The effects of variations in euphausiid and Pacific hake biomass on the productivity of British Columbian stocks of Pacific herring

Ron Tanasichuk,
Fisheries and Oceans Canada,
Pacific Biological Station,
Nanaimo, B. C. CANADA

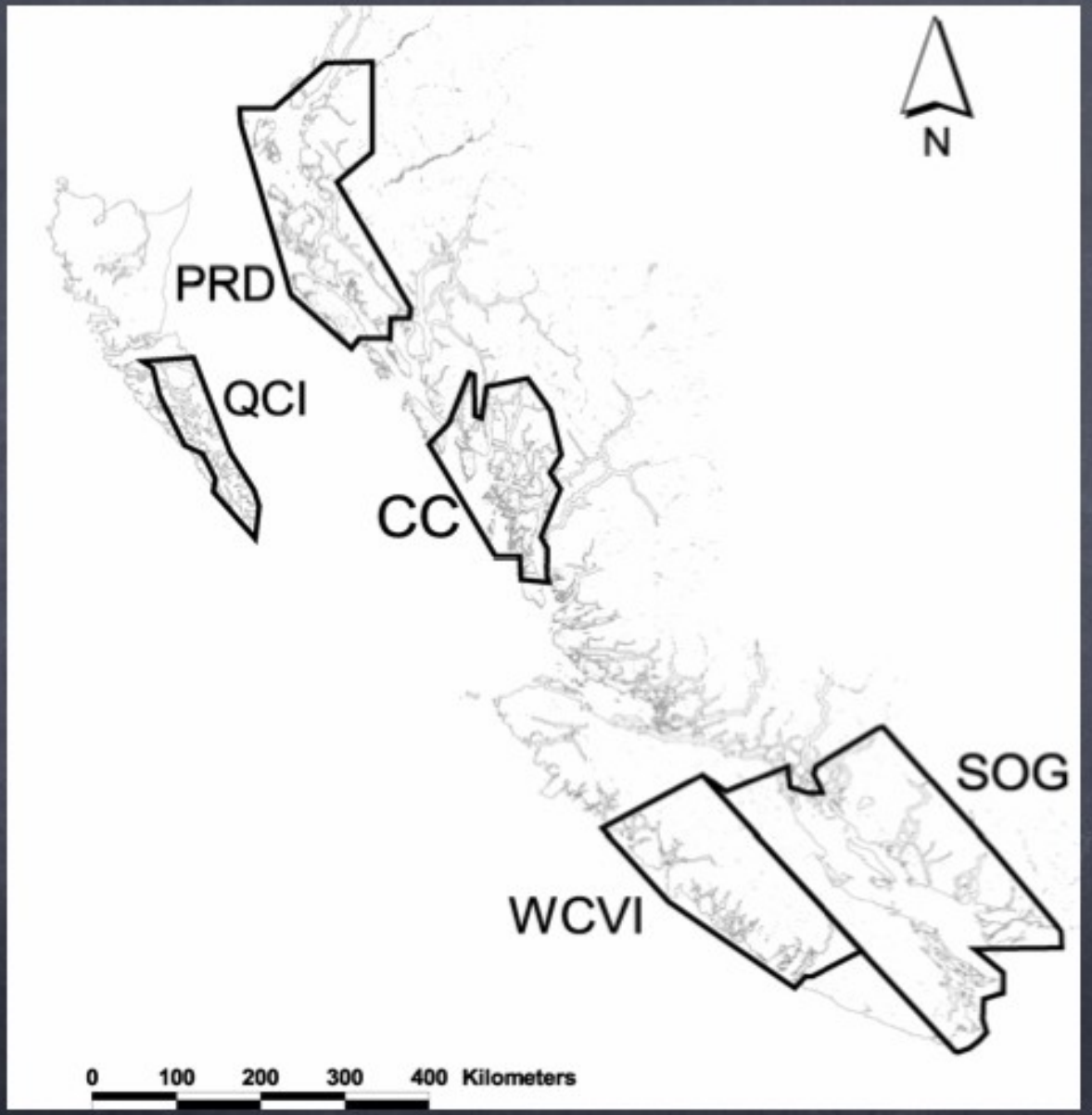
Topics to discuss

1. General overview of B. C. herring biology

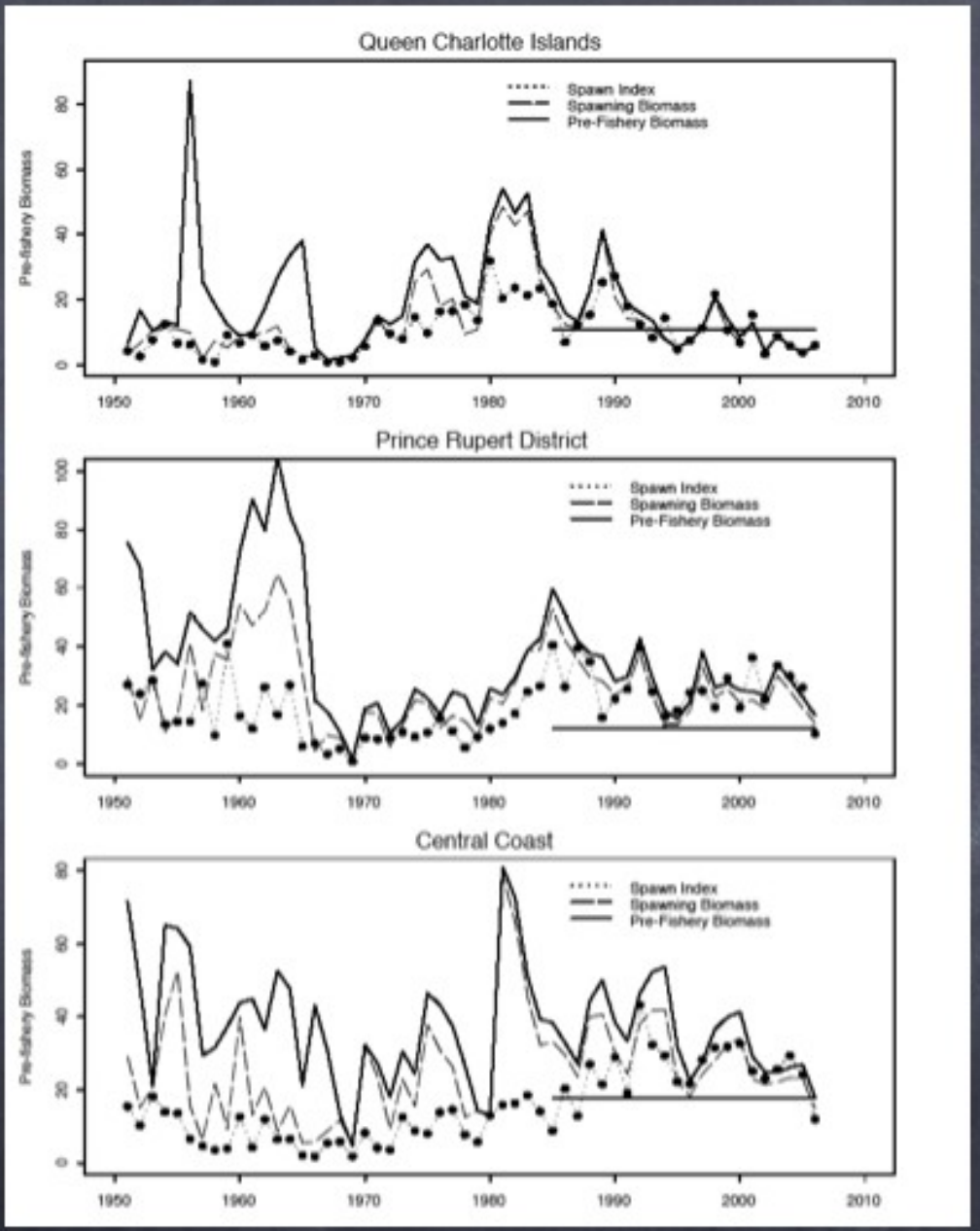
2. Relevant aspects of the biology of herring prey and predators

3. Descriptions of how stock, prey and predators affect herring recruitment, growth and mortality

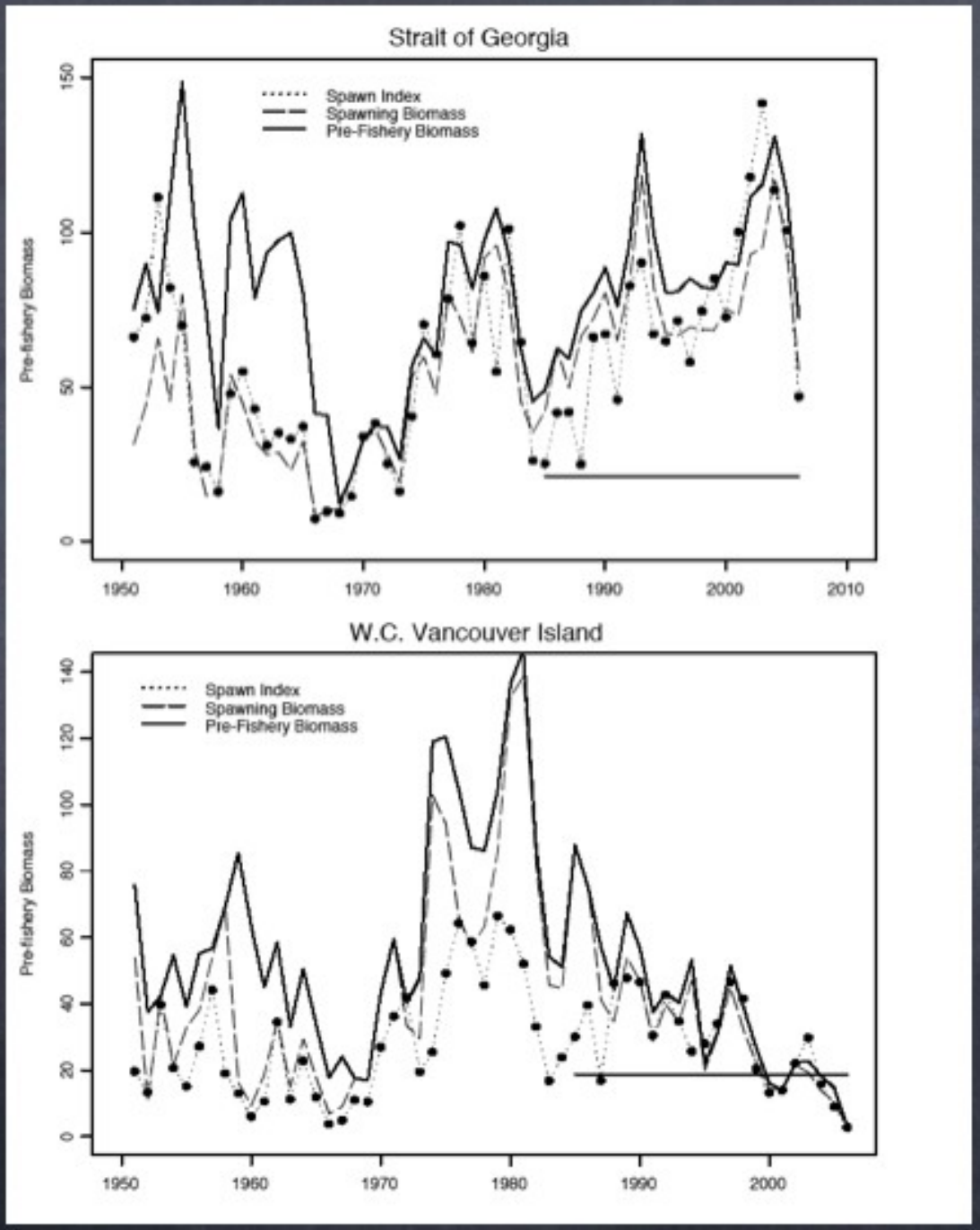
4. A preliminary exploration of the biological basis of variation in WCVI herring egg production; can we explain the current status of herring stocks and is fishing responsible for changes in stock status?



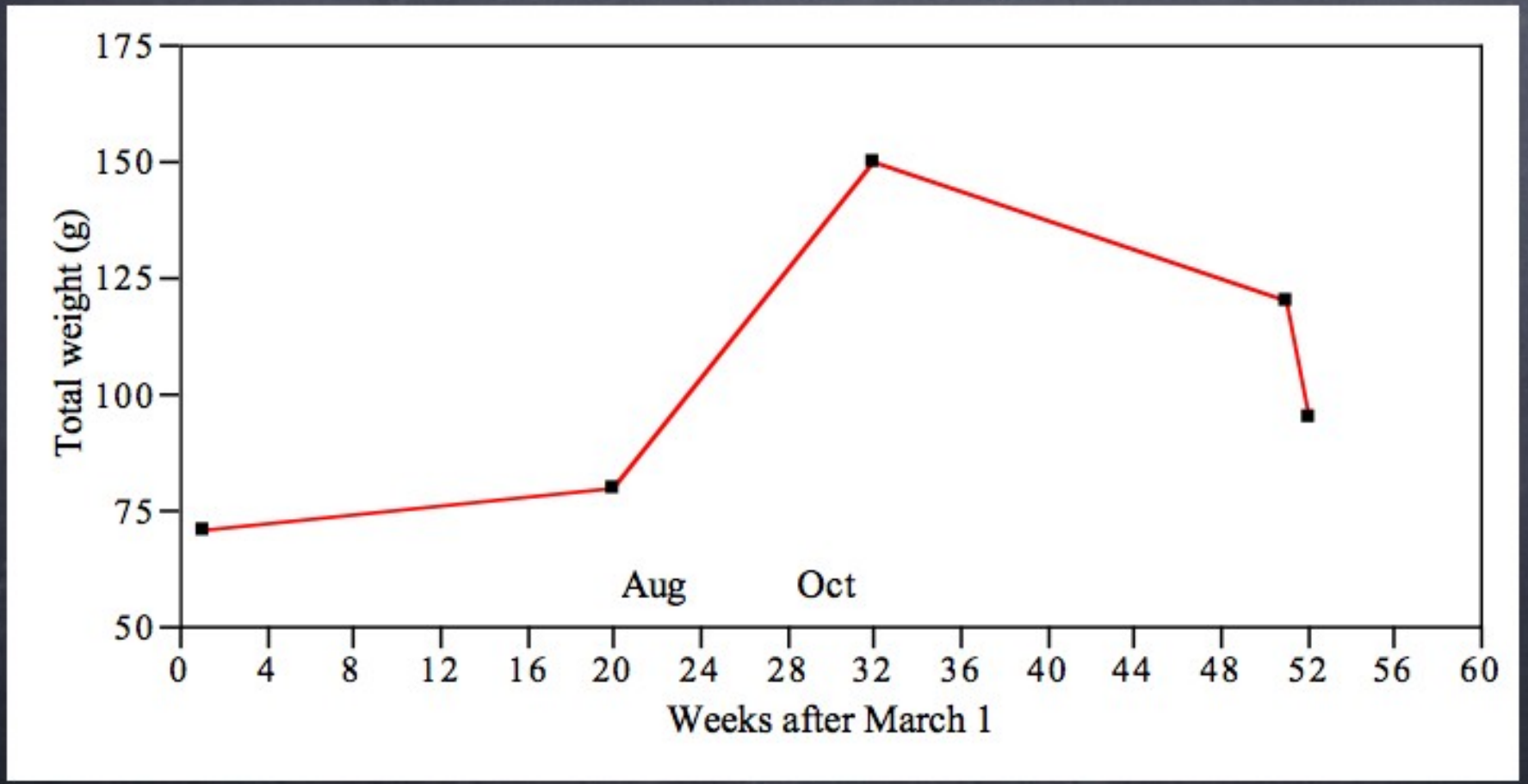
B. C. herring populations



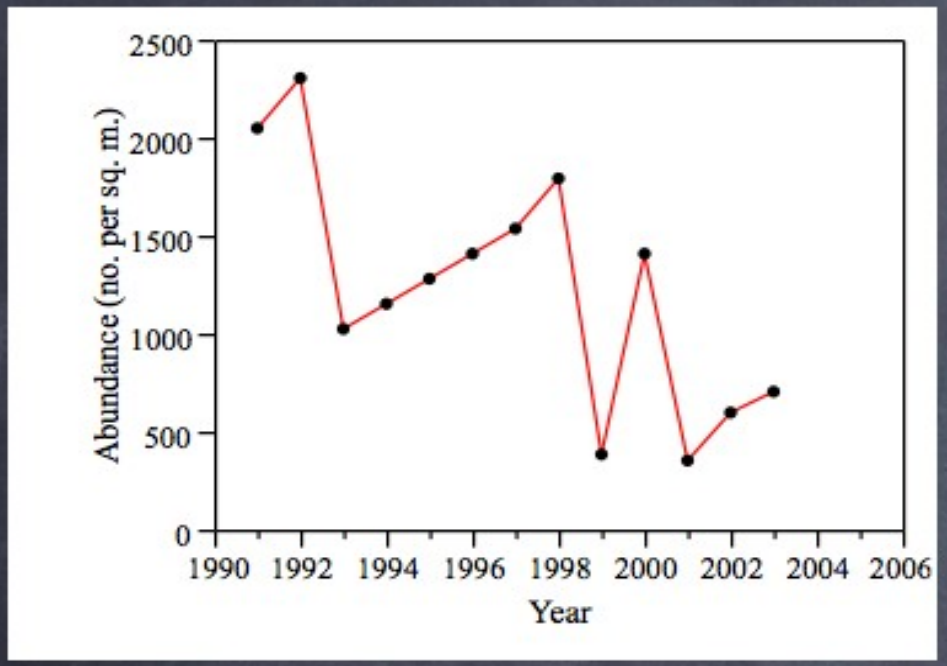
B. C. herring stock status and sampling; n=527,199

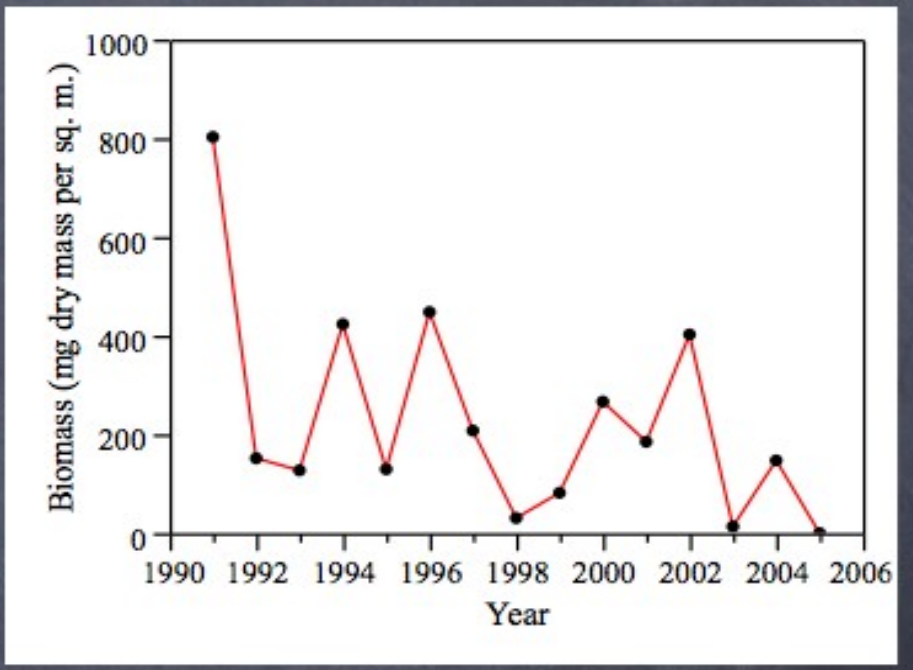

Strait of Georgia
Spawn Index
Spawning Biomass
Pre-Fishery Biomass
Pre-fishery Biomass
0
50
100
150
1950
1960
1970
1980
1990
2000
2010
W.C. Vancouver Island
Spawn Index
Spawning Biomass
Pre-Fishery Biomass
Pre-fishery Biomass
0
20
40
60
80
100
120
140
1950
1960
1970
1980
1990
2000

Apparent season growth trajectory



Prey





Young-of-the-year

Calanus marshallae

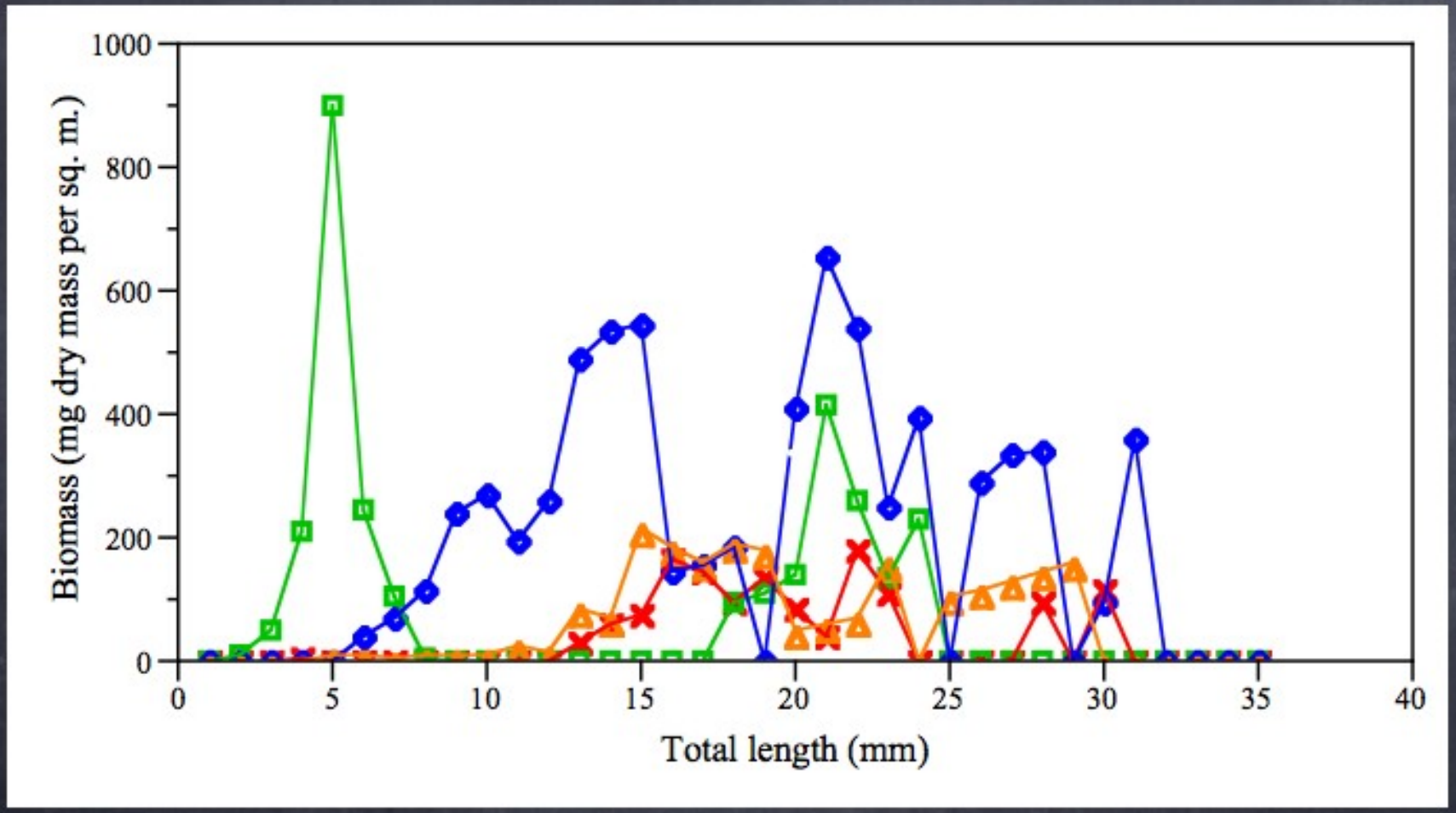
n=88,924

Older fish

Thysanoessa spinifera

n=119,917

Seasonal variation in euphausiid (T. spinifera) biomass



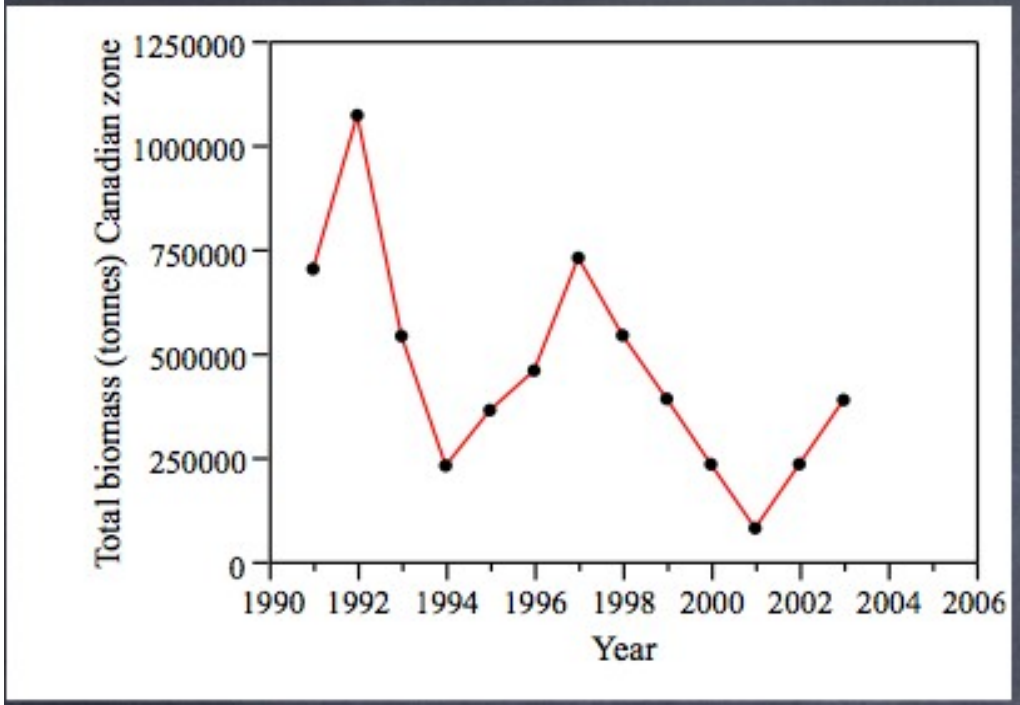
Red - March

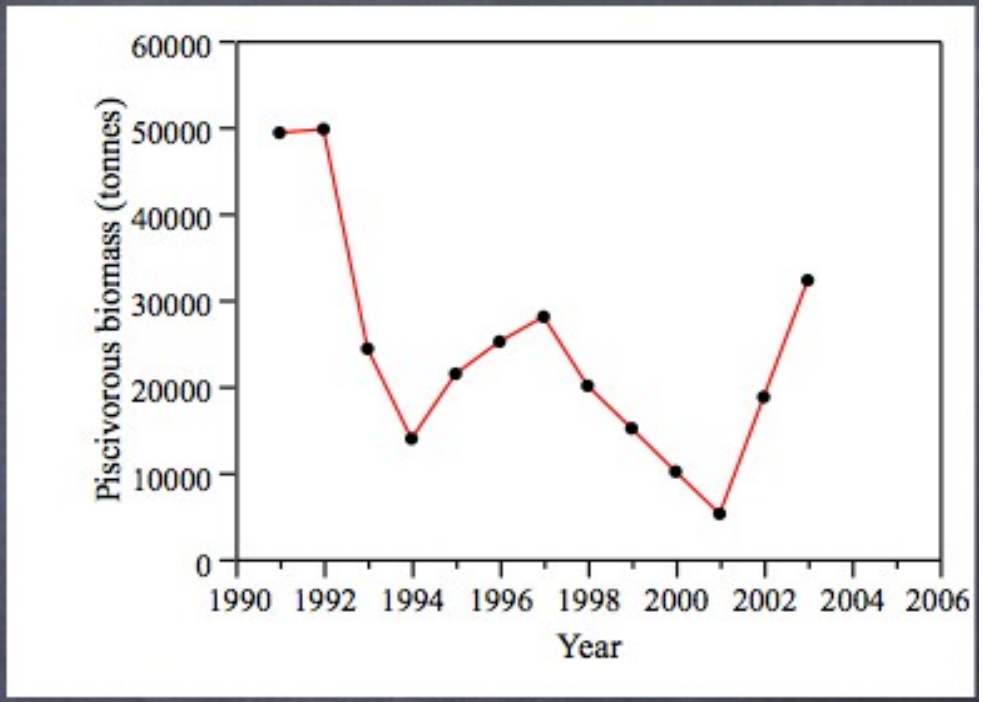
Blue - August

Green - May

Orange - October

Pacific hake





Competitive biomass

Predatory biomass

Hydroacoustic surveys; 1991-98, 2001, 2003

What do we need to know about to understand herring population productivity (=population fecundity) variations?

1. Biological basis of recruitment variability
2. Biological basis for recruit size variability because fecundity is closely related to fish weight
3. Biological basis of adult growth
4. Biological basis of adult mortality variation

Biological basis of recruitment variability

Environmentally-dependent Ricker stock-recruit analysis

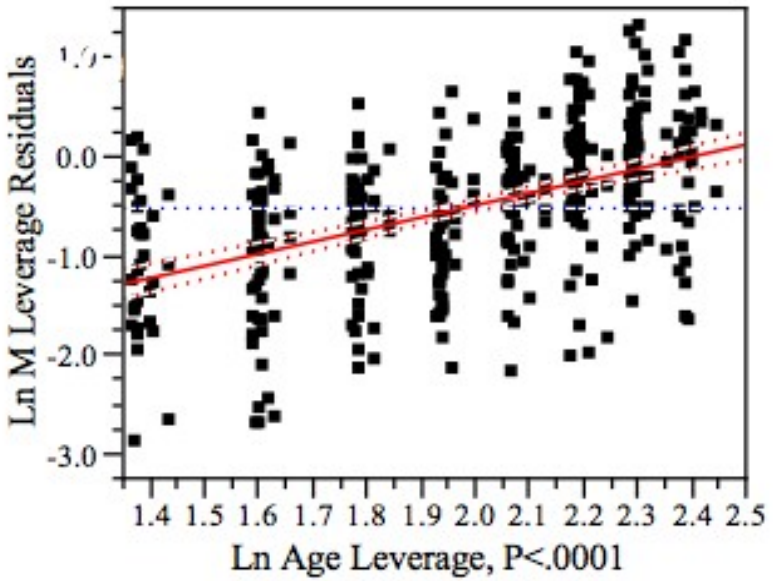
			Proportion variation explained				
Stock	Adj. R-square	Stock fecundity	Hake, year 1	Hake, year 2	T. spinifera, year 3	C. marshallae	Podon
WCVI	0.76		0.61		0.39		
Gulf	0.67	0.56		0.44			
Central	0.49	0.52			0.48		
PRD	0.82	0.33		0.42		0.24	
QCI	0.63	0.60					0.40

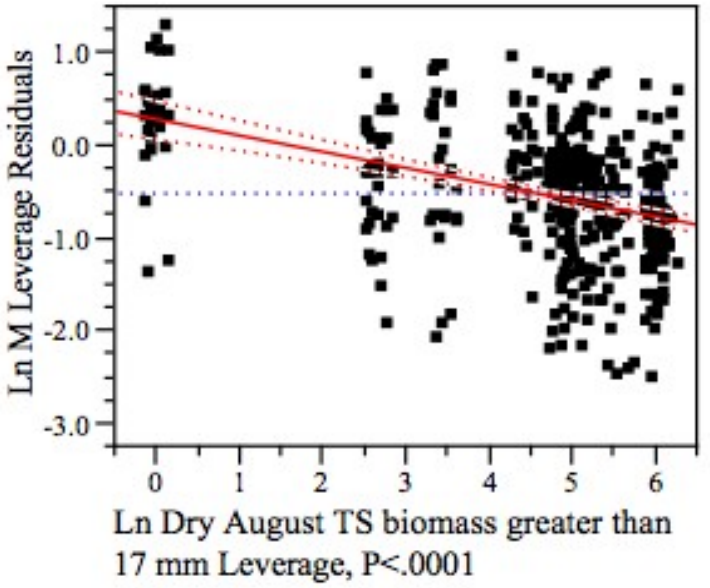
Hake effect is competitive biomass

Biological basis of recruit size variability

Stock	Adj. R-square	Proportion variation explained		
		C. marshallae	Oct. salinity	Calanus sp.
WCVI	0.49	0.65	0.35	
Central	0.47	1.00		
PRD	0.85			1.00
QCI	0.55	1.00		

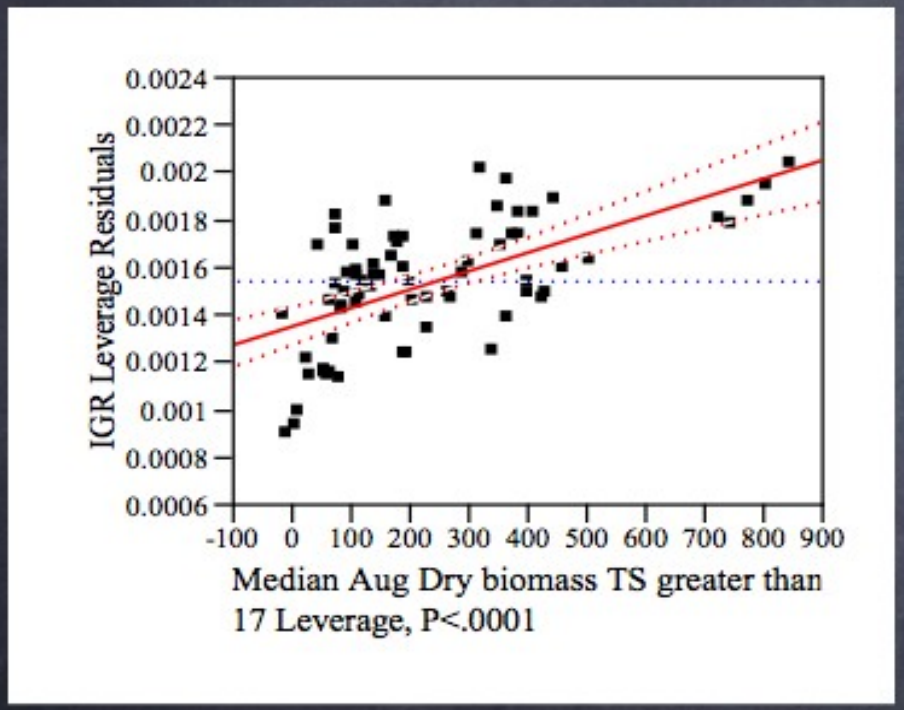
Biological basis of adult natural mortality rate variability for BC herring, excluding QCI

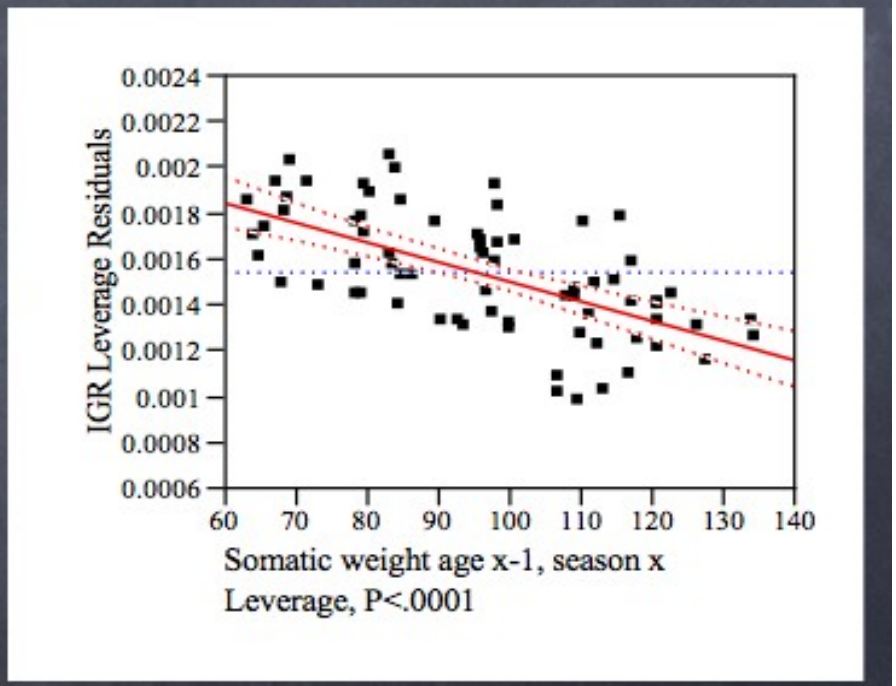




Adjusted R-square=0.31; exceptionally low T. spinifera biomass in 2005 caused high adult natural mortalities

Biological basis of WCVI adult IGR variability

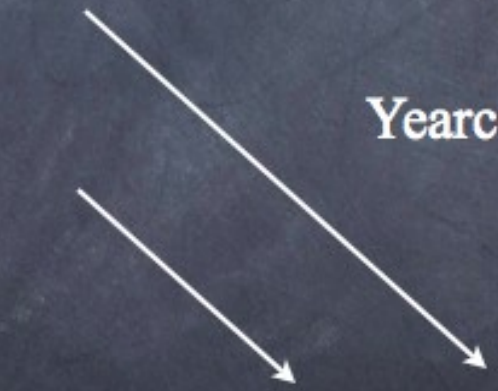




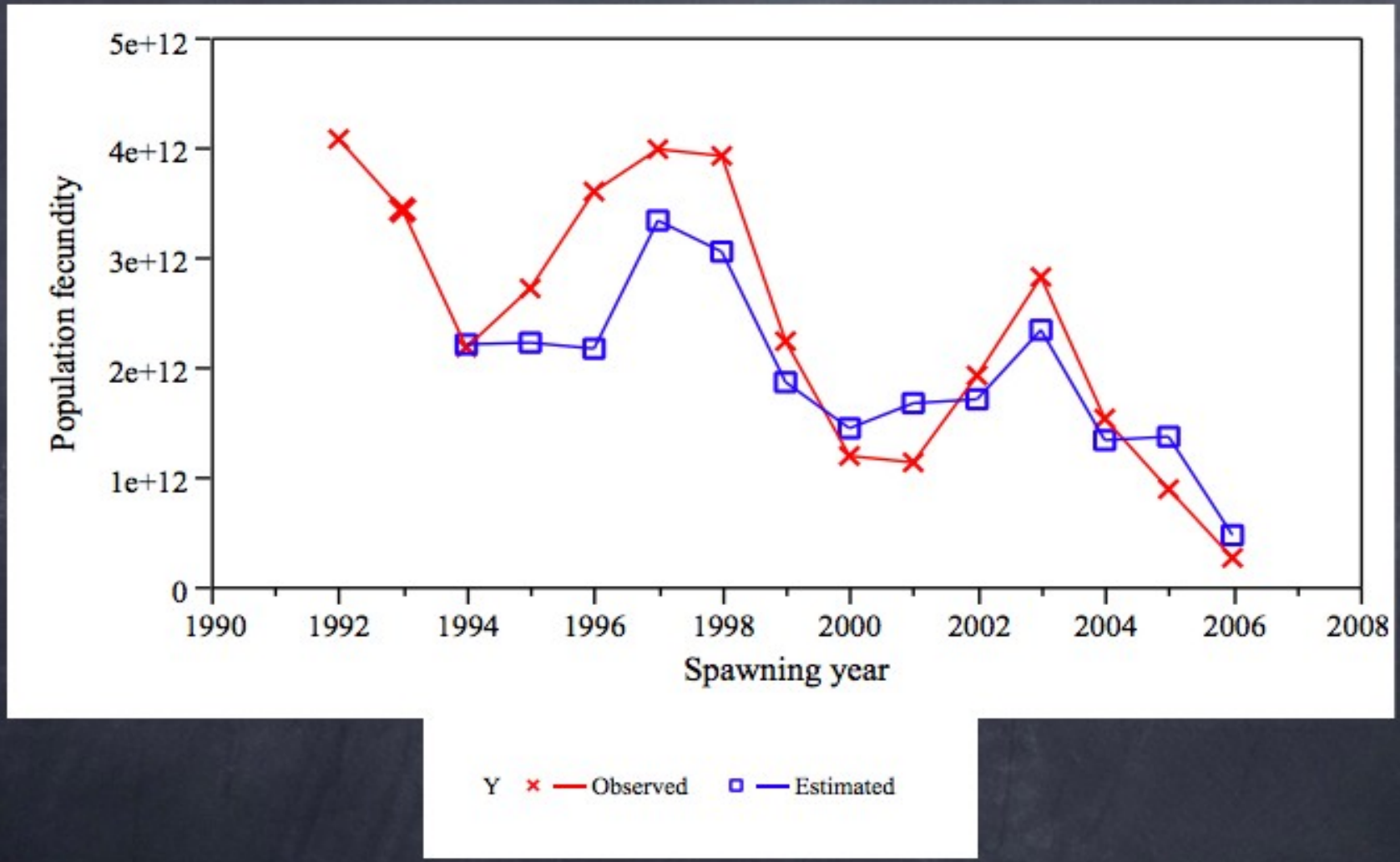
Adj. R-square=0.48

Schematic of herring productivity spreadsheet

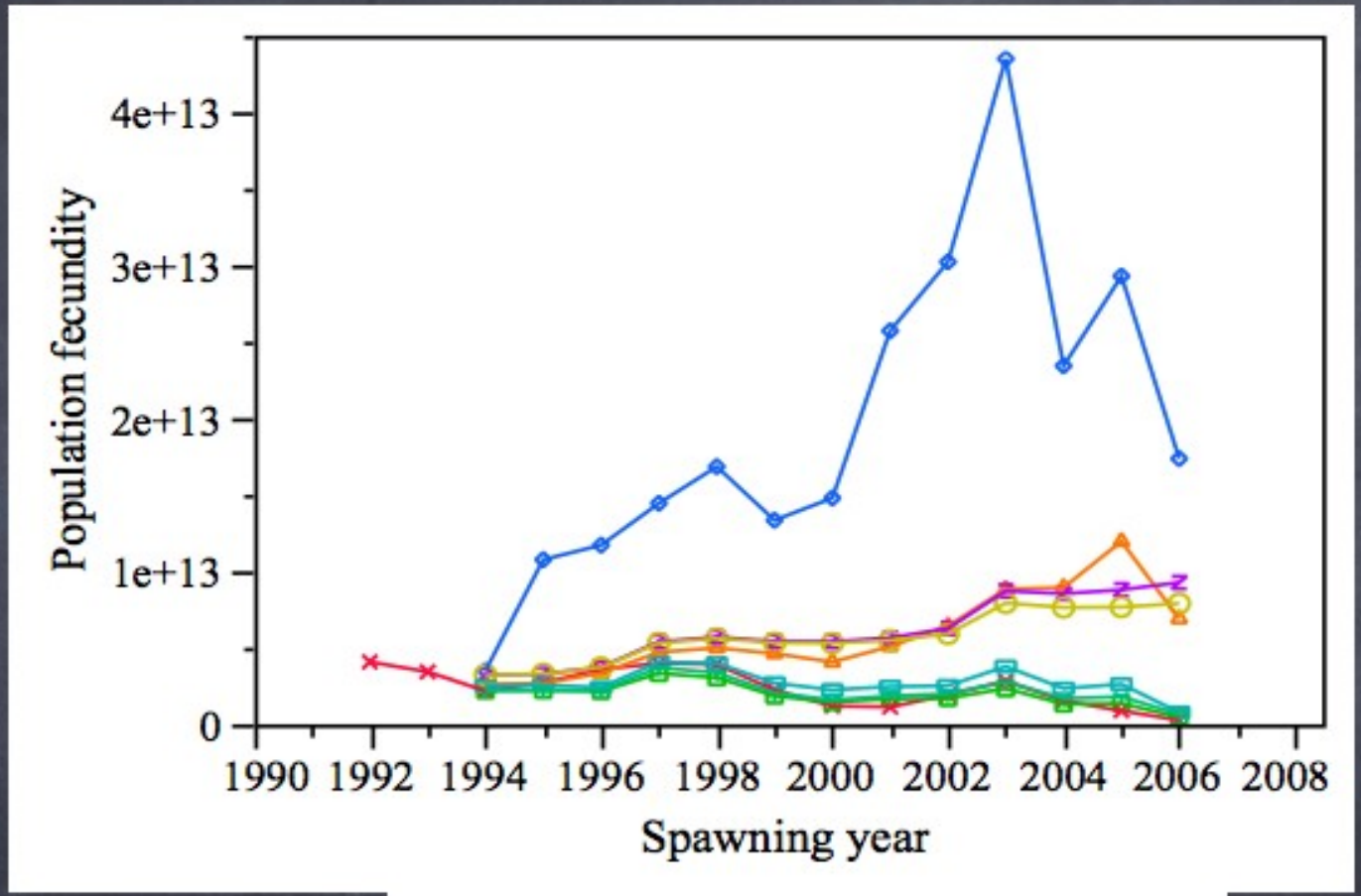
		Age			
Effect	Year	1	2	3	Sum
X,Y	1				
X,Y	2				
X,Y	3				



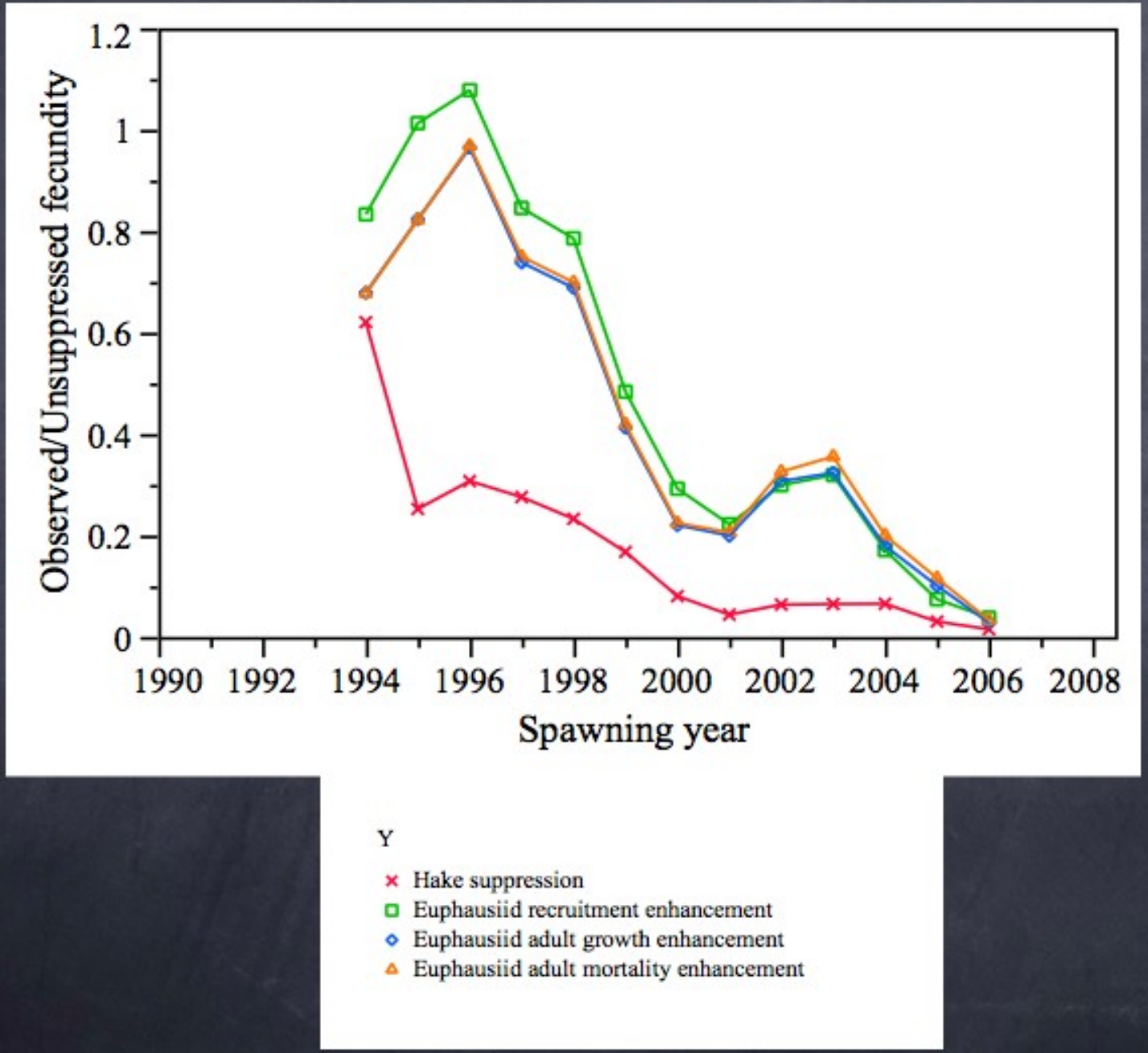
Comparison of observed and estimated population fecundity; p=0.20



Summary of "What if" scenarios



Population fecundity suppression



Summary and Conclusions

1. Relationships have been developed which describe the biological basis for variations in BC herring recruitment, recruit size, adult age-specific natural mortality, and adult growth rates

2. Recruitment variability is a consequence of different effects among stocks

3. Recruit size variability is a consequence of calanoid copepod abundance variations during the first year of life

4. Adult age-specific natural mortality rates for most stocks increase with age and low *T. spinifera* biomass in August

Summary and Conclusions

5. Instantaneous growth rates of adult WCVI herring vary as a consequence of initial size and *T. spinifera* biomass in August

6. Results of a series of "What-if" scenarios suggest that a 100-fold reduction in egg production would result from either an effect of hake on recruitment, or an effect of euphausiids on recruitment or adult growth and survival; there was no detectable effect of the commercial fishery

7. There appears to be no opportunity to affect how ecosystems influence BC herring productivity; results of this study provide an understanding and predictive capability