Shifts in trends in the dominance of Pacific salmon in the Strait of Georgia are related to life history strategies, regimes and climate warming.

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Vancouver Island
Fraser River
British Columbia
Strait of Georgia
Strait of Juan de Fuca

Fisheries Contributions to BC

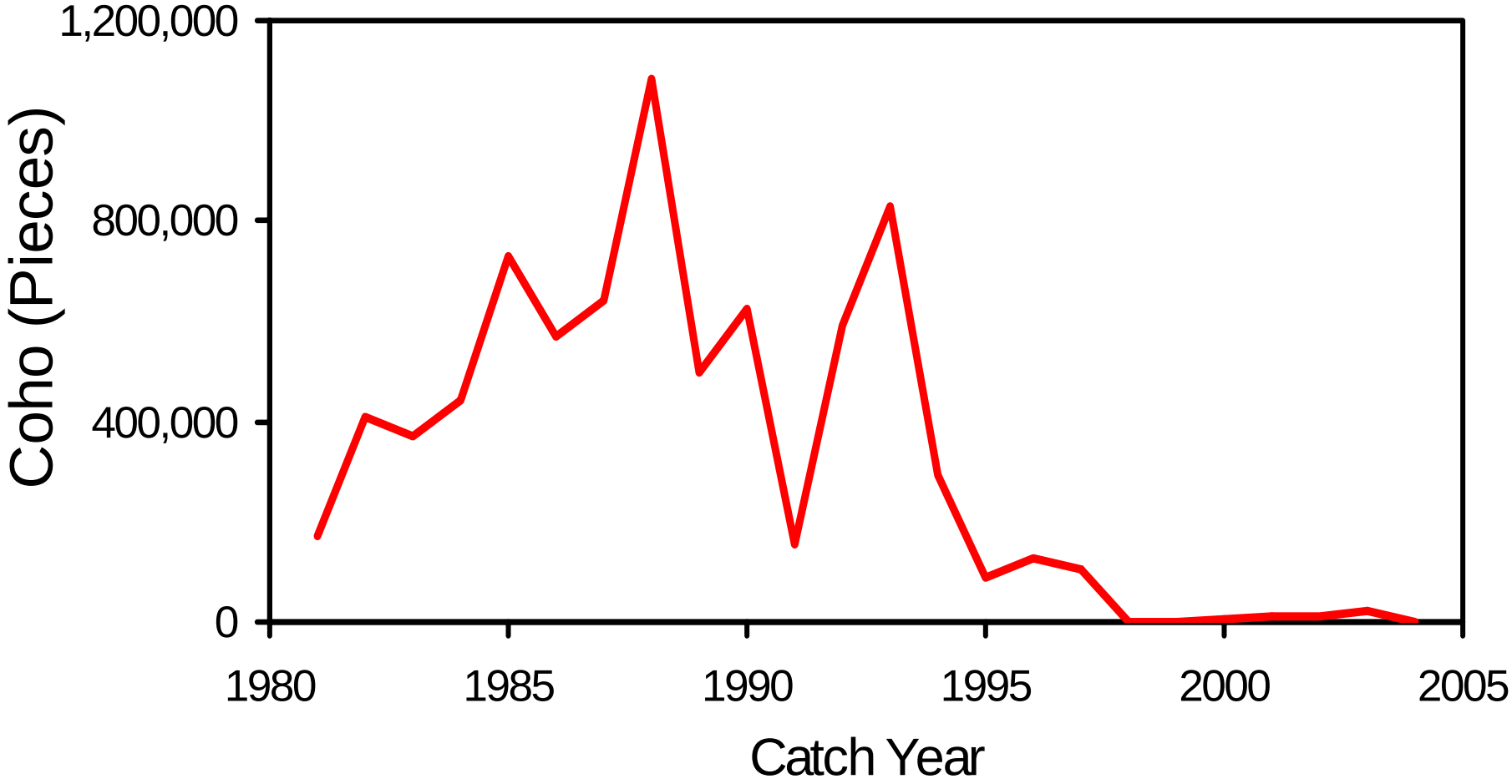
2002 -$1.6 BILLION

Sports fisheries	$675M
Capture fisheries	$358M
Processing	$602M

2002 ~ 18,000 jobs

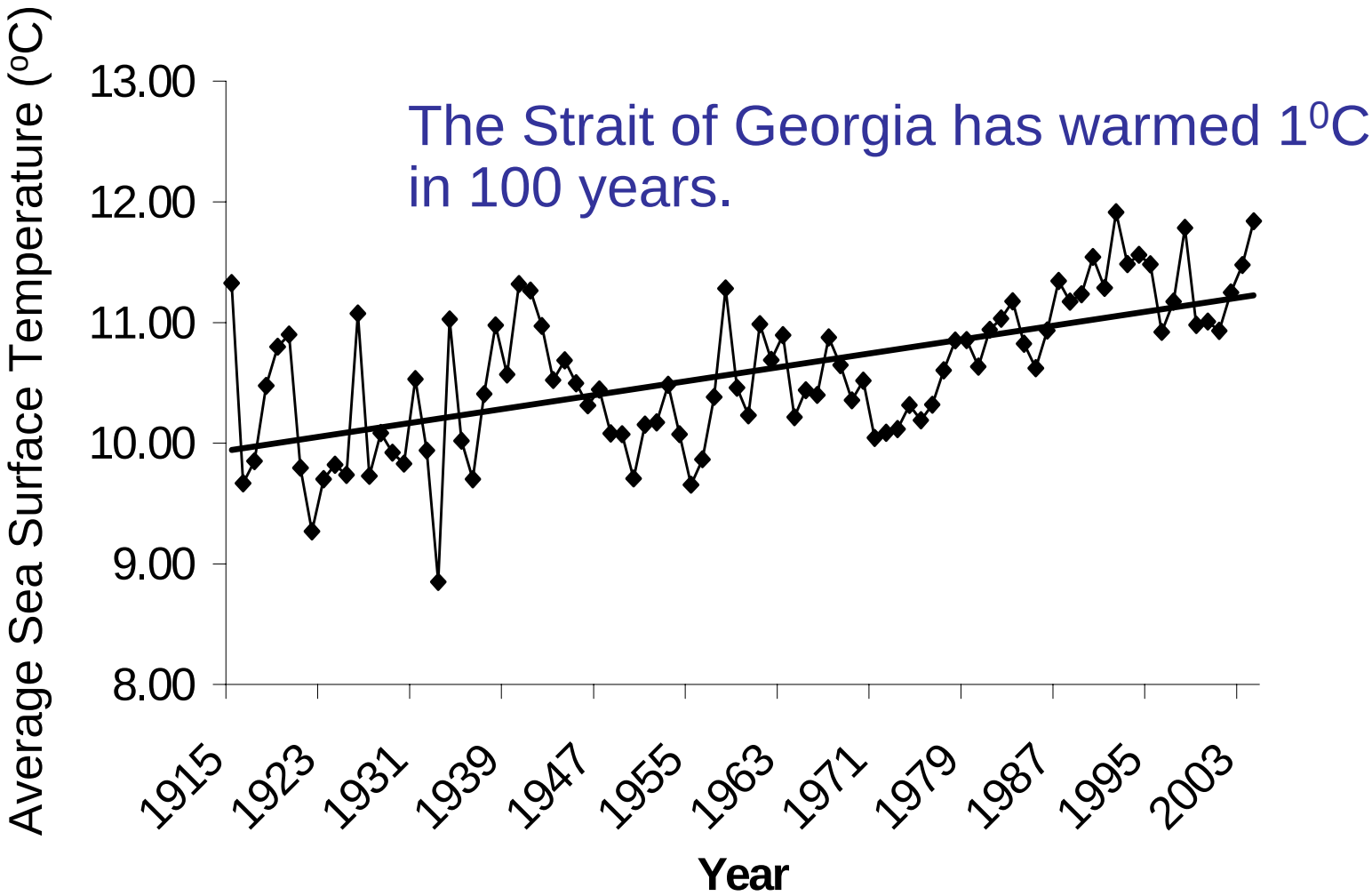
Sports fisheries	8,900
Capture fisheries	5,400
Processing	3,900

Strait of Georgia sport catch for coho



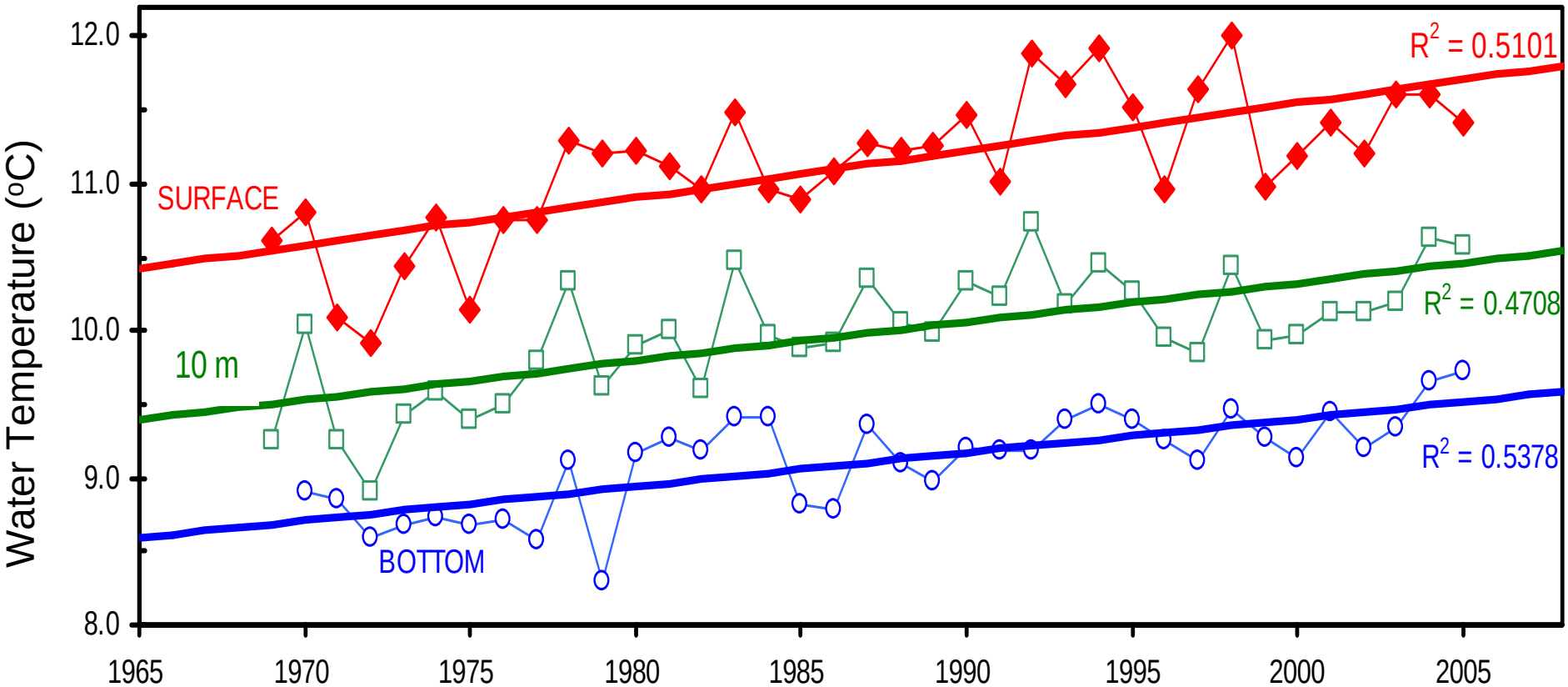
Source: DFO Pacific Regional Data Unit

Strait of Georgia



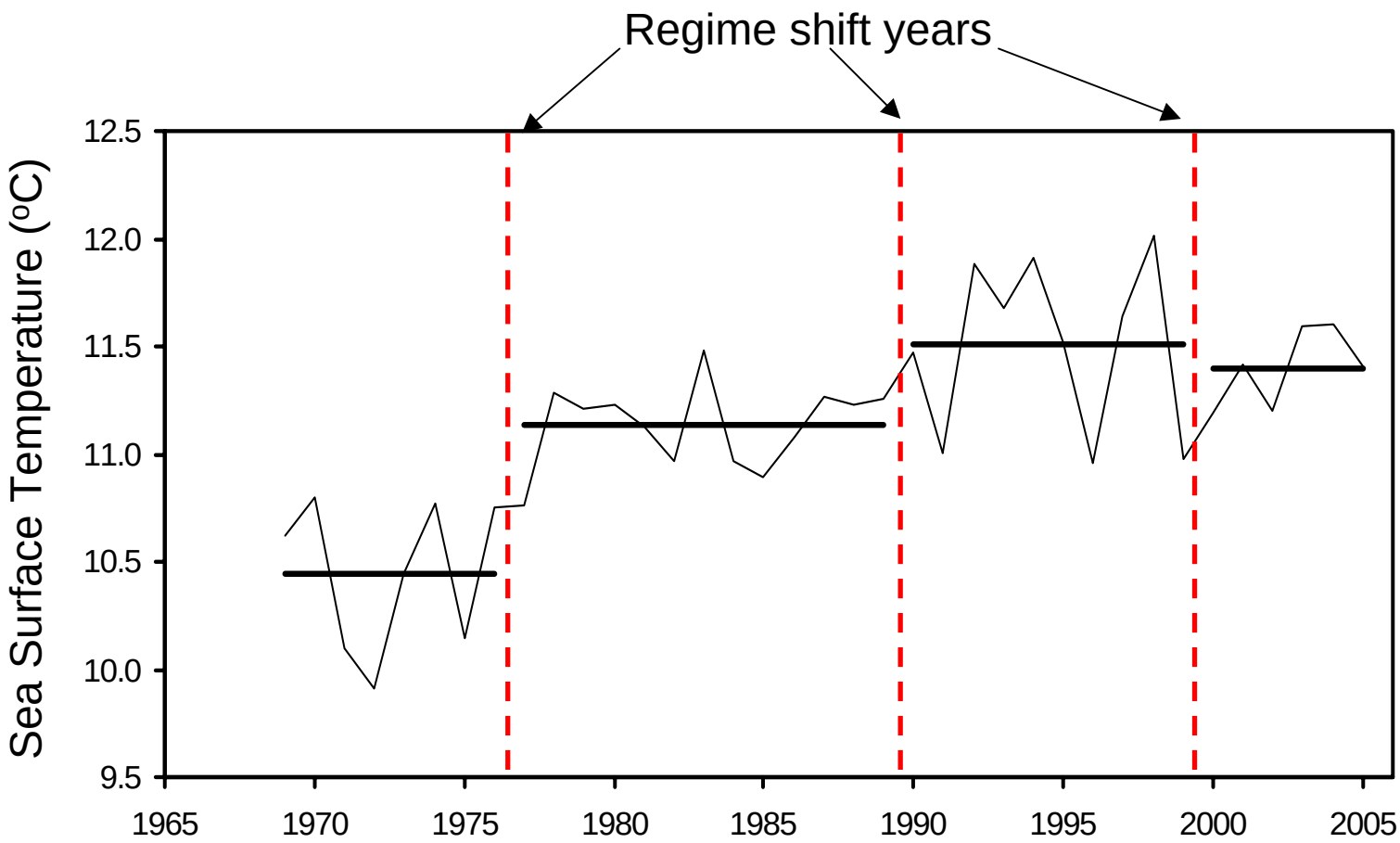
Beamish et al. 2006

Average Annual Water Temperatures at Nanoose.



Beamish et al. 2006

Average Annual Sea Surface Temperatures at Nanoose.



Estuarine Circulation

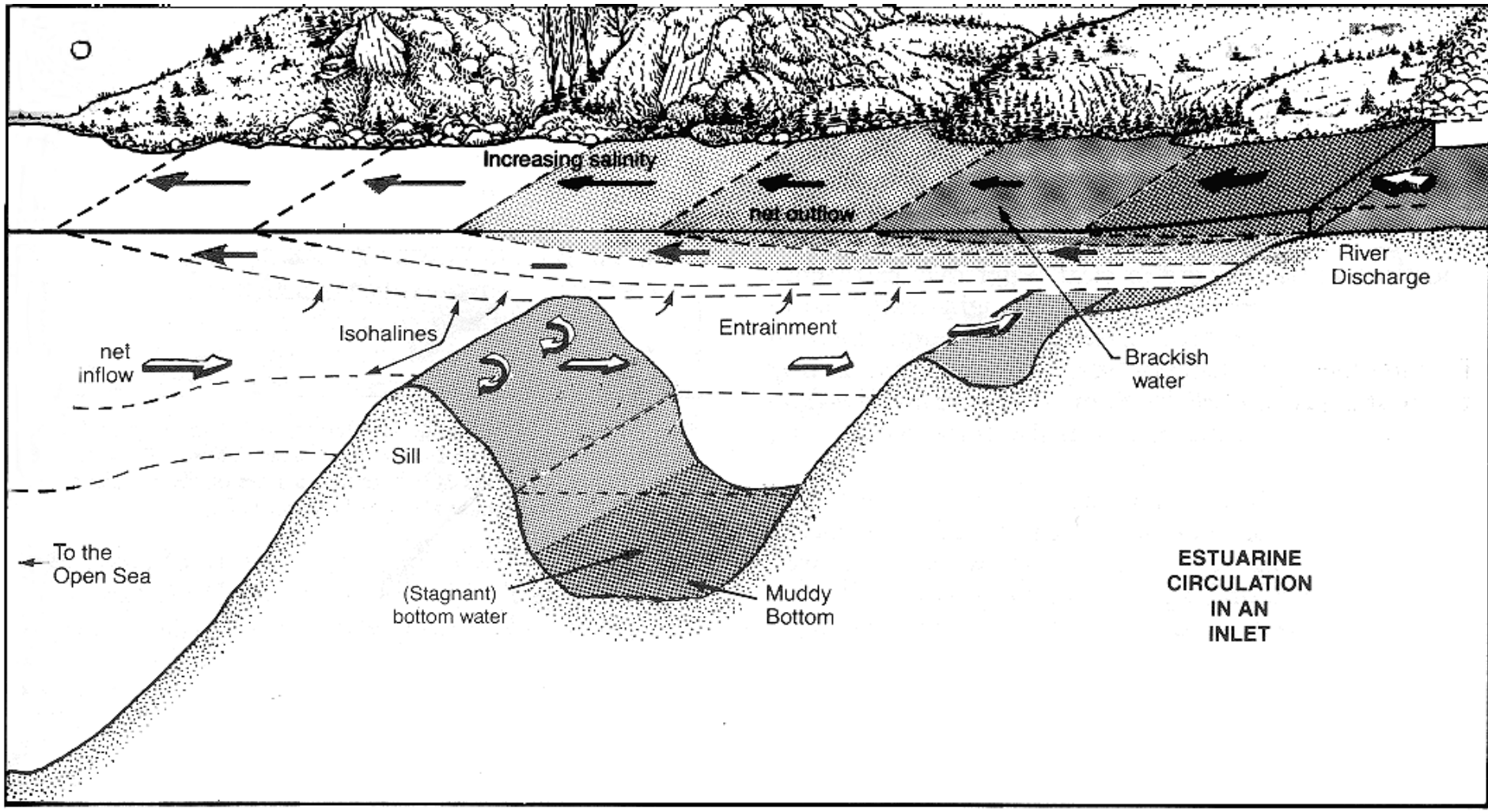
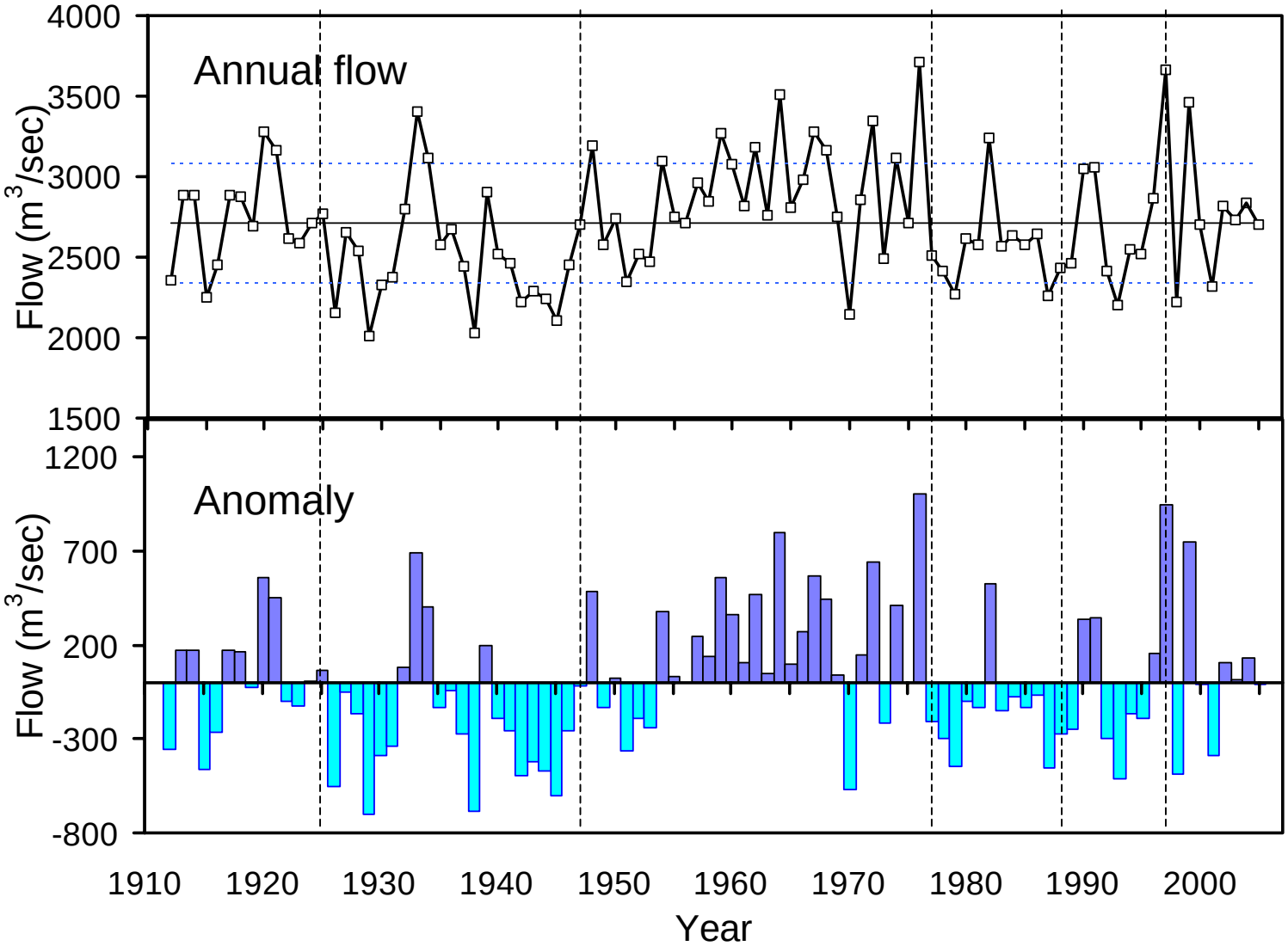


FIG. 2.7. Estuarine circulation in a typical British Columbia inlet. Salt water entrained and carried seaward by river outflow is replenished by a net inflow at depth. Sloping isohalines (lines of equal salinity) indicate a down-inlet increase in salinity in surface brackish layer. Turbulent mixing occurs in vicinity of sill.

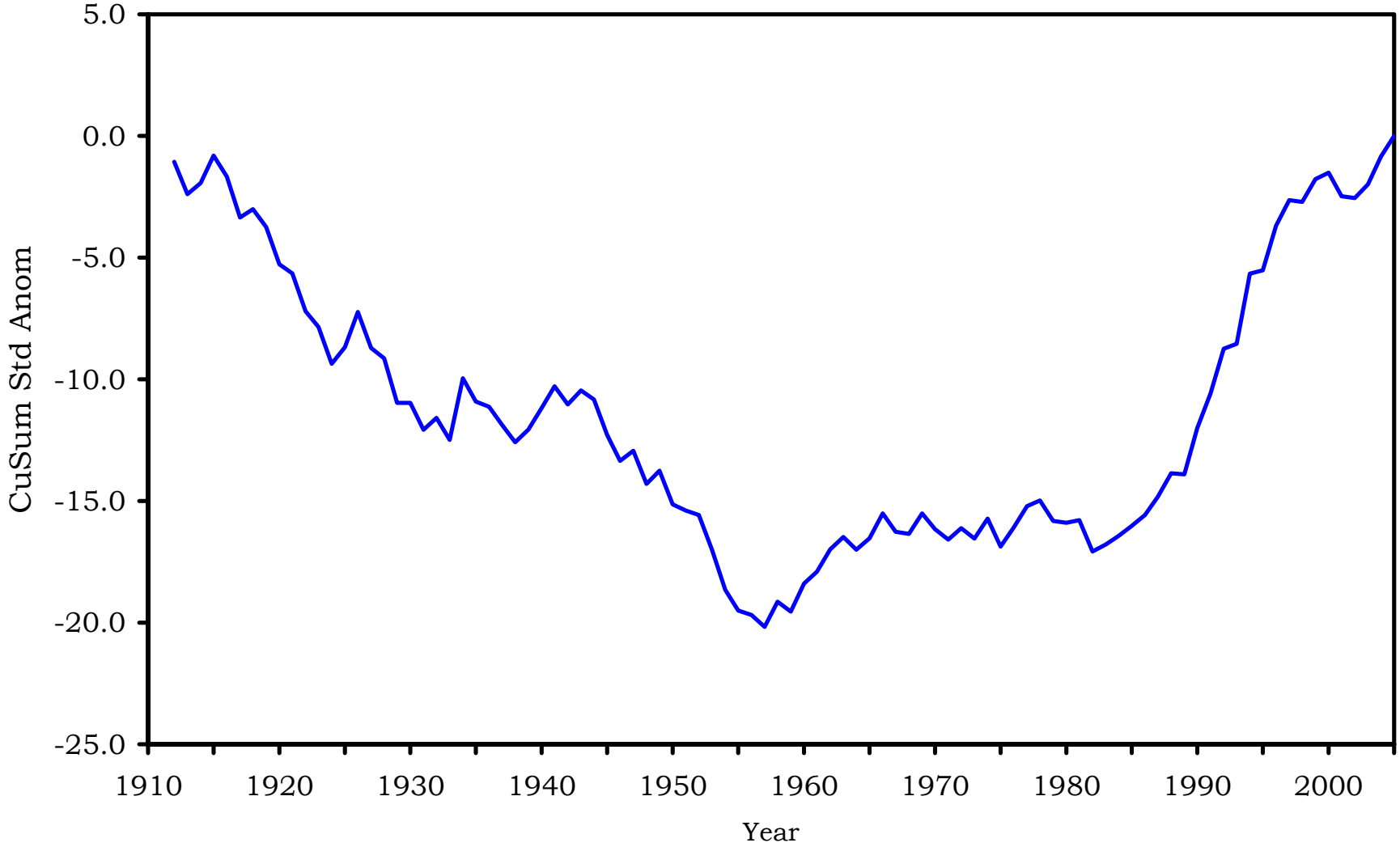
Thomson, 1981

Annual Fraser River flow (April – March)



April Fraser River Flow

CuSum 1912-2005



Fluctuating dominance of Pacific salmon in the Strait of Georgia

Coho Salmon

- Earlier primary production improves the marine survival of pink, chum and sockeye as they enter the Strait of Georgia first. Coho and chinook enter later and benefit from later production.
- However there is an important complication……

Dominance Index

~ estimated juvenile abundance

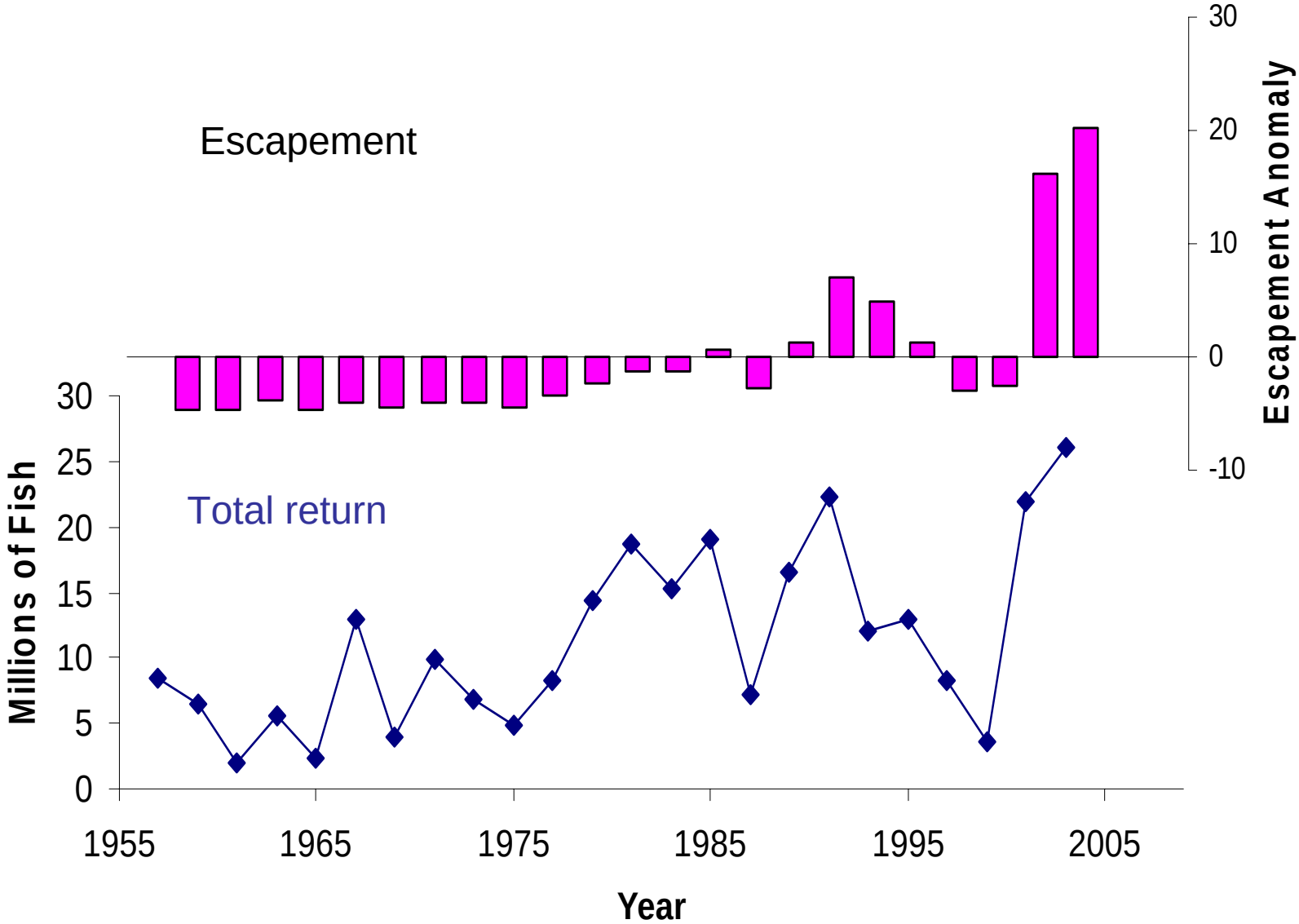
(pink+chum+sockeye)/(chinook+coho)

For the Strait of Georgia, the average DI

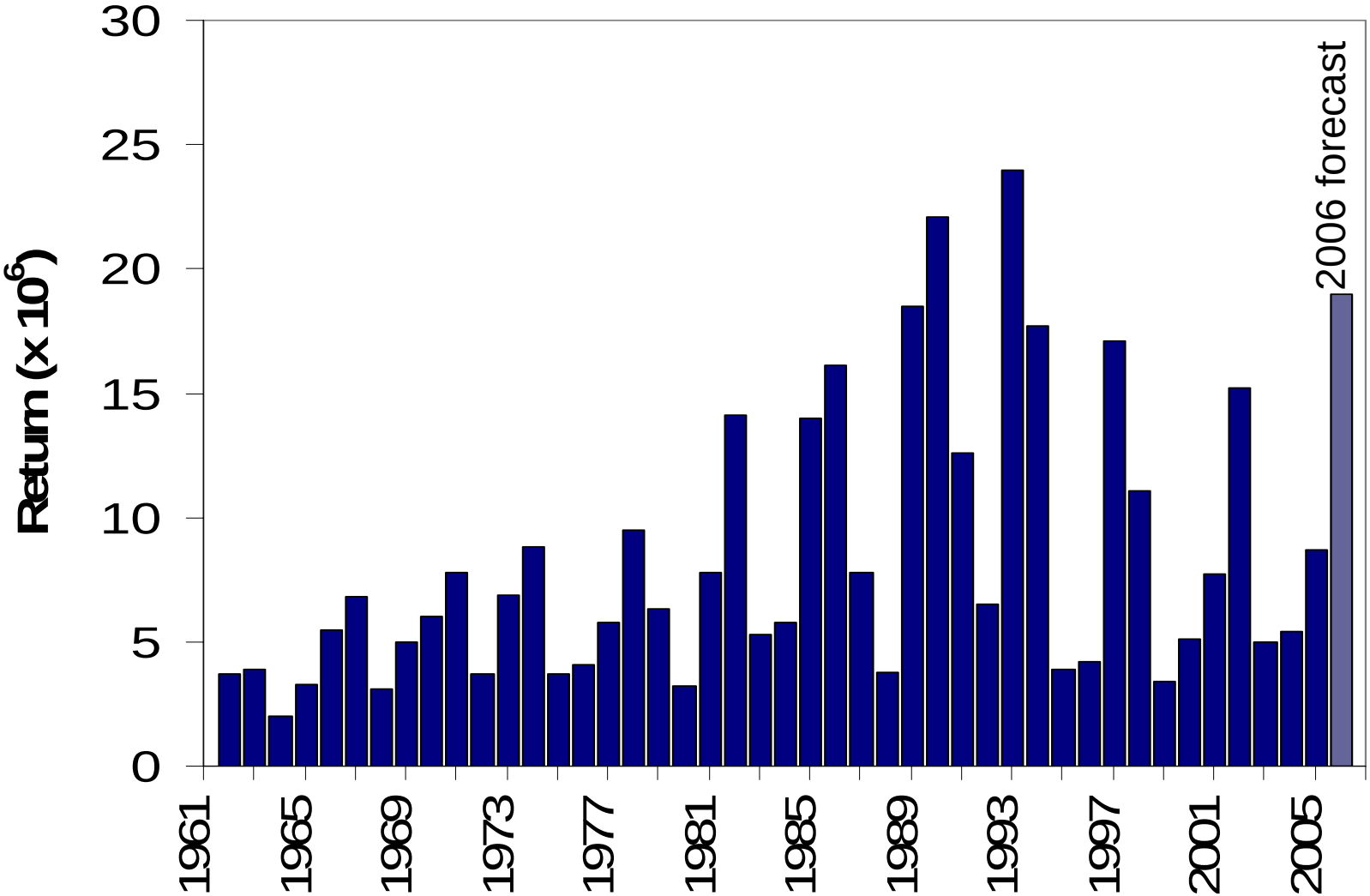
1970-1979	7.3 ± 3.6 SDev
1996-2004	16.6 ± 7.4 SDev

Therefore, the dominance of P/C/S appears to have more than doubled over the past 20 years.

Pink salmon returns to the Fraser River

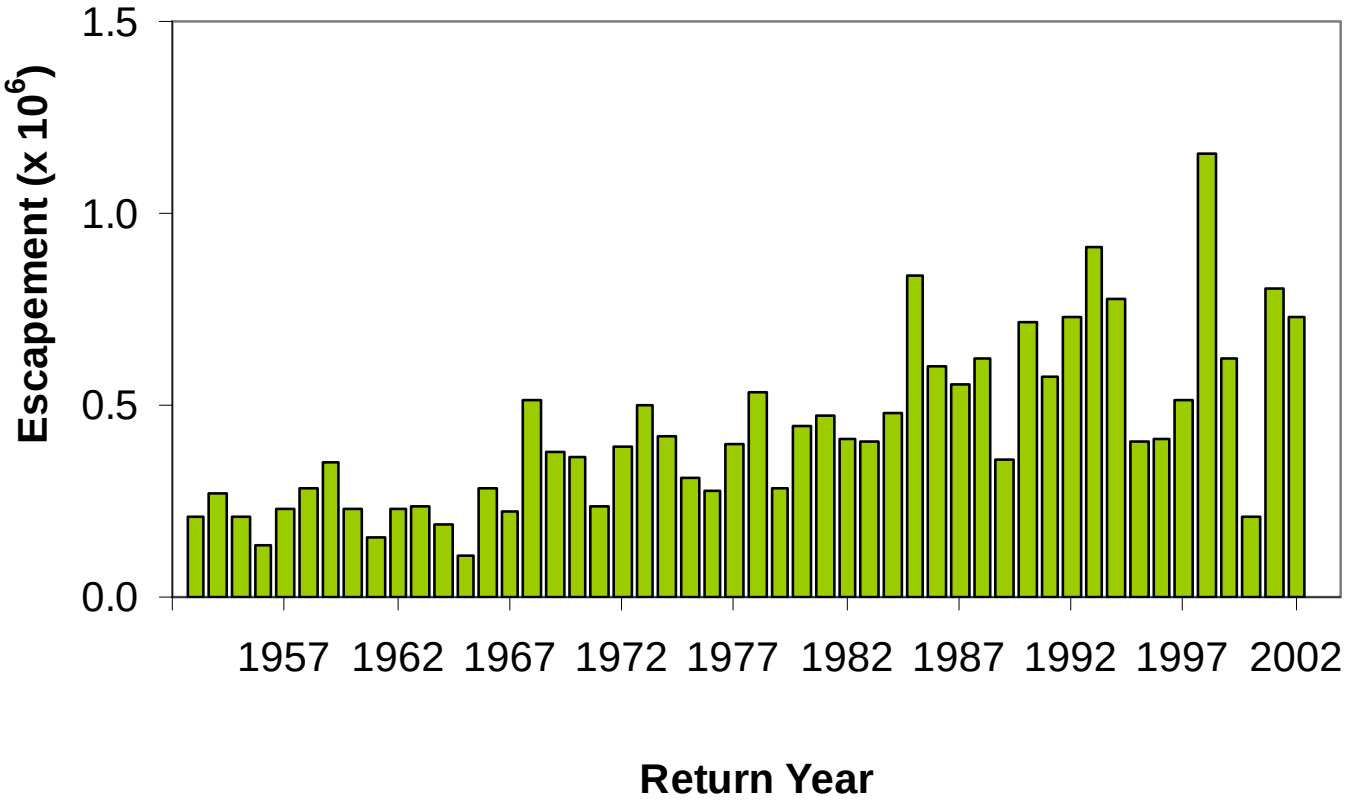


Total return (catch + escapement) of sockeye salmon to the Fraser River.

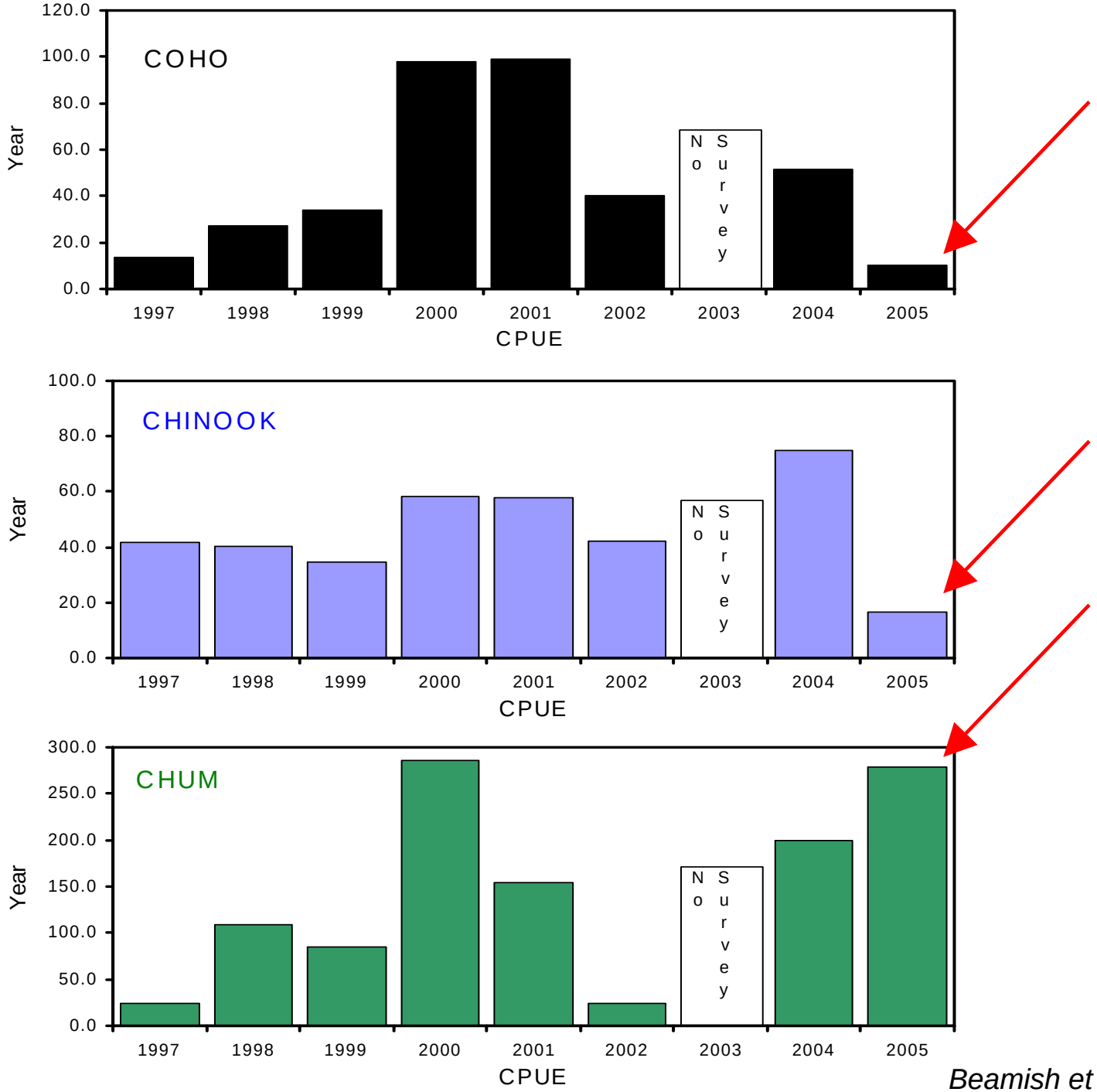


2003 and 2004 data is preliminary

Index of Chum salmon production



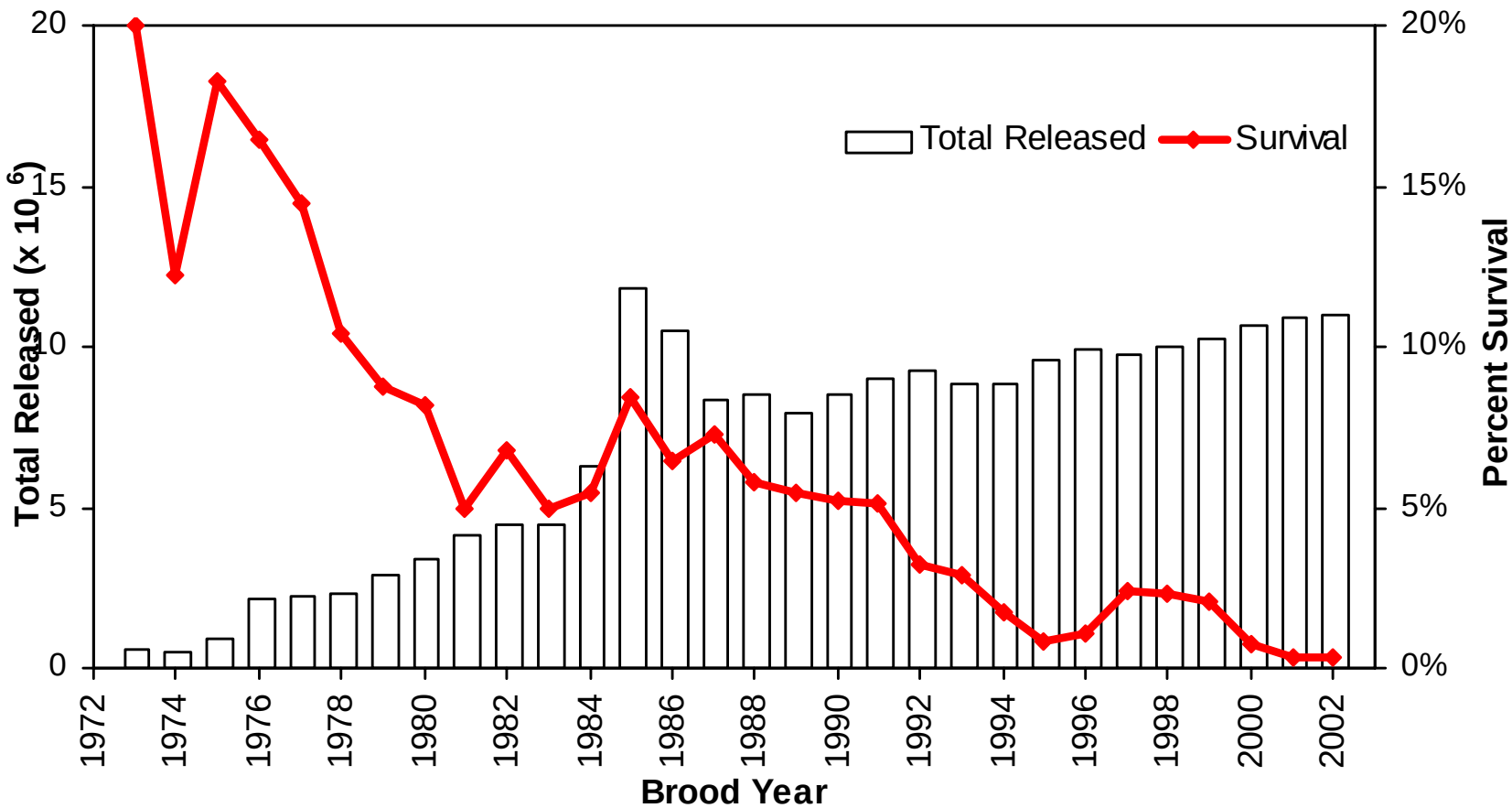
10 key streams



Beamish et al. 2006

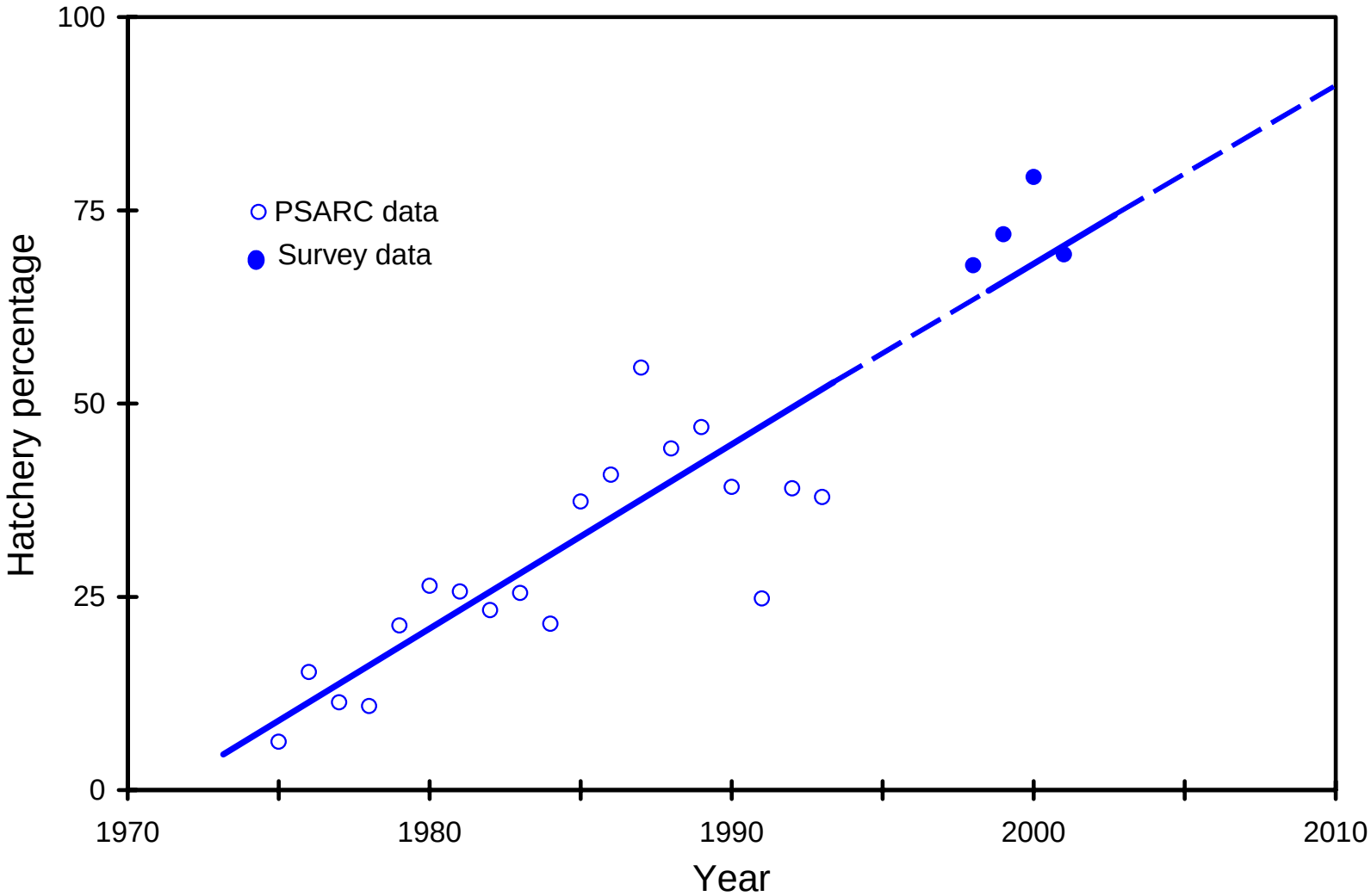
Strait of Georgia coho

Survival and hatchery releases 1973-2002



Strait of Georgia Coho

Percent hatchery contribution



modified from Sweeting et al. 2003

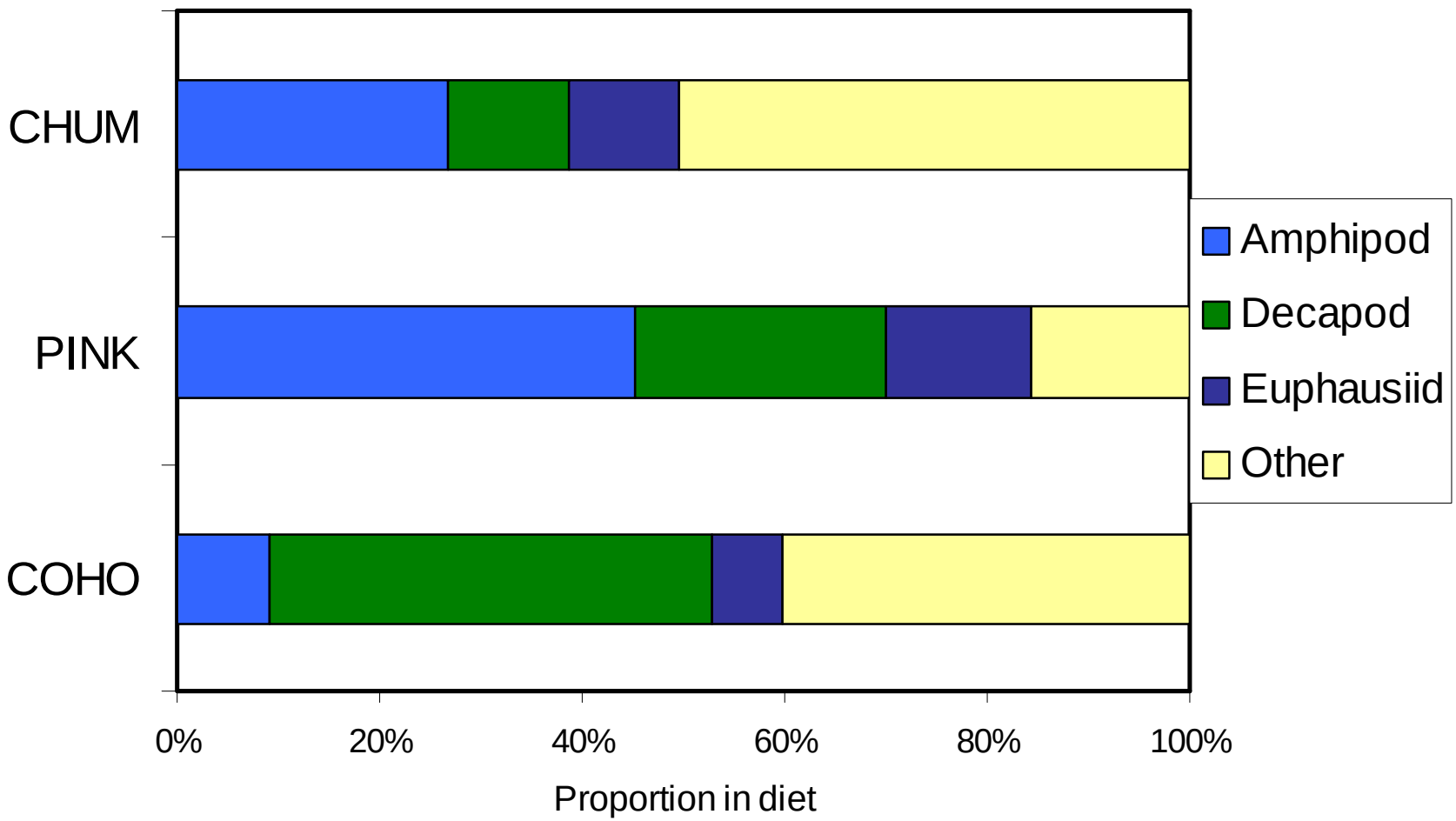
Mechanism: critical size/critical period

Juvenile salmon must grow to a critical size to store enough fat to be able to survive the winter when the fish loses energy.

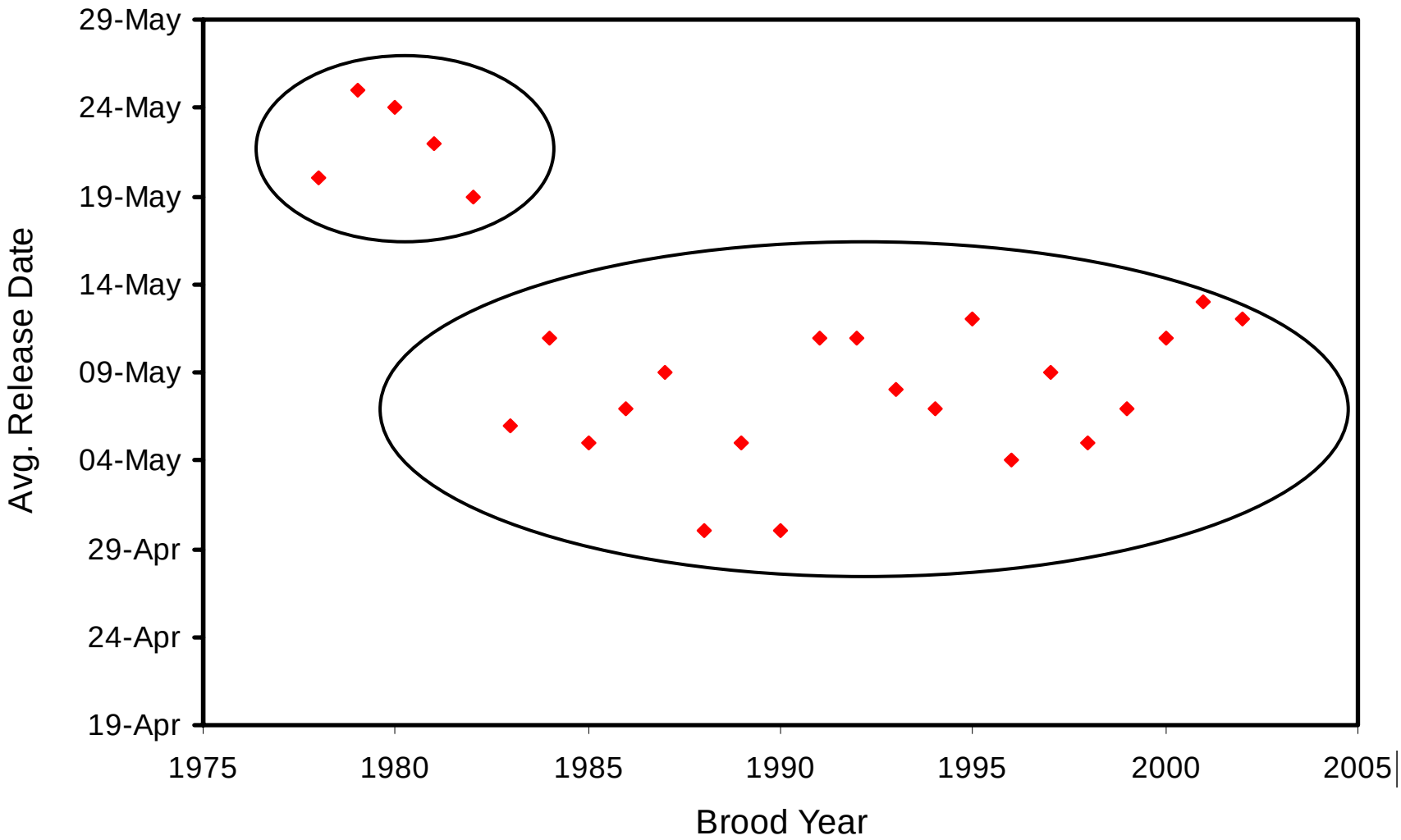
Beamish and Mahnken (2001) Prog. Oceanogr. 49:423-437

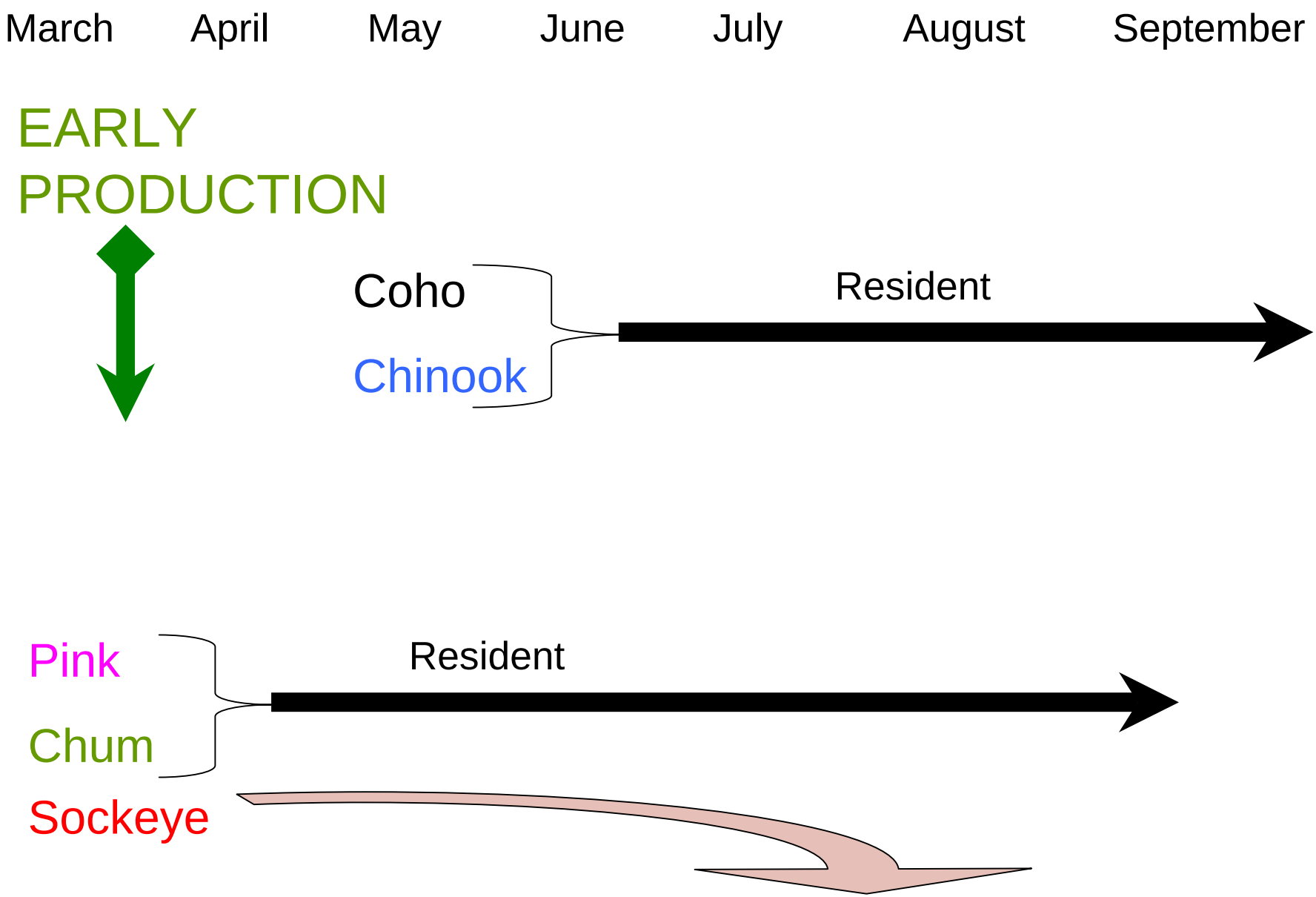
- Beamish et al. (2004) “Evidence that reduced early marine growth is associated with lower marine survival of coho salmon.” Trans. Am. Fish. Soc. 133:26-33.
- Moss et al. (2005) “Evidence for size-selective mortality after the first summer of ocean growth by pink salmon.” Trans. Am. Fish. Soc. 134:1313-1322.
- Morita et al. (2006) “Population dynamics of Japanese pink salmon (Oncorhynchus gorbushca): are recent increases explained by hatchery programs or climatic variations?” Can. J. Fish. Aquat. Sci. 63:55-62.

Comparison of diet of juvenile salmon



Average release timing of hatchery coho in the Strait of Georgia

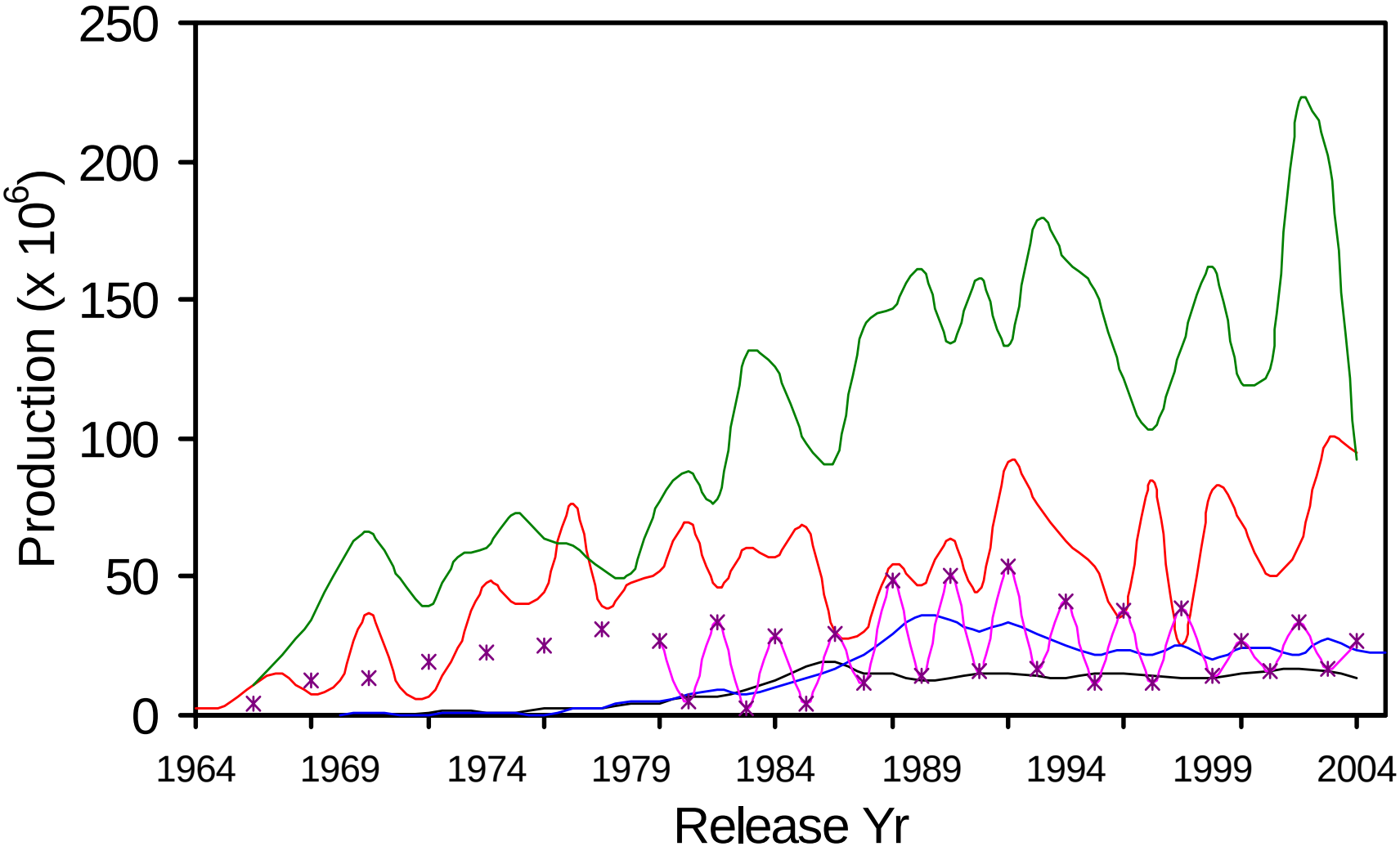



March
April
May
June
July
August
September
EARLY PRODUCTION
Coho
Chinook
Resident
Pink
Chum
Sockeye
Resident

Caution

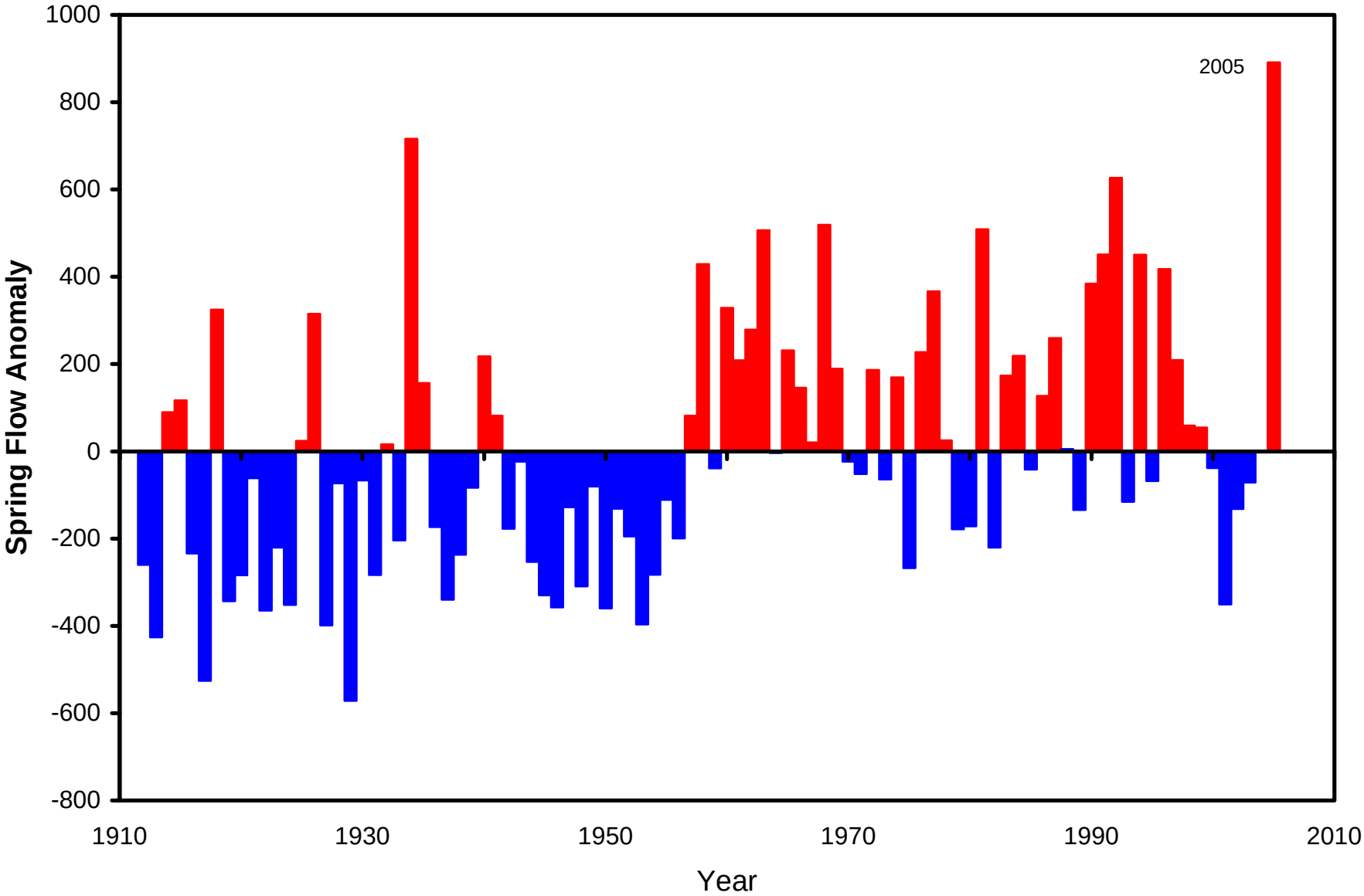
- Natural events → Earlier productivity
- But… over 80% of coho come from hatcheries and their natural behaviour is regulated
- Would wild coho behave this way or would they adapt to the shift in earlier productivity?

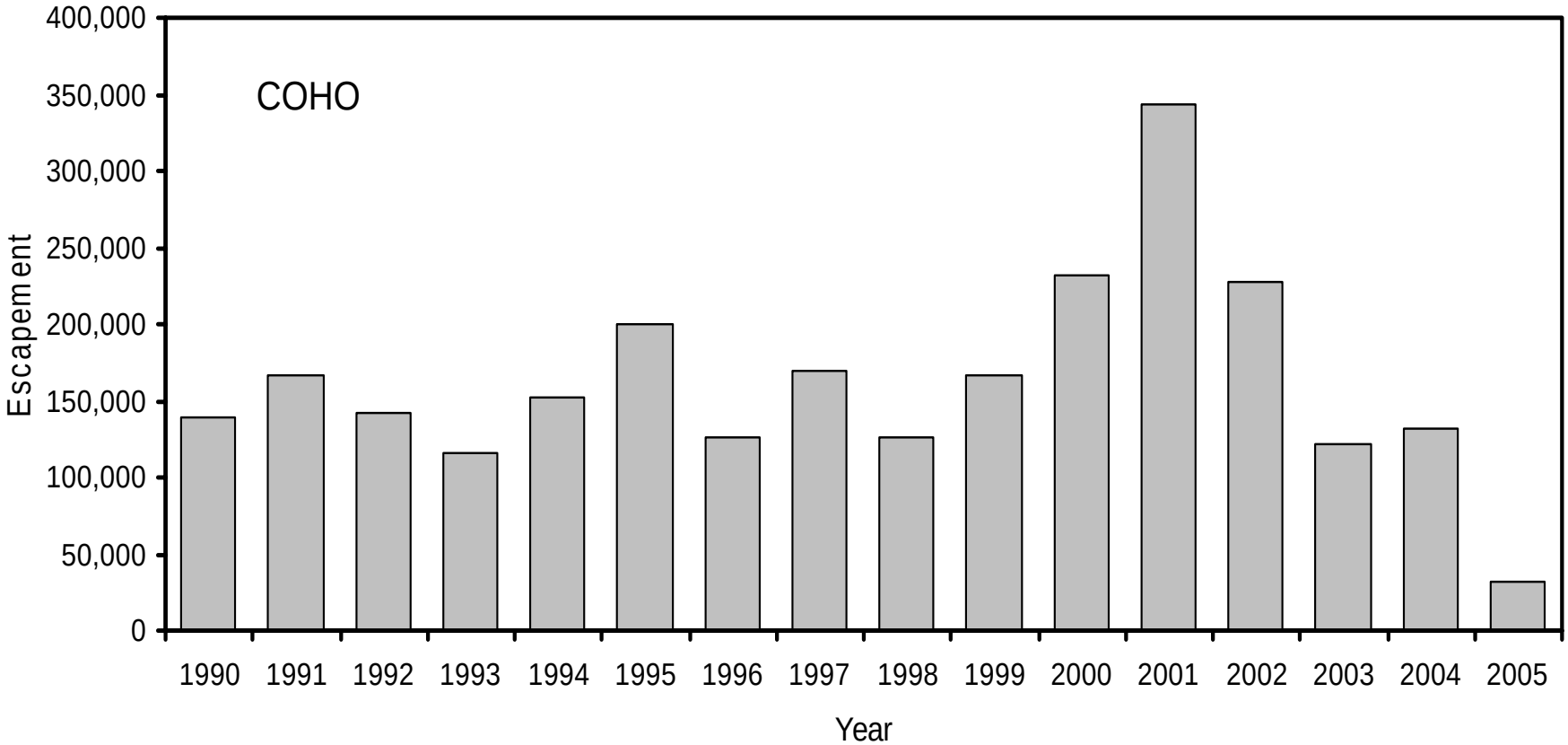
Strait of Georgia – hatchery production 1964-2004



CHUM SOCKEYE CHINOOK COHO PINK

Fraser River Spring Flow Anomaly (Jan – April)





Coho escapements for Capilano, Chehalis, Chilliwack, Inch Creek, Big Qualicum, Puntledge, Quinsam River, and Tenderfoot hatcheries. Represent 96.2% of total coho returns, not including 2005 (67%).

Beamish et al. 2006

Strait of Georgia

Hatchery production 1964-2004