*Resource Competition*

**Intra and Interspecific Competition**

Hutchinson’s concept of a **niche** is a multi-dimensional hypervolume comprised of the physical and biological environmental conditions that describes a species’ suitable habitat. In basic terms, a species’ niche includes how an organism lives in its environment; how it reacts to competitors, resource abundance and alters the environment for others. For example, a plant in the forest may grow when a neighboring tree falls over and increases available sunlight. As this tree grows it will create shade, suppressing the growth of younger trees in the immediate vicinity. Temperature, salinity, nutrients, precipitation, predators, prey, and competitors are all examples of environmental parameters that can define a species’ niche.

**Resource competition** occurs when individuals utilize the same resource pool to increase their growth, reproduction, or survival (Tilman, 1980). This means that there is **niche overlap** among individuals. **Resources** are any material that is used and made unavailable to other organisms. Some common examples of resources are nutrients, sunlight, food, and open space. For example, two plants may be competing for a shared source of nitrogen or two barnacles may be competing for a bit of open substrate on a rock.

There are two main types of competition. **Intraspecific competition** is when individuals of the *same* species are competing for a shared resource. **Interspecific competition** is when individuals of *different* species compete for a resource. The strength of competition depends upon the amount of overlap in the niche of the species. Here, the **niche** is the Hutchinson concept of a niche, involving all aspects of a species use of the physical and biological environment. The intensity of competition is contingent upon the amount of niche overlap among individuals. Greater overlap means more shared resources, resulting in stronger competitive effects. I**ntraspecific** competition is usually stronger as the two individuals require a nearly identical suite of resources.

Competition can modify ecosystem structure and function. Strong territorial behavior, a sign of competition among individuals for limited resources, can result in a **uniform** distribution of individuals in space. Also, in the presence of interspecific territorial aggression, some species may not be able to forage efficiently inside the territory of a different species. Accordingly, in the presence of competitors, individuals often experiences lower growth rates, reproductive output, or survival. Radishes grown in high density aggregations often have smaller tubers than when grown in isolation. In the presence of territorial damselfish, many reef fishes experience higher mortality as there is less available shelter open for them to hide from predators.

A **fundamental niche** describes the conditions in which an organism can survive based on physiological constraints. For example, tropical plants are incapable of surviving in areas that experience extreme cold. Similarly, freshwater fish die if they are introduced to saltwater environments. On the other hand there are large swaths of area in which organisms can exist physiologically, but don’t. The area in which organisms actually exist is referred to as their **realized niche**. Often, species are excluded due to biological interactions such as competition or predation. For example, many saltmarsh plants can actually grow better when moved to environments that are less salty, however they are not found naturally in these environments. In this example, while saltmarsh plants can survive in freshwater areas, they are excluded from them due to competition with organisms that are more capable of obtaining limited resources, such as light and nutrients.

The purpose of this lab is also to familiarize you with the concept of **density-dependent competition**. We will use basic activities to demonstrate both intra- and interspecific competition between resource specialists and resource generalists.

**ACTIVITY 1**

Noticing different beak size and shapes of birds in the Galapagos Islands was integral in Darwin’s development of the theory of evolution. By noticing that some beaks were long, others short, some curved, some straight, Darwin was able to theorize that the shapes of these species beaks evolved as species competed with each other over a finite set of resources. In order to persist, species needed to adapt to different foraging strategies. By becoming increasingly different from one another, they escaped competitive pressure. For example, some species developed long curved bills to be able to extract nectar from flowers while others developed strong thick bills that were useful for cracking open seeds. In this activity we will simulate foraging strategies while using different bird beaks to highlight the concepts of competition.

Diagram of Finch beak size and shape, reprinted by permission from Macmillan Publishers Ltd: <em>Nature,</em> Vol. 442,
    p. 515, 2006

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The lab will be split into four groups of six individuals. Before you start, decide with your TA how many treatments and replications each group will be doing. For data analysis, we are interested in comparing the effect of **inter-** and **intraspecific** competition. You can use the whiteboard to record the entire class data (next page has an example of a table you can use to record your treatments).

Boxes full of dry rotini pasta and wood chips will be seeded with two different resources (large white and small black beans). The individuals will compete for 5 minutes or until all beans have been recovered as explained below. The competition will be repeated 5 times for each pairing.

To quantify **intraspecific** competition, the box will be seeded with black beans and two individuals from the group will use tweezers to compete for the black beans (A). The same process will take place using white beans and tongs (B). Competition between individuals using the same tools is similar to intraspecific competition of birds with similar beaks.

Then **interspecific** competition will be quantified using the same set up. Separate experiments will be performed to collect either black (C) or white (D) beans. The same 2 individuals will compete each time (not the same 2 that competed previously). To quantify interspecific competition the boxes will be seeded with both white and black beans. One individual from the group will have tongs and the other will have tweezers. The same 2 individuals will compete each time.

Finally, you will assess how the **strength of competition** may affect resource acquisition (A vs. E). In this experiment 4 people with tweezers will try and collect black beans in the same amount of time. You will then take the average number of beans collected per individual with *four* people collecting (E), and compare it with the average number of beans collected per individual when only *two* people were collecting (A).

See table below for how you should organize your raw data.

**References**

Tilman, D. (1980). A graphical-mechanistic approach to competition and predation. *The American Naturalist, 116*(3), 362-393.

**Materials**

8 tweezers, 4 tongs

2 bags of large white beans and 2 bags of small black beans for each class

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | A | | B | | C | | D | | E | | | |
| Competition | Intraspecific | | Intraspecific | | Interspecific | | Interspecific | | Intraspecific | | | |
| Beak size | Small | | Large | | Large | Small | Large | Small | Small | | | |
| Bird density | Low | | Low | | Low | | Low | | High | | | |
| Food | Small (black) | | Large (white) | | Small (black) | | Large (white) | | Small (black) | | | |
| Trial | tweezers | tweezers | tongs | tongs | tweezers | tongs | tweezers | tongs | tweezers | tweezers | tweezers | tweezers |
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| Average |  |  |  |  |  |  |  |  |  |  |  |  |
| St Dev |  |  |  |  |  |  |  |  |  |  |  |  |