockeye run has resulted in an early and late run where it used to be one continuous run.

Hood Canal wild chum returns may have shifted up to two weeks later due to heavy fishing on the earlier hatchery chum. A similar change in timing may have occurred for wild steelhead in many areas of Washington State where early hatchery fish have been planted. These early hatchery fish generate heavier fishing on the early portion of the wild run, removing them from the population.

Where a fishery is selectively removing individuals, the population is affected by two forces: (1) natural selection, which leads to local adaptation, and (2) fishery selection, which leads the population in other directions. For a fishery to cause a measurable change in a population: (1) the fishery must selectively remove individuals with a particular trait (e.g., large body size or early run timing); (2) the trait must be heritable, and (3) the harvest rate in the fishery must be high enough to overcome natural selection. We cannot control item (2) because it is a basic part of the fish's biology. However, we can control items (1) and (3).

Habitat Loss and Fragmentation

One of the most important strategies for maintaining genetic diversity may be the maintenance of a wide variety of habitat types. Diversity can be lost directly due to the loss of an important segment of a population's distribution. Dams or culverts that block access or destroy habitat and cause a loss of the population reduce diversity. Loss of habitat may reduce population sizes so that they go extinct or are no longer large enough to maintain diverse traits.

Fragmented habitat may be a critical problem for protecting metapopulations. The loss of the connecting habitats between populations will reduce gene flow between them. This reduces the chances for fish to recolonize barren habitat where populations have gone extinct, or provide the low level of natural gene flow that is useful for maintaining genetic diversity within the populations.

APPENDIX F DISCUSSION OF ECOLOGICAL INTERACTIONS

Salmonid fishes not only live in a constantly changing world, but they also live in a very complicated world. It is a complicated physical world with different climates, land forms such as mountains, valleys, lakes, and rivers, different soils, and other features. It is a complex biological world that is shared with many other species of plants and animals. It is even more complex because these physical and biological worlds each affect the other in many ways. This complex mixture of the physical and biological world makes up an ecosystem. The interactions among all the different pieces — the ecological interactions — are the subject of this element. Salmonids have such a big influence on the ecosystems they live in that they have been described as a “keystone species.” Recently there has been a much greater recognition of the role that fish, and particularly salmonids, can play in shaping and regulating the abundance and behavior of the many other species they live with (Northcote 1988). At the same time, salmonids are greatly affected by what is going on around them.

A full development of an ecosystem management policy is beyond the scope of the Wild Salmonid Policy. However, to provide guidance to salmonid management, some key issues will be developed. The goal is to look at a few key ones that we can influence. As more comprehensive ecosystem policies are developed these will likely be adjusted.

Background

Salmonids play several different roles in influencing and shaping the ecosystems they inhabit: (1) as a source of nutrients, (2) as a direct source of food, and (3) as predators or competitors that can directly affect the abundance of other species. At the same time there are some key actions in the surrounding ecosystems that can affect salmonid populations. These include: (1) habitat changes, (2) the effects of predators, and (3) the effects of the introductions of salmonids and non-indigenous fish into salmonid waters.

Nutrient Source

Adult anadromous fish gain more than 90% of final weight while they are living in the ocean. When they return to spawn and die, they transfer those nutrients and minerals to the freshwater systems. Richey et al. (1975) described a similar process for kokanee that grow in Lake Tahoe, but spawn in the tributaries. This transfer of nutrients has been most clearly described for the role of sockeye salmon in Alaskan lakes. They make very important contributions of nutrients, particularly phosphorous, that contribute to lake fertility and productivity (Donaldson 1967, Kline et al. 1993).

Nitrogen is often a limiting nutrient in western Washington streams and forests. High rainfalls dissolve nitrogen out of soils, and wash it away (Larson 1979). Bilby et al. (1996) compared the types of nitrogen found in two streams in Puget Sound. One had abundant coho salmon spawners, the other was above a block to migration and had no coho spawners. They found that in the spawning stream as much as 42% of the nitrogen in aquatic insects in the period following spawning came from the ocean (i.e., from decomposing salmon carcasses). Ocean-origin carbon made up 38-45% of juvenile coho and steelhead. They also detected ocean-origin nitrogen in the riparian vegetation. Salmon may transfer important levels of nutrients that contribute to the overall productivity of both water-based and land-based systems.

Food Source

Many different kinds of animals directly feed on living or dead salmon. Cederholm et al. (1989) identified 22 species of mammals and birds that fed on adult salmon carcasses in seven streams on Washington's Olympic Peninsula. These included obvious ones like raccoons, otters, and bears, and less obvious ones like shrews, moles, flying squirrels, jays, thrushes, and chickadees. They even found some evidence of feeding by blacktail deer and elk. The yearly gathering of bald eagles in the upper Skagit River and the gathering of sea lions at the Ballard Locks are examples from Washington State where salmonid populations are an important part of some animals' life cycles.

Sometimes a population can become dependent on salmonid fishes as a food source. When salmonid populations change, it can have a dramatic impact on these other species. This happened with the decline of spawning kokanee populations in the late 1980s in McDonald Creek. This is an important spawning tributary in the Flathead Lake ecosystem in Montana (Spencer et al. 1991). The kokanee populations declined due to competition for food with opossum shrimp, which were introduced into Flathead Lake in the late 1960s. McDonald Creek had the densest concentration of bald eagles south of Canada during kokanee spawning activity. In 1981, McDonald Creek attracted 639 eagles. After the kokanee's decline, the eagle population declined to just 25 birds. There were also notable declines in the presence of other bird populations, grizzly bears, coyotes, mink, and river otters. These may represent real losses or simply displacement of the populations to other, less productive areas. In either case, it represents a cost to these populations. The decline in eagles was also accompanied by a decline in visitors to the area from 43,000 in 1983 to just 1,000 people in 1989, thus connecting economic and recreational impacts with the ecological impacts.

Bilby et al. (1996) showed that juvenile coho and cutthroat showed increased growth during the period when coho were spawning, likely due to direct feeding on carcasses and eggs. This led to significant increases in overall size, which typically results in higher overall survival. Recent work by Michael (1995) found a strong relationship between survival of coho salmon in the Skagit River and the number of pink salmon spawners, potentially for the same reason.

There is no definitive information on the right number of fish needed to supply nutrients or act as a food supply. It is expected that ecosystem health will benefit the most from having the largest number of spawners possible. This provides more nutrients and more prey items. Fewer spawners means fewer nutrients or fish to eat. However, it is not clear how much of a reduction can occur before significant impacts occur. It is likely that there is a point where most of the benefits from carcasses are met, and additional carcasses have much less added benefit. The desired number of carcasses may vary with our goals. For example, the number of fish needed to support eagle populations will depend in part on how many eagles are desired. This question is beyond the scope of the Wild Salmonid Policy, but the fact that salmonids are important for ecosystem health is clear.

Predator/Competitor

Northcote (1978) reviewed the scientific literature on fish predation effects on the presence, abundance, and life history characteristics of the prey species. He found that in some instances prey species were completely eliminated or severely reduced by introduced species. The loss of these prey items in turn has the potential to greatly effect the species they feed on, so that there can be significant overall changes in the types of species found in a lake or stream and their abundance. Historically, salmonids were not found in many of Washington's waters where they are found today. Alpine lakes and many lowland lakes in the Puget Sound Basin were often devoid of salmonids. In addition, many Washington streams had barriers to migration that blocked access to anadromous fish. Many of these lakes and streams that did not have salmonids, or only resident salmonids, supported populations of other fishes, amphibians, and other species that may have been disturbed by introductions of large numbers of salmonids.

If salmonids are added to places where they did not historically exist, there is a real potential for disrupting the processes that make those ecosystems work. If this is done on a widespread basis it may result in a fragmentation of the habitat for these species, and if severe enough, a loss of these other species.

Habitat

The relationship of salmonids and their physical world was discussed in the *Habitat* element. Habitat changes can clearly affect salmonid productivity. However, sometimes more subtle changes occur. In the Puget Sound Basin, there has been a shift in salmonid populations as development occurs (Luchetti and Fuerstenburg 1993). Development typically causes changes in hydrology, with higher peak flows and lower low flows. In addition, streams become less complex, with fewer pools and hiding places. One result can be a shift from the more typical natural coho populations to cutthroat trout. Salmonids are still present, but there can be a significant difference in the type and productivity of the populations.

Introductions

Introductions of salmonid and non-salmonid fishes can create risks for wild salmonid populations. Releases of hatchery fish of the same species can depress or replace existing wild populations. This has been documented for coho by Nicholson et al. (1986) on the Oregon coast and in the Queets River system (D. Seiler, WDFW, personal communication). Competition has been identified as a concern for wild chum populations in Hood Canal because of the presence of large numbers of hatchery chum. Cross-species competition also can often be a concern. For example, releases of hatchery coho may exclude wild steelhead and cutthroat from some preferred habitats they would have otherwise occupied.

Predation has been raised as an issue for the effects of hatchery coho releases on pink salmon. Predation by hatchery coho and steelhead on some wild chinook and chum stocks are additional examples. Johnson (1973) suggested that a general decline in chum salmon stocks associated with large-scale releases of coho was related to predation. This leads to a general caution about coho enhancement in pink and chum salmon areas. Sholes and Hallock (1979) suggested that increased predation on naturally produced fingerlings offsets many of the gains in survival from releases of yearling hatchery chinook in the Sacramento River system.

Introductions of other types of fish into salmonid habitats are also a concern. Nearly all of the warmwater fish that have become an important part of recreational fishing in Washington were not native to this state. Sometimes these exotic fishes can become competitors and predators of salmonid populations. This is particularly true in many of Washington's lowland lakes and slower moving mainstem waters where habitat is less favorable, but often vital for salmonids. The presence of large numbers of warmwater fish can make it difficult to maintain productive salmonid populations. Lake rehabilitation where these competitors and predators are removed by poisoning can improve salmonid production, but the lake rehabilitation typically kills native salmonids where they exist as well. This then reduces salmonid populations and reduces local adaptation and genetic diversity. Illegal introductions of warmwater fish have created additional problems in many areas.

Where exotic stocks occur, there may be opportunities to achieve desired benefits at the least cost to wild salmonids. For example, the man-made lakes of the Columbia Basin, which historically did not have salmonid populations, can be used for warmwater fish or hatchery salmonid production with little impact to historical wild salmonid populations. Other lowland lakes that historically did not produce significant salmonid populations also are important opportunities for warmwater or hatchery salmonid production. At the same time, the overall health of salmonid populations and the most productive waters need to be maintained and protected for salmonid production. Where exotic populations create significant impacts to native species, steps may be taken to limit their impacts. For example, the recovery plan for Snake River chinook calls for special fisheries approaches to reduce the populations of smallmouth bass in the Snake River to reduce predation on threatened and endangered species.

Policy Issues

Five key policy issues that directly relate to salmonids will be considered here: (1) spawner abundance and its impact on ecological processes, (2) the potential impacts on native populations and ecosystem process by the introduction of salmonids outside their historical distribution, (3) the impacts of healthy natural predator populations, particularly where human impacts have increased their effectiveness, (4) the impacts of the introduction of non-indigenous fish species, and (5) concerns about competition and predation by hatchery fish.

The policy questions primarily revolve around the level of allowable impacts to either the natural system or salmonid populations. These impacts are the result of actions that provide other benefits that must be considered as well. Should we require actions to avoid all negative impacts to salmonid populations, allow some impacts as long as they have no significant effect, or allow significant impacts if the overall survival of a species is not at risk?

APPENDIX G DISCUSSION OF HARVEST MANAGEMENT

Harvest has a special role in the Wild Salmonid Policy. Harvest is both an important goal of the policy, and an important source of mortality that must be properly controlled to meet other goals of the policy.

Background

Harvest opportunity is very important to many of Washington's citizens, and the loss of much of that opportunity in recent years has been a hardship to many people. Harvest provides many different benefits. It is an important source of recreation for many citizens. For avid anglers it is more than just another hobby. It can be a central part of their life's activities. For other anglers, it may be no more than a once or twice a year outing with friends and families. In any event, a large part of Washington's population takes part in fishing for salmonids at one time or another, and it is recognized as an important part of the quality of life.

Harvest opportunity generates significant economic benefits. Commercial fishing supports the well-being of a number of coastal ports and families across the state. Commercial fishing opportunities in Washington are one of the reasons that much of the economic benefits from Alaskan fisheries are imported into Washington State. A major industry has developed to support recreational anglers. Tackle, boats, bait, lodging, charter services, and marinas are just part of the fishing economy.

Finally, harvest is an important cultural factor. This is most clearly seen in tribal fisheries that depend on returns of salmon and steelhead as part of a long tradition of harvest central to tribal economics and culture, including religion. It is seen in commercial harvesters, many of whom come from multi-generational fishing families. It is seen in the recreational fishers where parent-child interaction occurs while enjoying fishing.

There are many kinds of harvest. Directed harvests in sport, commercial, and tribal fisheries are designed to remove fish from the population to serve a variety of needs. Fish that are hooked and lost in sport fisheries, net drop-out in gill-net fisheries, catches of coho in a fishery directed at sockeye, and catches of a weak coho stock while fishing a stronger coho stock are some examples of incidental catches. Catch-and-release fisheries have some level of mortality due to injury, and even the small level of disturbance from "non-consumptive" activities may kill some fish at sensitive times. The Independent Scientific Group (ISG 1996) that reviewed salmon production on the Columbia River suggested that all forms of human caused mortality (including mortalities at dams, or losses due to water withdrawals) be treated as a form of harvest.

One of the key challenges for harvest management is the problem of mixed-stock fisheries. As we noted in the *Spawner Abundance* discussion, each population of fish has its own unique spawner-recruit relationship. Some stocks are large, some small, some very productive, some less productive. As a result, each population will have its own unique optimum fishing level to achieve the desired spawner abundance level. The problem in Washington is that very often several different stocks will be found in the same fishery. Just about every coho and chinook population in the state contributes to the ocean recreational and commercial salmon fisheries, and all of the Puget Sound coho and chinook populations are found in recreational and commercial fisheries in Puget Sound marine waters. If you harvest at a level that provides for the spawner abundance of the least productive stock, you meet or exceed the spawner abundance requirements of them all. However, if the more productive stock is larger you may also lose a great deal of harvest opportunity. If you harvest at a rate to take advantage of the harvest from the more productive stocks, you may be able to increase your harvest, but you will overfish, depress, and perhaps even lose the less productive stocks.

In Washington, this challenge of mixed-stock fisheries most clearly occurs where there are mixtures of hatchery and wild fish. Hatchery fish are protected from a great deal of mortality during their time in the hatchery. Because of this they often have higher total survival and can be fished at higher rates. They often return to specific locations where they are visible to the public. This often creates great pressure to harvest all of the hatchery fish. This in turn can result in overfishing of the wild runs.

In order to take advantage of the stronger stocks, while protecting weaker stocks, it will be important to develop more selective ways of harvesting fish. Selective fisheries can take many forms. Fishing at specific times and places may direct the harvest primarily on one stock while protecting others. This has been used to reduce coho catches during commercial sockeye fisheries in Puget Sound, to reduce chinook harvests while fishing on coho in ocean fisheries, and to protect upriver spring chinook while harvesting lower river stocks in the Columbia River.

One common approach is to wait for the fish to separate themselves out as they return to their home streams. Then the fishing can be directed on just a few stocks at a time. While this has some distinct advantages, it also creates some problems. Many of the mixed stock fisheries developed because they increased the availability, accessibility, or value of fishing opportunities. Marine water salmon recreational fisheries provide a year round opportunity in many areas, compared to a more limited time period when fish return to spawn. Fish in saltwater may bite much more readily and provide greater harvest opportunity. Some species decline in value as they leave saltwater. Catching them in mixed-stock fisheries may increase their value. This approach may not work with hatchery and wild fish because they often return to the same rivers at the same time.

Other approaches may use different types of fishing gear that select one type of fish and not others, or that allow harvesters to examine fish and release those that need protection. All of these techniques have been used at some level. All hatchery steelhead and searun cutthroat are marked for easy identification and special regulations are often used to require the release of wild fish.

Policy Issues

Many of the key harvest management issues have already been discussed as part of the other elements. Concerns about harvest rates and escapement levels were discussed in the *Spawner Abundance* element. Issues of fisheries selectivity were discussed as part of the *Genetic Conservation* element. These issues will be briefly reviewed in this discussion along with some other issues specific to harvest management.

A. **Harvest Management and Spawner Abundance -** choosing a harvest strategy that will produce the desired escapement is a key issue between harvest management and spawner abundance. For more details on determining the desired spawner level see the *Spawner Abundance* element. Whatever harvest strategy is chosen, it should be designed to achieve the desired spawner abundance level, and meet any treaty and non-treaty harvest opportunity requirements. There are two key issues in doing this:

1. What level of harvest should be allowed on those populations that are not meeting their desired spawner abundance level? Should there be no harvest? Some limited incidental harvest to allow selective fisheries to take place? Limits developed as needed to respond to harvest opportunity and conservation needs?
2. What role should selective fisheries play? Should more selective fisheries be given a priority? Should selective fisheries be used only on an as needed basis?

B. **Harvest Management and Genetic Conservation -** while it is important to be able to selectively harvest strong stocks, any harvests should meet the requirements for fisheries selection under the genetic conservation criteria.

APPENDIX H DISCUSSION OF CULTURED PRODUCTION/HATCHERIES

Various forms of cultured production, including hatcheries, have been an important fish management tool in Washington for over a century. Hatcheries provide over 90% of the lake catch of resident salmonids. In 1992-93, about 88% of the steelhead caught were hatchery fish. From 1986-91, over 70% of the Puget Sound coho catch was hatchery reared. Hatchery-reared chinook and coho contribute heavily to catches in the Lower Columbia and Willapa Bay. Hatchery production has been a key part of the stock recovery programs for White River spring chinook, Dungeness native chinook, Yakima River spring chinook, and chinook and steelhead populations in the mid- and upper Columbia River system. Hatchery production has also been an important source of fish to mitigate for the loss of habitat due to dam construction and other habitat losses. Hatchery fish also buffer the impacts of harvest on wild fish in quota fisheries like the west coast of Vancouver Island troll and sport fisheries.

However, cultured production continues to be a source of some controversy. Some of these issues have been considered already: (1) gene flow between hatchery and wild fish, (2) mixed-stock fisheries that can overfish wild fish, and (3) competition and predation impacts on wild fish. Some people believe that hatchery production is the key to fishing opportunity in the future and others suggest that the presence of hatchery fish diverts public attention from important problems such as habitat protection. Several recent reviews of salmon management in the northwest provide excellent summaries in more detail (NRC 1996, ISG 1996).

An important objective of the Wild Salmonid Policy is to define appropriate standards and guidelines for using fish culture. Because hatcheries often contain important genetic resources and represent significant investments by the public, the health of the hatchery programs will be an important consideration.

Background

Washington State has one of the largest salmonid production systems in the world. WDFW currently operates 65 salmon and 30 trout rearing facilities. Five salmon species, steelhead, and sea-run cutthroat trout are included in anadromous hatchery production. Resident hatchery salmonids include rainbow, cutthroat, eastern brook, brown, lake, and golden trout; Arctic grayling; and kokanee. These facilities produced approximately 230 million anadromous and 20 million resident salmonids during 1992-93. In addition there are 12 federal and 17 tribal facilities that added another 50 million fish in 1992-93. There are also a large number of local volunteer fish culture programs operated by schools, clubs, community groups, and individuals.

Cultured production uses a wide range of techniques. The use of a specific technique depends on the species, goal of the program, limiting factors in the natural environment, costs, and physical constraints such as water or land. The following description of the potential programs is listed in order of increasing involvement of the hatchery environment (see *Genetic Conservation* for a discussion of the hatchery environment and domestication) on the fish:

A. **Spawning Channels** — these are typically flow-controlled channels with clean, properly sized gravel, and the ability to control the number and timing of spawners. They are used primarily to improve survival during spawning and incubation. They are most often used for pink, chum, and sockeye salmon, species where subsequent rearing area is usually not limiting. Spawning channels are considered a low intervention approach because the fish spend a limited amount of time in them and most of the fish's actions are directed naturally by the fish themselves.

B. **Remote Site Incubators (RSIs)** — These are typically low-tech hatching facilities that are located away from central hatchery facilities. They are primarily used to improve survival during incubation. They too are most often used with species where rearing habitat is not limiting, though they may be combined with short- and long-term rearing programs. RSIs have greater potential impact, since humans collect the fish for spawning, do the mate selection, and often provide some incubation in the central hatchery facility.

C. **Captive Rearing** — this is the opposite of the RSI approach. In this case wild juveniles are collected and brought to the hatchery for rearing. Mate selection, spawning, and some early rearing are done in the wild, while any later rearing is done under artificial conditions.

D. **Release and Recover** — These are the typical hatchery facilities for anadromous species. In this case eggs are taken from fish that are either returning hatchery fish or, in some cases, wild fish. Mate selection, incubation, and rearing up to release in the wild are under human control. Release may occur at any stage from early in the juvenile stage to full maturity. Intervention in the fish's life is fairly high in most cases.

E. **Captive Broodstock** — In this case eggs are taken from fish that have been in the hatchery their entire lives. This represents the highest level of intervention in the fish's life. It is used most often for resident trout populations, and as the last choice strategy to preserve a wild population that is likely to go extinct.

Within each of these approaches there are a variety of strategies that can be used to limit the impacts of the hatchery process. Spawning protocols can be used to limit the impacts from human mate selection. Rearing, feeding, and release strategies can be used that are more like natural conditions to reduce the potential of domestication. Release timing and location can mimic wild fish.

Salmonid culture programs typically address four key resource management needs: (1) *enhance* fishing opportunity, (2) *mitigate* for specific production losses, (3) *restore* depleted wild populations or *reintroduce* extirpated species, and (4) *research* to improve management and hatchery programs. A single facility may engage in several programs.

A. *Enhancement* programs are designed to increase the number of fish available for all forms of harvest. Enhancement programs are not designed to create more wild spawners, though this can occur.

B. *Mitigation* is used to make-up for production losses. Some people feel that all hatchery production is mitigation for production lost on a broad scale. However, the term is more typically used to describe a specific hatchery facility that was built because of a specific project. Most commonly, mitigation is used to replace production from the construction of dams and reservoirs that destroy habitat or increase the mortality rate during some part of the life cycle. The Cowlitz and Lewis River hatcheries are examples of mitigation hatcheries as are most Columbia River facilities.

C. *Restoration* is used to: (1) recover (supplement) populations that are having problems replacing themselves and are not likely to recover naturally, (2) reintroduce wild stocks that have been lost from areas they historically inhabited, and (3) maintain stocks that face extreme risks. Restoration programs are designed to put more spawners on the spawning grounds.

D. *Research* at hatchery facilities has played a vital role in understanding the biology and management of salmonid populations. Hatchery fish can be studied directly, or used as indicators of how similar, neighboring wild populations may be behaving. Issues such as diseases, growth, physical changes before migrations, and ocean distribution and catch patterns are all studied using hatchery fish. In many cases similar work on wild fish is much more difficult due to smaller numbers and the difficulties in creating controlled conditions.

Key Policy Issues

Many of the key policy issues dealing with hatchery production were discussed in the other policy elements. Concerns about gene flow and its affects on genetic diversity and local adaptation were discussed in the *Genetic Conservation* element. Potential impacts of predation and competition by hatchery fish were discussed in the *Ecological Interactions* element, and the interaction of hatchery production and harvests of wild fish were discussed in the *Harvest Management* element. In this section these will be briefly reviewed, with some specific examples for hatchery activities:

A. **Hatcheries and Genetic Conservation** — Gene flow and its impact on local adaptation and genetic diversity is the main issue with hatcheries and genetic conservation. Gene flow is the movement of genes from one population to another due to interbreeding between populations. For more details on the concerns about this see the *Genetic Conservation* discussion.

Hatchery to wild gene flow occurs when hatchery fish are transferred or stray from one area to another. This is not a unique problem for hatchery fish. Wild populations can be moved as well. However, transfers occur more with hatchery fish because of their availability.
Hatchery to wild gene flow within a single area has several sources. Anadromous fish released from a hatchery generally return to that hatchery. They are then captured and removed from the system. This results in no gene flow. However, some of the returning fish do not return to the hatchery and spawn in the wild with wild fish. The rate of straying varies widely depending on the species, location, water source for the hatchery, flow conditions, and capture facilities at the hatchery. In most cases this spawning in the wild is limited and occurs close to the hatchery. However, up to 40% of the hatchery fish may spawn in the wild in some areas. Even wild spawning by a relatively small portion of the hatchery population can have a big impact if the hatchery population is large compared to the wild population.

In some cases hatchery fish are released away from the hatchery site to supplement wild spawning or to create alternative harvest opportunities. Fry plants, acclimation ponds, off-site releases, RSIs, and a variety of other techniques are used. The term "supplementation" is sometimes used to describe any program that contributes adults to the natural spawning escapement. In this DEIS, supplementation has a very specific definition (see box). Supplementation is more than just putting additional spawners on the spawning grounds. These spawners must allow the wild population to retain the traits that make them productive in the wild.

A variety of approaches may be taken to supplementation:

1. Supplementation may not be allowed. This approach was not used in any of the alternatives, because there are cases where the survival of a stock may depend on supplementation.
2. Supplementation may be allowed only when a population is clearly at risk of extinction, and the risk of extinction clearly outweighs the risks of the supplementation process. Supplementation would occur only as part of a broader program to improve survival and develop a self-sustaining population.
3. Supplementation may be allowed at any time if the fish used for the supplementation meet some criteria such as local origin, generations in the hatchery, etc. These criteria may vary in strictness depending on the status of the target stock and the desire to produce additional fish.

> **Supplementation** — "The use of artificial propagation to maintain or increase wild production while maintaining the long-term fitness of the target population, *and* keeping the ecological and genetic impacts within specific biological limits" (RASP 1992)

A very important consideration in using supplementation is that it very likely will not work. Miller et al. (1990) reviewed 316 supplementation projects throughout the Northwest. They concluded that "there are no guarantees that hatchery supplementation can replace or consistently augment natural production". They felt that even this might be optimistic, because there is a tendency to report on only the projects that worked.

Supplementation is not a "stand alone" strategy. It should be part of a broader strategy to deal with the actual causes of the problem that has caused the population to decline. Actions for habitat protection, harvest management, and enforcement must be taken as well.

B. **Hatcheries and Ecological Interactions** — Hatchery fish concerns cover two key issues: (1) impacts on wild salmonids due to competition and predation, and (2) effects on the broader ecosystem. For more information see the *Ecological Interactions* element discussion in Appendix F.

Hatchery fish may compete with fish of the same species for food, space, or cover. While the total population of the species may be higher, the number of locally adapted wild fish may go down. This has been described for hatchery coho releases in the Queets River (D. Seiler, WDFW, personal communication). It may also be partly responsible for the decline in overall populations seen by Nicholson et al. (1986) for the Alsea River in Oregon.

Johnson (1973) described the potential for significant predation by hatchery coho on hatchery chum and pink salmon. The same impacts might be expected on wild pink and chum.

Introducing salmonids, either hatchery or wild, into areas where they did not historically live may disrupt ecological processes that support native populations of non-salmonid species.

C. **Hatcheries and Harvest Management** — The presence of large numbers of healthy stocks in a fishery creates strong incentives for resource users to press for harvest opportunity. Frequently, the healthy stocks are largely composed of hatchery fish. Allowing non-selective fishing opportunity on these healthy stocks would result in over harvesting co-mingled weaker stocks. The strong opening day fishery in many lakes that is highly dependent on hatchery fish is one example. Similar concerns are common in many salmon fisheries.

ANADROMOUS FISH -- Species that are hatched in freshwater, mature in saltwater, and return to freshwater to spawn.

ALEVIN -- Newly hatched juvenile salmonid with visible yolk sac.

BIODIVERSITY -- The variety and abundance of species, their genetic composition, and the natural communities, ecosystem, and landscapes in which they occur.

BROODSTOCK -- Those adult salmonids that are destined to be the parents for a particular stock or smaller group of fish.

CARRYING CAPACITY -- The maximum number of individuals or biomass of a given species or complex of species of fishes that a limited and specific aquatic habitat may support during a stated interval of time.

CATCH -- The act of landing a fish at which point the fisher has the option of releasing or retaining it.

CHANNELIZED -- A portion of a river channel that has been enlarged or deepened, and often has armored banks.

CO-OP OPERATION -- Projects funded under the Aquatic Lands Enhancement Account (ALEA) allowing individuals to do habitat enhancement projects plus rear and release salmon into state waters under the direction of WDFW.

CONSUMPTIVE -- Any human activity involving salmonids that induces mortality.

CRITICAL STOCK -- A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

DEPRESSED STOCK -- A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.

ECOLOGICAL INTERACTION -- The sum total of impacts of one species on another species, or on other members of the same species.

ECOSYSTEM -- A complex of biological communities and environment that forms a functioning, interrelated unit in nature.

ESCAPEMENT -- Those fish that have survived all fisheries and will make up a spawning population.

ESCAPEMENT FLOOR -- The lower bound of an escapement range.

ESCAPEMENT GOAL -- A predetermined biologically derived number of salmonids that are not harvested and will be the parent spawners for a wild or hatchery stock of fish.

EXOTIC SPECIES -- Salmonid species that were not native to Washington State (e.g., brown trout, brook trout, Atlantic salmon).

EXTINCTION -- The loss of a stock of fish from its original range, or as a distinct stock elsewhere. Individuals of the same species may be observed in very low numbers, consistent with straying from other stocks.

FISHERY -- The process of attempting to catch fish, which then may be retained or released.

FITNESS -- The relative ability of an individual (or population) to survive and reproduce (pass on its genes to the next generation) in a given environment.

FRY -- Young salmonids that have emerged from the gravel and are up to one month of age or any cultured salmonid from hatching through fourteen days after being ponded.

GEAR LIMITS -- Restrictions placed on sport or commercial fishing gear, which are used to control the take of fish.

GENETIC DIVERSITY -- All of the genetic variation within a group. The genetic diversity of a species includes both genetic differences between individuals in a breeding population (=within-stock diversity) and genetic differences among different breeding populations (=among-stock diversity).

GENETIC DRIFT -- The random fluctuation of allele frequencies in a population resulting from the sampling of gametes to produce a finite number of individuals in the next generation.

GENETIC RISK -- The probability of an action or inaction having a negative impact on the genetic character of a population or species.

GLIDE -- A part of a stream that is characterized by a smooth, easy movement of water, usually just upstream of a riffle.

HABITAT -- An area that supplies food, water, shelter, and space necessary for a particular animal's existence.

HARVEST -- Fish that are caught and retained in a fishery (consumptive harvest).

HARVEST RATE -- The proportion of a returning run or total population of salmonids that is taken by fisheries.

HATCHERY MANAGEMENT UNIT -- A group of fish managed to achieve hatchery salmonid escapement objectives. These areas typically support higher harvest rates (percent of returning fish harvested) than wild stock management areas.

HATCHERY PRODUCTION -- The spawning, incubation, hatching, or rearing of fish in a hatchery or other artificial production facility (e.g., spawning channels, egg incubation boxes, or pens).

HATCHERY STOCK -- A stock that depends upon spawning, incubation, hatching, or rearing in a hatchery or other artificial production facility (synonymous with cultured stock).

HEALTHY STOCK -- A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock. This does not imply that the habitat itself is necessarily "healthy."

HYBRIDIZATION -- The interbreeding of fish from two or more different stocks.

INBREEDING -- The mating of related individuals.

INCIDENTAL HARVEST -- The capture and retention of species other than those a fishery is primarily opened to target/take. It can also refer to marked fish of the same species.

INTEGRATED LANDSCAPE MANAGEMENT -- A management process that integrates the needs of multiple species across a broad landscape.

LARGE WOODY DEBRIS (LWD) -- Conifer or deciduous logs, limbs or root wads twelve inches or larger in diameter.

LOCALLY ADAPTED POPULATION -- A population of fish that has developed specific traits that increase their survival in a particular habitat or environment.

LOWER COLUMBIA -- That portion of the mainstem Columbia River below Bonneville Dam.

MANAGEMENT UNIT -- A stock or group of stocks which are aggregated for the purposes of achieving a desired spawning escapement objective. See wild and hatchery management unit definitions.

MASS MARKING -- The marking of all individuals in a population of fish so that individuals of that population can be identified in subsequent life history stages.

MAXIMUM SUSTAINED YIELD (MSY) -- The maximum number of fish from a stock or management unit that can be harvested on a sustained basis, measured as the number of fish that would enter freshwater to spawn in the absence of fishing after accounting for natural mortality.

MID-COLUMBIA -- That portion of the mainstem Columbia River between McNary and Bonneville dams.

MINIMUM SIZE LIMIT -- A sport fishery regulation that establishes a minimum size (usually length) for the retention of a fish to protect younger individuals in a fish population, or to protect other species of fish.

MINIMUM VIABLE POPULATION (MVP) -- The size of a population which, with a given probability, will ensure the persistence of the population for a specified period of time.

MIXED-ORIGIN STOCK -- A stock whose individuals originated from commingled native and non-native parents; or a previously native stock that has undergone substantial genetic alteration.

MIXED-STOCK FISHERIES --Any fishery that catches fish from more than one stock.

NATIVE SPECIES -- A species of fish indigenous to Washington State.

NATIVE STOCK -- An indigenous stock of fish that has not been substantially affected by genetic interactions with non-native stocks or by other factors, and is still present in all or part of its original range. In limited cases, a native stock may also exist outside of its original habitat (e.g., captive brood stock programs).

NATURAL SELECTION -- Differential survival and reproduction among members of a population or species in nature, due to variation in the possession of adaptive genetic traits. Natural selection, the major driving force of evolution, is a process leading to greater adaptation of organisms to their environment.

NET PEN --A fish-rearing enclosure used in lakes and marine areas.

NON-CONSUMPTIVE -- Any human activity involving salmonids that does not cause mortality.

NON-NATIVE STOCK -- A native species residing in an area outside its original habitat in Washington State (e.g., Chambers Creek steelhead, Soos Creek chinook).

OFF-CHANNEL AREA -- Any relatively calm portion of a stream outside of the main flow.

POOL -- A relatively deep, still section in a stream.

POPULATION -- Synonymous with the term stock.

PRIMARY MANAGEMENT UNIT -- A stock or group of stocks for which a specific spawning escapement goal is established with the intention of managing all impacting fisheries to meet that goal.

PRODUCTIVITY -- A measure of the capacity of a biological system. The efficiency with which a biological system converts energy into growth and production.

QUOTA --A number of fish allocated for harvest to a particular fishing group or area.

RECOLONIZATION -- The reestablishment of a salmonid stock in a habitat that the species previously occupied.

RECRUITS -- The total numbers of fish of a specific stock available at a particular stage of their life history.

REGIONAL FISHERIES ENHANCEMENT GROUP -- 12 regional fisheries enhancement (volunteer) groups funded under recreational and commercial salmon license fees, allowed to do habitat enhancement projects plus rear and release salmon into state waters under the direction of WDFW.

REMOTE SITE INCUBATOR -- A lightweight, dark colored plastic barrel incubator that employs plastic substrate (hatching medium), and can be sized to accommodate 5,000 to 125,000 eggs per incubator. They are used mainly for incubating chum salmon eggs.

RESIDENT SALMONID -- Those members of the family Salmonidae which spend their entire lives in freshwater.

RIFFLE -- A shallow gravel area of a stream that is characterized by increased velocities and gradients, and is the predominate stream area used by salmon for spawning.

RIPARIAN HABITAT --The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.

RISK ASSESSMENT -- Evaluating the probability of an action having a negative impact that is not within prescribed limits or acceptable bounds.

RIVERINE HABITAT --The aquatic habitat within streams and rivers.

RUN -- The sum of stocks of a single salmonid species which migrates to a particular region, river, or stream of origin at a particular season.

SALMONID -- Any member of the taxonomic family Salmonidae, which includes all species of salmon, trout, char, whitefish, and grayling.

SASSI -- Salmon and Steelhead Stock Inventory. A cooperative program by the Department of Fish and Wildlife and Washington Treaty Indian tribes to inventory and rate the status of salmon and steelhead stocks on a recurring basis.

SECONDARY MANAGEMENT UNIT -- A stock or group of stocks for which escapement is that which occurs primarily as a result of not being caught in fisheries directed at co-mingled primary stocks. A group of fish which an escapement goal may not be established.

SECONDARY PROTECTION -- Management activities that provide protection to stocks or runs of salmon after they have been subjected to harvest in mixed stock areas.

SELECTIVE BREEDING -- The intentional selection of individual spawners in artificial production programs to produce particular traits in subsequent generations.

SELECTIVE FISHERY -- A fishery that allows the release of non-targeted fish stocks/runs, including unmarked fish of the same species.

SELF-SUSTAINING POPULATION -- A population of salmonids that exists in sufficient numbers to replace itself through time without supplementation with hatchery fish. It does not necessarily produce surplus fish for harvest.

SMOLT -- A juvenile salmonid that is undergoing the physiological change to migrate from fresh to salt water.

STOCK -- The fish spawning in a particular lake or stream(s) at a particular season, which to a substantial degree do not interbreed with any group spawning in a different place at the same time, or in the same place at a different time.

STOCK ORIGIN -- The genetic history of a stock.

STOCK STATUS --The current condition of a stock, which may be based on escapement, run size, survival, or fitness level.

SUPPLEMENTATION -- The use of artificial propagation to maintain or increase natural production while maintaining the long-term fitness of the target population, and keeping the ecological and genetic impacts to non-target populations within specified biological limits.

TARGETED FISHERY -- A harvest strategy designed to catch a specific group of fish.

TERMINAL FISHING AREA -- A fishing area near the ultimate freshwater destination of a stock where a salmonid stock or run has separated from other stocks/runs.

TREATY TRIBES -- Any Indian tribe recognized by the United States government, with usual and accustomed fishing grounds, whose fishing rights were reserved under a treaty and have been affirmed by a federal court.

UNKNOWN STOCK -- This description is applied to stocks where there is insufficient information to identify stock origin or stock status with confidence.

UPPER COLUMBIA -- That portion of the mainstem Columbia/Snake River above McNary Dam.

VIABLE POPULATION -- A population in a state that maintains its vigor and its potential for evolutionary change.

WATERSHED -- A basin including all water and land areas that drain to a common body of water.

WILD MANAGEMENT UNIT -- A management unit where fisheries are managed to achieve wild salmonid escapement objectives.

WILD STOCK -- A stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage (including native).

WILD STOCK INITIATIVE (WSI) -- A cooperative program between the state and western Washington Indian tribes that is intended to maintain and restore healthy salmon and steelhead stocks and habitats.

WITHIN-STOCK DIVERSITY -- The overall genetic variability among individuals of a single population or stock.

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Libraries

Bellevue Community Col - Library Media Center
Centralia College Library Media Center
Clark College - Lewis D Cannell Library
Clover Park Technical College - Fv Miner Resource Center
Columbia Basin College - Library Services
CWU - University Library
Eastern Washington University - University Library
Edmonds Community College - Library Media Center
Everett Community College - Terrery Library Media Ctr
Gonzaga University - Ralph E & Helen Higgins Foley Ctr
Grays Harbor College - John Spellman Library
Green River Community College - Holman Library
Heritage College
Highline Community College - Library 25-4
Lower Columibia College - Alan Thompson Library
North Seattle Community College
Northwest College - Hurst Library
Olympic College - Learning Resource Center
Pacific Lutheran University - Mortvedt Library
Peninsula College - John D Glann Library
Pierce College Library
Renton Technical College - Library Resource Center
Saint Martin's College - Library
Seattle University - Lemieux Library
Seattle Pacific University - Weter Memorial Library
Seattle Central Community College
Shoreline Community College - Ray Howard Library Media Center
Skagit Valley College - Library Media Center
South Seattle Community College
Spokane Falls Community College - Library/media Services
Spokane Community College
South Puget Sound Community College - Library
Tacoma Community College - Library
The Evergreen State College - Daniel J Evans Library
University of Puget Sound - School of Law Library
University of Washington - University Library
Walla Walla College - Peterson Memorial Library
Washington State University - Holland Library
Wenatchee Valley College - John a Brown Library Media Center
Whitman College - Penrose Library
Whitworth College Library
Yakima Valley Community College Library

Asotin Public Library
Bellingham Public Library

Cathlamet City Library
Colville Public Library
Davenport Public Library
Dayton Memorial Library
Ellensburg Public Library
Everett Public Library
Fort Vancouver Regional Library (Goldendale)
Jefferson Co Rural Library Dist
Kelso Public Library
King County Library System
Kitsap Regional Library
Mid-Columbia Library
Mount Vernon City Library
North Central Regional Library
North Olympic Library System
Ocean Shores Public Library
Pend Oreille Co Public Library
Pierce County Public Library
Pomeroy Memorial Library
Port Townsend Public Library
Ritzville Public Library
Seattle Public Library
Sno Isle Regional Library
Spokane Co Library District
Tacoma Public Library
Timberland Regional Library
Walla Walla Public Library
Washington State Library
Whitman Co Library
Yakima Valley Regional Library

Governmental Organizations

Adams County Planning Department
Asotin County Planning Commission
Benton County Planning and Building Department
Chelan County Regional Planning Commission
Chelan County PUD
Clallam County PUD
Clallam County Environmental Review
Clark County PUD
Columbia County Planning Department
Douglas County Regional Planning Commission
Douglas County PUD
Ferry County Planning Department
Franklin County PUD
Franklin County Planning Department

Garfield County Environmental Review
Grant County Planning Department
Grant County PUD 2
Grays Harbor Planning and Building Department
Grays Harbor Conservation District
Grays Harbor County PUD
Island County Planning Department
Jefferson County Conservation District
Jefferson County Planning and Building Department
King County Planning Department
King County Conservation District
Kitsap County Department of Community Development
Kittitas County Planning Department
Klickitat County Planning Department
Lewis County Planning Department
Lewis County PUD
Mason County Conservation District
Mason County Planning Department
North Yakima Conservation District
Okanogan County Planning Department
Okanogan County PUD
Pacific County Planning Department
Pend Oreille County Planning Department
Pierce County Conservation District
Pierce County Public Works & Utilities
Pierce County Planning Department
San Juan County Planning Department
Skagit County Conservation District
Skagit County Planning Department
Skamania County Planning Department
Snohomish County Planning Department
Snohomish County PUD
Stevens County Department of Community Development
Thurston County Planning Department
USFWS - Ecological Services Environmental Review
Walla Walla Regional Planning Department
Whatcom County Planning Department
Yakima County Planning Department

General Interest and Sports Groups

Adopt a Beach
Allentown Plunkers Trout Unlimited
Anacortes Trout Unlimited
Association of Northwest Steelheaders
Backcountry Horsemen of Washington
Ballard Trout & Salmon Unlimited

Bellevue Issaquah Trout Unlimited #109
Big Bend Bass Masters
Black Lake Rv Park
Boise Cascade
Bremerton Trout Unlimited #143
Bremerton Sportsmens Club
Camas/Washougal Wildlife
Cascade Snow Drifters
Cashmere Sportsman
Cavenham Forest Industry
Cedar Wells
Central Washington Bass Club
Central Basin Audubon
Central Whidbey Sportsmens Association
Champion International
Chehalis Basin Fisheries Task Force
Clark Skamania Fly Fishers
Coalition of Sports Fishermen
Columbia Basin Flycasters
Columbia Basin Bass Club
Columbia County Sportsmen Association
Columbia River Estuary Study Task Force
Columbia River Fishermens Protective Union
Coulee City Sportsmens Association
Cowiche Canyon Conservancy
Cowlitz River Sportsmen
Cowlitz Game & Anglers
Custer Sportsmens Club Inc
Darrington Fish & Game Sports
Davenport Rod & Gun Club
Des Moines Trout Unlimited #366
Dryside Flyfishers
Eastside Steelheaders
Eatonville Sports Club
Edison Sportsmens Club
Elliott Bay Trout Unlimited #121
Ephrata Sportsman Association
Everett Trout Unlimited
Evergreen Sportsmans Club
Evergreen Fly Fishing Club
Fishing & Hunting News
Fort Vancouver Trout Unlimited
Four Shores Trout Unlimited
Free Columbia Trout Unlimited
Friends of Columbia Gorge
Friends of Mcneil Island
Georgia Pacific

Gig Harbor Trout Unlimited
Goldendale Northwest Steelheaders
Grand Coulee Dam Sportsman Association
Green River Steelhead Trout Club
Greenpeace
Holmes Harbor Rod & Gun Club
Hood Canal Environmental Council
Hood Canal Coordinating Council
Icicle Valley Trout Unlimited #391
Inland Empire Zoological Society
Inland Empire Public Lands Council
Inland Northwest Wildlife Council
Interlake Rod & Gun Club
Kent Bassmasters
Kittitas Audubon
Kiwanis Club of Arlington
Klickitat Trout Unlimited #484
Lake Stevens Trout Unlimited
Lake Chelan Snowmobile Club
Lower Valley Trout Unlimited #180
Mason County #520
Mccord Air Force Base Sportsmens Club
Mobrand Biometrics
Monroe Rod & Gun Club
Mount Si Fish And Game Club
Mukilteo Trout Unlimited
Native Plants Salvage Project
North Seattle Trout Unlimited
North Okanogan Sportsmens Council
North Pacific International Chapter American Fisheries Society
North Whidbey Sportsmens Association
Northwest Fund For Environment
Northwest Renewable Resources Center
Okanogan County Fly Fishing Club
Operation Cowslip
Orcas Island Sports Club
Oregon Natural Resources Council
Overlake Fly Fishing Club
Pacific County Trout Unlimited #341
Panorama Bass And Walleye Club
Pateros Sportsmen Association
Paws
Pend Oreille Valley Sportsmen
Plum Creek Timber
Potholes Bass Club
Puget Power
Rails to Trails Conservancy

Renton Fish & Game Club
Richland Rod And Gun Club
Riverside Sportsmen Association
Safari Club - International/Inland Empire West
Seattle Audubon
Seattle Trout Unlimited
Sierra Club - Spokane Chapter
Skagit Audubon
Snake River Preservation Council
Snohomish Sportsmens Association
Snohomish Sportsmen Club
South Sound Fly Fishing Club
South Lake Wash Trout Unlimited
South King County #115
Spiny Ray Club of The Northwest
Spokane Walleye Club
Spokane Audubon
St. Helens Hiking Club
Stream Team Olympia
Sultan Sportsmens Club
Sumner Sportsmens Club
Sun Cover Resort
Southwest Washington Anglers
Tacoma Poggie Club
Tacoma #146
Tamarack Bass Busters
The Mountaineers - Conservation Division
The Cascadians
The Izaak Walton League
The Nature Conservancy
Three Rivers Bassmasters
Toutle River Trout Unlimited
Tri-State Steelheaders
Twin City Sportsmen
Upper Columbia Trout Unlimited #093
Vancouver Wildlife League
Vashon Sportsmens Club
Washington Bass Association
Washington State Hi-lakers
Washington Wildlife Rehabilitator
Washington Wildlife Heritage
Wenaha Game Protective Association
Wenatchee Valley Fly Fishers
West Seattle Sportsmens Club
Western Bass Club
Weyerhauser Company
Whatcom County #178

Whidbey Environmental Action Network
Whidbey Audubon
White Pass Merchants Association
White River Trout Unlimited
Whitman County Sportsmens Association
Wilderness Society
Wolf Haven America
Yakima Trout Unlimited #-94
Yakima Training Center
Yakima Valley Audubon
Yakima Fly Fishers Association

Federal and State Agencies

Archives & Records Management Division
United States Department of Interior
Bonneville Power Administration
Bureau of Land Management - Oregon/Washington State Office
Department of Ecology
Department of Agriculture
Department of Natural Resources
Department of Natural Resources - Division of Geology
Department of The Interior
Interagency Committee For Outdoor Recreation
Office of The Governor
State Parks And Recreation Commission
U.S. Army Corps of Engineers
Washington State Energy Office

State and Federal Organizations, Sports and Interests Groups and Individuals

Tim Abena
Kathy Adams
Diane Adams
Al Adams - Hood Canal Salmon Enhancement
Tim Adderson
Jon Akers
Brian Allee - Harza Northwest Inc.
Stan Allen - Pacific States Marine Fisheries Commission
Steve Allen - Pacific State Marine Fisheries Commission
George Allen - Walleye Club
Bob Allen
Douglas Allen
Bob Alverson - Fishing Vessel Owners Association
Joe Anderson - Puyallup Tribe of Indians Fisheries
Robert Anderson
Robert Anderson

Mark Anderson - State Energy Office
Karl Anderson - Southwest Washington Anglers
Claude Anderson
Jim Anderson - Northwest Indian Fisheries Commission
Ross Antipa
Rick Applegate - Trout Unlimited
Rob Aramayo
Mark Ashley - Willapa Bay Fisheries Enhancement
Chuck Bagley - Washington Conservation Commission
David a Bailey
Jim Bain - Washington Outfitters & Guides Association
Rowan Baker - National Marine Fisheries Service
Jim Baker - Sierra Club
Bill Bakke - Native Fish Society
Heather Ballash - Tahoma Audubon
Dale Bambrick - Yakama Indian Nation
Bruce Barbor - Department of Ecology
Michael Barclay - Cascades Environmental Services
Katherine Baril
Jill Barker - Columbia Gorge Audubon
Sid Barnes - Boeing Creek Salmon Friends
William Barnett
Dana Base
David Bayles - The Pacific Rivers Council
John Beal - International Marine Association
Martha Bean - Triangle Association
Kurt Beardslee - Washington Trout
Candace Beardslee - Northwest Women Flyfishers
David Beatty
Walt Bendermann - North Olympic Salmon Coalition
Logan H Bennett
Paul Bentzen - University of Washington School of Fisheries
James C Bergdahl - Northwest Biodiversity Center
Marty Best - Emergency Management
Mary Betrand - Chums of Barker Creek
George Bettas
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Gordy Birkland - Seattle Poggie Club
Pete Bisson - Weyerhaeuser Company
Deb Black - Urban Resources Assistance Team
Hugh Black - United States Department of Agriculture - Forest Service
Pat Blackwell
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Elizabeth Blue
Joe Blum
Lorraine Bodi - American Rivers
Dan Bonk - Sprague Rod & Gun Club

Ralph Boomer - United States Fish and Wildlife Service
Carol Bordin - Chehalis River Council
Mark Bordsen - Whitman County Planning Office
Wendy Borgesen - Watershed Masters
Pam Botnen
Craig Bowhay - Pacific Coast Salmon Coalition
Del Boyer - Quinault Tribe
Hal Boynton
Bill Bradbury - For the Sake of the Salmon
Roger Braden - Mid-Columbia Conservation Program
Alex Bradley
Jim Brandy
William Brogley
Karl Brookins - Grays Harbor College
Jovana J Brown - Evergreen State College
Denise Brown - Northwest Indian Fisheries Commission
Denise Brown - Puyallup Tribe Fisheries Office
Scott Brummer - Lewis County Conservation District
Madeline Bryant
Linda Buck - Bainbridge Island Land Trust
Jared Burbidge - Stream Team Lacey
Beth Burman - Northwest Wilderness Programs
Joe Burton - Olympia Trout Unlimited
Jim Cahill
Jean Caldwell
Matt Campbell
Tom Campbell - Whidbey Audubon
Shawn Cantrell - Northwest Rivers Project - Friends of the Earth
Dan Carlson
Larry Carpenter
George Carr
Vince Carry - Pacific Seafood Products Association
Larry Cassidy
Tim Cathcart - Campbell Group
Claire Cdebaca - Nooksack Tribe Fisheries Office
Mark Cedergreen - Westport Charter Boat Association
Jeff Cederholm - Department of Natural Resources
Mike Chamberlin - Teds Sport Shop
Alan Chapman - Lummi Tribe Fisheries Office
Mark Chilcote - Oregon Department of Fish and Wildlife
Scott Chitwood - Quinault Tribe Fisheries
Kurt Christensen
Bill Clark
Gary Clark
Wendy Cole - Mt. Baker-Snoqulamie National Forest - Mt. Baker Ranger District
Kathleen Collins - Association of Washington Cities
Rhea Connors - Northwest Environmental Watch

Ed Conroy
Claribel Coronado
A Douglas Couvelier
Pat Crain - Lower Elwha S'klallam Tribe
Paul Crane - Boeing Company
Mike Cuenco
Eddy Cupp
Ned Currence - Makah Tribe Fisheries Management
Ken Davis - Washington Cattlemen's Association
Claire Debaca - Nooksack Tribe
Harold Deery - Willapa Hills Audubon
Mike Delarm - National Marine Fisheries Service
Larry Dennison - North Olympic Salmon Coalition
James Depew - Peninsula Neighborhood Association
Jack Deyonge
Jeff Dickison - Squaxin Island Tribe
Jerry Dierker
Doug Dippel
Ron Dockelman - R2 Resource Consultants
John Dodge - The Olympian
Ed Doran
Eric Doyle - University of Washington - School of Marine Affairs
John Drotts - Stillaguamish Tribe Fisheries Office
Pam Druliner
Judy Dudley - People for Puget Sound
Charles Dunning
Dan Dunphy
Ken Dyer - Drifters Salmon Club
Peter Dygert - National Marine Fisheries Service
Bob Eaton - Salmon for All
Tony Eldred
Peter Elich
Helen Engle
Mike Estes - Richland Rod and Gun Club
Lee Evenhuis - Squaxin Island Tribe
Colleen Fagan - Confederated Tribes of Warm Springs
Frank Faha
Jeff Feagin
Bruce Ferguson - The Federation of Fly Fishermen
Gabrielle Flannagan - Morrissett, Schlossser, Ayer & Jozwiack
Chris Foote - University of Washington - School of Fisheries
Sue Forker
Ed Forslof
Alix Foster
Gay Fournier
Mike Fraidenburg - Washington Fish & Wildlife Commission
Don Franett

Bill Frank Jr - Northwest Indian Fisheries Commission
Don Frannet
David Fraser
Mitch Friedman - Greater Ecosystem Alliance
Randy Frisvold
Don Frizzell
Rodney Fujita - Environmental Defense Fund
Fred Gaffney - Alaska Department of Fish and Game
Louis Gage
Sean Gallagher
Morrie Gatboy - Steelhead Trout Club
Merrie Gatcenil
Nick Gayeski
Ted Geise
Katherine Gerken
Larry Giese - Deep Sea Charters Inc.
Kirby Gilbert - EA Engineering
Eric Glover - Bureau of Reclamation
Sam Goddard
Terry D Goodman - Lincoln County Planning Department
Larry Goodrow - Spokane Tribe
John Gorman - Simpson Timber Company
Jerry Gorsline - Washington State Environmental Council
Mike Grady
Judy Graham - Washington Trollers Association
Gary Graves - Northwest Indian Fisheries Commission
Mike Grayum - Northwest Indian Fisheries Commission
Eugene Green Sr. - Confederated Tribes of Warm Springs
Liz Greenhagen - North Beach Environmental Coalition
Gail Greger - Stillaguamish Tribe
Christine Greszozuk - Kitsap Audubon
Kathy Grimes
Glenn Gross - Clark County Planning Division
Shari Gross
Elsa Gruber - Skagit Audubon
Richard Haberman - City of Forks
Paul Hage - Muckleshoot Tribe
Allan Hager - Department of Transportation
Robert Hamilton - Bureau of Reclamation
Pat Hamilton - Pacific County Commissioners
Dave Hamilton - Chehalis Basin Fish Task Force
Dave Hamilton - Elma Game Club
Elizabeth Hamilton - Yakama Nation
Dick Hansen
Pete Hanson - Neah Bay Recreation/Charter
Virgil Harder
Mary Pat Hardy

Bruce Harpham - Rainier Audubon Society
Polly Harris - The Nature Conservancy
Peter Hassemer - Idaho Department of Fish and Game
Jim Hastreiter
Gordon Haugen - United States Forest Service
Bob Hayman - Skagit System Coop
Jean Hays
Ray Heller
Dave Heller - United States Forest Service
Kevin Herrick - North Cascades Conserveration Council
William Hickey
Bill Hickey - Tacoma Poggie Club
Ray Hilborn -University of Washington - School of Fisheries
Judy Hildebrandt
Lew Holcomb - Trout Unlimited
Allan Hollingsworth - Grays Harbor Gillnetters
John Hollowed - Northwest Indian Fisheries Commission
Marvin & Sue Hoover - North Central Washington Audubon
Ray Horton - Oregon State University
Stacy Horton - Northwest Power Planning Council
Jay Huber - Washington Rivers Council
Kim Hubner
Chuck Huntington - Clearwater Biostudies
Dan Huppert - University of Washington - School of Marine Affairs
Gerry Isaacson - Fidalgo Fly Fishers
Ron Iverson - United States Fish and Wildlife Service
Alec Jackson
Gary James - Umatilla Indian Tribe
Paul James
Greg Jantzen
Joe Jauquet
Tom Jay
Norm B. Jelland
Jeff Jenkins
Amon Johnson - Middlebury College
Bob Johnson - Trout Unlimited
Dave Johnson
Eric Johnson - Washington Public Ports
Howard Johnson
J K Johnson
Judy Johnson - Blue Mountains Conservation Council
Kurt Johnson
Marc Johnson - Steamkeepers for Rock Creek
Marv Johnson
Orlay Johnson - National Marine Fisheries Service
Oscar Johnson
George Jolenson

Perry Jones
John Jordan
Jim Jorgensen - Hoh Tribe
Steve Kacas
Hiroeki Kakizawa - College of Forest Resources
John Karpinski - Clark County Natural Resource Council
Georgiana Kautz - Nisqually Indian Community
Holly Kean - East King County Regional Water Association
Maxine Keesling
Nancy Keith - Mountains to Sound Greenway Trust
Phil Kelley
John Kelly
Richard Kennon
Norm Keppler
Sieg Kiemle
Kip Killabrew - Stillaguamish Tribe Fisheries Office
Steve King - Oregon Department of Fish and Wildlife
Dan Kinney - Yakima Valley Audubon
Grant Kirby - Northwest Indian Fisheries Commission
George C. Kirkmire - Washington Contract Loggers Association
Ed Knight - Swinomish Tribal Community
Bill Koss - Department of Natural Resources
Gary Krein
Steve Kuchin - Puget Sound Gear Association
George Kushner - Washington State Divers Association
Keith Kutchins - Shoshone-Bannock Tribe
Wally Kydland - Olympia Salmon Club
Deanna Laird
Bob Lake
Jim Lamont
Nick Lampsakis - Point-No-Point Treaty Council
Glen Landry
Stephan Langer - Henderson Inlet Watershed Council
Ryan Langin
Steve Lanigan - Gifford Pinchot National Forest
John H Larsen Jr - Washington State University
Craig Larson
Joe Latourrette - Washington Wildlife Federation
Jeff Laufle
Terry Lavendar
Rick Leaumont
Eoffrey Lebon - Washington Trollers Association
Allen Lebovitz - Willapa Alliance
Ray Lebsack
Margaret & Emile Lecrampe - Olympic Peninsula Audubon
Jim Ledbetter
Richard Lee

Mary Leitka - Hoh Tribe
Katy Levenhagen - North Olympic Salmon Coalition
Hugh Lewis
Jim Lichatowich
Jeff Light - Weyerhauser Company
Evelyn Lindberg - Tracyton/Services Association
Tom Linde
Ian Lindsay
Barbara Lindsay - Northwest Sportfishing Industry Association
Duane Linkmeyer - Kitsap Poggie Club
Jim Lone
Matthew Longenbaugh - United States Fish and Wildlife Service
Lorraine Loomis - Swinomish Tribe
Dave Lopeman - Squaxin Island Tribe
Thomas Lufkin - Department of Ecology
Katherine Lynch - Seattle Water Department
Keith Macdonald
Mike Macelwich
Rod Mack - Department of Ecology
Mike Mackelwich - Central Washington University - Dept of Geography
Gary Macwilliams - Nooksack Tribe
Darlene Madenwald - Washington Environmental Council
Joseph Madrano
Walt O Malanz
Nancy Malmgren - Carkeek Watershed Community Action Project
Doreen Maloney - Upper Skagit Tribe
Mark Mandell
Jerry Marco - Colville Confederated Tribes
Kate Marsh - Hood Canal Salmon Enhancement Group
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John Martinis Jr. - Nsia
Tamara Massong - Weyerhaeuser Company
Steve Mathews - University of Washington - School of Fisheries
Mike Mattery
James Mauney - Nez Perce Tribe
Glen Maxim - Pope Resources
Bob Mc Laughlin
Don Mc Issac - Oregon Department of Fish and Wildlife
Ron Mcafee
Jim Mcafee
Peter Mcallister - South Vancouver Island Audubon
Clyde Mcbrayer
Dean Mcclary
Mike Mccrary
Ken Mcdonald - United State Fish and Wildlife Service - Wenatchee National Forest
Mike Mcginnis - Chehalis Tribe
Mike Mchenry - Lower Elwha S'Klallam Tribe

Brian Mclachlin
Jack Mcllellan
Bill Mcmillan
Tim Mcnulty - Olympic Park Association
Mike Mcrory
Steve Meadows - Quileute Tribe
John Means - South Sound Fly Fishers
Bob Meier - Rayonier
Arnold C Melbust
Bill Melton - Thurston Conservation District
Raymond Menard
Elliot Menashe - Greenbelt Consulting
Mandy Merklein - Pacific States Marine Fisheries Commission
Rod Meseberg - Central Washington Fish Advisory Commission
John Meyer - Olympic National Park
Steve Meyer - State Conservation Commission
Phyllis Meyers - Suquamish Tribe
Gene Meyers
Deborah Michel - Wild Olympic Salmon
Dave Michener
Dan Miller - Steelhead Trout Club
Glen Miller
Larabee Miller
Phil Miller - Department of Ecology
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Joan Miniken - Nisqually Tribe Fisheries
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Chris Mohr
Lloyd Moody - Governors Office
Mel Moon - Quileute Tribe
Dave Moore
Brenden Moorehead - United States Army Corps of Engineers
Lanny Morgan - Wildcat Steelheaders
Gary Morishima - Quinault Nation
Carol Morris
Tom O Morrison - Watershed Dynamics Inc.
John Myers
Robert Naiman - University of Washington - Center for Streamside Studies
Willa Nehlsen - Pacific Rivers Council
Bob Nelson - Holiday Market
Joy Nelson - Vashon Maury Island Audubon
Sandy Nelson - Northwest Rivers Council
Tom Nickleson - Oregon Department of Fish and Wildlife
Sandra Noble - United States Fish and Wildlife Service
John Noe
Lori Noll - San Juan Islands Audubon
George Nowadnick

Darryll Olsen - Pacific Northwest Project
Barry Olson - United States Forest Service
Jerry Opatz - United States Fish and Wildlife Service
George Orr
Jack Orsborn
Jim Owens
Nick Page
John Palisano
Paul Parker - Washington State Association of Counties
Steve Parker - Yakama Indian Nation
Chris Parsons - Black Hills Audubon
Jeff Parsons - People for Puget Sound
Jeff Parsons - Audubon Society
Mike Parton - United States Forest Service - Olympic National Forest
Scott Pascoe
Gil Pauley - University of Washington - School of Fisheries
Kit Paulsen - City of Bellevue
George Pess
Jack Petrie
Dan Pfeiffer
Bonnie Phillips-Howard - Pilchuck Audubon
Lloyd Phinney
Jim Pickrell
Ellen Pikitch - University of Washington - School of Fisheries
Lanny Pillatos - Puget Sound Gillnetters Association
Marvin Plenart - United States Fish and Wildlife Service
Alan Poobus
Randy Prince
Ellouise Pritchett - Water Tenders
William Quaade
Thomas P Quinn - University of Washington - School of Fisheries
Charles Raines
Buzz Ramsey
Martin Rand - White River Forest Management Committee
Katherine P Ransel - American Rivers
Kit Rawson - The Tulalip Tribe
Bob Reid - Friends of the Cowlitz
Reg Reisenbichler - United States Fish and Wildlife Service
David Renstrom - City of Federal Way
Richard Rhine
Paul Rickman
Dan Rieff
Brian Riordan
John Ritter - Vancouver Wildlife League
Dick Rivers - Spokane Audubon
Dan Roberts
Bill Robinson - National Marine Fisheries Service

Dennis Rohr - Mid-Columbia PUD
Phil Roni
Julia Rosander
Leslie Ann Rose
Kevin Rose - North Olympia Ancient Forest Council
Tim Roth - United States Fish and Wildlife Service
Rochelle Rothallis - Budd/Deschutes Project Green
Terry Rudnick
Ian Russell
Larry Rutter - Northwest Indian Fisheries Commission
Leslie Ryan - Citizens for a Healthy Bay
Mike Ryherd
Bruce Samuelson
Burt Sarver
Ron Sawyer
John Sayre - Long Live the Kings
Wendy Scherrer - North Cascades Institute
Hal Schlomann - Northwest Marine Trade Association
Al Schmauder - Clover Creek Council
John Schmidt
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J Pete Schroeder
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Jennifer Sepez
Bill Shake - United States Fish and Wildlife Service
Ken Shawcroft - Hansville Open Space Committee
Bob Sheffels
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Curt Smitch - United States Fish and Wildlife Service
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Al Smith
Cathy Smith
Cha Smith - Washington Toxics Coalition
Lorna Smith
Sam Smith - Fisherman's News
Stephen Smith -Bonneville Power Administration
Larry Snyder - Southwest Washington Anglers
Dave Sones - Makah Tribe Fisheries Office
Pete Soverel
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Don Splinter
Sallie Sprague
Gretchen Starke - Vancouver Audubon
Nancy Staub - Gonzaga University
Tim Stearns - Save Our Wild Salmon
Terald Steel - Friends of Skagit County
Carl Stein - United States Forest Service
Chantal Stevens - Muckleshoot Tribe
David Stevens
Cleve Steward - Sustainable Fisheries Foundation
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Bob Sumerland - Washington Farm Forest Association
Billie Sumrall - Grant County Planning Department
Maureen Sunn - East Lake Audubon
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Joseph Testu - Hood Canal Land Trust
Dick Thompson
Julie Thompson - Washington Forest Protection Association
Richard Thompson
Walt Thompson
Adam Thornbrough - Palouse Clearwater Environmental Institute
Sylvia Thorpe
Ron Tingley - Wildcat Steelhead Club

Isabel Tinoco - Muckleshoot Tribe
John Titland
William Towey - Kalispel Tribe
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Susan Treu - Palouse Audubon
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David Troutt - Nisqually Tribe Fisheries
Doug Tuffley
Paul Turcott
Rich Turner - Pacific Northwest Utilities
Judy Turpin - Washington Environmental Council
Judith Turpin - TMT Associates
Chuck Tyler - Tacoma Sportsmen Club
Frank Urabeck
Jerry Van Meter - United States Fish and Wildlife Service
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Bob Vreeland - Pacific Salmon Commission
Harry Wagner - Northwest Power Planning Council
Johnny Walker - Washington State Sports Council
Dick Wallace - Department of Ecology
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Phil Wampler - United States Fish and Wildlife Service
Robin Waples - National Marine Fisheries Service
Lowell W Warren
Ross Warren - Puget Sound Anglers State Board
Steve Watrous
Sandi Weaver - Wearth Community Group
Jim Weber
Reid Wheeler
Jean White
Bill White - Department of Community Development
Dennis White - Columbia Gorge Audubon
Ray White - Trout Habitat Specialists
Andy Whitener - Squaxin Island Tribe
Herbert Whitish - Shoalwater Bay Tribe
Steve Whitney - Ness Society
Jim Wilcox - Washington State Council Trout Unlimited
Bruce Williams - Port Gamble Klallam Tribe
Larry Williams - North Cascades Audubon

Eileen Wirkkala
Veronica Wisniewski
John Wonther
J Woodring - Washington Association of Realtors
Gene Woodwick - Information Services
Randy Woolsey
David Wright
Jim Wright - University of Washington
Steven Wright
Terry Wright - Northwest Indian Fisheries Commission
Wayne Wright - Fish Pro Inc.
Jacqueline Wyland - National Marine Fisheries Service
Vern Young - Washington Council Federation of Fly Fishers
Greg Zetner
Ken Ziebart - Department of Ecology
Vern Ziegler
Debie Zike- Riddell Williams
Rob Zuanich - Purse Seine Vessel Owners Association

Alternative

Summary

Matrix

	Current Approach - Alternative 1	Alternative 2
Spawner Abundance		
• Level	MSY is the intent for <u>primary</u> populations. No specific management intent for other populations.	Full utilization of habitat.
• Unit	Varies with species and location (stocks, management units, statewide)	Stocks
• What Counts?	Varies by species (salmon - all spawners, steelhead - wild fish only)	Fish whose parents spawned in the wild or hatchery fish that are part of a formal supplementation program.
• Accountability	Nothing formal	If stock fails to meet desired level three consecutive years or ≤80% for five year average, develop a plan and take all necessary steps.
• Monitoring	Nothing formalized	Every stock, every two years
Genetic Conservation		
• Minimum abundance for stocks	Nothing formal	Greater of 3,000 fish base up to full habitat utilization.
• Gene flow (human caused): between species within MALs, GDUs between stocks within GDU allowable percent of total spawners that are hatchery fish (non-supplementation cases) definition of similarity	Transfer guidelines for salmon. Nothing formal for steelhead and resident salmonids. Nothing formal Nothing formal	No gene flow allowable. ≤1%, ≤5%, ≤10% (low, medium, high similarity) Strict
• Fishery Selectivity	Nothing formal	Manage fishery selectivity to maintain population characteristics similar to wild unfished populations.
Harvest Management	Manage primarily in response to spawner abundance goals. Varies by species and location. Harvest management will meet treaty requirements for sharing of harvest opportunity.	Manage harvest to meet whatever spawner abundance and genetic conservation elements are chosen. Harvest will be managed in response to annual fluctuations in abundance of salmonid populations. Same

Alternative 3	Alternative 4	Alternative 5
Abundant utilization of habitat. Maintain or increase number of stocks, diversity, ecological processes. Where possible, provide surplus production for harvest and other benefits. **The starting point is a best point estimate of MSY but two buffers must be added to account for risk to the resource due to (1) uncertainty in parameters of population dynamics and (2) a manager's ability to deliver fish to the spawning grounds. A manager can default to an alternative strategy if it is clearly more conservative (less risk to the resource) than the MSY approach.** **Wild fish release for resident fish unless other approaches can be shown to maintain high abundance.**	Perpetuate each stock (maintain above level that provides <u>high probability of long-term survival</u>. Similar to the Minimum Sustainable Escapement from the National Research Council Report. Manage the MUs at spawner abundance levels that maximize the long-term harvest from the wild fish. Consider escapement needs to maintain ecosystem health.	Perpetuate each stock (maintain above level of <u>immediate risk</u> of permanent harm). Manage MUs for spawner abundance levels that maximize the long-term harvest levels from the wild fish; except where greater overall long-term benefits from the salmonid resource within the MU can be obtained by managing for a different objective.
Stocks	Management Units - fine scale	Management Units - greater aggregation
Fish whose parents spawned in the wild or hatchery fish that are part of a formal supplementation program.	Fish whose parents spawned in the wild or hatchery fish that are part of a formal supplementation program.	All spawners in the wild.
If stock fails to meet desired level three consecutive years or ≤80% for five year average, develop a plan and take all necessary steps.	If stock fails to meet desired level three consecutive years for MU or ≤80% for five year average, develop a plan and take all necessary steps.	If stock not meeting goal for MU ≤80% for five year average, develop a plan and take all necessary steps.
Every stock, every two years. Surrogate measures and index stocks may be used.	Every stock, every five years. Surrogate measures and index stocks may be used.	Every stock, every five years. Surrogate measures and index stocks may be used.
Greater of 3,000 fish base or abundant utilization of habitat.	2,000 fish base or level of long-term survival.	2,000 fish base or level of no <u>immediate</u> risk of permanent harm to the population.
No gene flow allowable. **≤1%, ≤5%, ≤10% (low, medium, high similarity)** **Strict**	No gene flow allowable. ≤1%, ≤5%, ≤10% (low, medium, high similarity) Strict	Gene flow should not result in genetic extinction or any loss of life history forms. 5-50% threshold to determine high priority of assessment for action (non-native stock origin - native stock origin). Moderate
Manage fishery selectivity to maintain Pacific salmon population characteristics similar to wild unfished populations. For other salmonids, prevent any significant shift to sexual maturity at a smaller size and/or age.	Manage fishery selectivity to maintain genetic variation in population characteristics for distributions similar to wild unfished populations.	Manage fishery selectivity to maintain genetic variation in population characteristics for distributions similar to wild unfished populations.
Same as Alternative 2 except for second buffer described above (spawning ground delivery).	Same as Alternative 2.	Same as Alternative 2.

	Alternative 1	Alternative 2
• Incidental harvests (limits to harvest of a population when it is below the desired spawner abundance level)	Varies by species and location	$\leq$5% of the Washington stock abundance in Washington fisheries.
• Selective fisheries	Nothing formal - technique is commonly used.	Non-treaty fishery priority will be given to those fisheries that can minimize their impacts on the weak stocks either by using gears that can selectively capture and release stocks with minimal mortality, or avoiding impacts by eliminating encounters with weak populations (e.g., proven time, area, and/or gear restrictions).
Ecological Interactions	Nothing formal	Maintain or restore diverse, abundant wild salmonid stocks at levels that naturally sustain ecosystem processes and diverse indigenous species and their habitats. Maintain healthy populations of indigenous species within levels that sustain or promote abundant wild salmonid populations and their habitats. Control the numbers, varieties and distribution of non-indigenous species or stocks that compete with, prey on, or parasitize salmonids and other indigenous species <u>to avoid negative impacts.</u> Hatchery or other enhancement programs, either individually or when evaluated on a whole watershed basis, <u>shall avoid negative impacts</u> due to predation or competition on the health and abundance of wild salmonid or other indigenous populations.
Cultured Productions/Hatcheries	Varies by species and management criteria for population. Meet criteria in *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State*.	Meet criteria under whatever genetic conservation and ecological interactions options are chosen. Same Hatchery programs will only be used where they can be expected to have a high probability of avoiding negative impacts to wild populations. Each hatchery program will be based on a complete operational plan that describes the specific operational components, measures to control risk, monitoring and evaluation, and performance audits.
• Supplementation	Nothing formal	Only where stock is well below desired levels and cannot rebuild itself or is being reintroduced, and the risks of potential stock loss through extinction are greater than the genetic risks due to gene flow and the supplementation process.
• Gene Banking	Nothing formal	Only where the natural environment cannot sustain a population, and until these factors can be corrected.

Alternative 3	Alternative 4	Alternative 5
≤10% of the Washington stock abundance in Washington fisheries.	≤10% of the Washington management unit abundance in Washington fisheries.	Determined on a case-by-case basis.
Same	Same	Selective fisheries are a tool that can be used as necessary to provide greater harvest opportunity.
Same **Same** **Control the numbers, varieties and distribution on non-indigenous species or stocks that compete with, prey on, or parasitize salmonids and other indigenous species <u>to have no significant negative impacts.</u>** **Hatchery or other enhancement programs, either individually or when evaluated on a whole watershed basis, shall <u>have no significant negative impacts</u> due to predation or competition on the health and abundance of wild salmonid or other indigenous populations.**	Same Same Same Same	Same Same Limit introductions or populations of non-indigenous species if ecological problems are demonstrated through monitoring and evaluation. Limit or control hatchery production if ecological problems are demonstrated through monitoring and evaluation.
Same **Same** **Hatchery programs will only be used where they have high probability of having no significant negative impacts on wild populations.** **Same** **All hatchery-origin anadromous salmonids shall be adipose-marked except for certain exemptions made on a case-by-case basis.**	Same Same Same Same	Same Same Hatchery programs will not cause loss of important wild populations. Same
Same, except that supplementation may be an appropriate tool for rebuilding locally adapted stocks in areas where past harvest management and hatchery objectives have significantly impacted diversity and abundance. Some exceptions may also be made for use in mitigation programs if sustainable habitat capacity is limited	Same, except that hatchery broodstocks can also be used to augment seeding or population abundance limited by environmental constraints or overfishing, consistent with gene flow constraints.	Desired outcome of all hatchery programs using locally collected broodstock.
Same	Same	Same

	Alternative 1 Current Approaches	Alternative 2 Regulatory Emphasis	**Alternative 3 Watershed Emphasis**	Alternative 4 Regulatory Emphasis	Alternative 5 Operating Principles
HABITAT					
Implementation Approach	Existing WDFW habitat policies and regulatory and proprietary authority. MOUs with various tribes, federal, state and local agencies. Other federal, state, local and tribal proprietary and regulatory authority.	State-prescribed performance standards. Action strategies with emphasis on locally-based watershed planning, regulatory presence clearly included.	**Performance measures. Action strategies with clear emphasis on locally-based watershed planning, regulatory default implied.**	Performance standards. Action strategies with blend of locally-based watershed planning and clearly defined regulatory defaults.	Narrative habitat sub-goals and performance measures. Representative action strategies. Locally based implementation planning coupled with some state-level regulatory changes (e.g., TFW process).
Performance Standards/Measures	Occur in an incomplete and uncoordinated fashion in existing laws, regulations, policies, procedures and publications.	Mixture of quantitative and narrative standards, including specific riparian/wetland buffer standards, fish passage and screening survival standards, etc. Generally inflexible to modification.	**Stated as "best available science." Mixture of quantitative and narrative standards, including specific riparian/wetland buffer standards, fish passage and screening survival standards, etc. Flexibility to modify at local level.**	Stated as "best available science." Mixture of quantitative and narrative standards, including specific riparian/wetland buffer standards, fish passage and screening survival standards, etc. Fairly inflexible to modification at local level.	Narrative life history and habitat requirements within WSP.
Determination of Desired Future Considerations	Variety of negotiating forums. No agreement.	Fish and Wildlife Commission	**Watershed planning groups.**	Local watershed planning groups, Fish and Wildlife Commission.	Watershed planning groups, state agencies.
Action Strategies	Occur in an incomplete and uncoordinated fashion in existing laws, regulations, policies, procedures, publications, and plans. Variety of local planning and coordination efforts beginning.	Presented as actions which will be taken. Inflexible to modification.	**Suggested as tools to achieve measures, but more flexible regarding local innovation. Suggests review/revision of most environmental statutes to benefit salmonids.**	Stated as what needs to occur. Somewhat inflexible regarding local modification. More stress on enforcement of existing regulations and on the need for additional specific legislation/rule making.	Presented as representative actions to be considered. Relies on local planning for most action strategies. Statewide collaborative processes for some issues.