



Independent Scientific Review Panel

for the Northwest Power & Conservation Council
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Memorandum (ISRP 2006-3)

February 14, 2006

To: Doug Marker, Fish and Wildlife Division Director, Northwest Power and Conservation Council
From: ISRP¹
Subject: Response Review of Fiscal Year 2006 Proposal, "An Acoustic Tracking Array for Studying Ocean Survival and Movements of Columbia River Salmon (2003-114-00)"

Background

At the request of the Council (dated 9 January 2006), the ISRP reviewed the revised Fiscal Year 2006 proposal "An Acoustic Tracking Array for Studying Ocean Survival and Movements of Columbia River Salmon" (dated 5 January 2006) and the project sponsor's response (dated 4 January 2006) to the ISRP's initial review² (dated 16 December 2005). In the initial review, the ISRP found the project fundable "in part (for 1 year) at a reduced level of funding and deployment of the proposed acoustic tracking array (restricted to the Columbia River Basin and Plume)." In addition, the ISRP did not "recommend funding or the proposed deployment of benthic acoustic receivers until further details" were provided on this method. A response loop was requested to address ISRP comments and recommendations. The ISRP was requested to review the sponsor's response on January 9, 2006. This memo is the ISRP's response review of the revised proposal.

Summary

The ISRP credits the sponsor of the revised proposal for addressing a fair number of our comments. These revisions improved the documentation of results of preliminary 2003-2005 studies, provided some additional and more complete references, and added some new explanations of study design details and methods. The proposal, however, has really not changed significantly. The sponsor's response reinforces the ISRP's initial recommendation and raises new concerns (see "Detailed ISRP Response Review Comments" below). The ISRP continues to recommend that proposed deployment of new acoustic arrays and equipment in 2006 be funded in part (for one year) at a reduced rate to test the feasibility of using data from POST arrays to estimate ocean movements and mortality of stream-type Columbia River Chinook salmon. The ISRP recommends limited deployment of proposed new benthic (VR-3) acoustic equipment and new arrays in 2006. Two outer-coast arrays south of the mouth of the Columbia River (Tillamook, Oregon, and one additional location) and two north of the mouth of the Columbia River (Willapa Bay, Washington, and Brooks Peninsula, B.C.) would be sufficient for proposed research in 2006. The full continental shelf should be covered at all outer-coast locations, where the test of "proof of concept" is zero detection of acoustic-tagged Columbia River Chinook at the offshore receiver.

¹ Dr. William Pearcy joined the ISRP as a Peer Review Group member for the review of this revised proposal.

² See ISRP 2005-19 for the original review of the proposal: www.nwcouncil.org/library/isrp/isrp2005-19.htm

Detailed ISRP Response Review Comments

1. Location and deployment of new arrays and benthic equipment in 2006

The sponsor's comments (p. 1-2) on problems with deploying benthic acoustic receivers near the Columbia River plume are valid, as this is a very dynamic and turbulent environment with high erosion and sedimentation rates. However, there is no discussion about this problem in the narrative of the proposal. The ISRP considers this to be significant problem that limits the utility of the POST project to address questions about mortality and movements during the critical period of ocean entry. The ISRP also agrees with the sponsor that determining whether the movements of a detected fish are independent or the result of being swept along in the plume or both is a problem. However, this problem could occur at any array location where there is a strong current, not just in the vicinity of the Columbia River mouth and its plume (e.g., the Alaska Coastal Current is a strong current with speeds up to 100 cm s⁻¹, Stabeno et al. 1995).

The ISRP considers detection of acoustically tagged fish through the Columbia River estuary to be a crucial linkage to any offshore, shelf array project. As currently designed the POST project will not be able to distinguish between freshwater (below Bonneville Dam), estuary, and marine mortality for Columbia River fish that are not detected by arrays. Double tagging with PIT tags may provide a check on detections missed at sea for adult survivors. However, the narrative does not provide information on whether the long "sleep period" for acoustic tags has been tested under marine conditions (temperature, salinity, pressure).

For assessing ocean entry and survival through the estuary, acoustical receivers in the lower estuary are necessary. A previous project by Carl Schreck (funded by the US Army Corps of Engineers) that used VEMCO tags and receivers mounted on buoys (not on the bottom) had good success in detecting fish in the lower estuary that were tagged at Bonneville. The ability to examine passage times and segregate estuary from ocean detections and survivals would significantly improve the sponsor's proposal.

Perhaps the proposed Tillamook and Willapa Bay lines would detect most stream-type Columbia River Chinook, but the full continental shelf should be covered at these array locations. Detection at the farthest offshore receiver, as shown by 2004-2005 results, suggests that some offshore fish were missed. The sponsor's results in inside water in British Columbia are not sufficient "proof of concept" for outer coast locations. Additional lines to the north are not needed for "proof of concept" in 2006, especially in view of the few detections so far reported at Brooks Peninsula in 2004-2005.

The ISRP continues to recommend that the proposed deployment of arrays in 2006 be funded in part (for one year) at a reduced rate to test the feasibility of using data from POST arrays to estimate movements and mortality of stream-type Columbia River Chinook salmon. The ISRP recommends that deployment locations of new VR-3 acoustic equipment in 2006 (Table on p. 20 of the narrative) be limited. Two arrays on the outer coast south of the mouth of the Columbia River (Tillamook, Oregon, and one additional location) and two arrays on the outer coast north of the mouth of the Columbia River (Willapa Bay, Washington, and Brooks Peninsula, BC) would be sufficient. The full continental shelf should be covered at all outer-coast locations, where "proof of concept" is zero detection of tagged fish at the receiver located farthest offshore. The ISRP does not recommend deployment in 2006 of new VR-3 acoustic equipment at existing array positions at Icy Strait (AK),

Baranof (AK), Queen Charlotte Strait (BC), N. Strait of Georgia (BC), Fraser River (BC), or Juan de Fuca (BC/WA). The ISRP advises that it is premature to place acoustic arrays in Puget Sound (revised narrative, p. 20, Table "1" should be corrected to Table "2"; "Tillamook, WA" should be corrected to Tillamook, OR").

2. Technical and Scientific Background

The study design is based on the sponsor's assumption that all Columbia and Snake River juvenile salmonids migrate along the coast in a narrow path confined to waters over the continental shelf. The sponsor's review of the scientific literature regarding this assumption in the revised narrative is not sufficient. For example, the ISRP is aware of many scientific publications which show that movements of juvenile salmonids in their first summer at sea are not always confined to waters over the continental shelf, for example, Hartt and Dell (1986), Percy and Masuda (1982), Burgner et al. (1992), Jaenicke and Celewycz (1994), Farley and Munk (1997). Ocean trawl data show that nearly all stream-type juvenile Chinook salmon are caught over the shelf, most north and a few south of the mouth. However, sampling with other types of gear (e.g., purse seines) has shown that at least some juvenile salmonids move off the shelf as early as June (coho) and July (stream-type Chinook, steelhead). The sponsor's response refers the ISRP to review data in project performance reports, unpublished manuscripts, etc.; however, the ISRP bases its review on the information included in the revised narrative.

Regarding the exclusion of arrays from wide areas of the shelf, e.g., SE Vancouver Island, the sponsor's response at the bottom of P. 5 does provide some clarification. The ISRP is still confused, because if smolts (life stage when mortality is highest) are not detected on the shelf, but returning adults (life stage of relatively low mortality) are detected on the shelf, then there is a possibility that the smolts reared offshore (off the shelf). Therefore, interpretations made using "on shelf" ecological conditions for smolt conditions may be wrong. Hence, the "geographic correlation" that is the main thesis of the work is diluted. Maybe this "on shelf-off shelf" issue will be resolved when the sponsor's manuscript (submitted to the Canadian Journal of Fisheries and Aquatic Sciences) is published, but it would have strengthened this proposal if the key data and results were revealed to reviewers instead of the sponsor's qualitative narrative.

Regarding the sponsor's response on p. 11, narrow channels have, in effect, three boundaries to a seaward migrating fish, i.e., two shores and an upstream direction, which a seaward migrating fish is not likely to take. The shelf has, in effect, only one boundary, to the east, the shore. A fish on the shelf can move north, south, and west, i.e., along shelf or off shelf. The POST scheme has to assume the Chinook move only along shelf (see above comments regarding Welch et al.).

The sponsor's need to identify the correct journal for Welch et al. (submitted a), that is, two journals are listed in the revised narrative on p. 42.

3. Quantity and quality of data on Columbia River salmon

The ISRP requested inclusion of the following information in the revised narrative: (1) the total numbers of fish detected at various arrays; (2) the number of fish detected by multiple arrays; (3) how many times an array did not detect fish that were later detected by another array; (4) what kinds of estimates of survival and migration timing were made; and (5) whether these estimates had endured peer review. The ISRP requested these data because they are necessary to evaluate the likelihood that POST would collect data of sufficient quantity and quality to support a robust analysis and convincing interpretation. The project sponsor provided most of this information in the revised narrative. Unfortunately, the data presented raise new concerns.

Specifically, the ISRP is concerned about the loss of the acoustic receivers and the attendant loss of data and efficacy of the project. Table 1 (p. 12) reports 0.0% efficiency for the Cape Elizabeth acoustic line, N/A for the Juan de Fuca line, and does not report the Brooks Peninsula line. These are the lines of immediate relevance for detecting Columbia River Chinook salmon. Importantly, many stations in these lines were lost or not recovered – establishing the ISRP’s worst-case scenario for the time being.

Further, on the “out side” lines the detection rates are not impressive – 19 of 198 tagged Columbia Chinook detected; 29 of 788 on the Juan de Fuca line, and 91 of 738 fish detected on the NSOG line. On Page 5, regarding the "200 tagged..." it is not clear why this is an estimate of 15% detection, and surely the sponsor does not mean that “all” fish were detected. In addition, the sponsor seems to miss the ISRP's point that although the array may be able to detect 148,000 unique codes, only a small percentage of these would be used for tracking Columbia River fish (e.g., 1000 fish in FY2006).

The sponsor's response regarding the mixing of Columbia River and Vancouver Island Chinook (middle paragraph, p. 6) presents one of the major dilemmas of the proposed project; i.e., without acoustic tagging of both stocks and/or trawl surveys and/or DNA work how would we know what is going on? At the least, we would not know if Columbia River fish survival was being affected by competition with the Vancouver Island stocks or by poor ecological conditions, which would need to be monitored.

As noted above in section 1, the sponsor's dilemma of distinguishing between emigration and mortality in the plume (p. 12 of sponsor's response) will also apply on the shelf (see page 6 of revised proposal – fish moved 25-40 km/day on the shelf).

4. Statistical Power Analysis

The sponsor's method for estimating statistical power (pages 29-31) is one of the common approaches used for this situation. The sponsor's analysis results in slightly smaller estimates of sample sizes than others have suggested, but on the whole the estimated sample sizes are valid. The ISRP questions whether type I error (alpha) and type II error (beta) should be something other than 0.10. That is, the "cost" of rejecting the hypothesis of equality of proportions when it is true versus the "cost" of failing to reject the hypothesis of equality of proportions when it is false should perhaps not be the same. Some justification of this trade-off in costs could be quite informative because it does influence sample size estimation. That is, the sponsor should explain which is the more serious error and why. The explanation that both errors are equally bad, as is proposed in the revised narrative, seems to ignore the question.

5. Proposed in-river tagging experiments

The sponsor's response regarding Leavenworth hatchery Carson Stock spring Chinook was inadequate. The sponsor acknowledged the issue but did not provide a rationale for using the stock, and deferred the decision to a later time (p. 26, revised narrative, last paragraph).

Releases of tagged fish should be timed so that ocean entry timings are similar, not releases for the hatcheries. As others have shown, ocean conditions very soon after ocean entry are best correlated with subsequent survivals, indicating that it is early ocean life that is critical.

The sponsor did not answer the ISRP's question about whether the required minimum body length (14-cm) of fish to be tagged is representative of Snake River Chinook (P. 10 of the sponsor's response).

6. Equipment

The ISRP still has the same concerns about the size (22 mm x 9 mm diameter) and weight (2 gm in water) of the acoustic tag to be implanted in yearling spring Chinook. For a yearling Chinook smolt of ~ 140 mm FL and weighing ~ 20 g, the tag would be ~10% the weight of the fish. Recent studies of tag effects (Perry et al. 2005) indicate that reduced swimming performance of radio-tagged juveniles occurred when tag weight relative to total fish weight exceeded 5%. Another concern, which may be related to tag effects, is how long the tag will continue to transmit reliable data following release (up to 3.5 mos.). A study comparing migration rates and survival between radio-tagged and PIT tagged juvenile Chinook salmon concluded that radio-tagged juvenile Chinook salmon could provide reasonable estimates of travel rate and survival comparable to PIT tag estimates as long as the duration did not exceed approximately 6 days (Hockersmith et al. 2003).

On page 10 of the revised narrative, the sponsor reports that 18 of 26 releases of acoustic receivers failed, which is considerably more than a 10% failure. Apparently, the manufacturers are working on a solution, but the sponsor's rebuttal tends to paint a more optimistic picture than reality.

On page 11 of the revised narrative, the sponsor reports that, "PIT tags cannot be detected in the Columbia River below the dams." The sponsor seems to be unaware of pair-trawl techniques that are being used to detect PIT tags in the Columbia River estuary (Ledgerwood, R.D., G.M. Matthews, A.S. Cameron, L.B. Way, and R.J. Mock. Estuarine detection of juvenile salmonids using pair-trawls, 2005. p. 18 *in* Proceedings of the Anadromous Fish Evaluation Program Annual Review, November 14-17, 2005, Maxey Hall, Whitman College, Walla Walla, Washington. Walla Walla District/U.S. Army Corps of Engineers.)

If the sponsor's only purpose for deploying acoustic receivers in the Columbia River above Bonneville is to test whether mortalities and migration timings are the same as PIT-tagged fish, this same objective could be accomplished by tagging each fish with a PIT tag and a dummy acoustic tag (double tagging).

It might also be possible to place independent acoustic transponders on the receivers so they can be released or detected without use of a remotely operated vehicle (ROV).

The revised description of the bottom deployment methods and equipment (p. 9 of the sponsor's revised narrative) was helpful, but the sponsor admits loss rate on the shelf has yet to be determined.

7. Communication and coordination

The sponsor's response (p. 8) seems to confirm the lack of coordination and communication with other researchers, e.g. Bottom et al., who are actually working in the estuary, and the NOAA "plume group." However, the sponsor proposes to establish residence time in the estuary (p. 37 of the narrative). The ISRP considers that better communication and coordination with other Columbia River Basin acoustic tracking projects is critical to sponsor's proposed ocean/estuary monitoring by acoustic tagging methods.

Is the CPR program (p. 17 of the sponsor's response) ongoing? The proposal would be improved by including a discussion of the long-term future of the CPR program as a complement to POST. Both are needed for an actual “ecosystem forecasting” system.

The sponsor's response is not clear on whether trawling activity on proposed and existing lines has actually been evaluated (p. 10) and whether trawlers have been notified. Most of the previous areas of array deployments have been fjords or inside waters where there is not a lot of trawling, but even there the sponsor has had problems (see comment re loss, bottom of page 10 on revised narrative). The other projects mentioned that have successfully deployed equipment on the seabed no doubt have contacted the trawling industry. The ISRP does not consider seabed deployment to be impossible or unworkable; however, the proposal would have been improved if the sponsor had discussed methods to decrease the loss rate of acoustic equipment.

ISRP Response Review Recommendation: Partially fundable (for one year) for a reduced rate.

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