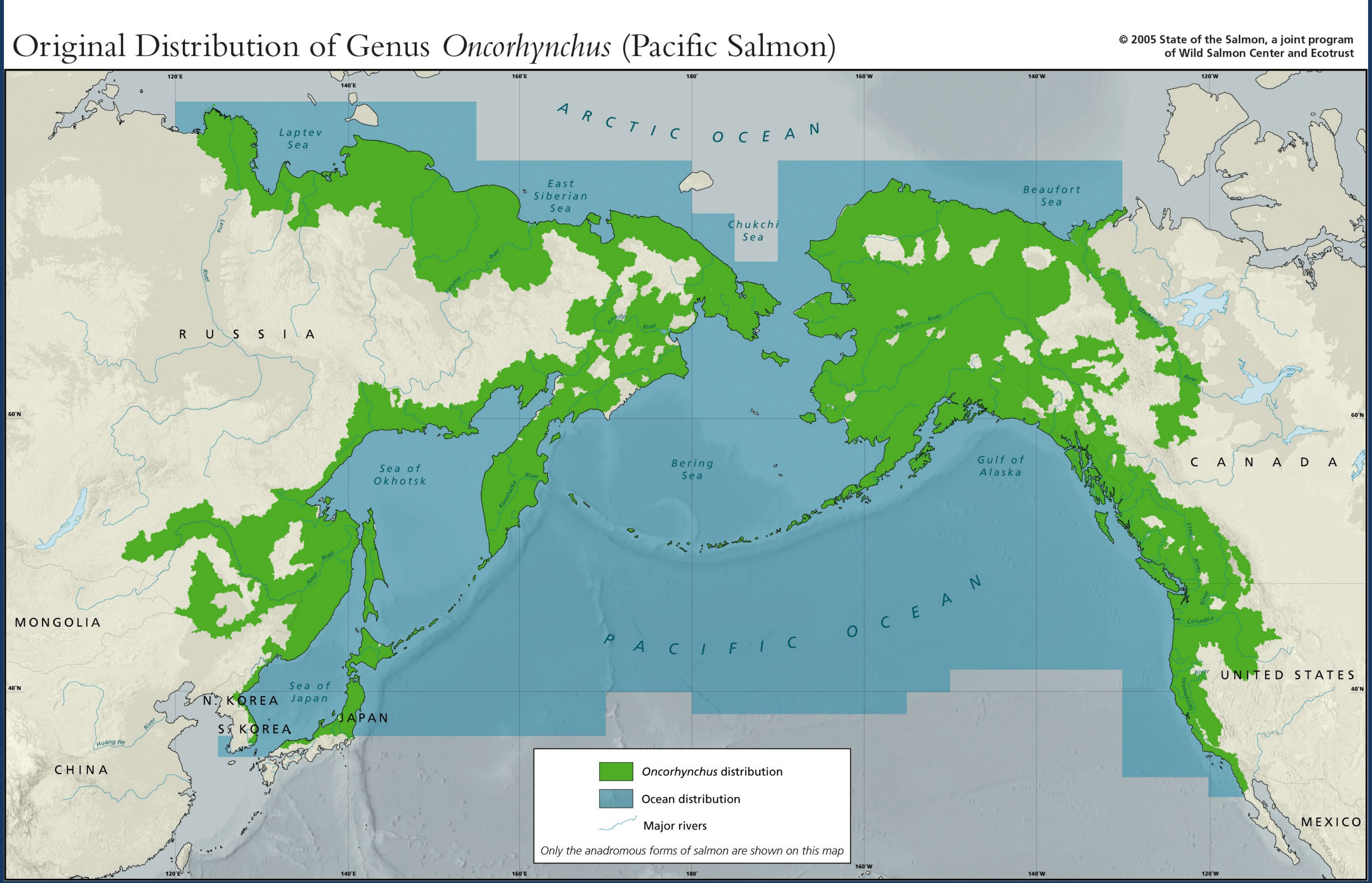
Flexible processes and firm principles:

Information for managing Alaska fisheries in the presence of change

PSC Seminar Series - *Environmental change and Pacific salmon management: the view from both sides of the border*

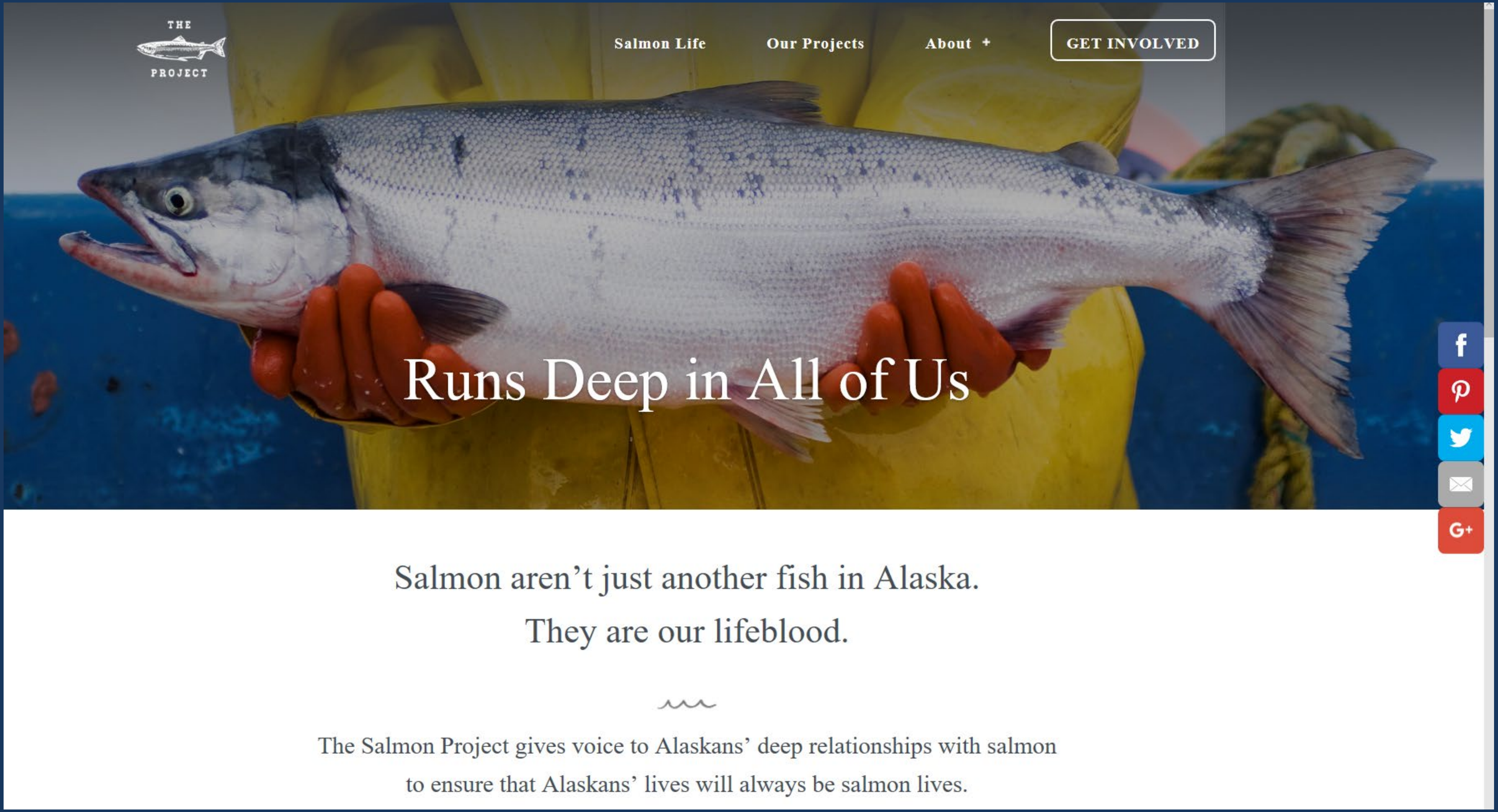
Bill Templin
Chief Fisheries Scientist for Salmon
Division of Commercial Fisheries
Alaska Department of Fish and Game

Alaska is in the Heart of the Salmon World



State of the Salmon

Salmon at the Heart of Alaska



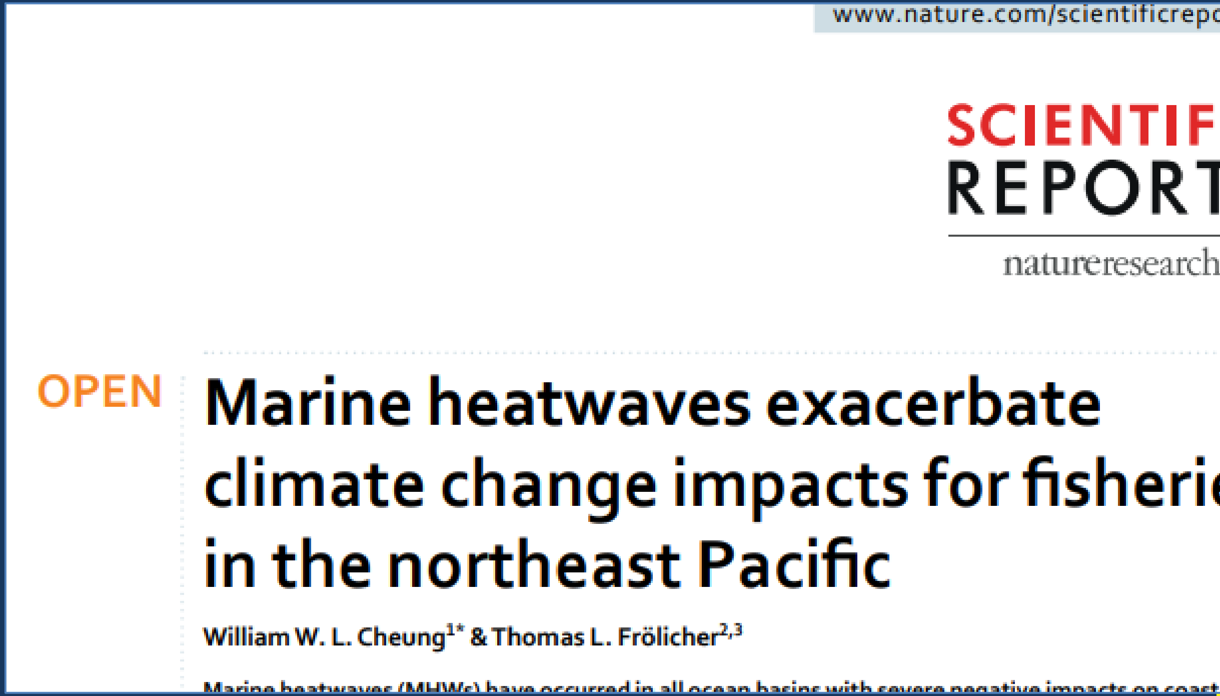
Runs Deep in All of Us

Salmon aren't just another fish in Alaska.
They are our lifeblood.

The Salmon Project gives voice to Alaskans' deep relationships with salmon to ensure that Alaskans' lives will always be salmon lives.

Salmonproject.org

Salmon are Affected by Changes in the Ocean



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SCIENTIFIC REPORTS

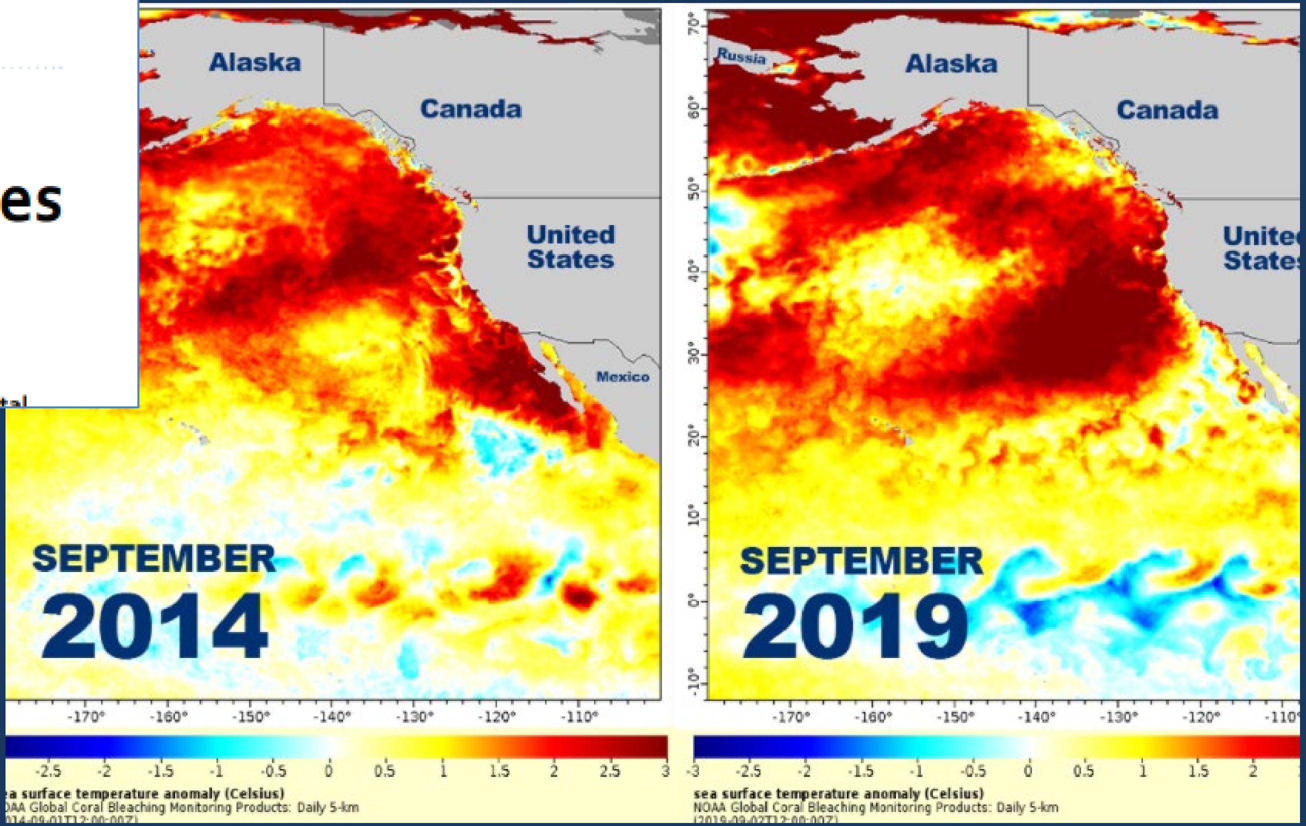
natureresearch

OPEN

Marine heatwaves exacerbate climate change impacts for fisheries in the northeast Pacific

William W. L. Cheung[1*] & Thomas L. Frölicher[2,3]

Marine heatwaves (MHWs) have occurred in all ocean basins with severe negative impacts on coastal

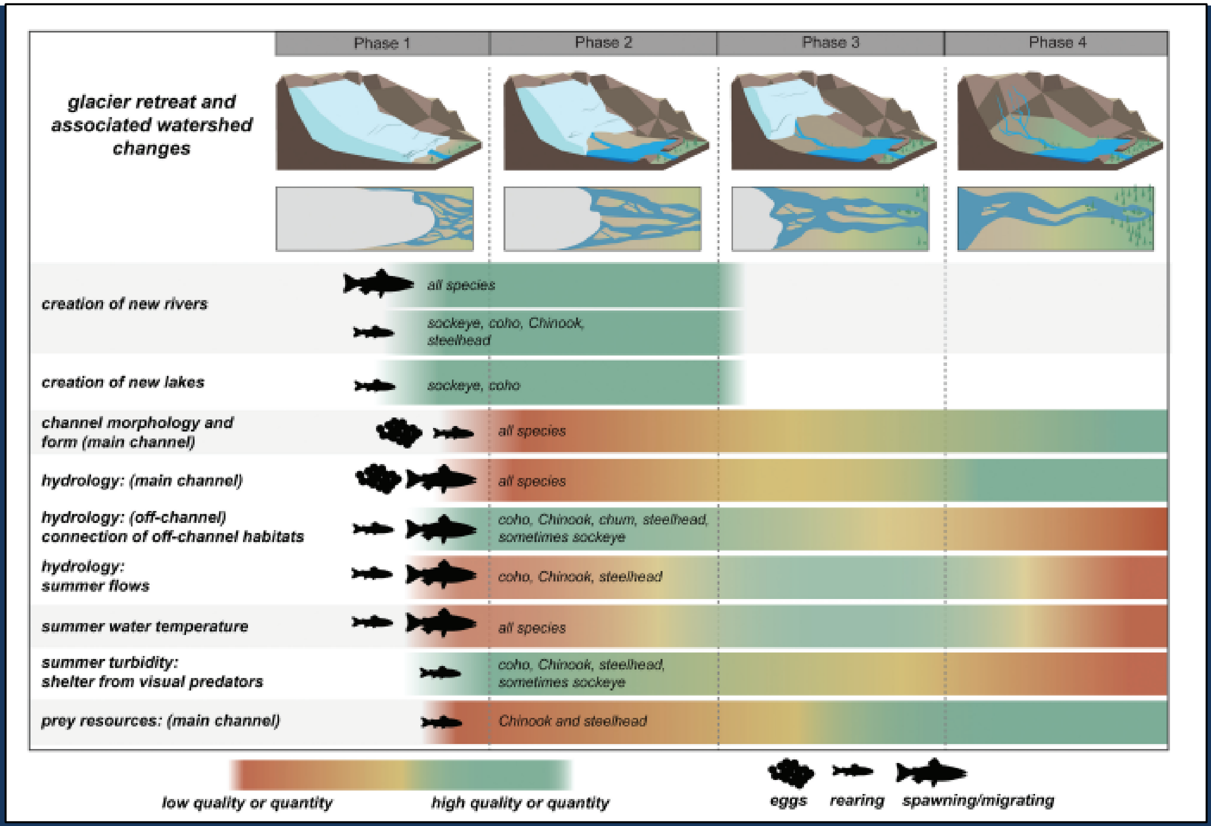


Cheung, W.W.L., Frölicher, T.L. Marine heatwaves exacerbate climate change impacts for fisheries in the northeast Pacific. *Sci Rep* **10,** 6678 (2020). https://doi.org/10.1038/s41598-020-63650-z

Salmon are Affected by Changes in Freshwater

Glacier Retreat and Pacific Salmon

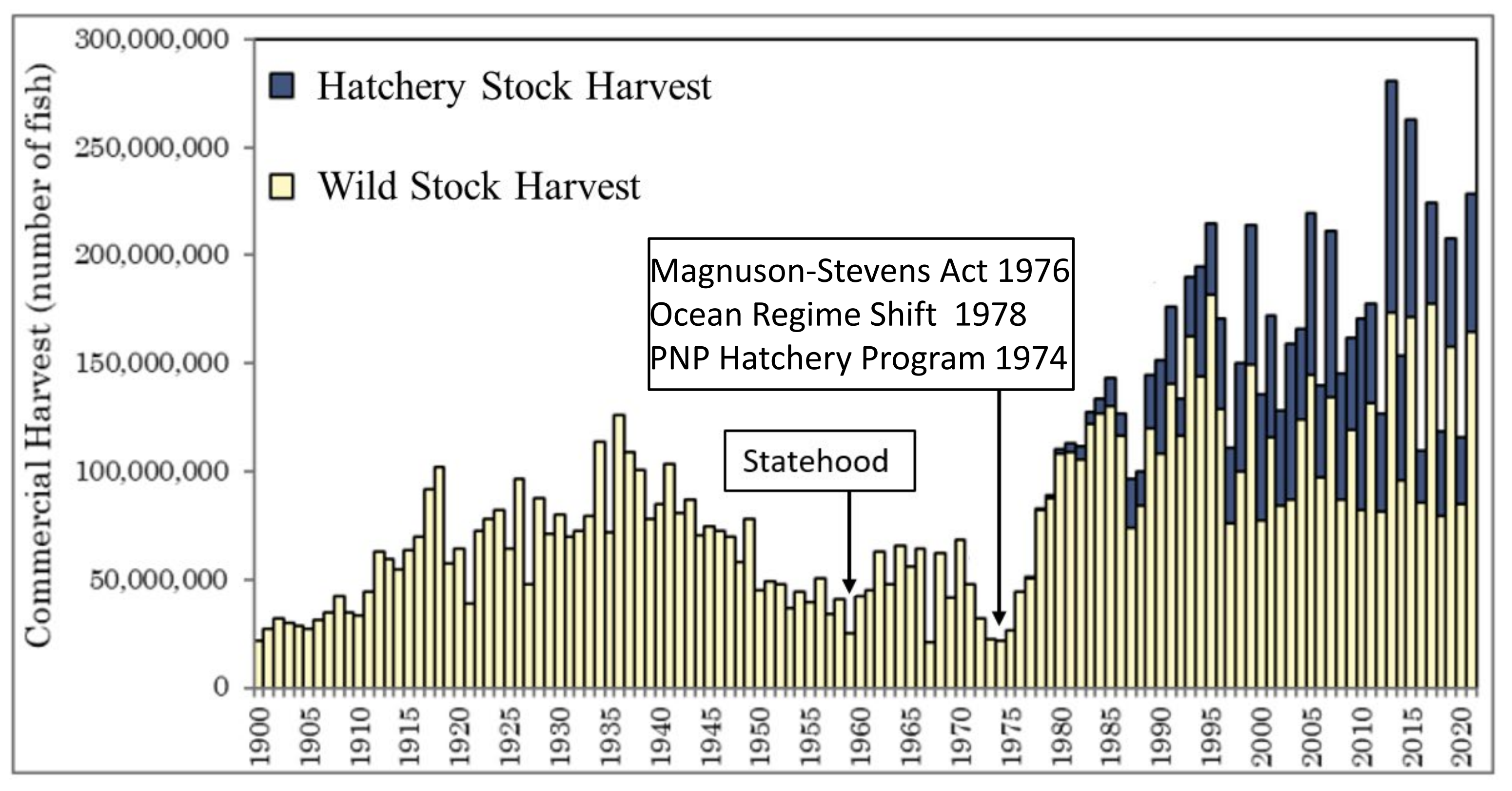
KARA J. PITMAN, JONATHAN W. MOORE, MATTHEW R. SLOAT, ANNE H. BEAUDREAU, ALLISON L. BIDLACK, RICHARD E. BRENNER, ERAN W. HOOD, GEORGE R. PESS, NATHAN J. MANTUA, ALEXANDER M. MILNER, VALENTINA RADIĆ, GORDON H. REEVES, DANIEL E. SCHINDLER, AND DIANE C. WHITED



Pitman, Kara J., et al. "Glacier retreat and Pacific salmon." *BioScience* 70.3 (2020): 220-236.

Alaska Salmon Fishery Management

- Alaska became a state during record low salmon production
- Principles and processes included to adapt to change



Magnuson-Stevens Act 1976
Ocean Regime Shift 1978
PNP Hatchery Program 1974

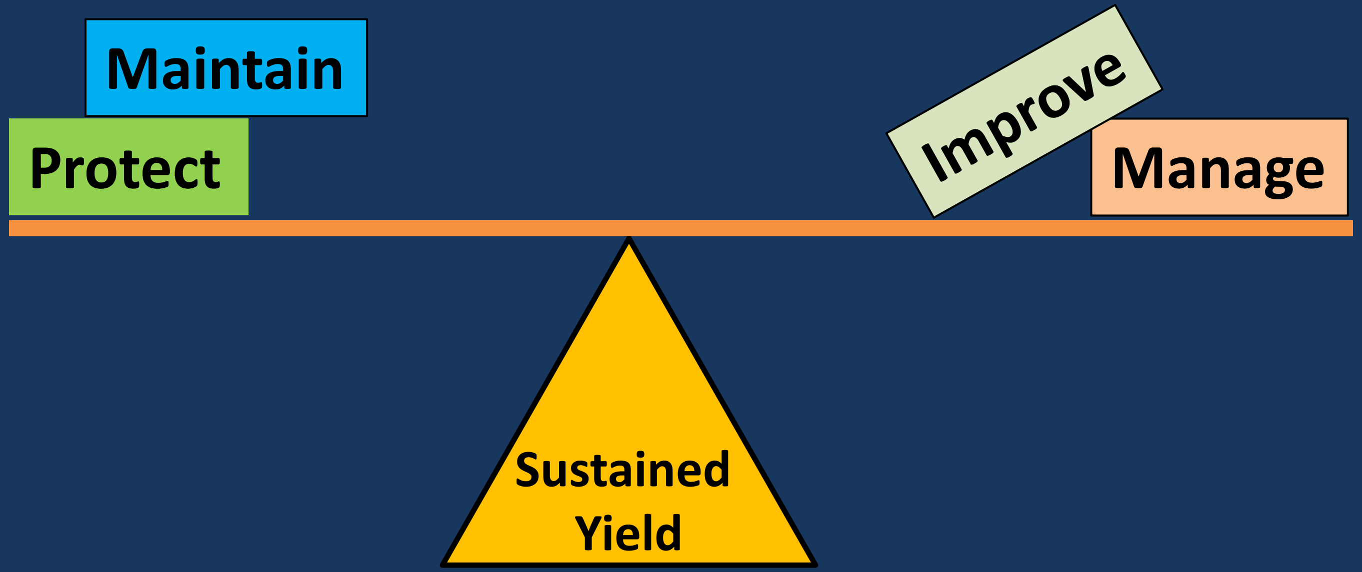
Principles and Processes of Alaska Salmon Fishery Management

Constitutional Provisions for Resource Management

Article VIII, Sec(4). Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

Alaska Department of Fish and Game Mission Statement

To protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle.



Maintain

Protect

Improve

Manage

Sustained Yield

Escapement Goals as Management Targets

- The escapement is the number of fish that make it to the spawning grounds to spawn.
- Goals for escapement are set to provide yield (harvest and other uses).
- Harvest decisions and regulations are determined based on the escapement goals.
- These goals are well above levels that cause conservation concern.
- Thus actions (and concern) happens early.

Alaska’s Management Process

Knowledge of productivity

Escapement objective/
Management plan

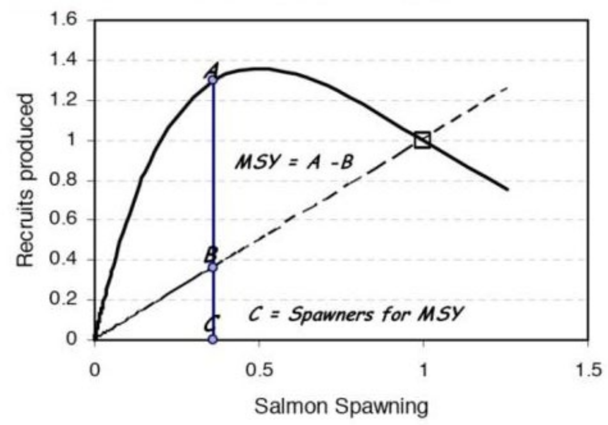
Manage harvests to achieve goal

Count escapement

Count harvest

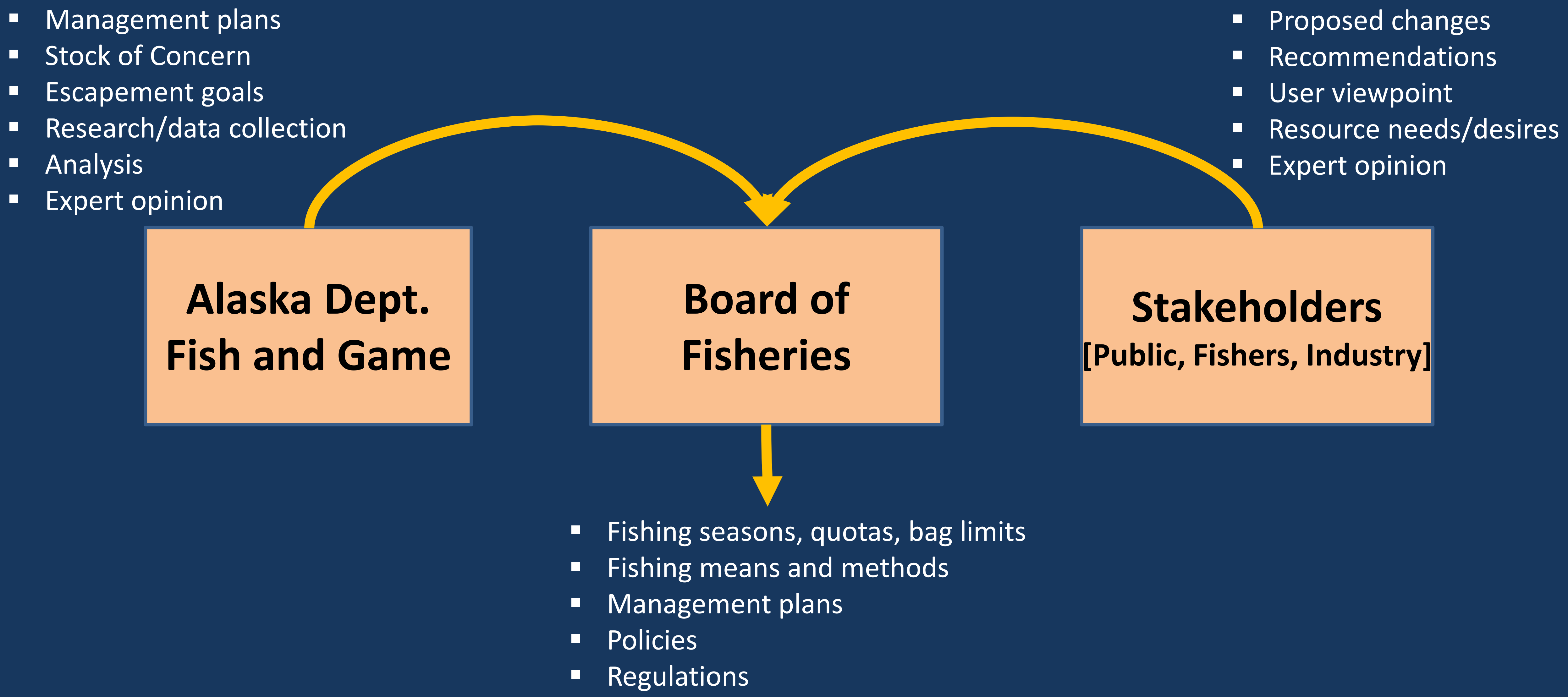
Segregate harvest

Measure success



Board of Fisheries Process

Ensures public access and local input



- Management plans
- Stock of Concern
- Escapement goals
- Research/data collection
- Analysis
- Expert opinion

- Proposed changes
- Recommendations
- User viewpoint
- Resource needs/desires
- Expert opinion

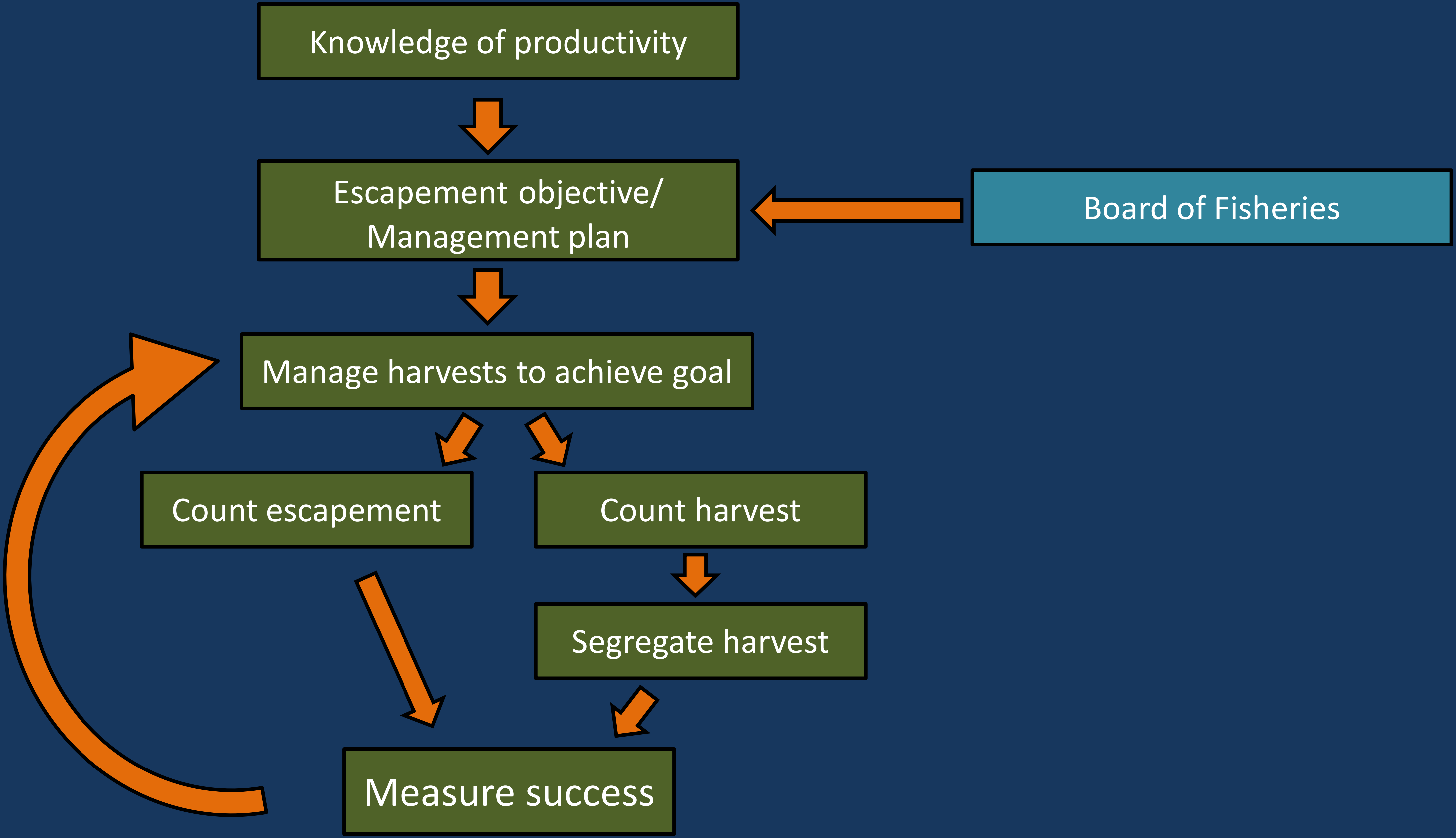
Alaska Dept. Fish and Game

Board of Fisheries

Stakeholders
[Public, Fishers, Industry]

- Fishing seasons, quotas, bag limits
- Fishing means and methods
- Management plans
- Policies
- Regulations

Alaska's Management Process



Knowledge of productivity

Escapement objective/ Management plan

Board of Fisheries

Manage harvests to achieve goal

Count escapement

Count harvest

Segregate harvest

Measure success

Sustainable Salmon Fisheries Management Policy

Principles

- Protect wild salmon and habitat
- Manage for escapement ranges that sustain production & consider uncertainty in production
- Develop effective management systems
- Precautionary approach to human activities
- Encourage public support and involvement
- Manage conservatively commensurate with uncertainty

Time Scales for Salmon Management

Data Timeseries

• Salmon catch	120 yrs
• Escapement	0 – 80 yrs
• Escapement goal	0 – 60 yrs

Salmon Lifecycle

• Chinook	2 – 7 yrs
• Chum	3 – 7 yrs
• Sockeye	3 – 6 yrs
• Coho	2 – 3 yrs
• Pink	2 yrs

Environmental Changes [AK examples]

• Glacial retreat	10s to 100s yrs
• Oceanic regimes	10+ yrs
• Marine heat waves	1 – 3 yrs

Regulatory Cycle

• Board of Fisheries	3 yrs
• Escapement Goal review	3 yrs
• Management Plan change	3 yrs

Assessment

• Escapement	Days to weeks
• Harvest	Days to weeks

Management of Fishery

• Season length	2 wk to 1 yr
• Inseason action	Days
• Harvest/fleet information	Daily

Strategic Initiatives in Alaska

Management is data intensive – assessment and research
  - Counting fish (escapement, harvest,…)
  - Tracking distribution/timing
  - Measuring age/size at return
  - Stock specific information (marking, tagging, genetics)

Local-scale
[Project]

Some issues require large-scale coordinated efforts
  - Statewide production trends, gauntlet fisheries, migration shifts
  - Multiple stocks, fisheries, and user groups involved

Expensive in funding and resources so need focus
  - Clear Goal
  - Achievable objectives
  - Answerable questions
  - Appropriate design

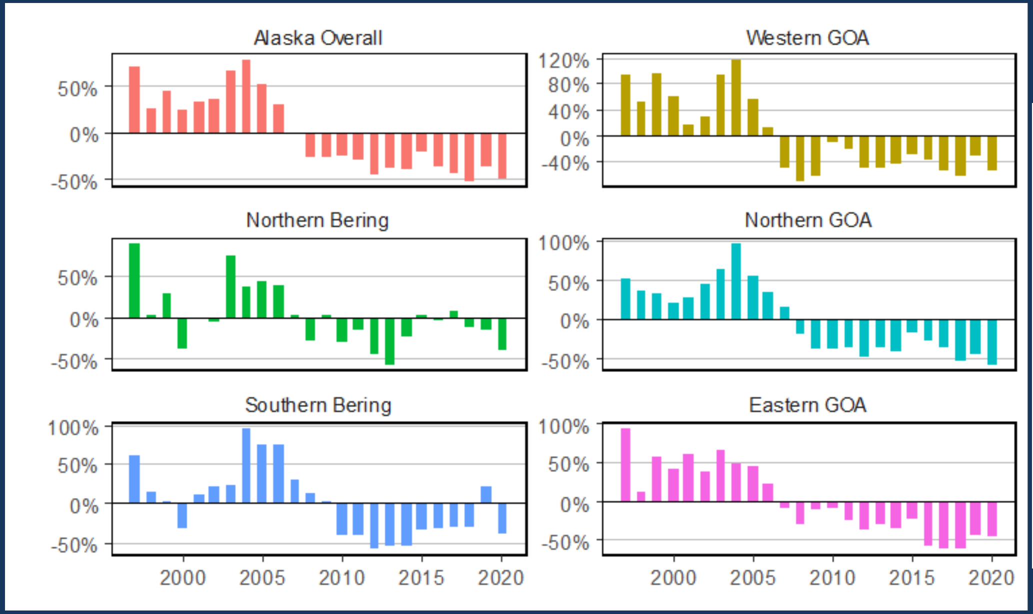
Thoughtful application to decision making

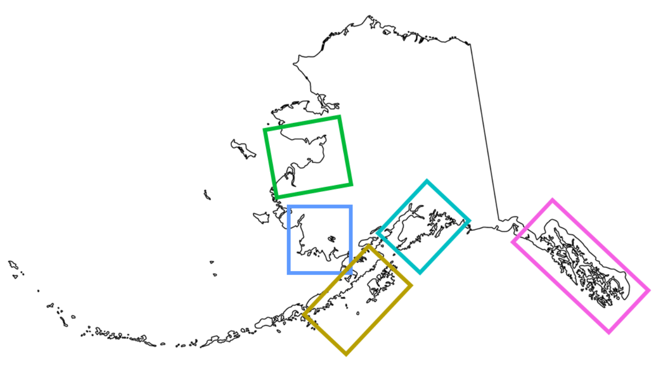
Wide-scale
[Initiative]

Types of Strategic Initiatives in Alaska

Assessment – Chinook Salmon Research Initiative [CSRI]

Statewide decline in Chinook salmon runs required a statewide approach to fill data gaps in assessing escapement, harvest and survival.





- 8 years
- 12 indicator stocks
- ADF&G & UAF
- US$ 15 million
- 20+ individual projects

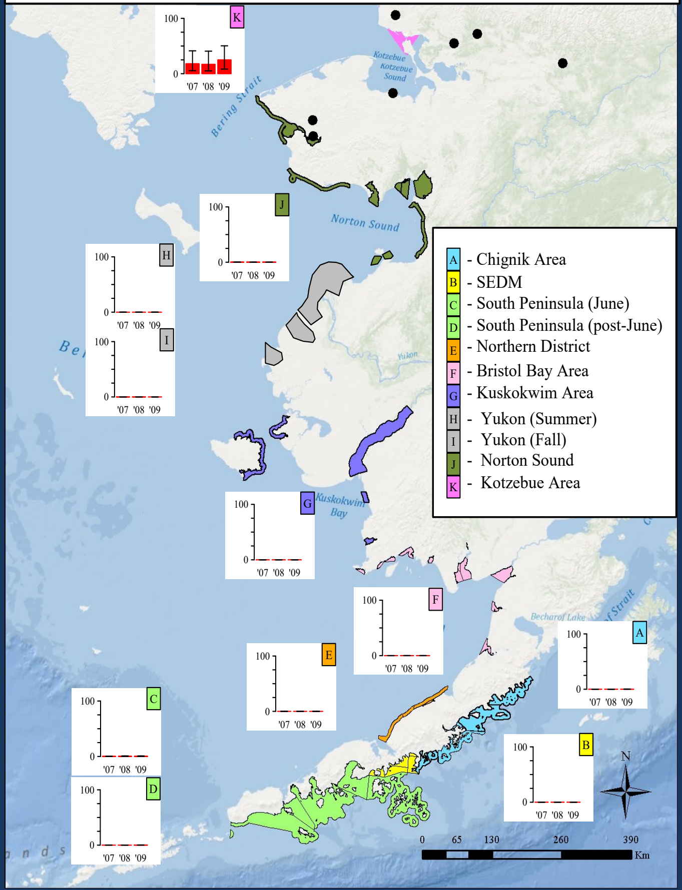
https://www.adfg.alaska.gov/index.cfm?adfg=chinookinitiative.main

Types of Strategic Initiatives in Alaska

Management – Western Alaska Salmon Stock Identification Program [WASSIP]

Low runs in western Alaska raised concern about allocation of salmon resources and harvest in distant fisheries.

Harvest rates on Kotzebue chum stocks in all fisheries from Chignik to Kotzebue Sound, 2007-2009



- 11 stakeholder groups on Advisory Panel
- 4 independent scientists on Technical Committee
- 2 species – sockeye, chum
- Coastwide genetic baselines developed
- All harvests sampled
- 250,000 samples collected/150,000 genotyped
- US $10 million
- 3 years of estimates; 7 years to complete and report

https://www.adfg.alaska.gov/index.cfm?adfg=wassip.main

Types of Strategic Initiatives in Alaska

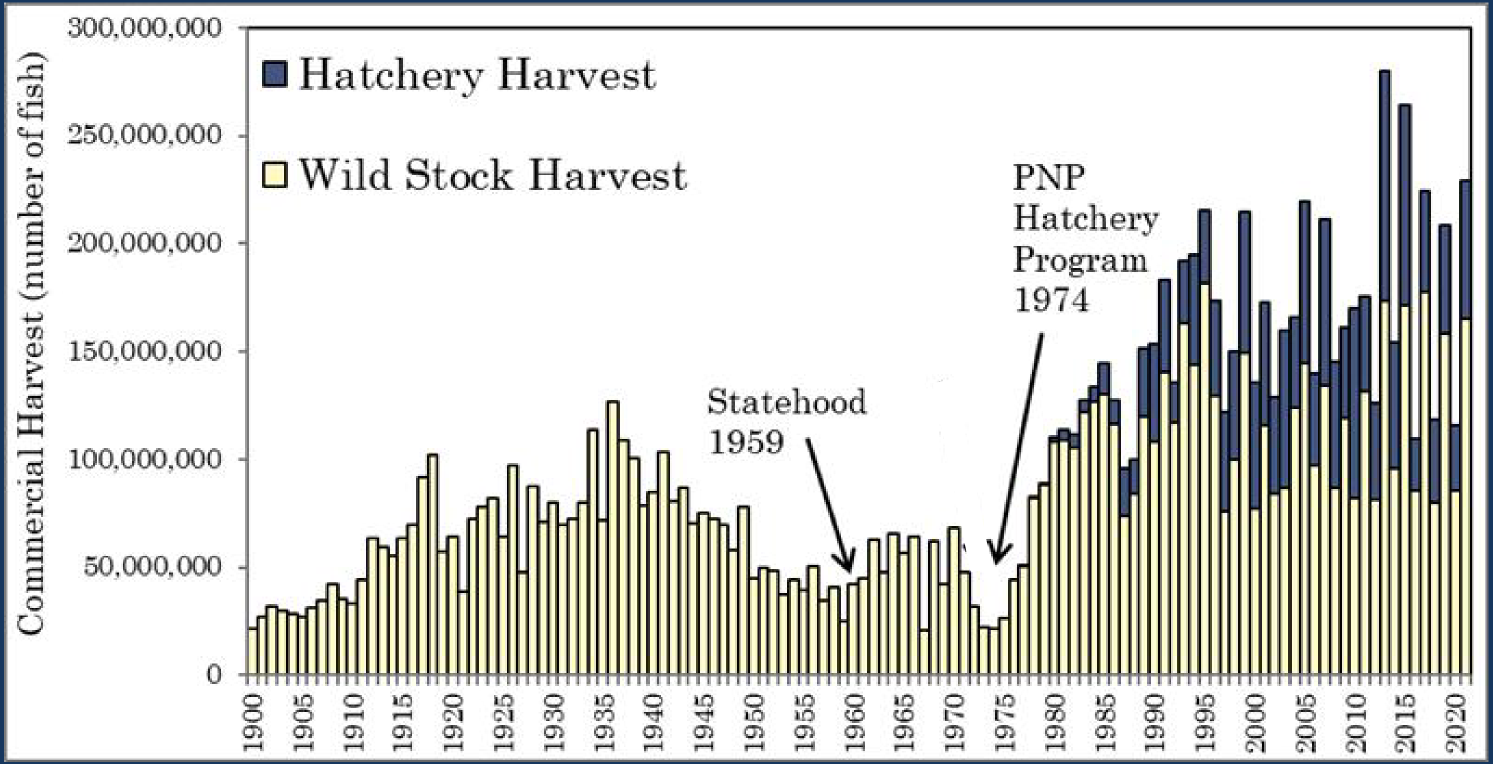
Enhancement – Alaska Hatchery Research Program/Hatchery-Wild Interactions Study [AHRP]

Concerns about interactions between hatchery and wild salmon and potential impact on wild salmon production was motivation for a comprehensive program to collect basic information.

https://www.adfg.alaska.gov/index.cfm?adfg=fishingHatcheriesResearch.main

Background

- Hatcheries began making substantial contributions to harvest in 1980’s
- Policies and statutes to protect wild fish developed early



Alaska commercial harvest of wild and hatchery salmon, 1900-2021

Vercessi (2022)

Background

Hatchery production largest contributor to pink and chum salmon harvest in PWS and chum salmon harvest in SEAK

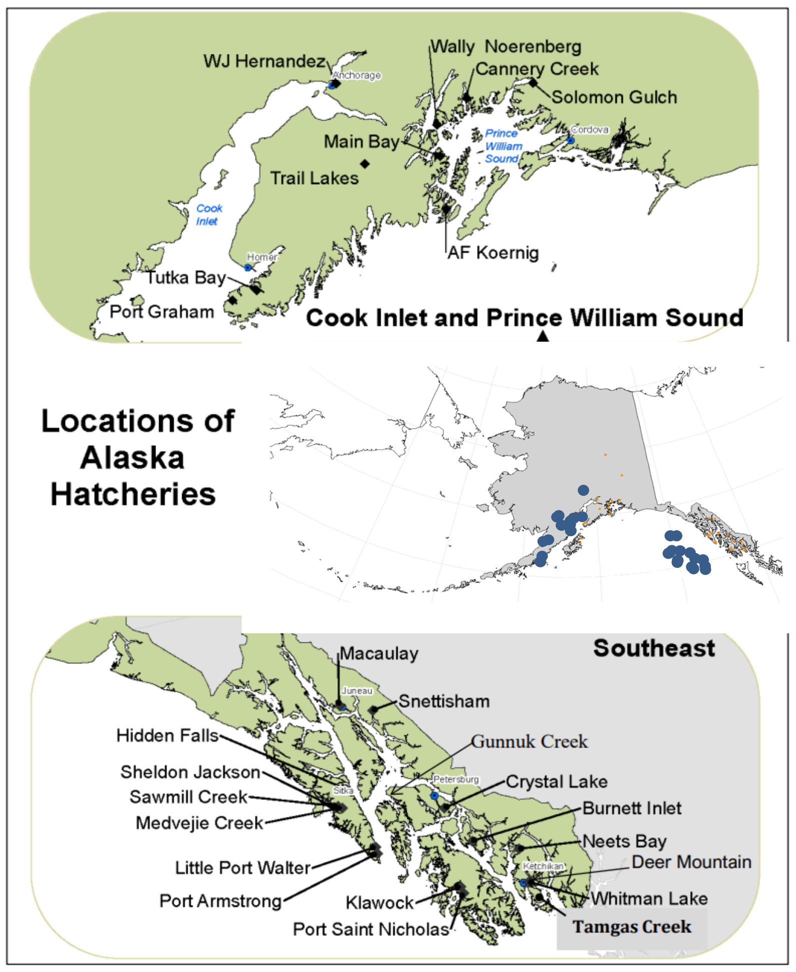


Figure 4.–Salmon hatcheries currently operating in Alaska.

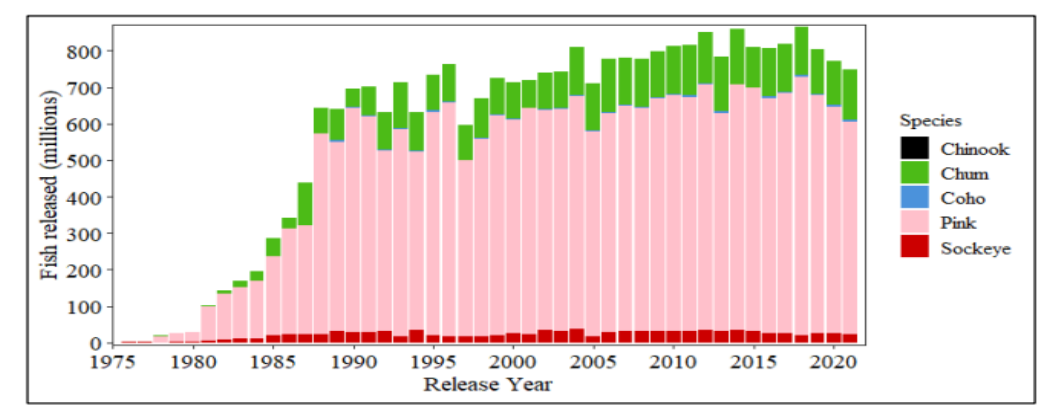


Figure 16.–Total salmon released for Prince William Sound Alaska hatchery programs, 1975–2021.

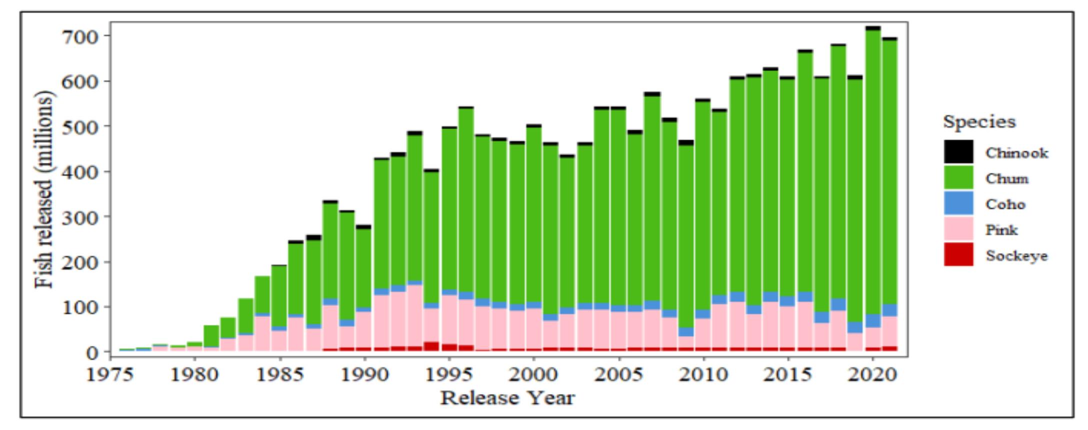


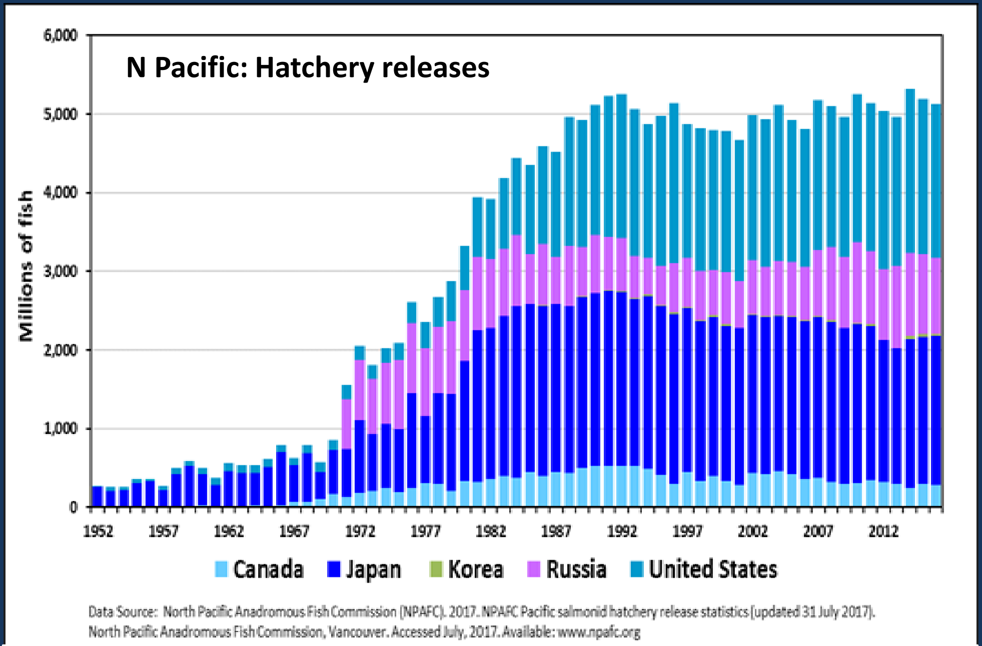
Figure 13.–Total salmon released for Southeast Alaska hatchery programs, 1975–2021.

Wilson, L. 2022. Alaska salmon fisheries enhancement annual report 2021. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 5J22-02, Juneau.

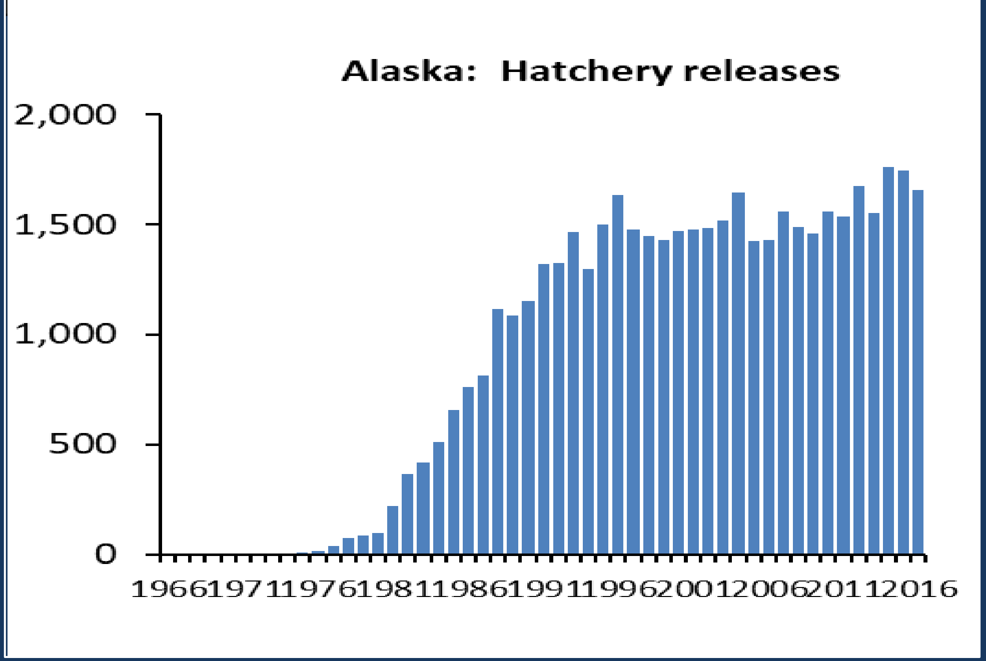
Background

Large-scale salmon releases raise concerns for wild stock impacts

- Do hatchery fish detrimentally affect productivity and sustainability of wild stocks?
- Alaska policy mandates sustainable productivity of wild stocks
- Not a new concern: Alaska first state to have a Genetics Policy in 1985



Data Source: North Pacific Anadromous Fish Commission (NPAFC). 2017. NPAFC Pacific salmonid hatchery release statistics (updated 31 July 2017). North Pacific Anadromous Fish Commission, Vancouver. Accessed July, 2017. Available: www.npafc.org



Protections for Wild Fish

- Management of Wild and Enhanced Stocks of Fish (AS 16.05.730)
  - *Fish stocks in the state shall be managed consistent with sustained yield of wild fish stocks*
- Policy for the Management of Mixed Stock Salmon Fisheries (5 AAC 39.220)
  - *...conservation of wild salmon stocks consistent with sustained yield shall be accorded the highest priority*
- Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222)
  - *Effects and interactions of introduced or enhanced salmon stocks on wild salmon stocks should be assessed*
  - *Wild salmon stocks and fisheries on those stocks should be protected from adverse impacts from artificial propagation and enhancement efforts*
- Alaska Salmon Hatchery and Enhancement Regulations (5 AAC 40.860)
  - *… hatchery does not significantly impact wild stocks in a negative manner.*

Protections for Wild Fish

ADF&G Genetics Policy (Davis et al., 1985)

- *priority will be given to protection of wild stocks from possible harmful interactions with introduced stocks.*
- Reduce gene flow from hatchery to wild

Pathology (5 AAC 41.010, 020; Meyers et al., 1988)

- Disease history, control and inspection

Fish Transport Permits (5AAC 41.005,010)

Published Hatchery/Natural Fitness Studies

Steelhead

433

Differential reproductive success of sympatric, naturally spawning hatchery and wild steelhead trout (*Oncorhynchus mykiss*) through the adult stage

Jennifer E. McLean, Paul Bentzen, and Thomas P. Quinn

MOLECULAR ECOLOGY

Molecular Ecology (2011) 20, 1860–1869 doi: 10.1111/j.1365-294X.2011.05058.x

Reduced reproductive success of hatchery coho salmon in the wild: insights into most likely mechanisms

VÉRONIQUE THÉRIAULT,* GREGORY R. MOYER,*[1] LAURA S. JACKSON,† MICHAEL S. BLOUIN‡ and MICHAEL A. BANKS*

Genetic Effects of Captive Breeding Cause a Rapid, Cumulative Fitness Decline in the Wild

Hitoshi Araki,* Becky Cooper, Michael S. Blouin

Pacific every year (7, 8). Although most of these hatchery programs are meant to produce fish for harvest, an increasing number of captive breeding programs are releasing fish to restore declining natural populations (8, 9). Hatchery fish breed in the wild, and many natural populations are affected by hatchery fish. The use of hatchery-reared fish as broodstock (parents of hatchery fish) for many generations has resulted in indi-

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Molecular Ecology (2007) 16, 953–966 doi: 10.1111/j.1365-294X.2006.03206.x

Effective population size of steelhead trout: influence of variance in reproductive success, hatchery programs, and genetic compensation between life-history forms

HITOSHI ARAKI,* ROBIN S. WAPLES,† WILLIAM R. ARDREN,*‡ BECKY COOPER* and MICHAEL S. BLOUIN*

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biology letters
Conservation biology

Biol. Lett. (2009) 5, 621–624
doi:10.1098/rsbl.2009.0315
Published online 10 June 2009

Carry-over effect of captive breeding reduces reproductive fitness of wild-born descendants in the wild

Hitoshi Araki*,†, Becky Cooper and Michael S. Blouin

with captive-bred organisms (supplementation) are not clear yet.

Any negative effects of captive breeding are especially relevant for salmonid species because of the worldwide decline of native salmonid populations and the huge scale of hatchery programmes to compensate for those losses. Firstly, there is scant evidence that adding captive-bred organisms has boosted the long-term productivity of wild salmonid populations (Fraser 2008). Secondly, supplementation of declining wild populations entails risks such as disease introductions, increased competition for resources, and genetic changes in the supplemented population (Waples & Drake 2004). The genetic risk results because artificial environments can select for captive-bred individuals that are maladapted to the natural environment (hereafter 'the wild'). For example, genetically-based

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Transactions of the American Fisheries Society

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/utaf20

Diminished Reproductive Success of Steelhead from a Hatchery Supplementation Program (Little Sheep Creek, Imnaha Basin, Oregon)

Ewann A. Berntson[a], Richard W. Carmichael[b], Michael W. Flesher[b], Eric J. Ward[c] & Paul Moran[c]

PNAS

Genetic adaptation to captivity can occur in a single generation

Mark R. Christie[a,1], Melanie L. Marine[a], Rod A. French[b], and Michael S. Blouin[a]

[a]Department of Zoology, Oregon State University, Corvallis, OR 97331-2914; and [b]Oregon Department of Fish and Wildlife, The Dalles, OR 97058-4364

Edited by Fred W. Allendorf, University of Montana, Missoula, MT, and accepted by the Editorial Board November 11, 2011 (received for review July 14, 2011)

Captive breeding programs are widely used for the conservation and restoration of threatened and endangered species. Nevertheless, captive-born individuals frequently have reduced fitness when have a high standing mutational load or spend many generations in captivity (9). Unintentional domestication selection, on the other hand, can rapidly reduce fitness in the wild, especially if

Chinook

North American Journal of Fisheries Management 28:1472–1485, 2008
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DOI: 10.1577/M07-195.1

[Article]

Use of Parentage Analysis to Determine Reproductive Success of Hatchery-Origin Spring Chinook Salmon Outplanted into Shitike Creek, Oregon

JASON BAUMSTEIGER[1]
U.S. Fish and Wildlife Service, 1440 Abernathy Creek Road, Longview, Washington 98632, USA

DAVID M. HAND* AND DOUGLAS E. OLSON
U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, 1211 Southeast Cardinal Court, Suite 100, Vancouver, Washington 98683, USA

ROBERT SPATEHOLTS[2] AND GEOFF FITZGERALD[3]
Confederated Tribes of the Warm Springs Reservation of Oregon, Department of Natural Resources, Warm Springs, Oregon 97761, USA

WILLIAM R. ARDREN[4]
U.S. Fish and Wildlife Service, Abernathy Fish Technology Center, 1440 Abernathy Creek Road, Longview, Washington 98632, USA

0:15 30 May 2014

1840

Factors influencing the relative fitness of hatchery and wild spring Chinook salmon (*Oncorhynchus tshawytscha*) in the Wenatchee River, Washington, USA

Kevin S. Williamson, Andrew R. Murdoch, Todd N. Pearsons, Eric J. Ward, and Michael J. Ford

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MOLECULAR ECOLOGY

Molecular Ecology (2012) 21, 5236–5250 doi: 10.1111/mec.12046

Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon

MAUREEN A. HESS,* CRAIG D. RABE,† JASON L. VOGEL,‡ JEFF J. STEPHENSON,* DOUG D. NELSON† and SHAWN R. NARUM*

Evolutionary Applications Open Access

Evolutionary Applications ISSN 1752-4571

ORIGINAL ARTICLE

Reproductive success of captively bred and naturally spawned Chinook salmon colonizing newly accessible habitat

Joseph H. Anderson,[1,3,*] Paul L. Faulds,[2] William I. Atlas[1,4] and Thomas P. Quinn[1]

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[2] Seattle Public Utilities, Seattle, WA, USA
[3] Present address: Northwest Fisheries Science Center, National Marine Fisheries Service Seattle, WA, USA
[4] Present address: Department of Biological Sciences, Simon Fraser University Burnaby, BC, Canada

Keywords
conservation, dams, hatchery, natural selection, pedigree, reintroduction, sexual selection

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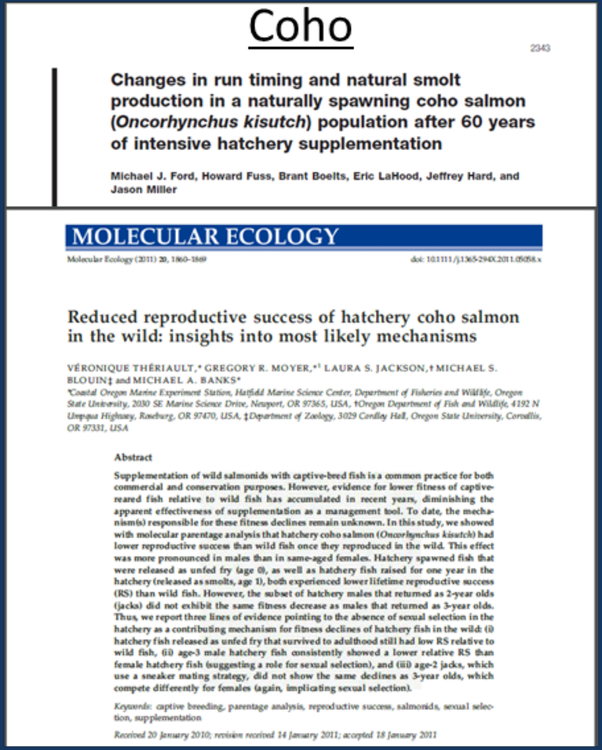
Received: 23 March 2012
Accepted: 2 April 2012

doi:10.1111/j.1752-4571.2012.00271.x

Abstract

Captively reared animals can provide an immediate demographic boost in reintroduction programs, but may also reduce the fitness of colonizing populations. Construction of a fish passage facility at Landsburg Diversion Dam on the Cedar River, WA, USA, provided a unique opportunity to explore this trade-off. We thoroughly sampled adult Chinook salmon (*Oncorhynchus tshawytscha*) at the onset of colonization (2003–2009), constructed a pedigree from genotypes at 10 microsatellite loci, and calculated reproductive success (RS) as the total number of returning adult offspring. Hatchery males were consistently but not significantly less productive than naturally spawned males (range in relative RS: 0.70–0.90), but the pattern for females varied between years. The sex ratio was heavily biased toward males; therefore, inclusion of the hatchery males increased the risk of a genetic fitness cost with little demographic benefit. Measurements of natural selection indicated that larger salmon had higher RS than smaller fish. Fish that arrived early to the spawning grounds tended to be more productive than later fish, although in some years, RS was maximized at intermediate dates. Our results underscore the importance of natural and sexual selection in promoting adapta-



Coho

2343

Changes in run timing and natural smolt production in a naturally spawning coho salmon (*Oncorhynchus kisutch*) population after 60 years of intensive hatchery supplementation

Michael J. Ford, Howard Fuss, Brant Boelts, Eric LaHood, Jeffrey Hard, and Jason Miller

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MOLECULAR ECOLOGY

Molecular Ecology (2011) 20, 1860–1869 doi: 10.1111/j.1365-294X.2011.05058.x

Reduced reproductive success of hatchery coho salmon in the wild: insights into most likely mechanisms

VÉRONIQUE THÉRIAULT,* GREGORY R. MOYER,*[1] LAURA S. JACKSON,† MICHAEL S. BLOUIN‡ and MICHAEL A. BANKS*

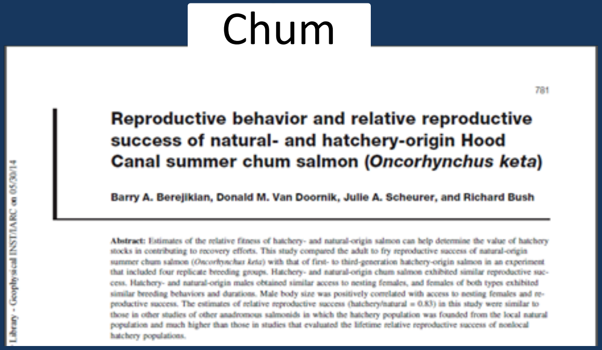
**Coastal Oregon Marine Experiment Station, Hatfield Marine Science Center, Department of Fisheries and Wildlife, Oregon State University, 2030 SE Marine Science Drive, Newport, OR 97365, USA, †Oregon Department of Fish and Wildlife, 4192 N Umpqua Highway, Roseburg, OR 97470, USA, ‡Department of Zoology, 3029 Cordley Hall, Oregon State University, Corvallis, OR 97331, USA*

Abstract

Supplementation of wild salmonids with captive-bred fish is a common practice for both commercial and conservation purposes. However, evidence for lower fitness of captive-reared fish relative to wild fish has accumulated in recent years, diminishing the apparent effectiveness of supplementation as a management tool. To date, the mechanism(s) responsible for these fitness declines remain unknown. In this study, we showed with molecular parentage analysis that hatchery coho salmon (*Oncorhynchus kisutch*) had lower reproductive success than wild fish once they reproduced in the wild. This effect was more pronounced in males than in same-aged females. Hatchery spawned fish that were released as unfed fry (age 0), as well as hatchery fish raised for one year in the hatchery (released as smolts, age 1), both experienced lower lifetime reproductive success (RS) than wild fish. However, the subset of hatchery males that returned as 2-year olds (jacks) did not exhibit the same fitness decrease as males that returned as 3-year olds. Thus, we report three lines of evidence pointing to the absence of sexual selection in the hatchery as a contributing mechanism for fitness declines of hatchery fish in the wild: (i) hatchery fish released as unfed fry that survived to adulthood still had low RS relative to wild fish, (ii) age-3 male hatchery fish consistently showed a lower relative RS than female hatchery fish (suggesting a role for sexual selection), and (iii) age-2 jacks, which use a sneaker mating strategy, did not show the same declines as 3-year olds, which compete differently for females (again, implicating sexual selection).

Keywords: captive breeding, parentage analysis, reproductive success, salmonids, sexual selection, supplementation

Received 20 January 2010; revision received 14 January 2011; accepted 18 January 2011



Chum

781

Reproductive behavior and relative reproductive success of natural- and hatchery-origin Hood Canal summer chum salmon (*Oncorhynchus keta*)

Barry A. Berejikian, Donald M. Van Doornik, Julie A. Scheurer, and Richard Bush

Abstract: Estimates of the relative fitness of hatchery- and natural-origin salmon can help determine the value of hatchery stocks in contributing to recovery efforts. This study compared the adult to fry reproductive success of natural-origin summer chum salmon (*Oncorhynchus keta*) with that of first- to third-generation hatchery-origin salmon in an experiment that included four replicate breeding groups. Hatchery- and natural-origin chum salmon exhibited similar reproductive success. Hatchery- and natural-origin males obtained similar access to nesting females, and females of both types exhibited similar breeding behaviors and durations. Male body size was positively correlated with access to nesting females and reproductive success. The estimates of relative reproductive success (hatchery/natural = 0.83) in this study were similar to those in other studies of other anadromous salmonids in which the hatchery population was founded from the local natural population and much higher than those in studies that evaluated the lifetime relative reproductive success of nonlocal hatchery populations.

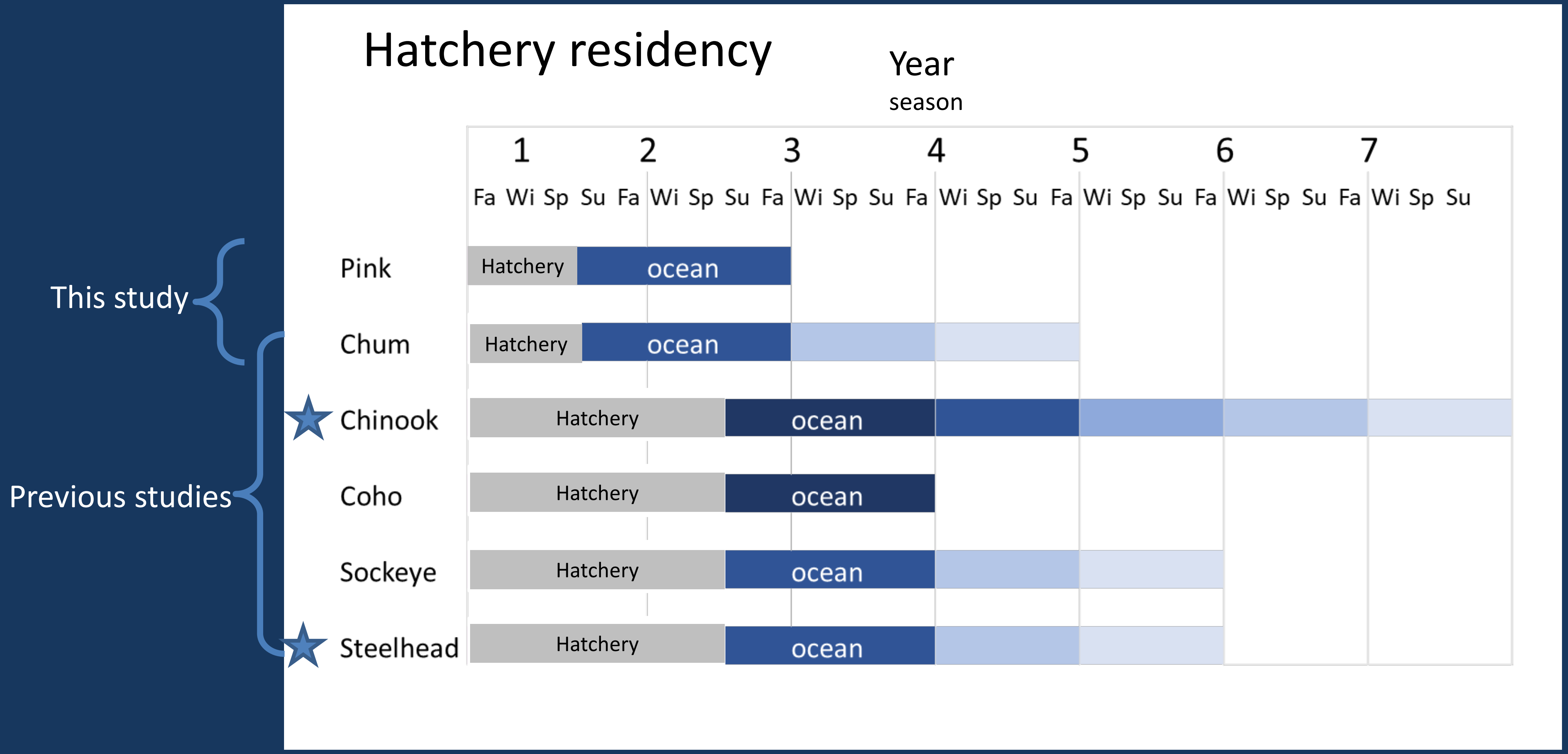
Hatchery/Natural Fitness

Difficulty with Applying Previous Studies

- Species with different life histories
- No studies in Alaska
- Different context: e.g., compromised habitats
- Non-local and small brood stock population sizes
- Different hatchery objectives (harvest vs mitigation)
- Different hatchery practices

Hatchery/Natural Fitness

Different Time in Hatchery Setting



Background

Plan:

PNPs proposed that ADF&G organize science panel to design/implement a research project to inform resource management decisions

Funding partnership:

State, Operators & Industry

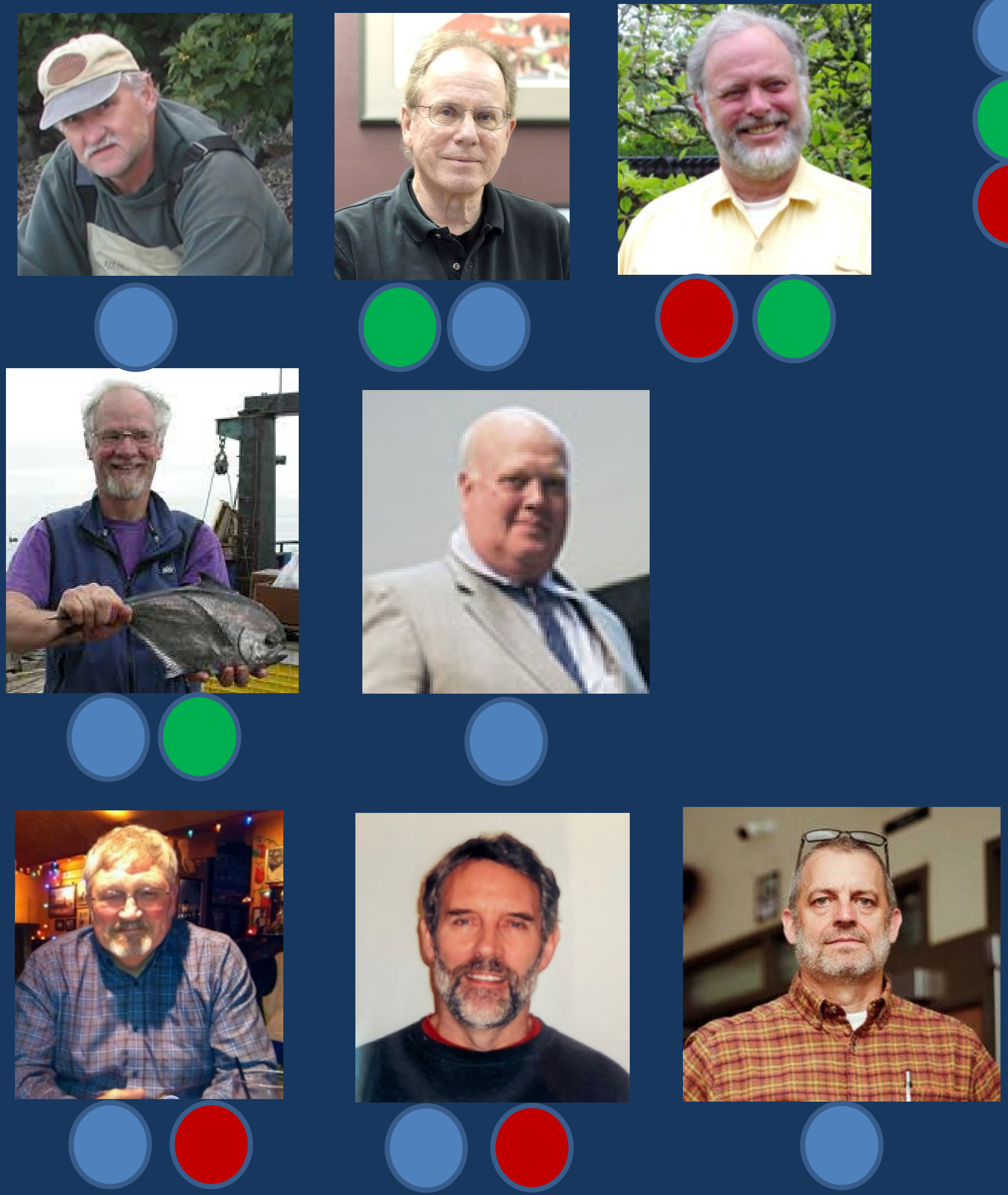
Purpose:

Examine potential effect of hatchery straying on fitness of wild stocks

- Pink and chum salmon PWS
- Chum salmon SEAK

Assemble Science Panel

Members since inception

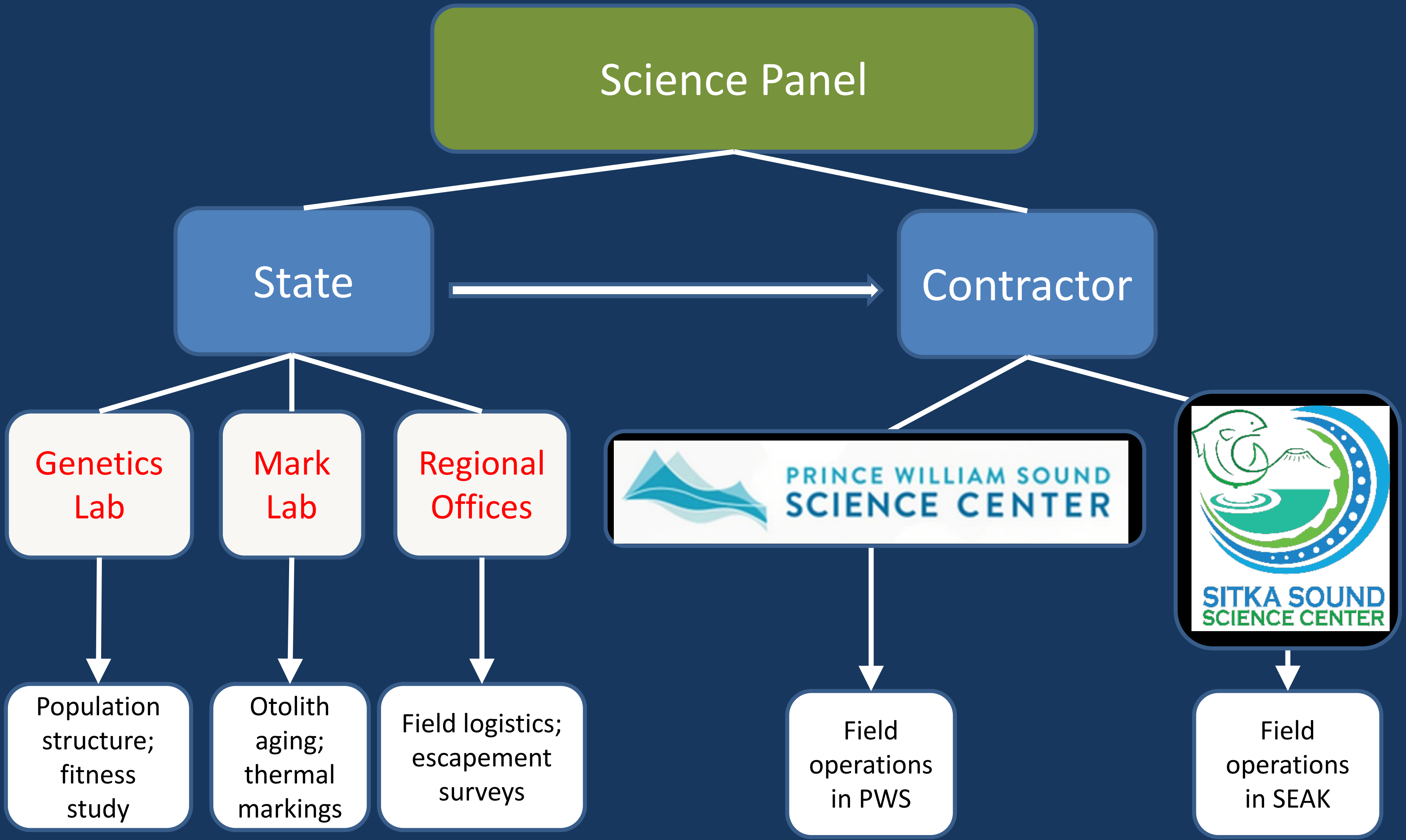


🔵 Government (state, federal)
🟢 Industry (hatcheries, processors)
🔴 University

Past members

Added members

Planning: Program Structure



Science Panel

State

Contractor

Genetics Lab

Mark Lab

Regional Offices

PRINCE WILLIAM SOUND SCIENCE CENTER

SITKA SOUND SCIENCE CENTER

Population structure; fitness study

Otolith aging; thermal markings

Field logistics; escapement surveys

Field operations in PWS

Field operations in SEAK

Funding Sources

THE SEAL OF THE STATE OF ALASKA

CFEC

VFDA

Prince William Sound Aquaculture Corporation
DEVELOPING SUSTAINABLE SALMON FISHERIES FOR ALASKA AND THE WORLD

PACIFIC SALMON COMMISSION

DIPAC

Cook Inlet AQUACULTURE ASSOCIATION

IDAHO · OREGON · ALASKA
PACIFIC STATES MARINE FISHERIES COMMISSION
WASHINGTON · CALIFORNIA

KODIAK REGIONAL AQUACULTURE ASSOCIATION

NOAA FISHERIES

PSPA
PACIFIC SEAFOOD PROCESSORS ASSOCIATION

SSRAA

NSRAA

NORTH PACIFIC RESEARCH BOARD

Anticipated total:
US$ 17M

Three Priority Questions

Start with questions that are fundamental, achievable and can be answered with scientific methods.

1. What is the genetic stock structure of pink and chum salmon in each region?

2. What is the extent and annual variability in straying of hatchery pink salmon in Prince William Sound (PWS) and chum salmon in PWS and Southeast Alaska (SEAK)?

3. What is the impact on fitness (productivity) of wild pink and chum salmon stocks due to straying of hatchery pink and chum salmon?

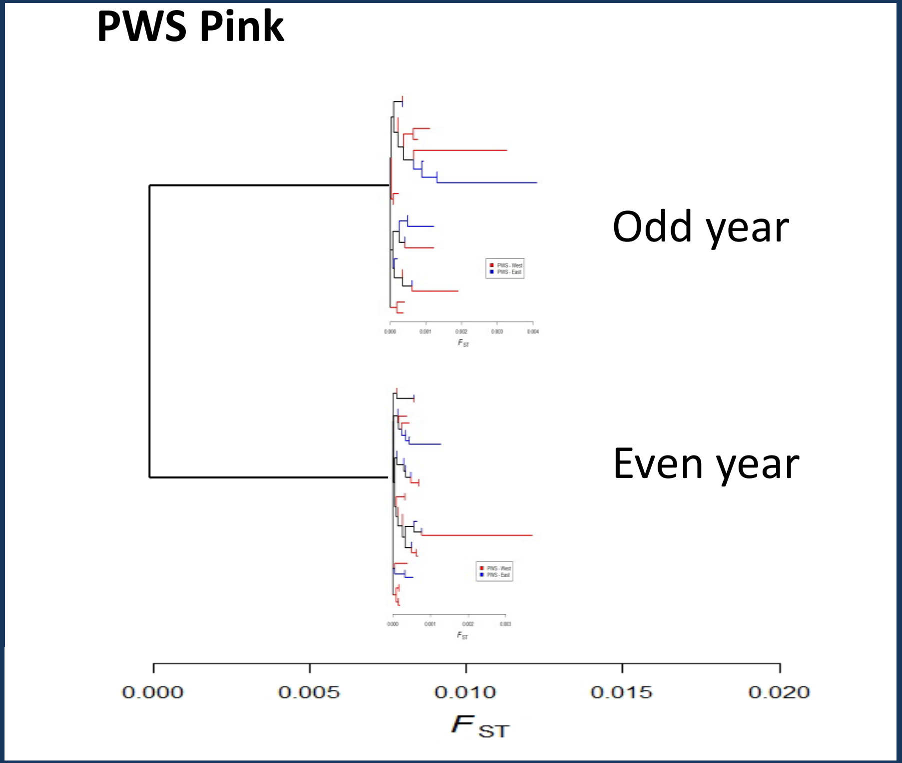
Question 1 Results

Question 1. What is the genetic stock structure of pink and chum salmon in each region?

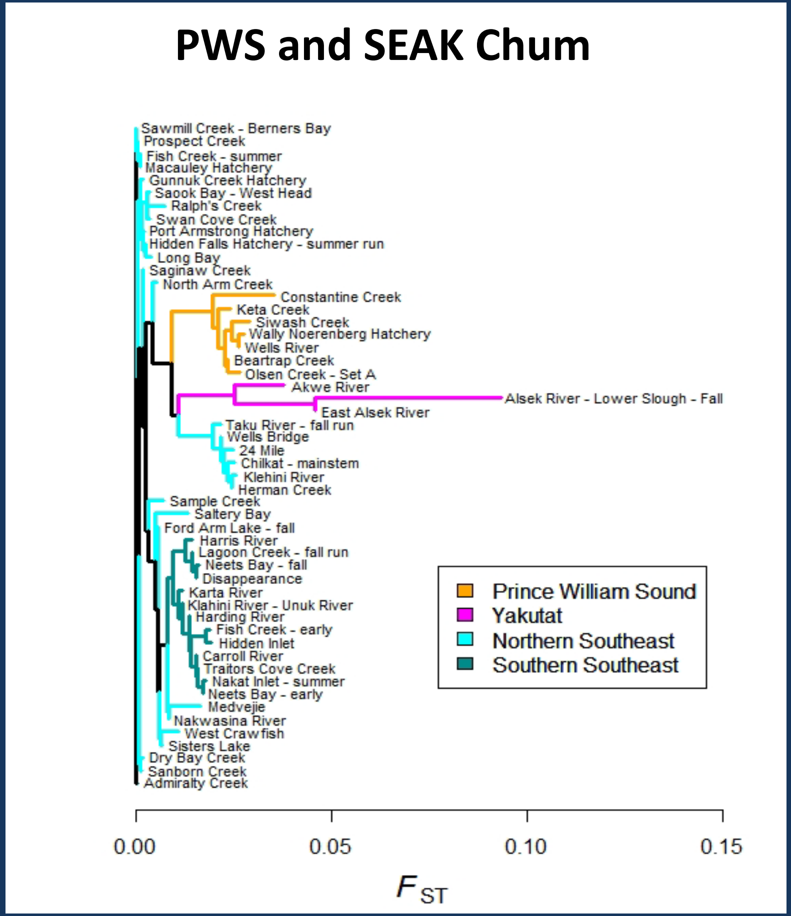
Population structure exists and is shallower in pink than in chum

Drivers of structure:

- Pinks: even vs odd; deeper structure in odd lineages
- Chums: run timing, geography



PWS Pink

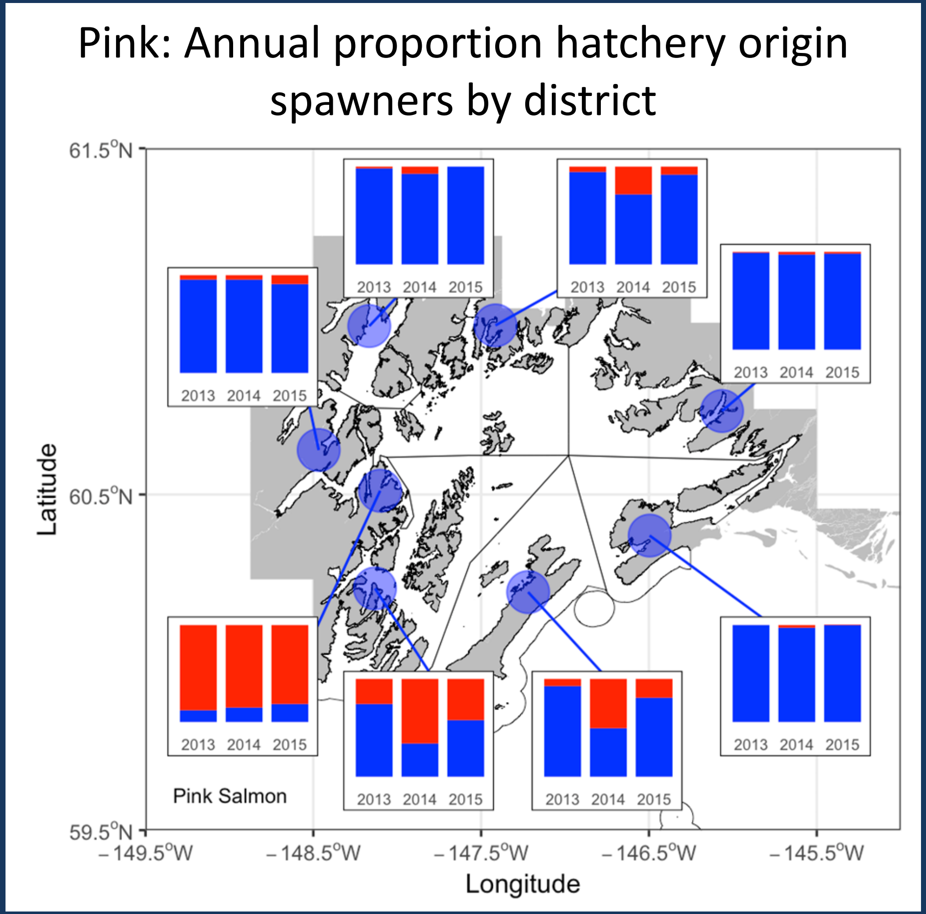


PWS and SEAK Chum

Question 2 Results

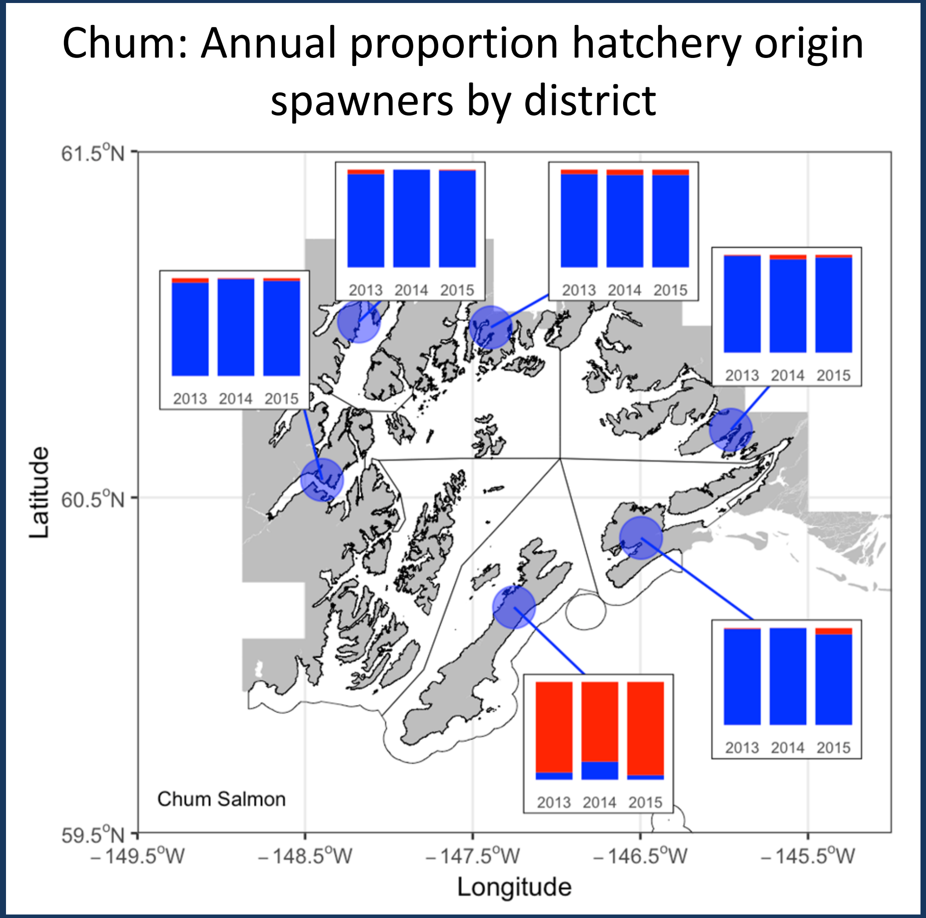
Question 2. What is the extent and annual variability in straying of hatchery pink salmon in Prince William Sound (PWS) and chum salmon in PWS and Southeast Alaska (SEAK)?

Prince William Sound



Pink: Annual proportion hatchery origin spawners by district

Regional annual PHOS estimates:
Pink: 5% - 15%
Chum: 3% - 9%



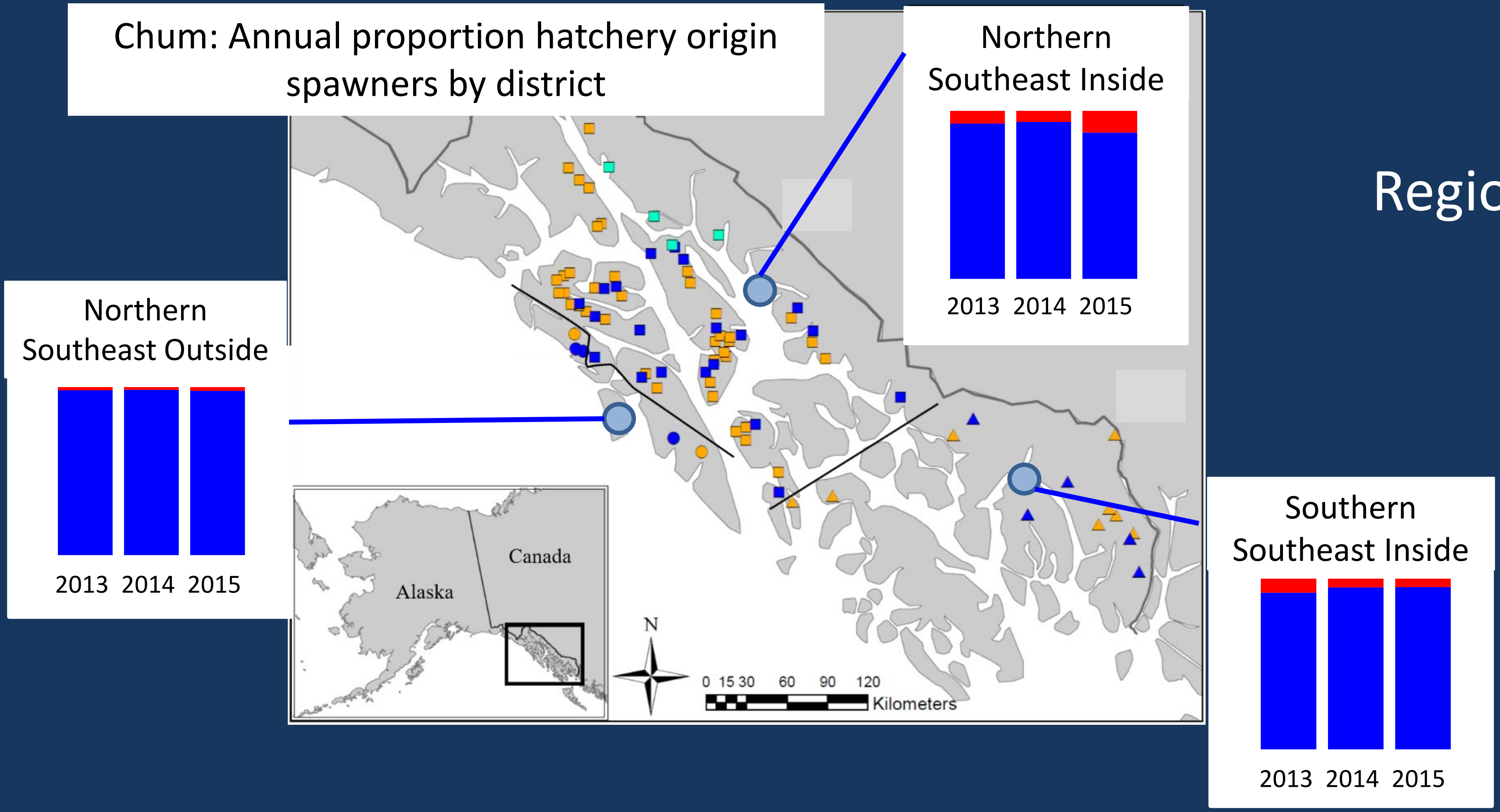
Chum: Annual proportion hatchery origin spawners by district

Knudsen, E.E., Rand, P.S., Gorman, K.B., Bernard, D.R. and Templin, W.D., 2021. Hatchery-origin stray rates and total run characteristics for Pink Salmon and Chum Salmon returning to Prince William Sound, Alaska, in 2013–2015. *Marine and Coastal Fisheries*, *13*(1), pp.41-68.

Question 2 Results

Question 2. What is the extent and annual variability in straying of hatchery pink salmon in Prince William Sound (PWS) and chum salmon in PWS and Southeast Alaska (SEAK)?

Southeast Alaska

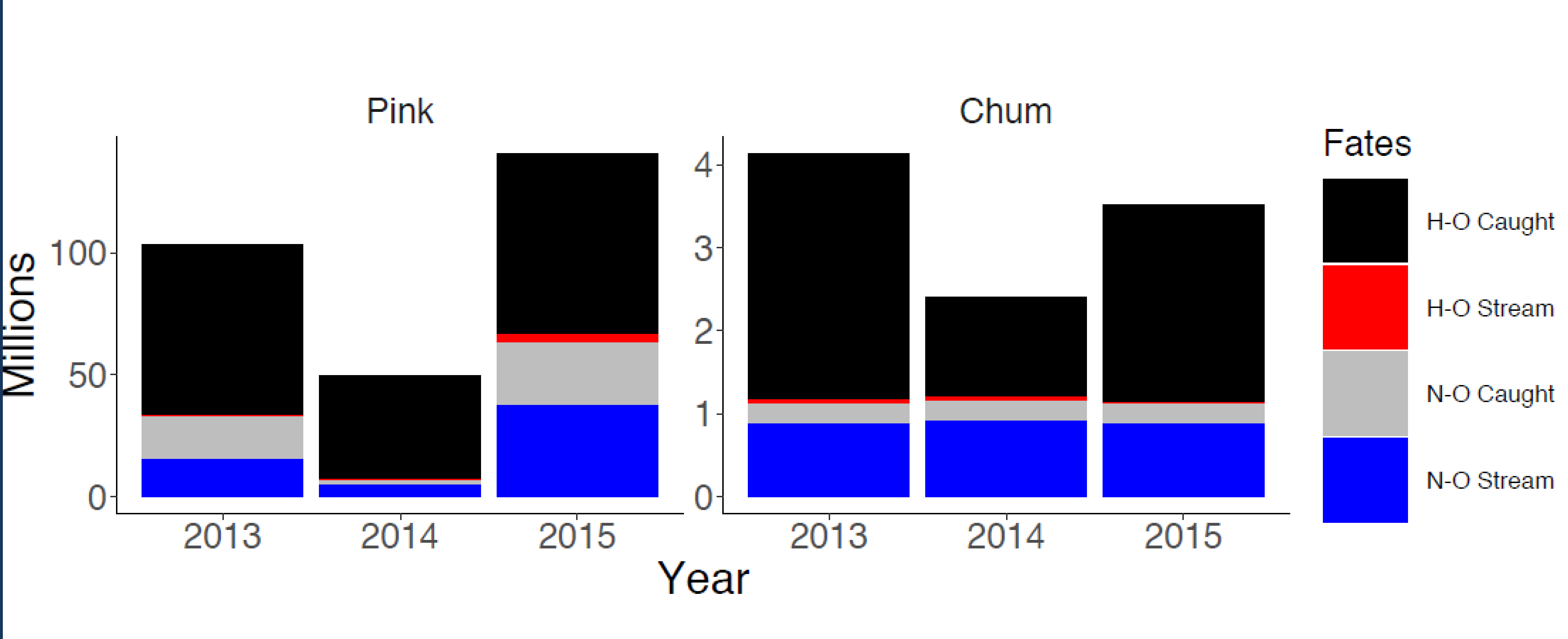

Chum: Annual proportion hatchery origin spawners by district

Regional annual PHOS estimates:
1.6% - 8.1%

Josephson, R., et al. "Proportions of Hatchery Fish in Escapements of Summer-Run Chum Salmon in Southeast Alaska, 2013–2015." *North American Journal of Fisheries Management* 41.3 (2021): 724-738.

Question 2 Results

Run Estimation: PWS Pink and Chum



Question 2 Results

Key Metrics from Run Estimation

Harvest rate on natural-origin Pink and Chum Salmon:

Species	2013	2014	2015
Pink	52.6%	26.3%	40.2%
Chum	21.6%	21.3%	21.1%

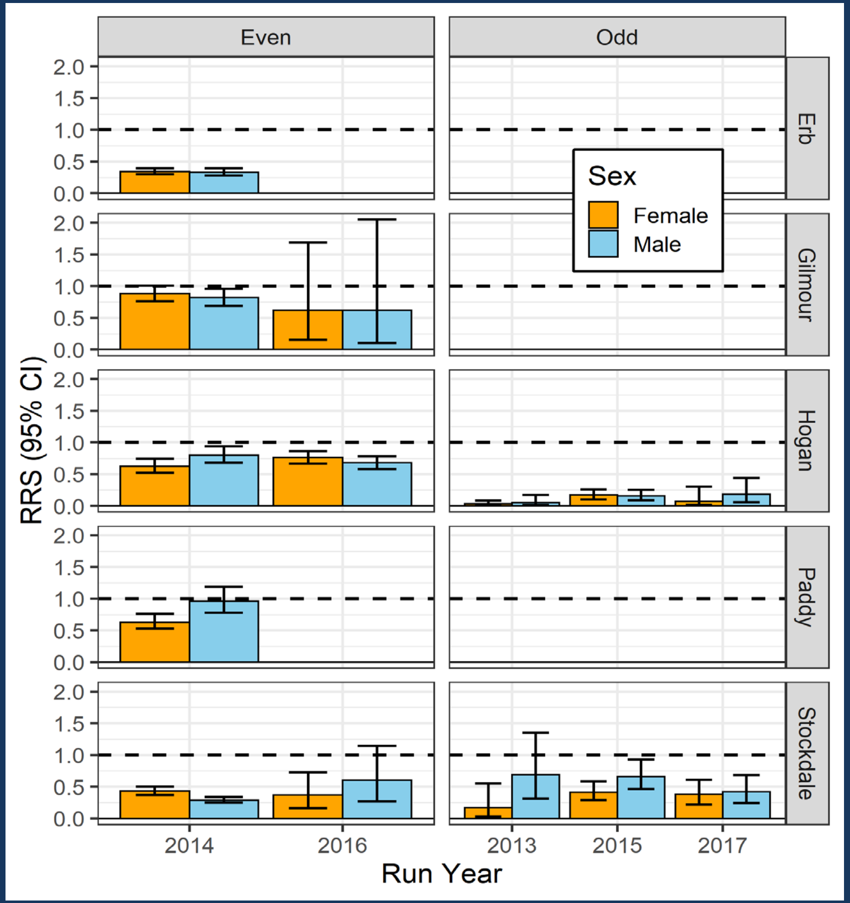
Hatchery donor stray rate of Pink and Chum Salmon:

Species	2013	2014	2015
Pink	1.0%	1.7%	5.2%
Chum	1.6%	4.0%	1.1%

Question 3 Results

3. What is the impact on fitness (productivity) of wild pink and chum salmon stocks due to straying of hatchery pink and chum salmon?

PWS: Pink



Constructing parent/offspring relationships from samples from spawner carcasses in 5 study streams over 3 generations for both Even and Odd year lines.

PWS pink salmon:

- Hatchery fish have lower fitness (productivity) in natural streams
- High variation; 50% RRS average
- Not all streams/brood years analyzed

SEAK Chum salmon:

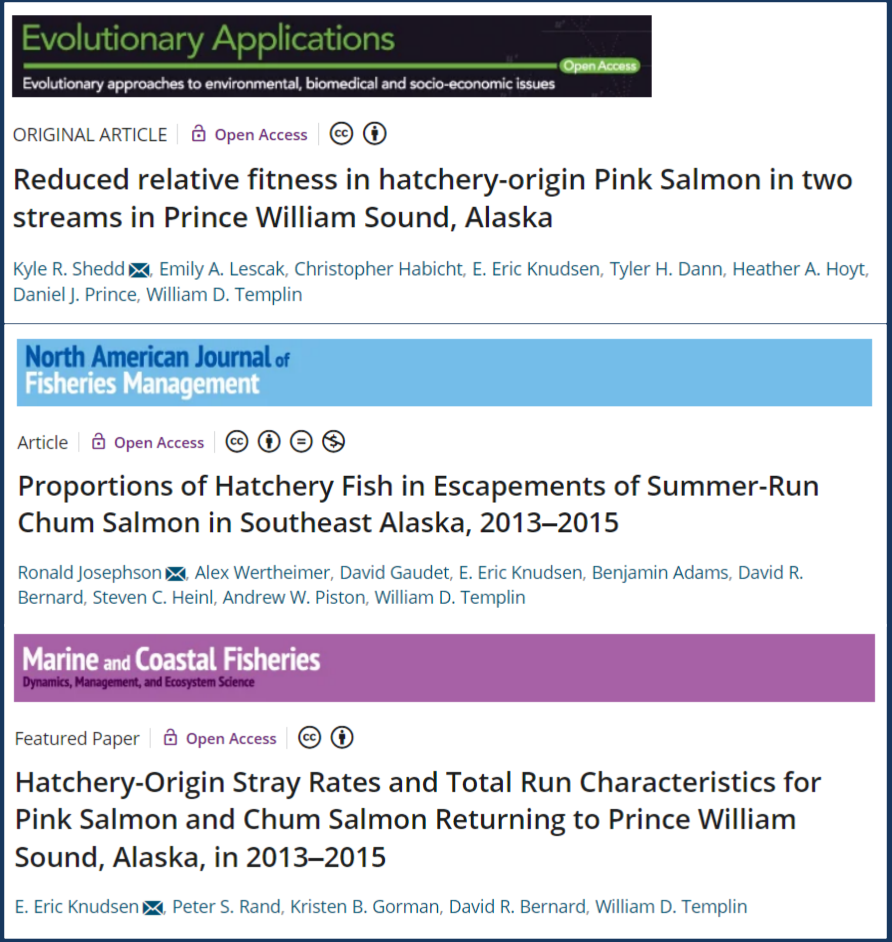
- Last year of field sampling 2023
- No analysis yet

Shedd, K.R., Lescak, E.A., Habicht, C., Knudsen, E.E., Dann, T.H., Hoyt, H.A., Prince, D.J. and Templin, W.D., 2022. Reduced relative fitness in hatchery-origin Pink Salmon in two streams in Prince William Sound, Alaska. *Evolutionary applications*, *15*(3), pp.429-446.

Communication of Results

Public, regulatory, and professional contexts

Peer-reviewed Journal Publications



Evolutionary Applications

Evolutionary approaches to environmental, biomedical and socio-economic issues

Open Access

ORIGINAL ARTICLE | Open Access | 🅭 🅯

Reduced relative fitness in hatchery-origin Pink Salmon in two streams in Prince William Sound, Alaska

Kyle R. Shedd ✉, Emily A. Lescak, Christopher Habicht, E. Eric Knudsen, Tyler H. Dann, Heather A. Hoyt, Daniel J. Prince, William D. Templin

North American Journal of Fisheries Management

Article | Open Access | 🅭 🅯 ⊜ 🄏

Proportions of Hatchery Fish in Escapements of Summer-Run Chum Salmon in Southeast Alaska, 2013–2015

Ronald Josephson ✉, Alex Wertheimer, David Gaudet, E. Eric Knudsen, Benjamin Adams, David R. Bernard, Steven C. Heinl, Andrew W. Piston, William D. Templin

Marine and Coastal Fisheries

Dynamics, Management, and Ecosystem Science

Featured Paper | Open Access | 🅭 🅯

Hatchery-Origin Stray Rates and Total Run Characteristics for Pink Salmon and Chum Salmon Returning to Prince William Sound, Alaska, in 2013–2015

E. Eric Knudsen ✉, Peter S. Rand, Kristen B. Gorman, David R. Bernard, William D. Templin

State of Alaska Website

Hatcheries Research

Overview

In 1971, the State of Alaska initiated its modern salmon fishery enhancement program in response to severely depressed commercial salmon fisheries. Protection of wild stocks has been foremost since the inception of the program and statutes, regulations, and policies are in place to provide for this

https://www.adfg.alaska.gov/index.cfm?adfg=fishingHatcheriesResearch.main

Public, Regulatory, Professional Meetings:

- 5 public information
- 5 Board of Fisheries
- 10 professional scientific

Application of Science to Policy

The AHRP is providing valuable biological information for understanding the interaction between hatchery and wild pink and chum salmon.

- Scientifically answerable questions
- Appropriate study design

However, more than biology must be considered when making decisions about salmon resources:

1) Biological, 2) Social, 3) Economic, and 4) Cultural

The interface of science and policy is where scientific knowledge is incorporated into belief/value systems to provide a bridge for decision making.

Application of Science to Policy

Some questions that are not addressed by AHRP

- What are the competition and predation effects of hatchery fish?
  - Within and across species
  - Within marine and freshwater habitats
- Do hatchery fish reduce genetic resilience of wild populations?
- If changes in productivity are observed, what mechanisms could be driving these differences?
- How do these hatchery fish in wild systems affect assessment of escapement?
- How will findings affect policy?

Application of Science to Policy

Applications may not be straightforward

Example: Many mechanisms may drive measured RRS

Many generations
(e.g. genetic)

One generation
(e.g. non-genetic)

Relaxation of natural selection

Domestication selection

Genetic drift

Broodstock incompatibility

Mate selection

Epigenetics

Spawning ground familiarity

Run timing-associated variables

- Fishery prosecution
- Spawning ground competition
- Straying fish delays

Application of Science to Policy

Proposed Model for Science – Policy Dialogue

<u>Questions for Prudential Judgment</u>

1. Does an event occur?	**Observe**
2. How often and to what extent? 3. Does the event have an effect?	**Measure/ Experiment**
4. Is the effect harmful?	**Compare to standard**
5. Would addressing the harm cost more than it would benefit?	**Collate/ Evaluate**

Any Questions?

Muir Glacier - Adrian Spidle