Salmon Anchor Habitats in Tillamook and Clatsop State Forests, Oregon: Science, Policy, Economics

An Annotated Bibliography

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OVERVIEW

This annotated bibliography was prepared for the Salmon Anchor Habitat Work Group. This group was formed by the Oregon Department of Forestry to review and evaluate the Salmon Anchor Habitat Strategy as directed by the 2003 Oregon Legislature. The Salmon Anchor Habitat Strategy is a component of management plans developed by the Oregon Department of Forestry for the Tillamook and Clatsop State Forests in northwestern Oregon.

The references in this bibliography are grouped according to the categories of questions raised by the Salmon Anchor Habitat Work Group:

NOTE CONCERNING THE ANNOTATIONS

There 2 kinds of material in the annotations in this bibliography:

1. Material that appears inside quotation marks was quoted or paraphrased directly from the reference.

2. Material that does not appear inside quotation marks was written by the bibliography preparer

Some of the annotations contain both types of material.

SALMONID STATUS, SCIENCE, PROTECTION, RECOVERY

Amend, D. F., J. Lannan, et al. (2001). The role of hatcheries in Pacific salmon management, Oregonians in Action.

Full text available online at:
http://www.propertyrightsresearch.org/role_o.htm

Position paper sponsored by Oregonians in Action, a private property rights advocacy group. Written by three retired Ph.d fisheries biologists. Argues in favor of using hatcheries to supplement salmonid stocks.

Beechie, T. and S. Bolton (1999). A brief guide to restoring salmonid habitat-forming processes in Pacific Northwest Watersheds. Seattle, WA, University of Washington College of Forest Resources.

Full text available online at:
http://www.cfr.washington.edu/Research/fact_sheets/13-CSS-Restore.pdf

2-page summary of recommendations that concentrate on diagnosing and treating the causes of habitat degradation rather than the symptoms. Authors note that traditional approaches to restoration have focused on creating specific habitat conditions rather than on restoring the processes that create and sustain salmonid habitat.

Beechie, T. and S. Bolton (1999). An approach to restoring salmonid habitat-forming processes in Pacific Northwest watersheds. Fisheries 24 (4): 6–15.

Full text available online at:
http://afs.allenpress.com/afsonline/?request=get-abstract&issn=0363-2415&volume=024&issue=04&page=0006

"We present an approach to diagnosing salmonid habitat degradation and restoring habitat-forming processes that is focused on causes of habitat degradation rather than on effects of degradation. The approach is based on the understanding that salmonid stocks are adapted to local freshwater conditions and that their environments are naturally temporally dynamic.

In this context, we define a goal of restoring the natural rates and magnitudes of habitat-forming processes, and we allow for locally defined restoration priorities. The goal requires that historical reconstruction focus on diagnosing disruptions to processes rather than conditions. Historical reconstruction defines the suite of restoration tasks, which then may be prioritized based on local biological objectives.

We illustrate the use of this approach for two habitat-forming processes: sediment supply and

stream shading. We also briefly contrast this approach to several others that may be used as components of a restoration strategy."

Bisbal, G., ed. (1999). Symposium on ocean conditions and the management of Columbia River salmon. Portland, OR, July 1, 1999. Sponsored by Northwest Power Planning Council.

Full text available online at:
http://www.nwppc.org/library/ocean/Default.htm

Series of presented papers on relationships between ocean conditions, freshwater habitat and salmonid populations. Titles of papers presented (each is available on the website):

1. Consideration of ocean conditions in the management of salmon
2. Long-term climate and ocean trends and salmon populations in the Pacific Northwest
3. Role of the Columbia River estuary and plume in salmon productivity
4. Climate, salmon, and preparing for the future
5. Managing for salmon as if the ocean mattered
6. Changes in size at maturity of salmon before and after the ocean regime change of 1976-77: management implications
7. Ocean variability and population diversity - a match made in heaven

Bisson, P. A., R. E. Bilby, et al. (1987). Large woody debris in forested streams in the Pacific Northwest: past, present and future. In Streamside Management, Forestry and Fisheries Interaction. Contribution 57. E. O. Salo and T. W. Cundy, eds. Seattle, WA, University of Washington, Institute of Forest Resources**:** 143-190.

Bisson, P. A., T. P. Quinn, et al. (1992). Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. In Watershed management: Balancing sustainability and environmental change. R. J. Naiman, ed. New York, Springer-Verlag**:** 189-232.

Bisson, P. A., G. H. Reeves, et al. (1997). Watershed management and Pacific salmon: desired future conditions. In Pacific salmon and their ecosystems: Status and future options. D. J. Stouder, P. A. Bisson and R. J. Naiman, eds. New York, Chapman and Hall**:** 447-474.

Bisson, P., C. Coutant, et al. (2002). Hatchery surpluses in the Pacific Northwest. Fisheries 27(12): 16-27.Article by members of the American Fisheries Society Independent Scientific Advisory Board.

"Chinook salmon (Oncorhynchus tshawytscha), hatchery-reared as juveniles, returned to the upper Columbia River Basin in numbers exceeding broodstock and fishery needs during the spring

of 2000. Plans to euthanize these adults were opposed by some regional stakeholders, who preferred letting them spawn naturally in streams also used by endangered spring-run chinook salmon.

The National Marine Fisheries Service requested that the Independent Scientific Advisory Board review the scientific literature and conclude whether it was biologically sound to permit hatchery-origin adult salmon to spawn in the wild in large numbers. Substantial experimental evidence demonstrates that domestication selection can genetically alter hatchery populations in a few generations and that hatchery-origin adults returning from the ocean and spawning in the wild produce fewer progeny than adults of wild origin spawning in the wild. More limited evidence suggests that interbreeding between hatchery-origin adults and wild fish can reduce the fitness of the wild population.

We conclude that decisions whether or not to permit hatchery-origin adults to spawn in the wild should be based on the needs of wild populations and the ability of the habitat to support additional reproduction, not based simply on the availability of hatchery-origin adults returning from the ocean."

Botkin, D., K. Cummins, et al. (1995). Status and future of salmon of western Oregon and northern California: findings and options. Santa Barbara, CA: The Center for the Study of the Environment.

Bradbury, B., W. Nehlsen, et al. (1995). Handbook for prioritizing watershed protection and restoration to aid recovery of native salmon. Portland OR, Pacific Rivers Council.

Full text available online at:
http://www.krisweb.com/biblio/gen_xxxx_bradburyetal_1995.pdf

Process initiated by then Senator Bill Bradbury in conjunction with Pacific Rivers Council.

"Brought together multi-disciplinary scientific experts to systematically identify areas and activities that can best protect and restore salmon and their watersheds. Objectives were 1) identify restoration activities for immediate implementation, where limited public funds are available and there is a need to quickly identify activities that may have a high certainty of effectiveness, and 2) provide the basis for protection and restoration strategies that may be implemented over longer time periods.

The handbook is intended to be used by watershed councils or other groups of interested citizens, and by federal, state, tribal and local natural resource managers."

Chilcote, M. W. (2003). Relationship between natural productivity and the frequency of wild fish in mixed spawning populations of wild and hatchery steelhead (Oncorhynchus mykiss). Canadian Journal of Fisheries and Aquatic Sciences 60(9): 1057-1067.

Full text available online at:
http://article.pubs.nrc-nrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfas&volume=60&calyLang=eng&articleFile=f03-092.pdf

From the abstract: "For natural populations [of steelhead] removal rather than addition of hatchery fish may be the most effective strategy to improve productivity and resilience."

From the conclusion: "The primary finding of this study was the apparent relationship between productivity and the proportion of wild fish in the spawning population. It is possible that this relationship was an outcome of naturally spawning hatchery fish having lower reproductive success than wild fish. Presumably, if hatchery fish had lower reproductive success, they would produce fewer recruits per spawner than wild fish. Therefore, adding hatchery fish to a natural spawning population would be expected to cause overall productivity, as defined in this study, to decline. Lower reproductive success for naturally spawning hatchery steelhead has been documented in several other studies.

However, it is also possible that this study's primary finding was the product of adverse ecological interactions between hatchery and wild fish and not differential reproductive success. Hatchery programs, in some unknown manner, may have been ecologically detrimental to the survival and recruitment of wild fish. This would have a depressing effect on overall population's productivity. It was beyond the scope of this study, partially because of the retrospective nature of its design, to resolve the question of ecological vs. reproductive mechanisms with respect to the observed relationship between productivity and the proportion of wild fish in the spawning population."

Full abstract: "The proportion of wild fish in 12 mixed populations of hatchery and wild steelhead (Oncorhynchus mykiss) was evaluated for its relationship to mean and intrinsic measures of population productivity. The population mean of ln(recruits/spawner) was used to represent mean productivity. Intrinsic productivity was represented by values for the Ricker a parameter as estimated from fits of spawner and recruit data. Significant regressions ($p < 0.001$) were found between both measures of productivity and the proportion of wild fish in the spawning population (Pw). The slopes of the two regressions were not significantly different ($p=0.55$) and defined a relationship suggesting that a spawning population comprised of equal numbers of hatchery and wild fish would produce 63% fewer recruits per spawner than one comprised entirely of wild fish. Study findings were not sensitive to likely levels of data error or confounded by extraneous habitat correlation with Pw. Population status assessments and conservation monitoring efforts should include Pw as a critical variable. For natural populations, removal rather than addition of hatchery fish may be the most effective strategy to improve productivity and resilience."

Cooper, A. B. and M. Mangel (1999). The dangers of ignoring metapopulation structure for the conservation of salmonids. Fishery Bulletin 97: 213-226.

Full text available online at:
http://fishbull.noaa.gov/01cooper.pdf

"Because of their tendency to return to natal streams, salmonid populations have often been viewed in ecological isolation, although the notion of an evolutionarily significant unit (ESU) recognizes dispersal on evolutionary timescales. We investigated the consequences of dispersal (straying) on an ecological timescale where straying creates a metapopulation structure for salmonid streams within an ESU. We developed a simple model for salmonid metapopulations, focusing on source and sink populations, and used the model to highlight the dangers of ignoring this structure in conservation efforts. We show that exactly the wrong conservation efforts may occur if metapopulation structure exists but is ignored."

Connolly, P. J. and J. D. Hall. (1999). Biomass of coastal cutthroat trout in unlogged and previously clearcut basins in the central coast range of Oregon. Transactions of the American Fisheries Society 128 (5): 890–899.

"Populations of coastal cutthroat trout Oncorhynchus clarki clarki were sampled in 16 Oregon headwater streams during 1991–1993. These streams were above upstream migration barriers and distributed among basins that had been logged 20–30 and 40–60 years ago and basins that had not been logged but had burned 125–150 years ago. The objective of our study was to characterize the populations and habitats of age-1 or older cutthroat trout within these three forest management types. Streams within unlogged basins had relatively low levels and a small range of trout biomass (g/m2). Streams in basins logged 40–60 years ago supported low levels but an intermediate range of trout biomass. Streams in basins logged 20–30 years ago supported the widest range of biomass, including the lowest and highest biomasses among all streams sampled.

The variable that best explained the variation of trout biomass among all 16 streams was the amount of large woody debris (LWD). All streams were heavily shaded during at least part of the year by mostly closed tree canopies. Deciduous trees were more prominent in canopies over streams in logged basins, while conifers were more prominent in the stream canopies of unlogged basins. Our results suggest that trout production in basins extensively clear-cut 20–60 years ago may generally decrease or remain low over the next 50 or more years because of decreasing loads of remnant LWD, persistent low recruitment potential for new LWD, and persistent heavy shading by conifers. These logged basins are not likely to show an increase in trout biomass over the next 50 years unless reset by favorable natural disturbances or by habitat restoration efforts."

Dewberry, C. (2003). Development and application of anchor habitat approaches to salmon conservation: A synthesis of observations from the Siuslaw watershed, coastal Oregon.

INR archive. *DRAFT unpublished manuscript.*

Duncan, S. (2001). Food for fish, food for thought: managing the invisible components of streams. Science Findings (32): 1-5. PNW Research Station, USDA Forest Service, Portland, OR.

Full text available online at:
http://www.fs.fed.us/pnw/sciencef/scifi32.pdf

"Over the years, scientists have published many results from studies about the importance of habitat such as woody debris for supporting fish populations. They also have learned much about the ways in which land management activities can enhance or degrade such habitat. They know much less, however, about the food half of this food-and-shelter equation.

In the nutrient-poor streams of Alaska, the mystery of how those streams are so productive of salmon is beginning to be solved by investigating the nutritional links between organisms and among ecosystems--many of which are nearly invisible. Crucial roles are played by seemingly fishless headwater streams, riparian vegetation along fish-bearing streams, and nutrients delivered from the ocean from salmon for stream productivity in Alaska.

The unseen connections of this vastly dispersed food web have significant implications for management and restoration activities that managers are beginning to recognize."

Ebersole, J. L., W. J. Liss, et al. (2003). Thermal heterogeneity, stream channel morphology, and salmonid abundance in northeastern Oregon streams. Canadian Journal of Fisheries and Aquatic Sciences 60 (10): 1266-1280.

"Heterogeneity in stream water temperatures created by local influx of cooler subsurface waters into geomorphically complex stream channels was associated with increased abundance of rainbow trout (Oncorhynchus mykiss) and chinook salmon (Oncorhynchus tshawytscha) in northeastern Oregon. The addition of cold water patch frequency and area as explanatory variables in salmonid habitat models indicated that doubling of cold water patch frequency was associated with increases in rainbow trout and chinook salmon abundances of 31% and 59%, respectively.

Doubling of cold water patch area was associated with changes of 10% in rainbow trout abundance but was not associated with chinook abundance after accounting for other habitat factors. The physiognomy, distribution, and connectivity of cold water patches, important attributes determining the effectiveness of these habitats as thermal refuges for stream fishes, were associated with channel bedform and riparian features. Monitoring of thermal heterogeneity and salmonid populations in response to ongoing habitat restoration efforts will provide additional insights into causal relationships among these factors."

Ecotrust, Oregon Trout., et al. (2001). A Salmon Anchor Habitat Strategy for the Tillamook and Clatsop State Forests. Portland, OR, Ecotrust, Oregon Trout, Wild Salmon Center**:** 27 plus appendices.

Full text available online at:
http://www.inforain.org/mapsatwork/anchorhabitats/

Proposal to designate a system of anchor habitats for salmon in Northwest Oregon state forests.

Emmett, R. L. and M. H. Schiewe (1996). Estuarine and ocean survival of northeastern Pacific salmon: Proceedings of the workshop. Seattle WA, National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division. 313 pages.

Full text available online at:
http://www.nwfsc.noaa.gov/publications/techmemos/tm29/index.html
(Brief presented papers are downloadable as individual files.)

Paraphrased from preface: "Northwest salmon populations have continued to decline, with 'poor' ocean conditions often being acknowledged as playing some ill-defined role. In an effort to highlight the importance of estuarine and oceanic residency to salmon survival and year-class strength, a 1996 workshop brought together scientists whose research addresses some aspect of this important issue."

Workshop in Newport, Oregon consisted of 25 presentations, organized in the following six sessions:

1) selected aspects of salmonid life histories
2) interannual variations in Northeast Pacific marine habitats and the effects on marine survival of salmonids
3) decadal variations in Northeast Pacific marine habitats and the effects on marine survival of salmonids
4) processes and mechanisms in estuarine habitats
5) processes and mechanisms in nearshore coastal habitats
6) processes and mechanisms in offshore marine habitats

Feist, B. E., E. A. Steel, G. R Pess, R. E. Bilby. (2003). The influence of scale on salmon habitat restoration priorities. Animal Conservation 6 (3) 271-282.

"Habitat loss and alteration is the leading cause of species' declines world-wide, therefore habitat restoration and protection is a prominent conservation strategy. Despite obvious connections between habitat and threatened or endangered species, conservationists have been hard pressed explicitly to link abundance or population health with habitat attributes. Given that habitat relationships with species are often characterized at a spatial scale that does not account for the functional relationships between habitat and populations, it is not surprising that the habitat-population conundrum persists.

In order to explore the influence of spatial scale on the apparent relationship between habitat and populations, we examined the relationship between GIS-based habitat data and spring/summer chinook salmon (Oncorhynchus tshawytscha) redd (spawning nests built by females) densities in the Salmon River basin, Idaho, at two very different spatial scales: stream reach and watershed. Redd density was strongly correlated with climate, geology, wetlands and terrain.

However, our stream-reach scale models provided poor predictive power compared with the watershed scale models. Based on these results, we conclude that our perception of which habitat

attributes were important was clearly a function of our scale of observation, and that restoration efforts should focus on conditions at the watershed or landscape scale when attempting to do local or reach scale restoration projects."

Flagg, T. and C. Nash (1999). A Conceptual Framework For Conservation Hatchery Strategies for Pacific Salmonids, U.S. Dept. of Commerce, NOAA Fisheries. NOAA Tech. Memo. NMFS-NWFSC-38**:** 46 pages.

Full text available online at:
http://www.nwfsc.noaa.gov/publications/techmemos/tm38/tm38.htm

"This technical memorandum presents a conceptual framework of production strategies which can be applied in conservation hatcheries to produce fish with the wild-like attributes necessary for rebuilding depleted stocks. The background of this document is the goal of rebuilding the endangered salmon stocks of the Columbia River Basin, but the framework can be applied equally for rebuilding or improving any endangered stock."

Hanski, I. and M.E. Gilpin (1991). Metapopulation dynamics: brief history and conceptual domain. Biological Journal of the Linnean Society 42: 3-16.

Hanski, I. (1991). Single species metapopulation dynamics: concepts, models and observations. In Metapopulation dynamics. M. E. Gilpin and I. Hanski, eds. London, Academic Press. 42: 17-38.

Hanski, I. (1994). A practical model of metapopulation dynamics. Journal of Animal Ecology 63(1): 151-162.

Hanski, I. (1998). Metapopulation dynamics. Nature 396: 41-49.

Full text available online at:
http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v396/n6706/full/396041a0_fs.html

"Metapopulation biology is concerned with the dynamic consequences of migration among local populations and the conditions of regional persistence of species with unstable local populations. Well established effects of habitat patch area and isolation on migration, colonization and population extinction have now become integrated with classic metapopulation dynamics. This has led to models that can be used to predict the movement patterns of individuals, the dynamics of species, and the distributional patterns in multispecies communities in real fragmented landscapes."

Hanski, I. and O. Ovaskainen (2000). The metapopulation capacity of a fragmented landscape. Nature 404: 755-758.

"Ecologists and conservation biologists have used many measures of landscape structure to predict the population dynamic consequences of habitat loss and fragmentation, but these measures are not well justified by population dynamic theory. Here we introduce a new measure for highly fragmented landscapes, termed the metapopulation capacity, which is rigorously derived from metapopulation theory and can easily be applied to real networks of habitat fragments with known areas and connectivities. Technically, metapopulation capacity is the leading eigenvalue of an appropriate 'landscape' matrix. A species is predicted to persist in a landscape if the metapopulation capacity of that landscape is greater than a threshold value determined by the properties of the species. Therefore, metapopulation capacity can conveniently be used to rank different landscapes in terms of their capacity to support viable metapopulations. We present an empirical example on multiple networks occupied by an endangered species of butterfly. Using this theory, we may also calculate how the metapopulation capacity is changed by removing habitat fragments from or adding new ones into specific spatial locations, or by changing their areas. The metapopulation capacity should find many applications in metapopulation ecology, landscape ecology and conservation biology."

Hare, S. R., N. J. Mantua, et al. (1999). Fisheries Habitat--Inverse Production Regimes: Alaska and West Coast Pacific Salmon. Fisheries 24(1): 6.

"Pacific salmon catches from Alaska and the U.S. West Coast have inversely alternated between high and low regimes during the past 70 years. The authors attribute this inter-decadal pattern of variability to climactic forcing."

Harrison, S. (1991). Local extinction in a metapopulation context: an empirical evaluation. Biological Journal of the Linnean Society 42: 73-88.

Harrison, S. (1994). Metapopulations and conservation. In Large-scale ecology and conservation biology. P. J. Edwards, R. M. May and N. R. Webb, eds. Oxford, England, Blackwell Scientific Publications.

Hilborn, R. (1992). Hatcheries and future of salmon in the northwest. Fisheries 17(1): 5-8.

"Artificial propagation is often seen as a way to maintain and increase or augment fish stocks that have suffered from habitat loss and overexploitation. Large-scale hatchery programs for salmonids in the Pacific Northwest have largely failed to provide the anticipated benefits; rather than benefiting the salmon populations, these programs may pose the greatest single threat to the long-term maintenance of salmonids. Fisheries scientists, by promoting hatchery technology and giving hatchery tours, have misled the public into thinking that hatcheries are necessary and can truly compensate for habitat loss. The author argues that hatchery programs that attempt to add

additional fish to existing healthy wild stocks are ill advised and highly dangerous."

Hilborn, R. and C. Coronado (1996). Changes in ocean survival of coho and chinook salmon in the Pacific Northwest. In Estuarine and Ocean Survival of Northeastern Pacific Salmon. R. L. Emmett and M. H. Schiewe, eds. Newport, OR, NOAA National Marine Fisheries Service.

Full text available online at:
http://www.nwfsc.noaa.gov/publications/techmemos/tm29/Papers/Hilborn.htm

"Management Implications:

This analysis suggests that much of the fluctuation in abundance of chinook and coho salmon can be explained by changes in ocean survival. This does not mean, however, that we should ignore human impacts and simply hope for better ocean conditions. The major purpose of looking at ocean survival is to eliminate this form of variability from analysis when we consider modification of habitat, harvest, hatcheries, and hydropower.

As an example, we have constructed a simple analysis of optimal harvesting for a coho salmon population with constant freshwater conditions, but under two different ocean regimes (Fig. 7). Here we assume that there is a freshwater carrying capacity and a density-independent ocean survival. In case 1, we assume a 15% ocean survival, roughly comparable to the conditions in British Columbia in the early 1970s. The optimal escapement of this hypothetical stock is 315, and the optimal exploitation rate is 63%. The sustainable yield is about 500 fish. If the ocean then turns bad and survival drops to 5% (roughly current survival rates), the sustainable yield drops to 50 fish. The optimum escapement is now only 105, and the optimum harvest rate is 37%.

Thus, while we cannot control the ocean, we must change our management actions as ocean conditions change. We suggest that under present ocean conditions there is little if any sustainable yield for chinook and coho salmon in Oregon, Washington, and British Columbia. Harvest rates need to be drastically reduced, and we should expect the escapements to drop. We might choose to maintain escapements at the old levels, but we should recognize that the reason to do this would be to try to retain a large population size until ocean conditions improve."

Huntington, C., W. Nehlsen, et al. (1996). A survey of healthy native stocks of anadromous salmonids in the Pacific northwest and California. Fisheries 21(3): 6-14.

INR archive.

"This report summarizes a survey of healthy native stocks of anadromous salmonids (Oncorhynchus mykiss) in the Pacific Northwest and California. We used a questionnaire approach combined with spatial analysis to describe the status and distribution of stocks considered to be in relatively good condition. These stocks now constitute a small fraction of the region's historic anadromous salmonid resource but are critical to maintaining current resource productivity. Several agencies have developed, or are in the process of developing, computerized

databases that will help organize predominantly quantitative data on native stocks of anadromous salmonids. Our survey supplements those efforts by summarizing some of the knowledge of biologists familiar with the stocks and by making status assessments that at times go beyond conservative analyses of quantitative data.

The survey identified 99 healthy native wild stocks of salmon and steelhead that biologists consider to be at least one-third as abundant as would be expected without human impacts, including 20 considered at least two-thirds as abundant. More than three-quarters of these stocks are fall chinook, chum salmon, or winter steelhead in Puget Sound or coastal watersheds of Oregon or Washington. Fewer healthy populations remain of summer steelhead and coho, pink, and sockeye salmon and spring or summer chinook. We suggest that healthy stocks provide unique opportunities for conservation and research that are at least as important to the future of the region's anadromous salmonids as those associated with at-risk stocks."

Independent Multidisciplinary Science Team (IMST). (1998). Pinniped and Seabird Predation: Implications for Recovery of Threatened Stocks of Salmonids in Oregon Under the Oregon Plan for Salmon and Watersheds. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/techindex.html (MS Word file)
http://www.fsl.orst.edu/imst/reports/1998-2.pdf (PDF file)

Independent Multidisciplinary Science Team (IMST). (1998). Review of the hatchery measures in the Oregon Plan for Salmon and Watersheds Part I: Consistency of the Oregon Plan with Recommendations from Recent Scientific Review Panels. Salem OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/1998-1.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/1998-1.pdf (PDF file)

Executive Summary: "The key question addressed by IMST in this report is: Does the Oregon Plan recognize the concerns common to the three science panels, and do the measures in the Oregon Plan adequately address those concerns? The three scientific panels were:

-National Fish Hatchery Review Panel.
-Up Stream: Salmon and Society in the Pacific Northwest.
-Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem.

The three panels were in agreement on four important issues. The IMST describes these issues, determined the consistency of the Oregon Plan with them, and makes recommendations where improvements are needed.

Issue 1. Hatchery programs have failed to meet their objectives. Most hatcheries were built to mitigate for habitat lost during the development of rivers by replacing native fish with hatchery-produced fish. In spite of some examples of success, they generally have not achieved that goal.

The IMST concludes that the Oregon Plan is not adequately addressing the question of hatchery effectiveness.

Issue 2. Management of hatchery programs has impacted wild stocks. Hatchery management such as broodstock selection, mixed stock fisheries, and interbasin transfers are perceived to be generally detrimental to wild stocks of salmon and has failed to conserve salmon biodiversity. Since these problems are largely related to hatchery management they should be solvable.

The IMST concludes that the Oregon Plan recognizes the issue because it has adopted measures designed to address at least two elements of the issue. However, the Oregon Plan does not include procedures to determine effectiveness, relying on indirect measures such as the ratio of wild to hatchery fish on spawning beds. ODFW's annual report of hatchery operations states that this monitoring strategy "… documents the presence and abundance of hatchery fish but not interactions between hatchery and wild fish." The ratio of wild to hatchery fish is one useful measure of the potential for interaction, but it is insufficient as a basis for evaluating the impact of such interactions, and therefore the degree to which hatchery management actions are addressing the concern in issue 2.

Issue 3. Monitoring of hatchery programs is inadequate. Hatchery programs have not been adequately monitored. This lack of monitoring has made it difficult to determine why hatcheries have failed to meet their objectives, and to identify and correct the genetic and ecological risks that hatcheries pose to wild stocks.

The IMST concludes that the Oregon Plan recognizes the need to monitor the hatchery program. However, the program described in the Oregon Plan is not adequate.

Issue 4. Hatchery programs need fundamental change in order to support recovery of wild stocks. This issue is a logical outcome of the first three. All three panels recognized the need for fundamental change in the hatchery programs. They generally acknowledge that hatchery programs can support the restoration of natural production, but as currently managed they do not.

The IMST concludes that the Oregon Plan recognizes the need for change in the hatchery program, as evidenced by two measures (1) fully implementing ODFW's Wild Fish Management Policy, and (2) reducing the number of hatchery fish released into coastal streams. The IMST's assessment of change in the hatchery program will be hampered until measure II.A.3 has been completed (adoption of objectives and management guidelines – see issue 1).

Other changes may be needed in hatchery management, but these changes will require additional information from research or monitoring. The IMST recommendations are directed at obtaining this information. Based on our findings, IMST recommends that:

1. ODFW give measure II.A.3 (development of management objectives for each hatchery program, including genetic guidelines) of the Oregon Plan higher priority and complete the development and adoption of objectives and management guidelines for each coastal coho hatchery as quickly as possible.

2. ODFW establish and implement a specific program to determine if its coastal coho hatcheries are meeting their objectives, and the process by which management will be adapted if they are not.

3. ODFW develop and implement a program of research that determines the effects of wild-hatchery fish interactions.

4. Based on research findings (see recommendation 3), ODFW develop monitoring measures that can be used to judge the operational effectiveness of hatchery management programs with respect to their adverse impact on wild fish stocks.

5. ODFW develop a strategy that will be useful in quantifying and reducing the impact of mixed stock fisheries on the recovery of depressed OCN stocks.

6. ODFW determine the impact of hatchery release practices on predation of hatchery and wild fish. This should be coordinated with the ODFW Action Plan to assess avian and pinniped predation

7. ODFW use hatcheries as important tools in research that supports monitoring programs.

8. ODFW establish explicit coordination between hatchery programs and monitoring programs to help them ensure that they accomplish management and research objectives."

Independent Multidisciplinary Science Team (IMST). (1999). Recovery of wild salmonids in western Oregon forests: Oregon Forest Practices Act Rules and the Measures in the Oregon Plan for Salmon and Watersheds. Technical Report 1999-1 to the Oregon Plan for Salmon and Watersheds. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/1998-2.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/1999-1.pdf (PDF file)

Addendum 1: November 3, 1999:
http://www.fsl.orst.edu/imst/reports/1999-1%20Addendum.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/1999-1%20Addendum.pdf (PDF file)

Paraphrased from the Executive Summary:

"Forested landscapes include both aquatic and terrestrial components. The linkage between aquatic and terrestrial components has been recognized for a long time and has been prominent in the Oregon Forest Practices Act (OFPA) since its creation in 1972. The OFPA and its Administrative Rules were developed primarily to protect resource values, including water quality and, indirectly, habitat for salmonids. They were not specifically directed towards the recovery of wild salmonids, which is the mission of the Oregon Plan. However, it is through the Administrative Rules of OFPA and the Measures in the Oregon Plan that the mission of the

Oregon Plan and Executive Order 99-01 are to be accomplished. The report addresses 3 science questions:

<u>1. What is the scientific basis for maintaining fish habitat/water quality in forested ecosystems with respect to riparian buffers, large wood, sedimentation, and fish passage at road-stream crossings?</u>

Riparian Protection: Managing riparian areas differently than upslope areas as a strategy for protecting fish habitat is scientifically valid only if it is done with the goal of maintaining the dynamics of landscape structure and function. Sharp demarcations between riparian forest and upslope forest, and between fish-bearing and nonfish-bearing streams are not consistent with the historic pattern.

Large Wood Management: Large wood is a key structural and functional component of aquatic systems. Most models of large wood recruitment focus on riparian areas as the source, ignoring the important contributions made by upslope sources, especially from landslides. There is a critical need to restore the ecological processes that produce and deliver large wood to the streams from riparian as well as upslope areas.

Sedimentation: Sediment is a natural part of forest stream systems, as are the more coarse elements of stream structure, such as large wood, boulders, and gravel. Roads and landslides increase the amount of fine sediment in streams, but do not always add the more coarse elements. In addition, fine sediment production from roads is chronic rather than episodic. Management of sedimentation from roads and landslides at the watershed level is more difficult, and the scientific basis for it is less well developed, although the concepts are known and provide a basis for reasonable conjecture on how to proceed. In essence, the concept is to vary the extent and intensity of disturbance in a watershed over space and time, emulating the historical pattern of disturbance.

Fish Passage at Stream Crossings: The road-stream crossing guidelines developed by ODFW (ODFW 1996) are based on science, although often not the result of explicit experimentation. They provide a scientifically sound basis for management of such crossings, although better information should result from monitoring.

<u>2. Are current forest practice Rules and Measures with regard to riparian buffers, large wood, sedimentation, and fish passage at road-stream crossings adequate to achieve the mission of the Oregon Plan?</u>

IMST concludes that current rules for riparian protection, large wood management, sedimentation, and fish passage are not adequate to preserve depressed stocks of wild salmonids. They are not adequate because they are dominated by site- and action-specific strategies. While these are important as an initial step in accomplishing the mission of the Oregon Plan, they are not sufficient for the recovery of critical habitat for wild salmonids.

<u>3. What strategies are needed in the management of forest resources to achieve the mission of the Oregon Plan?</u>

Recovery of wild salmonids requires, among other things, habitat that is functional across the landscape. This means that policy, management, regulation, and voluntary actions must also work across the landscape. Current State forest policy focuses on specific actions occurring within defined periods of time at specific sites. As an example, the rules provide for riparian protection on a site-by-site basis, rather than at the landscape level. Sharp distinctions in the management of riparian zones (as compared to upslope forests), based on the size of the stream and the presence or absence of fish, will result in a failure to maintain the dynamics of structure and function of riparian zones across the landscape. In other cases, hazardous sites on forest roads and railroad grades are exempt from current OFPA Rules because the actions occurred before the Rules were in effect. Mechanisms are needed to solve these problems on critical sites that are exempted from current rules. Similar examples can be drawn from conclusions about the recruitment of large wood and the management of sediment and fish passage. A policy framework that incorporates landscape perspectives and makes regulation, management, and voluntary actions possible at this scale is needed.

There are three major areas in which shifts in policy are needed:

1. Incorporate the objectives of the Oregon Plan and Executive Order 99-01 into the OFPA. This will place an emphasis of regulation on the protection and enhancement of habitat needed for the recovery of wild salmonids.

2. Develop policy that extends the management of forest resources to the landscape level. This does not delete the site-specific aspects of current rules, but applies them in a different context. It will entail a shift from prescriptive rules applied uniformly across the landscape to site-by-site regulations that take into account cumulative disturbance in the watershed, landscape features, and climatic variation.

3. Develop policy that brings roads not constructed to current standards and other hazardous settings in critical locations into compliance with current standards. This means having the current OFPA Rules applied to actions taken before the current Rules were in force. In many cases, the operator acted in good faith and within the rules of the day, but the outcome is not scientifically consistent with the mission of the Oregon Plan; thus, a provision by which remediation is accomplished is needed.

Independent Multidisciplinary Science Team (IMST). (1999). Defining and Evaluating Recovery of OCN Coho Salmon Stocks: Implications for rebuilding stocks under the Oregon Plan. Salem, Oregon, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/1999-2.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/1999-2.pdf (PDF file)

Independent Multidisciplinary Science Team (IMST). (2000). Influences of Human Activity on Stream Temperatures and Existence of Cold-Water Fish in Streams with Elevated

Temperature: Report of a Workshop. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/2000-02.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/2000-02.pdf (PDF file)
Paraphrased from the Executive Summary: "The IMST convened a panel of experts on stream temperature and fish ecology on October 5-6, 2000 for a scientific workshop on human influences on stream temperature and responses by salmonids. The workshop was designed to review and discuss scientifically credible data and publications about 1) factors related to human activity that influence stream temperature and 2) behavioral, physical, and ecological mechanisms of cold water fish species for existing in streams with elevated temperatures. The goal of the workshop was to review empirical evidence and to identify points of agreement, disagreement, and knowledge gaps within the scientific community concerning the factors that influence stream temperature and fish responses to elevated temperatures. This information will assist the IMST in preparing a broader temperature report on Oregon's stream temperature water quality standards and their implementation.

This report is prepared by the IMST. It was reviewed by workshop participants and revised by the IMST accordingly. The report includes abstracts of plenary presentations on factors that influence stream temperatures and fish responses, and the results of group discussions. The workshop participants focused on three main questions and were asked to list statements of agreement and disagreement, and to identify gaps in the scientific knowledge related to each question:

1. How and where does riparian vegetation influence stream temperature?

The influence of riparian vegetation on stream temperature is cumulative and complex, varying by site, over time, and across regions. Riparian vegetation can directly affect stream temperature by intercepting solar radiation and reducing stream heating. The influence of riparian shade in controlling temperature declines as streams widen in downstream reaches, but the role of riparian vegetation in providing water quality and fish habitat benefits continues to be important. Besides providing shade, riparian vegetation can also indirectly affect stream temperature by influencing microclimate, affecting channel morphology, affecting stream flow, influencing wind speed, affecting humidity, affecting soil temperature, using water, influencing air temperature, enhancing infiltration, and influencing thermal radiation. It is critical to know the site potential to understand what vegetation a site can support. There is not a good scientific understanding of how much vegetation shading is required to affect stream temperature. This lack of understanding may be due to the spatial and temporal variability in landscape components, and the resulting variability in both the direct and indirect influences of vegetation on stream temperature. Therefore, it is difficult to generalize about the effects of vegetation on stream temperature.

2. Do other changes in streams cause increases in stream temperature?

Yes, other physical changes in the stream system can modify stream temperatures. Stream temperature is a product of complex interactions between geomorphology, soil, hydrology, vegetation, and climate within a watershed. Changes in these factors will result in changes in stream temperature. Human activities influence stream temperature by affecting one or more of *four major components: riparian vegetation, channel morphology, hydrology, and surface/subsurface interactions. Stream systems vary substantially across the landscape, and site-specific information is critical to understanding stream temperature responses to human activities.*

3. How can apparently healthy fish populations exist in streams with temperatures higher than laboratory and field studies would indicate as healthy?

Workshop participants identified several mechanisms that might explain the ability of fish populations to exist at higher than expected temperatures: 1) Fish may have physiological adaptations to survive exposures to high temperatures. 2) Sstream habitats may contain cooler microhabitats that fish can occupy as refuge from higher temperatures. 3) Ecological interactions may be different under differing thermal conditions resulting, for example, in changes in disease virulence or cumulative effects of stressors. 4) Since substantial differences exist between laboratory and field studies, it is difficult to apply results of laboratory studies to fish responses in the field. It is important to note that these proposed mechanisms are speculative and, as the list of gaps indicates, substantial experimental work is required to establish their influences on fish in different stream systems.

Workshop Summary

Workshop participants recognized gaps in the available science. Additional knowledge about human influences on stream temperatures and, consequently, influences on cold-water fish populations, will improve our ability to prevent further degradation of stream habitat and will enhance efforts geared towards the recovery of depressed fish populations. Even with these gaps, there was enough agreement on factors that influence stream temperature to indicate information is available to start developing and implementing management practices that are designed to reduce stream warming. It was suggested that managers should consider riparian vegetation, channel morphology, and hydrology, and should account for site differences.

Independent Multidisciplinary Science Team (IMST). (2000). Conservation Hatcheries and Supplementation Strategies for Recovery of Wild Stocks of Salmonids: Report of a Workshop. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/2000-01.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/2000-01.pdf (PDF file)

Paraphrased from the Executive Summary:

The IMST convened regional leaders in hatchery management and salmon recovery on June 19-21, 2000 for a scientific workshop on Conservation Hatcheries and Supplementation Strategies for the Recovery of Wild Stocks of Salmonids. The purpose was to provide better information (a) to help the IMST with its work on hatchery reports, and (b) to help policy makers as they consider proposals for the State of Oregon to engage in a program of supplementation.

The goal of the workshop was to identify, clarify and compile the scientific basis on which conservation hatcheries and supplementation strategies may help accomplish the mission of the Oregon Plan for Salmon and Watersheds (Oregon Plan). Work group discussions focused on:

- *Conditions under which supplementation could be used in wild salmonid recovery*
- *Appropriate methods for supplementation*
- *Approaches for the evaluation of supplementation over time*

A series of major points organized by topic, summarize the most important factors to address when planning or implementing a supplementation program.

Overview and Conceptual Framework
- *Supplementation is part of a suite of strategies (e.g., habitat enhancement and restoration, changes in land use, changes in fish harvest activities, removing impediments to fish passage) that may be used together for recovery of wild salmonid populations.*
- *When possible, limiting factors (e.g., ecological or habitat conditions, impediments to fish passage) should be addressed before implementing a supplementation program.*
- *Supplementation may help to maintain a gene pool but is not likely to lead to recovery of salmonid populations unless the root causes of decline are addressed.*
- *Supplementation is still in experimental stages; alternative strategies for meeting the goals of a particular project should be considered before supplementation is used.*
- *During the design, implementation, and monitoring of supplementation, programs should, as much as possible, utilize what is known about wild salmonid life cycles while developing and testing supplementation strategies and tactics.*
- *Clearly defined goals and monitoring of their attainment are important to the success of supplementation programs.*

Assessment and Design of Supplementation Programs
- *The population status of the target population is a prime factor in considering supplementation. Supplementation efforts of greater risk can be tolerated in areas where the current probability of existing population/stock survival is very low.*
- *Risks and benefits should be evaluated before implementing a supplementation program.*
- *Supplementation might be implemented to provide "genetic conservation" while other measures (e.g., habitat improvement) that will greatly improve the chances of success of a supplementation program over the long term are also being implemented.*
- *Ideally, supplementation should end when recovery goals are met.*

Methods
- *It is extremely important to identify areas with suitable habitat and underutilized carrying capacity when choosing supplementation as a tool to aid recovery of salmonid populations.*
- *Supplementation should be placed in an ecosystem context. Important considerations include carrying capacity, the connectivity of the population, the impacts on existing populations/stocks and on other species, levels of adult returns, as well as additional ecological factors.*
- *Preservation of genotypic and phenotypic diversity is extremely important when stocks are selected or developed for supplementation. Domestication selection should be minimized. Use "local broodstocks" or an appropriate alternative to minimize divergence from the wild*

population. When possible, allow for a natural range in the diversity of life history patterns.

Evaluation
- *Monitoring and evaluation are essential to assessing whether supplementation was successful and goals of a particular program were met. This requires adequate experimental design and "references or controls" for comparisons.*
- *Abundance, stock productivity, ecological and genetic diversity, and fish distribution data are all important when evaluating the results and/or success of supplementation.*
- *Due to the inherent cost and limitations of monitoring programs, monitoring efforts will be most efficient, and will provide the most comprehensive information, when coordinated among agencies.*

Supplementation may be a useful strategy as part of a comprehensive program of species recovery. We note that it has not been extensively tested, therefore needs to be used cautiously and with a strong component of monitoring and adaptive management to ensure it is not harmful to recovery of wild stocks, and that it is achieving the intended goals.

Independent Multidisciplinary Science Team (IMST). (2000). Salmon Abundances and Effects of Harvest: Implications for Rebuilding Stocks of Wild Coho Salmon in Oregon. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/2000-03.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/2000-03.pdf (PDF file)

Independent Multidisciplinary Science Team (IMST). (2001). The Scientific Basis for Artificial Propagation in the Recovery of Wild Anadromous Salmonids in Oregon. Salem, OR, Governor's Natural Resources Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/2001-01.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/2001-01.pdf (PDF file)

Independent Multidisciplinary Science Team (IMST). (2002). Recovery of Wild Salmonids in Western Oregon Lowlands. Salem, Oregon, Oregon Watershed Enhancement Board Office.

Full text available online at:
http://www.fsl.orst.edu/imst/reports/2002-01.doc (MS Word file)
http://www.fsl.orst.edu/imst/reports/2002-01.pdf (PDF file)

Kaczynski, V. and J. Palmisano. (1993). Oregon's wild salmon and steelhead trout: A review of the impact of management and environmental factors. Oregon Forest Industries

Council, Salem, OR: 328 pages.

INR archive.

Forward: "Several parties reviewed and commented on our original report ('A Review of Management and Environmental Factors Responsible for the Decline and Lack of Recovery of Oregon's Wild Salmonids, June, 1992) and some additional information was provided by these reviewers. Because supplies of the report were exhausted and more copies were needed, we took this opportunity to revise our original report. A number of revisions have occurred in the Management Factors section of the report and the agriculture and mining sections contain much updated information. Revisions have also occurred in other report sections."

Introduction: "We need to seriously evaluate and address the problems that are adversely affecting our fish. Nehlsen et al. (1991) described 86 Oregon salmonid 'stocks' as being at moderate to high risk of extinction or of special concern. The authors' definition of 'stock' can be questioned, but the article does point out that many wild salmonid populations (regardless of number) are in trouble. Fishery resource agency staff and fishermen are concerned. Other resource agencies are affected and also are concerned.

The Snake River fall, spring-summer [Chinook?], and sockeye salmon were recently listed as endangered and threatened species by the NFMS. Upper Columbia-Snake River coho salmon are believed to be extinct. Oregon pink salmon are virtually non-existent today and chum salmon are severely depressed. Lower Columbia River native native coho salmon may be a genetic remnant within fish of mostly hatchery origin wild-spawning in tributaries. Coastal Oregon coho salmon are depressed.

This report is a preliminary examination of the problem. The study examined three management factors and three broad environmental factors to determine their contribution to the decline and lack of recovery of Oregon's native salmonid stocks.

A similar analysis of critical factors that adversely affected anadromous fish stocks in the Klamath River Basin in northern California (and historically in Oregon) concluded that historic and present day overfishing were the primary causes of that basin's fish stocks' decline and lack of recovery. Environmental degradation- caused by ongoing large water use projects and agriculture, historic and near present logging, and historic mining, along with natural phenomena- contributed to the lack of recovery (CH2M Hill, 1985).

The Klamath Basin situation offers a reasonable model for this study. Even though there are no major cities or industries in the Klamath Basin, its geography, climate, historic development and use of natural resources are similar. The anadromous salmonid stocks of the Klamath Basin migrate into the common nearshore northeastern Pacific Ocean nursery waters and mingle with Oregon, Washington and British Columbia stocks. They are commonly exploited by Oregon commercial and sport fisheries, and Oregon fish are caught in California fisheries.

The study was limited to a review of reasonably accessible literature, agency reports and communications."

Kaczynski, V. and J. Palmisano. (1993). Oregon's wild salmon and steelhead trout: A review of the impact of management and environmental factors: Recommendations, summary and conclusions. Oregon Forest Industries Council, Salem, OR: 62 pages.

INR archive.

Summary: "A review and analysis of available information indicate that several factors, now or in the past, have caused the decline and lack of recovery of Oregon's wild anadromous salmon and steelhead stocks. No one factor is responsible by itself, and all factors must be addressed for significant recovery. These factors can be grouped into management and environmental categories. Management factors include state and federal fishery agency policies and actions, related fish hatchery policies and practices, and harvests. Agency management and hatchery policies and subsequent harvest of salmonid fish, are inseparable today. Management factors have reduced the numbers and changed the genetic makeup of wild fish that can return to streams to spawn. Environmental factors include water and land use, human-influenced biological interactions, and natural phenomena. Environmental factors have affected the success of migration, spawning and growth, and the survival of wild fish."

Kauffman, J. B. (1988). The status of riparian habitats in Pacific Northwest forests. In Streamside management: Riparian wildlife and forestry interactions**,** K. J. Raedeke, ed. Seattle, WA: University of Washington Institute of Forest Resources. Contribution 59: 45-55.

Koslow, J. A., A. J. Hobday, et al. (2002). Climate variability and marine survival of coho salmon (Oncorhynchus kisutch) in the Oregon production area. Fisheries Oceanography 11(2): 65-77.

"Time series of adult recruitment for natural runs of coho salmon from the Oregon coastal region (1970–94) and marine survival of hatchery-reared coho salmon from California to Washington (1960–94) are significantly correlated with a suite of meteorological and oceanographic variables related to the biological productivity of the local coastal region. These variables include strong upwelling, cool sea surface temperature (SST), strong wind mixing, a deep and weakly stratified mixed layer, and low coastal sea level, indicating strong transport of the California Current.

Principal component analysis indicates that these variables work in concert to define the dominant modes of physical variability, which appear to regulate nutrient availability and biological productivity. Multiple regression analysis suggests that coho marine survival is significantly and independently related to the dominant modes acting over this region in the periods when the coho first enter the ocean and during the overwintering/spring period prior to their spawning migration. Linear relationships provided good fits to the data and were robust, capable of predicting randomly removed portions of the data set."

Lawson, P. (1993). Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8): 6-10.

INR archive.

"Conservation management is always a political, as well as a biological, problem. Oregon's coastal natural coho salmon (Oncorhyncus kisutch) populations have drawn political attention because abundances are at critically low levels. One of the underlying problems is a long-term trend of habitat degradation. In addition, decadal-scale cycles in ocean survival of coho salmon may lead to cycles in abundance that are independent of freshwater habitat trends. Programs to restore coho salmon populations through stream restoration will take decades to produce long-lasting results.

When population abundance varies widely over time, a rise in abundance following initiation of recovery measures can be taken as an indication of success even when the increase in numbers was independent of the actions taken. Support for recovery efforts must be sustained through the cycle of higher abundance. The true measure of success for such projects is the continued survival of the population through subsequent episodes of low abundance."

Lawson, P. W., E. A. Logerwell, et al. (2004). Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 61(3): 360-373.

"Climate variability is well known to affect the marine survival of coho salmon (Oncorhynchus kisutch) in Oregon and Washington. Marine factors have been used to explain up to 83% of the variability in Oregon coastal natural coho salmon recruitment, yet about half the variability in coho salmon recruitment comes from the freshwater life phase of the life cycle. This seeming paradox could be resolved if freshwater variability were linked to climate and climate factors influencing marine survival were correlated with those affecting freshwater survival. Effects of climate on broad-scale fluctuations in freshwater survival or production are not well known.

We examined the influence of seasonal stream flows and air temperature on freshwater survival and production of two stock units: Oregon coastal natural coho salmon and Queets River coho salmon from the Washington Coast. Annual air temperatures and second winter flows correlated strongly with smolt production from both stock units. Additional correlates for the Oregon Coast stocks were the date of first fall freshets and flow during smolt outmigration. Air temperature is correlated with sea surface temperature and timing of the spring transition so that good freshwater conditions are typically associated with good marine conditions."

Lichatowich, J. A. (1989). Habitat alterations and changes in abundance of coho (*Oncorhynchus kisutch*) and chinook (*O. tshawytscha*) salmon in Oregon's coastal streams.

Proceedings of the national workshop on effects of habitat alteration on salmonid stocks, Canadian Special Publication of Fisheries and Aquatic Sciences 105.

Lichatowich, J. (1999). Salmon without rivers: A history of the Pacific salmon crisis. Covelo, CA, Island Press.Book News, Inc.

"Lichatowich, a fisheries scientist who has spent the greater part of 30 years working in Oregon and Washington in salmon management, provides an account of the roots and evolution of the salmon crisis in the Pacific Northwest. He examines the failure of restoration efforts and insists that hatcheries are not the solution to the problem. As much a history as a scientific study, this book examines the indigenous fishing cultures, as well as the story of salmon extinction over the last few decades. Lichatowich argues broadly that society's world view must change, allowing for more connection between humans and the natural world, yet he also provides some more practical measures to help solve the salmon crisis."

Lichatowich, J. (2001). Salmon hatcheries: Past, present and future. Columbia City OR, Alder Fork Consulting.Report to the Oregon Business Council.

Full text available online at:
http://www.orbusinesscouncil.org/docs/hatcheries.pdf

From the introduction: Hatcheries have a long history of public support, but surprisingly little evaluation and accountability. Hatcheries have come under increasing scrutiny, and questions have been raised about hatchery practices in general and the role of hatcheries in the recovery of depleted salmon populations.

"The purpose of this report is to provide background information on hatcheries in a non-technical format that will clarify some of the concerns and answer some of the questions [about hatcheries].

Critical statements about hatcheries in this report apply to the older programs. The separation between older and newer programs is about 1980. The large number of hatcheries, built prior to 1980, are in greatest need of reform. The newer state and tribal programs are generally based on current science, although that science is still woefully inadequate. The newer and older programs share one attribute in common- an unverified optimism that hatcheries can overcome the consequences of poor habitat stewardship."

Ligon, F., A. Rich, et al. (1999). Report of the Scientific Review Panel on California forest practice rules and salmon habitat. Sacramento, CA, The Resources Agency of California and the National Marine Fisheries Service.

Logerwell, E. A., N. Mantua, et al. (2003). Tracking environmental processes in the coastal zone for understanding and predicting Oregon coho (Oncorhynchus kisutch) marine survival. Fisheries Oceanography 12(6): 554-568.

"To better understand and predict Oregon coho (Oncorhynchus kisutch) marine survival, we developed a conceptual model of processes occurring during four sequential periods: (1) winter climate prior to smolt migration from freshwater to ocean, (2) spring transition from winter

downwelling to spring/summer upwelling, (3) the spring upwelling season and (4) winter ocean conditions near the end of the maturing coho's first year at sea.

We then parameterized a General Additive Model (GAM) with Oregon Production Index (OPI) coho smolt-to-adult survival estimates from 1970 to 2001 and environmental data representing processes occurring during each period (presmolt winter SST, spring transition date, spring sea level, and post-smolt winter SST).

The model explained a high and significant proportion of the variation in coho survival (R2 = 0.75). The model forecast of 2002 adult survival rate ranged from 4 to 8%. Our forecast was higher than predictions based on the return of precocious males ('jacks'), and it won't be known until fall 2002 which forecast is most accurate. An advantage to our environmentally based predictive model is the potential for linkages with predictive climate models, which might allow for forecasts more than 1 year in advance.

Relationships between the environmental variables in the GAM and others (such as the North Pacific Index and water column stratification) provided insight into the processes driving production in the Pacific Northwest coastal ocean. Thus, coho may be a bellwether for the coastal environment and models such as ours may apply to populations of other species in this habitat."

Lynch, M. and M. O'Hely (2001). Captive breeding and the genetic fitness of natural populations. Conservation Genetics 2 (4): 363-378.

Full text available online at:
http://rainbow.dfw.state.or.us/nrimp/information/docs/fishreports/hatch.pdf

Study based on case of wild and hatchery salmonids.

"Many populations of endangered species are subject to recurrent introductions of individuals from an alternative setting where selection is either relaxed or in a direction opposite to that in the natural habitat. Such population structures, which are common to captive breeding and hatchery programs, can lead to a scenario in which alleles that are deleterious (and ordinarily kept at low levels) in the wild can rise to high frequencies and, in some cases, go to fixation.

We outline how these genetic responses to supplementation can develop to a large enough extent to impose a substantial risk of extinction for natural populations on time scales of relevance to conservation biology. The genetic supplementation load can be especially severe when a captive population that is largely closed to import makes a large contribution to the breeding pool of individuals in the wild, as these conditions insure that the productivity of the two-population system is dominated by captive breeders.

However, a substantial supplementation load can even develop when the captive breeders are always derived from the wild, and in general, a severe restriction of gene flow into the natural population is required to reduce this load to an insignificant level. Domestication selection (adaptation to the captive environment) poses a particularly serious problem because it promotes *fixations of alleles that are deleterious in nature, thereby resulting in a permanent load that cannot be purged once the supplementation program is truncated.*

Thus, our results suggest that the apparent short-term demographic advantages of a supplementation program can be quite deceiving. Unless the selective pressures of the captive environment are closely managed to resemble those in the wild, long-term supplementation programs are expected to result in genetic transformations that can eventually lead to natural populations that are no longer capable of sustaining themselves."

Mawle, G. W. and S. Duncan (2003). An integrated approach to salmonid management. Fisheries Research 62 (2): 229-234.

"This paper draws together the findings of the others in this special issue which explores the scientific background to salmonid fisheries management. It considers the various options for action and sets them into a framework of an overall management plan. The primary importance of sound habitat management is stressed, at all scales from national and regional down to the riparian and in-stream level.

An understanding of the fundamentals of population dynamics and carrying capacity is essential for effective management which involves management of exploitation and possibly stock enhancement. Benefit cost analysis, sustainability and risk management are also important elements of an effective management strategy.

Finally, while fisheries management needs to be effective and incisive it also needs to be unobtrusive and sympathetic, for sport fisheries in particular, in order to maintain the "wild" nature of the resource being exploited."

Martin, D. J., M. E. Robinson, et al. (1998). The effectiveness of riparian buffer zones for protection of salmonoid habitat in Alaska coastal streams. Seattle, Washington, Martin Environmental.

Martin, D. J., L. Benda, et al. (2004). Core areas: A framework for identifying critical habitat for salmon. Seattle WA, King County Department of Natural Resources and Parks, Water and Land Resources Division, Development of Salmonid Conservation Strategies Phase I, Project No. T01426T.

Full text available online at:
http://dnr.metrokc.gov/wlr/esa/core-areas-habitat-report.htm

Paraphrased from the preface: "Fundamental to salmon conservation planning is delineation of habitats that are known or suspected to have high use by salmonids for spawning, rearing, adult holding or refuge from periodic natural or human-caused disturbances. This strategy is consistent with NFMS planning and guidance criteria, which recommend a high level of protection for *existing or potentially highly productive areas, sometimes labeled 'core areas'.*

The core areas approach for identifying critical habitat areas is conceptually desirable because it helps focus attention on specific habitats that are considered important for population recovery.

This report: 1) reviews current knowledge concerning salmon population spatial structure, proposes that certain habitats (core areas) functionally control population spatial structure, and describes key criteria necessary to identify core areas, 2) identifies and describes landscape sources and mechanisms that underlie the non-uniform distribution of habitat patches in rivers, explores how differences in river morphology (e.g. size and separation distance of habitat patches) scale with size of river and vary within and across watersheds, and discusses roles watershed disturbances play in the non-uniform distribution of riverine habitats, and 3) describes an approach for identifying core areas in rivers that relies on identification of significant habitat forming features and delineation of specific habitats that function as core areas, based on core areas criteria described."

May, C. L. and Peterson, G. (2003). Landscape Assessment and Conservation Prioritization of Freshwater and Nearshore Salmonid Habitat in Kitsap County: Kitsap salmonid refugia report. Kitsap County, WA. 247 pages**.**

INR archive (CD-ROM).

Table of contents available online at:
http://www.kitsapgov.com/nr/refugia/front_matter.pdf

Bibliography available online at:
http://www.kitsapgov.com/nr/refugia/references.pdf

List of appendices available online at:
http://www.kitsapgov.com/nr/refugia/appendicies_overview.pdf

Comprehensive study of salmonid refugia in NW Washington. Discusses salmonid refugia theory, salmonid population theory, landscape approach to protection and restoration, watershed assessment and prioritization, refugia assessment methods, refugia delineation and classification.

EXECUTIVE SUMMARY: "The goal of this project is to identify and characterize potential salmonid conservation and restoration areas located within Kitsap County. After identification of these areas, a primary objective of this project was to analyze and prioritize these salmonid refugia to assist in conservation, enhancement, and restoration efforts. A major aim of the project is to support the early salmon recovery actions necessary to preserve the remaining areas of high-quality salmonid spawning and rearing habitat in the region. Protection of these 'last best places' is likely an essential part of the salmon recovery process, but alone will not be sufficient to ensure the restoration of natural runs of native salmonids.

Definition of Salmonid Refugia

'Salmonid' means 'of the salmon family.' Salmonids in the study area include coho, chum, chinook, and pink salmon, as well as steelhead and cutthroat trout. This report is based upon a multi-species approach and does not give special consideration to any individual species of salmon.

One ecological definition of refugia is an area where special environmental circumstances have enabled a species or community of species to survive after decline or extinction in surrounding areas. For the purpose of this report, salmonid refugia can be defined as 'habitats or environmental factors that provide spatial and temporal resistance and/or resilience to aquatic communities impacted by natural and anthropogenic disturbances'.

Refugia can be stream corridors, watersheds, or shoreline areas. No single factor leads an area to be designated as refugia, rather it is a convergence of several ecological (physical and biological) factors.

Areas that qualify as refugia typically have habitat features such as intact streamside forests, undeveloped floodplains, wetlands, and natural shorelines. Refugia are used intensively by salmon compared to non-refugia areas—they are biological 'hot-spots.'

Refugia areas are important for maintaining populations of salmon. Refugia act to 're-seed' nearby areas after natural or man-made disturbances. Figure ES-1 shows how a "core population" on the mainstem of a river can be a source for naturally re-stocking outlying populations. For wild salmon to continue to survive, these core populations (and their habitat) must remain viable. It is from these core populations found in refugia areas that salmon populations will recover and begin to use less ideal habitat, forming 'satellite populations.'

The refugia concept is similar to the thinking that led to the formation of the National Wildlife Refuge System. Migratory waterfowl and other wildlife benefited and thrived during the last century because key habitat was protected. Refugia areas are not only important for salmon but also for other wildlife and plant communities."

Meehan, W. R. (1996). Influence of riparian canopy on macroinvertebrate composition and food habits of juvenile salmonids in several Oregon streams. Portland, OR, USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP-496. 19 pages.

Full text available online at:
http://www.krisweb.com/biblio/gen_usfs_meehan_1996.pdf

"Conclusions: Significant differences were found between kinds of invertebrate sampled in the environment and those taken as food items by fish, and the kinds of invertebrates present in stream sections that had riparian canopy and those that did not. However, these differences did not appear to be make much difference in terms of the amount of preferred fish food organisms available. There were a few more invertebrates in non-canopied sections, but probably not enough to warrant a management prescription that would open up the riparian canopy for the sole purpose of providing more preferred food items for fish.

The community composition of macroinvertebrates and the feeding habits of juvenile salmonids were studied in eight Oregon streams. Benthic, drift, sticky trap, and water trap samples were taken over a 3-year period, along with stomach samples of the fish. Samples were taken in stream reaches with and without riparian canopy.

Both main effects--fish diet versus macroinvertebrate composition in the environment, and canopies versus noncanopied stream condition---were highly significant, but probably not of practical importance in terms of the amount of preferred food available to the fish. In all aquatic sample types, including fish stomachs, Diptera and Ephemeroptera were the predominant invertebrates collected. In sticky trap and water trap samples, Diptera and Collembola were the predominant orders, reflecting the input of terrestrial invertebrates."

Moilanen, A. and I. Hanski (1998). Metapopulation dynamics: Effects of habitat quality and landscape structure. Ecology 79 (7): 2503-2515.

Full text available online at:
http://www.findarticles.com/cf_dls/m2120/n7_v79/21231393/p1/article.jhtml

"Ongoing fragmentation and destruction of natural habitats are of great concern to conservationists and ecologists throughout the world. A small local population isolated from other conspecific populations is prone to local extinction, but the species may have a chance of survival in a network of habitat patches connected by dispersal. Ecologists have asked about the most appropriate and effective approaches to the study of populations in fragmented landscapes. The currently most popular approach is based on the metapopulation concept and on the study of metapopulation dynamics (for reviews see Gilpin and Hanski 1991, Hanski 1994b, 1997, Hastings and Harrison 1994, Hanski and Gilpin 1997).

The term metapopulation has been used in a variety of meanings. In our application a metapopulation is an assemblage of local populations inhabiting spatially distinct habitat patches. A conceptually important assumption is that all local populations have a significant risk of extinction. This assumption leads to a focus on extinction-colonization dynamics, in other words, the metapopulation is assumed to persist in a stochastic equilibrium between local extinctions and colonizations of currently empty but suitable habitat patches. Migration is assumed to be distance dependent and hence the spatial configuration of the landscape affects metapopulation dynamics, unlike in the well-known Levins model in which only the fraction of presently occupied habitat patches has an effect on colonization. Also, unlike the Levins model, we allow for differences in the areas of habitat patches. In contrast to another commonly studied metapopulation scenario, the mainland-island metapopulation structure, the structure assumed here has no single-habitat patch large enough to guarantee the long-term survival of the respective local population and thereby the metapopulation as a whole."

Mundy, P. R., T. W. H. Backman, et al. (1995). Selection of conservation units for Pacific salmon: lessons from the Columbia River. American Fisheries Society Symposium 17: 28-38.

National Research Council (NRC). (1995). Science and the Endangered Species Act. Washington, D.C.: National Academy of Science Press.

Full text available online at:
http://www.nap.edu/books/0309052912/html/

Includes a discussion of the "evolutionarily significant unit" (ESU) concept.

From the preface:

"The ESA is an important legislative tool for the protection of threatened and endangered species in the U.S. The ESA asserts legal claim on behalf of those species in the U.S. to habitat that sometimes conflicts with competing management goals for both private and public lands. It is inevitable that those conflicts play out in the political arena. Our committee was asked to provide advice on scientific aspects of the ESA and to consider whether the act is "protecting endangered species and their habitats." We have endeavored to restrict our advice to the areas where science can better inform the public policy debate. The distinction between science and public policy is often fuzzy, because the possession of scientific knowledge and the implementation of that knowledge are so closely linked. Our goal has been to explore and illuminate the knowledge side of the equation."

National Research Council (NRC). (1996). Upstream: Salmon and society in the Pacific Northwest. Washington, D.C., Committee on Protection and Management of Pacific Northwest Anadromous Salmonids, National Academy of Science. Washington, D.C.: National Academy of Science Press.

Full text of entire book available online at:
http://books.nap.edu/books/0309053250/html/index.html

Paraphrased from summary: "Pacific salmon have disappeared fir about 40% of their historical breeding ranges in Washington, Oregon, Idaho and California and many remaining populations are severely reduced. Most runs that appear plentiful today are composed largely of fish produced in hatcheries. (fall chinook, chum, pink, and winter steelhead) chiefly inhabit rivers and streams in coastal zones. Populations near the southern boundary of species' ranges tend to be at greater risk than northern populations. In general, proportionately fewer healthy populations exist in California and Oregon than in Washington and British Columbia. The reasons for this trend are complex and appear to be related to both . . . Ocean conditions and human activities.

Species with extended freshwater rearing (up to a year' such as spring/summer chinook, coho, sockeye, sea-run cutthroat, and steelhead are generally extinct, endangered, or threatened over a greater percentage of their ranges than species with abbreviated freshwater residence, such as fall chinook, chum, and pink salmon. In many cases, populations that are not smaller than they used to be are now composed largely or entirely of hatchery fish. An overall estimate of the proportion of hatchery fish is not available, but several regional estimates make clear that many runs depend mainly or entirely on hatcheries. Chapter 4 discusses some of the difficulties in evaluating the *status of wild populations and how these difficulties have been addressed in recently published status reports. Regional trends are summarized, and the overall conditions of the species are presented.*

The salmon problem is the decline of wild salmon runs and the reductions in abundance of salmon even after massive investments in hatcheries. The declines are largely a result of human impacts on the environment caused by activities such as forestry, agriculture, grazing, industrial activities, urbanization, dams, hatcheries, and fishing are widespread, although not universal. They have a variety of causes, and they are exacerbated by the unusual life cycle of Pacific anadromous salmon, which spawn in freshwater, migrate to sea to grow and mature, and return to their natal streams to reproduce. Salmon thus require high quality environments from mountain streams, through major rivers, to the ocean. Economic development and population growth have created widespread declines in anadromous salmon abundance in the Pacific Northwest. Variations in ocean conditions especially in water temperature and currents and the associated biological communities also contribute to the rise and fall of salmon abundance, often thwarting the interpretation of events in freshwater and the surrounding terrestrial systems."

GENERAL CONCLUSIONS: To achieve long-term protection for a diversity and abundance of salmon in the Pacific Northwest, two general goals must be achieved: The long-term survival of salmon depends crucially on a diverse and rich store of genetic variation. Because of their homing behavior and the distribution of their populations and their riverine habitats, salmon populations are unusually susceptible to local extinctions and are dependent on diversity in their genetic makeup and population structure. Therefore, management must recognize and protect the genetic diversity within each salmon species, and it must recognize and work with local breeding populations and their habitats. It is not enough to focus only on the abundance of salmon.

The social structures and institutions that have been operating in the Pacific Northwest have proved incapable of ensuring a long-term future for salmon, in large part because they do not operate at the right time and space scales. As described in Chapter 13, differences among watersheds mean that different approaches are likely to be appropriate and effective in different watersheds, even where the goals are the same. This means that institutions must be able to operate at the scale of watersheds; in addition, a coordinating function is needed to make sure that larger perspectives are considered. As a framework in which to approach its deliberations, the committee chose to focus on rehabilitation a pragmatic approach that relies on natural regenerative processes in the long term and the selected use of technology and human effort in the short term rather than on attempts to restore the landscape to some pristine foyer state and rather than on a primary reliance on substitution, i.e., the use of technologies and energy inputs, such as hatcheries, artificial transportation, and modification of stream channels.

Rehabilitation would protect what remains in an ecosystem and encourage natural regenerative processes. The solutions will not be easy or inexpensive to implement; even a holding action to prevent further declines will require large commitments of time and money from many people in many segments of society in the Pacific Northwest. Therefore, broad-based societal decisions are needed to successfully provide a long-term future for natural salmon populations.

Natural and human-caused environmental changes affect all aspects of salmon life histories.

Although humans can do little in the short term to control or even predict large-scale changes in environmental conditions, salmon-management programs must expect such changes and take them into account. Managers must also recognize that the natural variability in environmental conditions."

Nickelson, T. E. and P. W. Lawson (1998). Population viability of coho salmon, Oncorhynchus kisutch, in Oregon coastal basins: application of a habitat-based life cycle model. Canadian Journal of Fisheries and Aquatic Sciences 55(55): 2383-2392.

Full text available online at:
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfas&volume=55&calyLang=eng&articleFile=f98-123.pdf

"To assess extinction risk for Oregon coastal coho salmon, Oncorhynchus kisutch, we developed a life cycle model based on habitat quality of individual stream reaches estimated from survey data. Reach-specific smolt output was a function of spawner abundance, demographic stochasticity, genetic effects, and density- and habitat-driven survival rates.

After natural mortality and ocean harvest, spawners returned to their natal reaches. Populations in reaches with poor habitat became extinct during periods of low marine survival. With favorable marine survival, high productivity reaches served as sources for recolonization of lower quality reaches through straying of spawners. Consequently, both population size and distribution expanded and contracted through time.

Within a reach, populations lost resilience at low numbers when demographic risk factors became more important than density-dependent compensation. Population viability was modeled for three coastal basins having good, moderate, and poor habitat. With constant habitat conditions, extinction risk in 99 years was negligible in basins with good and moderate habitat and 5-10% in the basin with poor habitat. Reductions in habitat quality up to 60% in 99 years resulted in reduced coho salmon populations in all basins and significantly increased extinction risk in the basin with poor habitat."

Nickelson, T. (2001). Population assessment: Oregon Coast coho ESU. Salem OR, Oregon Department of Fish & Wildlife.

Full text available online at:
http://oregonstate.edu/Dept/ODFW/inforeports/2001-02.pdf

Includes detailed assessment and extinction risk analyses for coho by watershed. Includes several SAH watersheds.

"The status of wild populations of coho salmon (Oncorhynchus kisutch) in the Oregon Coast ESU is examined. Populations are grouped in to 12 units termed 'populations complexes'. Trends of

abundance of coho salmon of each complex are examined for the period 1990-2000 based on random surveys of spawners. Estimates of theoretical juvenile production for the 1997-99 broods are made of each complex. Probability of extinction is estimated for the major populations of most complexes. The relative health of each population complex is ranked relative to the other complexes based on metrics of abundance, viability, and productivity."

Nickelson, T. (2003). The influence of hatchery coho salmon (Oncorhynchus kisutch) on the productivity of wild coho salmon populations in Oregon coastal basins. Canadian Journal of Fisheries and Aquatic Sciences 60(9): 1050-1056.

Full text available online at:
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfas&volume=60&calyLang=eng&articleFile=f03-091.pdf

From a section titled 'Implications for recovery': "To aid in the recovery of depressed wild salmon populations, the operation of hatcheries must be changed to reduce interactions of juvenile hatchery fish with wild fish. The most effective options for reducing interactions between hatchery and wild salmon would be judicious siting of hatchery programs to avoid concentrations of wild fish. Hatchery programs designed for harvest augmentation should be removed from basins with habitat that has a high potential to produce wild salmonids. Such hatcheries should be located in basins in which the potential of the habitat to produce wild salmonids is low.

The greater influence of hatchery fish on productivity of wild fish compared to the influence of habitat quality observed in this study does not reduce the importance of restoring habitat to the recovery of wild coho salmon. The influence of hatchery fish reinforces the importance of a multi-pronged approach to recovery. A program that reduces harvest, restores habitat, and reduces hatchery effects is necessary. Without a proactive approach to reduce the effects of hatchery releases on the productivity of wild salmon, recovery is likely to be significantly hampered, in some case to the point of being unachievable."

Abstract: "To aid in the recovery of depressed wild salmon populations, the operation of hatcheries must be changed to reduce interactions of juvenile hatchery fish with wild fish. Evidence suggests that productivity of wild populations can be reduced by the presence of large numbers of hatchery smolts in lower rivers and estuaries that attract predators.

An index of productivity based on the density-independent rate of reproduction of wild coho salmon (Oncorhynchus kisutch) in 12 Oregon coastal river basins and two lake basins was negatively correlated with the average number of hatchery coho salmon smolts released in each basin. The index of productivity was not significantly correlated with the average proportion of hatchery coho salmon in each naturally spawning population or with habitat quality.

Alterations to hatchery programs that could encourage recovery of wild populations include (i) avoiding release of large numbers of smolts in areas with high concentrations of wild fish, (ii) decreasing the number of smolts released, and (iii) using a volitional release strategy or a strategy *that employs smaller release groups spread temporally."*

Pacific Fisheries Management Council. (1999). Identification of Essential Fish Habitat for Pacific Salmon:

The link http://www.psmfc.org/efh/efh.html is a web portal for Essential Fish Habitat provisions of the 1996 Sustainable Fisheries Act, also known as the Magnuson-Stevens Act. The portal provides links to:

1. Identification and description of essential fish habitat for salmonids:
http://www.pcouncil.org/salmon/salfmp/a14.html

2. Salmonid habitat objectives, including definitions for properly functioning habitat conditions:
http://www.psmfc.org/efh/Jan99-sec3-2.htm#TABLE3-3 and
http://www.pcouncil.org/salmon/salfmp/a14/99efh3.pdf

3. Essential Fish Habitat 2002 Final Rule in Federal Register:
http://www.nmfs.noaa.gov/habitat/habitatprotection/efhfinalrule.pdf

4. Final Rule fact sheet:
http://www.pcouncil.org/salmon/salfmp/a14/99efh3.pdf

Parker, S. J., A. G. Durbin, et al. (1990). Effects of leaf litter on survival and growth of juvenile coho salmon. The Progressive Fish-Culturist 52 (1): 62-64.

"Juvenile coho salmon (Oncorhynchus kisutch) were raised for a 6-week period from 2 weeks posthatching through yolk-sac absorption in oval tanks with or without a 5-cm layer of leaf litter. Each treatment was conducted in triplicate tanks; each tank initially contained 100 yolk-sac fry. The fish were fed at a reduced ration in order to discern nutritive effects (possibly from invertebrates) due to the presence of leaf litter. In each of the two consecutive years that the experiment was conducted, there was a third experimental condition – in year 1, a nylon screen was placed on top of the leaf litter to separate cover effects from nutritional effects; in year 2, a treatment group was fed full ration.

Examination of total treatment mortality suggested that some factor in the leaf litter tended to improve survival, although the added leaf litter did not have any statistically significant effect on growth during the experiment. Thus, leaf litter, a component of the natural habitat of coho salmon fry, may warrant further study to determine its practical value in hatcheries for improving survival during the time when salmon undergo the transition to independent feeding."

Pess, G. R., D. R. Montgomery, et al. (2002). Landscape characteristics, land use, and coho salmon (Oncorhynchus kisutch) abundance, Snohomish River, Wash., U.S.A. Canadian Journal of Fisheries and Aquatic Sciences **59**(4): 613-623.

"We used temporally consistent patterns in the spatial distribution of returning adult coho salmon (Oncorhynchus kisutch) to explore relationships between salmon abundance, landscape characteristics, and land use patterns in the Snohomish River watershed, Wash. The proportion of total adult coho salmon abundance supported by a specific stream reach was consistent among years, even though interannual adult coho salmon abundance varied substantially.

Wetland occurrence, local geology, stream gradient, and land use were significantly correlated with adult coho salmon abundance. Median adult coho salmon densities in forest-dominated areas were 1.5–3.5 times the densities in rural, urban, and agricultural areas. Relationships between these habitat characteristics and adult coho salmon abundance were consistent over time. Spatially explicit statistical models that included these habitat variables explained almost half of the variation in the annual distribution of adult coho salmon. Our analysis indicates that such models can be used to identify and prioritize freshwater areas for protection and restoration."

Policansky, D. and J. J. Magnuson (1998). Genetics, metapopulations, and ecosystem management of fisheries. Ecological Applications 8(1)(Suppl.): S119-S123.

Rahr, G., J. Lichatowich, et al. (1998). Sanctuaries for native salmon: A conservation strategy for the 21st century. Fisheries 23 (4): 6-7, 36.

INR archive.

"In 1892, at the American Fisheries Society (AFS)'s twenty-first Annual Meeting, speaker Livingston Stone, a retired Unitarian minister and one of the country's early advocates for fish conservation, delivered a passionate speech predicting the demise of salmon and calling on attendees to support establishment of "salmon parks:" In 1995, representatives of several conservation organizations and government agencies formed the Fish Refuge Working Group (FRWG), an association of experts in fisheries management, conservation policy, and science. The FRWG has developed a proposal to create refuges for fish in the Pacific Northwest and is working to integrate a refuge-based approach into local and regional conservation programs for salmon and steelhead. The purpose of this essay is to reintroduce Livingston Stone's proposal and to initiate a discussion among fisheries scientists concerning the design, utility, and feasibility of salmon refuges."

Raloff, J. (2001). Salmon hatcheries can deplete wild stocks. Science News **159** (22): 1 page.

Full text available online at:
http://www.sciencenews.org/articles/20010602/fob5.asp

Short, nontechnical summary of research findings.

"Populations of wild adults that had struck out for the ocean when near-shore food supplies were

low had high rates of mortality. This mortality was aggravated, Levin's team found, when large numbers of hatchery smolts had entered the ocean with the wild fish. In lean years, the more hatchery chinook released, the higher the mortality of wild stocks from that year's smolts. In contrast, the NMFS scientists detected no adverse effect of hatchery releases on wild smolts entering the Pacific in years with normal food supplies."

Reeves, G., L. Benda, et al. (1995). A Disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/reeves-disturbance-based-ecosystem.pdf

INR archive.

"To preserve and recover evolutionarily significant units (ESUs) of anadromous salmonids Oncorhynchus spp. in the Pacific Northwest, long-term and short-term ecological processes that create and maintain freshwater habitats must be restored and protected. Aquatic ecosystems throughout the region are dynamic in space and time, and lack of consideration of their dynamic aspects has limited the effectiveness of habitat restoration programs.

Riverine-riparian ecosystems used by anadromous salmonids were naturally subjected to periodic catastrophic disturbances, after which they moved through a series of recovery states over periods of decades to centuries. Consequently the landscape was a mosaic of varying habitat conditions, some that were suitable for anadromous salmonids and some that were not. Life history adaptations of salmon, such as straying of adults, movement of juveniles, and high fecundity rates, allowed populations of anadromous salmonids to persist in this dynamic environment.

Perspectives gained from natural cycles of disturbance and recovery of the aquatic environment must be incorporated into recovery plans for freshwater habitats. In general, we do not advocate returning to the natural disturbance regime, which may include large-scale catastrophic processes such as stand-replacing wildfires. This may be an impossibility given patterns of human development in the region. We believe that it is more prudent to modify human-imposed disturbance regimes to create and maintain the necessary range of habitat conditions in space (10 super(3) km) and time (10 super(1)-10 super(2) years) within and among watersheds across the distributional range of an ESU.

An additional component of any recovery plan, which is imperative in the short-term, is the establishment of watershed reserves that contain the best existing habitats and include the most ecologically intact watersheds."

Reeves, G., K. Burnett, et al. (2002). Fish and aquatic ecosystems of the Oregon Coast Range. In Forest and Stream Management in the Oregon Coast Range Hobbs, S.D., J.P

Hayes, R.L. Johnson, G.H. Reeves, T.A Spies, J.C Tappeiner III, G.E. Wells, eds. Corvallis, OR, OSU Press**:** 68-98.

INR archive.

Up to date, detailed but readable and non-technical summary of ecology, history and status of fish and aquatic ecosystems in the Oregon Coast Range.

Chapter contents:
Introduction
The Fish Fauna of the Oregon Coast Range
Distribution of Fish in Coast Range Rivers and Streams
Organization of rivers and stream systems
Watersheds
Reaches
Habitat units
Seasonal distribution
Spring
Summer
Fall
Winter
Human Impacts on Fish and Fish Habitat
Ecosystem Restoration
Current approaches
Ecosystem approach
The Future: Ecosystem and Landscape Management
A case study
Conclusions
A new disturbance regime
Literature Cited

Rieman, B. E. and J. B. Dunham (2000). Metapopulations and salmonids: A synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9(1-2): 51-64.

Full text available online at:
http://www.fs.fed.us/rm/boise/teams/fisheries/publications/Fish_Publications/rieman_and_dunham_meta_2000.pdf

Good explanation of metapopulation theory and its applicability to salmonids, but actual study pertains to interior mountain salmonids, not coastal stocks.

Roni, P. T., J. Beechie, R.E., Bilby, F.E. Leonetti, M.M. Pollock and G.P. Pess. (2002). A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds. North American Journal of Fisheries

Management 22 (1) 1-20.

Full text available online at:
http://afs.allenpress.com/pdfserv/10.1577%2F1548-8675(2002)022%3C0001:AROSRT%3E2.0.CO%3B2

From the summary: "Although we focus on restoration techniques in this paper, it is important not to overlook the need to protect high-quality habitats. Protection of high-quality habitat should be given priority over habitat restoration because it is far easier and more successful to maintain good habitat than to try and recreate or restore degraded habitat."

Abstract: "Millions of dollars are spent annually on watershed restoration and stream habitat improvement in the U.S. Pacific Northwest in an effort to increase fish populations. It is generally accepted that watershed restoration should focus on restoring natural processes that create and maintain habitat rather than manipulating instream habitats. However, most process-based restoration is site-specific, that is, conducted on a short stream reach. To synthesize site-specific techniques into a process-based watershed restoration strategy, we reviewed the effectiveness of various restoration techniques at improving fish habitat and developed a hierarchical strategy for prioritizing them. The hierarchical strategy we present is based on three elements: (1) principles of watershed processes, (2) protecting existing high-quality habitats, and (3) current knowledge of the effectiveness of specific techniques.

Initially, efforts should focus on protecting areas with intact processes and high-quality habitat. Following a watershed assessment, we recommend that restoration focus on reconnecting isolated high-quality fish habitats, such as instream or off-channel habitats made inaccessible by culverts or other artificial obstructions. Once the connectivity of habitats within a basin has been restored, efforts should focus on restoring hydrologic, geologic (sediment delivery and routing), and riparian processes through road decommissioning and maintenance, exclusion of livestock, and restoration of riparian areas.

Instream habitat enhancement (e.g., additions of wood, boulders, or nutrients) should be employed after restoring natural processes or where short-term improvements in habitat are needed (e.g., habitat for endangered species). Finally, existing research and monitoring is inadequate for all the techniques we reviewed, and additional, comprehensive physical and biological evaluations of most watershed restoration methods are needed."

Ruckelshaus, M., K. Currens, R. Fuerstenberg, W. Graeber, K. Rawson, N. Sands, J. Scott. (2003). Integrated recovery planning for listed salmon: Technical guidance for watershed groups in Puget Sound. Puget Sound Technical Recovery Team and Shared Strategy Staff Group. 72 pages.

Full text available online at:
http://www.sharedsalmonstrategy.org/files/Guidance%20Document02-03-03a.pdf

"This document describes the biological content of a recovery plan directed to ultimately fulfill

obligations of the ESA and address broader recovery goals. We frame the biological content through a series of technical questions that drive the development of: 1) a working hypothesis that describes the current interaction of the population and the ecosystem; 2) an integrated strategy that describes the types of habitat, harvest, and hatcheries measures that will lead to recovery; 3) a set of specific, integrated actions of habitat, harvest and hatcheries that are hypothesized to result in achieving the salmon population target; and 4) a suite of monitoring, evaluation, and decision criteria that facilitate adaptive implementation of the watershed plan."

Spence, B. C., G. A. Lomnicky, et al. (1996). An ecosystem approach to salmonid conservation. Corvallis, OR, ManTech Environmental Research Services Corp.

Full text available online at:
http://www.nwr.noaa.gov/1habcon/habweb/habguide/ManTech/front.htm#Abstract

Detailed technical document intended for use by government agencies to develop habitat conservation plans and salmonid protection strategies under the ESA.

"This document provides the technical basis from which government agencies and landowners can develop and implement an ecosystem approach to habitat conservation planning, protection, and restoration of aquatic habitat on nonfederal lands. The report also describes a process for developing, approving, and monitoring habitat conservation plans, pre-listing agreements, and other conservation agreements for nonfederal lands to be consistent with the mandates of applicable legal requirements. "

A significant cause of salmonid declines is degradation of their freshwater and estuarine habitats. Although Federal, State, and Tribal conservation and restoration programs have been established, there is no coordinated, region-wide Federal strategy for developing habitat conservation plans pursuant to ESA, for fostering habitat protection and restoration beyond minimum ESA requirements on nonfederal lands, or for providing education and training in habitat protection and restoration strategies.

The NMFS, EPA, and USFWS (the "Agencies") seek to develop 1) a training and outreach strategy to implement a coordinated ecosystem approach to ESA's habitat conservation planning as well as additional protection and restoration of aquatic habitat on nonfederal lands and 2) a process for developing, approving, and monitoring habitat conservation plans (HCPs), pre-listing agreements, and other conservation agreements for nonfederal lands that is consistent with the mandates of ESA, the Clean Water Act, and other applicable State and Federal requirements."

Stouder, D. J., P. A. Bisson, et al. (1997). Pacific salmon & their ecosystems: Status and future options. New York, Chapman & Hall. 685 pages.

"Integrating theory and practicality, Pacific Salmon and Their Ecosystems explores the links between the decline in salmonids and the biological, political, and social factors of natural resource management, restoration, and conservation. This unique reference goes one step further

to elucidate how this problem can be addressed by stepping into the arena of management policies, technological solutions, and institutional change. Scientists, resource managers, and all those concerned with conservation and restoration of biodiversity will find that this text provides a refreshing and unique approach to the examination of the decline in salmonids. It will also serve as a useful tool in the evaluation of other imperiled natural resources."

Tallabere, A. and K. Jones (2002). Pacific Salmon Conservation: Designating Salmon Habitat and Diversity Watersheds, A Process to Set Priorities for Watershed Protection and Restoration. Salem, OR, Oregon Department of Fish & Wildlife.

INR archive.

Study and report used by ODF to select Salmon Anchor Habitat basins. Unpublished draft.

Thom, B., K. Jones, et al. (2000). Stream habitat conditions in western Oregon. Portland, OR, Oregon Department of Fish & Wildlife. Monitoring Program Report Number OPSW-ODFW-2000-5. 50 pages.

Full text available online at:
http://oregonstate.edu/Dept/ODFW/freshwater/inventory/pdffiles/orplanhab99.pdf

Study and report conducted under an Oregon Plan for Salmon and Watersheds directive to assess the status of stream habitat in western Oregon.

From the conclusions:

"The random selection and survey of habitat in western Oregon helped to better understand the conditions salmonids face when spawning and rearing in the freshwater environment.

Habitat quality and quantity in western Oregon in 1999 appeared very similar to the 1998 data set. A majority of sampled areas had low wood levels, moderate pools, moderate gravel and fine sediment levels in riffles, and a low number of large riparian conifers. High quality habitat for salmonids occurred in the western Oregon landscape in 1999, but was very rare. These high quality areas may be the key to the conservation of salmonids.

With the exception of fine sediments, the Young Forest type appeared to be providing better salmonid habitat that the Mature Forest/Non-use streams. The Mature Forest/Non-use streams had high levels of wood and riparian conifers and low levels of fine sediments, but their position high in the watersheds precluded the formation of pool habitat. There are very few Mature Forested streams within the range of the coho salmon in coastal Oregon."

Other excerpts: "Currently, in coastal Oregon streams, a majority of the moderate and high quality anadromous habitat occurs in the Young Forest land use. A majority of the Mature Forest/Non-use lands occur in the upper portions of drainages, and in the high gradient large *streams of the south coast. These streams did not typically contain the highest quality salmon habitat. Historically, the highest quality habitats were located in the lower gradient, valley bottom streams, where pool habitat, woody debris, and gravel occurred simultaneously to form complex habitat. Sample size limitations and the lack of high quality habitat limited the conclusions drawn between land management interactions and stream habitat.*

In western Oregon, a majority of streams were categorized as moderate quality habitat. These moderate quality areas may, and do, support salmonids. Without high quality refuge habitat, moderate quality areas cannot support a large abundance of salmonids through periods of frequent disturbance."

Tschaplinski, P. J. The effects of forest harvesting, fishing, climate variation, and ocean conditions on salmonid populations of Carnation Creek, Vancouver Island, British Columbia. In Sustainable fisheries management: Pacific salmon, Knudsen, E. E. Steward, C.R. MacDonald, D.D. Williams, J.E. Reiser, D.W. (eds).: 297-327. Boca Raton, FL and New York: CRC Press.

"Reductions in summer rearing habitat in Carnation Creek, B.C. appear to explain the roughly 50% post-logging decline in abundance of coho salmon fry inhabiting the stream. However, the fewer coho fry have produced >1.5 times more smolts after logging due to improved overwinter survival, which is in turn correlated with increased winter water temperatures and summer growth. The abundance of coho smolts leaving Carnation Creek remains high.

However, the main-channel habitats of Carnation Creek continue to deteriorate: large portions of the stream will lack stable LWD for many decades. In a few years, the forest canopy will be re-established over the stream and begin to reduce winter temperatures. Some of the increases in fish growth and survival associated with elevated stream temperatures after logging will disappear. With poorer habitat quality and lower water temperatures, smolt production from Carnation Creek may begin to decline in a few years."

Waples, R. S. (1995). Evolutionarily significant units and the conservation of biological diversity under the Endangered Species Act. American Fisheries Society Symposium 17: 8-27.

Waples, R. S. (1999). Dispelling some myths about hatcheries. Fisheries 24 (2): 12-21.

INR archive.

"Contributing to the controversies that have surrounded fish hatcheries in recent years are a number of misconceptions or myths about hatcheries and their effects on natural populations. These myths impede productive dialogue among those with differing views about hatcheries. Most of the myths include a measure of truth, which makes it difficult to recognize the elements that are not true.

Consideration of these myths leads to the following conclusions: (1) Hatcheries are intrinsically neither good nor bad- their value can be determined only the context of clearly defined goals; (2) genetic changes in cultured populations can be reduced but not eliminated entirely; (3) empirical evidence exists for of many adverse effects of hatcheries, but some risks have been overstated; and (4) monitoring and evaluation programs are important but should not be used as a substitute for developing risk-averse hatchery programs in the first place.

A key step toward resolving some of the controversies will be moving toward agreement on a common version (rather than two or more separate versions) of the realities about hatcheries. More efforts are needed in four major areas: identifying goals, conducting overall cost:benefit analyses to guide policy decisions, improving the information base, and dealing with uncertainty."

Weitkamp, L. A., T. C. Wainwright, et al. (1995). Status review of coho salmon from Washington, Oregon, and California. Seattle, Washington, US Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division. 258 pages.

West Coast Coho Salmon Biological Review Team (BRT). (1997). Status review update for coho salmon from the Oregon and Northern California coasts. Seattle, Washington, Predecisional ESA Document, Northwest Fisheries Science Center.

Young, K. A. (1999). Environmental Correlates of Male Life History Variation among Coho Salmon Populations from Two Oregon Coastal Basins. Transactions of the American Fisheries Society 128 (1): 1-16.

Full text available online at:
http://afs.allenpress.com/afsonline/?request=get-document&doi=10.1577%2F1548-8659(1999)128%3C0001:ECOMLH%3E2.0.CO%3B2

"Documenting the spatial scale and possible causes of life history variation among populations of coho salmon Oncorhynchus kisutch can improve ecological understanding and guide efforts to conserve potentially adaptive intraspecific diversity. In this paper I use 14 years of spawning ground survey data for 10 populations from the Coos and Coquille basins on the southern Oregon coast to examine interpopulation differences in the proportion of males that spawn as 2-year-old jacks instead of as 3-year-old adults.

There were significant between-population differences in the proportions of males spawning as jacks, and mean "jack proportion" was significantly and positively correlated with mean spawner density (fish/km). Two principal components (PC1 and PC2) summarizing 98% of the variation in variables approximating stream level environmental conditions explained 60% of the variation in mean jack proportion and 32% of the variation in mean spawner density. Mean jack proportion was negatively and significantly related to PC1, which loaded positively for stream gradient, stream elevation, and smolt and adult migration distance, and to PC2, which loaded positively for

distance and negatively for gradient. Mean spawner density was similarly, though not significantly, related to the two principal components. The coefficient of variation for jack proportion was negatively and significantly correlated with mean jack proportion and mean spawner density.

Higher-density populations consistently had a higher proportion of spawning males returning as jacks. Because jacks provide the only gene flow between otherwise isolated brood years and may buffer populations from severe brood year loss due to environmental stochasticity, the frequency of this life history strategy critically affects the genetic structure and ecological function in regional coho salmon populations. Explicitly considering the genetic and ecological role of jacks should help improve conservation efforts and future decisions regarding the status of regional coho salmon populations."

Young, K. A. (1999). Managing the decline of Pacific salmon: Metapopulation theory and artificial recolonization as ecological mitigation. Canadian Journal of Fisheries and Aquatic Sciences 56: 1700-1706.

Full text available online at:
http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfas&volume=56&calyLang=eng&articleFile=f99-113.pdf

Author argues that management efforts to artificially increase the rate of colonization of unoccupied salmon habitats may promote recovery of Pacific salmon. Argues that these programs should be viewed as ecological mitigation, aimed at hastening the return of natural processes, and that any genetic risks may be less immediate than the effects of reducing extinction risk.

"Pacific salmon in the Pacific Northwest have suffered regional declines and local extinctions primarily because of freshwater habitat destruction and overexploitation by fisheries. Management efforts to reverse this trend have correctly focused on habitat restoration and enhancement and stricter regulation of fisheries. Metapopulation theory and the ecology of the genus suggest that the addition of management efforts that artificially increase the rate of colonization of presently unoccupied habitats may promote the recovery and persistence of Pacific salmon in an ecologically realistic way. Such programs are conceptually and operationally different from traditional stock transfer and enhancement programs, which aimed to maintain a harvestable surplus of salmon in the facr of habitat destruction and overfishing. I argue that artificial recolonization programs should be viewed as ecological mitigation, aimed at hastening the return of natural demographic and evolutionary processes, and hope here to promote an open discussion of the merits and risks as such."

REGULATORY & LEGAL ASSURANCES & CONSIDERATONS, POLICY QUESTIONS

(2003). Officials Say Salmon Strategy Achieves Environmental, Economic Balance. Forestry Source. Brief news article about the Salmon Anchor Habitat Strategy.

Full text available online at:
http://www.safnet.org/archive/0503_salmon.cfm

The Forestry Source, the newspaper of the Society of American Foresters, offers news on current forestry policy issues, developments in forestry research and technology and SAF programs and activities.

(2003). A Bill For An Act relating to state forests; creating new provisions; and amending ORS 527.630, 530.010 and 530.050.

Full text available online at:
http://www.leg.state.or.us/03reg/measures/hb3600.dir/hb3632.intro.html

Details of HB3632, which passed in the Oregon State Legislature House, but died in committee in the Oregon Senate in 2003.

"Specifies that certain state forests are primarily valuable for production of forest crops and secondarily valuable for other purposes. Directs State Forester to actively manage certain state forests primarily for timber production and timber harvest. Establishes policy direction for Tillamook and Clatsop State Forests. Directs State Board of Forestry to modify Northwest Oregon State Forests Management Plan."

Bauer, S. B. and S. C. Ralph (2001). Strengthening the use of aquatic habitat indicators in Clean Water Act programs. Fisheries 26 (6): 14-25.

"The loss of freshwater fluvial habitats is generally regarded as a key factor in the precipitous decline of native salmonids in the northwestern United States. State and federal water quality regulations, under the authority of the Clean Water Act (CWA), could be more relevant to recovery of Pacific salmon if physical habitat quality was explicitly integrated into water quality standards.

We examine the concept of incorporating instream habitat measures into water quality regulations since these standards are the foundation of CWA programs. Commonly measured instream habitat variables for salmonids (flow regime, habitat space, channel structure, substrate quality, streambank stability) were evaluated in terms of their suitability as water quality criteria.

The basis for this evaluation focused on these indicators in light of their: (1) relevance to ecological requirements of salmonid fishes, (2) applicability to landscape processes and the *stream network in which they occur, (3) responsiveness to human-caused stressors (linking cause v. effect), and (4) degree of measurement reliability and precision.*

Our evaluation suggests that most habitat indicators, as currently measured, do not meet these criteria due to the limitations in the state of the science as well as constraints imposed by the existing framework for water quality standards. There is general agreement on salmonid habitat requirements and the effects of land use on these habitats; there is less certainty on quantifying physical habitat quality and on the reliability of habitat assessment techniques.

These obstacles can be overcome by applying the principles of landscape ecology and stream network classification to indicator development, identifying and quantifying reference area conditions at a regional scale, calibrating relevant indicators to specific locales, and developing systematic monitoring procedures."

Bormann, B. T., P. G. Cunningham, et al. (1994). Adaptive ecosystem management in the Pacific Northwest. Portland OR, Pacific Northwest Research Station, Forest Service, US Department of Agriculture. PNW-GTR-341.

Full text available online at:
http://www.ecologyandsociety.org/vol4/iss2/art6/

"Adaptive ecosystem management has been adopted as a goal for decision making by several of the land management and regulatory agencies of the U.S. government. One of the first attempts to implement ecosystem management was undertaken on the federally managed forests of the Pacific Northwest in 1994. In addition to a network of reserve areas intended to restore habitat for late-successional terrestrial and aquatic species, "adaptive management areas" (AMAs) were established. These AMAs were intended to be focal areas for implementing innovative methods of ecological conservation and restoration and meeting economic and social goals.

This paper analyzes the primary ecological, social, and institutional issues of concern to one AMA in the Coast Range in northern Oregon. Based on existing knowledge, several divergent approaches are available that could meet ecological goals, but these approaches differ greatly in their social and economic implications. In particular, approaches that rely on the natural succession of the existing landscape or attempt to recreate historical patterns may not meet ecosystem goals for restoration as readily as an approach based on the active manipulation of existing structure and composition. In addition, institutions are still adjusting to recent changes in management priorities.

Although some innovative projects have been developed, adaptive management in its most rigorous sense is still in its infancy. Indeed, functional social networks that support adaptive management may be required before policy and scientific innovations can be realized. The obstacles to adaptive management in this case are similar to those encountered by other efforts of this type, but the solutions will probably have to be local and idiosyncratic to be effective."

Cantine, R. (2003). Association of Oregon counties legislative report. Salem, OR, Association of Oregon Counties.

Full text available online at:
http://www.aocweb.org/LEGISLAT/2003/may23rpt.pdf
http://www.aocweb.org/LEGISLAT/2003/may30rpt.pdf

Discusses details of hearing and testimony in Oregon State Legislature concerning potential effects of HB3632 (page 7).

Forest Ecosystem Management Assessment Team (FEMAT). (1993). Forest ecosystem management: an ecological, economic, and social assessment. Washington, D. C., US Government Printing Office for the USDA Forest Service; USDC National Oceanic and Atmospheric Administration National Marine Fisheries Service; USDI Bureau of Land Management; USDI Fish and Wildlife Service; USDI National Park Service; and the US Environmental Protection Agency.

Full text available online at:
http://pnwin.nbii.gov/nwfp/FEMAT/

Key watersheds discussed at:
http://pnwin.nbii.gov/nwfp/FEMAT/Chapter_5/5-4.htm#4c2

Kavanaugh, K., G. H. Stankey, et al. (1999). The integration of planted and natural forests in a regional landscape. New Forests 18 (1): 97-109.

"The 10,700 km2 region of northwestern Oregon, USA, is dominated by mountainous forested landscapes fringed by agricultural lands and rapidly expanding urban areas. The Douglas-fir/western-hemlock trees, admixed with other species, in the mild, moist regional climate with rich soils are among the most highly productive of temperate forests. Timber harvest has been the dominant land use for much of this century.

Many current forest stands are planted, and have the potentials to be managed and shaped for a variety of traditional and evolving forestry objectives. The ages, resilience and productivity of these forests and mosaics of land ownerships permit a variety of future scenarios of forested landscapes, constrained largely by capacities of social organizations to plan and execute management for desired future conditions."

Landman, C. (1995). Oregon board of forestry lands: An historical overview of the establishment of state forest lands. Salem, OR, Oregon Department of Justice. 28 pages, with 15 pages of endnotes.

A concise history of Oregon Board of Forestry lands. Author is a paralegal with the Oregon

Department of Justice.

Introductory paragraph: "The history of Oregon's state forests is inseparable form the history of forestry in Oregon. Acquisition of forest land by the state was the result of a long progression of forest policies and practices that began with disposal of public land after Oregon statehood, and culminated in the logging, abandonment and tax delinquency of millions of acres of once-productive private forest land. A review of Oregon's forests and forest industry provides an essential historical context for understanding the problems that developed in the 1920's and the political solutions that followed."

Levesque, P. (1985). A Chronicle of Tillamook County Forest Trust Lands. Volume I: Background., Tillamook County and Paul Levesque. 514 pages.

Meticulously researched history of Euro-American settlement and development of the Tillamook region. Many historical photographs.

Levesque, P. (1985). A Chronicle of Tillamook County Forest Trust Lands. Volume II: The Tillamook State Forest., Tillamook County and Paul Levesque. 535 pages.

Meticulously researched history of how and why lands in the Tillamook region passed from private to state ownership. Many historical photographs.

McLure, R. (2004). Agencies hatch plans to protect wild salmon runs. Seattle Post-Intelligencer, April 24, 2004.

Available online at:
http://seattlepi.nwsource.com/local/170533_hatch24.html

Full text: "Proclaiming a 'new era' in rebuilding Puget Sound's wild salmon runs, state, federal and tribal officials Friday unveiled more than 1,000 recommendations for reforming Washington's salmon hatchery system -- the world's largest. A panel of top fish scientists concluded it's possible to revamp how some hatcheries are run and close others so people can keep raising and eating hatchery-bred salmon without seeing them overwhelm protected wild runs. The blueprint, the result of four years and $28 million worth of work, sets the stage to 'rethink and redesign one of the most complicated, controversial and litigated elements of salmon recovery,' said Barbara Cairns, executive director of Long Live the Kings, the non-profit group tapped by Congress to shepherd the plan.

'It is crucial,' said U.S. Rep. Norm Dicks, D-Wash., speaking at a news conference in Seattle. 'What we're trying to do is restore the wild runs, and yet at the same time have hatchery fish to satisfy our recreational fishermen and our tribal fishermen.'

Hatchery-bred fish form the backbone of the state's $850-million-a-year sportfishing industry, the

nation's eighth largest. Much of that money flows to rural communities that are heavily dependent on tourism dollars generated by hatchery-bred fish.

But hatcheries traditionally have interfered with wild runs. Many scientists now blame the more numerous hatchery fish for edging out wild fish by eating their food and taking up prime habitat in streams, among other things. But fish raised in hatcheries usually prove less fit in the wild than their natural-born counterparts. And hatcheries reduce the genetic variability of salmon, causing scientists to wonder if they are as prepared to survive over many generations.

The reform plan unveiled yesterday seeks to end that cycle. It would force all hatcheries to make a choice -- either you're in this world to crank out fish for people to eat, or you're here to help the wild fish. Those focused on producing pink protein would keep those fish as separate as possible from wild runs and prevent them from interbreeding.

The hatcheries that set out to help wild fish are expected to take steps such as reinvigorating hatchery stocks with new genetic material from the wild. Rather than churning out as many young fish as possible, they would carefully limit numbers of hatchery fish released so they don't overrun wild stocks protected under the Endangered Species Act.

'This looks at hatcheries as part of a larger natural system,' said Lars Mobrand, a biomathematician who was chairman of the science panel. The scientists, known as the Hatchery Science Review Group, said some hatcheries that are especially detrimental to wild runs must close. That's already happened to 20 out of the approximately 200 hatchery programs in Puget Sound and coastal Washington covered by the plan.

Indian tribes and the state Department of Fish and Wildlife, which run most hatcheries, already have agreed with about nine-tenths of the recommendations. They and the science panel are still discussing the 'tough nuts,' Cairns said. But state and tribal officials proclaimed themselves committed to reform. 'The recovery of wild salmon requires that we use every strategy available to us,' said Gov. Gary Locke. 'We know that hatcheries have a vital role to play in recovering wild salmon, as well as maintaining a sustainable fishery.'

The Democratic politicians gathered for the announcement acknowledged important help from Congressional Republicans, including former U.S. Sen. Slade Gorton and outgoing U.S. Rep. Jennifer Dunn. 'It's not common to find this kind of bipartisan support on a controversial issue,' said Jim Waldo, an adviser to Locke and others in the process.

The 61-page blueprint, accompanied by hundreds of pages of appendices, only starts the process. 'This book,' said Billy Frank Jr., chairman of the Northwest Indian Fisheries Commission, patting the report, 'we're not going to allow dust to settle on it.'

The process is not without controversy. Some scientists and advocates for wild fish question whether hatcheries ever can be altered sufficiently. "It's way too early now to jump on board and say we can use hatcheries to recover wild fish," said Bill Bakke of the Native Fish Society.

But, said Jim Lichatowich, a scientist whose groundbreaking work helped launch the drive for *hatchery reform, 'If we start holding hatcheries accountable and start operating them in a different way, we can at least resolve this question about whether hatchery and natural production within one watershed can co-exist.'*

Jeff Koenings, the state's director of fish and wildlife, said he's confident they can. 'We still have a big job ahead of us, but we now have a road map, and that map is set by science.''

National Marine Fisheries Service (NMFS). (1996). Position paper on the Oregon Forest Practices Act.

Full text available online at:
http://www.umpqua-watersheds.org/local/nmfs_on_ofpa.html

This position paper was developed by the National Marine Fisheries Service (now NOAA Fisheries) and presented to ODF in 1996. It is posted on Umpqua Watersheds' website, an environmental advocacy group.

It should be noted that the OFPA has been strengthened since this position paper was developed.

Oregon Board of Forestry. (1998). Oregon Administrative Rules for chapter 530 lands.

Full text available online at:
http://arcweb.sos.state.or.us/rules/OARS_600/OAR_629/629_035.html

Oregon Administrative Rules for Chapter 530 lands (Oregon state forests other than school lands). Includes full text of "Greatest Permanent Value" (GPV) rule.

Oregon Board of Forestry. (2003). Oregon Forest Practices Act.

Full text available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/reflibrary/LawsRules/2003FPARulesLaws.pdf

Oregon Board of Forestry. (2003). Forestry Program For Oregon. Salem, OR, Oregon Board of Forestry**:** 84 pages.

Full text available online at:
http://www.oregonforestry.org/fpfo/2003/

"The Oregon Board of Forestry supervises all matters of forest policy within Oregon, appoints the State Forester, adopts rules regulating forest practices and provides general supervision of the State Forester's duties in managing the Oregon Department of Forestry.

The Forestry Program for Oregon is the strategic plan established by the Oregon Board of Forestry. It sets forth the board's mission and vision for Oregon's forests and the values and strategies that will guide the board's decisions over the next eight years. This edition of the Forestry Program for Oregon also introduces a new framework for discovering, discussing, and assessing the sustainability of Oregon's forests."

Oregon Department of Forestry and the Department of Environmental Quality (ODF/DEQ). (2002). Sufficiency analysis: A statewide evaluation of Forest Practices Act effectiveness in protecting water quality. Salem, OR, Oregon Department of Forestry. 81 pages plus appendices.

Full text available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/reflibrary/AllSAv1031.pdf

"The purpose of the recommendations included in this report is to ensure that the FPA goals and objectives, and thus water quality standards, are being met. The Board of Forestry will consider the recommendations in light of the relevant social, economic and environmental context of the FPA. Accordingly, the recommendations are offered to highlight general areas where current practices are either sufficient or could be improved in order to better meet the FPA goals and objectives and in turn provide added assurance of meeting water quality standards.

This report draws on available research and monitoring data to relevant to current forest practices, and demonstrates overall program adequacy at the statewide scale with due consideration to regional and local variation in effects. This analysis is based on the premise that achieving the goals and objectives of the Forest Practices Act will ensure the achievement and maintenance of water quality goals. Conclusions include the finding that there is some risk current protection may not be sufficient at site-specific scale for some small and medium streams, however, the significance and scope of this risk is uncertain.

Includes monitoring recommendations.

Oregon Department of Forestry. (2001). Northwest Oregon State Forests Management Plan, Final Plan. Salem OR, Oregon Department of Forestry.

Full text available online at:
http://www.odf.state.or.us/DIVISIONS/management/state_forests/sfplan/nwfmp01-final/nwfmp.asp

Concept of anchor habitats, and how it would be applied to salmonids, is explained in this document.

Oregon Department of Forestry. (2003). Salmon Anchor Habitat Strategy. Salem OR, Oregon Department of Forestry.

Full text available online at:
http://www.odf.state.or.us/DIVISIONS/management/state_forests/sfplan/ip03_finals/13_SAH.pdf

Oregon Department of Forestry. (2003). Implementation Plans for Northwest and Southwest Oregon Forest Management Plans. Salem OR, Oregon Department of Forestry.

INR archive.

Salmon Anchor Habitat basins and management standards are defined in this document.

Oregon Society of American Foresters. (1998). Position statements: Fish and riparian forests. Portland, OR, Society of American Foresters**:** 1 page.

Full text available online at:
http://www.forestry.org/or/position/riparian.html

Argues that "the need for further restrictions of forest practices in Oregon's riparian areas to improve fish populations has not been clearly supported by objective scientific analyses, and such limits may delay desired improvements in fish habitat in some streams...active management can accelerate habitat benefits where they are a high priority, by carefully applying professional forestry, fisheries, and hydrology expertise."

Oregon Logging Conference. (2003). A Resolution Supporting 15 Oregon Counties and their Interests in the State's Forest Trust Lands, Oregon Logging Conference.

Summary available online at:
http://www.oregonloggingconf.com/resolutions/2003/res-6.html

Resolution that provides a rationale for, and supports, increased timber harvests on Oregon state forest (Chapter 530) lands.

Rice, T. A. and J. A. Souder (1998). Pulp friction and the management of Oregon's state forests. Journal of Environmental Law and Litigation **13**: 209-273.

INR archive.

Detailed analysis of laws, statutes and court cases affecting management of Oregon state forests, including the "Greatest Permanent Value" (GPV) rule. Based on a study commissioned by Oregon Department of Forestry.

Shindler, B. and K. A. Cheek (1999). Integrating Citizens in Adaptive Management: A Propositional Analysis. Conservation Ecology 3 (1).

"Lee has advocated for the use of civic science in the implementation of adaptive management experiments, noting that people and political processes are central features of adaptive approaches to land management. This paper explores the growing relationship between the public and forest management agencies, and uses a propositional analysis to guide methods for integrating citizens into adaptive management situations. Important characteristics are organized and discussed in six thematic areas.

Citizen-agency interactions are more effective when (1) they are open and inclusive, (2) they are built on skilled leadership and interactive forums, (3) they include innovative and flexible methods, (4) involvement is early and continuous, (5) efforts result in action, and (6) they seek to build trust among participants. Particular attention to the situational context of actions and decisions helps to determine the relevance of adaptive management for individuals in these settings."

Smith, C. L. (2002). Institutional mapping of Oregon coastal watershed management options. Ocean and Coastal Management 45(6): 357-375.

"Institutional mapping is a technique that builds on the logic of Geographic Information Systems (GIS). In GIS, coverages placed over a base map show spatial relations. Social institutions are more difficult to "map" physically. Institutional mapping uses three social coverages- scale, power, and capital. Four sets of institutions affecting watershed management-salmon restoration, water quality improvement, forest management, and land-use planning-illustrate the institutional mapping process. Analysis indicates that water quality institutions under the Clean Water Act (CWA) have a slightly higher ranking on scale, power, and capital.

Based on these rankings, CWA requirements are predicted to have greater potential for improving watershed health in coastal settings than institutions associated with salmon restoration, forest management, or land-use planning. The differences are not large, and overlapping goals for protecting salmon, improving water quality, sustainable forest management, and effective land-use planning institutions offers the strongest prospect for improved watershed health.

This document provides the technical basis from which these goals can be accomplished. The primary intended audience is agency personnel who have background in the biological and physical sciences and who are responsible for overseeing land management activities. Use of technical terms that may be unfamiliar to some readers was at times unavoidable; consequently, the document may be less accessible to those without formal technical training in scientific disciplines."

Souder, J. A. and S. K.Fairfax. (1995). State Trust Lands: History, Management, and Sustainable Use. St. Lawrence, KS: University Press of Kansas. 360 Pages.

Summary: "Understanding and analyzing the state trust lands has always been difficult because they consist of twenty-two state programs and 200 years of history. In State Trust Lands, Jon A. Souder and Sally K. Fairfax examine the management programs instituted by each state, exploring them as models for public land administration.

They investigate the nature and role of public resources; observe how states regulate grazing lands and mineral leases; provide insight into subsidizations and self-sustaining land uses; illustrate how state and federal policies differ; and evaluate the strength and weaknesses of market-based approaches to public resource management. State trust lands, they contend, tend to be managed more conservatively and with more environmental awareness than federal lands.

This book provides an array of tested, viable alternatives to Bureau of Land Management and U.S. Forest Service management models and will be invaluable to anyone interested in the financial, use, and environmental planning of public resources. Exploring the diverse set of experiences of state land trust managers, Souder and Fairfax present successful and less successful management practices and offer new models and data for the debate on the future of public lands."

Stankey, G. H., B. T. Bornmann, et al. (2003). Adaptive management and the Northwest Forest Plan: rhetoric and reality. Journal of Forestry 101(1): 40-46.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/pnw_2003_stankey001.pdf

Study examines barriers to implementing adaptive management strategies, using adaptive management areas (AMAs) designated under the Northwest Forest Plan as examples.

"Adaptive management represents a process to use management policies as a source of learning, which in turn can inform subsequent actions. However, despite its appealing and apparently straightforward objectives, examples of successful implementation remain elusive, and a review of efforts to implement an adaptive approach in the Northwest Forest Plan proves the point. Barriers include an institutional and regulatory environment that stymies innovation, increasing workloads coupled with declining resources that constrain learning-based approaches, and a lack of leadership. The time is right to learn from experiences and consider alternatives."

State of Oregon. (1997). Oregon Coastal Salmon Restoration Initiative. Salem OR, Governor's Natural Resource Office.

Full text available online at:
http://www.oregon-plan.org/archives/ocsri_mar1997/index.html

Initiative intended to forestall listing of the Oregon coast coho under the Endangered Species Act. After Executive Order 99-01, OCSRI remains in effect as the coastal portion of the Oregon Plan for Salmon and Watersheds.

State of Oregon. (1999). Oregon Plan for Salmon and Watersheds. Executive Order 99-01. Governor's Natural Resource Office, Salem, OR.

Full text available online at:
http://www.ccrh.org/comm/slough/primary/oregnpln.htm

and at:
http://arcweb.sos.state.or.us/governors/Kitzhaber/web_pages/governor/legal/execords/eo99-01.pdf

Expanded and clarified the scope of the Oregon Plan.

Tillamook Rainforest Coalition. (2003). Tillamook 50/50 Initiative: Good for the Economy, good for the Environment, and good for Oregon!

Tillamook Rainforest Coalition webpage with details about the "Good for the Economy, good for the Environment, and good for Oregon!" Initiative, also known as the Tillamook 50/50 Initiative.

U.S. Dept. of Commerce NOAA National Marine Fisheries Service and U.S. Dept. of Interior Fish and Wildlife Service. (2003). NEPA review process on ESA "take" coverage for the Washington Forest Practices Regulatory Program. Draft Scoping Report. U.S. Dept. of Commerce NOAA National Marine Fisheries Service and U.S. Dept. of Interior Fish and Wildlife Service, Washington State Department of Natural Resources. 79 pages.

Full text available online at:
http://www.dnr.wa.gov/htdocs/agency/federalassurances/draftscopingreport.pdf

Draft report documents process that Federal agencies and Washington State are using to develop a Habitat Conservation Plan (including some listed salmonid species) for Washington state and private forests.

"This scoping report provides a summary of scoping activities and public/internal scoping results relative to the NEPA review process on ESA "take" coverage for the Washington State Forest Practices regulatory program. The NMFS and USFWS (Services) are leading this environmental review because of anticipated applications from the State of Washington (State) for take authorization or a take limit under the ESA. Both Services have threatened and endangered species in the State that are likely to be affected by this action. Therefore, the Services have sought public input on the scope of the required NEPA analysis, including the range of reasonable alternatives and potential impacts of any alternative.

This scoping report summarizes the issues to be analyzed in an EIS, based on a synthesis of scoping input, and describes the alternatives suggested for analysis during scoping."

U.S. Fish and Wildlife Service and NOAA Fisheries. (1996). Habitat Conservation Planning Handbook, USDI Fish and Wildlife Service/US Department of Commerce NOAA Fisheries.

Full text available online at:

http://endangered.fws.gov/hcp/hcpbktoc.pdf

Primary site explaining Habitat Conservation Plans:
http://endangered.fws.gov/hcp/

Washington State Department of Natural Resources, U.S. Dept. of Commerce NOAA National Marine Fisheries Service and U.S. Dept. of Interior Fish and Wildlife Service, U.S. Environmental Protection Agency, Office of the Governor, State of Washington, Washington State Dept. of Fish and Wildlife, Washington State Department of Ecology, Colville Federated Tribes, Washington State Association of Counties, Washington Forest Protection Association and Washington Farm Forestry Association. (1999). Olympia, WA: Washington State Dept. of Natural Resources. 179 pages.

Full text available online at:
http://www.dnr.wa.gov/forestpractices/rules/forestsandfish.pdf

In 1999, after several years of negotiation between federal and state agencies, treaty tribes, counties and small and large private landowners, the State of Washington adopted the Forests & Fish Report ("FFR").

The report was presented to the Washington State Forest Practices Board and Governor's Salmon Recovery Office, and guides policies to protect and recover salmonids on state and private forests in Washington.

Federal Assurances Program, Washington DNR: "FFR represents an historic shift in the way our state manages natural resources, resolves problems, and makes future management changes. It provides the basic framework for successfully managing our state's non-federal forests to meet the needs of a viable timber industry while continuing compliance with state laws and the federal ESA and CWA. The basic founding principles of the FFR provide flexibility to adapt elements over time based on new scientific and management information."

FOREST & WATERSHED ECOLOGY & MANAGEMENT, SILVICULTURAL ISSUES & STRATEGIES

Allen, M. and L. Dent. (2001). Shade conditions over forested streams in the Blue Mountain and Coast Range georegions of Oregon. ODF Technical Report No. 13. Salem, OR: Oregon Department of Forestry. 96 pages.

Full text available online at:
http://www.odf.state.or.us/DIVISIONS/protection/forest_practices/fpmp/Projects/Shade_Monitoring/ExecShade.pdf

Data collected in western Oregon included that Tillamook, lower Nehalem and Necanicum basins.

"The conclusions from this report were limited, primarily due to confounding effects that could not be adequately addressed with the study design. However, the study identified some key findings to be considered by the forest practices policy staff. Forest management in northwest and northeast Oregon resulted in a wide range of riparian stand structures and shade conditions. However, the riparian conditions resulted in consistently lower shade than what was observed on unharvested sites. While the unharvested sites did no provide ideal 'reference' conditions (inherent site differences other than harvesting) some of the findings were consistent with findings from ODF Technical Report 12 (Dent, 2001). Specifically, both studies concluded that harvested sites had less shade than unharvested sites, particularly small streams and, to some degree, on medium streams.

An analysis of shade as a function of stand structure indicated that basal area alone was not predictive for shade. However, combined with other stand structure parameters, the study concluded that increasing basal area in western Oregon and stand density in eastern Oregon could result in higher shade on east-west flowing streams. The lower basal area requirements on small and medium streams were, therefore, predicted to provide less shade than on large streams, particularly if the trees had larger diameters and higher live crown ratios. Conversely, the study also highlighted the potential downfalls of managing strictly for shade. With shade as the primary goal, the riparian area would likely be managed towards the stem exclusion stage. The stem exclusion stage is likely to promote small diameter trees of poor vigor and, therefore, is unlikely to meet the other important functions of riparian areas.

Recommendation: Consider the findings from this study in concert with other ODF riparian monitoring results during the rule revision process currently underway....specifically the Board of Forestry should consider changes to the vegetation retention rules to increase the maintenance and promotion of shade on small and medium streams in western Oregon, while ensuring that other important riparian functions are retained."

Alverts, B., B. Danehy et al. (2001). Headwaters Research Cooperative Workshop Summary. Oregon Department of Forestry Technical Report #16. 49 pages.

Full text available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/fpmp/MiscPDF/OHRCWorkshopSumm.pdf

"The ecology of headwaters systems and their importance to downstream function is not well understood. The Oregon Headwaters Research Cooperative was formed (with support from Boise Cascade, Oregon Department of Forestry, Oregon Forest Industries Council, Oregon Forest Resources Institute, Oregon Watershed Enhancement Board, Weyerhauser Company, and Willamette Industries) to address headwater research needs.

2001 workshop addressed wood dynamics, sediment routing, hydrologic function, temperature and dissolved oxygen, organic matter and nutrient cycling, riparian function and microclimate, geomorphology and classification, invertebrates and periphyton, fish and amphibians, and basin level effects.

Goals of this workshop were to:

1.) Frame the state of science on headwaters streams through technical presentations by speakers with recognized expertise in specific areas.

2.) Identify gaps in the science through follow-up facilitated discussions by workshop participants.

3.) Articulate hypotheses and research priorities through small-group sessions by workshop participants for the prospective research cooperative to pursue."

Document includes a summary of workshop presentations and discussions.

American Lands Forest Biodiversity Program. (2001). Summary of Aquatic/Riparian Protection Measures In Westside Forests. American Lands Forest Biodiversity Program.

Available online at:
http://www.ifish.net/aquatic.htm

Comparison table of riparian management standards under a variety of landownerships and goals.

"This summary provides a quick reference to existing and proposed forest management standards for riparian areas and other sites affecting aquatic resources in westside, non-federal forests in Pacific Coast states. Eastside standards are often significantly different. The summaries show the width of riparian management zones, and begin to indicate the management standards within these zones.

These summaries are highly simplified, omit many details of the actual rules and proposals, and rely upon judgements about how different stream classifications relate to each other. Actual implementation of existing standards may also vary; the California rules, for example, allow substantial deviations from the standard rules. Please also note that the summary of measures for *unstable slopes, roads, etc., is not complete.*

The HCP standards referenced here are stronger than those in most HCPs. The FSC Guidelines assume less intensive upslope logging."

Andrus, C. and H. A. Froehlich (1988). Riparian forest development after logging or fire in the Oregon coast range: wildlife habitat and timber value. In Streamside management: Riparian wildlife and forestry interactions. K. J. Raedeke, ed. Seattle, WA, University of Washington, Institute of Forest Resources. Contribution No. 59: 139-152.

Beach, E. (2000). Conditions needed to enhance natural regeneration of conifer in managed riparian forests. Seattle, WA, University of Washington College of Forest Resources and College of Ocean and Fishery Sciences Center for Streamside Studies.

Full text available online at:
http://www.cfr.washington.edu/Research/fact_sheets/26-CSSregeneration.pdf

Past disturbances, including fires, floods and logging have resulted in an abundance of non-coniferous species in many managed forests. This is a 1-page summary of a study on conditions that help or hinder conifer establishment in riparian areas forested primarily by red alder.

"Riparian areas in close proximity to mature (>60 years) forest patches containing shade-tolerant species had significantly higher rates of conifer regeneration than areas without such seed sources (e.g. areas dominated by cultivated stands of [non-shade tolerant] Douglas-fir in the adjacent upland forest.) In areas adjacent to mature seed trees, shade tolerant species including western hemlock, Sitka spruce and western red cedar were able to continually establish under a deciduous overstory.

Provided a seed source was present, rooting substrates and understory vegetation were found to significantly alter the patterns and rates of regeneration. Coarse woody debris and mineral soil substrates contributed to regeneration success, while seedling establishments were less successful on litter. All shade-tolerant species were able to successfully establish in areas of dense herb and shrub covers, although at lower rates than when herbs and shrubs were absent. The results suggest that green tree retention of shade tolerant species may be a more effective, less expensive, and lower maintenance management strategy than vegetation control for increasing the conifer component of riparian areas."

Benda, L. E., D. J. Miller, et al. (1998). Dynamic landscape systems. River ecology and management: Lessons from the Pacific coastal ecoregion. R. J. Naiman and R. E. Bilby. New York, Springer**:** 261-288.

Beschta, R. L., J. R. Boyle, et al. (1995). Cumulative effects of forest practices in Oregon:

Literature and synthesis. Dept. of Forest Resources, Corvallis OR, Oregon State University.

Consists of a large 3-ring binder of material, and a shorter executive summary.

Beschta , R.L. (1991). Stream habitat management for fish in the northwestern United States: The role of riparian vegetation American Fisheries Society Symposium 10: 53-58.

INR archive.

"Historical development and land-use patterns along streams draining forest and range watersheds in the northwestern USA have had major effects on riparian vegetation, channel characteristics, and fish habitat. The functional attributes of riparian vegetation that have been altered include the dissipation of stream energy and channel stability, stream shade and temperature control, nutrient cycling, sediment deposition and storage, water storage and release, and others.

Recent attempts at enhancing degraded fish habitat include many bioengineering projects that are adding structures of various sizes, materials and configurations to stream channels. However, a higher priority for the long-term improvement of fish habitat is the implementation of management practices that will allow and encourage the continued functioning and succession of riparian vegetation."

Bisson, P. A., B. E. Rieman, et al. (2003). Fire and aquatic ecosystems of the western USA: current knowledge and key questions. Forest Ecology and Management 178: 213-229.

Full text available online at: http://www.fs.fed.us/pnw/pubs/journals/pnw_2003_bisson001.pdf

"Understanding of the effects of wildland fire and fire management on aquatic and riparian ecosystems is an evolving field, with many questions still to be resolved. Limitations of current knowledge, and the certainty that fire management will continue, underscore the need to summarize available information. Integrating fire and fuels management with aquatic ecosystem conservation begins with recognizing that terrestrial and aquatic ecosystems are linked and dynamic, and that fire can play a critical role in maintaining aquatic ecological diversity.

To protect aquatic ecosystems we argue that it will be important to: (1) accommodate fire-related and other ecological processes that maintain aquatic habitats and biodiversity, and not simply control fires or fuels; (2) prioritize projects according to risks and opportunities for fire control and the protection of aquatic ecosystems; and (3) develop new consistency in the management and regulatory process.

Ultimately, all natural resource management is uncertain; the role of science is to apply experimental design and hypothesis testing to management applications that affect fire and aquatic ecosystems. Policy-makers and the public will benefit from an expanded appreciation of fire ecology that enables them to implement watershed management projects as experiments with

hypothesized outcomes, adequate controls, and replication."

Blinn, C. R. and M. A. Kilgore (2001). Riparian management practices: A summary of state guidelines. Journal of Forestry 99(8): 11-17.

INR archive.

"Individual states develop guidelines to protect and manage forest riparian resources. A review of 49 states' forest riparian guidelines revealed the primary focus is to protect the quality of water adjacent to perennial and intermittent streams and lakes. A commonly recommended riparian management zone is 50 feet wide with 50 to 75 percent crown closure (or 50–75 square feet per acre of residual basal area); however, the specific guidelines in each state vary tremendously. Although science cannot specify the management prescriptions needed to protect all riparian functions across all sites, understanding site-specific conditions is critical to effective guideline implementation."

Bordelon, M. D. McAllister, R. Holloway. (2000). Sustainable Forestry: Oregon Style. Journal of Forestry 98 (1), January: 26-34.

Full text available online at:
http://www.geo.oregonstate.edu/classes/geo300/Bordelon.htm

Summarizes management strategies for NW Oregon state forests. Discusses Greatest Permanent Value rule, active, structure-based management and how it will be applied to achieve 5 different forest stand types that represent "snapshots" across the continuum of historical forest development (regeneration, closed single canopy, understory, layered and older forest structure), designing for wildlife diversity, functional patch size, interior habitat area and patch placement.

Bragg, D. C. and J. L. Kershner (1999). Coarse woody debris in riparian zones. Journal of Forestry April: 30-35.

Brinson, M. M. and J. Verhoeven (1999). Riparian forests. In Maintaining biodiversity in forested ecosystems. M. L. Hunter, ed. Cambridge, England, Cambridge University Press**:** 265-299.

Bushman, M. (2003). Drinking from the rainforest: A survey of community watersheds in Oregon's northwest area state forests. Portland OR, Tillamook Rainforest Coalition.

Full text available online at:
http://www.tillamookrainforest.org/TRC/media/Resources/asset_upload_file668_866.pdf

Report commissioned by Tillamook Rainforest Coalition concerning relationships between Oregon state forests and municipal water supplies.

Cole, M. B., K. R. Russell and T. J. Mabee. (2003). Relation of headwater macroinvertebrate communities to in-stream and adjacent stand characteristics in managed second-growth forests of the Oregon Coast Range mountains. Canadian Journal of Forest Research 33 (8) 1433-1443.

"Although headwater streams constitute a significant portion of stream length within watersheds, their aquatic fauna, contributions to regional biodiversity, and responses to forest management have been understudied. Macroinvertebrate communities, physical habitat, and water chemistry were sampled from 40 headwater streams in managed forests in the Oregon Coast Range mountains. We characterized functional and structural attributes of macroinvertebrate communities in relation to physical, chemical, and biological gradients.

Substrate composition, specific conductance, and riparian forest age showed the strongest correlations with resultant ordination patterns in ma cro in ver te brate community composition. Among individual metrics of community structure and composition, total macroinvertebrate density and dominance by three taxa showed the strongest correlations with forest age. No community measures were related to densities of torrent salamanders (Rhyacotriton kezeri) or crayfish (Pacifastacus leniusculus), suggesting these potential predators had little influence on overall macroinvertebrate community structure.

Rare taxa were sampled from several reaches, including Rhyacophila probably viquaea for which little information is available, and an Eobrachycentrus sp., previously known to occur only in the Cascade mountains. Headwater streams within these managed forests of northwestern Oregon appear to be taxa rich, continue to support taxa limited to headwater streams, and harbor taxa about which little is known."

Curtis, R. O. (1995). Extended rotation and culmination age of coast Douglas-fir: Old studies speak to current issues. Portland OR, USDA Forest Service, Pacific Northwest Research Station Research Paper PNW-RP-485. 49 pages.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/rp485.pdf

"Trends of mean annual increment and periodic annual increment were examined in 17 long-term thinning studies in coast Douglas-fir (Pseudotsuga menziesii var. menziesii (Mirb.) Franco) in western Washington, western Oregon, and British Columbia. Maximum ages included ranged from about 90 years on high sites to 117 years on a low site. None of the stands had clearly reached culmination of mean annual increment, although some appeared close; periodic annual increments declined only slowly.

Extended rotations combined with increased thinning harvests are promising components of any *strategy to reduce conflicts between timber production and other forest values. These comparisons indicate that rotations can be considerably extended without reducing long-term timber production.*

A major problem in such a strategy is design of thinning regimes that can maintain some reasonable level of timber flow during any transition period."

Curtis, R. O. and A. B. Carey (1996). Timber supply in the Pacific Northwest: Managing for economic and ecological values in Douglas-fir forests. Journal of Forestry: 4-37.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/pnw_1996_curtis001.pdf

Nontechnical summary of silvicultural strategies for balancing timber harvesting with ecological values. From the introduction:

"The Douglas-fir region of western Washington and Oregon and coastal British Columbia contains the most productive forestlands in North America. Yet disagreement among user groups and conflicting goals, policies and laws have nearly paralyzed timber management on federal lands and greatly increased costs and complexity of management on nonfederal lands. Constructive compromise among competing interests is needed. Most private and state lands and some portion of federal lands will have timber production as a major objective for the foreseeable future. To accommodate this objective, we need to provide sustainable production of timber while minimizing conflicts with other forest values.

Extended rotations combined with certain other practices to promote nontimber values can be valuable tools in efforts to achieve this objective."

Curtis, R. O. (1997). The role of extended rotations. In Creating a Forestry for the 21st Century. K. Kohm and J. Franklin, eds. Washington D.C., Island Press**:** 165-170.

"The theme of this chapter is that progressive shortening of rotations in recent decades has been a factor in the genesis of current resource management controversies, and that a shift to extended rotations on some part of the land base- combined with certain other measures- can be a valuable component of any overall strategy to deal with these problems."

Curtis, R. O., D. S. Debell, et al. (1998). Silviculture for multiple objectives in the Douglas-fir region. Portland, OR, USDA Forest Service, Pacific Northwest Research Station PNW-GTR-435**:** 123 pages.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/gtr435/gtr435a.pdf

"Silvicultural knowledge and practice have been evolving in the Pacific Northwest for nearly a century. Most research and management activities to date have focused on two major topics: (1) methods to regenerate older, naturally established forests after fire or timber harvest; and (2) growth and management of young stands. Today forest managers can reliably regenerate the major conifer and hardwood species under most conditions by using combinations of natural and artificial regeneration. They also can control stand density and species composition and growth of individual trees, thereby influencing stand structure. Available growth models can reasonably predict the outcome of growing conifer stands under a range of densities, species composition, and management scenarios, providing tree numbers by size class as well as crown characteristics and wood yields.

Most silvicultural efforts have been financed through and directed toward production of wood. Although some other values have been produced or improved in conjunction with such activities, public interest and emphasis on nontimber values have increased. It has become apparent that some values are not benefited by silvicultural practices aimed solely at wood production. In most situations, however, desired nontimber values can be enhanced by silvicultural measures implemented for their direct benefit or by some modifications of practices applied primarily to produce wood. We discuss the historical development of silviculture in the Pacific Northwest and review the silvicultural practices currently available to forest managers. We then point out how these practices can be modified and used to maintain and produce wildlife habitat, diverse stand structures (including those usually associated with old forests) and pleasing scenery, while also producing wood products. Most of the silvicultural knowledge needed to design and implement regimes for integrated production of these multiple values already exists."

Dent, L. F. and J. B. S. Walsh (1997). Effectiveness of riparian management areas and hardwood conversions in maintaining stream temperature. Salem, OR: Forest Practices Monitoring Program, Oregon Department of Forestry. 65 pages.

Full text available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/fpmp/Projects/Stream_Temperature/techrpt3.pdf

Dent, L. (2001). Harvest effects on riparian function and structure under current Oregon Forest Practice rules. Salem, OR, Oregon Department of Forestry. Technical Report 12. 82 pages.

Full text available online at:
http://www.odf.state.or.us/DIVISIONS/protection/forest_practices/fpmp/Projects/Riparian_Inventory/RipFunFinal.PDF

Study investigated effectiveness of 1994 Oregon Forest Practice rules for riparian areas.

Recommendations: "The great amount of variability observed in existing basal areas indicates that a single basal area target is problematic. In general, the rules are adequate at maintaining

structure that is predicted to protect large wood recruitment and shade on large streams. The degree to which and the frequency with which pre-harvest basal area exceeded the standard target on small and medium streams indicates that the existing targets are likely to be too low to achieve the desired future condition as described in OAR-629-640-110 [LIVE TREE RETENTION CREDIT FOR IMPROVEMENT OF TYPE F STREAMS].

This conclusion is supported by the findings of substantial reductions in large wood recruitment (LWR) and cover on small streams and for riparian areas managed with a riparian conifer regeneration (RCR) prescription. Moderate reductions were also observed on medium streams. This conclusion is further supported by the finding that the standard targets underestimated average basal area for mature riparian forests in Interior and West Cascade streams.

The following recommendations are made:

The Board of Forestry should re-evaluate the standard targets for basal area to better address the range of conditions and better reflect the capabilities of riparian areas on medium and small streams, particularly in the Interior and West Cascade regions.

The Board of Forestry should consider changes to vegetation ruls to increase the maintenance and promotion of shade and potential LWR on small and medium streams.

The Board of Forestry should investigate the advantages and disadvantages of the RCR prescription with greater detail and on a larger scale. In the interim, riparian areas that are going to be managed undert this prescription should undergo a detailed assessment to ensure that existing sources of future large wood are adequately maintained and that regeneration stocking standards are achieved.

The Board of Forestry should evaluate on a larger scale the trends in both conifer and hardwood regeneration within riparian areas. The goal should be to determine if the results from this study are reliable and if there are management strategies that will continue to improve regeneration within 100 feet of the stream."

Duncan, S. (2002). Changing the scale of our thinking: landscape level learning. Science Findings (45): 1-5. PNW Research Station, USDA Forest Service, Portland, OR.

Full text available online at:
http://www.fsl.orst.edu/clams/pdf/pub_scifi45.pdf

"This science finding describes a new approach to evaluating sustainability that helps scientists, policymakers and the public understand the potential consequences of different forest practices at broad landscape scales.

The Coastal Landscape Modeling and Assessment Study (CLAMS) takes on the analysis of management and policy effects at broad scales. The study integrates remote sensing, inventory plots, GIS landowner management intentions, and biophysical models to project potential

ecological and socioeconomic consequences of different forest policies in a mapped format. The study is trying to anticipate future problems, rather than just focusing on resolving current ones."

Duncan, S. (2003). The scourge of the yellow trees: Tackling Swiss needle cast in the Coast Range. Science Findings (58), PNW Research Station, USDA Forest Service, Portland, OR.

Full text available online at:
http://www.fs.fed.us/pnw/sciencef/scifi58.pdf

Nontechnical summary of the Swiss needle cast epidemic in Pacific Northwest coastal Douglas fir timber plantations and forests. Includes a discussion of management options.

Durst, J. D. and J. M. Ferguson (2000). Buffer strip function and design: An annotated bibliography, Alaska Dept. of Fish and Game, Habitat and Restoration Division.

Full text available online at:
http://www.dnr.state.ak.us/forestry/docs/1LitBufferDesign8-7-00.doc

Summary of 32 references on stream buffers. Includes annotations of principal findings/conclusions from each.

Durst, J. D. and J. M. Ferguson (2000). Large woody debris: An annotated bibliography, Alaska Dept. of Fish & Game, Habitat and Restoration Division. 20 pages.

Full text available online at:
http://www.dnr.state.ak.us/forestry/docs/3Lit-LWD8-11.doc

Annotations are primarily author abstracts. Compiled for the Alaska Dept. of Fish & Game, Region III Forest Practices Riparian Management Committee.

Emmingham, B., S. Chan, et al. (2000). Silviculture practices for riparian forests in the Oregon Coast Range. Research Contribution 24. Corvallis OR, Oregon State University.

INR archive. Full text available online at:
http://fcg.cof.orst.edu/rc/RC24.pdf

"This publication is aimed at watershed councils, government agencies, and specialists (foresters, wildlife and fisheries biologists) interested in riparian area silviculture or watershed restoration. It contains information on the ecology of riparian forests and a checklist of recommended practices and common mistakes made in restoring conifers to hardwood-dominated riparian forests. Our recommendations are based on 1) an evaluation of 34 riparian restoration projects spanning the Coast Range of Oregon, 2) three case studies of riparian restoration projects, and 3)

ongoing research projects aimed at learning how to establish or release conifers in riparian forests.

We found that project managers were choosing appropriate conifer species and stock types for planting, but the survival and growth of conifers in the understory were poor. Managers were underestimating the competitive power of shrub and hardwood communities. In some cases, conflicting objectives and lack of priority setting led to the failure of expensive projects. We hope this publication will assist managers in efforts to restore healthy riparian forests and dwindling fish stocks."

Filip, G., A. Kanaskie, et al. (2000). Silviculture and Swiss needle cast: Research and recommendations. Forest Research Laboratory, College of Forestry, Research Contribution 30. Oregon State University, Corvallis, OR.

INR archive. Full text available online at:
http://fcg.cof.orst.edu/rc/RC30.pdf

Non-technical summary of knowledge about Swiss needle cast in NW coastal forests, including management recommendations.

Filip, G. (2003). Swiss Needle Cast Research Cooperative Annual Report. Corvallis OR, Department of Forest Science, Oregon State University**:** 75 pages.

Full text available online at:
http://www.cof.orst.edu/coops/sncc/sncc_03.pdf

Summarizes current knowledge, research and trends in Swiss needle cast infected forests.

Forest practices advisory committee on salmon and watersheds. (2000). Final report. Salem, OR, Oregon Department of Forestry**:** 74.

Full text (including the 24 recommendations) available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/FPAC/RptTOC.pdf

Paraphrased from the introduction/overview: "The FPAC was a diverse committee of Oregonians convened in 1999 in accordance with Governor Kitzhaber's EO 99-01, and charged with 1) determining what, if any, changes to forest practices, both regulatory and voluntary, are necessary to meet water quality standards and to protect and restore salmonids; and 2) making specific recommendations to the Board of Forestry.

The committee examined the scientific literature and monitoring results and heard from scientists and policymakers. They reviewed an IMST report of forest practices and deliberated on and sought scientific review on a series of issue papers, and debated options to achieve objectives

relating to fish passage, landslides, roads, landscapes, and riparian functions....following lengthy deliberations, the committee achieved consensus or strong agreement on 24 recommendations that included not only regulatory changes but also incentives and voluntary activities.

While there were often 13 different opinions among committee members, it is fair to say that there were two dominant mindsets...reflecting viewpoints regarding a range of issues and how facts are received and interpreted...these two mindsets had differences in viewpoints about desired future conditions, acceptable levels of risk and the probability of adverse effects, as well as different views in the relative importance of unintended consequences- land use change, disincentives for doing management, and maintaining a viable forest-based economy. Facilitators, committee members and staff worked diligently to create solutions that considered and balanced the range of viewpoints and that reflected a spirit of compromise."

The 24 recommendations were grouped into 4 major issue categories:

-fish passage
-forest roads
-landslides
-riparian function

Franklin, J. F., D. Perry, et al. (2000). Simplified forest management to achieve watershed and forest health: A critique. Seattle, WA, National Wildlife Federation**:** 46 pages.

Full text available online at:
http://www.coastrange.org/documents/forestreport.pdf

Critique of structure-based forest management commissioned by the National Wildlife Federation. Questions assertions that managed forests are not highly susceptible to destruction from natural disturbances whereas unmanaged forests are, and that forest reserves are thus a poor conservation strategy.

The authors agree that thinning (especially variable density thinning) of densely stocked, young to mid-aged stands can increase tree vigor, encourage understory growth and enhance structural complexity in managed stands. They also agree that thinning can reduce the risk of stand-replacing fire in forests where natural fire has been actively excluded.

Discusses management plan for NW Oregon state forests on pages 32-33. States that longer rotations and various-sized regeneration harvests specified by managers in order to move toward more complex and older forest structure on 20-30% of the landscape move in the right direction. Also argues that plans to leave no lands free from eventual harvest are a significant drawback from the standpoint of conservation biology, particularly in an area where land ownership patterns provide no other options for reserves.

"We support the notion that silvicultural activities- structure-based management in the broadest sense- can assist in the maintenance of biological diversity and other ecological services in

managed stands. We do not believe, however, that scientific literature or forestry experience supports the notions that intensively managed forests can duplicate the role of natural forests, or that sufficient knowledge and ability exist to create even an approximation of a natural old-growth forest stand."

Franklin, J. F., D. R. Berg, et al. (1997). Alternative silvicultural approaches to timber harvesting: Variable retention harvest systems. In Creating a Forestry for the 21st Century. K. Kohm and J. Franklin, eds. Washington D.C., Island Press**:** 111-139.

"Recent research on forest ecosystems has clarified the importance of structural complexity to forest ecosystem functioning and the maintenance of biological diversity. Important structural features include snags, woody debris on the forest floor, multiple canopy layers, varied sizes and conditions of live trees, and presence of canopy gaps. Research has also made clear the dramatic impacts that clearcutting and other management activities can have on biological diversity and ecosystem function. As a result of this new knowledge, the creation and maintenance of structurally complex managed stands is being developed as the primary approach to managing forests for multiple, complex objectives, including production of wood products.

Silvicultural methods based on significant structural retention at the time of harvest are the subject of this chapter. Such approaches may involve retention of individual trees, snags, logs, or small patches of forest on the harvest unit, usually for at least the next rotation. Such cuttings are conducted in stands that are at least at economic, if not biological, maturity. Because long rotations are often proposed as an alternative to retention harvest methods, we begin by contrasting the relative advantages of the two approaches. Next we illustrate the flexibility of using a retention harvest philosophy and identify the important variables in retention silvicultural prescriptions: which structures, how much of each, and in what spatial patterns. Current evidence for the effectiveness of structural retention in achieving objectives such as maintenance of wildlife habitat is reviewed, and important research needs are identified. We conclude by proposing that traditional regeneration harvest methods and terminology be supplemented by a more flexible and ecumenical approach based upon a continuum of retention levels."

Gende, S. M., R. T. Edwards, et al. (2002). Pacific salmon in aquatic and terrestrial ecosystems. BioScience 52 (10).

Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/pnw_2002_gende001.pdf

Discusses ecological role of salmon, especially transfer of ocean nutrients to terrestrial ecosystems.

"Salmon runs in the Pacific Northwest have been declining for decades, so much so that many runs are threatened or endangered; others have been completely extirpated. This "salmon crisis" looms large in the public eye, because it has serious and wide-ranging economic, cultural, and ecological repercussions. Billions of dollars have gone into industrial and agricultural projects

that alter regional rivers in ways that, often unintentionally, make them inaccessible or unsuitable for salmon. Recently, billions more have been spent in largely unsuccessful attempts to restore the languishing salmon runs. Moreover, enormous nonmonetary resources have been expended in assigning and denying responsibility for failed runs and debating the possible efficacy of various remedies.

As resources that are devoted to reversing declining runs of salmon have increased, scientists and resource managers have been expanding our understanding of the ecological role of salmon and other anadromous fishes, which return from the sea to spawn in fresh water. We have known for years that spawning salmon serve as a food resource for wildlife species and, when they die after spawning (as most Pacific salmon do), their carcasses provide nutrients (e.g., carbon [C], nitrogen [N], phosphorus [P]) to freshwater systems. More recently, scientists have documented that these "salmon-derived nutrient" subsidies may have significant impacts on both freshwater and riparian communities and on the life histories of organisms that live there.

Because of the burgeoning interest in salmon, growing indications of their ecological importance, and recent calls for management to consider the role of salmon in aquatic and terrestrial ecosystems, we take this opportunity to review what is understood about the function of salmon as key elements of ecological systems. Our objectives are twofold. First, we expand on previous reviews of salmon to include recent research that has amplified and modified earlier ideas about the contribution of salmon to ecosystem processes. In doing so, we describe the composition, magnitude, and distribution of marine inputs to freshwater and terrestrial systems via salmon.

We use an expanding group of studies pertaining to stream nutrient budgets and salmon physiology to construct a schematic that illustrates salmon-derived products and the pathways by which they enter and are retained in aquatic and terrestrial food webs. We then consider the ecological variation associated with salmonid ecosystems and how this may influence the ecological response to the salmon input. Second, we consider how this variation in ecosystem response may influence management and conservation efforts. We conclude by suggesting new research directions to help fill the gaps in our current understanding of salmonid ecosystems."

Grant, G. (1988). The RAPID technique: a new method for evaluating downstream effects of forest practices on riparian zones. Portland, OR, US Dept. of Agriculture, Forest Service, Pacific Northwest Research Station Gen. Tech. Rep. PNW-GTR-220**:** 36 pages.

Full text available online at:
http://www.krisweb.com/biblio/gen_usfs_grant_1988_gtr220.pdf

"The downstream effect of forest practices has proved difficult to evaluate for a number of reasons. Differences in rock type, hydrology, topography, soils and disturbance history may all produce highly variable responses among drainage basins. In particular, the management history of a basin is often complex, with logging and road construction taking place over prolonged periods in different parts of the basin, which makes comparisons between basins with different histories uncertain. In addition, similar processes can give rise to different end results, depending on the type of terrain. Conversely, a particular form of channel response can often be attributed to

multiple causative factors. All of these circumstances make it difficult to evaluate the causes and importance of downstream effects.

A study was undertaken to determine whether off-site effects of timber harvest activities were an important factor in producing channel changes among fourth and fifth order streams in the western Cascade Range of Oregon. In this paper, we suggest a theoretical framework for predicting how different off-site effect mechanisms might influence stream channel morphology. We also present an air photo interpretation technique for measuring stream channel response to disturbance, and report preliminary results from the analysis of a large storm event."

Gray, A. N. (2000). Adaptive Ecosystem Management in the Pacific Northwest: a Case Study from Coastal Oregon. Conservation Ecology **4**(2).

Full text available online at:
http://www.ecologyandsociety.org/vol4/iss2/art6/

Describes Adaptive Management Area (AMA) in region of federal lands adjacent to Tillamook State Forest.

"Adaptive ecosystem management has been adopted as a goal for decision making by several of the land management and regulatory agencies of the U.S. government. One of the first attempts to implement ecosystem management was undertaken on the federally managed forests of the Pacific Northwest in 1994. In addition to a network of reserve areas intended to restore habitat for late-successional terrestrial and aquatic species, "adaptive management areas" (AMAs) were established. These AMAs were intended to be focal areas for implementing innovative methods of ecological conservation and restoration and meeting economic and social goals.

This paper analyzes the primary ecological, social, and institutional issues of concern to one AMA in the Coast Range in northern Oregon. Based on existing knowledge, several divergent approaches are available that could meet ecological goals, but these approaches differ greatly in their social and economic implications. In particular, approaches that rely on the natural succession of the existing landscape or attempt to recreate historical patterns may not meet ecosystem goals for restoration as readily as an approach based on the active manipulation of existing structure and composition. In addition, institutions are still adjusting to recent changes in management priorities.

Although some innovative projects have been developed, adaptive management in its most rigorous sense is still in its infancy. Indeed, functional social networks that support adaptive management may be required before policy and scientific innovations can be realized. The obstacles to adaptive management in this case are similar to those encountered by other efforts of this type, but the solutions will probably have to be local and idiosyncratic to be effective."

Gregory, S. V., G. A. Lamberti, et al. (1987). Influence of forest practices on aquatic production. In Streamside management: Forestry and fishery interactions: Proceedings of a

symposium, Seattle, WA, University of Washington, Institute of Forest Resources.

Gregory, S. V., F. J. Swanson, et al. (1991). An ecosystem perspective of riparian zones: focus on links between land and water. BioScience 41(8): 540-551.

Full text available online at:
http://www.entomology.cornell.edu/Faculty_Staff/Peckarsky/Ento456/GregoryBioS91.pdf

Based on work in H.J. Andrews Experimental Forest, Oregon.

"We propose a conceptual model of riparian zones that integrates the physical processes that shape valley-floor landscapes, the succession of terrestrial plant communities on these geomorphic surfaces, the formation of habitat, and the production of nutritional resources for aquatic ecosystems."

Gregory, S. (1997). Riparian management in the 21st century. In Creating a Forestry for the 21st Century: The Science of Ecosystem Management. K. Kohm and J. Franklin, eds. Washington, D.C., Island Press**:** 69-86.

INR archive.

An excellent discussion of riparian ecology with an emphasis on watershed-scale management and ecosystem processes. Emphasis on the Pacific Northwest.

Gregory, S., K. Boyer, et al. (2003). The Ecology and Management of Wood in World Rivers. Bethesda, MD, American Fisheries Society. 431 pages.

Hagan, J. M. and S. L. Grove (1999). Coarse woody debris. Journal of Forestry January: 6-11.

Hairston-Strang, A. B. and P. W. Adams (1998). Potential large woody debris sources in riparian buffers after harvesting in Oregon, USA. Forest Ecology and Management 112(1-2): 67-77.

Hansen, E., J. Stone, et al. (2000). Incidence and impacts of Swiss needle cast in forest plantations of Douglas fir in coastal Oregon. Plant Disease 84: 773–778.

INR archive.

Abstract: "An epidemic of Swiss needle cast, caused by the ascomycete Phaeocryptus gaeumannii, is causing defoliation and growth reductions in Douglas-fir forest plantations along the Oregon

Coast. The area of symptomatic plantations has been monitored continuously since 1996, by aerial survey; in spring 1999, 119,500 ha were affected.

Pathogen and symptom development have also been monitored on nine permanent plots in stands of differing disease severity. Infection levels and symptoms severity are greatest in low elevation plantations close to the coast. In areas of severe disease, trees retain only current year needles. Defoliation is proportional to the number of stomata occluded by pseudothecia of the fungus, with needles being shed when about 50% of stomata are occupied, regardless of needle age. Fungus sporulation and premature needle abscission are greatest on the upper branches of trees. Annual application of fungicides increases needle retention significantly.

Tree height and diameter growth and total tree volume are reduced by disease, and tree volume is significantly correlated with needle retention on our plot trees. The epidemic continues to be most severe in Douglas-fir plantations established on sites where Sitka spruce and western hemlock or red alder predominated in earlier times."

Hayes, J. P. (1998). An Independent Scientific Review of Oregon Department of Forestry's Proposed Western Oregon State Forests Habitat Conservation Plan. Corvallis, OR, Department of Forest Science, College of Forestry, Oregon State University.

INR archives.

Report by a team of 26 researchers from OSU Department of Forestry, University of Washington, University of California, USFS Pacific Northwest Research station and other institutions. The team reviewed the scientific basis of conservation strategies identified in ODF's proposed northwestern Oregon state forest management plan and proposed Habitat Conservation Plan, and assessed the feasibility that the proposed strategies would achieve the objectives identified by ODF.

Some recommendations contained in this report were incorporated into ODF's management strategies for northwestern Oregon state forests, including the SAH Strategy.

Hermann, R. K. and D. P. Lavender (1999). Douglas-fir planted forests. New Forests 17(1-3): 53-70.

Argues that active management of Douglas-fir in cultivated forests can reduce pressure on other, more natural forests.

"A combination of superior wood quality and high productivity has made Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco) one of the premier timber trees in the world. As such, it is grown as a plantation species in several countries in Europe, South America, New Zealand, and Australia, as well as throughout its extensive natural range in western North America. Decades of experience with the silviculture of young stands have demonstrated that practices such as planting, the use of genetically improved seedlings, precommercial and commercial thinning, and

fertilization may dramatically increase the yield of industrial products over that of natural forests. Further, such silviculture is compatible with the production of desired amenities. Vigorous implementation of such practices wherever Douglas-fir is cultivated will increase the world's timber resources, and be an effective strategy for reducing the pressure, occasioned by the world's rapidly increasing population, to harvest the fragile tropical and boreal forests."

Hibbs, D. E. and P. A. Giordano (1996). Vegetation characteristics of alder-dominated riparian bufferstrips in the Oregon Coast Range. Northwest Science 70(3): 213-222.

Hibbs, D. E. and A. L. Bower (2001). Riparian forests in the Oregon Coast Range. Forest Ecology and Management 154: 201-213.

Hobbs, S. D., J. P. Hayes, et al. (2002). Forest and Stream Management in the Oregon Coast Range. Corvallis, OR, Oregon State University Press. 276 pages.

Up to date, comprehensive synthesis of several years of collaborative research. Deals exclusively with the Oregon Coast Range. Ten chapters written by scientists from leading research institutions. Chapters include:

-Forest and stream management in the Oregon Coast Range: Socioeconomic and policy interactions
-The ecological basis of forest ecosystem management in the Oregon Coast Range
-Fish and aquatic ecosystems of the Oregon Coast Range
-Ecology and management of wildlife and their habitats in the Oregon Coast Range
-Timber harvesting to enhance multiple resources
-Silviculture of Oregon Coast Range forests
-Major forest diseases of the Oregon Coast Range and their management
-Landslides, surface erosion, and forest operations in the Oregon Coast Range
-Moving toward sustainability

Hunter, M. G. (2001). Management in young forests. Corvallis, OR, Cascade Center for Ecosystem Management, Communique #3. Department of Forest Resources, Oregon State University/USDA Forest Service, PNW Research Station/Willamette National Forest. 28 pages.

Full text available online at:
http://www.fsl.orst.edu/ccem/pdf/Comque3.pdf

Excellent nontechnical review of young forest stand management and research in the Pacific Northwest since 1993, and examination of possible pathways to the future. Explores a range of active management options for setting densely stocked, even aged, young second growth stands on different trajectories to meet multiple future goals, and explores what is known as well as limitations in scientific understanding of possible consequences.

Much of the research reviewed is being conducted in Oregon westside forests.

Keim, R. F., A. B. Price, et al. (2004). An annotated bibliography of selected guides for stream habitat improvement in the Pacific Northwest. Corvallis, OR, Forest Research Laboratory, Oregon State University, Research Contribution 44. 32 pages.

INR archive.

Nontechnical summary of strengths and weaknesses of several guides. "Interest in aquatic habitat improvement in the Pacific Northwest has expanded beyond fisheries managers in recent years to include land managers, nongovernmental organizations, and the general public. The major difficulty faced by individuals who wish to improve aquatic habitat is that there is no single, concise source of information to help them make informed decisions about whether modifications are appropriate and if so, how to proceed.

In a recent publication, university researchers and USGS scientist Robert Gresswell developed an annotated bibliography that reviews 11 guides to stream habitat improvement so that readers can find literature appropriate to their needs. Each review begins with a summary of the contents, stated audiences, and goals of each guide. Reviews also include subjective comments on the strengths and weaknesses of each guide. This bibliography also includes recommendations of guides and combinations of guides judged most useful for a range of purposes."

Kohm, K. A. and J. F. Franklin (1997). <u>Creating a forestry for the 21st century: The science of ecosystem management</u>. Washington D.C., Island Press. 475 pages.

INR archive.

Excellent compilation of separately authored chapters on current forest management strategies. Detailed but non-technical.

"Creating a Forestry for the 21st Century is a multidisciplinary examination of the current state of forestry and its relation to the emergent field of ecosystem management. It provides an up-to-date synthesis of principles of ecosystem management and their implications for forest policy. Leading scientists examine topics that are central to the future of forestry:

> *-new understandings of ecological processes and principles, from stand structure and function to disturbance processes and the movement of organisms across landscapes*
>
> *-challenges to long-held assumptions: the rationale for clearcutting, the wisdom of short rotations, the exclusion of fire*
>
> *-traditional tools in light of expanded goals for forest landscapes*
>
> *-managing at larger spatial scales, including practical information and ideas for managing*

large landscapes over long time periods

-the economic, organizational, and political issues that are critical to implementing successful ecosystem management and developing institutions to transform knowledge into action."

Maas-Hebner, K. G. and B. A. Schraeder (2001). The effects of silviculture activities on wildlife and fish populations in Oregon and the Pacific Northwest: An annotated bibliography from 1960 to 1999. Corvallis, OR, College of Forestry, Oregon State University.

Macdonald, J.S., E.A. MacIsaac, H.E. Herunter. (2003). The effect of variable-retention riparian buffer zones on water temperatures in small headwater streams in sub-boreal forest ecosystems of British Columbia. Canadian Journal of Forest Research 33 (8): 1371-1382.

"Stream temperature impacts resulting from forest harvesting in riparian areas have been documented in a number of locations in North America. As part of the Stuart–Takla Fisheries–Forestry Interaction Project, we have investigated the influence of three variable-retention riparian harvesting prescriptions on temperatures in first-order streams in the interior sub-boreal forests of northern British Columbia. Prescriptions were designed to represent a range of possible harvesting options outlined by the Forest Practices Code of B.C., or associated best management practice guidelines.

Five years after the completion of harvesting treatments, temperatures remained four to six degrees warmer, and diurnal temperature variation remained higher than in the control streams regardless of treatment. Initially, the high-retention treatment acted to mitigate the temperature effects of the harvesting, but 3 successive years of windthrow was antecedent to reduced canopy density and equivalent temperature impacts. We speculate that late autumn reversals in the impacts of forest harvesting also occur.

Temperature impacts in this study remained within the tolerance limits of local biota. However, even modest temperature changes could alter insect production, egg incubation, fish rearing, migration timing, and susceptibility to disease, and the effects of large changes to daily temperature range are not well understood."

Maser, C. and J. R. Sedell (1994). From the forest to the sea: The ecology of wood in streams, rivers, estuaries, and oceans. Delray Beach, FL, St. Lucie Press.

"From the Forest to the Sea: The Ecology of Wood in Streams, Rivers, Estuaries and Oceans discusses the role wood plays in very complex and diverse aquatic ecosystems. Until now almost nothing has been published on this little understood topic.

1. Wood in streams and rivers is a source of food energy for invertebrate organisms; habitat for vertebrate organisms, such as fish; and a structural component that shapes, diversifies, and stabilizes channels while helping to dissipate the water's energy before it can scour channels.

2. Wood in estuaries is a major source of food and habitat for obligatory, wood boring, marine invertebrates that in their feeding , break it down and pass usable carbon into the water's current where it enters the detrital based marine food web.

3. Wood along the coastline stabilizes sand spits, beaches, and dune complexes, as well as battering rocky shores where it creates new habitats for intertidal organisms and provides small splinters of wood to the coastal food chain.

4. Driftwood floating in the open ocean attracts a variety of marine invertebrates and fishes, forming a floating surface community that helps organisms colonize new areas. Large fishes, such as tuna, not only feed on smaller fishes attracted to the wood but also drift with it because its movement is controlled by wind and current; thus tuna find the best feeding areas-current interfaces rich in food species.

5. A common textbook perception on marine biology is that, while communities of bacteria can use sulfur compounds as energy and animals can and do live around deep-sea hydrothermal vents through which hot water issues in the ocean's floor, the rest of the oceans bottom is almost devoid of life. But as driftwood becomes waterlogged and sinks, it represents terrestrially-fixed carbon in the energy poor deep-sea where at least three species of wood-borers convert it into a readily available source of detritus that in turn supports the development of complex communities of bottom-dwelling organisms.

6. The loss of wood to aquatic ecosystems means destabilization of streams, estuaries, dunes and beaches as well as food chains in the oceans of the world. Sooner or later it may mean the loss of jobs and unique cultural ways of life such as the commercial fishing of certain species."

May, C. L. and R. E. Gresswell (2003). Large wood recruitment and redistribution in headwater streams in the southern Oregon Coast Range, U.S.A. Canadian Journal of Forest Research 33 (8): 1352-1362.

"Large wood recruitment and redistribution mechanisms were investigated in a 3.9 km2 basin with an old-growth Pseudotsuga menziesii (Mirb.) Franco and Tsuga heterophylla (Raf.) Sarg. forest, located in the southern Coast Range of Oregon. Stream size and topographic setting strongly influenced processes that delivered wood to the channel network. In small colluvial channels draining steep hillslopes, processes associated with slope instability dominated large wood recruitment.

In the larger alluvial channel, windthrow was the dominant recruitment process from the local riparian area. Consequently, colluvial channels received wood from further upslope than the alluvial channel. Input and redistribution processes influenced piece location relative to the direction of flow and thus, affected the functional role of wood. Wood recruited directly from local hillslopes and riparian areas was typically positioned adjacent to the channel or spanned its full width, and trapped sediment and wood in transport.

In contrast, wood that had been fluvially redistributed was commonly located in mid-channel *positions and was associated with scouring of the streambed and banks. Debris flows were a unique mechanism for creating large accumulations of wood in small streams that lacked the capacity for abundant fluvial transport of wood, and for transporting wood that was longer than the bank-full width of the channel."*

McDade, M. H., F. J. Swanson, et al. (1990). Source distances for large woody debris entering small streams in western Oregon and Washington. Canadian Journal of Forest Research 20: 326-330.

Meleason, M. A., S. V. Gregory, et al. (2003). Implications of riparian management strategies on wood in streams of the Pacific Northwest. Ecological Applications 13(5): 1212–1221.

Full text available online at:
http://www.esajournals.org/esaonline/?request=get-document&issn=1051-0761&volume=013&issue=05&page=1212

"Riparian forest management plans for numerous regions throughout the world must consider long-term supply of wood to streams. The simulation model OSU STREAMWOOD was used to evaluate the potential effects of riparian management scenarios on the standing stock of wood in a hypothetical stream in the Pacific Northwest, USA. OSU STREAMWOOD simulates riparian forest growth, tree entry (including breakage), and in-channel processes (log breakage, movement, and decomposition). Results of three simulation scenarios are reported.

The first scenario assessed total wood volume in the channel from Douglas-fir plantations clearcut to the stream bank using three rotation periods (60, 90, and 120 yr). Without a forested riparian management zone, accumulation of wood in the channel was minimal and did not increase through time. In the second scenario, response of total wood volume to forested riparian management zones of widths between 6 m and 75 m was evaluated. Total wood volume associated with the 6 m wide nonharvested forest for forest ages ≥240 yr was 32% of the standing stock associated with a nonharvested forest buffer one potential tree height in width. Maximum standing stock associated with the channel for nonharvested riparian forests ≥30 m required 500-yr-old forests. In the third scenario, contribution of wood from forest plantations beyond nonharvested forests of various widths was explored. Forest plantations associated with nonharvested riparian buffers with widths >10 m contributed minimal amounts of wood volume to the stream.

These results suggest that forest age and width of the nonharvested buffers are more important than the rotation age of plantation forests in providing long-term supplies of wood to streams."

Minore, D. and H. G. Weatherly (1994). Riparian trees, shrubs, and forest regeneration in the coastal mountains of Oregon. New Forests 8: 249-263.

Mitchell, R., J. Franklin, et al. (2002). Natural disturbance-based silviculture for restoration

and maintenance of biological diversity. 120 pages.

Full text available online at:
http://www.ncseonline.org/ewebeditpro/items/O62F3299.pdf

"A natural disturbance model for management assumes that species have evolved to local environmental conditions and a particular disturbance regime, such that there is a greater opportunity for sustaining biodiversity when the disparity between managed disturbances and natural disturbances is reduced.

This document synthesizes current understanding of natural forest disturbances, particularly biological legacies associated with the disturbances, which is key to sustaining biological diversity. First we provide a review of what is generally know about natural disturbances and how they influence biological legacies. Secondly, we contrast how managed disturbances in forests differ from patterns and processes of natural disturbances, and how natural disturbance models may be implemented in silviculture for varied land objectives with a goal of conservation."

A case study from the Pacific Northwest is used to illustrate how silvicultural management is conserving native biodiversity by using natural disturbance as a guide."

Naiman, R. J., T. J. Beechie, et al. (1992). Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. In Watershed management: Balancing sustainability and environmental change. R. J. Naiman, ed. New York, NY, Springer-Verlag, New York**:** 127-188.

Full text available online at:
http://www.krisweb.com/biblio/gen_univwa_naimanetal_1992.pdf

"The premise of this article is that the delivery and routing of water, sediment, and woody debris to streams are the key processes that regulate the vitality of watersheds and their drainage networks in the Pacific Northwest coastal ecoregion. Five fundamental components of stream corridors are examined: basin geomorphology, hydrologic patterns, water quality, riparian forest characteristics, and habitat characteristics. Ecologically healthy watersheds require preservation of lateral, longitudinal, and vertical connections between system components as well as the natural spatial and temporal variability of those components. The timing and mode of interdependencies between fundamental components are as important as the magnitude of individual components themselves."

Naiman, R., P. Bisson, et al. (1997). Approaches to management at the watershed scale. In Creating a Forestry for the 21st Century: The Science of Ecosystem Management. K. Kohm and J. Franklin, eds. Washington, DC, Island Press: 239-254.

INR archive.

Naiman, R. J. and R. E. Bilby (1998). River ecology and management: Lessons from the Pacific coastal ecoregion. New York, Springer-Verlag.

"Touching all parts of the natural environment and nearly all aspects of human culture, streams and rivers act as centers of organization within landscapes. They provide natural resources such as fish and clean water, transportation, energy, diffusion of wastes, and recreation. Today, with unprecedented demands on streams and rivers by an exponentially increasing human population, a basic ecological understanding of the structure and dynamics of running waters is essential for formulating sound management and policy decisions. The vast Pacific coastal ecoregion of the United States contains an extraordinary array of physical settings and examples of the range of dynamics associated with rivers and their management. The interface between the science and policy of natural resource management is illustrated by examples from this ecoregion, including the protection of riparian forest, the marbled murrelet, salmon, and amphibians.

River Ecology and Management: Lessons from the Pacific Coastal Ecoregion includes sections on the Physical Environment, the Biotic Environment, Ecosystem Processes, Management, and Recommendations for the Future. Specific topics include channel dynamics, hydrology, water quality, microbial processes, primary production, fish and wildlife, riparian forest dynamics, organic matter and trophic dynamics, biogeochemical cycling, maintaining biodiversity, monitoring and assessment, economic perspectives, legal considerations, and the role of non-governmental organizations in river management."

Naiman, R. J., K. L. Fetherston, et al. (1998). Riparian forests. In River ecology and management: Lessons from the Pacific coastal ecoregion. R. J. Naiman and R. E. Bilby, eds. New York, Springer-Verlag**:** 289-323.

Naiman, R. J., R. E. Bilby, et al. (2000). Riparian ecology and management in the Pacific coastal rain forest. Bioscience 50(11): 996-1011.

INR archive. Full text available online at:
http://www.bioone.org/bioone/?request=get-document&issn=0006-3568&volume=050&issue=11&page=0996

"The last two decades have seen an enormous global research effort focused on understanding the dynamics and managerial uses of riparian zones. Riparius, a Latin word meaning "belonging to the bank of a river," refers to biotic communities living on the shores of streams, rivers, ponds, lakes, and some wetlands. Riparian zones strongly influence the organization, diversity, and dynamics of communities associated with aquatic ecosystems. Riparian areas possess distinct ecological characteristics because of their interaction with the aquatic system. Thus, their boundaries can be delineated by changes in soil conditions, vegetation, and other factors that reflect this aquatic–terrestrial interaction.

Riparian zones vary widely in their physical characteristics, which are vividly expressed by an array of life history strategies and successional patterns. Consequently, these areas are among the

biosphere's most complex ecological systems and also among the most important for maintaining the vitality of the landscape and its rivers. The variability of natural riparian zones reflects the inherent physical heterogeneity of the drainage network, the processes shaping stream channels, and the characteristics of the biotic community. In effect, riparian biota are the products of past and present interactions among biophysical factors. In turn, the biota themselves have strong, long-term influences on the geological structures and processes that shape them.

The riparian forests of the Pacific Coastal Ecoregion (PCE) of North America are floristically and structurally its most diverse vegetation, and their maintenance has become an integral component of watershed management strategies. Since 1990, significant advances in understanding the structure and dynamics of riparian zones in the PCE have led to their being recognized as key components of land and water management. Many of the region's management guidelines are based on these recent scientific advances as well as on the strong foundation of knowledge built by S.V. Gregory and his colleagues. In this article, we summarize the scientific advances of the last decade in understanding the ecology of PCE riparian zones and show how this understanding directly contributes to better stream and watershed management."

Nakamura, F. and F. J. Swanson (1994). Distribution of coarse woody debris in a mountain stream, western Cascade Range, Oregon. Canadian Journal of Forest Research 24: 2395-2403.

Newton, M., R. Willis, et al. (1996). Enhancing riparian habitat for fish, wildlife, and timber in managed forests. Weed Technology 10: 429-438.

Newton, M. and E. C. Cole (1998). Hardwood riparian forest rehabilitation and its impacts. Final report to: Starker Forests Inc.; Weyerhaeuser Co; Georgia Pacific Co; Cascades Timber Consultants Inc.; Oregon Department of Forestry, Forest Practices Division. Corvallis, Oregon, Oregon State University.

Nierenberg, T. R. and D. E. Hibbs (2000). A characterization of unmanaged riparian areas in the central Coast Range of western Oregon. Forest Ecology and Management 129 (1-3): 195-206.

"As an approach to providing baseline information about riparian ecosystems, this study characterized the dominant riparian vegetation along unmanaged streams in central Oregon Coast Range forests. We systematically sampled along various reaches of nine first- to fourth-order streams, all of which were subject to stand-replacing fires ca. 145 year ago. The near-stream communities were divided into different vegetative and/or topographic units called landscape units (LUs); LU1s were closest to the stream, and LU2s were farther from the stream. Fifty-two percent of LU1s had no trees, and among all LUs, red alder was the most frequently found tree species.

Although in some cases sample plots simply fell between widely spaced trees, we hypothesize that

red alder originally dominated many of the current treeless patches and has since senesced to release understory shrubs. With increased distance from the stream, hardwoods decreased in compositional importance relative to conifers, not because hardwood frequency changed, but because conifer frequency increased.

Our results suggest that the competitive advantage of hardwoods and shrubs is the biggest limiting factor of conifer growth in the near-stream micro-environment and that without vigorous competition conifers have the potential to grow over more of the riparian area than that on which they occurred in unmanaged areas. Calculations of disturbance frequency, based on ages of shade-intolerant stand dominants, indicate that along the stream reaches we sampled, a minimum of 2.6 disturbances per stream km per century occurred since the last stand-resetting fire. Riparian areas are spatially and temporally diverse, and any riparian management model should incorporate this variability."

Pabst, R. J. and T. A. Spies (1999). Structure and composition of unmanaged riparian forests in the coastal mountains of Oregon, U.S.A. Canadian Journal of Forest Research 29 (10): 1557-1573.

"We characterized the structure and composition of unmanaged riparian forests in three river basins in Oregon's coastal mountains. Our objective was to evaluate stand attributes at three spatial scales: streamside (site), drainage network (stream order), and basin (subregion). Data on basal area, species composition, snag density, canopy cover, and tree regeneration were collected along transects at 124 sites. Conifer basal area increased with distance from stream, a trend similar among subregions, and was highest at sites along first-order streams.

Hardwood basal area was relatively constant with distance from stream and was proportionally higher at sites along second- and third-order streams than at sites along first-order streams. Conifer and hardwood tree regeneration occurred infrequently and varied by topographic position, stream order, and subregion. Conifer regeneration was associated with basal area of shade-tolerant conifers and appeared to be limited by shrub competition.

The unmanaged forests we studied were characterized by a patchy mosaic of structure and composition. Hardwoods and shrubs were major components of the near-stream environment in these forests, whereas dominance of conifers was limited to hillslopes. It appears that fine-scale patterns associated with proximity to the stream are influenced by coarser scale factors such as valley-floor width and climate."

Pike, R. (2002). Bibliography of literature related to the effect of forest practices on water temperature and quality with a focus on Pacific Northwest coniferous studies. Victoria, BC, Canada, Southern Interior Forest Extension and Research Partnership.

Available online at:
http://www.forrex.org/programs/wmbibs/StreamTempAndBuffers.pdf

Reference list with 50 pages of references. Not annotated.
Pike, R. (2002). Stream temperature and buffer strips. Victoria, BC, Canada, Southern Interior Forest Extension and Research Partnership.

Available online at:
http://www.forrex.org/programs/wmbibs/StreamTempAndBuffers.pdf
Reference list with 6 pages of references. Not annotated.

Pike, R. (2002). **Turbidity and erosion.** Southern Interior Forest Extension and Research Partnership, Victoria, BC, Canada.

Full text available online at:
http://www.forrex.org/programs/wmbibs/SedimentTurbidityErosion.pdf

13-page bibliography of references related to the subjects of turbidity and erosion associated with forest management practices.

Poulin, V. A., B. S. Simmons, et al. (2000). Riparian silviculture: An annotated bibliography for practitioners of riparian restoration. BC Ministry of Forests: 35 pages.

Full text available online at:
http://www.clayoquot.org/cwfs%2002%20images/Riparian%20Silviculture%20An%20Annotated%20Bibliography%20for%20Practitioners%20of%20Riparian%20Restoration.pdf

Funded through BC Ministry of Forests by Forest Renewal BC, with assistance from several OSU professors. Annotated bibliography focusing on restoring riparian structure and function in managed forests with numerous references on western Oregon forests.

"The perspectives guiding choices of references include a conclusion that without active vegetation management, it may take 200 years to achieve diverse forest structure, and that watershed restoration should concentrate on restoring streamside vegetation rather than instream structural enhancement."

Rapp, V. (2002). Restoring complexity: Second-growth forests and habitat diversity. <u>Science Update 1</u>, USDA Forest Service, Pacific Northwest Research Station. 10 pages.

INR archive. Full text available online at:
http://www.fs.fed.us/pnw/scienceupdate1.pdf

"Many old-growth forests on federal lands were fragmented by timber harvests before old growth's ecological values were recognized. In the resulting mosaic, the development of the plantations will be an important factor affecting what ecological values will be provided by these landscapes. If the conifer plantations can develop some old-growth characteristics, then it is likely that the

broader forest landscape will provide the ecological values of old-growth forests.
Key findings:

1. Many old-growth trees grew more rapidly in their first 50 years than young trees in unthinned conifer plantations are growing today. Tree-ring studies show that in many old-growth forests, the dominant trees often gained diameter rapidly in their first 50 years.

2. In dense, uniform, conifer plantations, one or more variable-density thinnings could promote increases in biological diversity in the next one to three decades. The thinning likely would accelerate the development of some old-growth characteristics, perhaps by decades (compared to stand development without the thinning).

3. Habitat improvement activities can increase the likelihood that stands develop the vertical and horizontal complexity typical of old-growth forests. These activities include creating snags, adding large pieces of wood when ncessary, and underplanting with several tree species, especially shade-tolerant conifers where they are absent.

4. Trees grown in dense plantations are most responsive to thinning when they are less than 80 years old. Options for accelerating forest development may diminish substantially if stands are not thinned when young."

Rapp, V. (2002). Dynamic landscape management. Science Update. Portland, OR, USDA Forest Service, Pacific Northwest Research Station**:** 10 pages.

INR archive. Full text available online at:
http://www.fs.fed.us/pnw/scienceupdate3.pdf

"Forest management is creating new landscape patterns in the forests of western Oregon and Washington. In some cases, the large-scale patterns are unplanned because management focus has been on actions and consequences at smaller scales. In other cases, managers did plan landscape patterns, but some of the results are now considered undesirable. Dynamic landscape management uses historical disturbance regimes as a reference. By emulating key aspects of the historical disturbance regimes through forest management practices, scientists and managers expect to sustain native species and habitats and maintain ecological processes within their historical ranges, while providing a sustained flow of timber.

Key findings:

1. Over the last 600 years, two periods occurred when fires were widespread through the forests of western Oregon and Washington. The first period of widespread fire was from the early 1400s to about 1650, and the second from about 1800 to 1925. Many of the region's old-growth forests were established after the earlier period of widespread fire.

2. Forest management is creating distinctive landscape patterns in the forests of western Oregon *and Washington. Computer models show that if the matrix land-reserves approach of the Northwest Forest Plan continues, west-side national forests would eventually have a bifurcated forest: even-aged stands less than 80 years old on matrix lands, and forests older than 200 years in riparian corridors and reserves.*

3. Dynamic landscape management emulates historical disturbance regimes in some ways, yet does not replicate those regimes. Among differences, dynamic landscape management moderates the size of disturbance pulses compared to the size of some historical pulses, such as large fire episodes.

4. If continued for 200 years, the Blue River Landscape Study (BRLS) would result in a landscape with 71 percent of the area in mature and old forests, compared to 59 percent for the matrix-and-reserves approach of the Northwest Forest Plan. The BRLS dynamic landscape management approach would result in a less fragmented landscape than the Northwest Forest Plan approach, as measured by size, amount of interior habitat, and arrangement of the mature and old forests."

Reeves, G., K. Burnett and E.V. McGarry. (2003). Sources of large wood in the main stem of a fourth-order watershed in coastal Oregon. Canadian Journal of Forest Research 33 (8) 1363-1370.

We compared the contribution of large wood from different sources and wood distributions among channel zones of influence in a relatively pristine fourth-order watershed in the central Coast Range of Oregon. Wood in the main stem of Cummins Creek was identified as coming from either (i) streamside sources immediately adjacent to the channel or (ii) upslope sources delivered by landslides or debris flows more than 90 m from the channel.

About 65% of the number of pieces and 46% of the estimated volume of wood were from upslope sources. Streamside sources contributed about 35% of the number of pieces and 54% of the estimated volume of wood. The estimated mean volume of upslope-derived pieces was about one-third that of streamside-derived pieces. Upslope-derived pieces were located primarily in the middle stream reaches and in the zones of influence that had the most contact with the low-flow channel. Streamside-derived pieces were more evenly distributed among the examined reaches and were predominately in the influence zones that had the least contact with the low-flow channel.

Our findings suggest that previous studies that examined only streamside sources of wood have limited applications when designing and evaluating riparian management approaches in landslide-prone areas. The failure to recognize the potential sources of wood from upslope areas is a possible reason for the decline of large wood in streams in the Pacific Northwest.

Reid, L. M. (1993). Research and cumulative watershed effects. Albany, CA: USDA Forest Service, Pacific Southwest Research Station. Gen. Tech. Rep. PSW-GTR-141. 118 pages.

Full text available online at:
http://www.ucalgary.ca/UofC/faculties/SC/ENSC/ENSC_502/reid.pdf

"The mandate for land managers to address cumulative watershed effects (CWEs) requires that planners evaluate the potential impacts of their activities on multiple beneficial uses within the context of other coexisting activities in a watershed. Types of CWEs vary with the types of land-use activities and their modes of interaction, but published studies illustrate both descriptive and predictive evaluations of many of these types.

Successful evaluations have generally used geomorphological and ecological approaches based on the understanding of the processes involved. In contrast, most generalized "cookbook" analysis procedures are shown to be unable to assess accumulations of impacts through time, usually cannot evaluate the range of activities and uses that are necessary, and are rarely validated. A general approach to evaluation is proposed, and the types of information available for assessments are reviewed."

Reid, L. M. (1998). Cumulative watershed effects: Caspar Creek and beyond. Albany, CA:USDA Forest Service, Pacific Southwest Research Station. Gen. Tech. Rep PSW-GTR-168. 11 pages.

Full text available online at:
http://www.fs.fed.us/psw/publications/documents/gtr-168/14reid.pdf

Discusses how concepts and understanding of cumulative watershed impacts have changed.

Conclusions: "Understanding of cumulative watershed impacts has increased greatly in the past 10 years, but the remaining problems are difficult ones. Existing impacts must be evaluated to that causal mechanisms are understood well enough that they can be reversed, and regulatory strategies must be modified to facilitate the recovery of damaged systems. Methods implemented to date have fallen short of this goal, but the growing level of concern over existing cumulative impacts suggests that an opportunity is at hand to make useful changes in approach. Results from Caspar Creek and the Waipoa River illustrate that no single method for controlling cumulative impacts is applicable to every kind of impact. Whatever approaches are adopted for controlling cumulative impacts in an area need to founded on an understanding of the impact mechanisms present in that area."

Richardson, J. S., P. M. Kiffney, K. Cockle. (2002). An experimental study of the effects of riparian management on communities of headwater streams and riparian areas in coastal BC: How much protection is sufficient? Sustainable Forest Management Network Conference: Advances in forest management: From knowledge to practice. Edmonton, Alberta, Canada. November 13-15, 2002 :181-186.

Full text available online at:
http://faculty.forestry.ubc.ca/richardson/abstracts/Richardson_etal-SFM2002.pdf

"Riparian management along streams maintains strips of forest but has not received sufficient

testing for its efficacy in meeting its objectives, especially along small streams. We have carried out an experimental test of the effects of riparian management using a replicated and before and after experiment along small streams. Since objectives for riparian management extend beyond the protection of fish habitats to include terrestrial and aquatic habitat and clean water, we have taken an ecosystem approach. Even with 30m reserves there were measurable changes within the stream and riparian margins, but 30m still provided good protection relative to 10m reserves or clearcut to the stream margin. The potential and speed of recovery of riparian systems following disturbance needs to be carefully considered, as this is probably the most important indicator of sustainability, not short-term change."

Robison, E.G., K Mills, J. Paul, L.Dent, A. Skaugset. (1999). Storm impacts and landslides of 1996: Final report. Salem, OR: Oregon Department of Forestry. 145 pages.

Full text available online at:
http://www.odf.state.or.us/divisions/protection/forest_practices/fpmp/Projects/Storm_Impacts/StormFinalReport.pdf

Some key conclusions:

"-Landslide inventories using only aerial photographs without significant on-the-ground surveying do not identify the majority of shallow-type landslides.

-Coarse-scale digital elevation models underestimate slope steepness, especially in areas with irregular, steep slopes.

-Ground-based investigation provides the most reliable information on landslide occurrence and their characteristics in the forests of western Oregon.

-Timber harvesting can affect landslide occurrence on the steepest slopes. In 3 out 4 study areas, higher densities and erosion volumes were found in stands that had been harvested in the previous 9 years, compared to forests that were older than one hundred years

-Forested areas between the ages of 10 and 100 years typically had lower landslide densities and erosion than found in the mature forest stands.

-Landslides from recently harvested and older forests had similar dimensions; including depth, initial volume and debris flow volume

-Based on the low numbers of road-associated landslides surveyed in this study and on the smaller sizes of landslides (as compared with previous studies) current road management practices are reducing the size of road-associated landslides, as well as the number of landslides."

Robinson, E. G. and R. L. Beschta (1990). Identifying trees in riparian areas that can provide coarse woody debris to streams. Forest Science 36(3): 790-801.

Sedell, J. R., P. A. Bisson, et al. (1988). What we know about large trees that fall into streams and rivers. Portland OR, USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-229. 36 pages.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/229chpt3.pdf

Sessions, J., D. Johnson, et al. (2000). The Blodgett Plan: An active-management approach to developing mature forest habitat. Journal of Forestry 98(12): 29-33.

INR archive.

This non-technical article describes an active management approach to developing mature forest structure in even-aged second growth forests while maintaining a significant harvest revenue stream. Oregon Department of Forestry management plans for NW Oregon state forests are quite similar to those being used under the Blodgett Plan. According to the authors, under the scenario described all stands would eventually be eligible for harvest, even as goals for mature forest and forest connectivity are maintained.

"A nonreserve-based landscape plan for developing mature forest habitat has been developed for the Blodgett Forest, one of the research forest properties of OSU. Intended to provide a study and demonstration site for an alternative to fixed reserves, the plan calls for efficiently achieving and maintaining both mature forest and income. The forest goals include a mature forest acreage target, a mature forest landscape connectivity goal, a conversion time goal, and a net income goal. Spatial issues required development of a new harvest scheduling algorithm."

Spies, T. A., J. F. Franklin, et al. (1988). Coarse woody-debris in Douglas-fir forests of western Oregon and Washington. Ecology 69 (6): 1689-1702.

Spies, T. A. and S. P. Cline (1988). Coarse woody debris in forests and plantations of coastal Oregon, USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-229.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/229chpt1.pdf

State of Oregon. (1999). Oregon Aquatic Habitat Restoration and Enhancement Guide. Salem OR, Governor's Natural Resources Office.

Full text available online at:

http://www.oweb.state.or.us/publications/habguide99.shtml

"Handbook designed to facilitate and encourage habitat restoration across all landuses and ownerships. Under Executive Order 99-01 (Oregon Plan) the guidelines in this handbook establish the criteria for all restoration activities funded or authorized by state agencies.

Purposes:
1. To provide information as part of the Oregon Plan For Salmon and Watersheds (OPSW) to watershed councils, landowners and other interests to help them develop effective restoration projects across all landuses and ownerships

2. To define aquatic restoration and to identify and encourage aquatic habitat restoration techniques that restore salmonids

3. To define standards and priorities that will be considered for approving State funded or authorized restoration projects

4. To identify state and federal regulatory requirements and available assistance for completing restoration projects."

Swanson, F. J., L. E. Benda, et al. (1987). Mass failures and other processes of sediment production in Pacific Northwest forest landscapes. In Streamside management; Forestry and fishery interactions: Proceedings of a symposium, Seattle, WA.

Full text available online at:
http://www.humboldt.edu/~rrz7001/pubs/Swanson87.pdf

"Accelerated sediment production by mass failures and other erosion processes is an important link between management of forest resources and fish resources. Dominant processes and the rates of sediment production vary greatly throughout the Pacific Northwest in response to geologic and climatic factors. The complex sediment routing systems characteristic of the area involve numerous processes that move soil down hillslopes and sediment through channels. Sediment routing models and sediment budgets offer conceptual and quantitative descriptions of movement and storage of soil and sediment in drainage basins. Temporal and spatial patterns of sediment production and routing through basins have many direct and indirect effects on fish.

In addition to their role as dominant mechanisms of sediment production in many parts of the region, mass failures also affect the geometry and disturbance regimes of channels and streamside areas. Earth flows locally control the vegetation structure and composition of riparian zones through influences on valley floor width, gradient of side slopes and channels, and frequency of streamside debris slides. Debris flows can have long-term effects on channels and streamside landforms and vegetation. It is important to consider sediment production and the effects of mass failures on channels and riparian zones in the context of an entire drainage basin, because effects vary with location in a basin.

Forestry practices can increase production of sediment. Results of experimental manipulations of vegetation on small drainage basins and studies of individual erosion processes indicate that debris slides and road surfaces are commonly dominant sources of accelerated sediment production. Some techniques are available for locating sites susceptible to accelerated erosion, for predicting change in sediment production, for evaluating the biological consequences of accelerated erosion, and for designing mitigation measures, but clearly more work is needed in each of these areas.

A discussion of fishery-forestry interactions and sediment production should be in the context of the general geomorphic setting of the Pacific Northwest, here defined as northern California, Oregon, Washington, Idaho, and southeastern Alaska. We emphasize areas west of the crest of the Cascade Range where timber and fisheries values are highest and the bulk of research on fishery-forestry interactions has been conducted. The area comprises geologic terranes with a remarkable variety of landforms, dominant geomorphic processes, and rates of sediment production. This diversity of landforms and processes is controlled strongly by rate and recency of uplift, by hydrologic and geotechnical properties of soils and rocks, and by precipitation.

Fishery-forestry interactions should also be examined in relation to regional gradients in climate, stream hydrology, vegetation type and history, management history of channel morphology, and other factors beyond the scope of this paper. The efficiency of sediment delivery from hillslopes to channels and from tributary streams to main-stem rivers also varies across the region. Sediment delivery is efficient, for example, in areas of short, steep slopes and narrow valley floors, such as in low coastal basins from the Willapa Hills south through the Oregon Coast Range."

Swanson, F. J., S. L. Johnson, et al. (1998). Flood disturbance in a forested mountain landscape: interactions of land use and floods. BioScience 48(9): 681-689.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/pnw_1998_swanson001.pdf

Case study of 1996 flooding at H.J. Andrews Experimental Forest in upper McKenzie River basin.

"Floods trigger cascades of physical processes that alter streams and riparian zones of mountain landscapes, yet affected species are resilient.

Recent flooding in the Pacific Northwest vividly illustrates the complexity of watershed and ecosystem responses to floods, especially in steep forest landscapes. Flooding involves a sequence of interactions that begins with climatic drivers. These drivers, generally rain and snowmelt, interact with landscape conditions, such as vegetation pattern and topography, to determine the capability of a watershed to deliver water, sediment, and organic material to downstream areas.

Land-use practices can affect watershed responses to flooding through the influences of managed vegetation patterns and roads on delivery of water, sediment, and wood to streams. Watershed responses to floods include geophysical processes, such as landslides and channel erosion, and related disturbances of aquatic and riparian organisms and their habitats. We explore these

geophysical-ecological interactions using a recent flood in the Pacific Northwest as an example of flood effects in a managed mountainous landscape."

Tang, S. M., J. F. Franklin, et al. (1997). Forest harvest patterns and landscape disturbances processes. Landscape Ecology 12: 349-363.

"A physically-based model of the topographic influence on debris flow initiation and a rule-based model for wind damage were used to assess the influence of forest clearcutting patterns (i.e., location, size, shape and distribution of cut units) on the potential for landscape disturbance by these processes in Charley Creek watershed, Washington State, USA. Simulated clearcutting patterns consisted of 7, 9 or 26 ha square or rectangular harvest units distributed in either an aggregated or dispersed pattern under three stream-buffering scenarios. The slope-stability model predicted that potentially unstable ground is concentrated along steep headwater streams and inner-gorge side-slopes. Areas susceptible to wind damage were determined from the combination of slope, aspect, elevation, soil drainage and primary tree species.

Among the variables examined here, the location of harvest units constitutes the most important factor influencing the potential for shallow landsliding. In contrast, the location, size, and shape of clearcuts and the interactions among these three factors significantly influenced the potential for wind damage. Minimal correspondence between areas predicted to be potentially unstable and areas susceptible to wind damage implies that harvest patterns designed to mitigate the potential for shallow landsliding may not necessarily reduce the potential for wind damage.

Our results demonstrate that: (1) the location of timber harvesting is more important than the geometry of harvest activity in influencing shallow landsliding; (2) forest harvest patterns strongly influence the potential for disturbance processes; and (3) a single cutting pattern will often fail to meet all landscape management goals."

Tappeiner, J. C., D. W. Huffman, et al. (1997). Density, ages, and growth rates in old-growth and young-growth forests in coastal Oregon. Canadian Journal of Forest Research 27 (5): 638-648.

"We studied the ages and diameter growth rates of trees in former Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) old-growth stands on 10 sites and compared them with young-growth stands (50--70 years old, regenerated after timber harvest) in the Coast Range of western Oregon.

The diameters and diameter growth rates for the first 100 years of trees in the old-growth stands were significantly greater than those in the young-growth stands. Growth rates in the old stands were comparable with those from long-term studies of young stands in which density is about 100--120 trees/ha; often young-growth stand density is well over 500 trees/ha. Ages of large trees in the old stands ranged from 100 to 420 years; ages in young stands varied by only about 5 to 10 years.

Apparently, regeneration of old-growth stands on these sites occurred over a prolonged period, *and trees grew at low density with little self-thinning; in contrast, after timber harvest, young stands may develop with high density of trees with similar ages and considerable self-thinning. The results suggest that thinning may be needed in dense young stands where the management objective is to speed development of old-growth characteristics."*

Tappeiner, J. C., D. Lavender, et al. (1997). Silvicultural systems and regeneration methods: Current practices and new alternatives. In <u>Creating a Forestry for the 21st Century</u>. K. Kohm and J. Franklin, eds. Washington D.C., Island Press**:** 151-164.

"In this chapter, we discuss silvicultural systems and regeneration methods to meet the needs of society over the next several decades. We begin with a brief history of silvicultural systems and what we have learned about forest regeneration in the Pacific Northwest. We then discuss how regeneration methods might evolve over the next several decades.

We believe that the practice of silviculture generally will be applied to two different forest management philosophies and objectives, providing 1) old-forest characteristics and 2) wood production. Significant amounts of wood can be produced under objective 1, and considerable wildlife habitat and other values can be provided while producing relatively high yields of wood under objective 2. The knowledge and skills are available to pursue both objectives effectively. Moreover, many owners will likely manage their forests under both approaches."

Tillamook Coastal Watershed Resource Center. (2002). Tillamook region watershed reports.

http://www.tcwrc.org/html/reportsq-t.htm

Tillamook Coastal Watershed Resource Center website with downloadable/printable PDF files of watershed assessments and other reports for the Tillamook region, including:

An Environmental History of the Tillamook Bay Estuary and Watershed. Prepared by Kevin G. Coulton, Philip B. William's, and Patricia A. Benner, Philip Williams & Associates and Oregon State University. 1996. 120 pp., 47,328KB. Posted 2/12/01

Aquatic Inventories Habitat and Reach Data Coverages Metadata. Prepared by Kim Jones, Oregon Department of Fish and Wildlife. 1997. 22 pp., 78KB. Posted 2/12/01

Briefing on Proposed 1999 Ocean Salmon Fishing Options. Oregon Department of Fish and Wildlife Inter jurisdictional Fisheries Management Program. 1999. 10 pp., 44KB. Posted 1/15/01

Captive Breeding and the Genetic Fitness of Natural Populations, Prepared by Michael Lynch and Martin O`Hely, Department of Biology, University of Oregon, Eugene. April 2001, 16 pp 271kb Posted 1/2/02

Forest Roads, Drainage, and Sediment Delivery in the Kilchis River Watershed. Prepared by Keith Mills, Oregon Department of Forestry. 1997. 44 pp., 201KB. Posted 2/12/01

Kilchis Watershed Analysis. Prepared by Bruce Follansbee and Ann Stark, Tillamook Bay National Estuary Project. 1998. 219 pp., 4,850KB. Posted 1/15/01

Landscape Change in Tillamook Bay Watershed. Prepared by James R. Strittholdt Ph.D. and Pamela A. Frost, M.S., Earth Design Consultants. Tillamook Bay National Estuary Project, 1997. 27 pp., Posted 7/05/01 Part 1 - 4,694kb, Part 2 - 8,237kb, Part 3 - 7,375kb, and Part 4 - 3,452kb Posted 6/8/01

Methods for Stream Habitat Surveys Aquatic Inventory Project. Prepared by Kelly Moore, Kim Jones, and Jeff Dambacher, Oregon Department of Fish and Wildlife, Natural Production Program. 1998. 35 pp., 281KB.

Miami River Watershed Final Watershed Assessment. Prepared by Kai Snyder, Joseph Bischoff, Timothy Sullivan, Richard Raymond, Shawn White, and Susan Binder. E & S Chemistry, 2001. 193 pp., 7,563kb. Posted 12/29/01

Nestucca/Neskowin Watershed Council: Watershed Assessment. Prepared by Mary Barczak, Resource Assistance for Rural Environments, University of Oregon. 1998. 116 pp., 5,501KB. Posted 1/15/01

North Coast Stream Project Guide to Instream and Riparian Restoration Sites and Site Selection Phase II. Prepared by Barry Thom and Kelly Moore, Oregon Department of Fish and Wildlife. 1997. 48 pp., 239KB. Posted 2/12/01

Nehalem Watershed Assessment Draft for Public Review (web version)

Results of Storm Sampling in the Tillamook Bay Watershed. Prepared by Timothy J. Sullivan, Joseph M. Bischoff and Kellie B. Vache, E&S Environmental Chemistry, Inc. 1998. 158 pp., 17,165KB. Posted 1/15/01

River Water Quality Monitoring Plan. Prepared by T.J. Sullivan and J.M. Eilers, E&S Environmental Chemistry, Inc. 1999. 53 pp., 1,549KB. Posted 1/15/01

Standards for Fish and Fish Habitat Mapping. Fisheries Section, Resources Inventory Branch, Resources Inventory Committee. 1997. 79 pp., 446KB.

Tillamook Basin Temperature Total Maximum Daily Load (TMDL). Prepared by Matthew Boyd, Brian Kasper, and Allen Hamel, Oregon Department of Environmental Quality. 1999. 214 pp., 3,236KB. Posted 2/12/01

Tillamook Bay Comprehensive Conservation and Management Plan. Tillamook Bay National Estuary Project and Tillamook County Performance Partnership. 1999. 503 pp., 40,623KB. Posted 1/15/01. (Download individual chapters below)

Chapter 1 Chapter 2 Chapter 3 Chapter 4

Chapter 5 Chapter 6 Chapter 7 Chapter 8
Chapter 9 Chapter 10 Chapter 11 Appendices

Tillamook Bay Environmental Characterization: A Scientific and Technical Summary. Editors: Roxanna Hinzman and Steve Nelson, Tillamook Bay National Estuary Project, JoAnne Booth, Booth Media Services. 1998. 363 pp., 10,994KB. Posted 1/15/01

The Tillamook Bay National Estuary Project Sedimentation Study: Sediment Sources and the History of Accumulation in Tillamook Bay, Oregon. Prepared by James McManus, Paul D. Komar, Gregory Bostrom, Debbie Colbert, and John J. Marra, College of Ocean and Atmospheric Sciences Oregon State University, Shoreland Solutions. 1998. 62 pp., 629KB. Posted 1/15/01

Trask Watershed Assessment. Prepared by Bruce Follansbee and Ann Stark, Tillamook Bay National Estuary Project. 1998. 30 pp., 586KB. Posted 1/15/01

Water Quality Monitoring in the Tillamook Watershed. Prepared by Timothy J. Sullivan, Joseph M. Bischoff, Kellie B. Vache, Mark Wustenberg, and James Moore, E&S Environmental Chemistry, Inc. 1998. 99 pp., 3,026KB. Posted 1/15/01

Wilson River Watershed Final Watershed Assessment. Prepared by Kai Snyder, Joseph Bischoff, Timothy Sullivan, Richard Raymond, Shawn White, and Susan Binder. E & S Chemistry, 2001. 207 pp., 17,271kb. Posted 11/29/01

Watershed Professionals Network. (1999). Oregon Watershed Assessment Manual. Salem OR, Governor's Watershed Enhancement Board.

Full text available online at:
http://www.oweb.state.or.us/publications/wa_manual99.shtml

Comprehensive manual developed by the State of Oregon "...specifically to help watershed councils navigate through an evaluation of their watersheds, especially those councils participating in the Oregon Plan for Salmon and Watersheds."

Also intended to be used as a textbook to learn and teach about watersheds, a "cookbook" to compile and evaluate information about watersheds, and a reference of procedures for watershed assessment.

SALMONID AND RIPARIAN HABITAT MONITORING

Coutant, C., D. Goodman, et al. (2004). A joint ISAB and ISRP review of the draft research, monitoring & evaluation plan for the NOAA-Fisheries 2000 Federal Columbia River power system biological opinion. Portland, OR, Independent Scientific Advisory Board and Independent Scientific Review Panel for the Northwest Power and Conservation Council**:** 66.

Full text available online at:
http://www.nwcouncil.org/library/isab/isab2004-1.pdf

Contains recommendations for improving monitoring and evaluation of salmon protection and recovery strategies in the Columbia Basin.

Johnson, D. H., N. Pittman, et al. (2001). Inventory and monitoring of salmon habitat in the Pacific Northwest - Directory and synthesis of protocols for management/research and volunteers in Washington, Oregon, Idaho, Montana, and British Columbia. Olympia, WA, Washington Department of Fish and Wildlife. 212 pages.

Full text available online at:
http://www.krisweb.com/biblio/gen_wdfw_johnsonetal_2001_inv.pdf

An effort to establish a consistent format for salmonid habitat data collection and monitoring protocols across the Pacific Northwest.

"Objectives were to 1) provide a synthesis of the salmon habitat protocols applicable to the Pacific Northwest, 2) recommend a subset of these protocols for use by volunteers and management/research personnel across the region, 3) link these protocols with specific types of habitat projects, 4) establish a Quality Assurance/Quality Control framework for the data derived from the use of these protocols, and 5) to the degree possible, identify the format and destination where the data is routinely sent.

Objectives were achieved by developing 1-2 pages syntheses of 112 documents that detailed data collection and monitoring 429 protocols within 48 protocol focus types relevant to salmonids. Selection criteria were combined with a scientific peer-review process to recommend a subset of protocols for use in the Pacific Northwest. 68 protocols for use by volunteers, and 93 for use by management/research personnel were identified.

To gain the greatest benefit from the data collection and monitoring protocols in the document, users must first articulate a set of inventory or monitoring questions to be answered. Then, by linking these questions with the protocols in the document, users will be better able to maximize their inventory and monitoring investments."

Larsen, D. P., P. R. Kaufmann, et al. (2004). Detecting persistent change in the habitat of salmon-bearing streams in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic

Sciences 61 (2): 283-291.

"In the northwestern United States, there is considerable interest in the recovery of Pacific salmon (Oncorhynchus spp.) populations listed as threatened or endangered. A critical component of any salmon recovery effort is the improvement of stream habitat that supports various life stages. Two factors in concert control our ability to detect consistent change in habitat conditions that could result from significant expenditures on habitat improvement: the magnitude of spatial and temporal variation and the design of the monitoring network.

We summarize the important components of variation that affect trend detection and explain how well-designed networks of 30–50 sites monitored consistently over years can detect underlying changes of 1–2% per year in a variety of key habitat characteristics within 10–20 years, or sooner, if such trends are present. We emphasize the importance of the duration of surveys for trend detection sensitivity because the power to detect trends improves substantially with the passage of years."

Mulder, B. S., B. R. Noon, et al. (1999). The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. Portland, OR, U.S. Department of Agriculture, Forest Service Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-437. 138 p.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/gtr_437.pdf

"This report describes the strategy and design of an effectiveness monitoring program for the Northwest Forest Plan. The described premise is to implement a prospective and integrated habitat-based approach to monitoring that provides a gradual transition from an intensive, individual species-resource focus to a more extensive, ecosystems approach by using surrogates to measure the pattern and dynamics of habitat structure in place of monitoring biota. The report describes the scientific framework for monitoring, starting with conceptual models, that is the basis for designing plans for monitoring specific resources.

For species of concern, the design integrates animal populations with their necessary habitat and projects changes in population status by monitoring significant changes in habitat at several spatial scales. Anticipatory forecasting of changes in populations status assumes habitat to be a reliable surrogate for direct population measures. A surrogate-based approach requires an active period of model building that relates population to habitat variation to develop robust wildlife relation models. Essential components needed for program implementation, such as data collection, information management, report preparation, and feedback to management, are discussed."

Minshall, G. W. (1994). Stream-riparian ecosystems: Rationale and methods for basin-level assessments of management effects. Ecosystem management: Principles and applications. Portland, OR, USDA Forest Service, Pacific Northwest Research Station, PNW-GTR-318. 151-

167.

Full text available online at:
http://www.fs.fed.us/pnw/publications/gtr318/part1.pdf
(Pages 151-167)

"Stream-riparian ecosystems are directly responsive to land management practices. This paper addresses the sampling and analysis of stream-riparian ecosystems in a hierarchical framework of spatial and temporal scales. The paper also establishes recommendations for a protocol to assess the effects of land management practices on aquatic and adjacent terrestrial (riparian) conditions extending to basin-wide and other landscape levels."

Pacific Northwest Aquatic Monitoring Partnership. (2004). Strategy For Monitoring Watershed Health And Salmon Recovery In The Pacific Northwest (Northern California, Oregon, Idaho, Washington). Draft.

Selected text from the introduction:

"PNAMP is a voluntary, non-directive, self-organizing forum committed to developing a unified approach to monitoring in the Pacific Northwest. PNAMP provides a forum for collaboration of the members as they work towards developing a coordinated approach to monitoring by providing a durable structure for facilitating the development of cross-party linkages. The benefits of regional coordinated monitoring are desirable. However, if regional monitoring is not feasible or otherwise not implemented, it will be necessary to accept a number of risks. These include economic, biological, and societal risks.

For example, without adequate monitoring of salmon abundance, Washington, Oregon, Idaho, and California will incur continued economic impacts due to limited ability to document when salmon populations are no longer warranted for listing under the Endangered Species Act. Also, without adequate monitoring of stream flows and setting of instream flow requirements, we risk having water shortages, water disputes, and additional salmon and other aquatic plants and animals threatened with extinction. Economic and societal values associated with watershed health will likely not be achieved. Congressional and public support for salmon recovery and watershed health may decline or cease due to inability to document progress with the millions of dollars appropriated nationally and regionally for recovery."

Roni, P., M. Liermann, A. Steel. (2003). Monitoring and evaluating responses of salmonids and other fishes to in-stream restoration. In Restoration of Puget Sound Rivers, D.R. Montgomery, S. Bolton, and D. B. Booth (eds.). Seattle, WA: University of Washington Press.

State of Oregon. (2001). Water Quality Monitoring Guidebook. Salem OR, Governor's Natural Resources Office.

Full text available online at:
http://www.oregon-plan.org/cdrom/monguide2001.pdf

Chapter 14 Addendum "Stream Shade and Canopy Cover Monitoring Methods" available at:
http://www.oregon-plan.org/cdrom/monguide2001_ch14.pdf

"Complements OWEB Watershed Assessment Manual by presenting techniques and protocols for obtaining specific, field-based data about water quality. The Watershed Assessment Manual serves as a broad diagnostic tool, while the Water Quality Monitoring Guidebook is a verification tool that can be used to refine the public's understanding and diagnosis of watershed and water quality conditions."

State of Oregon. (2002). Monitoring Strategy for the Oregon Plan for Salmon and Watersheds. Salem, OR: Oregon Watershed Enhancement Board.

Full text available online at:
http://www.oweb.state.or.us/monitoring/MonitoringStrategy.pdf

"OWEB and Oregon Plan Monitoring Recent legislation, Senate Bill 945, directs the Oregon Watershed Enhancement Board (OWEB) to develop and implement a statewide Monitoring Program in coordination with state natural resource agencies for activities conducted under the Oregon Plan for Salmon and Watersheds. This Strategy describes an overall framework for structuring this cooperative effort and provides direction to help integrate Oregon Plan programs and monitoring with region-wide watershed enhancement and salmon recovery efforts."

Stevens, D. (2002). Sampling Design and Statistical Analysis Methods for the Integrated Biological and Physical Monitoring of Oregon Streams. Oregon Plan for Salmon and Watersheds and Oregon Dept. of Fish and Wildlife. Report Number: OPSW-ODFW-2002-07.

Full text available online at:
http://oregonstate.edu/Dept/ODFW/spawn/pdf%20files/reports/DesignStevens.pdf

Preface:

"This report describes the statistical analytical basis of an integrated monitoring program of salmonids and their habitats in coastal watersheds of Oregon. This monitoring encompasses sampling conducted by the Oregon Department of Fish and Wildlife for adult spawners, rearing juveniles and physical habitat. Additionally, the statistical framework presented in this report is the basis of the sampling design used by the Oregon Department of Environmental Quality to monitor water quality and macro invertebrates. This monitoring effort was initiated in 1998 as part of The Oregon Plan for Salmon and Watersheds and represents an unprecedented effort to comprehensively monitor the status and trends of coastal salmonids and their habitats. The results of this monitoring will be a key component in assessing the success of the Oregon Plan in restoring watershed health and natural salmonid production."

Sullivan, K., R. D. Martin, et al. (2000). An analysis of the effects of temperature on salmonids of the Pacific Northwest with implications for selecting temperature criteria. Portland, OR Sustainable Ecosystems Institute. 192 pages.

Full text available online at:
http://www.sei.org/downloads/reports/salmon2000.pdf

"To administer the Clean Water Act, the US EPA and state water quality agencies throughout the nation have adopted numeric and qualitative criteria that establish environmental conditions known to protect aquatic life from adverse effects. Pacific Northwest states have adopted temperature criteria designed specifically to protect fish with emphasis on salmonid species because water temperature plays a role in virtually every aspect of salmon life. Adverse levels of temperature can affect growth, behavior, disease resistance, and mortality.
In recent years, the EPA and National Academies of Science and Engineering have promoted risk assessment techniques to develop water quality criteria, including formal protocols that have been peer-reviewed nationally. Risk assessment is designed to combine information from biological studies with an analysis of each population's exposure to quantified effects. Risk occurs when the stress' magnitude, frequency and duration exceed the species' ability to deal with that stress. A risk-based approach seems ideally suited to developing criteria for and assessing temperature risk to fish because exposure has been well documented through temperature monitoring and extensive research on the lethal and sublethal effects on salmon physiology has been conducted over the past 40 years. Nevertheless, risk-based approaches have not yet been used to establish temperature criteria in recent state agency reviews of water quality standards.

We use a risk-based approach to analyze summertime temperature effects on juvenile salmon species. We use available research findings to quantitatively evaluate the biological effects of temperature in combination with measured stream temperature ranging from very cold to very warm. Many currently exceed Washington's temperature standard. Acute risk to high temperatures was assessed using laboratory-derived values of mortality in relation to duration of exposure. Despite warm temperatures, the risk analysis found that direct mortality from temperature is unlikely in the range of temperature in study streams because temperatures high enough to cause mortality are either never observed, or occur over too short of periods of time to cause death. The analysis suggested that there is little or no risk of mortality if annual maximum temperature is less than 26 C, although site-specific analyses are suggested when annual maximum temperature exceeds 24 C to affirm this result in local river conditions. Short-term occurrence of temperatures sufficient in duration and magnitude to cause mortality is feasible, within parts of the Pacific Northwest region, and therefore streams in other geographic areas or stream with known temperature extremes should be individually evaluated with this method.

Chronic exposure to temperature was based on the growth potential of fish as assessed using a simplified bioenergetics approach developed in the report. This analysis found that growth predicted from ambient temperatures is somewhat less than the maximum potential growth in all streams regardless of temperature regime, because no stream experienced temperatures that fully optimized growth all of the time during the summer rearing period. Generally the effect of *temperature regime on growth was small in the range of streams studied, but growth effects were evident at higher temperatures.*

These results suggest that quantitative analysis of growth effects can be determined with reasonably simple methods that can applied at specific sites or at a region scale to identify appropriate temperature thresholds. Assuming a 10% growth loss represents an appropriate risk level, an upper threshold for the 7-day maximum temperature of 16.5 C is appropriate for coho and 20.5 C is appropriate for steelhead. Criteria derived in this manner are somewhat lower than those developed in a US EPA paper in 1977 and close to, but not identical, to those currently specified in Washington and Oregon criteria."

PERCEIVED COSTS & BENEFITS OF SALMON ANCHOR HABITATS, ECONOMIC AND SOCIAL VALUES

Alaouze, C. M. (2004). The effect of conservation value on the optimal forest rotation. Land Economics 80(2).

"The conservation value of a forest can be high, but is usually omitted in determining the optimal forest rotation. For the Mountain Ash forests of South Eastern Australia, a function representing conservation value can be based on an estimated above ground bio-mass function of the dominant tree. An economic model, which includes a value of conservation function, is used to estimate the break-even conservation value required for the preservation of Mountain Ash forests in the catchment of the Thompson Dam in Central Victoria, Australia. The results suggest that timber harvesting in these forests should cease if society values the annual flow of non-market goods and services from these forests at or above $104,398.58 (in year 2000 Australian dollars)."

American Sportfishing Association. (1996). The economic importance of sport fishing. American Sportfishing Association/U.S. Fish and Wildlife Service.

Available online at:
http://www.tpwd.state.tx.us/texaswater/sb1/econom/econsportfish/econsportfish.html

Economic data on sportfishing throughout the entire United States, including data for Oregon. This economic study was funded by the U.S. Fish and Wildlife Service under Cooperative Grant Agreement No. 14-48-0009-1237.

Azuma, D. L., K. R. Birch, et al. (2002). Forests, farms and people: Land use change on non-federal land in western Oregon. Salem, OR, USDA Forest Service, Oregon Department of Forestry, Oregon Department of Land Conservation and Development and Oregon Department of Agriculture. 48 pages.

Full text available online at:
http://www.sustainableoregon.net/documents/ForestFarmsPeople.pdf

Notes: Update of 1998 report, includes analysis for 1994-2000. Addresses prevailing trends and changes in land use affecting western Oregon's farm and forest lands.

"Western Oregon's forests and agricultural lands are remarkable for their extent, diversity and contributions to the economies and lifestyles of the state; timber, agriculture and tourism are three of the top four industries. For other industries, quality of life perceptions- partially based on the forest-farm image- provide competitive advantages for attracting the best employees.

For those residing in our burgeoning metropolitan areas, as well as for visitors, land use policies in rural parts of the state will increasingly affect the ability of these areas to meet the growing *demand for recreation, solitude, and other values not available in urban settings. Clearly, maintaining and enhancing the contributions of farm and forest lands is vital to the well-being of all Oregonians.*

The purpose of this report in to provide the public and policy-makers with a summary of land use changes on western Oregon's non-Federal forests and farms since 1973."

Beuter, J. H. and D. C. LeMaster, eds. (1989/2003). Community stability in forest-based economies: Proceedings of a conference. Portland, OR: Timber Press.

Reprint of a conference proceedings, November 16-18, 1987.

Carey, A. B., B. Lippke, et al. (1999). Intentional systems management: Managing forests for biodiversity. <u>Journal of Sustainable Forestry</u> 9 (3/4): 83-125.

(INR archive.) Full text available online at:
http://www.fs.fed.us/pnw/pubs/journals/pnw_1999_carey001.pdf

Authors model three types of riparian management and conclude that an approach similar to that submitted in the ODF NW Oregon State Forest Management Plan would produce an optimal combination of wildlife habitat and economic benefits.

From the introduction: "Our goal was to develop the paradigm of conservation of biodiversity into a strategy for forest ecosystem management that could be applied across land ownerships (public and private) and that would provide for joint production of timber and wildlife in the context of environmental, economic and social sustainability in western hemlock- Douglas-fir forests in the Pacific Northwest, United States. This strategy would be in sharp contrast to existing de facto allocations of land in the Pacific Northwest either to intensive management for timber or reserves with little active management. In particular, we wanted to develop management pathways that would not only deliberately address the needs of all indigenous wildlife, including wildlife associated with old-growth forests, but also diverse societal wants and needs from forests.

Our approach is syncretic and hierarchical; it begins with ecosystem management and produces regional, long-term benefits. We provide principles, procedures, and recommendations for conservation of biodiversity that apply to 1) second-growth forests now managed primarily for wood products (state and private timberlands), 2) second-growth forests managed for restoration of ecological function as habitat associated with late-seral stages of forest development (late-successional reserves and adaptive management areas on federal lands) and ecological services (e.g. water, carbon sequestration), and 3) streamside, second-growth forests managed as biodiversity reserves to enhance riparian and landscape function.

Because many benefits of intentional management accrue to society and not to the landowner, but most costs accrue primarily to the landowner, we paid special attention to calculating costs and benefits of alternative approaches."

Abstract: "Conservation of biodiversity provides for economic, social, and environmental sustainability. Intentional management is designed to manage conflicts among groups with conflicting interests. Our goal was to ascertain if intentional management and principles of conservation of biodiversity could be combined into upland and riparian forest management strategies that would be applicable to various land ownerships and, consequently, help resolve land allocation problems associated with timber supply and threatened wildlife.

We used computer simulations to model three divergent management strategies for Pacific Northwest western hemlock (Tsuga heterophylla (Raf.) Sarg.) forests: preservation with no manipulation (NMP), maximizing net present value (npv) through timber and fiber production (TFP), and conservation of biodiversity (CBD) with intentional ecosystem management. We evaluated costs and benefits of alternatives. Economic measures included npv of timber, sustainable timber revenues, total and sustainable volume of wood products, and quality premiums for wood products.

Ecological measures included capacity to support vertebrate diversity, forest floor function based on the integrity of the forest-floor mammal community, ecosystem productivity based on the biomass of the arboreal rodent community, and production of wild ungulates. Index values were assigned to seral stages and aggregated across landscapes to evaluate conditions over 300 years. No manipulation resulted in long periods of competitive exclusion that could cause species declines or extirpations. When combined with TFP, wide riparian buffers removed 35% of the landscape from active management, >200 years were required to obtain 30% late seral-forest, late-seral forest were badly fragmented by intervening intensively managed forest, and npv=$48.5 million."

Donoghue, E. M. and R. M. Haynes. (2002). Assessing the viability and adaptability of Oregon communities. Portland, OR: USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-549. 18 pages.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/gtr549.pdf

No counties in NW Oregon were listed as "counties of concern", i.e. less resilient and able to adapt to changing socioeconomic conditions. However, the authors caution that the indicators they used to assess this should not be considered definitive (see pages 9-12).

"This work responds to the need to assess progress toward sustainable forest management as established by the Montréal Process Criteria and Indicators. The focus is on a single indicator (commonly referred to as Indicator 46) that addresses the 'viability and adaptability to changing economic conditions, of forest-dependent communities, including indigenous communities.'

Communities in Oregon were assessed in terms of their connectivity to service centers, socioeconomic well-being, and proximity to public lands. Fifty-four communities rated relatively low in these combined characteristics and were considered less adaptable to changing *socioeconomic conditions."*

ECONorthwest. (1999). Salmon and the economy: A handbook for understanding the issues in Washington and Oregon. Center for Watershed and Community Health, Mark O. Hatfield School of Goverment, Portland State University, Portland, OR. 35 pages.

Full text available online at:
http://cwch.uoregon.edu/ReportsFolder/EcoNWSalmon.pdf

"Summary:

1. Rebuilding healthy salmon populations requires significant changes in Washington and Oregon
-The problems are widespread
-The underlying causes have deep roots
-Habitats must be restored across large landscapes
-Federal law mandates change

2. Rebuilding healthy salmon populations will generate important economic benefits
-Salmon, themselves, are valuable
-Salmon provide a warning of wider environmental hazards
-There are many related benefits
-Government may become more efficient
-Salmon conservation will create employment and business opportunities
-Acting now will reduce future obligations

3. The costs of rebuilding healthy salmon populations probably will not be as bad as many believe
-Many changes will entail doing things differently, but will have few costs
-Many costs can be attenuated
-Many costs can be spread out
-Few workers will be adversely affected
-Most workers will adapt fairly easily
-The alternative may be even more costly

4. Win-win opportunities are possible
-Adopt tax incentives and other subsidies that help, not hurt, salmon
-Adopt environmental-regulations systems that boost BOTH salmon populations and economic prosperity
-Implement effective transition programs"

ECONorthwest. (2000). Saving salmon, sustaining prosperity: An introductory handbook and reference for the Puget Sound region and Washington. Seattle, WA/Portland, OR: ECONorthwest/Mark O. Hatfield School of Government, Portland State University. 31 pages.

Full text available online at:
http://cwch.uoregon.edu/

"This handbook offers a quick summary of the economic data and issues associated with efforts to restore healthy salmon runs in the Puget Sound Basin and the rest of Washington.

Salmon populations have declined enough for some of the state's salmon runs to have gone extinct, and others to be listed as threatened or endangered under the federal ESA. The listings have generated fear that taking the steps biologists say are needed to prevent salmon from extinction would impose extreme economic harm on taxpayers, business owners, workers, and property owners.

A closer look at the evidence, though, indicates that the reverse is true. In many instances, saving salmon will result in money savings that exceed initial costs. If taken efficiently and effectively, the steps needed to save salmon would enhance the value of the services taxpayers receive in return for their tax payments, improves business profits, generate new jobs, and enhance property values. In short, saving salmon will be a good investment for the economy and help communities, businesses and citizens throughout Washington State adopt more environmentally friendly and economically sustainable paths.

This report provides a summary of the evidence supporting these conclusions. It also contains information about the extent of the declines in salmon populations, a description of the factors contributing to these declines, and extensive endnotes and references pointing the interested reader toward more detailed information."

Gregory, R. (91987). Nonmonetary Measures of Nonmarket Fishery Resource Benefits. Transactions of the American Fisheries Society 116 (3): 374-380.

Abstract: "This paper addresses the validity and usefulness of nonmonetary approaches to valuing public investments in freshwater fishery resources. It identifies, defines, and gives examples drawn from four valuation approaches: measures of social well-being, psychophysical measures, attitude measures, and multiattribute choice measures. Each of these nonmonetary approaches provides useful information regarding the socioeconomic consequences of a proposed project, thereby complementing more conventional evaluation frameworks that tend to emphasize the biological or financial implications of a change. In addition, the argument is made that greater concern should be placed on the compatibility between a selected response mode and how people customarily think about the environmental asset under consideration."

Kelly, R. (2001). Tillamook Burn: History, reforestation, economics. Salem OR, Oregon State Legislature, Legislative Committee Services. 4 pages.

Full text available online at:
http://www.leg.state.or.us/comm/commsrvs/brief_tillamook_burn.pdf

Brief synopsis of Tillamook Burn and reforestation effort, summary of timber values and reforestation costs.

Knowler, D., B. MacGregor, et al. (2000). Valuing the quality of freshwater salmon habitat: A pilot project. Burnaby, B.C., Canada, School of Resource and Environmental Management, Simon Fraser University.

Full text available online at:
http://www.cd.gov.ab.ca/preserving/parks/fppc/freshwatersalmonhabitat.pdf

Pilot study into valuing the "societal benefits" of protecting spawning and rearing habitats for coho. Used a "bioeconomic" model to derive results that assume fishery is managed optimally, in the sense of maximizing its net social benefits. One case study is from western Oregon.

Knowler, D. J., B. W. MacGregor, et al. (2003). Valuing freshwater salmon habitat on the west coast of Canada. Journal of Environmental Management 69(3): 213-321.

"Changes in land use can potentially reduce the quality of fish habitat and affect the economic value of commercial and sport fisheries that rely on the affected stocks. Parks and protected areas that restrict land-use activities provide benefits, such as ecosystem services, in addition to recreation and preservation of wildlife. Placing values on these other benefits of protected areas poses a major challenge for land-use planning.

In this paper, we present a framework for valuing benefits for fisheries from protecting areas from degradation, using the example of the Strait of Georgia coho salmon fishery in southern British Columbia, Canada. Our study improves upon previous methods used to value fish habitat in two major respects. First, we use a bioeconomic model of the coho fishery to derive estimates of value that are consistent with economic theory. Second, we estimate the value of changing the quality of fish habitat by using empirical analyses to link fish population dynamics with indices of land use in surrounding watersheds.

In our example, we estimated that the value of protecting habitat ecosystem services is C$0.93 to C$2.63 per ha of drainage basin or about C$1322 to C$7010 per km of salmon stream length (C$1.00=US$0.71). Sensitivity analyses suggest that these values are relatively robust to different assumptions, and if anything, are likely to be minimum estimates. Thus, when comparing alternative uses of land, managers should consider ecosystem services from maintaining habitat for productive fish populations along with other benefits of protected areas."

Latta, G. and C. A. Montgomery ([in press]). Minimizing the cost of stand level management of older forest structure in western Oregon. Western Journal of Applied Forestry.

INR archive.

“The area of old-growth forest in the Pacific Northwest is estimated to have declined dramatically from historical levels. Active management involving repeated thinning that leaves substantially fewer trees than a typical commercial thin has been proposed as a way to speed the development of older forest structure in the region.

This study uses a random search heuristic and an individual tree simulation model, ORGANON, to search for cost-effective old forest management regimes for a wide range of stand types that occur on private land in western Oregon. The regimes were designed to meet older forest structural criteria, as defined by the ODF, for 30 years prior to clearcut harvest.

The opportunity cost of managing for older forest structure was estimated for each stand type as the value of foregone timber production under maximum net present value management. Opportunity cost was found to be positively correlated with site quality, stand age, and stocking. Cost-effective management for older forest structure is important because, the lower the cost of conservation, the more likely it will occur.”

From the conclusions: "Resulting Older Forest Structure (OFS) management regimes are characterized by repeated thinning with relatively high volume removals. This is consistent with management strategies recommended in recent literature by forest silviculturists and ecologists who are concerned that existing [young, second growth] stands, if left in unmanaged reserves, may never develop attributes that replicate the natural old-growth forests that developed historically at low densities....the OFS active management regimes contribute to the stand structure objective by encouraging tree growth and multiple story development and the financial objective by removing timber volume quickly so that revenue is generated early in the life of the stand.

Nonetheless, there is reason for caution. Although science supports the idea that active management can, indeed, achieve desirable outcomes, that is not known with certainty...in the face of this uncertainty, a cautious strategy would involve both active and reserve approaches to conservation."

Lee, R. G. and P. J.Eckert. (2002). Establishment size and employment stability in logging and sawmilling: a comparative analysis. Canadian Journal of Forest Research 32 (1): 67-80.

“Wood products employment stability (defined as year-to-year variation) was examined as a function of establishment size (grouped by number of employees). Small- and medium-sized establishments were consistently found to be more stable than large establishments. Comparison of Washington, Oregon, the United States, and Japan showed that the relationship between establishment size and employment stability was maintained regardless of long-term growth or decline in wood-products employment. Moreover, the smaller wood-products establishments in the United States were found to be more stable than the smaller establishments in other manufacturing industries. Structural stability in employment has been associated with the highly competitive nature of smaller wood-products establishments. Employment stability can best be promoted by policies that support the continued viability of smaller establishments.”

Lippke, B. and B. Bare (1999). Cost and compromise: Determining the public's willingness to pay for values received from forests. Seattle, WA, University of Washington College of Forest Resources**.** Research Fact Sheet #21.

Full text available online at:
http://www.cfr.washington.edu/Research/fact_sheets/21-CINTRAforvalues-4pg.pdf

2-page summary of a survey using "...experimental choice analysis (ECA) to measure a public's willingness to pay for hypothetical projects or activities that are difficult to quantify, such as pleasing views or the opportunity to fish, hunt or hike.

ECA requires that survey respondents choose among several forest management alternatives with varying costs and benefits. To help respondents make these decisions, the survey first asked them how they used or benefited from the forest. Then respondents studied photographs of various types of forests, from scrub to old-growth and different mixtures of both, and decided which they liked best and thought were most beneficial."

(There were significant differences between urban and rural households willingness to pay for biodiversity and esthetics, and the authors note that increasing biodiversity or esthetics is likely to reduce jobs in rural areas, which at least partly offsets the value of environmental benefits.)

"Both urban and rural residents were similar in their willingness to accept reduced jobs to gain other benefits....overall, survey respondents preferred forest management strategies designed for multiple uses. The analysis shows that [Washington's] public valuation of forests could be increased over existing and proposed practices by $1-2 billion per year by motivating more alternative management practices.

This number is arrived at by selecting management alternatives that provide the highest total value to the public as measured by the survey. The total value includes the value for increasing biodiversity and esthetics less the value lost from lower employment and higher costs accumulated across all the state's residents."

Lippke, B. and B. Bare (1999). Economic and Environmental Impact Assessment of Forest Policy: Western Washington. Seattle, WA, University of Washington College of Forest Resources. Research Fact Sheet #3.

Full text available online at:
http://www.cfr.washington.edu/Research/fact_sheets/03-assessWeWa-4pg.pdf

Study on economic and environmental impacts from past and prospective forest management alternatives, including a simulation of alternatives for riparian protection.

Concluded that active biodiversity management to restore riparian functions that existed in pre-European settlement times reduced harvest losses, increased jobs and resulted in biodiversity gains decades sooner than the reserve option with no active management.

Loomis, J. B. (1999). Passive use values of wild salmon and free-flowing rivers. U.S. Army Corps of Engineers/Agricultural Enterprises, Inc.

Full text available online at:
http://www.nww.usace.army.mil/lsr/REPORTS/misc_reports/passive.htm
http://www.nww.usace.army.mil/lsr/REPORTS/misc_reports/passive.pdf

Report was part of the U.S. Army Corps of Engineers Lower Snake River Juvenile Salmon Migration Feasibility Study.

"This technical chapter defines what is meant by passive use or existence values, describes their relevance to Lower Snake River feasibility study and presents the results of applying the existing literature to measure such values for the Lower Snake River.

Avoiding extinction of endangered species is recognized as a source of existence or passive use values (Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. Free-flowing rivers were one of the first examples of such resources with existence values. Essentially people who never plan to visit, raft, or fish these rivers may still pay something to have a free flowing river.

Wild stocks of Snake River Sockeye and Chinook Salmon clearly fit into this picture. As noted by Olsen et al. in his existence value of salmon study, 'existence values as the value an individual (or society) places on the knowledge that a resource exists in a certain state is theoretically sound and can be measured for assessment within the resource decision making arena'. Passive use value are also public goods, in that these benefits can be simultaneously enjoyed by millions of people all across the region and the country."

Loomis, J. P. Kent, L. Strange, K. Fausch, A. Covich. (2000). Measuring the total economic value of restoring ecosystem services in an impaired river basin: Results from a contingent valuation survey. Ecological Economics 33 (1): 103-117.

"Five ecosystem services that could be restored along a 45-mile section of the Platte river were described to respondents using a building block approach developed by an interdisciplinary team. These ecosystem services were dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. Households were asked a dichotomous choice willingness to pay question regarding purchasing the increase in ecosystem services through a higher water bill.

Results from nearly 100 in-person interviews indicate that households would pay an average of $21 per month or $252 annually for the additional ecosystem services. Generalizing this to the households living along the river yields a value of $19 million to $70 million depending on whether those refusing to be interviewed have a zero value or not. Even the lower bound benefit estimates exceed the high estimate of water leasing costs ($1.13 million) and conservation reserve program farmland easements costs ($12.3 million) necessary to produce the increase in ecosystem *services."*

Loomis, J. B. and D. S. White (1996). Economic values of increasingly rare and endangered fish. Fisheries 21 (11): 6–10.

"This paper discusses the types of economic benefits that rare and endangered fish provide members of the general public, and a survey method increasingly used to measure those benefits. The paper also presents results from recent surveys that have attempted to elicit the economic values the public holds for rare and endangered fish. These surveys indicate that citizens would pay US$4–$9 per year to increase stream flows and restore habitat of species such as the Colorado squawfish and $30–$60 per year for increasing populations of Pacific Northwest salmon.
Validation of market simulations shows that Montana resident anglers donated on average $2 and nonresident anglers $12 to The Nature Conservancy to increase flows in one river for the Arctic grayling and Yellowstone cutthroat trout. A large portion of the dollar values reflect the benefits citizens derive from simply knowing the abundance of these species will be increased and available for future generations. Legislators, policy makers, and social scientists should consider these economic factors when debating reauthorization of the Endangered Species Act."

Haynes, R.W. and J. F. Weigand. The context for forest economics in the 21st century. In Creating a Forestry for the 21st Century: The Science of Ecosystem Management. K. Kohm and J. Franklin, eds. Washington, DC, Island Press: 285-301.

INR archive.

"In this chapter, we discuss economic concepts that are central to achieving [a] balance as society expands the scope of forest ecosystem management. Forest management continues to be a social response to meet human demands for goods, services, and desired ecosystem conditions. Traditional concepts in neoclassical economic theory, such as supply and demand, efficiency, and equity, remain vital in any discussion of ecosystem management. Economic analysis will continue to examine management options and focus on the distribution patterns of costs and benefits to society over time.

Forest economics has traditionally concentrated on economic issues of timber production. Indeed the phrase 'forest products' continues to mean 'timber products' in common North American parlance. Increasingly, however, forest economists are exploring a spectrum of resources and public policy issues seldom addressed in North American society. Current forest economics research challenges traditional economic assumptions and methodologies that appear not to model current societal preferences and economic behavior adequately.

New economic concerns about forest ecosystems include, but are not limited to, valuation methods of nontraditional ecosystem products, discount rates that reflect societal preferences to preserve options for future generations, the human economic role in ecosystem sustainability, appropriate systems constructs to model complex economic-ecologic interactions by way of scenario planning, *methods to weigh the benefits and costs of ecosystem restoration, redefinition of old-growth as a sustainable resource, the significance of scale in economic analysis, and links between forest management and economic development for resource dependent communities. Also, the range and magnitude of goods, services and ecosystem states demanded are growing as knowledge of ecosystems and human population expands.*

Hence, economists find themselves challenged to be more inventive in their efforts to provide adequate models and explanations of economic interactions between people and forest ecosystems."

Howard, J. L. (2000). U.S. forest products annual market review and prospectus, 1999-2000. Madison, WI, USDA Forest Service, Forest Products Laboratory, FPL-RN-0278. 7 pages.

Full text available online at:
http://www.fpl.fs.fed.us/documnts/fplrn/fplrn278.pdf

"This report provides general and statistical information on forest products markets in terms of production, trade, consumption, and prices, as well as specifics describing the current state of the U.S. economy. Market developments are described for sawn softwood, sawn hardwood, softwood and hardwood log trade, pulpwood, wood-based panels, paper and paperboard, fuelwood, and forest product prices. The table presents detailed information and projections for 2001."

Niemi, E., E. Whitelaw, et al. (1999). Salmon, timber and the economy. Eugene OR, EcoNorthwest.

Full text available online at:
http://www.salmonandeconomy.org/pdf/SalmonTimberEconomy.pdf

Report prepared for Pacific Rivers Council, Oregon Trout, Audubon Society of Portland, Institute for Fisheries Resources. Discusses economic costs and benefits of restricting logging on private and state forest lands. Authors argue that costs are not as great as some landowners argue, and that some benefits are not accounted for.

Oregon Dept. of Fish and Wildlife. (2002). Economic impact statement for the August 9, 2002 hearing on the amendment of rules relating to the 2003 sport fishing regulations for finfish, shellfish, and marine invertebrates. Salem, OR: Oregon Dept. of Fish and Wildlife**.** 3 pages.

Full text available online at:
http://www.dfw.state.or.us/ODFWhtml/meeting_schedule/august/AUG_J3bps.pdf

Includes discussion of the economic impact of sportfishing in Oregon, and some recent estimates. State level angler trip expenditures were estimated at $286.6 million and total expenditures *including those for durable equipment was estimated at $622.8 million in 1996. Angler expenditures in Oregon were estimated at about $689 million in 2001. The 1991 Oregon Angler Survey indicated that residents spent about $42.15 per angler day, and non-residents spent $42.54 per angler day. Associated personal income impact at the state level was $31.34 and $33.14 per day for residents and non-residents respectively.*

Oregon Department of Forestry. (2003). Review of Tillamook Rainforest Coalition Report: Economic Realities in the Tillamook and Clatsop State Forests. Salem OR, Oregon Department of Forestry.

Unpublished, archived at INR.

ODF response to the 2003 Tillamook Rainforest Coalition report by Power and Ruder entitled "Economic Realities in the Tillamook and Clatsop State Forests: Possibilities for economic expansion and diversification."

Text of introductory paragraph: "Following are comments on the report Economic Realities in the Tillamook and Clatsop State Forests (ERTC) being distributed by the Tillamook Rainforest Coalition. The report is not an unbiased analysis of the economic consequences of different management alternatives for the Tillamook and Clatsop State Forests. Instead, the report misuses the information upon which it is based, where inconvenient ignores readily available information, and relies on speculation to attempt to economically justify a proposal to set aside one-half of the Tillamook and Clatsop State Forests from active forest management. Although better written than earlier and similar analyses, the report is deeply flawed and adoption of the report's recommendation could lead to environmental, social and economic losses, both to local counties and to the State as a whole."

Polasky, S., J. D. Camm, et al. (2001). Selecting Biological Reserves Cost-Effectively: An Application to Terrestrial Vertebrate Conservation in Oregon. Land Economics 77(1).

"Concerns that the loss of habitat has greatly increased species extinction rates have led to calls for establishing biological reserves to preserve key habitat. In this paper, we study reserve site selection for terrestrial vertebrates in Oregon using data on species ranges and land values. We find cost-effective strategies that represent a maximum number of species for a given conservation budget. By varying the budget, we find the cost of obtaining various levels of representation. In general, effective conservation decision-making requires integrated analysis of both biological and economic data."

Power, T. and R. P. (2003). Economic Realities in the Tillamook and Clatsop State Forests: Possibilities for economic expansion and diversification. Portland OR, Tillamook Rainforest Coalition.

Full text available online at:

http://www.tillamookrainforest.org/TRC/media/Resources/asset_upload_file247_866.pdf

Economic study commissioned by Tillamook Rainforest Coalition analyzes alternatives to focusing primarily on timber harvesting.

Radtke, H. and Davis, S. (1999). Economic Description of Selected Oregon and Washington Coastal Counties. Corvallis OR, The Research Group.

Full text available online at:
http://pdata.fish.washington.edu/pdfs/localeconomies.pdf

Describes social and economic conditions for four coastal counties (including Tillamook and Coos counties in Oregon) identified as important for understanding economic and ecological links. Sponsored by the University of Washington Sea Grant Program, administered by the Pacific Coastal Ecosystem Regional Study (PNCERS), a joint effort of the Oregon Coastal Management Program, the Oregon Sea Grant Program, the Washington Sea Grant Program and the National Marine Fisheries Service.

Form the preface: "Methodologies used to determine estimates were adopted with the understanding that technically sound and defensible approaches would be used. Where judgment was necessary, conservative interpretation was employed. Because this philosophy was strictly adhered to in all aspects of the report, the authors represent that the descriptions presented herein are reasonable."

Raettig, T. L. and H. H. Christiansen (1999). Timber harvesting, processing and employment in the Northwest Economic Adjustment Initiative region: Changes and economic assistance. USDA Forest Service, Pacific Northwest Research Station, PNW-GTR-465. 16 pages.

Full text available online at:
http://www.fs.fed.us/pnw/pubs/gtr_465.pdf

"Conclusions:
1. Timber harvests in the NWEAI region decreased by almost 50% between 1989 anbd 1994. Decreases in harvest from Federal lands have been even greater, with a decrease of 80% from 1989 levels. Total harvest in the NWEAI region now seems to be stabilizing as the Northwest Forest Plan is implemented and public timber sales are resumed at new, lower levels.

2. Employment in the lumber and wood products sector in the NWEAI region declined markedly as harvest levels were declining, with the loss of about 14,000 jobs in the region. Employment losses were not as large proportionately as harvest declines because of offsetting increases in secondary forest products manufacturing and those parts of the lumber and wood products sector not dependent on local timber harvests.

3. There are important differences in the patterns of timber harvest decline and employment losses within the region. Certain counties that were relatively more dependent on public sector timber supplies have experienced the most severe impacts.

4. The NWEAI was created to provide economic assistance to the region. Large amounts of Federal community and economic development financial resources have been directed to the impacted NWEAI region."

Robinson, A. P., D. C. Hamlin, et al. (1999). Improving forest inventories. Journal of Forestry 97 (12): 38-43.

Article is part of a special issue of JOF: "Forest Inventory and Analysis: Moving to an Annual National System." Other articles discuss the role of remote sensing, and analytical alternatives. "Precise estimates of standing inventory are often needed in a very short time; for example in appraisal situations for acquisitions and divestitures. Opportunities to integrate auxiliary information into forest stand inventory are considerable, and the potential benefits are very attractive. This article presents three popular techniques for incorporating auxiliary information into forest inventory: list sampling, stratification, and Poisson sampling."

Smith, C. L. and J. Gilden (2000). Human and habitat needs in disaster relief for Pacific northwest salmon fisheries. Fisheries 25 (1): 6–14.

"Since 1994, federal disaster relief programs have been implemented for New England, Pacific Coast, and Gulf Coast fisheries. The Pacific Northwest coho salmon (Oncorhynchus kisutch) fishery serves as a case study for results of a disaster relief program. To help salmon fishers, the U.S. government declared an ecological disaster and provided $37 million in relief over 3 years. Relief efforts included an emergency program that provided limited, one-year assistance to an estimated two-thirds of the salmon gillnetters and trollers in Oregon, Washington, and California.

A multi-year Northwest Emergency Assistance Program (NEAP) sought to reverse harmful habitat and capacity conditions and helped a quarter of the salmon gillnetters and trollers. NEAP was an important catalyst for programs to restore habitat, one of the primary causes of salmon stock decline. Interview, survey, and documentary data suggest that disaster relief helped commercial fishers continue fishing but did not adequately meet many human needs for assistance."

Temple, R. (2002). Forestry and wood products: Value added manufacturing. An Oregon perspective. Healthy Forests, Healthy Communities Partnership**:** 1 page.

Available at:
http://www.sustainableoregon.net/forestry/value_added.cfm

Short article discusses potential for value added manufacturing of wood products as a way to strengthen rural economies in Oregon.

Tillamook County Futures Council. (2002). Tillamook County Benchmarks 2002. Tillamook, OR.

The 2002 Benchmarks are available online at:
http://tcf.tillamook.k12.or.us/benchmarks2002.htm

The main Tillamook County Futures Council website is:
http://tcf.tillamook.k12.or.us/

"In 1997, the Tillamook County Commissioners appointed a 12-member Futures Council to "develop a long range vision for the county through broad-based citizen input representing the various geopgraphic regions and full range of interests that exist within the county". During a 6-month outreach process, the Futures Council conducted 17 focus group meetings, distributed 4000 surveys and held a series of public meetings.

1000 completed surveys formed the basis of the Tillamook County Strategic Vision, with long-range community goals for 4 areas: economy, growth and development, the natural environment, and society and culture. For each area, the Vision lays out strategies, and benchmarks that measure the county's progress."

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. (2003). 2001 national survey of fishing, hunting and wildlife-associated recreation: Oregon.

Full text available online at:
http://www.census.gov/prod/2003pubs/01fhw/fhw01-or.pdf

According to this report, sportfishing contributed over $600 million to Oregon's economy in 2001.

Van Vliet, A. and B. Lee. (2002). Economic characteristics of region 2: Multnomah County, Washington and Tillamook Counties, and City of Portland. Worksystems, Inc. 23 pages.

Full text available online at:
http://www.worksystems.org/contractor/EconChar02.doc

Report for Worksystems Inc. (WSI) Regional Workforce Planning Project - Community Planning 2002. Broken down by three characteristics:

1. *Top business and industry areas of growth*
2. *Lay off patterns in businesses/industries*
3. *Availability of entry-level jobs by growth business and industry*

Includes projections to 2010. Data provided by the Oregon Employment Department. An updated version of this report is scheduled to be available in June, 2004.

"WSI connects people with jobs. We are in the community, the board room, the classroom, and the workplace. We are rural & urban. We work with industries, small businesses & entrepreneurs. With adults, families & youth. We are out there, bringing it together, getting it to work. WSI, with our partners & contractors, operates a network of seven One-Stop Career Centers. These centers provide job search assistance and training, education, as well as, workforce related services to employers."

Von Hagen, B., J. F. Weigand, et al. (1996). Conservation and development of nontimber forest products in the Pacific Northwest: An annotated bibliography. Portland, OR, USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-375. 246 pages.

Full text available online at:
http://www.treesearch.fs.fed.us/pubs/viewpub.jsp?index=3059

"This bibliography encompasses literature on the historic and current scope of nontimber forest product industries in the Pacific Northwest and includes references on international markets and trade that bear on these industries. Key themes in the bibliography are biological and socioeconomic aspects of resource management for sustainable production; procedures for identifying, monitoring, and inventorying important resources; means for technical innovation and resource development; and public education about nontimber forest resources.

Social policy issues address the role of nontimber forest products in rural development and the spectrum of ethical considerations required for socially acceptable policy formulation. Economics literature covers estimating the contribution of nontimber forest products to a whole ecosystem economy, analyzing and planning for joint production of agroforestry systems, and enhancing the performance of nontimber forest product sectors."

Washington Department of Fish and Wildlife. (2002). Adding it up: Washington communities profit from fish, wildlife recreation. Washington Department of Fish and Wildlife. Olympia, WA.

Full text available online at:
http://www.wdfw.wa.gov/pubaffrs/adding_it_up_sm.pdf

Article discusses economic impacts of fishing, hunting and wildlife viewing, and states that most economic benefits accrue to rural communities.

Willer, C. (2001). Economics and private forest management. Corvallis, OR, The Coast Range Association. Issue Paper #2.

Full text available online at:
http://www.coastrange.org/FRNpaper2.htm

Discussion of economic pressures and considerations that influence management of forests from which timber is harvested. Includes a short discussion of the "net present value" concept that underlies most conventional economic analyses of forest management options.

"This is the second in a series of four papers establishing the basis for a dialogue of diverse interests around the economic and regulatory underpinnings of private industrial forestry. The result of this dialogue will be the formation of a Forestry Reform Network (FRN) capable of initiating policy solutions to improve coastal forest conditions. This paper:

1. Describes forestry's grounding in economics.
2. Describes discounting and net present value management.
3. Explores the controversy over discounting and the need to move away from a strict return-on-equity approach to forest management.
4. States the need for new investment approaches to forestry that recognizes social and biological values.

Conclusion:

Society's desire for the goods, services and amenities provided by long-living forests has created political pressure for companies to grow older forests. That political pressure is leveraged daily in the legal maneuverings between the environmental community and forest products industry. Our assessment is that forestry reform strategies based on environmental law and regulation, while necessary, will not be sufficient to achieve adequate reform. If companies are compelled to harvest on longer rotations, the economic reality of capital cost will apply, and investors will either take their money elsewhere, or devote whatever resources necessary to protect their profits from a political "takings."

Legal and regulatory initiatives to reform private forestry in the FRN Project area will advance based on their political strengths and legal merits. This paper is meant to refresh our appreciation of the underlying economics of forestry, its capital intensiveness and how that fact influences forest management and public policy. Reforming forestry in the 21st Century, as Kohm and Franklin suggest, involves the restoration and protection of landscape-level forest structure. The Forestry Reform Network appreciates that fact and seeks a dialog to further the Network's understanding of forestry economics, achieve a clear forestry reform problem statement, and identify policy solutions.

We conclude that to increase forest structure and advance rotation time requires a social investment in natural forest capital. If society desires long-lived forests, we must devise economic and political instruments to provide investment capital that is not subject to the normal business constraints of net present value management and discounting."

Wu, J., R. M. Adams, W. G.Boggess. (2000). Cumulative Effects and Optimal Targeting of Conservation Efforts: Steelhead Trout Habitat Enhancement in Oregon. American Journal of Agricultural Economics 82 (2) 400-414.

Full text available online at:
http://www.blackwell-synergy.com/servlet/useragent?func=synergy&synergyAction=showAbstract&doi=10.1111/0002-9092.00034&area=production&prevSearch=allfield%3A%28oregon+fishing%29

Cumulative effects exist in environmental management when a significant environmental improvement can be achieved only after conservation efforts reach a certain threshold. Cumulative effects exist particularly in conservation efforts involving fish and wildlife.

This study investigates allocation of funds to restore steelhead habitat in eastern Oregon. Results suggest that when conservation funds are limited, threshold effects should be considered. At least in some cases, when financial resources are limited, it may be more economically efficient to focus on improving habitat that is in relatively better shape than to focus on highly damaged habitat.

Abstract: "A major problem with some conservation programs is that they ignore potential cumulative (threshold) effects in environmental quality management. The objective of this study is to investigate the importance of cumulative effects in the targeting of conservation efforts. The empirical focus is on habitat investments to protect an important anadromous fish species in the Pacific Northwest, steelhead trout. Results of the analysis point to a substantial cumulative effect in the relationship between water quality and abundance in this fishery, which affects the efficiency of specific habitat investments."

Wu, J. and K. Skelton-Groth (2002). Targeting conservation efforts in the presence of threshold effects and ecosystem linkages. Ecological Economics 42(1): 313-331.

Study uses the case of salmon restoration efforts in Pacific Northwest.

"The prevailing federal policy of targeting conservation programs on the basis of physical criteria tends to ignore the threshold effect of conservation efforts and the correlation between alternative environmental benefits. In this article, we examine the extent to which conservation funds will be misallocated when threshold effects and correlated benefits are ignored. We show that targeting conservation efforts based on physical criteria or political equity concerns may actually lead to the lowest possible benefits to society from conservation expenditure.

Ignoring correlated benefits may lead not only to misallocation of conservation funds among watersheds, but also to incorrect resources (e.g. land, streams) being targeted for conservation. The empirical analysis focuses on riparian habitat investments for salmon restoration in the Pacific Northwest. We show that a large portion of conservation benefits would be lost when threshold effects and correlated benefits are ignored, and argue that funds should be allocated so that the total value of environmental benefits is maximized, not the total amount of resources protected."

Wu, J., K. Skelton-Groth, et al. (2003). Pacific salmon restoration: Trade-offs between economic efficiency and political acceptance. Contemporary Economic Policy 21 (1): 78-89.

"There is no simple solution to the problems of salmon restoration given substantial political and scientific uncertainties. There are, however, some local findings in Oregon that can provide guidance to resource managers charged with allocating funds for conservation purposes.

This article shows that in most salmon habitat investments, there are likely to be strong nonlinearities (cumulative and threshold effects) that mitigate against politically palatable allocation criteria. In fact, this research indicates that decisions based on political equity concerns may actually lead to the lowest possible benefits to society. These scientific nonlinearities may make the political resolution of salmon recovery more difficult."