Patterns of density dependence affect ability to detect a restoration response

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Washington Department of FISH & WILDLIFE

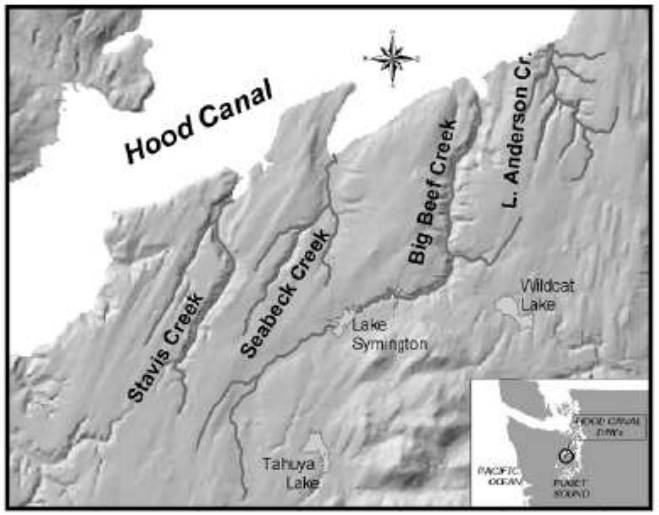
Intensively Monitored Watersheds

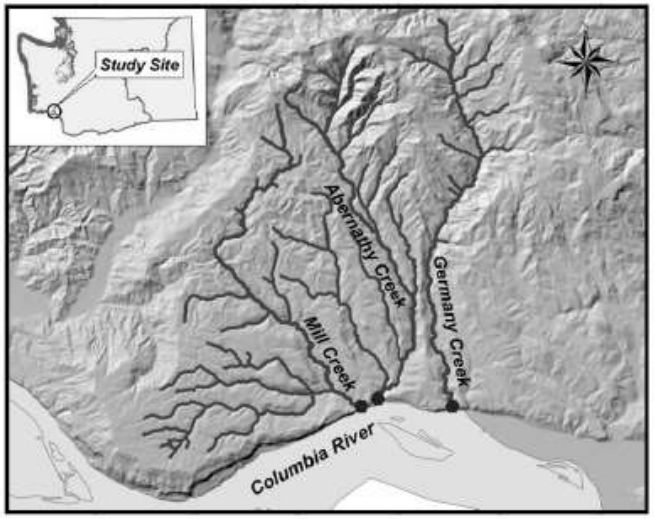
Overarching question
Does stream restoration measurably improve salmon habitat and fish population status?

Today's talk

- Background & study basics
- Conclusions & results
  - Compare habitat capacity limitation in Hood Canal and Lower Columbia IMWs
  - Response timelines in Hood Canal IMW
- Lessons for salmon recovery

Intensively Monitored Watersheds





	Hood Canal	Lower Columbia
Coho salmon ESA status	Not listed	*Threatened*
Land use	Primarily rural residential	Industrial logging & rural residential
Landscape	Low elevation, primarily forested	
Habitat issues	Impaired connectivity, especially at road crossings Sediment imbalance Lack of channel complexity	
Restoration techniques	Culvert replacement LWD addition Floodplain reconnection	Fish passage LWD addition Floodplain reconnection Nutrient enhancement

Road crossings impair connectivity

Seabeck Creek

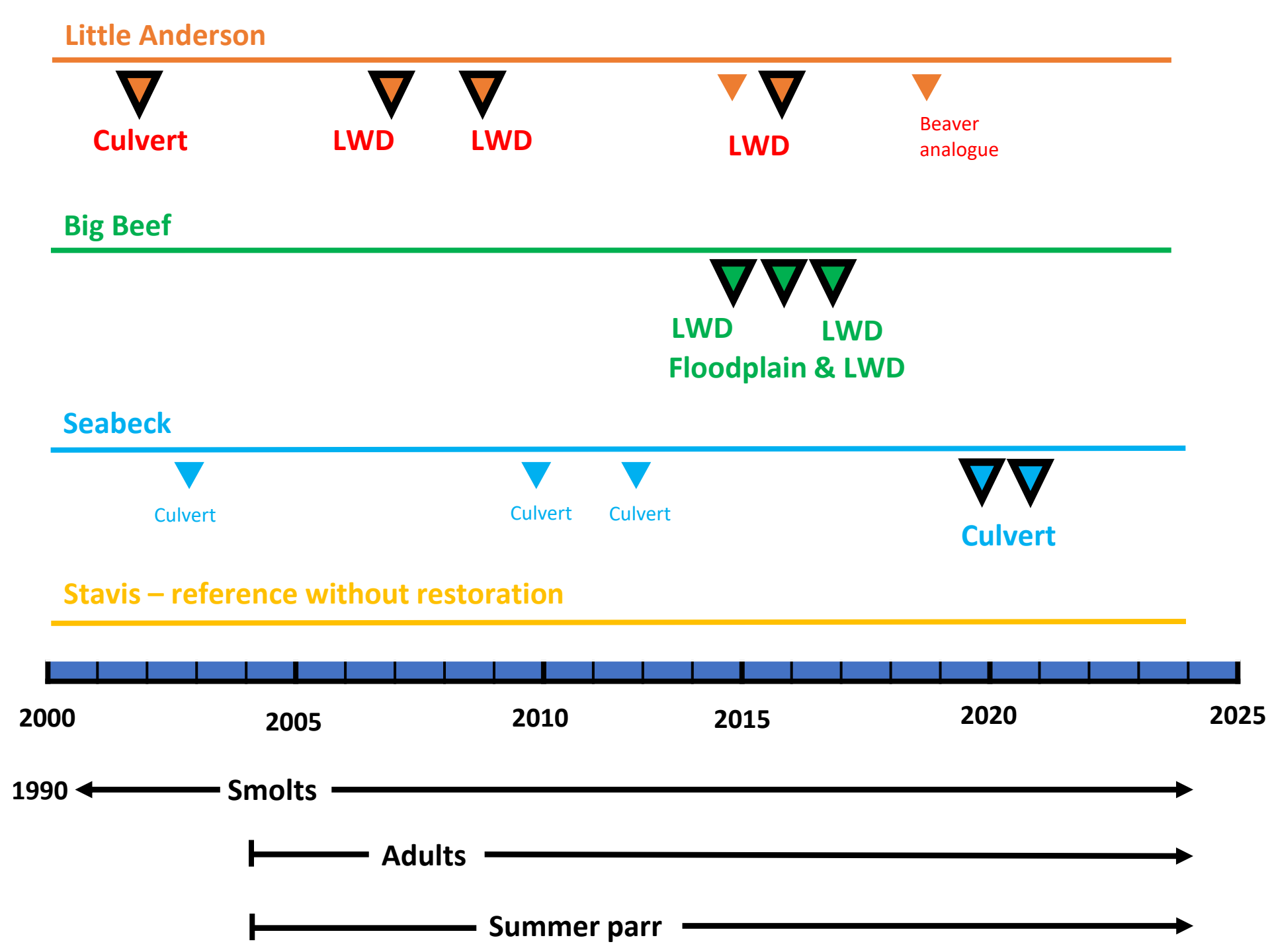
Seabeck Creek

Little Anderson Creek

Photos: Ned Pittman, Clayton Kinsel

Sediment imbalance

Incised channels **vs.** **Excessive deposition**


Little Anderson
Culvert
LWD
LWD
LWD
Beaver analogue
Big Beef
LWD
LWD
Floodplain & LWD
Seabeck
Culvert
Culvert
Culvert
Culvert
Stavis – reference without restoration
2000
2005
2010
2015
2020
2025
1990
Smolts
Adults
Summer parr

Coho salmon monitoring methods

Adult abundance

- Redd surveys throughout spawning distribution
- Big Beef: weir census count

Summer parr abundance

- Electrofish up to ten sites per stream
- Mark-recapture

Smolt abundance

- Channel spanning weir or rotary screw trap
- Big Beef: CWT program for marine survival & harvest

Conclusions – capacity limitations

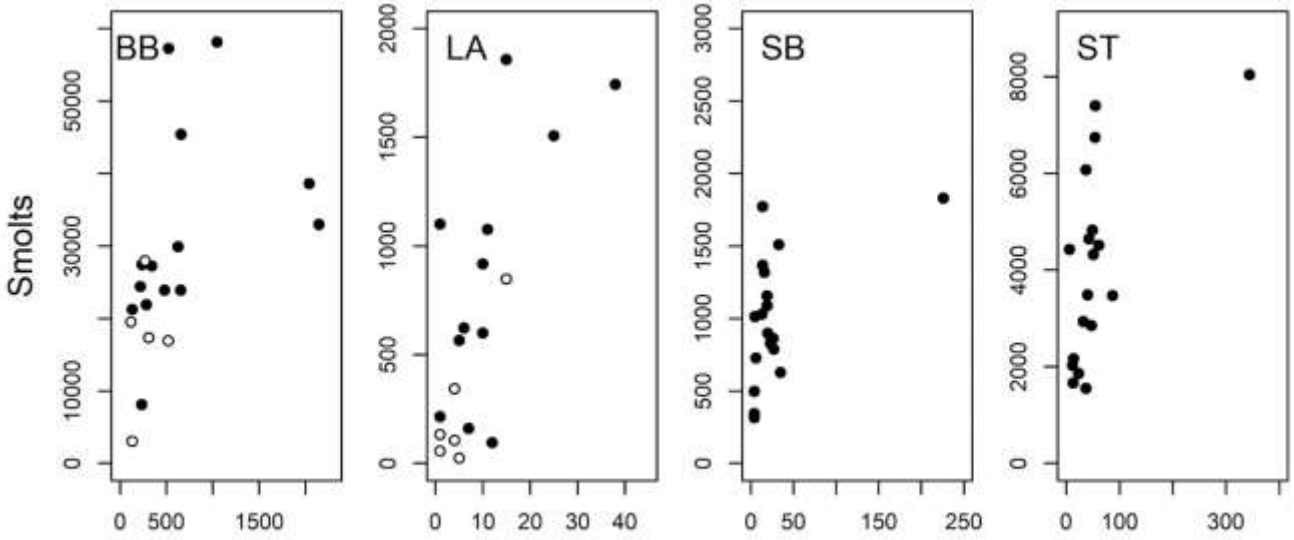
The degree to which freshwater habitat capacity limits population abundance varies substantially across watersheds, through time, and by life stage

Increases in abundance following freshwater restoration will likely be greater and more rapid when:

- Habitat capacity consistently limits smolt abundance
- Restoration alleviates those capacity constraints

Monitoring Results

HOOD CANAL



Restoratio
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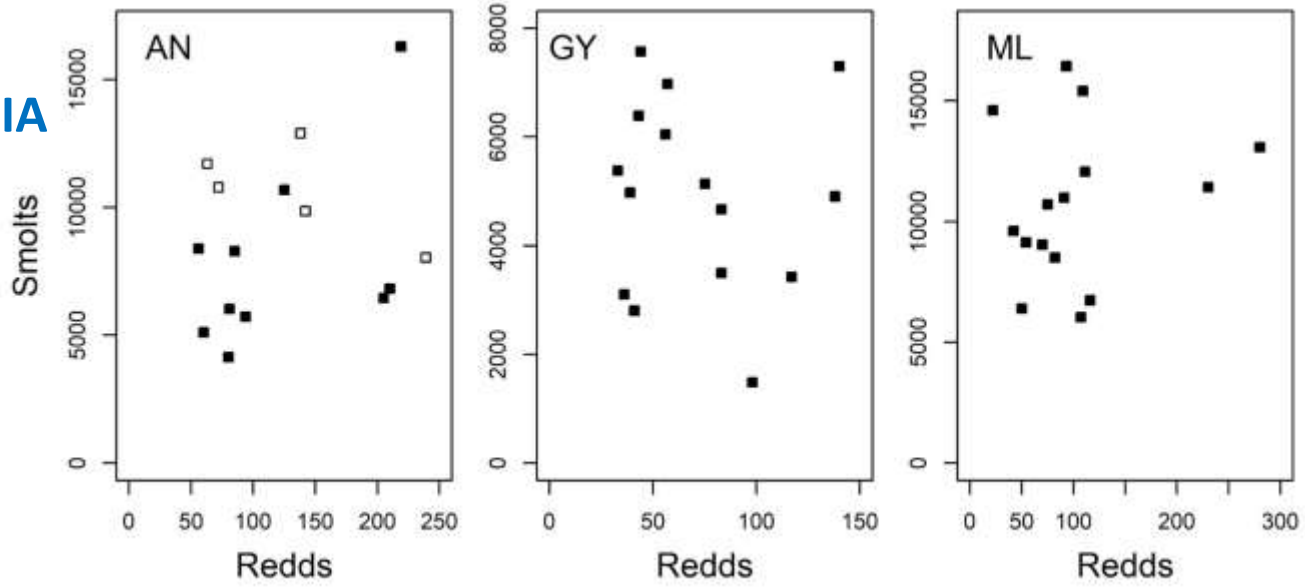
- Before
- After

LOWER COLUMBIA



Restoratio
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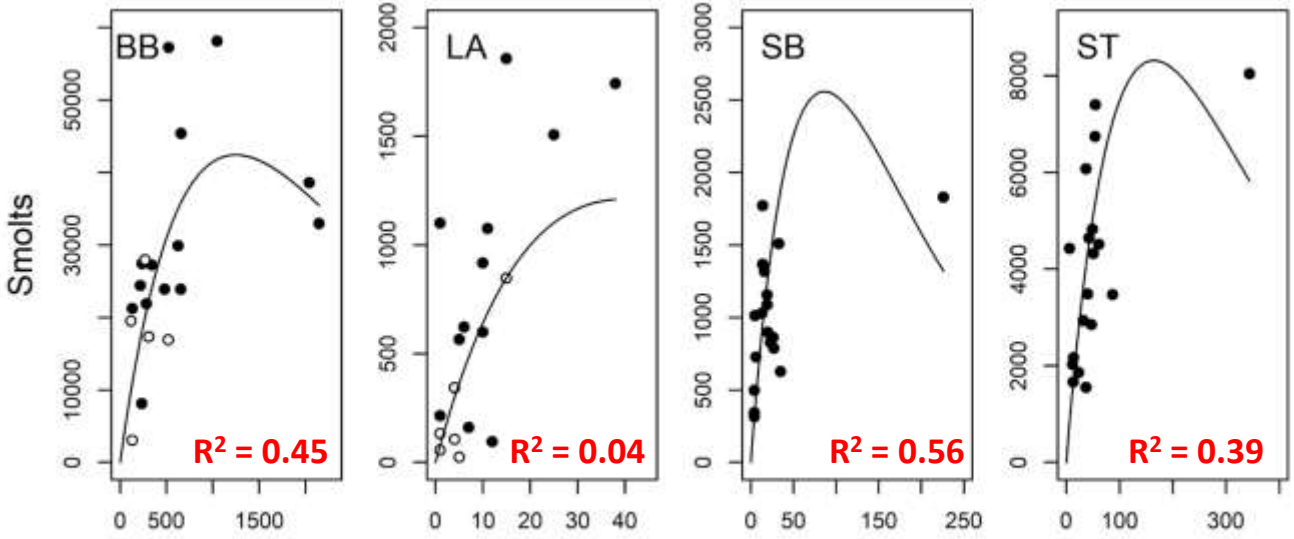
Monitoring Results

HOOD CANAL



Restoratio
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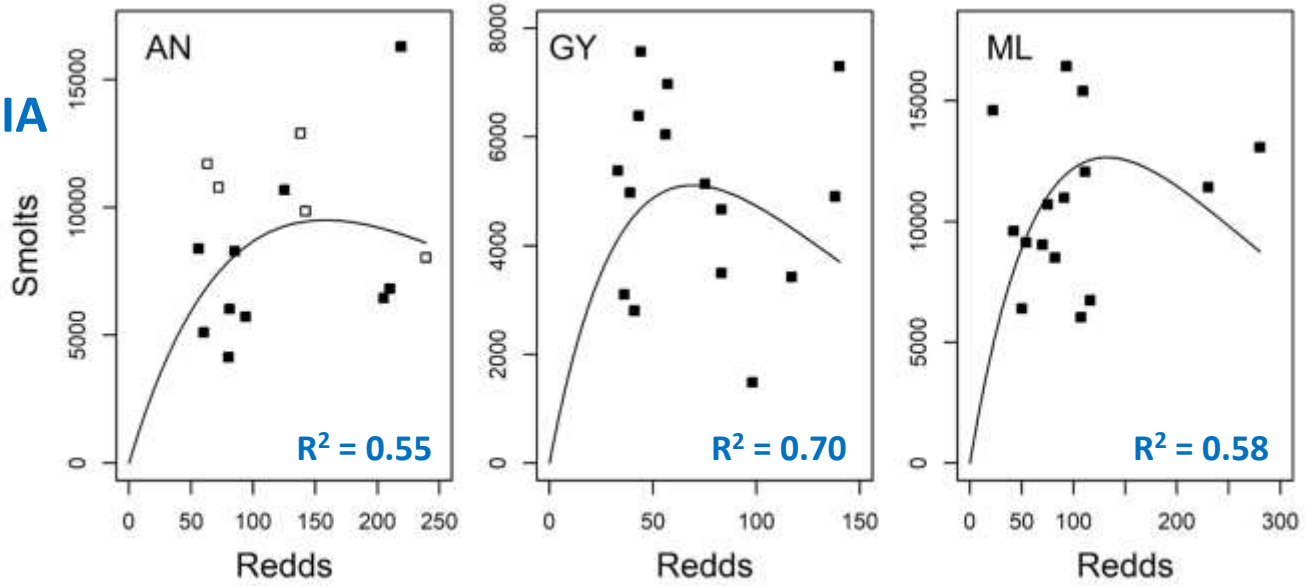
- Before
- After

LOWER COLUMBIA



Restoratio
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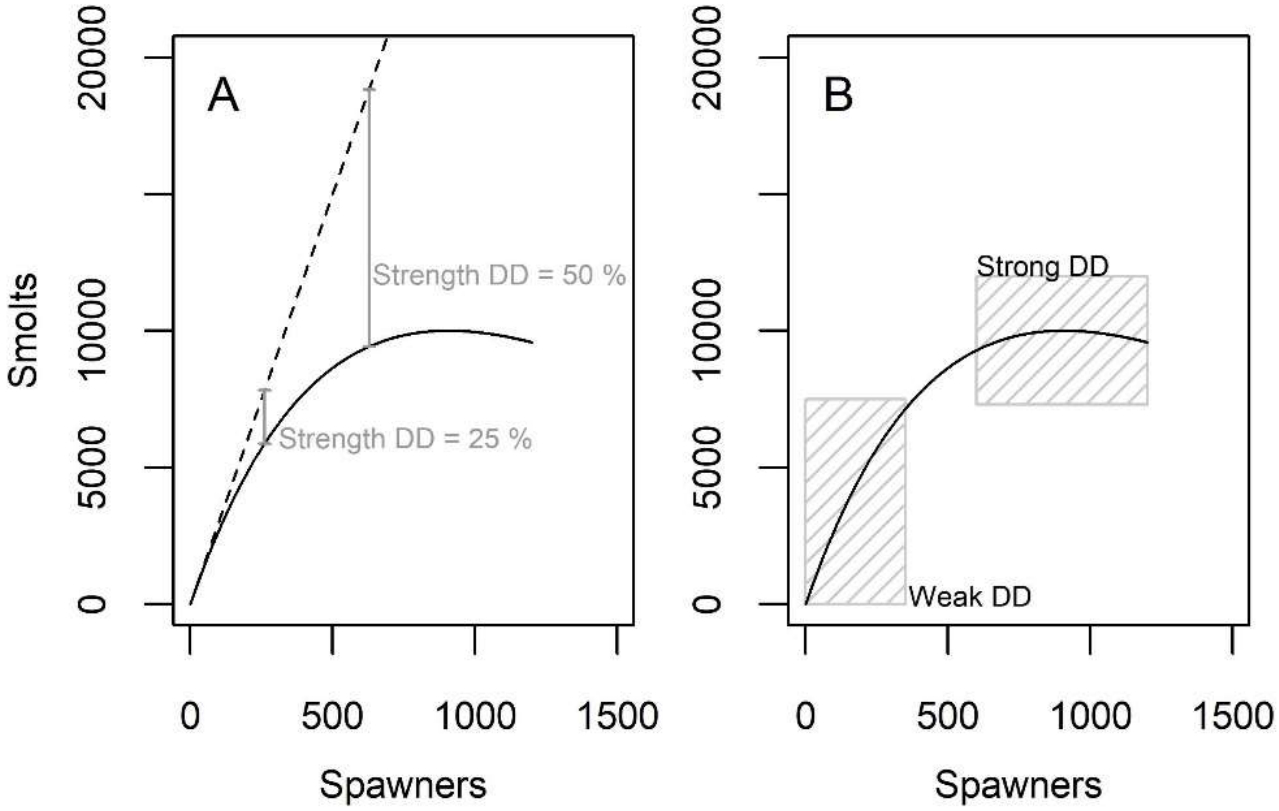
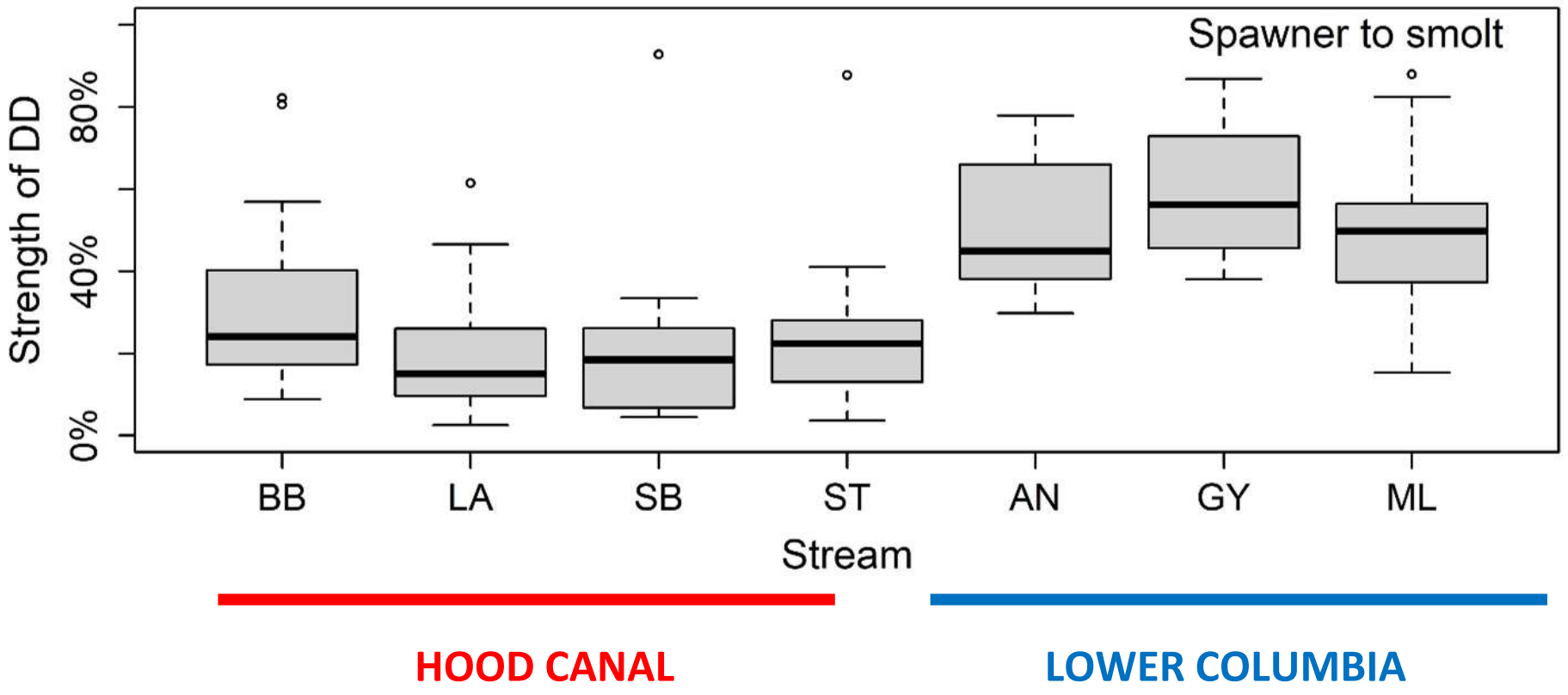
- Before
- After

Variation in habitat capacity constraints

Greater habitat capacity constraints under strong density dependence

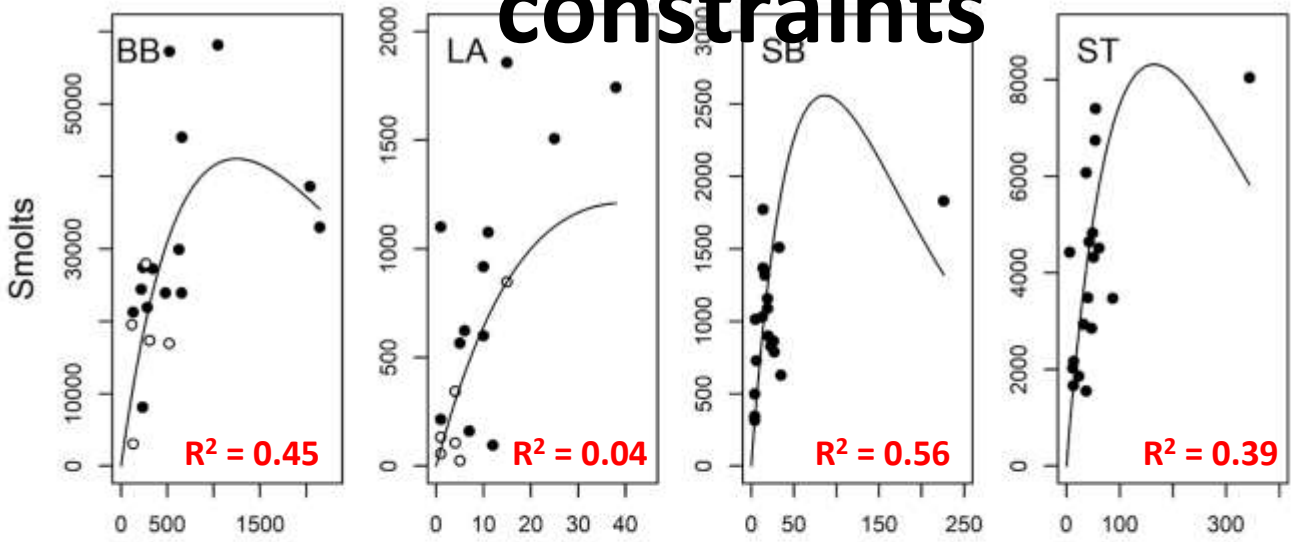


Strength of Density Dependence



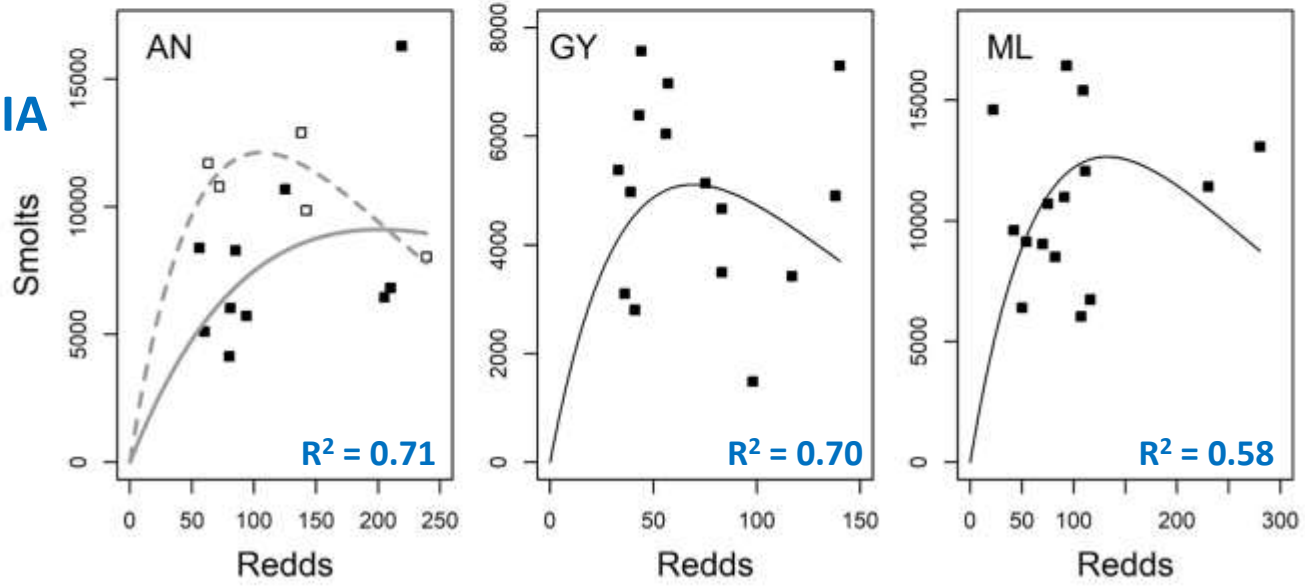
Variation in habitat capacity constraints

HOOD CANAL



Restoration
- Before
- After

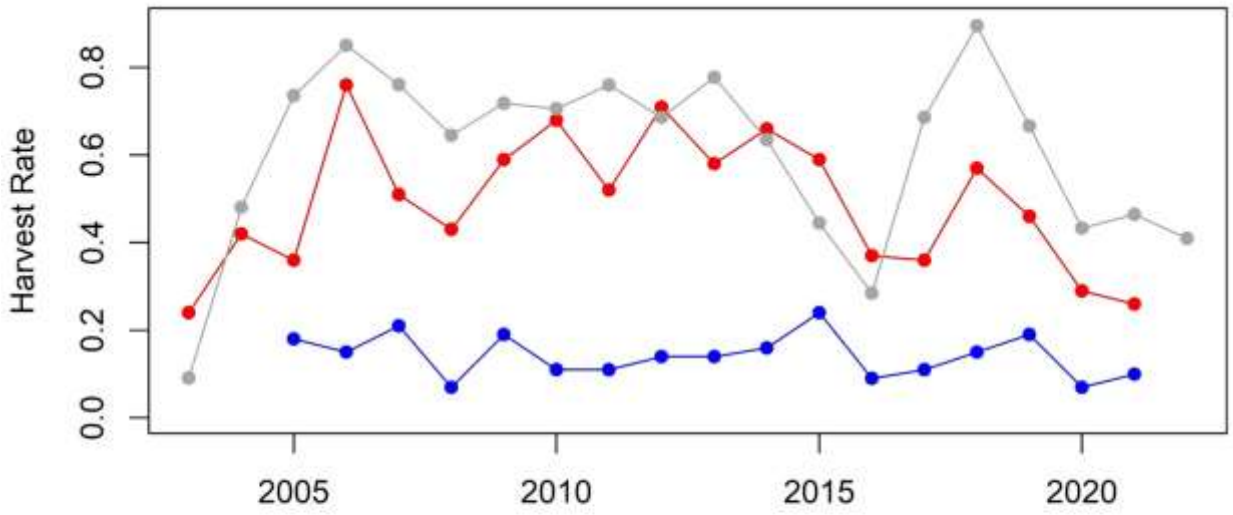
LOWER COLUMBIA

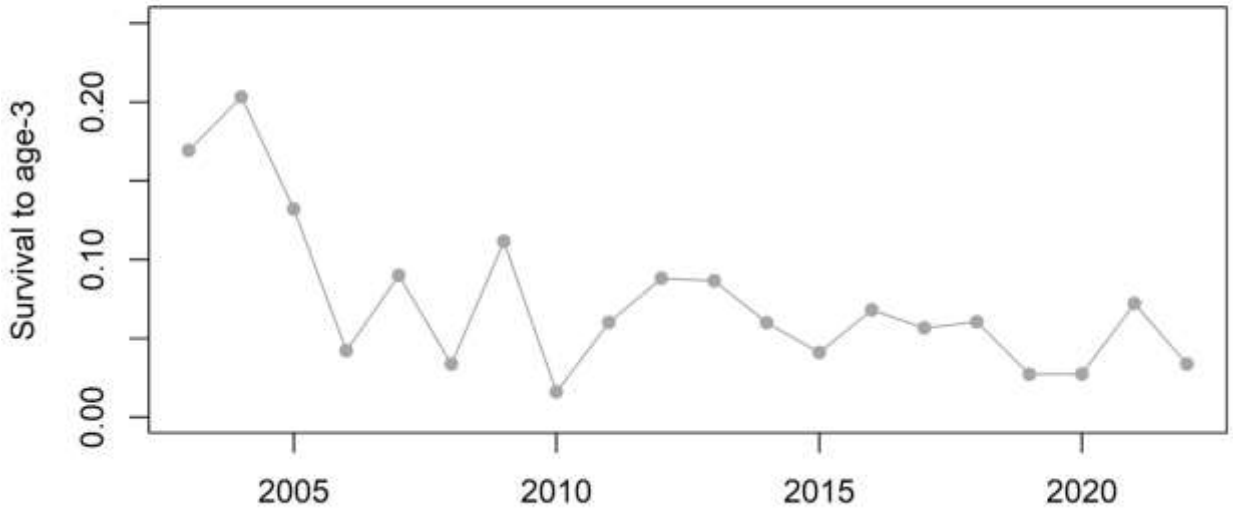


Restoration
- Before
- After

- Before
- After

Harvest & Marine Survival





Hood Canal

L Columbia

Big Beef Creek

Source:
FRAM model
Pacific States Marine Fishery Council 2021 Review Report
RMIS database

Conclusions – response timelines

Shifting baseline – restoration initially deemed a success later proved problematic

Little Anderson Creek – magnitude of LWD restoration insufficient (by itself) to provide long-term increase in smolt abundance

Big Beef Creek – apparent increase in parr to smolt survival associated with floodplain reconnection, but time will tell

Seabeck Creek – to early to assess recent culvert replacement project

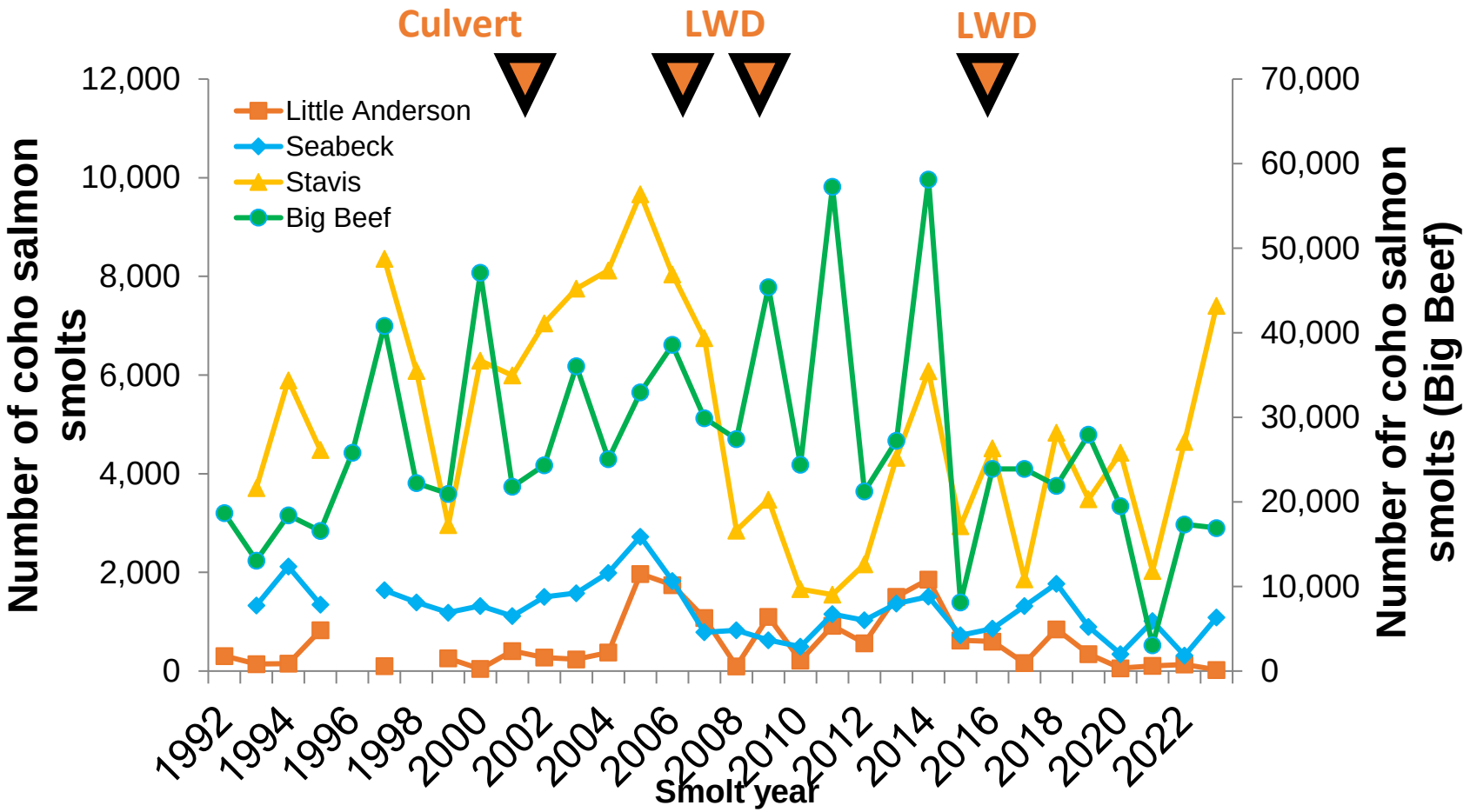
Shifting baselines

Little Anderson Creek, approximately 700 m from creek mouth

Bridge replaced barrier culvert in 2002

Photo taken April 20 2018

Shifting baselines

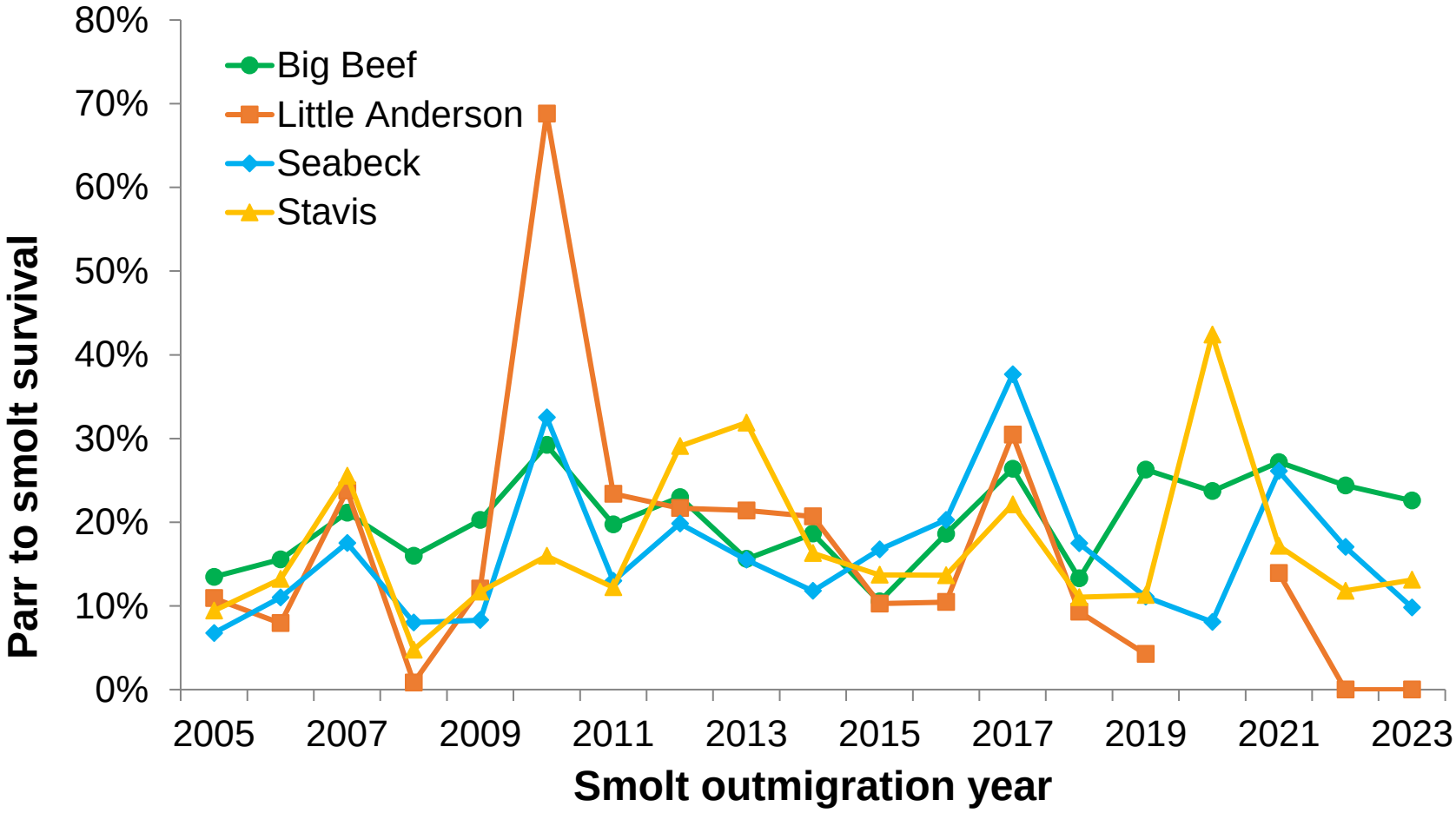


Little Anderson: Mean = 298 Mean = 1,105 Mean = 321

Big Beef floodplain reconnection

4.5 ha wetland
38 LWD structures
300+ total pieces LWD
2015 - 2017

Parr to smolt survival



Big Beef: Mean = 19 % Mean = 25 %

Importance of sediment and wood transport

Seabeck Creek at Seabeck-Holly Rd

May 9 2016

Nov 19 2021

Lessons for salmon recovery

All H integration continues to be a major challenge for salmon recovery

- Coordinating habitat restoration with harvest, hatchery and hydropower management

Extremely difficult to identify “limiting factors” in a predictive or time-stable sense

Increasing population resilience might be more important, more attainable (yet ultimately more difficult to detect) than increasing abundance

Lessons for salmon recovery

Increasing connectivity is more than just providing fish passage – should also aim to provide effective transport of sediment and woody debris

Managing expectations – increasing fish abundance through restoration takes

- Large magnitude projects covering large spatial extent
- Time, potentially decades
- Alignment with other factors affecting fish abundance

Salmon recovery is a social endeavor, not exclusively a biological endeavor

- IMWs are as much a social experiment as a biological experiment
- Importance of adaptive management

Building a Team

Stavis Creek, June 6 2023

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