INDEPENDENT
[M]ULTIDISCIPLINARY
SCIENCE TEAM
(IMST)

State of Oregon

March 26, 2001

The Honorable John A. Kitzhaber
Governor of Oregon
State Capitol
Salem OR 973 10

The Honorable Gene Derfler
Oregon Senate President
State Capitol
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The Honorable Mark Simmons
Oregon House Speaker
State Capitol
Salem OR 973 10

We provide the enclosed Technical Report on research priorities in response to specific requests from the 1999 Oregon Legislature's Joint Legislative Committee for Stream Restoration and Species Recovery and, independently, the Director of the Oregon Watershed Enhancement Board. We believe that focusing limited resources on the higher priority needs will increase the likelihood of the success of the Oregon Plan. We hope this report will be helpful for that purpose.

We'd be pleased to clarify any of the material in this report if that would be helpful.

]Sincerely yours,

Logan A. Norris
Chair, Independent Multidisciplinary Science Team

LAN:grs

Enclosure

cc with enclosure:
House Committee for Stream Restoration and Species Recovery
Roy Hemmingway, Manager, Oregon Plan
Geoff Huntington, Director, OWEB
IMST

Evaluation of Research Priorities for the Oregon Plan, 2001-2003

Technical Report 2001-2

A report of the Independent Multidisciplinary Science Team, Oregon Plan for Salmon and Watersheds

March 5, 2001

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EXECUTIVE SUMMARY

The Oregon Plan for Salmon and Watersheds, Technical Reports from the Independent Multidisciplinary Science Team (IMST) and numerous other documents identify an extensive array of research needed to recover depressed stocks of wild salmonids in Oregon. The limitation of such listings is that they do not prioritize the research needs, making them appear equally important. Given limited resources, a focus on the higher priority needs would increase the likelihood of success of the Oregon Plan. The 1999 Oregon Legislature's Joint Legislative Committee for Stream Restoration and Species Recovery and, independently, the Director of the Oregon Watershed Enhancement Board requested that the IMST identify the higher priority research needed to help ensure salmonid recovery.

This IMST Report identifies priority areas for research and puts them in broad priority groupings (highest, high, moderate, and low). The priority categories emphasize ***when*** specific research topics should be addressed, ***not if***, since they are all important. The highest priority items should be addressed first and the lower priority items addressed as funding and personnel become available. The priorities we assign are based on our reviews of recommendations for research already made by the IMST and others.

The challenge in developing this report is dealing with research needs that differ significantly in scale and scope. Each priority listed is fairly broad and we hope that this will facilitate interdisciplinary research, interagency collaboration, and the use of new technologies. The danger of this report is that the exclusion of a research area may lead to the incorrect conclusion that it is not important. In fact, it might be critically important at a specific site or local scale, but less important when considered against other needs that operate across the landscape, which is where we put our emphasis.

Highest Priority

- Assess the status of anadromous salmonid stocks (coho, chinook, and chum salmon, sea-run cutthroat trout, and steelhead) and the risk for their extinction by integrating dynamic ocean conditions, habitat availability and quality, and human activities. We see three sub-elements.
  1) Understanding interactions among basin populations, metapopulations, ocean survival rates, life history stage (survival) trends, and population viability.
  2) Integrate analysis of habitat characteristics and spawner surveys with models to assess trends in population dynamics and conduct sensitivity analysis of models and model parameters.
  3) Determine distribution of spawner abundance relative to spawning habitat of differing quality.

High Priority

- Determine how changes in plant communities, including riparian and upland vegetation, can affect salmonid habitat quality.
- Determine relationships between habitat quality and population trends of salmonids in estuaries, lowland streams, and urban/suburban and agricultural settings.
- Determine the effects of wild-hatchery fish interactions and the impacts of hatchery management programs on wild stocks.
- Test the assumptions about survival differences between hatchery and wild fish.
- Determine the origin and the temporal and spatial distribution of wild ocean-caught fish.
- Determine the spawning escapement rate of steelhead.
- Determine the genetic basis of various life history strategies in salmonids.

Moderate Priority

- Determine the impacts of declining wild salmonid populations on ecosystem processes (such as the transport of nutrients from ocean to upland settings).
- Determine the effects of predation on salmonid recovery and how predation interacts with other environmental factors.

Low Priority

- Determine the impact of non-indigenous (exotic) aquatic and terrestrial species on salmonid recovery.
- Determine the cause and effects of disease, tumors, and other abnormalities of fish on the population dynamics of the fish and the implications for ecosystem and human health.

INTRODUCTION

The Oregon Plan for Salmon and Watersheds, Technical Reports from the Independent Multidisciplinary Science Team (IMST) and numerous other documents identify an extensive array of research needed to recover depressed stocks of wild salmonids in Oregon. The limitation of such listings is that they do not prioritize the research needs, making them appear equally important. Given limited resources, a focus on the higher priority needs would increase the likelihood of success of the Oregon Plan. The 1999 Oregon Legislature's Joint Legislative Committee for Stream Restoration and Species Recovery and, independently, the Director of the Oregon Watershed Enhancement Board requested that the IMST identify the higher priority research needed to help ensure salmonid recovery.

This IMST Report identifies priority areas for research and puts them in broad priority groupings (highest, high, moderate, and low). The priority categories emphasize ***when*** specific research topics should be addressed, ***not if***, since they are all important. The highest priority items should be addressed first and the lower priority items addressed as funding and personnel become available. The priorities we assign are based on our reviews of recommendations for research already made by the IMST and others. The research needs ***within*** each category are listed in random (not priority) order. Each research need has a title and is followed by a brief explanation. Where applicable, each research need is also followed by a list of IMST research recommendations made in previous reports that are related to the discussed need. Accomplishing the research needs listed in this report would help satisfy some of the recommendations (related to the research need) made by the IMST to a particular agency.

The challenge in developing this report is dealing with research needs that differ significantly in scale and scope. Each priority listed is fairly broad and we hope that this will facilitate interdisciplinary research, interagency collaboration, and the use of new technologies. The danger of this report is that not listing a research area may lead to the incorrect conclusion that it is not important. In fact, it might be critically important at a specific site or local scale, but less important when considered against other needs that operate across the landscape, which is where we put our emphasis.

Resource managers often require immediate answers to problems they are facing. Some solutions are available through short-term research. Other issues, such as salmon recovery, are complex because the anadromous species must adapt to several environments and sustain healthy populations while encountering natural and human-related mortality. Predictions of population numbers and viability and management decisions made only on the basis of short-term studies may satisfy short-term pressures for immediate action, but ultimately are less successful than predictions made after sustained scientific study (McAninch and Strayer 1989). Therefore, the priorities listed in this report require long-term research.

Long-term research is important for understanding ecological processes that vary over long periods of time or large geographical areas, and how salmonid populations respond to their dynamic environments. Sustained research is also necessary to understand and predict the effects human activities have on oceanic, estuarine, riverine, and terrestrial ecosystems. Long-term research requires commitments from both research institutions and resource management agencies. Increased communication to identify information needs and ways to adapt research findings to management practices and policies are essential as is sustained funding (Likens 1989).

Research Needs

Highest Priority

Assess the status of anadromous salmonid stocks (coho, chinook, and chum salmon, sea-run cutthroat trout, and steelhead), and the risk for their extinction by integrating dynamic ocean conditions, habitat availability and quality, and human activities.

The IMST has identified the importance of adopting a landscape context for the Oregon Plan, and the need for long-term perspectives that incorporate changing conditions in terrestrial, freshwater, and ocean ecosystems. These are also necessary to accomplish this research priority.

The research needs (listed immediately below) must also be addressed and integrated with one another to accomplish the stock assessment called. These research areas are critical to establishing baseline data on salmonids and their interactions with their environments. Baselines have not been established for any of the anadromous species, and they are needed in order to determine the effectiveness of the Oregon Plan.

Each of the following bullets are equally important in achieving this goal. Each can be addressed by the expansion of the number and distribution of life history monitoring sites, and by linking these life history monitoring sites to habitat analysis to provide a landscape perspective. Presently, life history monitoring sites are concentrated in the coastal areas and are used to monitor the status of coho but need to be expanded statewide and encompass all the anadromous salmonid species.

1) **Understanding interactions among basin populations, metapopulations, ocean survival rates, life history stage (survival) trends, and population viability.** Accurate estimates of population size, ocean survival, and population viability all require widely distributed research/monitoring sites to monitor juvenile outmigration and spawning escapement. These sites could also provide information to aid in the understanding of the interactions among salmonid populations at the metapopulation level. Research is also needed on estuarine and ocean survival rates and estimation of recolonization rates.

2) **Integrate analysis of habitat characteristics and spawner surveys with models to assess trends in population dynamics, and conduct sensitivity analysis of models and model parameters.** Field research and monitoring data needs to be linked to the models in order to relate population responses with habitat quality. Sensitivity analysis of salmon population models are needed in order to understand the range of habitat conditions and population abundances that might be tolerated during different ocean regimes and under various harvest scenarios. An objective of the habitat surveys should be to determine the spawner "seeding" level as part of the process in deciding if supplementation or other programs should be considered for a particular area.

3) **Determine distribution of spawner abundance relative to spawning habitat of differing quality.**
This allows the assessment of the distribution of spawner abundance relative to the quality of habitat. The information from this effort could add to the understanding of the habitat requirements of salmonids and help determine what types of habitat are most important for conservation or restoration. Synthesis of the findings will provide an integrated assessment of salmonid populations and habitat conditions throughout basins, including the condition of stream, upland, lowland, and estuarine habitats. Comparisons among basins will be possible, which would form the preliminary basis for designating reference basins and could be used to evaluate critical habitat within basins.

Following are IMST Recommendations from other IMST reports that are related to this highest research priority topic:
Evaluate the ability of current monitoring and research programs to provide data required for life-cycling modeling and to measure the following: 1) recolonization of habitats as stocks recover, 2) straying rates, 3) distribution of spawners across their range, 4) degree of unoccupied habitats, and 5) ocean survival within and among Gene Conservation Groups (IMST 2000b).

Strengthen life-cycle modeling (IMST 2000b).

High Priority

Determine how changes in plant communities, including riparian and upland vegetation, can affect salmonid habitat quality.

Human activities have caused significant changes in vegetation covering watersheds and riparian areas. These changes have affected the hydrology of watersheds, channel morphology, instream large wood and gravel availability, water quality, and nutrient inputs. All of these ultimately affect salmonid habitat and productivity. Some of the best-documented effects of changes in vegetation on stream systems and salmonids come from western Oregon forests. Continued long-term research is needed to understand the effects of vegetation change on salmonid habitat, productivity, and recovery across the state. Site-specific research is needed to identify plant species and community structures necessary to maintain ecosystem integrity. Landscape level research is needed to understand how plant community changes can amplify or mitigate activities related to various land uses including, agriculture, forest management, industrial activities, and urban/suburban development.

Remote sensing and ground surveys are needed in these areas to establish baseline data and to compare to historical records in order to conduct trend assessments of watershed and habitat conditions. Currently, remote sensing has not been used to its fullest potential under the Oregon Plan. But in order to do so, we still need to determine what the accuracy of remotely sensed data and the proper scale at which it should be used. Then a statewide assessment of the status of riparian and upland conditions can be done. These data will also allow for comparative watershed analysis. The assessments need to be done in conjunction with determining other environmental factors, such as stream temperature over seasons.

Following are IMST Recommendations from other IMST reports that are related to this priority topic:
ODF should develop a policy framework to encompass landscape (large watershed) level planning and operations on forests within the range of wild salmonids in Oregon. IMST recommends that the following elements be included in this modified forest policy framework:

1) Long-term landscape level assessment of the upslope and riparian forest and associated aquatic systems to ensure that the desired condition is maintained across the landscape and through time;

2) Identified goals for the characteristics of aquatic systems and riparian and upslope forest across the landscape to ensure the integrity of salmonid habitat;

3) Monitoring that will provide the information needed to evaluate the aggregated outcomes of management at the landscape level (IMST 1999).

Determine relationships between habitat quality and population trends of salmonids in estuaries, lowland streams, and urban/suburban and agricultural settings.

Some data on fish abundance and distribution in Oregon stream systems is available, and monitoring is being conducted in many locations, but there has been little analysis to relate changes in salmon populations over time to habitat change related to land use. Research is needed to estimate (1) the past abundance and distribution of salmon throughout the landscape, (2) the changes in abundance and distribution through time, (3) the changes in habitat type and availability that have occurred as estuaries, rivers, and streams that have been modified to accommodate a variety of human activities. Estuaries have been modified for industrial uses, shipping, and agriculture; lowland rivers have been modified to expand the land-base available for agriculture, flood control, navigation, and development of cities and towns. Little is known about how these changes have directly and indirectly affected salmon abundance, distribution, and health across the landscape and how theses changes may affect recovery. As mentioned in the previous bullet, remote sensing and ground surveys are needed in lowland and estuarine areas to conduct trend analysis.

Following is a recommendation from an IMST Letter Report that is related to this priority topic:
The Interagency Monitoring Team has identified ocean and estuarine systems as key components in the Monitoring plan. These monitoring efforts have not been implemented, yet these environments are a critical part of the habitat (IMST Letter Report, April 1, 1999).

Determine the effects of wild-hatchery fish interactions and the impacts of hatchery management programs on wild stocks.

The Oregon Plan lists two general impacts that hatchery management can have on wild fish populations: the loss of genetic adaptation of wild populations from interbreeding with genetically dissimilar, less fit hatchery fish; or through direct competition between wild and hatchery-reared fish. These impacts need to be better understood and assessed to determine the effectiveness of hatchery management on minimizing impacts to wild fish. The reproduction and rearing of salmonids in the hatchery environment can initiate behavioral, physiological, and/or genetic changes in hatchery fish. The consequences of these changes differ depending on the degree of difference between hatchery and wild fish and the amount and type of interaction between them.

The fitness of wild and hatchery fish and their hybrids should be evaluated. Relatively little is known about the effects of interactions between wild and hatchery fish, including differences in survival and the amount and effect of interbreeding. Expanded monitoring and pedigree analysis could provide some of these data. Genetic studies of adults using pedigrees would allow a better understanding of the interactions between hatchery and wild fish as well as among wild fish populations. Genetic studies should also be used to determine the extent of interbreeding between hatchery and wild fish and to evaluate the long-term fitness of fish from supplementation programs.

Participants in an IMST workshop on conservation hatcheries and supplementation (IMST 2000a) noted that the effects of hatchery fish interactions with and influences on wild fish are not well known. There are many aspects of genetic and ecological interactions between hatchery and wild salmonids about which there are little or no data. For example, there are few studies that have tracked the effects of interactions between hatchery and wild fish on the long-term persistence of wild populations. Future research should include both genetic analysis and ecological analysis of the effects of competition.

Following are IMST Recommendations from other IMST reports that are related to this priority topic:
ODFW develop and implement a program that determines the effects of wild-hatchery fish interactions (IMST 1998a).

Based on research findings, 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 (IMST 1998a).

ODFW develop a strategy that will be useful in quantifying and reducing the impact of mixed stock fisheries on the recovery of depressed OCN stock (IMST 1998a).

Develop a strategy for evaluating hatchery performance that includes assessing the performance of fish outside of the hatchery (survival of hatchery fish from smolt to adult 0) (IMST Letter Report, October 25, 2000).

Develop a strategy for the assessment of the impact of hatchery-released fish on the performance, production, and survival of naturally spawning wild stocks of fish (IMST Letter Report, October 25, 2000).

Develop and use a consistent method for (a) evaluating the degree of straying of hatchery fish onto natural spawning beds and (b) assessing the impacts on wild stocks (IMST Letter Report, October 25, 2000).

Implement the recommendations made in IMST's Workshop on Conservation Hatcheries and Supplementation in the assessment and revision of supplementation programs (IMST 2001).

Support and participate in collaborative research efforts to determine the consequences of differences in phenotype and/or genetic changes in hatchery fish on hatchery wild crosses (IMST 2001).

IMST should convene a workshop to clarify the state of knowledge on the differences between hatchery and wild fish and the implications to supplementation programs and the fitness of naturally spawning populations (IMST 2001).
Hatchery management needs to consider and take into account the stream and ocean environment into which the hatchery fish are released, the effects of hatchery fish on other species, and the effects of hatchery fish on wild populations of the same and other species (IMST 2001).

Test the assumptions about survival differences between hatchery and wild fish.

In most cases, hatcheries provide a survival advantage, and egg to smolt survival in the hatchery is much higher than egg to smolt survival in wild fish. A key question is whether a net survival benefit through the entire life cycle results from the survival advantage during the early life stages. Data for survival in the wild and from many hatchery programs are often not available for comparisons through various life stages. How this changes over climatic cycles is critically important to know. Overall, better data is needed on wild fish survival rates. Post-release survival is often lower in hatchery fish than in wild fish, raising the question of whether hatcheries provide a net increase in survival. The answer to this question entails studies of both hatchery and wild survival through all life stages and over time.

Determine the origin and the temporal and spatial distribution of wild ocean-caught fish.

Salmon from various freshwater populations mingle as they migrate in the ocean. Harvest of salmon in the ocean can impact the abundance of populations originating from different freshwater streams, and reduce the number of spawners returning to specific basins. However, little is known about which populations of fish are actually harvested in the ocean, and where or when they are encountered.

Policies for harvest management are needed to protect endangered or threatened populations from additional harvest impacts. Decisions regarding when and where harvest can occur, which species can be targeted, and which freshwater populations are abundant enough to be harvested or impacted by harvest need to be based on accurate information. Unless we know which freshwater populations are impacted by ocean harvest, and when, where, and how many fish are encountered, harvest management decisions and policies will not be effective at reducing harvest impact on critically low populations.

Determine the spawning escapement rate of steelhead.

Compared with other anadromous salmonids, steelhead exhibit a diversity of life histories, including variance in the amount of time spent rearing in freshwater, the amount of time spent in the ocean, and the age and time of year of spawning. Therefore, it is more difficult to monitor spawning escapement and less data are available for steelhead than for other species. There are comparatively few steelhead survival data due to difficulties in monitoring both juvenile migrants and adult returns. Little is known about both freshwater and marine survival of steelhead. There is a need for increased emphasis on the spawning escapement of steelhead to obtain better estimates of survival and abundance.

Determine the genetic basis of various life history strategies in salmonids.

Salmon have evolved a wide variety of life history strategies for using habitats, including migrations from fresh water streams into estuaries and into the ocean at different times and sizes and differences in residence duration. This diversity of behaviors affords resilience to salmon species in a fluctuating environment. It also maximizes the productive capacity of estuaries (and other habitats) by dispersing fish throughout all available habitats and staggering migrating fish through the habitat to maximize resource use. The loss of life-history diversity could affect the salmon rearing capacity of a habitat independent of the total amount or quality of habitat available.

Environmental and genetic controls of life-history paths need to be determined so genetic life history stages can be preserved on both the population and metapopulation levels. The diversity in migration times, spawn times, and unique life history paths (e.g. residual fish and precocial males) should be preserved to maintain a population's resiliency.

Moderate Priority

Determine the impacts of declining wild salmonid populations on ecosystem processes.

Salmonids play an important role in the ecosystems of which they are a part. This includes the role of salmon carcasses in providing nutrients to the aquatic and riparian ecosystems, interactions between and among salmonid species, and interactions between salmonids and other aquatic species. Both intra- and inter-specific interactions could include the effects of fish released from a hatchery into the aquatic ecosystem, and the effects on predator/prey relationships in salmonid ecosystems. All aspects of salmonid management need to be viewed at the landscape level, considering broad spatial and temporal scales.

Examples of research needs include, but are not limited to:

1) Determining the response of juvenile salmonids and their food webs to carcass abundance and how many spawners are needed to support the next generation of developing salmonids. Experiments are needed to establish this relationship and to determine the processes involved. This is crucial when available carcass numbers are low.

2) Determining the effects of hatchery releases on the same and other species. Ecosystem attributes to consider include stream and ocean carrying capacity, biodiversity, life history diversity, the effects of inter and intra-specific competition, diseases, and ocean trends and climate conditions.

Following are IMST Recommendations from other IMST reports that are related to this priority topic:

The IMST recommends that ODFW advocate determining the relationship between the response of salmon juveniles and their food webs to carcass abundance (IMST Letter Report, September 16, 2000).

Determine the relationship between the response of salmon juveniles and their food webs to carcass abundance and distribution, and determine the process by which these relationships operate (IMST 2000b).

Adopt a cohesive approach to incorporate the landscape perspective into hatchery management (IMST 2001).

Determine the effects of predation on salmonid recovery and how predation interacts with other environmental factors.

Determining what impact predation has on the escapement of adults and recovery of Oregon's wild salmonid stocks relative to other factors is critical to evaluating the importance of predation. Even though predation, particularly by pinnipeds and birds, has been perceived as a problem for decades we know little about its actual impact. The answer is complex, involving assessment of other factors such as habitat complexity and prey vulnerability that affect recovery. Data are inadequate to prioritize various factors related to recovery. In addition, most factors, including predation, are dynamic and vary among stocks, life-history stages and species, watersheds, and years. The impact of predation also depends on the health and population size of salmonid stock. A holistic approach is required to evaluate predation in comparison with other causes of population declines and to effectively undertake management actions. The information required for this purpose is not currently available.

Following are IMST Recommendations from other IMST reports that are related to this priority topic:

ODFW should:

1) 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;

2) Determine the factors influencing high predation rates on salmonid smolts in the Columbia River estuary;

3) Improve the estimates of the impact of pinniped predation on salmonid stocks and on the recovery of depressed stocks;

4) Improve estimates of the impacts of seabird predators on wild salmonids;

5) Test the feasibility of relocation of Caspian terns to other nesting sites and evaluate the consequences of tern relocation on all salmonid stocks in the area;

6) Evaluate the effectiveness of cormorant hazing in Oregon's estuaries (IMST 1998b).

Low Priority

Determine the impacts of non-indigenous (exotic) aquatic and terrestrial species on salmonid recovery.

Non-indigenous species affect salmonids in several ways. Introduced fresh water fish such as largemouth and smallmouth bass, walleye, channel catfish, and brook and brown trout, are known to prey on native juvenile salmonids. Non-indigenous fish may also out-compete salmonids for critical resources. Aggressive plants, such as Himalayan blackberry, may colonize riparian areas and inhibit restoration of native plant communities, thereby affecting stream habitat conditions and nutrient input. Introduced aquatic plants may favor non-native fishes in critical lake habitats. The extent of deleterious effects from introduced species on salmonids and their recovery and the overall effect of introduced species on the health of natural ecosystems in the state are not known.

Determine the cause and effects of disease, tumors, and other abnormalities of fish on the population dynamics of the fish and the implications for ecosystem and human health.

Localized increases in the incidence of diseases, tumors, and physical abnormalities in salmon may indicate changes in environmental conditions resulting in increased levels of stress and mortality in the population. Susceptibility to environmental conditions varies by species, and the most vulnerable species serve as early indicators to more severe problems. Environmental stress and contaminant exposure may impair growth and increase disease susceptibility in juvenile salmon, which in turn may affect ocean survival of young salmon. Exposure of returning adults to contaminants may affect their reproductive capabilities and development of eggs. Bio-accumulation of toxins and other contaminants may pose health risks to humans consuming salmon as well as to other organisms within the ecosystem that depend on live or dead salmon. The extent and consequences of an increase in the incidences of diseases, tumors, and physical abnormalities and their epidemiology is not fully known but may have the potential to prevent some salmonid stocks from fully recovering.

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