Island Biogeography 182 version

Biodiversity is a measure of the amount of variety in organisms, generally the variety in an ecological community. Biodiversity takes into account both the total number of different species (species richness) and the relative numbers of different species (species abundance). Biodiversity tends to increase with habitat size, environmental variation (for example, topographic relief or climatic microclimates), and latitude (for example, there are more species in the tropics than at cooler climates).

Biogeography is the science that attempts to document and understand spatial patterns of biodiversity. In studying biogeography researchers seek to understand distribution patterns of organisms and the processes of evolution, dispersal and extinction that result in those patterns.

The field of island biogeography is the brainchild of Robert McArthur and Edward O. Wilson. The basis of island biogeography supposes there is a large source area of species and surrounding the source area is a series of islands of different sizes and distances from the source area. Species disperse from the source area to the islands. Thus, the biodiversity found on an island is a function of (1) how close the island is to the mainland, and (2) how large the island is. As you might imagine, larger islands tend to have more species than smaller islands because there is greater habitat diversity and, therefore, more resources available. In the theory's simplest form species from the source area disperse to an island at a particular rate (the immigration curve), depending on the island’s size and distance from the source area.

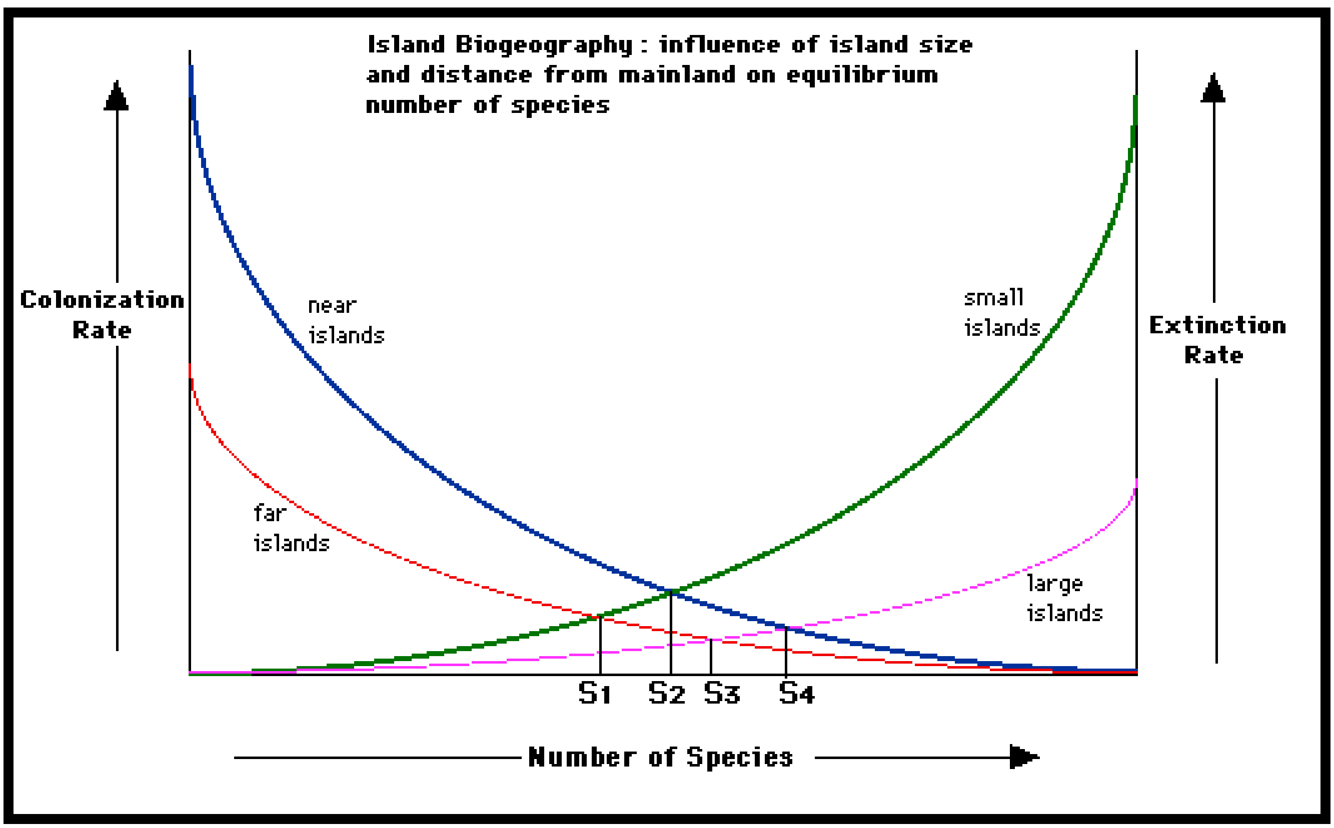
Biodiversity on island habitats is thought by many researchers to reach an equilibrium that is maintained by the new arrival of some species (immigration) while other populations are disappearing from the islands (extinction). Some of the most interesting research on biodiversity has examined species richness on island habitats (e.g., Simberloff and Wilson 1970).

Though extinction of local populations may occur, dispersing individuals from other habitat sources can reintroduce the same species. This is referred to as the rescue effect. The rescue effect can be important in maintaining higher levels of biodiversity in smaller habitats than expected when nearby source populations of species can disperse to these habitats. The rescue effect is thought to be closely linked with proximity and dispersal abilities of source populations. This has implications for conservation biology, since the closer two or more populations are to each other the less likely that any of them will suffer extinction, as population A may be rescued via migration from individuals in population B.

Though studies such as MacArthur and Wilson’s original model were for islands, ecologists have found the same trends on mainland habitqats. Mainland habitats oftern have large environment variations within a single ecosystem, creating mosaics fo ecological island-like habitat patches. Also, further alterations of habitats by humans, now estimated to have greatly altered at least 50% of all terrestrial ecosystems, has fragmented many formerly large and continuous habitats. These anthropomorphic (human induced) alterations increase island-like separations of mainland populations, which pose dispersal problems and reductions and extinctions for many species. Dispersal abilities vary widely from species to species. A formibable barrier to dispersal for one species (ex. Snails crossing roads), may be negligible to other species that can cross mountains or oceans without much difficulty (ex. Many birds).

The graph below shows the relationship between island size and distance from other habitats of the same type (the mainland). Note that large near islands (S4) have a higher equilibrium number of species than do small far islands (S1). Small and near islands (S2) and large and far islands (S3) have intermediate numbers of species. The idea is that the number of species on an island(S) is set by equilibrium between colonization rates and extinction rates. Large islands have higher colonization rates (they present a larger target) and lower extinction rates (they house larger populations) than small islands. Near islands have higher colonization rates than far islands because it is more likely that colonizing organisms will reach them.

Extinction rates are low when species numbers are low because there aren't that many species to go extinct. As species numbers increase, extinction rates increase. Colonization rates are high when species numbers are low because most organisms that reach the island will belong to species that are <u>not</u> already present on the island. As species numbers increase, new colonists will likely belong to species already present so colonization rates (of new species) drops.



http://euclid.dne.wvfibernet.net/~jvg/ENV101/lectures/Biodiversity.html

<u>The two main predictions of Island Biogeography Theory are</u>:

1. Islands close to a source area will have a higher number of species than islands of equivalent area that are further from the source area.
2. Larger islands will have more species than smaller islands located at similar distances from the source area.

These two predictions have been largely supported by observational and experimental data.

Island biogeography applies not only to islands, but can also be applied to any series of discontinuous habitats such as forest fragments. Of course, the theory of island biogeography has been expanded and refined since its earliest theoretical beginnings as outlined above.

Methods:

Measure and mark with tape your starting distance from the island habitats and stand no closer than the measured distance, which represents the mainland source of these populations. Each group of students 'disperses' (tosses) the species towards the islands in three times. First dispersal is towards the close island group, second dispersal is towards the middle island group, and third dispersal is towards the farthest island group. The first group of tosses to each islands are considered to be one gender. The partner(s) at your table will be tossing a second group (other gender of each species) in a similar manner.

Before doing this, make your predictions (hypothesis) as to what you expect to find from this lab results (ie. number of species colonizing each habitat type based on size and distance).

Hypothesis:

ISLAND BIOGEOGRAPHY EXERCISE -- INSTRUCTIONS

1. Work in table groups (2-4).

2. Each table group uses ONE type of object. Make sure you have 100 units of your object.

3. Measure off the distances for the small, medium, and large “island”. You will replicate tosses at three distances of 1.0, 2.0 and 3.0 meters

4. Toss the objects to the clustered “islands”, 5 at a time, or 20 total tosses for each distance

5. Count the total number of objects (1 object = 1 successful species dispersal) in each of the three islands at the end of the tosses.

6. The same person throws, ALWAYS, and the same person records, ALWAYS.

7. ALWAYS use an underhanded throw, with one or both hands.

10. Record all throws in the data tables provided.

11. Obtain equivalent data for the other pair of people at your table.

Results:

Island Colonization Data: List the number of species (1 object = 1 species) that “colonized” each island size and distance.

1m	Small	Medium	Large
Trial 1			
Trial 2			
Average (Total/2)			

2m	Small	Medium	Large
Trial 1			
Trial 2			
Average (Total/2)			

3m	Small	Medium	Large
Trial 1			
Trial 2			
Average (Total/2)			

Questions to be addressed include the following:

1. Make a graph, listing total number of species that successfully colonized each island (Y-axis). Denote island size and distance from source (tosses, X-Axis)

2. Using your experiment as a model for species dispersal:

a. How does distance from the original population affect colonization number?
b. How does island size (ie., bucket size) affect colonization number?

3. Consider island biogeography theory, current alteration and fragmentation of natural habitats and efforts towards conservation. In view of the species area relationships and distance from source populations, what types of habitat designs do you think would be most successful in species conservation and protection? What types of habitat designs would be least effective in species conservation and protection? For example, would you expect small habitats to be better towards conserving species with clumped or more even types of distribution?