



*An online toolkit for  
plankton time series  
analysis and visualization.*

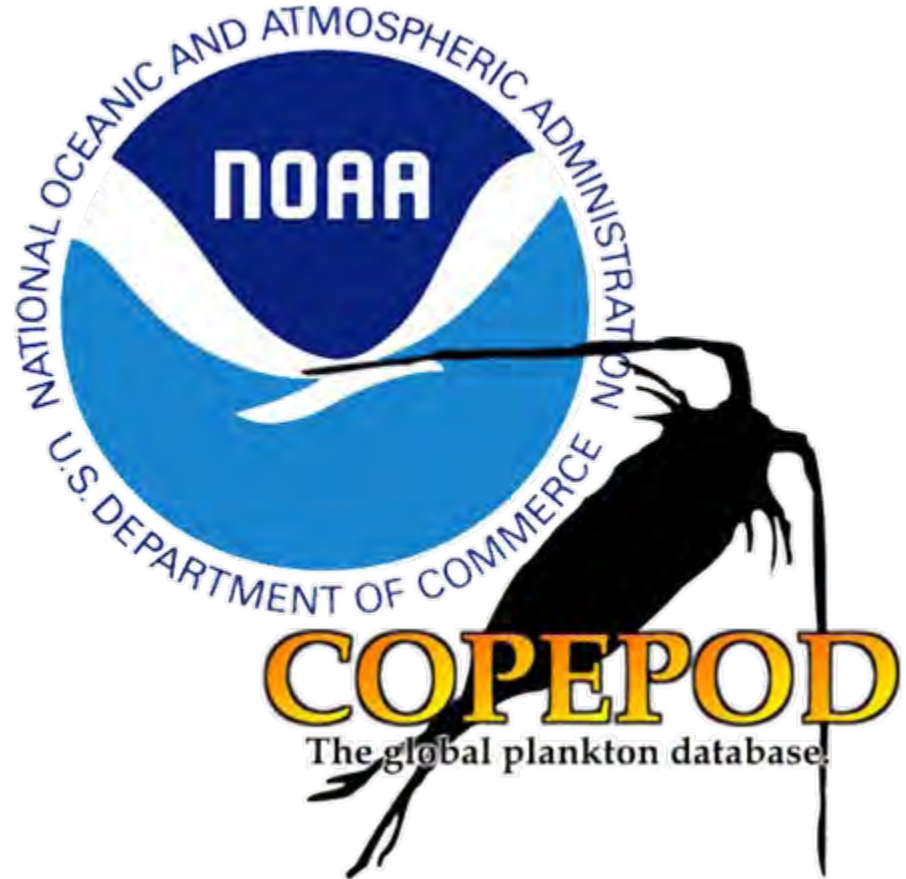
**COPEPODITE**



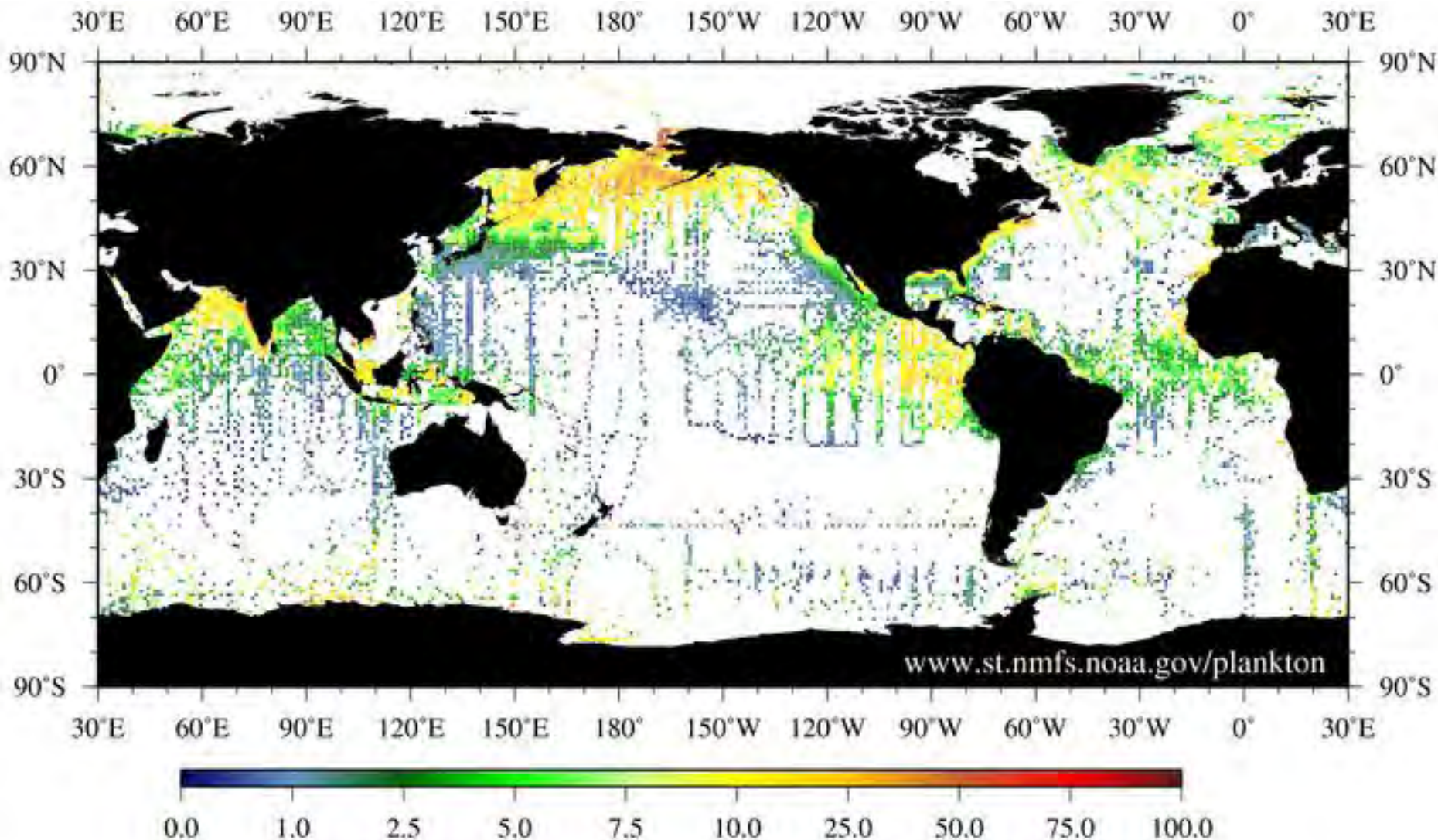
**Todd D. O'Brien**  
NOAA / NMFS / OST  
Marine Ecosystems Division

# What is **COPEPOD**?

**C**oastal &  
**O**ceanic  
**P**lankton  
**E**cology,  
**P**roduction, &  
**O**bservation  
**D**atabase

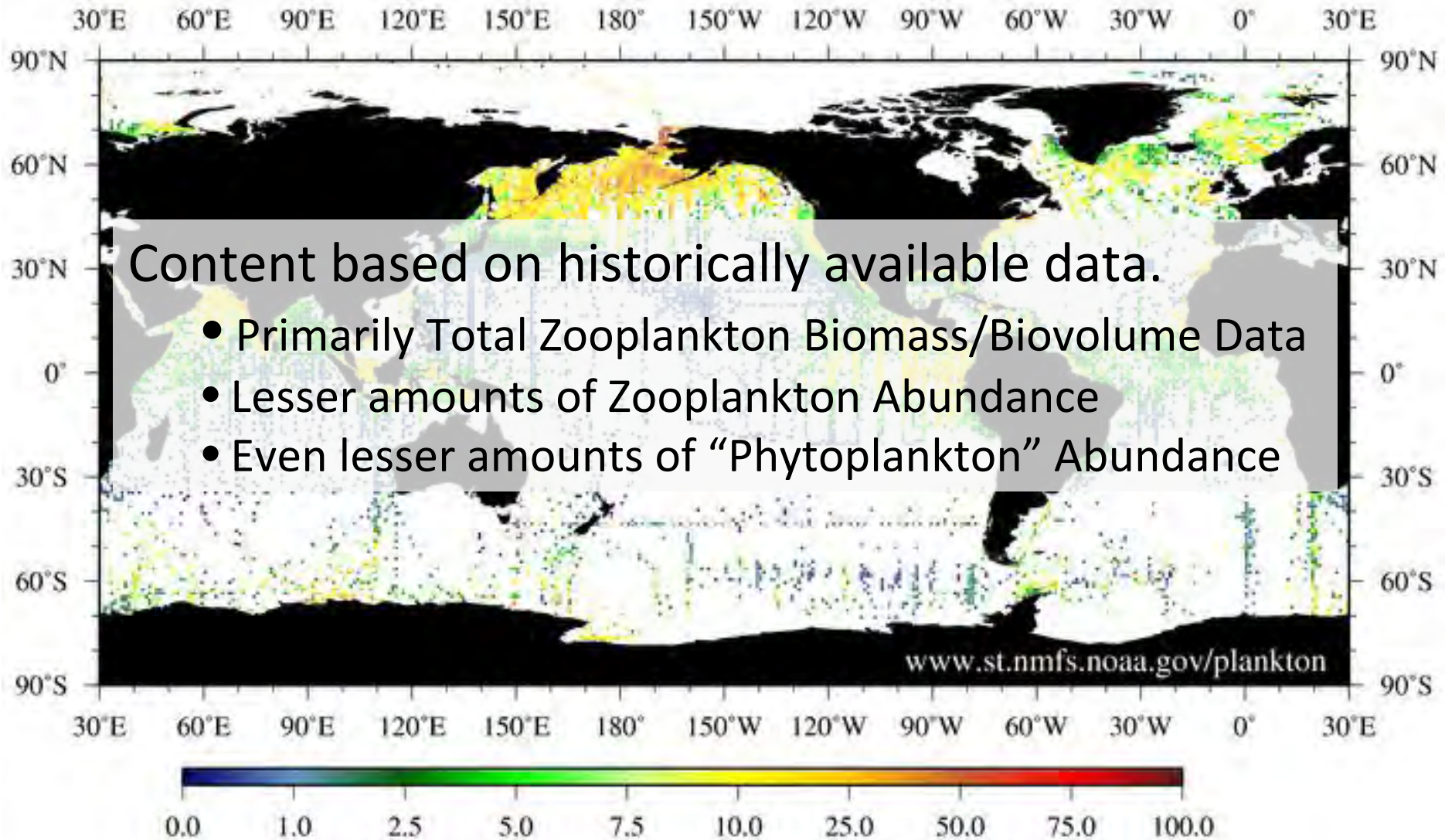


# COPEPOD is a global database of plankton ...



Zooplankton Carbon Mass (mg-C/m<sup>3</sup>)

# COPEPOD is a global database of plankton ...



Zooplankton Carbon Mass (mg-C/m<sup>3</sup>)

# What is **COPEPODITE**?

**COPEPOD**'s  
**I** nteractive  
**T** ime-series  
**E** xplorer



**COPEPODITE** was created by its support to and from plankton time series Working Groups.

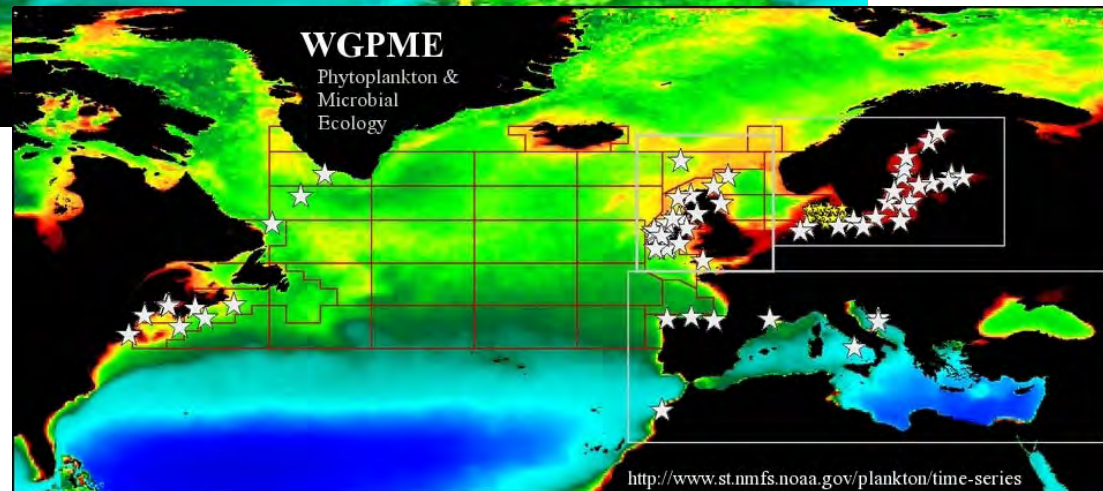
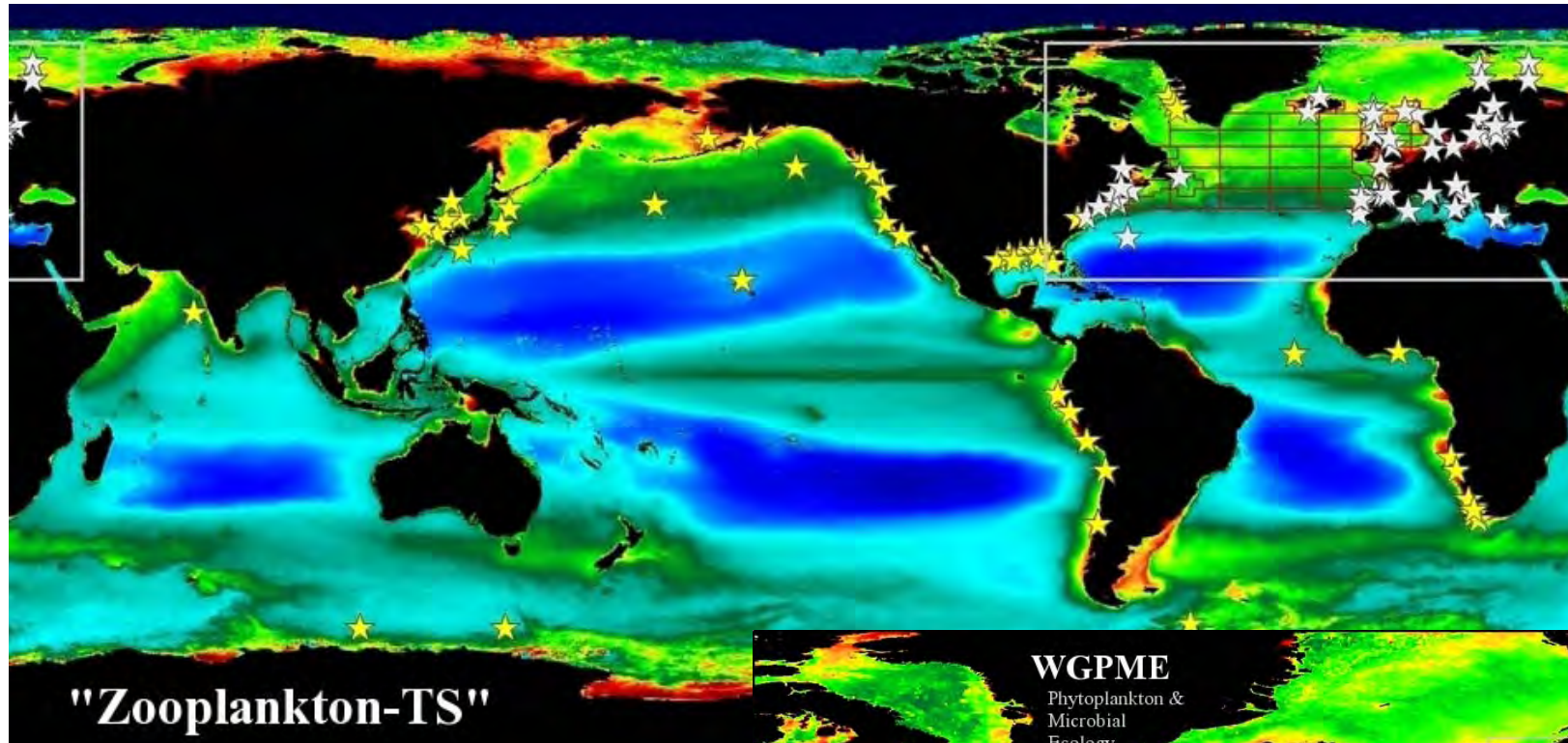
1. **SCOR WG125:** *Global Comparisons of Zooplankton Time Series*
2. **ICES WGZE:** *Working Group on Zooplankton Ecology*
3. **ICES WGPME:** *Working Group on Phytoplankton & Microbial Ecology*
4. **SCOR WG137:** *Global Patterns of Phytoplankton Dynamics in Coastal Ecosystems*

# COPEPODITE has two main components.



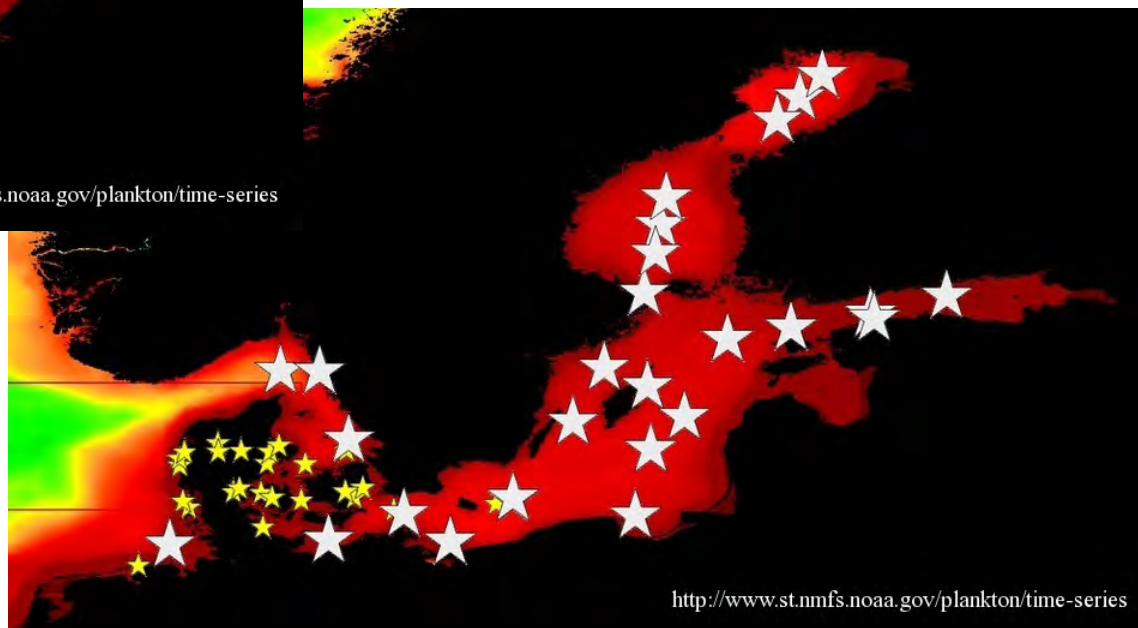
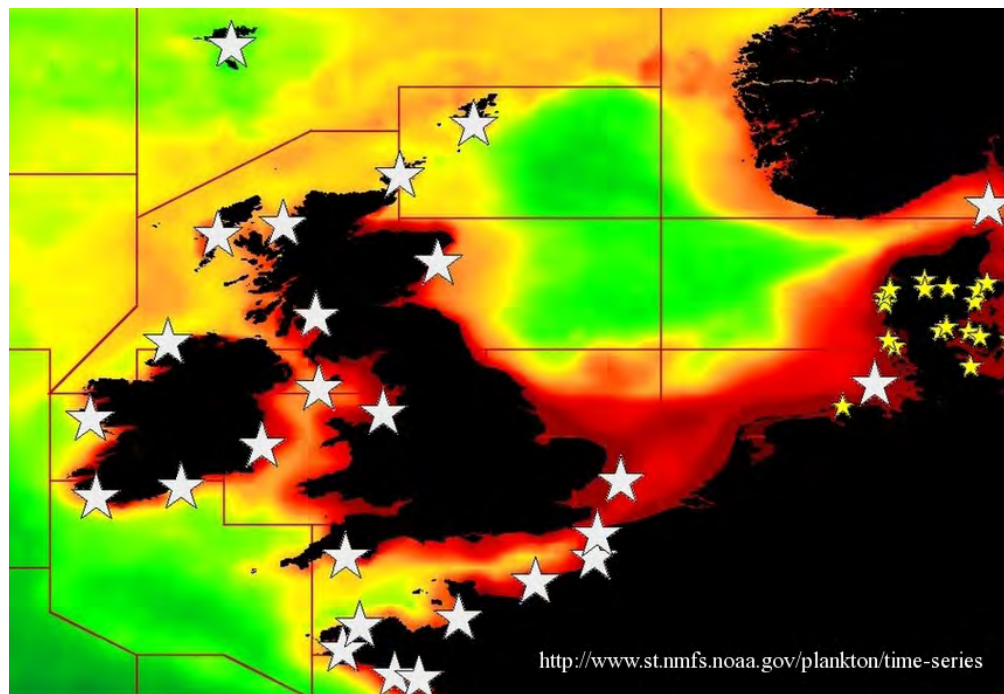
- An online informational database (metabase) of participating plankton time series and monitoring sites.
- An online toolkit of plankton time series data analysis and visualization tools.

# COPEPODITE features an interactive metabase of over 200 monitoring sites!

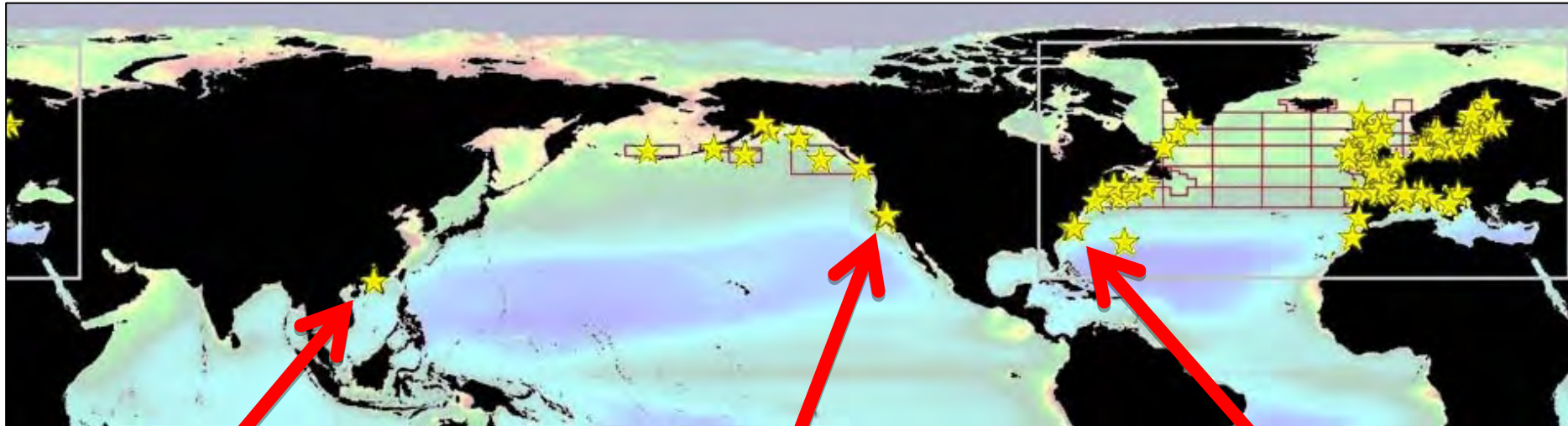




These sites can be accessed via a variety of interactive maps and searching tools.



# Each site in the metabase has its own standard text and visual summary pages.



The image displays a world map with numerous yellow stars representing sampling sites. Three red arrows point from the map to three detailed site summary panels, each titled "SCOR-WG137 Phytoplankton & microbial plankton of the Northwest Pacific".

### Hong Kong - Pearl River SM3

Latitude: 22.2519 Longitude: 114.1467

**Associated Investigator:**  
Kelong Yin [kelong.yin@noaa.gov]

**Associated Web Site:**  
[http://www.gsc.nyu.edu/programs/SCOR-WG137/]

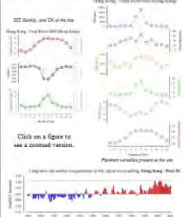
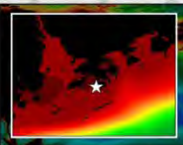
**Associated Plankton Time Series:**  
[Northern China Bay (2012)] [2013]  
[Southern China Bay (2012)] [2013] [2014]  
[2015] [2016] [2017] [2018] [2019] [2020] [2021] [2022]

The Environmental Protection Department (EPD) of the Hong Kong SAR Government monitors the water quality of waters 1,700 sq km off the western coast of Hong Kong. The monitoring programme covers the following program to indicate the state of health of marine waters in terms of compliance with the extensive Water Quality Objectives (WQOs) to meet long-term strategies in water quality, and to provide a basis for the planning, operations, control, strategies.

EPD's water monitoring programme covers about 20-year old 20 offshore sampling stations in the open sea, semi-enclosed bays and harbours along the western coastline. The monitoring programme covers the following program to indicate the state of health of marine waters in terms of compliance with the extensive Water Quality Objectives (WQOs) to meet long-term strategies in water quality, and to provide a basis for the planning, operations, control, strategies.

A range of physical and chemical parameters, including temperature, pH, salinity, turbidity and dissolved oxygen, are measured at sites by a continuous time-series monitoring system (CTDS) platform and the data are relayed to a computer. In addition, water and sediment samples are taken at a regular interval. The data are used to monitor the water quality, assess the status of the water body, and to provide a basis for the planning, operations, control, strategies.

Click on a figure to see a zoomed version.



### San Francisco Bay - mid South Bay

Latitude: 37.5638 Longitude: -122.3070

**Associated Investigator:**  
James E. Cloern [james.cloern@noaa.gov]

**Associated Web Site:**  
[http://www.scripps.edu/~cloern/]

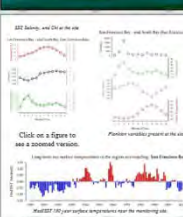

**Associated Plankton Time Series:**  
[Lower South Bay (02)] [Mid South Bay (02)]  
[North South Bay (02)] [Central Bay (04)]  
[San Pablo Bay (05)] [Lower Bay (07)]  
[Sacramento River (08)]

San Francisco Bay has a high degree of spatial variability in physical properties in a suspended sediment concentration, water depth, vertical mixing rates and the biological processes. For almost four decades the U.S. Geological Survey has maintained a program of research and observation in San Francisco Bay.

These quality measurements are made at a series of fixed stations from Rio Vista (Lower Sacramento River) to South Bay mouth of Coyote Creek. Data are collected using a subsurface mooring package that continuously measure multiple water quality parameters: depth, conductivity, temperature, suspended solids, chlorophyll, light penetration, and dissolved oxygen. Vertical profiles are obtained at each sample station resulting in a two-dimensional (horizontal and vertical) description of water quality for each sampling day. See our website for details. A continuous sampling along the 140 km coast since 1945 has with the research vessel Point.

These time series of water quality data are available for the Bay in tables for fish and organisms of the lower trophic levels.

Click on a figure to see a zoomed version.



### Neuse River Estuary NR030

Latitude: 35.1118 Longitude: -77.0555

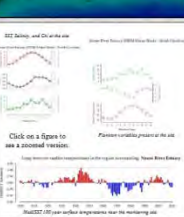
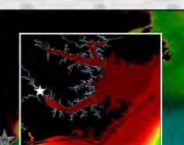
**Associated Investigator:**  
Hans Paerl [han\_paerl@noaa.gov]

**Associated Web Site:**  
[http://www.noaa.gov/estuary/estuary.html]


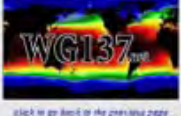
**Associated Plankton Time Series:**  
[Neuse River Estuary NR030] [NR020] [NR010]  
[NR050] [NR060] [NR070] [NR080] [NR090]  
[NR100] [NR110] [NR120] [NR130] [NR140] [NR150] [NR160] [NR170] [NR180]  
[Plankton Inund Program]

The Neuse River Estuary Modeling and Monitoring Project (EMMP) is a collaborative effort between the University of North Carolina and the North Carolina Department of Environmental and Natural Resources (NCEM). EMMP is funded by the North Carolina Department of Environment and Natural Resources (NCEM) and the Neuse River Commission (NRC). It supports North Carolina's needs for water and air quality monitoring and assessment of water quality and environmental conditions, including water temperature, dissolved oxygen, turbidity, and other parameters. EMMP also provides information to the public on water quality and the ability of NCEM to monitor water quality (EMMP) to provide critical data for water quality decisions. EMMP is the main source of data for sediment, water quality and water quality modeling. EMMP also provides information on water quality modeling and assessment of water quality and environmental conditions, including water temperature, dissolved oxygen, turbidity, and other parameters. EMMP also provides information to the public on water quality and the ability of NCEM to monitor water quality (EMMP) to provide critical data for water quality decisions.

Click on a figure to see a zoomed version.



# Each summary describes the site and variables monitored and provides full contact information.

## SCOR-WG137

### Phytoplankton & microbial plankton of the Northeast Pacific

### San Francisco Bay - mid South Bay

Latitude: 37.5639 Longitude: -122.2070

**Associated Investigators:**  
James E. Cloern [jcloern@ucsf.gov]


**Associated Web Sites:**  
[http://www.saga.gov/access/wqdata]

**Associated Plankton Time Series:**  
 [ Lower South Bay (01) ] [ Mid South Bay (02) ]  
 [ North South Bay (03) ] [ Central Bay (04) ]  
 [ San Pablo Bay (05) ] [ Suisun Bay (07) ]  
 [ Sacramento River (08) ]

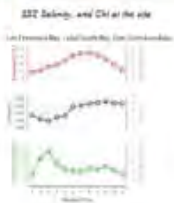
San Francisco Bay has a high degree of spatial variability in physical properties (e.g. suspended sediment concentrations, water depths, vertical mixing rates) that affect biological processes. For almost four decades the U.S. Geological Survey has maintained a program of research and observation in San Francisco Bay.

Water quality measurements are made at a series of fixed stations from Rio Vista (lower Sacramento River) to South Bay; mouth of Coyote Creek. Data are collected using a submersible instrument package that concurrently measures multiple water quality parameters (Depth, conductivity, temperature, suspended solids, chlorophyll, light penetration, and dissolved oxygen). Vertical profiles are obtained in each sample station resulting in a two-dimensional (longitudinal and vertical) description of water quality for each sampling date (see our recently collected data). Concurrent sampling along the 145-km transect takes 12-15 hours with the research vessel *Polaris*.


These basic elements of water quality define the sustainability of the Bay as habitat for fish and organisms of the lower trophic levels.




**EST Salinity, and Chl at the site**

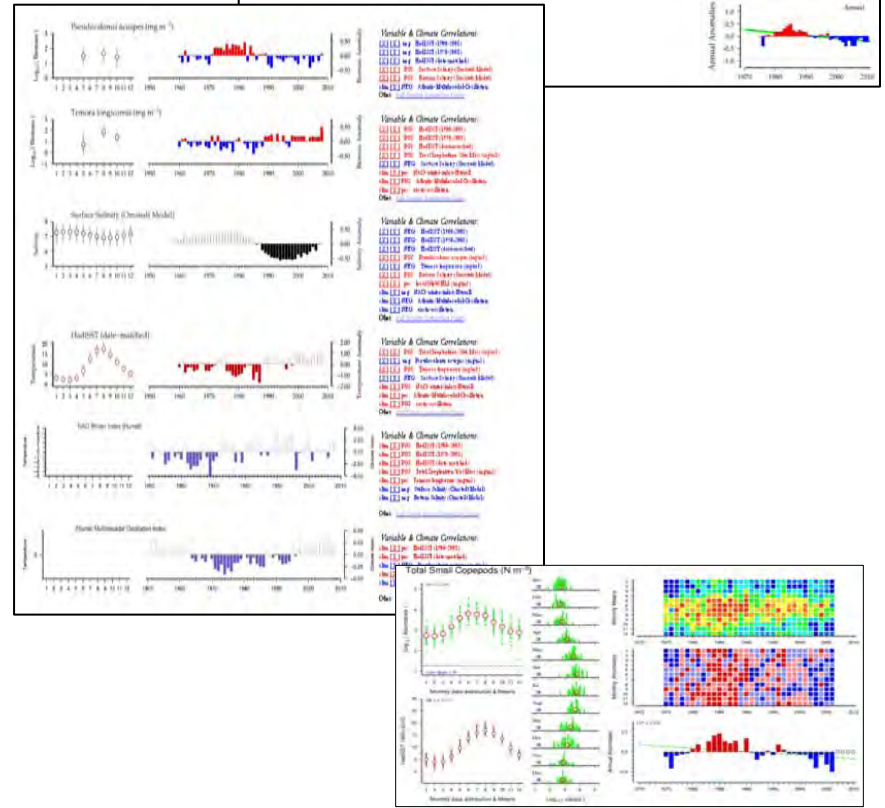
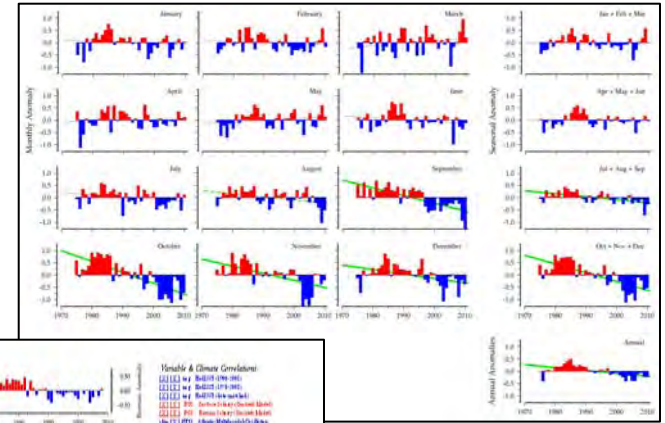


**San Francisco Bay - mid South Bay (San Francisco Bay)**



Click on a figure to see a zoomed version.





# Why was the Online Toolkit Created?

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**The Three Types of Plankton Time Series Researchers:**

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- **Type 1: Those that have insanely expensive software and the ability to use it and interpret it.**

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# Why was the Online Toolkit Created?

## The Three Types of Plankton Time Series Researchers:

- Type 1: Those that have insanely expensive software and the ability to use it and interpret it.
- Type 2: Those that have a computer genius who can mimic “Type 1” results for free by using “R”.
- **Type 3: The rest of us ...** (*including many who have only seen their data via basic Excel plots*).



# The **COPEPODITE** Online Toolkit

## Minimal Software Requirements:

- any “CSV-capable” spreadsheet software
- a web browser and internet access

## Three Simple Steps

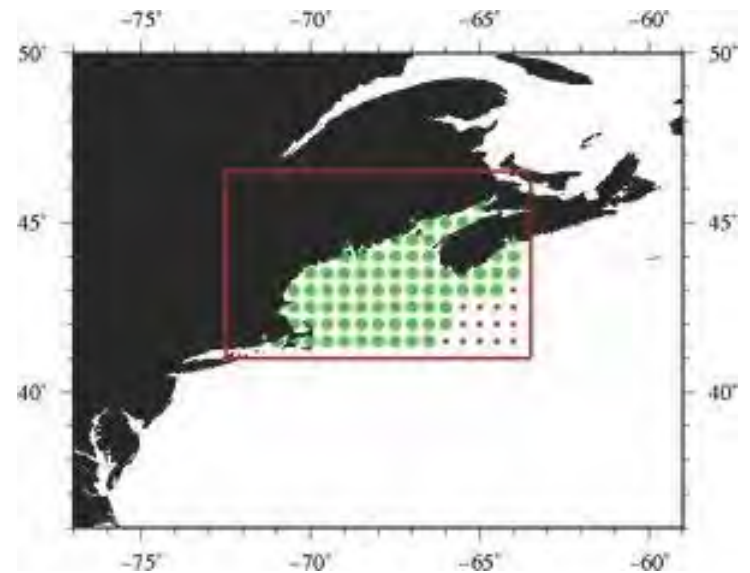
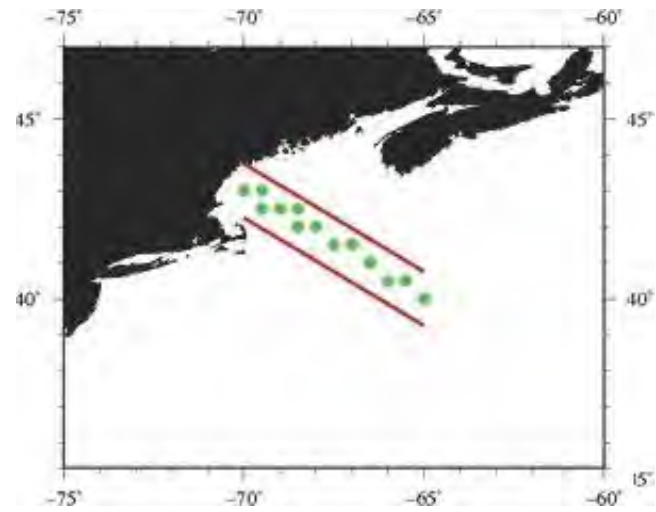
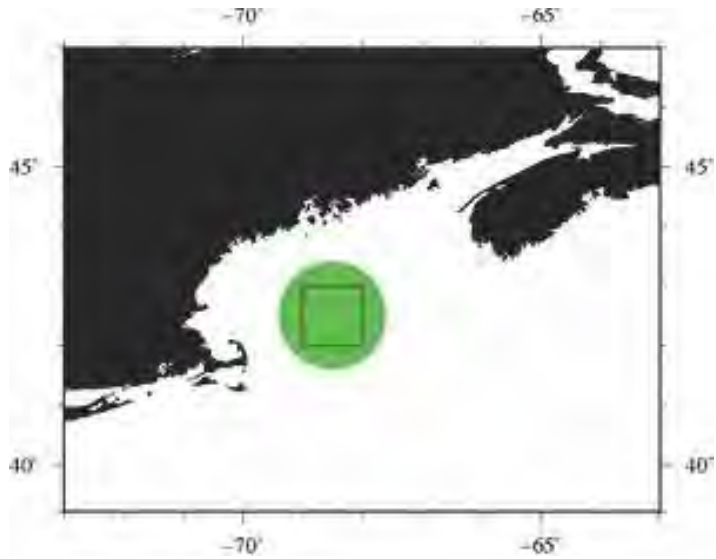
- 1. Prepare your data.
- 2. Select your geographic location.
- 3. Select the modules you want to run.

# STEP 1: COPEPODITE's Smart Data Format

DATE 1	(date 1)	(date 1)	DATE 2	(date 2)	(date 2)	DATE 3	(date 3)
DATE-YMD	BIOM= Wet Mass	ABND= Total Zoo	DATE-DMY	TEMP= SST	PSAL= Salinity	DATE-MDY	CHLA= Chlorophyll-a
MONTHLY DATA	123	43323	DAILY DATA	17.1	34.124	WEEKLY DATA	1.23
	34	23456		18.1	34.324		0.34
	122	642		18.4	34.324		1.22
	158	34236		17.5	33.985		1.58
	1008	23435		14.5	34.102		1.00
	300	65456		12.1	34.354		3.00

- Flexible sampling date handling (MDY, YMD, DMY, etc.)
- System automatically bins and synchronizes dates & data
  - Currently MONTHLY, but working on weekly and half-months
- Variable types identified using variable tags (TEMP=, ABND=)

# Step 2: Select your site's geographic area

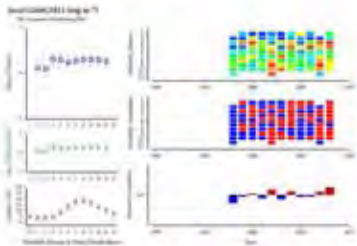
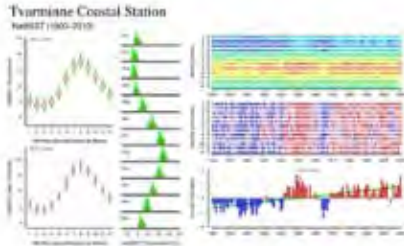
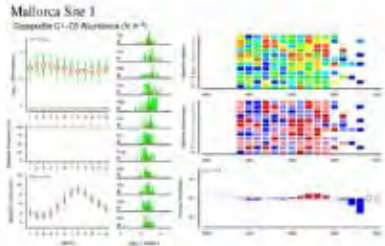
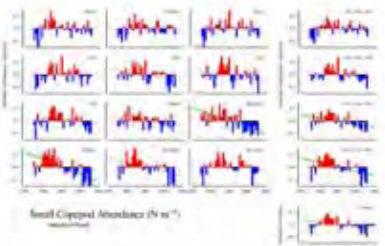
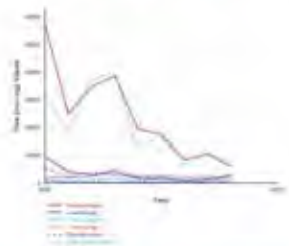
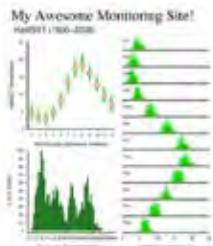


# Step 2: *Automatically-added,* *location-derived* Ancillary Data



- Hadley (UK-Met Office):
  - Sea Surface Temperature (1900-present)
  - Surface & sub-surface Temperature and Salinity (1950-present)
- ICOADS Surface Winds (1960-present)
- Model Products (e.g., Baltic-PROBE data)
- Satellite-based fields (Chl-A, MLD?, Upwelling Indices?, Precip?)
- Climate Indices
  - NAO, AMO
  - PDO, PNA, Nino 3.4, TNI, NPGO, BEST
  - SOI
  - AO / AAO
  - WeMO

# Step 3: Analysis Module Selection

<p><input checked="" type="checkbox"/> <b>WGZE Plot</b> <i>WGZE Standard Summary Plots</i></p>  <p>This plot displays the seasonal and interannual properties of your data variables using the WGZE standard presentation layout.</p>	<p><input type="checkbox"/> <b>WG125 Plot</b> <i>WG125 Standard Summary Plots</i></p> <p>Tyrrhenian Coastal Station 1960-2010</p>  <p>This plot displays the standard WG125 components with interannual trend lines (green = significant).</p>	<p><input type="checkbox"/> <b>WGPME "Species Plot"</b> <i>Species Presence Plots</i></p> <p>Mallorca Site 1 Dissolved O<sub>2</sub> (Moles/L)</p>  <p>This plot will only work correctly if you are using the "ABDT" tag (in place of "ABND").</p> <p>This plot is similar to the WG125 plot above, with the addition of monthly "% Relative Present" and "Absence Flagging".</p>
<p><input type="checkbox"/> <b>Month-Season-Annual Anom Plot</b> <i>MonAnoms Plots</i></p>  <p>This plot shows monthly, seasonal, and annual anomalies and any long term trends (green = significant).</p>	<p><input type="checkbox"/> <b>Group Plot</b> <i>Group Plots</i></p>  <p>This plot shows user-identified groups that are configured in your data file.</p>	<p><input type="checkbox"/> <b>Basic QC Plot</b> <i>Basic QC and Statistical Summaries</i></p> <p>My Awesome Monitoring Site! 1960-2010</p>  <p>This plot is useful for identifying numerical outliers and anomalous values by month or year.</p>

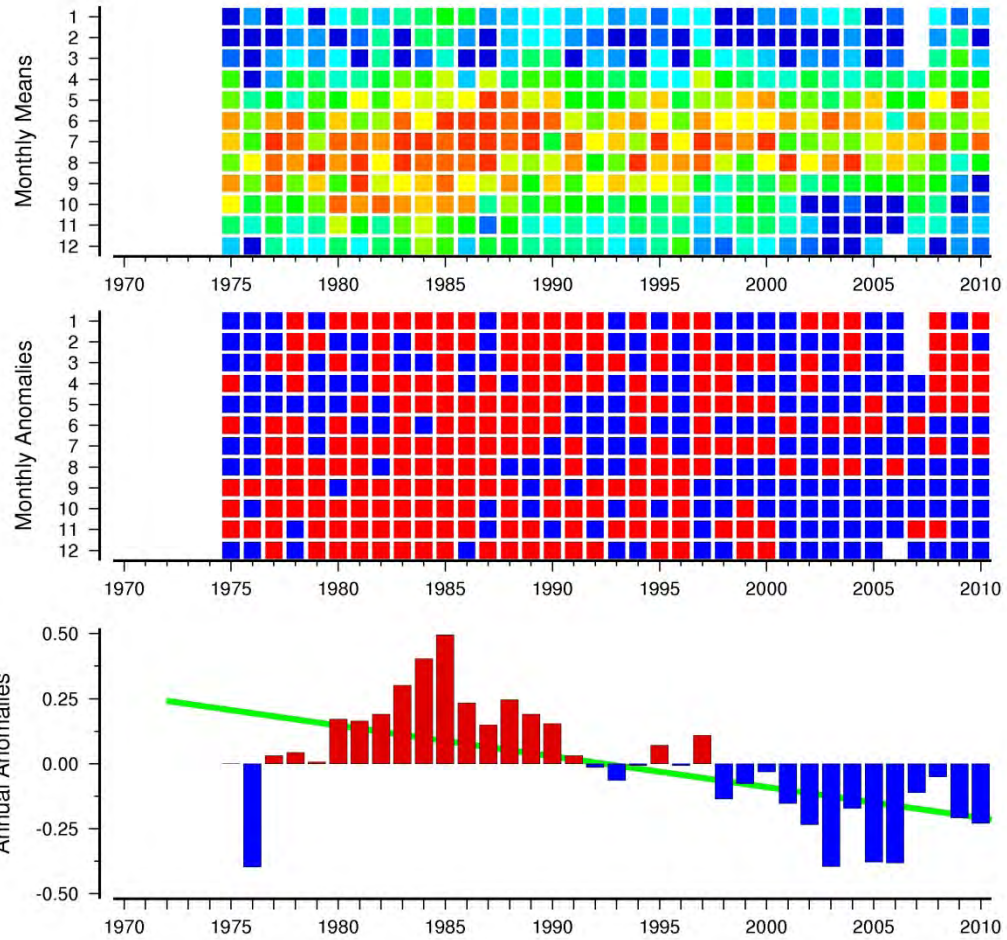
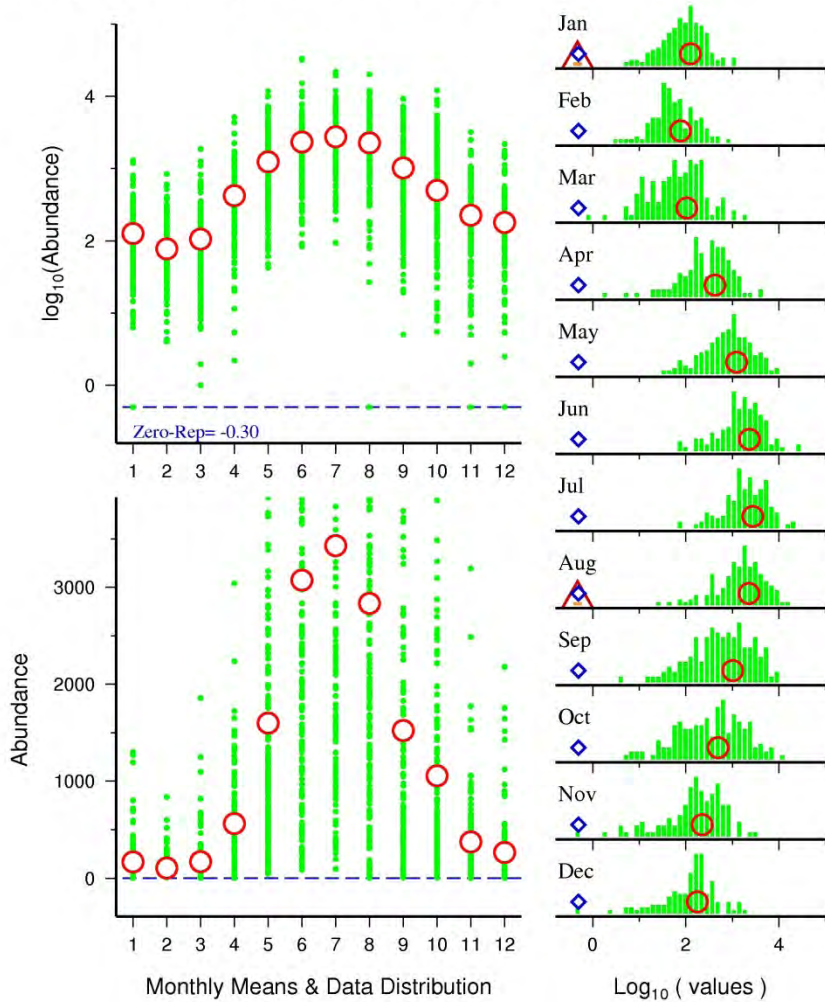
# The **COPEPODITE** Results Page:

- The COPEPODITE system returns your results via a custom web results page that is protected (private) using a 32-character unique web link that is mailed to you.
- This private web page contains all of the analysis results and figures from the modules you requested, including your original data in time-synchronized (monthly bin) format.

# Standard Plots

## Acartia spp. ( $N m^{-3}$ )

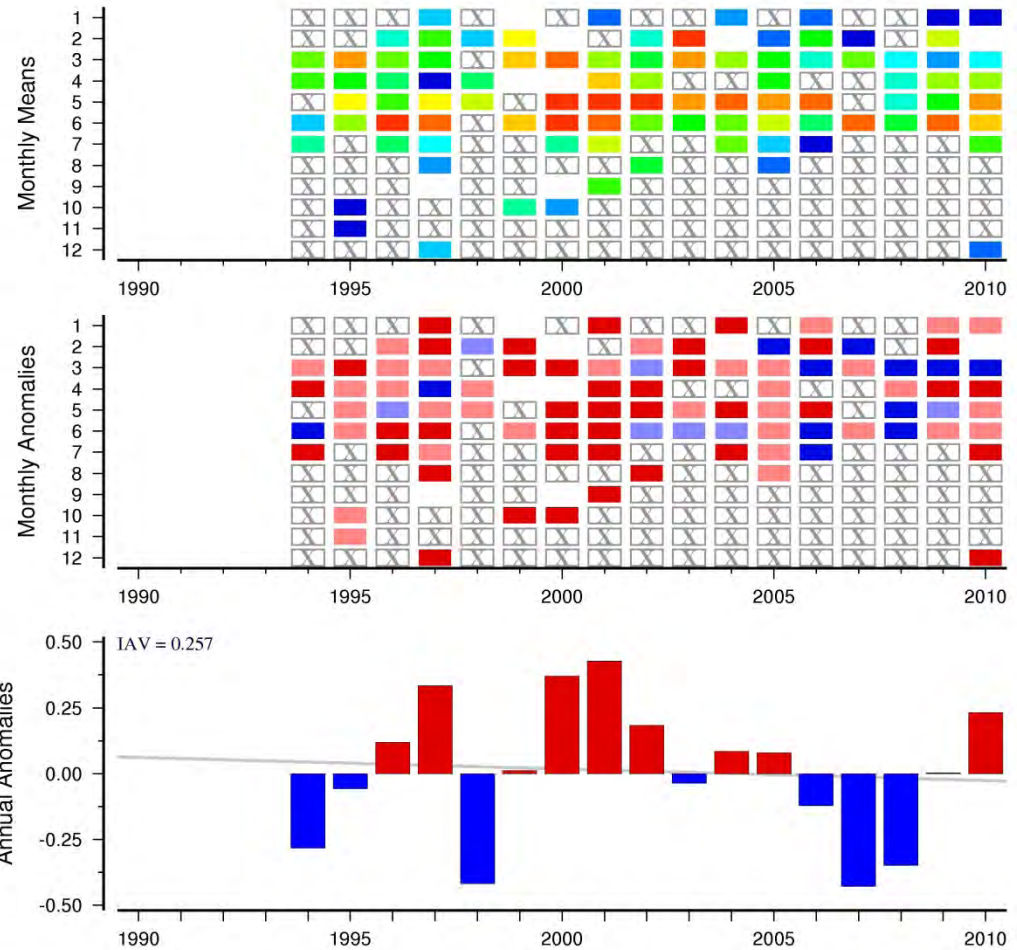
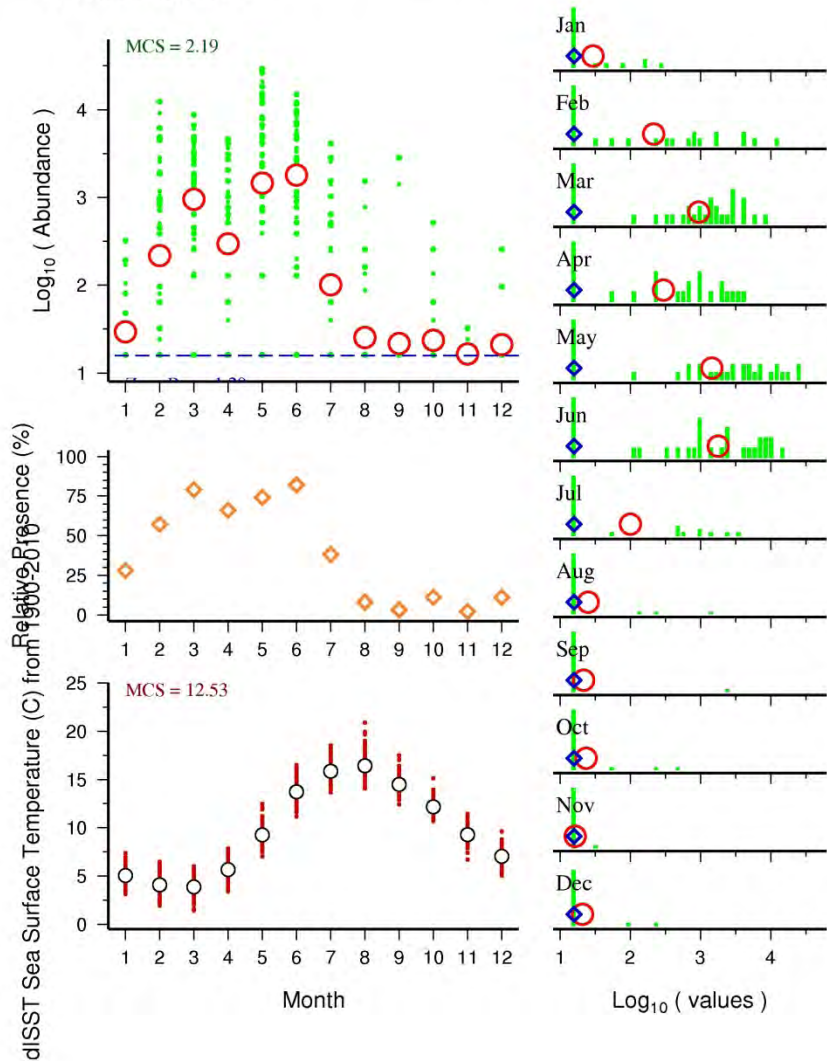
Helgoland Roads (Southeast North Sea)



# Species Presence Plot

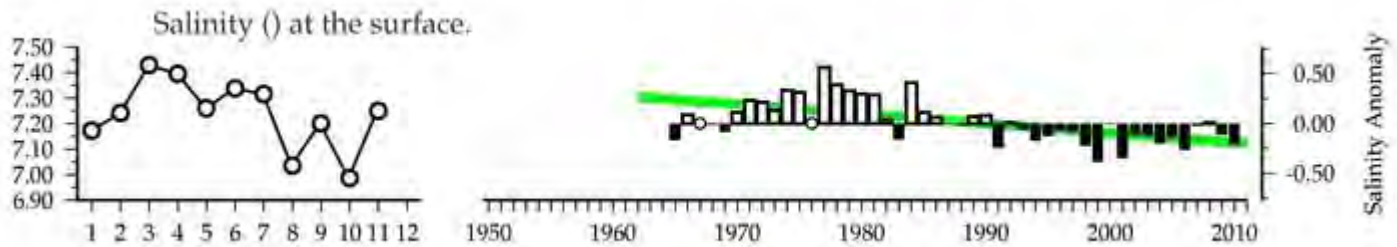
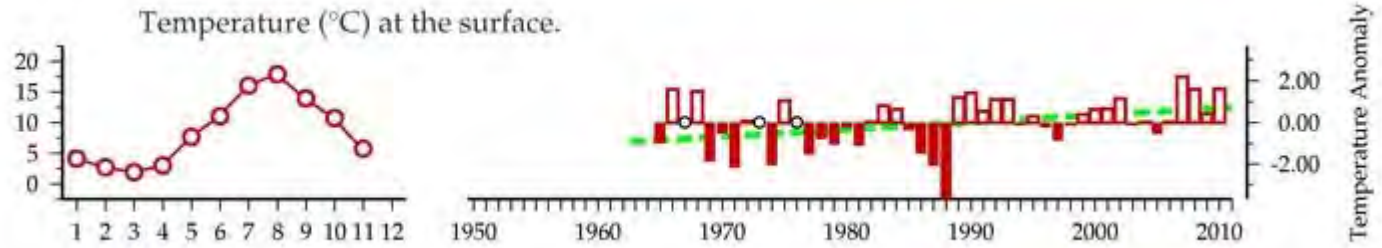
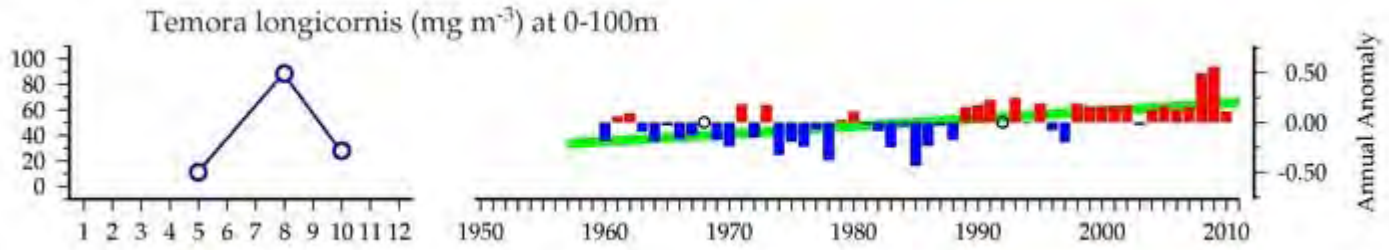
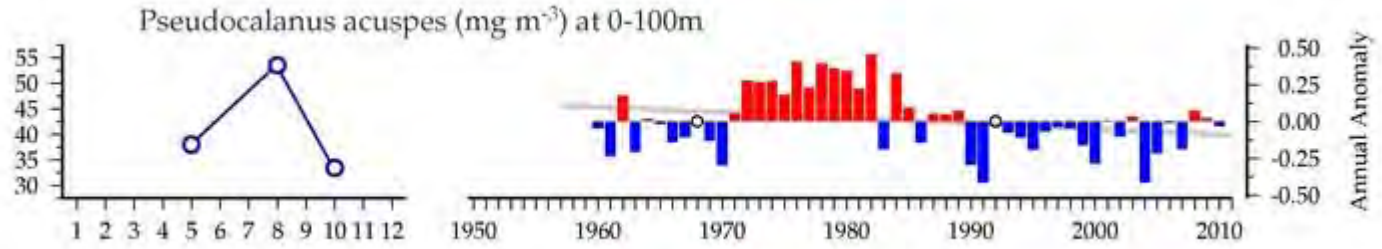
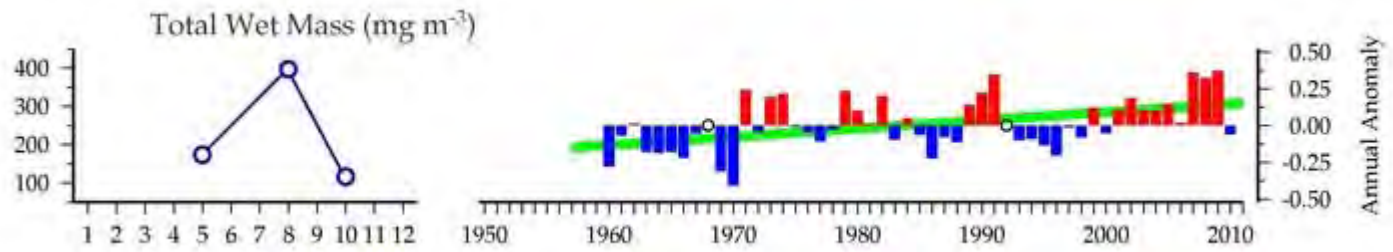
## Cirripede larvae (N m<sup>-2</sup>)

Arendal Station 2

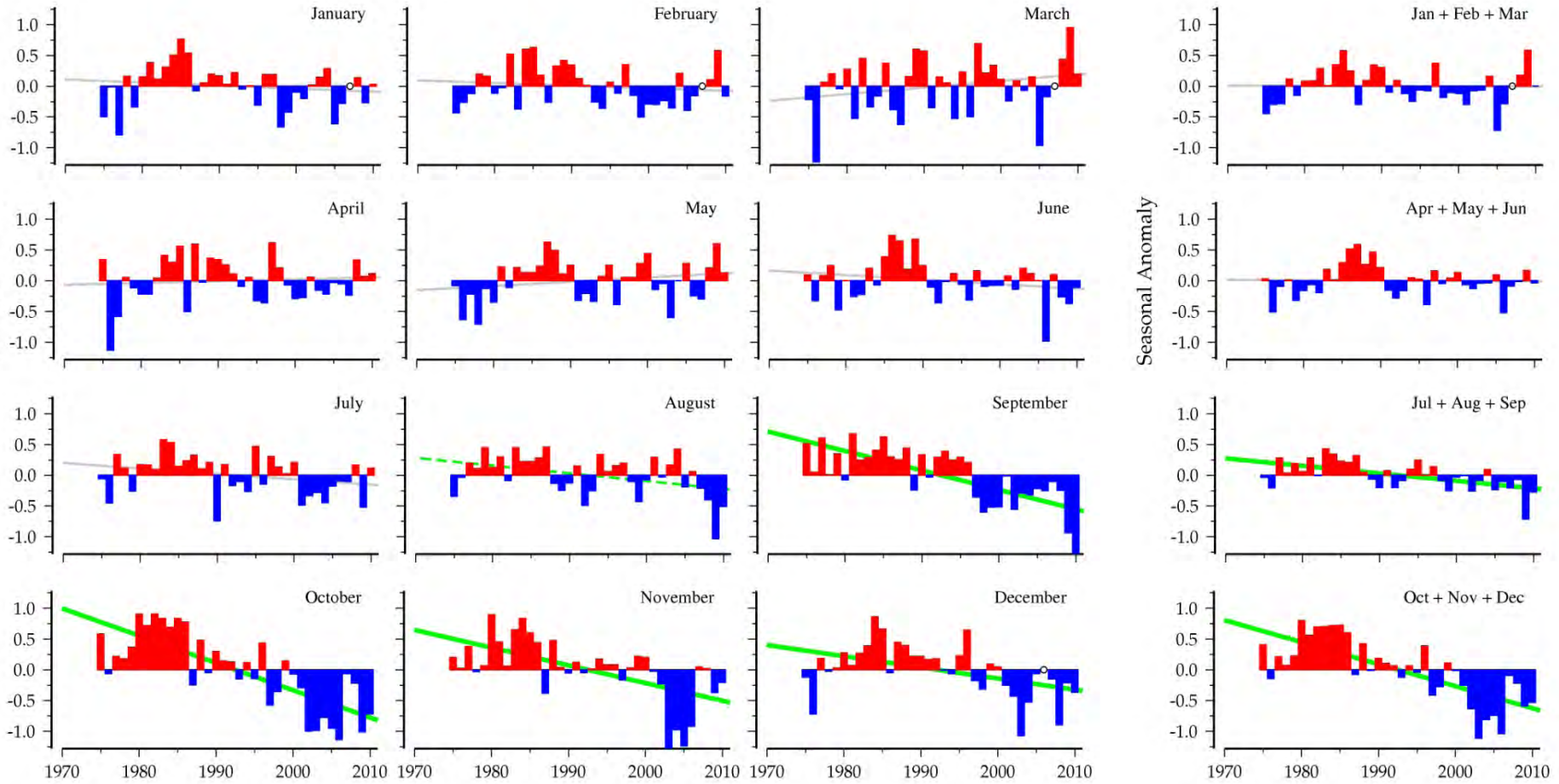




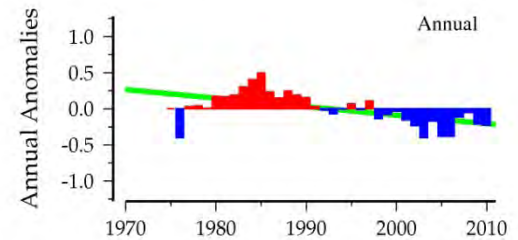
# Multi-Variable Comparison Plot



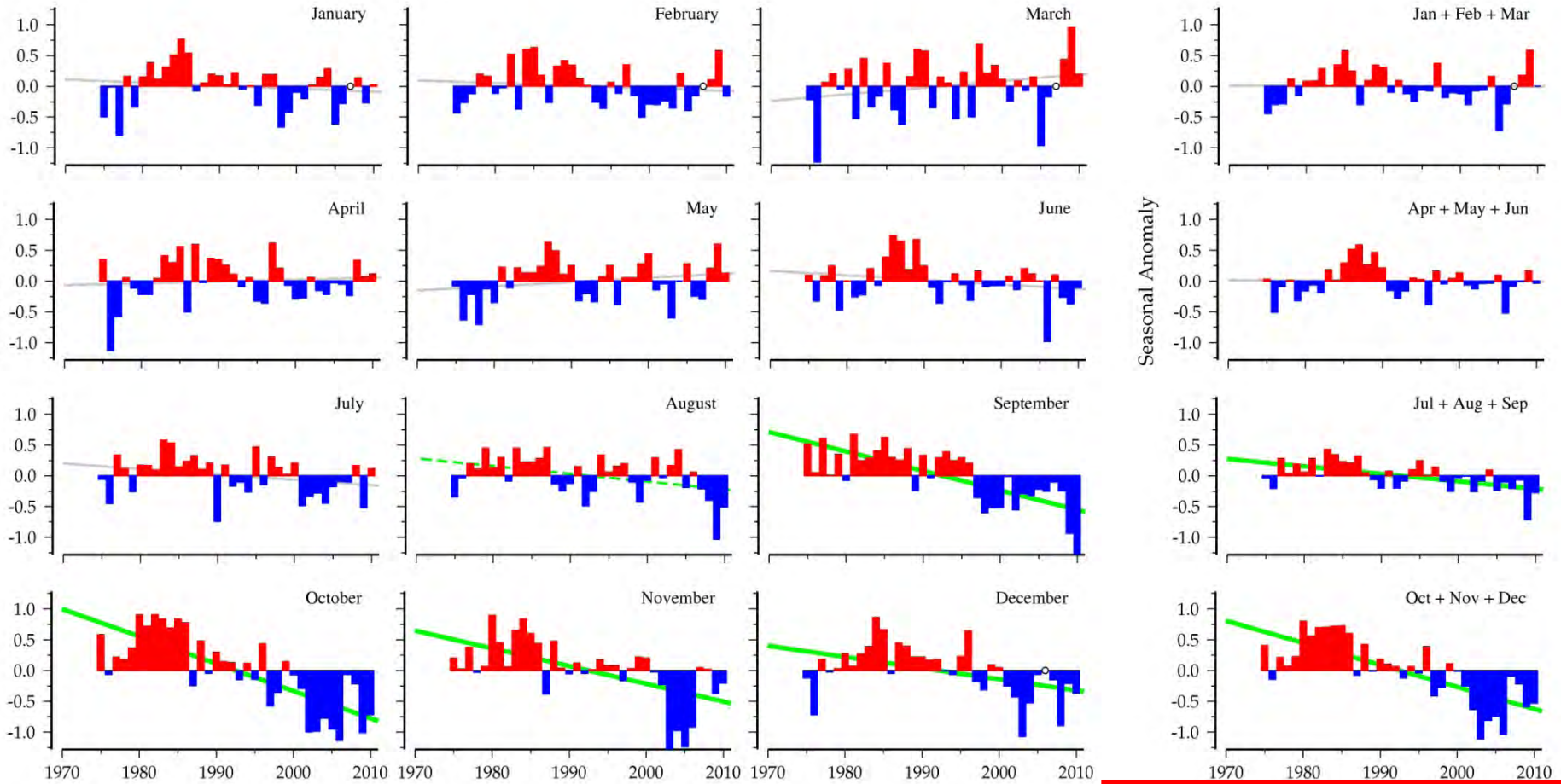
# Monthly/Seasonal/Annual Anomaly Plot (“MonAnom”)



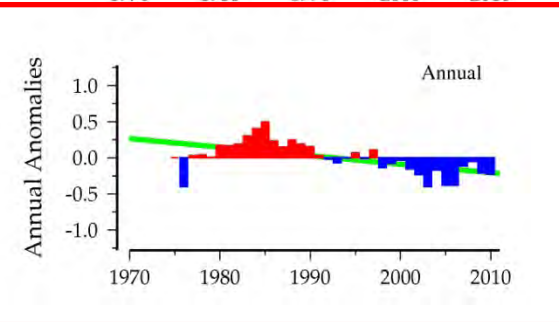
*Acartia* spp. ( $N\ m^{-3}$ )  
Helgoland Roads



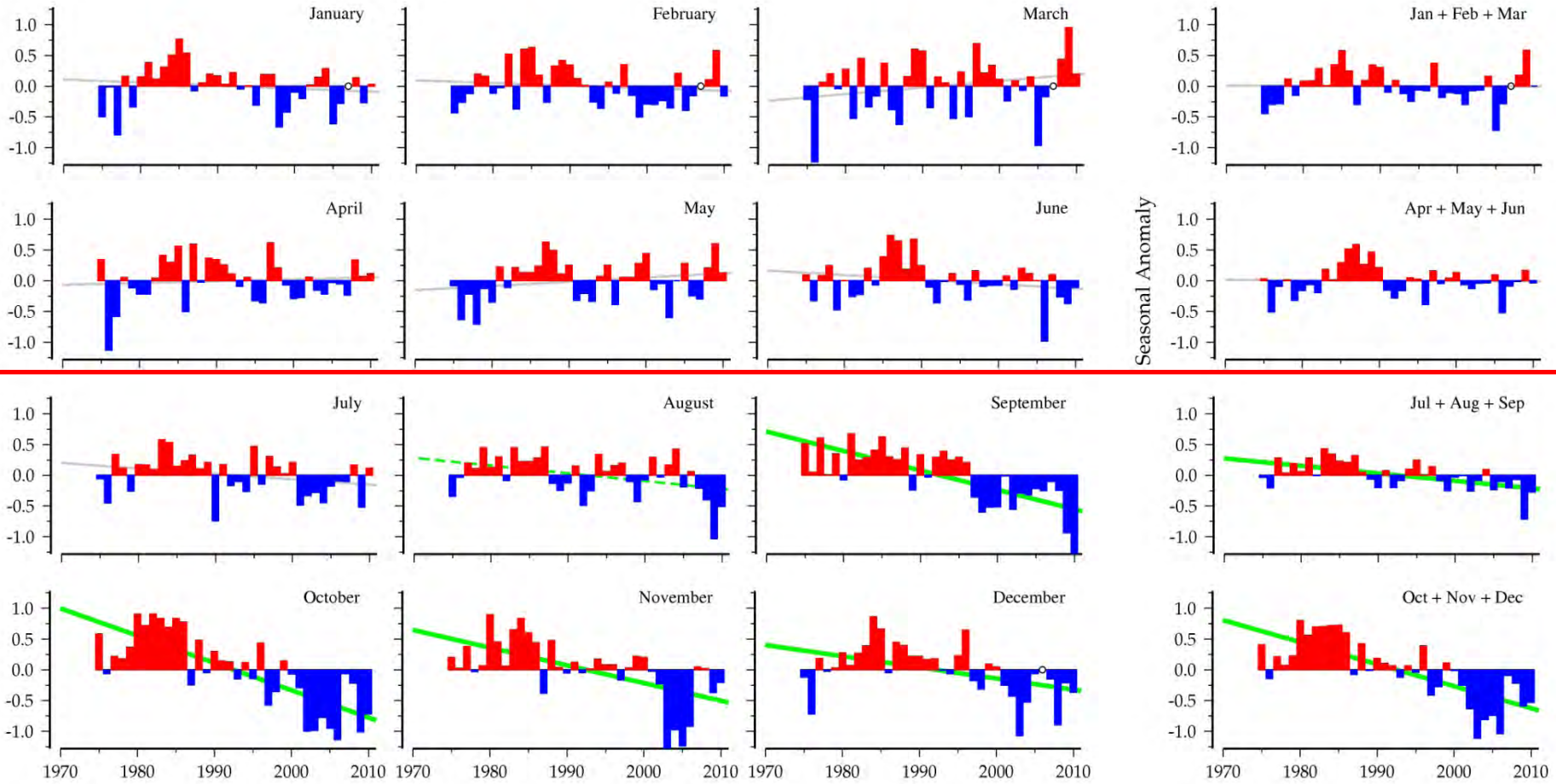
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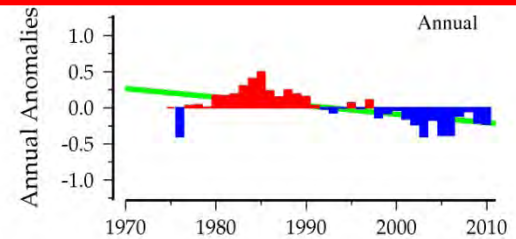
*Acartia* spp. ( $N m^{-3}$ )  
Helgoland Roads



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*Acartia* spp. ( $N\ m^{-3}$ )  
Helgoland Roads

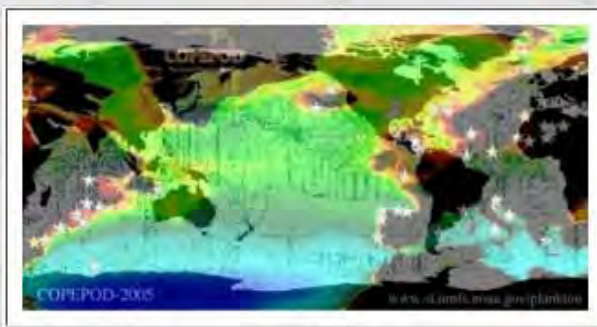
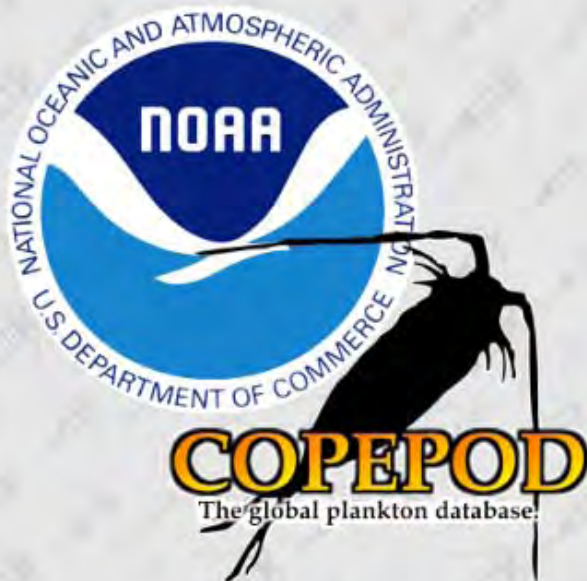


# Future Additions to **COPEPODITE**

- New Ancillary Data
  - E.g., Stratification, Precipitation, Upwelling Indices
- New Analysis Modules
  - Currently annual-focused ... will add monthly-based
    - **Weekly** (52) and **half-month** (24) time bins
  - Cross time-bin analyses
- **Better Statistics (!!!)**
- New Interface and Results Options
  - More user control over plots and plots sub-figures
  - Multiple-site uploading and comparison options

# COPEPOD

*A global plankton database of phytoplankton data and zooplankton data sampled from around the world.*



## Online Database

Search by: [ Geographic Region ] [ Taxonomic Group ] [ Other search options ... ]

## Data Products

[ Global Zooplankton Biomass Fields ] [ Global Group Compilations ] [ More ... ]

## Time Series

[ Zooplankton ] [ Phytoplankton ] [ COPEPODITE Toolkit ] [ Methods ]

*What is COPEPOD?*

*The Coastal & Oceanic Plankton Ecology, Production, & Observation Database (COPEPOD)*

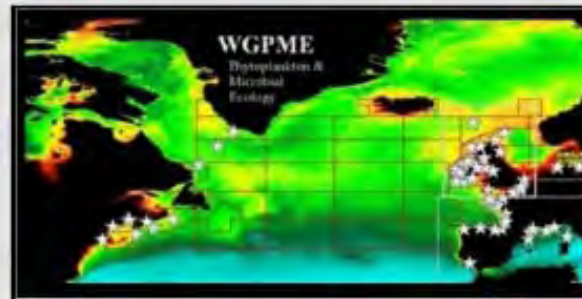
<http://COPEPOD.org>

# COPEPODITE

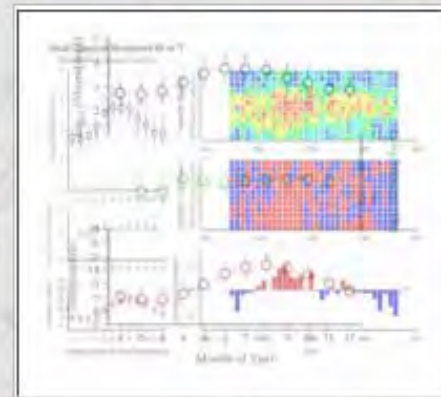
*An online plankton time-series analysis and visualization toolkit.*



**COPEPODITE**



*Plankton Time-series Metabase*



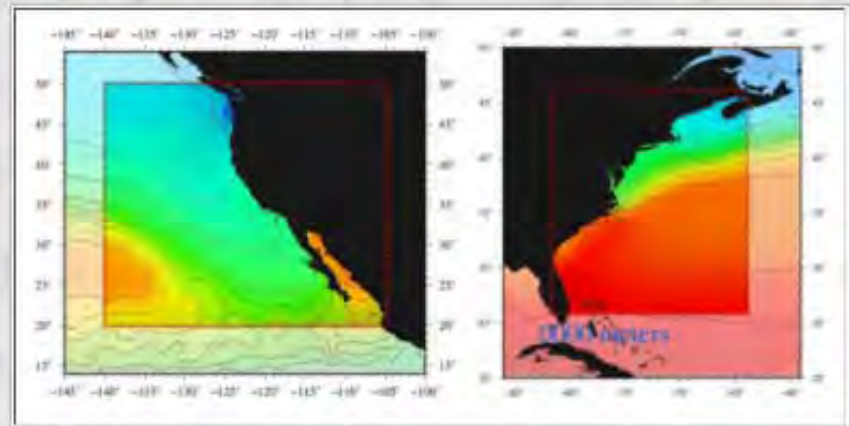
*Interactive Time-series Explorer*

*COPEPODITE is the Interactive Time-series Explorer module of the COPEPOD global plankton database project.*

<http://COPEPODITE.org>

# NAUPLIUS

*Advanced Plankton & Ecosystems Data Products & Visualization Tools.*



NAUPLIUS ties together data and visualization components from the **COPEPOD**, **COPEPODITE**, and **ECHO** projects, creating a comprehensive ecosystem overview from hydrography to biology.

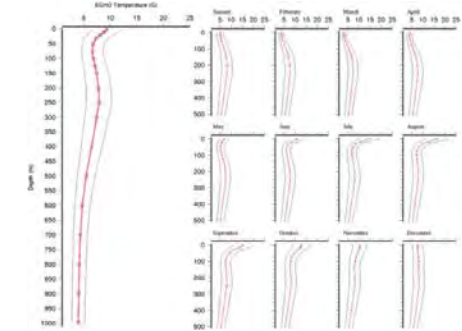
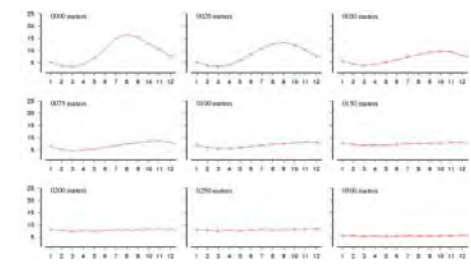
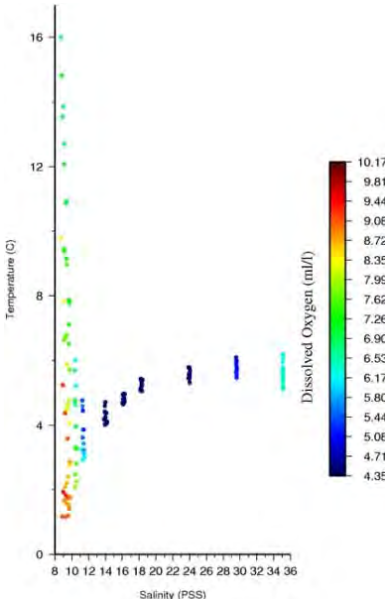
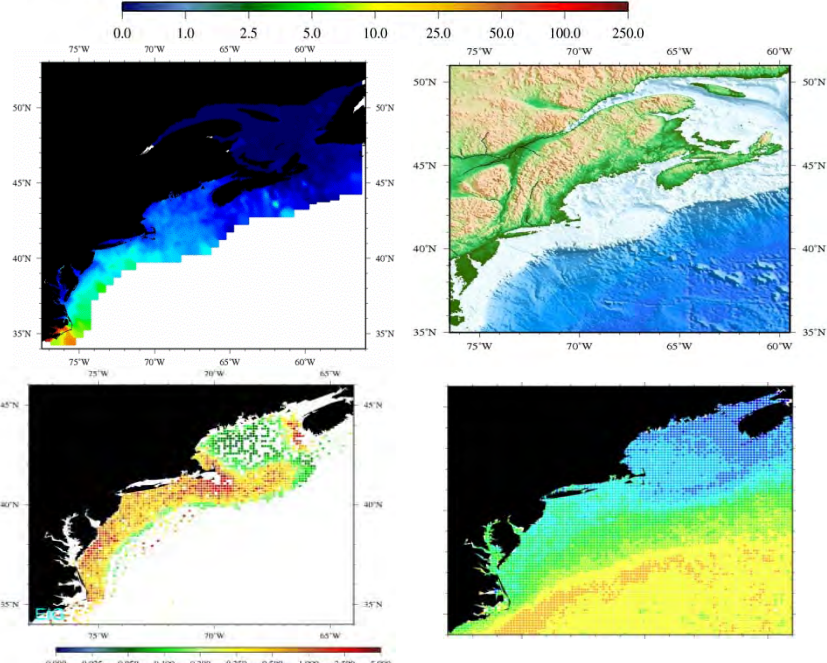
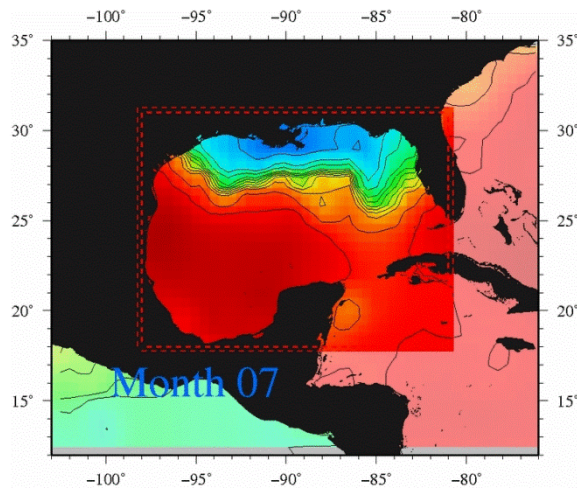
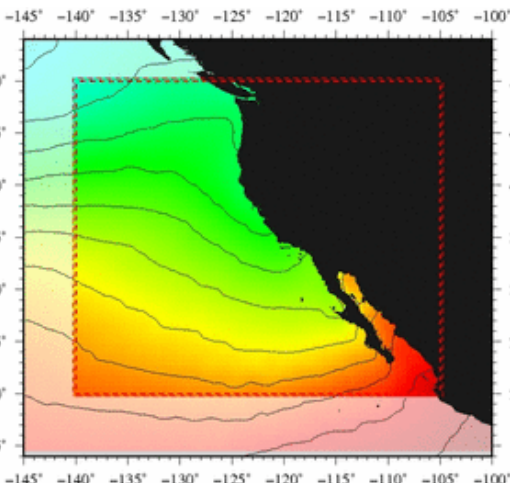
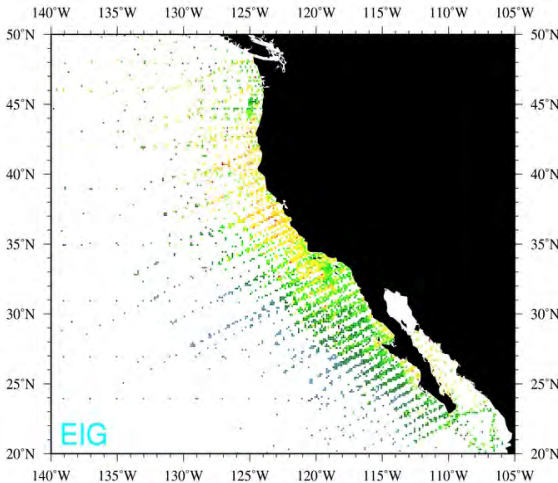
NAUPLIUS provides comprehensive data access and visualization tools for use in the classroom, laboratory, and management office.

<http://NAUPLIUS.org>



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## ***Internet Shortcuts:***

- <http://COPEPOD.org>
- <http://COPEPODITE.org>
- <http://NAUPLIUS.org>

## ***The “Official” Web Addresses:***

- <http://www.st.nmfs.noaa.gov/copepod>
- <http://www.st.nmfs.noaa.gov/copepodite>
- <http://www.st.nmfs.noaa.gov/nauplius>