The use of hatchery fish to rebuild populations of Snake River Sockeye Salmon in Idaho

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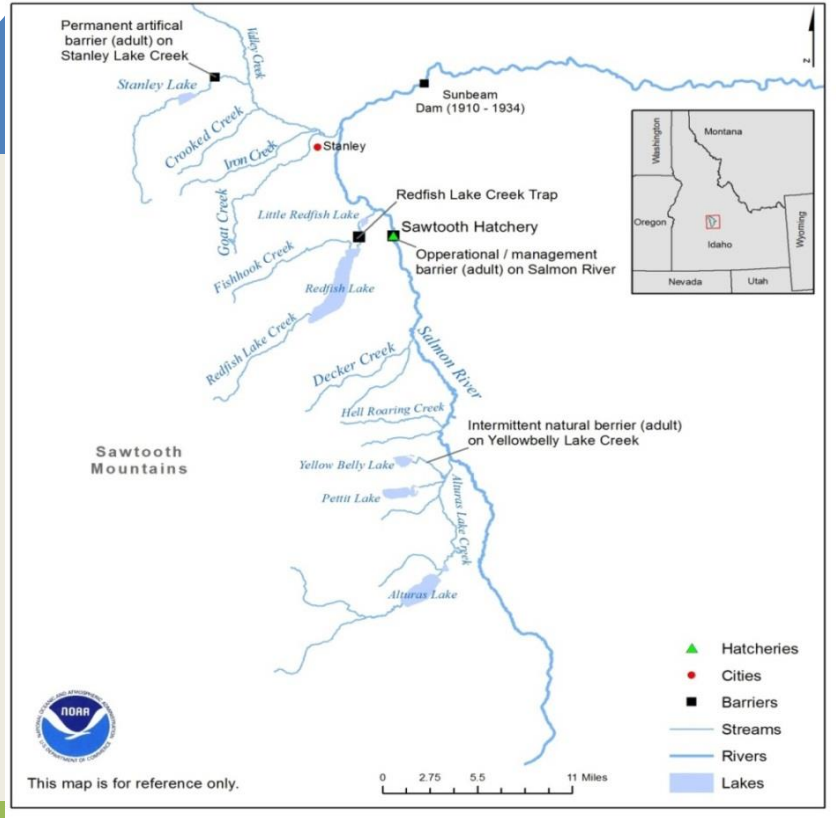
Implementation

- Cooperative effort
  - IDFG
  - NOAA
  - ODFW
  - SBT
  - BPA

Sawtooth Valley lakes

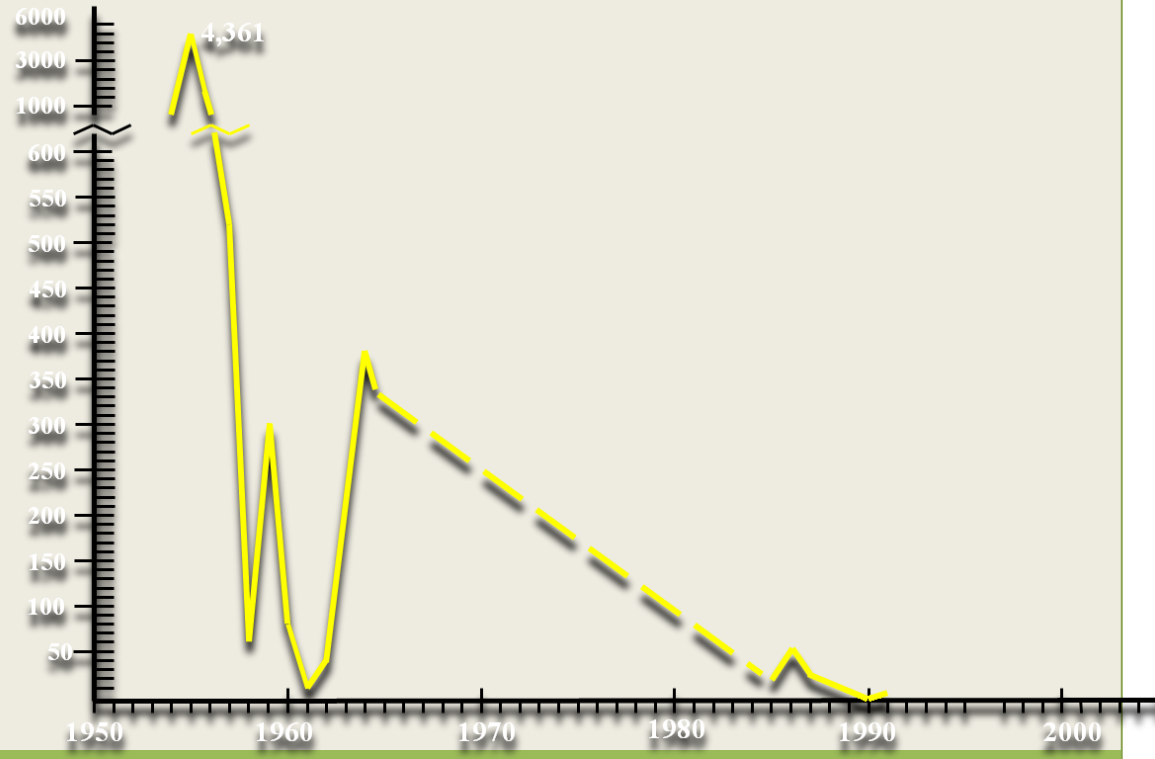
- Sockeye Salmon are native to 5 nursery lakes:

- Redfish Lake*
- Pettit Lake*
- Alturas Lake*
- Yellowbelly Lake
- Stanley Lake



Sockeye Salmon Historical Abundance

- In the 1890's, 150,000 fish returning (Evermann 1896)
- Numbers declined through the early and mid 1900's
- Between 1985 – 1989, 62 adults returned cumulatively
- In 1990, no adults returned



ESA listing decision

- In 1990, the Shoshone-Bannock Tribe of Idaho petitioned NMFS to list
- Spring, Summer 1991: IDFG collected Redfish Lake smolts and anadromous adults that returned to initiate the captive broodstock
- November 1991: ESU was listed as endangered

Captive Broodstock Development

Broodstock Collection (1991 – 1998)

- 16 wild sockeye (all that returned in ‘90s)
- several hundred out-migrating sockeye smolts (1991 – 1993)
- 26 “residual” sockeye salmon (1993 – 1995)

Broodstock & Production

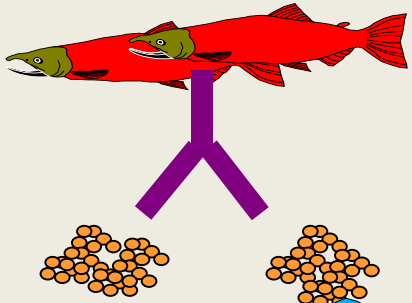
Captive Broodstock:
800 -1500 eyed eggs from IDFG representing each subfamily are kept at IDFG and NOAA and reared to maturity.

Some may be released as adults

NMFS Manchester Research Station

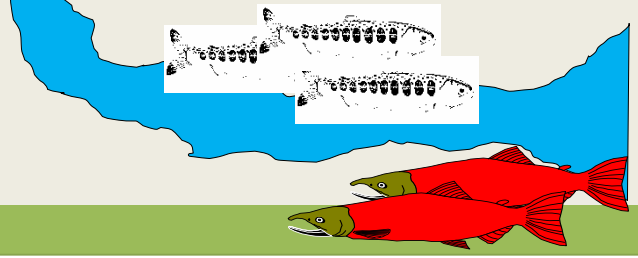
IDFG Eagle Fish Hatchery

Adults are spawned at the IDFG and NOAA



Production: Remaining eyed eggs from IDFG and NOAA are sent to OFH, SFH, or SPFH and are reared to release. Another group of eyed eggs may be outplanted.

Smolts migrate to the ocean



Adults return from the ocean

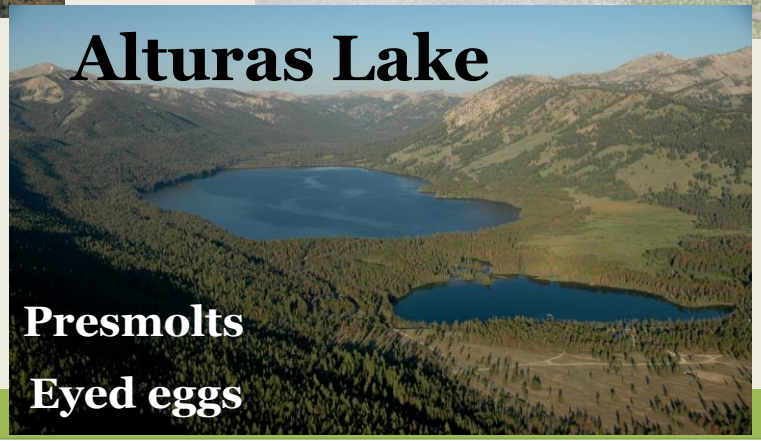
Initial Objectives of the Program

- Utilize Captive Broodstock Technology to avoid extinction and “gene banking”
  - Successfully culture Sockeye Salmon
  - Conserve genetic diversity
  - Increase the numbers of individuals

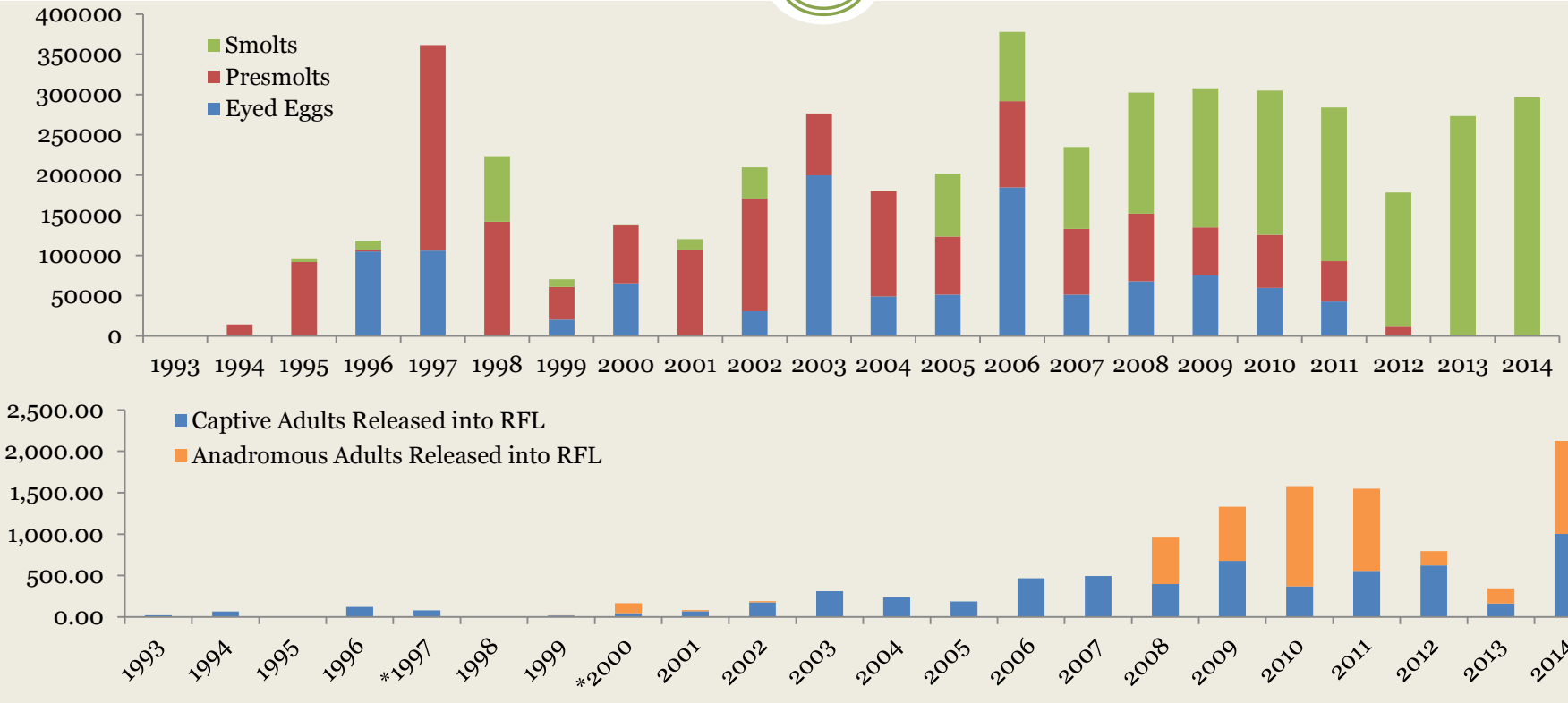
Objectives of this study

- Evaluate different release strategies
- Use Parentage Based Tagging to determine age and origin of Sockeye Salmon
  - Compostion in anadromous return
  - Productivity metrics (R/S, SARS) from hatchery and natural releases
- Describe the future direction of the program

“Spread the Risk” Release strategies



Annual Release Numbers



Marking of release strategies

Separate marks identified release strategies with the exception of offspring from egg-boxes, adult outplants, and un-sampled natural spawners

BUT:

The HSRG "recommends that managers tag/mark all fish released by this program"…. But "finding alternative means of identifying fish and discontinuing the practice of ventral fin clipping" (HSRG 2009)

AND:

CWT can shed

Genetic Marking – No needs for marks

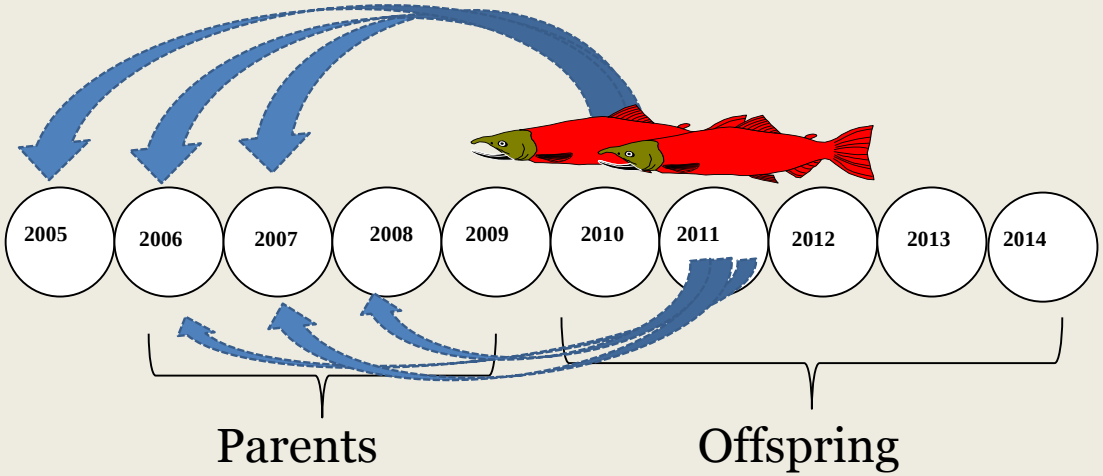
Advantages of genetic marking (PBT)

- Higher tagging rates than CWT (Steele et al. 2014)
- Less invasive (only need a clip or scales)
- Can be applied at any life stage
- Can address other questions such as heritability, family correlated survival, lifetime reproductive success

*Caveat – different families need to be kept separate for evaluations (cannot split eggs into different groups) or marks are still needed.

In 2006, PBT was initiated

Starting in 2006 (BY03), every adult that spawned, released or an ocean return was genotyped for pedigree analysis for the captive broodstock



So, jacks in 2009 and all adults returning in 2010 could be assigned an age and origin (release strategy)

PBT Methods

Genotyped spawned and/or released adults w/ 9 – 16 microsatellite loci

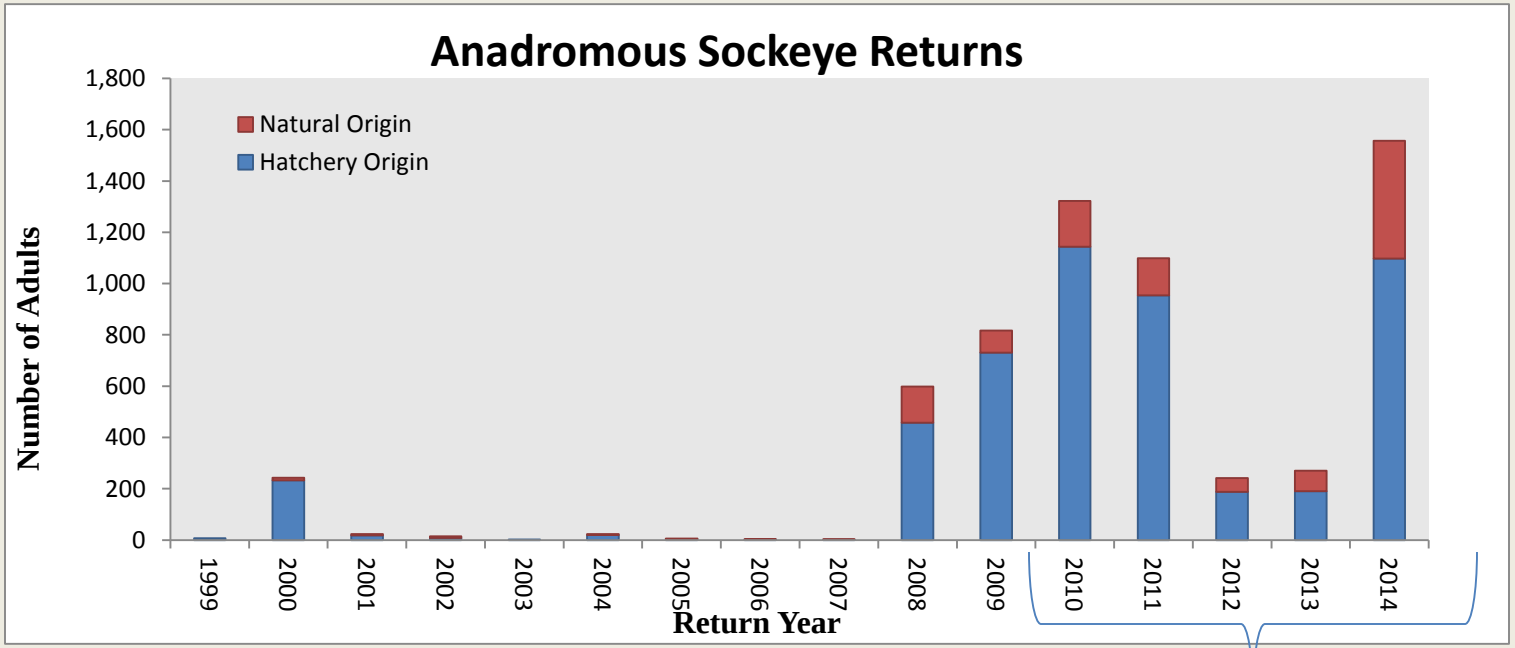
Parentage analysis (Cervus 2.1)

Expand assignments based upon tagging rates or use age length key (R – code, Ogle et al. 2013)

First Generation Returning Fish:

Calculate R/F
Calculate SARs

Adult Offspring Sampled



4,449 adults returned

Adult Spawners and Releases (PBT)

Year	Spawners	Released
2006	657	465
2007	574	497
2008	603	966
2009	593	1330
2010	546	1577
TOTAL	2973	4835

Tagging rates

- Tagging Rates were calculated by release strategy and cross information and were greater than 95% except one instance (2008 Release).

Assignment Results

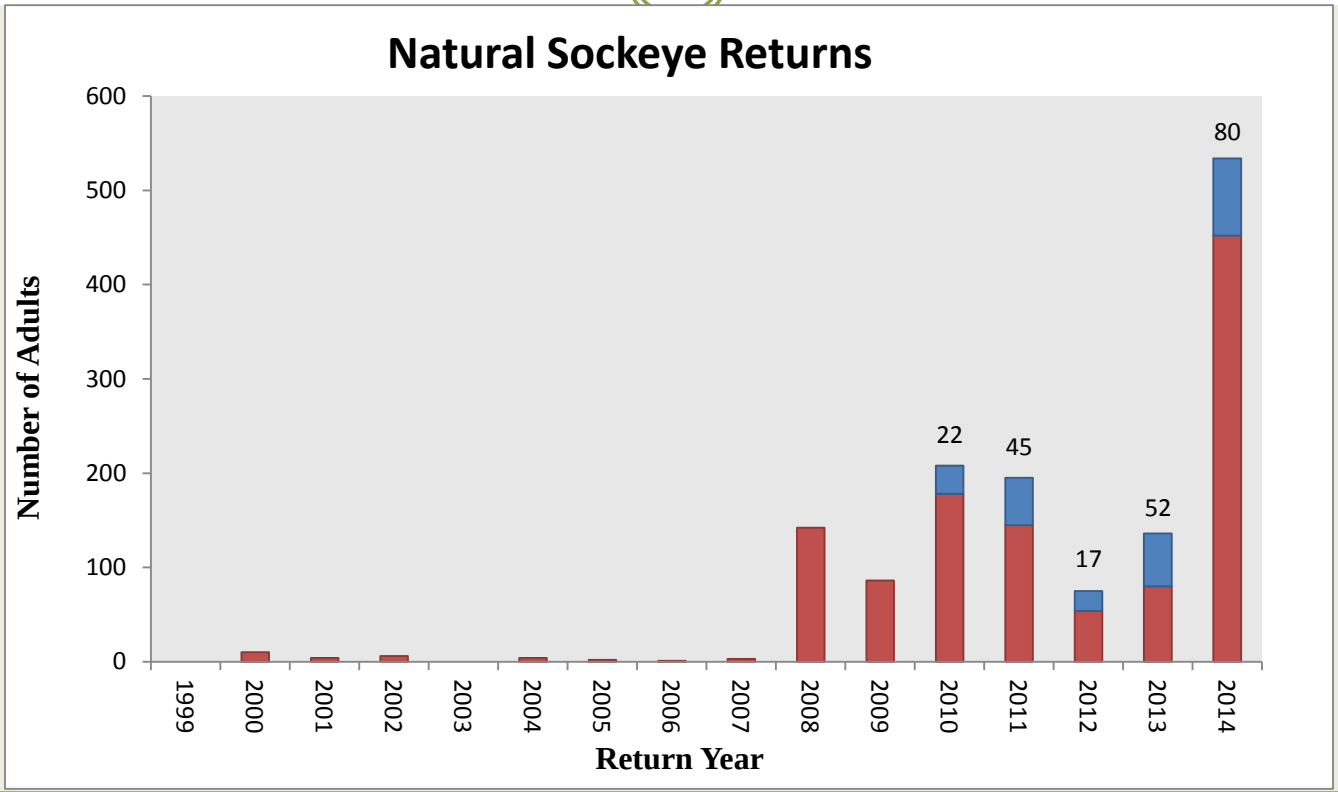
(expanded by tagging rate)

Anadromous Return year	Hatchery Origin Assignments	Natural Origin Assignments	Overall Assignment Rate
2010	99%	86%	97%
2011	96%	67%	92%
2012	99%	67%	92%
2013	97%	32%	79%
2014	96%	82%	92%

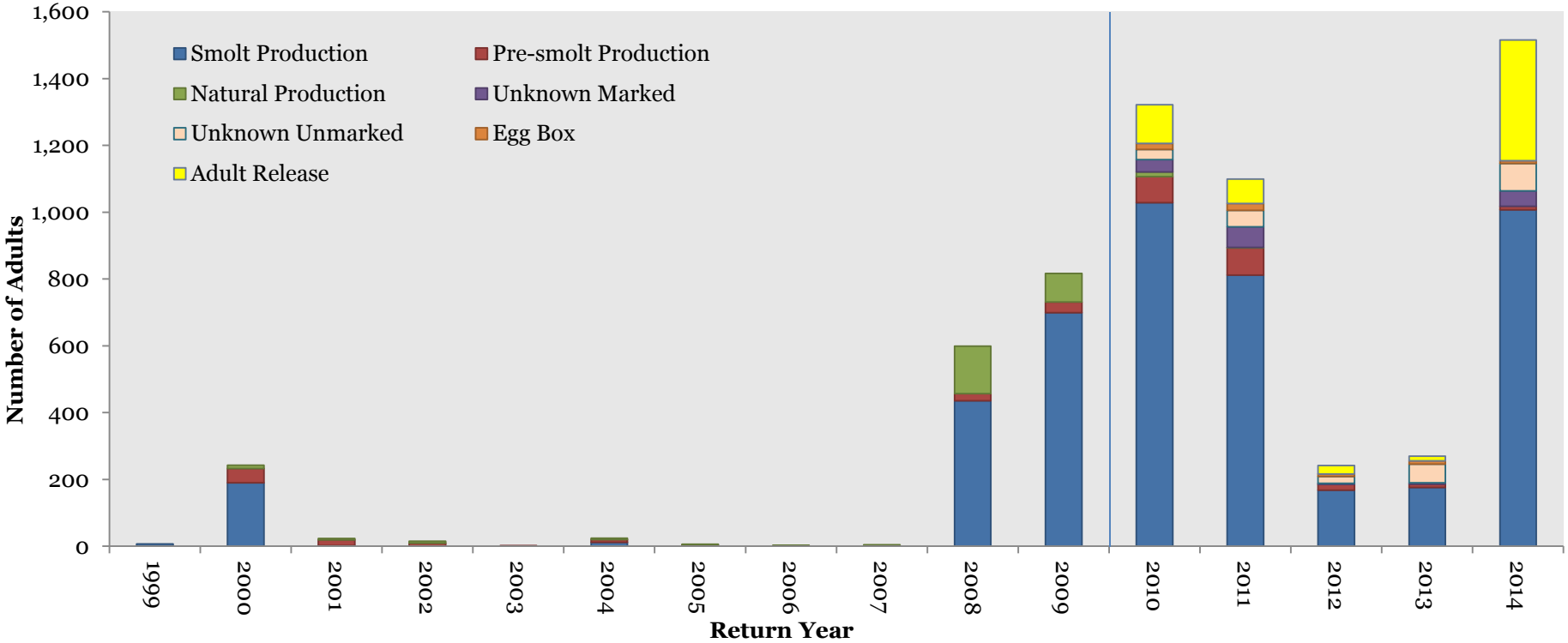
R code was used to assign an age based on length data for un-assigned fish

Natural Returns

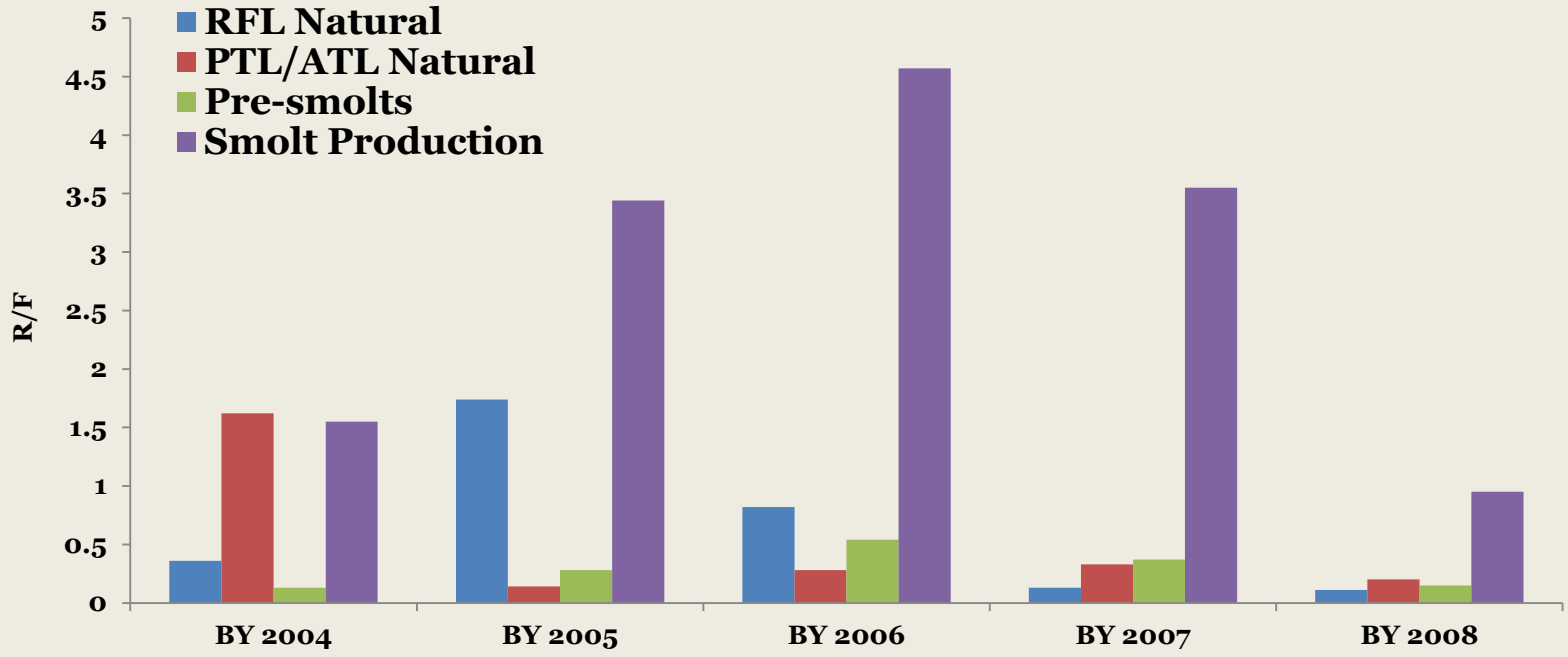
(not assigned after expansions)



Anadromous Sockeye Salmon Returns By Release Strategy



Recruits per female by strategy



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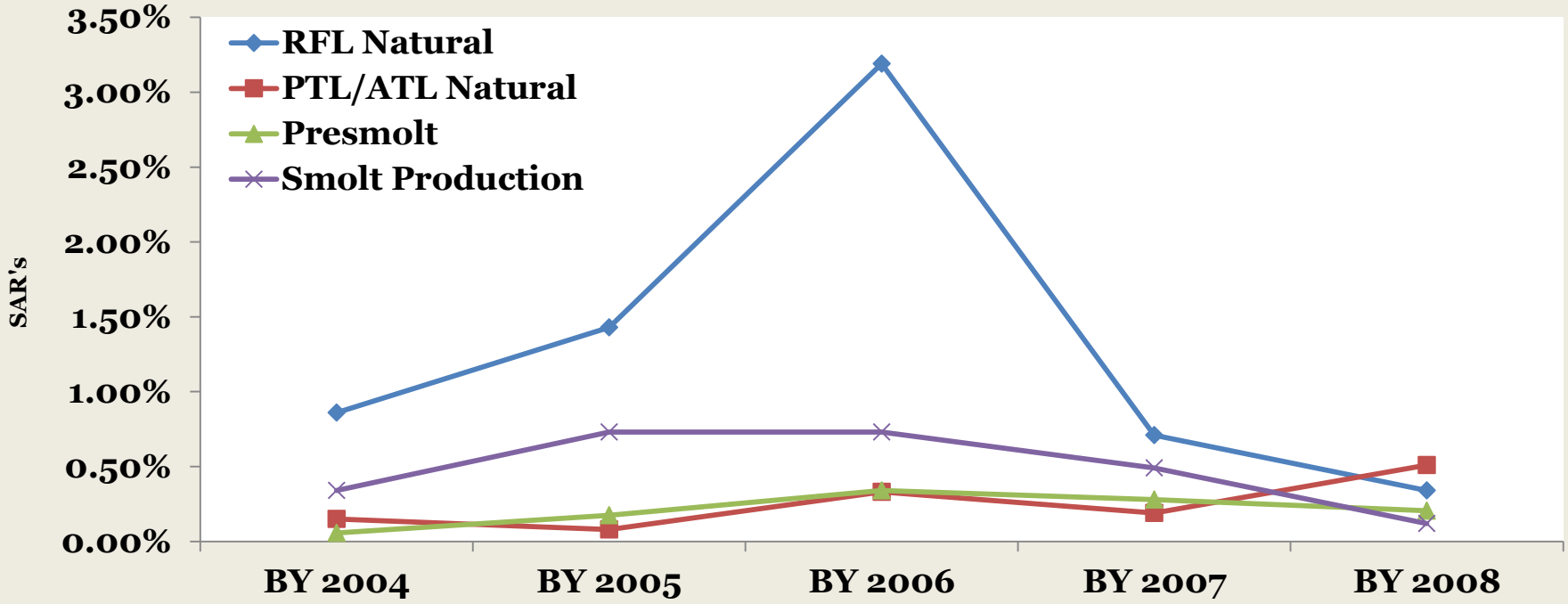
SAR for Redfish Lake

	BROODYEAR					
Estimated Emigration By Strategy	1996	2004	2005	2006	2007	2008
Estimated RFL emigration from pre-smolt releases	152,322/28,435	39,870/16,612	61,804/15,164	62,015/16,857	57,093/13,544	34,561/5,704
Estimated RFL emigration from smolt releases	81,615	86,052	101,676	150,395	173,055	179,278
Estimated RFL emigration from natural production	2,799	5,609	6,088	6,338	4,822	12,558

	BROODYEAR					
Estimated Returns By Strategy	1996	2004	2005	2006	2007	2008
Estimated adult returns to RFL from pre-smolt releases	42	5	24	57	36	13
Estimated adult returns to RFL from smolt releases	186	289	746	1,101	853	220
Estimated adult returns to RFL from natural production	10	48	87	202	34	43

407,665 Pre-smolts planted → 177 adults back → 0.04% SAR
772,071 Smolts planted → 3,395 adults back → 0.44% SAR
32,214 Natural smolts produced in lake → 424 adults back → 1.32% SAR

SARs per release strategy



Kline and Flagg 2014

Next phase of the program

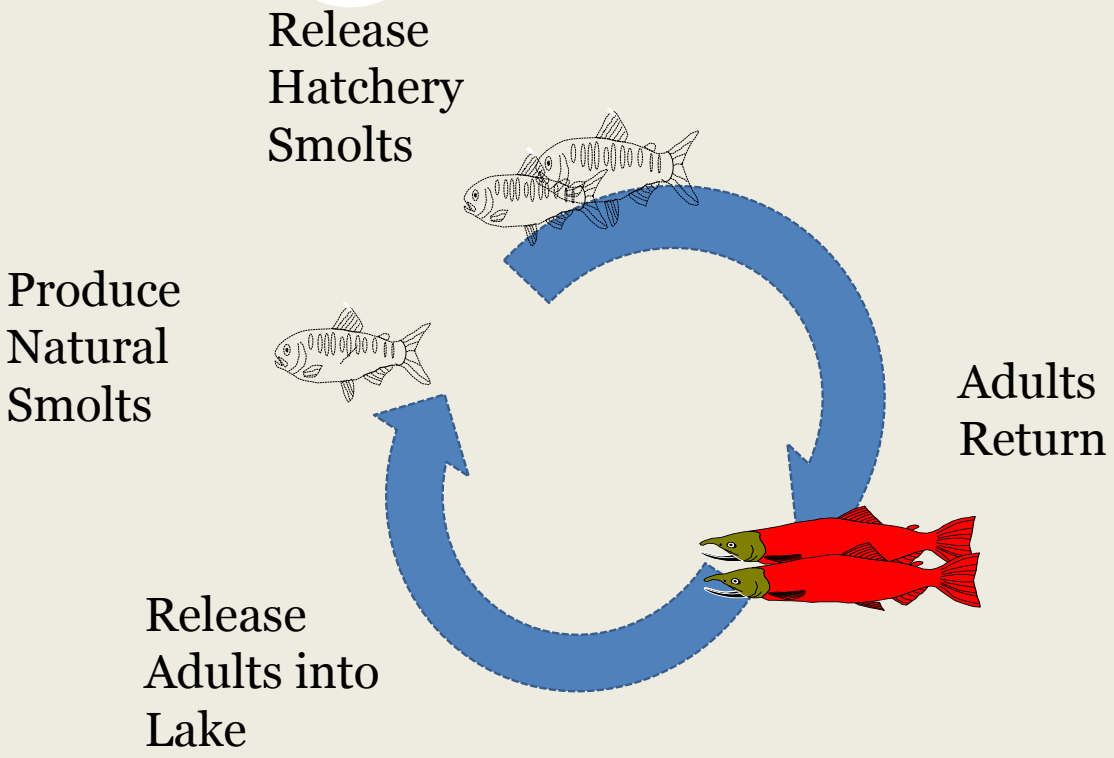
- Program has successfully met its initial objectives:
  - Staving off extinction
  - Maintaining population diversity (Kalinowski et al. 2012, 95%)
  - Increasing the size of the program in captivity
  - Learned about success of release strategies and that captive fish can reproduce in the wild

- Ready to move into the next phase:

Phase 2: Re-Colonization

Phase 2 Strategy

- Utilize the two release strategies that provide the greatest demographic boost and increase population fitness



Phase 2

Initiate with development of expanded smolt program at Springfield Hatchery (first release in 2015)

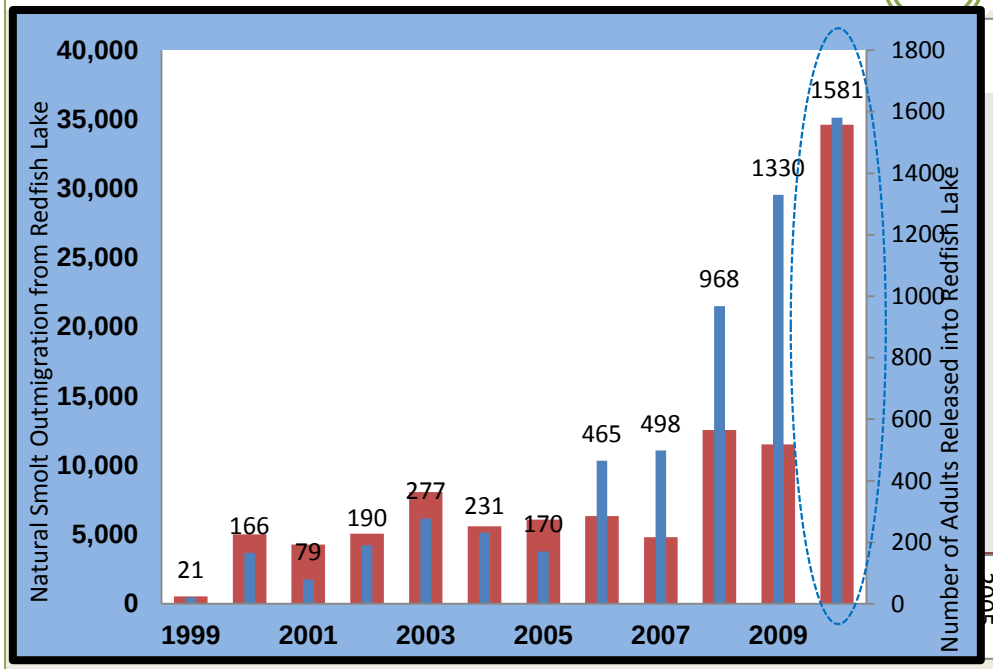
Springfield Hatchery – rear 1 million full-term smolts (~3X the current numbers, 2017)

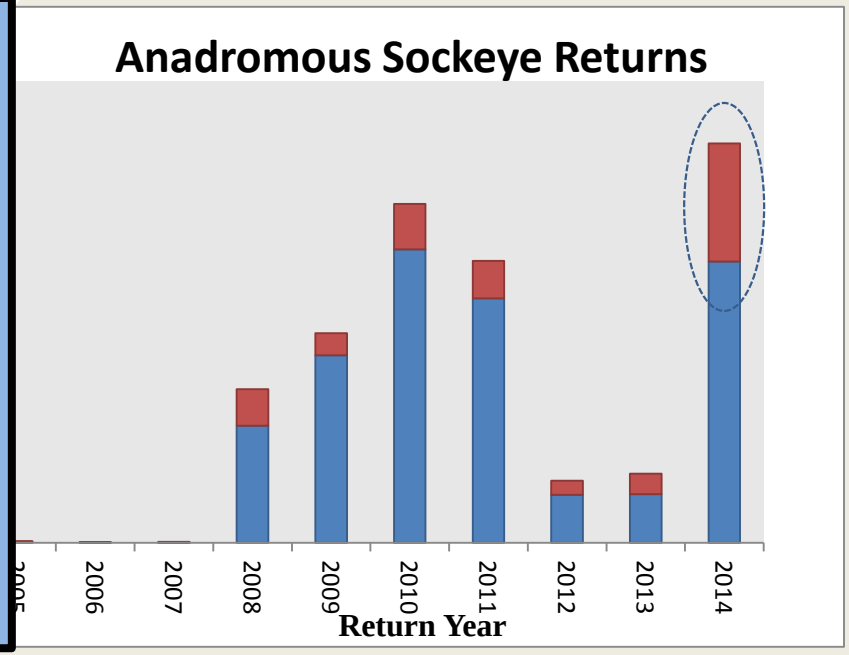
Phase 2 Goals/Triggers

- Generate anadromous adult returns sufficient to meet broodstock and escapement objectives
- Increase population fitness

- Establish a self-sustaining anadromous broodstock and reduce reliance on captive broodstock
  - Trigger 1: When 5-yr avg return > 1,000, begin to phase out NOAA
  - Trigger 2: When 5-yr avg return > 2,150, Eagle Hatchery terminated
  - Trigger 3: When 5-yr avg return of natural adults > 750, Reduce size of hatchery program and intiate integrated broodstock

Expectations of strategy





May already be seeing benefits with record natural return in 2014 (BY2010)

Summary

- The program has been successful in achieving early goals of the program
  - Prevented extinction
  - Maintained genetic diversity
- A phased approach to recovery is in place and the recovery plan has been completed.
- Still challenges and uncertainties
- Expect to continue to see record returns.

Acknowledgements

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Oxbow Fish Hatchery Staff
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Questions?