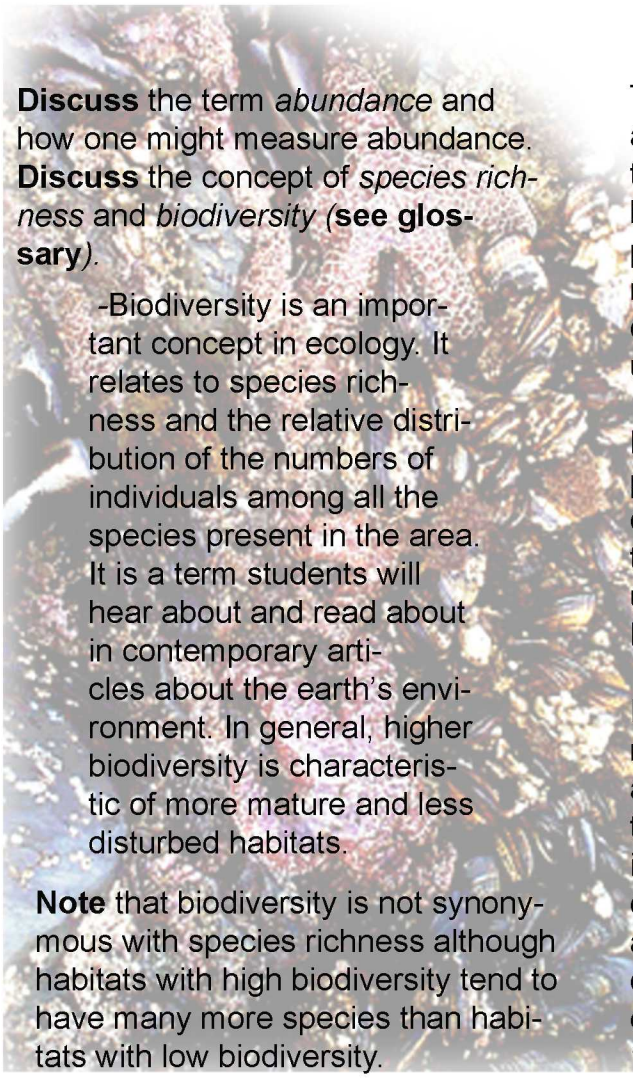
Exercise 1: Sampling a tidepool plot

Learning Objectives	Process Skills
-Determine the abundance of a plot by comparing estimates, counts, means, and percent cover	**-Determine whether a count of individuals or a percent cover measurement is best used when evaluating abundance.**

Introduction:



Discuss the term *abundance* and how one might measure abundance. **Discuss** the concept of *species richness* and *biodiversity* (**see glossary**).

-Biodiversity is an important concept in ecology. It relates to species richness and the relative distribution of the numbers of individuals among all the species present in the area. It is a term students will hear about and read about in contemporary articles about the earth's environment. In general, higher biodiversity is characteristic of more mature and less disturbed habitats.

Note that biodiversity is not synonymous with species richness although habitats with high biodiversity tend to have many more species than habitats with low biodiversity.

The easiest way to measure the abundance of *discrete individuals* is to count them. However, if the item being counted is a colonial animal or plant, it is very hard to count them. A measure of *percent cover*, or amount of area covered by that species, is used to determine abundance.

Look at the photos provided. In the photo of mussels, these individuals can be counted. In the field, scientists both measure and count individual animals such as mussels, limpets, sea stars and abalone.

In the photo of anemones, this colonial form grows so close together and has attached so many shell particles that it is almost impossible to identify individual anemones. The only appropriate way to measure abundance is by looking at percent cover. If the anemones covered the entire plot, it would be recorded as 100% cover.

Classroom Activity 1: **Counting Mussels**

Materials: Enlarged photo of mussel plot (2' by 3'), sheet of laminate, "vis-a-vis" markers

Preparation: Enlarge mussel plot photo to 2' by 3' and divide into quarters with masking tape.

a. Have the students estimate the number of mussels in the first plot.
b. Lay the photo on the floor and cover with laminate.
c. Ask four students to count the mussels in each quadrant and add the values of the four quadrants to get a total for the entire plot.
d. Compare the total number estimated for the plot to the values obtained by taking a value for any one quadrant and multiplying by "4". Determine the mean value of mussels for each quadrant. Discuss any *outliers.*

Classroom Activity 2: **Estimating Percent Cover**

Materials: Enlarged photo of anemone plot (2' by 3'), sheet of laminate (2' by 3'), "vis-a-vis" markers

Preparation: Enlarge anemone plot photo to 2' by 3' and score 2' by 3' sheet of laminate with 100 evenly spaced points.

a. Looking at the photo, ask each student to estimate the percent cover of anemones and green algae (*Ulva*).
b. Overlay laminate with 100 evenly spaced points. Ask several students to identify what is under each point as being 1) anemone, 2) green algae (*Ulva*) or 3) other (mussel, rock, sand, etc.)
c. Calculate percentages for "1", "2", and "3", or percent cover (for example: # of "1's"/ 100).
d. Compare calculated percentages with the original estimates.

Exercise 2:

Methodology: Random, Systematic, and Targeted Sampling

Learning Objectives	Process Skills
-Take a sample of a mussel plot using random, systematic, and targeted sampling approaches.	-Compare three sampling schemes, random, systematic and targeted.

Note: In order to demonstrate this concept in the classroom setting, we are constructing a hypothetical sampling within the mussel photo, assuming that the 2' by 3' plot is representative of the entire habitat site. Realistically this would be done on a much larger scale. Explain to the class that normally this type of sampleing would be done with a plot encompassing an entire habitat.

Classroom Activity 3:

Materials: Enlarged mussel photo, vis-a-vis" markers, 5 small laminate 2" squares

Preparation: cut sheet of laminate into five 6" squares, (note: the size of the square will cange according to the size of enlarged photot) Enlarge mussel plot photo to 2' by 3' (if not done with previous exercise)

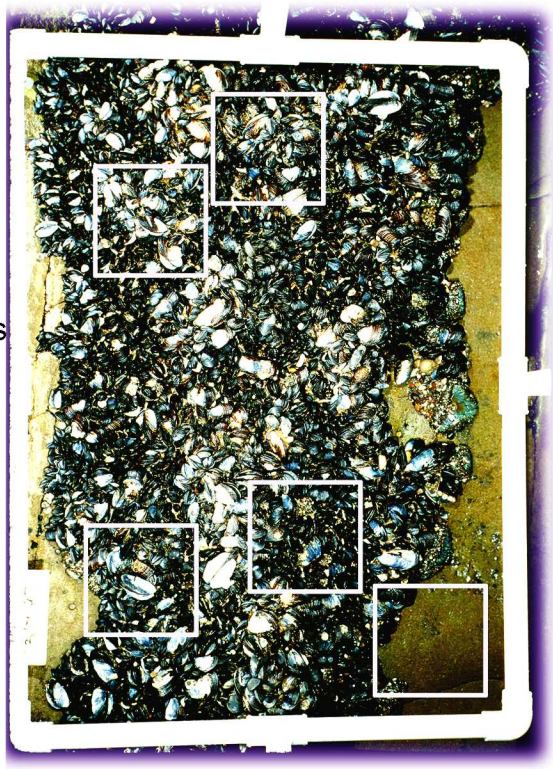
a. Place enlarged 2'x3' mussel photo on the floor.

b. Place measuring tapes or yard sticks along the x and y axis of your photo.

c. Use a random number table to generate 5 numbers between 1 and 24 and 5 numbers between 1 and 36. Pair numbers to generate 5 coordinates which can be marked on the laminate.

d. Make 5 sampling "squares" by cutting laminate into 2" squares and covering edges with masking tape.

e. Lay the five squares onto the photo using the paired coordinates to locate the upper left corner of the square. Count mussels under each square. Add numbers and calculate a mean.

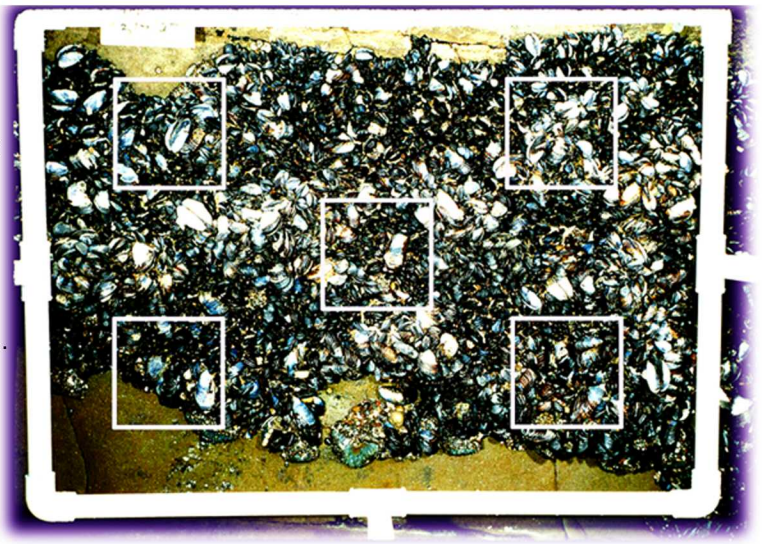


Classroom Activity 4: **Sample the plot systematically.**

Materials: Enlarged mussel photo, vis-a-vis" markers, 5 small laminate 6" squares

Preparation: cut sheet of laminate into five 6" squares, Enlarge mussel plot photo to 2' by 3' (if not done with previous exercise)

a. Place the five squares at regular intervals on the plot like a "five" on a dice. Measure distances between the squares so that they are the same distances apart.
b. Record the mussels counted under each square.. Calculate the mean.

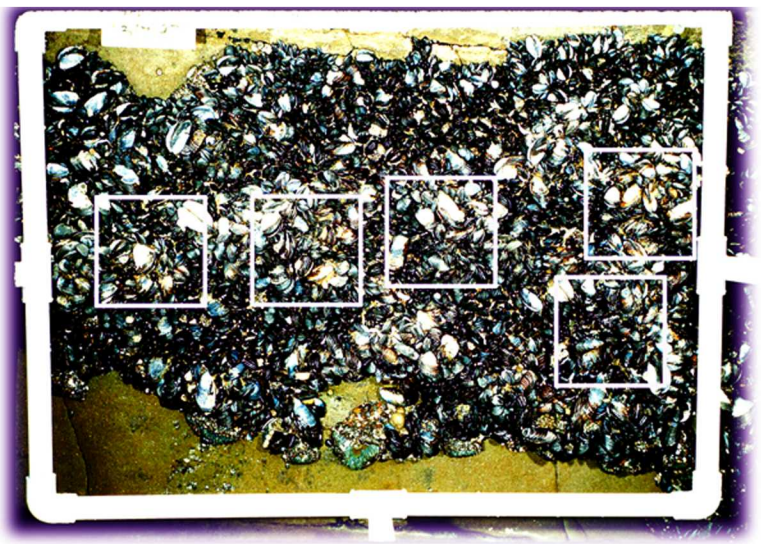


Classroom Activity 5: **Sample the plot with a targeted scheme.**

Materials: Enlarged mussel photo, vis-a-vis" markers, 5 small laminate 6" squares

Preparation: cut sheet of laminate into five 6" squares, Enlarge mussel plot photo to 2' by 3' (if not done with previous exercise)

a. Determine where the mussels are concentrated on the photo. Generate random number pairs which only fall within this area.
b. Place the squares randomly within the targeted area.
c. Record the mussels counted under each square. Calculate the mean.



Compare the three sampling schemes with the original counts of mussels in the plot. Determine which sampling method best describes the number of mussels in the plot.

Exercise 3: Species Diversity Index

Learning Objectives

-Compare the species richness and species diversity at two inter-tidal sites (photoquadrats).

Process Skills

-Calculate a species diversity index (a mathematical index or measure of diversity).

Introduction:

The Shannon-Weiner Diversity Index is a simple index that is used frequently in ecological analyses to calculate *biodiversity*. It is calculated by the following formula:

$$H' = \sum_{i=1}^{s} (p_i)(\log p_i)$$

Where s is *species richness* and pi is the proportion of each organism in the photoquadrat.

Species richness is simply the number of different species counted in all samples for each photoquadrat.

Classroom Activity 6: Calculating biodiversity

Materials: Two large laminated photoquadrats (separate locations), small 6" sample squares, data recording sheets, random number table.

1. Sample the mussel plot randomly.

a. Place enlarged 2'x3' mussel photo on the floor.
b. Place measuring tapes or yard-sticks along the x and y axis of your photo.
c. Use a random number table to generate 5 numbers between 1 and 24 and 5 numbers between 1 and 36. Pair numbers to generate 5 coordinates which can be marked on the laminate.
d. Make 5 sampling "squares" by cutting laminate into 6" squares and covering edges with masking tape.
e. Lay the five squares onto the photo using the paired coordinates to locate the upper left corner of the square. Count the number or percent cover of each separate species under each square and record on data sheet.

2. Calculate the Shannon-Weiner Species Diversity Index for each photoquadrat.

3. Compare a) the species richness and; b) Shannon-Weiner Diversity Index of the two photoquadrats.

Exercise 4: Statistical Analysis of Photoquadrats

Learning Objectives	Process Skills
-Compare mean density of mussels (or other abundant species) from two locations	-Determine if there is a statistically significant difference in mean density of mussels in different locations.

Introduction:

This exercise compares the species richness and species diversity at two intertidal sites (photoquadrats). The mean densities of populations of mussels (students can select other abundant species as options) from two locations (photoquadrats) will be compared. Students will determine if there is a statistically significant difference in the mean (average) *density* **(numbers) of mussels.**

Hypothesis: There is no difference between the two locations' (photoquadrats) average number of mussels (or other organism selected).

Classroom Activity 7: Comparing mean densities

Materials: Two large laminated photoquadrats (separate locations), small 2" sample squares, data recording sheets, random number table, Analysis of Variance (ANOVA) worksheet, F statistic Table.

1. Sample the mussel plot randomly.

a. Place enlarged 2'x3' mussel photo on the floor.
b. Place measuring tapes or yardsticks along the x and y axis of your photo.
c. Use a random number table to generate 5 numbers between 1 and 24 and 5 numbers between 1 and 36. Pair numbers to generate 5 coordinates which can be marked on the laminate.
d. Make 5 sampling "squares" by cutting laminate into 2" squares and covering edges with masking tape.
e. Lay the five squares onto the photo using the paired coordinates to locate the upper left corner of the square. Count mussels under each square and record on data sheet.

2. Using the ANOVA worksheet, calculate the means and variances (total, within, and between), and the F statistic. Using the F table, look up whether the F statistic is significant.

3. Compare the original null hypothesis (there is no statistical difference between the two populations) with the result from the F table.