Enhancement Related Research

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Alaska Department of Fish and Game

March 14, 2019

Constitutional Provision for Sustained Yield

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.

It must be recognized that the welfare of people and not fish is the [reason] for a management program, and that if maximum sustained yield has any validity, it is as a means to important human ends rather than as an end in itself.

RA Cooley in *Politics and Conservation: The decline of Alaska salmon*

Working definitions

<u>Sustainable development</u>

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

- Brundtland Commission, UN 1987

Can substitute "fishery" for "development" in this definition

United Nations. 1987. "Report of the World Commission on Environment and Development." General Assembly Resolution 42/187, 11 December 1987.

Policy for the management of sustainable salmon fisheries 5 AAC 39.222(c)(5)

(5) in the face of uncertainty, salmon stocks, fisheries, artificial propagation, and essential habitats shall be managed conservatively as follows:

(A) a precautionary approach, involving the application of prudent foresight that takes into account the uncertainties in salmon fisheries and habitat management, the biological, social, cultural, and economic risks, and the need to take action with incomplete knowledge, should be applied to the regulation and control of harvest and other human-induced sources of salmon mortality; a precautionary approach requires

(i) consideration of the needs of future generations and avoidance of potentially irreversible changes;

(ii) prior identification of undesirable outcomes and of measures that will avoid undesirable outcomes or correct them promptly;

(iii) initiation of any necessary corrective measure without delay and prompt achievement of the measure's purpose, on a time scale not exceeding five years, which is approximately the generation time of most salmon species;

(iv) that where the impact of resource use is uncertain, but likely presents a measurable risk to sustained yield, priority should be given to conserving the productive capacity of the resource;

(v) appropriate placement of the burden of proof, of adherence to the requirements of this subparagraph, on those plans or ongoing activities that pose a risk or hazard to salmon habitat or production;

(B) a precautionary approach should be applied to the regulation of activities that affect essential salmon habitat.

Working definitions

Precautionary Principle — Rule or Standard

When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm.

- COMEST/UESCO

Precautionary Approach — Method

A set of agreed cost-effective measures and actions, including future courses of action, which ensures prudent foresight, reduces or avoids risk to the resources, the environment, and the people, to the extent possible, taking explicitly into account existing uncertainties and the potential consequences of being wrong.

- S. Garcia, FAO Fisheries Dept

COMEST, UNESCO. "The precautionary principle." *World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris* (2005).

Definition Precautionary Approach SSFP 5 AAC 39.222(c)(5)(A)

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Prudent foresight accounts for:

1. Uncertainty
   a) Fisheries
   b) Habitat
2. Risk
   a) Biological
   b) Social
   c) Cultural
   d) Economic
3. Need to act with incomplete knowledge

Straying and Homing in Salmon Life History

C. Habicht and W. D. Templin
Alaska Department of Fish and Game Gene Conservation Lab
Alaska Board of Fisheries, Hatchery Committee Meeting
March 8, 2019

Pacific salmon: a balance of homing and straying

- Homing selection
  - Development of local adaptations
  - Increased differences among populations
  - Improved survival – successful area, familiarity with area

- Straying selection
  - Colonization of new habitats
  - Increased diversity within populations
  - Buffers temporal variation in habitat quality

Hutchings, J.A., Hendry, A.P. and Stearns, S.C., 2004. Evolution illuminated: salmon and their relatives.

Example – Sockeye salmon

- Long freshwater residency
- Higher variability in habitat
- Higher annual stability in habitat
- Variable-year life cycle = higher selection for homing

Beach

River

Stream

J. Armstrong

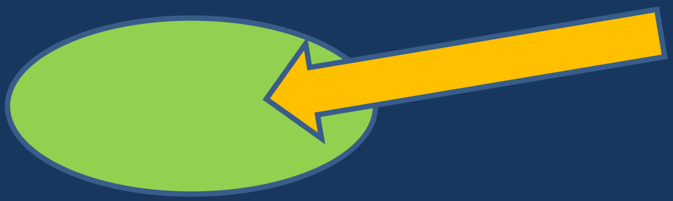
https://weslarson.wordpress.com/

Example – Pink salmon

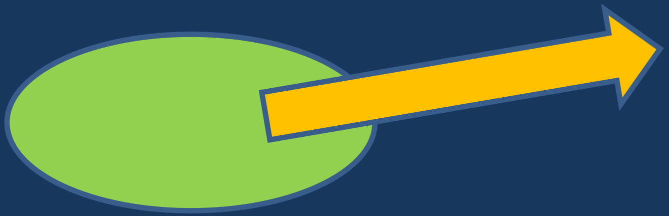
- Short freshwater residency
- Lower variability in habitat
- Lower annual stability in habitat
- One-year life cycle = lower selection for homing

Stray Rate Definitions: Depends on Perspective

- Stray in rate = recipient stray rate
  - Proportion of fish in a spawning location that did **<u>not come from that location</u>**



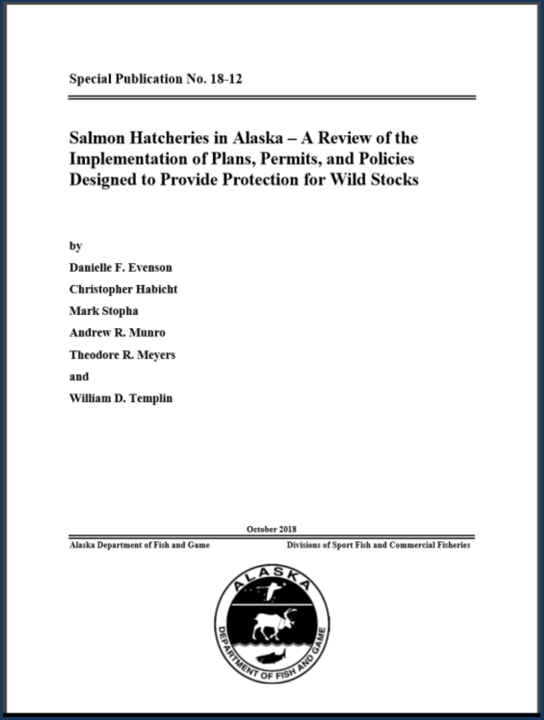
- Stray out rate = donor stray rate
  - Proportion of fish from a spawning location that did **<u>not return to that location</u>**



Alaska’s Precautionary Approach to Hatcheries

Alaska's Precautionary Approach Policy and Implementation

1. Overview of the structure of Alaska's approach – Policies, Plans, Permits
2. Elements used for implementation of policies
   – Management
   – Fish health
   – Genetics
3. Case studies
   – Southeast Alaska king salmon
   – Prince William Sound pink salmon
4. Recommendations



Special Publication No. 18-12

Salmon Hatcheries in Alaska – A Review of the Implementation of Plans, Permits, and Policies Designed to Provide Protection for Wild Stocks

by

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October 2018

Alaska Department of Fish and Game — Divisions of Sport Fish and Commercial Fisheries

Alaska Department of Fish and Game, Special Publication No. 18-12

Alaska's Precautionary Approach
Relevant policy elements

1. Management
   – Wild stock conservation priority
   – Management for sustained yield
   – Assessment of stock interaction: fisheries and escapement
2. Fish Health
   – Hatchery inspections
   – Disease reporting and history
3. Genetics
   – Use appropriate local stocks
   – Identify significant or unique wild stocks, and wild stock sanctuaries
   – Assessment of hatchery/wild stock interaction and impacts

Hatchery/Wild Interactions Research

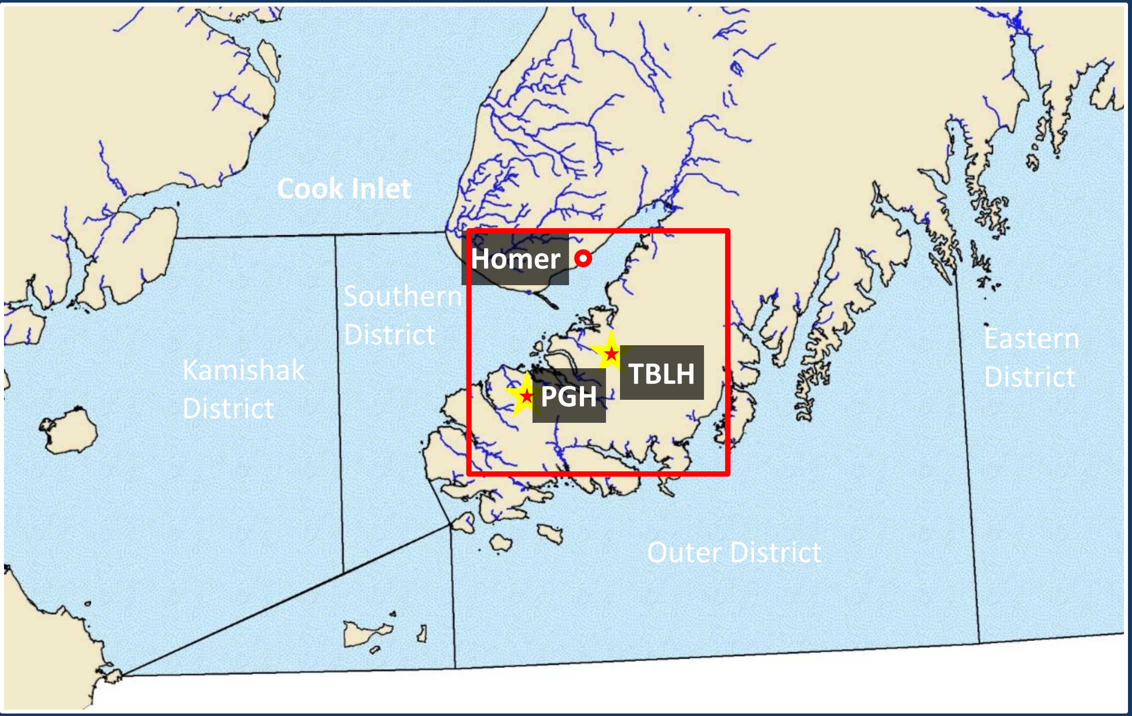
Two ongoing studies

1. Lower Cook Inlet pink salmon
    a. Harvest sampling
    b. Escapement sampling

2. Alaska Hatchery Research Program
    a. Two regions – PWS & SEAK
    b. Two species – pink & chum salmon
    c. Three big questions

Lower Cook Inlet Pink Salmon

Ted Otis & Glenn Hollowell



Tutka Bay Lagoon Hatchery

- Brood Stock: Tutka Lagoon Ck.
- Dormant: 2004-2011

Port Graham Hatchery

- Brood Stock: Port Graham R.
- Dormant: 2007–2014

Permitted: 125 million pink salmon eggs

100% thermally marked

Purpose: Gather baseline data on the hatchery-wild composition of harvests and escapements in LCI as 2 recently reopened hatcheries began releasing marked fry.

Objectives:

- Estimate hatchery-wild composition of commercial harvest
  - Hatchery cost-recovery targets hatchery fish
  - Hatchery contribution to the **common** property harvest
- Monitor escapements to pink salmon index streams in Southern and Outer districts
- Estimate percentage of strays of Tutka hatchery produced pink salmon in select streams
- Provide information regarding levels of strayed LCI fish for use in managing Tutka and Port Graham hatcheries to minimize straying and impacts to wild pink salmon

Hatchery Composition - Harvest Samples

Cost Recovery Harvest

Tutka Lagoon SHA:
- Inside lagoon: 98.7% - 100%
- Outside lagoon: 92.1% - 96.2%

Port Graham SHA:
Hatchery Cost-Recovery: 86.3%

Hatchery IDs (TL SHA):
- 99.6% Tutka Hatchery
- 0.4% PWS hatcheries

Hatchery IDs (PG SHA):
94.2% Port Graham Hatchery
4.3% Tutka Hatchery
1.4% PWS Hatcheries

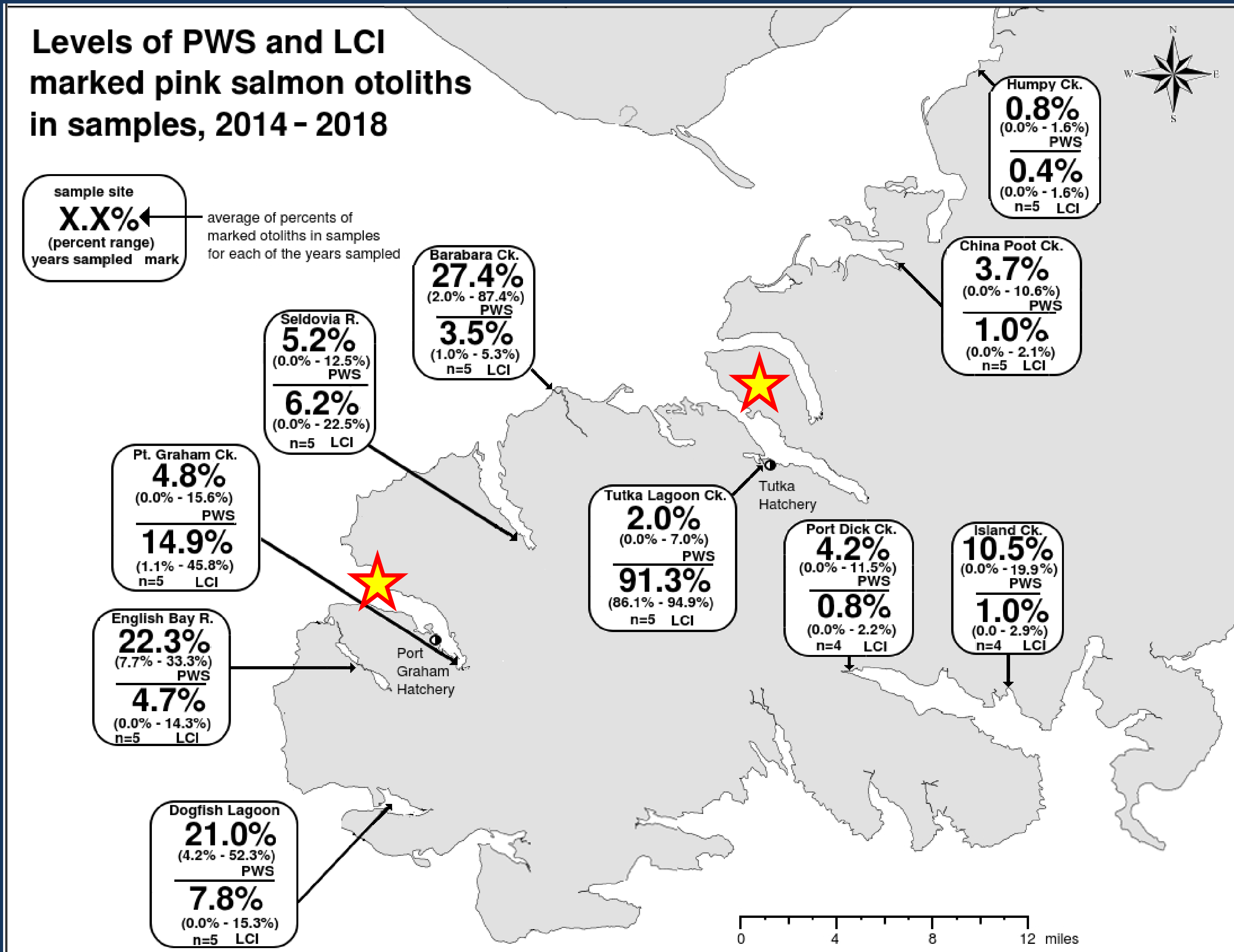
Common Property Harvest

CCP Catch:
- Overall Avg: 59.6% (0–99%); n=53, 4,277 fish
- Purse Seine Avg: 62.3% (0–99%); n= 45, 3,514 fish
  SGN Avg: 44.8% (22–80%); n= 8, 763 fish
- Port Graham CCP Catch: 16.1–56.3%

Hatchery IDs (CCP Catch):
90.8% Tutka Hatchery
6.2% Port Graham Hatchery
3.0% PWS hatcheries

- Escapement Monitoring: generally meeting escapement goals

Hatchery Composition – Escapement Samples



Conclusions

- > 95% of pink salmon collected from cost-recovery harvests in SHAs hatchery marked
- Hatcheries contributed substantially to samples from common property pink salmon harvest in the Southern District:
  - ~62% of CCP seine samples marked;
  - ~45% of CCP SGN samples marked
- Pink salmon index streams met their escapement goals despite increased harvest effort on hatchery pink salmon
- LCI hatchery produced pink salmon present in streams (0-87%)
  - sampled at lower than expected level
- PWS hatchery pink salmon present in LCI collected samples
  - not expected when study conceived
- Interpretation of current data limited given few years sampled
  - need to continue sampling based on comprehensive study design

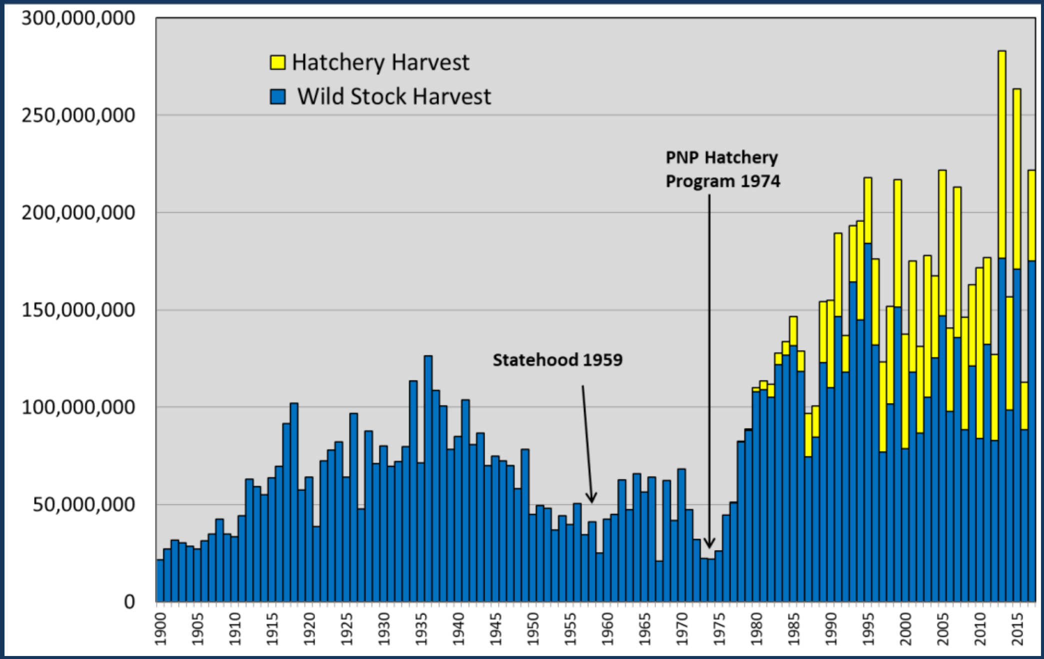
Alaska Hatchery Research Program

Collaborative Research

AHRP

Background

- Alaska salmon fisheries were severely depressed at statehood, and reached their nadir in 1973 and 1974, when statewide harvest of all species was 22 M
- Alaska initiated State (1971) and PNP (1974) hatchery programs to support the recovery and enhancement of Alaska salmon fisheries.
- Remarkable recovery of Alaska salmon following the 1977 “regime” shift and improved management by ADF&G
- Wild stock harvest exceeded 100 M in 1980



Alaska commercial harvest of wild and hatchery salmon, 1900-2017.
Stopha (2018)

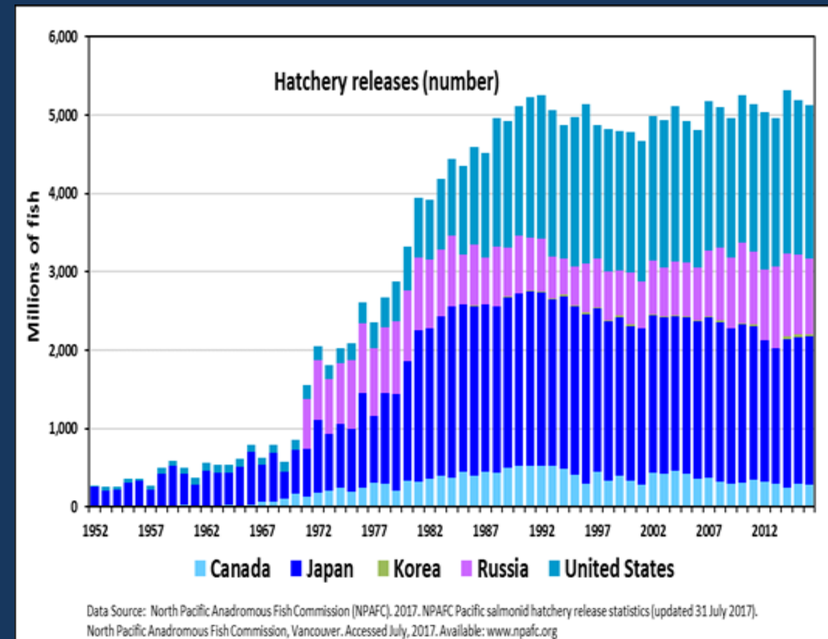
- Hatcheries began making substantial contributions to harvest in 1980’s
- Statewide harvests have averaged 175 M for 2008-2017

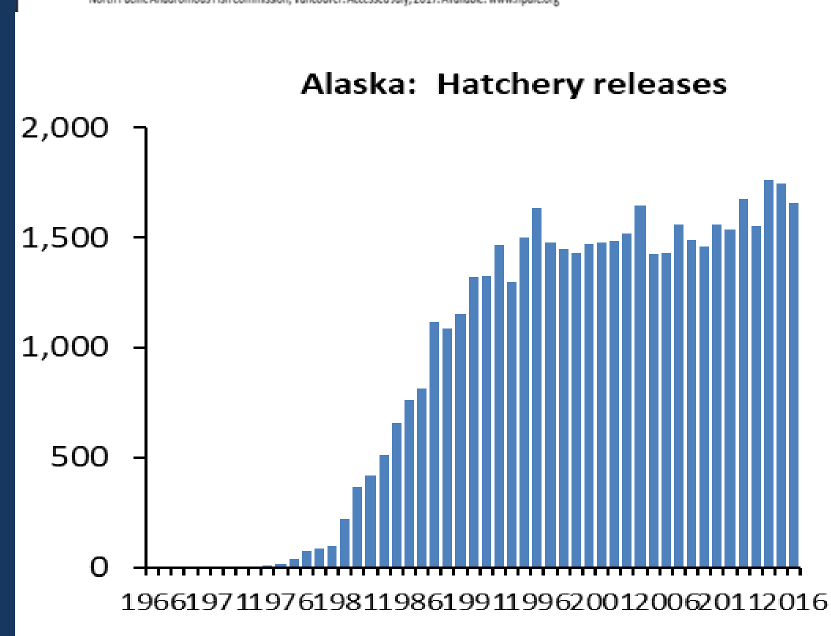
AHRP

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





Recognition of need to examine extent and impact of hatchery strays on wild stock fitness and productivity

- PNP operators proposed that ADF&G organize a science panel of experts to design and implement a long term research project to inform future resource management decisions

- Funding partnership: State, Operators & Industry

- Fundamental questions aimed at examining extent and potential impacts of hatchery straying on fitness of wild stocks
  - * Pink and chum salmon PWS
  - * Chum salmon SEAK

AHRP Science Panel

Panel Charge –

Identify priority research questions and develop a framework for research that could be used to address these questions.

Panel Makeup – 13 members:

- Alaska Department of Fish and Game
- National Marine Fisheries Service
- University of Alaska
- Aquaculture associations

AHRP Research Questions

1) What is the genetic stock structure of pink and chum in PWS and SEAK?

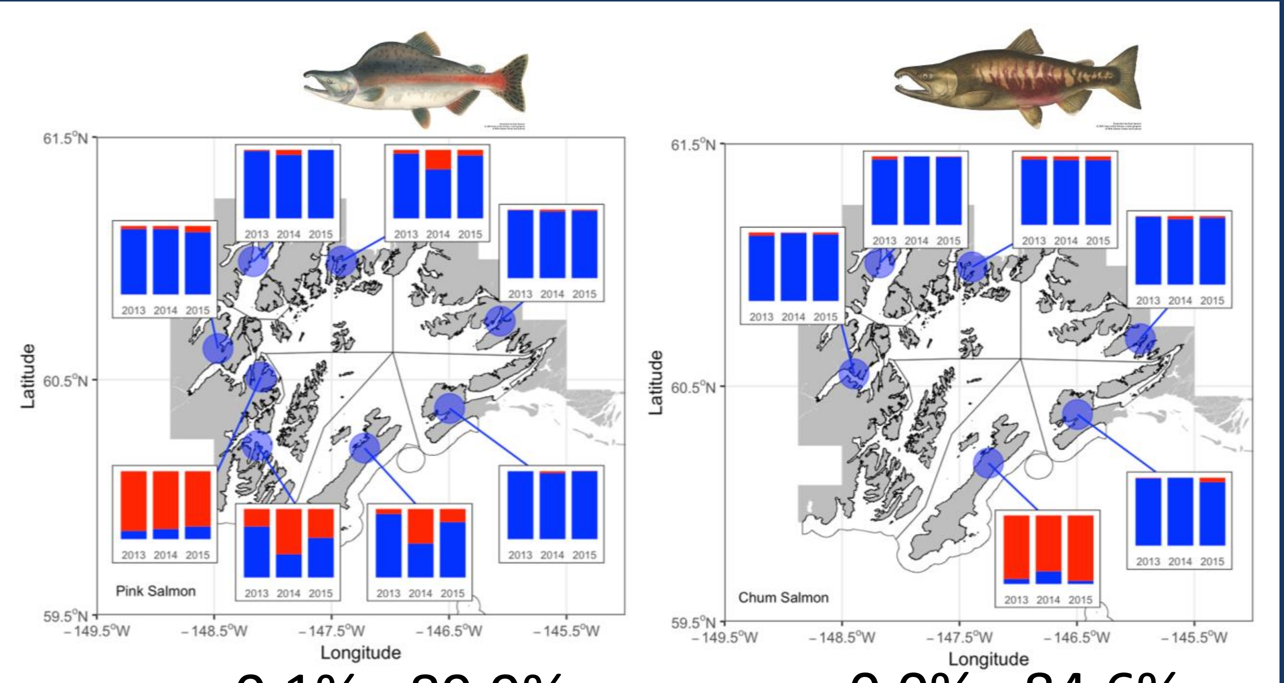
2) What is the extent and annual variability of straying?

3) What is the impact on fitness (*productivity*) of natural pink and chum stocks?

Question 2

PWS: Straying results, 2013-2015

By District



0.1% - 89.9%

0.0% - 84.6%

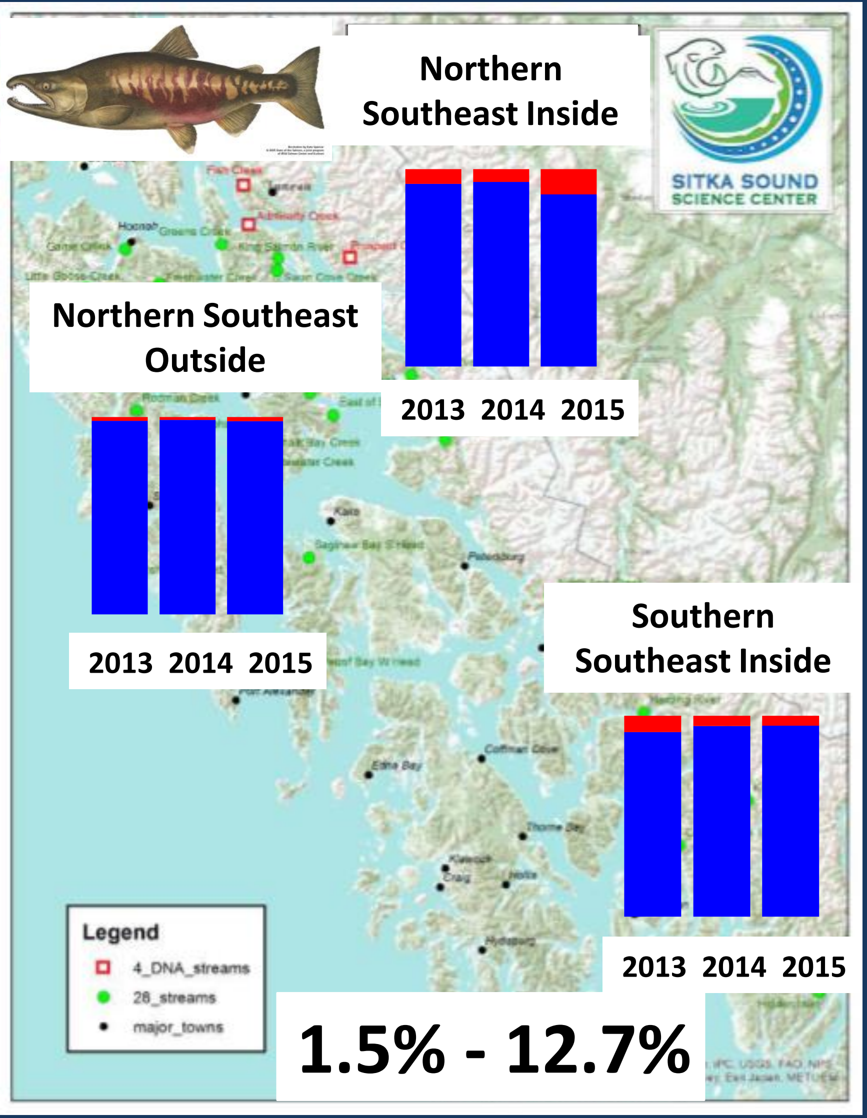
All PWS

Species	2013	2014	2015
Pink	4.4%	14.8%	9.5%
Chum	2.8%	3.2%	3.1%

Question 2

SEAK: Straying results, 2013-2015

By District



All SEAK

Species	2013	2014	2015
Chum	7.3%	5.4%	9.2%

Question 2

Wild and Hatchery Run Size Estimates, 2013-2015

Species Year	Natural spawners	Hatchery strays	Total spawners	Natural run	Hatchery run	Total run
Pink salmon						
2013	15,698	701	16,399	33,096	69,888	102,985
2014	5,130	741	5,872	6,960	42,757	49,718
2015	37,972	4,009	41,981	63,531	77,335	140,866
Chum salmon						
2013	894	50	944	1,141	3,007	4,148
2014	925	49	975	1,175	1,228	2,404
2015	890	28	919	1,128	2,484	3,612

	Estimated Harvest Rates	
Year	Hatchery	Natural
2013	0.99	0.53
2014	0.98	0.26
2015	0.95	0.40

Knudsen et al. (2016). Interactions of Wild and Hatchery Pink Salmon and Chum Salmon in Prince William Sound and Southeast Alaska.

Question 3

Preliminary Fitness Results

- Sample offspring and assigned to parents
  - Collect parents one year & offspring 2 years later
  - 5 streams
  - Sampled 7 yrs
    2013-2019
  - > 150,000 fish

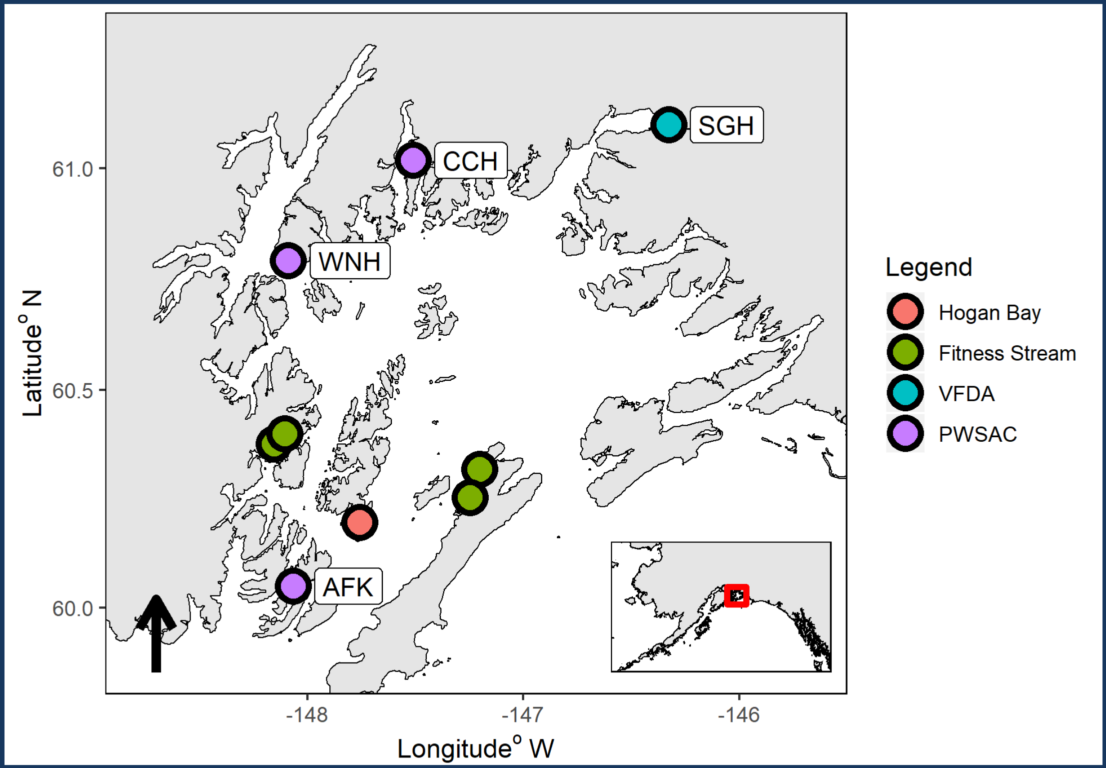


Figure 1 – Lescak et al. *in prep*

Question 3

Results from 1 Generation of Hogan

- Pedigree in natural system possible
- Even-lineage
  - 451 offspring to 184 parents
  - Offspring assignment rate 11.0%
  - RRS = **<u>0.47</u>** (significant) for females
  - RRS = **<u>0.87</u>** (not significant) for males
- Odd-lineage
  - 48 offspring to 20 parents
  - Offspring assignment rate 2.5%
- Under-representation of offspring assigned to hatchery-origin parents in both lineages

Question 3

Conclusions from Hogan Bay

- Hatchery-origin fish spawned and produced adult offspring that were sampled
- Hatchery-origin fish spawned with both other hatchery-origin fish as well as natural-origin fish
- On average, hatchery-origin fish produced fewer adult offspring that returned to Hogan Bay and were sampled than their natural-origin conspecifics
- There are potentially important differences in RS between male and female hatchery-origin fish

Department Framework for Interpretation of Results

Some Questions Asked but 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 will findings affect policy?
- How do these hatchery fish in wild systems affect assessment of escapement?

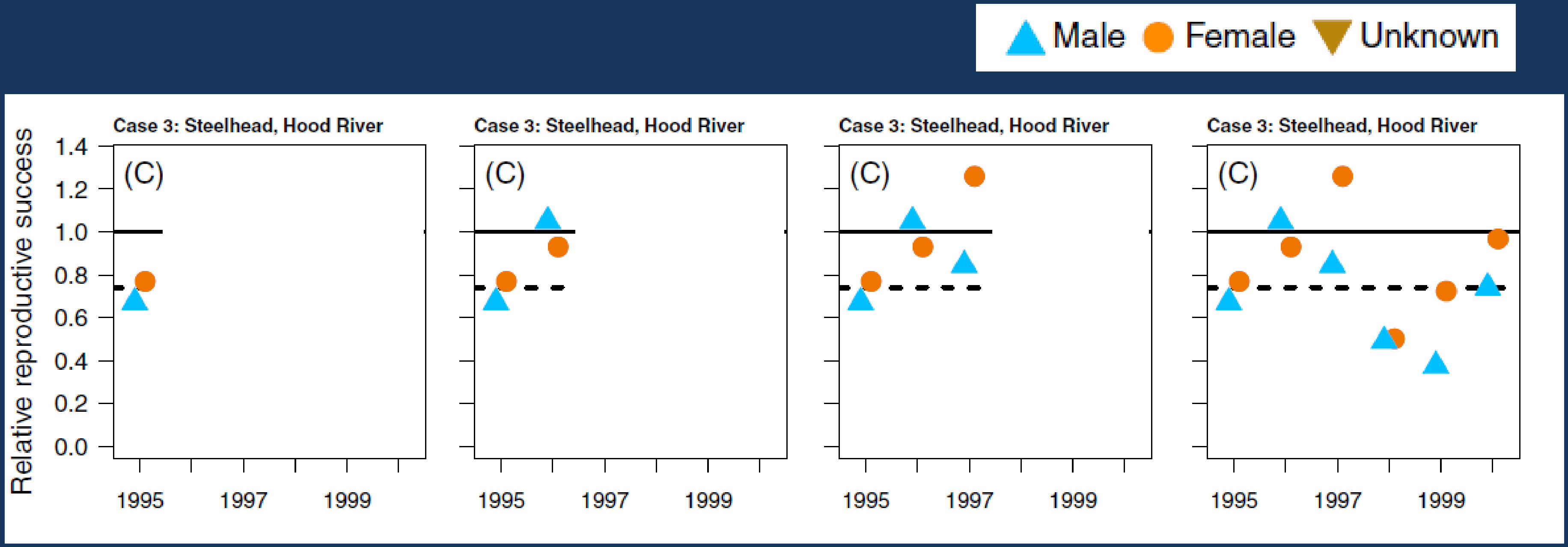
ADF&G is Assessing Risk

- Information we have now:
  - Wild system productivity
  - Hatchery proportions
- Information we are collecting now:
  - Genetic background
  - Relative productivity – Hatchery and Wild

- Once all AHRG RRS results are complete:
  - Interpretation of results
  - Implications for management of resource

- Analyses and interpretation will inform policy maker decisions

Example of Relative Productivity (Hat/Wild) Steelhead, Hood River



From Christie et al. 2014; original data Araki et al. 2007

Many Mechanisms Drive Relative Productivity

Many generations (e.g. genetic) ⟷ One generation (e.g. non-genetic)

Relaxation of natural selection

Spawning ground familiarity

Domestication selection

Epigenetics

Genetic drift

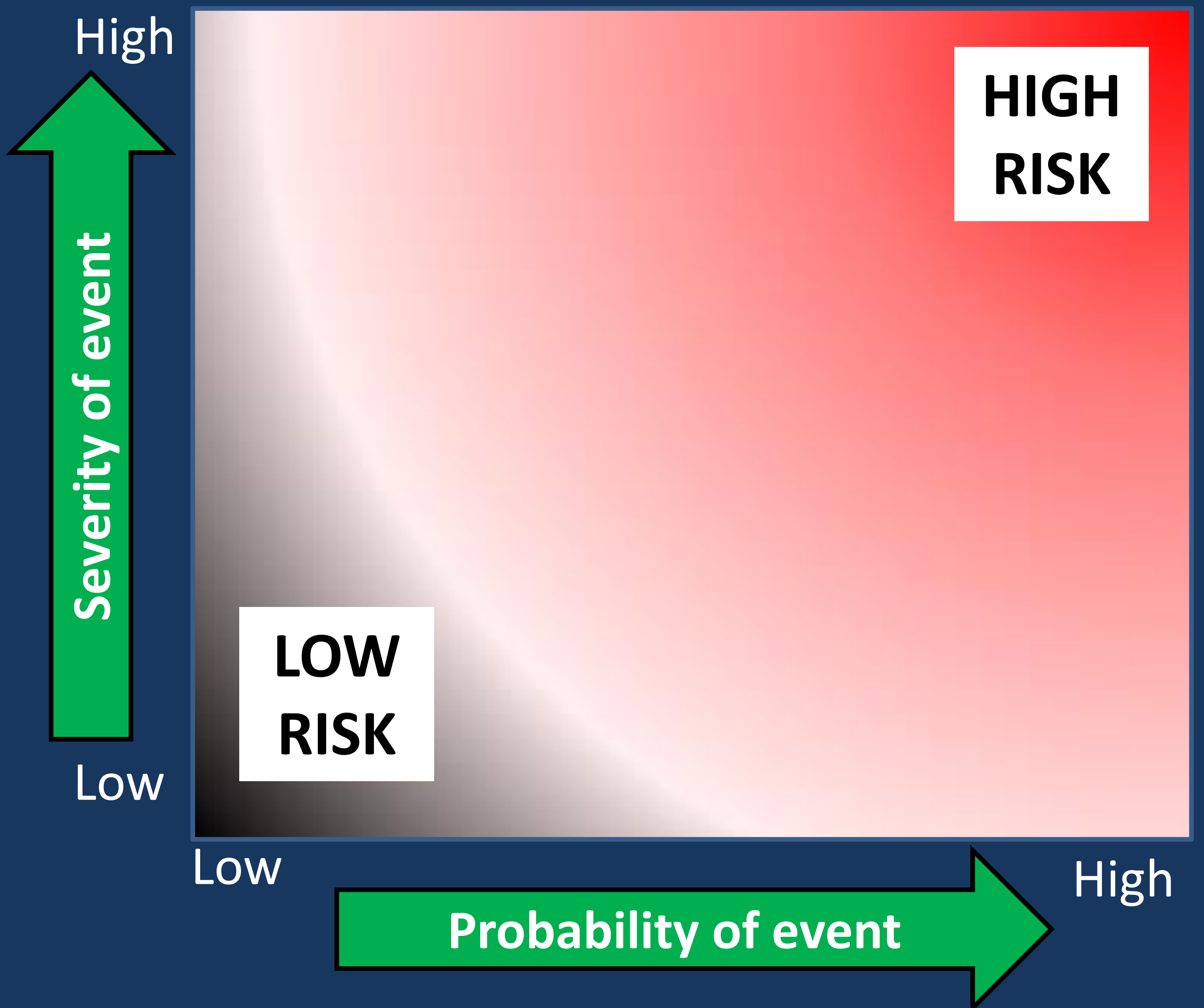
Broodstock incompatibility

Run timing-associated variables

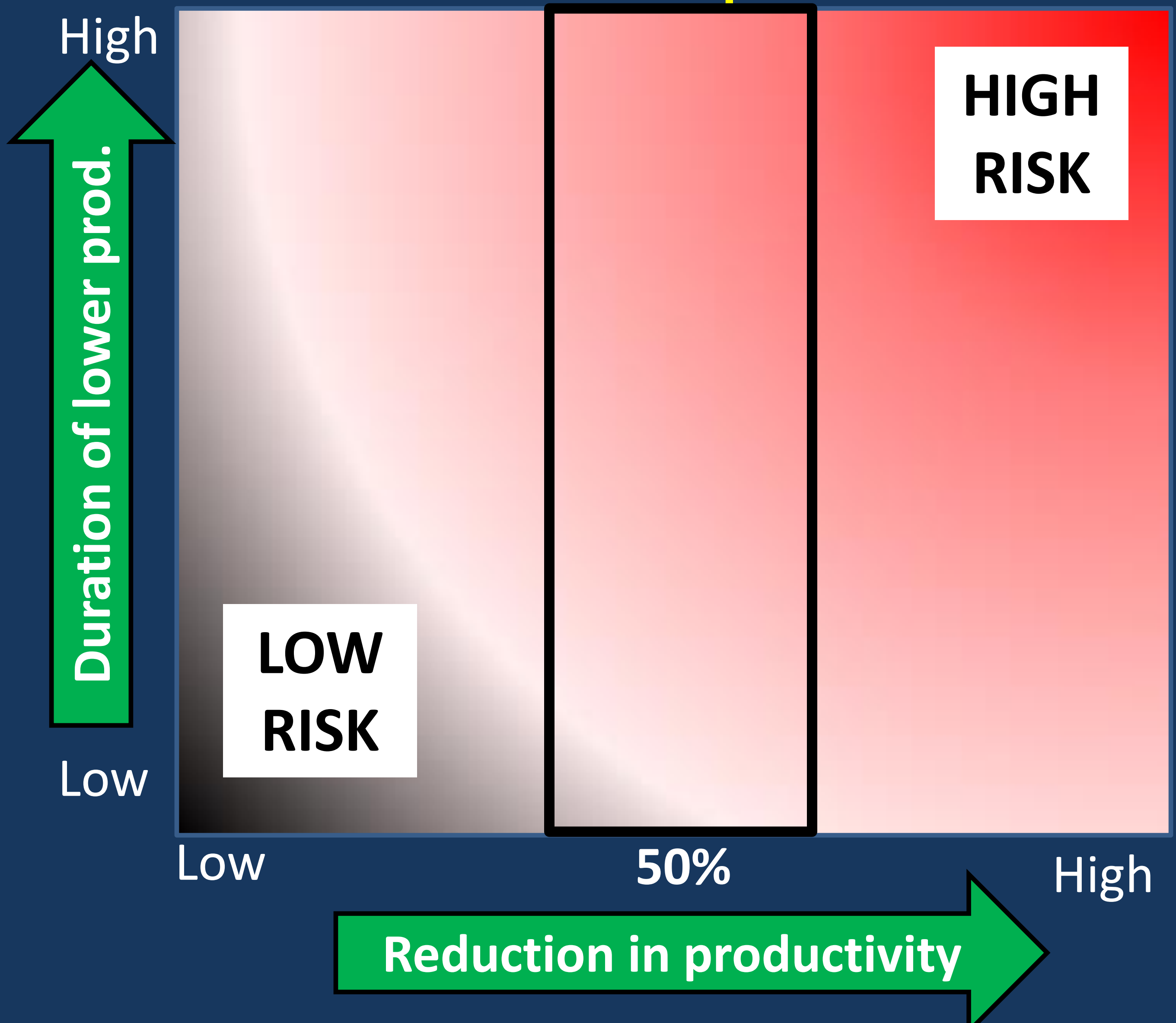
- Fishery prosecution
- Spawning ground competition
- Straying fish delays

Sexual selection

Conceptual Model for Assessing Risk



Conceptual Model for Assessing Risk Example



On Being a Wise Consumer of Science

On Being a Wise Consumer of Science

The scientific method

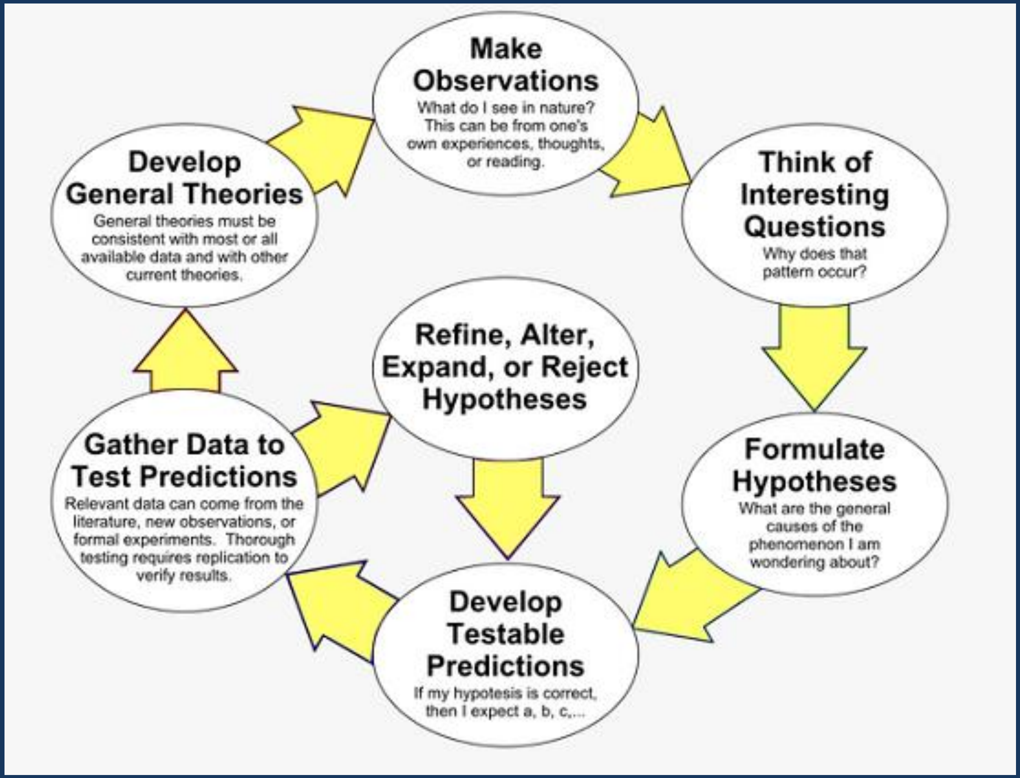


Image from: Chiswick Chap from Wikimedia Commons

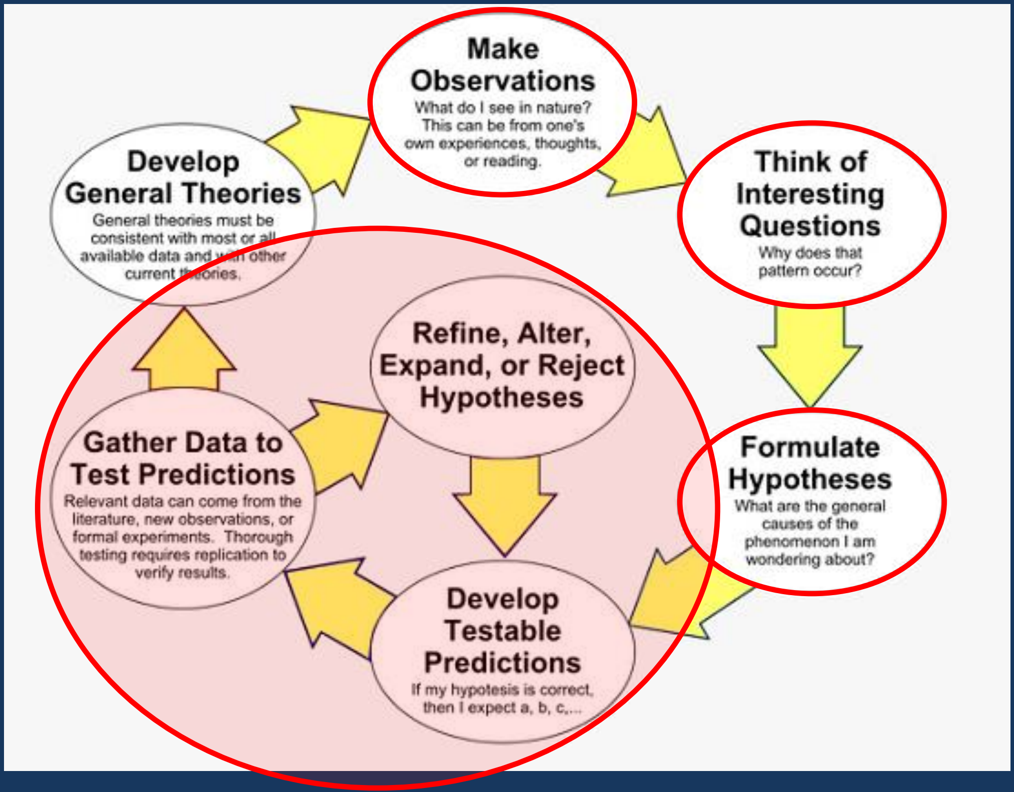
Principles:

- Careful observations
- Formulating and testing hypothesis that can be falsified
- Refinement of hypotheses
- Skepticism

The scientific method in practice – an example

Critical-Period Hypothesis

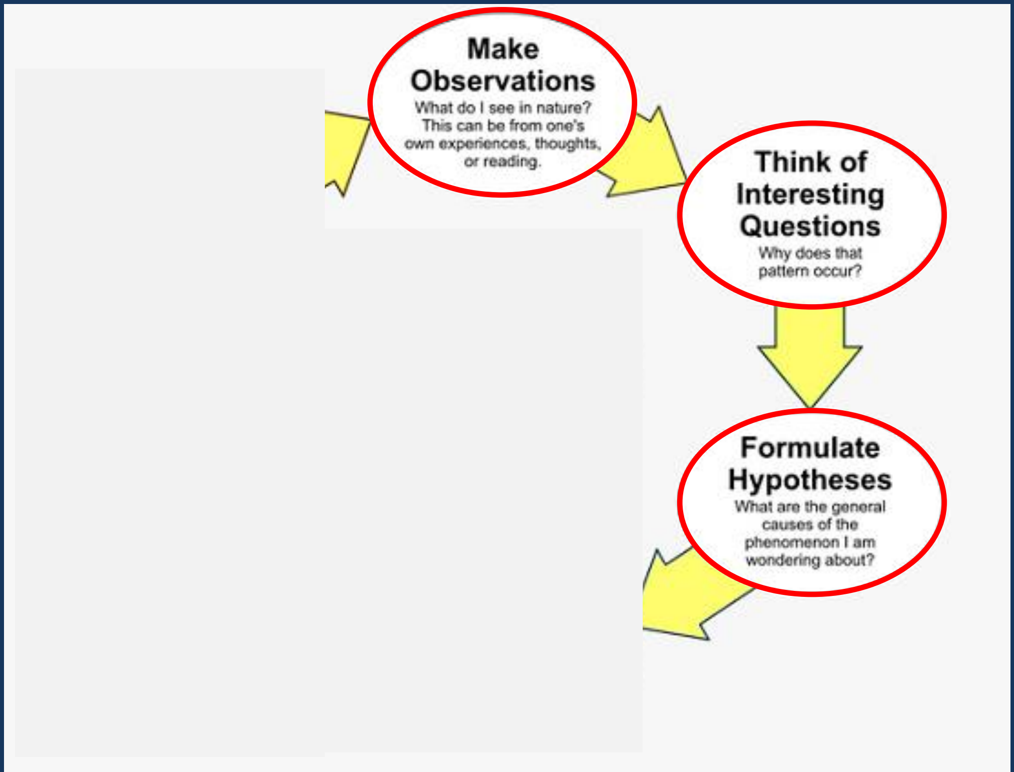
- Juvenile salmon entering marine environment
  - Compelling hypothesis
  - Many studies, but mixed result
  - Debate is elevating the science



Ramifications of incomplete scientific process

- Not always negative
- Burden on reader to understand limitations
- Does not move science forward

Pink salmon and orcas – another example



Observations

- Southern resident killer whale population decline in Puget Sound
- Two-year pattern in mortality
- Pink salmon have two-year life cycle

Interesting Question

- Pink salmon responsible for pattern in mortality?

Hypotheses

- Abundant odd-year pink salmon interfere with the ability of whales to feed on co-migrating Chinook

OR

- Less abundant even-year pink salmon enhance the ability of whales to feed = lower mortality

Pink salmon and orcas – another example

“We recognize the need for additional analyses and rationale to explain this pattern but we wish to facilitate rapid communication of these unique findings because a greater understanding of SRKW demography enhances the likelihood for advancing their recovery.” (page 292)

RICHMOND NEWS ≡ MENU

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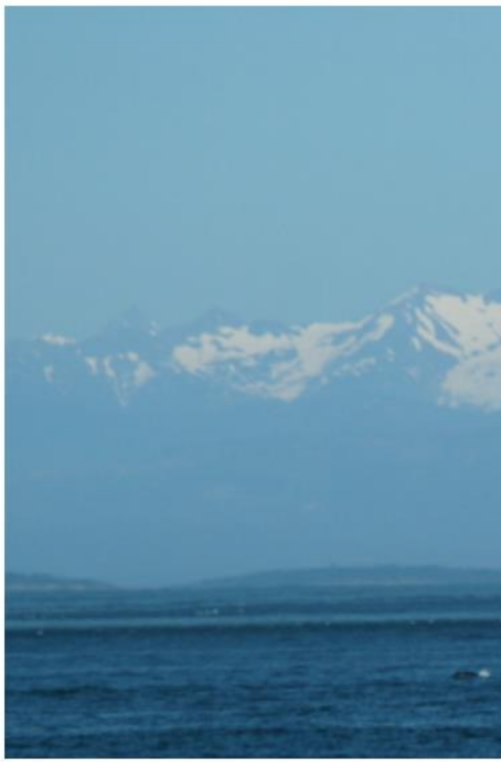
Scientists find ‘odd’ pattern in killer whale birth, death rates

Fisheries scientists suspect odd-even year fluctuations may have something to do with pink salmon

Nelson Bennett / Business in Vancouver
JANUARY 21, 2019 11:46 AM



Study says things like ship noise and contaminants don't explain why Southern Resident Killer Whale birth and death rates would fluctuate on odd-even year cycles. | Photo Joan Lopez.

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SOMETHING TO THINK ABOUT, PERHAPS

“Ships are expendable; the whales are not.” – Paul Watson

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orcas: pink

TAKE ACTION

Pink salmon and orcas – another example

Manuscript section

	Abstract/ Key words	Intro	Methods	Results	Discussion	Conclusions
Pink	2	0	0	0	16	3
Chinook	2	2	0	0	11	2
Salmon	4	2	0	0	34	5
Whale	6	4	12	13	5	0
SRKW	0	4	8	2	20	8

Concluding thoughts

Responsibilities

- Scientists: communicate research clearly and effectively
- Readers: evaluate the strength of evidence & conclusions
    - e.g., Is chocolate good or bad for you?

Peer review process not perfect

- Review of manuscripts is voluntary
- Reviewers evaluate for science not “splash”-factor
- Publication does not imply full acceptance by science community
- Incentives to publish papers that generate attention


Questions?
J. Hyde