Chapter 9
Finding the Most Important Places on Earth for Birds

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9.1 Birds as Gauges of Changes in the Environment

Bird song is a signature of the arrival of spring and it can be used as a gauge of ecosystem health. In Rachel Carson's *Silent Spring* (1962), she writes, "And as the number of migrants grows and the first mists of green appear in the woodlands, thousands of people listen for the first dawn chorus of robins throbbing in the early morning light. But now all is changed, and not even the return of birds may be taken for granted." Looking and listening are ways we can observe the ecology around us. However, with the distractions of daily life, we may be more concerned with politics, writing book chapters, and deciding on what to cook for dinner, than listening for birds or thinking about birds as monitors of the environment. With these preoccupations in place, how can we convince ourselves, or others, to make time to enjoy birds and their leafy habitats which would naturally lead to concern for their well-being? In this chapter, the mutualistic relationship between birds and humans is explored. Perhaps we will learn to care about birds after we gain an understanding of the beneficial roles of birds in our lives, neighborhoods, and the world.

Observing species in nature is a good way to monitor issues of sustainability, including the impact of changes in climate, land use, and the way humans use resources. Birds, in particular, are commonly regarded as monitors of environmental change. You can make casual observations of birds, insects, plants, *etc*., during hiking and gardening, among other things. The next level is to include where and when you made these observations, an important step in making the data valuable and worthy of contribution to scientific databases that scientists use such as eBird or iNaturalist apps. This is community science and bird watchers are active community scientists and therefore able to contribute to data-driven conservation activities.

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Birds are responsive, ubiquitous, easily surveyed, and have interesting ecological requirements. Noticing which birds are where and their relative abundances has great value and is the basis for important contributions to conservation policy by the general public as well as scientists. We know that birds like the Golden-winged Warbler are declining in part because of land-use issues such as habitat destruction and the natural succession of shrubby habitat to the forest (Confer et al., 1992). Carolina Wrens in the Northeast are expanding northward in range in response to climate change (Hitch & Leberg, 2007). Both nicely illustrate how birds can be monitors of change in the environment. In Rachel Carson's *Silent Spring* (1962), some of her case studies focused on declining bird populations in general and, specifically, the discoveries of dead birds in areas just after marshes and other habitats were sprayed with insecticides. This drew attention to and highlighted the use of birds as sentinels of environmental health and the interconnectedness of nature in general.

Historically, bird watchers and academics have been collecting bird presence and abundance data for over one hundred years, beginning with the first Audubon Christmas Bird Count in 1900. In spring, Breeding Bird Surveys have been conducted since 1966 across Canada and the United States to monitor bird populations in the region with the goal of applying the data to conservation. The Breeding Bird Surveys were started in response to the profligate use of pesticides and the concern that these chemicals posed threats to wildlife and humans. Trends revealed in bird monitoring data have historically shown declines of charismatic birds such as the Peregrine Falcon, the Osprey, and the Bald Eagle due to the pesticide DDT. These observations prompted actions, such as banning DDT and reintroducing the species. As a result, these species of birds have recovered.

In another example, a concerned group of women from Boston in the late 1800s brought attention to the decline of various wading birds due to the unfortunate use of the long and ornate feathers from species such as the Great Egret. The population of these large, white, wading birds was shrinking because they were collected and killed for their breeding plumes which were in high demand to decorate fashionable hats worn at the time. This episode of activism was the stimulus for the formation of the first chapter of the Audubon Society (Weidensaul, 2008, p. 157) and legislation to protect these species. Today, New York City Audubon monitors Great Egret populations in New York Harbor and the wetlands throughout the New York metro area where the birds are successfully breeding.

Currently, birders are entering their observational data directly into their phones while in the field using the ebird app (Ebird, 2021) which is a portal developed by Cornell University for collecting georeferenced bird data, a powerful tool that has great conservation value. Ebird allows visualizations of where birds are, their movements, and their abundances. One of my favorite products from eBird is the animated migration maps where entire northbound and southbound routes across the Western Hemisphere are shown for 118 avian species (Powell, 2016). The bird and habitat conservation that is informed by these data collection efforts aligns nicely with the Life on Land United Nations Sustainable Development Goal 15, which specifically states, "Protect, restore and promote sustainable use of terrestrial

ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (United Nations, 2021).

9.2 Our Relationship with Birds

In a mutualistic ecological relationship, the interacting species both benefit in that each provides a helpful service for the other. Some of the more familiar mutualism examples are mycorrhizae (the connection between plant root tips and fungal hyphae) where sugars made in photosynthesis, water, and minerals are shared between plants and fungi. And, of course, there are various pollination mutualisms. What could birds possibly do for us? What can we do for birds? There are some fundamental and beneficial conditions and commodities that are provided to humans that are due to the workings of the bird community. Drinking water quality, coffee bean quality, and seed dispersal are just a few of these services. Humans need to do more in return.

9.2.1 Bird Stories: Purification of Drinking Water

Let's say you are not moved to care that much about a bird's well-being. You can frame the issue in another way…what do the birds do for you? What do you get out of it? One answer is clean drinking water. Before reading on, can you assemble the puzzle pieces in your mind that support this truth? Here is a clue: think watersheds, as seen in Fig. 9.1.

In a forested watershed, trees – and the soil they are rooted in – purify drinking water. As rain falls, trees intercept precipitation which infiltrates the soil where tree roots and soil microbes remove impurities. When you turn on the tap in New York City, the high-quality water originated from and was purified in forested watersheds in upstate New York. What keeps the forests healthy? This is where birds fit in. Birds keep forests healthy through their consumption of forest insect pests. As a

Fig. 9.1 Students at Black Rock Forest exploring the area near Jim's Pond, a nice example of a forested watershed

matter of fact, in spring, migratory birds from the tropics head north through eastern North America following a green wave of tree leaf bud bursts. Along with those bud bursts, large quantities of leaf-eating caterpillars also hatch. Birds eat them as they move north. In this mutualism, trees provide bird habitat and the birds provide insect control. It has been shown that forest birds can reduce the defoliation of forest trees by 50% by eating these caterpillars (Marquis & Whelan, 1994). In their study, Marquis and Whelan wrapped trees with mesh that excluded birds but allowed insects free access. Unwrapped trees served as the control that birds and insects could get to. The wrapped trees experienced more biomass loss (leaves were eaten by the insects) compared to unwrapped trees, thus illustrating how birds keep herbivores (in this case – caterpillars) under control. Therefore, you can thank a bird for your clean drinking water, especially if you are in New York City.

9.2.2 Bird Stories: Coffee

To further the mission of convincing readers to care about birds and their habitat, let's talk about coffee. What can get more personal than that? There are two broad categories for coffee: sun-grown and shade-coffee. Sun-grown coffee is an ecological disaster. To grow it, tropical forests must be cut down and a monoculture of sun-grown coffee is planted. As is typical of a monoculture, disease can spread fast, so pesticides are applied. The result is tropical forest habitat loss with a reduction of associated biodiversity and a loss of forest ecosystem services. Plus, there is chemical contamination of the crop and watershed and dangerous exposure to chemicals for farmers. In comparison, shade-grown coffee is sustainable. The forest is not removed, coffee plants are grown in or near the understory. Since the structure of the forest is not damaged, the associated animals, for example, birds, do not move out. As a matter of fact, the birds keep the coffee plants healthy by eating coffee berry pests. This, in turn, reduces or eliminates the need for pesticides, decreases watershed contamination, and keeps farmers safer. Research has shown that birds reduce berry infestation and can do so up to 50% in agroforestry settings (Kellermann et al., 2008; Martínez-Salinas et al., 2016). This translates to an increase in coffee yield and farm income, a financial incentive for growers to choose shade-grown coffee. You can thank several species of warblers and vireos and other avian species for this service. Many of these birds are the same birds that migrate to North America in the spring and summer, for example, the American Redstart and the Ovenbird. In the winter they are in the tropics carrying out various ecosystem services like keeping coffee plants healthy. The bird-coffee berry story is another tangible example of ecological mutualism and why we should care about birds. Students can connect with these issues and get enthusiastic. Now that coffee woke everyone up, it is time to talk about migration.

9.2.3 *Bird Stories: Migration of the Red-Eyed Vireo*

Anyone that has spent time in eastern North American forests has heard the incessant song of the Red-eyed Vireo, consciously or not (check out Red-eyed vireo sounds, at https://www.allaboutbirds.org/, Cornell Lab of Ornithology). If you stop to look, you will see this lovely common forest songbird, with its black and white eyebrow and red eye, and hopefully wonder about its story. This species migrates to our eastern forests in spring and summer to pair up with a mate and raise young among lush trees and ample food. Many other species, like warblers and thrushes, *etc*., do this too. We pretty much know exactly where in the tropics the Red-eyed Vireo spent its winter before coming here, which route it took to get here and where it stopped to rest. This has been made possible with geolocators (Stutchbury et al., 2009) which are lightweight devices that are attached to (and later retrieved from) the birds. These instruments record how light levels change along their journeys, over time, which translates to latitude and longitude information. For example, one particular Red-eyed Vireo left northwest South America on April 6, stopped over in Central America on April 29 for about a week, crossed the Gulf of Mexico in one night on May 8, rested in vegetation on the Gulf Coast from May 9 to 12 and finally arrived in Pennsylvania on May 18 (Callo et al., 2013). What was your immediate reaction to this information? I think it is amazing that these birds can do this and survive the trip and that we know the details. Many of the birds that cross the Gulf do not make it, especially if a rainstorm with winds from the north develops during their crossing. My reaction is – if they are coming all this way, it is our responsibility to protect the habitat here for them.

9.3 What Do Birds Need from Us?

Birds need us to protect their habitats. An important and ecologically supportive place for birds is one that has a structurally complex layering of vegetation: canopy, understory, shrubs, herbs, and ground layers – in other words, a diverse and inclusive environment. The location should have access to water (streams and ponds) and be large in area while being connected to other large patches of vegetation that have different characteristics due to differences in topography and/or land-use history. In short, healthy habitat for birds is an expanse of land that is a mosaic of habitats analogous to the squares in a quilt. The more diverse the habitats in the landscape the more "living" options for the birds and therefore the higher the bird diversity. When areas like this exist and the resident bird communities have been documented by bird clubs, conservationists, and academic groups, it is a perfect opportunity for humans to participate in their part of mutualism: land conservation. Humans have the responsibility to preserve this land from disturbances and degradation. Figure 9.2 shows some species found in northeastern North America.

Fig. 9.2 Eastern Screech Owl, Ovenbird, and Scarlet Tanager at Black Rock Forest

Let's get back to my earlier comment – if they (birds) are migrating all this way to spend a portion of their life cycles in North America, we had better protect the forests here for them, as well as forests in the tropics. Recall the long and potentially dangerous journey of the red-eyed vireo described above. Upon arrival, these birds need a habitat for resting and eating and, eventually, reproduction.

9.3.1 How to Identify Ecologically Important Places for Birds

Identifying ecologically important places for birds is what I do. Students and I have identified some of these important places and our work has successfully informed land conservation policy for the Audubon New York Important Bird Area (IBA) program (Audubon New York, n.d.). Through the IBA program, the most important places on Earth for birds are identified and conserved. IBAs have been identified throughout the United States. New York state has well over 100 IBAs alone. When nominating a region for IBA designation, there are three key components that must be investigated for the application. The first is whether there are significant populations of "listed" species. A listed species is a bird that in previous surveys has been shown to be declining in numbers and is therefore of conservation concern. Examples of some of the listed species in New York state forests are the Wood Thrush, Prairie Warbler, Cerulean Warbler, and Scarlet Tanager. The second criterion considered in the IBA application is the presence of all or most of the responsibility species assemblage. This is an assemblage of species that together typifies or represents a particular habitat. For example, an eastern deciduous forest is represented by various species of hawks, thrushes, vireos, warblers, and flycatchers, *etc*. The third requirement is large numbers of migratory birds.

Barnard students assisted me and colleagues from other institutions in the effort to collect data for the Black Rock Forest IBA application. Surveys revealed that the proposed area met all three criteria of the IBA program: significant populations of "listed" species, presence of all or most of the responsibility species, and large numbers of migratory birds. In particular, thresholds of key individual birds such as

Cerulean Warbler, Worm-eating Warbler, Wood Thrush, Blue-winged Warbler, and Prairie Warbler were well above the required levels. As a result of our research, Black Rock Forest was awarded IBA designation in June 2016 by Audubon New York (Maenza-Gmelch et al., 2016). Thus, to hold up the human end of our responsibility to birds and provide them with ecojustice, an inclusive set of circumstances is required: habitat diversity, organized research, authentic citizen input, organizational approval, as well as local management – described below.

9.4 Black Rock Forest

What is Black Rock Forest? Black Rock Forest is a 3914 acre, eastern deciduous forest field station that Barnard College, and other member institutions, have the opportunity to use for research and education endeavors. It is a gem of a field station because of its natural beauty and amazing staff. Black Rock Forest is about one hour north of Manhattan and is in the Hudson Highlands of New York State. The forest is part of a northeast-southwest trending corridor of preserves and parks that has tremendous wildlife and ecosystem service value. The region has high species and habitat diversity due to topographical sequences of ridgetops, slopes, ravines, lakes, and streams with more than 1000 feet of relief. Also contributing to this habitat diversity are chronological sequences featuring a mosaic of different aged forest patches within the forest matrix that is maintained through natural disturbance and thoughtful forest management. Figures 9.3 and 9.4 show such a diverse landscape. Vegetation structural complexity, a natural feature of a healthy deciduous forest, plays an important role in supporting a diverse animal population, especially if its integrity is maintained and enhanced through excellent timber and deer management plans, which is the case at Black Rock. A large contiguous area is also important and its almost 4000-acre size is comparable to more than four Central Parks.

Fig. 9.3 Example of the diverse landscape at Black Rock Forest as seen from the summit of Black Rock

Fig. 9.4 Examples of the plant diversity that arises from the topographical diversity in the forest. Shown here are the native shrubs: Pink Azalea, Choke Cherry, and Mountain Laurel

Fig. 9.5 Students measure herb diversity in an area of the forest that had been burned

9.4.1 Getting Students into the Field

My spring and summer research projects with students (Fig. 9.5) focus on the exploration of why Black Rock Forest supports a diverse bird community and investigation of possible threats. Questions considered have included: Where are the bird diversity hotspots in the forest? Is vegetation structural complexity important? Is plant diversity important? Is habitat heterogeneity important? What are the threats? Do roads and trails negatively impact bird communities? Is connectivity important? Can we avoid putting forest activities in the middle of biodiversity hotspots?

Our research plan started out by showing that unique habitats within the forest matrix support species that are not found in other parts of the forest, for example, the Chestnut-sided and Blue-winged Warblers in early successional patches, Acadian Flycatchers in hemlock ravines, and Cerulean Warblers in deciduous forest areas near streams. How did we do this? We developed a plan for authentic, direct observations. After dividing the forest into habitat types we did point-count bird surveys in each. In point-counts, you look and listen for birds for 5 or 10 min within a circle that has a 50-meter radius centered in the targeted habitat. You typically visit each survey site several times during the season. After surveys were completed, the data revealed that some birds were everywhere (generalists) and some birds were only found in certain habitats (specialists). For example, we found that Prairie Warblers are usually at higher elevation sites in the forest, such as the open tops of Mount Rascal and Black Rock Summit. Eastern Towhees like the shrubby areas typically found at Jim's Pond and by The Stone House. Other birds, such as the Red-eyed Vireo and the American Robin, seem to be everywhere.

In another study, we set out to determine how vegetation structural complexity, plant diversity, and habitat diversity (when the landscape has a mosaic of habitats – like the patches in a quilt) affect bird distribution. We began by surveying bird populations, again using point-counts, throughout the breeding season in six different habitats. Each habitat was visited several times spanning two breeding seasons for 5 or 10-min counts totaling 100 min at each habitat. The habitats were either structurally homogeneous or structurally heterogeneous. We conducted a vegetation survey with vertical and horizontal components for each habitat in order to calculate plant vertical density indices (as a measure of forest structural complexity) and plant species richness values (Fig. 9.6).

Our data suggest that structurally complex habitats at Black Rock Forest (BRF) support a higher diversity of birds than simpler ones. We also confirmed that landscape heterogeneity and habitat vertical complexity were positively correlated with bird species richness (Maenza-Gmelch & Gilly, 2015). The fifteen most abundant bird taxa during the breeding season at this location are American Robin, Red-eyed Vireo, American Crow, Veery, Cedar Waxwing, Common Yellowthroat, Gray Catbird, Chipping Sparrow, Scarlet Tanager, American Goldfinch, Great-crested Flycatcher, American Redstart, Baltimore Oriole, Yellow Warbler, and Eastern Towhee.

Another project was aimed at understanding the impacts of various road types and trails on bird abundance and diversity in order to inform land-use decisions in and near this forest for bird conservation purposes (Maenza-Gmelch & Wasmuth, 2017). A total of 692 detections were made of 57 bird species in this survey. Measures of bird species richness and diversity were not significantly different between paved roads, dirt roads, and trails. Since Black Rock Forest exists in a landscape matrix that is heavily forested in general, it is not surprising that the bird diversity and abundance near roads and trails may not differ significantly (Rodewald & Arcese, 2016). We plan to repeat this study with more sites and an expanded analysis that separates nesting and foraging guilds. Looking at nesting and foraging diversity, as opposed to just species diversity, in relation to habitat structure could reveal important relationships.

Fig. 9.6 Students use a vegetation complexity board to estimate vertical vegetation density

Conservation recommendations to preserve bird diversity (and biodiversity in general) at Black Rock Forest include: continue to maintain the mosaic of different aged forest patches within the forest matrix (burning at the Stone House, mowing at the reservoirs, *etc*.); continue maintaining/creating structural complexity during timber management and hemlock ravine restoration (planting white pine to replace hemlocks); continue to speak up about threats to the composition and configuration of landscapes around the forest; and continue with partnerships in land acquisition for the wildlife corridor (Anderson et al., 2012). The Wildlife Corridor Project, conducted by colleagues at the forest, aims to reveal how animals, such as bobcats and fishers, move around and use the land. Habitat fragmentation, such as land divided by highways, is a major threat (Tucker et al., 2018). The IBA designation, the Wildlife Corridor Project, and Conservation Easement status all serve as "clout" when proposing policy recommendations.

9.4.2 Data Collection Using the Soundscape

I am sitting in the forest writing this paragraph and I hear these sounds: ank-ank, peter-peter-peter, pee-ah-wee, and tea-kettle-ettle. Therefore, I know that a White-breasted Nuthatch, a Tufted Titmouse, an Eastern Wood Pewee, and a Carolina Wren are nearby. Since it is early August and these birds have been singing in the area since April, it is probable that they spent their breeding times in these woods.

Birders and academics have been birding by ear for a very long time. As a student, I began to learn bird songs by listening to A Guide to Bird-song Identification, a collection of bird sounds put together by Richard Walton and Robert Lawson. Along with their recordings, they offered a study tool which was an alphabetical list of phonetic phrases that were assigned to each bird song because they provided a memorable phrase that had the same cadence as the bird song. For a completely amusing moment, check out Lang Elliot's recording of the Eastern Towhee (The Music of Nature, 2010a) and see if you agree that this bird is saying "Drink your tea-hee-hee" and listen to his White-throated Sparrow recording and consider if you hear this bird say "Old Sam Peabody, Peabody." (The Music of Nature, 2010b).

Since students often join me to do bird projects at Black Rock Forest, I wanted to create a bird sound tutorial for the BRF website. With a small grant, I was able to hire and collaborate with an amazing audio archivist named Martha Fischer from the Macaulay Library at Cornell's Laboratory of Ornithology. Martha accompanied me to the forest one spring and brought along an impressive collection of sound recording equipment (Fig. 9.7). We set out before dawn to get in position to record general habitat soundscapes as well as specific bird songs in the Forest. We went to the bird hotspots that I knew of and to the unique habitats that harbored some avian specialists. On some occasions when students joined us, it was a challenge to keep perfectly quiet during recordings since everyone had the urge to swat at the mosquitoes that were landing on us. Keeping our feet completely still on the gravelly paths (which make a lot of noise when you move your feet) was also key. The result of this effort is the "Listen to the Forest" website (Listen to the Forest, 2021). This resource is used as a learning tool for students in my bird ecology classes and summer research students, as well as anyone else who wants to practice birding by ear in preparation for a walk-in the forest.

Fig. 9.7 The author is shown recording birds at Black Rock Forest

9.4.3 Land Protection Is Not the Only Issue We Need to Address for Bird Conservation

Climate change, invasive species, and pollution are three additional threats that impact the well-being of all biodiversity, not just birds. Plants and animals are interdependent on each other due to their web-like links. Climate influences the timing of their natural life cycle events (phenology) like egg-laying, flowering time, and leaf fall. Thus climate change is predicted to impact the life cycles of plants and animals. Already there is a large and growing body of peer-reviewed research that reveals many of these impacts. One of the first studies, a rigorous meta-analysis by Terry Root and others (2003), showed that several groups of organisms (invertebrates, plants, amphibians, and birds) are carrying out various natural life events several days earlier per decade in response to rising global temperatures. Each species responds to the changes in climate at a different pace resulting in the uncoupling of interactions, such as those between pollinator and plant. For example, a plant might flower earlier and its pollinator may not arrive or hatch in time (Snow, this volume). This results in an ecological mismatch.

Over the last several years, much attention has been focused on the phenology data collected by Aldo Leopold and Henry David Thoreau. Not many people know that Thoreau kept careful field journals based on his natural history observations, many of which were precise recordings of when the plants near Walden Pond first flowered each spring. Ellwood et al. (2013) compared recent first flowering dates in Wisconsin and Massachusetts with Leopold's Wisconsin data from 1935 and Thoreau's Massachusetts flowering time data from 1852. Their analyses revealed that, at both locations, plants are flowering earlier now than in the past. This is important because of the potential to disrupt ecological interactions.

Plants are responding to climate change not only through changes in flowering time. Some plants cannot tolerate the new higher temperatures so they redistribute northward, if they can, via seed dispersal and successful establishment. Plants at their southern limit are stressed. Tree physiology research by Dr. Angelica Patterson at Black Rock Forest (2021) reveals that the various tree species, based on range distribution, experience different impacts on their photosynthetic efficiency (Patterson, 2021). Oaks, the most common tree in the Northeast, are less efficient at sequestering carbon which may weaken their ability to compete with migrant trees under a warming climate.

Plant migration results in new plant communities in which the interconnected insects and birds may or may not be able to tolerate the habitat changes. Audubon's Birds and Climate Change Report (Survival by Degrees, 2021) shows that "birds are on the move" as they keep up with shifting and shrinking habitat ranges. This report shows that 389 bird species are at risk of extinction. The scientists arrived at their conclusions by comparing United Nations estimates of climate change for 2050 and 2080 with Audubon's data from Christmas bird counts – based on citizen inputs – and spring breeding bird surveys. They created maps of current temperatures and associated bird geographical ranges. Then, they created maps with projected

temperature changes and modeled how the birds would respond. The models indicate loss of ranges and shifting ranges which set the stage for new species interactions such as competition for limited resources or danger of predation. More recent research shows that bird abundance is declining, nearly three billion birds have been lost since 1970 and not just rare and threatened species, but also species that are common and widespread (Rosenberg et al., 2019). This is mainly due to habitat loss as well as climate change. In addition, insects, a very important part of the food web, are in decline. Habitat loss, invasive species, climate change, and chemical and light pollution are among the threats to insects (Wagner et al., 2021).

9.5 How Do I Engage and Prepare Students for Bird Projects?

In one of my classes at Barnard College called Bird, Plant, and Land-use Dynamics, I cover many topics in ecology and environmental science using bird and plant community ecology as the case studies. The students analyze content like ecosystem services, trophic mismatch, and invasion biology through lectures, readings, presentations, and field trips. They also "get trained" in bird identification by sight and by ear so that they can join my field projects later in the course to collect data for analysis and presentation. Some move on to a senior thesis in bird conservation. In this class, students take a journey themselves. The learning experience spans from January to May where they start by learning birds' names, they draw and color them, they memorize and are quizzed on bird songs and they hone their identification and surveying skills on winter days by observing the bird forms and behaviors in Riverside Park near campus. They read and present papers from the scientific literature. Then, the migratory birds arrive and the students are ready. Beginning at the end of March the class takes field trips around the region: Central Park, Jamaica Bay, The Great Swamp, Black Rock Forest, and Sterling Forest (Fig. 9.8). Here they meet the species they have been studying and observe their interactions at each habitat. At all sites, we are interested in observing and quantifying the relationship between bird diversity and habitat structural complexity. Students collect data on birds and vegetation, plot and analyze the findings and write reports. I typically bridge my research with the curriculum in my classes by having students assist with authentic data collection and/or use previous results as problem sets and case studies. These data are contributed to long-term databases and can also be used for projects by future students. Most years we present at one or more conferences and my collaborators are often students.

After discussing, anticipating the onset of, observing, and quantifying spring migration for several weeks during the semester, the final class assignment is posted: go to the top of the Empire State Building at night to count migrating birds. Specifically, go to the 86th-floor observation deck on an evening in late April or early May. Select an evening as late in the spring semester as possible, one close to the full moon, with a wind from the south or southwest. Be sure it is an evening with good

Fig. 9.8 Students on a class trip to Jamaica Bay National Wildlife Refuge in Queens, New York. Jamaica Bay is one of New York's most famous Important Bird Areas

visibility and pick a night when the building's lighting schedule calls for "white" lighting. Arrive just after sunset. Migration will start about one hour after sunset. Purpose: to document and count night-flying migratory songbirds as they head to their northern breeding grounds after spending the winter in the tropics. With all of these conditions required, it is a challenge to organize. However, on a visit one late April evening, all of the conditions were optimal. I positioned 9 students and myself 1050 feet above street level and waited. There was a noticeable breeze from the south and the sky was clear. We all faced south looking upward in the direction of lower Manhattan along the Hudson River, even the Statue of Liberty could be spotted. At 8:45 pm the first birds flew over, with 200 in the first 15 min. Then, the pace picked up. Heading north and passing just over the peak of the building at 1472 feet, another 261 birds were counted in a 15-min period. Students estimated that 800–1000 northbound migratory birds flew over the building per hour that night when conditions were right. The birds cannot be identified under these conditions, just size class can be determined, for example, songbird, heron, raptor, *etc*. During a trip to Sterling Forest (40 miles north of the Empire State Building) 2 days later, the class found numerous newly arrived migrant birds like Wood Thrush, Prairie Warbler, Scarlet Tanager, and Great-crested Flycatcher. These species could possibly have been among the flocks that were flying over the Empire State Building.

As the semester closes, if a student was not already a bird conservation sympathizer, they are now. In course evaluations, students report increased awareness and tuning in to a more inclusive appreciation of the environment around them through bird songs. One student wrote, "The course has taught me to appreciate the birds

and trees around me. Sometimes I pay careful attention when I walk outside or when I am sitting near my window and I am surprised to find myself listening and spotting many of the birds we learned about." Another wrote, "I have found a new appreciation of birds. I've found myself going more often to Riverside Park and trying to test my knowledge and notice the wildlife around me in ways I didn't before. These are skills I want to continue to develop." A third said, "I had no experience with and very little prior interest in (birds) and it turned into one of my major passions." The students finish the course knowing the answers to these questions: What could birds possibly do for us? What can – and should – we do for birds? And I believe they will move on to their own various careers and somehow share what they learned in this class. Mission accomplished.

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