Population Structure of Pink Salmon in Prince William Sound

Wei Cheng, Chris Habicht, Bill Templin
Alaska Department of Fish and Game

Tony Gharrett
University of Alaska Fairbanks

Alaska Hatchery Research Program

Anchorage, Alaska

December 12, 2014

Outline

- Purpose
- Current knowledge
- Study design
- Progress
- Future work

Purpose

- What is the genetic stock structure of pink and chum salmon in each region?
- 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)?
- What is the impact on fitness (productivity) of wild pink and chum salmon stocks due to straying of hatchery pink and chum salmon?

Purpose

- **What is the genetic stock structure of pink and chum salmon in each region?**
- **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)?**
- **What is the impact on fitness (productivity) of wild pink and chum salmon stocks due to straying of hatchery pink and chum salmon?**

Genetic Stock Structure
(Population Structure)

- **Affected by four evolutionary processes:**
  - **Natural selection**
  - **Genetic drift**
  - **Mutation**
  - **Migration**

Genetic Stock Structure
(Population Structure)

- **Affected by four evolutionary processes:**
  - **Natural selection**
  - **Genetic drift**
  - **Mutation**
  - **Migration**

Genetic Stock Structure
(Population Structure)

- **Affected by four evolutionary processes:**
  - **Natural selection**
  - **Genetic drift**
  - **Mutation**
  - **Migration**

- **Quantified by allele frequency variation (gene frequencies)**

Outline

- Purpose
- **Current knowledge**
- Study design
- Progress
- Future work

Current Knowledge

Genetic Characterization of Prince William Sound Pink Salmon Populations

Report
to
Alaska Department of Fish and Game
Feb. 15, 1977
by
Jim Seeb
and
Lisa Wishard

INFORMATIONAL LEAFLET NO. 181

SEPARATION OF SOME PINK SALMON (Oncorhynchus gorbuscha Walbaum) SUB-POPULATIONS IN PRINCE WILLIAM SOUND, ALASKA BY LENGTH-WEIGHT RELATIONSHIPS AND HORIZONTAL STARCH GEL ELECTROPHORESIS

By
Richard B. Nickerson

Ecology of Freshwater Fish 1999: 8: 122–140
Printed in Denmark · All rights reserved

ECOLOGY OF FRESHWATER FISH
ISSN 0906-6691

Allozyme and mitochondrial DNA variation describe ecologically important genetic structure of even-year pink salmon inhabiting Prince William Sound, Alaska

Seeb JE, Habicht C, Templin WD, Seeb LW, Shaklee JB, Utter FM. Allozyme and mitochondrial DNA variation describe ecologically important genetic structure of even-year pink salmon inhabiting Prince William Sound, Alaska.
Ecology of Freshwater Fish 1999: 8: 122–140. © Munksgaard, 1999

Abstract – Allozyme and mitochondrial DNA (mtDNA) data were obtained from pink salmon throughout Prince William Sound, Alaska, from two hatchery, five upstream, and 20 tidal locations distributed among five management regions collected during 1994. Screening for allozymes included 66 loci for 92 to 100 fish per sample. Thirty-four loci had variant allele frequencies >0.01 in one or more collections and were used for population analyses. Eight haplotypes were detected after screening 40 fish per collection for variation at the ND5/ND6 region of mtDNA using six restriction enzymes. Significant and apparently stable differences detected by both data sets permit rejecting a null hypothesis of panmixia and support managing native populations in Prince William Sound at the regional level. Distinctions between upstream and tidal collections were detected within Lagoon Creek (allozymes) and Koppen Creek (mtDNA). Significant regional heterogeneity was detected within upstream (allozymes and mtDNA) and tidal (allozymes) collections; however, upstream collections were more divergent from each other than were tidal collections. The absence of distinction of Armin F. Koernig Hatchery from almost all regions was consistent with multiple origins of this stock. Conversely, Solomon Gulch Hatchery in the East Region was distinct from all regions but East, consistent with a more restricted origin and influence.

J. E. Seeb[1], C. Habicht[1], W. D. Templin[1], L. W. Seeb[1], J. B. Shaklee[2], F. M. Utter[3]

[1]Alaska Department of Fish & Game, Commercial Fisheries Division, Anchorage, Alaska, [2]Washington Department of Fish & Wildlife, Olympia, [3]School of Fisheries, University of Washington, Seattle, Washington, USA

Key words: allozyme; mtDNA; genetics; pink salmon

J. E. Seeb, Alaska Department of Fish & Game, Commercial Fisheries Division, Anchorage, AK 99518, USA

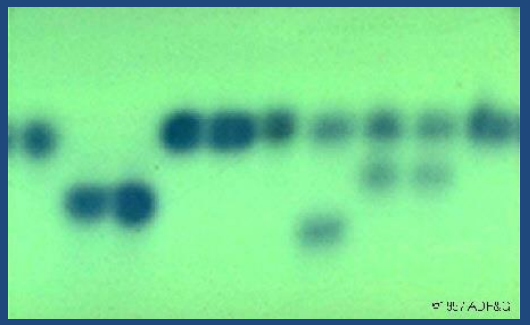
Accepted for publication April 9, 1999

Un resumen en español se incluye detrás del texto principal de este artículo.

Current Knowledge

- **Allozymes**

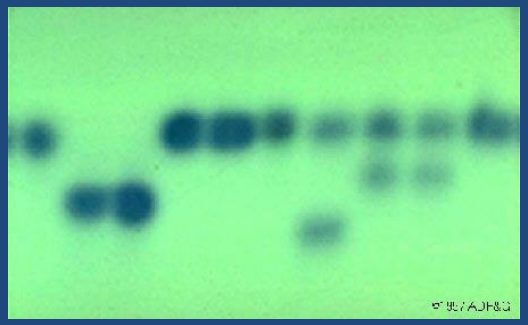
  Variant forms of an enzyme

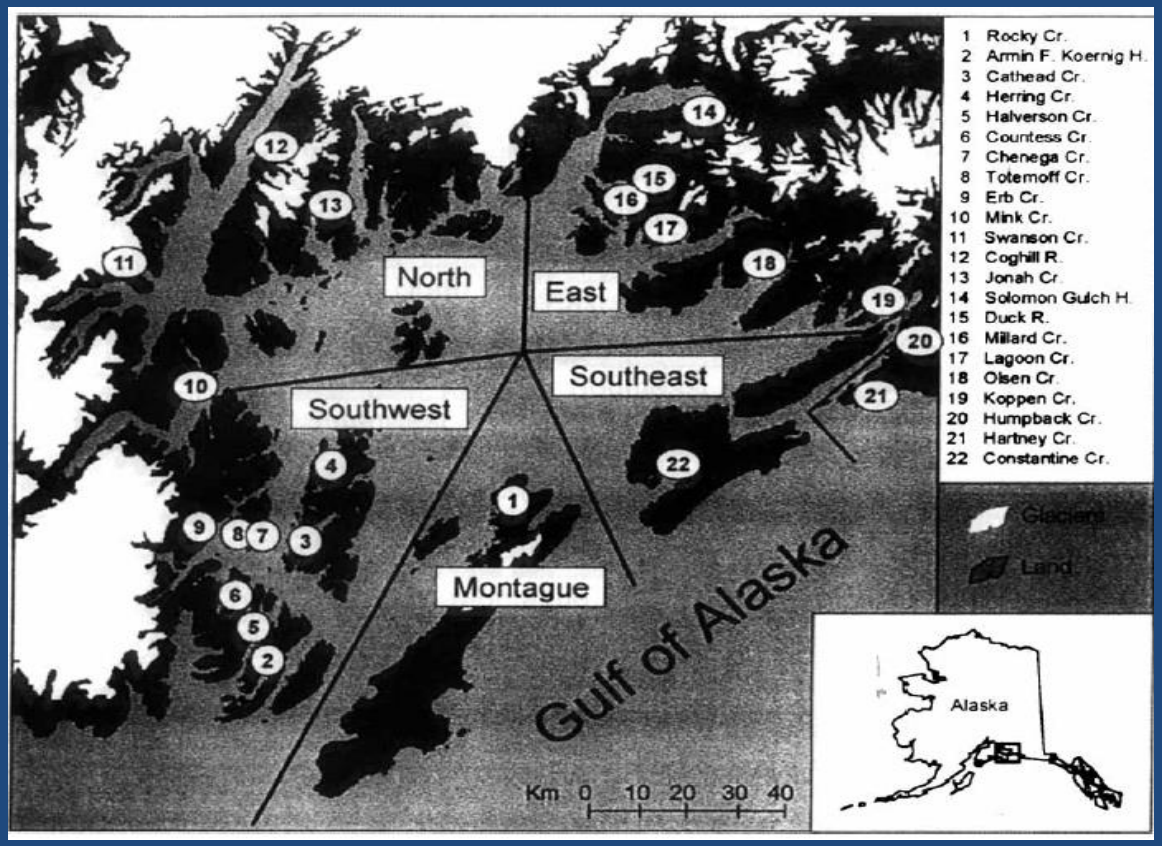


Current Knowledge

- **Allozymes**

  Variant forms of an enzyme





(Seeb et al. 1999)

Found:

Intertidal-upstream
East-West
Hatchery-hatchery

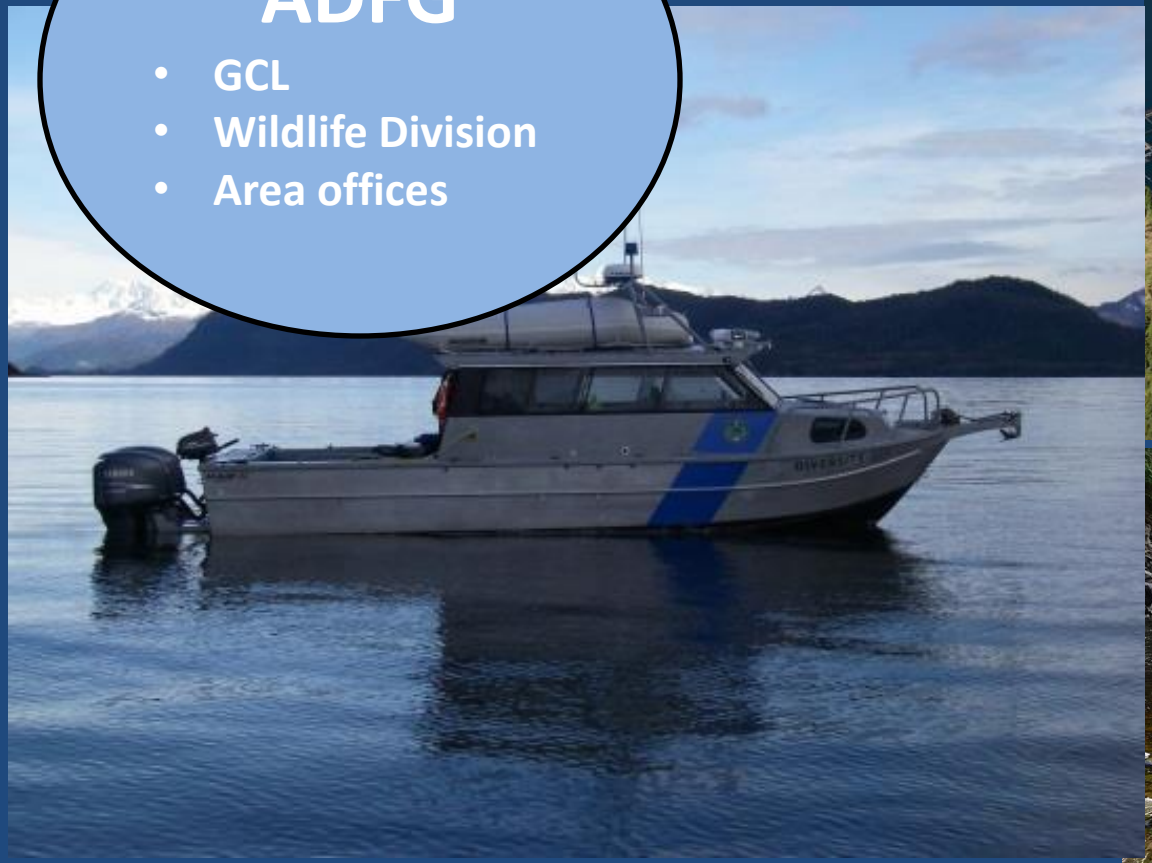
Outline

- Purpose
- Current knowledge
- **Study design**
- Progress
- Future work

Field sampling

ADFG

- GCL
- Wildlife Division
- Area offices



Hatcheries

- PWSAC
- VFDA
- KRAA

PWSSC

Genetic Markers Used in This Study

- **Microsatellite DNA**

Genetic Markers Used in This Study

- **Microsatellite DNA**

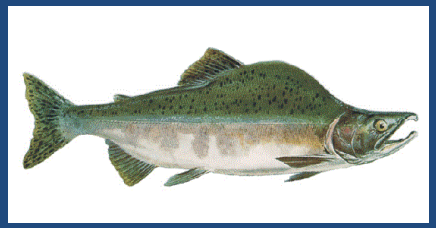
CAAGGCGTGTGTGTGTGTGTCTTATCA

7 repeats

CAAGGCGTGTGTGTGTGTGTGTGTCTTATCA

9 repeats

Laboratory Work

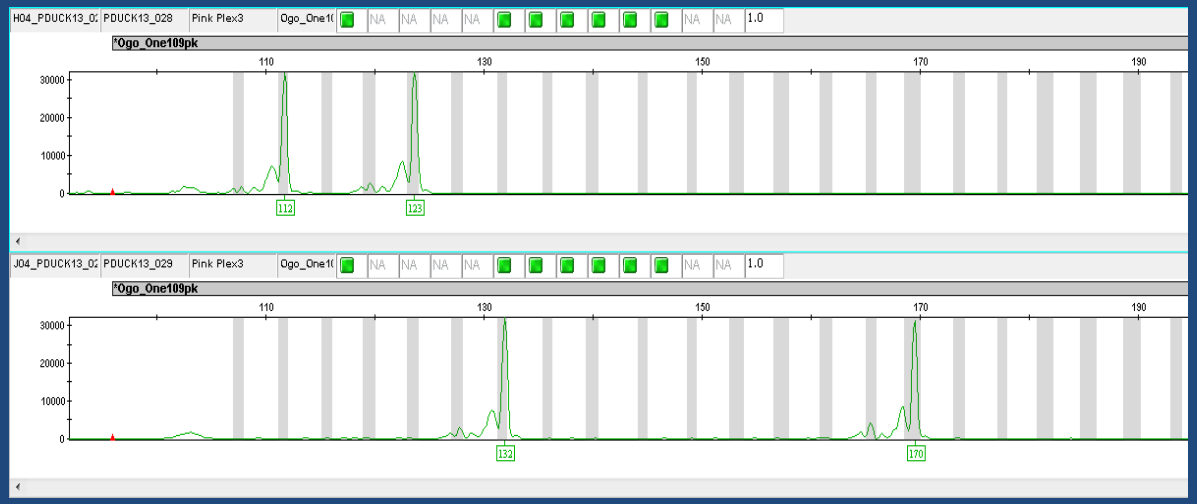


Sample

Extract DNA

PCR

Genotype



Data Analysis

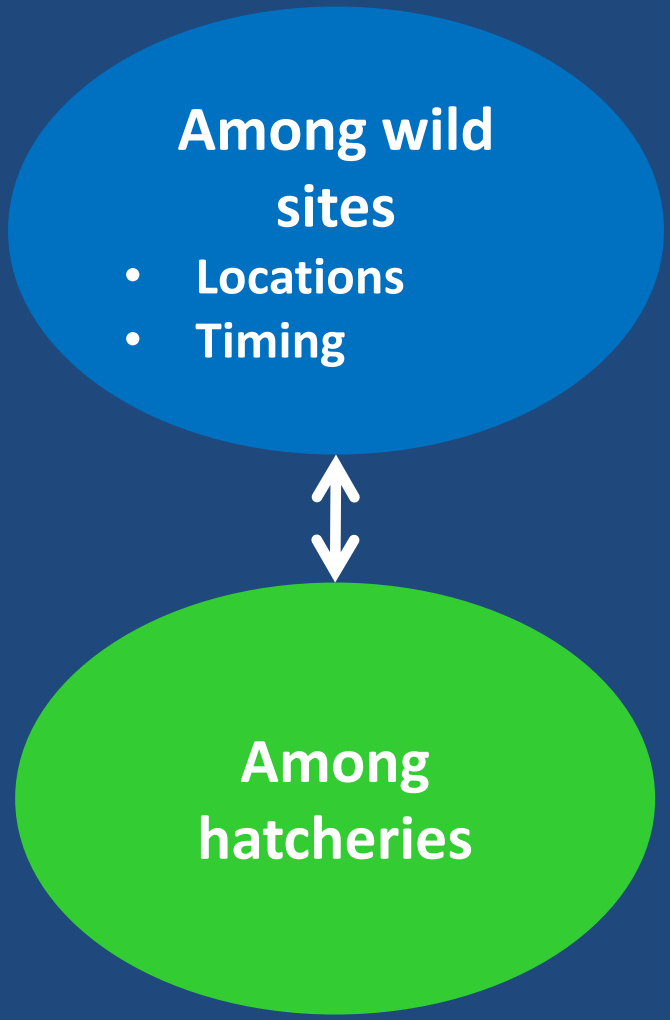
Contemporary

Among wild sites

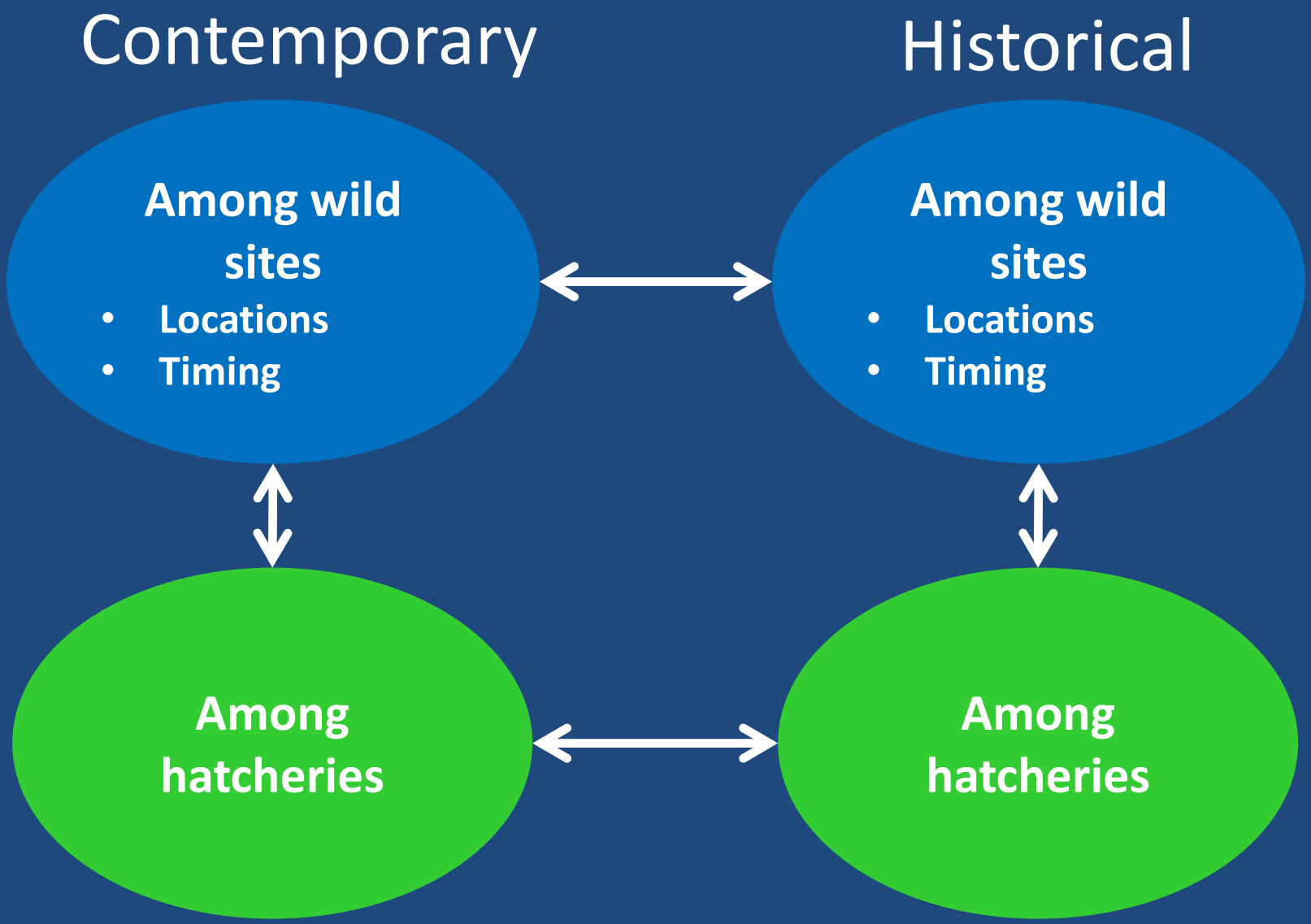
- **Locations**
- **Timing**

Data Analysis

Contemporary



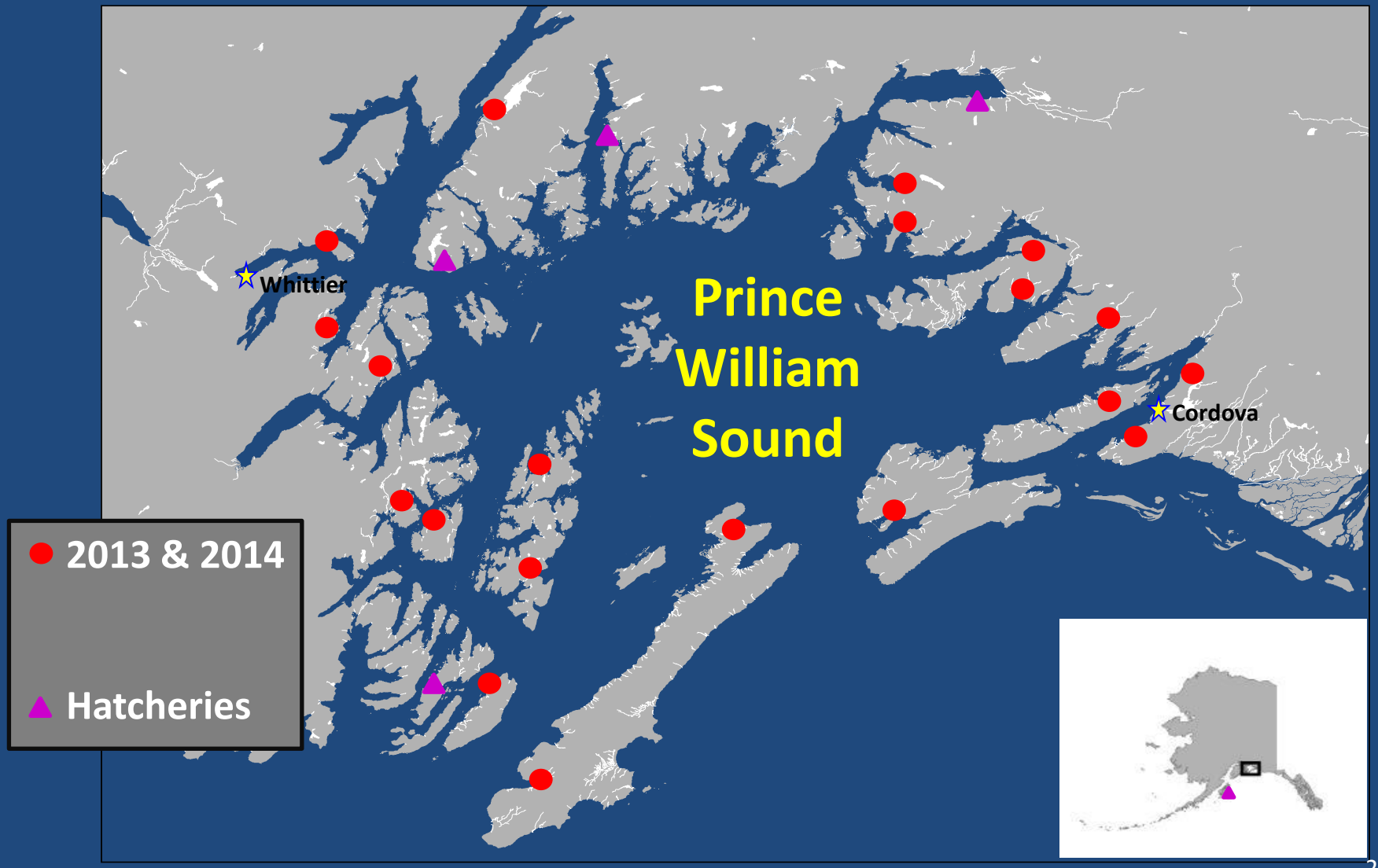
Data Analysis



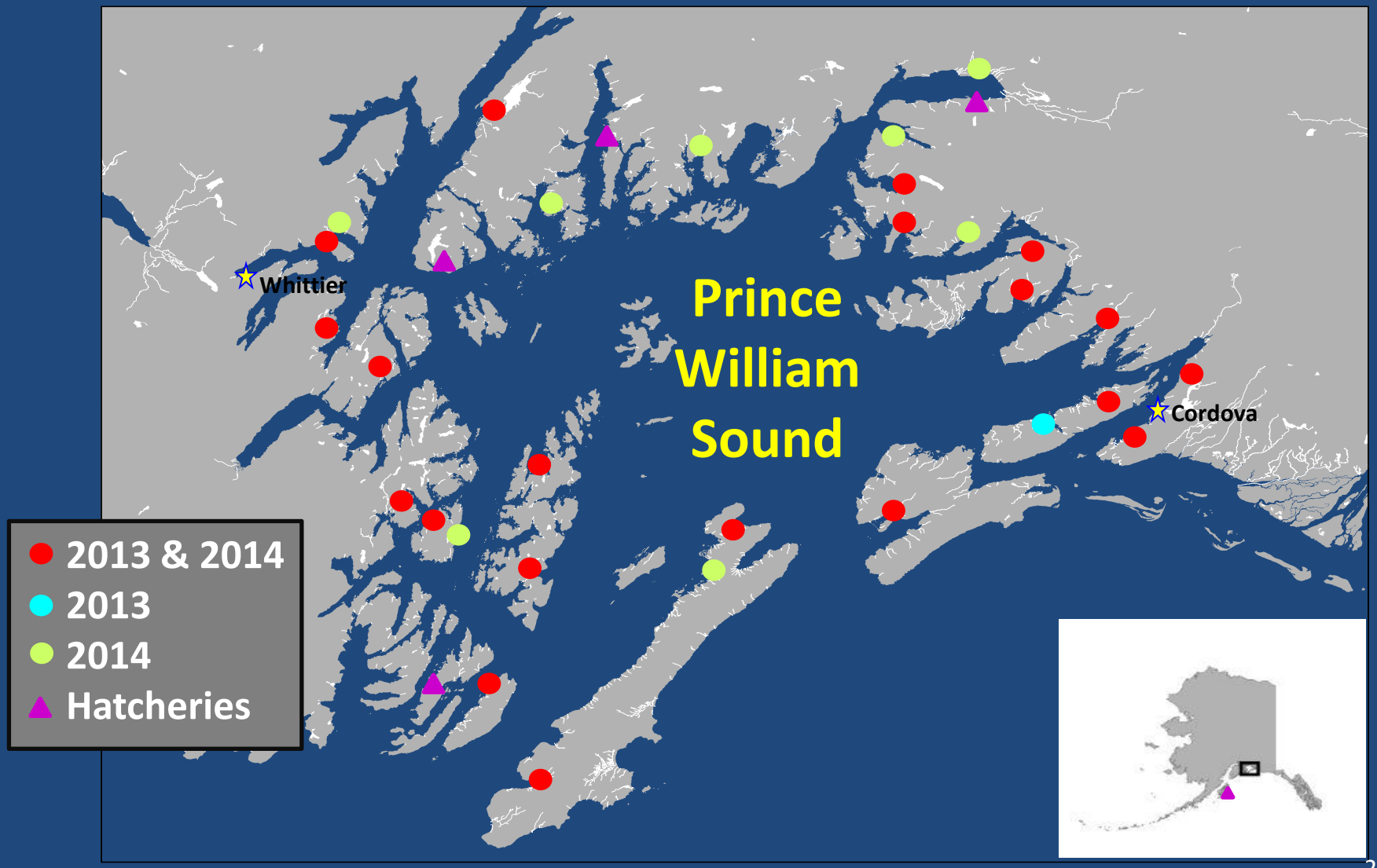
Outline

- Purpose
- Current knowledge
- Study design
- **Progress**
- Future work

2013 and 2014 Paired Collections



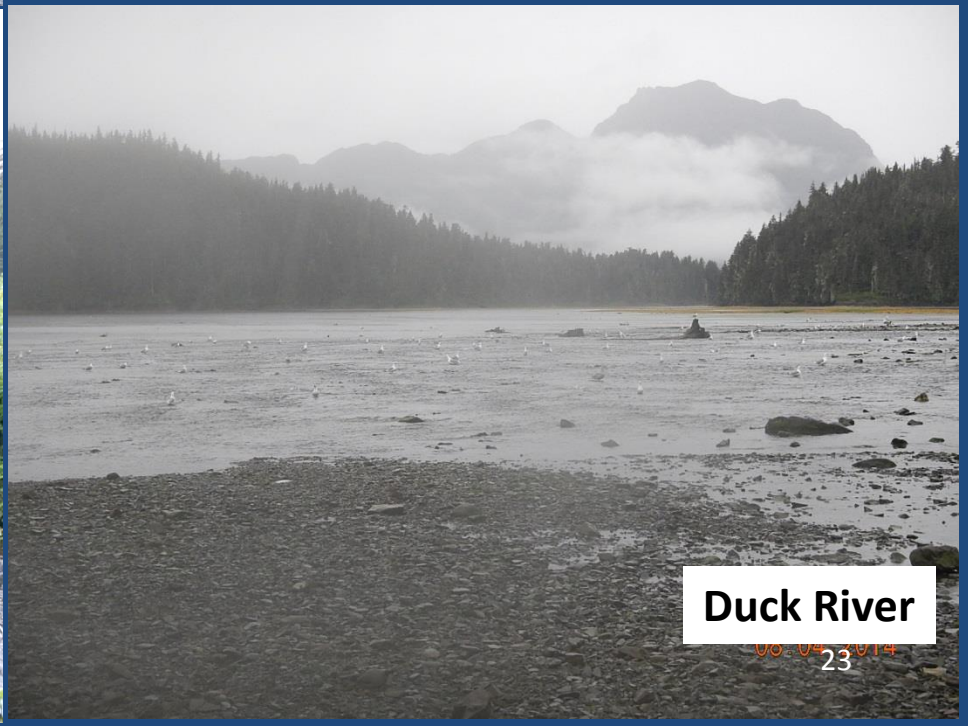
2013 and 2014 All Collections



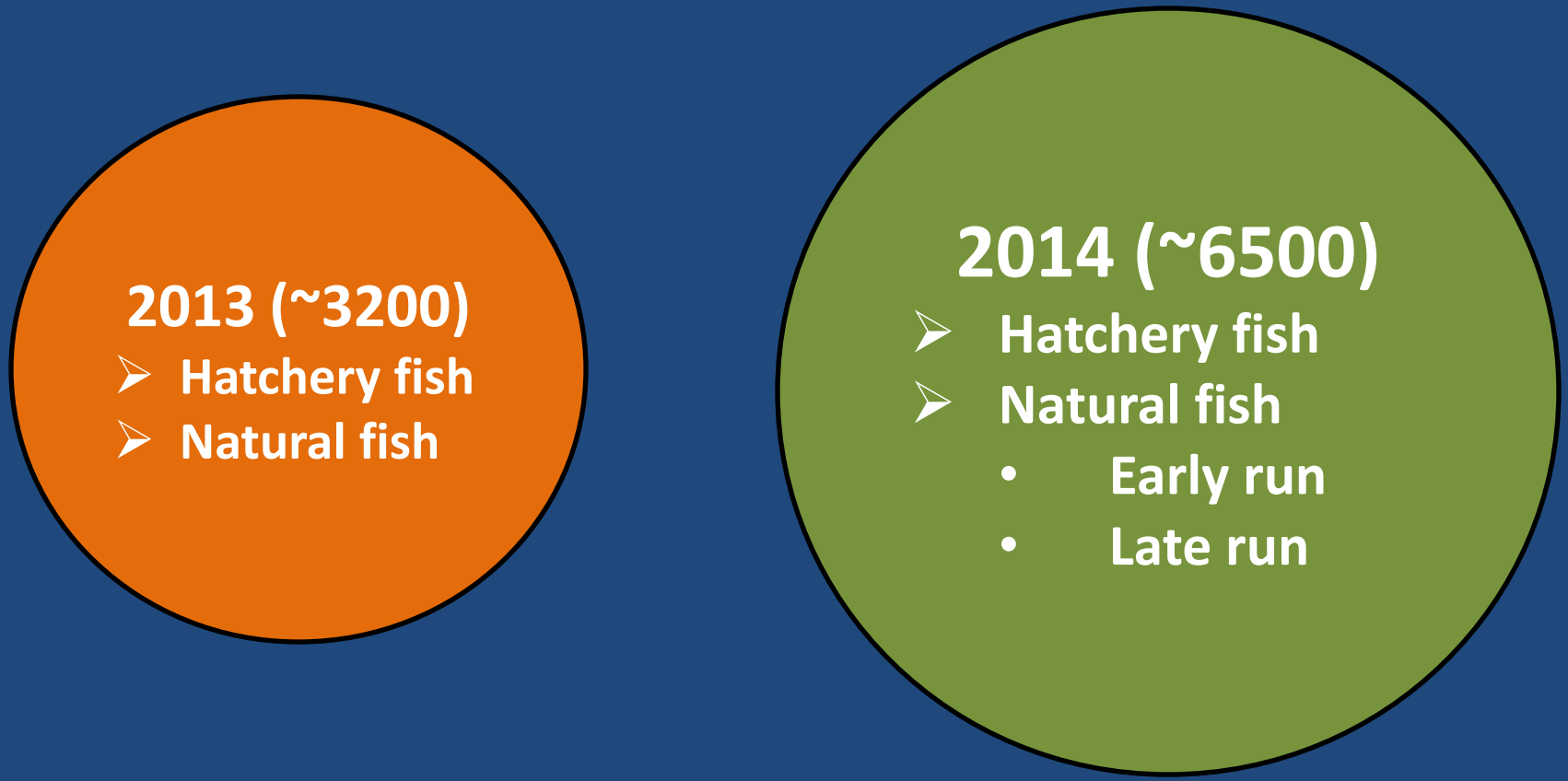

Swanson Creek


McCleod Creek


Rocky Creek


Duck River

Number of Samples



Laboratory Work (Complete)

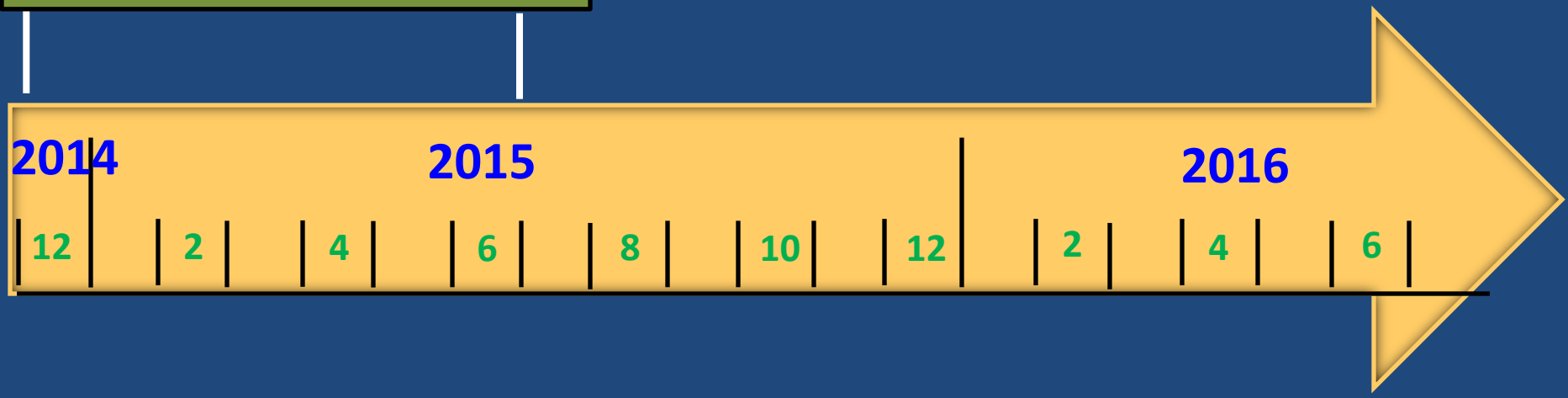
- **Primer optimization**
  - **16 microsatellite primers (Beacham et al. 2012)**
- **Genotyping**
  - **First pass for samples collected in 2013**
  - **Samples collected in 1990's**

Outline

- Purpose
- Current knowledge
- Study design
- Progress
- **Future work**

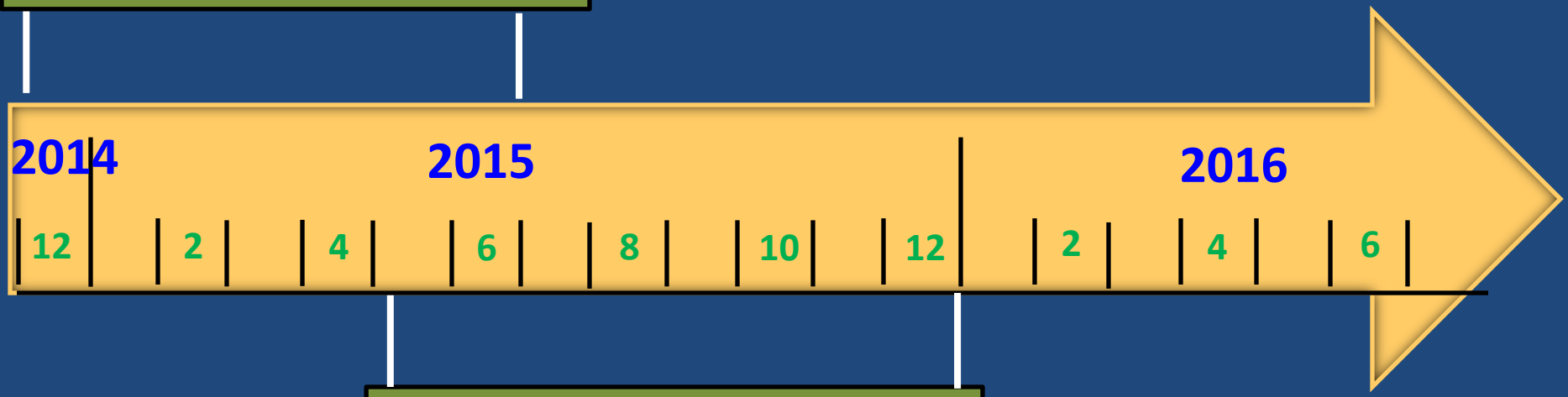
Timeline

- Second pass genotyping 2013
- Preliminary data analysis
- Technical document for 2013



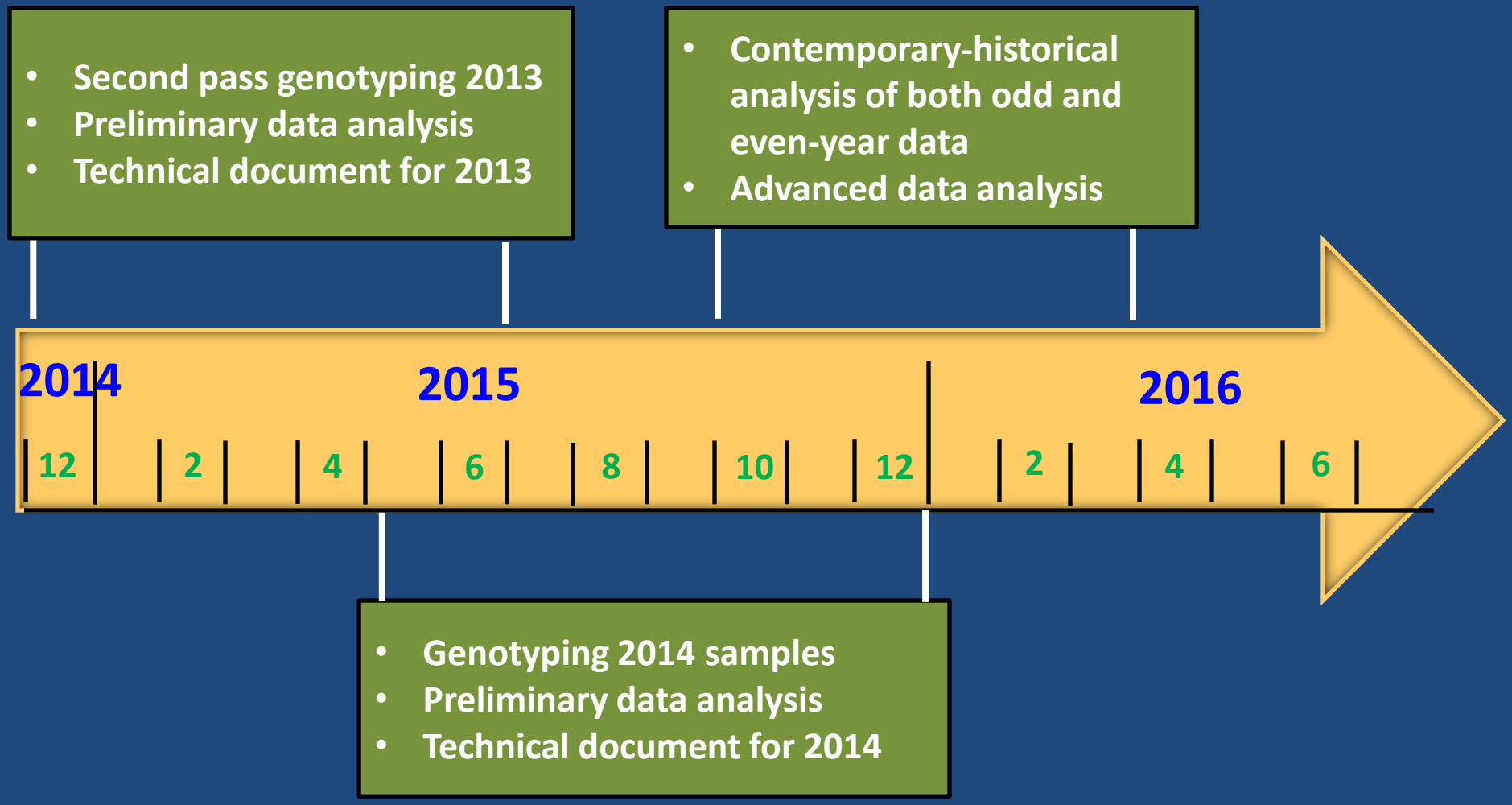
Timeline

- Second pass genotyping 2013
- Preliminary data analysis
- Technical document for 2013

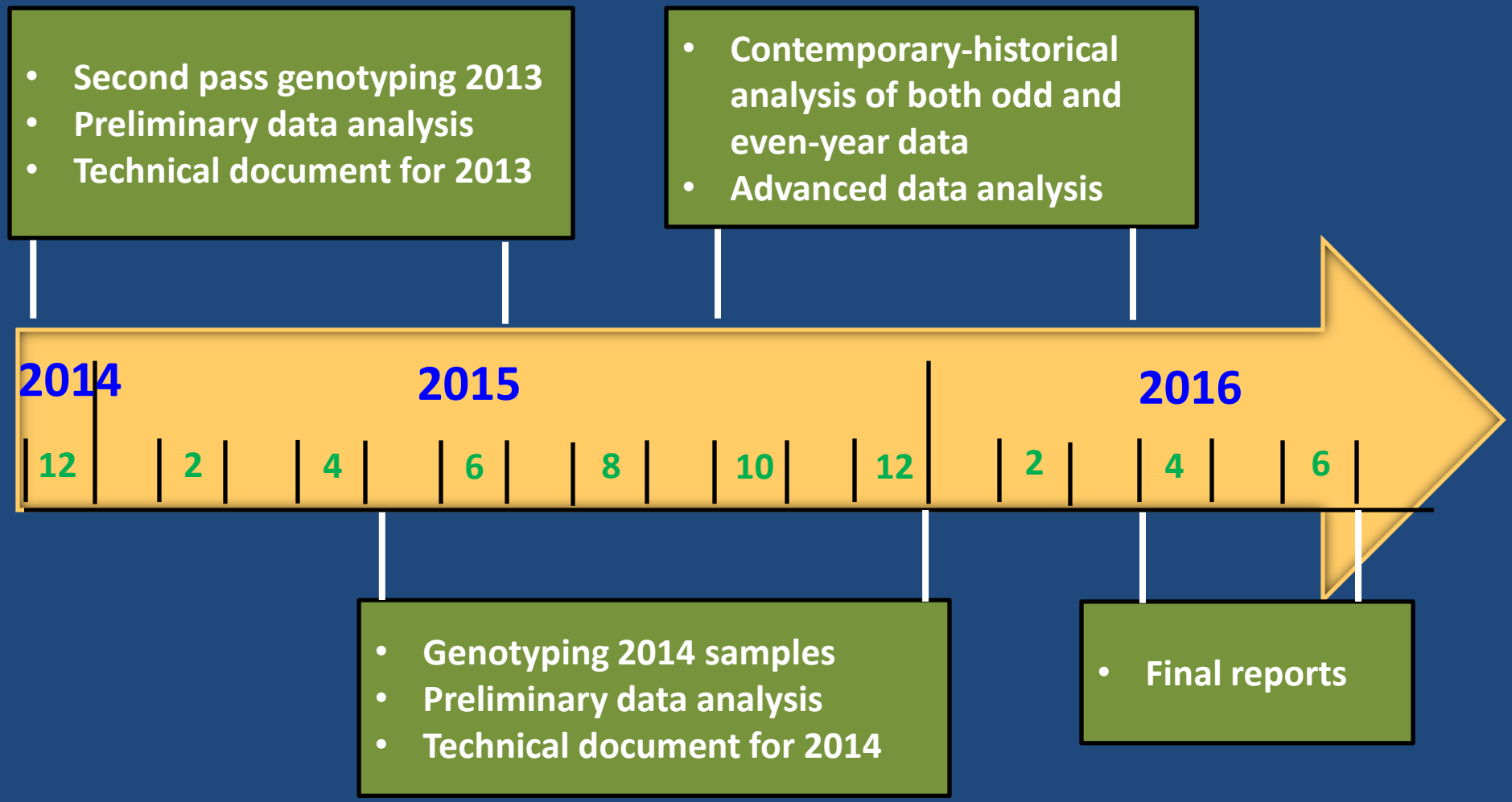


- Genotyping 2014 samples
- Preliminary data analysis
- Technical document for 2014

Timeline


• Second pass genotyping 2013
• Preliminary data analysis
• Technical document for 2013
• Contemporary-historical analysis of both odd and even-year data
• Advanced data analysis
2014
2015
2016
12
2
4
6
8
10
12
2
4
6
• Genotyping 2014 samples
• Preliminary data analysis
• Technical document for 2014

Timeline


• Second pass genotyping 2013
• Preliminary data analysis
• Technical document for 2013
• Contemporary-historical analysis of both odd and even-year data
• Advanced data analysis
2014
2015
2016
12
2
4
6
8
10
12
2
4
6
• Genotyping 2014 samples
• Preliminary data analysis
• Technical document for 2014
• Final reports

Acknowledgements

- Hatcheries
  - PWSAC, VFDA, KRAA
- University of Alaska Fairbanks – Juneau Center
- Prince William Sound Science Center
- Canadian Department of Fisheries and Oceans
  - Pacific Biological Station
- ADFG
  - Division of Wildlife Conservation
  - Division of Sport Fish
  - Commercial Fisheries Division

Acknowledgements

Hatcheries

David Reggiani/ his staff; Jason Woodhull; Mike Wells/ his staff; Rob Unger; Tina Fairbanks/ her staff; Trent Dodson

UAF

Bill Smoker; Milo Adkison; Megan McPhee

PWSSC

Katrina Hoffman; Eric Knudsen/his staff; Kristen Gorman; Davis Randall

DFO

Terry Beacham; Brenda McIntosh; Colin Wallace

ADFG

Andy Barclay; Ashley Fitzsimmons; Ben Histand; Bruce Whelan; Chase Jalbert; Christina Cupp; Drew Hamilton; Eric Lardizabal; Eric Volk; Erica Chenoweth; Hans Thompson; Heather Hoyt; Heather Liller; Jim Jasper; Judy Berger; Katie Froning; Kyle Shedd; Laural Junge; Nick Decovich; Paul Kuriscak; Zac Grauvogel; Zach Pechacek

Heath Kimball; Bert Lewis; Jan Conitz; Katie Sechrist; Paul Salomone; Xinxian Zhang

Angelina Kelly; Darren Roberts; Elena Fernandez; Ellen Americus; Jane Allen-Schmid; Cindy Stimson; Jim Orourke; Jimmy Osga; Martin Schuster; Megan Urton; Rich Brenner; Steve Moffitt; Thomas Sheridan;

Dion Oxman; Lorna Wilson; Megan Lovejoy; Timothy Frawley

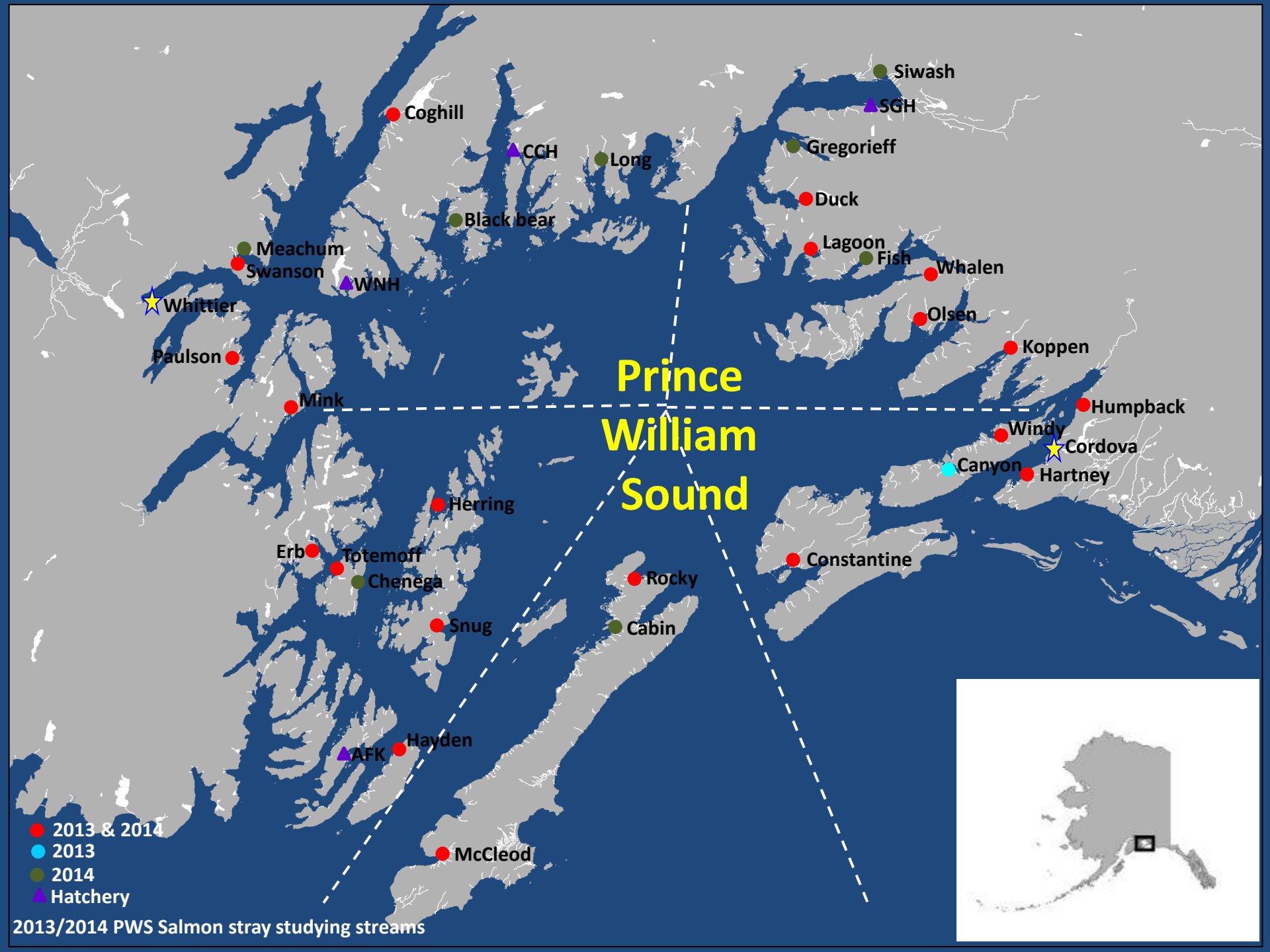
Lorraine Vercess; Mark Stopha; Ronald Josephson; Samuel Rabung

David Tessler; Howard Golden; Michael Harrington

Dan Bosch; Jiaqi Huang; Jay Baumer

Celia Rozen

Questions?


Siwash
SGH
Coghill
CCH
Long
Gregorieff
Duck
Black bear
Lagoon
Meachum
Swanson
Fish
Whalen
WNH
Whittier
Olsen
Koppen
Paulson
Prince
William
Sound
Mink
Humpback
Windy
Cordova
Canyon
Hartney
Herring
Erb
Totemoff
Constantine
Chenega
Rocky
Snug
Cabin
AFK
Hayden
McCleod
2013 & 2014
2013
2014
Hatchery
2013/2014 PWS Salmon stray studying streams