3. Japanese mist-nets of 1½, 2½ and 4 inch stretched mesh were used in the same area.
4. Records are available for 3,140 birds of 106 species caught between May 6 and November 20, 1960, as to whether they were taken in nets or the trap. 1,513 birds of 93 species were netted and 1,627 birds of 88 species trapped.
5. A comparison was made of the species and families of birds caught by the two methods and it was found that some were taken much more frequently by one method than the other. In particular 66.2% of the sparrows taken were trapped, while 77.7% of the flycatchers taken were netted.
6. The operation of the Heligoland trap and mist-nets at Long Point is discussed, and it is concluded that the trap was more efficient in dealing with large influxes of migrants, but that the nets were more versatile. Heligoland traps should be advantageous in exposed situations with thin cover, where sizeable waves of migrants occur.

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Received February, 1961

CONSTRUCTION AND USE OF HELIGOLAND TRAPS*

BY JAMES WOODFORD AND D. J. T. HUSSELL

The Heligoland trap, a large wire-netting funnel, has been used in Europe for many years to catch large numbers of birds, principally migrants. Despite a greater number of co-operators and of birds banded in North America, the Heligoland trap was apparently not used until 1954, when one was constructed at Point Pelee, Ontario (Gunn, 1954). There were reviews of reports of the stations at Heligoland and Rossitten in *Bird-Banding* (C.L.W. [Whittle], 1930 *et subsq)*, in which the traps were mentioned. Lincoln and Baldwin (1929) did not mention Heligoland Traps in "*Manual for Bird Banders.*"

The purpose of this paper is to review the techniques of construction and operation of Heligoland traps in the light of recent experience at Point Pelee (Woodford, 1959) and Long Point, Ontario (Hussell and Woodford, 1961), and to discuss their possible further application to

*A publication of the Ontario Bird Banding Association.

North American conditions. In so doing, we have drawn heavily on the available European literature.

HISTORICAL

The Heligoland Trap was originally developed by Dr. Hugo Weigold from the Troosel-goards or "Thrush-bushes" which were used by the Heligoland islanders to catch migrant thrushes for food.

Gatke (1895), in *The Birds of Heligoland,* described the troosel-goards as follows: ". . . A space about 20 ft. long, and from 6 to 8 ft. broad, is surrounded by a fencing of bushes, 10 ft. high, and placed fairly close together, so that there is just room enough left between them to allow the thrushes to run comfortably through at the bottom. The bushes forming one of the long sides of this arrangement are put up perpendicularly, those of the opposite side in such a manner as to incline towards them. Over this latter side a strong net is stretched, reaching from the top of the bushes to within 2 ft. of the ground, and enclosing one side of the enclosure in a long semi-circle; a second net of strong thread loosely strung on a line, is stretched tightly by means of the latter round the lower portion of the same side of the thrush-bush. Below, however, this net is spread loosely on the ground for a distance of 6 ft. from the bottom of the bushes; in this manner, the depth of the whole arrangement is considerably increased . . . the thrushes, used to shady woods, are powerfully attracted by the few dead twigs and bushes stuck in the ground, and hasten towards them with the utmost readiness. Once inside the bush they are, by means of long sticks, driven without much trouble to that portion of the net which lies loose on the ground, where for the most part they stick their heads through the meshes, and are unable to get back again."

Weigold (1956) describes the first trap which was built about 1919 or 1920. This led to the founding of the world-famous "Fanggarten," or ringing garden, which on barren Heligoland offered shelter to migrant birds. It was simply a planted area surrounded by a cat-and human-proof fence and containing three small and one large funnel or Heligoland traps. An article in *British Birds* by W. B. Alexander (1934) contained a description and photographs of the ringing garden.

The first Heligoland traps were constructed on Heligoland Island (as mentioned above) and at Rossitten. In the British Isles the first were erected at Skokholm in 1933 and on the Isle of May in 1934 (Lockley and Russell, 1953).

DESIGN

Although no two Heligoland traps are exactly the same, most are patterned on a basic model, described by Brownlow (1952) as: ". . . a tapering wire netting enclosure open at the wide end, and closed at the narrow end by a collecting box with a transparent back, which appears to birds driven into the trap as a way of escape, and induces them to enter the box." As Williamson (1957) points out it is often, ". . . expedient to modify the design and construction of the traps to suit the terrain, and exploit to full advantage the natural behaviour of the migrant birds."

The size and shape will depend primarily on the site and resources available for construction. Of secondary consideration is the number of trappers available to operate the trap or traps. It is generally thought that a long, low trap is most effective. However, the results at Point Pelee and Long Point show that numbers may be taken in a trap having a relatively high entry and catchment area.

It is essential that the trap be constructed so that it presents the birds driven into it with a "point of no return" (Brownlow, *op. cit.)*, beyond which the transparent back of the catching-box appears as the only, or at least the most obvious way of escape. This is accomplished by progressively angling the direction of the trap (particularly the funnel area), usually in two stages, so that a bird near the catching-box can see only netting behind it. If possible the roof of the last section of the funnel area should slope up towards the catching-box. The changes in direction should not be too sudden; some trappers, particularly in Scandanavia, recommend curving part of the catchment and the funnel area roughly in a quadrant.

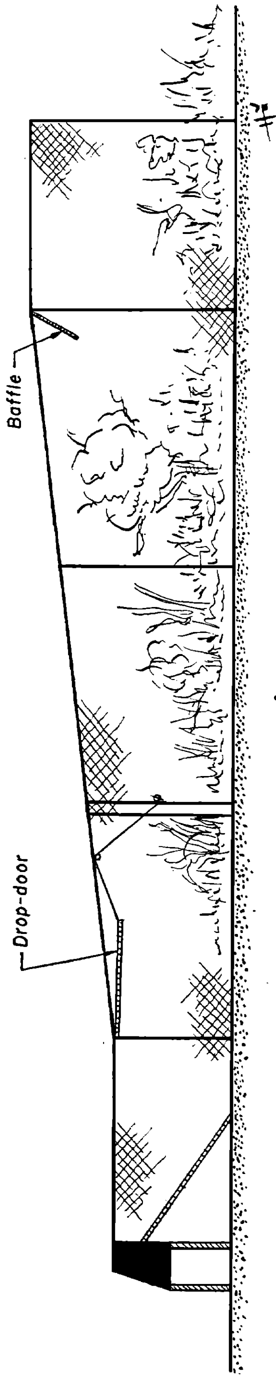
The principle of the Heligoland trap may be used in various situations. Brownlow *(op. cit.)* and Williamson *(op. cit.)* describe several variations of the Heligoland Trap. The "Gully" or Vaadal traps which consist of a wire-netting roof carried on girders or cables across the upper ends of steep-sided and narrow gullies, the upper end of which is closed by a funnel and a catching-box. The Double or "Double-Dyke" traps used at Spurn and Fair Isle were designed to catch birds such as the Wheatear, which move along the stone-walls on Fair Isle and to be convenient for both migration movements at Spurn, which is a peninsula. They were first built with the two entries facing in opposite directions, but sharing a common funnel and catching-box. This was not satisfactory, as the change in direction was too great. They were later fitted with separate funnels, properly angled. The "Double-Dyke" trap at Fair Isle actually straddled a stone-wall. "Ditch" traps have been built at points where a natural hollow or ditch runs alongside a wall; these are more economical to build than the Double traps.

Brownlow *(op. cit.)* describes portable Heligoland traps, simply light wood or metal frames, covered with netting, and with a catching-box. They were designed so that they could be set up in an hour or two to take advantage of a local movement of birds. This was before the era of the mist-net, which does this much more easily and effectively.

Hollom and Brownlow (1955) describe portable "Minigoland" Traps, which are a combination of the Heligoland funnel and a drop-door trap.

For descriptive purposes the Heligoland trap may be divided into four areas (see fig. 1).

Assembly area—This is the area immediately in front of the trap, including the area within the wing-walls. There should be adequate cover (bushes, trees) leading into the trap. It is very important that this be somewhat lower than the entry, perhaps 2/3 its height, otherwise some birds are likely to fly up and over the trap. The cover should not be too dense or some "skulking" species may find temporary refuge there and the trappers may miss driving them into the trap. Any cover at the sides of the entry which might lead birds away from the trap should be removed.



A.

Figure 1. Heligoland Trap
A. Side View

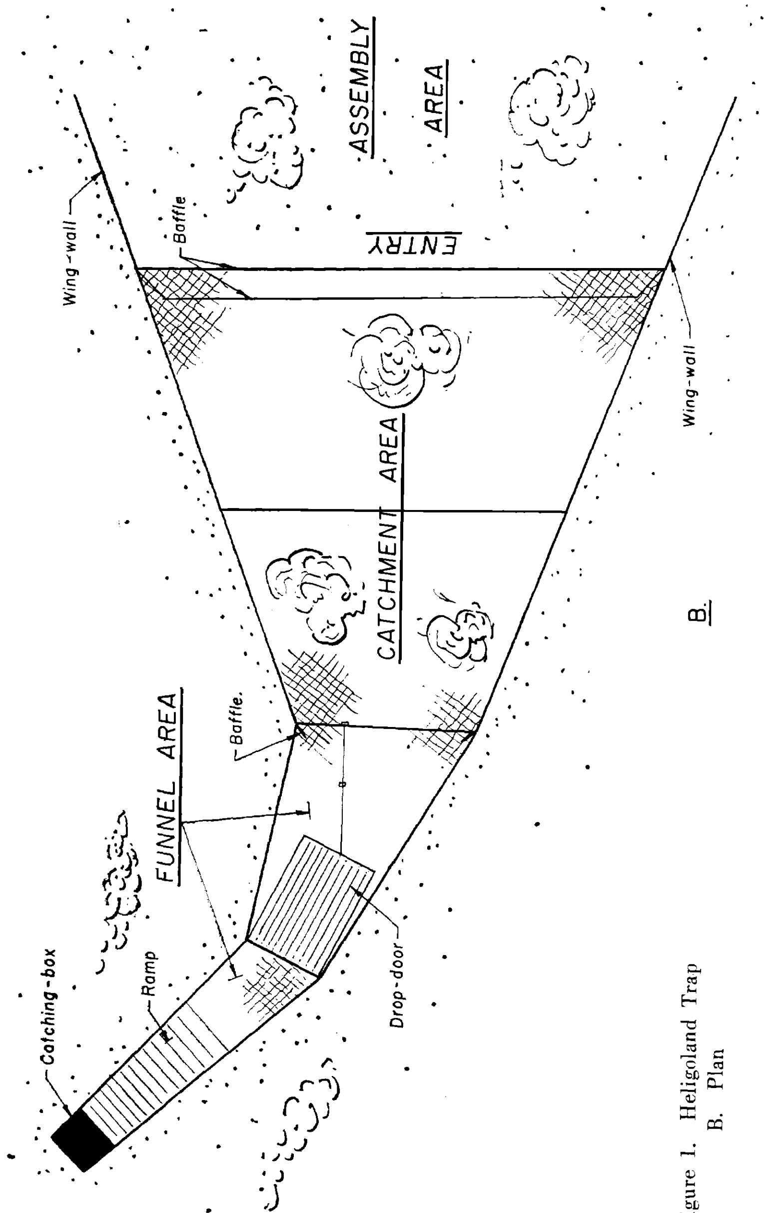


Figure 1. Heligoland Trap
B. Plan

On most traps the assembly area is partially "enclosed" by wing-walls which lead out from each side of the entry. These may be of varying length, usually 10 to 20 feet and from 6 to 15 feet high. Wing-walls the same height (15 feet) as the entry have proved very effective at Long Point. The wing-walls tend to guide birds into the trap and prevent them from by-passing the entry.

Catchment area—This is the main body of the trap. It is wide (15 to 35 feet) at the entry and some 20 to 40 feet long, narrowing down to 3 to 6 feet. The height drops from 8 to 20 feet at the entry to 6 to 8 feet at the beginning of the funnel.

Baffles, both horizontal and vertical, should be placed at the entry and at other points in the catchment area. These are strips of ½ inch wire-netting, 1 to 3 feet wide, and sloping inwards at about 60° to the main wire-netting of the trap. These tend to prevent the escape of many of the birds which break back along the walls or roof towards the entrance, by confronting them with a "wall," which causes most of them to turn again and fly towards the funnel area.

Brownlow *(op. cit.)* recommends stretching a wire across the entry about a foot below the roof to act as a perch for flycatchers *(Musicapa sp.)*. Although the behaviour of American flycatchers may be different this might still be useful.

Funnel area—This is also called the "lock-up." It is a narrow, sharply converging passage leading from the catchment area to the catching-box. On many traps this area may be closed, when desired, by a drop-door, which is controlled from a point in the catchment area. Once the door has been dropped the birds are confined to a relatively small area, and there is not the danger of them flying back out the entry. However, a drop-door is often difficult to install and operate efficiently. There may also be a trapper's door, leading to the outside from the funnel area. This saves trappers having to go round by the entry to get to the catching-box. The trap at Long Point has no doors; the drop-door was not found to be necessary due to the efficient catch-box and the driving technique, and the trapper's door was not built for reasons of economy. A trap with no doors simplifies construction and lowers the cost.

The principal changes in direction, which present the birds with "a point of no return," are usually made in the funnel area. In most traps there are two "bends," so that the catching-box will be angled about 35° to 50° from a line drawn through the center line of the entry. This is usually accomplished by having two sections of narrow passageway. The first 6 to 8 feet long, and virtually devoid of cover; and a second 8 to 12 feet long, containing the ramp, which leads up to the catching-box. If possible the roof of this last section should slope slightly upwards to the catching-box. This helps in creating the illusion of a "point of no return," the birds fly naturally upwards.

The ramp leads from the ground up to the catching-box. It should be solid, offering the birds no means of escape, and strong enough to support the weight of a trapper who may want to catch by hand a bird in the upper compartment of the catching-box.

Catching box: This is a box with a transparent back, shelves to divide the box into compartments, an opening to the funnel and some means of removing the birds. Several types of catching-boxes are in use and have been described by Brownlow *(op. cit.)*, Lockley and Russell *(op. cit.)* and Hussell and Woodford *(op. cit.)*. A simple yet effective one is shown in figure 2.

Some workers favour a fairly large catching-box, as sometimes large numbers of birds are caught in one drive. However, this leads to difficulty in removing the birds, unless some sort of "piston" arrangement to reduce the box area is used, which is not too practical on most boxes. A medium sized box—perhaps about 18 inches square and 2 feet high—is a useful size. There is enough room to accommodate a good number of birds, yet a trapper can easily reach any part to remove a bird.

The box should be at a convenient height from the ground, so that a trapper will have no trouble getting his arm in the box, 3 to 4½ feet is an ideal height, although steps and a platform can be built if necessary.

The box is divided by shelves into two or three compartments. The upper one opens to the funnel, and birds seeing sky or landscape, through the transparent back, fly in and flutter against the glass. Then most drop down into the lower compartment, where they usually remain until removed by the trapper. Some boxes have two lower compartments, separated by a floor which is part wood and partly a grille of metal rods, spaced 1¼ to 1½ inches apart. The grille allows small birds to drop to the lowest compartment. On some boxes this is accomplished by having a "small-bird" box, attached to the side of the catching-box, with a grille vertically between the two.

Details of construction will be discussed in a later section.

SITE

The trap-site must be carefully chosen in an area where a variety of species occur in numbers during migration. It is recommended that possible sites be kept under observation for at least one year, noting carefully the local movements of migrants.

Traps have been built in various situations. A good one is near the end of an isolated, narrow line of low cover. The best cover is bushes, with some small trees, but *no* high trees in front or behind the trap, as this will encourage some species to fly over the trap. If possible the trap should be protected from the wind, Brownlow *(op. cit.)* recommends a natural hollow as an ideal site.

Other situations where traps have been built are: around an isolated clump of evergreens (Long Point), across a narrow valley, along stone-walls, over the exit of a small stream (Fair Isle), in an enclosed garden (Heligoland), around a bush overgrown with vines (Long Point) and on barren islands artificial cover (rolls of rusted netting or barbed wire, driftwood, etc.) may be used and the trap built around it.

The mouth should, if possible, face the direction of migrants' local movements at the season when it is likely to be most productive. As previously noted, "double" traps, along stone-walls, have been built at Fair Isle, the two mouths facing opposite directions.

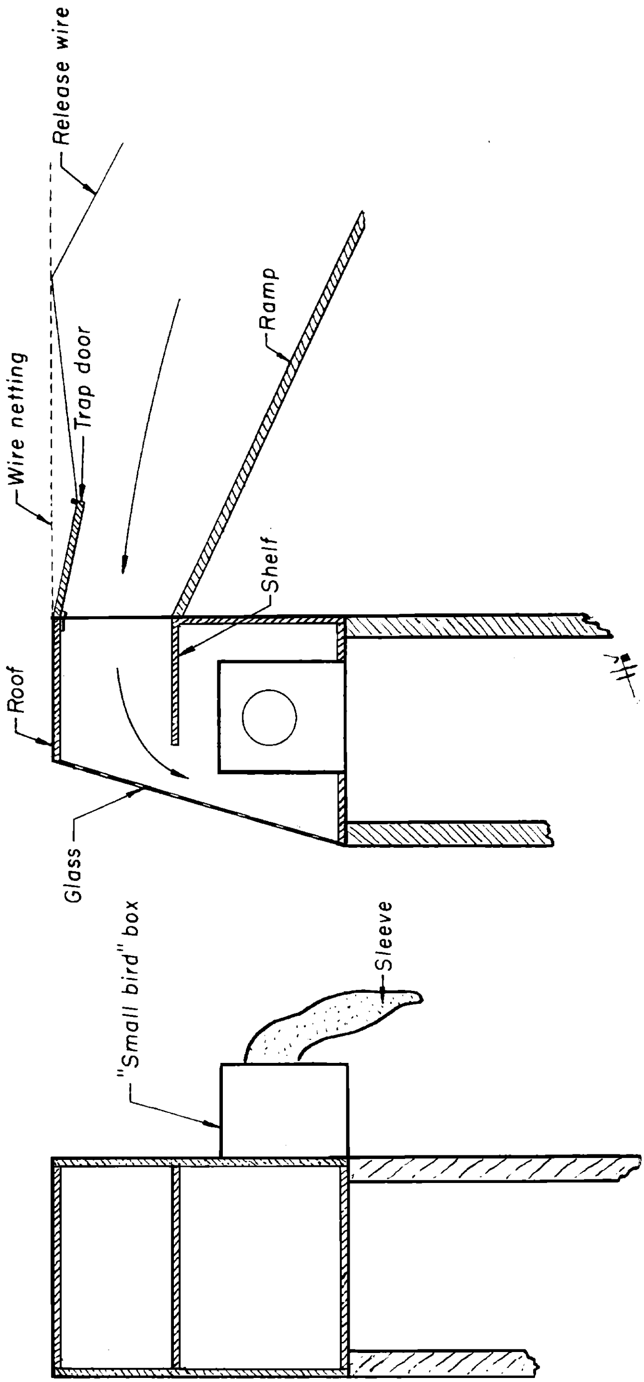


Figure 2. Details of Catching-box

CONSTRUCTION

Tools: The following are recommended as useful in building Heligoland traps:

Shovel—long-handled and short-handled.
Post-hole digger—effective in some situations.
Saw—"Swede" or cross-cut—for cutting larger poles; hand saw for general cutting.
Axe—one with a good blade and heavy head.
Hatchet—useful for recessing poles to set in cross-pieces.
Hammer—several.
Crow-bar—especially if salvaged lumber is being used.
Tin-snips—to cut wire-netting.
Pliers—to cut and twist wire used in "sewing."
Tape measure—10′ and 50′.
Level—to line up posts and platform for catching-box.
Staple-gun—useful in attaching wire-netting to uprights.
Rope—to haul cross-pieces into place.
Ladder—10 to 20 feet long; a one-inch board about 8 inches by 3 feet nailed to one side allows a ladder to be leaned against the the wire-netting without bending it badly. A step-ladder is also of use.
Gloves—ones with leather palm are sometimes useful in handling wire-netting.

Materials: A variety of materials are necessary for the construction of a Heligoland trap. Considerable savings may be effected by utilising used lumber for the framework. At Long Point frameworks for two traps have been built from wood found along several miles of uninhabited beach.

Lumber—posts for uprights, 4 to 10 inches in diameter and 10 to 30 feet long.
2 x 4's and 2 x 2's—for uprights and cross-pieces.
1 x 6 to 12 inch flooring—for ramp.
waterproof plywood—5/8 to 1 inch, for catching-box.
1 x 4—to build framework for drop—or trappers' door (if used).
Wire-netting—1/2, 1, 1 1/2 inch mesh of a fairly heavy grade and in the largest width available.
Nails—6, 4, 2 1/2 and 1 1/2 inch.
Staples—3/4 to 1 inch.
Wire—good supply of wire usually referred to as "stove-pipe" wire—no. 16-18.
Glass—sheets of double-diamond to fit catching-box.
Misc.—hinges for catching-box and doors, catches for doors, sheet metal for treadle, wood preservative, etc.

Framework: The framework of the catchment and funnel areas consists of a number of uprights or posts, laid out roughly in pairs, and gradually diminishing in height and width from front to back. Each upright is joined at the top by cross-pieces, both laterally and along the length of the trap. A variety of materials may be used for the uprights—wooden posts or poles are ideal; pipe (1 to 2 inch) and angle-iron have also been used. At Long Point wooden posts (5 to

10 inches in diameter) have been used for some of the uprights; 2 x 4's and 2 x 2's were also used, especially in the funnel area.

The uprights should be sunk in the ground at least 18 inches in firm conditions and up to five feet in sand. If pipe or angle-iron are used as uprights they may have to be set in concrete—possibly about 2 feet deep and 1 foot in diameter. It is wise to treat the bottom sections of wooden posts with wood preservative.

The cross-pieces may be 2 x 4's, 2 x 2's or smaller. A sturdy cross-piece makes for more rigid construction, although some workers contend that it makes the roof more obvious. They recommend that wire be used instead of wood to support the roof; however, this means that the uprights would have to be braced, either by guy-wires or wooden supports.

The ramp, which leads up to the catching-box, should be of fairly solid construction, so that it will support the weight of a trapper if necessary. It is best to build the ramp before the wire-netting is attached. Two supports, either 2 x 4's or 2 x 2's, should run from the ground to just below the catching-box. These should be placed so that there will be no gap between the ramp and the wire-netting of the wall. These supports should be covered by 1 inch flooring, 6 inches or more wide.

The ramp should be built at such an angle that a bird alighting near its base will be able to see the sky or landscape through the transparent back of the catching-box.

Some ramps have a 1 by 4 inch board running up each side, along the wire-netting, to try and prevent birds from sticking their bills or heads through the netting. This is not always effective as often the bird hops up on the board, and proceeds to stick its bill through.

Doors—drop or trappers'—will complicate the construction of the trap. If they are used they should be set into carefully constructed frames; otherwise birds will escape through gaps left if the door does not shut tightly. A drop-door is best hinged at the top to a sturdy horizontal cross-piece of the frame. The top of the frame should be sloped back towards the catching-box about 15 to 20°; then the door will be kept shut by gravity. The door should be controlled by a wire led back to a point in the catchment area by small pulleys or tubes. Cord is unsatisfactory as it stretches. It is sometimes helpful to fasten a strip of ½ inch wire-netting, about 6 inches wide, around the inside of the frame, as an additional deterrent to birds trying to escape. The trappers' door may be hinged on the side. Brownlow *(op. cit.)* describes a useful device for keeping the trappers' door shut as: ". . . boring a hole through the upright of the frame at a convenient height, pushing a metal rod through the hole and bending its ends at right angles close to the upright so that they can swing to embrace the closed door. A nail on the inside and on the outside of the door on which they can rest in the closed position completes the device, which is easily operated from either side."

Wire-netting: On most traps this is the major expense, but it is false economy to use poor quality wire-netting because it will not stand-up to the weather. The finer the mesh the higher the cost yet ½ inch mesh should be used on most of the trap, otherwise many birds will escape.

The walls and roof of the funnel, the walls of the catchment area and if possible the wing-walls should be of ½ inch mesh. If a drop-door or trappers' door are used they should be covered with ½ inch mesh.

The wire-netting should be buried at least 6 inches in the ground. Trenches, about 6 inches deep should be dug along the walls before the netting is put in place. After the bottom section of netting is in place the trench may be filled in.

Adjacent sections of netting should be overlapped, at least 3 times the mesh-size (e.g. ½ inch should overlap 1½ inches). They can then be sewn together with wire, number 16-18. The job of sewing, if left until after the wire is on the trap, is best done by two people, one on either side so they can thread the wire back and forth through the netting. It is much easier to join the sections together before they are put in place. A section of the trap wall, or a wing-wall, may be "pre-fabricated" on the ground, stapled to the horizontal cross-piece and then hoisted into position. This requires careful measuring and adequate working room on the ground. Make sure the area is clear of debris before laying the wire on the ground.

Sewing the wire netting joints is very time consuming and it is, therefore, advisable to get wire-netting of the greatest width obtainable.

Brownlow (1955) mentions that wire-netting is liable to corrosion when the trap is sited near salt-water. He recommends painting the netting with black bitumastic paint or with tar. This also tends to make the wire-netting, and thus the trap, less conspicuous.

Catching-box: An excellent material for the construction of catching-boxes is outdoor plywood—either ⅝ or ¾ inch, for the frame and ⅜ or ½ inch for the shelves. The best material for the transparent back is a sheet of glass. This should slide in and out by means of grooves so that the trap may be put out of action if it is not being used. The glass should slope, because a slope tends to deflect downwards to the lower compartment of the box, and also the impact of a bird flying against the glass is reduced. The slope should be about 50°. Plastic such as "perspex" may be used instead of glass, but it soon discolors and is difficult to clean. If several traps are being built in one locality it is a good policy to make all the catching-boxes of one size, as then only one size of sheet glass is needed as a spare.

Circular openings to remove birds (about 6 inches in diameter) should be cut in the side of the box, one for each compartment, including the top one. These must be closed by either shutters or sleeves. A shutter, simply a circle of plywood 8 inches in diameter and hinged by a single screw at the top, may be used to close the opening to the upper compartment. A square shutter, running in two "tracks" may also be used. The lower openings may be closed by cloth sleeves, about 6 inches in diameter and 12-16 inches long. The sleeve may get damp and difficult to use in wet weather. This may be partially overcome by building a "roof" over the sleeves. Part of an old trouser leg, especially denim, makes a good sleeve.

Mather (1960) describes another alternative to sleeves or shutters. A piece of pure sheet rubber—3/16 inches thick—is fastened over the opening in the catching-box. Then two cuts the length of the opening are made, dividing the area into four equal parts; each part is then bisected by a cut one-quarter the diameter. The hand may then be inserted and extracted, with the rubber springing back into place after each insertion/extraction.

It is a good policy to have some ventilation holes (4-6″ circles, covered by fly-screening) in the front of the box, particularly when birds may be caught automatically and be in the trap for a short period of time, possibly between drives or the trapper's regular visits.

On some boxes a metal platform or treadle is used, between the glass back and the floor of the top compartment. This makes the box "automatic." A bird fluttering against the glass eventually alights on the treadle, which tilts down, dropping the bird into the lower compartment. Once the bird is in the lower compartment it does not have much chance of escaping by fluttering up along the glass, as is the case in the box shown in fig. 2. Brownlow (1952) figures a treadle used at Fair Isle. This is a light metal plate, which pivots on a central pin and is balanced to return to the normal position against a stop. However this has the disadvantage that occasionally when a bird activates the treadle and drops into the lower compartment another bird, already in the box, may escape out the other side, which tilts upwards. This can be overcome by hinging the treadle near the back (see Hussell and Woodford, 1961) so that the whole treadle tilts downwards, with no space at the back. If a centrally-pivoted treadle is used it will be necessary to increase the gap between the glass and the top shelf from 3 to 6-8 inches.

A treadle increases the efficiency of the trap. Any birds which are self-caught (not driven in) cannot escape and may be picked up when the trap is next visited by a trapper. Some days this may amount to a fair number of birds. Secondly, an automatic box is more effective in confining birds once they are near the end of the funnel area, so that it is possible to dispense with the drop door, simplifying the construction.

COVER

The amount and position of cover is a very important factor in the number of birds caught. At most sites it will be necessary to do some "gardening," that is removing or trimming trees or bushes; and some planting. However no more cutting than is necessary to allow construction should be done until the trap is operating.

Any tall trees in the trap area, both behind and in front of the trap, may have to either be "topped" or removed. Bushes or trees at either side of the entry may have to be removed, as they may induce birds to by-pass the trap. Bushes or trees in the entry and catchment area should be considerably less than the height of the entry or the catchment area.

The cover in the entry and catchment should not be so dense as to hamper the movements of trappers driving the trap. Selective thinning may be necessary in some locations. There should be paths for at least four trappers through the cover in the assembly area. The walls of the catchment area should be free of cover as many birds tend to "fly-back" towards the entry along the walls and may find shelter in any cover near the walls long enough to be by-passed by the trappers driving the trap. A bit of cover, possibly a sapling, in the middle of the narrow end of the funnel helps to slow birds down, before they enter the catching-box.

In some situations some planting may be necessary. Careful planting in the assembly and catchment areas, especially in barren and exposed areas, may greatly increase the number of birds naturally attracted to the trap area. It is wise to consult a horticulturist before doing any planting, to determine if the selected bushes or trees are suitable, particularly for the soil conditions. The rule followed at Long Point, and probably elsewhere, has been to obtain trees or shrubs from as near the trap-site as possible, as any items transplanted carefully have a very good chance of survival. There are a number of good references on planting to attract birds, such as Terres (1953) and Mackintosh (1956).

At Point Pelee wild vines eventually covered much of the trap, especially the wing-walls and catchment area. While this in some ways makes the wire-netting less conspicuous, there is considerable weight on the netting and the vines intertwine in the mesh so badly that they are difficult to remove. It also provides sufficient cover for some birds, so that they may be by-passed by the trappers. Snow is more likely to remain on a vine-covered roof and may cause serious damage.

Some writers advocate planting berry- or seed-bearing plants, which are attractive to birds, in or near the entry. This may be successful in some areas, although baiting insures a more constant food supply.

BAIT

One of the best lures is water. A small pool set in the ground, with water dripping into it, is most effective. A simple drip arrangement is a large tin can, suspended over the pool, with a hole in the bottom that will allow a drop to fall every few seconds. An uncovered feeding tray—2 feet square—may be set near the center of the entry. A variety of baits, such as millet, bread crumbs, mixed grain, sunflower seeds, may be used. Seed thrown on the ground may soon be covered over by the repeated visits of the trappers, especially in sand areas.

OPERATION

The operation of Heligoland traps has been described by Brownlow (1952) and others. Although some birds are trapped "automatically," most are driven into the trap. The birds may be attracted to bait or water near the mouth and then driven a short distance or several trappers may drive the birds some distance into the trap. The driving technique will vary with every trap and with the species of bird being trapped.

Under most conditions drivers should proceed as follows:

1. The trappers (2-6) should take up positions some distance from the trap, in a straight line or possibly the two outer trappers might be a little ahead of the rest.

2. They walk forward slowly, "beating" the vegetation with a stick (too much noise causes some birds either to fly back over the trappers' heads or out of the area entirely). It is important that the trappers keep in formation as birds are more likely to "break-back" if one trapper gets out of line.

3. Under *no* circumstances should a trapper break the line and attempt to bring back a bird that has slipped by. (Unless the bird in question is a rarity and the drive has been organized to catch that particular bird.)

4. When the trappers are almost to the entry it may be advisable to move in quickly to push the birds in the entry well into the trap. The two outer trappers might move in slightly ahead of the others and stand near the end of the wing-walls. They may then head-off some birds which otherwise by-pass the trap.

5. The trappers should then move through the catchment area driving the birds before them (a trapper should be assigned to cover each wall as many birds attempt to fly-back along the walls). If the trap has a drop-door one trapper should be ready to drop it when most of the birds are in the "funnel" area. One trapper may be locked in the "funnel" area with the birds and then gently drive them to the catching-box, perhaps catching some by hand. If a bird is fluttering against the glass but not alighting on the treadle the door on the catching-box may be closed by the trapper in the "funnel" area to confine the bird to the catching-box.

6. When all the birds are in the catching-box the trappers may move around to the back of the trap and remove the birds from the catching-box. A number of multi-cell gathering-boxes should be available so that the captured birds may be separated by species, family, or size.

7. After the birds have been removed one trapper should make certain that the drop-door has been raised, the door on the catching-box is open, and the shutter or sleeve on the catching-box is closed.

8. The trappers should then leave the area, either continuing on to drive another trap or going back to band the birds. The trappers should leave the area by the back of the trap, otherwise they may disturb any birds which are in the area in front of the trap.

DISCUSSION

In a paper published in *Bird Banding*, Bergstrom and Drury (1956) reviewed trapping methods as a means of sampling migration, and commented: "We do not know of any full-scale Heligoland traps in use on this side of the Atlantic, and it is unlikely that any will be built as an alternative to mist-nets." In our experience this represents the prevailing opinion among North American banders, and it is therefore necessary to decide whether Heligoland traps do in fact have any application as a means of sampling migration in North America.

In order to evaluate the relative merits of traps and nets it is necessary to refer to the experience of trappers who have used both techniques, and although expense is an important consideration, their efficiency in operation is of primary importance. The coastal bird observatories in Europe have used Heligoland traps for many years, and the recent introduction of nets on a large scale has not curtailed their use as the most productive trapping method of these stations. Indeed, in some locations nets are considered to have a rather limited application. Williamson (1957), in a paper stimulated by the remarks of Bergstrom and Drury, states that "Fair Isle is too wet, windy and bare to promise notable success with Japanese mist-nets. In these respects it may prove similar to other exposed offshore islands in Europe and North America, particularly as the big falls of migrants at such places are often associated with low pressure weather in which mist-nets cannot be used." Williamson regards nets as a useful ancillary to the permanent traps at Fair Isle.

The present position in the British Isles has been summarized by Spencer (1959) as follows: "At the observatories, Heligoland traps have continued to dominate the scene, as many as ten being in use at a single observatory, and with their aid over 600 warblers have been caught in a day at one station. . . . The mist-net, by its mobility and versatility, has done much to make each ringer a mobile bird-observatory, but this very success has tended to attract man-power from the main observatories, thereby endangering the continuity of effort. This is to be regretted insofar as it is often impossible to see in its proper context a bird caught in a local bramble-patch in the way that a migrant caught at a regularly manned site can frequently be related to a particular movement. On the other hand there is much to be said for the more extensive cover made possible by mist-nets." In North America the wide-spread use of mist-nets has stimulated the founding of a number of coastal stations, particularly those taking part in Operation Recovery (Baird, *et al*, 1958). This does not alter the fact that Heligoland traps are more efficient in dealing with large waves of migrants.

Woodford (1959) has outlined some of the advantages and disadvantages of Heligoland traps and mist-nets based on the use of a trap and nets at Point Pelee. Although Point Pelee is a much less exposed situation than Fair Isle, the results indicated that Williamson was correct in concluding that conditions at coastal stations in North America would prove to be essentially similar to those at Fair Isle. Experience at Long Point (Hussell and Woodford, 1961) has reinforced this conclusion, and a detailed comparison of catches by the two methods has shown that the trap at Long Point has a distinct advantage over nets in dealing with large falls of migrants. This is probably one of the more important advantages of Heligoland traps since the study of the occurrence of large waves of migrants is usually a major concern of coastal stations, and therefore careful consideration should be given to the most efficient method of sampling the migration, so that both an adequate sample may be trapped and sufficient time left for other important activities, such as taking weights and measurements of trapped birds and making sight observations of the migration in progress.

Heligoland traps require an outlay of effort, money and time beyond the resources of most individual banders. They are best built at places where the results will justify the initial investment. Permanent or semi-permanent stations, such as those taking part in Operation Recovery, and established with the definite object of compiling information over a number of years about the migration at a particular location, might make good use of them.

In the long run Heligoland traps may prove to be less expensive than mist-nets. The initial cost of materials in an average sized Heligoland trap would be in the vicinity of $200.00, and provided they are built and maintained properly they will last for years. Costs may be reduced somewhat by using salvaged materials whenever possible. The average net lasts no more than one season, and soon develops some holes, no matter how careful a bander may be. At about $2.50 per net it does not take long to spend on nets the price of materials necessary for a trap. An interesting point is that, unlike mist-nets, a trap has the same "catching-potential" throughout the season.

When a station is to be manned by volunteers it will be necessary to be sure that enough are available to keep the traps operating over a reasonable proportion of the migration period. For this reason, and also because of the expense involved in building traps, such stations usually have to be operated on a cooperative basis. Building a Heligoland trap is not too formidable a task if a number of volunteers are available. At Long Point four men gathered the material and put up the framework for a full-size trap in a weekend. Covering the framework with wire netting is more time consuming. Probably two or three men could build a complete Heligoland trap in about a week, although it is usually possible to get a trap into a workable condition in a much shorter time.

When a co-operatively manned station, using Heligoland traps and mist-nets, is established it will be found convenient to have a series of bands assigned to the station, rather than having individual banders use their personal bands. Records for the station will then be kept centrally and be readily available for analysis. In Ontario this has not proved to be an obstacle to finding sufficient experienced banders to man the stations at Long Point and Point Pelee.

ACKNOWLEDGMENTS

We are grateful to D. H. Baldwin, John Lunn, and W. J. R. Wasserfall for reading this paper and offering criticisms and suggestions.

Harold Vanstone kindly drew the illustrations.

We are indebted to many members of the Ontario Bird Banding Association who have co-operated in building and operating the traps at Long Point and Point Pelee; to the Long Point Company, the Ontario Department of Lands and Forests, and the Canadian Department of Transport, for permission to work at Long Point; to the National Parks Service for permission to work at Point Pelee and the Federation of Ontario Naturalists for financial assistance.

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Received February, 1961

ARTIFICIAL INCUBATION OF EGGS OF VARIOUS BIRD SPECIES AND SOME ATTRIBUTES OF NEONATES

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Introduction. In connection with a study of the morphology of just-hatched birds we have accumulated collateral data that may be of some general value to ornithologists. More than 2,000 specimens of 83 species were hatched in incubators. No species tried in adequate samples failed to be amenable to artificial incubation. Incubation data determined in the laboratory where conditions can be standardized are basic to an understanding of the biological problems of natural incubation studied by ecologists.

Evans (1891 and 1892) in Scotland and Heinroth (1908 and 1922) in Germany first and most extensively hatched out Old World species. Baldwin and Kendeigh (1932), Kendeigh (1940), and Graber (1955) investigated artificial incubation of wild birds' eggs in America. Present manuscript was completed in 1957.

Acknowledgments. Grateful acknowledgment is made to the many people who helped search for nests. Dr. Kay T. Rogers encouraged the use of artificial incubation in 1951 when science foundations spurned the practicality of artificial incubation of wild birds' eggs.