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ISSUES – FIGURE SET

Ecological Impacts of High Deer Densities

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White-tailed deer, © Kelly Bolton

Figure Set 2: Deer and Birds: Which Species Do Deer Favor?

Purpose: To explore relationships between white-tailed deer and the abundance and diversity of breeding birds.
Teaching Approach: pairs share
Cognitive Skills: (see Bloom's Taxonomy) — comprehension, interpretation, application
Student Assessment: concept map

CITATION:

Schusler, T. M. August 2004, posting date. Ecological Impacts of High Deer Densities. Teaching Issues and Experiments in Ecology, Vol. 2: Issues Figure Set #2 [online]. http://tiee.ecoed.net/vol/v2/issues/figure_sets/deer/abstract.html

BACKGROUND

Many species of forest birds have been declining over recent decades. This issue looks at whether a relationship exists between declining populations of forest birds and increasing populations of white-tailed deer. As large herbivores, white-tailed deer (*Odocoileus virginianus*) affect forest plant communities directly through browsing (eating) and indirectly through the cycling of nutrients and energy in food webs. These activities change characteristics of the forest habitat. Songbirds are especially sensitive to habitat changes, such as the volume (amount) and composition (types) of vegetation, because of their foraging and nesting behaviors. By changing forest vegetation, deer alter habitat for forest birds and could affect both the abundance (number) and diversity (variety) of birds.

To examine the effects of deer on forest bird populations, McShea and Rappole monitored (a) the density and diversity of vegetation, and (b) the abundance and diversity of birds at eight 4-hectare forested sites in northern Virginia. The sites were located within 25 km of Front Royal, VA in large forest tracts in either the Shenandoah National Park or the Smithsonian Institution's Conservation and Research Center. Initially the 8 sites contained similar understory vegetation and deer densities. The researchers fenced 4 of the sites to exclude deer. They then examined changes in vegetation and bird communities that occurred between the fenced (exclosure) and non-fenced (control) sites over a 9-year period.
The purpose of the research was "to test whether deer can serve as agents of structural change in protected forests and whether manipulation of deer numbers can affect bird populations, with understory vegetation as the short term link between these two trophic levels" (McShea and Rappole 2000). McShea and Rappole found the following:

- The exclusion of deer increased the density and diversity of understory woody shrubs relative to control sites.
- Fifteen of 25 bird species examined responded positively to the increase in vegetation that resulted from deer exclusion.
- Patterns of change observed in bird populations can be grouped into three categories that are best described by the species included in Figure 2.
- Diversity of birds did not change with exclusion of deer at the geographic and time scales examined in this study.

STUDENT INSTRUCTIONS

McShea and Rappole (2000) examined changes in vegetation and bird populations on 8 forested sites in northern Virginia over 9 years. Four sites were fenced to exclude deer. The other 4 served as controls. McShea and Rappole wanted to see how reducing the number of deer in a protected forest affected the abundance (number) of birds and diversity (variety) of bird species. Figure 2 reports their results for 3 representative bird species. With a partner, examine Figure 2 and the additional explanation provided below. Then discuss the questions that follow. You and your partner should be prepared to share your analysis of Figure 2 during full class discussion.

Results of Vegetation Monitoring

McShea and Rappole found that excluding deer over the 9-year period increased the density of understory woody shrubs relative to control sites. Species richness of understory woody plants also increased within the exclosure areas over the course of the study. In other words, researchers found more shrubs and more different species of shrubs in the sites excluding deer than in the control sites.

About the Bird Species

Chipping Sparrows prefer *open* understory. They breed in open woodlands with grass, along river and lake shorelines, orchards, farms, and in urban and suburban parks. They winter in similar areas. They forage primarily on the ground and eat grass and other small seeds, small fruits, and insects. The Chipping Sparrow's next is a loosely woven open cup of rootlets, grasses, and other fine materials placed in a small tree or shrub (Cornell Lab of Ornithology. 2003. All About Birds. http://birds.cornell.edu/programs/AllAboutBirds/BirdGuide/Chipping_Sparrow_dtl.html)

Indigo Buntings prefer dense *herbaceous* ground cover, such as brushy vegetation, saplings, and weeds. They eat seeds. The Indigo Bunting's nest consists of grasses, leaves, and weed stems. Nests are found in trees or tangles. (Conservation Commission of Missouri. 1995-2002. Missouri Breeding Birds Atlas. http://www.conservation.state.mo.us/nathis/birds/birdatlas/maintext/0400015.htm)

Ovenbirds prefer a dense, *woody* understory. They breed in mature deciduous and mixed deciduous and coniferous forests. They winter in primary and second growth forests. They eat forest insects by picking them off leaf litter on the forest floor. The Ovenbird's nest is a woven domed coup of dead leaves and plant stems, with the entrance on the side, placed on the ground. (Cornell Lab of Ornithology. 2003. All About Birds. http://birds.cornell.edu/programs/AllAboutBirds/BirdGuide/Ovenbird.html)

Graph Interpretation

Note that the hatched bars represent the exclosure sites (i.e., no deer) and the solid bars represent the control sites (i.e., deer present). On the Y-axis, you will find the number of birds recorded for each species. (Note that the scale on the top graph differs from the other two.) On the X-axis, you will find each of the 9 years during which the study was conducted. Look for patterns in the number of each bird species over time. Compare and contrast the exclosure and control sites.

Questions to Answer

- How would you describe the changes over time in the number of Chipping Sparrows in sites without deer (hatched bars)?
- How would you describe the changes over time in the number of Indigo Buntings in sites without deer?
- How would you describe the changes over time in the number of Ovenbirds in sites without deer?
- Is the response of each species consistent with its known biology (see “About the bird species” above)?
- What plausible explanations can you offer for the changes in relative abundance of these species over time?

FIGURES

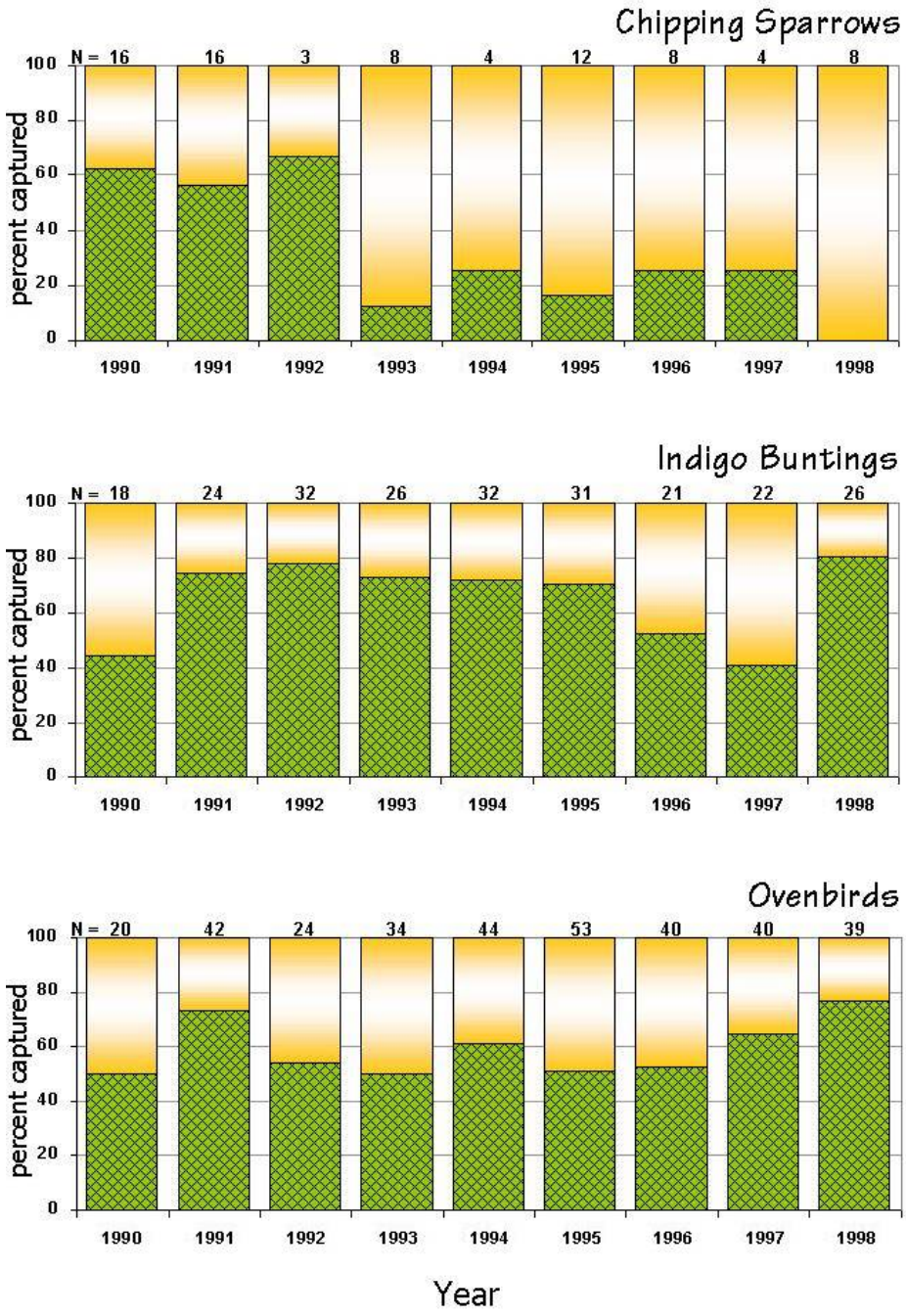

Figure 2. Abundance of three representative bird species at four deer exclosure sites (hatched bars) and four control sites (solid bars). Deer exclosure sites were fenced in early 1991. (From McShea, W. J. and J. H. Rappole. 2000. Managing the abundance and diversity of breeding bird populations through manipulation of deer populations. Conservation Biology 14(4):1161-1170.)

NOTES TO FACULTY

You can ask students to work individually, in pairs, or in small groups. It might be helpful to provide students with the background information in addition to the figure. You may also want to note that while this figure uses bar graphs to illustrate temporal trends, line graphs are generally preferable for this purpose.

Brief notes on methods should students inquire: The researchers measured vegetation by counting and identifying to species all woody plants >1m in height and <4cm in diameter within three 24x24m quadrats at each site. The researchers captured birds by mist-netting. Every year at each site, they strung 25 fine mesh nets between trees for 3 days during the month of June. Each day at dawn and dusk, researchers removed birds caught in the nets; recorded their species, sex, and reproductive condition; and then released them. They recorded data for 25 bird species of which 3 are reported in Figure2.

Answers for Student Questions:

Chipping Sparrow numbers declined in exclosure sites over the 9 years. Chipping Sparrows were negatively related to deer exclosure. Indigo Bunting numbers initially increased in exclosure sites and then decreased back to similar levels as those in control sites (with the exception of 1998). Indigo Buntings were initially positively related to deer exclosure but this relationship did not persist over time. With the exception of a spike in 1991, Ovenbird numbers generally remained constant between exclosure and control sites through most of the study; however, Ovenbird numbers increased in exclosure sites during the final years of the study. Initially Ovenbird abundance appeared unrelated to deer exclosure. The data of 1997-1998 suggested that a positive relationship could exist.

The key to explaining these patterns is succession. Students will need a hint to realize this. As McShea and Rappole (2000:1168) concluded:

“Release from deer browsing caused rapid successional changes in the forest understory as vegetation progressed from grasses to forbs to *Rubus* spp. to woody saplings. These changes corresponded to a shift in bird species composition from Chipping Sparrows to Indigo Buntings to Hooded Warblers to Ovenbirds. This successional process, in combination with site differences, makes it difficult to say whether or not a particular species will increase in response to lower deer densities, because the answer depends on the site characteristics and the time span involved. For example, Indigo Buntings responded immediately to removal of deer but then declined at exclosure sites until the ninth year, when an ice storm opened the canopy and resulted in a second pulse of herbaceous vegetation and a second pulse of birds.”

The main point of this activity is that deer’s impact on forest vegetation also affects other animals. In this case, Figure 2 shows that excluding deer from protected forests changed the relative abundance of 3 bird species. Whether the impact of deer is

good or bad is largely in the “eye of the beholder.” Is one bird species of greater value than another species? Rappole and McShea found that several resident birds in their study sites, such as Tufted Titmouse, Blue Jay, Northern Cardinal, and Carolina Wren, showed marked decreases in abundance after removal of deer. These species tend to have stable or increasing populations in national bird surveys and are not normally of management concern. Migrant birds that foraged either in the understory or higher in the canopy responded positively to the increases in vegetation density and diversity that followed deer exclosure. Many of these species are of greater conservation concern than the resident birds (McShea and Rappole 2000).

The take home messages from this example are:

a. interactions at one trophic level (deer herbivory) influenced another (birds), and

b. humans decide what to manage for (e.g., conservation of specific rare bird species) and must understand complex ecosystem interactions to achieve management goals.

Student Assessment: Concept Map

Respond to short-answer questions included in student instructions. You can also ask students to draw a concept map illustrating the relationships that they believe are occurring over time between deer, herbaceous and woody forest vegetation, and birds in the experimental forest plots.