

Determinants of Migratory Life History Phenotypes in Juvenile Spring Chinook Salmon



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Life History

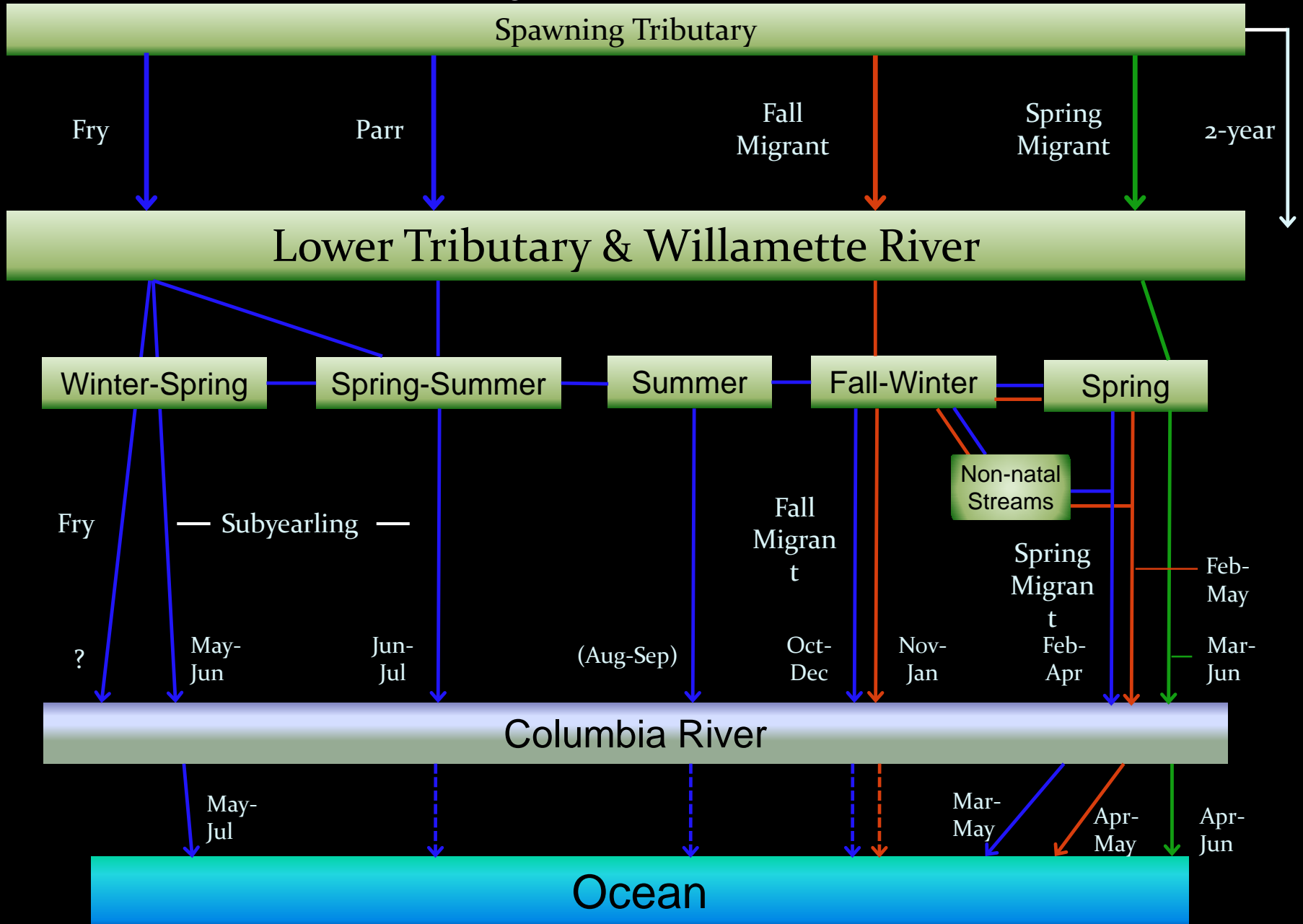
The series of changes undergone by an organism during its lifetime.

Life History

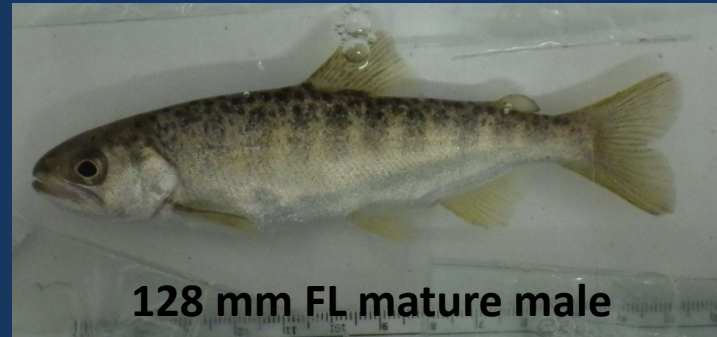
- STRATEGY
 - “A rule that specifies how the organism deals with every possible circumstance.”
 - “A rule for action.” (algorithm)
 - “A pre-programmed rule that an animal obeys.”
- TACTIC
 - “Individual actions or responses, comprising a strategy” (moves)

Willamette Juvenile Chinook Migratory & Rearing Pathways

Kirk Schroeder, Oregon Department of Fish and Wildlife



Challenge of developing wild surrogates



- Managing growth and early maturation with constraints of end user's research objectives
- Balancing equation:
environment + diet = growth + condition + life history tactic

“Behaviour”

- “Genetic Determination” (= genes)
- “Environment” (physical, biological)
- “Genetic – Environment Interaction”

Fjórðungi bregður til fósturs, fjórðungi til móður,
fjórðungi til föðurs og fjórðungi til nafns.

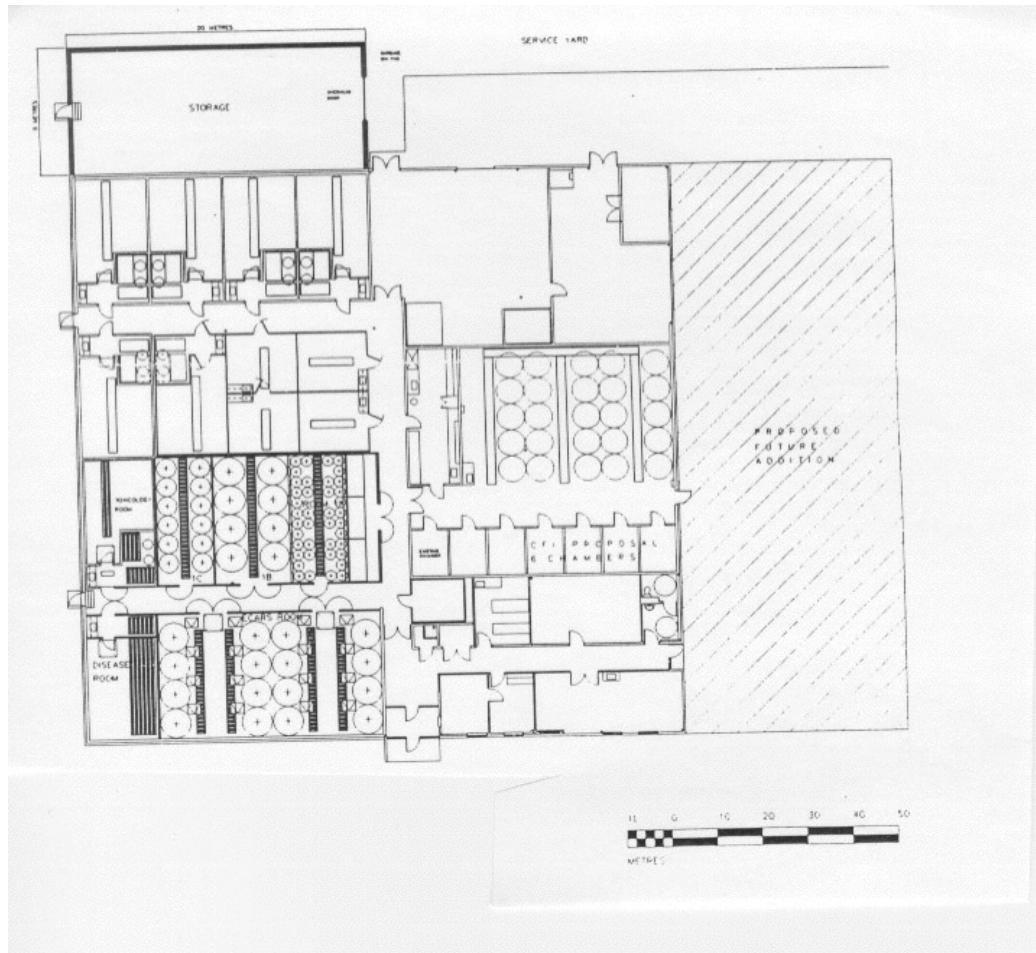
“Fjórðungi bregður til fósturs”

Njáls saga

Genes and Environment

- “Blueprints” vs “Recipes”
- Ontogeny (development)
- Interactions

“Blueprint”



“Recipe”

Basic Brownies

You can microwave brownies from a mix using these same directions.

POWER LEVEL: High (10)

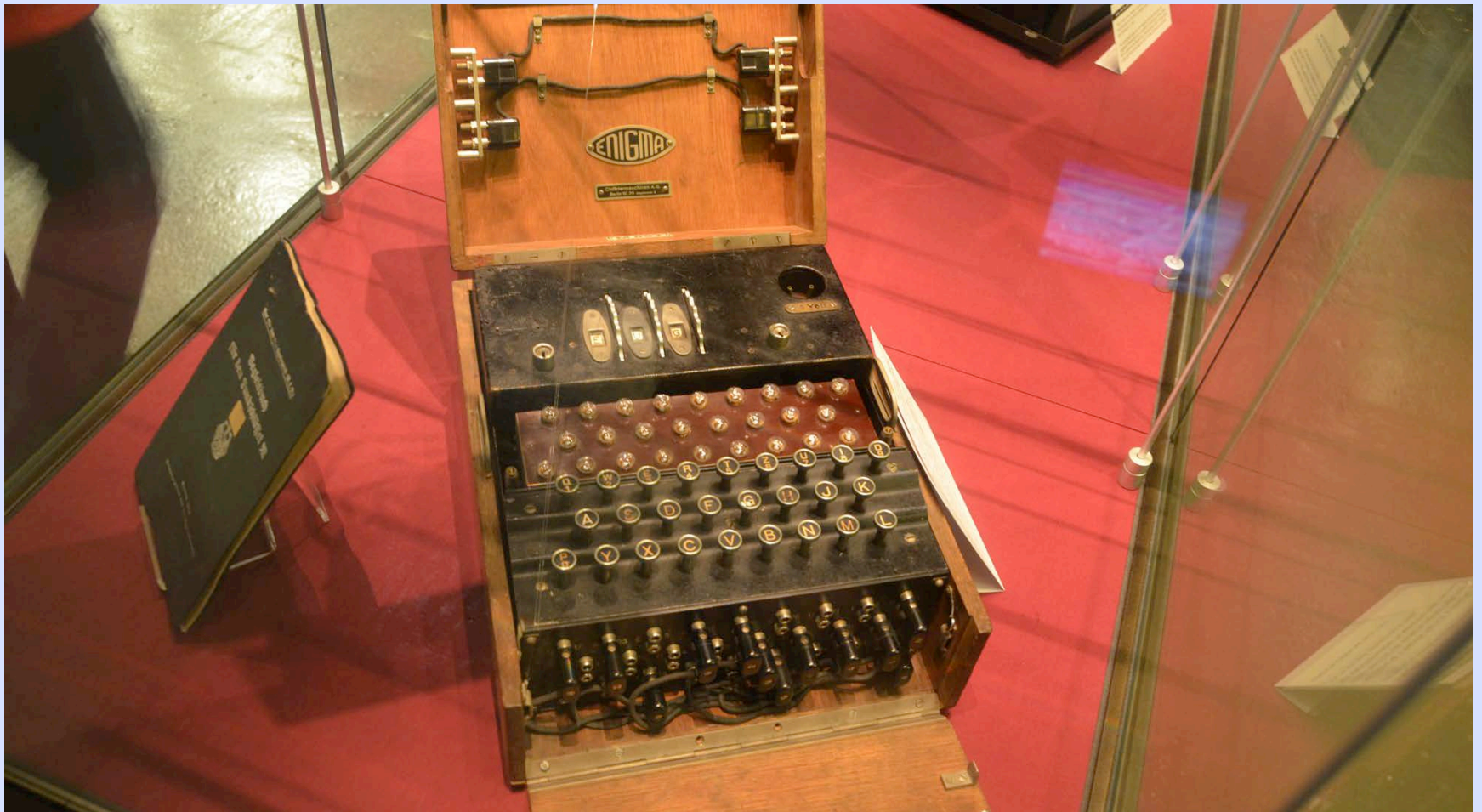
MICROWAVE TIME: 6 to 7 min., total

- | | |
|---|--|
| 2 eggs | In small bowl at medium speed on mixer, beat together eggs, sugar, salt and vanilla, about 1 minute until light. |
| 1 cup sugar | |
| 1/2 teaspoon salt | |
| 1 teaspoon vanilla extract | |
| 1/2 cup (1/4-lb.) butter, melted | Add melted butter. Continue beating until thoroughly blended. |
| 3/4 cup unsifted all-purpose flour | Mix in flour and cocoa at low speed. |
| 1/2 cup cocoa | |
| 1 cup chopped nuts | Stir in nuts. Spread evenly in greased 8-in. square dish. |

Microwave at High (10) 6 to 7 Minutes, rotating dish 1/2 turn after 3 minutes. When done, top looks dry and will spring back when lightly touched. Cut when cold.

Makes about 20 brownies

The Enigma



Computing Machinery and Intelligence

A. M. Turing

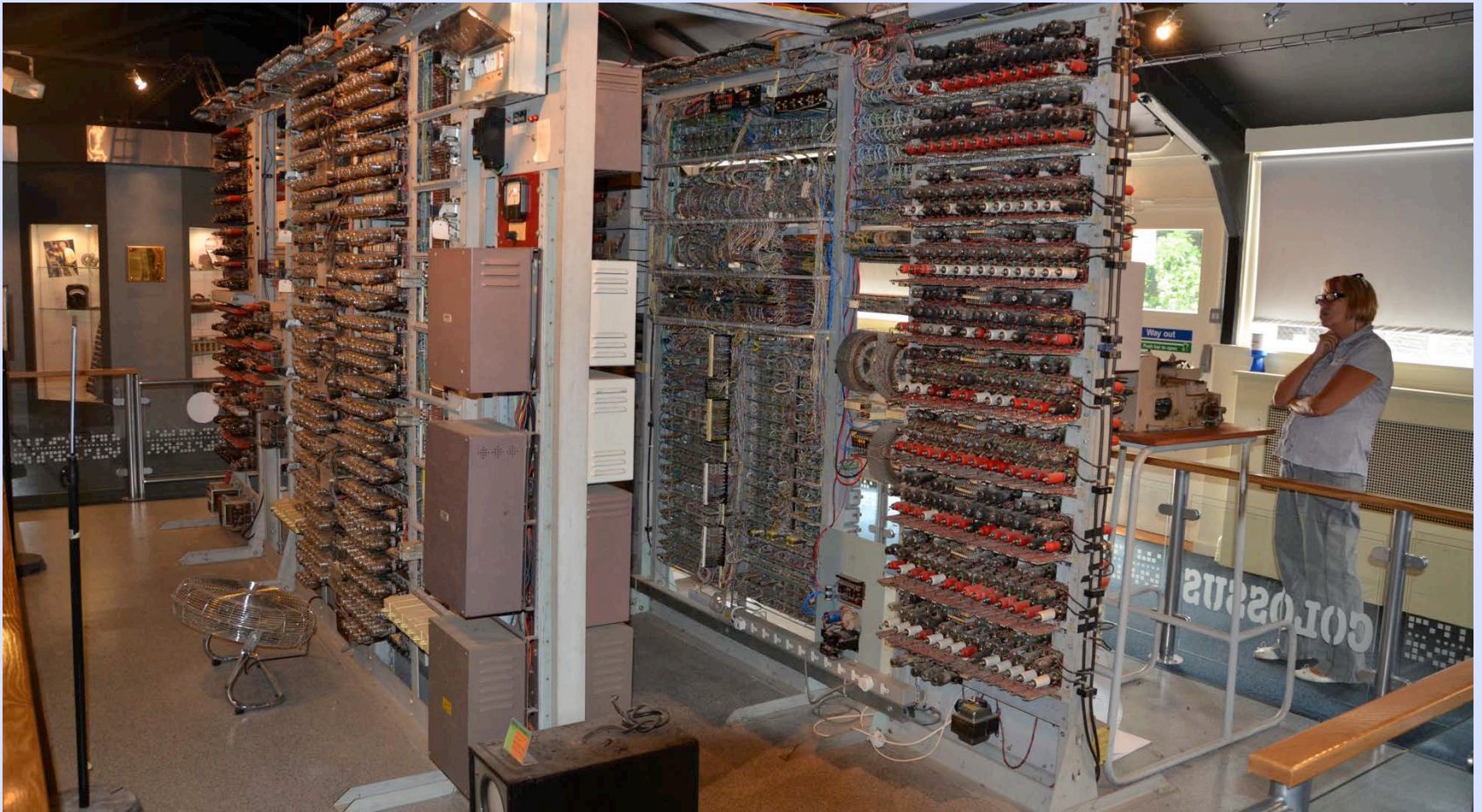
1950

1 The Imitation Game

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words "machine" and "think" are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, "Can machines think?" is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the "imitation game." It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A." The interrogator is allowed to put questions to A and B thus:

The Solution



Wild Chinook



Courtesy Peter Moyle, U.C. Davis

Factors contributing to the expression of life history tactics

- Are there behavioral phenotypes expressed early in life that indicate life history tactic that will be expressed later?



F11ETWIWWLADGBCT

F – Facility (FPGL)

11- Brood Year (2011)

ET- Treatment (Experimental)

WI- Incubation Temp. (Well Water ambient)

WW- Rearing Temp. (Well Water ambient)

L – Density (Low)

AD – Abernathy (Experimental Diet # 1)

GB- Substrate (Gravel Bottom)

CT – Container (Circular Tank)

Experimental research

Rearing protocol + Phenotype = Optimize surrogates

Incubation temperature

Incubation substrate

Rearing temperature

Cover

Substrate

Density

Circular tank

Trough

Artificial stream

Diet

Feeding regime

Behavioral phenotypes

Growth patterns

Maturation

Movement

Morphology

Coloration

Fin condition

Lipid content

Fatty acid composition

Stress response

Brain development

Metabolic rate

Migratory patterns



- What aspects of rearing protocol are necessary to produce desired phenotype for wild fish surrogates?

Wild fish surrogates

Wild fish

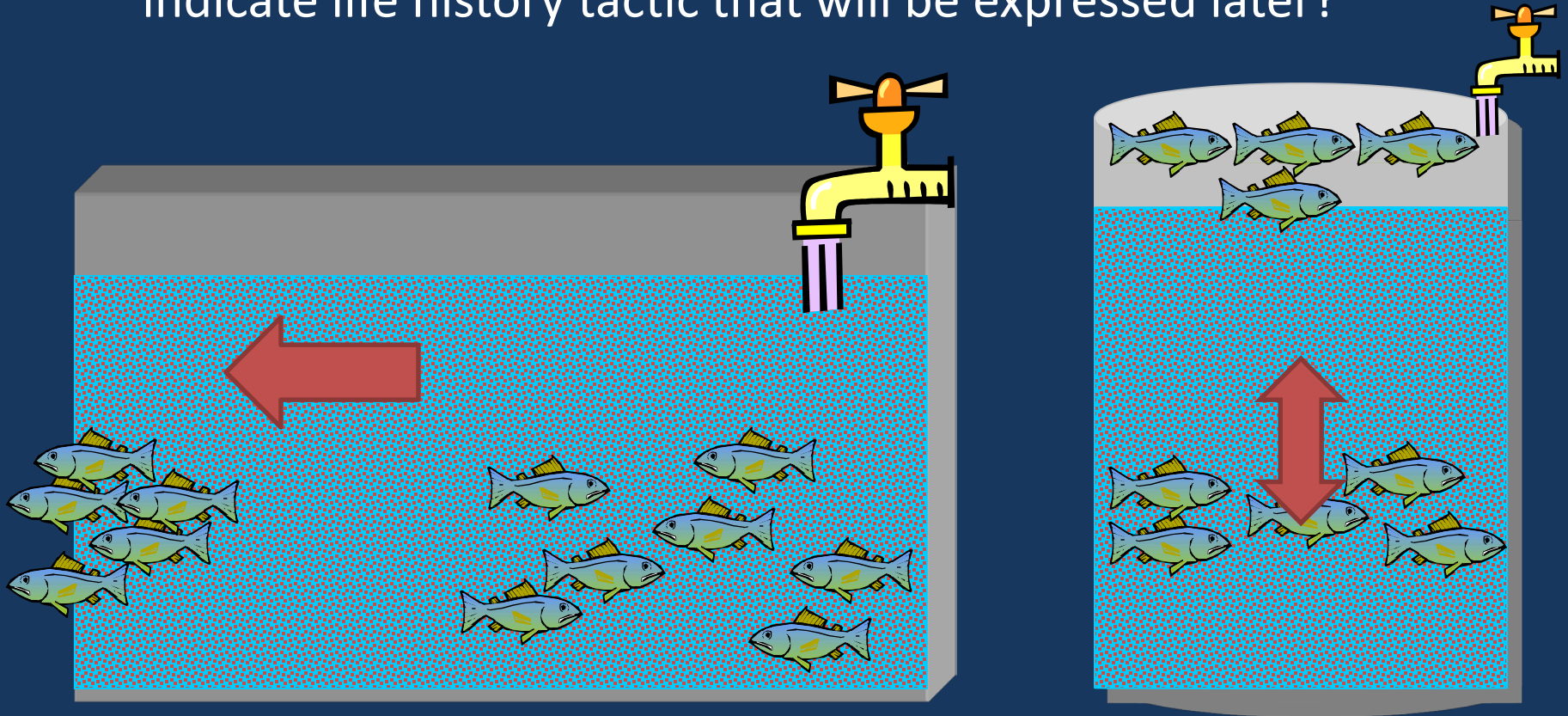


Wild fish surrogates

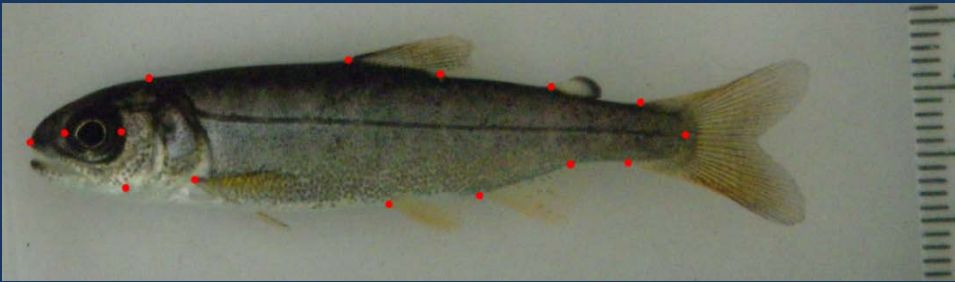


Relationship between life history tactics and behavioral phenotypes early in life

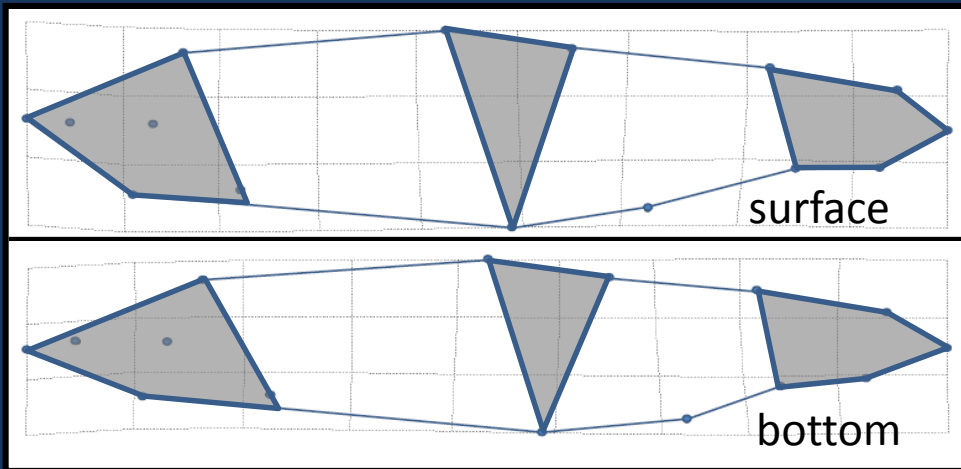
- Is juvenile migration phenotype established from recent stimuli or is it established earlier in life?
- Are there behavioral phenotypes expressed early in life that indicate life history tactic that will be expressed later?



Vertical position in tanks of first-feeding fish

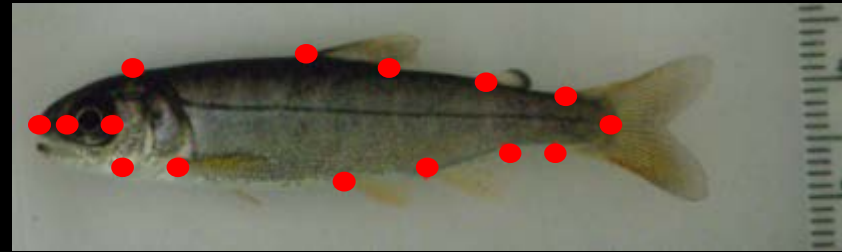


- Surface vs bottom
 - Shorter head
 - Smaller eye
 - Deeper body
 - Shorter caudal peduncle

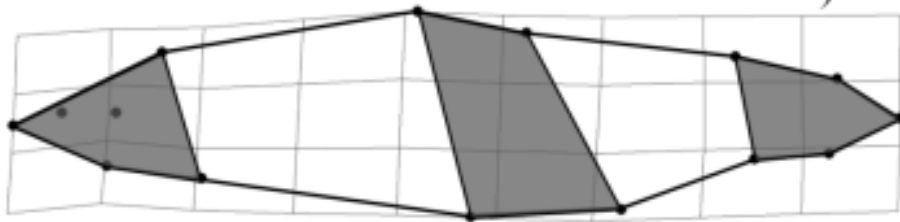


Morphological variation at 60 mm FL

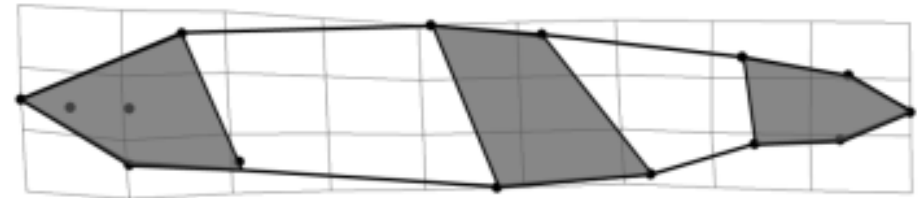
Body shape predicts life history tactic in wild juveniles



a) Migrants

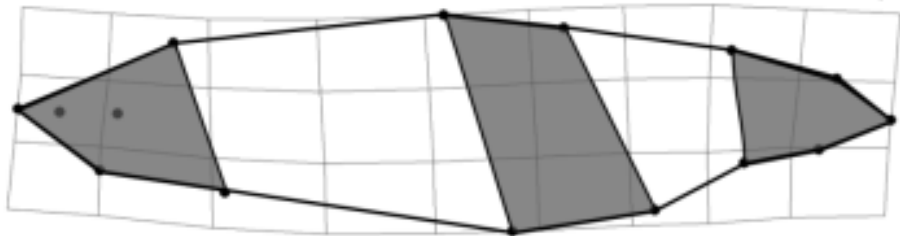


Fall migrant

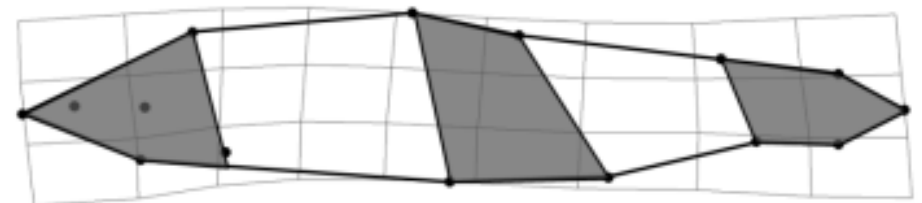


Yearling smolt

b) Parr



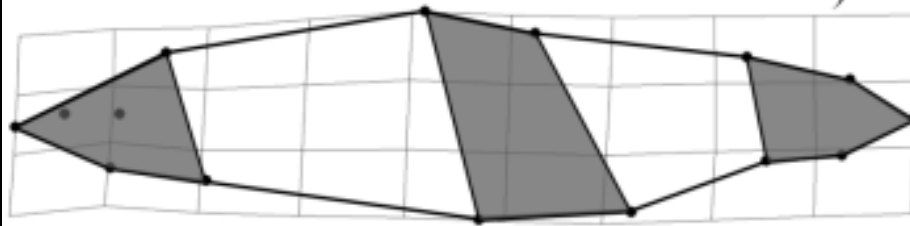
Downstream



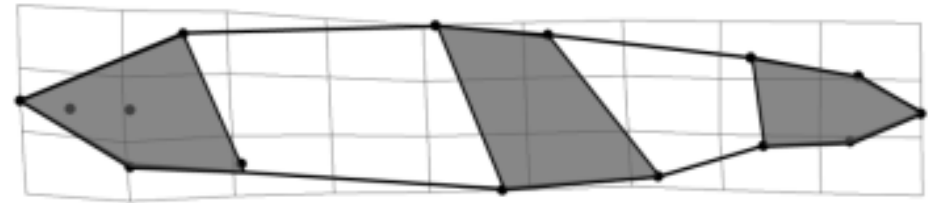
Upstream

Morphological variation & vertical position

a) Migrants

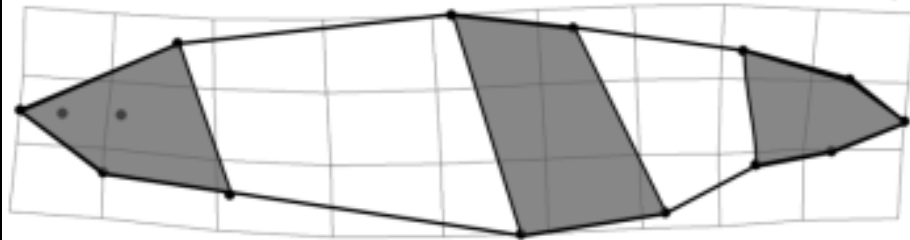


Fall migrant

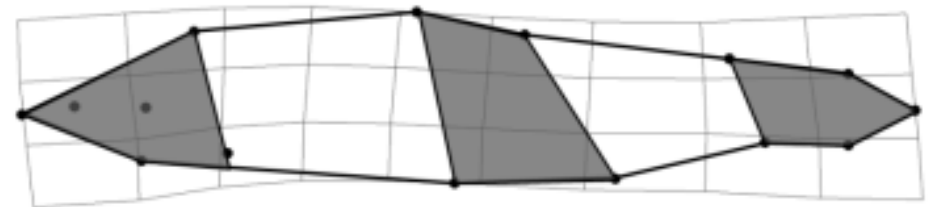


Yearling smolt

b) Parr

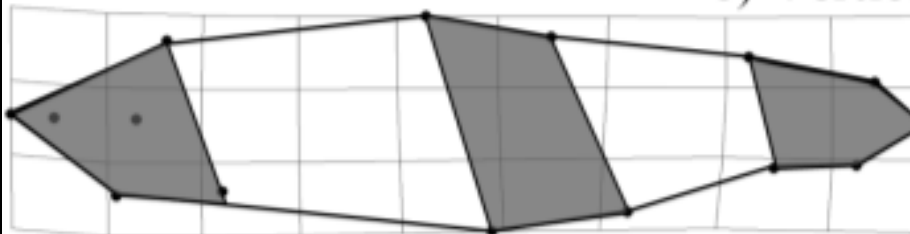


Downstream

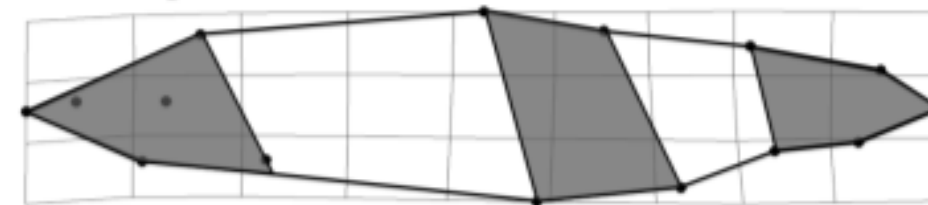


Upstream

c) Vertical sorted parr



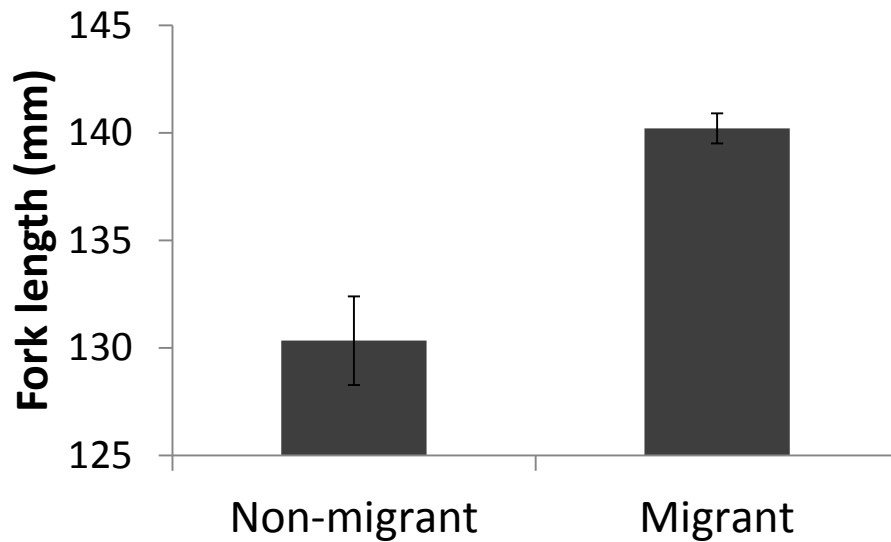
Surface



Benthic

Evaluating surrogates

- Tested movement patterns in artificial streams
 - Movement at night
 - Movement associated to rain events
 - (both like wild fish in streams)



Downstream movement of fish after swim-up



- Experiment manipulations
 - Development of fish
 - Density
 - Presence of feed
 - Acclimation time
 - Vertical position in tank
 - Substrate

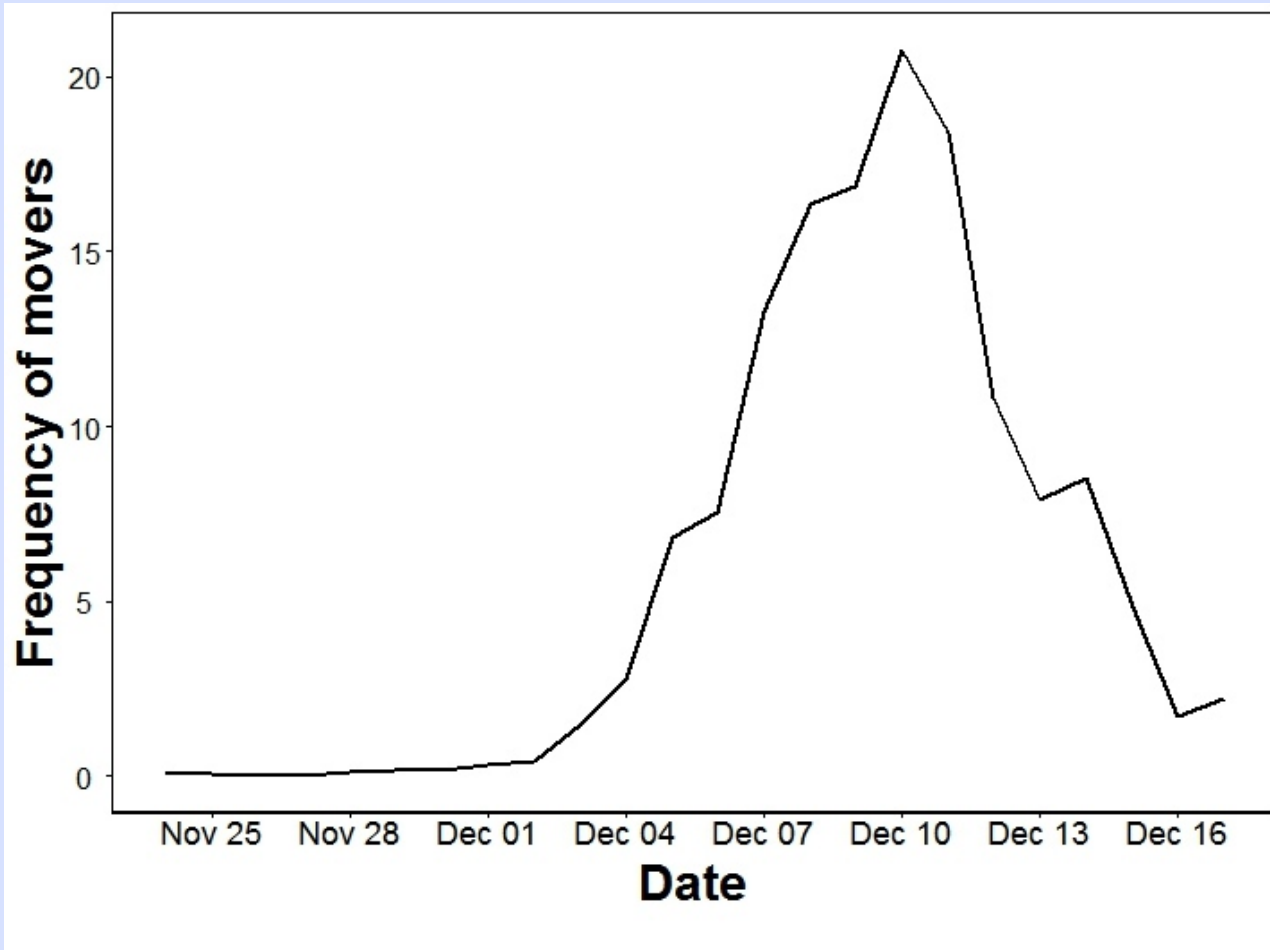
Self-Sorting Tank



Self-Sorting Tanks



Voluntary Movement

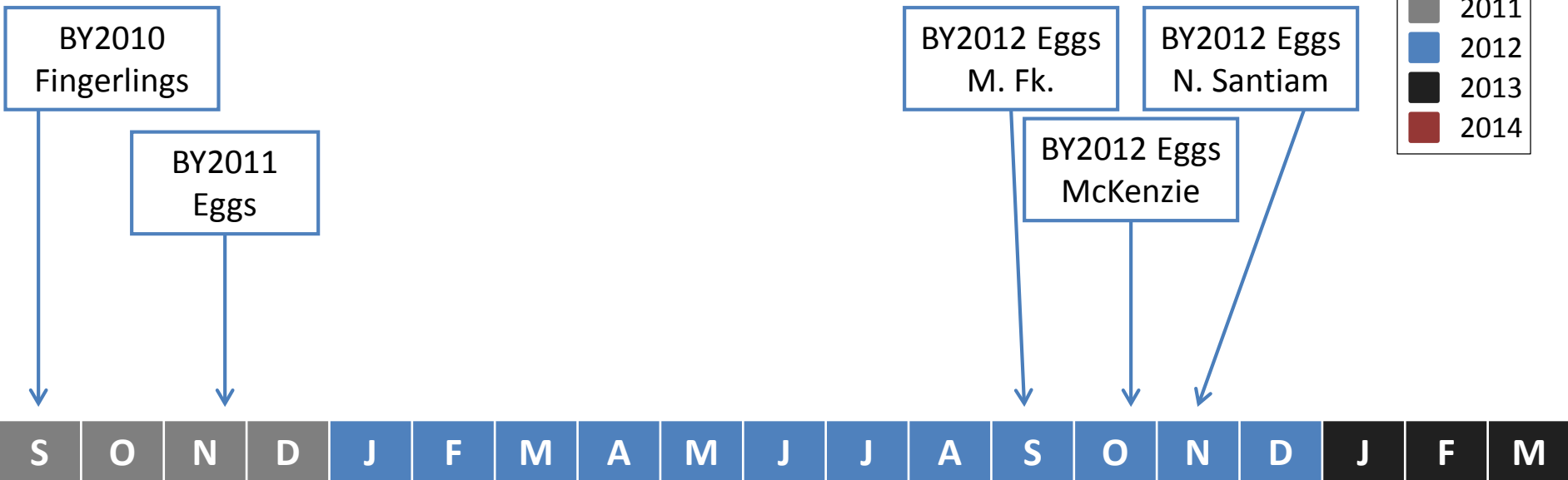
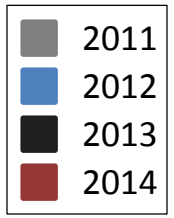


Questions



Questions





BY2010
Fingerlings

BY2011
Eggs

BY2012 Eggs
M. Fk.

BY2012 Eggs
N. Santiam

BY2012 Eggs
McKenzie

Deliverables

↓ ↓ ↓ ↓
BY2010 JSATS
Cougar & Detroit

↓ ↓ ↓ ↓
BY2011 JSATS
Cougar & Detroit

↓
BY2011 JSATS
Cougar & Detroit

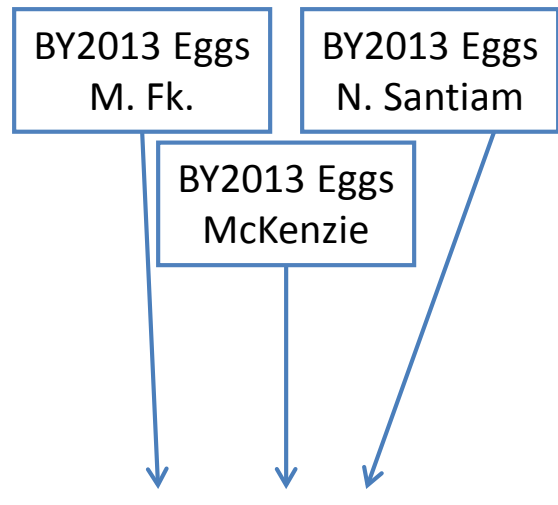
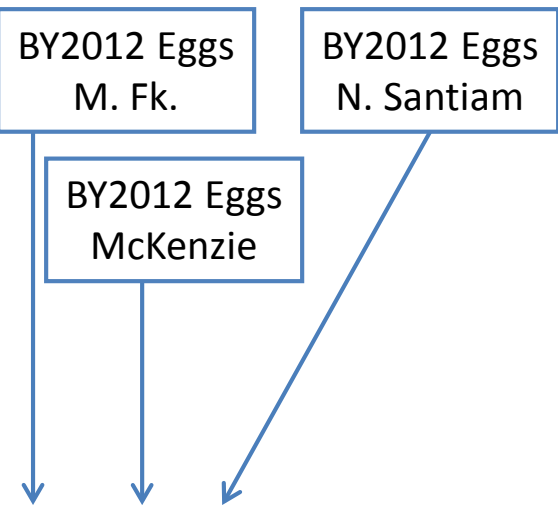
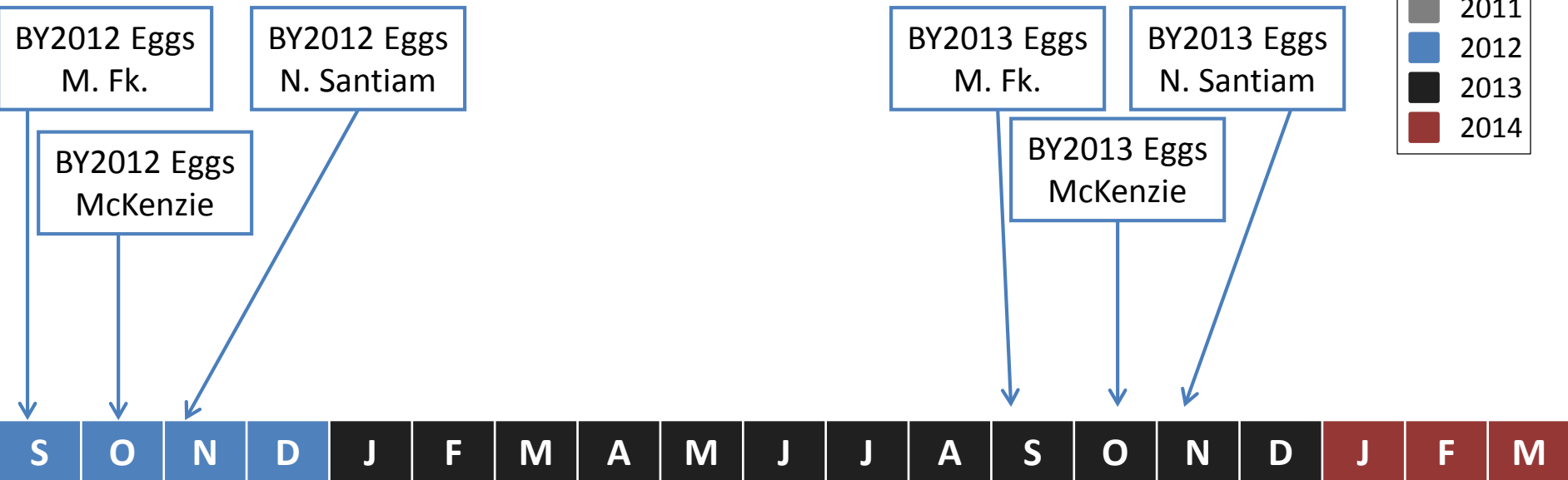
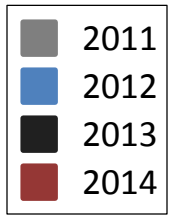
↓ ↓
BY2011 Radio
tag: Cougar

Literature Review

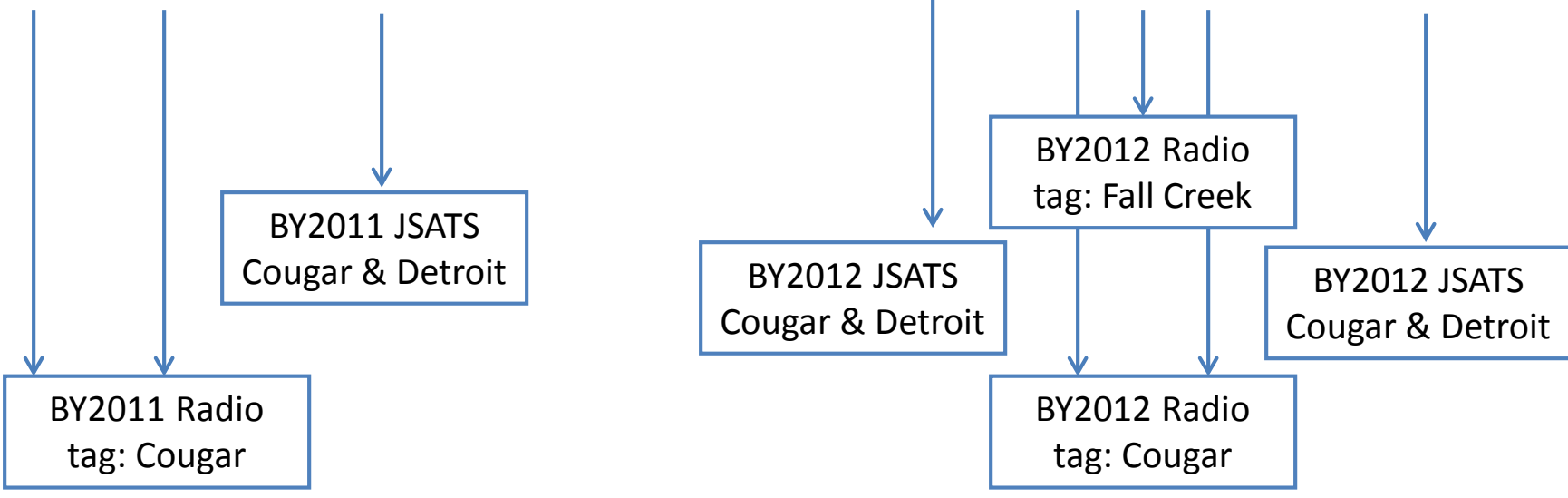
Chinook Phenotype
Workshop

Workshop report

Annual report



Deliverables

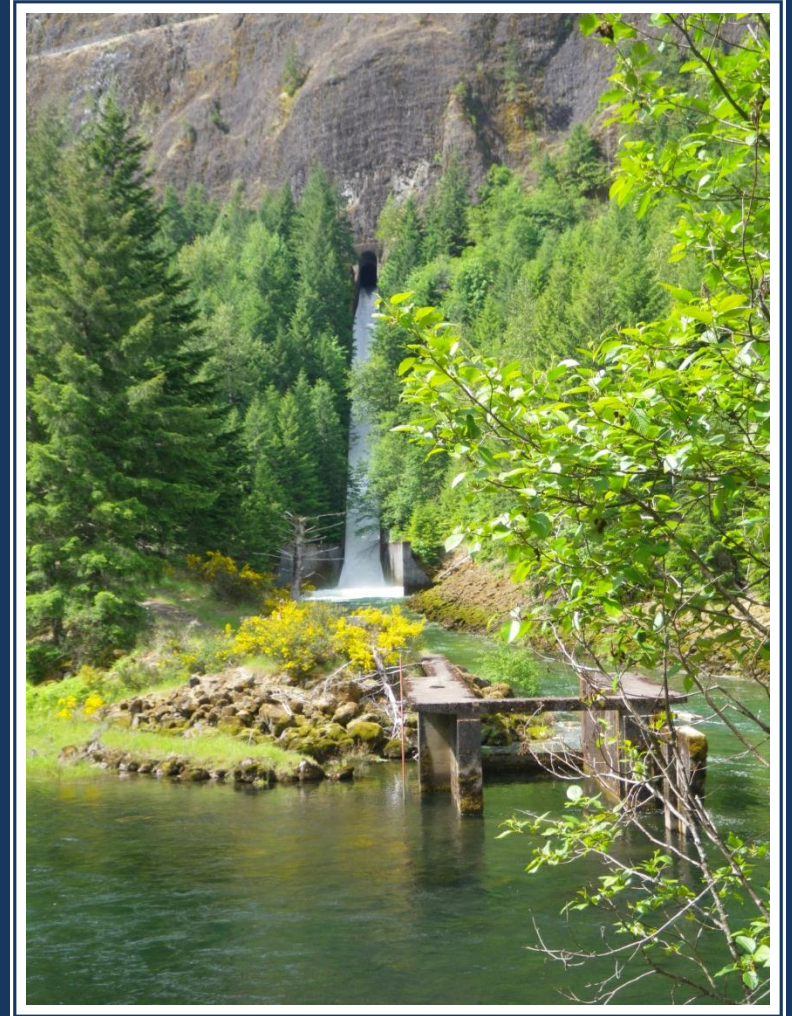
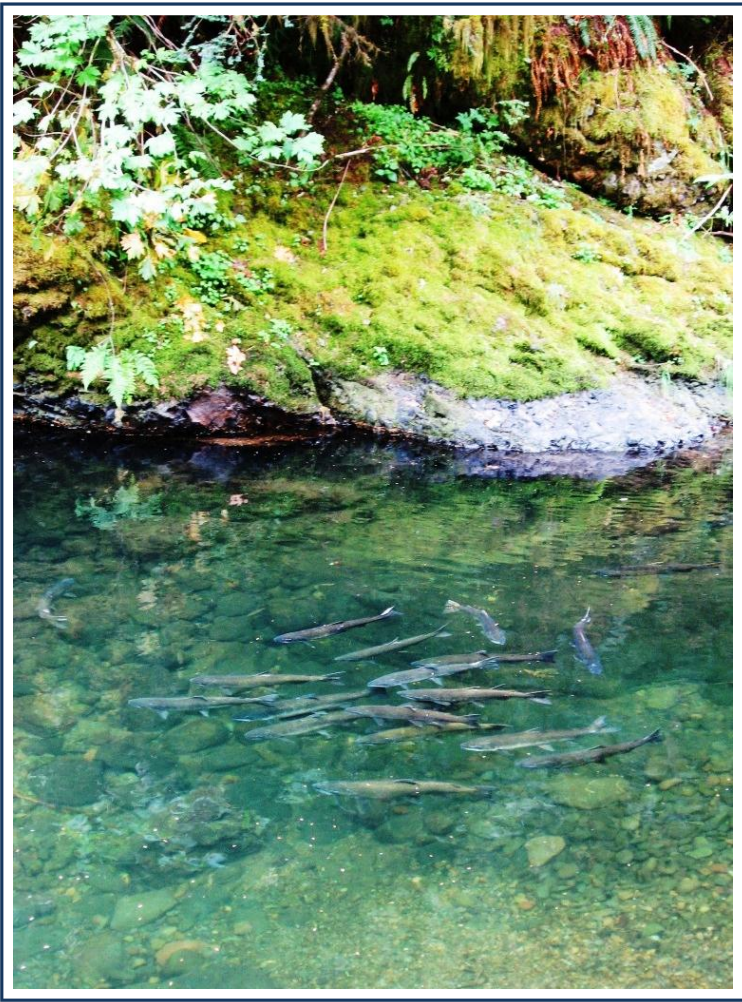


Annual report

Steelhead Surrogates

Annual report

Need for wild surrogates for studies for the Willamette Valley Project RME Plan



Experimental research to optimize performance of wild fish surrogates

- Research facilities
 - Fish Performance and Genetics Lab
 - Oregon Hatchery Research Center
- Controlled studies to determine aspects of rearing necessary to produce desired phenotype
- Establish measurable criteria to evaluate wild fish surrogates



Future plans

Provide wild fish surrogates
with desired phenotypes

```
graph BT; A["Establish target:  
Collection and synthesis  
of wild fish data"] --> D["Provide wild fish surrogates  
with desired phenotypes"]; B["Experimental research:  
Determine appropriate  
rearing protocols"] --> D; C["Validate surrogates:  
Measurable criteria to  
assess performance"] --> D;
```

Establish target:
Collection and synthesis
of wild fish data

Experimental research:
Determine appropriate
rearing protocols

Validate surrogates:
Measurable criteria to
assess performance

Evaluating surrogates

- Tested movement patterns in artificial streams
 - Movement at night
 - Movement associated to rain events

