An Ecology Field Project Book

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I. GENE FLOW IN PLANT POPULATIONS

A. Introduction: Gene flow between populations may influence the amount of genetic variation in the population and put limits on the amount of local adaptation that can take place. Many animals are mobile; gene flow in these species primarily results from the dispersal of individuals out of their population. Most plants, however, are sedentary; adult plants can't move from place to place. In this project, you will study the two primary methods leading to gene flow in plants: pollen and seed dispersal.

B. Equipment Needed: Notebook paper

C. Pollen dispersal:

1). Locate as many different types of plants that are currently flowering as you can (try to find 10 different species).

Record the following characteristics for each species: flower shape, flower color, flower size, flower scent, approximate number of flowers/unit area (e.g. 1 square foot), and any animals (record the type) that visit the flower.

2). If you see an animal at a flower, watch it for 5 minutes, or until you can no longer see it (different group members can watch different individuals). During this time, try to determine its pattern of flower visitation by recording how many flowers it visited on a plant before moving to a different plant. If more than one pollinator is present, repeat your observations.

Pollen Questions: Which of your plants would you expect to have pollen dispersed by animals? By wind? What flower characteristics are associated with each type of dispersal? What patterns do you see between flower species and the species of animal (e.g., type of insect, etc.) visiting the flower? Do you think flowers are "designed" to match a specific type of pollinator? What evidence do you have to support your view? Did the pollinators you observed visit only one flower before moving to another plant, or did they visit multiple flowers on the same plant? Relate these pollinator observations with what you know about gene flow and inbreeding. Do you think the pollinator behavior poses a problem for the plants?

D. Seed dispersal:

1). Collect a few representative samples of as many different types of plant seeds as possible (can you find 20?). Blow lightly on the flower. What happens?

2). Do you see any animals eating seeds? If so, try to observe if the animal eats the seed whole, or in pieces. Remember to look closely at the seed itself for possible animal signs.

Seed Questions: Why might a parent plant not want its seeds to grow close to it (think from both the parent plant and the offspring plant's perspective)? What dispersal "agent" (e.g., wind, animal species, etc.) do you think is responsible for most of the dispersal for each type of seed? What seed characteristics support your view? How effective do you suppose each type dispersal is (i.e., what percentage of the parent plant's seeds do you think live to grow into adult plants themselves)? Why?

E. General Question: In general, why might a plant want to spread its genes out spatially in the environment?

II. DUCK FORAGING BEHAVIOR

A. Introduction In lecture, we discussed several different concepts relating to the behavioral ecology of individual animals, particularly to foraging behavior (including group foraging). For your field trip project, your group will have an opportunity to test some of these ideas with the Mrak ducks.

B. Equipment Needed stopwatch or watch with second hand, notebook paper, graph paper, loaf of whole wheat bread.

C. Procedure: You will need two groups of two people each (one bread thrower and one data collector in each group). Flip a coin to decide which group will be the "fast" group and which group will be the "slow" group. Cut the bread into fourths before starting. Space the two groups out on the edge of Mrak Pond (50 ft or so). Starting at the same time, the slow group should throw out one (small!) piece of bread every minute, while the fast group should throw out one piece of bread every 15 seconds.

The data collectors should record the number of ducks which are present at their site every minute. Also, the data collectors should record any interesting behaviors the ducks seem to be exhibiting (e.g. aggression towards one another, gender differences, etc.). If possible, try and count the number of "aggressive acts" by the group as a whole (per minute).

After 15-20 minutes, switch the fast and slow groups and note the response of the ducks.

D. Discussion What patterns do you see in the results (e.g. what differences were there, if any, between the two groups)? Howdo you explain your results? Are the individual ducks maximizingenergy gained per time (energy unit = 1 chunk of bread)?

III. CALCULATING A GAIN CURVE

A. Introduction The marginal value theorem (MVT) is one of the major theories in behavioral ecology, and a critical component of the MVT is the gain curve. In this project, you will calculate a gain curve using ducks and bits of bread.

B. Equipment Needed Stopwatch or watch with a second hand, notebook paper, graph paper, loaf of whole wheat bread with each slice cut into fourths.

C. Procedure Your group will need to have one person who observes an individual duck, and one person who records the data. If you have four people in your group, record data from two ducks at the same time (i.e., have two duck watchers and two recorders). Starting as soon as the bread is thrown out, the data recorder will call out "time" every four seconds, and the duck watcher will report the number of crumbs eaten by their duck in that interval. Continue until no more bread crumbs remain. Repeat the experiment a couple of times, switching your data collection roles if you wish.

D. Analysis Calculate your gain curve(s) by plotting time on the x-axis and the total number of crumbs eaten (cumulative) on the y-axis.

E. Discussion In what ways, if any, does your curve differ from what you expected? What do you think caused these differences? What other information would you need to have in order to make a prediction for how long an individual duck should stay in your bread crumb "patch"? Given the availability of other foraging patches, did your ducks behave as predicted by the MVT?

IV. "SEED RAIN"

A. Introduction Where a seed ends up after "detaching" from the parent plant determines both whether the seed will grow at all and the environment of the offspring plant. The spatial distribution of seeds from the parent plant can be represented by plotting graphs of the "seed rain". In this project, you will calculate and interpret "seed rain" graphs.

B. Equipment Needed Notebook paper, graph paper, and tape measure.

C. Methods Find an oak tree that is dropping acorns. In a straight line ("transect") out from the tree, record the number of acorns per unit area (e.g., sheet of notebook paper; 1 square meter). That is, starting at the trunk, lay the notebook paper down lengthwise, record the number of acorns underneath the paper, shift the paper out from the tree one paper length, record the number of acorns, etc. Continue until you are well out from underneath the canopy. Do at least three transects for a tree, and repeat on at least one more oak tree. Better yet, if you can find a different type of plant/tree that is dropping seeds, use it. Make sure the area unit you choose is appropriate for the plant and seeds you sample.

D. Analysis Make a graph of each transect, plotting "Distance" (e.g., number of sheets from tree) on the x-axis and "number of acorns" on the y-axis. For each tree, average the number of acorns found among your different transects at each distance, and make an overall seed-rain plot for the tree.

E. Discussion Questions How would you describe the spatial pattern of seeds? Do you think our method gives an adequate picture of the spatial distribution of seeds? How do the seed-rain graphs compare for the different trees/plants? What pattern of seed distribution do you think the tree "wants" (think in terms of parent-offspring competition, offspring-offspring competition, finding suitable areas to grow, gene flow, etc.)? What factors might contribute to the dispersal of seeds from the parent plant?

V. MOSQUITOFISH

A. Introduction The mosquitofish (*Gambusia affinis*) is related to guppies and mollies (of aquarium fame) that naturally occurs in the eastern United States. Mosquitofish commonly have been introduced into other sections of the country (including Mrak Pond and Putah Creek) as an attempt at the biological control of mosquitoes. In this project, you will 1) observe and interpret natural mosquitofish behavior; 2) attempt to estimate the mosquitofish population size in Mrak Pond; and 3) observe and interpret mosquitofish morphology.

B. Equipment Needed Notebook paper, aquatic net, clear container for viewing mosquitofish

C. Methods/Questions

Natural observations: Sit quietly on the side of the pond - if possible, find a spot where the sun is shining on the water so you can see the fish better. Where do the mosquitofish appear to be located in the water? What do they seem to be doing? Do they appear to be in groups, or do they move singly? Relate their behavior to 1) physiological ecology (e.g., metabolism, temperature regulation, etc.) and 2) behavioral ecology (e.g., foraging behavior, anti-predator behavior, mating behavior, etc.).

Come up with one hypothesis (e.g., related to their anti-predator behavior), and design an experiment to test your idea. Make sure you include appropriate controls and the type of data you would collect in your design. Do not conduct this experiment.

Population size: You might notice that mosquitofish are quite abundant in Mrak Pond. Estimate the total number of mosquitofish 1) per square meter; and 2) in the whole pond, from bridge to bridge. To do this, make several counts of mosquitofish in an approximate square meter in different locations, and average. Then estimate the total square meters of Mrak Pond. What sources of error are there in your estimates? Given any resources/equipment you could have, think of two other ways you estimate the number. Try and think up methods that would maximize accuracy, while minimizing disturbance to the animal population and environment. Why do you think mosquitofish are so abundant?

Mosquitofish characteristics: Using a net, capture some mosquitofish and place them in a container with water (this may take some patience!). What do you notice about their body shape, mouth position, and coloration? Do they seem to be adapted for the environment they live in? Male mosquitofish have an elongated anal fin (the bottom fin closest to the tail). How do you think they use this special fin? Try to distinguish the males from the females in your sample. What do you notice about male size vs. female size? How can you explain this? Think up an experiment to test your hypothesis, including appropriate controls and the type of data you would collect.

VI. SPECIES-AREA RELATIONSHIPS

A. Introduction Later, you will learn about the relationship between the number of species present and the amount of area sampled. For your field trip project, you will gather some data in order to calculate and interpret a "species-area" curve.

B. Equipment Needed Graph paper, notebook paper, yard/meter stick (optional)

C. Procedure To calculate a species area curve, you need two types of data: 1) increasing amounts of sampled area, and 2) the number of different species present in a given area. You might have to experiment with different area "scales" to see which works best. I suggest you start with something simple. For example, try different numbers of sheets of notebook paper (i.e., your area unit = 1 sheet of paper). If you think a larger scale would work better, go ahead and try it, just remember to keep your area increments constant. Don't worry about "properly" identifying species- for our purposes, if it looks like a different species, call it a different species!

D. Locations Try as many locations and/or types of communities as you have time for (allowing time for analysis and discussion). Work with one first, then add others if you have time.

Suggestions:

1) species of animals under leaf litter (or decorative bark) on the ground

2) species of plants in grassy areas (if you can't find a "naturally grassy" area, just use a good section of lawn)

3) species of insects on plants (here instead of area you might try using "number of plants sampled")

4) species of birds in the arboretum (if you know bird species)

E. Discussion After (or while) gathering your data, make a plot of # of different types of species (y-axis) and amount of area sampled (x-axis). How can you interpret the shape of your species-area curve? If you had time to sample different communities, how do their species-area curves compare? If you were given the task of conserving as many species as possible, but only given enough money to buy 1000 acres total of land, do you think you would be better off buying two 500 acre parcels or one 1000 acre parcel? How could you tell?

VII. ESTIMATING DIVERSITY

A. Introduction In this project, you will compute and compare the diversity for two different habitats.

B. Equipment Needed notebook paper, calculator, and a tape measure.

C. Procedure Although the usual measures of species diversity require biomass measurements, you will be using "number of individuals" instead. The habitats will be two different "leaf-litter" habitats - try and choose two which appear to be different somehow (e.g. wet vs. dry, leaves/bark vs. pine needles, etc.). Sample the same amount of area in each habitat (e.g. 1 m^2): count the number of individuals present in that area of all animal species. Don't worry about "properly" identifying species- for our purposes, if it looks like a different species- call it a different species.

D. Analysis To compare the species diversity in the two areas, calculate the "equitability index". Use the number of each species to calculate your "p_i' 's" (proportion of total number of individuals of all species that were species type i). Then use these pi's to calculate the equitability index (E) for each area:

$$E = \frac{1}{N} \sum_{i=1}^{N} p_i^2$$

E. Discussion What are the range of possible values for E? Where do the E's for your sampled habitats fall within this range? Compare the diversities of the two habitats. Which habitat has the highest diversity (if any)? Why do you think this is the case? Were the same species present in both habitats? How might your measures of diversity have differed if you had used biomass instead of numbers of individuals?

VIII. DISTURBANCE

A. Introduction Disturbances of different kinds can play a major role in shaping plant and animal communities. Here , you will be comparing various aspects of disturbed and undisturbed areas and trying to relate the patterns you see to ideas we've discussed in lecture.

B. Equipment Needed Notebook paper, calculator, and a tape measure.

C. Procedure Locate at least two disturbed locations (e.g., heavily walked on, eroded, etc.) and at least two undisturbed locations (try and match the general type of area). For each location: 1) count the number of different species of plants in a given amount of area (say 1 m^2). Don't worry about "properly" identifying species- for our purposes, if it looks like a different species - call it a different species. 2) Count the number of individuals of each species present in the same type of area. 3) Compare the plants in the two types of areas - what differences (i.e., in morphology, size, etc.) do you notice between species in disturbed vs. undisturbed areas? Do you notice any difference within the same species between the two areas?

D. Analysis To compare the species diversity in the two areas, calculate the "equitability index". Use the number of each species to calculate your "p_i' 's" (proportion of total number of individuals of all species that were species type i). Then use these p_i's to calculate the equitability index (E) for each area:

$$E = \frac{1}{N} \sum_{i=1}^{N} p_i^2$$

E. Discussion What are the range of possible values for E, and how do they relate to species diversity? Where do your values fall in this range? Compare the diversity of the disturbed and the undisturbed areas, which area is more diverse (if any)? What do you think leads to this result? What differences did you see between plants in the two areas (i.e. results of part B #3). What effect do you think the type and frequency of the disturbance would have on your results? How might your measures of diversity have differed if you had used biomass instead of numbers of individuals?

IX. SUCCESSION

A. Introduction: In this project, you will locate and identify different types of succession and hypothesize as to the underlying mechanisms.

B. Equipment Needed Notebook paper

C. Procedure: Locate areas where you think succession may be taking place - try to find at least one example each of primary succession, secondary succession, and degradative succession. For each of these areas: 1) Identify/describe the "new" habitat - what disturbance caused the creation of the new habitat? 2) Identify the type of succession taking place 3) Describe the plant/animal community involved in the succession - what types of organisms are present? 4) Hypothesize a mechanism: is it facilitation, inhibition, or tolerance? 5) Is the succession at an early or late stage? 6)

What do you anticipate the climax community (if any) of the succession to be?

D. Discussion: Compare the plant/animal communities involved in the different types/stages of succession - do you see any patterns? How does the type/frequency of the disturbance affect the succession? Pick one of your examples of succession, and design an experiment to test your hypotheses about the underlying mechanism of succession.