

# Fraser River Sockeye Return Forecasts: Methods, Indicators, and Uncertainty




Fisheries and Oceans  
Canada

Pêches et Océans  
Canada

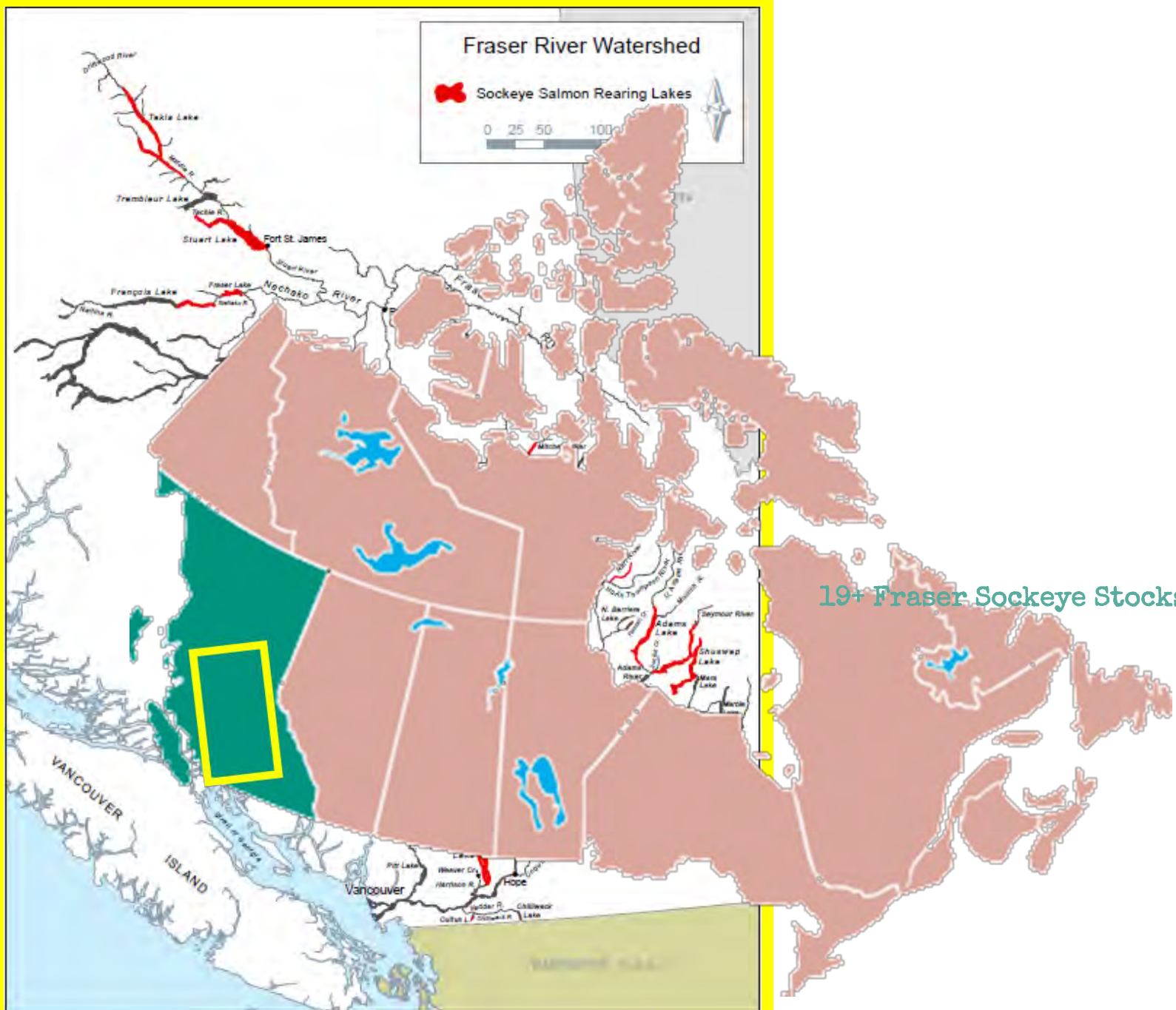
Sue Grant & Bronwyn MacDonald  
PICES Oct 14, 2013



# Fraser River Watershed

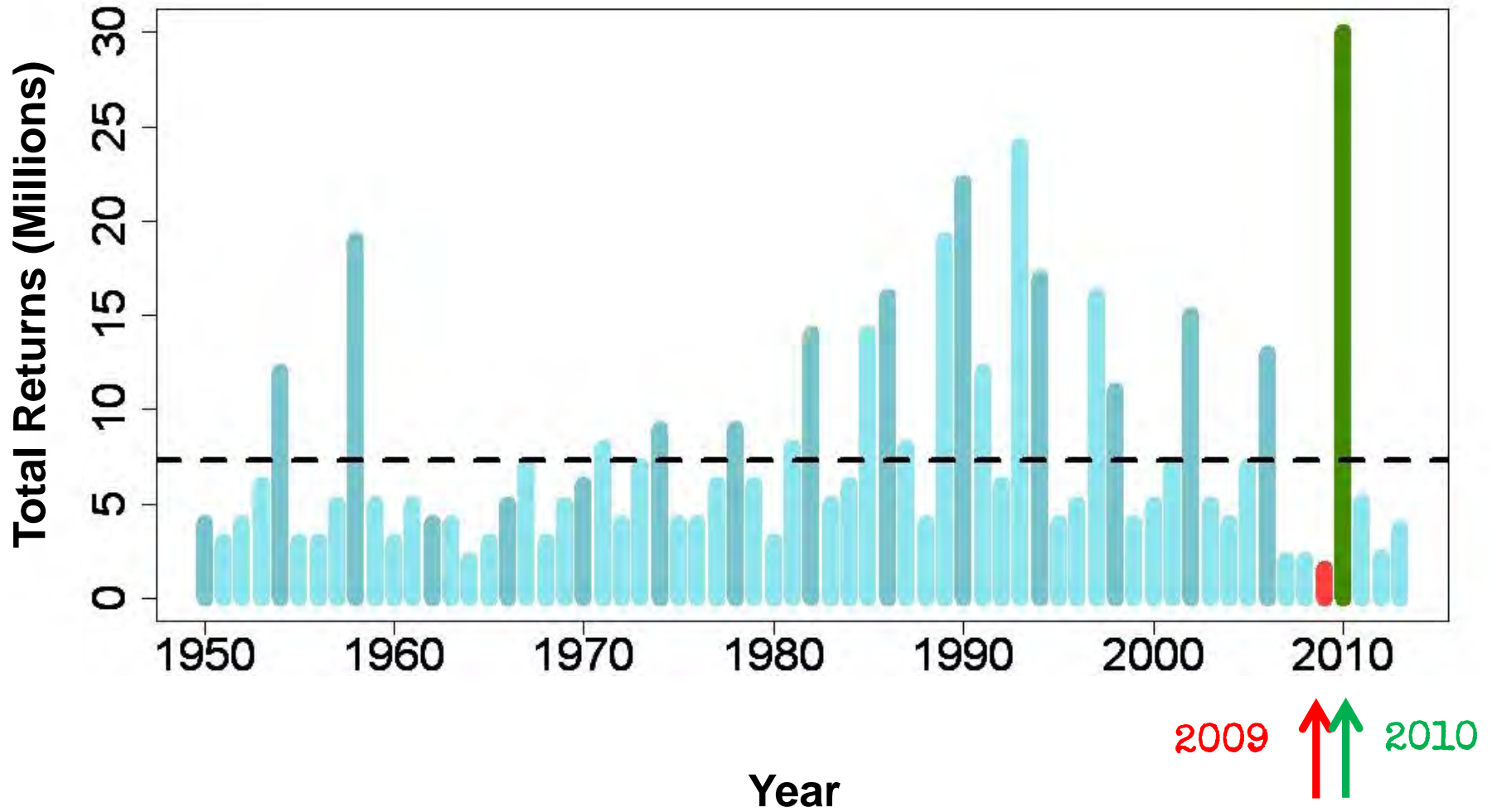
 Sockeye Salmon Rearing Lakes

0 25 50 100



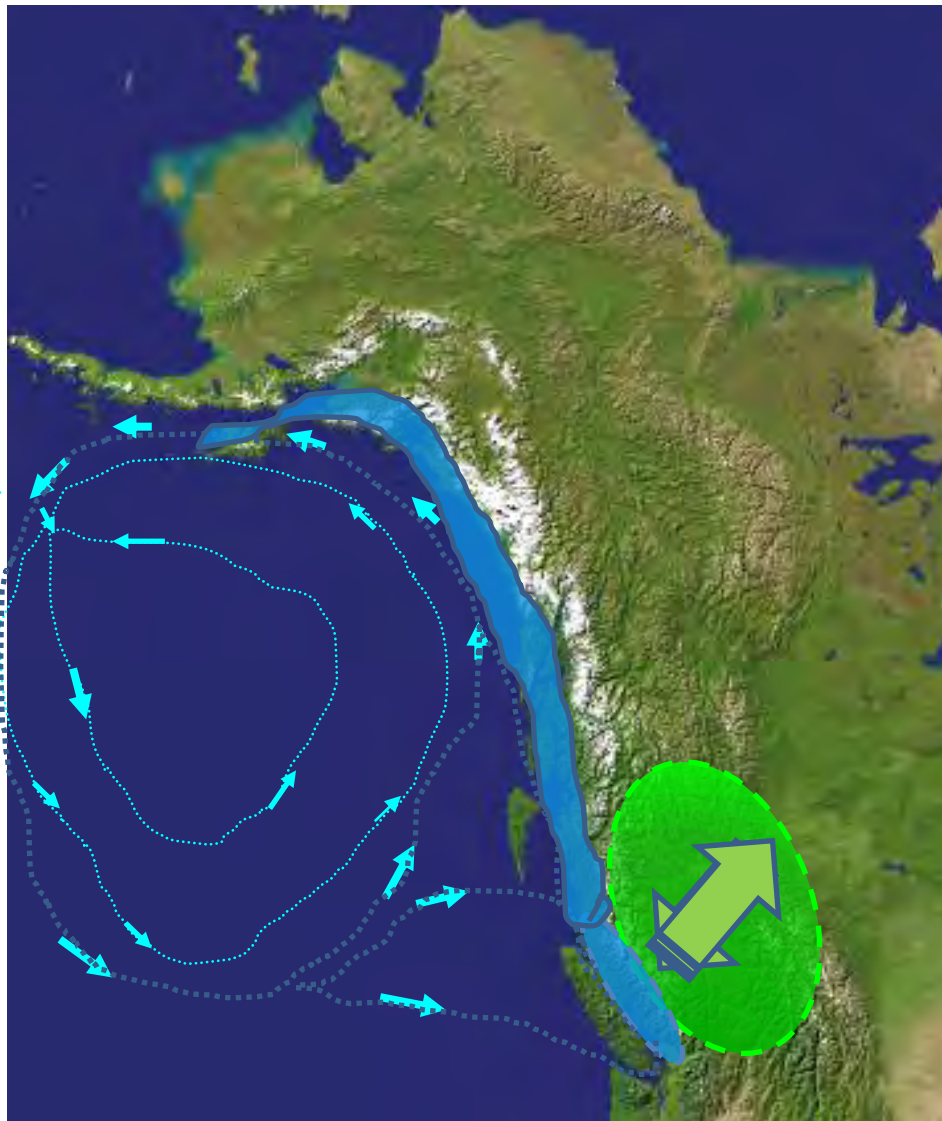
19+ Fraser Sockeye Stocks

# Total Returns



# Survival Overview

Marine  
2 Winters



Freshwater  
2 Winters

Hume, Selbie, Pon, Shortreed, Bradford

Chilko: Hinch et al.  
Mission: Whitehouse, Neville, Tadey,  
Patterson

Beamish, Neville, Sweeting

Trudel, Tucker, Welch

Benner, Patterson, Hinch

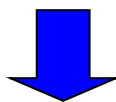
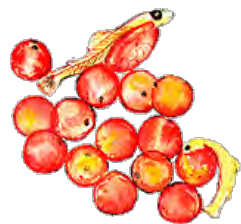


# Chilko Sockeye

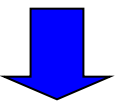
## Fraser Sockeye Indicator Stock



# Chilko Survival



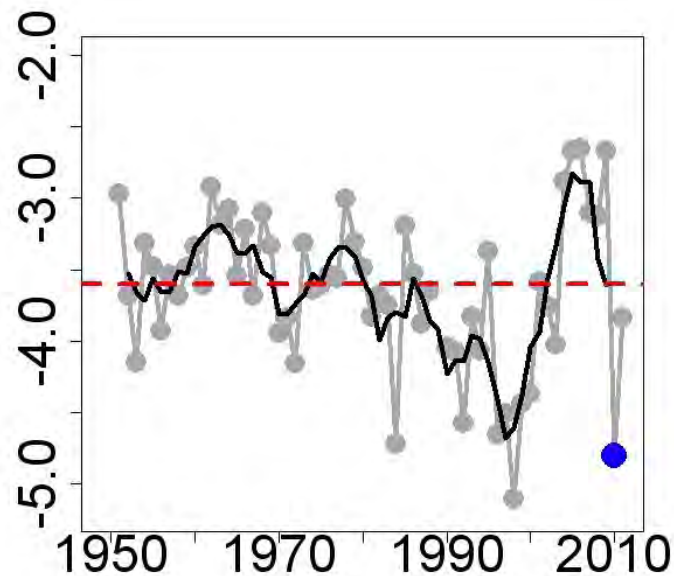
Freshwater



Marine  
includes smolt  
downstream  
migration

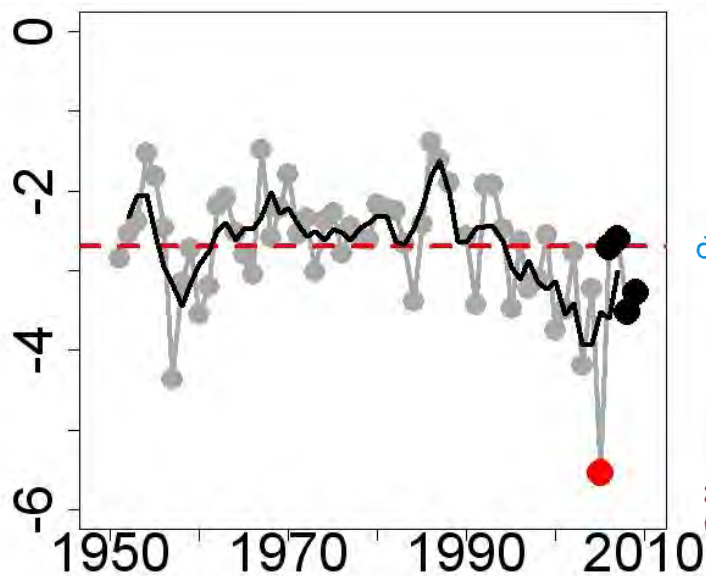


Freshwater Survival ( $\text{Log}_e$ )



In part:  
density-dependent survival

Marine Survival ( $\text{Log}_e$ )



density-independent survival

2007 Ocean Entry  
(2009 Returns)



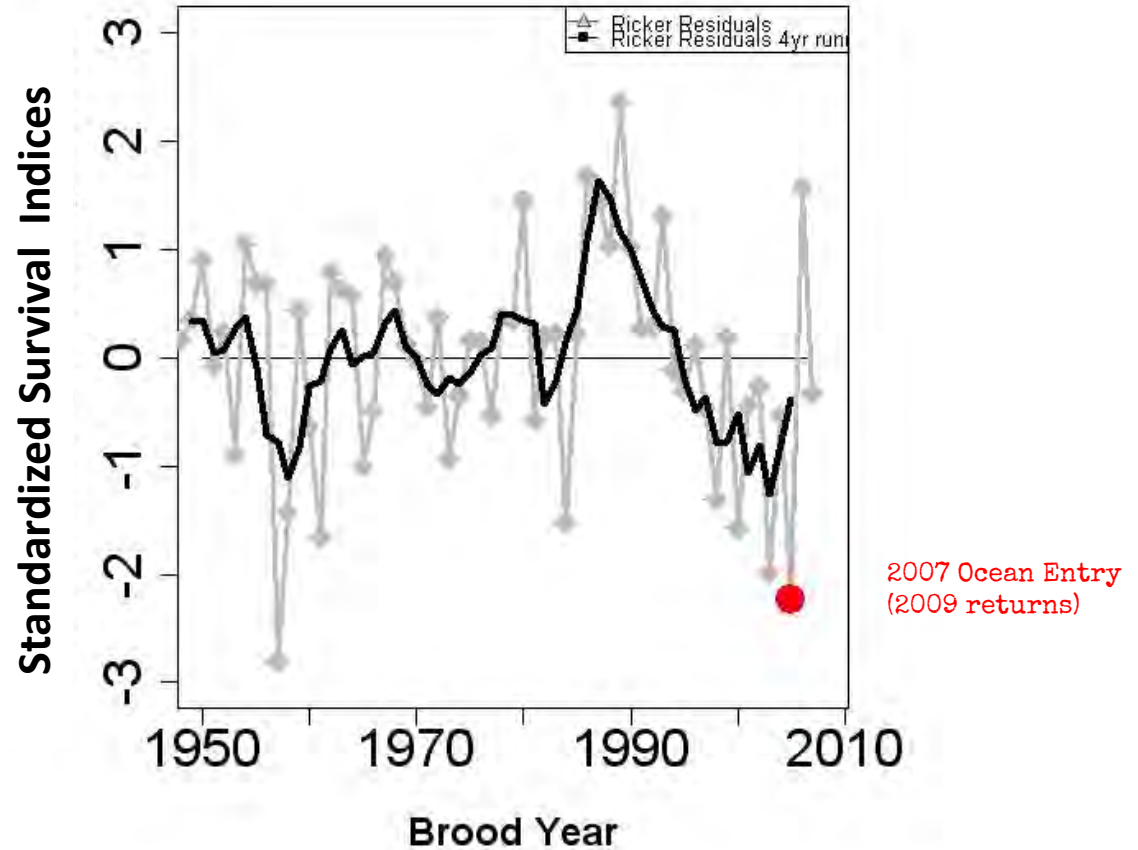
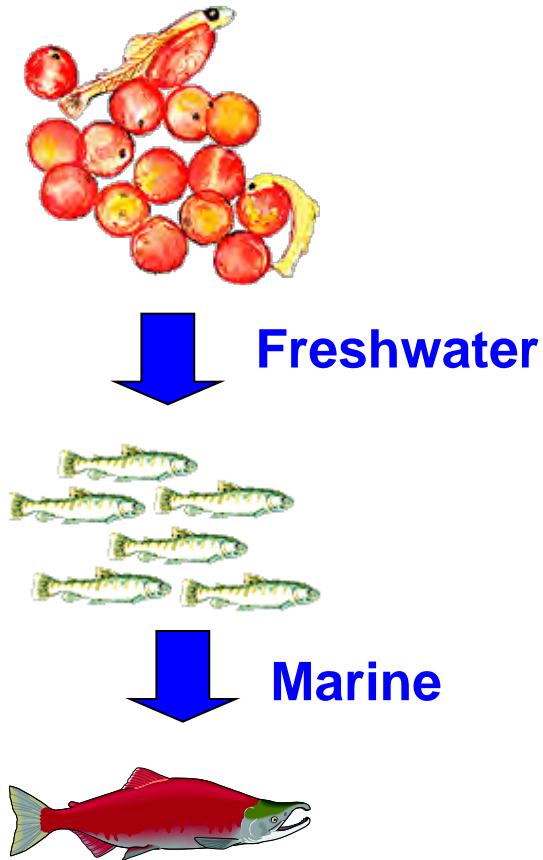
# Total Survival

Freshwater & marine



# Total Survival

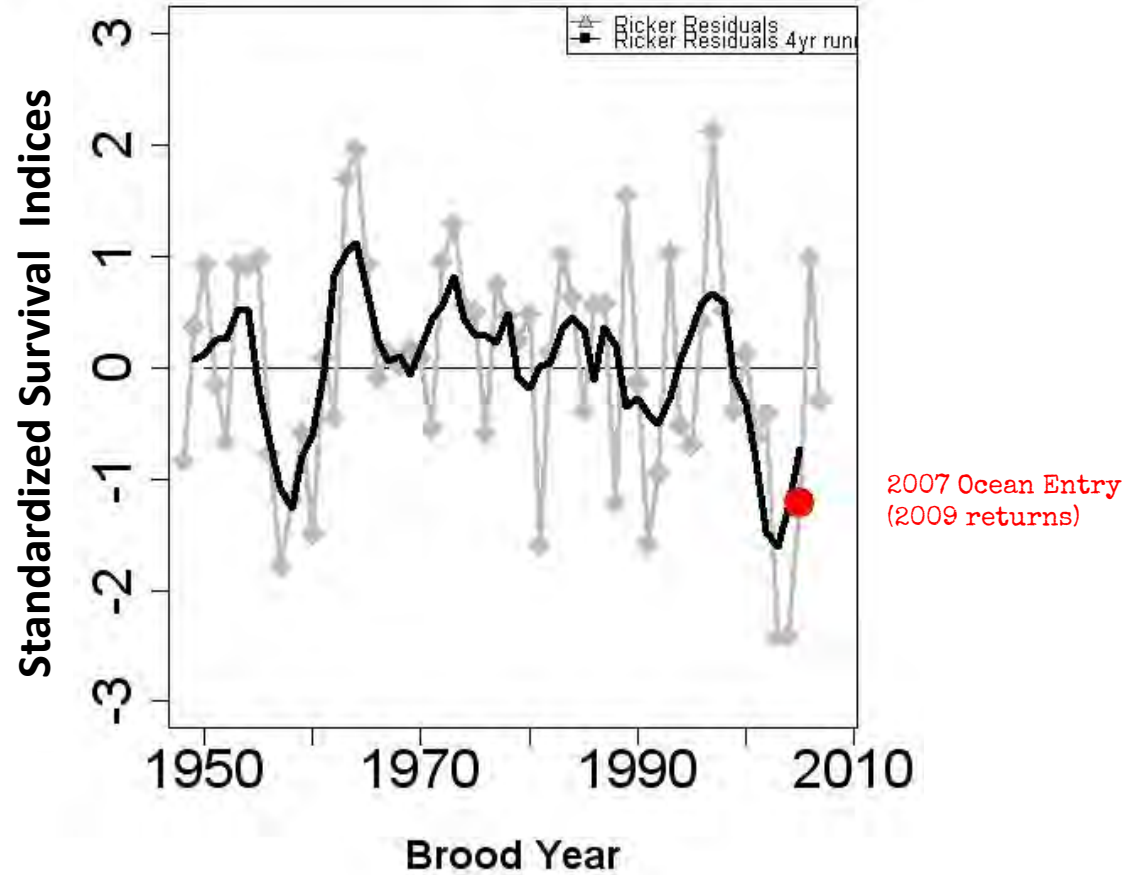
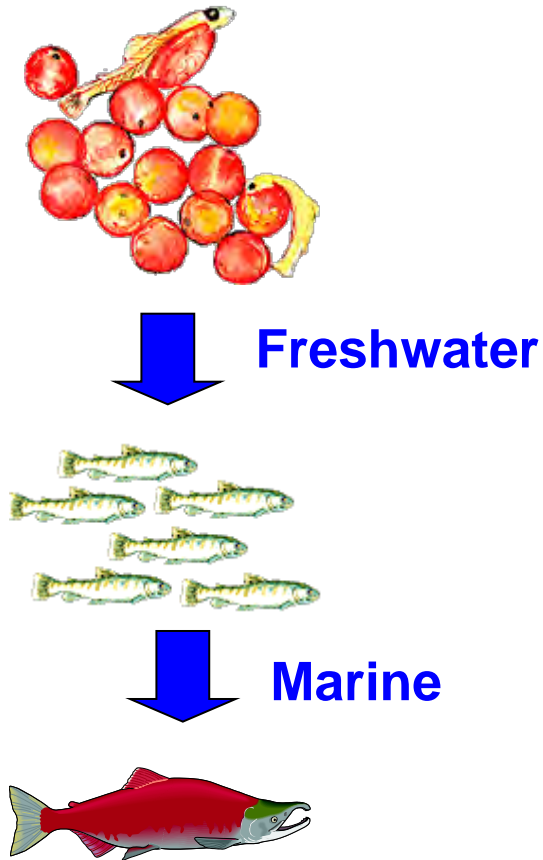
## Chilko





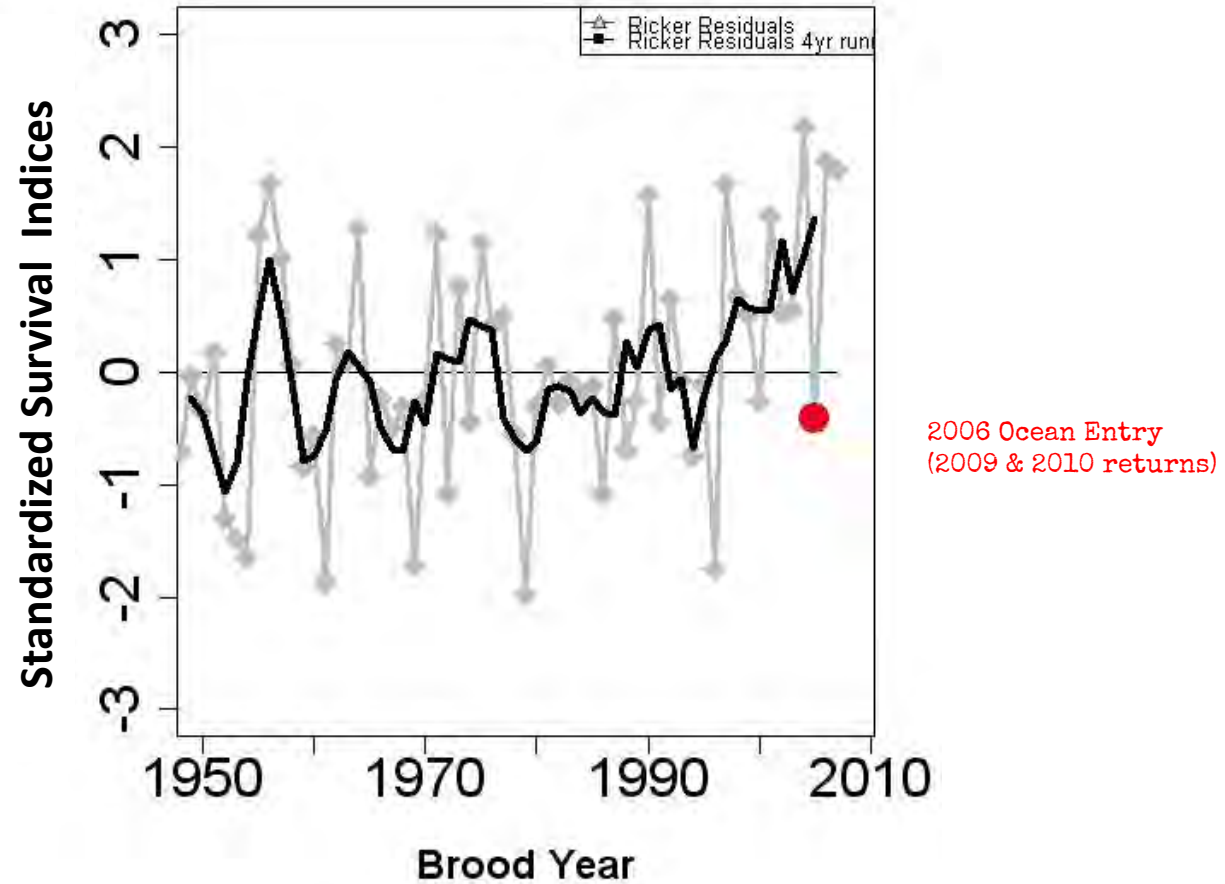
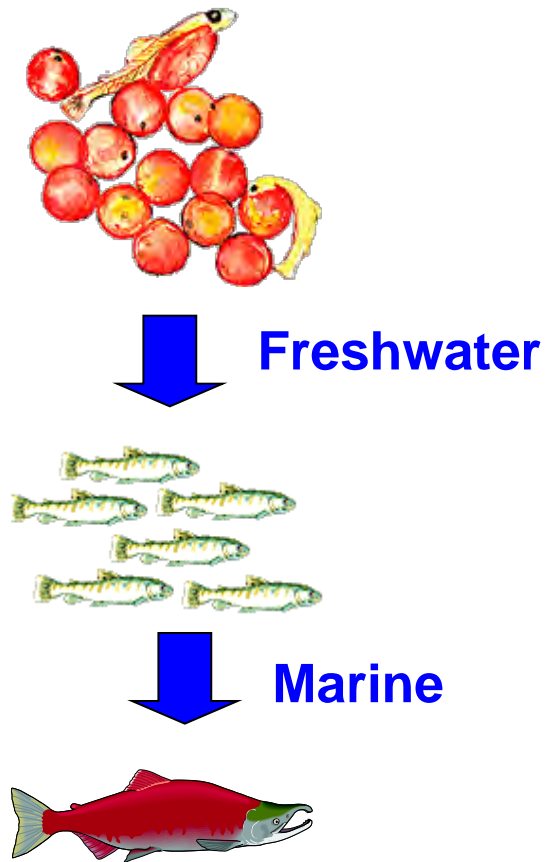
# Total Survival

## Late Shuswap



# Total Survival

## Harrison

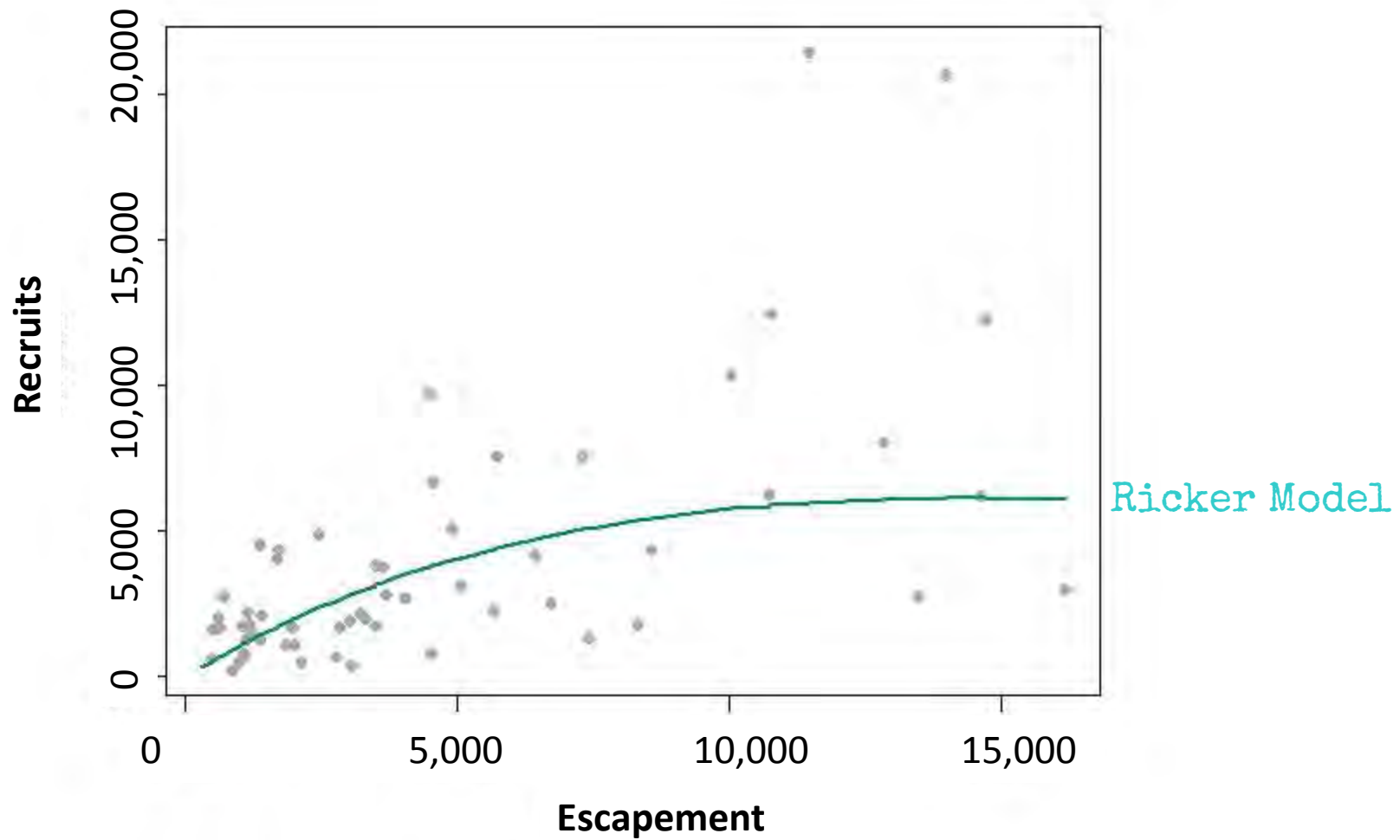




# FORCAST METHODS AND INDICATORS



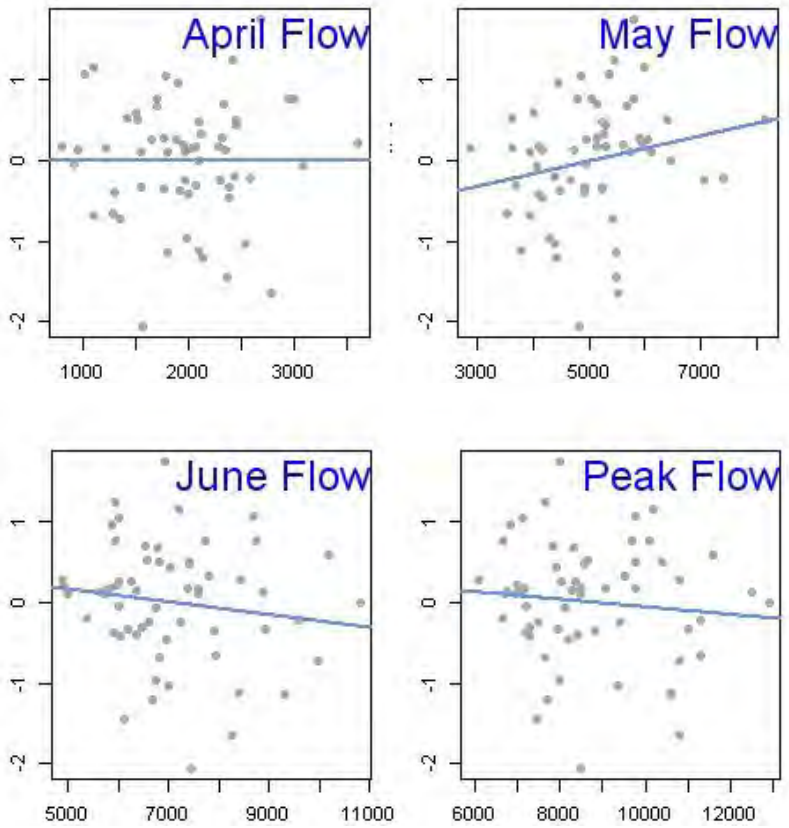
# Forecast: models



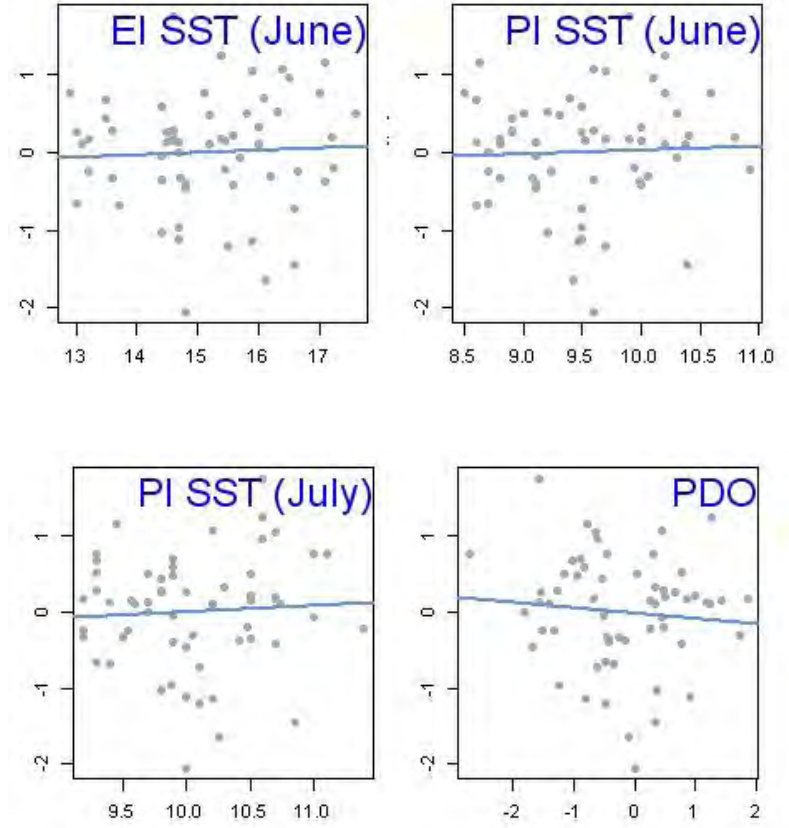


# Forecast: indicators

Chilko Ricker Residuals



Fraser River Flow



Pacific Sea Surface Temperatures



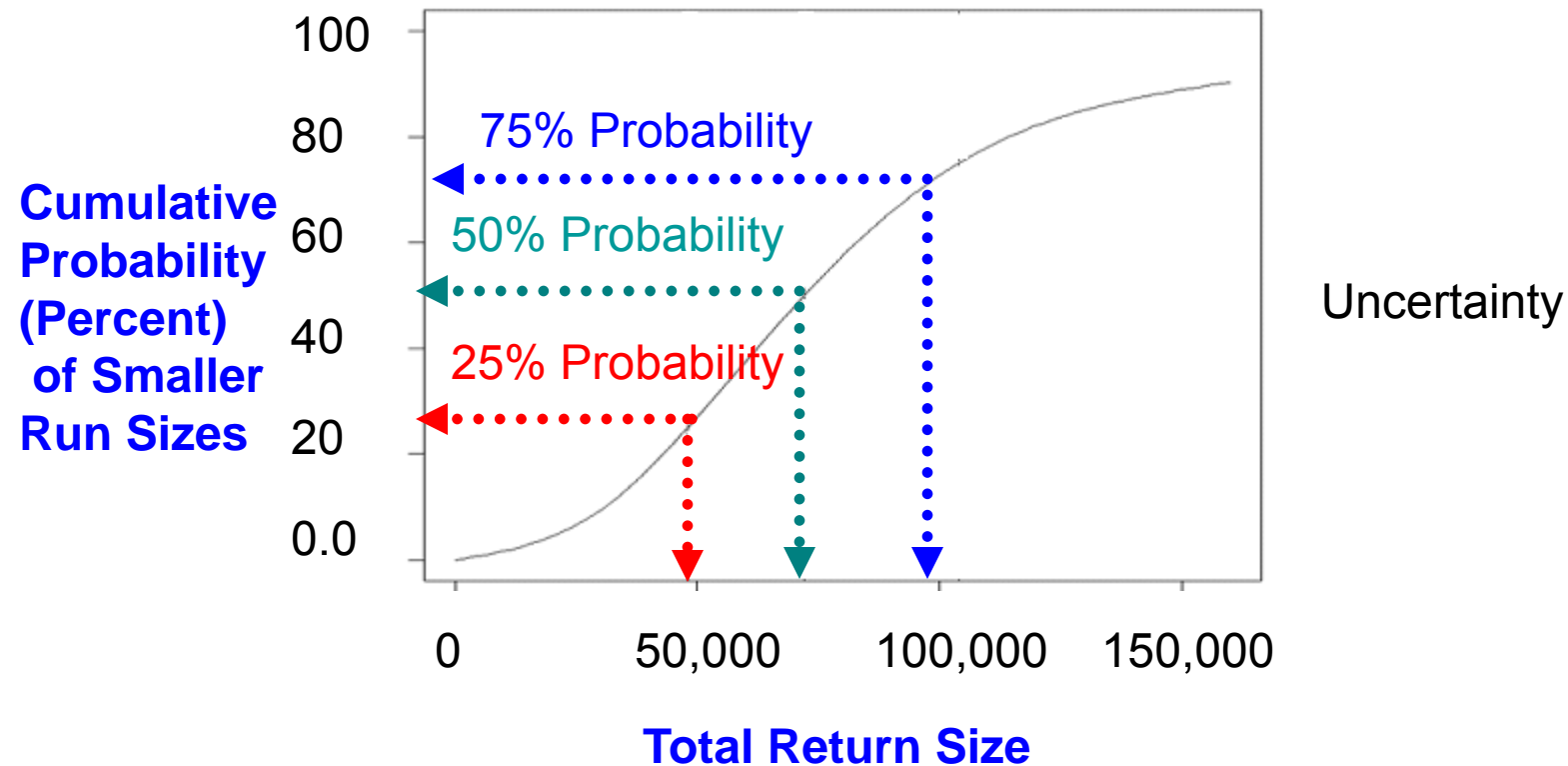
# Forecast Uncertainty

Chilko smolts



# Forecasts: uncertainty

Stock	25%	50%	75%
Hypothetical	48,000	75,000	98,000



Run timing group	Probability that Return will be at/or Below Specified Run Size <sup>a</sup>				
	10%	25%	50%	75%	90%
Stocks					
<b>Early Stuart Run</b>	<b>92,000</b>	<b>137,000</b>	<b>211,000</b>	<b>331,000</b>	<b>507,000</b>
<b>Early Summer Run</b>	<b>73,000</b>	<b>130,000</b>	<b>253,000</b>	<b>468,000</b>	<b>844,000</b>
	<b>55,000</b>	<b>94,000</b>	<b>180,000</b>	<b>342,000</b>	<b>621,000</b>
Bowron	2,000	3,000	7,000	14,000	26,000
Fennell	3,000	5,000	9,000	15,000	25,000
Gates	24,000	37,000	67,000	115,000	191,000
Nadina	10,000	20,000	44,000	95,000	189,000
Pitt	5,000	9,000	15,000	28,000	50,000
Scotch	4,000	8,000	17,000	39,000	82,000
Seymour	7,000	12,000	21,000	36,000	58,000
Misc (EShu & Taseko)	2,000	4,000	13,000	18,000	20,000
Misc (Chilliwack)	15,000	31,000	57,000	103,000	194,000
Misc (Nahatlatch)	1,000	1,000	3,000	5,000	9,000
<b>Summer Run</b>	<b>1,222,000</b>	<b>2,095,000</b>	<b>3,718,000</b>	<b>6,663,000</b>	<b>12,131,000</b>
	<b>1,218,000</b>	<b>2,088,000</b>	<b>3,705,000</b>	<b>6,637,000</b>	<b>12,079,000</b>
Chilko <sup>e</sup>	736,000	1,147,000	1,829,000	2,929,000	4,482,000
Late Stuart	80,000	151,000	333,000	686,000	1,393,000
Quesnel	277,000	596,000	1,218,000	2,445,000	5,188,000
Stellako	91,000	131,000	192,000	291,000	423,000
Raft <sup>g</sup>	22,000	32,000	51,000	81,000	124,000
Harrison <sup>f &amp; g</sup>	12,000	31,000	82,000	205,000	469,000
Misc (N. Thomp. Tribs) <sup>g</sup>	100	300	1,000	1,000	2,000
Misc (N. Thomp River) <sup>g</sup>	4,000	7,000	12,000	25,000	50,000
<b>Late Run</b>	<b>167,000</b>	<b>293,000</b>	<b>583,000</b>	<b>1,133,000</b>	<b>2,126,000</b>
	<b>160,000</b>	<b>280,000</b>	<b>559,000</b>	<b>1,091,000</b>	<b>2,053,000</b>
Cultus <sup>e</sup>	2,000	3,000	7,000	16,000	33,000
Late Shuswap	14,000	36,000	111,000	274,000	574,000
Portage	2,000	5,000	12,000	28,000	61,000
Weaver	42,000	76,000	147,000	281,000	506,000
Birkenhead	100,000	160,000	282,000	492,000	879,000
Misc. non-Shuswap <sup>h</sup>	7,000	13,000	24,000	42,000	73,000
<b>TOTAL SOCKEYE SALMON</b>	<b>1,554,000</b>	<b>2,655,000</b>	<b>4,765,000</b>	<b>8,595,000</b>	<b>15,608,000</b>

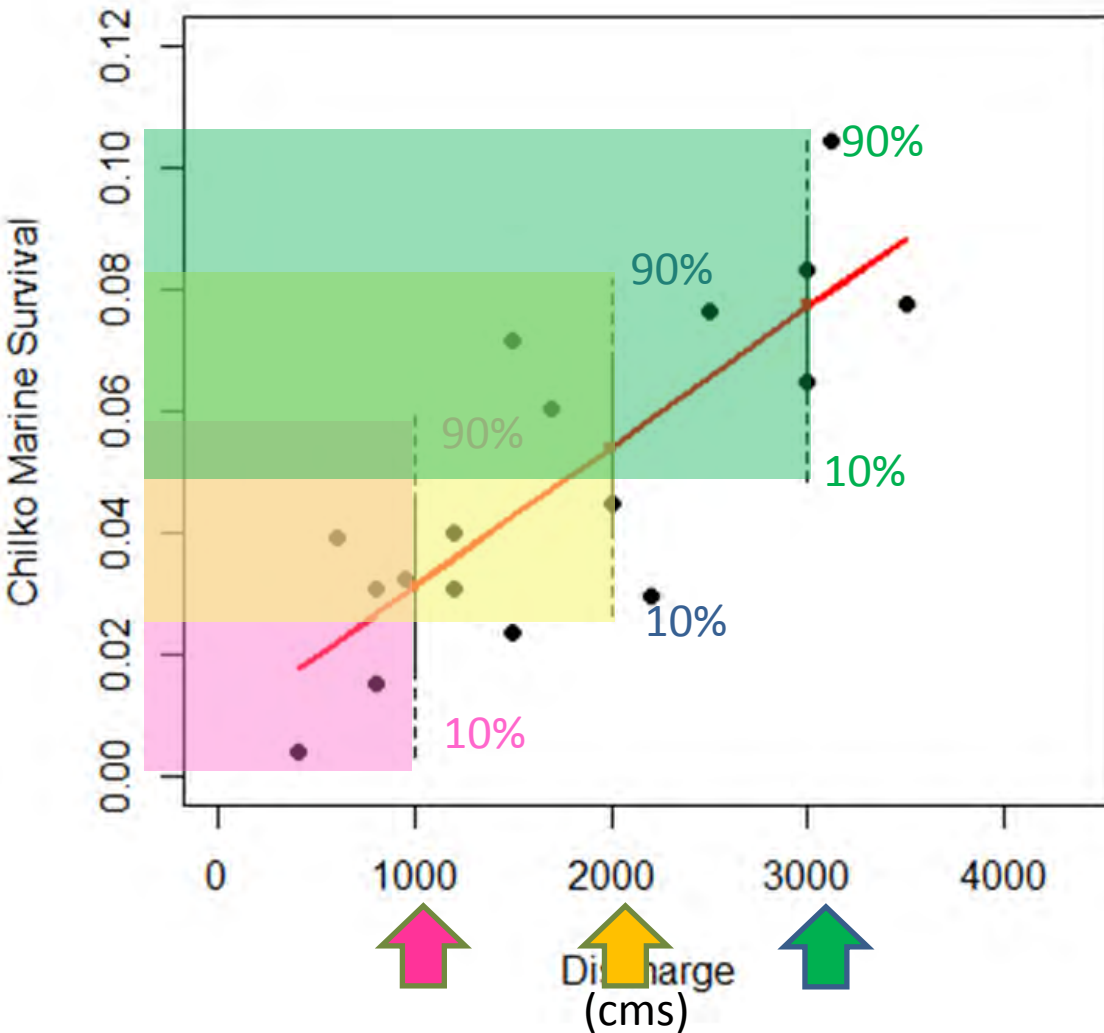
**Pre-Season:**  
 use forecasts  
 distribution  
 to explore escapement  
 plans under different  
 survival conditions  
 for consultation

**In-Season:**  
 use forecast  
 distribution  
 as Bayesian priors for  
 in-season test  
 fisheries on returns

C. Michielsens

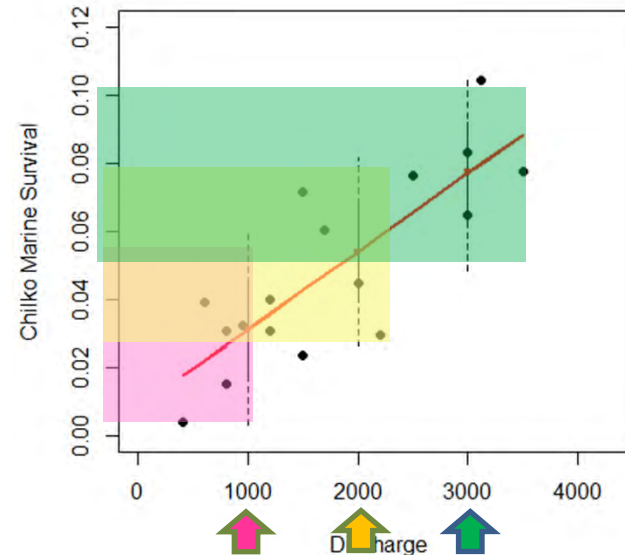


# Indicators: Incorporating Uncertainty



# Forecasts: uncertainty

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<b>Early Stuart</b>	92,000	137,000	211,000	331,000	507,000
<b>Early Summer</b>	73,000	130,000	253,000	468,000	844,000
<i>(total excluding miscellaneous)</i>	55,000	94,000	180,000	342,000	621,000
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1.5 M  
(10% p-level)

15 M  
(90% p-level)



# CONCLUSIONS



DFO Stock Assessment Field Crew Assessing Big Silver Sockeye (Harrison System) in 2013



For some stocks understanding what drives survival is complex;  
i.e. stocks with broad FW & marine distribution



Differences in survival trends between stocks are useful to explore hypotheses  
(useful starting point for indicator exploration)



Indicator exploration should describe uncertainty in relationships  
(Bayesian approaches)



Even indicators that frame out extremes in survival  
could be helpful in traditional stock-recruit forecasts



End



DFO Stock assessment field crew assessing the large Adams River Sockeye Run in 2010 (setting the stage for 2014)