Developing ecosystem-based management in a human-dominated marine system: the Strait of Georgia, Canada

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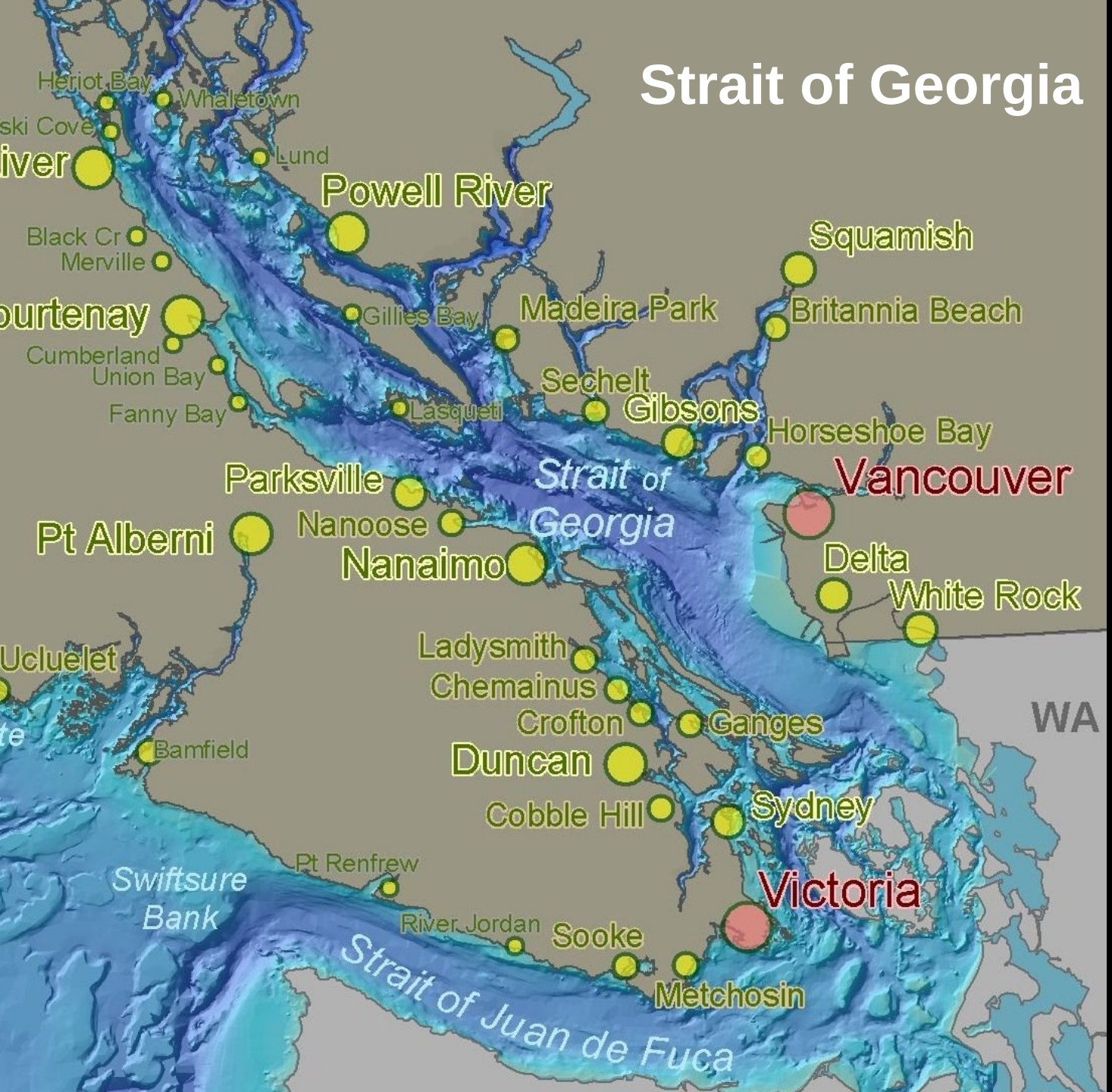

A human-dominated system

Area = 6,800 km^2

Human population about 3 million

Killer whale population about 100

The Strait of Georgia is changing

- Large increases in human population (10 to >70% over past 20 years)
- Strait has warmed by 1°C in past 100 years; by 0.3 °C in past 25
- Salmon abundances are changing:
  - pink and chum are at high abundances;
  - coho and Chinook abundances low – poor marine survivals;
  - sockeye abundances declining with large variability
- Herring at relatively high abundances, with some recent declines
- Pacific hake are largest biomass of resident fish in the strait
- Pacific cod, lingcod, several rockfish species almost absent
- Seals are at high abundances

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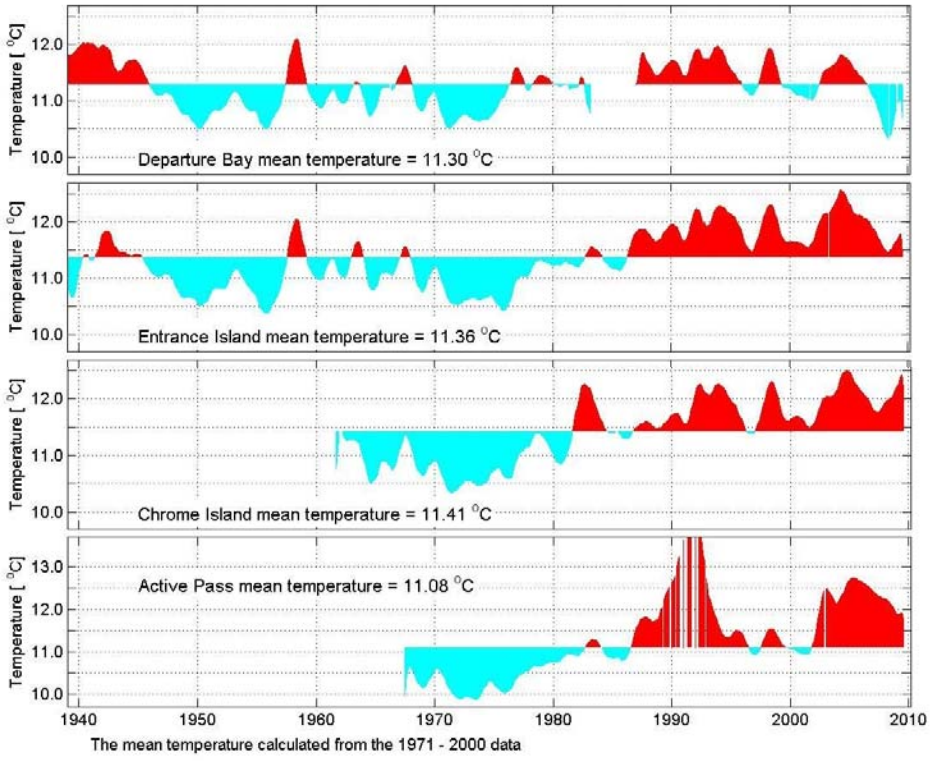
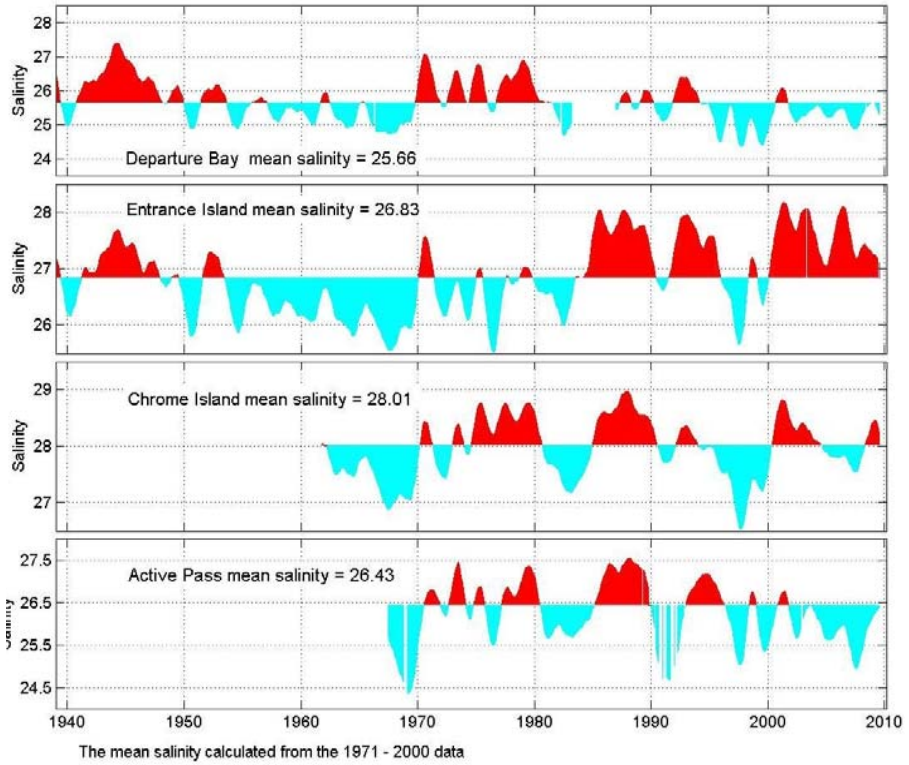
Status and Trends – Physical conditions

Temperature anomalies



Salinity anomalies



Courtesy P. Chandler

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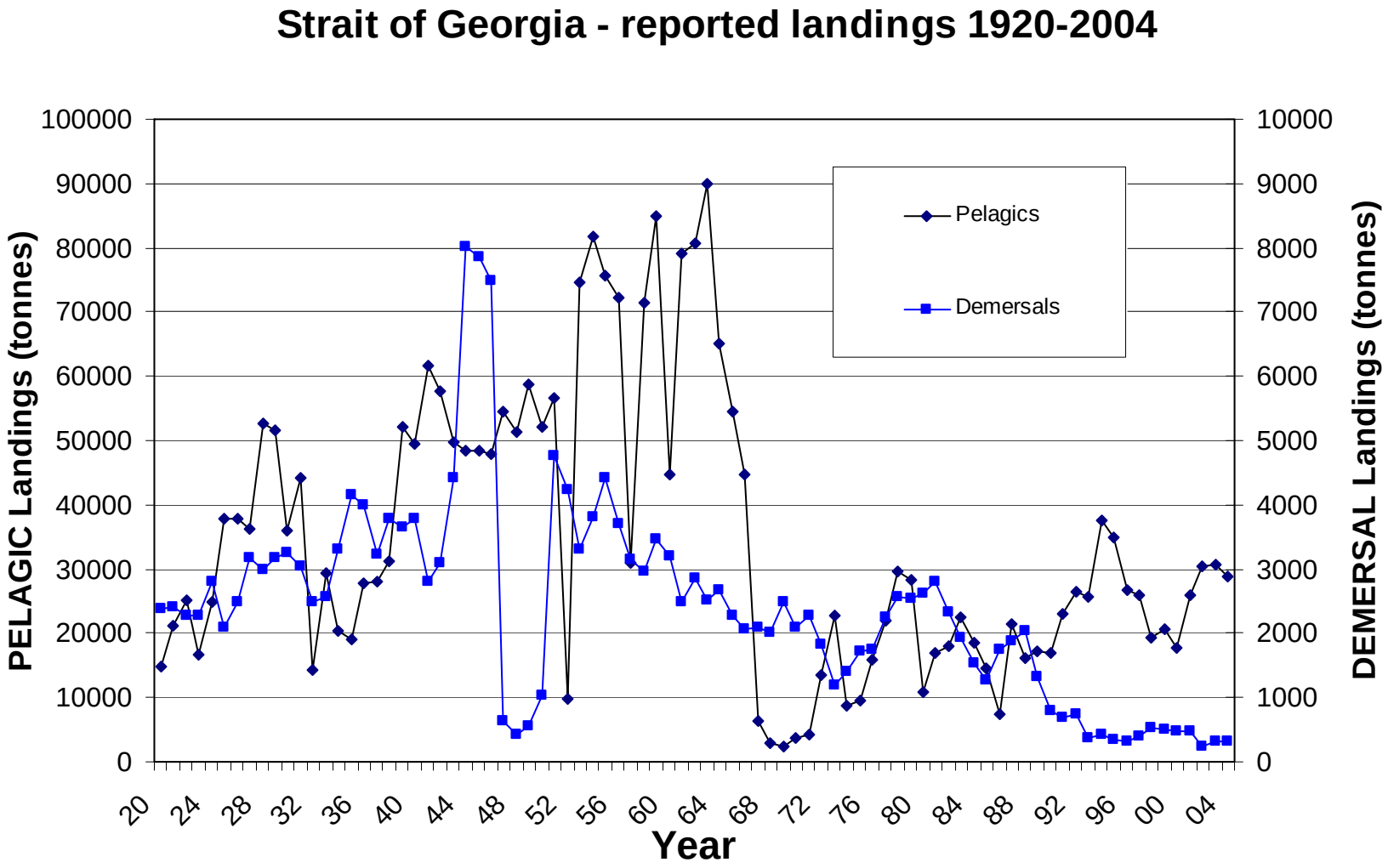
Status and Trends - Historical fishery landings



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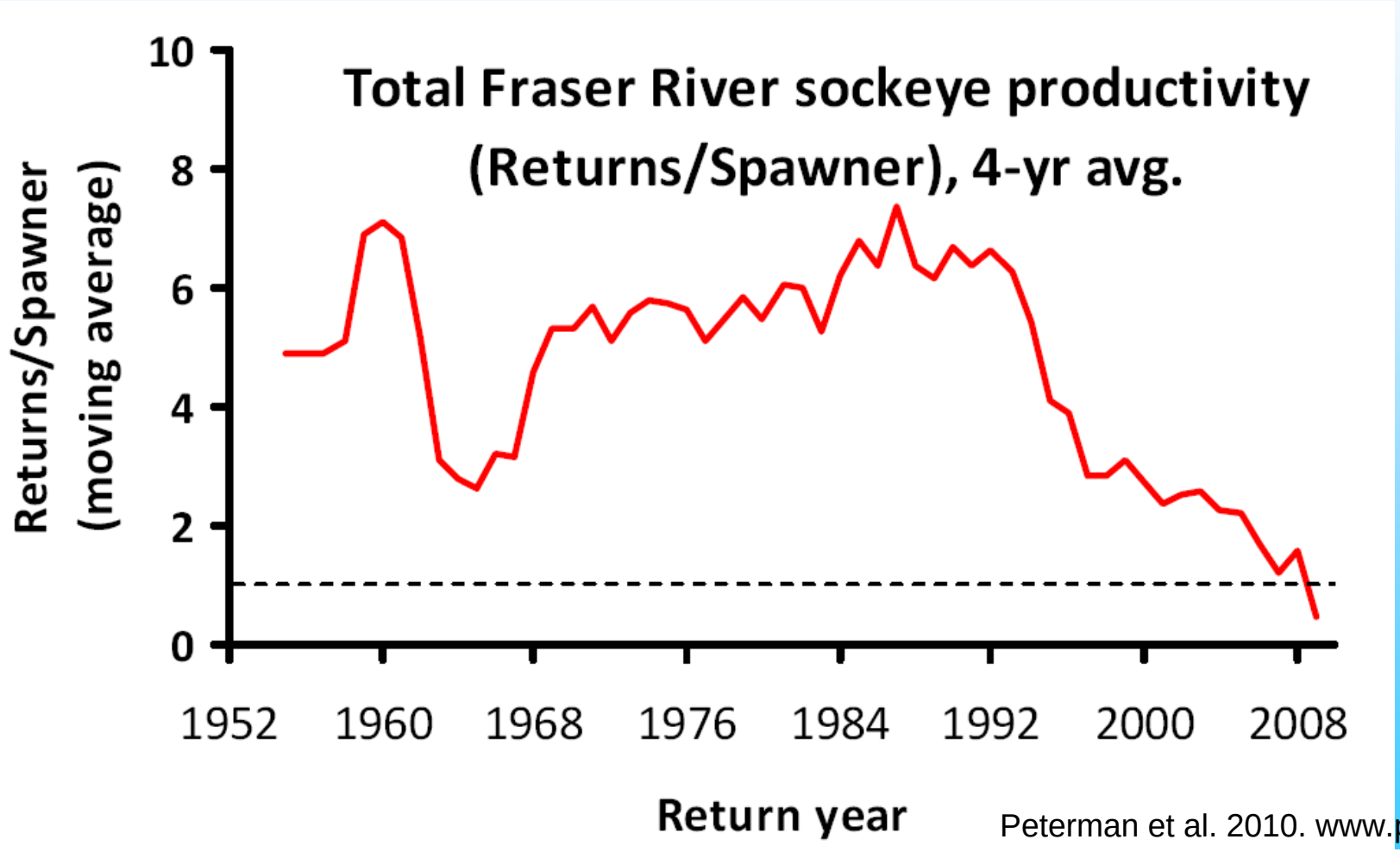
Total Fraser River sockeye productivity

(Returns/Spawner), 4-yr avg.



Peterman et al. 2010. www.psc.org

The Strait of Georgia Ecosystem Research Initiative (2008 – 2011)

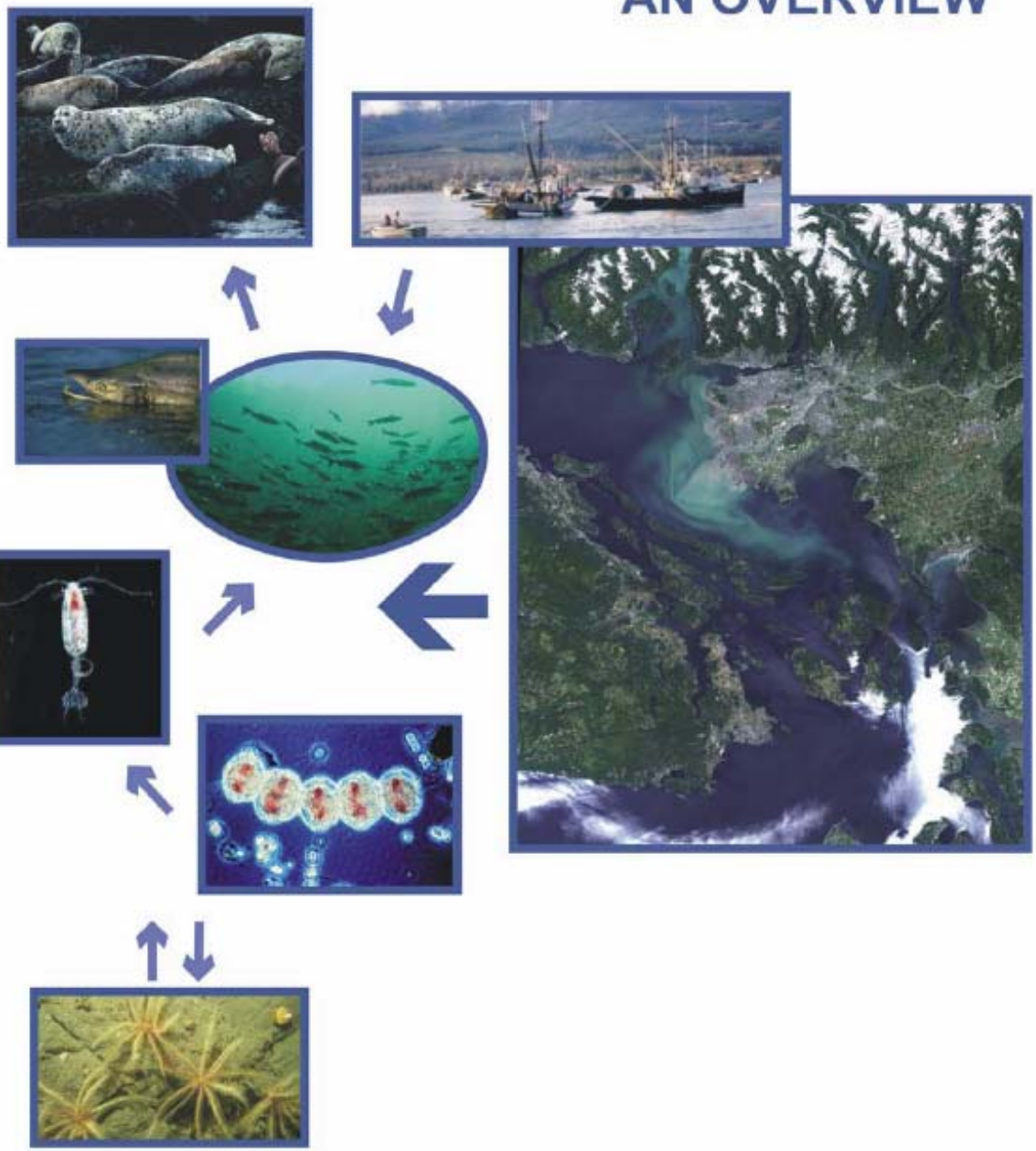
Main themes: Ecosystem studies and management of human interactions in an ***integrative framework***:

1) Understanding how this system works (What controls the ***productivity***?)

2) Identifying the drivers of change acting on the Strait and how these drivers might change in the future (What controls the ***resilience***?)

3) Developing science-based management and decision-making tools to support healthy and sustainable marine resources

STRAIT OF GEORGIA ECOSYSTEM RESEARCH INITIATIVE: AN OVERVIEW



DATA ANALYSIS

- Bottom type
- Zooplankton data
- Satellite imagery
- Bibliography
- Cetacean diets
- Forage species distribution
- Radar winds
- Contaminants in seals
- Salmon: abundance, distribution, timing

NUMERICAL MODELS & ECOSYSTEM INDICATORS

- ROMS/physical
- ROMS/NPZD
- OSMOSE
- ECOPATH
- Ecosystem indicators

FIELD WORK

- Seal tagging/survey
- Salmon/acoustic tags
- Salmon prey quality
- Herring+hake/acoustic survey
- Moorings/short-term events
- Sediment/water exchanges

Outline of reporting

- Strait of Georgia – current status and trends
- Ecosystem structure and function
  - benthic habitat – resuspension of materials; contaminants; nearshore habitat types
  - pelagic habitat hotspots – central SofG; Gulf Islands
  - food webs – drivers of productive capacity and species linkages
- Putting it all together – modelling and synthesis
- Into the future – climate change and other stressors
- Management – decision-making tools; ecosystem approaches

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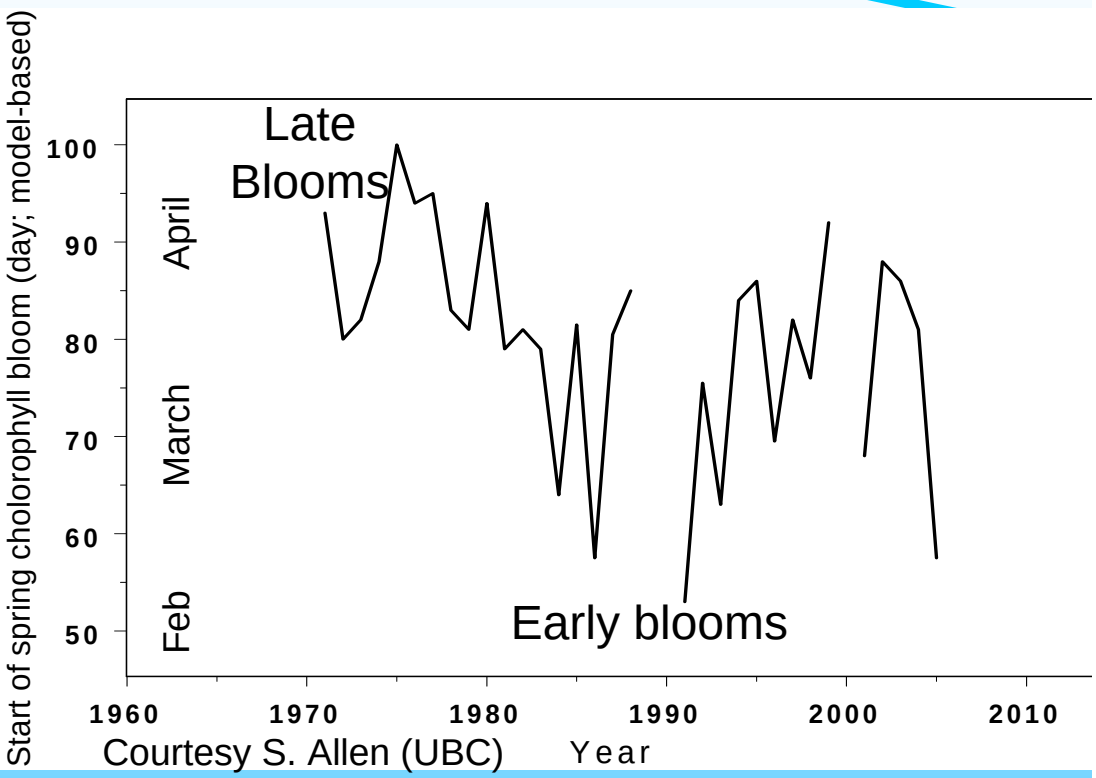
Ecosystem structure and function - Foodwebs

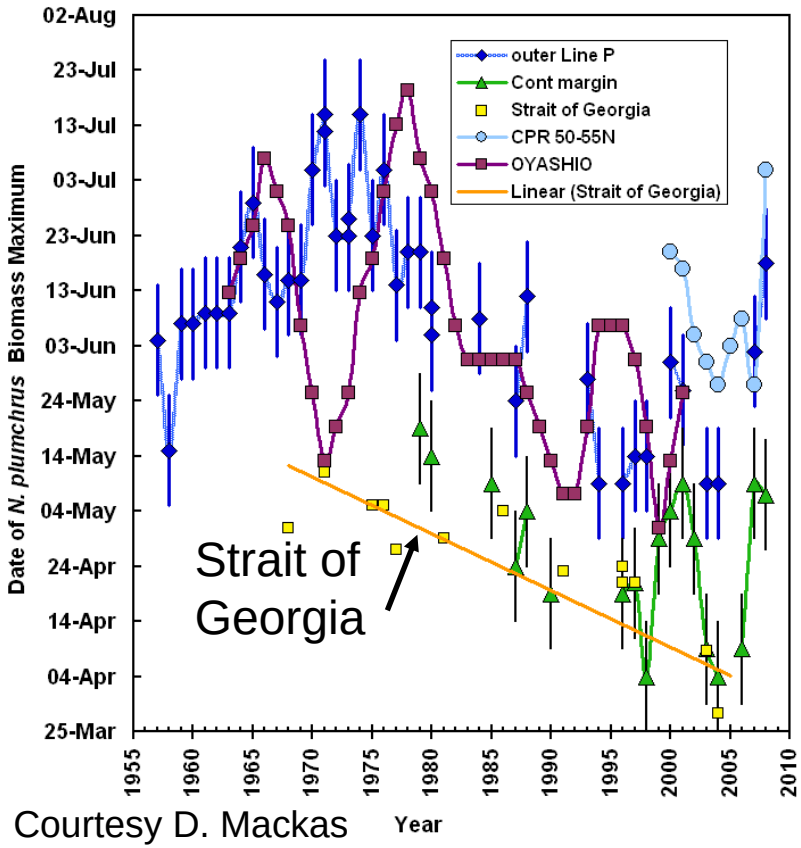
Spring Phyto bloom timing



Courtesy S. Allen (UBC)

Timing of start of spring phytoplankton bloom is variable and has been getting earlier

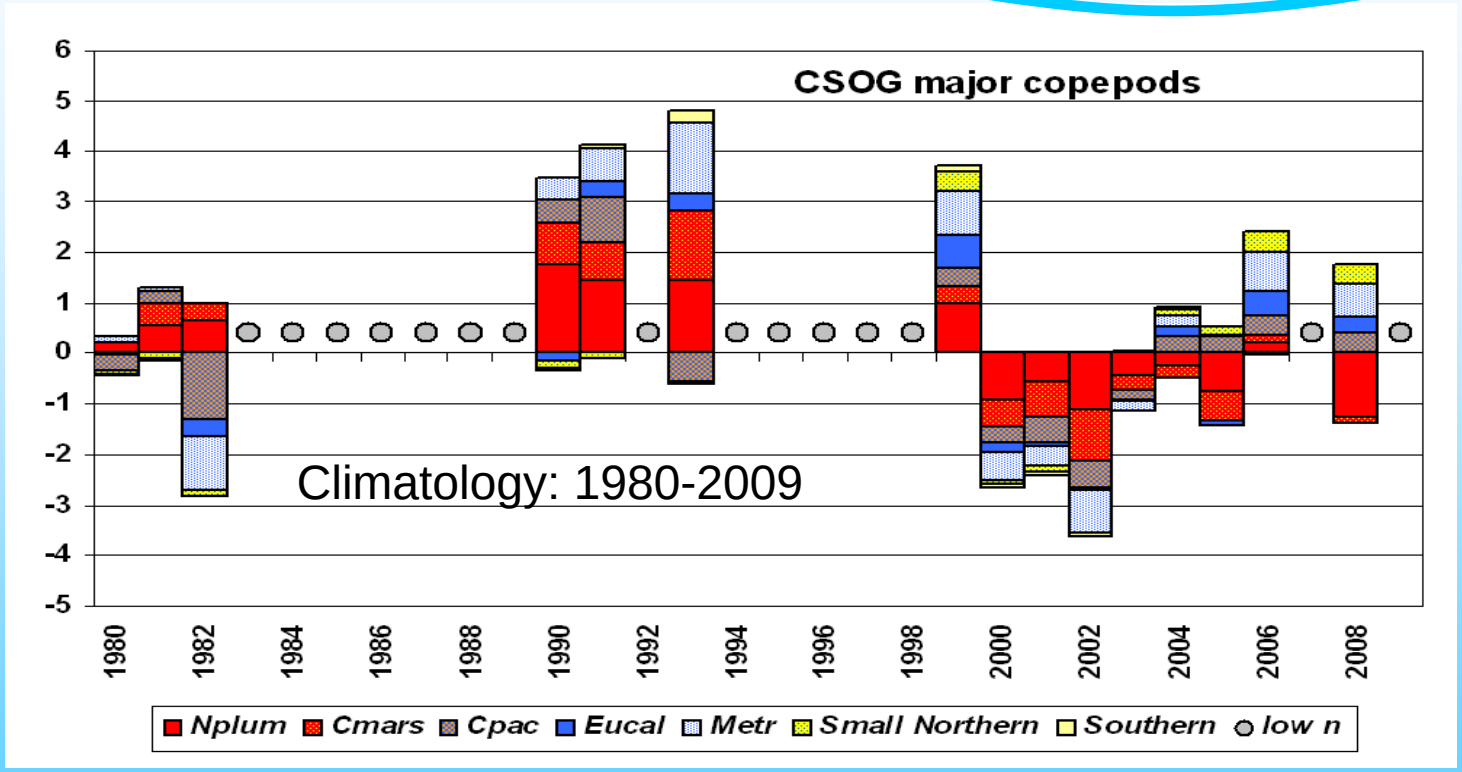
Spring Zoopl biomass peak



Courtesy D. Mackas

Trans-Pacific trend toward earlier onset of diapause, associated with warming ocean climate

Ecosystem structure and function - Foodwebs

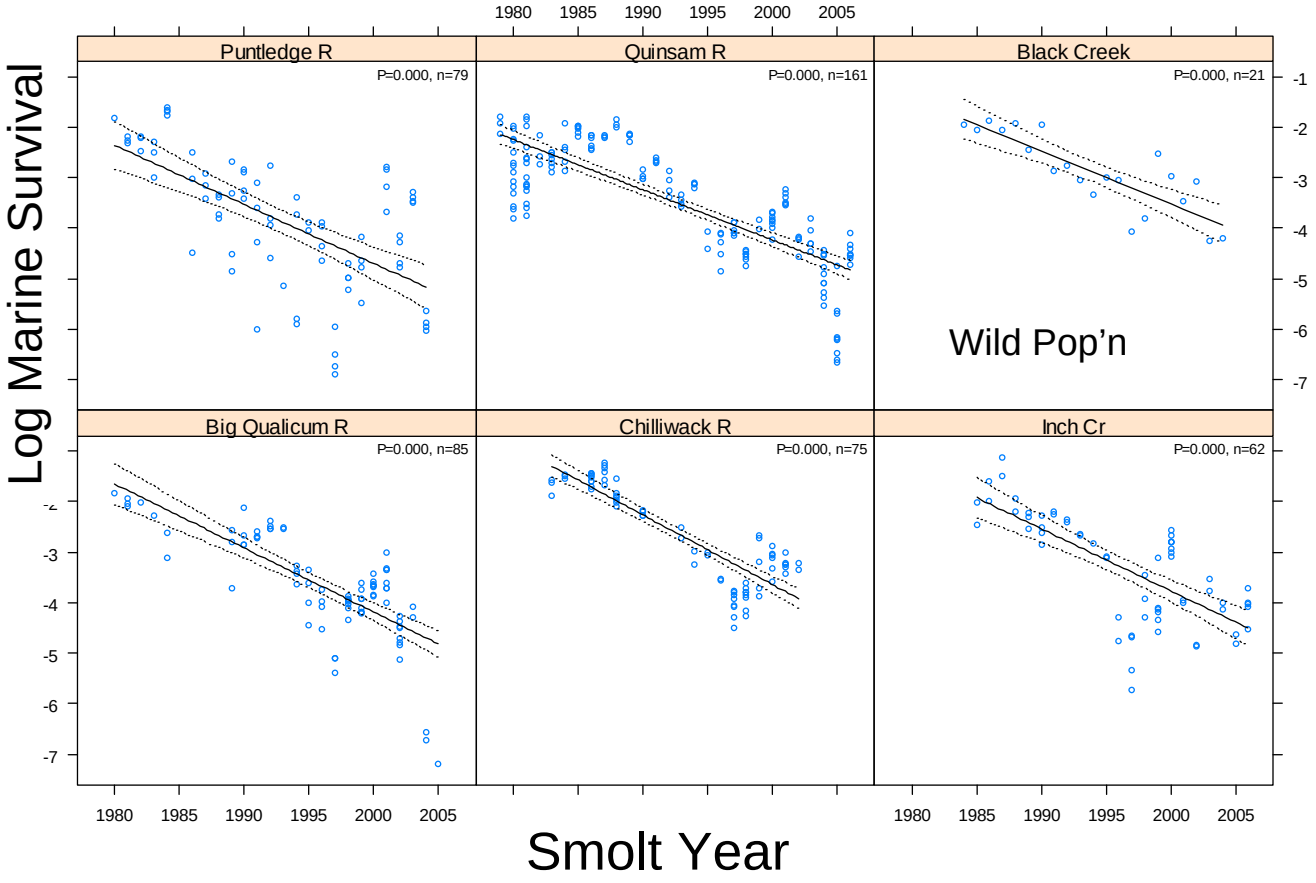


- Color bar (red – blue – yellow) ranks taxa by size & "fatness"
- Big change ~1999-2000 from "BigLipidRich" species replaced by "BigButLean" & "Small" species

Courtesy D. Mackas

Ecosystem structure and function - Foodwebs

Factors influencing survival rates of hatchery-released coho salmon



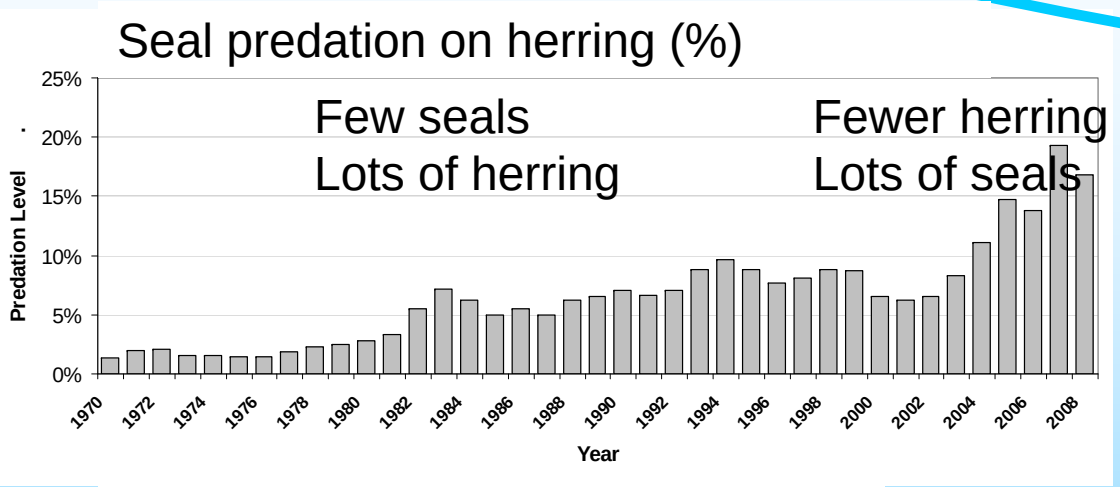
Year has greatest effect on survival (poor survival in recent years)

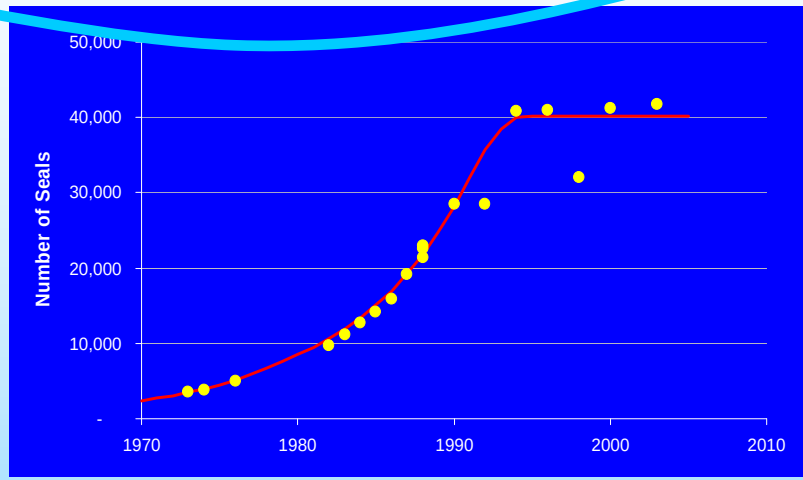
Larger smolts survived better

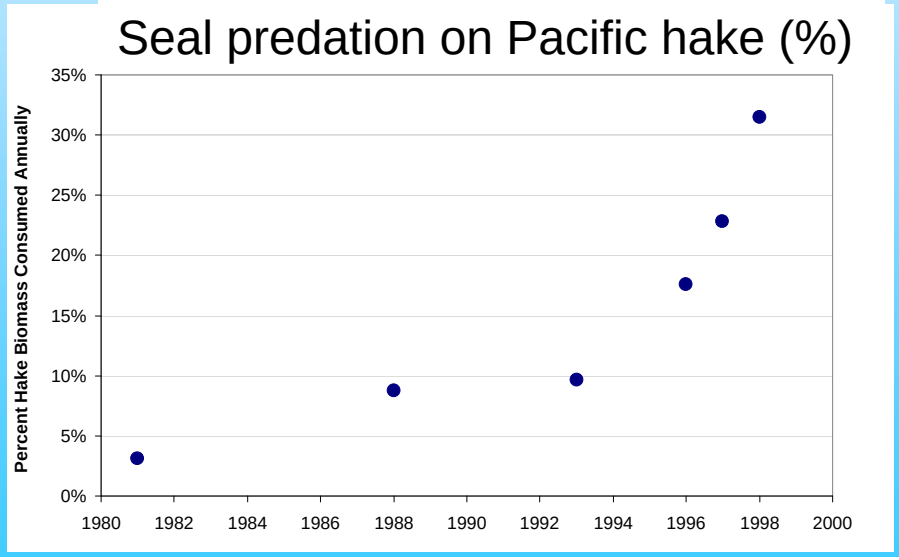
Earlier releases did better in early time series; later releases did better in later time series

Courtesy J. Irvine, M. O'Neil

Ecosystem structure and function - Foodwebs







- seal populations ‘stabilised’ => equilibrium?
- seals now appear to be making more extensive movements and spending more time foraging than in 1990’s
- seal predation on herring has increased as seals have increased and herring has declined – prefer larger older herring
- seal predation on hake also increasing

Courtesy P. Olesiuk

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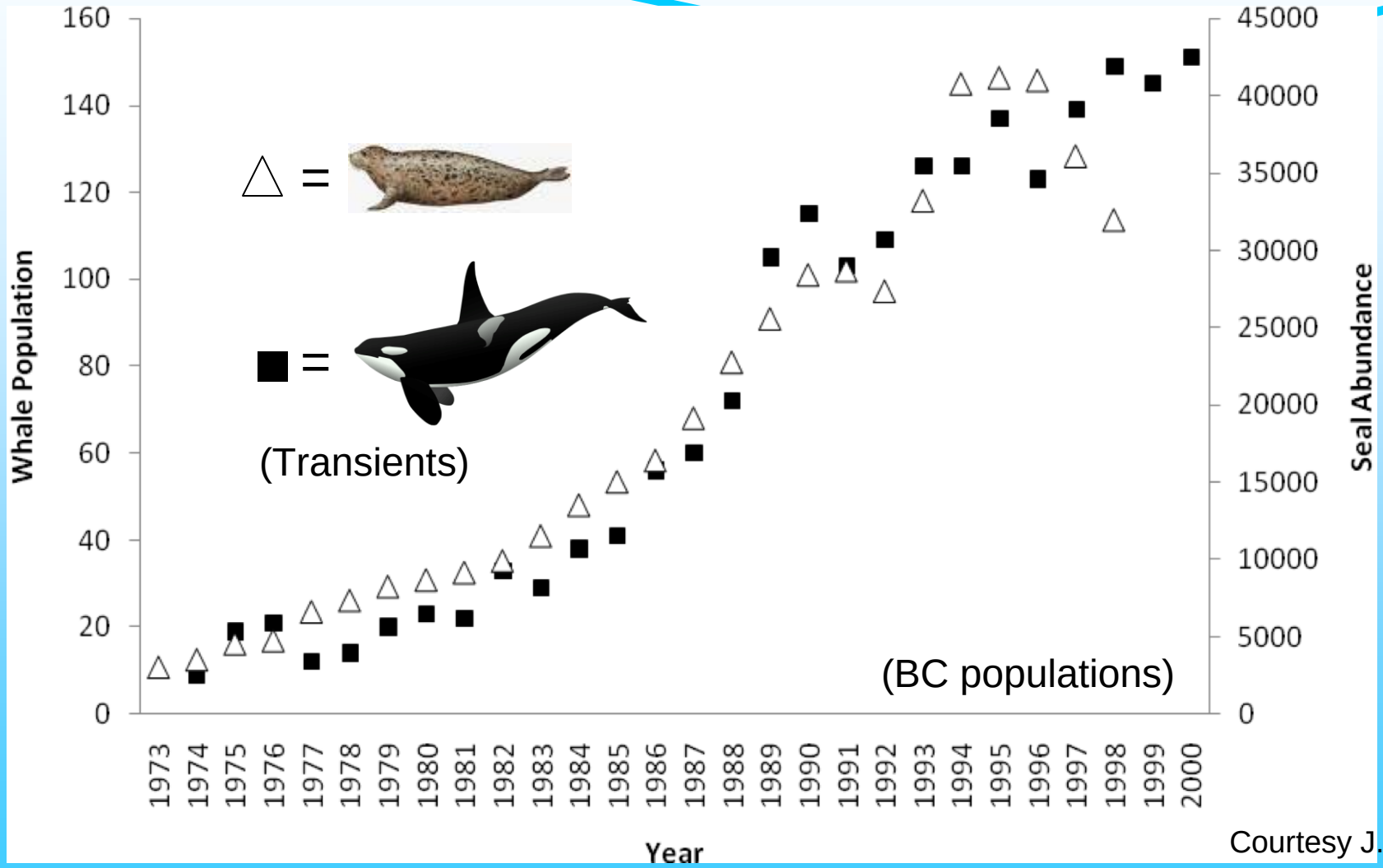
Ecosystem structure and function - Foodwebs



Courtesy J. Ford

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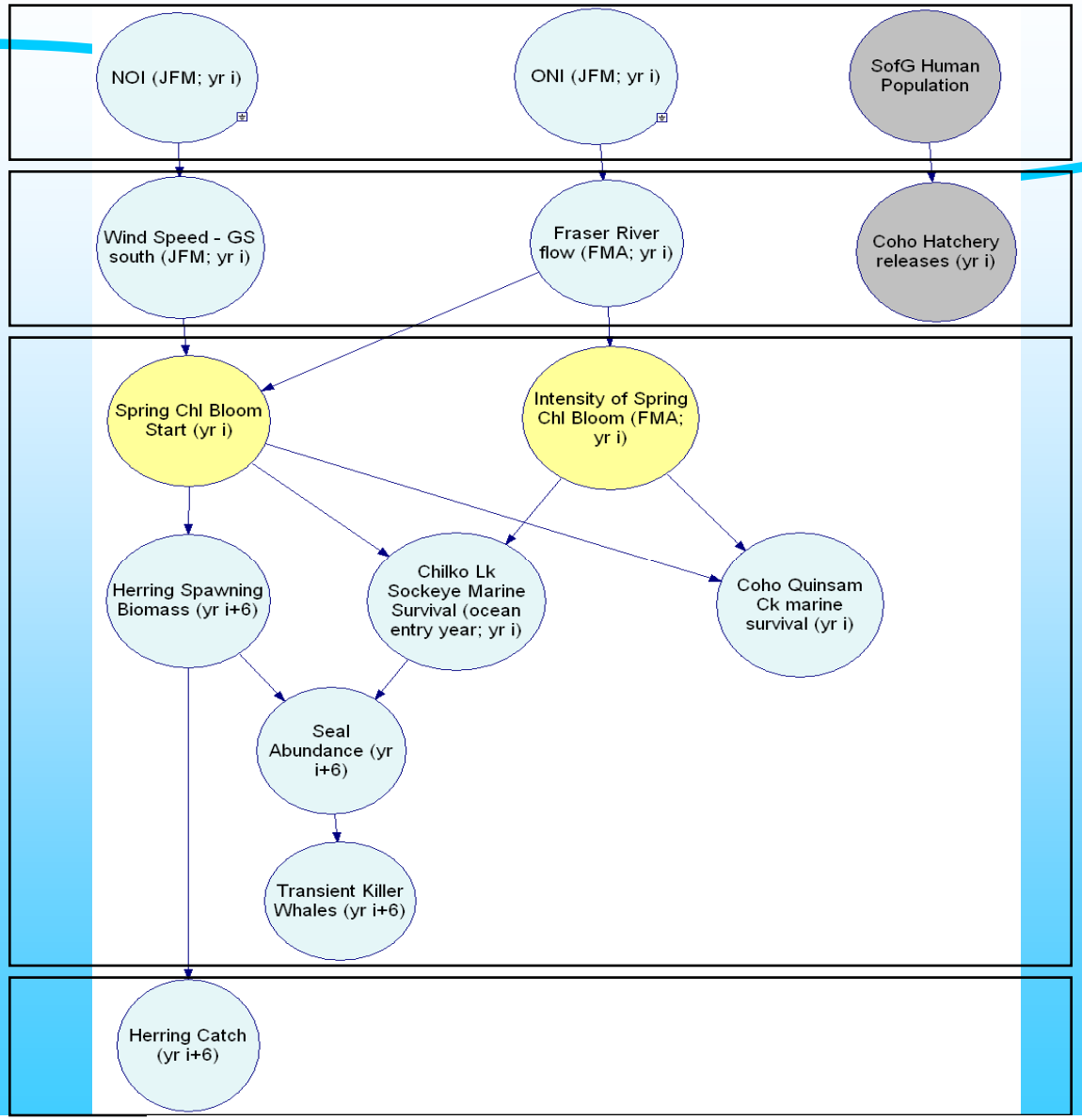
Ecosystem Indicators



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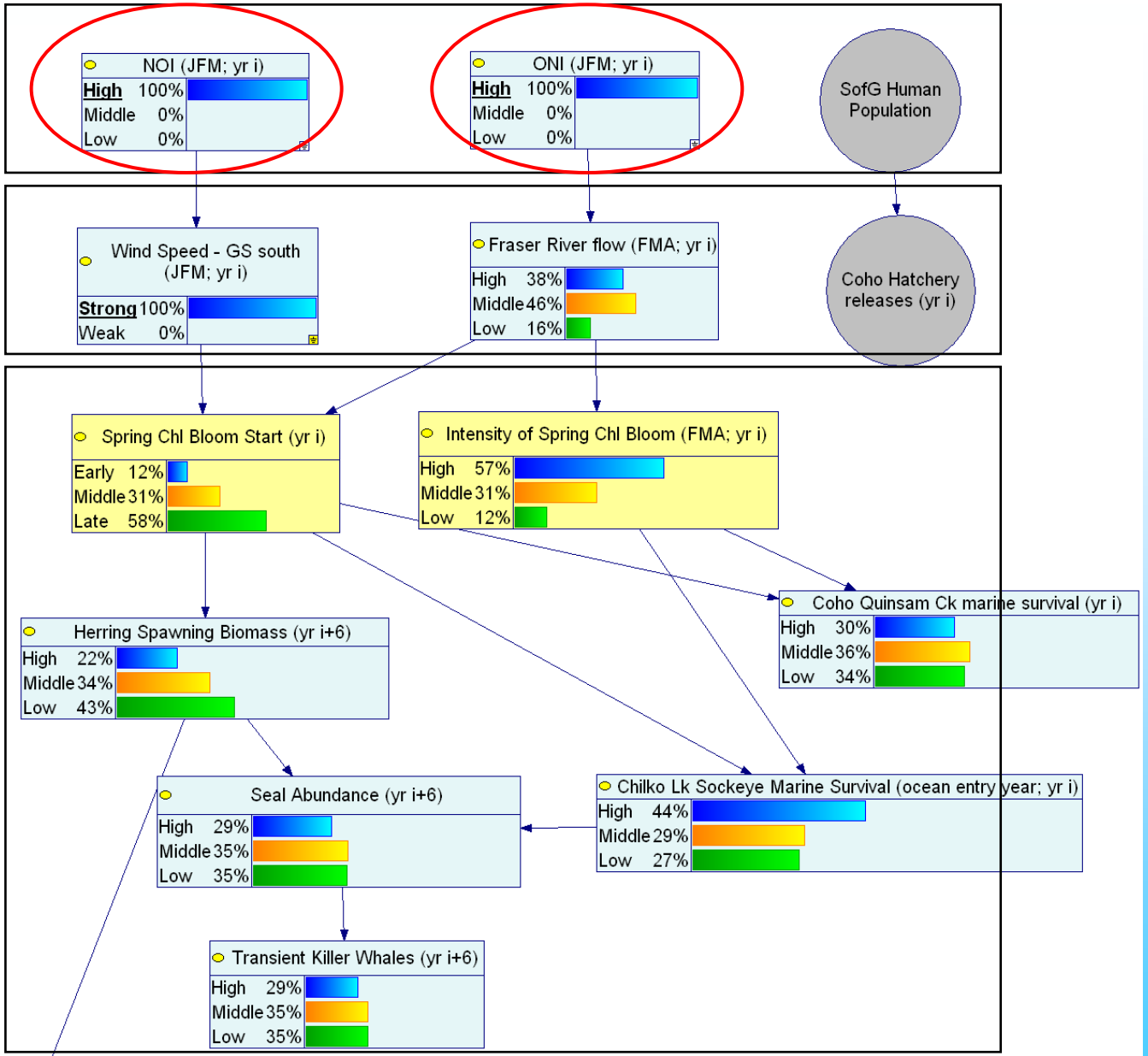
Drivers

Pressures

States

Impacts



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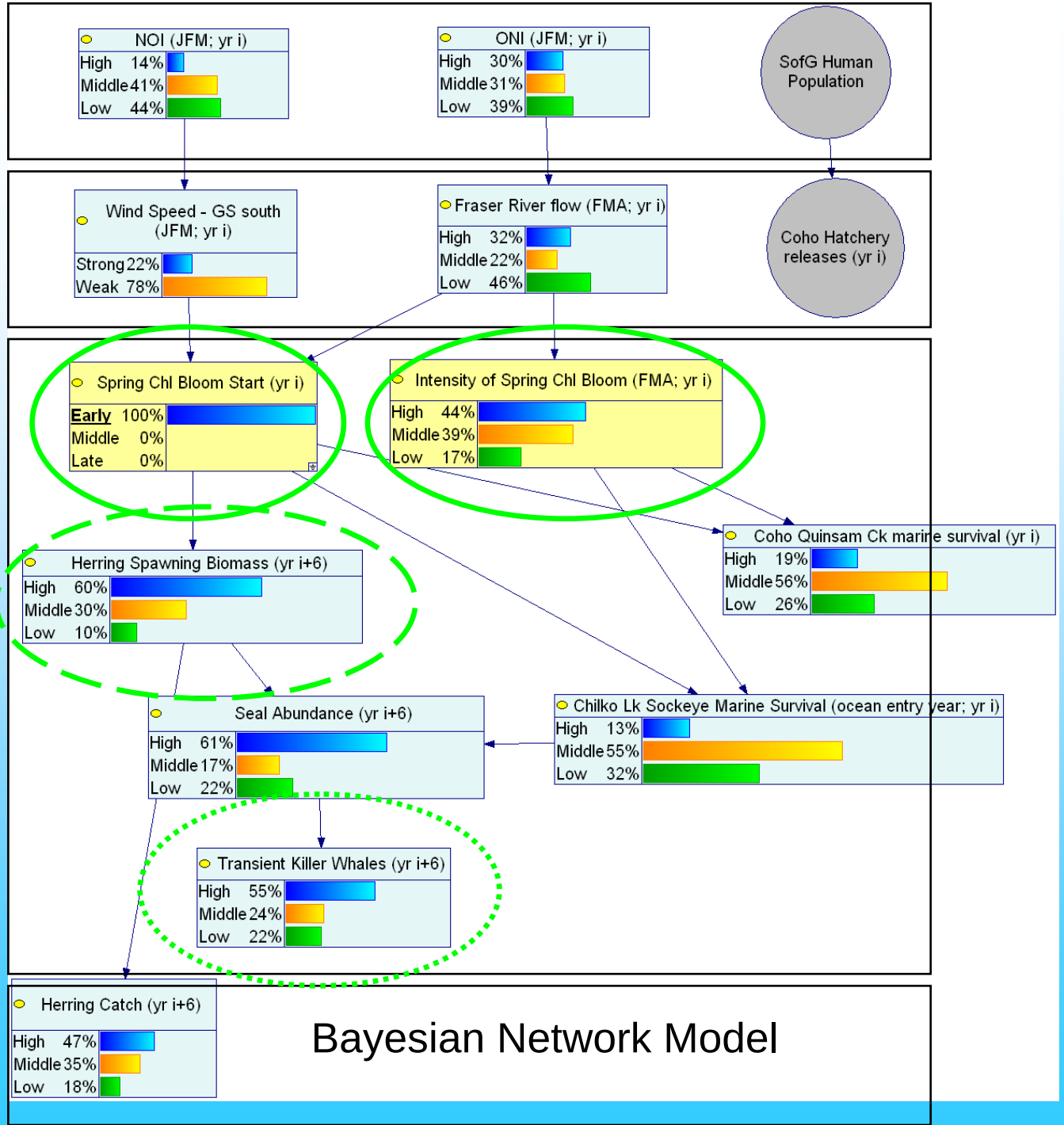

Management in an ecosystem context

Given the forces driving changes in the Strait of Georgia, it has become:

- increasingly dominated by human impacts, although environmental (climate-related) changes remain important
  - climate likely dominates inter-annual variability
  - climate and human impacts force decadal and longer variability
- different now than 30-50 years ago
- concern regarding possible reductions in the ability of the Strait to adjust to, and recover from, changes
  - i.e. reduction in the resilience of the Strait
- must maintain the natural abilities of this ecosystem to adjust to natural and human-induced changes
  - which processes and places are important: when, and how?
  - what indicators to monitor, and what are the 'threshold' levels?

Participants

B. de Lange Boom, J. Galloway, P. Wills, N. Sutherland, E. Gregr, G. Jamieson, J. Lessard, J. Schweigert, C. Fu, A. Pena, J. Holmes, T. Therriault, K. Cooke, L. Nichol, J. Ford, G. Ellis, P. Olesiuk, R. Sweeting, D. Mackas, R. Beamish, K. Lange, C. Neville, P. Ross, **S. Johannessen**, R. Macdonald, M. Galbraith, D. Faust, J. Gower, S. King, M. Foreman, M. Trudel, S.Tucker, J. Irvine, L. Godbout, D. Preikshot, T. Sutherland, P. Cummins, J. Curtis, C. Holt, M. Ikonomou, L. Godbout

www-sci.pac.dfo-mpo.gc.ca/sogeri/default_e.htm