

Size at Release of Imnaha River Smolts: Does Size Matter?

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Imnaha River Spring Chinook Salmon LSRCP Program Objectives

- 1. Prevent extinction of Imnaha River Chinook Salmon populations.**
- 2. Maintain genetic and life-history characteristics of natural Chinook Salmon population.**
- 3. Meet mitigation goal of 3,210 hatchery adults returning to the Imnaha Basin.**
- 4. Re-establish historic tribal and recreational fisheries.**
- 5. Minimize impacts of hatchery programs on resident fish populations.**

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4. Re-establish historic tribal and recreational fisheries.
5. Minimize impacts of hatchery programs on resident fish populations.
6. Operate hatchery program so that the genetic and life history characteristics of hatchery salmon mimic those of wild salmon, while achieving mitigation goals.

Research & Monitoring Objectives

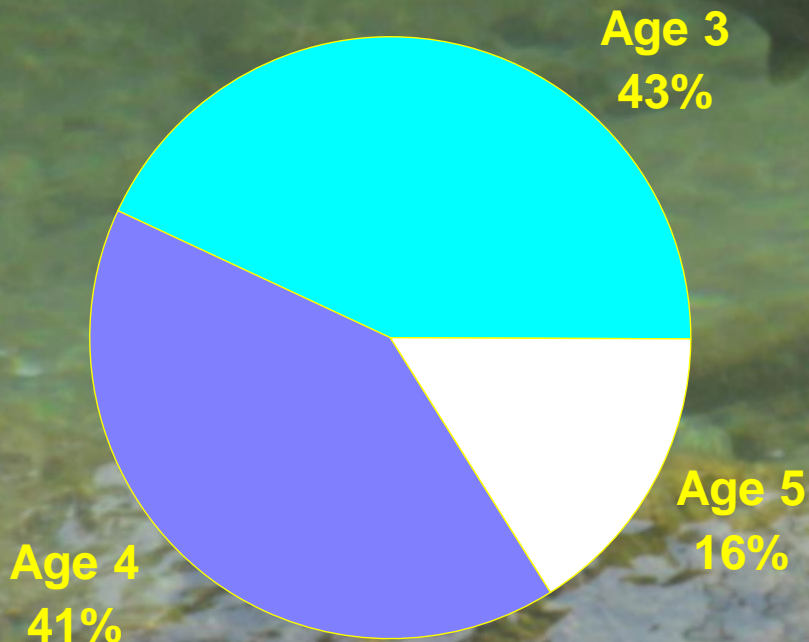
- Compare life history characteristics of hatchery and natural origin Chinook Salmon.
 - Juvenile/adult migration survival
 - Adult run timing
 - Age and size of maturity
- Identify optimum rearing and release strategies that will produce maximum survival to adulthood for hatchery-produced Chinook Salmon smolts.
 - Smolt-to-adult return (SAR) and survival (SAS) rates
 - Production Efficiency - number of mature salmon produced per 10 kg of smolts released

The Problem: Age Structure Differences

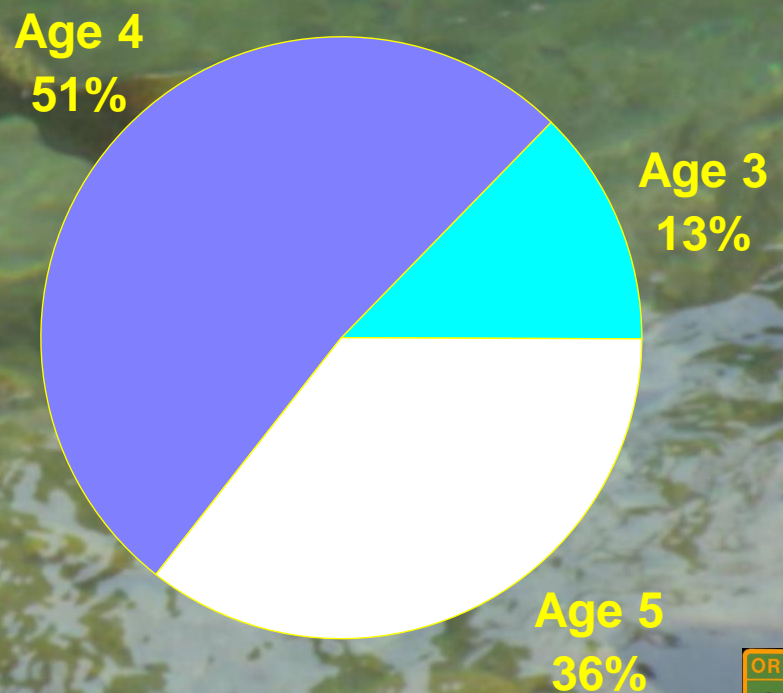
Imnaha River 1982-1987 Brood Year returns:

- Age 3: $H > N$
- Age 4: $H < N$
- Age 5: $H < N$

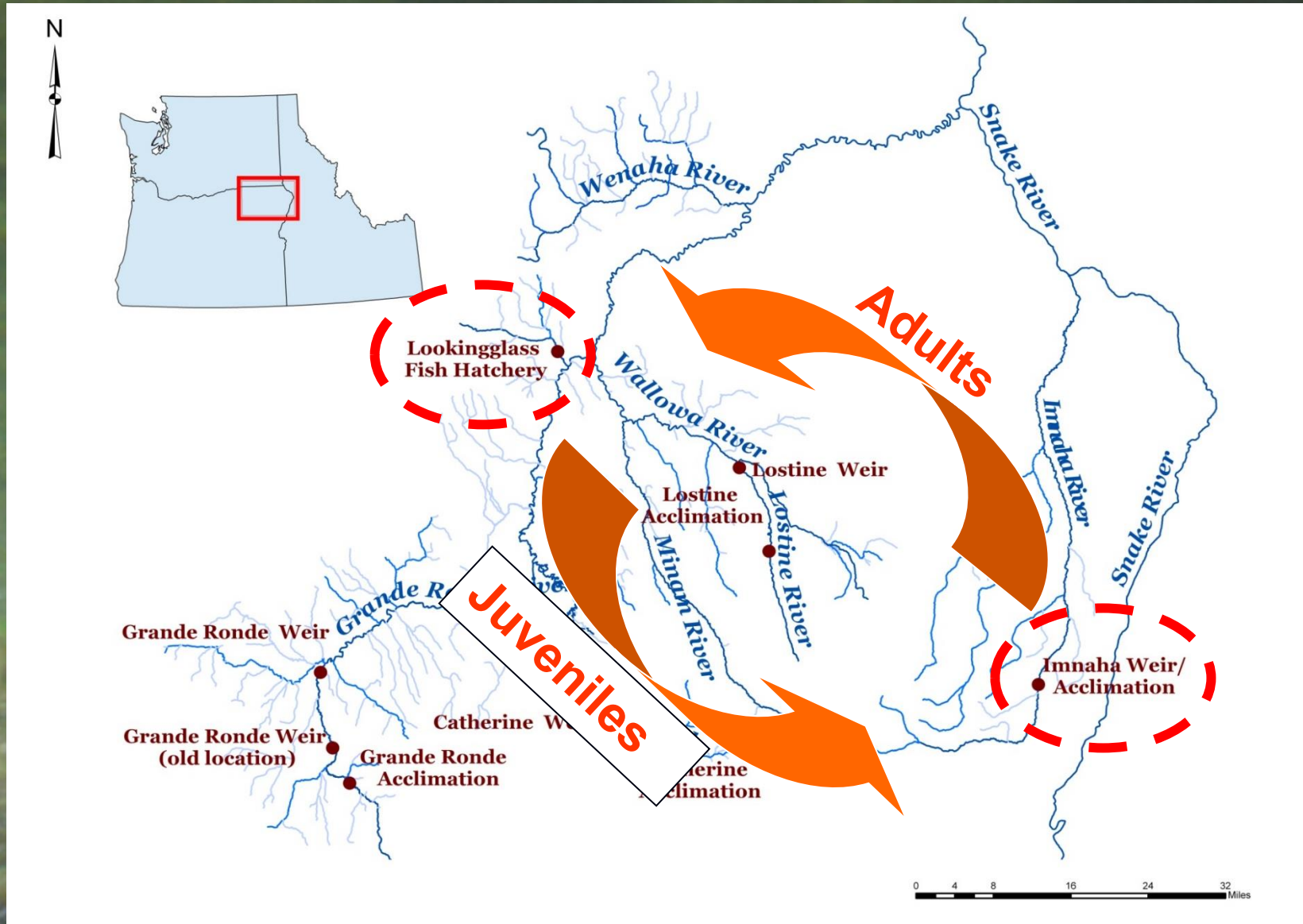
Hatchery



Natural



Lookingglass Fish Hatchery and Imnaha River Acclimation Site



Study Design

10 Brood years: 1988-1990 and 1992-1998
(BY 1991 had BKD and was not included)



Large Smolts

Target: 30-38 g (15-12 fpp)

Actual: 26-41 g (17.5-11.1 fpp)



Small Smolts

Target: 18-23 g (25-20 fpp)

Actual: 18-25 g (25.2-18.2 fpp)

Dependent Variables

- Juvenile survival to Lower Granite Dam (PIT tags in BY 1992-1998)
- Age composition
- Length at maturity
- Harvest, stray, and smolt-to-adult return (SAR) and survival (SAS) rates
- Production efficiency: returns/10 kg of smolts released

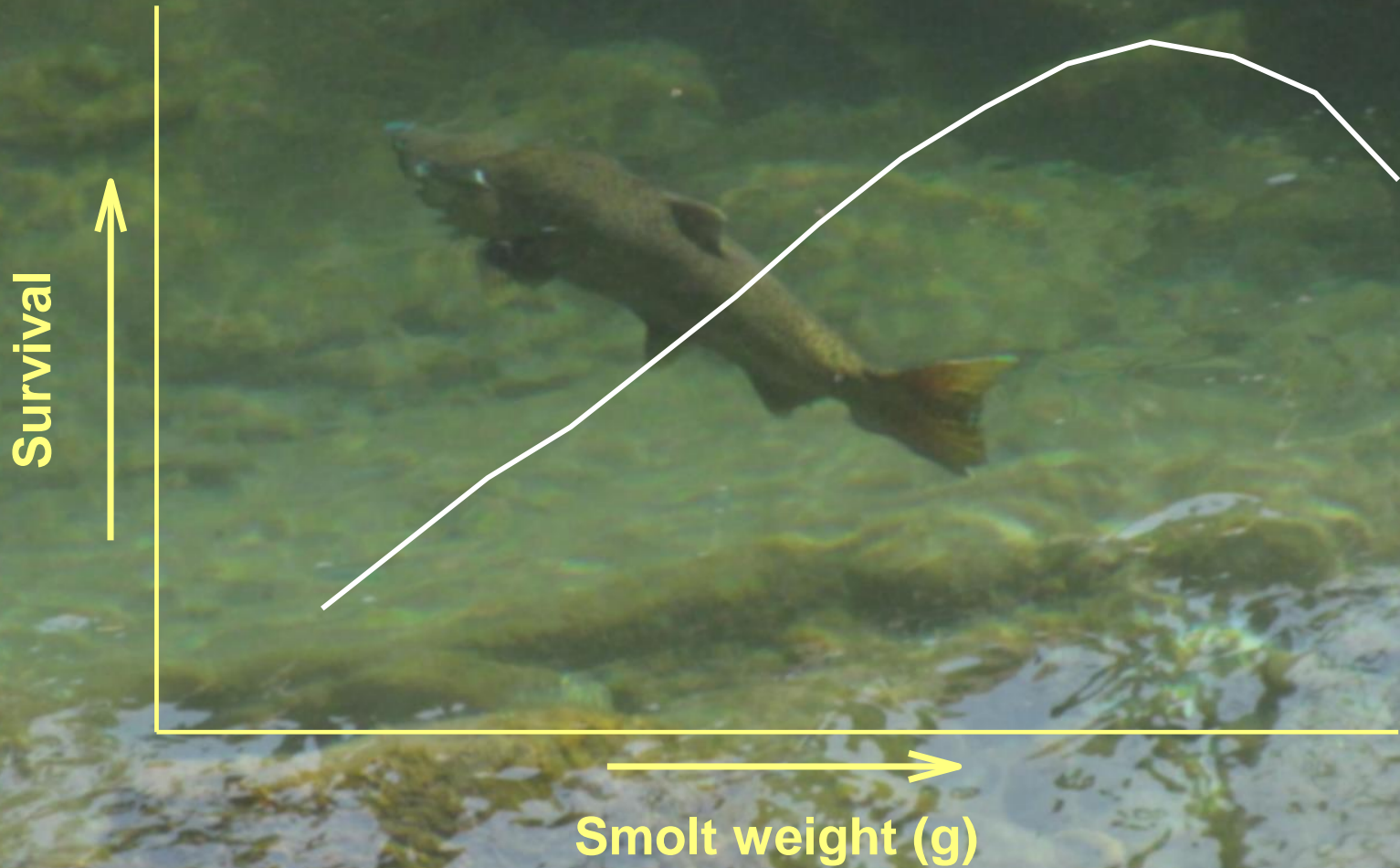
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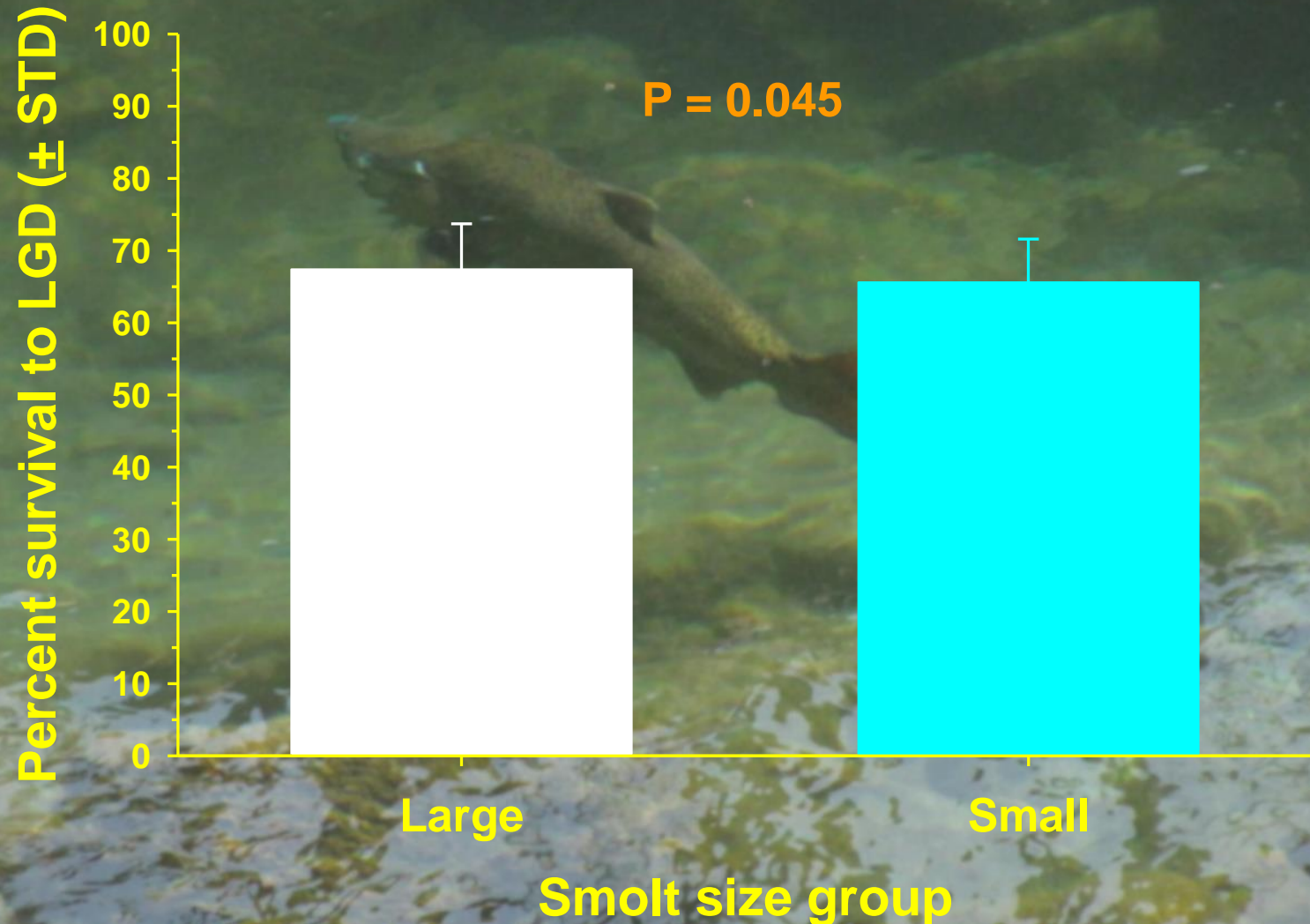
Hypothesis

There is no difference between large and small smolts.

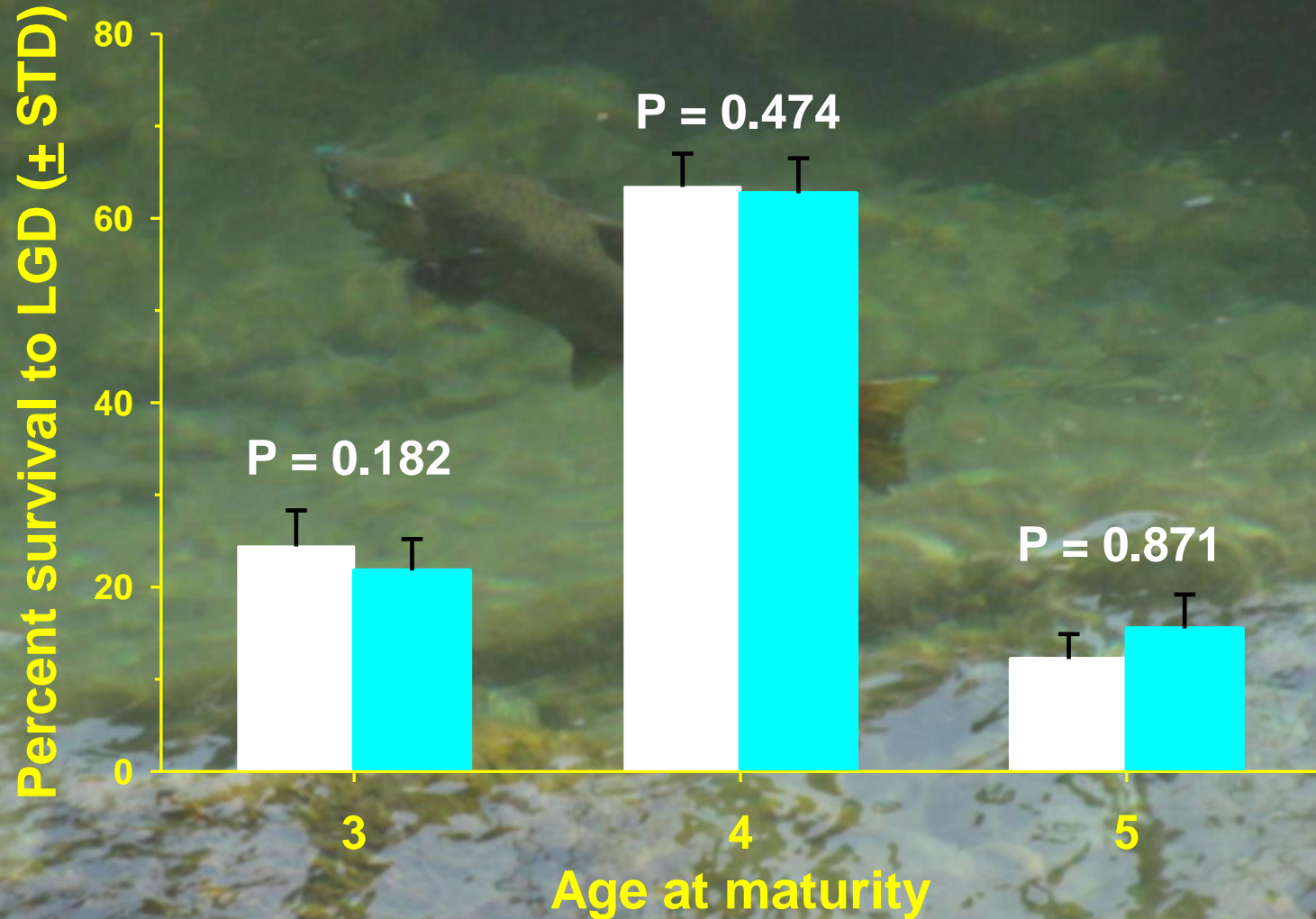
Smolt Size and Survival



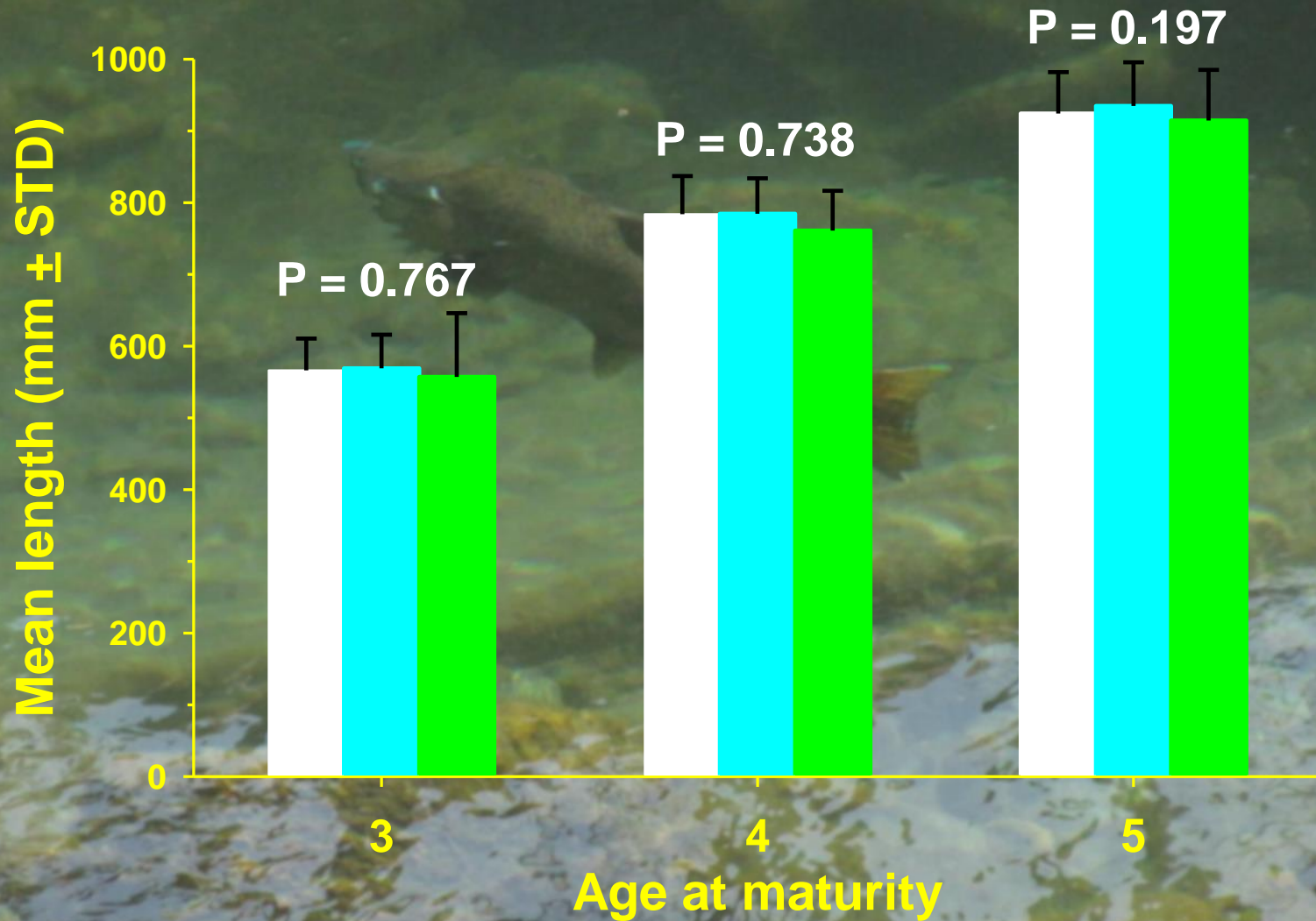
Overall Smolt Survival to Lower Granite Dam (LGD) BY 1992-1998



Age Composition



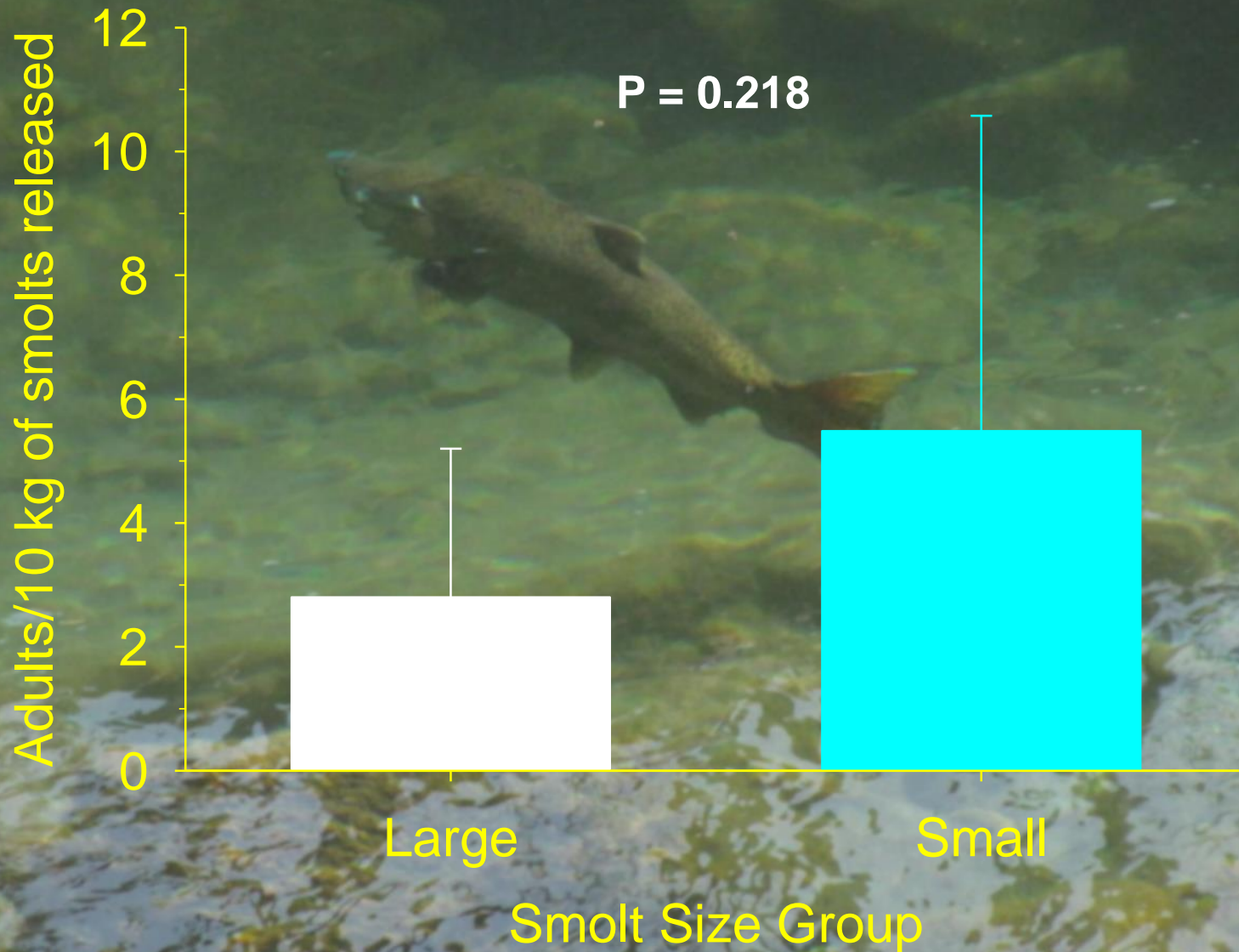
Length at Maturity



Harvest, Stray, SAR and SAS Rates

	Large Smolts (30 g)	Small Smolts (21 g)	P-value
Harvest	0.022%	0.028%	0.035
Stray	0.012%	0.007%	0.184
SAR	0.846%	0.920%	0.282
SAS	0.881%	0.955%	0.287

Production Efficiency



Study Design: Size Group and Density

High Density

44,346 - 85,796 smolts / rcwy
BY 1988-1993

Low Density

6,613 – 26,796 smolts / rcwy
BY 1994-1998



Large Smolts
26-41 g



Small Smolts
18-25 g



Large Smolts
26-33 g

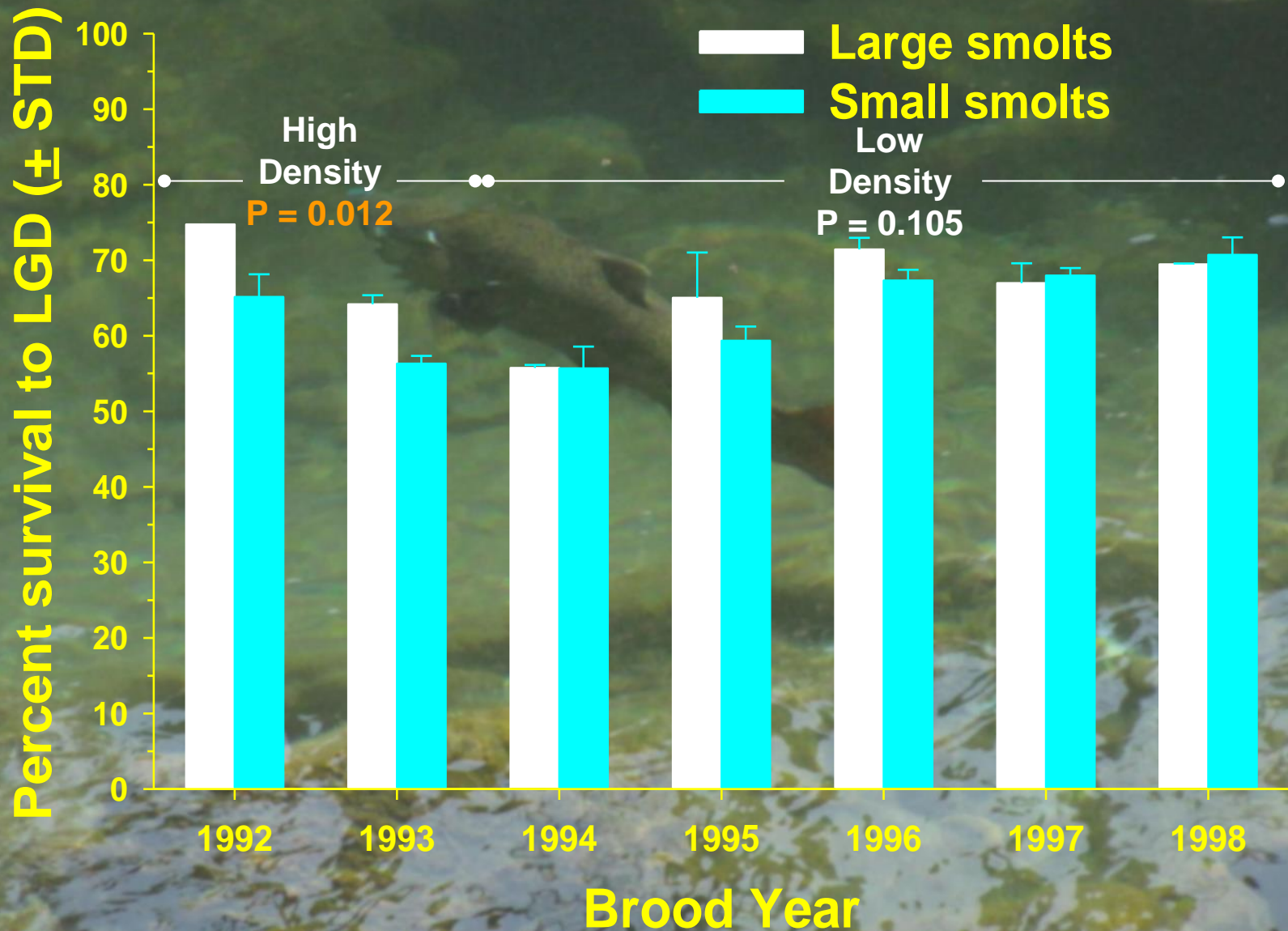


Small Smolts
19-23 g

Dependent Variables

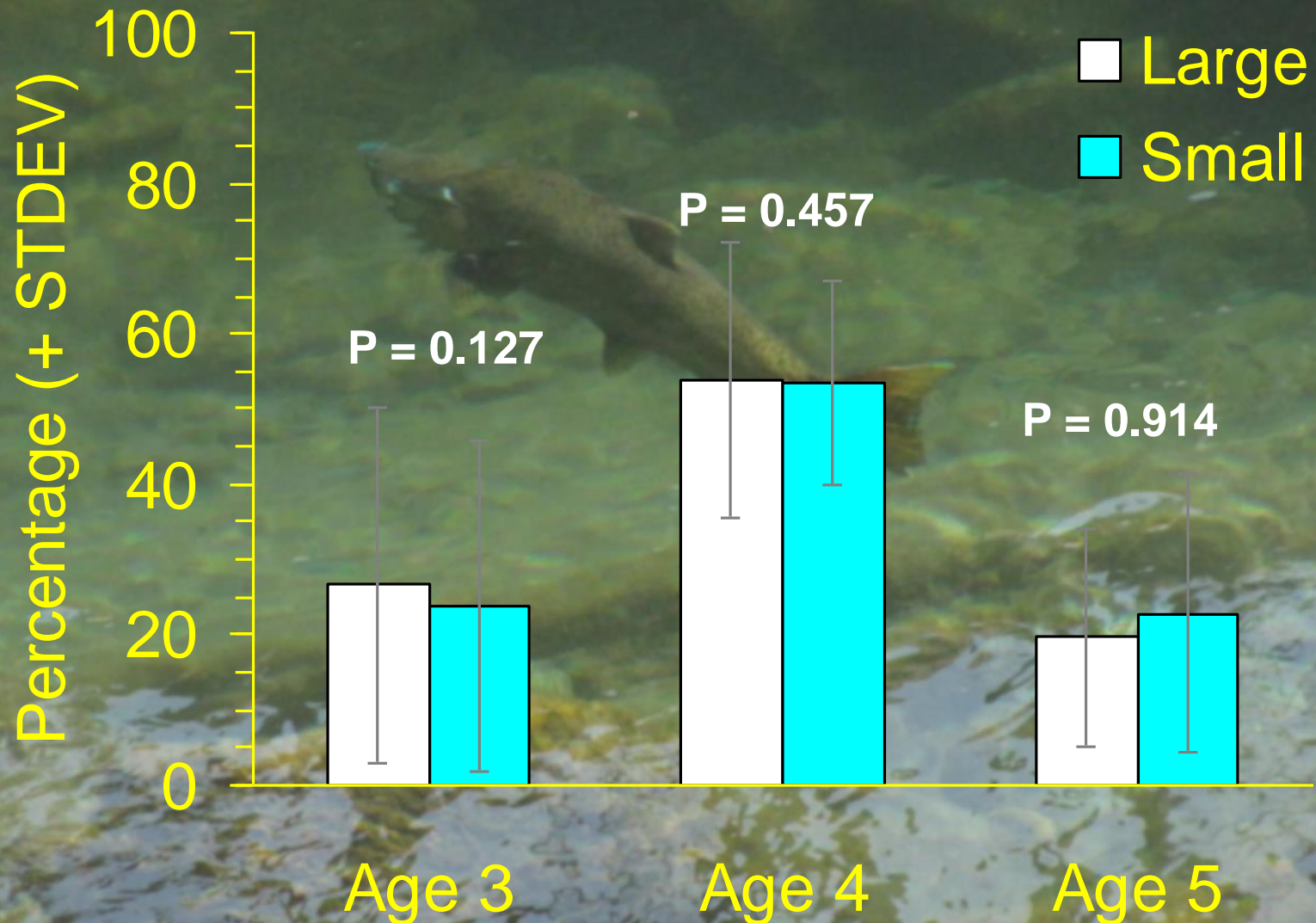
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Smolt Survival to Lower Granite Dam



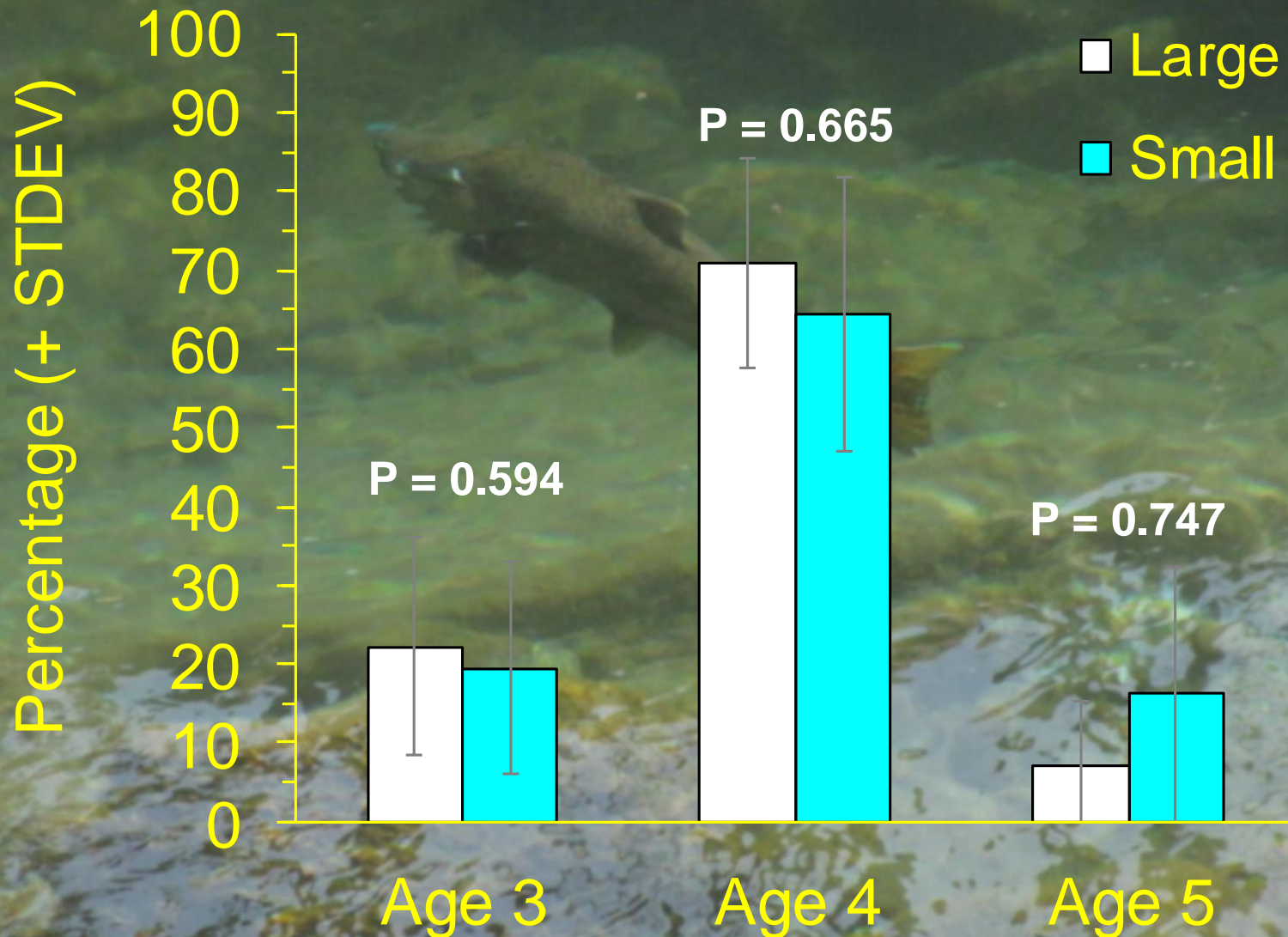
Age Composition

High Density (BY 1988-1993)

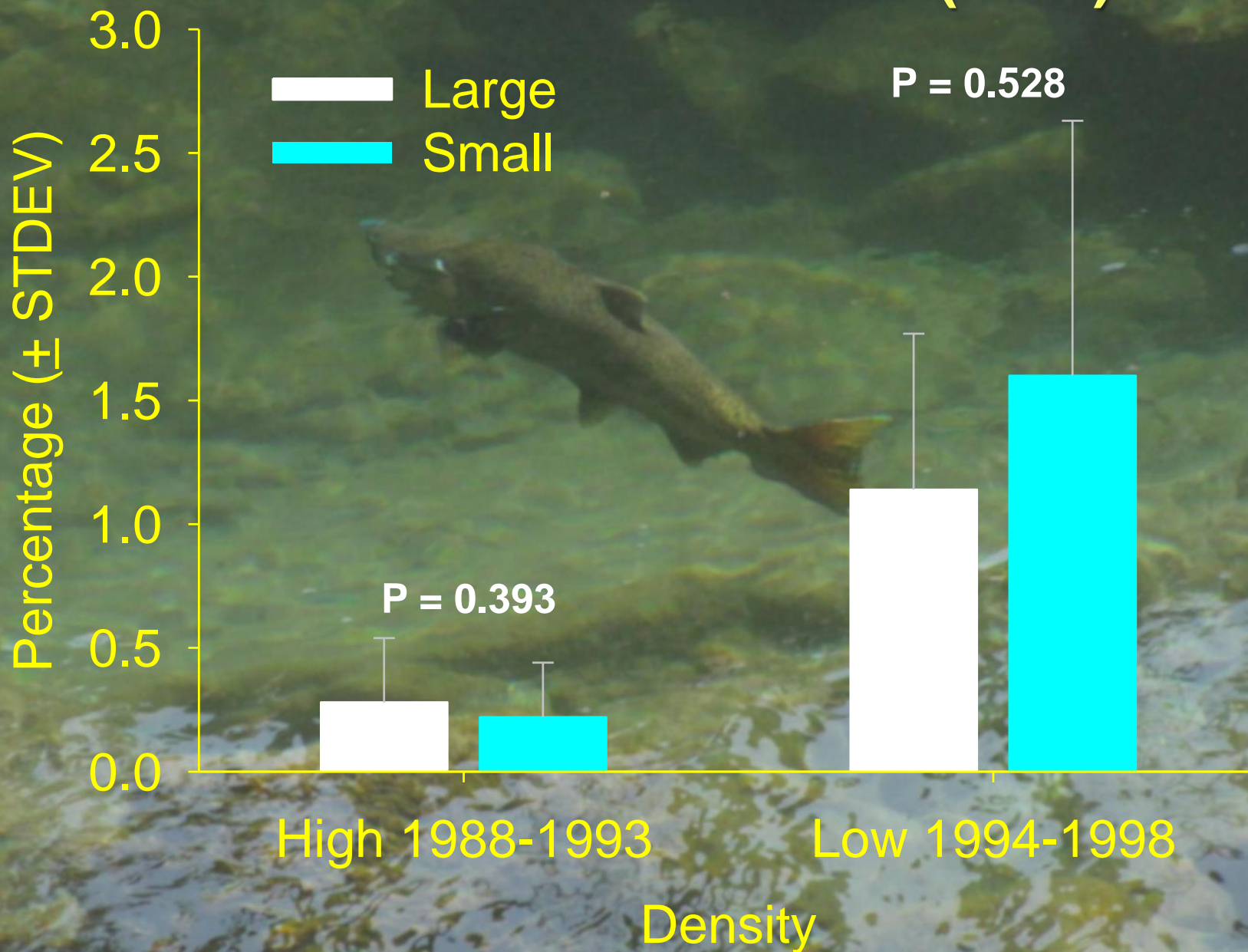


Age Composition

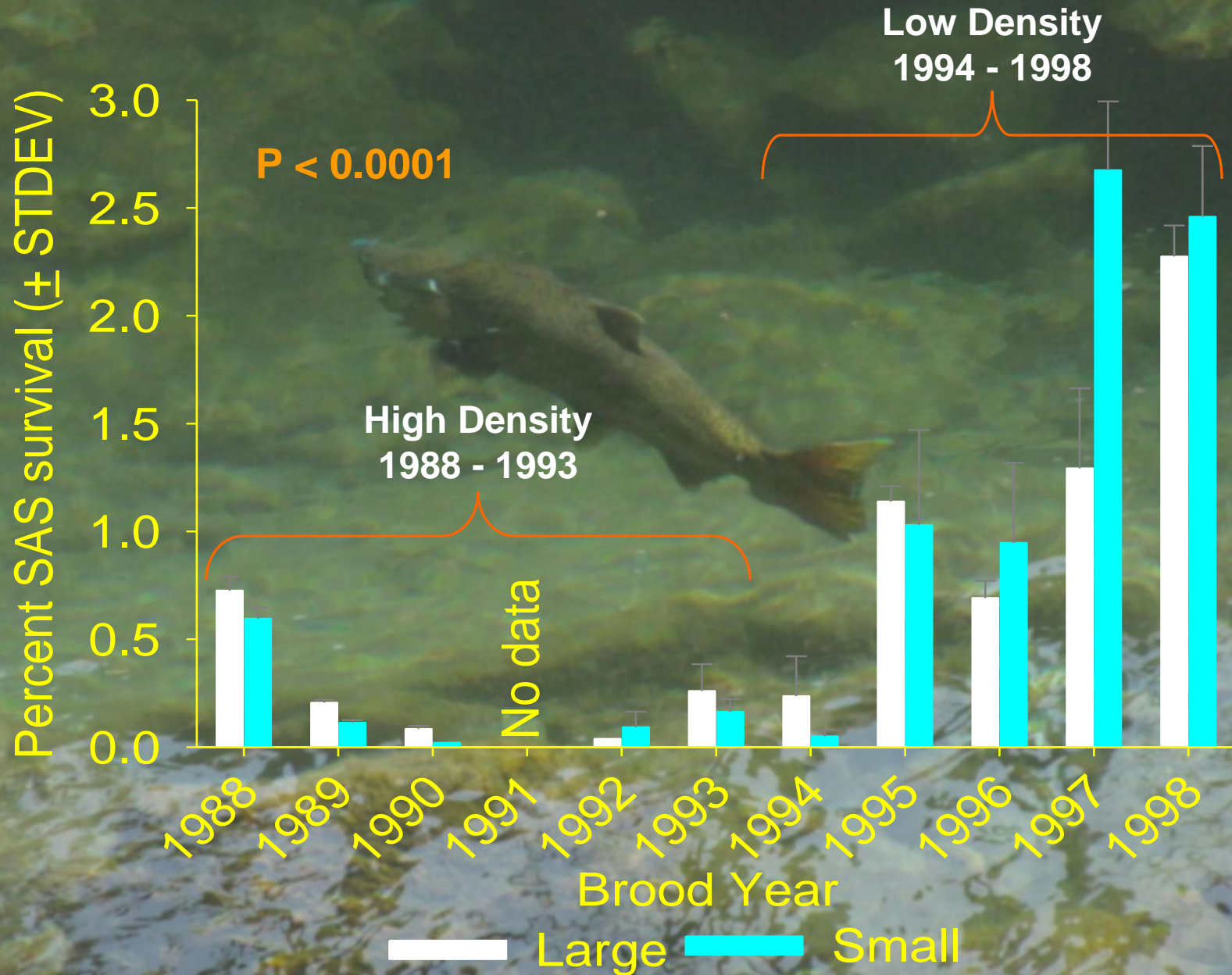
Low Density (BY 1994-1998)



Smolt-to-Adult Survival (SAS)



SAS variation between brood years



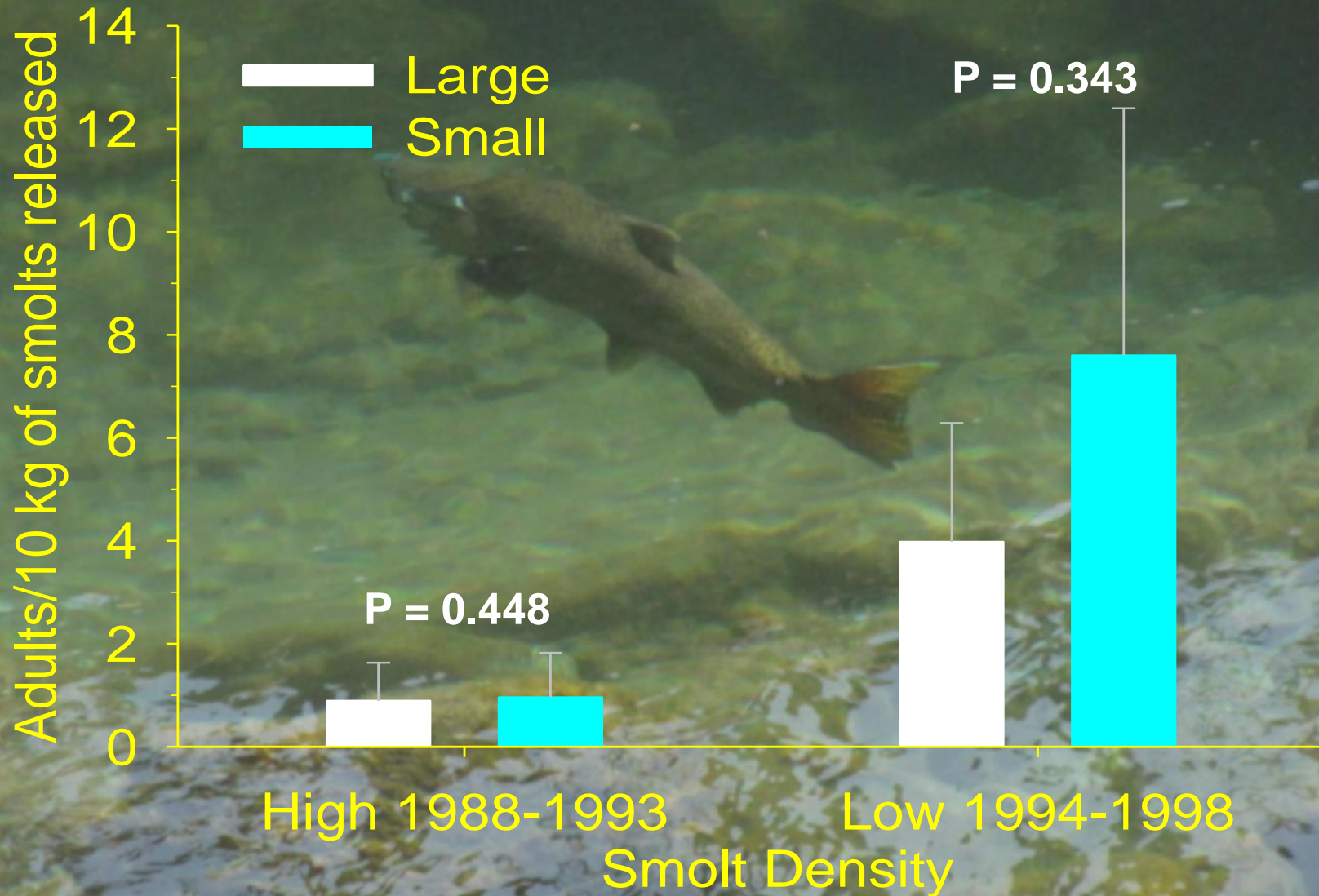
Harvest, Stray, SAR, and SAS Rates

High Density (1988-1993)

Low Density (1994-1998)

	Large	Small	P-value	Large	Small	P-value
Harvest	<0.001%	0.001%	0.197	0.038%	0.048%	0.035
Stray	0.007%	0.004%	0.299	0.016%	0.009%	0.278
SAR	0.264%	0.273%	0.376	1.249%	1.417%	0.537
SAS	0.271%	0.279%	0.393	1.302%	1.475%	0.528

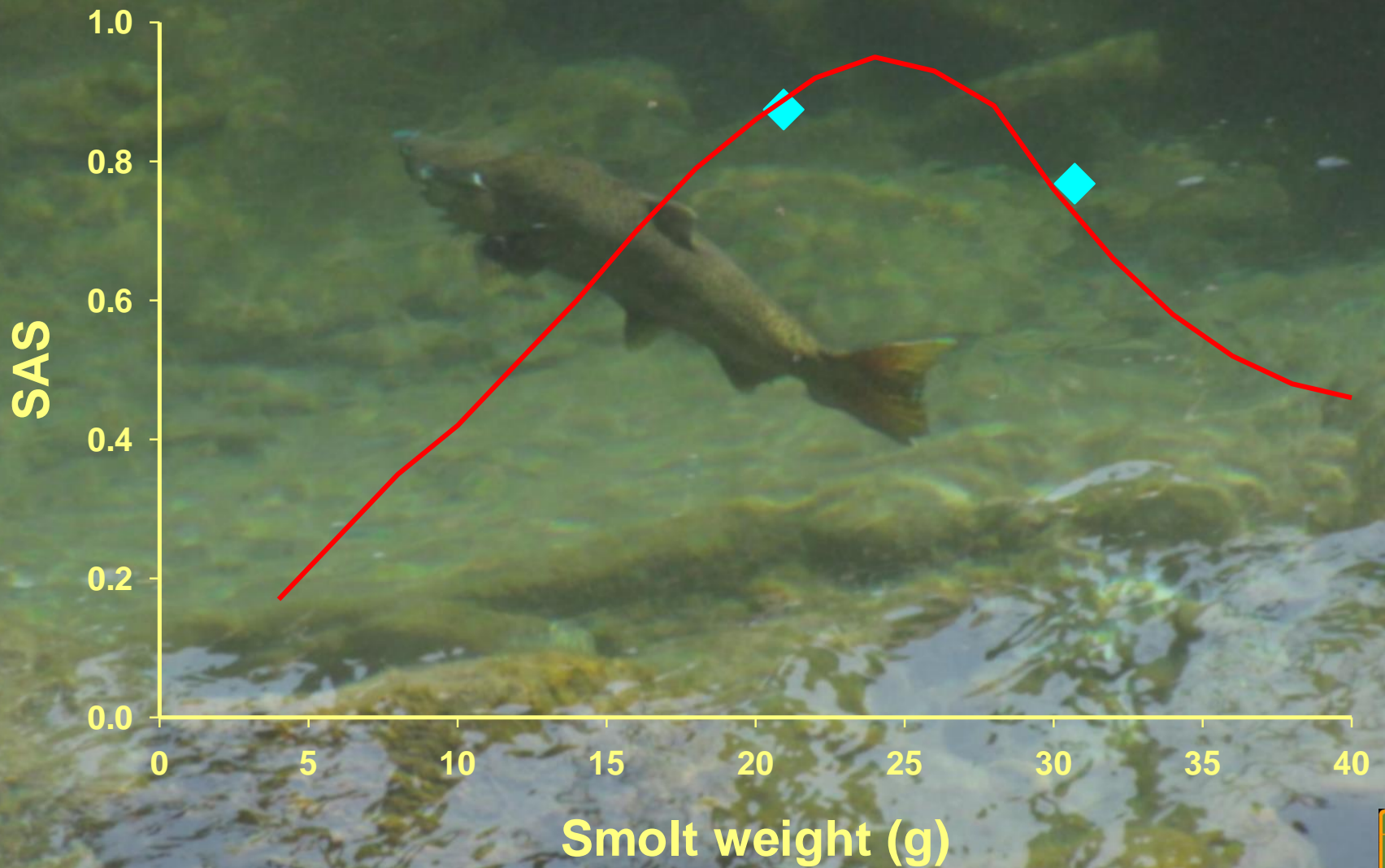
Production Efficiency



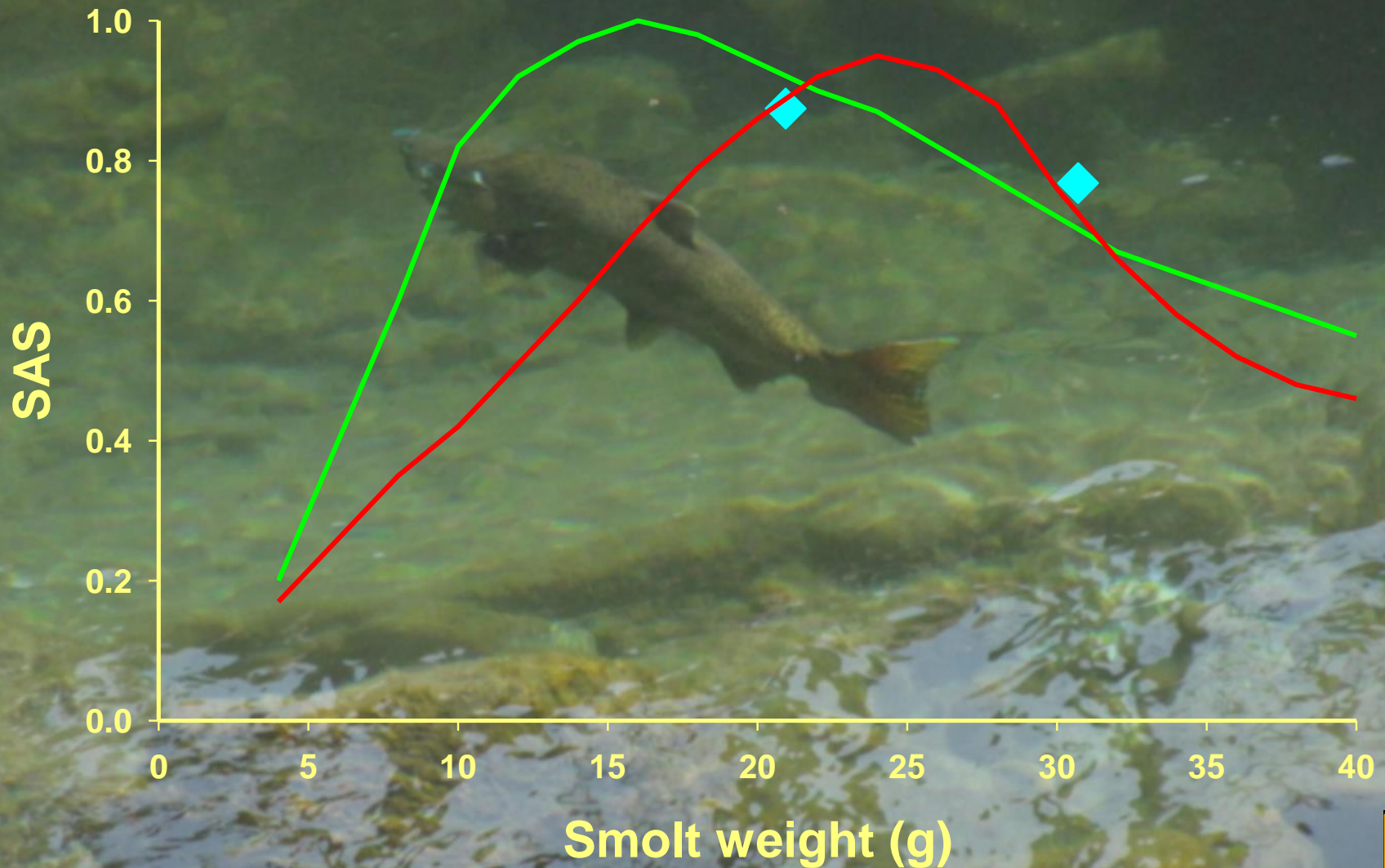
Evaluation Summary

- Large smolts survived better to LGD during high density years.
- Smolt size did not affect age composition, or harvest, stray, SAR, or SAS rates.
- Imnaha River spring Chinook Salmon have a very low stray rate.
- Brood year/migration year variation is more important than smolt size.
- Small smolts produced twice the number of returning mature salmon as large smolts.

Smolt Size and Survival



Smolt Size and Survival



Production Efficiency

1,700 kg smolts / raceway

Large Smolts

34 g / smolt

37,000 smolts

Mean SAS = 0.881%

Small Smolts

20 g / smolt

65,000 smolts

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326 mature salmon:

Age 3: 80

Age 4: 207

Age 5: 40

Small Smolts

20 g / smolt

65,000 smolts

Mean SAS = 0.955%

621 mature salmon:

Age 3: 135

Age 4: 389

Age 5: 96

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Small smolts produce **295** (nearly 2X) more mature salmon than large smolts:

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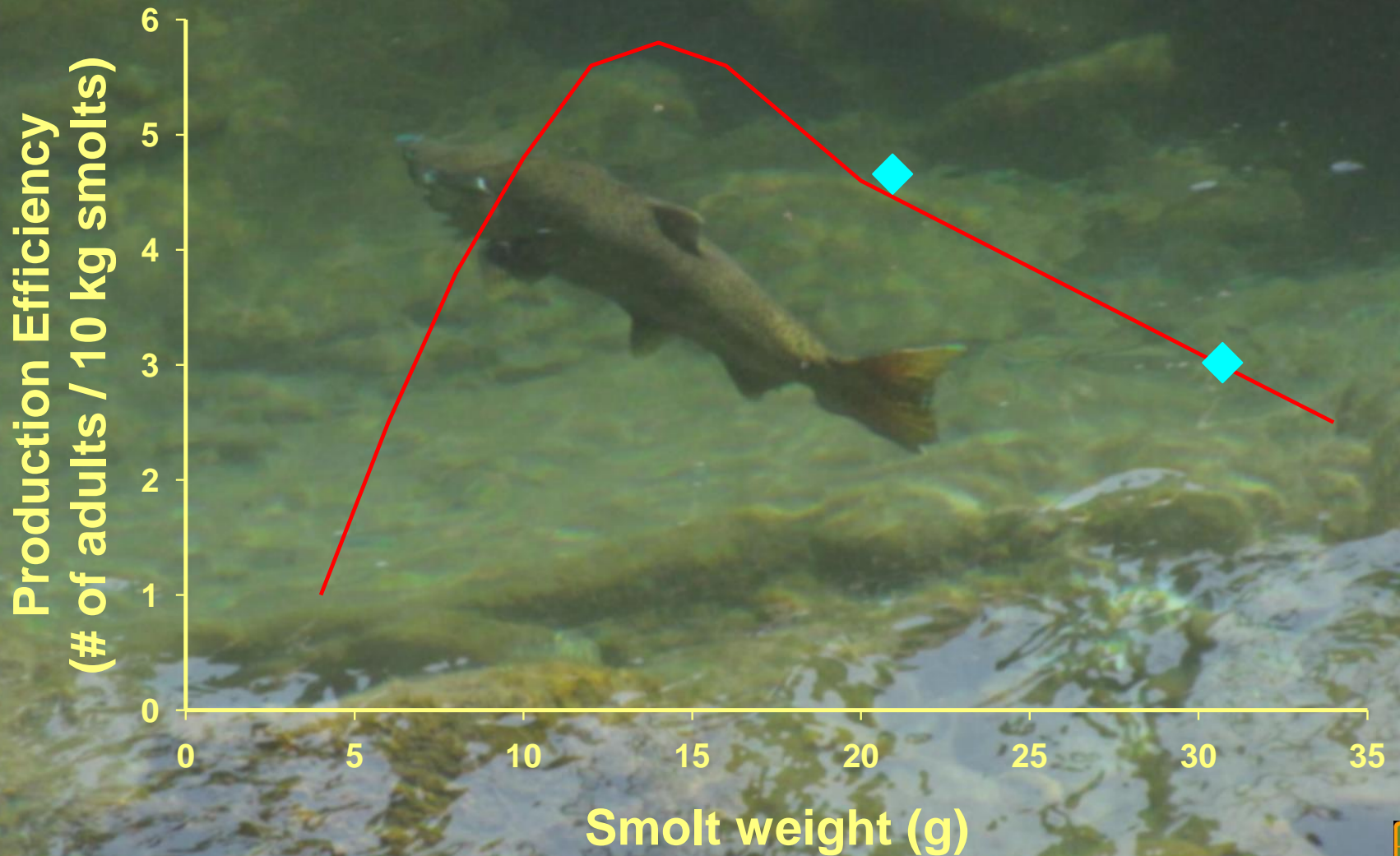
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Small smolts produce **295** (nearly 2X) more mature salmon than large smolts: **56** age 3, **183** age 4, and **56** age 5.

Smolt Size and Survival



Management Implications

- The yearly environmental challenges encountered during migration are more important than smolt size (i.e. brood year effect).
- In a space-poor and egg-rich environment (e.g., most hatcheries), to maximize the number of adult returns consider releasing smaller smolts.
- This study occurred with brood years experiencing “Max Transportation.” With changing operations in the Columbia River Hydrosystem (e.g., barged vs. in-river, & flow requirements), a new pattern may emerge!

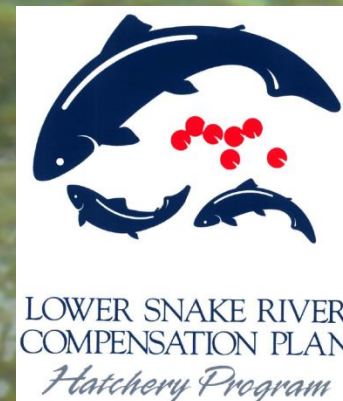
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- Spread the risk: release both large and small smolts?

Acknowledgments



Lookingglass Fish Hatchery



Source: USGS
Source: NASA, NGA, USGS
© 2000, Monmouth County, Oregon

289ft



Imnaha River Weir and Acclimation Ponds

Acclimation Ponds



Adult Weir

Source: USGS

Source: NASA, NGA, USGS

Source: ESRI, i-cubed, USDA FSA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGP

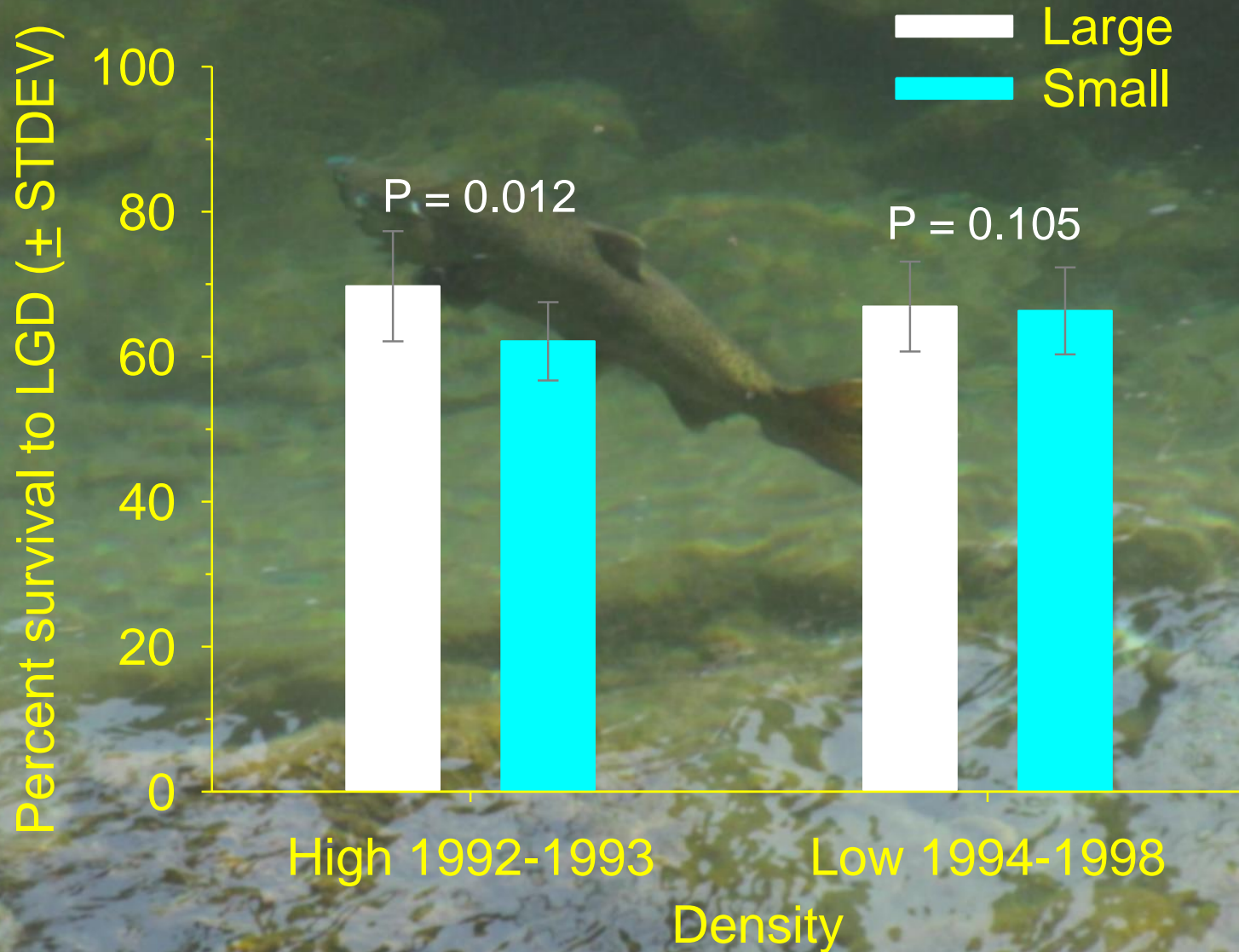
270ft



Smolt-to-Adult Survival (SAS)

	Large Smolts (30 g)	Small Smolts (21 g)	P-value
Age 3	0.18%	0.25%	0.968
Age 4	0.56%	0.70%	0.701
Age 5	0.08%	0.23%	0.165
Total SAS	0.82%	1.17%	0.287

Survival to LGD BY 1992-1998



SAS variation between brood years

