# Interactions Between Wild and Hatchery Spring Chinook Salmon Spawning In An Artificial Stream

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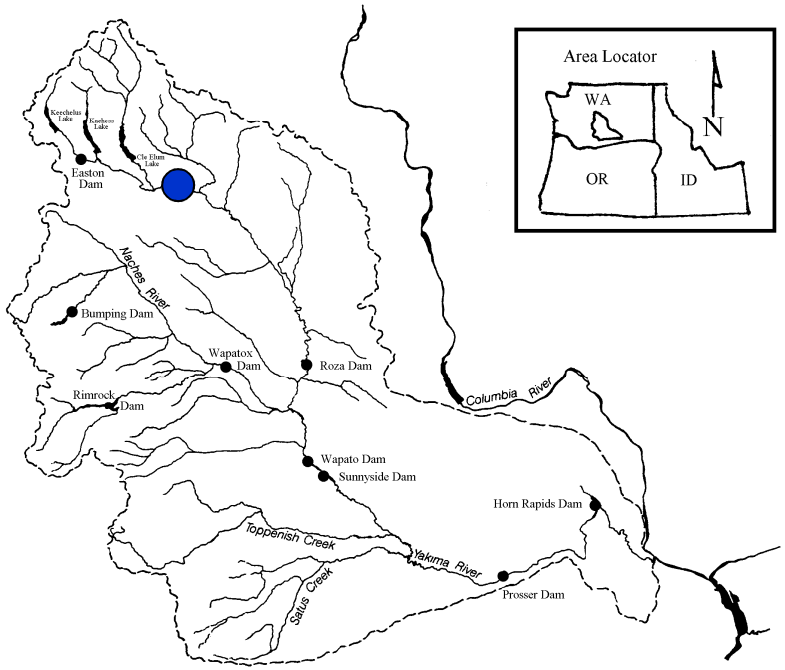
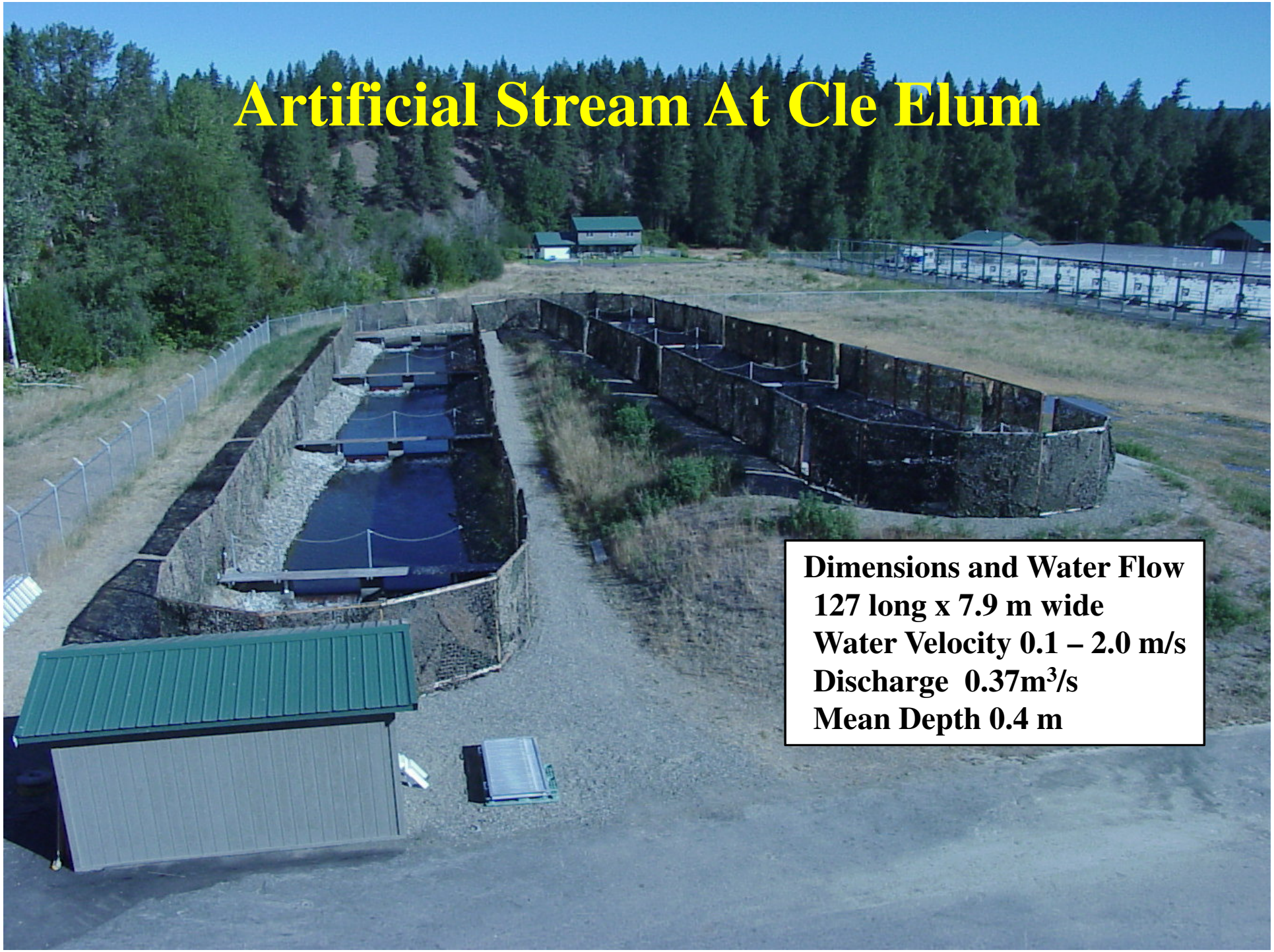
# Types Of Fish Used




Location Of The Cle Elum Supplementation Research Facility

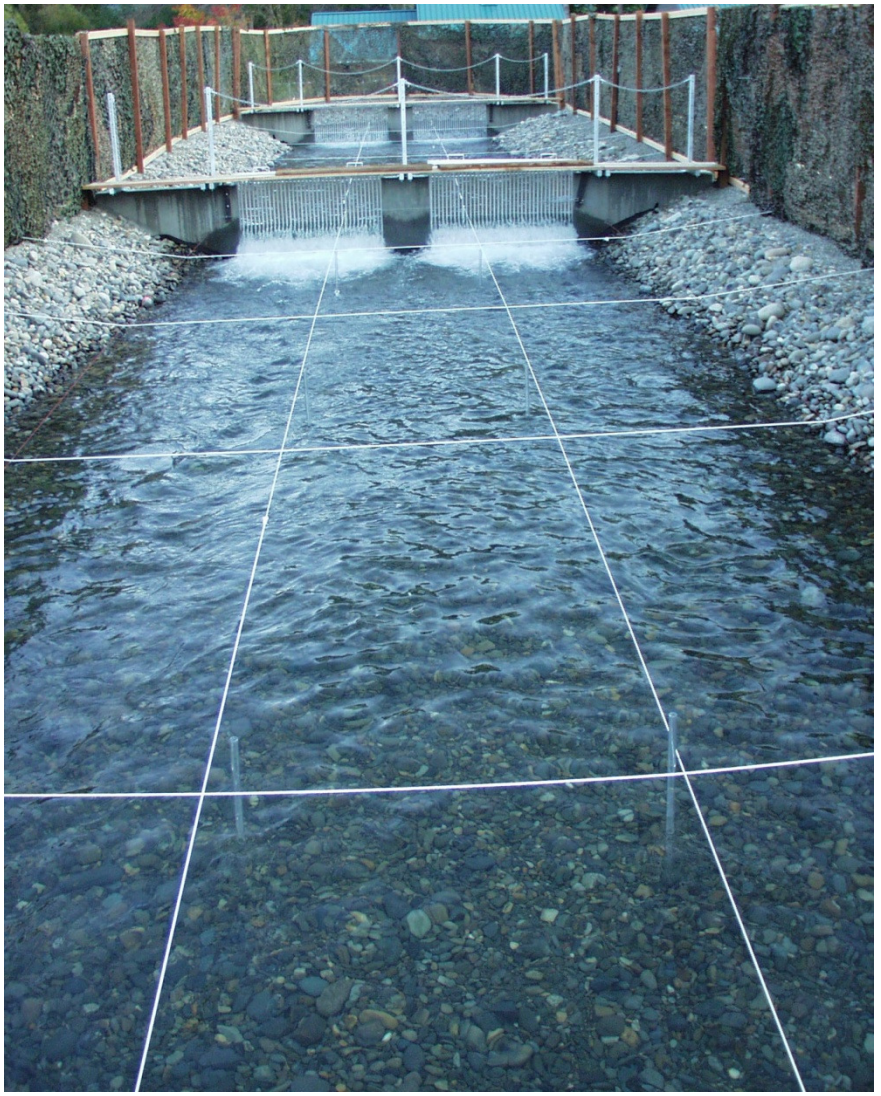
- Wild: Native Upper Yakima River Spring Chinook With Little Or No Hatchery History
- Hatchery: First-Generation , Derived From Native Upper Yakima River Spring Chinook (Local Stock)


Artificial Stream At Cle Elum
Dimensions and Water Flow
127 long x 7.9 m wide
Water Velocity 0.1 – 2.0 m/s
Discharge 0.37m3/s
Mean Depth 0.4 m

# Why An Artificial Stream?

## Confounding Factors Can Be Controlled

- **Physical Environment** (Gravel, Water Velocity & Depth)
- **Fish** (No., Type, Maturation, Condition, Entrance Timing)
- **DNA** (All Adults & Subsample Of Fry)
- **Behavior** (Correlate Individual Behavior with Fish Origin & Breeding Success)



# Types Of Fish Placed Into The Stream

**Hatchery & Wild** 4 & 5 yr –old males & Females:
("Large Anadromous Fish")

**Hatchery & Wild** 3-yr-old males:("Jacks")

# Types Of Fish Placed Into The Stream

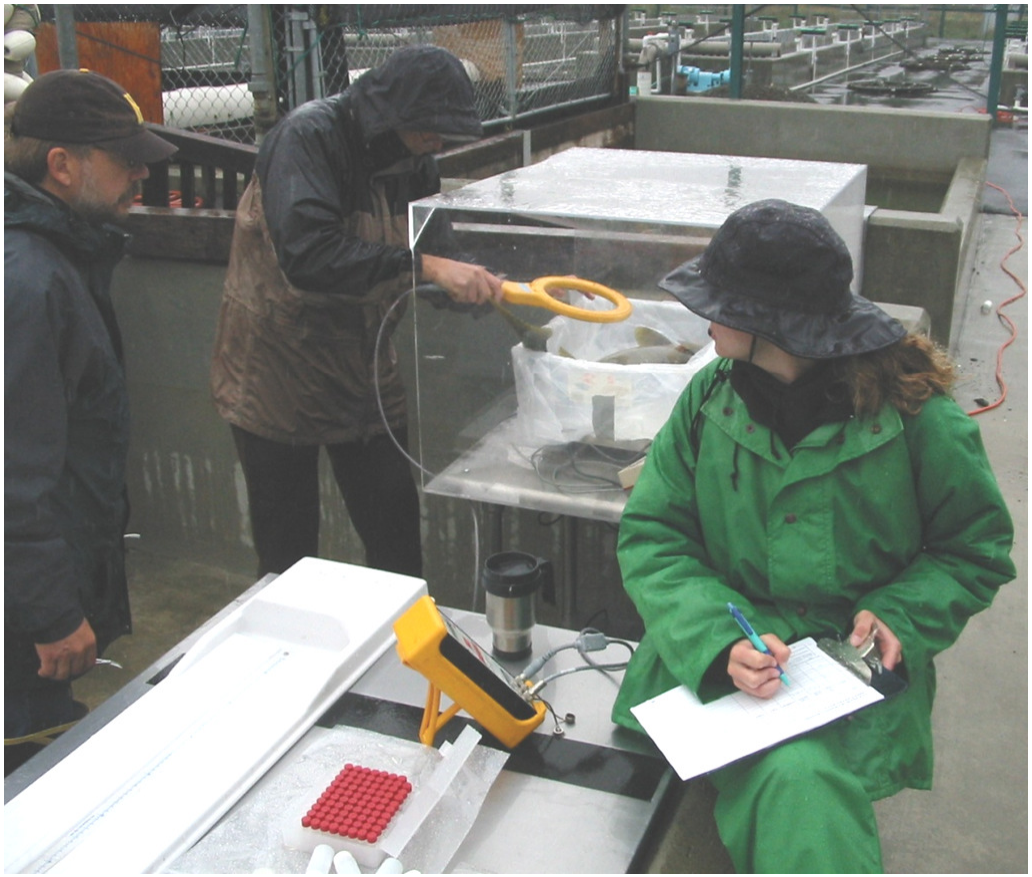
Hatchery Origin “Yearling Precocious Male”

Wild Origin “Yearling Precocious Males”

# Types Of Fish Placed Into The Stream

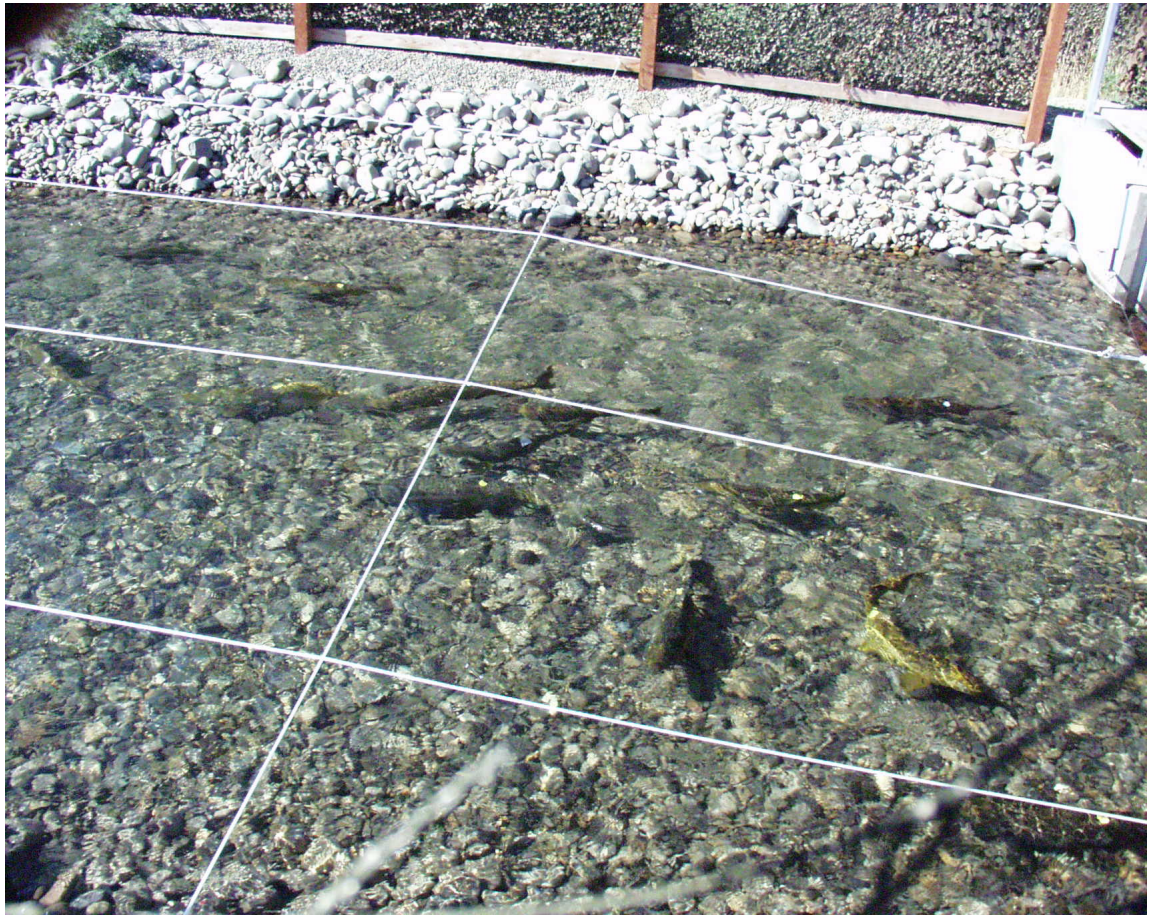
Wild “Sub Yearling Precocious Male”

# Prior To Placement, Each Fish Was:



# And, A Small Bit Of Fin Material Was Removed For Later DNA Extraction

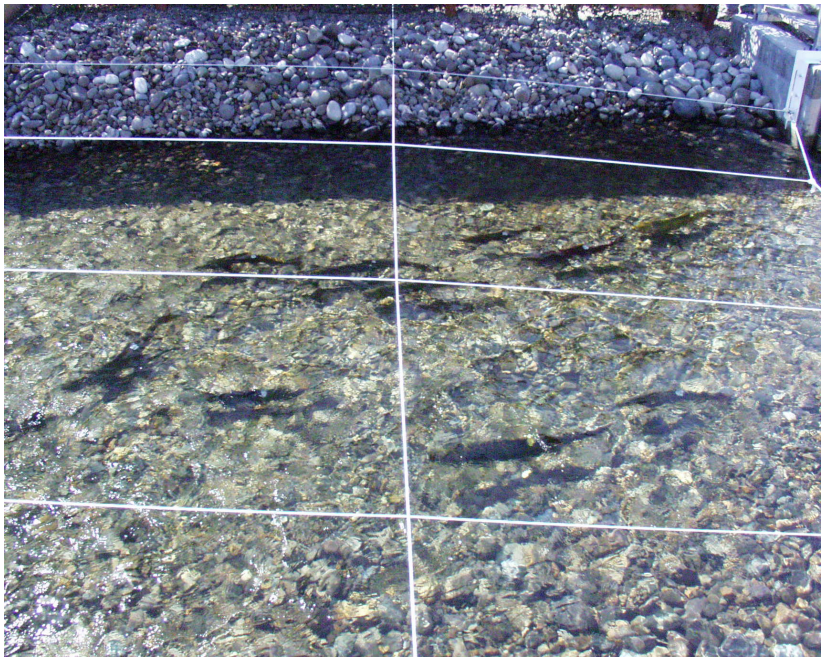
# They Were Then Released Into The Stream & Spawned Under Quasi-Natural Conditions

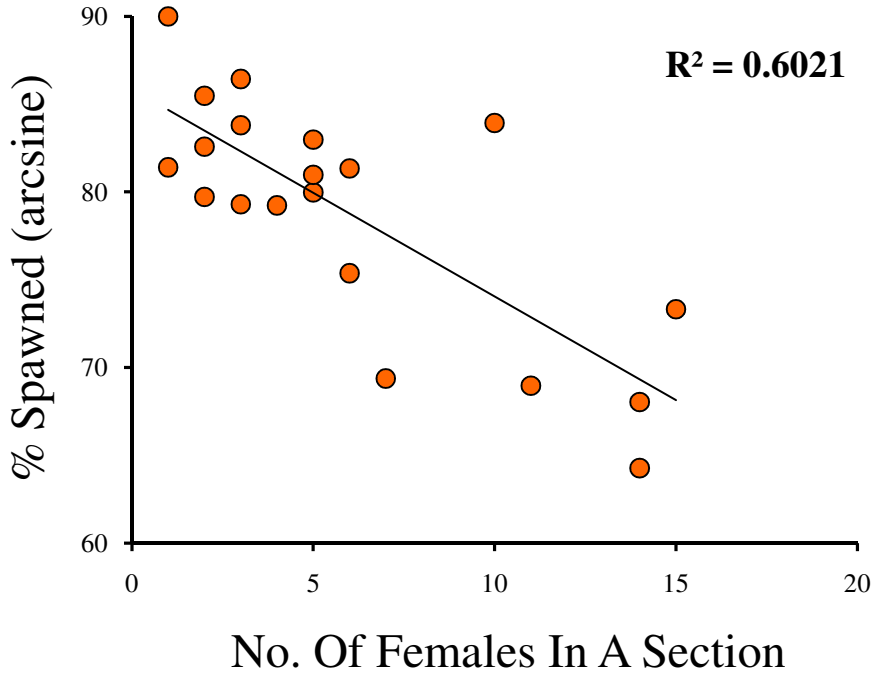


# Data Sources

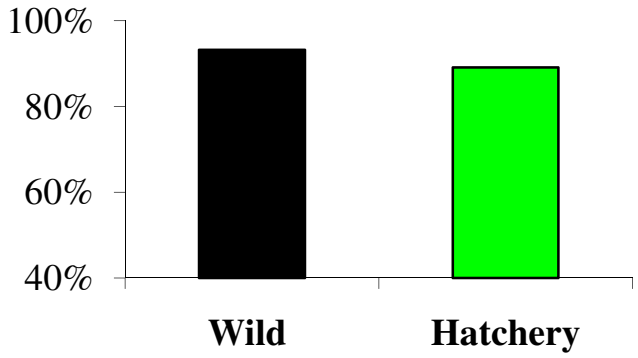
| Typ | DNA Pedigree Results | Fry Produced | Number Sampled | Number Analyzed | Number Assigned | % Assigned | OTAL |
|---|---|---|---|---|---|---|---|
| | | **350,439** | **30,683** | **13,779** | **13,216** | **96%** | **387** |

# Effect Of Female Density On Egg Deposition



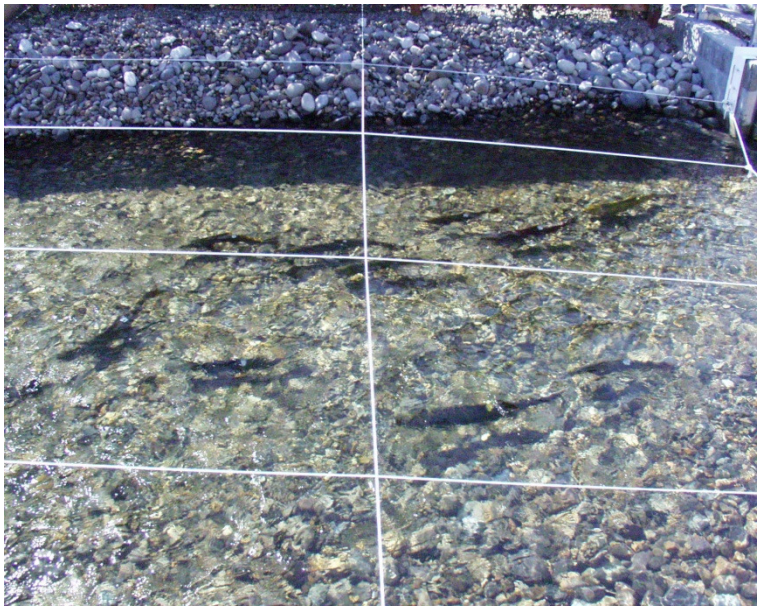


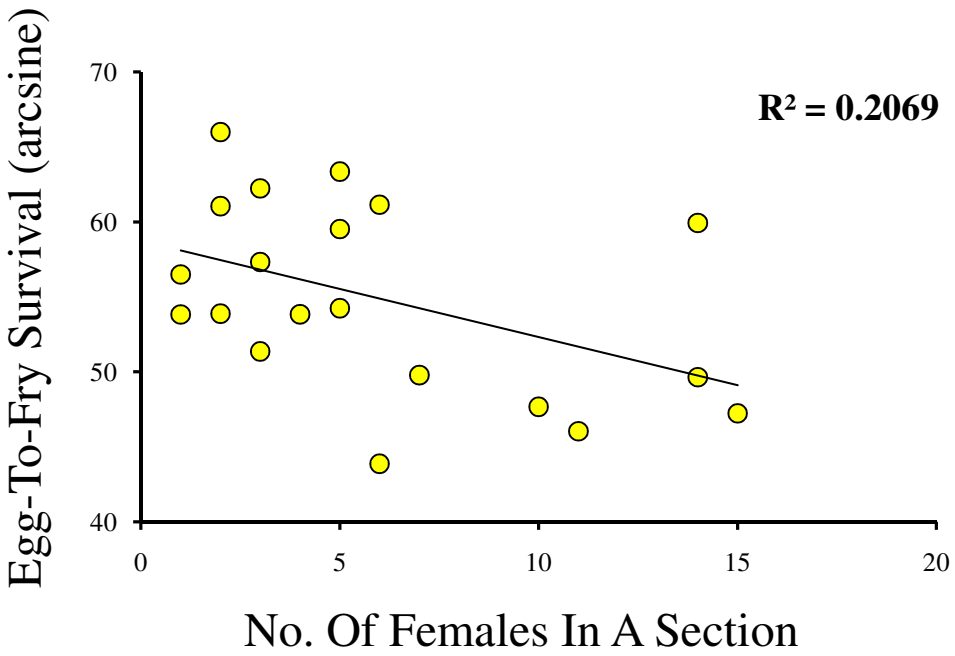
# Egg Deposition



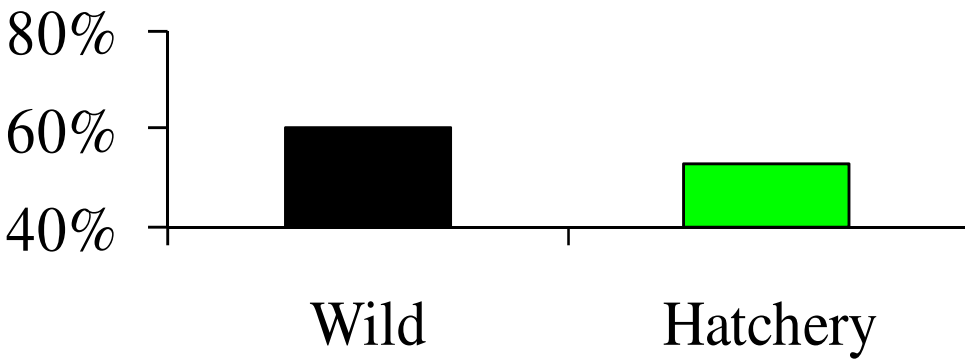

Wild = 93.2%
Hatchery = 89.1%
*P* = 0.15 paired-*t* test

# Effect Of Female Density On Survival Of Deposited Eggs





# Survival Of Deposited Eggs

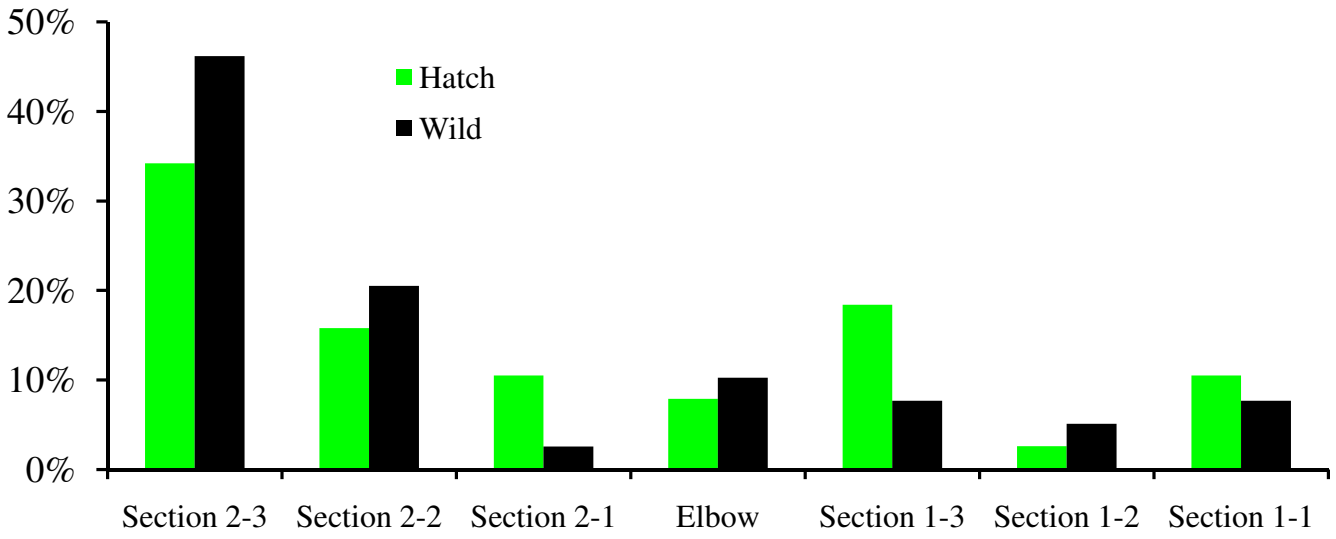


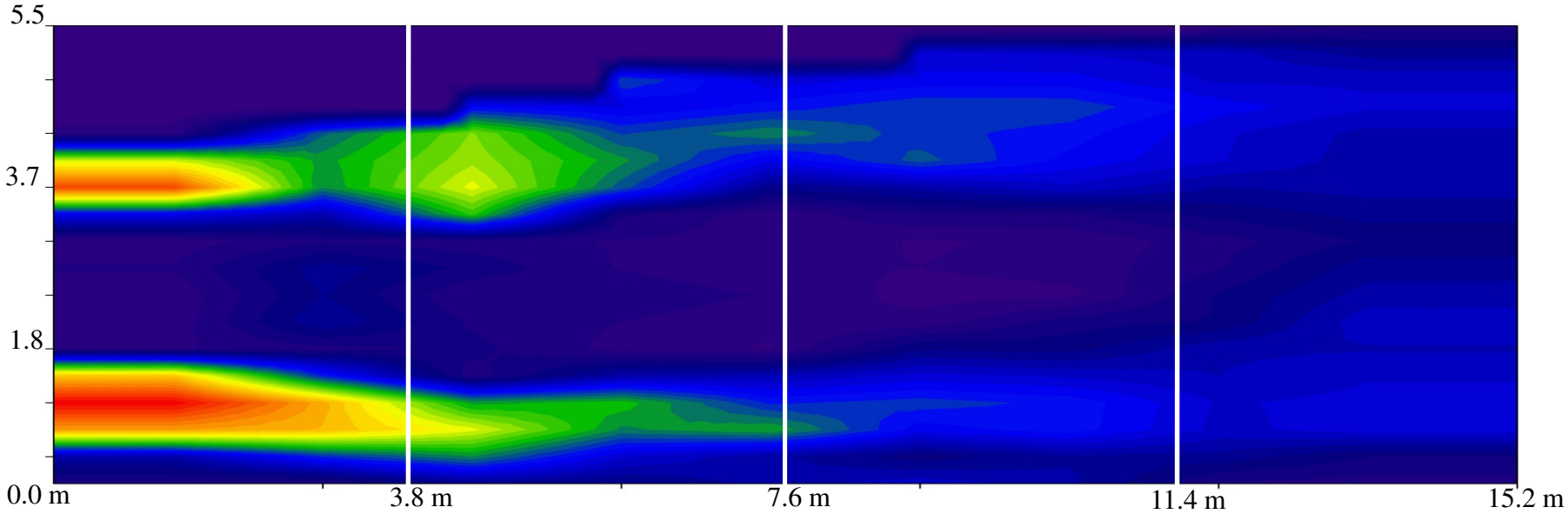

Wild = 60.2%
Hatchery = 54.6%
*P* = 0.04 paired *t*-test

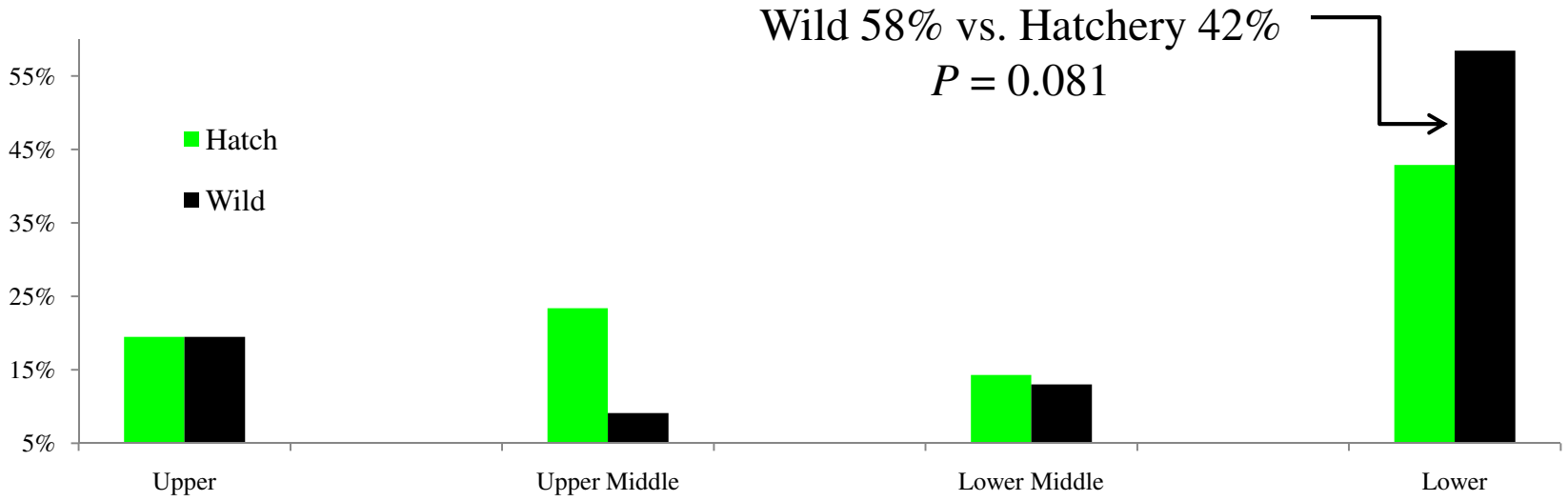
# Factors Affecting Egg-To-Fry Survival Rates

- Redd Location
- Nest Construction & Egg Burial
- Redd Defense

# Distribution Of Hatchery and Wild Females Throughout The Observation Stream



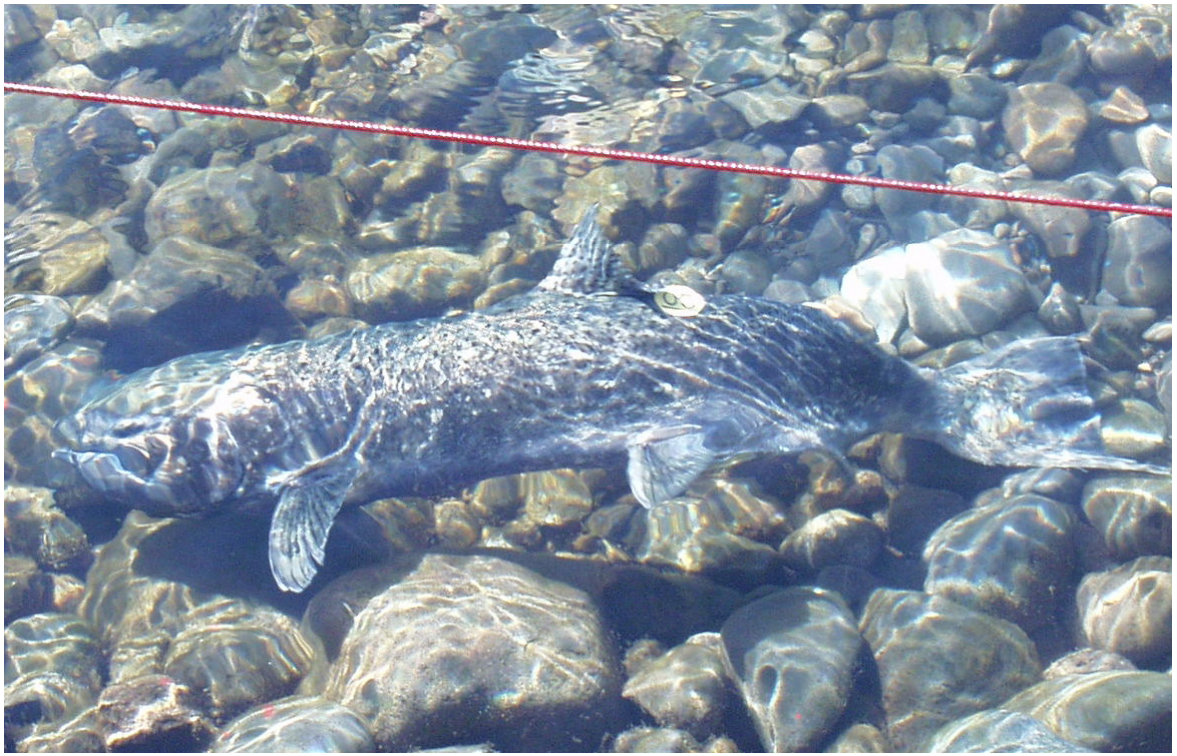


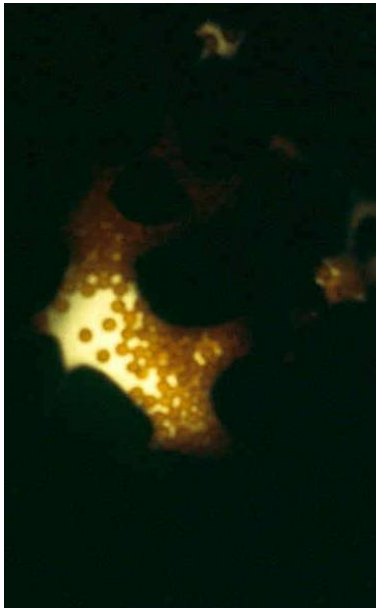



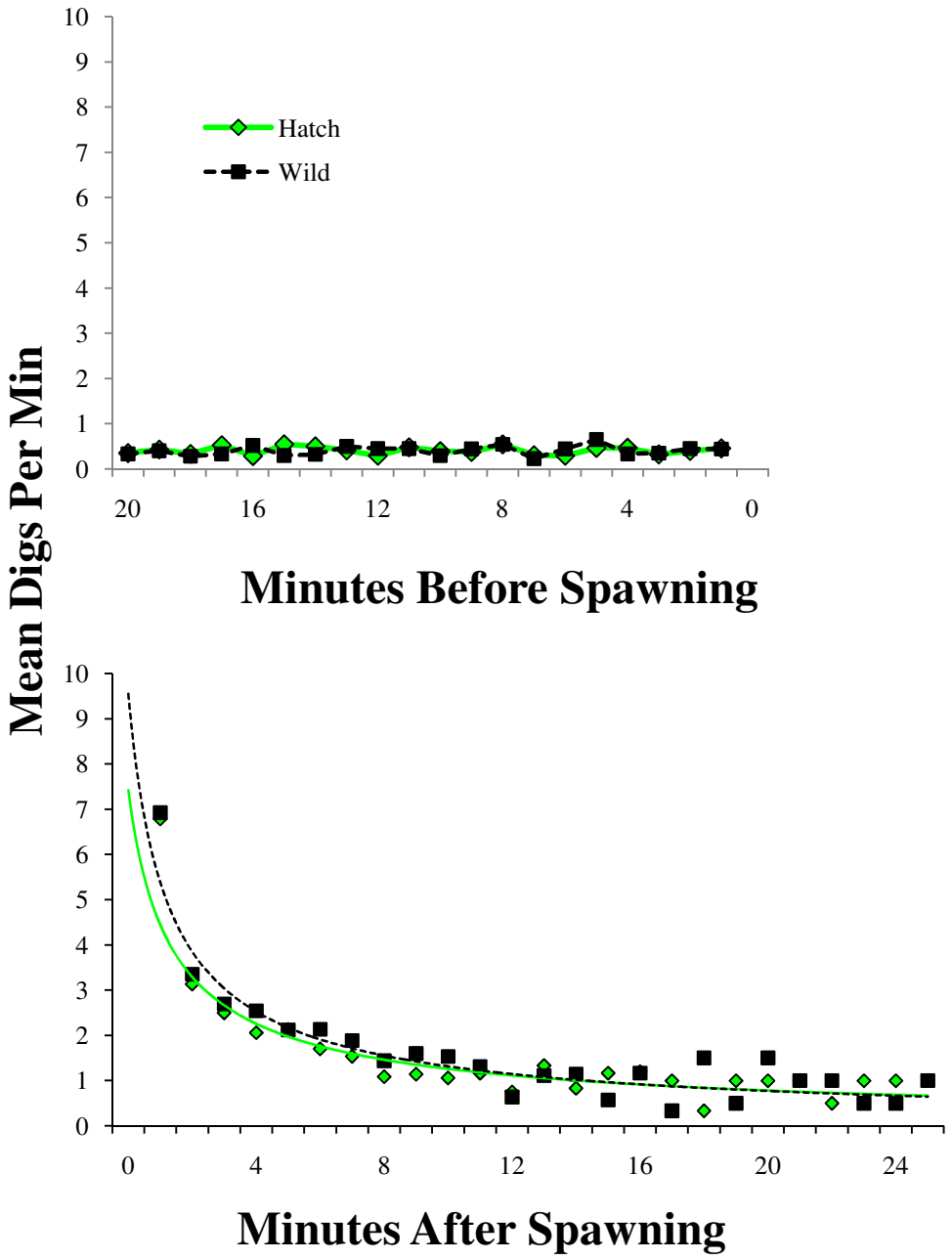

# Redd Locations Of Hatchery & Wild Females

# Nest Construction Activities Compared

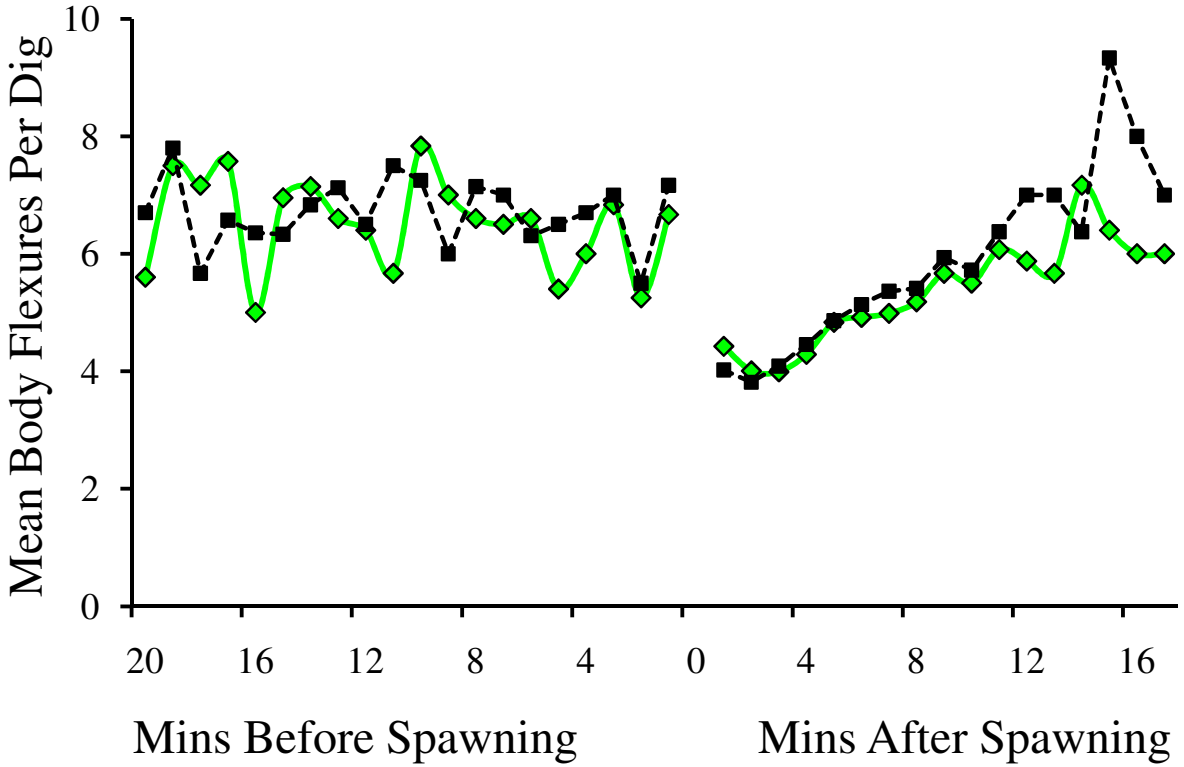
- **Digging Frequency**
- **Body Flexures Per Dig**
- **Egg Burial**



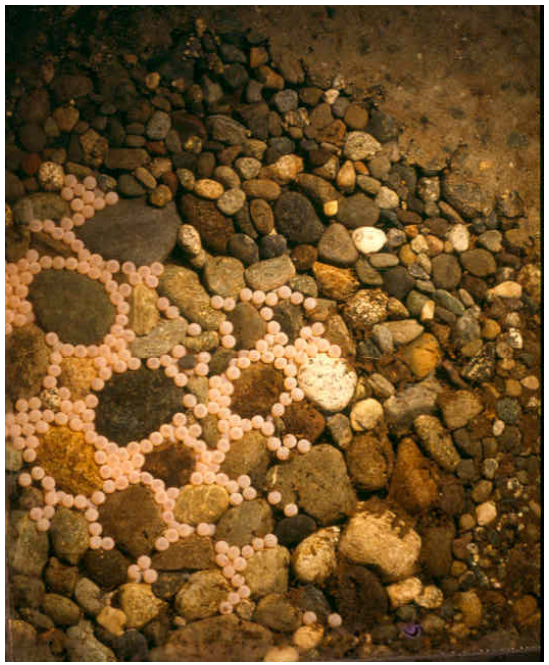


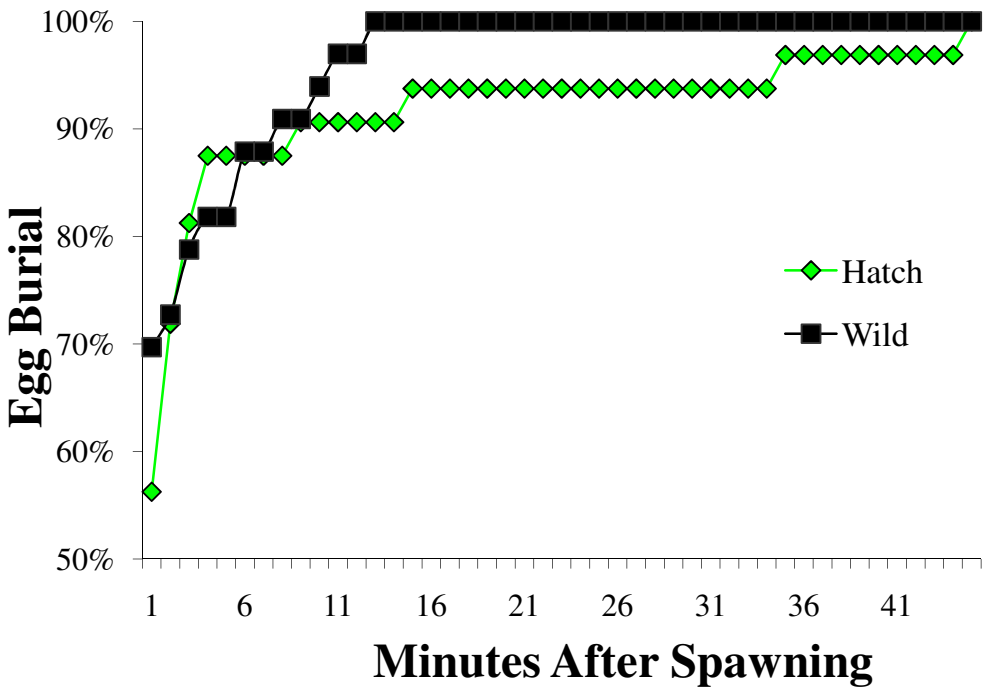

Mean Digs Per Min
10
9
8
7
6
5
4
3
2
1
0
Hatch
Wild
20
16
12
8
4
0
Minutes Before Spawning
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
Minutes After Spawning

# Body Flexures Per Dig Before & After Spawning



# Egg Burial Times For Hatch & Wild Females

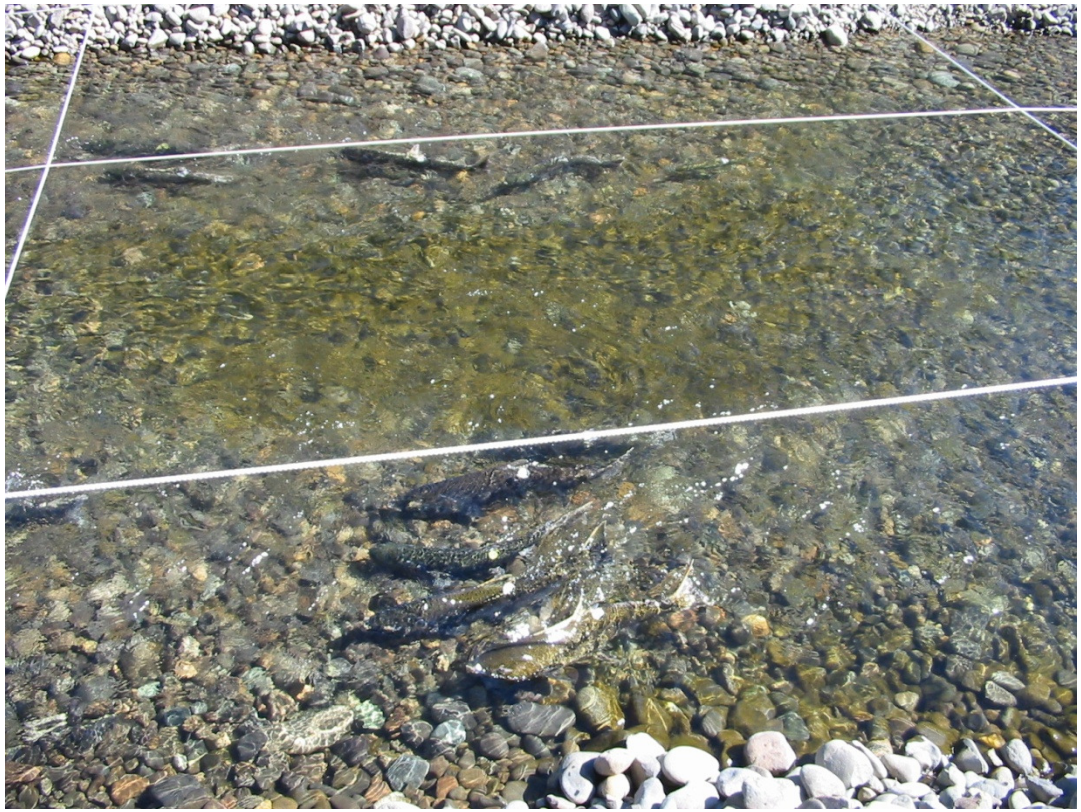




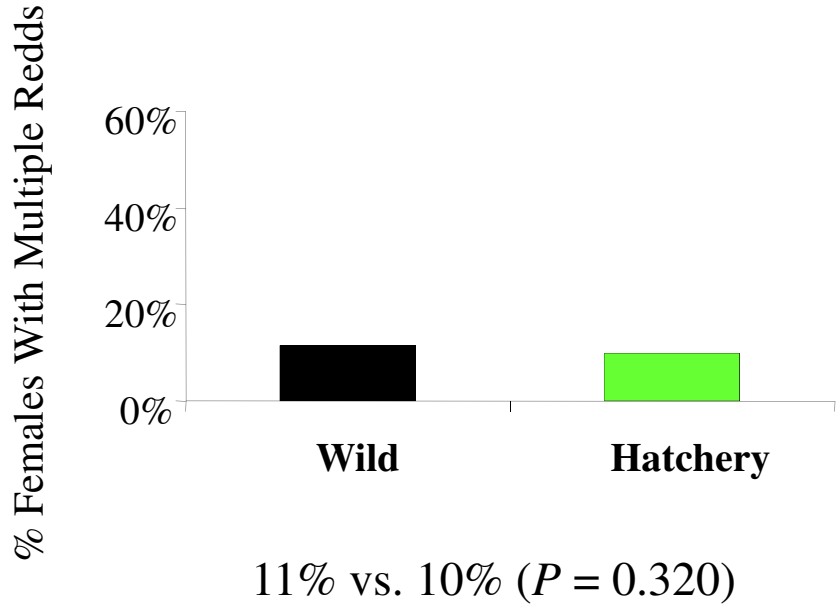
# Redd Abandonment

## Observed Causes:

- Weakness
- Eviction
- Establishment Of Another Redd*
- Unknown*

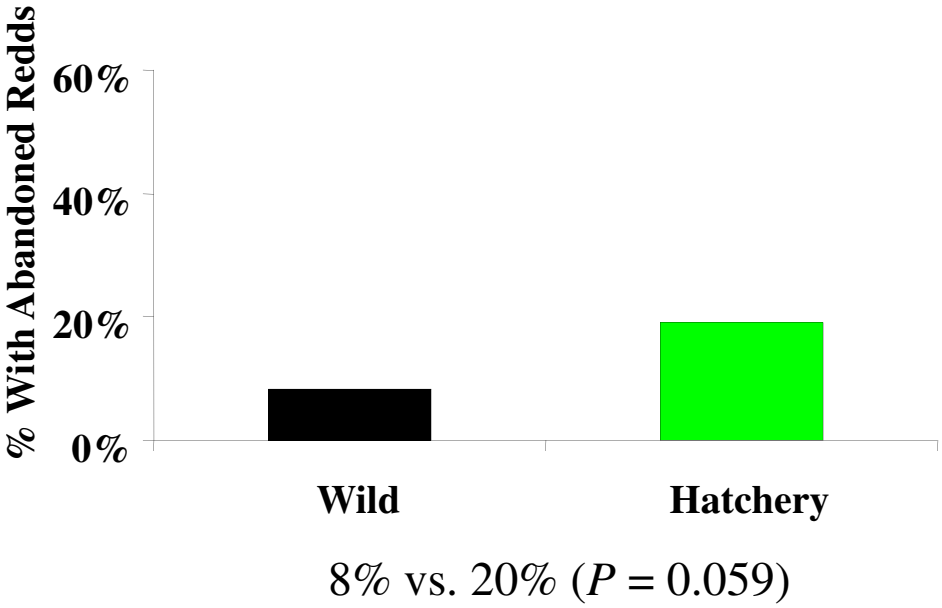


# Affect Of Female Origin & The Occurrence Of Multiple Redds




11% vs. 10% ($P = 0.320$)

# Female Origin &Redd Abandonment




8% vs. 20% ($P = 0.059$)

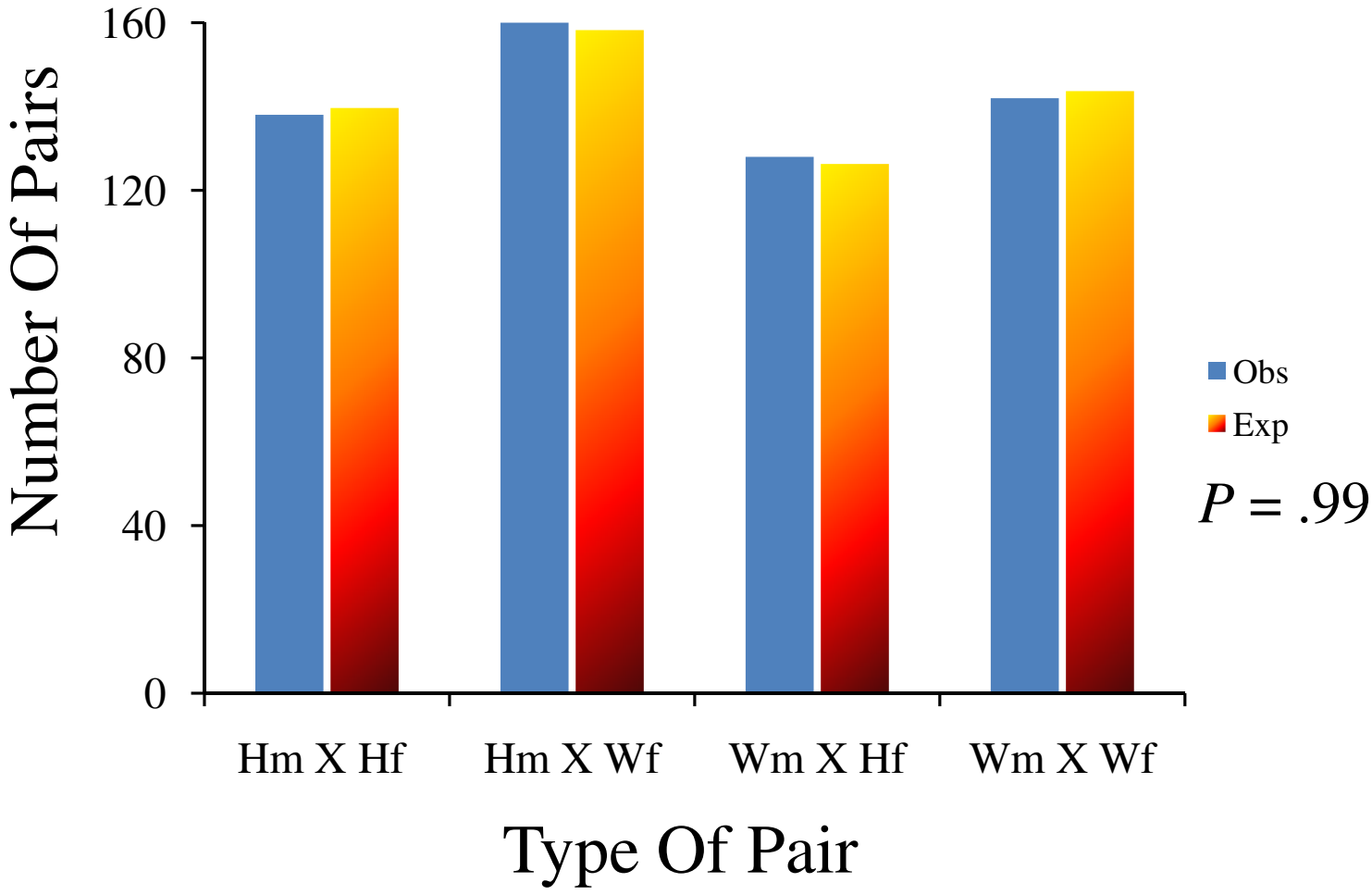
# Male Breeding Success Depends Upon:

**Mate Choice**

**Behavior & Gamete Viability**

**Relative Size**

# Mate Choice By Female Origin



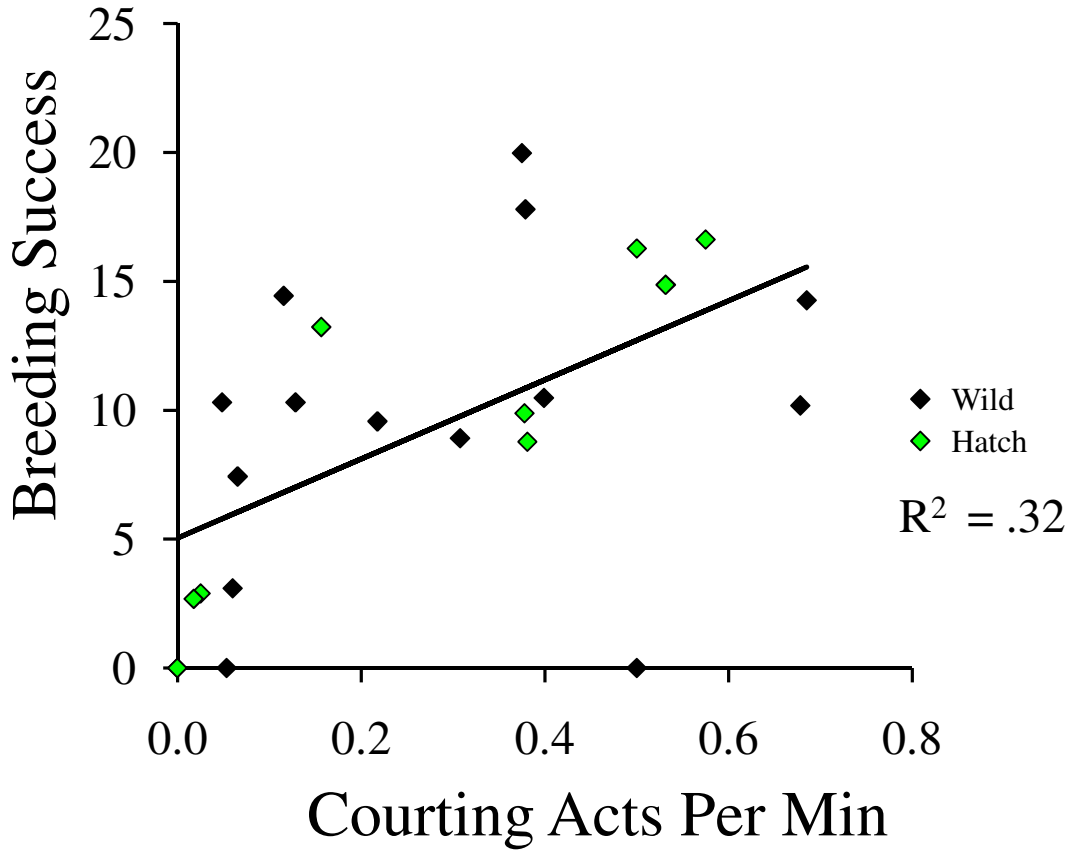
# Male Behavior: Courting

# Mean Courting Acts Per Min

**No Difference** Between Hatchery & Wild Males

H = .20 acts/min
W = .25 acts/min

P = 0.16



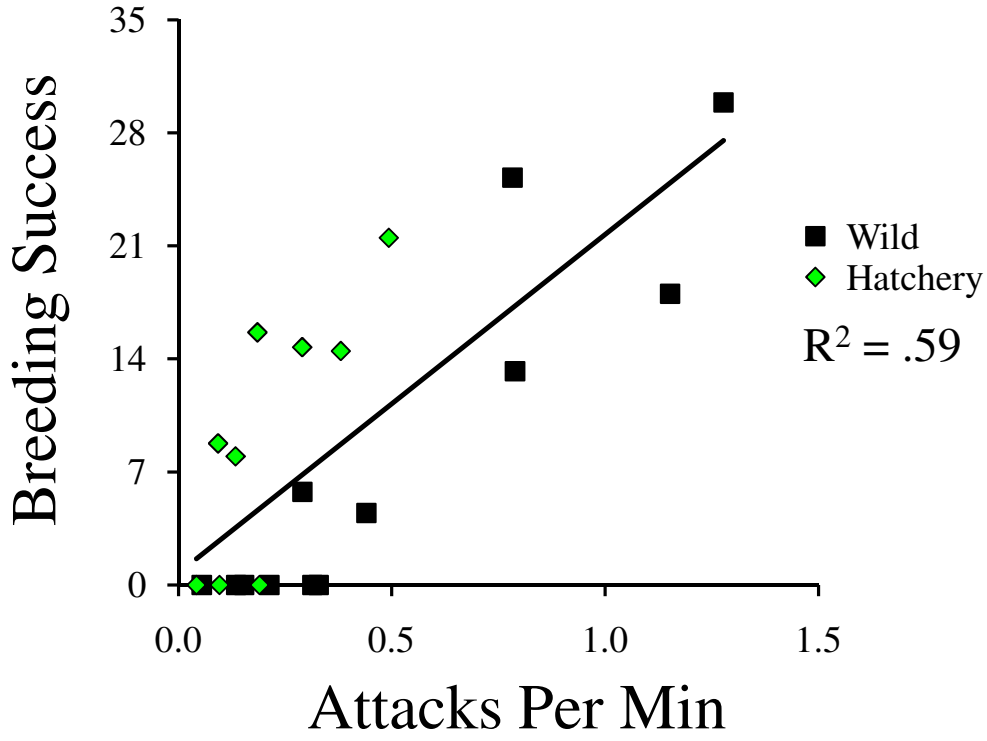
# Male Behavior: Agonism

# Attacks Per Min

Wild > Hatchery

H = .34 attacks/min
W = .45 attacks/min

P = 0.015



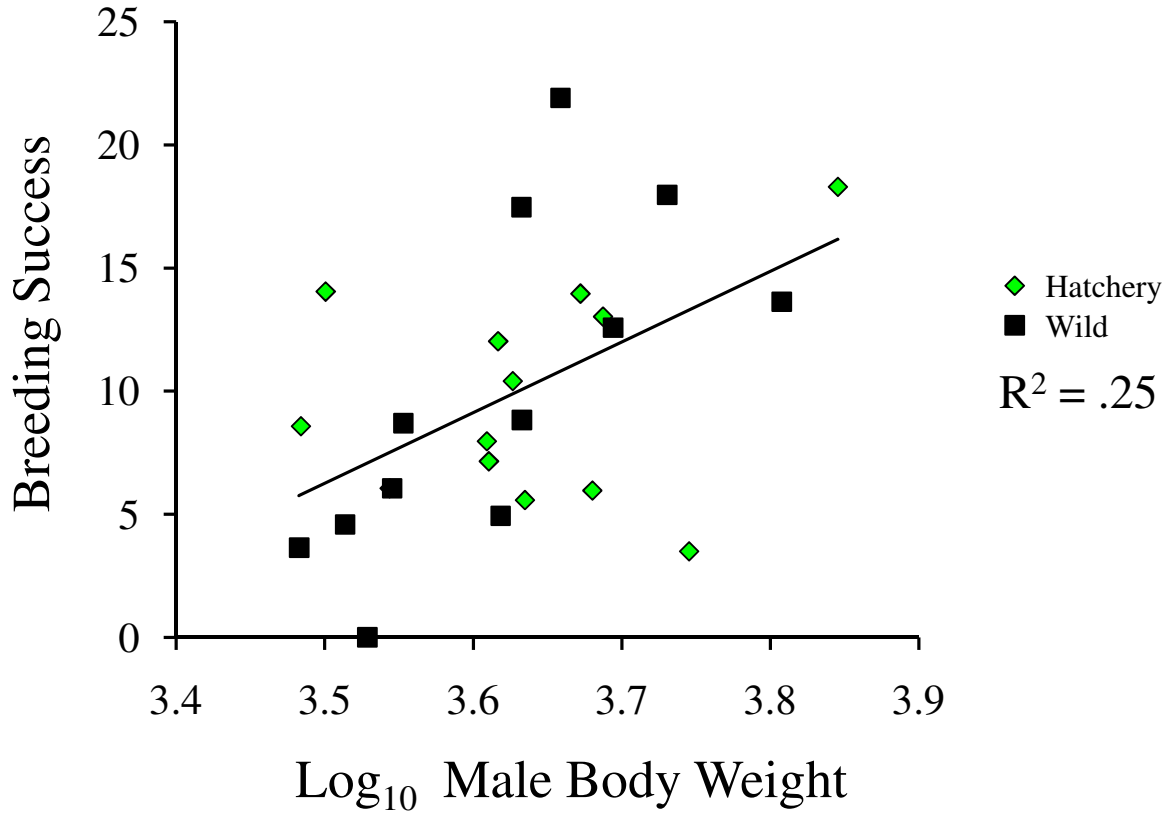
# Affect Of Male Body Wt On Breeding Success

Wild > Hatchery

H = 3.67 K
W = 4.05 K

9.3% Difference

*P* = 0.035



# Male Breeding Success

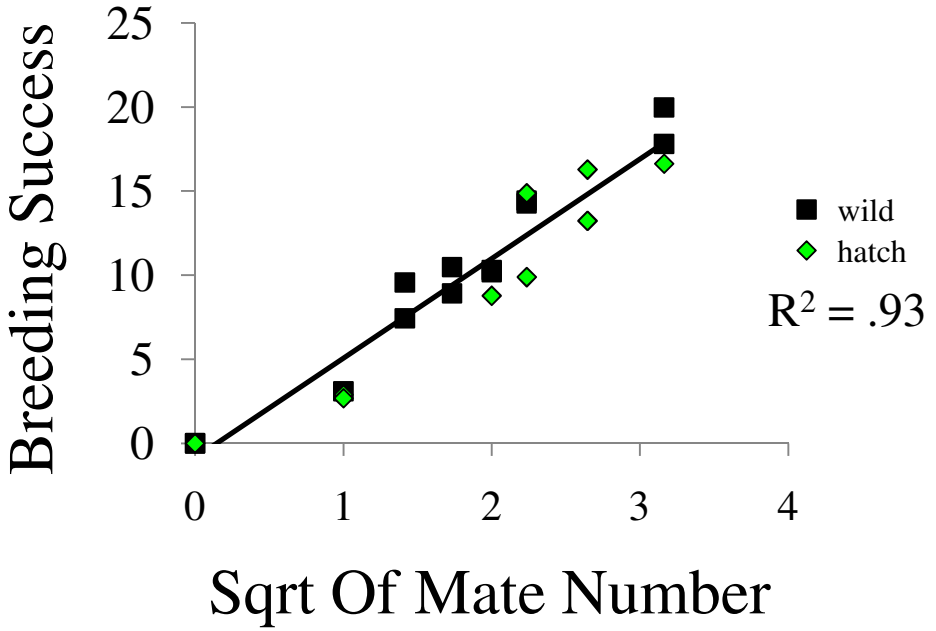
- Number of Mates
- Production of Progeny

# Number of Mates

**No Difference** Between Hatchery & Wild Males

H = 3.5 Mates/male
W= 3.6 Mates/male

P = 0.79

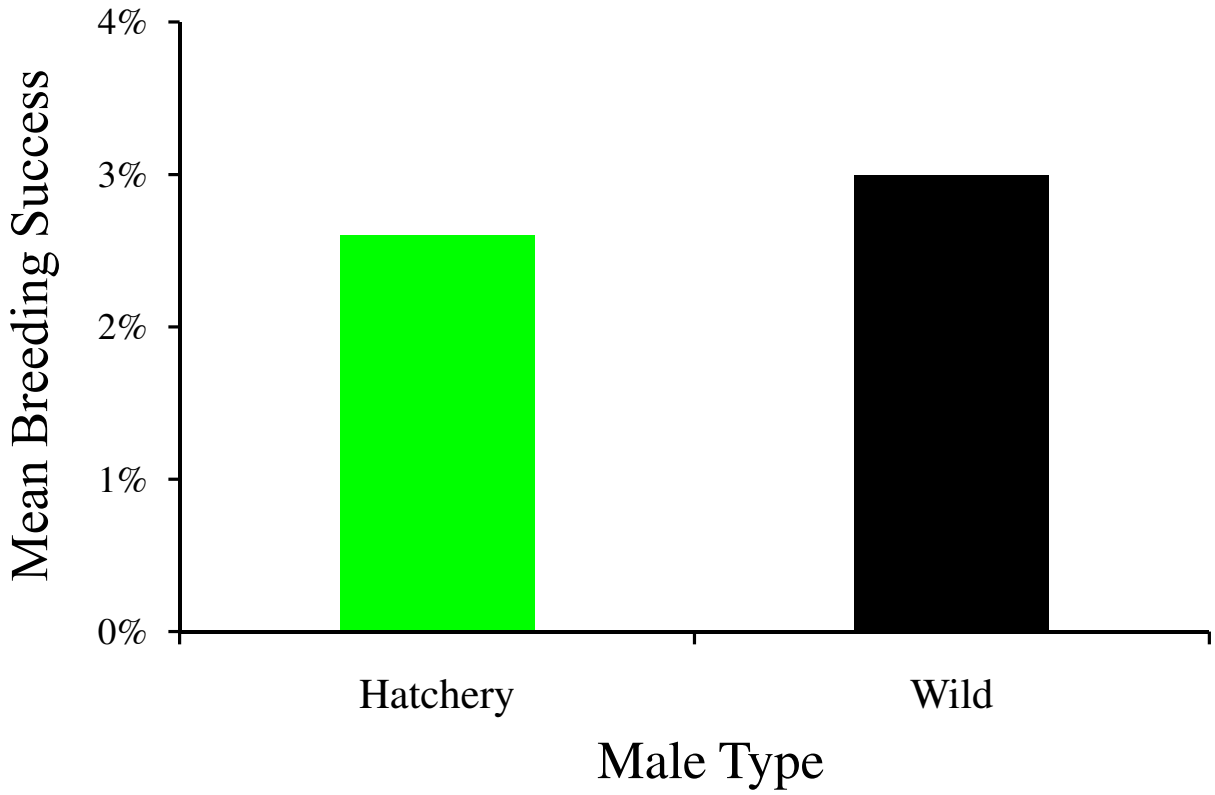


# Mean Breeding Success

No Difference Between
Hatchery & Wild Males

H = 2.6%
W = 3.0%

*P* = .22



# Jack & Precocious Male Abundance May Increase Due To Artificial Culture

**At The Cle Elum Supplementation Research Facility:**

- 37 – 49% Of All Males Matured At Age 2 (Larson et al. 2004)
  125,000/yr (Pearsons et al. 2009)

- Jacks increased From 8.5% To 22.9% After One Generation Of Culture (Knudsen et al. 2006)

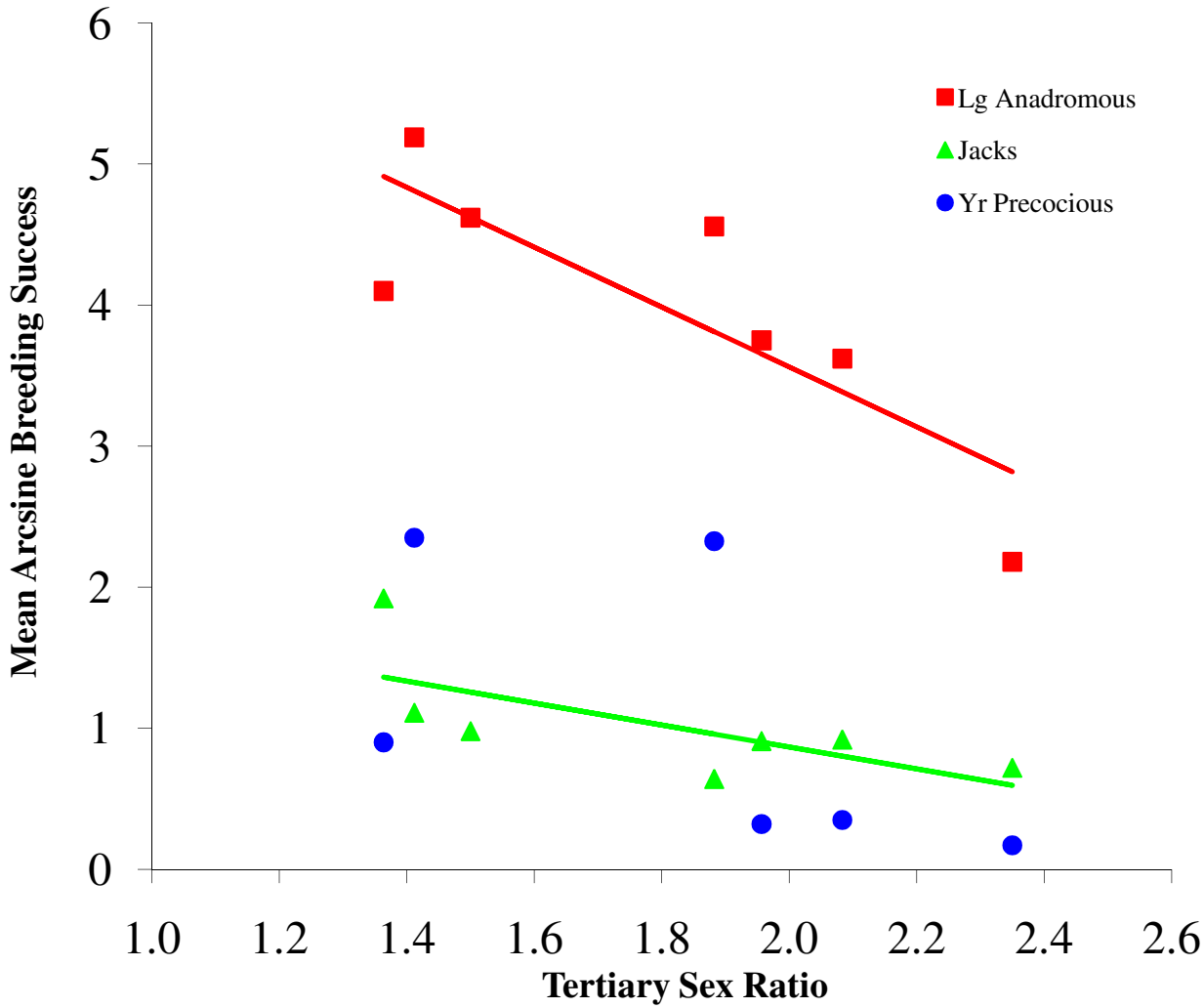
- Similar Decreases in Male Age At Maturity Have Been Observed In Other Hatcheries (e.g. Mullan et al. 1992)

# What Genetic Effects Might Enhanced Numbers Of Early Maturing Males Have On Wild Spring Chinook Populations?

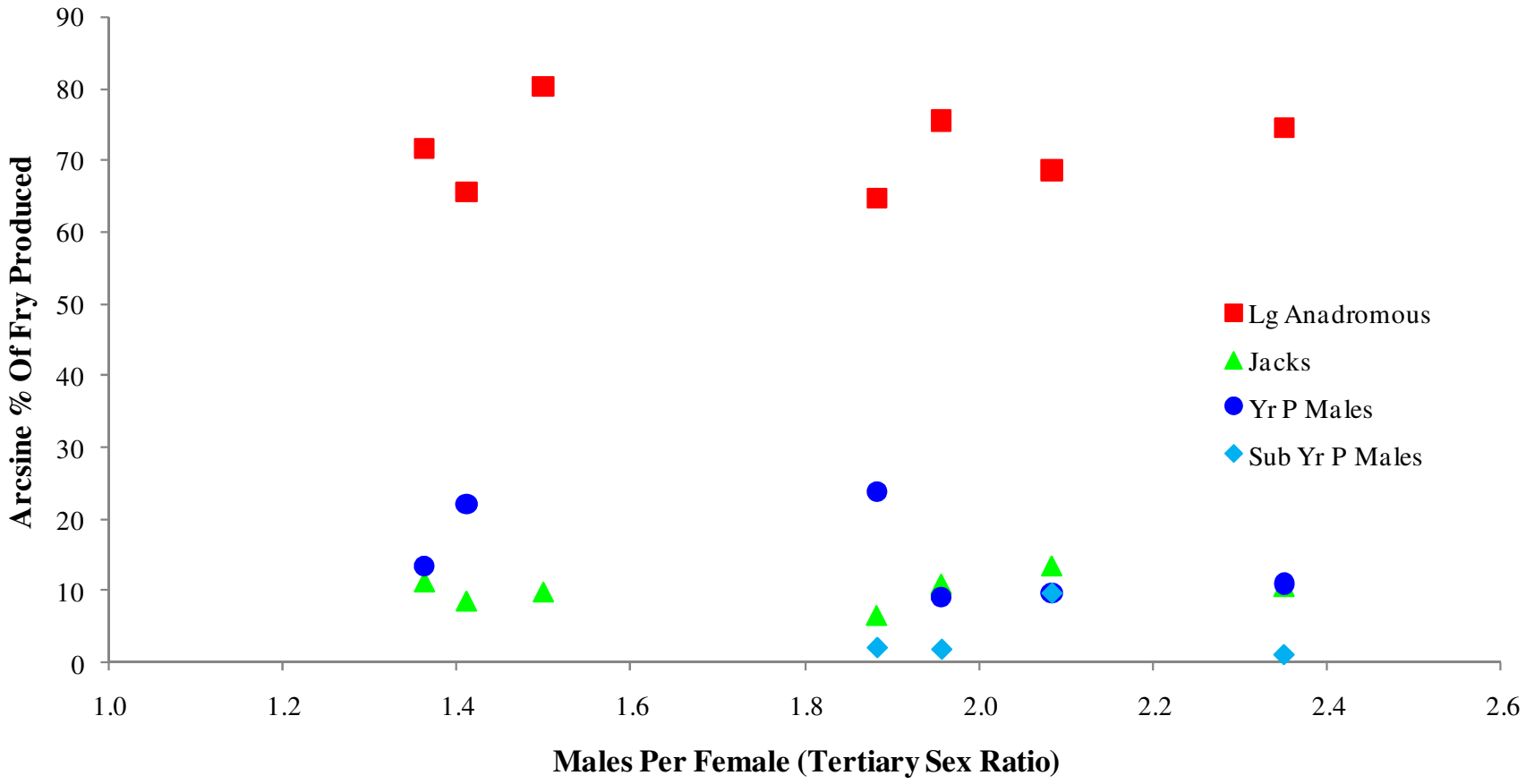
1) Must Know Their Abundance On The Spawning Grounds, and

2) **Their Relative Breeding Success Under Natural Conditions**

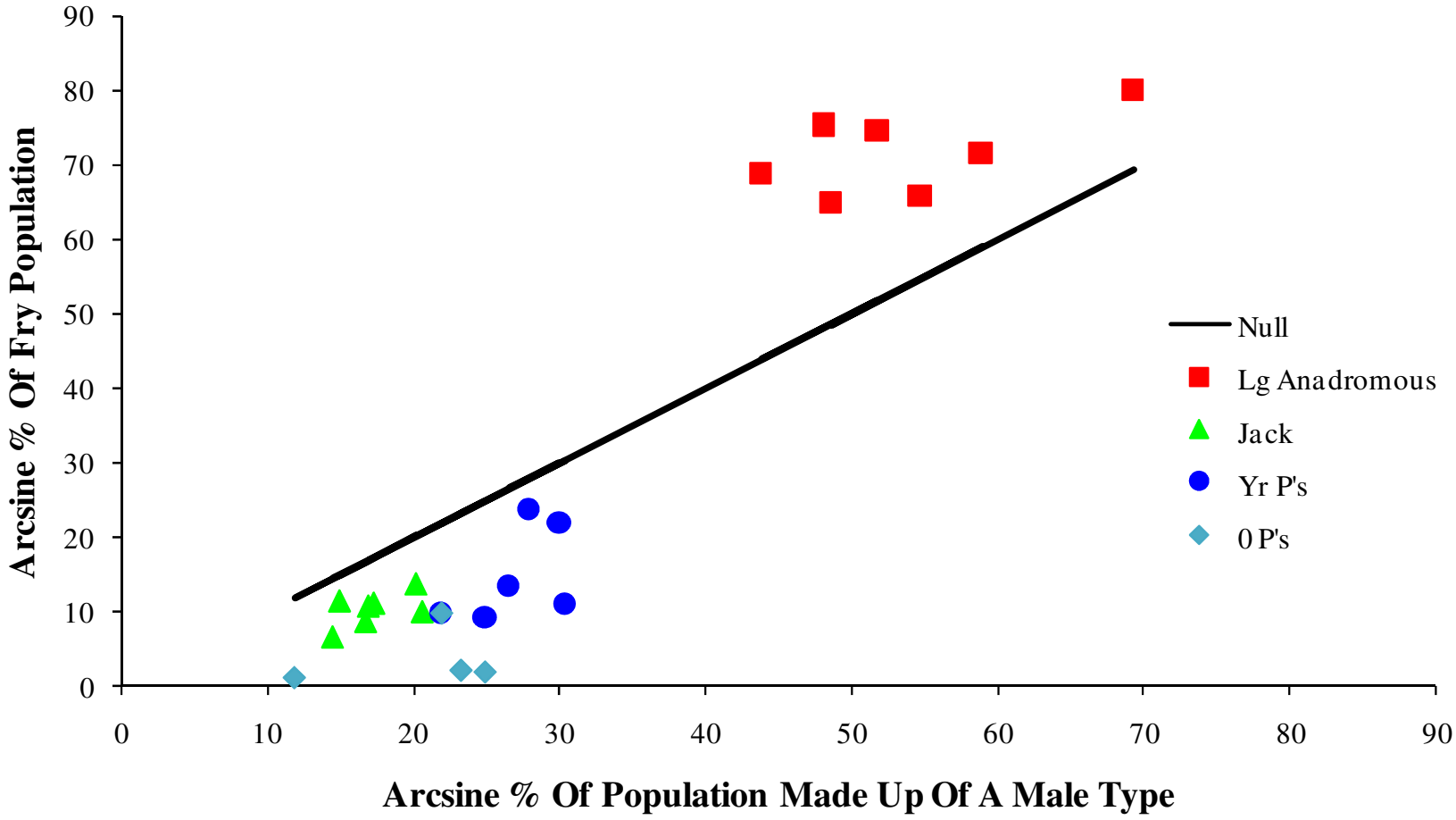
# Effect Of Tertiary Sex Ratio On Individual Male Breeding Success



# Tertiary Sex Ratios Vs. Progeny Paternity



# % Male Life History Type Vs. Progeny Paternity



# % Male Life History Type Vs. Progeny Paternity