# Evaluation of Methods to Reduce Straying Rates of Barged Juvenile Steelhead


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# Objective

**Identify and evaluate methods to reduce migration delay, wandering, and stray rates of transported steelhead**

# Background

**1998-2002 Telemetry study indicates increased straying in barged vs. in-river fish.**


**(Keefer et al. 2008)**

**Mid-Columbia R. steelhead - ESA listed (Deschutes, John Day, Umatilla) populations essential for DPS recovery. Snake River hatchery strays are considered the primary threat to Deschutes River and John Day River (Carmichael and Taylor 2009).**

# Hypothesis

Collecting and barging steelhead rapidly downstream disrupts sequential imprinting leading to increased straying

(COE website photo)

# Steelhead outmigration/sequential imprinting

## In-river

-Volitional movement between water sources

-Slower outmigration

-”Pausing” at tributaries

-Rheotactic cues



## Barged

-Navigation channel

-Fast “outmigration”

-No tributary sampling

-No rheotactic cues

-Stress

# Objectives

**Objective 1.** Assess imprinting success by monitoring imprinting-associated changes in physiological function in barged vs. In-river migrants.

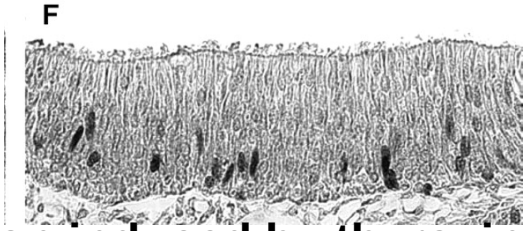
**Objective 2.** Identify key environmental parameters that are important for successful imprinting in barged fish using a controlled laboratory study.

**Objective 3.** Initiate tests of a modified barge protocol designed to maintain survival benefits while reducing wandering, delay, and straying behavior of returning adults.

# T3/T4 surge during smolting is associated with anatomical and physiological changes in olfactory system

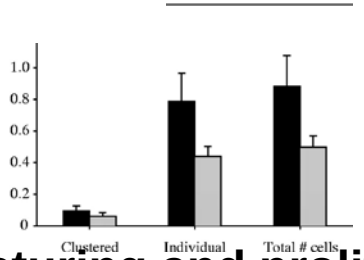
- **Quadrupling of ORN number during smolting**

(Bowers 1988, Jarrard 1997)




- **ORN proliferation induced by thyroxine implants**

(Lema and Nevitt 2003)



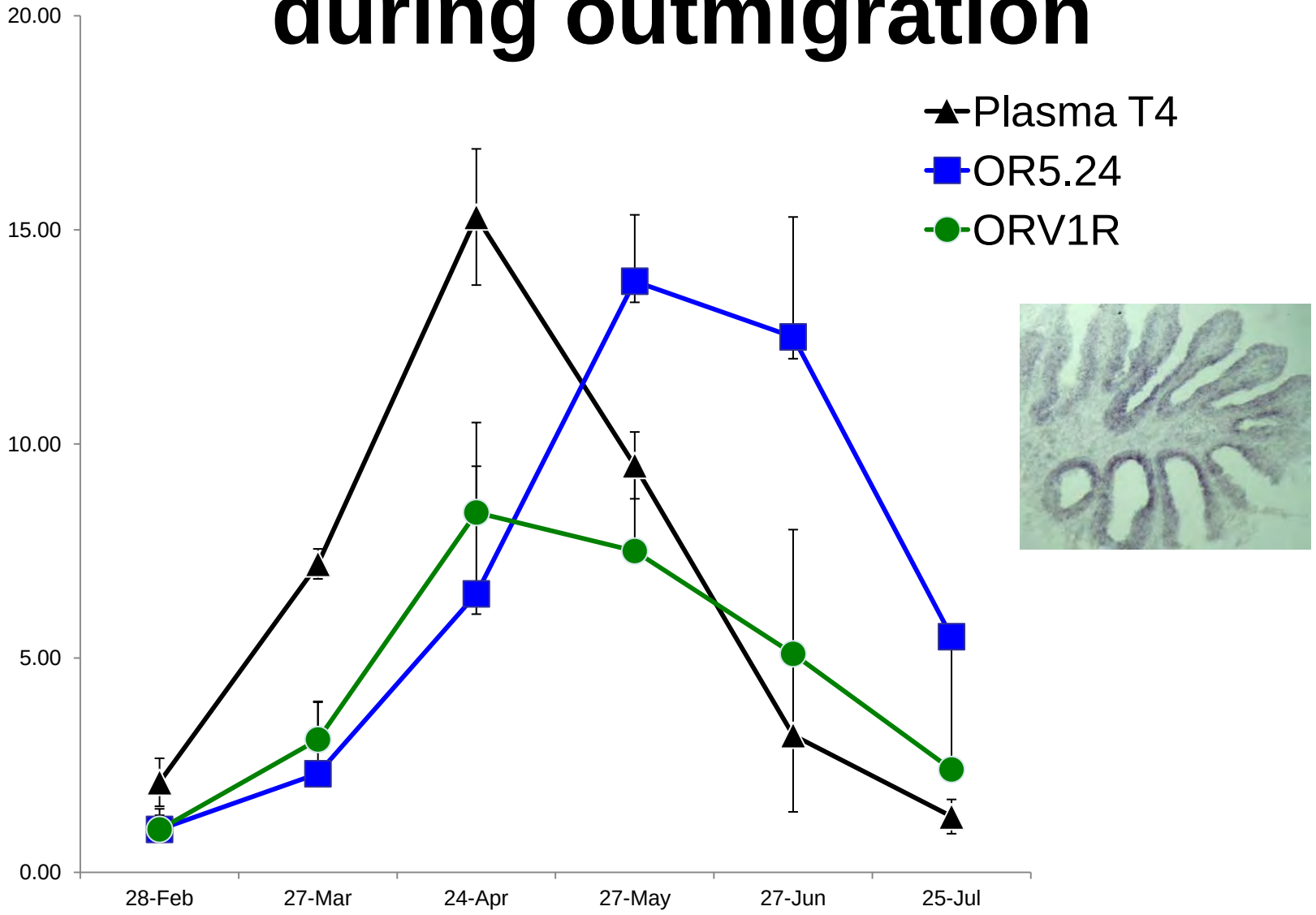

- **Restructuring and proliferation of glomeruli in bulb**

(Jarrard 1997, Nevitt unpub.)

- **Heightened/altered sensitivity to odorants/increased OR expression**

(Morin et al 1989, 1992; Dittman unpub.)

# Changes in endocrine/olfactory system during outmigration



# Hypothesis

Decreased environmental stimuli associated with barging inhibits thyroid signaling and imprinting success

-Lack of novel tributary waters

-Insufficient exposure for successful memory formation

-Insufficient current/rheotactic information

-Stress-induced impacts on thyroid activity

# Objective 1. Assess imprinting success by monitoring imprinting-associated changes in physiological function

- Standard barge vs. In-River migrants
- Assess smolting/imprinting metrics including plasma and pituitary hormone levels, gill ATPase activity, expression of olfactory signaling and memory-associated genes in olfactory rosettes and bulbs.
- Collect 20 hatchery and 20 wild Snake River steelhead at each sampling location/date.
- Assess imprinting metrics for early (Apr 30-May 10) and late (May 22-June 8) migrants/riders.

# Objective 1. Barged fish

- Collect Steelhead smolts at Lower Granite Dam on Snake River
- Load steelhead smolts into net pens within barge holds and sample (20H/20W) fish at:

  -Lower Granite (Day 1, ~10 AM)

  -McNary (Day 1, ~Midnight)

  -Bonneville (Day 2, ~6 PM)
- Conducted 2x:

  -early (May 1-4

  -late (May 22-25)


WEAR YOUR
LIFE JACKET
Juvenile Fish
Transportation


UMATILLA
Juvenile Fish Transportation
UMATILLA
UMATILLA


ARGONAUTS
DARBAN
HIGH FIVE

# Objective 2. In-river migrants

- Pit tag Steelhead smolts at Lower Granite Dam on Snake River

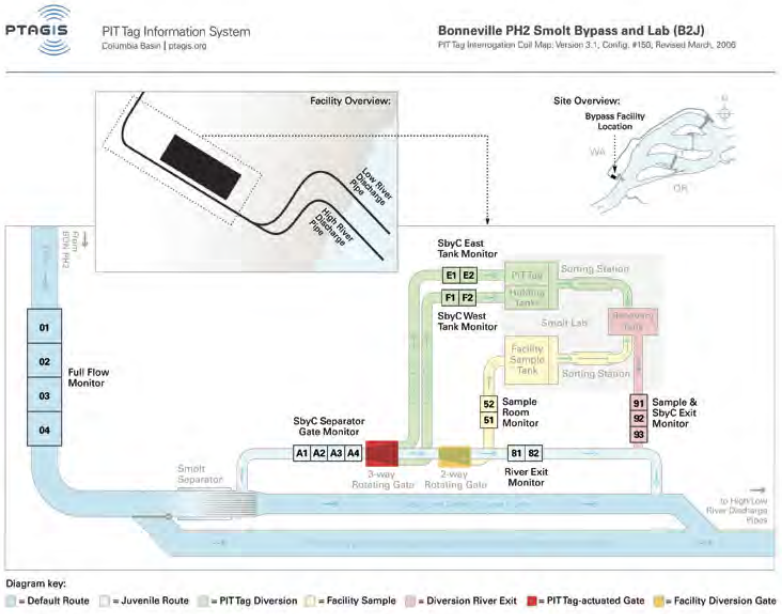
  Early: May 1-4 (Hatchery 2931; Wild 2865)

  Late: May 22-25 (Hatchery 1945; Wild 3923)

- Using Sort by Code system, sample (20H/20W) from this cohort of fish at:

  -McNary (Day 6-7)

  -Bonneville (Day 10-15)

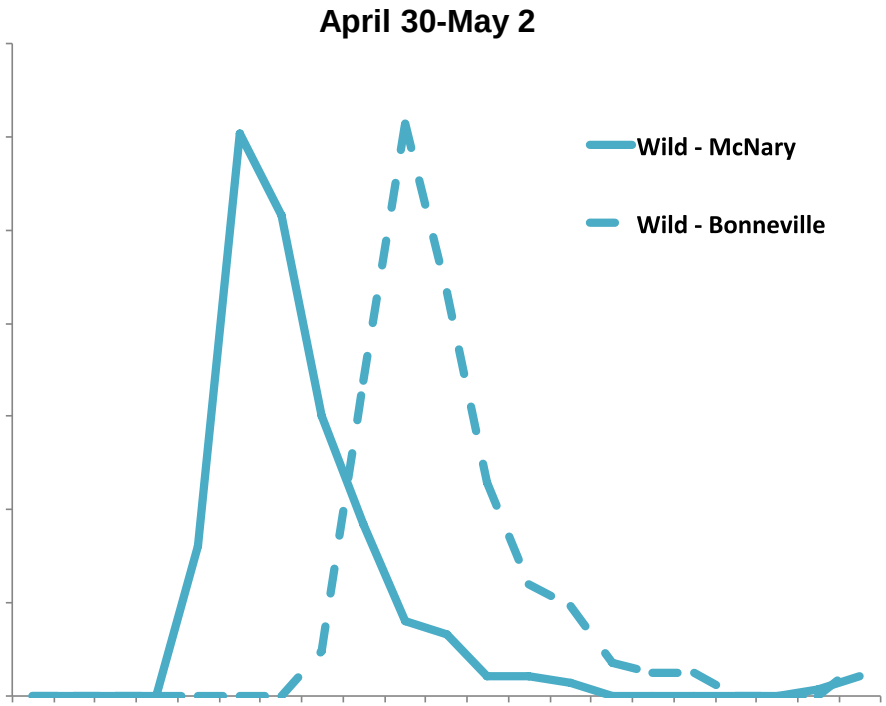



# Objective 2
# Preliminary Results

- **Migration Behavior and Timing**
- **Plasma Thyroxine**
- **Gill Na+/K+ ATPase**

# Differences between Barged and In-river Steelhead

## Timing



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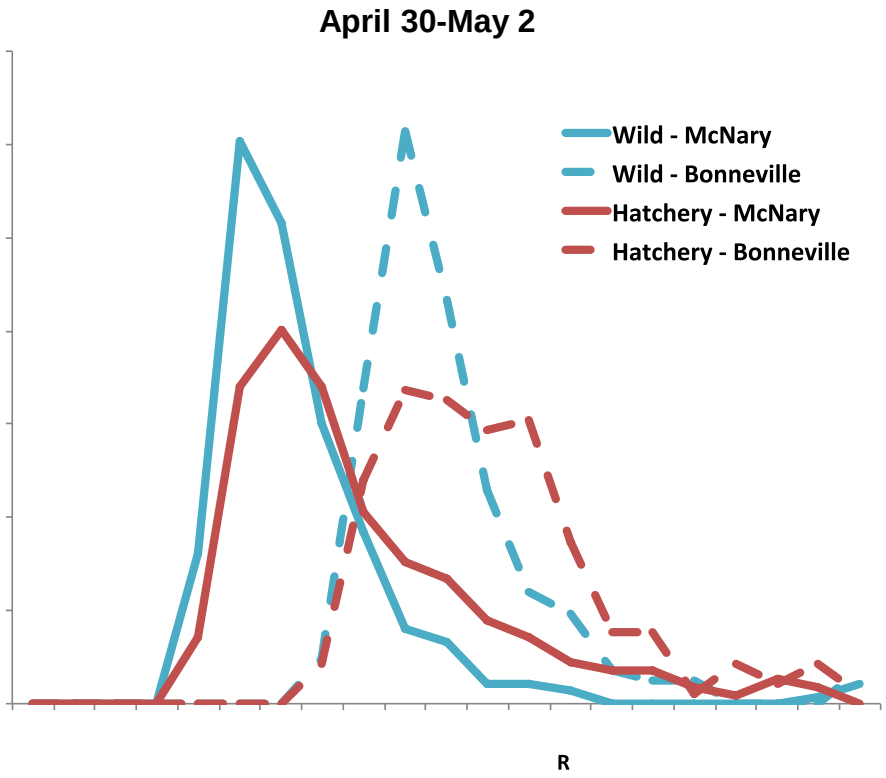

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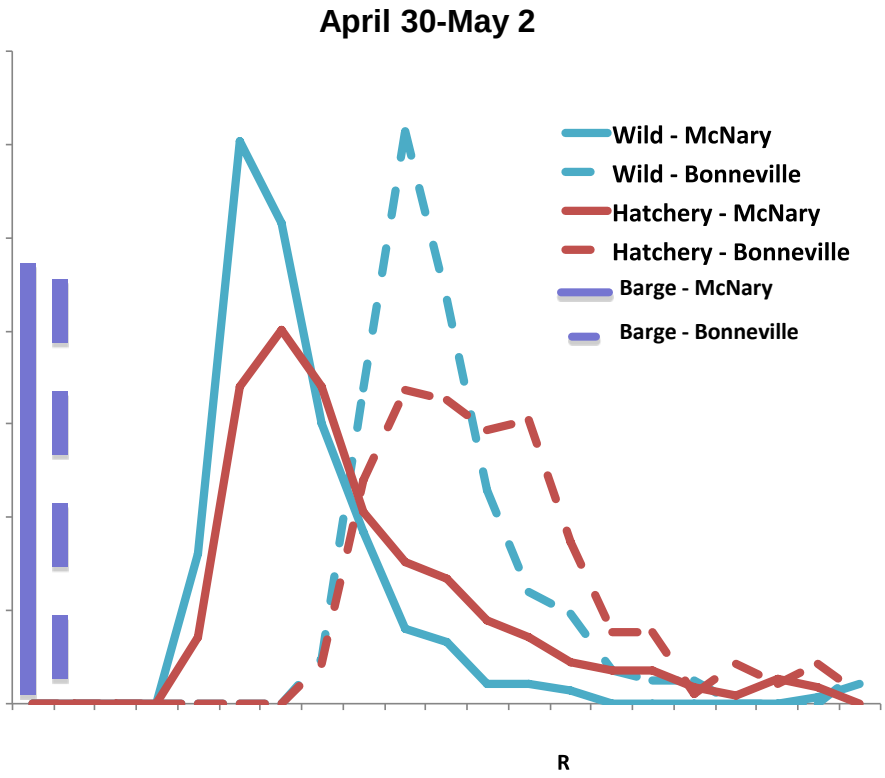

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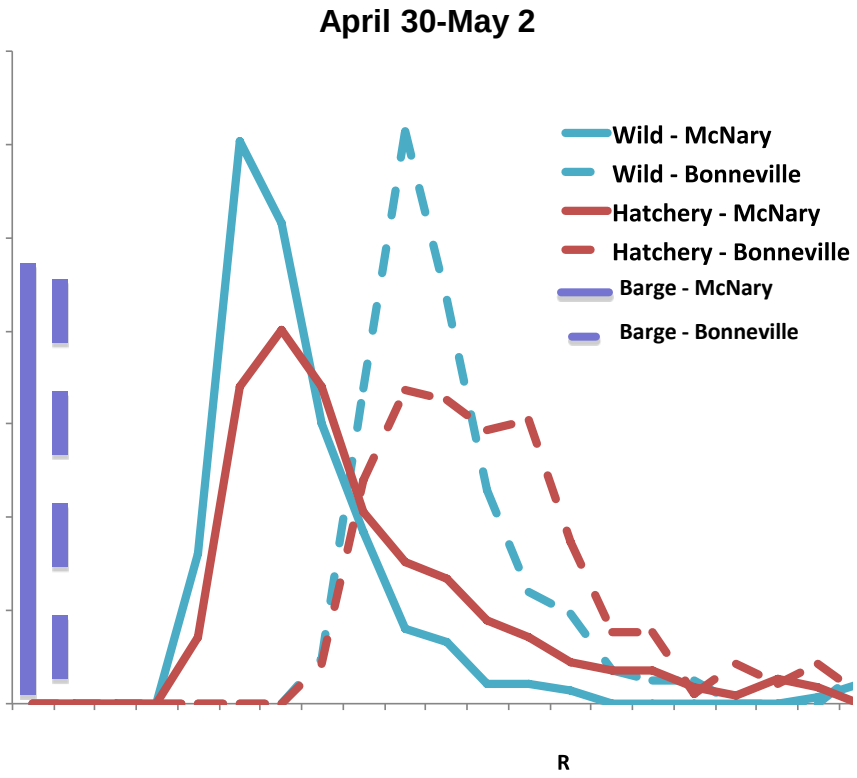
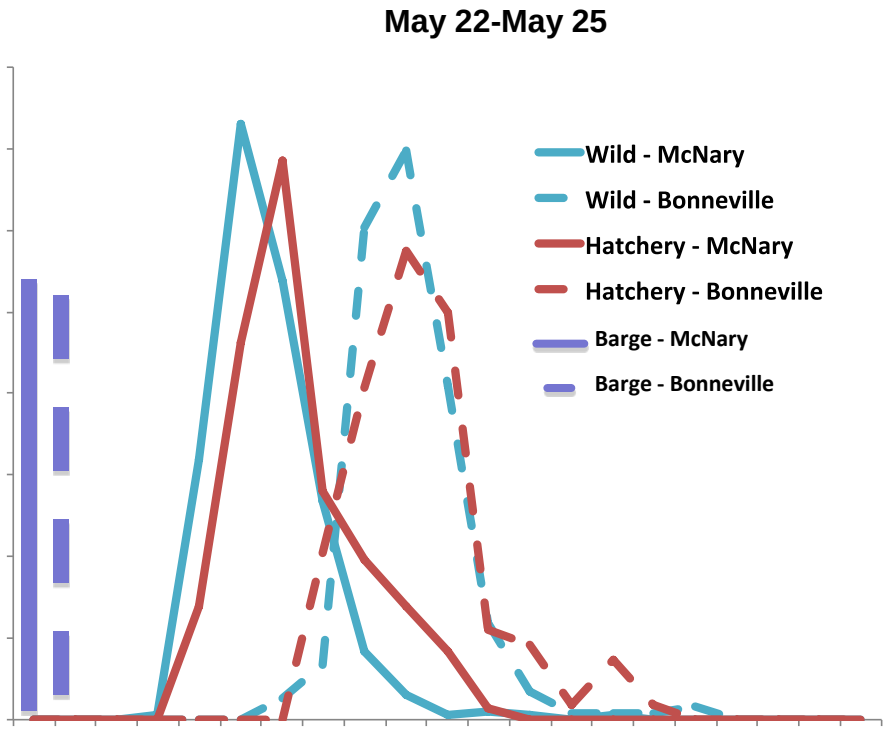
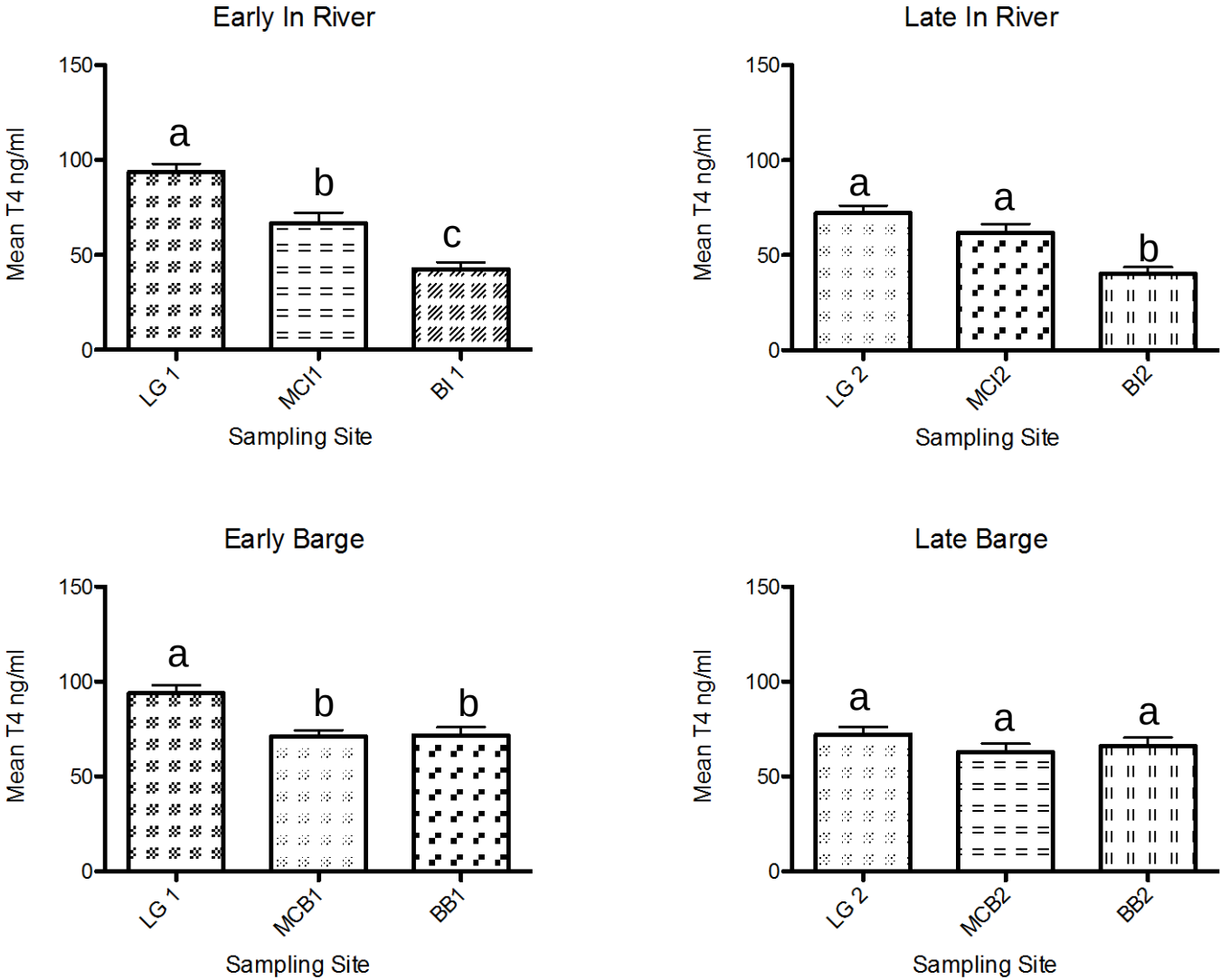


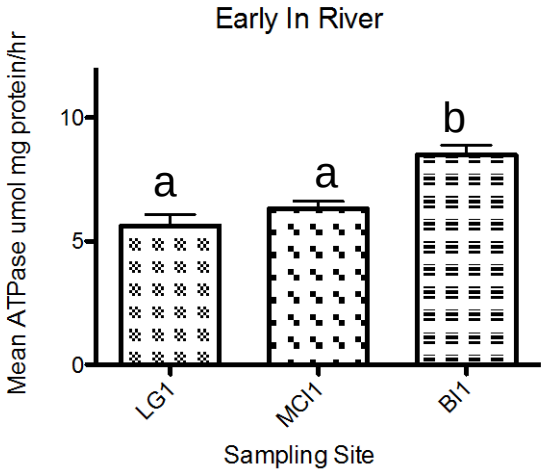
# Differences between Barged and In-river Steelhead

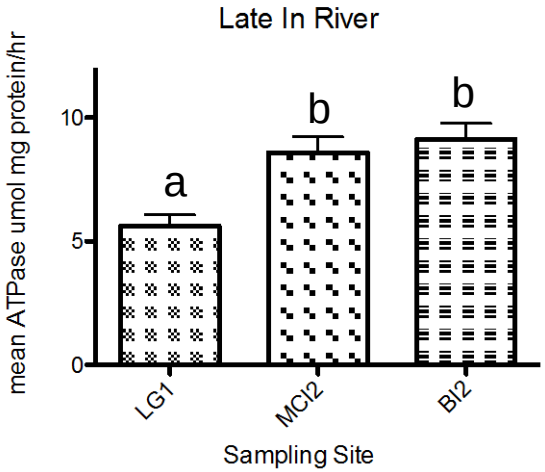
## Plasma Thyroxine

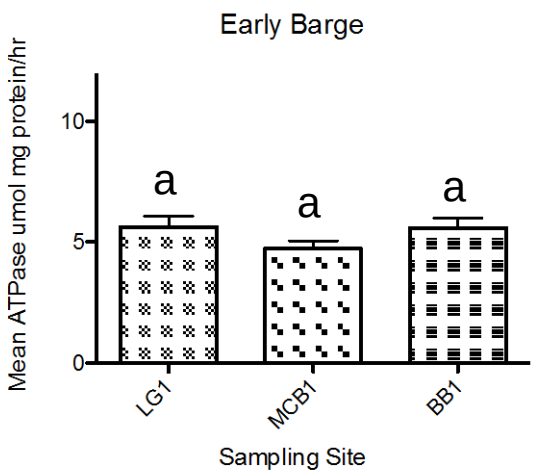


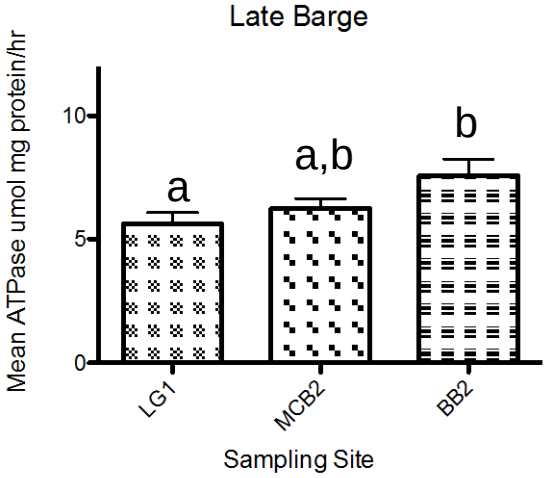
# Differences between Barged and In-river Steelhead

## ATPase



# Differences between Barged and In-river Steelhead

**-Downstream timing is clearly different**

**-Physiological Indices of smolting (T4, ATPase) are muted in barged salmon**

**-Thyroid hormone signaling dynamics are altered in barged fish**

- **-novel water imprint to barge?**
- **-stress effect on T4?**
- **-altered dynamics alter imprinting?**

**-Olfactory gene imprinting indicators should shed further light**

# Objective 2. Identify key environmental parameters that are important for successful imprinting in barged fish using a controlled laboratory study.

**Assessment of alternate barging protocols using imprinting-associated changes in physiological function**

**-Initiated in 2011 with Wallowa hatchery steelhead**

**-2012: Assess importance of tributary sampling/period**

**-2013:Assess importance of rheotactic cues and movement**

# Objective 2. Assess importance of tributary experience (novel water) and exposure period

Wallowa Hatchery steelhead

↓

Reared to match Snake River hatchery practices (i.e. 60-100gm at release)
(establish smolt profile for physiological parameters by sampling every 3 weeks)
February-July 2012

Novel water treatments
(May 2012)

1. Control – Maintained on 100% hatchery water
2. 10% change (90% hatchery water, 10% Creek water)
3. 50% change (50% hatchery water, 50% Creek water)
4. 100% change (100% Creek water)
5. 100% change (100% Creek water); 1 hour
6. 100% change (100% Creek water), 12 hours

↓

Sample fish at t=0,1,2, 4, 7, 14 days

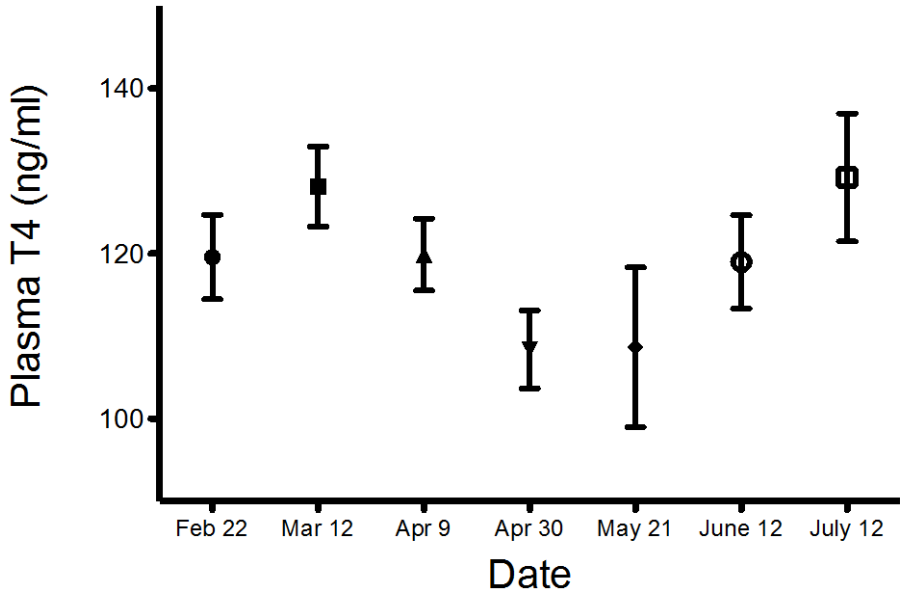
# Objective 2
# Preliminary Results

- **Physiological Smolt/Imprinting Profile in hatchery**
- **Effects of novel waters**
- **Time of exposure to novel water**

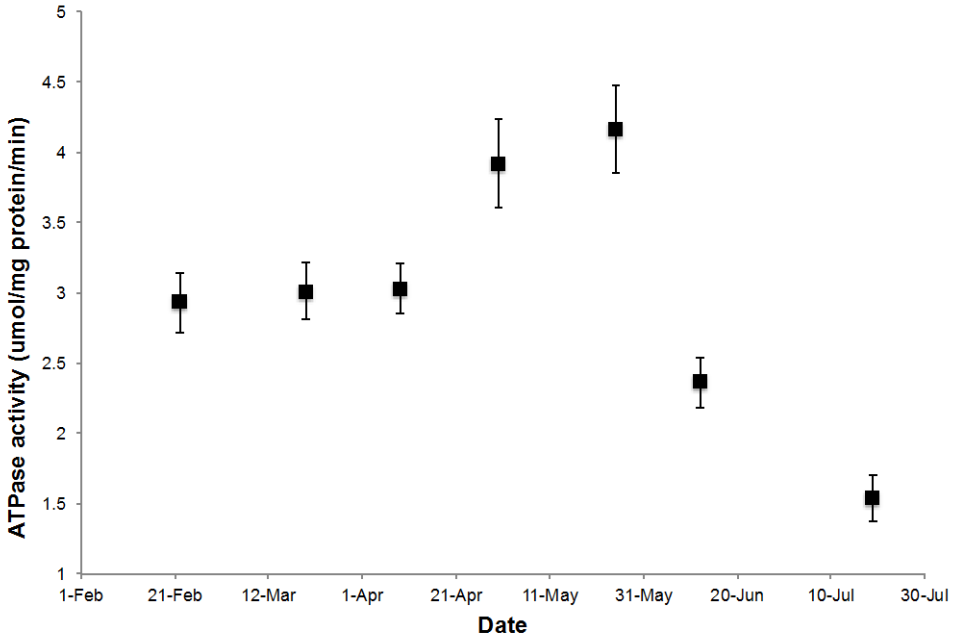
# Objective 2

## Smolt Profile

### Thyroxine

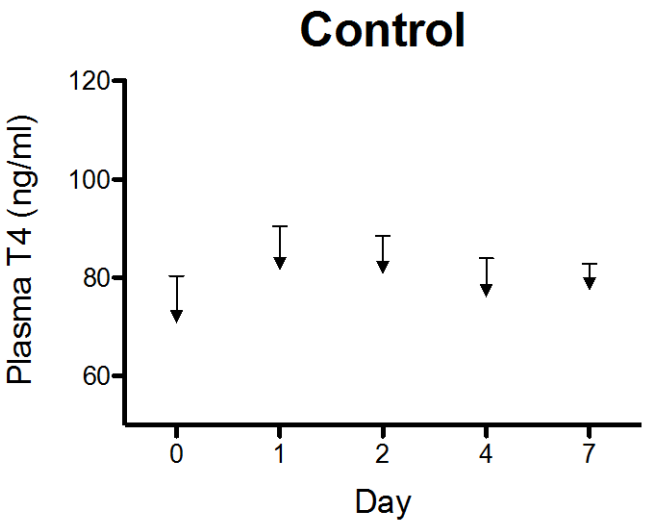


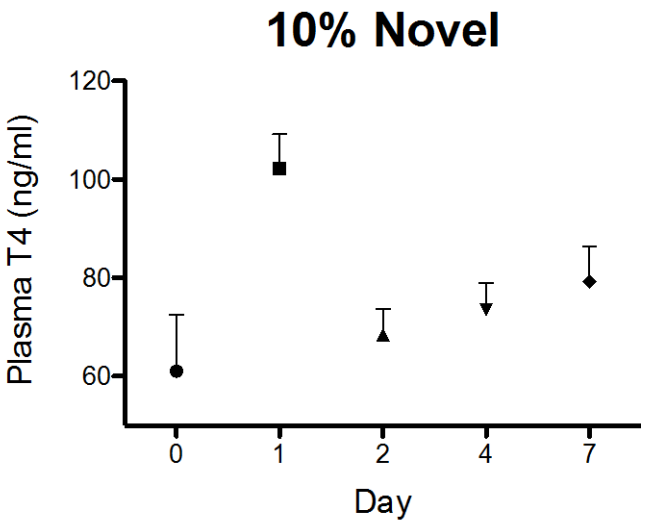

### ATPase

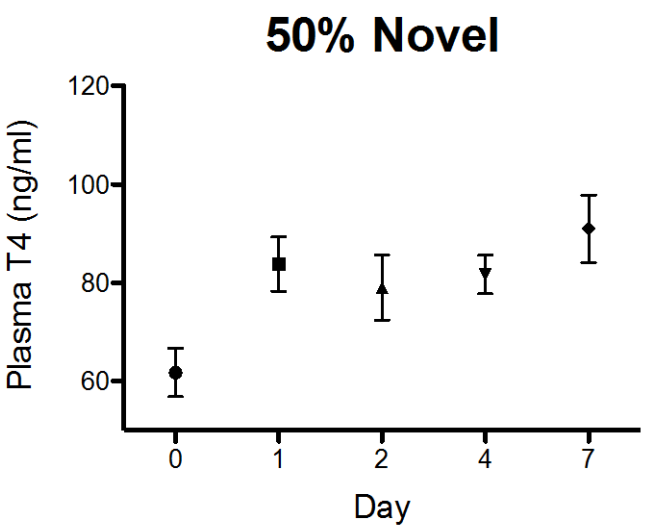


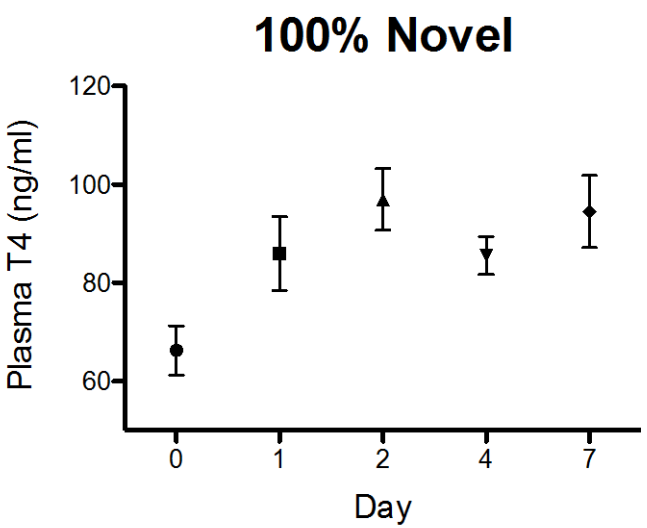
# Objective 2

## Effects of Novel Waters on Thyroxine



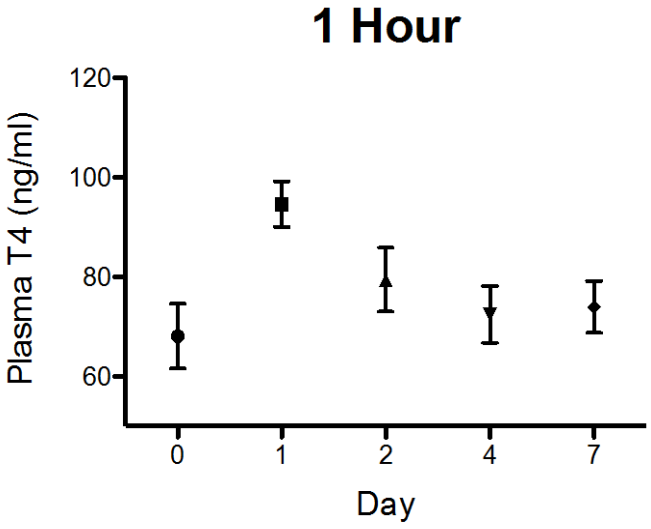



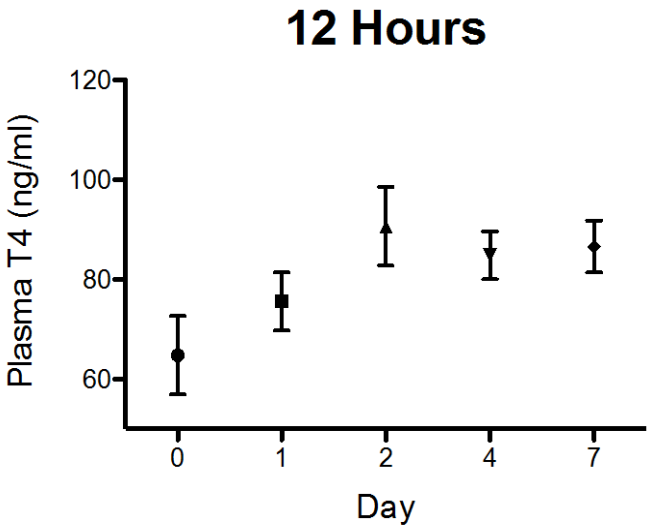



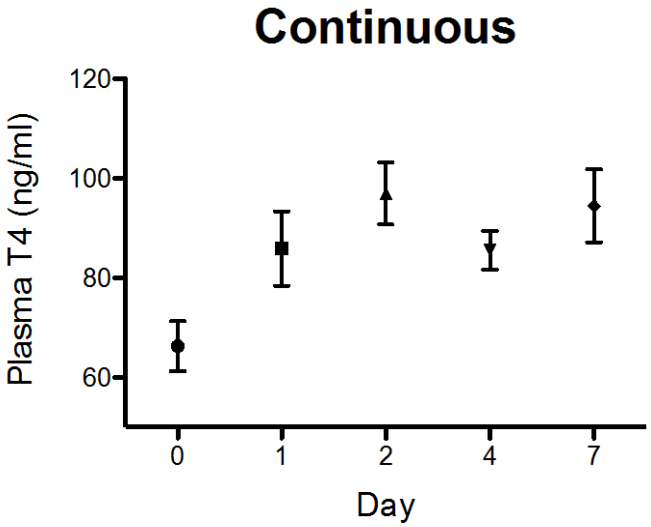



# Objective 2

## Effects of Exposure Time on Thyroxine



# Effects of Novel Water Exposure

**-Hatchery steelhead display normal (albeit muted) smolt profiles**

**-Exposure to as little as 10% novel water may elicit transient increases in T4, higher % novel water may maintain higher levels longer.**

**-Exposure to novel water for as little as little as 1 hour may elicit transient increases in T4, longer exposures may maintain higher levels longer.**

# Next…….

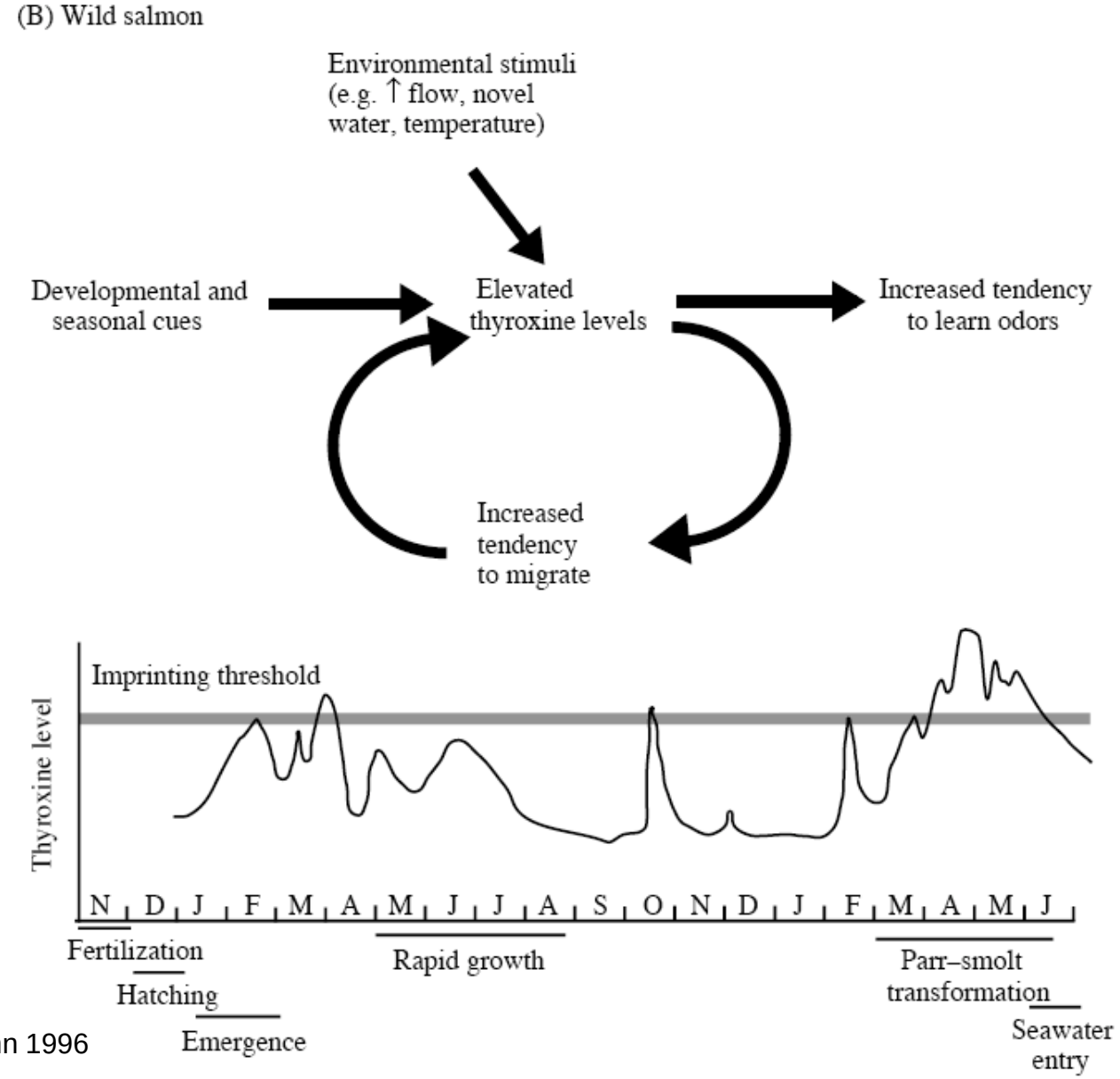
-Complete analysis of olfactory gene expression imprinting markers

-Initial recommendations for alternate barge protocols to minimize straying

-2nd year In-river-barge comparisons; importance of rheotactic cues

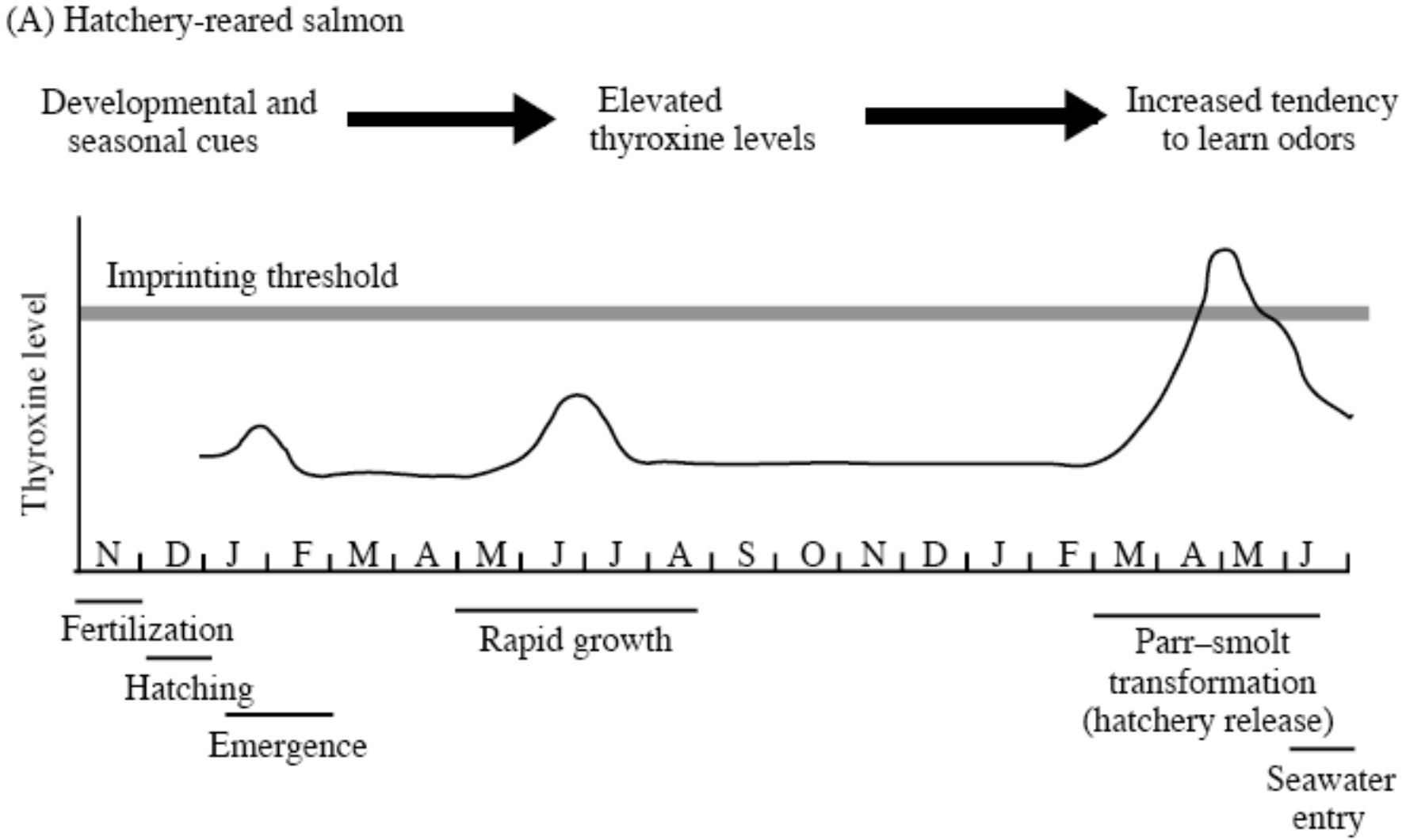
# Questions?

# Thyroid hormone signaling (& imprinting) is a dynamic process influenced by development and environmental stimuli




Dittman and Quinn 1996

# Thyroid signaling is muted in stable environments

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