Independent Multidisciplinary Science Team
Scientific Workshop Summary

Hatchery Research Center

Prepared by Oregon Department of Fish and Wildlife

October 21 and 22, 2003
LaSells Stewart Center
Oregon State University
Corvallis, Oregon

Aerial View of Hatchery Research Center Site

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Executive Summary

The Independent Multidisciplinary Science Team (IMST) convened a two-day workshop on October 21 and 22, 2003 at the LaSells Stewart Center in Corvallis, Oregon. The purpose of the workshop was to provide a scientifically credible basis for the operation of the research aspects of the Hatchery Research Center (HRC). The comments and guidance offered by this unique gathering of distinguished fisheries professionals will serve as a valuable guide to the Oregon Department of Fish and Wildlife (ODFW) as they design the facility and determine the highest priority experiments. A list of workshop attendees, their affiliations and a group photograph are shown in Appendix 3 and 4, respectively.

The HRC mission is to develop an understanding of the mechanisms that may create differences between hatchery and wild fish and devise ways to manage the differences so that hatcheries can be used responsibly in the conservation and use of Oregon's native fish. The HCR will be a state-of-the-art facility incorporating a wide range of design options for investigating the effects of different spawning, incubation, and rearing treatments on hatchery and wild fish performance (growth, survival, and reproductive measures). Planning for the facility must emphasize design flexibility, replication of treatments, and low-cost, dependable options for implementation.

Workshop discussions resulted in the identification of four principal research objectives for the HRC.

> Determine the pattern, rate and process by which:
>
> 1) Naturally-produced fish change within and across generations when introduced to the hatchery environment.
>
> 2) Hatchery-produced fish re-adapt to the natural environment.
>
> Use the information obtained from 1 and 2 above and other studies in Oregon and the Northwest to determine:
>
> 3) The consequences of hatchery operations to native fishes, and
>
> 4) If hatchery operations can be modified so that artificially propagated fish can contribute to the harvest and recovery of naturally produced salmon and steelhead.

Achieving the first and fourth objectives will require using an array of treatment types within and near the HRC including the natural stream, artificial streams, modular stream segments, experimental aquaria and conventional raceways. Achieving the second, third and fourth objectives will require sampling and data collection that encompasses the entire life history of the experimental fish and

may include sampling and data collection at Fall Creek proper, the Alsea River basin, and, perhaps, other basins.

Introduction and Opening Remarks

Opening remarks by Dr. Carl Schreck (IMST member and USGS Oregon Cooperative Fish and Wildlife Research Unit Leader), ODFW Director Lindsay Ball and ODFW Fish Division Administrator Ed Bowles established the framework and focus for workshop participants. The emphasis of the HRC will be research, not production. There are no production objectives established for this facility, nor will they be established in the future. The primary focus of the research performed at the HRC will be to address fish management issues in the coastal zone. The center will be unique in that it will provide a laboratory within the natural environment specifically designed to test and compare performance of hatchery-produced fish to those in the natural environment. While not duplicating experiments from other northwest hatchery research, the HRC will build on results from other studies and determine appropriate application for Oregon coastal salmonids. The role of hatcheries is changing rapidly and fish managers are looking to hatcheries to provide a wider variety of alternatives. Demands on hatcheries range from providing refuge for critically endangered stocks of salmon to the production of fish intended for consumptive harvest. A wide range of supplementation options include the use of all life stages from egg to adult.

Additional points made in opening remarks include:

- Oregon coastal hatcheries provide harvest opportunities.
- Fish culture techniques can influence survival and homing.
- The HRC, in conjunction with Oregon State University, will provide educational opportunities for undergraduate, graduate and post-graduate researchers.
- The HRC will provide outreach and education opportunities for the public.

The HRC will work to achieve goals and priorities identified in the Oregon Plan for Salmon and Watersheds. The workshop used results of two previous IMST workshops regarding artificial propagation. The first workshop identified hatchery measures included in the Oregon Plan (IMST 1998) and a second workshop focused on the scientific basis for artificial propagation (IMST 2001). The current workshop used these results to guide planning and development of the HRC. Reports of these workshops are available on the IMST website at www.fsl.orst.edu/imst/reports/techindex.html.

Workshop Results

Major Themes Guiding Design

Workshop participants identified four principles intended to give guidance on large-scale planning issues for the HRC. They identified general principles for guiding design including flexibility and replication for experimentation and reliability and redundancy for the facility infrastructure. It was pointed out that low technology systems often operate more reliably. For example, participating scientists advised using gravity flow systems instead of relying on pumping facilities to provide water to the experimental organisms. Flexibility is another critical design consideration. For example, all pipes should be easily accessible and lend themselves to easy alterations, as facility needs will change over time. A third major design principal is the need to accommodate experimental replication. Participants recognized the requirement for designing a facility where scientifically valid replications of experimental treatments can be easily accommodated. The need for backup systems and a certain amount of redundancy was identified as the fourth design consideration. For example, an oxygen supply system should be installed to insure experimental organisms could be sustained in the event of a failure of the water supply system.

In addition to general design considerations, workshop participants identified some of the unique attributes that would be associated with the HRC. These include such features as the feasibility to provide the entire range of environments from natural to completely artificial throughout the freshwater life cycle. The research facility will be able to produce distinct family groups of fish and marked populations of both hatchery and wild salmon and trout. These fish would be available to experimentally test a wide range of management uncertainties related to the consequences of hatchery and wild fish interactions. Workshop participants suggested that the Research Center focus on research questions that have obvious implications for fisheries management in the coastal zone.

Participants pointed out on numerous occasions throughout the workshop that a basin to landscape scale perspective is needed to address the pertinent management issues. They identified the need to track the entire life cycle, egg to returning adult of both hatchery and wild fish, in order to adequately understand the implications of fish management alternatives. For example, it would be necessary to monitor experimental adult salmon and trout returns throughout the entire Alsea basin if the basin scale effects of changes in management or fish cultural techniques are to be critically evaluated. It was also suggested that sampling of juvenile fish releases from the HRC be conducted throughout the entire downstream migration to assess the effects these fish may have on predator behavior, especially on marine mammals in the estuary. Monitoring local fish populations in Fall Creek was identified as a critical need to determine

how similar the experimental fish might be to the local wild fish populations in terms of size and timing of downstream migration.

Opportunities to expand the current ODFW life-cycle monitoring sites were identified in several areas of the Alsea basin. At the present time ODFW operates a life-cycle monitoring site in Cascade Creek in the Alsea Basin (Five Rivers). Additional potential sites include the fish ladder on the North Fork Alsea above Alsea Hatchery (see map in Appendix 2), Bohannon Falls in the Drift Creek drainage, and the HRC's fish ladder. Participants pointed out the need to handle, process, sort and potentially tag all returning adult fish at the adult collection facility. They suggested this aspect of the facility be designed to allow fish to be processed with minimal stress on the fish.

Broad Research Categories

Workshop participants identified a wide range of research questions that the HRC could address. These questions were not prioritized by the breakout groups and are discussed below with no priority intended. A question that surfaced several times was: how do incubation, rearing and release strategies affect homing and rearing of hatchery fish? Participants suggested this issue was among the most important to be addressed by the HRC, because fish managers need information not only on the extent of straying of hatchery fish, but also need to understand the biological consequences of the interactions of naturally produced fish and hatchery fish. If the interaction of hatchery and naturally produced fish results in a significant loss of productivity in wild populations, then managers might reduce the number of hatchery fish available to interact with naturally produced fish. If there is no significant loss of productivity in wild populations as a result of these interactions, then managers may elect to use the hatchery product in a wider range of management programs. Under either scenario management alternatives are limited by a lack of adequate information. The HRC would be an excellent location to address these issues.

Somewhat related to this issue is the question of how to maintain consumptive harvest on hatchery fish while minimizing impacts on wild fish populations. Participants suggested that the lack of information on this question imposes a wide range of constraints on harvest opportunities. The issues are similar to those described above.

Participants also identified an evaluation of the costs and benefits of hatchery fish production as an important issue to address. The question posed was: how does hatchery smolt performance compare to wild smolt performance after release from the hatchery?

Another major issue to investigate is the impacts of juvenile hatchery fish on local fish populations and their predators after release from the hatchery. The

question was: how do hatchery fish release strategies affect wild fish and predator behavior patterns? Previous large-scale hatchery production releases have been implicated as a potential cause of increased predator abundance in the lower Alsea River and estuary.

Several questions related to the inadvertent effects of hatchery practices and fish culture techniques on fish domestication need further investigation. These questions were: what are the inadvertent effects of domestication, how well do hatchery fish spawn in the wild, how well do the progeny of these fish survive and reproduce, and how rapidly do hatchery fish re-adapt to the wild environment? These issues take on increased importance if the results of initial experiments suggest that, due to the effects of domestication, hatchery fish will be unable to adequately survive or reproduce in the wild or will add to the genetic load on existing wild fish populations.

The next questions asked were: to what extent are the observed differences between hatchery and wild fish due to genetics, environmental or other outside influences; what are the consequences, and thus management concerns, associated with the differences between hatchery and wild fish; and what are the factors that control the variation in life history and reproductive success in hatchery and wild fish? A variety of questions related to the concept that the phenotype of an organism (what you see) is equal to the genetics plus the environment (P=G+E). One of the tools that geneticists use to examine the genetic make-up of an organism is to rear individual stocks (or groups) of organisms from a wide range of natural environments in a similar environment (common garden). This holds the environmental factor in the above equation the same for all of the stocks; thus, the phenotype is a function of the organism's genetic make-up. Participants suggested that the HRC be designed so that a variety of these "common garden" type experiments could be performed on a variety of coastal salmon, steelhead and cutthroat stocks. An additional question is whether to include lamprey in these experiments.

Suggestions for Specific Experiments

Scientists outlined a variety of specific experiments that could be accomplished at the HRC. Some of these directly relate to further understanding the consequences of the interactions between hatchery and wild fish and some represent the interest of specific participants. Several participants suggested an experiment requiring the development of two lines of fish, one as close to the wild as possible and the other adapted to the hatchery environment, or fully domesticated. Experiments would be performed to assess the relative merits of each line of fish to achieve a particular management objective. Contribution to fisheries and stray rate would be two characteristics that would be evaluated. These two lines of fish would provide a wide range of experimental options.

The effect of the early rearing environment on the immune system of juvenile hatchery salmon and trout was identified as an area in need of additional research. The method used to release juvenile anadromous fish from the hatchery (forced release versus volitional release) was identified on several occasions as a potential factor influencing post release survival and in need of quantitative evaluation. The role of resident males in the population structure of anadromous cutthroat trout was also identified as an avenue of potential research. The effect of tagging on survival of hatchery fish was identified as a potential problem wherever hatchery fish are marked in an effort to distinguish them from wild fish.

Facilities Design Considerations

Workshop participants spent considerable time identifying some of the specific design features that should be incorporated into the HRC. These discussions were wide-ranging and succeeded in providing a plethora of guiding principles for facilities design. The suggestions for specific features to include in the design of the HRC are listed below:

- Isolation facility to hold exotic (out of basin) stocks of salmon and trout
- State of the art effluent treatment system
- New life-cycle monitoring site using the upstream and downstream traps at Fall Creek
- Space and facilities to tag adults and juveniles
- Space to hold and rear separate family groups of fish
- Ability to remotely view or observe fish behavior without disturbance
- Electronic tracking of releases from facility to ocean.
- Trap all upstream migrant fish and sample a known proportion of downstream migrants
- Temperature and photoperiod control to the extent feasible
- Adequate space in spawning and adult sorting facility
- Variety of incubation and early rearing options, including a wide range of containers and media
- Facility use as an environmental monitoring station (water and air)
- Backup systems for most equipment
- Environmentally-friendly, “green” design used when possible

Semi-natural stream channels that could be replicated were identified as one of the unique features that should be incorporated into the design of the HRC. These stream channels would provide an opportunity to critically examine a wide range of biological attributes associated with hatchery and wild fish behavior and the interactions between the two groups of fish. Stream channel characteristics that were identified included the ability to control flow into each channel, to easily modify channel design every 3-5 years, and to seal channels to prevent ground water penetration and potential loss of flow. Semi-natural steam channels should be designed to accommodate 100 spawning fish and provide a variety of

potential rearing habitats. Due to water availability limitations, it was suggested that the channels might only be functional during moderate to high flow periods. Specific recommendations regarding appropriate channel width and flexibility requirements were described.

Important Issues Addressed but Lacking Detail

Participants raised a number of issues that were not discussed in depth, but are worth noting. These include:

- Hire director for facility, identify administrative structure, develop guiding principles for future research and operations and secure a stable funding source.
- Identify stable funding for operations and maintenance.
- Coordinate research with ongoing coastal monitoring program to help assess extent of straying into other coastal basins.
- Conduct research to aid the development of local conservation plans.
- Provide computer facilities and equipment space; consider upkeep needs and fiber-optic connectivity.
- Develop alternative well water supply if feasible.
- Include research effort directed at hatchery effluent issues, DEQ requirements, etc.
- Establish requirements for dry lab space, freezers, etc.
- Determine details of large arenas for spawning and early rearing experiments.
- Determine details of conference area, living areas, and staffing requirements.
- Determine details of tank farm, indoor vs. outdoor location, sizes, shapes, and numbers.
- Determine water treatment (UV, filter, chlorine, etc.).

Outreach and Education

Outreach and education for the public and schools will be an important component of the HRC. An Outreach and Education Plan will be developed to direct interpretation and education programs. Workshop participants recommended the following educational and interpretive topics:

- Importance of understanding differences in wild and hatchery fish and implications for fish management (Why should the average person care?)
- Benefits of investing in research (Why are tax dollars needed to study these issues?)
- Interpretation of HRC research activities and results (research on salmonids and other potential research within the watershed)

- Aquatic/terrestrial wildlife and forest/plant communities in the watershed
- Investigating social, cultural and historical dimensions of the watershed
- Helping people make the connection between the uniqueness of the salmon life cycle and the need for stewardship
- Providing opportunities to link scientists with others outside their field to bridge scientific and cultural dimensions (e.g. writers)

The Research Center could also be used to develop techniques/programs or potential research topics beyond the scientific research on salmonids. This might include other scientific research and sociological research. Ideas included:

- Opportunity to conduct other scientific research on-site and within the watershed (e.g., ornithology)
- Investigate how science informs policy and vice versa (How can science and the public help each other reach good decisions?)
- Look at effectiveness of Watershed Councils (What is the relation between watershed restoration and the creation of biocultural communities?)
- Investigate how social/cultural values linked to hatchery fish and wild fish have changed over time
- Interactions between people and fish (linking youth, families and communities with the resource)

Spaces for outreach and education in the facility design and site plan could include gathering/meeting space, a small conference/classroom area, outdoor covered areas near hatchery facilities, outdoor covered areas along the stream, and outdoor covered areas in the forest. “Experiential space” could include an observation chamber, camera ports, observation decks, and pathways that illustrate the concepts used at the HRC (natural stream, semi-natural stream, and holding or lab systems).

Conclusion

The concepts presented by workshop participants were developed by a diverse group of professional fishery scientists, managers and academicians. The oversight provided by the IMST was very helpful in maintaining an objective and meaningful set of criteria to help guide the near and long-term development of the Hatchery Research Center. The concepts presented by workshop participants will be useful in the design, development and operation of Oregon's Hatchery Research Center.

The Oregon Department of Fish and Wildlife extends its thanks and appreciation to the IMST for hosting a successful Scientific Workshop.

Citations

Independent Multidisciplinary Science Team. 1998. Review of the Hatchery Measures in the Oregon Plan for Salmon and Watersheds. Report 1998-1 to the Oregon Plan for Salmon and Watersheds. Governor's Watershed Enhancement Board. Salem, Oregon.

Independent Multidisciplinary Science Team. 2001. The Scientific Basis for Artificial Propagation in the Recovery of Wild Anadromous Salmonids in Oregon. Technical Report 2001-1 to the Oregon Plan for Salmon and Watersheds. Oregon Watershed Enhancement Board Office. Salem, Oregon

Appendix 1
IMST Scientific Workshop

List of Research Questions that Could be Addressed by the Hatchery Research Center

(not in priority order)

- How do incubation, rearing and release strategies affect homing and rearing of hatchery fish?

- How can fish managers maintain consumptive harvest on hatchery fish while minimizing impacts on wild fish populations?

- How does hatchery smolt performance compare to wild smolt performance after release from the hatchery?

- How do hatchery fish release strategies affect wild fish and predator behavior patterns?

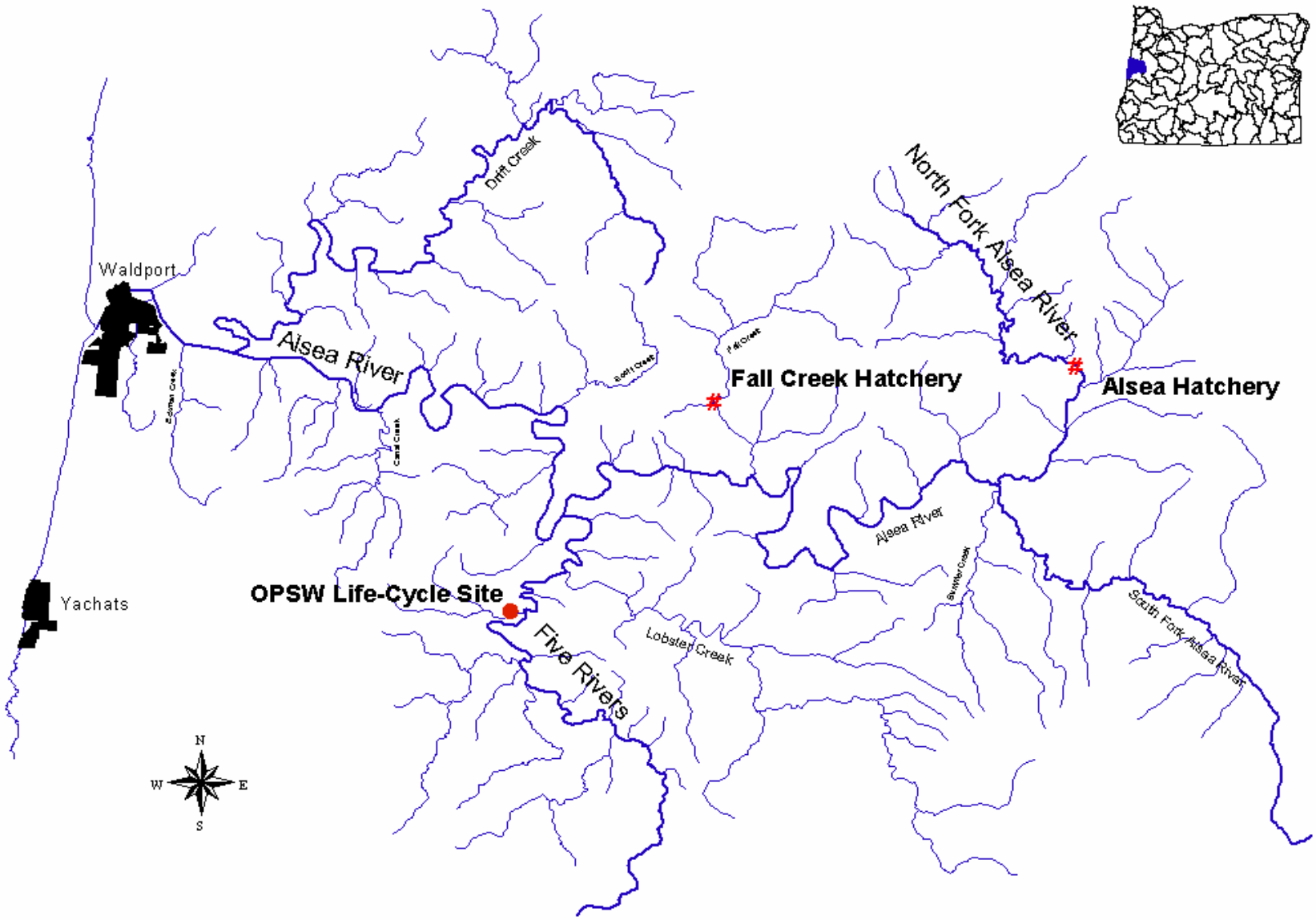
- What are the inadvertent effects of domestication of hatchery fish?
  - How well do hatchery fish spawn in the wild?
  - How well do the progeny of these fish survive and reproduce?
  - How rapidly do hatchery fish re-adapt to the wild environment?

- To what extent are the observed differences between hatchery and wild fish due to genetics, environmental or other outside influences?
  - What are the consequences, and thus management concerns, associated with the differences between hatchery and wild fish?
  - What are the factors that control the variation in life history and reproductive success in hatchery and wild fish?

- Should lamprey be included in any of these experiments?

Appendix 2
IMST Scientific Workshop

Alsea Basin Map



Appendix 3
IMST Scientific Workshop

Participant List

Craig Banner	Fish Health Services, ODFW, Dept of Microbiology
Barry Berejikian	National Marine Fisheries Service, Manchester Field Station,
Henry Booke,	USGS, retired
Ed Bowles	Oregon Department of Fish and Wildlife
Randy Brown	California Bay-Delta Authority
Bob Buckman	Oregon Department of Fish and Wildlife
Mary Buckman	Oregon Department of Fish and Wildlife
Rich Carmichael	Oregon Department of Fish and Wildlife
Mark Chilcote	Oregon Department of Fish and Wildlife
Charlie Corrarino	Oregon Department of Fish and Wildlife
Richard Ewing	Biotech Research and Consulting
Ian Fleming	Hatfield Marine Science Center, Oregon State University Department of Fisheries and Wildlife
Julie Firman	Oregon Department of Fish and Wildlife
John Fryer	Oregon State University (Disting. Prof. Emeritus)
Guillermo Giannico	Department of Fisheries and Wildlife, Oregon State University
Judy Gordon	US Fish & Wildlife Service, Abernathy Fish Technology Center
Stan Gregory	Department of Fisheries and Wildlife, Oregon State University
Jeff Hard	NW Fisheries Science Center, NOAA Fisheries

Pat Hulett	WA Department of Fish and Wildlife
Michael Kent	Dept of Microbiology, Oregon State University
Jim Lannan	Oregon State University (emeritus)
Mark Lewis	Oregon Department of Fish and Wildlife
Hiram Li	Oregon Cooperative Fishery Research Unit - NBS-USGS, OSU Department of Fisheries and Wildlife
Jim Lichatowich	Alder Fork Consulting
Eric Loudeslager	Department of Fisheries Biology, Humboldt State University
Kathy Moore	Department of Philosophy, Oregon State University
Kelly Moore	Oregon Watershed Enhancement Board
Jim Myron	Natural Resource Policy Advisor, Office of the Governor, State or Oregon
George Nandor	Oregon Department of Fish and Wildlife
Pete Nelson	Civil, Construction, and Environmental Engineering, Oregon State University
William Pearcy	College of Oceanic & Atmospheric Sciences
Todd Pearsons	Washington Dept of Fish and Wildlife
Jeff Rodgers	Oregon Department of Fish and Wildlife
Carl Schreck	Oregon Cooperative Fishery Research Unit, NBS - USGS, OSU Department of Fisheries and Wildlife
Steve Schroder	WA Department of Fish and Wildlife
Court Smith	Dept of Anthropology, Oregon State University
Mario Solazzi	Oregon Department of Fish and Wildlife
Stan van de Wetering	Confederated Tribes of Siletz Indians
Rick Williams	Clear Creek Genetics

Appendix 4
IMST Scientific Workshop

IMST Workshop Group Photograph
October 22, 2003
Oregon State University
LaSells Stewart Center
Corvallis, Oregon