This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Hydro Proposed Action Summary

Hydro Action Objective for All ESUs: Improve juvenile and adult fish survival as they pass through the hydrosystem.

Hydrosystem Strategy 1: Operate the FCRPS to more closely approximate the shape of the natural hydrograph and to improve juvenile and adult fish survival.

Performance Goals: Flow objectives and estimated fish system survivals under a range of water conditions.

Performance Standards: Specific operating commitments for individual reservoirs and stored water; preparation of annual Water Management Plan

Funding Source(s): Corps and Reclamation congressional appropriations for Operation and Maintenance and BPA direct funding.

Rationale: Passage through the hydrosystem is a limiting factor for all upriver listed fish, and also affects the lifecycle of lower river fish. Water is managed to assist juvenile and adult fish survival, although there is limited storage in the Columbia Basin compared to other large watersheds.

What's New: Better defined operating commitments for water management; inclusion of the Montana operation for listed resident fish; commitments regarding Canadian storage priorities, negotiation, and coordination; inclusion of reporting velocity equivalents for flow levels; clarifications of what occurs in fish emergencies; inclusion of a dry water year provision; coordination of forecasting.

1.0 <u>Manage stored water to provide enhanced flows for listed fish</u>

As described in more detail below, the Action Agencies will use three primary components of the FCRPS operations to benefit flows for ESA-listed juvenile and adult fish:

- **Water management and releases for the FCRPS projects.** The Action Agencies will operate the FCRPS storage projects to shape spring and summer flows as needed to benefit fish migration and operate certain run-of-river projects to minimize water travel time through the lower Columbia and Snake rivers.
- **Coordinated Canadian Reservoir Operations**. The BPA and Corps will continue to seek mutually acceptable annual agreements with Canada under the Columbia River Treaty to provide 1 Maf of storage in Treaty space that will be used to enhance flows for listed fish. BPA also will seek new agreements with BC Hydro on the operation of non-Treaty storage to

shape flows for multiple purposes, including improved flows for ESA-listed fish, consistent with the Treaty.
  - **Dry Year Operations.** The Action Agencies implement certain flow operations and agreements, and are exploring other means to improve flow conditions under dry water year conditions.

Substrategy 1.1 FCRPS Project Operations for Improved Flows

Action 1. Reservoir Operations for Migration and Spawning Flows

The Action Agencies will manage water and reservoir operations available for fish benefits using the specific operations described for each project in Attachment 1. These operations determine water available to shape for optimal benefit to anadromous migrants and spawners, while taking into account the needs of resident fish In general, this includes the following:

- Operate storage projects to be at their flood control elevation in early April (the exact date to be determined during in season management) to maximize flows for spring flow management.
- Refill the storage projects by the end of June/early July (exact date to be determined during in-season management) to provide summer flow augmentation consistent with available water supply, spring operations, and flood control requirements.
- Provide fall and winter tailwater elevations/flows to support chum salmon spawning and incubation in the Ives Island area below Bonneville Dam and to provide access for chum spawning in Hamilton and Hardy creeks.
- Identify opportunities to shift system flood control from Brownlee and Dworshak reservoirs to Lake Roosevelt and implement when feasible.
- Balance the consideration of these priorities for various listed fish (resident and anadromous).

Action 2. Flow Objectives and Velocities

The Action Agencies will manage FCRPS storage projects to provide water throughout the year for various fishery needs, placing a high priority for the needs of ESA listed fish, including salmon, steelhead, bull trout, and sturgeon.

- Flow objectives and velocity conversions are set out in Attachment 1 for purposes of planning and for consideration in inseason management. (Velocities are not measured, but will be provided inseason as an informational "rule of thumb" conversion of flow data to velocity.) However, it is recognized that these objectives cannot be fully achieved in many water years because available storage in the Columbia basin is limited relative to total annual runoff in the Basin.
- Hydro system performance regarding flow management from the FCRPS projects will be assessed annually by considering whether water was stored and released consistent with the guidelines described in Attachment 1.

Action 3. In Season Water Management

Each year the Action Agencies will prepare an annual Water Management Plan, in coordination with the Regional Forum, Technical Management Team, reflecting the above commitments and constraints, as well as the water conditions for that year. Within each water management year, sovereigns can make operational requests to adjust water management consistent with parameters identified in Attachment 1, recognizing that this may require tradeoffs among priorities under some conditions. The Action Agencies will seek to meet these requests by optimizing the overall use of available volumes in storage reservoirs to benefit migrants and spawners, as necessary throughout the seasons, taking into account the needs of resident fish and other reservoir objectives.

Action 4. Forecasting

The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will convene regional parties to discuss possible implementation.

Action 5. Emergency Operations

- **Operational Emergencies:** Interruptions or adjustments in water management actions may occur due to unforeseen power system, flood control, dam safety or other emergencies. Such emergency actions will be viewed by the Action Agencies as a last resort and will not be used in place operations outlined in the annual Water Management Plan. Emergency operations will be managed in accordance with TMT emergency protocols The action agencies will take all reasonable steps to limit the duration of any emergency impacting fish
- **Fish Emergencies:** Operations for fish passage and protection at FCRPS facilities may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration resulting from emergencies impacting fish, the Action Agencies will develop in coordination with the Regional Forum and implement appropriate adaptive management actions to address the situation

Substrategy 1.2 Coordinate Canadian operations for improved flows

Action 6. Treaty Storage:

BPA and the Corps will pursue negotiations with Canada of annual agreements to provide 1 Maf of storage in Treaty space by 15 April consistent with:

- Providing the greatest flexibility possible for releasing water to benefit US fisheries May-July
- Giving preference to meeting April 10 URC elevation or achieving refill at GCL over flow augmentation storage in Canada in lower water supply conditions

- Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the US or Canada

BPA and the Corps will coordinate with federal agencies, states and tribes on The Treaty operating plans.

Action 7. NonTreaty Storage:

Remaining non-treaty storage space under the 1990 non-treaty storage agreement will be refilled by June 30, 2011, as required in the1990 agreement. Refill will be accomplished with minimal adverse impact to fisheries operations to the extent possible.

- BPA will pursue negotiation of a new long-term agreement on use of non-treaty space in Canada so long as such an agreement provides both power and non-power benefits for B.C. Hydro, BPA, and Canadian and U.S. interests. As part of these negotiations, BPA will seek opportunities to provide benefits to ESA-listed fish, consistent with the Treaty.
- If a new long-term non-Treaty agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits, consistent with the Treaty.
- Prior to negotiations of new long-term or annual non-Treaty storage agreements, BPA will coordinate with federal agencies, states, and tribes to obtain ideas and information on possible points of negotiation, and will report on major developments during negotiations.

Substrategy 1.3 Dry Year Operations to improve flows

Action 8. Flow Management

- Within the defined “buckets” of available water (reservoir draft limits identified in Attachment 1), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The Action Agencies will coordinate use of this flexibility in the Regional Forum.
- Consistent with operating plans develop under the Treaty, in dry water years, Treaty reservoirs will be operated below their normal refill levels in the late spring and summer, therefore increasing flows during that period relative to a standard refill operation.
- Annual agreements between the U.S. and Canadian Entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.
- BPA will explore opportunities in future long-term non-Treaty storage agreements to develop mutually beneficial in-season agreements with Canada to shape water releases using non-Treaty storage space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed ESUs, considering ESU status.
- Upon issuance of the FCRPS BiOp, the Action Agencies will convene a technical workgroup to scope and initiate investigations of alternative dry water year flow strategies to enhance flows in dry years for the benefit of ESA-listed ESUs.

Action 9. Spring Transport

In dry years, the Action Agencies will provide spill and bypass for Snake River migrants in early spring, spill and transport in mid spring and maximize transport in late spring through May 31.

Action 10. Other Dry Year Tools

BPA will implement as appropriate it's Guide to Tools and Principles for a Dry Year Strategy to reduce the effect energy needs may pose to fish operations and other project purposes.

Hydrosystem Strategy 2: Modify Columbia and Snake River Dams to Maximize Juvenile and Adult Fish Survival.

Performance Standards: 95% dam survival on average for spring migrating fish and 93% dam survival on average for summer migrating fish through surface passage improvements; maintenance of current high adult survival levels; implementation of specific passage actions at individual dams.

Funding Source(s): Corps appropriations through Columbia River Fish Mitigation Program.

Rationale: Passage through the hydrosystem is a limiting factor for all upriver listed fish, and also affects the lifecycle of lower river fish. Improving and maintaining safe passage at individual dams is key to juvenile and adult fish survival, building on the $1 billion recently invested in overhauling the FCRPS dams.

What's New: Specific and higher juvenile dam survival performance standards; major new investment in surface passage improvements at the lower river dams which affect all upriver ESUs; additional spillway and powerhouse improvements designed to improve survival, depending on the dam.

2.0 Modify Dams to Achieve Biological Performance Standards

The Action Agencies will implement dam modifications (also referred to as configuration improvements) to improve juvenile fish survival and maintain current high levels of adult fish passage at the FCRPS dams.

- Performance standards for juvenile dam modifications are to achieve 95% juvenile dam survival on average for spring migrants and 93% for summer migrants. The primary approach to achieve these performance standards is enhancement of surface bypass such as removable spillway weirs (RSWs) and similar mechanisms.
- The Action Agencies, in coordination with the Regional Forum, are completing configuration and operation plans (COPs) for each of the eight mainstem projects to identify and prioritize dam modifications based on performance standards. Phase I priority actions will be implemented under the Biological Opinion, with particular focus on The Dalles, John Day, and McNary Dams.
- The Action Agencies will consider the results of action effectiveness monitoring to determine if performance standards have been achieved, or if additional actions (Phase II actions) are required to achieve performance standards.
- The current implementation schedule and locations for key surface bypass actions are set out in Attachment 3. These are subject to change based on feasibility, biological priorities, and data.

Substrategy 2.1 Powerhouse Improvement Actions

Action 11. Powerhouse Improvements

The Action Agencies will implement specific powerhouse improvement actions designed to improve fish survival, as set out in Attachment 3 for Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams. Generally, these actions include:

- Providing or enhancing powerhouse surface flow outlets
- Making improvements to juvenile bypass systems including full-flow bypass and outfall relocation at appropriate projects
- Improving turbine operations

Substrategy 2.2 Spillway Improvement Actions

Action 12. Spillway Improvement Actions

The Action Agencies will implement specific spillway improvement actions designed to improve fish survival, as set out in Attachment 3 for Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Chief Joseph Dams. Generally, these actions include:

- Providing or enhancing spillway surface flow outlets (e.g. RSWs and TSWs)
- Making improvements to spillways to reduce injury, reduce tailrace predation, facilitate downstream egress, and reduce TDG levels

Substrategy 2.3 Adult Passage Improvement Actions

Action 13. Adult Passage Improvements

The Action Agencies will implement specific adult passage actions designed to maintain or enhance fish survival are set out in Attachment 3 for The Dalles, John Day, Lower Granite, and other dams. Generally these actions include:

- Enhancing adult fishways to improve upstream passage
- Installing PIT-tag detection systems to improve monitoring capabilities of SARs

Hydrosystem Strategy 3: Implement Operation Improvements (Spill and Transportation) at Columbia and Snake River Dams to Maximize Juvenile and Adult Fish Survival.

Performance Standards: Specific initial spill operations for individual dams, subject to adaptive management as new data emerges and as surface passage is installed (when 95%/93% standard would apply; specific fish indices to control the termination and re-initiation of summer spill; specific initial transportation protocols, also subject to adaptive management as new data emerge.

Funding Source(s): Corps congressional appropriations for Operations and Maintenance and BPA Direct Funding.

Rationale: Passage through the hydrosystem is a limiting factor for all upriver listed fish, and also affects the lifecycle of lower river fish. Spill is often the most effective means of passage at dams, alleviating both turbine passage and delay. Spill levels below are based on biological study results rather than spill formulas (e.g. 24/7 spill to the gas cap), because more spill is not always a biological improvement. Summer spill fish indices are based on recent data regarding timing of fish passage for fall chinook and recent life history information on when they are shifting from migrating to rearing (generally late July). Transportation protocols are based on adult return information and are subject to adaptive management over time.

What's New: Continued interim implementation and evaluation of 2006 court-ordered summer spill at collector projects to determine appropriate management strategies for Snake River fall Chinook. Manage duration of Snake River summer spill to match fish run timing. Potential for shared savings of spill efficiencies through surface passage improvements to be used for additional offsite actions to provide further benefits to listed ESUs. Provide additional transportation barges.

3.0 Implement Spill Operations and Fish Transportation Based on Biological Performance.

The Action Agencies will use spill-based passage and fish transportation at the FCRPS dams as described below.

- As surface flow outlets are provided or enhanced through dam modifications, spill levels will be optimized to help achieve 95%/93% per dam average performance standards.
- Summer spill duration will be calibrated to fish passage indices rather than to calendar dates.
- Transportation protocols, which trigger the decision to transport rather than spill and bypass, are based on the most recent fish survival information.

Substrategy 3.1 Spill Operations

Action 14. Spill Operations.

The Action Agencies will implement the initial spill levels and planning start dates for voluntary spill operations, which are identified below for each mainstem project (Table 1). At some projects, the spill levels listed in Table 1 are currently being evaluated to determine if a survival benefit may be gained from the operation(s). Additionally, the Action Agencies will continue to evaluate and optimize voluntary spill operations as configuration improvement actions are implemented at each project to address performance standards, while adhering to the requirements of the Clean Water Act. To the extent that configuration improvements such as surface passage systems may allow reduction of voluntary spill while still meeting performance standards, the Action Agencies may reallocate a portion of the resultant power revenue gained for additional off-site actions to provide further biological benefit to ESUs.

Table 1. - Initial voluntary spill operations at Columbia and Snake River dams.

Project	Spring Operation (Day/Night)	Spring Planning Start Date	Summer Operation (Day/Night)	Summer Planning Start Date
Bonneville	100 kcfs/100 kcfs	4/10	75 kcfs/Gas Cap	6/16
The Dalles	40%/40%	4/10	40%/40%	6/16
John Day	0/60%[A]	4/10	30%/30%	6/16
McNary	40%/40%	4/10	40%/40% vs. 60%/60%	6/16
Ice Harbor	30%/30% vs. 45 kcfs/Gas Cap	4/3	30%/30% vs. 45 kcfs/Gas Cap	6/1
Lower Monumental	27 kcfs/27 kcfs (Bulk Spill Gas Cap)	4/7	17 kcfs/17 kcfs	6/1
Little Goose	30%/30%	4/5	30%/30%	6/1
Lower Granite	20 kcfs/20 kcfs	4/3	18 kcfs/18 kcfs	6/1

A – John Day spill operation during the spring will likely shift to 24-hour operation after construction of surface flow outlets.

Beginning August 1, if the number of collected subyearling Chinook (hatchery and naturally produced) has fallen below 1,000/day for 3 sequential days, spill will be discontinued on a per project basis, beginning with the most upstream project (Lower Granite). If after shutting off spill, collection numbers exceed 1,000 subyearling fish per day for 2 sequential days, spill will be reinitiated and fish numbers will be reevaluated.

Substrategy 3.2 Juvenile Fish Transportation

Action 15. Juvenile Fish Transportation

The Action Agencies will implement the juvenile fish transportation program to help meet system survival performance targets for Columbia and Snake River salmon and steelhead, particularly when transportation improves survival compared to inriver migration.. The Action Agencies will collect and transport juvenile fish at Lower Granite, Little Goose, Lower Monumental and McNary dams under initial operation strategies outlined below in Table 2. While the dates specified in Table 2 are considered firm planning dates, if in-season information or results of ongoing RM&E indicate a need for modification of the action, the Action Agencies will consider revising the dates and operations through the Regional Forum.

Table 2. - Initial juvenile fish transportation operation strategies at McNary, Lower Monumental, Little Goose, and Lower Granite dams.

Project	Flow Condition	Spring Transportation Strategy				Summer Transportation Strategy			
		Spill/ Bypass	Spill/ Transport	Max Transport	Adaptive Transition[A]	Spill/ Transport	Adaptive Transition[A]	Max Transport	Adaptive Transition[A]
McNary									
	Low (season avg < 125 kcfs)	None	None	4/10-6/14	6/15-6/30	July	Aug	Sept	Oct +
	High (season avg >125 kcfs)	4/10-6/14	None	None	6/15-6/30	July	Aug	Sept	Oct +
Lower Mon									
	Low (season avg < 65 kcfs)	None	None	4/3-5/31	June	July	Aug	Sept	Oct +

Project	Flow Condition	Spring Transportation Strategy				Summer Transportation Strategy			
		Spill/ Bypass	Spill/ Transport	Max Transport	Adaptive Transition[A]	Spill/ Transport	Adaptive Transition[A]	Max Transport	Adaptive Transition[A]
	Mid (season avg 65 – 80 kcfs)	4/7-5/1	5/2-5/9	5/10-5/31	June	July	Aug	Sept	Oct +
	High (season avg > 80 kcfs)	4/7-5/1	5/2-5/9	None	June	July	Aug	Sept	Oct +
Little Goose									
	Low (season avg < 65 kcfs)	None	None	4/3-5/31	June	July	Aug	Sept	Oct +
	Mid (season avg 65 – 80 kcfs)	4/5-4/28	4/29-5/4	5/5-5/31	June	July	Aug	Sept	Oct +
	High (season avg > 80 kcfs)	4/5-4/28	4/29-5/31	None	June	July	Aug	Sept	Oct +
Lower Granite									
	Low (season avg < 65 kcfs)	None	None	4/3-5/31	June	July	Aug	Sept	Oct +
	Mid (season avg 65 – 80 kcfs)	4/3-4/20	4/21-4/30	5/1-5/31	June	July	Aug	Sept	Oct +
	High (season avg > 80 kcfs)	4/3-4/20	4/21-5/31	None	June	July	Aug	Sept	Oct +

A – The term "adaptive" in this table refers to a transition between two adjacent management strategies in the table. For example, where "Adaptive" is between "Max transport" and "Spill/ Transport", the decision for each option would be made based on in-season data.

Hydrosystem Strategy 4: Operate and Maintain Juvenile and Adult Fish Passage Facilities at Corps' Mainstem Projects to maintain biological performance.

Funding Source(s): Corps congressional appropriations for Operations and Maintenance and BPA Direct Funding

Rationale: Passage through the hydrosystem is a limiting factor for all upriver listed fish, and also affects the lifecycle of lower river fish. Good operation and maintenance of fish passage facilities is key to their continued safe performance.

4.0 Operation and Maintenance of Juvenile and Adult Fish Passage Facilities.

Action 16. Operation and Maintenance

The Corps will operate and maintain juvenile and adult passage facilities at the mainstem lower Snake and Columbia River projects to maintain biological performance. Key actions include:

- Operate fish passage facilities in accordance with the annual fish passage plan coordinated with regional interests.
- Take advantage of low river conditions, low reservoir elevations or periods outside the juvenile migration season to accomplish repairs or inspections operations so there is little or no effect on juvenile fish.
- Coordinate routine and non-routine maintenance that affects fish operations or structures as appropriate to eliminate and/or minimize fish operation impacts.
- Schedule routine maintenance during non-fish passage periods
- Conduct non-routine maintenance activities as needed

Attachment 1: Fish Operations at Federal Reservoirs

Dworshak

- Operate to standard flood control criteria; shift system flood control to Grand Coulee in below average water years, if possible.
- Provide minimum flows while not exceeding Idaho State TDG water quality standard of 110%.
- Refill by about June 30.
- Draft to meet elevation 1535 feet by end of August with draft to 1520 feet in September.
- Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below 68^{o} F.
- Maximum project discharge for salmon flow augmentation to be within State of Idaho TDG water quality standards

Libby

- Follow interim VARQ flood control procedures
- Follow variable December 31 flood control draft based on early season water supply forecast
- When not operating to minimum flows, operate to achieve 75% chance of reaching the upper flood control rule curve on or about April 10 (the exact date to be determined during inseason management)
- Operate to provide tiered white sturgeon augmentation volumes for spawning/recruitment consistent with the 2006 USFWS BiOp in May, June and July; shaped in coordination with TMT.
- Refill by early July (exact date to be determined during in-season management) as best as possible given available water supply and spring operations and consistent with flood control requirements to provide summer flow augmentation.
- Draft to 10 feet from full by the end of September (except in lowest 20^{th} percentile water years, as measured at The Dalles, when draft increased to 20 feet from full by end of September). If project fails to refill to draft limit, release inflows or operate to meet minimum flows.
- Meet minimum flow requirements for bull trout from May 15 to September 30 and 4000 cfs in October through April for resident fish.
- Provide even or gradually-declining flows during the summer months (minimize double peak).
- Limit spill to avoid exceeding Montana State TDG standard of 110%, when possible, and in a manner consistent with the Action Agencies responsibilities to resident listed fish under the ESA.
- Limit outflow fluctuations by operating to ramping rates set in the 2006 USFWS BiOp to avoid stranding bull trout.

Grand Coulee

- Use standard flood control criteria including adjustments for flood control shifts from Dworshak and Brownlee.
- Operate to achieve 85% chance of reaching URC elevation by about April 10.
- Refill by about June 30 each year (exact date to be determined during inseason management).
- Take advantage of reservoir draft for flood control during high water years to perform drum gate maintenance. Drum gate maintenance may be deferred in some dry water years; however, drum gate maintenance must occur at a minimum one time in a three year period, two times in a five year period and three times in a seven year period.
- Draft to meet salmon flow objectives during July-August with variable draft limit of 1278-1280 feet by August 31 based on the water supply forecast.

  - Implementation of the Lake Roosevelt drawdown component of Washington's Columbia River Water Management Program will draft an additional 1.0 foot in non-drought years and 1.8 feet in drought years from Lake Roosevelt by the end of August for instream and out-of-stream use.
  - Reduce pumping into Banks Lake; and allow Banks Lake to operate up to 5 feet from full pool during August to help meet salmon flow objectives when needed.
- May be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation.
- Operates to help meet Priest Rapids flow objective to support fall Chinook spawning and incubation.
- Operate to minimize TDG.

Hungry Horse
- Follow interim VARQ flood control procedures.
- Maintain minimum flows all year for bull trout with a sliding scale based on the forecast. Operate to meet minimum flows of 3200-3500 cfs at Columbia Falls on the mainstem Flathead River and 400-900 cfs in the South Fork Flathead River.
- When not operating to minimum flows, operate to achieve 75% chance of reaching URC elevation by about April 10.
- Refill by about June 30 each year (exact date to be determined during inseason management).
- When needed to meet lower Columbia flow augmentation objectives, draft during July-September to a draft limit of 3550 feet (10 feet from full) by September 30, except in the driest 20 percentile of water conditions limit draft to 3540 feet (20 feet from full). If don't refill to the draft limit pass inflows or operate to meet minimum flows.
- Provide even or gradually-declining flows during summer months (minimize double peak).
- Limit spill to maximum of 15% of outflow to avoid exceeding Montana State TDG standards of 110% to the extent possible.
- Limit outflow fluctuations by operating to ramping rates set in 2006 USFWS BiOp to avoid stranding bull trout.

Albeni Falls
- Use standard flood control criteria.
- Operate to provide kokanee spawning conditions (winter pool levels).

Lower Snake projects
- Operate at minimum operating pool (MOP) elevation from April 3 until small numbers of juvenile migrants are present unless adjusted to meet authorized project purposes. For Lower Granite – operate at MOP until enough natural cooling has occurred in the Lower Granite forebay, generally after October 1.
- Configure fish passage facilities and conduct fish passage operations to achieve the juvenile passage performance goals.
- Spill in accordance with Water Management Plan (WMP) Table 4 unless modified by implementation planning and adaptive management decisions.
- Collect fish and transport at Lower Granite, Little Goose and Lower Monumental dams; provide fish spill in years when seasonal average flows are greater than 65,000 cfs during spring months.

Lower Columbia projects

- Operate John Day pool at the lowest elevation that continues to allow irrigation from April 10 through September 30.
- Configure fish passage facilities and conduct fish passage operations to achieve the juvenile passage performance goals.
- Spill in accordance with WMP Table 4 unless modified by implementation planning or adaptive management decisions.
- Collect fish and transport during the summer at McNary unless modified through implementation planning or adaptive management decisions.

Seasonal Flow Objectives and Planning Dates

Operate reservoirs to attempt to meet these flow objectives (UPA Table 3):

	Spring		Summer	
Location	**Dates**	**Objective**	**Dates**	**Objective**
Snake River at Lower Granite Dam	4/03 - 6/20	85 - 100[1]	6/21 - 8/31	50 - 55[1]
Columbia River at McNary Dam	4/10 - 6/30	220 - 260[1]	7/01 - 8/31	200
Columbia River at Priest Rapids Dam	4/10 - 6/30	135	N/A	N/A
Columbia River at Bonneville Dam	11/1 - emergence	125 – 160[2]	N/A	N/A

[1] Objective varies according to water volume forecasts.
[2] Objective varies based on actual and forecasted water conditions.

Flow Objectives to Velocities Conversion Tables

Lower Columbia Water Travel Time			
Scenario	**July- Aug Ave (Kcfs)**	**WTT IHR to Bon Pool at Flow days**	**WTT IHR to Bon Pool at Flow ft/s**
Min Spring BIOP	220000	8.8	0.97
Max Spring BIOP	260000	7.4	1.15
Summer BIOP	200000	9.7	0.89

Lower Snake Water Travel Time			
Scenario	**Flow Ave (Kcfs)**	**WTT through LGR pool to IHR at Flow days**	**WTT through LGR pool to IHR at Flow ft/s**
Min Spring BIOP	85000	10.1	0.71
Max Spring BIOP	100000	8.6	0.84
Min Summer BIOP	50000	17.2	0.42
Summer BIOP	55000	15.6	0.46

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Hydro Proposed Action

1. Hydro Actions (Step 5)

The Federal Action Agencies (Action Agencies) remain committed in their efforts towards reversing the decline of endangered salmonid species in the Columbia River Basin. The Action Agencies understand that hydropower actions will be a key component in the steps to recovery and are committing to provide the necessary modifications to facilities and operations at the hydropower projects in an effort to improve adult and juvenile dam passage survival. As such, the Action Agencies have developed an overall hydro strategy that includes water management operations, juvenile and adult dam passage modifications, and operational and maintenance activities aimed towards improving juvenile passage survival and adult returns.

Because modifications at the projects to improve passage and survival are site specific, modifications at a given project may affect entire ESUs or only portions of ESUs depending on its location. For example, modifications at Bonneville Dam are anticipated to directly affect all Middle Columbia steelhead, however modifications at McNary may only affect some populations of the Mid Columbia Steelhead, and those modifications at Lower Monumental Dam are not expected to directly affect any of those populations since they do not occur in the vicinity. Table 1 shows those populations that would be directly affected by modifications at each of the mainstem dams.

In addition, because specific information is not available at this time, the assumption was made that the effect obtained for specific actions would be similar for similar ESUs. Therefore, yearling migrant Chinook, steelhead and subyearling Chinook would be anticipated to have similar direct responses for the same action. For example, a turbine modification action that provides a change in survival of 2% at John Day Dam for Snake River Basin steelhead, may be assumed to have a 2% change for Mid-Columbia and Upper Columbia steelhead as well.

Table 1. Mainstem projects and ESUs which are either entirely or partially affected by upstream and downstream passage actions.

	Chinook					Steelhead					Sockeye	Chum	Coho
	Snake River Spring/Summer run	Snake River Fall Run	Upper Columbia Spring Run	Lower Columbia River	Upper Willamette River	Snake River Basin	Upper Columbia River	Middle Columbia River	Lower Columbia River	Upper Willamette River	Snake River	Columbia River	Lower Columbia River
Bonneville Dam	●	●	●	○		●	●	●	○		●	○	○
The Dalles Dam	●	●	●			●	●	●			●		
John Day Dam	●	●	●			●	●	●			●		
McNary Dam	●	●	●			●	●	○			●		
Ice Harbor Dam	●	●				●					●		
Lower Monumental Dam	●	◘				◘					●		
Little Goose Dam	◘	◘				◘					●		
Lower Granite Dam	◘	◘				◘					●		

● = All ESU populations

◘ = Most ESU populations

○ = Some ESU Populations

Overall Hydro Strategies by ESU

<u>Snake River Spring/Summer Chinook, Steelhead and Sockeye ESUs</u>

Juvenile Migration

The overall Hydro strategy for juvenile Snake River Spring/Summer Chinook, Steelhead and Sockeye ESUs is to produce a high level of dam passage survival and maximize adult returns. In order to do so, a strategic combination of inriver migration and transportation will be used with an emphasis on balancing the various migrational needs among the species.

Planning documents including Configuration and Operations Plans, will be produced for each project. This will include examination of some passage routes where it has been determined that survival is lower or injury is higher than desired (e.g. The Dalles Dam spillway, turbines, etc). Configuration and operation changes will continue towards increasing direct survival and decreasing the potential for latent mortality. In addition, Research, Monitoring and Evaluation (RM&E) will be conducted as necessary to facilitate decision making towards adaptively managing hydrosystem operations for inriver salmonid migration, transportation and the other authorized purposes of the system.

When inriver conditions are suitable, available passage routes will be optimized to facilitate safe passage for inriver migrating fish. This will be accomplished using a combination of strategies that includes surface flow bypass (RSWs, corner collectors, e.g.) along with spill at the Snake and Columbia River dams. These strategies are anticipated to provide benefits to downstream migrants by reducing forebay delay, and providing dam passage routes where injury potential is minimized and egress through the tailrace is optimized. Surface bypass routes are generally more efficient (greater proportion of fish passed per unit of water) and thus are showing potential for providing effective passage with lower Total Dissolved Gas levels. Surface passage routes also hold some potential for reducing latent mortality. For those fish collected by juvenile bypass systems, the strategy would be to maximize their potential of survival to adulthood by using full flow bypass systems to route these fish back to the river during early April (immediately following primary dewatering of bypass system flow) to minimize handling during that time period. In addition, relocating juvenile bypass outfalls as necessary would provide good egress conditions, minimize predation, and decrease the potential for latent mortality.

In late April to early May, transportation would be employed at the collector projects to increase the potential for maximizing adult returns. Because fish have a tendency to return at lower rates the later into the season that they migrate, transportation will be used to increase the adult returns of those later migrants. During the lowest of low flow years, when survival studies have shown high levels of both direct and latent mortality, transportation will be maximized in an effort to avoid prolonged inriver migration times, thereby improving adult returns.

Adult Migration

Overall, adult survival through the hydropower system has been relatively high. The Action Agencies will monitor the passage success of adult fish to assess if performance remains at those high levels. In addition, improvements will be made to adult passage systems as necessary to improve passage timing. Investigations will be performed on downstream adult and kelt steelhead passage during periods when bypass systems and spill are not normally provided, to determine the effectiveness of alternative operations.

Upper Columbia Chinook, Upper and Mid-Columbia Steelhead, and Columbia River Coho ESUs

Juvenile Migration

The overall Hydro strategy for juvenile Upper Columbia Spring Chinook, Upper and Mid-Columbia Steelhead, and Columbia River Coho ESUs is to produce a high level of dam passage survival and ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas.

Planning documents, including Configuration and Operations Plans, will be produced for each Columbia River project. This will include examination of some passage routes where it has been determined that survival is lower or injury is higher than desired (e.g. The Dalles Spillway, Turbines, etc). Configuration and operation improvements will continue to be used to increase survival and decrease the potential for latent mortality. In addition, RM&E will be conducted as appropriate to facilitate decision making towards adaptively managing the operations in the hydropower system for inriver salmonid migration and the other authorized purposes of the system.

Passage conditions for inriver migrating fish will be optimized. This will be accomplished using a combination of strategies that includes surface flow bypass (RSWs, Corner Collectors, e.g.) along with spill at the Snake and Columbia River dams. These strategies are anticipated to provide benefits to downstream migrants by reducing forebay delay, and providing dam passage routes where injury potential is minimized and egress through the tailrace is optimized. Surface bypass routes are generally more efficient (greater proportion of fish passed per unit of water) and thus show potential for providing effective passage with lower Total Dissolved Gas levels. Surface passage routes also hold some potential for reducing latent mortality. For those fish collected by the juvenile bypass systems, the strategy would be to maximize their potential of survival to adulthood by using full flow bypass systems to route these fish back to the river (immediately following primary dewatering of bypass system flow) to minimize handling. In addition, relocating juvenile bypass outfalls as necessary would provide good egress conditions and minimize predation. This will also serve to decrease the potential for latent mortality.

During the lowest of low flow years, when survival studies have shown high levels of both direct and latent mortality, transportation will be maximized at McNary in an effort to avoid prolonged inriver migration times, thereby improving adult returns. In addition, if modifications to the bypass systems are unsuccessful, transporting collected fish will be reconsidered at this facility.

Adult Migration

Overall, adult survival through the hydropower system has been relatively high. The Action Agencies will monitor the passage success of adult fish to assess if we are still performing at those high levels. In addition, improvements will be made to adult passage systems as necessary to improve passage timing. Investigations will be performed on downstream adult and kelt steelhead passage during periods when bypass systems and spill are not normally provided, to determine the effectiveness of alternative operations.

Snake River Fall Chinook ESU

Juvenile Migration

The overall Hydro strategy for juvenile Snake River Fall Chinook is to provide a spread the risk operation of inriver passage through surface flow bypass/spill and transportation. Operations will be adaptively managed to better match the times during which fall Chinook are being collected at the projects to attempt to achieve a 50/50 split of transport and inriver migrants and to determine when transport and/or spill should be discontinued. When transportation is not provided, full flow bypass would occur. A complimentary evaluation will be conducted to assess the most effective passage mechanism in that existing data is inconclusive as to whether transport or inriver migration is the preferred passage method.

Planning documents will be produced for each project, including Configuration and Operations Plans. This will include examination of some passage routes where it has been determined that survival is lower or injury is higher than desired (e.g. The Dalles Spillway, Turbines, etc). Configuration and operation improvements will continue to be used to increase survival and decrease the potential for latent mortality. In addition, RM&E will be conducted as necessary to facilitate decision making towards adaptively managing hydro system operations for inriver salmonid migration, transportation and the other authorized purposes of the system.

Adult Migration

Overall, adult survival through the hydropower system has been relatively high. The Action Agencies will monitor the passage success of adult fish to assess if we are still performing at those high levels. In addition, improvements will be made to adult passage systems as necessary to improve passage timing. Investigations will be performed on downstream adult and kelt steelhead passage during periods when bypass systems and spill are not normally provided, to determine the effectiveness of alternative operations.

Columbia River Chum

Provide an adequate elevation of water for chum in redds downstream from Bonneville Dam and ensure that voluntary spill will not result in unsafe TDG levels for juveniles rearing in shallow water areas. Adult passage will also be provided to those few fish that may migrate past Bonneville Dam.

Lower Columbia Fall Chinook

Provide corner collector flow for Spring Creek Hatchery releases, ensure adequate water over redds downstream from Bonneville Dam and ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas. Adult passage will also be provided to those fish that migrate past Bonneville Dam.

Lower Columbia Steelhead

For those fish originating from upstream of Bonneville Dam, provide optimum passage conditions for inriver migrants originating from tributaries to Bonneville Pool. Also, ensure that voluntary spill will not result in unsafe TDG levels for fish in shallow water areas. Adult passage will also be provided to those fish that migrate past Bonneville Dam. Investigations for downstream kelt passage will be conducted to determine optimum management strategy.

Upper Willamette Chinook and Steelhead

Ensure that voluntary spill will not result in unsafe TDG levels for juveniles rearing in shallow water areas.

1.1 Federal Columbia River Power System (FCRPS)

For purposes of this consultation, the Federal Columbia River Power System is defined as the operation and maintenance of 14 Federal projects as shown in Table 2. Various Congressional and Secretarial authorizations provide authority for the Corps of Engineers (Corps) and Bureau of Reclamation (Reclamation) to construct, operate, and maintain various water development facilities for multiple purposes, including flood control, irrigation, hydropower generation, navigation, recreation, fish and wildlife, water quality, and municipal and industrial water and other purposes. Similar authorizations provide authority for the Bonneville Power Administration (BPA) to market and distribute power generated by these projects. The Action Agencies continue to authorize, fund, and carryout the operation and maintenance of these projects.

Table 2. General Project Characteristics[1]

Project	Operator	Location	Year Completed	Type	Original Primary Authorized Purposes
Libby	Corps	Kootenai near Libby, Montana	1973	Storage	Flood control, power
Hungry Horse	Reclamation	South Fork for the Flathead, near Hungry Horse, Montana	1953	Storage	Flood control, power, irrigation
Albeni Falls	Corps	Pend Oreille, near Newport, Washington	1955	Storage	Flood control, power, navigation
Grand Coulee	Reclamation	Columbia, at Grand Coulee, Washington	1942	Storage	Flood control, power, irrigation
Chief Joseph	Corps	Mid-Columbia, near Bridgeport, Washington	1961	Run-of-river	Power
Dworshak	Corps	North Fork of the Clearwater, near Orofino, Idaho	1973	Storage	Flood control, power, navigation
Lower Granite	Corps	Lower Snake, near Almota, Washington	1975	Run-of-river	Power, navigation
Little Goose	Corps	Lower Snake, near Starbuck, Washington	1970	Run-of-river	Power, navigation
Lower Monumental	Corps	Lower Snake, near Kahlotus, Washington	1970	Run-of-river	Power, navigation
Ice Harbor	Corps	Lower Snake, near Pasco, Washington	1962	Run-of-river	Power, navigation
McNary	Corps	Lower Columbia, near Umatilla, Oregon	1957	Run-of-river	Power, navigation
John Day	Corps	Lower Columbia, near Rufus, Oregon	1971	Run-of-river[2]	Flood control, power, navigation

[1] Source: Table 3-1 from BPA *et al.* 1995.
[2] John Day has allocated flood control storage but is operated in a manner that is similar to other mainstem dams that are run-of-river projects.

Project	Operator	Location	Year Completed	Type	Original Primary Authorized Purposes
The Dalles	Corps	Lower Columbia, at The Dalles, Oregon	1960	Run-of-river	Power, navigation
Bonneville	Corps	Lower Columbia, at Bonneville, Oregon	1938	Run-of-river	Power, navigation

Table 2 presents general information for the FCRPS projects, including the projects' original primary authorized purposes. More specifically, the Corps and Reclamation operate the FCRPS and Reclamation projects as described below. The following list does not imply prioritization (which can vary seasonally and with other factors) and does not display the large numbers of significant activities that are currently taken to improve conditions for listed salmonids under the ESA:

- **Flood Control** – The Corps is authorized to direct flood control operations for specific Federal and non-federal storage projects, including Canadian projects subject to the Treaty, in the Columbia River basin. The management of damaging floodwaters for the protection of the cities of Portland and Vancouver was one of the original incentives for the construction of the storage projects.
- **Irrigation** – Reclamation is authorized to develop water resources for the irrigation of arid lands. Some Reclamation projects involved the development of full water supplies for the irrigation of new lands, others involved only the rehabilitation of privately developed facilities, while still others involved various combinations of full water supplies for new lands and full or supplemental water supplies for previously irrigated lands. Water supplies for these projects may include a single source or some combination of storage, natural flow, and ground water. Corps projects also may have irrigation storage space. Generally, Reclamation markets the irrigation space on behalf of the Corps.
- **Hydropower generation** – The Corps and Reclamation are authorized to generate electricity at their hydropower facilities. The federal dams in the Pacific Northwest supply more than one third of the region's power. BPA sells power from the dams and the power produced by certain other generating plants and constructs, operates, and maintains transmission lines to deliver the electricity.
- **Navigation** – The Corps is authorized to maintain navigation within the lower Columbia and Snake Rivers. Four lower Columbia River projects and the lower Snake River projects were constructed with navigation locks to allow passage for boats and barges to transport products from the Pacific Ocean to inland ports as far upstream as Lewiston, Idaho. Reclamation's Grand Coulee and Hungry Horse facilities are also authorized for navigation and provide flows in support of this function.
- **Recreation** – The reservoirs and project lands provide recreational opportunities for boaters, anglers, swimmers, hunters, hikers, and campers throughout the year.

- **Fish and wildlife** – The Corps and Reclamation operate and maintain, and they and BPA fund project facilities to support the protection and conservation of fish and wildlife species both in the reservoirs as well as downstream.
- **Water quality** – The Corps and Reclamation operate the FCRPS to maintain water quality by releasing water in ways to meet downstream flow and temperature objectives.
- **Municipal and industrial water supply** – The Corps and Reclamation are authorized to operate some projects to provide water to numerous municipalities and industries.

Operation of the FCRPS is very complex and requires coordination on many levels to meet the multiple authorized purposes. The project uses are interdependent, and operating for one use can affect one or more of the other uses. The operators (Corps and Reclamation) are authorized to determine how best to serve the needs of competing interests. For example, meeting optimal flows for adult spawning or juvenile rearing chum salmon can adversely affect storage for other purposes, such as flows for other salmon species or reservoir elevations desirable for irrigation, recreation, navigation, or power production.

The Action Agencies operate the FCRPS in coordination with several Public Utility Districts (on the middle Columbia River, the Snake River and other tributaries) and three Canadian projects (pursuant to the Columbia River Treaty between the United States and Canada).

The Action Agencies have chosen, as a matter of administrative convenience, to address several proposed actions within this single biological assessment. In addition to the FCRPS action, this consultation will address the mainstem effects of the operation and maintenance of 16 Reclamation projects, the future operation and routine maintenance of the Columbia Basin Project including various related activities, and other Reclamation actions regarding future new uses of Columbia Basin Project water supplies. Of the 16 Reclamation projects those which are located on tributaries occupied by the listed ESUs, the tributary effects of the operation of these projects are covered or will be covered in separate consultations. In addition, the effects of Reclamation's Upper Snake River projects are undergoing a separate consultation.

Table 3. Project, location, and subbasin

Project	Location	Subbasin or Stream
Upper Columbia River (Upstream of Snake River Confluence)		
Hungry Horse[1]	Western Montana, north of Flathead Lake	South Fork Flat Head River
Missoula Valley	Western Montana, north of Missoula	Clark Fork River
Frenchtown	Western Montana, north of Missoula	Clark Fork River
Dalton Gardens	North Idaho, north of Coeur d'Alene	Spokane (Hayden Lake)
Avondale	North Idaho, north of Coeur d'Alene	Spokane (ground water)
Rathdrum Prairie	North Idaho, northwest of Coeur d'Alene	Spokane (ground water)
Spokane Valley	Eastern Washington, east of Spokane	Spokane (ground water)
Columbia Basin[1]	Central Washington	Columbia River
Chief Joseph Dam	North-central Washington, from Canadian border to Wenatchee	Okanogan and Columbia Rivers

Project	Location	Subbasin or Stream
Okanogan	North-central Washington, near Okanogan	Okanogan River
Yakima	Central Washington, near Yakima	Yakima River
Lower Columbia (Downstream of the Snake River Confluence)		
Umatilla	Northeast Oregon	Umatilla and Columbia Rivers
Crooked River	Central Oregon, north of Bend	Crooked River
Deschutes	Central Oregon, north of Bend	Deschutes River
Wapinitia	North-central Oregon, south of The Dalles	Deschutes River
The Dalles	North-central Oregon, near The Dalles	Columbia River
Tualatin	Northwest Oregon, west of Portland	Tualatin River (Willamette River)
Snake River		
Lewiston Orchards	West-central Idaho, near Lewiston	Clearwater River

[1]Reclamation is consulting on the future operations and routine maintenance of the Hungry Horse and Columbia Basin Projects. In addition this consultation will address the mainstem effects of the operation and maintenance of the other 16 tributary projects.

The proposed action for the Columbia Basin Project primarily includes: (1) Storage in and release of water from Lake Roosevelt, Banks Lake, and other re-regulation reservoirs. (2) Diversion of water at the Grand Coulee pump/generating plant. (3) Power generation at Grand Coulee. (4) Routine maintenance of project facilities. The major facilities of the Columbia Basin Project are Grand Coulee Dam and its impoundment, Lake Roosevelt, the powerplant complex, the pump/generating plant, Banks Lake and Potholes Reservoir.

More details can be found in the Facilities Operations and Maintenance (O&M) document (in preparation).

This proposed action addresses 13 species listed under ESA under the jurisdiction of the NOAA. The Action Agencies have considered the effects of the proposed action on other listed species addressed in the 2000 USFWS Biological Opinion on the FCRPS Operations and the 2006 USFWS Biological Opinion on Libby Dam Operations for the Kootenai River white sturgeon and bull trout. The Action Agencies have concluded that the proposed action is consistent with the operations addressed in these USFWS BiOps.

1.2 Reservoir Operations and System Flow Management towards Improving Fish Survival

The Action Agencies will operate the FCRPS storage projects to shape spring and summer flows as needed to benefit fish migration, and will operate certain run-of-river projects to minimize water travel time through the lower Columbia and Snake rivers as follows:

Storage Reservoirs: The Action Agencies will continue to use the following general guidelines for flow management to aid anadromous fish. Specific project operations are identified in Attachment 1.

- When not operating to meet minimum flows, operate Libby, Hungry Horse and Grand Coulee storage projects to achieve a 75% chance for Libby and Hungry Horse and 85% chance for Grand Coulee to be at their upper flood control elevation on or about April 10, (the exact date to be determined during inseason management) to increase flows for spring flow management. The Action Agencies will manage storage reservoirs to ensure they are as full as possible at the start of each spring fish passage season recognizing flood control requirements, in-season management decisions, emergency provisions or other extraordinary requirements for dam safety, thereby making available as much water as possible for the spring migration period.
- Reservoir storage will be managed (pass inflow, fill or draft) as necessary to help meet requested weekly average flow objectives during spring migration period, consistent with flood control operations and reservoir refill considerations and other authorized purposes as described in the annual Water Management Plan. These include minimum recommended project outflows for listed resident and anadromous fish, ramping rates and limited outflow fluctuations to avoid stranding fish.
- Storage reservoirs will be refilled prior to the summer migration period as much as possible given available water supply and spring operations and consistent with flood control requirements.
- Storage projects will be drafted to elevation limits as described in Attachment 1 to provide flow augmentation and cool water releases to improve downstream water quality. If the project does not refill to the draft limits identified below, the project will release inflows or operate to meet minimum project flows. These operations and reservoir elevation draft limits are currently set out as follows:
  - Libby – Draft limits are 2449 feet (10 feet from full) by September 30 except in the driest 20 percentile water conditions draft limit to 2439 feet (20 feet from full). Rationale for these limits were developed by the State of Montana and adopted by the Northwest Power Conservation Council.
  - Hungry Horse – Draft limits are 3550 feet (10 feet. from full) by September 30, except in the driest 20 percentile of water conditions draft limit of 3540 feet (20 feet from full). Rationale for these limits were developed by the State of Montana and adopted by the Northwest Power Conservation Council.
  - Grand Coulee – Draft limits are 1280 feet and 1278 feet (10 feet and 12 feet from full respectively) by August 31, exact elevation is dependent on the Water Supply Forecast.
  - Banks Lake (part of the Columbia Basin Project along with Grand Coulee Dam and FDR Lake) – reduce pumping and allow Banks Lake to sag to 1565 feet (5 feet from full) by August 31.
  - Dworshak – Draft limits are elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the “Agreement between the United States of America and the Nez Perce Tribe for water use in the Dworshak Reservoir.

- Provide fall and winter tailwater elevations/flows to support chum salmon spawning and incubation in the Ives Island area below Bonneville Dam and to provide access for chum spawning in Hamilton and Hardy creeks.
- Identify opportunities to shift system flood control from Brownlee and Dworshak reservoirs to Lake Roosevelt and implement when feasible.

Mainstem Run-of-River Projects: Snake River reservoirs will be operated at minimum operating pool (MOP) with a one foot operating range from April 3 until small numbers of juvenile migrants are present unless adjusted to meet authorized project purposes. For Lower Granite, the project will be operated at MOP until enough natural cooling has occurred in the Lower Granite forebay, generally after October 1.

John Day Reservoir will be operated at the lowest elevation (with a 1.5 foot operating range) that continues to allow irrigation from April 10 through September 30. Slight deviations from these levels, based on navigation needs, load following and operational sensitivity, may be required on occasion.

1.2.1 Natural Hydrograph, Flow, Velocity and Temperature

The Action Agencies will use a variety of operational objectives to operate the FCRPS throughout the year for various fishery needs. Inherent in the operation is recognition that available storage - water that actually can be managed - is limited relative to total annual run off in the Columbia River basin. One of the purposes of the storage projects in the Columbia River basin is to reduce peak flood flows, however these projects do not have sufficient storage to alter the overall shape of the natural hydrograph. Flow objectives have been identified for purpose of planning and implementing annual, seasonal and shorter time-step operations to best meet biological needs of salmon and steelhead.

The purpose of the flow objectives shown are intended to be used for purposes of pre-season and in-season water management, but are not expected to be achieved in all years or periods, because they are largely dependent on annual and seasonal water conditions, including natural runoff volume and shape.

Table 4. Seasonal Flow Objectives and Planning Dates for the Mainstem Columbia and Snake Rivers

	Spring		Summer	
Location	**Dates**	**Objective**	**Dates**	**Objective**
Snake River at Lower Granite Dam	4/03 - 6/20	85 - 100[1]	6/21 - 8/31	50 - 55[1]
Columbia River at McNary Dam	4/10 - 6/30	220 - 260[1]	7/01 - 8/31	200
Columbia River at Priest Rapids Dam	4/10 - 6/30	135	N/A	N/A
Columbia River at Bonneville Dam	11/1 – emergence	125 – 160[2]	N/A	N/A

[1] Objective varies according to water volume forecasts.
[2] Objective varies based on actual and forecasted water conditions.

Computer modeling has been used to assess the ability of the hydro system to augment flows for migrating juvenile anadromous fish. Using 50 historical water conditions(1929-1978) in the Columbia River basin and augmenting those natural flows with reservoir operations within the limits prescribed in the Proposed Action, spring and summer season average flows are equal to, or greater than, the season average flow objectives as follows:

	out of 50 years
Lower Snake spring:	34
Lower Snake summer:	5
Lower Columbia spring:	42
Lower Columbia summer:	16

The seasonal objective will be shaped each week for particular reaches through the regional Technical Management Team (TMT) forum. To help meet the weekly flow objectives, the seasonal flow augmentation volumes in the storage projects will be used. Sovereigns can make operational requests to adjust flow on a weekly average basis consistent with parameters describing discretionary flexibility identified in Attachment 1 – "Fish Operations at Federal Reservoirs" and Attachment 2 – "Operational Flexibilities and Requirements". Such requests are not precluded from exceeding weekly or seasonal flow objectives and shall be made through SORs (System Operational Requests) in the in-season management process.

The Action Agencies will seek to meet these weekly flow requests, at the highest possible frequency based on optimal overall use of available volumes in headwater dams to benefit migrants and spawners, as necessary throughout the seasons, taking into account the needs of resident fish and other reservoir objectives through implementation of the Water Management provisions in section 1.2, which determine the actual managed flows that can be provided at a given time. For example, available storage will not necessarily be used to achieve weekly flow objectives if available storage would be prematurely depleted; rather, the available water would be distributed across the expected migration season to optimize biological benefits/fish survival.

The Action Agencies seek to meet temperature objectives at the Lower Granite Dam tailrace for the summer migration period through the use of available tools, including storage, e.g. Dworshak Reservoir operations, which are described in Attachment 1. However, as in the case of flow objectives, it is recognized that temperature objectives cannot be achieved at all times and under all water conditions due to reservoir storage limits, tributary inputs, dissolved gas limits and natural temperature conditions.

The Action Agencies will also consider other flow related objectives in water management including flows for Hanford Reach fall Chinook, ESA-listed chum, as well as flows for ESA-listed sturgeon and bull trout.

The weekly flow performance will be translated mathematically through a simple conversion into a velocity as shown in Attachment 1. The velocity component is neither established for, nor monitored and evaluated as absolute physical performance requirements of the hydrosystem.

Hydro performance regarding attributes associated with flow will be assessed annually by considering how well water was stored and released consistent with the identified constraints.

Inseason Management

The Action Agencies will attempt to manage stored water to shape flows as needed towards improving juvenile and adult fish survival. There is a limited amount of water available for flow augmentation and flow objectives provide guidelines for how that water should be shaped. It should be recognized, however, that there are tradeoffs associated with operating for each flow objective. The use of the available water to improve flows for one ESU could affect the water available for another. For example, water releases from November through the spring to enhance chum salmon spawning and incubation as well as flows to benefit Hanford Reach fall Chinook salmon spawning and incubation could affect the ability to meet flow objectives in the spring or could affect the probability of summer refill. Likewise operations to help meet spring flow objectives can impact project refill and vice versa. The level to which one objective impacts the ability to meet another objective changes from year to year. Prioritization of the use of flow augmentation water is done through in-season management.

Each fall the Action Agencies prepare an annual Water Management Plan (WMP) that describes planned hydrosystem fish operations for the upcoming fall/winter, spring and summer passage seasons. The annual Water Management Plan strives to achieve the best possible mainstem passage conditions, recognizing the priorities established in this document and the need to balance the limited water and storage resources available in the region. Fall/winter and spring/summer updates are prepared as more data is available on the water conditions for that year.

The WMP is prepared by the Action Agencies and reviewed by the Technical Management Team (TMT). The TMT is a regional forum in which technical representatives from federal agencies with regulatory or action authority in the Columbia River Basin, and sovereign states and tribes with management responsibility over fish and wildlife resources in the Columbia River Basin, work together to adaptively manage operations of the FCRPS to protect ESA-listed fish species. The TMT meetings are public and facilitated by an impartial third party. Recommendations to the Action Agencies are made on a consensus basis. Consensus is defined as the lack of formal objection. The TMT also considers in-season changes to FCRPS operations. These changes are formally proposed as a System Operation Request (SOR). If the TMT cannot reach consensus on an SOR the SOR is elevated to the Implementation Team (IT) which includes policy representatives from the same federal agencies, states and tribes. The TMT also serves as a forum for the exchange of data and research findings, which assures that the FCRPS is managed according to the most up-to-date information available.

The TMT was initiated with the 1995 FCRPS Biological Opinion. Its structure has since been emulated in other areas in the Unites States such as with the Adaptive Management Work Group (AMWG) which contends with Glen Canyon Dam and the Colorado River.

Forecasting Measures

Forecasts are used by the Action Agencies to identify appropriate flood control operations at the storage projects during the winter/spring and inform regional discussions on water supply for fishery operations. There are various forecasts prepared:

- Each project operator is responsible for the preparation of the Water Supply Forecasts (WSF) at their headwater storage project: BC Hydro prepares Mica, Keenleyside, and Duncan; the Corps prepares Libby and Dworshak; and Reclamation prepares Hungry Horse.

- Additional statistical water supply forecasts are prepared for all other basins and sub-basins by the Northwest River Forecast Center (NWRFC).

- The Natural Resources Conservation Service (NRCS) also produces water supply forecast for a subset of basins in the Northwest.

The “final”, “official” water supply forecasts from the Corps and the NWRFC are generally made available during the first ten days of each month from January through June. These water supply forecast can only be prepared once each month because they typically require snow course data readings which are only taken once each month. All of the above forecasts are statistical forecasts from regression equations based on such variables as precipitation and snowfall, and in some cases a climate indicator such as the Southern Oscillation Index (SOI).

In addition to the “final” forecast prepared early in the month, the NWRFC also prepares mid-month and early bird water supply forecasts. The mid-month forecast uses about half the precipitation reports and no updated snow or runoff values. The early-bird forecast is prepared toward the end of a month; it includes about half the precipitation reports, estimated end of month snow from available automated snowpillow sites, and estimated monthly runoff. Since these forecasts do not include a complete input dataset, the mid-month and early-bird forecasts are only used as a trend of the forecast and are not used to determine specific reservoir operations.

The NRCS has recently developed water supply forecasting models that are updated daily, however these forecasts are currently only available for a limited subset of sites. The NRCS forecasts are currently utilized only for comparison to the “official” forecasts.

The NWRFC also prepares Ensemble Streamflow Prediction (ESP) hydrographs for all projects on at least a weekly schedule. The ESP model utilizes physical based equations to produce a collection of possible streamflows at each site. A water supply volume can be calculated from each ESP streamflow series and a statistical analysis can be done to provide a probabilistic look at the seasonal water supply. The ESP water supply forecast product is not used to determine reservoir operational strategies; however individual hydrologic sequences that are developed by the ESP may be used to test the sensitivity of particular operations at headwater to The Dalles.

The Action Agencies held a regional workshop in June 2006 to discuss currently available seasonal volume forecast procedures and ways of improving water supply forecasting. Some suggestions from this workshop included:

- Resurrecting a forecasting group to annually examine WSF methods and verification at the end of each water year.
- Focusing next workshop on inseason streamflow forecasting, both short and long term.
- Incorporating other forecast methods (e.g., Bayesian techniques) developed by universities, and other agencies, to improve the forecasting process and product.

The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and are identified to have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will discuss the implementation possibilities with regional interests.

Climate Change Uncertainty

All climate models project that temperatures will increase during the 21st century. The projected increases exceed the year-to-year variability in temperature experienced during the 20th century and occur across all seasons.

Many climate models project a slight increase in precipitation, especially during the fall and winter months during the 21st century. However, natural year-to-year and decade-to-decade fluctuations in precipitation are likely to be more noticeable than longer term trends associated with climate change.

Summary of the range of potential climate change scenarios over the next century[3]

2020	Temperature	Precipitation
Low	0.7˚ F	-4%
Medium	1.9˚ F	+2%
High	3.2˚ F	+6%

2040	Temperature	Precipitation
Low	1.4˚ F	-4%
Medium	2.9˚ F	+2%
High	4.6˚ F	+9%

[3] Scenarios of Future Climate for the Pacific Northwest, Philip Mote, Eric Salathe, and Cynthia Peacock (CIG)

2080	Temperature	Precipitation
Low	2.9˚ F	-2%
Medium	5.6˚ F	+6%
High	8.8˚ F	+18%

Even with the climate change signal for precipitation being difficult to detect due to the natural variability that exists, the temperature trend alone is enough to have potentially detrimental impacts to the Columbia Basin. Warming temperatures in a snowmelt driven system can potentially lead to the following impacts to the hydrologic characteristics of the Basin:

- Higher flows and an increase in potential flood situations during the winter
- A reduction in the snowpack and subsequent runoff volume
- Earlier shift in the spring freshet
- Reduced flows in the late spring and summer due to earlier runoff and a smaller snowpack
- Warmer instream water temperatures due to reduced flows in the summer

It would be difficult at this time to predict how climate change is likely to affect the Columbia River Basin over the course of this proposed action. The Action Agencies will monitor climate trend issues on an annual basis as more information becomes available.

1.2.2 Emergency Operations

Interruptions or adjustments in water management actions may occur due to unforeseeable power system, flood control, dam safety or other emergencies. Such emergency actions will be viewed by the Action Agencies as a last resort and will not be used in place of long-term investments necessary to allow full, uninterrupted implementation of the planned reservoir operations while maintaining other project purposes, such as an adequate and reliable power system and appropriate levels of flood control. During winter power system emergencies, water being held in reservoirs for spring and summer flow augmentation may be drafted. Once the emergency is resolved, the Action Agencies will replace this water as soon as, and to the maximum extent, possible. During summer emergencies, storage reservoirs may be drafted below biological opinion draft limits, or bypass spill for fish may be reduced. Emergencies will be managed in accordance with the Regional Forum TMT emergency protocols. Discussion of emergencies with effects of exceptional magnitude or duration will include involvement of regional executives.

1.2.3 Fish Emergencies

Operations for fish passage and protection at FCRPS facilities may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Conditions will be restored as soon as reasonably possible.

Fish emergencies may occur for several reasons, including but not limited to those listed below.

1) Mechanical breakdown, malfunction, failure, or closing of:
    A. Adult or juvenile fish passage/collection facilities,
    B. Transport barges, tanks, or trucks, or
    C. Spillway, powerhouse, navigation lock, and project structures.
2) Unexpected outages or repairs for dam safety reasons.
3) Severe debris loads requiring special project operations.
4) Untreated chemical contaminant releases or spills (oil, fuel, herbicides, etc.). This may occur at the project or at another location in the river where water will flow through project structures and fish passage facilities.
5) Adjustments in discharges or navigation lock operation for vessel safety (for example, due to grounding or sinking).

These emergencies will be managed in accordance with the Regional Forum TMT emergency protocols. The Action Agencies will take all reasonable steps to limit the duration of any fish emergency. In addition, where there are significant biological effects of more than short duration resulting from the emergency, the Action Agencies will develop in coordination with the Regional Forum (or established regional governance body) and implement appropriate adaptive management actions to address the unique circumstances of the situation.

1.2.4 Canadian Operations

Treaty Operations

The Columbia River Treaty provides far-reaching measures for cooperative development and operation of the Columbia River hydrosystem for flood control and power purposes. In addition to the Treaty itself, there are the Treaty Protocol and Treaty Annexes that were negotiated between the two governments in the 1960s. These supplementary documents serve to interpret the provisions of the Treaty and provide more specific direction on the agreed-upon approach to management of the Columbia River Basin. When considering the Treaty, it is important to keep in mind that although the Treaty calls for cooperation between the U.S. and Canada, the Treaty also clearly gives Canada great discretion to operate its storage facilities in Canada in whatever manner they see fit with little to no say by the U.S., so long as Treaty objectives for flow at the border are met.

Non-Treaty Storage Operations

When the Canadians constructed the Mica project on the Columbia River in Canada in the 1970s, Canada elected to construct this dam significantly larger than as called for by the Columbia River Treaty. Specifically, Mica also was constructed to provide an additional 5.0 Maf of storage beyond that required by the Columbia River Treaty. As such, this additional storage is not operated under the Treaty; it thus is referred to as "non-Treaty storage," which is managed for Canada by BC Hydro. There are two important limitations on use of non-Treaty storage.

First, in accordance with Treaty terms, this additional storage may not be operated in a manner that would reduce the flood control and power benefits produced under the Treaty operation. Second, the U.S. and BPA have no inherent right to use of this storage. BC Hydro however, has occasionally agreed to allow BPA use of this storage when its use is consistent with Treaty requirements and provides mutual benefits to both parties. Agreements involving use of this storage are referred to as non-Treaty storage agreements. The most recent non-Treaty storage agreement was negotiated in 1990 and expired in June of 2004, following a one-year extension. Under that agreement, the parties have until June 30, 2011 to refill the non-Treaty storage space, which, as of 15 April 2007, is about 78 percent full. At the present time, there is simply no agreement in place with B.C. Hydro that would allow BPA or other federal agencies to provide a release of water from non-Treaty storage space.

Criteria/Protocols for Canadian Operations to Support ESA Objectives

The following section of the Proposed Action includes activities related to: 1) coordination with Canada under the Columbia River Treaty for possible use of Treaty storage to support U.S. flow operations that would benefit the ESA-listed ESUs during the migration season, considering ESU status; 2) coordination with Canada regarding non-Treaty refill activities; 3) coordination with Canada regarding possible new use of Canadian non-Treaty storage to support U.S. flow operations that would benefit ESA-listed ESUs during the migration season considering ESU status, to the extent that such activities and use are agreed to by Canada and, as required by the Treaty, do not adversely affect flood control and power benefits under the Treaty, and 4) coordination with federal agencies, states, and tribes regarding certain Treaty and non-Treaty matters.

Specific actions are as follows:

1. **BPA and the Corps will continue to seek through negotiations with Canada annual agreements to provide 1 Maf of storage in Treaty space by 15 April consistent with the following:**

   - Agreements should provide the greatest flexibility possible for releasing water in a pattern beneficial for U.S. fisheries operations during the May through July period.
   - In the event of limited available water, preference should be given to achieving refill or flood elevation (upper rule curve) at Grand Coulee over flow augmentation storage in Canada.
   - Flow augmentation storage should be managed to avoid causing or contributing to damaging flow/TDG levels in the U.S. or Canada. Flow augmentation storage often occurs early in the season when volume forecast uncertainty is high. To avoid exacerbating high flow-related adverse impacts, while providing additional flows during low and average water conditions, flow augmentation should not be stored when it is likely that a high flow condition will occur. The following standard is proposed as guidance to determine when a "high flow condition" is likely to occur.

A "high flow condition" is likely to occur when early season volume forecasts indicate with 95% confidence that the January-July unregulated volume at The Dalles will exceed 90 Maf. Using current water supply forecast procedures and their associated forecast errors, use of this standard would result in not storing flow augmentation in January in years when the January volume forecast exceeds 117.3 Maf or in February when the volume forecast exceeds 110.4 Maf. A review of these criteria as applied to actual forecasts from 1970-2005, shows that use of this standard would prevent storing flow augmentation in the highest 8 runoff years, with volumes ranging from 123 to 159 Maf, and would impact only one "average" year which had a volume of 106 Maf.

It has been suggested that an additional check be made to ensure adequate volume will also be available in the mid-Columbia. Development of a volume forecast criteria for Grand Coulee will be explored as a possible second criteria.

To the extent that flow augmentation, if released in May/June, is expected to contribute to potentially damaging flow/TDG levels in the U.S. or Canada, release of water may occur in a pattern intended to minimize adverse effects.

2. Refill of Storage Space required under the 1990 Non-Treaty Storage Agreement

It is recognized that BPA and BC Hydro have a contractual obligation to refill non-Treaty storage (NTS) space by 30 June 2011. The purpose of the following guidelines is to enable this refill to occur in a prudent manner. Storage into NTS should be accomplished with minimal adverse impact to fisheries operations to the extent possible.

Minimal adverse impact to fisheries operations is in large measure determined by the ability to maintain flows during the fish passage season while reducing the likelihood that storage will occur during a low flow year to meet the contractual refill obligation. There are alternative views as to what flow standard should be used during the April-August fish passage season to define acceptable storing conditions. This section should be informed by the results of the collaborative process and the proposed action. Storage would occur in a manner that allowed meeting flow objectives consistent with those outlined in Attachment 1 of the proposed action to the extent possible while still meeting the 2011 obligation to refill.

Alternative suggested criteria for storage operations given are listed below.

Storage to refill NTS space may occur when flows at Priest Rapids and McNary:

(1) are expected to meet flow targets both on a season-average basis and on a weekly basis during the week in which the storage occurs.

OR

(2) are 120% of the flow target during the week in which storage occurs.

OR

(3) exceed the flow target and are expected to exceed flow targets for 80% of the remaining weeks in the season.

OR

(4) exceed weekly average flow targets or when dissolved gas standards are exceeded.
OR
(5) if NTS space still remains unfilled in spring 2011, storage to refill must occur whether any of the preceding 4 conditions exist.

3. Future Annual and Long-term Non-Treaty Storage Agreements:

- BPA will seek to negotiate a new long-term agreement with BC Hydro to enable use of non-Treaty storage space in Canada once (a) BPA and BC Hydro have made substantial progress in refilling non-Treaty storage space, and (b) the collective U.S. interests in terms of such a new agreement are established.
- A new long-term agreement utilizing non-Treaty storage space is viable only if it provides power and non-power benefits for B.C. Hydro, BPA, and Canadian and U.S. interests.

  If a new long-term agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits consistent with the Treaty.
- In accordance with Treaty requirements, non-Treaty storage may not be operated under any new agreement to reduce Treaty power and flood control benefits.
- If BC Hydro agrees to attempt to negotiate a new long-term non-Treaty agreement that is mutually beneficial, as part of these negotiations, BPA will attempt to achieve opportunities to provide benefits for ESA-listed ESUs by using the storage to shape water releases within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of the ESA-listed ESUs, considering ESU status.

4. Coordination with federal agencies, states and tribes:

- BPA and the Corps will coordinate with federal agencies, states, and tribes on Treaty operating plans. In a given operating year, this coordination will include holding discussion(s) with federal agencies, states, and tribes about planned operations and operating plans to solicit ideas and information, informing federal agencies, states, and tribes of the final selected operation and/or operating plan, and providing an annual update during the fish passage season.
- If BC Hydro is interested in negotiating a new annual or long-term non-Treaty storage agreement, BPA will coordinate with federal agencies, states, and tribes prior to any such negotiation to obtain ideas and information on possible points of negotiation, and will report on major developments during the negotiations. If negotiations are successful and result in a new agreement between BPA and BC Hydro, BPA will report to federal agencies, states, and tribes on the resulting agreement.

1.2.5 Dry Water Year Operations

Some actions are modified in dry water years to optimize benefits to ESA-listed salmon and steelhead in light of environmental conditions. These specific modifications are as follows:

Flexibility in Managing Flows

Dry water years can amplify the tradeoffs between managing flows to meet competing fishery objectives. For example, maintaining rearing flows for chum below Bonneville Dam and fall Chinook in the Hanford Reach can reduce the amount of water available for spring migrants, and refilling reservoirs for summer migrants may divert flows for spring migrants. The operational flexibilities outlined in Attachment 2 can be used to address such tradeoffs and to distribute the available water across the expected migration season to optimize biological benefits and anadromous fish survival in dry years, while taking into account the needs of resident fish and other reservoir objectives. Exercise of this flexibility will be coordinated through the TMT's in-season management process.

Treaty and Non-Treaty Storage Operations

- Operations of Treaty Storage in Dry Years. Operating plans develop under the Treaty and prepared in advance of the operating year, are developed to meet power and flood control objectives. These operating plans include draft of Treaty projects in low water conditions to meet regional loads – termed "proportional draft." In dry water years, Treaty reservoirs would be operated below their normal refill levels in the late spring and summer, therefore increasing flows during that period relative to a standard refill operation.

- Store in Canada for Non-Power Purposes. To the extent possible, annual agreements between the U.S. and Canadian Entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits.

- Use of Non-Treaty Storage Space. BPA will explore opportunities in future long-term non-Treaty storage agreements to develop mutually beneficial in-season agreements with Canada to shape water releases using non-Treaty storage space within the year and between years to improve flows in the lowest 20^{th} percentile water years to the benefit of ESA-listed ESUs, considering ESU status.

Spring Transportation

- In water years when the Snake River projected seasonal average (April – June) flow is less than 65kcfs (~ lowest 15% of all water years), transportation will be initiated on April 3 at the Snake River collector projects and will be maximized (i.e. no voluntary spill or bypass provided) until May 31.

- In water years when the Snake River projected seasonal average (April – June) flow is between 65 and 80 kcfs (~lowest 15-28% of all water years), inriver migration would be provided through spill and bypass in the early spring, followed by spill and transportation in the early-mid spring, and maximized transportation in the late-mid spring until May 31 at all Snake River Collector projects.

- If average seasonal (April-June) flows in the Columbia River are predicted to be below 125 kcfs (roughly the 2001 level of 124.1kcfs), transportation from McNary Dam would be maximized from April 10 - June 14.

Investigation of Other Dry Water Year Flow Strategies

The issue of improving spring flows in dry water years has been deliberated in the collaboration process. Though the relationship of flow levels to survival of juvenile fish migrating through the hydroelectric system is not clear, it is generally understood that inriver survival of juvenile migrants is considerably lower in low flow years than in average and higher flow years. During the collaboration, several scenarios were modeled to investigate alternative flow management actions that might improve spring flows in low flow years for the benefit of juvenile spring Chinook, steelhead and sockeye from the upper Columbia and Snake rivers. Though the collaboration did not reach definitive conclusion on this topic, the Action Agencies believe this issue warrants further investigation and propose the following:

Upon issuance of the FCRPS BiOp by NOAA Fisheries, the Action Agencies will convene a technical workgroup under the guidance of the Policy Work Group to scope and initiate investigations of a dry water year flow strategy. The investigations will include modeling of FCRPS operations, COMPASS fish survival modeling, and consideration of compatible operations of Canadian projects possible new Non-Treaty storage agreements. Operational constraints and guidelines under the discretion of the Action Agencies and the fishery management entities will be relaxed, as needed and appropriate, to ensure consideration, evaluation, and development of options to improve spring flows in dry water years. Biological and economic effects of various dry water flow options will be estimated. Changes in administrative procedures and agreements necessary to implement a given option will be documented and assessed.

A technical workgroup will be convened and preliminary results will be reported by August 31, 2008.

Implementation of BPA's "Guide to Tools and Principles for a Dry Year Strategy"

Implementation of BPA's "Guide to Tools and Principles for a Dry Year Strategy" (Guide) may reduce the effect energy needs may pose to other projects purposes, including fish and wildlife needs, by increasing the supply or reducing the demand for energy in dry years. The Guide was developed in response to the energy crisis of 2000 and 2001 and addresses principles and tools BPA will employ to meet its load obligations in dry water conditions; the Guide does not address changes to fish operations, but lists the tools to be considered in dry water conditions.

Principles: During dry years, BPA will make decisions on what dry year tools to pursue to maintain power system stability and reliability while meeting other statutory responsibilities, including responsibilities to:

- Balance both non-power and power uses during the energy shortage;
- Maintain federal trust responsibilities;
- Protect fish and wildlife consistent with Endangered Species Act; the 1980 Northwest Power Act, and other laws;
- Act in a sound and business like manner;
  - Provide an adequate, efficient, economical, and reliable power supply;
  - Provide a cost-effective solution to the energy shortage to maintain rates as low as possible to minimize the economic impact to the region and the FCRPS.

Tools: It is impossible to create, in advance, a meaningful and prioritized list of events that would trigger the use of dry year tools. The individual circumstances associated with a dry year (such as the regional scope and the state of the regional economy) and the relative cost (including energy and commodity market prices) and availability of tools all impact the appropriate response. Therefore, the use of dry year tools can be used at any time to temporarily solve energy shortages that threaten the ability of BPA to meet its load obligation subject to the dry year principles.

Dry Year Tools that add flow to the Columbia and reduce power emergency risk:

- **Columbia Basin Project Water Conservation.** Enter into agreements with the U.S. Bureau of Reclamation and the irrigation districts to leave project land fallow, capped at some percent in order to limit disruption to the local agricultural economy. Approximately 4 acre feet of water per acre of land left fallow would remain in the mainstem Columbia River to improve flows and increase power generation. This would also save energy by reducing energy consumed pumping water into Banks Lake from Roosevelt reservoir. This program has to be triggered early in January/February before investments and contracts are entered into by irrigators.
- **Irrigation Load Buy-down.** Enter into agreements with BPA's eastside load-following customers to reduce irrigation pump load (either aquifer or surface water lift). Note that this program has to be triggered in January/February before investments are made in planting. In addition, because this program is done on a public utility or electric cooperative scale, it is difficult to assign what portion of the program would be attributable to pumps that take water directly out of surface streams or rivers to those pumps which access aquifer storage.

Dry Year Tools that reduce power emergency risk:

- **Direct Service Industry (DSI) Load Buy-down.** DSIs no longer purchase power directly from BPA, but receive a capped financial benefit based upon their level operation and other criteria. DSI are also currently operating at levels substantially below historical levels. These two factors limit the potential amount of load reduction that could be achieved.

- **Direct Service Industry (DSI) Load Buy-down.** DSIs no longer purchase power directly from BPA, but receive a capped financial benefit based upon their level operation and other criteria. DSI are also currently operating at levels substantially below historical levels. These two factors limit the potential amount of load reduction that could be achieved.
- **Energy Efficiency.** Three energy efficiency programs could by implemented relatively quickly: compact fluorescent bulbs, Irrigation Scheduling, and commercial pre-rinse valves.
- **Industrial Load Buy-down.** The four largest industrial end-use consumers of BPA's load-following customers consume approximately 400 average megawatts total. There may be opportunities to either substitute market purchases for energy intensive processes (such as buying market pulp as opposed to grinding it on site) or to temporarily shut down processes or machines. The price and quantity of opportunities depend in part on the economic conditions of the commodity products that these mills produce.
- **Market and Option Purchases.** There are power products available in power markets that can be used to meet BPA's load obligations but prices and quantities available may not always be advantageous.
- **Power Exchanges.** Power from one utility is exchanged for power from another utility system. Utilities may have unique load and resource characteristics that make energy trades advantageous. For example, California generally has peak load in the summer while in the Pacific Northwest loads (in the major west side load centers) peak in the winter.
- **Public Awareness Campaign.** This can be acted on alone or the first step before a Regional Curtailment is enacted. The amount of energy conserved by eliciting public requests is hard to quantify, but it has been estimated at around a 5 percent. The amount of energy conserved is also not only unpredictable, it is usually only for very short-term periods.
- **Regional Curtailment.** Coordinate with regional governors to exercise emergency powers to impose mandatory load curtailments.
- **Storage Agreement.** Storage agreements between BPA and other utilities that have storage capability may be used to improve reliability in a low flow period. This would reduce power production in one period while increasing it in another. This type of agreement involving energy shaping can usually be reached in a short time frame. However, in order to provide additional water (not just energy) during dry water years the only likely reservoirs that can be used are in Canada and it takes considerably more time to develop agreements and store the water to be re-shaped. Any such storage agreements would be under the auspices of the Columbia River Treaty or would utilize non-Treaty storage space in Canada, as outlined above.

1.2.6 Experimental Operations

The adaptive management approach anticipates the desire or need to make modifications in current operations to balance the needs of listed species both resident and anadromous.

1.2.6.1 2003 Council's Mainstem Amendments

The Action Agencies are charged with balancing the needs of both resident and anadromous species. Operations which are based solely on efforts to achieve flow objectives in the lower Columbia River adversely affect resident fish and may fail to benefit anadromous fish if they do not take into account reasonable storage project operations. In order to make a more informed decision on operations the Action Agencies propose to implement, on an experimental basis, one element of the Northwest Power and Conservation Council's (Council) 2003 Mainstem Amendments as it pertains to the operations of Hungry Horse and Libby Reservoirs from July through September.

In 2004 the state of Montana in System Operational Request (SOR) to the Technical Management Team (TMT) proposed a three year study be done to analyze the effects to both resident and anadromous fish due to the implementation of the Council's proposal. The hypothesis is that this proposed operation "will significantly benefit listed and non-listed resident fish in the reservoirs and in the portions of the rivers below the reservoirs without discernable effects on the survival of juvenile and adult anadromous fish (in the Columbia River mainstem) when compared to ordinary operations of the biological opinion."

Study sideboards:

- An experimental operation consisting of interim summer reservoir drafting limits at Hungry Horse and Libby should be 10 feet from full pool by the end of September (elevations 3550 and 2449, respectively) in all years except the lowest 20th percentile water supply (drought years) when the draft limit is increased to 20 feet from full pool by the end of September.
- In its FY 2007-2009 funding decision, BPA committed to fund and implement the MFWP's proposal for evaluation of the biological and physical effects of this operation on the fisheries upstream and downstream of Hungry Horse and Libby Dams, Montana. The study shall utilize MFWP's current biological baseline data as a basis for comparison.
- The MFWP's study results will be used to determine the benefits to resident fish associated with the new reservoir operations relative to the baseline. After completion of the three-year study, the information gathered will inform future policy considerations of Libby and Hungry Horse reservoir operations.

In addition to the Libby and Hungry Horse study proposal:

- Consistent with the 2003 Council's Mainstem Amendments, water management operations of Lake Roosevelt will be optimized to meet the needs of anadromous and resident fish species with the lease cost so that the actions taken maximize benefits to all species while ensuring an adequate, efficient, economical and reliable power supply.
- Building upon available scientific information, the Action Agencies will work with the sovereigns to review the current state of evidence related to the relationship between flow and fish survival. This review should include the Snake River interactions of flow, turbidity, temperature, reservoir fluctuations and reservoir hold-over fish. (Emerging information indicates that some fall Chinook over-winter in the reservoirs and migrate out the following year.)
- Research and experiments that take into account biological effectiveness, cost-effectiveness, feasibility and adequacy to compare and evaluate the fish survival benefits of flow management, impacts on resident fish, and the fish survival benefits of other offsite actions may be useful within the period of the proposed action/BiOp. Other actions include but are not limited to water storage projects, installation of screens, removal of tributary blockages, water acquisition, water use efficiencies, and restoration of habitat. The Action Agencies and sovereigns plan to review ongoing habitat effectiveness research, and develop any new or revised proposals collaboratively, with the use of the ISRP or other independent scientific team as necessary to address study design concerns. These studies will be placed and prioritized within the RM& E framework.

1.2.6.2 Proposal to Consider Drafting Lake Roosevelt to 1278 Only in Lower Water Years

Flow Augmentation is provided by drafting Lake Roosevelt, and other reservoirs, in July and August. Currently Lake Roosevelt is drafted to 1280 feet when the water supply forecast (WSF) is greater than 92 maf (wettest 50% of water years) at The Dalles. When the WSF is lower than 92 maf (driest 50% of water years) at The Dalles, Lake Roosevelt is drafted to elevation 1278 feet. There has been proposal to consider drafting Lake Roosevelt to 1278 during July-August in the lowest 20 percentile of water years only; in other years it would only be drafted to 1280 feet, which would lessen effects on Lake Roosevelt but provide less downstream flow in other water years. This proposal would be subject to additional evaluation inluding modeling. Based on evaluations, it will be considered as we explore adaptive management for future operations, including future flow provisions for anadromous fish.

1.2.7 Washington State's Columbia River Water Management Program (CRWMP): Early Actions – Lake Roosevelt Drawdown

The 2006 Washington State Legislature passed the Columbia River Water Resource Management Act (HB 2860) directing the Washington Department of Ecology (Ecology) to pursue development of new water supplies from the mainstem Columbia River, over the next 20 years, for both instream and out-of-stream uses. The new supply is to be developed through storage, conservation, improved management of existing facilities, voluntary regional water management agreements, water rights transfers and exchanges, and potentially increased access to Canadian storage.

Ecology describes how they intend to implement the new legislation in a Final Programmatic Environmental Impact Statement for the Columbia River Water Management Program (Program) dated February 15, 2007 (2007 FEIS) that was prepared pursuant to the State Environmental Policy Act (SEPA). Major components that are evaluated include storage, conservation, Voluntary Regional Agreements, instream flow, and policy alternatives for implementing requirements of the legislation. Three early implementation actions are also evaluated, two of which, Lake Roosevelt Drawdown and Potholes Reservoir Supplemental Feed Route, involve Reclamation cooperation.

In 2004, Reclamation entered into a Memorandum of Understanding (MOU) with the State of Washington and the Columbia Basin Project irrigation districts (the South Columbia Basin Irrigation District, the East Columbia Basin Irrigation District, and the Quincy-Columbia Basin Irrigation District). The MOU describes roles and expectations of those parties during conduct of the then anticipated Program (known then as the Columbia River Initiative), and specifically contemplates the Lake Roosevelt Drawdown. The MOU and subsequently the 2007 FEIS specifically describe the allocated use of the stored water as follows:

In non-drought years 82,500 acre-feet providing:

- 25,000 acre-feet of municipal/industrial supply
- 30,000 acre-feet of irrigation water to replace ground water supply in the Odessa Subarea
- 27,500 acre-feet for streamflow enhancement downstream Grand Coulee Dam

In drought years (when March 1 April-September water supply forecast at The Dalles is less than 60 MAF (statistically 1 in 26 years of record)) an additional 50,000 acre-feet:

- 33,000 acre-feet for Columbia River main stem interruptible water right holders
- 17,000 acre-feet for flow augmentation downstream of Grand Coulee Dam

For any withdrawal from Lake Roosevelt, the CRWMP provides that one-third of the water would be available to supplement water for fish flows during the lowest flow periods (April-

August period). This "no net loss plus 33%" formula is water that would not otherwise be available to benefit ESA-listed fish anytime from April through August.

Implementation of the new CRWMP draft of Lake Roosevelt under this consultation would be reviewed to ensure that enhanced fish flows under the CRWMP provide maximum biological effectiveness to the ESUs most in need of such benefit in accordance with the best current evidence as to the relationship between flow and fish survival. Such review should also address overall cost-effectiveness, and include an analysis of impacts on tribal interests such as resident fish and cultural resources, and appropriate mitigation for any such impacts.

When implemented as described, the new CRWMP drawdown would result in a net increase to instream flows out of McNary during the summer (July-August) flow augmentation period – roughly 225 cfs[4] average (corresponding to the 27,500 AF listed above) in non-drought years and roughly 360 cfs[5] average (44,500 AF, which represents the sum of the 27,500 AF and 17,000 AF listed above). However, the instream component of the new drawdown could also be utilized at any time from April through August. This would provide flexibility to ensure that water is released in a manner tailored to meet the needs of listed ESUs during that period of time.

The proposed delivery would result in an additional drawdown of approximately 1-foot in non-drought years, and another 0.8 foot in non-drought years. Existing operations provide that during July-August, Lake Roosevelt may be drafted to 1280 feet elevation in the wettest 50% of water years, and to 1278 feet in the driest 50%. Therefore, when conjoined with existing operations, the new CRWMP drawdown would lower the July-August elevation to 1279 feet in normal water years and to 1276.2 feet in drought years. Computer models indicate that refill of Lake Roosevelt would not be affected by the implementation of this additional draft.

According to a 2005 Government-to-Government Agreement in Principle (AIP) between the State of Washington and the Confederated Tribes of the Colville Reservation, the reservoir space vacated by the new draft would be refilled by September 30th of each year to ensure access to spawning habitat for resident kokanee populations in Lake Roosevelt.

In accordance with Section 24 of the 2004 MOU regarding Endangered Species Act (ESA) consultation, Reclamation proposes to implement the Lake Roosevelt Drawdown as described above. This consultation is intended to cover only the Early Action - Lake Roosevelt Drawdown component of the CRWMP. Implementation of any non Lake Roosevelt drawdown Program components will require separate ESA compliance at the appropriate time. Fundamental commitments made in the AIP, indicate that for the duration of the CRWMP, the State will not seek further drawdowns from Lake Roosevelt for use in meeting stream flow requirements or out-of-stream water supply needs along the mainstem of the Columbia River.

[4] Flow numbers may increase slightly due to return flows from M&I supply.
[5] Flow numbers may increase slightly due to return flows from M&I supply.

Section 23 of the 2004 MOU recognizes that the primary effects of the drawdown would be to Lake Roosevelt elevations and may affect the interests of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians (Tribes). Reclamation will not implement this drawdown unless the State of Washington has secured the concurrence of the Tribes and Reclamation has separately consulted with them on a Government to Government basis.

In addition, the State as well as Reclamation must comply with the State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA). Finally, Reclamation would need to submit a water permit application for approval by the State.

1.2.8 Measures to Address Total Dissolved Gas and Temperature

The Action Agencies will continue development and implementation of water quality measures to enhance juvenile and adult fish survival and mainstem spawning and rearing habitat. This includes actions as identified in the comprehensive *Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers* that will make further progress towards meeting water quality standards for TDG and water temperature. Other measures include continued water quality monitoring in the mainstem rivers, performing the necessary quality assurance and control to ensure accurate measurements and sharing this information on a real-time basis. Other measures would include performing the necessary modeling efforts (including SYSTDG) in both the action area and conjoining areas to make the best in-season management decisions for operating the river and implementing voluntary spill to improve fish passage and survival. The Action Agencies will continue to use the SYSTDG model as a river operations management tool. SYSTDG results will be coordinated through the Water Quality Team, the TMT, and the Mid-Columbia Public Utility Districts.

Total dissolved gas measures. The Action Agencies have worked with a Water Quality Team subcommittee on a systematic review of the forebay fixed monitoring sites (FMS). Changes at some sites have been implemented. Review and evaluation of forebay fixed monitoring stations at McNary Dam and the Snake River projects was initiated during the 2003 spill season and continued during the 2004 spill season. Alternative monitor locations were evaluated and compared to the existing FMS station. Findings and recommendations for more representative alternate forebay FMS locations were presented to the WQT in October 2004, and recommendations adopted by the Action Agencies were implemented.

The Corps will continue to monitor and prepare an annual report of the physical monitoring program for TDG, and will continue to coordinate the annual reporting of biological monitoring. The reports will be sent annually to the Oregon DEQ and Washington DOE. The program currently consists of forebay and tailwater monitoring stations, along with a few locations in free-flowing reaches. The use of back-up monitors and a quality assurance/quality control (QA/QC) program have been implemented.

We have installed spillway flow deflectors to reduce TDG production at most mainstem dams and plan to install end bay deflectors at Little Goose Dam. At various projects, we will consider spillwalls to reduce TDG supersaturation of powerhouse flows and to increase survival of juvenile migrants. Spillwalls may be necessary concurrent with spill reducing measures such as RSWs. RSWs, BGSs, or similar devices also can reduce gas entrainment through reduced spill while maintaining or improving juvenile passage survival. We will continue research to determine TDG effects on both juvenile and adult salmonids and implement solutions where appropriate.

Temperature measures. Temperature studies that include the Columbia River upstream of McNary Dam, trash racks, gatewells, and draft tubes were completed in 2004 and 2005. A computational fluid dynamics (CFD) model of the hydrodynamics and thermal characteristics of the project was completed in 2006. This model is currently being used to evaluate several temperature management alternatives at McNary Dam. Similarly, a study that examines the spatial and temporal characteristics of the 2004 temperature dataset, along with a comparison to historical information is currently underway. The model and this information will be used to investigate optimal powerhouse operations or structural modifications for minimizing thermal stress of juvenile salmon collected in the summer.

The Action Agencies have been working with an ongoing Water Quality Team subcommittee since 2001 to develop a plan to model water temperature effects of alternative Snake River operations. The 2001 and 2002 subcommittee work efforts determined the goals of water temperature modeling, investigated and evaluated multi-agency existing data, determined what questions can be answered without modeling, recommended and started additional water temperature and meteorological data collection, and recommended numerical models to be considered. The technical team recommended to the regional WQT that the CE-QUAL-W2 model be adopted for development in the river reaches of interest and identified a data collection strategy. The workgroup proposed to build the model in phases. The initial Phase 1 includes the North Fork Clearwater at the mouth, Mainstem Clearwater at Orofino, Upstream Snake River at Anatone to the Downstream Snake River at Lower Granite Dam. Phase 2 will include Dworshak Reservoir, and the Snake River up to the tailwater of Hells Canyon Dam, Phase 3 would extend the model up the Snake River to include the Brownlee Reservoir. Phase 1 was completed in 2004. Phase 2 is currently in progress and is scheduled for completion in 2007.

The Action Agencies will continue to refine the water temperature model and its use as a river operations management tool. Forebay temperature strings are deployed at Dworshak Dam, the four lower Snake River projects, and McNary Dam. These will continue to be used as in-river measurement points. The model applications and results will be coordinated with the Water Quality Team and the TMT.

The Action Agencies will complete studies to evaluate temperature effects on adult Snake River steelhead and fall Chinook of drafting Dworshak Reservoir to 1520 feet elevation and extending the draft period into September. Provisions of the Snake River Basin Adjudication (SRBA)

Agreement will be implemented, which will include Dworshak drafting to elevation 1535 feet by the end of August and the remaining 200 KAF from elevation 1535 feet to elevation 1520 feet in September. This operation has proven to be an effective tool to cool the temperature at the tailwater of the Lower Granite Dam. The Action Agencies coordinate through TMT and the Nez Perce Tribe (for SRBA actions) to determine water temperature releases from Dworshak during late June through September to make best use of the cool water at depth in the reservoir.

1.3 Juvenile and Adult Passage at Mainstem Dams

The primary mechanism that the Action Agencies intend to use for adaptive management towards meeting both biological and water quality performance measures and targets, is through the development of detailed Configuration and Operation Plans (COPs). The overall intent of the COPs is to develop an approach for improving fish survival through all routes of passage at each project to meet the requirements of the ESA while also meeting the performance targets for the Clean Water Act. The Corps has prepared a COP for RSWs and other dam passage modifications at the Lower Columbia and Snake River projects and one is being (or will be) developed for each of the mainstem projects and the transportation program.

These plans will be developed in close coordination with the region at the technical level. In addition to considering the complexities associated with the varying authorities of the projects, the Action Agencies must take into account multiple factors associated with the environmental needs of species affected by the projects. Operation and configuration of hydropower projects for fish can be even more complex and the Action Agencies must make decisions on how to operate the projects, specifically for fish, considering a large number of variables and the best available data.

When designing changes for fish, the Action Agencies typically consider variables including river hydraulics (e.g. project forebay and tailrace flow conditions) and site specific hydraulics (e.g. flow characteristics over an RSW). This information is typically collected via physical models, typically a scale model of a dam, and numeric models. In addition, biological data including fish behavior (e.g. where fish first arrive at the project, what type of delay occurs), and resultant fish injury and survival is gathered through pre-construction evaluations as well as lessons learned from studies at other locations. The engineering and design is then married with the biological parameters and the best possible configuration and operation for passage through all routes is developed.

The COPs will consider multiple alternatives for configuration and operation changes and will prioritize those alternatives into Phase I and Phase II actions. Phase I modifications are those that are anticipated to bring survival levels either up to or to exceed the hydro performance standards and are what are being brought forward in the PA. However, if the proposed modifications fail to meet the targets, then Phase II items will be considered for further implementation. The modifications in configurations and operations will be evaluated through RM&E as appropriate.

1.4 Actions for Juvenile Fish Survival

These actions address the operation and maintenance of juvenile bypass systems, turbines and spill at dams, including the installation, testing, and operation of "surface passage systems," such as removable spillway weirs (RSWs). Specific operations are developed for individual dams and are adjusted through adaptive management. Modifications would be implemented according to the attached planning schedule, which is subject to change.

What is being proposed is an interim operation based upon the best available data. It must be understood that as conditions change, due to the effects of operations and configurations, the effects of passage through the FCRPS will change. This will likely make the existing data less reliable and therefore additional RM&E will be required. Future operations will be based on adaptive management using the results of the proposed RM&E.

The Action Agencies will examine and discuss the levels and duration of spill that should be provided at each dam to meet improved survival standards; modifications may be made through the Collaborative Process.

[PLACEHOLDER] Surface passage systems (RSWs) currently operating at Lower Granite and Ice Harbor dams have proven highly effective at passing juvenile salmonids safely with less water than conventional spill. The Action Agencies anticipate similar performance with surface passage systems proposed for implementation at Lower Monumental, Little Goose, McNary, and John Day dams. To the extent that these surface passage systems may allow reduction of voluntary spill for juvenile fish passage, yet provide a means to improve or maintain juvenile survival to achieve performance standards; the Action Agencies may reallocate a portion of the resultant power revenue gained from these spill reductions for additional off-site actions to provide further biological benefit to ESUs affected by the FCRPS.

1.4.1 Spill Operations for Inriver Passage

The Action Agencies will continue to consider the following to establish spill priorities.

- **Dissolved gas management** – We will provide specific spill levels for juvenile fish passage at each project, not to exceed established TDG levels (either the 110 percent

TDG standard, or as modified by state water quality waivers, up to 115% TDG in the dam forebay and up to 120% TDG in the project tailwater). Additionally, we will manage spill on a system basis according to a priority list. In high runoff conditions, this distributes spill across the region and prevents dissolved gas supersaturation "hotspots."

- **Adult salmon fallback and delay** – We will limit spill for juvenile fish passage to reduce adult fish fallback and delay.
- **Passage survival research** – We will continue spill-related research in order to evaluate juvenile passage survival, spill effectiveness in relation to spill levels and duration, effect of spill on juvenile fish retention in forebays and tailraces, tailrace egress, and effect of spill on adult fallback. The results of this research will inform future spill management decisions in the context of achieving biological performance standards and optimizing the biological benefits of current spill levels at individual dams. In some cases, we may modify normal spill operations to support such research. To the extent that greater spill duration and/or levels are required for the purposes of spill evaluation at some projects, efforts will be made to minimize or offset additional effects to the hydropower system.
- **Spread the Risk** – Under mid-low to above-average spring runoff conditions, spill at both transport and non-transport projects will be used to "spread the risk" between transportation and in-river migration. Under low-flow conditions in the spring, spill will not occur at collector projects to enable maximum transportation. Summer spill operations will be implemented as described in the table below to enable implementation of the fall Chinook transport vs. in-river migration study.

The Action Agencies will provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems. The dates and levels for spill may be modified through the implementation planning process and adaptive management decisions. The initial levels and dates for spill operations are identified in Tables 5 and 6 below. Future Water Management Plans will contain the annual work plans for these operations and spill programs, and will be coordinated through the TMT. The Action Agencies will continue to evaluate and optimize spill passage survival to meet both the hydrosystem performance standards and the requirements of the Clean Water Act.

Table 5. Spring Spill Operations and Planning Dates: Snake River: June 1 – August 1 (adaptive); Columbia River: June 16 – August 31 (adaptive)

Project	Operation (Day / Night)
Lower Granite	20 kcfs / 20 kcfs
Little Goose	30% / 30 %
Lower Monumental	27 kcfs / 27 kcfs (Bulk Spill Gas Cap)
Ice Harbor	30% / 30% vs. 45 kcfs / Gas Cap
McNary	40% / 40%
John Day	0 / 60%
The Dalles	40% / 40%
Bonneville	100 kcfs / 100 kcfs

Table 6. Summer Spill Operations and Planning Dates: Snake River: June 1 (adaptive) – August 1 (adaptive); Columbia River: June 16 – August 31 (adaptive)

Project	Operation (Day / Night)
Lower Granite	18 kcfs / 18 kcfs
Little Goose	30% / 30%
Lower Monumental	17 kcfs / 17 kcfs
Ice Harbor	30% / 30% vs. 45 kcfs / Gas Cap
McNary	40% / 40% vs. 60% / 60%
John Day	30% / 30%
The Dalles	40% / 40%
Bonneville	75 kcfs / Gas Cap

Spillway tailrace erosion – The Action Agencies are developing plans to evaluate and monitor tailrace erosion in response to voluntary spill for juvenile fish passage. The current operations are substantially different than the spillways were originally designed for. (2005)

Transmission reinforcements – The Action Agencies will continue to evaluate transmission system capabilities and transmission constraints on fish operations. If new transmission constraints to fish operations are identified, the Action Agencies will coordinate transmission system modifications with NOAA.

1.4.2 Juvenile Fish Transportation

The overall intent of the proposed juvenile transportation operation is to balance the varying degrees of transportation and inriver migration benefits, both across the season and among the various species of fish, towards maximizing adult returns for all species passing the collector projects. This strategy has evolved from recent studies that have demonstrated that transportation may benefit wild Snake River steelhead throughout the season, however, may only benefit wild yearling Chinook for part of the season, and that the trigger at which the benefits are realized is, as yet, uncertain.

What is being proposed is an interim operation based upon the best available data. It must be understood that as conditions change, due to the effects of operations and configurations, the effects of passage through the FCRPS will change. This will likely make the existing data less reliable and therefore additional RM&E will be required. Future operations for transportation will be based on adaptive management using the results of the proposed RM&E.

As a result of the existing data, the Federal Action Agencies are proposing an interim juvenile salmonid transportation program that relies less on early spring transportation, more on later spring transportation, and a mixture of transportation and inriver migration (i.e. spread the risk) when data is less certain. In most years, we would initiate transportation in late April with a staggered start date for downstream projects, increase the reliance on transportation during May, but adaptively manage for spill and transportation in early June when more subyearling Chinook were present. In addition, flow triggers for maximization of transportation will be lower than in past years. A configuration and operations plan will be developed to assist in developing and prioritizing the structural modifications and RM&E which will be implemented to further refine and improve operations at the collector projects towards maximizing Smolt to Adult Returns to the extent possible.

A detailed rationale for this interim transport operation is included as Appendix 1.

1.4.3 Continuing Interim Transportation Actions

The Action Agencies will continue the juvenile fish transportation program towards meeting system survival performance metrics of Snake and Columbia River salmon and steelhead with some adaptive management modifications based on results of RM&E. The Action Agencies will continue to collect and transport juvenile fish at Lower Granite, Little Goose, Lower Monumental and McNary dams however under a modified operation as described below. While the dates mentioned in this section should be considered firm planning dates, if inseason information or results of ongoing RM&E indicates a need for adaptive management, the Action Agencies will consider revising the dates and operations through the regional forum.

Spring Migrants

In water years when the Snake River projected seasonal average (April – June) flow is less than 65kcfs (~ lowest 15% of all water years), transportation will be initiated April 3 at the Snake River collector projects (Table 7). The seasonal average flow projection will be based on the Corps' STP model and the April final forecast (late March report). Transportation from Snake River projects will be maximized (i.e. no voluntary spill or bypass provided) until May 31. Beginning June 1, to spread the risk for migrating subyearling Chinook, spill and transportation would be adaptively managed, such that when subyearling Chinook exceeded 50% of the collection for a 3 day period, a spill and transportation operation would be initiated at each dam.

Table 7. Proposed interim transportation strategy for Snake River collector projects. All flows are in average thousands of cubic feet per second (KCFS) for the April-June time period.

Lower Granite Dam	**Spring Migrants**				**Summer Migrants**			
	Spill and Bypass	Spill and Transportation	Max Transportation	Adaptive	Spill and Transportation	Adaptive	Max Transportation	Adaptive
Seasonal Average Flows < 65	None	None	April 3-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 - 80	April 3-April 20	April 21-April 30	May 1-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 3-April 20	April 21- May 31	None	June	July	Aug	Sept	Oct +
Little Goose Dam								
	Spill and Bypass	Spill and Transportation	Max Transportation	Adaptive	Spill and Transportation	Adaptive	Max Transportation	Adaptive
Seasonal Average Flows < 65	None	None	April 3-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 - 80	April 5-April 28	April 29-May 4	May 5-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 5-April 28	April 29-May 31	None	June	July	Aug	Sept	Oct +
Lower Monumental Dam								
	Spill and Bypass	Spill and Transportation	Max Transportation	Adaptive	Spill and Transportation	Adaptive	Max Transportation	Adaptive
Seasonal Average Flows < 65	None	None	April 3-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows 65 - 80	April 7-May 1	May 2-May 9	May 10-May 31	June	July	Aug	Sept	Oct +
Seasonal Average Flows > 80	April 7-May 1	May 2-May 9	None	June	July	Aug	Sept	Oct +

Note: The term "adaptive" in this table refers to a transition between two adjacent management strategies in the table. For example, where "Adaptive" is between "Max transportation" and "Spill and Transportation", the decision for each option would be made based on in-season data.

In water years when the Snake River projected seasonal average (April – June) flow is between 65 and 80 kcfs (~lowest 15-28% of all water years), spill and bypass would be provided beginning April 3 at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental, followed by spill and transportation in the early-mid spring, and maximized transportation in the late-mid spring until May 31 at all Snake River Collector projects (Table 7). Between June 1 and June 30, to spread the risk for migrating subyearling Chinook, spill and transportation would be adaptively managed, such that when subyearling Chinook exceeded 50% of the collection for a 3-day period at each project in turn (beginning with the most upstream project), a spill and transportation operation would be reinitiated. Although spill and transportation would be initiated on a staggered basis in the Snake River (April 21 at Lower Granite, April 29 at Little Goose and May 2 at Lower Monumental), spill and primary bypass would be provided throughout the season at McNary Dam, pending results of ongoing RM&E.

When average seasonal flows are projected to be above 80 kcfs (~72% of all water years), spill would be provided beginning April 3 at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental (Table 7). A combination of spring spill operations and maximized transportation would be provided through May 31, followed with adaptive management for subyearling migrants through June 30. The Action Agencies would plan to initiate transportation on April 21, April 29 and May 2 at LGR, LGO and LMN respectively, however, adaptive management of a start date would be considered through the regional forum, with LGR transportation starting no later than May 1. When involuntary spill is anticipated in May and June, project operations would be designed towards meeting both the dam passage survival performance standard while increasing the proportion transported, because all studied spring migrating stocks have demonstrated high benefit of transportation during May. This includes a reduction of spill to increase the proportion of fish transported, however also includes providing higher than minimum spill at collector projects using RSW + training spill.

If average seasonal flows in the Columbia River are predicted to be below 125 kcfs (roughly the 2001 level, transportation from McNary Dam would be maximized until June 14. This is based on low inriver survival measured in 2001 and preliminary research results of effects of transportation versus bypassed fish. Spill and transportation would be adaptively managed beginning June 15, with the similar protocols for subyearling fish to that for the Snake River projects. When seasonal average flows are predicted to be 125 kcfs or above, spill and primary bypass would be provided throughout the season at McNary Dam (Table 8).

Ultimately, operations will be adaptively managed with consideration of in-season fish migration, inriver conditions, and results of RM&E. The transportation and inriver migration strategy that best contributes toward achievement of the highest level of adult returns for each species will be implemented. Continued research and monitoring, combined with key structural modifications will provide the means and information to implement a long-term transportation program to positively affect spring migrating species.

Table 8. Proposed interim transportation strategy for McNary Dam. Average flows reported in thousands of cubic fet per second (KCFS) for April-June.

McNary Dam	**Spring Migrants**				**Summer Migrants**			
	Spill and Bypass	Spill and Transportation	Max Transportation	Adaptive	Spill and Transportation	Adaptive	Max Transportation	Adaptive
Seasonal Average Flows < 125	None	None	April 10 – June 14	June 15-June 30	July	Aug	Sept	Oct +
Seasonal Average Flows > 125	Apr 10-June 14	None	None	June 15-June 30	July	Aug	Sept	Oct +

Note: The term "adaptive" in this table refers to a transition between two adjacent management strategies in the table. For example, where "Adaptive" is between "Max Transportation" and "Spill and Transportation", the decision for each option would be made based on in-season data.

Summer Migrants

Beginning in June at Lower Snake River collector projects, with the actual date based on adaptive management, (as determined by the 50% collection criteria above), RSW and training spill would be provided, not to exceed gas cap or at least one unit operation for station service. All collected fish would be transported, other than those necessary for research. This is consistent with a spread the risk operation until RM&E indicates otherwise.

Beginning August 1, if the number of collected subyearling Chinook (hatchery and naturally produced) has fallen below 1,000/day for 3 sequential days, spill would be discontinued on a per project basis, beginning with the most upstream project (Lower Granite). If after shutting off spill, collection numbers exceed 1,000 subyearling fish per day for 2 sequential days, spill would be reinitiated and fish numbers would be reevaluated. (Note: In 2005 and 2006 when summer spill was provided, the maximum number of fish collected for a single day in August and September was 242 and 303 respectively with a daily average of 58 and 63 fish across those 2 months. The last 1,000+ fish day for both of those years was July 5 and 12 respectively). In addition, if collected fish numbers are below 1,000 per day on a per project average, barging would be discontinued and trucking would commence. Between September 1 and 30, transportation would be maximized, and after September 30, adaptive management (i.e. bypass or transportation) will be considered based on number of fish passing the projects and other factors. After September, operation of the projects in primary bypass mode with PIT detection will be conducted as necessary for research, with the potential for bypass operations to continue into December where feasible.

This operation would facilitate intensive RM&E efforts for subyearling Chinook (PIT Tagging) and would occur at least through 2009 (see transportation RM&E section). After 2008, initial adult returns from PIT releases from 2005-2006 will be assessed. If there are any significant apparent differences for the various release groups, summer operations will be reconsidered and adjusted appropriately. Transportation, spill, and use of bypass systems will be re-examined as management tools as adult study fish return and operations will be adaptively managed as appropriate through the FPOM and TMT.

At McNary Dam, about June 15-August 31, spill will be provided and all fish collected will be transported, other than necessary research fish. Transportation, spill, and bypass systems will be reexamined as management tools as RM&E is conducted, and operations will be adaptively managed as appropriate through the FPOM and TMT. Transportation would be provided in September as long as numbers of migrants warranted and juvenile shad did not inhibit the operation.

1.4.4 New Actions for Transportation

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out further transportation actions at each dam. Construction actions for transportation are primarily in the context of changes to juvenile bypass systems. Changes meant to increase adult salmon returns through the juvenile fish transportation process are being evaluated. Some changes include additional barges, a new juvenile fish facility at Lower Granite Dam and modifications to the juvenile fish facilities at Little Goose, Lower Monumental and McNary dams.

Continued RM&E: Continued research and monitoring will provide information to develop a long-term juvenile fish transportation and spill program towards increasing the SARs of spring and summer migrating species. The Action Agencies will adaptively manage activities with consideration of in-season fish migration conditions and research results, and adopt the operational strategy that most contributes toward achievement of the total system survival performance standard. Key research will include intensified efforts to determine effects to all spring migrating populations, to determine the most reasonable date or trigger to initiate transportation, to determine ways to improve transportation (including increasing the "D" value), to assess the affect of transportation and inriver migration on sockeye if feasible, to assess the transportation and inriver migration strategies for Fall Chinook, and to complete the Upper Columbia transportation studies conducted at McNary Dam.

Additional barge(s): Pending research results on alternative barging operations, the Action Agencies propose to build a new barge(s) for the transportation program to facilitate alternative management strategies. Post release survival of juvenile fish transported is anticipated to increase in response to the addition of barges by facilitating potential operations including direct loading, reduced densities, alternative release scenarios and the ability to maintain species (size) separation. These potential operations have the ability to reduce stress, predation, injuries, and disease transmission, thereby reducing the potential for latent mortality for transported fish, thereby increasing SARs. Benefits from this have not yet been determined, but RM&E results are anticipated during the BiOp period.

Improved juvenile fish facilities: Changes to juvenile fish facilities that are anticipated to improve the survival of bypassed fish (Section 1.4.5) are also anticipated to improve conditions for transported fish. Changes at these facilities geared towards improving transportation are expected to provide better facility egress conditions, species separation, reduced potential for stress, and alternative barge loading capabilities. While major modifications are planned for Lower Granite Dam, including a different collection channel conduit, orifices, etc…, minor modifications are being considered for the other collector projects including improving flumes and separators to develop better species specific separation. Decreased potential for delay, stress, chance of injury, and disease transmission in the new and/or modified facilities are expected to result in reductions in latent mortality for transported fish, thereby increasing SARs. Benefits from this have not yet been determined, but RM&E results are anticipated during the BiOp period.

1.4.5 Juvenile Passage at Mainstem Dams

Presently, the mainstem, fish-passing, FCRPS dams, are being operated to balance fish passage and water quality performance with cost effective authorized project purposes, under the existing configuration, using the best available data. To achieve this, a combination of fish passage configurations and operations (C&O) are used on a project by project basis, considering the needs of both adult and juvenile fish as informed by RM&E. The purpose of this section is to provide an overview of the primary mechanisms of how fish are passed at the dams and the rationale for why specific operations are in place as of May 2007. The intent of this section is also to set the scene for what is currently in place and why the configuration and operations modifications, which will be proposed later in the document, are appropriate.

As might be anticipated, dates of operations typically reflect the presence and relative absence of fish species which might encounter the project. While it is generally understood that some ESA listed fish may reside within the hydrosystem year round, over winter, etcetera, in general the operations were designed to protect the vast majority of the fish as they pass the project. Where possible, some level of passage or protection measure is provided for fish that may encounter the projects when outside of the normal migration periods.

In general, juvenile fish pass the dams via a few primary routes including through spillways, surface passage routes, conventional turbine bypass systems, and through the turbines. Typically, spillways and surface bypass routes are thought to provide the quickest and safest route of passage at the projects; however this is not always the case as some spillways have lower than desired survival. While conventional bypass systems can improve the survival of fish by routing them around turbines, they are thought to be less desirable than surface passage routes. Turbines continue to be, overall, one of the lowest survival routes for passage at the dams, however, as with spillways, this must be examined on a case by case basis as there are exceptions to the rule. Adult fish passage configurations and operations typically provide high upstream success, however, at times, operations for juvenile passage can cause negative impacts to adults, and this is detailed below. In addition, there are currently measures in place to protect downstream migrating adults (e.g. kelts, fallbacks).

Developing the configurations and operations to balance the requirements is challenging and not without contention. The following will discuss operations specific to the adult and juvenile migrations both from a system wide approach for some passage routes and on a project by project basis where appropriate. These operations will be explained in further detail where appropriate. Where survival estimates are reported, these numbers come from the COMPASS modeling effort.

The Action Agencies will continue to evaluate and make capital modifications towards improving fish passage survival rates. We will generally give schedule and funding priority to modifications at dams where the passage survival rates are lowest but will coordinate through the Regional Forum. To accomplish this, the Action Agencies will develop comprehensive passage modification plans for each passage dam. These plans will guide future configuration investments and aid hydrosystem operations in meeting hydrosystem passage survival targets and standards.

Key Actions for Passage Modifications

Summarized below are the existing configuration and operations and the major modifications at each dam that the Action Agencies are considering or anticipating as key alternatives under development. Development of COPs is underway, and therefore, the ultimate configuration (and related operational) recommendations at each project cannot yet be specified. We will compare biological effectiveness and costs to determine the optimum configuration and operation at each project that will contribute to achievement of performance requirements.

Actual construction of these features and schedules will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. While the order of construction and final configuration may vary, surface bypass modifications are expected to be in place at the eight lower mainstem dams within the course of the BiOp.

Bonneville Dam

Existing Configuration and Operations

The existing configuration and operations of Bonneville Dam, specific to fish passage is as follows:

Bonneville Dam	Current Configuration	Current Operation
Spillway	18 Spill Bays, Vertical lift Leaf Gates Flow deflectors every bay	4/10-6/30 100kcfs Day/Night 7/1-8/31 75kcfs Day/ Gas Cap (~120kcfs) Night)
Juvenile Bypass System (PH1)	Submerged Traveling Screens - 2 Units	9/15-12/15 (Adult Fallback Operation Only)
Juvenile Bypass System (PH2)	Submerged Traveling Screens - 8 Units Bypass to tailrace	3/1-12/15
Surface Bypass (PH1)	Yes - Ice and Trash Sluiceway	3/1 - 11/30, 1.6 kcfs in addition to spill
Surface Bypass (PH2)	Yes - Corner Collector	3/1-8/31, 5 kcfs in addition to spill
Turbines (PH1)	10 Main Units, 7 of which are MGRs	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Turbines (PH2)	PH2 Priority Operation, 8 Main Units (STS) 2 Fish Units (No STS but otherwise screened)	
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 4 primary ascension routes	2 ladders with counting 3/1-11/30 1 ladder minimum 12/1-2/28

Rationale for Operations

Spring Operations – Presently at Bonneville Dam, the surface bypass routes at both powerhouses are operated for fish passage to provide good juvenile egress and survival, ranging from 93% survival at PH1 to 100% survival at PH2 for Chinook. The juvenile bypass facility is also operated at PH2, providing approximately 98% survival, which is an improvement over turbine passage survival of roughly 94%. The juvenile bypass system at PH1 is no longer in operation because with the installation of Minimum Gap Runners (MGRs, new turbine runners), survival through those routes (~97%) was higher, therefore the screens were pulled and the bypass system abandoned. Powerhouse 2 has been designated as the priority powerhouse for power generation in part due to high survival through the passage routes, however also because the propensity for adults to pass upstream via the PH2 ladder system, improving overall adult performance by reducing fallback and eventual overall upstream passage success.

Spill is presently provided in the spring at 100kcfs both day and night. Spillway survival for Chinook at Bonneville Dam is not as high as through other passage routes, ~90% during the day and ~97% at night, so increased spill has not been proposed due to higher spill levels drawing more fish away from the higher survival routes. In addition, higher spill levels during daylight hours causes greater potential for both passage delay and fallback of adult fish attempting to pass and migrate upstream, thereby decreasing overall upstream passage success. Spill is also limited to 100kcfs towards attempting to get closer to the requirements of the Clean Water Act with respect to TDG and to protect redds and organisms residing in shallow water habitats downstream from the dam.

Summer Operations – Summer operations at Bonneville Dam differ somewhat from the spring operations in that reduced levels of spill are provided during the day time, however increased levels of spill are provided during the night. Spill survival at Bonneville for fall migrants has been estimated at around 91%, and passage through the other routes, including turbines, has been estimated at higher than 92%. Increased levels of spill are not provided during the day to limit the impacts to adult passage. Spill is also limited towards attempting to get closer to the requirements of the Clean Water Act with respect to TDG and to protect organisms residing in shallow water habitats downstream from the dam.

Modifications

Passage modifications at Bonneville Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Bonneville Lake). However, in that most populations of Lower Columbia River Chinook, Steelhead, Coho and Columbia River Chum occur downstream of the project, only portions of those ESUs are anticipated to be directly affected by actions at Bonneville Dam.

The Action Agencies, in coordination with the Regional Forum, are updating a planning document that presents the strategy for prioritizing and carrying out actions for fish passage actions at Bonneville Dam. This document, the Bonneville Dam Configuration and Operation Plan (COP, previously titled the Bonneville Decision Document) will consider the alternatives listed below. This BA describes actions identified in the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. As actions are implemented, effectiveness monitoring will be used to validate performance. The Action Agencies, in coordination with the Regional Forum, will use action effectiveness monitoring information to determine if performance objectives have been achieved, or if additional actions are required to achieve biological performance objectives.

1st Powerhouse surface bypass (sluiceway modifications): The Action Agencies are investigating modifications in the sluiceway for passing juvenile salmonids. These sluiceway alternatives may include automating sluiceway entrances, removing the juvenile bypass wall, and returning it to its original design while improving and smoothing the sluiceway conveyance. In collaboration with the Regional Forum, a subset of these alternatives will be implemented and construction could begin as soon as 2007. While these modifications are expected to increase sluiceway passage efficiency up to as much as 60% for yearling Chinook and steelhead, fish passage modeling has shown no direct increase in dam survival (survival across the concrete) from this action. The reason that modeling has shown no dam passage survival increase due to this action is that current input data were collected under limited Powerhouse 1 operation. As such, using these data to predict future performance indicates that fish survival through the 1st

Powerhouse turbines is as high as or higher than fish survival through the sluiceway. However, route-specific survival could be very different under higher flow conditions, when more smolts would pass Powerhouse 1 and survival rates on those fish may differ. In addition, modifications to the sluiceway are expected to reduce forebay residence time which may decrease the potential for forebay mortality due to predation and could reduce potential stressors associated with latent mortality. Mortality in the forebay of Bonneville Dam has not been estimated in past studies, and is therefore not part of the analysis of effects in this assessment.

Spillway Survival Modifications: In 2002, six new lower (7' msl) spillway flow deflectors were installed in spillbays that previously did not have deflectors (1, 2, 3, 16, 17, and 18, enabling greater volumes of water to be spilled in the summer without exceeding TDG limits. This was assumed to effect juvenile salmonid survival. However, post construction juvenile fish survival studies demonstrated that spillway passage survival was lower than desired at lower discharges and was lower at bays with the higher elevation deflectors., These same studies indicated that survival for fish passing through the B2 Corner collector and B2 JBS were both higher than survival through the spillway. In addition, adult salmonid migration over Bonneville Dam was delayed when daytime spill was at the total dissolved gas cap. Further analysis of these data indicates that the spill discharge threshold for this delay is around 100 kcfs. Operational changes are presently being pursued, however, additional measures, including changes to the flow deflectors, are presently being considered (2008-10). Spillway measures, whether structural or operational, are anticipated to result in an increase in spillway survival of up to 4% for yearling and subyearling Chinook and steelhead. This could equate to a dam survival increase of up to 0.5% for yearling Chinook, 1.8% for steelhead, and 3.9% for subyearling Chinook.

***2nd Powerhouse FGE and bypass modifications*:** The Action Agencies are presently performing construction modifications that decrease turbine entrainment of juvenile salmonids by improving the fish guidance efficiency (FGE) of the turbine intake screens at the 2nd powerhouse. These modifications are scheduled to be completed by 2008. FGE increases of up to 8% for yearling Chinook and up to 18% for subyearling Chinook would yield an increase in dam survival of 0.2% for yearling Chinook and 0.3% for subyearling Chinook.

The Corps and BPA have implemented less-intrusive, PIT-tag interrogation methods at Bonneville Dam; including full flow PIT-tag detection capability in the Second Powerhouse juvenile bypass system (2006). While no direct survival effects are anticipated, bypassing fish through a larger pipe in a larger volume of water than for normal PIT detection is expected to help reduce stress of bypassed fish. Concern with orifice passage at the 2nd Powerhouse is also an issue that has been raised and orifice passage will be investigated (2008).

The Corps will investigate the use of a trash shear boom as a way to increase the proportion of salmon that pass Powerhouse 2 through the Corner Collector in 2008. It is assumed that the trash boom could increase the Corner Collector efficiency for yearling and subyearling Chinook up to 15% and up to 5% for steelhead. These increases in efficiency would result in dam passage survival increases of 0.2% for yearling Chinook, subyearling Chinook, and steelhead.

1st Powerhouse installation of Minimum Gap Runners: The Action Agencies will continue to install minimum gap runners (MGR) at the Bonneville Dam first powerhouse. Currently, six

MGRs are installed and biological testing has indicated that a 40% reduction in injury rate to juvenile Chinook compared to the existing turbine units may be achievable. The remaining 4 units are scheduled to have new runners installed by 2010 pending funding for the installation. Main unit 10 is to be commissioned in April 2007 bringing the total MGR units completed at PH1 to seven. The new runners are estimated to increase the turbine passage survival rates of yearling and subyearling Chinook and steelhead by 2%, 2%, and 1.5% respectively, and a reduction in stressors that may lead to reduced latent mortality for all ESUs originating upstream from the dam.

***Changes in passage survival*:** The proposed actions, including all combined construction and operational modifications at Bonneville Dam, is expected to increase survival by as much as 1.5% for yearling Chinook, 2.8% for steelhead, and 4.9% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam.

The Dalles Dam

Existing Configuration and Operations

The existing configuration and operation of The Dalles Dam, specific to fish passage is as follows:

The Dalles Dam	Current Configuration	Current Operation
Spillway	23 Spill Bays, Tainter Gates, No Flow deflectors Spill Wall between bays 6 and 7	4/10-8/31 40% Spill Day/Night Bulk spill to the north of the spill wall
Juvenile Bypass System	NA	NA
Surface Bypass	Yes - Ice and Trash Sluiceway	4/1-11/30 4.6 kcfs in addition to spill
Turbines	22 Main Units, 2 Smaller Fish Units, No Fish Screens	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	Both Ladders 3/1-11/30, 1 Ladder Minimum, 12/1-2/28

Rationale for Operations

Spring and Summer Operations -

At The Dalles Dam, 40% spill is provided in a bulked pattern through the northernmost 6 spillbays during both fish passage seasons for 24 hours. This operation, in tandem with sluiceway operation, tends to pass 80-90% of the juvenile migrants through non-turbine routes. While the sluiceway typically provides the highest survival of all routes (~95-99%), the spillway tends to be next highest (~86-92%), and turbine survival tends to be the lowest (~80-84%).

Spill is provided at the 40% level because this level not only provides a high percentage of fish passing over the spillway (~70-80%) but also provides reasonable egress in the tailrace and limits the exposure to predation by reducing entrainment of fish into the higher predation areas in the south shore islands downstream. In addition, spill volume behind this wall is limited by maximum gate opening because of the potential for spillway erosion and unknown effects on fish survival.

The 40% spill level, while shifting adult use away from the north shore ladder, has not resulted in additional delay or reduced passage success at the project. Adults have simply increased usage of the east ladder with no apparent increase in adult passage times through the project.

Modifications

Passage modifications at The Dalles Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Celilo).

The Action Agencies, in coordination with the Regional Forum, are developing a configuration and operation (COP) planning document that presents the strategy for prioritizing and carrying out fish passage actions at The Dalles Dam. This PA describes actions identified in the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. As actions are implemented, effectiveness monitoring will be used to validate performance. The Action Agencies, in coordination with the Regional Forum, will use action effectiveness monitoring information to determine if performance objectives have been achieved, or if additional actions are required to achieve biological performance objectives.

***Spillway modifications*:** The spillway at The Dalles Dam is the primary juvenile fish passage route, however survival of spillway-passed fish at The Dalles is substantially lower than spillway survival at other dams. A spill wall that was constructed in 2003-04 reduced direct injury and mortality, but did not show an appreciable total survival increase for juvenile Chinook salmon that passed through the spillway. To reduce predation on spillway-passed fish, the spillwall will be extended downstream to the river's thalweg. This action is expected to achieve 98% total survival for juvenile salmon and steelhead that pass through the spillway.

Assuming an increased spillway survival rate to 98% and the current passage distribution estimates, overall dam-passage survival could increase by as much as 4% for both yearling Chinook and steelhead, and 3% for subyearling Chinook. These increases alone could result in dam survival rate increases of 2.0%, 2.0%, and 2.4% for yearling Chinook, steelhead, and subyearling Chinook respectively, and a reduction in stressors that may lead to latent mortality.

***Sluiceway guidance efficiency modifications*:** The Action Agencies will evaluate ways to increase passage efficiency of the ice and trash sluiceway for juvenile salmonids by either modifying gate entrance configurations or increasing overall sluiceway capacity (or a combination of both). This would increase dam-passage survival at The Dalles Dam and would also reduce forebay residence time which may also decrease juvenile salmonids' exposure to predation. Assuming a 50% reduction in turbine entrainment occurs for all ESUs as a result of sluiceway entrance modifications, dam survival would increase by 0.3% for yearling Chinook, 0.1% for steelhead, and 1.0% for subyearling Chinook, and a reduction in stressors that may lead to latent mortality.

Turbine Survival Actions: The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is an increase in turbine survival for spring and summer juvenile salmonid migrants, as well as a reduction in stressors that may lead to latent mortality.

***Changes in passage survival*:** Phase 1 of the proposed actions, including all combined construction and operational modifications at The Dalles Dam, indicates a potential to increase survival from 2.0 - 5.0% for yearling Chinook, 2.0 - 4.8% for steelhead, and 2.4% - 8.1% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from this dam.

Optional Alternatives: If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For The Dalles Dam, potential alternatives for consideration include moving the sluiceway outfall or developing a behavioral guidance structure in the forebay.

John Day Dam

Existing Configuration and Operations

The existing configuration and operation of John Day Dam, specific to fish passage is as follows:

John Day Dam	Current Configuration	Current Operation
Spillway	20 Spill Bays, Tainter Gates, Flow deflectors every bay	4/10-6/30 (0%/60% Day/Night) 7/1-8/31 (30% Day/Night)
Juvenile Bypass System	Submerged Traveling Screens - All Units Bypass Downstream to Tailrace	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	16 Units, 4 Skeleton (Empty) Turbine bays	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	Both Ladders 3/1-11/30 1 Ladder Minimum, 12/1-2/28

Rationale for Operations

Spring Operations – For Spring operations at John Day Dam, 0% daytime and 60% nighttime spill is provided (April 10 – 20 June) in tandem with the juvenile bypass system to reduce overall turbine entrainment and increase survival for fish passing the project. This combination of operations, which approaches the TDG waiver limits for 60% spill, is believed to provide the highest dam passage survival for yearling Chinook and steelhead based on two years of evaluations of “night spill only” versus “24-hour spill” (Corps estimate of 91-93%). These studies indicated that when daytime spill of 30% was provided, steelhead survival was reduced compared to “night spill only” operations. In addition, two years of evaluating 12- vs 24-hour spill at John Day Dam also showed that there was no survival benefit to yearling Chinook by spilling during the day, and that turbine entrainment for yearling Chinook and steelhead (hatchery and wild) was not reduced. Fish passage and hydraulic model observations have indicated that spill at higher levels can increase tailrace egress times of fish that pass not only through the juvenile bypass system, but also through turbines, and studies at John Day Dam have demonstrated that longer tailrace egress times are related to lower survival.

Summer Operations – During the Summer (21 June – 31 August), 30% of the total river flow is spilled 24-hours per day in tandem with the juvenile bypass system operation. This operation is based on survival data from 2 years of study (2002 and 2003) which indicate that 24-hour spill results in higher survival for subyearling Chinook compared to 12-hour night spill. Data from these studies also suggested that increasing spill percentages increases tailrace egress times and decreases survival of subyearling Chinook that pass through the juvenile bypass system. Based on hydraulic model studies, this would also likely be the case for fish that pass through turbines.

Modifications

Passage modifications at John Day Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Umatilla).

The Action Agencies, in coordination with the Regional Forum, are developing a configuration and operation planning document (COP) that will present a strategy for carrying out fish passage actions at John Day Dam. Recent survival estimates suggest that there is good potential for additional survival improvements at this project. This BA describes actions identified in the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. As actions are implemented, effectiveness monitoring will be used to validate performance, which the Action Agencies, in coordination with the Regional Forum, will use to determine if performance objectives have been achieved.

Surface flow bypass and Tailrace egress actions: Good tailrace egress is a critical factor for improving juvenile fish survival at John Day Dam. Alternatives that reduce the proportion of smolts passing through turbine units and improve tailrace egress ranked highest in the draft COP. The concept of surface flow bypass is to divert a proportion of turbine-bound fish to the spillway or skeleton bay surface bypass outlet. The COP analyzed surface flow bypass under a range of 24-hour operations. For this PA, the Action Agencies assumed a 20 kcfs surface flow outlet with 30% training spill. Design of these alternatives will include consideration of improvements to tailrace egress. Tailrace egress actions may involve a spillway divider wall (a wall dividing the powerhouse from the spillway), turbine operations, modifying tailrace bathymetry, surface bypass outfall flow in the skeleton bay area, relocating the juvenile bypass outfall, or a combination of these. Locating a surface flow outlet at or near the north end of the powerhouse is estimated to provide up to a 50% reduction in the proportion of fish passing through the powerhouse for all ESUs, assuming a 24-hour 30% spill level. In addition, tailrace egress changes could increase survival of fish passing through the juvenile bypass system by up to 1% for yearling Chinook and up to 3% for steelhead as well as reduce the stressors that may lead to latent mortality. The potential dam passage survival increase estimated for surface flow bypass and tailrace egress actions (assuming 20% training spill) is up to 1.4 - 2.7% for yearling Chinook salmon, 1.4 - 4.1% for steelhead trout, and 4.4 - 7.0% for subyearling Chinook salmon (2013). Surface flow bypass is also anticipated to reduce forebay residence time for juvenile salmon and steelhead.

Turbine survival actions: Starting in 2006, the Action Agencies began evaluating turbine operation and geometry, seeking ways to increase turbine survival. The effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on the overall tailrace (see tailrace actions above). The anticipated result of this work is an increase in turbine survival for spring and summer juvenile salmonid migrants.

Full flow bypass PIT Tag Monitoring: The Action Agencies are evaluating less-intrusive, PIT-tag interrogation methods at John Day Dam, including full flow PIT-tag detection capability, in the juvenile bypass system. This is anticipated to help reduce the potential for stress and reduce the potential for latent mortality.

***Changes in passage survival*:** Phase 1 of the proposed actions, including all combined construction and operational changes at John Day Dam, is anticipated to increase survival by up to1.4 - 2.7% for yearling Chinook, 1.4 - 4.1% for steelhead, and 4.4 - 6.4% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam.

Optional Alternatives: If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP, will be considered. Additional juvenile fish passage alternatives that will be considered include extended length screens, juvenile bypass outfall relocation, and a forebay behavioral guidance system.

McNary Dam

Existing configuration and operation

The existing configuration and operation of McNary Dam, specific to fish passage is as follows:

McNary Dam	Current Configuration	Current Operation
Spillway	22 Spill Bays, Vertical-Lift Split Leaf Gates Flow Deflectors Every Bay	4/10-6/30 (40% Day/Night) 7/1-8/31 (40%/40% vs. 60%/60% Day/Night testing)
Juvenile Bypass System	ESBS, All Units Bypass Downstream to tailrace or Transport	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	Yes - 2 TSWs	~14 kcfs as part of Spill
Turbines	14 Units	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	Yes - Summer/Fall Only	~6/20 ~ 8/15 Barge Transport ~ 8/16 ~ 9/31 Truck Transport
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1-12/31

Rationale for Operations

Spring Operations - During the spring, operations at McNary include a combination of 40% spill and full flow bypass to provide safe passage and egress and avoid turbine passage for spring migrants. This operation is provided because the spillway typically provides the highest survival route at the project (~96%), followed by the bypass system (~91-96%) and turbines (~80-97%). Using bypass and 40% spill provides a high percentage of the fish with a non turbine passage route and the Corps estimates that survival through the dam for spring migrants is approximately 94-95%. While 40% spill is the planned operation, limited powerhouse capacity often forces the operation to above that level, however 40% spill is expected to provide a reasonable level of survival, to trend towards a balanced flow through the project, provides good tailrace egress for powerhouse and spillway passed fish, and also results in achieving TDG waiver goals in the tailrace.

While McNary dam has the potential to transport fish during the spring, transport evaluations to date have been inconclusive and transport operations were discontinued in the 1995 BiOp. However with a juvenile fish facility constructed in 1994, an evaluation of transportation versus inriver migration and bypass with Upper Columbia Chinook and Steelhead is currently in progress, and we are awaiting adult returns. When results of this research are finalized, operations may be revisited.

Summer operations - During the summer, operations at McNary include a combination of 40% and 60% spill (presently under evaluation) and transportation to provide safe passage and egress and avoid turbine passage for spring migrants. This operation is provided because the spillway typically provides the highest survival route at the project (~100%), followed by the bypass system (~85%) and turbines with unknown but anticipated low survival. Using 40% spill would provide a high percentage of the fish with a non turbine passage route, and would tend towards balancing the flows from the project. The Corps estimates that project survival for summer migrants is approximately 97%. Transportation is provided in part due to the lower bypass survival and due to the deterioration of inriver conditions late in the summer, including high water temperatures and low total river discharges.

Modifications

Passage actions at McNary Dam are anticipated to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Walulla). However, while effects to populations of the Middle Columbia River steelhead ESU in the Walla Walla River and Yakima River populations are expected, no direct effect from actions at McNary Dam would be anticipated for downstream populations of this ESU.

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out additional fish passage actions at McNary Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions. The COP will identify the actions to implement in the near term (phase I) and others for potential implementation in latter phases if necessary. This document identifies actions that the Action Agencies expect would be recommend by the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. Relative effects of in-river versus transport passage strategies will be a key consideration in recommendations to implement actions and their uses in future project operations.

Powerhouse Actions**:** Fish survival effects identified through Biological Index Testing (BIT) of existing turbine operations could provide improvements in direct survival and/or the tailrace egress of turbine-passed fish. This may also help minimize predation that can occur in the tailrace. It is anticipated that improvements in operations and tailrace conditions could provide a 2% survival increase for yearling Chinook, steelhead, and subyearling Chinook passing through turbines at McNary Dam.

Debris Management: During the spring, large volumes of vegetative debris can accumulate on turbine intake trash-racks at McNary Dam. Both screened bypass and turbine-passed fish experience elevated injury and mortality as a result of passage through debris-clogged trash-racks. In the summer, aquatic vegetation clogs the vertical barrier screens. Changes in debris monitoring, management and cleaning procedures could reduce injury and mortality of fish passing through turbines and the screened bypass system and is expected to provide a 0.5% increase in turbine and bypass survival for yearling Chinook, subyearling Chinook and steelhead.

Surface Passage Actions**:** Surface passage routes at other Columbia River projects have proven to be highly effective at passing juvenile salmonids. As a result, two temporary top-spillway weirs (TSWs) will be constructed, installed, and evaluated in 2007 to determine the potential for surface passage structures to help improve fish passage survival at McNary. Additional surface passage structures may be located at optimum locations to provide permanent surface passage routes. Spillway surface passage route alternatives at McNary are anticipated to have a passage effectiveness of approximately 4.0:1 with a survival equal to current survival through the spillway (yearling Chinook 96.2%, subyearling Chinook 98%, and steelhead 95.9%), however powerhouse entrainment is anticipated to be reduced.

Juvenile fish facility actions**:** Actions to the juvenile fish facility will include relocation of the juvenile fish facility outfall pipe to improve egress conditions and reduce piscivorous and avian predation at the outfall site for juvenile salmon. Anticipated survival improvements are 3% for yearling Chinook and steelhead and 5% for subyearling Chinook.

Changes in passage survival**:** Analysis of the proposed Phase I Alternatives including all combined construction actions expected to be implemented during the period of this Biological Opinion at McNary Dam, with 40% spill 24 hours a day in both spring and summer, is estimated to effect direct survival between -0.6% and 0.1% for yearling Chinook, -0.1% and 0.5%for steelhead, and -0.1% and 0.5% for subyearling Chinook. While the values of these ranges demonstrate modeled potential, the baseline was not modeled with the full complement of the range of survival estimates, therefore the low end of the range for these estimates (negatives) are likely an artifact of the analysis process. In addition, because these actions are also expected to decrease the potential for latent mortality for all species originating upstream from the dam, the overall value of the improvements may not be quantifiable.

Optional Alternatives: If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For McNary dam, potential alternatives for consideration include, additional surface bypass system in the powerhouse, behavioral guidance structure in the forebay, and a divider wall in the tailrace.

Ice Harbor Dam

Existing Configuration and Operations

The existing configuration and operation of Ice Harbor Dam, specific to fish passage is as follows:

Ice Harbor Dam	Current Configuration	Current Operation
Spillway	10 Tainter Gates, Flow deflector every bay RSW Bay 2	4/3-8/31 Testing Operations (30%/30% vs 45kcfs /gas cap Day/Night)
Juvenile Bypass System	STS, All Units Bypass Downstream to tailrace	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	Yes - RSW	~8kcfs as part of Spill
Turbines	6 Units	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	NA	NA
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1-12/31

Rationale for Operations

Spring and Summer Operations – At Ice Harbor Dam, the Action Agencies use a combination of spill using the RSW (presently testing 30%/30% vs 45kcfs /gas cap Day/Night) and full flow bypass, in an effort to increase survival of fish passing the dams through reduction of turbine entrainment and a trend towards balancing of flow through the project. The Corps estimates that this operation provides survival through the dam of roughly 96-99% with survival levels through the bypass system and RSW ranging from 97-100%. With the recent installation of the RSW, evaluations have indicated that 30% spill is providing a similar level of survival for the project overall, as was the previous spill levels (45kcfs day/gas cap night), therefore the additional spill did not appear to provide any additional benefit. In addition, the reduced spill also resulted in a lower level of TDG in the tailrace, in an effort to attain the goals of the Clean Water Act.

Modifications

Passage actions at Ice Harbor Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Sacajawea).

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out additional fish passage actions at Ice Harbor Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions. The COP will identify the actions to implement in the near term (phase I) and others for potential implementation in latter phases if necessary. This document identifies actions that the Action Agencies expect would be recommend by the COP as Phase I actions. Actual implementation of

Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations.

RSW Actions**:** Fish passing near the ogee of the spillway at Ice Harbor experience relatively high rates of injury and the Action Agencies believe the injuries are likely caused by impact on the spillway chute and/or flow deflectors. Further, across many studies and dams, bays with deflectors tend to have lower survival rates. As the RSW is concentrating passage through one spillbay, modification of the spillway chute and/or deflector in this bay could decrease both injury and direct mortality. The Action Agencies believe the survival rate of all stocks passing the RSW could increase by 1% with the proper flow deflector modifications. Also, the overall effects could include a reduction in latent mortality, as the observed injuries may not result in immediate mortality, but may occur days or even weeks after a fish passes Ice Harbor Dam.

Powerhouse Actions**:** Relative survival of bypassed fish has consistently been near 100% while turbine survival has been under 90%; therefore, increased FGE would likely increase dam survival by diverting additional fish from turbine passage, which has a higher mortality rate. Model investigations of the IHR turbine intake indicate a significant gain in FGE may be obtained through minor modifications to the existing submerged traveling screens by way of gap closure, flow vanes, or even raising the screen. The Action Agencies anticipate this could increase FGE up to 5% for yearling and subyearling Chinook and up to 2.5% for steelhead. Because of the high survival rates of bypassed fish (consistently near 100%) improvements in FGE would result in an overall increase in dam survival.

Turbine Survival Actions: The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is 2% increase in turbine survival for both spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

In support of major hydropower system rehabilitations and replacement of aging turbine units, a research test turbine will be developed for fish passage improvements. This turbine will be installed at Ice Harbor Dam as a replacement to Unit 2 and will be tested as a proof of concept for fish passage. If successful, units 1 and 3 may be replaced as well. Given lower summer river discharges and expected fish spill, all turbine passage would likely be through these new units. Therefore, the Action Agencies estimate subyearling survival through the turbines could increase by as much as 3%. However, during spring, some of the existing units (4-6) would likely be operating, so only a portion of the turbine-passed fish would be going through the new turbines; therefore, the Action Agencies estimate survival to increase through the turbines for both yearling Chinook and steelhead by about 0.75%.

Changes in passage survival**:** Analysis of the proposed Phase I Alternatives including all combined construction actions expected to be implemented during the period of this Biological Opinion at Ice Harbor Dam with 30% spill 24 hours per day is estimated to increase direct survival between 0.2% and 1.1% for yearling Chinook, >0.1% and 0.9% for steelhead, and 0.1% and 1.3% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species originating upstream from this dam.

Optional Alternatives: .If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Ice Harbor dam, potential alternatives for consideration include a behavioral guidance structure in the forebay, extended turbine intake screens, and tailrace divider wall.

Lower Monumental Dam

Existing Configuration and Operations

The existing configuration and operation of Lower Monumental Dam, specific to fish passage is as follows:

Lower Monumental Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflector every bay Bulk Spill to Gas Cap	4/3-6/20 (~27kcfs Day/Night) 6/21-8/31 (17kcfs Day/Night)
Juvenile Bypass System	STS, All Units Bypass Downstream to tailrace or Transport	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	6 Units	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	Yes	~5/4 ~ 8/15 Barge Transport ~ 8/16 - 9/31 Truck Transport
Fish Ladders	2 Main Ladders, 2 primary ascension routes	3/1-12/31

Spring Operations – During the spring at Lower Monumental Dam, the Action Agencies use a combination of spill, bypass, and transportation in an effort to increase survival of fish passing the dams through reduction of turbine entrainment and a trend towards balancing of flow through the project. The Corps estimates that this operation provides survival through the dam of roughly 95%. High spillway survival rates have been achieved by using, fewer gates opened wider, however, this also increased TDG production, therefore limits spill to about 27 kcfs. Transportation is provided at Lower Monumental later in the season when evaluations have shown that adult returns trend towards an increase over allowing fish to migrate inriver.

Summer Operations – During the summer, Lower Monumental Dam uses a combination of spill (17kcfs) and transportation, in an effort to increase survival of fish passing the dam. The Corps estimates that this operation provides survival through the dam of roughly 94%. While transportation is believed to be a good tool for managing the summer migration, the determination of whether inriver migration or transportation yields more adult returns has not yet been established, therefore a "spread the risk" approach has been adopted, until a definitive evaluation has been conducted. In order to spread the risk, an operation of 17kcfs spill would likely serve to achieve an appropriate split of inriver and transport.

Modifications

Passage actions at Lower Monumental Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Herbert G. West). However, in that a very small proportion of Snake River Fall Chinook may occasionally spawn in the Snake River downstream of the powerhouse near Lower Monumental Dam, direct effects to passage should not be attributed to those few fish.

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out additional fish passage actions at Lower Monumental Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions. The COP will identify the actions to implement in the near term (phase I) and others for potential implementation in latter phases if necessary. This document identifies actions that the Action Agencies expect would be recommend by the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. Relative effects of in-river versus transport passage strategies will be a key consideration in recommendations to implement actions and their uses in future project operations.

***RSW*:** An RSW is planned to be installed for operation during the spring of 2008. RSW passage survival is estimated to be about 98% (96-100%) representing an increase in survival through that spill bay of 1.9% for yearling Chinook and steelhead and 3.7% for subyearling Fall Chinook, with an assumed passage effectiveness ranging from 3.5 to 7.3:1 for all species. With the RSW in operation, fewer fish should pass through the turbines, increasing overall dam survival. In addition to the direct survival actions, reduced forebay delay and safe passage through the RSW should decrease the potential for latent mortality.

Primary Bypass: Currently when not transporting from Lower Monumental, fish collected in the bypass system are routed through the juvenile fish facility to get PIT (passive integrated transponder) detections. This operation subjects them to additional dewatering, size separation, and routing through relatively small pipes and flumes. In 2007 the Action Agencies will install a full flow juvenile PIT tag monitoring system on the primary bypass system leading to the 36-inch outfall pipe. This will allow for PIT detections while avoiding potential stressors in the facility while bypassing collected fish back to the river. This modification is estimated to increase bypass survival by about 0.5% for all species. Additionally, the Action Agencies plan to relocate the outfall to an area with higher water velocities and consistent downstream flow. This is expected to decrease predation on the bypassed fish. These actions are estimated to provide up to a 2% improvement in survival for steelhead and yearling Chinook and up to a 3% improvement for subyearling Chinook. Additional effects of reduced latent mortality could result by lower stress, less delay, and lower probability for disease transmission.

Turbine Survival Actions: The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work should yield a 2% increase in turbine survival for yearling Chinook, subyearling Chinook, and steelhead, and a reduction in stressors that may lead to latent mortality.

***Changes in passage survival*:** Analysis of the proposed Phase I alternatives, including all combined construction actions expected to be implemented during the period of this Biological Opinion at Lower Monumental Dam with 30% spill (combined RSW and standard spillbay), is estimated to increase direct survival between 0.6% and 3.4%% for yearling Chinook, 0.5% and 3.3% for steelhead, and 1.3% and 4.2% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives: .If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Lower Monumental dam, potential alternatives for consideration include extended length intake screens, tailrace divider wall, and a behavioral guidance structure in the forebay.

Little Goose Dam

The existing configuration and operation of Little Goose Dam, specific to fish passage is as follows:

Little Goose Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflectors middle 6 bays	4/3-6/20 (30% Day/Night) + 14 days of gas cap 6/21-8/31 (30% Day/Night)
Juvenile Bypass System	ESBS, All Units Bypass Downstream to tailrace or Transport	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	No	NA
Turbines	6 Units	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	Yes	~5/1 ~ 8/15 Barge Transport ~ 8/16 ~ 10/31 Truck Transport
Fish Ladders	1 Main Ladder, 1 primary ascension route	3/1-12/31

Existing Configuration and Operations

Spring and summer operations – At Little Goose Dam, the Action Agencies use a combination of 30% spill, bypass, and transportation in an effort to increase survival of fish passing the dam through a reduction of turbine entrainment and a trend towards balancing of flow through the project. The Corps estimates that this operation provides survival through the dam of roughly 97% in the Spring and 92% in the Summer. Dissolved gas levels are also maintained below total dissolved gas waiver limits with this operation.

Spills greater than 30% tend to create large, strong eddies on both the north and south sides of the tailrace, increasing the predation risk to juveniles and causing adult upstream passage concerns. During the Spring of 2006 with higher percent spills, Lower Monumental and Little Goose ladder counts suggested some delay or blockage in adults passing Little Goose. Further, in summer 2005 passage was completely blocked by tailrace conditions until the spill proportion was dropped to 30%.

Transportation is provided at Little Goose later in the spring season when evaluations have shown that adult returns are increased over allowing fish to migrate inriver. While transportation is believed to be a good tool for managing the summer migration, the determination of whether inriver migration or transportation yields more adult returns has not yet been established, therefore a "spread the risk" approach has been adopted, until a definitive evaluation has been conducted. In order to spread the risk, an operation above 30% spill would likely serve to achieve an appropriate split of inriver and transport.

Modifications

Passage actions at Little Goose Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lake Bryan). However, no direct effects would be attributed to Snake River steelhead or Spring/Summer Chinook populations that spawn in the Tucannon River or the populations of Snake River Fall Chinook that are released downstream of Little Goose Dam from Lyon's Ferry Hatchery or those that are naturally produced in the Tucannon River, Palouse River, and the mainstem Snake River downstream of Little Goose Dam.

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out additional fish passage actions at Little Goose Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions. The COP will identify the actions to implement in the near term (phase I) and others for potential implementation in latter phases if necessary. This document identifies actions that the Action Agencies expect would be recommend by the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. Relative effects of in-river versus transport passage strategies will be a key consideration in recommendations to implement actions and their uses in future project operations.

RSW: A removable spillway weir is scheduled for operation in spring 2009. A survival rate of 98% is expected for yearling Chinook and steelhead (0.8%), and 94% survival for subyearling Chinook (1.0%) through this route based on available survival estimates through spill bays. The RSW operation should decrease the portion of fish passing the turbines, increasing dam survival.

Turbine Survival Actions: The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work may yield up to a 2% increase in turbine survival for spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

Primary Bypass: Modification of the primary bypass system is scheduled for 2008. Presently, the primary bypass outfall is near the shore in a less than optimum location, however, the PIT return to river and facility outfall are well off shore in faster water. The Action Agencies will move the primary outfall to the more preferred location and will include PIT detection, allowing for primary bypass and PIT detection while avoiding secondary dewatering, separation, and smaller flumes. The modification of the bypass system at Little Goose is anticipated to increase survival rates of bypassed yearling Chinook and steelhead by about 0.5% and subyearling Chinook by about 1%. Additional effects will likely include reduced latent mortality through reductions in stress, delay, and potential for disease transmission for bypassed fish.

***Changes in passage survival*:** Analysis of the proposed Phase I alternatives, including all combined construction actions expected to be implemented during the period of this Biological Opinion at Little Goose Dam with 30% spill (RSW and standard spillbays combined), is estimated to increase direct survival between 0.2% and 1.7% for yearling Chinook, 0.3% and 1.6% for steelhead, and 0.9% and 2.1% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives: .If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Little Goose dam, potential alternatives for consideration include a behavioral guidance structure in the forebay, tailrace divider wall, deflector modification in all spillbays, and bypass changes.

Lower Granite Dam

Existing configuration and operation

The existing configuration and operation of Lower Granite Dam, specific to fish passage is as follows:

Lower Granite Dam	Current Configuration	Current Operation (Spring)/(Summer)
Spillway	8 Tainter Gates, Flow deflector every bay RSW Bay 1	4/3-6/20 (20kcfs Day/Night) 6/21-8/31 (17kcfs Day/Night)
Juvenile Bypass System	ESBS, All Units Bypass Downstream to tailrace or Transport	4/1-12/15 Juvenile Passage and Adult Fallback
Surface Bypass	RSW with Spill	~8kcfs as part of Spill
Turbines	6 Units	1% Soft Constraint (11/1-3/31) 1% Hard Constraint, (4/1-10/31)
Transportation	Yes	~4/20 ~ 8/15 Barge Transport ~ 8/16 - 10/31 Truck Transport
Fish Ladders	1 Main Ladder, 1 primary ascension route	3/1-12/31

Rationale for Operations

Spring Operations – During the spring, Lower Granite Dam uses a combination of spill using the RSW (20kcfs) bypass and transportation, in an effort to increase survival of fish passing the dams through reduction of turbine entrainment and a trend towards balancing of flow through the project. The Corps estimates that this operation provides survival through the dam of roughly 97% with survival levels through the bypass system and RSW ranging from 97-98%. Further, bypass survival is nearly as high as RSW survival and fish guidance efficiency is high; therefore, higher spill levels may decrease the survival rate passing the project because spill through non RSW bays tends to have lower survival. Transportation is provided at Lower Granite later in the season when evaluations have shown that adult returns are increased over allowing fish to migrate inriver. Dissolved gas levels are also maintained below total dissolved gas waiver limits with this operation.

Summer Operations – During the summer, Lower Granite Dam uses a combination of spill using the RSW (17kcfs) and transportation, in an effort to increase survival of fish passing the dams. The Corps estimates that this operation provides survival through the dam of roughly 92%. While transportation is believed to be a good tool for managing the summer migration, the determination of whether inriver migration or transportation yields more adult returns has not yet been established, therefore a "spread the risk" approach has been adopted, until a definitive evaluation has been conducted. In order to spread the risk, an operation above 17kcfs spill with RSW would likely serve to achieve an appropriate split of inriver and transport.

Modifications

Passage actions at Lower Granite Dam are expected to directly affect all populations of fish originating upriver from the dam and reservoir (Lower Granite Lake). However, no direct effects would be attributed to Snake River steelhead or Spring/Summer Chinook populations that spawn in the Tucannon River or the populations of Snake River Fall Chinook that are released downstream of Little Goose Dam from Lyon's Ferry Hatchery or those that are naturally produced in the Tucannon River, Palouse River, and the mainstem Snake River downstream of Lower Granite Dam.

The Action Agencies, in coordination with the Regional Forum, will develop a Configuration and Operations Plan that will present a strategy for prioritizing and carrying out additional fish passage actions at Lower Granite Dam. This plan will consider the alternatives listed below, as well as additional potential alternatives, under a range of flows and project operating conditions. The COP will identify the actions to implement in the near term (phase I) and others for potential implementation in latter phases if necessary. This document identifies actions that the Action Agencies expect would be recommend by the COP as Phase I actions. Actual implementation of Phase I actions will be dependent on results of on-going research, regional collaboration and prioritization, and future appropriations. Relative effects of in-river versus transport passage strategies will be a key consideration in recommendations to implement actions and their uses in future project operations.

New Juvenile fish facility: Under consideration for the juvenile fish facility are changes to the collection channel, orifice configuration, primary dewatering, and bypass (with PIT detection) without secondary dewatering. Fish facility modifications are expected to increase bypass survival of yearling Chinook and steelhead up to 1%, and up to a 2% survival increase for bypassed subyearling Chinook. Decreased delay, stress, chance of injury, and reduced opportunity for disease transmission in the new facility are expected to result in reductions in latent mortality for bypassed and transported fish.

Turbine Survival Actions: The Action Agencies will evaluate turbine operation and geometry as a way to increase turbine-passage survival. This effort will employ a biological index test strategy (BIT) to examine both the internal turbine environment as well as the effects turbines have on tailrace egress conditions. The anticipated result of this work is a 2% increase in turbine survival for spring and summer juvenile salmonid migrants, and a reduction in stressors that may lead to latent mortality.

***Changes in passage survival*:** Analysis of the proposed Phase I Alternatives including all combined construction actions expected to be implemented during the period of this Biological Opinion at Lower Granite Dam with combined spill (RSW and standard spillbay) of 20 Kcfs is estimated to increase direct survival between >0.1% and 0.5% for yearling Chinook, >0.1% and 0.2% for steelhead, and >0.1% and 0.4% for subyearling Chinook. These actions are also expected to decrease the potential for latent mortality for all species.

Optional Alternatives: .If the Phase I items described above do not realize the effects anticipated and the overall performance standards are not being met, Phase II items, as outlined in the COP will be considered. For Lower Granite dam, potential alternatives for consideration include a behavioral guidance structure in the forebay, additional surface collection, and debris management.

Overall Anticipated Survival Changes

Therefore, considering the suite of actions proposed at each project for improving passage success over the term of the Biological Opinion, the potential range of per project survival actions is anticipated to yield absolute survival increases for yearling Chinook, for steelhead and for subyearling Chinook (Table 9). In addition, these actions are anticipated to raise dam passage parameters to the performance standards for all species and are expected to decrease the stressors that may be influencing latent mortality.

Table 9. Survival improvements anticipated from configuration and operation actions.

	Anticipated Range of Survival Changes for Configuration and Operation Actions		
	Yearling Chinook	Steelhead	Subyearling Chinook
Bonneville	Up to 1.5%	Up to 2.8%	Up to 4.9%
The Dalles	2.0 - 5.0%	2.0 - 4.8%	2.4 - 8.1%
John Day	1.4 - 2.7%	1.4 - 4.1%	4.4 - 6.4%
McNary*	-0.2 - 0.1%	-0.2 - 0.2%	-0.2 - 0.2%

	Anticipated Range of Survival Changes for Configuration and Operation Actions		
	Yearling Chinook	Steelhead	Subyearling Chinook
Ice Harbor	0.1 - 1.3%	>0.1- 0.9%	0.1 - 1.3%
Lower Monumental	0.6 - 3.4%	0.5 - 3.3%	1.3 – 4.2%
Little Goose	0.2 - 1.7%	0.3 - 1.6%	0.9 – 2.1%
Lower Granite	>0.1 – 0.5%	>0.1 – 0.2%	>0.1 – 0.4%

* - See text for comment

Chief Joseph: Flow deflector construction is underway at Chief Joseph Dam and is expected to be completed in 2008. Deflector construction was initiated in 2005 in response to RPA 136 in the 2000 BiOp and previous discussions on the importance of these deflectors. Chief Joseph dam does not have spill for fish passage but water is spilled at this project and Grand Coulee in order to pass high flows. Investigations by the Corps of Engineers concluded that installation of flow deflectors at Chief Joseph Dam, which is immediately downstream of Grand Coulee, and shifting spill and power generation between the projects is the most cost-effective alternative for gas abatement at these two dams.

With flow deflectors in place, spillway water would not plunge deep into the stilling basin and gas levels from Grand Coulee and Chief Joseph would remain below 120%, the commonly understood threshold for damage to fish and the recommended maximum concentration by NMFS. The effects of lower gas levels would persist downstream as far as Priest Rapids Dam in the mid Columbia River. Without flow deflectors at Chief Joseph Dam, gas concentrations could range from 120% - 135% during the spring snowmelt in one out of four years. This action is anticipated to decrease the potential for direct and latent mortality due to high TDG levels for Upper Columbia River Chinook and steelhead.

Surface Passage Implementation

As noted above, the Action Agencies continue commitments to pursue surface passage actions such as removable spillway weirs (RSWs) or similar surface bypass devices where feasible. These configuration modifications, combined with operational spill levels based on biological performance (to include 24 hour spill where it does not presently occur), are expected to improve juvenile survival, improve forebay and tailrace egress, reduce the potential for predation and decrease the potential for latent mortality at federal dams compared with existing conditions for all ESUs originating upstream from Bonneville Dam. Reductions in TDG would also be anticipated to affect all ESUs. The Action Agencies will expedite the development, installation and testing of surface passage devices at the four lower Columbia River and four lower Snake River dams, consistent with the overall plan identified in Table 10. Inherent with expedited implementation are risks associated with design, cost, schedule and biological effects. The Corps will continue to collaborate regarding the implementation of these structures with the salmon managers and others through the Regional Forum.

Table 10 below includes planning dates for development of surface passage technologies at the mainstem passage projects. These planning dates are subject to change based on regional input, research results, design requirements, annual flow conditions, and funding availability.

Table 10. Surface Passage Actions

Project	**Progress to date**	**Schedule**
Bonneville Second Powerhouse	B2 Corner Collector post-construction monitoring completed in 2005. HiQ PIT Detection: installed in 2006.	• Update Bonneville Configuration and Operation Report 2007 • HiQ PIT detection efficiency testing in 2006 and 2007. • BGS: Investigate using a commercially available shear boom to increase the corner collector's passage efficiency– Design, install and evaluate as warranted.
Bonneville First Powerhouse		• Completion of ITS Modifications Letter Report (2007) • P&S for sluiceway channel and new overflow gate design (2007). • Construct modifications if warranted (2007-08) • Post construction testing (2008)
The Dalles	Evaluate operation of existing sluiceway 2005 Spillwall completed in 2004 Biological test 2004-2006	• Monitoring/Reporting for spillwall evaluation (2006-07) • Update COP report 2006/2007. • Design for spillway modifications in 2007 and 2008. • Construct Modifications if warranted 2009 and 2010.
John Day		• Update COP report 2007 • Prototype installation of PTSW in 2008/2009 pending results of the McNary test in 2007. • Anticipate 24-hour spill and spill testing in 2008 pending installation of PTSW • Surface flow bypass system construction: 2010/2011 • BGS construction if warranted: 2012 • Post Construction Testing: 2011, 2012, 2013
McNary	TSW installed, Biological testing occurring 2007	• Biological studies including approach distribution in forebay, 2005-2007 • Modeling and COP development in 2006/07/08 • Temporary spillway weir test in 2007, pending results potential temporary spillway weir for full testing in 2007 and 2008. • Prototype installation 2009 • Final construction 2012
Ice Harbor	RSW installed 2005 Biological test 2005/06	• Complete COP report 2007/08 • Biological test 2006-07 • Determine need for BGS 2008 • Installation of BGS if warranted

Project	**Progress to date**	**Schedule**
Lower Monumental	Evaluate spillway approach distribution and survival 2005 - 2007	• Complete COP report 2008 • Install RSW FY08 • Biological testing 2008/09
Little Goose	Biological testing approach distribution and survival 2006/07	• Initiate and complete COP report 2008/09 • Complete design and Plans and specs 2007 • Install RSW 2009 • Biological testing 2009/2010
Lower Granite	RSW installed 2001 Biological test 2002-2006	• Complete COP report 2008 • Biological test of BGS in 2006. • Pending results, install BGS if warranted

* McNary Dam: Pursuing testing to verify structure's safety for fish tentatively scheduled for spring 2007 prior to the juvenile migration season. If the structure is viable, install two prototypes at McNary in order to evaluate performance in 2007. This economical approach may potentially advance a final installation at McNary from the 2012 planning date.

1.5 Adult Passage Through the FCRPS

The objective of the adult passage program is to maintain a high level of adult passage survival through the FCRPS and ensure passage times through the system provide for successful escapement to the spawning grounds. Typically, ladders are operated on the Columbia River from March through November and on the Snake River from March through December, however at specific projects, as warranted and where possible, at least one ladder may be operated year round for passage of over wintering steelhead. In the 2004 BiOp, NOAA concluded that adult survival through the FCRPS is similar to survival under un-impounded conditions in the Snake and Columbia Rivers. They also suggested that overall travel times and migration rates of radio and PIT tagged adult salmonids are similar to times and rates observed during early development of the FCRPS when few dams were operational. However, operations for juvenile passage (i.e. voluntary spill) can obstruct passage into ladders by providing unfavorable currents near downstream entrances. Juvenile operations must then be adjusted accordingly to provide good upstream passage conditions.

A considerable number of adult modifications have been incorporated at the projects over the last 30 years as well as a comprehensive adult research program. In order to maintain a high level of adult passage survival, several actions are ongoing and should be continued. These actions are included in three categories of actions including configuration actions, operations and maintenance, and research and monitoring to ensure continued adult passage success.

Lower Granite transition pool modifications. Radiotelemetry studies have shown passage delay at transition pool areas in the adult passage facilities. The Lower Granite transition and junction pools were modified during January and February, 2006 to decrease delay in that fishway. Adult passage will be evaluated in this area in 2006-2007 to determine the effects associated with this modification. Upon completion of the post construction evaluation, modifications at other projects will be considered.

John Day Ladder Modifications: Historically, adult passage times at John Day dam have been among the longest of any FCRPS dam. In ladder temperature differentials, relatively longer passage times when compared to other dams, fish jumping, and difficulties with counting fish have been of concern at John Day dam for many years. A planning effort will consider modifications to the John Day ladder systems including the auxiliary water supply system, lower ladder transition pool, count station, and upper ladder flow control section. Implementation of this plan could begin in 2008 depending on the recommendations of the report. Effects of this action include reducing migration delay for adult salmonids at John Day Dam and improving the accuracy of adult counts.

AWS modifications: Consider auxiliary water supply modifications at The Dalles East Shore. The AWS supply water to the adult fishways and modifications would increase the reliability of the adult passage facilities. There is also a need to make better use of available water through structural changes in the fishway at Lower Granite Dam (e.g. possibly reduce the width of the north shore entrances and close the floating orifice gates). Further modifications at these and all other projects would be achieved through appropriate operational changes and better maintenance.

Installation of adult PIT tag monitoring facilities: Adult PIT tag monitoring facilities have already been installed at Bonneville, McNary, Ice Harbor, and Lower Granite dams. Adult PIT monitoring facilities will also be completed at Bradford Island and McNary North and South shore adult ladders in 2006. The intent of adult PIT facilities is to provide a method for evaluating survival and passage rates for PIT tagged fish through the hydrosystem and potentially to major tributaries.

Installation of additional PIT tag monitoring facilities has been recommended at John Day and The Dalles dams and the Action Agencies will work with the region for installation of additional PIT facilities at other FCRPS projects as warranted.

Adult Trap Modifications at Lower Granite: The adult trap and work platform will be modified to provide for additional fish handling and holding capability.

Adult Fishway Water Temperature Modifications: A study completed by the Corps in 2004 found that water temperature differentials in the adult fishway at Lower Granite Dam during the summer can exceed 5-10 degrees F. Similar but generally lesser differentials were documented at the other Lower Snake River dams. Continuing biological studies will determine the effects of these temperature differentials on fish passage. Pending the results of the study and follow-up discussions with the Regional Agencies and Tribes, corrective actions will be considered if warranted.

Adult Surface Flow Winter Fallback Routes for Over wintering Steelhead: Relatively little is known about the winter distribution or behaviors of adult summer steelhead within the FCRPS. Research has indicated that adult steelhead migration during winter is complex and fallback at some dams in the lower Columbia was quite common during winter. In addition, these results suggest winter mortality in the FCRPS may be disproportionately high for Snake River populations. Undertaking studies at surface passage routes in the lower river during the over wintering period should indicate whether operating these passage routes during the winter can improve escapement of ESA listed steelhead. The appropriate management decision would be made in the Regional Forum after results from RM&E are finalized.

1.6 System Assessments

1.6.1 Flood Control Study

Regarding future system operations, a reconnaissance level study of modifying current system flood control operations to benefit the Columbia River ecosystem, including salmon was completed in 2006 and was coordinated with NOAA and the Region. The Corps does not anticipate further system flood control studies at this time.

1.6.2 Turbine studies

The Turbine Survival Program (TSP) will continue to focus on Biological index testing (BIT) for unique families of turbine units, model investigations and field testing to determine the best turbine operating range for juvenile fish passage, and tailrace egress studies will to establish project operations that optimize tailrace conditions for egress of powerhouse passed fish (both turbine and bypassed fish) as well as spillway passed fish. Turbine pressure investigations will also be conducted to determine the impact of turbine pressures on juvenile fish to support future turbine designs and to support the development of better operational guidelines. In addition, a risk assessment for turbine passed fish utilizing existing field data, laboratory data, physical hydraulic model data and CFD model data will be conducted. This assessment will be updated continually as new data become available. Validation of using the physical models to estimate biological performance of turbines and the turbine environment will also be conducted. Through this work major hydropower system rehabilitations and replacement of aging turbine units will be supported. Specific actions are detailed in Section 1.4.5 juvenile passage improvements section.

1.6.3 Routine Operation and Maintenance of Facilities

Water Control and fish passage facilities require periodic inspection, maintenance and repair. Reclamation and the Corps conduct routine maintenance activities daily, monthly, semi-annually, and annually. In addition, BPA conducts maintenance on the Federal Columbia River Transmission System that can require modifications to project generation. When possible the Agencies will take advantage of low river conditions, low reservoir elevations or periods outside the adult and juvenile migration seasons to accomplish repairs or inspections so that there is little or no affect on normal operations. In some cases, these activities may require reducing the water surface elevation or river flows. However, this is avoided whenever possible and depends on the water conditions of that particular year.

Operation and Maintenance of Juvenile and Adult Fish Passage Facilities

Anadromous adult fish passage facilities, such as fish ladders and auxiliary water supplies, were provided at the time many FCRPS projects were completed. The original facilities have been updated and new facilities added to improve juvenile and adult fish passage. The Action Agencies will continue to operate and maintain these facilities to aid fish passage. Each dam has staff to carry out day to day Operation and Maintenance (O&M) requirements. O&M of fish passage facilities is an ongoing process during the fish passage seasons, and in the case of juvenile fish transportation facilities, is a 24-hour per day program. Fish passage facilities are inspected regularly by project personnel to ensure they are operating within established criteria and to make sure they are effectively and safely passing fish. Major maintenance of fish passage facilities, such as dewatering and annual maintenance of equipment, are conducted during established winter maintenance periods. In-season maintenance of fish passage equipment is accomplished in a manner to minimize impacts on fish passage. The Fish Passage Operations and Maintenance Coordination Team (FPOM) consisting of federal, state, and Tribal representatives, develops operational priorities and O&M criteria that are summarized in the Corps' Fish Passage Plan (FPP). This plan is updated annually and implemented by project personnel and others involved with river operations It can be referenced at http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/. Routine O&M activities will follow procedures identified in the FPP.

1.6.4 Non-Routine Maintenance of Facilities

Operation and Maintenance of Facilities

Non-routine O&M activities are infrequent or one-time activities or are very extensive and so are differentiated from routine O&M. Reclamation and the Corps will conduct non-routine maintenance activities as appropriate as funding and prioritized needs dictate. Non-routine maintenance that affects fish operations or structures will be coordinated in FPOM and/or TMT as appropriate.

Operation and Maintenance of Fish Passage Facilities

Non-routine O&M activities are periodic or one-time activities or are very extensive and so are differentiated from routine O&M. The Corps will conduct non-routine maintenance activities as appropriate as funding and priority needs dictate. Non-routine maintenance that affects fish operations or structures will be coordinated in FPOM and/or TMT as appropriate. To address maintenance of aging structures and equipment, the Corps will continue to inspect and evaluate the maintenance of fishways and associated structures and equipment (including spillways, turbines, and cranes). Any deficiencies identified will be evaluated and determinations made for corrective actions to be taken.

Attachment 1: Fish Operations at Federal Reservoirs

Dworshak

- Operate to standard flood control criteria; shift system flood control to Grand Coulee in below average water years, if possible.
- Provide minimum flows while not exceeding Idaho State TDG water quality standard of 110%.
- Refill by about June 30.
- Draft to meet elevation 1535 feet by end of August with draft to 1520 feet in September.
- Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below 68^{o} F.
- Maximum project discharge for salmon flow augmentation to be within State of Idaho TDG water quality standards

Libby

- Follow interim VARQ flood control procedures
- Follow variable December 31 flood control draft based on early season water supply forecast
- When not operating to minimum flows, operate to achieve 75% chance of reaching the upper flood control rule curve on or about April 10 (the exact date to be determined during inseason management)
- Operate to provide tiered white sturgeon augmentation volumes for spawning/recruitment consistent with the 2006 USFWS BiOp in May, June and July; shaped in coordination with TMT.
- Refill by early July (exact date to be determined during in-season management) as best as possible given available water supply and spring operations and consistent with flood control requirements to provide summer flow augmentation.
- Draft to 10 feet from full by the end of September (except in lowest 20th percentile water years, as measured at The Dalles, when draft increased to 20 feet from full by end of September). If project fails to refill to draft limit, release inflows or operate to meet minimum flows.
- Meet minimum flow requirements for bull trout from May 15 to September 30 and 4000 cfs in October through April for resident fish.
- Provide even or gradually-declining flows during the summer months (minimize double peak).
- Limit spill to avoid exceeding Montana State TDG standard of 110%, when possible, and in a manner consistent with the Action Agencies responsibilities to resident listed fish under the ESA.
- Limit outflow fluctuations by operating to ramping rates set in the 2006 USFWS BiOp to avoid stranding bull trout.

Grand Coulee

- Use standard flood control criteria including adjustments for flood control shifts from Dworshak and Brownlee.
- Operate to achieve 85% chance of reaching URC elevation by about April 10.
- Refill by about June 30 each year (exact date to be determined during inseason management).
- Take advantage of reservoir draft for flood control during high water years to perform drum gate maintenance. Drum gate maintenance may be deferred in some dry water years; however, drum gate maintenance must occur at a minimum one time in a three year period, two times in a five year period and three times in a seven year period.
- Draft to meet salmon flow objectives during July-August with variable draft limit of 1278-1280 feet by August 31 based on the water supply forecast.
    - Implementation of the Lake Roosevelt drawdown component of Washington's Columbia River Water Management Program will draft an additional 1.0 foot in non-drought years and 1.8 feet in drought years from Lake Roosevelt by the end of August for instream and out-of-stream use.
    - Reduce pumping into Banks Lake; and allow Banks Lake to operate up to 5 feet from full

pool during August to help meet salmon flow objectives when needed.

- May be used to help meet tailwater elevations below Bonneville Dam to support chum spawning and incubation.
- Operates to help meet Priest Rapids flow objective to support fall Chinook spawning and incubation.
- Operate to minimize TDG.

Hungry Horse

- Follow interim VARQ flood control procedures.
- Maintain minimum flows all year for bull trout with a sliding scale based on the forecast. Operate to meet minimum flows of 3200-3500 cfs at Columbia Falls on the mainstem Flathead River and 400-900 cfs in the South Fork Flathead River.
- When not operating to minimum flows, operate to achieve 75% chance of reaching URC elevation by about April 10.
- Refill by about June 30 each year (exact date to be determined during inseason management).
- When needed to meet lower Columbia flow augmentation objectives, draft during July-September to a draft limit of 3550 feet (10 feet from full) by September 30, except in the driest 20 percentile of water conditions limit draft to 3540 feet (20 feet from full). If don't refill to the draft limit pass inflows or operate to meet minimum flows.
- Provide even or gradually-declining flows during summer months (minimize double peak).
- Limit spill to maximum of 15% of outflow to avoid exceeding Montana State TDG standards of 110% to the extent possible.
- Limit outflow fluctuations by operating to ramping rates set in 2006 USFWS BiOp to avoid stranding bull trout.

Albeni Falls

- Use standard flood control criteria.
- Operate to provide kokanee spawning conditions (winter pool levels).

Lower Snake projects

- Operate at minimum operating pool (MOP) elevation from April 3 until small numbers of juvenile migrants are present unless adjusted to meet authorized project purposes. For Lower Granite – operate at MOP until enough natural cooling has occurred in the Lower Granite forebay, generally after October 1.
- Configure fish passage facilities and conduct fish passage operations to achieve the juvenile passage performance goals.
- Spill in accordance with Water Management Plan (WMP) Table 4 unless modified by implementation planning and adaptive management decisions.
- Collect fish and transport at Lower Granite, Little Goose and Lower Monumental dams; provide fish spill in years when seasonal average flows are greater than 65,000 cfs during spring months.

Lower Columbia projects

- Operate John Day pool at the lowest elevation that continues to allow irrigation from April 10 through September 30.
- Configure fish passage facilities and conduct fish passage operations to achieve the juvenile passage performance goals.
- Spill in accordance with WMP Table 4 unless modified by implementation planning or adaptive management decisions.
- Collect fish and transport during the summer at McNary unless modified through implementation planning or adaptive management decisions.

Seasonal Flow Objectives and Planning Dates
Operate reservoirs to attempt to meet these flow objectives (UPA Table 3):

Location	Spring Dates	Spring Objective	Summer Dates	Summer Objective
Snake River at Lower Granite Dam	4/03 - 6/20	85 - 100[1]	6/21 - 8/31	50 - 55[1]
Columbia River at McNary Dam	4/10 - 6/30	220 - 260[1]	7/01 - 8/31	200
Columbia River at Priest Rapids Dam	4/10 - 6/30	135	N/A	N/A
Columbia River at Bonneville Dam	11/1 - emergence	125 – 160[2]	N/A	N/A

[1] Objective varies according to water volume forecasts.
[2] Objective varies based on actual and forecasted water conditions.

Flow Objectives to Velocities Conversion Tables

Lower Columbia Water Travel Time

Scenario	July- Aug Ave (Kcfs)	WTT IHR to Bon Pool at Flow days	WTT IHR to Bon Pool at Flow ft/s
Min Spring BIOP	220000	8.8	0.97
Max Spring BIOP	260000	7.4	1.15
Summer BIOP	200000	9.7	0.89

Lower Snake Water Travel Time

Scenario	Flow Ave (Kcfs)	WTT through LGR pool to IHR at Flow days	WTT through LGR pool to IHR at Flow ft/s
Min Spring BIOP	85000	10.1	0.71
Max Spring BIOP	100000	8.6	0.84
Min Summer BIOP	50000	17.2	0.42
Summer BIOP	55000	15.6	0.46

Attachment 2: Operational Flexibilities and Requirements

Operations at Salmon Manager's Discretion

General Principles:

- Consideration will be given to resident fish when making operational decisions.
- The greatest flexibility exists In-Season (April through August).
- While specific minimum reservoir elevations, flow priorities, minimum flows and flow objectives are identified in the Biological Assessment, after meeting statutory and legal obligations, there is some level of flow, and shaping of flow at the salmon manager's discretion during the April – August period (subject to April through July flood control limits).
- Operations at Dworshak for temperature control during July and August are at the salmon manager's discretion, while the Corps meets its statutory obligation (CWA and TDG standards), and must be consistent with the SRBA agreement.
- Aside from planning dates established to bookend juvenile bypass spill; its start and end are at the salmon manager's discretion.
- As long as the planning date for the beginning of MOP operations has been met, the specific operation to draft pools to MOP is at the salmon manager's discretion.
- [PLACEHOLDER] Up to four days of B2 Corner Collector flow will be provided in March for Spring Creek hatchery releases

Period	Operational Discretion
April	▪ On or after April 3 on the Snake and April 10 on the Columbia, specify beginning of juvenile passage spill ▪ Specify beginning and shape of steelhead flows in the mid-Columbia
May	▪ Shape spring flow augmentation for mid-Columbia steelhead as needed.
June	▪ Shape spring flow augmentation for mid-Columbia steelhead as needed. ▪ No later than June 30 dictate transition from spring to summer operation at McNary ▪ Within 2006 USFWS BiOp, set duration and shape of sturgeon pulse at Libby once the Corps has met statutory obligations for flood control. ▪ Use Dworshak as needed to manage temperature (while meeting state TDG objectives)
July	▪ Define shape of summer flow augmentation ▪ Use Dworshak as needed to manage temperature (while meeting state TDG objectives)
August	▪ Define shape of summer flow augmentation ▪ Use Dworshak as needed to manage temperature (while meeting state TDG objectives)

Hydro System Operating Rules

General Principles:

- Operate to meet April 10 Upper Rule Curve at Libby, Hungry Horse and Grand Coulee within parameters described in the BA, while meeting minimum flow requirements.
- Refill storage projects by about June 30 (exact date to be determined through inseason management).
- Draft storage projects no lower than summer draft limits (August 31 for GCL, September 30 for LIB, DWR and HGH) identified in Attachment 1 while meeting statutory obligations. If the project fails to refill to draft limit, release inflows or operate to meet minimum flows.
- Provide flow to meet the Hanford Reach Fall Chinook Protection Program.
- Operate to draft limits informed by flow and temperature objectives identified in section 1.2.1 (Table 2) and Attachment 1. Draft limits may not be needed at all reservoirs in all years to meet these objectives.

- April through August flows are a higher priority than chum flow in the fall and winter.

Project	Operation
Storage Projects	• Implement storage project operations as prescribed in Attachment 1.
Run of River Projects	• Spill in accordance with Tables x and x in section 1.4.1 and Proposed interim transport strategy in table xx in section 1.4.3 unless modified by implementation planning and adaptive management decisions. • End MOP as stated in Attachment 1.

ATTACHMENT 3: Specific Project Passage Improvement Actions

1. Specific Powerhouse Improvement Actions for Substrategy 2.1:

- Bonneville Powerhouse I
  - Sluiceway modifications to optimize surface flow outlet to improve fish passage efficiency (FPE) and reduce forebay delay
  - Minimum-gap turbine runner installation to improve survival of fish passing through turbines
- Bonneville Powerhouse II
  - Screened bypass system modification to improve fish guidance efficiency (FGE) and reduce gatewell residence time
  - Shallow behavioral guidance structure installation to increase corner collector efficiency and reduce forebay delay
- The Dalles Dam
  - Sluiceway modification to improve FPE and reduce forebay delay
  - Turbine operation optimization to improve overall dam survival
  - Phase II Optional - Sluiceway outfall relocation to further improve egress and reduce predation on sluiceway passed fish if needed to achieve performance standards
- John Day Dam
  - Tailrace egress improvements (alternatives include guidewall(s), operation changes, introducing flow into the skeleton bay area…)..
  - Surface flow outlet at the skeleton bays to decrease turbine entrainment, reduce forebay residence time, improve tailrace egress, and increase dam survival. This may be an alternative to or in conjunction with surface spillway weirs.
  - Full-flow bypass and PIT-tag detection installation to reduce handling stress of bypassed fish
  - Turbine operation optimization to improve overall dam survival
  - Phase II Optional - Install extended-length guidance screens to improve FGE if needed to achieve performance standards
  - Phase II Optional – Relocate juvenile bypass outfall to improve egress and reduce predation on bypassed fish if needed to achieve performance standards
- McNary Dam
  - Turbine operation optimization to improve survival of fish passing through turbines
  - Improve debris management to reduce injury of bypass and turbine passed fish
  - Relocate juvenile bypass outfall to improve egress, direct, and indirect survival on bypassed fish
  - Phase II Optional – powerhouse surface flow outlet to improve FPE and reduce forebay delay if needed to achieve performance standards
- Ice Harbor Dam
  - Guidance screen modification to improve FGE
  - Turbine operation optimization to improve survival of turbine passed fish
- Ice Harbor Dam turbine unit 2 replacement (Units 1 and 3 optional)
  - Turbine unit 2 replacement to improve the survival of fish passing through turbines and reduce oil spill potential (Phase II Optional – Replace units 1 and 3 if needed to achieve performance standards)
  - Phase II Optional – Extended-length guidance screen installation to improve FGE if needed to achieve performance standards
- Lower Monumental Dam

    - Full-flow bypass and PIT-tag detection installation to reduce handling stress of bypassed fish
    - Juvenile bypass system outfall relocation to improve egress, direct and indirect survival on bypassed fish
    - Turbine operation optimization to improve the survival of fish passing through turbines
    - Phase II Optional – Extended-length guidance screen installation to improve FGE if needed to achieve performance standards
- Little Goose
    - Turbine operation optimization to improve the survival of fish passing through turbines
    - Full-flow bypass and PIT-tag detection installation to reduce handling stress of bypassed fish
    - Juvenile bypass system outfall relocation to improve egress, direct and indirect survival on bypassed fish
- Lower Granite Dam
    - New juvenile fish facility including orifice configuration changes, primary dewatering, holding for transport, primary bypass, and outfall relocation to improve direct and indirect survival for all collected fish.
    - Turbine operation optimization to improve survival of turbine passed fish
    - Phase II Optional - Improve debris management to reduce injury of bypass and turbine passed fish if needed to achieve performance standards
    - Phase II Optional – Powerhouse surface flow outlet construction if needed to achieve performance standards

2. Specific Spillway Improvement Actions for Substrategy 2.2:

- Bonneville Dam
    - Spillway operation or structure (eg. spillway deflectors) modification to reduce injury and improve survival of spillway passed fish; and to improve conditions for upstream migrants.
- The Dalles Dam
    - Tailrace spill wall extension to increase direct and indirect survival of spillway passed fish
    - Phase II optional - Forebay behavioral guidance structure installation to improve FPE and reduce spill, thereby lowering total dissolved gas (TDG) levels.
- John Day Dam
    - Surface flow outlet(s) construction to increase FPE, reduce forebay delay and improve direct and indirect survival (see also under powerhouse improvements).
    - Phase II optional - Tailrace divider wall construction to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.
    - Phase II optional - Tailrace bathymetry modification to improve egress conditions
    - Phase II Optional - Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay
- McNary Dam
    - Top-spill weir(s) installation to improve FPE and reduce forebay delay.
    - Phase II Optional - Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay
    - Phase II Optional - Tailrace divider wall construction to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.
- Ice Harbor Dam

    - Spillway deflector modification to reduce injury and improve survival of spillway passed fish through the RSW.
    - Phase II Optional - Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay.
    - Phase II Optional - Tailrace divider wall construction to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.
- Lower Monumental Dam
    - Removable spillway weir installation to improve FPE, reduce forebay delay, and improve direct and indirect survival.
    - Phase II Optional – Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay
    - Phase II Optional - Tailrace divider wall construction to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.
- Little Goose Dam
    - Surface spillway weir installation to improve FPE, reduce forebay delay and improve direct and indirect survival.
    - Phase II Optional - Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay
    - Phase II Optional - Tailrace divider wall construction to improve egress and reduce predation; and to reduce entrainment of powerhouse flow into spillway flow, thereby reducing TDG levels.
    - Phase II Optional - Spillway deflector modification to reduce injury and improve survival of spillway passed fish.
- Lower Granite Dam
    - Phase II Optional - Forebay behavioral guidance structure installation to improve FPE and reduce forebay delay.
- Chief Joseph Dam
    - Spillway deflector construction to reduce TDG levels at downstream Columbia River projects

3. Specific Adult Passage Improvement Actions for Substrategy 2.3:

- The Dalles Dam
    - Adult water supply system modification for ladders to improve upstream adult passage conditions
    - Adult PIT-tag detection system installation to allow more comprehensive monitoring of smolt-to-adult returns (SARs)
- John Day Dam
    - Adult ladder systems modification to improve upstream adult passage conditions
    - PIT-tag detection system installation to allow more comprehensive monitoring of smolt-to-adult returns (SARs)
- Lower Granite Dam
    - Adult trap modification to provide greater and more efficient adult collection capability and to reduce handling stress of adult salmonids during collection
    - Adult fishway modification to reduce temperature fluctuations and improve upstream adult passage conditions (need will be determined by results of further research)
- Systemwide
    - Investigate surface-flow outlets during wintertime to provide safer fallback opportunity for over wintering steelhead (need will be determined by results of further research)

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Appendix 1
Rationale for Transport Operation

Development of the Rationale

The Challenge

Transportation has long been viewed as a tool to decrease direct mortality of juvenile fish as they migrate through the Federal Columbia River Power System. While it has been successful at doing so, it has not been the silver bullet that many had hoped for. Results of transport research have been debated for many years and issues including "Differential Delayed Mortality", undetected fish compared to bypassed or transported fish, seasonal effects, and the fact that a large proportion of fish tend to be transported every year (leaving fewer inriver migrants which may then be subject to higher predation) continue to be debated.

Additional scientific challenges include the confounding information associated with inriver survival and SARs. While providing good inriver conditions and structural changes to dams for inriver migrating fish is a priority in this Proposed Action, recent data from NOAA has suggested that there is little tie in with inriver survival and adult returns. While this does not preclude the need to minimize the effects of the hydropower projects, it calls into question the debates about transportation in that the AAs stated goal is to maximize adult returns. Therefore transportation is a critical piece of the puzzle.

Apart from scientific debates, however, are economic and philosophic debates regarding transport. Philosophic debates include premises such as: even if transport is shown to increase adult returns by 10%, inriver migration is preferred in that it is a more natural migration method. Economic concerns include that although spill can provide higher survival at the individual collector projects, it is costly through lost revenue, and transport can help ameliorate those costs. Unfortunately, the lines between these three disciplines are often blurred, leading to the continued conflict.

Through the Biological Remand process, a great deal of concern has been expressed about transportation. In addition to the scientific debate, some concerns have included general concepts including; even with transport, fish will not reach recovery goals; a heavy reliance on transportation will have the effect of decreasing improvements at the dams for those fish that migrate inriver; etc…

The Endangered Species Act is clear that the Action Agencies must use the best available data to make its decisions. By using this information, the Action Agencies understand that the various species of transported fish have various responses to transport, and that what benefits some species during one part of the year, may not be beneficial at another time. Where data appears to be more certain, i.e. in low flow years and during May in most years, actions were proposed that rely on this best available data. Where data is less certain or uncertain, the Action Agencies proposed to better spread the risk (e.g. fall Chinook and late April). In addition, this rationale is further based on directing operations specifically at the species that the Action Agencies are attempting to manage for. This includes a modified, sliding scale to both the initiation and curtailment of summer operations towards better managing for Snake River Fall Chinook.

This transportation strategy should be considered as an interim strategy. When implementation of surface passage structures is complete at the collector projects, this strategy will need to be reevaluated through RM&E efforts. The Action Agencies view transportation as a reasonable tool that can be used towards increasing adult returns and furthering the goal of recovery. When used properly, it can be a strong tool, however when used improperly, it could decrease the potential for adult returns. This Proposed Action for Transportation was developed towards balancing those potential benefits.

What was considered

This rationale for the proposed transportation operation is based on consideration of the best available data regarding transportation and inriver migration, information gathered in the April 2006 meetings of the transportation technical group meeting of the Biological Opinion remand process, and COMPASS model results. The Action Agencies also considered other relevant information including some of the uncertainties surrounding transport that may be affecting different species.

Understanding that the best available data may not be irrefutable, the Action Agencies used the most up to date reports and ad hoc analyses for developing the proposed action. For Snake River Spring/Summer Chinook, recent data analyses have demonstrated that for most years, inriver passage for early spring migrants appears to be the best management option. However, this data also demonstrates that late spring transport appears to be the best management alternative. Fall Chinook, however continue to be difficult to study and the existing data indicates that transport does not appear to either help or harm the species (Williams et al 2005).

As part of the biological remand process, a Transportation Technical Group convened on April 13 and 24, 2006 to discuss spring transport, including the trigger to begin transport, data sufficiency, spreading the risk and potential alternative spring transport operations (See attachments for meeting notes). The Action Agencies considered the information gathered in the technical group meeting and additional information towards developing the proposed transport operation. While the Action Agencies feel that the data appears clear in some areas, there are some critical unknowns regarding operations that we may not be able to answer either at this time or in the future.

The Action Agencies considered some preliminary COMPASS modeling efforts to assist in proposing the following information. The COMPASS results showed that seasonality of initiating transport had significant effects on maximizing adult returns.

Uncertainties considered included the undetected component of fish, the effect of transport on unstudied species (sockeye), the need for a better understanding of the seasonal triggers that may affect this ESU, differential delayed mortality and the consideration of the undetected component of fish.

Proposed Flow Targets:

Rationale for Snake River Flows:

In the 2004 Biological Opinion, an average seasonal flow (Apr-Jun) of 70kcfs at Lower Granite Dam (~ lowest 19% of flow years) was the upper limit described for when the Action Agencies should maximize transport. However, in 2005, seasonal average flows were about 66kcfs, and reasonably high (~53%) inriver survival was measured for yearling Chinook from the Snake River Trap to below Bonneville (Smith et al 2006).

The Action Agencies do not yet have SARs from the 2005 outmigration to determine how relative adult return rates performed for that year, therefore the threshold of 65kcfs (~lowest 15% of flow years) was selected as the top of the range for maximizing transport because of the reasonable inriver survival above that level. Although runoff was low for 2005, this was a unique year with a short peak in flow accompanied with high turbidity, which may have been responsible for the higher survival. The Action Agencies are cautious with attributing this high survival with other low runoff years because fewer migrational cues are available to inriver migrants during low flow years, which may not be represented by the 2005 year. A lower flow year was experienced in 2004 (~67kcfs) and lower than desired inriver survival (~40%) was measured (Smith et al 2006). Therefore 65kcfs is likely a reasonable threshold. This threshold may be revisited once SARs for both transported and inriver fish from this outmigration are analyzed.

Within the average seasonal flow range of 65-80kcfs, there is insufficient empirical data to determine what the most appropriate flow trigger might be for this range; therefore the mid range was selected based on professional judgment. This professional judgment was based in part on past biological opinions where maximum transport trigger was required below 85kcfs and 70kcfs (2000 and 2004 respectively) and the preference of continuing an inriver operation in the early season when inriver migrants typically do better, but increasing transport levels when fish do not perform as well inriver.

When seasonal average flows exceed 80kcfs, inriver conditions are expected to be relatively good, and therefore an inriver operation will be used early, and a spread the risk will be used over the rest of the season, towards maximizing adult returns. This flow range is reasonably supported by the data (Smith et al 2006) where spring Chinook inriver survival between Lower Granite and Bonneville dams exceeded 50% in 1999, 2002 and 2003 when annual average flows exceeded 80kcfs. In addition, (Plumb et al 2006) indicated that when flows were above 85 kcfs, it appeared to provide better inriver conditions for steelhead.

Rationale for McNary Flows:

In 2001, the average seasonal flow at McNary Dam was approximately 124kcfs. During that year, little spill was provided for fish passage throughout the basin, in part due to the potential for a power emergency. Under those conditions, survival for the McNary to John Day Dam reach was approximately 82% for yearling Chinook salmon and approximately 35% for steelhead.

Recent preliminary data from the 2002 outmigration indicated that although upper Columbia hatchery Chinook and steelhead appeared to return at higher SARs when undetected at McNary (i.e. likely passing through spill), transportation yielded roughly 20% more fish than bypassing fish at this location (Marsh AFEP 2006). While the AAs are not proposing transport over bypass at McNary at this time as a routine operation due to the preliminary nature of the data, the indication is that transport would be a reasonable tool during the lowest of low flow years when spill may not be provided.

Proposed Operation Dates:

Spring – Low Flow Conditions

In low flow years (lowest ~15% of all flow years), collection at the transport projects would be initiated on or around April 1, and the dates proposed for initiating transport would be April 3 on the Snake and April 10 at McNary. These have been the planning dates for initiating fish passage operations at the transport projects in the past due to the earliest migrating smolts beginning roughly at this time. By initiating transport at this date in low flow years, the Action Agencies will have the opportunity to transport the most fish through the hydrosystem as possible, thereby providing the largest proportion of the ESUs the best performing route during this low flow condition.

Spring – Above Low Flow Conditions

In above low flow years (highest ~85% of all flow years), operations at the collector projects (bypass only) would be initiated consistent with the low flow years on or around April 1, with the initiation of bypass and spill operations occurring on April 3, 5 and 7 at LGR, LGO and LMN respectively. Bypassing between April 1 and the start of spill would reduce turbine entrainment (likely increasing survival) for those fish entering the turbine intakes prior to spill, but is not anticipated to have a population level effect. A staggered start date is proposed for spill, in that early in the season, the median travel time for fish migrating through the system is roughly 6 days between LGR and LGO and roughly 3 days between LGO and LMN. Staggering of the initiation of spill by only two days at each of the downstream projects was believed to provide faster migrating smolts with spill as they travel downstream.

Beginning around April 21 at Lower Granite, April 29 at LGO and May 2 at Lower Monumental, spill and transportation would be provided, and increased or maximized transportation in the late-mid spring until May 31 at all Snake River Collector projects. While these dates are considered firm planning dates, if in season information (e.g. smolt numbers, fish condition, or inriver conditions) or results of ongoing RME indicates a need for adaptive management, the Action Agencies will consider revising the dates through the regional forum, however with a start date of no later than May 1 at Lower Granite.

Best available data has demonstrated that for Chinook, there is not a benefit for transporting during the early April time frame, and while there are benefits to steelhead, only a small portion of the population is migrating at that time. The proposed planning dates are meant to balance the needs between yearling Chinook and steelhead. Best available data also appears clear that effects of transport for all studied populations during the May time frame appear to have a substantial benefit. There is some level of uncertainty as to what is the best date to transition between these two time frames, therefore a spread the risk approach was taken for a mid-portion of the runs.

Summer Initiation - All flow Conditions

Although Snake River fall Chinook numbers have been increasing under maximized transport operations (close to interim recovery targets), the empirical data is not clear as to whether transportation helps or harms fall Chinook. Therefore, a spread the risk approach will be applied to this species until RME efforts yield better information.

Past biological opinions have focused on June 20 as the planning date for initiating summer operations, due in large part to the tie-in with summer flow augmentation. However, with the increasing population of subyearling Chinook in the Snake River and changes to hatchery practices, larger proportions of subyearling fish are arriving earlier in June. To follow the best available data and provide spread the risk operations for subyearling Chinook, the Action Agencies are proposing to direct project operations at when the species (hatchery and wild) is passing, rather than for a set date.

The Proposed Action indicates that when 50% of the dailycollection at a collector project is composed of subyearling Chinook for a 3 day period, that operations would be shifted to summer operations to target the summer migrating fish. While the Action Agencies understand that the collection at a Juvenile Fish Facility is not always representative of the run at large due to a myriad of conditions (e.g. spill conditions, differential guidance by screens, etc…) it can provide an index of what is passing the dam, and can be useful for planning purposes. For reference, using the 50% 3 day daily passage criteria over the past 6 years would have yielded an initiation of summer operation dates at Lower Granite Dam ranging from June 4 – June 26 rather than just the June 20 date (Table xx). A 3-day criteria was selected over a 1-day criteria to ensure that the summer migration was indeed in progress. In addition, the 3 day criteria is believed to be better assurance that as many of the spring migrants have passed as can be reasonably expected, to better target operations for those species as well.

While the initiation of summer operations using a sliding scale would more accurately tie the management action of spread the risk with the species of interest, only a slightly different proportion of yearling Chinook and steelhead would experience the alternative operation. For example, at Lower Granite, by using the June 20 operation in 2003, approximately 43% of the collected fall Chinook were seen before that date, however using the 50% 3-day criteria (June 7), only 13.5% were detected before the June 7 date, thereby applying the summer operations more appropriately to the summer migrants (Table 1). By changing the summer operations date, the percentage of steelhead and yearling Chinook collection that would be exposed to summer versus spring operations between June 7 and 20 would have been roughly 1.4% and 0.4% more, respectively. Slightly more of those percentages of spring migrants would be exposed to transportation during most flow years, however a population level effect would not be anticipated.

Collection Criteria for LGR Summer Operations		Date	% of Subyearling Chinook Collected before:	% of Steelhead Collected After:	% of Yearling Chinook Collected After:
2001	50% / 1-day	11-Jun	10.2%	4.2%	0.6%
	50% / 3-day	13-Jun	17.7%	4.0%	0.4%
	Standard	20-Jun	29.6%	3.1%	0.2%
2002	50% / 1-day	11-Jun	4.4%	3.2%	1.1%
	50% / 3-day	26-Jun	15.8%	0.8%	0.3%
	Standard	20-Jun	8.1%	1.9%	0.6%
2003	50% / 1-day	2-Jun	8.6%	3.5%	0.7%
	50% / 3-day	7-Jun	13.5%	2.2%	0.5%
	Standard	20-Jun	43.3%	0.8%	0.1%
2004	50% / 1-day	7-Jun	7.0%	1.2%	0.6%
	50% / 3-day	9-Jun	13.7%	1.1%	0.5%
	Standard	20-Jun	47.6%	0.5%	0.3%
2005*	50% / 1-day	2-Jun	48.0%	1.3%	1.0%
	50% / 3-day	4-Jun	58.3%	1.0%	0.7%
	Standard	20-Jun	96.5%	<0.1%	0.1%
2006*	50% / 1-day	2-Jun	29.0%	1.1%	0.8%
	50% / 3-day	4-Jun	46.2%	0.9%	0.5%
	Standard	20-Jun	71.0%	<0.1%	<0.1%

* Summer spill was provided these years, decreasing the total number of fish collected past June 20, skewing collection numbers towards the earlier season.

Table 1. Estimates of the percentages of Snake River ESUs that could be affected by modifying the designation of summer operations from June 20, to a subyearling presence criteria beginning June 1.

Summer Spill Curtailment - All flow Conditions

From 1-31 August, when all collected subyearling Chinook (hatchery and naturally produced) have fallen below 1,000/day for 3 sequential days, spill would be discontinued on a per project basis and max transportation would be initiated, beginning with the most upstream project. If after shutting off spill, collection numbers exceeded 1,000 subyearling fish per day for 2 sequential days, spill would be reinitiated and fish numbers would be reevaluated.

In 2005 and 2006 when summer spill was provided, the maximum number of fish collected for a single day in both August and September was 242 and 303 fish respectively with a daily average of 58 and 63 fish across those 2 months. The last 1,000+ fish day for both of those years was July 5 and 12 respectively. From 2001-2004, years without spill, collection of less than 1,000 fish per day for a 3 day period with a 2 day check-in, occurred between August 5 and 31 (Figure 1).

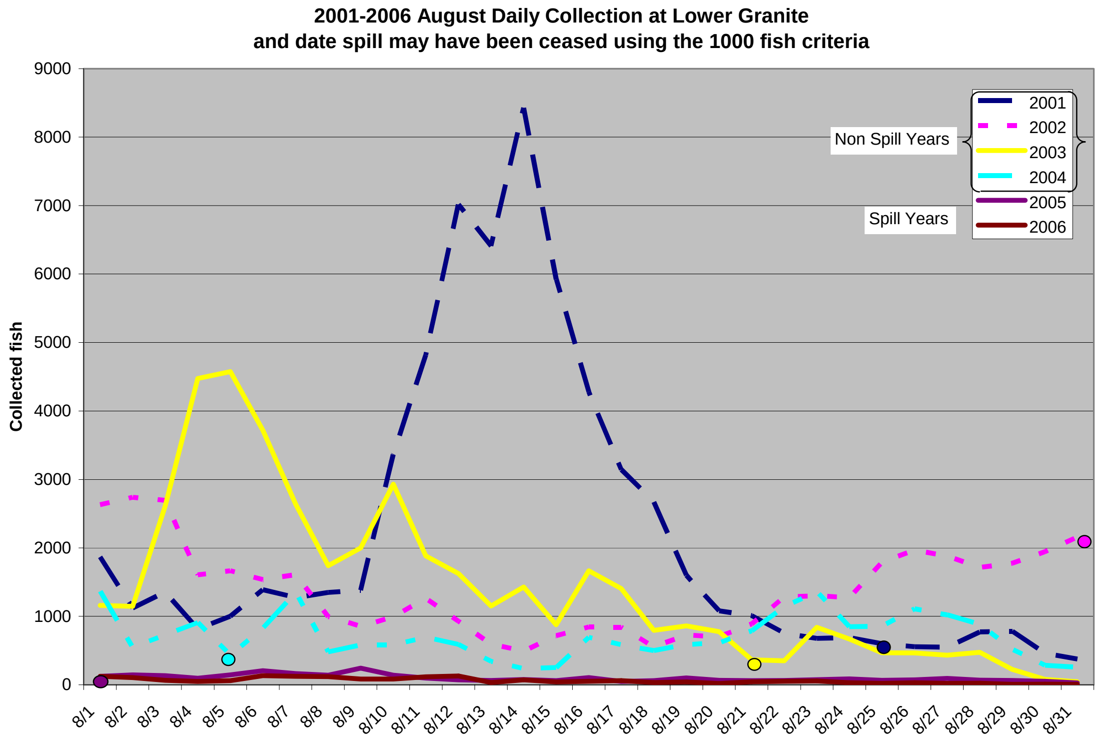


Figure 1. Numbers of subyearling Chinook collected during August at Lower Granite Dam during non summer spill years, 2001-2004, and years when summer spill was provided, 2005-2006.

The 1,000 fish per day threshold was chosen for spill years primarily because it was much higher than the numbers anticipated to be collected in August under a summer spill operation and a daily total of 1,000 fish, over the last six years collections, accounted for .1-.2% of total annual collection. After the 3-day 1,000 fish or Sept 1 threshold was met, collection amounted to a range of 1.9-5.7 % of total annual collection in non-spill years and 0.6-1.7% in spill years. This threshold will likely be adjusted througth adaptive management in the future.

<u>September-October Operations</u>

Between September 1 and 30, transportation would be maximized, and after September 30th, adaptive management (i.e. bypass or transportation) will be considered based on number of fish passing the projects and other factors (e.g. overall fish numbers, numbers of other species collected, river conditions, etc…). In October, operation of the projects in primary bypass mode with PIT detection will be conducted only if necessary for research.

Recent information on trucked fish, (Marsh – NOAA unpublished data), has indicated that trucking fish in the late season has yielded SARs of around 2-4%. While this number is quite high, there remains a question as to what the SARs are for inriver fish during that time. The AAs believe that transportation is beneficial to fish during that operation and believe that truck transportation in the late season is a reasonable tool. The use of this tool may require revisiting and adaptive management in the future.

Proposed Low Flow Operation:

In water years when the Snake River projected seasonal average (April – June) flow is less than 65kcfs (~ lowest 15% of all water years), transportation will be initiated on April 3 at the Snake River collector projects. The seasonal average flow projection will be based on the Corps' STP model and the March – mid month, and revisited through May forecast. Transportation from Snake River projects will be maximized (i.e. no voluntary spill or bypass provided) until May 31.

Twenty-four hour monitoring of the smolt migration would continue at the collector projects to facilitate transportation.

Rationale for Snake River Operation:

In 2001, the region experienced some of the lowest flows on record from the Snake River with a seasonal average flow of approximately 42.5kcfs (~7.7 MAF). Although the majority of fish were transported and little to no spill was provided, inriver survival for Snake River Sp/Su Chinook and Steelhead were some of the lowest measured in recent years (<30% and <5% respectively). The 2000 and 2004 Biological Opinion indicated that in low flow years, below 85kcfs and 70kcfs respectively, that removing fish from the river was the most prudent operation. Justification from the 2004 BiOp, or 2000 BiOp.

Data collected in 2001 indicated a significant benefit of transport, including yielding an 800% increase for wild Chinook salmon, 900% more hatchery spring Chinook, and 1760% more hatchery summer Chinook (Berggren et al 2004) over undetected inriver migrants. NOAA Fisheries conducted an ad hoc analysis on data from the most recent transport years for hatchery Spring Chinook on a weekly time step and showed that when compared to fish bypassed at Lower Granite Dam in 2001, transport yielded roughly 800-4000% more fish back on a weekly basis. In addition, transport yielded more adult returns during every week of that year, including the early weeks when no fish that were returned to the river as juveniles returned as adults. (Muir 2006, attached) For those weeks when there were adult returns to compare to inriver fish, the 95% confidence intervals were all above 1. In addition, the NOAA analysis indicated that for the entire spring transportation period, hatchery Chinook returned to the river at Lower Granite experienced an overall SAR of just 0.04% compared to 1.09% for those transported.

Rationale for McNary Dam Operation:

For McNary Dam, preliminary data for transported upper Columbia hatchery fish (Marsh et al 2006) has demonstrated that in a normal flow year, while spill yielded higher SARs than transported fish, transport yielded higher SARs than bypassed fish.

Therefore, if not spilling during a low flow year due to power emergencies, etc..., the data indicates that transport would likely yield a higher adult return for spring migrants than bypassed fish.

Proposed Low to Mid Low flow operation

In water years when the Snake River projected seasonal average (April – June) flow is between 65 and 80kcfs (~lowest 15-28% of all water years), spill and bypass would be provided beginning April 3rd at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental. Beginning around April 20 at Lower Granite and staggered downstream, spill and transportation would be provided. Transportation would be maximized in the late-mid spring until May 31 at all Snake River Collector projects.

Although proposing to maximize transportation during May, the Action Agencies recognize that some level of spill would be required at the collector projects because May is typically a peak runoff month regardless of water year and some involuntary spill would likely occur. However, when spill is provided, it would be managed to best meet the dam survival performance standards.

Between June 1 and June 30, to spread the risk for migrating subyearling Chinook, spill and transportation would be adaptively managed, such that when subyearling Chinook exceeded 50% of the collection for a 3-day period at each project in turn (beginning with the most upstream project), a spill and transportation operation would be reinitiated.

Although spill and transportation would be initiated on a staggered basis in the Snake River, spill and primary bypass would be provided at McNary Dam throughout the spring until June 15th or when conditions were no longer spring like.

Rationale for Snake River Operation:

Lower Granite Dam

Under these flow conditions, voluntary spill would begin on April 3rd at Lower Granite Dam and would continue through April 30th. All fish collected would be bypassed back to the river through the juvenile fish facility until April 20th, when fish collection for transport would be initiated. On May 1st spill would be either stopped or minimized and transportation would be maximized. If minimized, the spill level provided would be designed to provide good egress and survival conditions. In general, 50% of yearling spring Chinook have typically passed lower Granite by May 1 and 50% of juvenile steelhead by May 9th.

The initiation of transport was delayed in the 2004 UPA due to recent evidence suggesting that early transport was providing no benefit to yearling Chinook, on average before April 20th. (Anderson 2004). Anderson also reported that the benefits to in river passage versus transport reversed at water temperatures in the Lower Granite forebay of about 9.5°C. As a point of reference, the average daily water temperature met or exceeded 9.5°C on April 20 in 9 of the 11 available data years between 1995 and 2006.

Recent data from Petrosky et al (Petrosky report to the ISAB) for the years 1998-2003 has indicated that SARs for bypassed yearling Chinook ranged from 1.76 for the first 1/3 of the Chinook run, 1.03 for the middle 1/3 and .56 for the last 1/3 of the run. On average, for 2001-2006, the first 1/3 of the yearling Chinook run occurs at Lower Granite on about April 30. This indicates that a reasonable management option for transport would include a seasonal component.

In addition, NOAA's ad hoc analysis indicated that for yearling Chinook and Steelhead transported for the week of April 20th-26th (Midpoint of April 23) there was typically a benefit for transporting over bypassing fish at Lower Granite. However, for fish transported up until May 1st, the benefits are typically more modest than during the May timeframe (where they tend to be substantial) and the 95% confidence intervals around the data typically contain the value 1. This provides some level of uncertainty such that recommending spill and transport be provided until sufficient data can be gathered for the late April time frame to recommend one operation over another.

Twenty-four hour monitoring of the smolt migration would continue at Lower Granite Dam. The discussion on the importance of this monitoring in the early season after a new juvenile bypass facility is constructed will be coordinated through the FPOM. Primary bypass would preclude any sampling of fish at this facility, reducing the ability to conduct early season research and annual monitoring of the smolt migration, and is therefore not proposed at this time. Future configurations including the redesign of the juvenile fish facility, would allow for separate transport and bypass of fish of different sizes, or primary bypass of all fish if warranted.

Little Goose Dam

Under these flow conditions, voluntary spill would begin on April 5th at Little Goose Dam and would continue through May 4th. Transportation would be maximized through stopping or minimizing spill beginning May 5th.

The initiation of spill would occur two days after the initiation of spill at Lower Granite Dam. Data suggests that the time for 50% of inriver migrant fish to travel from Lower Granite to Little Goose Dam in April is roughly 4-5 days, therefore providing spill at a two day stagger would provide an inriver passage route at Little Goose to faster migrating fish. The initiation of transport and ceasing of spill would be staggered from Lower Granite Dam by 8 days, which is approximately the time it takes for 80% of the migration to pass Little Goose after passing Lower Granite in late April (NOAA 2006 Attached). The intent is to allow the majority of those fish migrating past Lower Granite inriver to thereby migrate inriver past Little Goose.

After the outfall flume is routed to a better release location and full flow PIT tag detection is added at Little Goose Dam, 24-hour sampling would be discontinued at this site until required for transport, on April 28th, to reduce the potential of fish incurring unnecessary potential stressors in the smaller pipes and flumes of the facility (which possibly lead to potential latent bypass effects). Sampling at the juvenile facility would occur on a limited basis as needed to ensure optimum facility operation and research purposes. Until construction improvements are made, fish will continue to be bypassed via the facility to collect PIT information.

Lower Monumental Dam

Under these flow conditions, voluntary spill would begin on April 7th at Lower Monumental Dam and would continue through May 9th. All fish collected would be bypassed back to the river through the juvenile fish facility until May 1st, when fish collection for transport would be initiated. Spill would then be stopped on May 9th, and transportation would be maximized through stopping or minimizing spill.

The initiation of spill would occur two days after the initiation of spill at Little Goose Dam, because data suggests that the median time for fish to travel from Lower Granite to Little Goose Dam in April is roughly 3 days and providing spill at a two day interval would provide an inriver passage route to the faster migrating fish. The initiation of transport and ceasing of spill would be staggered from Little Goose Dam by 5 days, which is approximately the time it takes for 80% of the migrants to pass Lower Monumental after passing Little Goose in late April (NOAA 2006 Attached). The intent is to allow the majority of those fish migrating past Little Goose Dam inriver to thereby migrate inriver past Lower Monumental Dam.

After the outfall flume is routed to a better location and full flow PIT tag detection is added at Lower Monumental Dam, 24-hour sampling would be discontinued at this site until transport was initiated on May 2, to reduce the potential of fish incurring unnecessary potential stressors in the smaller pipes and flumes of the facility. Sampling at the juvenile facility would occur on a limited basis as needed to ensure optimum facility operation and research purposes. Until construction improvements are made, fish will continue to be bypassed via the facility to collect PIT information.

The Action Agencies would perform RME on fish encountering Lower Monumental Dam to determine if there were benefits to transporting these fish.

Rationale for McNary Operation:

Under these flow conditions, voluntary spill would begin on April 10 at McNary Dam and would continue through June 15th or when conditions were no longer spring like. All fish collected would be bypassed back to the river through the primary bypass until June 15th, when adaptive management for summer operations begin. Sampling at the juvenile facility would be performed in a limited manner, on an as needed basis, to determine facility condition and facilitate research.

Results of RME conducted on upper Columbia Spring Chinook and Steelhead will be assessed upon completion of adult returns in 2008. The use of transportation from this facility as a management tool will be discussed at the FPOM at that time and will either remain in its current status of no spring transport, or will be adjusted (e.g. seasonally, by fish size, etc…) depending on the results of the research, or additional research will be performed if data is unclear. Until that time, operation of the fish facility during the spring at these flows will consist of bypassing only.

Proposed mid-Low to High operation:

When average seasonal flows in the Snake are projected to be above 80kcfs (~72% of all water years), spill would be provided beginning April 3rd at Lower Granite, April 5 at Little Goose and April 7 at Lower Monumental. Spring spill operations would be provided through June 1, however the spill level would be reduced later in the season to the extent possible to facilitate higher transportation ratios. The Action Agencies would plan to initiate transportation on April 21, April 29 and May 2 at LGR, LGO and LMN respectively, however, adaptive management of a start date would be considered through the regional forum, with LGR transportation starting no later than May 1.

However, the Action Agencies will continue to be conservative regarding the start dates of transport. The AAs believe that leaving a large proportion of steelhead in river late into the season, as would occur with a May 1 start date (table 2), would significantly reduce the returning number of steelhead, which typically see strong benefits of transport across the season.

At Lower Granite Dam		% of Fish Collected before April 20	% of Fish Collected before May 1
2001	YR Chin	3.0%	30.8%
	STHD	0.4%	17.8%
2002	YR Chin	14.6%	30.2%
	STHD	10.3%	31.4%
2003	YR Chin	8.7%	36.5%
	STHD	4.8%	27.1%
2004	YR Chin	7.5%	32.0%
	STHD	1.8%	17.2%
2005	YR Chin	4.4%	34.4%
	STHD	2.9%	22.5%
2006	YR Chin	9.1%	28.9%
	STHD	8.2%	36.3%

Table 2. Percentages of the yearling Chinook and steelhead runs at Lower Granite Dam that would have been expected to have been left in river without the opportunity to transport using an April 20 and May 1 transport start criteria.

While proposing an increase in transportation during May, the Action Agencies realize that maximization of transportation will likely mean that some level of spill would be required. May is typically a peak runoff month regardless of water year and while spilling, spill would be optimized towards the operation that best meets the dam survival performance standards.

Lower Granite Dam

Under these flow conditions, voluntary spill would begin on April 3rd at Lower Granite Dam and would continue through June 1. All fish collected would be bypassed back to the river through the juvenile fish facility until April 20th, when fish collection for transport would be initiated. Spill would be reduced in May and June to the extent possible to transport more fish during the time period which has consistently shown the most benefit. Spill would not be discontinued entirely due to the unknown effect of transport on sockeye.

Twenty-four hour monitoring of the smolt migration would continue at Lower Granite Dam. The discussion on the importance of this monitoring in the early season after a new juvenile bypass facility is constructed will be coordinated through the FPOM.

Little Goose Dam

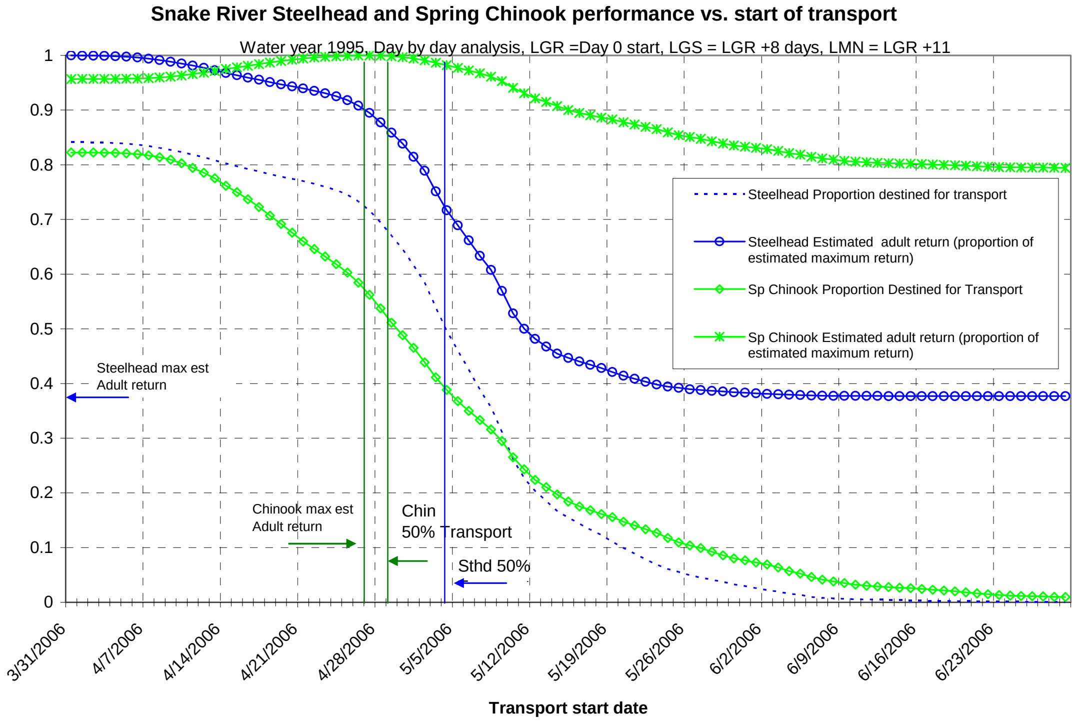
Under these flow conditions, voluntary spill would begin on April 5th at Little Goose Dam and would continue through June 30th. Transportation would be initiated April 29th. Spill would be reduced in May and June to 30% max spill, or RSW and training flow (after implementation) to the extent possible to transport more fish during the time period which has consistently shown the most benefit. Spill would not be discontinued due to the unknown effect of transport on sockeye. Sampling at the juvenile facility would be performed in a limited manner, on an as needed basis to determine facility condition and to facilitate research until required for transport.

Lower Monumental Dam

Under these flow conditions, voluntary spill would begin on April 7th at Lower Monumental Dam and would continue through May 9th. Collection for transport would be initiated on May 1st. Spill would be reduced in May and June to RSW and training flow to the extent possible to transport more fish during the time period which has consistently shown the most benefit for presently studied stocks. Spill would not be discontinued entirely due to the unknown effect of transport on sockeye. Sampling at the juvenile facility would be performed in a limited manner, on an as needed basis to determine facility condition and to facilitate research until required for transport.

COMPASS results

A preliminary COMPASS analysis, using an average water year, indicated that in order to maximize adult returns for yearling Chinook, the optimum transport initiation date was April 27, with 99% of the benefits to adult returns realized between April 20 to May 2 (i.e. if transport were started between those dates, overall adult returns would likely be within 1% of maximum potential). For Snake River steelhead, the optimum time to begin transporting would be March 31 with 99% of the benefits realized if transportation began up to 8 April. To balance the maximization of adult returns for each species, and considering a 95-100% maximization of adult return threshold for both species, the start dates of transport would range from March 31 to Apr 19 for Steelhead, and March 31 to May 9 for yearling Chinook. April 20 was chosen as a planning date because it appeared to have minimal risk to both steelhead and yearling Chinook.



Between 28 April and 5 May, modeled benefits for yearling Chinook adult returns dropped a small amount, from 99 to 98 percent of maximum adult returns. However for steelhead, the modeled benefits dropped from 87 to 69 percent of the benefit during the same time period. This led the Action Agencies to be extremely cautious regarding the modification of the start date to May 1 as requested by many managers in the region, where only 81% of the modeled benefit for steelhead was realized.

References

Berggren, Thomas., Henry Franzoni, Larry Basham, Paul Wilson, Howard Schaller, Charlie Petrosky, Kristen Ryding, Earl Weber, and Ron Boyce. 2004. COMPARATIVE SURVIVAL STUDY (CSS) of PIT Tagged Spring/Summer Chinook 2003/04 Annual Report Migration Years 1997 – 2002 Mark/Recapture Activities and Bootstrap Analysis. BPA Contract #19960200

Plumb, J.M., Russell W. Perry, Noah S. Adams, and Dennis W. Rondorf. 2006. The Effects of River Impoundment and Hatchery Rearing on the Migration Behavior of Juvenile Steelhead in the Lower Snake River, Washington. North American Journal of Fisheries Management 2006; 26:438–452

Smith, Steven, William Muir, Douglas Marsh, John Williams, John Skalski, "Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs", 2005-2006 Annual Report, Project No. 199302900, 125 electronic pages, (BPA Report DOE/BP-00004922-7)

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the federal Columbia River power system on salmonid populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-63, 150 p.

<u>Annexes</u>

Transportation Technical Group for the Remand Process
April 13, 2006 – 13:00-16:00
Bureau of Reclamation Office
Final Notes

Purpose: To discuss spring transport operations for BiOp Remand process including the trigger to begin transport, data sufficiency, spreading the risk and potential alternative spring transport operations.

Guidance: Convene a discussion on the topic of transportation operations for the Remand Process Policy Work Group (PWG). Have at least two meetings prior to April 30 regarding the following topic:

Max Transport vs. spread the risk after April 20, & potential triggers

1) Is there sufficient existing information to warrant going to a transport program that is more seasonally adjusted (e.g. SARS)?

2) Are the proportions of fish transported an appropriate representation of a spread the risk policy and is there information available to support?

3) Does current information support current transportation triggers?

4) What additional information would be helpful to answer these questions and better managing the fish transport program?

Attendees: Blane Bellerud, Tom Berggren (P), Ron Boyce (P), Michele Dehart (P), Margaret Filardo (P), Derek Fryer (P), Kim Fodrea, Bob Heinith, Dave Hurson, Russ Kiefer, Bill Muir, Paul Ocker, Marvin Shutters, Paul Wagner, Rod Woodin

Next Meeting: April 24, 2006
1-4 PST, Columbia Rm A&B, NOAA
1-773-681-5866, passcode 5543

Primary Topics

Two Triggers for Transport

1) The current transport trigger for initiating Snake River Transport at flows above 70kcfs is April 20th at all each of Lower Granite, Little Goose and Lower Monumental Dams.

    a. April 20th Initiation was based on return rates of fish for both across the season.
        i. Chinook demonstrate a trend towards benefits of transport in the late season, but possibly a detriment early in the season
            1. Jim Anderson Corps Report
            2. Bill Muir Handed out data
        ii. ODFW indicated that transport should not occur prior to April 20th
        iii. NWFSC indicated that it may be valuable to provide some level of transport on a research basis for comparative purposes.
            1. The Corps expressed that any study on this operation would need to be done carefully to avoid any bias of low density transport and holding of fish

    b. A proposal was made to move the trigger back to May 1
        i. The stated reason was that the wild yearling Chinook do not appear to have a transport benefit; therefore, we would want to transport as few as possible before that point.
        ii. Muir stated data appeared that same temporal benefits of the hatchery yearling applied to wild yearlings.
        iii. Shutters agreed observing however that the data were more variable and therefore less certain.
        iv. FPC staff indicated they had done some analyses and estimated that 45-48% of the wild spring Chinook and 52% of wild steelhead would be past the dams assuming a 2006 condition and a staggered transport start dates: May 1 at Lower Granite, May 6 at Little Goose, and May 11 at Lower Monumental.
        v. Date was suggested as being later than April 20th when providing spill. Looking at temperature and flow ranges could help.
        vi. The Corps expressed significant concern for steelhead which typically show a benefit for transportation even into the early season
            1. It was suggested that for those fish being bypassed, if we had sufficient separation at the collection facilities, that we could transport those fish that benefited by transport early, and bypass those fish that did not receive a benefit
            2. Significant concern was expressed by IDFG in that undue stress would be caused by separation, therefore the option outlined above was less preferable

2) The second existing trigger for initiating transport involves the predicted seasonal discharge for the lower Snake River. This trigger includes a maximum transport trigger for the entire season for predicted flows under 70k, spill until April 20th and then maximize transport after in years when seasonal average is between 70 and 85k, and finally when seasonal average flows are expected to be above 85k, initiate transport after April 20th and continue a spread the risk operation with spill.

    a. There was a request to reassess transport above the 85kcfs trigger to determine if there should be a transport program at all above that point
        i. The existing data suggests that transport does provide a benefit in high flow years later in the season
        ii. Could we shift the initiation date further out due to good inriver conditions
    b. There was a suggestion that there could be an upper level flow criteria, say about 100-120kcfs where transport does not happen at all that year during the spring
        i. There is not enough data from high flow years in order to set this criterion. There is a little data from 1997 but no data for other high flow years.
    c. There was a concern that max transporting fish in a low flow year was a self fulfilling prophecy, in that fewer fish inriver causes a lower survival rate and therefore boosts the transport benefit
        i. There was a request to study transport versus inriver during low flow years with sufficient fish inriver to truly determine the effect
    d. There was acknowledgement that power generation is more of an issue during the low flow years.

Minimizing Transport, Staggering Operations, Stepped transport

3) Suggestions were made regarding the minimization of the transport program
    a. WDFW expressed a desire to minimize the transport of wild yearling chinook program, and a push was made to examine a later than 1 May date for initiating transport.

    b. IDFG expressed the desire to provide as much spillway passage as possible for wild yearling Chinook

    c. ODFW indicated a desire to have no more than 50% of a population transported in any given year achieved primarily by providing spillway and RSW passage for inriver migrants

    d. CRITFC would like to see spread-the-risk operations in all years, even low flow years, given the limited data available on a wide variety of flow years. Also CRTIFC is very concerned about sockeye and would like to see spill for them.

e. The suggestion was made to minimize transport sites that have not provided a notable benefit to stocks

f. Lower Monumental was suggested for changing operations from transport to full flow bypass only
    i. Shutters stated that significant changes at Lower Monumental over the last 5 years have likely decreased the risk of stress and injury to those fish, therefore transport starting in 2005may yield higher adult returns
    ii. Muir pointed out that T?M from a biological perspective would be expected to decrease as you go farther downstream in that you would be bypassing fewer projects

g. Another suggestion was made to limit transportation at Lower Monumental to those fish migrating late in the season since it may be wise to move those late migrating juveniles out

h. The suggestion was made to minimize cumulative stress
    i. Minimizing separation effects could reduce stress
    ii. Implementation of surface passage routes may provide better inriver passage routes, decreasing our reliance on transportation

i. The suggestion was made that if we had a trigger date for transport at an upstream dam, that a staggered initiation of transport at downstream dams would be reasonable
    i. There was some push for this to occur in 2006. There was a suggestion and general agreement that changes to this year's operation should be taken to the TMT for discussion.
    ii. The suggestion was made that a 3-5 day lag time per initiation of transport at each dam may be reasonable based on smolt migration time between dams

j. The suggestion was made that a stepped level of transport may be appropriate with maximized inriver fish early, a moderate level of transport mid season as a spread the risk and a ramped up transport rate late in the season
    i. Suggestion was made that perhaps 0 transport with spill early, perhaps a 50/50 mid season, and heavier transport later in the season would be appropriate.
    ii. The question was brought up regarding Fall Chinook, when the trigger would end. The concern is that fall Chinook begin migrating late in the spring season when spring Chinook may benefit from maximized transport.
        1. It was suggested perhaps the planning dates would remain the same, about June 15
        2. It was suggested that it may be based on numbers of FACH present
    iii. The question what is the appropriate management option for of Sockeye was brought up in that they migrate late in the season

k. It was discussed that as we put more fish inriver, that the benefits may change the trigger date.
    i. The more inriver migrating fish that occur earlier in the season may reduce the predators effects on inriver migrating stocks, therefore the trigger date may move later in the season

Other Considerations

Spread The Risk — There was discussion of the need to define what is meant by spread the risk. To some it means that a 50/50 split of transport and inriver migration is targeted for the population. To some it means that no more than 50% are transported. To others, it makes more sense to provide the best operation possible when/where data is available, and then target a 50/50 split during periods when the data is not clear or not available.

The Corps — indicated that if we do substantially shift the start of transport, that we needed to accurately shift the D value (based on the seasonal numbers that Bill Muir showed to us) in the COMPASS modeling efforts.

IDFG — There was a suggestion that if the transport-to-inriver ratio is near one or even slightly higher than one (say 1.1) then the fish should be left inriver because it is the more natural migration choice.

Indicated that a spread the risk strategy would be preferable. The strategy could be to transport more steelhead (60% transport and 40% spilled) yet spill more yearling Chinook (40% transport and 60% spill). Spillway passage would be preferred over bypass with RSWs playing a large factor.

There is not enough data on Sockeye to make an informed decision. However, considering that most sockeye are transported and we do not have rebounding stocks, IDFG does not believe that transport is a viable management tool for this stock. Therefore some level of spill would be advocated for SR Sockeye and Max transport would not be.

ODFW — indicated that no more than 50% of a population should be transported

WDFW — indicated that yes we get the most benefit to transport when most of the fish are there; however, could it be done better? E.g. could reduce the crowding (more barges) and stress (direct loading so that fish are not handled twice) dramatically boost the numbers during that time of year when the barges are the fullest? Can we do the transport better? We should focus on steelhead?

If we can increase the SAR for these fish, is it enough to fill the gap?

Based on the data available it appears reasonable to make a management change, however future investigations will be required to assess that change and confirm the operation.

We should have a discussion on McNary Transportation for Fall Chinook

CRITFC is not comfortable with any more than a 50% transport component.

Would prefer a continued spread the risk, even in low flow years

Maximize spill for sockeye

Questioned whether a transportation program was really necessary.

NOAA Believes that this discussion is going in the right direction

Rather than just adopting a trigger date, more effort should be placed on learning the appropriate initiation trigger, which seems to be something going on in the ocean/estuary: temperature, chlorophyll in the estuary, assuring that the salmon arrive when their predators have other prey available to consume, PDO, satellite imaging, etcetera.

In considering the question of spread the risk, it should be used as a tool to address uncertainty.

Data available

2) Williams declaration
3) Williams, J. G., S. G. Smith, R. W. Zabel, W. D. Muir, M. D. Scheuerell, B. P. Sandford, D. M. Marsh, R. A. McNatt, and S. Achord. 2005. Effects of the Federal Columbia River Power System on salmonid populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-63, 150 p.

Immediate Data Needs

Power analysis on a weekly basis for all years to look at trends?

Data for smolt run timing between dams early in the season?

RME

Future transport and in river studies would need to occur after initiating the new transport program
Data would be necessary in some sort of time step, monthly, 10 day weekly, etc…
Presently the tails of the data (early and Late season) are weak data points and it may be valuable to increase the data confidence at those locations to make better informed decisions.
Higher levels of Sockeye tagging may be required
Research should be continued to determine the primary factor causing the temporal patterns in SAR so that operations could be better targeted to maximize the operational transport.
ODFW indicated that the primary metric should be undetected versus transported.

Additional Topics

It will be challenging to estimate weekly early season SAR while at the same time minimizing transportation

Follow up in regard to the discussion on transporting B-side fish from Little Goose prior to the targeted transportation of yearling Chinook:

> The operation at Little Goose and Lower Granite prior to transportation, at the request of FPAC, is for all collected fish to be passed through the juvenile fish facility, including the separator so that the fish are returned through the outfall far out into the river and also to get PIT detections. Therefore, there would be no added stress or handling to A-side fish to transport the B-side fish.

Need to explicitly state whether maximization of transport would include shutting off spill.

Transportation Technical Group for the Remand Process
April 24, 2006 – 13:00-16:00
Bureau of Reclamation Office
Draft Notes

Purpose: To discuss spring transport operations for BiOp Remand process including the trigger to begin transport, data sufficiency, spreading the risk and potential alternative spring transport operations.

Attendees: Tom Berggren (P), Ron Boyce (P), Margaret Filardo (P), Kim Fodrea, Dave Hurson, Russ Kiefer, Bill Muir, Paul Ocker, Marvin Shutters, Jason Sweet, Paul Wagner, Rod Woodin

Next Meeting: Not Set

Note: It is important to note that the meeting notes from April 13 and those from April 24th draw heavily upon each other and both sets of meeting notes should be considered when reviewing this information

Response to PWG Questions

The technical work group believed that it would be prudent to directly answer the 4 questions posed by the PWG. Additional information was provided to coincide with the guidance that the discussion should not be limited to those questions. The following should be understood as the technical discussions and further discussions at the policy level will be forthcoming.

Q. 1 **Is there sufficient existing information to warrant going to a Max Transport vs. spread the risk after April 20th?**

A.1 Overall, the group agreed that there was sufficient uncertainty in the data presented by Bill Muir for Sp/Su Chinook and Steelhead (See attached 1), particularly in the tail ends of the run, such that going to a maximized transport scenario after April 20th was likely not supportable from the standpoint of existing biological data. Maximization of transportation may not be prudent late in the season when considering that sockeye migrate during that time (Attachment 2) and that it was estimated that somewhere around 70% of sockeye have been transported in the past (See Attachment 3) and the run is still in decline. The Williams - NOAA tech memo indicates that sockeye do not appear to have been benefited by transport.

Q.2 **Are the proportions of fish transported an appropriate representation of a spread the risk policy and is there information available to support this?**

A.2 The first part of this question was believed to be a policy question as to what the preferred level of transportation should be; however the technical group discussed the overall question of spread the risk with a range of responses (See attachment 4).

For the second half of the question, sufficient information exists to inform a spread the risk if percentage of fish is the policy call. From 1993-2003, a range of 61.5% to 99.3% of fish have been transported (See attachment 3) from the collector projects depending on flow year and stock of fish.

Q.3 Does current information support current transportation triggers?

A.3 This was considered a two part question. The first trigger was considered to be when to transport based on the annual flow forecast, and the second trigger would be as to when to initiate transport in any given year.

As far as the flow target for initiating transport, it was generally understood that the trigger of 85kcfs was taken from historic documentation and had not been examined using existing biological information. The trigger of 70kcfs was based on professional judgment. (See attachment 5) There was a desire by some to reduce the existing targets towards a spread the risk program during the lower flow years.

There was not agreement on what was appropriate for a start date in a given year. Although most were in agreement that transport should not start before April 20th during most flow years, there was a desire by some to keep more fish in river during the early part of the season, so a May 1st date was proposed. In addition, a staggered transportation date at downstream projects may be appropriate. Early dates could be informed by Bill Muir's data (Attachment 6)

Q.4 What additional information would be helpful to answer these questions and better managing the fish transport program?

A.4 This question was taken as a two part question. The first would be whether there were existing or pending data that had yet to be analyzed towards further resolving the above questions, the second was what RM&E would be required in the future to address these topics.

Additional review of data, including examining the bypassed group in Bill Muir's and other data should be considered more so in the context of undetected fish. It was determined that this may be possible, but the methods would need to be worked out.

Further RM&E would likely need to use a long-term monitoring and evaluation to assess any changes that were made. This would encompass an assessment of changes made to lower flow operations as well as higher flow. Discussion of time step was discussed as either a weekly or monthly analysis but agreement was not reached. The preference would be to use wild and hatchery fish if adequate numbers could be obtained, (a surrogate sp/su Chinook raised to wild size was suggested to represent the wild stocks). Further monitoring of the ocean may be a key RME factor as to when to initiate transport, a real time management may be achievable through examining satellite imagery and chlorophyll concentrations off the coast to indicate better ocean conditions for starting transport in any given flow year. ODFW indicated that any decisions we make or RME to be performed should incorporate looking at the undetected component of fish as compared to transport, not just the bypassed component.

Immediate Data Needs

Could a power analysis on a weekly basis be done for all years to look at trends?

Bill Muir could provide CIs and Ns on the data he presented, however, it may tell us what we already know, that the CIs are wide and the Ns are small in the tails.

Thoughts expressed regarding Future RM&E

ODFW expressed a strong desire for the primary metric for any transport comparisons to be made with undetected fish.

Examining the undetected fish as compared to bypassed fish is more of a challenge in that we still do not have an accurate assessment of when undetected fish out migrate.

Using bypassed fish as a surrogate for inriver may be appropriate if we can agree on a possible method and mechanism, including the potential to adjust bypassed fish SAR using a factor for SARs for undetected fish.

NOAA indicated that size selectivity of bypass systems may still be an issue and should be considered a potential mechanism for transport and inriver success.

Concern was expressed that fish tagged at Lower Granite have consistently shown a lower than desired SAR as compared to fish that are not tagged at LGR. This was noted in the Williams Tech Memo. Tagging at Lower Granite is a less desirable technique, but tagging above the dam may require a huge number of fish. It was noted that in a comparative study, it would not necessarily be appropriate to compare absolute SARs, rather just the comparative.

A long term monitoring program would need to occur for the population, regardless of seasonality. There is also the need to answer specific questions including seasonality.

The RM&E was assumed to be with present day technology and would rely heavily on PIT technology. Should other techniques come in the future, these may need some adaptive management and regional discussion.

The important thing to do is make a management change and thoroughly monitor/evaluate it.

Data would be necessary in some sort of time step, monthly, 10 day, weekly, etc…

Presently the tails of the data (early and Late season) are weak data points and it may be valuable to increase the data confidence at those locations to make better informed decisions.

Higher levels of Sockeye tagging may be required

Research should be continued to determine the primary factor causing the temporal patterns in SAR so that operations could be better targeted to maximize the potential benefit of transport.

Research should be conducted to determine if there is an ability to increase the benefit of transport during those times when most of the fish are present. If the present benefits are high, then can we make them higher?

Attachment 1

Data from Bill Muir regarding seasonal transport to bypass SARs

Wild and Hatchery Chinook and Wild and Hatchery Steelhead

Table 1. Weekly and yearly estimates of percent migrant survival (S_M) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SAR_T) or returned to the river (SAR_M) at Lower Granite Dam, transport migrant ratio ($T:M$), and post-hydropower system differential mortality (D) **for hatchery Chinook salmon** PIT-tagged upstream of Lower Granite Dam, 1997-2002. An value of 0.98 was used for survival during transport (S_T).

	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1997					
S_M	-	55.5	48.0	71.9	46.0	35.8	49.2	-	-	48.5
SAR_T	-	-	0.10	0.81	1.09	0.86	1.09	0.30	0.76	0.89
SAR_M	-	-	0.00	1.36	0.81	1.10	0.42	0.21	-	0.69
$T:M$	-	-	-	0.60	1.35	0.78	2.60	1.43	-	1.29
D	-	-	-	0.44	0.63	0.28	1.31	-	-	0.64
					1998					
S_M	-	50.2	51.5	55.0	54.0	56.2	57.1	60.9	45.7	53.3
SAR_T	0.43	0.59	0.77	0.98	2.22	2.37	2.39	1.74	-	1.73
SAR_M	1.84	2.27	1.25	0.88	0.51	0.54	0.82	1.88	-	0.73
$T:M$	0.23	0.26	0.62	1.11	4.35	4.39	2.91	0.93	-	2.37
D	-	0.13	0.33	0.62	2.40	2.52	1.70	0.58	-	1.29
					1999					
S_M	51.5	54.1	45.4	54.7	56.0	56.5	57.5	56.7	49.5	55.7
SAR_T	-	-	0.00	0.76	2.32	3.20	4.01	3.86	4.61	2.75
SAR_M	-	-	0.80	0.82	1.33	1.60	1.57	1.70	2.93	1.47
$T:M$	-	-	-	0.93	1.74	2.00	2.55	2.27	1.57	1.87
D	-	-	-	0.52	1.00	1.15	1.50	1.31	0.79	1.06

Table 1. Continued.

					2000					
S_M	-	-	58.2	45.6	48.6	46.8	45.5	45.6	52.0	48.8
SAR_T	-	-	1.61	1.97	2.71	3.34	3.99	4.27	1.71	3.07
SAR_M	-	-	1.12	1.48	1.80	1.95	1.08	0.50	0.91	1.56
T:M	-	-	1.44	1.33	1.51	1.71	3.69	8.54	2.21	1.97
D	-	-	0.85	0.62	0.75	0.82	1.71	3.97	1.17	0.98
					2001					
S_M	-	15.4	28.8	29.5	29.6	25.9	22.8	17.5	8.3	27.8
SAR_T	0.00	0.68	0.91	0.66	1.02	1.64	1.17	1.02	1.02	1.09
SAR_M	0.00	0.00	0.00	0.05	0.05	0.04	0.03	0.00	0.11	0.04
T:M	-	-	-	13.20	20.40	41.00	39.00	-	9.27	27.25
D	-	-	-	3.97	6.16	10.84	9.07	-	0.78	7.73
					2002					
S_M	44.9	55.0	56.5	58.4	59.1	58.0	59.3	60.0	-	57.9
SAR_T	0.98	1.08	0.35	0.67	0.85	1.00	1.96	2.08	-	1.20
SAR_M	-	0.38	0.75	0.66	0.63	0.76	0.86	0.89	0.41	0.76
T:M	-	2.84	0.47	1.01	1.35	1.32	2.28	2.34	-	1.58
D	-	1.59	0.27	0.60	0.81	0.78	1.38	1.43	-	0.93

Table 2. Weekly and yearly estimates of percent migrant survival (S_M) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SAR_T) or returned to the river (SAR_M) at Lower Granite Dam, transport migrant ratio ($T:M$), and post-hydropower system differential mortality (D) for **wild Chinook salmon** PIT-tagged at Lower Granite Dam, 1998, 1999, and 2002. A value of 0.98 was used for survival during transport (S_T).

	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1998					
S_M	-	51.9	53.8	52.2	61.6	53.8	54.9	45.9	42.7	53.2
SAR_T	-	1.41	0.65	0.31	0.60	0.41	0.00	-	-	0.60
SAR_M	-	1.58	0.90	0.13	0.37	0.27	0.31	-	-	0.63
$T:M$	-	0.89	0.72	2.38	1.62	1.52	-	-	-	0.95
D		0.47	0.40	1.27	1.02	0.83	-	-	-	0.52
					1999					
S_M	52.7	57.7	57.6	55.9	56.5	53.0	50.4	53.5	-	55.7
SAR_T	1.04	0.78	1.26	1.33	2.72	2.30	4.53	-	-	2.11
SAR_M	1.27	1.53	0.24	0.91	1.82	1.53	0.55	-	-	1.22
$T:M$	0.82	0.51	5.25	1.46	1.49	1.50	8.24	-	-	1.73
D	0.44	0.30	3.09	0.83	0.86	0.81	4.24	-	-	0.98
					2002					
S_M	-	56.5	56.3	67.8	53.7	58.0	48.8	65.9	83.9	58.6
SAR_T	-	0.89	0.38	1.31	1.02	0.57	0.47	2.42	1.69	1.25
SAR_M	-	1.41	0.97	0.55	0.48	0.65	0.92	0.62	0.59	0.69
$T:M$	-	0.63	0.39	2.38	2.13	0.88	0.51	3.90	2.86	1.81
D	-	0.36	0.22	1.65	1.17	0.52	0.25	2.62	2.45	1.08

Table 3. Weekly and yearly estimates of percent migrant survival (S_M) from Lower Granite Dam to Bonneville Dam, percent smolt-to-adult return for fish transported (SAR_T) or returned to the river (SAR_M) at Lower Granite Dam, transport migrant ratio (*T:M*), and post-hydropower system differential mortality (*D*) for **wild and hatchery steelhead** PIT-tagged at Lower Granite Dam, 1999-2002. A value of 0.98 was used for survival during transport (S_T).

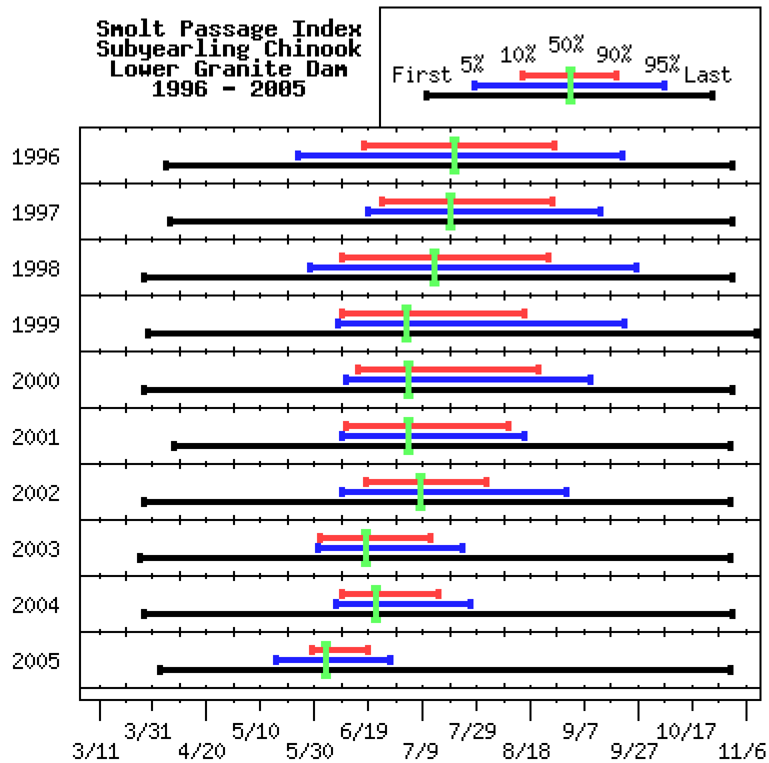
	April 2	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	Year
					1999 (hatchery)					
S_M	48.1	44.7	45.4	44.2	42.7	37.8	39.8	49.1	46.9	43.1
SAR_T	0.00	0.17	0.21	0.73	1.06	1.25	1.19	1.39	0.90	1.08
SAR_M	0.81	0.29	0.79	0.72	0.71	0.77	0.57	0.44	0.37	0.60
T:M	0.00	0.60	0.26	1.01	1.51	1.61	2.08	3.16	2.45	1.79
D	-	0.27	0.12	0.46	0.66	0.62	0.84	1.58	1.17	0.79
					1999 (wild)					
S_M	45.4	53.0	57.6	49.3	49.9	40.3	43.3	47.6	50.4	47.7
SAR_T	-	-	-	1.13	1.14	1.29	2.40	3.14	1.07	1.42
SAR_M	-	-	0.78	0.96	0.38	0.48	0.96	0.61	0.81	0.68
T:M	-	-	-	1.18	2.95	2.70	2.49	5.16	1.33	2.08
D	-	-	-	0.59	1.50	1.11	1.10	2.51	0.68	1.01
					2002 (wild)					
S_M	-	-	32.3	30.6	19.3	23.1	22.5	28.6	-	28.9
SAR_T	-	-	4.49	1.80	3.15	1.44	-	1.44	3.27	2.60
SAR_M	-	2.40	1.52	0.57	0.17	0.35	0.35	0.23	0.40	0.61
T:M	-	-	2.95	3.16	18.87	4.12	-	6.27	8.13	4.29
D	-	-	0.97	0.99	3.72	0.97	-	1.83	-	1.26

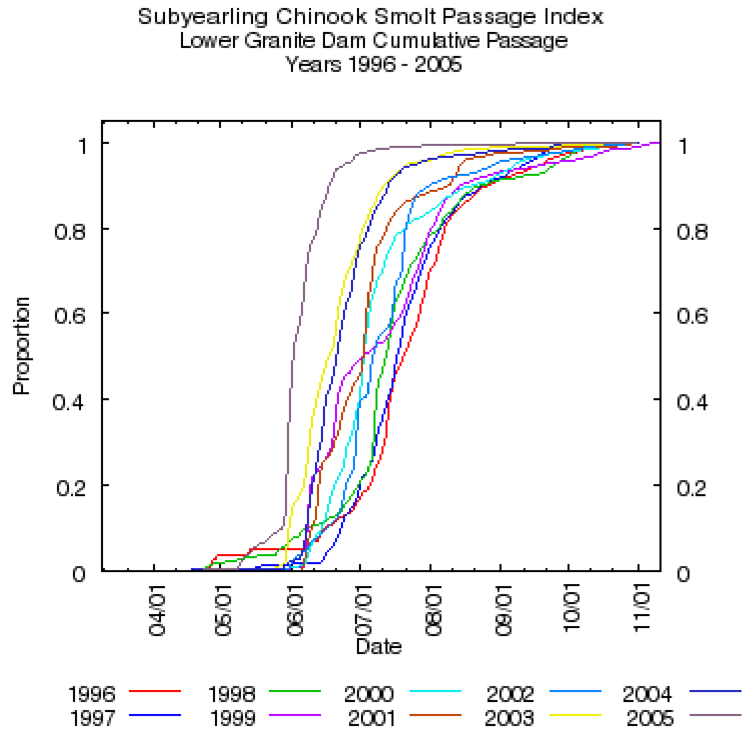
Attachment 2

Data from Dart Regarding Run Timing of Smolts at Lower Granite Dam

Steelhead, Sp/Su Chinook, Sockeye and Subyearling Chinook

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Subyearling Chinook at Lower Granite Dam
Data Courtesy of Fish Passage Center

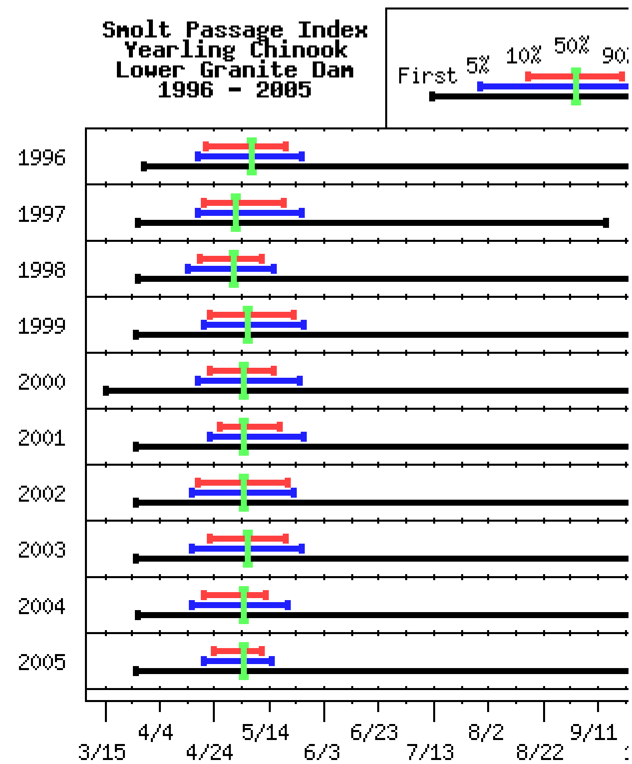


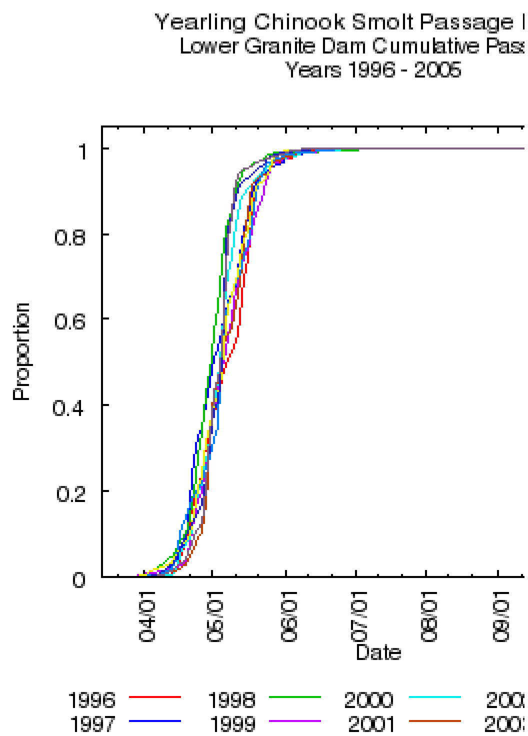


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	04/04	04/27	05/23	06/16	07/20	08/26	09/20	10/31	72
1997	04/06	05/17	06/19	06/24	07/19	08/26	09/13	11/01	64
1998	03/28	04/29	05/28	06/09	07/13	08/25	09/26	11/01	78
1999	03/29	06/07	06/08	06/09	07/03	08/16	09/22	11/10	69
2000	03/27	06/04	06/10	06/14	07/03	08/20	09/08	10/31	68
2001	04/08	06/07	06/09	06/11	07/04	08/10	08/16	10/31	61
2002	03/28	06/02	06/09	06/18	07/08	08/02	08/31	10/31	46
2003	03/26	05/27	05/31	06/01	06/18	07/12	07/24	10/31	42
2004	03/27	05/29	06/06	06/08	06/21	07/14	07/26	10/31	37
2005	04/03	05/10	05/16	05/29	06/03	06/19	06/27	10/31	22

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Yearling Chinook at Lower Granite Dam
Data Courtesy of Fish Passage Center

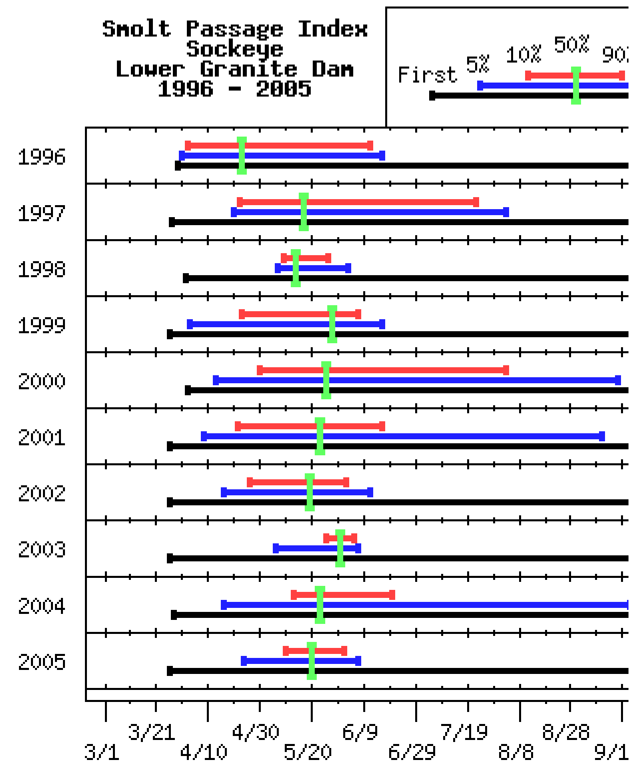


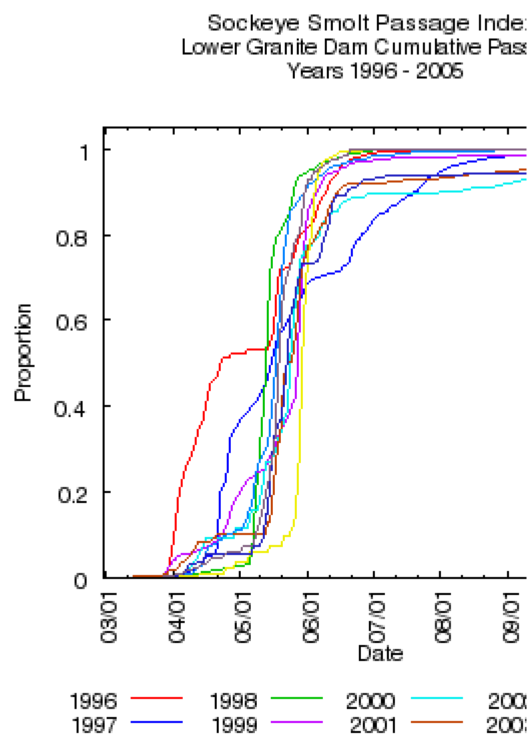


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	03/28	04/13	04/17	04/20	05/07	05/19	05/25	10/31	30
1997	03/27	04/10	04/18	04/20	05/02	05/19	05/26	09/14	30
1998	03/27	04/05	04/14	04/19	05/01	05/11	05/16	11/01	23
1999	03/26	04/05	04/20	04/22	05/06	05/23	05/27	11/10	32
2000	03/14	04/13	04/17	04/21	05/04	05/15	05/24	10/31	25
2001	03/26	04/12	04/22	04/26	05/05	05/18	05/27	10/31	23
2002	03/26	04/11	04/16	04/18	05/05	05/21	05/23	10/31	34
2003	03/26	04/04	04/16	04/22	05/06	05/20	05/26	10/31	29
2004	03/26	04/08	04/15	04/19	05/04	05/12	05/20	10/31	24
2005	03/26	04/12	04/20	04/24	05/05	05/11	05/15	10/31	18

* * Columbia River DART * * 10 Year Historical Run Timing Smolt Passage Index Sockeye at Lower Granite Dam
Data Courtesy of Fish Passage Center

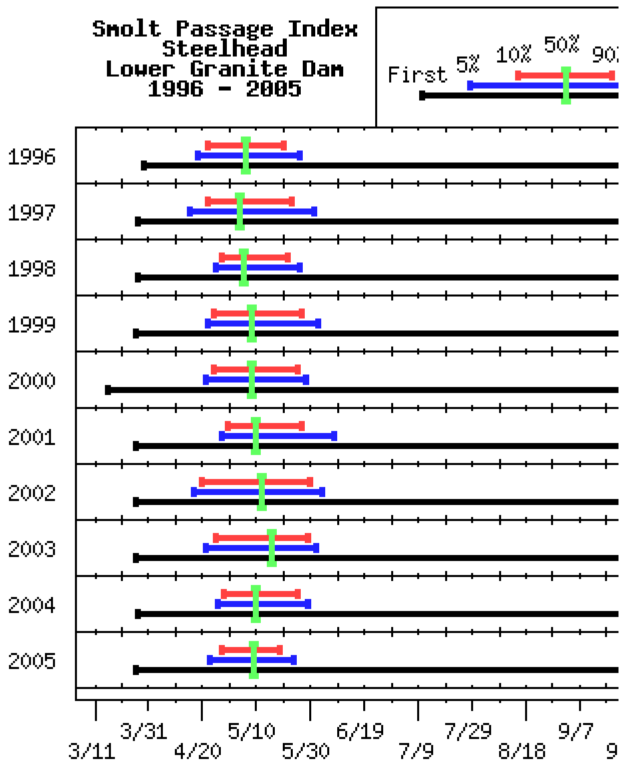


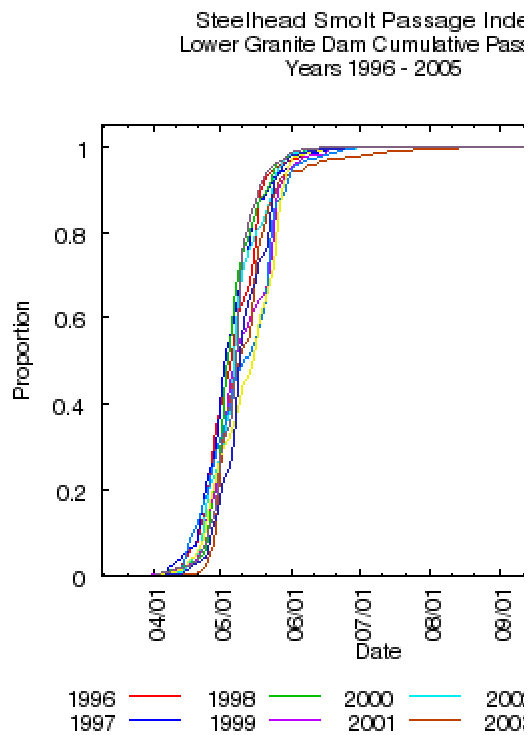


Migration Timing Characteristics

Year	First	1%	5%	10%	50%	90%	95%	Last	Middle 80% Days
	Passage Dates								
1996	03/28	03/28	03/30	04/01	04/22	06/10	06/15	10/30	71
1997	03/27	04/02	04/20	04/22	05/17	07/22	08/03	11/01	92
1998	04/01	05/06	05/07	05/09	05/14	05/26	06/03	11/01	18
1999	03/26	03/28	04/03	04/23	05/28	06/07	06/16	11/10	46
2000	04/01	04/05	04/12	04/29	05/24	08/02	09/14	10/31	96
2001	03/26	03/29	04/08	04/21	05/23	06/16	09/09	10/31	57
2002	03/26	04/09	04/16	04/26	05/19	06/02	06/11	10/31	38
2003	03/26	04/13	05/06	05/25	05/31	06/05	06/07	10/31	12
2004	03/27	04/05	04/15	05/12	05/22	06/19	09/19	10/31	39
2005	03/26	04/04	04/24	05/10	05/20	06/01	06/07	10/31	23

* * Columbia River DART * *
10 Year Historical Run Timing Smolt Passage Index Steelhead at Lower Granite Dam
Data Courtesy of Fish Passage Center





Migration Timing Characteristics

	Passage Dates								Middle 80%
Year	**First**	**1%**	**5%**	**10%**	**50%**	**90%**	**95%**	**Last**	**Days**
1996	03/28	04/11	04/17	04/21	05/05	05/19	05/25	10/31	29
1997	03/27	04/08	04/15	04/22	05/04	05/23	05/31	11/01	32
1998	03/27	04/08	04/25	04/27	05/05	05/22	05/26	11/01	26
1999	03/26	04/10	04/22	04/24	05/08	05/27	06/02	11/10	34
2000	03/15	04/13	04/20	04/23	05/07	05/24	05/27	10/31	32
2001	03/26	04/22	04/27	04/29	05/10	05/27	06/08	10/31	29
2002	03/26	04/12	04/17	04/20	05/12	05/30	06/03	10/31	41
2003	03/26	04/11	04/21	04/25	05/16	05/29	06/01	10/31	35
2004	03/26	04/15	04/25	04/27	05/09	05/24	05/28	10/31	28
2005	03/26	04/08	04/23	04/27	05/09	05/19	05/24	10/22	23

Attachment 3

Excerpts from the Williams 2005 NOAA Tech Memo
Regarding Sockeye Transportation and Percentages of fish transported

"We have little specific information about Snake River sockeye salmon. Between 1990 and 2001, 478 PIT-tagged sockeye salmon arriving at lower Snake River dams were transported, while 3,925 migrated in-river. Of these, two transported fish (0.4% SAR) and one in-river fish returned (0.03% SAR). Adult returns of sockeye salmon to Lower Granite Dam between 1990 and 2003 ranged from 3 to 282 fish (annual median was 13 fish). Snake River sockeye salmon have not demonstrated increased SARs in the last several years, similar to what occurred for Snake River Chinook salmon and steelhead."

"We note that transportation apparently has not provided any benefit to Snake River Sockeye salmon."

The following data represents the percentage of yearling Chinook and steelhead transported from 1993-2003 and it is anticipated that approximately this percentage of sockeye had also been transported.

Table 6. Estimated combined annual percentage of the nontagged yearling Chinook salmon population transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams.

Year	Wild	Hatchery
1993	88.5	88.1
1994	87.7	84.0
1995	86.4	79.6
1996	71.0	68.7
1997	71.1	71.5
1998	82.5	81.4
1999	85.9	77.3
2000	70.4	61.9
2001	99.0	97.3
2002	72.1	64.2
2003	70.4	61.5

Table 12. Estimated combined annual percentage of the nontagged steelhead population transported from Lower Granite, Little Goose, Lower Monumental, and McNary dams.

Year	Wild	Hatchery
1993	93.2	94.7
1994	91.3	82.2
1995	91.8	94.3
1996	79.8	82.9
1997	87.5	84.5
1998	88.2	87.3
1999	87.6	88.5
2000	83.9	81.5
2001	99.3	96.7
2002	75.2	70.4
2003	72.9	68.4

Attachment 4

Discussion Topics on Spread the Risk from the April 13 and 24th meetings

In General

Spread The Risk — There was discussion of the need to define what is meant by spread the risk. To some it meant that a 50/50 split of transport and inriver migration is targeted for the population. To others it meant that no more than 50% are transported. To others, it was suggested that providing the best operation possible when/where data is available, and then target a 50/50 split during periods when the data is not clear or not available.

Specific Responses

a. ODFW indicated a desire to have no more than 50% of a population transported in any given year achieved primarily by providing spillway and RSW passage for inriver migrants

b. The Corps expressed that "spread the risk" should be an adaptive management approach whereby operations should focus on how to maximize adult returns. When transport is an effective tool, it should be used, when it is not effective, it should be discontinued.

c. IDFG indicated that a spread the risk strategy would be to transport more steelhead (60% transport and 40% spilled) yet spill more yearling Chinook (40% transport and 60% spill). Spillway passage would be preferred over bypass with RSWs playing a large factor.

d. WDFW expressed a desire to minimize the transport of wild yearling Chinook, indicating a desire for a 1 May date for initiating transport.

e. NOAA agreed with the Corps and added that in considering the question of spread the risk, it should be used as a tool to address uncertainty.

f. CRITFC indicated that they were not comfortable with any more than a 50% transport component and that they would prefer a continued spread the risk, even in low flow years. They also questioned whether a transportation program was really necessary.

Attachment 5

Discussion Topics on Flow Targets for initiating transport

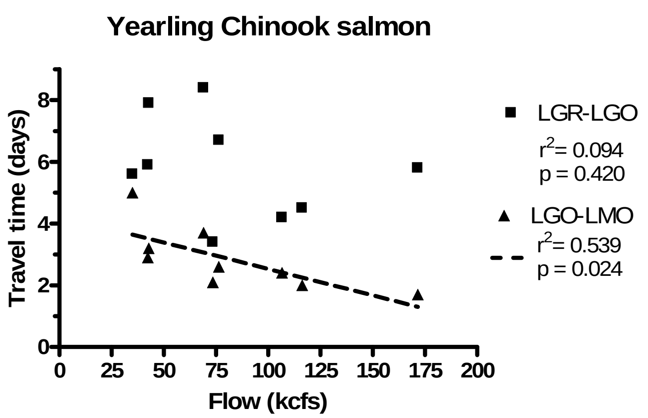
IDFG	Indicated that the 70-85 kcfs trigger was not necessarily based on biology, more so on professional judgment from the older water budget days. They believe that the triggers are set too high and that the triggers should be relaxed, however data would be needed on that as well. They believe that the trigger should be below 70kcfs, possibly employing a split season where spreading the risk is used, being negotiated in the TMT. Spillway passed fish (undetected) are still believed to be the best passage route as evidenced in Sandford and Smith, CSS and the Tech memos. They would prefer to investigate a spread the risk operation throughout the season in flow years above 70kcfs.
WDFW	Believed that the flow threshold should be lowered below the existing target, but is not sure what that target should be. This is also based on the data that indicates undetected fish survive better.
ODFW	In general agreement with IDFG and WDFW
BPA	From the existing biological data, it does not appear statistically significant to support the existing flow triggers; however this is likely more than a question of biological triggers and needs to be considered by the policy group.
Corps	Nothing to add
NOAA	Agreed that previous triggers were based on best professional judgment. Paul Wagner indicated that there were many more variables than just flow as to when we should initiate transport. The physical parameters of the river and ocean (e.g. temperature, flow, turbidity, upwelling, chlorophyll, etc…) may all be important factors as well.

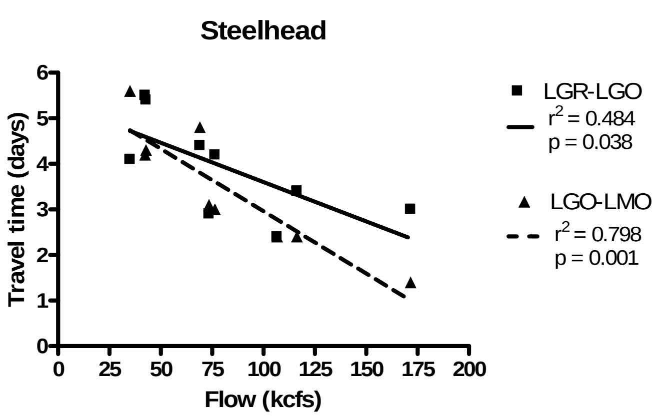
Attachment 6

Data provided by Bill Muir regarding early season travel times for TMT discussion on April 19, 2006

Average flow (KCFS) measured at Lower Granite Dam (LGR) and travel time (days) between LGR and Little Goose Dam (LGO), and LGO and Lower Monumental Dam (LMO) for yearling Chinook salmon and steelhead (hatchery and wild combined) between 20 – 26 April, 1997-2005.

Year	Yearling Chinook salmon				Steelhead				
	LGR-LGO		LGO-LMO		LGR-LGO		LGO-LMO		Flow
	Med.	80%	Med.	80%	Med.	80%	Med.	80%	(KCFS)
1997	5.8	8.9	1.7	2.5	3.0	5.0	1.4	3.0	171.6
1998	6.7	9.1	2.6	3.5	4.2	5.8	3.0	5.2	76.4
1999	4.5	6.1	2.0	2.8	3.4	4.8	2.4	4.7	116.3
2000	4.2	6.4	2.4	3.3	2.4	3.3	2.4	4.0	106.6
2001	5.6	8.0	5.0	12.4	4.1	6.4	5.6	13.8	35.1
2002	8.4	11.4	3.7	6.6	4.4	6.8	4.8	8.9	69.0
2003	3.4	5.0	2.1	2.8	2.9	4.1	3.1	7.9	73.5
2004	5.9	8.9	2.9	4.8	5.5	8.7	4.2	7.4	42.4
2005	7.9	12.1	3.2	4.7	5.4	9.9	4.3	7.9	42.8
Ave	**5.8**	**8.4**	**2.8**	**4.8**	**3.9**	**6.1**	**3.5**	**7.0**	





Average Release Date	Average Travel Time to LGS	Average Travel Time to LMN
1995		
4/22	6.8 (709)	8.6 (810)
4/28	4.3 (985)	6.1 (935)
5/1	4.3 (843)	5.8 (824)
5/4	4.1 (968)	5.4 (1068)
5/7	3.5 (656)	5.2 (607)
1996		
4/20	5.2 (377)	6.6 (327)
4/21	4.4 (303)	5.5 (371)
4/22	3.6 (323)	4.6 (368)
4/25	2.6 (337)	4.7 (242)

Data Courtesy of DART

This is not a final federal agency product. Rather, it is a pre-decisional document prepared by the Action Agencies that reflects present understandings of currently available information and analyses, and of the progression of discussions with the sovereigns in the collaborative process. Revisions and refinements are to be expected based on further discussions with the sovereigns over new and modified proposed federal actions upon which the action agencies will ultimately consult. Finally, the information in this product does not constitute an analysis of whether the identified measures would or would not jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Furthermore, this document does not in any way interpret or apply the regulatory definitions of the statutory phrases "jeopardize the continued existence of" and "destruction or adverse modification."

Analysis of Effects of Hydro Actions

Prior to construction of the FCRPS, downstream survival of juvenile fish was not well quantified, however, it is without question that some level of natural downstream mortality occurred. With the FCRPS in place, the mortality levels are assumed to be above that which might have naturally occurred due to both the existence and operation of the hydropower projects. While, the Action Agencies have been able to demonstrate causative factors of mortality within the FCRPS, we do not believe that it is presently possible to definitively separate the overall differences between natural, hydro related and other anthropogenic causes of mortality.

The proposed hydro actions are expected to change the current levels of direct and indirect mortality due to the operations of the projects, however many of the actions are also expected to change the levels of mortality due to the existence of the projects. Because of the difficulty of separating the factors for mortality, the following Base, Current and Prospective analyses aggregate the four primary sources of mortality including the natural, other anthropogenic, operational and existence.

Overall analysis

In developing the overall analysis of the effects of the proposed hydro action on listed anadromous fish, the Action Agencies relied on both hydrologic and biologic model outputs and previous analyses for assessing the effectiveness of the hydro actions. Our analysis incorporated an ESU by ESU analysis for three primary time periods of hydropower system existence, the Base (corresponding to the general conditions that were experienced by juveniles during the 1980-2001 outmigrations), Current, and Prospective conditions, with results reported as an average across all water years.

The analysis began with baseline survival estimates primarily from the TRT or other relevant sources – with consideration of estimates for key parameters (i.e., direct inriver survival, percent transported, etc.). Next, we estimated effects that have already occurred (Current) and a range of effects that might occur (Prospective) from operation and configuration changes to the hydropower system. To estimate the hydrologic effects due to operations and existence of the FCRPS and the upper Snake projects, the MODSIM model was used for the upper Snake River above Brownlee Reservoir and the HYDSIM model was used for the rest of the Columbia River. Model runs were made to simulate both the Current and Prospective operations.

For the prospective effects, changes provided in the proposed action were based on best professional judgment, however at times encompassed the potential upper end of the range of those effects. These estimates along with the results from the hydrologic models were then input into the COMPASS model, yielding an output of potential direct inriver survival. From this, an overall direct survival estimate to the Bonneville Dam tailrace was calculated which included transport survival and Mid-Columbia PUD effects for the applicable ESUs.

Finally, Smolt to Adult Returns (SARs) were estimated for both inriver and transported juveniles (using the Scheurell and Zabel hypothesis) and an overall SAR was estimated. The COMPASS model results were used to comparatively assess the relative effects of Current operations to Base operations, and Prospective operations to Current operations. For Upper Columbia River ESUs, these effects were aggregated with the observed (Base to Current) or anticipated (Current to Prospective) survival changes that are resulting from actions taken to improve juvenile survival through the Mid-Columbia Public Utility District (PUD) dams as a result of settlement agreements and biological opinions. The overall results of the COMPASS modeling are in attachment XX.

Analysis by ESU

The ESU by ESU hydro effects analysis for the interior Columbia ESUs is outlined in Table A. Snake River steelhead and spring/summer Chinook were aggregated across the entire ESU because inriver hydro improvements were expected to affect populations similarly. For upper Columbia Chinook and steelhead, although they are assumed to experience similar conditions through the fish passing FCRPS dams, different effects are experienced upstream (in that they migrate past a different number of dams and reservoirs), therefore they are reported on separately as three primary populations. For

Mid-Columbia steelhead, because this ESU inhabits tributaries that enter the Columbia River between Bonneville Dam and McNary reservoir, the effects of the FCRPS experienced by this ESU is notably different from one population to the next; therefore, these populations were analyzed by aggregating them according to which pool they initially entered on their downstream migration. Thus the analysis for Mid-Columbia steelhead examined the Yakima/Walla Walla aggregate, Umatilla /John Day aggregate, Deschutes River, and Bonneville pool tributaries aggregate as distinct groups.

Table A. ESU by ESU Analysis Matrix.

ESU	Hydro Analysis	Rationale
Snake Sp/Su Chinook	Aggregated for ESU	Similar FCRPS experience
Snake Steelhead	Aggregated for ESU	Similar FCRPS experience
Upper Columbia Chinook	Independent by population	Different downstream migration experience
Upper Columbia Steelhead	Independent by population	Different downstream migration experience
Mid Columbia Steelhead	Aggregated by entry point into FCRPS	Notably different FCRPS experience

Because the data used in the analysis was more robust for Snake River migrants traveling through the lower Columbia River, the assumption was made that the effects of hydro actions in the lower Columbia River would be consistent for both upper Columbia and Snake River ESUs. However, empirical data was used to provide separate estimates of passage timing at McNary Dam as upper Columbia River fish generally arrive at this project many days later than Snake River fish.

Base Condition

For the five interior ESUs of Chinook and steelhead, base conditions for direct inriver survival (DIS) were taken from Technical Recovery Team estimates (largely for average survival rates and transport rates) for the 1980 to 2001 juvenile migrations which used both empirical and interpolated information. For the Mid-Columbia steelhead ESU, the Base condition for DIS was empirically derived by calculating inriver survival from Lower Granite to Bonneville, which was 26.5%. From this estimate, a per-project survival estimate of 84.7% was derived. This was then applied on a project by project basis to determine the survival of fish encountering from 1-4 projects.

Current Condition

The Current condition was developed via the MODSIM, HYDSIM and COMPASS modeling using the 2006 hydropower configuration (i.e., implementation of structural measures from the 2000/2004 FCRPS Biological Opinions to date), and the operation plan that was laid out in the 2004 Biological Opinion.

Prospective Condition

For the Prospective condition, information developed in the collaboration process was considered when developing the proposed action for both operation and configuration changes.

Changes to the *operational* scenarios for water management and transportation were considered and the Action Agencies included these in the Proposed Action (PA). Several scenarios evaluating different water management actions were modeled using HYDSIM. The changes in operations as reflected in HYDSIM and other changes including level of spill, initiation of transport, etc., were analyzed in COMPASS and subsequent survival changes were calculated.

With respect to *configuration* changes, the Proposed Action included the prospective construction and operation of surface passage, spillway improvements and other changes. The ranges of potential effects for each of these changes were estimated by the Action Agencies, and discussed and modified with input from NOAA technical staff. This information was then shared with the state and tribal co- managers that work in the AFEP process as provided in the December 20, 2006 PA draft to the Policy Work Group.

The best professional judgment of the effects for route specific survivals were included in the prospective COMPASS model (often including the upper end of the range), with the assumption that all of the configuration elements would be in place by 2017. Changes associated with structural configuration actions (e.g. surface passage) were reflected as an improvement in the timing of the arrival of fish arrive in the estuary (consistent with the estuary arrival time hypothesis).

After the potential operation and configuration survival changes were input into the model, the analysis was run with both the Current condition (2006 configuration/2004 operations) and the full complement of proposed actions (2017) in place for the 50 year water record (1929-1978).

Effects Description

The effects examined are reported stepwise here to provide a thorough explanation of how the analysis was conducted.

Direct Inriver Survival (DIS) – This analysis used the calculations of the anticipated direct inriver survival changes to juvenile migrants resulting from proposed operation and configuration actions. For this analysis, neither transportation effects nor the effects of the Mid Columbia PUD actions are included.

With the proposed actions, mean DIS effects ranged from improvements of 5.0 to 6.0% for the Upper Snake ESU's with a relative difference ranging from 12.1 to 12.8% improvements. For the upper Columbia ESUs, the relative change in mean DIS ranged from improvements of 5.5 to 7.7% with a relative difference ranging from 8.5 to 13.0% improvement. (Table B)

Table B - Direct Inriver Survival changes for upper river Chinook and steelhead ESUs

Direct Inriver Survival Effects		COMPASS Analysis for FCRPS			
ESUs	TRT Base Case	2004/2006 Current	2007 BiOp Prospective	Absolute Difference Prospective/Current	Relative Difference Prospective/Current
Snake River Sp/Su Chinook	33.4%	49.6%	55.6%	6.0%	**12.1%**
Snake River Steelhead	26.5%	39.4%	44.5%	5.0%	**12.8%**
Upper Columbia Sp. Chinook	44.1%	64.8%	70.3%	5.5%	**8.5%**
Upper Columbia Steelhead	51.5%	59.2%	66.9%	7.7%	**13.0%**

For mid Columbia steelhead the relative change in mean DIS ranged from 0.4% improvement for the populations that entered in the Bonneville pool to 13.0% percent improvement for those fish entering via the McNary pool. (Table C)

Table C – Direct Inriver Survival changes for Mid Columbia steelhead populations

Direct Inriver Survival		COMPASS Analysis for FCRPS			
Mid Columbia Steelhead Populations	TRT Base Case	2004/2006 Current	2007 BiOp Prospective	Absolute Difference	Relative Difference Prospective/Current
Yakima/Walla Walla Rivers	51.5%	59.2%	66.9%	7.7%	**13.0%**
Umatilla/John Day Rivers	60.8%	64.4%	71.5%	7.1%	**11.1%**
Deschutes River	71.7%	80.4%	83.3%	2.9%	**3.7%**
Bonneville Pool Tributaries	84.7%	94.4%	94.8%	0.3%	**0.4%**

Overall Direct Survival (ODS) – This analysis uses the effects incorporated in the DIS in concert with the aggregated effects of downstream passage. This is considered as an interim step between the DIS and the SAR estimates.

For the Snake River ESUs, ODS incorporates the downstream survival of transported fish. Note that when comparing the value of overall direct survival effects for inriver and transported fish, the number will be lower when the number of fish transported is decreased. This is due to the assumption of 98% survival of transported fish and because the relative SARs of transported vs. inriver fish or "D" has not yet been applied.

For the upper Columbia ESUs, the estimates provided in this table incorporate the effects of passage improvements at the Grant, Douglas, and Chelan County PUD projects. The improvement estimates for those projects come from the NOAA Qualitative Analysis Report as developed under the HCP process and the NOAA Hydro Module for recovery planning. The final estimate incorporates the changes at the lower river FCRPS projects as estimated by the COMPASS model.

With the proposed actions, ODS effects ranged from absolute decreases of -3.4 to -6.10% for the upper Snake ESUs with a relative difference ranging from decrements of -3.8 to -6.8%. For the upper Columbia populations, the relative change in ODS ranged from improvements of 4.6 to 11.5% with a relative difference ranging from 8.6 to 26.7% improvement. (Table D)

Table D – Overall Direct Survival Changes for upper river Chinook and steelhead ESUs and populations

Overall Direct Survival Changes		COMPASS for FCRPS and QAR for Upper Columbia			
ESU/Population	TRT Base Case	2004/2006 Current	2007 BiOp Prospective	Absolute Difference	Relative Difference Prospective/Current
Snake River Sp/Su Chinook	72.2%	90.1%	86.7%	-3.4%	**-3.8%**
Snake River Steelhead	89.9%	91.6%	85.4%	-6.1%	**-6.8%**
Upper Columbia Sp. Chinook (Wenatchee)	44.1%	53.3%	57.9%	4.6%	**8.6%**
Upper Columbia Sp. Chinook (Entiat)	38.2%	48.2%	53.8%	4.7%	**11.6%**
Upper Columbia Sp. Chinook (Methow)	34.0%	47.2%	51.8%	4.6%	**9.8%**
Upper Columbia Steelhead (Wenatchee)	35.5%	43.0%	54.5%	11.5%	**26.7%**
Upper Columbia Steelhead (Entiat)	32.6%	41.2%	52.2%	11.0%	**26.7%**
Upper Columbia Steelhead (Methow)	28.3%	39.7%	50.2%	10.5%	**26.5%**

For mid-Columbia steelhead, the ODS is expected to be the same as the DIS. No additional analysis was performed for this ESU for transport scenarios, because only in the very lowest of low flow years in the lower Columbia River would transport occur from McNary Dam.

<u>Estimated SARs</u> – Estimates of Smolt to Adult Returns incorporates ODS results as well as the Scheuerell and Zabel hypothesis on delayed timing to the estuary for both upper Snake and upper Columbia ESUs. For modeling purposes, estimates of "D" were based on the Scheuerell and Zabel hypothesis being applied to both inriver and transported fish. For the Snake River ESUs, these numbers were very sensitive to the "D" component in that Chinook had a lower "D" and steelhead had a higher "D". Therefore, the more steelhead that are left in river, the lower the estimated adult returns. (Table E)

Table E – Lifecycle effects for upper river Chinook and steelhead ESUs and populations.

SAR Effects	Relative Change with only FCRPS	Relative Change Including PUD Improvements
ESU/Population	Prospective	Prospective
Snake River Sp/Su Chinook	6.5%	NA
Snake River Steelhead	-8.9%	NA
Upper Columbia Sp. Chinook (Wenatchee)	9.1%	9.1%
Upper Columbia Sp. Chinook (Entiat)	9.1%	10.3%
Upper Columbia Sp. Chinook (Methow)	9.1%	10.3%
Upper Columbia Steelhead (Wenatchee)	14.7%	28.3%
Upper Columbia Steelhead (Entiat)	14.7%	28.4%
Upper Columbia Steelhead (Methow)	14.7%	28.3%

SAR effects are expected to be the same as the DIS for mid Columbia steelhead. (No latent mortality was ascribed in this component of the analysis because no hypothesis regarding latent mortality for this ESU exists.).

Interior Columbia Technical Recovery Team and R. W. Zabel. June 20, 2006. Assessing the Impact of Anticipated Hydropower Changes and a Range of Ocean Conditions on the Magnitude of Survival Improvements Needed to Meet TRT Viability Goals

Williams, J.G., S.G. Smith and W.D. Muir. Survival Estimates for Downstream Migrant Yearling Juvenile Salmonids through the Snake and Columbia Rivers Hydropower System, 1966–1980 and 1993–1999. North American Journal of Fisheries Management 21:310–317, 2001.

Williams, J. G., S. G. Smith, R. W. Zabel, W. D. Muir, M. D. Scheuerell, B. P. Sandford, D. M. Marsh, R. A. McNatt, S. Achord. 2005. Effects of the Federal Columbia River Power System on Salmonid Populations. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-63, 150 p.

Attachment 1 – COMPASS Modeling Results

Snake River Spring/Summer Chinook **NWFSC reservoir model** **Proposed Action** **1**

Average estimates for analysis parameters

		In River Survival	"destined" for transport	Median day of arrival: In River Migrants	Median day of arrival: Transported	Proportion of population below Bonneville: In River Migrants	Proportion of population below Bonneville: Transported	FCRPS Survival: Survival without "D"	FCRPS Survival: "D" estimate	FCRPS Survival: Survival with "D"	Composite Bon-Bon SAR Estimate: In River Migrants	Composite Bon-Bon SAR Estimate: Transported	Whole population LGR-LGR SAR
base case	50 year Average	0.496	0.817	132.342	128.694	0.121	0.879	0.901	0.605	0.575	0.01652	0.00999	0.00949
Proposed Action		0.556	0.691	134.588	131.368	0.234	0.766	0.867	0.615	0.589	0.01647	0.01013	0.01011
absolute change		0.060	-0.125	2.247	2.674	0.114	-0.114	-0.034	0.010	0.013	-0.00005	0.00014	0.00062
Relative Change		12.1%	-15.3%	1.7%	2.1%	94.2%	-12.9%	-3.8%	1.7%	2.3%	-0.3%	1.4%	6.5%
base case	<65 KCFS n=8	0.349	0.994	146.348	132.450	0.002	0.998	0.976	0.722	0.706	0.01361	0.00984	0.00929
Proposed Action		0.339	0.977	164.294	132.175	0.009	0.991	0.966	1.174	1.132	0.00842	0.00988	0.00924
absolute change		-0.010	-0.016	17.946	-0.275	0.007	-0.007	-0.010	0.451	0.426	-0.00519	0.00005	-0.00006
Relative Change		-2.9%	-1.6%	12.3%	-0.2%	274.0%	-0.7%	-1.0%	62.5%	60.4%	-38.1%	0.5%	-0.6%
base case	65-80 KCFS n=6	0.411	0.979	140.507	130.498	0.009	0.991	0.969	0.652	0.634	0.01520	0.00991	0.00934
Proposed Action		0.510	0.895	137.553	131.678	0.064	0.936	0.934	0.610	0.589	0.01648	0.01006	0.00964
absolute change		0.099	-0.085	-2.953	1.180	0.055	-0.055	-0.035	-0.042	-0.045	0.00128	0.00015	0.00031
Relative Change		24.2%	-8.6%	-2.1%	0.9%	586.2%	-5.5%	-3.6%	-6.4%	-7.2%	8.4%	1.5%	3.3%
base case	80-130 KCFS n=26	0.538	0.799	130.105	128.528	0.128	0.872	0.893	0.579	0.561	0.01736	0.01005	0.00954
Proposed Action		0.607	0.656	128.993	131.509	0.255	0.745	0.855	0.556	0.566	0.01832	0.01019	0.01028
absolute change		0.070	-0.143	-1.112	2.982	0.127	-0.127	-0.038	-0.023	0.005	0.00096	0.00013	0.00074
Relative Change		13.0%	-17.9%	-0.9%	2.3%	99.5%	-14.6%	-4.3%	-4.0%	0.9%	5.5%	1.3%	7.7%
base case	>130 KCFS n=14	0.559	0.624	122.052	125.041	0.263	0.737	0.822	0.574	0.561	0.01746	0.01002	0.00961
Proposed Action		0.626	0.433	123.591	130.170	0.462	0.538	0.779	0.565	0.595	0.01809	0.01023	0.01066
absolute change		0.067	-0.191	1.539	5.129	0.199	-0.199	-0.042	-0.008	0.034	0.00062	0.00021	0.00104
Relative Change		12.0%	-30.6%	1.3%	4.1%	75.7%	-27.0%	-5.2%	-1.4%	6.0%	3.6%	2.1%	10.9%

Snake River Spring Chinook Salmon

Relative Improvements from "Base" to "Current" to "Prospective" Hydro Survival Adjustments

NOTE: When Hydro and other Prospective Actions are added to a life-cycle model, the populations may grow to a point where density dependent effects occur; which would be equivalent to reducing the survival improvements.

Population	Avg System Survival Estimates [1]			Avg Smolt to Adult Survival Estimates (Scheurell-Zabel Hypothesis) [2]			Source
	Base	Current	Prospective	Base	Current	Prospective	
Populations Upstream of LGR	0.722			0.0081			Rich Zabel: pers. comm. Mar 26, 2007 e-mail providing TRT "Base" parameters used for life-cycle modeling. SAR estimates for Inriver and Transported migrants assumed to be equal to COMPASS estimates for "Current" conditions.
		0.901	0.867		0.0095	0.0101	May 9, 2007 COMPASS modeling results using NWFSC reservoir survival hypothesis
	0.722	**0.901**	**0.867**	**0.0081**	**0.0095**	**0.0101**	**Best Estimate**
		1.249	**0.962**		**1.175**	**1.065**	**Relative Adjustment**

1) Average "Base" (1980 to 2001 migration years) system survival was estimated assuming: Inriver survival = 0.334; Proportion transported = 0.600; and % transport survival = 0.98; average "Current" and "Prospective" system survival was estimated using COMPASS.

2) Average "Base" (1980 to 2001 migration years) system survival was estimated assuming average system survival parameters (footnote 1) and estimated SARs from COMPASS: average Inriver SAR of 0.01652 for Base and Current (0.01647 for Prospective); and average transported SAR of 0.00999 for Base and Current (0.01013 for Prospective).

Snake River Steelhead **NWFSC reservoir model** **Proposed Action**

Average estimates for analysis parameters

		In River Survival	"destined" for transport	Median day of arrival: In River Migrants	Median day of arrival: Transported	Proportion of population below Bonneville: In River Migrants	Proportion of population below Bonneville: Transported	FCRPS Survival: Survival without "D"	FCRPS Survival: "D" estimate	FCRPS Survival: Survival with "D"	Composite Bon-Bon SAR Estimate: In River Migrants	Composite Bon-Bon SAR Estimate: Transported	Whole population LGR-LGR SAR
base case	50 year Average	0.394	0.869	135.533	133.808	0.077	0.923	0.916	1.368	1.216	0.01520	0.02079	0.01790
Proposed Action		0.445	0.707	138.928	134.851	0.209	0.791	0.854	1.360	1.072	0.01499	0.02038	0.01630
absolute change		0.051	-0.162	3.395	1.042	0.133	-0.133	-0.061	-0.008	-0.144	-0.00021	-0.00041	-0.00160
Relative Change		12.8%	-18.7%	2.5%	0.8%	172.7%	-14.4%	-6.7%	-0.6%	-11.8%	-1.4%	-2.0%	-8.9%
base case	<65 KCFS n=8	0.175	0.999	150.314	137.316	0.000	1.000	0.979	1.668	1.633	0.01141	0.01902	0.01831
Proposed Action		0.162	0.979	170.208	136.769	0.005	0.995	0.963	4.991	4.791	0.00387	0.01933	0.01802
absolute change		-0.014	-0.020	19.894	-0.548	0.004	-0.004	-0.016	3.323	3.158	-0.00753	0.00031	-0.00029
Relative Change		-7.8%	-2.0%	13.2%	-0.4%	1410.1%	-0.4%	-1.6%	199.3%	193.4%	-66.0%	1.6%	-1.6%
base case	65-80 KCFS n=6	0.272	0.988	139.770	135.518	0.004	0.996	0.972	1.435	1.393	0.01387	0.01990	0.01899
Proposed Action		0.320	0.936	141.763	135.980	0.025	0.975	0.940	1.334	1.243	0.01476	0.01968	0.01792
absolute change		0.048	-0.053	1.993	0.462	0.022	-0.022	-0.033	-0.102	-0.150	0.00089	-0.00022	-0.00107
Relative Change		17.5%	-5.3%	1.4%	0.3%	561.3%	-2.2%	-3.3%	-7.1%	-10.8%	6.4%	-1.1%	-5.7%
base case	80-130 KCFS n=26	0.426	0.855	133.407	133.848	0.076	0.924	0.902	1.286	1.140	0.01618	0.02081	0.01750
Proposed Action		0.490	0.671	133.081	134.984	0.220	0.780	0.828	1.170	0.931	0.01738	0.02034	0.01577
absolute change		0.064	-0.184	-0.326	1.136	0.144	-0.144	-0.074	-0.116	-0.209	0.00120	-0.00048	-0.00173
Relative Change		15.0%	-21.5%	-0.2%	0.8%	188.9%	-15.5%	-8.2%	-9.0%	-18.3%	7.4%	-2.3%	-9.9%
base case	>130 KCFS n=14	0.559	0.728	126.694	129.873	0.184	0.816	0.866	1.375	1.133	0.01647	0.02265	0.01795
Proposed Action		0.628	0.444	127.403	132.292	0.457	0.543	0.785	1.223	0.881	0.01779	0.02175	0.01533
absolute change		0.069	-0.284	0.709	2.419	0.273	-0.273	-0.081	-0.153	-0.252	0.00132	-0.00090	-0.00262
Relative Change		12.4%	-39.1%	0.6%	1.9%	148.6%	-33.4%	-9.4%	-11.1%	-22.3%	8.0%	-4.0%	-14.6%

Snake River Steelhead

Relative Improvements from "Base" to "Current" to "Prospective" Hydro Survival Adjustments

NOTE: When Hydro and other Prospective Actions are added to a life-cycle model, the populations may grow to a point where density dependent effects occur; which would be equivalent to reducing the survival improvements.

Population	Avg System Survival Estimates [1]			Avg Smolt to Adult Survival Estimates (Scheurell-Zabel Hypothesis) [2]			Source
	Base	Current	Prospective	Base	Current	Prospective	
Populations Upstream of LGR	0.899			0.0185			Rich Zabel: pers. comm. Mar 26, 2007 e-mail providing TRT "Base" parameters used for life-cycle modeling. SAR estimates for Inriver and Transported migrants assumed to be equal to COMPASS estimates for "Current" conditions.
		0.916	0.854		0.0179	0.0163	May 9, 2007 COMPASS modeling results using NWFSC reservoir survival hypothesis
	0.899	**0.916**	**0.854**	**0.0185**	**0.0179**	**0.0163**	**Best Estimate**
		1.018	**0.933**		**0.966**	**0.911**	**Relative Adjustment**

1) Average "Base" (1980 to 2001 migration years) system survival was estimated assuming: Inriver survival = 0.265; Proportion transported = 0.887; and % transport survival = 0.98; average "Current" and "Prospective" system survival was estimated using COMPASS.

2) Average "Base" (1980 to 2001 migration years) system survival was estimated assuming average system survival parameters (footnote 1) and estimated SARs from COMPASS: average Inriver SAR of 0.01520 for Base and Current (0.01499 for Prospective); and average transported SAR of 0.02079 for Base and Current (0.02038 for Prospective).

Upper Columbia Chinook **NWFSC reservoir model**

Average estimates for analysis parameters

		In River Survival	Median day of arrival		Estimated SAR BON-RIS	Estimated RIS to RIS SAR
base case	50 year Average	0.648	147.369		0.01427	0.00927
Proposed action		0.703	147.082		0.01435	0.01012
absolute change		0.055	-0.287		0.00008	0.00085
Relative Change		8.5%	-0.2%		0.6%	9.1%
Base Case	<200,000 n=11	0.596	149.903		0.01344	0.00802
Proposed action		0.647	149.679		0.01353	0.00876
absolute change		0.051	-0.223		0.00009	0.00074
Relative Change		8.5%	-0.1%		0.7%	9.3%
base case	200,000-325,000 n=29	0.655	147.126		0.01440	0.00944
Proposed action		0.713	146.741		0.01450	0.01034
absolute change		0.057	-0.385		0.00010	0.00090
Relative Change		8.7%	-0.3%		0.7%	9.5%
base case	>325,000 n=10	0.688	145.096		0.01489	0.01025
Proposed action		0.743	144.996		0.01491	0.01109
absolute change		0.055	-0.100		0.00002	0.00084
Relative Change		8.0%	-0.1%		0.2%	8.2%

Upper Columbia Steelhead **NWFSC reservoir model**

Average estimates for analysis parameters

		In River Survival	Median day of arrival		Estimated SAR BON-RIS	Estimated RIS to RIS SAR
base case	50 year Average	0.592	150.656		0.01336	0.00785
Proposed Action		0.669	150.135		0.01355	0.00900
absolute change		0.077	-0.521		0.00019	0.00115
Relative Change		13.0%	-0.3%		1.4%	14.7%
Base Case	<200,000 n=11	0.408	149.183		0.01407	0.00576
Proposed Action		0.483	148.303		0.01434	0.00695
absolute change		0.076	-0.880		0.00027	0.00120
Relative Change		18.5%	-0.6%		1.9%	20.8%
base case	200,000-325,000 n=29	0.628	150.470		0.01346	0.00844
Proposed Action		0.708	149.978		0.01365	0.00964
absolute change		0.079	-0.493		0.00019	0.00120
Relative Change		12.6%	-0.3%		1.4%	14.2%
base case	>325,000 n=10	0.701	152.869		0.01229	0.00860
Proposed Action		0.775	152.670		0.01238	0.00957
absolute change		0.073	-0.199		0.00009	0.00097
Relative Change		10.5%	-0.1%		0.7%	11.3%

Upper Columbia River Spring Chinook Salmon

Relative Improvements from "Base" to "Current" to "Prospective" Hydro Survival Adjustments

NOTE: When Hydro and other Prospective Actions are added to a life-cycle model, the populations may grow to a point where density dependent effects occur; which would be equivalent to reducing the survival improvements.

Population	Avg System Survival Estimates [1]			Avg Smolt to Adult Survival Estimates (Scheurell-Zabel Hypothesis) [2]			Source
	Base	Current	Prospective	Base	Current	Prospective	
Wenatchee River (7 dams)	0.441						Rich Zabel: pers. comm. Mar 26, 2007 e-mail providing TRT "Base" parameters (RIS to BON) used for life-cycle modeling.
		0.648	0.703	***0.0143***	***0.0143***	***0.0144***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.662	0.823	0.823				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.441	**0.533**	**0.579**	**0.0063**	**0.0076**	**0.0083**	**Best Estimate**
		1.210	**1.085**		**1.210**	**1.091**	**Relative Adjustment**
Entiat River (8 dams)	0.666						Estimated MCN to BON survival equals 66.6% (RIS to BON = 0.441 / RIS to MCN = 0.662)
		0.648	0.703	***0.0143***	***0.0143***	***0.0144***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.573	0.757	0.765				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.382	**0.491**	**0.538**	**0.0054**	**0.0070**	**0.0077**	**Best Estimate**
		1.286	**1.097**		**1.286**	**1.103**	**Relative Adjustment**
Methow and Okanogan Rivers (9 dams)	0.666						Estimated MCN to BON survival equals 66.6% (RIS to BON = 0.441 / RIS to MCN = 0.662)
		0.648	0.703	***0.0143***	***0.0143***	***0.0144***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.511	0.728	0.736				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.340	**0.472**	**0.518**	**0.0049**	**0.0067**	**0.0074**	**Best Estimate**
		1.387	**1.097**		**1.387**	**1.103**	**Relative Adjustment**

1) Average "Base" (1980 to 2001 migration years) system survival was estimated as 0.441 from Rock Island to Bonneville Dams (7 dams).

2) COMPASS Inriver SAR estimates: Current (and assumed for Base) = 0.01427; Prospective = 0.01435.

3) Final Draft QAR Report (Sept 2002): Avg survival estimates (1982-1996) through Mid-Columbia River Dams (Table 18); NMFS Hydro Module - Mid-Columbia River Projects (2004-2009) - Table 4.1a; and (2010-2013) Table 4.1.b.

Upper Columbia River Steelhead

Relative Improvements from "Base" to "Current" to "Prospective" Hydro Survival Adjustments

NOTE: When Hydro and other Prospective Actions are added to a life-cycle model, the populations may grow to a point where density dependent effects occur; which would be equivalent to reducing the survival improvements.

Population	Avg System Survival Estimates [1]			Avg Smolt to Adult Survival Estimates (Scheurell-Zabel Hypothesis) [2]			Source
	Base	Current	Prospective	Base	Current	Prospective	
Wenatchee River (7 dams)	0.515						Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^4.
		0.592	0.669	***0.0134***	***0.0134***	***0.0136***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.690	0.727	0.814				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.355	**0.430**	**0.545**	**0.0047**	**0.0058**	**0.0074**	**Best Estimate**
		1.212	**1.265**		**1.212**	**1.283**	**Relative Adjustment**
Entiat River (8 dams)	0.515						Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^4.
		0.592	0.669	***0.0134***	***0.0134***	***0.0136***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.633	0.696	0.780				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.326	**0.412**	**0.522**	**0.0044**	**0.0055**	**0.0071**	**Best Estimate**
		1.265	**1.266**		**1.265**	**1.284**	**Relative Adjustment**
Methow and Okanogan Rivers (9 dams)	0.515						Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^4.
		0.592	0.669	***0.0134***	***0.0134***	***0.0136***	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.549	0.670	0.750				Mid-Columbia River projects survival estimates: "Base" from 2002 Final Draft QAR Report; "Current" and "Prospective" from NMFS' Hydro Module. [3]
	0.283	**0.397**	**0.502**	**0.0038**	**0.0053**	**0.0068**	**Best Estimate**
		1.404	**1.265**		**1.404**	**1.283**	**Relative Adjustment**

1) Average "Base" (1980 to 2001 migration years) Snake River steelhead inriver survival estimate (0.265) through 8 dams system equals an average pre project survival of 0.847. 0.847^4 = 0.515 (and estimate of the average survival through the 4 lower Columbia River projects.

2) COMPASS Inriver SAR estimates: Current (and assumed for Base) = 0.01336; Prospective = 0.01355.

3) Final Draft QAR Report (Sept 2002): Avg survival estimates (1982-1996) through Mid-Columbia River Dams (Table 18); NMFS Hydro Module - Mid-Columbia River Projects (2004-2009) - Table 4.1a; and (2010-2013) Table 4.1.b.

Mid Columbia Steelhead **NWFSC reservoir model** **Proposed Action**

Average estimates for analysis parameters

		Project Survival					Stock survivals			
		McNary	John Day	The Dalles	Bonneville		Yakima Walla Walla	Umatilla, John Day	Deschutes	Bonneville Pool
base case	50 year Average	0.907	0.801	0.851	0.944		0.592	0.644	0.804	0.944
Proposed Action		0.925	0.859	0.879	0.948		0.669	0.715	0.833	0.948
absolute change		0.018	0.057	0.028	0.003		0.077	0.071	0.029	0.003
Relative Change		2.0%	7.2%	3.3%	0.4%		13.0%	11.1%	3.7%	0.4%
Base Case	<200,000 n=11	0.862	0.629	0.821	0.904		0.408	0.467	0.743	0.904
Proposed Action		0.882	0.702	0.850	0.908		0.483	0.542	0.772	0.908
absolute change		0.020	0.074	0.029	0.003		0.076	0.075	0.029	0.003
Relative Change		2.3%	11.7%	3.5%	0.4%		18.5%	16.0%	3.9%	0.4%
base case	200,000-325,000 n=29	0.918	0.834	0.858	0.954		0.628	0.683	0.818	0.954
Proposed Action		0.937	0.889	0.886	0.957		0.708	0.754	0.848	0.957
absolute change		0.019	0.055	0.027	0.004		0.079	0.071	0.029	0.004
Relative Change		2.0%	6.6%	3.2%	0.4%		12.6%	10.4%	3.6%	0.4%
base case	>325,000 n=10	0.927	0.907	0.866	0.964		0.701	0.756	0.834	0.964
Proposed Action		0.942	0.952	0.894	0.966		0.775	0.823	0.864	0.966
absolute change		0.014	0.046	0.028	0.003		0.073	0.066	0.030	0.003
Relative Change		1.6%	5.0%	3.3%	0.3%		10.5%	8.8%	3.6%	0.3%

Middle Columbia River Steelhead

Relative Improvements from "Base" to "Current" to "Prospective" Hydro Survival Adjustments

NOTE: When Hydro and other Prospective Actions are added to a life-cycle model, the populations may grow to a point where density dependent effects occur; which would be equivalent to reducing the survival improvements.

Population	Avg System Survival Estimates [1]			Source
	Base	Current	Prospective	
Bonneville Pool Tributaries (1 dam)	0.847			Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^1.
		0.944	0.948	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.847	**0.944**	**0.948**	**Best Estimate**
		1.115	**1.004**	**Relative Adjustment**
Deschutes River (2 dams)	0.717			Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^2.
		0.804	0.833	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.717	**0.804**	**0.833**	**Best Estimate**
		1.120	**1.037**	**Relative Adjustment**
Umatilla and John Day Rivers (3 dams)	0.608			Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^3.
		0.644	0.715	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.608	**0.644**	**0.715**	**Best Estimate**
		1.060	**1.111**	**Relative Adjustment**
Yakima and Walla Walla Rivers (4 dams)	0.515			Estimated as TRT "Base" inriver survival estimate (0.265) from LGR to BON (.847 per project survival)^4.
		0.592	0.669	May 9, 2007 COMPASS modeling results (MCN through BON) using NWFSC reservoir survival hypothesis
	0.515	**0.592**	**0.669**	**Best Estimate**
		1.151	**1.130**	**Relative Adjustment**

1) Average "Base" (1980 to 2001 migration years) Snake River steelhead inriver survival estimate (0.265) through 8 dams system equals an average pre project survival of 0.847. 0.847^(# of dams) = the estimated average survival through the corresponding number of lower Columbia River projects.

NOTE: For MCR Steelhead, no assumption is made regarding changes in SARs between the Base, Current, and Prospective periods. It seems likely that improving passage conditions ("Current" and "Prospective" model output compared to estimated average "Base" conditions) has reduced sub-lethal effects to some extent, which would in turn be likely to increase, by some unquantifiable amount, the average SAR's of these fish compared to SARs during the average "Base" period. This analysis is therefore conservative in that it only estimates direct survival improvements and does not presume any positive adjustment related to likely increased SARs (reduced latent mortality) for populations in this DPS.