Science, Service, Stewardship

Genetics: Science and Implications in Salmon Management

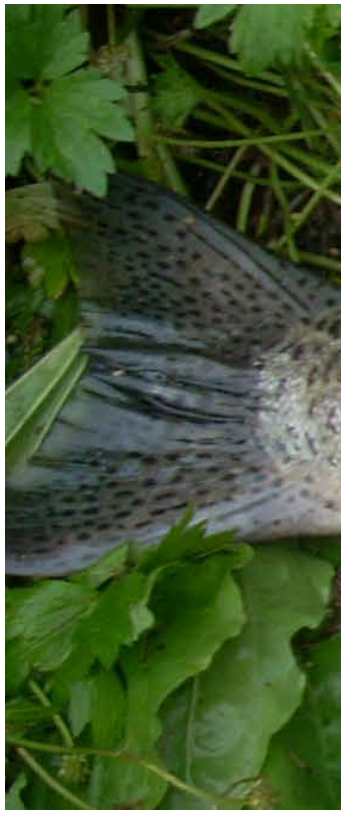
Doug DeMaster
Director, Alaska Fisheries Science Center
NMFS

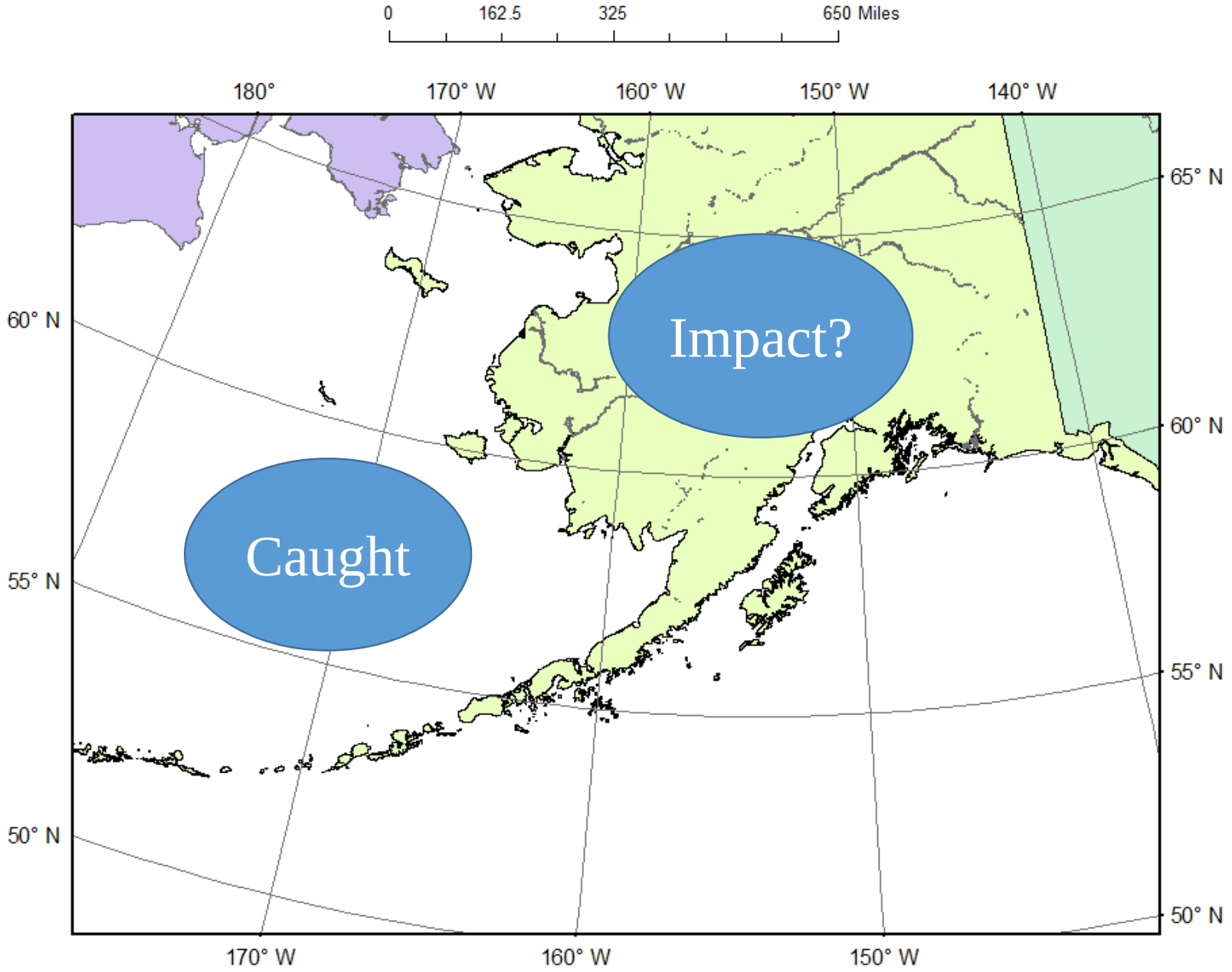
Jeff Guyon
Genetics Program Manager, Auke Bay Laboratories
NMFS

Bill Templin
Principle Geneticist, Gene Conservation Laboratory
ADF&G

NOAA FISHERIES SERVICE

August 25, 2015




0
162.5
325
650 Miles
180°
170° W
160° W
150° W
140° W
65° N
60° N
55° N
50° N
Impact?
Caught

Timeline

8-8:10 AM Doug DeMaster – Director, Alaska Fisheries Science Center

8:10-8:35 AM Bill Templin – Alaska Department of Fish and Game Alaska State Fisheries

8:35-9:00 AM Jeff Guyon – National Marine Fisheries Service Alaska Federal Fisheries (marine)

9-9:30 AM New technologies and panel discussion

Alaska's Genetics Program

Genetics applications for fisheries management

Gene Conservation Laboratory
Division of Commercial Fisheries
Alaska Department of Fish and Game

Why does ADF&G have a genetics lab?

Alaska Department of Fish and Game uses genetic information to achieve its mission 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*.

Why does ADF&G have a genetics lab?

Alaska Department of Fish and Game uses genetic information to achieve its mission 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*.

The activities of the Gene Conservation Laboratory fall into 4 main categories:

1. Basic research to understand the resource
2. Development of capabilities
3. Inform/Assess management actions
4. Research to inform human activities

Questions that use genetic information

Did exposure to mutagens cause genetic injury?

- EVOS oiling experiments

What species of salmon is this?

- Atlantic salmon escapees

Is this crab a hybrid?

- Snow/tanner crab hybrids

Which broodstock are these unmarked salmon from?

- DIPAC broodstock

What is the structure of these populations?

- Sockeye salmon in Bristol Bay lakes

Where are these fish going?

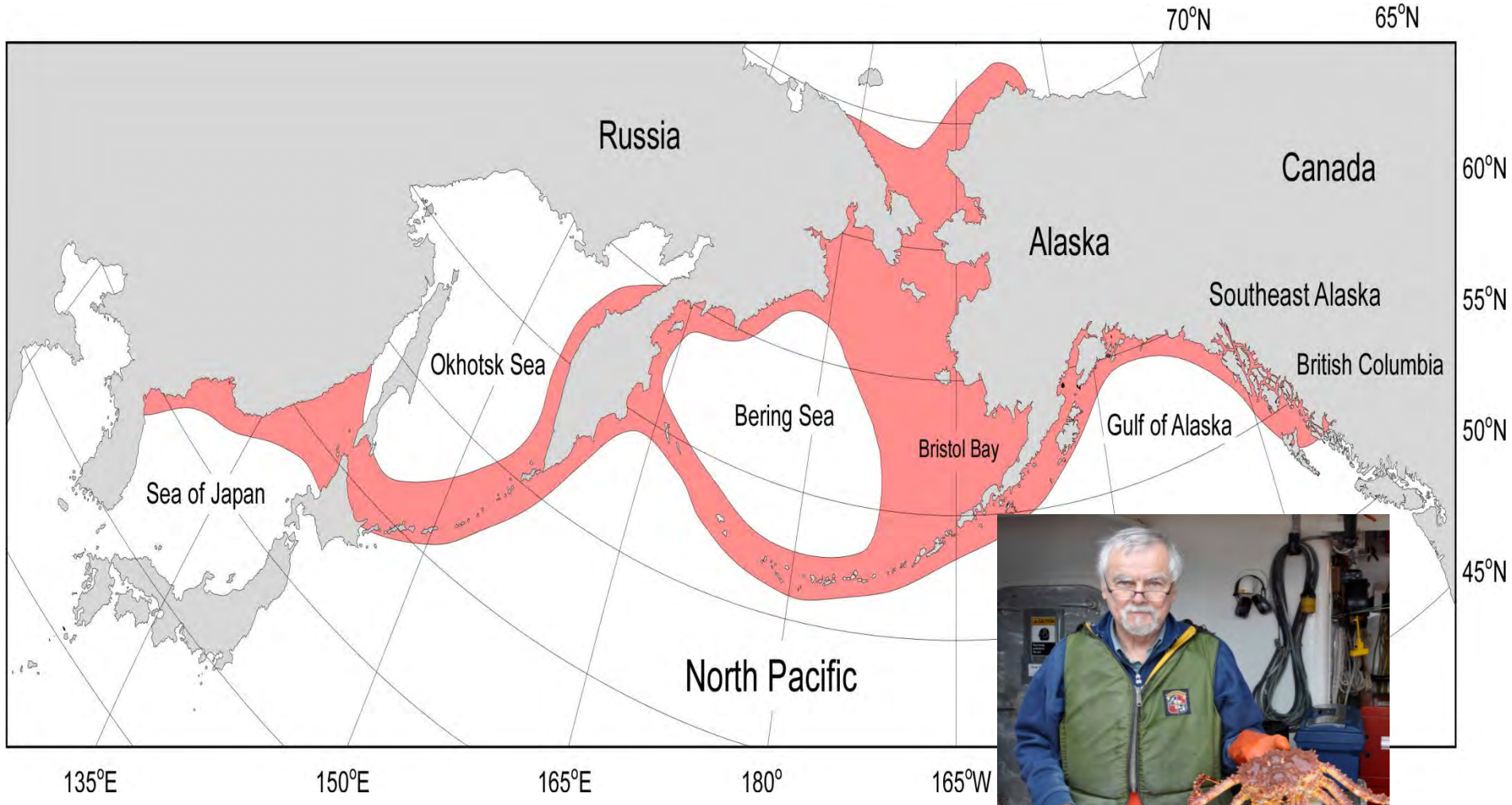
- Chinook salmon in SE Alaska
- Sockeye salmon in the Bering Sea

Who's fish are being harvested?

- Bering Sea salmon bycatch

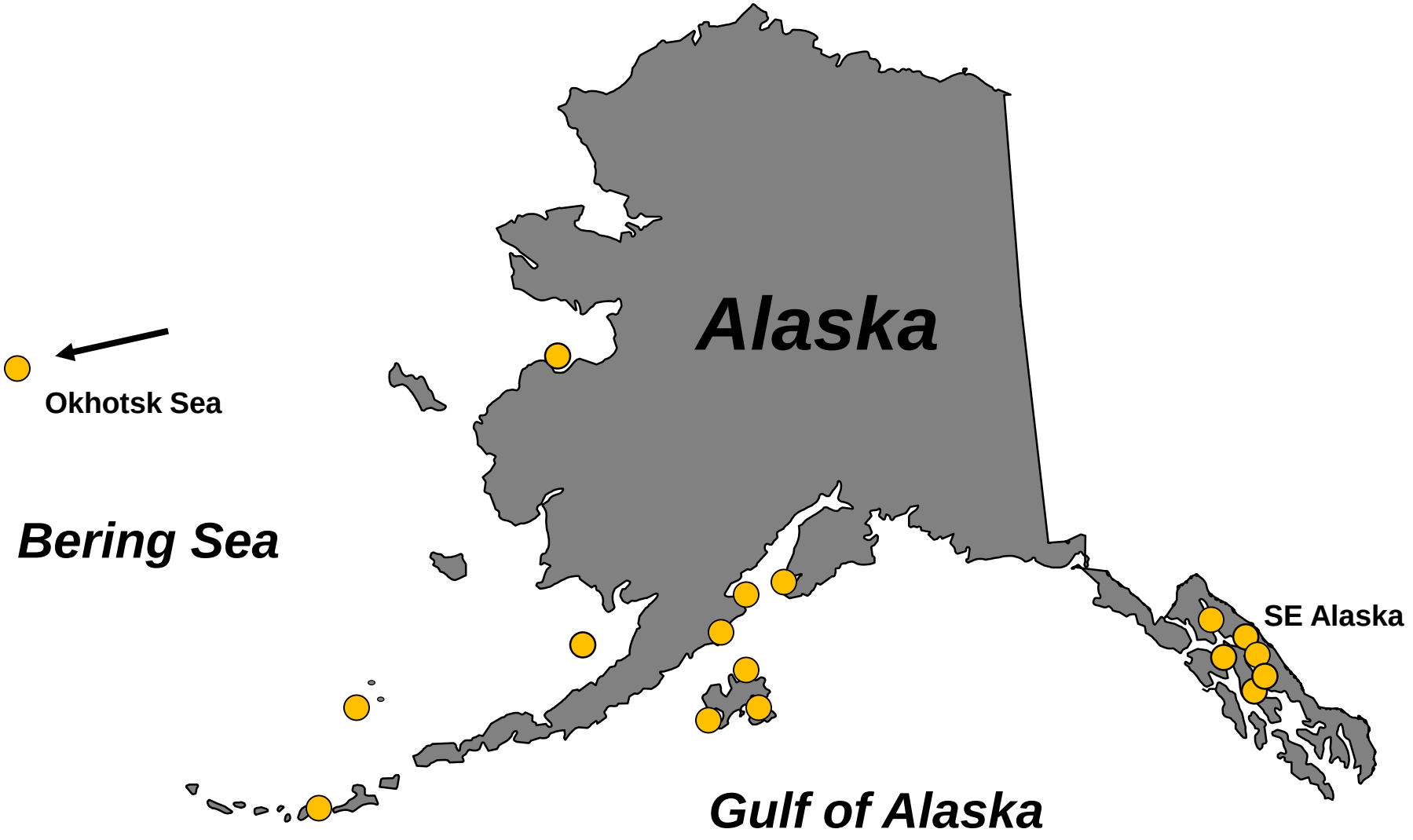
Applications: Understanding the Resource

Example: Red king crab population structure



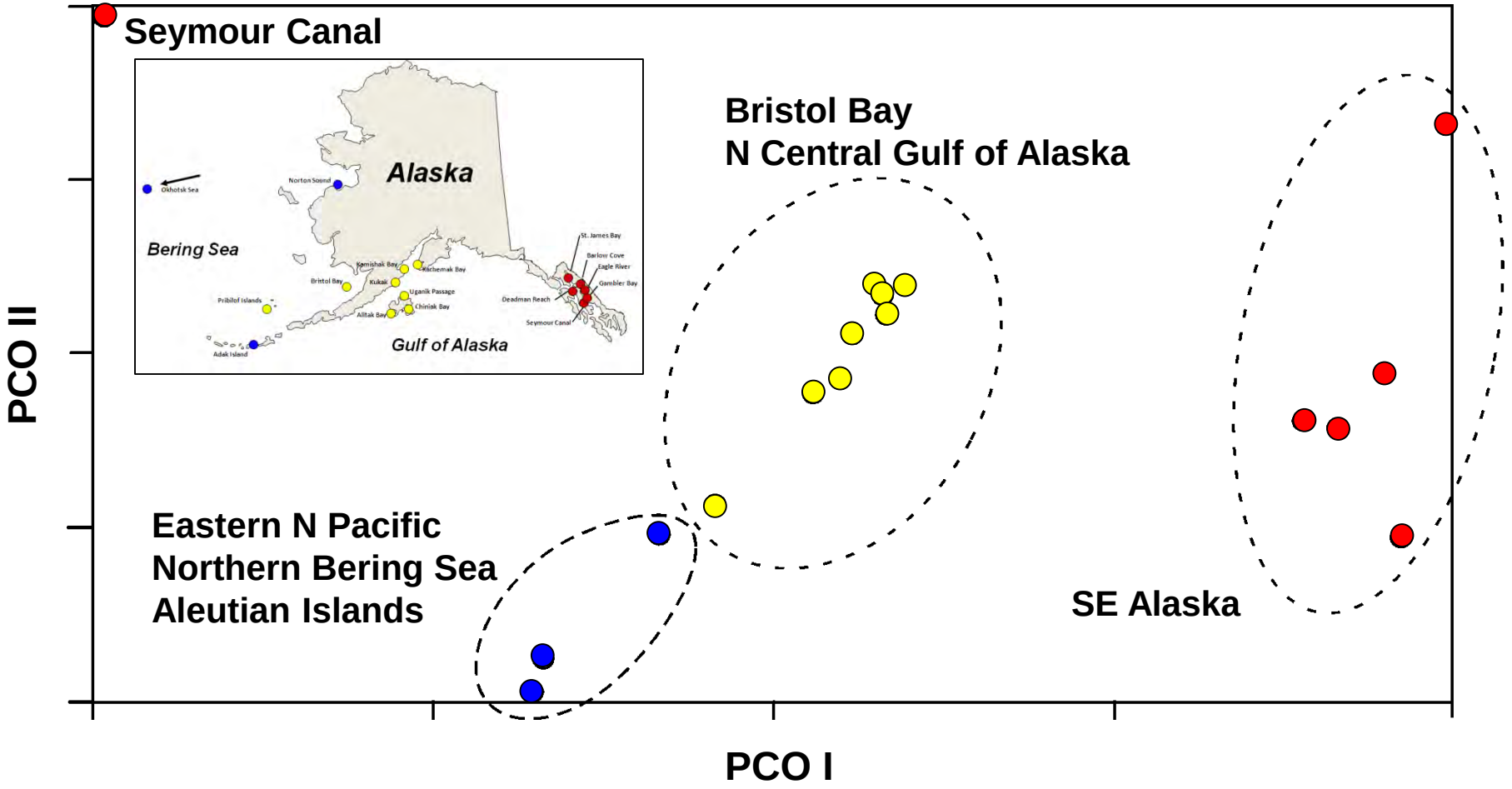
Applications: Understanding the Resource

Example: Red king crab population structure



Applications: Understanding the Resource

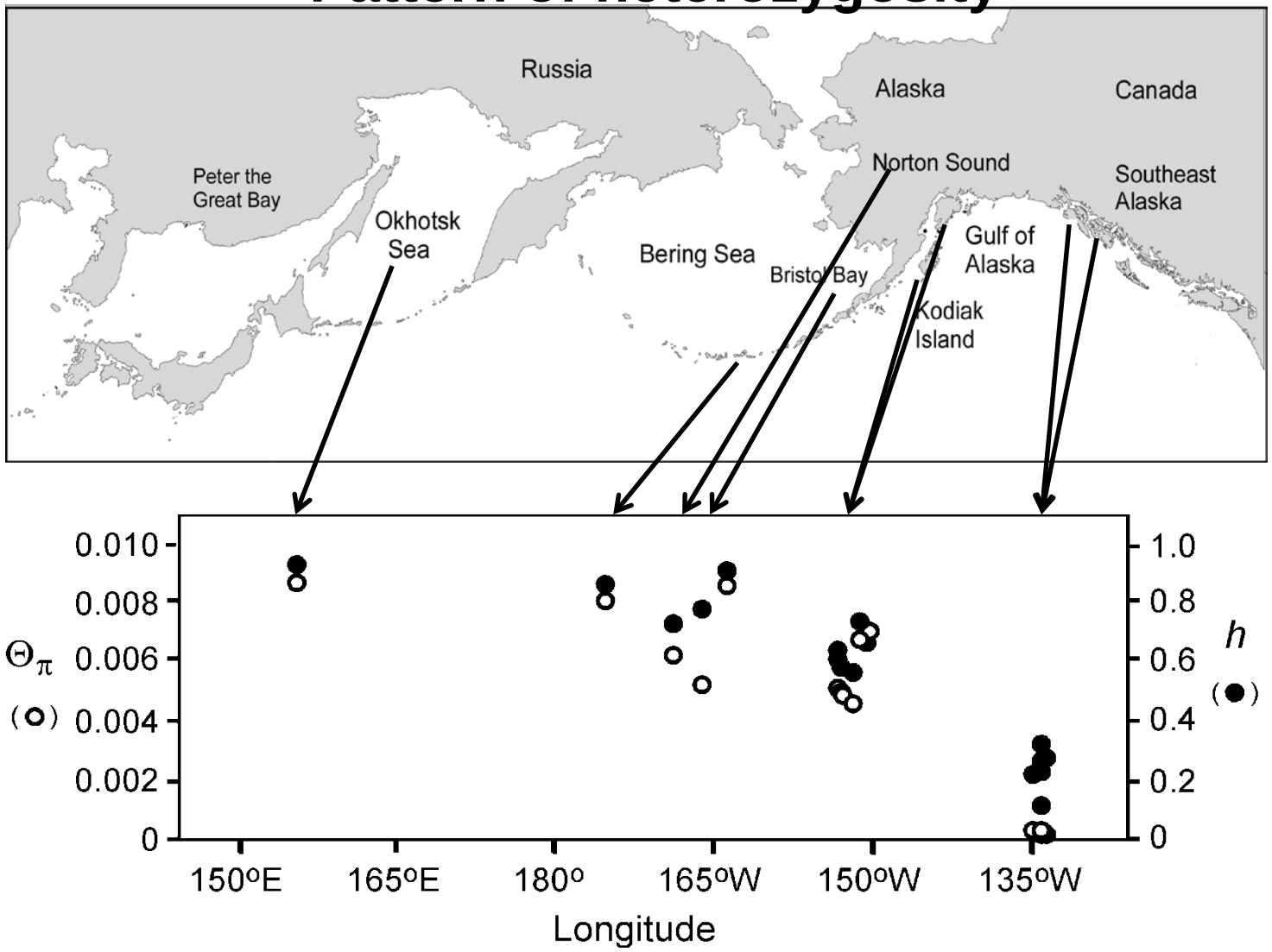
Example: Red king crab population structure



Applications: Understanding the Resource

Example: Red king crab population structure

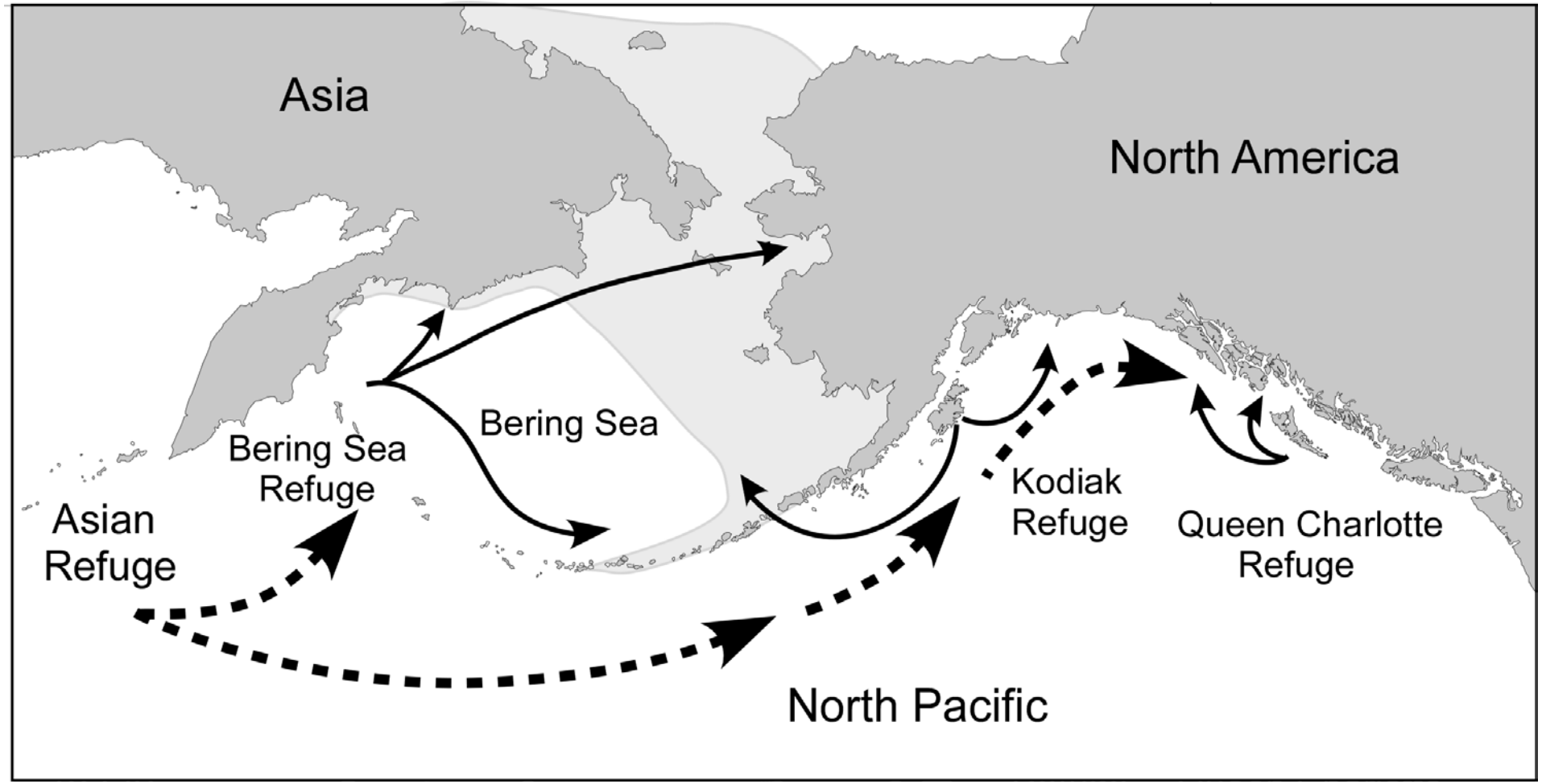
Pattern of heterozygosity



Applications: Understanding the Resource

Example: Red king crab population structure

Post-glacial Colonization Routes



Applications: Understanding the Resource

Example: Red king crab population structure

Implications

- **Gene flow and ice-age isolations**
- **Red king crab might be managed on a small geographic scale in some regions**
- **Guidance for possible stock enhancement**

Applications: Develop Capabilities

Example: Chinook salmon coastwide baseline

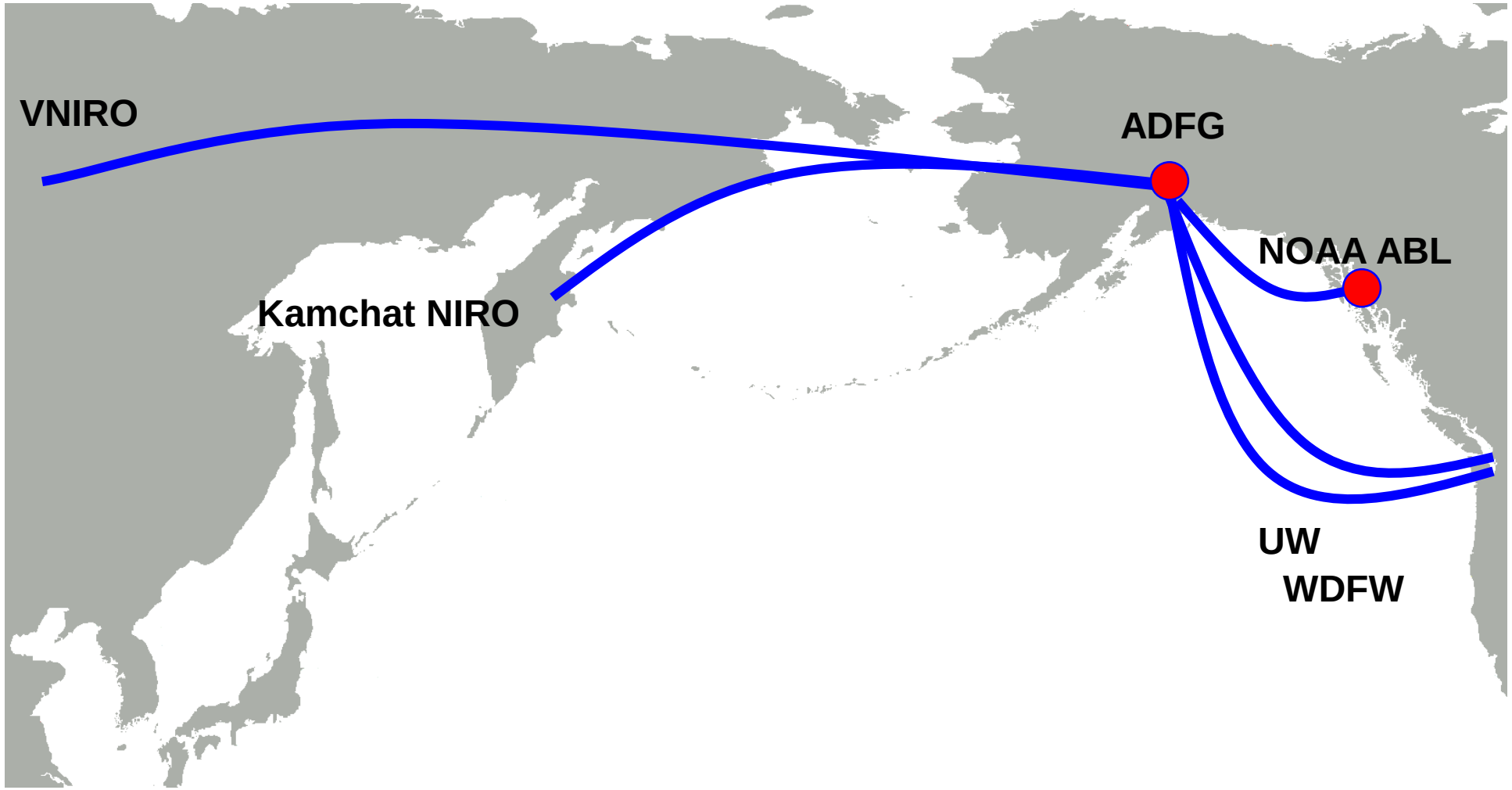
Alaska Department of Fish and Game

NOAA Fisheries

University of Washington

Applications: Develop Capabilities

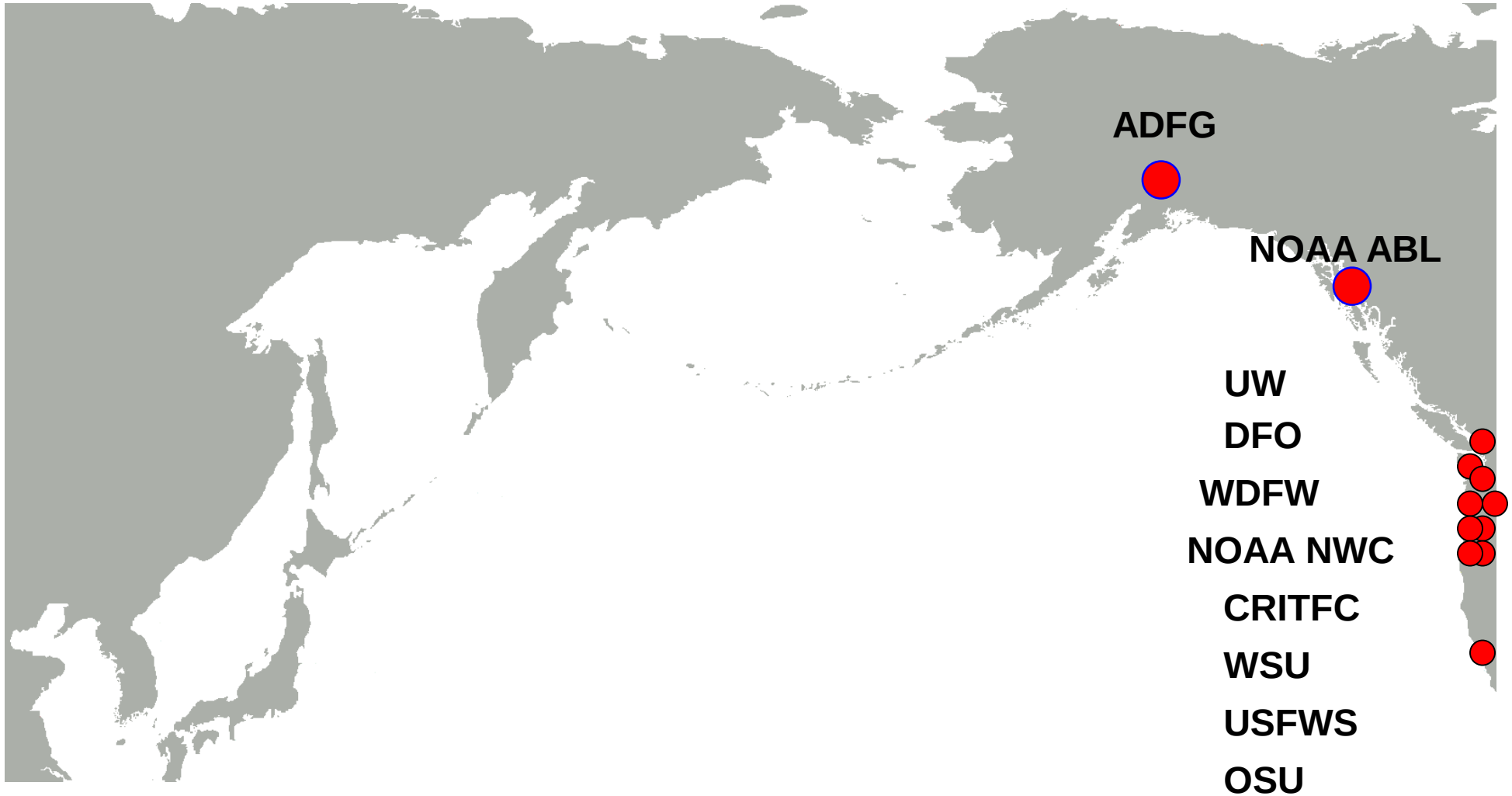
Example: Chinook salmon coastwide baseline



North Pacific Anadromous Fish Commission Partners

Applications: Develop Capabilities

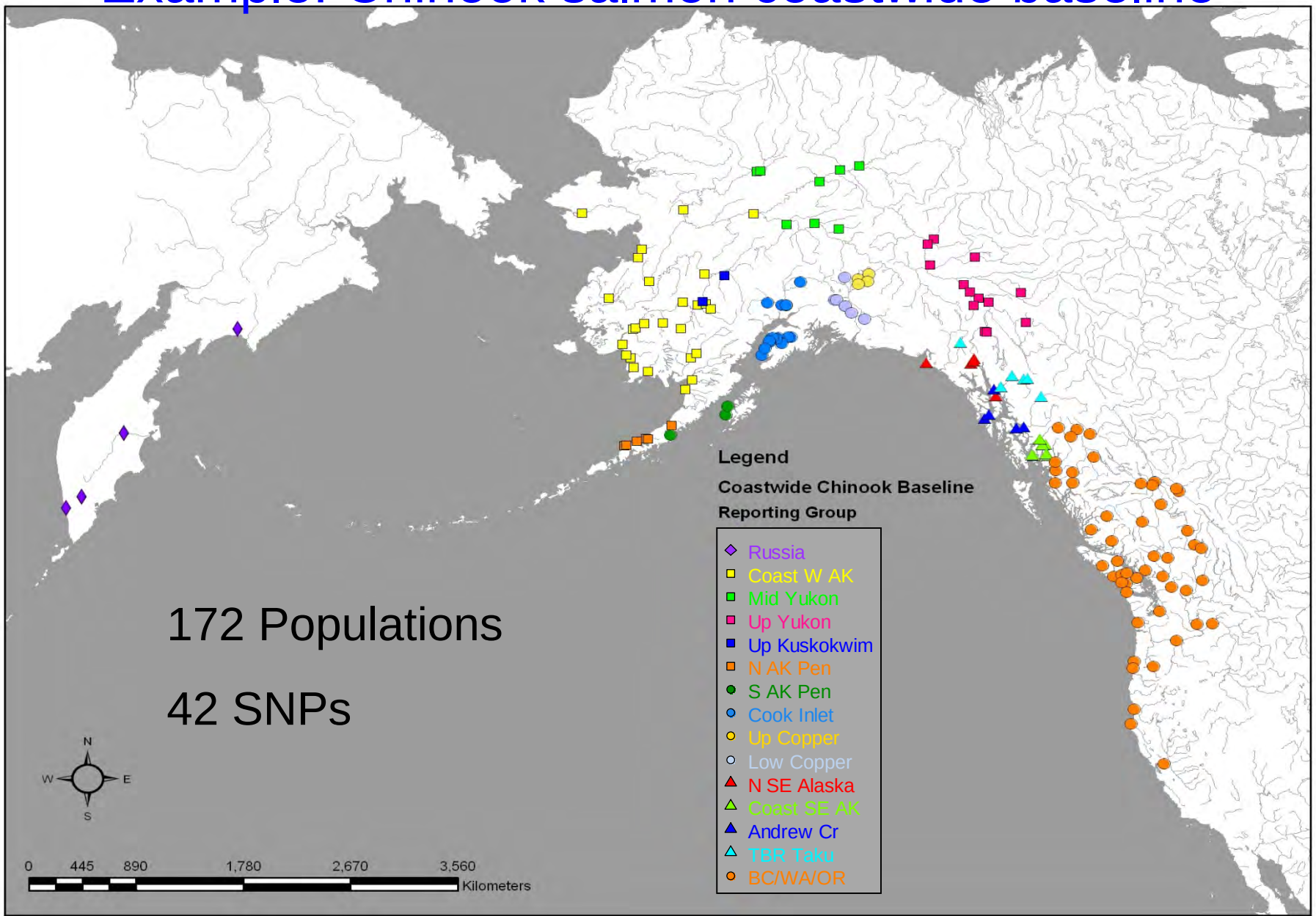
Example: Chinook salmon coastwide baseline



Pacific Salmon Commission Partners

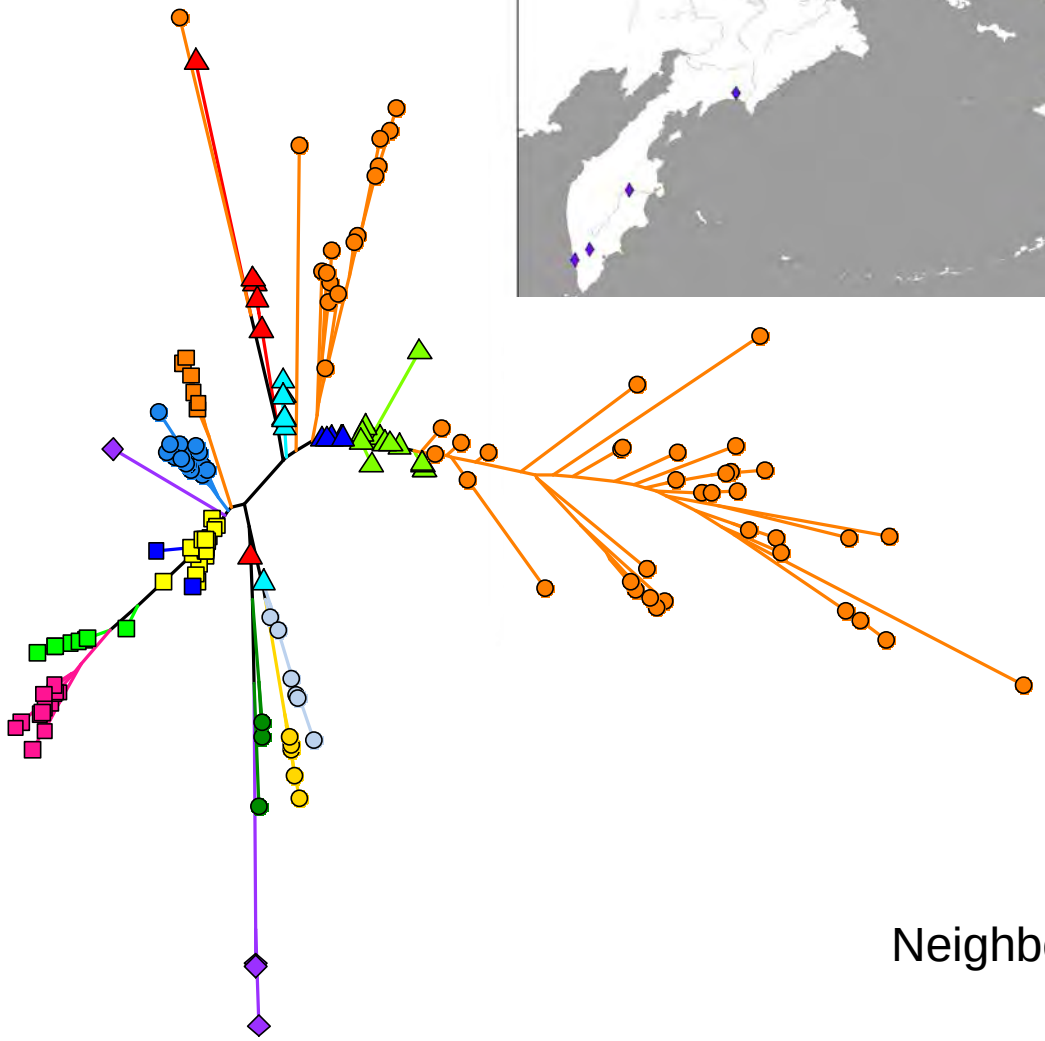
Applications: Develop Capabilities

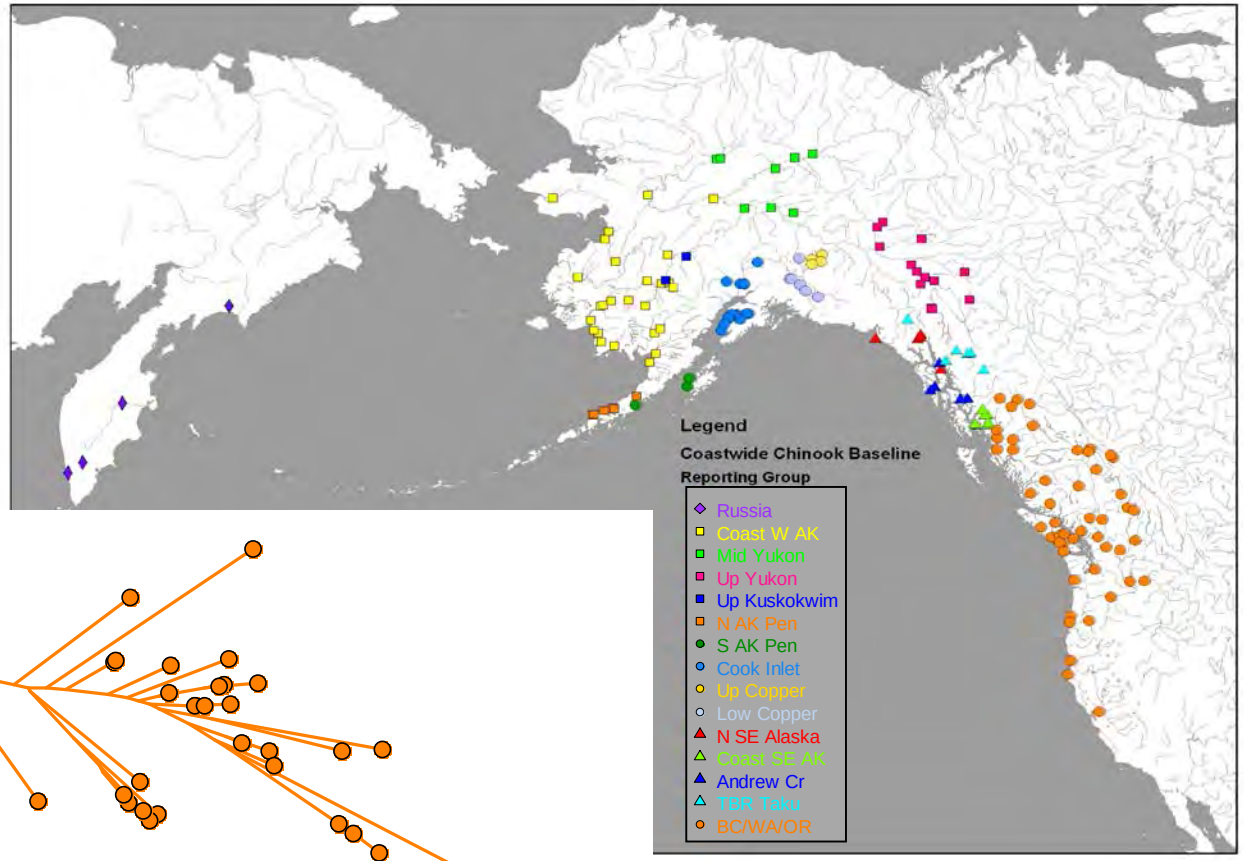
Example: Chinook salmon coastwide baseline



Applications: Develop Capabilities

Example: Chinook salmon coastwide baseline



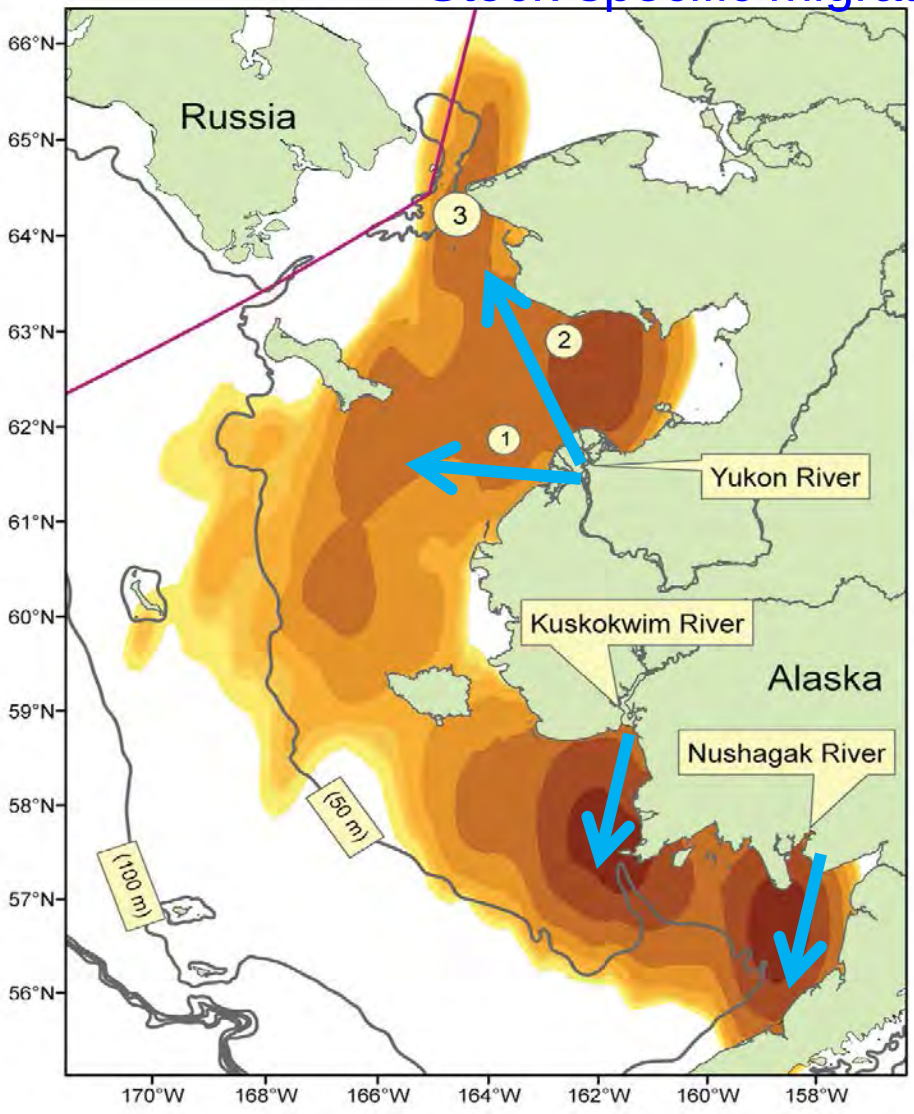


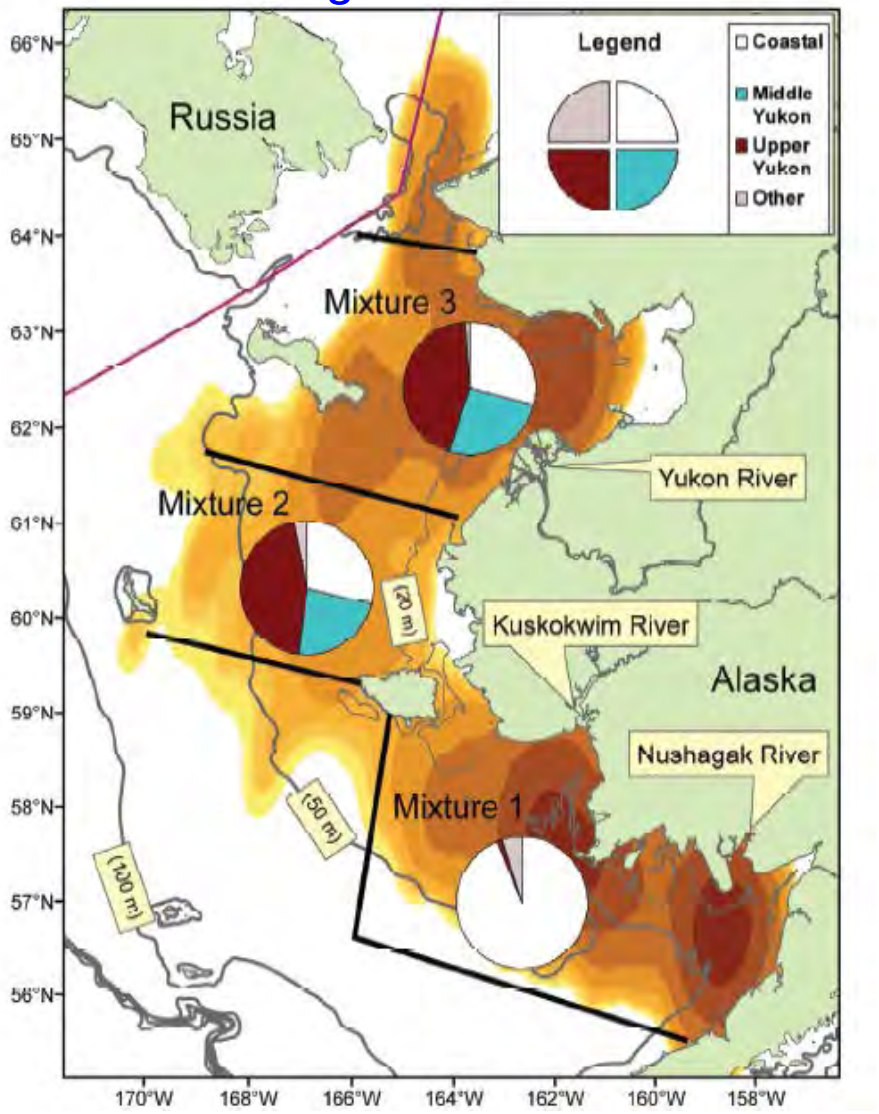
Neighbor Joining based on F_{ST}

Applications: Develop Capabilities

Example: Chinook salmon coastwide baseline

Stock-specific migration in the Bering Sea





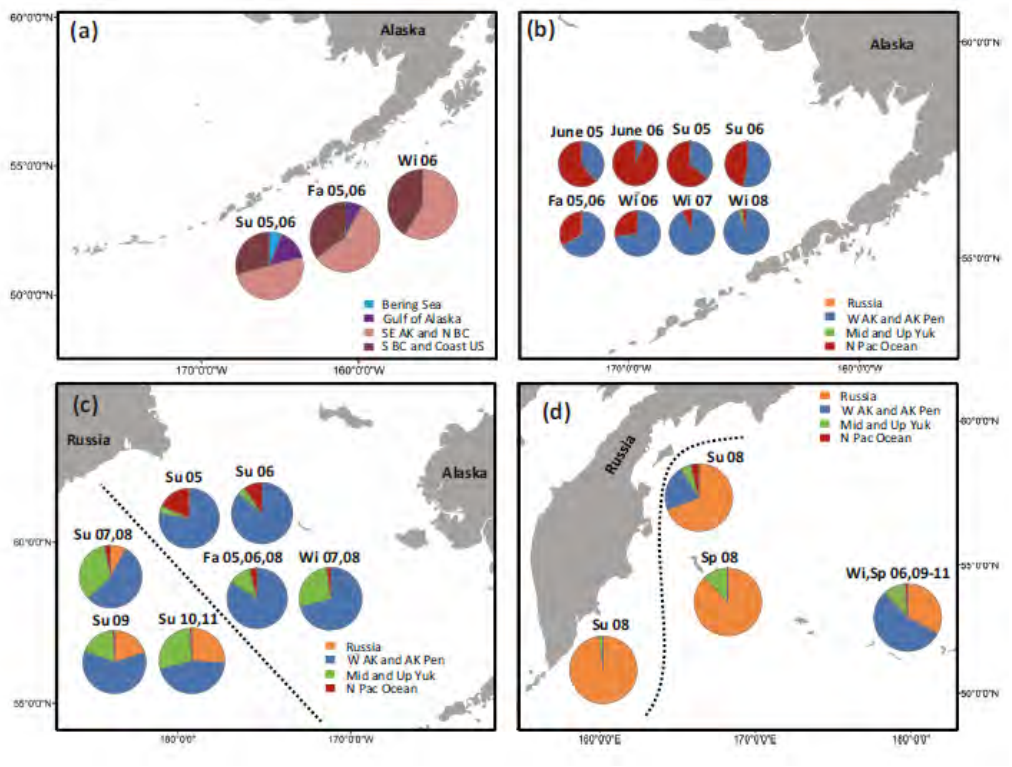
Murphy et al. 2009

Stock-Structured Distribution of Western Alaska and Yukon Juvenile Chinook Salmon from United States BASIS surveys, 2002-2007

Applications: Develop Capabilities

Example: Chinook salmon coastwide baseline

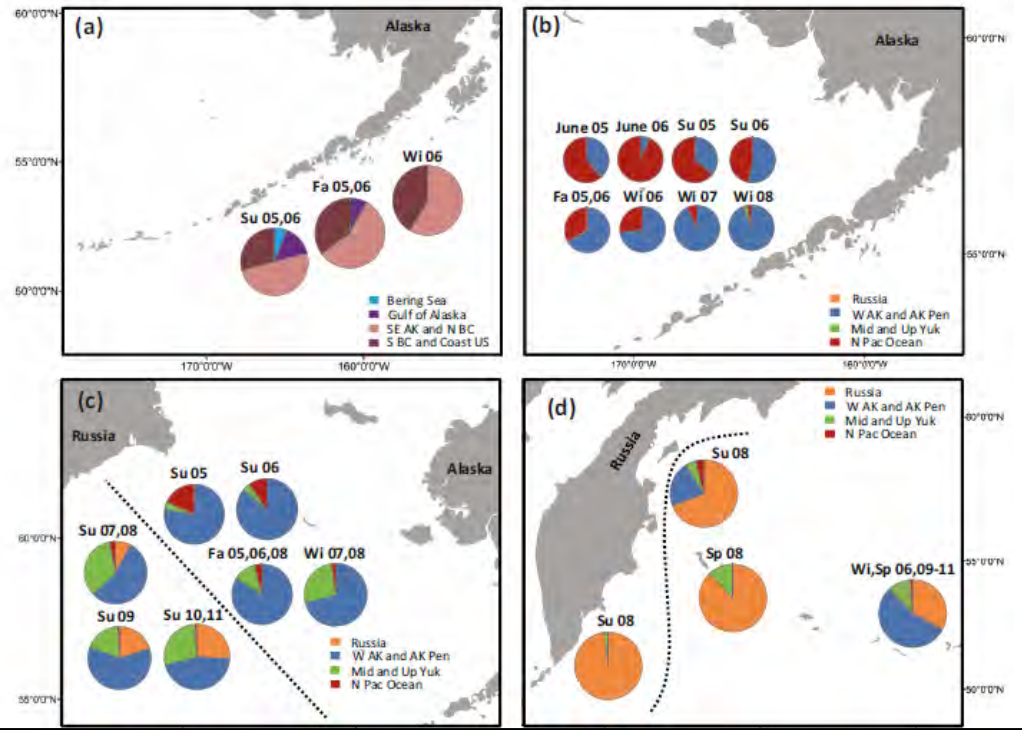
Stock-specific migration in the Bering Sea

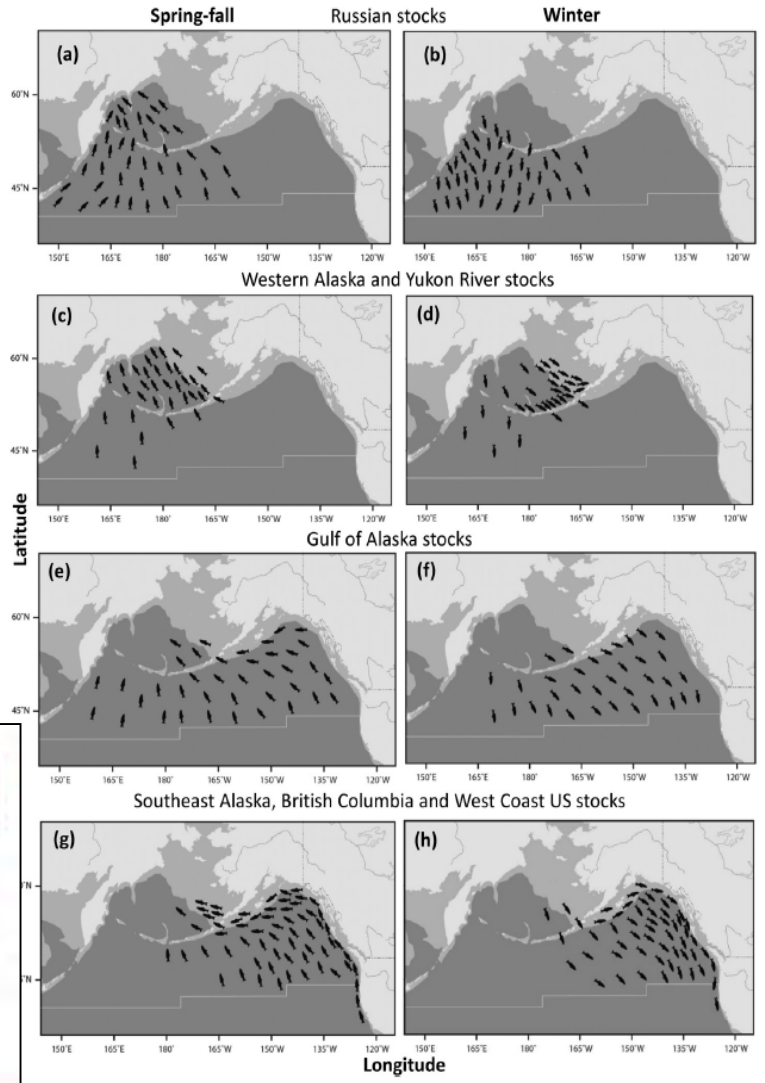


Applications: Develop Capabilities

Example: Chinook salmon coastwide baseline

Stock-specific migration in the Bering Sea





128

NRC Research Press

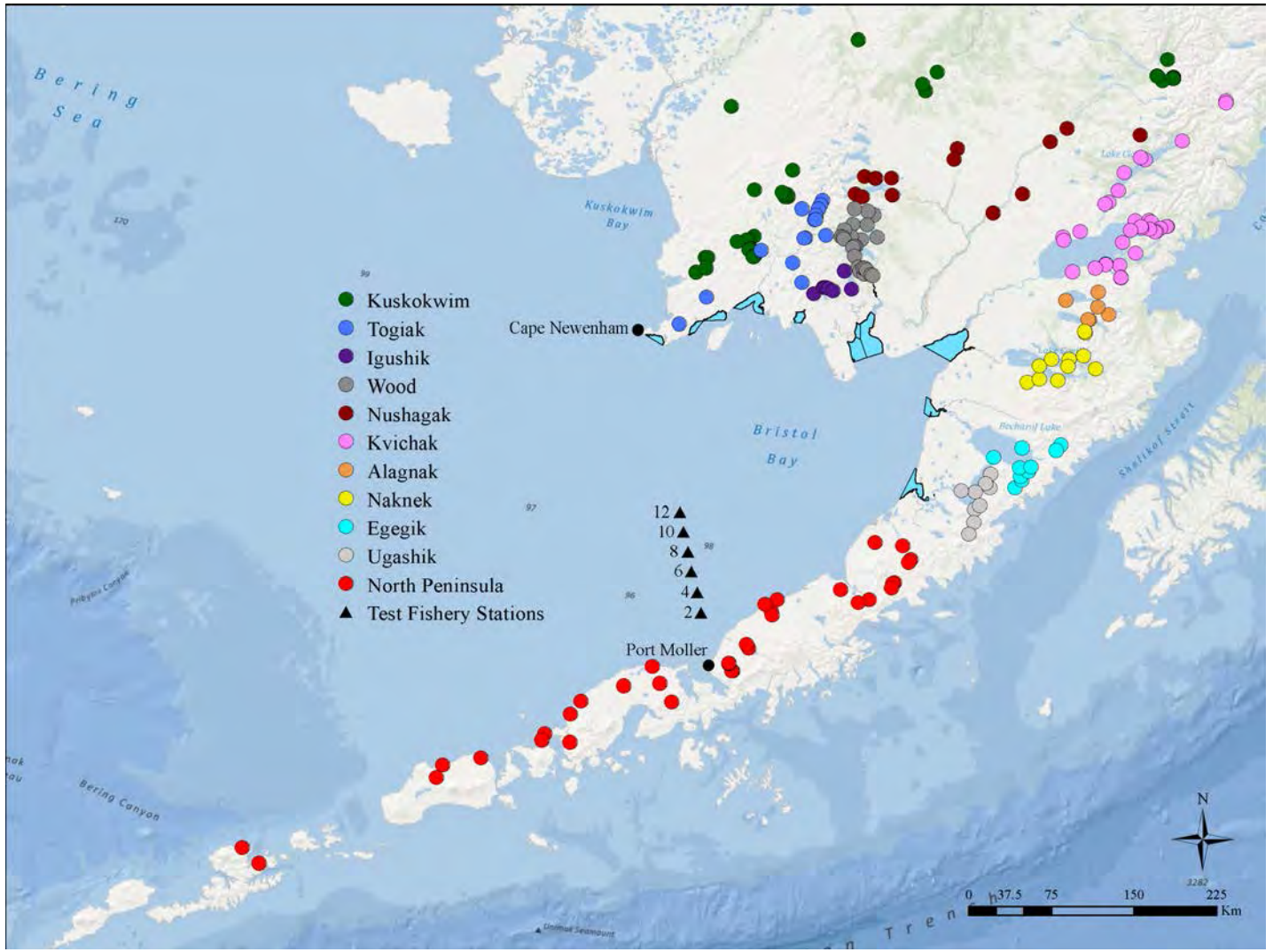
ARTICLE

Single-nucleotide polymorphisms reveal distribution and migration of Chinook salmon (*Oncorhynchus tshawytscha*) in the Bering Sea and North Pacific Ocean

Wesley A. Larson, Fred M. Utter, Katherine W. Myers, William D. Templin, James E. Seeb, Charles M. Guthrie III, Alexander V. Bugaev, and Lisa W. Seeb

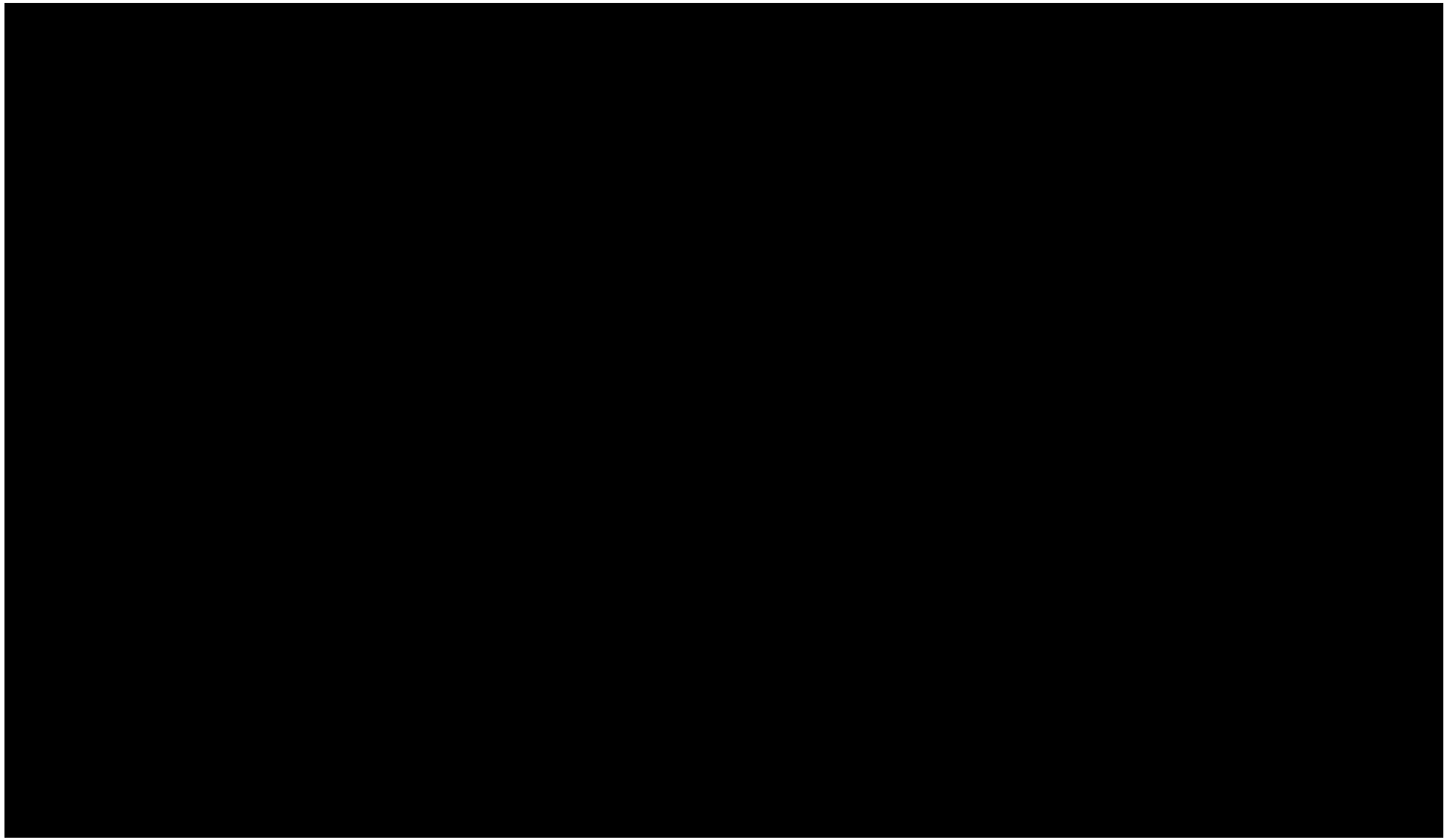
Applications: Inform/Assess Management

Example: Stock composition of harvest
Port Moller Test Fishery - Inseason



Applications: Inform/Assess Management

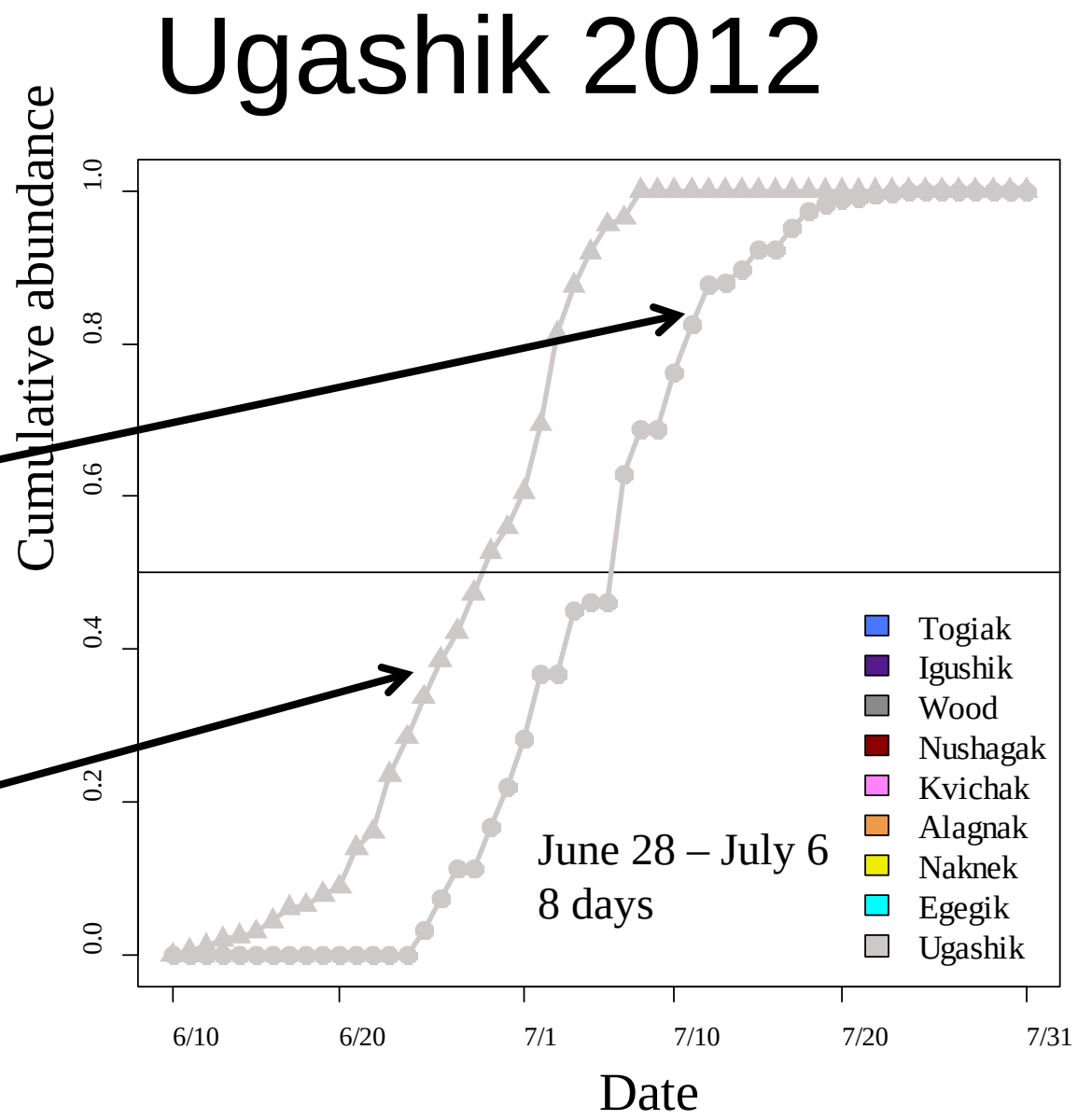
Example:Port Moller Test Fishery - Inseason



http://vimeo.com/110201354

Applications: Inform/Assess Management

Example:Port Moller Test Fishery - Inseason



Applications: Inform/Assess Management

Example: Stock composition of harvest

Western Alaska Salmon Stock Identification Program – Post season

Applications: Inform/Assess Management

Example: Stock composition of harvest

Western Alaska Salmon Stock Identification Program – Post season

- Political support to fund large scale, collaborative genetic stock identification study

IF

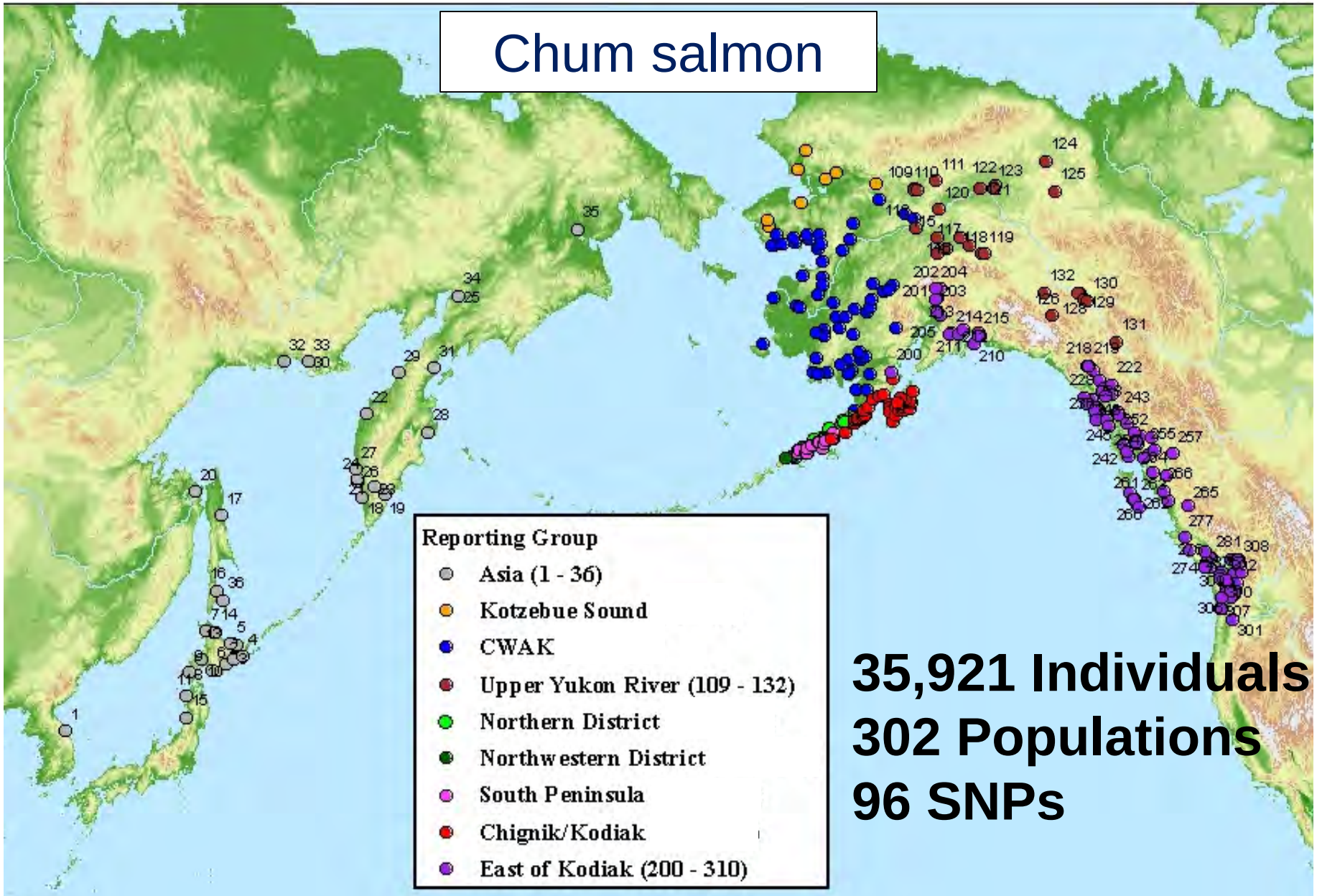
- Stakeholders agree on necessary information, study design and results

WASSIP Advisory Panel

Alaska Fish and Game
Aleut Corp
Aleutians East Borough
Assoc. Village Council Presidents
Bering Sea Fishermen's Association
Bristol Bay Native Association
Concerned Area M Fishermen
Kawerak Inc.
Lake and Peninsula Borough
Tanana Chiefs Conference
Yukon River Drainage Fisheries Assoc.

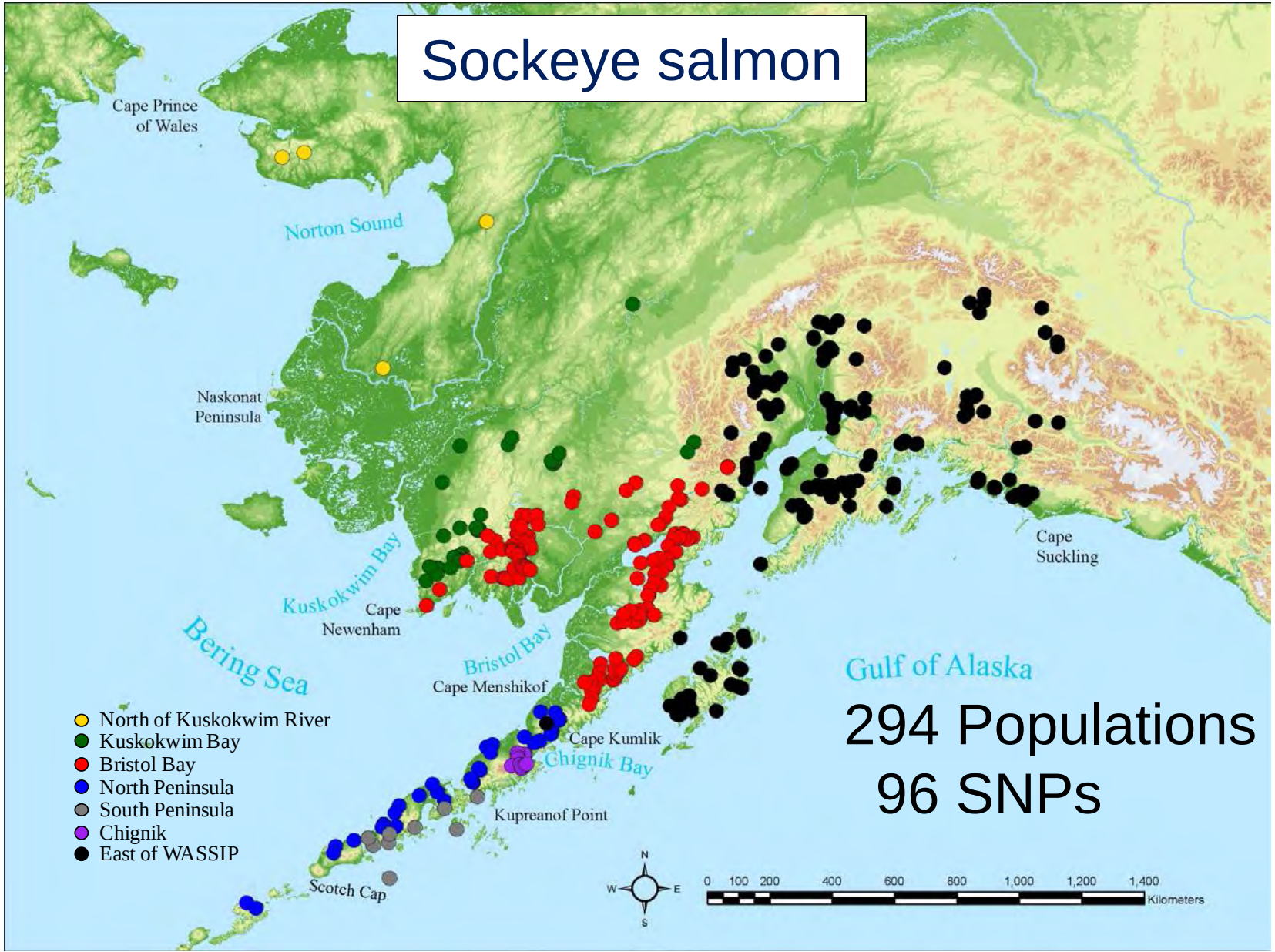
Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program



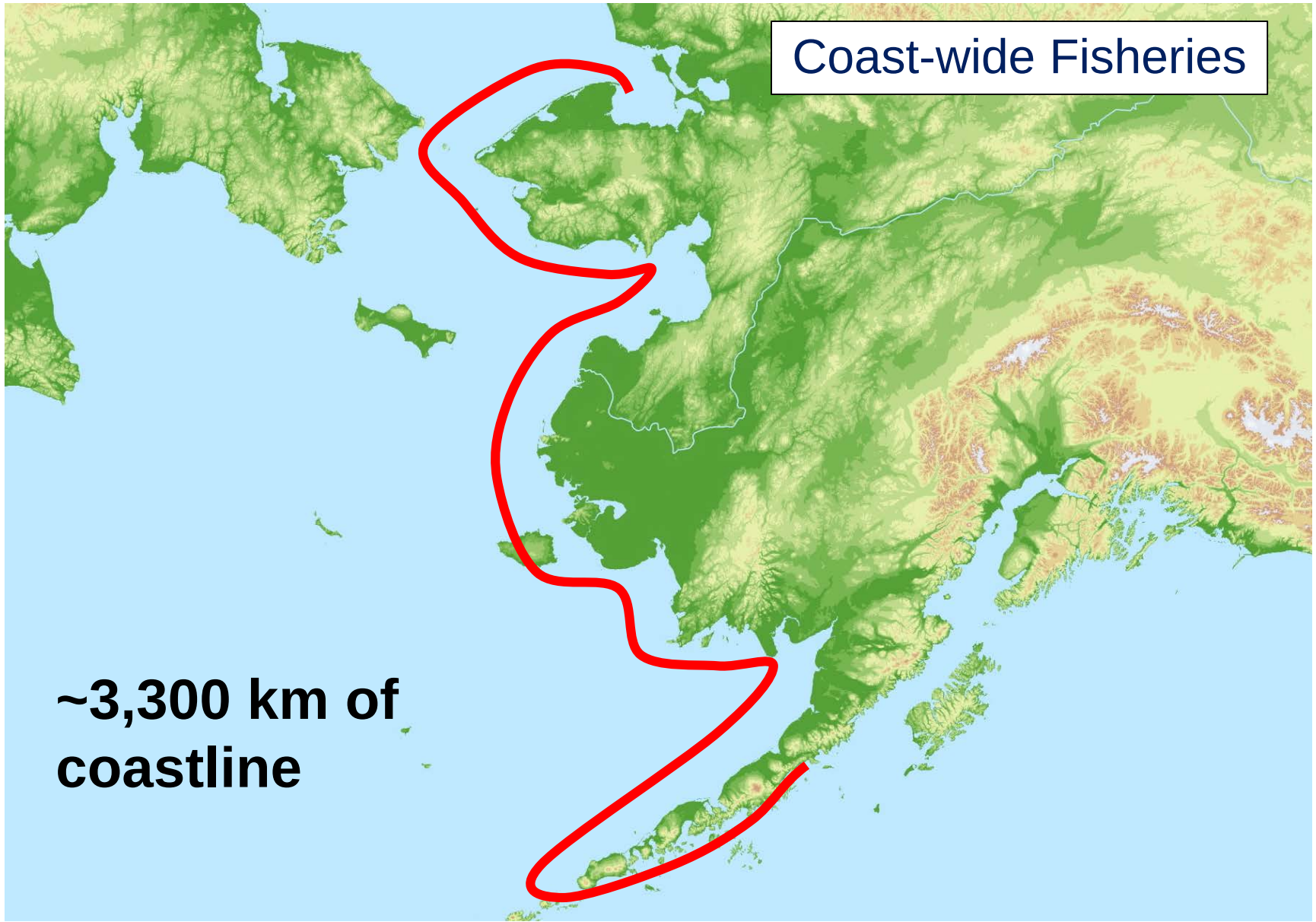
Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program



Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

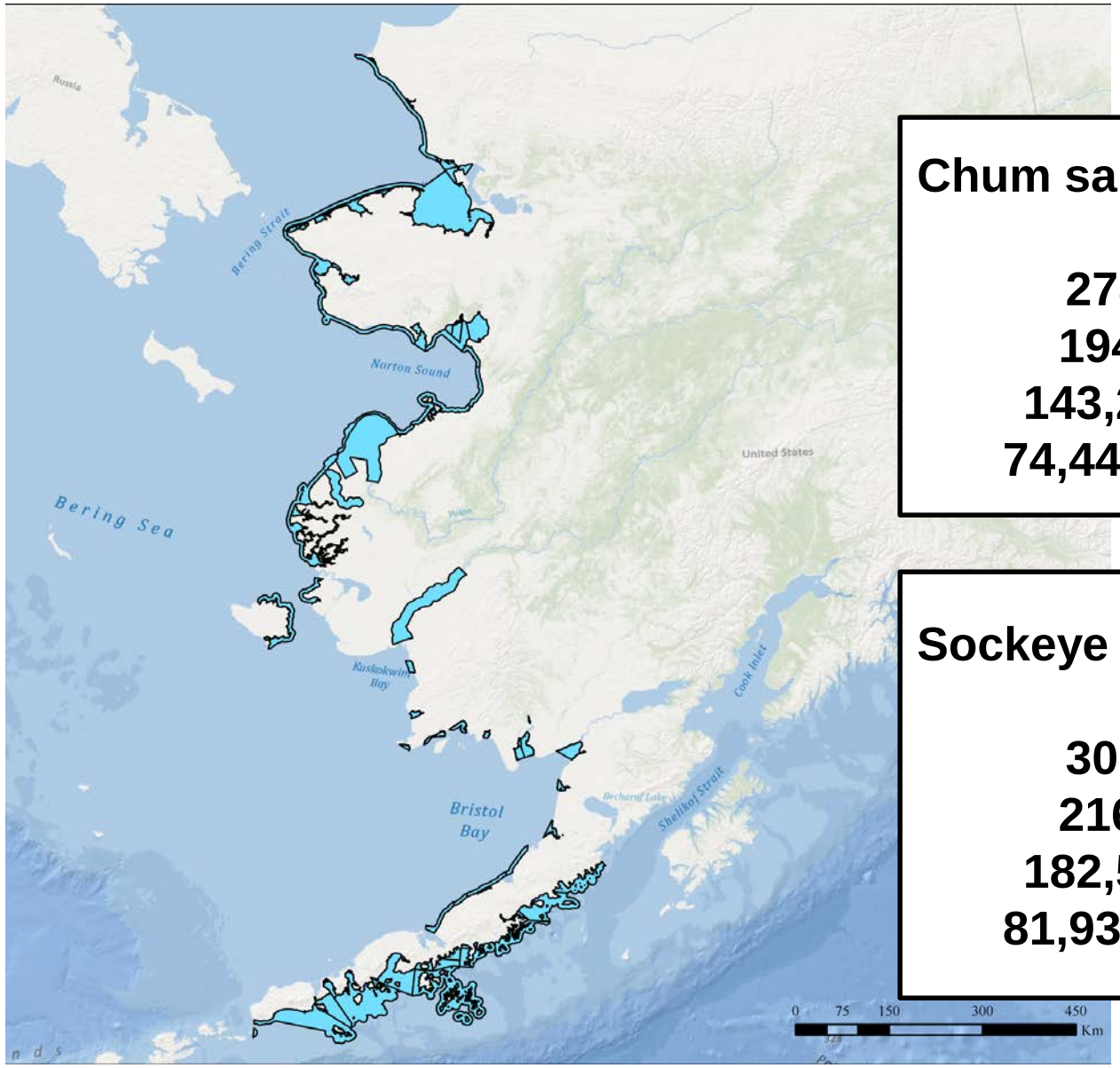


Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program



Chum salmon:

278 fishery strata sampled
194 fishery strata analyzed
143,258 individuals sampled
74,445 individuals genotyped

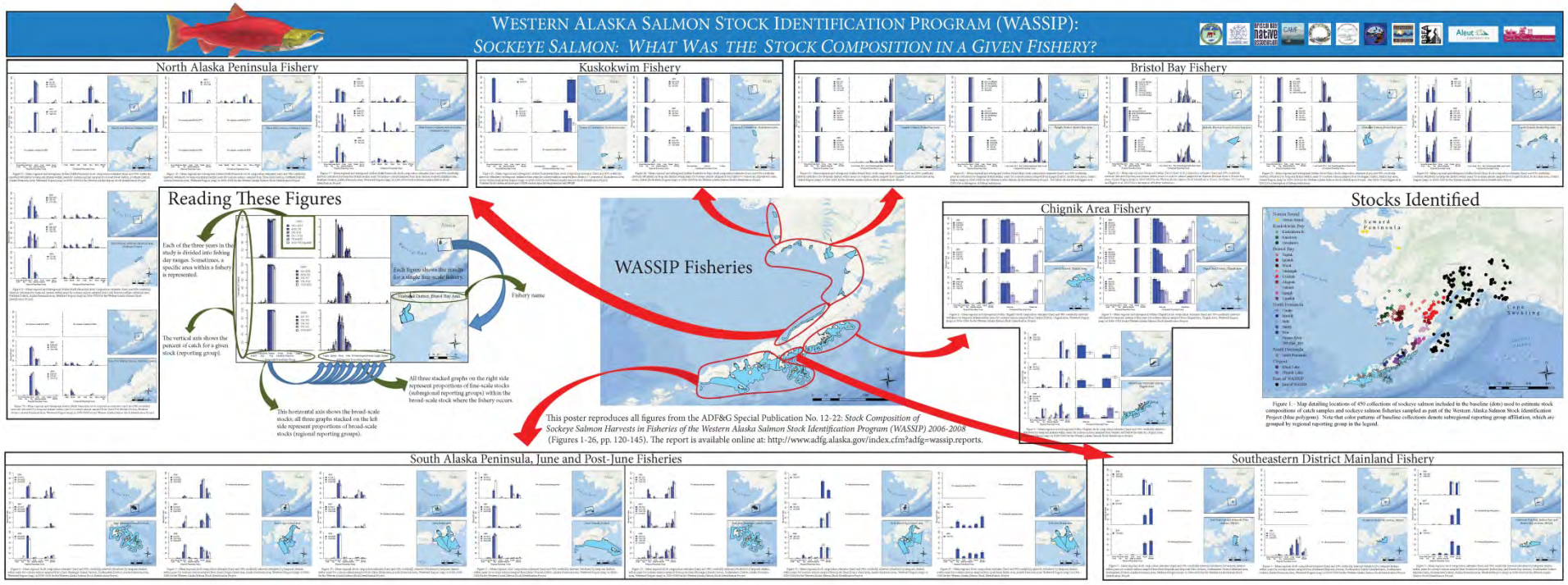
Sockeye salmon:

307 fishery strata sampled
216 fishery strata analyzed
182,523 individuals sampled
81,932 individuals genotyped

Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

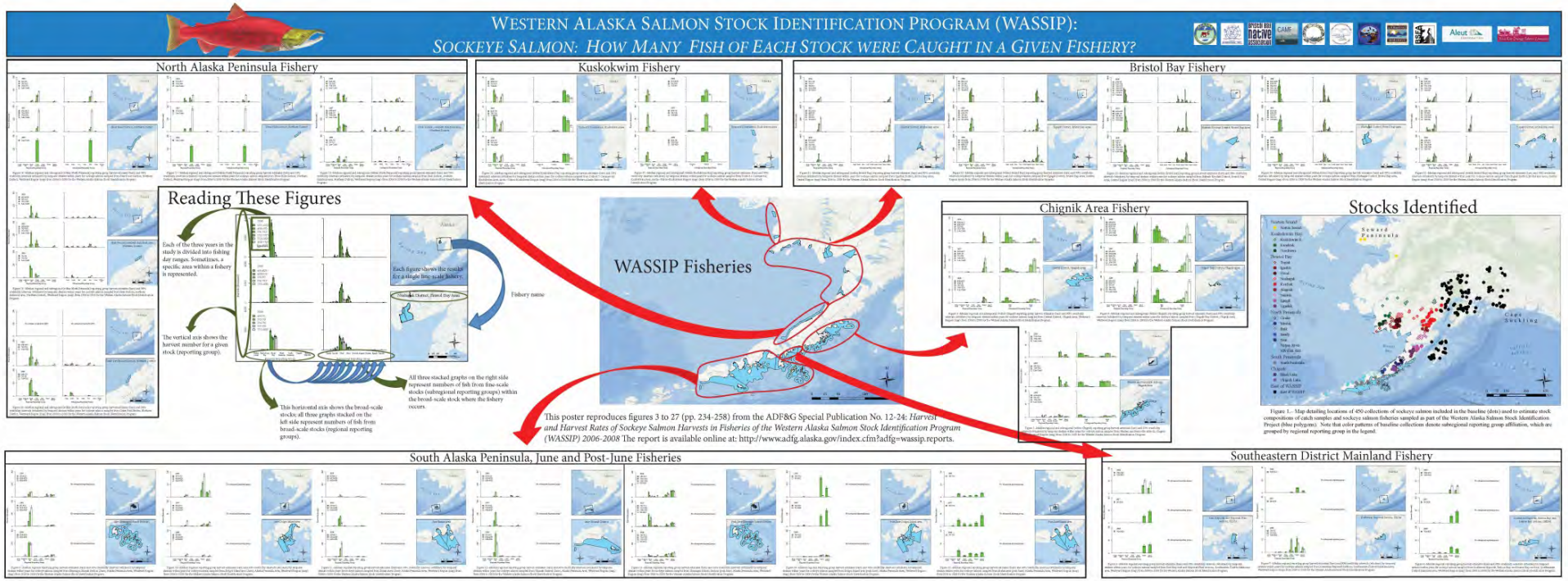
What stocks are caught in my fishery?



Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

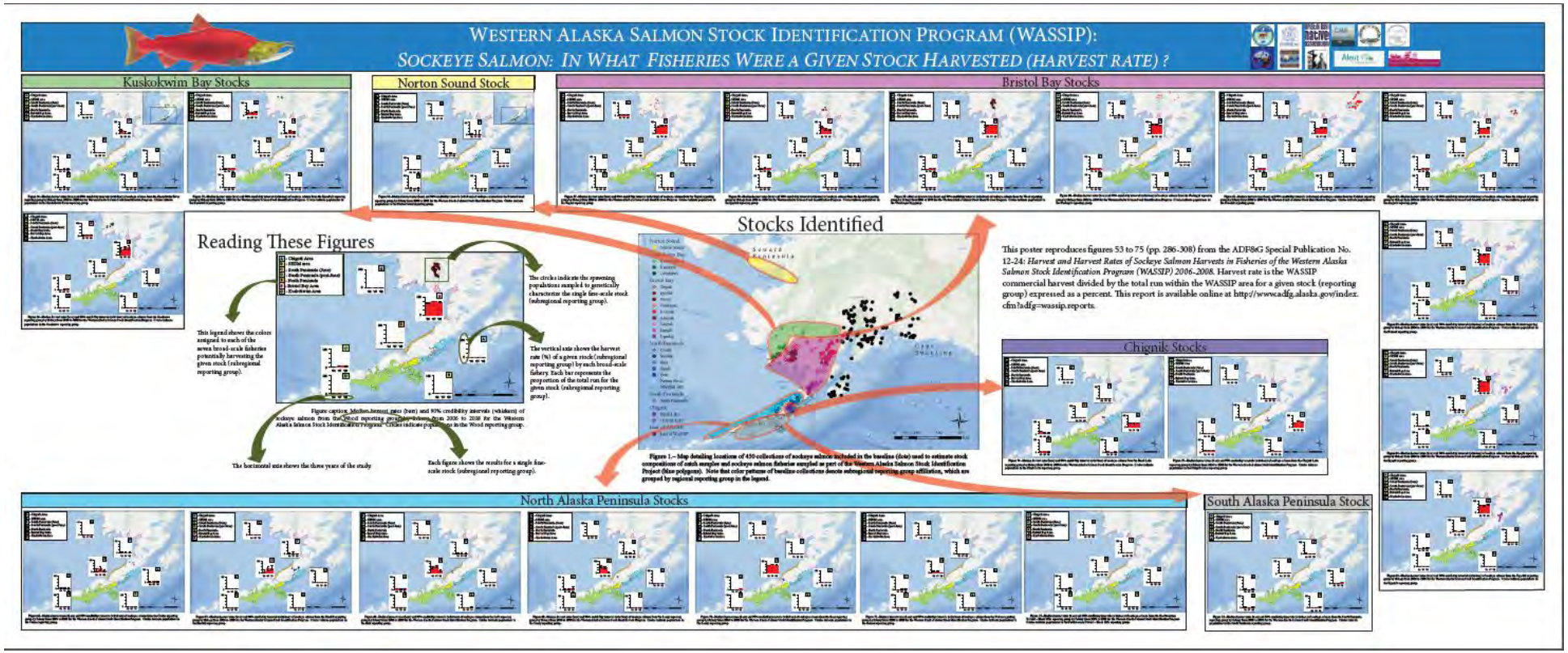
How may fish of each stock were caught in my fishery?



Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

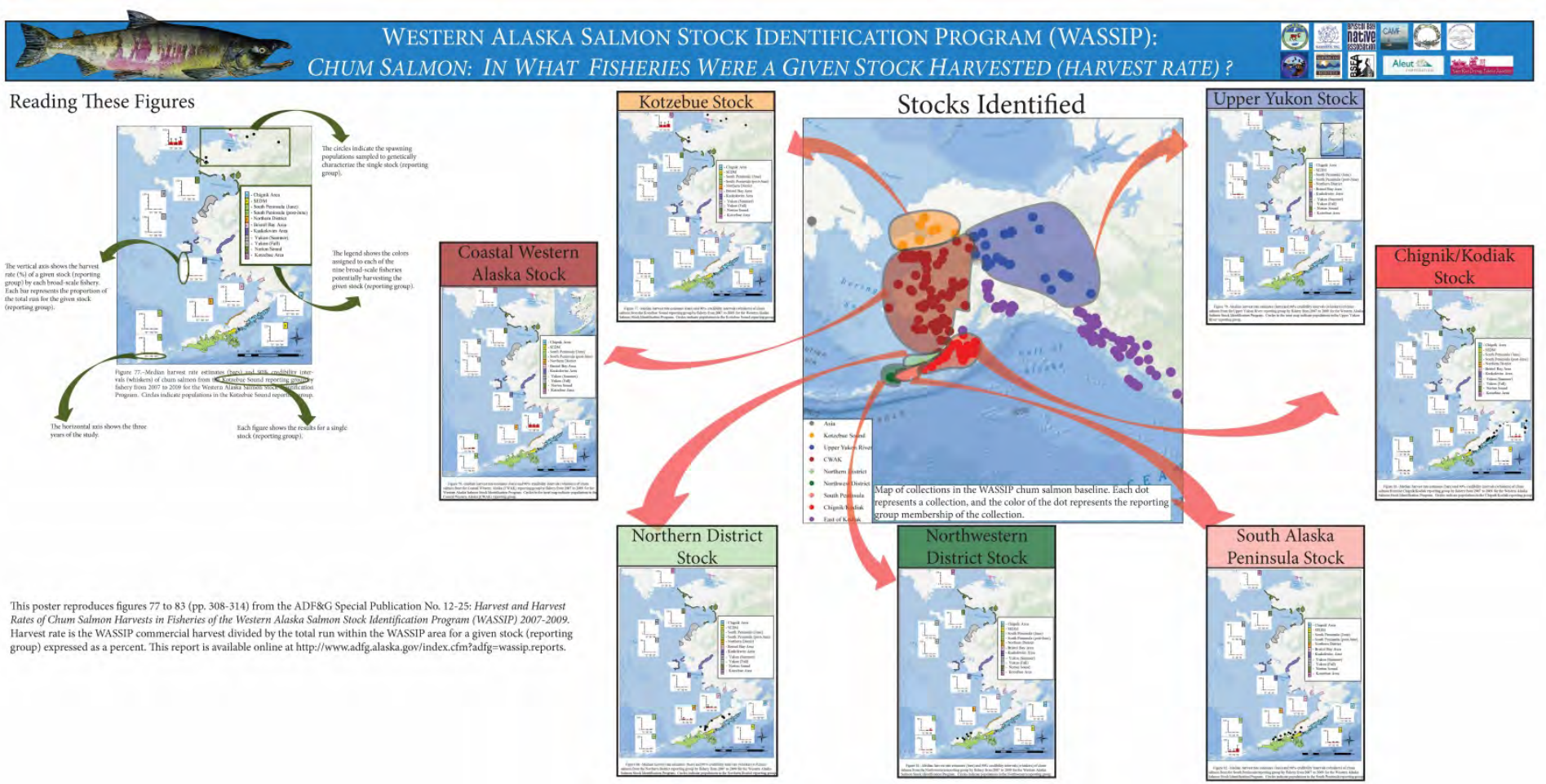
What fishery catches my stock?



Applications: Inform/Assess Management

Example: Western Alaska Salmon Stock Identification Program

What fishery catches my stock?



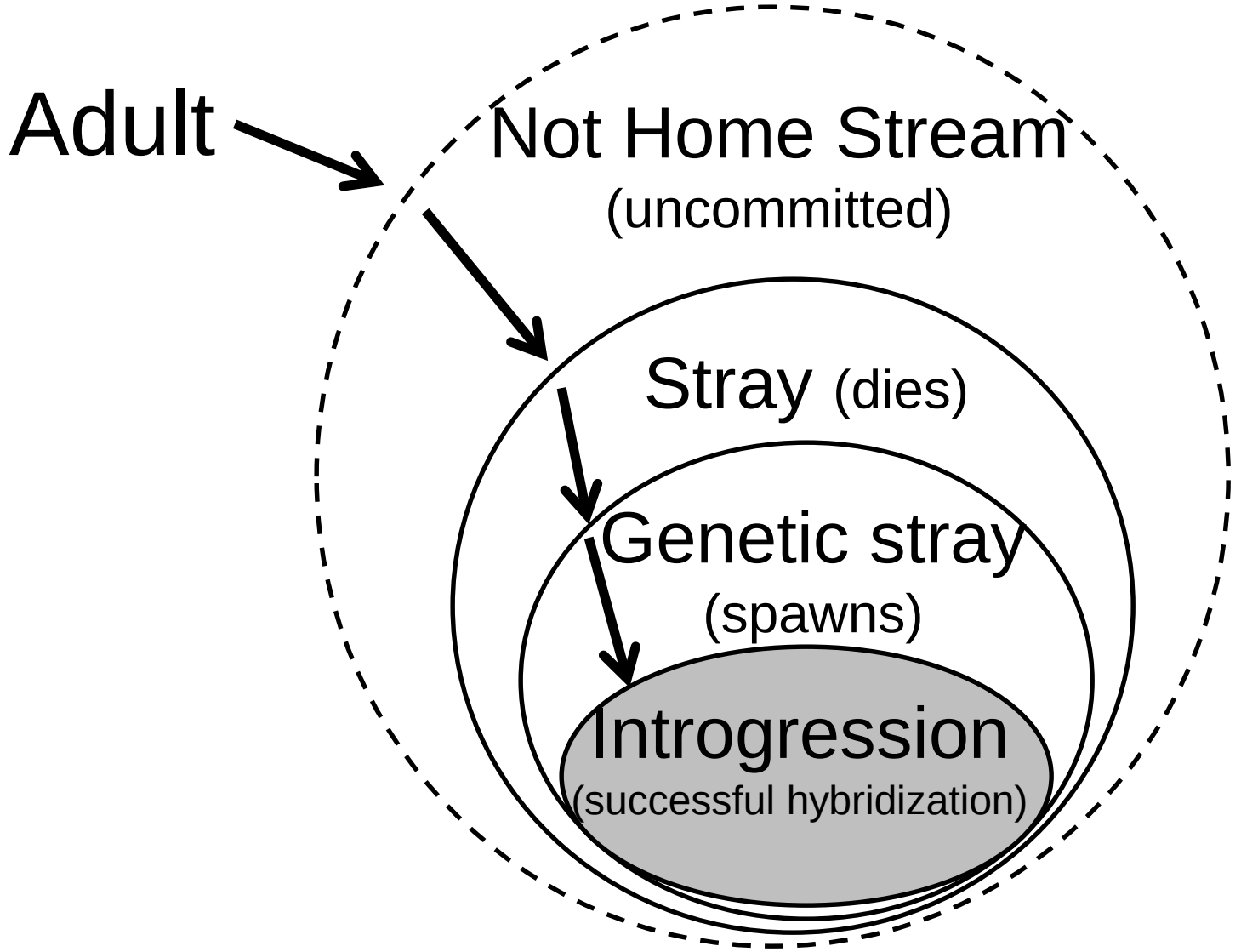
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

Straying Definitions

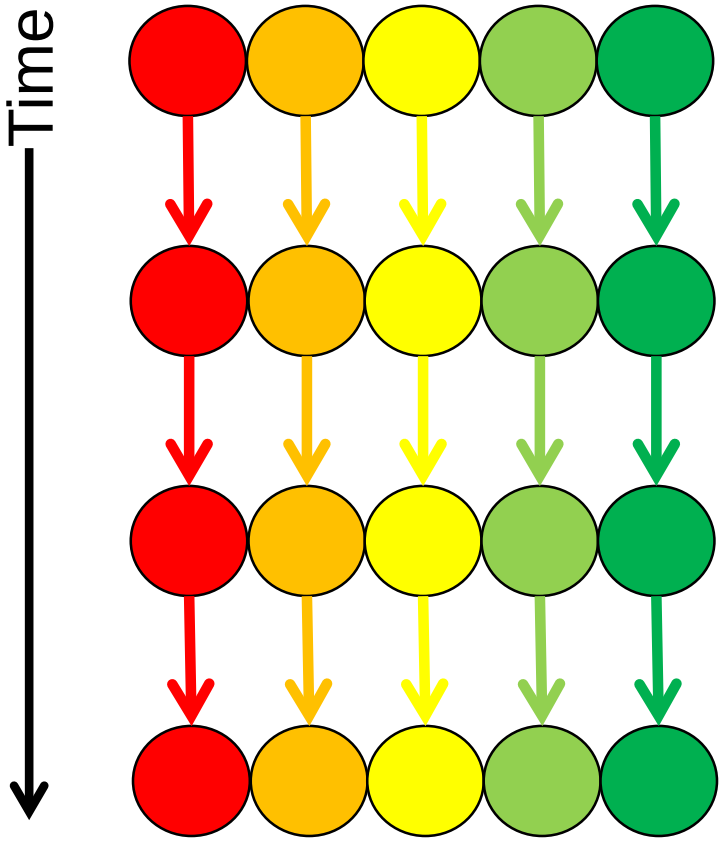


Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

Idealized natural system

No straying

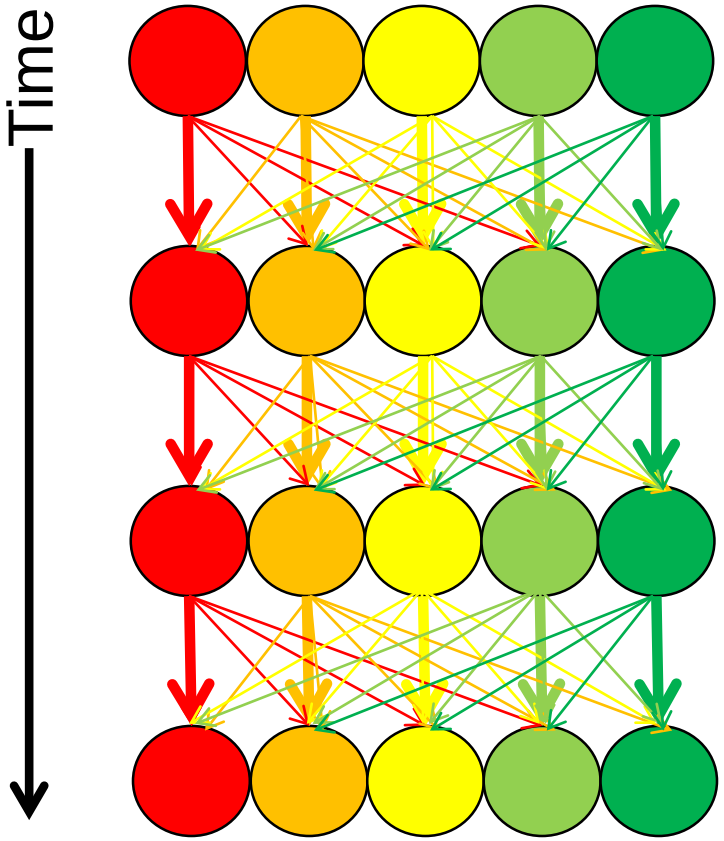


Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

Reality natural system

Straying/drift equilibrium

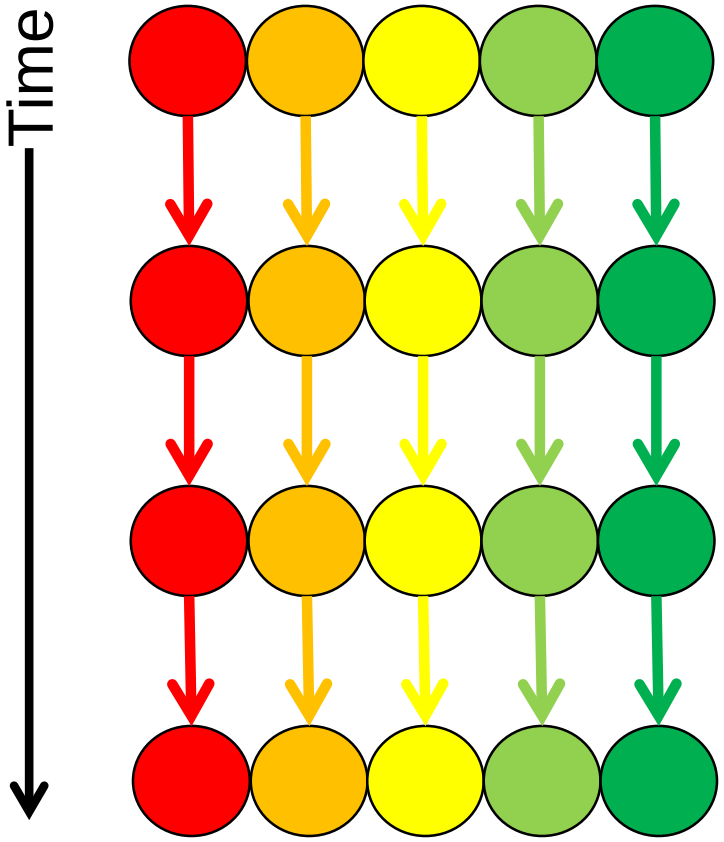


Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

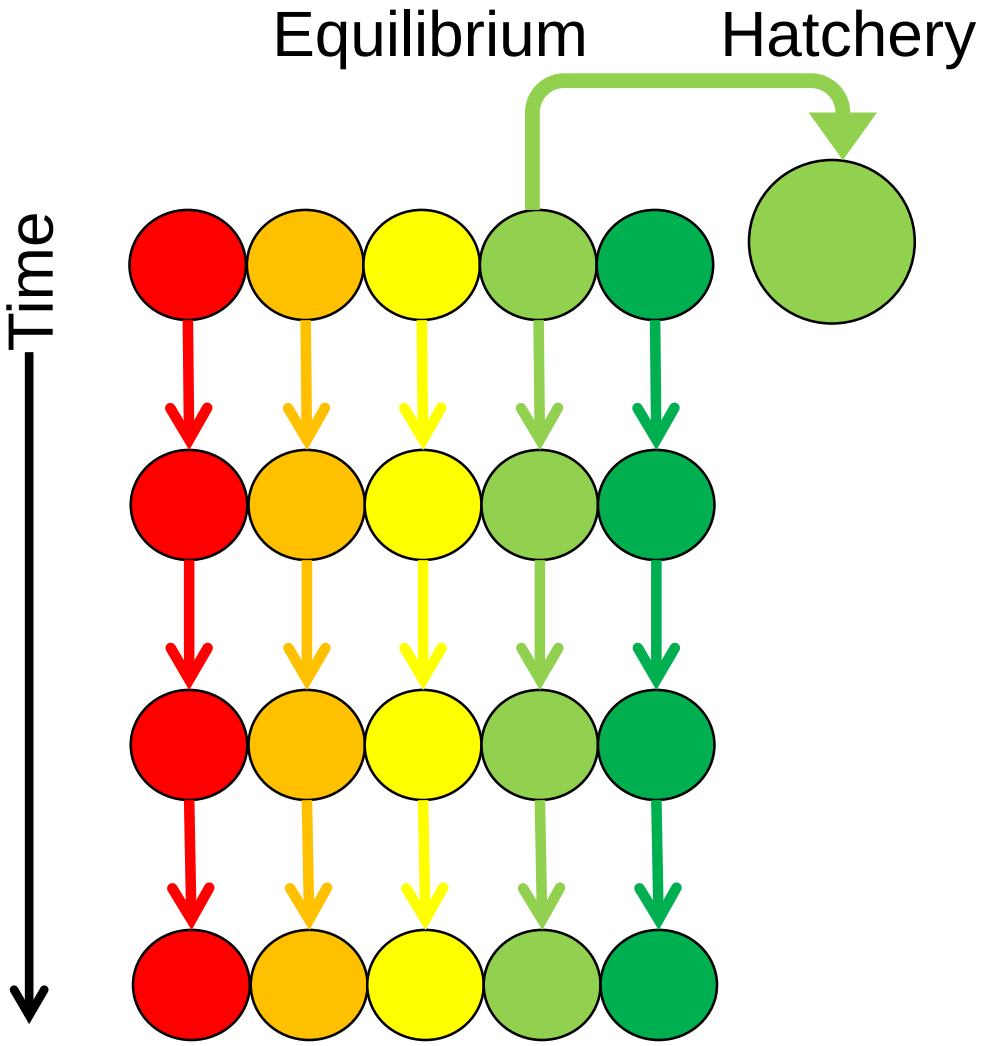
Reality natural system

Equilibrium



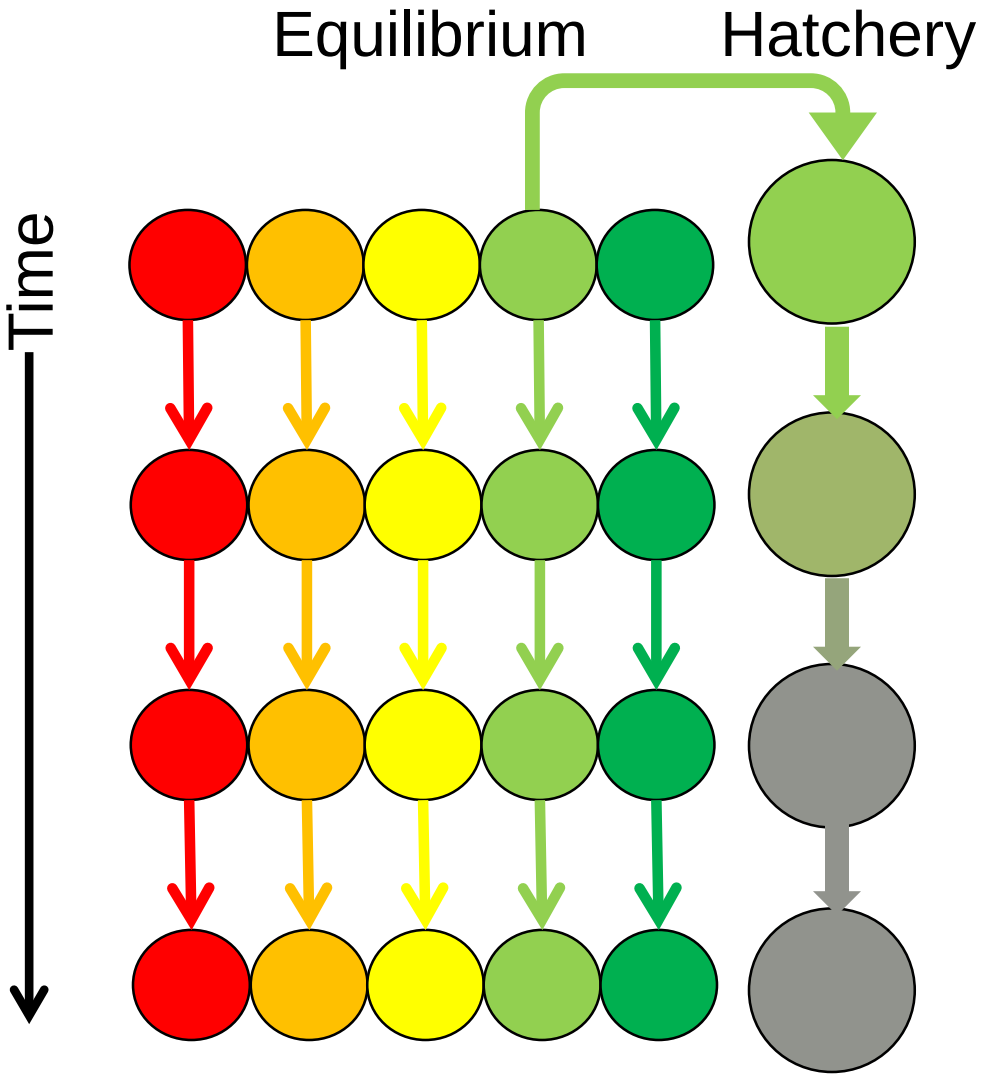
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



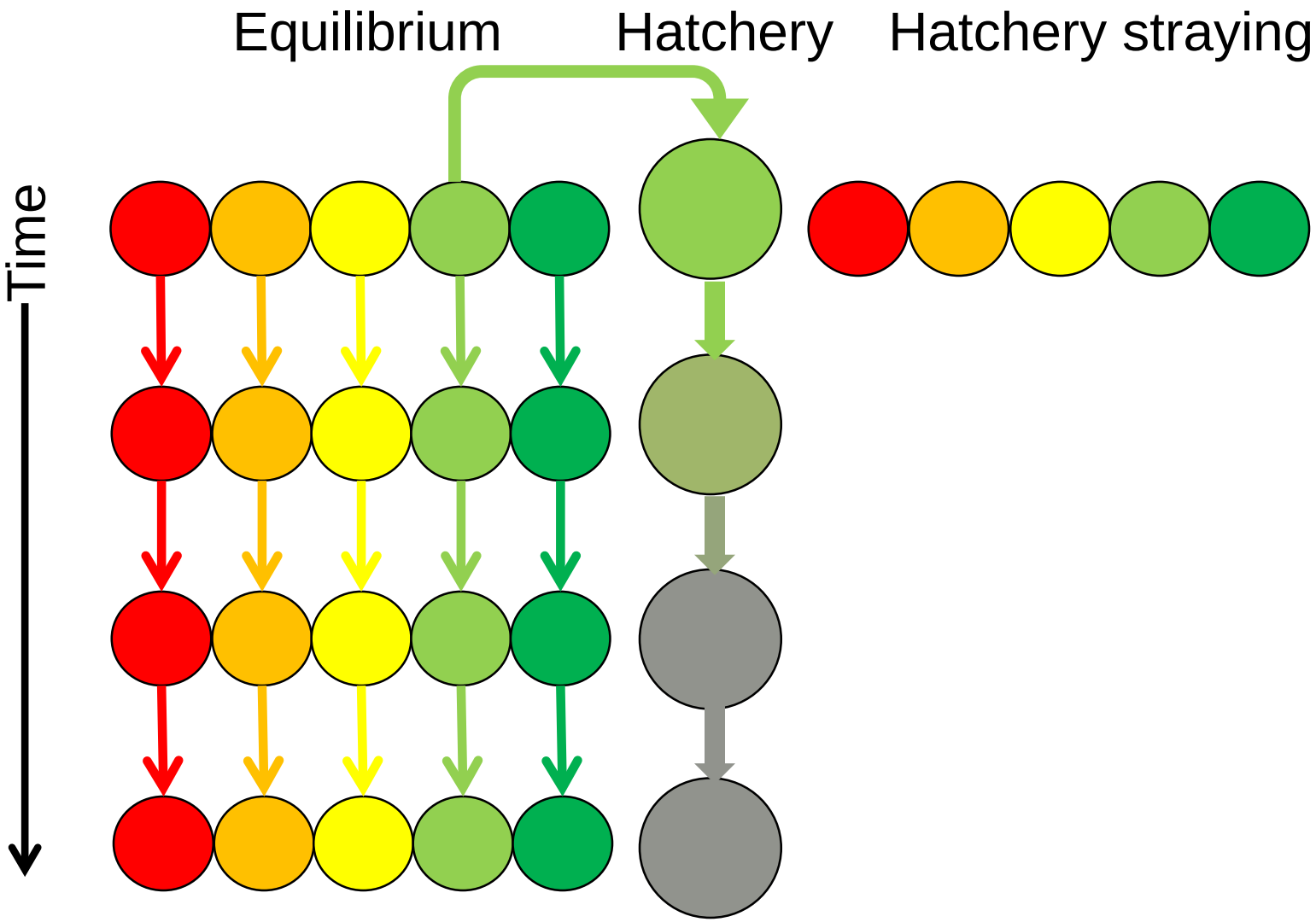
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



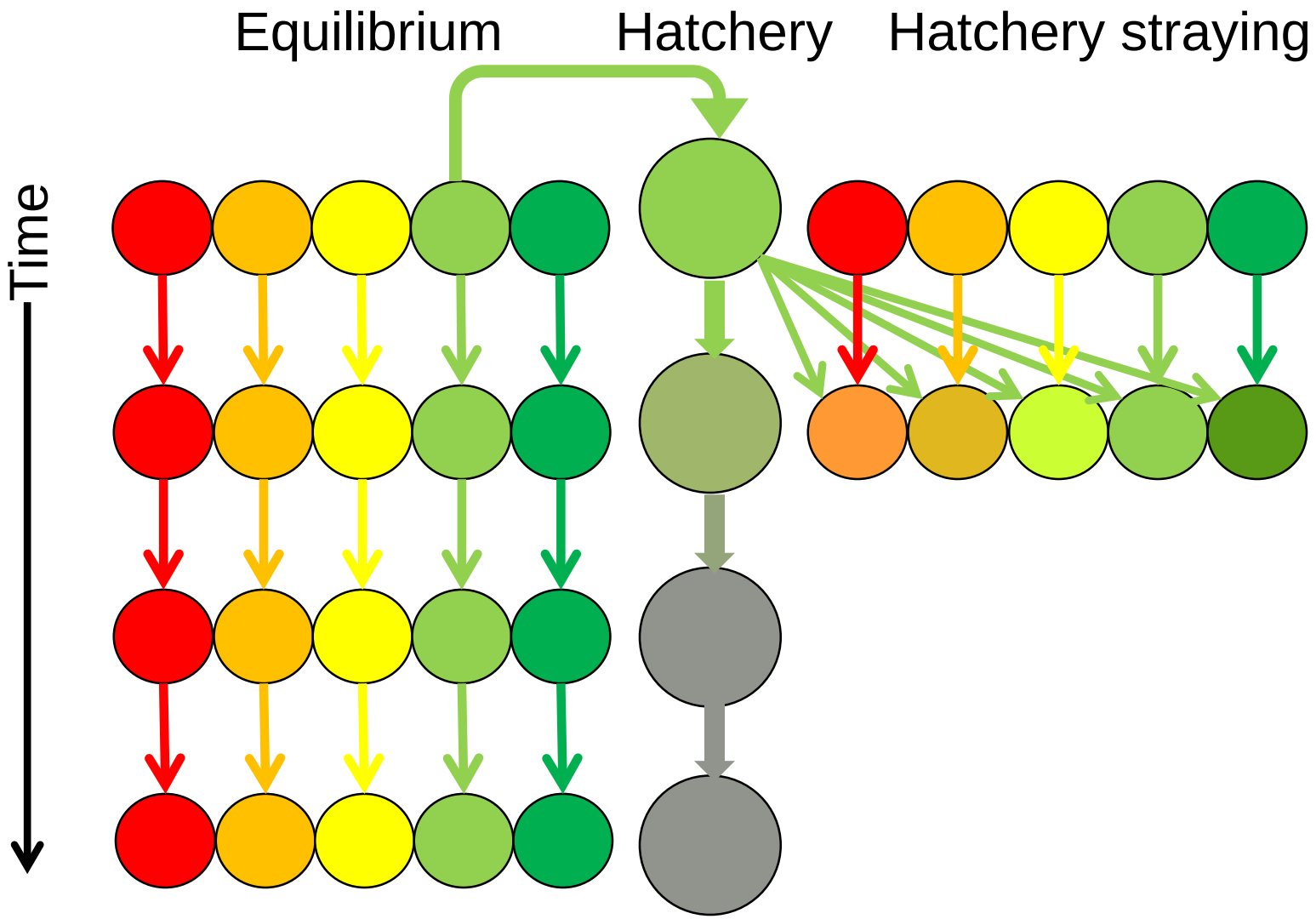
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



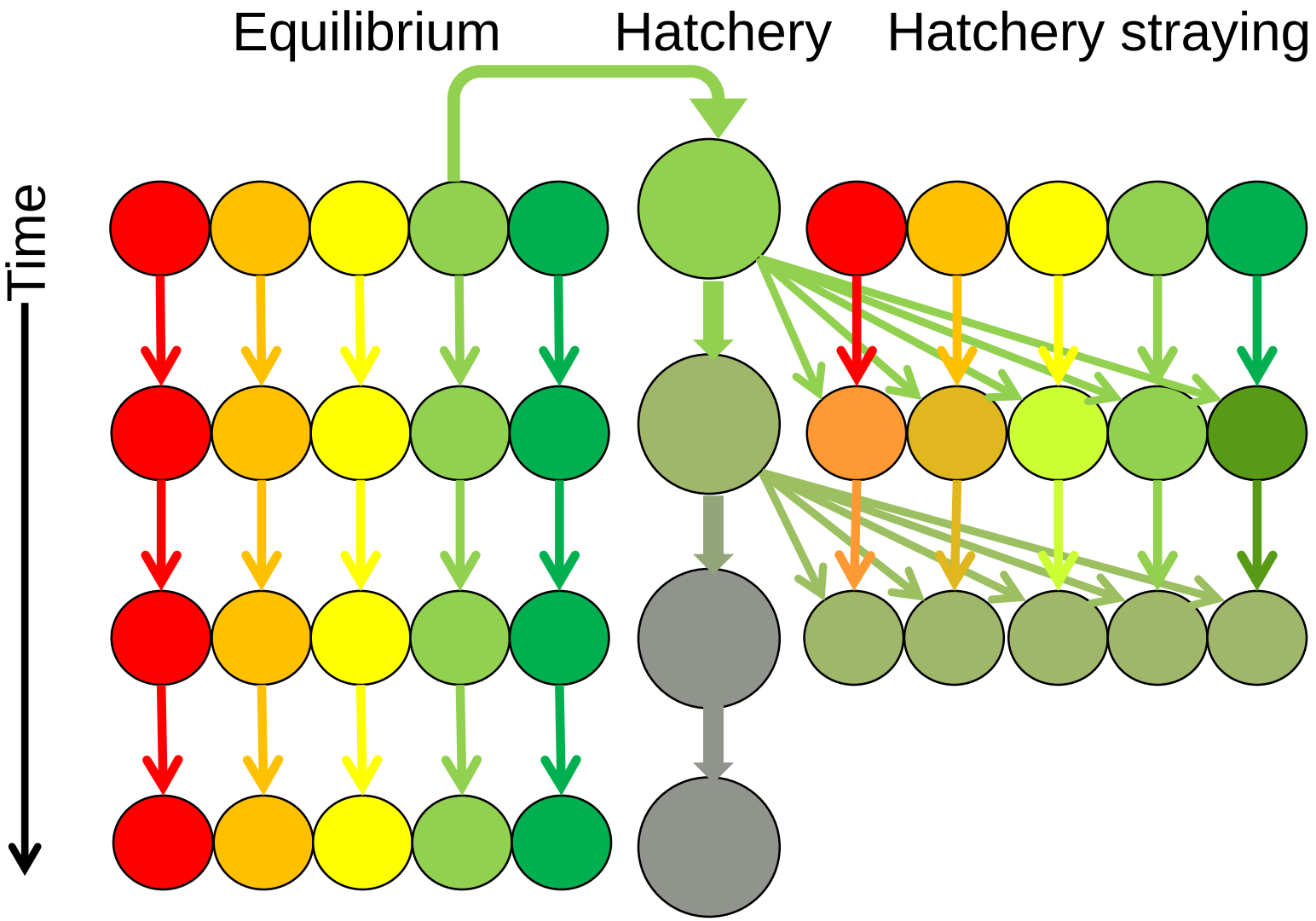
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



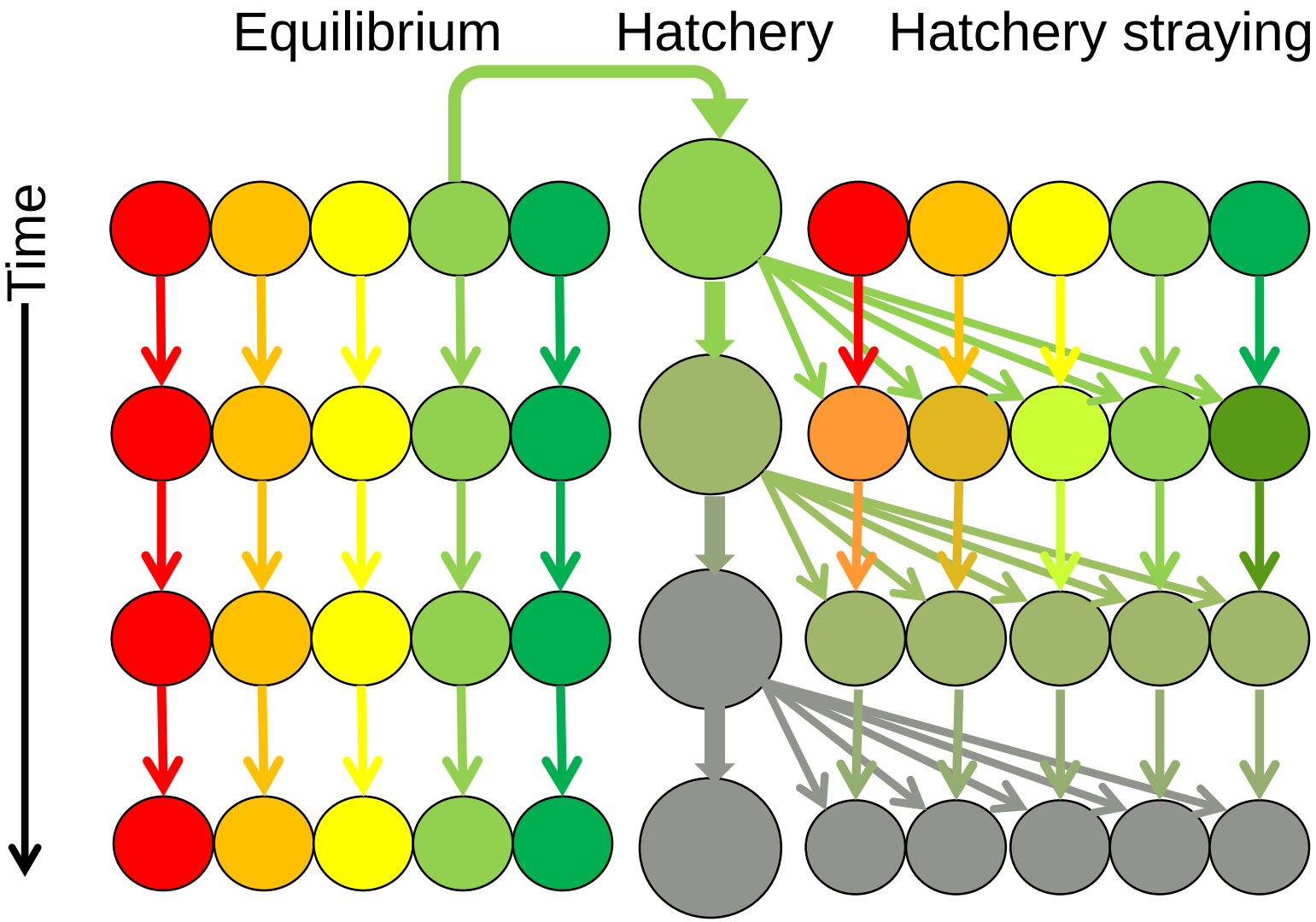
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



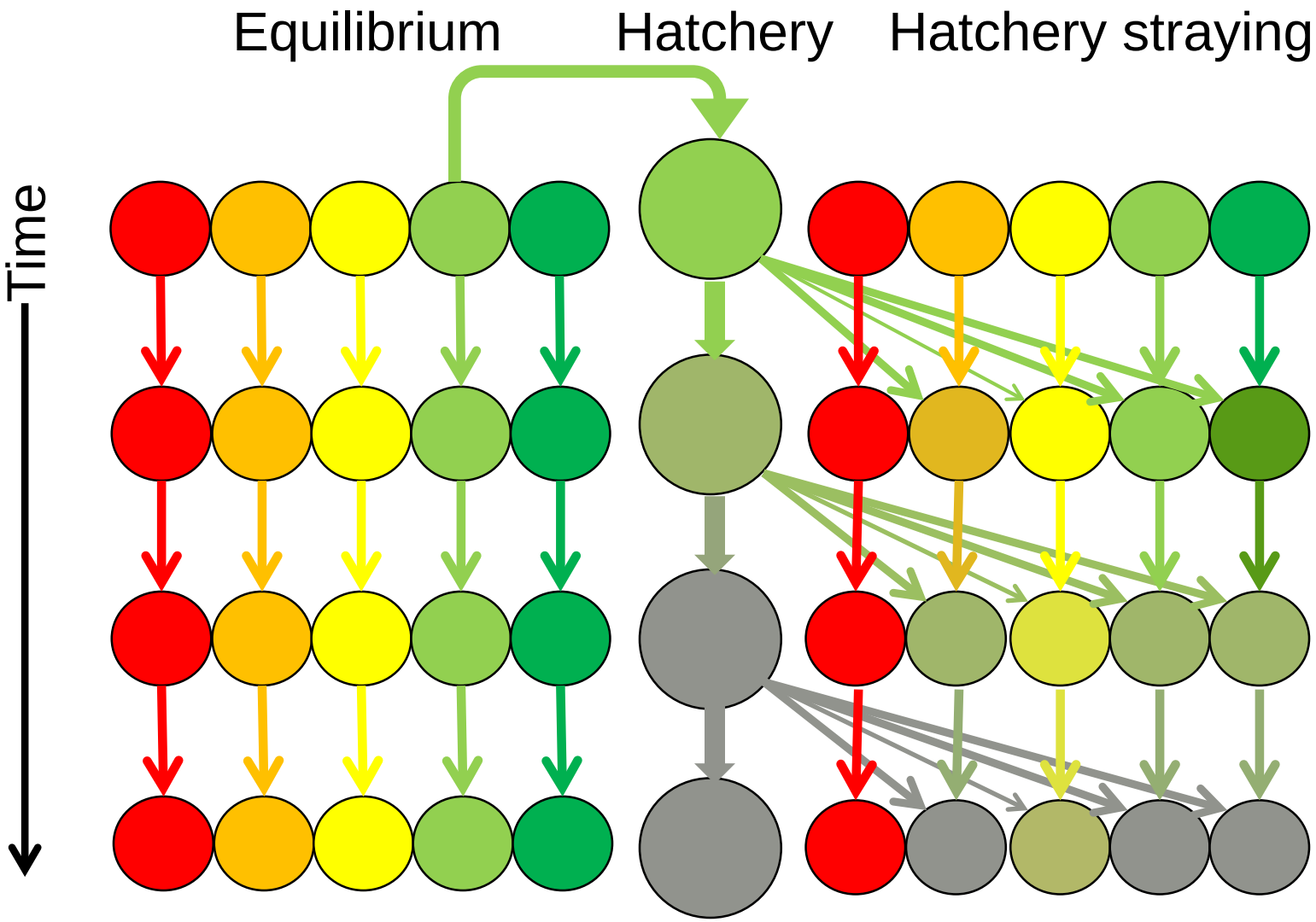
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

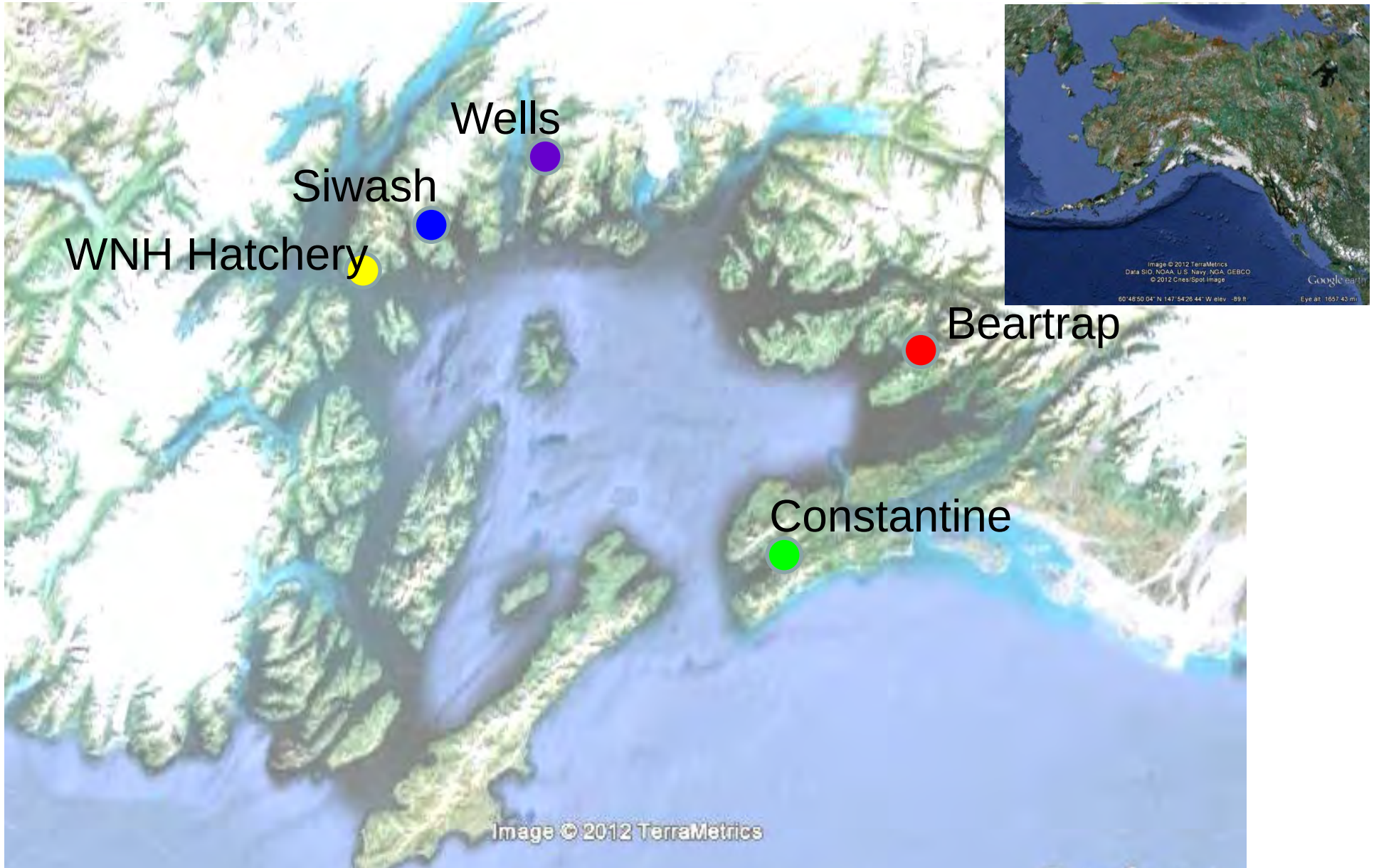


Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

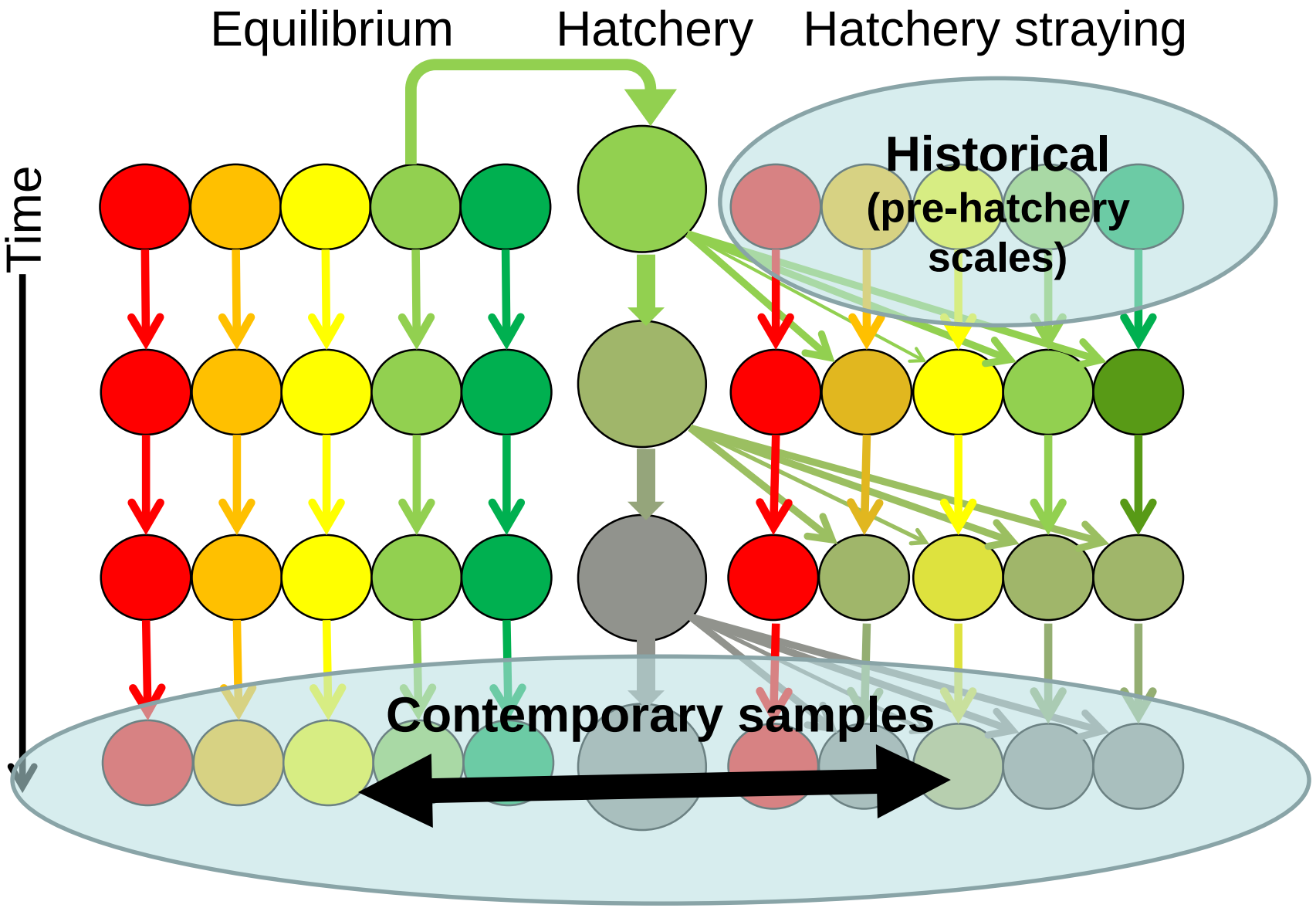
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



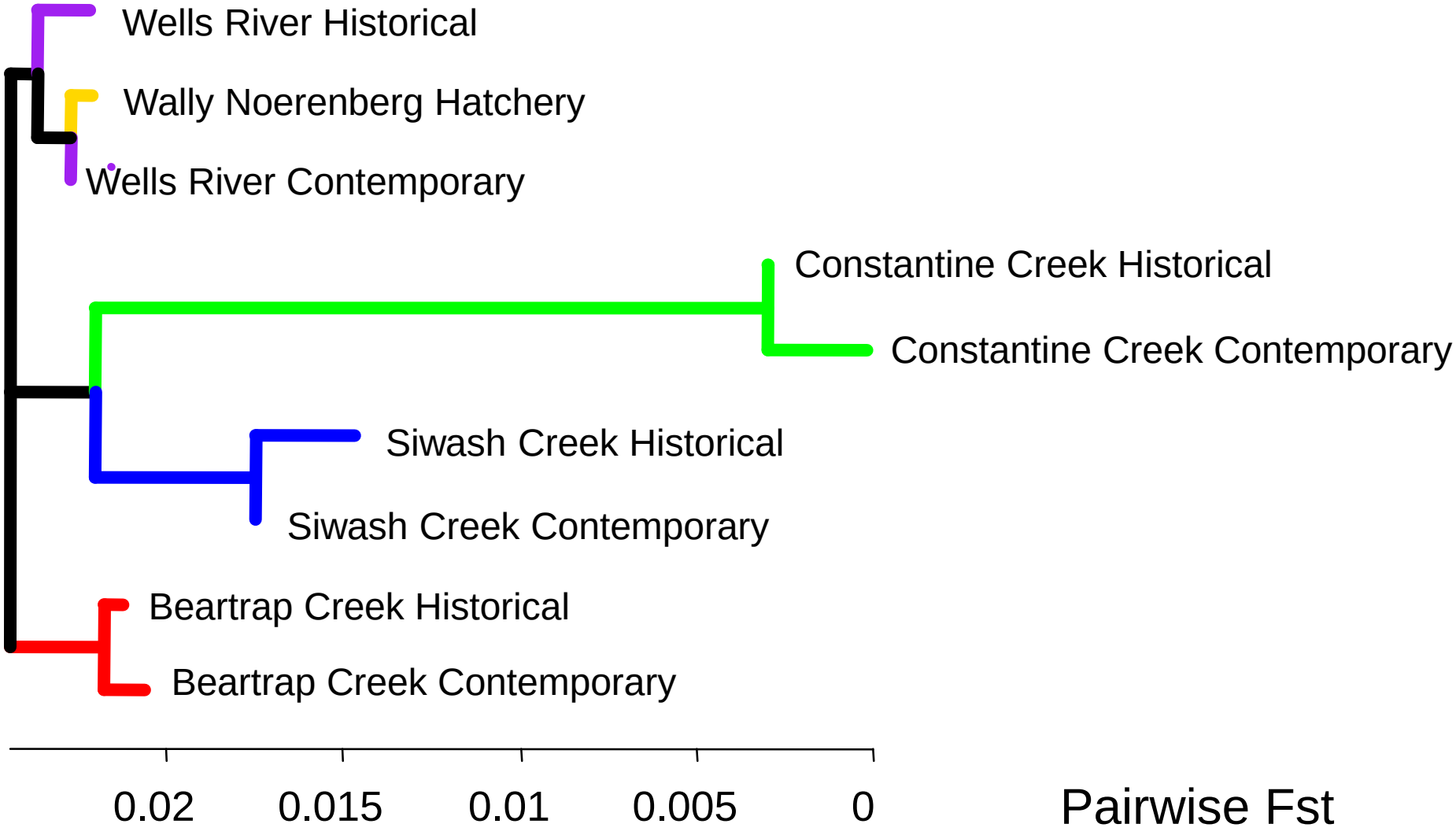
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



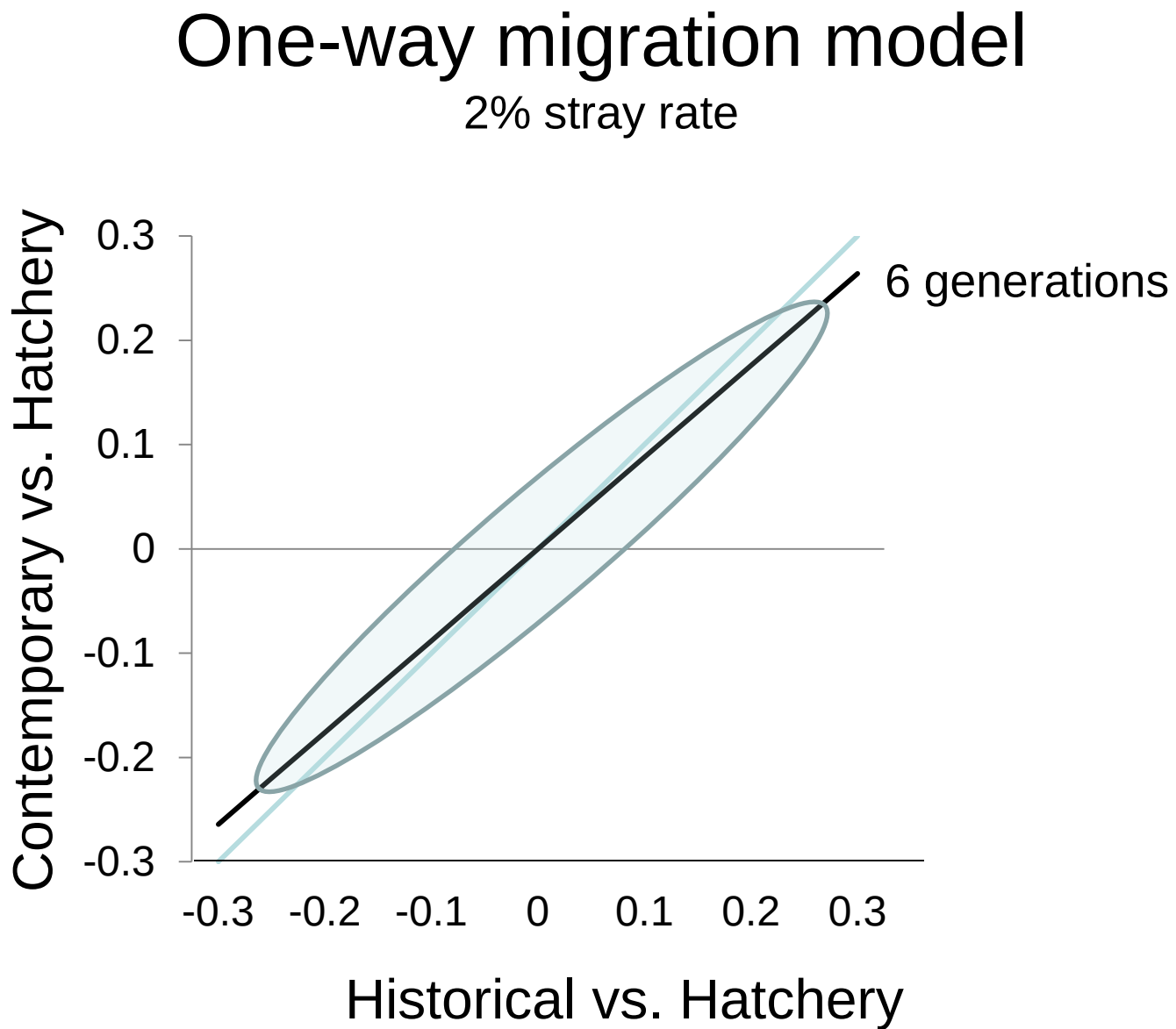
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



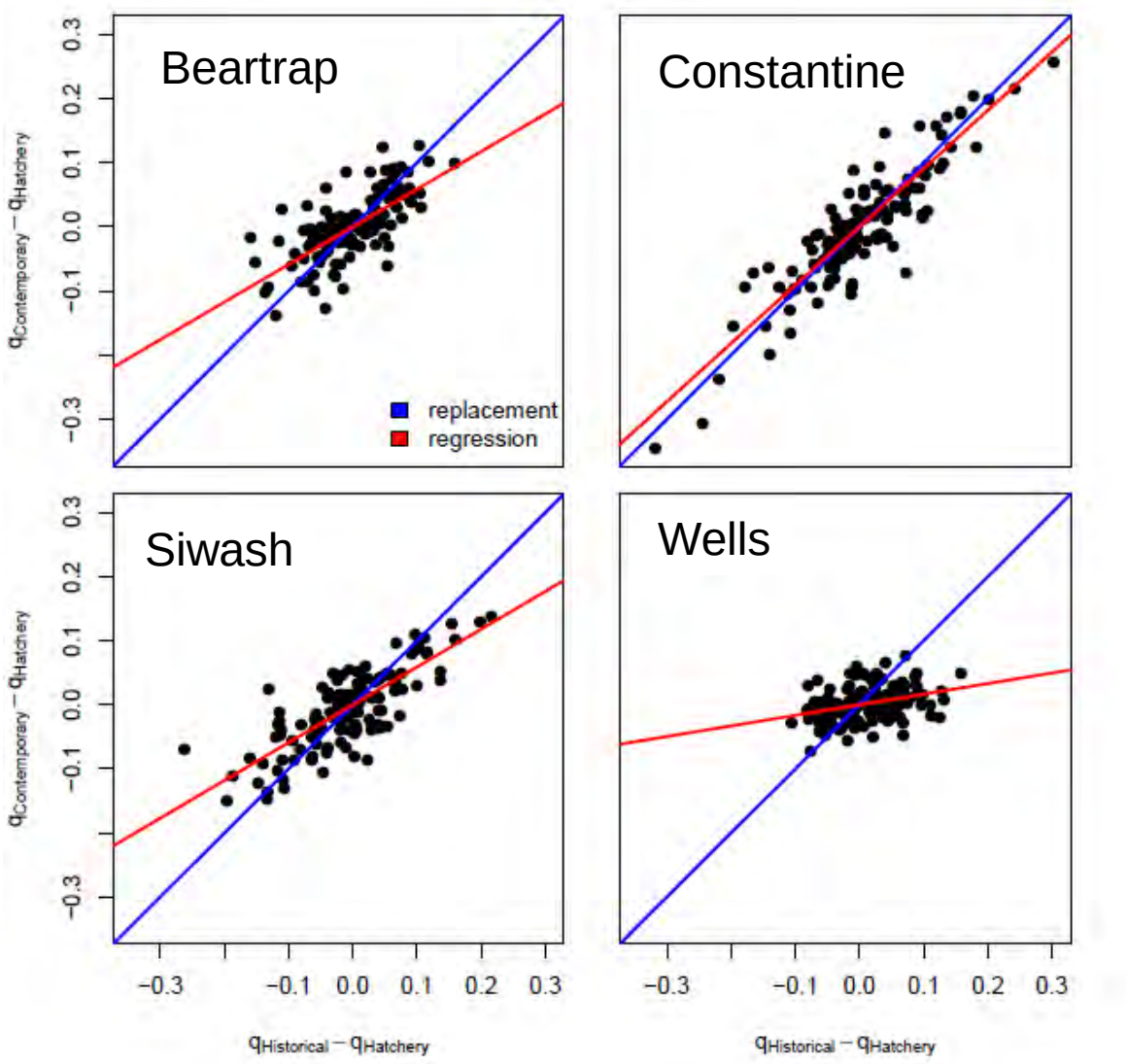
Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction



Applications: Inform Human Activities

Example: Chum salmon hatchery/wild interaction

Implications

- **Population structure not visibly eroded**
- **Introgression rates are highly variable among locations**
- **Distance from the hatchery and life history affect introgression rates**

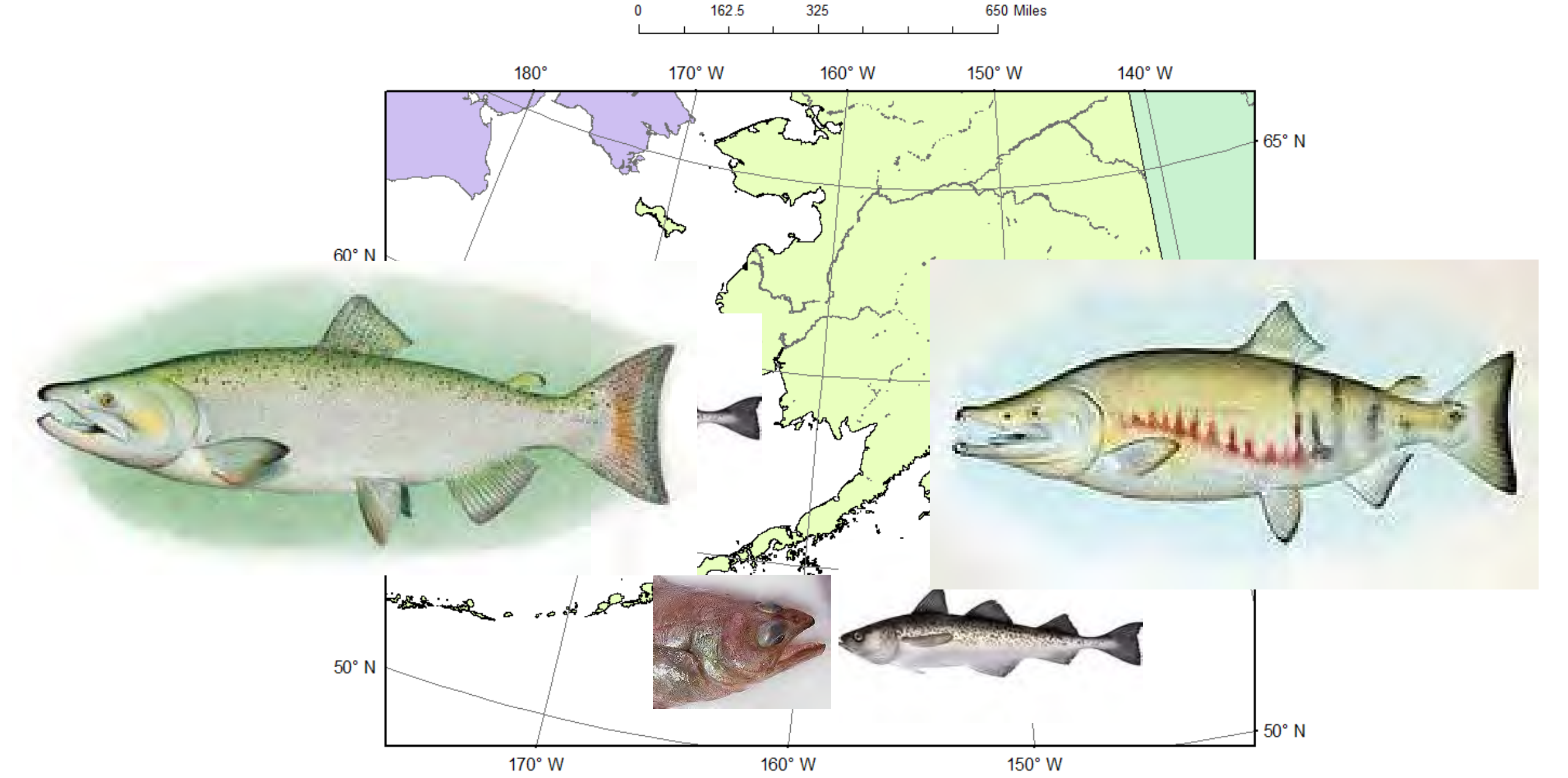
Science, Service, Stewardship

Genetic stock composition analysis of salmon caught in Alaska federal groundfish trawl fisheries

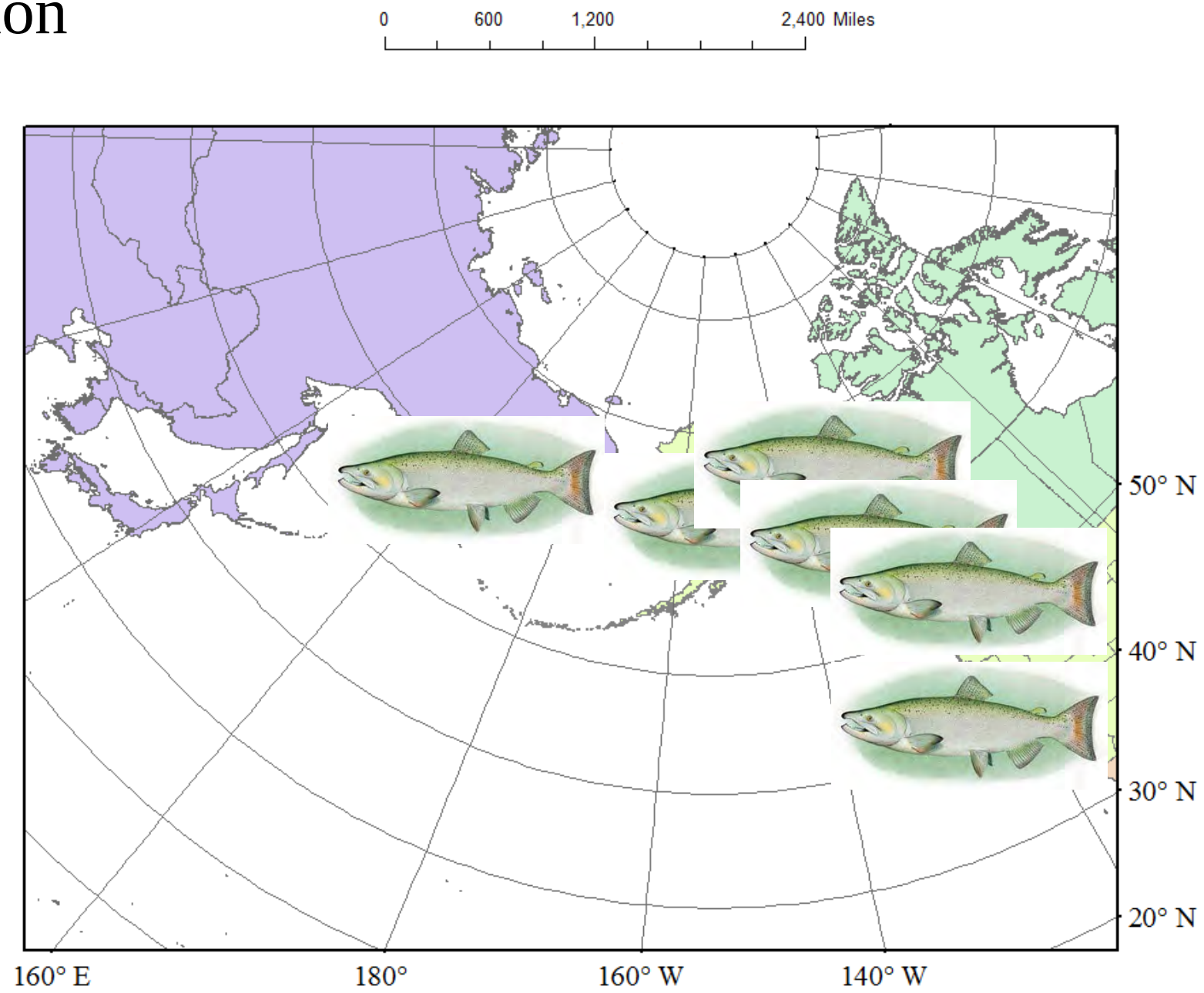
Jeff Guyon, PhD
Genetics Program
Auke Bay Laboratories
Juneau, AK

NOAA FISHERIES SERVICE

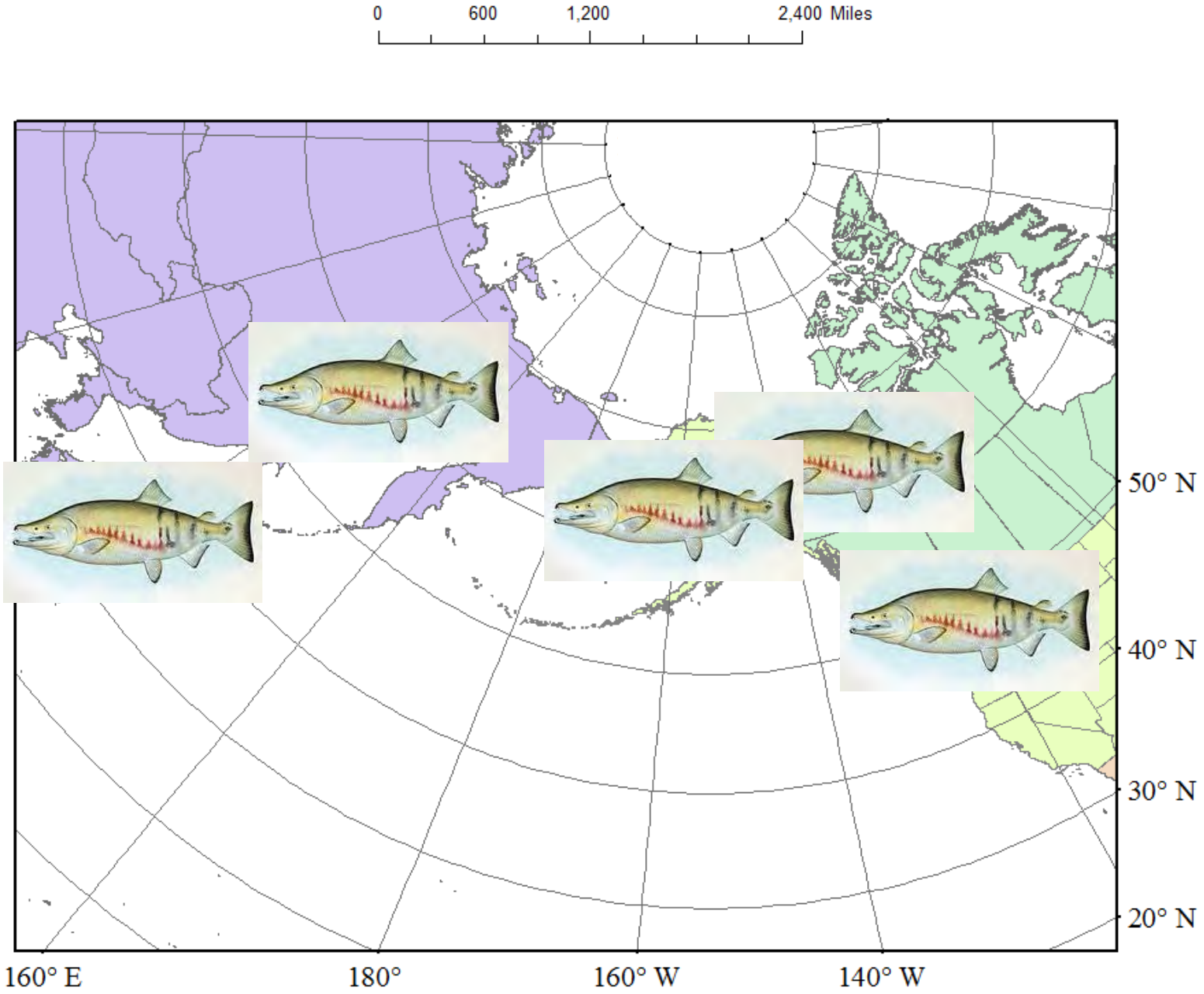
August 25, 2015


0
162.5
325
650 Miles
180°
170° W
160° W
150° W
140° W
65° N
60° N
50° N
170° W
160° W
150° W

Chinook Salmon



Chum Salmon



Science, Service, Stewardship

NMFS-AFSC-292

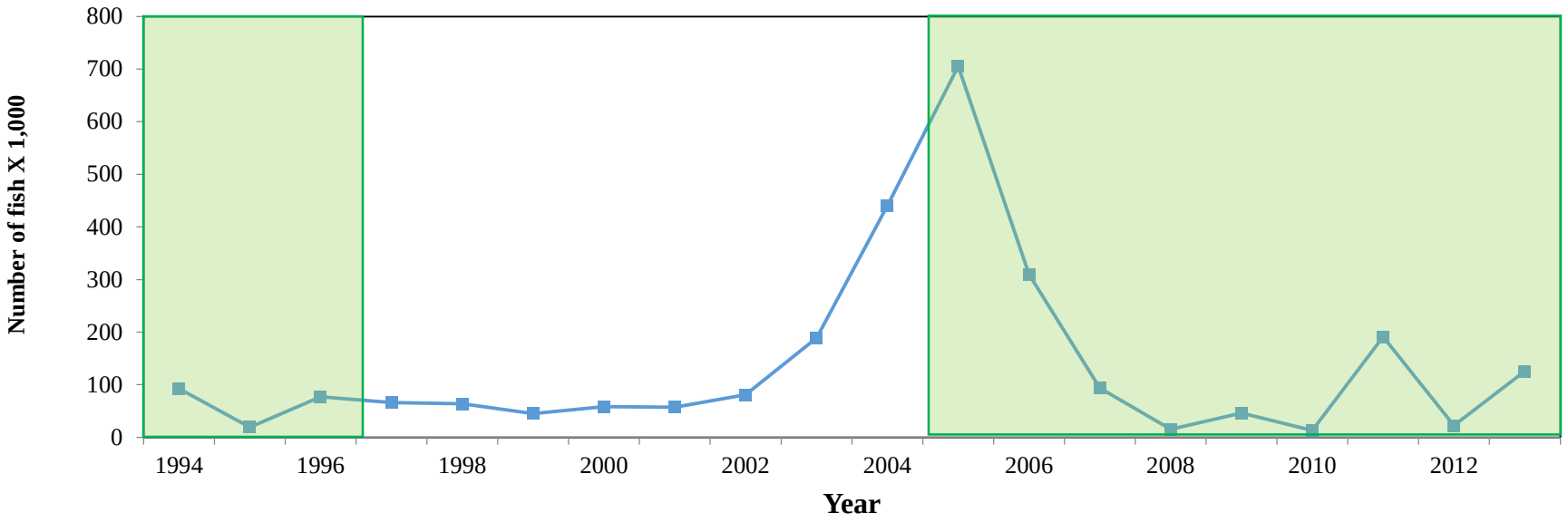
Genetic Stock Composition Analysis of Chum Salmon Bycatch from the 2013 Bering Sea Walleye Pollock Trawl Fishery

J. A. Whittle, S. C. Vulstek, C. M. Kondzela, and J. R. Guyon
Genetics Program
Auke Bay Laboratories
Juneau, AK

NOAA FISHERIES SERVICE

August 25, 2015

2013 Chum Salmon Bering Sea Bycatch



1994: Scales (Patton et al., 1998) - 1,204 samples

1994-1995: Allozymes (Wilmot et al., 1998) - 457 (1994) and 1,680 (1995) samples

1996: Allozymes (Seeb et al., 2004) – Eastern shelf

2005–2013: Microsatellites - 1,084 (2005), 1,367 (2006), 1,279 (2007), 629 (2008), 1,437 (2009), 1,048 (2010), 1,472 (2011), 673 (2012), 4,094 (2013) samples

DFO Microsatellite Chum Salmon Baseline

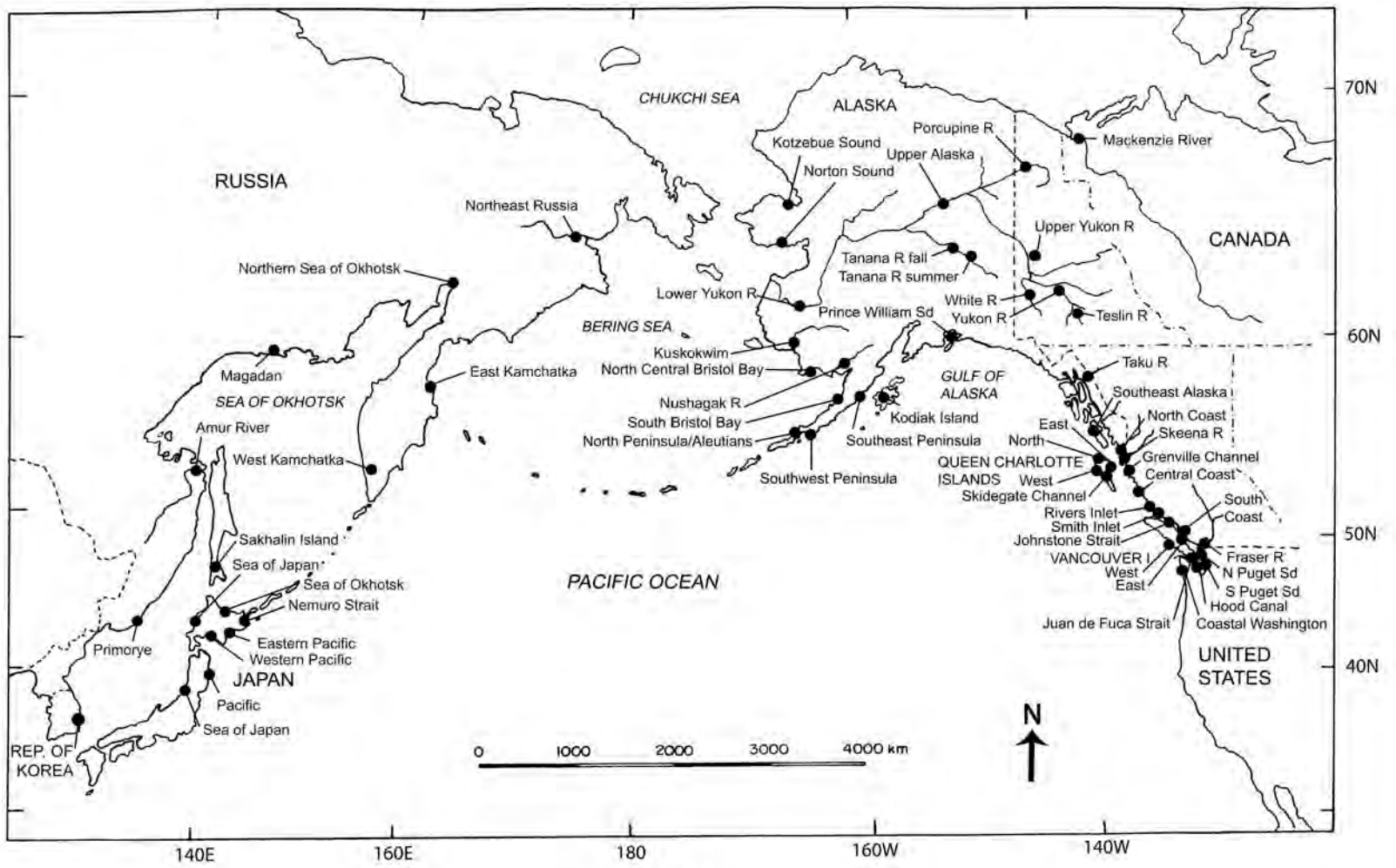


Figure 1

Map of the Pacific Rim indicating the general geographic regions where chum salmon (*Oncorhynchus keta*) from 381 populations were surveyed. The regions are listed in Table 1.

Beacham et al., 2009

Our Stock Groupings

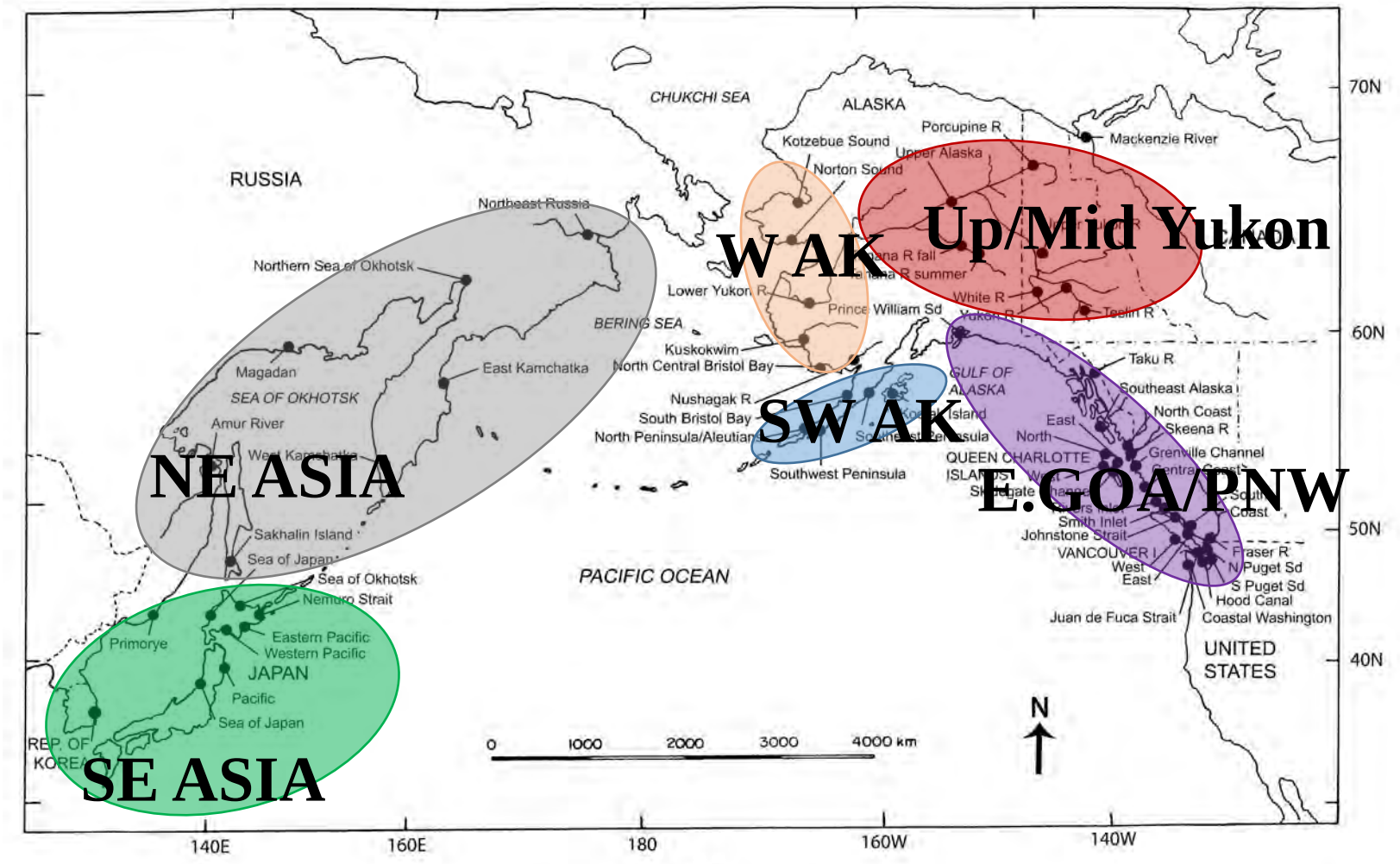
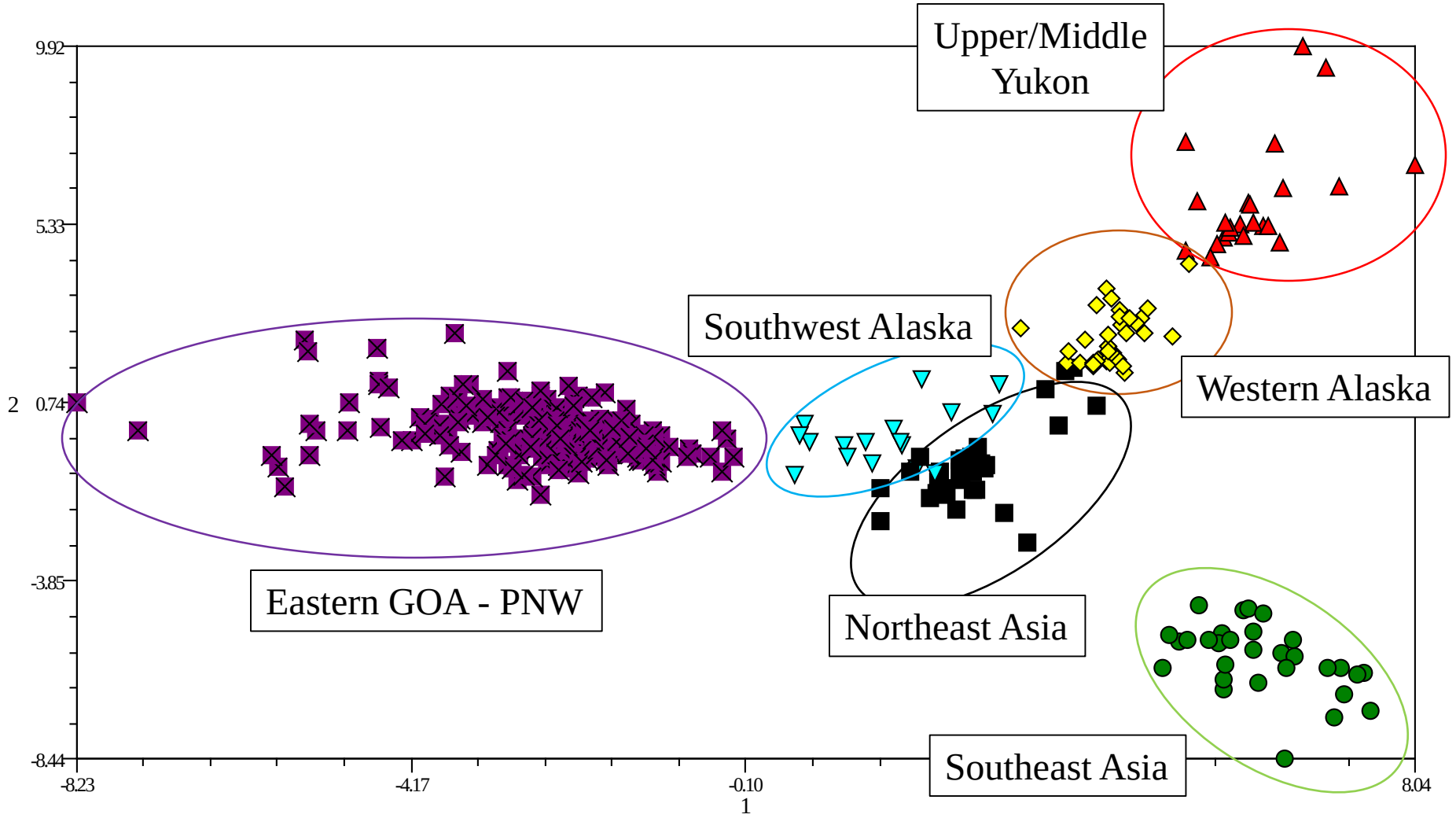


Figure 1

Map of the Pacific Rim indicating the general geographic regions where chum salmon (*Oncorhynchus keta*) from 381 populations were surveyed. The regions are listed in Table 1.

Principal Coordinate Analysis

11 microsatellites, CSE



CIAP-WASC chum salmon collections

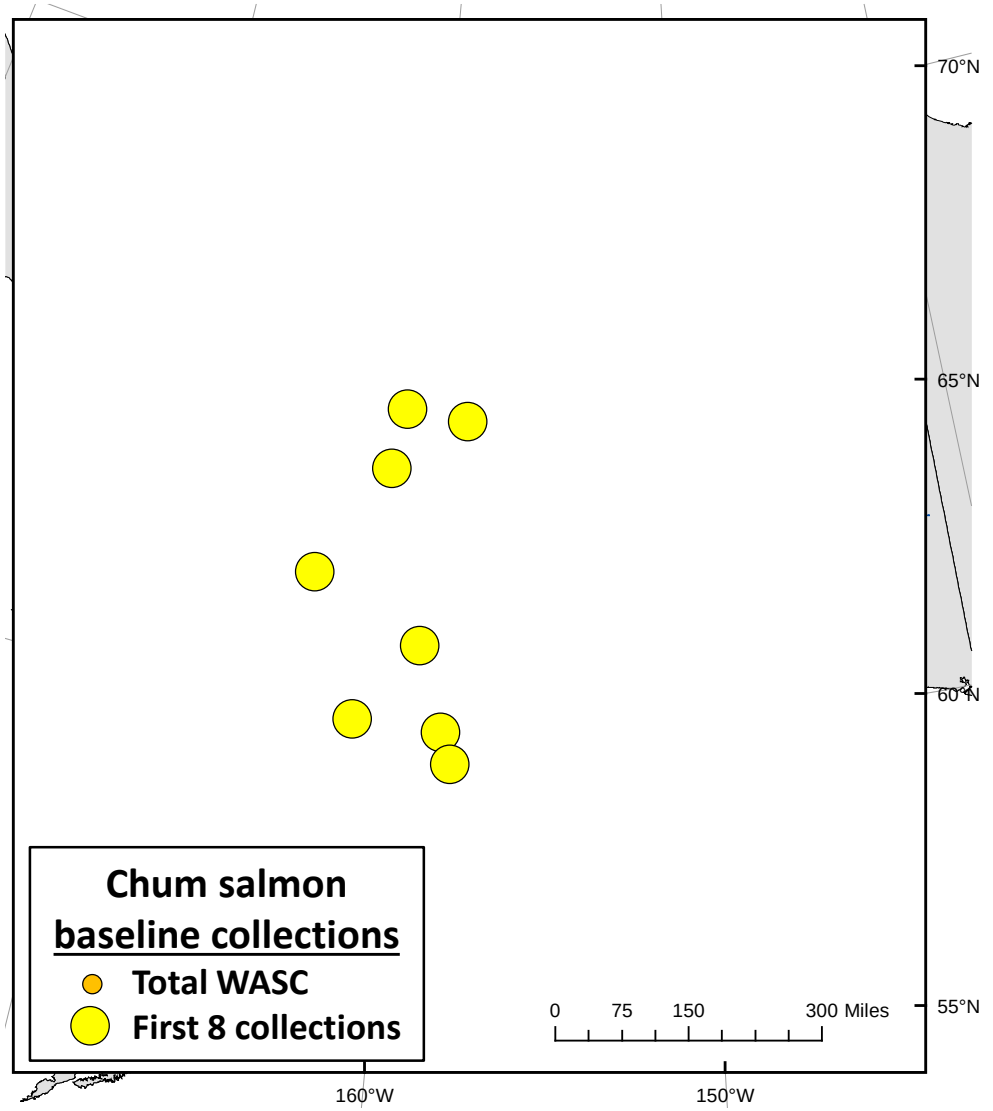
Goal II

Objective 1

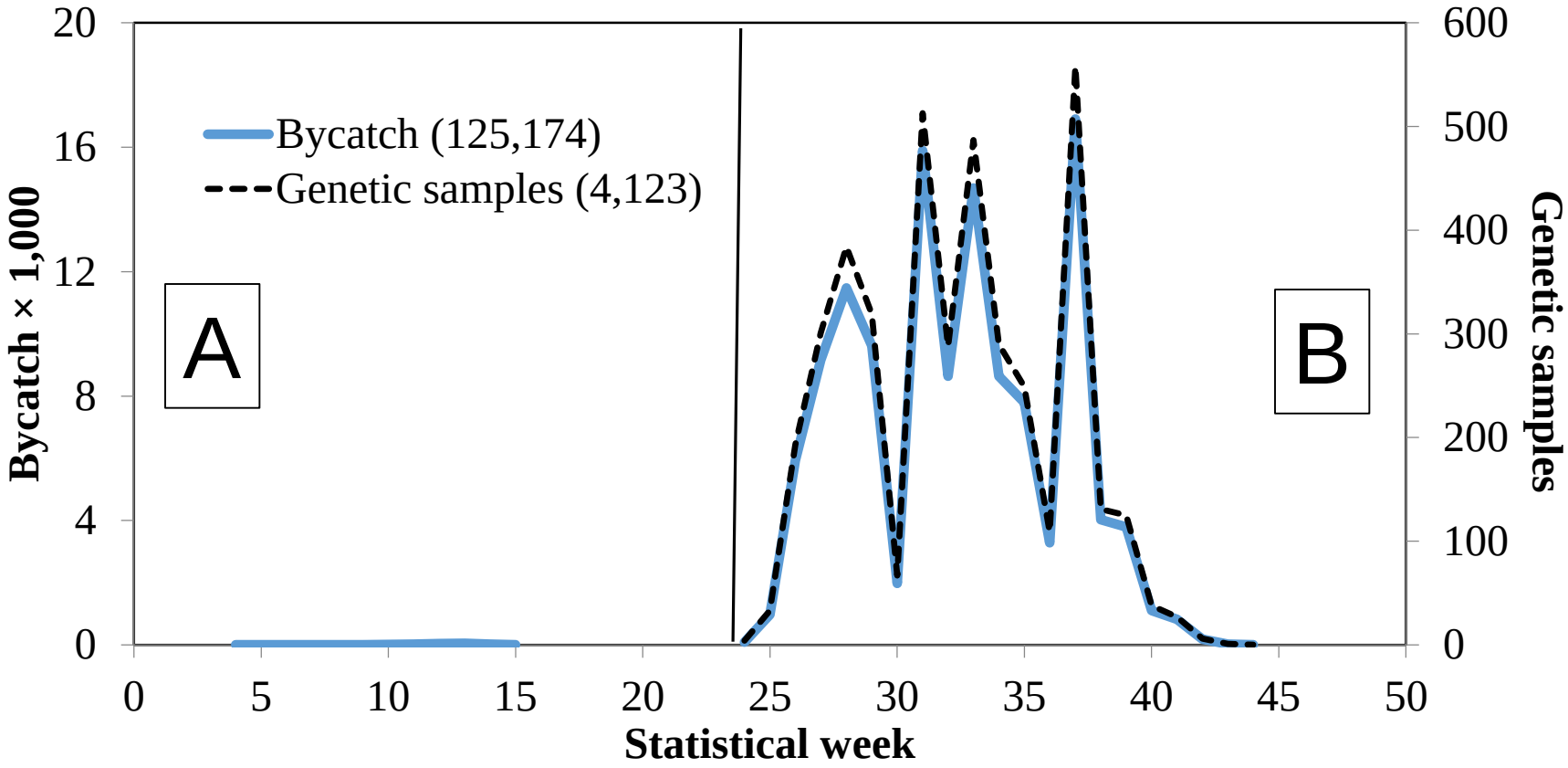
- Genotype 144 samples from each of 32 collections at pre-existing and new microsatellite markers.

Objective 2

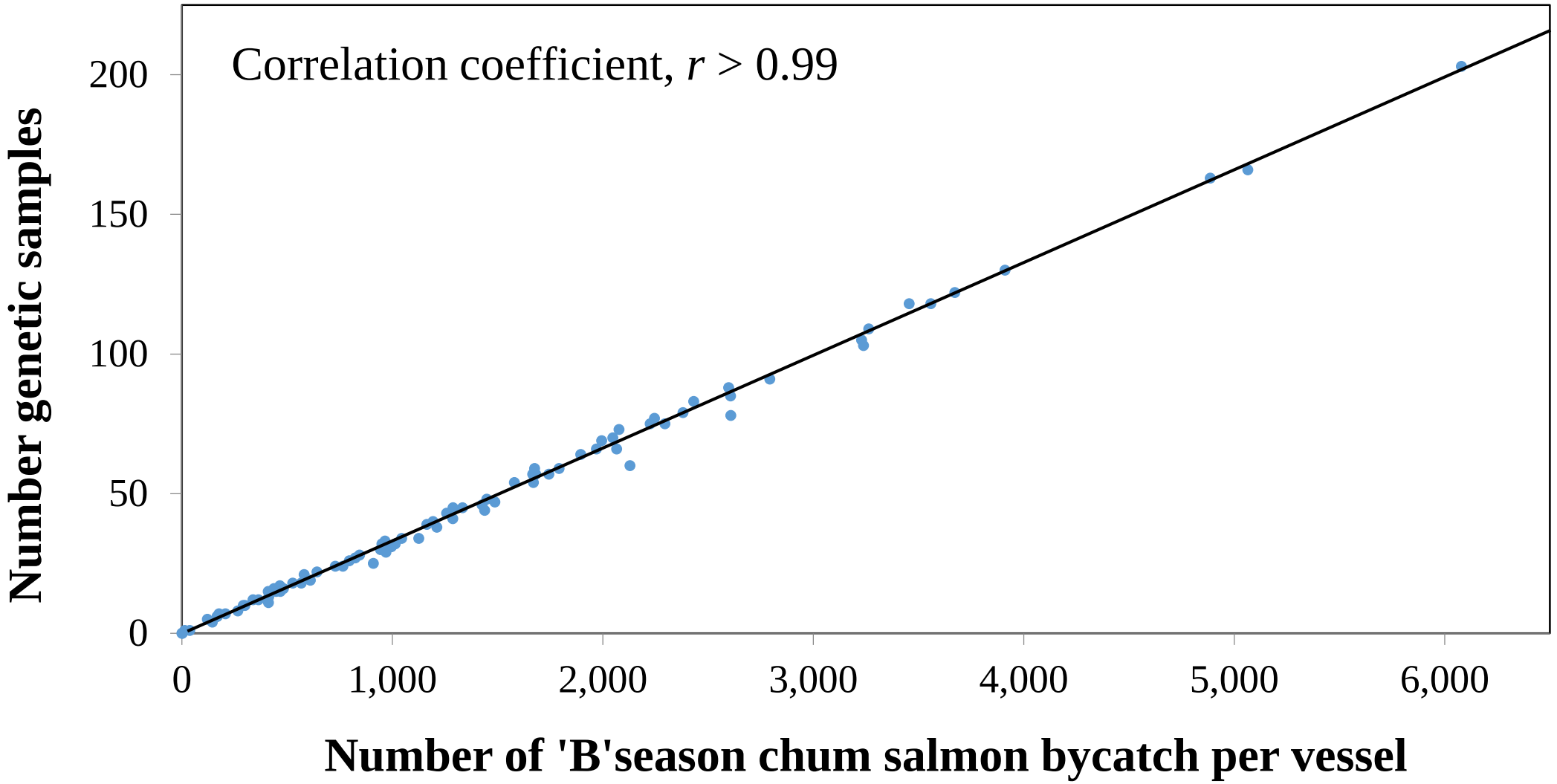
- Genotype mixture samples from lower Yukon and Kuskokwim rivers.



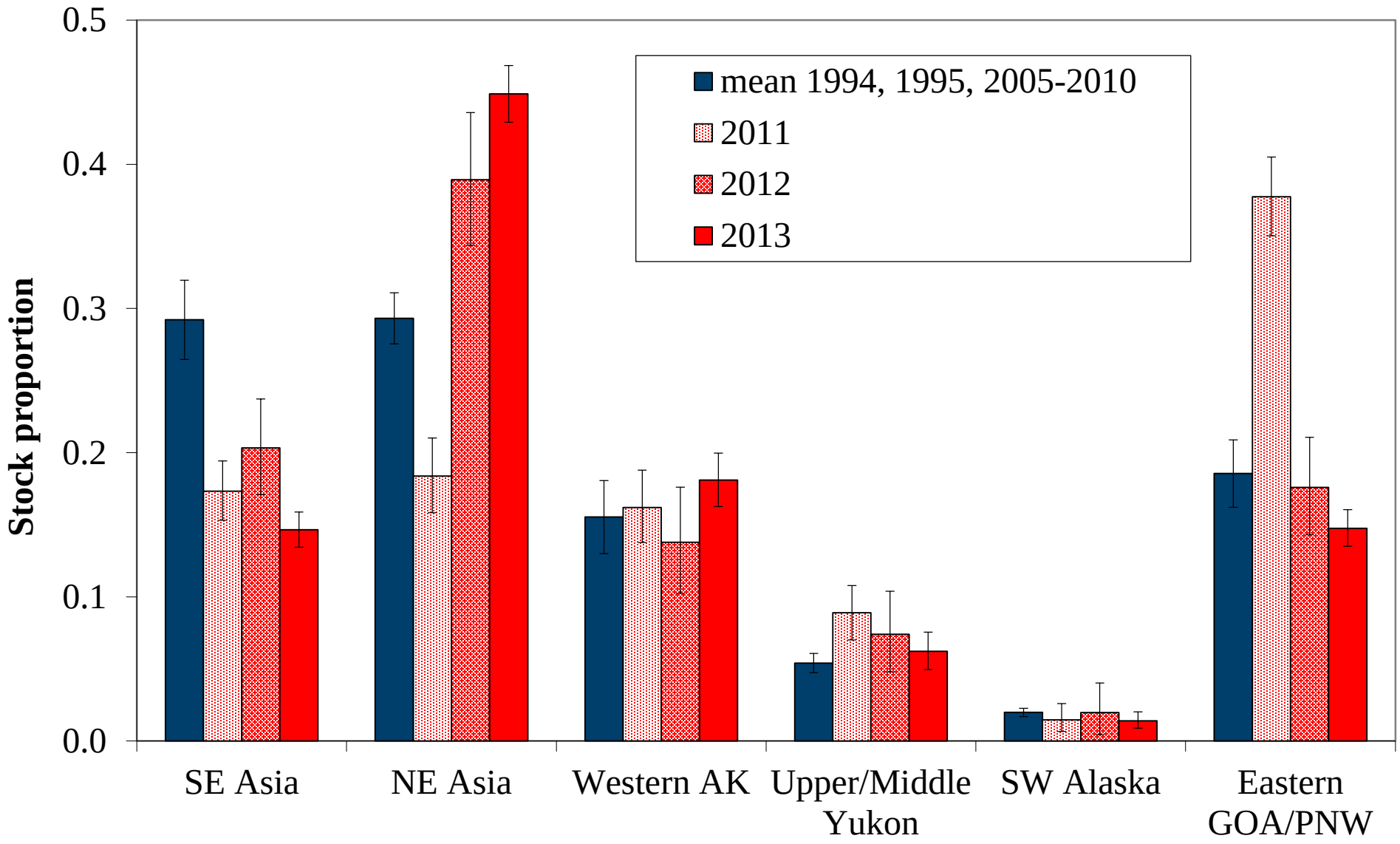
2013 Chum Salmon Bering Sea Bycatch



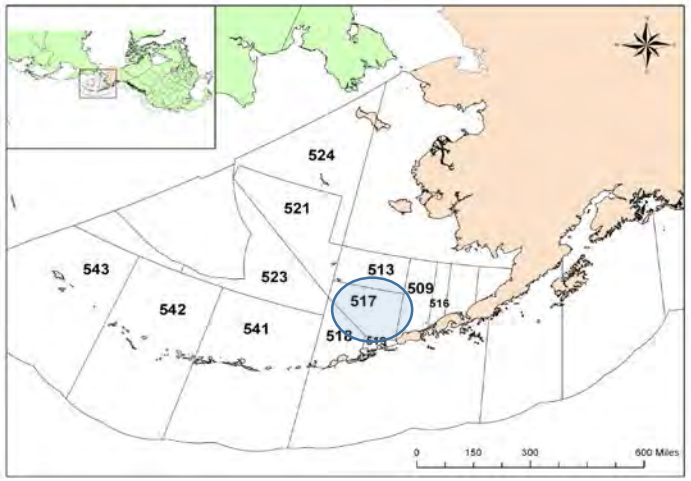
2013 Chum Salmon Bering Sea Bycatch



2013 Chum Salmon Bering Sea Bycatch

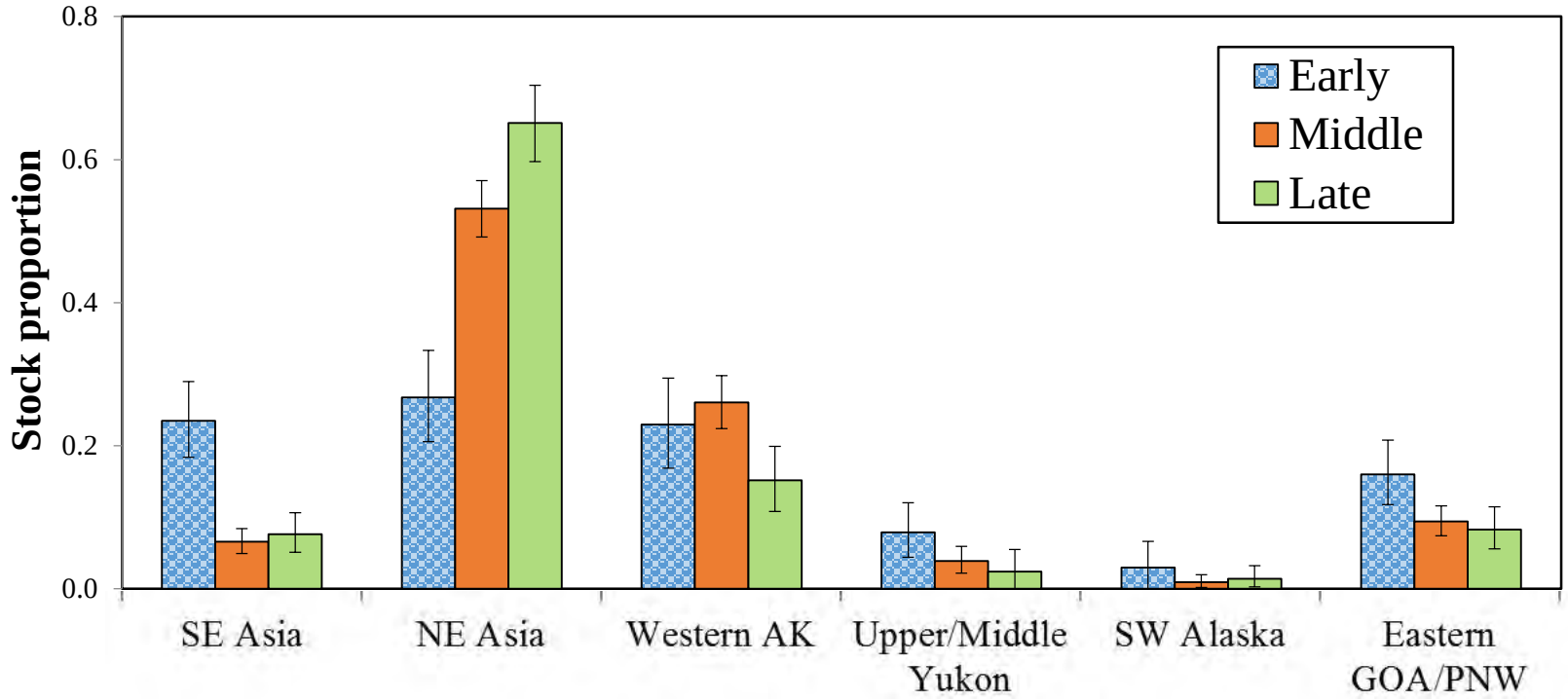


2013 Chum Salmon Bering Sea Bycatch



Area 517

Reporting area	Time period	Number of samples
517	Early	304
517	Middle	1,004
517	Late	473



Science, Service, Stewardship

NMFS-AFSC-290

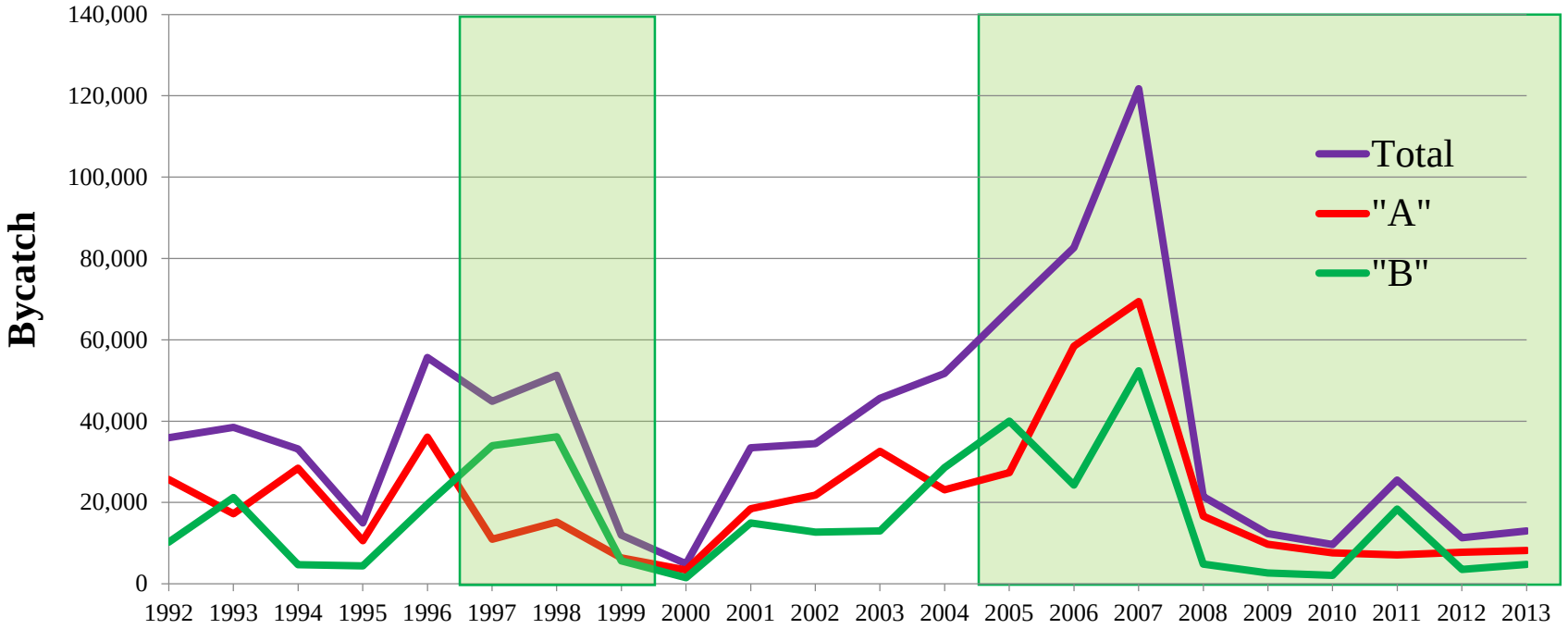
Genetic Stock Composition Analysis of the Chinook Salmon Bycatch from the 2013 Bering Sea Walleye Pollock (*Gadus chalcogrammus*) Trawl Fishery

C.M. Guthrie, H. T. Nguyen, and J.R. Guyon
Genetics Program
Auke Bay Laboratories
Juneau, AK

NOAA FISHERIES SERVICE

August 25, 2015

2013 Chinook Salmon Bering Sea Bycatch

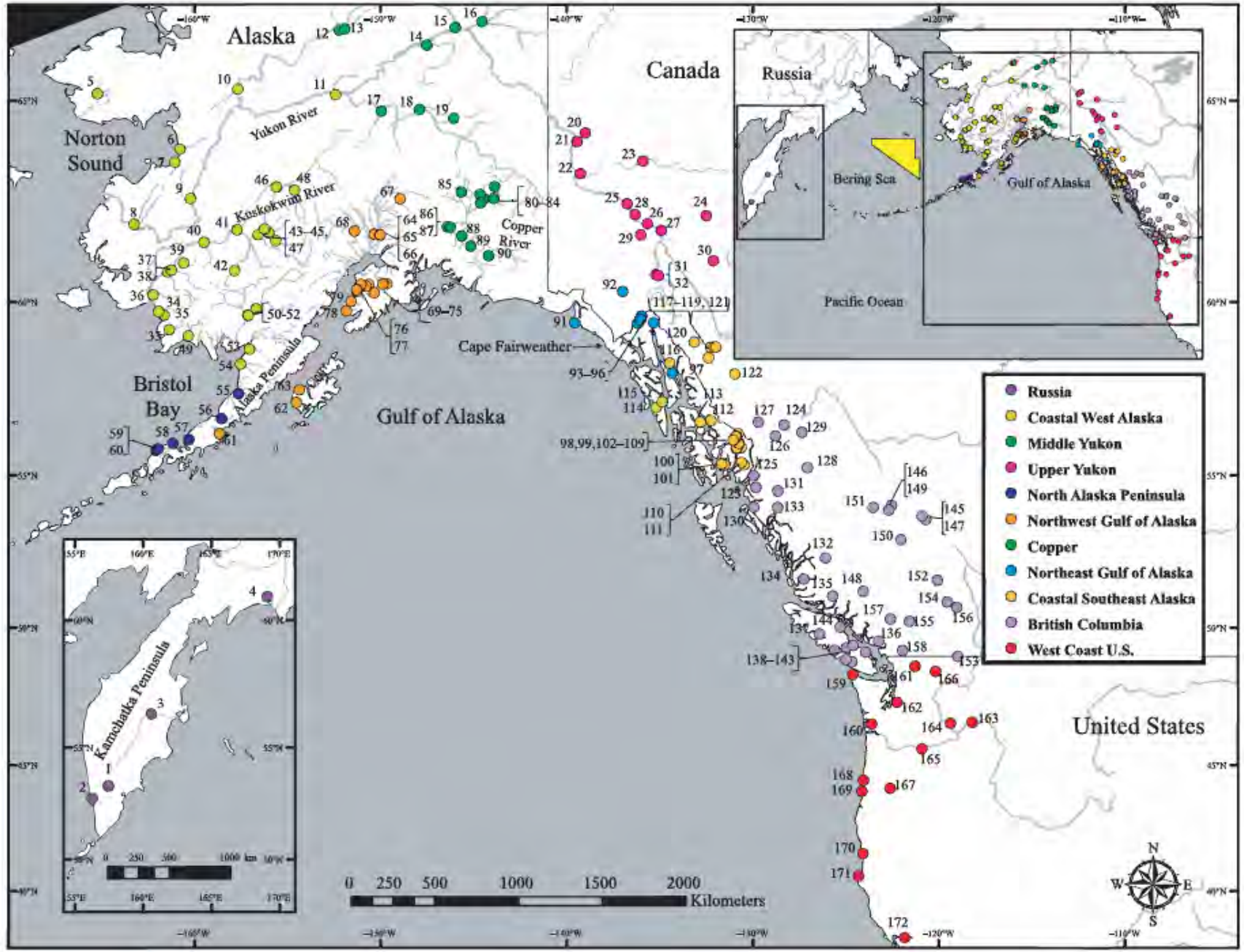


1979-1982: Scales (Myers and Rogers, 1988)

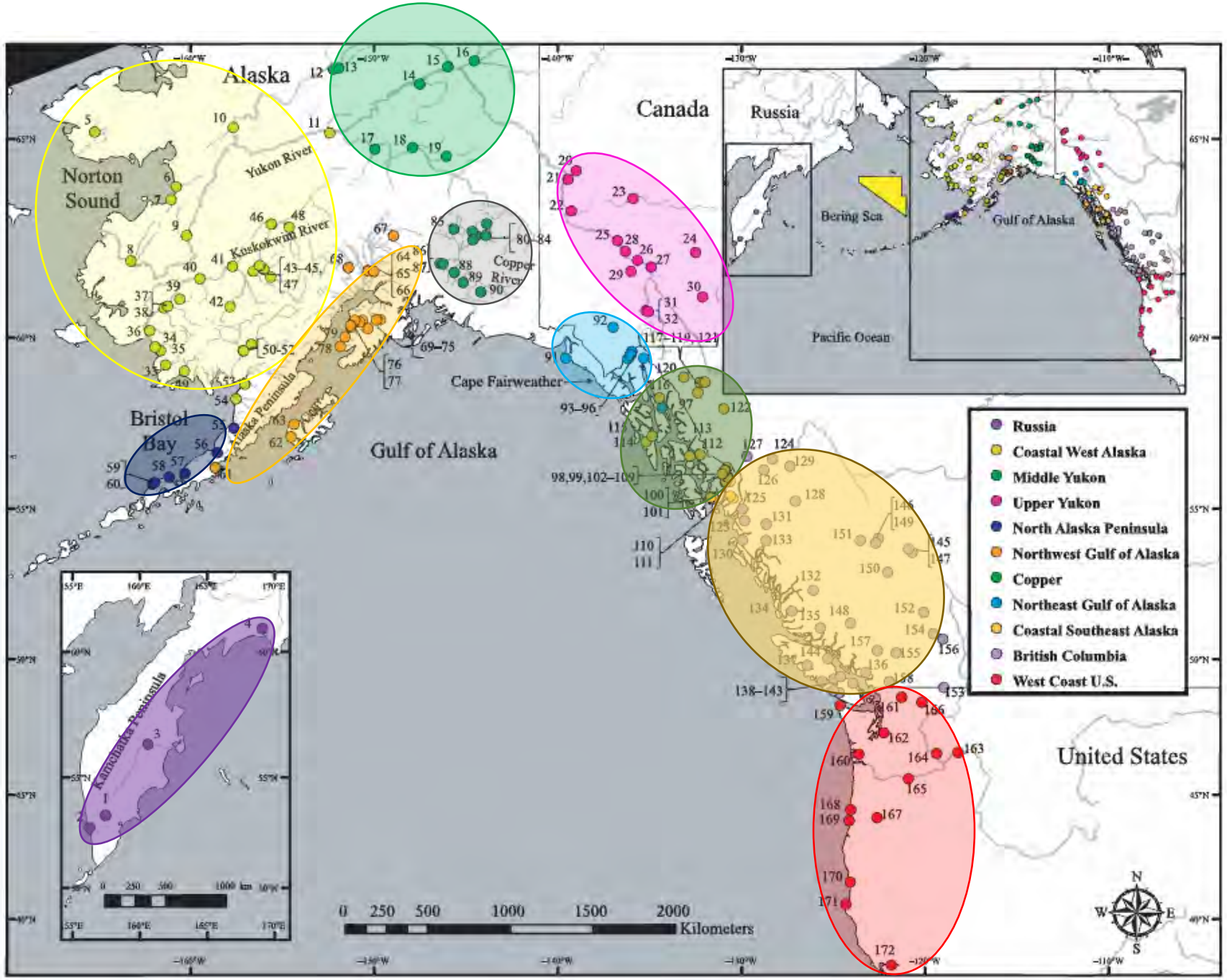
1997-1999: Scales (Myers et al., 2004)

2005 “B” - 2006: SNPs (ADF&G, Chinook Salmon EIS)

2007 – 2012: SNPs – 867 (2007 “B”), 863 (2008), 386 (2009), 826 (2010), 2,473 (2011), 1,111 (2012), and 1,246 (2013) samples.

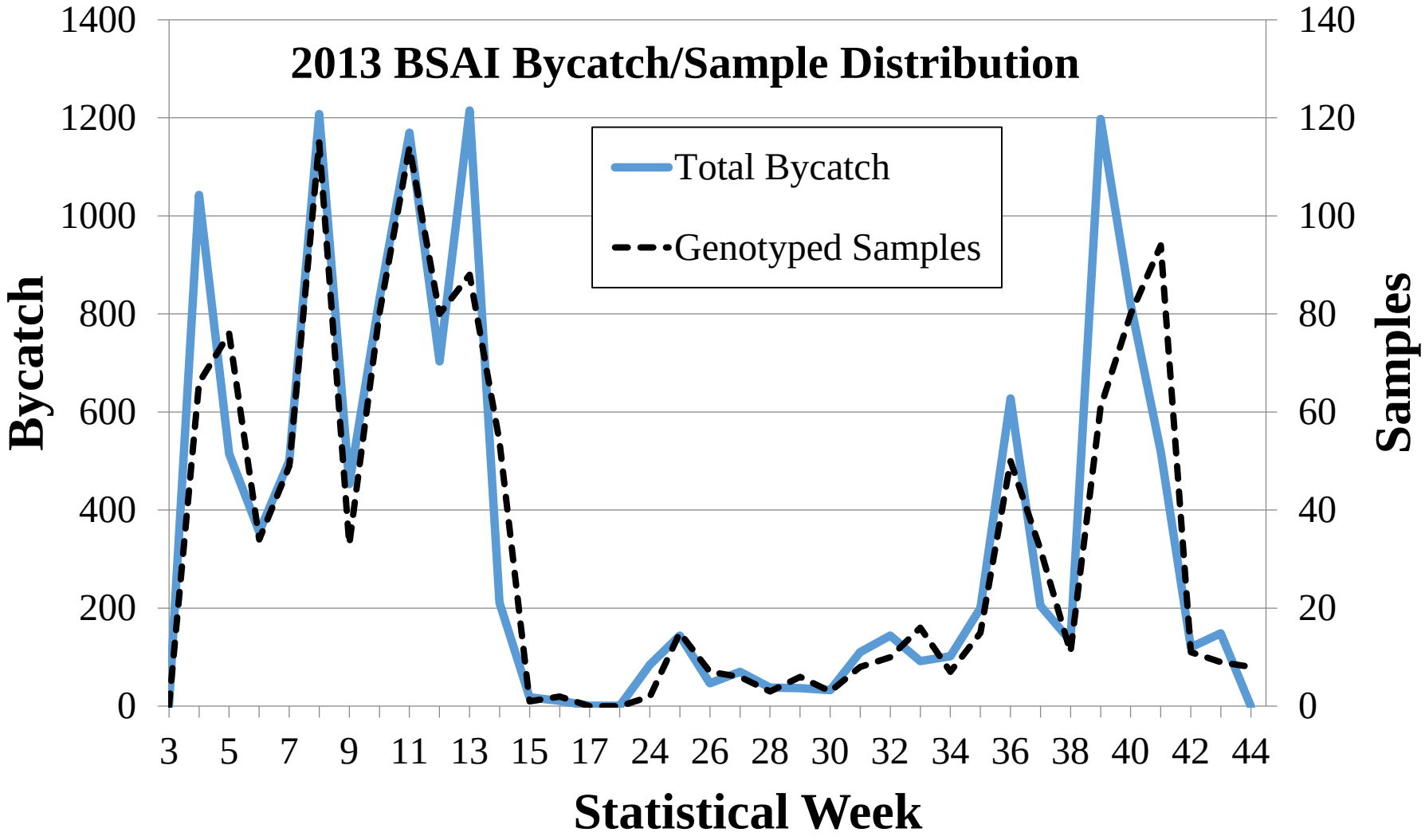


Templin et al., 2011

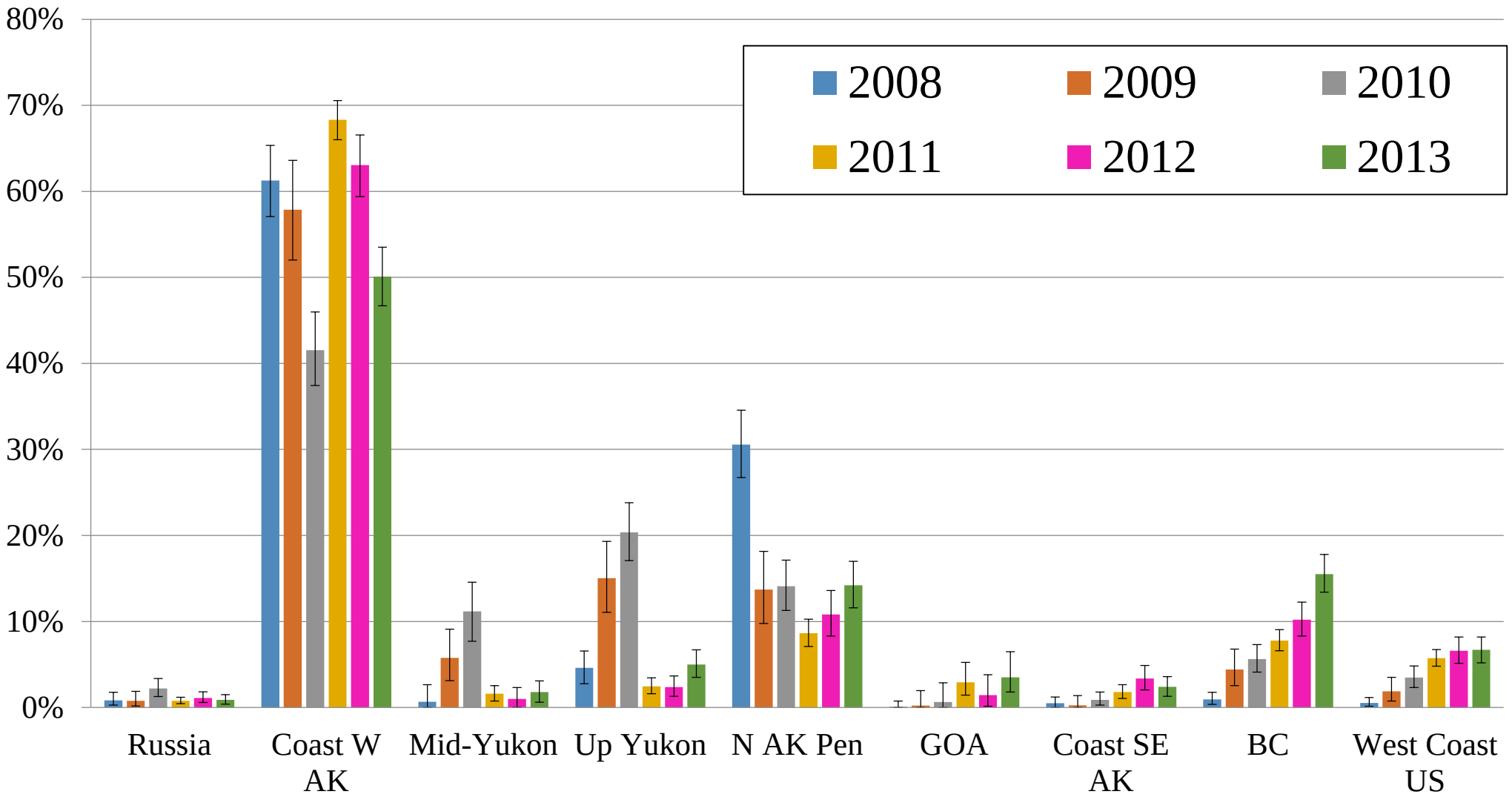


Templin et al., 2011

2013 Chinook Salmon Bering Sea Bycatch



2013 Chinook Salmon Bering Sea Bycatch



Science, Service, Stewardship

NMFS-AFSC-291

Extension of Genetic Stock Composition Analysis to the Chinook Salmon Bycatch in the Gulf of Alaska Walleye Pollock (*Gadus chalcogrammus*) Trawl Fisheries, 2013

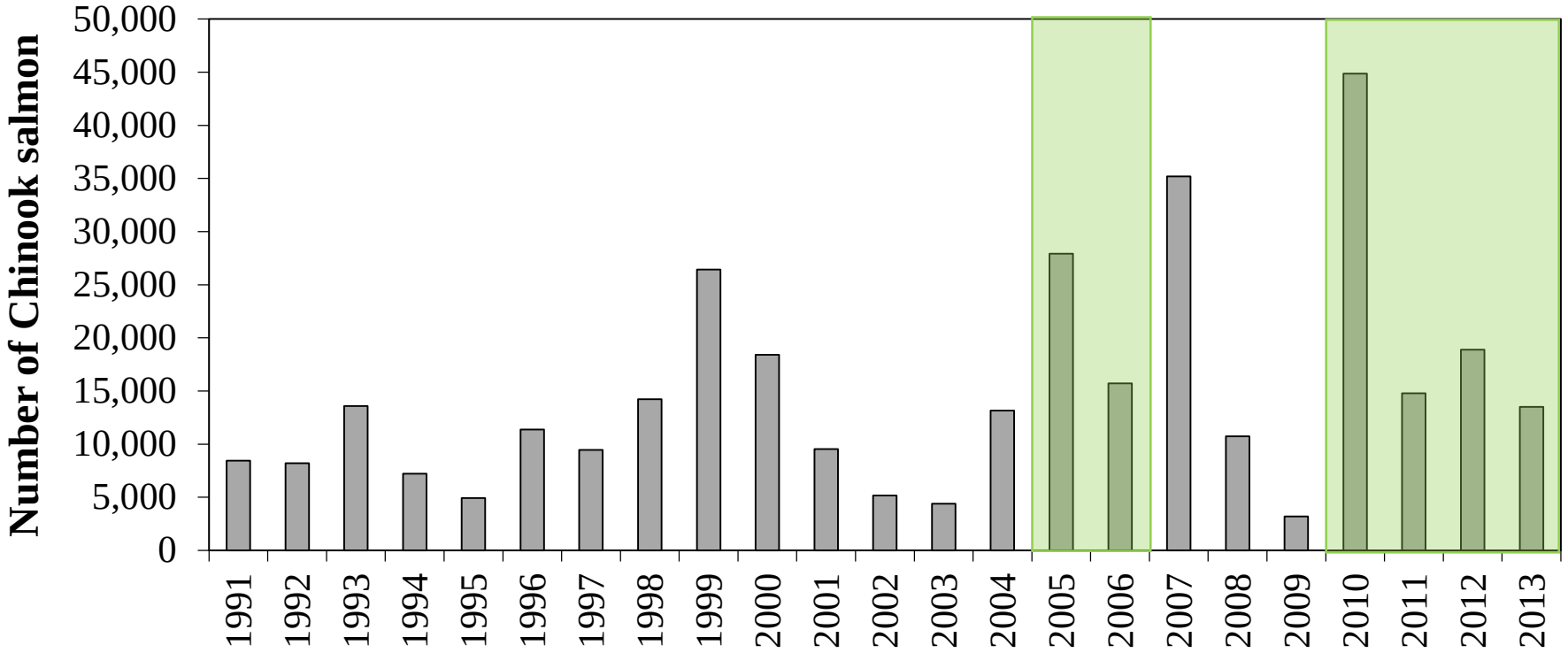
Jeff Guyon
Charles Guthrie, III
Genetics Program
Auke Bay Laboratories
Juneau, AK

Andrew Munro
William Templin
Jim Jasper
Gene Conservation Laboratory
Alaska Dept of Fish and Game
Anchorage, AK

NOAA FISHERIES SERVICE

August 25, 2015

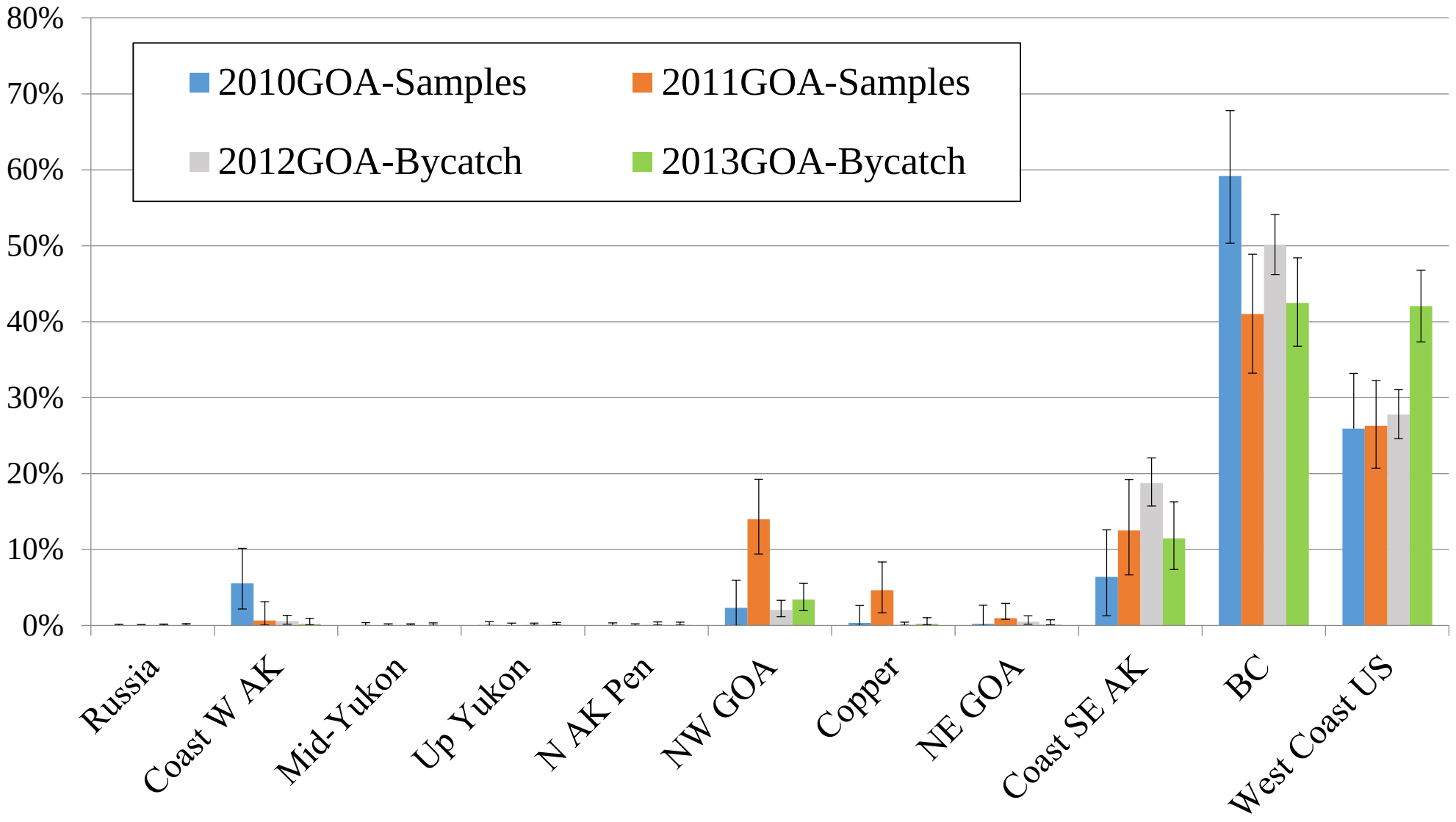
2013 Chinook Salmon GOA Bycatch



2005 – 2006: SNPs – 219 (Winter 2006), 62 (Summer 2005-6), 127 (Fall 2005-6) samples

2010 – 2013: SNPs – 161 (2010), 240 (2011), 948 (2012), and 693 (2013) samples.

2013 Chinook Salmon GOA Bycatch - Pollock



Acknowledgements

NMFS
Chris Kondzela
Chuck Guthrie
Sharon Wildes
Hanhvan Nguyen
Jackie Whittle
Scott Vulstek
North Pacific Observer Program

ADF&G
Bill Templin
Andrew Munro
Jim Jasper

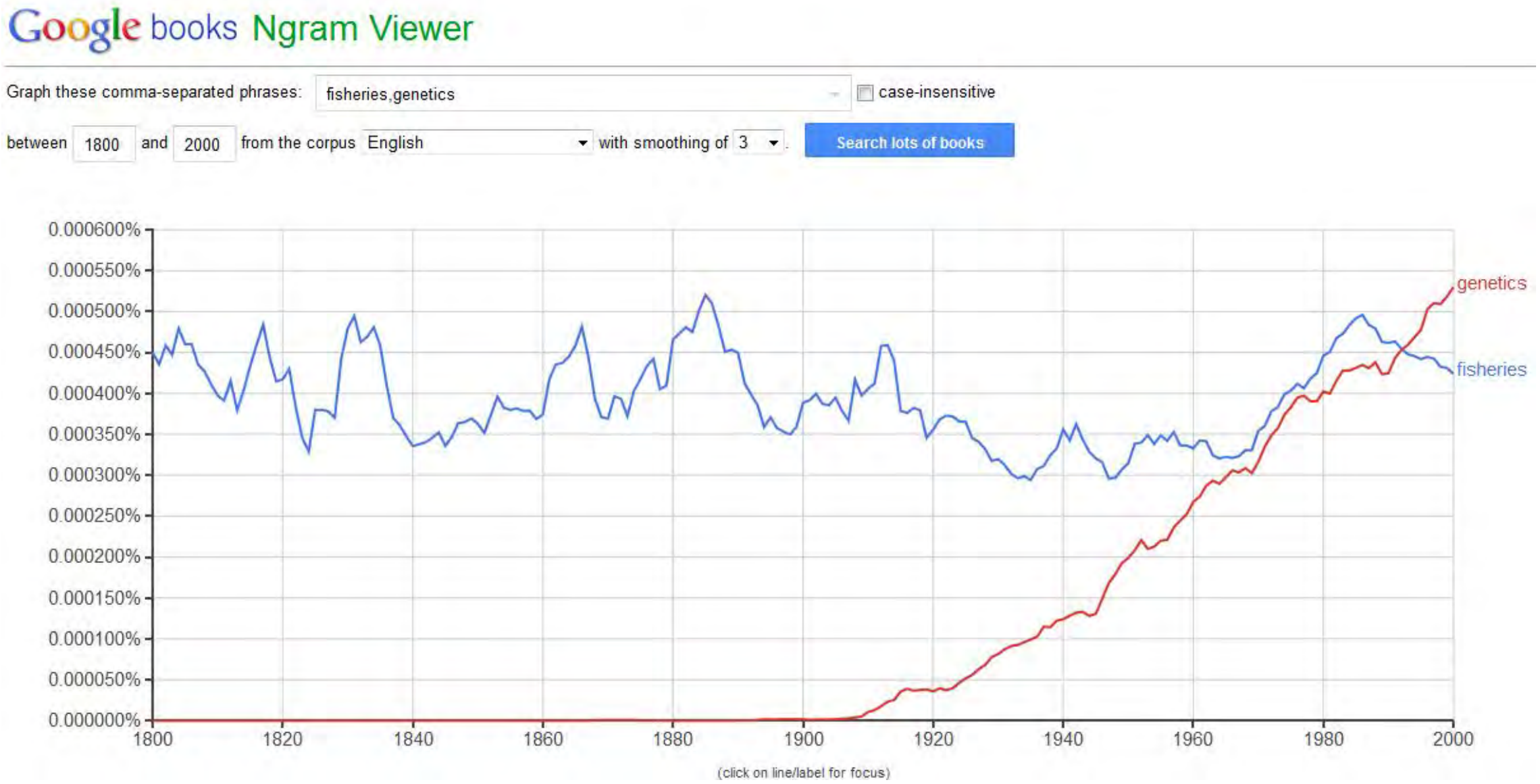
Alaska Groundfish Data Bank
Julie Bonney
Katy McGauley
Ken Hansen

Alaska Seafood Cooperative
John Gauvin

Funding
NMFS AKSSF NPFRF

New Genetic Technologies

Genetic tools and their uses for management are increasing

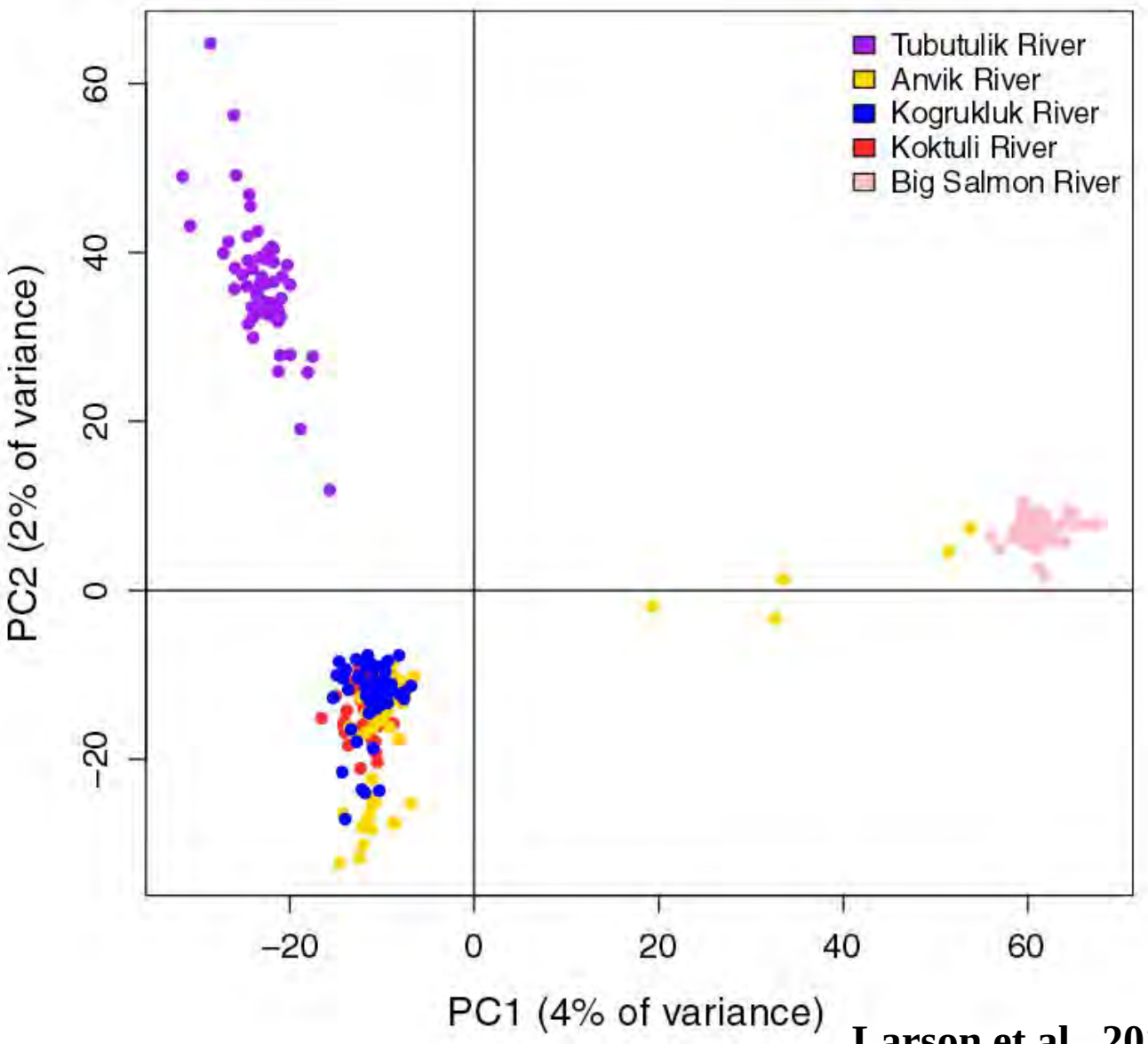


RAD Sequencing

…ACTAGCTGACTGTACGTAC…

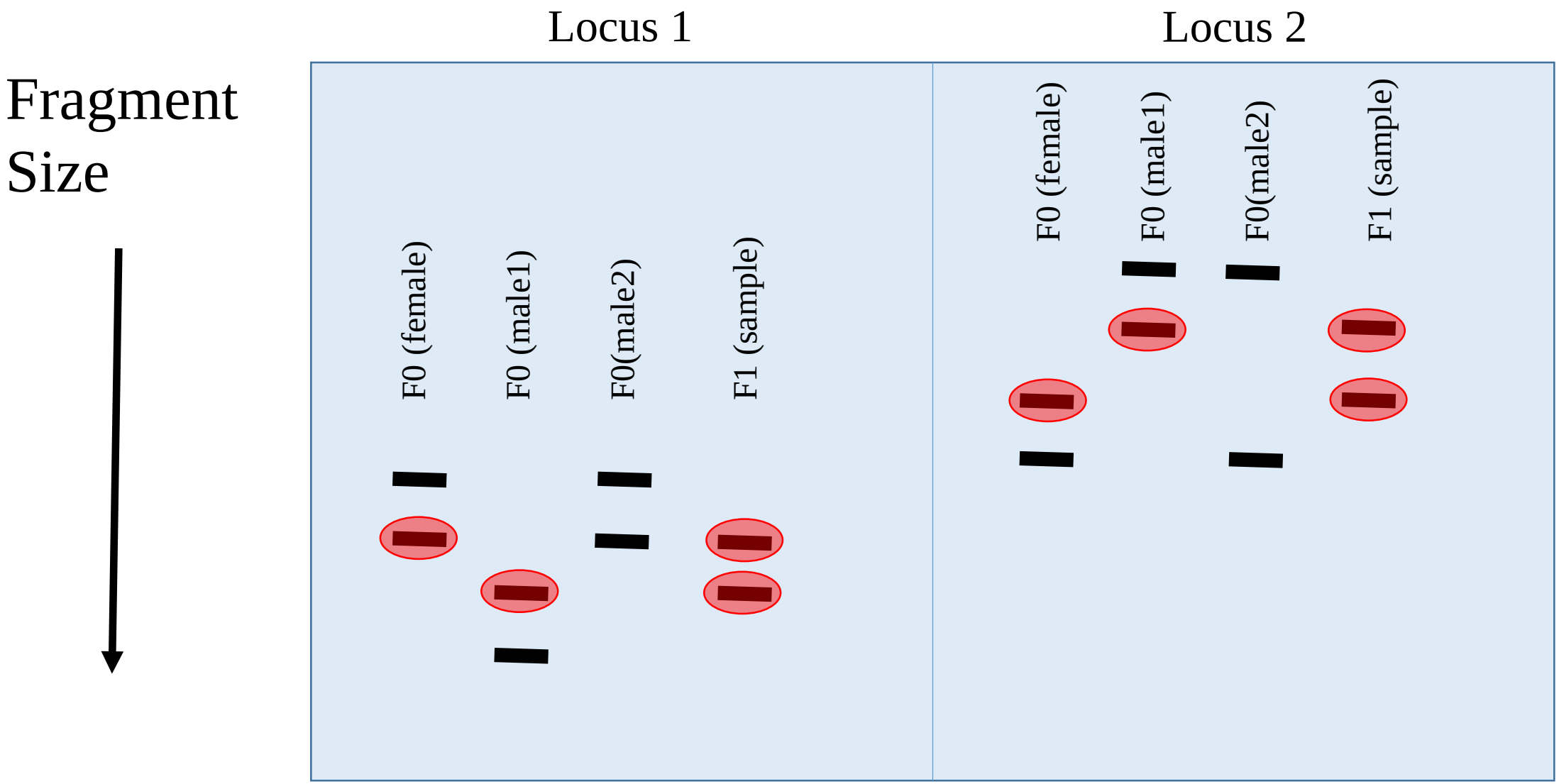
…ACTAGCTGGCTGTACGTAC…

RAD Sequencing/Genomics – Example from UW and ADFG



Larson et al., 2014

Parentage Analysis



Parentage Analysis (SWFSC) - Slide from Carlos Garza

Hatchery programs with current broodstock sampling

Steelhead: Russian River; Central Valley (four programs)

Coho salmon: Klamath River-Iron Gate; Russian River

Chinook salmon: Trinity River- spring and fall run; Feather & San Joaquin River- spring run; Sacramento- winter run

Forensic Analysis (NWFSC) – Slide from Linda Park and Jeff Hard

A National Forensics Program for NOAA

Provide genetic and morphological analyses

Serve all regions of the Office of Law Enforcement (OLE)

eDNA (metagenomics)

Collect water sample

Isolate residual DNA
from sloughed cells

Sequence DNA for species ID


AMNION