but about 12 ectoparasites crawled onto my hand as I held it. This has not occurred on any of a few hundred captures of adult males with normal bills. At this capture the bird received a unique color-band combination. I observed it once more that year, on 13 June, in an area where a flock of males was beginning to congregate. By then it had lost the horny outgrowth.

I again observed the bird on 7 May 1978, when it intruded briefly into the territory of another male. On several occasions from 28 July–13 August 1978, it appeared with other males feeding on cracked corn on the lawn under my feeding tray. It picked up the corn from among blades of grass with as much facility as the other birds, scooping up a grain with the mandible then manipulating it at the base of the bill as do normal birds. Its behavior was sufficiently normal that, although I was only 5 m distant, I recognized the bird by its color bands sooner than by its bill.

My final observation of the bird was on 24 March 1979, when it briefly visited the trapping station. I did not specifically note its bill on this occasion and identified the bird only after a later check of the color bands.

Bill structure is usually associated most closely with survival aspects of fitness, but it probably has indirect effects on reproductive success as well. Unfortunately, I have no information on this bird's reproductive success. During the four breeding seasons in which I observed the bird I was studying the redwings breeding in the marshes near the trapping site and would have found its territory had it had one there. However, there are numerous other marshes slightly more distant where it could have had a territory.

I thank A. Martin for editorial suggestions.—KENT L. FIALA, *Museum of Zoology, Univ. Michigan, Ann Arbor, Michigan 48109.* (Present address: *Dept. Ecology and Evolution, SUNY, Stony Brook, Long Island, New York 11794.)* *Accepted 24 Nov. 1980.*

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Minimizing investigator disturbance in observational studies of colonial birds: access to blinds through tunnels.—Colonial nesting birds present unique advantages and disadvantages to the investigator of behavior and ecology. A major advantage is that there are many birds concentrated in a relatively small area, which allows accumulation of large data sets. A disadvantage is that investigator disturbance can bias or affect efficiency of data collection, particularly if birds in a colony are not accustomed to humans. Investigator effects can range from simple disruption of ongoing breeding activities and colony dynamics (Vermeer, Can. Wildl. Serv. Rept. Series 12, 1970; Smith, Br. Birds 68:142–156, 1975; Sears, Bird-Banding 49:1–16, 1978) to chick mortality as young run from their territories and become lost or are killed (Emlen, Wilson Bull. 68:232–238, 1956; Ashmole, Ibis 103b:297–364, 1961; Kadlec and Drury, Ecology 49:644–676, 1968; Kadlec et al., Bird-Banding 40:222–232, 1969; Roberts and Ralph, Condor 77:495–499, 1975; Gillet et al., Condor 77:492–495, 1975; Davies and Dunn, Ibis 118:65–77, 1976). Predacious gulls (*Larus* spp.) also may take advantage of the disturbance and eat eggs and chicks of their own and other species nesting in or near the same colony (Kury and Gochfeld, Biol. Conserv. 8:23–34, 1975; Ellison and Cleary, Auk 95:510–517, 1978). These disturbance related effects are inherent in studies conducted from observation blinds placed within nesting colonies simply because the investigator creates a disturbance while entering a blind. To minimize unwanted disturbance and related effects in sparsely vegetated Lake Michigan bird colonies, we have designed and used an easily constructed tunnel system which permits access to blinds.

Methods and materials.—The design described here was used in 1978 and modified in

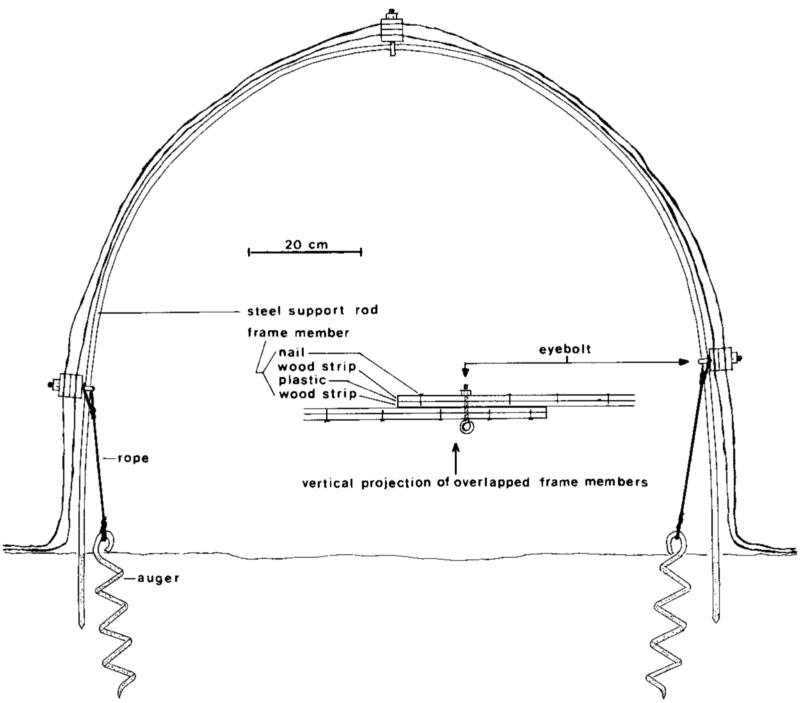

FIG. 1. Cross section of tunnel showing details of construction where two tunnel sections join; drawn to scale.

1979 to withstand high winds. The tunnel described in this paper is the one used in 1979 unless otherwise noted. Modifications can be made depending on conditions unique to the investigator's study area and species.

The tunnel consisted of 3.1 m (10 ft) × 2.4 m (8 ft) black plastic sheets that were attached to 9.5 mm (0.375 in) × 38.0 mm (1.5 in) × 3.1 m (10 ft) wooden strips (Figs. 1, 2). English equivalents are provided to facilitate purchasing of material.) Sections of tunnel were prefabricated by nailing two wood strips together with the plastic sandwiched between at the center of each 3.1 m length of plastic (Fig. 2). At 0.8 m (2.5 ft) on either side of the center of each 3.1 m length of plastic, two more strips were nailed together. This resulted in three wooden frame members 19 mm 0.75 in) × 38.0 mm (1.5 in) per tunnel section.

We formed the tunnel by joining the three frame members from each section end-to-end with frame members from another section (with 0.2 m overlap) using eyescrews or eye-bolts (Figs. 1, 2). Frame members were pre-drilled to save time in the field if eye-bolts were used. Metal supports for the plastic sections were 2.4 m (8 ft) lengths of 6 mm (0.25 in) steel rod bent in a U-shape. Tunnel erection initially consisted of threading a metal rod through the eyes, standing the metal support rods with ends down, forcing the ends of the metal rod into the substrate, and spreading the plastic over the metal frame.

The end-to-end attachment of tunnel sections created uneven overlaps of the frame members when sharp changes of direction or elevation were attempted. When such angular

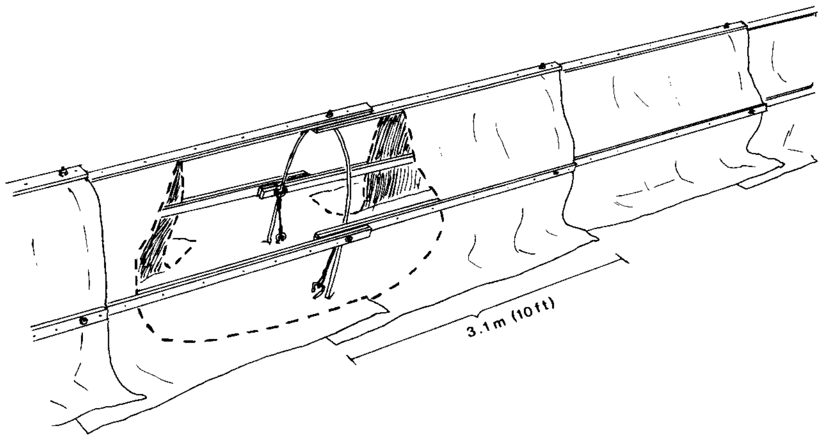

FIG. 2. Plastic removed from a portion of the tunnel (dotted line) to show construction details; drawn to approximate scale.

changes were necessary we simply lashed the wooden frame members to the metal frame after compensating for the uneven overlap.

After initially setting the tunnel up and adjusting the plastic, we entered the tunnel and attached it to the ground with augers that we had pre-formed by twisting 0.6 m (2 ft) sections of 6 mm (0.25 in) steel rod around 24 mm (1 in) diameter soil-pipe. Two augers were twisted into the ground at each hoop, and the eye-bolt was tied to the auger (Fig. 1). Additional augers or conventional stakes were added midway between hoops and the frame members were tied to these. Augers were used because of superior holding power in sand, cobble, and gravel as compared with conventional stakes. They also were easier to manipulate inside the tunnel. Staking the tunnel down from inside reduced disturbance to incubating birds during tunnel erection.

Results and discussion.—We bolted five sections (15 m) of tunnel together outside the colony, threaded the rods through the eyes and carried six 15-m lengths of tunnel into position. Bolting the sections together took about 3 h and moving them into position and initial erection took approximately 1 h. Six hours were required to securely stake the tunnel from the inside. When completed the tunnel was approximately 1 m wide at the base and 1–1.2 m high. A 2 m tall human could easily crawl the 90 m length with a 10 kg pack around the neck in a few minutes.

The tunnel entrance was located in the shrub and tree covered island interior where we entered without being seen by birds. The tunnel passed 90 m through a Herring Gull (*Larus argentatus*) colony and terminated in a blind adjacent to a Caspian Tern (*Sterna caspia*) colony. A Herring Gull observation blind was also placed at the midpoint.

Moving through the tunnel created a peristaltic-like movement of the plastic sheet. Since the plastic flapped and fluttered in the wind, birds did not notice our passing on windy days. On calm days, gulls standing on top of the tunnel or adjacent to it gave low intensity alarm calls when we passed. In contrast, all birds within 100 m took to the air when a human emerged from the vegetation and walked to a blind.

In both seasons, the tunnel was unprotected from winds. Since the plastic covering presents a large surface area to the wind, the wood and metal frame was subjected to considerable stress. In 1978, this caused problems when smaller diameter rods (3 mm or 0.125 in) were bent out of shape and narrower wood strips (19 mm or 0.75 in) were broken by gales in excess of 60 kph. With 6 mm (0.25 in) rods and 38 mm (1.5 in) frame members in 1979 neither problem recurred. The tunnel withstood five gales, each of which blew for 24 h or longer.

Three frame members per section were used to minimize weight and cost. The plastic tended to sag in between frame members, but this did not necessitate the addition of another frame member on each side. Placement of the side frame members at 0.8 m (2.5 ft) from the center left a 0.5 m (1.5 ft) skirt that allowed ventilation, reduced wind stress and permitted young gulls to enter and exit.

We used 4 and 6 mil plastic in 1978 and 1979, respectively. In both years, Herring Gulls pecked and tore the plastic to such an extent that it had to be replaced or repaired on 50% of the sections. The 6 mil plastic used in 1979 apparently fatigued in the wind or sun and tears began appearing after 3 months exposure. The 4 mil plastic used in 1978 retained its resiliency through 1979. Reasons for the different wear characteristics apparently were related to different composition.

Preliminary evaluation.—Is the tunnel worth the effort? We can provide an initial assessment based on observations of Caspian Terns by Shugart and Herring Gulls by Fitch.

During 1977 through 1979 breeding seasons, Shugart observed individually marked Caspian Terns during the last part of incubation until after young could fly. An observation blind was approximately 10 m from the study area in each year. During this period in 1977, Shugart entered the blind one day and exited the next, creating one brief disturbance per day. Eight (of 8) marked pairs and their young moved at least 50 m away from the blind by the time the oldest study chick was 10 days of age. Observation of these individuals was terminated at this time because the birds were too far away from the blind to be seen clearly. It appeared that the movement away from the observation blind in 1977 was due to disturbance (see also Smith 1975, Sears 1978). In 1978, to minimize this possible effect on colony dynamics and to increase the period that marked individuals could be observed, Shugart alternated 5-day periods in the blind and 2 days out after the first study chick was 4 days old. In 1978, between the times Shugart left the blind and returned 2 days later, 2 of 22 (10%) study chicks were lost, and 3 of 12 (25%) family groups moved too far away to been seen clearly. We assume that the chick loss and movement were affected by exiting and entering disturbances as no movement or chick loss occurred after the birds had calmed down during the 5-day periods in the blind.

In 1979, tunnels were erected during late incubation and used to enter and exit the blind after the oldest study chicks were 4 days old. This permitted daily entering and exiting with minimal disturbance and observation of a near normal colony. Of 15 family groups marked, 14 centered activities at their natal site until at least 1 week after young could fly. The remaining family group moved from 10 m to within 3 m of the blind where they remained until after the young could fly.

Fitch's Herring Gull studies during 1977–1979 required placement of blinds throughout a colony to allow observation of widely spread polygynous groups. At blinds where tunnels were not used, the disturbance Fitch caused by walking through the colony to a blind indirectly resulted in chick mortality as the young ran from their territories and were killed by neighbors. Four of 10 (40%) chicks from two of four polygynous groups were killed in this way (Fitch, pers. obs.). Fitch observed 14 groups (monogamous and polygynous) from blinds that were entered by tunnels, and no chick mortality occurred due to entering blinds.

The disturbance-related effects on Caspian Terns and Herring Gulls that we have observed may not be important in all studies, but they were in ours. Movement of Caspian Tern families away from blinds reduced or eliminated the small sample of marked individuals, and altered relationships between families as the remaining birds shifted to fill in vacated areas. In Fitch's study, the dispersion of polygynous groups made possible the observation of only a few polygynous groups per year. When chicks were lost from these groups differences in reproductive success and behavior between and within polygynous and monogamous mating types were masked or biased.

Although investigator disturbance and associated effects probably cannot be entirely eliminated, we feel it is best to conduct observations under conditions which are as natural as possible. This is particularly important when attempting to generalize reproductive and behavioral data taken from the necessarily small sample sizes that detailed observations require. It is also of importance when investigators attempt to assess inter-individual differences in reproduction and behavior.

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REQUEST FOR ASSISTANCE

Study collection.—Bird study skins, skeletons and alcoholics (world) are wanted for undergraduate and graduate ornithology collection. Labelled and unlabelled specimens sent collect shall be greatly appreciated and acknowledged in the collection. Contact John P. Ryder, Dept. Biology, Lakehead University, Thunder Bay, Ontario P7B 5E1 Canada. (807) 345-2121.