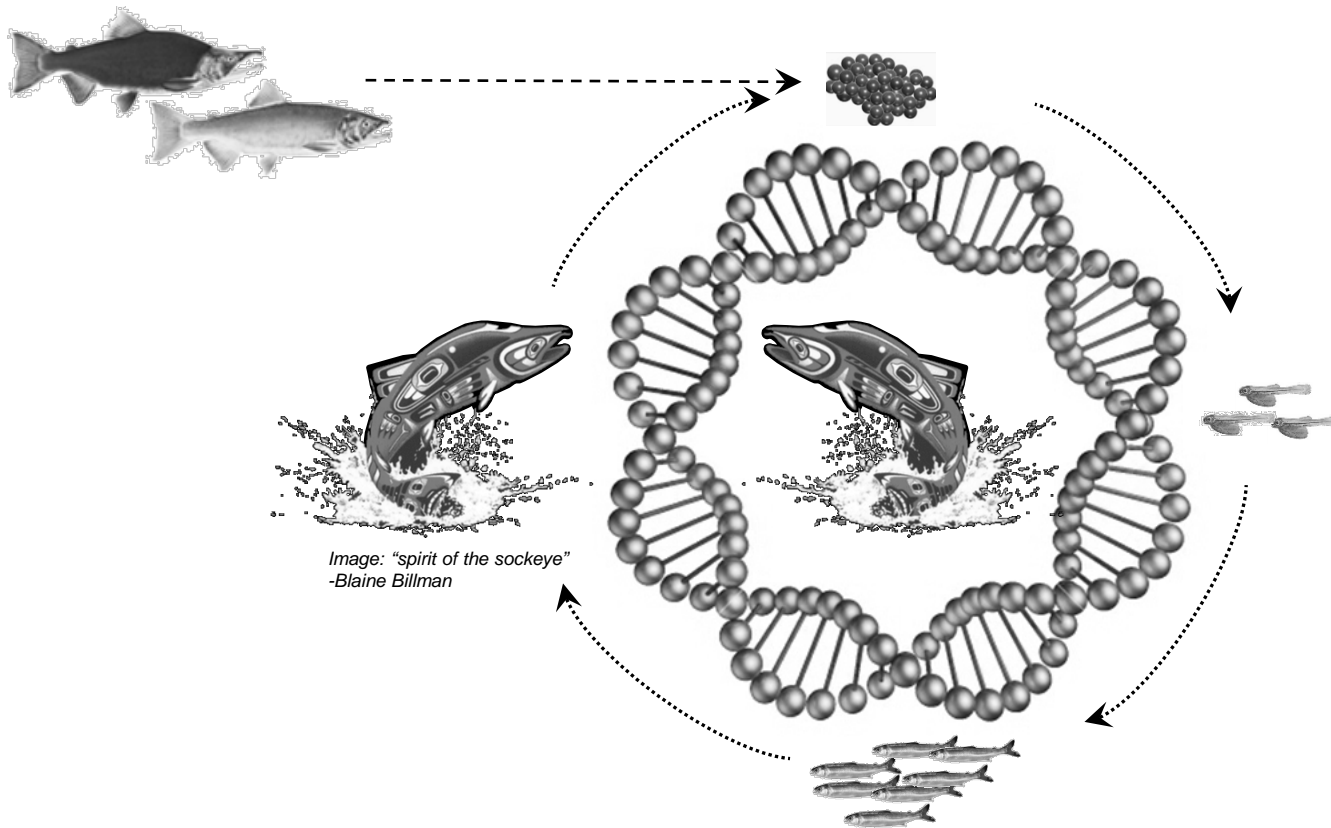


# "Genetic monitoring of sockeye salmon reintroduction in Cle Elum Lake: evaluating relative productivity among two donor stocks"



Andrew P. Matala, Peter Galbreath

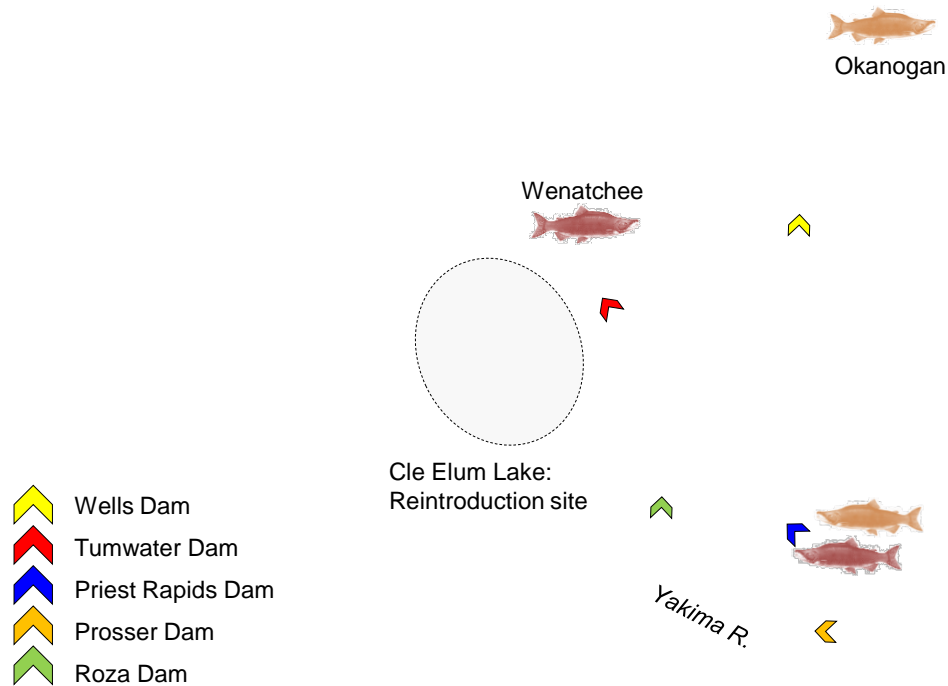
Columbia River Inter-Tribal Fish Commission

Brian Saluskin, Mark Johnston

The Confederated Tribes and Bands of the Yakama Nation



# Background: reintroduction



- Donor stocks: Upper Columbia River from The Wenatchee River & Okanogan River systems
- Collected at Tumwater Dam and Wells Dam for baseline
- Outplants collected at Priest Rapids dam, downstream of both locations of origin
- Proportions among outplants for reintroduction are unknown

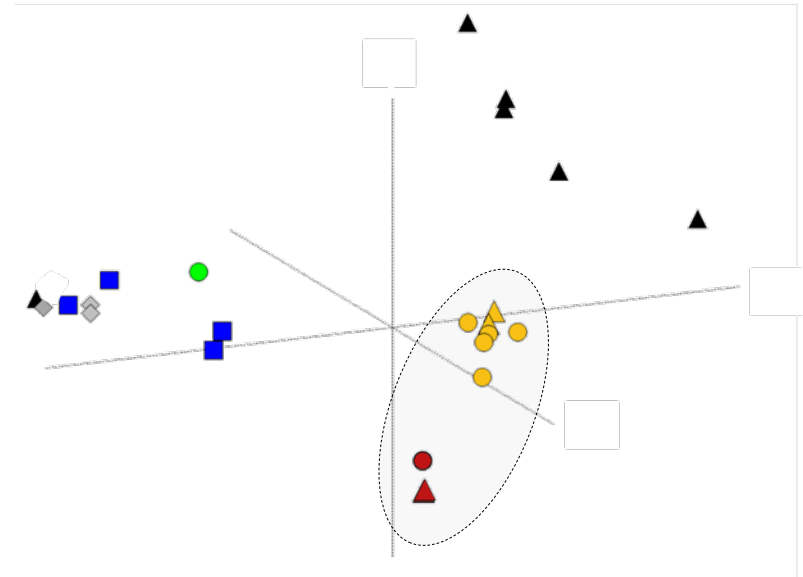
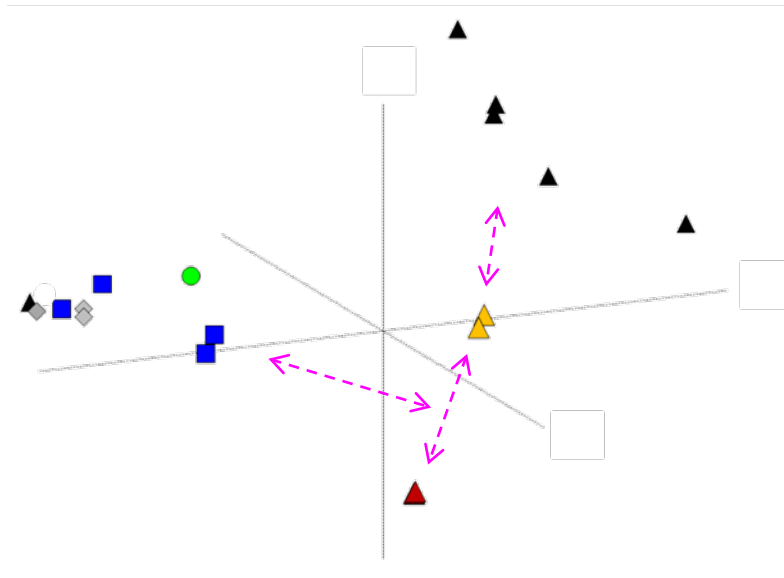
# Sampling & Analysis to date

- An *O. nerka* reference baseline: - includes Wenatchee River stock and Okanogan River stock
- PRD outplant random sample: - 2011 (n=275), and 2012 (n=849)
- Outmigrating juvenile collections: - 2012 Chandler trap (n=196), and Roza (n=7)
- Carcass collections:
  - 1<sup>st</sup> spawn run 2011 (n=38)
  - 2<sup>nd</sup> spawn run 2011 (n=23)
  - 1<sup>st</sup> spawn run 2012 (n=29)
- Putative adult “strays” sampled at Roza: - sampled 2009, 2010 & 2012 (n=207)

**Genotyped using a suite of 96 Single Nucleotide Polymorphism (SNP) loci**

# Genetic structure: Columbia-wide perspective

Three dimensional scatter plot of PCA Eigen Vectors - (Kamakura@duke.edu)



*Note distinction*

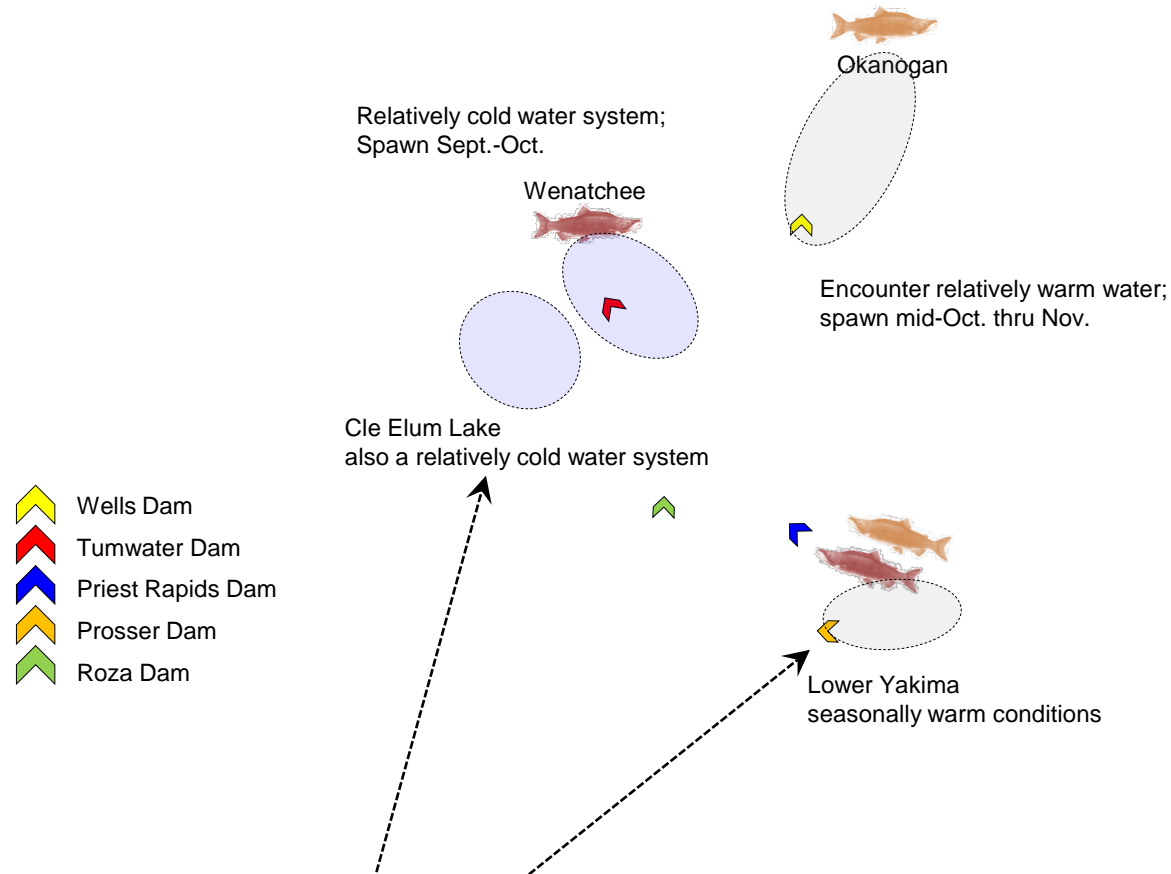
- Deschutes River
- ▲ Idaho (e.g. Redfish)
- Wallowa Lake
- ◆ Kokanee Hatchery stocks  
(Whatcom, Meadow, Wizard)

- ▲ Okanogan (OK)
- ▲ Wenatchee (WE)

Cle Elum collections cluster with

- OK ●
- WE ●

# Background: factors of distinction



Will colder environment favor one reintroduced stock (“Wenatchee origin” spawners)?

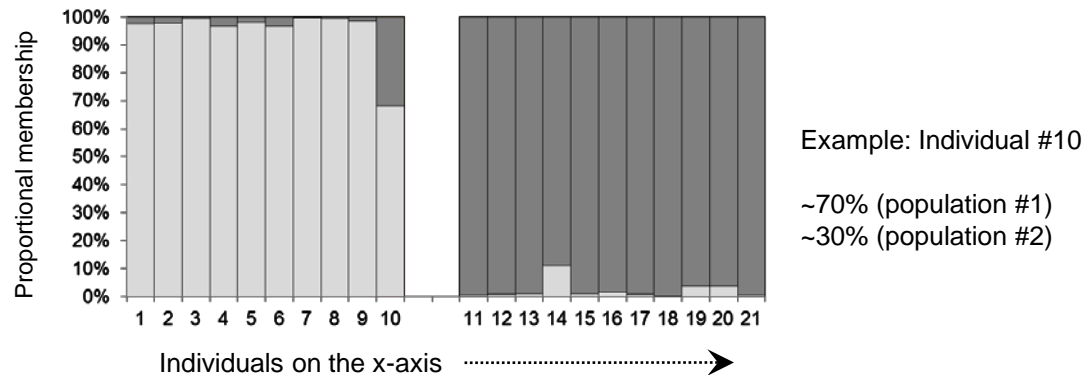
Will environmental extremes in migratory corridor benefit one reintroduced stock (“Okanogan origin” spawners)?

Will stock mixing (hybridization) be prevalent & productive? Or will differential spawn times be maintained?

# Two Methods To Estimate Stock Proportions

## 1. Bayesian cluster analysis: STRUCTURE v.2.3.4

- For each individual, determine “membership” in two inferred populations



## 2. Genetic Stock Identification (GSI): ONCOR

- test assignment accuracy for reference baseline using simulation.....then,
- assign origin of “unknown” sample using maximum likelihood

# Testing Reference Populations: Baseline



baseline analysis: [Method Concordance](#)

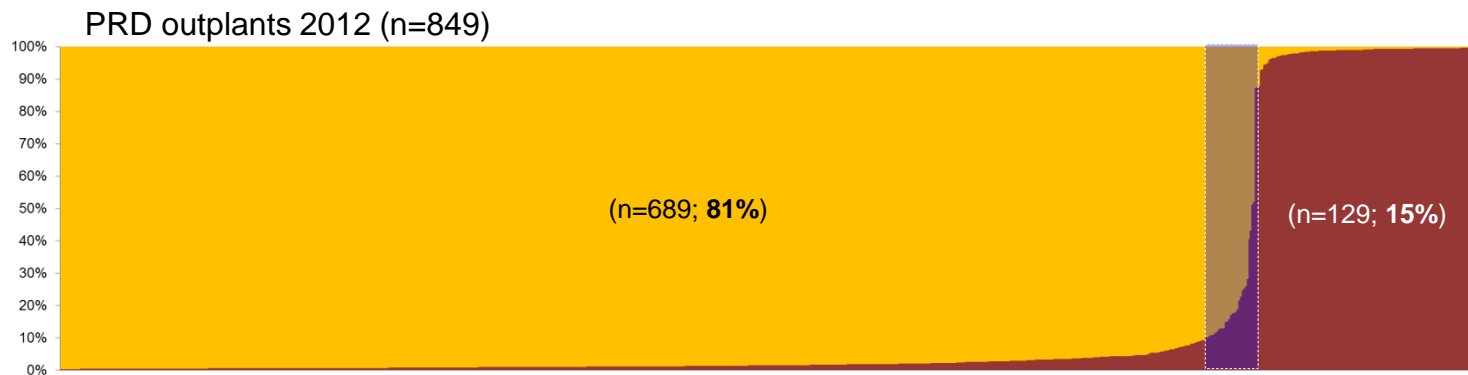
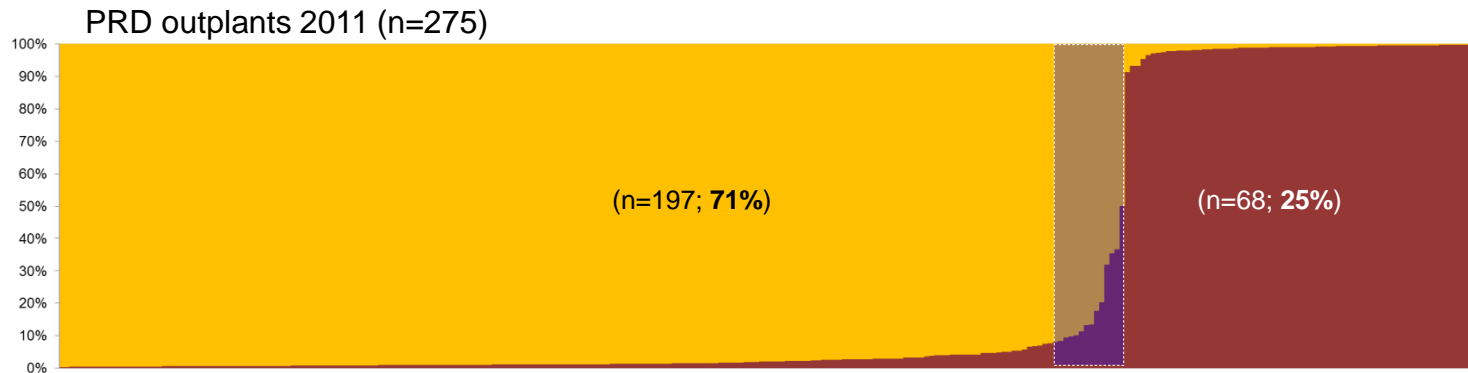
collection	(n)	structure mean		ONCOR 100% sim.	STD
		WE	OK		
Wenatchee_2012	92	<b>0.98</b>	0.02	1.00 (WE)	0.0004
Tumwater Dam 2004	97	<b>0.98</b>	0.02	1.00 (WE)	0.0000
Tumwater Dam 2005	155	<b>0.98</b>	0.02	1.00 (WE)	0.0000
Wells Dam 2004	91	0.02	<b>0.98</b>	1.00 (OK)	0.0003
Wells Dam 2005	121	0.03	<b>0.97</b>	1.00 (OK)	0.0000

basically the rate of self-assignment

# Estimates for Sockeye Reintroduction

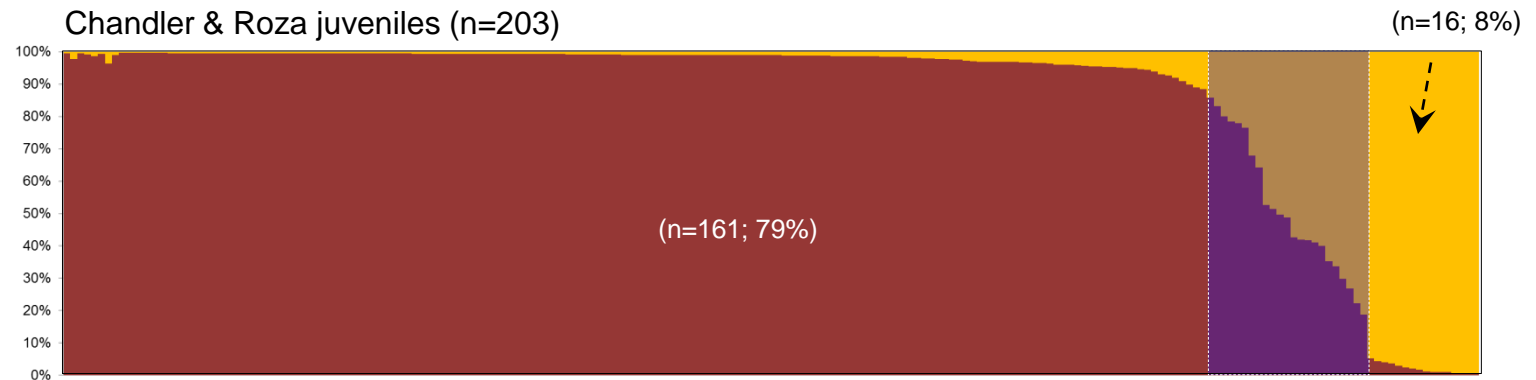
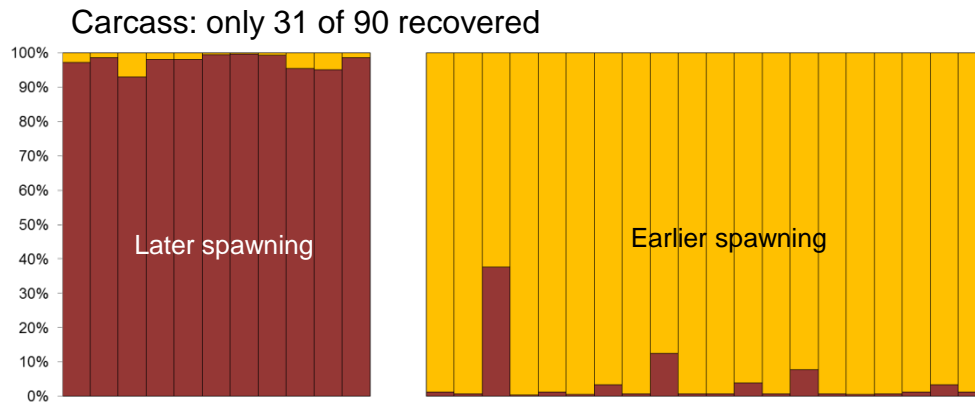
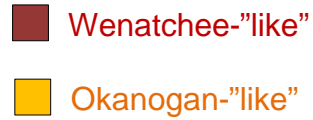
■ Wenatchee-"like"

■ Okanogan-"like"

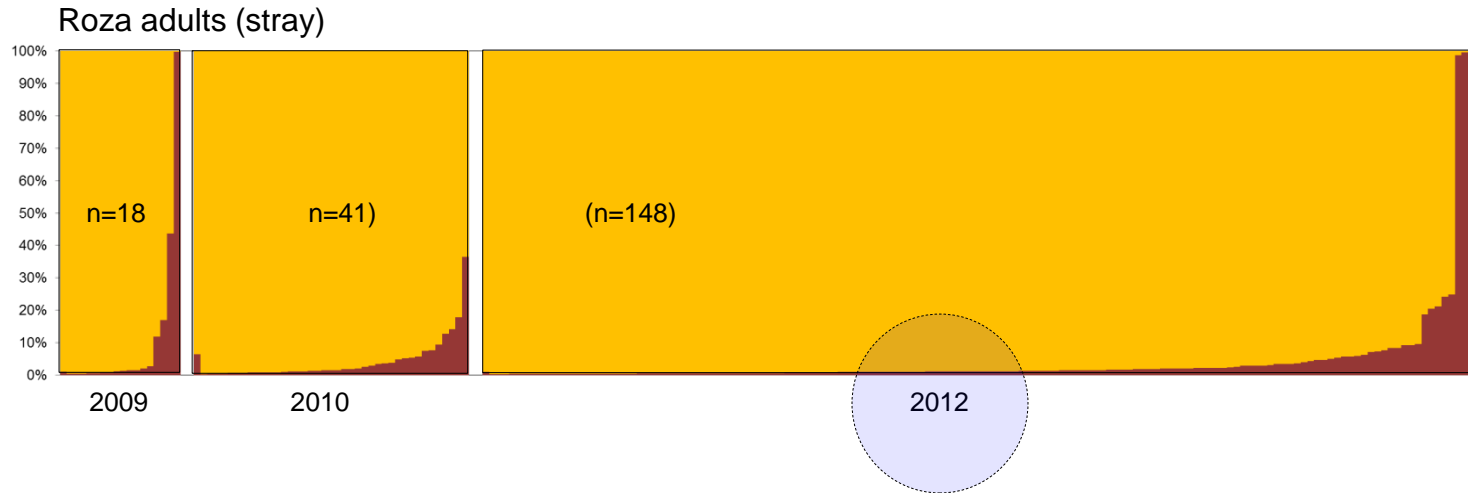
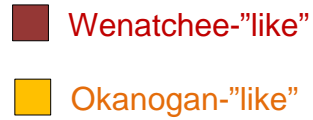




# Estimates for Sockeye Reintroduction











# Estimates for Sockeye Reintroduction



- Some of these may be jacks (?), OR fish that left the lake through the dam (?)  
*Wenatchee population exhibits low frequency of 3-year old fish (Gustafson et al. 1997)*

# In Summary

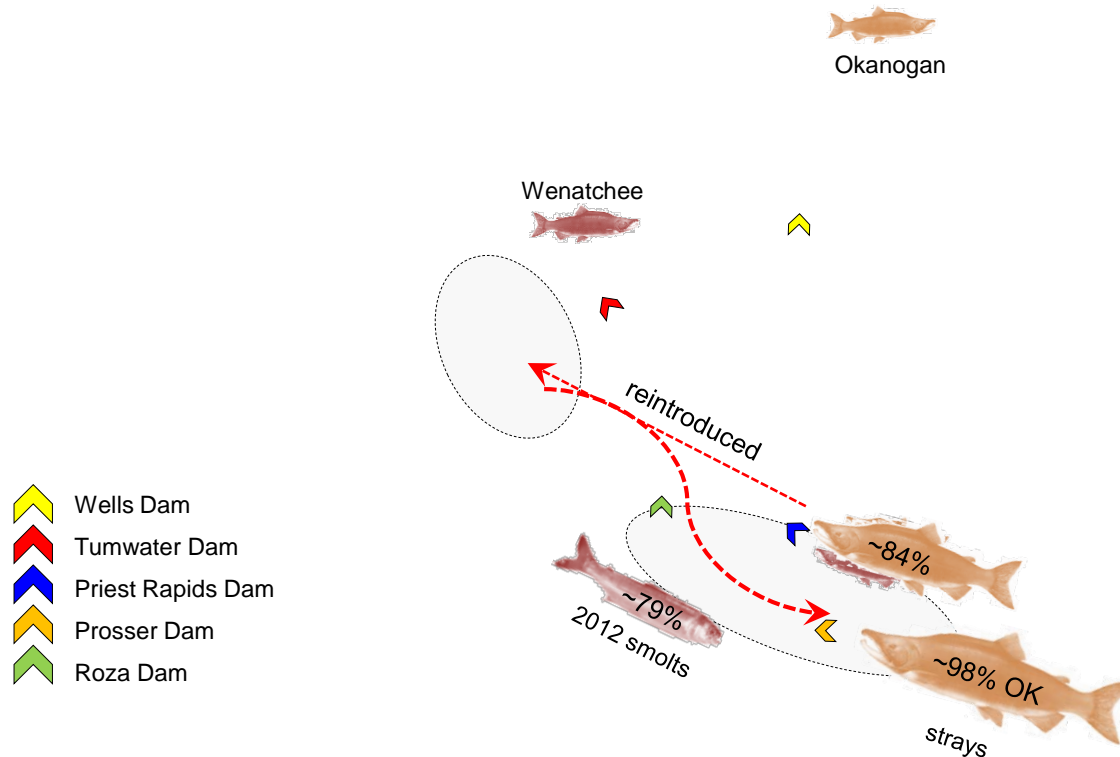
## GSI (ONCOR)

collection	(n)	stock proportions		mean Prob.		
		WE	OK	WE	OK	
<u>Cle Elum Reintroduction</u>						
 OK	Priest outplants 2011	275	0.25	<b>0.75</b>	1.00	1.00
 OK	Priest outplants 2012	849	0.16	<b>0.84</b>	1.00	1.00
 OK	Carcass (early)	20	0.00	<b>1.00</b>	---	1.00
 WE	Carcass (late)	11	<b>1.00</b>	0.00	1.00	---
 WE	Chandler Trap juveniles	196	<b>0.84</b>	0.16	1.00	0.99
<u>strays</u>						
 OK	Roza adults (2009)	18	0.06	<b>0.94</b>	1.00	1.00
 OK	Roza adults (2010)	41	0.00	<b>1.00</b>	---	1.00
 OK	Roza adults (2012)	155	0.06	<b>0.94</b>	1.00	1.00

- Stock proportions observed among juveniles seem to complement carcass results: **very few hybrids (OK x WE) = temporally differentiated spawning times (?)**
- Need to validate potential temporal differentiation in spawning time: **timing contrary to populations of origin (i.e., Wenatchee-type later spawning)**

# In Summary: Questions to explore

- Outplants predominantly of Okanogan (OK) origin
- Outmigrating smolts predominantly of Wenatchee (WE) origin, sampled in only a few days (?) Is this representative of total outmigration (?), and indicative of higher productivity (?)
- Wenatchee stock essentially not present among sampled strays (?) Outplants didn't volitionally enter the Yakima, how will their progeny behave (?)



# Goals for future genetic monitoring .....

⇒ MORE ⇐

- Continued carcass sampling: focus on fresher morts, spatial distributions, sample dates
- Continued juvenile sampling: focus on temporal distributions (protracted sampling)
- Continued outplant sampling: stock proportions

## And the meat & potatoes

- Evaluate returning adult progeny arising from reintroduction efforts
  - stock proportions and/or hybrids
  - second generation productivity

# Acknowledgements



**Mark Johnston, YN field technical staff,  
Roza and Chandler technical staff**



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- (Peter Galbreath)**



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Shawn Narum: Lead Geneticist**