Science in Support of Preserving, Protecting and Perpetuating Fish and Wildlife

A joint presentation by
Habitat, Fish and Wildlife Science Divisions

Today's Discussion

- Overview selected projects from each Science Division
- Introduce you to WDFW Scientists
- Answer Questions

Hallmarks of WDFW Science

- Specific and adaptive to WDFW management challenges
- Wide breadth of issues
- Cooperative to leverage limited funding and produce useful results for multiple stakeholders

Snowy Plover and Marbled Murrelet Monitoring in a Research and Management Framework




Goal

- Use two monitoring examples
  - Work with partners
  - Inform management
  - Adaptive management
  - Make the most of the information

Western snowy plover

INFORMING MANAGEMENT

Snowy Plover

- Small shorebird
- Listed as “threatened” by the State and Federal Governments
- Breeds from Baja to Washington

Use Specific Habitat Types

- Sites adjacent to the ocean or marine waters that are relatively flat

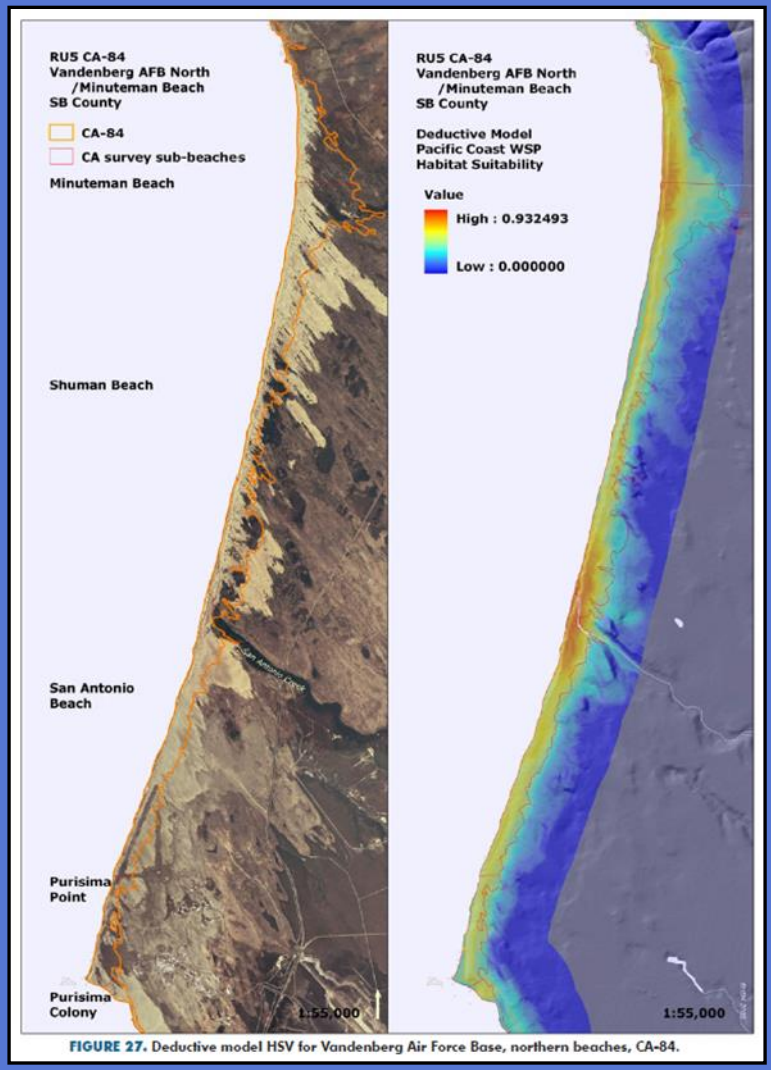
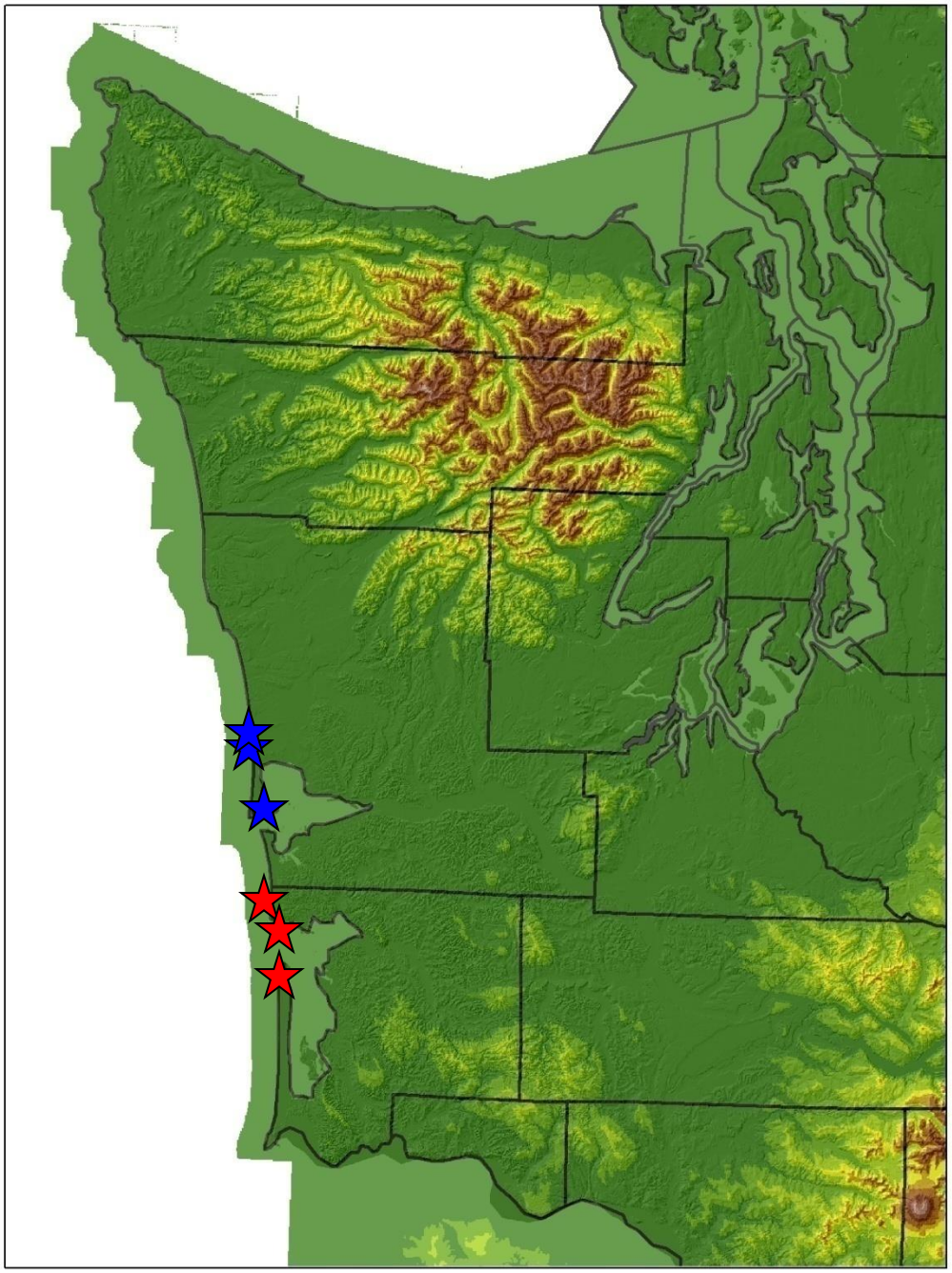


FIGURE 27. Deductive model HSV for Vandenberg Air Force Base, northern beaches, CA-84.



Monitoring

- Nest success
- Fledging success
- Breeding adult population size

Working with Partners

Washington Department of FISH and WILDLIFE

IOWA STATE UNIVERSITY
IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY
IOWA STATE UNIVERSITY

INSTITUTE FOR NATURAL RESOURCES

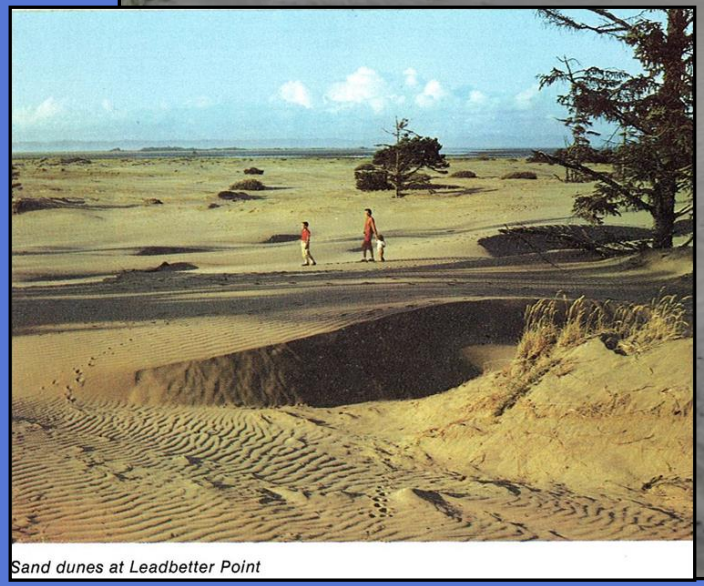
U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

WASHINGTON STATE PARKS

Is habitat Restoration effective?

Leadbetter Point Coastal Habitat

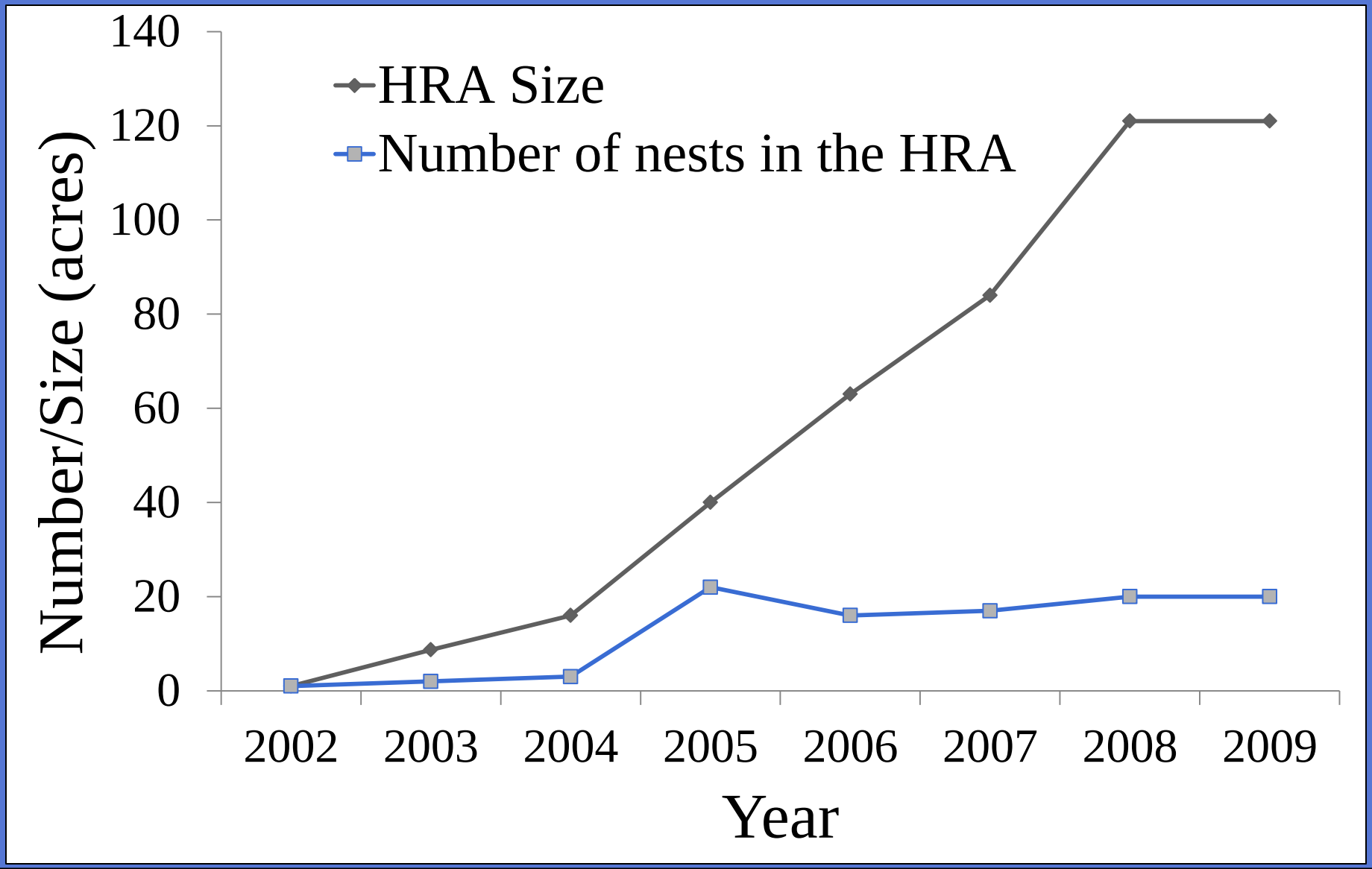
Today



50 yrs. ago

Leadbetter Point Restoration

Habitat Restoration



Predation is the primary source of nest failure, especially by crows and ravens

Reducing Predation

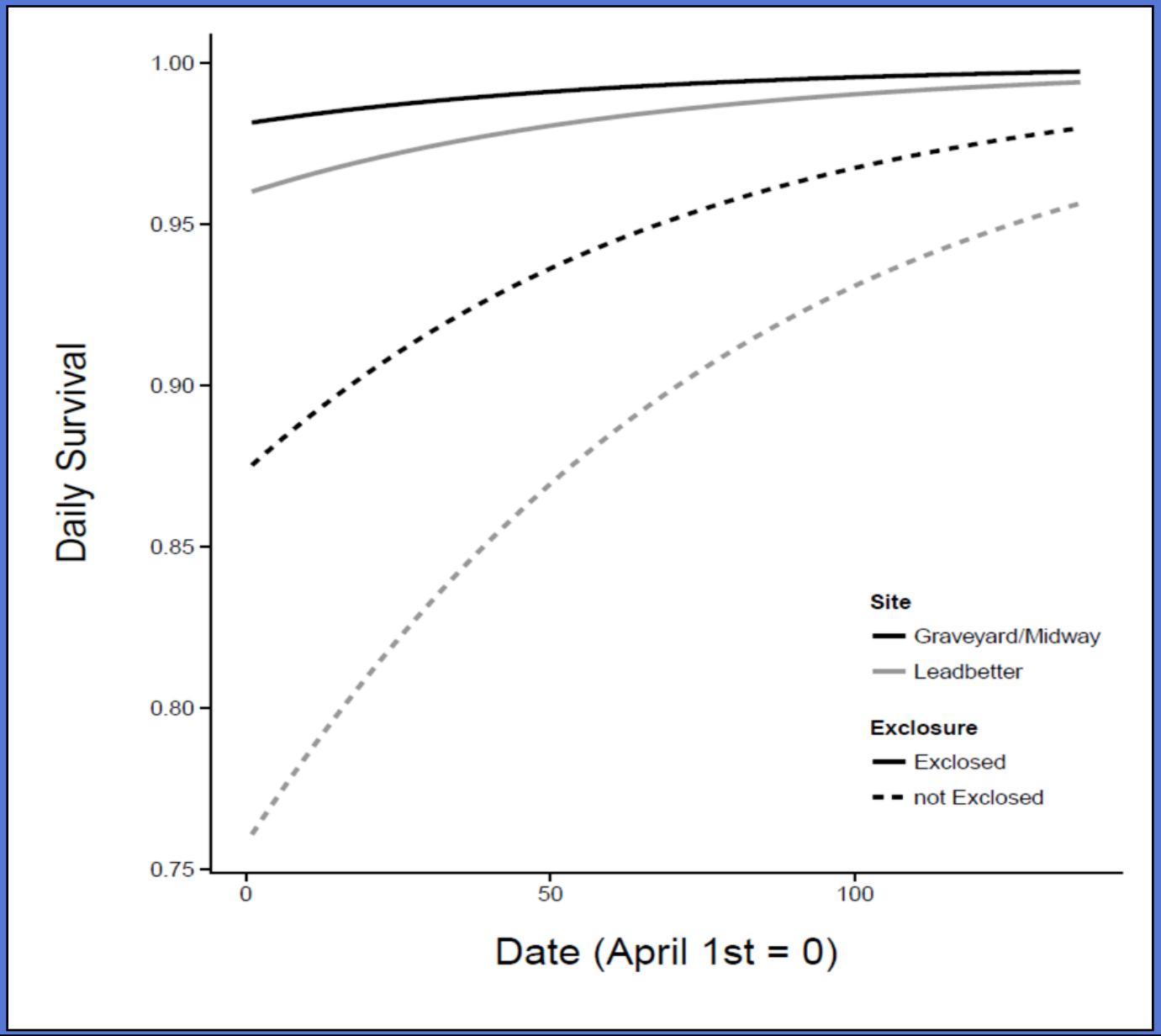
- Harassing
- Capture and removal
- Killing
- Aversion conditioning
- Predator exclosures
- Removing predator's food sources
- Removing predator perches

Pearson et al. 2014 Bird Conservation International

Nest exclosures

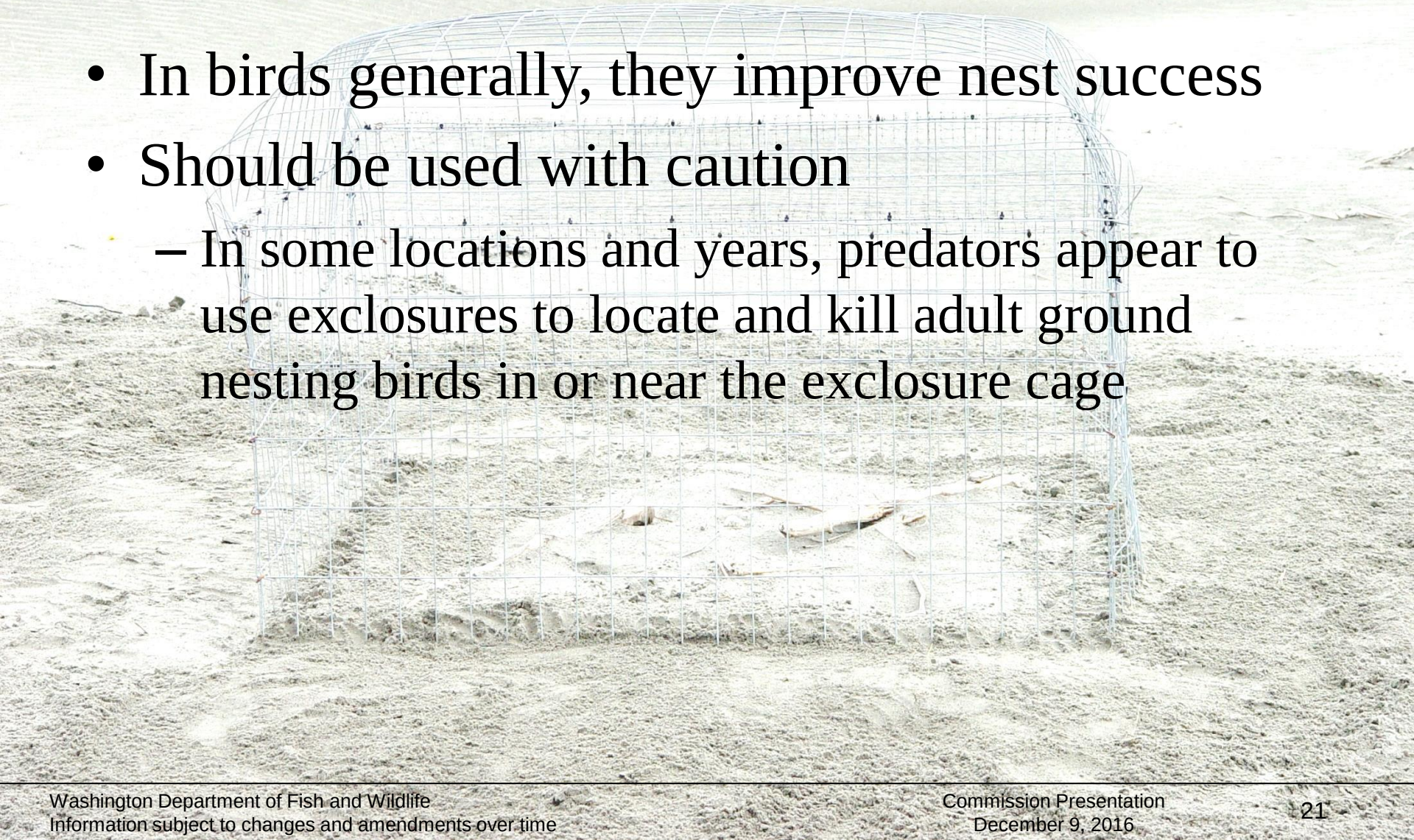
Nest Exclosures

Exclosed nests survived much better



Pearson et al. 2014 Bird Conservation International

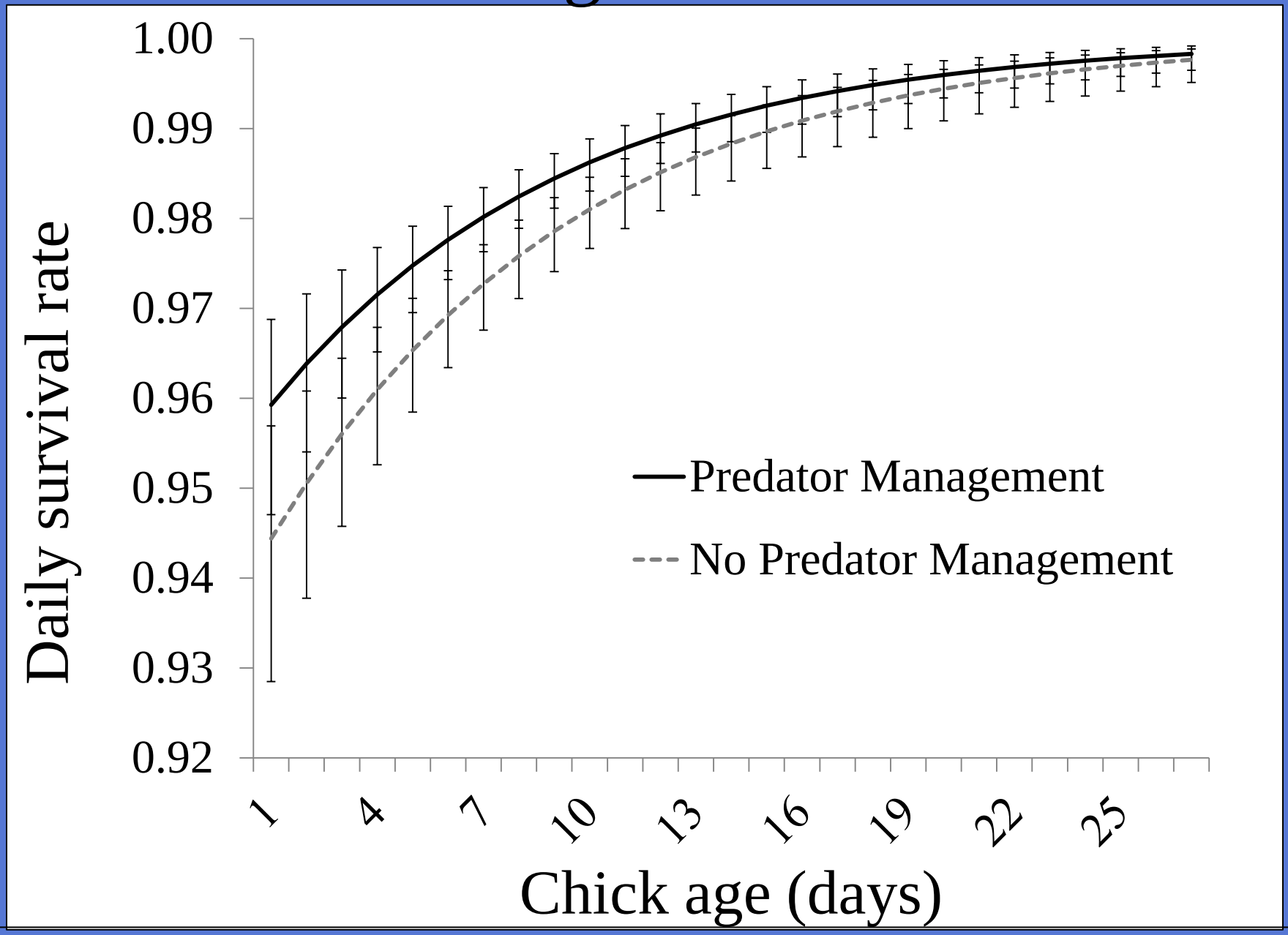
Nest exclosures



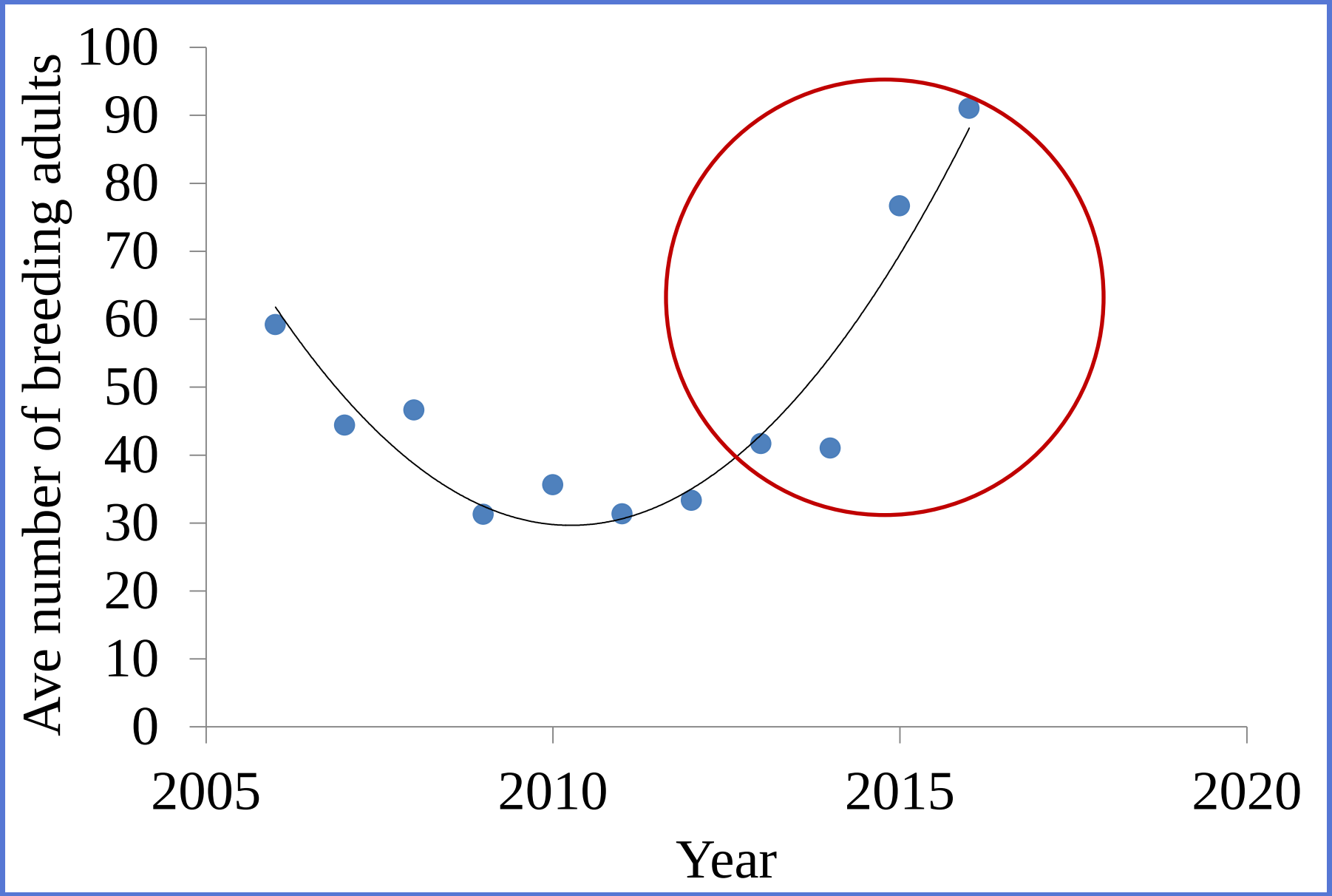
- In birds generally, they improve nest success
- Should be used with caution
  - In some locations and years, predators appear to use exclosures to locate and kill adult ground nesting birds in or near the exclosure cage

Chicks survived poorly!

Predator management is effective



Predator Management Effective?



Marbled murrelet

MAKING THE MOST OF OUR INFORMATION

Working with Partners

Washington Department of FISH and WILDLIFE

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Crescent Coastal Research

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

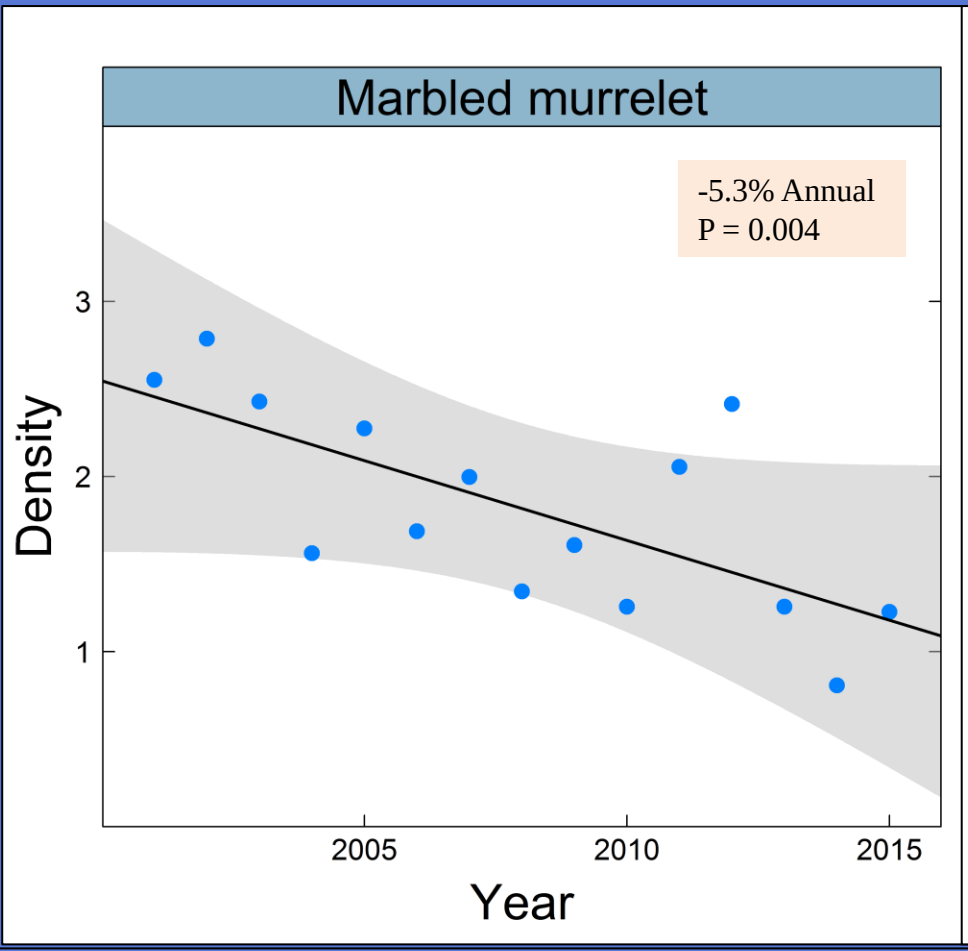
PNW

Primary Goal

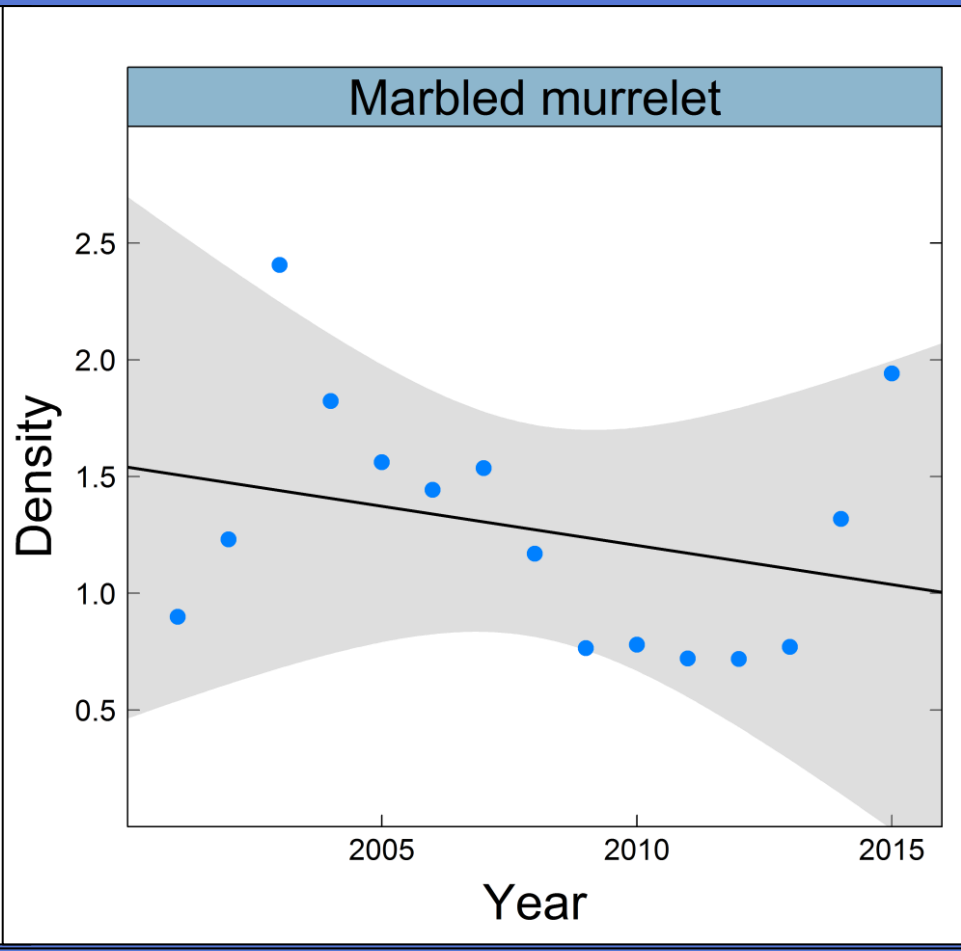
- Estimating population size and trends

Marbled Murrelet

Salish Sea 2001-2015



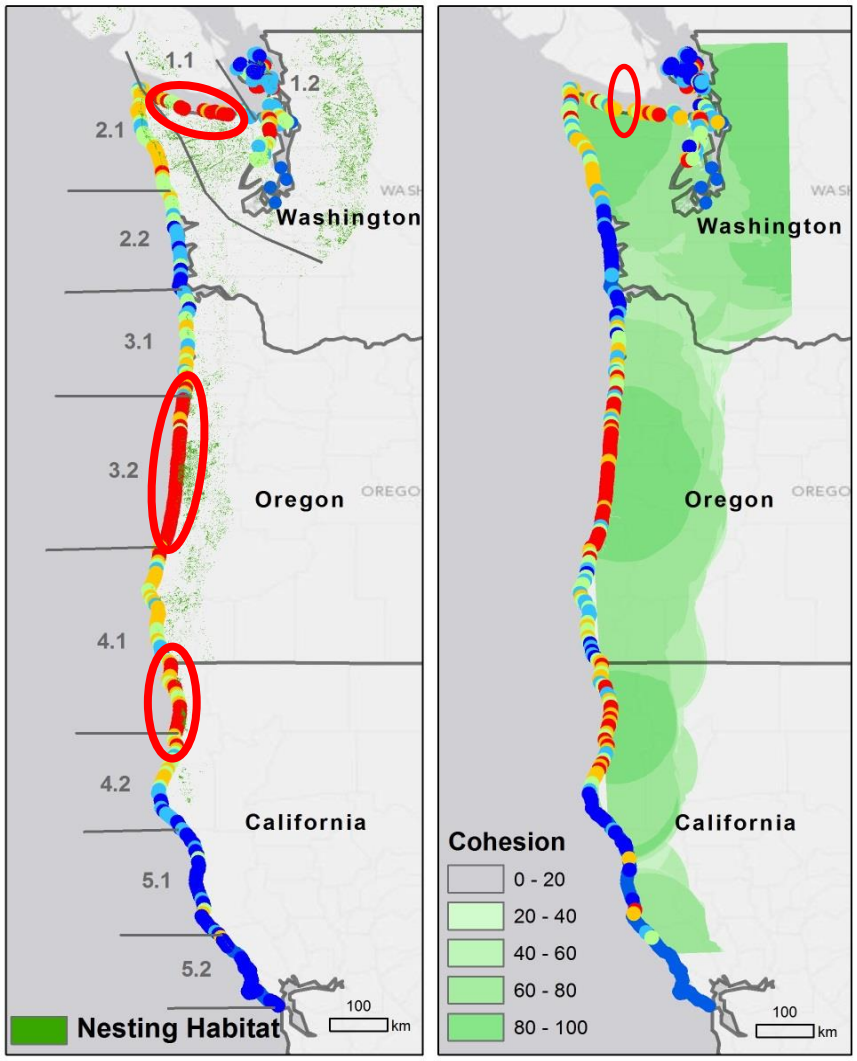
Washington Coast 2001-2015

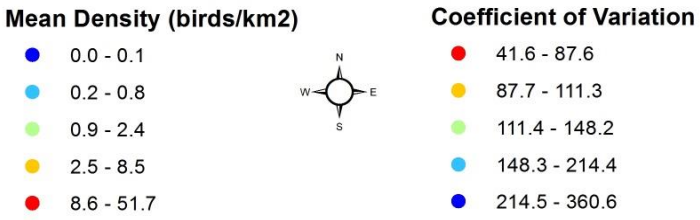


Making the most of our information

- Identifying “hotspots” of murrelet abundance
- Insights into mechanisms driving murrelet population trends
- Trends of other species of conservation concern
- Trends of species that have top down influence on marine system
- Vital sign indicator
- Marine spatial planning

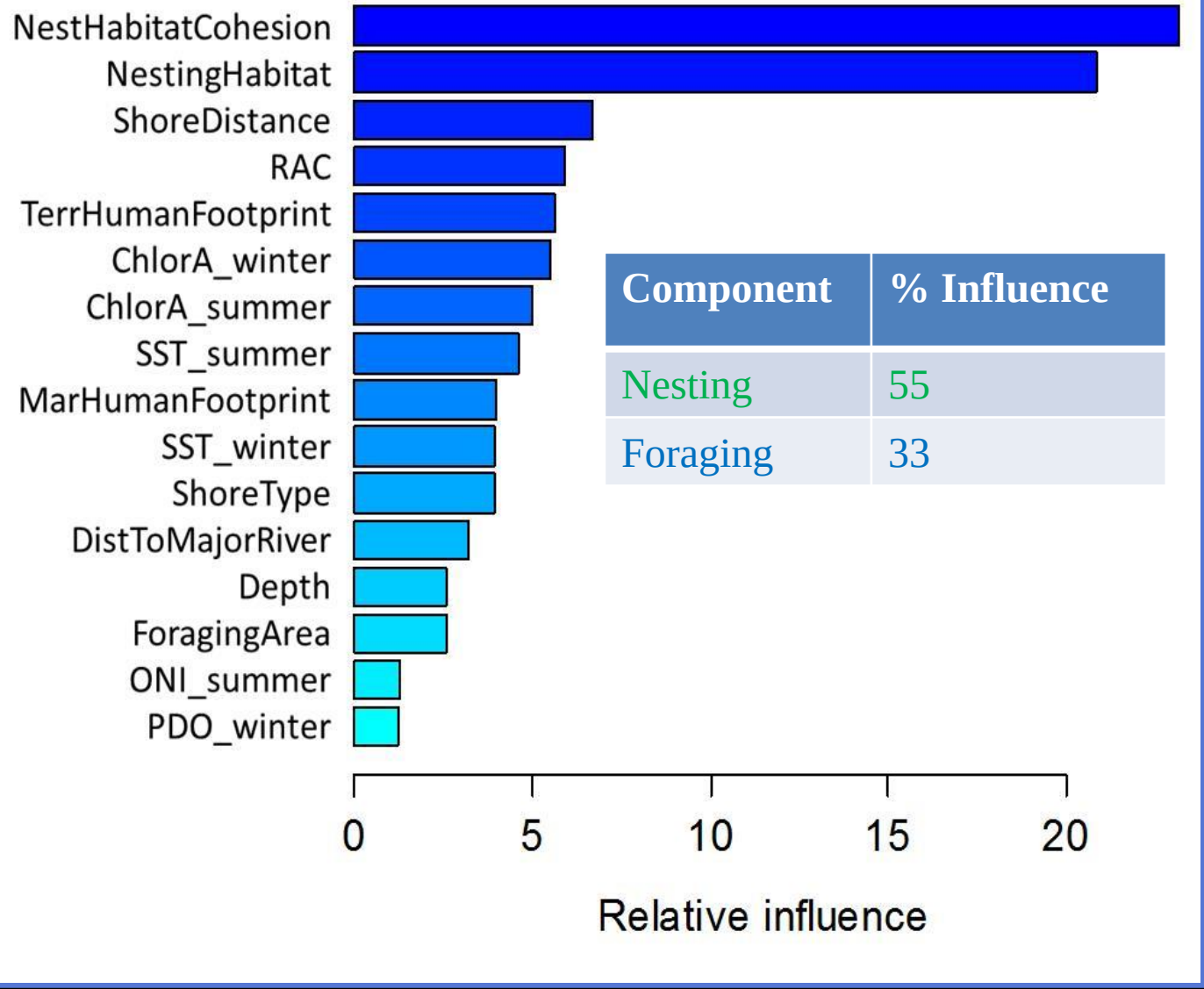
Identifying "hotspots" of murrelet abundance





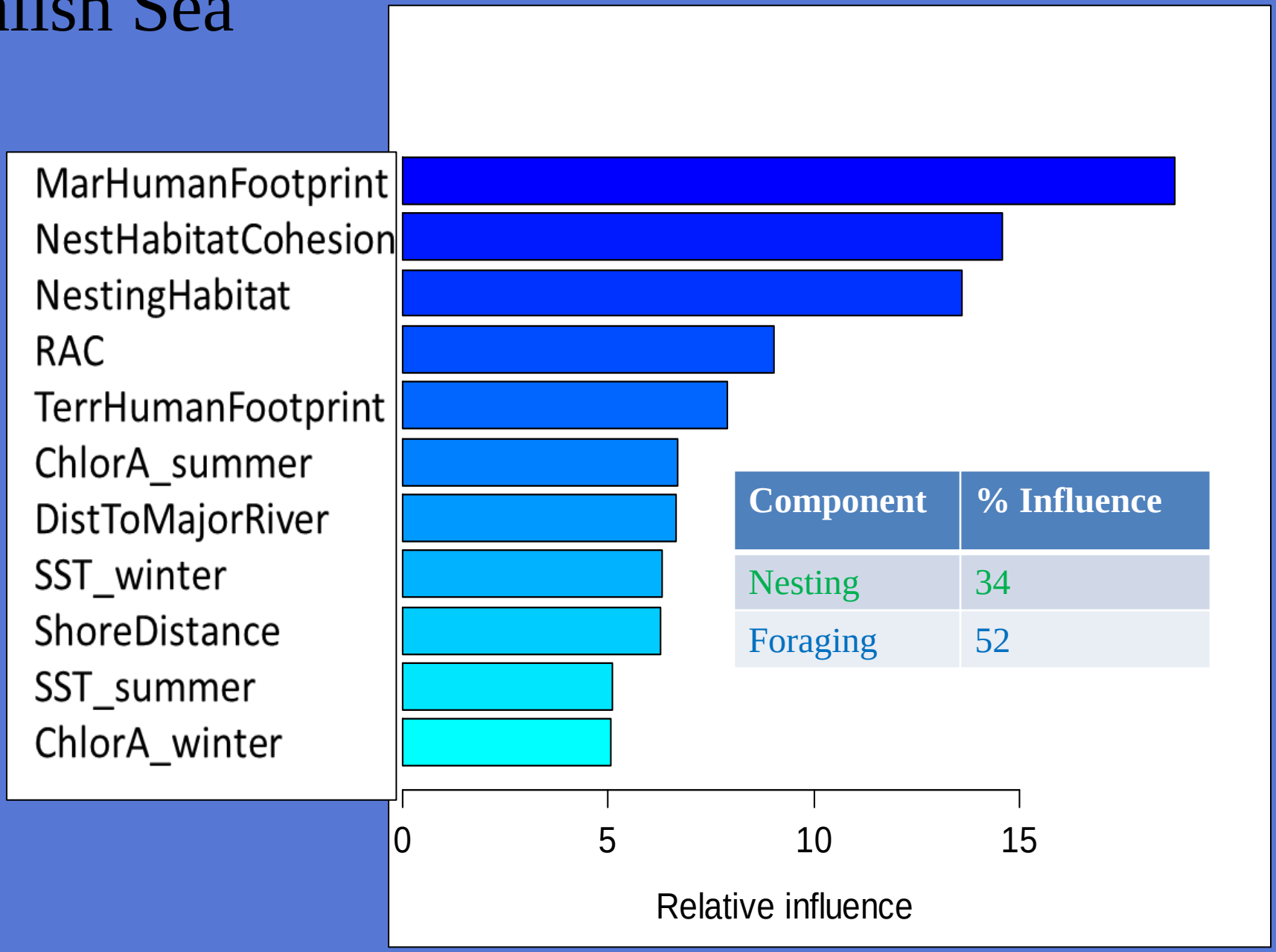
Raphael, M.G., A. Shirk, G.A. Falxa, and S.F. Pearson. 2015. Habitat associations of marbled murrelets during the nesting season in nearshore waters along the Washington to California coast. Journal of Marine Systems 146:17-25.

Insights into mechanisms driving murrelet population trends



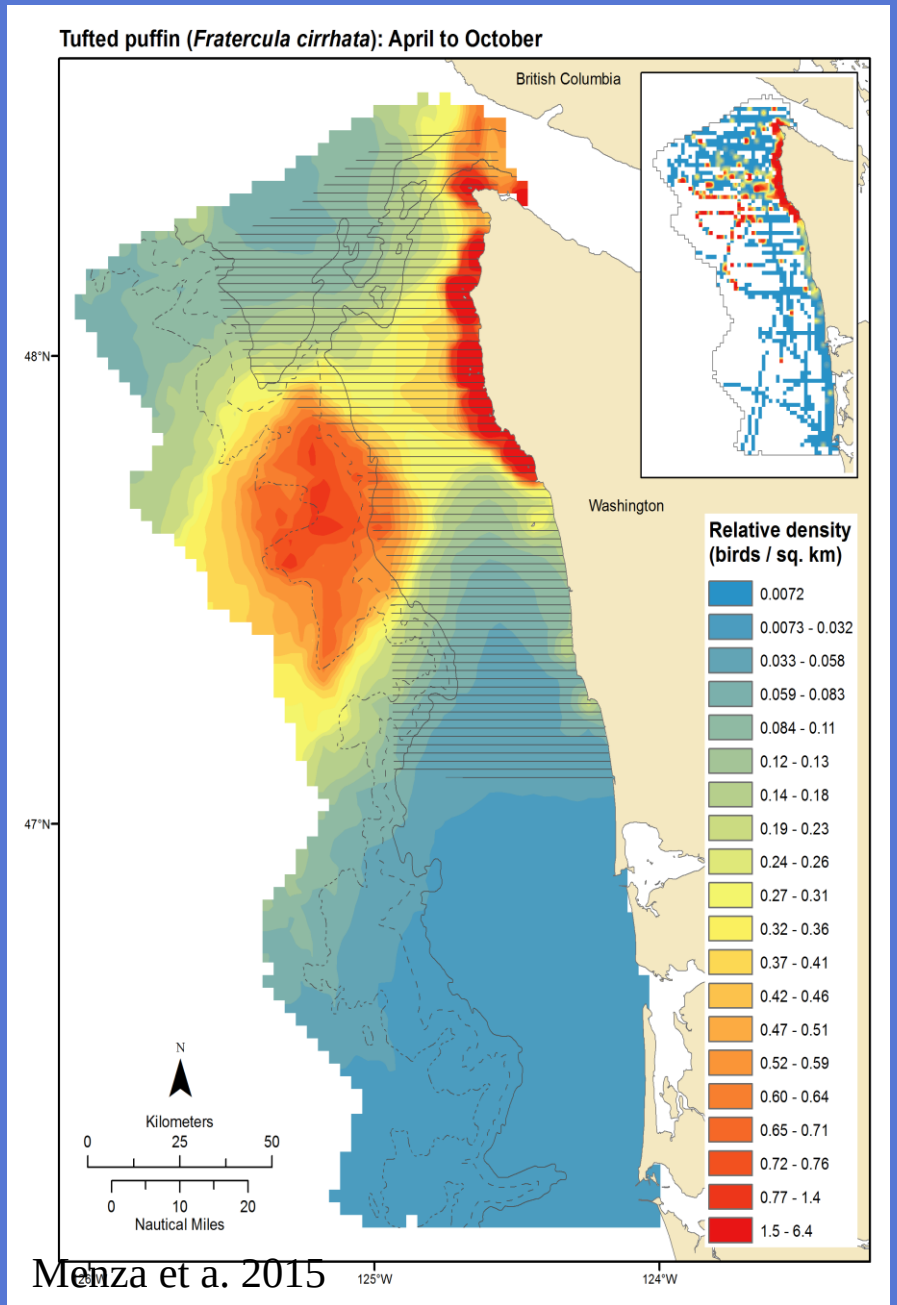
Component	% Influence
Nesting	55
Foraging	33

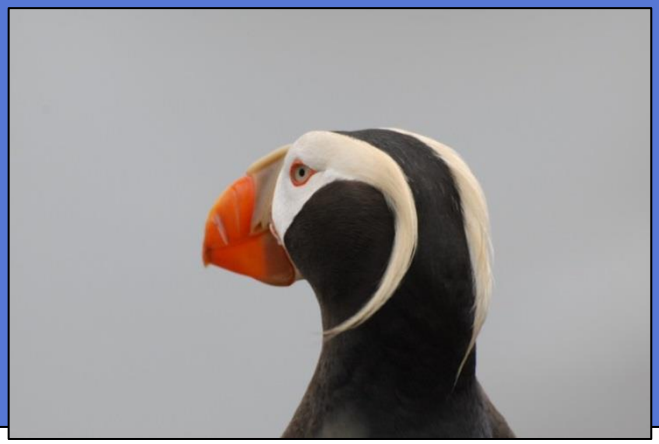
Salish Sea

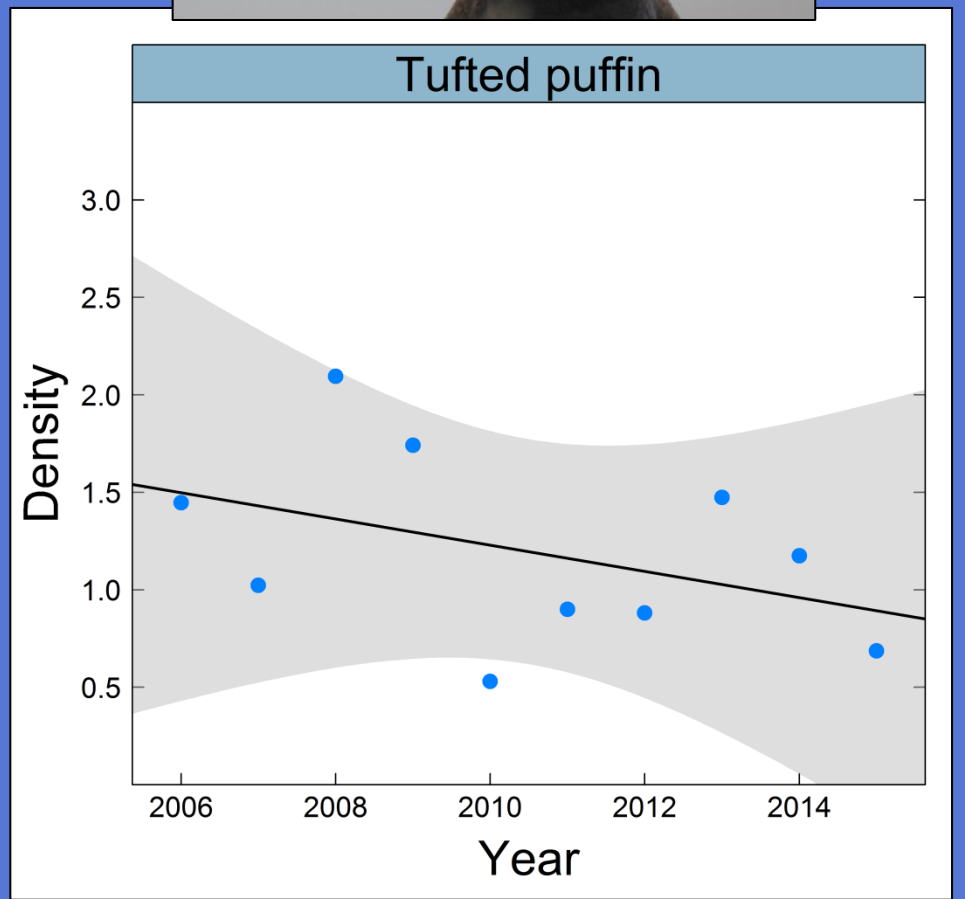


Component	% Influence
Nesting	34
Foraging	52

Trends of other species of conservation concern





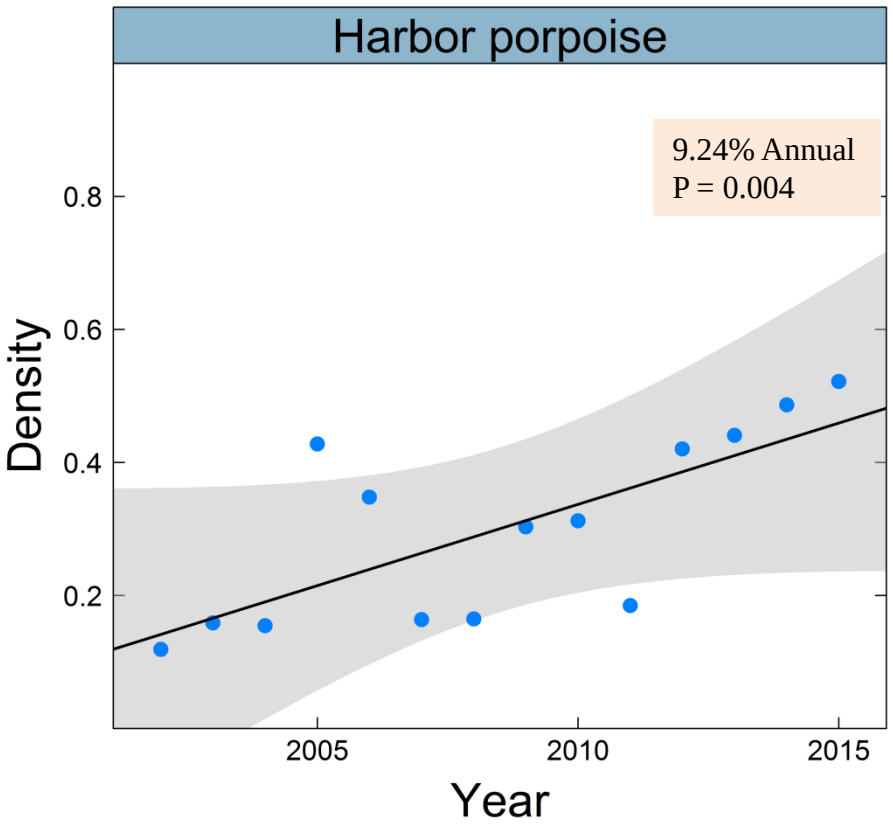


Menza et a. 2015

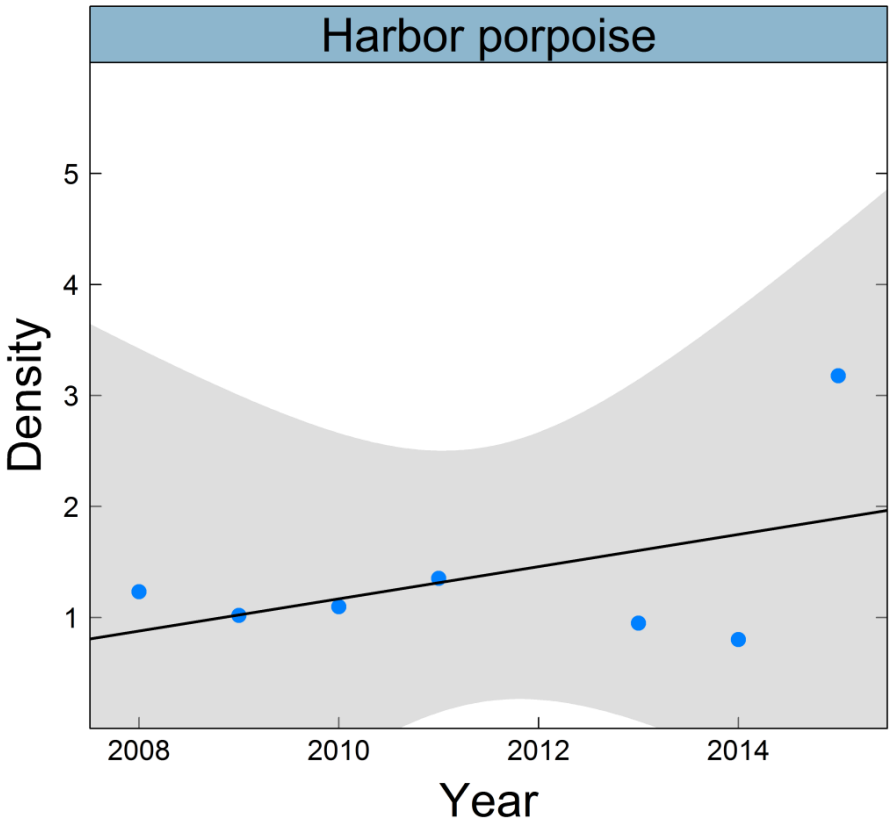
Trends of other species of conservation concern

Harbor Porpoise

Salish Sea
2002-2015



Washington Coast
2008-2015

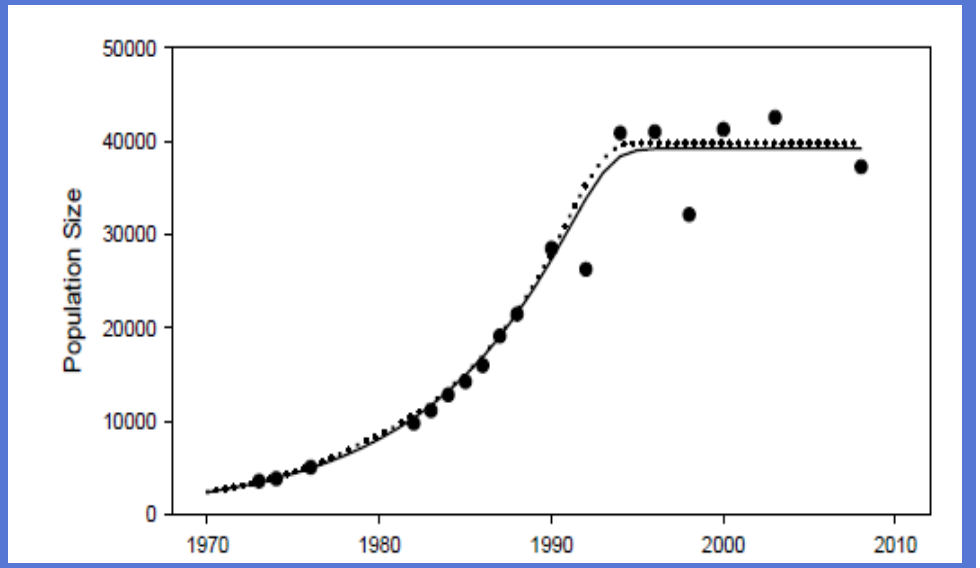


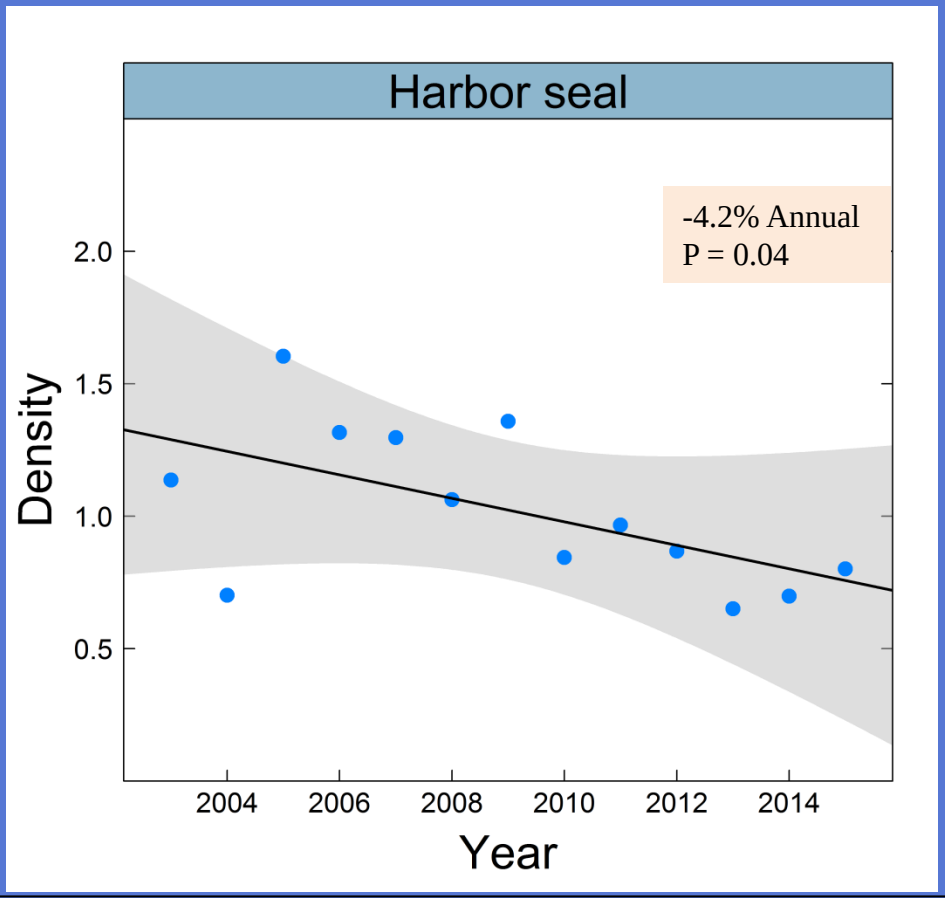
Trends of species that have top down influence on marine system

Harbor Seal

Salish Sea
2003-2015

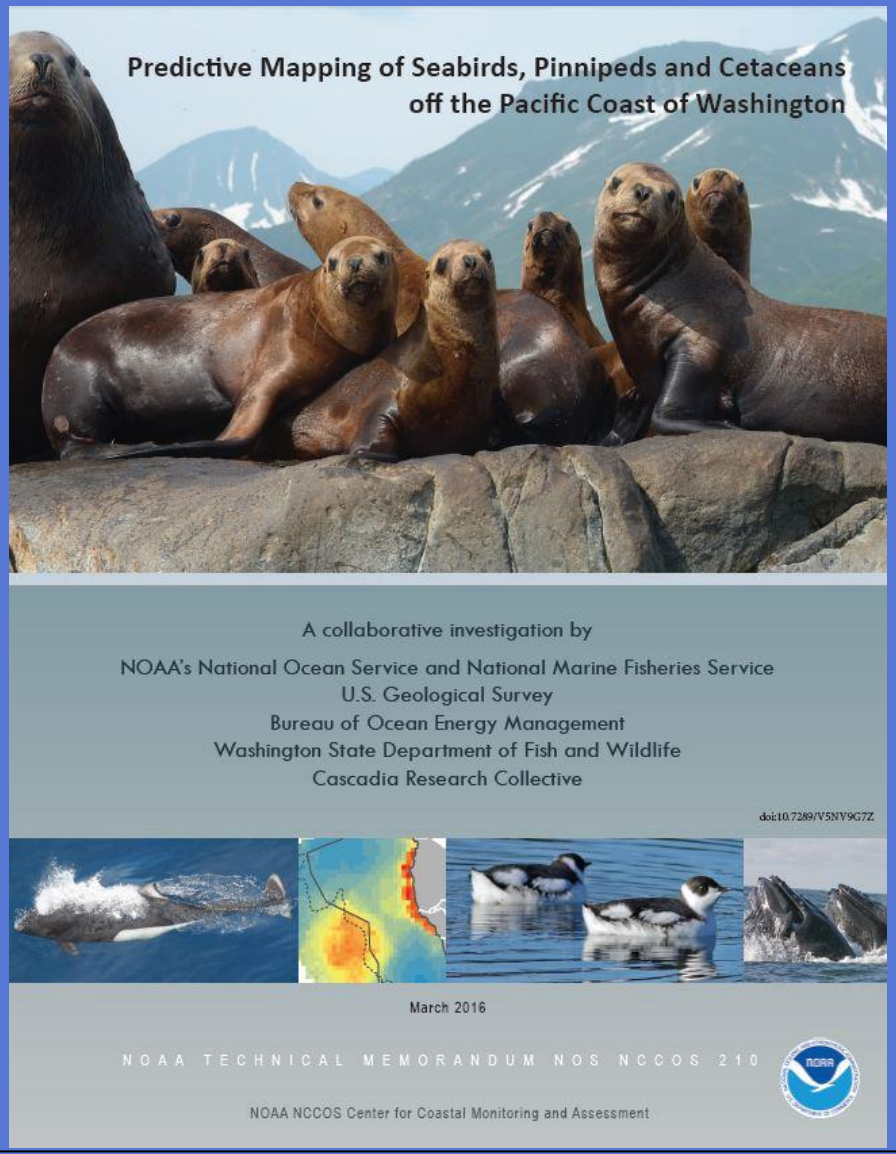
Previous work

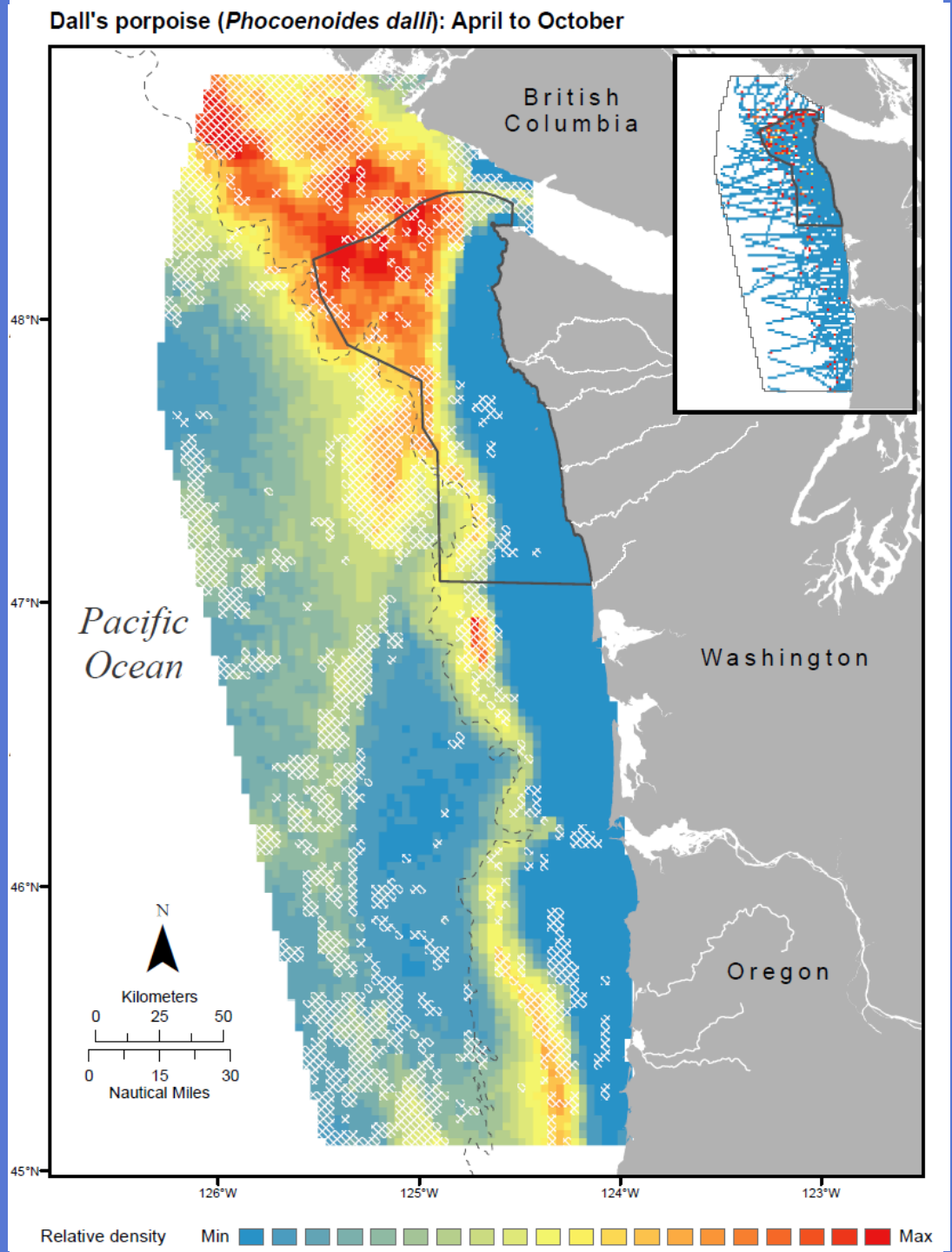




Vital Sign indicator

Marine spatial planning




Dall's porpoise (*Phocoenoides dalli*): April to October
British Columbia
Pacific Ocean
Washington
Oregon
48°N
47°N
46°N
45°N
126°W
125°W
124°W
123°W
N
Kilometers
0 25 50
0 15 30
Nautical Miles
Relative density
Min
Max

Take home messages

- Partners
- Monitoring in a research/management context
- Adaptive management
- Making the most of our information

Questions?

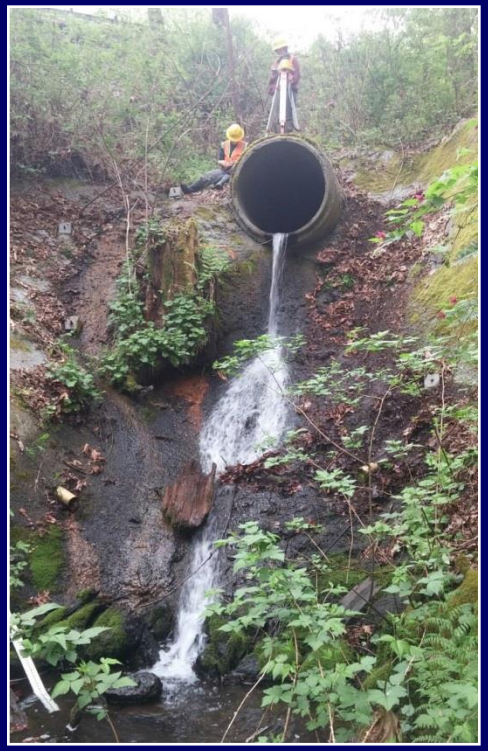
THE GOLDEN AGE OF CULVERTS

Science Division & Engineering Section

Habitat Program

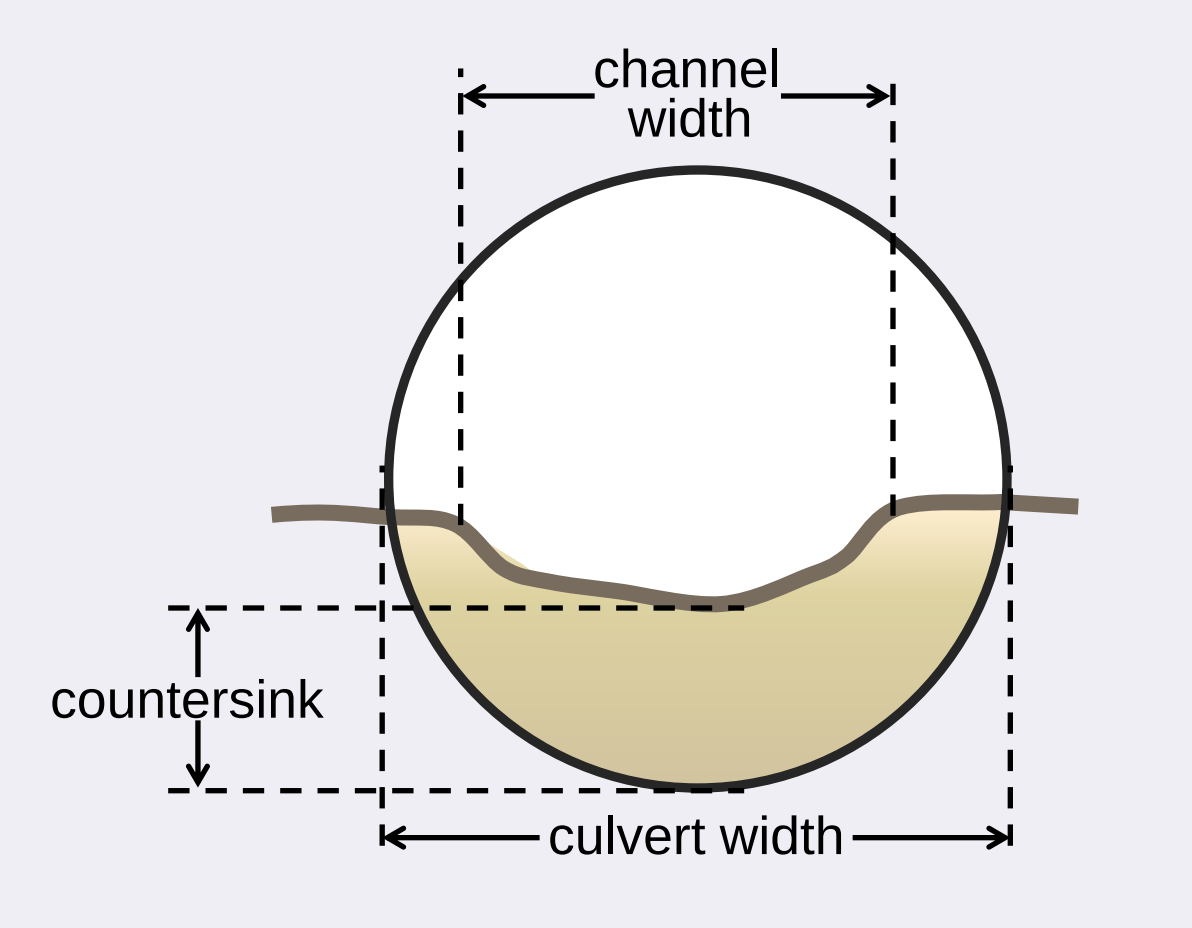
Roman Culvert: circa 1st century C.E.

The Dark Ages of Culverts



Invention of Stream Simulation Culvert

Theory: Simulate stream inside the culvert!



Transportation Research Record –

a publication of the
National Academy of Engineering

"The concept of stream simulation was first introduced by the **Washington Department of Fish and Wildlife** in 1999."

An Evaluation of the Stream Simulation Culvert Design Method in Washington State

Barnard et al. (2015)

Reference Reach

Culvert

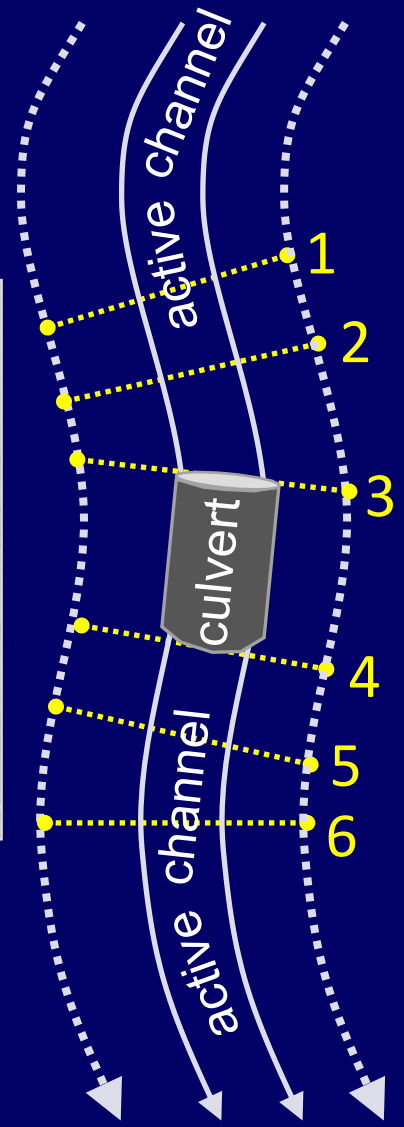
only *in situ* study in peer-reviewed literature

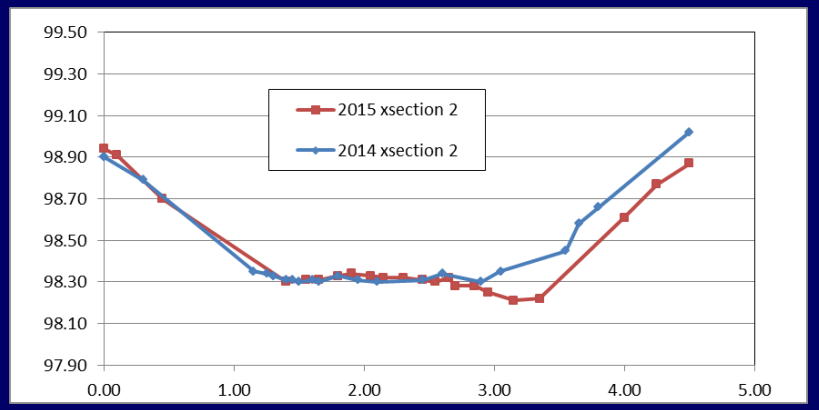
Long-term Culvert Monitoring

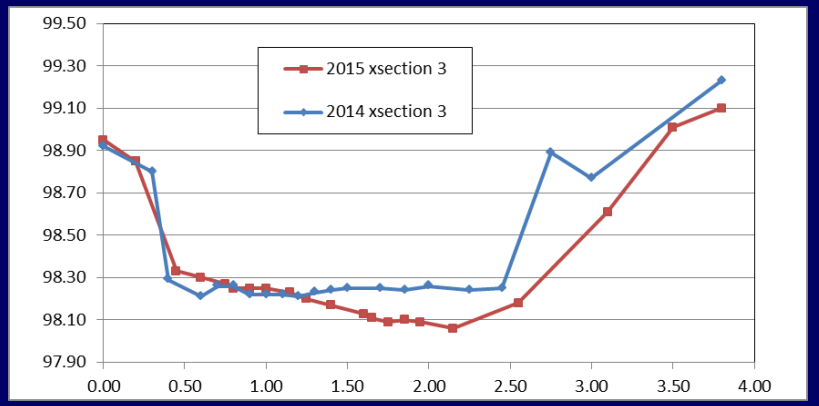
2011

2014

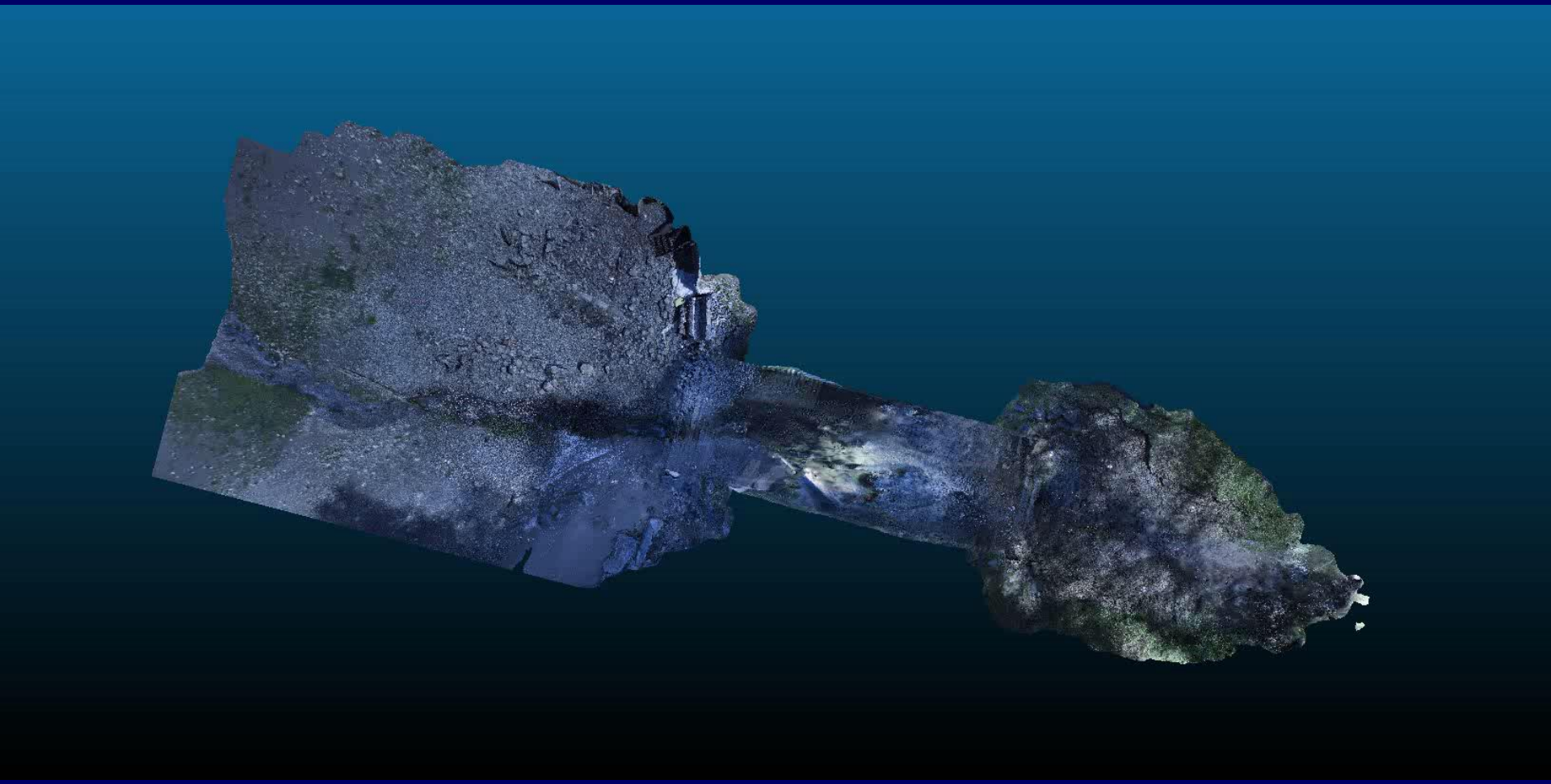
Long-term Culvert Monitoring



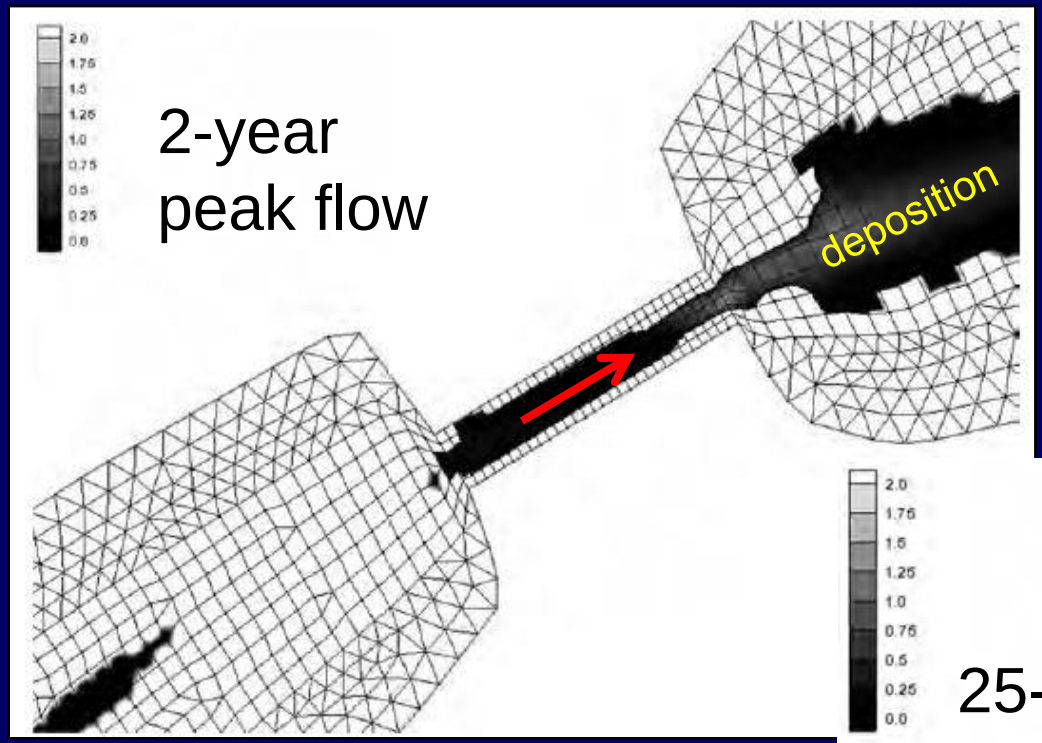


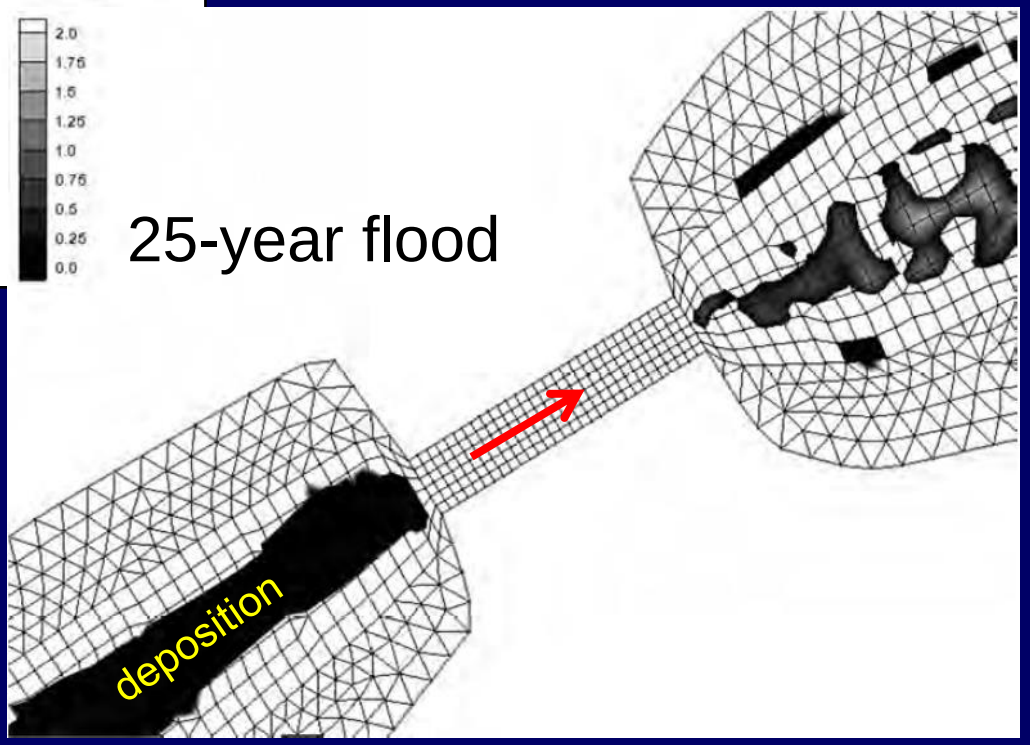


Advanced Monitoring Technology



Computer Simulation of Culverts





Culverts and Climate Change

Climate Change

Temperature

Precipitation

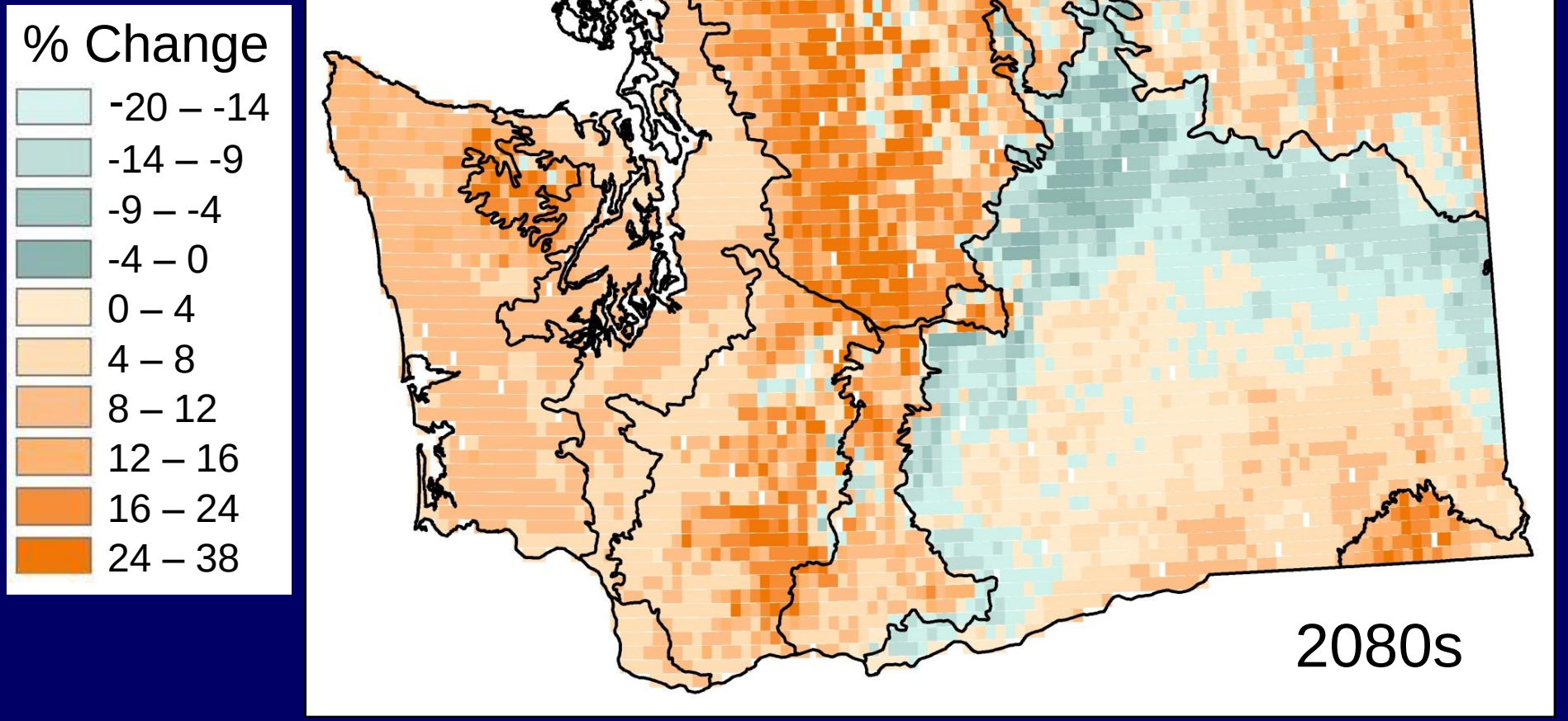
Runoff

Streamflow

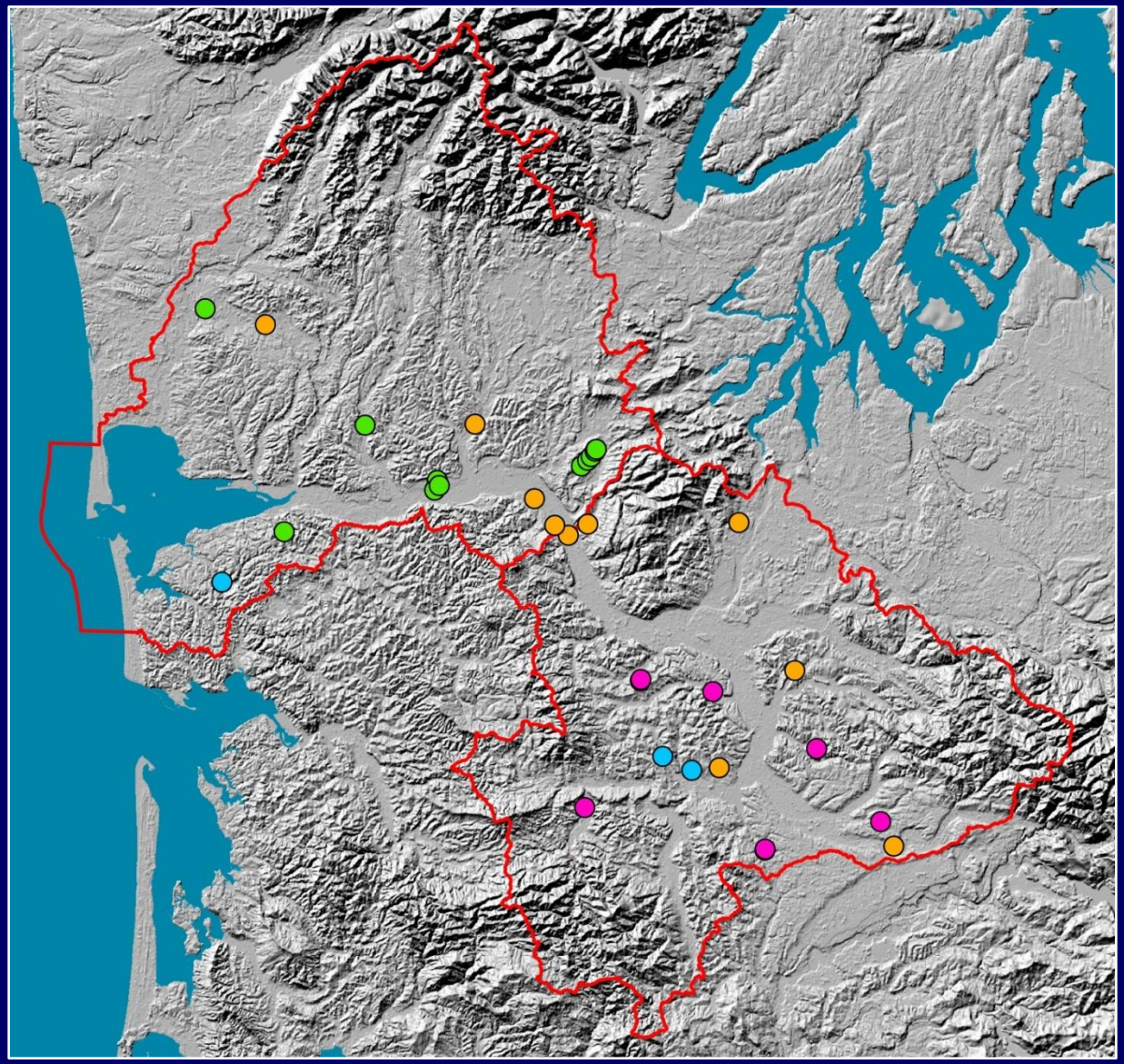
Channel Width

Culvert Width

Projected Change in Channel Width due to Climate Change

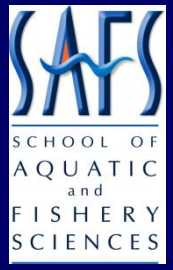


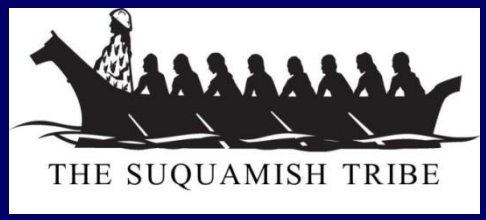
Application of Culvert Research



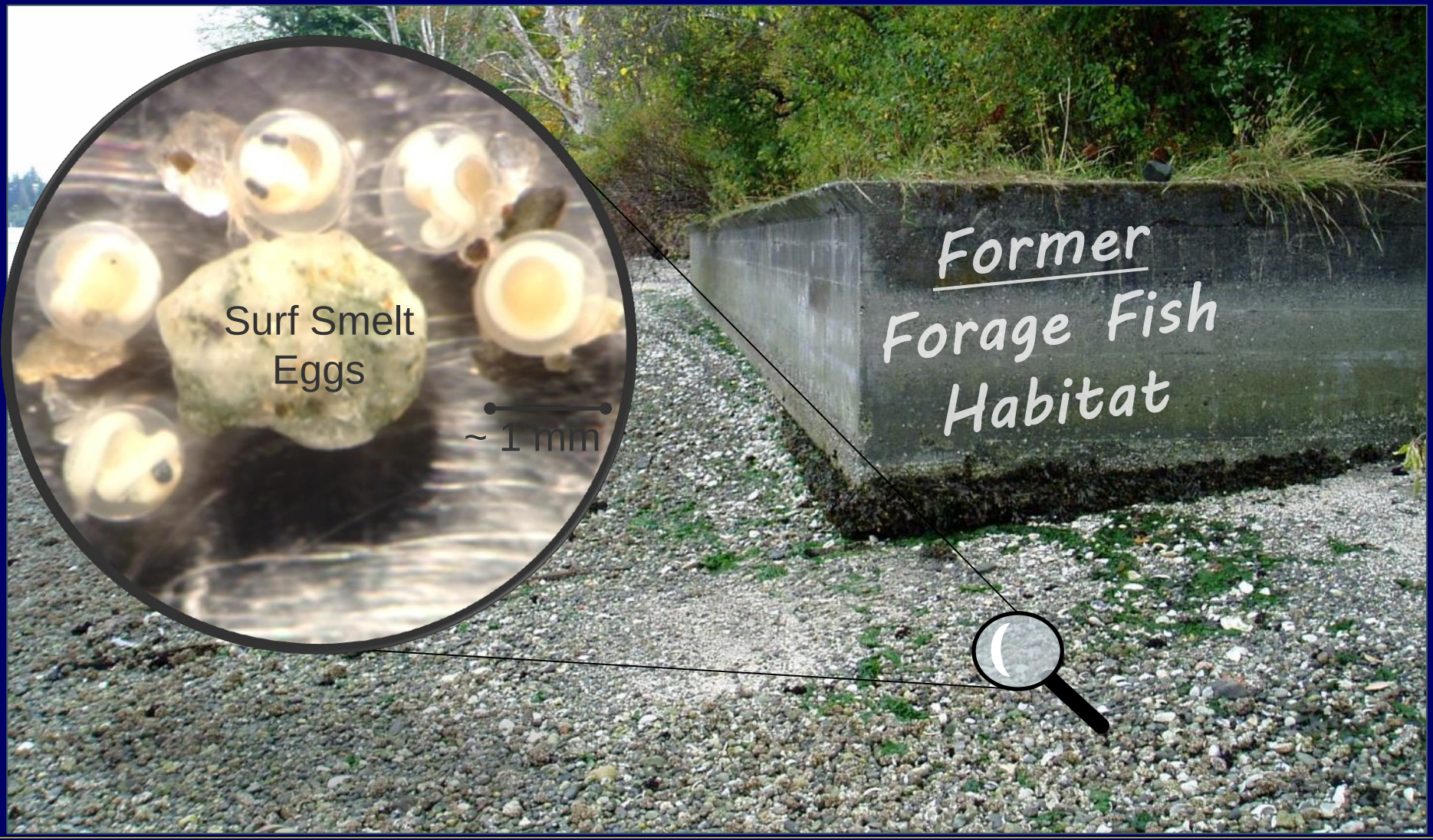
Culverts of the Golden Age

Special thanks to:





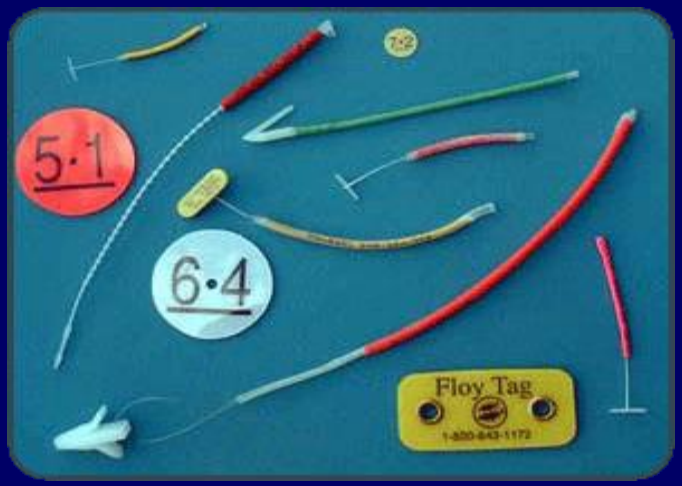
Nearshore Habitat



Nearshore Habitat

Study Questions

+



?

1.) Can we mark Surf Smelt without killing them?

- *Holding Trial*

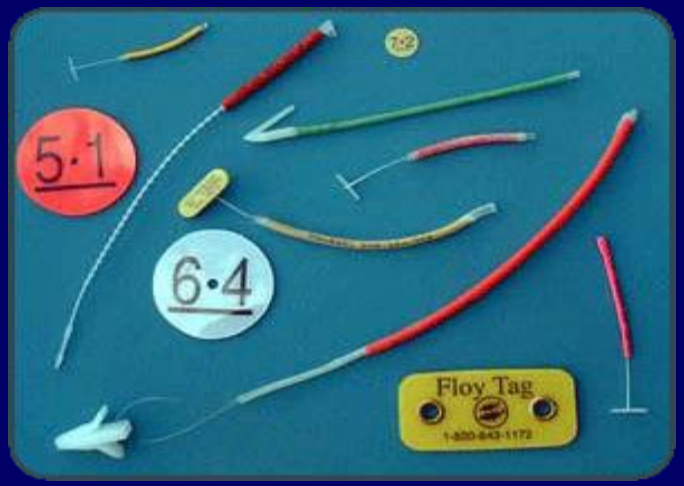
2.) Can we mark and recapture Surf Smelt in the wild?

- *Field Trial*

3.)What can we learn about their movements and biology using these methods?

Tag Selection

+



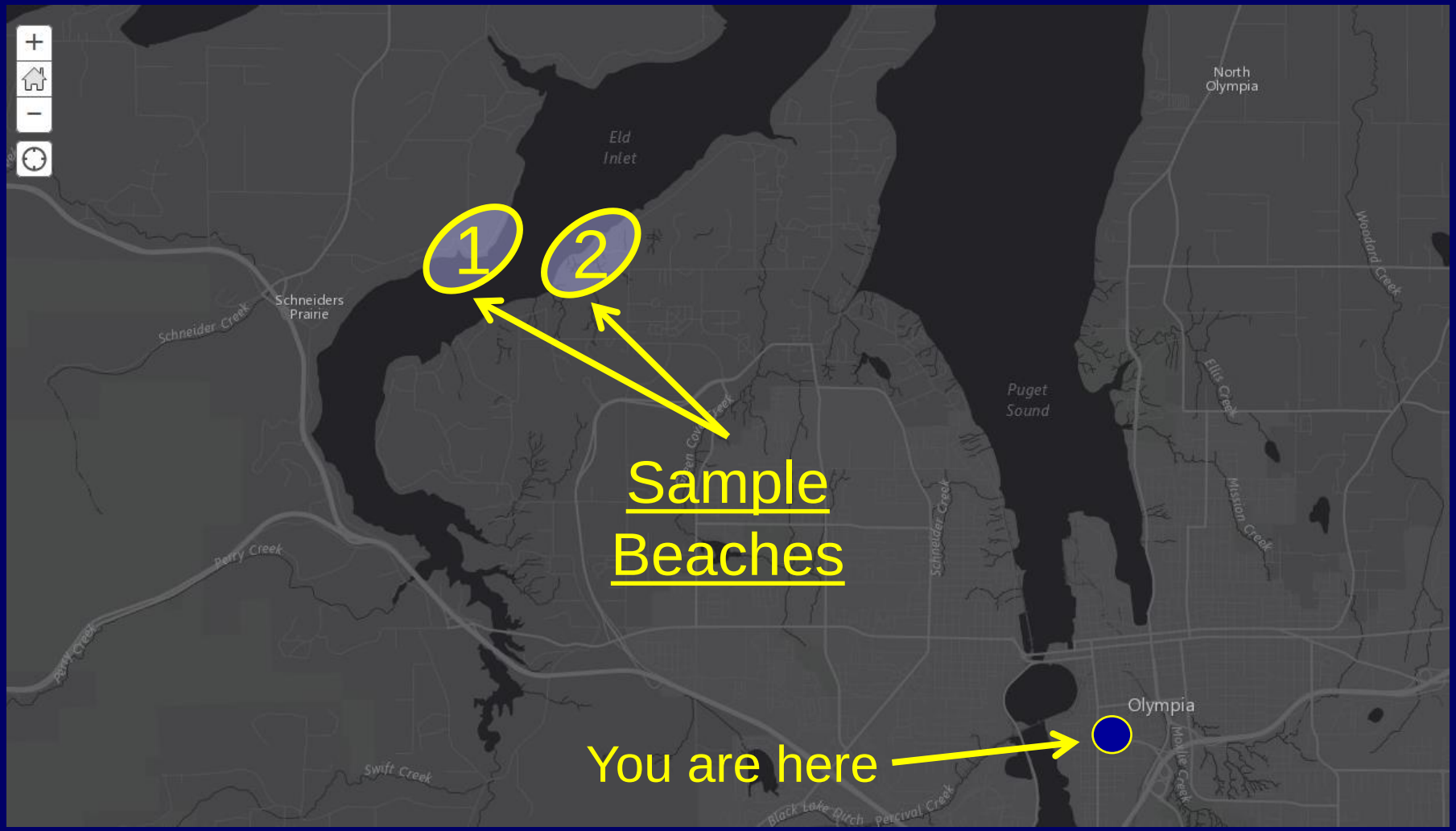
?

- Selected Visible Implant Elastomer (VIE) tags
  - Low cost
  - Minimally invasive
  - Easy to use
  - Non-toxic

Holding Trial

- 119 marked smelt held for 3 weeks
- **Results:**
  - **Tag Retention: 100%**
  - **Survival: 92%**
- Question 1 = Yes

Field Trial


1
2
Sample Beaches
You are here
Eld Inlet
North Olympia
Schneiders Prairie
Schneider Creek
Puget Sound
Olympia
Berry Creek
Swift Creek
Black Lake Ditch
Percival Creek
Mission Creek
Ellis Creek
Woodard Creek
Moxlie Creek

Field Trial

Step 1: Catch Smelt

Field Trial

Step 2: Tag with site & date specific marks

Field Trial

Step 3: Record biological data

-Sex/Spawning Condition & Length

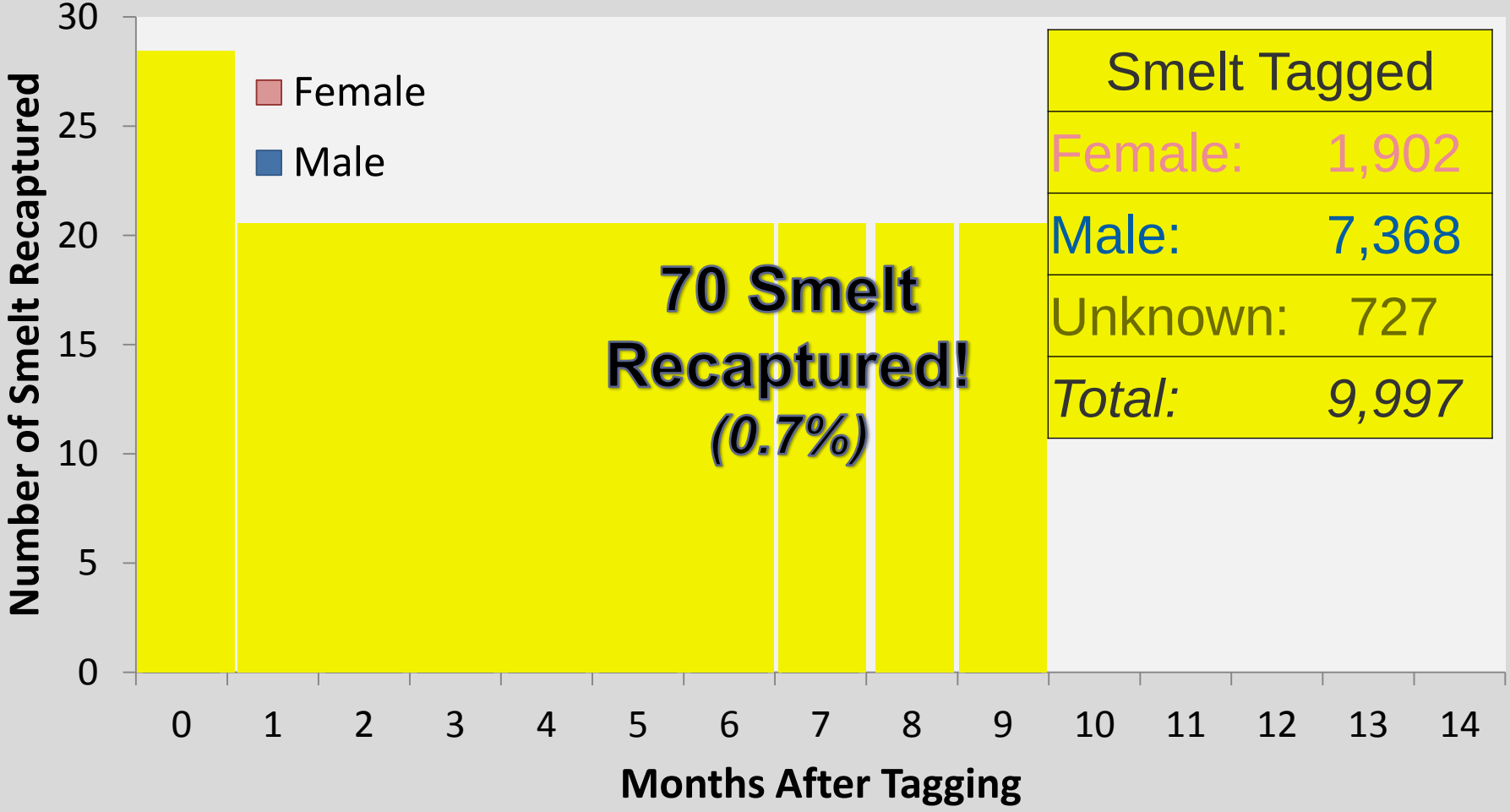
Field Trial

Step 4: Release marked smelt - alive

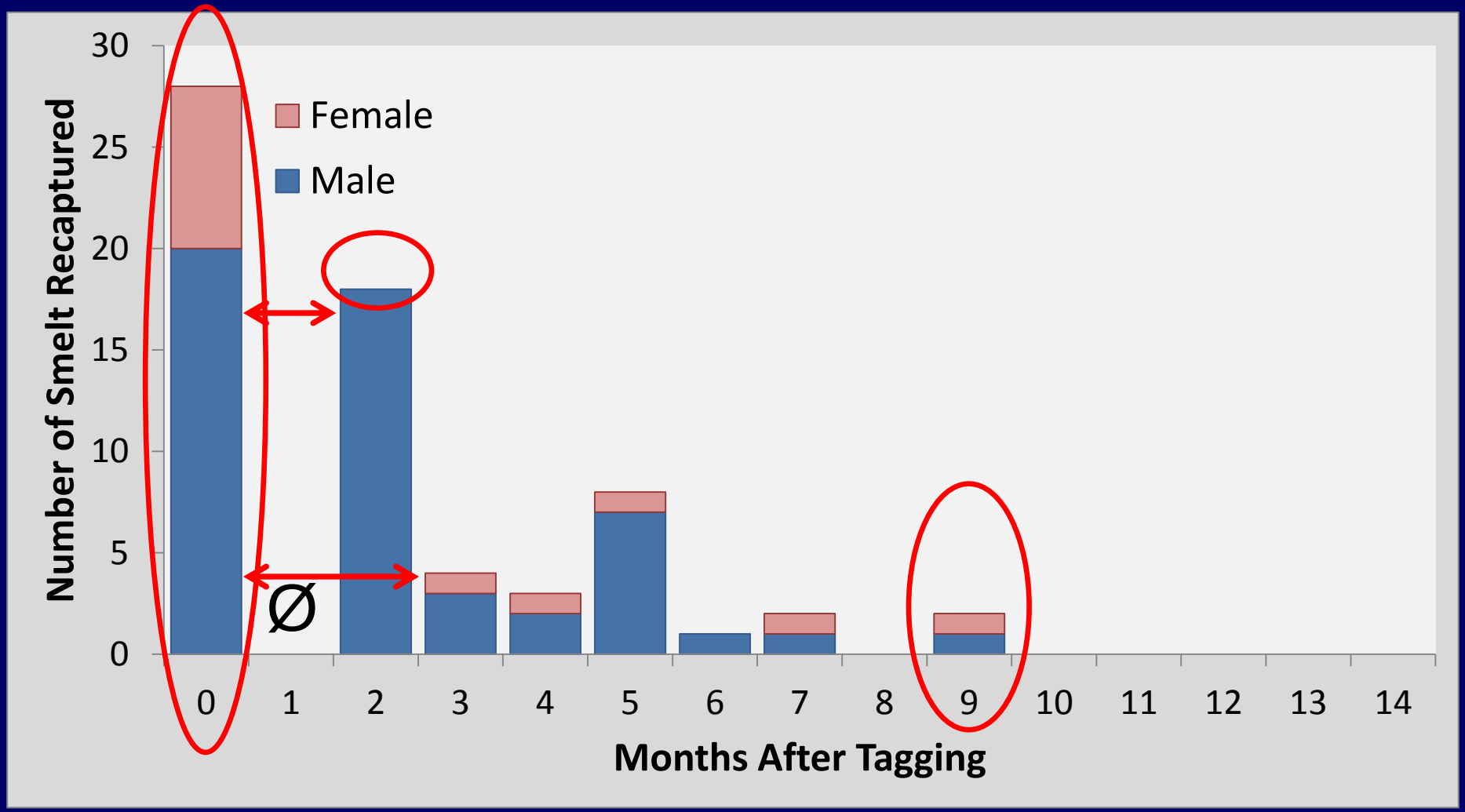
Field Trial

Step 5: Repeat monthly for 15 months

Results: Recaptures



What did we learn?

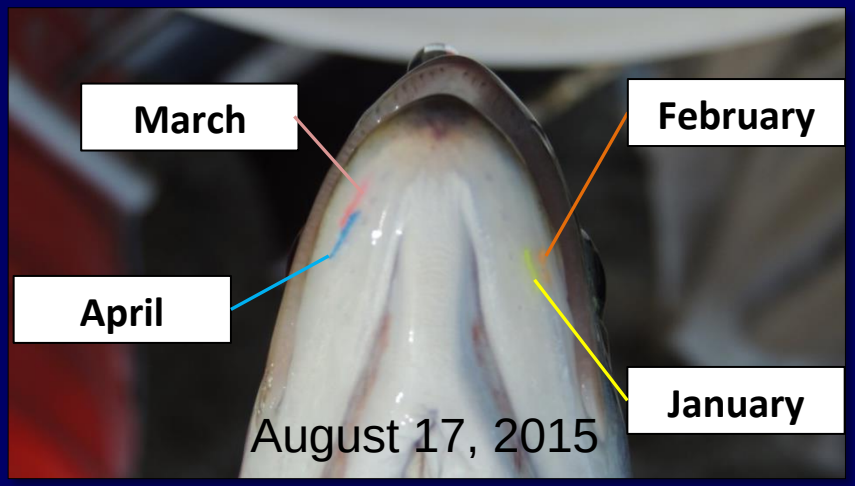


What we learned

- Surf Smelt are hardy enough to mark with VIE tags
  - Adult Surf Smelt retain VIE tags up to 9 months
- Individual Surf Smelt will spawn multiple times and on multiple beaches
- Differential spawning frequency may explain the male biased sex ratios

What's next?: More Questions!

- What happened to the other 9,927 smelt?
- Can we enhance smelt creel surveys by combining with these tagging efforts?
- Can we learn more about other Puget Sound species using similar methods?



Thank you!

Fish Science

Use science to affect change and increase conservation, recovery, and fishing opportunities

Current

Photo: T. Buehrens

- **Population monitoring**
- Fishery evaluation
- Run size forecasts
- Fish health
- Data management

Emerging

- Declining marine productivity
- **Dam removals**
- Dam proposals
- **Adaptive management**

Thinking ahead

- Change
  - **Habitats**
  - Fishing patterns
  - Stream temperatures
  - Stream flows
- Resilience to change
- **Salmon recovery**

Fish Science

Use science to affect change and increase conservation, recovery, and fishing opportunities

Current

Photo: T. Buehrens

- Population monitoring
- Fishery evaluation
- Run size forecasts
- Fish health
- Data management

Population Monitoring

Hatchery fish – where do they go?

- Many hatcheries have both harvest and conservation objectives
  - Have we met our conservation objectives?

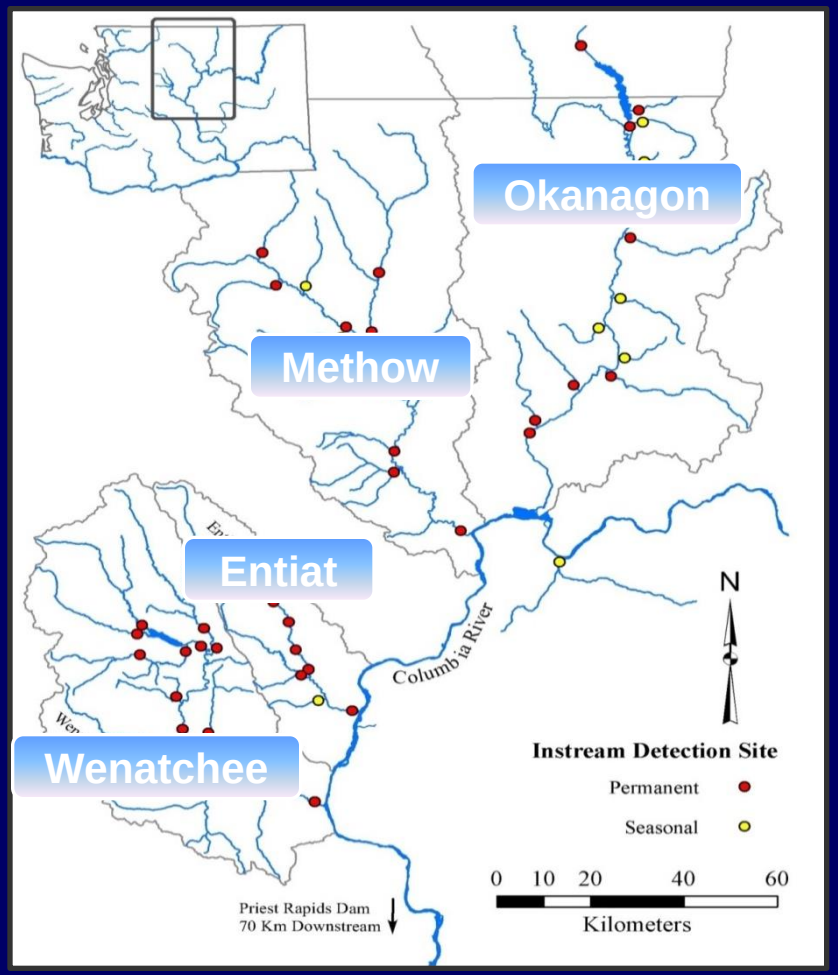
- <u>Science Questions</u>

  How many hatchery and wild fish?

  How much overlap exists?

Population Monitoring

Upper Columbia River Summer Steelhead



- Numbers of hatchery and wild steelhead

  - Among populations
  - Among streams

Population Monitoring

Upper Columbia River Summer Steelhead

- Previous method
  - Counts and annual sampling at main stem dams
  - Population distribution (1999 – 2001 study)
  - Quality (bias and precision) of estimate is unknown

- New method
  - Improved tagging and antenna infrastructure in Columbia River basin
  - Updated analysis methods
  - Quality (bias and precision) of estimate is known

Population Monitoring

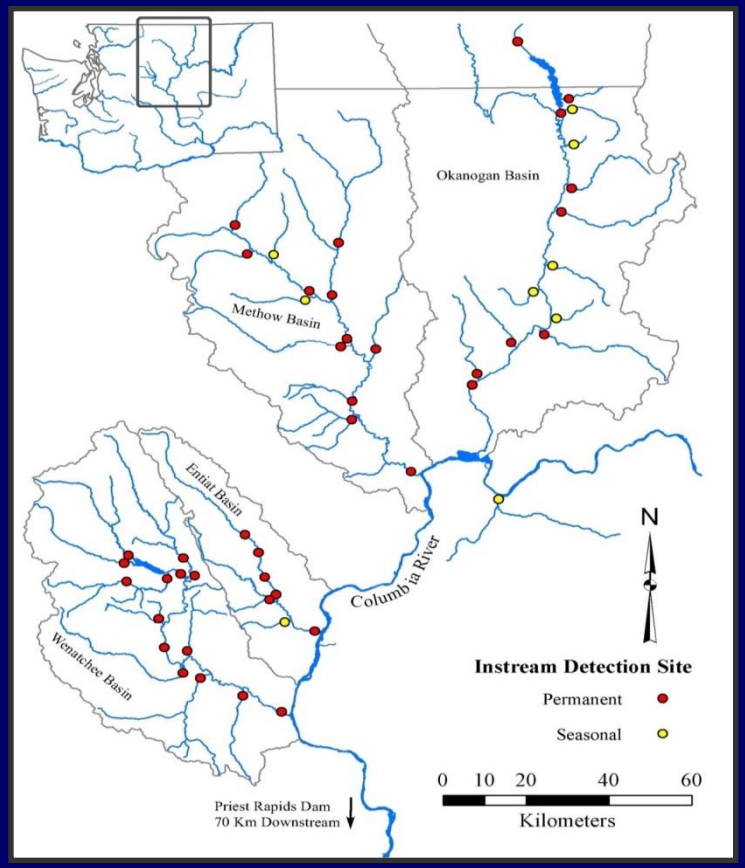
Upper Columbia River Summer Steelhead

Tag inserted into the pelvic girdle of adult steelhead to track fish across four watersheds.

In-stream arrays designed, built, and installed to detect returns of steelhead to each watershed.

Population Monitoring

Upper Columbia River Summer Steelhead



Locations of detection arrays

- Total counts at main stem dams

&

- Final spawning location of tagged fish (in-stream arrays)

=

- Estimate of wild and hatchery steelhead

Population Monitoring

Upper Columbia River Summer Steelhead

2015 Steelhead Estimates

Population	Origin	Old method	New method	CV	Difference (Old vs New)
Wenatchee	Wild	2,016	1,307	6%	+54%
	Hatchery	301	1,407	6%	-79%
Entiat	Wild	260	578	9%	-55%
	Hatchery	422	58	31%	+628%
Methow	Wild	1,343	1,081	5%	+24%
	Hatchery	2,582	2,121	7%	+22%
Okanogan	Wild	395	465	11%	-15%
	Hatchery	1,837	976	7%	+88%

CV = Coefficient of variation (measure of precision)

Fish Science

Use science to affect change and increase conservation, recovery, and fishing opportunities

Current

Photo: T. Buehrens

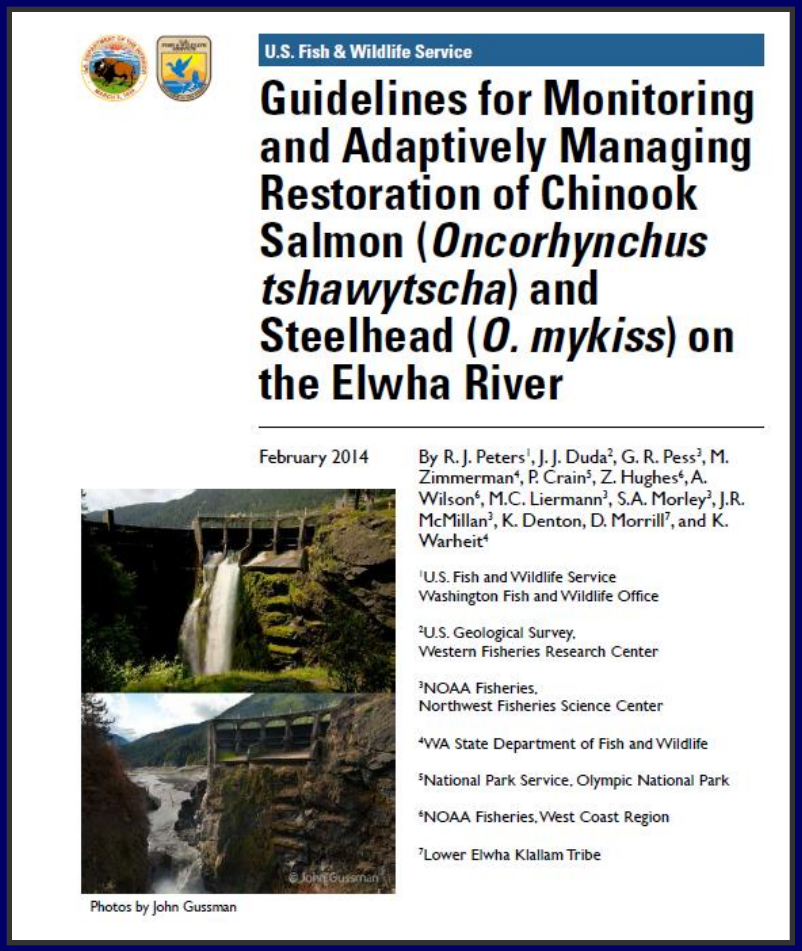
Emerging

Thinking ahead

- Declining marine productivity
- Dam removals
- Dam proposals
- Adaptive management

Dam Removal & Adaptive Management

Elwha River Chinook Salmon



U.S. Fish & Wildlife Service

Guidelines for Monitoring and Adaptively Managing Restoration of Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*) on the Elwha River

February 2014

By R. J. Peters[1], J. J. Duda[2], G. R. Pess[3], M. Zimmerman[4], P. Crain[5], Z. Hughes[6], A. Wilson[6], M.C. Liermann[3], S.A. Morley[3], J.R. McMillan[3], K. Denton, D. Morrill[7], and K. Warheit[4]

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Western Fisheries Research Center

[3]NOAA Fisheries,
Northwest Fisheries Science Center

[4]WA State Department of Fish and Wildlife

[5]National Park Service, Olympic National Park

[6]NOAA Fisheries, West Coast Region

[7]Lower Elwha Klallam Tribe

Photos by John Gussman

- 70 miles of newly opened and pristine habitat
- Hatchery stock retained native population genetics
- <u>Science Question</u>
  How do we achieve long-term goal of healthy and harvestable wild populations?

Dam Removal & Adaptive Management

Elwha River Chinook Salmon

Four Restoration Phases

1. **Preservation**
2. **Recolonization**
3. **Local Adaptation**
4. **Viable Natural Population**

Hatchery

Wild

Peters et al. 2014
Elwha Monitoring and Adaptive Management Guidelines

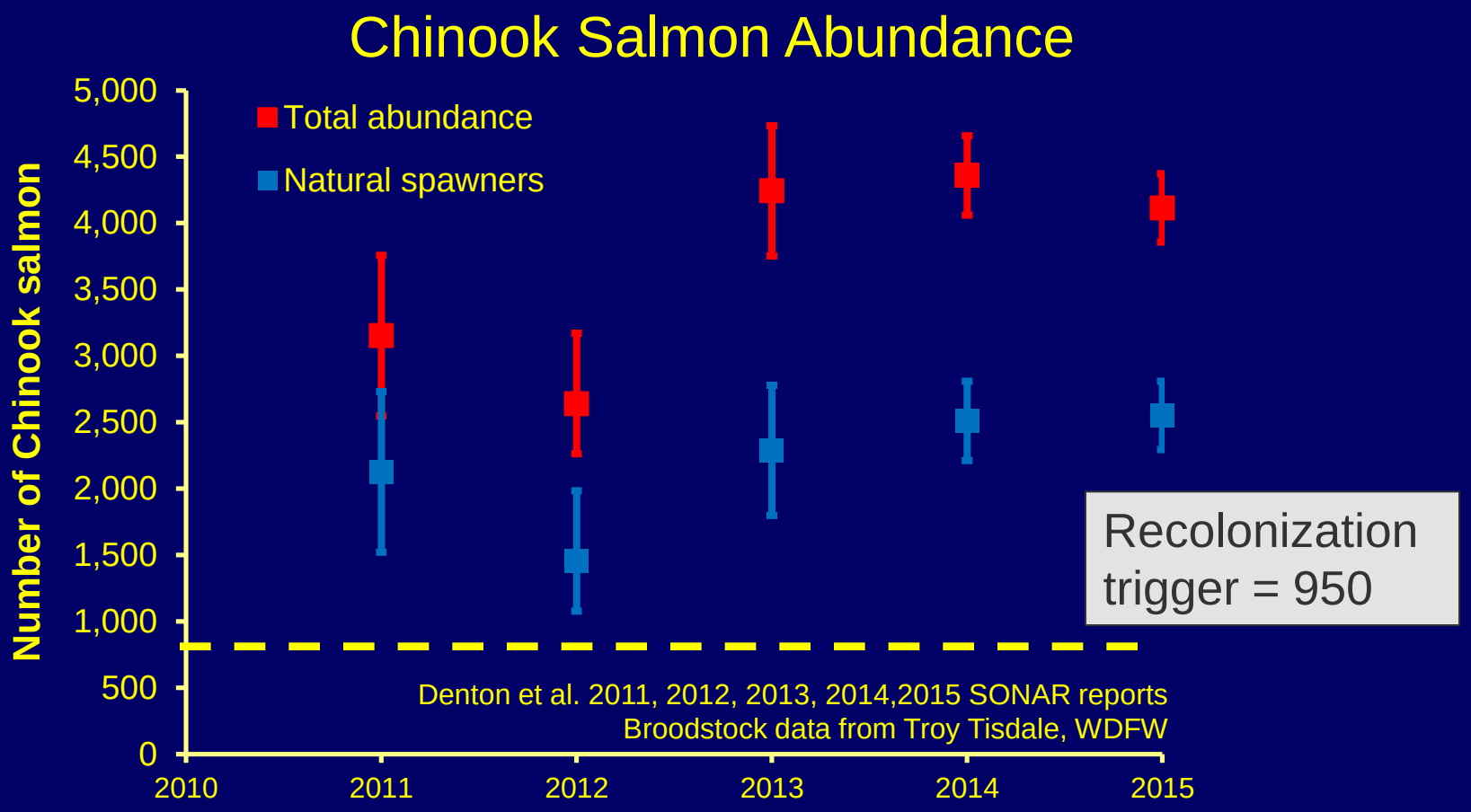
Dam Removal & Adaptive Management

Elwha River Chinook Salmon

	Question	Recolonization trigger
Abundance	How many adult Chinook salmon spawn naturally in the Elwha River?	> 950 for 4 years
Spatial distribution	Where do they spawn?	Some upstream of Elwha Dam
pHOS	How many hatchery and naturally produced salmon return to the Elwha River?	No trigger
Diversity	What is the proportion of stream type juvenile life histories?	No trigger
Productivity	For each spawning adult, how many • adult salmon return in the next generation? • juvenile salmon are produced?	Adult returns • N only: no trigger • H + N > 1.0

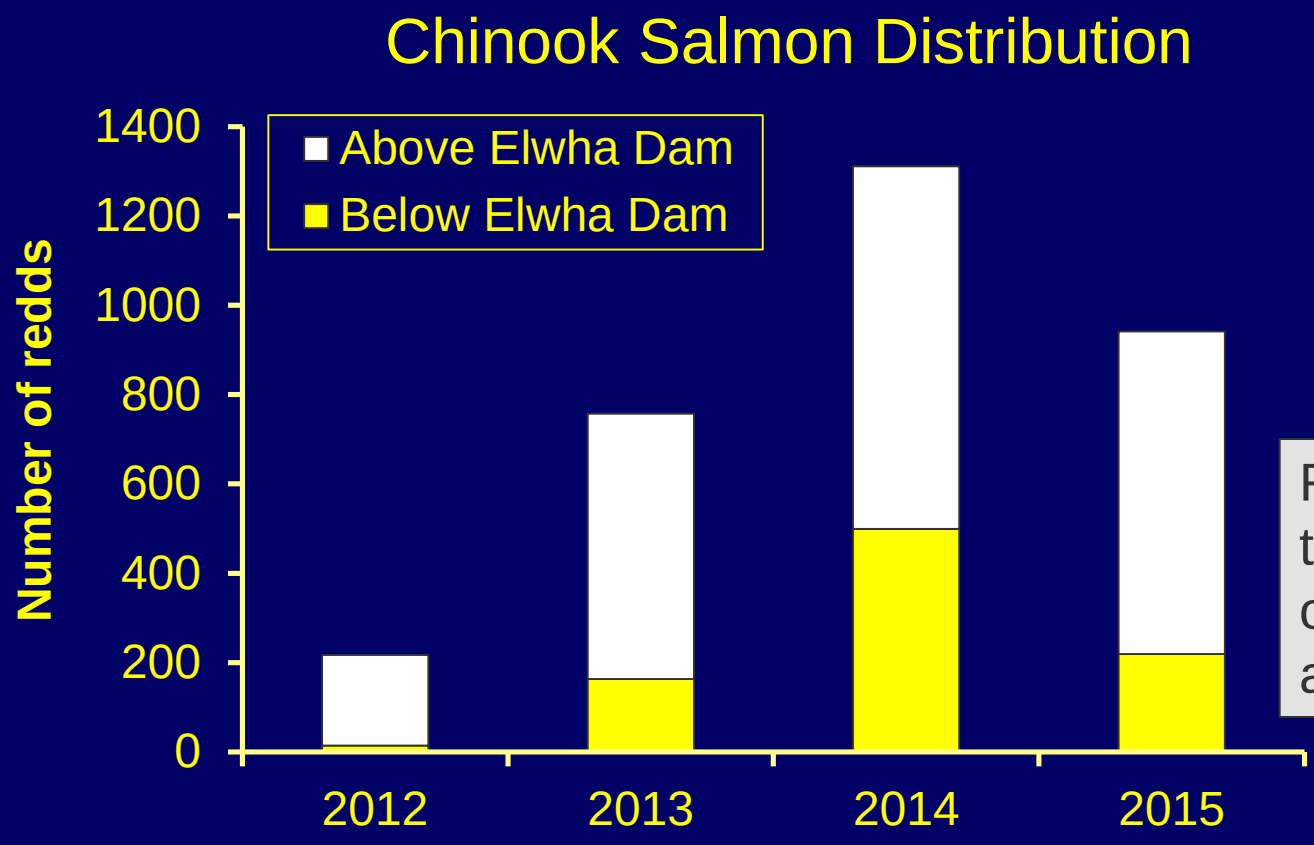
Dam Removal & Adaptive Management

Elwha River Chinook Salmon



Dam Removal & Adaptive Management

Elwha River Chinook Salmon



Recolonization trigger: A portion of fish accessing above Elwha Dam

McHenry, M, G. Pess, R. Moses, S. Brenkman, P. Crain, H. Hugunin and J. Anderson. 2016. Spawning distribution of Chinook Salmon in the Elwha River, Washington State during dam removal from 2012 – 2015.

Dam Removal & Adaptive Management

Elwha River Chinook Salmon

Chinook Salmon Productivity

Natural + hatchery spawners

Recolonization trigger ≥ 1.0

Brood year	Spawners	Age-2	Age-3	Age-4	Age-5	Total	Productivity
2004	3,439	NA	143	279	23	445	0.13
2005	2,231	29	784	2,053	507	3,372	1.51
2006	1,920	0	116	226	5	347	0.18
2007	1,140	0	354	613	67	1,034	0.91
2008	1,137	191	1,034	756	123	2,105	1.85
2009	2,192	210	1,680	3,041	846	5,778	2.64
2010	1,278	134	986	2,481	576	4,178	3.27
2011	1,862	92	1,003	2,660		3,756	2.02
2012	2,638	31	813				
2013	4,243	34					
2014	4,360						
2015	4,112						

Dam Removal & Adaptive Management

Elwha River Chinook Salmon

	Question	Recolonization trigger
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Productivity	For each spawning adult, how many • adult salmon return in the next generation? • juvenile salmon are produced?	Adult returns • N only: no trigger • H + N > 1.0 **Not yet**

Fish Science

Use science to affect change and increase conservation, recovery, and fishing opportunities

- Change
  - Habitats
  - Fishing patterns
  - Stream temperatures
  - Stream flows
- Resilience to change
- Salmon recovery

Salmon Recovery

What is the role of fish diversity?

- Chinook salmon have diversity life histories
- Each life history is dependent on specific habitats

- Science Question

  How are habitat and diversity connected to the abundance of Chinook salmon?

Salmon Recovery

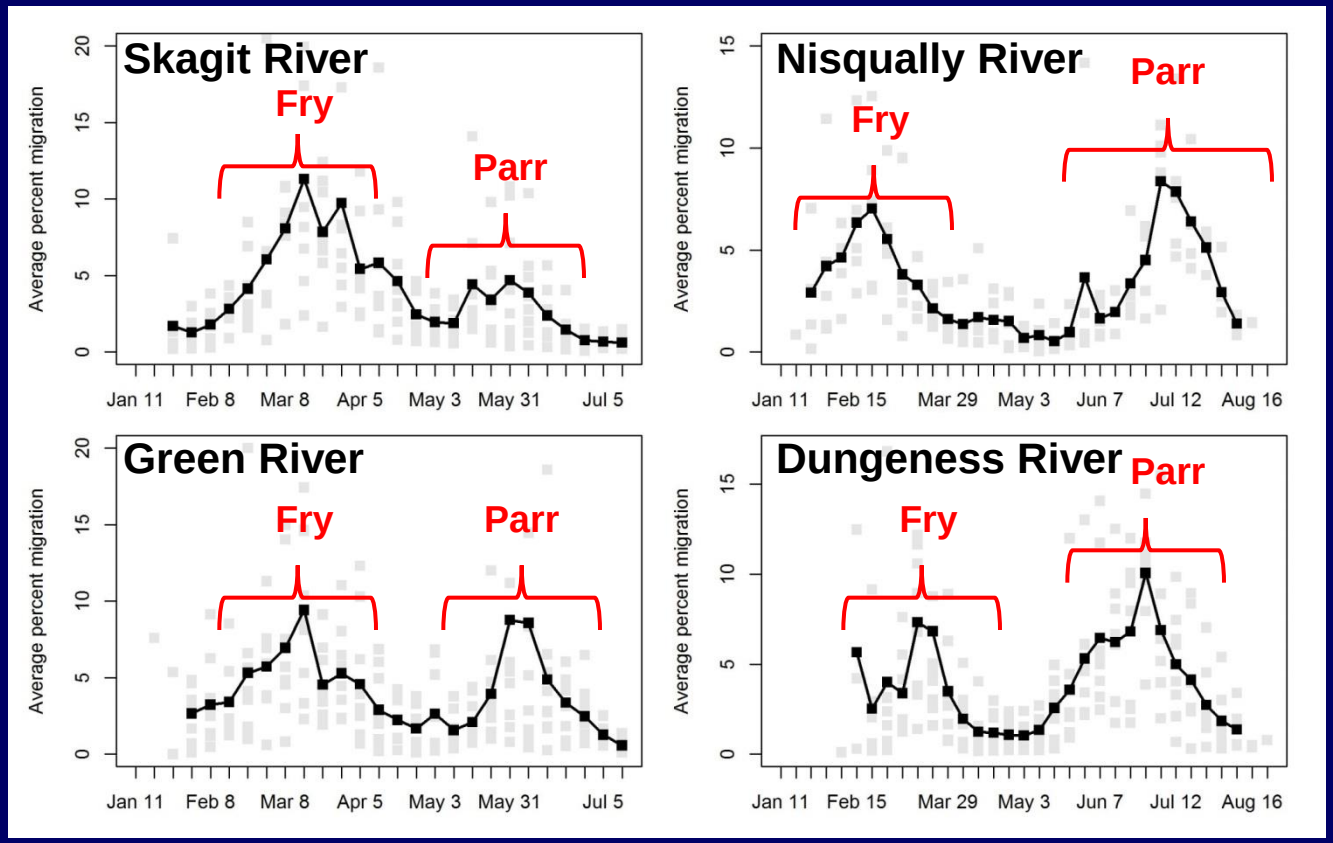
Diversity of Puget Sound Chinook salmon

Smolt trap on the Dungeness River

- Numbers and timing of juveniles leaving Puget Sound rivers are monitored annually

Salmon Recovery

Diversity of Puget Sound Chinook salmon



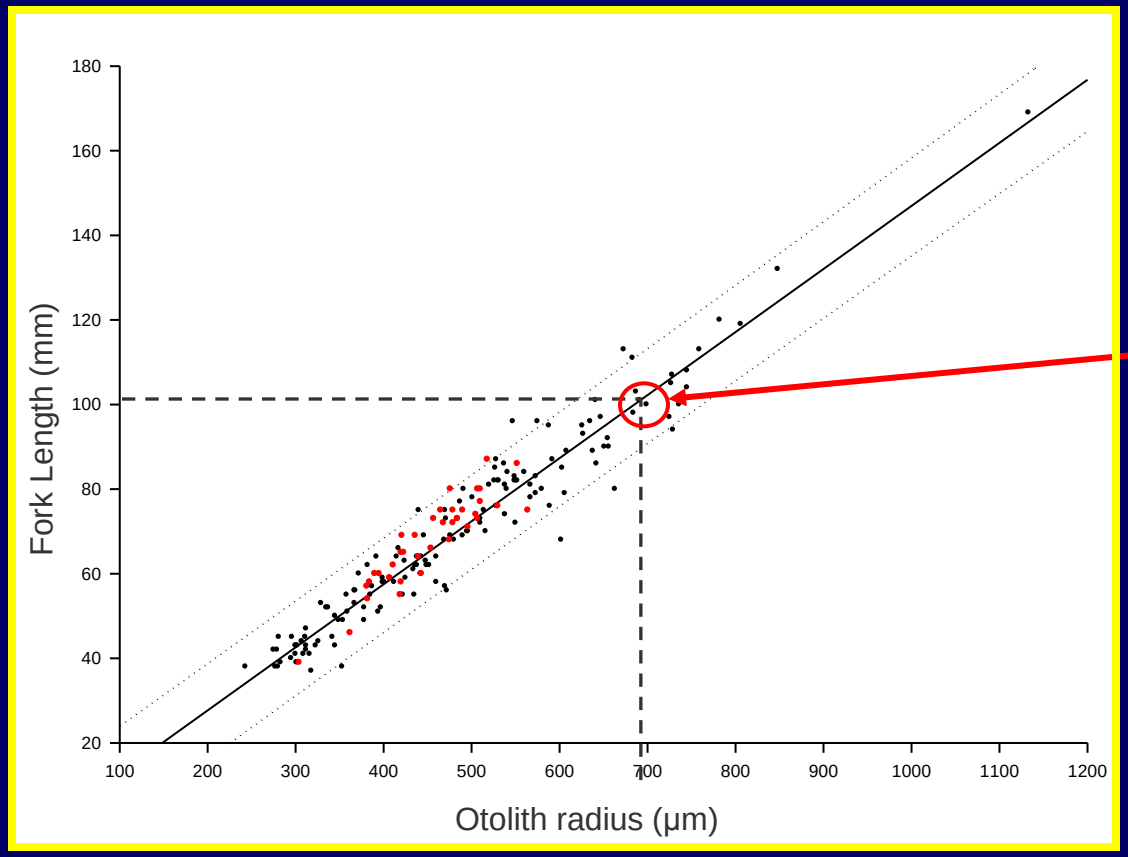
Fry migrant

Parr migrant

Salmon Recovery

Diversity of Puget Sound Chinook salmon

Otoliths are small bones located inside the skull that record fish growth history

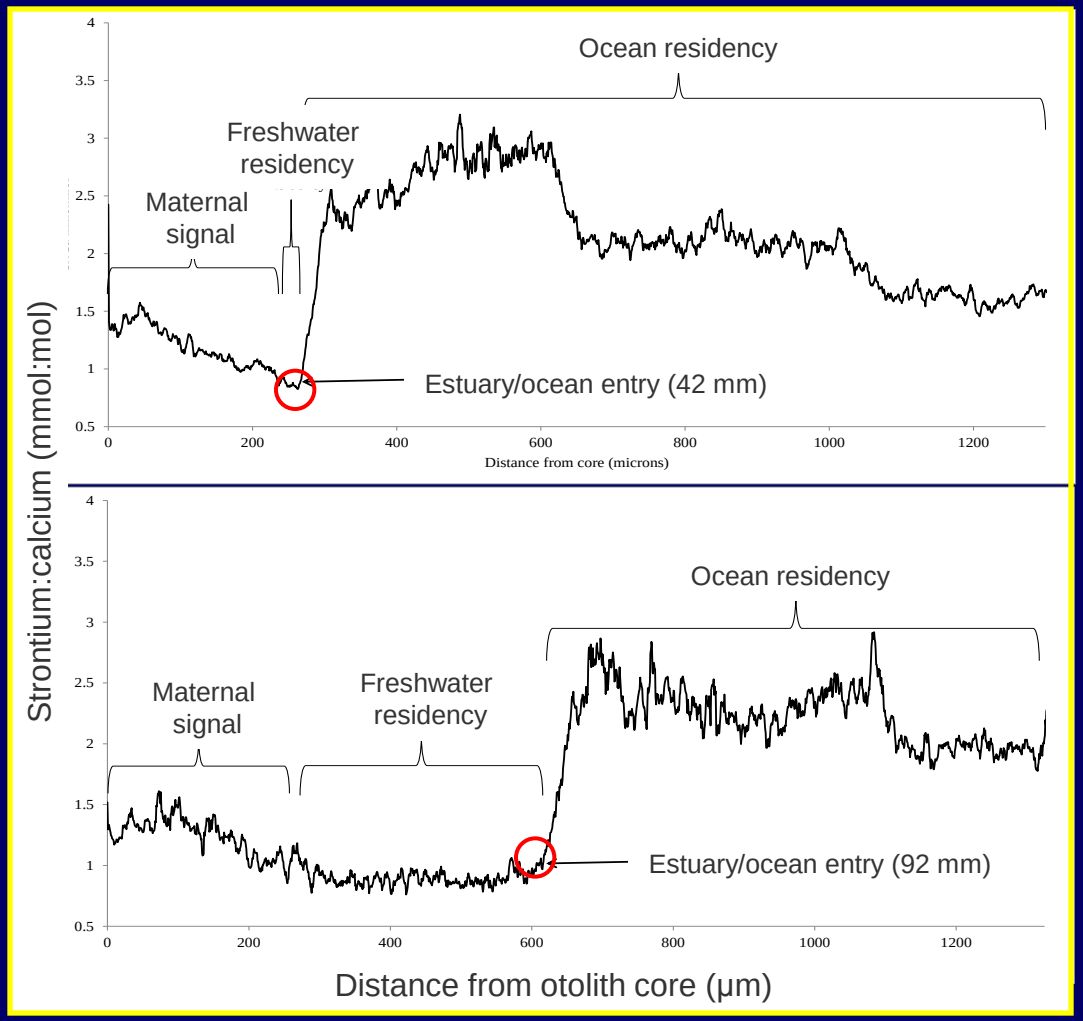


Salmon Recovery

Diversity of Puget Sound Chinook salmon

Fry

Parr



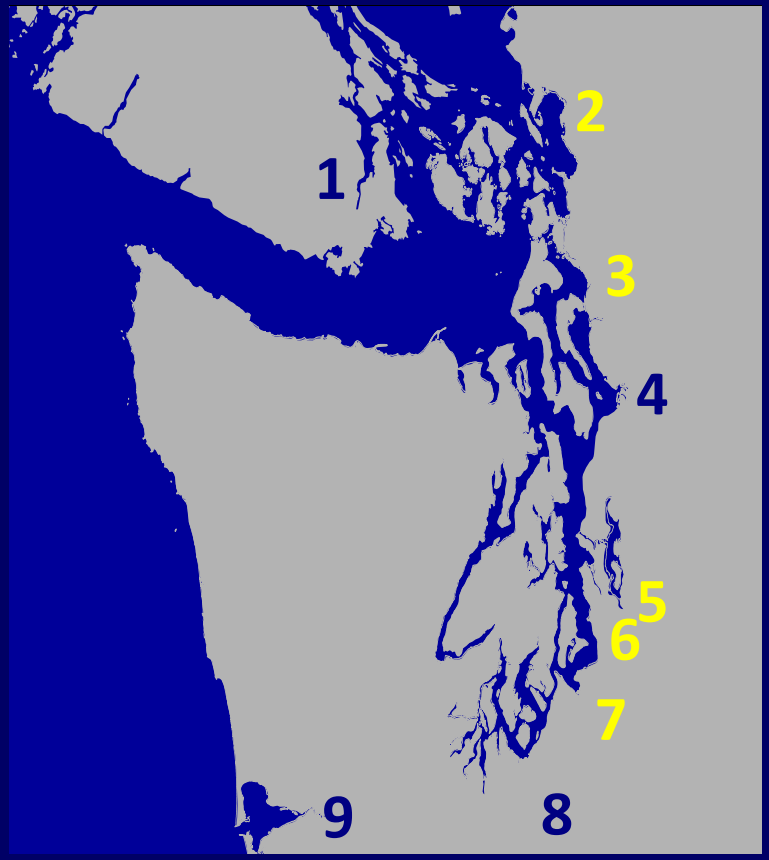
Microchemistry of otolith cross-sections record the growth history in freshwater versus saltwater habitats

Salmon Recovery

Diversity of Puget Sound Chinook salmon

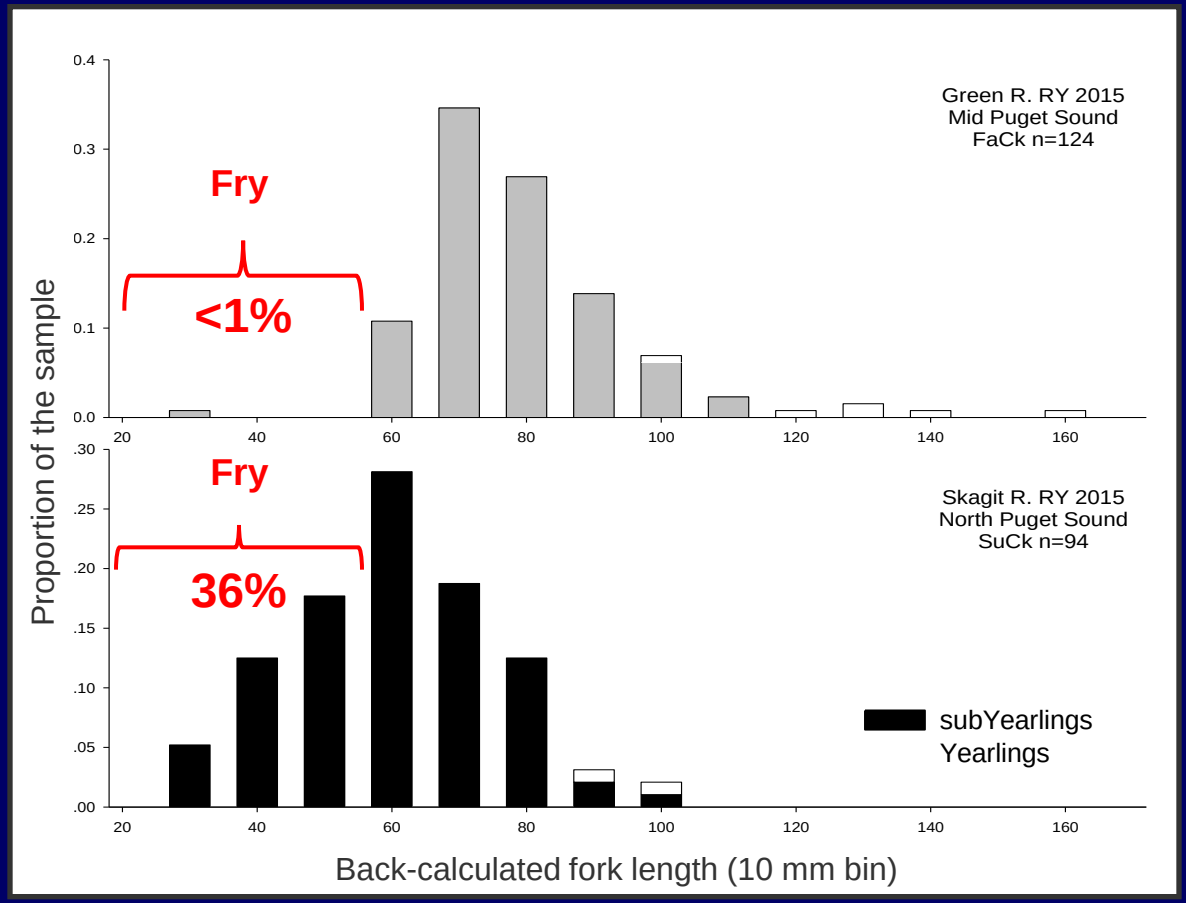
Locations where Chinook salmon life history are being compared

1.Cowichan
2.Nooksack
3.Skagit
4.Snohomish
5.Cedar
6.Green
7.Puyallup
8.Nisqually*
9.Chehalis



Salmon Recovery

Diversity of Puget Sound Chinook salmon



Graph shows lengths of fish at saltwater entry that survived to return to the river

Who survives to return to the river?

Fry migrant survival higher in rivers with:

- Intact estuaries
- Low pollution
- Shorter distance to ocean

In Summary...

New methods for Upper Columbia steelhead increases certainty in population numbers and expands options for fishery management

Adaptive management of Elwha River recovery provides scientific framework for decision making

New life history tools for Puget Sound Chinook directly inform recovery and habitat restoration