Marine Plankton:

Using Scientific Collection Methods and Analysis to Understand the Relationship Between Nutrients and Algal Growth

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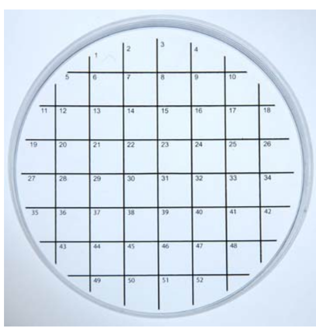


University of California, Santa Barbara
Research Experience for Teachers (RET II)
Spring 2014

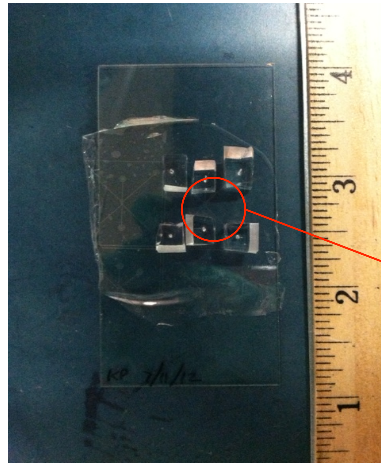
RET I: Micropatterned Hydrogens in Microfluidic Devices

What Are Hydrogels?

•A semi-permeable material (e.g.,PEG-DA)

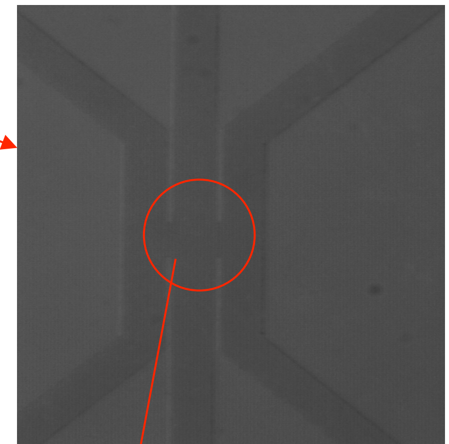
•Allows certain chemicals to diffuse through one micro-channel into another

•Stop flow; allow for only diffusion



Microfluidic sticker device

Microfluidic channels



Hydrogels in channel

Experimental Goal:

Hydrogel technology will allow for more controlled experiments on a much smaller scale.

•Characterization and experimentation with hydrogels will promote more useful micro fluidic devices in the future.

Marine Plankton Unit

Unit Goal: to teach abstract topics in science in *context* with an aquatic environment using relevant scientific methods.

Target Audience: 10-12th grade general college-prep science

- •Marine Biology,
- •Biology,
- •Environmental Science,
- •Honors/AP

➢Unit is <u>adaptable</u> and can be taught in sequence or piecemeal to fit a pacing calendar or resource availability.

Unit Learning Experience and Technique

- ✓Inquiry
- ✓Field Biology/Hands-on
- ✓Laboratory Analysis
- ✓Reading and Organization
- ✓Graphing
- ✓Computer Graphing (variable manipulation)
- ✓Student AND Teacher versions with answers and insights

Next Generation Science Standards Addressed:

Interdependent Relationships in Ecosystems: HSLS2-2, HSLS2-5, HSLS2-6, HSLS2.B (cycle of energy)

Differentiated Instruction:

Beginning/Intermediate

- Basic microscope skills
- Visualizing living organisms in the context of their environment
- Data collection and interpretation

Advanced

- Complex lab analysis and procedures
- Identifying complex scientific relationships
- Graphing Multiple Variables and Data Analysis

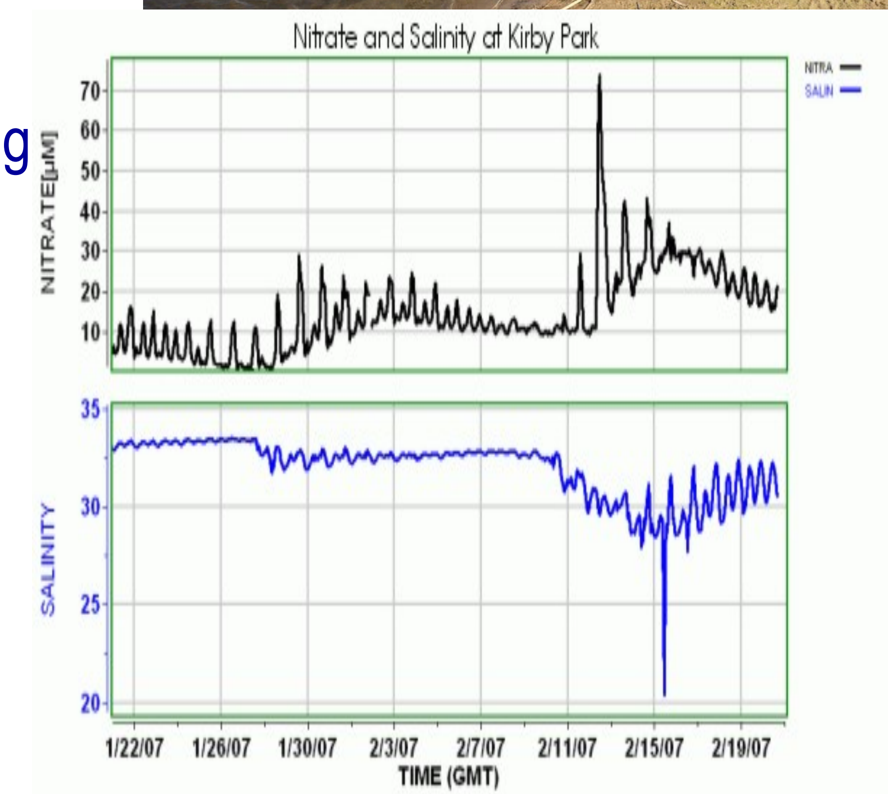
Unit Overview

Part I Plankton Collection and Analysis

1. Inquiry: Build a Plankton Net
2. Field: Collect a Plankton Sample
3. Lab Skills: Plankton Sample Analysis

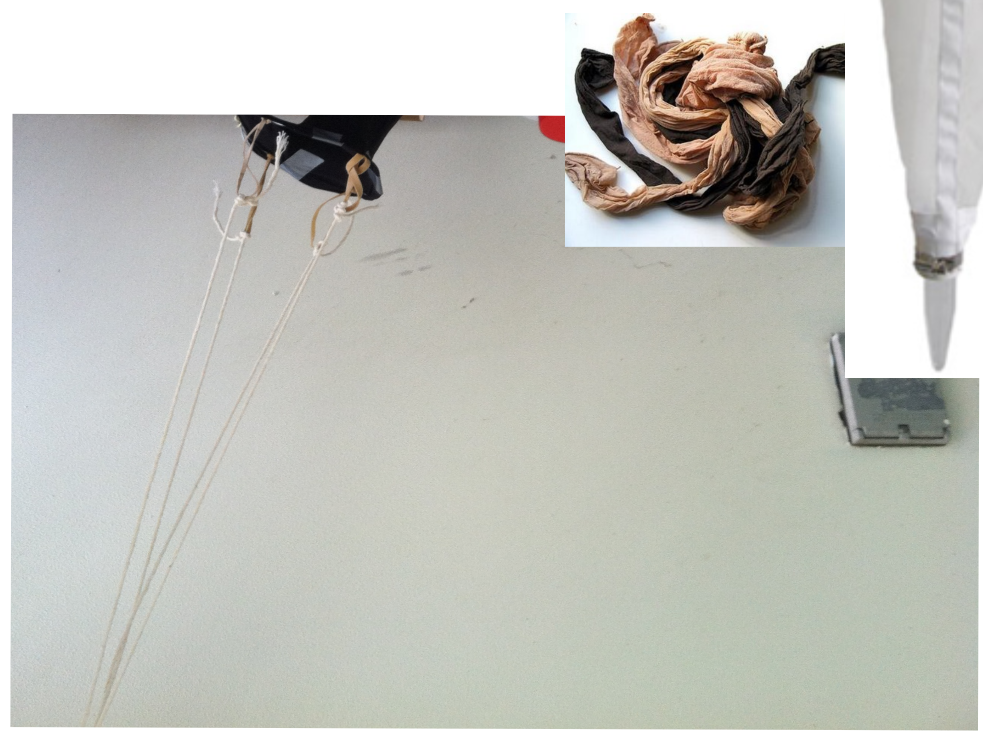
Part II Plankton As Indicators of Upwelling and Agricultural Run-Off

1. Reading and Interpreting: The Carbon Cycle and Upwelling
2. Graph: Identifying Upwelling
3. Computer Graph and Data Manipulation: Predicting Agricultural Run-off



Part I: Inquiry Activity- Building a Plankton Net

Students volunteer to bring in materials to work in a group creating a home-made plankton net.



1. Minimal guidance: design based on need, function and example.
2. Assessment based on teamwork and functionality- test in large bins or pool

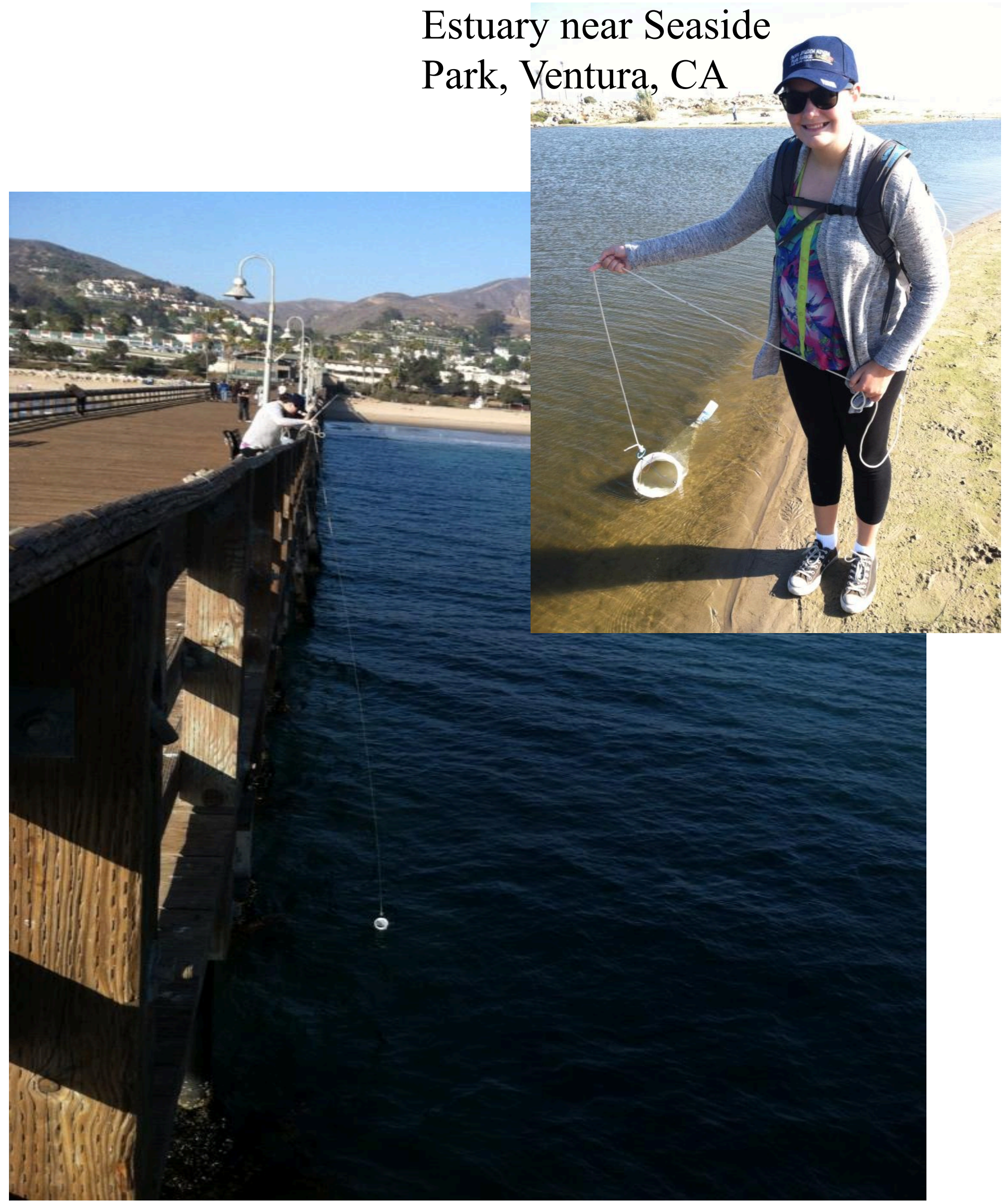
Field Biology- Plankton Collection

Goal: Compare zooplankton populations between sites and attribute differences to abiotic factors such as nutrient levels.

Students sample plankton from three different locations:

- •Pier
- •Harbor
- •Estuary or Outlet

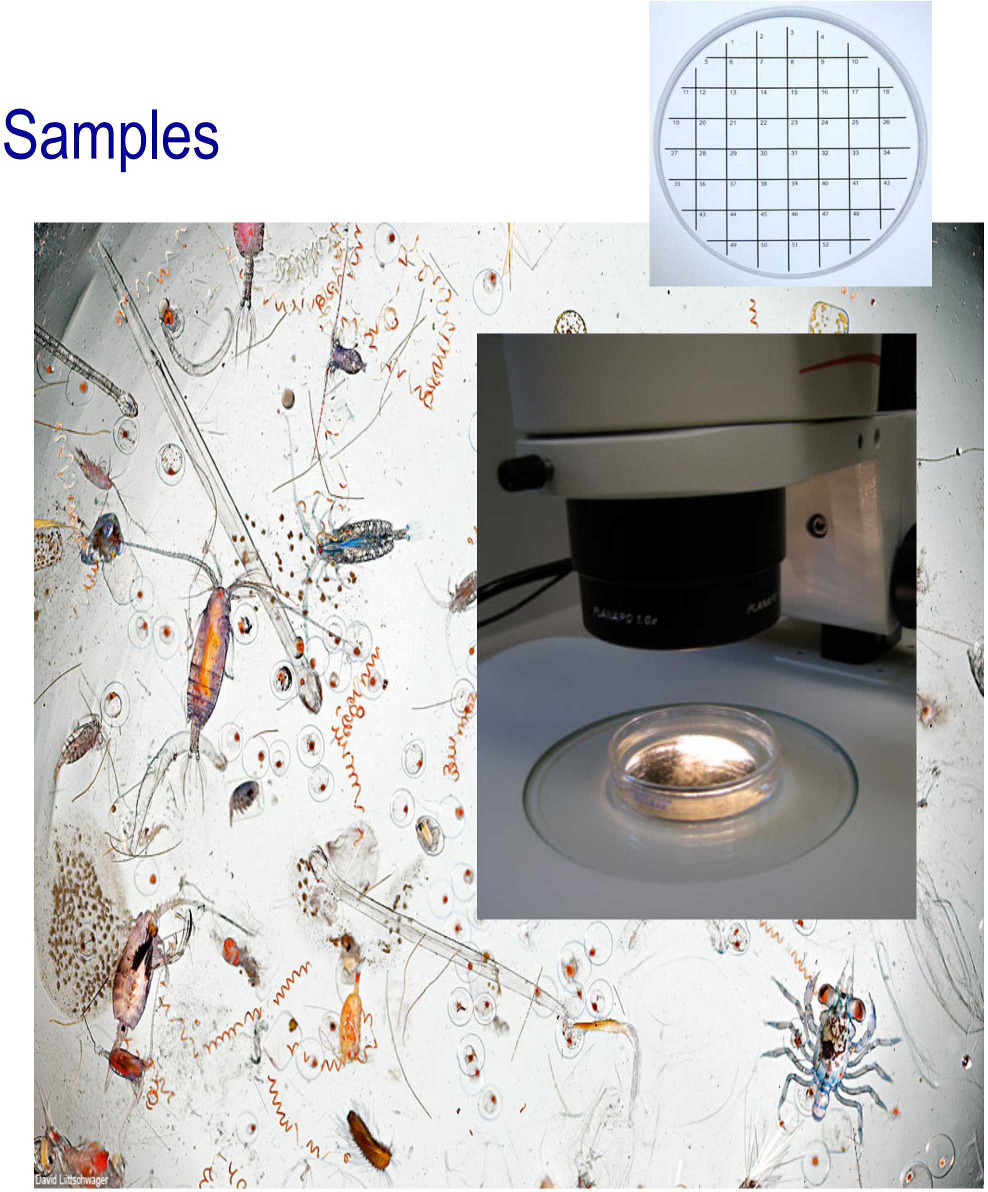
Estuary near Seaside Park, Ventura, CA



Ventura Pier, CA

Lab Activity: Analysis of Plankton Samples

Overview:



1. Practice distinguishing zooplankton and phytoplankton
2. Sort and tally zooplankton in pairs
3. Determine average for each location
4. Make inferences about the differences in each environment in relation to the zooplankton found

Lab Activities: Analysis of Plankton Samples

1. Before plankton collection and sampling, students practice distinguishing between phyto- and zoo- plankton in their lab notebooks

DIATOMS

- These phytoplankton are tiny producers shaped like a Petri dish; a top half and a bottom half that fit together
- Along with dinoflagellates, they are one of the most common types of phytoplankton and are often used as environmental indicators
- Some diatoms exist in colonies, forming chains or filaments
- The shell of a diatom is made of silicon, the same chemical from which glass is made
- Their silicon shells do not dissolve easily in water seawater so when diatoms die their tiny shells sink to the bottom of the ocean and pile up.

DINOFLAGELLATES

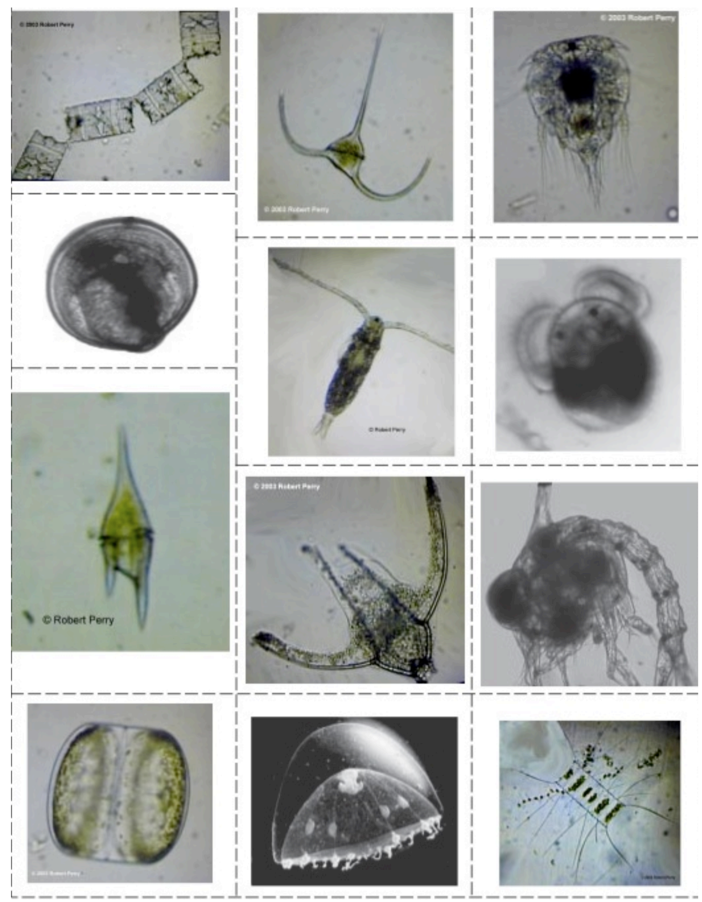
- These phytoplankton are tiny producers with the ability to move, although very slowly
- Their name is derived from their tail-like projections called ‘flagella’, which when whipped back and forth allows them to move in a distinctive ‘whirling’ motion
- Theirs shells are made of cellulose, similarly to cardboard or wood
- Along with diatoms, they are one of the most common types of phytoplankton
- Some are reddish-brown in color and are responsible for ‘red tides’ – a phenomenon caused by a sudden bloom of these microscopic organisms
- Many dinoflagellates are also bioluminescent and toxic.

COPEPODS

- These zooplankton are tiny animals related to shrimp, crabs and lobsters – crustaceans
- They are the most abundant animal on Earth, alongside Krill
- They graze on phytoplankton and are hence consumers, often the first trophic level of consumers in aquatic ecosystems, comparable to rabbits or cows in terrestrial ecosystems
- Copepods tend to feed near the surface of the water at night, and then sink to deeper depths during the day to avoid predators
- The sinking of their fecal pellets is an important flux of organic carbon to the deep
- sea/seafloor
- Copepods are typically 1-2mm long, with a teardrop-shaped body and large antennae
- As with many zooplankton, copepods are also often naturally transparent to camouflage with the water

LARVAE

- These organisms make up a significant portion of the zooplankton group and are the early developmental stages of numerous aquatic animals
- Larval stages are part of a life-cycle that involves metamorphosis, where an organism will have different appearances at different stages of their lives
- Organisms such as fish, crustaceans, insects and amphibians have larval stages, meaning that many creatures (even terrestrial) spend at least part of their life in an aquatic environment
- As many species of organisms have larval stages, different larvae have different features, although some will show characteristics of their future adult form.

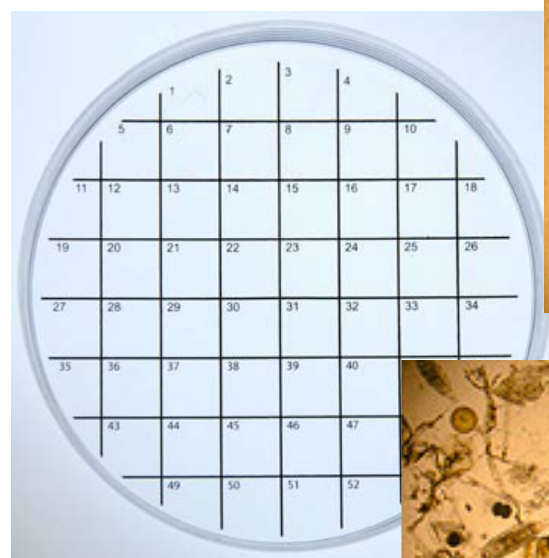


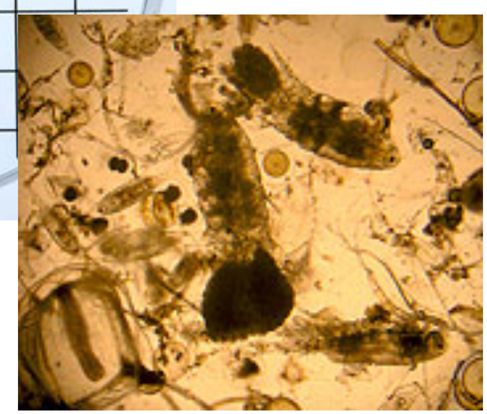
Lab Activities: Analysis of Plankton Samples

2. After taking plankton samples from pier, harbor and estuary, student randomly select and pipette water from each location to count the number of zooplankton as a ratio between locations.

Hypothesis:

which site will have the most zooplankton? The fewest? Why?





Lab Activities: Analysis of Plankton Samples

3. Students count zooplankton from pipetted sample twice, per pair, as tally marks. They record their data from each location and average their number's with their lab group.

	Count 1- Zooplankton	Count 1- Larval Fish	Count 2- Zooplankton	Count 2- Larval Fish	**Total average # of zooplankton
Harbor Sample					
Pier Sample					
Estuary Sample					

Lab Activities: Analysis of Plankton Samples

4. **Was their hypothesis correct**? As a class, discuss results and write group averages on the board. There should be a pattern, but if not, you can address scientific error as well!

- Estuary- highest number of zooplankton (and phytoplankton from visual)
- Harbor- low number of zoo plankton, but larval fish present.
- Pier- lowest number of plankton

Relate to abiotic factors:

Temperature/depth

Water flow

Wind

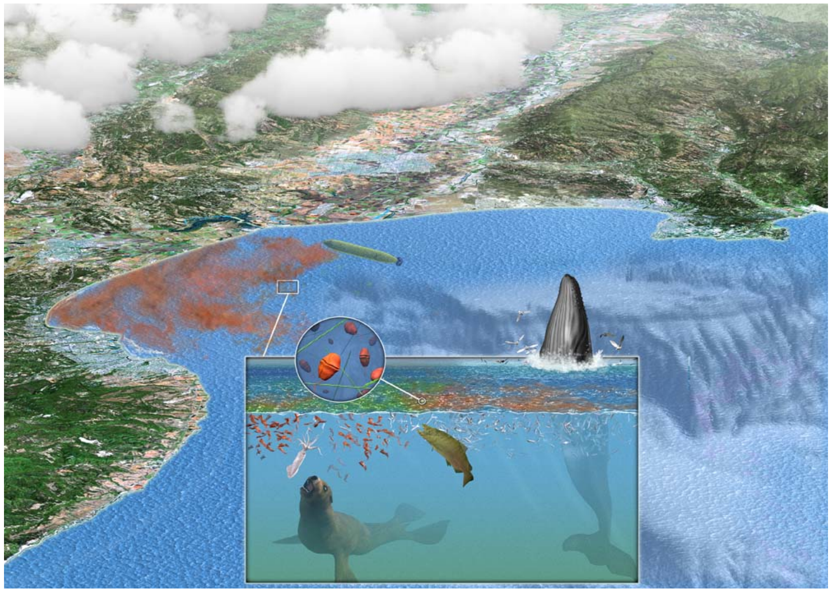
Nutrients (run-off)

Pollution (harbor)

Salinity (fresh water estuary)

Connecting to a Bigger Picture…

Part II: Upwelling and Agricultural Run-Off

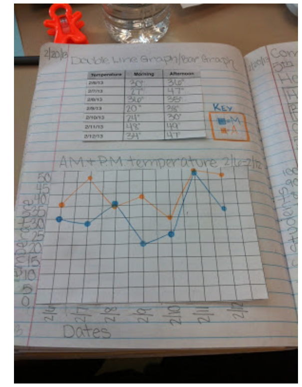


Activities:

1. Diagramming the Carbon Cycle and Upwelling
2. Reading Focus: Algal Blooms (HABs)
3. Graphing Data: Identifying Upwelling
4. Computer Graphing Activity: Predicting Agricultural Run-Off Near Monterey Bay, CA using real-data.

Graphing Real Data

1. <u>Identifying Upwelling</u>: Uses a data table to plot monthly changes in temperature and nitrates and other nutrients over a one-year period in Monterey Bay, CA



✓ Results demonstrate an *increase* in nitrates and other nutrients during a *decrease* in temperature in May 2005.

DATA TABLE

Data from Monterey Bay Aquarium Research Institute

*This data was generated by the MBARI Biological Oceanography Group, Monterey Bay, California using offshore buoys and can be found in more detail at: http://www.mbari.org/chemsensor/Data/Monterey%20Bay/lobosFeNuts_web.xls

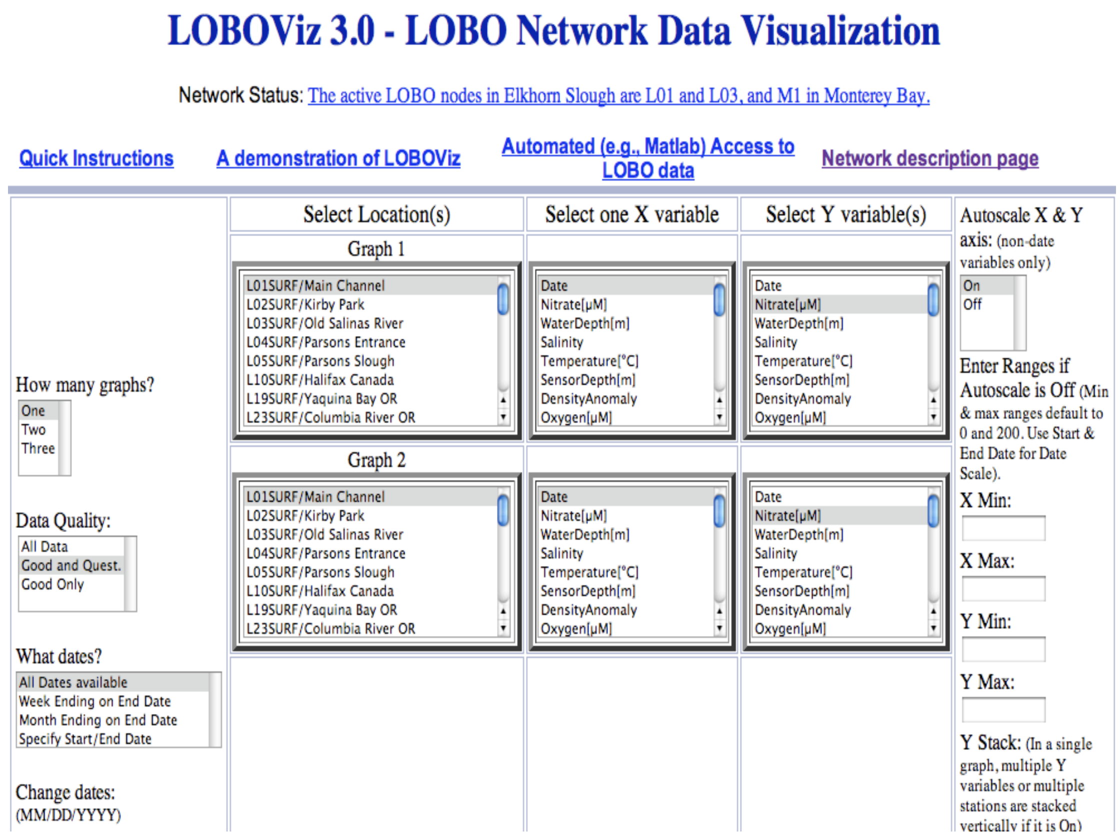
Month/Year M/YYYY	Sea Surface Temperature in °C	Sea Surface Temperature in °F	Nitrate Concentration (micromoles/L) (µM/L)	Phosphate Concentration (micromoles/L) (µM/L)	Dissolved Oxygen (micromoles/liter) (µM/L)	Chlorophyll Concentration (micrograms/Liter) (µg/L)	[1]Hours of Daylight (hours, minutes) (hours)	Silicate Concentration (micromoles/liter) (µM/L)	Iron Concentration (nanomoles/liter) (nM/L)
1/2002	12.13	53.84	7.53	0.88	258.23	0.33	10 h 3 m (10.05 h)	8.36	.20
2/2002	12.83	55.09	3.87	0.59	299.85	0.87	10 h 54 m (10.90 h)	4.63	.69
3/2002	12.20	53.96	2.13	0.52	301.99	2.95	11 h 57 m (11.95 h)	1.09	.66
4/2002	11.10	51.98	12.54	1.35	287.61	6.41	13 h 9 m (13.15 h)	20.14	4.82
5/2002	9.88	49.78	25.83	1.96	155.19	1.33	14 h 8 m (14.13 h)	30.90	33.78
6/2002	12.05	53.69	12.02	1.05	241.66	0.67	14 h 39 m (14.65 h)	18.29	1.08
7/2002	11.04	51.87	21.62	1.88	250.36	0.78	14 h 25 m (14.42 h)	28.55	2.60
8/2002	13.30	55.95	1.82	0.52	288.56	13.81	13 h 33 m (13.55 h)	2.24	.85
9/2002	13.71	56.68	0.88	0.60	308.63	6.28	12 h 25 m (12.42 h)	4.79	4.51
10/2002	13.26	55.86	4.63	0.55	247.53	0.36	11 h 16 m (11.27 h)	6.72	13.69
11/2002	12.68	54.83	6.05	0.66	258.68	0.45	10 h 13 m (10.22 h)	5.86	2.15
12/2002	12.55	54.59	7.18	1.15	246.19	0.24	9 h 40 m (9.67 h)	6.63	4.42

[1]Information from the U.S. Naval Observatory

DLESE TEACHING BOXES OCTOBER 2005

Graphing Real Data

2. Computer Lab Graphing Activity: Predicting Agricultural Run-Off near Monterey Bay, CA



http://www.mbari.org/lobo/loboviz.htm

Summary

By teaching both biotic (plankton) and abiotic topics (upwelling and run-off) in science with other related topics in an environment or ecosystem (carbon cycle, algal blooms) students are able to understand that the world is dynamic and interrelated.

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