A Bird in the Hand: A Place-based, Hands-on Curriculum in Ornithology

Stephen C. Trombulak

Stephen C. Trombulak (trombulak@middlebury.edu) is a professor in the Department of Biology and the Program for Environmental Studies at Middlebury College, Middlebury, Vermont 05753 U.S.A.

Bird banding offers students the opportunity to get "up close and personal" with one of the most popular taxa for natural history studies. Here I describe a curriculum for teaching students how to net and band birds safely. This exercise is part of a course on vertebrate natural history taught at the undergraduate level, and it takes place over a six-week period coincident with fall migration in western Vermont. I discuss all aspects of the logistics for teaching this curriculum, including permitting, site selection, equipment, timing, and activities while in the field.

Citation.—Trombulak, S.C. 2009. A bird in the hand: a place-based, hands-on curriculum in ornithology. Journal of Natural History Education 3: 9-23.

One of the most widely appreciated branches of the Tree of Life is that of the birds. It is almost certainly no exaggeration to say that we know more about the natural history of birds—including their distribution, ecology, behavior, and taxonomy—than of any other group of animals. Part of the reason for this that they are so easy to study; they are numerous, morphologically diverse, colorful, primarily day-active, and large enough to see with the naked, or slightly aided, eye. These same characteristics have led birds to be among the most popular of organisms for study in natural history classes; in general, students get far more excited about the natural world when they are given the opportunity to encounter animals that are easy to see, beautiful, and readily identifiable to species.

In this paper I describe a portion of a curriculum I have developed over the past twenty-three years that uses a hands-on approach to teaching ornithology. It is part of a one-semester undergraduate course on vertebrate natural history (and therefore also includes mammals, fish, amphibians, and reptiles) that I teach in western Vermont. The students in the course are primarily third- and fourth-year undergraduates who have already had an introductory-level course on ecology. The majority of the students are majoring in one of the life science majors offered at Middlebury College (particularly Biology or Environmental Studies/Conservation Biology), but on occasion students from other majors will take the course out of general interest.

The course is taught in the Fall Semester (September – December) because of the timing of bird migration through western Vermont. The peak of spring migration does not occur here until very close to the end of the Spring Semester (mid-May); thus, because Middlebury College does not offer life science courses during the summer, Fall Semester is the best one for teaching ornithology here.

The setting for the course is the Vermont portion of the Champlain Valley, which stretches from its highest elevation (> 1,200 m) in the Green Mountains in the east down to the shore of Lake Champlain (100 m) approximately 50 km to the west. Over this gradient, land cover changes from alpine meadows through spruce-fir and maple-beech-birch forests to oak-hickory forests, with abundant hemlock coves, swamps, marshes, old fields, and active agricultural lands (Klyza and Trombulak 1999). Thus, within reasonable driving distance, a wide variety of natural plant communities are found, which in turn leads to a wide variety of bird species. This is particularly true during the fall migration, where numerous species, ranging from waterfowl to wood warblers, use the Champlain Valley as part of their flyway.

The overall goals for this natural history course are:

- Develop an appreciation for the diversity of species that live in the various natural plant communities found in western Vermont;
- Develop the ability to handle animals safely and respectfully while also collecting data useful to understanding an organisms' natural history; and
- Develop the ability to use taxonomic classifications to the family level as the

doorway to learning quickly the flora or fauna of any region.

I have designed the course to achieve these goals for each vertebrate taxon found in this region, including birds. While I also incorporate traditional birding activities and skills into the curriculum, and in fact have the students carry and use binoculars on all class field trips, I primarily focus on two curricular elements that emphasize working with birds in the hand rather than simply viewed from afar. These elements are (1) bird banding and (2) study of museum skins. In this paper, I describe the first of these two elements. The second element, study of museum skins, will be described in a subsequent paper.

Bird banding is carefully regulated in the United States by the U.S. Fish and Wildlife Service's (USF&WS) Bird Banding Laboratory (BBL). A complete description of the BBL and its regulations is beyond the scope of this paper, but detailed information on all aspects of banding can be found at their web site. In brief, bird banding can only be carried out with a valid permit from the BBL, which requires proper training (see the North American Banding Council's web site on training opportunities) and a commitment to maintaining excellent data records. Further, incorporating bird banding into a curriculum requires a commitment to close supervision of students to ensure each bird's well-being.

However, for those teachers who have or obtain a valid banding permit, incorporating a banding program into a curriculum has numerous rewards, ranging from giving students the opportunity to hold wild birds in their hands safely (about which very few students can ever be blasé) to giving them an opportunity to participate on one of the longest-running cooperative natural history investigations in the world.

This paper does not try to serve as a tutorial on how to band birds. That task is better served by other sources, especially the USF&WS Bird Banding Laboratory. The purpose of this paper is simply to describe in detail how I have incorporated bird banding into my undergraduate course on vertebrate natural history.

Learning Goals

I have several learning goals for the students during this exercise, ranging across the spectrum from pure kinesthetic to pure intellectual, and from basic biology to conservation management:

- Learn how to operate mist nets to catch birds.
- Learn how to band birds following approved USF&WS procedures.
- Learn how to safely handle birds, identify them to species using USF&WS-approved technical references, and inspect them for general condition, age, and sex.
- Learn not to be afraid to handle animals.
- Learn the basic characteristics and behavior of the families of birds found in Vermont.
- Learn to appreciate the beauty of birds, especially when held and observed up close.
- Learn to associate bird species with particular habitats.
- Learn to identify the various regions of a bird's body, especially those that are important for species, age, and sex determination.
- Learn to record banding data clearly and completely.
- Learn to appreciate the role of bird banding in developing a better understanding of avian ecology and conservation in North America.
- Learn how the USF&WS's bird banding program operates, and why.
- Learn to manage and care for bird banding equipment.
- Learn to appreciate the simple joy of being out in the field before dawn, watching the sun come up silhouetting an oak tree or burning through valley-bottom fog.
- Observe the seasonal patterns of migration among the birds in this region, as well as the seasonal changes in conditions in one location.
- Learn to identify a subset of the species we encounter by call and song.
- Learn that not all education takes place inside of a classroom during regular hours, and that not all knowledge will come to them in planned, predictable packets.

- Learn that sometimes, learning has to happen immediately and not be put off until it is time to study for an exam.

Description of the Class and Students

As mentioned above, this activity is part of a class called Vertebrate Natural History. Its description in the Middlebury College catalog is as follows:

> **BIOL 0302 Vertebrate Natural History.** This course deals with the natural history of vertebrates in the context of the forests, fields, wetlands, and rivers of western Vermont. We will explore in depth the taxonomy of the local vertebrate fauna; techniques for capturing and handling live animals, particularly birds, mammals, and fish; and address experimentally specific questions about the distribution and abundance of vertebrates in a range of natural plant communities. Topics considered will include conservation biology, population and community ecology, and behavior. Field work will involve several early morning and weekend trips.

The class is officially scheduled as having both a lecture and lab. The lecture is scheduled three days per week (MWF) in the earliest lecture time slot available at Middlebury College (8:00 to 8:50 am). The class has two lab sections (typically W and Th, 1:30 to 4:15), and each student must enroll in one of those sections. Class size is limited to 24 students, with 12 in each lab section. I have found that 12 students is the largest number I can adequately supervise in the field at a time.

Fall Semester runs for 13 weeks, from early September to early December. The bird banding portion of the course runs for only the first six weeks of the semester. Because the lecture section is scheduled for the earliest time slot in the day, my class is the students' first commitment in the morning. Therefore, I am free to schedule class to begin even before 8:00. During our bird banding activity, class begins at 6:00 am, which in central Vermont during September-October has us in the field just as it is becoming light and the birds are becoming active.

On the first day of class I ask how many students are free to meet 6:00 to 8:50 am on Tuesday and Thursday, days when my class normally would not meet. Invariably, about half of the students indicate that they could meet on TTh. This gives me the opportunity to split the class into two groups, MW and TTh, so that I do not have more than 12 students at the banding station at any one time. Friday is reserved as a make-up day, if needed (see below).

Although splitting the class into two increases my own time commitment, I find that preferable to having too large of a group at the station at any one time. Thus, it represents a compromise between total class size (24 instead of 12) and group size at any one time (12 instead of 24) vs. days per week per student (2 instead of 3) and days per week for me (4 instead of 3). I find that the decrease in time for the students is more than compensated for by the increase in the quality of the time they spend.

I also hire student teaching assistants to help me at the banding station each morning. These are typically students who have taken the class before and who enjoy bird banding. Having student assistants increases my ability to keep the birds safe, keep the students safe, and effectively manage everyone's time. I have found it sufficient to have only one assistant per morning.

Admittedly, it may seem as if this schedule (MW or TTh 6:00 to 8:50 am for six weeks) would be viewed by students as impossibly daunting. However, I rarely have less than full enrollment in the class and often have a waiting list for admission. In other words, while certainly not all students would sign up for such a class, student interest in hands-on natural history is more than enough to fill the class. The key element, I find, is not so much when the class meets, but the quality of the experience; and netting, handling, and banding birds is a very high-quality experience.

This class has the Biology Department's introductory course on ecology and evolution as a pre-requisite. This guarantees that all students have at least a basic understanding of general ecological and evolutionary principles, which allows me to use those concepts to explain the particulars of what we observe in the field.

Location

I have used the same general location for my banding program since 1986. I chose a portion of the college's campus that is within easy walking/biking distance of the main campus so that students can get to the banding station each morning under their own power. This eliminates the need for me as the teacher to arrange for transportation every morning. In addition, however, the portion of the campus that I chose borders a river and includes a significant floodplain forest and wetland complex. This has guaranteed that the college has not sought to expand the built portion of the campus into that area. I also asked for and received written permission from my administration to develop this area as a natural history teaching area.

The entire area is approximately 8 hectares of mixed field (Fig. 1), forest, and wetland, but only a portion of it is used for the bird banding curriculum proper.

Figure 1. The field at the natural area used for the banding station. The paths with the rows of nets are cut into the second-growth vegetation of the type seen at the far end of the field.

The field is kept open by a management plan developed with the college's Facilities Services staff. All of the paths where bird nets are set are brush-hogged each year. In addition, the open field (1.5 ha total) is kept open by brush-hogging one-fifth of it each year on a five-year rotation, thus preventing forest succession. The rest of the area (forest and wetland) is left undisturbed. The vegetational diversity found here maximizes the diversity of birds that pass through this natural area during fall migration.

Permits

IACUC protocol. All teaching and research use of vertebrate animals at colleges and universities in the U.S. is strictly regulated by both the Animal and Plant Health Inspection Service (of the U.S. Department of Agriculture) and the Public Health Service (of the U.S. Department of Health and Human Services). (Oddly enough, however, this is not uniformly true for use of vertebrate animals by federal agencies or primary and secondary schools.) At most, if not all, institutions of higher education, this is administered through an Institutional Animal Care and Use Committee (IACUC). This curriculum is authorized through an approved protocol with IACUC, evaluated annually and re-authorized every three years pending review.

The process of obtaining IACUC approval for the first time can be intimidating because many IACUC's are not used to dealing with requests that do not involve laboratory animals, controlled lab conditions, or studies where the exact number and identities of individual animals to be handled are not known in advance. IACUC's without previous experience evaluating protocols for field studies are often confused about how such protocols should be evaluated, and the Principle Investigator (i.e., the teacher) has to walk them through the purpose and methodologies of such studies. However, with patience, the first protocol approval can be obtained; after that, annual evaluations and tri-annual renewals are much less time consuming. The process can be made easier if everyone involved (teacher and IACUC alike) can review a protocol for bird banding from another institution; I am happy to share mine on request.

USF&WS permit. As I noted above, bird banding in the U.S. is strictly regulated by the U.S. Fish and Wildlife Service. No capture, handling, or banding of birds should be carried out without a valid permit. The process of obtaining a permit is described in detail at the Bird Banding Laboratory web site. Permits are generally valid for two years and are generally automatically renewed at two-year intervals as long as proper procedures are followed for reporting data.

State permit. Every state follows its own procedures for permitting the trapping and handling of animals for educational purposes. I recommend contacting your state Department of Fish and Wildlife (or its equivalent) and ask about the necessary procedures to follow.

Equipment

Bird banding requires a fair amount of field equipment, but all of it can be obtained either through a supplier specializing in equipment for bird studies or from a hardware store. The supplier that I most commonly use is Avinet, although numerous other excellent suppliers exist. A more complete list of sources can be found through the BBL's web page on Banding Equipment Suppliers.

Appendix 1 lists all of the equipment I use for bird banding in this class, along with quantity, sources, and disposition through the semester. After we

complete the banding at the end of six weeks, all of the equipment is brought back to my lab for cleaning, repair, restocking, and storage for use the following year.

Before the Semester Begins

Prior to the start of the semester, I set up the mist nets so that they are ready to be used on our first day in the field. I have found that the optimal number of nets is three rows of 11 24-foot nets each, with each row located in a different part of the study area. This arrangement provides plenty of opportunity for all students to practice the techniques being taught and for me and my assistants to properly supervise them to make sure the birds remain safe.

I also set up the banding station, which is simply a table placed in a small clearing near the nets. In addition to the table, I have at the station (1) a portable white board that I can use as an aid when talking to the students, (2) a clothesline strung between two poles on which captured birds, enclosed within bird holding bags, can be placed to keep them safe until they can be banded, and (3) large Rubbermaid storage bins for miscellaneous items, such as clothes pins, markers and erasers for the white board, and citronella candles (for when mosquitoes are abundant).

The table, white board, and clothesline remain at the banding station through the six weeks of this activity. Between mornings, the white board and storage bin are kept under the table, and the table is covered with a large waterproof tarp. While I run the risk of losing this equipment to theft or vandalism, it is not practical to remove everything after each morning's work.

The First Day of Bird Banding

I meet the students at 6:00 am at an easily found location. Each student is responsible for their own transportation to the site, and most bike or walk (Middlebury is primarily a residential college). Once we have gathered, I lead them to the banding station, and then tell them that for the next six weeks they need to be at the station at 6:00 am. I also tell them that before they leave for the banding station each morning, they need to check their email or voicemail for a message from me confirming that the weather is appropriate for netting and that we are still meeting (see more on this point below).

At this point I have them leave all of their belongings except their field notebooks at the station and have them follow me to one of the net paths. (It is usually at this point that they give me the opportunity to talk about the importance of putting their belongings off to the side of the station clearing; otherwise, someone could trip on a daypack and get hurt.)

At the net path, I show them how to open and set the nets correctly, and then I ask them to work as a group to open all 11 nets in the row. After they finish this, I walk with them along the row pointing out corrections and enforcing upon them the importance of doing this task correctly every time, or else they will be putting birds at risk.

After the nets are open, we stand off a short distance at the end of the path, and I talk to them about the history of mist netting, the history of the USF&WS bird banding program, the role of bird banding in avian ecology and conservation, how the nets are constructed, the ethics and regulations associated with bird banding, and the plant ecology and history of the study area until the first bird flies into a net. I rarely get through this entire list of topics before we capture a bird (in fact, we rarely have to wait more than a couple of minutes), so I work this information into other conversations over the next few days.

With the 12 students observing, I teach them how to remove a bird from the net, verbalizing all of the techniques that make this quick and safe for the birds, and how to put a bird in a holding bag. If other birds have flown into the nets, I repeat this for each bird, slowly working some of the more-confident students into the process. The goal at this initial step is to help the students find the right balance between being too gentle with the birds (and thus having them escape) and being too rough.

Once the first flush of birds is removed from the nets and the birds are placed in holding bags, I teach the students how to close the nets, and we then return to the banding station. Here, I show them how to pin the holding bags to the line with clothes pins, safely remove a bird from a bag, safely hold a bird (the "bander's grip", Fig. 2), identify the bird to species, apply the USF&WS numbered aluminum band, use the standard bander's reference (Pyle 1997) to determine age and sex, and release the bird.

Importantly, I teach the students how to enter the data collected on standardized data sheets I created specifically to ensure that the data are recorded completely, legibly, and using the correct USF&WS codes (Appendix 2). I have the students always work in pairs at the banding station, which ensures that the birds are handled safely and the data are recorded accurately.

Figure 2. A student and an Eastern Phoebe demonstrating the bander's grip.

I also introduce them to a handful of other references that will help them, particularly the bird field guide I require each of them to have as a textbook (currently *The Sibley Guide to Birds*) and the *National Audubon Society Master Guide to Birding: Old-World Warblers-Sparrows*. I also make available a list of all the species we have caught at the banding station in previous years in order to give the students a sense of what they are likely to catch (Appendix 3).

While each bird is in hand, I tell them what I know about the bird's taxonomy (particularly the order and family, since this information is useful for helping students group birds by characteristics of ecology and behavior), habitat, patterns of seasonal movement, diet, life history, and song. At one level, this might be considered "lecturing," but I try to keep the tone conversational and off-the-cuff in order to convey the idea that we are talking about nature rather than me lecturing to them about nature.

Figure 3. A student holding an American Woodcock and showing it to the others in the class.

While some teachers might find this aspect of the exercise the most intimidating, seemingly requiring a photographic memory of all details about all bird species, in reality the students benefit by having the teacher focus primarily on the 10-15 species most commonly encountered.

The last thing I have them do is to take every bird holding bag they have, turn them inside out, and put them back into the storage bin. The purpose of this is to ensure that no birds were accidentally forgotten, thus further reinforcing for the students the importance to us of the birds' safety.

After the First Day of Bird Banding

Subsequent days involve a regular routine. I leave a message via email/voicemail confirming that the weather is appropriate for banding and that we are meeting at the banding station. As the students arrive at the station, I send them out to open the nets, increasing the number of nets we open as the students gain experience and confidence in freeing birds from the net until eventually we are opening the full complement of 33 nets. The teaching assistant and I circulate continuously among the rows and the banding station. We check to make sure that each net is opened correctly and throughout the next two hours carefully monitor the efforts of each student to

make sure that no bird remains in a net or kept in a holding bag for more than a few minutes. If the bird captured is a species the class has not seen yet, if it clearly is not under any thermal stress, if the weather is warm, and if the time is close to when we will close the nets, I may instruct a student to keep a bird in a bag until all the students have returned to the banding station so that everyone will have a chance to see it (Fig. 3).

Over time, I teach them more about the biology of the species we catch, see, or hear in the study area and how to take and record morphological measurements (e.g., wing chord, tail length, culmen length, and weight).

Typically, once it is 8:00 am, I have the students close the nets and return to the banding station so we can talk about the birds as a group and review the data from that day. The group is dismissed at a time sufficient to allow them to get to their next class on time. I then pack up the banding supplies and secure the station so that it is ready for the next morning.

Not every morning follows the ideal schedule, however. For example:

- If the weather forecast for the morning (which I obtain on-line from Weather Underground) calls for rain while we will be at the station, I cancel the trip because it would not safe for birds to be caught in mist nets, where the threads of the nets can expose bare skin to cold and wet conditions. If a class is cancelled, I use the Friday of that week to make up the class.

- If bird activity is too low to make netting a worthwhile use of time, I have the students close the nets early and take the opportunity to talk with them about aspects of bird biology we have not yet covered.

- If bird activity is so high that we cannot safely manage all the nets, I have the students close one or more of the rows earlier than usual and concentrate our efforts on only a subset of them.

- If bird activity is so high that we capture a larger number of birds than we can band quickly, I have the students close down all of the nets and get the entire group to work at banding the birds at the banding station.

In other words, this kind of field activity requires the instructor to be flexible and alert to conditions so that the birds are kept safe and the students are effectively engaged in some kind of meaningful activity. At first, I found this to be intimidating since I felt that so much of the learning experience was not under my control. However, over time I came to appreciate the fact that the unpredictability was an advantage; every morning brought some new observation or experience to the class, and contrary to conventional wisdom, the students actually appreciated not having each moment pre-programmed and predictable.

The Last Day of Bird Banding

On our last morning in the field, we follow the same schedule as usual to open the nets and band the birds; however, we close the nets about 30 minutes earlier than usual and I show the students how to secure the nets for storage and how to take the nets down off of the poles. I then ask them to completely disassemble the three rows and bring all equipment back to the banding station for later pickup and storage.

We then gather as a group to summarize everything we did over the previous six weeks: what they learned intellectually and kinesthetically, how their attitudes and perspectives have changed as a result of having close and frequent contact with living birds in the birds' own habitats, and how their appreciation for the natural history of a single place has grown.

Managing the Data

As I noted above, I have the students record the data on sheets prepared for different band sizes (0A through 2, see Appendix 2) and organized into different binders at the banding station. Students always work in pairs, one to hold the bird and one to apply the band and record the data. Having different binders for each band size allows more than one group of students to handle birds and record data at the same time.

The BBL provides software called Bandit, which allows data on band inventories, banding locations, and the banded birds to be easily recorded and reported on-line. I have found it most efficient to transcribe the results each day in order to keep tabs on the quality of the students' work. This requires less time than one might think; once familiar with Bandit, one can usually transcribe and report a day's work in less than 15 minutes.

Results

Bandit provides a number of useful data reporting features that allow banding results to be easily summarized both within and across years. Typically I find students get very excited about a number of patterns that are readily derived from the data and I

create opportunities to integrate discussion of these patterns into our conversations at the banding station:

1. How do the numbers of birds banded per unit time compare across years? This allows students to get a sense of how population sizes change. While there is no easy way to control precisely for year-to-year differences in how many birds escape before banding (and thus aren't included in the bands/time ratio), I find it sufficient for pedagogical reasons to assume that this ratio is the same across years.

2. How do the number and identity of bird species captured compare across years? Surprisingly, even after having banded birds at this location for over 20 years, we still encounter new species every year. In 2007, for example, we netted seven species that we had never caught before. This tally adds excitement to the experience because students see that even after so many years of effort, there are still new things to see. It also opens up opportunities for discussions about dynamism in the natural world, driven by everything from chance to human-induced environmental change.

3. How does the timing in species abundance change during the migration season, and how do these patterns change across years? Typically, Gray Catbirds and Common Yellowthroats are the most abundant species caught in early September. By mid-October, these species have largely moved on, replaced by White-throated Sparrows. In between, waves of warblers (especially Yellow-rumped), wrens (both Marsh and House), and kinglets (both Golden-crowned and Ruby-crowned) move through the study area. The timing of these changes gives students exposure to the nuances of migratory behavior and how much variability there can be even within generalized patterns that are fairly consistent from year-to-year.

After the Semester Ends

Maintaining the equipment is easier if I take care of it at the end of the semester. My end-of-the-semester checklist is as follows:

- Inventory and replace as necessary all equipment from the banding box (Appendix 1).
- Double check all band strings and order more bands as necessary.
- Store all field data sheets into a permanent archive.
- Label and store all nets, poles, and tables.
- Wash, dry, and store all bird holding bags.
- Air dry and store all ropes, clothes pins, and other field supplies.

Evaluation of and by the Students

I evaluate the students throughout their work at the banding station. My assessment is based on (a) on-going observation of the quality of their field skills (e.g., safe removal of birds from the net; accurate and legible data recording; correct use of reference material to identify species, age, and sex; consistent attention to proper procedures for all methods), and (b) their field notebooks. Although a complete description of the field notebook is beyond the scope of this article, in brief I use the students' daily entries to assess the quality and depth of their engagement with the entire experience at the banding station.

I am confident that this long-term natural history exercise results in positive learning outcomes for the students. By the time our work at the banding station is done, all of the students have had multiple opportunities to hold many individuals of many different species, to participate in a long-term study at a single location that itself is part of a long-term study managed by both U.S. and Canadian federal agencies, and to glimpse the natural world through the eyes of migratory birds. Student opinions of the class are quite positive. Examples to highlight *their* impressions of the experience include the following:

> "I would say that the opportunity to mist net birds—to handle them and feel them, and to truly examine them—is so different (and much more rewarding) than reading about them and looking at photographs of them. By getting the close contact with the birds, you get to truly understand what fat reserves are, you get to feel primary flight feathers, and you understand what 8 grams feels like. It gives an appreciation for what their life history truly entails and has led me on a career in wildlife conservation. My work has given me the opportunity to have hands on experience with numerous wildlife species including eagles, black footed ferrets, lynx, burrowing owls, and numerous other species, and I still look back on the first time I held a songbird in my hand

and how that has had such a strong and indelible influence on me."

"Mist netting birds was the most rewarding hands on experience in my environmental studies education. Banding birds gave me more than biological techniques; it led me to natural history. In order to understand birds, I had to get close to them, listen to them, watch them, touch them, maybe even expose them to the dangers of a trap or net. But in doing so, my understanding led to a connection, and this connection led to the desire to live with nature and protect it."

"It is one thing to memorize the taxonomy of a white throated sparrow, stuffed and mounted, to score well on an exam. But to listen to its song at dawn as the sun rises, to feel your own heart racing with anticipation as you head out to check the nets, to hold it alive in your hands feeling its heart beating while you carefully untangle its feet from the net, to measure the wingspan and weight and study its markings, and then to set it free again; these are memories never forgotten."

Main Points

- Choose an area that is easy for the students to get to but that has a minimal chance of being developed for several years.
- Develop and implement an enforceable management plan for the area that will maximize the chances that it will remain in an ecological state that promotes bird diversity.
- Obtain necessary permits and approvals, including those required at the federal, state, and institutional (IACUC) levels.
- Prepare the field site (e.g., clearing paths, setting rows of nets, and setting up the banding station) shortly before the start of the semester.
- Schedule the exercise for a time of year when you are likely to get lots of bird activity and a high diversity of species, such as during migration.
- Schedule the class for the students' first time slot in the morning; this allow you to get them out into the field at dawn when bird activity is at its peak.
- Keep the class size small enough for you to manage the students' work and to ensure that students have multiple opportunities to handle the birds directly.
- Manage the data frequently, even daily, to catch errors before they are repeated.
- Maintain a list of equipment to make the task of inventory, repair, and replacement easier.
- At the field station, balance your time with the students among opening the nets, checking them for birds, banding birds, closing the nets, and debriefing about the morning's results.
- Realize that you don't need to know everything about every species of bird in order to effectively teach this subject. The vast majority of what the students will experience will focus on a few key topics (e.g., diet, distribution, habitat, behavior) of only 10-15 common species.

Relevance to Other Audiences

While the course described here is tailored toward students at a residential college in a rural setting, many aspects of it can easily be adapted to other learning environments. I've described what has worked for me, recognizing that other strategies would be more appropriate for other classes. The experience is worthwhile no matter how much or little time a teacher can devote to it. What matters most is that the students get into the field, see (and hopefully experience) the techniques used, and hold a living bird in their hands. Everything else is extra.

Acknowledgments

This article reports on a curriculum that would never be possible without the encouragement of numerous faculty, staff, and administrators at Middlebury College who supported my efforts to develop this field experience for the students. I am particularly grateful to two of them. The first is Dr. Bruce Peterson, Professor Emeritus of Mathematics and formerly Vice-President for Academic Affairs when I joined the faculty at Middlebury in 1985. Bruce was extremely supportive of my desire both to establish a long-term banding station on college-owned land and to incorporate it into my teaching program. As an avid birder himself, he was especially empathetic toward the incorporation of real field experiences into the natural history curriculum at the college, and his authorization of my use of the land was a critical first

step in the development of everything described here. Second, Luther Tenny, Assistant Director of Facilities Services, has been my active partner in developing and implementing the management plan for the study area. For many years, maintenance of the ecological health of the study area was made difficult by personnel who, by ignorance or design, undercut the natural history education program at the college. Luther's arrival at the college several years ago signaled a new era in land management at Middlebury College, and the curriculum described here was made much the better for it.

I am also thankful to my children, Sage and Ian, who grew up having to contend with their father's odd work hours during the fall migration and who, on many occasions, had to join me in the field with my students despite the early morning hours or their preference to be allowed to continue sleeping in their own beds. Their patience and good humor have always been a blessing.

I would also like to thank John Anderson and two anonymous reviews whose suggestions improved the content and presentation of this article.

I am most grateful, however, to the generations of students who have come through this course. Their smiles, enthusiasm, and infectious wonder at all they saw and experienced were all I ever needed to know that this is the way that natural history should be taught. As a student remarked on one really special day, "This is way better than the Discovery Channel." So true.

References

Klyza, C.M., and S.C. Trombulak. 1999. *The Story of Vermont: a natural and cultural history*. University Press of New England.

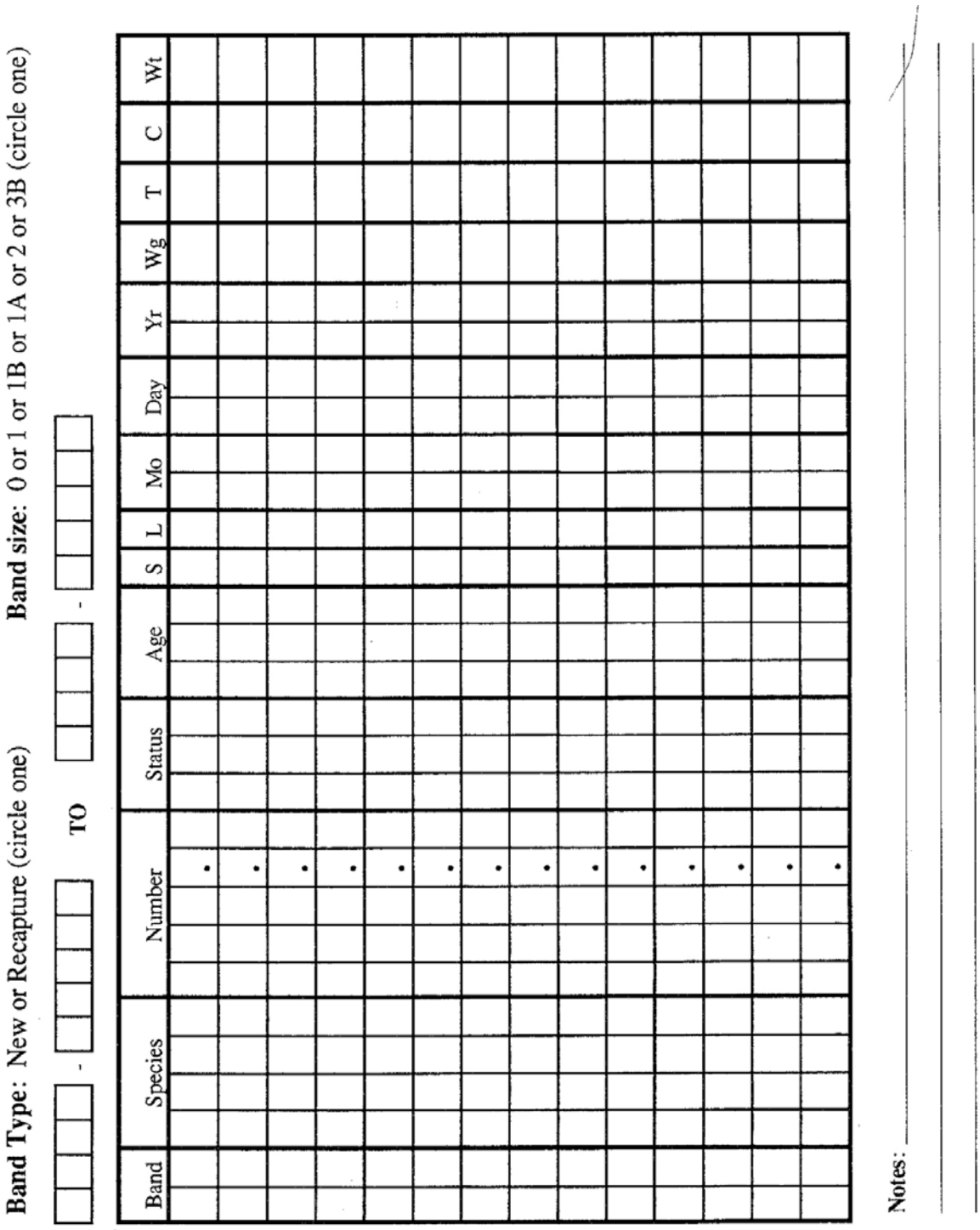
Pyle, P. 1997. *Identification guide to North American Birds, part I: Columbidae to Ploceidae*. Slate Creek Press.

Appendix 1. Equipment used for bird banding. Disposition refers to where the equipment is kept during the banding season, and "kept in field" can refer to either the banding station or the net rows, as appropriate.

Item	Quantity	Source	Disposition
Master birding guides			
Identification Guide to North American Birds (Pyle 1997)	3	Bookstore	Kept in field
The Sibley Guide to Birds	1 per student	Bookstore	Students acquire their own copy as a textbook
Audubon Society Master Guide to Birding	1	Bookstore	Kept in field
Vermont Daily Field Card	1 per student	Vermont Institute for Natural Science	Students given their own copy
Data binders	1 per band size	Bookstore	Removed each morning
Nets	33	Banding supplier	Kept in field
Poles (10-ft, ¼ inch conduit)	38	Hardware store	Kept in field
Nylon rope (to add tension to the ends of the rows of nets and as a clothesline for holding bags)	30 yards	Hardware store	Kept in field
Stakes (to hold down the nylon rope)	6	Hardware store	Kept in field
Weighing bags	30	Banding supplier	Kept in field
Limb cutter	1	Hardware store	Kept in field
Field table	1	Hardware store	Kept in field
Ziploc bags	1 box	Grocery store	Kept in field
Sledge	1	Hardware store	Kept in field
Clothes pins	50	Hardware store	Kept in field
White board	1	Educational supplier	Kept in field
Dry erase markers	3 (different colors)	Educational supplier	Kept in field
Eraser	1	Educational supplier	Kept in field
Citronella candles	2	Hardware store	Kept in field
Storage container	2 20-gallon bins	Hardware store	Kept in field
Tarp	1	Hardware store	Kept in field
Banding box (plastic fishing tackle box)	1	Hardware store	Removed each morning
bands	1-2 strings of 100 per size, stored separately in different ziplock bags and labeled on each end)	USF&WS	
Pesola scales	3 for each of 3 ranges (50 g, 100 g, and 500 g)	Banding supplier	
banding pliers	5	Banding supplier	
band removal pliers	1	Banding supplier	
pliers	1	Hardware store	
rulers	3	Banding supplier	
pencils	5	Stationary store	
magnifying glass	1	Hardware store	
tags	Several (for labeling nets, bands, etc.)		

permit	1	USF&WS	
wire cutters	1	Hardware store	
pocket knife	3	Hardware store	
pocket flashlight	1	Hardware store	
flashlight batteries and bulb	2 each	Hardware store	
dial calipers	3	Banding supplier	
marking tape	1 roll	Stationary store	
pencil sharpener	1	Stationary store	
index cards	Several	Stationary store	
forceps	1	Educational supplier	

Appendix 2. The banding data sheet.



Appendix 3. Bird species banded at the bird banding station (as of Fall 2007). Numbers in the last three columns refer to the page numbers for that species account in Sibley's Guide (S), Guide to Passeriformes (Pyle), and Audubon Master Birder's Guide (A), and are given to make it easier for the students to find the relevant species account quickly.

Species	Code	#	Band	S	Pyle	A
Non-passeriformes						
American Woodcock	AMWO	228.0	3	192	---	---
Ruby-throated Hummingbird	RTHU	428.0	XB	299	136	---
Downy Woodpecker	DOWO	394.0	1B	312	187	---
Passeriformes						
Flycatchers						
Eastern Phoebe	EAPH	456.0	0-1C-1	330	240	---
Great Crested Flycatcher	GCFL	452.0	1A-1B	333	247	---
Eastern Wood-Pewee	EAWP	461.0	0-1C	323	217	---
Jays and Crows						
Blue Jay	BLJA	477.0	2-3	351	297	---
Chickadees and Titmice						
Black-capped Chickadee	BCCH	735.0	0-1C	374	334	---
Tufted Titmouse	ETTI	731.0	1B	373	345	---
Wrens						
House Wren	HOWR	721.0	0-1C	386	365	---
Marsh Wren	MAWR	725.0	1C-1	389	369	---
Nuthatches						
White-breasted Nuthatch	WBNU	727.0	1B-1	381	352	---
Kinglets						
Golden-crowned Kinglet	GCKI	748.0	0A	394	374	36
Ruby-crowned Kinglet	RCKI	749.0	0A	394	375	36
Thrushes						
Hermit Thrush	HETH	759.0	1B-1	409	399	54
American Robin	AMRO	761.0	2	403	403	58
Swainson's Thrush	SWTH	758.0	1B	407	397	52
Veery	VEER	756.0	1B	406	95	52
Wood Thrush	WOTH	755.0	1A	406	401	54
Mimic Thrushes						
Brown Thrasher	BRTH	705.0	2-3	412	411	66
Gray Catbird	GRCA	704.0	1A	410	408	62
Waxwings						
Cedar Waxwing	CEDW	619.0	1B	423	437	84
Vireos						
Blue-headed Vireo	BHVI	629.0	1C-1	349	281	100
Red-eyed Vireo	REVI	624.0	1C-1-0	342	288	106
Warblers						
American Redstart	AMRE	687.0	0A-0	446	496	160
Black-and-White Warbler	BAWW	636.0	0-0A-1C	446	495	160
Black-throated Green Warbler	BNTW	667.0	0A-0	439	477	142
Chestnut-sided Warbler	CSWA	659.0	0A-0	433	462	128
Common Yellowthroat	COYE	681.0	0-1C-0A	452	510	176
Magnolia Warbler	MAWA	657.0	0A-0	433	464	130
Mourning Warbler	MOWA	679.0	0-1C-1	451	506	172
Myrtle's Warbler	MYWA	655.0	0-1C-0A	436	469	134
Nashville Warbler	NAWA	645.0	0A-0	430	450	118
Northern Waterthrush	NOWA	675.0	1C-0	449	502	166

Species	Code	#	Band	S	Pyle	A
Ovenbird	OVEN	674.0	1C-1-0	448	501	164
Palm Warbler	YPWA	672.9	0-0A	441	488	154
Pine Warbler	PIWA	671.0	0-0A	442	484	148
Tennessee Warbler	TEWA	647.0	0A-0	428	447	114
Wilson's Warbler	WIWA	685.0	0A-0	454	515	180
Yellow Warbler	YWAR	652.0	0-0A-1C	432	459	126
Yellow-rumped Warbler	see Myrtle's Warbler					
Sparrows						
American Tree Sparrow	ATSP	559.0	0-1C	483	549	230
Chipping Sparrow	CHSP	560.0	0-1C	485	550	232
Dark-eyed Junco	see Slate-colored Junco					
Field Sparrow	FISP	563.0	0-1C	483	555	236
Lincoln's Sparrow	LISP	583.0	1C-0	499	584	264
Savannah Sparrow	SAVS	542.0	1C	490	565	248
Slate-colored Junco	SCJU	567.0	0-1C-1	501	593	272
Song Sparrow	SOSP	581.0	1B-1	498	579	262
Swamp Sparrow	SWSP	584.0	1C-1	499	585	264
White-crowned Sparrow	WCSP	554.0	1B	495	589	268
White-throated Sparrow	WTSP	558.0	1B	494	587	266
Cardinals						
Indigo Bunting	INBU	598.0	1C-1	468	618	210
Northern Cardinal	NOCA	593.0	1A-2	464	607	201
Rose-breasted Grosbeak	RBGR	595.0	1A-2	466	609	
Tanagers						
Scarlet Tanager	SCTA	608.0	1B	463	527	194
Finch						
American Goldfinch	AMGO	529.0	0-0A-1C	535	686	344
Purple Finch	PUFI	517.0	1-1C-1B	528	668	328