Stoddard, Sr. kindly supplied dead buntings from a TV tower near Tallahassee, Florida, and Robert A. Norris read an early version of this paper.

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THE USE OF CANNON AND ROCKET-PROJECTED NETS FOR TRAPPING SHOREBIRDS

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In 1964 the Smithsonian Institution undertook an investigation of the trans-Pacific migration of the Ruddy Turnstone, *Arenaria interpres*, through an intensive program of banding. Although several potential banding sites were investigated, only on St. George Island, one of the Pribilof Group in the Bering Sea, did a large-scale banding effort seem feasible. J. Vincent Hoeman and Max C. Thompson began operations on St. George Island in mid-July 1964 and Robert L. DeLong and Thompson continued field work during the summers of 1965 and 1966. Initial attempts at obtaining large numbers of turnstones with mist-nets failed due to high winds, foxes, and the ability of the turnstones to see the nets. Due to large concentrations of 5,000 to 6,000 birds in one small area, we decided to attempt cannon-netting. We believe this was the first use of a projected net for mass banding of shorebirds although the method is commonly used for capturing game birds and gulls (Dill and Thornberry, 1950).

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EQUIPMENT

Mr. L. J. Schoonover, Refuge Manager, Sand Lake National Wildlife Refuge, kindly supplied us with the necessary cannon-netting equipment in 1964. The net was 75 feet by 35 feet and was projected with three Miller-modified cannon. Our first year was such a success that we invested in our own equipment in 1965, using lighter projectiles and a knotless nylon net. The lighter cannon were inadequate to extend the net fully and the net had to be rerigged for use with four cannon. Even with these, the net did not extend satisfactorily. Late in 1965, a new recoilless net trap cannon (hereafter referred to as rockets) was developed by Central Technology Incorporated (CTI), Herrin, Illinois, for projecting nets (Figure 1). The net equipped with three rockets was much faster and complete extension of the net was achieved.

Figure 1. CTI Recoilless Net Trap Cannon (rocket) used to project nets in 1966.

METHODS

Turnstones utilize St. George Island as a major feeding stop (15,000 to 20,000 birds at the peak period) on the southward migration. We used the projected net effectively only where large quantities of turnstones were present in relatively dry, compact feeding or resting areas. The birds were feeding on large quantities of blow fly larvae, *Calliphora vomitora*, and were concentrated in three areas where these larvae were feeding on carcasses of Northern Fur Seal, *Callorhinus ursinus*, left on the killing fields by the annual seal harvest. Nets were usually set in the early morning where the birds were actively feeding. In 1964 and 1965 grass cuttings were used to camouflage the nets and in 1966 brown and green variegated camouflage netting was used. The camouflage netting proved superior to grass cuttings and the turnstones tend to ignore it.

Arctic Foxes, *Alopex lagopus*, were a problem on St. George Island as they would chew the firing line in two when nets were left unattended. In 1966 we were able to make sets on East Killing Field (one of three areas where nets were set) the night before the firing, with no trouble from foxes. This may have been due to a fox population reduction program by the Bureau of Commercial Fisheries in the winter of 1965-66. Small mammals would probably not be a problem in continental areas with a much lower predator density. Although birds may utilize another area the next day, the advantages of previous-day sets far outweigh the occasional necessity of moving a net after the set has been made.

In 1964, the birds were banded and released immediately from the net. In 1965 and 1966, the birds were removed from the net and placed in 60-compartment holding cages (Fig. 2). The birds were then taken to an abandoned fox-trapping shed converted to a banding station where they were banded, weighed, and released. The birds were under the net from a few minutes to several hours, depending on the number captured at one time. The length of time the birds are under the net, the weight of the net, and their struggles,

Figure 2. Ruddy Turnstones being removed from net and placed in holding cages.

tire small shorebirds to such an extent that holding cages are a necessity to allow them to rest before releasing. Larger shorebirds (e.g., Bar-tailed Godwit, *Limosa lapponica*) were better able to withstand the shock of the netting and were strong enough to fly away without a holding period. A major factor (in part) in whether the birds are able to depart immediately after being released is the amount of fat stored. Heavy birds need more rest in holding cages than light birds before release.

The areas most shorebirds frequent are by nature wet and muddy. Although the killing fields on St. George are usually dry, they can

become extremely muddy after a heavy rain. Banding operations were suspended in 1964 during the wet days. The summer of 1965 was so wet that we frequently had to make sets in the rain. We were forced to bring wet, muddy birds to our living quarters where they were washed in warm water with detergent, rinsed in warm, clear water, and put in a warm room to dry for four to five hours. After the birds had preened and dried themselves in the warm room they were released. This worked well and little mortality was experienced. We made but one firing over mud in 1966 and subsequently allowed the birds to dry without washing them. Due to the wet, cold climate, this was a mistake. When the dirty birds walked in the grass or came in contact with water, the dirty plumage absorbed the water and they apparently died of exposure or were taken by predators. Birds might be released unwashed where the climate is more temperate and the predator density lower.

RESULTS

The number of Ruddy Turnstones handled in our operation documents the value of using projected nets for trapping concentrations of shore birds (Table 1). These numbers could not have been captured by any other method known to us.

TABLE 1. RESULTS OF PROJECTED NET TRAPPING OF RUDDY TURNSTONES, ST. GEORGE ISLAND, ALASKA. 1964, 1965, 1966

Year	Handled	Firings	Mean per firing	Firing Days	Mean per day	New Bandings
1964	2092	24	87.1	21	99.6	1975
1965	4519	41	110.2	34	132.9	3421
1966	10906	62	175.9	35	311.6	7543
Totals	17517	127	137.9	90	194.6	12999

Mortality from the use of the cannon-net was quite low, with a known mortality rate of .2 percent in 1964, .8 percent in 1965, and 2.1 per cent in 1966. The higher mortality rate in 1966 is attributed to two bad firings (23 percent of total mortality) in which an almost imperceptible rise in the ground in front of the net caused the leading edge of the net to hit the birds. A rise in ground in front of the net in effect reduces the angle at which your cannon are fired even though the angle at the spot where fired may be the same angle one has used previously without disasterous results. When making a set, the terrain must be looked at carefully to prevent such mortality.

Increasing the angle of the rockets reduced the mortality but also reduced the number of birds taken. Shorebirds standing more than 15 feet in front of the net were almost certain to fly from under the net before it dropped on them.

As mentioned previously, a group of birds was released in 1966 without washing and were killed by exposure and predators. Our own inexperience with the CTI type rockets in 1966 was an added mortality factor.

Several other species of shorebirds were trapped with projected nets and banded, incidental to our main effort, as follows: Golden Plover 243, Bar-tailed Godwit 100, Sharp-tailed Sandpiper 45, Rock Sandpiper 68, Red Phalarope 18, Pectoral Sandpiper 8, Baird's Sandpiper 3, Ruff 2, Sanderling 1, and Polynesian Tattler 1.

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WARBLER RETURNS FROM SOUTHEASTERN MASSACHUSETTS

By KATHLEEN S. ANDERSON AND HERBERT K. MAXFIELD[2]

Long-term ecological research at permanent study areas provides unique opportunities for studies of individual birds and species. Farner (1955) pointed out that the use of banding data relative to concepts of population dynamics is in its infancy and that "there is a great need for intensive sustained programs concentrating on individual species or groups of species with carefully integrated field studies to establish the plausability of the calculations". Stamm (1966) emphasized the need for information on bird population abundance, dynamics, and movements for correlation with the work of virologists studying arboviruses in which birds play a role.

Unfortunately, few long-continuing studies have been undertaken in this country. For the past ten years the Encephalitis Field Station (formerly the Taunton Field Station) has been capturing birds as part of a surveillance program of two arthropod-borne viruses, Eastern Encephalitis (EE) and Western Encephalitis (WE). Although the main emphasis is on these viruses, nevertheless, information on many phases of bird life has also been obtained.

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