

# Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program: F<sub>1</sub> Generation

Tim Hoffnagle, Rich Carmichael, Joseph Feldhaus,  
Deb Eddy, Nick Albrecht and Sally Gee

Oregon Department of Fish and Wildlife



# **Background**

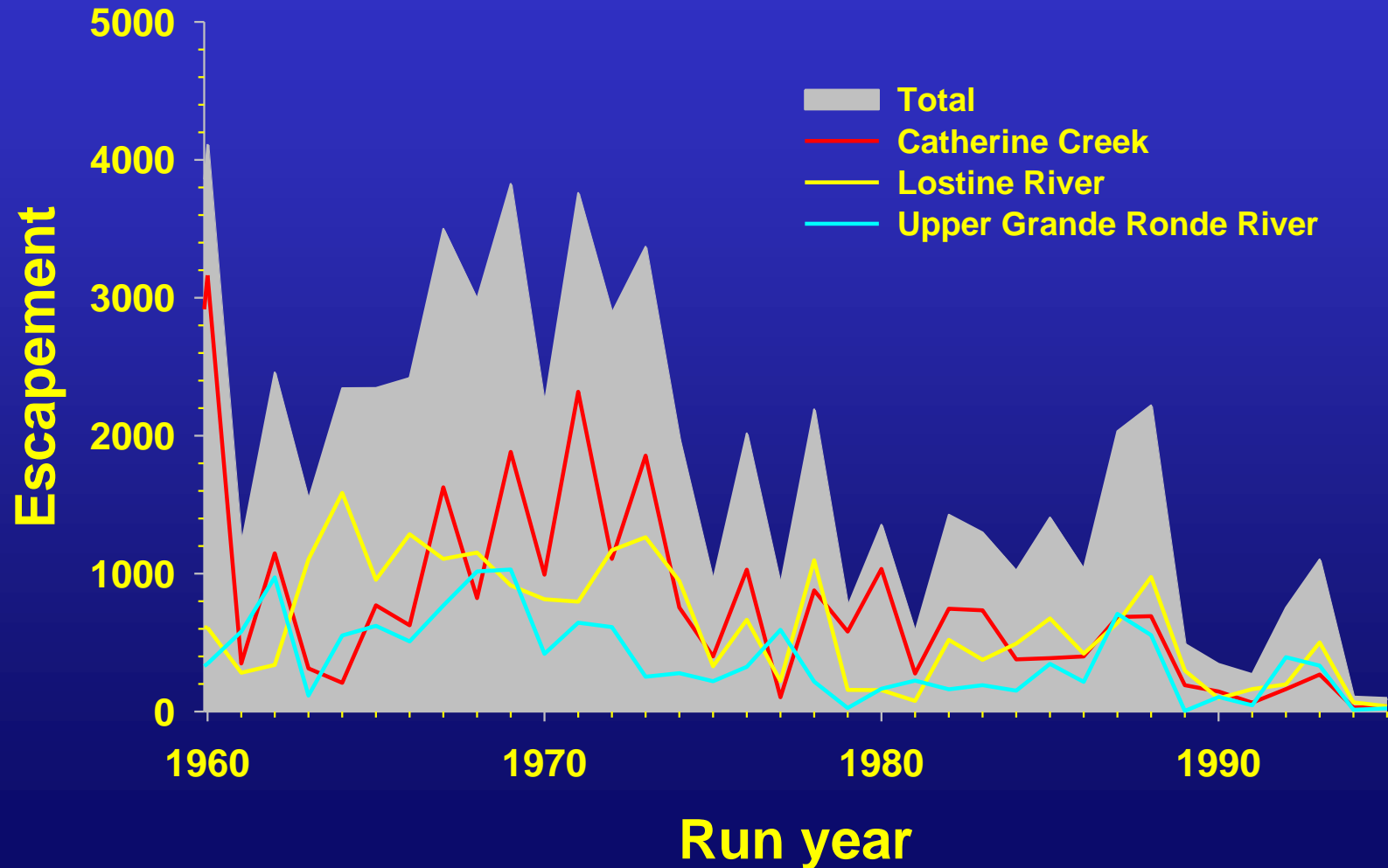
## **Captive Broodstock Rearing**

### **Captive Broodstock Program F<sub>1</sub> Generation vs. Conventional Hatchery Program**

# History

- ❁ Steady decline in Chinook salmon abundance in the Grande Ronde Basin since the late 1950's.
- ❁ Lower Snake River Compensation Plan (LSRCP) was initiated in Oregon in the late 1970s - hatchery supplementation began with the 1982 cohort
  - ❁ Carson stock: 1982-1987 cohorts
  - ❁ Rapid River stock: 1986-1996 cohorts
  - ❁ Neither stock performed well in the Grande Ronde Basin.

# Adult Returns 1960-1995



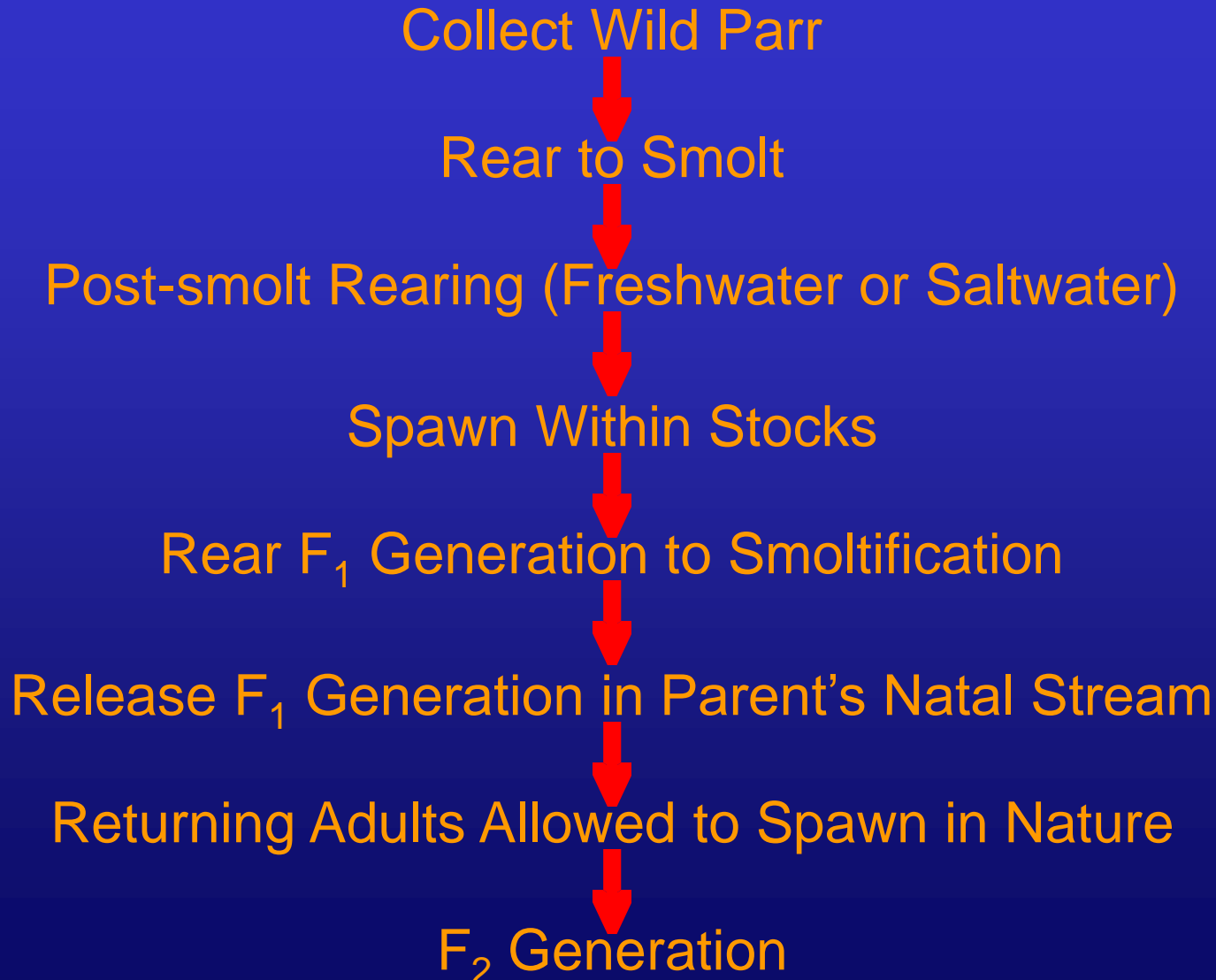
## History (cont'd)

- ❁ Snake River spring Chinook salmon were listed as threatened in 1992.
- ❁ Grande Ronde Basin streams still had genetically distinct populations.
  - ❁ ODFW began to manage for native stocks.
- ❁ Captive Broodstock Program began in 1995 with collection of the 1994 cohort.
- ❁ Conventional Hatchery Program began in the Lostine River in 1997 (skipping 1998 and 1999) and in Catherine Creek and the Upper Grande Ronde River in 2001.

# LSRCP Management Objectives

- ✿ Establish adequate broodstock to meet annual production needs.
- ✿ Restore and maintain natural spawning populations of spring Chinook salmon in the Grande Ronde Basin.
- ✿ Reestablish historic tribal and recreational fisheries.
- ✿ Mitigation goals for the Grande Ronde Basin:
  - ✿ Release 900,000 smolts annually
  - ✿ 0.65% smolt-to-adult survival
  - ✿ Establish an annual return of 5,820 hatchery fish.
- ✿ Minimize impacts of the hatchery program on resident stocks.
- ✿ Maintain endemic wild populations of spring Chinook salmon in the Minam and Wenaha rivers.

# Life History of Captive Broodstock



# Grande Ronde Basin





# **Captive Broodstock Results**

# Targets & Results - Rearing

Collection		500	Yes, except GR 1994, 1995, 1999
Sex ratio		1F:1M	1F:1.08M
Growth		Similar to natural	~35% smaller
Survival	Parr-smolt	90%	97%
	Smolt-adult	55%	55%
	Overall	50%	53%

# Targets & Results - Spawning

Age at maturation	2	3	4	5
Females	0 / 0	6 / 1	78 / 88	16 / 11
Males	2 / 20	35 / 69	48 / 10	15 / 1

Spawn timing	August- September	September- October
--------------	----------------------	-----------------------

Fecundity	Age 3	Age 4	Age 5
Predicted	1200	3000	4000
Actual	1232	1715	1588

~20% (0-77%) of collected eggs have been culled for BKD prevention.

# Targets & Results – F<sub>1</sub> Generation

---

Fertility	75%	85%
Eyed egg-smolt survival	80%	83%
Return Rate	0.1%	0.35%

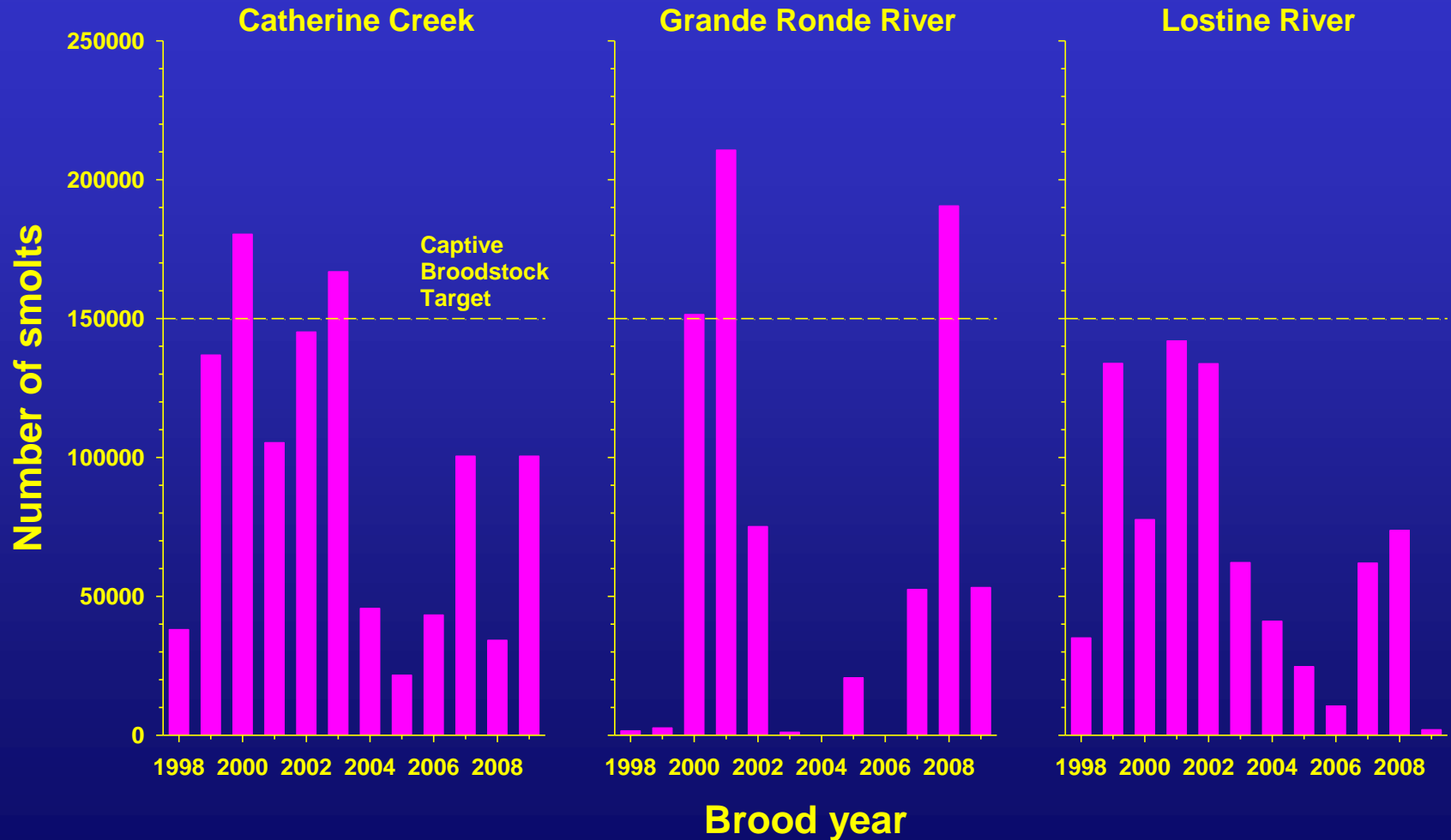
---

---

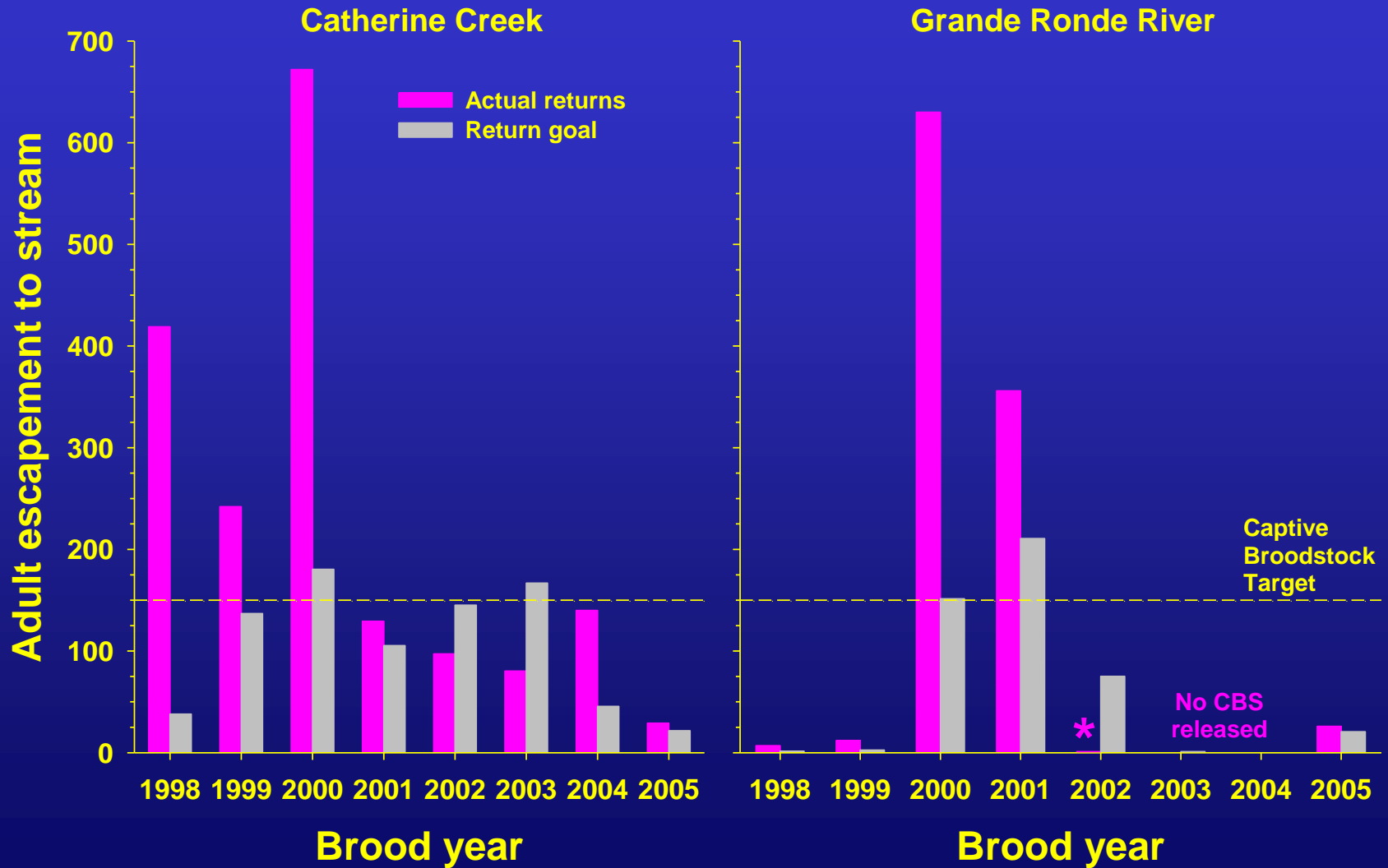
Age Composition	Age 3	Age 4	Age 5
Predicted	10	60	30
Actual	15	71	14

---

# F<sub>1</sub> Smolt Production



# F<sub>1</sub> Returns



\* CBS smolts w/o ad clip

# Program Challenges

- ❄ Inability to collect 500 parr each year in the Grande Ronde River
  - ❄ Reduce BKD-caused mortality
  - ❄ Reduce BKD culling
  - ❄ Improve growth of saltwater fish
  - ❄ Synchronize maturation timing with wild fish
  - ❄ Early detection of maturing fish
  - ❄ Improve egg-to-smolt survival of  $F_1$  generation
  - ❄ Disposition of excess  $F_1$  fish in years of overproduction
- **Success of program will be determined by returns of  $F_2$  generation**

**Captive Broodstock Program**

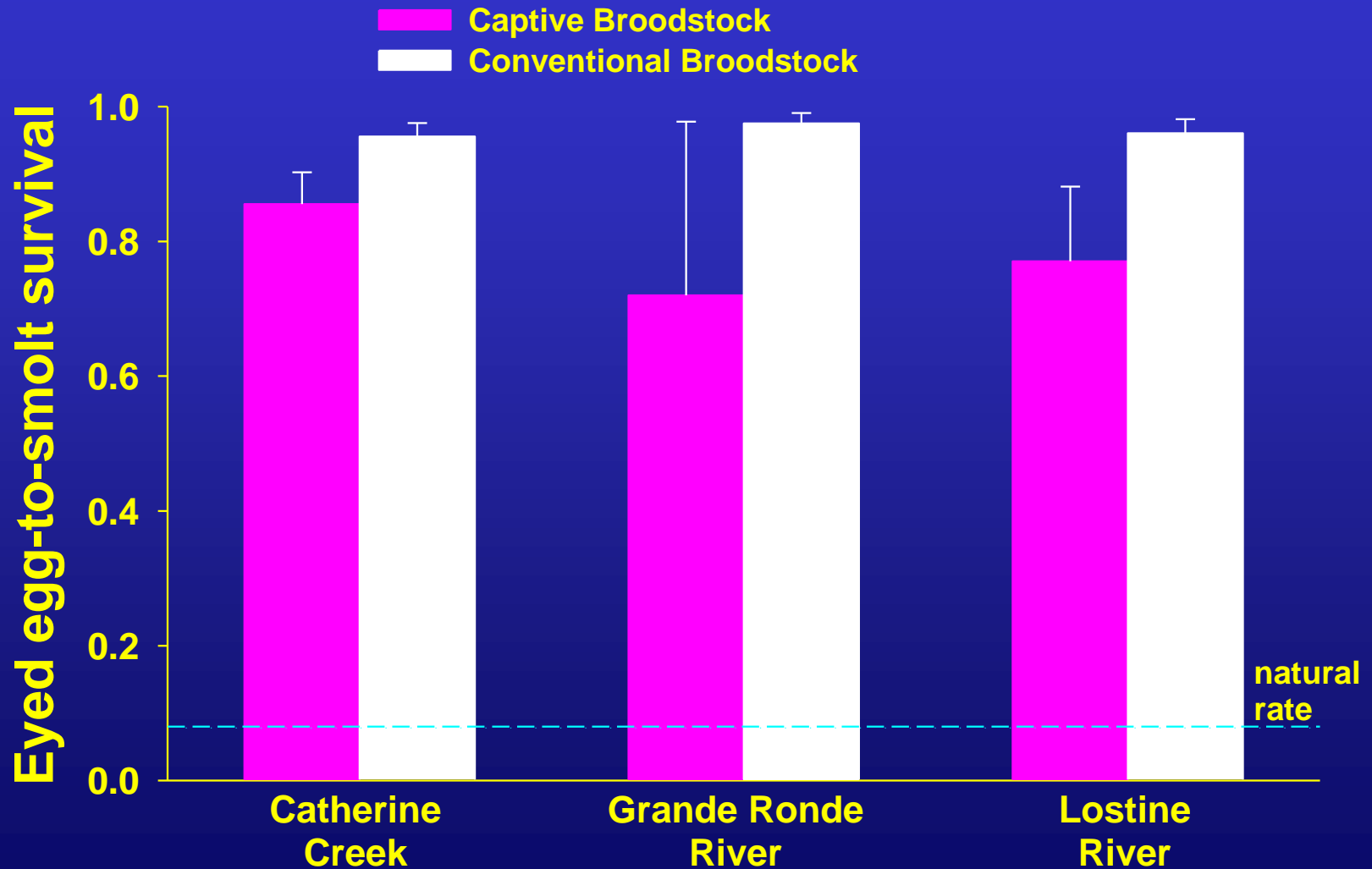
**F<sub>1</sub> Generation**

**vs.**

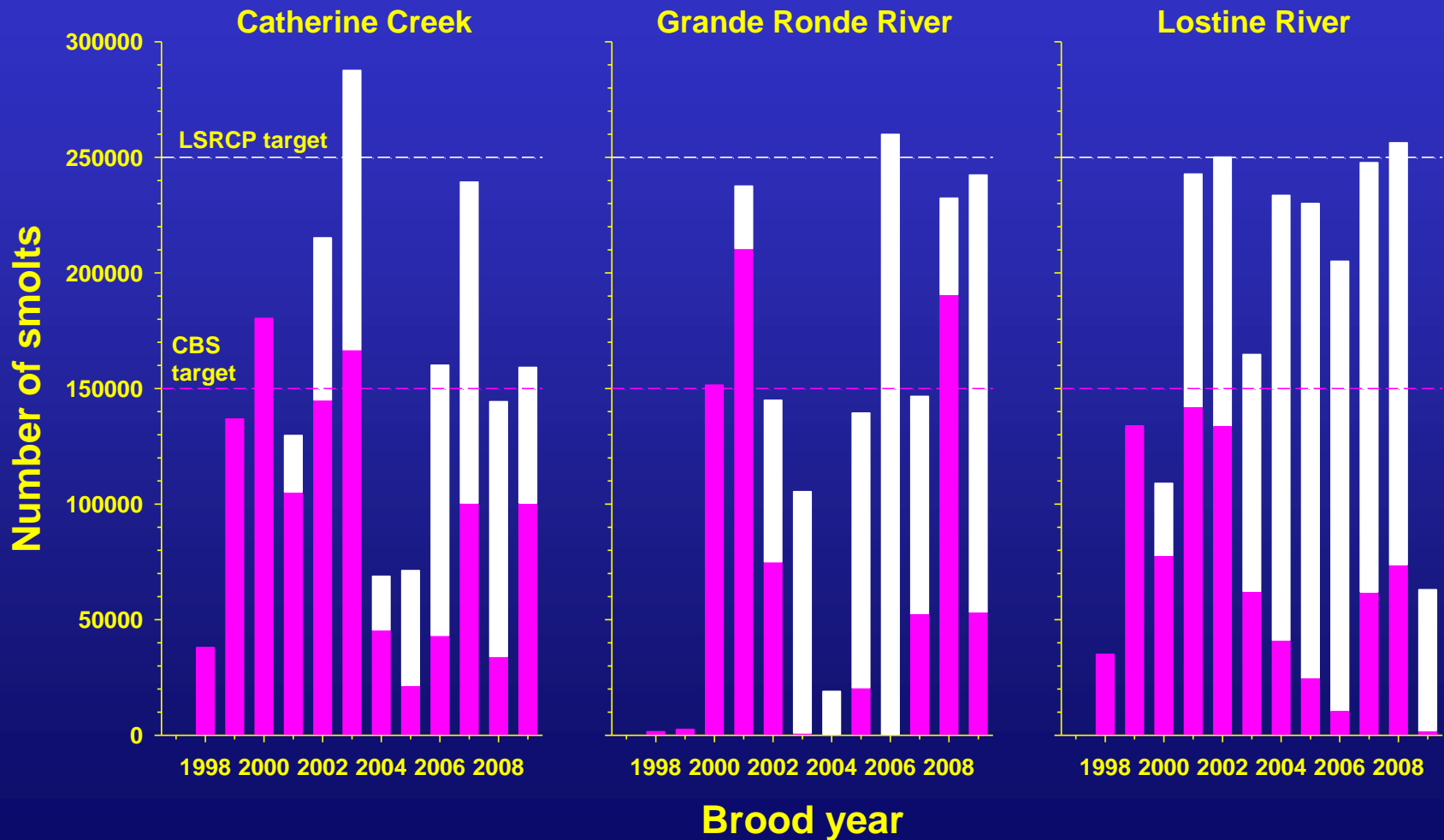
**Conventional Hatchery Program**



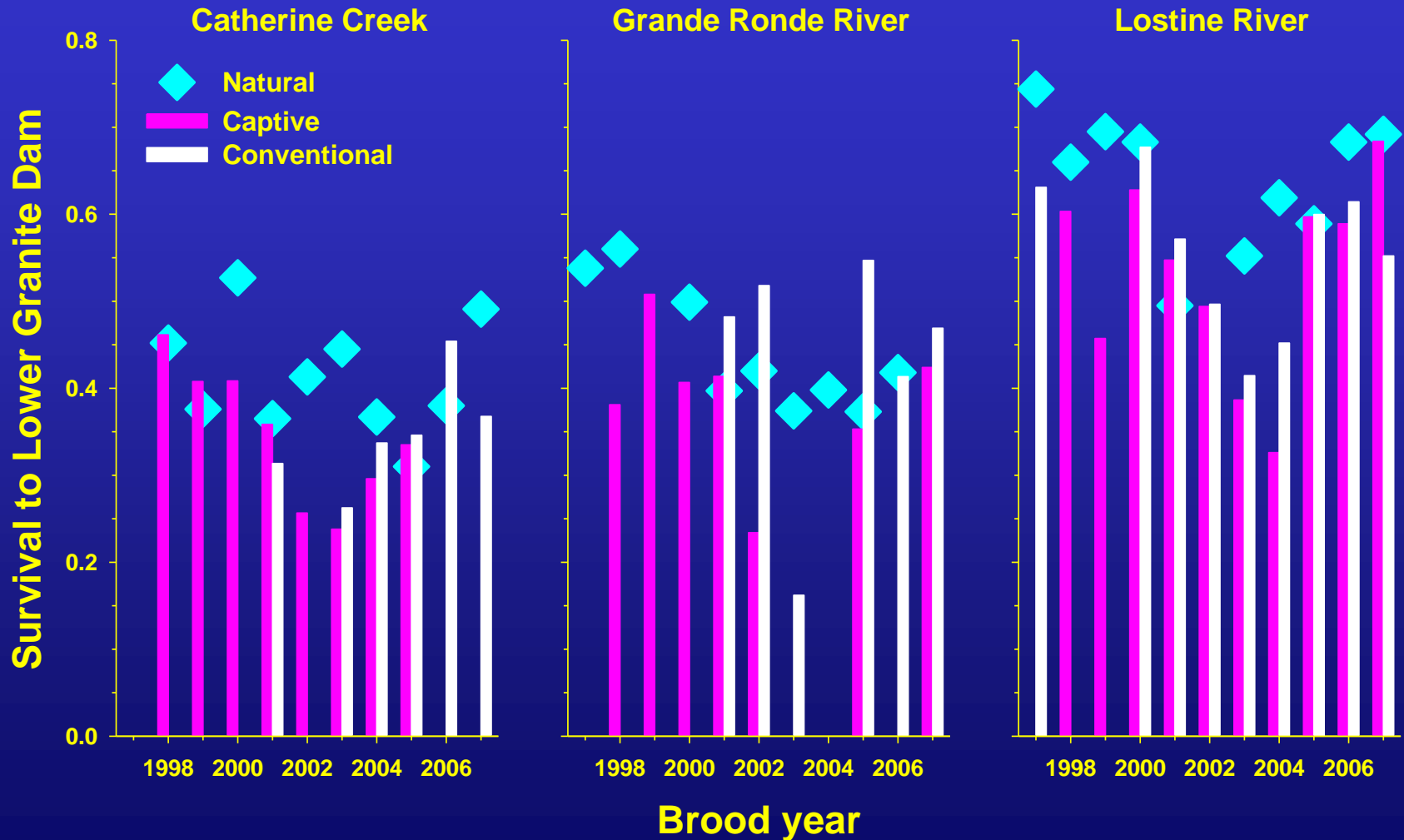
# Eyed Egg-to-Smolt Survival



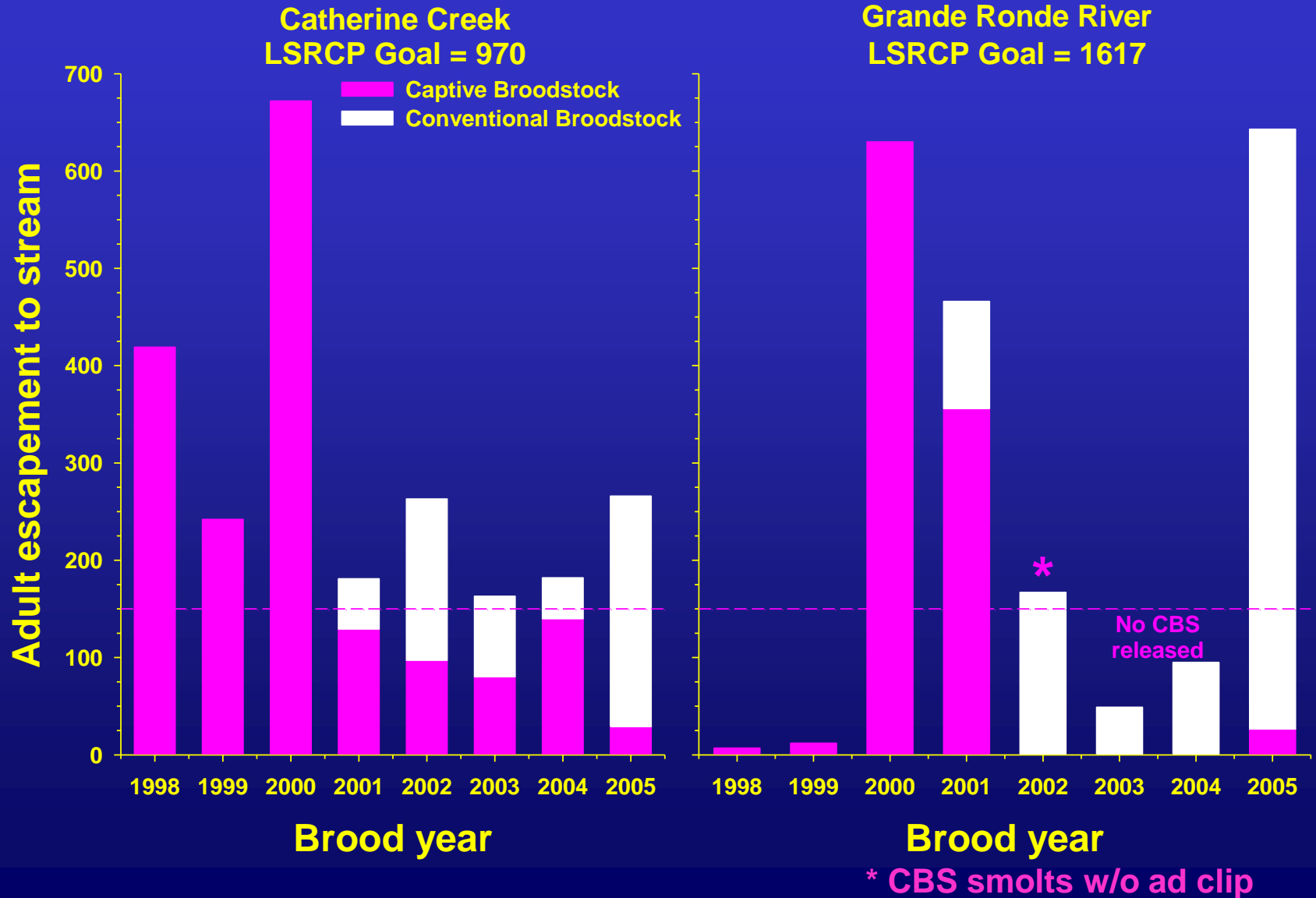
# Smolt Release



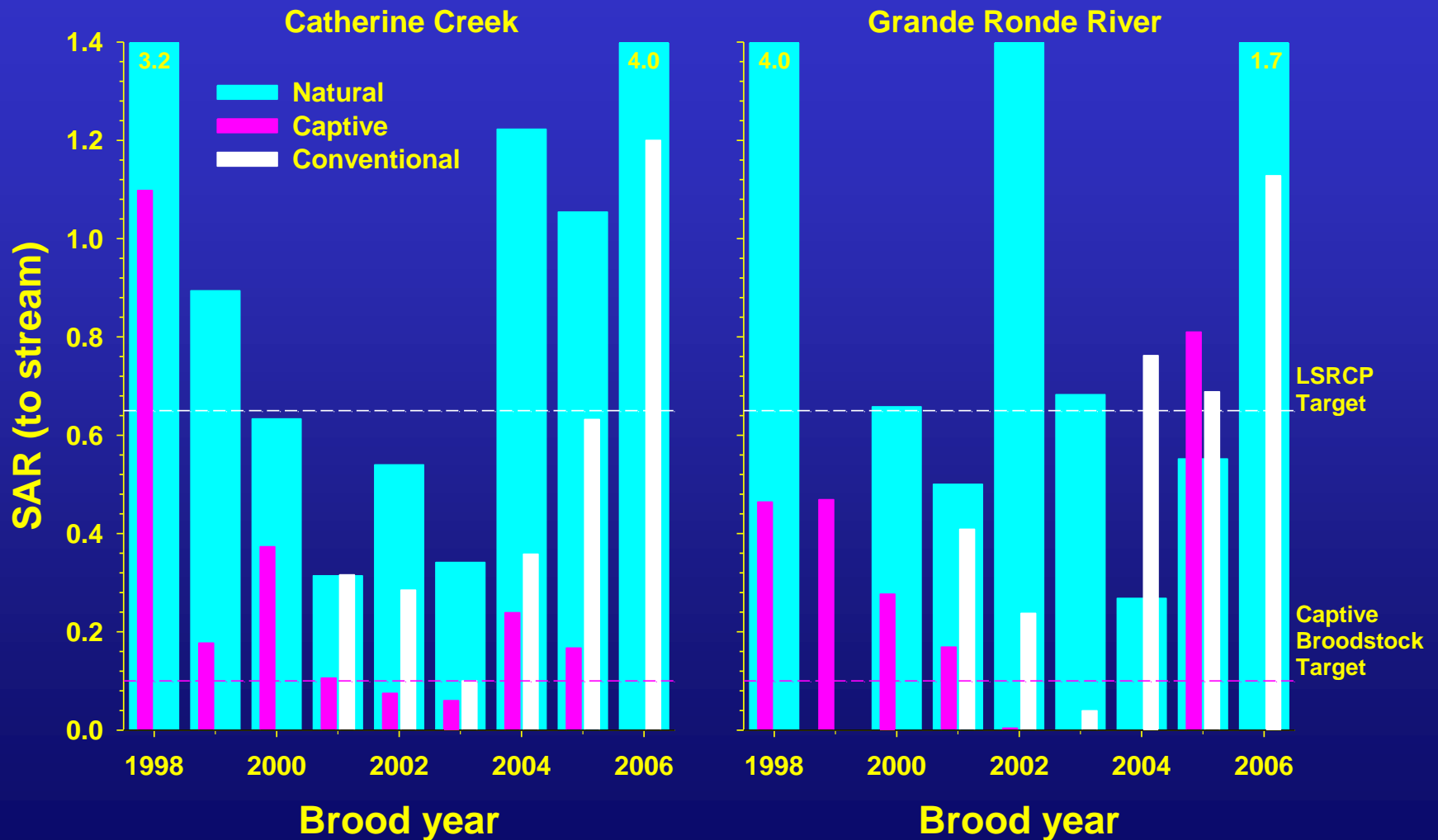
# Juvenile Survival to LGD



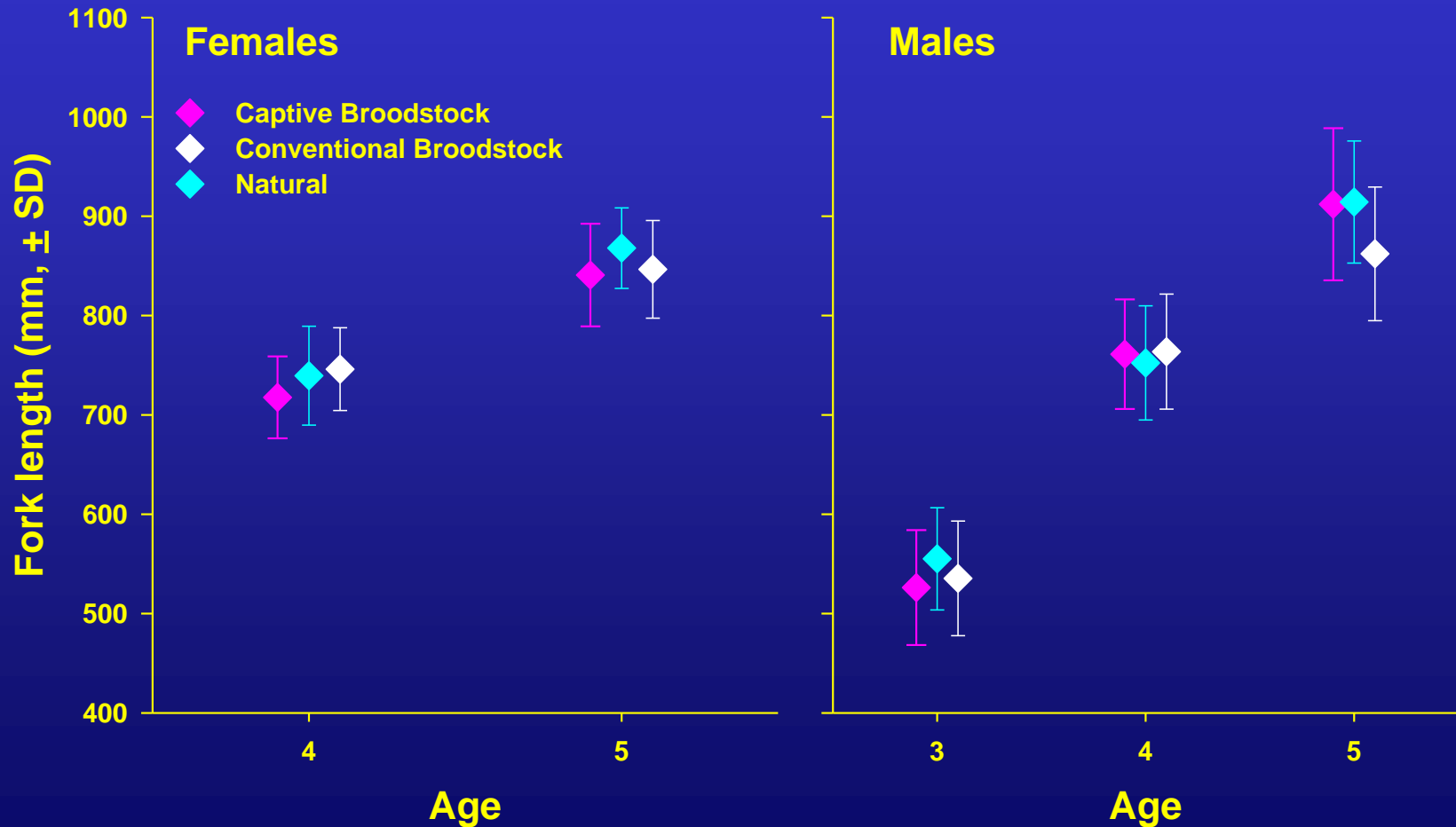
# Adult Returns



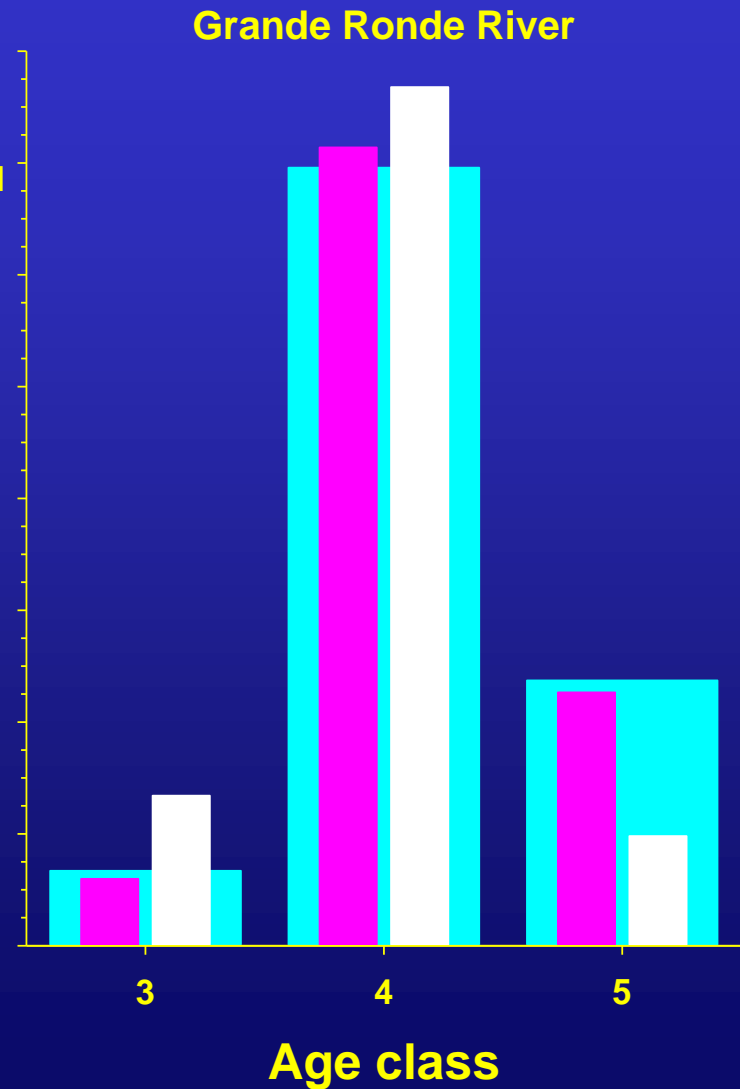
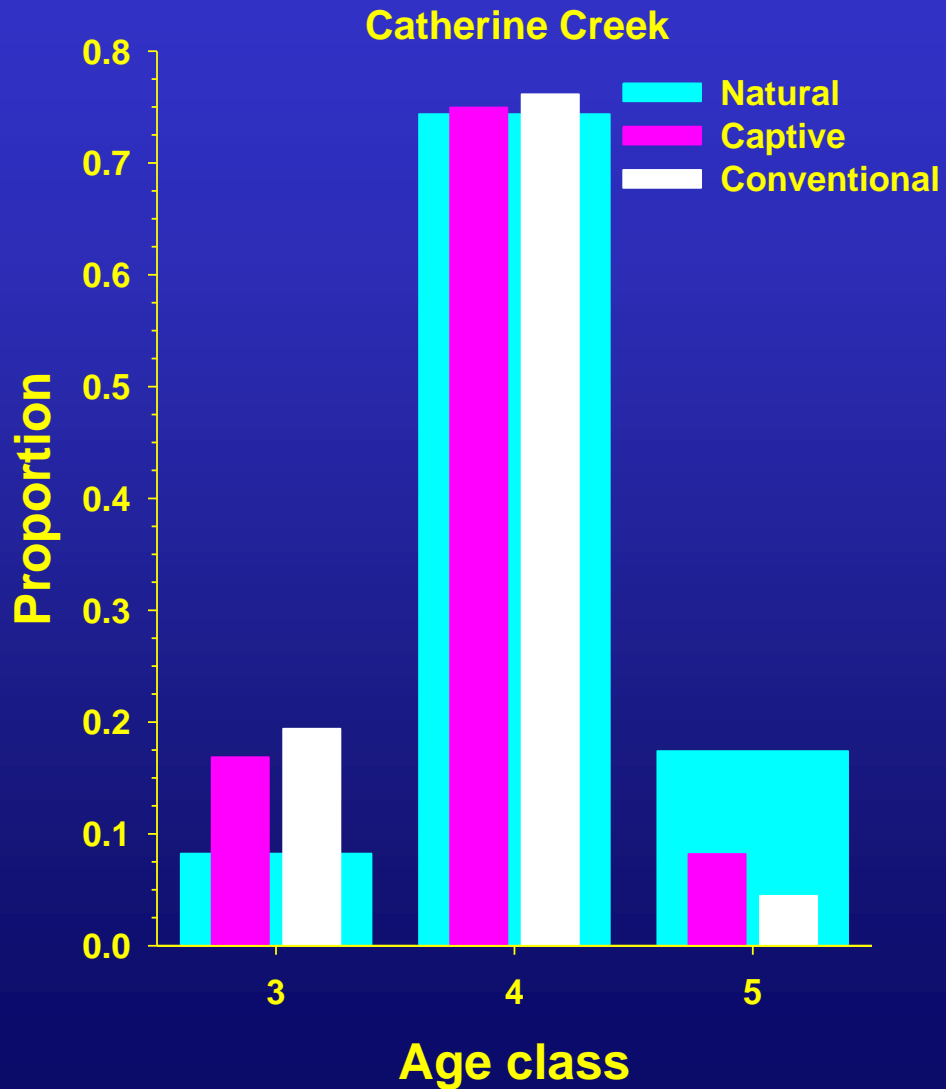
# Smolt-to-Adult Survival (SAR)



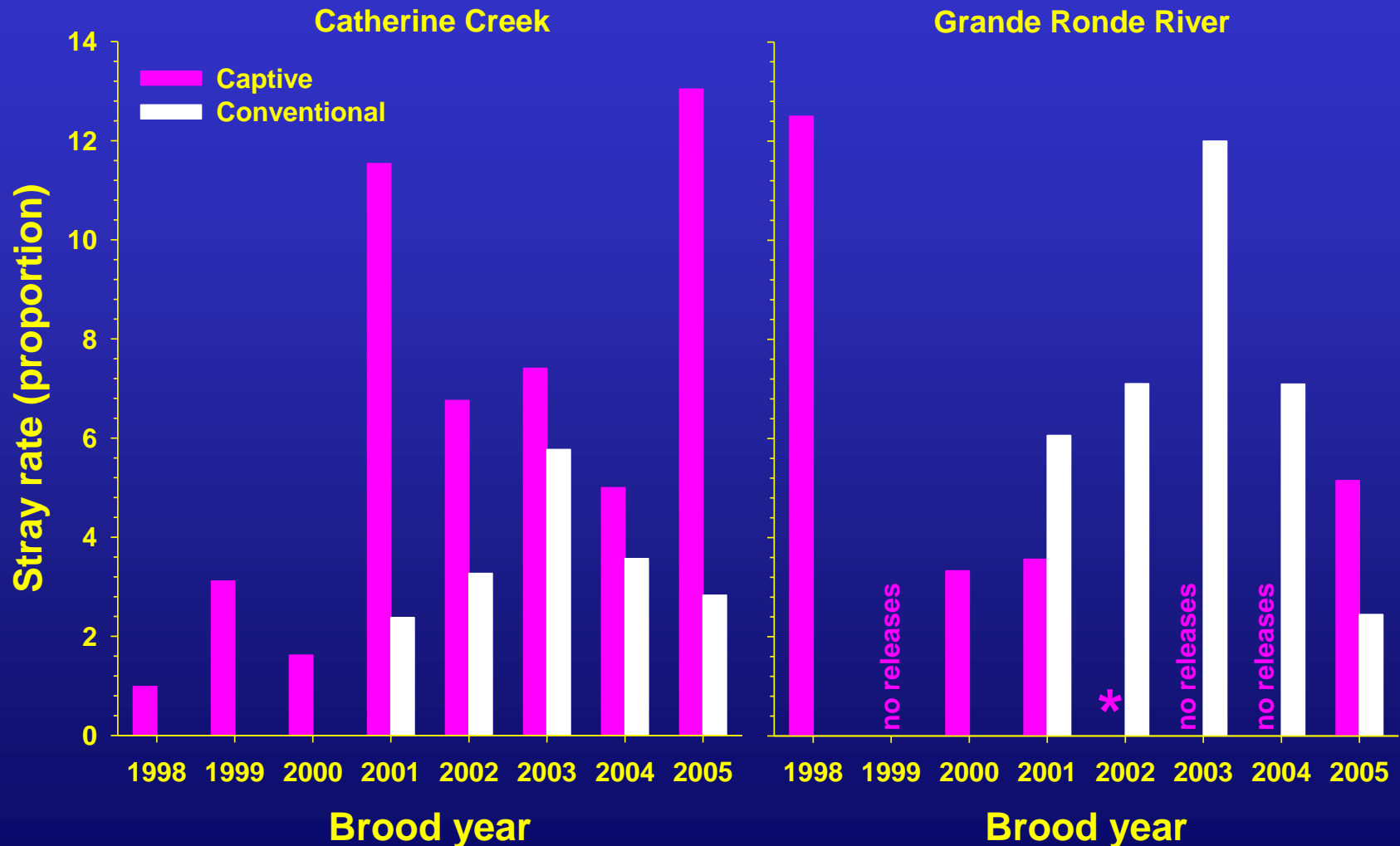
# Size at Maturity



# Age Composition



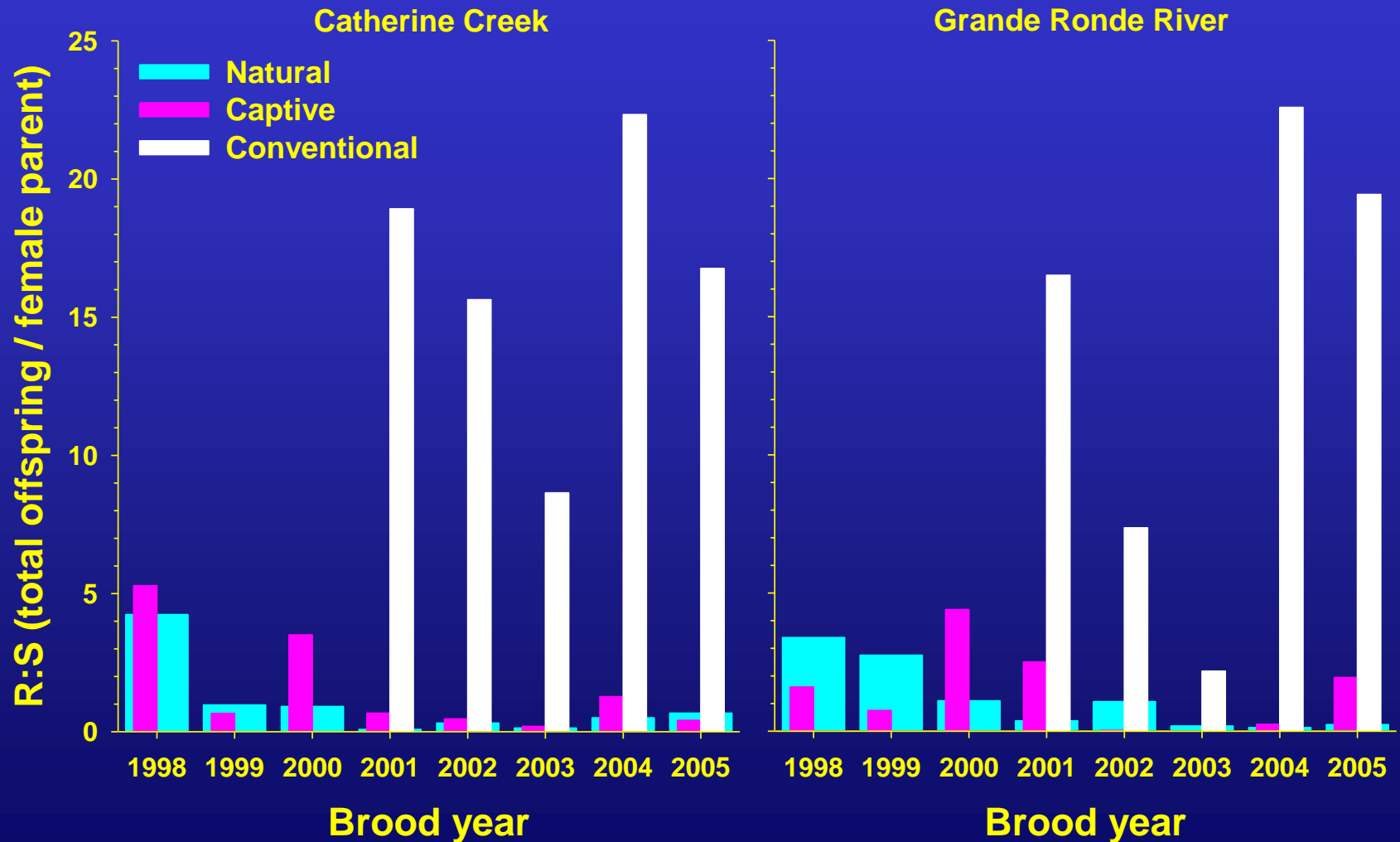
# Stray Rate



\* CBS smolts w/o ad clip



# Recruits per Spawner



# Summary – F<sub>1</sub> Generation

- ✿ Egg-to-smolt survival better in Conventional Program
- ✿ Smolt production – rarely achieved CBS or LSRCP goals
- ✿ Survival to Lower Granite Dam better for Conventional Program
- ✿ Adult returns – usually met Captive Broodstock goal but not LSRCP goal
- ✿ SAR – met Captive Broodstock but not LSRCP
- ✿ Size at maturity – similar among programs and with Natural
- ✿ Age composition similar between programs but younger than Natural
- ✿ Stray rate higher in Captive Broodstock
- ✿ Run timing similar between program and with Natural
- ✿ Spawning distribution – hatchery fish tend to spawn near acclimation site
- ✿ Recruits per spawner higher in Conventional Program. CBS low due to low fecundity and fertility.

# CBS vs. CHP vs. Natural Production

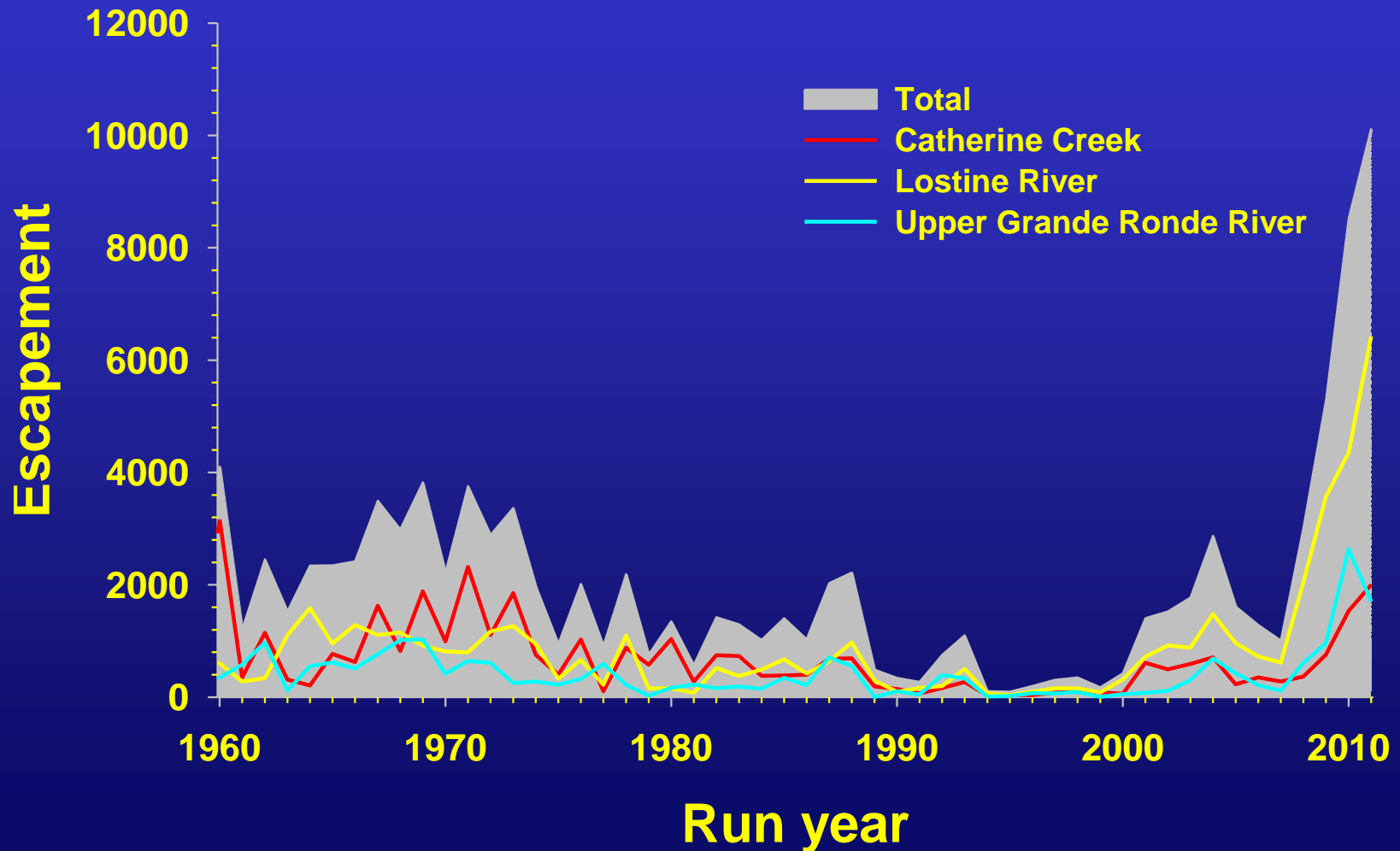
Parameter	<u>Natural</u>		<u>CHP</u>		<u>CBS</u>		Units
	Rate	Number	Rate	Number	Rate	Number	
Fecundity	4,141	0.44	3,977	0.14	4,141	0.44	Females
Fertility	0.906	1,840	0.891	570	0.906	1,840	Green
Eyed-to-Parr	0.3	1,667	0.965	508	0.3	1,667	Eyed
Number of parr		<b>500</b>		<b>500</b>		<b>500</b>	<b>Parr</b>
Parr-to-Smolt	0.13	65	0.98	490	0.97	485	Smolts
Smolt-to-Adult	0.019	1.2	0.005	2.3	<b>0.55</b>	<b>266.8</b>	Adults
Sex Ratio	0.5	0.6	0.5	1.1	0.5	133.4	Females
Fecundity	4,141	2,492	3,977	4,492	1,795	239,408	Eggs
Fertility	0.906	2,258	0.0891	4,002	0.811	194,160	Eyed
BKD Culling	1	2,258	0.99	3,962	0.8	155,328	Eyed
Eyed-to-Smolt	0.039	88	0.965	3,824	0.688	106,866	Smolts
Smolt-to-Adult	0.019	<b>2</b>	0.005	<b>18</b>	0.003	<b>370</b>	Adults

# Conclusions

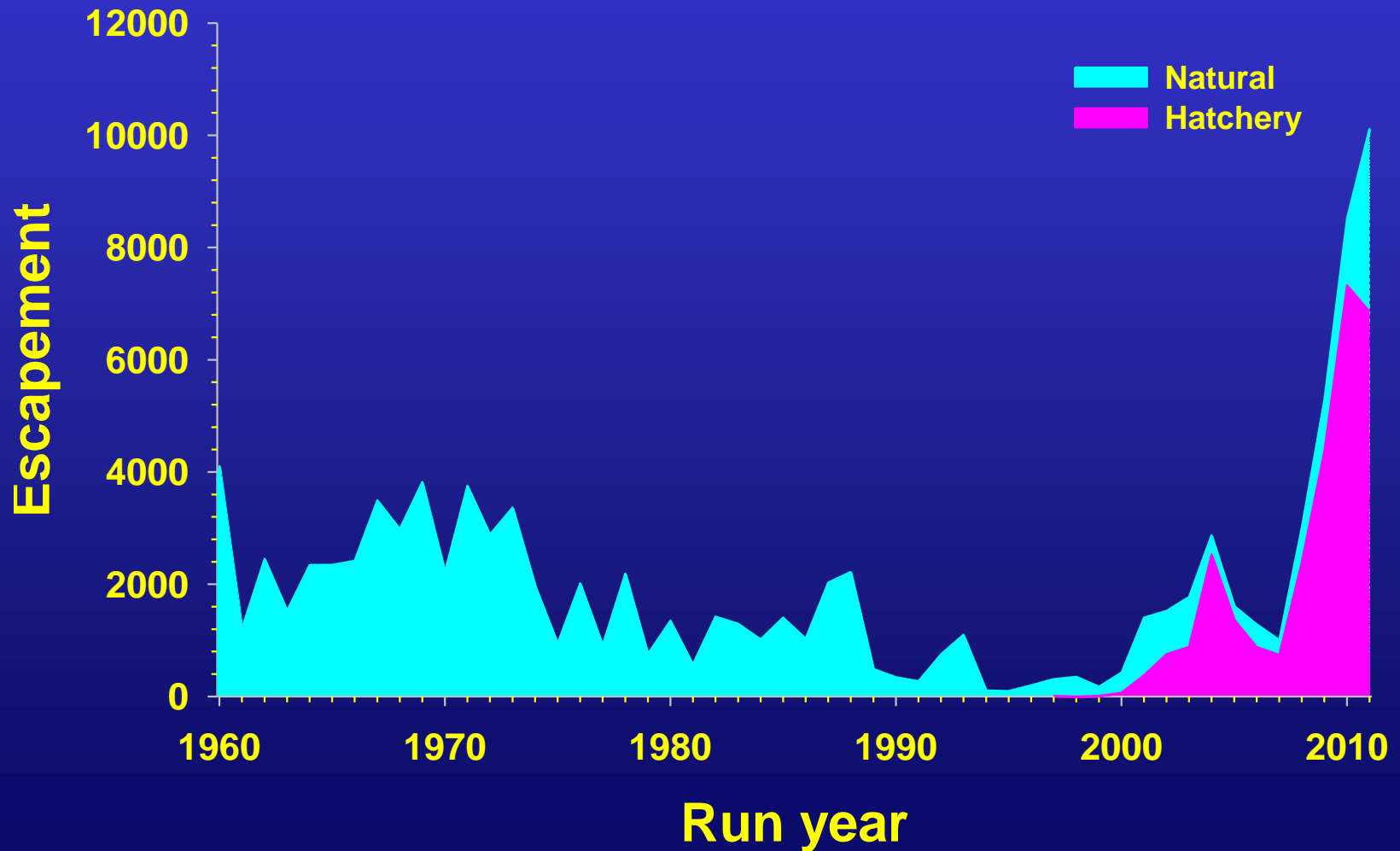
Captive Broodstock programs can rapidly increase numbers of returning adults but has issues to address:

- ⚙ Growth and Fecundity
- ⚙ Disease and Culling
- ⚙  $F_1$  performance in hatchery and nature
- ⚙ Amplifying genes in population?

# Adult Returns 1960-2009



# F<sub>2</sub> Generation?





# Questions?





# Captive Broodstock Life History





This map illustrates the Snake River watershed, which spans across Washington, Idaho, and Oregon. The main river is shown in blue, with its major tributaries labeled: Grande, Boise, Lostine, Wallowa, and Imnaha. Key locations marked include La Grande, Catherine Creek, and Lostine. A red shaded area indicates the study region, with an inset map showing the location within the Pacific Northwest. A north arrow is also present.



# Captive Broodstock Life History



# Captive Broodstock Life History



# Captive Broodstock Life History



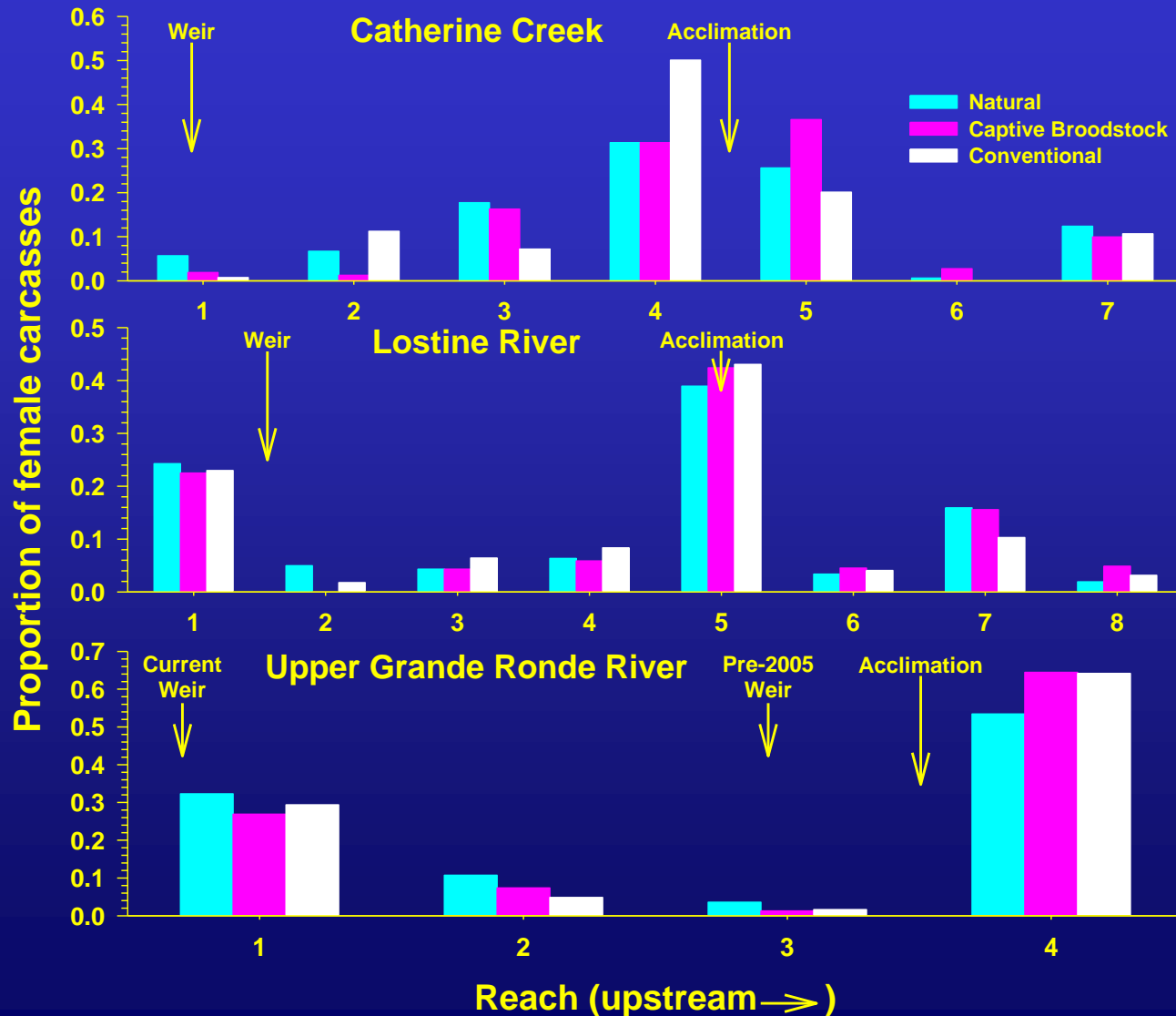
# Captive Broodstock Life History



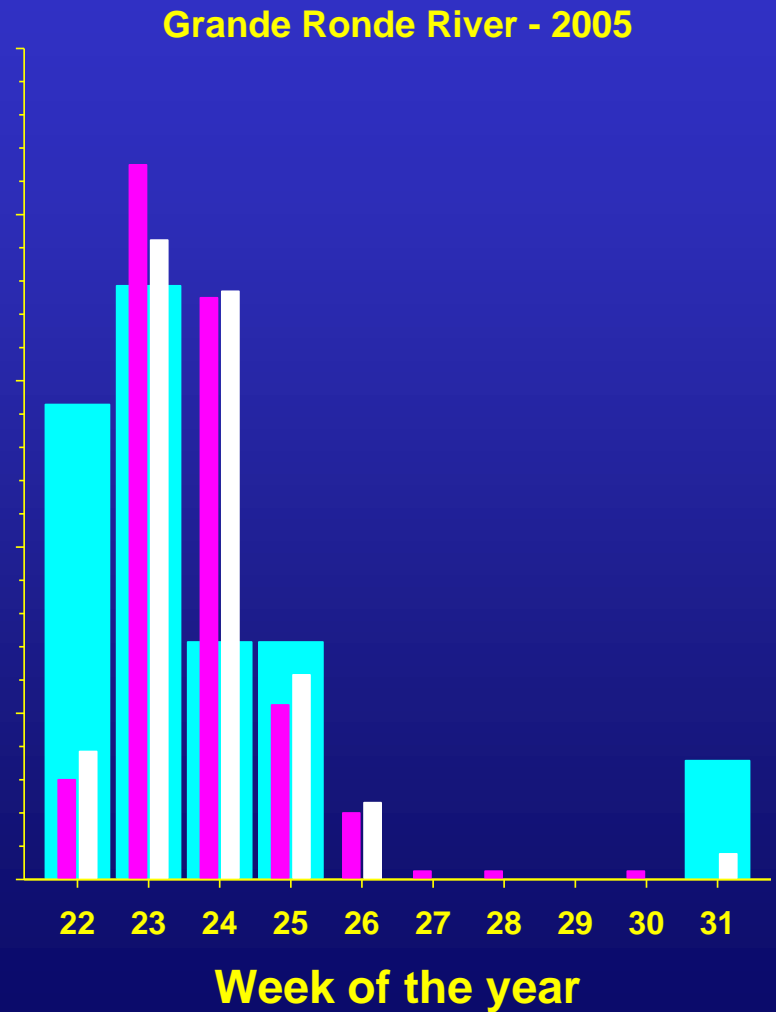
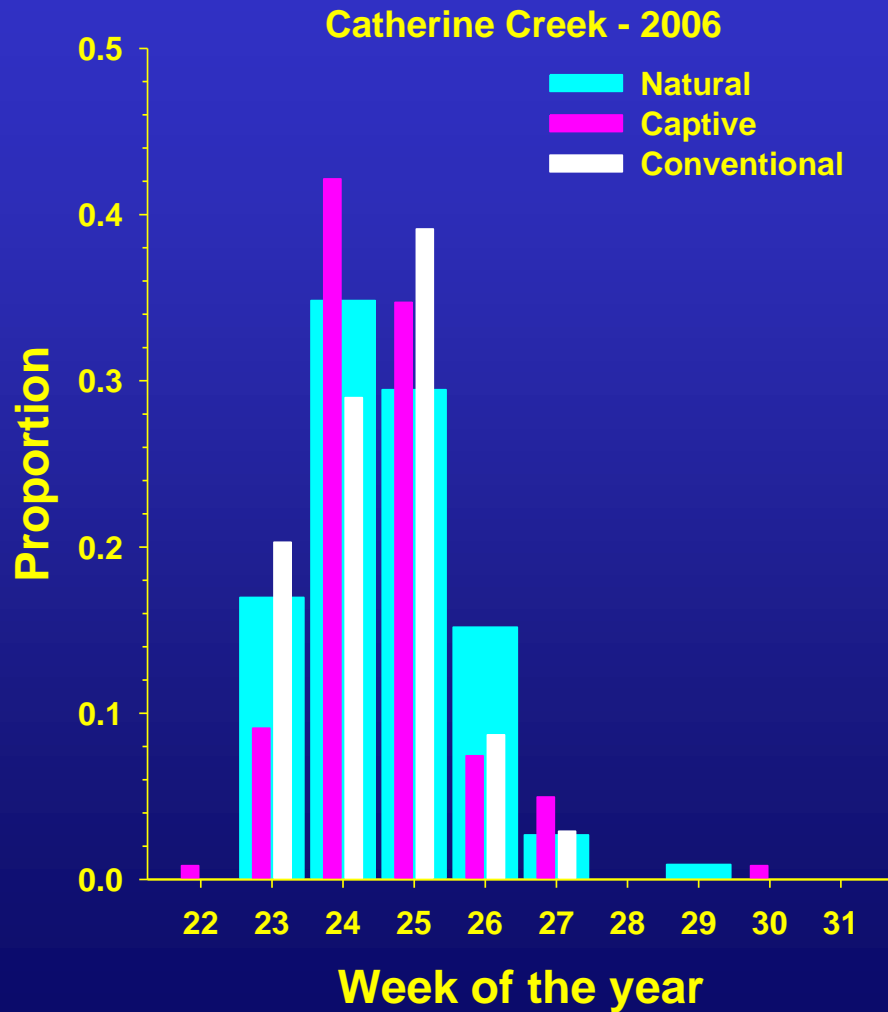
# Captive Broodstock Life History



# Spawning Distribution

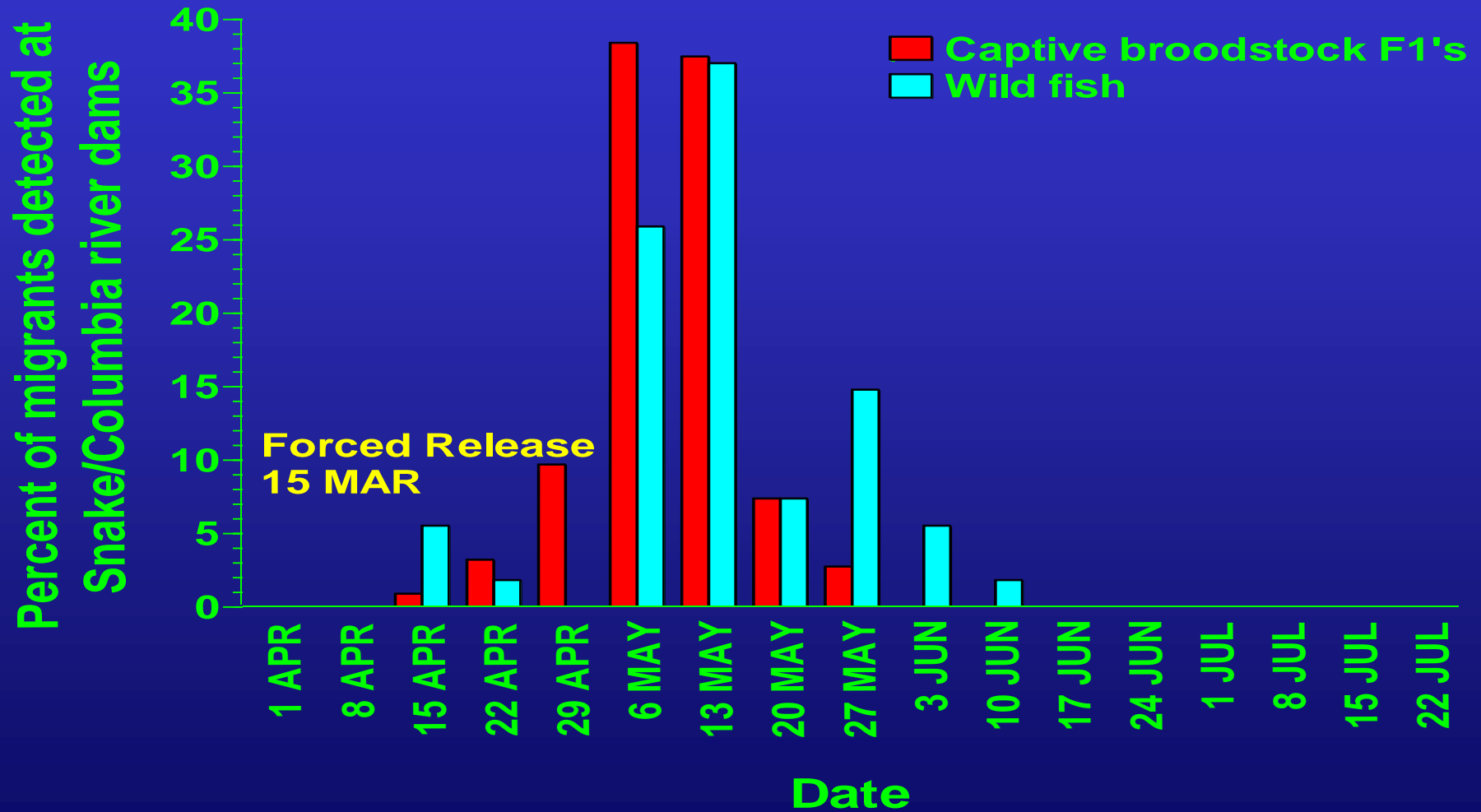


# Run Timing

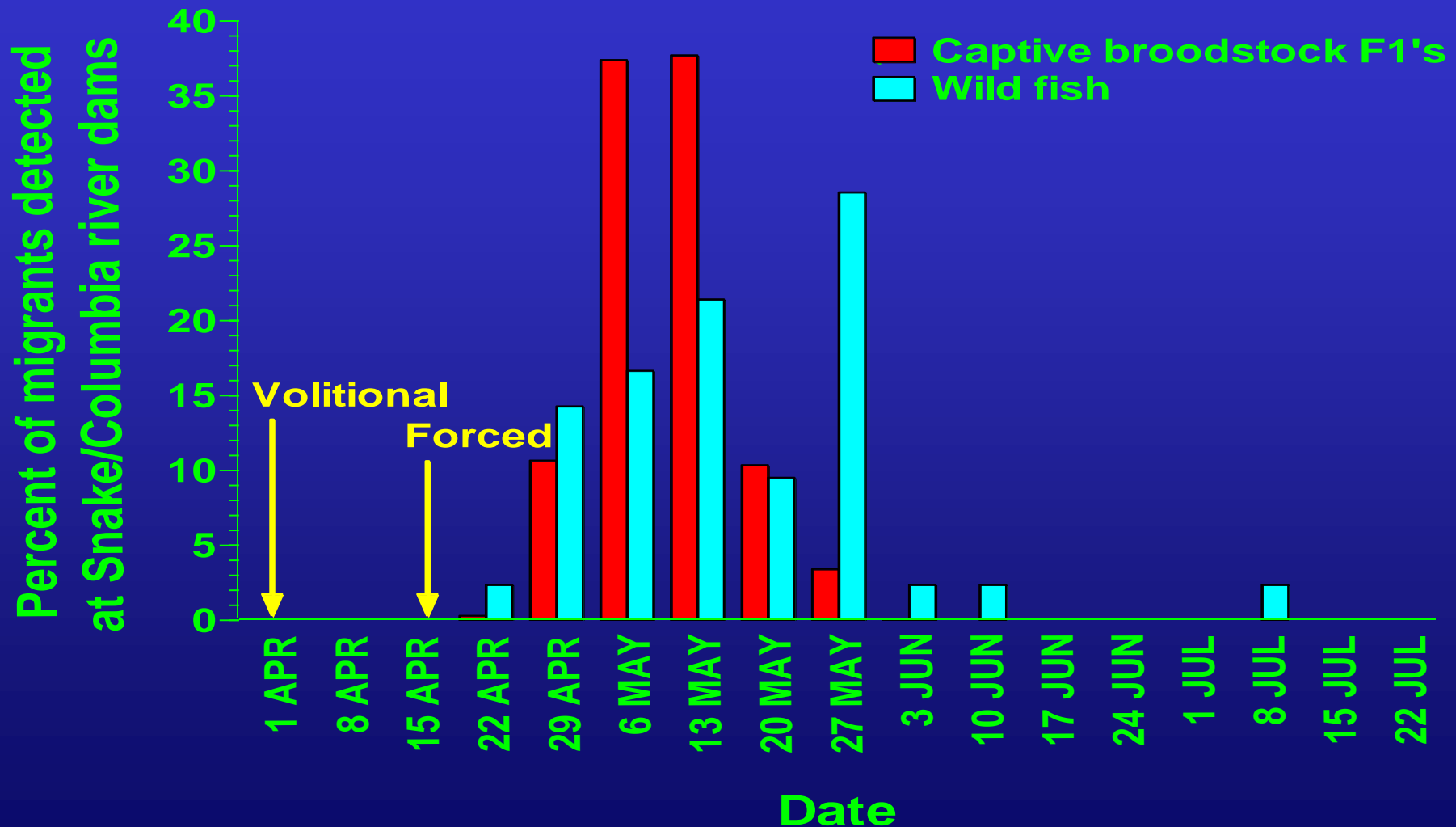




# F<sub>1</sub> Migration Timing – Grande Ronde River



# F<sub>1</sub> Migration Timing – Lostine River



# Assumptions/Targets

Collection.....500 parr/stock/year

Sex ratio.....1:1

Age at maturation:

Age	2	3	4	5
Percent females	0	6	78	16
Percent males	2	35	48	15

# Assumptions/Targets continued

Female maturation timing.....Aug/Sept

Female gamete production:

Age	3	4	5
Number of eggs	1200	3000	4000

Survival .....90% parr to smolt  
55% smolt to adult  
50% overall

# Assumptions/Targets continued

Egg viability.....75%

F<sub>1</sub> egg-to-smolt survival.....80%

Return Rate of F<sub>1</sub>'s.....0.1%

F1 age of maturity:

Age	3	4	5
Percent return	10%	60%	30%

# Summary

## ❁ **Parr Collections:**

- ❁ Met goal of 500 parr/stock/year (except for Grande Ronde River BY's 1994, 1995 and 1999)

## ❁ **Growth:**

- ❁ Growth was slower than expected

## ❁ **Survival:**

- ❁ Parr-to-Smolt survival was above 95% expected
- ❁ Smolt-to-Spawn survival met the 55% goal but varied widely

## ❁ **Mortality:**

- ❁ BKD was the largest causes of mortality

## ❁ **Maturity and Spawning:**

- ❁ Males matured earlier than expected – most Age 3
- ❁ Females matured later than expected – fewer Age 4, more Age 5
- ❁ Fecundity was 60% lower than expected

# Endpoints and Off ramps

- ❁ Disposition of excess  $F_1$  fish in years of overproduction.
  - ❁ We have outlet streams into which we can stock excess production.
- ❁ Endpoints for program - goal of consistent return of 150 adults spawning in nature.
  - ❁ We have achieved this goal for the Catherine Creek and Lostine River populations. The 2005 brood year was the last collected for these populations.
  - ❁ Upper Grande Ronde River population has not achieved this goal and the program is continuing as a Safety Net Program.

# Captive Broodstock Program Objectives

- ✿ Prevent extinction of the native Catherine Creek, Lostine River and upper Grande Ronde River Chinook salmon populations.
- ✿ Maintain genetic diversity of indigenous artificially propagated Chinook salmon populations.
- ✿ Maintain the genetic diversity in wild, endemic Chinook salmon populations in the Minam and Wenaha rivers.
- ✿ Provide a future basis and methodologies to reverse declines in stock abundance and ensure a high probability of population persistence until causes of population declines have been addressed.
- ✿ Establish an annual supply of spring Chinook salmon broodstock capable of meeting annual hatchery production goals.
- ✿ Restore and maintain naturally spawning populations of spring Chinook salmon.

Captive Broodstock offspring would be incorporated into the Lower Snake River Compensation Plan production.



# Monitoring and Evaluation Objectives

- ❁ Monitor, assess and compare the effects of pre- and post-smolt rearing treatments.
- ❁ Develop and evaluate the effectiveness of innovative methodologies for rearing, spawning and disease treatment and prevention.
- ❁ Monitor and compare aspects of life history and production performance between Captive and Conventional broodstock programs.
- ❁ Monitor and assess the performance of captive broodstock offspring in captivity (pre-smolt) and in nature (post-smolt) and their offspring.
- ❁ Assess our ability to achieve the genetic conservation goals and production benchmarks.
- ❁ Develop and maintain a comprehensive database for the program.