

## Overview

In this lesson students will gain hands-on knowledge and skills in monitoring biodiversity through novel ecological assessment practices. In doing so, students will be introduced to several disciplines of biology including: zoology, evolution and physiology. Students will first discover and describe the evolution of the major animal phyla and their specific organ systems. The simultaneous research in animal evolution with the study of physiology results in enhanced student understanding.

After becoming familiar with the “ins and outs” of the marine invertebrates students will develop and conduct an environmental assessment of intertidal invertebrates along a coastal ecosystem. By developing and practicing transect surveys they will achieve a working understanding of different methodology employed for conducting ecological surveys and the math behind designing the sampling method and analyzing the results.

### Extensions Projects:

- Field Guide, Data Submission and Long-term Assessment

### Materials Needed:

- Computers with internet access, PVC pipe, ¼ inch elastic bands, rope, laser pointer, level, GPS units (optional).

### Activity

### CA Biology Standards

1. Comparative physiology: Evolution of organ systems	6 g; 8 a,e,f; 9 a-e
2. Ecological assessment: Sub-sampling a biological community	6 b,c
3. Surveying the shore at low tide	6 b,c
4. Survey data analysis	6 a-f

2007

Winning Lesson Plan  
from San Diego,  
California

*Evolution to Ecology:  
Knowing and Surveying  
Intertidal Invertebrates*

by Jay Vavra  
High Tech High

Subject: Biology  
Grade Level: 11  
Duration: Five weeks

## Activity 1. Comparative Physiology: Evolution of Organ Systems

### Purpose:

Most students don't realize that the vast majority of animals do not have a spine. The invertebrates are cold, squishy, crunchy, spineless wonders that make up more than 98% of the world's living fauna. To introduce physiology, students will take a phylogenetic approach to survey the major invertebrate phyla, leading up to the Chordata. In other words, they will worm their way around the evolutionary tree from the primordial ooze into the highest branches just below "us."

### Objective:

During this section of the lesson students should be able to identify the major invertebrate phyla by understanding the key characteristics of each phylum and the relationship of those key characteristics to the phylogeny and ecology of each group.

### Procedure:

1. Choose a partner and a phylum.
2. Design a PowerPoint presentation with the following:
  - a. Define etymology of phylum name and common marine Classes within.
  - b. Describe common members.
  - c. Describe general morphology of the primitive/general form.
  - d. Define major organ systems (at least 3) and how they are related to groups more primitive and advanced than your phylum.
  - e. Relate the above organ systems to humans.
  - f. Other interesting information (e.g. Barnacles of the phylum arthropoda have the largest muscle fibers of any animal).
  - g. Commercial properties (e.g. Oxygen-binding proteins from mollusks are used to design vaccines for lymphoma patients).

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Sub-sampling a Biological Community****Purpose:**

There are many reasons why a biologist may need to determine the species abundance and diversity of a particular community or ecosystem—for example, to determine the allowable take for a fishery or to determine the natural state of a habitat before a planned environmental disturbance or development activity. Biologists sub-sample communities in a variety of ways. A bat or bird specialist may hang fine nets between trees to “catch” local species to determine something about the species abundance and diversity. For a fixed population of creatures, such as those along the rocky intertidal zone, sampling is quite a bit easier.

**Objective:**

Students will consider the many variables and challenges in designing and implementing an optimal method for determining population structure of a particular organism or group of organisms in a habitat.

**Procedure:**

In order to survey the animals of the rocky intertidal zone students will determine how a biologist might sub-sample this habitat. Describe in detail the approach you plan to take in conducting your survey. Here are some considerations to take into account:

1. Materials needed.
2. Statistical methods to be used.
3. Random or targeted approach.
4. Timed or untimed.
5. Method for locating vertical height in a tidal series.

Students will also make a diagram of the survey approach(es). This will be done by placing the survey method onto aerial photography.

## Activity 3. Surveying the Shore at Low Tide

### Purpose:

A baseline measurement of a shoreline population can represent an important environmental assessment tool. Fundamentally, this is also an opportunity to reconnect students with nature, put them in touch with wild life. By getting wet and dirty, students can begin to appreciate nature first hand.

### Objective:

Students will apply survey techniques that they have developed (See Activity 2) to determine species abundance and diversity in the habitat of choice. The considerations from Activity 2 must be taken into account when conducting the actual survey. It is important that students record all necessary information for each survey. This information may include date and time of day, location, GPS coordinates, tide height, weather conditions, and data recorders (student names).

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## Activity 4. Survey Data Analysis

### Purpose:

A good field survey is useless unless it has been properly analyzed. Proper analysis must be connected to initial hypothesis testing. Species diversity may be an indicator of the health of the ecosystem. Species abundance may be connected to nutrient availability.

### Objective:

Following the intertidal surveys students will conduct data analysis of the transect data with Excel to determine the species composition and the population size at each region.

### Procedure:

First, students will need to set up a spreadsheet and enter all of the accumulated data. They can then generate graphs showing species distribution and abundance compared to a variety of parameters, including site, tide height, location from the ocean, or other features. Students can also compare different survey techniques done in the same region to assess the accuracy of the approaches. Because of the additional variables with different survey techniques, it is very important for long term studies that the method be employed for each type of survey conducted.

### Resources:

See Perspectives of San Diego Bay: A Field Guide (pp 96-99) for optimized methodology for intertidal surveys with high school students.

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## Extension Projects

### 1. Field Guides

To provide a complete picture of their fieldwork, the students could produce field guides which include not only their scientific studies, but also creative writing, photographs, and histories of human development, industry, environmental measures, mapping and other changes to their coastal environment. See [www.sdbayguide.com](http://www.sdbayguide.com) for more information.

### 2. Data Submission

The purpose should be to generate substantive research that could be used by the city or state governments, environmental and other groups to help evaluate the health of their local ecosystem and seek solutions to improve its ecology.

### 3. Long-term Assessment

Once students establish a faunal baseline, the study can be conducted annually, charting changes over time and measuring the abundance and diversity for comparison between sites and environmental perturbations such as development, pollution, global warming, and/or introduced species.

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