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BIOLOGY AND STRUCTURE OF THE CASPIAN TERN (HYDROPROGNE CASPIA) POPULATION OF THE GREAT LAKES FROM 1896 - 1964

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A population of the cosmopolitan Caspian Tern (*Hydroprogne caspia*) breeds on islands in the Great Lakes of North America. First report of this population came from Cass who collected eggs at Shoe Island in 1896, and Reed found a colony at Hat Island in 1904 (Barrows, 1912). All colonies in this population (except Charity Islands' Reef) are in northern Lake Michigan and Lake Huron, falling in a rectangle bounded by 080°20′, 087°40′, 46°10′, and 45°20′. Since 1896, thirteen colonies have been found, ten of them active in 1964. Banding was begun in 1922 at Shoe Island, 1924 at Gravelly Island, and 1927 at South Limestone Island, and continued through 1964.

This paper deals primarily with an analysis of 370 recoveries of Caspians banded as chicks in the Great Lakes' colonies. F. E. Ludwig (1942) and Hickey (1952) each analyzed a part of the recoveries used in this paper. Data gathered between 1959 and 1964 on population size, nesting, food habits, and endoparasites are also presented. Data on population and nesting were gathered by counting nests, dead chicks, etc., or by standard census procedures.

NESTING

Although Bent (1921) states that the Caspian Tern "nests under widely different conditions", I found colonies only on islands with sand-gravel or limestone substrates which had sparse or no vegetation. Ordinarily the nest is a simple unlined hollow in the gravel, but it may be thinly lined by grasses. Colonies are densely packed as shown by my measurement of 1.2 to 1.7 square yards per territory in six colonies, 1963-64. Nests are placed as close as 21 inches (center to center) to each other. Bent (1921) recorded the nesting of one or two pairs in Virginia and Pettingill (1957) found a pair nesting within a Ring-billed Gull (*Larus delawarensis*) colony. I did not find such solitary nesting although I did note a pair of Ring-billed Gulls nesting within a Caspian colony (Ludwig, 1964). Wood (1951) estimated 1,000 - 1,500 pairs nesting at Shoe Island in 1923, but the largest Caspian colony I saw was 500 pairs. The average size of Great Lakes' colonies from 1962-64 was 151 pairs with extremes of 35 and 350 pairs (see Table 1).

Bent (1921) lists May 25 as earliest egg date for this population. Since I found young by June 1 and incubation is about 26 days,

TABLE 1. COLONIES OF CASPIAN TERNS ON THE GREAT LAKES

Colony	Location Geog. Coordinates	Earliest Year Recorded	First Year of Banding	Population Estimates 1959	'61	'61	'62	'63	'64
Shoe Island	Lake Michigan 4548-08518	1896	1922	200	100	30	100	225	280
Hat Island	Lake Michigan 4549-08518	1904	1938	300	300	500	350	300	250
High Island Shoal	Lake Michigan 4545-08529	1938	1938	Present in 1938 only.					
Gravelly Island	Lake Michigan 4550-08650	1924	1924	X	X	X	X	X	X
Little Charity Island	Lake Huron 4400-08650	1938	1938	Present in 1938 only					
Charity Islands' Reef	Lake Huron 4401-08320	1962	1962	0	0	0	75	75	65
Calcite Pier at Rogers City	Lake Huron 4430-08350	1957	1958	(See Pettingill, 1957))					
South Limestone Island	Lake Huron (GB) 4523-07023	1927	1927	X	200	150	150	150	150
Halfmoon Island	Lake Huron (GB) 4527-08129	1933	1933	X	X	75	150	150	150
Gull Island	Lake Huron (GB) 4548-08116	1960	1961	ND	X	75	150	175	185
Papoose Island	Lake Huron (GB) 4548-08121	1959	1962	X	X	35	35	35	35
Elm Island	Lake Huron (NC) 4608-08209	1962	1962	0	0	0	125	160	110
Cousins Islands	Lake Huron (NC) 4605-08249	1960	1961	ND	X	300	150	200	105

Under Location: (GB) and (NC) refer to the Georgian Bay and North Channel portions of Lake Huron.
Under Population Estimates: X = colony present, size unknown; ND = No Data.

Note: In 1964 there may have been a colony in the St. Mary's River or Potagannissing Bay areas of Lake Huron. I saw adults there, but could not locate a colony. Several islands in these areas possess suitable habitat.

eggs must be laid as early as May 5. Eggs are laid up to July 1, but some of these are probably replacement clutches. I found the mean clutch size for 225 initial clutches to be 2.81. Bent's (1921) and A. H. Miller's (1943) figures for Louisiana and California colonies respectively suggest a mean clutch size of less than two in those populations. Hatching success based on counts of 200 nests was 81% per cent. Like Miller (1943), I found as much as eight per cent of eggs broken and rolled out of nests. Chick mortality at four weeks old averaged 19 per cent for six colonies in 1963-64. Since chicks fledge when six to eight weeks old, this estimate is low and probably near 30 per cent died before leaving the colonies. Using the formula Clutch Size (2.81) x Hatching Rate (.81) x Survival to Fledging (1.00 – .30) I estimated fledging rate at 1.61 chicks per pair per year for 1963-64.

BANDING DATA

As of June 30, 1963, 465 recoveries of birds from this population were available from the banding of upwards of 26,000 chicks. Ninety-five were from chicks found dead in the same colony where banded in the same year. I used all remaining 370 reports for plotting distribution and dispersal, but eliminated 90 more recoveries from birds banded after 1953 in studying population structure. Inclusion of these 90 reports would bias the data strongly in the first five-year-classes because of a great upsurge of banding activity since 1959. These birds are not yet old enough to give a normal death distribution. Banding from 1922 – 1942 was done yearly; from 1943 – 1958 banding was sporadic; since 1959 almost every colony has had birds banded each year, and in most colonies half or more of the young were tagged each year.

In the case of inexact dates of recoveries, I assumed that a recovery from the first ten days of the month came on the fifth, etc., that a seasonal recovery took place in midseason, and when the only date available was that of the original letter reporting the bird, I assumed that was the recovery date. There were 84 (22.8 per cent) inexact dates. I refer to birds recovered prior to January 1 of the year following the banding year as juveniles (0-6 months old); immatures are birds recovered during the first calendar year after banding (6-18 months old); subadults are birds recovered in the second calendar year after banding (18-30 months old); the term adults refers to all other recoveries. Table 2 lists the geographical areas of the recoveries.

DISPERSAL OF JUVENILES

Juveniles fledge from the colonies in July and August. Individuals find their way to wintering grounds very rapidly as shown by an October 13 recovery from Colombia and September 1 and 9 records from Louisiana. (see Map 1). Average dates of recovery are August 17 in Virginia, September 11 in North Carolina, and September 12 in Louisiana. November and December dates comprise the bulk of records from Mississippi, Georgia, and Florida. The westernmost recovery is from Minnesota, while the most northerly and easterly recoveries are four from Newfoundland in 1958. Tordoff and South-

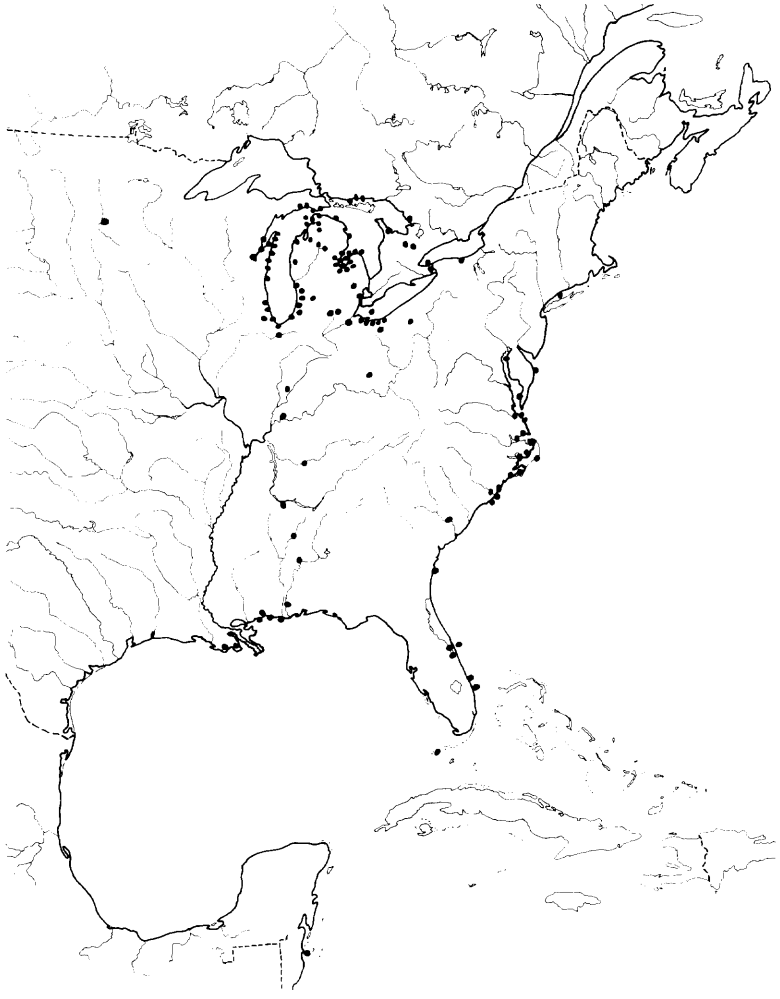
TABLE 2. GEOGRAPHIC DISTRIBUTION OF CASPIAN TERN RECOVERIES

State	Number of Recoveries
Alabama	20
British Honduras	2
Colombia	22
Connecticut	2
Cuba	13
Delaware	1
England	1
Florida	43
Georgia	7
Haiti-Dom. Republic	9
Illinois	6
Indiana	5
Jamaica	2
Lesser Antilles	1
Louisiana	25
Manitoba	1
Maryland	2
Michigan	87
Minnesota	2
Mississippi	10
Missouri	1
Newfoundland	4
New York	5
North Carolina	20
Nova Scotia	3
Ohio	16
Oklahoma	1
Ontario	18
Panama	1
Pennsylvania	1
South Carolina	6
Tennessee	1
Texas	1
Vermont	1
Virginia	7
Wisconsin	23
37 Localities	370

ern (1959) noted one of these birds as the first record of the Lakes' population in Newfoundland and suggested that it was blown there by hurricane Helene of that year. The appearance of skimmers and three more Caspian recoveries add support to their theory of storm displacement. Normally Caspians are found in small numbers no farther north than Long Island (1,100 miles to the southwest). Most of the dispersal is along the Mississippi flyway to the Gulf Coast, but some birds apparently move along Lake Erie and Ontario to the watersheds of New York and Pennsylvania and thence to the Atlantic Coast. There is no suggestion that Caspians from the lakes use the St. Lawrence River as an outlet to the Atlantic Coast as do Great Lakes' populations of Herring Gulls (Smith, 1959; Hofslund, 1959) and Ring-billed Gulls (F. E. Ludwig, 1943).

MOVEMENT OF IMMATURES

Recoveries of immatures are largely confined to the southern Atlantic states, the Gulf coast states, the Caribbean islands, and Co-



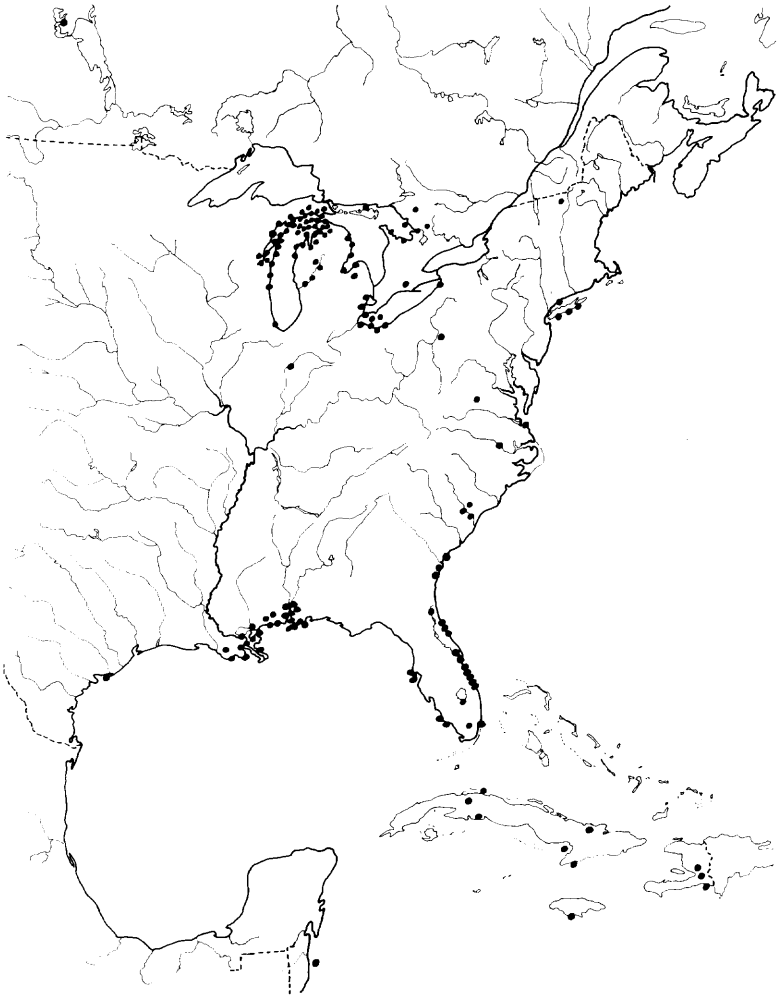
MAP 1.
Recoveries on Juvenile Caspian Terns Age 0-6 Months N = 143

lumbia. (see Map 2). A few birds (less than 10 per cent) apparently find their way back to the lakes in their first summer, but most of these recoveries are probably birds that died the previous fall and were found the next season. Three recoveries from Nova Scotia in 1924 (600 miles northeast of their normal range) with two recorded as "dead from weather conditions" suggests displacement owing to a storm. There is little evidence for Caspians wandering similar to individual Herring Gulls in this phase of their lives (Smith, 1959; Paynter, 1947). Caspian Terns are quite sedentary at this age.

MAP 2.
Recoveries on Immature Caspian Terns Age 6 Months to 18 Months N = 78

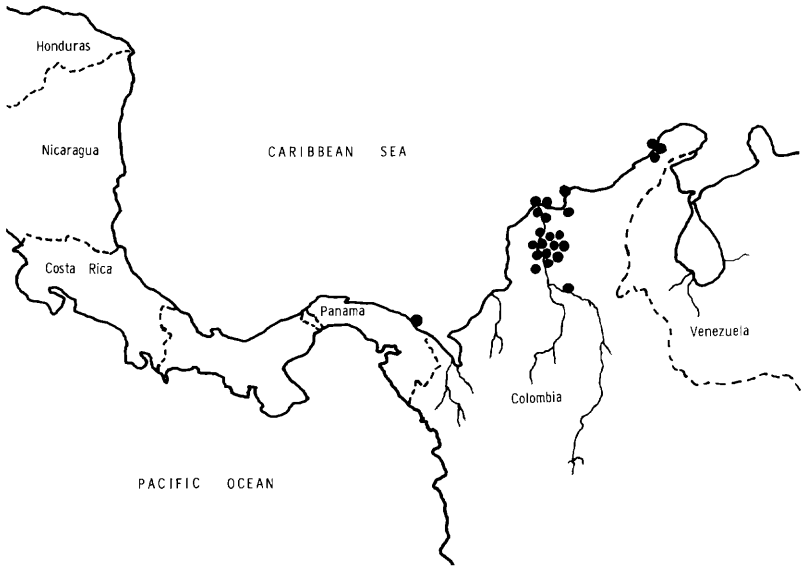
MOVEMENTS OF SUBADULTS AND ADULTS

Recoveries of adults are divided into two distinct, geographically isolated groups. (see Map 3.) Nearly all late spring and summer recoveries come from the Great Lakes and contiguous watersheds with many in the immediate vicinity of the breeding colonies. In winter the majority of recoveries come from the Gulf and Atlantic Coasts, the Caribbean Islands, and Colombia. Fall and early spring recoveries come from the middle Atlantic states, the same watersheds where juveniles are recovered, and along the Mississippi flyway, indicating that adults, like juveniles, use both pathways to and from the Great Lakes.



MAP 3.
Recoveries on Sub-Adult and Adult Caspian Terns Age 19 Months to 26 Years
N = 149

It is interesting that Caspians of all ages use the same pathways in their movements. Unlike North American populations of Herring Gulls (Smith, 1959; Hofslund, 1959) and Ring-billed Gulls (Ludwig, 1943) whose juveniles and immatures have wintering ranges different from adults, these data show that Caspians of all ages winter in the same places. Adults disperse as far south as other age classes (Colombia) and odd recoveries of adults from Manitoba, Texas, and England indicate that adults may wander even more widely than younger birds. Table 2 lists the geographical areas of recovery and numbers of birds recovered in each place. Map 4



Map 4—Recoveries of all age classes of Caspian Terns from Panama and South America. N = 23.

shows the recoveries made in Panama and South America on all age classes.

DEATH DISTRIBUTION

The mortality rate of preadult birds is very high. Juveniles account for 28.7 per cent of all recoveries, immatures for 21.8 per cent, subadults for 10.7 per cent, while adults make up the remaining 38.5 per cent of recoveries. In this sample nearly 62 per cent of the birds died prior to their third year or first year of breeding. Of ten spring and summer recoveries on subadults, only one returned to the lakes; possibly it bred. Probably most birds do not breed until their third year. The majority of recoveries for all ages come in summer and early fall months. For juveniles, post-fledgling mortality is highest in August and September. Immatures died most heavily in June, while 45 per cent of subadult and adult recoveries were concentrated June through September. The fewest recoveries were made in March and April, probably because many birds were wintering south of the southern United States where the recovery rate is lower (Owen, 1962). The bulk of recoveries outside the United States came from January 15 to April 15.

CAUSES OF DEATH

Table 3 lists the causes of death reported for the recovered birds. The most important point is the incredible number reported as shot or taken as scientific specimens. Compared with three North American Herring Gull studies (Smith, 1959; Hofslund, 1959; and Paynt-

TABLE 3. CAUSES OF DEATH REPORTED FOR CASPIAN TERNS OF THE GREAT LAKES

Number of Recoveries	Per Cent of Recoveries	Reported Cause of Death
183	49.4	Found dead.
77	20.8	Shot.
31	8.4	Found injured.
18	5.0	Collected for scientific specimens.
11	3.0	Sick when captured.
15	4.2	No information (Includes "Caught" and "Band found").
7	1.9	Trapped and released in different 10 minute block than where banded.
7	1.9	Killed by weather conditions.
5	1.4	Entangled in string, nets, fishhooks, etc.
3	0.8	Band removed (No more information).
2	0.6	Caught in trap.
2	0.6	Killed by flying into object.
2	0.6	Killed by automobile.
2	0.6	Caught by hand.
1	0.3	Killed by hawks and owls.
1	0.3	Killed by train.
1	0.3	Found exhausted.
1	0.3	Trapped and released in the same 10 minute block where banded.
370 Total Recoveries		

er, (1947) which, (when averaged) show a mean rate of 5.4 per cent recovered by gunning, and F. E. Ludwig's (1943) Ring-billed Gull study where 9.8 per cent were reported as shot, the 25.8 per cent of these Caspian recoveries from shooting and collecting stands out as an exceptionally high rate. This is probably due to three causes. The Caspian Tern is a rare or unusual bird in many places and ornithologists collect them for distributional records and specimens. Hunters, probably familiar with gulls, shoot them out of curiosity. Unlike gulls which rarely disperse beyond the southern United States where they are protected, Caspians frequent Colombia and the Caribbean Islands where they are shot for food. Of 49 recoveries made beyond the southern United States, 28 (57 per cent) were shot.

The recoveries indicate that the lakes' population maintains itself independent of other Caspian populations. The nearest populations to the Great Lakes are in Louisiana on the Gulf Coast (Bent, 1921) and in California (A. H. Miller, 1943) and there are no recoveries to indicate exchange of breeding birds among these three North American populations. Figures 1 and 2 illustrate the apparent death rate and survivorship for the Great Lakes population. Two individuals lived longer than twenty-six years. Once a bird matures, it has an excellent chance of living a long time. I calculated the average adult life span at 8.88 years by the formula

$$\frac{A_1 N_1 + A_2 N_2 + A_3 N_3 \ldots \text{etc.}}{\text{Total N}}$$

where A1 = the first adult age-

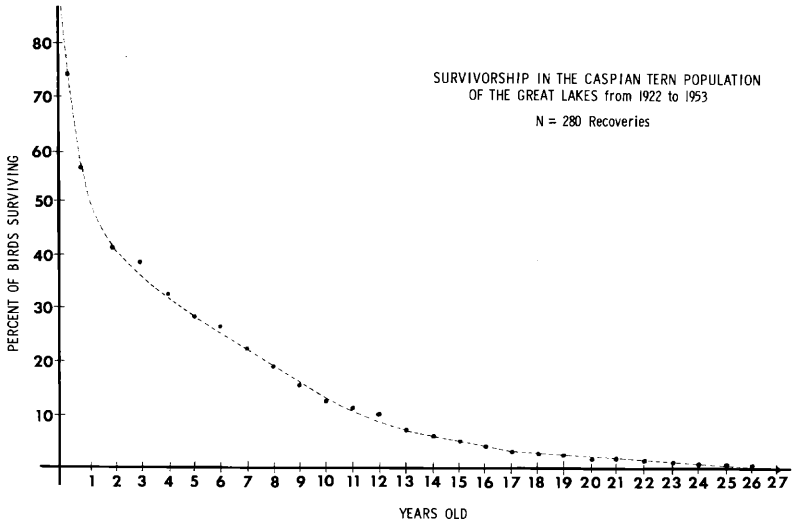


FIGURE 1. Survivorship in the Caspian Tern Population of the Great Lakes. This figure illustrates that once a bird reaches the age of first breeding (three years after fledging) it has an excellent chance of surviving a long time. The oldest bird in this sample survived to 26.1 years of age.

class, and N1 = the number of recoveries in that age class, etc. Average annual loss of adults is $\frac{1}{8.88}$ = 11.3 per cent per year.

Lack (1954) noted the annual loss of adults for several species of gulls and terns as 30 per cent per year. The low death rate in this Caspian population hints that it was probably decreasing slowly. Population estimates confirm this hypothesis. In 1923, about 2,400 adult pairs made up the breeding population, but by 1960 it had declined to 1,400 pairs. In order to maintain the 1923 population with an annual loss of 271 pairs (.113 × 2,400 pairs) an equal number had to be recruited from chicks fledged three years previously. On the average, fewer new pairs than necessary were recruited and the population declined.

THEORETICAL POPULATION

A theoretical Great Lakes' population of 1,000 pairs during the period 1922-53 needed to recruit 113 pairs or 226 individuals annually to maintain a stable size. Clutch size and hatching rate I noted previously as 2.81 and .81 and banding recoveries show that 62 per cent of fledged young died prior to first breeding. Using these figures in the formula Fledging Rate (X) × Proportion Surviving to Maturity (1.00 − .62) = Recruitment rate (.226), I found that .60 fledged young per pair per year were required to maintain the population. However, since the average rate of producing new

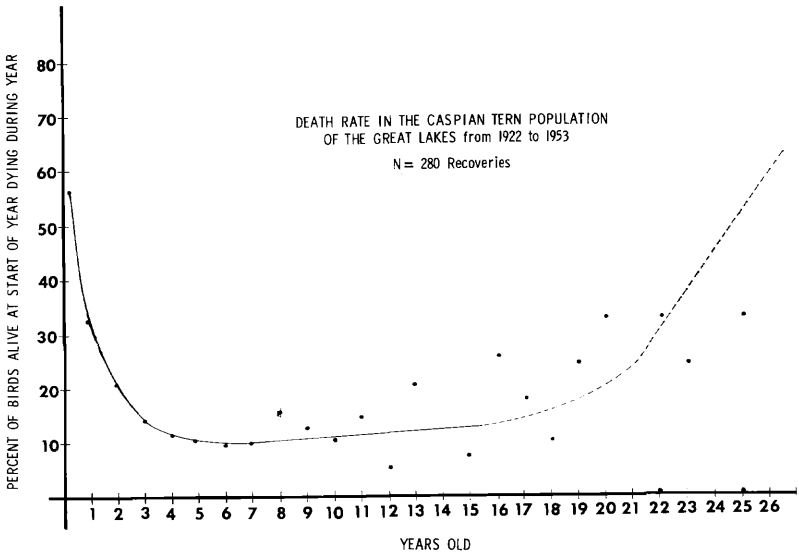


Figure 2. Death Rate in the Caspian Tern Population of the Great Lakes. Note that although the data suggests a rising death rate with increasing age after fifteen years, the data are too fragmentary to form a conclusive opinion. Death rate is constant from three to fifteen years. Sixteen birds lived longer than fifteen years.

adults was 102 pairs per year or 204 individuals, the population decreased. In terms of average fledging rate, only .54 fledglings per pair per year were produced.

A comparison of the fledging rate computed from banding data and my 1963-64 field estimate of 1.61 chicks fledged per pair per year suggests that now the population may be increasing. Population estimates confirm this for from 1960 to 1964, the population increased by 220 breeding pairs, from 1,400 to 1,620 pairs. This increase represents birds fledged in 1958-61, and assuming that the preadult mortality rate remained the same as the 1922-53 period, or 62 per cent, the fledging rate had to rise to 0.79 chicks per pair per year for recruitment rate to rise and thereby increase the population. However, this recruitment rate could be low in that it is based on the estimates of breeding adults in the colonies which I was able to find, and I may well have missed a new colony in 1964 in the St. Mary's River. Yet the computed estimate does approach the field estimate based on 1963-64 fledging rate.

A comparison of this tern population with two gull populations reveals that all are similar in structure. Drost (1961) found an annual loss of ten per cent of adult European Herring Gulls (*Larus a. argentatus*) and a fledging rate of .7 chicks per pair, for a population maintained by recruiting birds from other populations. Veemer (1963) found an annual loss of ten per cent of adults, calculated that 80 per cent of preadult birds died before first breeding, and found an average fledging rate of 1.35 chicks per pair in a slowly increasing

Glaucous-winged Gull population. (*Larus glaucescens*). Emlen (1956) in studying a Ring-billed Gull (*Larus delawarensis*) colony on the Great Lakes found a fledging rate of .67 chicks per pair for a stable population in 1952-53. The primary factor involved in maintainence or change of population structure for these populations is the fledging rate. Increased fledging rate, after a time lag for the birds to reach maturity, results in a growing population, while decreased fledging rate results in a lower recruitment rate and a shrinking population. The Great Lakes' Caspian population has shown both a shrinking phase and a growing phase and with the high fledging rates of 1963 and 1964, the population should continue to expand at least through 1967. Table 4 compares several gull populations with this Caspian Tern population.

TABLE 4. REPRODUCTIVE SUCCESS OF SEVERAL SPECIES OF GULLS AND GREAT LAKES CASPIAN TERNS

Species	Ave. Annual Loss of Adults	Average Fledg. Success	Population Structure Source
Larus a. argentatus[1]	10%	.67	Increasing, Drost (1961)
Larus glaucescens	10%	1.35	Increasing, Veemer (1963)
Larus delawarensis	11.3%	.67	Stable, Emlen (1956)
Hydroprogne caspia	11.3%	.77	Decreasing, this study, 1922-53
Hydroprogne caspia	11.3%	1.26	Increasing, this study, 1960-64
Hydroprogne caspia	11.3%	1.61	Predicted to increase in 1966-67

[1]This population increased due to recruitment of adult birds from other colonies.

Comparing this Caspian Tern population with the well banded Common Tern population of Cape Cod, Massachusetts (see Austin & Austin, 1956) suggests a number of significant differences between the species. Table 5 lists a six point comparison between these populations. Apparently Austin's sample of data is biased by band loss after eight years, but these data on Caspian Terns do not suggest band loss at any time in that the survivorship curve (Figure 2) shows a constant decline from three to fifteen years old, and another constant decline from sixteen through twenty-six years. Band loss would tend to curve the line downward and clearly this is not the case. Austin further believes that Common Terns die more rapidly after the nineteenth year with the "onset of old age": This may be true for the Caspian population. Probably the small very old (sixteen to twenty-six years) segment of the Caspian population is not of critical importance to the population, as three to fifteen year olds certainly have a much higher reproductive potential and form the nucleus of the breeding birds just as the three to ten year old Common Terns are of primary importance to that population.

TABLE 5. GREAT LAKES CASPIAN TERN POPULATION COMPARED WITH CAPE COD COMMON TERNS

	Clutch Size	Fledging Rate	Percent of Fledglings dying before first breeding	Average Adult Life Span	Maximum age attainable	Age at First Breeding
Sterna hirundo	2.3	2.2[a]	80	?	24 yrs.	1-3 years
Hydroprogne caspia	2.81	0.77-1.61	62	11.88[b] yrs.	26 yrs.	3 years

[a]Maximum estimated rate. Probably the real fledging rate is much lower, in the range of 1 - 2 chick per pair per year.

[b]11.88 years is the average life span of those birds attaining adulthood, i.e. 3 years to mature + 8.88 years of reproductive productivity.

All data on the Massachusetts Common Tern population comes from Austin and Austin (1956).

CHANGING ECOLOGY OF THE LAKES

The unanswered question is why did the lakes Caspian population decline over a thirty-five year period only to reverse the trend in 1957 and begin to increase? Recent papers on the fish populations of the lakes suggest the answer. Smith (1963) followed the populations of nine species of lake herrings (*Leucichthys*) in Lake Michigan from 1930 to 1963, noting serious declines in numbers of all species but *L. hoyi*. He attributed the decline of these fishes to heavy pressure from the commercial fisheries industry and the invasion of the sea lamprey (*Pteromyzon marinus*). The increase in *L. hoyi* was attributed to its being too small for lampreys to attack successfully and subsequent strengthening of its competitive position with other species of *Leucichthys*. Thomas (1947) found a species of lake herring (*L. artedi*) the common food of Caspian Tern chicks in Lake Michigan colonies during his investigations (1939-1945). I did not find any herring in the diet of Caspians in 1963-64 (see Table 6). This suggests that the Caspian population of the period 1922-53 (for which there is banding data) was supported by a steadily diminishing food supply. Probably many chicks starved and failed to fledge from the colonies at this time, resulting in a lower recruitment rate and a slowly shrinking population.

However, R. R. Miller (1956) described a burgeoning Alewife (*Alosa pseudoharengus*) population in Lakes Michigan and Huron from 1954 to 1956. Graham (1953) described the habits of the Alewife, noting that it rises to shoal waters in April, breeds there in June, summers in shallow waters, and retreats to deep parts of the lake in November. Prior to 1953, the Alewife was rare in these upper lakes although it had been abundant for twenty or more years in Lakes Erie and Ontario. Apparently, the Alewife invaded Lakes Michigan and Huron from Erie in the mid 1950's in large numbers, for by 1957 its annual spring mortality (due to inability to adjust to rising water temperatures) was serious enough to become a nuisance to property owners along the shores of the upper lakes. It appears that by 1957, Alewives became available to the

TABLE 6. FISH RECOVERED FROM THE STOMACHS OF 22 CASPIAN TERNS AND DROPPED IN EIGHT COLONIES IN LAKE HURON AND LAKE MICHIGAN IN 1963 AND 1964

Species	Numbered Recovered	Per Cent of Sample
Alewife (*Alosa pseudoharengus*)	132	73.7
American Smelt (*Osmerus mordax*)	27	15.1
Yellow Perch (*Perca flavascens*)	10	7.8
Rock Bass (*Amploblites rupestris*)	4	2.3
Lepomis sp.	1	0.6
Semotilus sp.	1	0.6
TOTAL	169	100%

terns when needed to feed chicks. This eliminated the food shortage, resulting in an increasing fledging rate from 1957 on and an increasing adult population by 1960.

FOOD HABITS

My study of the food habits of Caspian Terns show that nearly three-fourths of the fish eaten in 1963 and 1964 were Alewife, while not a single Lake Herring was found in their diet. Unlike Bent (1921) who suggested that Caspians consume quantities of shellfish, I found them to eat fish exclusively (see Table 6).

ENDOPARASITES

My studies of endoparasites of Caspians based on examination of twenty-two birds taken from 1962 – 1964 also indicate the disappearance of Lake Herring from the diet of Caspians. Thomas (1947) described the life cycle of a pseudophyllidean cestode, *Dibothriocephalus oblongatum*, from the Caspian Terns of Shoe Island, Lake Michigan. This cestode used the Lake Herring, *L. artedi*, as final intermediate host. Thomas found this parasite in 12 of 22 birds (53 per cent) he examined from 1939-1945. It was not found in my sample. I did find *Schistocephalus solidus* and *Clinostomum sp.* and Thomas (University of Michigan Biological Station Host Records, Unpublished) found both of these in his sample. Table 7 summarizes available information on endoparasites of the Caspian Terns when present on the Great Lakes.

SUMMARY

The history, breeding biology, and structure of the Caspian Tern population of the Great Lakes from 1896 – 1964 was analyzed on the basis of band recoveries of chicks tagged 1922 – 1953, and from data gathered in a survey of the colonies from 1959 – 1964. Caspian colonies were found on islands with sand-gravel or limestone substrate and little vegetation. An estimated 1,620 breeding pairs were present in 1964. Mean clutch size was 2.81, Hatching Rate .81, and Fledging Rate 1.61 chicks per pair of adults in 1963 and 1964. Juveniles disperse rapidly from the colonies in August, wintering on the Gulf Coast, Colombia, and Caribbean islands. Immatures

TABLE 7. ENDOPARASITES RECOVERED IN AUTOPSYING 22 CASPIAN TERNS 1962-1964

Species	Number Hosts Infected	Ave. Number Parasites per Infection	Recorded by Thomas (UMBS Host Records)
Cestodes			
Dibothriocephalus oblongatum	0	0	From 12 of 22 examined
Schistocephalus solidus	8	1.33	Yes
Paricterotaenia sp.	3	1.0	No
Nematodes			
Cosmocephalus (oblevatus?)	3	1.67	No
Trematodes			
*Diplostomum sp.**	5	3.0	No
Cotylurus sp.	3	5.33	No
Ornithobilharzia (lari?)	6	2.67	No
Clinostomum sp.	15	3.7	Yes
*Stephanoprora sp.**	2	1.5	No

*Note: All *Diplostomum* and *Stephanoprora* recovered were sexually immature. Probably these parasites are not definitive in Caspian Terns; they are found in large numbers in both Herring and Ring-billed gulls from the lakes.

are rather sedentary, spending their first full year on the wintering grounds. Adults summer on the lakes and winter in the same places as other age classes. The bulk of recoveries for all age classes come in the summer. The fewest recoveries are made in March and April. Over one-fourth of the Caspians recovered from the Great Lakes' population are killed by shooting. The Great Lakes' population is self-supporting. After declining slowly for 35 years, it reversed the trend, beginning to increase in 1960. Adults average 8.88 years of reproductive productivity, dying at a rate of 11.3 per cent per year. Increased fledging rate is cited as the immediate factor involved in changing the population structure. Preadult mortality was found to be 62 per cent of the fledged young. This Caspian population has a structure similar to gull populations. Increasing food supplies in the form of Alewife are cited as the major reason for increasing tern numbers. Three-fourths of the fish eaten by Caspians while on the lakes in 1963 and 1964 were Alewife. No Lake Herring were found in the tern's diet. The disappearance of *Dibothriocephalus oblongatum* from the Great Lakes' population of the Caspian Tern is cited as further evidence that the ecology of the lakes has changed.

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LITERATURE CITED

AUSTIN, O. L., M.D., and AUSTIN, O. L. JR.
1956 Some Demographic Aspects of the Cape Cod Population of Common Terns (*Sterna hirundo*). *Bird-Banding* **27:** 55-66.

BARROWS, W. B.
1912 Michigan Bird Life.
Special Bulletin of the Department of Zoology and Physiology of the Michigan Agricultural College.

BENT, A. C.
1921 Life Histories of North American Gulls and Terns.
Bulletin 113 United States National Museum.

DROST, R., E. FOCKE and G. FREYTAG
1961 Entwicklung und Aufbau einer Population der Silbermowe. *Larus a. argentatus.*
Journal für Ornithologie **102.** Heft 4: 404-429.

EMLEN, J. T.
1956 Juvenile Mortality in a Ring-billed Gull Colony.
Wilson Bulletin **68:** 232-238.

GRAHAM, J. J.
1953 Observations on the Alewife, *Pomolobus pseudoharengus* (Wilson), in fresh water.
Publication of the Ontario Fisheries Research Laboratory Number 74. University of Toronto Press.

HICKEY, J. J.
1952 Survival Studies of Banded Birds.
United States Department of the Interior Special Scientific Report: Wildlife, **15:** 1-177.

HOFSLUND, P. B.
1959 Fall Migration of Herring Gulls from Knife Island, Minnesota.
Bird-Banding **30:** 104-114.

LACK, D.
1954 The Natural Regulation of Animal Numbers.
Oxford at the Clarendon Press.

LUDWIG, F. E.
1942 Migration of Caspian Terns in the Great Lakes Area.
Bird-Banding **13:** 1-9.
1943 Ring-billed Gulls of the Great Lakes.
Wilson Bulletin **55:** 234-243.

LUDWIG, J. P.
1962 A Survey of the Gull and Tern Populations of Lakes Huron, Michigan, and Superior.
Jack-Pine Warbler **40:** 104-120.
1965 Nesting of a Pair of Ring-billed Gulls within a Caspian Tern Colony.
Jack-Pine Warbler **44:**

MILLER, A. H.
1943 Census of a Colony of Caspian Terns.
Condor **45**: 220-225.

MILLER, R. R.
1956 Origin and Dispersal of the Alewife (*Alosa Pseudoharengus*) and the Gizzard Shad (*Dorosoma cepedianum*) in the Great Lakes.
Trans. of the American Fisheries Society **86**: 97-111.

OWEN, D. F.
1962 Mortality of the Great Blue Heron as Shown by Banding Recoveries.
Auk **76**: 464-470.

PAYNTER, R. A.
1947 The Fate of Banded Kent Island Herring Gulls.
Bird-Banding **18**: 156-170.

PETTINGILL, O. S.
1957 Nesting of the Caspian Tern within a Ring-billed Gull Colony.
Jack-Pine Warbler **36**: 183-184.

SMITH, S. H.
1964 Status of the Deepwater Cicso Population of Lake Michigan.
Trans. of the American Fisheries Society **93**: 155-163.

SMITH, W. J.
1959 Movements of Michigan Herring Gulls.
Bird-Banding **30**: 69-104.

THOMAS, L. J.
1947 The Life Cycle of *Diphyllobothrium oblongatum*.
Journal of Parasitology **33**: 107-117.

TORDOFF, H. B. and SOUTHERN, W. E.
1959 Caspian Tern and Black Skimmer in Newfoundland.
Wilson Bullettn **71**: 385-386.

VEEMER, K.
1963 The Breeding Ecology of the Glaucous-winged Gull (*Larus glaucescens*) on Mandarte Island, B. C.
British Columbia Provincial Museum, Occasional Papers Number 13.

WOOD, N. A.
1951 The Birds of Michigan
Miscellaneous Publications 75, University of Michigan Museum of Zoology.

Bird Division, Museum of Zoology, Ann Arbor, Michigan.

Received October, 1964.

BANDING OF THRUSHES AND CATBIRDS AT ALMIRANTE, PANAMA. SECOND YEAR OF OBSERVATIONS[1]

By PEDRO GALINDO[2] AND EUSTORGIO MÉNDEZ

Banding of migrant thrushes in Almirante, Republic of Panama, was started during the Fall of 1962 and Galindo *et al* (1963) reported results of the first year of work. Operations were continued during last Fall, Autumn and Spring and catbirds were added to the list of species under study. The present paper covers results obtained from September, 1963 through August, 1964.

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