



Imprinting of Hatchery-reared Salmon to Targeted Spawning Locations: A New Early Imprinting Paradigm for Supplementation Programs?

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Millions of hatchery salmon are transported and released annually into Northwest Rivers



Smolt acclimation is the primary tool for imprinting salmon to release locations.



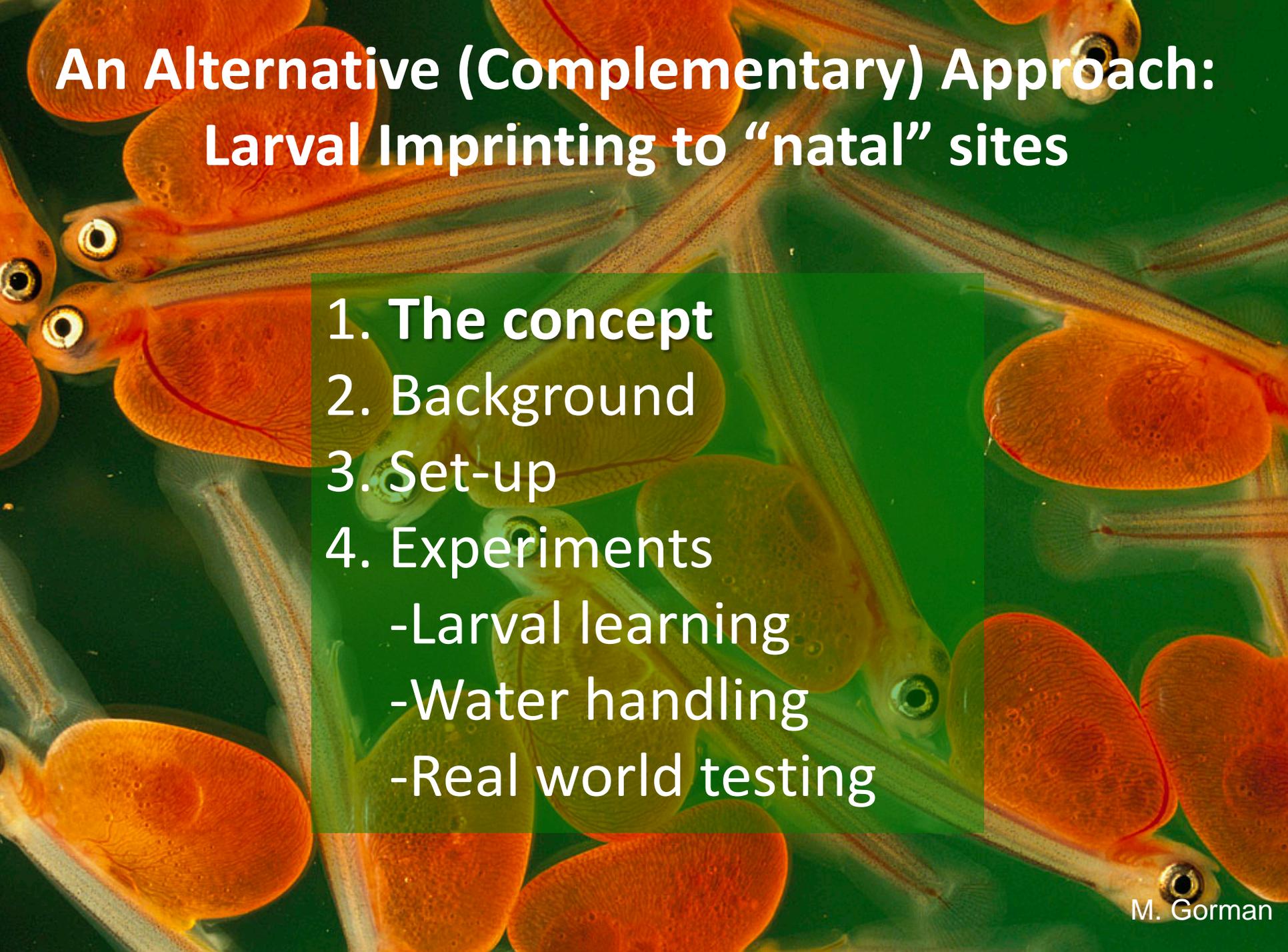
Smolt acclimation is the primary tool for imprinting salmon to release locations.



Issues:

- Cost
- Permitting
- Logistics
- Multiple locations
- Inappropriate locations

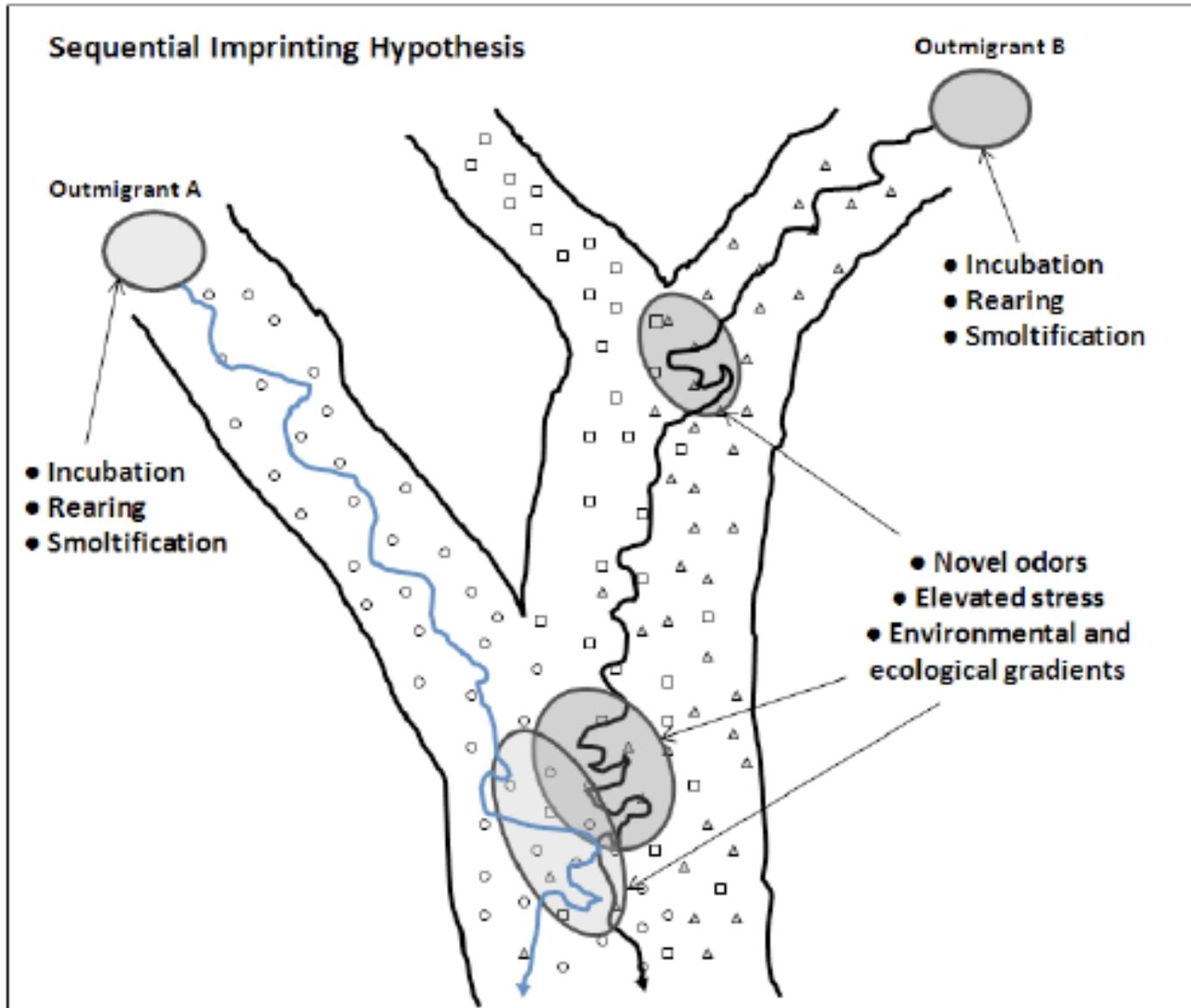




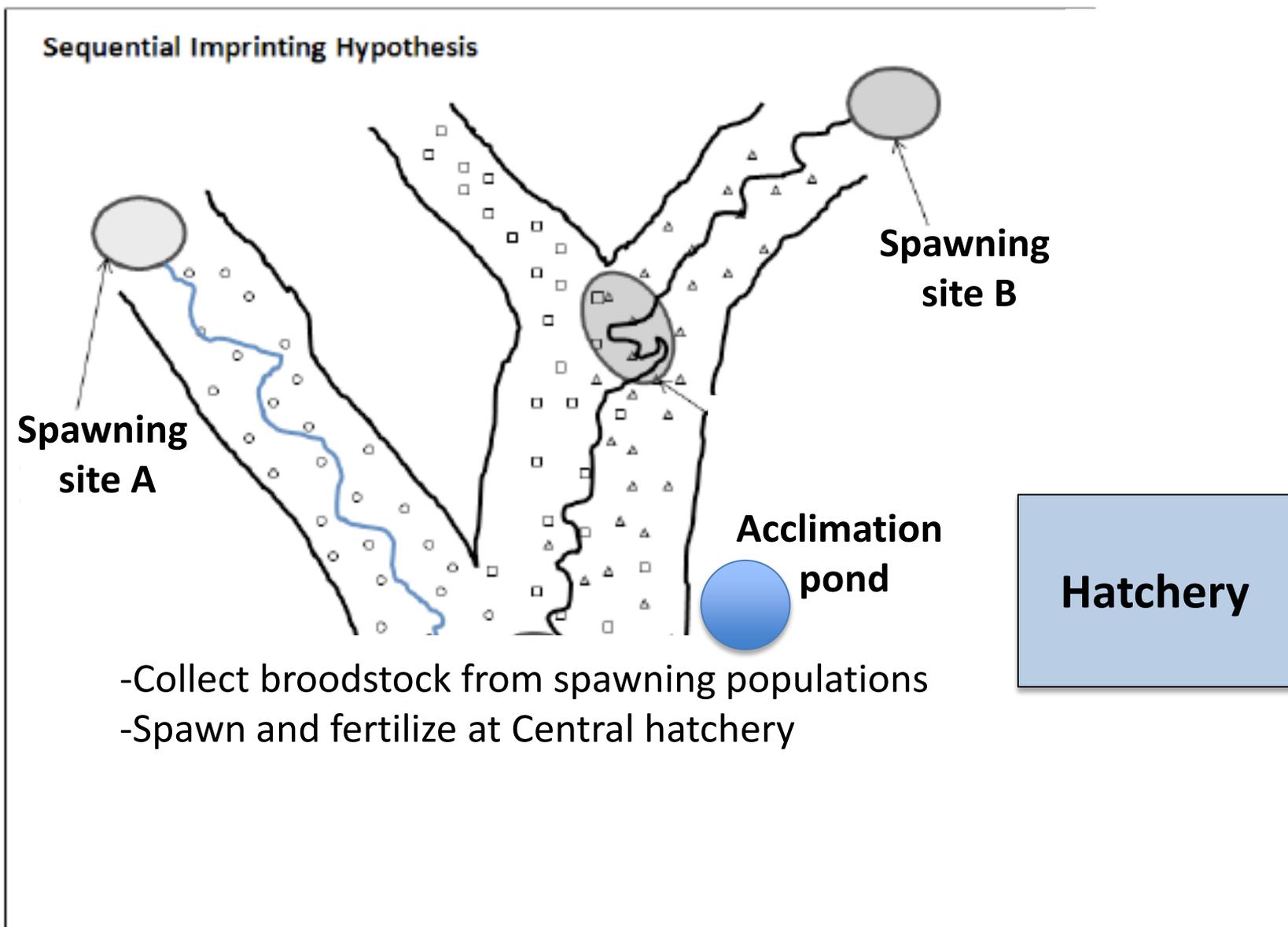
An Alternative (Complementary) Approach: Larval Imprinting to “natal” sites

1. The concept
2. Background
3. Set-up
4. Experiments
 - Larval learning
 - Water handling
 - Real world testing

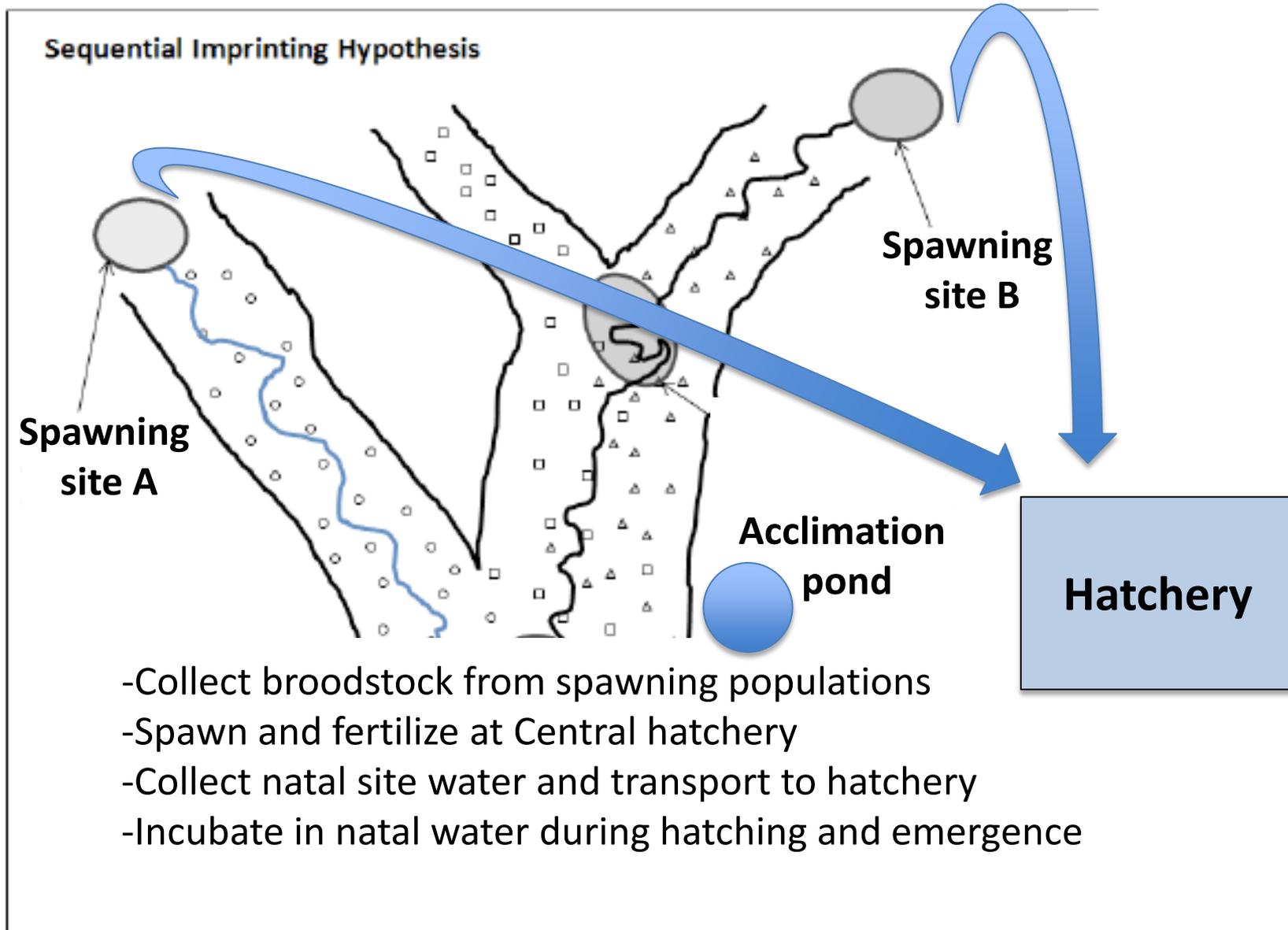
Sequential Imprinting hypothesis



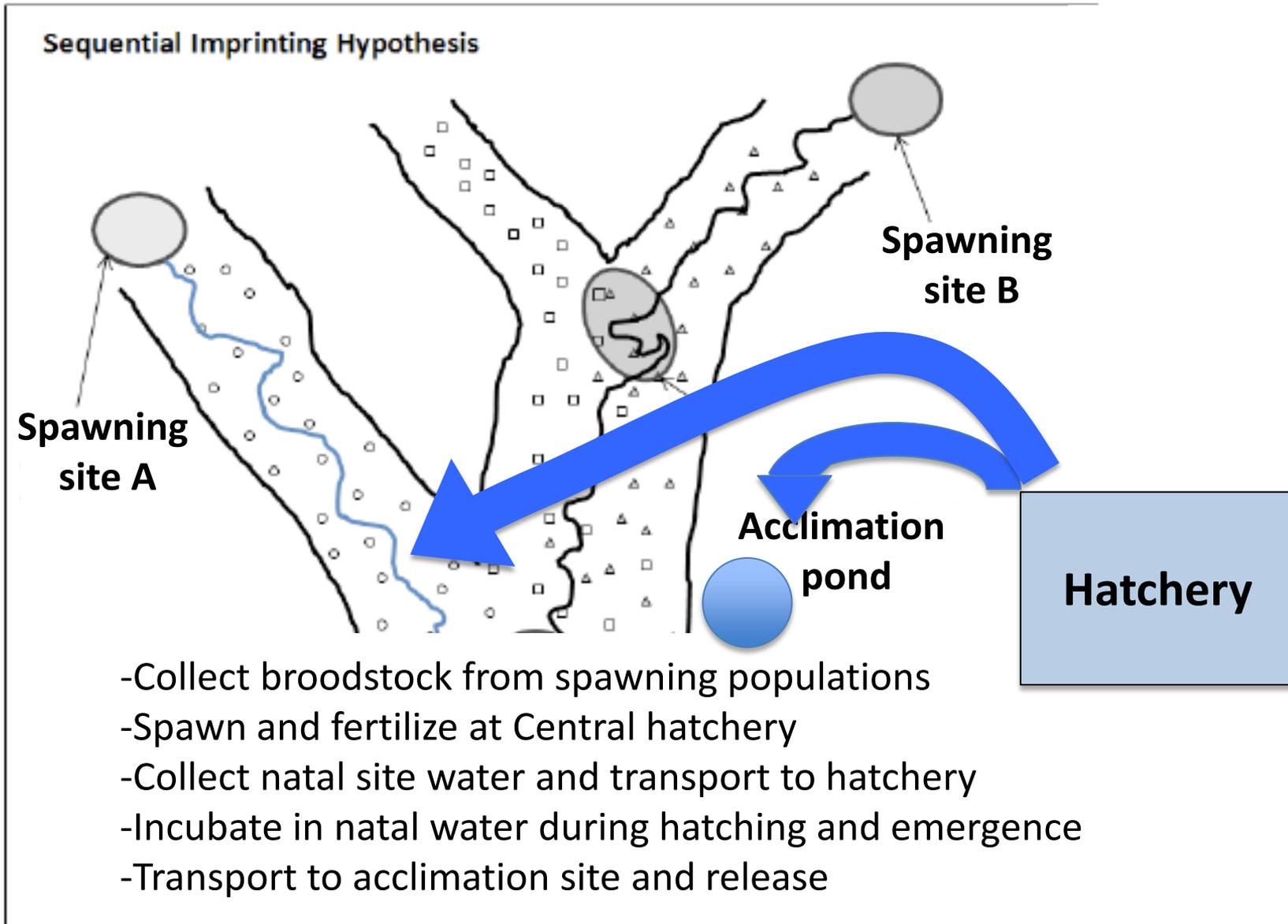
Larval Imprinting Scenario



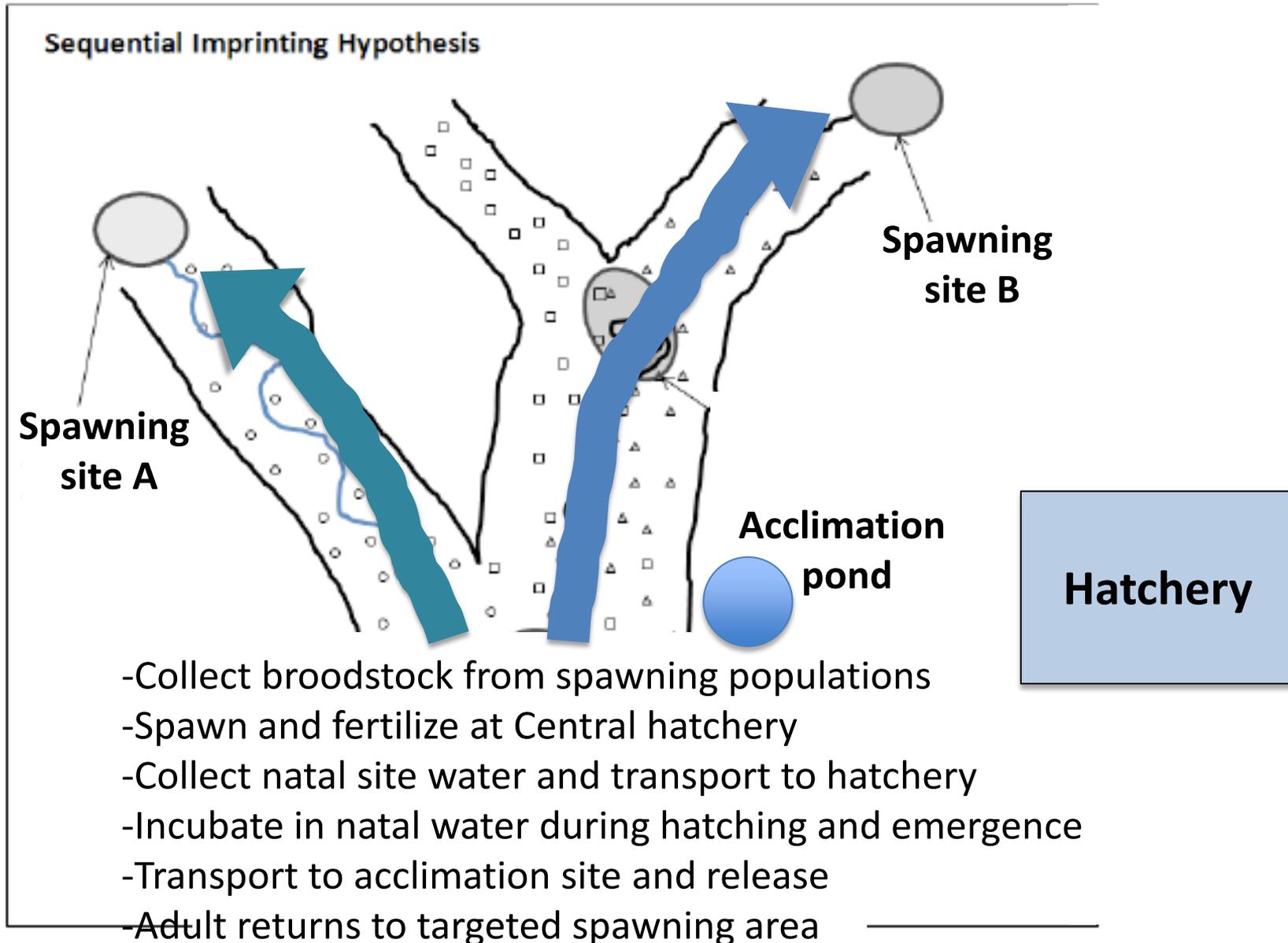
Larval Imprinting Scenario

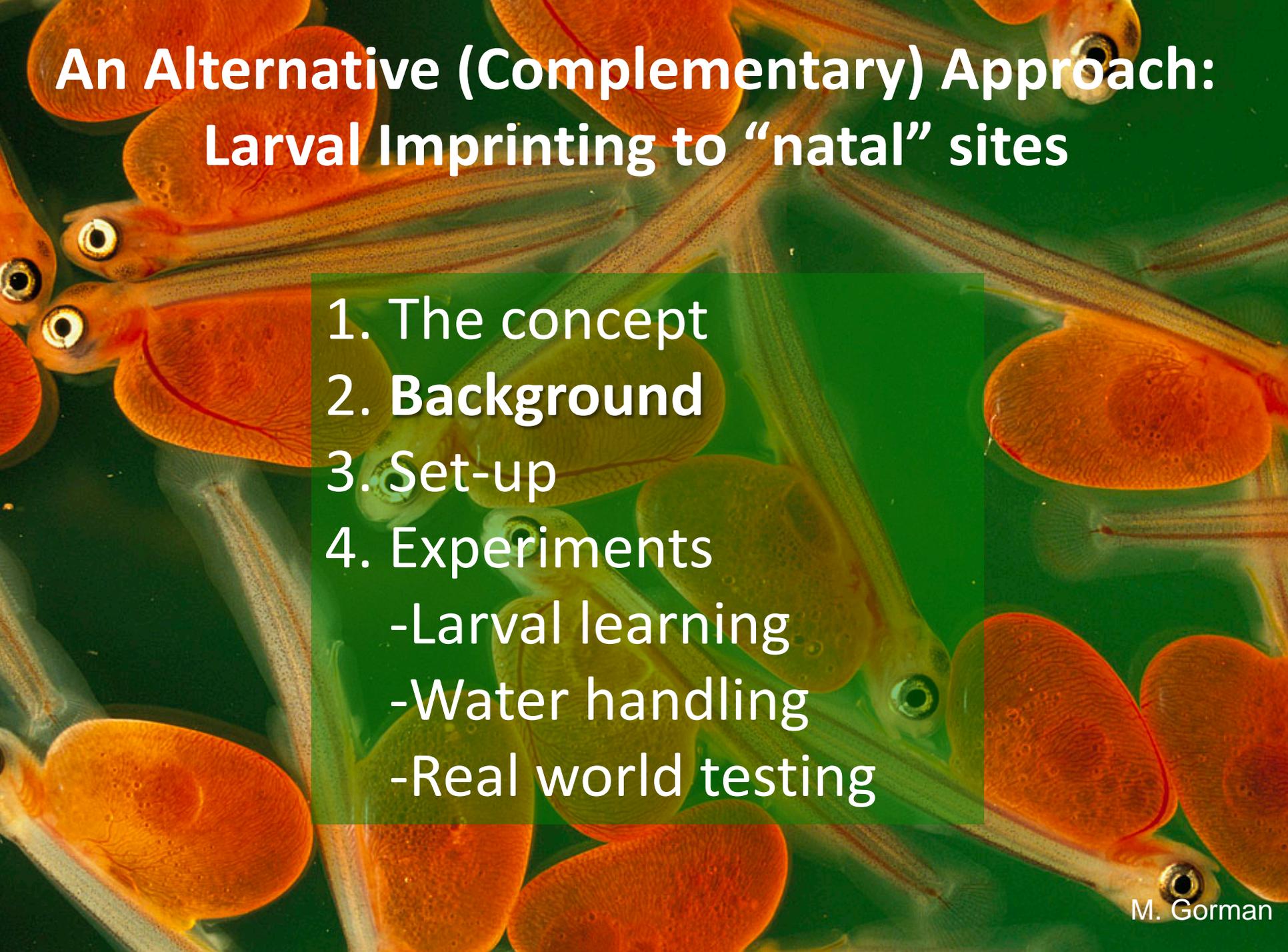


Larval Imprinting Scenario



Larval Imprinting Scenario





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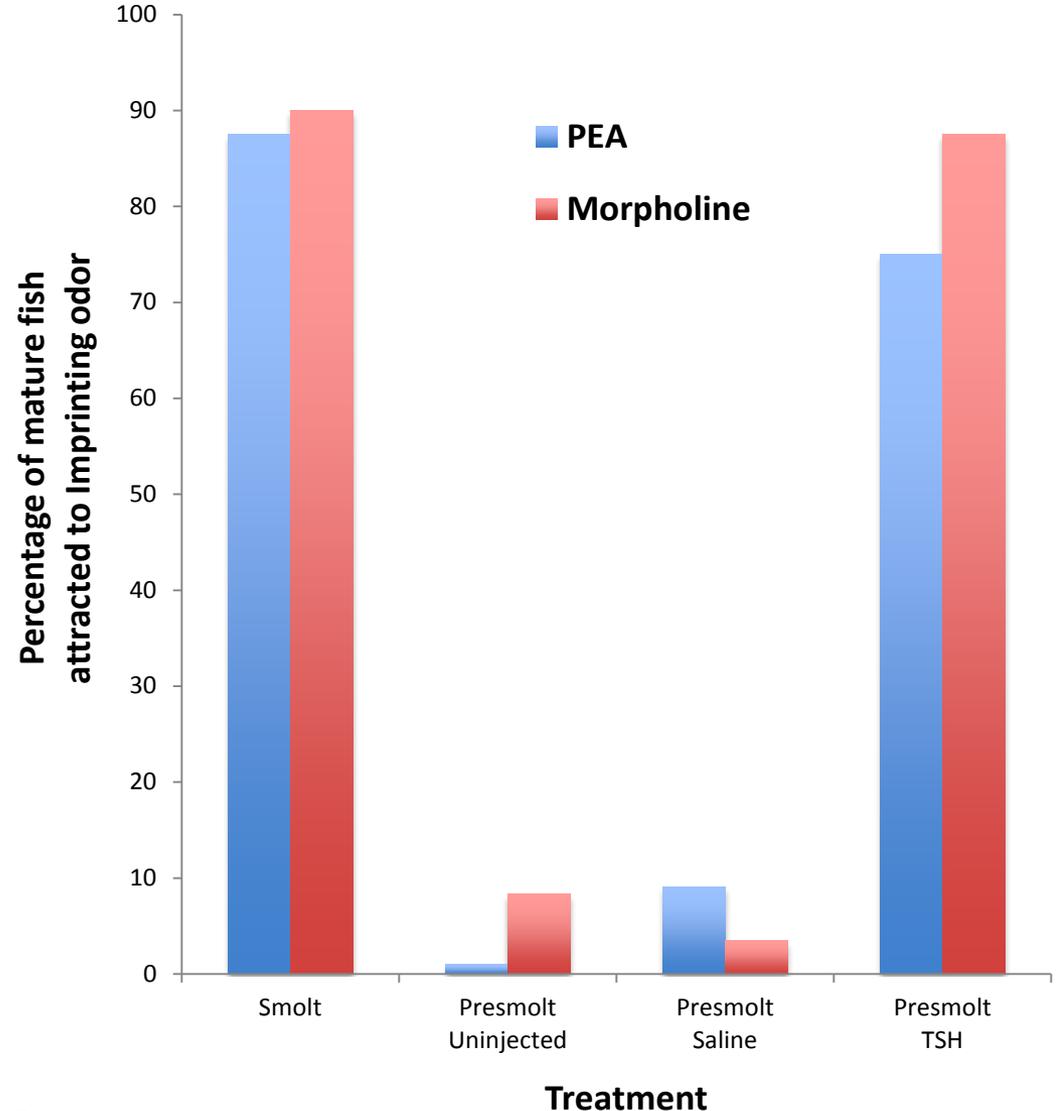
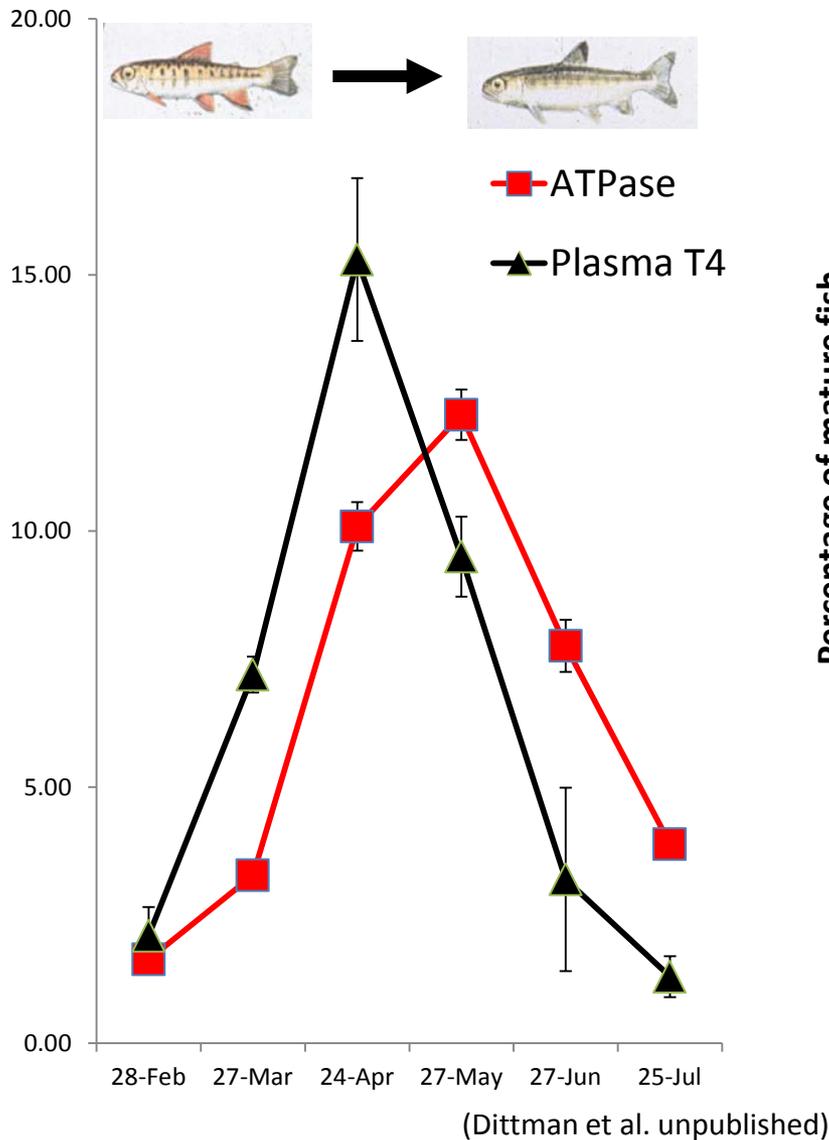
Experimental evidence for imprinting hypothesis



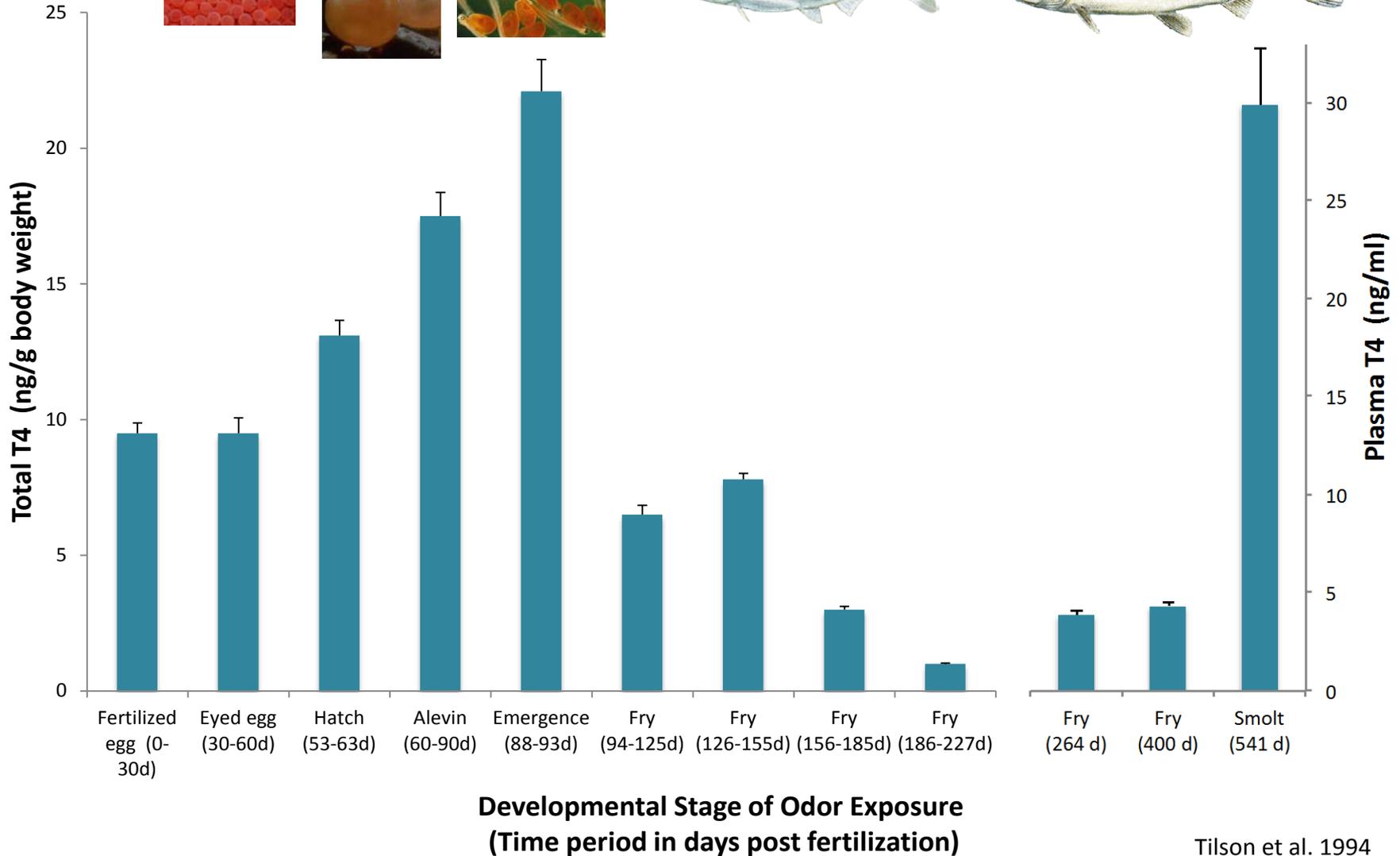
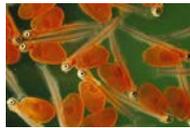
Salmon recovered during homing

<u>Location</u>	Morpholine	PEA	Control
Twin Rivers (PEA)	8	333	55
L. Manitowac (Morpholine)	659	20	76
Other Rivers	14	9	154

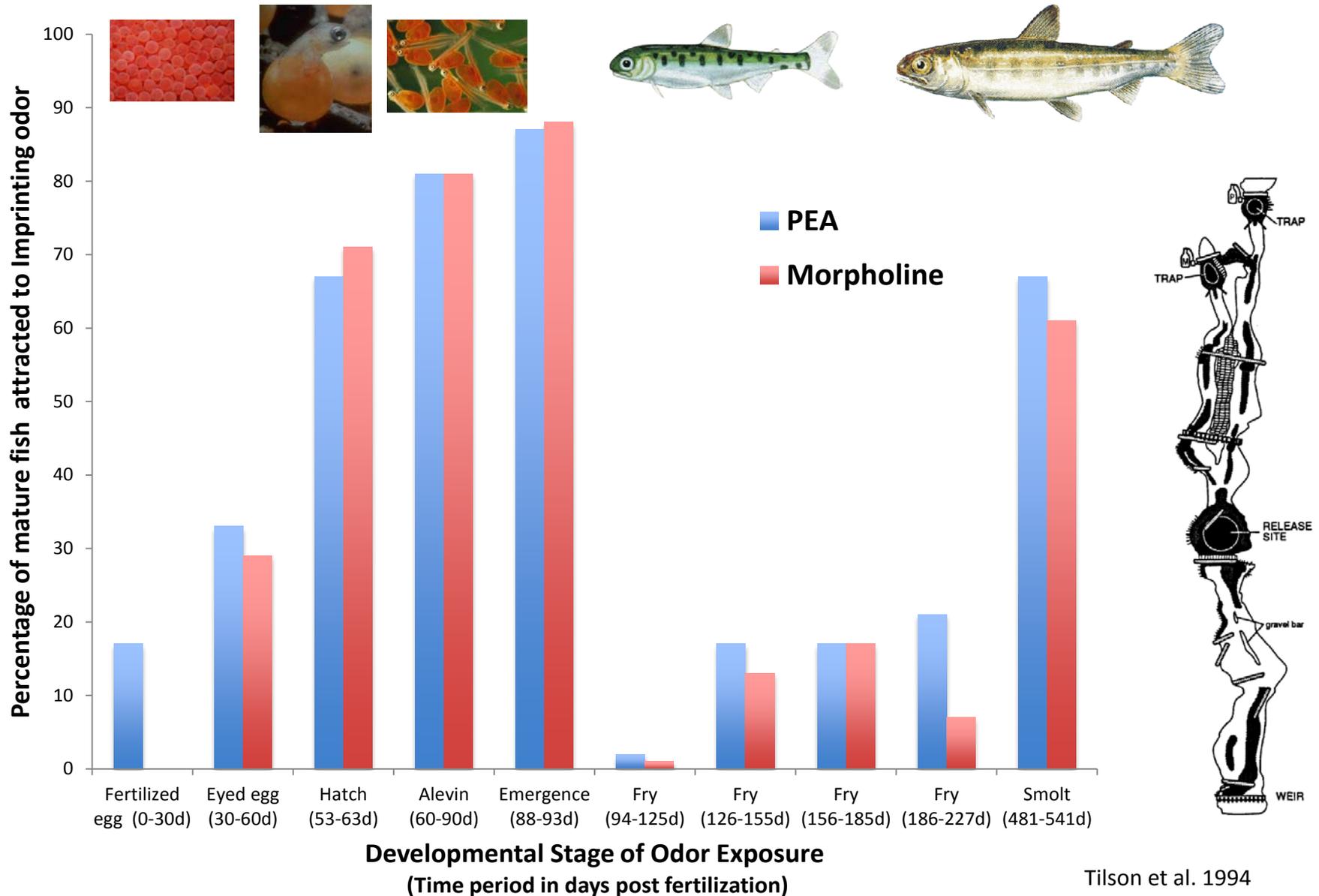
Imprinting is associated with thyroid hormone surges that occur during smolting



Salmon experience T4 surge as smolts and as embryos

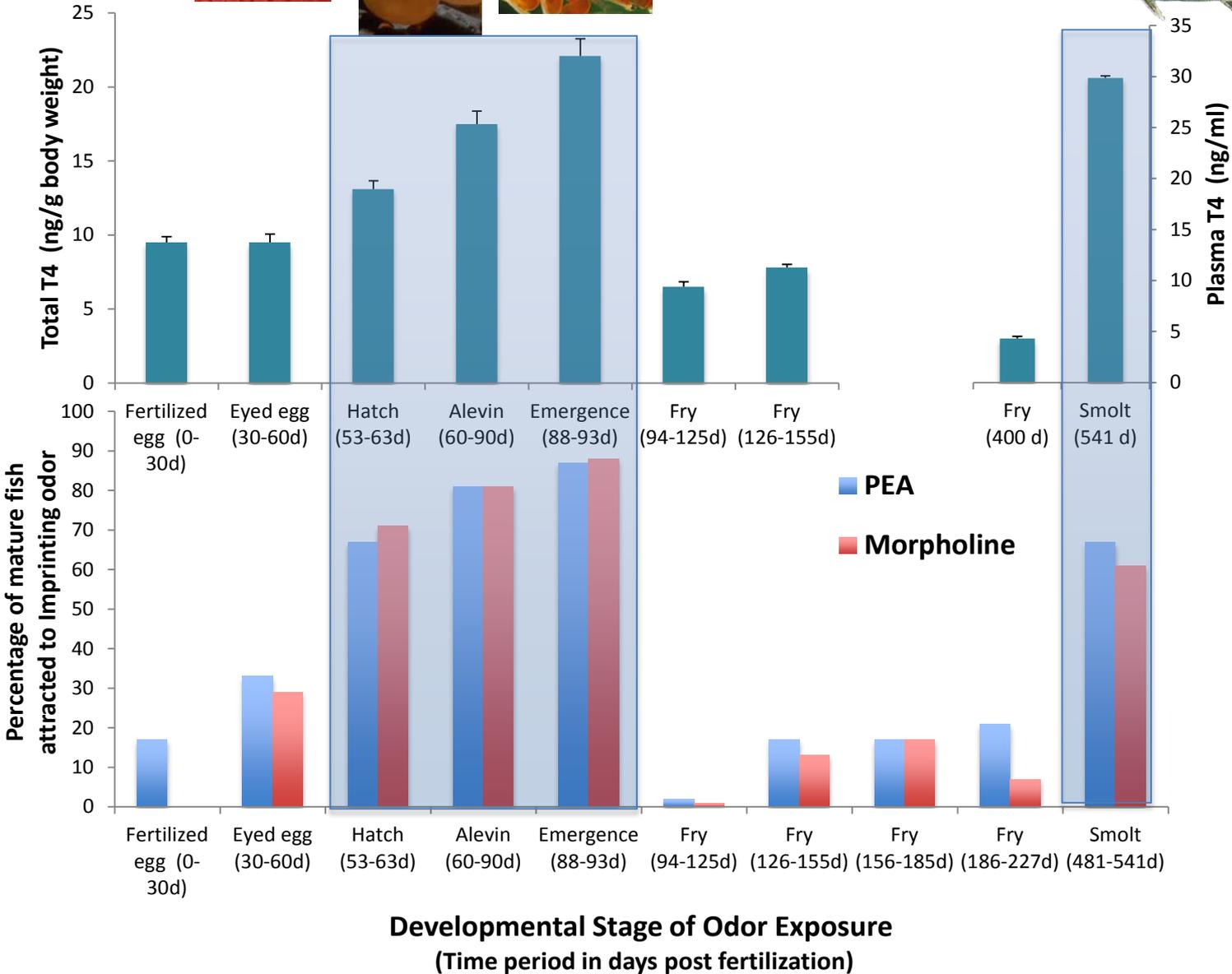


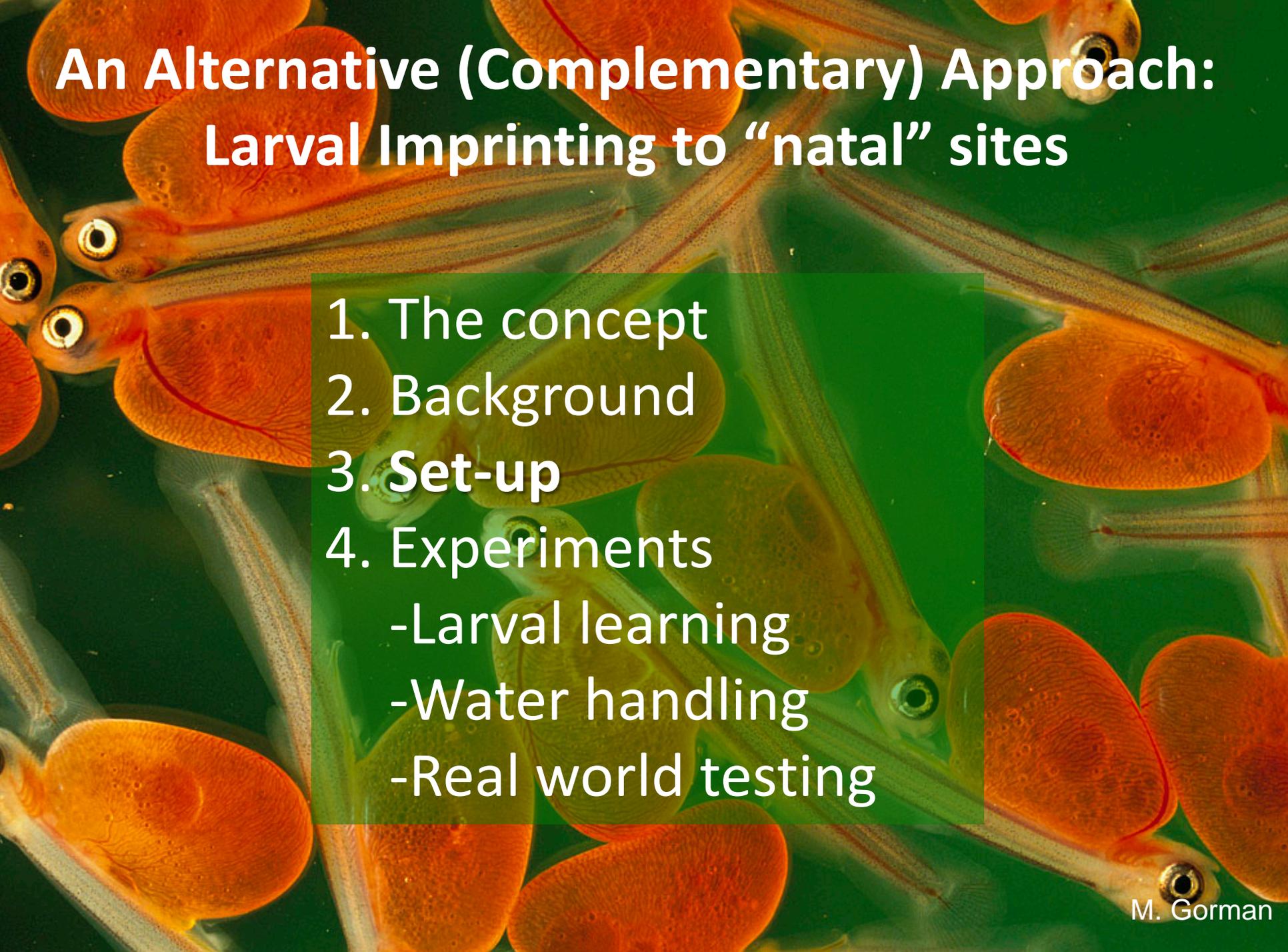
Salmon imprint to natal site as smolts and as embryos



Tilson et al. 1994

T4 surges are associated with imprinting



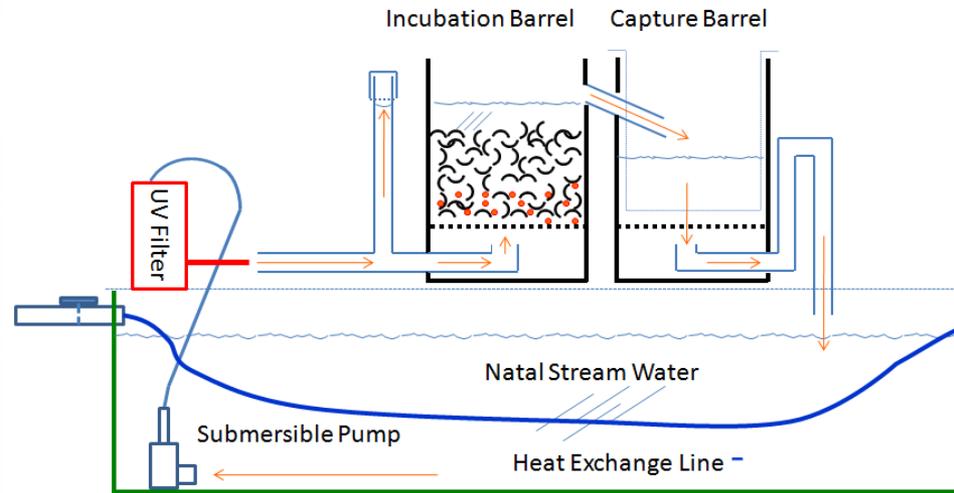


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Lake Sammamish Kokanee



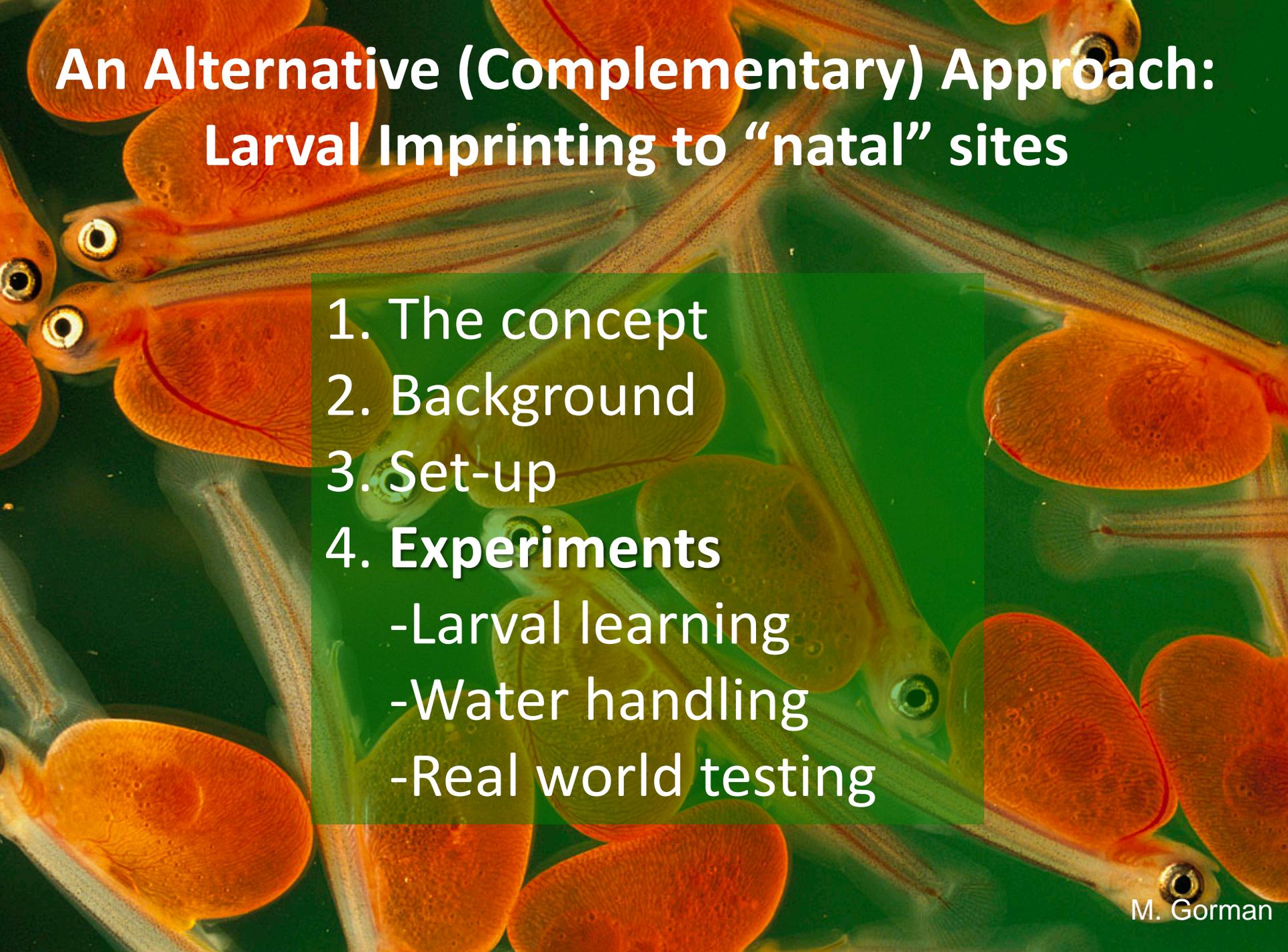


Re-circulating Incubation System Concept and Design by S. Schroder, E. Sanborn & E. Jouper. WDFW

Recirculating incubation system for natal imprinting



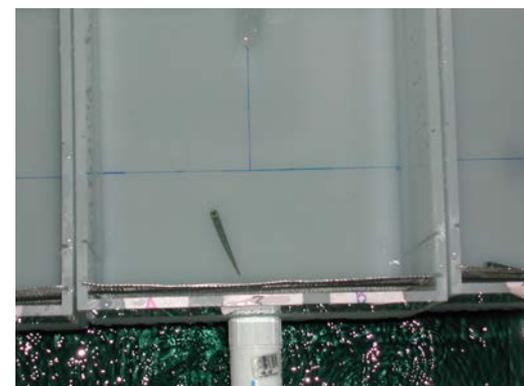
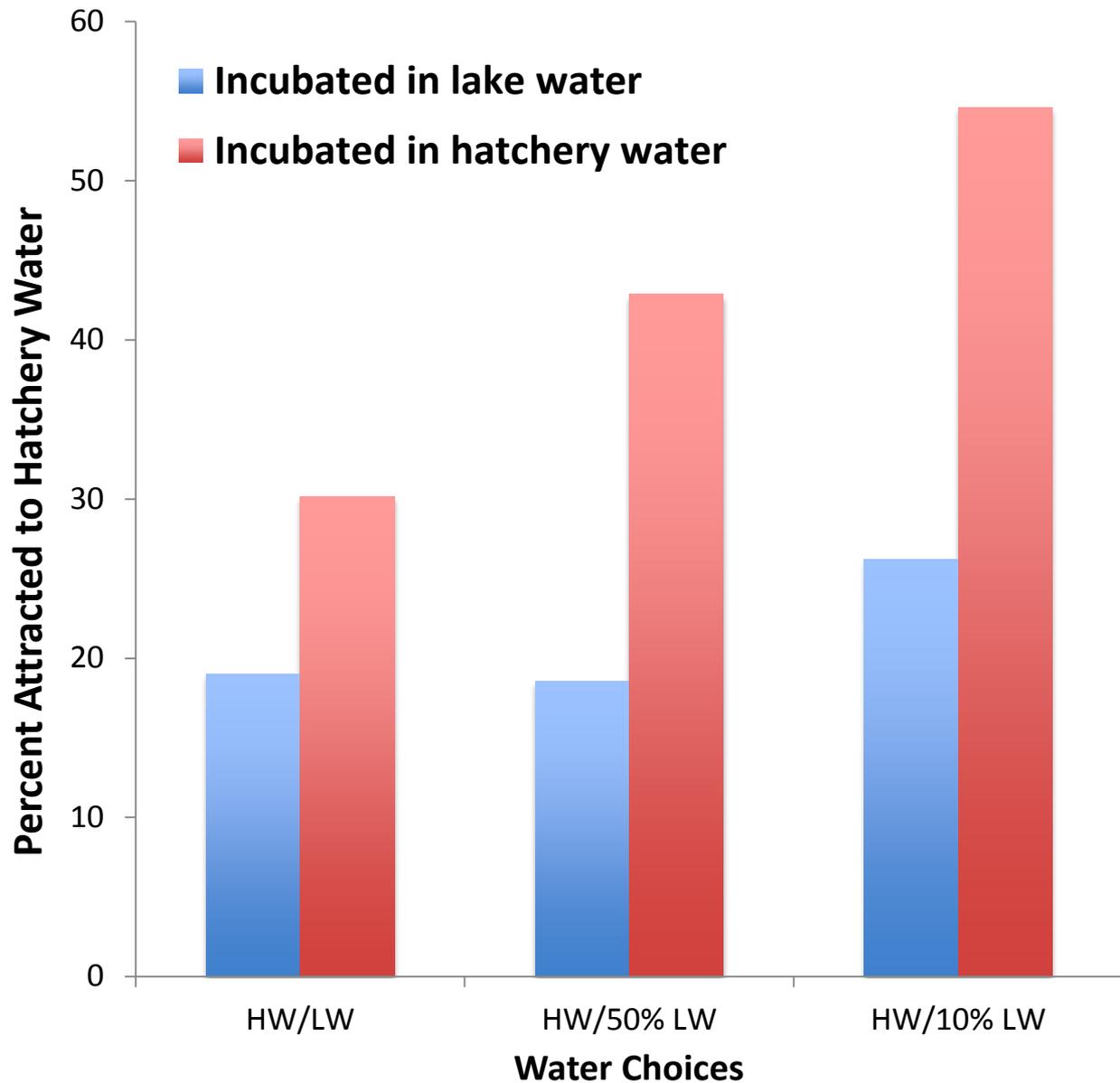
S. Schroder, E. Sanborn & E. Jouper. WDFW



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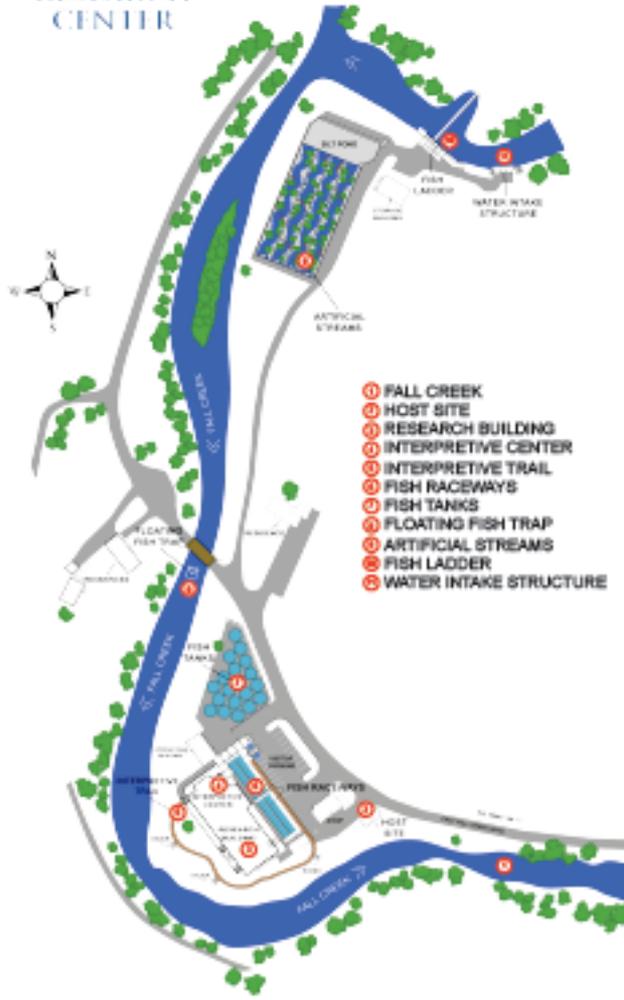
Salmon learn natal waters during embryonic exposure



Can larval Chinook and steelhead learn tributary waters?



OREGON
HATCHERY
RESEARCH
CENTER



Clackamas Spring Chinook



Fall Creek

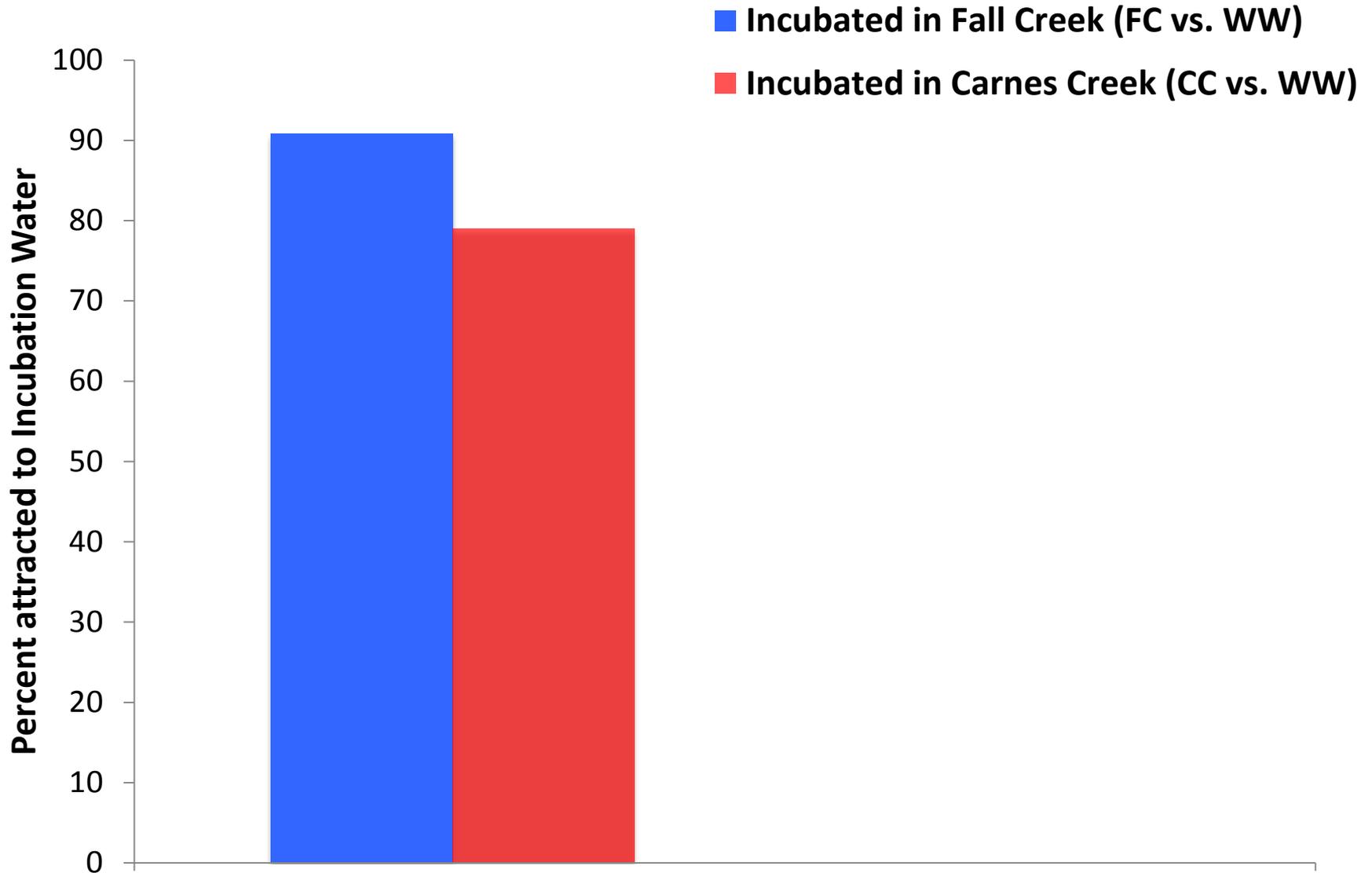
Well water

Carnes Creek

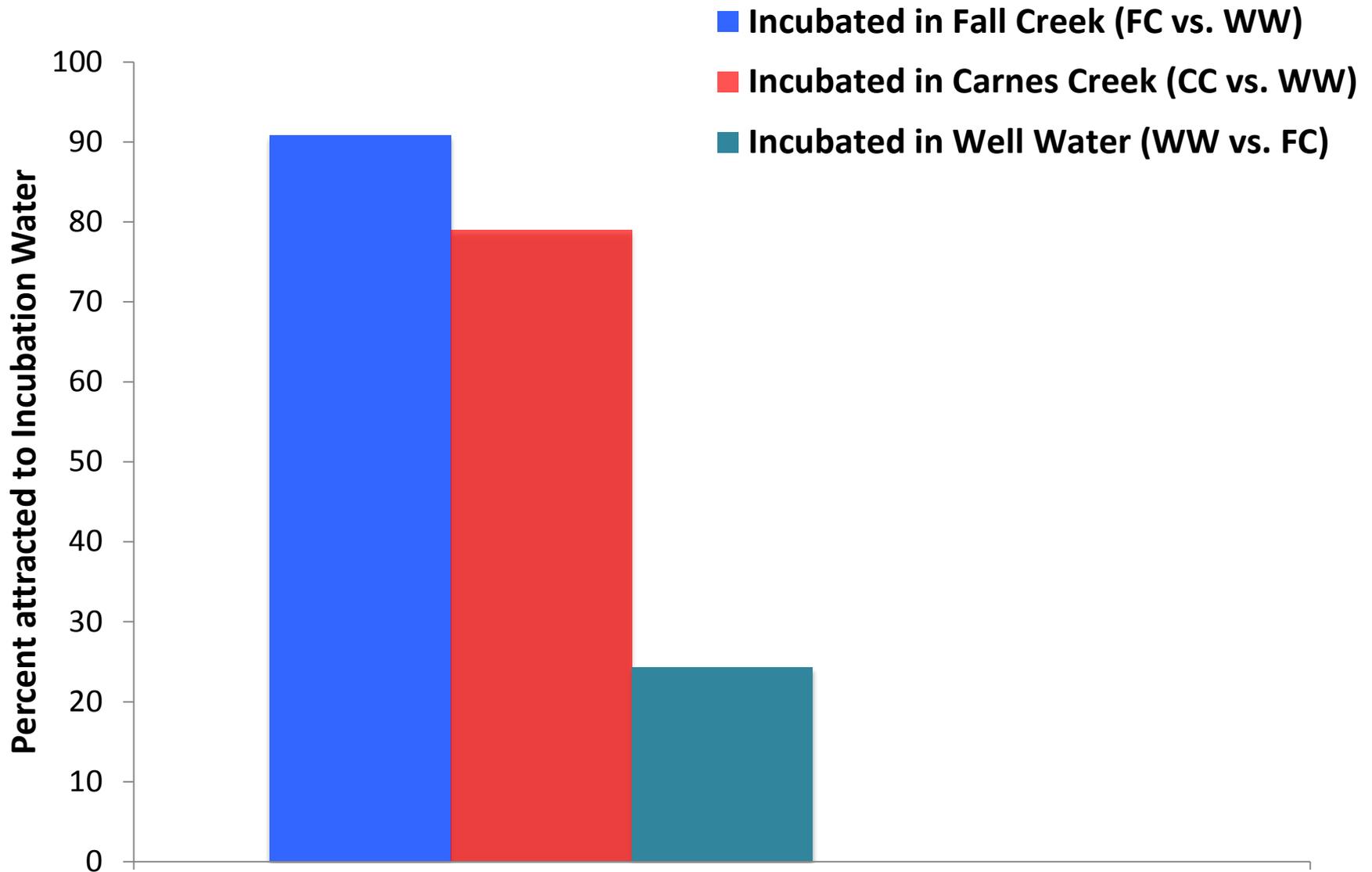
Y-maze testing
of emergent fry



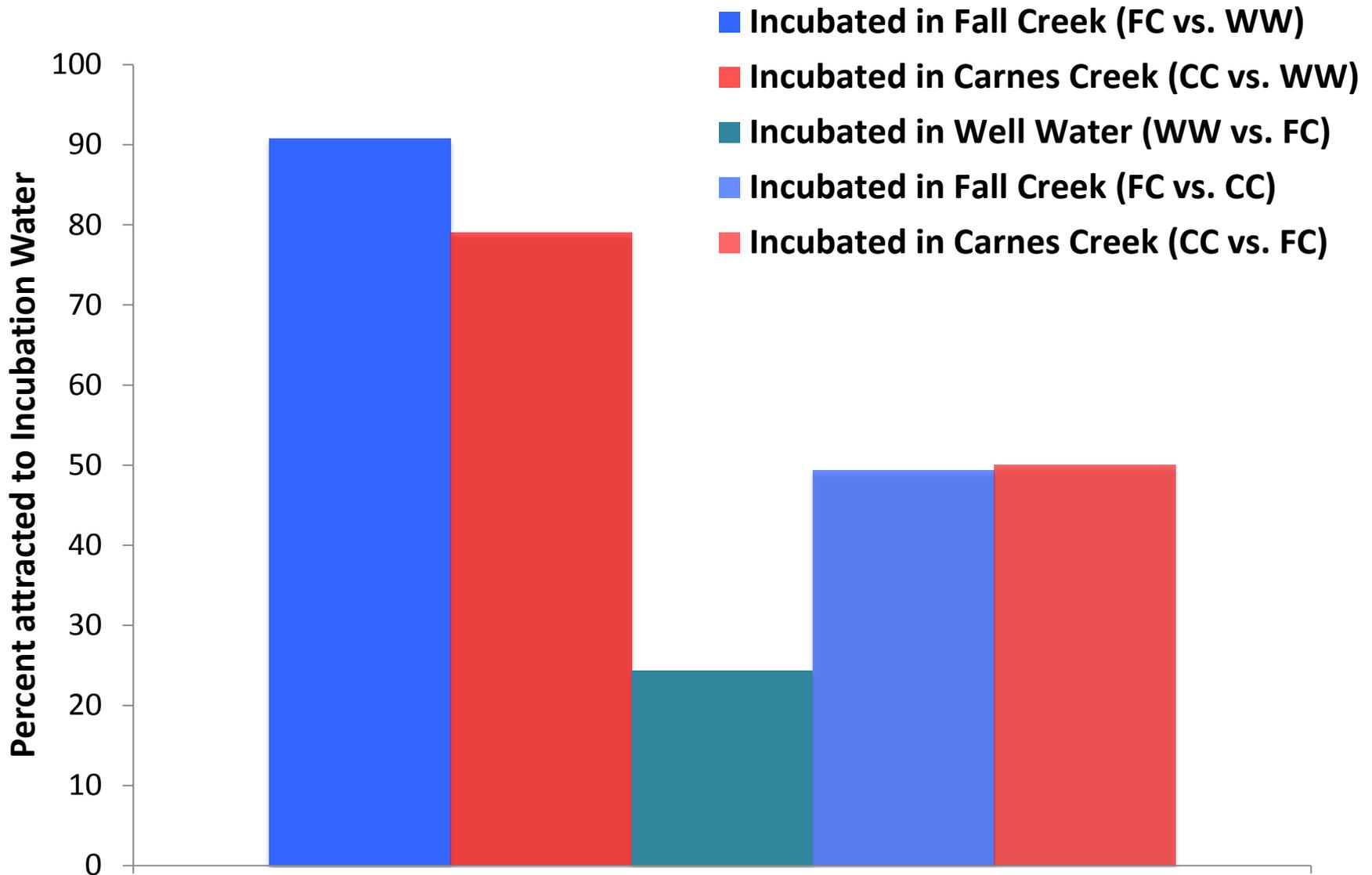
Spring Chinook embryonic learning?

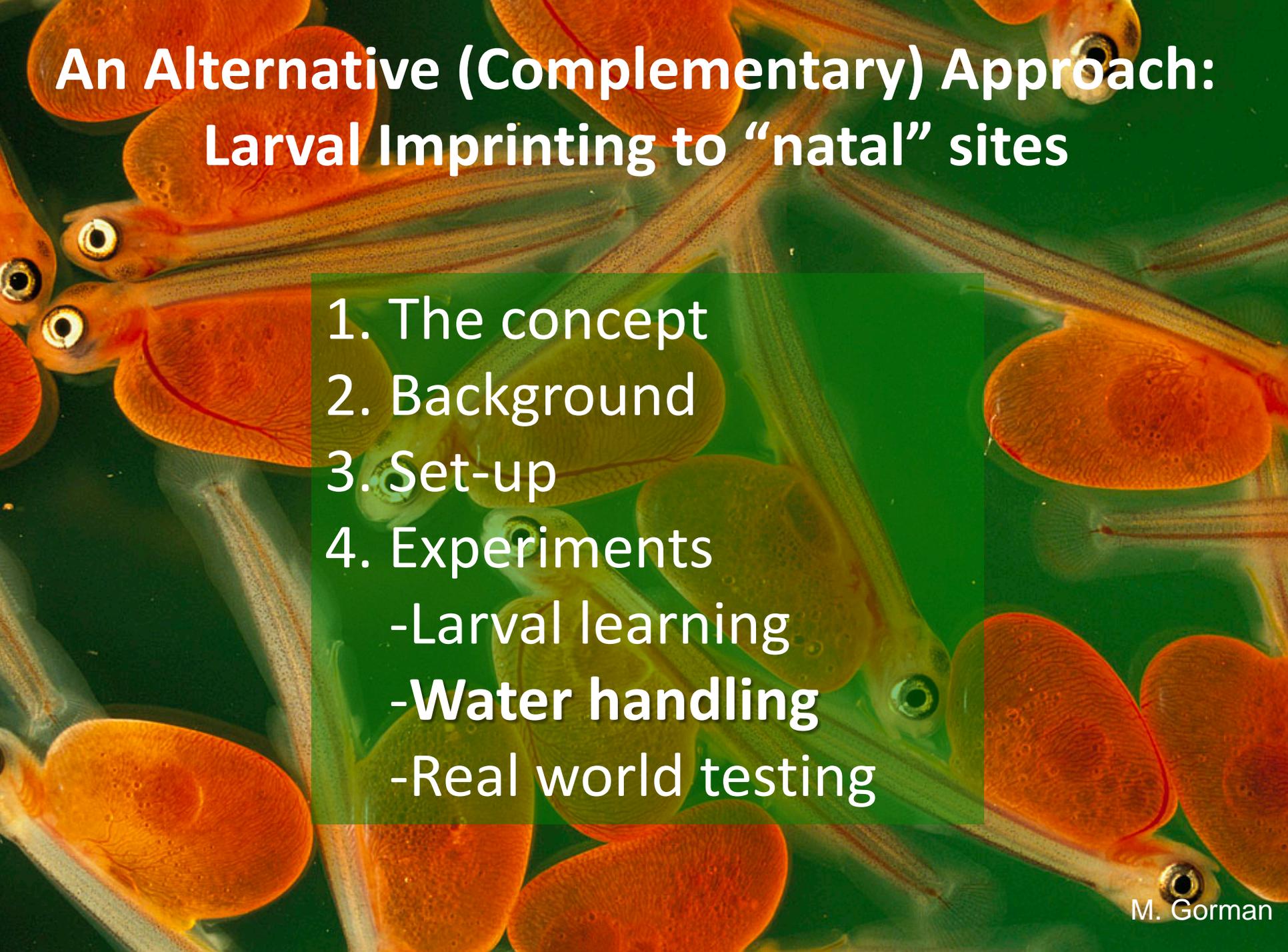


Spring Chinook embryonic learning?



Spring Chinook embryonic learning?



The background of the slide is a close-up photograph of several larval fish. The fish are translucent with a prominent orange or reddish-brown coloration on their bodies, particularly around the head and midsection. They have large, clear eyes and visible internal structures like the gut and yolk sacs. The water they are in is a deep green color.

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White River Spring Chinook acclimation/release sites



Tall Timber Ranch
White River rm 11.5

Bridge Site
White River rm 2
Chiwawa

Lake Wenatchee
net pens
(acclimation)

Wenatchee River outlet
(release)

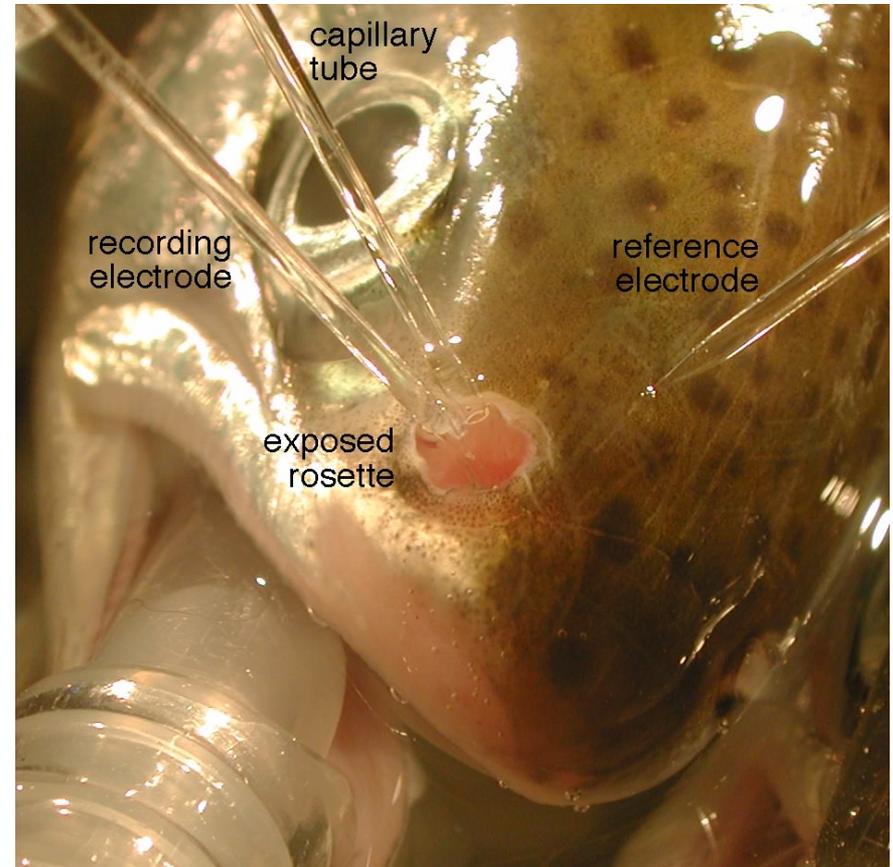
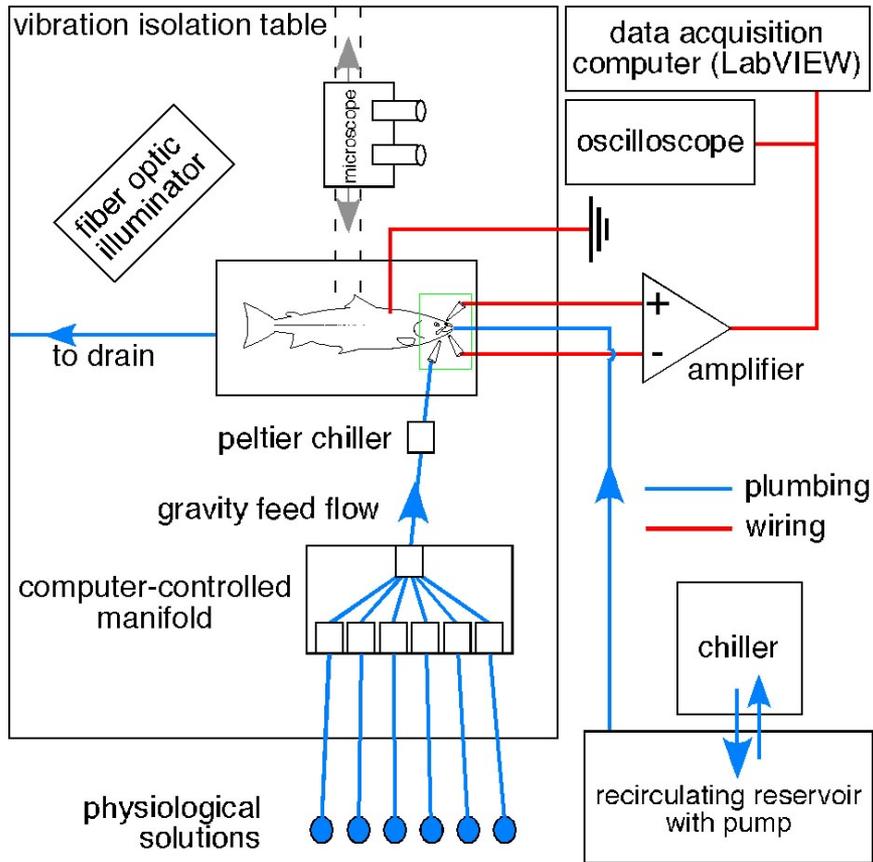
White River Experiments

Assess different strategies for collecting and storing imprinting waters to retain chemical properties that are critical for olfactory discrimination.

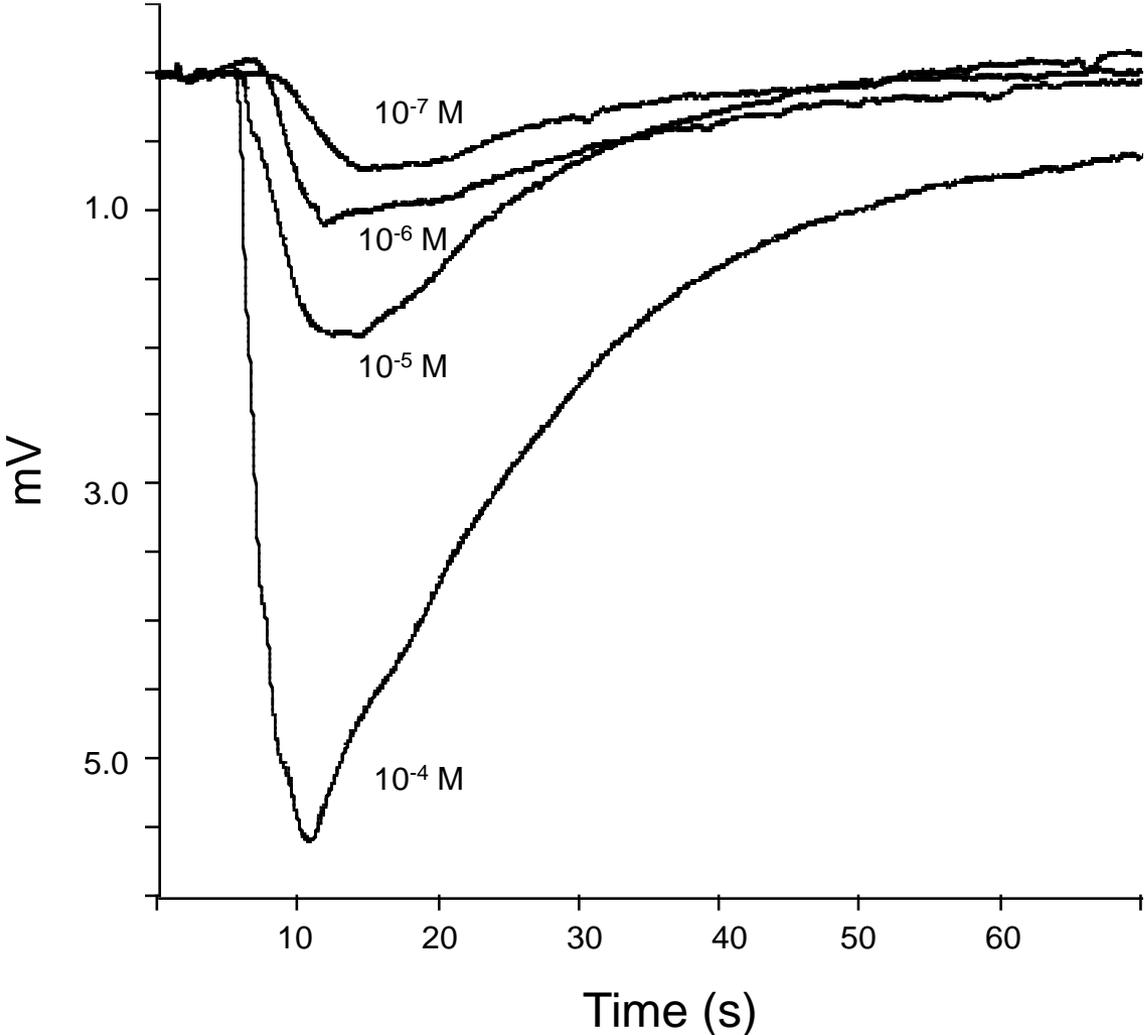
Electro-olfactogram analysis (EOG)

- Assess olfactory sensitivity to spawning target site waters**
- Using cross-adaptation studies, identify differences between olfactory signature of different spawning target site water.**
- Using cross-adaptation studies, assess different strategies for collecting and storing imprinting waters.**
 - Control water (Bridge site (BS), collected and tested same day)**
 - BS water held 12-72 hr at 4° C (~40° F) and 50° F (ambient hatchery)**
 - BS water frozen at -20° C**
 - BS water UV-treated**
 - BS water lyophilized**

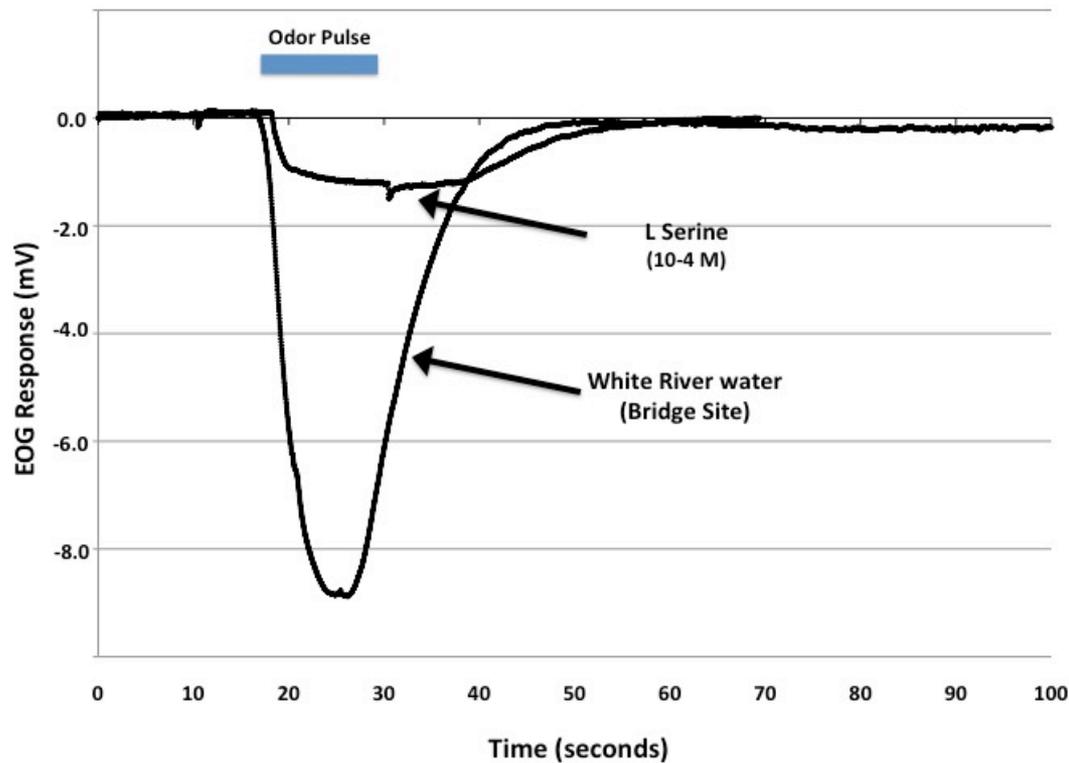
EKG apparatus for measuring olfactory sensitivity to imprinted odors

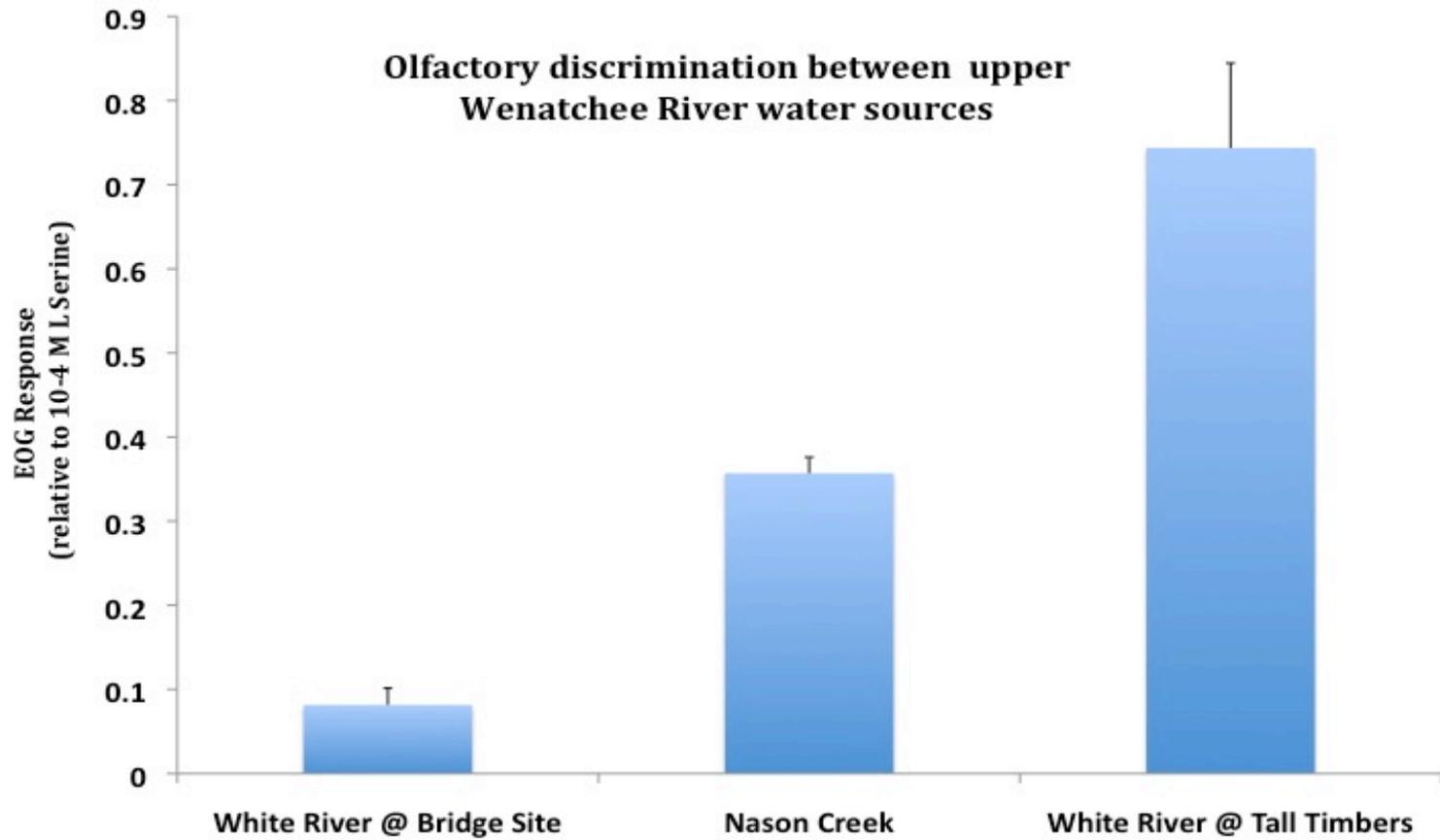


Typical EOG responses of coho salmon to increasing concentration of amino acids

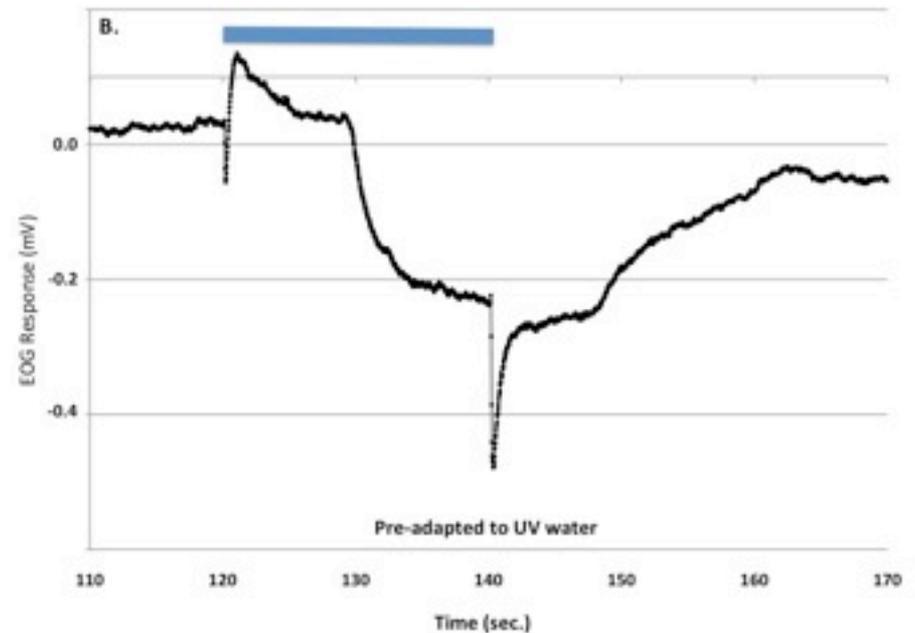
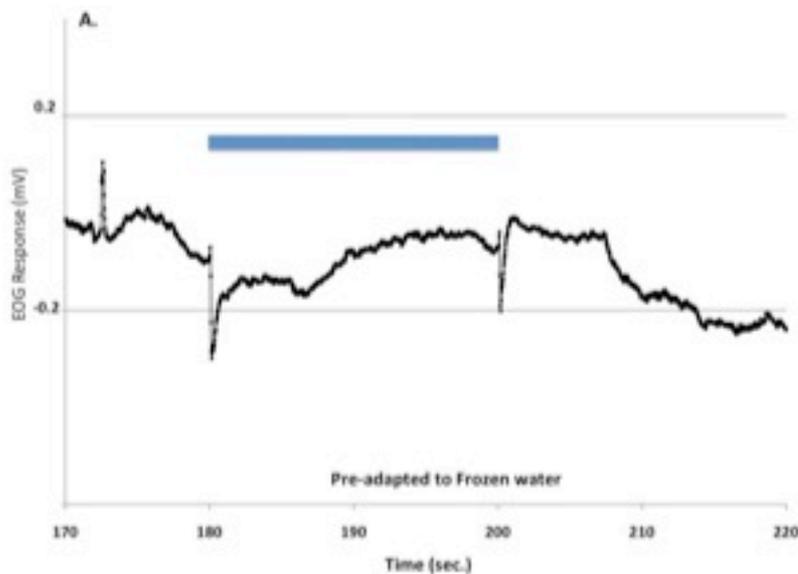


EOG response to White River water (Bridge site)



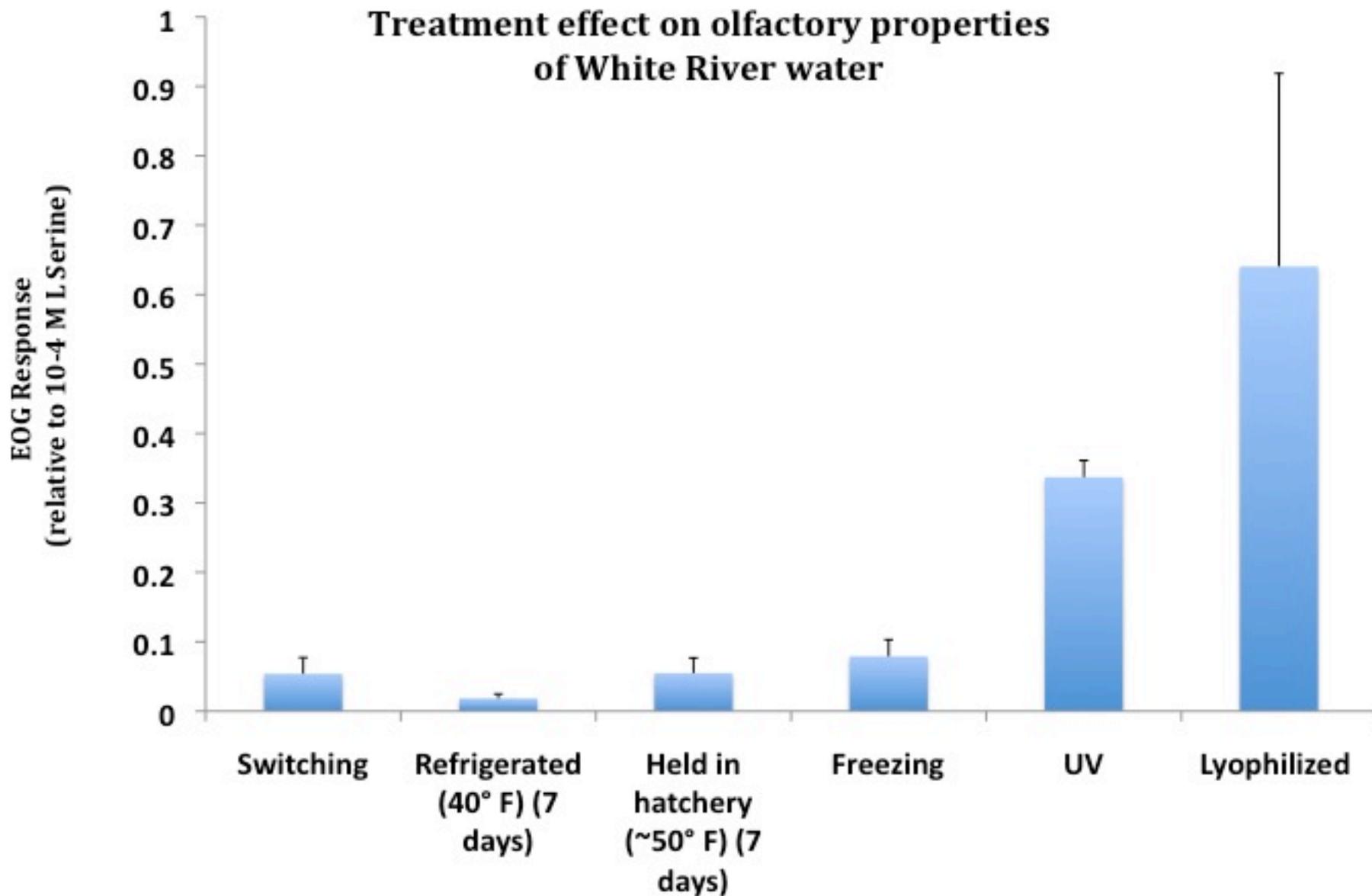


EOG Cross Adaptation Studies



Representative EOG traces in salmon pre-adapted to treated water A) Frozen water, B) UV-treated water, and then pulsed with BS water.

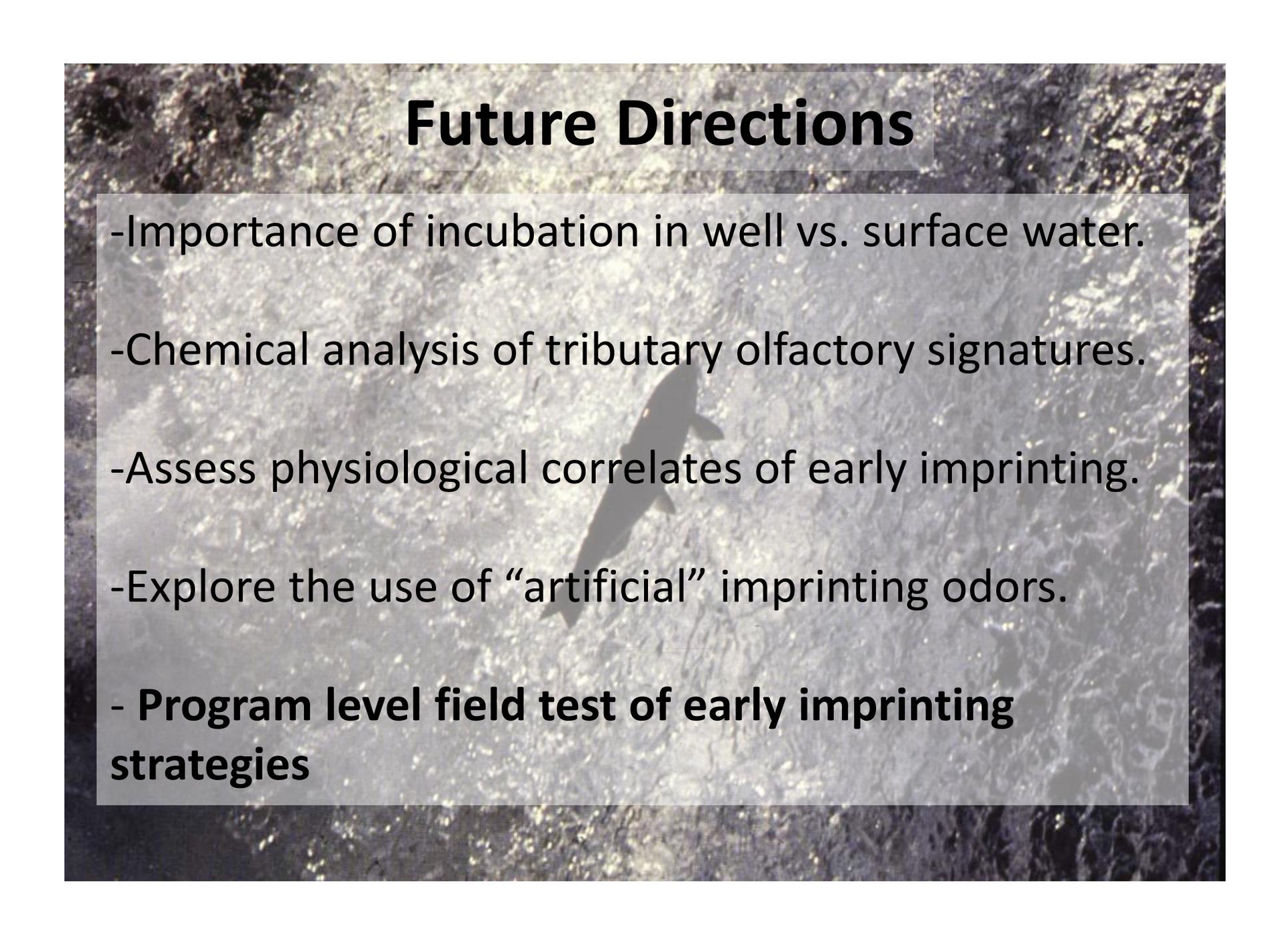
Treatment effect on olfactory properties of White River water



Conclusions

- Water at proposed acclimation sites are chemically distinct
- Freezing or holding BS water at 40° and 50° for up to one week did not compromise the olfactory integrity of the water
- UV treatment and lyophilization did alter the olfactory properties of BS water

Future Directions

A top-down view of a fish swimming in clear water over a rocky riverbed. The fish is dark and elongated, moving towards the bottom right. The water surface is textured with light reflections. A semi-transparent grey rectangular box is overlaid on the image, containing the title and a list of future research directions.

- Importance of incubation in well vs. surface water.
- Chemical analysis of tributary olfactory signatures.
- Assess physiological correlates of early imprinting.
- Explore the use of “artificial” imprinting odors.
- **Program level field test of early imprinting strategies**