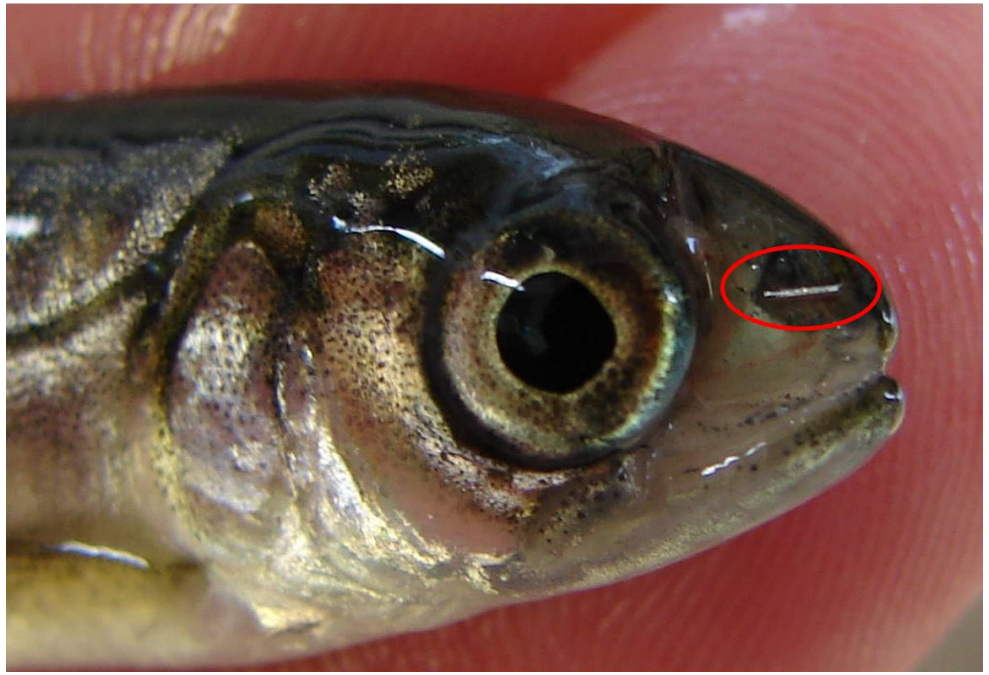
Using Parentage Based Tagging (PBT) to Manage Idaho's Anadromous Fisheries

John Hargrove
Pacific States Marine Fisheries Commission

Chris Sullivan
Idaho Department of Fish and Game

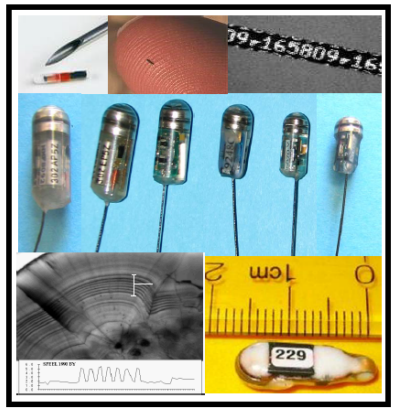
Tagging in the Columbia River Basin

- Key to effective management
- Variation in tags/marks used through time/space



INDEPENDENT SCIENTIFIC REVIEW PANEL
INDEPENDENT SCIENTIFIC ADVISORY BOARD

TAGGING REPORT



A comprehensive review of Columbia River Basin fish tagging technologies and programs

March 17, 2009
ISRP/ISAB 2009-1

Recommendations to encourage the development and use of innovative tagging technologies relevant to program RM&E needs:

3.1 We endorse the development of standardized single nucleotide polymorphism (SNP) markers for all Columbia River salmon and steelhead ESUs.

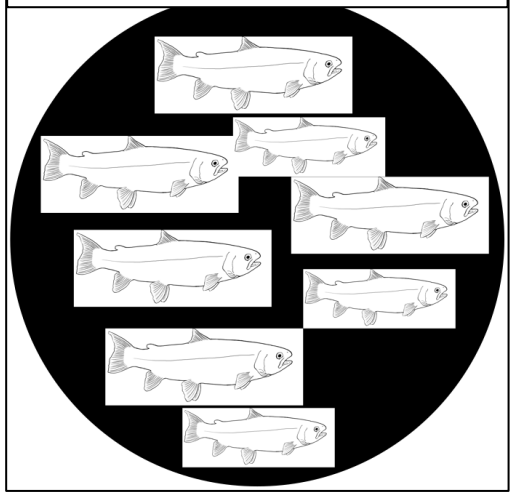
3.2 We endorse the development of fishery and management models that use genetic data for both ocean harvest and in-river fisheries.

3.3 We endorse pilot and proof-of-concept trials for Parental Based Tagging of hatchery populations of salmon and steelhead.

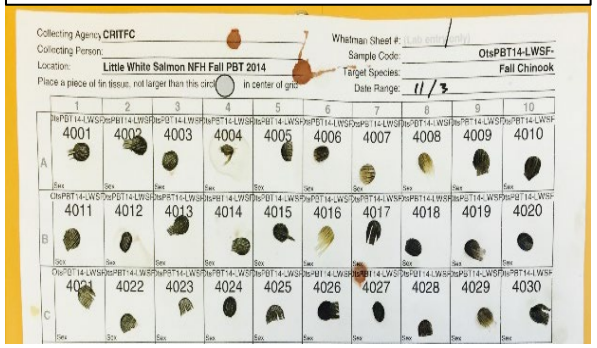
What is PBT?

Genetic tagging method that involves genotyping hatchery broodstock

Oxbow Hatchery
Brood year 2014



Genetic Fin Clips

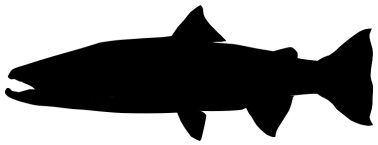


Genetic Database of Potential Parents

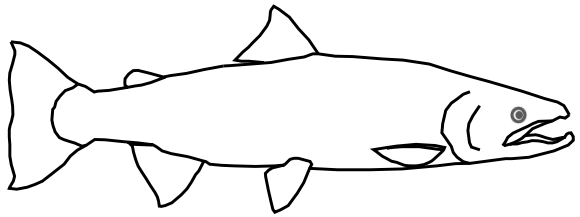
Pedigree	Individual.Name	Gender	SNP1	SNP1	SNP2	SNP2	SNP3	SNP3	SNP4	SNP4	SNP5	SNP5	SNP6	SNP6
OmyOXBO19S	OmyOXBO19S_0002	F	T	T	G	G	G	G	C	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0003	F	T	C	A	A	G	G	C	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0004	F	T	T	A	A	G	G	A	A	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0006	F	T	T	G	A	G	G	A	C	C	C	G	G
OmyOXBO19S	OmyOXBO19S_0007	F	T	T	G	A	G	G	C	C	C	C	G	G
OmyOXBO19S	OmyOXBO19S_0008	F	C	C	G	A	G	G	A	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0009	F	T	C	G	G	G	G	C	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0010	F	T	T	G	G	G	G	C	C	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0011	F	T	C	G	G	G	G	A	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0012	F	T	T	A	A	T	G	A	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0013	F	T	T	G	A	G	G	A	C	T	T	G	G
OmyOXBO19S	OmyOXBO19S_0014	F	C	C	G	A	G	G	A	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0015	F	T	C	G	G	T	G	A	A	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0016	F	T	C	G	A	T	G	A	C	T	C	T	G
OmyOXBO19S	OmyOXBO19S_0017	F	T	T	G	G	T	G	C	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0018	F	T	T	G	A	T	G	A	C	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0019	F	T	C	G	G	G	G	A	C	T	T	G	G

1. **Sample hatchery broodstock for fin clips**
2. **Genotype at standard set of genetic markers**
3. **Store genotypes in a centralized database (PBT baseline)**

What is PBT?



Unknown sample



Genotype

Fishery_0001	T	C	G	G	G	G	A	C	T	C	T	G	

Parentage analysis

Genetic Database of Potential Parents

Pedigree	Individual.Name	Gender	SNP1	SNP1	SNP2	SNP2	SNP3	SNP3	SNP4	SNP4	SNP5	SNP5	SNP6	SNP6
OmyOXBO19S	OmyOXBO19S_0002	F	T	T	G	G	G	G	C	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0003	F	T	C	A	A	G	G	C	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0004	F	T	T	A	A	G	G	A	A	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0006	F	T	T	G	A	G	G	A	C	C	C	G	G
OmyOXBO19S	OmyOXBO19S_0007	F	T	T	G	A	G	G	C	C	C	C	G	G
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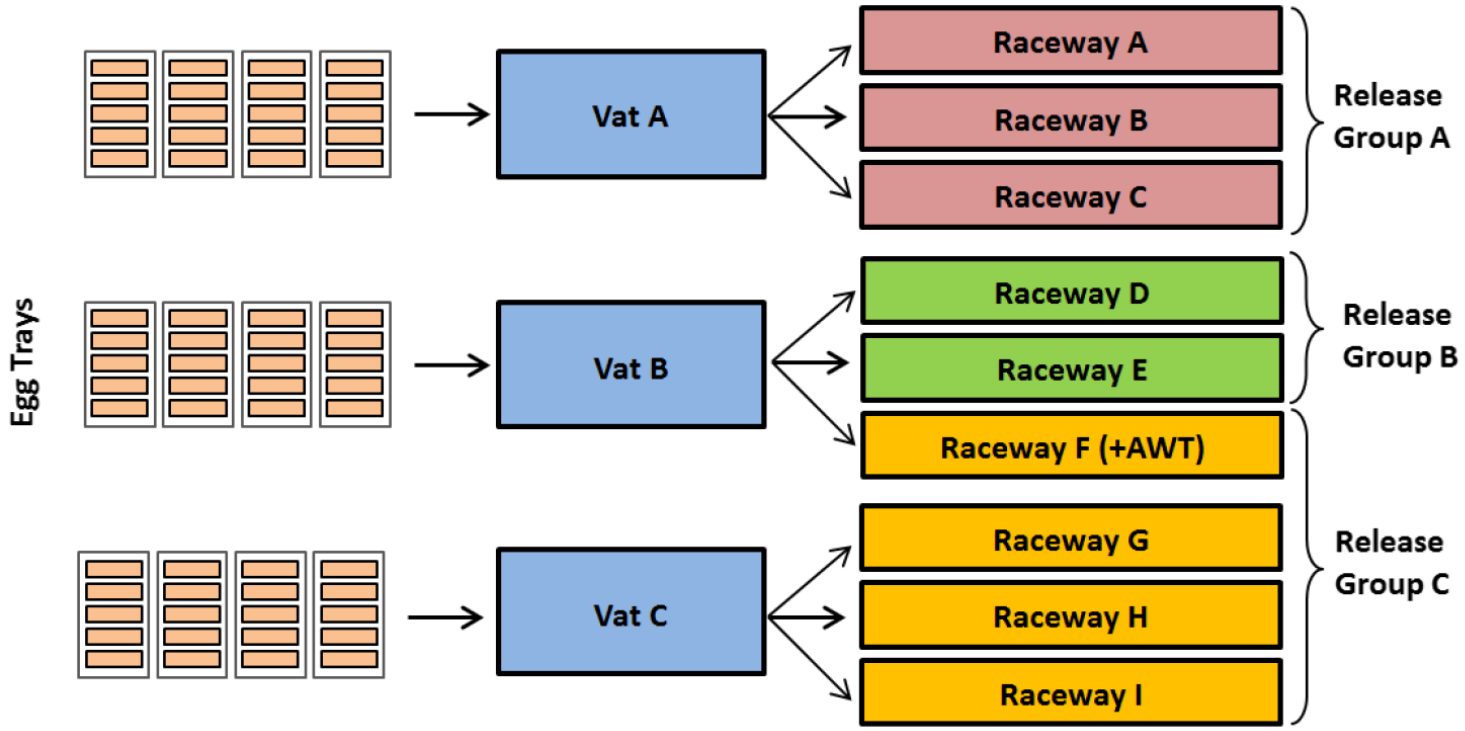
OmyOXBO19S	OmyOXBO19S_0010	F	T	T	G	G	G	G	C	C	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0011	F	T	C	G	G	G	G	A	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0012	F	T	T	A	A	T	G	A	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0013	F	T	T	G	A	G	G	A	C	T	T	G	G
OmyOXBO19S	OmyOXBO19S_0014	F	C	C	G	A	G	G	A	C	T	C	G	G
OmyOXBO19S	OmyOXBO19S_0015	F	T	C	G	G	T	G	A	A	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0016	F	T	C	G	A	T	G	A	C	T	C	T	G
OmyOXBO19S	OmyOXBO19S_0017	F	T	T	G	G	T	G	C	C	C	C	T	G
OmyOXBO19S	OmyOXBO19S_0018	F	T	T	G	A	T	G	A	C	C	C	T	T
OmyOXBO19S	OmyOXBO19S_0019	F	T	C	G	G	G	G	A	C	T	T	G	G

4. **Genotype unknown sample**
5. **Perform parentage analysis to identify parent-pair**

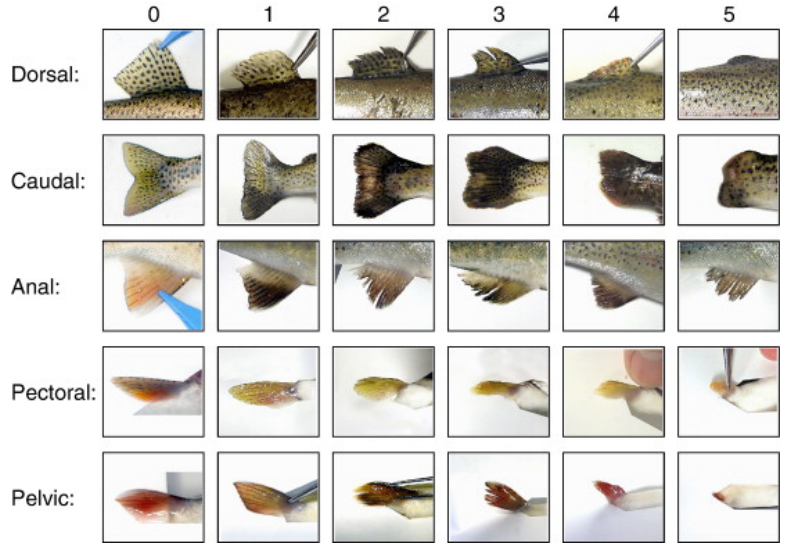
What information is provided?

- Hatchery of origin
- Brood year
- Release site/strategy



Benefits of PBT

- Non-invasive
- Highly efficient
- Unambiguous assignments
- High tag rates (>90% offspring)



PBT in the Snake River Basin

1046

NRC Research Press

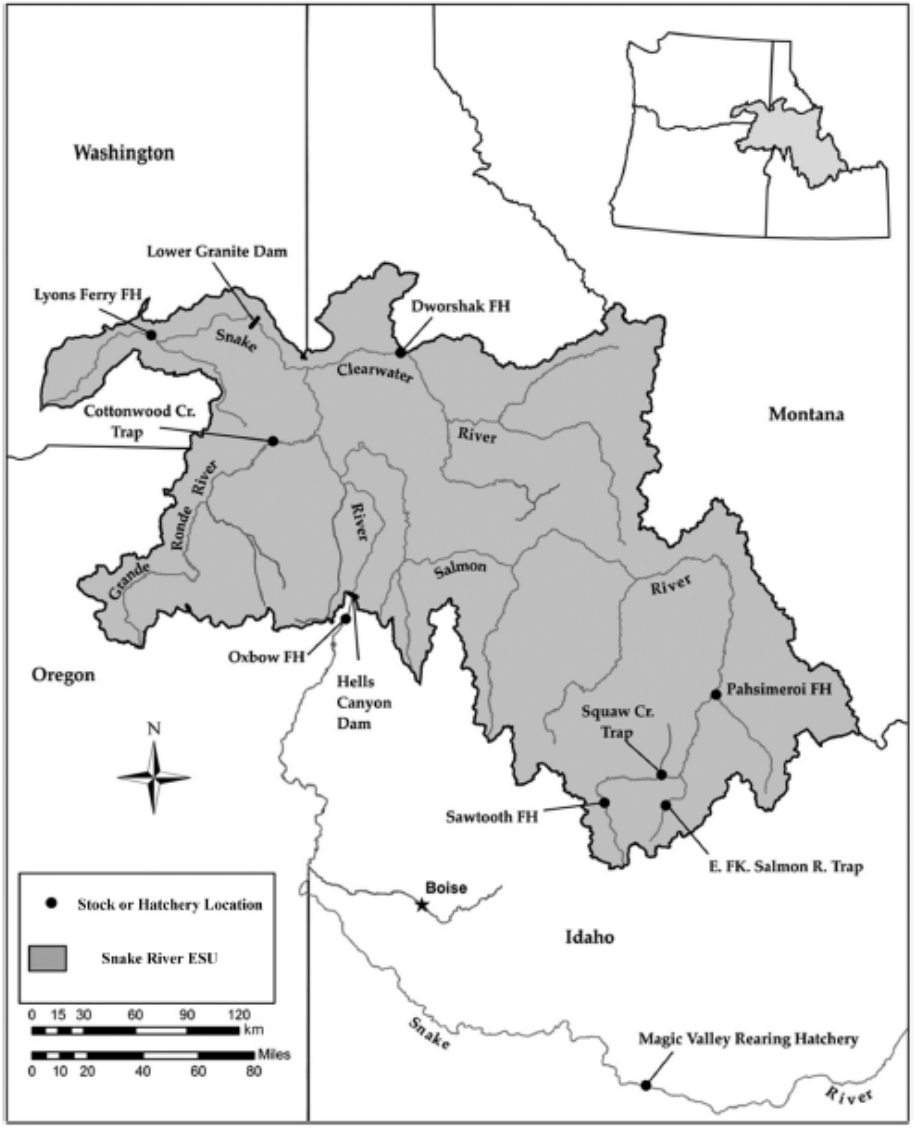
ARTICLE

A validation of parentage-based tagging using hatchery steelhead in the Snake River basin

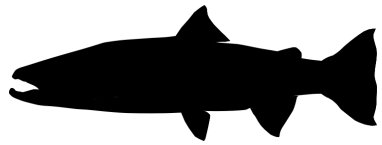
Craig A. Steele, Eric C. Anderson, Michael W. Ackerman, Maureen A. Hess, Nathan R. Campbell, Shawn R. Narum, and Matthew R. Campbell

Key take homes

- One of first large-scale implementations
- < 100 SNPs necessary for parentage analysis
- Equivalent accuracy of CWT



PBT in the Snake River Basin



Annual broodstock genotyping

- ~9,000 sp/su Chinook
- ~2,500 fall Chinook
- ~5,000 steelhead

Received: 7 January 2025 | Revised: 30 June 2025 | Accepted: 2 July 2025

DOI: 10.1111/jfb.70143

REVIEW ARTICLE

JOURNAL OF FISH BIOLOGY fsbi

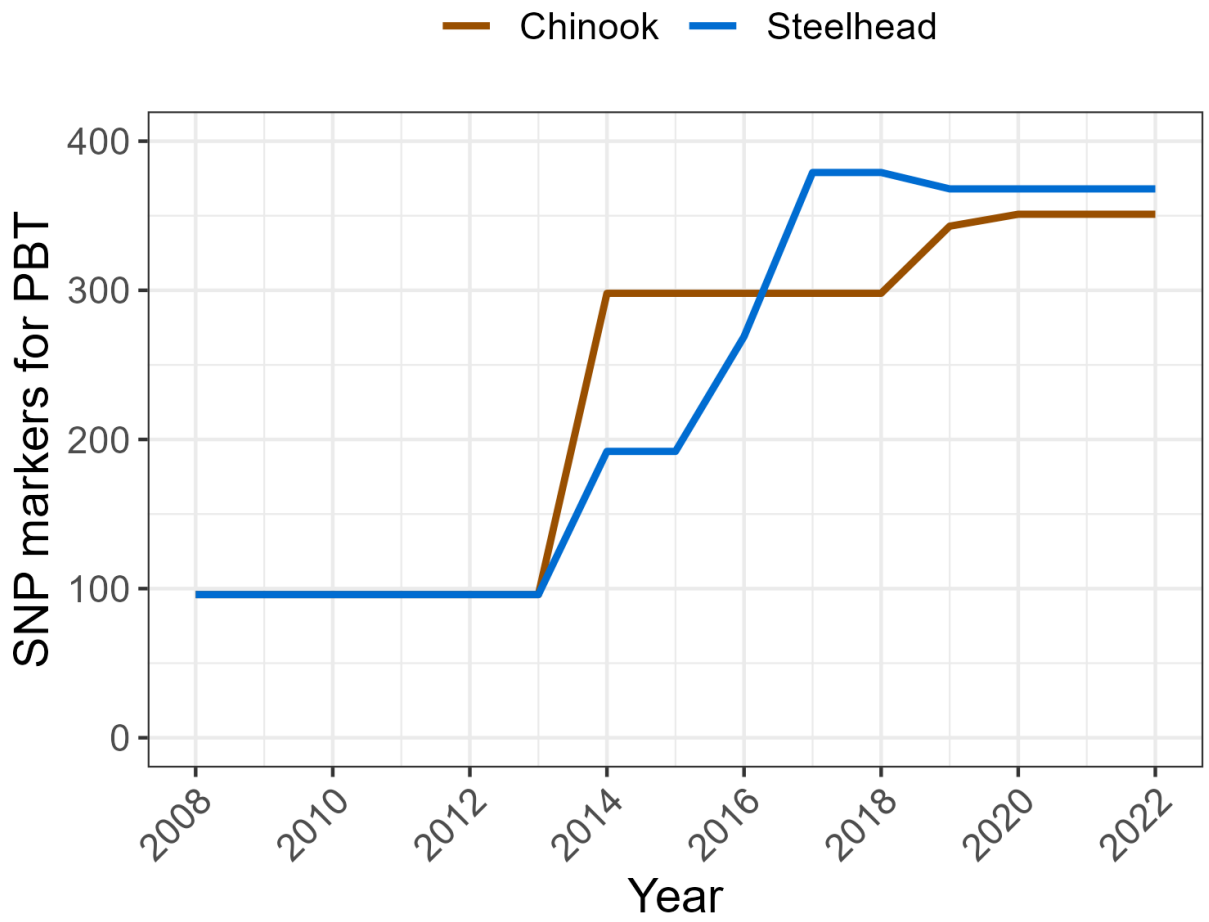
Genetic methods for informing conservation and management of salmonids in the Pacific Northwest, USA

John S. Hargrove[1] | Matthew R. Campbell[2] | Audrey C. Harris[1] | Shawn R. Narum[3] | Rebekah L. Horn[3] | Jon E. Hess[4]

Tag rates

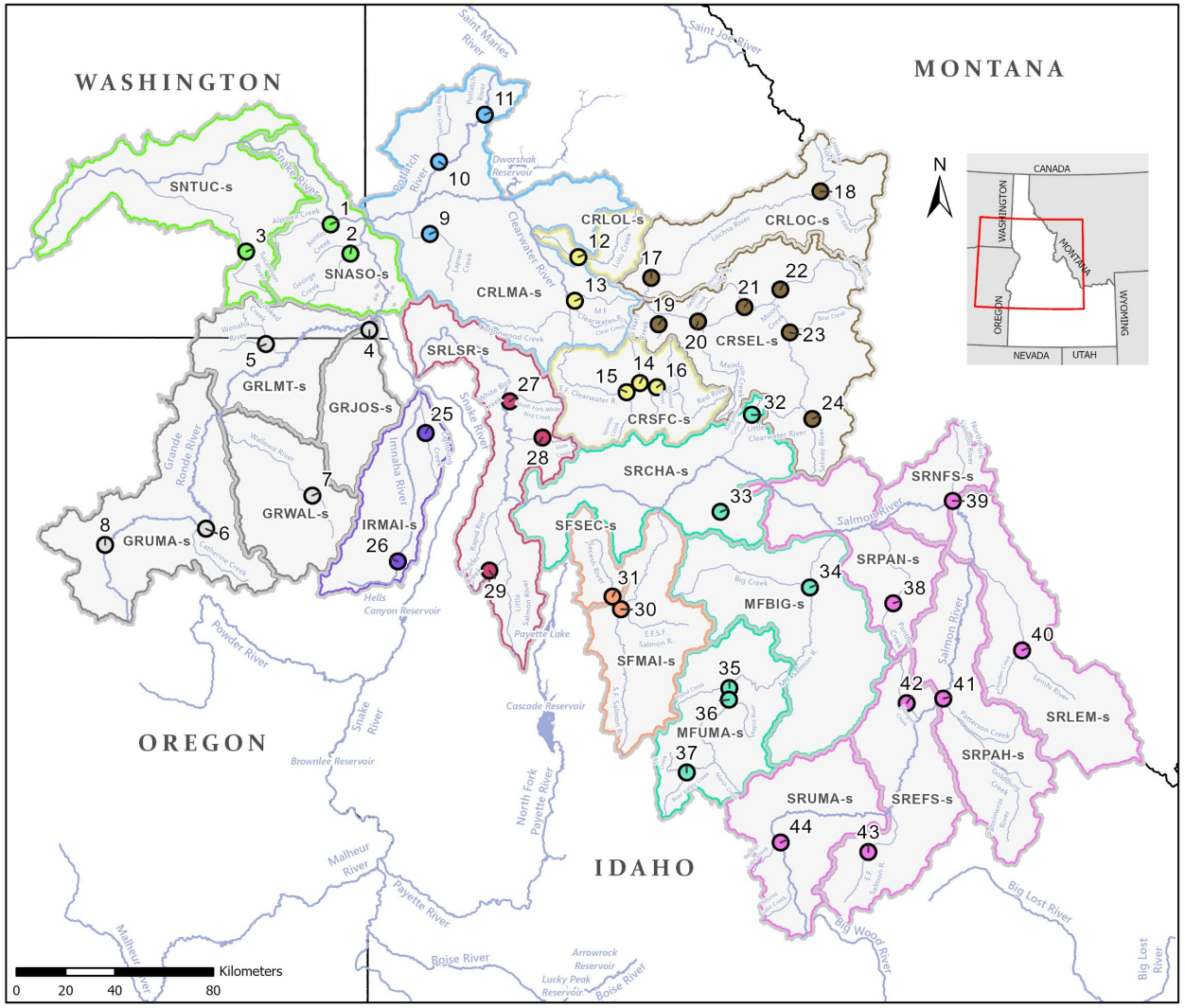
- ~27–31 million smolts per year between (2011 – 2022)
- >90% tag rate for all species and spawn years
- ≥95% for over 75% of species × year combinations

Genetic markers



- Genotyping-in-Thousands by sequencing (GT-seq)
- Markers under selection
  - Run timing
  - Age at sexual maturity
- Microhaplotypes
  - Multiple tightly linked SNPs

Genetic stock identification (GSI)



Hargrove et al. 2023

Steelhead

- 10 genetic stocks

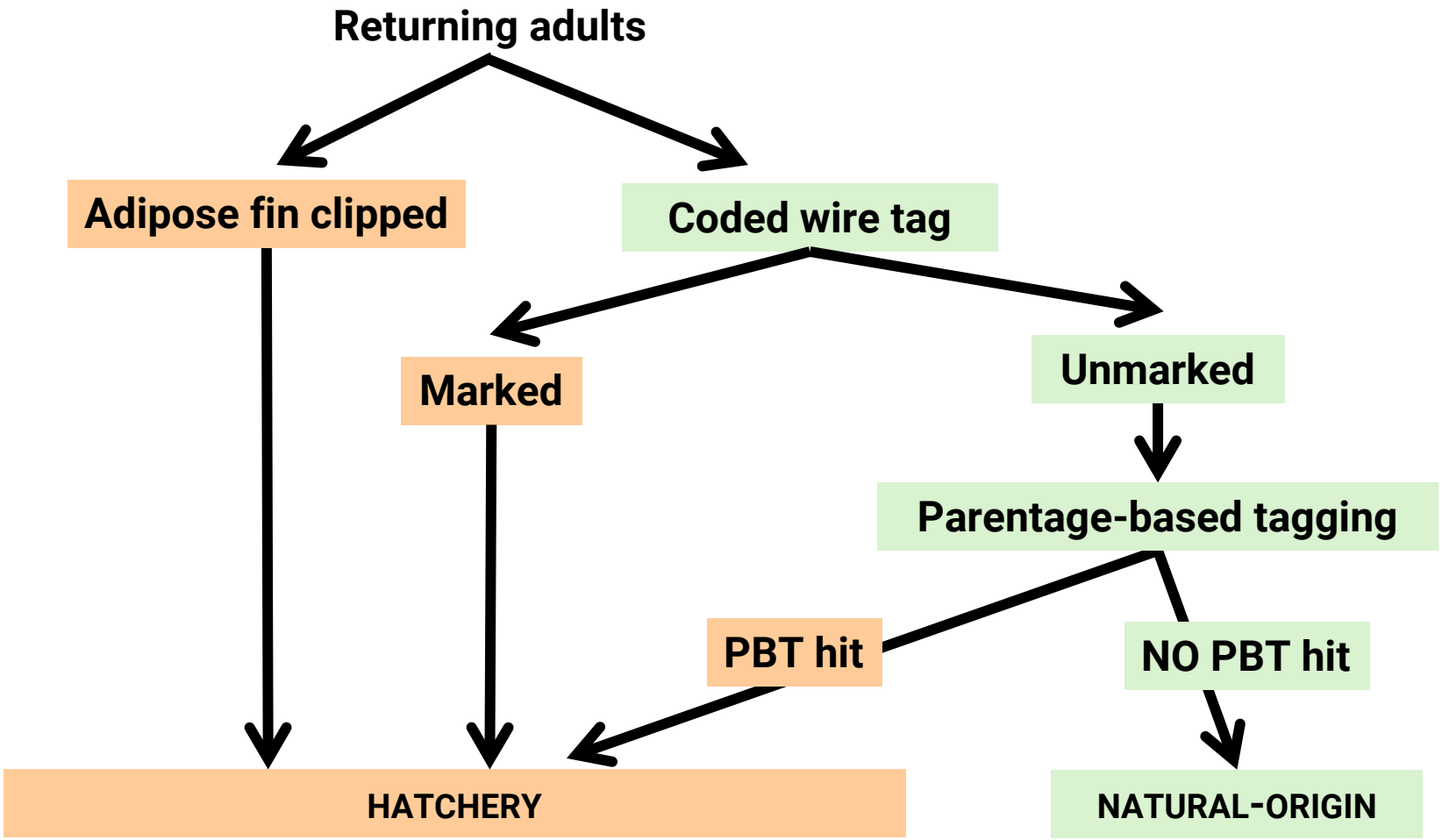
Chinook

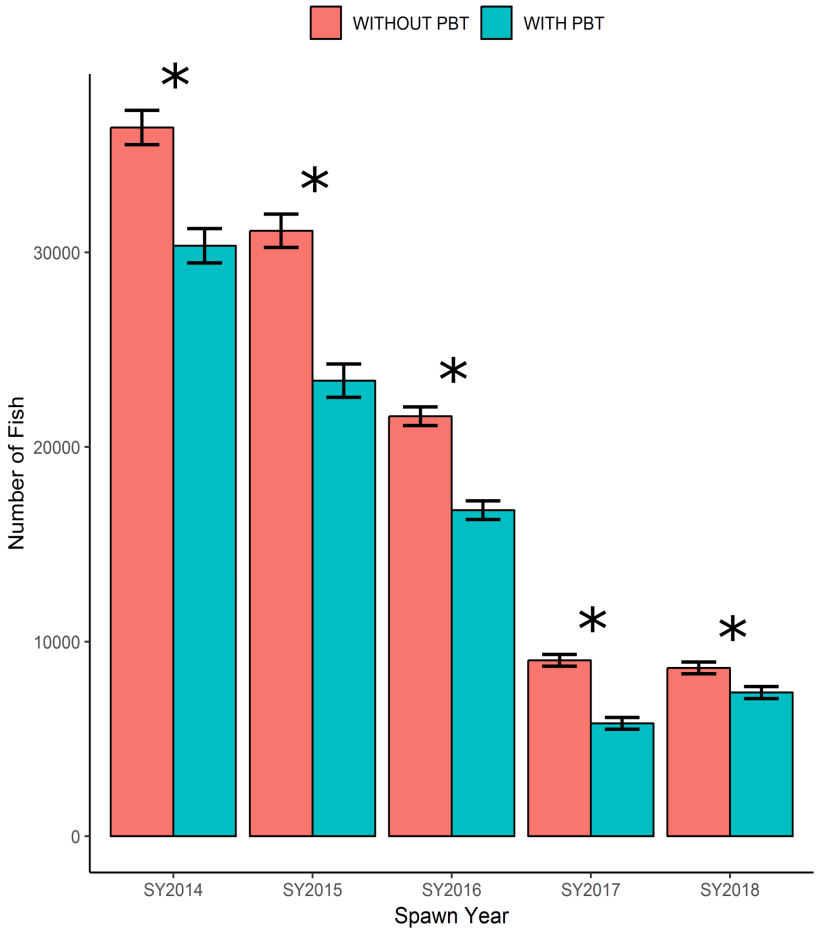
- 7 genetic stocks

Escapement estimation

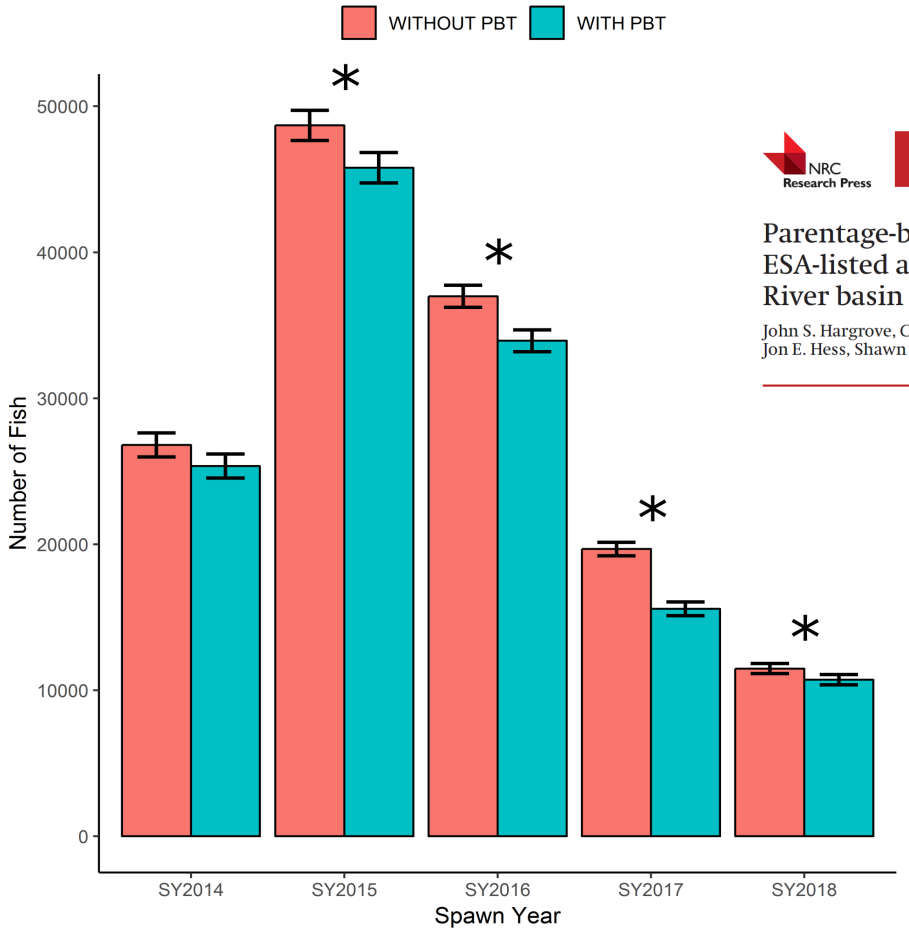
https://upload.wikimedia.org/wikipedia/commons/0/0c/John_Day_Dam_fish_ladder.jpg

Photo credit: IDFG





Chinook



Steelhead

NRC Research Press

ARTICLE

Parentage-based tagging improves escapement estimates for ESA-listed adult Chinook salmon and steelhead in the Snake River basin

John S. Hargrove, Carlos A. Camacho, William C. Schrader, John H. Powell, Thomas A. Delomas, Jon E. Hess, Shawn R. Narum, and Matthew R. Campbell

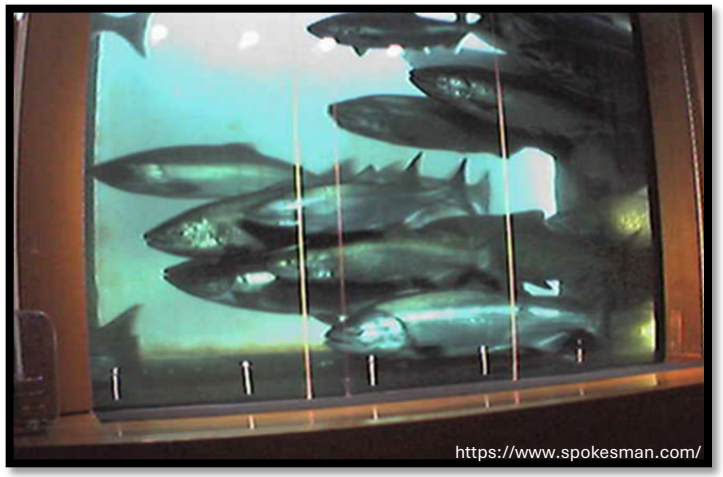
Implementation of PBT

Lower Granite Dam Abundance

In-season Fishery Management

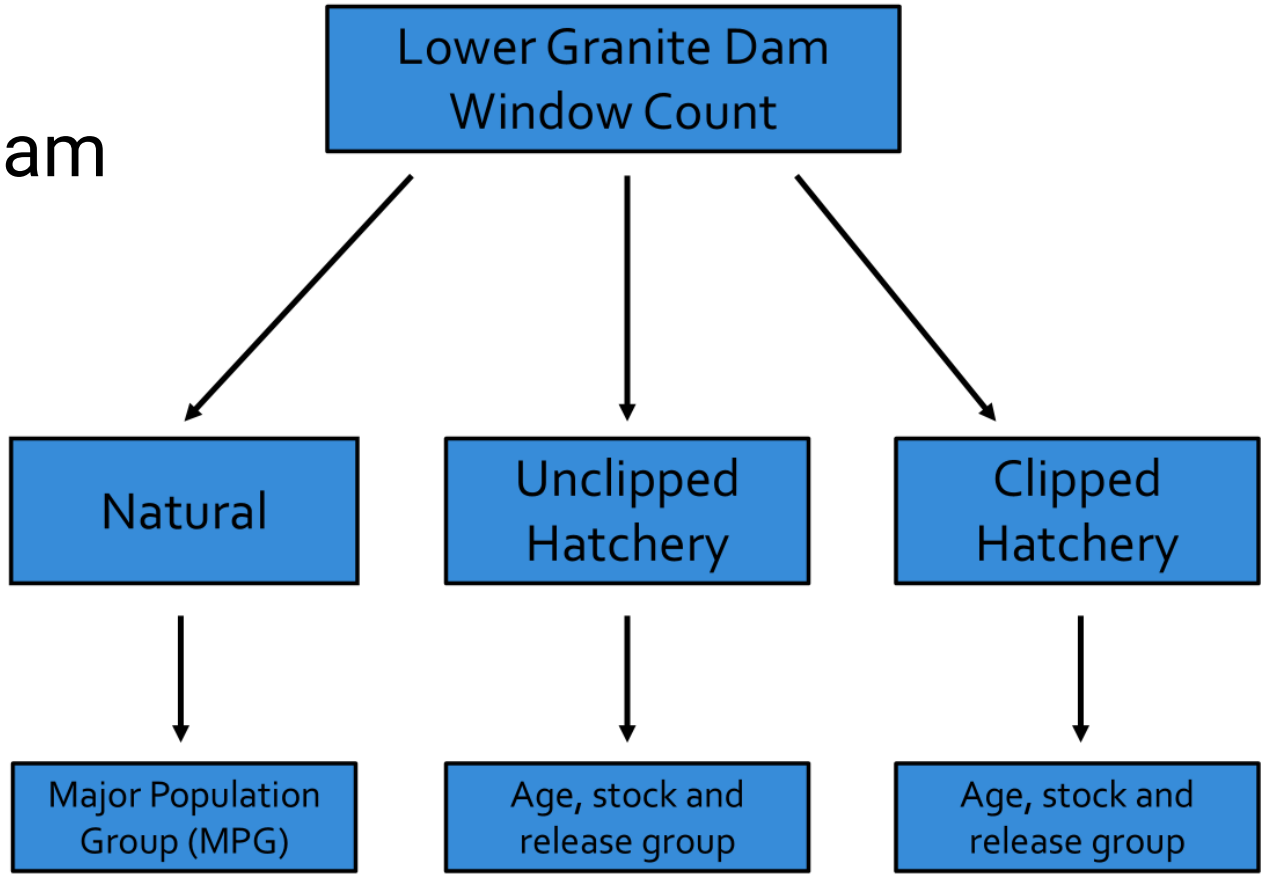
Stock Composition of Harvest

Lower Granite Dam Abundance



Lower Granite Dam Abundance

- GSI and PBT @Lower Granite Dam
  - Steelhead
  - Spring/Summer Chinook
  - Fall Chinook
  - Sockeye



Lower Granite Dam Abundance

- Genetic-informed escapement data fulfills multiple data needs:
  - Run reconstruction for Snake River Basin steelhead, Chinook (all runs), and Sockeye
  - ESA reporting
  - Hatchery mitigation program performance
  - Supporting Regional databases (PNAMP, StreamNet)

LOWER SNAKE RIVER COMPENSATION PLAN
Hatchery Program

IDAHO POWER®
An IDACORP Company

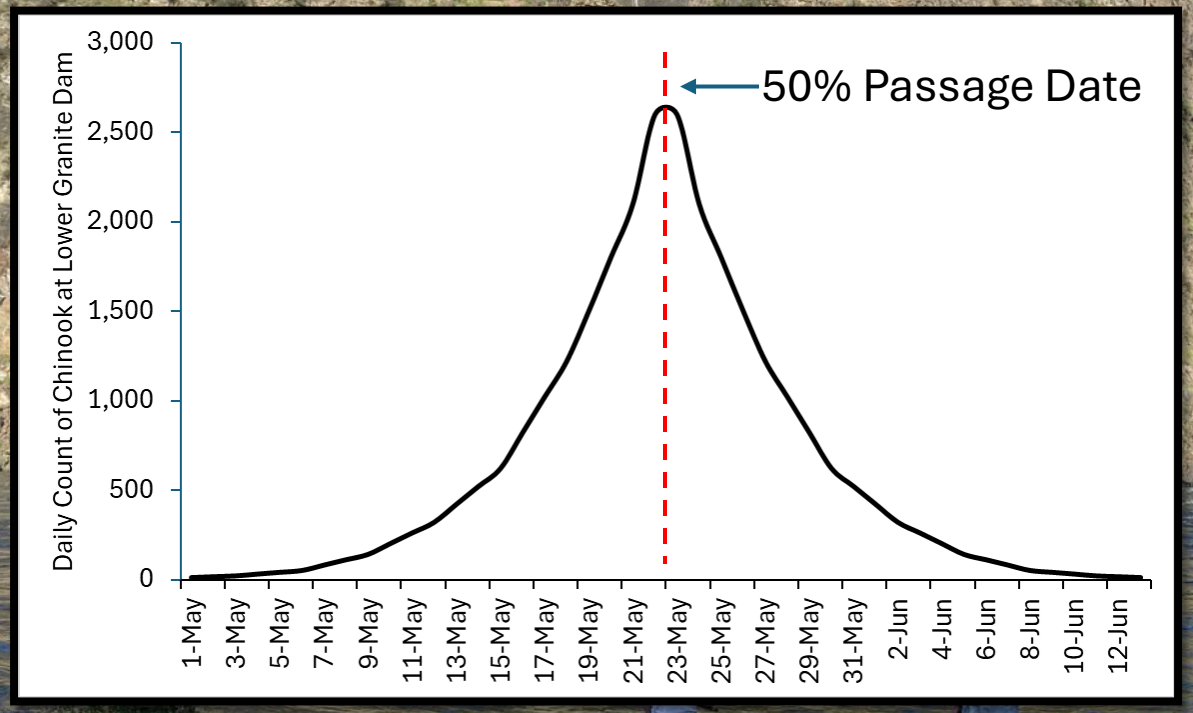
Pacific Northwest Aquatic Monitoring Partnership

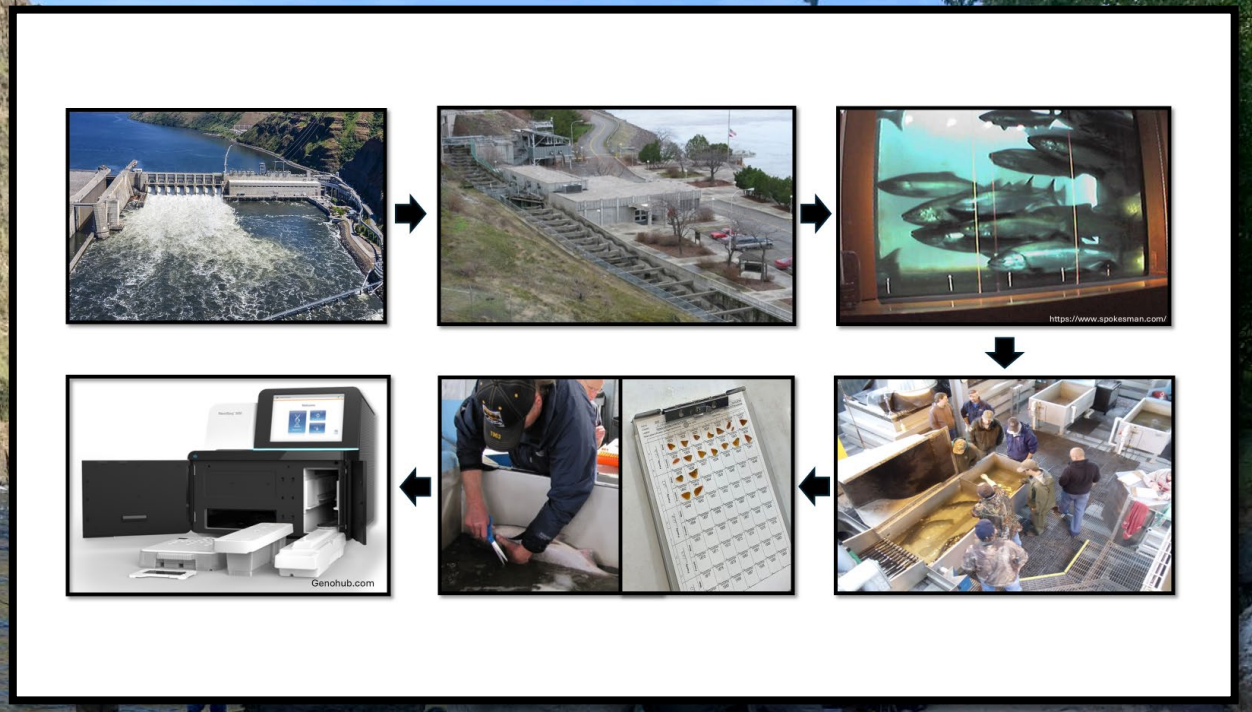
StreamNet
Fish Data for the Northwest

In-season Fishery Management

- Spring/Summer Chinook – Real Time PBT
  - Fisheries managed on harvest shares (quotas)
  - PIT tagged hatchery fish for in-season abundance
    - PIT tags underrepresent actual returns
    - Tag shedding and differential mortality
  - In-season genetic analysis used to refine PIT tag estimates and adjust harvest shares

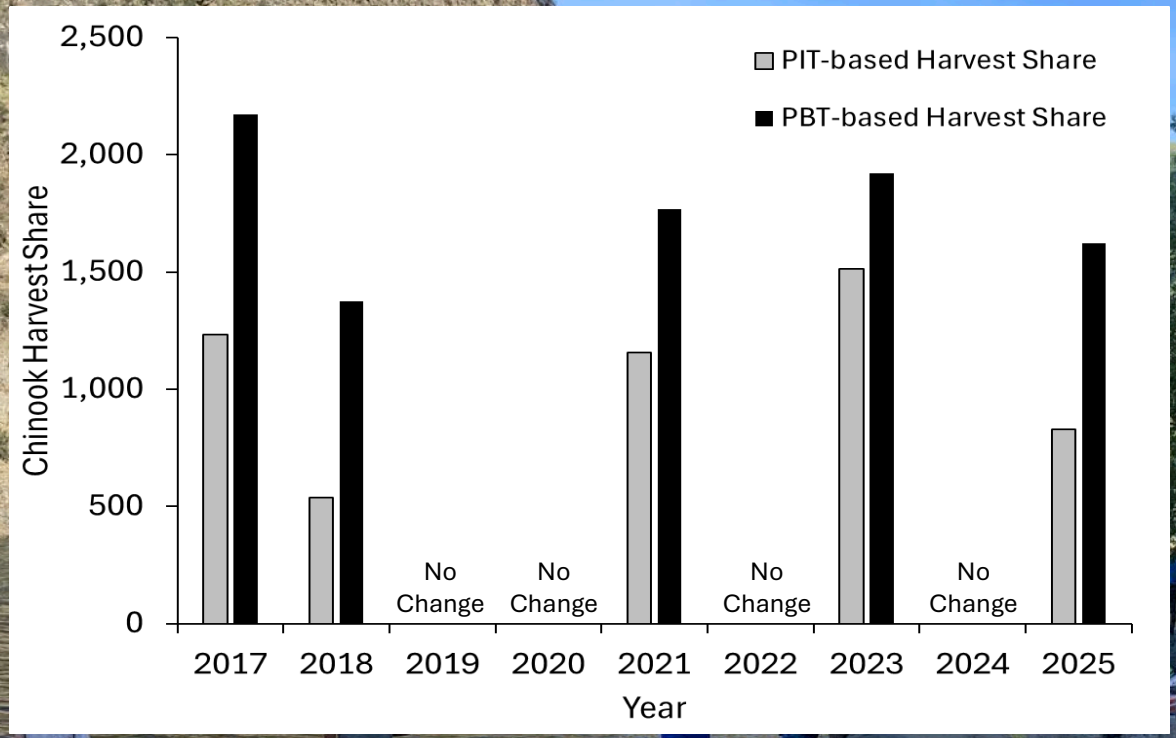
In-season Fishery Management





- Compare PIT estimate and PBT-based estimate at Lower Granite Dam
  - If PIT tags are <65% of the PBT estimate, harvest share is adjusted

In-season Fishery Management

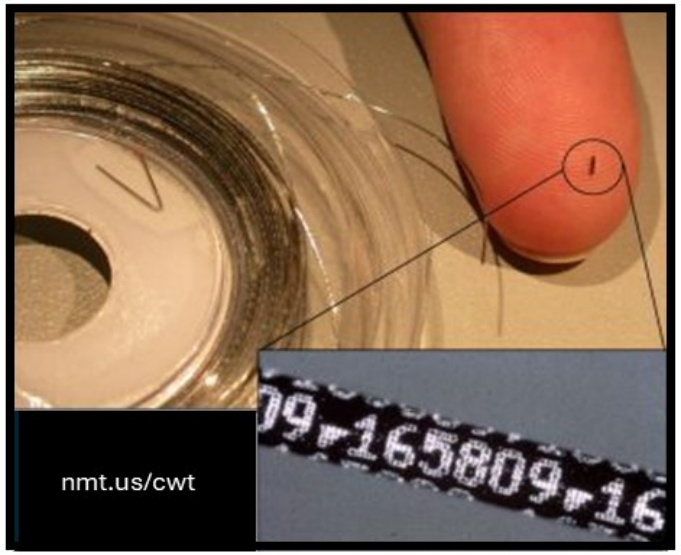


- Spring Chinook Salmon fishery in Idaho – Rapid River run
  - Increased harvest shares for sport and tribal fishery in 5 of 9 years
  - Average 42% increase in harvest shares (range 21 – 61%)
  - Brood needs for Rapid River Hatchery met in all years

Stock Composition of Harvest

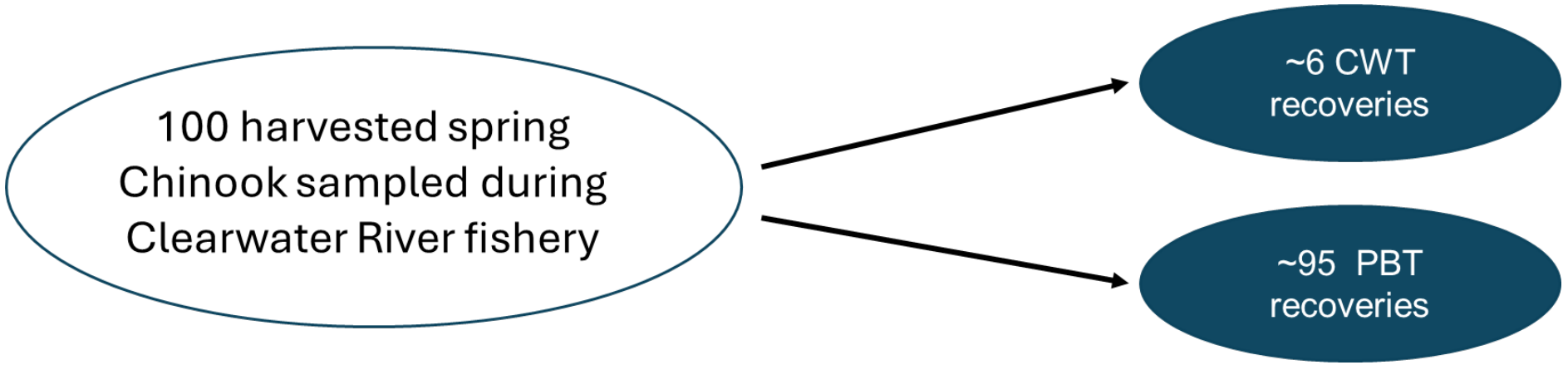
- Steelhead
  - PBT used in Columbia and Snake rivers downstream of Idaho and all Idaho fisheries

- Spring, Summer, and Fall Chinook Salmon
  - PBT used in all fisheries in Idaho



Stock Composition of Harvest

- Increased efficiency for field staff
- Increased precision for stock composition estimates of harvest



Acknowledgements

- Funding:
  - Bonneville Power Administration
  - Pacific Coast Salmon Recovery Fund
  - Idaho Power Company
  - Lower Snake River Compensation Plan
- Sample collection
  - Lower Granite Dam trap staff
  - IDFG Scale Aging Lab
  - IDFG, IPC, ODFW, WDFW, USFWS hatchery and creel staff
- Data inventory/management
  - Jesse McCane, Lynn Schrader, Jeff Stephenson
- Laboratory analysis
  - Angie Chia, Kelly Heindel, Chyanne Rosenbaum, Odbayar Tumendemberel
- Analyses
  - Katharine Coykendall, Maureen Hess, Nate Campbell, Brian Leth, Chris Noyes, Nicolette Beekin