THE NORTH AMERICAN BANDERS' MANUAL FOR BANDING PASSERINES AND NEAR PASSERINES (EXCLUDING HUMMINGBIRDS AND OWLS)

A product of the
NORTH AMERICAN BANDING COUNCIL

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(EXCLUDING HUMMINGBIRDS AND OWLS)

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PREFACE

The purpose of the publications of the North American Banding Council is to provide for all banders in North America the basic information to safely and productively conduct bird banding.

This manual is an integral part of other publications, primarily *The North American Banders' Study Guide*. It is assumed that the person reading this manual already has read fully that guide. Further, we also assume that the introductory material on pages 1-40 in Pyle (1997a) also has been read. With this background, this manual will augment the information that pertains especially to landbirds.

The Banders' Study Guide is intended to cover various aspects of banding that are across taxa; where this manual covers only the passerines and close relatives. In addition to an Instructor's Guide, for persons training banders, the North American Banding Council is producing other taxon-specific manuals for hummingbirds, shorebirds, raptors, waterfowl, seabirds, and perhaps other groups. While some of the material in this manual may apply to taxa other than landbirds, the material was included if the primary use by banders would be with landbirds. For instance, the traps for catching landbirds are covered in this manual, although similar traps are used for shorebirds and waterfowl. The Committee felt, however, that the special adaptations required for capture of these quite different taxa merited separate treatment in the taxon-specific manuals.

We trust that this guide will be read by all banders and trainers involved in passerine banding. While guidelines used by various individual trainers and stations may differ slightly from the general guidelines set down in the manuals and guides, we and the North American Banding Council recommend that full consideration be given to the guidelines presented here, and that trainees be fully exposed to the full variety of opinions that are captured in these publications.

This is a truly cooperative venture, representing many hours of work by many individuals and their institutions and including, as much as possible, all responsible views of banding in North America. We trust that the final product is worthwhile to those involved in the capture and banding of landbirds.

—The Publications Committee of the
North American Banding Council
C. John Ralph, Chair

ACKNOWLEDGMENTS

This manual had its origin in part as the Canadian Banders' Study Guide by Jon D. McCracken, Lisa Enright, David Shepherd, Julie Cappleman, and Erica H. Dunn. Kenneth Burton led the effort to revise this to pertain solely to landbirds. It has been augmented and edited by David DeSante, Geoff Geupel, Sara Morris, Robert Mulvihill, T. Pearl, Paul Prior, Jennifer Weikel, Glen Woolfenden, and Bob Yanick. We thank Jerry Verner and Glen Woolfenden of the Editorial Board for their insightful editing.

—The Publications Committee

1. INTRODUCTION

The capture and banding of landbirds, especially those described as "passerines and near passerines" by Peter Pyle (1997a) in his recently revised, monumental work, includes most of the species commonly caught in mist nets and in baited traps.

This manual is largely a compendium of material taken from other sources. Some parts summarize important details presented in *North American Bird Banding: Volume I* (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1991) (see also http://www.pwrc.usgs.gov/bbl/manual/manual.htm) and *North American Bird Banding Techniques: Volume II* (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1977). These manuals are hereafter referred to simply as the "Bird Banding Manual." This manual is not intended to supplant the Bird Banding Manual; they are still required reading.

Technical sections of this manual profited enormously from *The Ringer's Manual* (Spencer 1992), *The Australian Bird Bander's Manual* (Lowe 1989), *A Manual for Monitoring Bird Migration* (McCracken et al. 1993), *A Syllabus of Training Methods and Resources for Monitoring Landbirds* (Ralph et al. 1993a), *Handbook of Field Methods for Monitoring Landbirds* (Ralph et al. 1993b), *Identification Guide to North American Passerines* (Pyle et al. 1987), *Identification Guide to North American Birds(Part 1)* (Pyle 1997a), the *MAPS Manual* (Burton and DeSante 1998), and the *MAPS Intern Manual* (Burton et al. 1999). These references (and others listed in the Bibliography section of the Banders' Study Guide) should be read to gain further insight.

2. THE BANDER'S CODE OF ETHICS

Bird banding is used around the world as a major research tool. When used properly and skillfully, it is both safe and effective. The safety of banding depends on the use of proper techniques and equipment and on the expertise, alertness, and thoughtfulness of the bander.

The Bander's Code of Ethics applies to every aspect of banding. The bander's essential responsibility is to the bird. Other things matter a lot, but nothing matters so much as the health and welfare of the birds you are studying. Every bander must strive to minimize stress placed upon birds and be prepared to accept advice or innovation that may help to achieve this goal.

Methods should be examined to ensure that the handling time and types of data to be collected are not prejudicial to the bird's welfare. Be prepared to streamline procedures of your banding operation, either in response to adverse weather conditions or to reduce a backlog of unprocessed birds. If necessary, birds should be released unbanded, or the trapping devices should be temporarily closed. Banders should not consider that some mortality is inevitable or acceptable in banding. Every injury or mortality should result in a reassessment of your operation. Action is then needed to minimize the chance of repetition. The most salient responsibilities of a bander are summarized in the Bander's Code of Ethics; more details are found in Section 13 of the Banders' Study Guide.

Banders must ensure that their work is beyond reproach and

The Bander's Code of Ethics

1. ***Banders are primarily responsible for the safety and welfare of the birds they study so that stress and risks of injury or death are minimized.*** **Some basic rules:**
   - handle each bird carefully, gently, quietly, with respect, and in minimum time
   - capture and process only as many birds as you can safely handle
   - close traps or nets when predators are in the area
   - do not band in inclement weather
   - frequently assess the condition of traps and nets and repair them quickly
   - properly train and supervise students
   - check nets as frequently as conditions dictate
   - check traps as often as recommended for each trap type
   - properly close all traps and nets at the end of banding
   - do not leave traps or nets set and untended
   - use the correct band size and banding pliers for each bird
   - treat any bird injuries humanely

2. ***Continually assess your own work to ensure that it is beyond reproach.***
   - reassess methods if an injury or mortality occurs
   - ask for and accept constructive criticism from other banders

3. ***Offer honest and constructive assessment of the work of others to help maintain the highest standards possible.***
   - publish innovations in banding, capture, and handling techniques
   - educate prospective banders and trainers
   - report any mishandling of birds to the bander
   - if no improvement occurs, file a report with the Banding Office

4. ***Ensure that your data are accurate and complete.***

5. ***Obtain prior permission to band on private property and on public lands where authorization is required.***

assist fellow banders in maintaining the same high standards. Every bander has an obligation to upgrade standards by advising the Banding Offices of any difficulties encountered and to report innovations.

Banders have other responsibilities too. They must submit their banding data to the Banding Offices promptly, reply promptly to requests for information, and maintain an accurate inventory of their band stocks. Banders also have an educational and scientific responsibility to make sure that banding operations are explained carefully and are justified. Finally, banders banding on private property have a duty to obtain permission from landowners and ensure their concerns are addressed.

3. TRAPPING TECHNIQUES

Biologists use a wide variety of devices to capture birds. Some common methods of trapping used for passerines are discussed in this section. Mist netting is discussed at length in the Banders' Study Guide. For information on other techniques, consult Lockley and Russell (1953), McClure (1984), Bub (1991), or the Bird Banding Manual (1977, 1991).

Well-designed traps usually are safer to use than mist nets, but even so, several factors must be considered to minimize casualties. Most traps are made from welded wire mesh or plastic netting. Chicken wire has a tendency to have loose ends that can injure birds and should be avoided, if possible. In general, the material selected should be of the largest mesh size

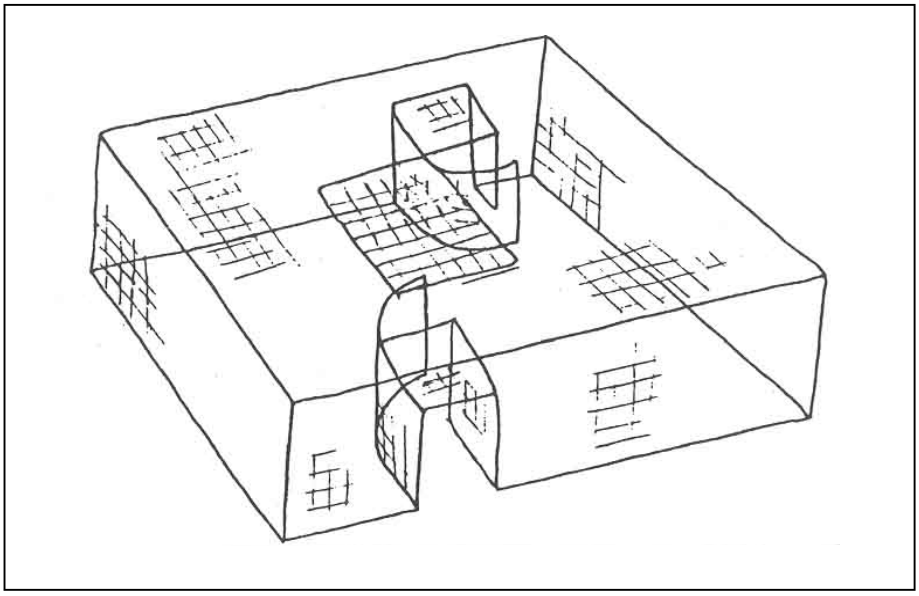

Figure 1. One design for a ground trap, showing two funnel entrances on the sides and the bander's-access door on top.

that will contain the target species and of the best-quality material. Welded wire mesh measuring 2.5 x 1.25 cm. (1 x 0.5 inch) is generally considered to be the optimum mesh size for songbirds. If birds regularly scuff their foreheads, consider coating the wire with a suitable plastic coating. Edges of wire traps that birds can contact should be cut and bent back in such a way as to eliminate sharp points; this not only is safer for birds but also reduces snagging by hands and clothing. Alternatively, large, framed traps should be clad with plastic netting, which is inexpensive and easy to install. It will not withstand a snow load when used as a roof, nor will plastic walls take heavy abuse; still, in the interest of bird safety, plastic mesh clearly is the best material.

3.1. Ground Traps

Portable ground traps (also called walk-in traps; Fig. 1) are used to catch small, ground-feeding, seed-eating birds. They are best made out of 1.25- x 2.5-cm (0.5- x 1-inch) welded wire mesh, which will help reduce injury to the bill if the long axis of the mesh is vertical. The traps typically measure 1 x 0.7 m (3 x 2 ft). Ground traps are baited with seed scattered in the center of the trap and lightly around the entrance funnels. As in the House Trap, described below, birds enter through the funnels and generally cannot escape. Birds can be extracted by means of a hinged door in the roof or side of the trap; use your free hand to block the rest of the doorway.

Many banders prefer a "gathering box" placed against a door opening on the side of the trap, at one corner of the ground trap. Birds can be herded into this gently and sheet metal doors then slid into place in grooves in the sides of the box between the gathering box and trap. The gathering box is made from lumber with two ends left open. Nail hardware cloth over one end. On the opposite end, cut a door matching in size the door on the side of the ground trap. Provide a top slit and interior grooves for this too.

To set the trap, simply close the access door. As with the House Trap, put seed out in the trap locations a few days before you wish to begin banding to give birds time to find the food. Traps should be checked every 30 minutes (or less, depending on weather conditions and human traffic) to reduce the risk of predation and because some birds will struggle to escape.

Because the birds can feed while trapped, ground traps can be used on cold days, but they should be checked frequently. Stop trapping if birds are getting wet, cold, or hot.

Traps are closed simply by turning them upside down or, preferably, by carrying them back to the banding station, where they are less likely to be pilfered. Maintenance is simply a matter of repairing any holes in the mesh as well as any sharp edges that may develop. The traps can be plastic-coated or a layer of plastic mesh can be laced into the inside of the trap to eliminate the chance of any cuts. It is sometimes difficult to place your hand over the bird in the trap to catch it. If the "chase" continues for too long, the bird will over stress and exhaust, perhaps injure itself. Simply lift the cage to release the bird if the "chase" has gone on too long! The bird will return. A gathering box largely eliminates this problem.

3.2. Potter Traps

The Potter trap is an automatic, versatile, baited trap made of 1.25- x 2.5-cm (0.5- x 1-inch) hardware cloth (Fig. 2). It can be constructed to any size specifications depending on the target species; a 10- x 10-cm (4- x 4-inch) entrance door is large enough for robins. Generally, it is used to capture seed-eating birds, but it can be adapted for other species.

The Potter trap is set by raising the entrance door and placing a wire attached to a treadle beneath the bottom edge of the door. When a bird steps into the trap, it triggers the treadle and the door falls closed behind it. Potter traps must be reset each time

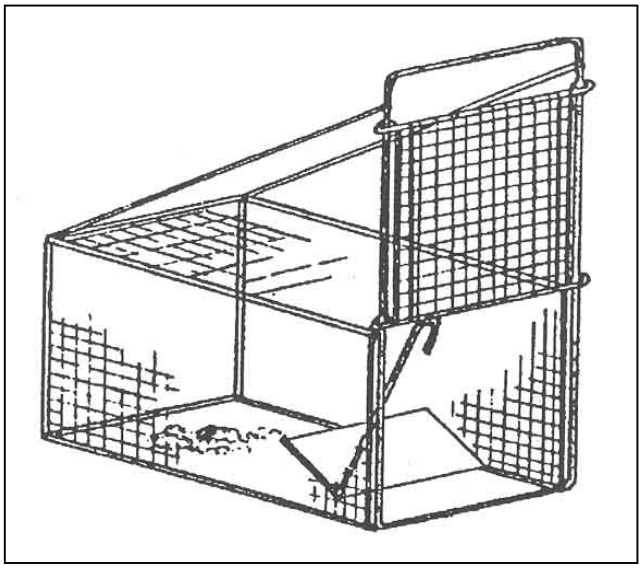

Figure 2. One design for a Potter trap (from Bub 1991).

a bird is extracted and watched closely if predators are in the area. When not in use, traps can be left out with the doors held open with clothespins or twist-ties and baited to acclimatize birds, or they can be retrieved. Traps can be operated singly or in a series of multi-celled Potter traps, keeping in mind that they usually catch only one bird at a time per cell. As shown in Figure 2, having the treadle set back from the door captures more wary birds.

3.3. House Traps

A house trap is essentially a large, square cage equipped with a bander's access door, which should be built so it can be latched open or closed, and a catching box at the end of a ramp on the inside (Fig. 3). These traps traditionally were clad in hardware cloth, but plastic netting is much better because it reduces any risk of injury. Funnels around the base of the trap allow seed-eating, ground-feeding birds to enter. If the roof is made of chicken wire or 1-cm (0.4-inch) hardware cloth, 10- to 30-cm (4- to 12-inch) slots in the central furrow in the roof will allow blackbirds or crows, respectively, in to feed. The trap is baited on the inside and sparingly baited at the funnel entrances to attract birds.

Before setting the trap, it is good to leave the bander's access door open for the first few days so birds can find the seed and get accustomed to entering the trap. When setting the trap, close the access door. You can leave birds in the trap to lure others, but not for more than an hour or if large numbers accumulate. Remove or release birds as soon as they realize they are caught, otherwise they will panic (usually as soon as they have seen a human approach the trap). To extract birds, enter via the bander's access door and close it behind you. Use the draw string to pull the catch-box door open and herd the birds up the ramp and into the catching box.

To unset the trap, **latch** the bander's-access door **open** to allow birds to come and go freely. Close the catch-box door so birds are not caught inadvertently.

The grass inside house traps should be kept short and the entrance funnels should be kept clear of excess vegetation.

3.4. Bal-chatri Traps

Used mainly for raptors, Bal-chatri traps (Fig. 4) also can be used for catching shrikes. When a shrike lands on the trap, monofilament nooses entangle its toes. The trap is usually fashioned into a square, circular, or conical cage, which holds a live mouse or beetle in a 10-cm x 20-cm-wide (4- x 8-inch) cage.

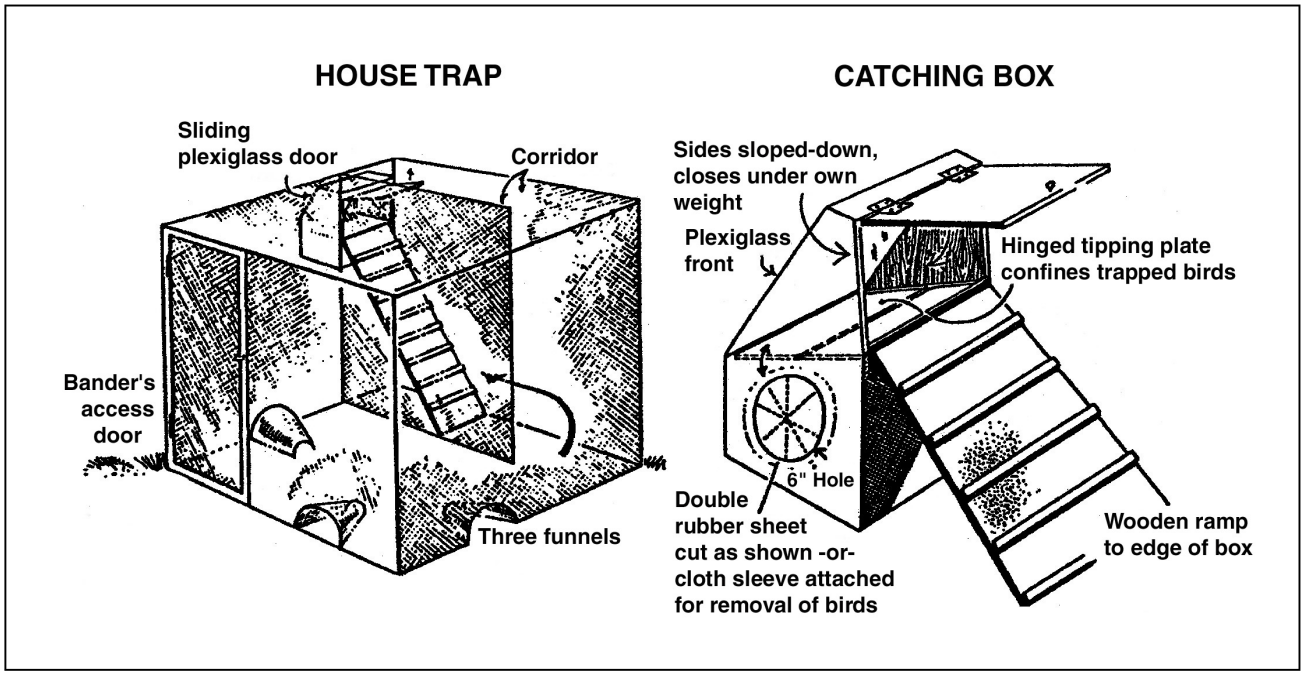

Figure 3. One design for a house trap and catching box (from Davis 1981).

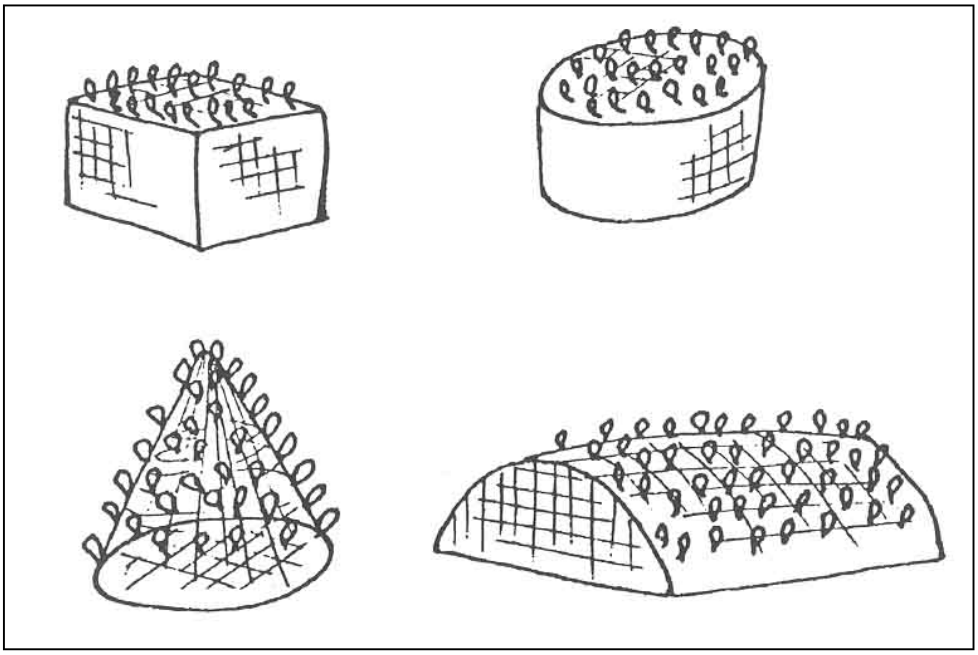

Figure 4. Several Bal-chatri trap designs.

Up to 60 (and sometimes more) nooses are attached to the top and sides of the trap, and the trap is set out in an open field or along a roadside to attract hunting birds.

The cage can be made of 1-cm (0.4-inch) hardware cloth. Sections of 2- to 4-kg (4- to 8-lb) test fishing line are cut to form loops 3-5 cm (1.5-2.5 inches) in diameter. Each loop is formed using a slipknot, and the other end of the line is tied to the cage mesh. If held out from the mesh while a drop of liquid cement or quick-dry glue is placed on the anchoring knot, the noose will stand out from the trap. The entire device must be heavy enough so that a caught bird cannot fly off with it.

Bal-chatris must be tended constantly to prevent injury to birds trapped. Hence, you must sit and wait until a bird has been caught and then immediately free it from the trap. Nooses must be maintained in working order and holes or sharp edges that develop on the trap should be repaired immediately. Treat lure mice humanely. This includes providing them with sufficient food, water, and shade, minimizing the time they must spend near predators, and removing them from the trap when their "job" is done.

3.5. Helgoland Traps

This type of trap originated in Helgoland, Germany. It is a huge, funnel-shaped trap (Fig. 5) made of wooden posts that support a welded-wire mesh or plastic netting (the latter is preferred for the walls, though welded wire makes a better roof.) The Helgoland trap is designed to catch migrating landbirds over a long, narrow area such as a peninsula, ridge, narrow strip of vegetation, or some similar formation where birds are liable to concentrate. Banders walk toward the open end, herding birds into the trap opening and ultimately into a catching box situated at the end of the funnel. Helgoland traps are among the most efficient ways to catch large numbers of birds. The Helgoland trap can be run in almost any weather and by one person if need be. The trap does not have to be monitored closely throughout the day, provided the catching-box door is kept **closed**. Reference for more detailed instructions for construction are in Hussell and Woodford (1961).

The vegetation leading toward the Helgoland trap should be kept in its natural state, but near the trap entrance it should taper downwards in height so it is slightly shorter than the entrance, getting shorter farther into the funnel. The trap itself tapers down to about 1.5 m in height at the catching box. About 2 to 3 m from the catching box, the funnel bends and a ramp leads up to the catch-box door. The bend slows birds down so that they can enter the catching box without injuring themselves. The front of the catching box is made of plexiglass or clear, plastic sheeting set at an angle to prevent injury; birds fly into the "open" box thinking they can get through it. The plexiglass should be kept clean and dry to lure birds into the catching box, and on foggy or frosty mornings it must be cleaned off before you make your first run. Repair any holes in the walls or roof and occasionally trim or plant vegetation as needed. Establishing and maintaining brush piles (used to attract skulking birds) is useful.

The trap needs no setting. Provided the arm holes in the catching box are closed and the glass is in place, it always is ready to trap. If you are catching seed-eating birds, the funnel-entrance portion of the trap can be baited lightly. Be aware that this can dramatically and perhaps dangerously increase the number of individuals trapped (especially icterids). Two to four people are ideal to run the trap. Drivers form a U-shaped line, the outer people walking about 8 m ahead of the others. Pishing, clapping, and shouting as you walk towards the open end of the trap will drive the birds ahead of you. Do not make too much noise too early, otherwise birds will flush too early and have time to double back before you reach the trap. Of course some birds will turn and fly behind the driving line. About 3 m from

the entrance, herd the birds gently into the funnel. As you approach the far end of the trap interior, pull the string that opens the catching-box door and herd the birds up the ramp and into the catching box, closing the door behind them. Never chase a bird for so long that it becomes exhausted or injures itself trying to squeeze out of the mesh. Indeed, a catch of ten birds is sufficient, so do not risk undue stress or injury by trying to catch large numbers. As always, you are not out to set any records for how many birds you can catch.

Remove birds from the catching box gently and quickly. Do not stand in front of the plexiglass because this will scare the birds deeper into the catching box where they will be harder to remove. Instead, stand out of sight to the side near the arm-access holes. The differently sized shelves of the catching box (see below) should separate birds of different sizes automatically but if, for some reason, small birds get caught up on the same shelf with larger birds, remove the smaller ones first. Some banders suggest that you should first remove the size range that is in the minority. One large bird can do a lot of damage in a box full of small birds.

When you are finished banding for the day, close the trap by ensuring that the catching-box door and arm holes are closed. If the catching-box door is left open, birds can catch themselves and may die. Although some banders think it is acceptable to leave the door open during the day, even hoping to catch the occasional bird incidentally, we recommend keeping the catching-box door **closed** at all times, except during a drive, thus averting much grief and criticism.

The material needed to build a Helgoland trap is expensive, and construction is laborious. When used properly and in optimal habitat, however, the trap is extremely safe and effective. This trap requires little maintenance.

3.5.1. Injuries

Watch for impact injuries, especially likely if metal mesh is used (check for broken mesh with spikes that could penetrate).

3.5.2. Disarming the trap over long periods of non use

Remove the plexiglass; better still, remove the whole catching box, allowing birds flying down the funnel to fly straight through (e.g., if being chased by predators). If only plexiglass is removed, then lock the trap door open.

3.6. Catching-Box Design

Large traps, such as a House or Helgoland trap, should incorporate a catching box into the design to help you extract birds quickly and safely. Angle the top plate at 45° to deflect

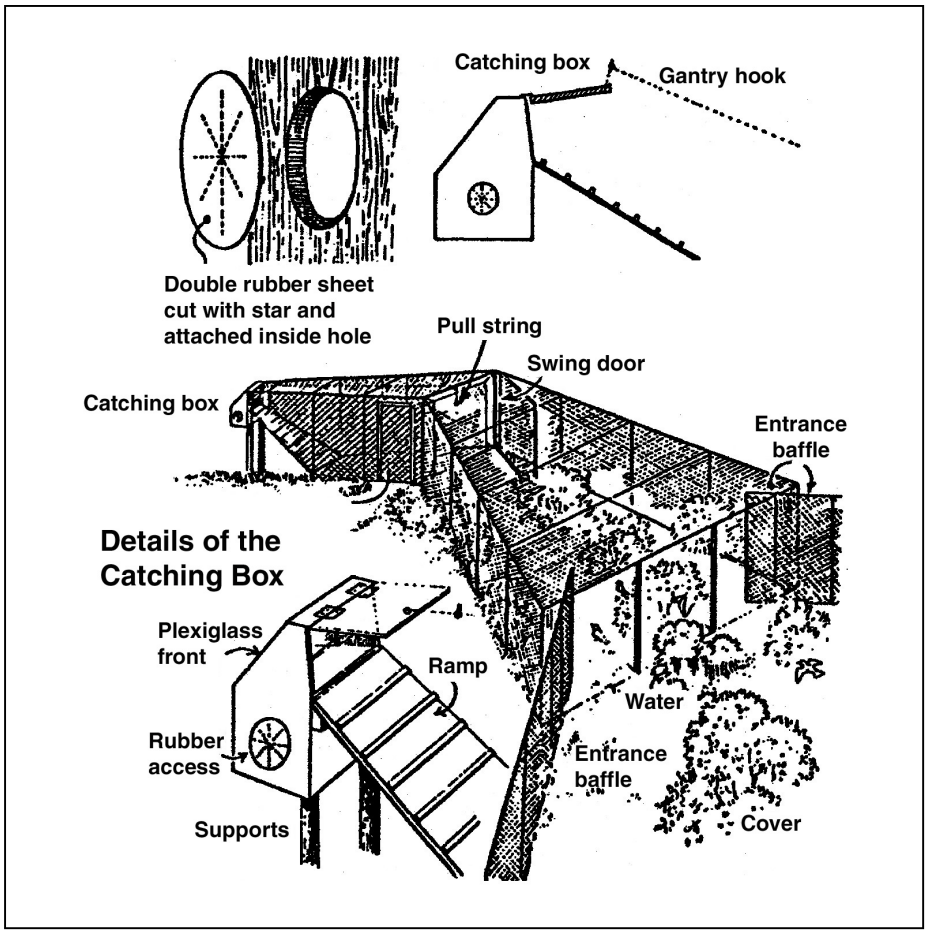

Figure 5. One design for a Helgoland trap (from Davis 1981).

fast-moving birds. Make the transparent surfaces out of thin plexiglass or (better yet) heavy plastic sheeting, instead of glass. The flexibility of the plexiglass and plastic sheeting relative to glass, especially if installed loosely, will further reduce injuries. You also should place a branch or two just in front of the box to slow birds down. Finally, arrange some grading device in the holding box to keep large birds from trampling smaller ones. A simple method is to install a middle shelf inside the holding box. If this shelf is recessed away from the plexiglass by a distance of about 40-50 mm, sparrow-sized birds will slip between the gap down into the lower compartment, leaving larger birds in the upper compartment.

4. AGEING AND SEXING BIRDS

The Identification Guide to North American Birds, Part 1 (Pyle 1997a) contains the most current available information for determining the age and sex of North American birds and is endorsed by both Banding Offices. However, much of this information was obtained from museum specimens. Banders have a unique opportunity to examine live birds closely, and this opportunity should not be wasted. By observing many individuals of a species closely, you may begin to recognize age- or sex-related features not noted previously. These observations should be recorded and published. Jenni and Winkler's (1994) *Moult and Ageing of European Passerines* is essential reading for those interested in various aspects of the subject.

A bird is aged according to the number of **calendar** years it has survived. Birds in their first calendar year are designated hatching year (HY) birds until 31 December of that year. On 1 January of the next calendar year, the bird is considered to be in its second calendar year (SY) even though it may be only 6 to 7 months old. This system of ageing allows the bander to place a bird in any of the following year classes:

(1) U denotes birds of unknown age. The corresponding numeric code is 0.

(2) HY, SY, and TY refer to birds in their first, second, and third calendar year, respectively. These age classes are coded numerically as 2, 5, and 7, respectively.

(3) AHY, ASY, and ATY denote birds that are **at least** in their second, third, or fourth calendar year, respectively. AHY stands for "after hatching year"; the bird is **at least** in its second calendar year. A bird hatched in May will be AHY the next January, but it is still only about 8 months old. AHY is simply a catch-all code to designate birds that are at least SY but whose age could not be determined more precisely. These age classes are coded numerically as follows: AHY = 1; ASY = 6; and ATY = 8.

Alpha and numeric codes are also used to indicate sex: M (or 4) = male; F (or 5) = female; and U (or 0) = unknown sex.

Bird descriptions in Pyle (1997a) usually correspond to age choices, with the age classes separated by a slash (e.g., HY/SY). The slash merely represents the new calendar year. Choose the correct code depending on whether the season is before the next new year and postbreeding (e.g., fall HY) or after the new year and prior to breeding (e.g., spring SY). Hence, as examples, a bird banded on 31 December might be aged correctly as HY. If it is recaptured on 1 January, however, it automatically becomes SY (i.e., it is in its second calendar year). Likewise, a bird aged U in December automatically becomes AHY in January.

Often it is impossible to age a bird correctly unless you know its sex. Just as often, you will need to know its age before you can sex it. It sounds a little confusing, but it is a matter of applying what you know in a logical sequence.

Be aware of the difference between "useful" characteristics (e.g., retrix shape) and "reliable" ones (e.g., degree of skull pneumatization). A general rule of thumb is that reliable characteristics receive greatest priority; useful characteristics are used primarily as additional clues.

If you are not certain of a bird's age or sex, **do not guess!** Guesswork destroys the reliability of your data, making them less useful. If you have a good hunch, though, record it in the "remarks" or "notes" section of your banding sheet. Subsequent recaptures may verify or refute your hunch, and in either case you will have learned something.

Many physiological processes cause age-dependent changes in birds and are used primarily as age indicators, while other processes, such as the development of cloacal protuberances in males during the breeding season, also can be used as sex indicators. Measured characteristics are used to indicate sex more often than age. Males are usually larger than females. As a general rule, graded characters (e.g., "less dark," "more pointed") should not be used *alone* as criteria for age or sex.

The following sections provide an overview of age- and sex-related physiological processes and useful measuring techniques for landbirds. For a thorough treatment of the subject, see Pyle (1997a).

4.1. Physiological Processes

4.1.1. Skulling

Among the reliable tools for ageing (and occasionally sexing) passerines, one of the most common is "skulling," the determination of the degree of pneumatization (sometimes called "ossification"). Other methods are covered in Pyle (1997a).

As with humans, the skulls of young birds take several months to develop. Although not as commonly used in Europe, skulling is a standard ageing technique in North America. While a very useful technique, it does take considerable practice before it is mastered. An experienced person should check your age determination for each bird until you are completely trained.

The juvenile skull is composed of a single layer of bone. As the bird matures, a second layer of bone forms underneath the first, and thin columns of bone form pillars between the two layers. The entire process of skull pneumatization usually takes several months, but this is extremely variable. For example, many warblers have fully formed skulls in about 4-6 months, whereas thrushes still may have incompletely pneumatized skulls in their second calendar year and even beyond. Many people find it possible to accurately skull with strong daylight and the unaided eye. However, strong direct sunlight, easily visible skulls, and excellent vision are not always coincident or sufficient. A substantial fraction of the birds (perhaps 5%) have thick or darkened skin. Further, birds with little pneumatization have only a few “dots” to see, and those, along with fully pneumatized skulls, are the most difficult to detect. For these

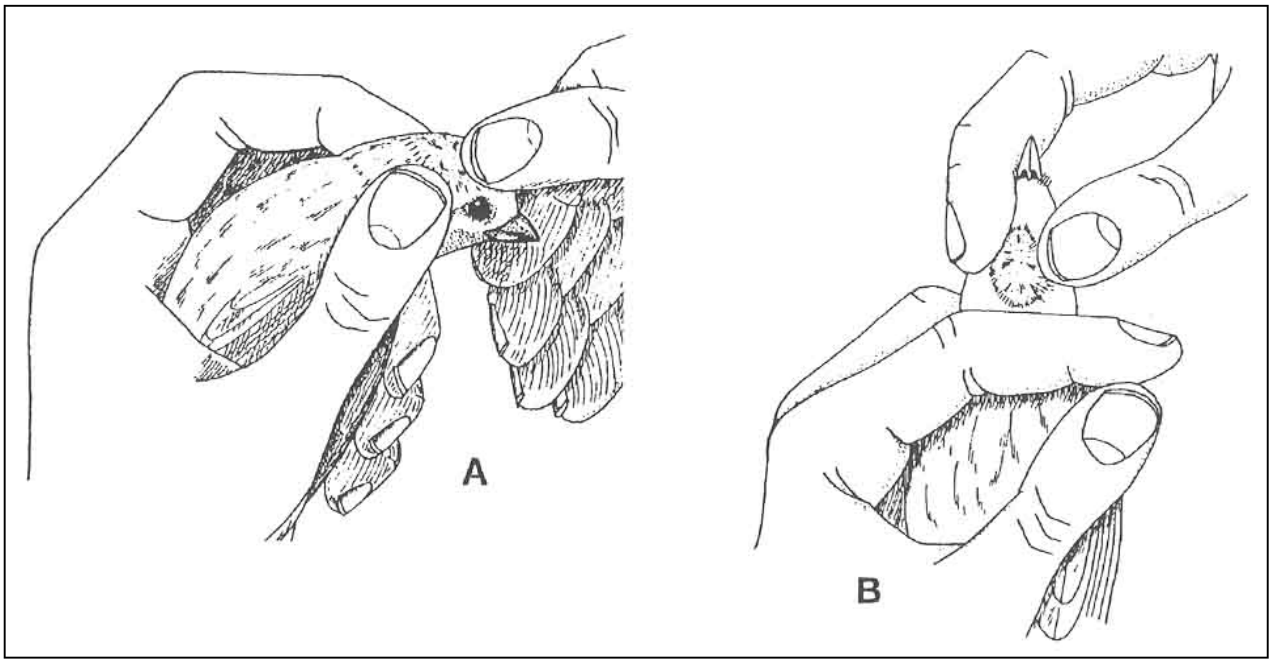

Figure 6. Two ways to hold a bird for skulling (from Pyle 1997a).

reasons, many banders strongly urge that a light source *and* magnification be used on *every* bird processed. Without such aids, some banders feel that even the most experienced banders will make errors approaching 5%–far too high for most studies.

Unpneumatized areas of the passerine skull usually appear pinkish or dull reddish, whereas pneumatized areas appear grayish, whitish, or pinkish-white, with small white dots indicating the pillars of bone. You should look for the dots. The color or contrast between these two color patterns, or both, can usually be seen through the skin of the head, especially after the head has been wetted to allow parting of the feathers and to make the skin more transparent. This contrast **must** be confirmed, however, by seeing dots in the part of the skull that is pneumatized.

To skull a passerine, start by holding the bird in the position shown in Figure 6. This hold facilitates skulling because the skin more readily can be moved around on the skull, allowing a large area of the skull to be viewed through a small area of skin. To see the skull, part the feathers such that a small opening of bare skin is created. This can be accomplished without wetting the feathers but is more easily done if a small amount of water is applied to the head (do not apply detergent or alcohol solutions). Many banders feel that the few drops of water used to make the skin more transparent have no effect on the bird's ability to maintain its temperature, even during cold weather. If you have concern about this, simply put the bird out of the wind in a dry bag for a few minutes before releasing it, or try skulling with a minimum amount of water.

Start parting the feathers **to one side of the midline**, as the feathers along the center of the skull will make it difficult to see through the skin. Instead, find the area with a relative lack of feathers just to the side. It is usually easiest to part the feathers by running your thumb or finger forward over the crown, against the direction in which the feathers lie, and then moving the feathers off to each side. In the summer and early fall, when most young birds are just beginning the pneumatization process, it is good to start at the rear and the side of the skull, working up towards the crown. Later in the fall, the parting can be made farther forward, but still off the mid-line, on the crown (in the areas just above and behind the eyes), where the last unpneumatized windows usually occur. With thicker-skinned birds, one can improve viewing by parting the feathers farther down on the side of the head, or back at the base of the skull at the neck (where the skin is more transparent), and moving the skin up to the crown. When the skulling process is finished, the feathers can be smoothed back into place.

It is usually best to hold the bird under a fairly strong lamp or in *indirect* sunlight to achieve the best lighting conditions for viewing. Very bright light often creates a glare off the skin. It is often helpful to put the head into different positions, because different angles of light can make it easier to see through the skin. We strongly recommend using a magnifying device, such as a visor that slips over your head.

Moving the skin back and forth makes the dots, which are stationary, more visible. *If the tiny white dots are not visible, one is not properly viewing the skull*, or the bird is a very young juvenile with an entirely pinkish skull. "Seeing" a boundary between whitish and pink areas is not enough, because one might be seeing only bone structure unrelated to pneumatization. It is best to start looking at the skull at a point at its base and slightly to one side. Continue looking forward until just halfway between the eye and the top of the crown. If at no point the dots disappear and are replaced by a clear pink area, the skull is fully pneumatized. Because the pneumatization usually proceeds toward the center and anteriorly (Fig. 7), be sure to examine the area between and forward of the eyes of all birds with seemingly fully pneumatized skulls to be sure that they are not "advanced" immatures.

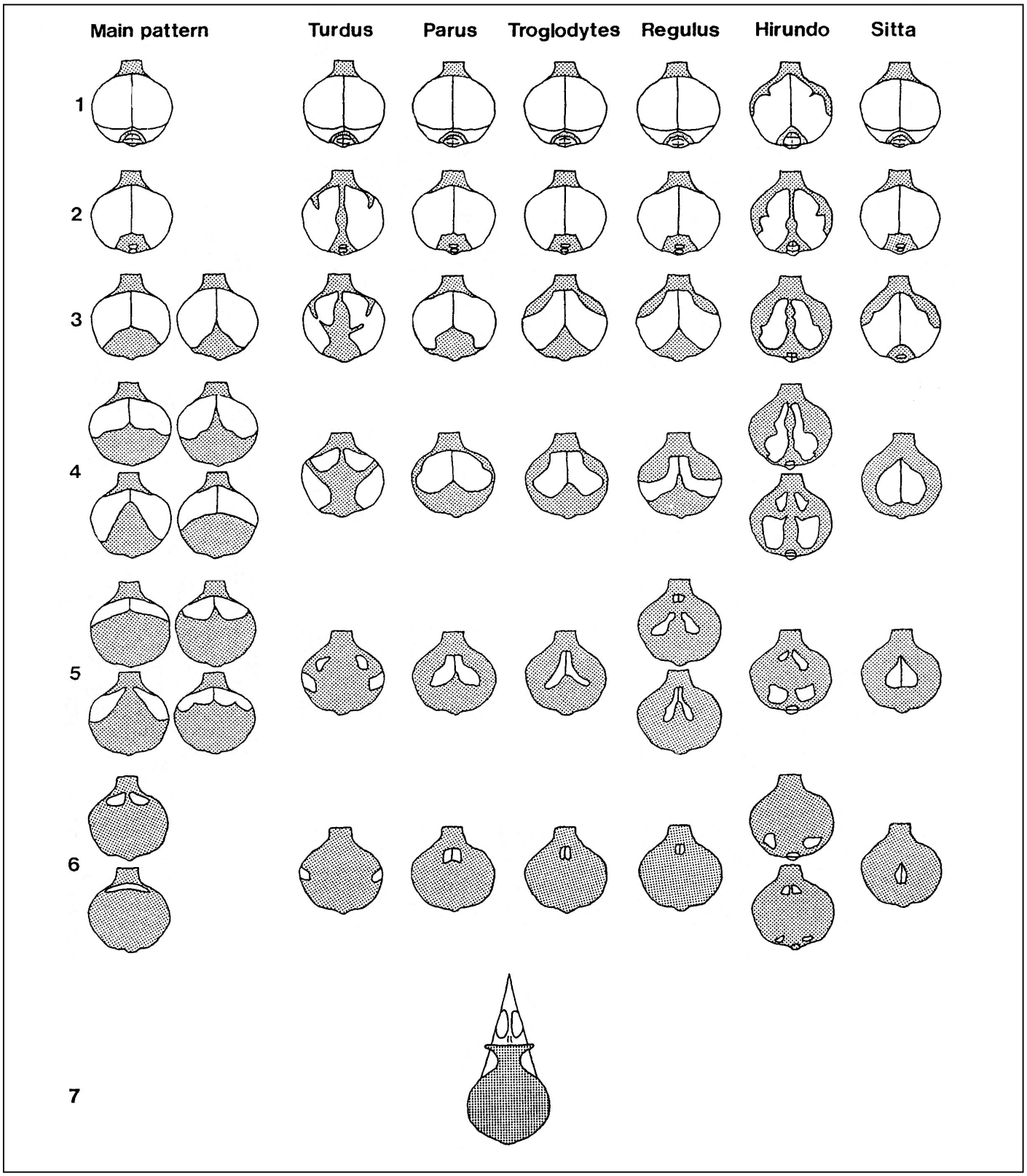

Figure 7. Scoring categories for the pneumatization of the skull roof in passerines (after Winkler 1979). Pneumatized parts (dotted) are indicated on a skull seen from above. Generally, pneumatization starts in the occipital region and ends over the forehead. Stage 1 denotes the unpneumatized skull roof or the first evidence of pneumatization in the form of a semi-circle framing the cerebellum. At stage 2, pneumatization has expanded over the whole cerebellum leaving one or two small windows in the center. In stage 3 about a third, in stage 4 about half, and in stage 5 about three-quarters of the skull roof is pneumatized. Stage 6 is recognized by one or two small windows remaining over the forehead. Stage 7 denotes the fully pneumatized skull roof. Most species follow the main pattern, but some species show patterns specific to certain genera. *Turdus* species may follow both the main and the *Turdus* pattern (from Jenni and Winkler 1994).

Also look for entirely pinkish skulls in very young birds (Fig. 7-1) in June-July and for contrasts between the pneumatized and unpneumatized areas in older birds (most frequently after August). Search carefully for small windows (Fig. 7-6) at all times.

Any of several factors may make it difficult or impossible to see the pneumatization of the skull. These include the skin of the head being too thick, large amounts of fat in the skin during fall migration and winter, and dark, or otherwise opaque, skin (especially in molting or injured birds). It is especially difficult to see the pneumatization of the skull in molting birds because of the thickening and excessive flaking of the skin.

Skulling should be done whenever time and the bird's condition permit (providing that the temperature is above freezing) but check the various references, especially Pyle 1997a, to see how late in fall skulling is reliable for ageing, as it varies among species. If birds with completely pneumatized skulls cannot be aged reliably by other criteria after certain dates, record their age as "U." Skulling should continue beyond the skull-completion dates, however, because many birds still have incompletely pneumatized skulls and can be reliably aged as HY. Also, some species (e.g., thrushes and swallows) may be aged reliably as SY by skulling and seeing windows into the spring, especially when used in combination with other features.

4.1.2. Molt

Birds cope with the constant wear and degeneration of their plumage by molting. Among landbirds in general, molt is usually confined to two times of the year. The prebasic (postnuptial) molt occurs after the breeding season, though nonbreeders may molt during the breeding season. The prealternate (prenuptial) molt occurs just before the breeding season, when the bird molts from its basic (winter) plumage into its alternate (breeding) plumage. All North American passerines have a prebasic molt, but only about half the species have a prealternate molt. Many species that lack a prealternate molt acquire alternate plumage through the wearing away of the tips of body feathers. Male Blue Grosbeaks, for example, lose the brownish tips of fresh basic plumage as they approach the breeding season. During their first fall, a few species have a presupplemental molt, resulting in supplemental plumage and delaying the first prebasic molt until winter.

Depending on the species, the prebasic molt usually occurs sometime between May and December, often between July and September. At this time, the adults of most passerine species have a complete molt, meaning that all flight and body feathers are replaced. Hence, for many species, a bird captured in midsummer and undergoing a complete molt is almost certainly an adult. On the other hand, the juveniles of most species usually do not molt their flight feathers. They have a partial molt in which replacement includes only body feathers; lesser and middle coverts; and none, some, or all of the greater coverts. Many young birds, therefore, can be aged by the degree of contrast between the older, retained, juvenal feathers and the more recently replaced, next-generation feathers. This contrast is most marked in the spring after some wear.

The boundaries between replaced and retained feathers, resulting from partial or incomplete molts, are called "molt limits." This concept is crucial for accurate ageing of passerines and, in fact, virtually all bird species. It is thoroughly discussed in Pyle (1997a:206-211) and Pyle (1997b:12-18). Passerine banders ***must*** understand this material.

4.1.3. Feather characteristics: shape and wear

Although feather shape and wear are useful features to examine when ageing birds, the differences between adult and HY/SY feathers often are subtle and differ between groups. Hence, as an ageing technique, feather characteristics are usually applied most appropriately in conjunction with other ageing techniques.

Feather condition can tell you a lot about a bird's age, provided you have a basic understanding of the bird's molt strategy. In contrast to old feathers, new feathers appear smoother, with more color and sheen. Abrasion wears away the tips of feathers. This is most noticeable in old flight feathers ("remiges" = primaries, secondaries, and tertials; "rectrices" = tail feathers). When you are looking for contrast in wear of the feathers, look for the tiny notches and frayed edges of older feathers. Between molts, the sun causes the color and sheen of feathers to fade and change in quality. This is evident in many brightly colored birds, such as Northern Cardinals and Blue Jays, but in duller, brown birds the alteration is often noticeable only when it contrasts with recently replaced feathers. As mentioned above, **contrast** between new and old feathers is the important feature.

Juvenile primaries and tail feathers tend to be thinner, more tapered, and less durable than adult feathers and show pronounced wear more quickly than adult feathers. Also, because juveniles undergo only a partial molt, older juvenal feathers retained after prebasic molt often contrast with the recently replaced, next-generation feathers. Therefore, depending on time of year and molt sequence of the species, feather shape and wear can be useful age indicators.

A juvenile's outer second and third rectrices and longest primaries will show the most pronounced difference in shape from those of adults. In juveniles, these feathers usually are slender and tapered, forming a sharp angle where the outer web of the feather declines from the feather tip (Figs. 8 and 9). Adult feathers often are more truncate, and the angle formed by the outer web and the feather tip is less sharp. Many individuals, however, show intermediate feather shape and cannot be aged reliably by this criterion. Even experienced banders have difficulty assessing this feature consistently.

The use of feather wear to indicate age is most effective immediately after the first prebasic molt, when the retained juvenal feathers are 2-3 months old and contrast with freshly molted flight feathers. In spring, the adult feathers will be worn but usually still retain more sheen and color relative to retained juvenal feathers. The central rectrices receive the most wear, although they sometimes are replaced during the first prebasic molt.

Wing-covert contrast often is useful for ageing some groups (e.g., vireos, warblers, and sparrows) because the juvenal primary coverts usually are retained, whereas most or all of the secondary coverts are usually replaced. Thus, the new secondary

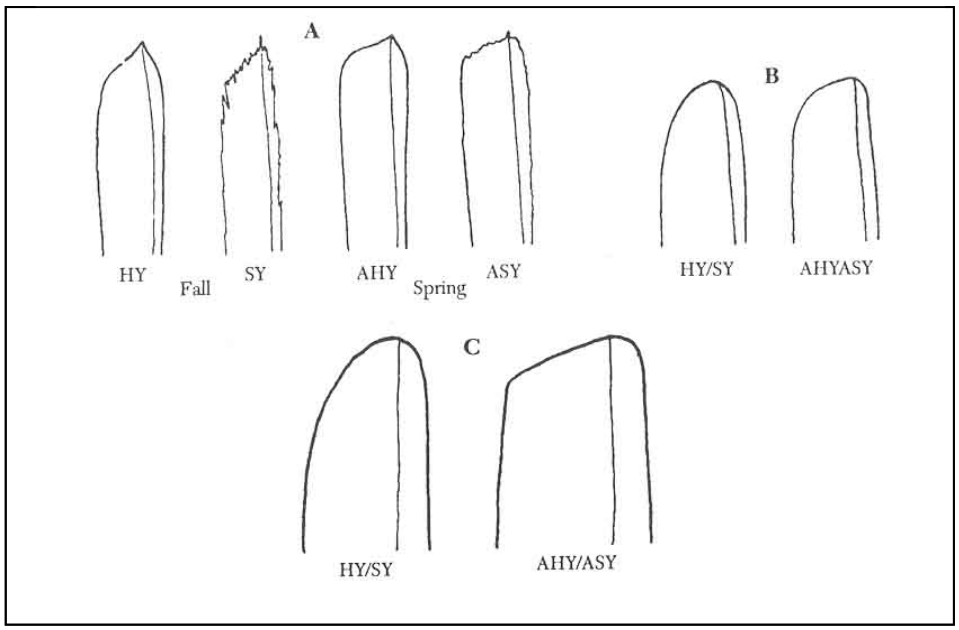

Figure 8. The shape of the outer rectrices (r4-r6) by age. (A) The juvenal feathers of SY typically become more abraded by spring than the adult feathers of ASY, although many adults, especially nesting females of arid habitats, also can show extremely abraded rectrices; (B, C) The "corner" effect on the inner webs of AHY/ASY feathers, absent or reduced in HY/SY feathers (from Pyle 1997a).

coverts of HY/SY birds will have more sheen and darker color than the older primary coverts. Adults, by comparison, will have uniform coverts with fresher, paler edges. Around the time of the prealternate molt, however, this characteristic becomes less useful. Both ASY and SY birds of species with a prealternate molt could replace the greater coverts, resulting in contrast between two feather ages in full adult plumage, and two or possibly three feather ages in SY birds.

When flight feathers are examined carefully in reflected light, one often can see alternating patterns of light-and-dark bars across the width of the feathers, known as growth bars. Each alternative dark-and-light pattern represents one 24-hour period of feather growth. A different phenomenon is known as fault bars. These occur under certain circumstances, probably severe nutritional stress. In this event, the feather's growth is disturbed, resulting in bars lacking pigment or some degree of structural integrity. These fault bars are actual points of weakness where the feather could break. Because juveniles grow their tail feathers all at the same time, growth and fault bars will span the width of the tail and lie parallel to one another. In adults replacing their feathers symmetrically, one on each side, these bars appear scattered (Fig. 9). However, an adult bird could lose its tail and have to regenerate all its feathers at once, and juveniles may molt some of their rectrices and appear to have scattered growth bars. Therefore, growth and fault bars should be used only to support other ageing criteria.

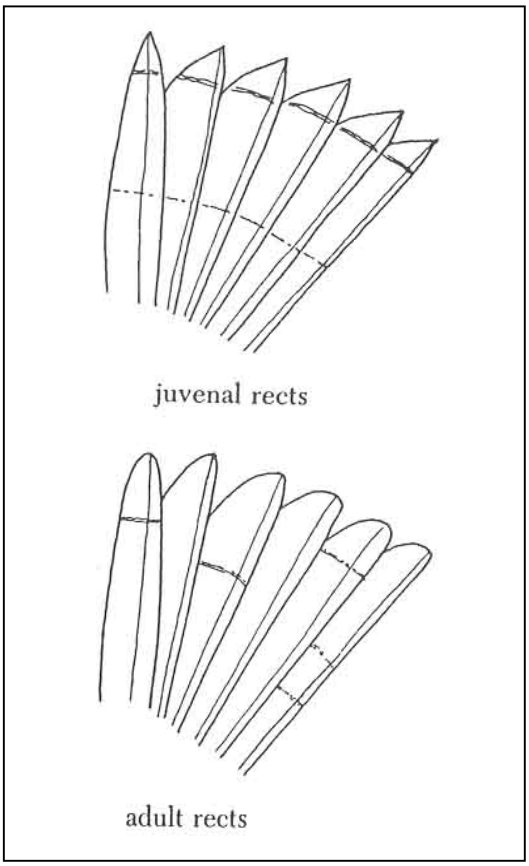

Figure 9. Fault bars in juvenal and adult tail feathers (from Pyle 1997a).

4.1.4. Plumage color

Plumage color can vary with both sex and age. Males are apt to be brighter or more iridescent than females. Young birds are apt to be more spotted or streaked and duller than adults. Plumage color is often the most obvious and, at times, the easiest

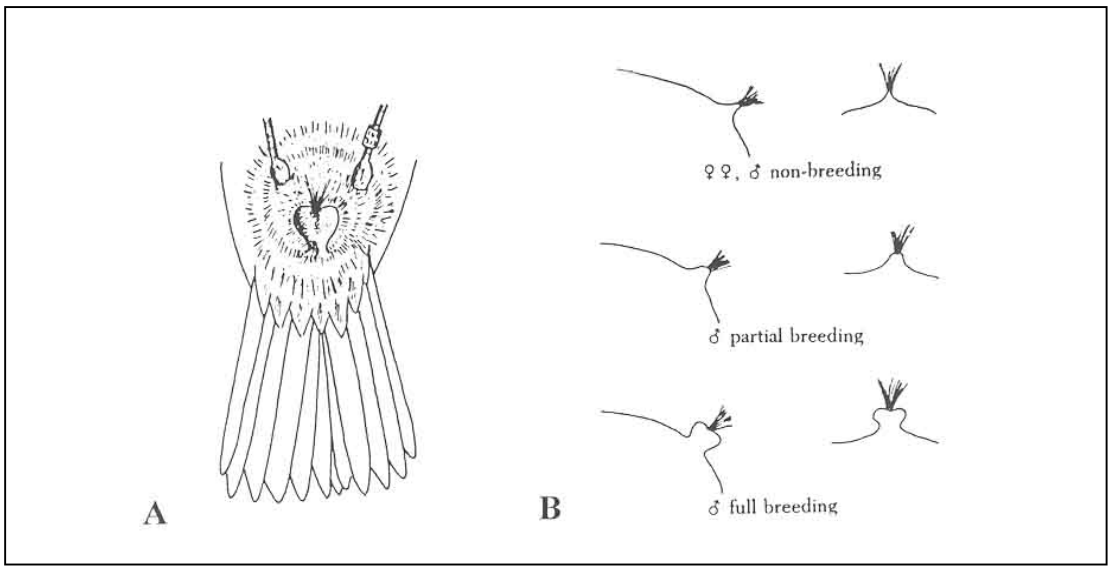

Figure 10. (A) A cloacal protuberance (at its peak) in male passerines; (B) profiles of cloacal protuberances in different breeding conditions (from Pyle 1997a).

way of ageing or sexing a bird. Banders should be aware, however, that in some species plumages may change with both molts, or may not differ at all between ages and sexes.

SY males and ASY females often are easily confused (as are local-unknowns vs. AHY/ASY females), so beware of birds with intermediate plumage characteristics. Bright, well-marked, young birds are likely to be males, and bright females are likely adults. In this way, plumage can be used as an indicator of either sex or age. Unless a clear distinction exists between plumages of different ages or sexes, use caution and seek other clues.

4.1.5. Cloacal protuberances and brood patches

The best method for determining the sex of sexually monomorphic passerine birds during the breeding season is by the presence of the cloacal protuberance in the male of certain species and the brood patch, which primarily occurs in females. All North American landbirds develop at least one of these characteristics, at least partially, and most are reliably sexed by them during the late spring and summer months. Central American birds are less well known, but these guidelines should generally apply.

4.1.5.1. *Cloacal protuberance*

To store sperm and to assist with copulation, external cloacal protuberances, or bulbs, are developed by many male passerine birds during the breeding season. They usually begin to develop early in the spring and reach their peak size in 3-5 weeks (Fig. 10a). Depending on the species and the number of clutches attempted during the breeding season, cloacal protuberances will recede from mid- to late summer.

Although the cloacal regions in females will sometimes swell slightly, or show a small protuberance, it rarely approaches the size of those in the males (the Wrentit is an exception). If the swelling forms a gradual slope on the abdomen, ending with the cloacal opening pointing towards the tail, then it is probably a female in breeding condition. When the female is most swollen in this area, usually she also will have a brood patch. A typical male protuberance essentially forms a right angle to the abdomen and is somewhat larger at the end than at the base (Fig. 10b). We suggest that they be categorized into four size classes: none, small, medium, and large.

To view the protuberance, blow the feathers apart in the region of the vent. The shape of the protuberance can be somewhat variable, and nonbreeding males may not develop one. After a little experience with the shape of the cloacal region during the nesting season, biologists should have no problem separating breeding males from females and nonbreeding males of most of most passerines.

4.1.5.2. *Brood patch*

Incubation or brood patches are developed in order to transfer body heat to eggs or young. In most landbirds, females perform all or most of the incubating and develop more substantial brood patches than males. The presence of a distinct brood patch can thus be used to reliably sex breeding females of the large majority of passerine species.

The development of the brood patch begins with the loss of the feathers of the lower breast and abdomen, about 3-5 days before the first eggs are laid (Blake 1963). Shortly thereafter, the blood vessels of the region increase in size and the skin becomes thicker and filled with an opaque, whitish fluid. Figure 11a illustrates a full brood patch as viewed by blowing the feathers of the breast aside. A few days after the fledglings leave the nest, the swelling and vascularization begin to subside. If a second clutch of eggs is laid, the process will be repeated. A new set of feathers on the abdomen is usually not grown until the prebasic molt, which begins after completion of nesting. Between the end of nesting and the onset of molt, the skin of the abdomen often appears grayish and wrinkled. Many young, and especially juvenile, passerine birds have little or no down or feathers on the belly; therefore the belly of some rather young

birds looks much like that of an adult that is just beginning to develop a brood patch, but the area will be smoother and usually a pink or dark red, whereas the adult's brood patch will be more whitish.

In most North American passerine birds, the male does not develop a brood patch in the breeding season. Slightly fewer feathers may be present on the abdomens of male passerines during the incubation period than are found in the winter, but the breast retains a feathered appearance. In a few groups in North America, notably the mimids, vireos, *Myiarchis* flycatchers, and a few other species (see Pyle 1997a), the male assists with incubation and develops an incomplete brood patch. This will include partial or complete feather loss and slight to moderate vascularization and swelling, which rarely or never approaches the extent of development typically found in females of the same species. In the Wrentit, cuckoos, and woodpeckers, the male develops a full brood patch.

We suggest recording brood patch in the order of its development as follows (in codes):

- *No brood patch present*–Breast more or less feathered. Nonfeathered areas of the breast and abdomen are smooth without evident vascularization. In some species, such as hummingbirds, and in most young birds, the breast is normally not feathered.
- *Smooth skin*–A loss of breast and some abdominal feathers, but most of the area is still rather smooth and dark red.
- *Vascularized*–Abdominal skin thickened with increased fluid and vascularization. This is the peak of incubation.
- *Wrinkled*–Abdominal skin thinning, wrinkly, and scaly.
- *Molting*–New pin feathers are coming in on the abdomen. Nesting is usually completed by this time.

Some researchers, including the Monitoring for Avian Productivity and Suvivorship (MAPS) program, distinguish an extremely "Heavy" stage of vascularization, which never occurs on males of species that develop partial brood patches (e.g., vireos and mimids). Use of this additional category can help in accurate sexing of species in these families.

4.1.6. Features of juveniles

No standard reference exists for identification of juvenile passerine birds to species, although Pyle (1997a) wrote a brief description of the juvenal plumage of each passerine and near passerine species. Nevertheless, juveniles are usually fairly easy to distinguish from adults. Feather structure of juveniles is slightly looser and less dense than that of adults (especially on the belly and the undertail coverts) and the plumage is often more streaked or spotted. In contrast to adults, juveniles often have wing bars and lack eye rings.

Juveniles retain some of their nestling characters for a period after fledging. For example, the feathers of the leg and belly develop slowly in juveniles, and these areas may remain bare for some time after fledging. Do not mistake a juvenile's smooth, bare belly for a brood patch! The gape remains swollen and more brightly colored for a time in juveniles, and the inner mouth lining, bill, and iris can remain a lighter color even beyond the first prealternate molt. The legs are swollen and fleshy in fledglings, and the bill, tail, and primary feathers can take almost a month after fledging to reach full size. Look for remains of feather sheaths at the bases of flight feathers. Adults will have remains of feather sheaths of molted feathers, but feathers will be at different stages of development and will exhibit a left-right symmetrical pattern.

In summer, the flight feathers of juveniles will appear much fresher (less worn) than those of adults, which have been wearing their alternate plumages for some time. Skull pneumatization will be in the early stages.

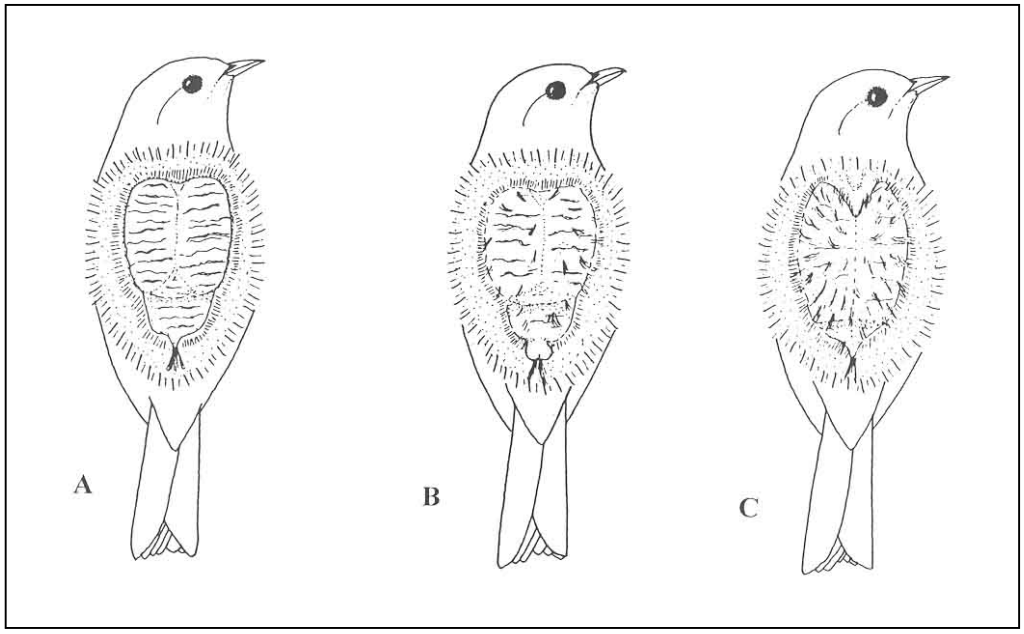

Figure 11. Brood patches in different stages of development. (A) full-breeding female; (B) full-breeding male; (C) nonbreeding (from Pyle 1997a).

Juveniles usually cannot be sexed reliably. In a few species, sexual differences occur in flight-feather coloration, bill color, or wing length. Keep in mind that juvenal flight feathers may not be fully formed and therefore will be on the lower end of the wing-length range cited for each sex.

4.2. Useful Measurements ("Biometrics")

Many measurements are used in sexing, ageing, as well as identification. Consult the Banders' Study Guide, Baldwin et al. (1931), and Pyle (1997a) for details. They include wing length, wing formula, tail length, tarsus length, various bill measurements, and weight.

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APPENDIX A. THE NORTH AMERICAN BANDING COUNCIL

The mission of the North American Banding Council (NABC) is to promote sound and ethical principles and techniques of bird banding in North America. Skill levels of banders will be increased by the preparation and dissemination of standardized training and study materials and the establishment of standards of competence and ethics for banders and trainers.

The immediate objectives are:

(1) to develop a certification and evaluation program by setting standards for experience, knowledge, and skills that must be attained at each level (Assistant, Bander, and Trainer);
(2) to produce and update training materials such as manuals and perhaps videos;
(3) to identify and certify an initial pool of trainers; and
(4) to encourage cooperative efforts in the use of banding in the study and conservation of North American birds.

The NABC consists of 18 to 20 voting members, including one representative appointed by each of the following organizations: American Ornithologists' Union, Association of Field Ornithologists, Cooper Ornithological Society, Colonial Waterbird Society, Eastern Bird Banding Association, Inland Bird Banding Association, Ontario Bird Banding Association, The Pacific Seabird Group, Raptor Research Foundation, Society of Canadian Ornithologists, Western Bird Banding Association, Western Hemisphere Shorebird Reserve Network, and Wilson Ornithological Society; and two representatives appointed by the International Association of Fish and Wildlife Agencies (one from Canada and one from the United States). Other groups have been invited to become affiliated. The NABC also designates from four to six additional members. The directors of the Canadian and U. S. Bird Banding Offices are nonvoting members of the NABC. The NABC was incorporated as a non-profit, California corporation in 1998.

APPENDIX B. LOCATING A PASSERINE MONITORING STATION WITHIN THE LANDSCAPE

A passerine monitoring station should be located in representative habitat for a given region, or in a habitat of concern. A station may have a variety of habitat types, and some will have a higher density of birds than others. Because the derived population and demographic parameters are likely to be sensitive to successional changes in the habitats sampled, usually stations should not be placed in very young habitats, unless the goal of the effort is to study the effects of successional change, or unless they are held in a lower successional stage by active management. For constant-effort mist netting (Ralph et al. 1993b), we suggest that the capture array be placed where a high rate of capture can be achieved.

B.1. Permanent Stations

Although the need for broad-scale monitoring is vitally important, in-depth studies in small, protected areas, such as natural areas, nature reserves, and parks can contribute much to our knowledge of landbird populations. In-depth studies of avian life histories (normally using individually color-banded birds) can provide important insights into vulnerability and management of species. Other biological studies done concurrently at the station can add to our knowledge of the factors affecting local landbird populations. Monitoring stations with active field programs and/or living quarters for biologists are ideal for intensive programs in remote areas and often can attract volunteers.

Obtaining institutional sponsorship of permanent stations can provide long-term commitment over many years. A monitoring program with such a commitment will continue despite turnover in personnel and hopefully can provide some stability in funding. Furthermore, by using local volunteers to collect data in such a program, a community outreach and education program can be established. Bird observatories and some field stations in North and Latin America have been conducting programs similar to this for many years.