Long term zooplankton monitoring and database programs in British Columbia:

tools and data to better understand a changing ocean

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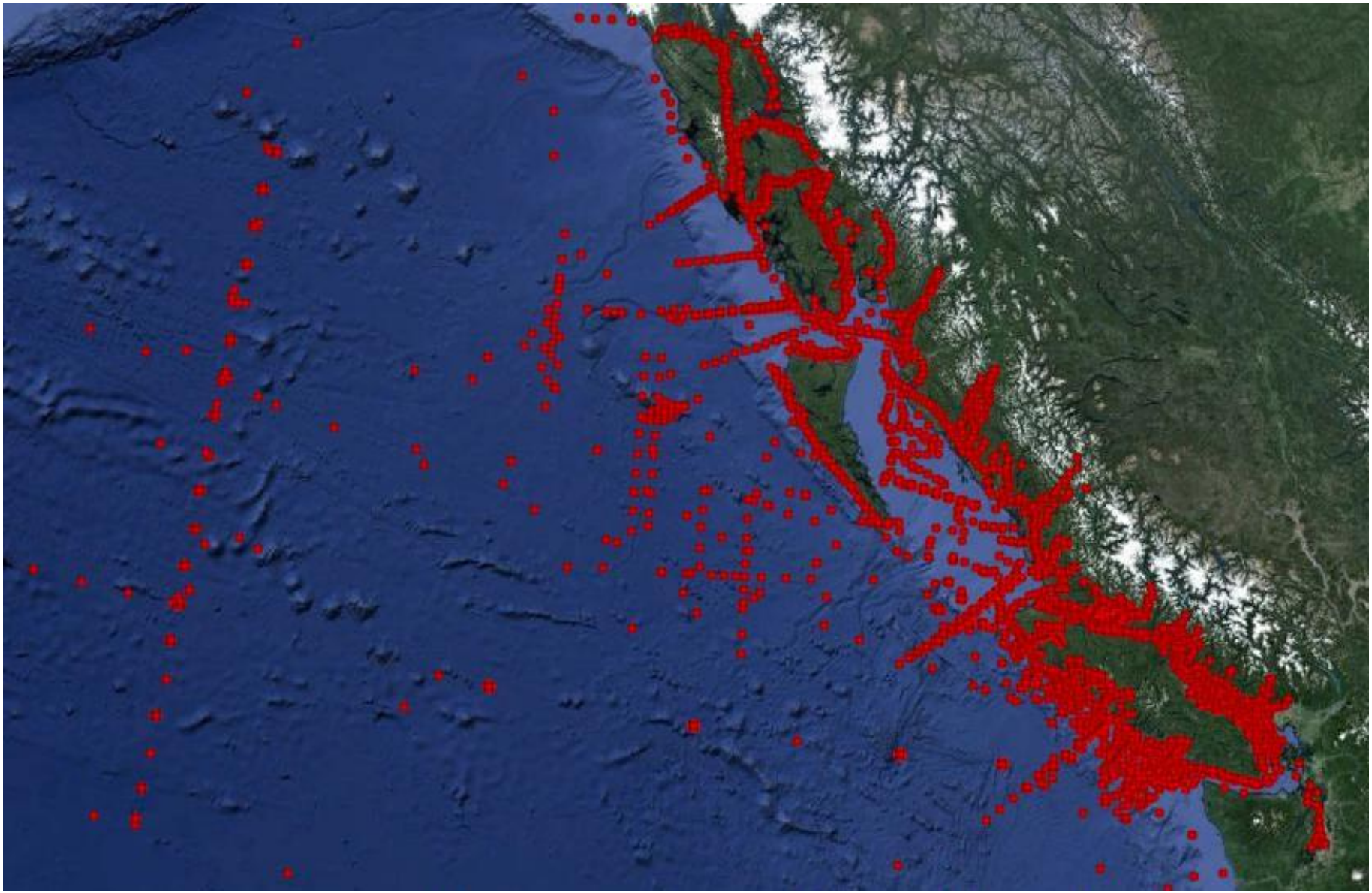
Objective

- to describe the DFO Pacific Region zooplankton database, and
- how it is being used to inform decisions in management and policy concerning climate, ecosystems, and fisheries

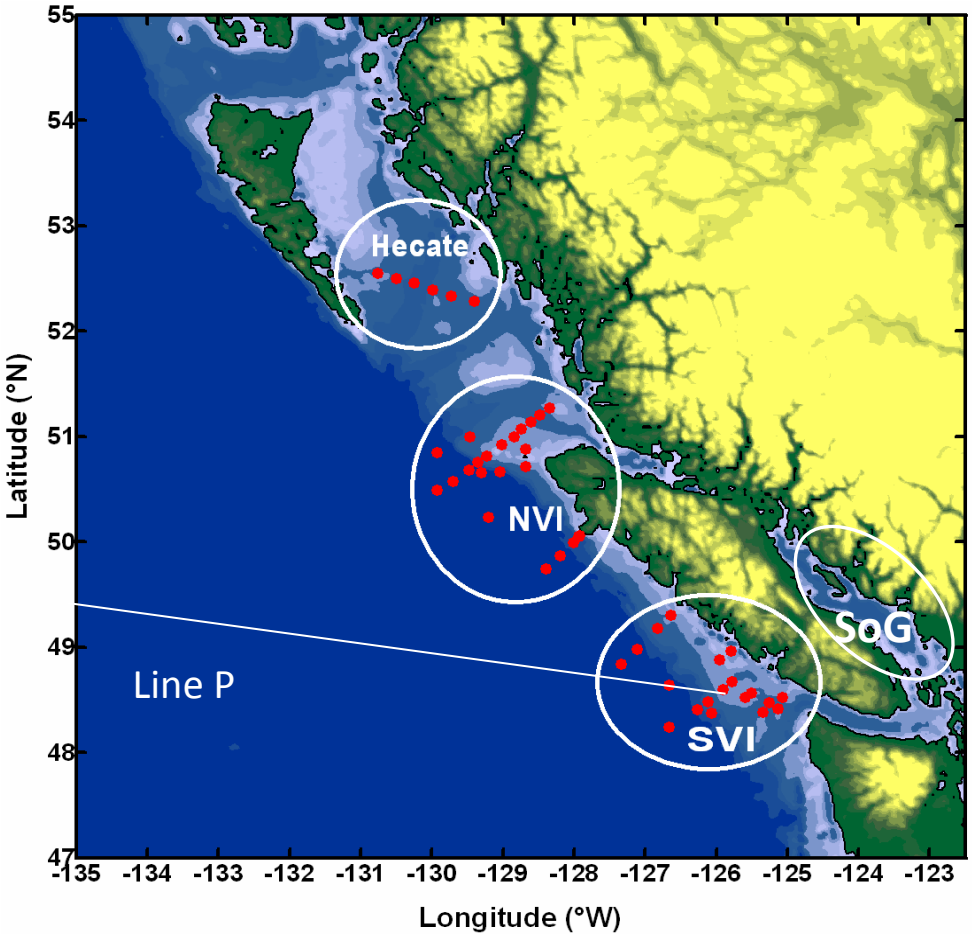
Why zooplankton time series?

- Zooplankton sampling methods are (relatively) :
  - simple,
  - intercomparable,
  - fishery-independent
- Key link between “physics” and “fish”
- Time scale of population response (~1 year or less) gives strong response to climate forcing at seasonal-decadal time scales
- Low cost (relatively)
- BUT needs a long-term commitment. Much of the interesting signal is decadal (or longer), and sustained sampling is necessary to develop a baseline climatology



West Coast of Canada: stations occupied 1979-2013

DFO Pacific Coast zooplankton sampling



Duration:

Southern Vancouver Island ~30y
Northern Vancouver Island ~20y
Hecate Strait ~12 years

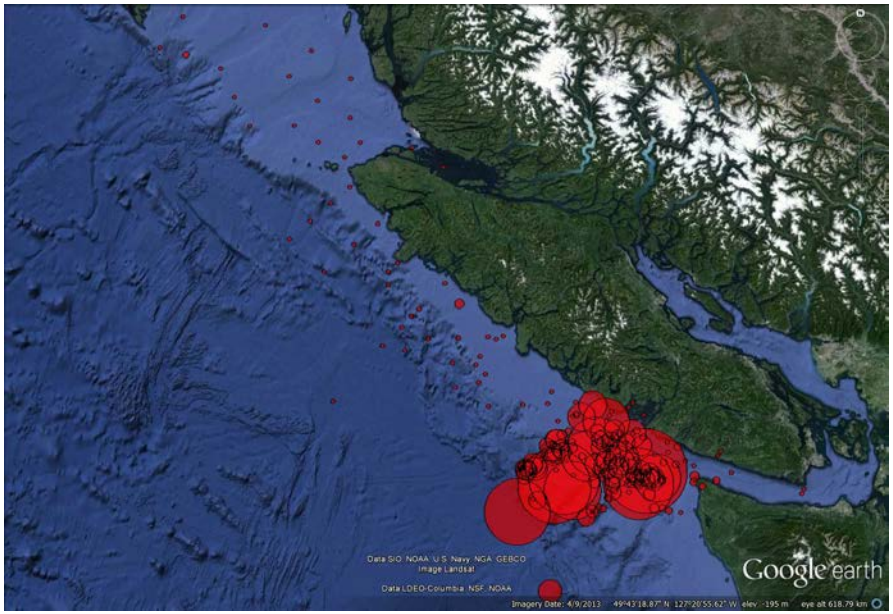
6 'statistical areas':

SVI offshore, SVI shelf, SVI eddy
NVI offshore, NVI shelf
Hecate Strait

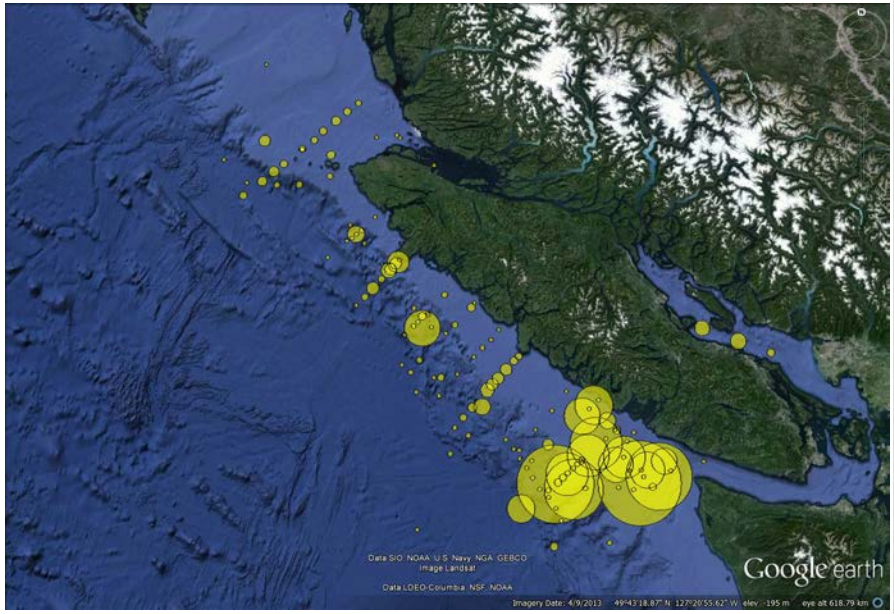
2-4 surveys per year in each region, total 10-30 samples per region per year

Also have:

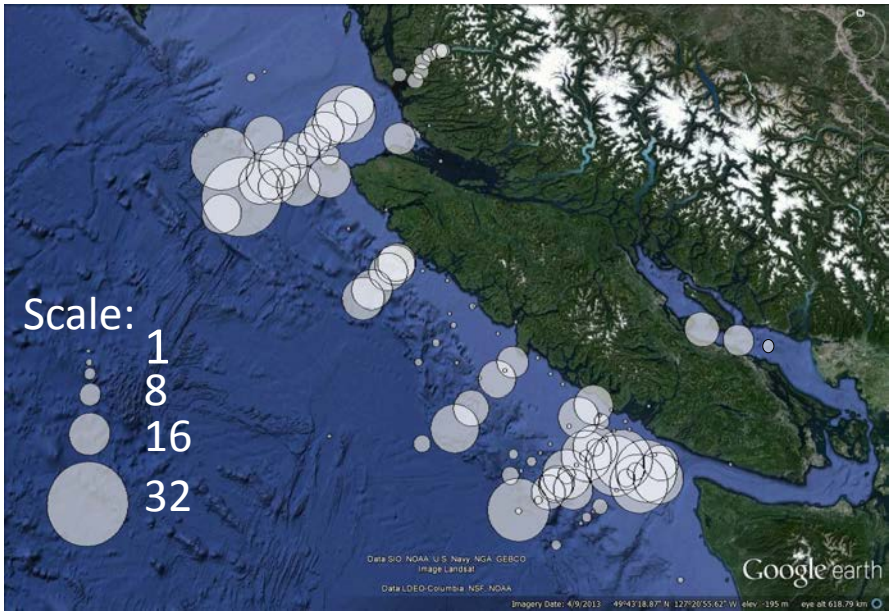
- **Station P biomass 1956-68**
- **Line P species count time series (7 stations, 3X per year~25 years)**
- **Strait of Georgia time series (a composite ~30 years)**



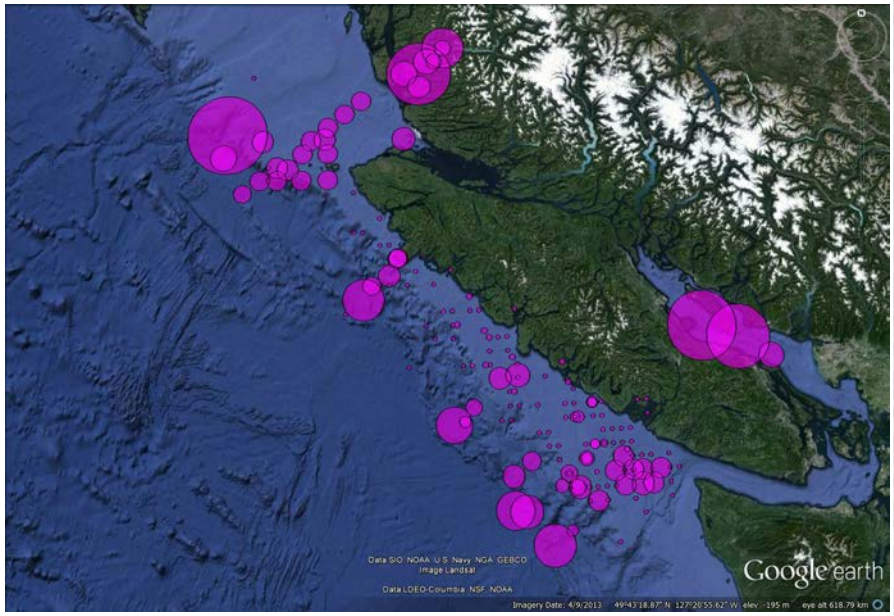
1979-1989



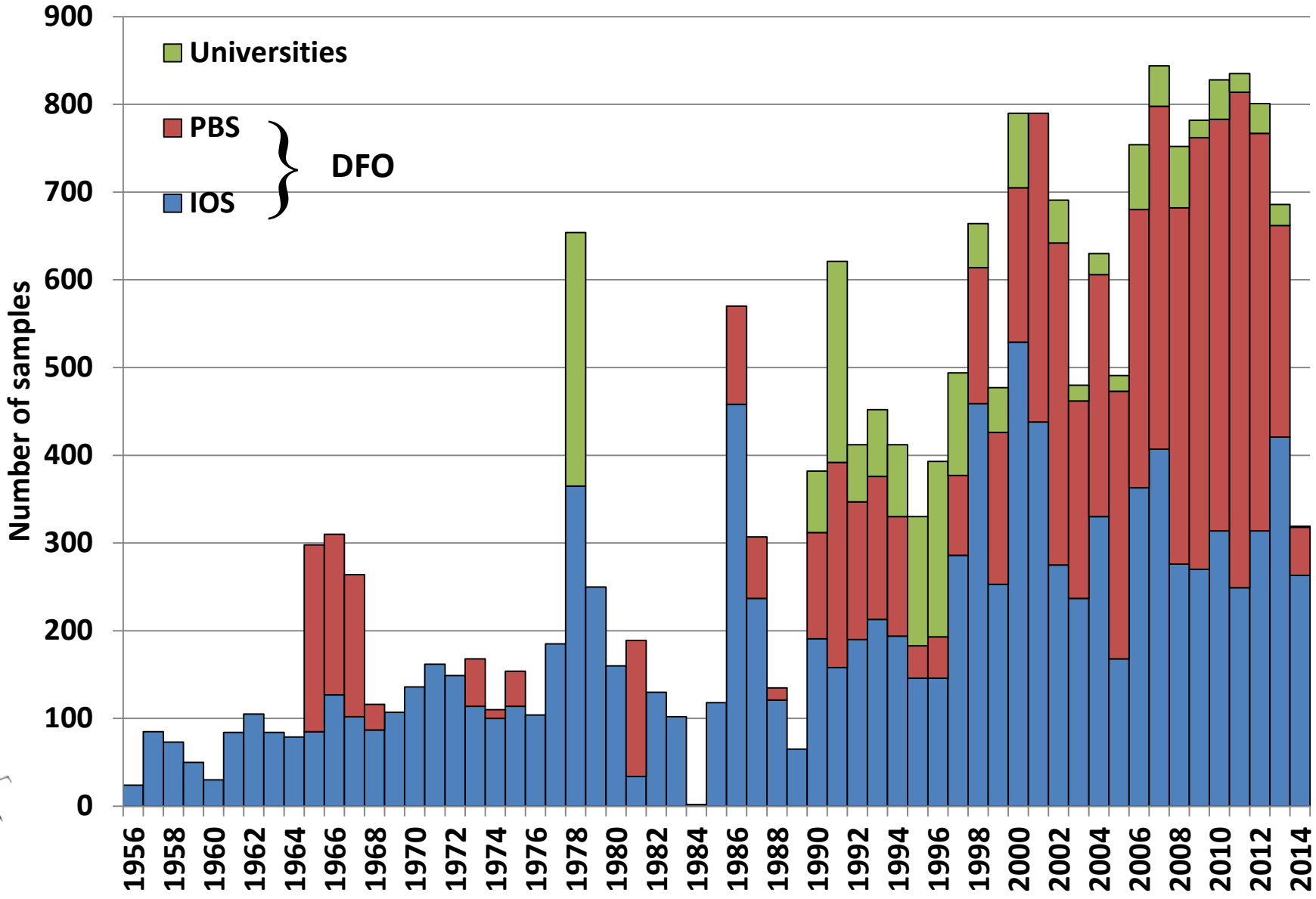
1990-1999



2000-2009



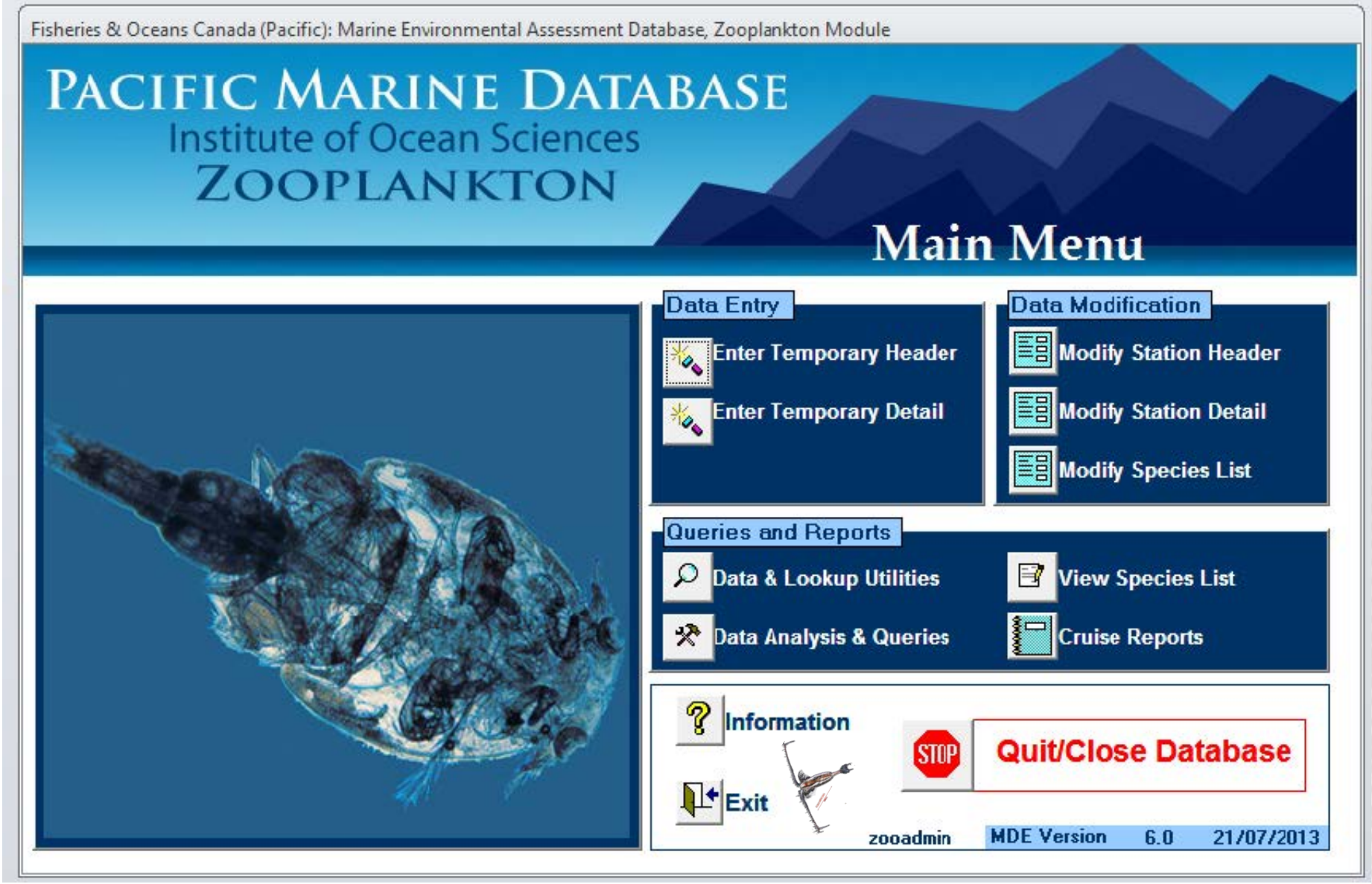
2010-2014



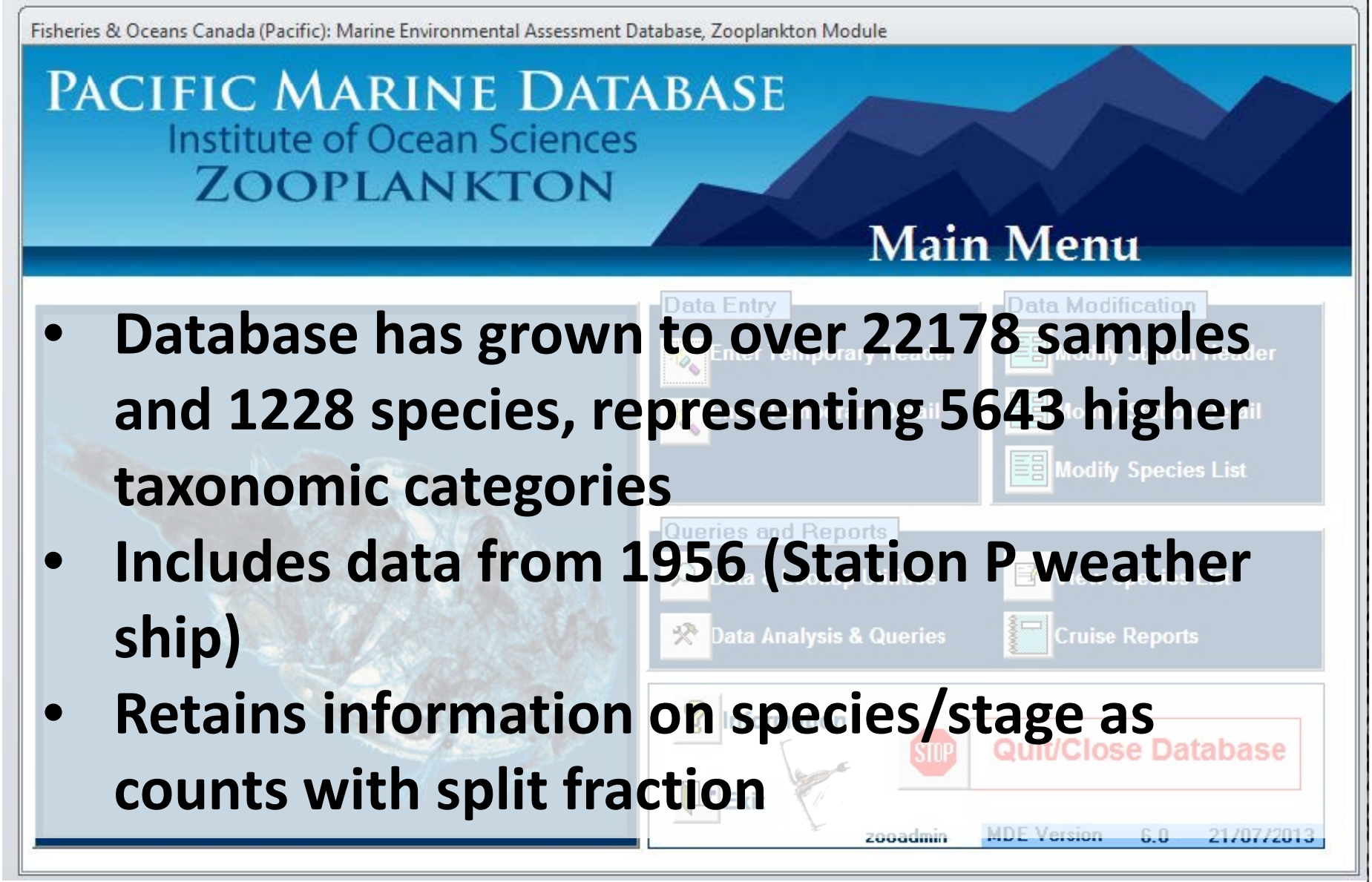
IOS Zooplankton Database samples by contributor

Important Variations in Sampling Methodology

Source 	Depth Range	Mesh Size	Region(s)	Taxonomy
PBS-60s	Water column	0.35 mm	All	"Major Groups"
UBC 70s-early 80s	Water column	0.35 mm	Central Strait	Copepods
IOS VNH 80s-now	0-250 m	0.23 mm	All (but sparse)	Species
IOS BIONESS	0-250 m	0.23 mm	All (targeted)	Euphausiids & Amphipods
PBS- Herring 90s-2010	0-20 m	0.35 mm	All (but mostly nearshore)	Species (copes pooled 90-94)
UBC & UVic 90s-2010	mix	0.23 mm	Central & Northern	Species
PBS-High Seas 2008-now	0-250 m	0.23 mm	Central & Northern	Species



Four parts: header (metadata), detail (species/counts), modify (quality control and updating), queries (analysis)



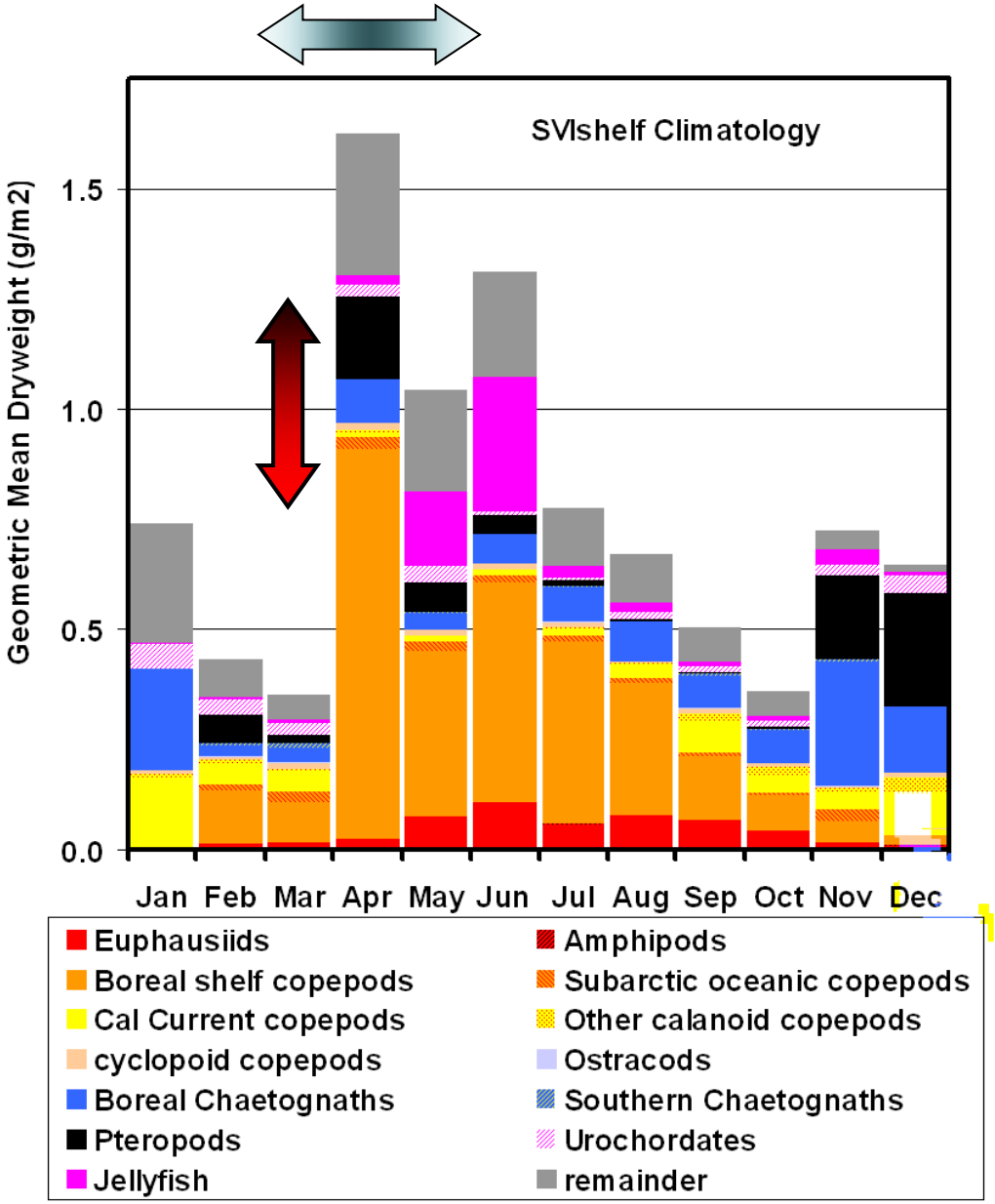
- **Database has grown to over 22178 samples and 1228 species, representing 5643 higher taxonomic categories**
- **Includes data from 1956 (Station P weather ship)**
- **Retains information on species/stage as counts with split fraction**

Four parts: header (metadata), detail (species/counts), modify (quality control and updating), queries (analysis)

Zooplankton have strong variability at many scales

- **Strong seasonality is the norm for mid-latitude zooplankton communities. Need to compare within-year data against a local "Climatology"**

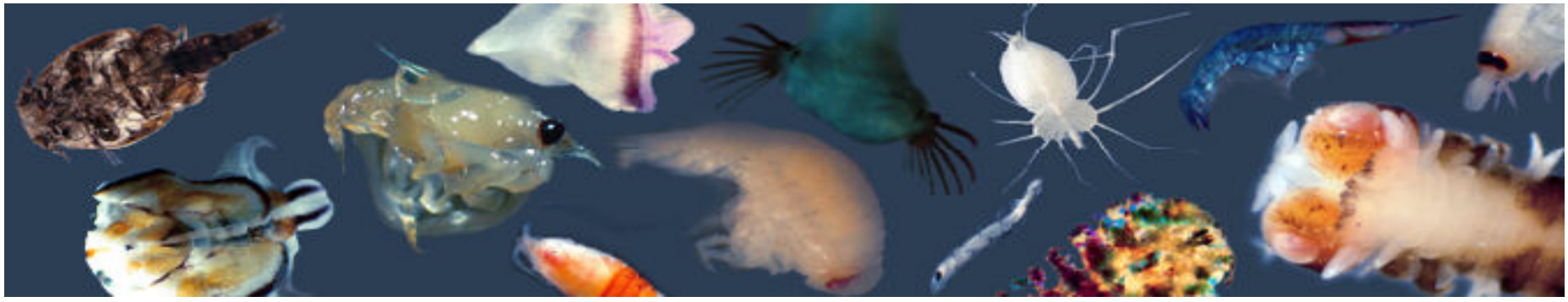
- **Key modes of variability:**
  - **Amount (Max, Min, and/or Integral)**
  - **Number and timing of biomass peaks**
  - **Composition (species dominance & diversity)**



Data processing methods: averaging and differencing to partition total zooplankton variance

Source/scale of variability	*How dealt with*
Unresolved small-scale patchiness plus sampling error	Minimized by averaging of 'replicates' at all levels
Persistent mesoscale spatial structure	Stratification of samples into spatial averaging units
Annual seasonal cycle	'Climatology': averaging within seasons across years
Interannual & decadal variability	'Anomalies': space-time averaged differences from climatology
'Global warming' trends	As for decadal

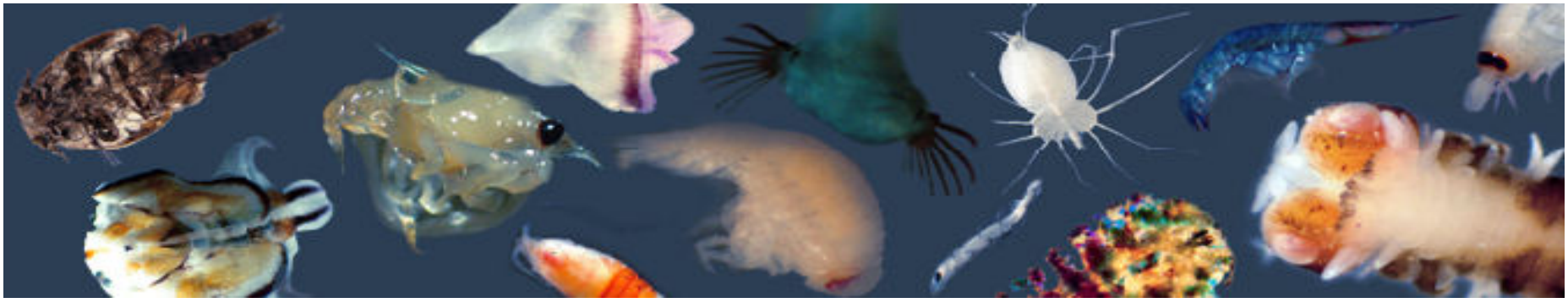
“Products” and their use in management and advice



“Products” and their use in management and advice

What are management and policy needs for zooplankton information?

- advance warning of major environmental changes, e.g. of ecosystem productivity
- direct predictors of changes in specific fish stocks
- separating changes related to fishing from changes related to the environment



Any plankton database has many potential users.

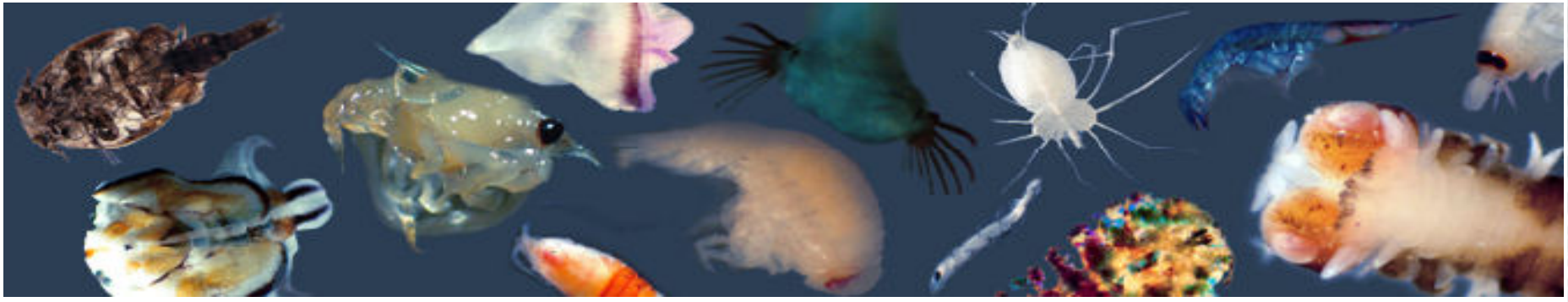
"Open Data" is a great goal, but there are risks and costs

Experience/understanding needed regarding:

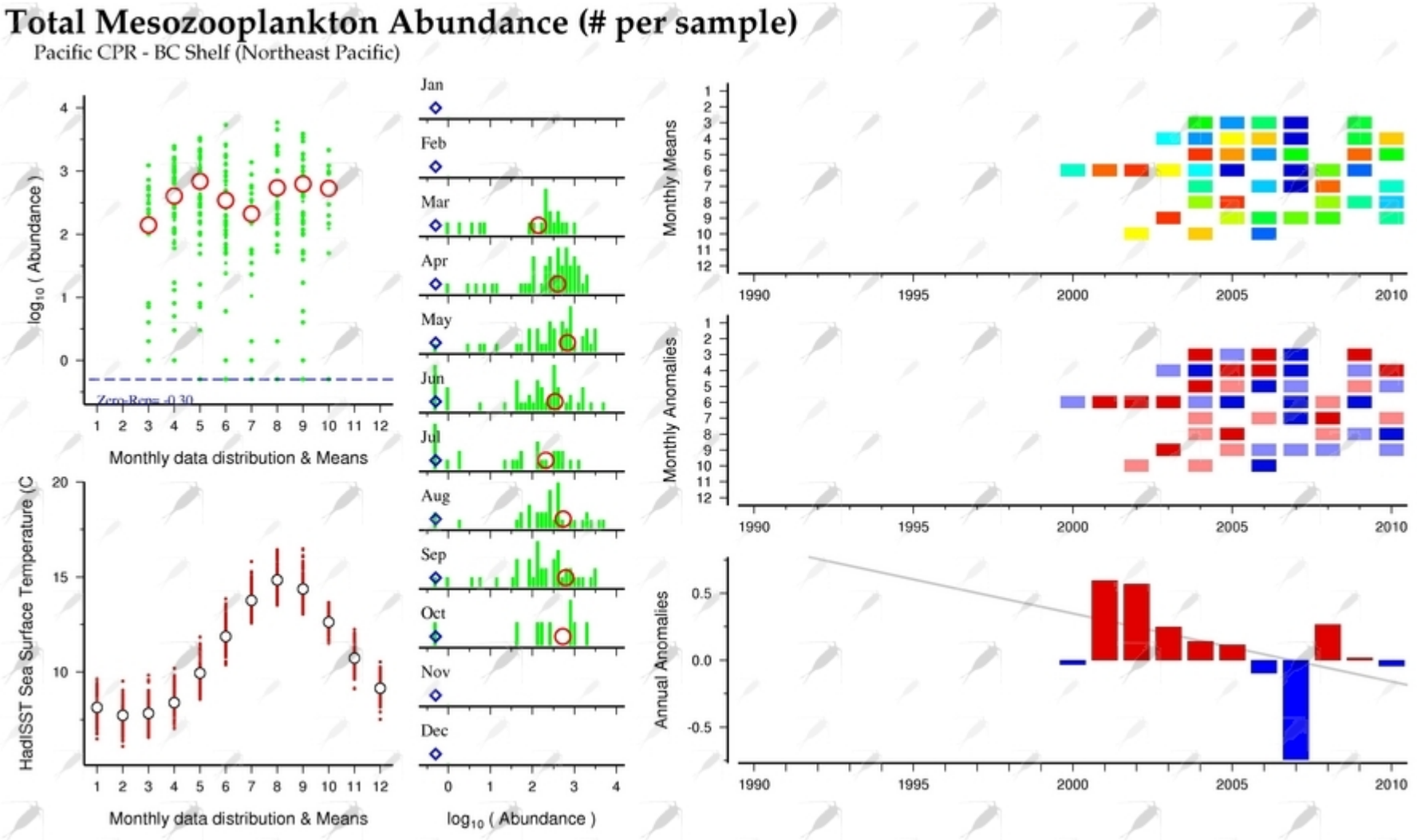
- Interpretive skills
- Knowledge of oceanography
- Strong in statistics
- Experience in sampling methods

Risks:

- Wrong comparison
- Inattention to fine detail
- Miss the big picture
- Apply wrong analysis
- Pick inappropriate data points
- Compare apples to oranges



Contributions to global plankton databases: Example of going from observed data to seasonal cycle to anomalies (COPEPOD database; Todd O'Brien, NOAA)



DFO's Annual 'State of the Pacific Ocean' Reports

State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems in 2013

R. Ian Perry (Ed.)

Fisheries & Oceans Canada
Pacific Biological Station,
3190 Hammond Bay Road,
Nanaimo, B.C. V9T 6N7
Canada

2014

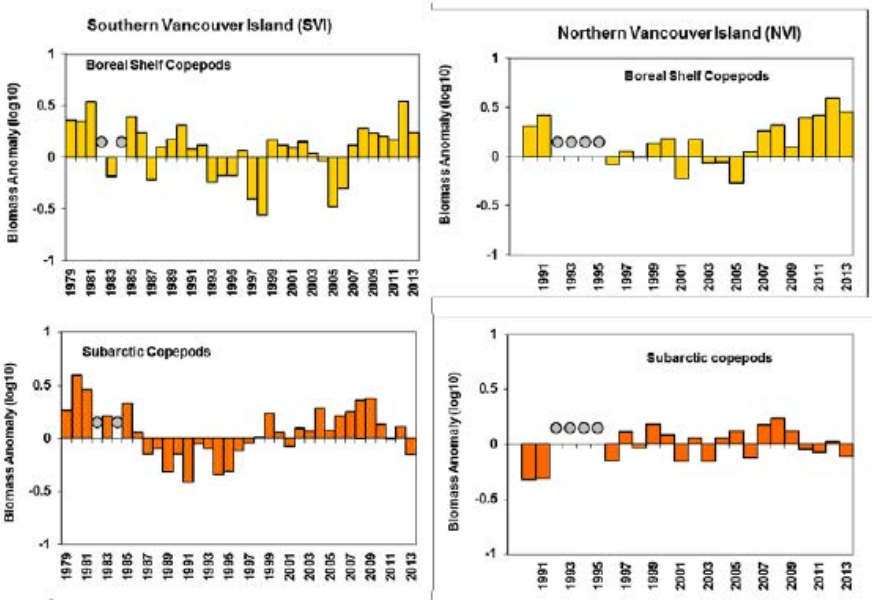
Canadian Technical Report of Fisheries and Aquatic Sciences 3102

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

15. Zooplankton along the BC continental margin: a near-average year

Moira Galbraith, Dave Mackas and Kelly Young, Fisheries & Oceans Canada, Institute of Ocean Sciences, Sidney, B.C.

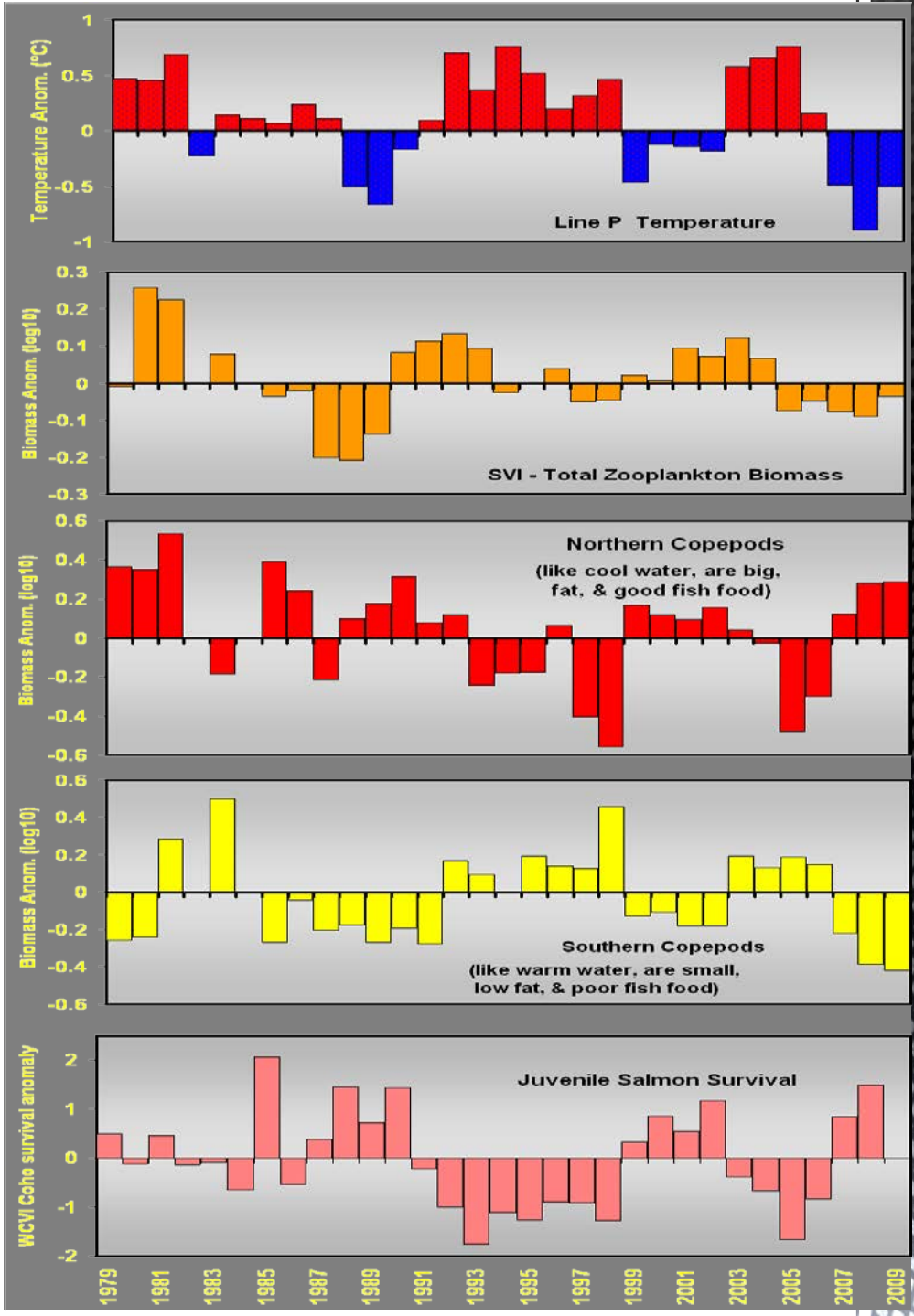


Changing Zooplankton Communities:

Zooplankton community composition also responds strongly to ocean currents and temperature

Composition anomalies are larger, and are better predictors of fish growth and survival, than anomalies of "Total Biomass"

Hypothesized mechanism behind the correlation: differences in FOOD QUALITY



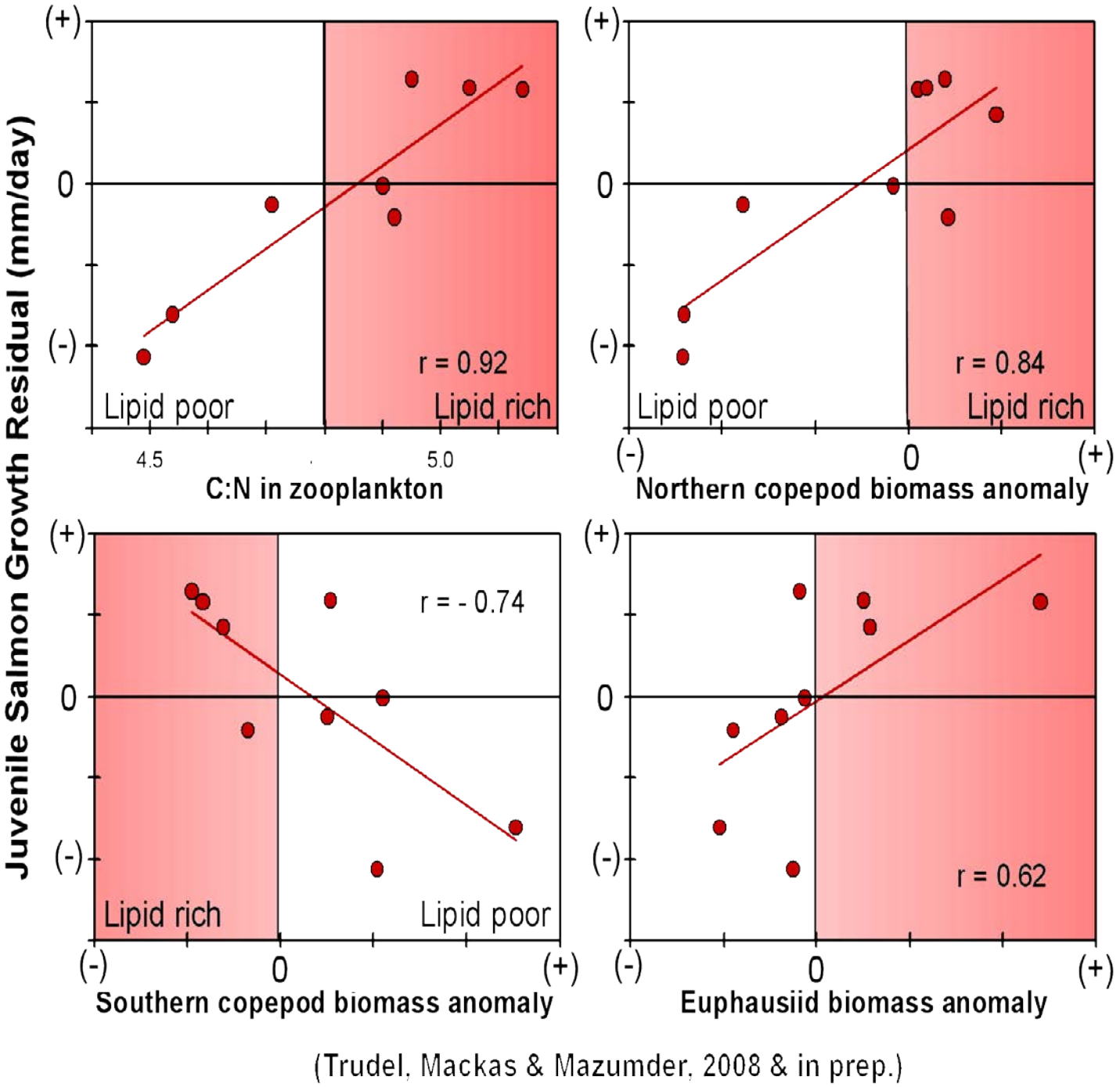
“Lean Cuisine” and Salmon

Young fish must grow fast to survive

Young fish must eat well to grow

Large fat zooplankton are energy rich food

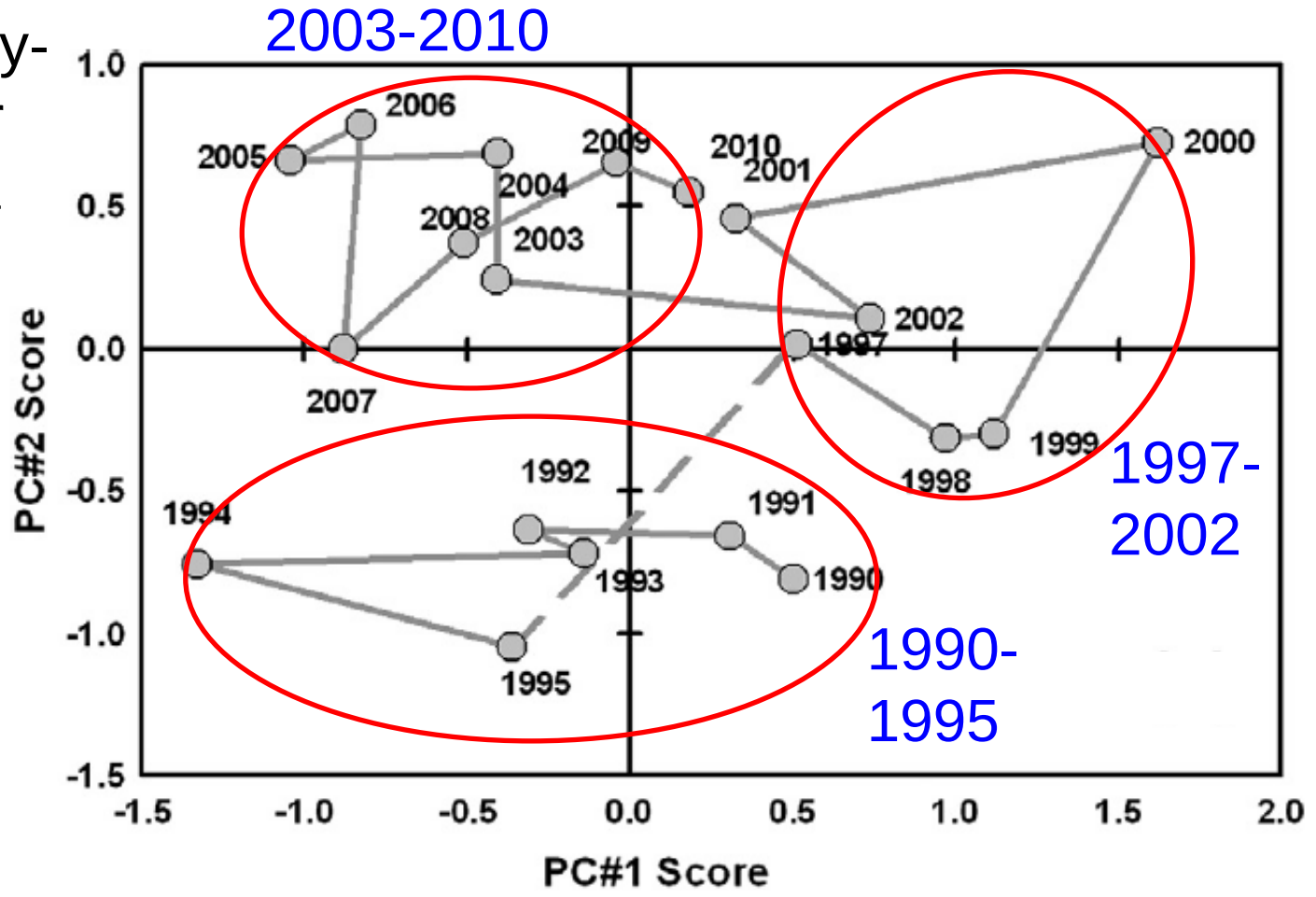
‘Quality’ transmits quickly to higher trophic levels



(Trudel, Mackas & Mazumder, 2008 & in prep.)

Zooplankton productivity and community composition – Strait of Georgia

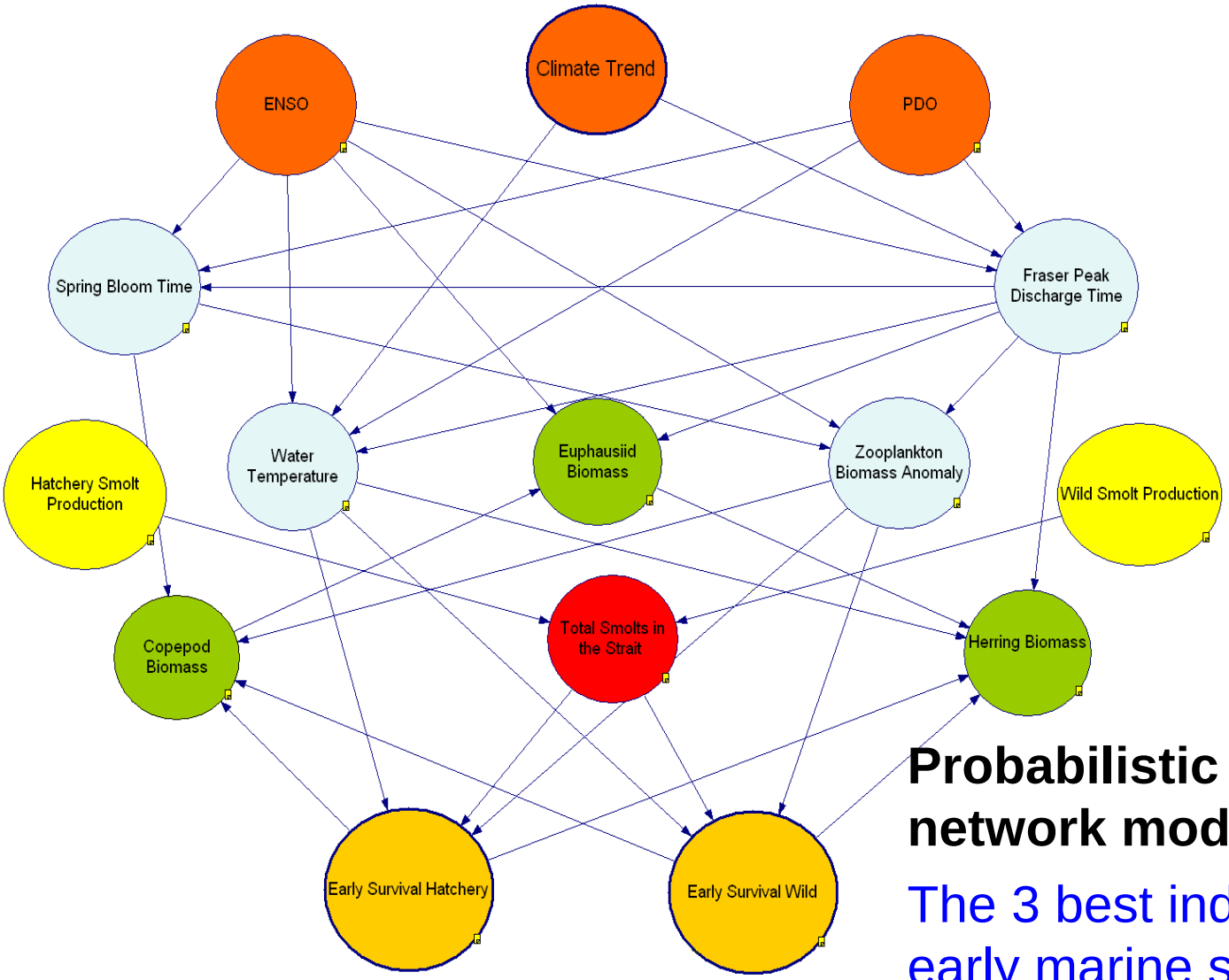
Energy-poor taxa



Energy-rich taxa

Mackas et al. 2013. Prog. in Oceanogr. 115:129-159.

Coho in the Strait of Georgia



Probabilistic (Bayesian) network model

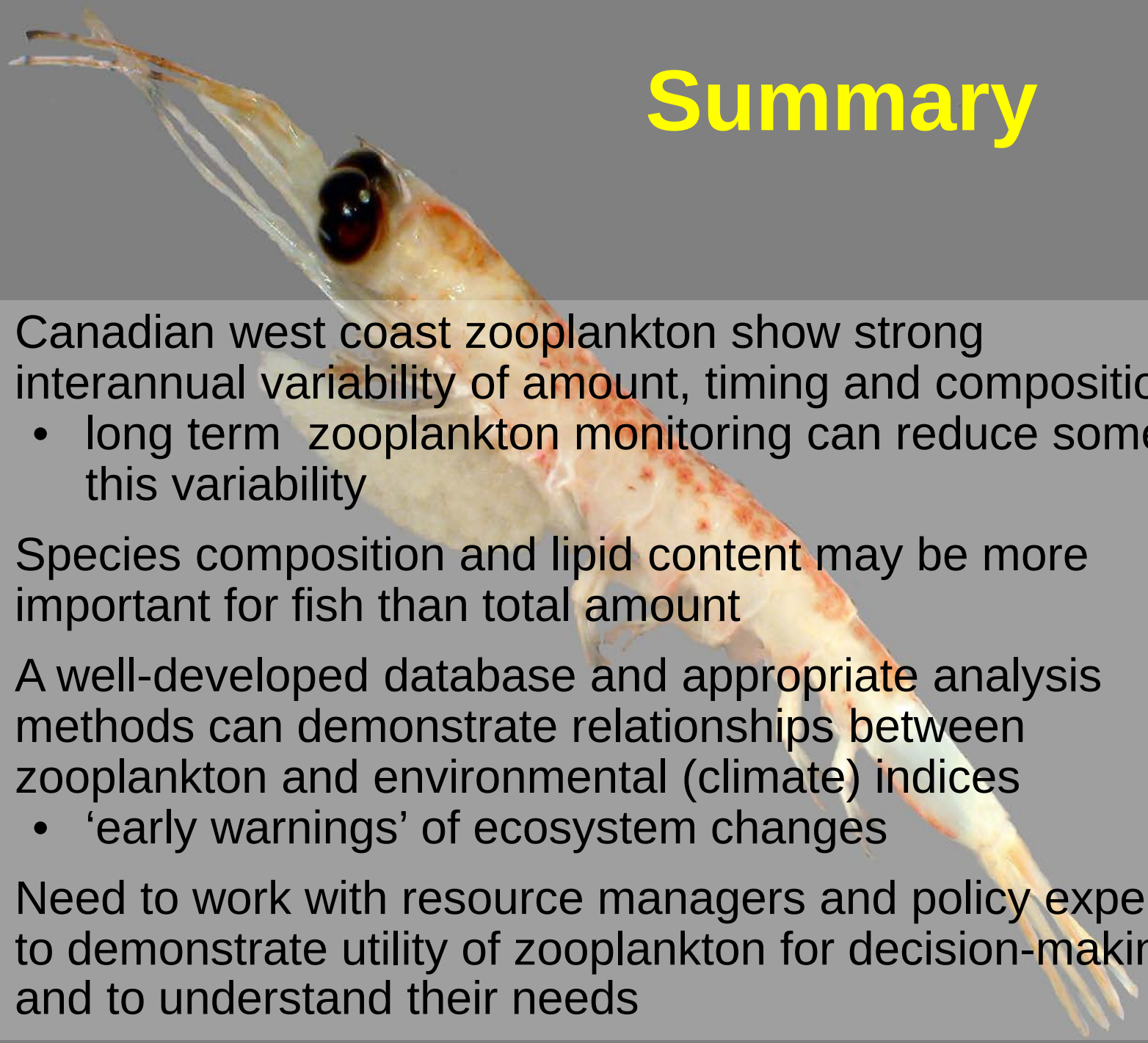
The 3 best indicators of Coho early marine survival:

- zooplankton biomass anomaly,
- calanoid copepod biomass,
- biomass of herring

Araujo et al. 2013. Progress in Oceanography 115: 41-52.

Difficulties in using zooplankton routinely in support of (fisheries) management and policy advice:

- Observations of mechanisms for direct links between particular zooplankton species and particular fish stocks are difficult to obtain
  - because of sampling issues in matching prey available in the environment with predator gut contents
  - links are usually indirect, e.g. correlations – but these require long time series to obtain
- Absolute abundance/biomass may not be the ultimate indicator – “food quality” may add complications
- Expense and delays in collecting and processing samples
- Difficulties in institutional support for long-term plankton monitoring programs



Summary

- Canadian west coast zooplankton show strong interannual variability of amount, timing and composition
  - long term zooplankton monitoring can reduce some of this variability
- Species composition and lipid content may be more important for fish than total amount
- A well-developed database and appropriate analysis methods can demonstrate relationships between zooplankton and environmental (climate) indices
  - ‘early warnings’ of ecosystem changes
- Need to work with resource managers and policy experts to demonstrate utility of zooplankton for decision-making and to understand their needs