Northwest **Power** and **Conservation** Council

December 7, 2021

MEMORANDUM

TO: **Council Members**

FROM: **Erik Merrill, Independent Science Manager, and Leslie Bach, Senior Program Manager and ISAB Ex Officio**

SUBJECT: **Presentation by the Independent Scientific Advisory Board on Three Reviews of Salmon Survival Analyses**

BACKGROUND:

Presenters: ISAB members Stan Gregory (Chair) and Kenny Rose.

Summary: The ISAB will present conclusions from three reviews of salmon survival analyses. Together, these reviews identify progress made, remaining uncertainties, and opportunities for synthesis to learn more from existing data through coordinated analyses.

- Dam Bypass Selectivity Report: Review of Analyses of Juvenile Fish Size Selectivity in Dam Bypass Systems and Implications for Estimating and Interpreting Fish Survival (ISAB 2021-1; April 12, 2021)

For this report, the ISAB reviewed scientific findings and subsequent dialogue associated with two published papers (Faulkner et al. 2019, Storch et al. 2021) that investigated fish size selectivity in juvenile bypass systems and its implications for estimating and interpreting juvenile salmonid survival. It has long been observed that juvenile salmonids that encounter multiple juvenile bypass systems during downstream migration return as adults at a lower rate, on average, than those that have fewer bypass encounters. Two, non-mutually exclusive, hypotheses have been suggested to explain this phenomenon: 1) bypass systems impart damage

or stress that results in mortality, but not until the fish have completed passage through the hydropower system; 2) bypass systems select for individuals that are smaller or have other characteristics that result in a survival disadvantage regardless of passage routes at dams. Addressing the issue of effect of passage history on ocean mortality is important because the current management strategy of maximizing spill is designed to route fish away from bypass systems.

The ISAB found the publications and analyses were reasonable and scientifically sound but ultimately did not provide definitive conclusions on the two hypotheses. The analyses and data advanced the scientific discussion and provide an opportunity to better understand the role of body length in how the fish use the bypass system. This information may clarify the effect of length on bypass usage and perhaps, return probability. If size-selection affects bypass probability, then there may also be an opposite effect on powerhouse passage probability, which suggests the need for further analysis.

- Comparison of Research Findings on Avian Predation Impacts on Salmon Survival (ISAB 2021-2; April 23, 2021)

This ISAB report examines similarities and differences in the conclusions and management implications of the following two publications on Columbia River Basin steelhead trout (*Oncorhynchus mykiss*): “Avian predation on steelhead is consistent with compensatory mortality” (Haeseker et al. 2020) and “Measuring the additive effects of predation on prey survival across spatial scales” (Payton et. al 2020). These papers analyze the extent to which avian predation is additive or compensatory. At their extremes, (completely) additive means that changes in predation are reflected in one-to-one changes in the overall survival of a population, whereas (completely) compensatory means that other life cycle factors operate to negate or counteract the effects of predation so that long-term survival is unaffected by the predation in question. More often in nature, partial additivity and compensation are observed rather than the extremes of complete additivity or compensation. Results of analyses examining compensatory versus additivity in survival can strongly affect decisions about future regional management actions designed to reduce avian fish predators, for example, hazing, re-locating, and culling.

While the studies were conducted in different basins and employed only partially overlapping time series, the ISAB concluded that, despite these differences, the two studies are not inconsistent in their results.
Both studies looked at mortality during the estuarine/marine phase and concluded that predation is either largely (Payton et al.) or fully (Haeseker et al.) compensatory. Only Payton et al. assessed smolt survival during in-river migration, and there appears to be strong additivity of predation for this life history phase. Results of both studies are consistent with the possibility of low-level partial additivity of predation effects on smolt-to-

adult returns (SAR). For populations at risk, avian predation that is partially additive could affect population sustainability.

A major question for management is whether an increase in SARs is worth the cost of suppressing avian predators or is critical to the support of ESA-listed salmonid species. Answering these questions requires estimates of the magnitude of avian predation effects as well as estimates of the degree of additivity or compensation, and also requires consideration of social concerns, cost effectiveness, and ecosystem consequences of avian control actions (ISAB 2019-1). Important future steps include reconciling results from these studies in a side-by-side analysis, evaluating additional methods for obtaining predation effect size from tagging data, and incorporating these into life cycle models for different species and populations. The findings of strong additivity of predation for the in-river portion of steelhead life histories and possible low-level partial additivity of predation on SARs warrant further research and careful consideration of possible management actions.

- Review of the Coast-Wide Analysis of Chinook Salmon Smolt to Adult Returns (SARs) by Welch et al. (ISAB 2021-3; June 29, 2021)

This ISAB report reviews the Welch et al. (2020) paper "A Synthesis of the Coast-wide Decline in Survival of West Coast Chinook Salmon" that examined time series of annual smolt to adult return (SAR) values for many West Coast Chinook salmon populations. The analysis of Welch et al. (2020) highlights the generally low SAR values of Chinook salmon that have occurred along the West Coast recently, and the paper calls into question the view that Columbia River SARs are anomalously low. Their publication raised questions about the general efficacy of hydrosystem passage and freshwater habitat actions because of some of their broadly stated conclusions. Most importantly, they concluded that changes in freshwater habitat would have little impact on SARs and therefore have only small effects on Chinook salmon populations, a finding which could have major implications for how salmonids are managed in the Columbia River Basin. The ISAB also considered a review of the Welch et al. (2020) paper by the Fish Passage Center (FPC 2020) and Welch et al.'s (2021) response to the FPC review.

Welch et al. (2020) conducted simple analyses of the assembled SAR time series data and reach a series of conclusions – some supported by the analysis and some not supported. At a coarse resolution, the descriptive observations of Welch et al. (2020) that SARs for Chinook populations are low in the region and the values for the Columbia system are not dissimilar from those of other systems, including those with no dams, are supported by the analysis presented in the paper. The ISAB also agreed with their findings that low SAR values from marine survival affect the realization of long-term population-level benefits of freshwater

management actions. These findings are useful contributions to the wider literature on Chinook survival patterns and for informing management.

However, Welch et al.'s conclusions involving causal inferences, for example about the effectiveness of freshwater habitat initiatives (management actions), are not adequately supported by the evidence. Such conclusions therefore should be considered speculation, especially when interpreted for individual populations. Moreover, inferring management implications based on their results alone would be premature. In particular, the degree to which freshwater mortality during juvenile migration influences SAR values varies across populations has not been determined by the Welch et al. (2020) analysis. One cannot directly compare SAR values to infer how freshwater survival differs among populations without making major unsupported and untested assumptions, for example, assuming that marine survival is constant across populations.

The Welch et al. (2020) paper adds to other evidence for the need to further investigate SAR values across populations and to continue investigating oceanic and freshwater contributions to low SARs as a critical uncertainty in the basin. The ISAB offers recommendations for further analyses of coastwise SARs to increase our understanding of their temporal trends and broad spatial patterns throughout the region.

Workplan: Independent scientific review is an integral and ongoing component of the Fish and Wildlife Program and the Division's workplan. The three reviews address Program strategies and priorities including hydrosystem passage, predator management, ocean survival, and adaptive management.

Background: In December 2020, the ISAB's Administrative Oversight Panel – consisting of the Council's Chair, Columbia River Inter-Tribal Fish Commission's (CRITFC) Executive Director, and NOAA Northwest Fisheries Science Center's Science Director – approved these three ISAB reviews. The request to review the avian predation analyses originated with CRITFC, the size selectivity in dam bypass systems analyses with NOAA Fisheries, and the Welch et al. request was developed based on group discussions.

More Info: The ISAB's full reports are available online: ISAB 2021-1, ISAB 2021-2, ISAB 2021-3.

ISAB Salmon Survival Reviews 2021

Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
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Photo of ISAB and ISRP March 2020

Three 2021 Reviews of Salmon Survival Analyses

- Dam Bypass Selectivity Report: Review of Analyses of Juvenile Fish Size Selectivity in Dam Bypass Systems and Implications for Estimating and Interpreting Fish Survival (ISAB 2021-1; April 12, 2021)
- Comparison of Research Findings on Avian Predation Impacts on Salmon Survival (ISAB 2021-2; April 23, 2021)
- Review of the Coast-Wide Analysis of Chinook Salmon Smolt to Adult Returns (SARs) by Welch et al. (ISAB 2021-3; June 29, 2021)

Review Questions

1. Were the analyses scientifically sound and the data used appropriate for answering the question?
2. Were the conclusions supported by the results?
3. How did the studies' analyses differ, and do these differences or other reasons account for contrasts in the conclusions?
4. What are the management implications of the results?
5. What are the ISAB's recommendations to improve the analyses?

Faulkner et al. 2019

Transactions of the American Fisheries Society 150:196–206, 2021
Published 2020. This article is a U.S. Government work and is in the public domain in the USA
ISSN: 0002-8487 print / 1548-8659 online
DOI: 10.1002/tafs.10280

COMMENT

Associations among Fish Length, Dam Passage History, and Survival to

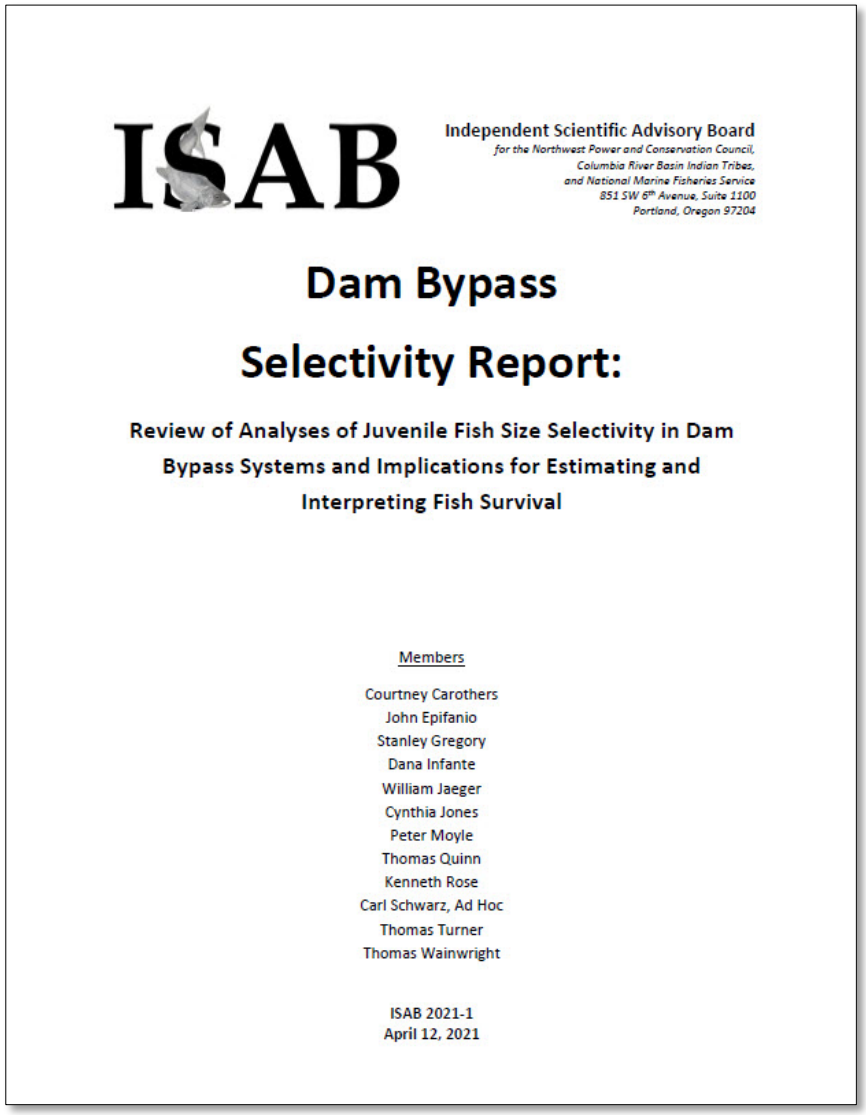
Storch et al. 2021

Transactions of the American Fisheries Society 150:189–195, 2021

ISSN: 0002-8487 print / 1548-8659 online
DOI: 10.1002/tafs.10279

COMMENT

Comment: Associations among Fish Length, Dam Passage History, and Survival to Adulthood in Two At-Risk Species of Pacific Salmon



ISAB

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Dam Bypass

Selectivity Report:

Review of Analyses of Juvenile Fish Size Selectivity in Dam Bypass Systems and Implications for Estimating and Interpreting Fish Survival

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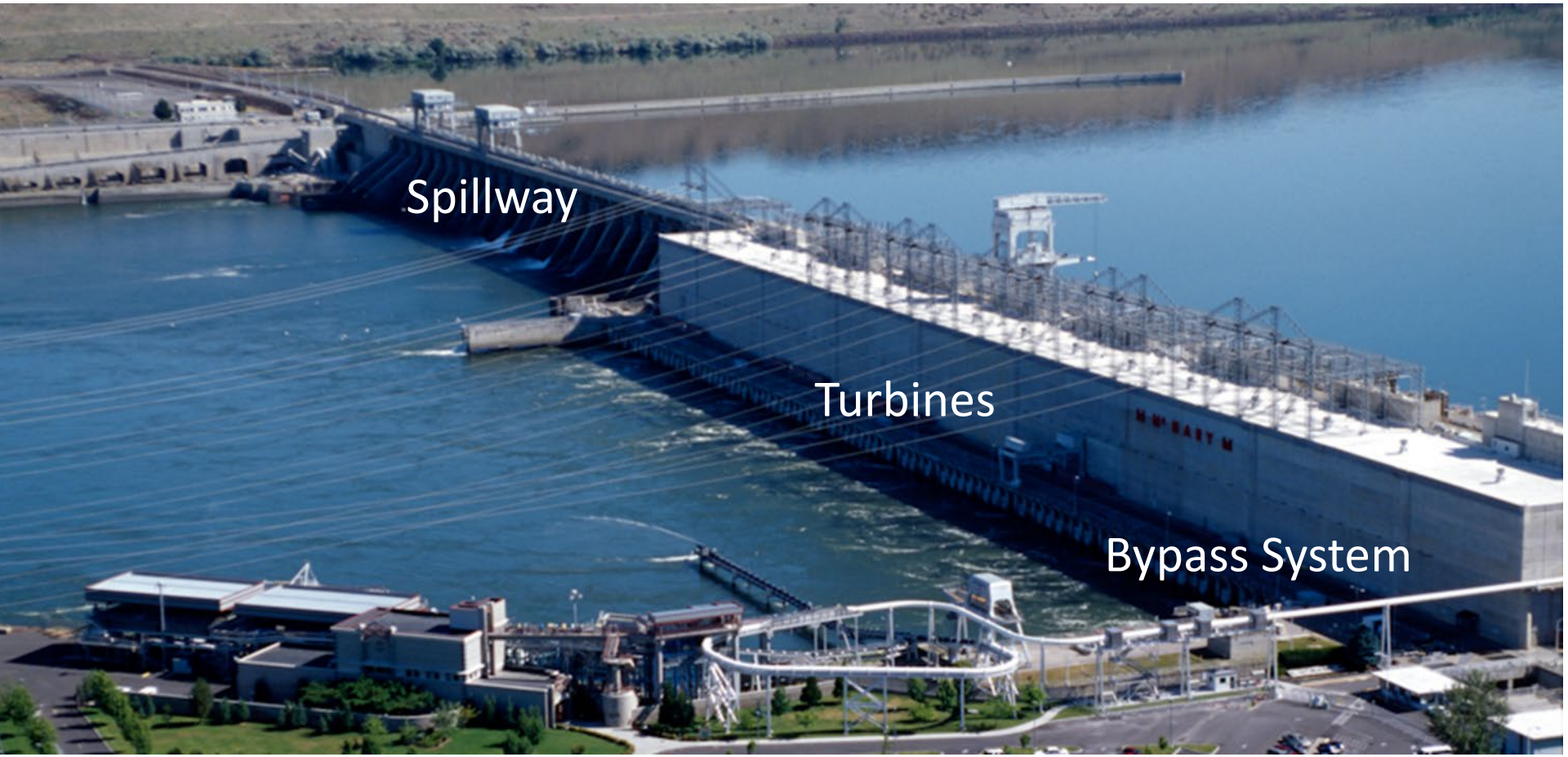
ISAB 2021-1
April 12, 2021

Dam Bypass Selectivity Report

- Faulkner et al. 2020
  - Negative relationship between fish length and bypass probability
  - Positive relationship between fish length and return probability
- Storch et al. 2020
  - Length does not explain differences in survival among different populations

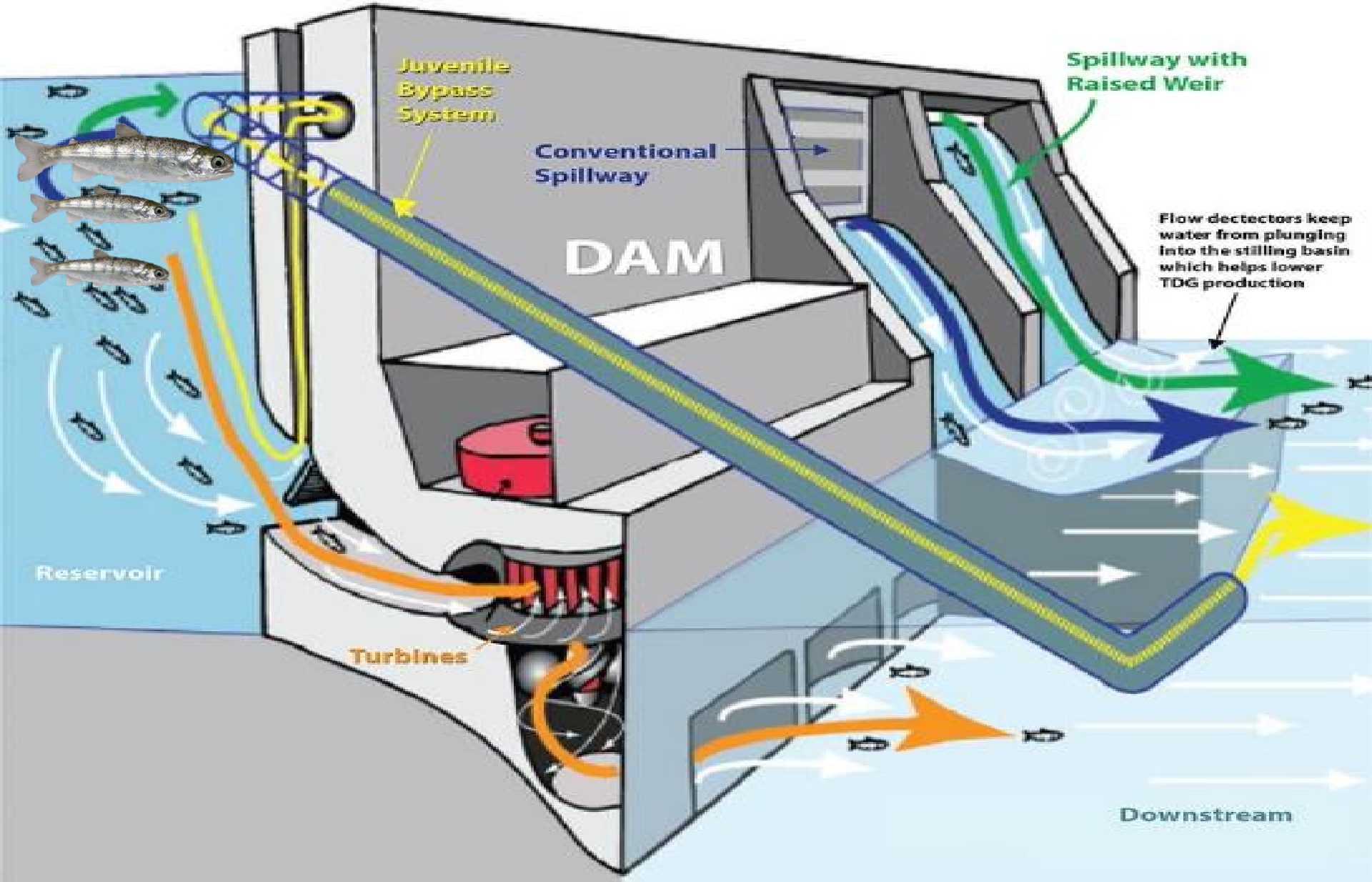
Dam Passage



Taken from presentation by Faulkner to ISAB

Dam Passage

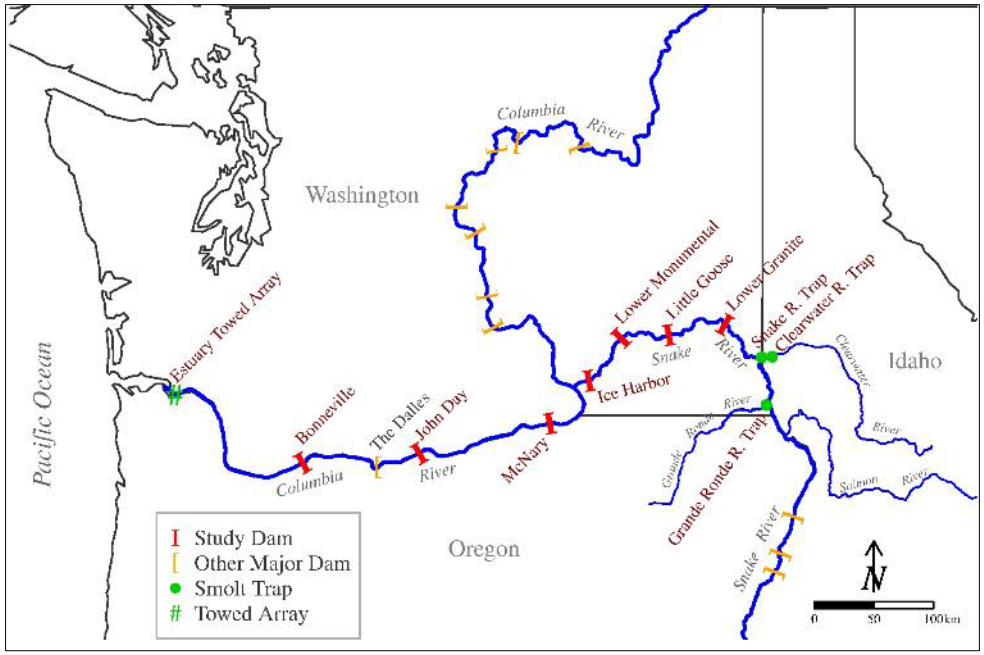
Taken from presentation by Faulkner to ISAB



Graphic from Columbia Basin Bulletin, April 23, 2021

Bypass Encounters

- Adult salmon return rates are lower, on average, for fish that encounter greater numbers of bypass systems during downstream migration.



Taken from presentation by Faulkner to ISAB

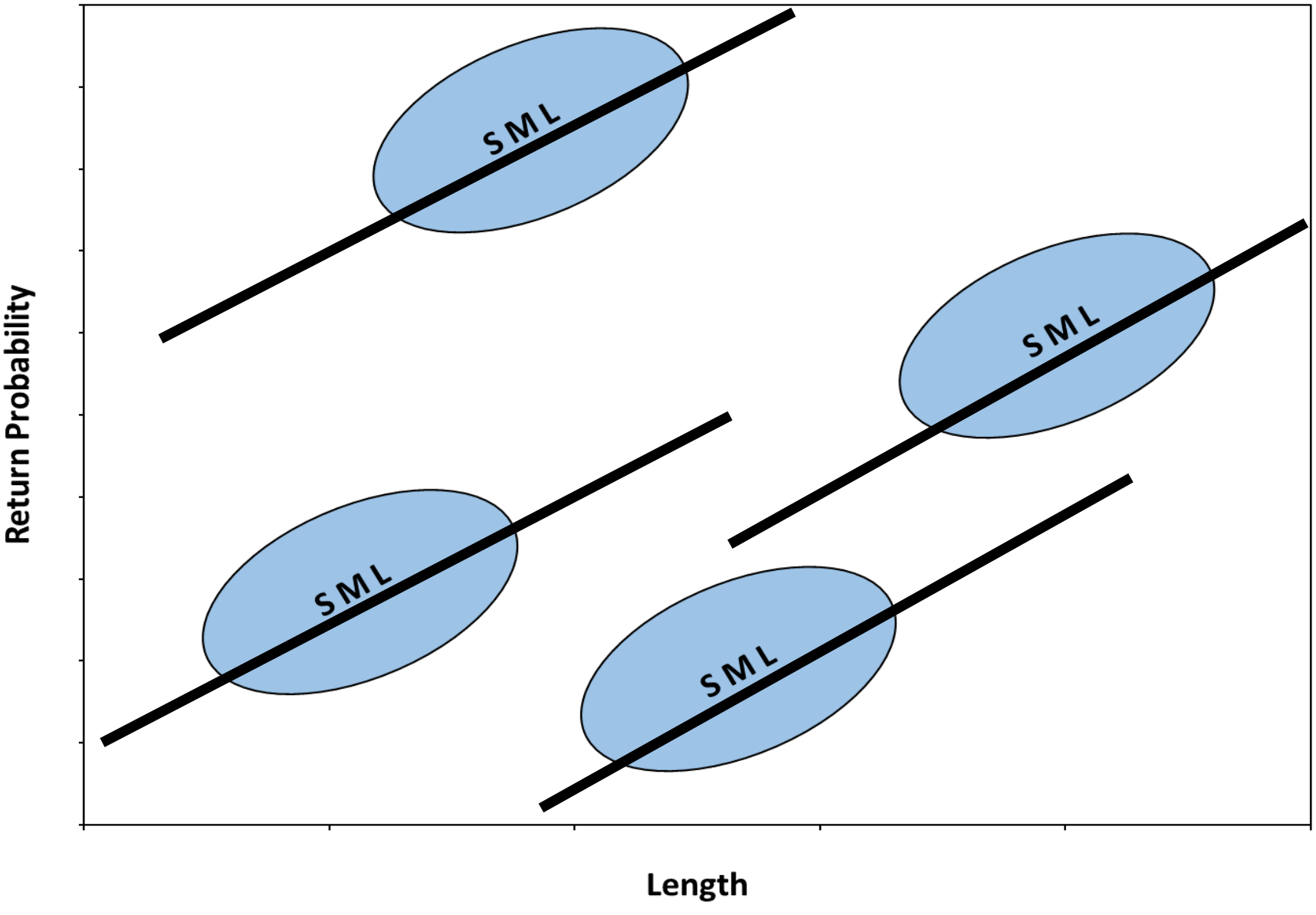
Hypothetical Causes of Bypass Effects on Survival

- Damage or stress that results in mortality after fish have passed through the hydropower system.
- Selection of smaller individuals, which have lower survival, on average, regardless of passage routes at dams.

Management Implications

- Current strategy of maximizing spill is designed to route fish away from bypass systems.

Image from presentation by Faulkner to ISAB


Return Probability
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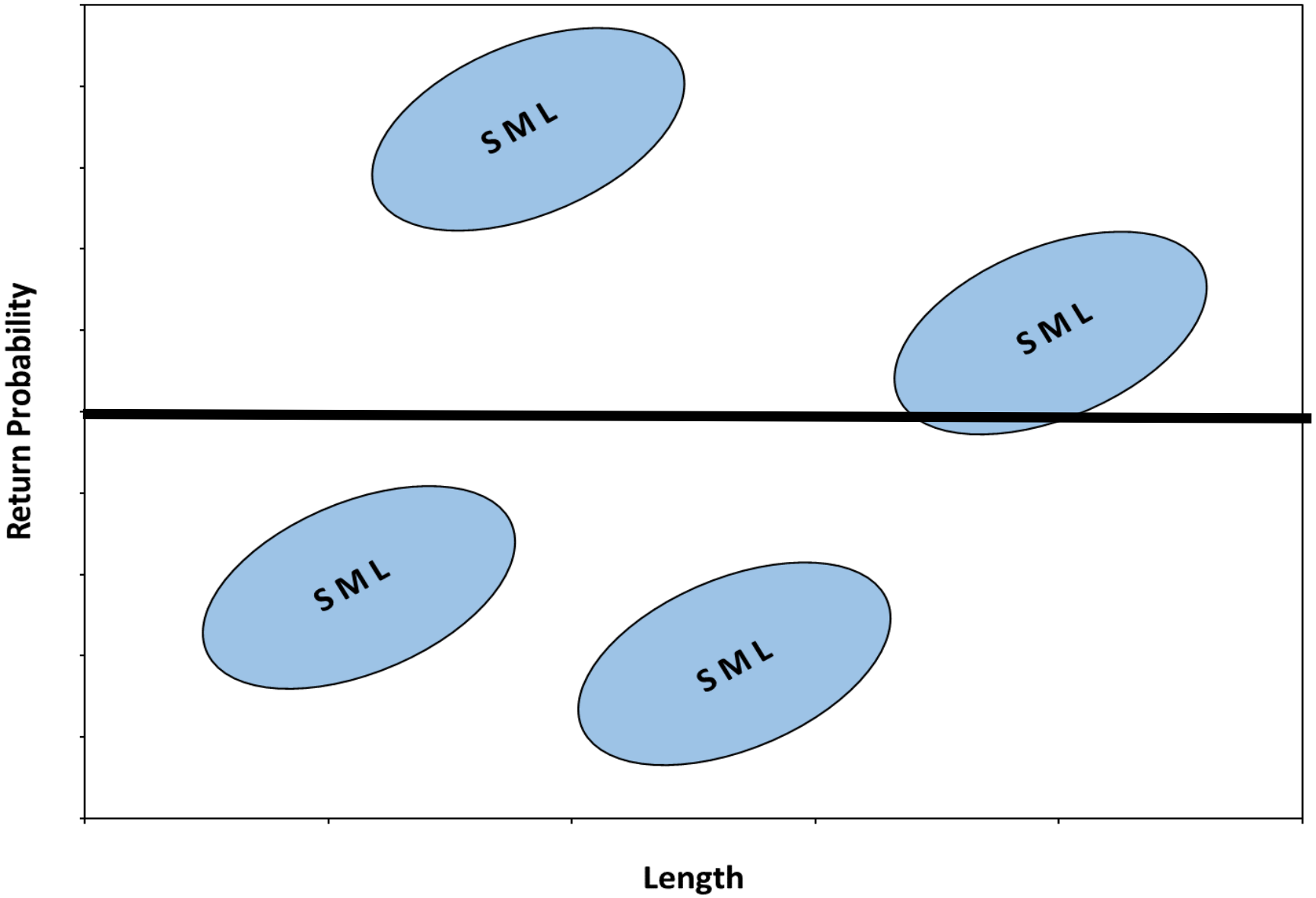
Length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Return Probability
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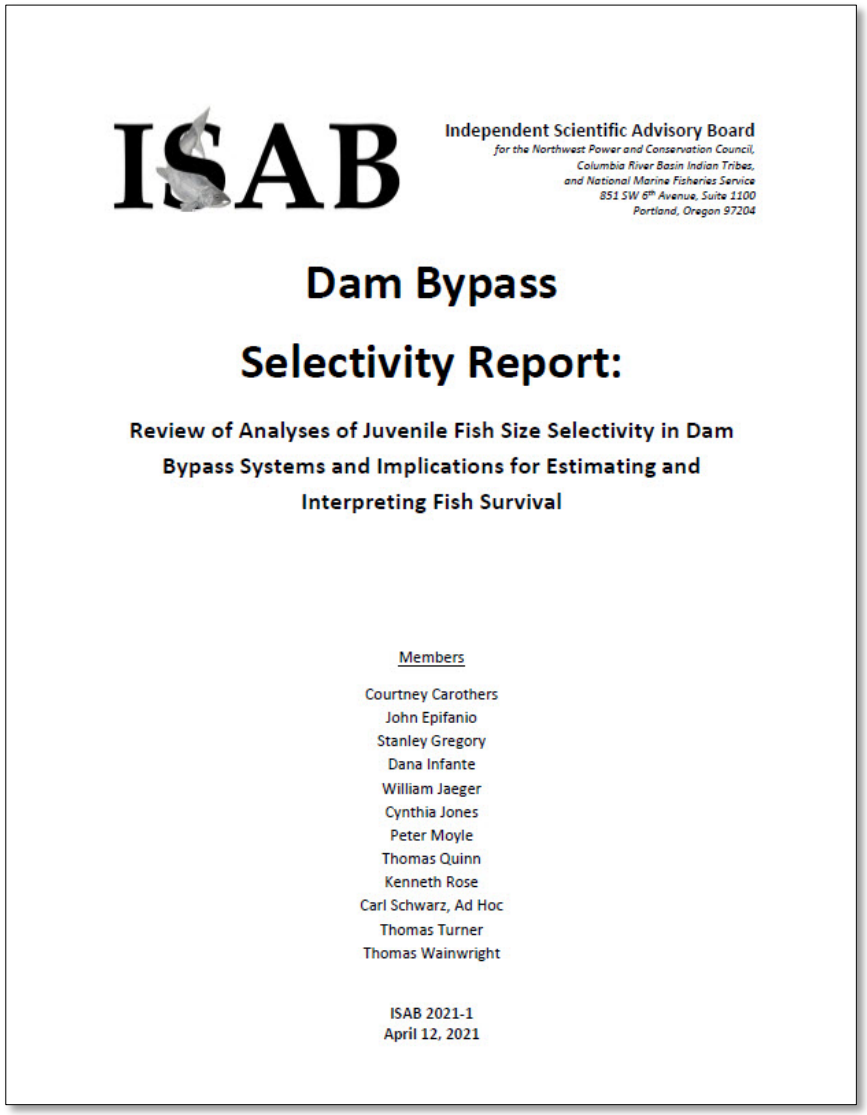

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ISAB 2021-1
April 12, 2021

Dam Bypass Selectivity Report

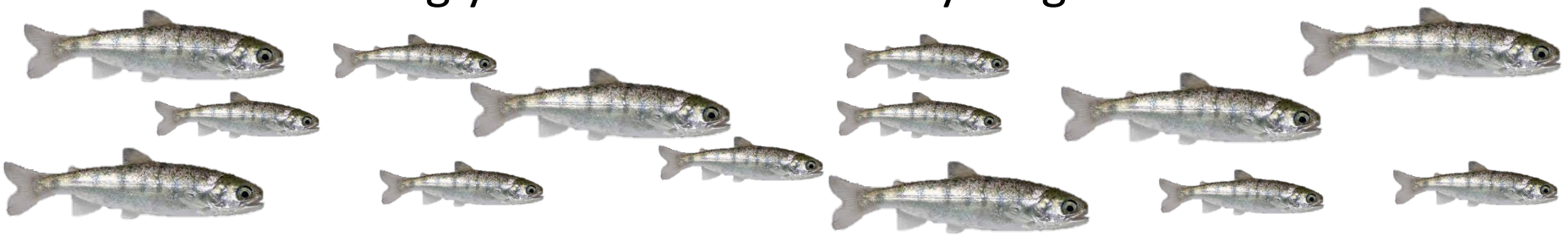
- Faulkner et al. (2019) looked at the effect of fish length on survival within populations.
- Storch et al. (2021) looked at the effect of fish length on survival across populations.

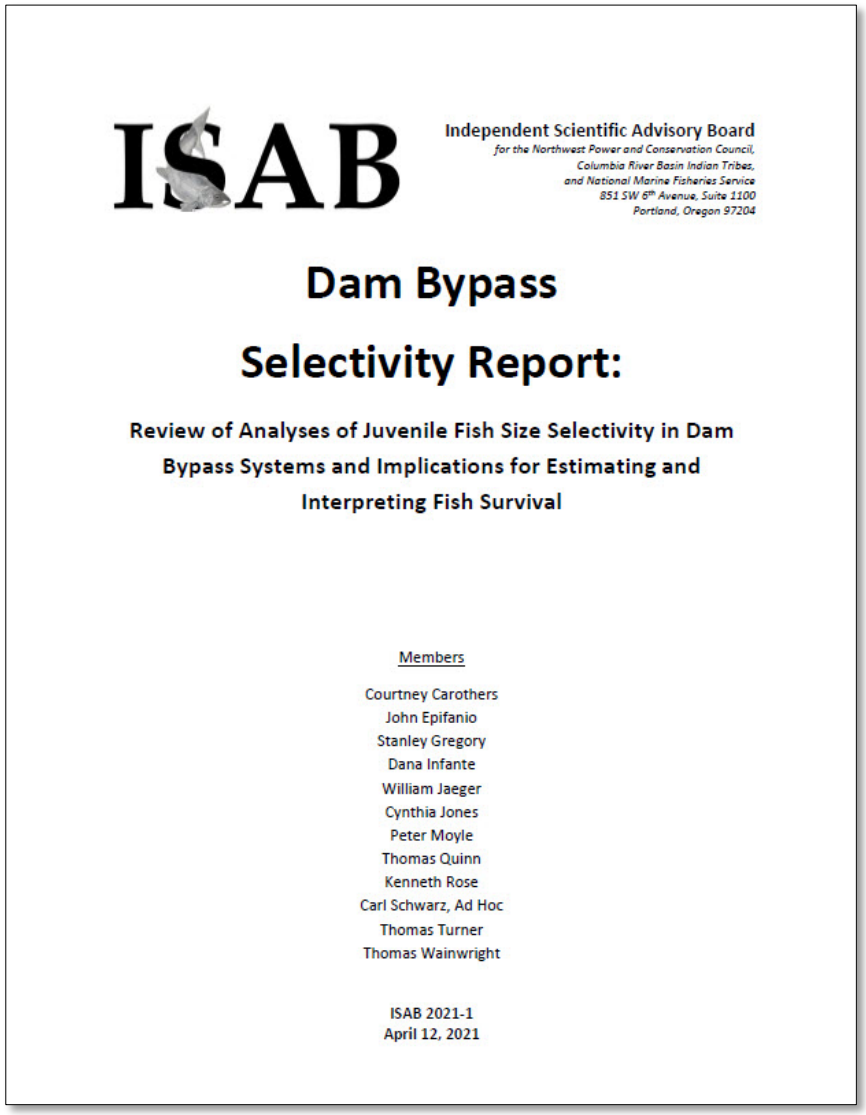
For example, larger individuals of salmonid smolts going to sea of a given population in a given year are more likely to return than are smaller ones.

For example, larger individuals of salmonid smolts going to sea of a given population in a given year are more likely to return than are smaller ones.

However, the average smolt length has little or no explanatory power for predicting the marine survival of that year's cohort relative to smolts from other years

The average marine survival observed among populations is not strongly associated with body length either.





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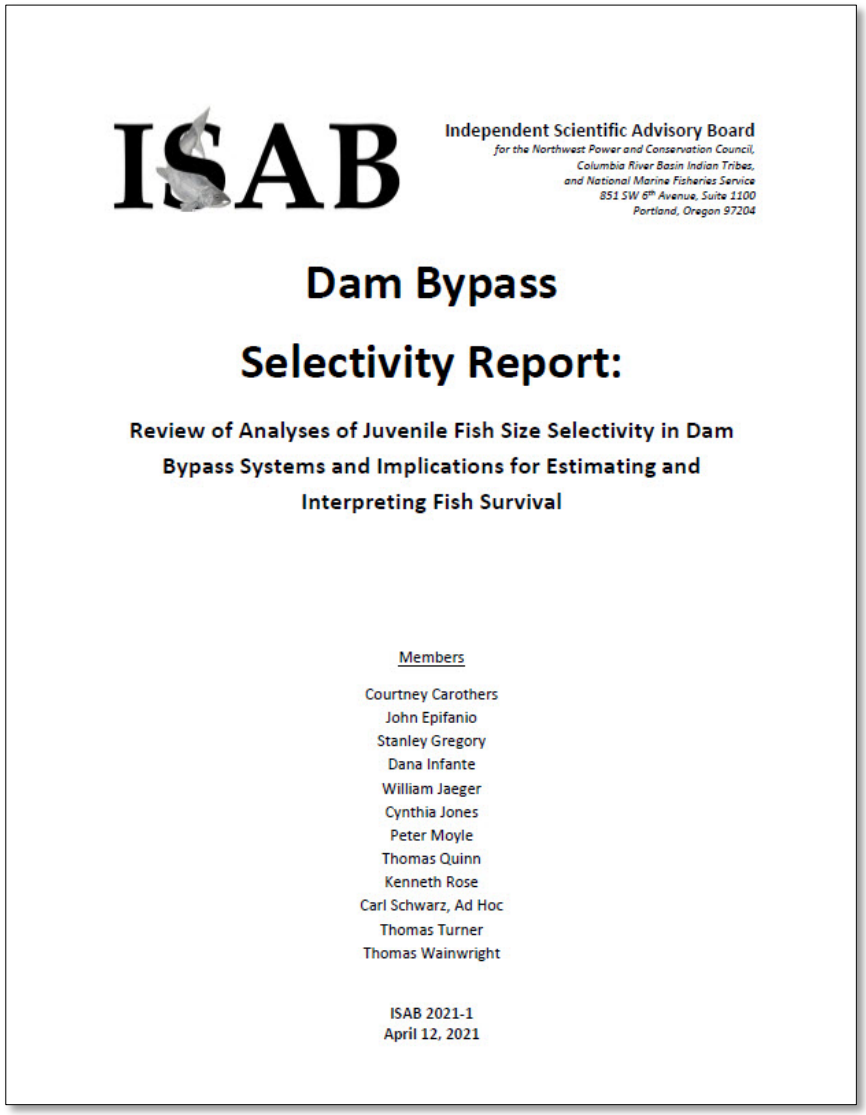
ISAB 2021-1
April 12, 2021

Dam Bypass Selectivity Report

The ISAB concluded that:

- A negative relationship between fish length and bypass probability (at most dams) and a positive relationship between fish length and return probability are supported.
- A major issue is the apparent small differences in lengths that underlie the contrasts in the analysis.



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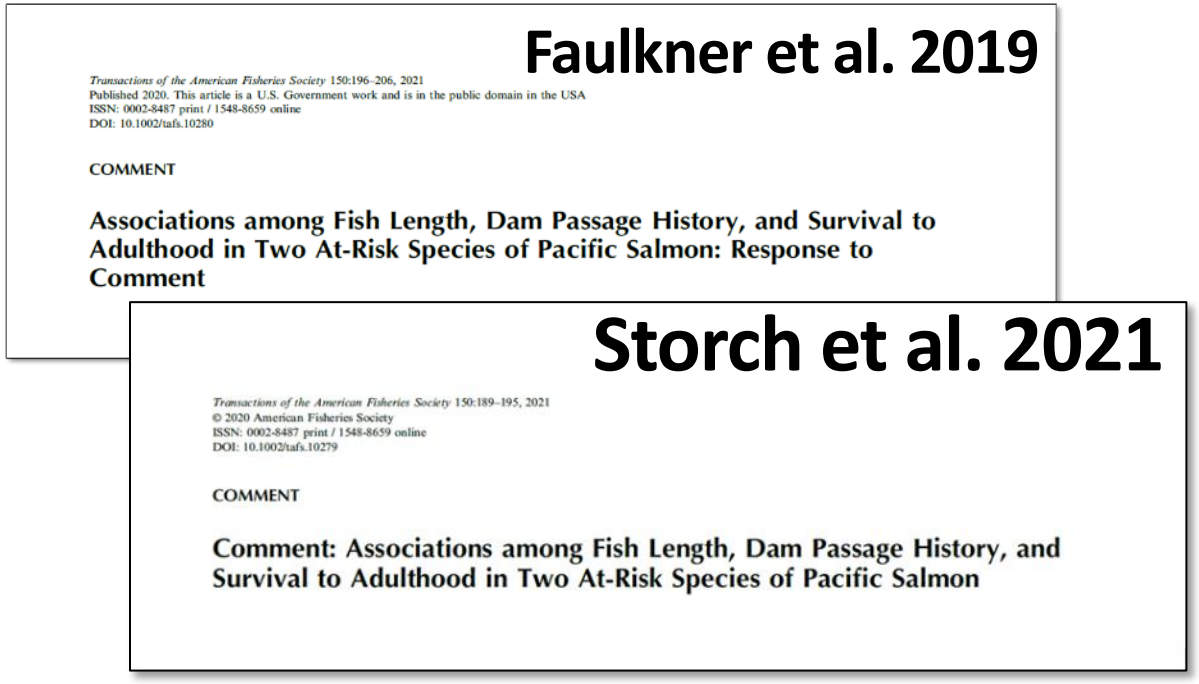
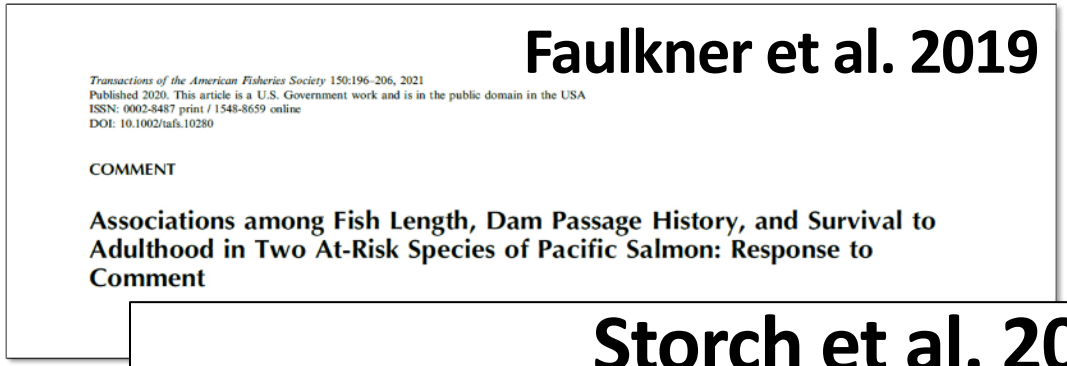
ISAB 2021-1
April 12, 2021

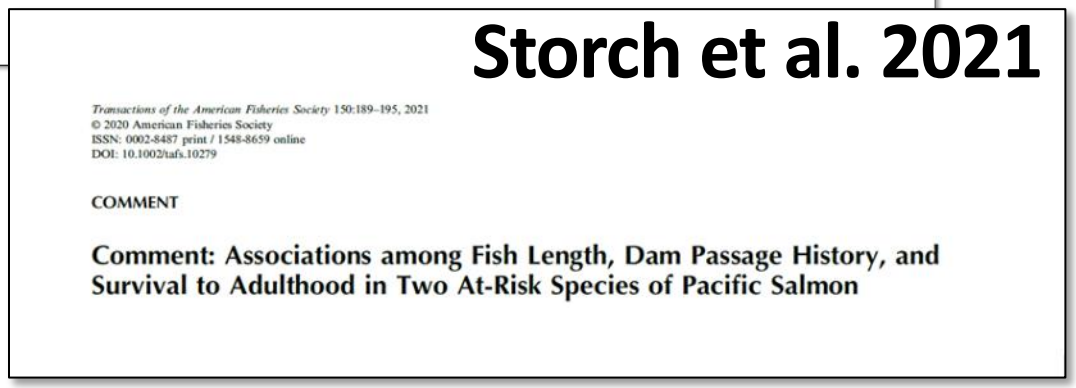
Dam Bypass Selectivity Report

- The finding of fish length affecting return probability is of great interest.
- But it is more tenuous than the finding of the relationship between fish length and bypass probability.



- The analyses and data provide an opportunity to better understand the role of body length in how the fish use the bypass system.





- This information may clarify the effect of length on bypass usage and perhaps, return probability.

- If size-selection increases bypass probability, then it may decrease powerhouse passage probability, which warrants further analysis.

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Comparison of Research Findings on Avian Predation Impacts on Salmon Survival

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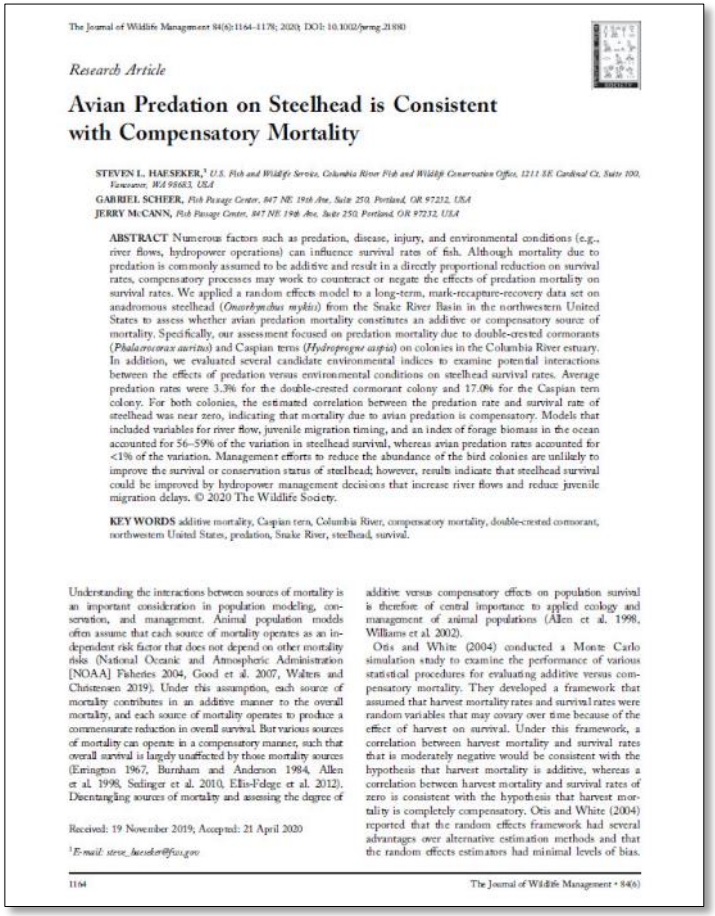
ISAB 2021-2
April 23, 2021

Avian Predation Impacts Analysis Report

Haeseker et al. 2020



The Journal of Wildlife Management 84(6):1164–1178; 2020; DOI: 10.1002/jwmg.21930

Research Article

Avian Predation on Steelhead is Consistent with Compensatory Mortality

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ABSTRACT Numerous factors such as predation, disease, injury, and environmental conditions (e.g., river flows, hydropower operations) can influence survival rates of fish. Although mortality due to predation is commonly assumed to be additive and result in a directly proportional reduction on survival rates, compensatory processes may work to counteract or negate the effects of predation mortality on survival rates. We applied a random effects model to a long-term, mark-recapture-recovery data set on anadromous steelhead (*Oncorhynchus mykiss*) from the Snake River Basin in the northwestern United States to assess whether avian predation mortality constitutes an additive or compensatory source of mortality. Specifically, our assessment focused on predation mortality due to double-crested cormorants (*Phalacrocorax auritus*) and Caspian terns (*Hydroprogne caspia*) on colonies in the Columbia River estuary. In addition, we evaluated several candidate environmental indices to examine potential interactions between the effects of predation versus environmental conditions on steelhead survival rates. Average predation rates were 3.3% for the double-crested cormorant colony and 17.0% for the Caspian tern colony. For both colonies, the estimated correlation between the predation rate and survival rate of steelhead was near zero, indicating that mortality due to avian predation is compensatory. Models that included variables for river flow, juvenile migration timing, and an index of forage biomass in the ocean accounted for 56–59% of the variation in steelhead survival, whereas avian predation rates accounted for <1% of the variation. Management efforts to reduce the abundance of the bird colonies are unlikely to improve the survival or conservation status of steelhead; however, results indicate that steelhead survival could be improved by hydropower management decisions that increase river flows and reduce juvenile migration delays. © 2020 The Wildlife Society.

KEY WORDS additive mortality, Caspian tern, Columbia River, compensatory mortality, double-crested cormorant, northwestern United States, predation, Snake River, steelhead, survival.

Understanding the interactions between sources of mortality is an important consideration in population modeling, conservation, and management. Animal population models often assume that each source of mortality operates as an independent risk factor that does not depend on other mortality risks (National Oceanic and Atmospheric Administration [NOAA] Fisheries 2004, Good et al. 2007, Walters and Christensen 2019). Under this assumption, each source of mortality contributes in an additive manner to the overall mortality, and each source of mortality operates to produce a commensurate reduction in overall survival. But various sources of mortality can operate in a compensatory manner, such that overall survival is largely unaffected by those mortality sources (Errington 1967, Burnham and Anderson 1984, Allen et al. 1998, Selinger et al. 2010, Ellis-Felege et al. 2012). Disentangling sources of mortality and assessing the degree of additive versus compensatory effects on population survival is therefore of central importance to applied ecology and management of animal populations (Allen et al. 1998, Williams et al. 2002).

Otis and White (2004) conducted a Monte Carlo simulation study to examine the performance of various statistical procedures for evaluating additive versus compensatory mortality. They developed a framework that assumed that harvest mortality rates and survival rates were random variables that may covary over time because of the effect of harvest on survival. Under this framework, a correlation between harvest mortality and survival rates that is moderately negative would be consistent with the hypothesis that harvest mortality is additive, whereas a correlation between harvest mortality and survival rates of zero is consistent with the hypothesis that harvest mortality is completely compensatory. Otis and White (2004) reported that the random effects framework had several advantages over alternative estimation methods and that the random effects estimators had minimal levels of bias.

Received: 19 November 2019; Accepted: 21 April 2020

[1]*E-mail: steve_haeseker@fws.gov*

Payton et al. 2020

Ecological Applications, 0(0), 2020, e02193

Measuring the additive effects of predation on prey survival across spatial scales

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Citation: Payton, Q., A. F. Evans, N. J. Hostetter, D. D. Roby, B. Cramer, and K. Collis. 2020. Measuring the additive effects of predation on prey survival across spatial scales. Ecological Applications 00(00): e02193. 10.1002/eap.2193

Abstract. The degree to which predation is an additive vs. compensatory source of mortality is fundamental to understanding the effects of predation on prey populations and evaluating the efficacy of predator management actions. In the Columbia River basin, USA, predation by Caspian Terns (*Hydroprogne caspia*) on U.S. Endangered Species Act (ESA)-listed juvenile salmonids (smolts; *Oncorhynchus* spp.) has led to predator management actions to reduce predation; however, the assumption that reduced predation translates into greater salmonid survival, either within the life stage where predation occurs or across their lifetime, has remained untested. To address this critical uncertainty, we analyzed a long-term (2008–2018) mark–recapture–recovery data set of ESA-listed steelhead trout (*O. mykiss*) that were tagged ($n = 78{,}409$) and subsequently exposed to predation during smolt out-migration through multiple river reaches (spatial scales), jointly estimating weekly probabilities of steelhead survival, mortality due to bird predation, and mortality due to other causes. This concurrent estimation across time-stratified cohorts allowed for the direct measurement of the strength, magnitude, and direction of relationships between survival and Caspian Tern predation. Estimates of Tern predation on steelhead were substantial in most years, with cumulative annual estimates ranging from 0.075 (95% creditable interval = 0.058–0.099) to 0.375 (0.290–0.461). Increases in Tern predation probabilities were associated with statistically significant decreases in steelhead survival probabilities in all evaluated years and salmonid life stages (smolt out-migration and smolt-to-adult returns). Results provide novel evidence that predation by Caspian Terns may have been a super-additive source of mortality during the smolt life stage and a partially additive source of mortality to the adult life stage. Annual estimates of the difference between observed survival and baseline survival (i.e., in the absence of Tern predation) ranged from 0.052 (0.017–0.103) to 0.314 (0.172–0.459) during the steelhead smolt life stage and from 0.011 (0.001–0.029) to 0.049 (0.025–0.078) to the adult life stage. The estimated levels of compensation have important implications for predator management actions aimed at increasing the survival of endangered salmonids, and the modeling approach developed herein provides a framework to directly quantify the impacts of source-specific mortality factors on prey populations.

Key words: capture–recapture–recovery; compensatory mortality; hierarchical Bayesian model; population dynamics; predator–prey dynamics; state-space models.

Introduction

Predator–prey dynamics are fundamental to evolutionary and ecological processes (Holling 1959), yet the full impact of predation on prey populations has been a topic of continuing debate (Serrouya et al. 2015). Assessing the effects of predation on prey populations generally requires information about (1) the number or proportion of available prey consumed, (2) which individuals or life stages are targeted by which predators, and (3) the levels at which other mortality sources or vital rates may compensate for predation (Caswell 2001, Mills 2012). Most predator–prey studies focus on kill rates and predation probabilities (Vucetich et al. 2011). Relatively large kill and predation probabilities, however, do not necessarily imply that predators are limiting prey populations. Metrics measuring how a prey population responds demographically may be more pertinent (Serrouya et al. 2015). For example, largely compensatory predation has little effect on prey survival probabilities

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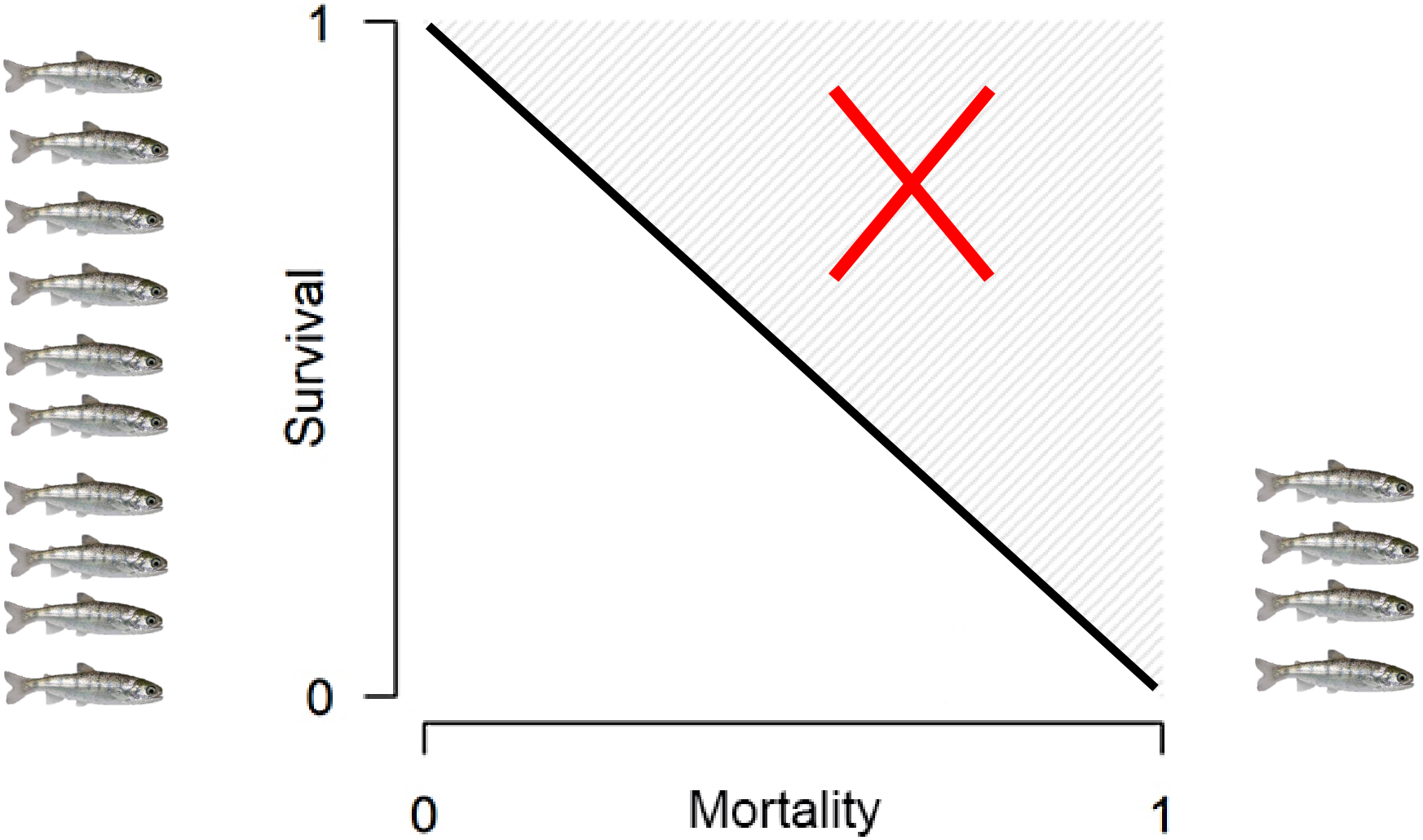
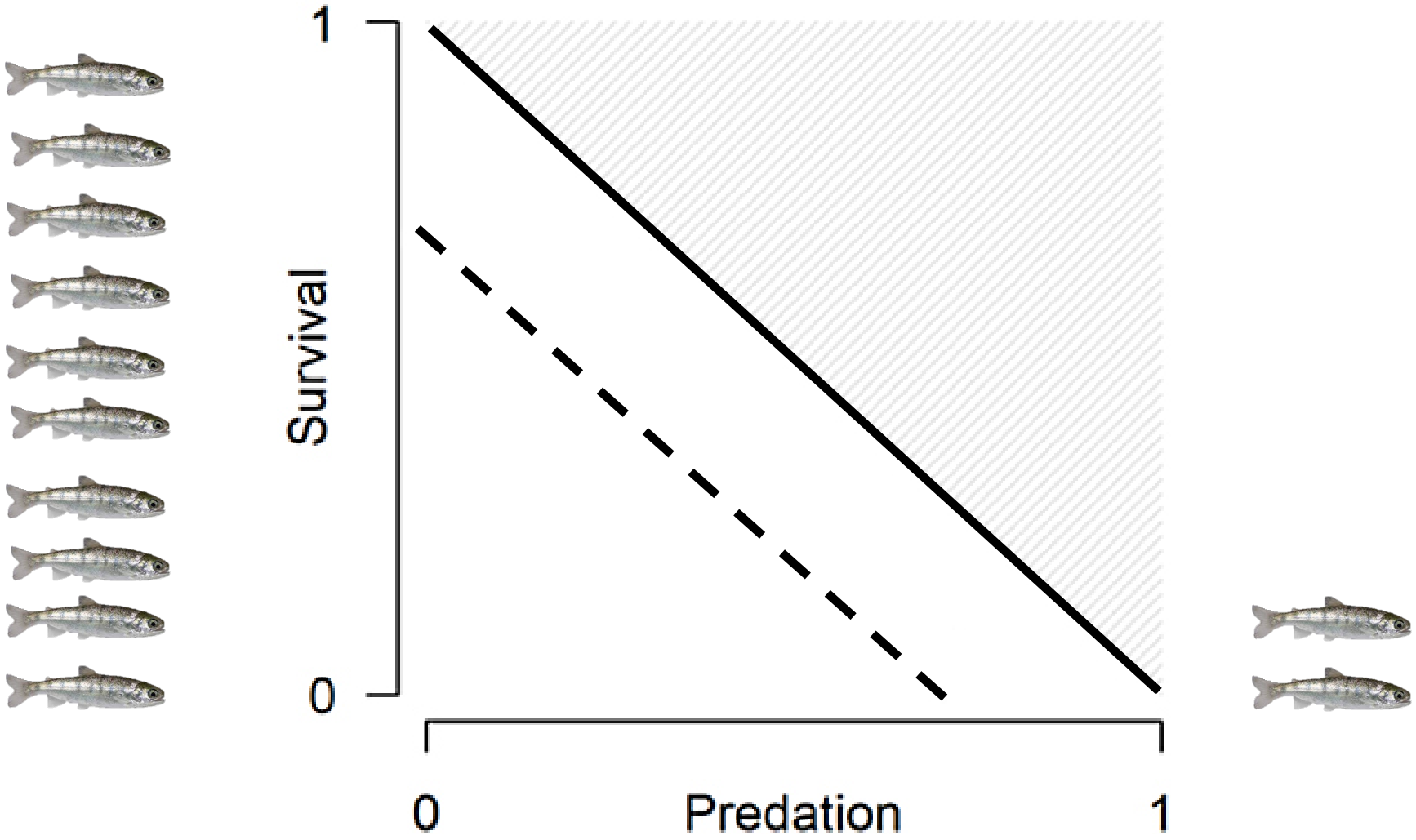
[4]E-mail: quinn@realtimeresearch.com

Both papers analyze the extent to which avian predation is additive or compensatory for steelhead

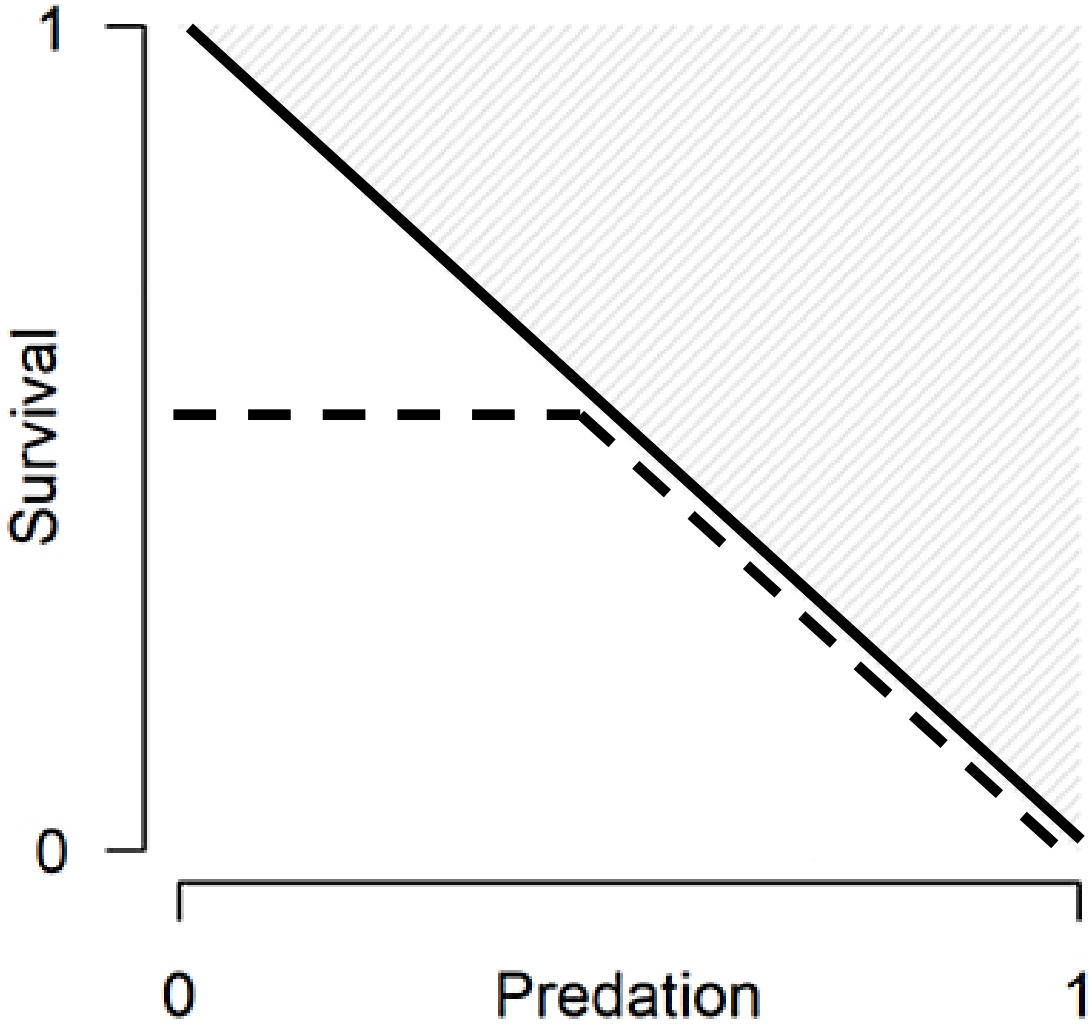
Survival and Mortality

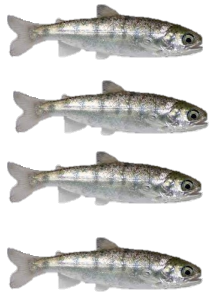


100% Additive

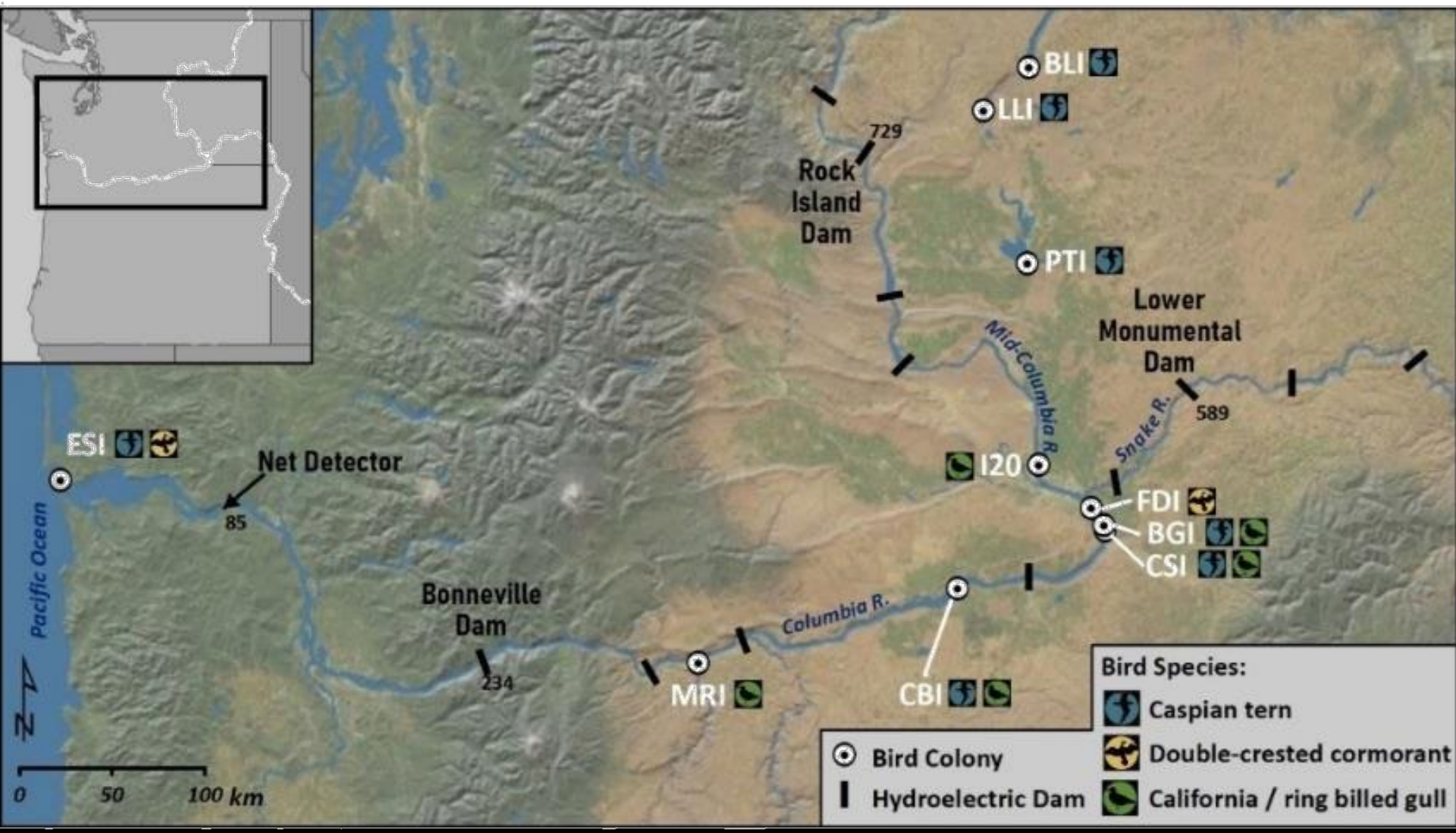


100% Compensatory



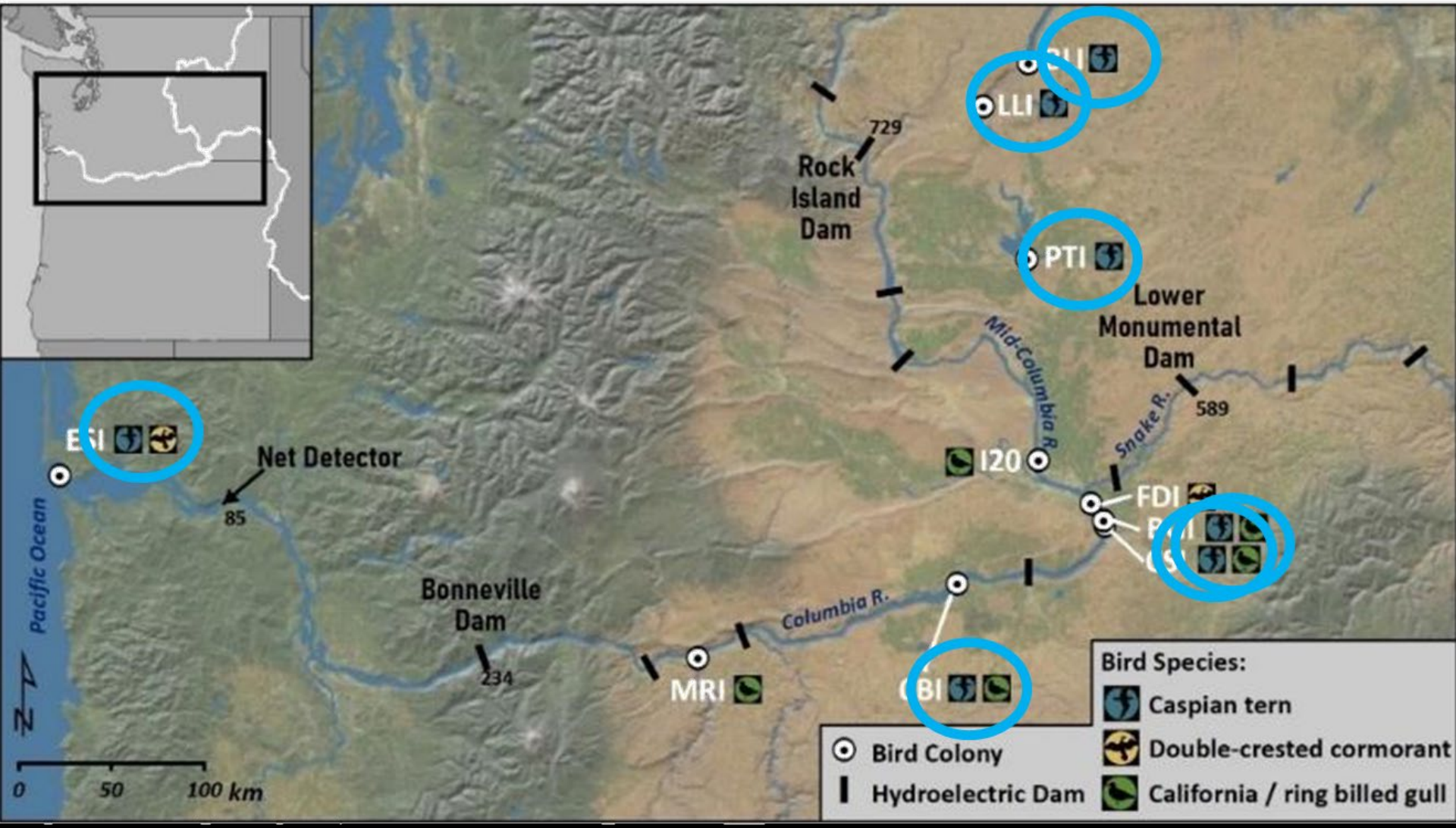


Columbia River Dams



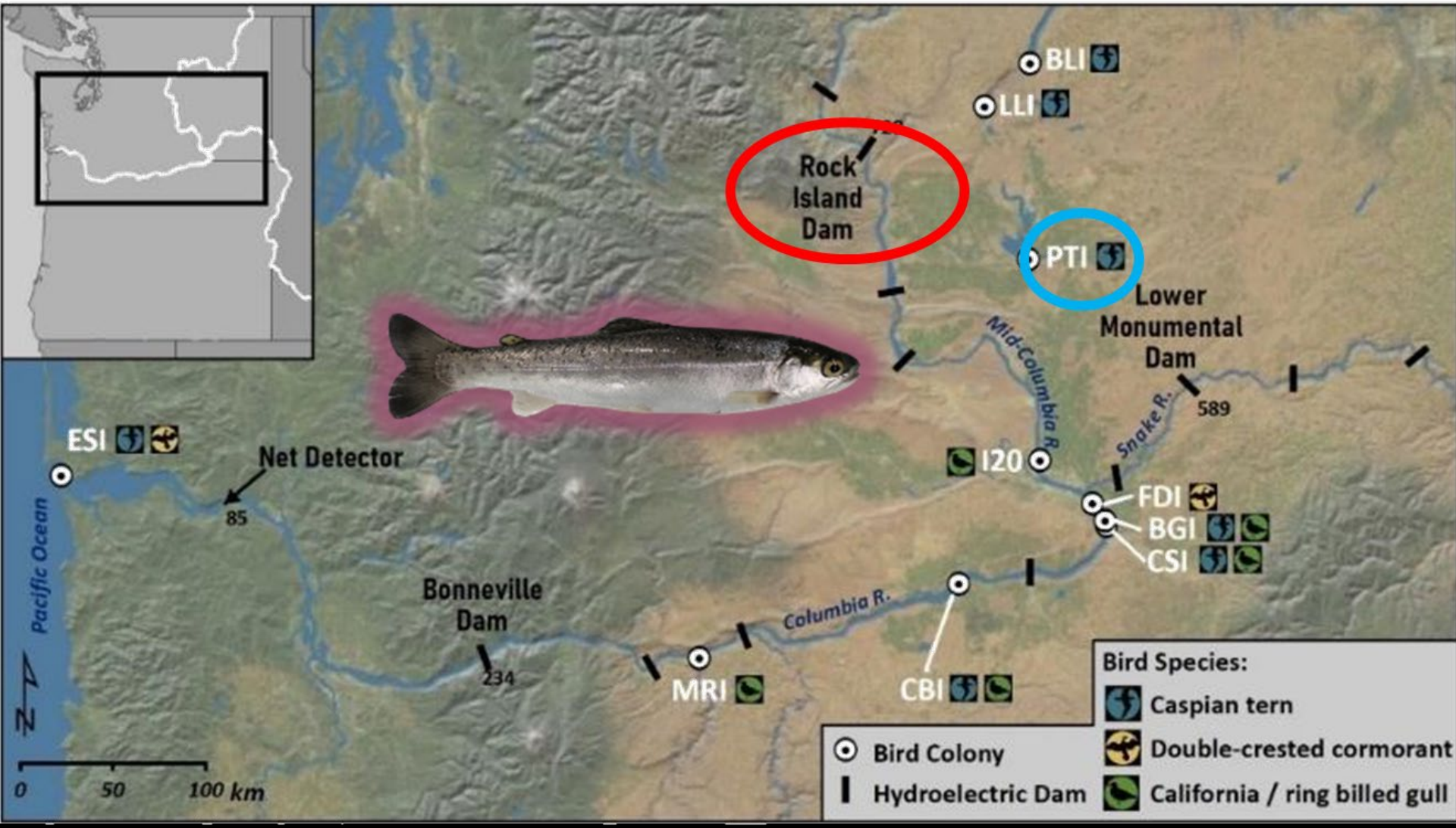
Graphic from briefing by Payton et al.

Caspian Tern Colonies



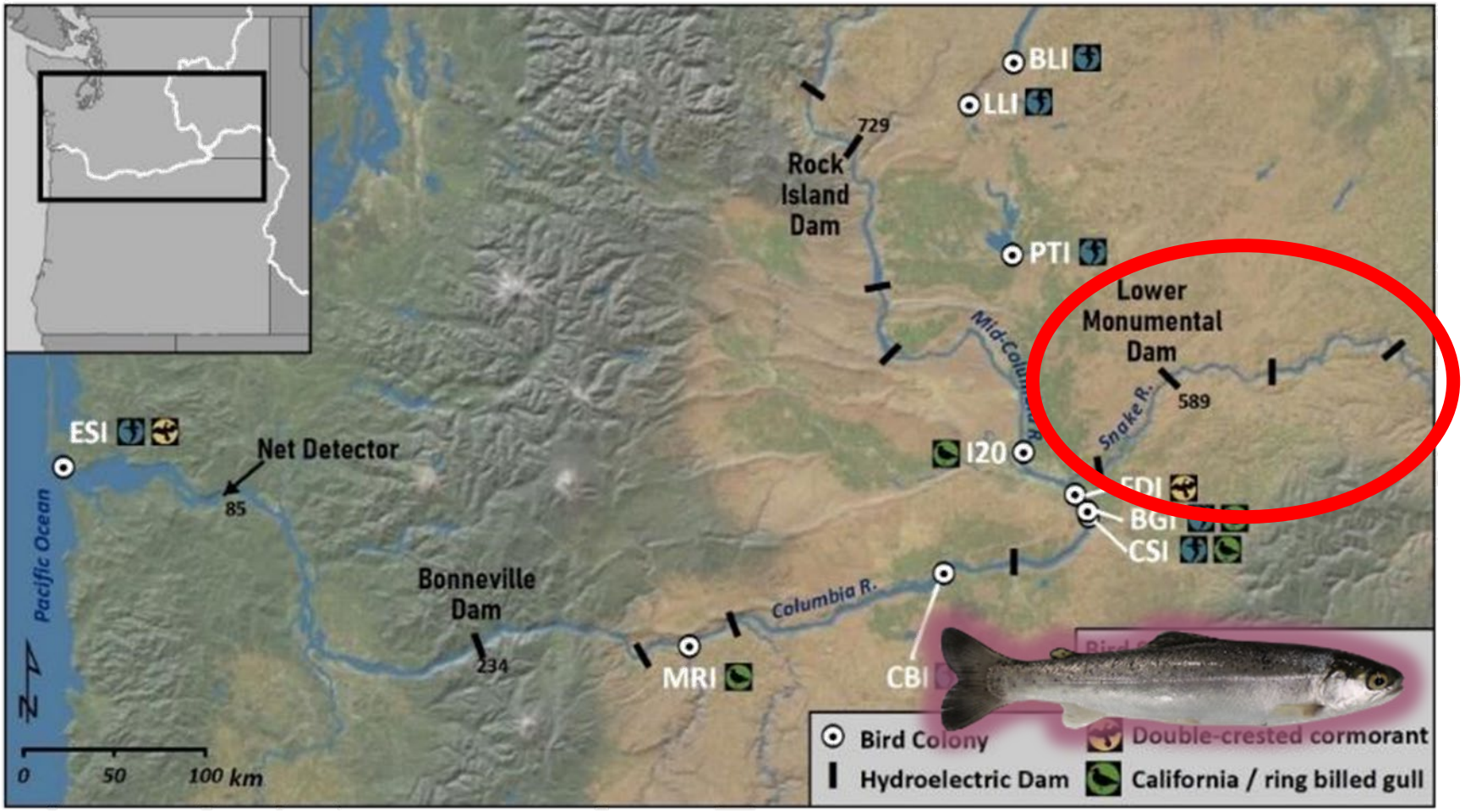
Graphic from briefing by Payton et al.

Payton et al. 2020



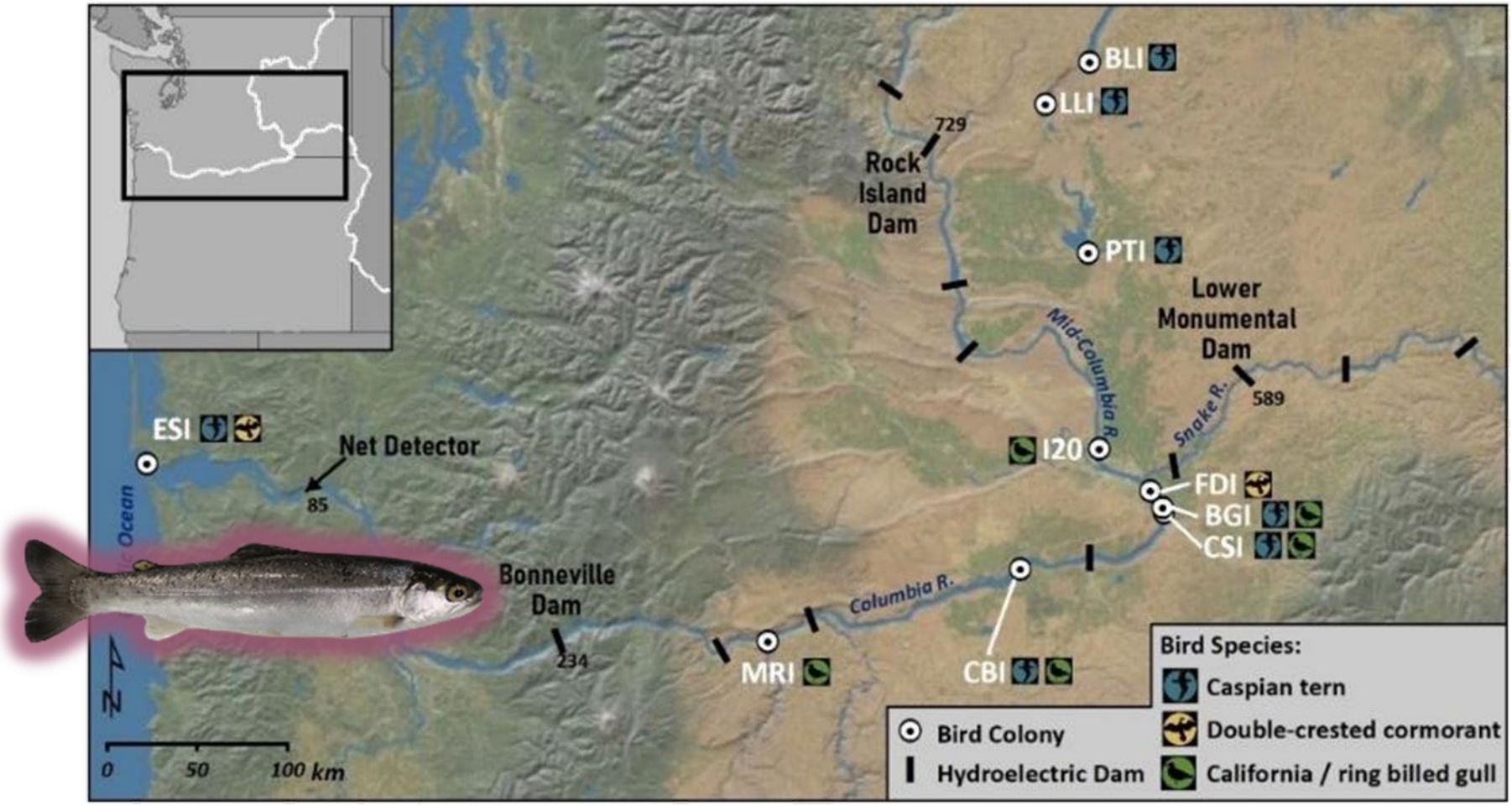
Graphic from briefing by Payton et al.

Haeseker et al. 2020



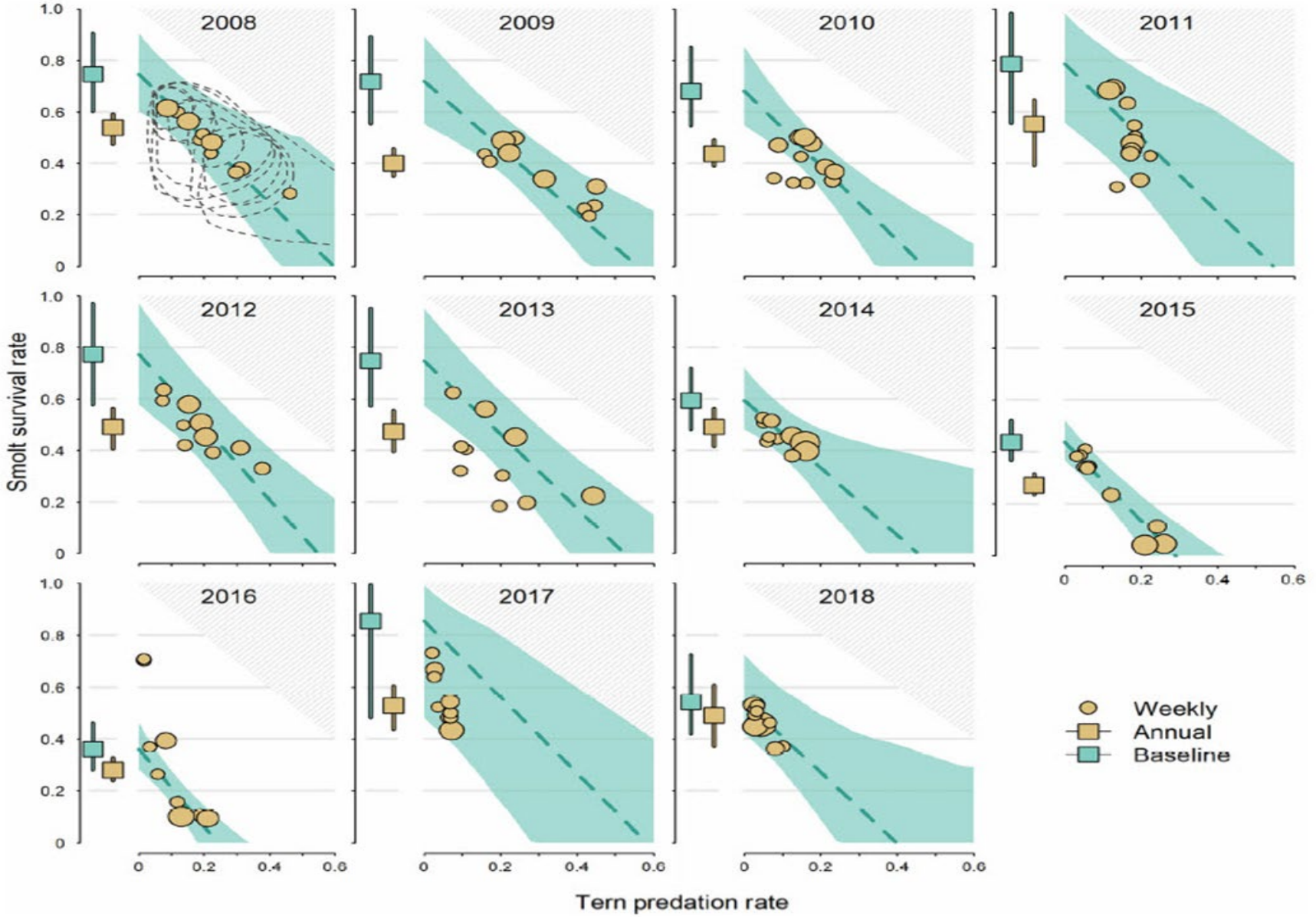
Graphic adapted from briefing by Payton et al.

Haeseker et al. 2020



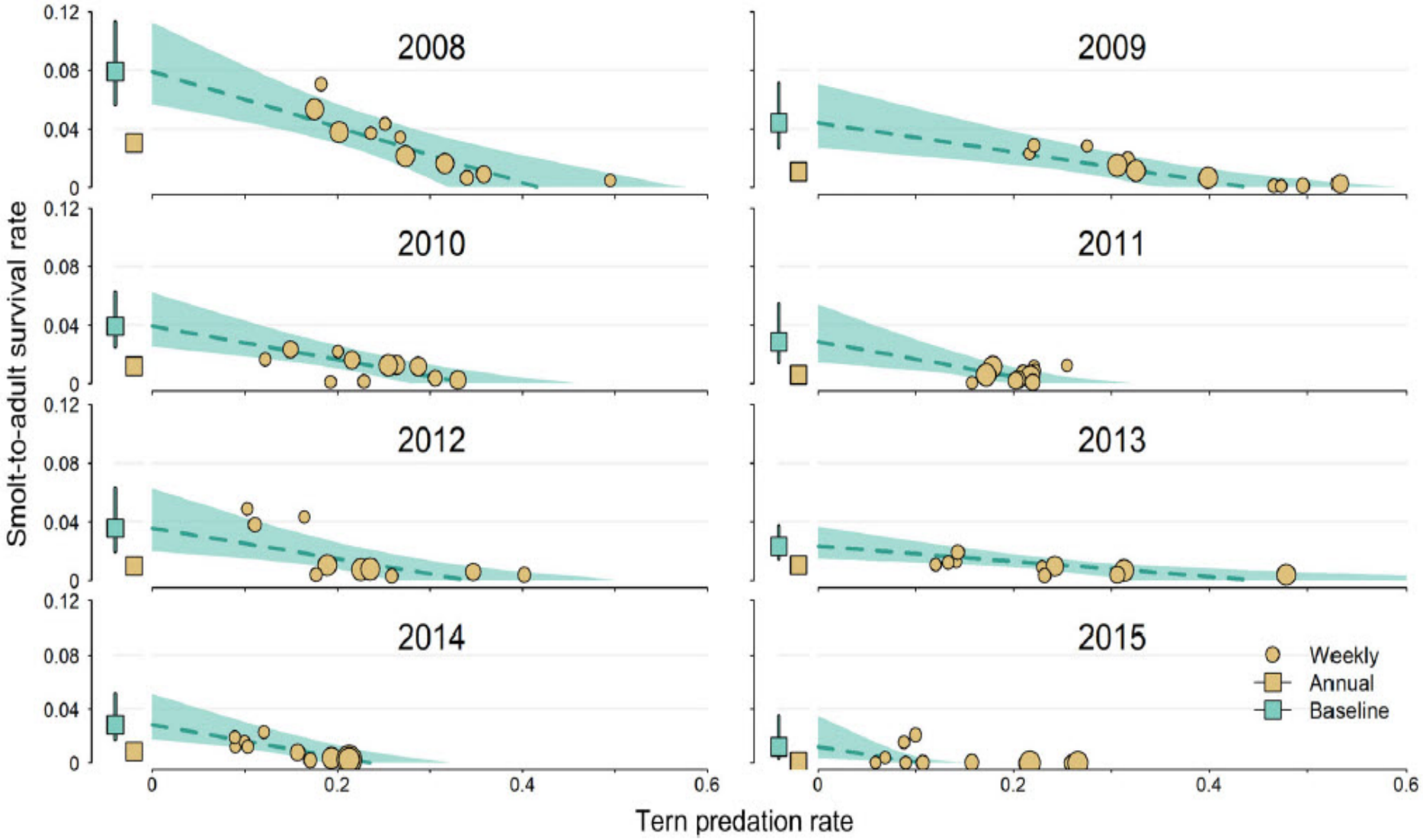
Graphic adapted from briefing by Payton et al.

- Only Payton et al. assessed smolt survival during in-river migration.


2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Smolt survival rate
Tern predation rate
Weekly
Annual
Baseline

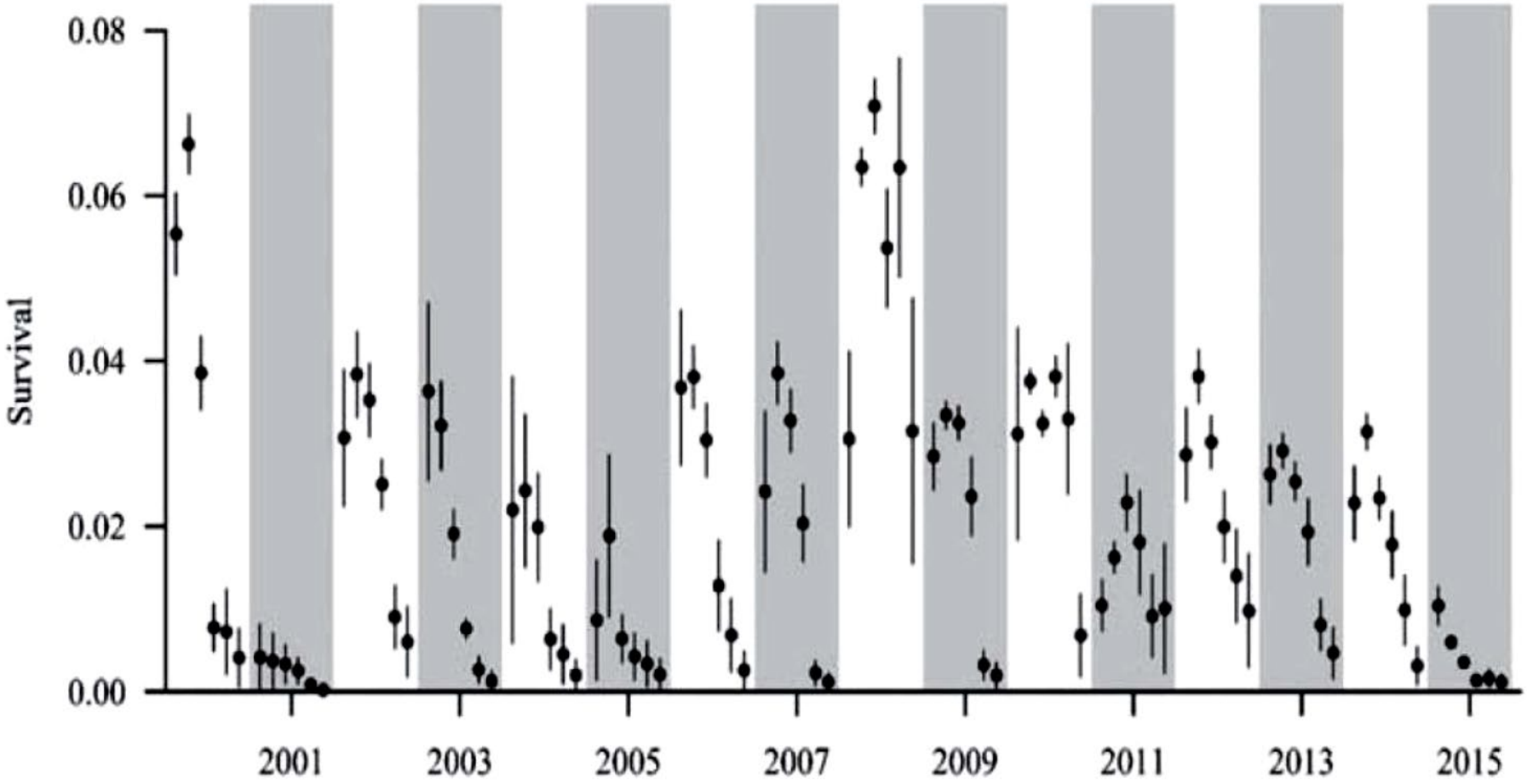
- There appears to be strong additivity of predation for this life history phase.

- Payton et al. also examined smolt-to-adult survival to Bonneville.


2008
2009
2010
2011
2012
2013
2014
2015
Smolt-to-adult survival rate
Tern predation rate
0.12
0.08
0.04
0
0.2
0.4
0.6
Weekly
Annual
Baseline

- Payton et al. concluded that there is evidence for weak additivity of predation for the smolt-to-adult phase.

- Haeseker et al. examined smolt-to-adult survival to Bonneville using a correlation analysis of multiple years combined.


Survival
0.08
0.06
0.04
0.02
0.00
2001
2003
2005
2007
2009
2011
2013
2015

- Haeseker concluded that the lack of correlation is evidence for full compensation for smolt-to-adult phase.

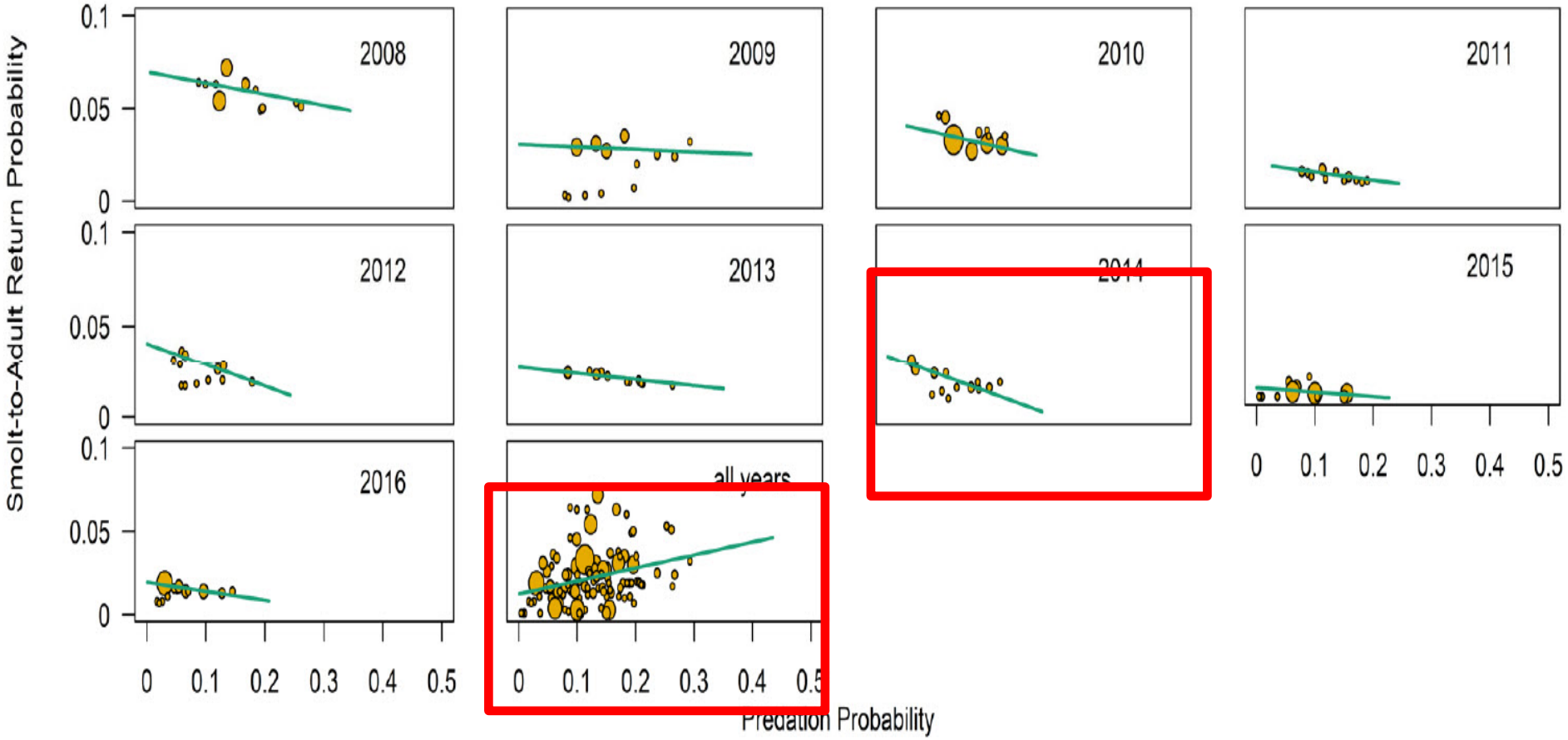
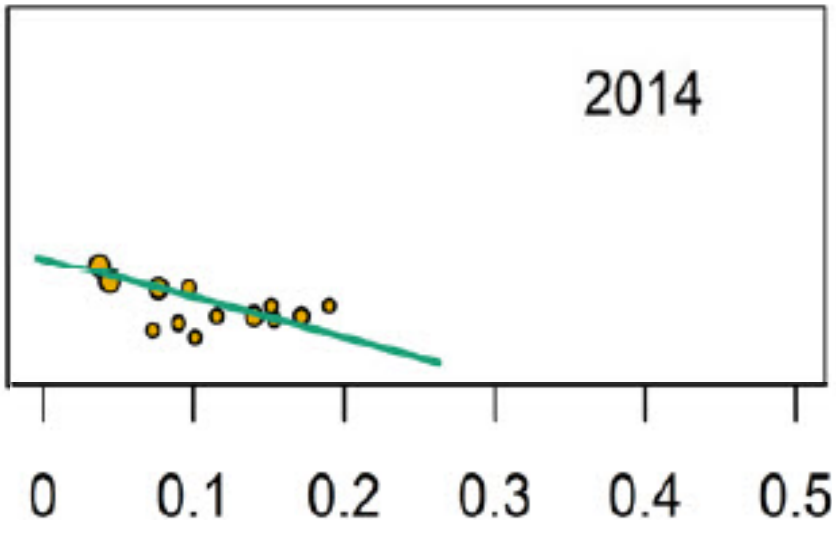


Figure 8.S3 in Payton et al. 2021



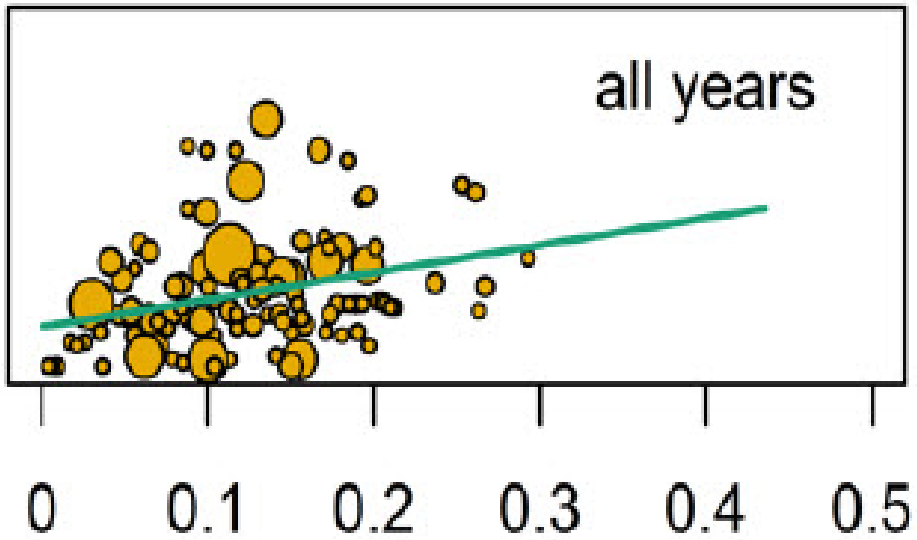


Figure 8.S3 in Payton et al. 2021

Results of both studies are consistent with the possibility of low-level partial additivity of predation effects on smolt-to-adult returns.

Management Implications

- Previous management actions have included hazing, culling, and habitat modification to discourage nesting.

- The findings of strong additivity of predation for juvenile steelhead and possible low-level partial additivity of predation on SARs warrant further research and careful consideration of possible management actions.

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ORIGINAL ARTICLE

FISH and FISHERIES WILEY

A synthesis of the coast-wide decline in survival of West Coast Chinook Salmon (*Oncorhynchus tshawytscha*, Salmonidae)

David Warren Welch | Aswea Dawn Porter | Erin Leanne Rechisky

FISH PASSAGE CENTER

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MEMORANDUM

TO: Tucker Jones, ODFW

FROM: Michele DeHart

DATE: January 10, 2019

SUBJECT: Comments on Welch et al manuscript "*The coast-wide col… survival of west coast Chinook and steelhead: slow moving… failure?*"

KINTAMA

Technology that Provides Answers

1 February 2021

Erik Merrill
nager, Scientific Review Program
rthwest Power and Conservation Council

Rebuttal of Fish Passage Center Memo 53-20 & Schaller et al. Memo

ISAB Meeting - Coastwide Chinook Survival Briefing and...

Friday, February 5, 2021 · 1:00 – 3:15pm

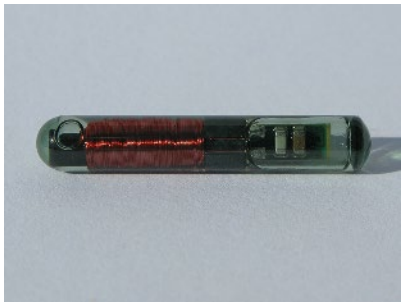
GoToMeeting

16 guests
16 awaiting

Reminder for tomorrow's meeting Part 1:

ISAB Meeting - Coastwide Chinook Survival Briefing and Discussion - Welch et al. 2020
Morning session: Fri, Feb 5, 2021 10:00 AM - 12:15 PM (PST)

Welch et al. Paper

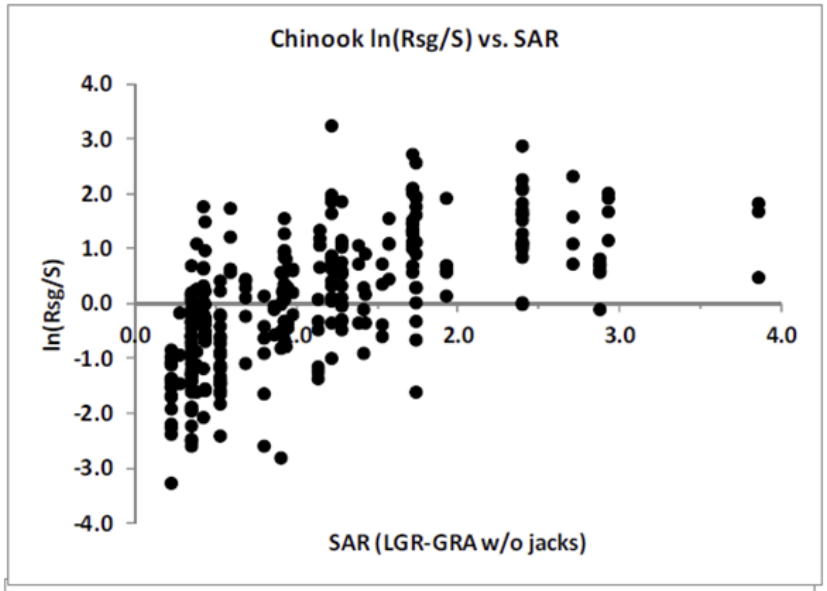


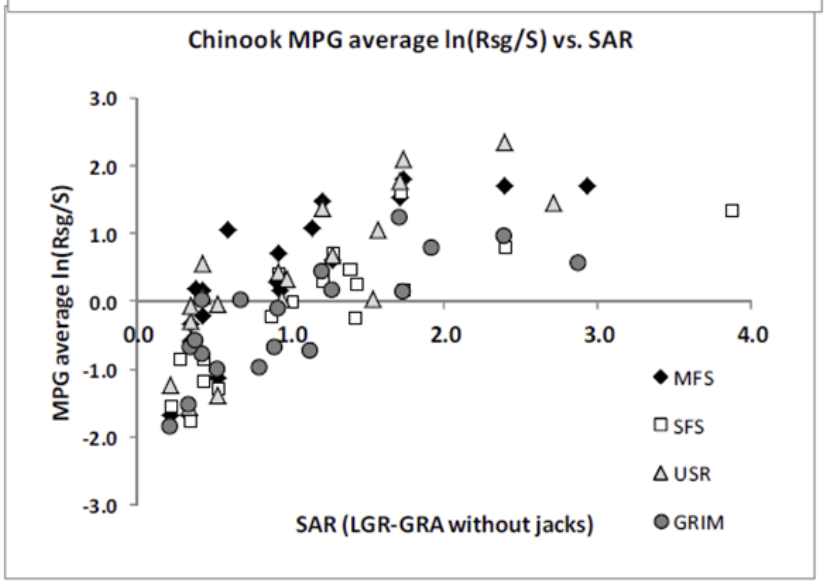
- Smolt-to-adult ratio (SAR)
- Chinook
  - 123 populations
  - 94 hatchery, 26 wild, and 3 mixed
  - Ocean and stream-type life histories

- Tag data

- Time periods, releases, etc. vary

Top – FISHBIO.com; Middle/Bottom -IDFG.IDAHO.gov





- Recruits/Spawner (R/S)
- SARs
- 17 Snake River Chinook pop
- Brood years 1992-2010

Figure 5.1 in CSS 2017 Annual Report

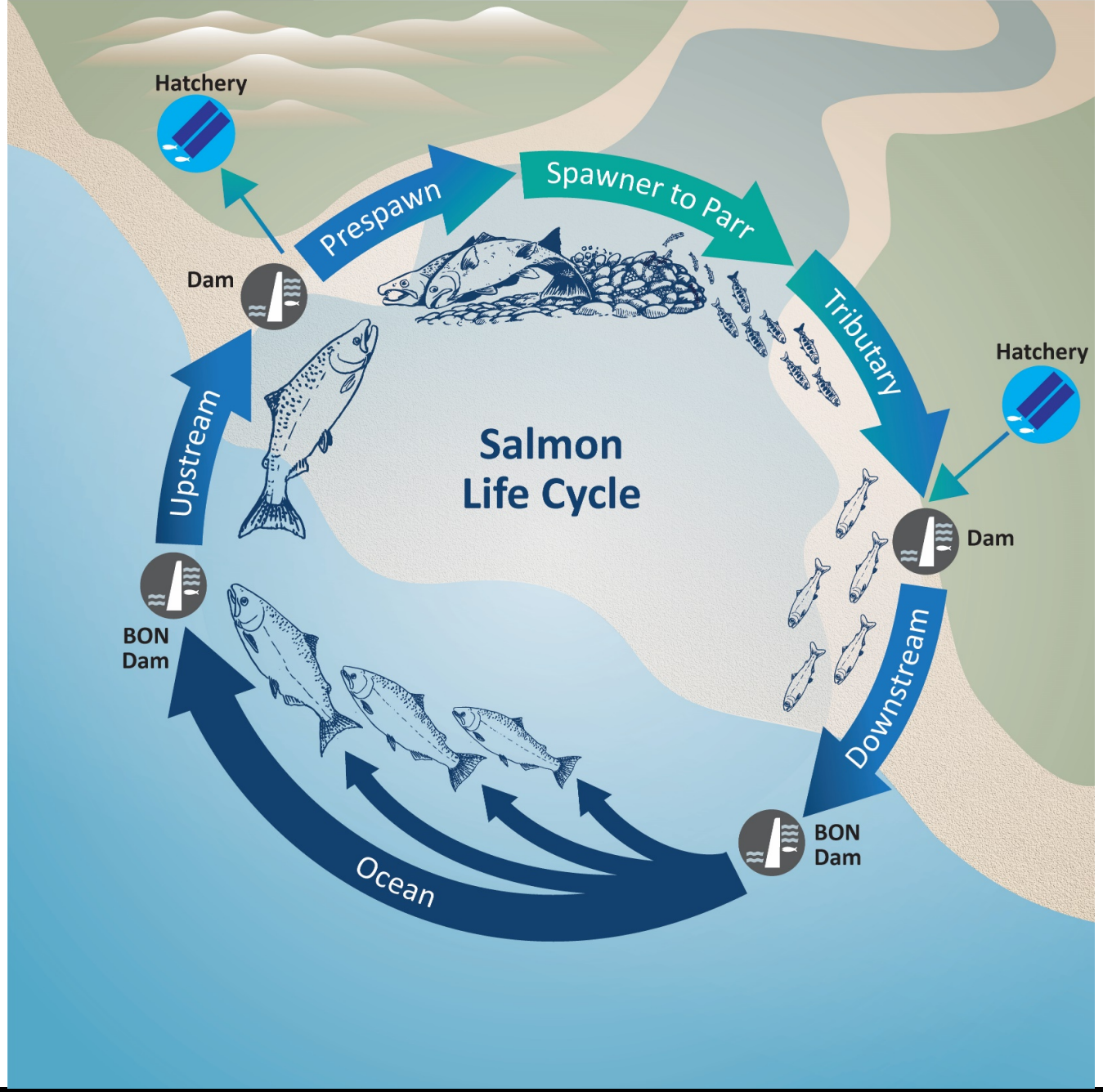
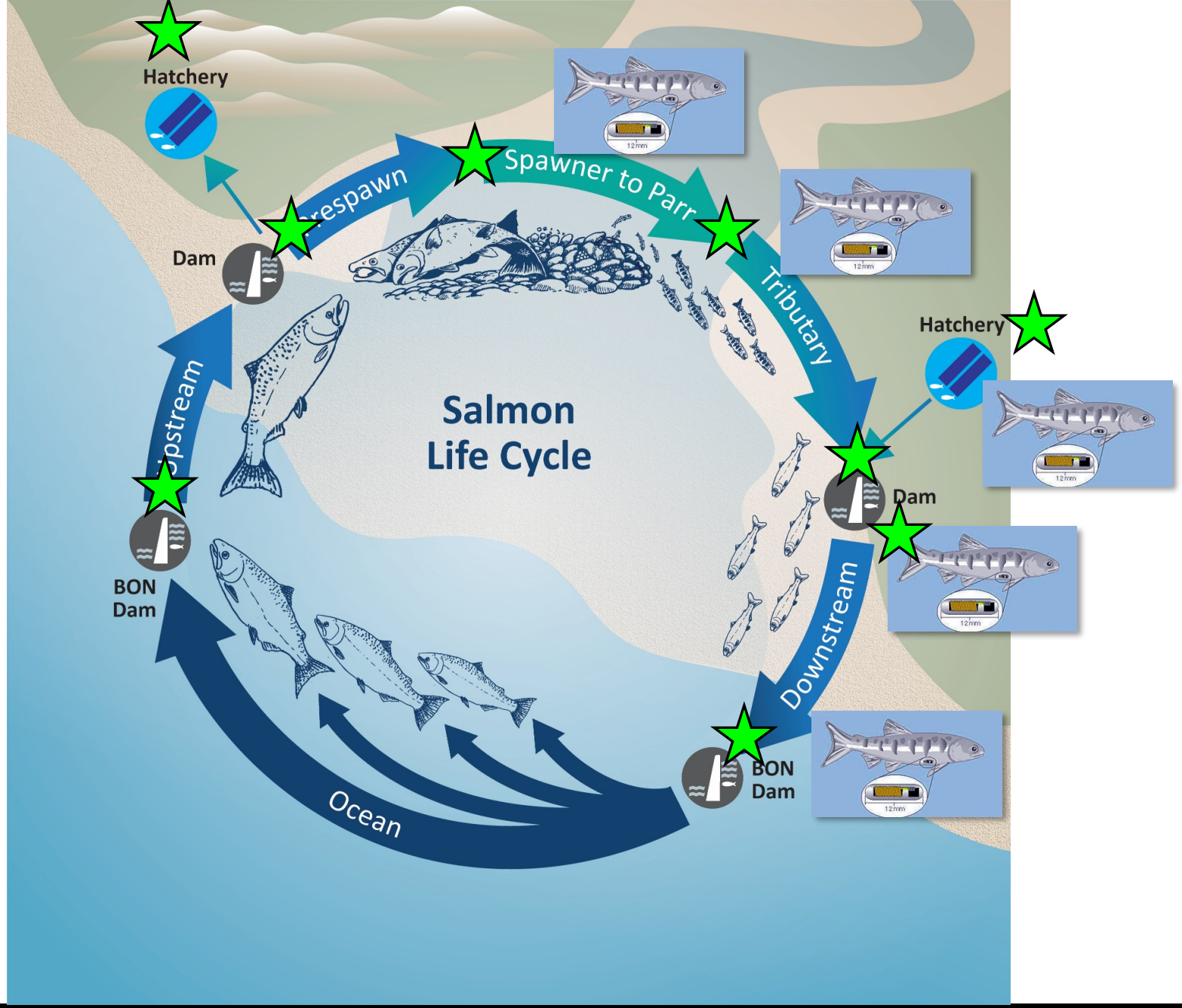


Diagram is modified from a NWFSC/NOAA Fisheries graphic



Symbol represents typical detection locations

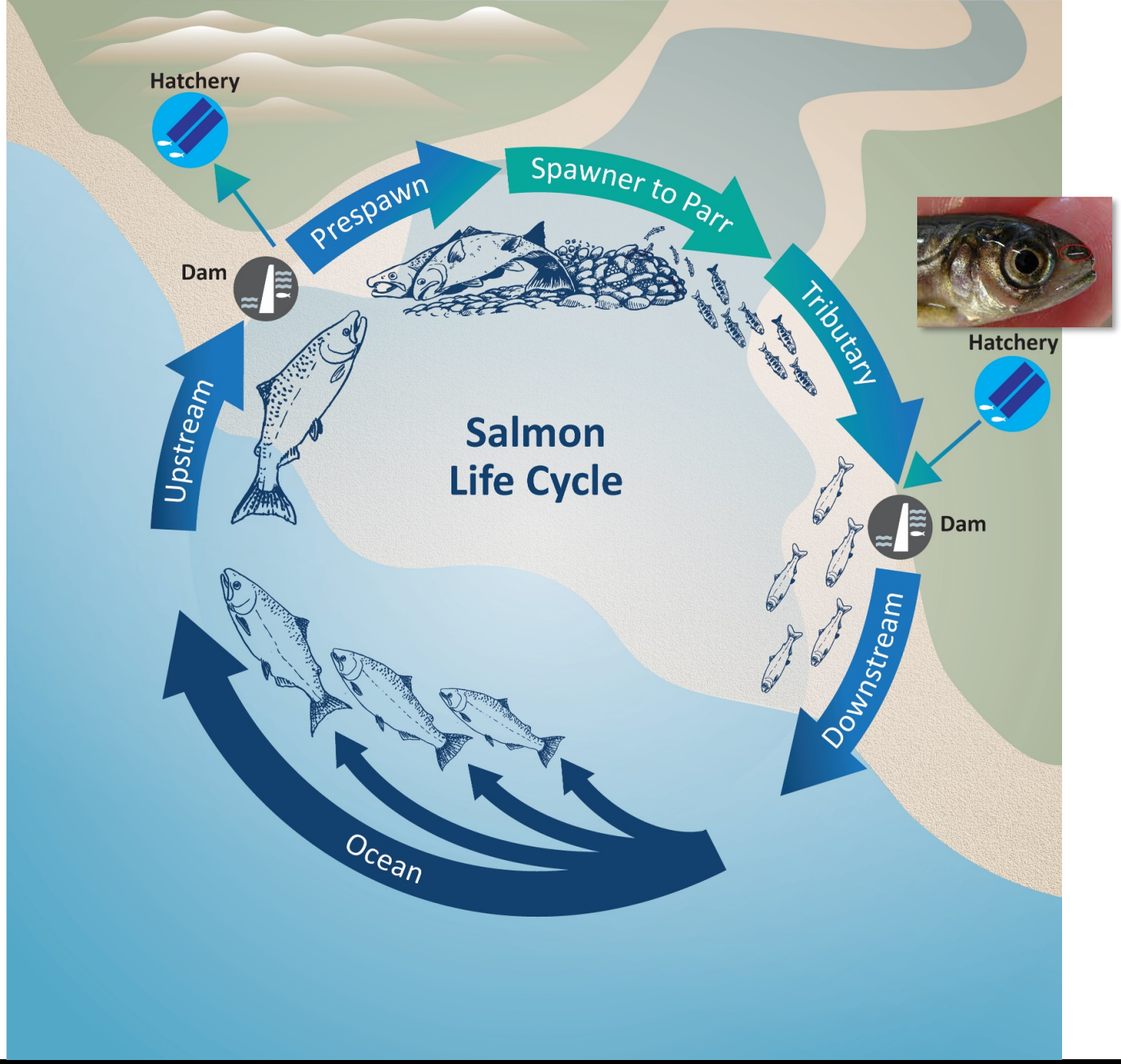
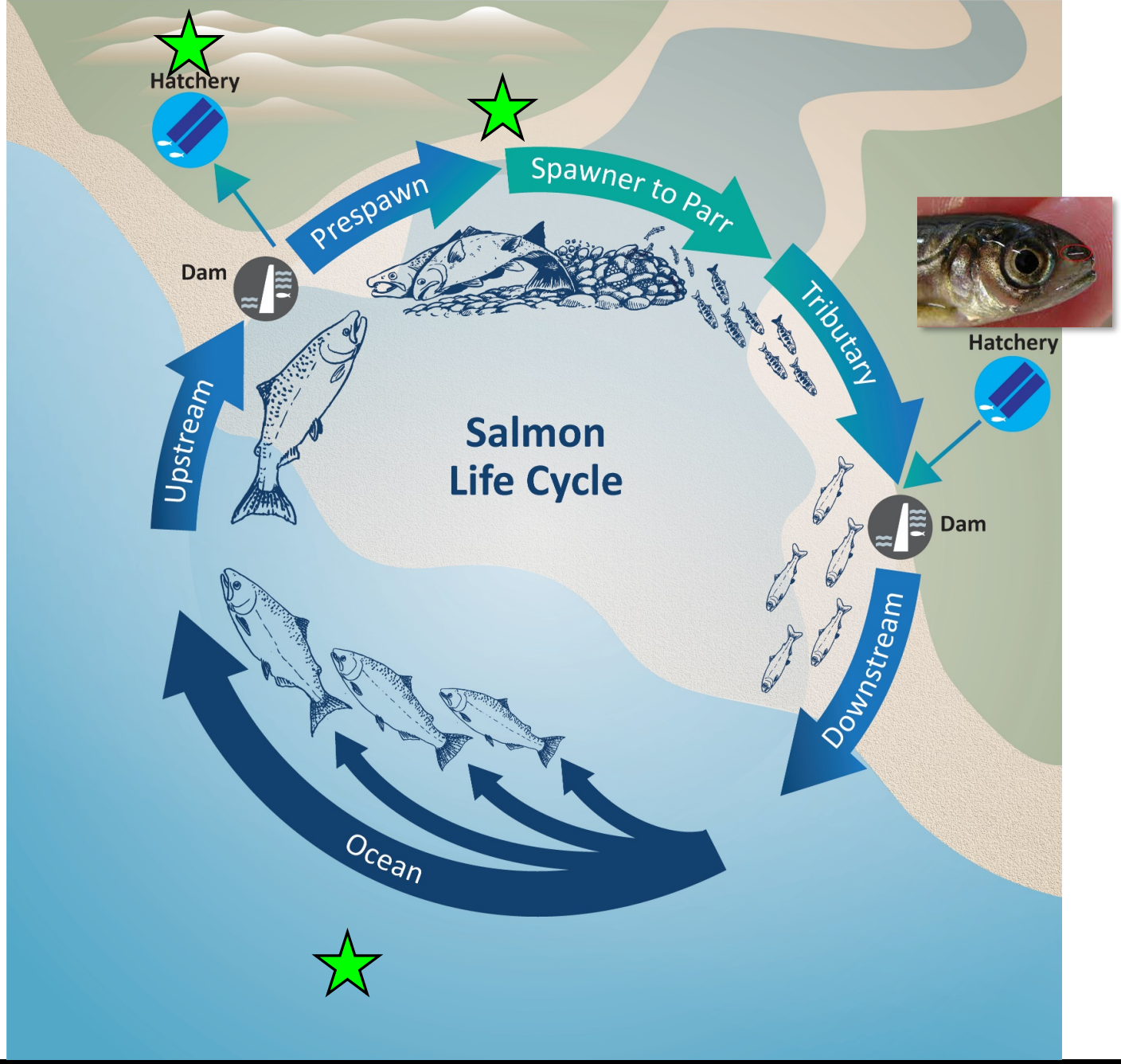
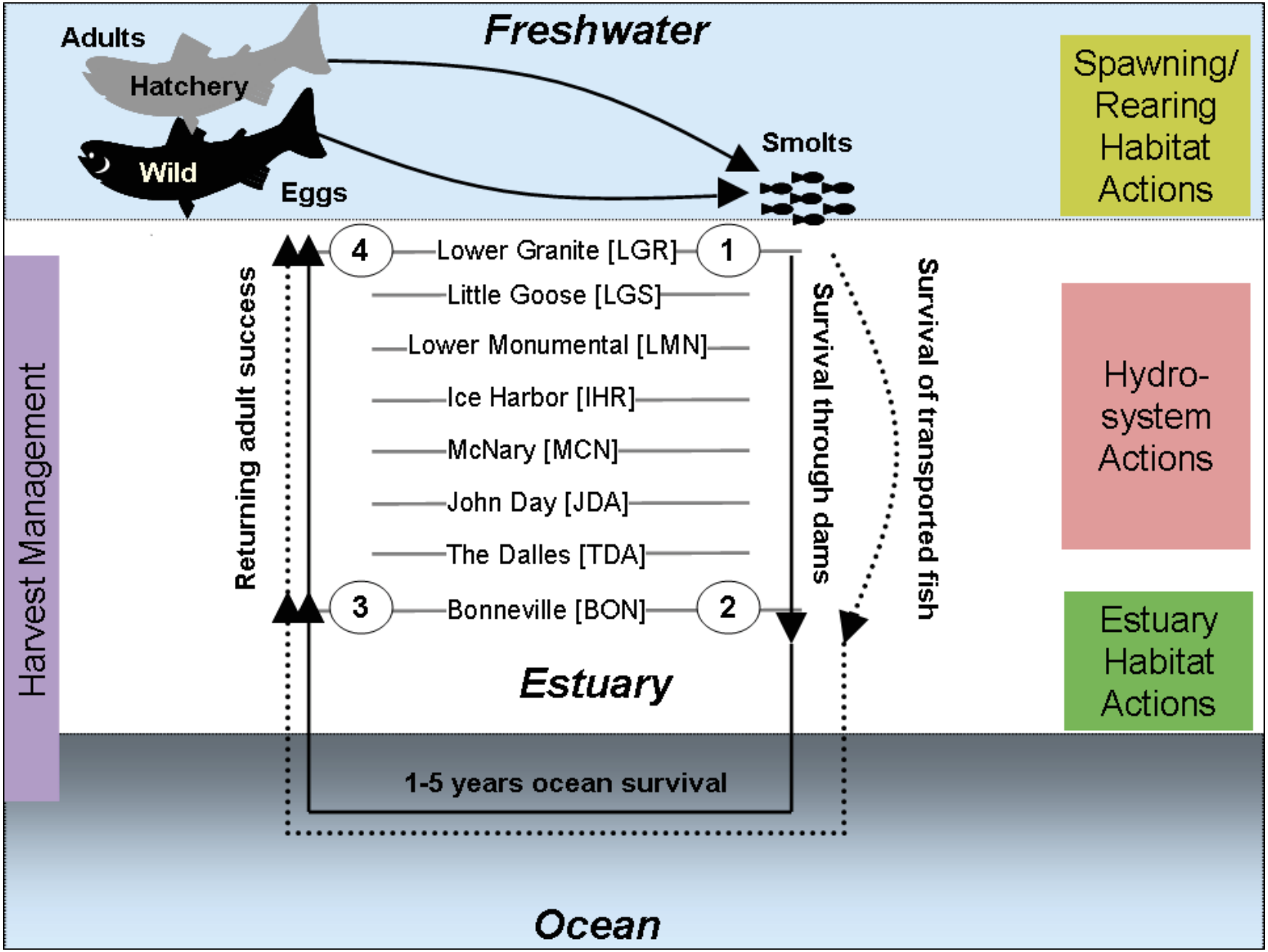
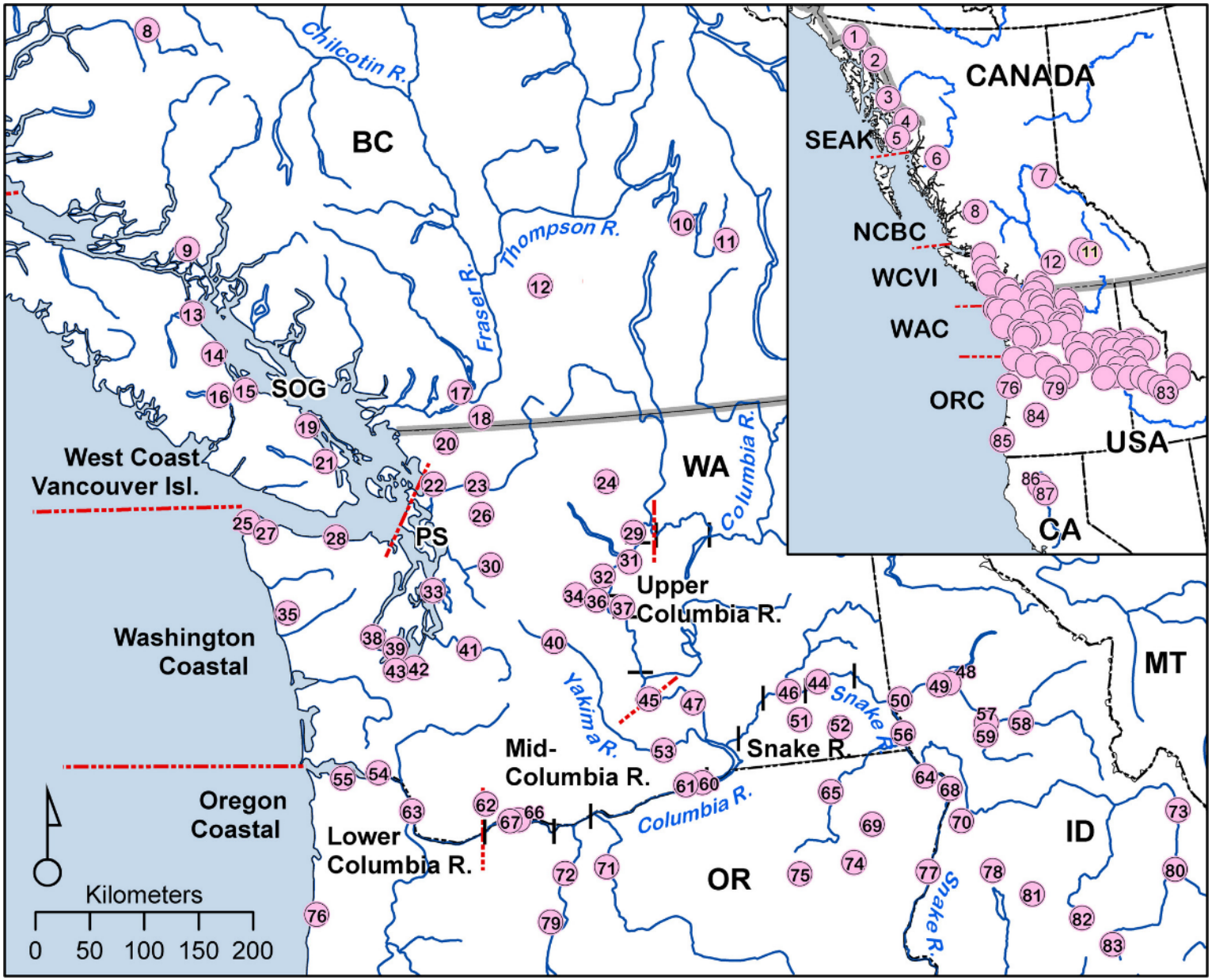


Diagram is modified from a NWFSC/NOAA Fisheries graphic

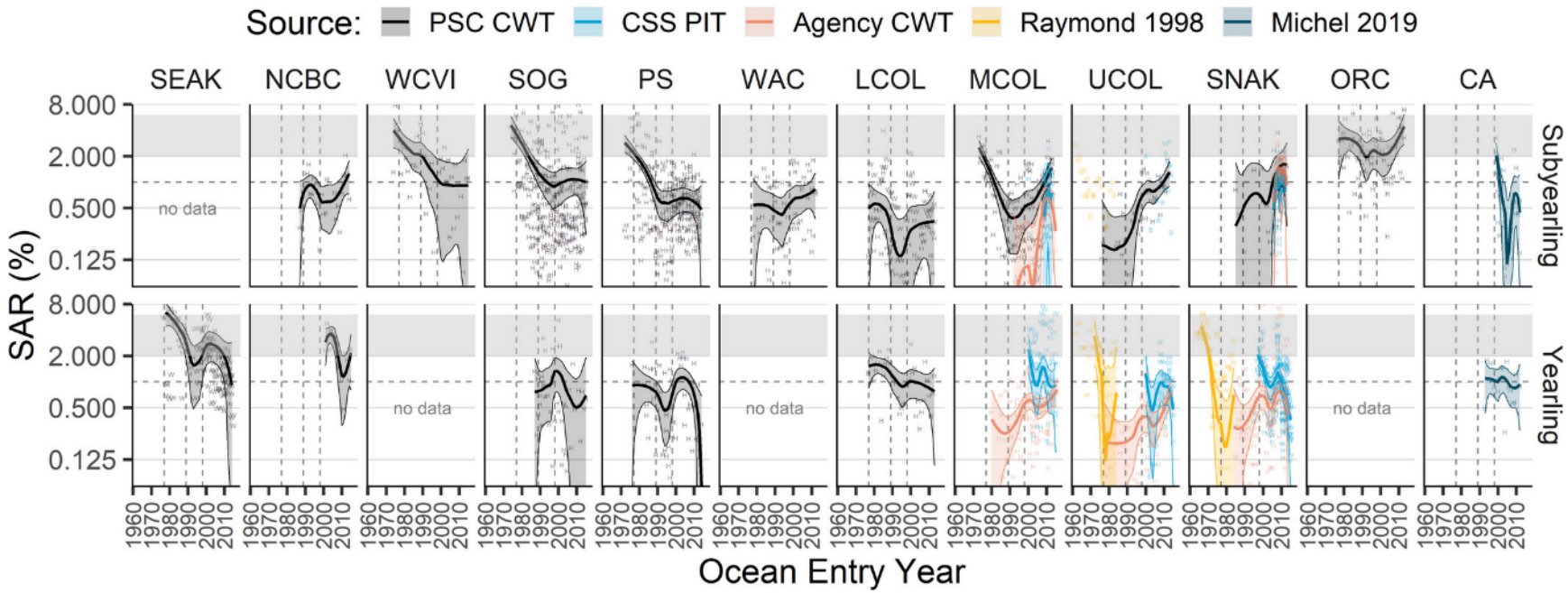


Symbol represents typical detection locations

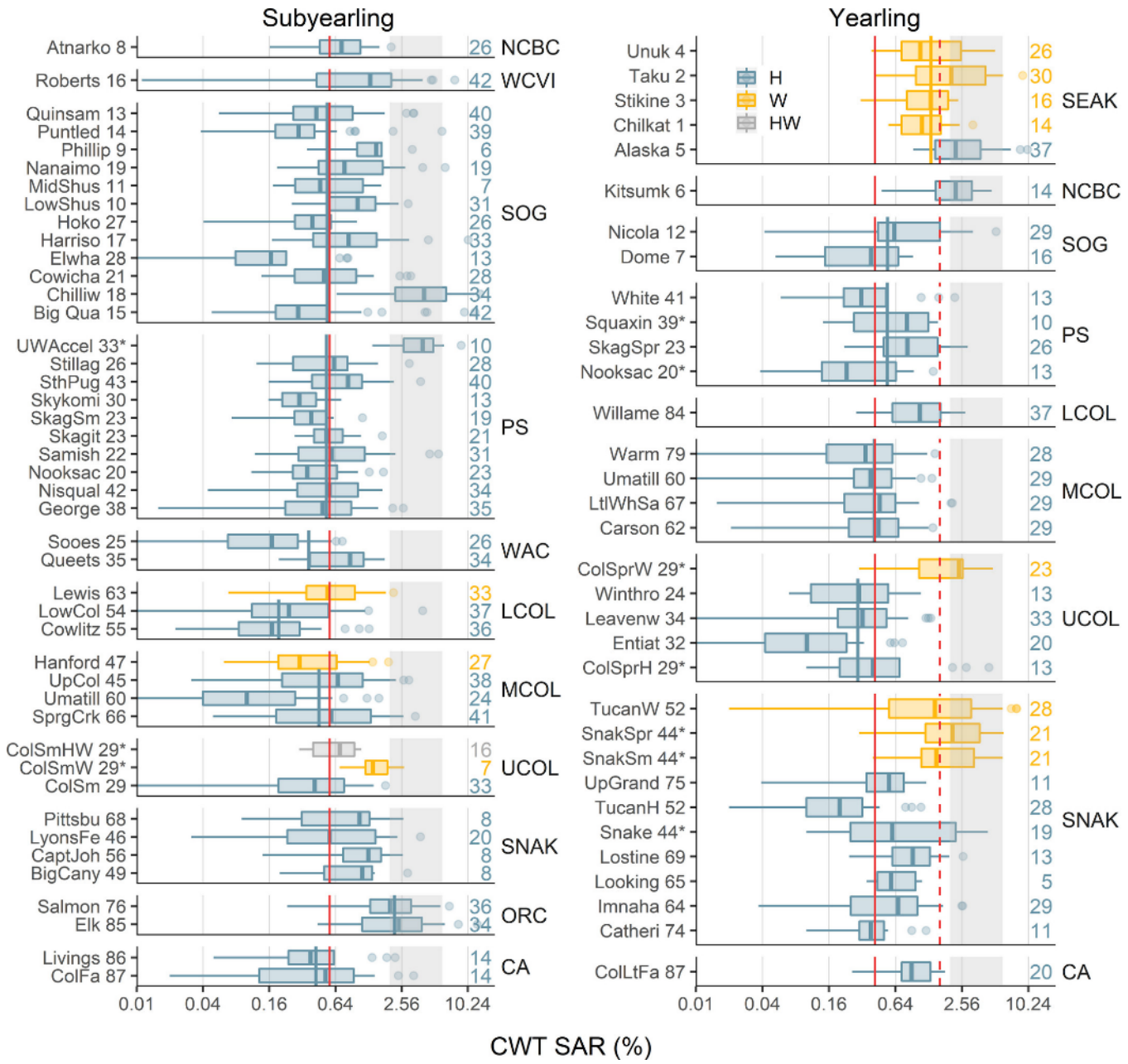

Adults
Hatchery
Wild
Eggs
Freshwater
Smolts
Spawning/ Rearing Habitat Actions
4
Lower Granite [LGR]
1
Little Goose [LGS]
Lower Monumental [LMN]
Ice Harbor [IHR]
McNary [MCN]
John Day [JDA]
The Dalles [TDA]
3
Bonneville [BON]
2
Returning adult success
Survival through dams
Survival of transported fish
Harvest Management
Hydro-system Actions
Estuary Habitat Actions
Estuary
1-5 years ocean survival
Ocean



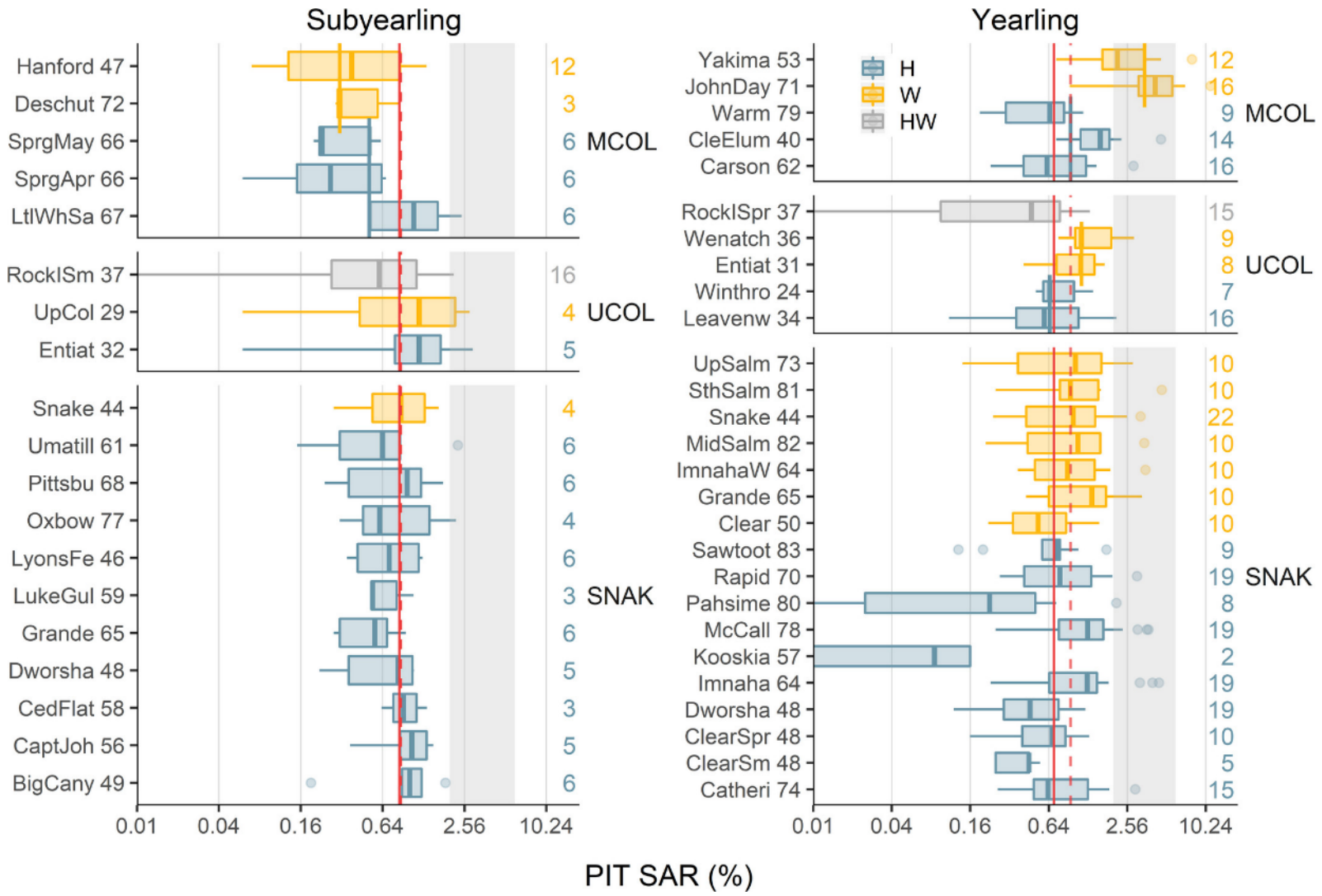
From Welch et al. 2020



From Welch et al. 2020



From Welch et al. 2020



From Welch et al. 2020

Summary of Responses
Conclusions Supported by the Results

- Supported
  - SARs are low
  - Columbia similar to other systems

- Unsupported
  - Whether little evidence of delayed mortality
  - Separation of SAR into marine/freshwater, especially for specific populations

- May be valid but cannot determine from the analyses

Summary of Responses
Scientifically Sound & Data Used Appropriately

- Descriptive analyses reasonable (but subjective) for general trends in SAR values

- Causal interpretations are speculative
  - Differences in tagging among populations
  - Variation and inseparability of freshwater from SARs
  - Effectiveness of freshwater management actions

- Note: similar general comments as the FPC review

Summary of Responses
Management Implications

- SAR values are generally low
- Low marine survival affects (constrains) long-term benefits of restoration

Summary of Responses
Management Implications

- Effectiveness of freshwater habitat improvements for Columbia Basin was not determined
    - Inseparability of SARs
    - More site-specific data than used
    - Not distinguish hydrosystem versus habitat
    - Should consider proportional gains

Summary of Responses
Management Implications

- **Wrongly conclude** that Welch et al. showed future freshwater actions are futile

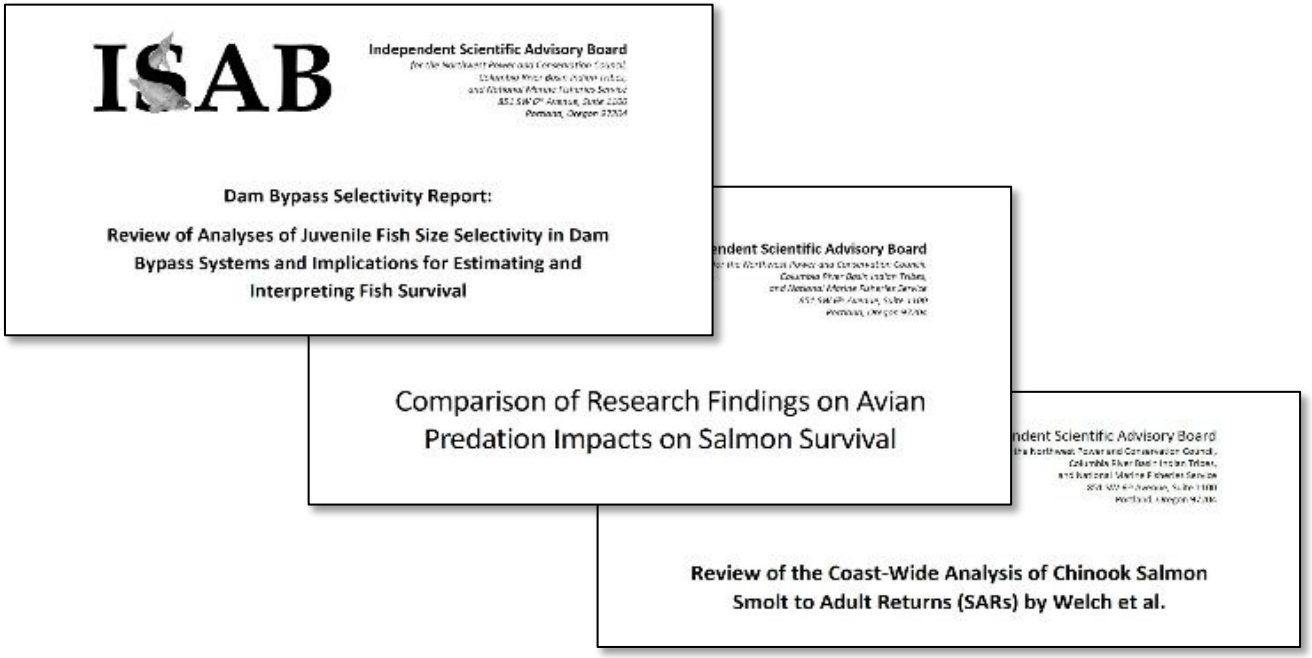
- Restoration must consider **the uncertain future of the ocean**, the full life cycle, and the benefits of habitat restoration

Summary of Responses
Improve Analysis and Interpretation

- Synthetic analyses like Welch et al. are useful
- Adding explanatory variables
- Marine and freshwater components of SARs

Summary of Responses
Improve Analysis and Interpretation

- Unified statistical approach
- Identify speculation to ensure proper interpretation
- Use best data when available for locations
- Warrants analyses by the Fish & Wildlife Program



Together, these reviews:

- Describe progress made
- Add clarity to the methods, results, and conclusions
- Highlight remaining uncertainties
- Identify opportunities for synthesis to existing data through coordinated analyses
- Describe management implications for decision makers

Acknowledgements

- James Faulkner and Richard Zabel (NOAA Fisheries, NW Fisheries Science Center)
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- Jerry McCann, Brandon Chockley, Gabe Scheer, and Michele Dehart (Fish Passage Center)
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- Nathan Hostetter (University of Washington)
- Tami Wilkerson and Maggie Willis (CRITFC Columbia Basin Fish and Wildlife Library)
- David Welch, Erin Rechisky, and Aswea Porter (Kintama Research, Nanaimo, British Columbia)

Photo by Tony Grover