Marine Ecology – Elkhorn Slough Field Trip

**Spatial Patterns of Shorebird Abundance and Feeding:
Resource Partitioning and the Ghost of Competition Past??**

The purpose of this lab is four-fold; **<u>firstly</u>** to introduce you to a unique and fascinating environment, Elkhorn Slough, and **<u>secondly</u>**, to the shorebirds that inhabit Elkhorn Slough at this time of year. People visit Elkhorn Slough from all over the world to enjoy the phenomenal diversity and abundance of birds that occur here. **<u>Thirdly</u>**, is to use this system to reinforce some ecological concepts raised in class and, **<u>fourthly</u>**, how to make field observations to test the predictions of hypotheses, generated from ecological theory.

In class, we will discuss concepts of competition, the competitive exclusion principle, niche diversification and resource partitioning. Such concepts have been major areas of ecological investigation. Early in the history of ecology, workers documented that coexisting potential competitors often exhibit differences in resource use when and where they co-occur with one another. This pattern has been uncovered repeatedly, and prompted the creation of the "Competitive Exclusion Principle", which can be stated as follows: if two competing species coexist in a stable environment, then they do so as a result of resource partitioning. If, however, there is no such partitioning, then one competing species will eliminate or exclude the other.

When there is coexistence of competitors, a differentiation of resource use may arise from present-day competition (i.e. an ecological effect). An example from class is the vertical distribution of intertidal barnacles (Connell 1961). On the other hand, competition may provide a selective force resulting in the two species developing different patterns of resource use (i.e. an evolutionary effect). Connell (1980) referred to this evolutionary effect as the "ghost of competition past". In other words, potentially competing species can coexist as the result of evolutionary responses to competition. This occurs because whenever two species compete, individuals of both species, by definition, suffer a reduction in their fitness. The fittest individuals of both species will be those that can escape competition and contribute disproportionate numbers of offspring to future generations. Natural selection should favor such individuals, and eventually the population may consist entirely of them. Thus, the two species evolve in a manner that makes them more different from one another than they were previously, such that they compete less and are thus able to coexist.

There are severe problems with invoking the "ghost of competition past." This hypothesis cannot be falsified. We cannot go back in time to check whether the species ever competed more than they do now. Species are distinct, and have distinctive features. It is possible that species have, in the course of their evolution, responded independently, though differently, to selective forces. These species do not compete now, nor have they ever competed; they simply happen to be different. Another explanation is that competition in the past eliminated a number of other species leaving only those that are different in their utilization of the habitat. Therefore, we can still see the hand of the ghost of competition past, but manifested as an ecological force (eliminating species) rather than an evolutionary force (changing characteristics of species).

There are profound difficulties in invoking competition as an explanation for observed patterns, and especially in invoking it as an evolutionary explanation. An experimental manipulation (for example Connell's barnacle experiments) can indicate the presence of current competition. But what do we do with experimental outcomes that are negative? Negative results from competition experiments would be equally compatible with the past elimination of species by competition, the evolutionary avoidance of competition in the past, and independent evolution of non-competing species.

In this lab we will document differences in resource use and behavior of a guild of shorebirds feeding on mudflats in Elkhorn Slough National Estuarine Research Reserve in Moss Landing, California. Large numbers of migrant and resident shorebirds feed in wetlands along the California coast; however, more than 70% of coastal wetlands in California have been degraded by human activities. Elkhorn Slough is

one of the largest remaining salt marshes in California and provides critical habitat to migratory shorebirds using the Pacific Flyway. The large numbers and high diversity of shorebirds makes this an excellent system to examine potential partitioning of resources. Differences among species will certainly emerge; the challenge is in interpreting these differences.

General hypothesis: **Resource partitioning** contributes to the coexistence of shorebird species potentially competing for a limited prey resource.

How might shorebirds partition infaunal prey?

Four *specific hypothesized mechanisms* for spatially partitioning resources:
  (1) Geographical: species of shorebirds segregate themselves along the seaward-shoreward length of the slough.
  (2) Tide height: species feed at different tide heights.
  (3) Microhabitat: species feed in different microhabitats (e.g., edge of water vs. pools vs. dry sand)
  (4) Sand Depth: species feed at different depths in the sand depending on length of beak or how deep they probe (pecks vs. probes).

For each of the above alternative hypotheses, there is a corresponding null hypothesis (i.e., no difference among species with respect to any of the four spatial scales of habitat).

Testable *predictions* of all of the above hypotheses:

(1) Abundance of each species varies along the length of the slough and varies differentially among species (i.e. species A more abundant at the mouth of the slough and species B more abundant at the inshore end of the slough).

(2) Abundance of each species varies across the tidal heights and varies differentially among species (i.e. species A more abundant at highest tidal zone and species B more abundant in lower tidal zone).

(3) Abundance of each species varies among habitat types and varies differentially among species (i.e. species A more abundant in damp sand and species B more abundant in shallow pools).

(4) Feeding behavior differs among each species (i.e. species A probes and species B pecks).

Finally, recall that according to the theory, segregation (i.e. differences in spatial arrangement or feeding behavior among species) is greatest between species of most similar morphology or distribution, respectively.

Study Area
Elkhorn Slough is a shallow tidal embayment and seasonal estuary on Monterey Bay. The slough has an axial length of 10km and maximum width of 100m at its mouth. The main channel of the slough is bordered by mudflats and is intersected throughout by small tidal creeks. At low tide, about 170 ha of intertidal mudflats are exposed.

Procedures
Groups of 2 should separate from one another by 50 - 100 meters.

1. Description of Shore Bird Abundances: We will census shorebirds on the mudflats along the shore of Elkhorn Slough. A census simply consists of a scan of the area.

For the *geographic* comparison and *tidal height* comparison, rapidly census all individuals of each shorebird within each of three tidal categories within your sampling area and note the approximate area you are sampling (try to sample an overall area roughly 100 m x 30 m). Repeat this for each species. Repeat this three times over the entire period you are at the site. This should generate three counts of each species in each of the three tidal habitats. You should work in groups of 2. One-person should census birds while another records data.

For comparison of bird abundance among the five *microhabitats* indicated on your data sheet, record the number of each species in each of the five microhabitats. Count no more than 50 birds of each species. Again, you should work in groups of 2. One-person should census birds while another records data.

2. *Description of Bird Feeding:* Each group will study the behavior of individual birds feeding on the mudflats in their area. Work in pairs, one observing and the other taking data. For each observation, pick one individual bird feeding in a microhabitat (mud, wet mud, water, etc.). Observe the number of pecks (< 1/4 bill length) or probes (> 1/4 bill length) for 60 seconds if possible. If the bird changes microhabitat or repertoire, stop observations and start over with a new individual. Try not to observe the same individual in the same microhabitat or during the same repertoire more than once if possible (i.e., independence of replicate observations).

YOU ARE RESPONSIBLE FOR YOUR DATA! Do not lose you data sheets. We recommend that you photocopy it as soon as you return from the field. We want you to enter your data into a database using Excel. The database will be made available on the web page through the "Field Trips" link. We will compile these databases for the class data set and summarize patterns in class.