# Testimony presented before the

Subcommittee on Water and Power of the US House of Representatives Committee on Resources. June 1995 Washington D.C.



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June 8, 1995

# Decline and Recovery of Snake River Salmon

## Information based on the CRiSP[1] research project

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Columbia River stock declines resulted from long term loss of habitat, commercial harvest, changes in the ocean, and development of the hydrosystem.

The completion of Snake River dams in 1976 changed the river ecology. To mitigate these changes fish are now barged from Snake River dams to below Bonneville dam. Coincident with hydrosystem completion and barging, the ocean went through a fundamental change which decreased survival of fish entering the ocean.

Controversy exists as to the importance of the ocean and dams in producing the recent stock declines. The controversy can be distilled into two competing stories: *It's natures fault (ocean)* vs. *It's our fault (dams).*

Our research indicates that, although many factors have caused the salmon decline, barging and improved dam passage have mitigated much of the effects of dams. Poor ocean survival is likely the most important factor in the recent decline.

Flow and spill actions in the recovery plan are analyzed and shown to be ineffective recovery actions. Contrary to the claims of some analyses, the flow augmentation will have little impact on survival. Spill can actually *decrease* survival because of the resulting gas bubble trauma. Moreover, it is likely that the 1995 spill actions decreased fish survival significantly. Our research suggests that improving barging and dam passage are the most effective salmon recovery actions.

The controversy can be resolved by testing scientific claims in a peer review process and by continued monitoring, experimentation, and evaluation of barging, flow, spill, ocean conditions, and fish condition on fish survival. Open access of information, models and analyses is essential for salmon recovery. The World Wide Web is a our best means of achieving open access.

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1. The University of Washington has developed the Columbia River Salmon Passage model under funding by Bonneville Power Administration. The project began in 1989.

# Life history of salmon

Habitats used by Endangered Snake River salmon

1 - Egg in redds

2 - Juveniles in tributaries

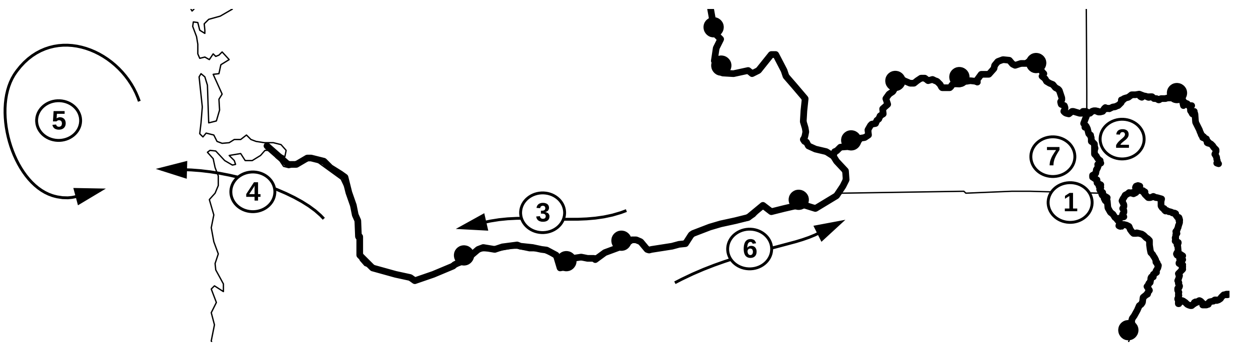
3 - Smolts in river migration

4 - Smolts in estuary

5 - Adults in ocean

6 - Adults in river

7 - Adults on redds




• Major recovery actions focus on mainstem juvenile passage (3) Including:

Barging fish around dams

Increasing water flows in river

Spilling water over dams

Improving fish diversion away from turbines

To determine if these actions are prudent we must consider the reasons for fish declines and the effectiveness of the recovery actions.



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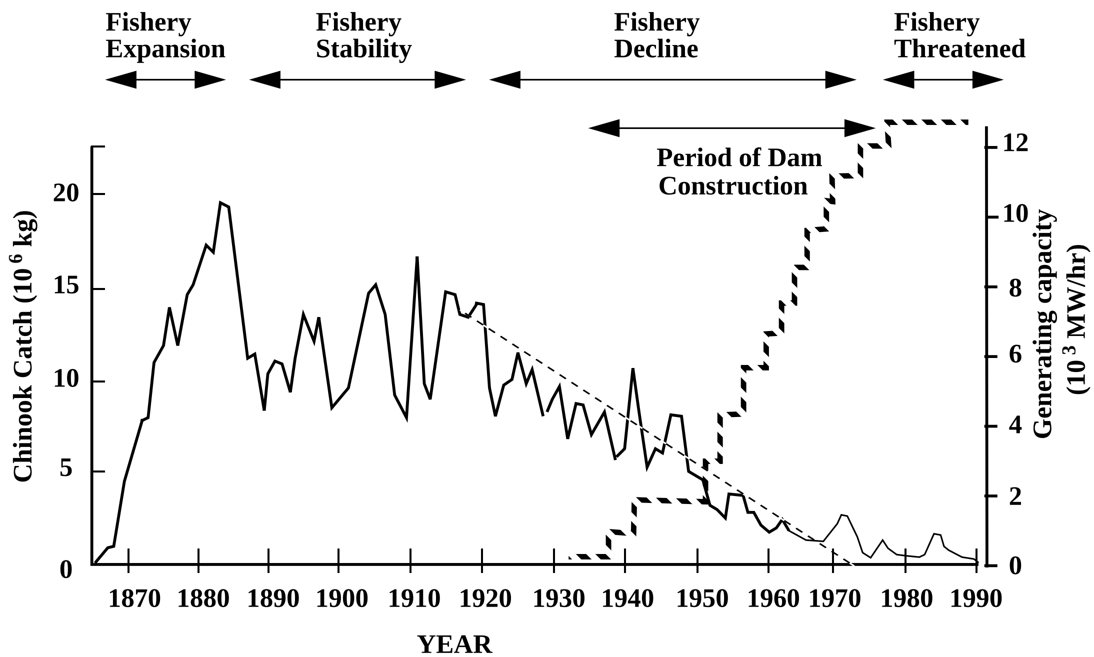
# Events in salmon decline




Significant events in the Columbia River chinook populations:

- Fishery expansion between 1865 and 1885
- Stable fishery between 1885 and 1920
- Fishery decline after 1920
- Population declined to record lows after 1977
- First dam on-line in 1932, last dam on-line in 1982
- Snake River populations declared Endangered in 1992



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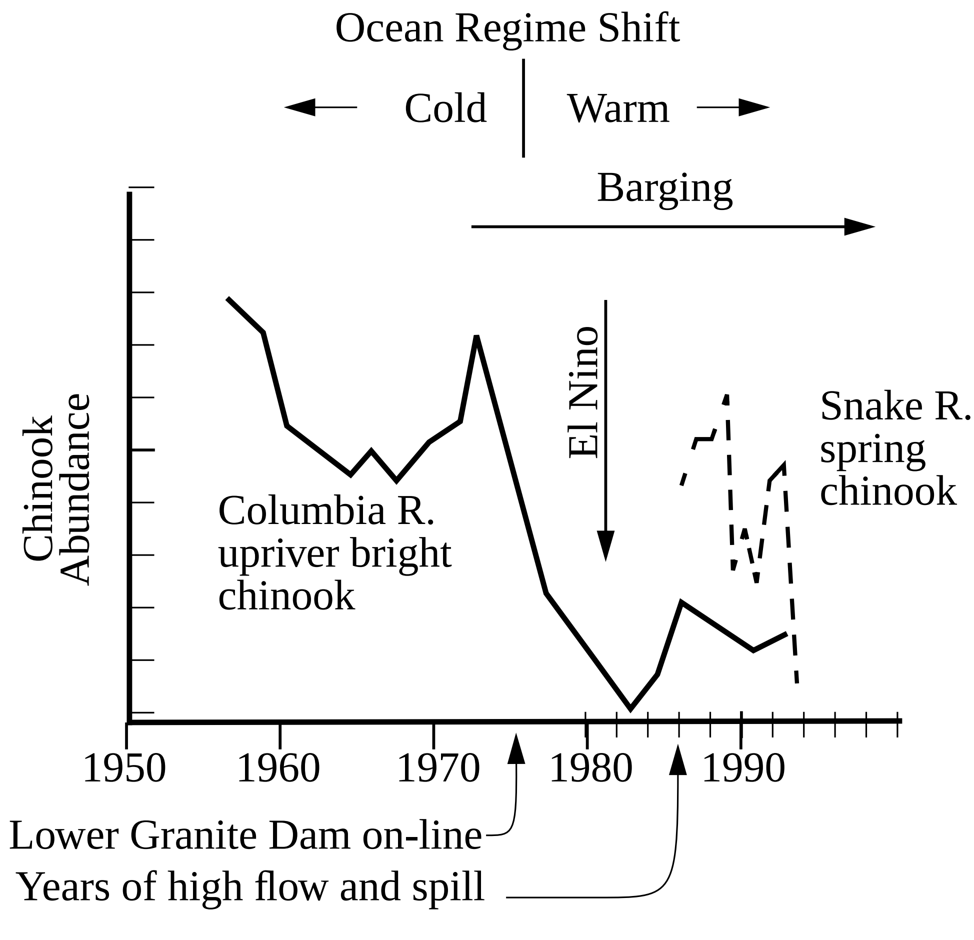
# Beliefs in why stocks have decline are influence by several simultaneous events

- Ocean conditions changed negatively impacting survival
- River conditions worsened by low flows and dams
- Fish barging coincided with changes in river and ocean conditions



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# Two opposing stories and reasons for the recent stock decline

**It's Our Fault: Mitigation efforts have failed**

- barging kills fish *(based on stock decline with barging)*
- low flow kills fish *(based on smolt-adult returns & travel time)*
- high mortality passing dams (*based on turbine survival studies*)

***Recovery plan actions for it's our fault:***

- stop fish barging
- add more flow to entire river
- improve dam passage with spill and bypass systems

**It's Nature's Fault: Mitigation efforts have worked**

- barging saves fish (*based on transport & in-river adult returns)*
- poor ocean survival kills fish *(based on decadal patterns in stocks, temperature and winds)*
- high mortality passing dams (*based on turbine survival studies*)

***Recovery plan actions for it's nature's fault:***

- increase and improve fish barging
- add more flow to collector dam
- improve collection for barging



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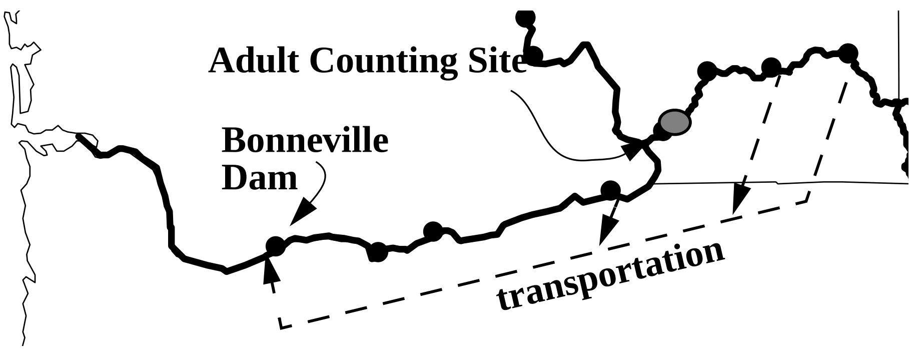
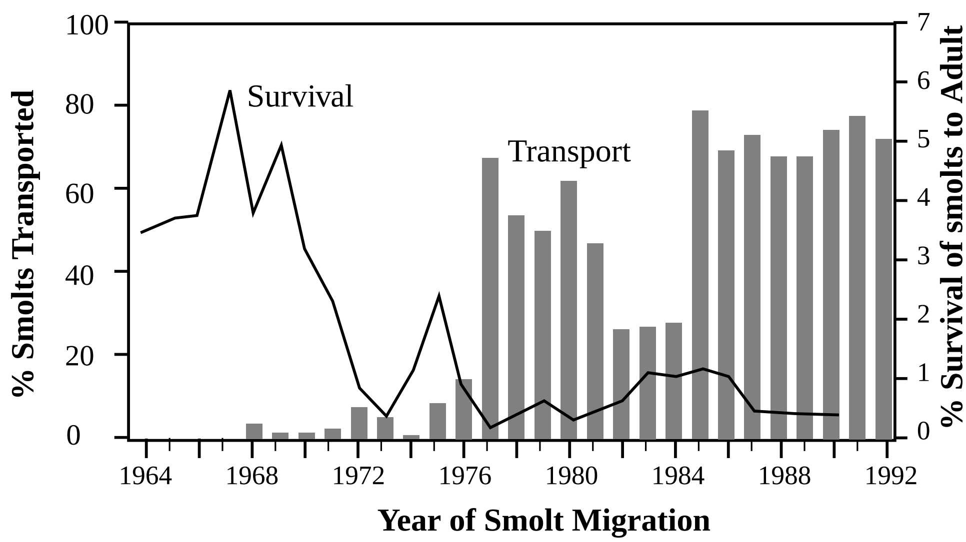
# Evidence for and against fish barging




- Evidence against: Fish runs have declined during barging, therefore barging is ineffective




- Evidence for: In nearly all barging studies the survival of returning adults barged as juveniles was 50% to 300% greater than the survival of adults that were not barged as juveniles.



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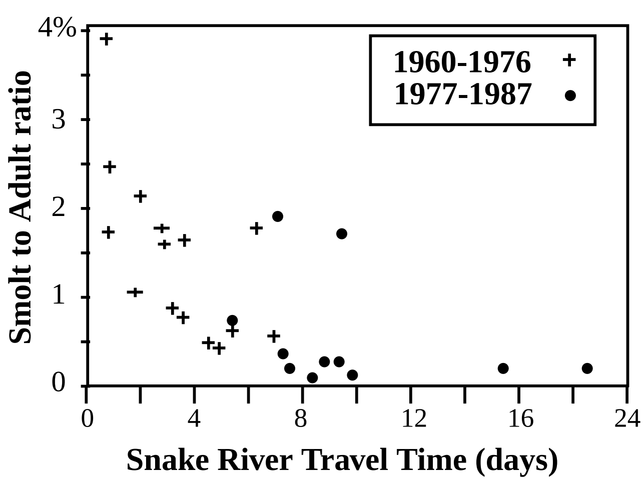
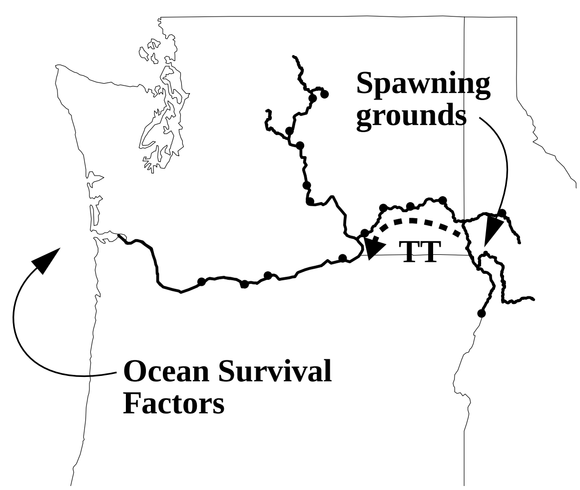
# Effect of travel time on survival

A measure of survival, smolts to adults returns (SAR), increases with decreasing travel time through the Snake River (TT). This finding has been used to justify flow augmentation and reservoir drawdown to improve survival to adults. The rationale is that increased flow or reservoir drawdowns will decrease travel time of smolts in the Snake River, thereby increasing survival of adults back to the spawning grounds.

The analysis ignores non-travel time effects including the relationship of seasonal temperature and flow and the ocean regime shift that affected all North Pacific stocks. Both factors can have a significant effect on survival and generate a correlation between SAR vs. TT.

Reservoir drawdown and flow augmentation will have very different, and possibly negative, impacts on temperature and little impact on ocean conditions.



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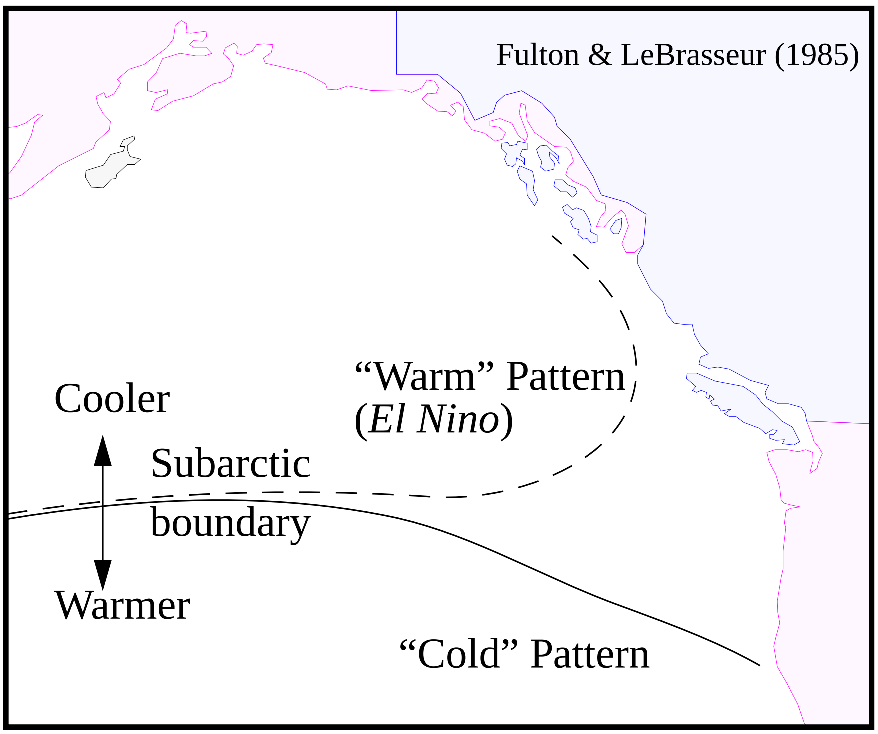
# Ocean regime shift and smolt survival

The ocean regime shift involves a switch between two basic patterns of temperature and currents in the North Pacific. In the shift the subarctic boundary moves, north in warm years and south in cold years. The shift occurs every few decades. The last major shift occurred in 1977 when the ocean switched from the cold year pattern to the warm year pattern. We are currently in a warm pattern.




The ocean regime shift is correlated with stock abundances. The warm pattern favors Alaskan salmon. The cold pattern favors west coast salmon.



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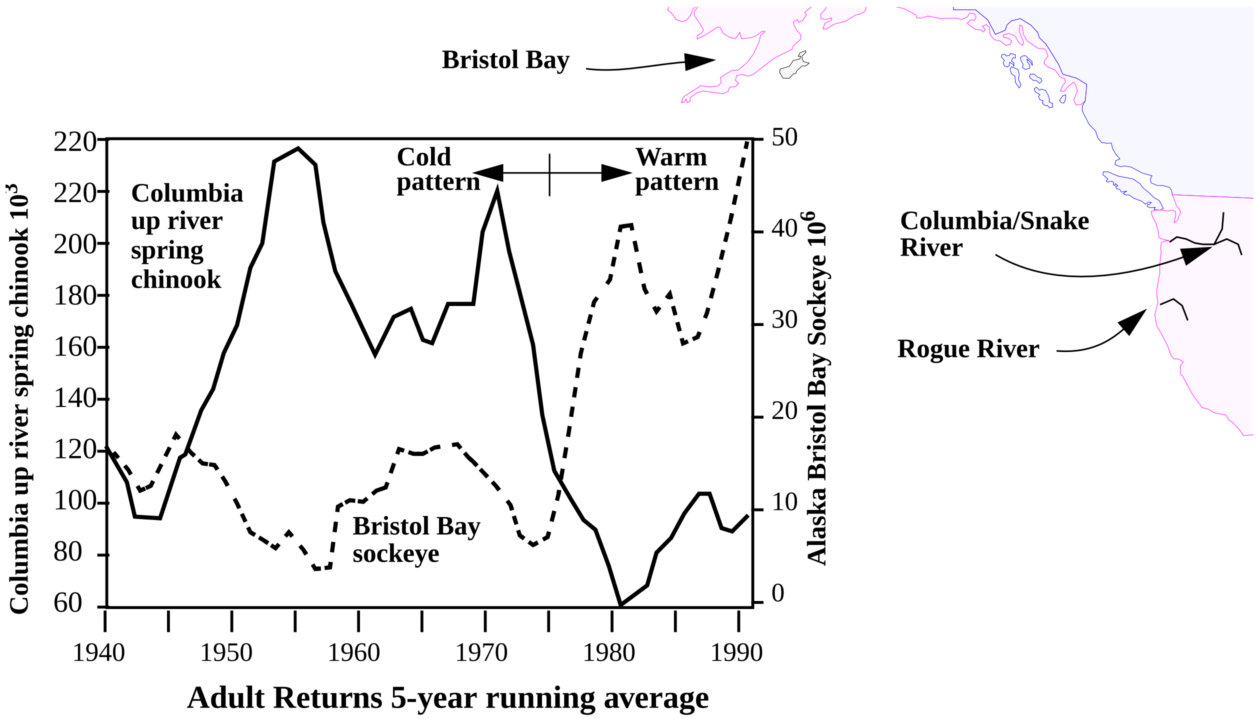
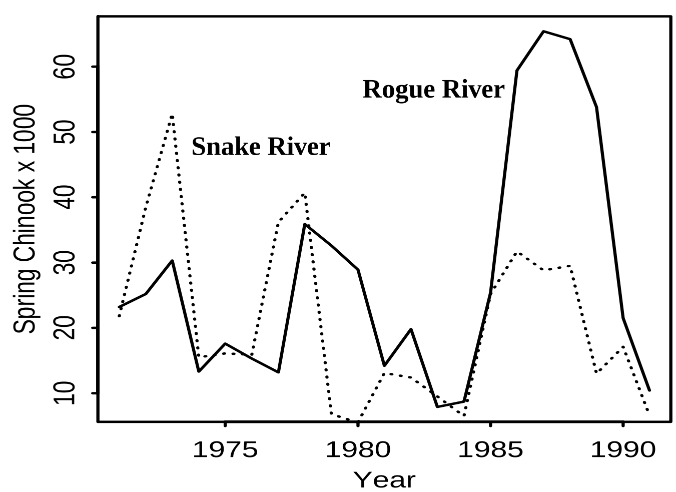
# Abundance patterns of salmon

Decadal shifts in salmon abundance suggest ocean factors play an important role in the Smolt to Adult survival relationship.




Coastal and Snake/ Columbia River stocks follow similar patterns and are out of phase with Alaskan stocks.



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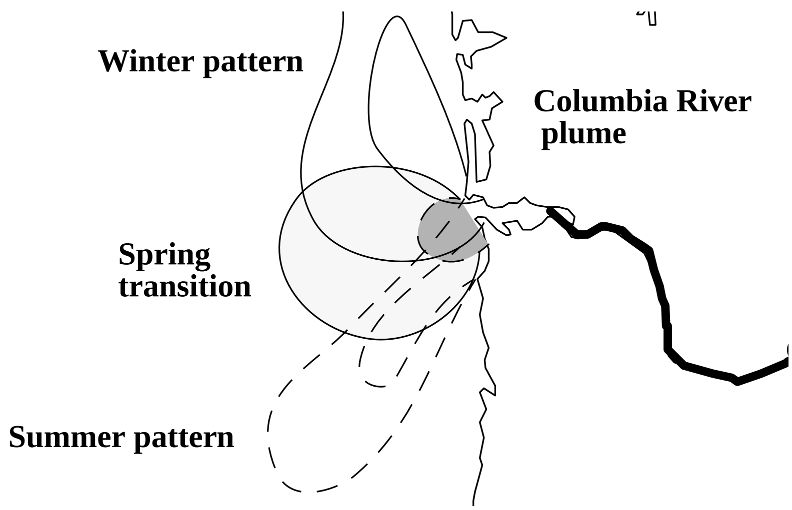
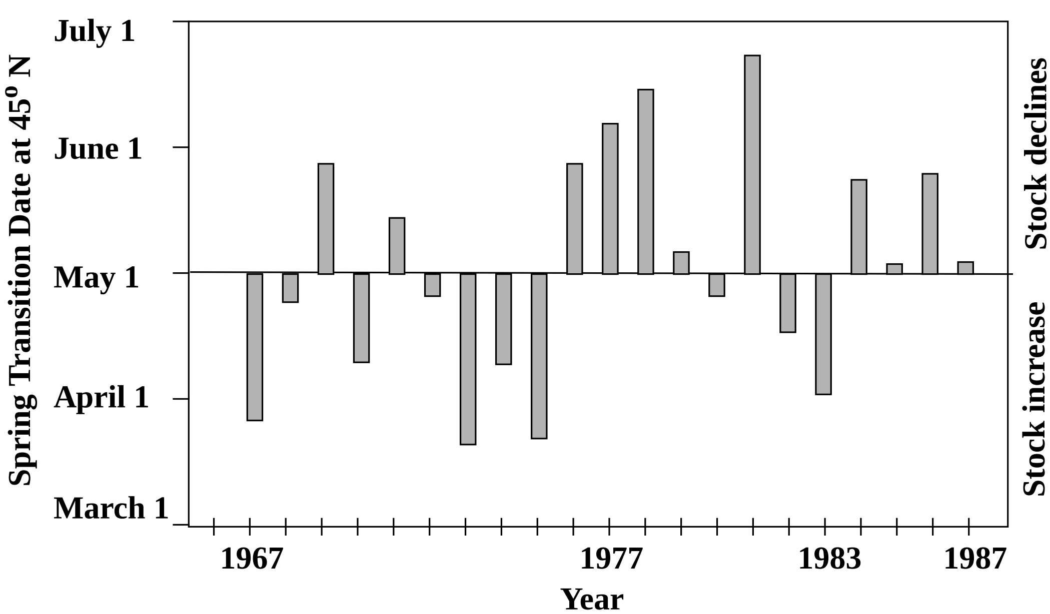
# Columbia River spring transition

The ocean regime shift alters the date of the transition from winter to summer river plume patterns. The timing of the transition and smolt ocean entry may affect smolt survival. Fish entering the estuary prior to the transition appear to have lower survival than fish entering after the spring transition.



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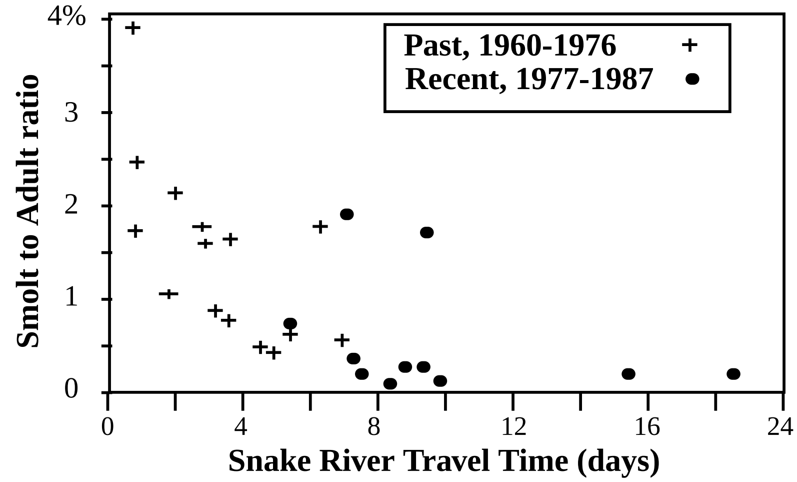
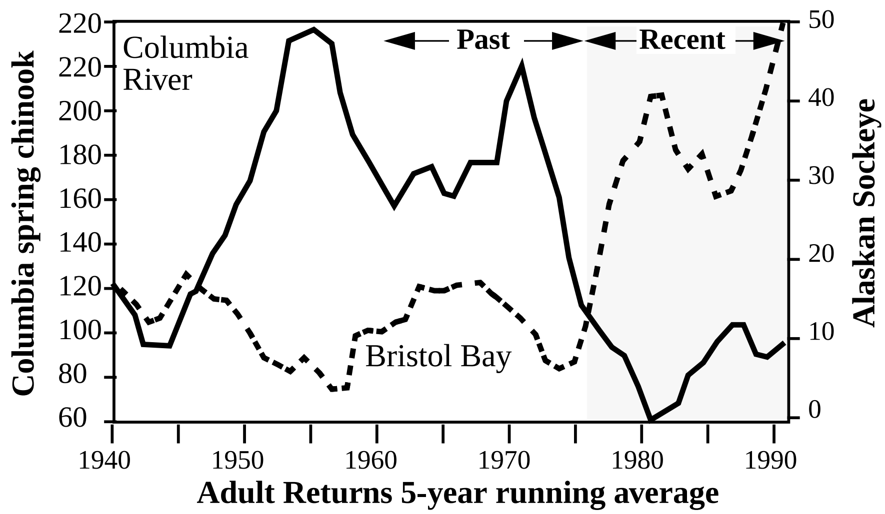
# Which story is right?

- The story, *"It's Our Fault,"* is based on river correlations
- The Story, *"It's Nature's Fault,"* is based ocean correlations

The survival/travel time relationship is generated by data from the period prior to the Snake River dams (1976) and the ocean regime shift. Both graphs below can be generated with the ocean survival hypothesis.



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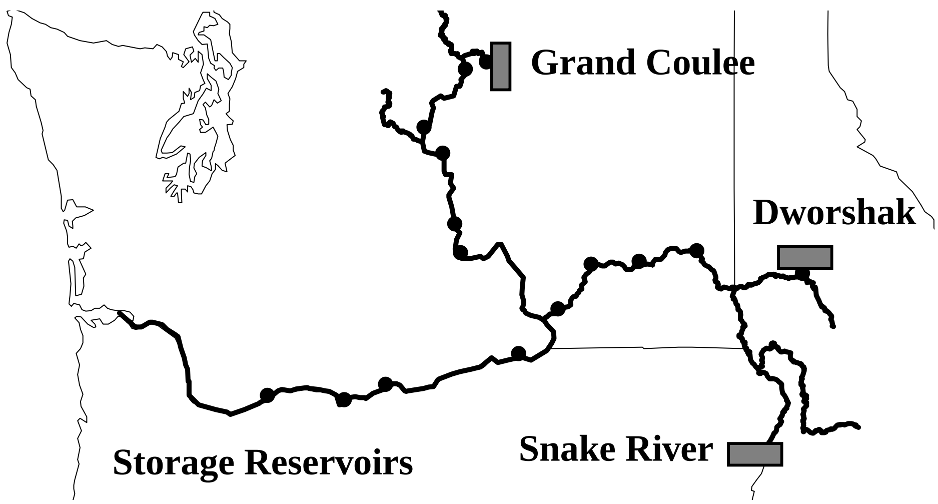
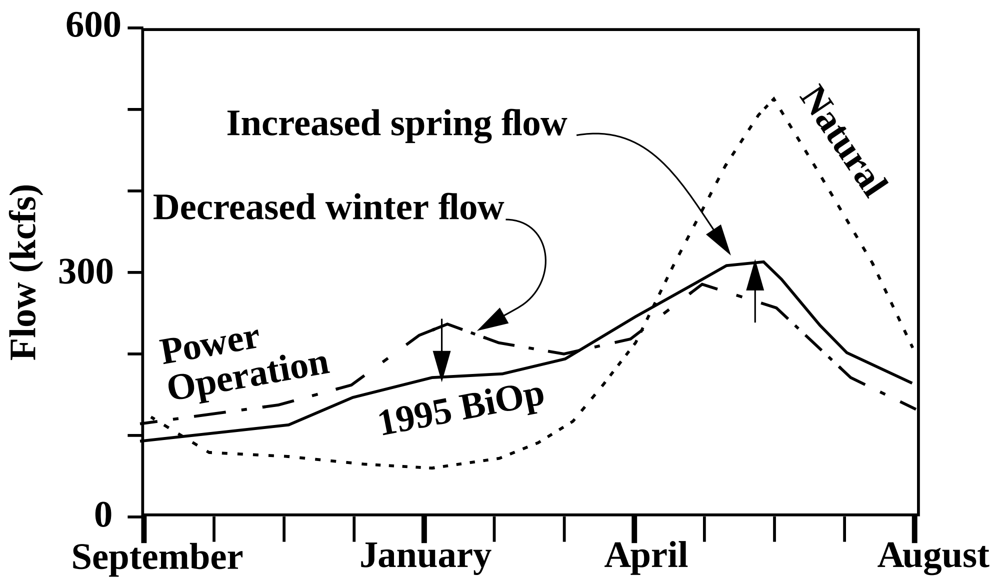
# Flow as a recovery action

Increased spring flows from storage reservoirs is proposed as a recovery action (BiOp[1]). This requires restricting flows in the winter.




1. Biological Opinion is a flow proposal for salmon recovery



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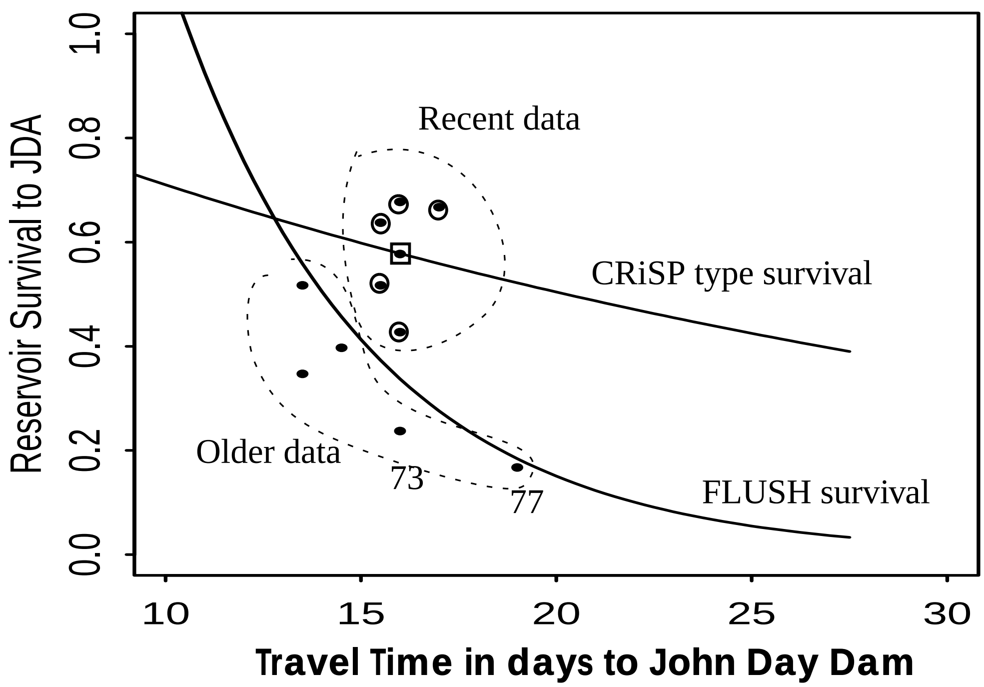
# Flow benefits are evaluated with models

Models of mainstem juvenile survival disagree on the impact of flow. The FLUSH[1] model uses older survival data and predicts large benefits from faster travel through the river. The CRiSP[1] model uses more recent data and predicts smaller benefits from faster travel through the river.




Spring chinook survival vs. travel time to John Day (JDA) or Little Goose dam using the FLUSH model and a corrected curve assuming a constant rate coefficient based on survival data from 1978 onward, which are indicated by circled dots. The square is the result of the 1994 survival study projected to John Day Dam.

1. FLUSH was developed by the States and Tribes; CRiSP was developed by U. Washington



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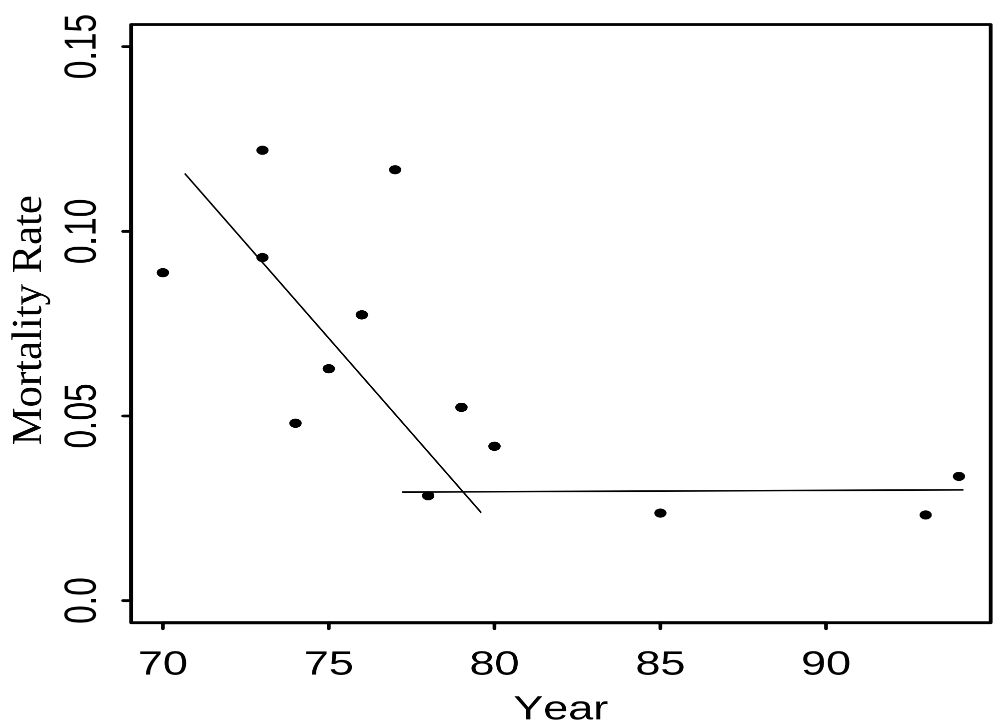
# Why are the models different

Survival has improved in the river since the 70's. CRiSP considers the recent passage survival information from 80's onward. The strong travel time survival relationship in FLUSH is biased by early survival studies. The estimates of reservoir survival in FLUSH did not account for high dam passage mortality in the early years. As a consequence, the additional dam passage mortality was included in the reservoir survival biasing that information. Because of steady improvements in the hydrosystem, fish in-river passage survival has improved over the years. This is illustrated by plotting the mortality rate coefficient (lower values equate to higher survival) against year.




Rate coefficient estimates vs. year show improving survival over the years



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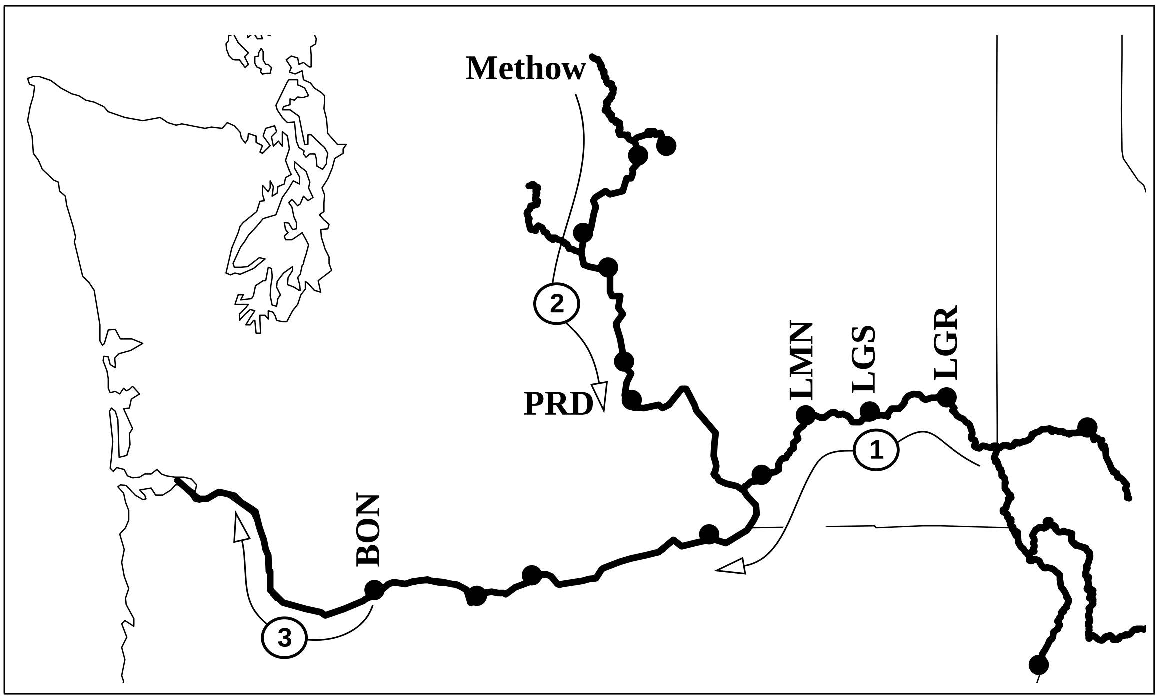
# High river survival is supported by studies

CRiSP predictions of improved river survival are supported by independent studies.

- (1) Spring chinook survival to Little Goose dam (LGS) in 1993 (CRiSP 70% vs. obs 78%) and Lower Monumental dam (LMO) in 1994 (CRiSP 65% vs. obs 66%)
- (2) Mid-Columbia spring chinook survivals from Methow to Priest Rapids dam (PRD). (CRiSP 45.1% and 46.8% vs. obs 47% and 47.3%)
- (3) Spring chinook survival from radio tag tracking of fish released below Bonneville dam (BON) (CRiSP 90% vs. obs. > 80%)




Validation sites used in the CRiSP salmon passage model



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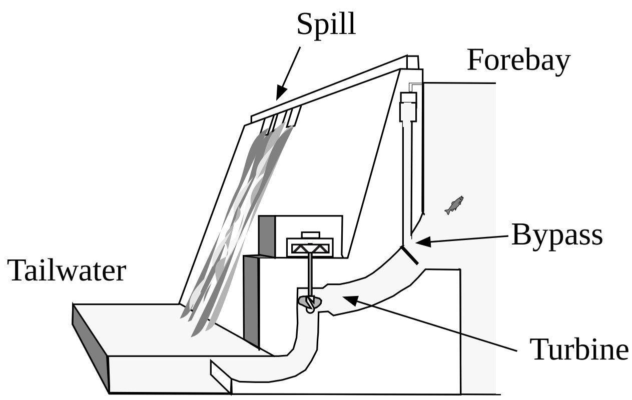
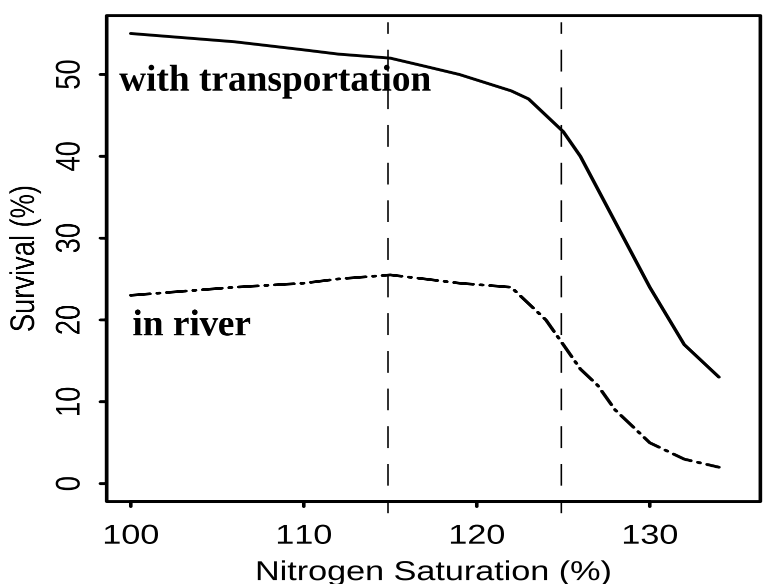
# Spill as a recovery action




- Fish survival in spill passage is higher than in turbine passage
- Spill increases gas supersaturation in tailwaters and reservoirs
- Gas supersaturation in water kills fish in downstream of dams




CRiSP predicted survivals with spill produced gas levels



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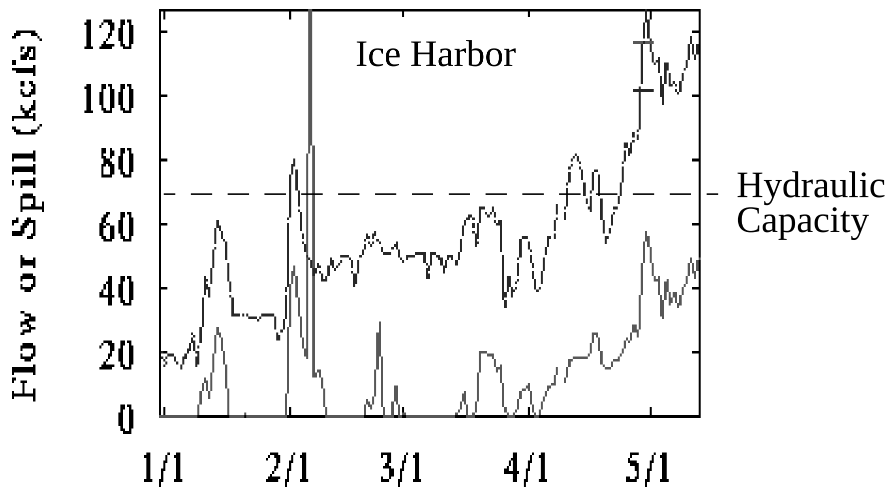
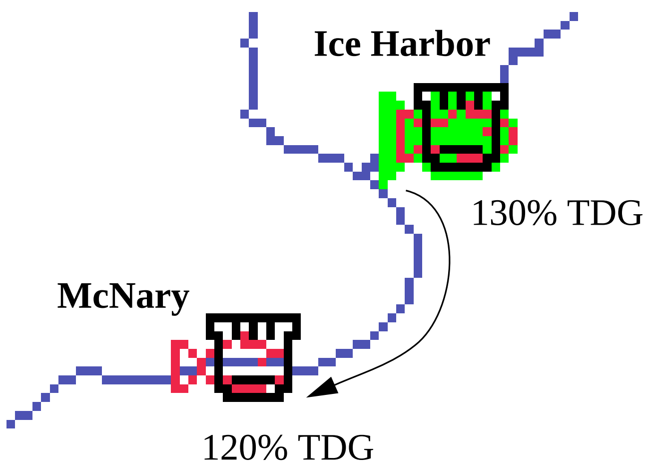
# Analysis of 1995 Snake River spill

Information on flow, spill and total dissolved gas are available on the Columbia River Web pages and can be accessed through the Internet from http://www.cbr.washington.edu.

The impacts of the 1995 spill program were evaluated with the CRiSP mainstem passage model.




With the Spill
12 to 25% fish mortality
from ICH dam to MCN dam

Without the Spill
8% fish mortality
from ICH dam to MCN dam

TDG = total dissolved gas



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# CRiSP analysis of Recovery Plan benefits

An analysis of mainstem recovery actions indicates the actions should have little impact on juvenile passage. In terms of additional adults returning to spawn, the actions will yield few additional fish over current operations.

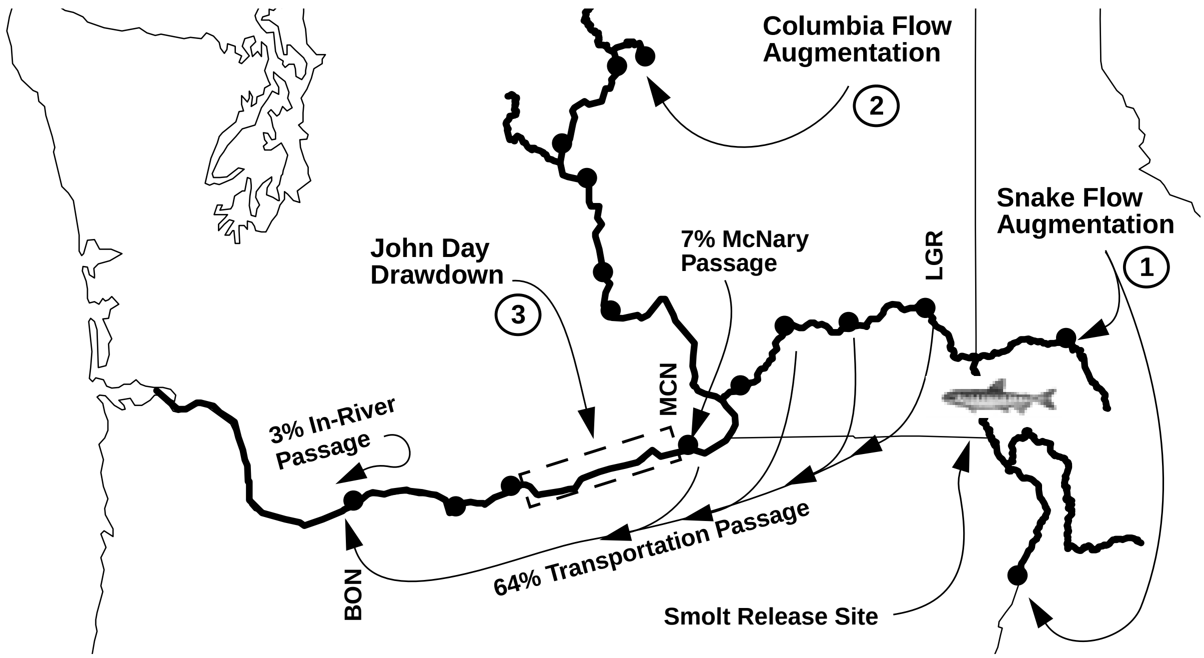


**Table 1.** Smolt passage gains from three actions are expressed as the average number of smolts as modeled with a passage model CRiSP1.5 and the life cycle model, SLCM. Initial Snake River smolt migration is assumed to be one million spring/summer chinook.

| Action | Survival to Below Bonneville | | | Survival to Spawner | | |
|---|---|---|---|---|---|---|
| | Number | Percent | Gain | Number | Percent | Gain |
| (1) Base Case | 554175 | 55.417% | | 3310 | 0.331% | |
| (2) Columbia Flow | 555891 | 55.589% | 1716 | 3330 | 0.333% | 20 |
| (3) Drawdown | 555946 | 55.595% | 55 | 3332 | 0.333% | 2 |



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# Open access to information

The information present here is in sharp contract to the beliefs held by many salmon advocates. Much of the controversy involves competing models for smolt passage through the hydrosystem. Depending on which model is believed very different approaches should be taken to recover the endangered species. Although there is uncertainty in how to proceed, I believe a significant amount of this uncertainty is in the agencies' and public's understanding of the issues and not in the science. I believe that extensive and peer reviewed model evaluations will advance our understanding, and clarify the real scientific uncertainty. In the current climate much of the public confusion is being attributed to scientific uncertainty. Open access to information can reduce this confusion. The World Wide Web is a vehicle to achieving open access.

Information on which this paper is based is available through the Web page http://www.cbr.washington.edu.

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Dr. James J. Anderson is an Associate Professor in the School of Fisheries and Center for Quantitative Science at the University of Washington. His work on salmon issues has been funded by Bonneville Power Administration and the Army Corps of Engineers. The views in this document are a result of that research. The presentation of this paper was supported by the Direct Service Industries, Inc.