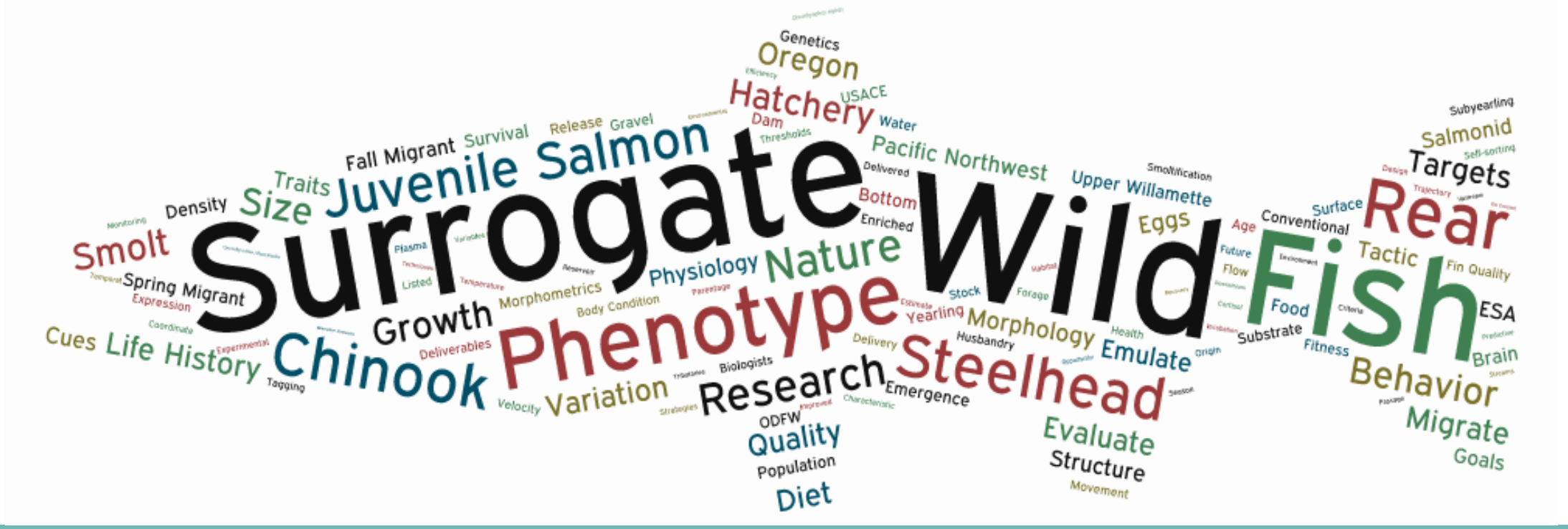
THE MAKING OF DESIGNER FISH FOR PASSAGE STUDIES



Karen Cogliati, Cameron Sharpe, David Noakes, Carl Schreck

OREGON STATE UNIVERSITY

USGS science for a changing world

US Army Corps of Engineers.

OREGON Fish & Wildlife

OREGON HATCHERY RESEARCH CENTER

OREGON COOPERATIVE FISHERY RESEARCH UNIT Semper Catostomus

Pacific Northwest NATIONAL LABORATORY

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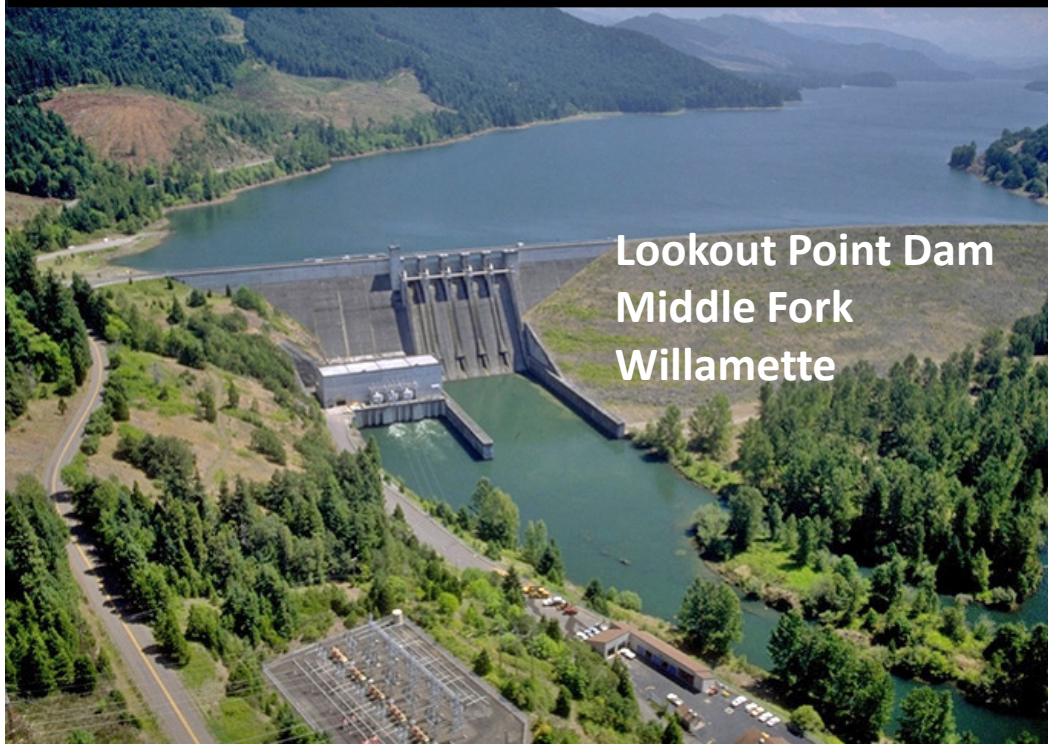
ODFW Researchers

Funding: Army Corps of Engineers

* past members

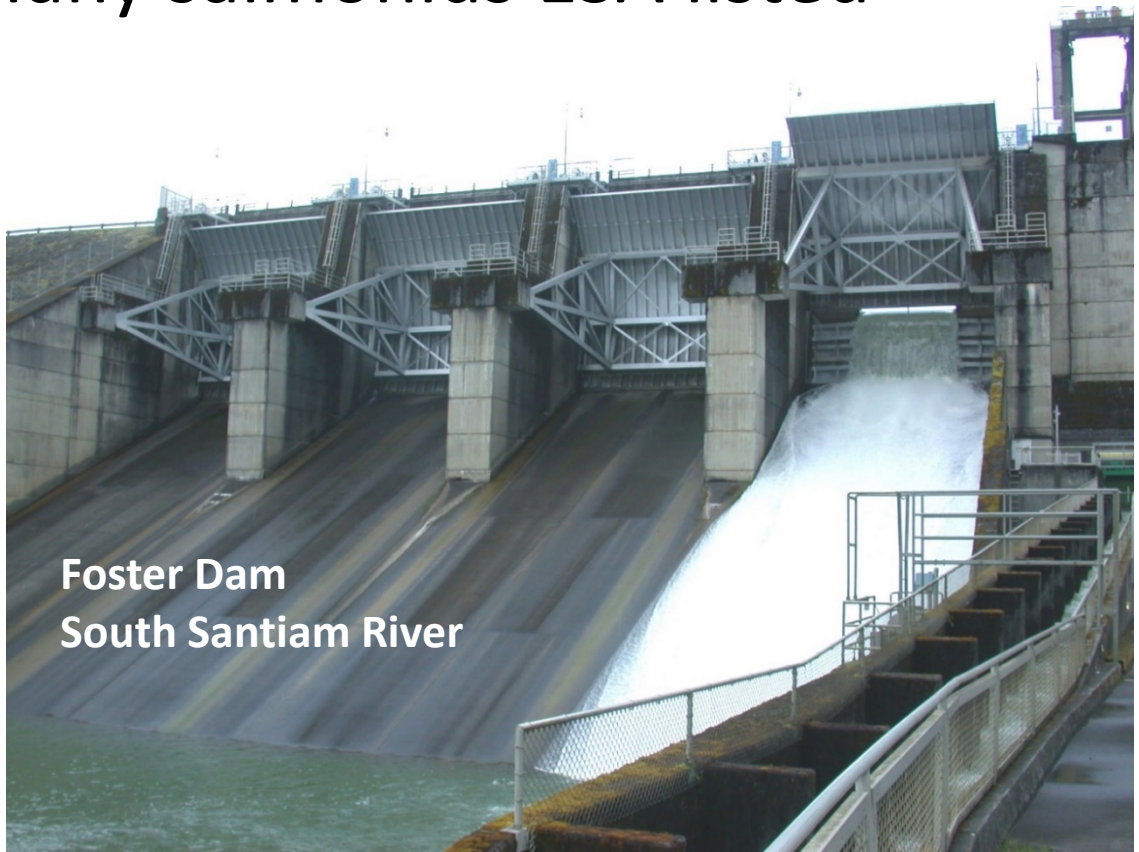
The complex issue of dams

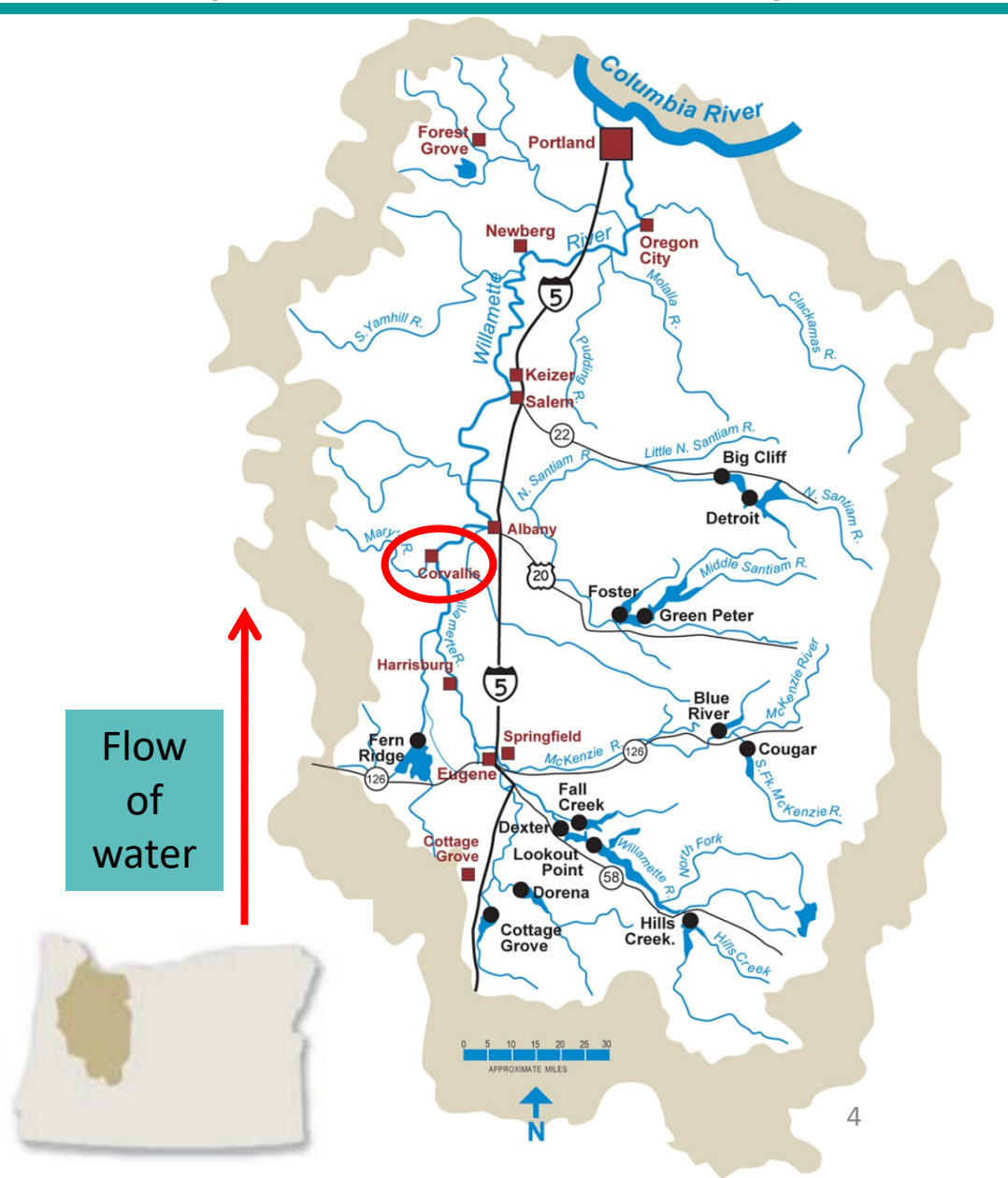
- Numerous benefits:
  - Hydroelectricity, flood control, recreation
- But, they change the landscape and environment
- Impair anadromous fish passage
  - Declines in wild fish populations
  - Hatchery fish added to the system



Willamette Valley Project Dams (Oregon USA)

- Adults moved above dams
- Studies evaluating juvenile salmonid movement to and through dams
- Many salmonids ESA listed

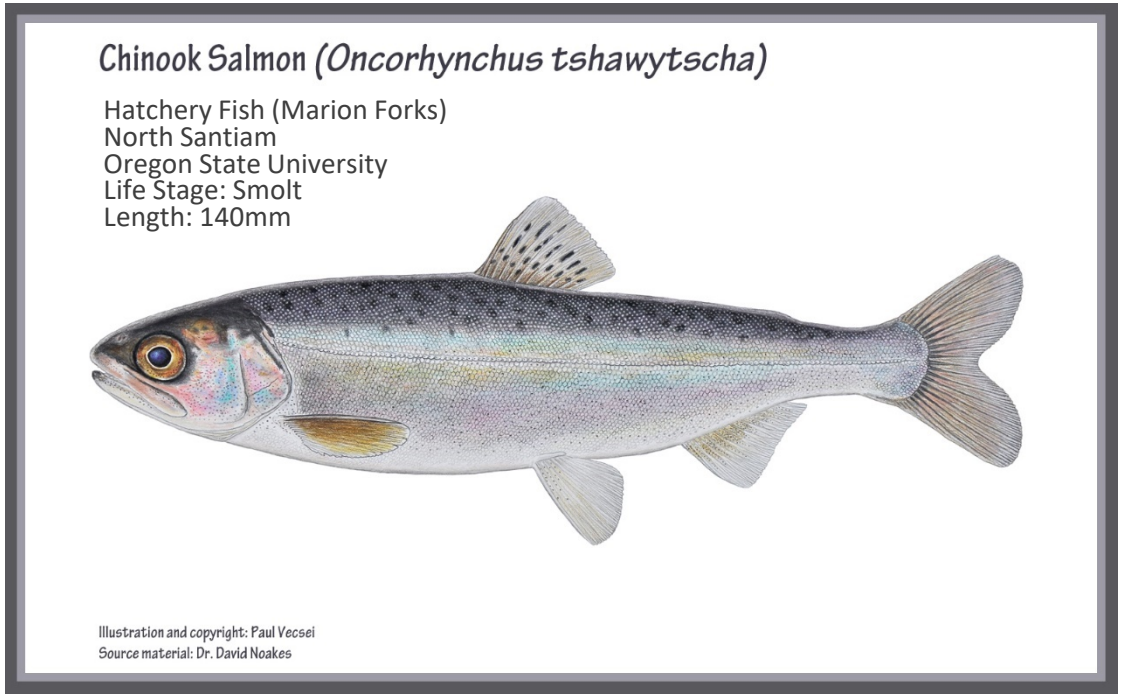




Option to use hatchery fish

- Sufficient numbers to conduct rigorous tests
  - Paired release above and below dams
  - Multiple treatments and control for bypass tests

HATCHERY AND NATURAL FISH DIFFERENCES



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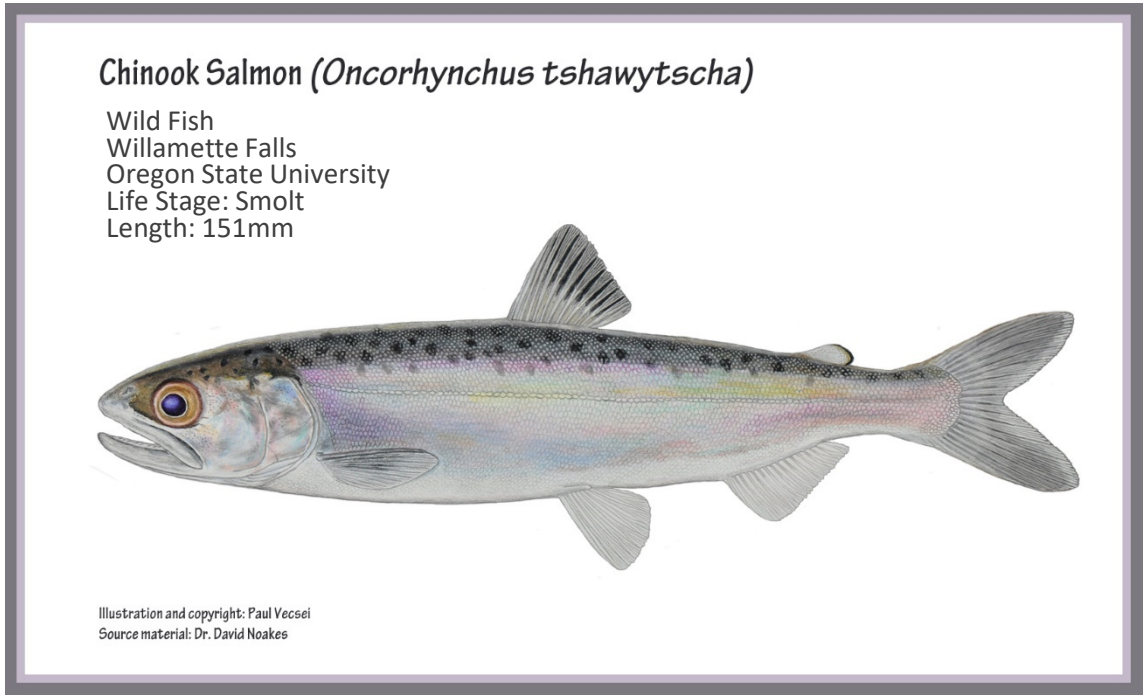

Hatchery origin

Natural origin

Behavior
Morphology
Physiology
Genetics

HATCHERY AND NATURAL REARING ENVIRONMENT

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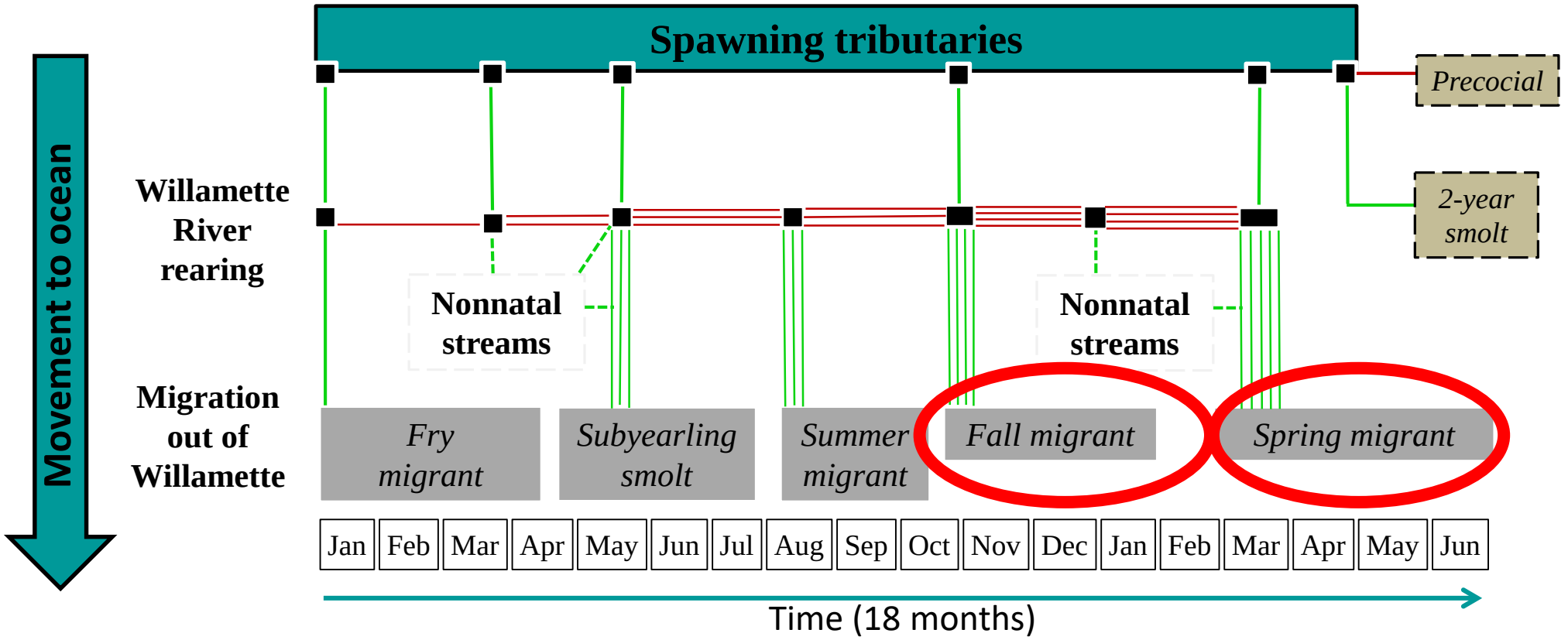
Challenge

Evaluate impacts on wild fish, with no wild fish available?

WILD FISH SURROGATE PROJECT

- Produce juvenile salmonids in artificial environments that emulate specific wild fish phenotypes
  - Spring Chinook salmon
  - Winter steelhead trout

VARIATION IN JUVENILE MIGRATION AND REARING



■ **Threshold or decision points**

Migration downstream

Rearing

Schroeder et al. 2015

Wild Fish Surrogate Project

Goal:

Rear and deliver wild fish surrogates to researchers

Objectives:

1. Establish fish needs and targets with researchers
2. Develop rearing protocols that produce more wild-like fish
3. Evaluate the quality and phenotypic accuracy of our surrogates
4. Describe phenotypes of naturally-reared fish to establish target phenotypes
5. Describe phenotypes of hatchery-reared fish to determine the effects of conventional hatchery protocols

Step 1: Coordinate with researchers

- Planning 1-2 years in advance of fish needs
  - Rear from eyed-egg or green egg stages

- Information required from researchers:
  - Brood stock
  - Brood year
  - Time of release
  - Target size at release

Step 1: Coordinate with researchers

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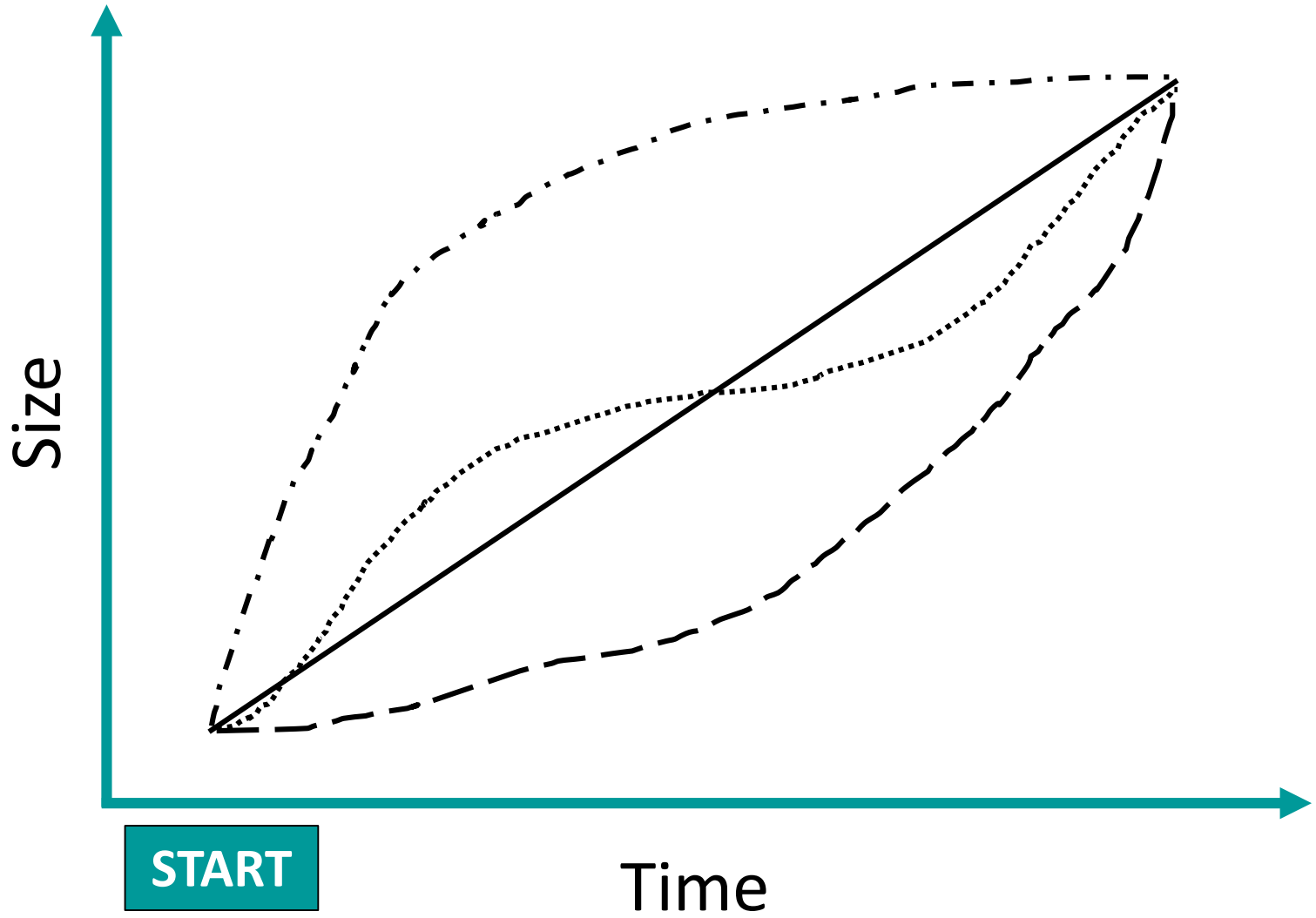
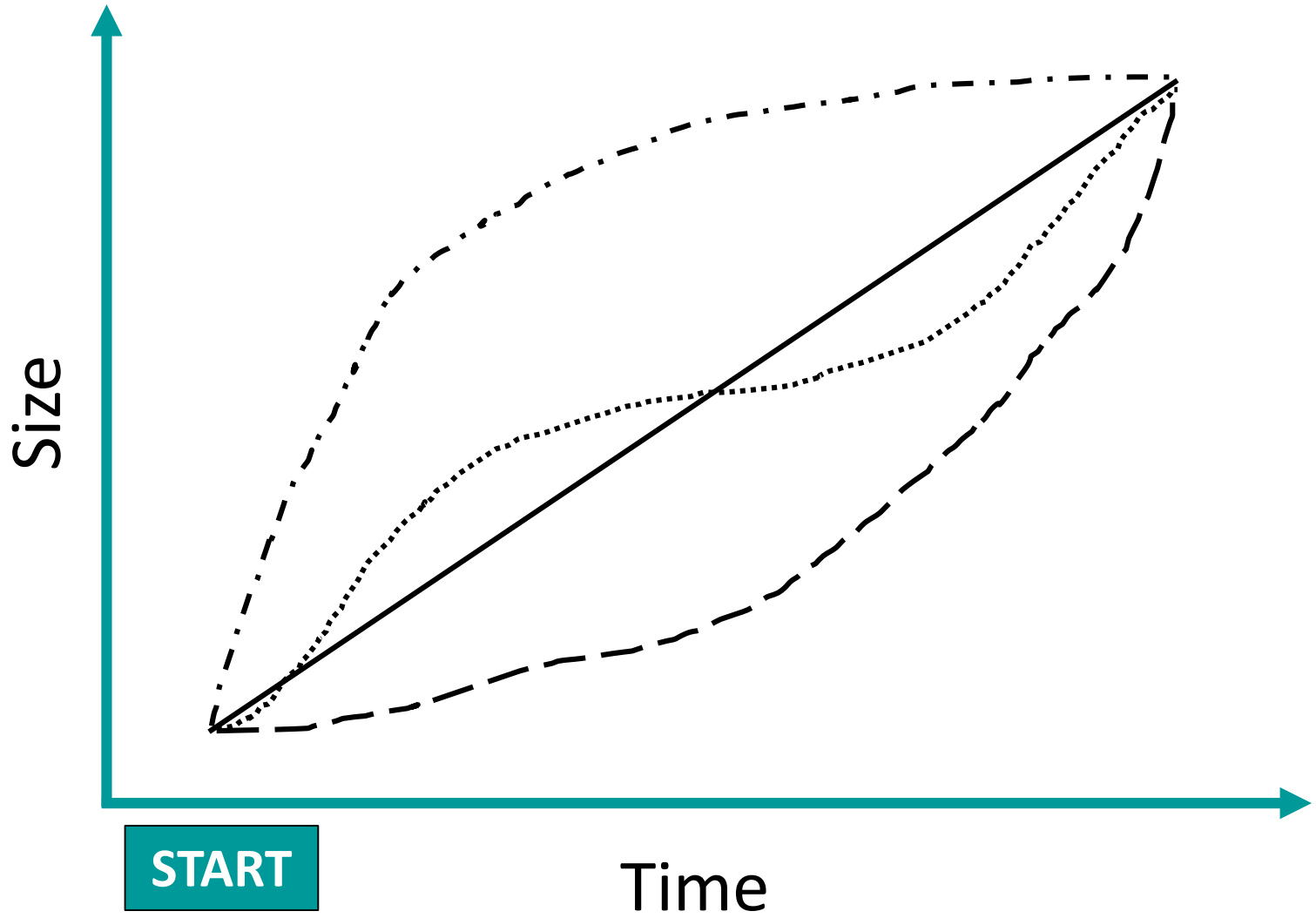
  - Brood stock
  - Brood year
  - **Time of release**
  - **Target size at release**

Target Size and Time



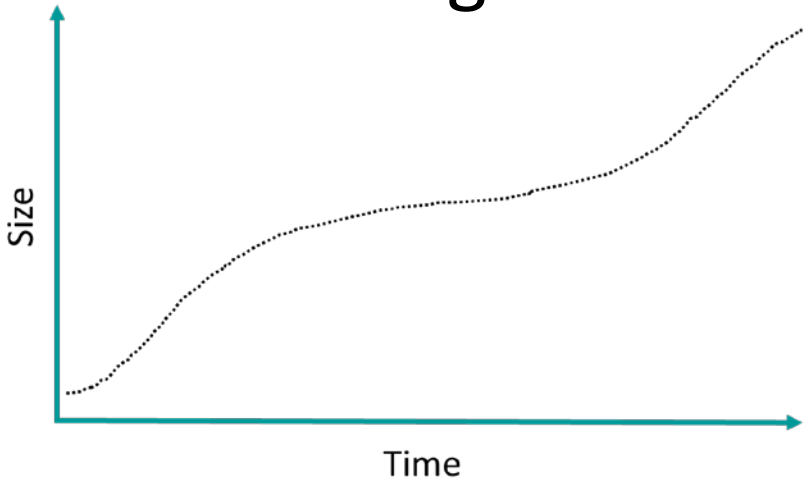
Target Size and Time



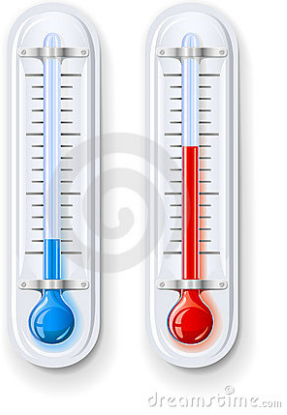
ESTABLISHING TARGET PHENOTYPES

ALTERED REARING ENVIRONMENT

Wild-like growth



Temperature



Diet quality and pattern of delivery

Density

Tank environment

CHINOOK SALMON 2017 DELIVERIES

Location	Brood Year	Target type	# fish	Status
Lookout Point	15	Yearling	600	JSATS and PIT tagged at FPGL Spring 2017
Cougar	15	Yearlings	1,500	JSATS and PIT tagged at FPGL Fall 2017
Lookout Point	16	Sub-yearling	1,625	JSATS and PIT tagged at FPGL Fall 2017
Lookout Point	16	Fry	48,000	Parental based tags for April 2017
Lookout Point	16	Parr	44,000	Parental based tags for May 2017
Lookout Point	16	Parr	4,000	Parental based tags for June 2017

CHINOOK SALMON UPCOMING REQUESTS

Location	Brood Year	Deliverable type	#	Target date	Target size (mm)
Cougar	16	Yearling	1,500	May 2018	150
Foster	16	Yearling	1,500	March-April 2018	210
Lookout Point	16	Yearling	1,625	March-April 2018	200
Cougar	17	Yearling	2,000	May 2019	150
Foster	17	Sub-yearling	1,500	Fall 2018	200
Foster	17	Yearling	1,500	Spring 2019	200
Green Peter	17	Yearling	2,000	May 2019	150
Lookout Point	17	Sub-yearling	2,000	Fall 2018	190
Lookout Point	17	Yearling	2,000	Spring 2019	200
Lookout Point	17	Fry	135,000	April 2018	45
Lookout Point	17	Parr	65,000	June 2018	97

WINTER STEELHEAD 2017 DELIVERIES

Location	Brood Year	Target type	# fish	Status
Green Peter	16	Yearling	200	Bypass study May 2017
Detroit	16	Sub-yearling	27,000	Released by ODFW January 2017

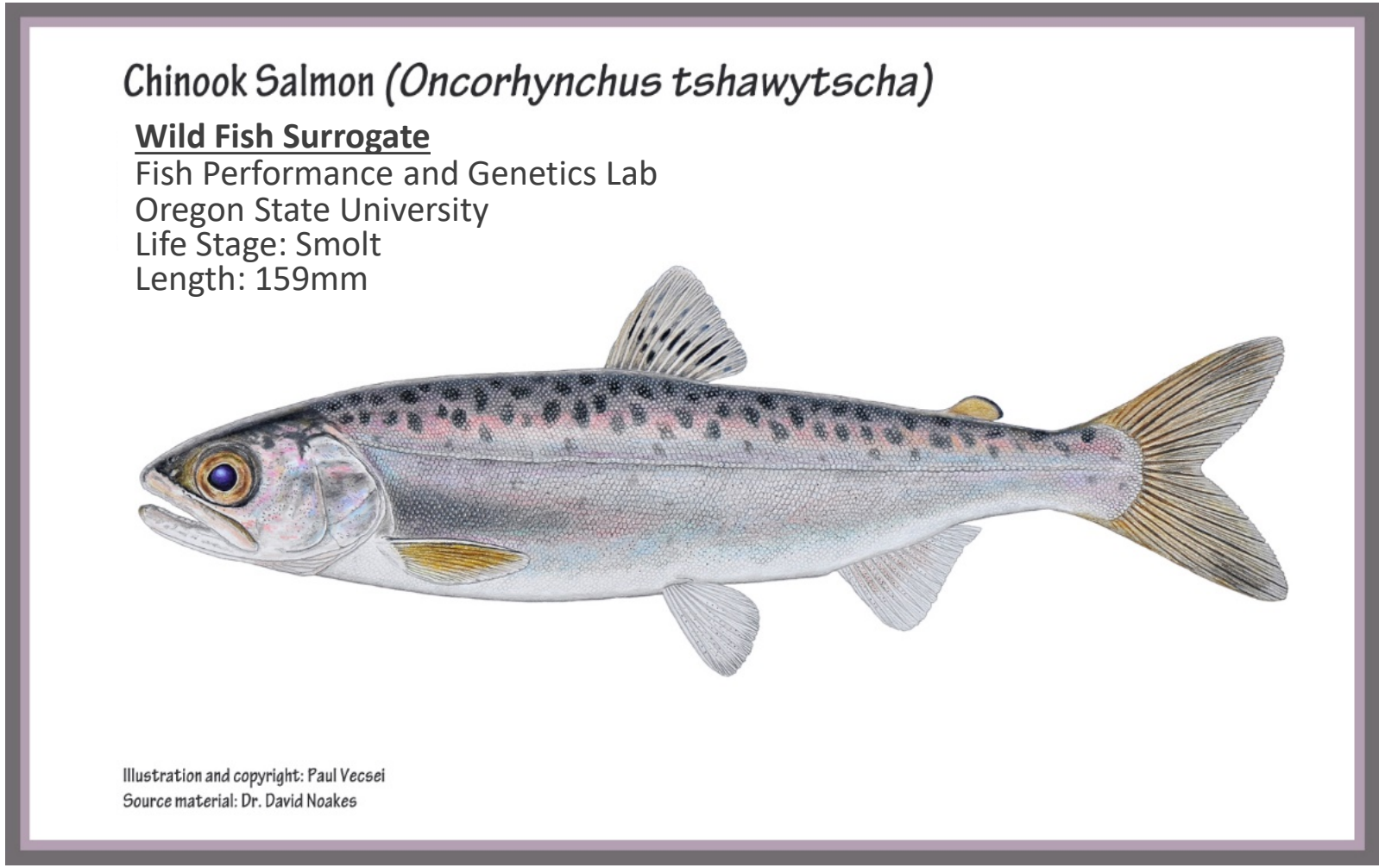
WINTER STEELHEAD UPCOMING REQUESTS

Location	Brood Year	Deliverable type	#	Target date	Target size (mm)
Foster	16	2-yr smolt	1,200	Spring 2018	160
Foster*	17	Yearling	800	Spring 2018	180

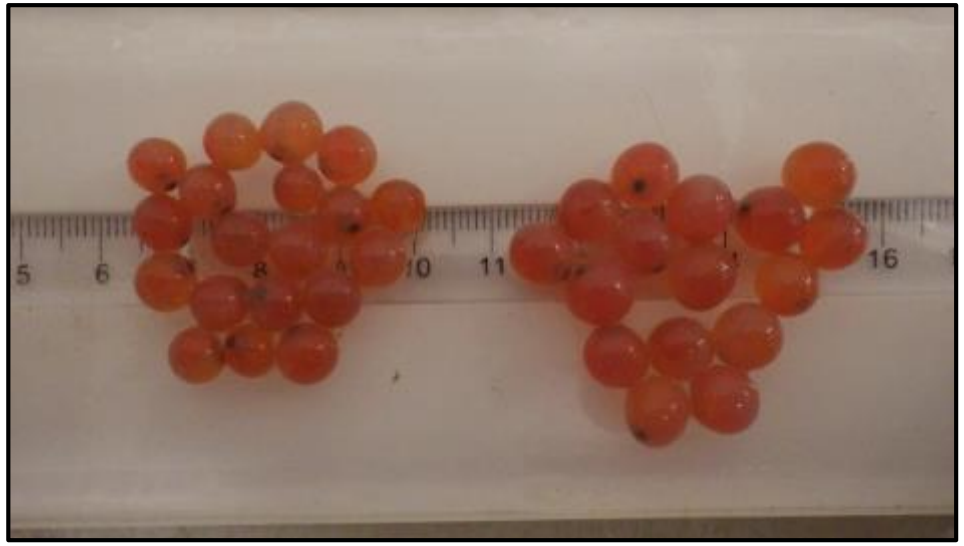
* South Santiam summer steelhead hatchery fish for comparison with winter steelhead

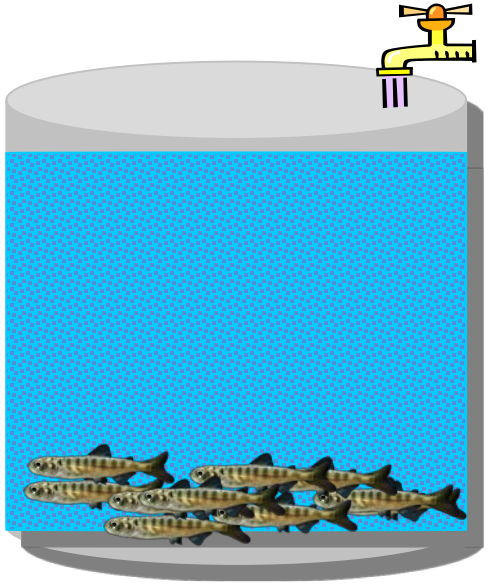
Our surrogates are more like wild fish migrants

- Body shape
- Osmoregulation
- Physiology
- Behaviour
- Genetics
- Fin quality
- Body composition
- Lack of early maturing males
- Migration



NATURAL LIFE HISTORY VARIATION

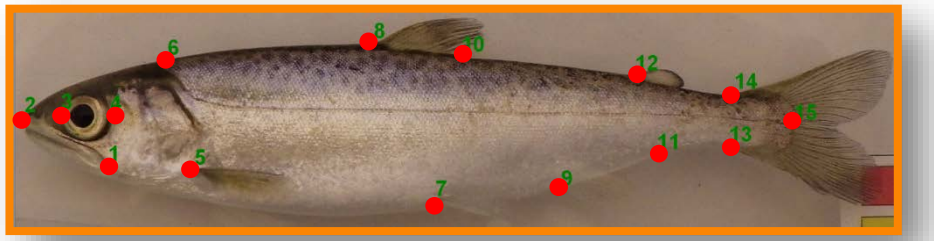


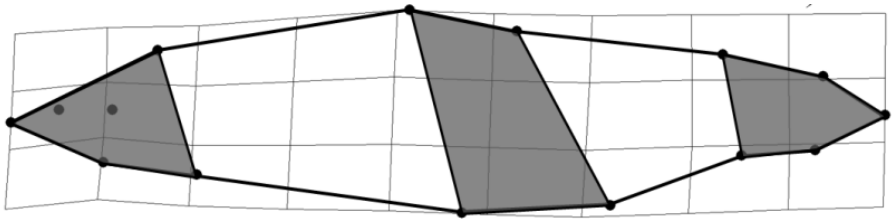


Phenotypic differences expressed early in life lead to different phenotypes expressed later

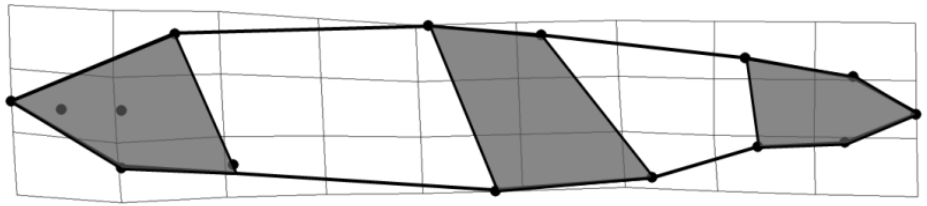
SURFACE FISH MORE SIMILAR TO FALL MIGRANTS

Landmark-based geometric morphometrics

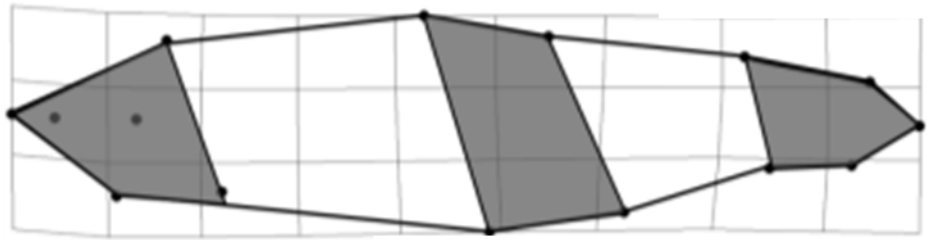




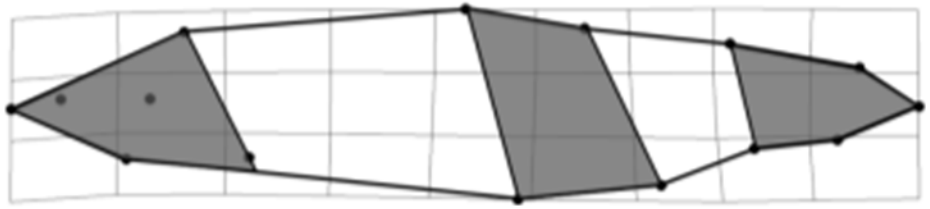
Fall migrant



Spring migrant



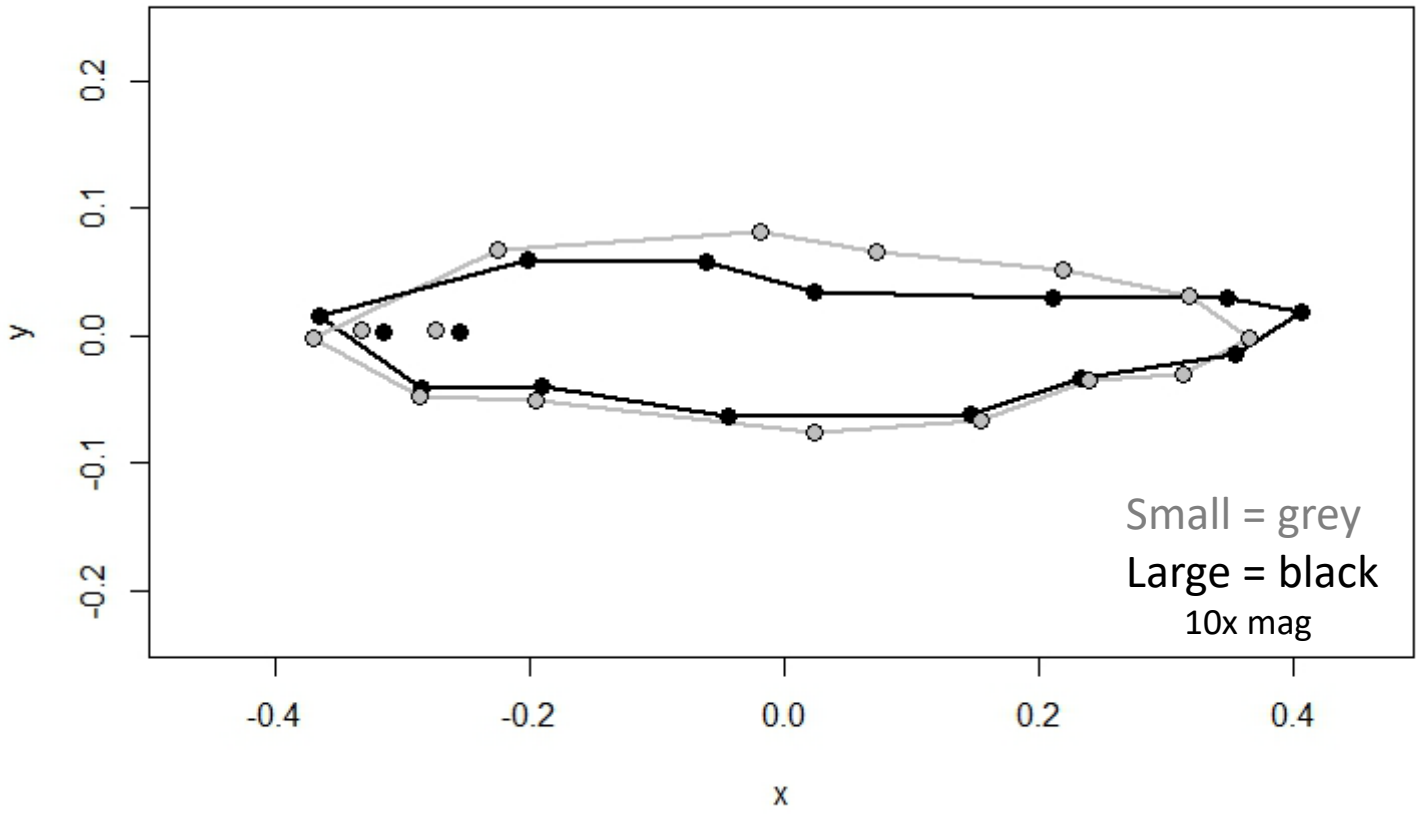
Surface

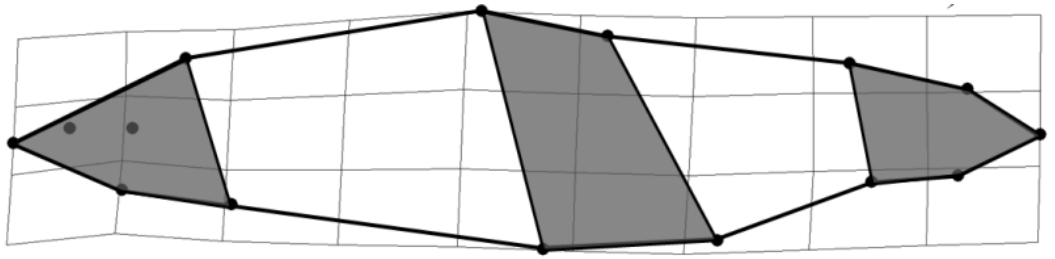


Bottom

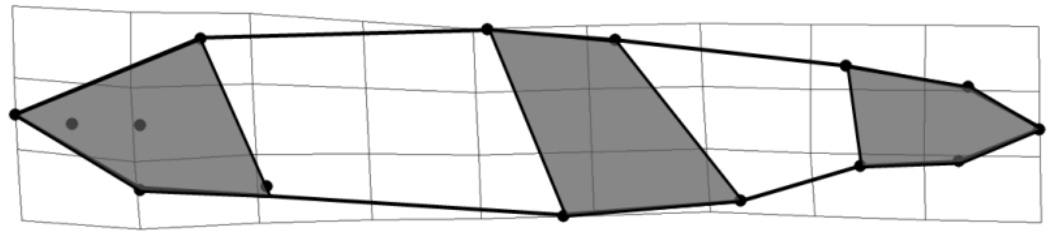
Unrein et al. 2018 *Environ. Biol. Fish.*

FISH FROM SMALL EGGS MORE SIMILAR TO FALL MIGRANTS





Fall migrant



Spring migrant

Cogliati et al. 2018, *Ecol and Evol*

HIGH QUALITY SURROGATES

Altered rearing environment

+

Natural life history differences

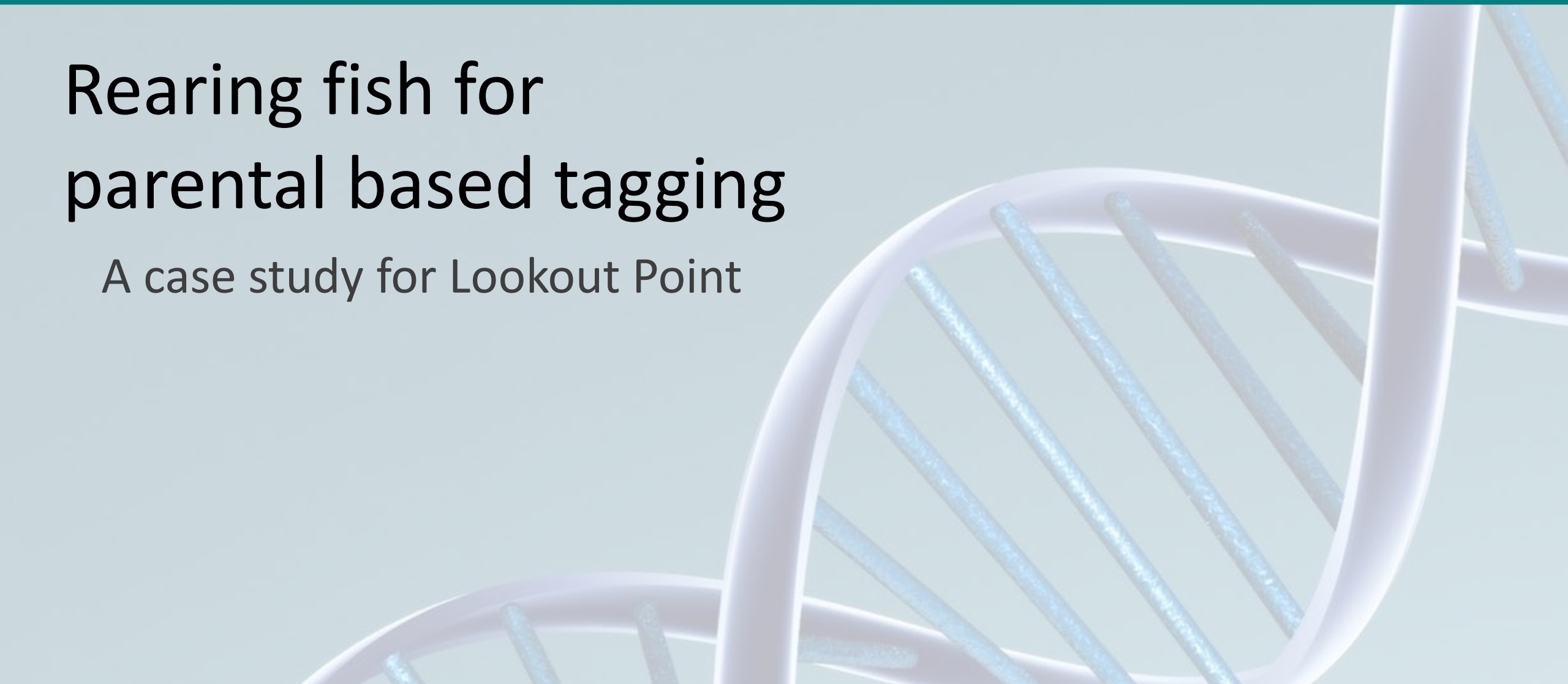
=

More wild-like fish?

Photo by Todd Pierce

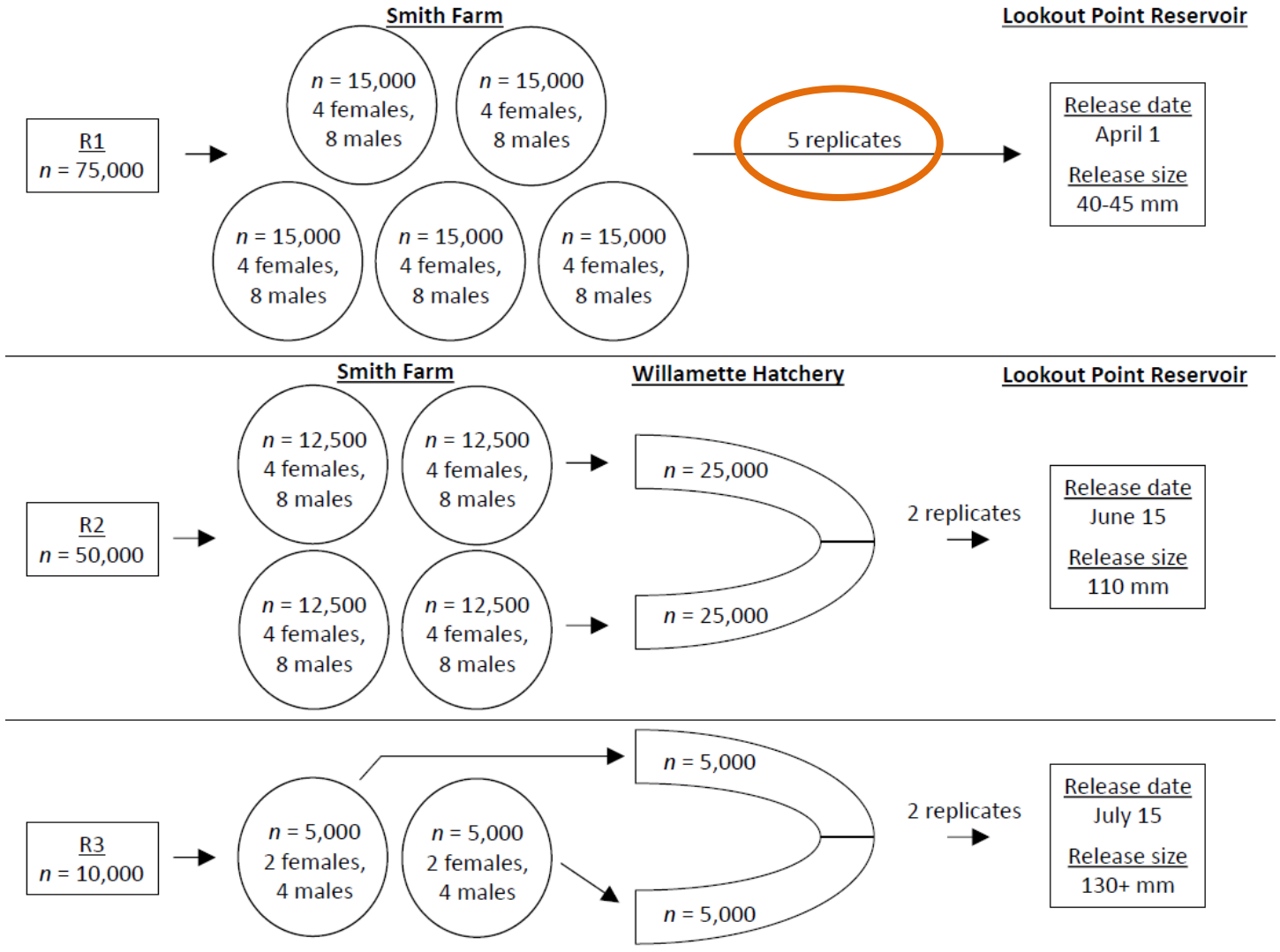
Rearing fish for parental based tagging

A case study for Lookout Point



How many fish can we raise?

3 release groups



How many fish can we raise?

USGS fish request for BY2016

	R1	R2	R3
How many?	75,000 fish	50,000 fish	10,000 fish
What size?	45 mm	97 mm	120 mm
By when?	April 15	June 15	July 15

1.

2.

Hold them back

Speed them up

Coordinate with Willamette Hatchery

- Number of adults
- Spawning
- Final rearing of fish in replicated design

SPAWNING

- Collected gametes at Willamette Hatchery on:
  - September 6 for fast growing fish
  - September 26 for slow growing fish
    - Additional fish were not available at late spawn
- Spawned 22 females with 44 males on each time
- Transported to OSU's FPGL

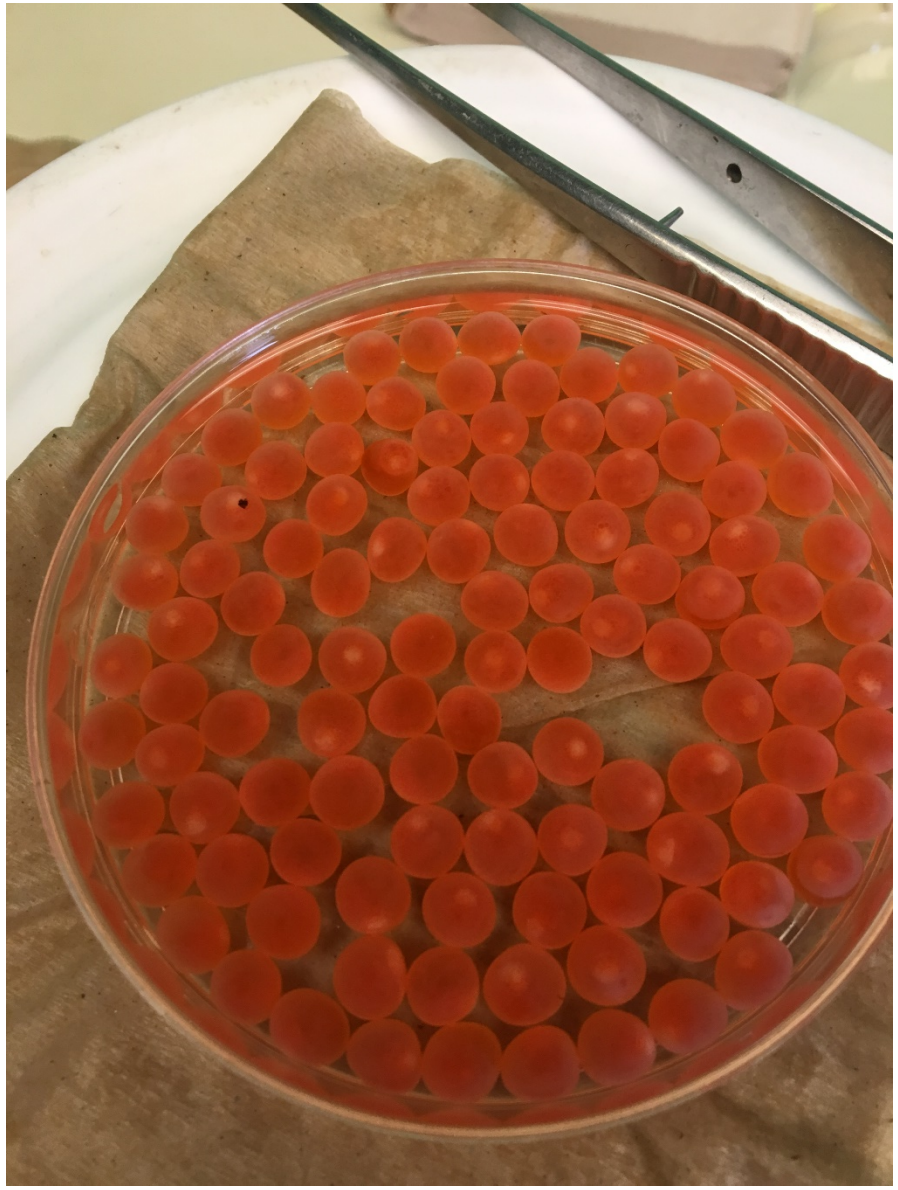
EARLY REARING

- 1 tray/female
- Early spawn on ambient water
- Late spawn on chilled water

FERTILITY, EGG PICKING, AND INVENTORY BY FEMALE

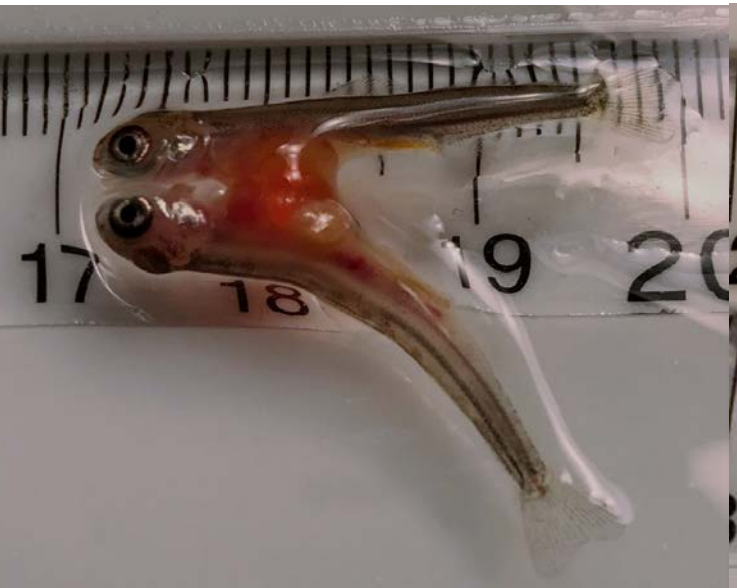
Challenges

- Fecundity lower than expected (counting everything)
  - ~3,500
- Fertility lower than expected
  - ~ 82%



CHALLENGES

- Deformities
  - Family effect



Mixing specific families to equalize numbers

- Specific families mixed into replicate tanks when fish ready to feed
  - No mixing families across tanks
  - Keep inventory of each family, then each replicate

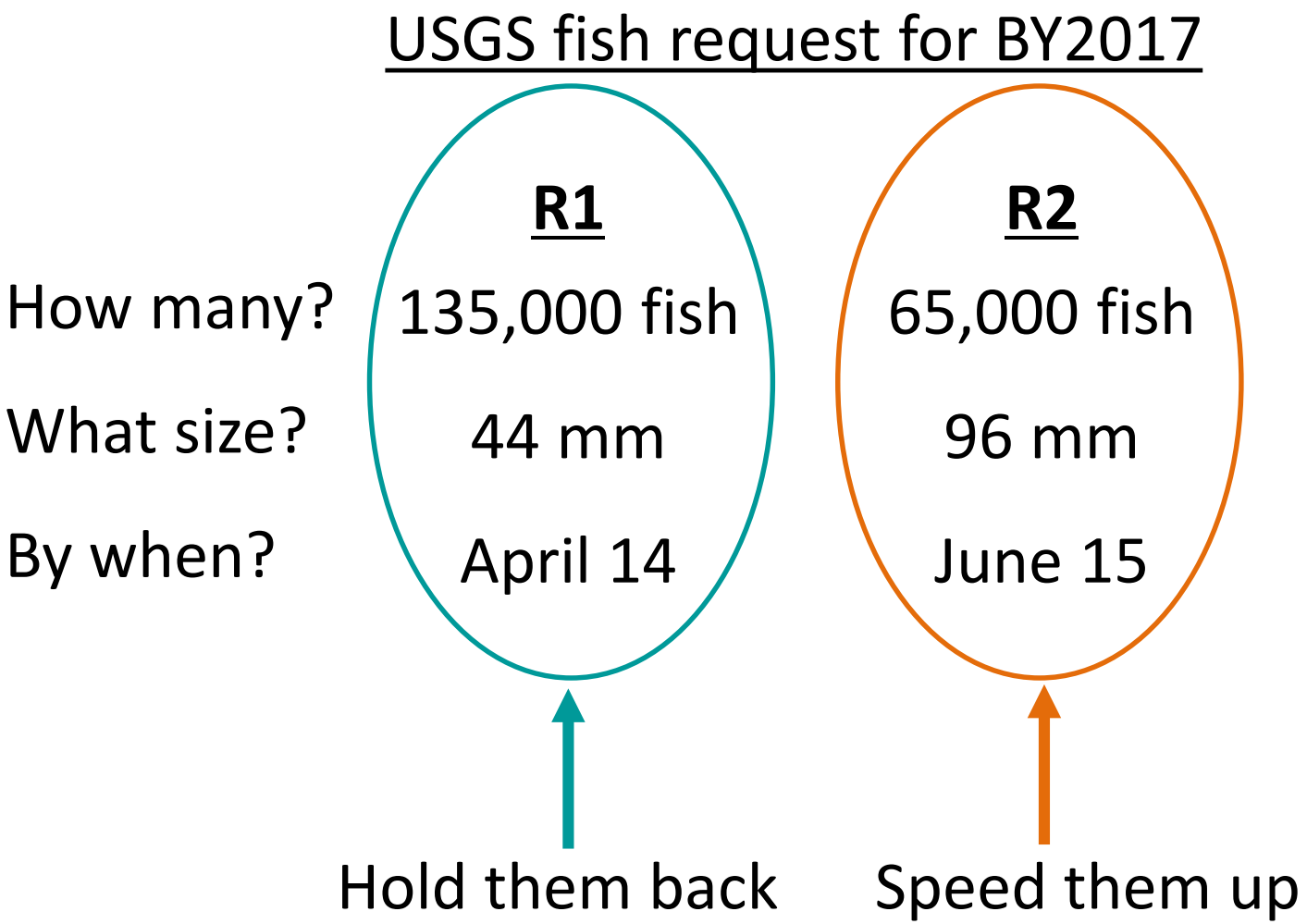
FAST GROWING FISH – FINAL REARING

- Moved 48,000 to Willamette Hatchery
  - 2 replicates combined into each half of raceway
- Challenge:
  - Adjusting to diet in new environment

Slow growing fish – FPGL to reservoir

- Another 48,000 provided
- USGS transported 2 replicates/day over 2 days
- Altogether provided ~96,000 fish

COULD WE RAISE EVEN MORE FISH?



A FEW CHANGES…

- Requested more females (larger buffer)
- Held females at FPGL through summer

- Spawned at FPGL

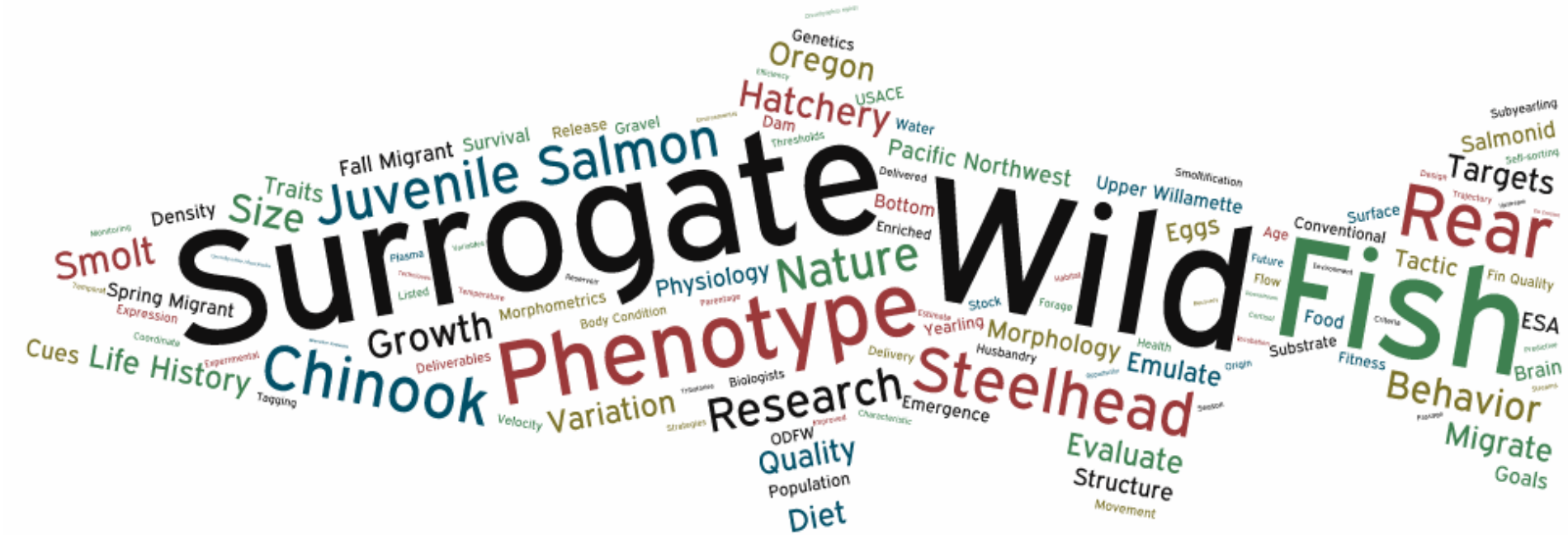
- Fertility ~90%
- Still see deformities

TAKE HOME MESSAGES

1. Continuing to produce high quality deliverables

2. Provided fish for parental based tagging studies
   - Kept track of families and numbers

THANK YOU



QUESTIONS?