Northwest Power and Conservation Council

February 23, 2012

MEMORANDUM

TO: Fish and Wildlife Committee

FROM: Patty O'Toole, Program Implementation Manager

SUBJECT: Panel discussion – Ocean Projects Synthesis Report

In its final recommendations (July 2011) for the Review of Research, Monitoring and Evaluation and Artificial Production Projects, the Council recommended that the three project proponents conducting ocean research under the Council's Fish and Wildlife Program jointly complete a comprehensive synthesis report summarizing their ocean research. The project proponents responded to this recommendation by preparing *The Marine Ecology of Juvenile Columbia River Basin Salmonids: A Synthesis of Research 1998-2011*.
http://www.nwcouncil.org/library/report.asp?docid=660

The RME review included three research projects studying the survival of salmon and steelhead in the ocean. Each project has its particular merits and issues, addressed by recommendations and comments associated with each project. But the RM&E review raised broader issues about the ocean research, including the lack of any overarching plan for the ocean research, concerns about coordination among the projects, and a lack of coordination with the projects in the estuary also attempting to estimate juvenile salmon mortality. It was also not clear how the projects collectively are addressing the ocean strategies in the 2009 Fish and Wildlife Program and thus how the information to be gained will help us distinguish the effects of ocean conditions from other effects and help us manage in freshwater for variable ocean conditions.

The Council recommended that funding for the ocean research projects through FY 2012 was to include the completion of the synthesis report and to allow for subsequent ISRP review and a Council recommendation on future implementation and funding. The Council and Bonneville will decide on additional funding for these projects in out years depending on the review of the synthesis report, and then on how the project sponsors propose to re-shape the research projects consistent with the recommendation here and the outcome of the synthesis report review.

At the March 2012 Fish and Wildlife Committee meeting, staff expects to have several experts and interested stakeholders participate in a Fish and Wildlife Committee discussion to regarding

the ocean research under the Program Staff anticipates that the project sponsors will provide a presentation of their synthesis report. Following this presentation, a summary of the Independent Scientific Review Panel's review of the synthesis report will be provided. Perspectives about how this research relates to the needs described in the Council's Fish and Wildlife Program and the FCRPS Biological Opinion will be presented by Council staff, NOAA, and Bonneville. Finally, there will be an opportunity for interested parties to provide public comment on the ocean synthesis report or the ISRP's review.

The ISRP review of the synthesis report is expected at the end of February. A public comment period will begin immediately and continue through most of March. Staff will seek a Committee recommendation on future funding for the ocean projects at the April 2012 meeting. Staff anticipates that a Committee recommendation will be brought to the full Council for a decision in May 2012.

The three projects affected by this recommendation are:

Ocean Survival of Salmonids	1998-01-400	NOAA Fisheries
Salmon Shelf Survival Study	2003-00-900	Canada Department of Fisheries and Oceans
Coastal Ocean Acoustic Salmon Tracking (COAST)	2003-11-400	Kintama Research

These projects were recommended by the Council for funding through FY 2012. Funding for the NOAA and DFO projects beyond FY 2012 will be based on the Council and ISRP review of the synthesis report. The remaining project was not recommended by the Council for funding past 2012. All project sponsors participated in the development of the synthesis report.

Marine Ecology of Juvenile Columbia Basin Salmonids: A Synthesis of Research 1998-2011

Presentation to NWPCC
6 March 2012

Kym Jacobson, Marc Trudel, David Welch,
Bill Peterson, Cheryl Morgan and Kurt Fresh

Fisheries and Oceans Canada

Cooperative Institute for Marine Resources Studies
CIMRS

NOAA

KINTAMA

Plan of the Presentation

- Introduction and Overview of Ocean Programs
- Select results:
  - Ocean sampling (NOAA & DFO)
  - Acoustic tracking (Kintama)
- Forecasting and Key Findings
- Management Implications and Future Efforts

Introduction

- Despite extensive mitigation efforts in freshwater, concerns for salmon recovery have not changed.
- The role of the ocean as a critical habitat for juvenile salmon survival has received limited attention in recovery planning efforts.
- We need to understand interactions between salmon diversity and ocean variability to realistically plan recovery goals and management options for different ESUs.
- We expect climate change/global warming to reduce marine survival. It is imperative to distinguish between freshwater and marine impacts now to be proactive.

Overview of Research Projects

NOAA and DFO: Complementary Trawl Surveys (central Oregon through SE Alaska)

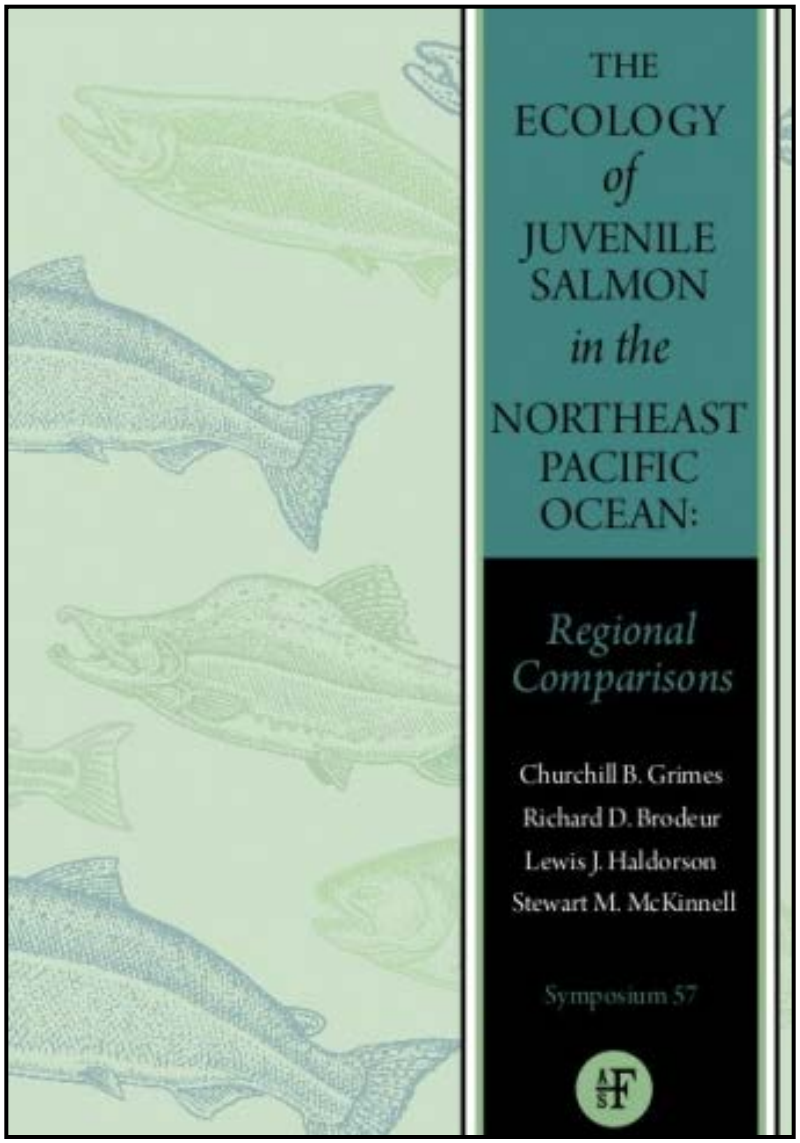
- Measure distribution & abundance of juvenile salmonids with metrics of growth & condition
- Measure physical and biological oceanographic conditions (temp, salinity, plankton, predators)
- Provide biannual summaries of ocean conditions and salmon forecasts

Overview of Research Projects (con't)

Kintama Ltd. - Acoustic Telemetry Array

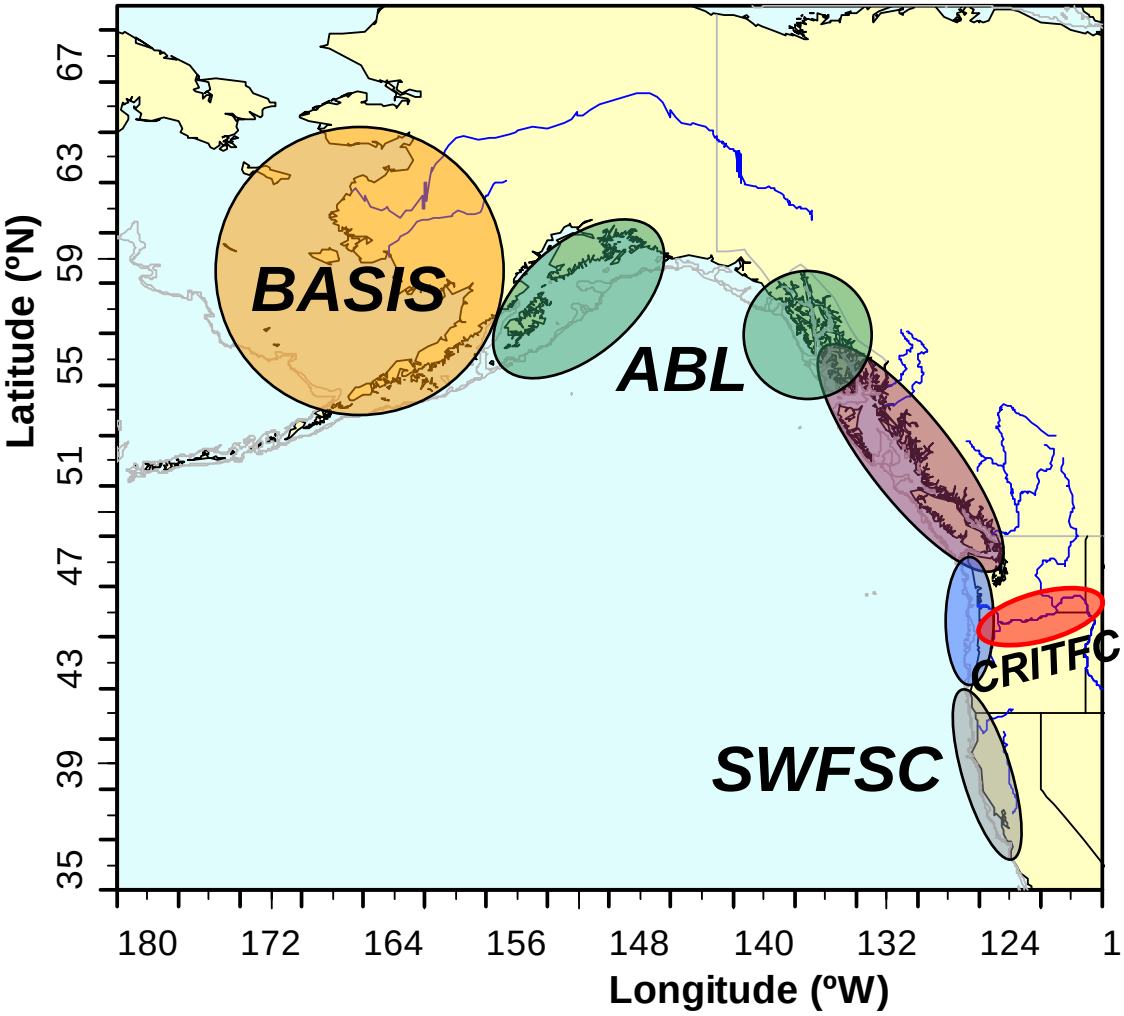
- Measure juvenile salmon survival in different habitats
- Experimentally test key hydrosystem theories (delayed & differential-delayed mortality)

Coordination & Collaboration Within the Ocean Program



- Adopted the same conceptual ecosystem framework
- Similar sampling strategies and compatible methods
- Joint research projects
- Sharing of data, samples and results
- Joint publications
- Proposal development
- Annual workshops (e.g. Ocean Ecology and Ocean Salmon Meetings)

Coordination & Collaboration With Other Projects

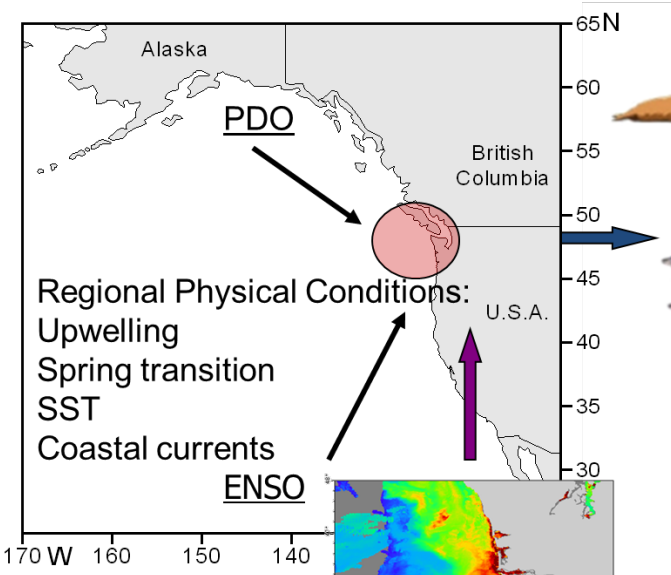


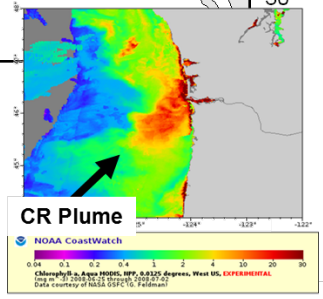
Organizations/Programs:

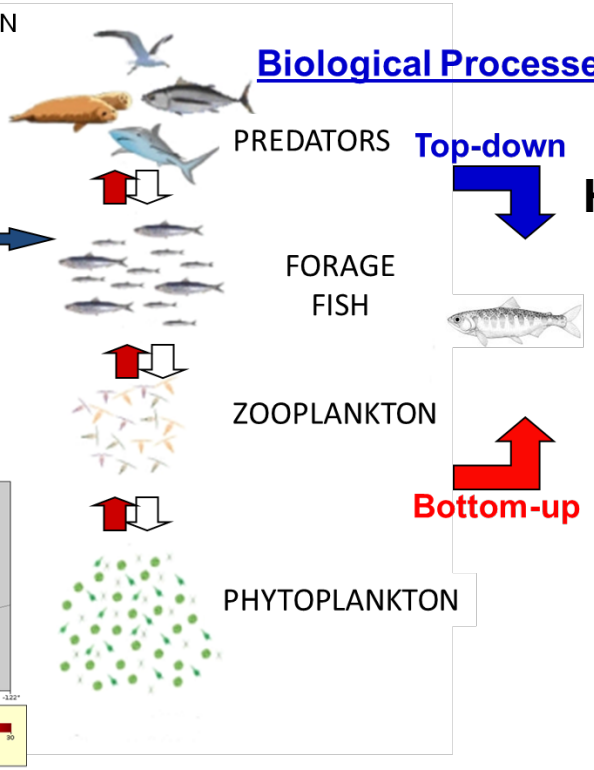
- BASIS: Bering-Aleutian Salmon International Survey (NOAA)
- ABL: Auke Bay Laboratories (NOAA)
- SWFSC: Southwest Fisheries Science Center (NOAA)
- CRITFC: Columbia River Inter-Tribal Fish Commission
- Other estuary programs

Conceptual Model for Ocean Surveys

Physical forces acting at all scales can influence biological processes important for salmon







H2: Predators & Pathogens

H1: Food quantity & quality

H3: Plume Structure

H4: Hydropower System

H5: Freshwater vs. Ocean Survival

Basin scale forces:

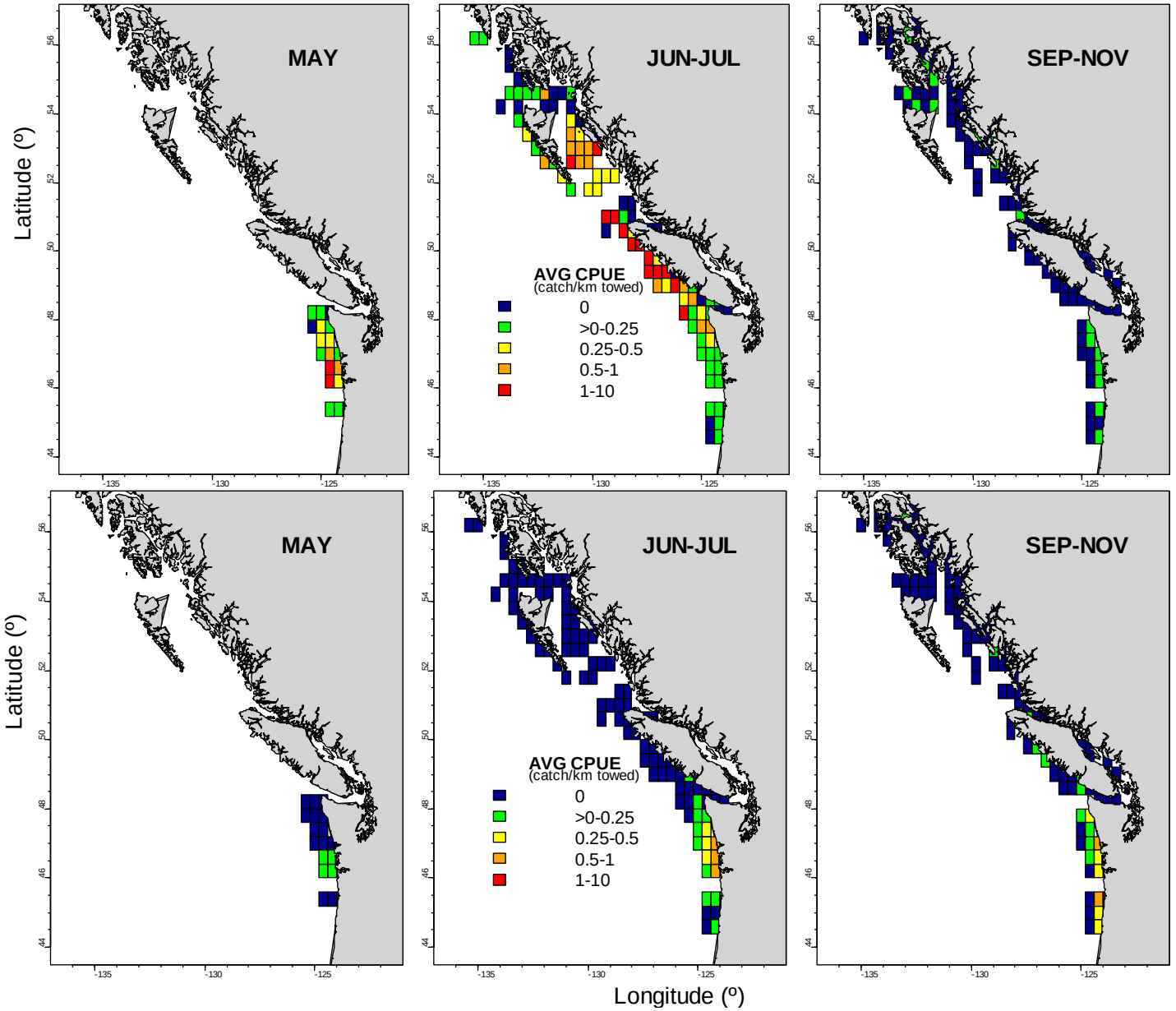
Pacific Decadal Oscillation (PDO)

El Niño Southern Oscillation (ENSO)

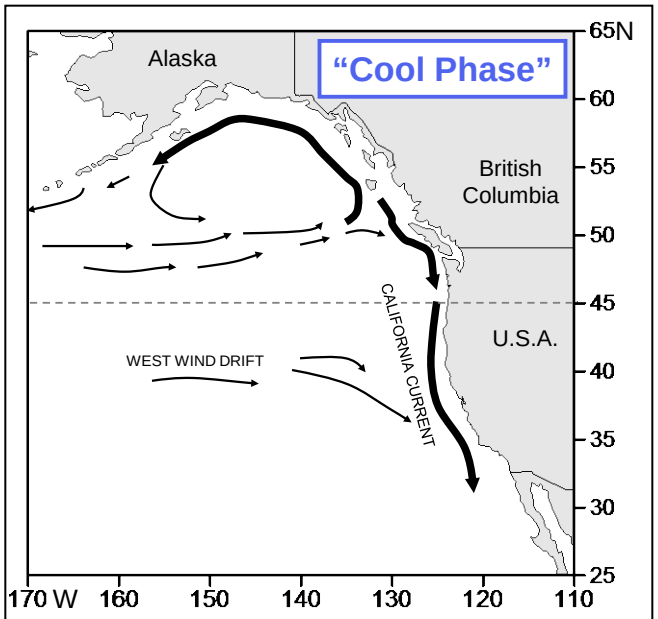
Distribution of Snake River Juvenile Chinook Salmon

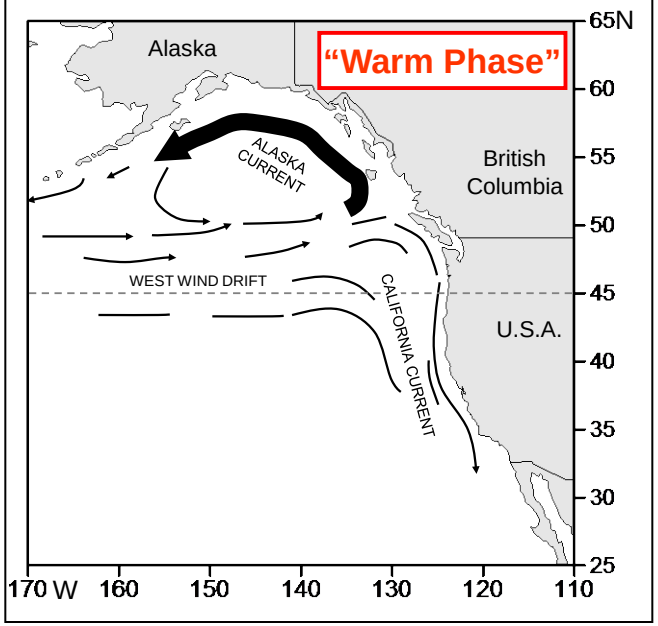
Yearling Spring/Summer

Subyearling Fall



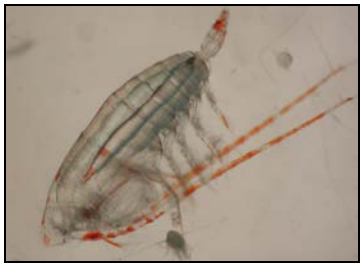
Basin Scale Effects on Trophic Interactions





Cool Phase of PDO

- Water from the north
- Cold water = copepods with fat
- Few large predators on the shelf
- High survival of salmon

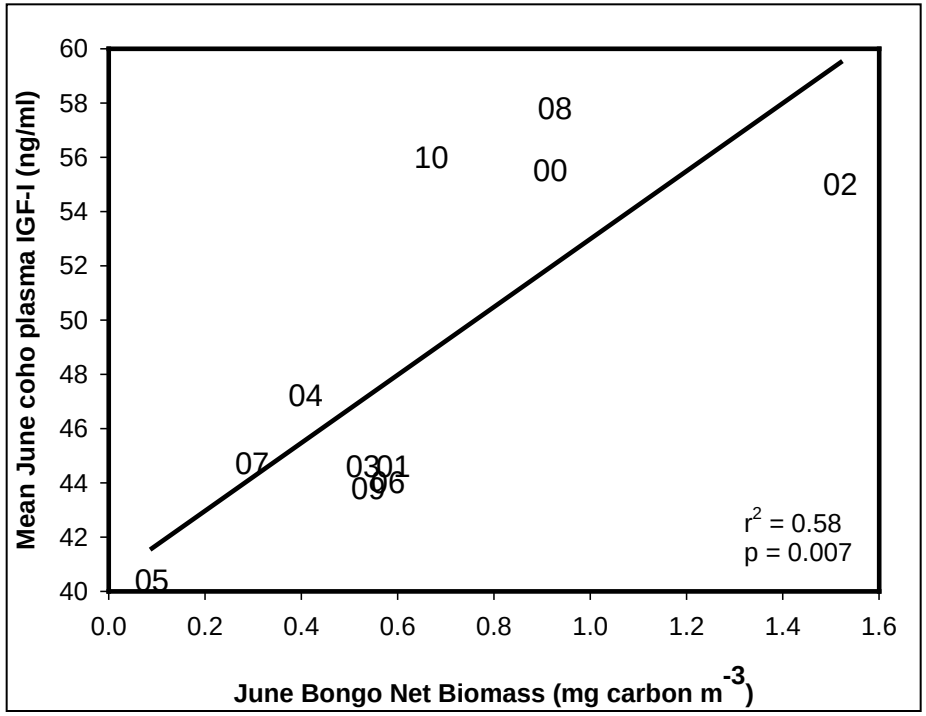


Warm Phase of PDO

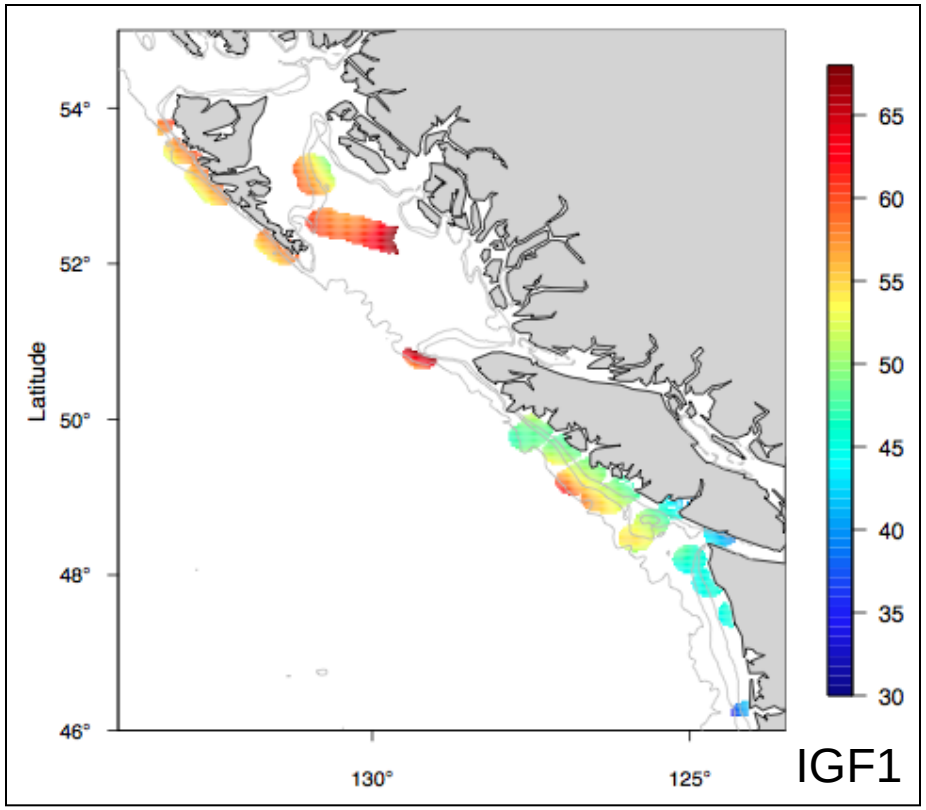
- Water from offshore & south
- Warm water = copepods w/o fat
- Many large migratory predators
- Low survival of salmon

Early Ocean Growth & Survival

Zooplankton biomass correlates with early ocean growth (Insulin-like growth factor 1)

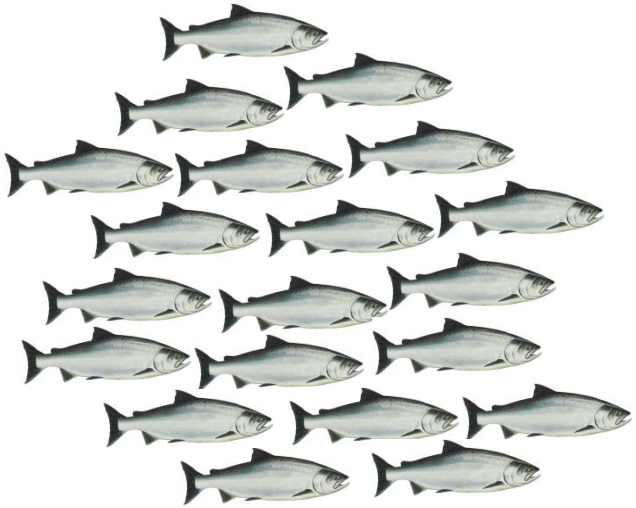


Juvenile salmon growth is higher to the north



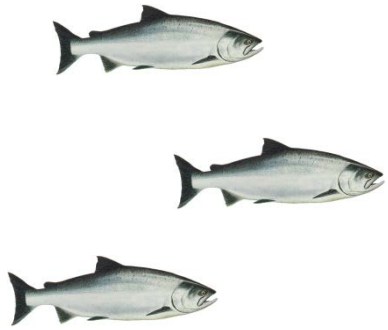
Winter mortality at sea may be as important as summer mortality

October



80-90 % Mortality

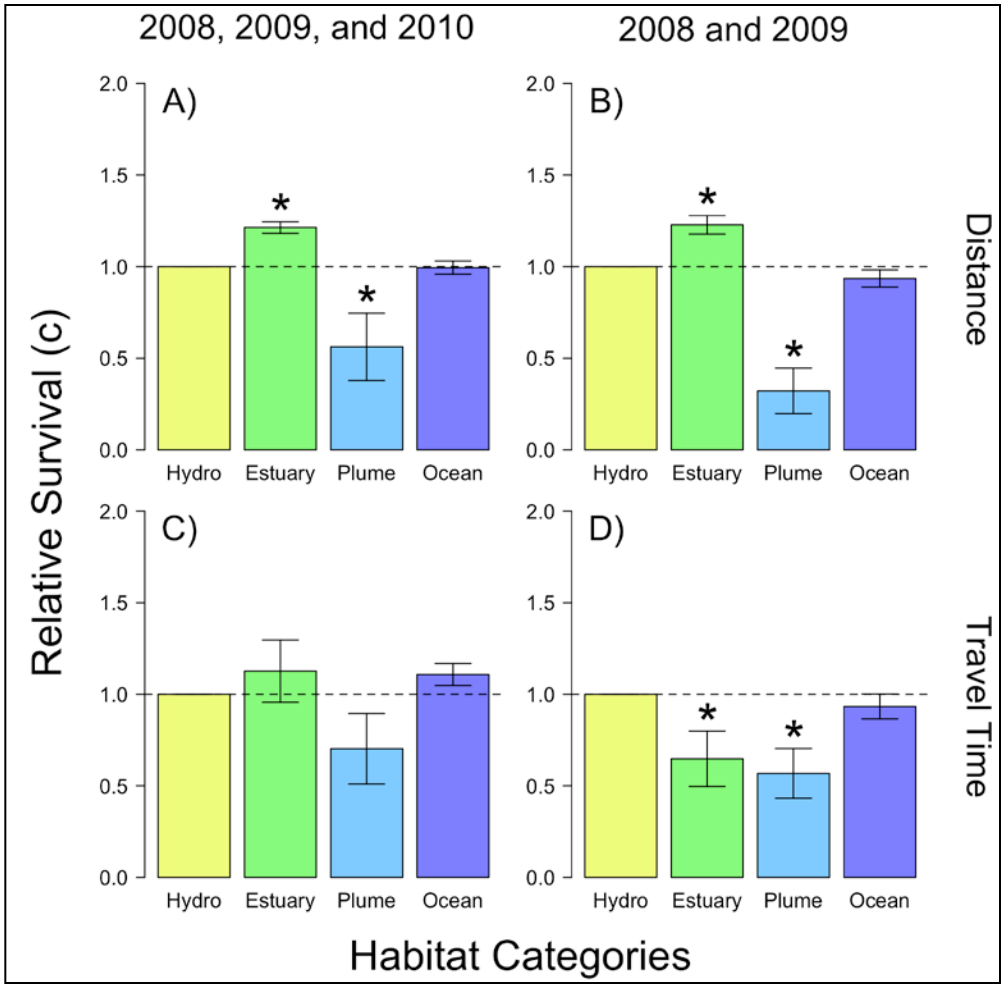
March



Acoustic Measurements of Survival

- Telemetry array used to measure Snake River Spring Chinook survival in four habitats:
  - Hydrosystem (Release through Bonneville)
  - Estuary
  - Plume
  - Coastal Ocean

Relative Survival in Different Habitats



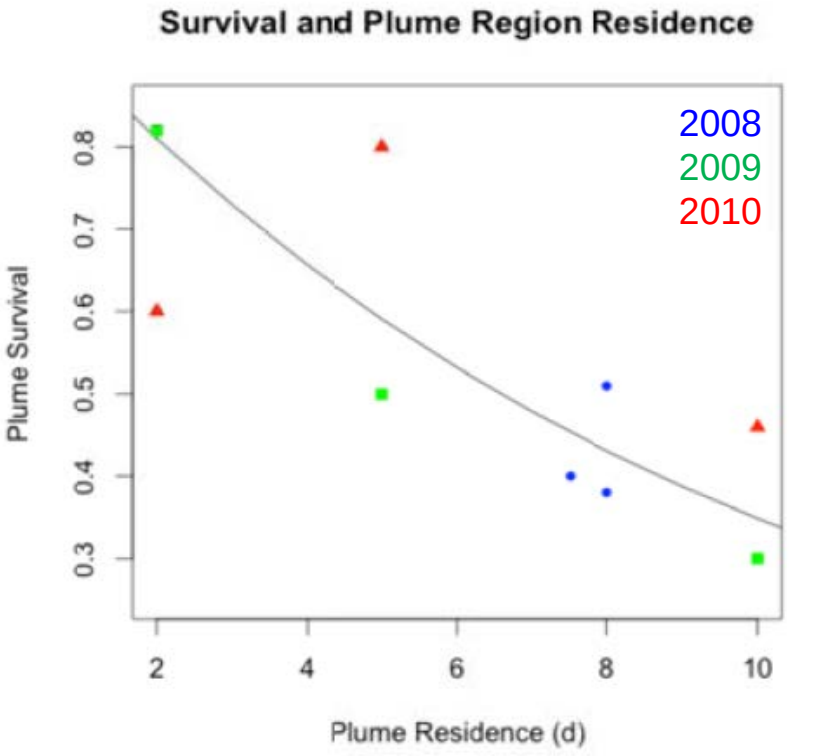
- Measured hydrosystem and coastal ocean survival rates are nearly identical: $S_{FW} \approx S_{Ocean}$
- This means that moving smolts out of the river faster will not necessarily benefit salmon conservation, but may just change where the smolts die: *"no net benefit".*

Plume Survival

- Daily survival rates in the plume were poorest amongst the four habitats.
- The longer Spring Chinook smolts stayed in the plume, the lower their survival.
- Earlier expectation was that the plume was a survival refuge.

Table 4. Average habitat survival rates (%) per day

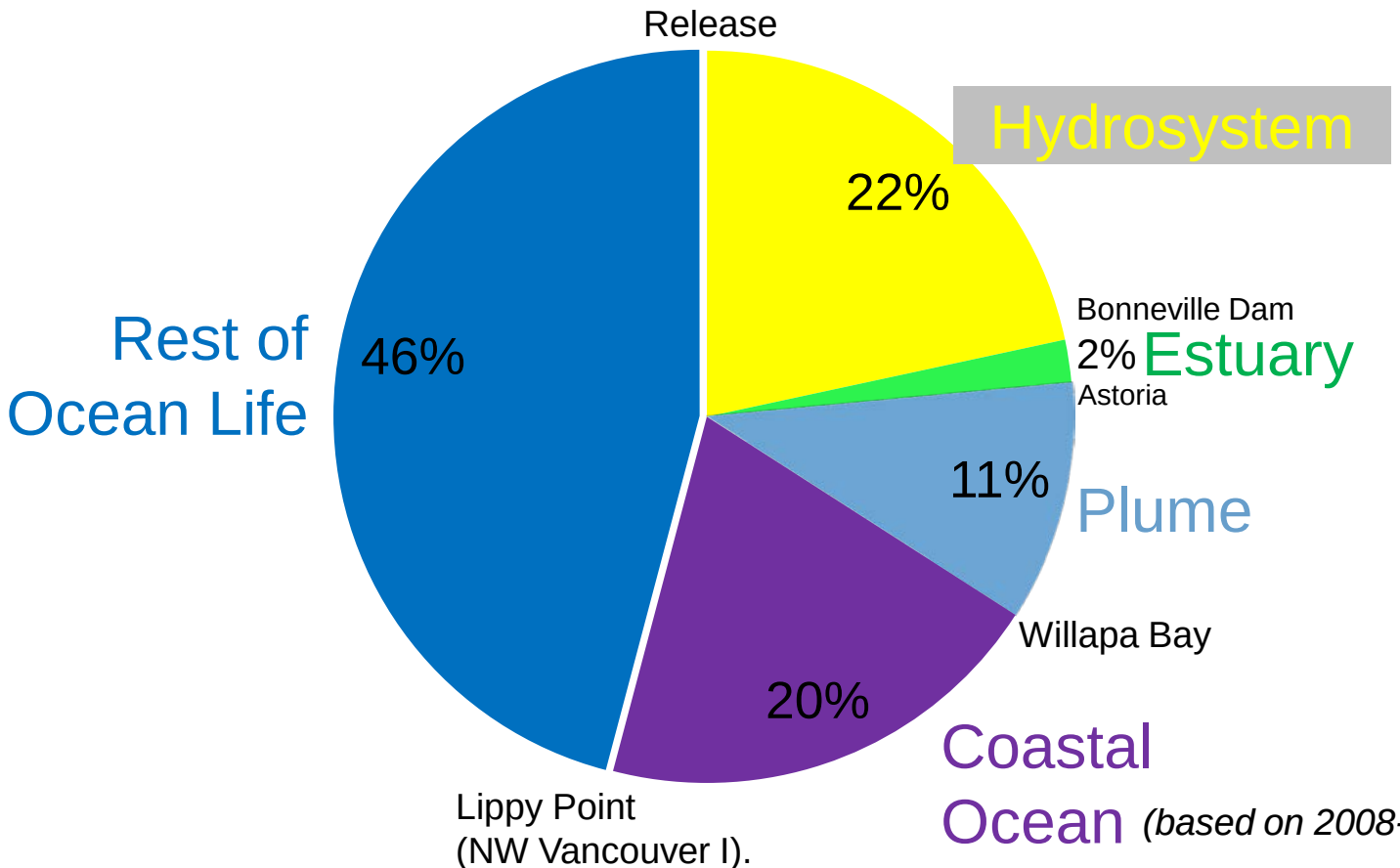
Habitat	2008, 2009, 2010		
	$\hat{S}$	se ($\hat{S}$)	95% CI
Hydrosystem	94.4	0.37	(93.7, 95.1)
Estuary	96.0	2.05	(92.0, 100)
Plume	89.8	3.51	(82.9, 96.7)
Ocean	95.8	0.78	(94.3, 97.3)



I. Brosnan (Cornell Univ., Ph.D. Thesis)

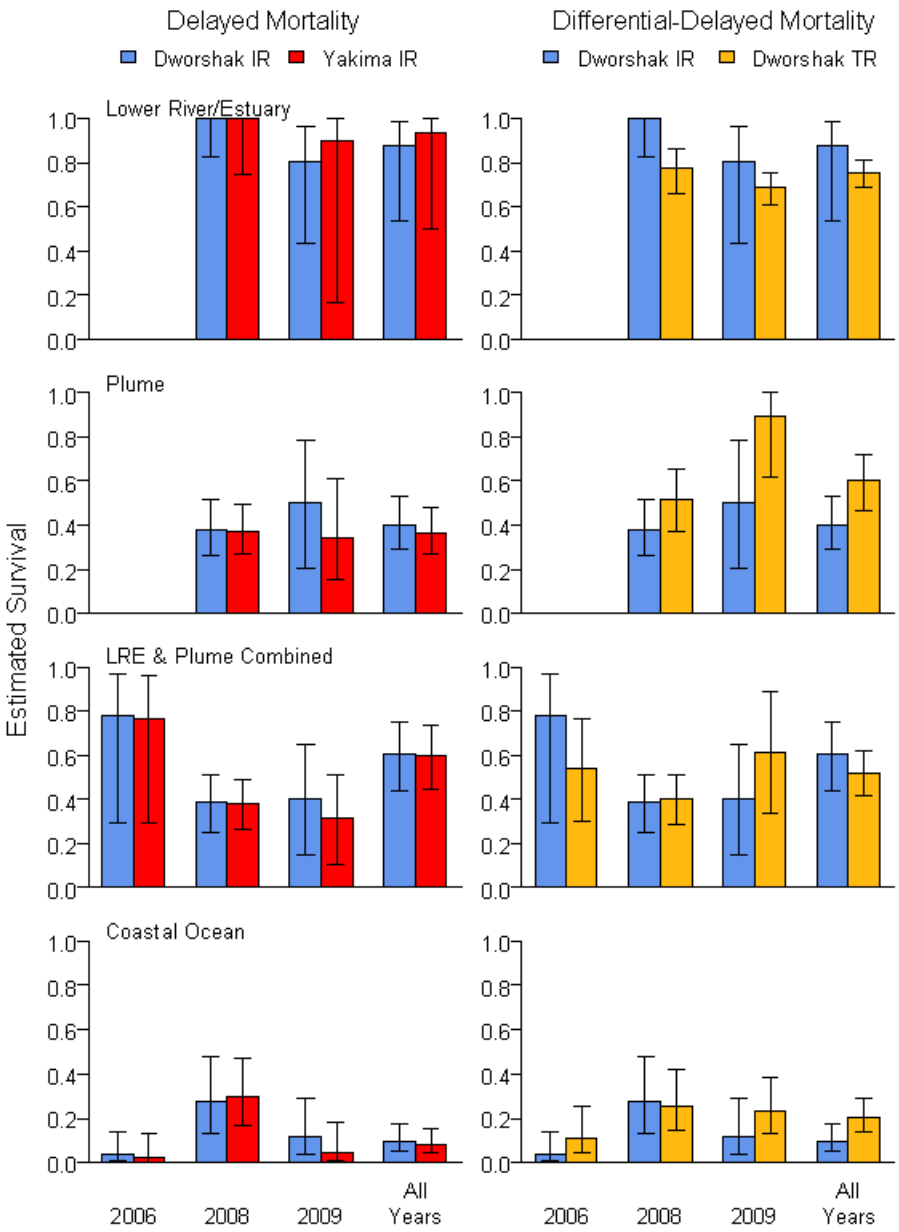
Where Does Most Mortality Occur?

- POST acoustic tag-based survival estimates indicate that most Spring Chinook mortality happens at sea; hydrosystem migration & estuary have low mortality compared to the ocean (Plume, Coastal Ocean, & “Later Ocean”).



Testing Latent Mortality Theories

- Neither Delayed nor Differential-Delayed Mortality seems to occur for Snake River Spring Chinook.
- Indicates latent effects of the dams on ocean survival absent, at least for Snake River Spring Chinook.



Stoplight Charts: Conditions for salmon

NOAA

Ecosystem Indicators	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PDO (December-March)	13	5	2	9	6	14	8	12	10	7	4	1	11	3
PDO (May-September)	8	3	5	4	9	13	12	14	10	11	1	7	6	2
ONI Jan-June	14	1	1	5	10	11	9	12	6	8	3	7	13	4
SST at 46050 (May-Sept)	12	8	3	4	1	7	14	11	5	13	2	9	6	10
SST at NH 05 (May-Sept)	8	4	1	6	2	5	14	11	7	13	3	12	10	9
SST winter before (Nov-Mar)	14	11	3	5	7	10	12	9	8	2	1	4	13	5
Physical Spring Trans (UI Based)	3	6	13	12	4	9	11	14	9	1	5	2	7	8
Upwelling Anomaly (Apr-May)	7	1	12	3	6	10	9	14	7	2	4	5	11	12
Length of upwelling season (UI Based)	6	2	13	9	1	10	8	14	5	3	7	3	11	12
Deep Temperature at NH 05	14	4	6	3	1	9	10	11	12	5	2	8	7	13
Deep Salinity at NH05	14	3	6	2	5	12	13	8	7	1	4	10	11	9
Copepod Richness Anomaly	14	2	1	5	4	10	9	13	11	8	6	7	12	3
N.Copepod Anomaly	13	9	5	6	3	12	11	14	10	8	2	7	4	1
Biological Transition	13	9	6	5	7	12	8	14	11	2	1	4	10	3
Copepod Community structure	14	4	3	6	1	10	11	13	12	8	2	5	9	7
Winter Ichthyoplankton	14	6	2	4	5	13	12	8	11	10	1	7	3	9
Catches of salmon in surveys														
June-Chinook Catches	13	2	3	11	7	9	12	14	8	6	1	4	5	10
Sept-Coho Catches	10	2	1	4	3	6	11	13	8	9	7	14	12	5
Mean of Ranks	11.3	4.6	4.8	5.7	4.6	10.1	10.8	12.2	8.7	6.5	3.1	6.4	8.9	6.9
RANK of the mean rank	13	2	4	5	2	11	12	14	9	7	1	6	10	8

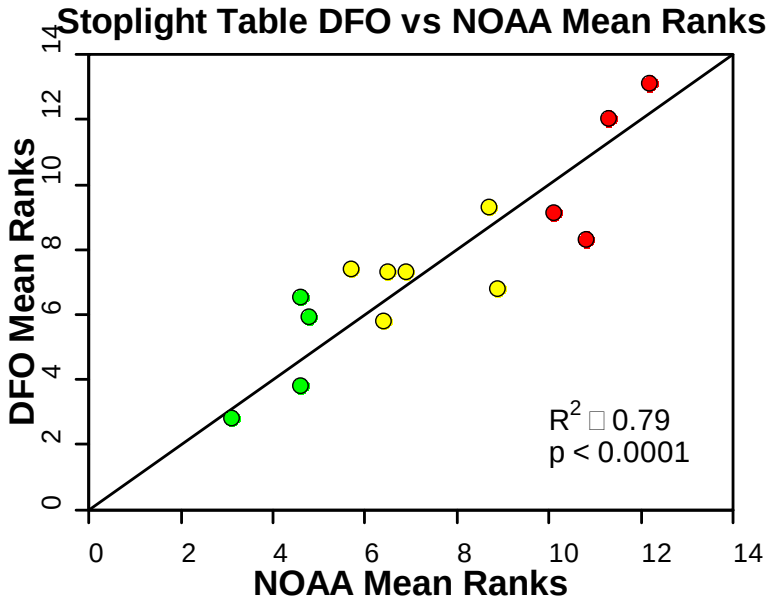
DFO

Environmental Variables	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Online Data														
Mean SST - WCVI (Amphitrite) - Mar-Jun	13	1	6	2	3	10	12	14	9	4	5	7	11	8
Survey Data - Zooplankton														
C/N Zooplankton Ratio (WCVI)	13	6	12	7	5	8	3	14	10	9	1	11	4	2
Northern (Boreal) Copepods (SVI)	14	3	6	7	4	9	11	13	12	5	1	2	8	10
Southern Copepods (SVI)	14	7	8	5	4	13	10	12	11	3	2	1	9	6
Survey Data - Juvenile Salmon														
WCVI Coho Summer Growth	13	1	3	7	2	8	4	14	9	10	6	11	5	12
WCVI CR CK CPUE - Jun-Jul	5	2	6	13	11	9	10	14	8	12	1	7	3	4
WCVI sockeye CPUE - Jun-Jul	13	7	4	10	14	3	2	12	11	5	1	6	8	9
WCVI coho CPUE - Jun-Jul	11	3	2	8	9	13	14	12	4	10	5	1	6	7
Mean Rank	12.0	3.8	5.9	7.4	6.5	9.1	8.3	13.1	9.3	7.3	2.8	5.8	6.8	7.3
Rank of Mean Rank	13	2	4	9	5	11	10	14	12	7	1	3	6	7

Poor for salmon Average for salmon Good for salmon

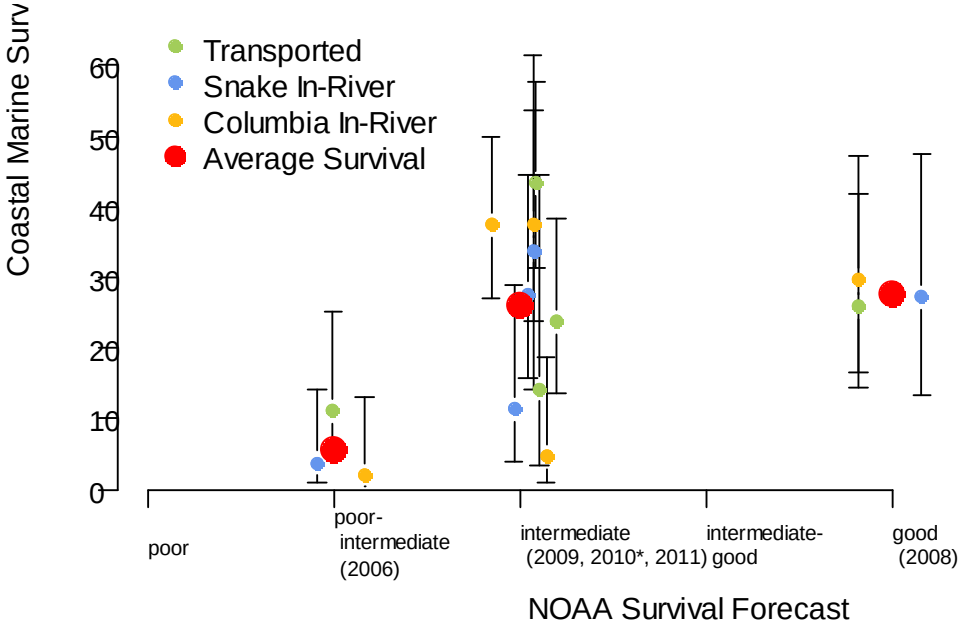
Ocean Projects Draw Similar Conclusions

- NOAA & DFO stoplight charts show similar coastal ocean conditions.

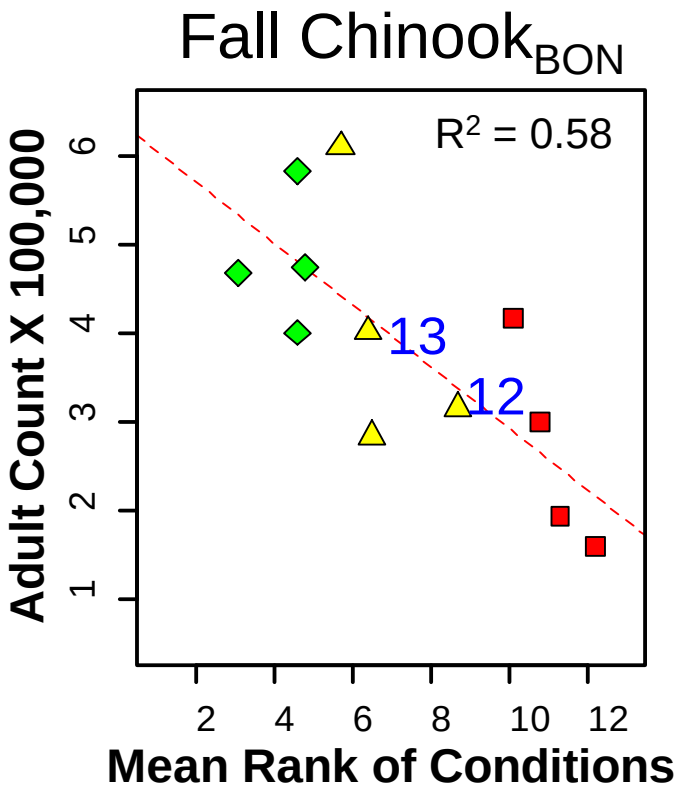


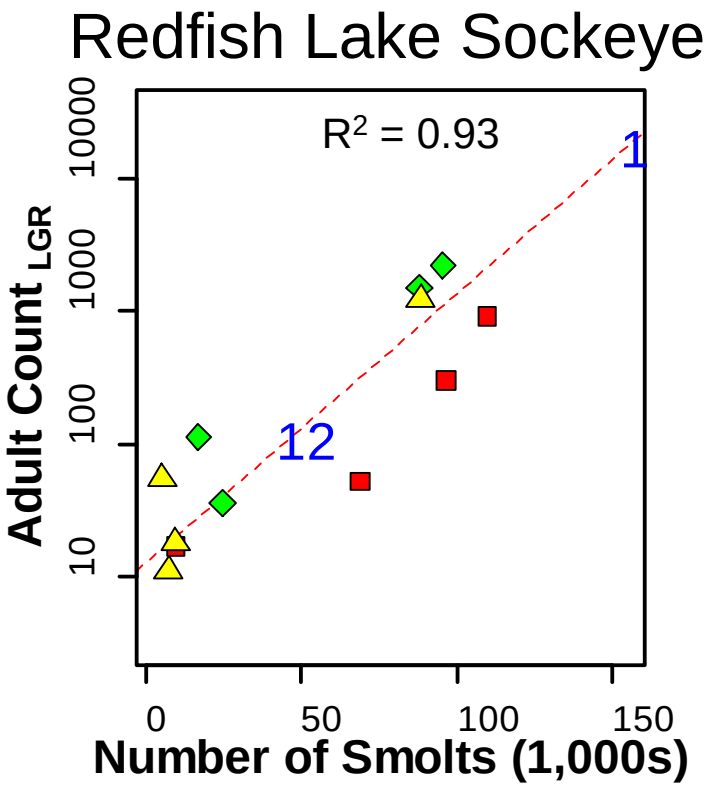
- Kintama's survival estimates are similar to NOAA & DFO stoplight forecasts.

- Results suggest a 3-5 fold variation in coastal survival between years of poor & good ocean conditions.



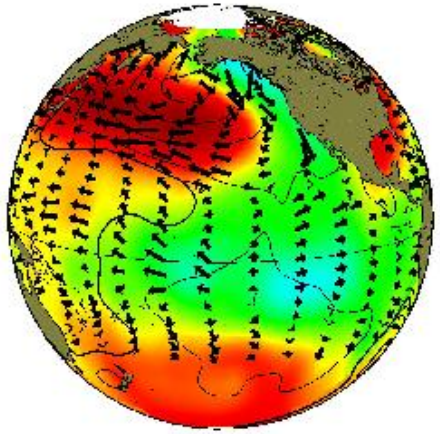
Ocean Indicators Predict Adult Returns in the Columbia River



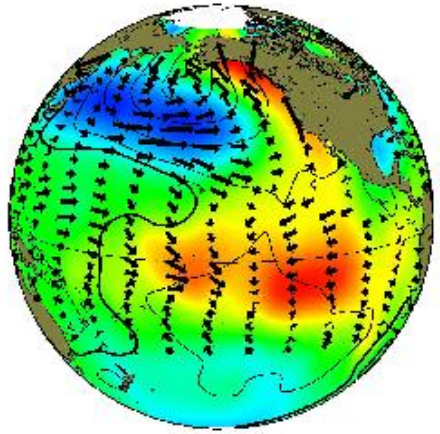


Key Findings

PDO COOL PHASE

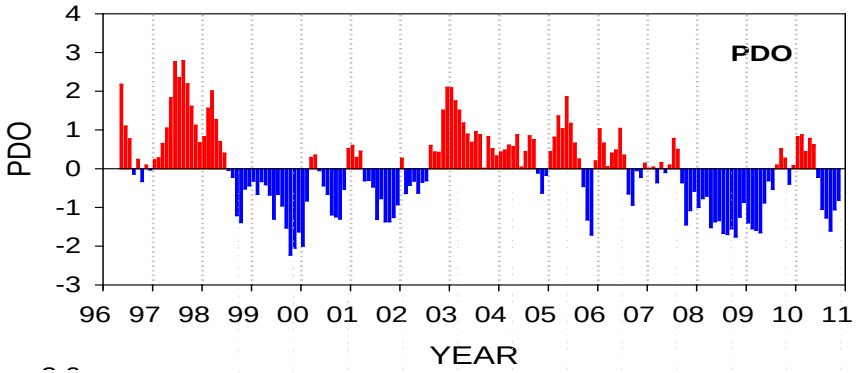


PDO WARM PHASE



- Large-scale atmosphere-ocean forcing controls local food web structure and affects juvenile salmon growth.
- Ocean growth and predator abundance are important determinants of adult returns.
- Survival for spring Chinook salmon during hydrosystem migration is less variable year to year than during ocean residence.
- Different salmon life history types may respond differently to ocean conditions.

Management Implications - I



- Ocean variability provides a context for understanding and evaluating the response to 4-H recovery actions.
- Thus, managers could decouple the effects of the 4-Hs from the ocean on smolt survival.
- Management strategies may have conflicting effects on different ESUs; *"One management strategy may not fit all ESUs"*.
- Ocean information can improve harvest planning and habitat restoration strategies.

Management Implications - II

- We need to know when ocean survival will be better or worse than freshwater.
- In climate with poor ocean survival, delaying smolt movements to the ocean could be beneficial.
- If latent effects do not affect ocean survival, management can focus on hydrosystem effects.

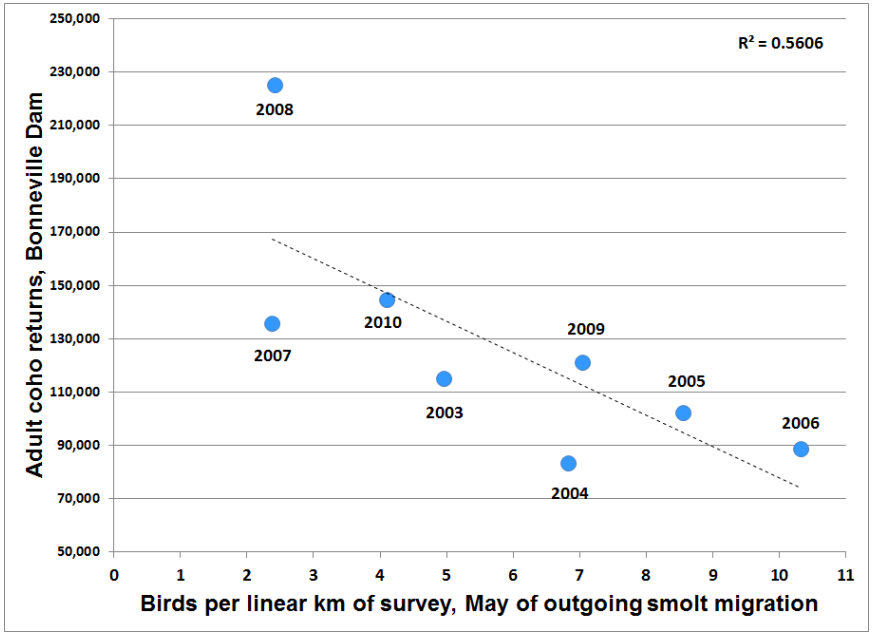
Next Steps

- Maintain ocean sampling efforts to identify mechanisms & provide context to salmon recovery efforts.
- ESU-specific analyses: not all salmon respond similarly.
- Continue to refine genetic analyses to improve identifications.
- Continue to explore how we can investigate hatchery/wild interactions & potential density dependence.
- Resolve remaining uncertainties concerning relative ocean & hydrosystem survival rates (small smolts, earlier & later migration timing).
- Conduct workshops with managers to prioritize research efforts.

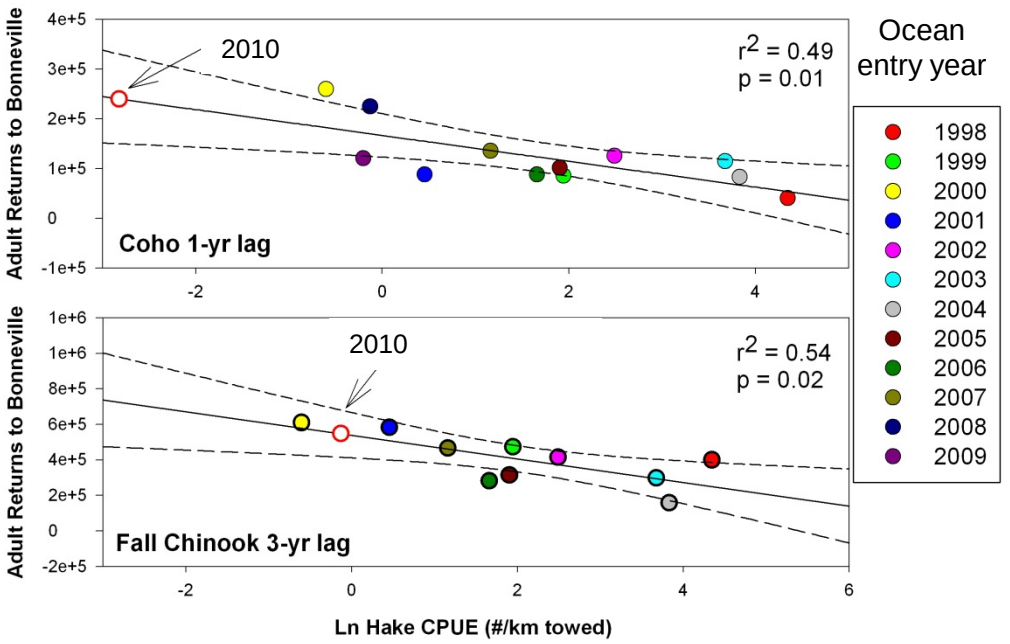

Thank you

Predation

Fewer birds relate to higher salmon returns

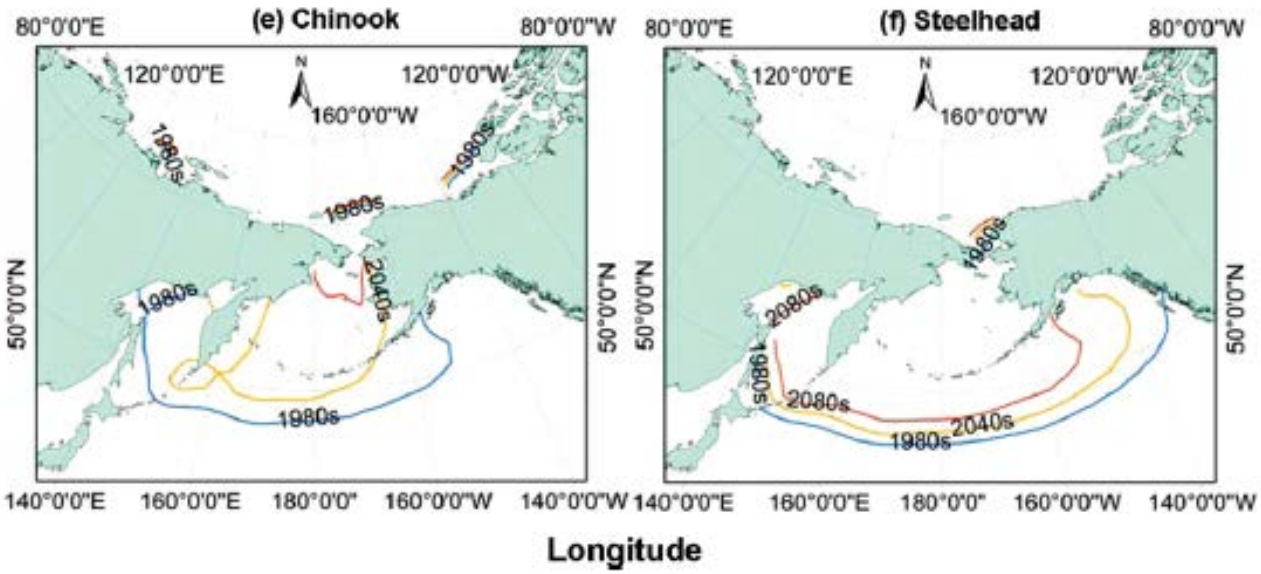


Fewer hake relate to higher salmon returns



Chinook & Steelhead Temperature Limits

- Climate models predict a loss of acceptable Pacific ocean temperatures over the next 80 yrs.
- We need to distinguish between freshwater and ocean effects on salmon; otherwise, a failure of adult returns may be incorrectly attributed to hydropower operations



Projected Location of Thermal Limits in July (Abdul-Aziz, Mantua, & Myers, 2011 CJFAS).