POPULATION AFFILIATION OF CANADA GEESE FROM SIX SOUTHERN REFUGES

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Abstract: Personnel of 6 National Wildlife Refuges in Arkansas, Mississippi, and Tennessee captured and neckbanded 1,462 Canada Geese *(Branta canadensis)* in 1977-80. Of these, 728 individuals were observed 1,430 times in the Mississippi Flyway. These observations and 44 hunting recoveries indicated that geese from the 6 refuges had varying degrees of association with both the Mississippi Valley Population and the Eastern Prairie Population. Geese banded at White River refuge tended to show greater affiliation with the Eastern Prairie Population than did geese banded at 3 other refuges.

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Two major goals of migratory bird management are maintenance or enhancement of population levels and preservation or restoration of distribution patterns which are beneficial to both birds and humans. Numerical objectives have been or can be attained for most populations of Canada geese in North America, but alteration of distribution patterns of Canada geese has been a large and growing problem for some waterfowl managers in the Atlantic and Mississippi Flyways. Before 1944, Louisiana wintered more Canada geese than any other state in the Mississippi Flyway (Hankla and Rudolf 1967). In the December 1979 Canada goose inventory less than 0.6 percent of the wintering Canada geese in the Mississippi Flyway were in Louisiana (Gamble 1980). This drastic change has given rise to 2 hypotheses explaining the current distribution: (1) The "short-stopping" hypothesis contends that changes in distribution were brought about by creation and improvement of habitat on the more northerly wintering areas (Hankla and Rudolf 1967). (2) The "differential survival" hypothesis contends that wintering groups of geese are essentially discrete populations which fluctuate with variations in mortality, primarily from hunting (Crissey 1968, Raveling 1978).

The objectives of our study were: (1) to describe the geographic and temporal distribution of Canada geese marked in winter on refuges south of the 36° parallel; and (2) to document the affiliation of geese from these refuges with 2 major goose populations in the Mississippi Flyway, the Mississippi Valley Population (MVP) and the Eastern Prairie Population (EPP). Such data could lead to improved identification of discrete remnant populations and/or improved protection and survival for segments of populations which intermittently wintered on these refuges.

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METHODS

Geese were captured with rocket and cannon nets (Dill and Thornsberry 1950) propelled over corn bait at 6 National Wildlife Refuges (NWRs) south of the 36° parallel (Table 1,

Fig. 1). All geese were banded with standard U.S. Fish and Wildlife Service legbands and neckbanded (Ballou and Martin 1964, Craven 1979). All subsequent references to marked individuals refer to the unique 4 digit, alpha-numeric code engraved on each neckband. An observation in this paper refers to a code which was identified in the field. Field crews of from 3 to 4 people were employed in Wisconsin and the Southern Illinois-Western Kentucky region to observe and record marked geese in conjunction with a continuing study on the distribution and migration of Canada geese in the Mississippi Flyway. Additional observations were provided by cooperating state and federal wildlife agency personnel.

Table 1. Numbers of Canada geese neckbanded at six southern national wildlife refuges; 1977-80.

	Year of Banding			
Refuge of Banding	1977-78	1978-79	1979-80	Total
Big Lake NWR, Ark.	---	10	---	10
Wapanocca NWR, Ark.	---	525	45	570
White River NWR, Ark.	200	250	97	547
Holla Bend NWR, Ark.	---	---	12	12
Hatchie NWR, Tenn.	67	169	1	237
Yazoo NWR, Miss.	45	35	6	86
Total	312	989	161	1,462

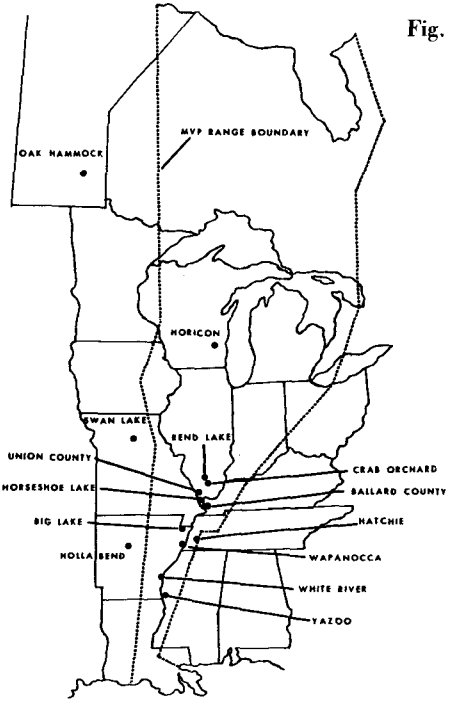

Fig. 1. Location of several refuges at which geese concentrate in the Mississippi Flyway.
The range boundary given for the Mississippi Valley Population is derived by the outside limit of the boundaries given by Hanson and Smith (1950), Vaught and Arthur (1965), and Reeves et al. (1968).

In order to compare population affiliations of geese banded at various refuges, we considered Rend Lake Conservation Area, Crab Orchard NWR, Union County Conservation Area, Horseshoe Lake Conservation Area (all Illinois), Ballard County Waterfowl Management Area (Kentucky), and Horicon NWR (Wisconsin) to be concentration areas for MVP Canada geese. Swan Lake NWR (Missouri) and Oak Hammock Marsh Wildlife Management Area (WMA in Manitoba) were considered refuges for mainly EPP geese. Conclusions about population affiliations of southern goose flocks were derived from observations made at the above refuges. We considered any hunting recoveries of birds banded during this study west of the MVP range boundaries to be within EPP range (Fig. 2).

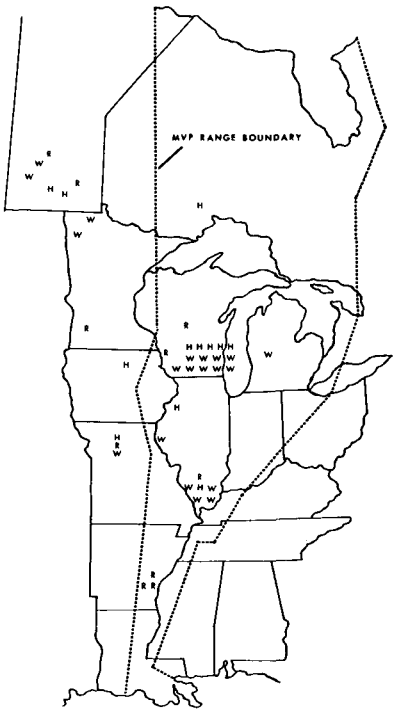

Fig. 2. Location and number of hunting recoveries of Canada geese banded at Hatchie NWR, Tennessee (H); Wapanocca NWR (W) and White River NWR (R), Arkansas. The range boundary given for the Mississippi Valley Population is derived from the outside limit given by Hanson and Smith (1950), Vaught and Arthur (1965), and Reeves et al. (1968).

Data were analyzed at the University of Wisconsin, Madison. Programs employed were developed by J. Cary, Department of Wildlife Ecology, University of Wisconsin, Madison, and the authors. Estimates of populations, survival, and recruitment follow the procedures described by Jolly (1965) and Seber (1973).

RESULTS

Wapanocca NWR, Arkansas

Of all refuges south of the 36° parallel, Wapanocca NWR has shown the greatest increase in numbers of geese in recent years (Table 2). To date 570 geese have been marked

Table 2. Mean peak and annual peak numbers of Canada geese on National Wildlife Refuges in Arkansas, Mississippi and Tennessee, 1961-80[1].

Interval	Refuge					
	Big Lake, Ark.	Wapanocca, Ark.	Hatchie, Tenn.[2]	White River, Ark.	Yazoo, Miss.	Hillside, Miss.[3]
1961-65	168	214	---	3,232	110	---
1966-70	330	1,963	343	3,030	111	---
1971-75	1,180	3,287	118	3,300	182	---
1976-80	2,660	24,500	7,694	7,740	3,180	868
1976	1,000	11,000	280	4,200	300	---
1977	2,800	26,500	30,000	8,000	4,500	1,100
1978	2,000	20,000	4,000	4,000	1,500	350
1979	2,500	50,000	4,000	20,000	6,600	2,000
1980	5,000	15,000	188	2,500	3,000	20

[1]Data courtesy of USFWS region IV.

[2]Refuge established in 1967.

[3]Refuge established in 1976.

there (Table 1), 316 of which have been observed 630 times in the Mississippi Flyway (Table 3). Most of the observations (72%) were obtained in the Southern Illinois-Western

Table 3. Observations by year of Canada geese neckbanded at 6 NWRs in the Mississippi Flyway and seen throughout the flyway.

	Year of Observation			
Refuge of marking	1977-78	1978-79	1979-80	Total
Big Lake NWR, Ark.	---	2 (3)[1]	4 (9)	6 (12)
Wapanocca NWR, Ark.	---	111 (138)	205 (492)	316 (630)
White River NWR, Ark.	3 (5)	109 (194)	154 (321)	266 (520)
Hatchie NWR, Tenn.	---	35 (60)	58 (107)	93 (167)
Yazoo NWR, Miss.	---	20 (49)	17 (28)	37 (77)
Holla Bend NWR, Ark.	---	---	10 (24)	10 (24)
Totals	3 (5)	177 (444)	448 (981)	728 (1430)

[1]Number of individual geese encountered (total number of observations).

Kentucky region. The number of observations of marked individuals in any area was a function of number and observability of marked birds and observer effort; all were high in this area. Some observations of geese marked at Wapanocca NWR were made throughout the Mississippi Flyway in both the primary ranges of the MVP and EPP. A total of 197 marked geese were encountered in MVP range whereas 22 individuals (10%) have been seen in EPP range. To adjust for differences in observer effort and observability of geese, we calculated estimated numbers of geese originally neckbanded at Wapanocca NWR in 1978-79 and present in Southern Illinois-Western Kentucky during the winter of 1979-80 (Table 4). If the survival rate of these geese was about 0.80 and neckband retention was about 0.80 (Craven 1978, 1979), then about 336 individuals should have been alive and retaining their neckbands at the close of the 1979-80 goose hunting season. Approximately 40 percent of this estimated number were calculated to be present in Southern Illinois-Western Kentucky at the close of the 1979-80 goose hunting season (Table 4).

The distribution of 22 recoveries of geese shot or found dead by hunters and reported to the U.S. Fish and Wildlife Service Bird Banding Laboratory gave another index to fall distribution of geese banded at Wapanocca. Five recoveries were in EPP range and 15 were in MVP range (Fig. 2). The proportion in EPP range was higher ($P < 0.001$) than that encountered from geese banded at Horicon NWR, a traditional MVP area from which Craven (1978) reported 21 recoveries in EPP range and 898 in MVP range in 1975-78. There were 2 recoveries from geese banded at Wapanocca NWR which were not used in the comparison, 1 from Idaho and 1 from the Northwest Territories.

White River NWR, Arkansas

Personnel of White River NWR marked 547 geese in 1977-80 (Table 1); 266 of these were observed 520 times in the Mississippi Flyway (Table 3). Southern Illinois-Western Kentucky yielded 47 percent of the observations and Oak Hammock Marsh WMA yielded 22 percent. As indicated earlier, the distribution of observations was biased by the distribution of effort and the opportunities for observing geese. We estimated that 302 of the 450 geese marked at White River NWR were still alive and retained their neckbands by the fall of 1979. Of these survivors with neckbands, about 43 percent passed through Oak

Table 4. Estimates of numbers of neckbanded Canada geese present during the winter of 1979-80 in Southern Illinois and Western Kentucky which were originally banded at 3 National Wildlife Refuges in Arkansas and Tennessee in 1977-79, expressed with 90 percent confidence intervals and as percentages of the estimated numbers of marked survivors.[1]

	Refuge of Banding								
	Wapanocca NWR			White River NWR			Hatchie NWR		
Interval[2]	est.	90 percent C.I.	Percent of marked survivors	est.	90 percent C.I.	Percent of marked survivors	est.	90 percent C.I.	Percent of marked survivors
December 31 - January 13	38	---	11	30	---	12	---	---	---
January 14 - January 27	136	107-165	40	42	30- 54	17	14	7-20	10
January 28 - February 10	112	91-133	33	70	30-110	29	31	7-55	23
February 11 - February 24	131	82-180	39	59	0-148	24	17	5-29	13
February 25 - March 10	40	10-70	12	22	8 - 35	9	28	19 - 37	21

[1]Estimates derived from methods described by Jolly (1965) and Seber (1973). Estimated numbers of marked survivors were 336 from Wapanocca NWR, 242 from White River NWR and 135 from Hatchie NWR. These estimates were calculated from original numbers banded (Table 1), assuming annual rates of survival and neckband retention to be 0.80.

[2]There were not sufficient observations of these marked cohorts before these dates for the calculation of estimates. This implies that these cohorts were among the later migrating segments of the MVP in 1979-80.

Hammock Marsh WMA (Table 5). The total number of unique codes from White River NWR encountered in EPP range was 56 whereas 132 were encountered in MVP range. At least 29 percent of the marked survivors from White River NWR apparently spent the winter of 1979-80 in Southern Illinois-Western Kentucky (Table 4). There have only been 10 hunting recoveries from White River NWR and 3 of these were direct recoveries from near the refuge (Fig. 2). Of the 7 remaining recoveries, 4 were in EPP range and 3 were in MVP range.

Table 5. Estimates of immigrants to the cohort of geese marked at White River NWR, Arkansas, in 1977-79 and observed at Oak Hammock Marsh WMA, Manitoba, in the Fall of 1979.[1]

Interval	Estimated number of immigrants
September 18 - September 22	7
September 23 -September 27	22
September 28 - October 1	7
October 2 - October 6	55
October 7 - October 11	1
October 12 - October 16	38
Total	130

[1]Total number of immigrants is the sum of recruitment to the cohort of marked geese at Oak Hammock as estimated by the methods of Jolly (1965) and Seber (1973).

Hatchie NWR, Tennessee

Personnel at Hatchie NWR have marked 237 geese in 1977-80 (Table 1) which were seen 167 times in the Mississippi Flyway (Tables 3). A total of 12 individual geese were encountered in EPP range while 68 were seen in MVP range. We calculated that 31 of a possible 135 (23%) survivors from geese banded at Hatchie NWR were present in Southern Illinois-Western Kentucky at the close of the 1979-80 hunting season (Table 4). The low number of geese observed in the Mississippi Flyway (93 of 237) relative to other refuges (316 of 570 at Wapanocca NWR and 266 of 547 at White River NWR) raises the possibilities that some geese from Hatchie either survived less well or stopped at refuges where observations were less probable, perhaps within the range of the Tennessee Valley Population (TVP). However, there were no recoveries of geese banded at Hatchie NWR within TVP range.

Yazoo NWR, Mississippi

Eighty-six geese were banded at Yazoo NWR in 1977-80 (Table 1). Thirty-seven individuals have been seen 77 times in the Mississippi Flyway (Table 3); Southern Illinois-Western Kentucky yielded 43 percent of the observations and 15 of the 30 marked individuals encountered. EPP range has provided observations of 5 individuals and MVP range has yielded 24. To date, no hunting recoveries of geese banded at Yazoo NWR have been reported to us by the U.S. Fish and Wildlife Service Bird Banding Laboratory. The number of observations of marked geese from Yazoo NWR has not been sufficient for calculation of cohort numbers anywhere in the Mississippi Flyway.

Big Lake and Holla Bend NWRs, Arkansas

To date, small numbers of Canada geese have been banded at these refuges (Table 1). Although only 10 geese were banded at Big Lake NWR, 12 observations of 6 individuals have already been reported in the Mississippi Flyway. All observations have been within MVP range and 8 have been in Southern Illinois-Western Kentucky. The geese banded at Holla Bend NWR in 1980 have only been observed at that refuge to date.

DISCUSSION

Improved understanding of the origin, migration and survival of geese wintering at southern refuges is probably a prerequisite for development of successful management strategies for enhancement of numbers. However, our ability to describe the population attributes of these geese is severely limited by the absence of discrete boundaries for most goose populations, small sizes of remnant goose flocks, and bias in our indices to goose presence. Numbers of recoveries of leg-banded geese reported to the Bird Banding Laboratory were dependent upon band reporting rates and harvest rates, whereas numbers of neckbanded geese seen in the field were dependent upon observability of marked birds and observer effort. We hope the data reported here will provide valuable leads for goose managers, but we cannot yet describe the precise distribution and population affiliation of geese marked on the 6 refuges in Arkansas, Mississippi, and Tennessee. In EPP range, particularly, we have been unable to accumulate sufficient observations for reasonable estimation of the size of the various marked cohorts. Hunting recoveries give some idea of relative degrees of association of marked birds with the major populations (EPP and MVP) but calculations of absolute affiliation from recovery data are risky. In addition, there is the confounding effect of movement of individual geese between EPP and MVP range in the same year (7 known cases). However, both the distribution of hunting recoveries and encounters of marked individuals indicate that geese from White River NWR exhibited a stronger affiliation ($P < 0.001$) with the EPP than did geese from 3 other southern refuges (Wapanocca NWR, Yazoo NWR, Hatchie NWR). Many geese marked at White River were encountered at Oak Hammock Marsh WMA, Manitoba. This strong apparent affiliation of geese from White River with the EPP may be due to a traditional association between White River and EPP geese, or it may be a result of extensive transplanting of EPP geese from Swan Lake NWR to White River NWR during the 1960s (Hankla 1968). It is interesting to note that both Wapanocca and Yazoo NWRs also received transplanted geese at the same time, but the vast majority of the geese transplanted to these refuges were from MVP refuges (Hankla 1968).

Where sufficient data have been accumulated, they indicate that geese from the sampled southern refuges were associated with both the MVP and EPP. However, with the possible exception of White River NWR, the strongest affiliation seems to be with the MVP. Although Canada geese have been increasing in Arkansas, Tennessee and Mississippi in recent years (Table 2), the trend has been irregular and during the severe winters of 1976-77 and 1978-79 larger numbers of geese moved south. In the milder winters of 1977-78 and 1979-80, rates of increase have been less. Our estimates of numbers of marked geese indicate that substantial numbers of geese banded on southern refuges in the winters of 1977-78 and 1978-79 spent the winter of 1979-80 in Southern Illinois-Western Kentucky. This suggests to us that some MVP geese did alter their wintering habits and moved further south when the more traditional wintering areas became inhospitable because of cold weather, deep snow or lack of food. We suspect that further alterations of the distribution of geese in the Mississippi Flyway can be attained through management efforts on state and federal refuge systems. Where sufficient data were available, all southern refuges sampled had a higher association with the EPP than our control group of geese banded at Horicon NWR (Craven 1978). These preliminary data indicate both MVP and EPP geese were associated with the refuges in Arkansas, Mississippi and Tennessee. Therefore, we feel that planning for Canada geese in this area should involve representa-

tives of the MVP and EPP.

We believe that, in contrast to traditional legbanding methods, intensive and widespread observation of color marked samples can provide adequate data on distribution, migration and survival of Canada geese from these and other small flocks.

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