Ship of Opportunity Sampling of Lower Trophic Levels

Sonia Batten





Since 1853 there has been an international scheme using Ships of Opportunity to collect weather data.

sailwx.info

At any one time there are 100s of vessels crossing the oceans.

Oct 1st, 2013

Ship locations map **Tides and currents** Ship tracker Weather observations Resources Zoom in Zoom out www.sailwx.info Siku 50 Berling See 200 00 -100 00 Perseverance St Paul Research · Valdez Research Millennium Star, **Roger Blough** Alaska Mariner Justine Foss Ethan B Polar Viking Paul R Tregurtha. M/V Aurora APL Scotland Maia H 10028 Sam Laud Taurus Rainier 40700 40532 USCGC Healy 10 508 Western Navigator Walter J Mccarthy Star Dieppe Smit Dawn 10582 45767 Osaka Express Karen An Polar Adventure Kodiak Ocean Eagle Odiak Polar Enterprise 40005 40.00 40924 Kodiak 40761 Polar Ent 40902 Ace Century Serene 46517 Sea-land Charger 47903 40510 40705 Westerdam Henry Sause Santa Romana, F/V Lisa Melinda Zivili! 40502 40504 4058540584 Star Kvarven 2 1905 Sea-land LightningAmerican Dynasty Pegasus CMA CGM Butterfly 40500, 21913 21917. Overseas Los Angeles Norwegian Pearl 2 1892 21919 21022, Polar Discovery a lisce Ever Conquest Falcon Trader 1 30 Fuckushima Maru AMOHK01 Harmony 30 Gulf Reliance Star Atlantic Maple Fortune 21954 MSC Lisbon 40704 40587 El Mirar II 40518 40011 Dumun Monte Olivia, Maersk Winnipeg 78-519 4690651018 APL Malaysia Sun Round 51640 anone. 21853 Red Rooster III Horizon Reliance Nyk Lynx Tamina 40021 MOL Precision \$1041. 51042, Taipan Forever Sw Emu Arrow Moran 51039, 20 00 20 Volendam Tb Az Marigold 21539 Kilo Moana. 51520 Pride of America Sloss, 228 448 660 888 NH 10

In this presentation:

 Pros and cons of SoOp sampling & the CPR approach

Adding value to the CPR survey
Additional variables
The CPR as a platform
Increasingly diverse applications

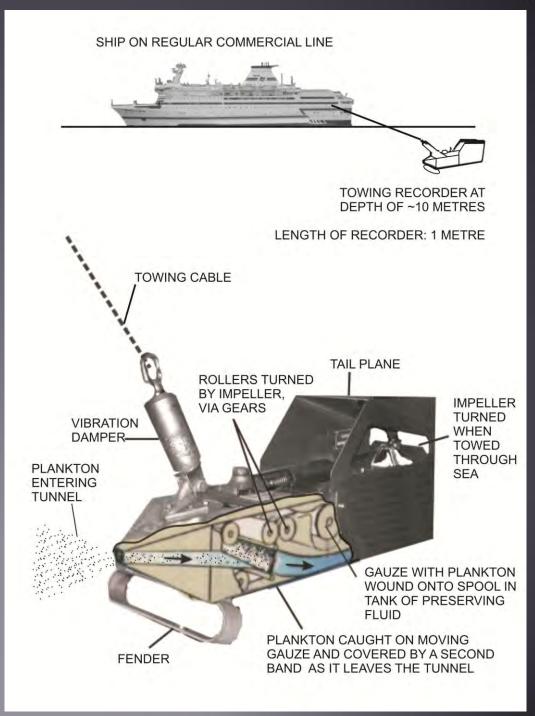
What is a CPR?

•A robust device for collecting surface plankton over large spatial scales

•capable of operating at high speeds (>20 knots)

needs a minimum of attention

designed for ships of opportunity



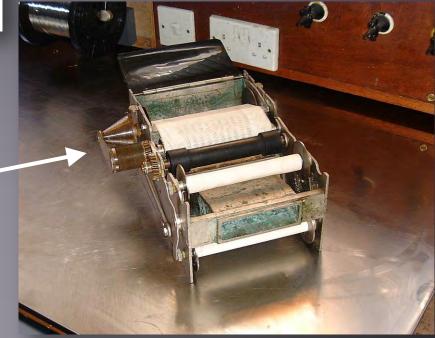
Designed by Alister Hardy in the 1920's



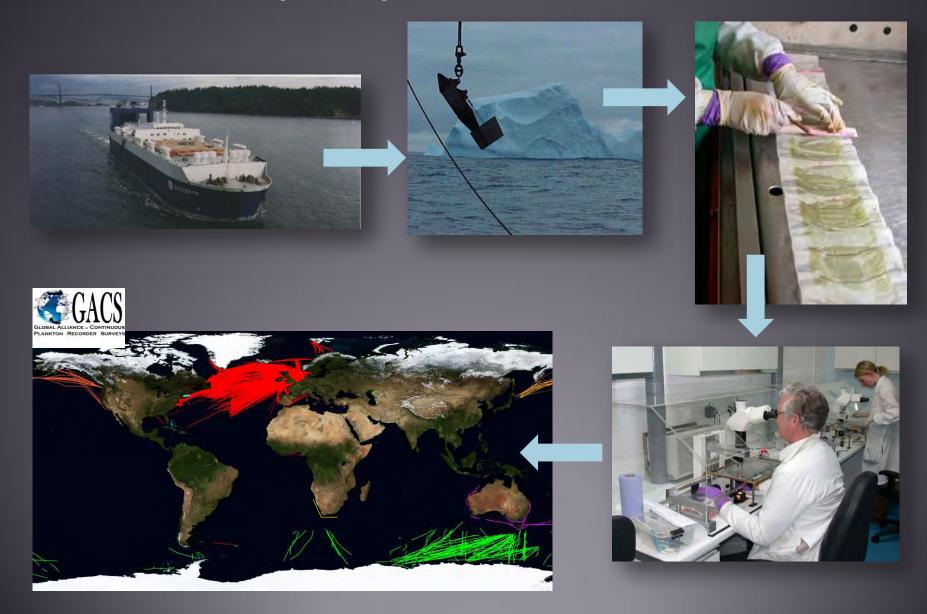


An internal cassette fits into the towing body

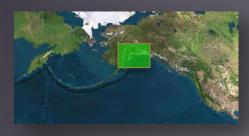
Pre-loaded with filtering mesh and wire on a fusee to drive the uptake spool



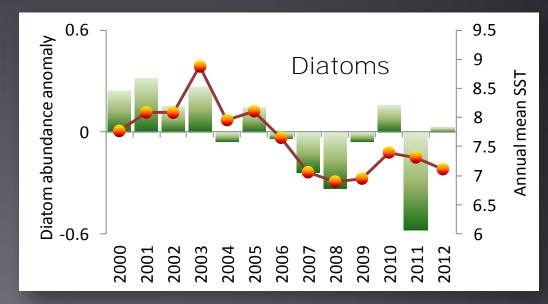
The CPR Survey today



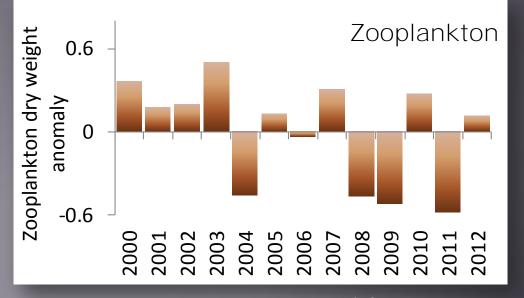
Annual abundance anomalies, all shelf samples



SST data courtesy of http://las.pfeg.noaa.gov



positive correlation ($r^2=0.42$, p<0.02)



Strong positive correlation btwn diatoms and zoopl ($r^2=0.53$, p<0.01)

Pros and Cons: (note that limitations of the methodology won't be discussed here, too big a topic, but see literature)

+ Cheap!

- + particularly important for remote ocean regions
- + can tailor analysis to match funding.

+ Reliable

- + Internally consistent
- + Other instrumentation can be added (see later)
- + Sample archive for future studies (see later)
- Sample analysis is labour intensive
- Lack of control over timing and locate
- Liaising with ships
 - low on their priority list
 - discrepancies with info.

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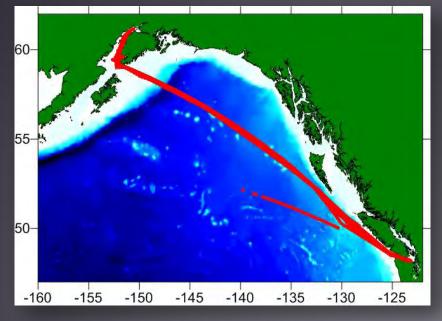
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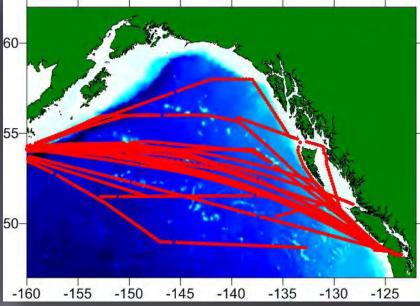
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Examples of route consistency





Pacific survey, north south transect.

53 separate transects,2004-2012High repeatability

Pacific survey, east-west transect.

33 separate transects,2000-2012Lower repeatability

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Example of Ship's log conflict

CPR with a temperature sensor fitted was deployed in the N Atlantic. **Arrows mark ship's log times of shoot and haul –** first 2 agree with temperature record, but 4 hour discrepancy with 2nd shoot. What to do?

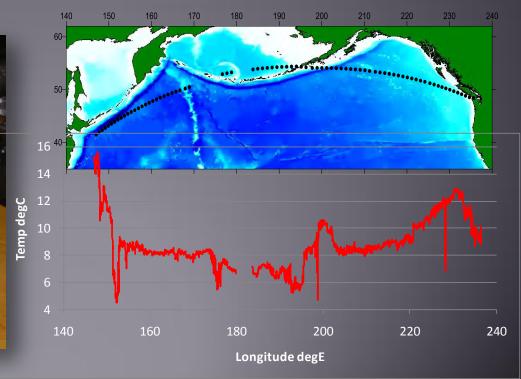


The CPR as a platform – adding instrumentation

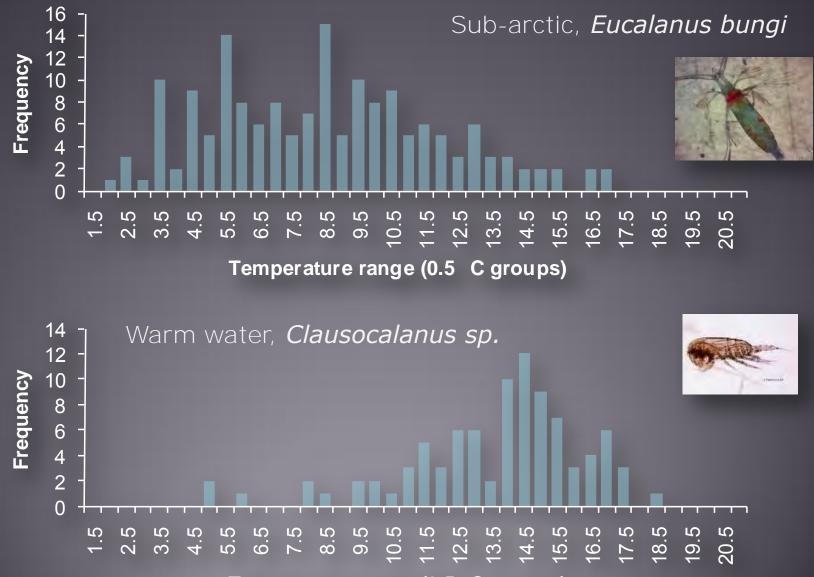
Temperature loggers (most basic) CTD-F (more expensive)

(R-620



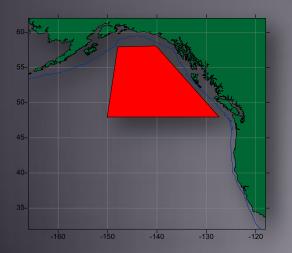


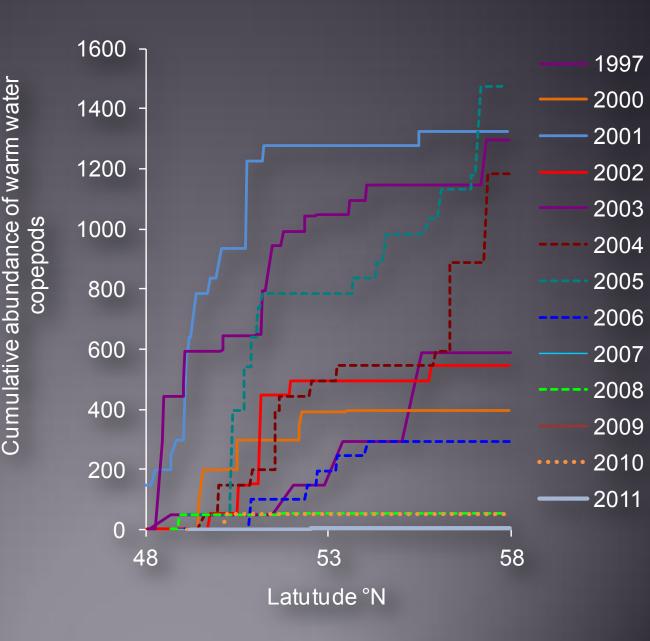
Temperature distributions of two example taxa



Temperature range (0.5 C groups)

Cumulative abundance of warm-water copepods each year, south to north, Mar-Sept, for oceanic region



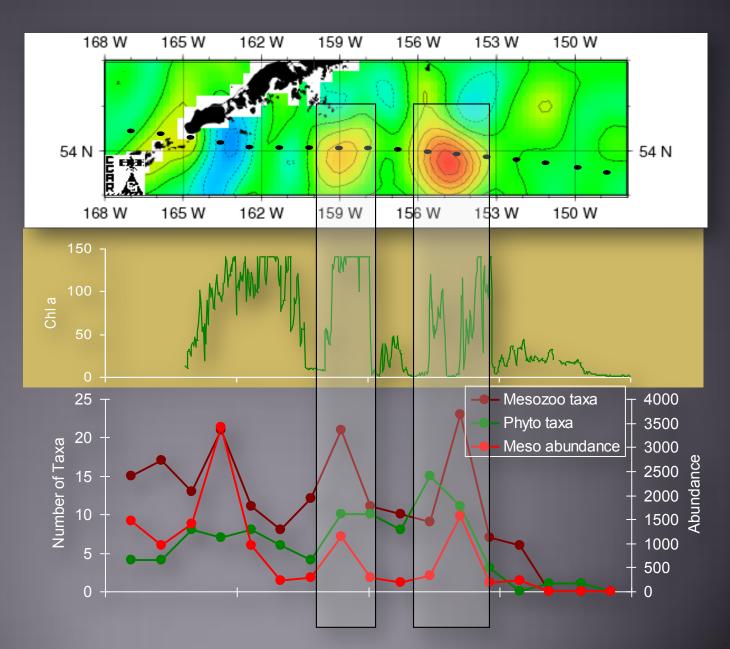


Updated from Batten & Walne (2011), Journal of Plankton Research

Chlorophyll from the CTD-F

June 2005

Transect through 2 eddies



Bird/mammal observers

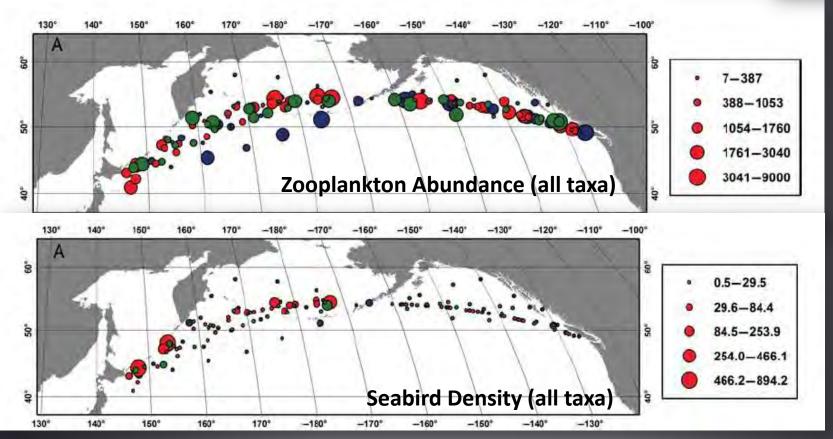
- logistically more complex (e.g. diversion insurance, port of departure/arrival)
- more expensive



Macro-ecology of plankton-seabird associations in the North Pacific Ocean

¹FARALLON INSTITUTE FOR ADVANCED ECOSYSTEM RESEARCH, PO BOX 750756, PETALUMA, CA 94952, USA, ²CANADIAN WILDLIFE SERVICE, ENVIRONMENT CANADA, C/O INSTITUTE OF OCEAN SCIENCES, FISHERIES AND OCEANS CANADA, 9860 W. SAANICH ROAD, SIDNEY, BRITISH COLUMBIA, CANADA AND ³SIR ALISTER HARDY FOUNDATION FOR OCEAN SCIENCE, CITADEL HILL, THE LABORATORY PLYMOUTH PLI 2PB, UK





Water and Microplankton Sampler (WaMS). Aimed at smaller size-fraction (nano and pico) plankton community. Flow cytometry, Molecular probes and barcoding, Harmful Algal Bloom microarrays





"Bring back data, not samples" MBARI

However, an archive of samples allows for un-envisaged future applications, e.g. (just in last few years):

Mapping microplastics

•Stable isotope work to reveal trophic linkages

Molecular studies

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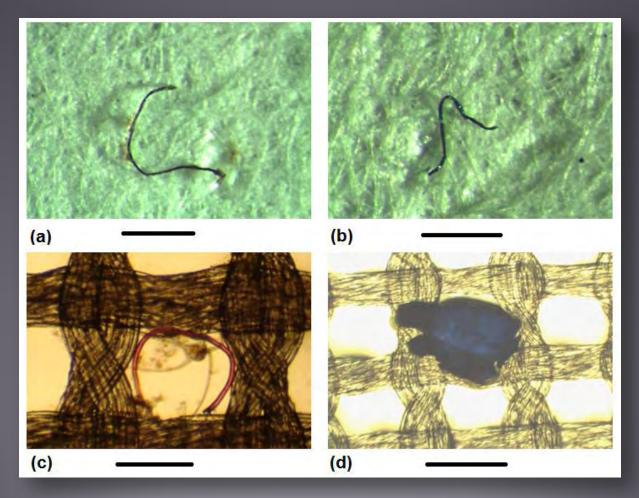
Mapping microplastics

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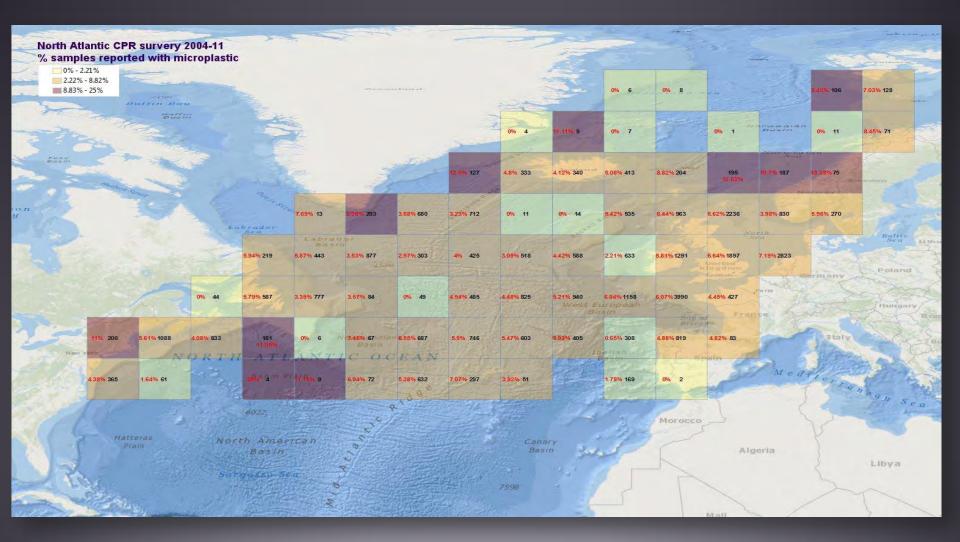
•Molecular studies

Examples of different forms of microplastic debris found in CPR samples.

Polyester fibres (a,b), nylon (c) and Polyethylene terephthalate fragments (d). Scale bar represents 270 μ m.



Courtesy of Saeed Sadri, PhD student, University of Plymouth/SAHFOS



5x5 degree grid with number in black representing the sampling effort.

Courtesy of Saeed Sadri, PhD student, University of Plymouth/SAHFOS

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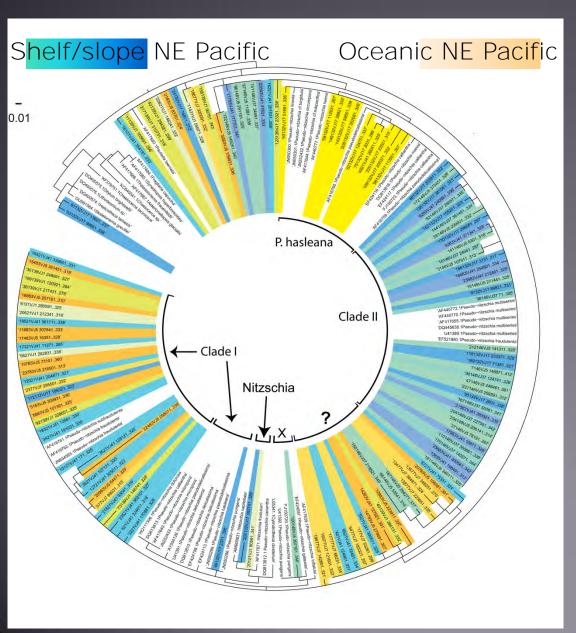
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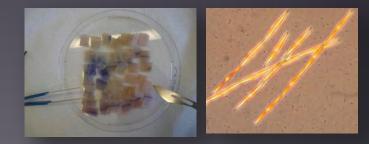
•Mapping microplastics

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Molecular studies

Molecular studies on NE Pacific CPR samples





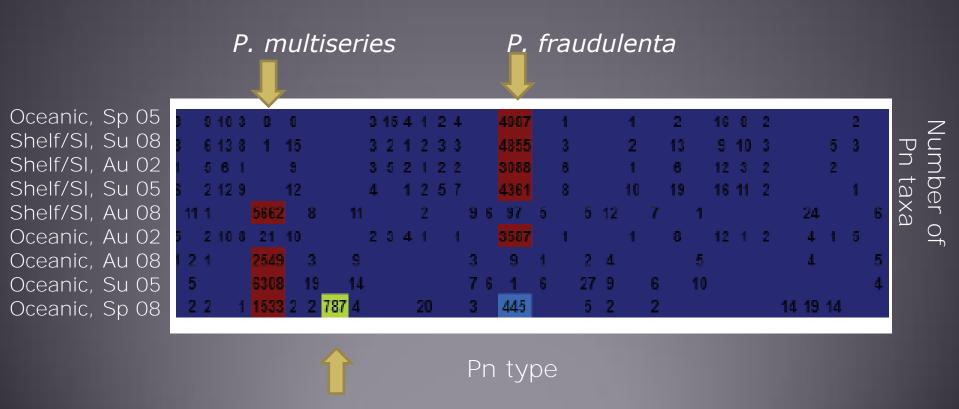
12 out of 30+ Pseudonitzschia spp. form HAB
Not identifiable by microscopy
Using DNA marker: D1-D2 large ribosomal subunit, identified into genetic clades

CPR samples contained

- Clade I: P. fraudulenta
- Clade II: *P. multiseries*
- P. hasleana- new Pacific
 NE species

Courtesy of Rowena Stern, SAHFOS

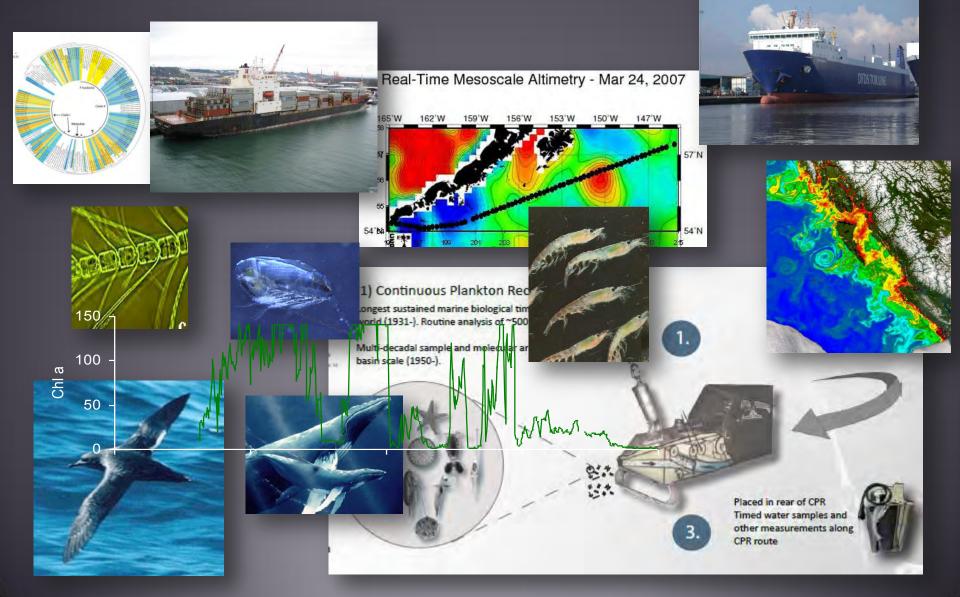
Regional differences (Oceanic v shelf/slope)Anomalous seasons (e.g. Spring 2008)



P. hasleana

Courtesy of Rowena Stern, SAHFOS

The capabilities for a multi-disciplinary, costeffective sampling program exist.



Further information can be found at:

www.globalcpr.org (GACS)

www.sahfos.org (CPR parent organisation)

www.pices.int/projects/tcprsotnp/default.aspx (N Pacific survey and CTD data)



Fisheries and Oceans Pêches et Océans Canada

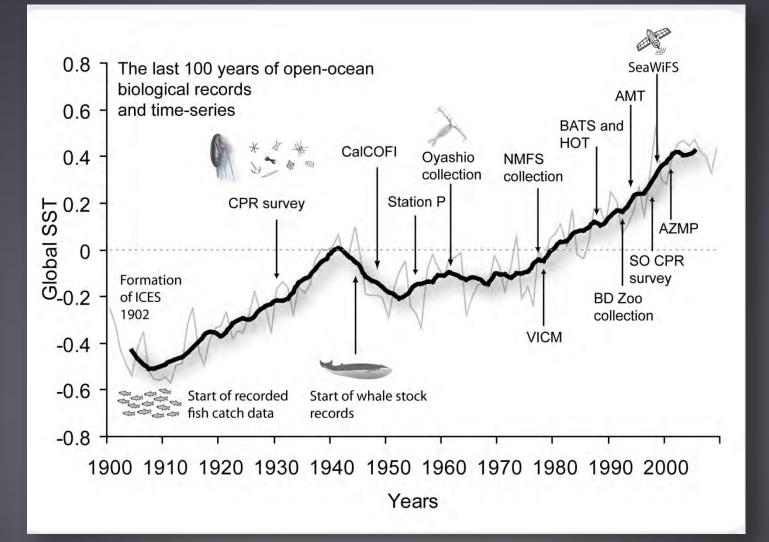








Sustained open ocean biological time series are rare.....



Edwards et al., Trends in ecology and Evolution, 25, 2010