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September 27, 2012

## DECISION MEMORANDUM

**TO:** Council members

**FROM:** Tony Grover  
Director, Fish and Wildlife Division

**SUBJECT:** Fish Tagging Forum Progress Report and Decision to Support an IEAB Task to assist the Fish Tagging Forum with Cost Effectiveness analysis modeling.

**PROPOSED ACTION:** Decision to Support an IEAB Task to assist the Fish Tagging Forum with Cost Effectiveness analytics.

**SIGNIFICANCE:** The Fish Tagging Forum members seek to provide a rigorous analytic framework for the determination of cost effectiveness among alternative portfolios of tagging tools. The IEAB proposed to analyze the cost effectiveness of fish tagging technologies and programs.

**BUDGET IMPACT:** Independent Economic Analysis Board Task 199 is proposed to cost \$54,700 from the FY 2013 IEAB budget.

## UPDATE ON THE FISH TAGGING FORUM – SEPTEMBER 2012

The Fish Tagging Forum (FTF) was chartered in July 2011, to evaluate the program and cost-effectiveness of fish tagging under the Program as well as other issues discussed in the March 2009 ISAB/ISRP report regarding fish tagging technologies and programs. The FTF has held seven meetings between November 2011 and September 2012. Presentation materials, meeting summary notes, and related documentation are available at <http://www.nwcouncil.org/fw/tag/>.

The meetings have been regularly attended by 20 to 30 subject matter experts from the following entities: BPA, USACE, NOAA, NPCC, USFWS, USGS, WDFW, ODFW, IDFG, PSMFC, tribes, Public Power Council, Northwest River Partners, Mid-Columbia PUDs, consultants, universities, and other interested parties.

**Tagging Technologies:** To date, the meetings have been primarily focused on presentations from subject matter experts on various tagging technologies/methods including:

- Acoustic Tags
- Passive Integrated Transponder (PIT) Tags
- Genetic Marking (PBT and GSI)
- Coded Wire Tags
- Otolith Marks
- Radiotelemetry Tags (Scheduled for October 11, 2012)

For each technology, the forum has discussed the basic design/function of the tags; associated detection, recovery, and data management infrastructure; unit and life-cycle costs; relevance to specific management questions, application limitations, and potential for technological advancement. Attributes such as these will provide a basis for evaluating program and cost-effectiveness.

**Management Questions and Indicators:** In addition to the technology focused presentations and discussions, a sub-committee has been working to define specific Management Questions and Indicators that are supported by fish tagging data. The Management Questions and Indicators have been defined around Hydro, Hatchery, Harvest, Habitat, Predation, and Species Recovery decision making. Once completed, this effort will provide a basis for establishing a clear connection between management questions and tagging efforts, including instances when more than one technology is being, or can be used, to support decision making.

**Program and Cost-Effectiveness Evaluations:** During the next 3 months, the FTF will focus on developing an evaluation framework that will be the basis for assessing program and cost-effectiveness. As part of this evaluation, the FTF will be synthesizing the information gathered to date in a manner that will support the identification of gaps, overlaps, and opportunities to gain efficiencies in tagging-related projects. Additionally, the IEAB has developed a task to structure the cost-effectiveness evaluation through economic modeling, which is described in the following pages.

**Path Forward:** The last of the technology-specific discussions (radiotelemetry tags) will occur in October 2012, along with finalization of the Management Questions and Indicators. Between November 2012 and February 2013, the forum will be focused on the evaluation of program and cost-effectiveness and formulation of preliminary recommendations. Formal recommendations will be drafted, reviewed, and finalized between March 2013 and May 2013.

## **INDEPENDENT ECONOMIC ANALYSIS BOARD proposed Task 199**

On the following pages is a description of the IEAB's proposed Task 199, including a budget and schedule that is integrated with the Fish Tagging Forum's activities. Both the IEAB Task and the Fish Tagging Forum Recommendations will be ready for Fish and Wildlife Committee review in May of 2013.



Proposed Scope of Work for  
IEAB TASK 199  
Analysis of the Cost-Effectiveness of Fish Tagging Technologies and Programs

Independent Economic Analysis Board,  
Northwest Power and Conservation Council  
September 26, 2012

## **BACKGROUND**

The Northwest Power and Conservation Council (Council) is charged by the Northwest Power Act to develop a fish and wildlife program (FWP) for the Columbia River Basin that effectively achieves its biological objectives with minimum economic cost.

Fish tagging and marking play important roles for stock assessment, research, management, and recovery efforts for salmonid and other fishes in the Basin. Data from tagging are critical for effective decision-making. Fish of various species and stocks are tagged to obtain data on their numbers, harvest rates, behavior, habitat use, mortality rates, as well as the success of hatchery and other enhancement programs. Information obtained from tagging efforts influence decisions on hydrosystem management such as water spill at dams and fish transport; harvest regimes in the ocean and river; hatchery practices; and endangered species risk assessment (ISRP/ISAB 2009). Investigations using tagged fish typically involve collecting, tagging, releasing, and recapturing or detecting fish, and analyzing data to estimate vital statistics. The design of tagging programs requires establishing effective sample sizes for groups to be tagged and developing capture or tag detection methods to recover sufficient numbers of tagged individuals for statistical purposes” (ISRP/ISAB 2009).

During the Council’s 2010 and 2011 review of all “Research Monitoring Evaluation and Artificial Production” projects the Fish and Wildlife Committee requested staff develop a charter for a facilitated workgroup to address costs, efficiencies and gaps for all fish tagging efforts that take place under the Council’s Fish and Wildlife Program, including expense, capital and reimbursable programs.

In the 2009 Tagging Report, the ISRP and ISAB stated that cost-effectiveness is “an aspect of tagging that would be best addressed as part of the Fish and Wildlife Program amendment and program-level decision process” and that the “Independent Economic Advisory Board (IEAB) could collaborate with the ISAB or ISRP on evaluating the cost effectiveness of alternative tagging technologies,” adding that program effectiveness is “as important as cost effectiveness.”

During the Council’s 2010/11 review of all Research Monitoring Evaluation and Artificial Production projects, the Fish and Wildlife Committee requested staff develop a charter for a facilitated workgroup to address costs, efficiencies and gaps for all fish tagging efforts that take place under the Council’s Fish and Wildlife Program, including expense, capital and reimbursable programs. This led in July 2011 to the charter of the Fish Tagging Forum (Forum),

to address the cost effectiveness and the program effectiveness of tagging under the Program as well as other issues discussed in the ISAB/ISRP report.

The Fish Tagging Forum has been meeting regularly since November 2011 with a stated goal “to address costs, efficiencies and gaps for all fish tagging efforts that take place under the Council’s Fish and Wildlife Program, including expense, capital and reimbursable programs.” The Forum is compiling information on the following types of tagging technologies: Coded Wire Tags, PIT Tags, Radio Tags, Acoustic Telemetry, Data Storage Tags, Genetic Markers, Otolith Thermal Marks, and Natural Marks and Tags (Otoliths, Scales, and Parasites). The Forum has also developed a framework to identify and organize different management categories, management questions, and relevant indicators. For each of these indicators/questions, relevant forums, responsibilities, and interests have been identified, as well as the relevant tagging technologies.

## **ADDRESSING COST-EFFECTIVENESS**

Current fish tagging programs reflect a complex set of activities that pose challenges for evaluating cost-effectiveness and program effectiveness. The management questions being addressed relate to multiple objectives, multiple species, and differing spatial and temporal scales and geographic domains. These specific tagging activities involve various government agencies and non-governmental entities that overlap and intersect in terms of their interests, responsibilities, and funding.

Evaluating cost-effectiveness can be relatively straightforward when two or more alternative actions are alternatives (substitutes) and each can independently achieve a desired outcome or goal. The costs of each can be estimated, and compared directly. Fish tagging activities are not always independent, but instead are overlapping and interconnected in ways that affect both the cost and effectiveness of particular tagging programs and their ability to address specific management questions effectively. The situation is more like a multi-dimensional puzzle where the pieces are overlapping and interconnected. There are multiple levels between tagging and addressing management questions: (1) a fish tagging activity involves choosing a particular tagging technology, (2) this technology is used to collect data, (3), the data is used to estimate or compute indicators, and (4) the indicators will shed light on a specific management question. There can be complementarities and overlaps at each of these levels. Fixed costs such as infrastructure can be shared among activities, lowering the portion of those costs attributable to a given activity. Data can be used to produce multiple indicators. And for some management questions, multiple indicators are needed, or can improve, the degree of certainty for the answers provided.

If the number of options is limited and the complementarities are few, all of the combined options could be identified and enumerated, and the cost-effectiveness of each possible combination for addressing each management question could be evaluated. A manageable set of options of this kind is characterized in Figure 1 where four tagging options could be used in different combinations to answer two management questions.

For the current situation, however, the Fish Tagging Forum has identified 8 tag types, 19 management questions, and 112 indicators, and these apply in many cases to multiple species residing in various rivers. Tagging technologies also differ in terms of their applicability to a

given species, river or management question, and the data collected using different technologies often differs qualitatively in ways that affect the precision of the indicators.

Given this complex situation, addressing questions related to cost-effectiveness for the fish tagging program is unwieldy without a quantitative framework within which to account for the interrelationships and complementarities that exist. This kind of systematic assessment can be accomplished, however, using a type of programming model that is a common tool used in economics.

Such a model could be constructed using the information already compiled by the Fish Tagging Forum, along with detailed cost estimates for each aspect of the different technologies (tagging, data retrieval data analysis, etc.). Such a model would integrate information about the feasibility of using specific technologies to estimate individual indicators (see Table 1). Building such a model would involve populating a set of matrices indicating the relevant relationships. These components would be combined with cost information, as well as accounting for agency responsibilities, funding, and priorities. The resulting model could be used in a variety of ways that address some of the central questions being posed by the Fish Tagging Forum:

- What is the most cost-effective technology or technologies to answer management question X with the desired level of confidence? How important are “shared costs” with other activities to address other management questions to this result?
- How would the elimination of tagging technology Z alter the effectiveness and costs of existing programs? What kinds of changes in the use of other technologies would represent the most cost-effective way to respond to the elimination of technology Z?
- What set of technologies appear to be the most cost-effective way to address: a) all management questions, b) the highest priority management questions as identified by the Council, c) or by BPA, or d) by all interested parties taken together?
- Given anticipated innovations and future cost reductions for some technologies, how are the answers to the above questions likely to change in the next ten years?
- How sensitive are the answers to the questions above to the choices of parameters in the model? Do differing opinions about these parameter values give rise to significantly different answers to the above questions?
- Given stated “priorities” (quantified subjectively), what is the most cost-effective way to address those priorities to the greatest extent?
- What technologies and costs are associated with the mandates and priorities of different agencies, and how are costs affected by the inclusion of the different agency priorities?

## IEAB PROPOSAL

The IEAB proposes to

1. Assist the Fish Tagging Forum (FTF) with development of information needed to support cost-effectiveness analysis of fish tagging,
2. Construct a programming model for evaluation of the cost-effectiveness of the fish tagging programs, and
3. Apply the model to answer the kinds of question listed above.

This task would fund IEAB to work with Council staff, the Fish Tagging Forum, and members of the ISAB and ISRP, and to provide a separate report to Council regarding opportunities to improve the cost-effectiveness of tagging activities. An IEAB member will be assigned as lead researcher, and the IEAB will assign other members to distinct tasks where appropriate. The proposed tasks will include:

1. Technical understanding and scoping

Fish tagging is complicated. IEAB members who work on this report will need to research existing and potential tagging technologies to understand their existing and potential uses, quality of information, and costs. In particular, each tagging technology is somewhat unique in terms of the types and qualities of information it can provide. Federal laws, treaties and agreements among governments affect tagging mandates and priorities. Also, institutional histories, existing requirements such as contracts, and tagging infrastructure are important.

The lead researcher will work with the tagging forum to understand these histories and requirements. We propose that the main researcher should attend Fish Tagging Forum meetings (One IEAB member has already attended three such meetings). Additional time is provided for reading and discussions with experts, as needed to develop the detailed relationships required for the model.

Scoping involves the fish species, technologies, data, indicators, and management questions to be included in the model. It is likely that the model scope will include anadromous salmonids only. Tagging issues for other species will be considered, but they probably do not require modeling in the same detail as with the anadromous salmonids. Also, scoping includes an accounting perspective. The model will need to count costs from multiple perspectives. At a minimum, total cost and Fish and Wildlife program costs will be counted.

2. Tagging costs

The costs associated with each fish tag technology will be estimated including fixed costs (infrastructure for producing tags, tagging fish, detection/retrieval, data evaluation), variable costs (costs per fish for tags, tagging, retrieval/detection, evaluation), and costs of non-tagging information needed to complete measurements. The work will include estimating how future costs are likely to change, and how and when new infrastructure

may be needed. The costs of tagging fish are quite complex, including the cost of each tag, the cost of technologies and labor required to read the tags, and costs of activities required to utilize the tagging information. Cost analysis using budgets would allow for comparative cost estimates across technologies that can provide the same information. The IEAB will work with Council staff and the tagging forum to develop tagging budgets that can be used to compare costs. Also, tagging budgets will help evaluate the reasonableness of future tagging cost proposals.

### 3. Characterize products and benefits of fish tagging

Fish tagging products will be characterized at different levels including data, indicators, management questions and management issues. Based largely on the work of the Fish Tagging Forum, the model will incorporate management questions for all management issues.

### 4. Tagging cost-efficiency concepts

The IEAB will complete and calibrate the programming model. The model will be utilized to look at cost-effectiveness from a variety of perspectives and appreciate how costs and effectiveness are sensitive to various assumptions such as those related to the inclusion of different technologies, budgets, and legal constraints. These analyses will be used with technical and cost information to develop realistic alternatives for analysis by the tagging forum and the IEAB.

Factors affecting cost-effectiveness may include, for example, substitution between tagging technologies that can provide the same or better information at lower cost; sharing or development of more information from existing tagging studies and technology; potential for complementary relationships (Could some technologies be complements such that one technology can leverage the usefulness of another?). Cost-effectiveness may also relate to the amount and quality of information obtained. Data may be too sparse to provide useful results, or the amount of tagging might be reduced where sample sizes are larger than needed.

### 5. Reporting and sharing of analysis

The IEAB analysis will be documented in a report to the Council, and for use by the Fish Tagging Forum. Prior to completing the report, preliminary results will be shared with the Fish Tagging Forum, the ISAB and the ISRP, for comment. The IEAB will work cooperatively with the Forum to answer questions and address concerns raised regarding the preliminary findings.

### 6. Future usefulness of the model

The model will be developed so that it can be used for subsequent analyses and in future years as parameters change and questions of cost-effectiveness need to be revisited. Limitations of the model will be identified, and additional future work could improve the



model's ability to accurately reflect the tradeoffs and complexities underlying the questions the model seeks to address.

## **PROPOSED LEVEL OF EFFORT**

Budget (October 2012 – May 2013)

Labor:	
Lead researcher (280 hours @\$90/hr)	\$25,200
Additional researchers (250 hours @\$90/hr)	\$22,500
Software (GAMS)	\$2,000
Research assistance	\$3,000
Travel	\$2,000
<b>Total</b>	<b>\$54,700</b>

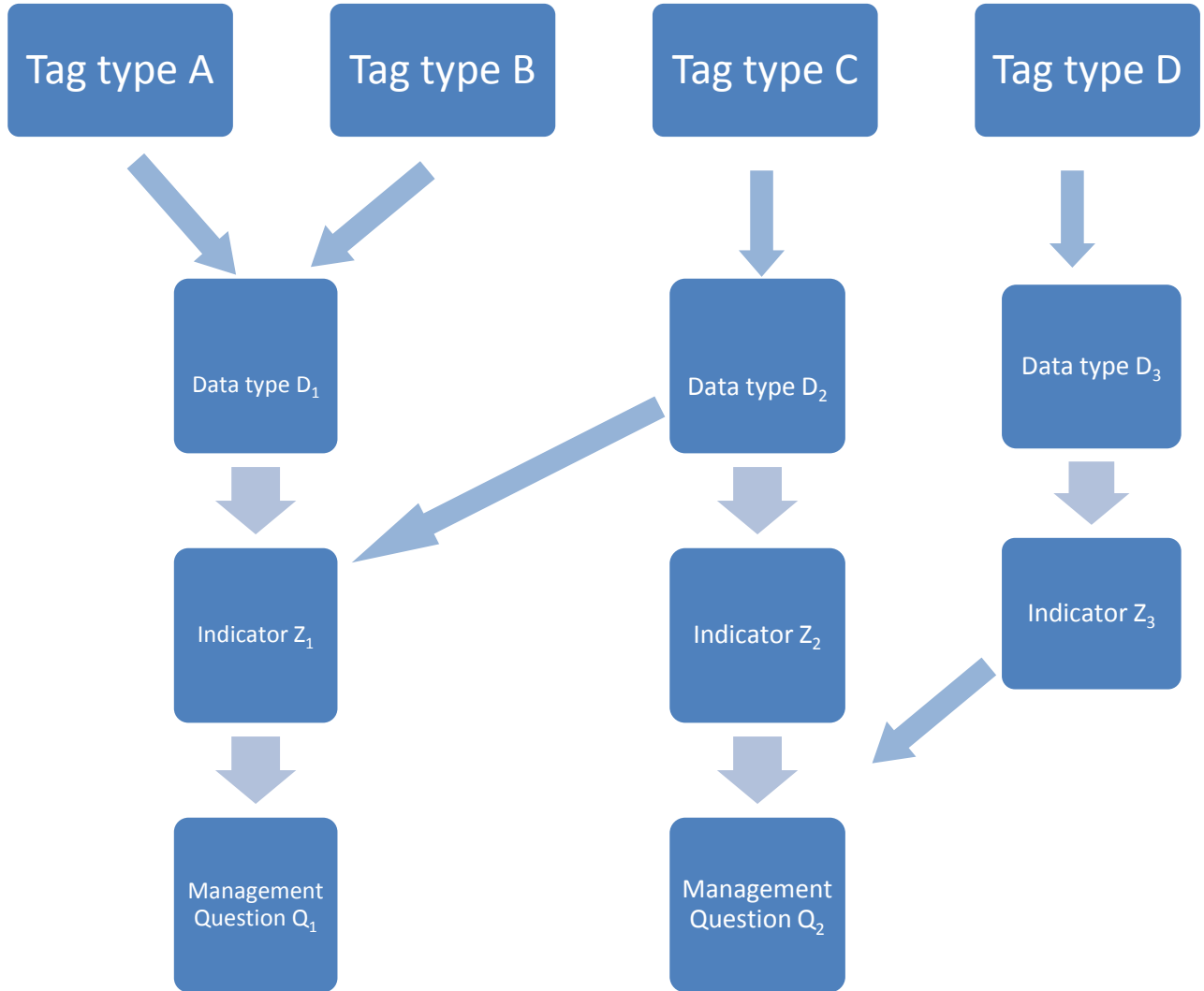
## **REFERENCES**

ISRP/ISAB (Independent Scientific Review Panel/Independent Scientific Advisory Board), 2009. Tagging Report. A comprehensive review of Columbia River Basin fish tagging technologies and programs. ISRP/ISAB 2009-1, March 17.

Pacific Northwest Electric Power and Conservation Planning Council. Charter of the Fish Tagging Forum. July 13.

The Northwest Power Act. P.L. 96-501, 16 U.S.C. §839 *et seq.*  
<http://www.nwcouncil.org/library/poweract/default.htm>

Figure 1. Schematic representation of elements relevant to fish tagging cost-effectiveness



**Table 1. Tagging technology application to management questions.**

**Key:** 1= Current technology addresses the management question or need  
 2= The ability to address the management question is in active development  
 3= The tag technology has the potential to address the management question but further development is necessary

Management Question	Tagging Technology							
	PIT-Tag	Radio Telemetry	Acoustic Telemetry	Otolith		Genetic Marker	Coded Wire Tag	Data Storage Tag
				Micro-structure	Micro-chemistry			
<b>Hydrosystem Operations</b>								
<i>Survival Studies During Juvenile Migration</i>								
Hydrosystem Survival	1	3	2					
Reach Survival	1	1	1					
Longer Reach Survival (i.e., LWG to MCN)	1	3	1					
Project Survival (Tail race to tail race)	1	1	1					
Post Bonneville to Estuary Survival & Behavior	1*	3#	1					
Route-Specific Survival	2**	1	1					
<i>Juvenile Behavioral Studies</i>								
Forebay/Project Delay		1	1					
Migration timing	1	1	1	1	1	2		3
Residence time within the river or reservoirs	1^	1	1	1	1	2		3
Growth rates and bioenergetics	1			1				3
Over Wintering of Juvenile Migrants:	1	3	3	1	1	1		3
<i>Adult Return Studies</i>								
Smolt-to-Adult Return Rates	1						1	
Adult Survival and Passage through Hydrosystem	1	1	1					1
Adult Survival Post Hydrosystem (i.e., survival to tributaries)	3	1	1					
Measuring physiological stressors & environmental conditions								1
Tributary Survival and Spawning Success	1^	1				1		