BIRD-BANDING

A JOURNAL OF ORNITHOLOGICAL INVESTIGATION

VOL. XXX JULY, 1959 No. 3

OPERATION RECOVERY—REPORT ON MIST-NETTING ALONG THE ATLANTIC COAST IN 1958

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A summary of the first three years of coordinated netting at Atlantic coastal concentration spots was published in the July 1958 issue of *Bird-Banding* (Baird *et al.*, 1958). The primary purpose of the present paper is to analyze the effects of weather conditions on autumnal migration in 1958 in and near the coastal areas from Nova Scotia to Virginia. Although the daily banding records of the coastal netting stations are the principal sources of information on the composition and magnitude of the major migratory movements, these data have been supplemented by banding records at a few stations away from the coast, by records of casualties at television towers and ceilometer beams, and by direct observations of migration at coastal and inland localities.

We are aware that coastal concentrations are not exactly proportional to the daily magnitude of autumnal migration, for they may be augmented by such effects as coastward drift in offshore winds. The banding data can be used as a good indication of species composition and of relative magnitude of migration at different stations with about the same weather conditions. They can be used also, but less reliably, as a measure of comparative migratory activity under differing weather conditions. Careful analysis of the records, especially comparison of coastal data with inland data, meanwhile may help to evaluate the importance of wind-drift.

Most of the information included in the present report is directly related to the weather and migration analysis: a summary of the 1958 coastal bandings, station summaries, and recoveries. Habitat descriptions, unless specifically mentioned under the station summaries, are essentially the same as in 1957 (Baird *et al.*, 1958). Analysis of repeat data and of weights and measurements will be made in separate papers.

To state that the present report would not have been possible without the wholehearted support of more than 125 banders, observers, record-keepers and other participants is indeed an understatement. Those who have not participated in this project can hardly appreciate the painstaking detail necessary to the operation of a large-scale field station—especially when each bander is using his own supply of bands. The banders, whose names appear in the Station Summaries, have been most generous and cooperative in making their records available for study. Our thanks also are extended to the many observers, weighers, record-keepers, and others who assisted in the operation of the larger stations. Mrs. M. Stuart Roesler furnished detailed information on diurnal migratory flights over her home in Cos Cob, Conn., Richard Simmers

supplied counts of thrush calls heard at night in Cambridge, Mass., and David B. Wingate made available his daily records of North American transients in Bermuda. Casualties from the TV towers at Needham, near Boston, Mass., were collected by Bagg. We are indebted to Christopher Packard for information regarding the Portland, Maine, ceilometer accident of September 19-20; and to Floyd P. Wolfarth for data regarding the Newark, N. J., ceilometer casualties of September 19-20. John Conover of Harvard University's Blue Hill Meteorological Observatory has been most helpful in supplying weather information and in preparing Figures 4 and 5; additional meteorological records were provided by the Meteorology Department of the Massachusetts Institute of Technology.

SUMMARY OF 1958 BANDINGS

During the period August 1 through October 31, 20,221 birds of 149 species were banded at the 18 most active stations. Of these birds, 1,299 were taken in traps rather than in nets, and 27 were nestlings; therefore, the total net-hours, 55,471, may be applied only to the 18,857 netted birds.

Because of differences in habitat, weather conditions, type and location of nets, and other factors, accurate direct comparisons cannot be made between stations or between seasons. The following examples illustrate specific situations that preclude precise comparisons: (1) At Island Beach and Tiana Beach the vegetation is hardly higher than the nets, whereas at Milbridge and Middletown many canopy birds are far above netting range; (2) The erecting of nets at additional stations at Nantucket or in additional lanes at Island Beach provides an increase in birds roughly proportional to the number of nets in operation; at Ocean City, on the other hand, doubling the number of nets in the 10-acre woodlot has little effect on the number of additional birds banded; (3) A high percentage of stormy and windy days at Milbridge in 1958 greatly reduced netting efficiency, so a comparison of birds per net-hour does not give a true indication of the relative number of birds each year; (4) As the number of birds present at any banding site varies considerably from day to day (see Weather and Migration), a station such as Chincoteague, which was in operation only during the interval *between* heavy flight days, has a much lower seasonal total in terms of birds per 1,000 net-hours than does a station that also operated during the peak flights; (5) Heavy flights of certain species may occur during a very short period or under unusual combinations of weather conditions; for example, 46% of all the 1958 Baltimore Orioles were banded on a single day, Sept. 9; stations that were not in operation on this day had low seasonal totals for this species.

In spite of the many variable factors that limit direct comparisons it is reasonable to expect that an operation of this size will give some indication of changes in abundance, at least for the more common species. Whether these apparent changes represent actual changes in abundance of the species, or just differences in migration pattern resulting from specific weather conditions, cannot be appraised from the data at hand. However, because many coastal station operators remarked on such things as the scarcity of Catbirds and the abundance of American Redstarts in 1958, comparative figures for the more com-

mon species are presented in Table 1. Three different comparisons are made: (1) total individuals banded; (2) percent of total birds; and (3) birds per 1,000 net-hours. In order to make the figures in Table 1 as nearly comparable as possible, only the August and September bandings are compared for the two years.

Seven of the species shown in Table 1 were banded in greatly reduced numbers during August and September of 1958. Of these, the Catbird is the only one that showed a general decline in all areas. The other six species (Robin, Myrtle Warbler, Savannah Sparrow, Slate-colored Junco, White-throated Sparrow, and Song Sparrow) are primarily October migrants, and in September 1957 they were banded in numbers at just a few of the more northern stations. Their scarcity in September 1958 has no significance other than to suggest a delay in their migration in 1958. That several of these species were not scarce later in the season is demonstrated in Figure 1, which shows that four of the

TABLE 1. *Comparison of 1957 and 1958 August-September bandings*

	Total bandings		Percent of total		Birds per 1,000 net-hours	
	1957	1958	1957	1958	1957	1958
Catbird	1,968	1,492	16.9	11.0	63	30
Song Sparrow	847	674	7.3	5.0	27	14
Swainson's Thrush	677	1,089	5.8	8.0	22	22
American Redstart	626	1,412	5.4	10.4	20	29
White-throated Sparrow	440	296	3.8	2.2	14	6
Yellowthroat	365	660	3.1	4.9	12	13
Savannah Sparrow	363	106	3.1	0.8	12	2
Red-eyed Vireo	285	453	2.5	3.3	9	9
Slate-colored Junco	274	26	2.4	0.2	9	1
Cape May Warbler	263	272	2.3	2.0	8	6
Robin	251	167	2.2	1.2	8	3
Myrtle Warbler	246	95	2.1	0.7	8	2
Rufous-sided Towhee	237	375	2.0	2.8	8	8
Northern Waterthrush	184	486	1.6	3.6	6	10
Gray-cheeked Thrush	180	248	1.5	1.8	6	5
Blackpoll Warbler	156	248	1.3	1.8	5	5
Ovenbird	150	270	1.3	2.0	5	6
Black-and-white Warbler	134	340	1.2	2.5	4	7
Veery	104	389	0.9	2.9	3	8
Baltimore Oriole	103	279	0.9	2.0	3	6
White-crowned Sparrow	7	4	0.1	0.0	0	0

species in question were among the six most commonly banded species for the three-month period, August through October, 1958.

Figure 1 is similar to Figure 3 of the 1957 summary (Baird *et al.*, 1958) in that a different symbol is used for each station where more than 50 individuals were banded. Data from stations with totals of 50 or less are combined in the white areas at the right.

More than 250 individuals of each of the following species were banded during the August through October period of Operation Recovery in 1958: Catbird, 1,560; American Redstart, 1,434; White-throated Sparrow, 1,371; Slate-colored Junco, 1,312; Song Sparrow, 1,254; Myrtle Warbler, 1,249; Swainson's Thrush, 1,205; Yellowthroat, 673; White-crowned Sparrow, 533; Northern Waterthrush, 494; Rufous-sided Towhee, 477; Red-eyed Vireo, 474; Veery, 389; Black-

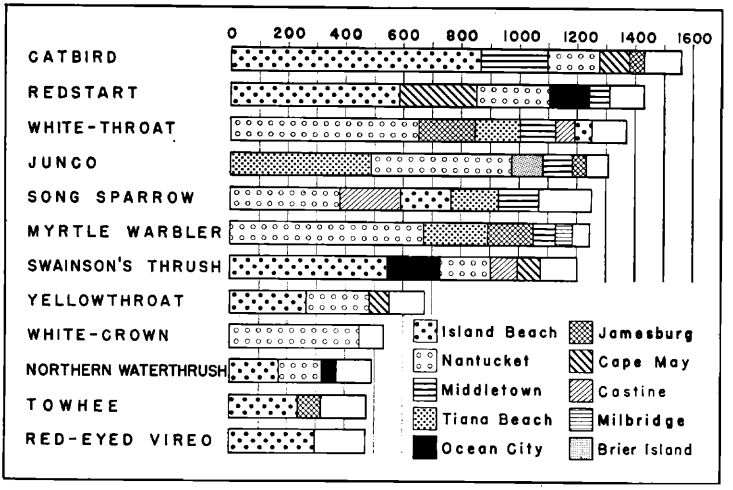

Fig. 1. Station totals for 12 top species, 1958.

and-white Warbler, 365; Blackpoll Warbler, 342; Cape May Warbler, 290; Ovenbird, 285; Gray-cheeked Thrush, 284; and Baltimore Oriole, 280. In 1957 only four species were banded in numbers exceeding 500; in 1958, nine species fell in this category. In 1957 only four species were taken in numbers of 50 or more at four or more stations. In 1958, on the other hand, five species (Catbird, American Redstart, Slate-colored Junco, White-throated Sparrow, and Song Sparrow) were taken in numbers exceeding 100 at four or more stations, and totals for two additional species (Swainson's Thrush and Myrtle Warbler) exceeded 50 at four stations.

The continuation of Operation Recovery bandings into October in 1958 resulted in a much higher percentage of Fringillidae (29.5% instead of 19.8%) and Parulidae (33.9% instead of 28.1%) in the total bandings, and a corresponding decrease in Mimidae (8.8% instead of 18.3%). Percentages for the smaller families did not change more than 1% from 1957, except for a drop in the Icteridae (3.0% instead of 4.5%).

STATION SUMMARIES

The 1957 report (Baird *et al.*, 1958) included a description of each station location as well as a map showing all but the smallest stations. Detailed descriptions are given below for the new stations, but only a brief summary of 1958 activities is given for the others (see also Table 2). Stations were operated daily within the extreme dates shown on the table, except as specified under the individual stations.

BRIER ISLAND, Digby County, Nova Scotia. 44°17′ N, 66°21′ W. Principal species: 104 Slate-colored Juncos* (maximum of 65 on Oct. 19), 33 Myrtle Warblers (14 on Oct. 18). No returns; 6 repeats. Rarities: Brown Thrasher banded, Dickcissel and Western Kingbird seen. Dr. Harrison F. Lewis (station leader), W. J. Mills, and Wickerson Lent (Nova Scotia Bird Society).

*See Appendix for scientific names.

Table 2. *Summary of 1958 operations*

State or province	Locality	Extreme dates	Maximum no. of nets	Total bandings	Total net-hours
N. S.	Brier Island	Oct. 15-Oct. 20	5	209	101
Maine	Milbridge	Aug. 12-Sept. 25	10	253	2,593
Maine	Castine	Sept. 2-Oct. 31	8	840	996
Maine	Medomak	Aug. 16-Sept. 4	6	87	390
Maine	Lisbon	Aug. 30-Sept. 14	5	62	173
Mass.	Gloucester	Aug. 30-Sept. 13	3	71	162
Mass.	Nantucket	Aug. 1-Oct. 31	40	5,665	8,271
R. I.	Middletown	Aug. 1-Oct. 28	18	1,701	6,592
R. I.	Kingston	Aug. 23-Sept. 30	2	273	131
N. Y.	Tiana Beach	Sept. 20-Oct. 31	10	1,507	966
N. J.	Jamesburg	Aug. 1-Oct. 31	8	984	5,550
N. J.	Island Beach	Sept. 5-Sept. 26	124	5,745	16,827
N. J.	Cape May	Sept. 10-Oct. 12	26	972	3,125
Pa.	Tinicum	Aug. 6-Oct. 25	5	182	94
Pa.	Ardmore	Aug. 6-Oct. 31	5	315	553
Md.	Claiborne	Aug. 28-Sept. 17	3	130	699
Md.	Ocean City	Sept. 5-Sept. 21	50	1,122	7,248
Va.	Chincoteague	Sept. 14-Sept. 19	19	103	1,000
Other stations		Aug. 1-Oct. 18		98	137
Totals				20,319	55,608

MILBRIDGE, Washington County, Maine. 44°28′28″ N, 67°51′47″ W. Operated 33 days. Principal species: 59 Myrtle Warblers (7 on Sept. 3), 35 White-throats (8 on Sept. 11), 24 Swainson's Thrushes. Persistent stormy or windy weather limited netting operations. One return; 53 birds repeated a total of 93 times. Mr. and Mrs. G. Hapgood Parks.

CASTINE, Hancock County, Maine. 44°23′ N, 68°50′ W. Peninsula extending into Penobscot Bay from the northeast; Bagaduce River to the east. Principal trees and shrubs: alder, cedar, tamarack, wild crab-apple, blackberry, blueberry. Natural food considered above average; much better than last year, causing much more dispersion of bird population. Operated 44 days. Nets set usually at ground level; at times to height of 12 feet. Principal species: 213 Song Sparrows (46 on Oct. 19), 112 Chipping Sparrows (29 on Oct. 8), 94 Swainson's Thrushes (20 on Sept. 14). No returns; 9 individuals repeated. Rarities: Clay-colored Sparrow, Saw-whet Owl, Barred Owl. Lt. and Mrs. M. C. Morse, Jr.

MEDOMAK, Lincoln County, Maine. 43°56′ N, 69°24′ W. Operated 10 days. Little evidence of waves. Principal species: 13 Song Sparrows. Four returns; 1 repeat. Rarity: Yellow-breasted Chat. Joseph M. Cadbury.

LISBON, Androscoggin County, Maine. 44°04′ N, 70°05′ W. Operated 11 days. Principal species: 12 White-throated Sparrows (8 on Sept. 14). Douglass H. Morse.

GLOUCESTER, Essex County, Massachusetts. 42°35′ N, 70°39′ W. Operated 9 days, August 30 to Sept. 13. Two returns; 9 birds repeated a total of 20 times. Mrs. Sarah F. Robbins.

NANTUCKET ISLAND, Nantucket County, Massachusetts. 40° N, 70° W (several locations). Operated 67 days. Principal species: 672 Myrtle Warblers (198 on Oct. 13), 656 White-throated Sparrows (105

on Oct. 13), 487 Slate-colored Juncos (83 on Oct. 13, 79 on Oct. 6), 452 White-crowned Sparrows (87 on Oct. 17), 382 Song Sparrows (20 on Sept. 25), 256 American Redstarts (31 on Sept. 23), 220 Yellowthroats (20 on Aug. 17). Rarities: Worm-eating, Golden-winged, Blue-winged, Orange-crowned, Mourning, and Hooded Warblers, Blue Grosbeak, Dickcissel, Lark and Clay-colored Sparrows. John V. Dennis (station leader), Mrs. Roy E. Larsen, Mrs. Edith Andrews, Dr. Lee J. Whittles, John Boyd, Elizabeth Van Duyne, Mabel Depue, Mr. and Mrs. Philip Heywood, Mr. and Mrs. E. A. Bergstrom, Mrs. Stanley S. Dickerson, Frank Frazier, Jr. (Nantucket Ornithological Research Station).

MIDDLETOWN, Newport County, Rhode Island. 41°30′ N, 71°20′ W. Norman Bird Sanctuary. Includes 3 days on Block Island, R. I., October 11-13. Operated 62 days. Principal species: 234 Catbirds (22 on Sept. 20), 140 Song Sparrows (14 on Oct. 14), 124 White-throated Sparrows (43 on Oct. 13, Block Island), 115 Yellow Warblers (25 on Aug. 4), 104 Slate-colored Juncos (64 on Oct. 13, Block Island). Rarities: Western Kingbird, Orange-crowned Warbler, Kentucky Warbler, Dickcissel. James Baird (station leader), Ralph O. Udall, Mrs. James Baird.

KINGSTON, Washington County, Rhode Island. 41°2-′ N, 71°2-′ W. Operated 13 days. Principal species: 78 American Goldfinches (14 on Sept. 13), 31 Catbirds (8 on Sept. 20). Six returns (all Black-capped Chickadees); 17 repeats. Douglas L. Kraus.

TIANA BEACH, Shinnecock Bay, Suffolk County, Long Island, New York. 40°49′ N, 72°32′ W. Outer beach near Tiana Coast Guard Station (7 miles west of Southampton). This barrier beach is only 180 yards wide from bay to ocean at the Coast Guard Station, where the nearest nets were 80 yards from the ocean. The best location was a lane 2,000 feet west of the Tiana Coast Guard Station, in a clump of low pines (maximum height 10 feet) about 90 feet by 100 feet, where nets were 225 yards from the ocean. This lane was long enough for only 3 nets, with the balance of the beach between pines and ocean covered only by short beach grass. On the peak day, Oct. 31, one net in this lane caught 30 birds in 30 minutes. Four to 10 nets, running north-south, operated on 14 days. Principal species: 490 Slate-colored Juncos (118 on Oct. 31), 223 Myrtle Warblers (100 on Oct. 18), 165 Song Sparrows (35 on Oct. 30), 157 White-throated Sparrows (62 on Oct. 31). No station returns; 128 repeats. Rarities: Sage Thrasher, Dickcissel, Red-headed Woodpecker. LeRoy Wilcox (station leader), Walter Terry.

JAMESBURG, Middlesex County, New Jersey. 40°2-′ N, 74°2-′ W. Jolian Farm. Principal species: 189 White-throated Sparrows (28 on Oct. 24), 158 Myrtle Warblers (17 on Oct. 14), 80 Rufous-sided Towhees (7 on Oct. 9). Mrs. Joseph Cardinali.

ISLAND BEACH, Ocean County, New Jersey. 39°46′ to 39°54′ N, 74°05′ W. Principal species: 864 Catbirds (130 on Sept. 6, 100 on Sept. 12); 583 American Redstarts (149 on Sept. 20), 546 Swainson's Thrushes (168 on Sept. 20, 100 on Sept. 9), 298 Red-eyed Vireos (96 on Sept. 20), 266 Yellowthroats (46 on Sept. 6), 239 Rufous-sided Towhees (36 on Sept. 13), 173 Veeries (92 on Sept. 9), 170

Song Sparrows (28 on Sept. 12), 165 Northern Waterthrushes (32 on Sept. 9). Thirty-seven returns; 709 repeats. Rarities: Blue Grosbeak, Clay-colored Sparrow, Lark Sparrow. Mrs. Stanley S. Dickerson (station leader), Stanley S. Dickerson, Bennett K. Matlack, William Pepper, Frank Frazier, Sr., Frank Frazier, Jr., John Given, Mrs. Frank Townsend, John C. Miller, Mr. and Mrs. Albert Schnitzer, Stephen Harty, LeRoy Wilcox, Richard Riesz, Darwin Wood, Joseph R. Jehl, Jr., Mrs. Mabel Warburton, Mrs. Earl Smith, Mr. and Mrs. John Schmid, Mr. and Mrs. Herman Kuch, Mrs. Marie Dumont, G. Dumont, L. Dumont, Gilbert Raynor, Bertram G. Murray, Jr., Michael Logue, Stanley Quickmire, John Dornan, Mr. and Mrs. John Frankenfield, Peter Westcott.

CAPE MAY POINT, Cape May County, New Jersey. 38°56′14″ N, 74°57′10″ W. Wetherbee Woods. Operated daily, Sept. 10-21 and Oct. 11-12. Area was sprayed from one to three times daily in September. Principal species: 266 American Redstarts (88 on Sept. 19), 102 Catbirds (22 on Sept. 19), 80 Swainson's Thrushes (27 on Sept. 20). Eleven returns; 33 repeats. Seth H. Low (station leader), George Hitchner, M. S. Cottrell, Pete Davis.

TINICUM WILDLIFE PRESERVE, Philadelphia, Pennsylvania. 39°5-′ N, 75°1-′ W. Operated 23 days. Principal species: 49 Song Sparrows (12 on Sept. 29), 35 Semipalmated Sandpipers (19 on Aug. 13), 31 Savannah Sparrows (10 on Oct. 13). John C. Miller.

ARDMORE, Montgomery County, Pennsylvania. 40°00′ N, 75°17′ W. Includes 95 birds taken in traps. Operated 65 days. Principal species: 50 White-throated Sparrows (19 on Oct. 19), 37 Catbirds, 35 Robins. Eleven returns; 55 birds repeated a total of 113 times. Dr. E. Wayne Marshall.

CLAIBORNE, Talbot County, Maryland. 38°50′ N, 76°18′ W. Principal species: 24 American Redstarts (9 on Sept. 12), 13 Tennessee Warblers (5 on Sept. 4). One return; 4 birds each repeated once. W. M. Davidson.

OCEAN CITY, Worcester County, Maryland. 38°24′25″ N, 75°03′45″ W. Principal species: 186 Swainson's Thrushes (77 on Sept. 9), 137 American Redstarts (27 on Sept. 9), 94 Veeries (59 on Sept. 9), 82 Baltimore Orioles (57 on Sept. 9). Two returns; 637 repeats. Chandler S. Robbins (station leader), Mrs. Richard D. Cole, Mrs. M. B. Peacock, Arthur H. Fast, Mr. and Mrs. A. J. Fletcher, Gordon Knight, Mr. and Mrs. Edgar Reynolds, Mrs. E. W. Goodpasture, Mr. and Mrs. Carl Lubbert.

CHINCOTEAGUE National Wildlife Refuge, Accomack County, Virginia. 37°54′30″ N, 75°21′15″ W. Principal species: 26 Pine Warblers (20 on Sept. 17); 15 American Redstarts (5 on Sept. 19). One return; 1 repeat. Frederic R. Scott.

OTHER ATLANTIC COASTAL STATIONS. Netting was conducted on 1 to 4 days at the following stations: Kent Island, New Brunswick, 6 birds in 18 net-hours by C. E. Huntington and D. W. Matheson; Rockaway Beach, Long Island, New York, 58 birds in 11 net-hours by P. A. Buckley, P. W. Post, W. Cashman; New Lisbon, New Jersey, 31 birds in 90 net-hours by J. M. Cadbury; Morehead City, North Carolina, 3 birds in 48 net-hours by Dr. Charles H. Blake.

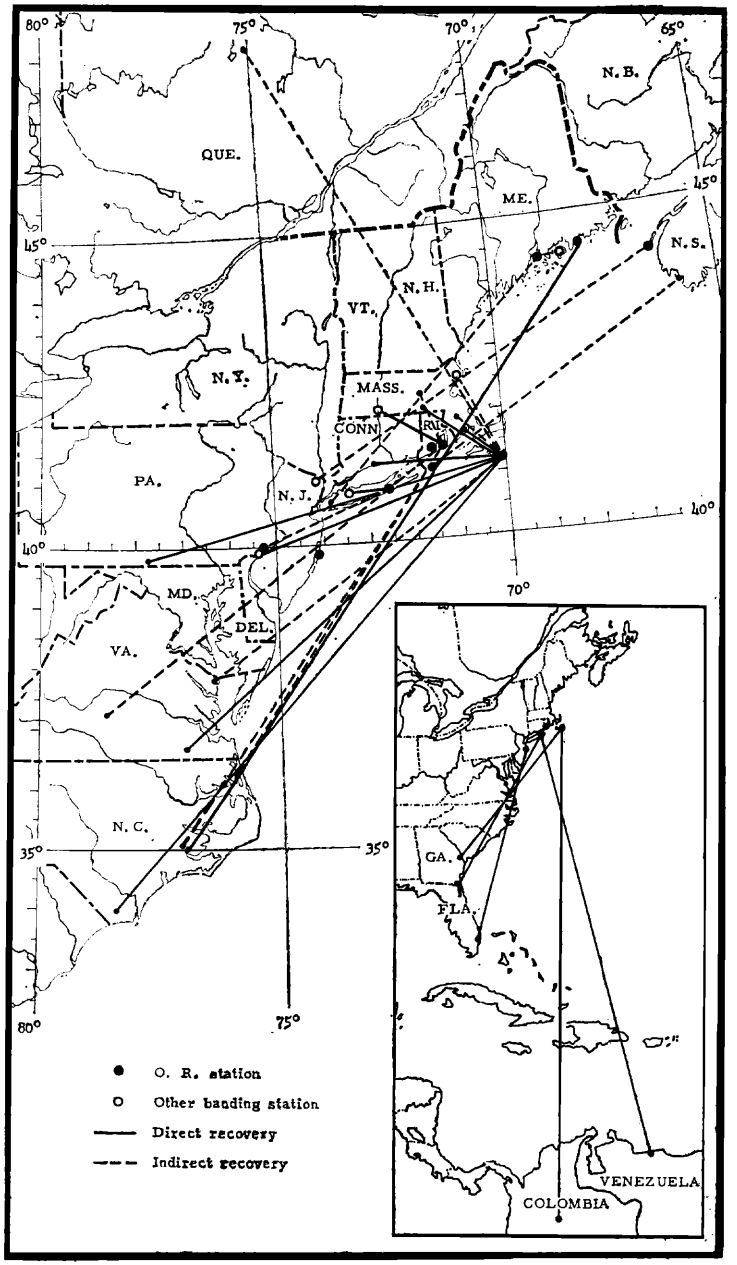

Fig. 2. Additional recoveries of Operation Recovery birds.

STATIONS AT INLAND AND GULF LOCALITIES. Intensive netting operations were conducted at Point Pelee, Ontario (Dow, 1959), and at the Cedar Grove Ornithological Station on the Wisconsin shore of Lake Michigan (Mueller, 1959). Preliminary operations were conducted at several other stations, including the Michigan shore of Lake Michigan (Lawrence H. Walkinshaw), Bear Rocks on the Allegheny Front in West Virginia (Ralph K. Bell *et al.*), and the entrance to Mobile Bay, Alabama (Thomas A. Imhof *et al.*). As these localities are outside the geographic scope of the weather analysis of the present paper, further details of the inland and Gulf Coast bandings will not be presented here. It is hoped that series of netting stations similar to the one along the Atlantic Coast can be in operation in several other parts of the continent in the fall of 1959.

RECOVERIES

Direct recoveries of birds from Operation Recovery in 1955, 1956, and 1957 were listed and mapped in the 1957 report (Baird *et al.*, 1958). Although direct recoveries (those retaken in another locality during the same fall or winter) are of primary interest to the banders, indirect recoveries (those from subsequent seasons) can furnish valuable clues to the approximate origin of birds banded at coastal localities. The origin of coastal migrants takes on increasing significance as understanding of the relation between weather and migration becomes more refined.

Additional recoveries of 1957 birds as well as those available for 1958 birds as of April 10, 1959, are listed in Table 3 and illustrated in Figure 2. The distribution pattern of these birds is quite similar to that of the birds mapped in the 1957 report. Of the 11,613 birds banded in the 1957 operation, 12 (0.10%) furnished direct recoveries and 6 others (total of 0.15%) were recovered during the first 12 months after banding. Recoveries of birds banded at Castine, Nantucket, Middletown, and Kingston after the dates given in Table 1 of the 1957 report are not included in these percentages.

The total number of recoveries to date from each year's bandings (including October, 1957) is as follows: 1 from 1955, 1 from 1956, 30 from 1957, and 10 from 1958. In addition, two birds previously banded by inland banders were captured at coastal netting stations in 1958.

WEATHER AND MIGRATION

Introduction.

Analysis of records from the 1957 bandings in Operation Recovery showed that most good periods of migration came one or two days after the passage of a cold front across the Northeast. The second day often produced the greatest density of migrants, especially when an area of general precipitation followed passage of the front (Baird *et al.*, 1958). A number of exceptions to this generalization were noted, however, and it was found that certain species did not figure prominently in the main migration waves of the more common species.

As the Operation Recovery program expands, it becomes possible to examine these anomalies in more and more detail. The analysis that follows will be concerned mainly with extension and qualification of

Table 3. *Additional recoveries of Operation Recovery birds*

Species	*Band number*	*Banding date*	*Banding locality*	*Bander*	*Recovery date*	*Recovery locality*	*Elapsed time (days)*
Yellow-shafted Flicker	563-48655	9/17/57	Nantucket, Mass.	Whittles	5/15/58	Clova, Que.	239
Catbird#	56-158350	10/ 5/57	Kingston, R. I.	Kraus	about 2/10/58	Jacksonville, Fla.	128±
Wood Thrush	56-120536	9/19/57	Middletown, R. I.	Baird	late summer 1958	Boylston, Mass.	350±
Cedar Waxwing	24-189121	9/ 4/57	Middletown, R. I.	Baird	4/24/58	New Bern, N. C.	232
Brown-headed Cowbird	55-101439	9/ 6/57	Nantucket, Mass.	Whittles	3/28/58	Middleboro, Mass.	203
Brown-headed Cowbird	55-101463	9/ 6/57	Nantucket, Mass.	Whittles	about 2/25/58	East Douglas, Mass.	142±
Brown-headed Cowbird*#	53-178740	10/22/57	Nantucket, Mass.	Dennis	4/13/58	Beverly Farms, Mass. by Samuel Cabot, Jr.	173
Purple Finch*	55-71752	10/ 1/57	Castine, Maine	Morse	5/22/58	Mount Desert, Me. by Mrs. R. Patterson	233
Slate-colored Junco*	22-46660	9/22/57	Brier Is., N. S.	Lewis	4/20/58	Ramsey, N. J. by Mrs. J. Y. Dater	210
Chipping Sparrow#	27-51162	10/13/57	Block Is., R. I.	Baird	10/20/58	Upper W. Pubnico, Nova Scotia	372
White-throated Sparrow*#	25-177097	10/ 3/57	Nantucket, Mass.	Larsen	11/ 6/57	Glenolden, Pa. by Mrs. John Gillespie	34
White-throated Sparrow#	25-176908	10/ 2/57	Nantucket, Mass.	Larsen	1/ 6/58	Hallsboro, N. C.	96
White-throated Sparrow#	24-189599	10/23/57	Middletown, R. I.	Baird	4/11/58	Coinjock, N. C.	170
White-throated Sparrow#	24-189327	10/ 3/57	Middletown, R. I.	Baird	2/15/59	Pamplin, Va.	500
Song Sparrow	23-115448	10/ 5/57	Castine, Maine	Morse	3/24/58	Queens Village, N. Y.	170
Song Sparrow	26-102040	8/28/57	Nantucket, Mass.	Andrews	12/26/58	Harryhogan, Va.	485
Pigeon Hawk	514-09953	9/20/58	Island Beach, N. J.	Dickerson	12/ 8/58	Delray Beach, Fla.	79

Yellow-bellied Sapsucker	26-185831	10/ 6/58	Nantucket, Mass.	Frazier, Jr. about	3/ 2/59	Clyo, Ga.	147±
Robin	532-21698	9/20/58	Milbridge, Me.	Parks	12/17/58	Bridgeton, N. C.	88
Swainson's Thrush	26-171230	9/21/58	Nantucket, Mass.	Larsen prior to	12/11/58	Moniquirá, Colombia	81—
Northern Waterthrush*	61-67303	9/27/58	Tiana Beach, N. Y.	Wilcox	11/29/58	Caracas, Venezuela by Paul Schwartz	63
Baltimore Oriole*	55-117507	6/30/58	Springfield, Mass.	W. A. Tompkins	9/ 6/58	Middletown, R. I. by Baird	67
Common Grackle	623-35727	9/17/58	Nantucket, Mass.	Larsen	1/15/59	Franklin, Va.	118
Brown-headed Cowbird	56-157305	9/13/58	Nantucket, Mass.	Dennis	10/27/58	Branford, Conn.	44
Slate-colored Junco	28-81401	10/ 7/58	Nantucket, Mass.	Frazier, Jr.	letter of 10/31/58	New Bedford, Mass.	24—
Slate-colored Junco*	61-94225	10/30/58	Tiana Beach, N. Y.	Wilcox	2/27/59	Huntington, L. I., N. Y.	120
White-crowned Sparrow	26-171449	10/13/58 repeat 10/16	Nantucket, Mass.	Larsen	letter of 11/ 7/58	by G. Gill Greencastle, Pa.	22
White-throated Sparrow*	26-111640	11/27/57 repeat 3/8/58	Ardmore, Pa.	Marshall	10/30/58	Tiana Beach, N. Y. by Wilcox	236

Banded after specified O. R. period; not included in total bandings in 1957 report.
* Recaptured by another bander.

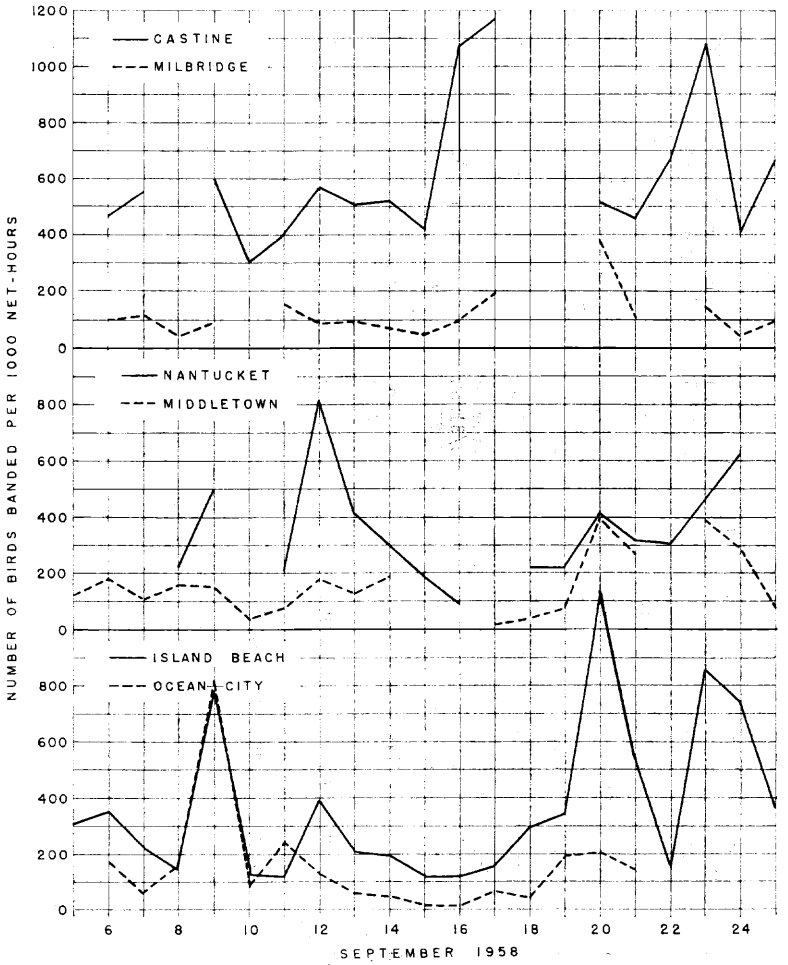

Fig. 3. Total birds banded per 1,000 net-hours during the period September 5 to 25 at the six most active stations.

the generalization in the paragraph above, and will deal mainly with the period September 5-26, 1958, when the six most active coastal stations (Milbridge and Castine, Maine; Nantucket, Mass.; Middletown, R. I.; Island Beach, N. J.; and Ocean City, Md.) were manned almost daily and provided comparable records. Relevant data from other periods and other stations will be mentioned more briefly.

Figure 3 shows the daily fluctuations in the netting rate at these six stations, expressed in terms of total birds banded per 1,000 net-hours. These figures, which eliminate the variation in the number of hours of

netting per day, provide the most reliable index of the fluctuations in migration intensity. They still are susceptible to bias produced by the variable factors mentioned on page 144. For this reason it is necessary to consider the total number of birds that was banded as well as the number banded per net-hour in order to properly evaluate the significance of an observed migration wave; this has been done throughout the following analysis.

It can be seen from Figure 3 that, with a few minor variations, there were five migration peaks shared by most or all of the stations, namely: September 6, 9, 12, 20, and 23. Special emphasis is placed on these peaks in the following analysis.

September 6.

A cold front, which moved eastward over the Northeastern States during daylight hours of the 5th, stalled on a line through southern Pennsylvania and Long Island during the night. To the north of this front the weather was cool (an average drop of 8° from the previous night)* and calm with variable cloudiness in northern New England and total overcast in a narrow belt along the front and in western New York. South of the front the weather was clear and warm with very light winds tending to SW along the coast.

At Island Beach there was a major wave of Catbirds (130 banded) together with good numbers of a few other species, notably Yellowthroat (46), Northern Waterthrush (29), Yellow-breasted Chat (7), Baltimore Oriole (9), and *Empidonax* flycatchers (18). The Ocean City movement was smaller, but included a similar range of species: Northern Waterthrush (11), Ovenbird (6), Yellow-breasted Chat (3), and the season's peak of Catbirds (4). North of the front, movement was relatively light: Castine had small numbers of Savannah Sparrows (6) and Swainson's Thrushes (4); Milbridge noted Swainson's Thrushes (3) and White-throated Sparrows (3). No movement was noted at Nantucket, while the species netted at Middletown were similar to those at the more southern stations: Catbird (10), Northern Waterthrush (2), and Baltimore Oriole (9, including the bird that was banded in Springfield, Mass.—see Table 3).

The paucity of migrants on the New England coast despite the sizable temperature drop may be due to the cloudy conditions behind the front, and perhaps also to the lack of offshore wind that might have concentrated the birds along the coast. The large migration in the very warm conditions south of the front may be associated with the light SW winds near the coast, as large numbers of Catbirds were recorded at Island Beach under similar weather conditions later in the month.

September 9.

During September 6, the Low that had been bringing cloud cover to western New York during the previous night moved across the Great

*Temperature changes mentioned in this section are based on averages of the 0100 hour E.S.T. readings, in degrees Fahrenheit, from Montreal and Quebec, Canada; Caribou and Portland, Me.; Burlington, Vt.; Boston, Mass.; Hartford, Conn.; Albany and Syracuse, N. Y.; and Avoca, Pa.; as published in the *Daily Weather Map* of the U. S. Weather Bureau.

Table 4. *Banding totals (birds per 1,000 net-hours) of the main species involved in the wave of Sept. 8-9, 1958.*

Species	Nantucket		Middletown		Island Beach		Ocean City	
September	8	9	8	9	8	9	8	9
Empidonax spp.	9	51	13	4	7	65	7	42
Swainson's Thrush	5	62	4	4	15	92	32	178
Veery	—	15	4	—	4	84	12	136
Red-eyed Vireo	—	10	—	—	9	55	5	30
Black-and-white Warbler	5	5	—	17	2	28	9	35
Ovenbird	—	10	—	—	2	28	—	46
Northern Waterthrush	23	10	4	—	9	29	19	28
Yellow-breasted Chat	23	5	4	—	2	12	7	16
American Redstart	32	108	4	21	14	85	25	62
Baltimore Oriole	—	51	4	—	3	53	2	132
Net-hours	216	195	234	234	987	1090	432	432

Lakes to the St. Lawrence, and a Tropical warm sector occupied the Northeastern States during the 7th. This was displaced as the cold front moved across the Eastern States during the afternoon and evening, clearing the coast by 0100 on the 8th. The remainder of this night was mainly cloudy with intermittent rain in northern and inland districts, but it was largely clear near the coast from New York City southward. Clearing was complete by the following night, and the weather situation was then the classic one for large migration on the Atlantic coast: a High centered in Ohio, the pressure gradient falling northeastward to a Low in the Gulf of St. Lawrence, and cool clear weather throughout the Eastern States. The temperature dropped an average of 8° on the night of September 7-8, and a further 8° the next night.

No significant immigration was noted on the night of the 7th, but on the 8th an increase was recorded at Nantucket, Middletown, and Ocean City, followed by a major wave on the 9th at all stations except Middletown. Table 4 gives banding totals of the species prominent in this wave. A wide variety of other species also was involved. This wave was noted also at Cos Cob, Conn., where unusually large numbers of birds, mostly northern warblers such as the Tennessee, Cape May, Black-throated Green, Magnolia, and Blackburnian, passed south and southwest throughout the day.

The lack of migration at Island Beach and the relatively small influx at Ocean City on the 8th presumably can be related to the wide area of cloud and rain that extended during the night south to central New Jersey. As similar weather prevailed over most of New England, it is hard to interpret the arrivals at Nantucket and Middletown on the 8th in terms of movement from the north. However, the weather southwest of these stations was clear with SW wind, and it is significant that there was a sudden influx of Yellow-breasted Chats both at Nantucket (5) and Middletown (1), the first recorded at these stations during the month.

September 11-12.

The next cold front passed eastward across the coast during the afternoon of the 10th, and the weather sequence on the 11th-12th was a close parallel to that on the 8th-9th, with the exception that there was less rain behind the front; the night of the 10th-11th was largely clear in coastal districts from southern Maine southward. The temperature

dropped 5° on the night of the 10th-11th, and a further 6° on the 11th-12th, which was the coolest night of the month in the Northeast.

On the 11th a small influx was noted at Milbridge (notably 8 White-throated Sparrows), Nantucket (a few warblers and flycatchers), and Middletown (a few warblers). More significant influxes were noted at Island Beach (66 Red-eyed Vireos, a major peak), at Cape May (58 American Redstarts and 27 thrushes), and at Ocean City (mainly thrushes and warblers). In contrast, on the 12th, Ocean City and Cape May had far fewer new birds and Island Beach had little more than a wave of Catbirds (100 banded); but the northern stations reported a large influx, especially at Nantucket, where 135 warblers were banded. The differential timing of this migration may perhaps be related to the concentrating effect of NW winds, for these were prevalent only at the southern stations during the first night, whereas winds in the north were mainly from the SW at this time; on the night of the 11th-12th the winds were light NW in New England and near calm in the Middle Atlantic States. Records from two inland stations were significant in this connection. Jamesburg, N. J., had a movement of Catbirds, Ovenbirds, American Redstarts, etc. on the 11th-12th, reaching a peak (17 birds banded in 96 net-hours) on the 13th; Claiborne, Md., had a peak (17 birds banded, including 9 American Redstarts) on the 12th. Both peaks took place in calm weather, when little migration was evident at the nearby coastal stations.

September 15-21.

There was no widespread migrational activity at the coastal stations in the few days following the wave of the 12th. The Catbird migration at Island Beach and Cape May continued in the calm weather of the 13th (58 and 10 banded, respectively), while in similar weather small movements of Swainson's Thrushes and White-throated Sparrows occurred at the Maine stations, increasing slightly as a weak front passed southward on the night of the 13th-14th. Ahead of this front Middletown experienced a small influx of warblers and Catbirds on the 14th, and Nantucket a wave of Catbirds on the 14th (21) and 15th (17), before the retreat of the front as a Tropical air flow developed from the SW.

This air flow formed the warm sector of a Low that moved across James Bay and Labrador during the 15th; its associated cold front crossed the New England States late that day and during the 16th. The front stalled over Long Island and Nantucket during the night of the 16th-17th, however, with the result that an area of cloud and rain extended north to southern Maine. Meanwhile a new Low developed from a wave on the front over Missouri. This Low, intensifying rapidly, moved through the Lower Great Lakes Area during the 18th, bringing rain to the Northeastern States; rain ended on the morning of the 19th as the Low moved out to sea. However, the weather in the ensuing high pressure ridge, although calm, remained overcast in the area south and west of Massachusetts, where the sky did not clear until the 22nd (Figs. 4 and 5). North of the overcast area the temperature dropped sharply on the night of the 19th-20th, but in the overcast area radiational cooling was prevented and temperatures actually rose slightly.

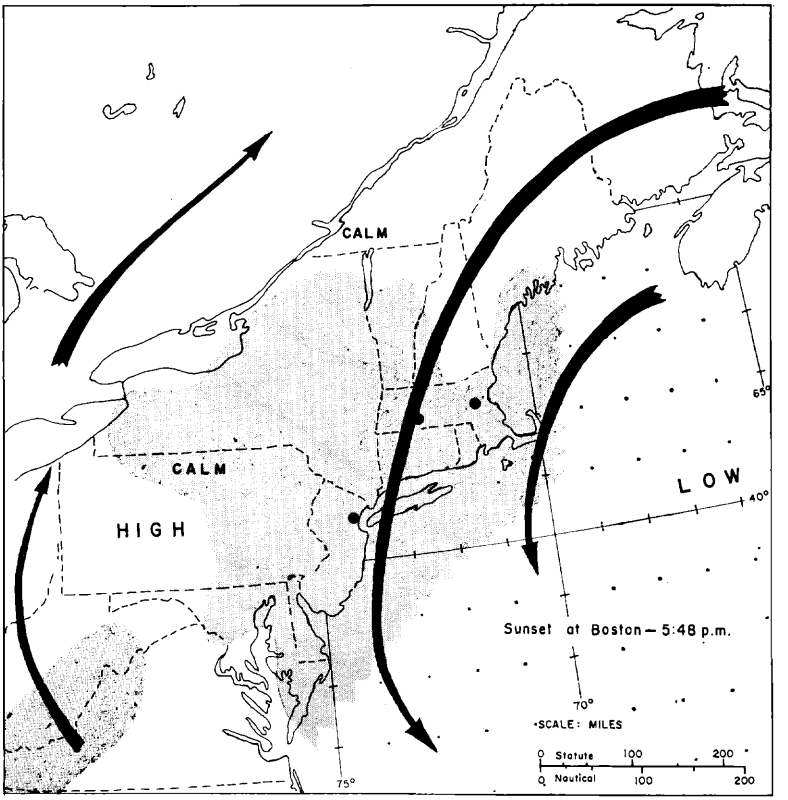

Fig. 4. Weather map for Sept. 19, 1958 at 1800 E.S.T., showing circulation and areas of overcast skies.

No appreciable migration occurred south of Maine on the 16th and 17th, but Maine banders noted movement of Swainson's Thrushes on both dates, and also of Myrtle Warblers and other species on the 17th. During early morning hours of the 17th, as the cloud cover lowered (Packard, 1958), hundreds of birds were killed near the Maine coast at the Portland airport ceilometer (Blackpoll and other warblers, 76%; flycatchers 13%). Many birds were killed at the ceilometer at Rome, N. Y., on the same night (Scheider, 1959), but only two Swainson's Thrushes and one Veery were killed at one of the Boston television towers. It appears that birds which had started to migrate under conditions of broken cloud had been stopped by the rain and cloud in southern Maine and central New York, and that few if any penetrated to the southern New England coast.

There was little migration at the northern stations on the 18th, but at Island Beach, close to the apex of the warm sector, there was a small increase in netted birds, including 34 Yellow-breasted Chats and 24 Baltimore Orioles. Orioles also showed a peak at Ocean City on the 17th (11) and Yellow-breasted Chats on the 18th (4). A sprinkling of southern and western birds appeared between the 13th and 18th at the

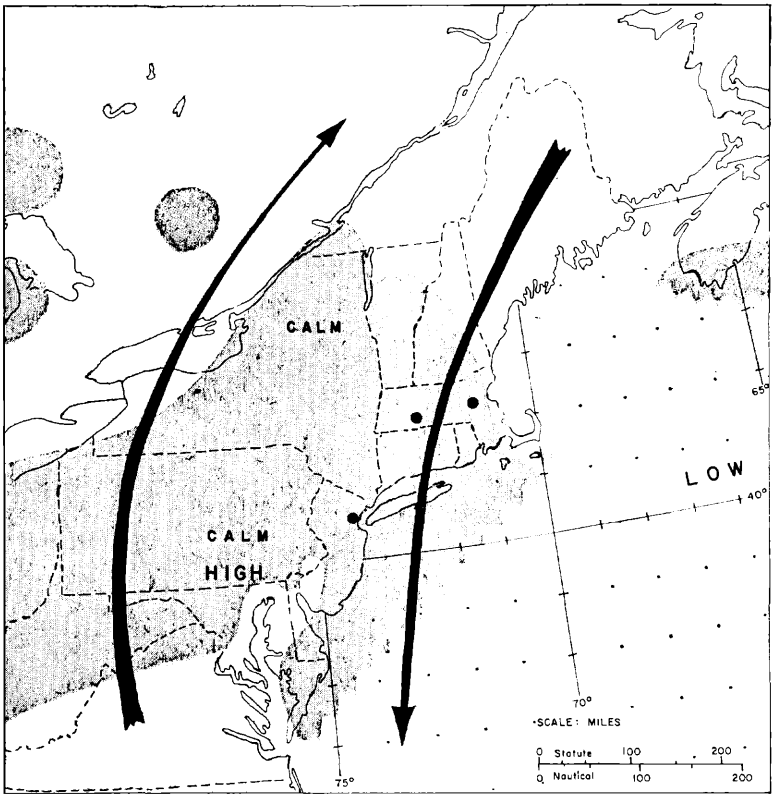

Fig. 5. Weather map for Sept. 20, 1958 at 0100 E.S.T., showing circulation and areas of overcast skies.

stations lying within the Tropical air flow: Blue Grosbeak (2) on the 13th at Nantucket; Summer Tanager (2) on the 14th at Ocean City; Lark Sparrow on the 15th at Nantucket: Clay-colored Sparrow on the 16th at Island Beach; Summer Tanager at Chincoteague, Va., and Island Beach on the 17th; and Blue Grosbeak at Island Beach on the 18th. In addition to these birds at the banding stations, other records during the same period were: three Western Kingbirds, ten Blue-gray Gnatcatchers, two Yellow-breasted Chats, a Hooded Warbler, and two Western Tanagers on Cape Cod, Mass., a Lark Bunting at Plum Island, Mass., and a Say's Phoebe at Gilgo, Long Island, N. Y. (Stackpole and Emery, 1959; Nichols, 1959).

A major wave started on the 19th at most stations, especially at Ocean City and Cape May. It reached a peak at all stations on the 20th and continued to a lesser extent on the 21st. Table 5 gives the banding totals (per 1,000 net-hours) of the most numerous species in this wave at the five major stations, and also the number of dead birds of these species recovered at two Boston television towers. On the night of September 19-20, heavy mortality also was reported from ceilometers

Table 5. *Television tower mortality and banding totals (birds per 1,000 net-hours) of the main species involved in the wave of Sept. 19-21, 1958.*

Species	Boston TV towers			Nantucket			Middletown			Island Beach			Cape May			Ocean City		
September	19	20	21	19	20	21	19	20	21	19	20	21	19	20	21	19	20	21
Empidonax spp.	—	—	1	14	7	11	—	9	—	6	37	35	45	4	—	5	3	—
Brown Creeper	—	—	—	—	46	9	—	—	—	2	2	—	—	—	—	—	—	—
Catbird	—	—	—	6	55	51	8	100	78	15	80	20	91	70	107	4	3	8
Swainson's Thrush	—	—	—	6	7	17	8	5	4	27	196	75	45	118	143	20	20	8
Gray-cheeked Thrush	—	—	—	3	2	7	—	9	17	4	42	20	17	39	71	2	—	3
Veery	—	1	—	—	—	6	—	—	—	4	30	7	45	118	107	9	8	—
Red-eyed Vireo	—	20	6	8	9	4	—	9	—	24	104	33	12	96	—	2	29	8
Black-and-white Warbler	—	44	3	11	19	11	8	45	13	5	39	29	17	18	—	4	5	5
Magnolia Warbler	—	19	2	11	7	4	—	5	4	14	40	9	8	4	71	12	2	—
Blackpoll Warbler	—	18	4	3	5	4	—	14	—	50	14	22	4	—	—	7	3	3
Bay-breasted Warbler	—	15	2	11	5	2	—	—	—	1	9	2	—	4	—	—	3	—
Ovenbird	—	30	8	—	7	11	—	5	4	1	27	20	25	31	107	2	2	—
Northern Waterthrush	—	—	1	14	12	21	—	9	9	1	25	18	12	75	107	2	12	3
Yellowthroat	—	1	—	6	19	13	—	14	22	8	27	15	128	53	71	4	15	3
Yellow-breasted Chat	—	—	2	9	2	—	—	—	4	12	8	11	29	—	36	20	5	—
American Redstart	—	30	5	11	33	37	8	77	4	30	174	84	364	232	107	30	32	30
Scarlet Tanager	—	—	—	—	5	—	—	—	—	5	5	2	4	—	—	9	8	3
Rose-breasted Grosbeak	—	1	—	—	5	—	—	—	—	4	19	—	4	—	—	4	3	3
Net-hours	—	—	—	354	583	534	120	220	232	948	855	455	242	228	28	564	591	368

at West Springfield, Mass., and Newark, N. J., involving a range of species very similar to that at Boston. On the same night there was a large migration of thrushes over Cambridge, Mass., and Middletown, R. I.; and on the next day large numbers of birds were recorded all along the New England coast (Stackpole and Emery, 1959; Baird, 1959).

A most interesting feature of this wave is the weather pattern in which it originated. In the other situations in which heavy flights originated, both in September 1957 and September 1958, clear skies and falling temperatures prevailed over a wide area immediately to the north of those netting stations that experienced a heavy influx of transients. On the night of September 19-20, 1958, on the other hand, a cloud blanket covered southern New England and adjacent areas. Figures 4 and 5 show the extent of cloud cover in the Northeast at 1800 E.S.T. on September 19 and 0100 on September 20. Although the great majority of the birds that struck the Boston TV towers that night, and many of the birds that arrived at the New England coastal netting stations, probably originated north of the overcast area, it is debatable whether all the birds that were recorded at the Newark ceilometer and Island Beach could have come from areas where skies had begun to clear. Unfortunately, it has not been possible to ascertain the time of night at which the Newark ceilometer kill started, so that the distance the birds might have flown cannot be calculated; but the weather records show that there were no breaks in the overcast within 180 miles of Newark at sunset on the 19th. Thus it is quite possible that much of this flight originated under largely or totally overcast conditions, as was almost certainly true for part of the flight that reached southern New England on the previous night.*

In this connection it should be noted that: (1) There had been no heavy migration through southern New England since September 12 (8 days); (2) A cold front had moved slowly southward through New England, causing a sharp temperature drop in the north on September 17 and 18; (3) Overcast skies and general rain had blanketed New York and most of New England on the nights of September 16-17 and 17-18, but precipitation had ceased over most of the area by sunset on the 19th.

Weather conditions like those that existed on the night of September 19-20 over southern New England normally would have seemed very unfavorable for the initiation of a substantial migration wave. However, the combination of a long period of "hold-up," cold frontal passage three days before and an associated temperature drop (followed by a continuation of low temperatures), cessation of precipitation, and possibly indication of clearing weather, apparently produced an exceptionally strong motivation to migrate. It seems possible also that the stormy weather in the intervening period had provided an additional stimulus so that the flight was released at the very first sign of improvement (*cf.* Ball, 1947; Nisbet, 1957). The separate effects of these individual factors cannot be evaluated at the present time.

*In particular, thrushes were heard over Cambridge, Mass. (84 calls in 11 minutes) two hours after sunset on the 18th, although 20 stations within 200 miles northeast and northwest all reported solid overcast at sunset.

Ten of the 23 Ovenbirds preserved from those killed at the Boston TV towers on the night of September 19-20 were identified by T. D. Burleigh as *S. a. furvior*. This confirms the northeastern origin of some of the birds reaching Boston in that wave.

In contrast to the wave of the 12th, there was little offshore wind on the night of the 19th-20th and none at all on the 20th-21st; thus the wind could not have been the primary cause of a concentration on the coast. The large numbers of birds at the coastal stations may have been in part a result of disorientation and confused flight caused by overcast weather. This explanation has been suggested by Baird (1959) for the birds seen off the Rhode Island coast on the 20th; overcast weather also is associated with the collision casualties, such as those that occurred at the television towers and at the ceilometers that night.

It is interesting to note from Table 5 that a few species (*e.g.*, Blackpoll Warbler, Yellow-breasted Chat, and Scarlet Tanager) arrived in greater numbers on the 19th, the first day of the wave. This movement of chats may be connected with the waves in SW winds on the previous two days, and it is interesting that other southern and western birds also appeared at this time; *viz.*, 4 Dickcissels at Nantucket on the 19th and 20th; Blue Grosbeak at Ocean City on the 19th; White-eyed Vireos at Middletown and Kingston, R. I., on the 20th; Hooded Warblers at Nantucket on the 19th, at Cape May and Island Beach (2) on the 19th-20th, and at Ocean City on the 20th-21st; Lark Bunting at Nantucket on the 20th; 5 Western Kingbirds in New England, including one at Middletown on the 21st; and a Yellow-headed Blackbird and a Clay-colored Sparrow at Nantucket on the 21st.

September 23.

The wave of the 21st was stopped by a complex low pressure system that passed through on the night of the 21st-22nd, bringing rain to the entire Atlantic seaboard. This was succeeded in the latter part of the night by a SW airflow followed by a second cold front, which passed rapidly out to sea on the 22nd. By 0100 on the 23rd, the High was centered over Pennsylvania and produced a light NW airflow over the Northeast. On the following night, calm clear weather prevailed along the entire coast; the wind returned to SSW late on the 24th as the High moved out to sea. The average temperature dropped 6½° on the night of the 22nd-23rd and rose again 2½° the following night.

Very little migration was noted at the coastal stations after the SW wind on the night of the 22nd, but a Worm-eating Warbler was trapped at Nantucket and some 10 birds, including a Yellow-breasted Chat, a Connecticut Warbler, and a Scarlet Tanager, were killed at the Boston television towers. The 23rd was a peak day at all the stations manned: Milbridge had an influx of Robins (9); Nantucket banded 95 warblers (including 13 Blackpolls, 31 American Redstarts, and a Yellow-breasted Chat), 16 Catbirds, 13 Brown Creepers, 11 Swainson's Thrushes, and 32 White-throated Sparrows; and Middletown netted 5 Swainson's and 4 Gray-cheeked Thrushes, 4 Ovenbirds, and 3 Blackpoll Warblers. Island Beach, like Nantucket, had a sudden influx of Brown Creepers (17) and White-throated Sparrows (53), in addition to a peak of 24

Rufous-sided Towhees and many other common species. An all-day diurnal movement of similar species was noted at Cos Cob, Conn.

This wave provides an excellent example of the importance of falling temperature in initiating a migratory flight, because the peak coincided with the drop in temperature, and the decline in migration the next day coincided with a warming trend. As on September 6 and September 13, the Catbird was the main species to move in the calm center of the High.

Other waves.

Fewer stations were manned outside the period September 5-26, so it is not possible to analyze the remainder of the migration in similar detail; but all the large waves that were recorded followed closely after the passage of cold fronts. The following few examples in August and October provide particularly interesting data.

The cold front of August 31—September 1 was followed in New England by an area of cloud that persisted for some 36 hours; a small wave of warblers arrived at Middletown on the 2nd and 3rd, and a more pronounced wave reached Nantucket, where 15 American Redstarts were banded on the 2nd and 27 Northern Waterthrushes on the 3rd. Like the cold front of September 18 (but unlike others during the month, which were not preceded by a strong flow of Tropical air from the SW), this front was preceded and followed by the arrival of a number of southern and western birds, notably Yellow-breasted Chats, Blue-gray Gnatcatchers, and Lark Sparrows on the New England coast (Stackpole and Emery, 1959); there was also a Kentucky Warbler at Middletown on September 1, and single Worm-eating and Hooded Warblers were banded at Nantucket on September 2.

The cold front of September 26-27 was followed by a cloud belt associated with hurricane "Helene"; skies cleared when the flow of Polar air was re-established on the night of the 28th-29th. Little migration was evident until the 29th, when Nantucket had its largest banding total of the month (250 birds).

The cold front of October 5 was the first since August to be followed closely by clear skies and a strong flow of Polar air. At Nantucket, these conditions resulted immediately in a large wave on the 6th (179 birds per 100 net hours), composed principally of White-throated Sparrows and Slate-colored Juncos. Large numbers of these two species and of White-crowned Sparrows also were present on the next two days in the center of the high pressure ridge.

The cold front of October 10-11 was noteworthy for its strong flow of Polar air from the NW; this persisted until late on the 13th and resulted in an aggregate temperature drop of 20°-30° in the Northeast. This produced the largest wave of the season, building up to a peak on the 13th, when 597 birds were trapped in 197 net-hours at Nantucket, and 236 in only 20 net-hours at Block Island, R. I., where tens of thousands of migrants were present (Baird and Nisbet, in prep.). The most numerous species were Yellow-shafted Flicker, Myrtle Warbler, Savannah Sparrow, Slate-colored Junco, Chipping Sparrow, and White-throated Sparrow; unusually large numbers of White-crowned Sparrows were noted on outer Cape Cod and on Nantucket.

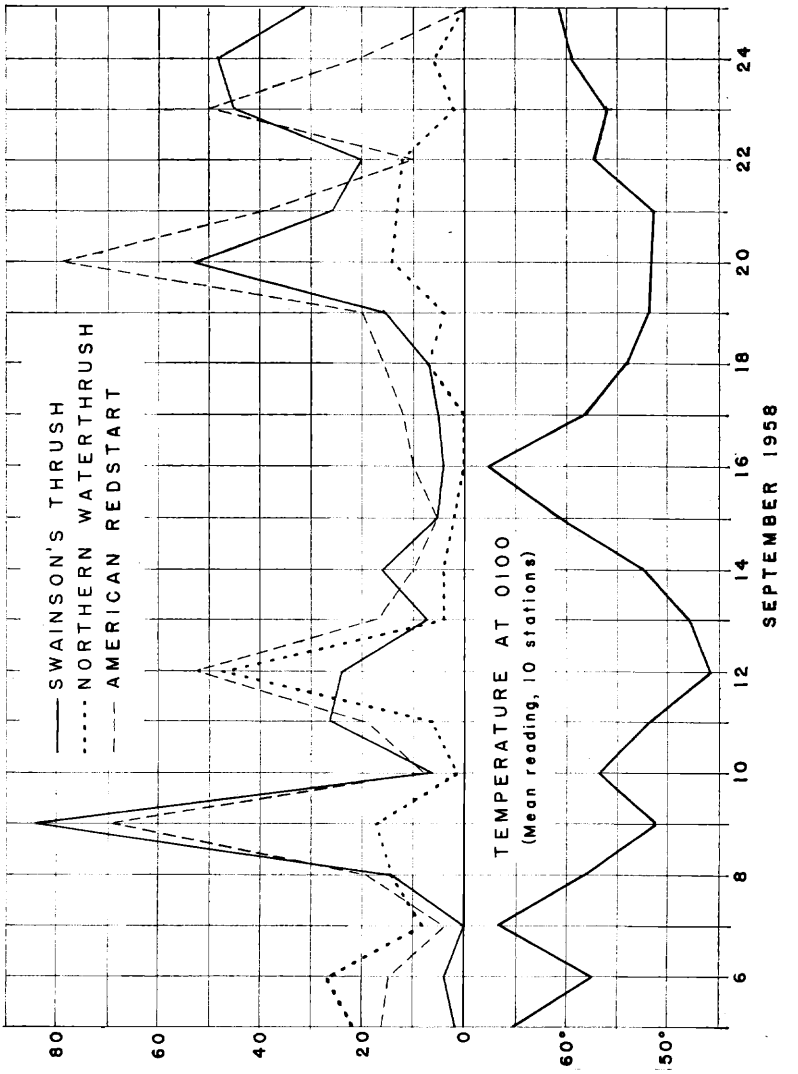

Fig. 6. Graph showing migration peaks coinciding with marked temperature drops.

The cold front of the 17th-18th produced waves as far apart as Brier Island, N. S., and Long Island, N. Y., but no very striking influx was noted at Nantucket. This wave was notable at Brier Island for late records of Canada and Black-and-white Warblers, among others, and for records of 2 Western Kingbirds, 2 Brown Thrashers, a Yellow-breasted Chat, and a Dickcissel. A Sage Thrasher was netted at Tiana Beach, Long Island, on the 18th, and on the same day Western Kingbird, Blue Grosbeak, Lark and Clay-colored Sparrows were seen at Riis Park. Although the migration on the Long Island coast had dropped

off markedly on the 19th, that day marked the peak inland at Jamesburg, N. J., where 32 birds were trapped as compared with 14 on the 18th. The same anomaly was noted in several earlier waves at this station when inland peaks occurred on September 2-3, 13, 24 and 30, and on October 9 and 14-15, corresponding to coastal waves on September 2, 11-12, 23 and 29, and October 6 and 12-13.

The last major wave in the Operation Recovery period occurred at the end of October, following the clearance of a persistent coastal Low that brought continuous rain to southern New England, October 22-29. At Tiana Beach, L. I., the wave was noted from October 29 through October 31, and involved mainly Slate-colored Juncos, other sparrows, and Myrtle Warblers (550 birds per 100 net-hours for the three-day period). At Nantucket, however, the movement began on the 28th, while the Low was still centered in the Hudson Valley and was producing SW winds along the coast north of Virginia and rain over the entire area northward. It is therefore difficult to account for the arrival of the birds at Nantucket unless it is supposed that they came from the southwest. This hypothesis would explain the occurrence of many late stragglers there, including Red-eyed Vireo, Black-and-white Warbler, American Redstart, Ovenbird, and Baltimore Oriole.

Discussion and Conclusions.

Although the autumn's records provide abundant confirmation of the correlation between waves of migrants on the coast and the NW flow of Polar air behind cold fronts, the detailed analysis of the records for September emphasizes the diversity of factors to which the birds actually react. The influx of Polar air usually leads to a sharp fall in temperature that is closely correlated with clearance of cloud behind the cold front. In typical circumstances, both factors stimulate migrants simultaneously. The effect of temperature is shown in Figure 6, which demonstrates the close correlation between the average temperature in the region and the observed migration waves of three species of common nocturnal transients; the number of birds per 1,000 net-hours is the mean from four stations (Nantucket, Middletown, Island Beach, and Ocean City), each station weighted equally. Specific examples of temperature effects also are provided by the chronology of the wave of September 23-24 and the large number of birds on the island stations on October 13.

The wave of September 19-21 shows that in unusual circumstances birds may start to migrate in numbers under an overcast sky, apparently influenced by a temperature drop a few days earlier and the cessation of stormy weather. As was particularly emphasized by this latter wave, the amount of stimulation necessary to initiate migration thus will depend upon the specific and individual stage of the migration cycle, and will be less for a bird that is late or has been held up for a long period.

As usual, many of the large waves (with exceptions to be discussed below) took place in NW winds. We believe that this correlation is exaggerated by concentration against the coast by wind-drift of the kind discussed elsewhere by Baird and Nisbet (in prep.). Three separate features of the 1958 records suggest that at times such drift can be important:

1. During the wave of September 5-6, migrants were seen in large numbers only at stations where the wind was blowing from the NW.
2. Migration peaks at the inland station at Jamesburg, N. J., consistently occurred in calm weather, one day later than the corresponding peaks in NW winds at the nearby coastal station at Island Beach.
3. During September, cold frontal activity was weak, and there were few periods of prolonged NW winds of any strength on the Atlantic coast. Correspondingly, several stations in New England agreed in reporting a poor migration, without well-marked waves. In contrast, after the cold front of October 10-11, NW winds persisted in unusual strength for nearly 72 hours, and produced the best migration wave of the season on the 13th.

On the other hand, there were several times when northern species arrived at Nantucket in N or NE winds, which suggests that they crossed the Gulf of Maine directly from the north or northeast (Dennis, 1957-58). The significance of these records is discussed more fully elsewhere (Baird and Nisbet, in prep.). They do suggest that the occurrence of migrants on the coast is not completely dependent on offshore winds.

As was noted in the analysis of the 1957 Operation Recovery data, the sequence of migration events at the coastal stations usually can be correlated with the eastward movement of high pressure cells: the largest immigrations take place in the eastern and northeastern parts of the Highs. Although this conclusion was confirmed in the 1958 season, it also was found that arrivals of some species often continued in the central and western parts of the Highs. This happened under the specialized conditions outlined below.

Some common coastal migrants (notably the Catbird) often are poorly represented in the big waves that take place in NW winds, and instead occur in largest numbers in calm weather or even in SW wind. As their migration on the days of peaks of other species is liable to be overemphasized by the effect of drift against the coast in NW winds, it is evident that these species migrate at least as often in the central or western part as in the eastern part of a high pressure cell.

The species whose occurrence on the coast is most closely associated with SW wind is the Yellow-breasted Chat; in fact, *all* the waves of chats at the more southern stations, both in 1957 and 1958, took place within tropical air flowing from the southwest. Significantly, many of these waves coincided with arrivals of chats at Middletown and Nantucket, close to the northeastern edge of the species' range. In view of the occurrence of other, rarer, southern and western species at the same stations at the same time (*e.g.*, during September 13-19), it is natural to suspect that these chats arrived in New England from the southwest, flying in the SW winds within a Tropical warm sector. The wave of chats on September 18, at Island Beach, at the apex of a warm sector, is a very striking parallel to the waves of northeastward flying migrants that are produced in spring by the same conditions (Gunn and Crocker, 1951; Bagg, 1957, 1958).

The occurrence of Yellow-breasted Chats, and other southern and western birds, on the New England coast in NW winds, in conjunction with waves of northern migrants, now takes on new significance. The birds that are found on the mornings after overnight cold front passage

(as on September 1 and 19 and October 18, 1958) may well be birds whose northeast flight has been "arrested" by the front, as often happens in spring (Bagg *et al.*, 1950). Others may have arrived from the southwest one or more days earlier, and then been stimulated by the cold frontal passage to return southward; their migration would thus be "redetermined passage" of the kind discussed by Nisbet (1957). Classic examples of redetermined passage date from the autumn of 1954, when many southern vagrants were carried north by hurricanes, and then filtered southward through New England following subsequent cold fronts (Baird, 1955). Migration sequences such as that of September 13-19, 1958, certainly give much support to the hypothesis that chats and other southern and western species usually reach New England from the southwest, flying within Tropical warm sectors.

Waves of chats usually are associated with relatively small influxes of more common species at the coastal stations, and it is hard to believe that their origins could be dissimilar. A suggestive case is the chat movement of September 6, 1958, when Catbirds, Baltimore Orioles, Northern Waterthrushes and Ovenbirds also reached peak numbers at Island Beach in SW winds, and were also the dominant species at Middletown, although the more northern stations recorded a quite different range of species. Catbirds and Baltimore Orioles also were prominent in the movements in the SW winds in mid-September. Daily banding totals of Catbirds at Island Beach from the 15th to the 18th were 28, 25, 56, and 50. The number dropped to 14 on the 19th as other species began to arrive in numbers. Pending further investigation, it seems reasonable to suggest that the northeast movements in Tropical air are shared by a variety of different species, those of southern and western range (*e.g.*, Yellow-breasted Chats and Western Kingbirds) providing useful clues as to the origin of the others.

This hypothesis would account for many puzzling features of migration on the northern half of the Atlantic coast: the northeastward movement of some banded birds (Lincoln, 1939; Baird *et al.*, 1958); the simultaneous arrival of rarities of southern and western origin (Baird *et al.*, 1958); and the prolongation of the migration of many species into October and November, long after their passage is over at comparable latitudes inland (Borror, 1950; Griscom and Snyder, 1955). It is difficult, however, to suggest any plausible reason for such reverse movements. Disorientation by cloud, the cause of similar movements in Europe (Williamson, 1955), is ruled out, as Tropical air usually is clear. The wind usually is not strong enough to force birds northeastward if they are attempting to fly toward the south or southwest: the birds must be orienting northeastward.

There is evidence from the Boston television tower and Empire State Building records in 1957-58 (see, for example, the movement of September 22 discussed above) that northeastward movement of chats and other species sometimes takes place if the wind is SW *behind* a cold front (*i.e.* not in Tropical air); this suggests that the direction of the wind may be an important factor in orienting these movements. Further investigation of these puzzling reverse movements will be one of the major tasks of "Operation Recovery" in future years.

PARASITES

At the Middletown, R. I., station during the 1958 period, 72 specimens of two species of flies (Hippoboscidae—*Ornithomyia fringillina* and *Ornithoica vicina)* and one tick *(Haemaphysalis leporis-palustris)* were collected from 18 species of birds. The number and hosts of flies seen but not captured also were noted. All information and specimens were sent to Dr. Joseph C. Bequaert at the University of Houston, Houston, Texas.

BIRD WEIGHTS

Body weights, fat class data, and wing measurements from several thousand birds banded in 1958 and prior years are being analyzed for separate publication.

PLANS FOR 1959

It is expected that the 1958 netting stations will be in operation again in 1959, and that a few additional staions will be established. Banders who wish to operate nets at old stations or to establish new netting locations are urged to notify the senior author of their intentions, in order that the best possible coverage may be arranged. In addition to the coastal network, series of netting stations are being planned along some of the Great Lakes, the Appalachian Mountains, the Gulf of Mexico, and possibly the east face of the Rocky Mountains. Participants are also welcome in inland localities away from concentration points, provided their stations are operated on a daily basis during the peak period.

Although Operation Recovery will extend through the months of August, September, and October, it is hoped that all of the principal stations can be in continuous operation during the period from September 5 to 27 inclusive. In previous years the suggested dates were staggered in order to coincide with the southward progress of the peak of the insectivorous migrants. It now is apparent, however, that the advantages of having all stations in operation at the same time greatly outweigh the advantages of attempting to follow the peak of migration. The greatest usefulness of the data has been in showing the effects of weather conditions over a large area.

There is still an urgent need for systematic observations of visible migration, for nocturnal call counts, and for lunar observations, both at the netting stations and at other localities during the Operation Recovery period. Other ways in which non-banders can contribute to this project can be outlined by any of the station operators.

SUMMARY

Operation Recovery, 1958, resulted in the banding of 20,221 birds during August, September and October at the 18 most active netting stations on and near the Atlantic coast from Nova Scotia to Virginia. Banding totals for the more common species in the months of August and September were compared with totals for the same period in the preceding year. The Catbird was the only common species that registered a general decline in 1958. A summary of banding activity

at each station is given. At Middletown, R. I., 72 specimens of 2 species of Hippoboscidae and one tick were collected from netted birds.

One additional direct recovery and 6 subsequent recoveries of 1957 birds are listed and mapped together with several from October 1957 bandings (after the O. R. period). Ten direct recoveries of 1958 birds, including two from South America, also are listed and mapped.

The relation between the weather and the arrivals of migrants at the coastal stations is analyzed with special reference to the period September 4-24, when a number of stations were manned simultaneously. All the large waves of migrants followed closely after the passage of cold fronts through the coastal areas. Largest numbers usually coincided with a sharp temperature drop in the Northeast and a strong flow of Polar air from the NW. Several waves in September were delayed for one or two days by areas of cloud and rain behind the cold fronts. In one unusual case when cloudy, wet weather persisted for several days over southern New England, some birds appear to have started to migrate under totally overcast skies; but complete analysis of this situation is complicated by the simultaneous arrival of other birds from clear areas to the northeast.

Migration usually declined at the coastal stations as the high pressure cells moved eastward and the NW winds dropped; but movements of Catbirds usually continued or even strengthened under these conditions. Waves of Yellow-breasted Chats frequently occurred at the coastal stations in SW winds within Tropical warm sectors, and it is suggested that the birds were arriving from the southwest. Such movements appear to coincide with arrival of many other southern and western birds in the Northeast, and there is circumstantial evidence that these movements are shared also by a number of more common species.

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APPENDIX

Scientific Names of Bird Species Mentioned in the Text

Pigeon Hawk, *Falco columbarius*
Semipalmated Sandpiper, *Ereunetes pusillus*
Barred Owl, *Strix varia*
Saw-whet Owl, *Aegolius acadicus*
Yellow-shafted Flicker, *Colaptes auratus*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Western Kingbird, *Tyrannus verticalis*
Say's Phoebe, *Sayornis saya*
Black-capped Chickadee, *Parus atricapillus*
Red-breasted Nuthatch, *Sitta canadensis*
Brown Creeper, *Certhia familiaris*
Catbird, *Dumetella carolinensis*
Brown Thrasher, *Toxostoma rufum*
Sage Thrasher, *Oreoscoptes montanus*
Robin, *Turdus migratorius*
Wood Thrush, *Hylocichla mustelina*
Swainson's Thrush, *H. ustulata*
Gray-cheeked Thrush, *H. minima*
Veery, *H. fuscescens*
Blue-gray Gnatcatcher, *Polioptila caerulea*
Cedar Waxwing, *Bombycilla cedrorum*
White-eyed Vireo, *Vireo griseus*
Red-eyed Vireo, *V. olivaceus*
Black-and-white Warbler, *Mniotilta varia*
Worm-eating Warbler, *Helmitheros vermivorus*
Blue-winged Warbler, *Vermivora pinus*
Tennessee Warbler, *V. peregrina*
Orange-crowned Warbler, *V. celata*
Yellow Warbler, *Dendroica petechia*
Magnolia Warbler, *D. magnolia*
Cape May Warbler, *D. tigrina*
Black-throated Green Warbler, *D. virens*
Blackburnian Warbler, *D. fusca*
Myrtle Warbler, *D. coronata*
Bay-breasted Warbler, *D. castanea*
Blackpoll Warbler, *D. striata*
Pine Warbler, *D. pinus*
Ovenbird, *Seiurus aurocapillus*
Northern Waterthrush, *S. noveboracensis*
Kentucky Warbler, *Oporornis formosus*

Connecticut Warbler, *O. agilis*
Mourning Warbler, *O. philadelphia*
Yellowthroat, *Geothlypis trichas*
Yellow-breasted Chat, *Icteria virens*
Hooded Warbler, *Wilsonia citrina*
Canada Warbler, *W. canadensis*
American Redstart, *Setophaga ruticilla*
Yellow-headed Blackbird, *Xanthocephalus xanthocephalus*
Baltimore Oriole, *Icterus galbula*
Brown-headed Cowbird, *Molothrus ater*
Western Tanager, *Piranga ludoviciana*
Scarlet Tanager, *P. olivacea*
Summer Tanager, *P. rubra*
Rose-breasted Grosbeak, *Pheucticus ludovicianus*
Blue Grosbeak, *Guiraca caerulea*
Dickcissel, *Spiza americana*
Purple Finch, *Carpodacus purpureus*
Rufous-sided Towhee, *Pipilo erythrophthalmus*
Lark Bunting, *Calamospiza melanocorys*
Savannah Sparrow, *Passerculus sandwichensis*
Lark Sparrow, *Chondestes grammacus*
Slate-colored Junco, *Junco hyemalis*
Chipping Sparrow, *Spizella passerina*
Clay-colored Sparrow, *S. pallida*
White-crowned Sparrow, *Zonotrichia leucophrys*
White-throated Sparrow, *Z. albicollis*
Song Sparrow, *Melospiza melodia*

Norman Bird Sanctuary, Third Beach Road, Middletown, R. I.; Farm Street, Dover, Mass.; 19 Wendell Street, Cambridge, Mass.; Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior, Patuxent Research Refuge, Laurel, Md.

OBSERVATIONS OF DIURNAL MIGRATION IN THE NARRAGANSETT BAY AREA OF RHODE ISLAND, IN FALL 1958

By JAMES BAIRD and IAN C. T. NISBET

INTRODUCTION

In spite of its great development in Europe, the study of the diurnal migration of passerines has been badly neglected in North America. Indeed, we have found only the most casual references to it in the literature of New England birds. Nevertheless, while the east coast of North America has nothing to rival the vast finch migrations of Europe, visible migration is a conspicuous phenomenon in New England and can at times be quite spectacular.

In this paper we describe intermittent observations of diurnal migration made during the fall of 1958 in the Narragansett Bay area of Rhode Island. The geography of this area (Fig. 1) raises problems of special interest in regard to the behavior of migrating birds faced with a water crossing. Birds flying west along the coast must make several water crossings of a mile or more in order to pass through the area, while even those flying further inland, away from the coast, encounter wide stretches of open water in the upper bay. Observations at Brenton Point in 1956 and 1957 (Baird *et al.*, 1958) had shown that many coasting birds, particularly Eastern Kingbirds *(Tyrannus tyrannus)*, Bobolinks *(Dolichonyx oryzivorus)* and Redwinged Blackbirds