Developing Methods to Improve Homing by Hatchery Salmon

Andrew Dittman, NWFSC, NOAA Fisheries

Collaborators

Maryam Kamran, David Noakes; Oregon State University
Darran May, Tom Quinn; University of Washington
Marc Johnson, Brent Hinner; ODFW
Gabriel Singer, Beatriz E Noriega-Ortega;
Leibniz Institute of Freshwater Ecology and Inland Fisheries

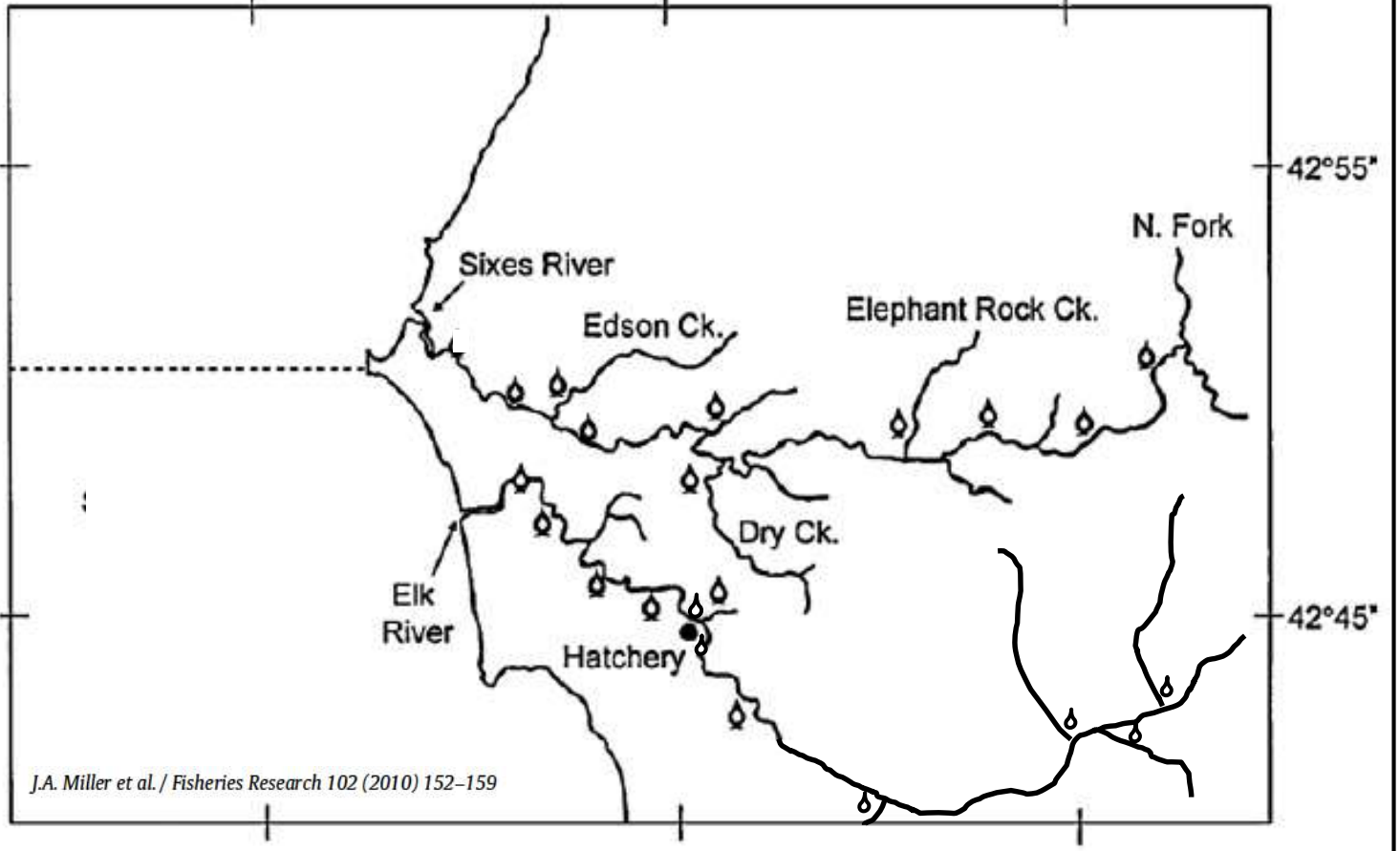
Washington-British Columbia
AFS Meeting
April 11, 2019

B.

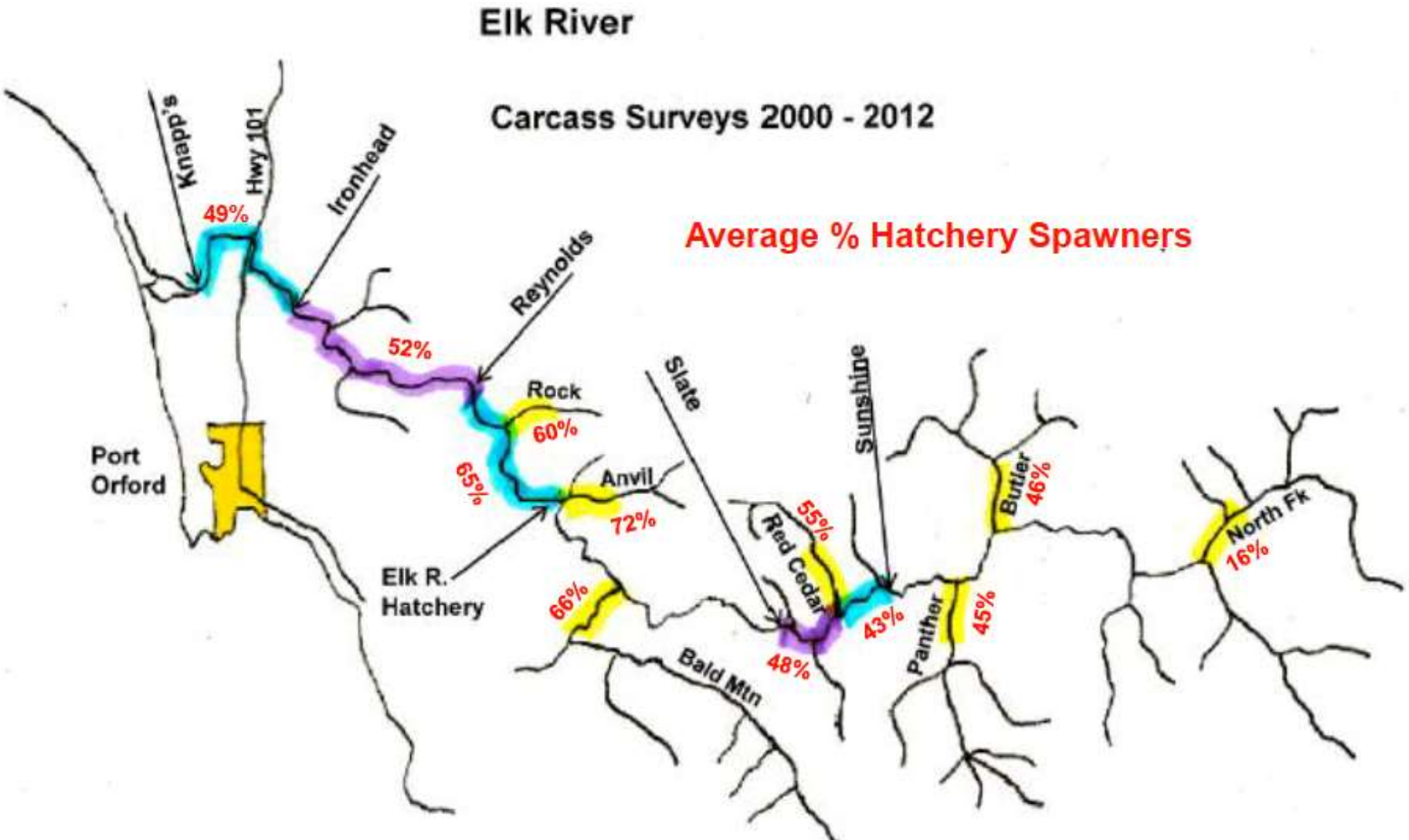
Elk River Hatchery

-Key river for fisheries managers, well studied, Cape Blanco break

-Fall Chinook, Late run/spawn timing (Nov-Jan.; peak late-December)



- **> 50% of Chinook salmon spawning in the Elk River are hatchery fish**
- **> 30% of Chinook salmon spawning in the Sixes River are Elk River hatchery fish**



2014 Coastal Management Plan

COASTAL MULTI-SPECIES CONSERVATION AND MANAGEMENT PLAN

EXECUTIVE SUMMARY

OREGON DEPARTMENT OF FISH AND WILDLIFE

JUNE 2014

ODFW MISSION

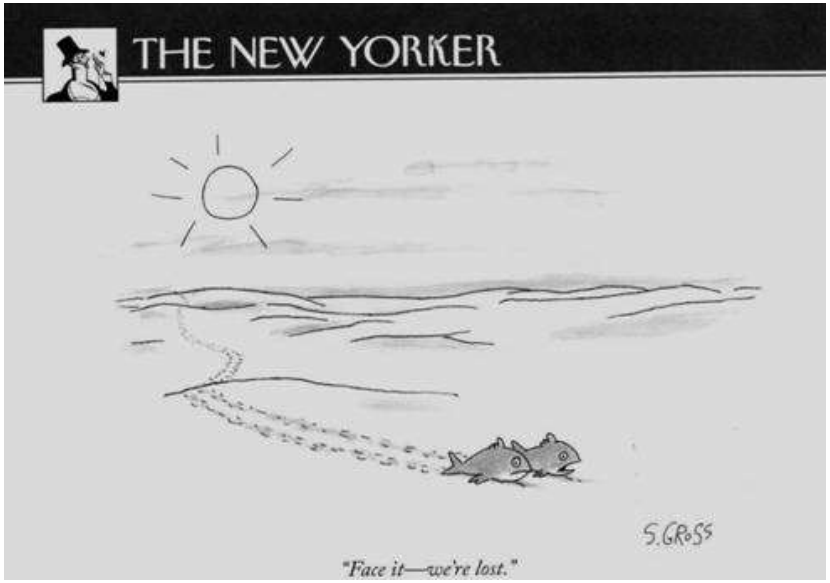
TO PROTECT AND ENHANCE OREGON'S FISH AND WILDLIFE AND THEIR HABITATS FOR USE AND ENJOYMENT BY PRESENT AND FUTURE GENERATIONS

- Out of 63 populations assessed in the CMP, there are only two non-viable populations – Elk River Chinook and South Umpqua River spring Chinook. (Netarts River chum were also assessed and non-viable, but it is unclear if this is a population.)

The status assessment of the Elk population of fall-run Chinook indicated that the population has low probability of persisting in the long term when the abundance and productivity of the population were assessed.

A reduction in hatchery production in Elk River from 325,000 to 275,000, and other actions, are intended to improve the conservation status of Chinook (currently non-viable) by significantly reducing hatchery strays on spawning grounds (currently >60%).

Why do salmon stray?



Failure to home

- **Imperfect imprinting**
- **Memory loss**
- **Sensory failure**
- **Signal changed or masked**
- **Exhaustion**

Decision to stray → **Tradeoff between homing and spawning site selection**

Investigation of Methods to Improve Homing by Hatchery Salmon

Overall project goal: reduce the number of hatchery fish that do not return to the hatchery and instead spawn in the wild.

1. Explore methods to attract more hatchery fish into Elk River Hatchery, including the use of an odorant in the water to give it a distinct scent that would attract more returning hatchery fish to the hatchery trap and keep them from spawning in the wild.

2. Determine whether timing the releases of Elk River fall Chinook to coincide with the normal parr-smolt transformation will improve homing to the Elk River hatchery.

3. Determine whether exposure to surface water during incubation and early rearing periods will improve homing to the Elk River Hatchery

Investigation of Methods to Improve Homing by Hatchery Salmon

Overall project goal: reduce the number of hatchery fish that do not return to the hatchery and instead spawn in the wild.

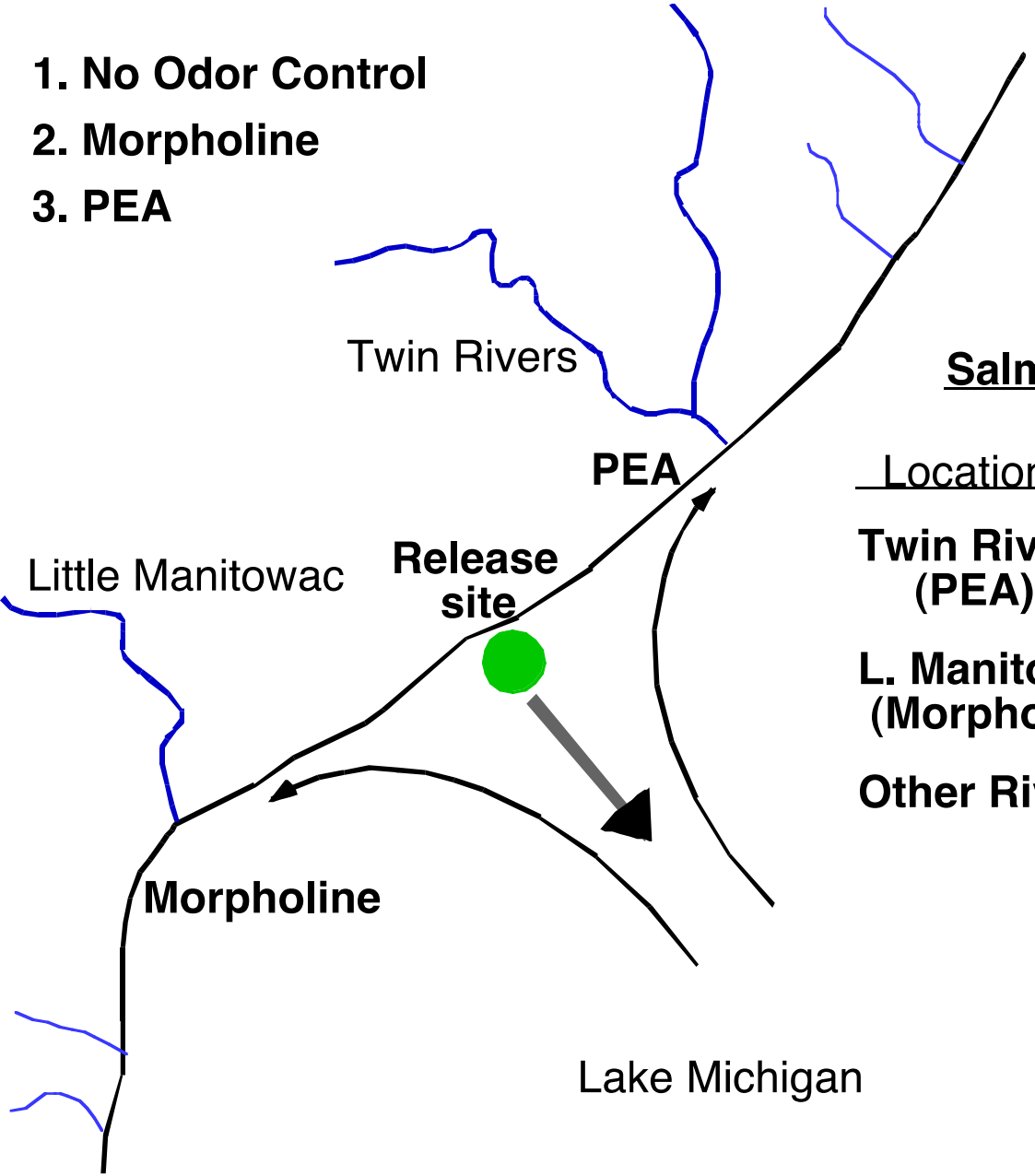
1. Explore methods to attract more hatchery fish into Elk River Hatchery, including the use of an odorant in the water to give it a distinct scent that would attract more returning hatchery fish to the hatchery trap and keep them from spawning in the wild.

2. Determine whether timing the releases of Elk River fall Chinook to coincide with the normal parr-smolt transformation will improve homing to the Elk River hatchery.

3. Determine whether exposure to surface water during incubation and early rearing periods will improve homing to the Elk River Hatchery

Experimental verification of imprinting hypothesis

1. **No Odor Control**
2. **Morpholine**
3. **PEA**



Salmon recovered during homing

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

Elk River Hatchery

Hatchery Outlet/ladder

Hatchery Intake

Returns of Morpholine-Imprinted Coho Salmon to the Mad River, California

THOMAS J. HASSLER

U.S. Fish and Wildlife Service, California Cooperative Fishery Research Unit[1]
Humboldt State University, Arcata, California 95521, USA

STEPHEN T. KUCAS[2]

California Cooperative Fishery Research Unit
Humboldt State University, Arcata, California 95521, USA

TABLE 2.—Return of experimental coho salmon to the Mad River Hatchery, California (T = treated; C = control).

Brood year and group	Number released	Number returned[a]				χ^2-test
		1979	1980	1981	Total	
1977						
T	50,800	25[b]	54	1	80	$P < 0.005$
C	38,418	13[b]	8	1	22	
1978						
T	11,170		76[b]	1	77	$P < 0.005$
C	8,367		21[b]	0	21	

HOMING OF COHO SALMON (*ONCORHYNCHUS KISUTCH*) EXPOSED TO MORPHOLINE

B.G. REHNBERG[1], L. CURTIS[2] and C.B. SCHRECK[1]

Returns of adult coho salmon to the Salmon River Hatchery when morpholine was present or absent in the fish ladder. Adults were exposed to morpholine or not exposed (controls) as smolts

Treatment as smolts	Fish ladder water		Totals
	Morpholine present	Morpholine absent	
Morpholine-exposed	9	18	27
Control	17	18	35
Totals	26	36	62

Aquaculture, 44 (1985) 253—255

Calif. Fish and Game 76(1): 31–35 1990

HOMING BY CHINOOK SALMON EXPOSED TO MORPHOLINE [1]

THOMAS J. HASSLER AND KEITH KUTCHINS [2]

Phase 1.
Characterize the chemical signatures of hatchery/river water

1. Characterize the chemical constituents of:

-Hatchery intake and outlet

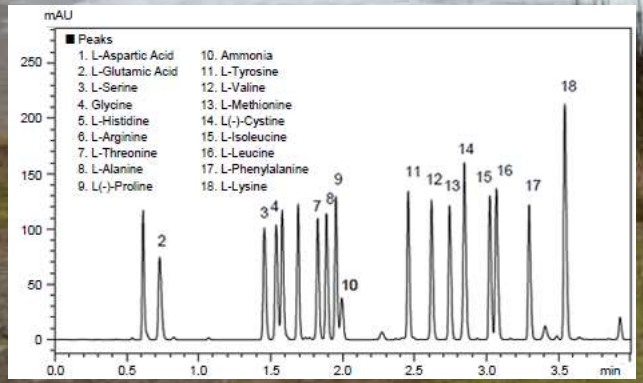
-Natural river system

2. Riverscape analysis of chemical fingerprints at tributary confluences throughout Elk and Sixes River:

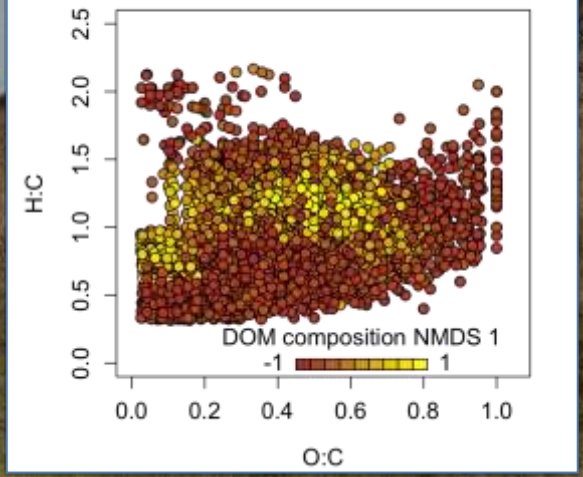
-Spatial patterns (40 sites at time of homing migration)

-Temporal patterns (12 sites) seasonally (4x)

Amino acid analysis



Orbitrap mass spec.



Hatchery sampling

A.

Elk R. above hatchery outlet

Hatchery outlet

k above w/ Elk R.

NOTE: INVENTORY NOS SHOWN IN ( ).

REARING PONDS

ADULT POND (08025)

SPAWNING SHED (08025)

ANVIL CREEK

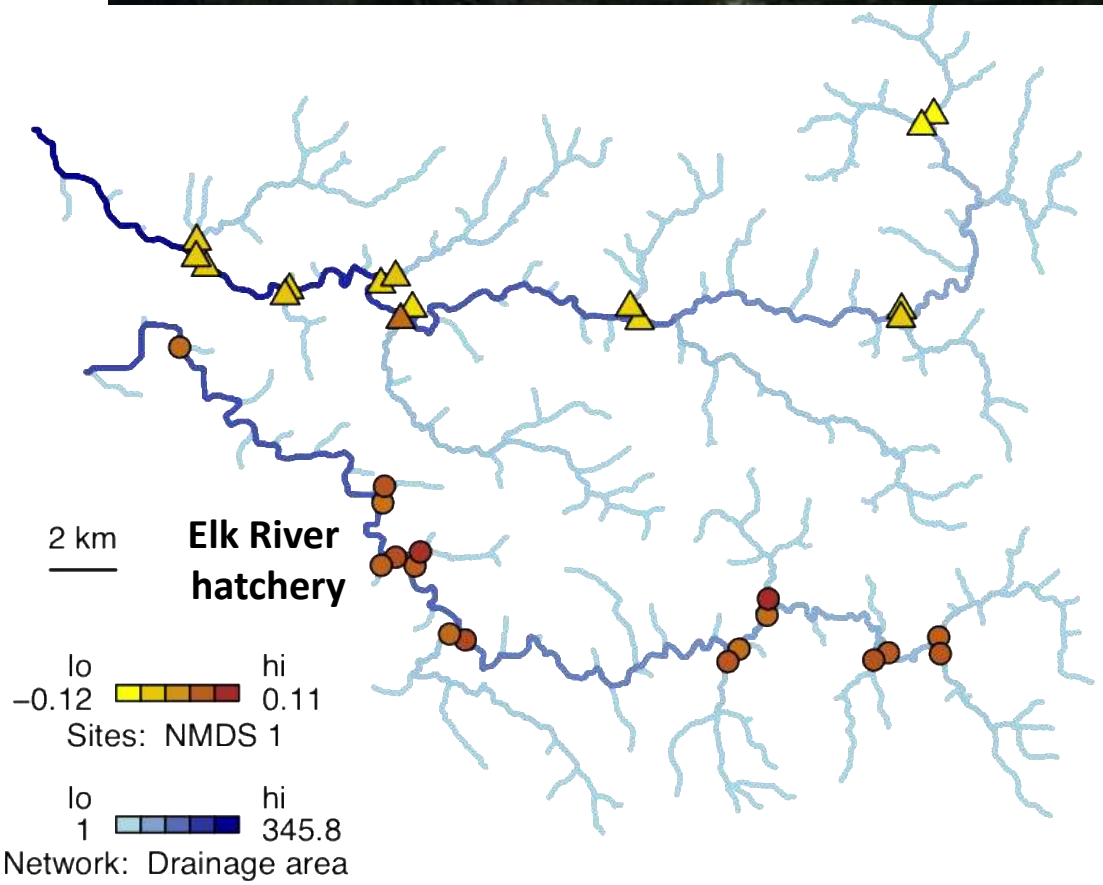
U.S. 101

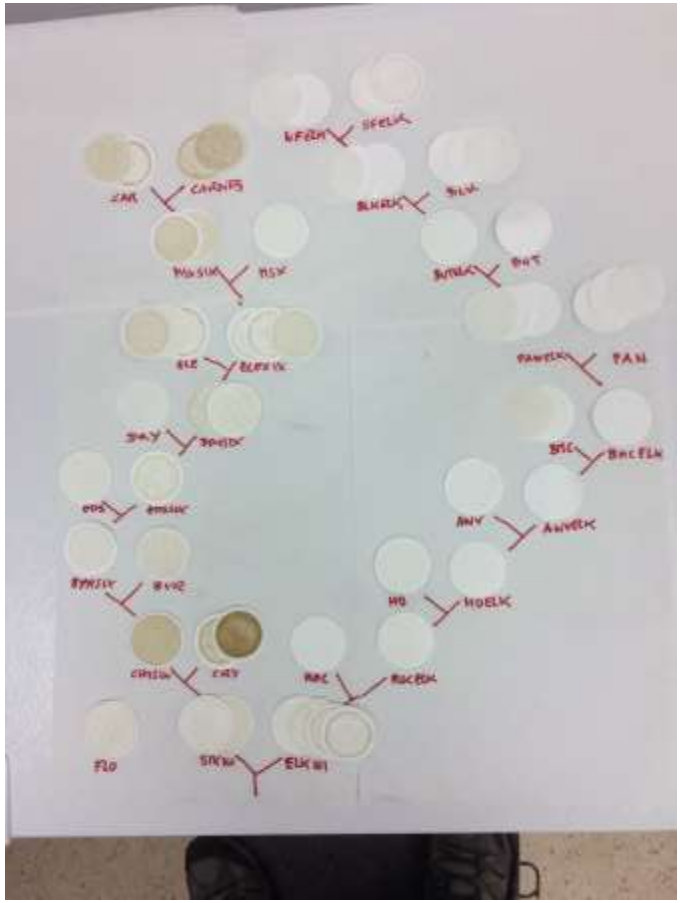
INVENTORY ITEMS
DRAWING
08026 FENCE
08027 HANDRAILS
08039 GRADING, LANDSCAPING
08040 ROADWAYS, DRIVEWAYS
08041 BURIED ELECT. SERV.
08042 POND WIRING, LAMPS
08043 ELECT SYS. TO INTAKE 3
08044 PIPE, DRAIN & WATER
08071 LAND ACQUISITION

08046 INCUBATION WATER WELL

Elk River Ha

River sampling

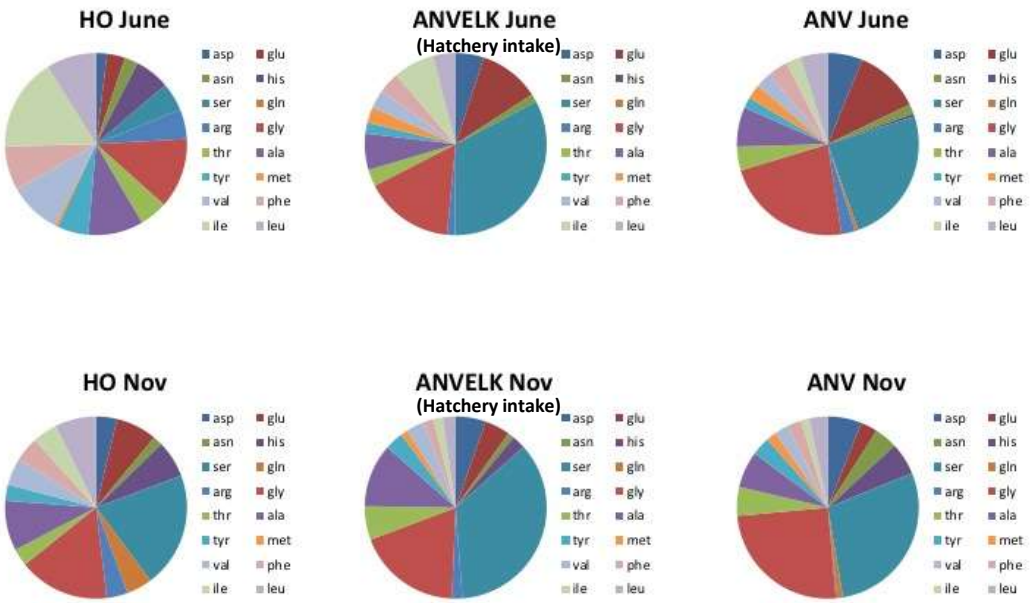


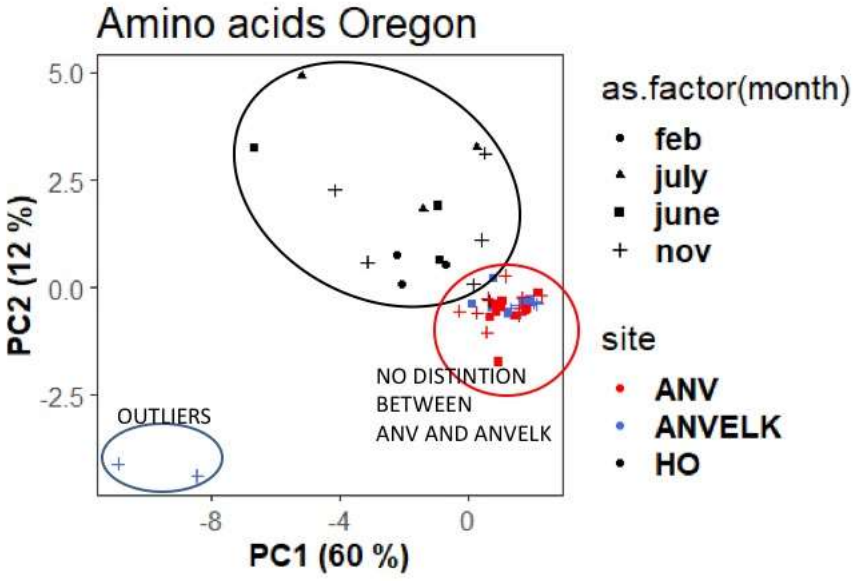


Amino acid analysis– Hatchery

Hatchery outlet water has a different amino acid profile than the intake water but these differences may be less distinct in November when salmon are returning.

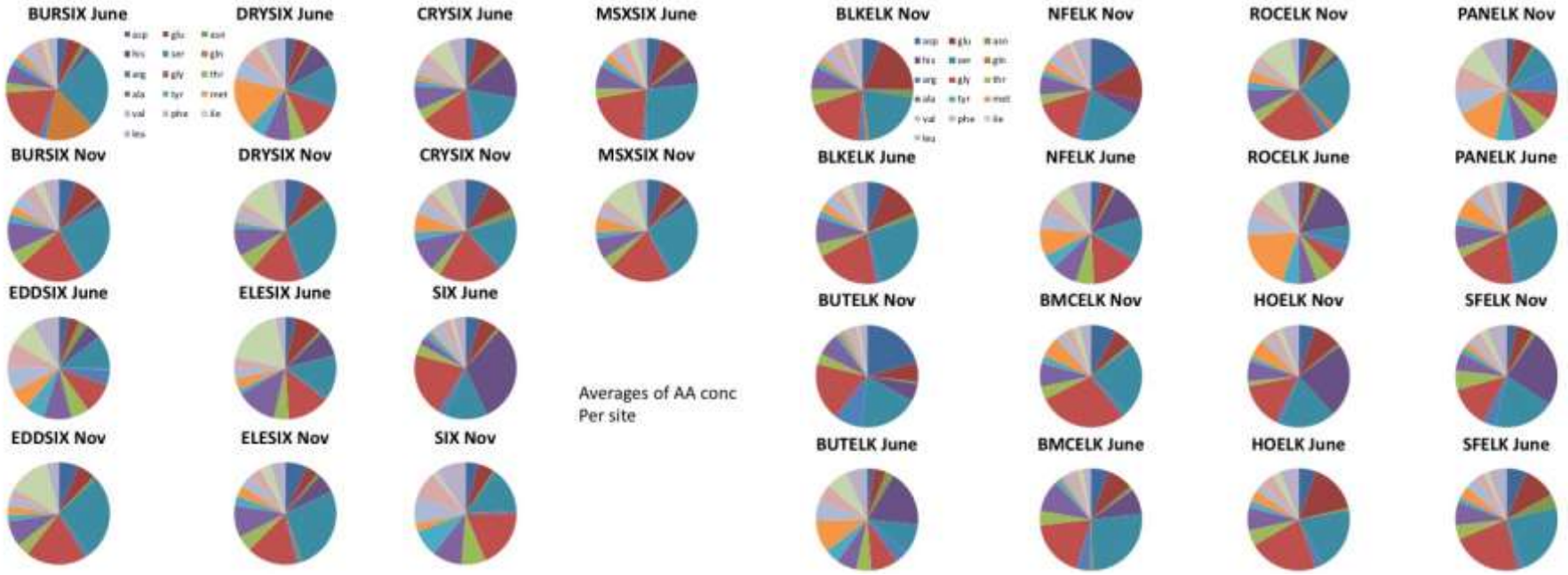
Averages of AA concentrations per site (no outliers incl)





Amino acid analysis– Rivers/tributaries

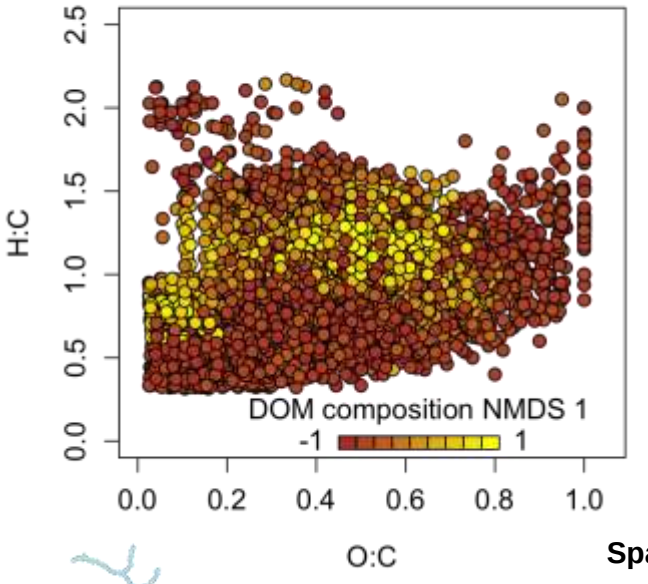
There are distinct site-specific patterns but also seasonal variation.
Patterns are complex. Analysis is ongoing.

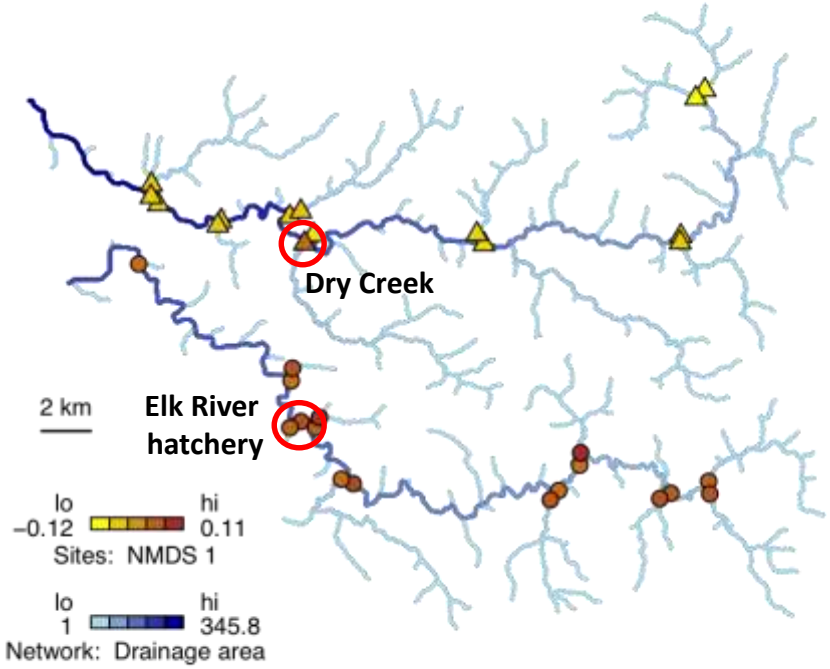


Orbitrap MS analysis – all sites

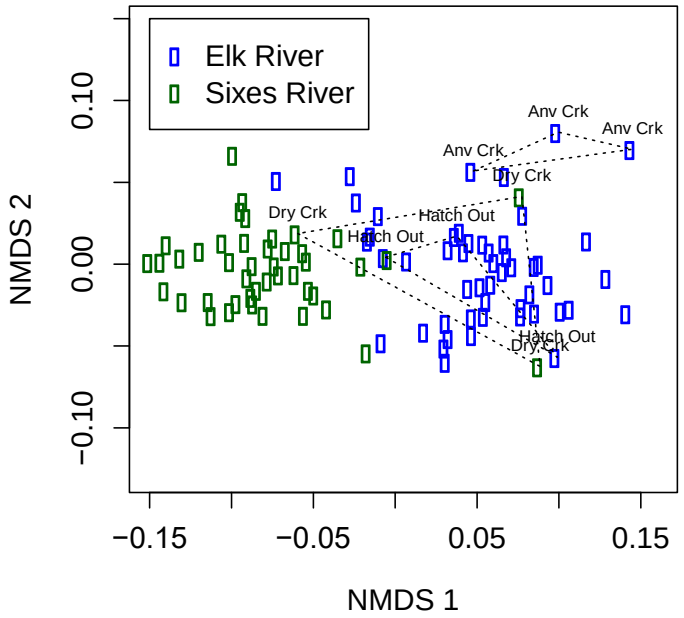
Initial analysis completed; very distinct patterns between Elk and Sixes.

Individual compounds identified in Elk and Sixes river





Spawning season (Nov 2016)



Phase 2: Odorant Selection and Imprinting Effectiveness

Identify and screen a variety of natural compounds released from aquatic plants and organisms and other known fish odorants for their potential use as artificial imprinting/homing cues and identify the most likely effective scent(s) to incorporate into Elk River Hatchery water.

1) safe for release into natural waters

2) inexpensive and readily available

3) stable for storage and after release into natural waters

4) detected by the salmon olfactory epithelium at relatively low concentrations

5) ideally does not elicit innate behavioral (attraction or avoidance)

6) embryo and juvenile salmon are able to learn and respond behaviorally to the compound.