Northwest Power and Conservation Council

February 1, 2007

DISCUSSION MEMORANDUM

TO: Fish and Wildlife Committee

FROM: Steve Waste and Jim Ruff

SUBJECT: Discussion of staff tagging review

Purpose

The staff is initiating a comprehensive review of fish tagging technologies in the Columbia River Basin.

Background

In their 2007-2009 Programmatic Review the Independent Scientific Review Panel (ISRP) recommended undertaking this review. The ISRP urged the Council to review past, ongoing, and potential future tagging projects in the Columbia River Basin to determine if there are opportunities for efficiency from coordinating the development of tagging technologies.

The Council's decision memo concurred, noting that the Fish and Wildlife Program would benefit from a comprehensive, comparative review of different tagging technologies utilized by the program. The various fish tagging projects for survival and migration studies, as well as hatchery and harvest programs, funded by Bonneville and the Corps will be included in the review.

Elements of the Review

Staff proposes using a framework for this review (attached) which includes the elements:

- Objectives of the review
- Scope of the review

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- Sequence of the review
- Schedule for the review
- Implementation of review results

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Framework for a Comprehensive Review of Fish Tagging in the Columbia River Basin

This paper proposes the necessary steps for conducting a comprehensive review of fish tagging technologies, projects, and programs in the Columbia River Basin.

Background

The Independent Scientific Review Panel (ISRP) has recommended, and the Council has concurred, that the Fish and Wildlife Program would benefit from a comprehensive, comparative review of different tagging technologies utilized by the program. A review focused on past, ongoing, and potential future tagging projects in the Columbia River Basin would be useful to determine if there are potential efficiencies to be gained as a result of developing tagging technologies. The various fish tagging projects for survival and migration studies, as well as hatchery and harvest programs, funded by Bonneville and the Corps will be included in the review.

For example, in the FY 2007-09 project review the ISRP identified that a number of projects are using, or have proposed to use, acoustic telemetry to track salmon movements and estimate survival in the Columbia River, estuary, and ocean. Acoustic tagging technology is expensive, and tags and listening nodes produced by different manufacturers are not comparable or compatible (different tag sizes, signal frequencies/encoding, detection efficiencies, and battery life, etc.). A permanent Passive Integrated Transponder (PIT) tag detection system, already in place at federal dams and other locations in the Columbia River Basin, is also being used to study fish migration timing and survival. This comprehensive review would examine issues such as these on the various tagging technologies, study designs, and infrastructure capabilities.

Moreover, the use of mass marking and selective fisheries will have far-reaching, confounding effects on the interpretation of current tagging data and the implementation of treaty requirements of the Pacific Salmon Treaty. The negative impacts of mass marking and selective fisheries on the Coded Wire Tag (CWT) program have been recognized by the scientific community, but have not been broadly addressed by the Council or other responsible agencies. A complete redesign of the CWT program may be required. Because the regulations requiring mass marking of hatchery fish and selective fisheries have significant impacts on the results of the projects under the Fish and Wildlife Program a comprehensive review of the tagging technologies utilized by the program is warranted. The ISRP has been unable to conduct a comprehensive review during the standard project review process due to time and logistical constraints; consequently, a comprehensive review outside the standard review process is necessary.

Objectives of the Review

The objectives of the review are to:

- Recommend specific types of tags for use in the Fish and Wildlife Program project review process
- Facilitate coordination of fish tagging projects and programs
- Encourage the development and use of innovative tagging technologies relevant to program needs

Scope of the Review

The tagging techniques and technologies to be reviewed include:

- Passive Integrated Transponder (PIT) Tag

Much has been learned about survival and return rates of salmonids based on PIT-Tag technology. However, there is not a coordinated annual operations and management project for application of PIT-tags in support of long-term monitoring and evaluation of out-migration survival of juveniles and return rates of adults. Fortunately, there have been enough special interest research projects in the past, for example, the Comparative Survival Study, to provide large numbers of PIT-tagged anadromous juveniles in the river system for various analyses. A permanent PIT-tag detection system, already in place at federal dams and other locations in the Columbia River Basin, is also being used to study fish migration timing, movements, and survival.

- Radio Telemetry Technology

Radio-tagged fish can be mobile tracked by vehicle, on foot, by boat, or by air, which allows efficient surveys of remote or very large study areas. Other tag technologies (freeze brands, CWT, PIT tag, or acoustic telemetry) typically either do not provide the same level of detail or are not as applicable for tracking individual fish within the freshwater portion of the Columbia River Basin.

Radio telemetry has been used to study passage behavior for adult salmonids in the Columbia River Basin since 1971 and juvenile salmonids since 1980. The first application of radio telemetry to assess juvenile survival in the Columbia River was in 1997. Within the Columbia River Basin most radio telemetry studies for fish have used transmitters operating at 30 MHz or 149 MHz.

NMFS are the only researchers in the Columbia River Basin using 30 MHz radio transmitters, while all other researchers using radio telemetry in the basin use Lotek (149 MHz) transmitters. Due to the numbers of studies in the basin using Lotek transmitters,

extensive coordination of frequency and codes among various research projects is required. Radio telemetry is limited to use in the freshwater environment because salinity attenuates the signal from the transmitter. Depths greater than 9 meters can also limit the detection of radio transmitters unless underwater antennas at depth are used.

Radio telemetry technology has worked well for evaluating both adult and juvenile passage at dams, resulting in structural and operational fish passage improvements. Radio telemetry has been a useful tool to evaluate metrics such as project survival, dam survival, pool survival, route-specific survival, passage efficiencies, forebay delay, tailrace egress, travel times, avian predation, straying of adult returns, spawning distribution and timing, and adult fallback at dams. Radio telemetry detection probabilities on riverine gates are typically between 90 and 98%. Detection probabilities within passage routes at the dams are typically 95 to 100%. Currently, radio telemetry can be used to study all species of adult salmonids, adult Pacific lamprey, and juvenile salmonids as small as 90-mm fork length in the Columbia River Basin.

- Coded Wire Tag (CWT)

This technology has been effective for many years as a way of rapidly and indelibly marking juvenile salmonids (often at hatcheries) with tiny bits of metal on which an identifier code is etched. Coded-wire tags are the principal means for identifying origin of fish harvested by commercial fisheries and are also used for other stock-identification purposes. The technology thus serves multiple and important uses for the Fish and Wildlife Program. The current CWT program represents a complex set of projects, many of which might be incorporated into a single program proposal, experimental design, and administrative oversight.

- Acoustic Tagging

A number of projects are using, or have proposed to use, acoustic telemetry to track salmon movements and estimate survival in the Columbia River, estuary, and ocean. Therefore, a review of past and ongoing acoustic telemetry and PIT tagging projects in the Columbia River Basin would be useful to determine if there is unnecessary expense and duplication of research efforts as a result of competing tagging technologies.

Acoustic tagging technology is expensive, and tags and listening nodes produced by different manufacturers are not comparable or compatible (different tag sizes, signal frequencies/encoding, detection efficiencies, and battery life, etc.).

- Genetic Markers

Genetic Stock Identification - Both environmental and genetic factors determine if individual *O. mykiss* remain as resident rainbow trout, or undergo the necessary physiological changes (smoltification) to prepare for anadromy. While some of the associated environmental factors (i.e. water flow and temperature) have been evaluated, the genetic mechanisms that contribute to life history selection are unknown. Unknown

origin smolts can be collected and genotyped and assigned to their population of origin based on genetic information. This method is commonly referred to as Genetic Stock Identification (GSI).

Single Nucleotide Polymorphisms - Analyses using Single Nucleotide Polymorphisms, or SNPs, have been proposed for assessing intraspecific hybridization between coastal and interior *O. mykiss*. Once identified SNPs can be used as fixed diagnostic markers for identifying and distinguishing between pure populations of redband trout that should be protected and hybridized redband trout populations where invasive management actions may be needed. SNPS markers can also help distinguish between natural hybridization between sympatric redband trout and westslope cutthroat trout, and hybridization between non-native hatchery rainbow trout and westslope cutthroat trout.

Sex-specific Biomarkers - Sex-linked genetic markers have been used to assess whether exposure of fish to estrogens and contaminants has occurred. For example, there is evidence from Hanford reach sexual disruption (females testing positive for male-specific genetic markers) is associated with biomarkers indicative of contaminant exposure.

- Otolith Microstructure and Microchemistry Technologies

Otoliths, or ear stones, are found in heads of all bony fishes. Annual rings in otoliths have been used to age fish for more than 100 years. Evaluation of otoliths has become an important research tool for understanding the life history of fish and fish populations. Since otoliths are the first calcified structures that appear during early development of most fish, they have been a reliable indicator of age. Otoliths show annual, and for juvenile fish, daily patterns of growth and therefore form a permanent record of life history events.

There are two different otolith micro technologies; otolith microstructure and microchemistry technologies, which can provide valuable insights unavailable through other research or tagging techniques. The otolith microstructure technique is useful for determining both age and growth of fish. From the literature, it is apparent that aging fish based on otholiths is often more reliable than other techniques, as the otolith is the only structure that consistently records daily events in the early life stages and annular events throughout life.

Otolith microchemistry has become an important tool for tracking fish movement in aquatic systems. This technique works best for fish that move between or inhabit very different aquatic environments with respect to nearness to land and elemental composition. Freshwater, estuarine and near-coastal waters tend to have more pronounced differences in water chemistry. Thus it may be possible to use this technique to determine residence times in freshwater and saltwater habitats, as well as migration timing, of Columbia Basin salmonids. For example, use of microchemical analysis of SR fall Chinook otoliths, sampled from both juveniles and adults, has been proposed to examine important management questions such as: a) growth rates and bioenergetics; b) residence times in freshwater and saltwater habitats; and c) migration timing. By

analyzing these geochemical signatures, such as strontium: calcium ratios and scrontium isotopes, research is proposed to identify the location and duration of juvenile SR fall Chinook residences during their downstream migration to rearing areas, through the hydropower system and through the estuary.

- New Technologies

These are yet to be developed, for example the active/passive life-cycle tag, also known as the "Holy Grail" tag.

Sequence of the Review

This memo proposes the following steps to guide the review.

Step 1. Define the objectives of a coordinated, regional approach to tagging that would benefit the program by:

- Increasing compatibility between the results of different tagging studies
- Facilitating the interpretation of the science
- Making the program more cost-effective

Step 2. Identify and profile the various fish tagging technologies currently in use in the Columbia River Basin on the following attributes:

- The physical characteristics of the tag
- How the tag works
- How the tag is deployed
- Life expectancy of the tag
- Infrastructure and labor needed for tag detection
- The cost of the tag
- Advantages and disadvantages of tag
- Examples of their use in projects and/or programs

This portion of the review will be conducted in tandem with the Tagging Technologies Focus Group, recently convened under the auspices of the Corp Studies Review Work Group.

Step 3. Identify and profile an example or two of major tagging projects on the following attributes:

- Type of tagging project and research, monitoring, and evaluation effort
- Purpose of the monitoring
- Entities utilizing the technology and/or resulting data
- Cost of the monitoring
- Supported by short- or long-term funding source
- Experience of project to date, accomplishments and failures
- Examples

(Sources of information from prior surveys include CBFWA's 2003 Summaries; the MSRT Review; and, AFEP reviews.)

Step 4. Identify and profile an example or two of major tagging programs on the following attributes:

- Type of tagging program and research, monitoring, and evaluation effort
- Purpose of the monitoring
- Entities utilizing the technology and/or resulting data
- Cost of the monitoring
- Supported by short- or long-term funding source
- Experience of program to date, accomplishments and failures
- Examples: Smolt monitoring program

Step 5. Identify and characterize the interactions between the projects and programs, including areas of overlap in terms of objectives, fish populations tagged, study area, or funding sources. Tagging projects and programs with significant overlap will be considered as opportunities for coordination and/or integration of efforts.

Step 6. Determine whether gaps exist in our capacity to collect life history information at the project or program scale because of the absence of relevant tagging technology. Assess the feasibility of developing and utilizing new technology to address any gaps.

Step 7. The joint ISAB and ISRP review group prepares a report with tagging recommendations.

Schedule for the Tagging Review

The starting date for the review will be determined in part by the role of the ISAB and ISRP in the review and their schedule. The sequence of the review:

- Council staff will initially compile a draft tagging report based on information that is readily available and using the TTFG tagging report (March 2007).

- The Tagging Technologies Focus Group or an ad hoc work group convened by the ISAB will then provide an initial review of the staff draft report (April 2007).

- Staff will make revisions based on this initial review and then submit the revised tagging report to the ISRP and ISAB for their science review (May 2007).

- The ISRP and ISAB tagging review (June to September 2007).
    - Review of staff tagging report (June 2007).
    - The ISRP and/or ISAB may complement the efforts of the staff by interviewing key practitioners and/or reviewing tagging project and program designs (June to August).

- Prepare science report with tagging recommendations (August to September 2007).

Implementation of Review Results

In Project Design - Coordination amongst future tagging efforts would be encouraged by ISAB/ISRP recommendations to use specific, compatible, technologies. Project sponsors should consider and incorporate the results of the tagging review.

In Project Review - The ISRP project review can evaluate whether proposed tagging projects and programs incorporate the recommendations of the ISRP/ISAB tagging review.

In Project Implementation - The recommended use of specific tagging techniques and technologies could be set forth during the funding process as contract stipulations.

Attachment 1. Examples of Management Questions Relevant to Tagging Projects

Hydro - What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem?

Hydro - What is the relationship between ratios of transport and inriver return rates and measurements of juvenile survival (D values)?

Hydro - What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates?

Habitat - To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

Estuary - What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?

Ocean - Can stock-specific data on ocean abundance, distribution, density-dependent growth and survival, and migration of salmonids, both hatchery and wild, be used to evaluate and adjust marine fishery interceptions[1], harvest, and hatchery production in order to optimize harvests and ecological benefits within the Columbia River Basin?

Harvest - What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

Population Structure and Diversity - What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

[1] Interceptions are catches of juvenile, immature, or maturing fish by non-target fisheries.