NMFS responses to RME Group and ISRP comments on the proposal:

Evaluate Delayed (Extra) Mortality Associated with passage of Yearling Chinook Salmon Smolts through Snake River Dams **ProjectID: 35047**

RME Group Comments

Comment: *"The objective of RPA 185…."* In this section, the RME Group questioned the relevance of the study to the objective of RPA 185 (actually 188).

Response: We agree with this assessment and have removed the reference to RPA 188 from the proposal.

Comment: *"The objective of RPA 195*…this proposal is relevant to the fundamental intent of this RPA…clearly addresses the hydrosystem contribution to any extra, unexplained mortality…the experimental approach appears sound…however, sample sizes…are considerable and may be a challenge to acquire in some years."

Response: We agree that the proposal is relevant to RPA 195 and clearly addresses the question of hydrosystem-related extra mortality. In response to a statistical comment by the ISRP detailed below, we have reduced the total PIT-tagging requirement from 236,000 fish to 186,758 fish. We believe this tagging requirement will be achievable at Lower Granite Dam in any near-future smolt year.

Comment: "*Ancillary Benefits*: These tagged juveniles will also yield inriver survival estimates. This could be…incorporated into survival Performance Standards tests…. The proposal does not discuss the suitability of these estimates for such evaluations…(we) encourage the authors to…incorporate this as a section in the proposal."

Response: We agree and will include such language in the proposal.

ISRP Comments

Comment: "The ISRP questions whether this experiment will settle the issue because concern was originally for extra mortality to Bonneville and it is not clear that results from this experiment will apply."

Response: The study is not intended to completely settle the issue or answer all of the questions relative to extra mortality. At this point, extra mortality related to the act of smolts passing through any dams and reservoirs or combinations of dams and reservoirs is entirely hypothetical. Currently, there are no empirically-derived data that clearly demonstrate the existence of extra mortality. All we can do is ask specific important questions and then design experiments to answer them as cleanly as possible which is what we are attempting in this study. According to PATH results, the hypothetical extra mortality appeared to increase considerably after the final three dams on the Snake River were constructed. Our study is designed to determine if extra mortality is a consequence for smolts that have passed through three Snake River dams and reservoirs, thereby providing the first empirically-derived evidence for or against the actual existence of extra mortality. The study will also provide valuable information relative to the potential benefits of breaching Snake River dams.

Comment: "In this proposal, although the objectives are clearly defined, methods do not appear appropriate to determine a clear answer to the hypothesis being tested. Determination of significant differences in delayed mortality due to passage through 8 dams versus 4 or fewer dams will not be possible with the current study."

Response: We disagree with this comment. The hypothesis in the proposal quite clearly states that we are attempting to determine if delayed effects result from passage through three, rather than eight, dams. One group will pass through only four dams (McNary, John Day, The Dalles, and Bonneville Dams) while the other group will pass through seven dams (the same aforementioned four dams plus three additional dams on the Snake River—Little Goose, Lower Monumental, and Ice Harbor Dams). We are attempting to detect any additional extra mortality that may be a result of passage through three Snake River dams and reservoirs rather than the total extra mortality that may result from passing through all eight dams and reservoirs on the lower Snake and Columbia Rivers. We believe our methods are appropriate to test this hypothesis as stated in the proposal.

Comment: "An assumption (unstated) is that the effect due to transport is the same for fish experiencing dam passage plus transport stress as it is for fish experiencing only transport stress. Is this assumption justified? It is possible that some fish experiencing dam passage alone would survive but due to experiencing transportation stress prior to dam passage stress, they succumb. Therefore comparing extra mortality for transportation only with extra mortality for transportation plus dam passage may not provide an unbiased estimate of the dam passage effect."

Response: This comment puzzled us. The study does not compare extra mortality for transportation only with extra mortality for transportation plus dam passage. Transportation is used by necessity to transfer both groups from the marking site to their respective release sites. Both groups will experience equal transport effects, whether they are positive, negative, or neutral. The only treatment difference between the two groups will be that one group will pass through three more Snake River dams and reservoirs than the other group. Other than that, both groups will be treated exactly the same.

The comment also implies that transportation imparts a negative effect or stress in fish. In fact, during nearly all investigations of stress and transportation, stress indices have been found to either decrease or remain unchanged during the actual transport process, particularly during truck transport. For example, Matthews et al. (1987) conducted an extensive evaluation of the stress involved during a smolt marking and truck transport operation that was very similar to the one we are proposing in this study. Plasma cortisol was used as the primary stress indicator and was sampled in spring chinook salmon smolts in a serial fashion prior to and after marking and after a roughly 2-3 hour truck transport from Lower Granite Dam to the Little Goose Dam tailrace. The sampling was replicated five times during the 1986 smolt-migration season. In each replicate of samples, plasma cortisol values decreased significantly (P<0.05) and substantially to pre-mark levels during truck transport. This study is but one of many conducted over the past 20 years that have nearly always shown either a reduction or no change in stress indices during transport by either truck or barge (e.g., Schreck et al 1983, Congleton et al. 1984).

Comment: "An excellent effort was made to do a power analysis… . One correction necessary is…alpha should be used rather than alpha/2 in the sample size formula."

Response: We concur with this comment and will change the proposal accordingly.

Question: "Have the authors considered conducting a study on fall chinook instead or in addition to spring/summer chinook?"

Response: We have not considered conducting this study on any other deems except Snake River spring/summer chinook salmon at this time, although that possibility does exist for the future.

Question: "Could something be done to estimate the effects of the impacts of spill, turbines, and bypass system instead of merging everything in dam passage as one thing?"

Response: There is a very limited opportunity to examine route-of-passage effects, although we could look at SARs based on detection history at Little Goose and Lower Monumental Dams. However, even then we would not be able to distinguish between spillway and turbine passage routes.

Question: "Are there procedures in place to ensure that good estimates of expected mortality at the dams for fish migrating in-river are obtained so "extra mortality" is clearly defined?"

Response: As outlined in the proposal, we control for differences in inriver survival between the two groups by using only those fish from both groups in the analysis that are known to have survived to and passed McNary Dam. These fish will be those that are detected and returned to the river at that dam. In addition, we will conduct ancillary analyses that estimate direct survival differences between the two groups using standardized contemporary survival estimation procedures.

Citations

Congleton, J. L., T. C. Bjornn, C. A. Robertson, J. L. Irving, and R. R. Ringe. 1984. Evaluating the effects of stress on the viability of Chinook salmon smolts transported from the snake River to the Columbia River estuary. Idaho Cooperative Fisheries Research Unit. Technical report 84-4. 67 p.

Matthews, G. M., D. L. Park, J. R. Harmon, C. S. McCutcheon, and A. J. Novotny. 1987. Evaluation of transportation of juvenile salmonids and related research on the Columbia and Snake Rivers, 1986. Report to the U.S. Army Corps of Engineers, Contract DACW68-84-H-0034, 123 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Schreck, C. B., H. W. Li, A. G. Maule, B. Barton, and L. Sigismondi. 1983. Columbia River salmonid outmigration: McNary Dam passage and enhanced smolt quality. Annual Report of Research to Bonneville Power Administration Code 82-16. 41 p.

Bonneville Power Administration
FY 2003 Provincial Project Review

Mainstem & System-wide Province

First, read the help documents

Please carefully read the **Proposal Development and Selection Criteria** document, which contains information on the review process, and the **instructions** document, which provides field- and content-related help for the form. If you are missing either document, please visit http://www.cbfwa.org/reviewforms/systemwide/default.htm or call 503-229-0191.

Important notes

- This form is to submit projects or proposals for BPA FY 2003-5 funding for Mainstem & System-wide Province only.
- This document is only available for Word97/Word2000/WordXP. Do not save down to older formats, or use in another word processor such as WordPerfect, even if it supports Word conversions. You will lose the auto-calculations, and won't be able to add or delete table rows. You may also risk not being able to re-open the document.
- Some help text is included as "hidden" comments on the data form, which is displayed by resting the mouse cursor over any yellow text (usually section headings or field names)
- Use these keystroke macros to assist you in the form. If the macros aren't available (nothing happens when you press these keys), then you need to enable macros in Word: In Word97, close the proposal, then open again and choose Enable macros if prompted. In Word2000/XP, close the proposal, choose Tools, Macro, Security, and set the security level to medium. Re-open the proposal and choose Enable macros when prompted.

To	Press
insert rows in tables	Alt-R and you'll be asked whether to insert a row at the current position or add one to the end of the table
delete rows in tables	Alt-D at the row you want to delete
calculate budget totals	Alt-C either periodically, or when you're done with the form
Spellcheck	Alt-S

Steps to complete the form

1) First, read the help documents (get them at http://www.cbfwa.org/reviewforms/systemwide/default.htm)
2) There are two documents to this form:
   a) Part 1 (**blank_sys.doc)** consists of administrative and budgeting information. Your input is restricted to the grey fields.
   b) Part 2 (**narrative.doc)** allows you to describe your project at length, including maps, tables, graphics, etc.
3) Save this as something other than blank_sys.doc. Preferably, use the BPA 9-digit project number, like "198906200.doc" or if your project has no project number, the first few words of the title, like "RestoreFish.doc", and a proposal number will be assigned to you by BPA upon receipt of your proposal.
4) Your cursor is already in the first input field, Title of Project, so start typing

5) Fill in all fields (gray boxes) pressing Tab to advance from one field to the next
6) Press Alt-C when complete to calculate totals
7) Save document, then open **narrative.doc** to begin Part 2.
8) Please print the completed documents. Part 1 prints in landscape (sideways) orientation, Part 2 in portrait (regular).

Save the documents and then **email** your forms and any attachments to fwproposals@bpa.gov. **NOTE: BPA cannot receive e-mails larger than 5 MB.** Or mail paper and diskette(s) to:

Bonneville Power Administration
Attention: Cate Hanan - KEWB-4
FY 2003 Proposals – Mainstem & System-wide Province Review
905 NE 11th Avenue
Portland, OR 97232

9) Monitor the http://www.efw.bpa.gov/cgi-bin/FW/02MainstemSystemwide.cgi.website to verify your project funding request is received and posted correctly.

All projects must be received no later than 5:00pm PST on Monday, June 3, 2002.
No late proposals will be reviewed for FY 2003 funding.

PART 1 of 2. Administration and Budgeting

Section 1 of 10. General administrative information

Title of project
Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon Smolts through Snake River Dams

BPA project number 35047

Business name of agency, institution or organization requesting funding
National Marine Fisheries Service

Business acronym (if appropriate) NMFS

Proposal contact person or principal investigator:

Name Gene M. Matthews
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Email address Gene.Matthews@noaa.gov

Manager of program authorizing this project John G. Williams

Location of the project

Latitude	Longitude	Description
N46 39 6	W117 25 6	Lower Granite Dam on the lower Snake River in Garfield County, Washington.
N46 14 4	W118 56 4	Ice Harbor Dam on the lower Snake River in Franklin County, Washington

Target species

Snake River hatchery-reared spring/summer chinook salmon; a small percentage will be Snake River ESA-listed hatchery fish

Short description
Determine if downstream migration through Snake River dams results in extra or delayed mortality.

RPAs. View guidance on proposal development and selection criteria named mainstem_systemwidecriteria.pdf, available as a link from the main proposal solicitation page. Indicate what, if any, ESA Biological Opinion action(s) will be met by the proposed project. Explain how and to what extent the project meets the ESA requirement.

NMFS and/or FWS Reasonable and Prudent Alternatives (RPA)

RPA Number	Description
Hydro 188	The study is designed to test the hydropower-related extra mortality hypothesis.

Information transfer

The expected outcomes of this project are (check one)
☒ quantitative ☐ qualitative ☐ indirect

Data generated by this project are (check one)
☒ primary ☐ derived ☐ indirect

Are there restrictions on the use of the data? (check one)
☒ none ☐ non-commercial use only
☐ educational use only ☐ requires prior approval
☐ sensitive ☐ proprietary, no public distribution

Where do the data reside (check one or more)?
Private/managed locally: ☐ printed ☐ electronic
Public access:
Printed at ☒ BPA ☒ Peer-reviewed journal or other
Internet at ☒ BPA ☐ StreamNet ☐ Fish Passage Center ☐ DART or other web address

In what other ways will information from this project be transferred or used?
Information will be transferred by oral presentations at various symposia and workshops as necessary.

Section 2 of 10. Past accomplishments

Year	Accomplishment
N/A	New project

Year	Accomplishment

Section 3 of 10. Relationships to other projects

Project #	Project title/description	Nature of relationship
199302900	Survival estimates for the passage of juvenile salmonids	Staff conducting juvenile survival analyses will determine survival of the fish detected at McNary Dam that become part of the evaluation groups for extra mortality in this proposal. They will also help in evaluations of adult returns

Section 4 of 10. Estimated budget for Planning & Design phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcontractor
1. Develop annual plan	a. Determine marking and implementation strategies	ongoing	20,400	☐
1.	b. Apply for federal, state, and local permits	ongoing	5,300	☐
				☐
				☐
		Total	$25,700	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost
1. Develop annual plan	2004	2007	111,100

Out year estimated budgets

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget	$26,600	$27,400	$28,200	$29,000

Section 5 of 10. Estimated budget for Construction/Implementation phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcon-tractor
1. Modify fish marking facility	a. modify fish marking facilities at Lower Granite Dam	1	187,800	☐
2. Conduct study	a. mark and release fish	ongoing	616,900	☐
2.	b. collect and analyze data	ongoing	45,700	☐
2.	c. prepare reports and presentations	ongoing	50,500	☐
				☐
		Total	$900,900	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost
1. Modify fish marking facility			0
2. Conduct study	2004	2007	3,073,000

Out year estimated budgets for construction/implementation phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget	$734,500	$756,600	$779,300	$802,700

Section 6 of 10. Estimated budget for Operation & Maintenance phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcon-tractor
1. Repair and maintain marking facility	a. modify, repair & maintain equipment	ongoing	23,000	☐
				☐
				☐
		Total	$23,000	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost
1. Repair and maintain marking facility	2004	2007	99,200

Out year estimated budgets for operations & maintenance phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget	$23,700	$24,400	$25,200	$25,900

Section 7 of 10. Estimated budget for Monitoring & Evaluation phase

Task-based estimated budget

Objective (1. text, 2. text...)	Task (a. text, b. text...)	Task duration in FYs	Estimated FY 03 cost	Subcon-tractor
				☐
				☐
				☐
		Total	$ 0	

Out year objective-based estimated 2004 - 2007 budget

Objective (1. text, 2. text...)	Starting FY	Ending FY	Estimated cost

Out year estimated budgets for monitoring & evaluation phase

	FY 2004	FY 2005	FY 2006	FY 2007
Total budget				

Section 8 of 10. Estimated budget summary

Itemized estimated budget

Item	Note	FY 2003
Personnel	FTE: 2.96	179,200
Fringe benefits		41,800
Supplies, materials, non-expendable property		117,300
Travel		19,000
Indirect costs		120,200
Capital acquisitions or improvements (e.g. land, buildings, major equip. over $10,000)		
NEPA costs		
PIT tags @$2.25/ea	# of tags: 190000	427,500
Subcontractor	PSMFC / FishMarkers	44600
Other		
	Total BPA funding request	$949,600

Total estimated budget

Total FY 2003 project cost	$949,600
Amount anticipated from previously	-

committed BPA funds (carryover)	
Total FY 2003 budget request	$949,600
FY 2003 forecast from FY 2001	
% change from forecast	0.0% increase

Reason for change in estimated budget

Reason for change in scope

Cost sharing

Organization	Item or service provided	Amount ($)	Cash or in-kind?
			cash
			cash
			cash
			cash
	Total cost-share	$ 0	

Out year budget totals

	FY 2004	FY 2005	FY 2006	FY 2007
Planning & design phase	26,600	27,400	28,200	29,000
Construction/impl. phase	734,500	756,600	779,300	802,700
O & M phase	23,700	24,400	25,200	25,900
M & E phase	0	0	0	0
Total budget	$784,800	$808,400	$832,700	$857,600

Other budget explanation

Part 1 of 2 complete!

Press Alt-C to calculate totals on the document. If any totals don't match, you'll see a message.
Then save this document, and open "narrative.doc" to begin Part 2, which includes Sections 9-10.

Bonneville Power Administration
FY 2003 Provincial Project Review

PART 2. Narrative

Important notes

Unlike Part 1, this document is unprotected, meaning it does not restrict where you provide input. Please only type in the places indicated and do not delete section headings. Any changes to this document aside from normal input may invalidate the form during automated processing.

Steps to complete Part 2

1. Provide as much detail as you need in the spaces marked "(Replace this text with your response in paragraph form)." Do not leave parentheses around your response.
2. If appropriate, insert tables, graphics or maps into this document. For help in adding graphics, contact Amy Langston at 503-229-0191 or sysadmin@cbfwa.org.
3. This document will be used on the Internet. If you make reference to online documents, include web addresses and use Word's hyperlink tool to make those addresses active links in the document. Contact Amy for help.
4. You can spellcheck this document using Word's spellcheck tool.
5. Save this document using the same name you used for Part 1 but add an N to the end, like "198906200n.doc".
6. Return the two documents as indicated in Part 1 instructions.

Project ID: 35047

Title: A Study to Evaluate Delayed (Extra) Mortality Associated with Passage of Yearling Chinook Salmon Smolts through Snake River Dams

Section 9 of 10. Project description

a. Abstract

It has been hypothesized that the differential return rate (extra mortality) of Snake River yearling chinook salmon compared to yearling chinook salmon from areas downstream of the Snake River results from the Snake River fish passing eight mainstem hydroelectric dams compared to the lower river stocks passing four or fewer dams. To test this hypothesis, we propose to PIT tag hatchery-reared yearling chinook salmon smolts at Lower Granite Dam and assign them randomly to one of two treatment groups. One group will be transported for release into the Ice Harbor Dam tailrace. The other group will be transported in the vicinity of Lower Granite Dam an equal amount of time before release into the Lower Granite Dam tailrace. Both groups will thus experience the same handling treatment, but one group will pass through seven dams and reservoirs while the other only four. To control for differences in direct mortality above McNary Dam, the analysis of returning adults will be restricted to fish that are detected as smolts at McNary Dam. The proportions of detected fish from the two groups of adults returning to Bonneville Dam will be computed. That is, for this study, smolt-to-adult-return rates (SAR) will be measured from smolts counted at McNary Dam and adults counted at Bonneville Dam. A significantly higher SAR for the group released into the Ice Harbor Dam tailrace will constitute evidence for extra mortality associated with passage through Little Goose, Lower Monumental and Ice Harbor Dams and their reservoirs.

b. Technical and/or scientific background

Snake River spring/summer chinook salmon (*Oncorhynchus tshawytscha*) abundance decreased precipitously after completion of the Federal Columbia River Hydropower System (FCRPS) (Raymond 1979, Schaller et al. 1999). The initial decline occurred in the early 1970s as Lower Granite, Little Goose, Lower Monumental, and John Day Dams were added to the existing FCRPS. The decline was roughly proportional to the direct mortality suffered by smolts during downstream migration through the completed system. Direct smolt mortality has decreased considerably over the past 2 decades (Williams et al. 2001) coincidental with installation of structural improvements at dams and initiation of operational procedures designed to enhance survival (Williams and Matthews 1995). However, despite the substantial gains realized in direct smolt survival, adult return rates of Snake River spring/summer chinook salmon have not increased.

One of the most important and enigmatic questions currently facing the region is whether or not migration through the FCRPS, as currently configured, causes mortality to anadromous salmonid smolts that is not expressed until after they have passed through the system. This hydropower-related extra mortality was hypothesized during the regional plan for analyzing and testing hypotheses (PATH) process to explain the relative change in productivity calculated for Snake River basin spring/summer chinook salmon populations compared to populations downstream of McNary Dam after construction of John Day, Lower Granite, Little Goose, and Ice Harbor Dams (Schaller et al. 1996). Evidence from spawner and recruit data indicated that productivity declined more for upriver stocks which were most affected by hydropower development, and that this reduction occurred primarily after completion of the three final dams on the Snake River. Further, the differential decline was greater than could be explained by differences in direct mortality caused by the additional dams. Schaller et al. (1999) argued there was little evidence that factors unrelated to the FCRPS could account for the differences in productivity and survival between upstream and downstream stocks. On the other hand, Zabel and Williams (2000) and Hinrichsen (2001) questioned this conclusion and provided evidence that several other factors could be at least partially responsible for the observed differences in productivity between salmon populations from the two areas. The scientific debate surrounding this issue will continue unresolved in the absence of experimental data.

Over the last 30 years, considerable effort has focused on measuring the direct mortality that occurs during migration through various reaches of the FCRPS. However, there have been no empirical experiments designed to quantify delayed effects associated with hydrosystem passage. The research detailed in this proposal is designed to address the lack of specific information in this important area. We propose to use smolt-to-adult return rates (SAR) of PIT-tagged yearling chinook salmon smolts exposed to two different migrational experiences within the FCRPS to test the hypothesis of extra or delayed passage mortality.

c. Rationale and significance to Regional Programs

The goal of this study is to determine whether migration through Snake River dams and reservoirs causes extra mortality in Snake River yearling chinook salmon smolts. Specifically, the study will determine if survival downstream from McNary Dam is significantly higher for yearling chinook salmon released into the Ice Harbor Dam tailrace than for counterparts which must pass three additional dams and reservoirs after release into the Lower Granite Dam tailrace.

Whether or not migration through the FCRPS, as currently configured, causes mortality to anadromous salmonid smolts that is not expressed until after they have passed through the system is one of the most important questions currently facing the region. Experimentation will be required to confirm or refute this hypothesized mortality. If it is real, a precise estimate of its magnitude will be essential to determine the degree to which dam removal would increase life-cycle survival.

Research designed to address the hypothesis of extra mortality resulting from downstream migration through dams was addressed in Reasonable and Prudent Alternative 195 of the 2000 FCRPS Biological Opinion (BiOp) for operation of the Federal Columbia River Hydropower System (FCRPS) and is considered an immediate funding priority by the Bonneville Power Administration.

d. Relationships to other projects

Information gained in this study will be useful to judge the potential of the smolt transportation program to recover these salmon stocks. The study will also provide ancillary data that may be useful for other comparisons. For example, many study fish will undergo single or multiple bypass events. SARs of fish with different detection histories can be compared to one another and possibly improve our understanding of the patterns of mortality for these fish. These types of analyses are specifically called for by RPA 189 of the 2000 BiOp. Instructive comparisons between fish from this study and transported and non-transported fish from other studies might also be possible.

Study fish will also provide additional inriver survival estimates. The large sample sizes will produce highly precise estimates of inriver survival which can be incorporated into Performance Standard tests as outlined in the 2000 BiOp.

Juvenile study fish will be sampled and marked simultaneously with wild fish that are currently being sampled and marked for the U.S. Army Corps of Engineer's long-term transportation research program at Lower Granite Dam. Study fish will be acquired from the same sample of hatchery fish that are currently being handled and sorted at the dam in order to acquire sufficient numbers of wild fish for transport research tagging requirements. Conducting both studies simultaneously from the same facility will allow us to tag sufficient numbers of smolts for both studies without the need to handle additional fish or increase sampling. It will also eliminate the need for a separate sampling/handling/marking facility and operation to conduct the extra mortality study.

e. Project history

N/A—New project.

f. Proposal objectives, tasks and methods

Objective: **Determine if passage through three Snake River dams and reservoirs results in extra mortality in spring/summer chinook salmon smolts.**

We will mark sufficient numbers of hatchery yearling chinook salmon smolts at Lower Granite Dam to test the null hypothesis (H_o): Migration though Snake River dams and reservoirs does not cause extra mortality compared to fish that do not migrate through the dams; that is, after accounting for difference in direct mortality, SAR for the group that migrated through Snake River dams is at least as high as for the group that did not. We will test this by comparing the SARs of Snake River yearling chinook salmon (smolts detected at McNary Dam and adults detected at Bonneville Dam) from a group of smolts migrating from the Ice Harbor Dam tailrace compared to a group migrating from the Lower Granite Dam tailrace.

Task 1:

PIT tag hatchery-reared yearling chinook salmon smolts at Lower Granite Dam and assign them randomly to one of two treatment groups. Transport one group by truck for release into the Ice Harbor Dam tailrace and transport the other group by truck an equal amount of time in the vicinity of Lower Granite Dam prior to release into the Lower Granite Dam tailrace. Record PIT tags from both groups detected during passage through the bypass system at McNary Dam.

We propose to mark and release 10 discrete groups of study fish over roughly a 10-15 day period beginning about 25 April. Study fish will represent the composite population of hatchery-reared yearling chinook salmon smolts (not previously marked) collected at Lower Granite Dam. As in the past, all handling/marking will be done using preanesthesia techniques that have shown to greatly reduce the stress associated with this procedure (Matthews et al. 1997). After the fish are anesthetized, they will be gravity-transferred in water into the sorting building as is done at the primary fish-sampling facilities at other dams. Study fish will be randomly assigned for PIT tagging into one of the two study groups. Fish markers will be rotated among tagging stations hourly. After tagging, fish in each study group will be gravity-transferred in water directly to their respective trucks for transport. One study group will be transported and released below Ice Harbor Dam and the other study group will be transported an equal amount of time in the vicinity of Lower Granite Dam before eventually being released in the Lower Granite Dam tailrace.

Analyses will be based on the proportion of fish from each group detected as smolts at McNary Dam that return as adults to Bonneville Dam. That is, outcomes of interest are smolt-to-adult-return rates, SAR_{LGR} for fish released into Lower Granite Dam tailrace and SAR_{IHR} for those released in Ice Harbor Dam tailrace, calculated from smolts counted at McNary Dam and adults counted at Bonneville Dam.

The study will be replicated for a minimum of 3 years. Evaluation will be based on annual ratios of adult return rates: SAR_{LGR}/SAR_{IHR} (L/I). (Note that L/I is a measure of differential "post-McNary" survival; as such, it is analogous to the "D" parameter that is computed for transported fish). An L/I ratio significantly less than 1.0 indicates significant extra mortality for fish that passed through the hydropower system between Lower Granite and Ice Harbor Dams. Sample sizes will be set such that each year we will have an 80% probability (β = 0.20) of detecting a significant difference from 1.0 using a one-sided hypothesis test at the 0.05 significance level (α) if the true L/I is equal to 0.80 (i.e., survival decreased by 20% for fish released at Lower Granite Dam) and SAR_{IHR} is at least 1.5% (see below).

Deriso et al. (1996) and Schaller et al. (1999) compared the performance of yearling chinook salmon stocks originating in areas above and below the majority of the FCRPS for brood years 1957-1990. Their analyses suggested that after accounting for differences in direct mortality during downstream migration through the FCRPS, Snake River yearling chinook salmon stocks experienced additional, or "extra," mortality between 37% and 68% compared to downriver stocks. Moreover, extra mortality apparently increased substantially during the most recent period from 1984-1990 (Marmorek and Peters 1998, Budy et al. 2002).

The 37-68% additional extra mortality for Snake River stocks compared to downriver stocks equates to L/I ratios between 0.32 and 0.63. We have planned sample sizes for this study assuming a conservative amount of extra mortality (20%), or an L/I ratio of 0.80. If extra mortality for our upriver release group is greater, L/I will be smaller, and our power to detect the difference will be greater.

SARs of PIT-tagged Snake River hatchery spring/summer chinook salmon to Lower Granite Dam have increased substantially over the last several years, and indications suggest that higher SARs can be expected to continue into the near future. For example, for PIT-tagged smolts bypassed at Lower Granite Dam in 1997 and 1998, SARs (based on adult returns to Lower Granite Dam) were 0.70% and 0.74%, respectively. For the smolts bypassed in 1999 1.46% has already returned to Lower Granite Dam, with 3-ocean-age adults yet to return. Jack returns for smolts bypassed at Lower Granite Dam in 2000 suggested that the SAR for that migration year will also exceed 1.0%. In this study, SARs will be computed from smolts counted at McNary Dam and adults counted at Bonneville Dam. To compute sample sizes, we will assume that this SAR will be at least 1.5% for smolts released in Ice Harbor Dam tailrace.

Required sample sizes are derived by determining the required precision around the estimated L/I such that the one-sided confidence interval on the true L/I will not contain the value 1, or the confidence interval on the true natural-log-transformed L/I, LN(L/I), will not contain 0. If the confidence interval excludes 1.0, then we reject the null hypothesis that the true value is 1.0. Therefore, for a desired a and ß and specified true L/I, the number of fish needed can be determined in the following manner.

Sample sizes are needed such that:

$$LN(L/I) - (t_a + t_ß)*SE(LN(L/I)) \approx 0$$

where $SE(LN(L/I)) \approx SQRT(1/n_I + 1/n_L) = SQRT(2/n)$, where $n_I = n_L = n$ is the number of adult returns per treatment (n for Ice Harbor Dam and Lower Granite Dam tailrace groups set equal for simplicity). The previous two statements imply that the required number of adults is:

$$n \approx 2*(t_a + t_ß)^2 / [LN(L/I)]^2.$$

As described above, we selected a = 0.05, ß = 0.20, and an expected SAR_{IHR} of at least 1.5%. Sample sizes needed at McNary Dam are listed as follows (N denotes the number of juveniles):

True L/I	n	N_I	$N_L = N_I/(L/I)$	N_{Total}
0.80	249	16,600	20,750	37,350

The above calculations give the number of juveniles required at McNary Dam. These samples are obtained by releasing tagged fish upstream and counting the number detected at McNary Dam. Because mortality will occur before our release groups arrive at McNary Dam, and because we detect only a portion of the fish arriving, this will require the release of greater numbers of tagged fish to provide the required numbers in our samples. To determine the total tagging requirement, we assumed probabilities of survival to McNary Dam and of detection at the dam for the two study groups.

Based on survival estimates from previous years, we assumed survival probabilities from Ice Harbor Dam tailrace to McNary Dam and Lower Granite Dam tailrace to McNary Dam at 0.93 and 0.72, respectively. In 2000, the detection probability in the collection system at McNary Dam for yearling chinook salmon smolts was 0.3. Therefore, we will conservatively assume a detection probability of 0.25 for study smolts passing McNary Dam. Thus, to realize the necessary number of study fish detected at McNary Dam will require releasing approximately 71,475 fish (16,600/0.929/0.25) into the Ice Harbor Dam tailrace and 114,799 fish (20,750/0.723/0.25) into the Lower Granite Dam tailrace or a total tagging requirement of about 186,274 fish.

Task 2:

Recover adult study fish at Bonneville Dam and analyze data.

Bonneville Dam will serve as the principal adult recovery site for this study. Using this site for adult recovery will maximize study SARs by avoiding upstream passage mortality and mainstem fisheries above the dam. Data acquired from other areas will be considered ancillary. To analyze results, statistical tests will be applied when adult returns for the study are complete. Each year, the study will provide a seasonal L/I estimate. Confidence intervals for L/I will be calculated using the ratio (survival) estimate (Burnham et al. 1987) and its associated empirical variance.

HYPOTHESIS AND ASSUMPTION

Overall Objective: Determine if passage through three Snake River dams and reservoirs results in extra mortality in spring/summer chinook salmon smolts.

Null Hypothesis (Ho): Migration through Snake River dams and reservoirs does not cause extra mortality compared to fish that do not migrate through the dams; that is, L/I (SAR_{LGR}/SAR_{IHR}) is not less than 1.0. We will test for this by comparing the SARs of Snake River yearling chinook salmon (smolts detected at McNary Dam and adults detected at Bonneville Dam) from groups of smolts migrating from the Ice Harbor Dam tailrace compared to those migrating from the Lower Granite Dam tailrace.

Corollary: If the null hypothesis is rejected, it is highly likely that migration through Snake River dams does cause extra mortality in spring/summer chinook salmon smolts.

Criteria for Rejecting Ho: The null hypothesis will be rejected if estimated L/I is significantly less than 1.0 (one-sided test). Significance will be set at ($\propto < 0.05$).

Assumption: An average 9-10 day difference in migration timing between the two study groups as they pass downstream of McNary Dam will not bias study results.

Marking the two study groups simultaneously at Lower Granite Dam and releasing one of the groups below that dam and the other group below Ice Harbor Dam on the same day will result in an approximate 9-10 day earlier migration timing for the latter release group as both groups pass through the lower Columbia River after detection at McNary Dam. Based upon past adult returns of spring chinook salmon smolts tagged and released into the river at Lower Granite Dam, we have seen no relationship between SARs and flows in recent years. Furthermore, SARs of inriver-migrating fish appear to be relatively stable particularly during the middle 60% of the annual outmigrations. Therefore, we will target this portion of the annual outmigrations for tagging of study fish.

g. Facilities and equipment

Coordination with Corps of Engineer operations will be required at Lower Granite Dam for smolt sampling and marking and use of marking facilities. The study may also require the use of two U.S. Army Corps of Engineers fish transport trucks. Coordination with projects will be required to set up smolt release facilities at both dams. PIT-tag detections are automatic as smolts pass through the collection system at McNary Dam and adults pass through the detection systems in the fish ladders at Bonneville Dam.

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Reference (include web address if available online)	Submitted w/form (y/n)

Section 10 of 10. Key personnel

Gene M. Matthews, Fisheries Research Biologist. B. S. (1970) in Wildlife Biology, Washington State University. National Marine Fisheries Service, Fish Ecology Division (1973 to present). Mr. Matthews has worked as a Research Biologist for the National Marine Fisheries Service for more than 29 years, working primarily on smolt transportation and smolt survival research. He has been the Principal Investigator for the transportation research project for the past 15 years and has primary responsibility for overall project supervision, proposal preparation, and research report writing. Mr. Matthews will spend 25% of his time on this project.

Selected publications related to his research:

Matthews, G. M., George A. Swan, and Jim Ross Smith. 1977. Improved bypass and collection system for protection of juvenile salmon and steelhead trout at Lower Granite Dam. Mar. Fish. Rev. Vol. 39 (7): 10-14.

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Douglas M. Marsh, Fisheries Research Biologist. B. A. (1977) in Zoology, Miami University and 130 quarter hours of graduate studies at Florida State University in Biological Oceanography. National Marine Fisheries Service, Fish Ecology Division (1973 to present). Mr. Marsh has worked as a Research Biologist for the National Marine Fisheries Service for 12 years, working primarily on smolt transportation research. He has been a co-investigator on this research project for the past 11 years and has primary responsibility for overall field supervision and smolt tagging operations and research report preparation. Mr. Marsh will spend 25% of his time on this project.

Selected publications related to his research:

Marsh, D. M., G. M. Matthews, S. Achord, T. E. Ruehle, and B. P. Sandford. 1999. Selection of PIT-tagged salmonid smolts from an untagged population passing a juvenile collection system. North American Journal of Fisheries Management. North American Journal of Fisheries Management 19:1142-1146. 1999.

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Benjamin P. Sandford, Statistician, B.S. (1986) in Mathematics, Central Washington University; M.S. (1988) in Statistics, Oregon State University. National Marine Fisheries Service, Fish Ecology Division (1988 to present). Manages data, performs analyses, writes reports, assists with field research as necessary. Mr. Sandford has worked as a Statistician for the National Marine Fisheries Service since 1988. He has been responsible for study design, database management, and data analysis, for multiple Fish Ecology Division studies annually, focusing on data obtained from PIT- and and radio-tag technologies during which time his principal responsibility has been management and analyses of PIT-tag data. 25% of his time will be spent on this project.

Selected publications related to his research:

Sandford, B. P., and S. G. Smith. 2002. Estimation of smot-to-adult return percentages for Snake River basin anadromous salmonids, 1990-1997. Journal of Agricultural, Biological, and Environmental Statistics 7:243-263.

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Congratulations!