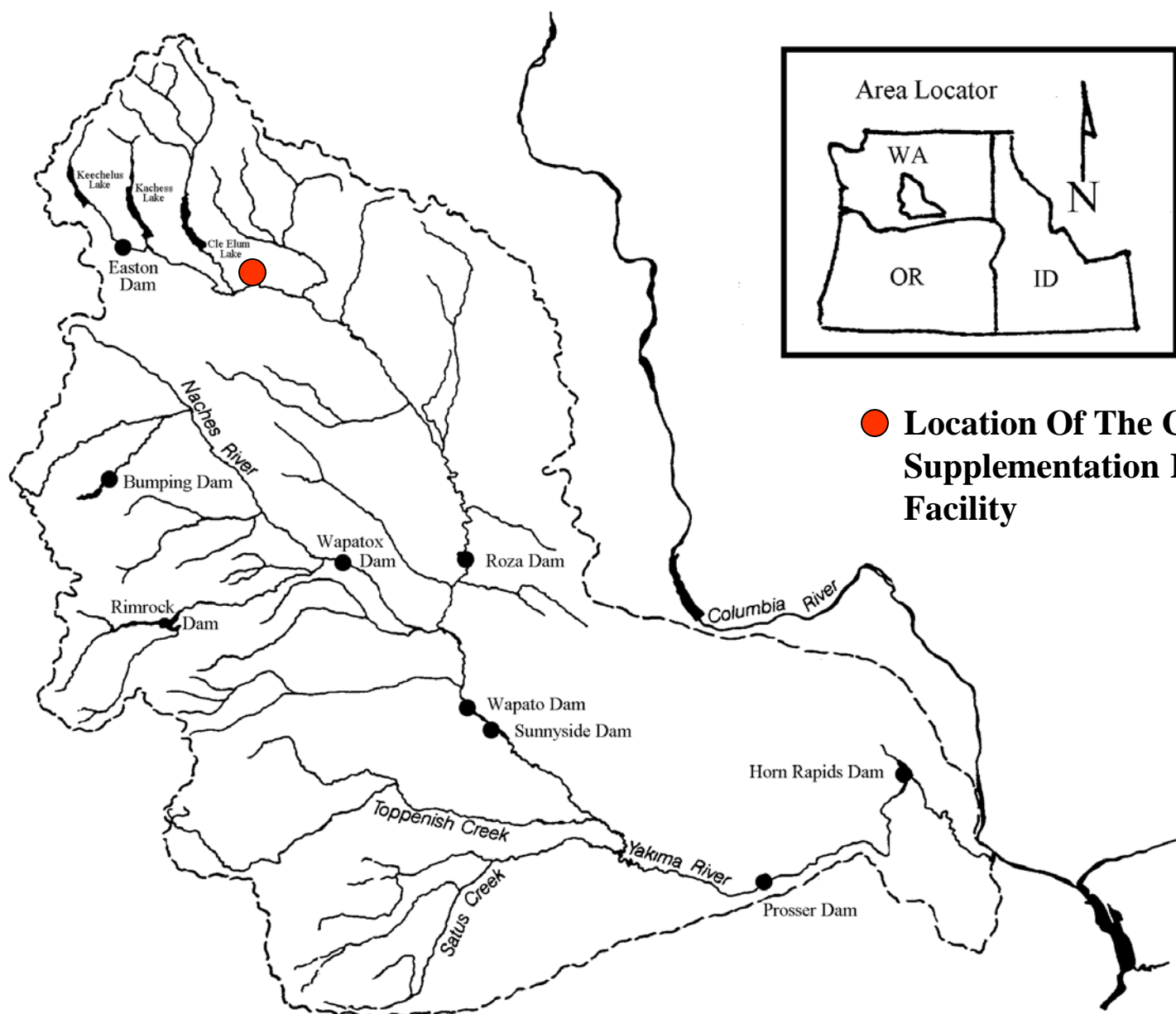


Breeding Success Of Wild & First Generation Hatchery Female Spring Chinook In An Artificial Stream

**S.L. Schroder,
C.M. Knudsen,
T.N. Pearsons,
S.F. Young,
T.W. Kassler,
C. Busack
D.E. Fast &
B.D. Watson**





**● Location Of The Cle Elum
Supplementation Research
Facility**

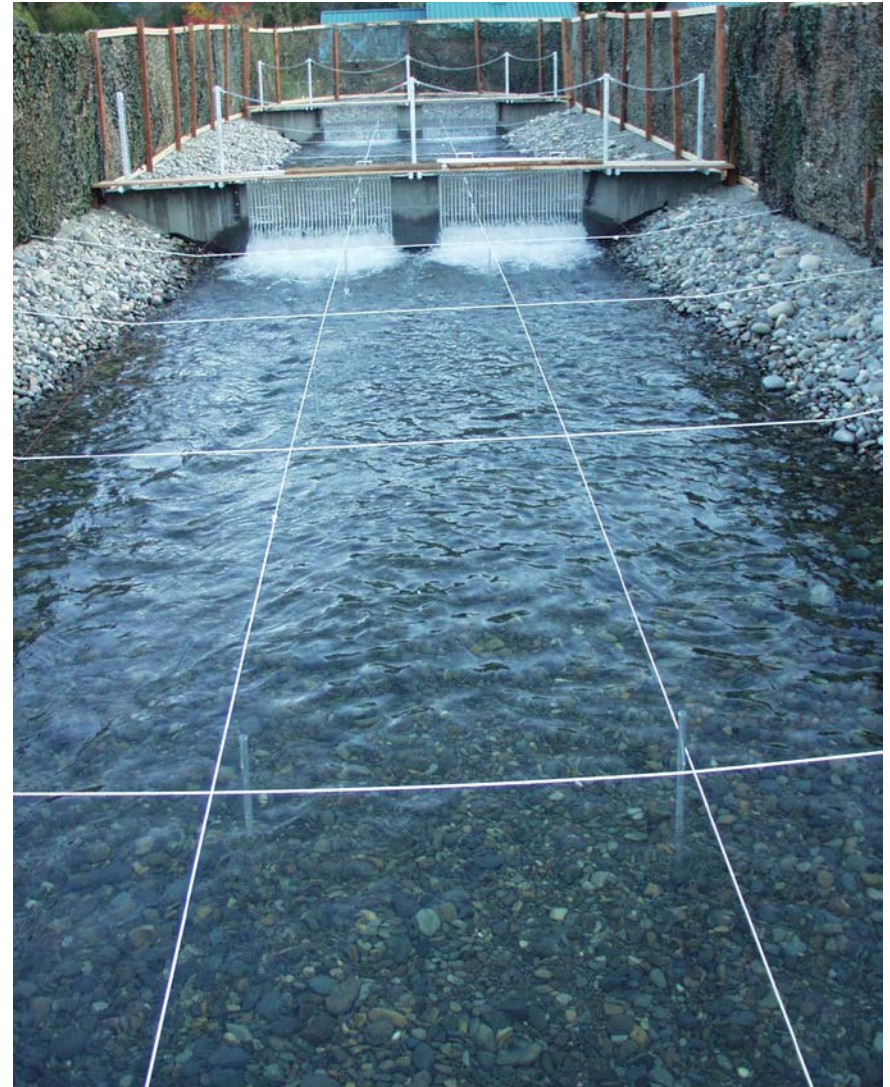
Artificial Stream At Cle Elum



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 Reproductive Success)



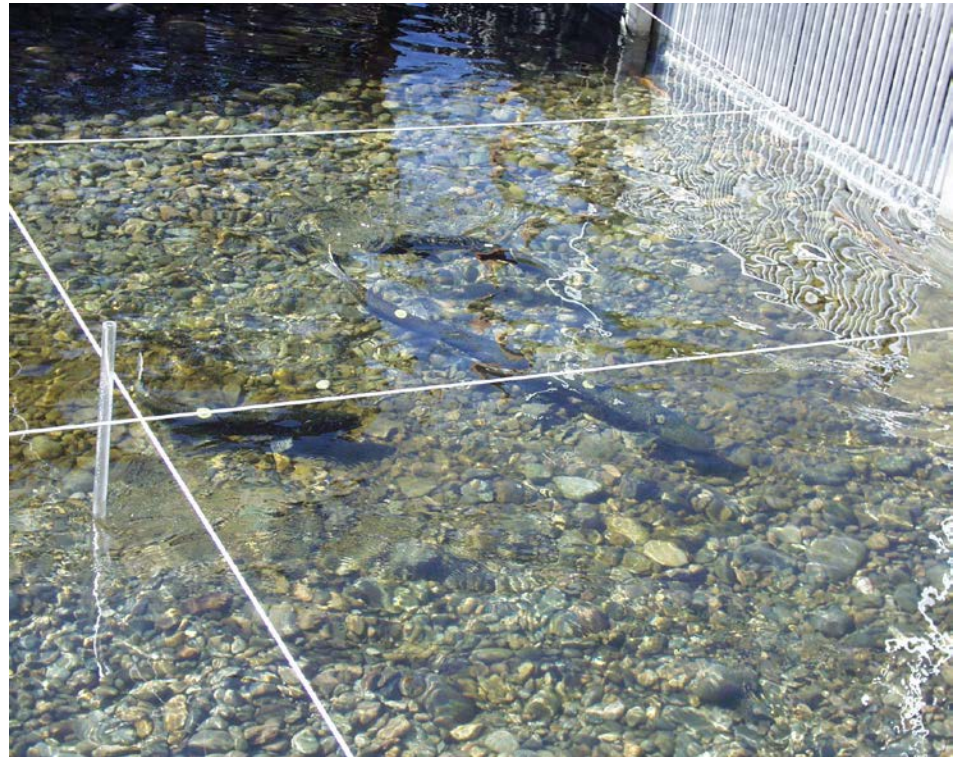
Experimental Approaches To Evaluating Breeding Success

- **Homogenous Pops:**

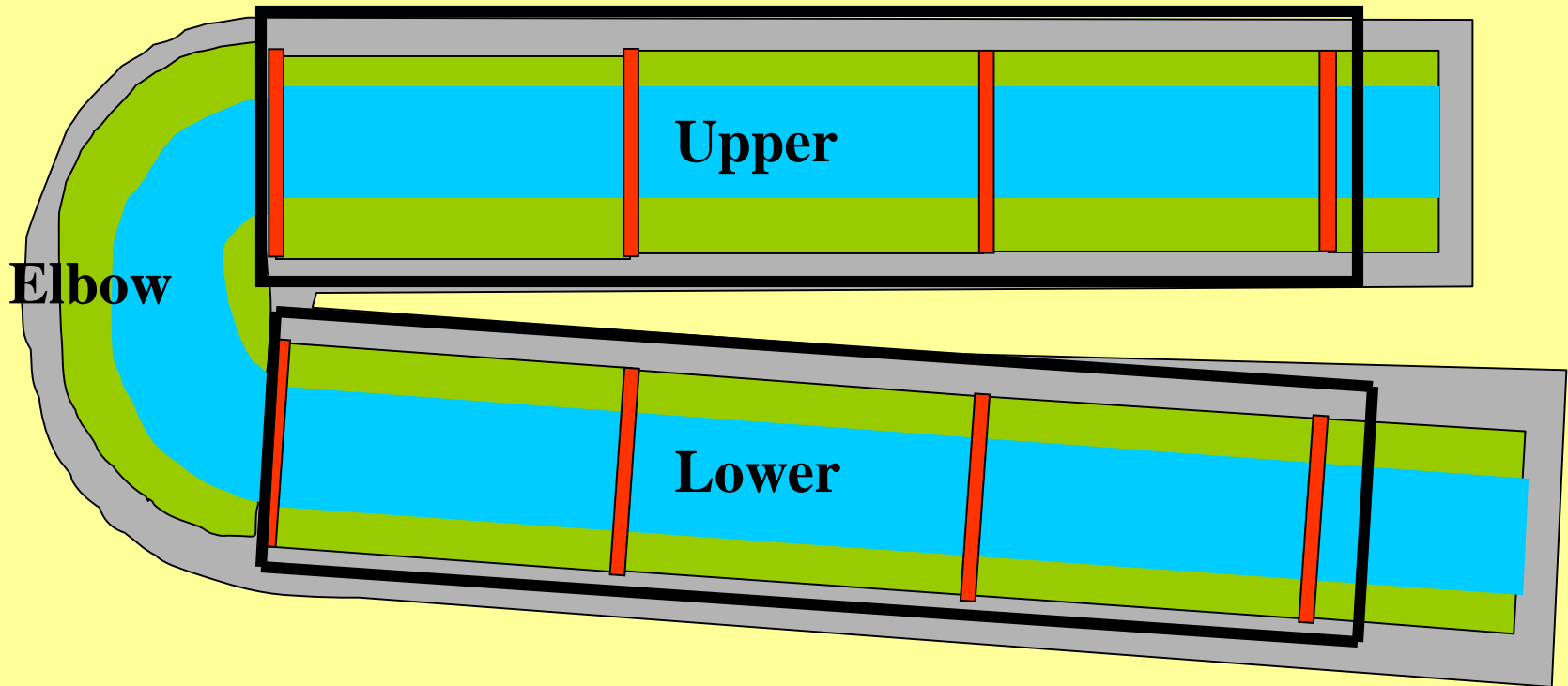
Fish origin is the same:
Comparing productivity
Of Populations

- **Heterogeneous Pops:**

Fish Origin Is Mixed:
Competition Occurs
Between Fish Of Different
Origin (Females for
Space; Males for Mates)

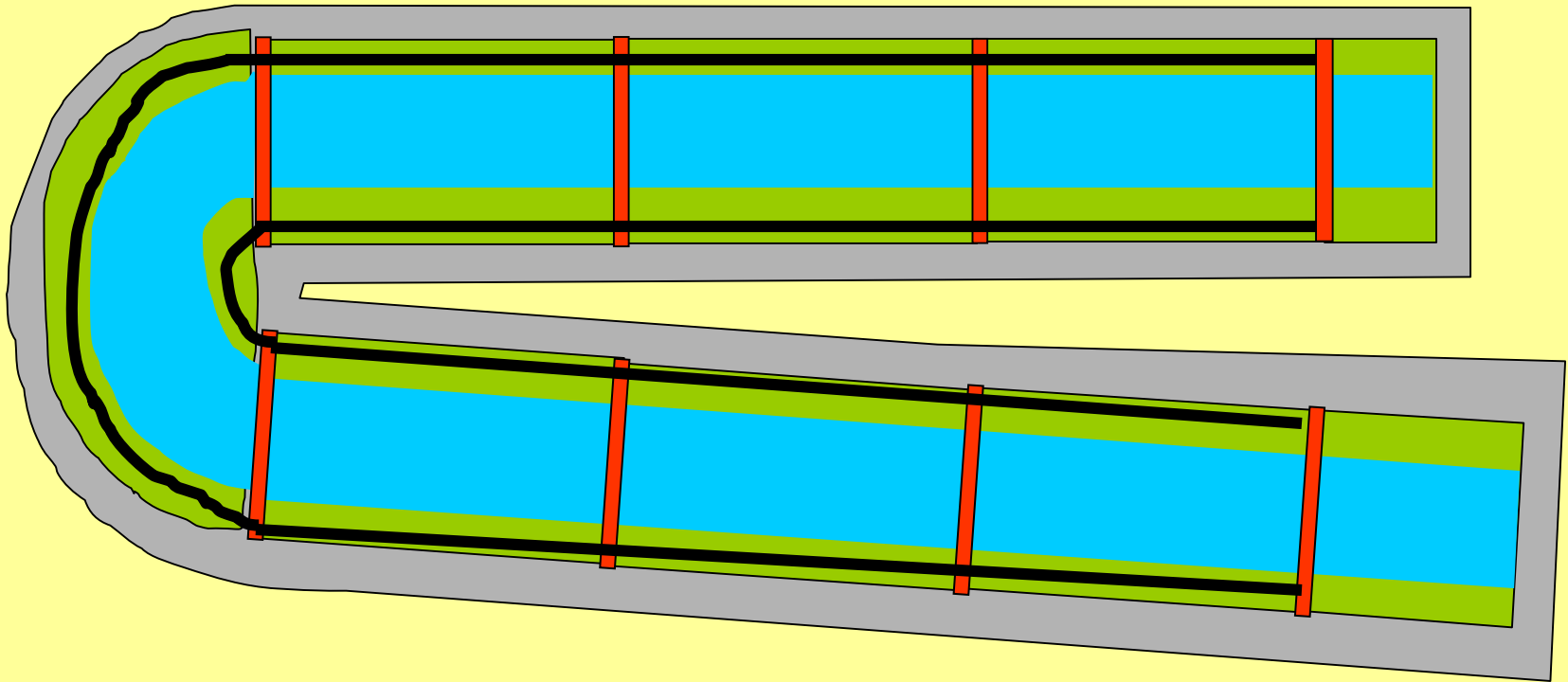


Sections Of The Artificial Stream Used In 01 & 02



**Upper & Lower Sections Were
46 m long by 5 m wide**

Area Used In 2003, 04, & 05



Entire Stream Was 127 m long by 5 m wide

Artificial Stream: Adult Handling Protocols

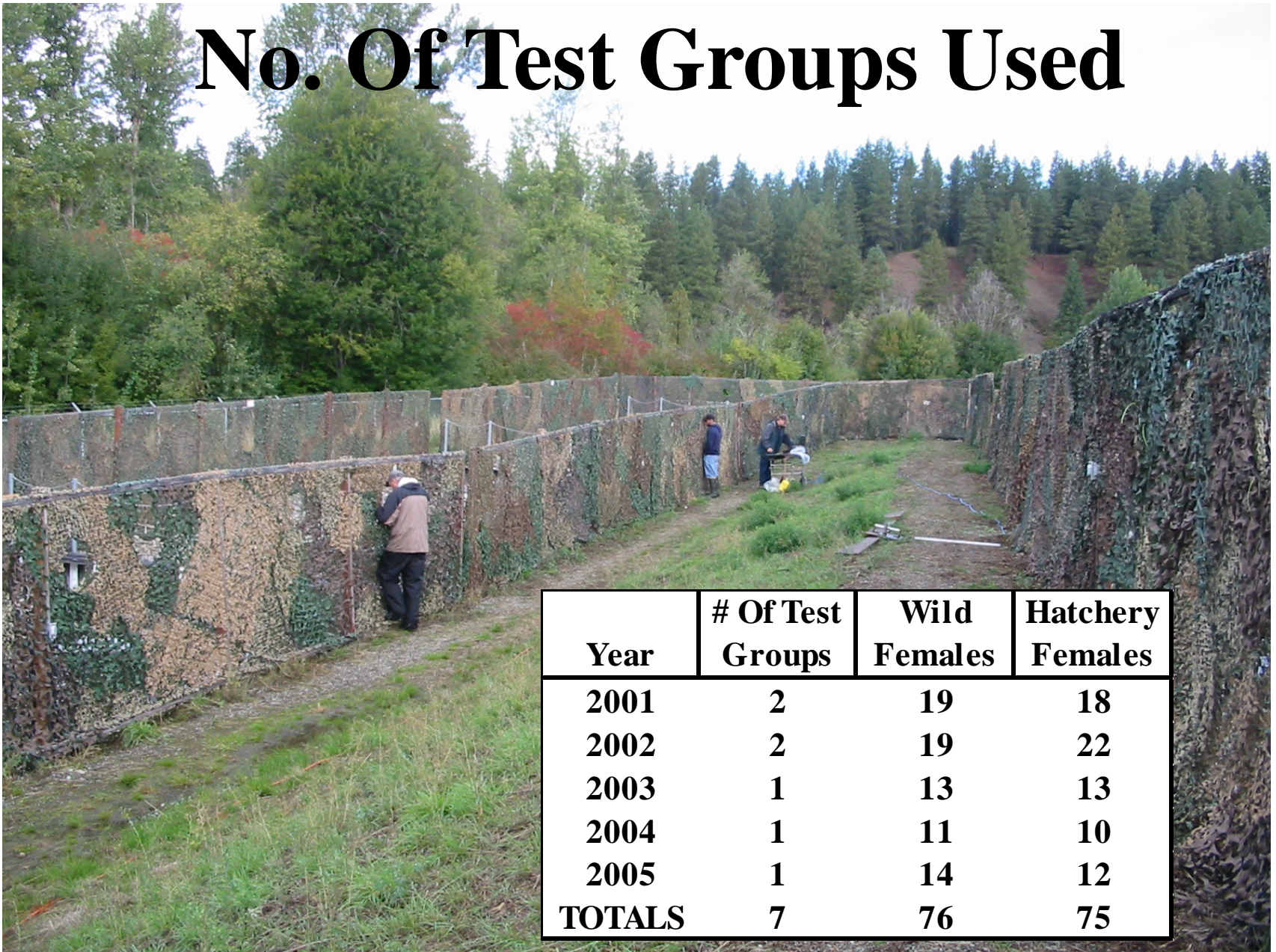


Artificial Stream:

Placement Into the Artificial Stream



No. Of Test Groups Used



Year	# Of Test Groups	Wild Females	Hatchery Females
2001	2	19	18
2002	2	19	22
2003	1	13	13
2004	1	11	10
2005	1	14	12
TOTALS	7	76	75

No Of Fry Used In Pedigree Evaluations

Test Group	No. Of Fry Assigned To Parents
2001A	991
2001B	780
2002A	1566
2002B	1264
2003	2750
2004	2892
2005	2973
Totals	13216



Measures Of Female Breeding Success:

- Performance Based & Independent Of Total Offspring Production



Measures Of Female Breeding Success:

- **The Ability To Spawn & Deposit Eggs**
(% Spawned)



Measures Of Female Breeding Success:

**The Survival Of
Spawned Eggs To
The Fry Stage**

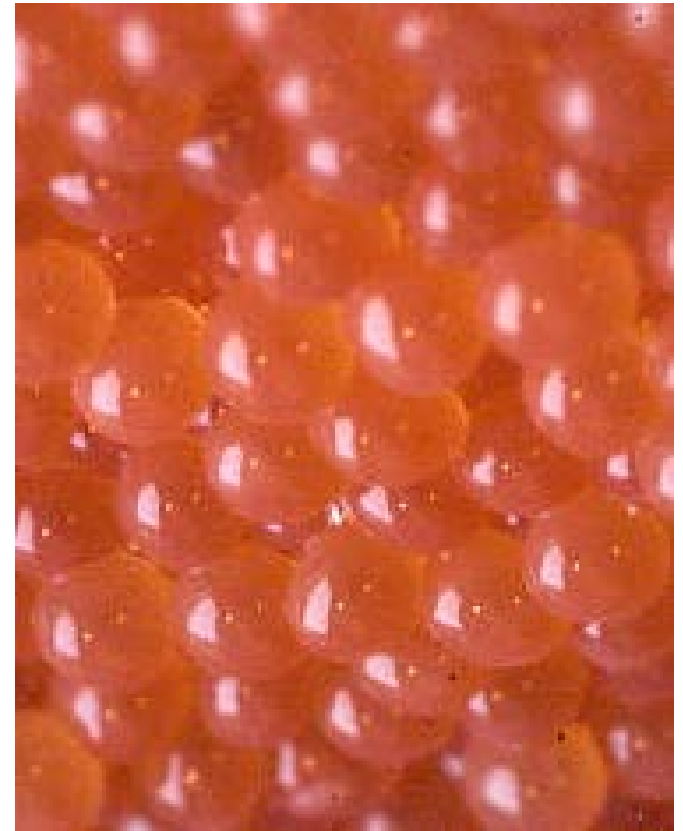
**(% Actual Egg
Deposition Survival)**



Measures Of Female Breeding Success:

The Ability To Convert Absolute Fecundity To Fry

(% Survival of Potential Egg Deposition to Fry)



Breeding Success Measures Depend Upon: Fecundity Estimation

**Multiple Regression
Models**

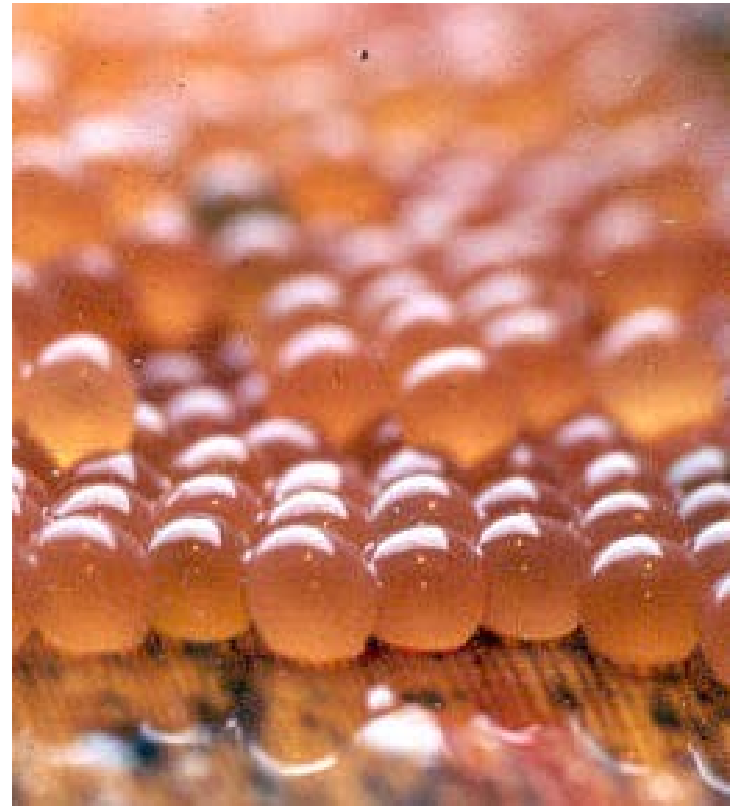
Independent Variables:

Body Weight

Age

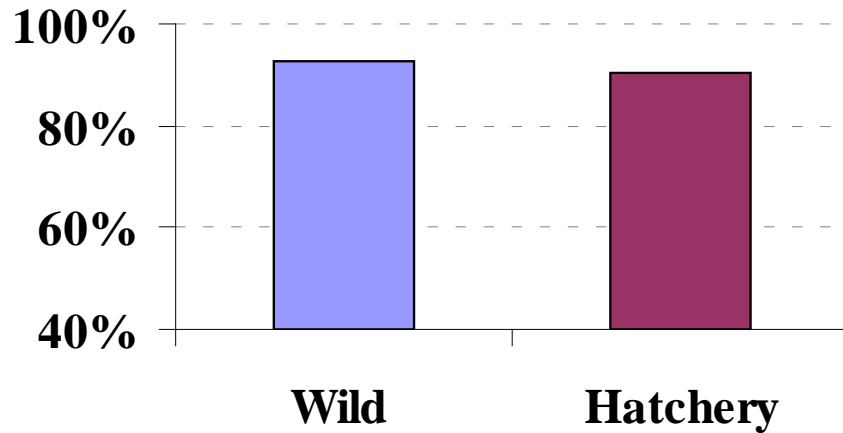
Egg Weight

(For Each Return Year)



Female Breeding Success

% Spawned



Wild = 92.8%

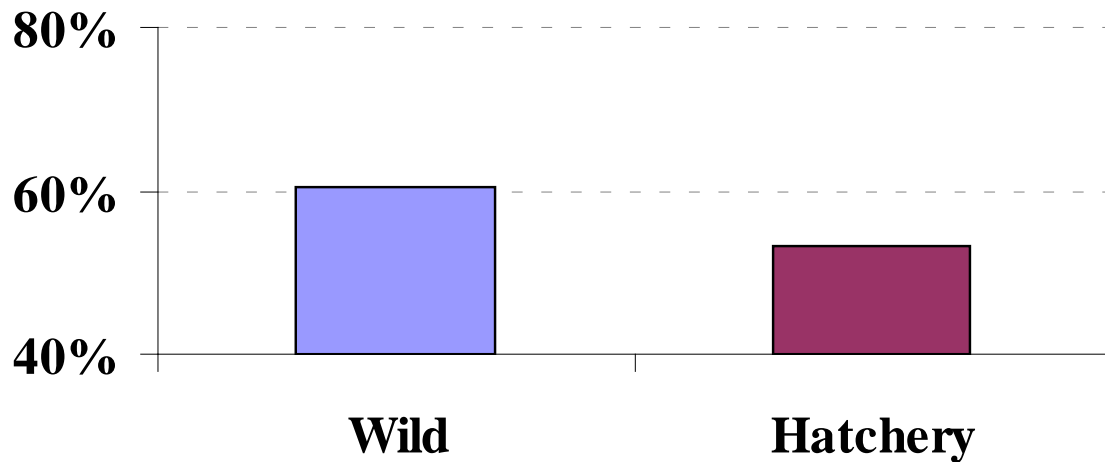
Hatchery = 90.4%

$P = 0.228$ paired- t test



Female Breeding Success:

% Survival Of Actual Egg Deposition

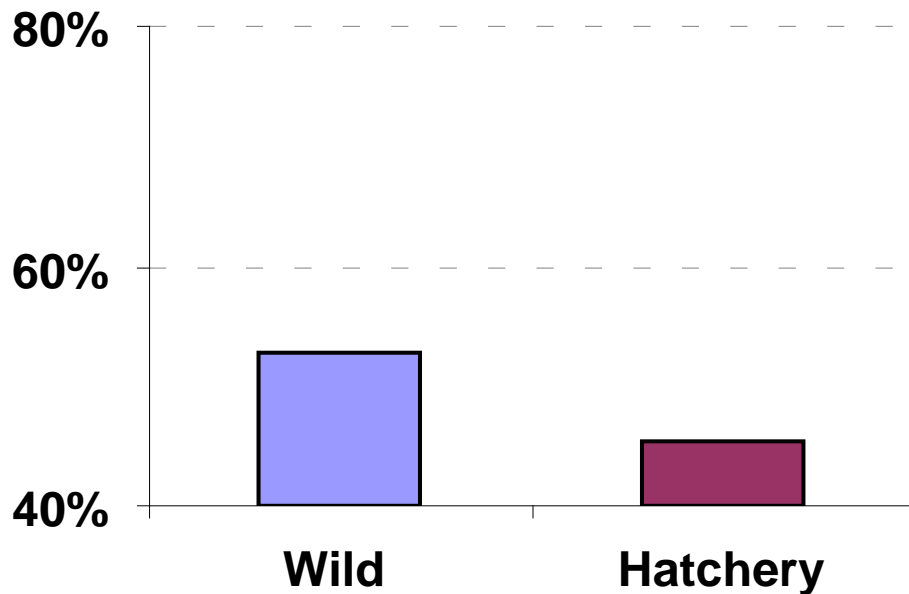


Wild = 60.5%

Hatchery = 53.2%

$P = 0.01$ paired t -test

Female Breeding Success: Potential Egg Deposition To Fry Survival



Wild = 52.8%

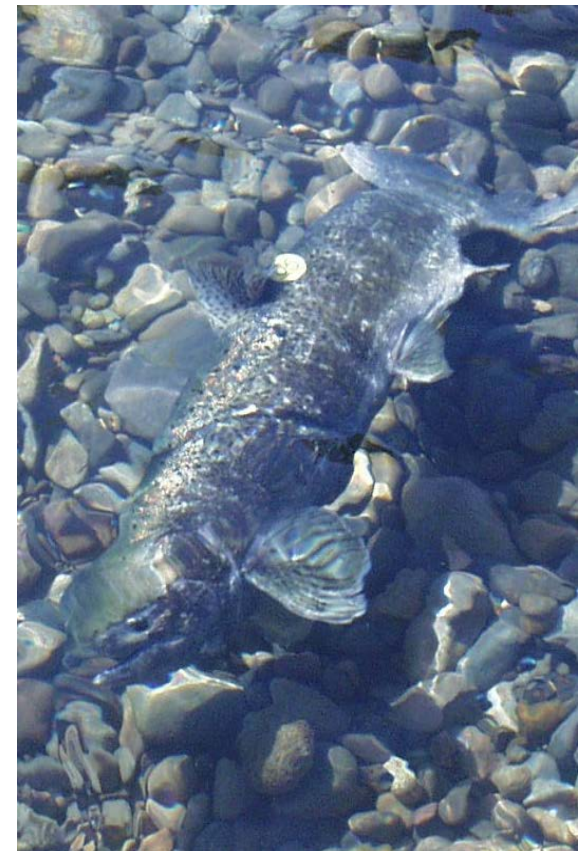
Hatchery = 45.4%

$P = 0.063$ paired- t test



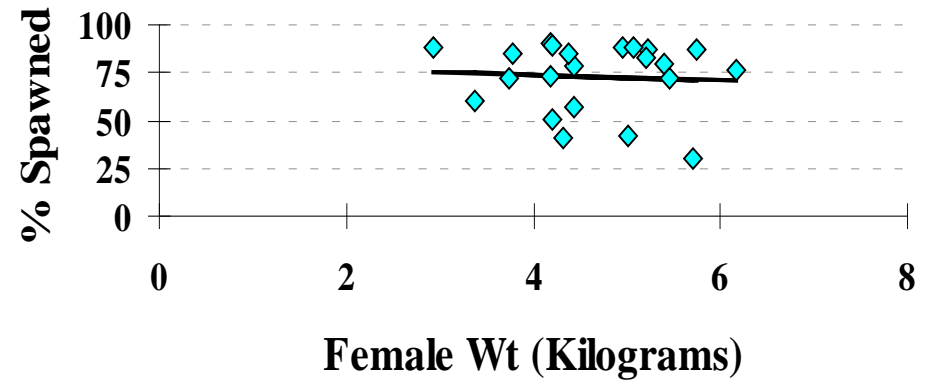
Factors Examined That May Affect Female Breeding Success

Factors Examined	
Morphological & Physiological	Behavioral
Body Size	Instantaneous Density
Longevity	In-stream Distribution
	Redd Abandonment
	Nest Construction
	Egg Burial

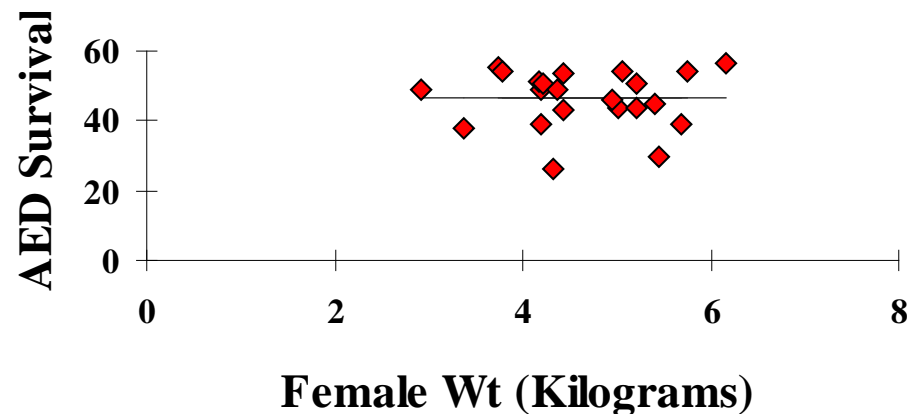


Affect Of Body Size On Female Breeding Success

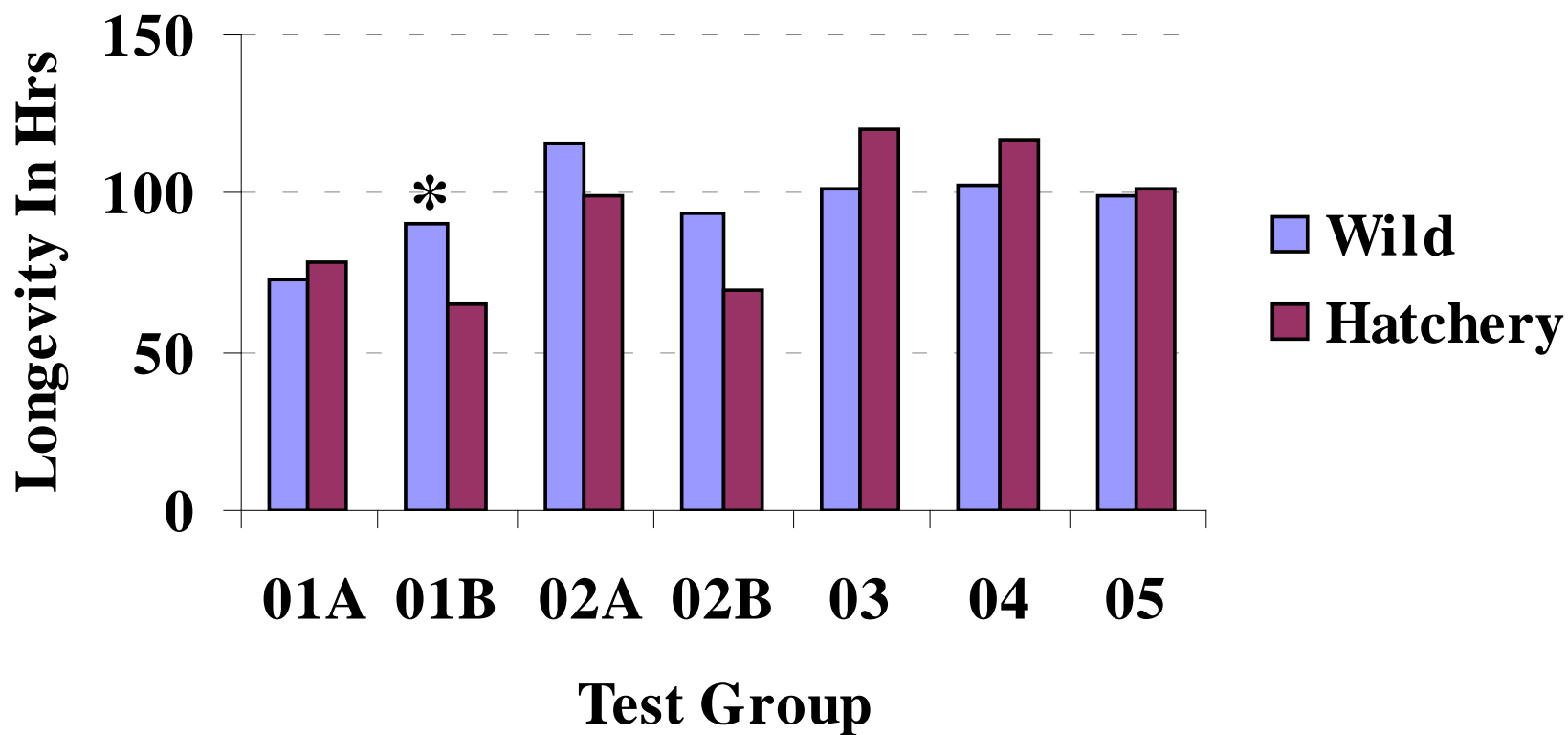
- No Affect On Egg Deposition



- No Affect On AED Survival (spawned egg-to-fry survival)

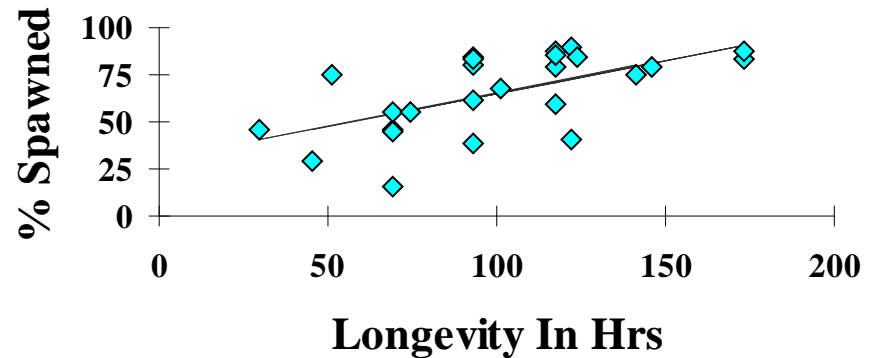


Affect Of Female Origin On Longevity

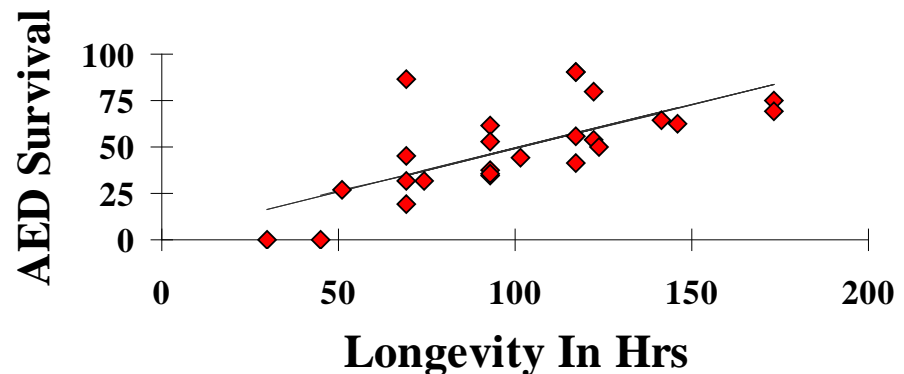


Longevity & Female Breeding Success

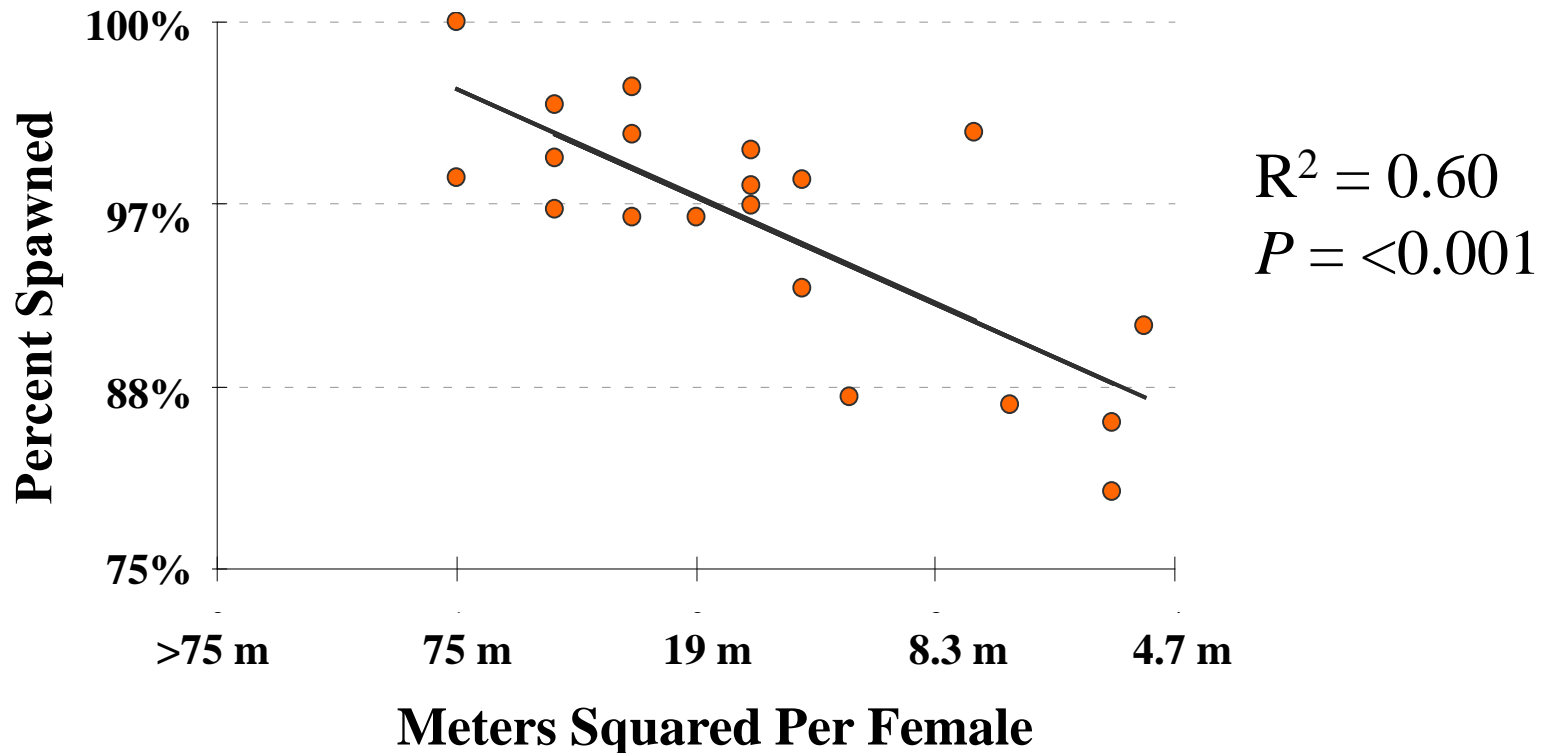
- **Positive Relationship Between % Spawned & Longevity**
Tau = 0.473, $P = <0.01$



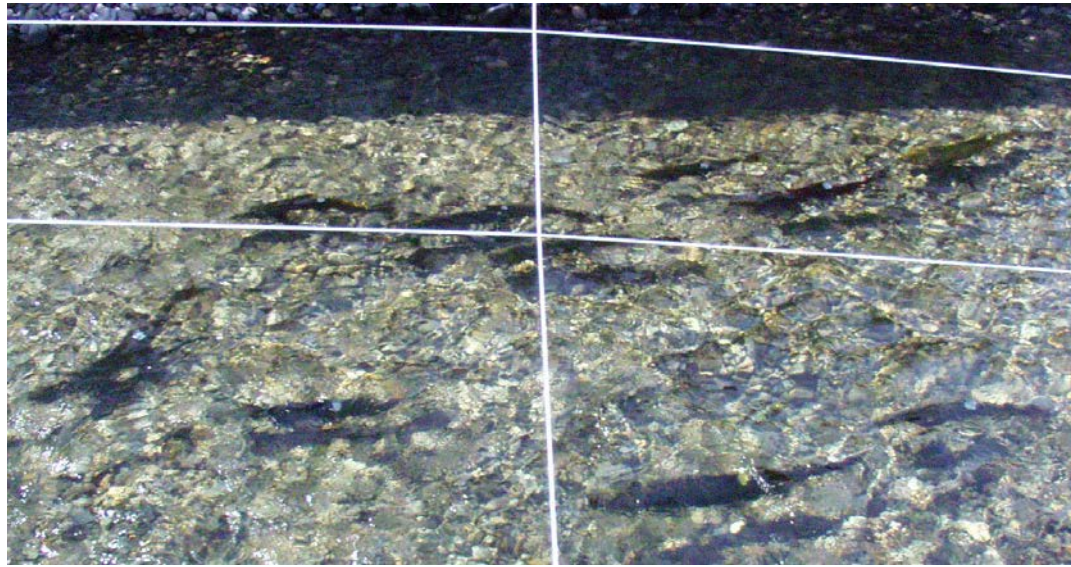
- **Positive Relationship Between AED Survival & Longevity**
Tau = 0.568, $P = <0.01$



Affect Of Instantaneous Density On Female Breeding Success: % Spawned

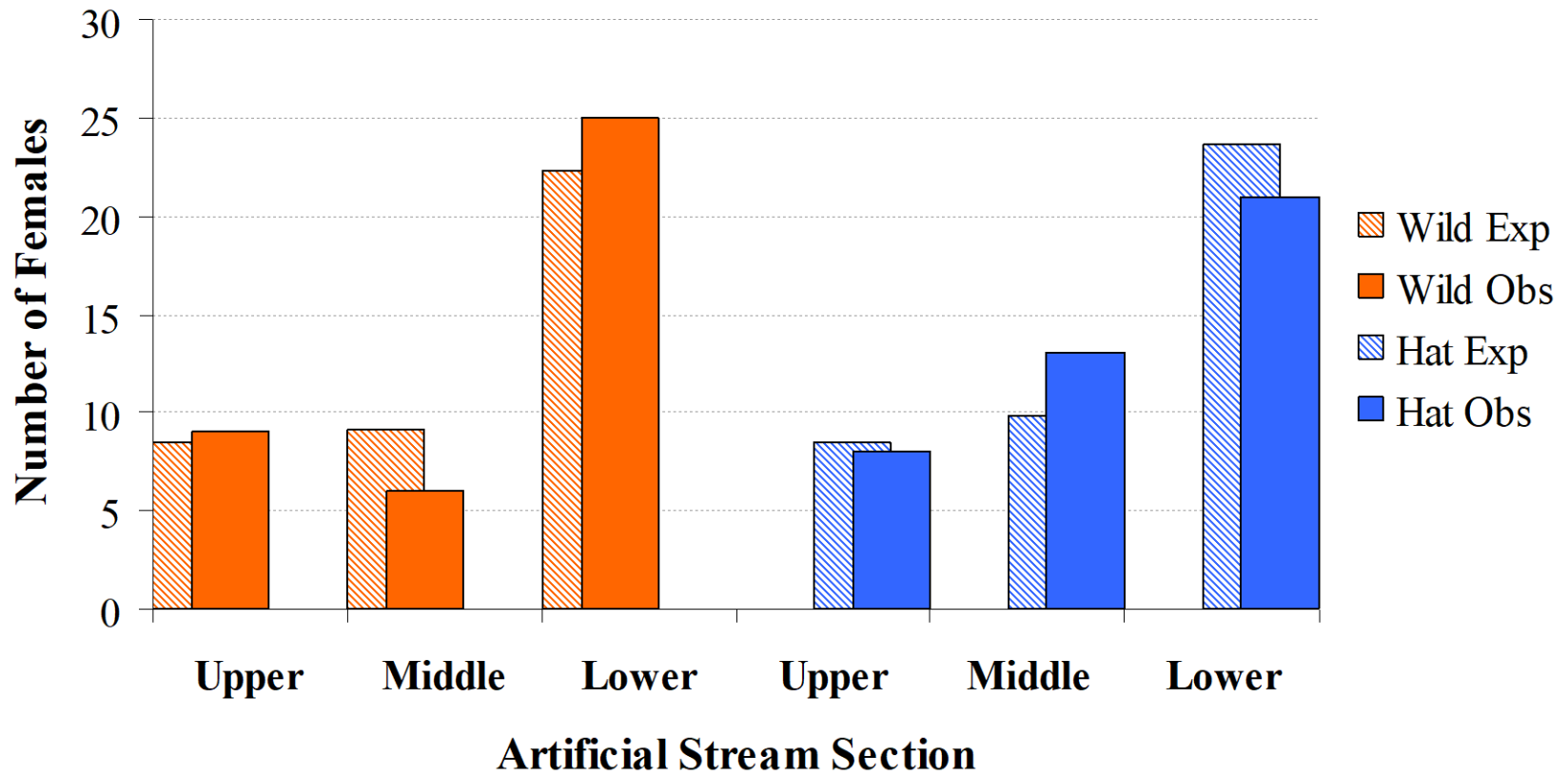


Affects Of Instantaneous Density: AED Survival, PED Survival

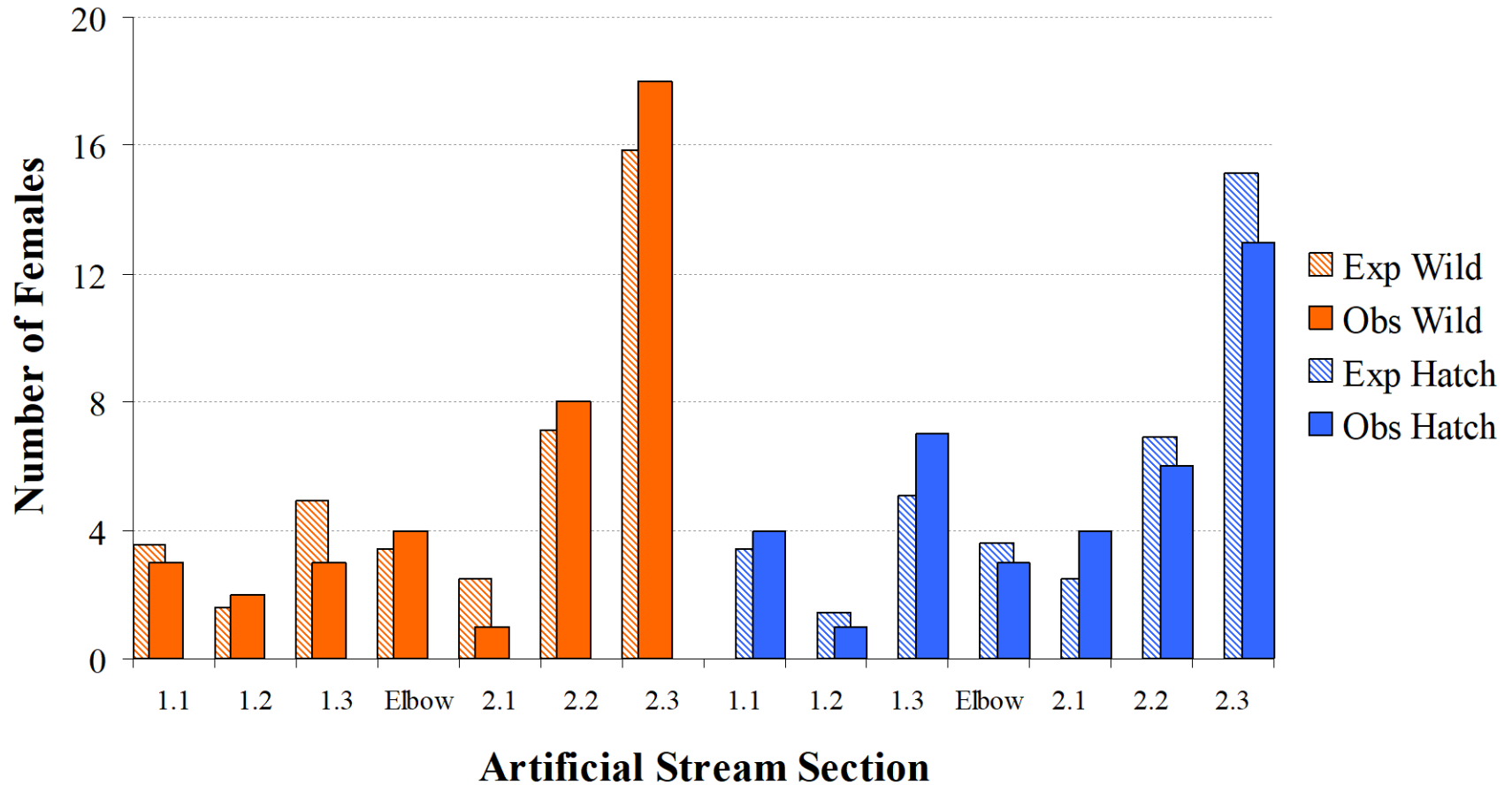


Relationship	r^2	<i>P</i> Value
Density vs. AED Survival	0.21	0.044
Density vs. PED Survival	0.48	<0.001

In Stream Distribution Of Wild & Hatchery Females: Half Stream

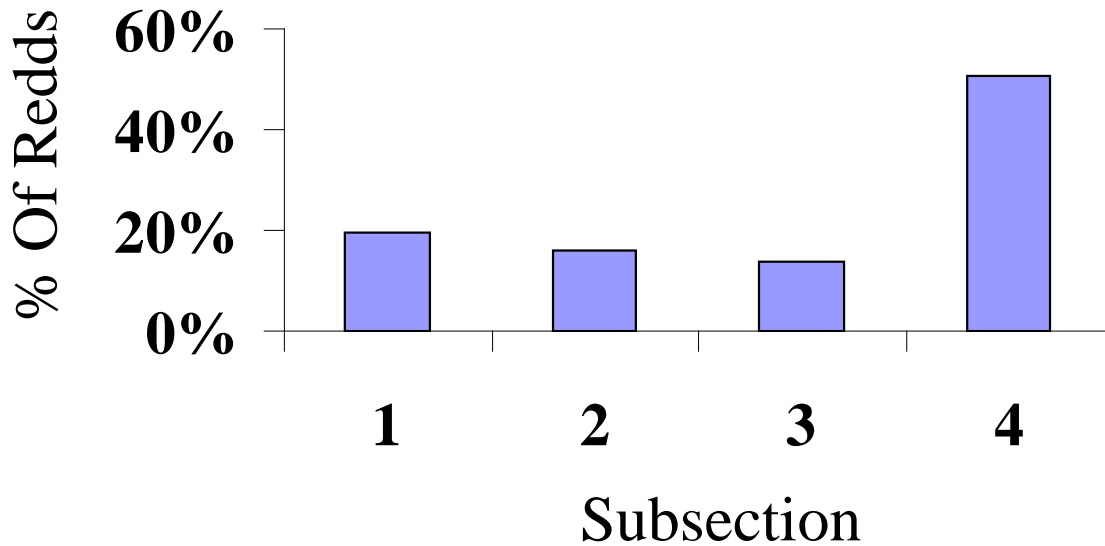
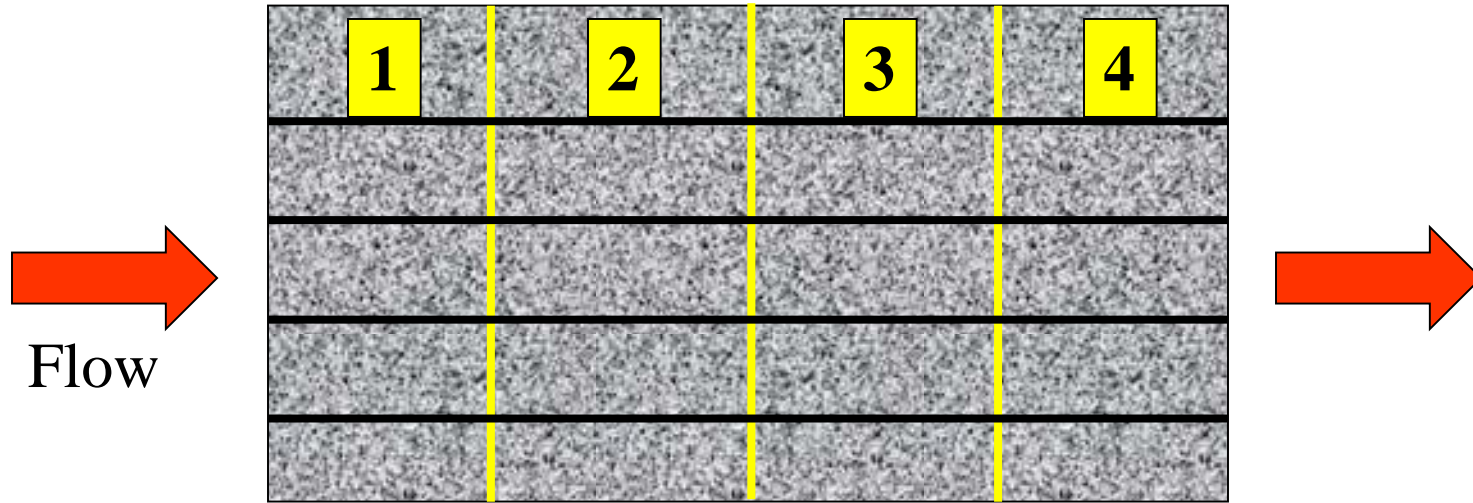


In Stream Distribution Of Wild & Hatchery Females: Entire Stream

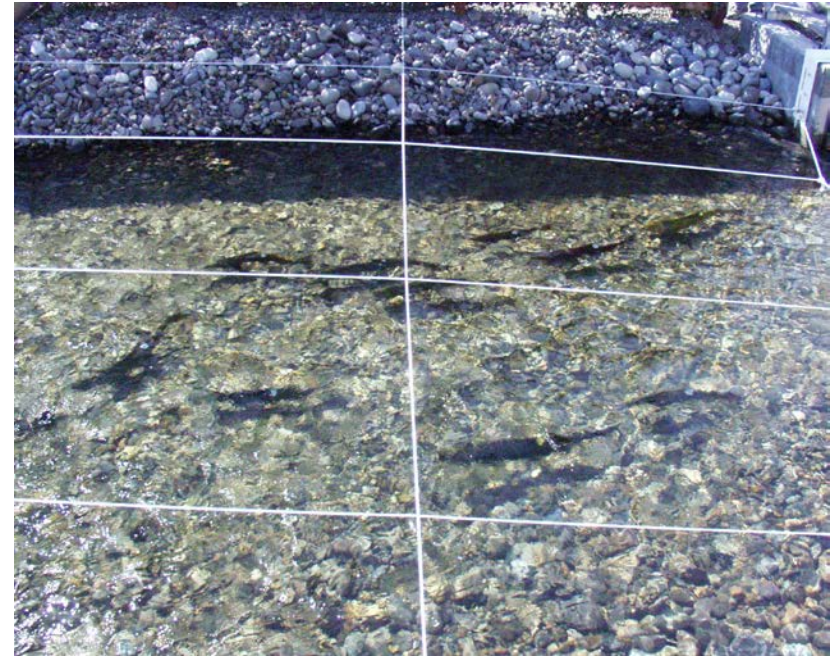
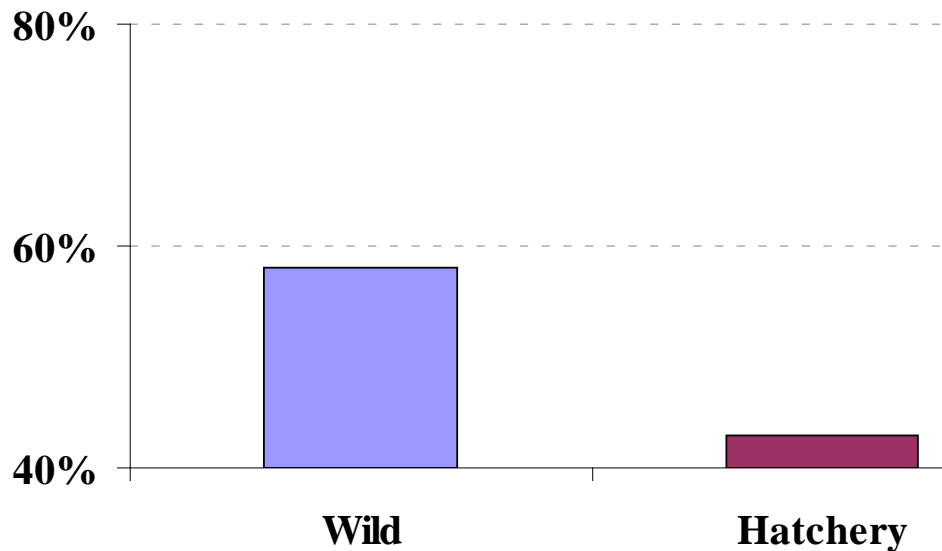


Redd Placement Within Artificial Stream

Sections: Hatchery & Wild Combined



Redd Placement By Wild & Hatchery Females: % Of Redds In Lowest Portion Of A Stream Section

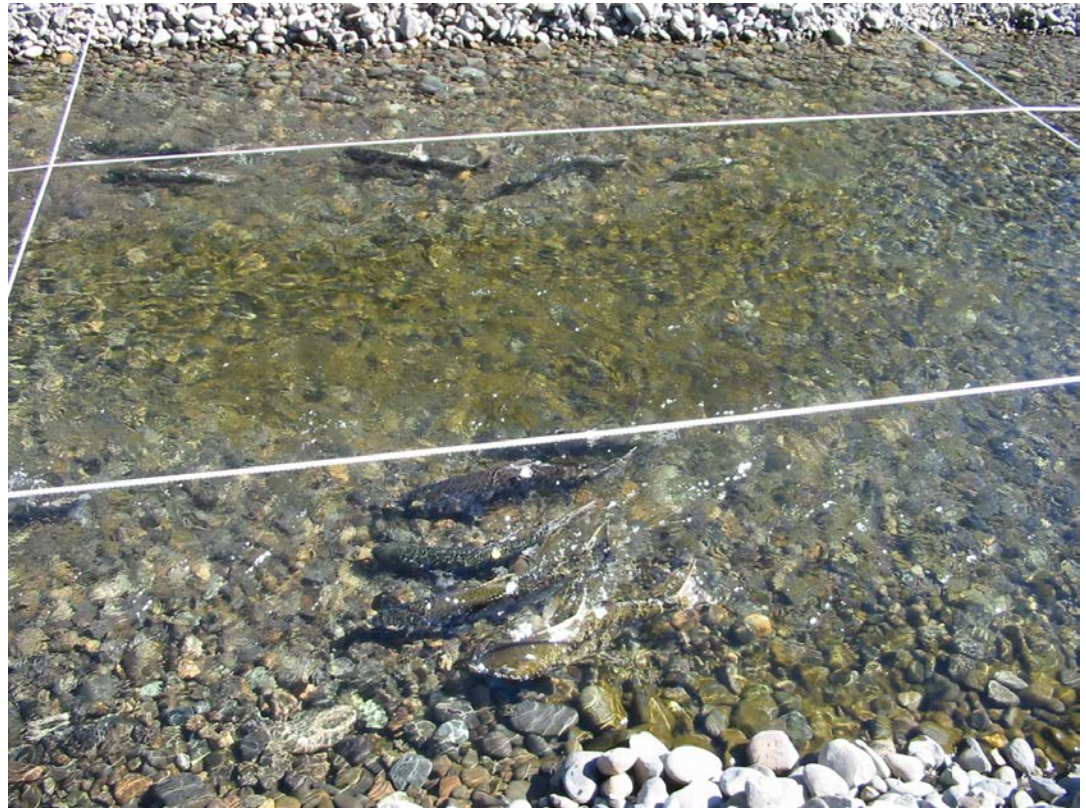


Females Preferred Lowest Portions Of A Stream Section
& More Wilds Appeared To Spawn In These Sections
(58% vs. 42% $P = 0.08$)

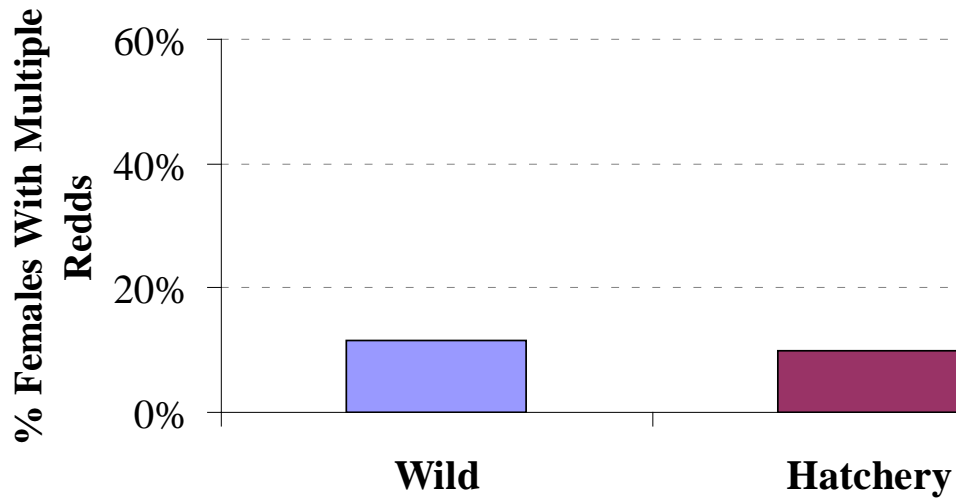
Redd Abandonment

Observed Causes:

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



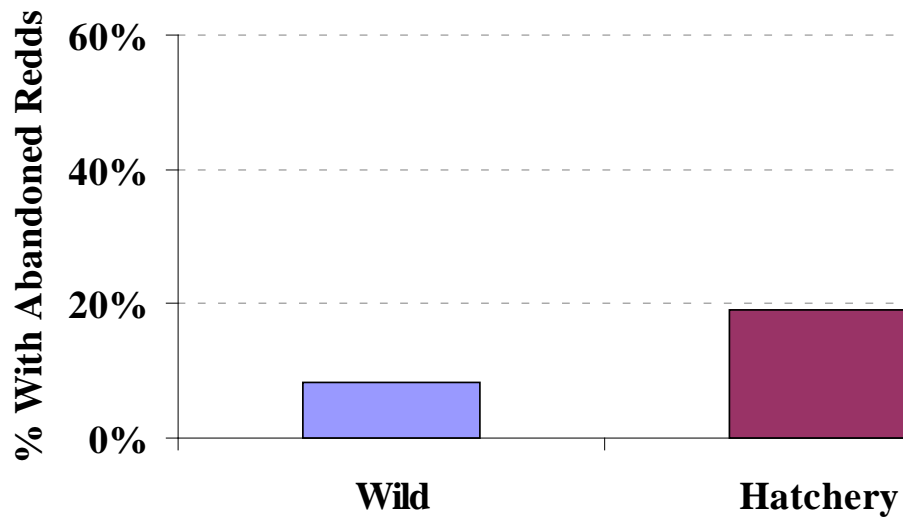
Affect Of Female Origin & The Occurrence Of Multiple Redds



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



Affect Of Female Origin & Redd Abandonment

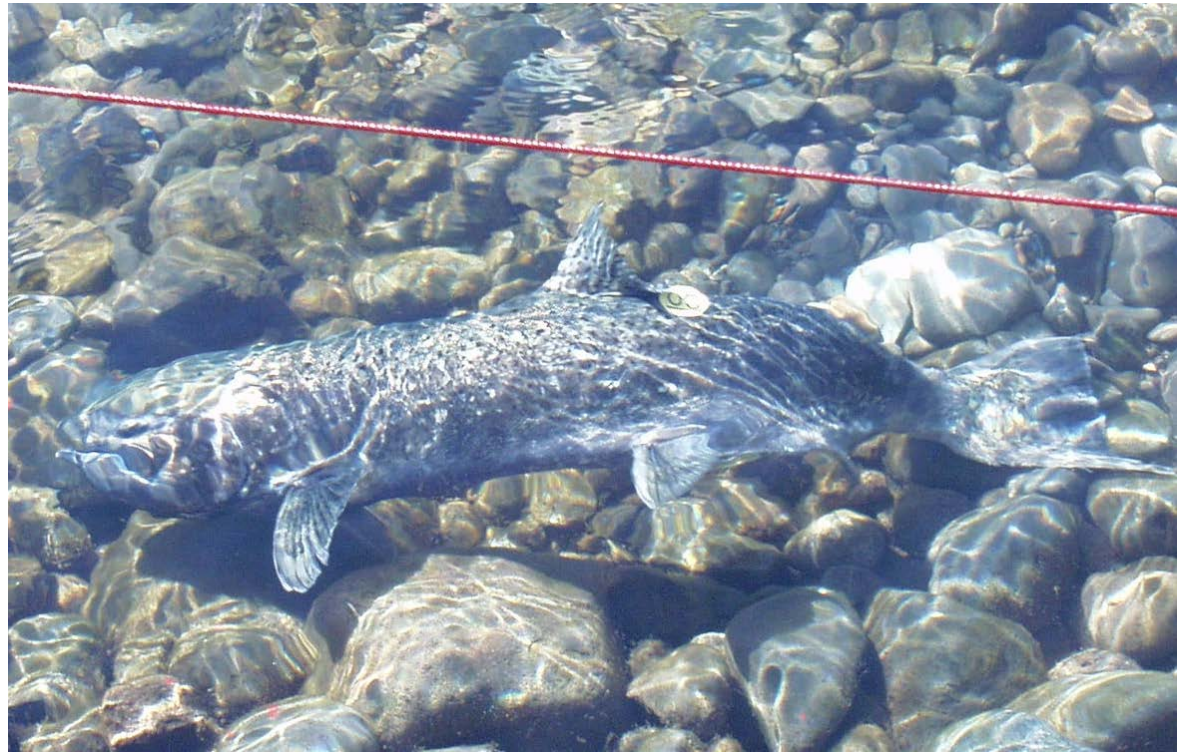


8% vs. 20% ($P = 0.059$)

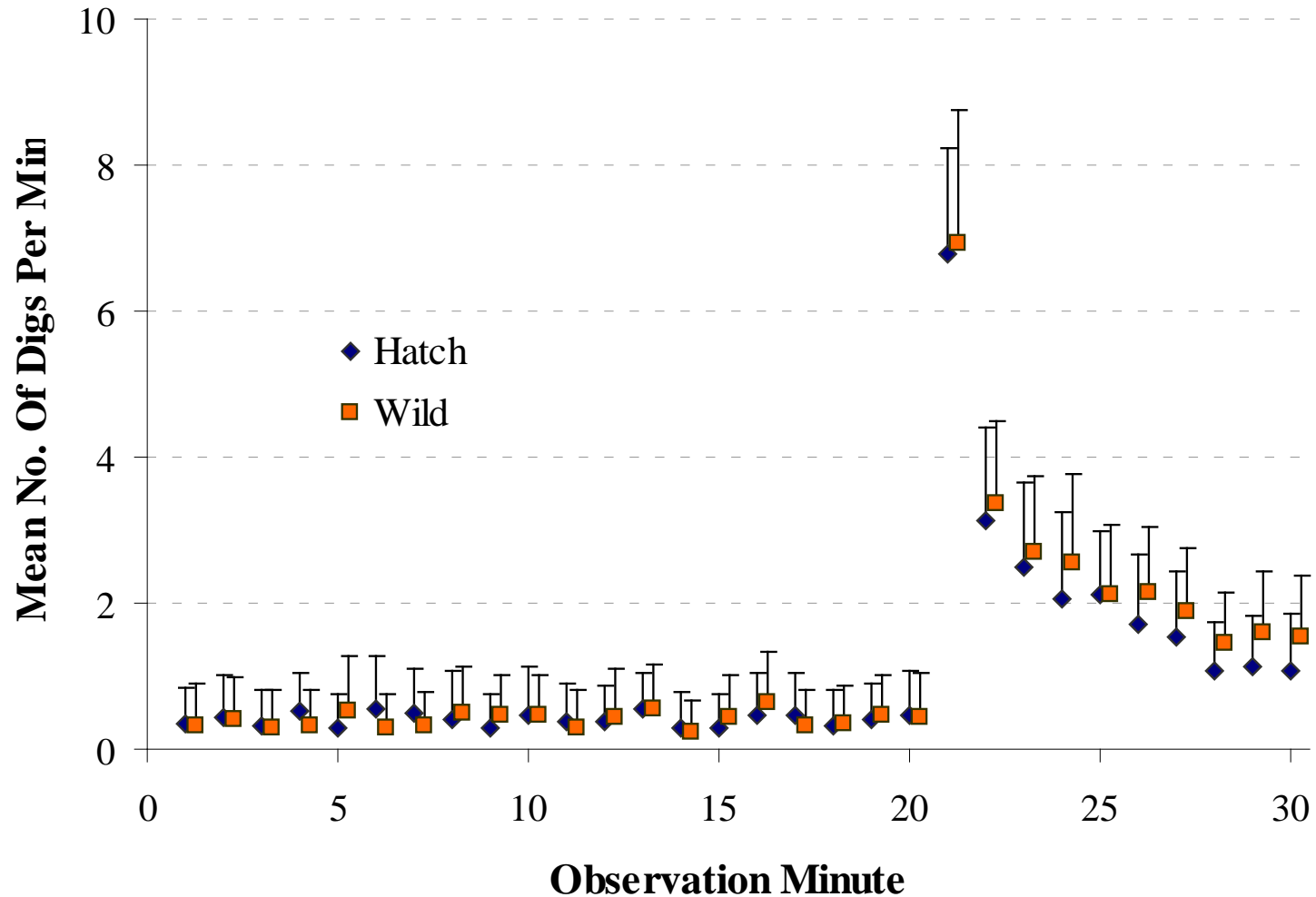


Nest Construction Activities Compared

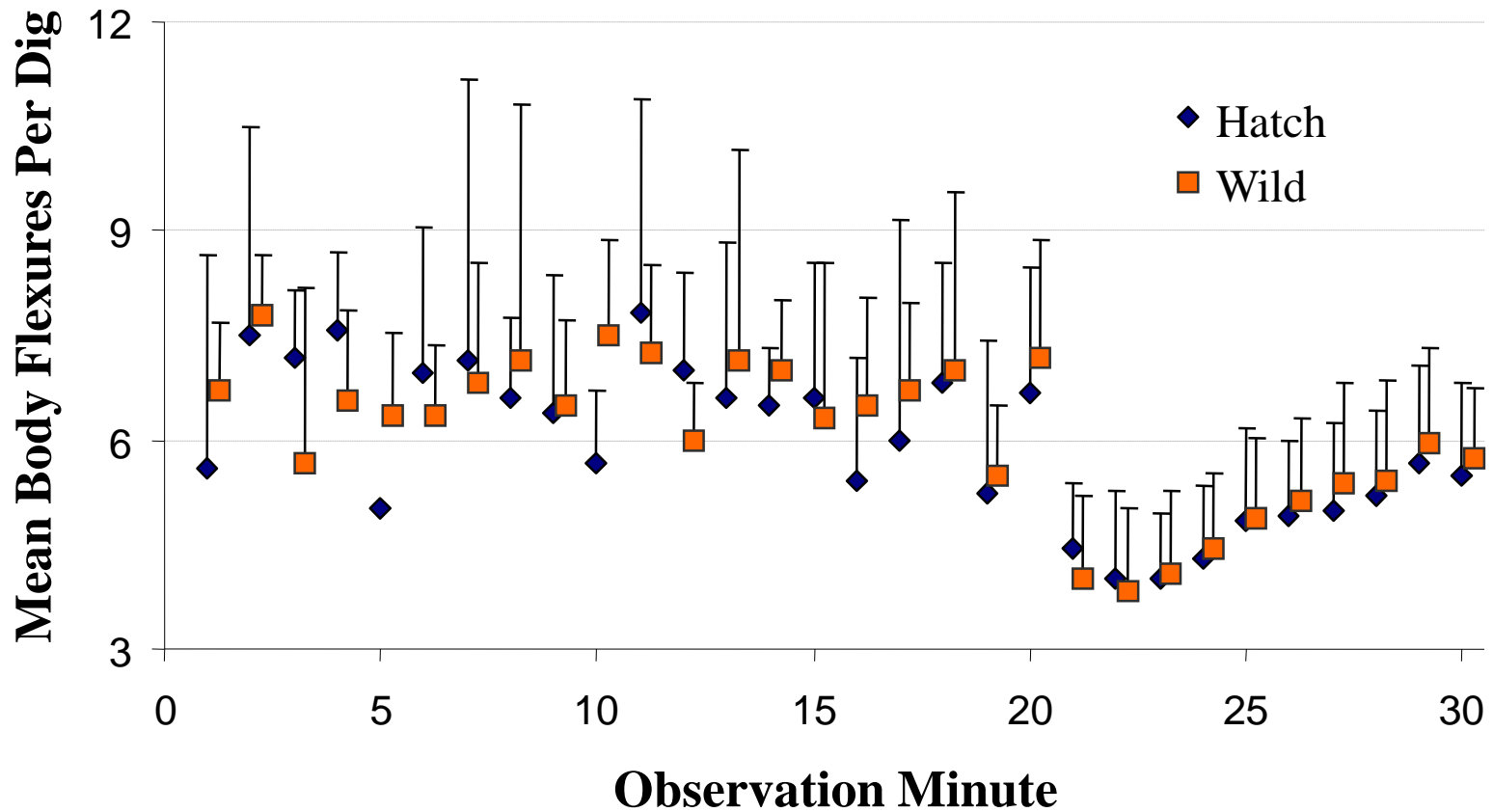
- **Digging Frequency**
- **Body Flexures Per Dig**
- **Egg Burial**



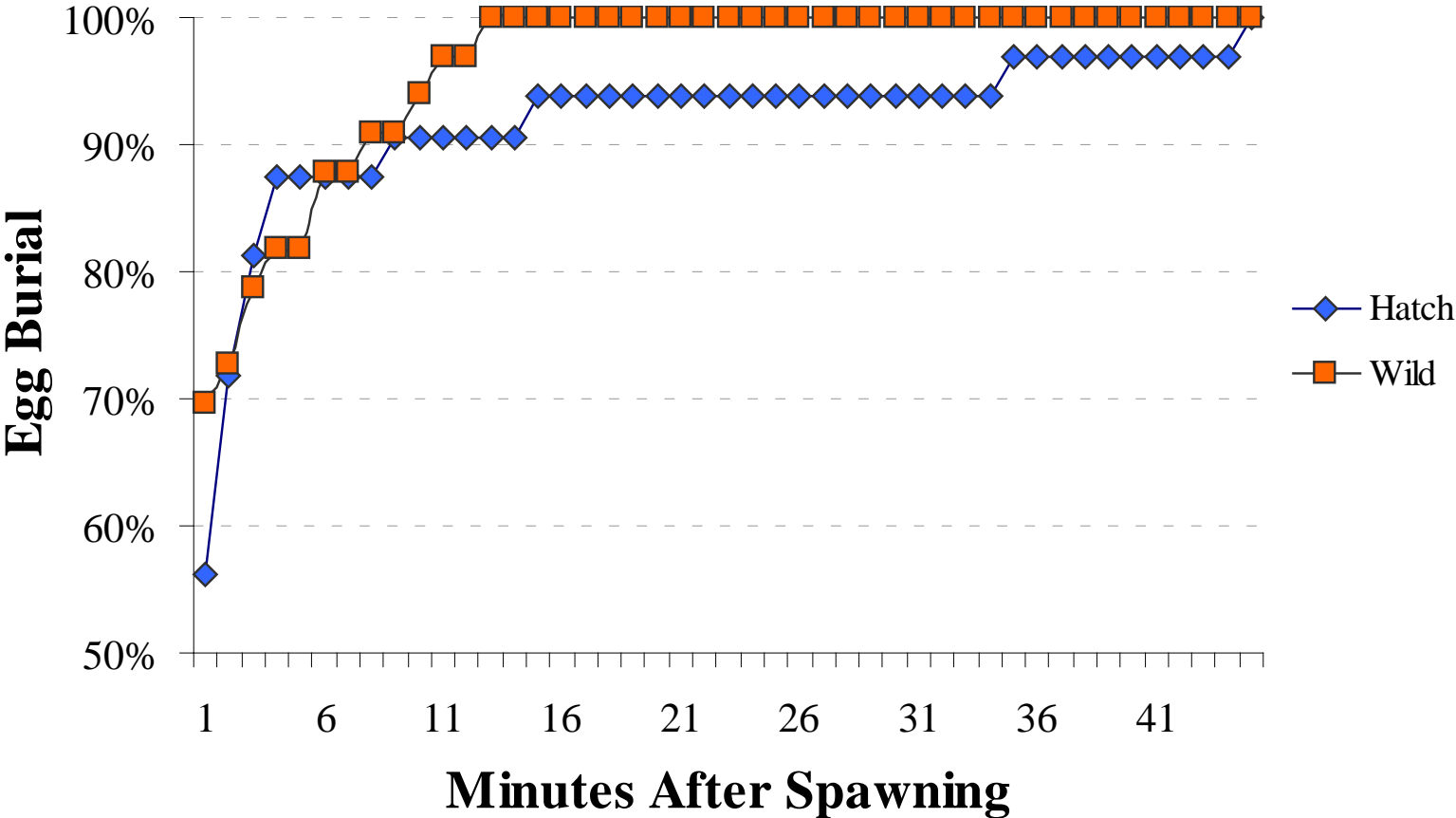
Digging Frequency Of Hatchery & Wild Females



Body Flexures Per Dig in Hatchery & Wild Females



Egg Burial Times For Hatchery and Wild Females



Factors Responsible For Differences In Breeding Success

Differences Between Wild & Hatchery Females

- Redd Location (Wild: more at tail end of sections)**
- Redd Abandonment (Wild: less likely to abandon)**
- Egg Burial Time (Wild: more rapid burial)**

Special Thanks To:

Yakama Nation Staff

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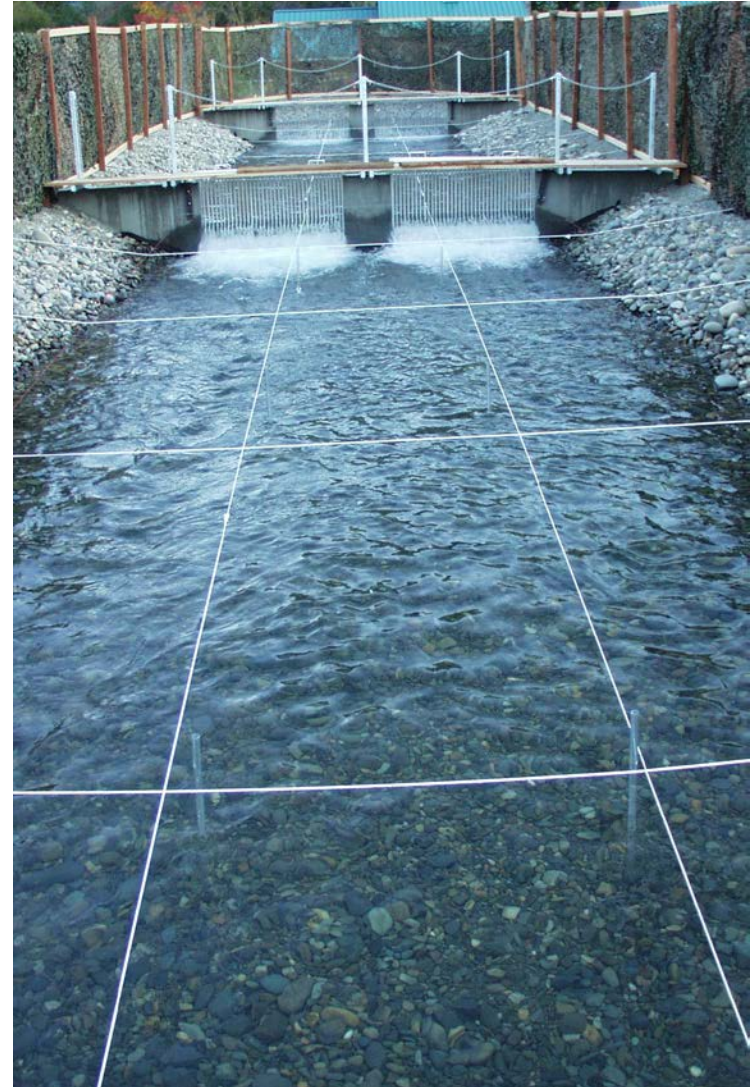
Bonneville Power Administration

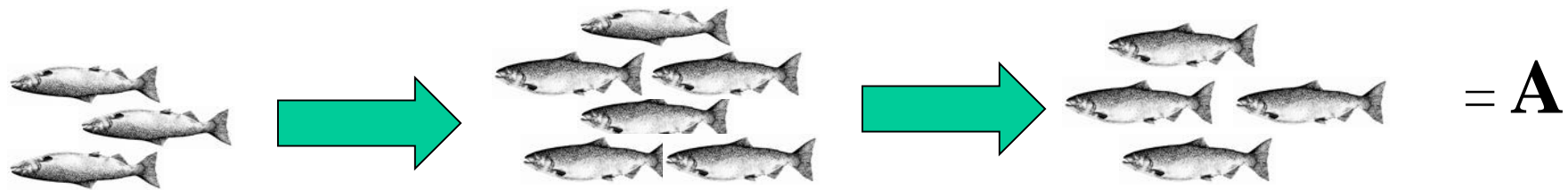
DAVID BYRNES AND PATTY SMITH

Applicability Of Results From An Artificial Stream

- **Natural Variation Will Swamp Out Effects** Seen Under Controlled Conditions
- **Differences Will Be Accentuated** Under Less Forgiving Conditions

For Management It Seems Prudent To Assume That Differences Seen Will Be Expressed Under Natural Conditions





Wild Fish To Hatchery

1st Generation Hatchery Adults To The Wild

NORs From 1st Generation Hatchery Parents

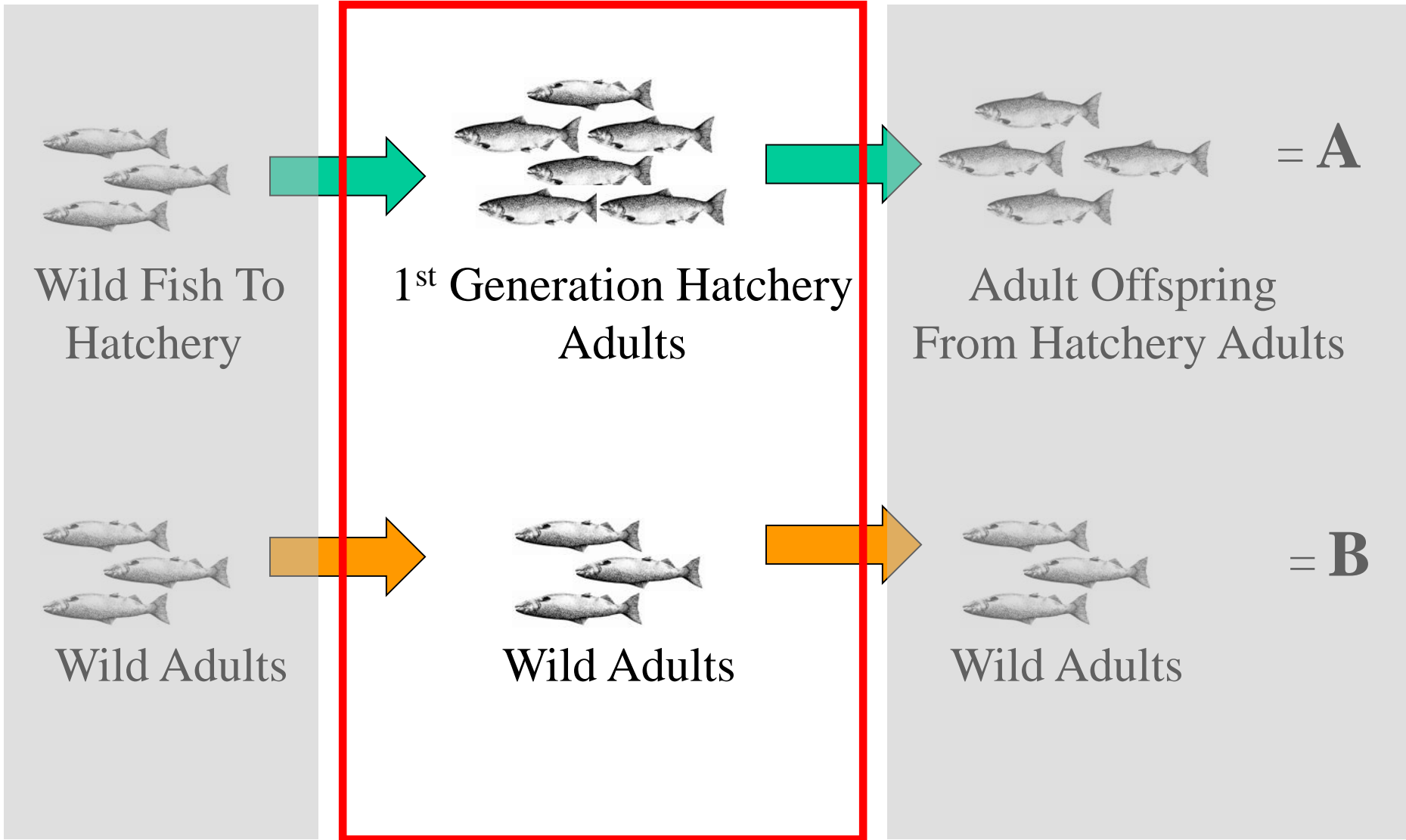


Wild Fish To Wild

Wild Fish To Wild

Wild Fish To Wild

Is $A > B$?



Comparing The Breeding Success Of 1ST Generation Hatchery & Wild Adults

Hypothetical Cumulative Effects Of Inadvertent Domestication

Life History Stage	Wild	Hatchery	Assumptions	Source
Fecundity	4200	3927	6.5% Decrease	Knudsen et al. 2006
No. Eggs Spawned	3898	3550	2.4% Decrease	Schroder et al. Submitted
No. Of Emerged Fry	2358	1889	7.3% Decrease	Schroder et al. Submitted
No Of Parr	2358	1734	8.2% Decrease	Fritts et al. In Press Pearsons et al. In Press
Smolt Production	236	173	90% Mortality	Healey 1991
Adult Production	2.4	1.7	1% Smolt-to-Adult	Bosch 2006

Conclusion: Small changes have made hatchery fish about 71% as productive as wild fish