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RESULTS OF THE PACIFIC GULL COLOR-BANDING PROJECT

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INTRODUCTION

Following the lead of the Herring Gull Banding Project on the Atlantic slope, the Pacific Gull Color-banding Project, a similar study of gulls of the Pacific slope of North America, was undertaken in the years 1937 to 1942 under the sponsorship of the Western Bird-Banding Association. During the operations, 14,091 gulls of three species were banded and more than 1000 recoveries and sight records were obtained. From the activities involved, significant information has been obtained concerning nesting, geographic movements in migration, longevity, mortality trends, population shifts, subspeciation and various other items.

On March 20, 1937, C. L. Whittle, then editor of Bird-Banding, wrote to E. L. Sumner, Sr., president of the Western Bird-Banding Association, telling him of the Herring Gull Banding Project on the East Coast and suggesting that a similar project be started in the West. Western bird banders were enthusiastic over the prospects of such a study and considerable organizational work was instigated immediately. By the nesting season of 1938, banders, aluminum survey bands and colored celluloid bands were ready. The area covered by these West Coast banding activities extended from north Coronado Island, Mexico, northward to Mittlenatch Island, Gulf of Georgia, British Columbia, Canada. Later the work was extended inland to Utah.

The project was at first planned to last three years, but it was extended in some places to 1942, in others to 1946, and in still others to 1949. No colored bands were used after 1946. Mrs. M. C. Sargent acted as general chairman of the project, organized the work, and correlated the data until 1948 when she was unable to carry it further. The work of finishing the study was transferred to the senior author of this article.

The Western Bird-Banding Association extends sincere thanks to each of the cooperating banders and their associates, listed in table 1, particularly to Mrs. M. C. Sargent, whose patience, energy, and skill is much in evidence when one reads through the correspondence she carried on in behalf of this project, and to Mr. Laidlaw O. Williams of Carmel, California. Appreciation is also extended to the many people who assisted in the banding operations, to the finders of bands who returned them to the U. S. Fish and Wildlife Service, to the scores of ardent "birders" who reported sight records, to several Audubon clubs of California and to the research staff at Scripps Institution of Oceanography.

BIRDS BANDED

During the first year of banding, 1938, operations were confined mainly to the Pacific coast, but some banding was done as far inland as Klamath Falls in southern Oregon and Mono Lake in eastern California. In 1939, banding activities were extended to Great Salt Lake and, in 1940, to Utah Lake in the Great Basin. These areas and the number of birds banded are listed in table 1.

Table 1

Summary of Banding Activities

Bander	Location	Years	Number banded	Totals
Larus glaucescens				
Theed Pearse	Mittlenatch Is., B.C.	1938–40	760	
Kenneth Alexander	Gull Is., B.C.	1938–40	186	
Dennis Ashby	Yellow Is., B.C.	1938–40	699	
Robert S. Bach	Puget Sound, Wash.	1940	500	2135
Larus occidentalis occidentalis				
Reed W. Ferris	Three Arch Rock, Ore.	1938–40	291	
	Haystack Rock, Ore.	1938–40	2010	2301
Larus occidentalis wymani				
Mrs. M. C. Sargent	No. Coronado Is., Mex.	1938–40	1097	1097
Larus californicus				
Walter W. Nichols	Mono Lake, Calif.	1938–40	1510	
Carl Richardson	Klamath Falls, Ore.	1940–41	325	
V. M. Tanner and associates	Rock Is., Utah Lake, Ut.	1940–42	2300	
A. M. Woodbury and associates	Eggs Is., Gt. Salt Lake, Ut.	1939–41	4423	8558
				14091

Several extensions of this project, not covered in this report, include the following. In British Columbia, Theed Pearse of Comox has continued banding Glaucous-winged Gulls (*Larus glaucescens*) since the main project was completed. Miss Zella McMannama has banded 3383 Glaucous-winged Gulls in 1947, 1948 and 1949 on Puget Sound in San Juan County, Washington. Perhaps others have also been banding. In 1944, Harold M. Hill and Telford H. Work banded 113 Western Gulls (*L. o. wymani*) at Point Lobos, California, but turned their attention to the Farallon Islands in 1945 and 1946 where they banded 348 gulls (*L. o. occidentalis*).

At Great Salt Lake, Utah, banding operations on the California Gull (*Larus californicus*) on Egg Island were stopped in 1942. In 1944, banding operations were transferred to an artificial refuge on the shore of the lake about 20 miles east of Egg Island and about 15 miles from Salt Lake City. Banding has been continued annually since that time with cooperation from Dr. William H. Behle, who in later years has taken over most of the responsibility. During these years, 300 gulls were banded on June 8, 1944; 500 on June 16, 1945; 1000 on June 1, 1946; 1500 on June 7, 1947; 2500 on June 4, 1948; and 2500 on June 4, 1949. At Utah Lake, Dr. Tanner resumed banding operations in 1944, but in 1945 and 1946, Rock Island was inundated and the banding interrupted.

PROCEDURES

Two procedures were used. First, survey bands that were taken from dead, ill, or captured birds, were mailed by the finder to the United States Fish and Wildlife Service, Washington, D.C. That office then notified the bander, giving all information offered by the finder and sending duplicates to Mrs. Sargent, who compiled and filed the data.

The second procedure was carried out largely by bird watchers along the Pacific coast who had been alerted to watch for banded birds. Observations of gulls wearing color-band combinations were forwarded directly to Mrs. Sargent. The total number of survey band recoveries exceeded the number of sight records. Birds bearing colored bands formed such a small part of the total population of gulls that they were difficult to find. When they were encountered, it was often difficult to observe accurately the combination of colors on the legs and sometimes improper combinations were reported that did not correspond with those reported by the bander. Although some excellent

results were obtained, a feeling of uncertainty about some of them developed during the study of the records.

Exigencies of war time such as heavy work schedules and lack of gasoline, tires, and boat transportation all tended to prevent gathering of data after the birds had been banded. This seriously interfered with the accumulation of data which could provide information on life history, molting, age at breeding time, flock mixing, segregation and other topics. If a similar project could be conducted during peace time, there is little doubt that trained and interested observers along the Pacific coast could gather much information that was not obtained by this project.

Banding recoveries came largely from laymen and amateur observers who picked up the bands wherever they were found. Many of them were accidentally located, but some were gathered as a result of careful watching. The sight records were usually reported by interested persons who knew of the banding operations. The high percentage of sight records of the southern race of the Western Gull (*L. o. wymani*) was due to the activity of Mrs. Sargent and the scientific staff of the Scripps Institution of Oceanography at La Jolla, California. Table 2 gives a summary of the banding recoveries and sight records.

Table 2

Summary of Results

Species	Number banded	Recoveries		Sight records	
		Number	Per cent	Number	Per cent
L. glaucescens	2135	137	6.4	49	4.4
L. o. occidentalis	2301	216	9.3	73	2.6
L. o. wymani	1097	74	6.7	134	12.0
L. californicus	8558	212	4.8	108	2.4
Averages			6.9		3.8
Totals	14091	639		364	

REVIEW OF LITERATURE

Previous to this work, gulls have been banded off and on since the 1920's in various parts of North America. Pearse (1923, 1929) reported banding Glaucous-winged Gulls in Georgia Strait, British Columbia. Much of the banding work of the first quarter century was correlated and studied in the former Biological Survey. F. C. Lincoln published many papers emanating from this banding work. His paper dealing with the migration of young North American Herring Gulls (Lincoln, 1928) indicated some of the general patterns of movement and opened the way for more detailed studies.

Results of banding Herring Gulls of many breeding colonies along the North Atlantic coast and in the Great Lakes region were reported by Eaton (1933, 1934). He indicated that a population breeding along the eastern seaboard from Massachusetts north to New Brunswick, Canada, was highly migratory and during the first year reached the Gulf coast as far as Texas, but when two years old the gulls made shorter migrations to the south Atlantic coast. Gulls of a population breeding around the mouth of St. Lawrence River were shown to be more sedentary than those of other colonies and did not undertake such long migrations (this was later denied by Poor, 1943). A population of the Great Lakes Region was shown also to be highly migratory, spreading out over the lakes, along the eastern seaboard, and through the Mississippi Basin to the Gulf coast. His report raised many questions which stimulated further banding work.

Banding of Ring-billed and California gulls was conducted by Frank L. Farley (1932) at Bittern Lake, Alberta, in the years 1927 to 1932. Returns from his banding

show that these birds fan out southward in migration but most of them generally go to the Pacific coast, although a few go southeastward to the Gulf of Mexico.

In the middle thirties, interest in gull banding grew, and in 1937 Hickey and Allen outlined plans for a cooperative study which, in the ensuing years, resulted in the banding of 22,561 gulls along the Atlantic coast and lower St. Lawrence River. Progress reports were published by Hickey (1937), Allen (1937), by Hickey and Allen (1938) and by Allen and Hickey (1940). Color combinations used in the years 1937 to 1939 were reported in Bird-Banding (Gull Survey Committee, 1939).

A careful analysis of the returns of Herring Gulls banded at Kent Island, New Brunswick, Canada, was made by Gross (1940) in which he showed that there was a general explosive dispersal at the end of the nesting season, most marked in the young which fly farther and exhibit a greater migratory instinct than older birds. He also found that the gulls tended to stay close to the Atlantic coastline or to shores of lakes and river courses.

An analysis of the records of immature color-banded gulls banded at many points along the Atlantic coast but found in New York was made by Poor (1943). He showed that the young gulls coming from many places began to arrive mainly in September and reached a peak in numbers of arrivals in November. Poor (1944) also made an analysis of banding records of adult gulls from Kent Island, in which he showed that many of them reached New York in winter, more than five hundred miles distant. Still later (1946), he analyzed the plumage changes of gulls as they were deduced from the gull banding records.

On the Pacific coast, in an analysis of returns from gulls banded in Georgia Strait, British Columbia, Sprot (1937) showed that the majority of the young gulls never left the confines of the coastal networks within the Georgia Strait–Puget Sound area, but that lesser movements occurred within the almost land-locked region.

During the development of the Pacific Gull Banding Project, Mrs. Sargent kept the public well informed on the data gathered and on future plans (Sargent, 1939, 1940*a-b*, 1942, 1946*a-c*, 1947). She indicated (1942) that the young gulls of the three species banded spread out in fan-shaped patterns from the nesting colonies. With reference to the California Gull, she wondered if the young gulls had a tendency to follow water courses in their movements toward the coast; and since several records of young gulls had come from inland points, she raised the question whether it was the weak or sick young birds that remained inland or whether some healthy California Gulls remained throughout their lives on inland waters.

At the close of the three-year banding program, Ferris (1940) summarized the results of eight years of banding at Haystack Rock off the Oregon coast. He showed that the banded gulls move in nearly equal numbers north and south from the breeding colony; that the young tend to become resident during their years of immaturity in the locality in which they settle during their first winter; that adults probably return to the general region, but not necessarily to the colony, in which they were hatched. Results of banding at Utah Lake were reported by Tanner (1941, 1942, 1947) in which he showed that Utah gulls tended to move toward the Pacific coast, some of which were back as breeders in 1946, and that occasional stragglers went in other directions. An outgrowth from these bandings, a study of plumage changes in the California Gull, was reported by Beck (1942) in which he showed that gulls occasionally mature in two years but usually mature in three years and then return inland to breed.

Preliminary results of banding operations at Great Salt Lake were used by Woodbury (1941) to show that young California Gulls reared in Great Salt Lake migrate

westward to the Pacific coast in late summer and fall at a time when there would be little significant change in either temperature or day length westward on the Pacific coast. A detailed analysis of the Salt Lake banding data was reported by Woodbury, Behle and Sugden (1946) in which it was well established that longitudinal migration was the rule and that young birds do not usually return to their natal region until sexually mature.

SEASONAL PERIODS SUITABLE FOR GULL BANDING

Banding operations have shown that there are differences in nesting times of the various colonies (see fig. 1). These differences are based on the approximate times when

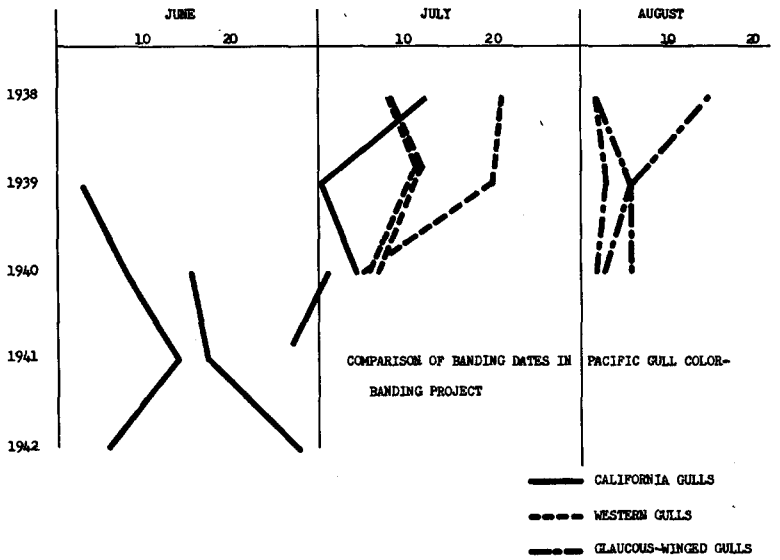

Fig. 1. Graphs showing variation in banding dates. Each line represents a separate colony.

the majority of young gulls have reached the age best suited to banding, that is, when they are young enough so that they can be captured readily and yet old enough so that the bands will not slip over the feet. This usually occurs when they are about three weeks (two to four) of age. Developments within a colony are far from uniform. Often the first hatchlings are nearly ready to fly before the last eggs are hatched. Optimal banding time therefore is a practical approximation that might vary several days. It might also vary slightly from year to year but even so, the data seem to indicate significant general differences.

California Gull.—Experience from banding gulls in Utah indicates the young are usually of a size suitable for banding in the second week of June. Banding dates at Egg Island in Great Salt Lake are June 3, 1939; June 8, 1940; June 14 and 22, 1941; and June 6, 1942. Those at Rock Island in Utah Lake are June 15, 1940; June 17, 1941; and June 27, 1942. It was found that June 3 was too early and June 22 and 27 too late and that the best dates ranged from June 6 to 15. On June 22, the young birds at Great Salt Lake were so far advanced that many of them were hard to catch and often escaped into the water.

Gulls at Mono Lake, California, were banded on July 12, 1948; June 30 and July 1, 1949; and July 4 and 5, 1940. A banding attempt on July 12 was too late; young birds had reached the stage of trying out their wings and had to be run down individually. Even July 4 and 5 were late. Gulls

banded at Klamath Falls, Oregon, on July 1, 1940, and June 27, 1941, probably fell within the proper range.

Western Gull.—Of the southern race, *wymani,* on North Coronado Island, Mexico, visited on May 3, 1938, Mrs. Sargent writes: "The young gulls were still in their eggs." She returned on July 21 and banded 153 birds. This was obviously too late. The next year she and her party banded 486 young gulls on June 20, 1939, and 331 on July 5, 1940. The optimal period of banding appears to fall around the 1st of July.

Ferris banded Western Gulls of the northern race, *L. o. occidentalis,* on July 16, 1938; July 9 and 10, 1939; and July 6, 7, and 12, 1940. Of the July 16 date, he reports they were too large for efficient banding, but thought they were about the right size on July 9 and 10. However, on July 6 and 7, he found that "the young were about a week too old for best results, the season being earlier than usual." In general, however, he considered July 8 as about the optimal time.

Glaucous-winged Gull.—Concerning banding of gulls on the islands of Puget Sound, Washington, Bach states, "We found the gulls a trifle small for banding on July 6, 7, 8, 19, 1940." In later correspondence, he says the "gulls are found in better banding condition after the first of August." Pearse, in British Columbia, says that "Sprot and myself have come to the conclusion that there is no use attempting banding operations until after the first week in August." Miss McMannama's experiences on islands in Puget Sound, San Juan County, Washington, indicated that the best time for banding had proved to be from July 15 to 26. This difference may be due to the fact that some colonies begin to breed earlier in a given season than others of the same species.

Discussion.—The evidence indicates that there is a graded series of differences in the time of nesting in the colonies of the gulls studied. The California Gulls in Utah nest the earliest. They nest so that on the average the majority of their young are ready for banding about the second week of June. Perhaps the nesters on Utah Lake may be slightly later than those of Great Salt Lake. By comparison, those nesting nearer the Pacific coast at Mono Lake in eastern California and at Klamath Falls, Oregon, are ready about two or three weeks later, usually a few days earlier or later than the first of July.

Western Gulls of the race *wymani* on North Coronado Island, Mexico, appear to nest about the same time, the young being ready for banding usually around the first of July. Western Gulls of the nominate race breeding farther north along the Pacific coast are slightly later, the young being ready about the second week in July. The overlap between the times of nesting of both subspecies, however, is so great and the difference in the optimal time for banding is so slight that it probably is of but small significance as a factor in subspeciation to be discussed later.

The Glaucous-winged Gulls of the Puget Sound area in Washington and British Columbia are the latest nesters. The optimal time appears to vary from the middle of July to the second week in August, about one and one-half to two months later than that for the California Gulls of the Great Salt Lake area.

These differences in time of nesting are derived largely by inference from data collected with other objectives in mind and doubtless represent only approximations of actual breeding times. There is great need for concerted action on the part of field ornithologists to locate and make censuses of all of the breeding colonies of each species and subspecies and to obtain actual dates of breeding, such as times of egg-laying, hatching, fledging and flying of the young in order to get more accurate data for use in comparing the various species.

GEOGRAPHIC MOVEMENTS

As banding returns began to accumulate, it soon became evident that the birds which nested along the Pacific coast simply moved back and forth along the coast in their wanderings, but that those nesting inland made migrations toward the coast and back

again. In attempting to analyze these movements, we have plotted the banding returns and reliable sight records on maps to show the point of banding and the point of observation or the point of banding recovery. Banding recoveries are indicated on the maps by solid dots or parts of dots and the sight records by hollow circles or parts of circles.

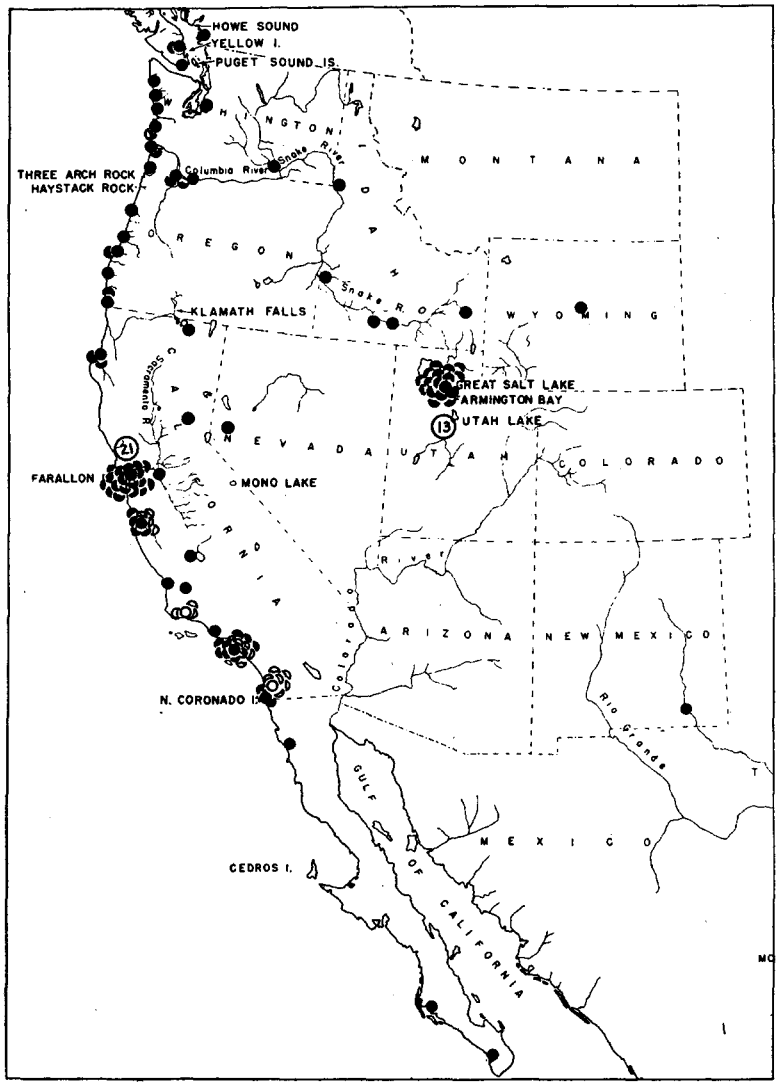

Fig. 2. Map showing returns of California Gulls banded at Great Salt Lake and Utah Lake.

California Gull.—The greatest range of geographic movement is exhibited by the California Gulls banded in the Great Basin at Great Salt Lake and Utah Lake. The majority of the young birds banded here fan out toward the Pacific coast during the first few months of their life. The records and map (see fig. 2) indicate that they are dispersed along the coast from Vancouver, B.C., southward almost to the tip of Lower California. A few returns come from points which could well be regarded as intermediate

between the banding site and the coast. Two returns, however, from Riverton, Wyoming, and Carlsbad, New Mexico, evidently represent exceptional individuals that did not go directly toward the coast.

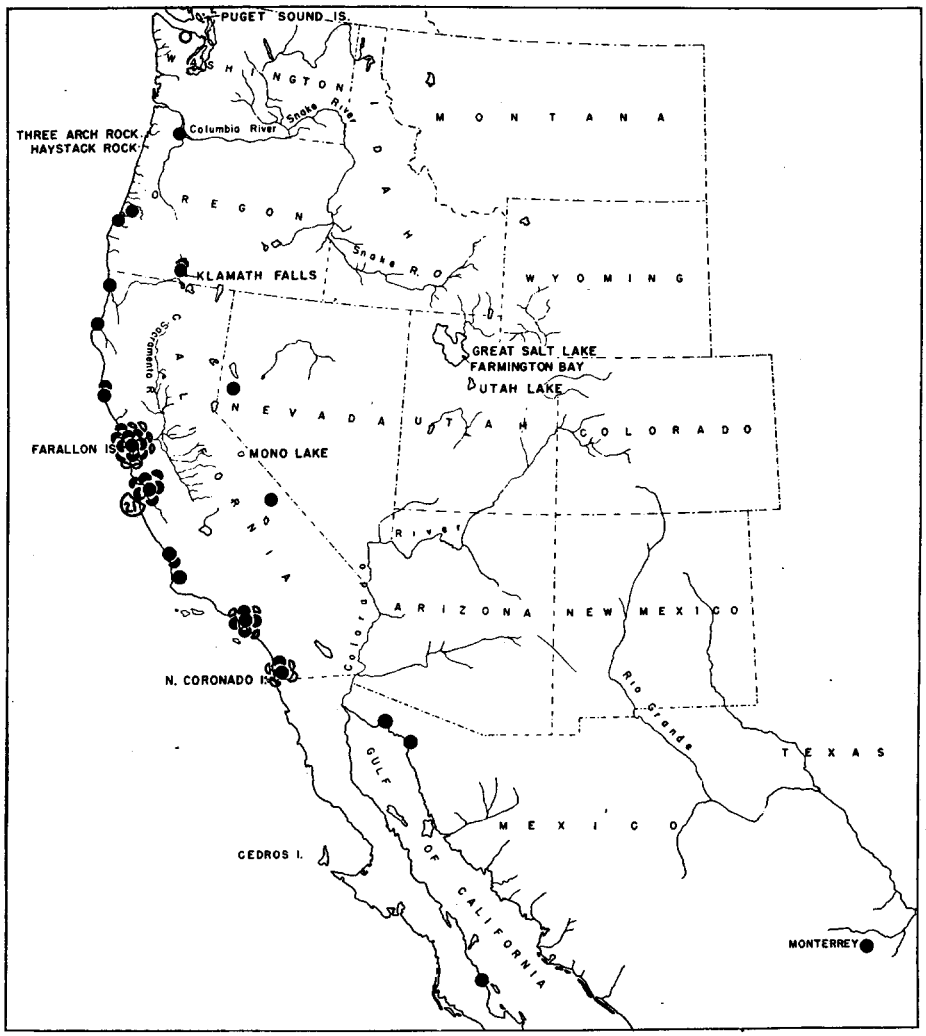

Fig. 3. Map showing returns of California Gulls banded at Mono Lake, California, and Klamath Falls, Oregon.

Gulls banded at Mono Lake, California, and Klamath Falls, Oregon, also make their way to the Pacific coast as do those banded farther inland, but they do not have as far to go. They appear to spread north and south along the coastline in a similar pattern, but there seems to be a greater concentration of records from parts of the coast close to points of banding than from those at greater distances away. Recoveries from Mono Lake are concentrated mostly along the California coast, while those from Klamath Falls are mostly along the Oregon coast, although there are three returns from California and the Mexican mainland (see fig. 3).

Western Gull.—Perhaps the most sedentary of all gulls banded are Western Gulls of the southern race, *wymani,* on the Coronado Islands (see fig. 4). Returns from them are concentrated mainly around San Diego and Los Angeles, but a few scattering returns

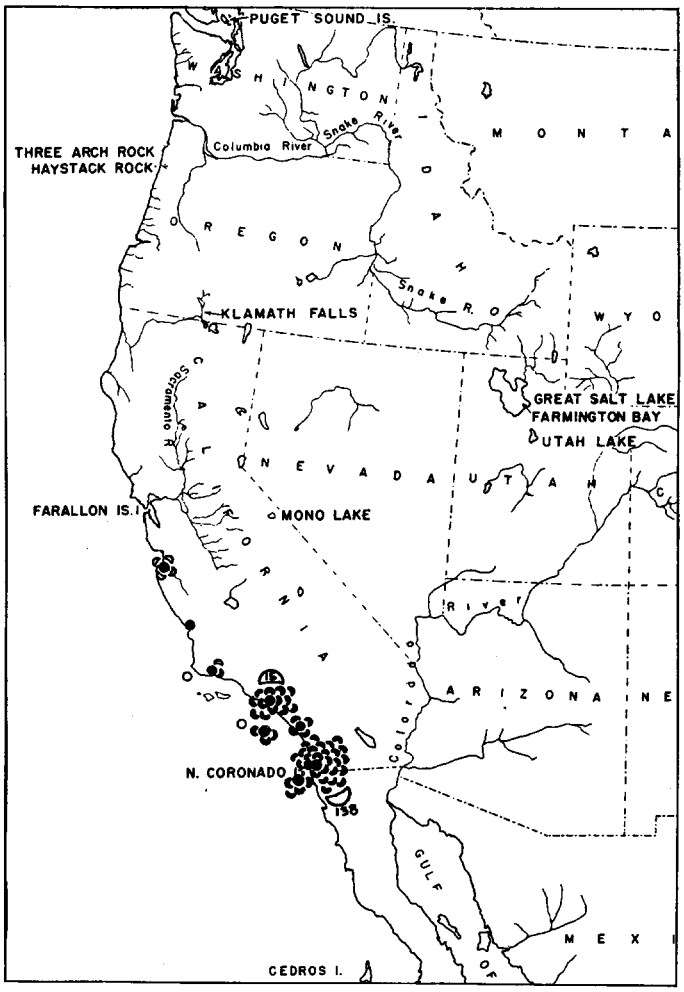

Fig. 4. Map showing returns of Western Gulls of the race *L. o. wymani* banded at North Coronado Island, Mexico.

come from farther north although none of them is beyond Monterey, California. The heavy concentrations of records around San Diego and Los Angeles probably result from the concentration of observers at both places and from the attractions of food at the city garbage dumps.

Returns from bandings of Western Gulls (*L. o. occidentalis*) at Three Arch Rock and Haystack Rock, islands off the coast of Oregon, are plotted in figure 5. The distribution pattern indicates that the young birds, after banding, spread north and south along the coast from Vancouver Island, British Columbia, south as far as Los Angeles. Most of the returns are concentrated on the Oregon and Washington coasts near the banding site but lesser numbers occur as far south as San Francisco and only scattering

records come from Puget Sound, the lower Columbia River, and the Californian coast south of San Francisco.

Glaucous-winged Gull.—Returns from the bandings of Glaucous-winged Gulls in the Puget Sound–Georgia Strait area of northwest Washington and southwestern British

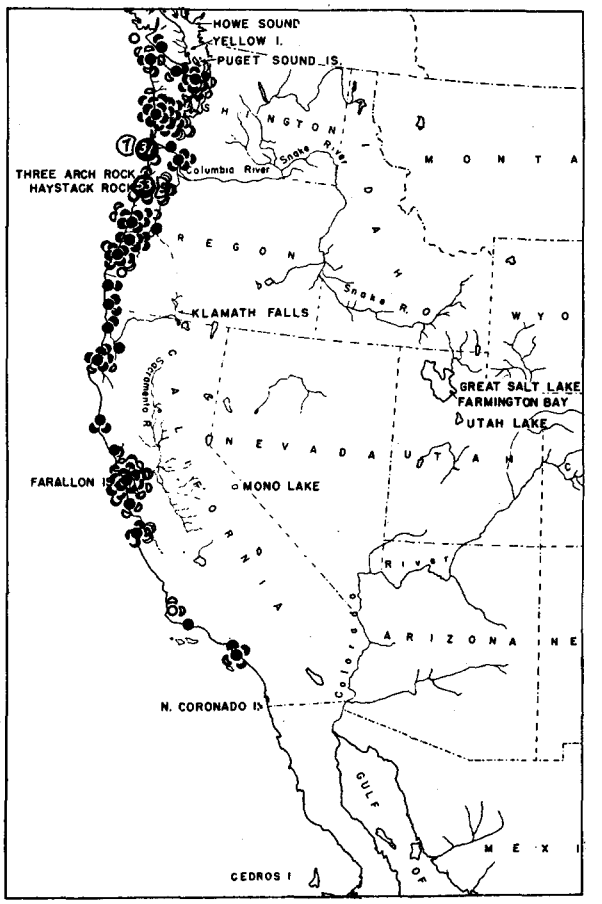

Fig. 5. Map showing returns of Western Gulls of the race *L. o. occidentalis* banded at Three Arch Rock and Haystack Rock, Oregon.

Columbia indicate that the majority of the young birds are relatively sedentary in their habits but that a few travel long distances down the coast (see fig. 6). Most of the returns are concentrated on the islands and coastlines of the interior waterways between Vancouver Island and the mainland. The northernmost record is near Prince Rupert beyond Vancouver Island and the southernmost record is at San Diego, California, thus indicating that the young birds have a spread of at least 1500 miles along the coastline. Despite this wide latitudinal spread by young of the year, Theed Pearse believes that most of them tend to stay in the vicinity of their original home. This does not agree with the ideas of Miss Zella McMannama (letter) who thinks that young birds spread a great deal from their natal islands. She finds only about one yearling to 12 or 15 older birds at the salmon canning works at Friday Harbor, San Juan Island, but the ratio of two-

or three-year old birds to older ones is about one to five. If her sample is large enough to be significant, it may mean that some of the yearling wanderers return when two or three years old. She also doubts whether the mainland between Puget Sound and the coast is so much of a barrier as the banding recoveries indicate.

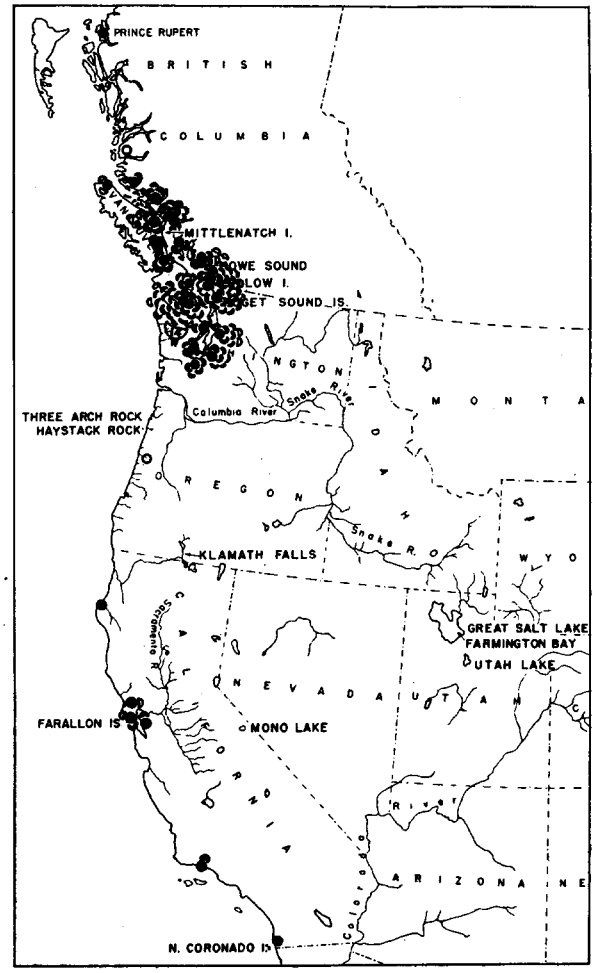

Fig. 6. Map showing returns of Glaucous-winged Gulls banded at Mittlenatch Island, Gull Island in Howe Sound, and Yellow Island, British Columbia, and at Puget Sound Islands, Washington.

The situation indicated by Pearse in the Glaucous-wings is in direct contrast with that in the California Gulls in Utah in which the young leave for the coast in mid-summer without the adults when waters are not frozen and when food supplies have not yet begun the winter decline.

TRAVELS OF YOUNG GULLS

If the banding returns are used to indicate the distance that the bird had traveled at the time when the band was recovered, new light is thrown on comparative travels of the young birds of the various colonies. By analyzing these returns from this point

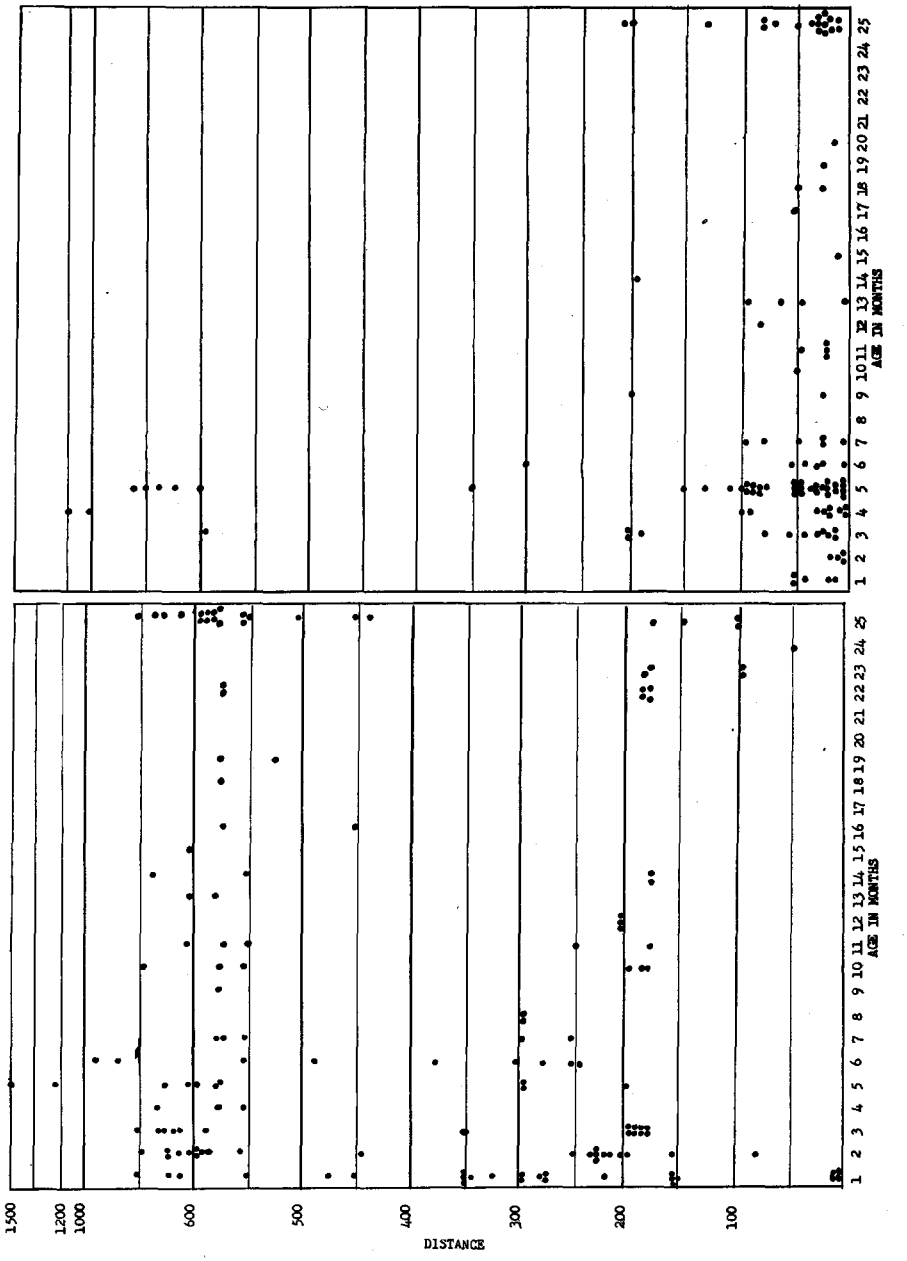

Fig. 7. Scatter graph of banding returns showing distances travelled in miles and age in months. Upper, Glaucous-winged Gull; lower, California Gull.

of view and plotting them on a scatter graph, using age in months on one axis and distance traveled on the other, some of these comparisons become clear.

The scatter graph in figure 7 shows two areas of concentration for the California Gull, one at distances between 150 to 350 miles, the other in the region of 550 to 650 miles. These are well distributed in age from one month after leaving the banding site

to twenty-five months or more where everything over that age is plotted. The area of concentration with the shorter distance represents mainly travels of young gulls from the Mono Lake and Klamath Falls sites whereas those showing a longer-traveled distance are mainly from the Utah sites. The patterns of movement are similar but the distances traveled to get to the coastline are greater from the Utah sites.

Travels of *wymani* are shown in figure 8. It may be noted that most of these occur within 150 miles of the banding site and that only four extend beyond 200 miles. By contrast, *occidentalis* (fig. 9) shows a much greater dispersion in distance in the first year of life. Seven represent distances between 600 and 1000 miles of travel.

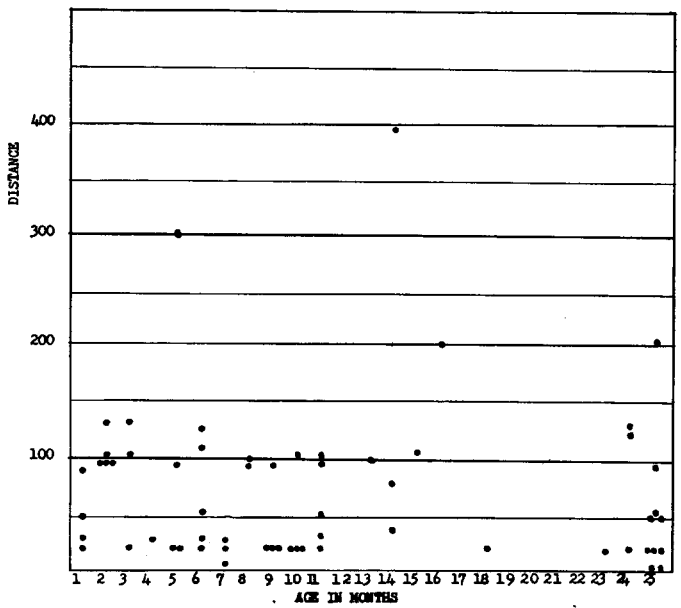

Fig. 8. Scatter graph of banding returns showing distances travelled and age in Western Gulls of the race *L. o. wymani*.

Travels of the Glaucous-winged Gulls (see fig. 7) are quite similar to those of *wymani* except that there are eight records indicating travels of about 600 to 1200 miles. There are no records lying between approximately 350 and 600 miles, thus leaving these long distance travelers isolated from the rest of the group in the scatter graph. The explanation probably lies in the fact already indicated by the map in figure 6 that the young birds tend to remain along the interior coastlines between Vancouver Island and the mainland but that if they get out of this area, then there is no natural barrier to stop them and they may travel far.

Urge to travel.—It is well established from these banding returns that there is great variation in the distance traveled by young gulls, not only among members of the same colony but also among colonies, populations or species. These variations must be due in part to hereditary physiological phenomena which drive some individuals to greater movements than others and in part to the physiographic or ecologic conditions which are encountered by the young gulls.

In considering colonies or species, it seems certain that the average of some colonies or some species is greater than that in others. For example, the Glaucous-wing and *wymani* usually do not go as far as the average California Gull and *occidentalis*.

The California Gulls from Klamath Falls and Mono Lake do not travel as far as those from Utah. The Glaucous-wings from the landlocked coastlines between Vancouver Island and the mainland seem to be held by land barriers that few cross whereas most of the California Gulls are hemmed in by land barriers which they cross in order to get to suitable water courses or shorelines.

There seem to be no barriers affecting the movement of Western Gulls along the coast but since they seldom leave the coast, the land and ocean seem to act as barriers to confine them to the shorelines.

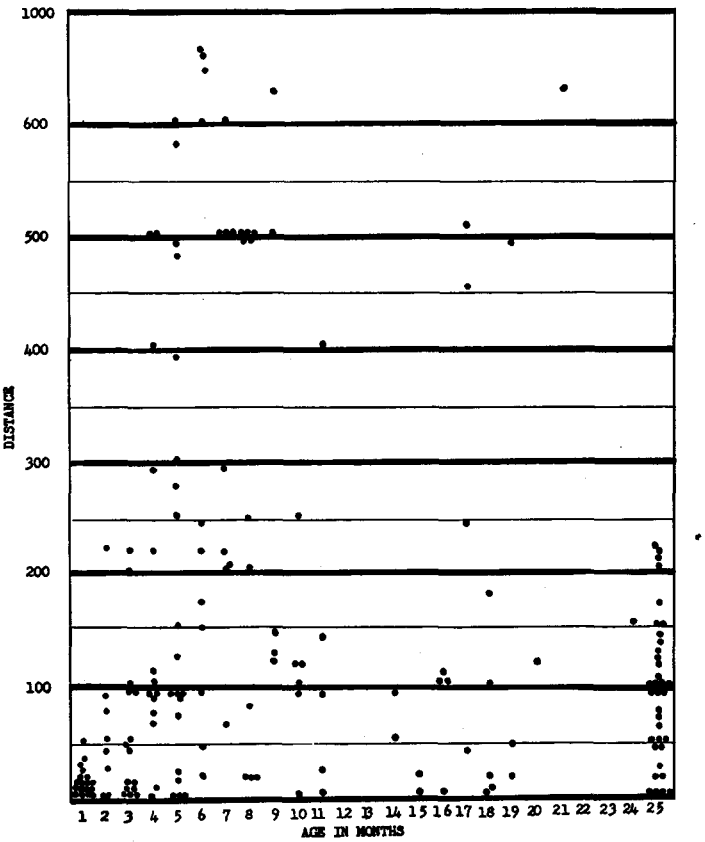

Fig. 9. Scatter graph of banding returns showing distances travelled and age in Western Gulls of the race *L. o. occidentalis*.

The California Gulls that summer in Utah are replaced in winter by Ring-billed Gulls (*Larus delawarensis*) that presumably come from Canadian breeding grounds. Why one leaves and the other comes to Utah is not easily answered but the urge of young gulls to leave their natal region may be a factor in both instances. Perhaps the inherent drive so evident in the genus becomes more or less adapted through natural selection or adjusted by "cultural" patterns to fit the physiographic conditions which they encounter and so tends to vary from colony to colony or from species to species. Such a tendency toward adaptation might be obliterated by thorough intermixing.

Guidance in travel.—It is obvious that each young gull must do a lot of flying in

order to earn a living. If such flight is limited by attraction to a given locality, the bird is not likely to wander far from its home range or territory. If, however, the young gulls have some guiding mechanism that takes them in a given direction, they are likely to travel as far as their drive to travel takes them. Western Gulls appear to be guided along the coast because they are attracted to shorelines but why some go north and some south is not answered by available information.

Nearly all the young California Gulls go westward toward the Pacific coast although some go northwest and some go southwest. A few fail to find the coast and sometimes "get lost" in the interior. Apparently, the guiding mechanism is not fully effective in all cases. In the majority of cases, however, they go toward the coast and do not stop until they get there. How they recognize the place and why they stop when they get there are questions not answered by the banding data. A partial answer is available, however, if it is assumed that they recognize the place by means of an inherited attraction to shore lines and that they occupy such areas as soon as the ocean is reached. What of the erratic gulls that do not follow the usual pattern? Can they be explained on the basis that the mechanism they inherit does not guide them in the same direction as the others?

Doubtless the matter of guidance would also be affected by natural selection. Those young gulls which were guided in a direction that led them to suitable places of survival would be more likely to survive and pass on their hereditary attributes that guided them than those erratic individuals that get lost and fail to find suitable survival areas. In other words, natural selection must be called upon to explain the development of both drive and guidance. It seems probable that there are variations in the intensity of the urge to travel and that it is most highly developed in the California Gull and least in the Glaucous-wing and in *L. o. wymani.*

Double records.—In the ordinary band recoveries, there are only two dates and locations available, one when the bird was banded and one when it died. The intervening travels between these two points are not known. Among the banding returns of this project, there are four double records that help to fill the gap. Such a double record occurs when a survey band is identified on a living bird and is later returned after the bird's death. This gives a slight idea in some cases of the routes of travel.

One of these is a record of *wymani,* USBS 40–683634, banded at North Coronado Island, Mexico, on June 5, 1940. It was caught about six weeks later on fishing tackle on the shore of the island where it was banded, and found dead on the mainland of California about 15 miles north and east of its banding site, November 21, 1940. This bird, although at least five months of age, had not traveled far. The other three birds were Western Gulls banded at Haystack Rock, Oregon. One of these, banded on July 16, 1938, was identified while alive along the Oregon coast about 35 miles north of the banding site at Wheeler, Oregon, about three months after banding. It was later found dead at Long Beach, Washington, April 6, 1940, about 18 months after the previous identification. This is about 55 miles north of the previous site. It indicates that the bird had moved northward along the coast about 35 miles in three months and about 90 miles within less than two years.

The other two were banded on July 6, 1940. One of these was identified by its number while alive at Hermosa Beach, California, December 8, 1940, about six months after banding and approximately 860 miles south of its banding place. Thirty-six days later it was found dead at Seaside, California, which is about 270 miles north of Hermosa Beach. This bird, after having traveled southward at least 860 miles in six months, had moved back north 270 miles in 36 days.

The last example was a gull first identified while alive, on September 16, 1940, at

Klipson Beach, Washington, approximately 95 miles north of the banding site. It was found dead at Seaview, Washington, about 85 miles north of the banding site on November 24, 1940. It had moved only about 10 miles during its last nine weeks.

The travels of these four birds tend to corroborate the data derived from other tabulations. The Western Gull of the southern race showed the characteristic sedentary pattern indicated from the returns plotted on the map (fig. 4), whereas the three Western

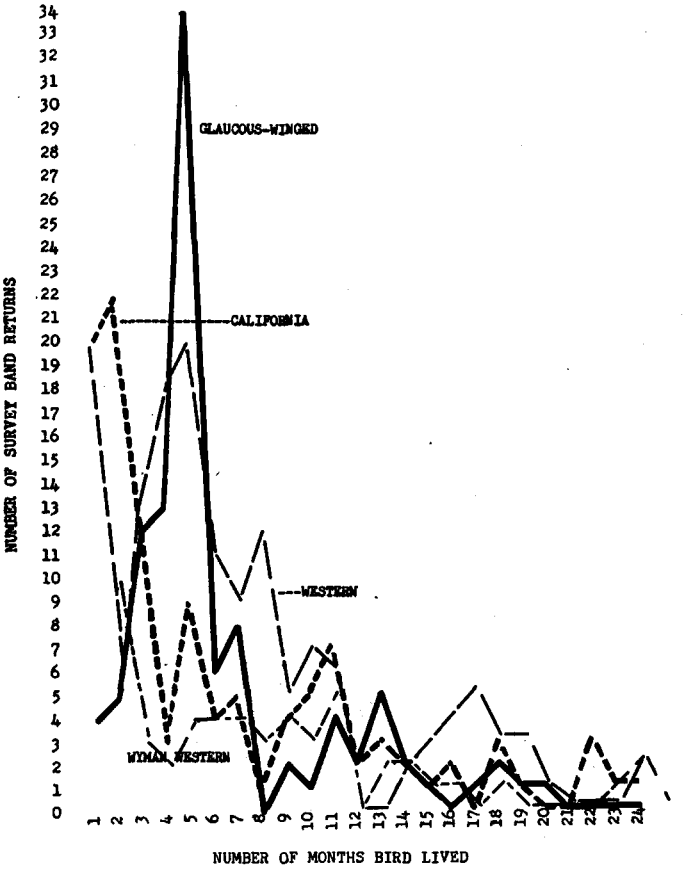

Fig. 10. Graph of banding returns showing ages of birds in months after banding at time of band recovery.

Gulls of the northern race show variable travel patterns, one traveling a maximum of about 35 miles, one about 95 miles, and the other one at least 860 miles along the Pacific shoreline but two of these had returned 10 and 270 miles, respectively, toward their banding sites.

LONGEVITY AND MORTALITY TRENDS

The banding returns also serve to throw light on longevity of gulls. It is assumed that a banding return implies the death of the bird from which it was taken. This is generally true, but there may be cases in which the bird had been dead some days or even weeks when the band record was obtained. Such circumstances are usually indicated by the finder and were taken into consideration in compiling the recoveries. However, there may be a small percentage of cases in which the fact of death earlier than

the date indicated escaped notice. It is believed, however, that these would introduce only a small margin of error and would not vitiate the general value of the data. This mortality problem was studied by plotting graphs in which the age of the bird as indicated by the time lapse between date of banding and date of band recovery was used on one axis and the number of individuals on the other. Graphs thus plotted for each species and subspecies studied (see figs. 7-10) show certain similar characteristics. A

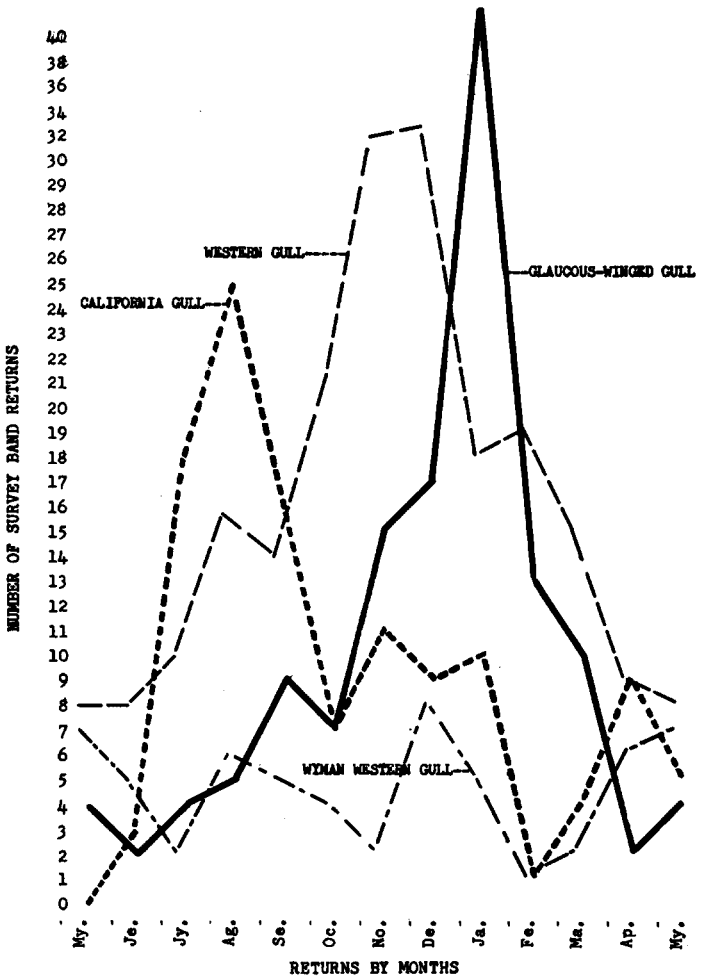

Fig. 11. Graphs showing number of returns by months.

large majority of the young birds perishes during the first year; those living until the second year are fewer in number and hence the returns are fewer, as shown in figure 10. Beyond two years, only sporadic records are available and a smoothed curve would taper off to practically nothing by the third year.

The few birds that survive this early decimation have a much greater chance for a long life. Ferris has returns from his bandings of Western Gulls at Haystack and Three Arch rocks off the Oregon coast that reach as high as 6 to 13 years of age. These are as follows, the two dates given representing times of banding and recovery: July 19, 1937, to

January 16, 1944, nearly 6½ years; July 7, 1940, to January 12, 1947, over 6½ years; July 14, 1939, to January 27, 1946, over 6½ years; July 19, 1937, to May 6, 1944, over 6 years and 9½ months; July 19, 1937, to August 1, 1945, over 8 years; July 9, 1939, to July 27, 1947, over 8 years; July 6, 1940, to July 3, 1949, nearly 9 years; July 16, 1938, to April 15, 1948, 9 years and 9 months; and July 10, 1935, to December, 1948, about 13 years and 5 months.

The graphs showing longevity also have a bearing upon mortality trends as they suggest peaks of mortality at certain seasons of the year that differ among the forms studied. In order to see if there is any correlation between mortality and season, figure 11 was plotted. This shows banding returns by season of the year rather than by inferred age of the birds. In comparing returns of the Glaucous-winged and California gulls, it is obvious that the peaks of mortality come at different seasons of the year, that of the California Gull in late summer and early fall near the close of its migratory season and that of the Glaucous-winged Gull later in the year when it would be expected that winter decimation would be at its height. Since the Glaucous-winged Gulls appear to wander relatively short distances and most of them do not make long migratory flights when young, there would appear to be no heavy mortality such as that found in the California Gull at the close of the migratory season.

In the Western Gull, it is found that the peak of mortality of the northern subspecies comes in November and December, a month or two earlier than that of the Glaucous-winged Gull, and two or three months later than that of the California Gull. The number of recoveries for *wymani* are too few for safe analysis.

In attempting to explain the mortality trend, it must be recognized that the decimation process is a complex affair modified by many factors and that the obvious correlation may not give the whole picture. It might be speculated that *wymani*, living in a region with a more uniform climate and less fluctuations in temperature, would be expected to have a more uniform mortality trend during the year than the others. *L. o. occidentalis* and Glaucous-winged Gulls show trends that are quite similar in pattern. They differ, however, from each other in the time of year that the mortality reaches its height by about two months. The reason for this difference is obscure and needs further investigation, especially with reference to climatic conditions and food supply.

The mortality peak of the California Gull bears a totally different relation to the seasons of the year. It occurs at the end of migration instead of in the winter. It should be remembered that the California Gulls leaving the interior in July and August and undertaking an east-west migration would encounter little significant difference in day-length relations on the coast from those which existed at the point whence they came but would find important advantages in climate, especially in more uniform temperatures and greater humidity and disadvantages in greater competition on crowded beaches. The mortality peak coming at the end of migration is supplemented by a secondary peak reaching from November to January which occurs simultaneously with the primary peaks of the other two species. Thus it appears that the mortality following migration in the California Gull is not shown in the other species.

Causes of death.—The records of banding recoveries did not always indicate the cause of death of the bird. Many of the reports merely said "found dead." In a few instances, however, such causes as shooting, catching with fishing tackle, killed by a hawk, broken wings and legs, accidentally caught in conveyor belts at canneries, and others have been reported. These causes are not extensive and would not account for the great bulk of the deaths. It has been shown in figures 11 and 12 that there are seasonal peaks of mortality in the various species not explainable by items given with

the banding data. The additional causes must be sought in more general terms, as the great numbers of young that are produced in each breeding season cannot possibly persist as a permanent part of the population.

In terms of a general conception, the breeding population of one year would be increased to a maximum population about the time the young gulls leave the nest. Numbers would then decline until a normal breeding population was left just prior to the next breeding season. This would include loss of a small percentage of adults. The balance of the loss would come from the young. In other words, the annual increase would be eliminated before the next breeding season arrived and only enough of the young on the average could survive to replace the adults that are lost. This general picture, however, is modified in the case of the gulls which take two or three years to mature and hence the basic population prior to the breeding season includes not only the breeders, but many immature birds that have not yet reached breeding age. These, however, are separated from each other in range during the breeding season and the basic breeding population that returns to the nesting colonies would be comparable from year to year devoid of the young that remain on the coast. The general conclusion, however, remains essentially the same, that on the average, the annual increase or its equivalent must be removed before the next breeding season.

It has already been shown that the seasonal decline in the California Gulls comes in late summer, but that of the other two species occurs some time in the winter. Apparently there are enough young California Gulls to survive the rigors of migration and still leave an excess population to be removed in a secondary cycle of loss that is correlated with high losses of the other two species. Since the other two species involved do not have a regular migration in the sense that the California Gulls have, the die-off is delayed until the food supply, climatic factors, or other conditions combine to cause the necessary reduction each year.

FLUCTUATIONS

During the banding operations, considerable evidence developed of fluctuations in populations or in the places of breeding. In 1939, both Theed Pearse and Dennis Ashby found that there were more young Glaucous-winged Gulls on the islands in British Columbia where they banded "than ever before." Presumably, this was an upward fluctuation in numbers of that species at those places but since available data are inadequate, it may mean only a shift in place of breeding.

Some changes were noted in the number of California Gulls nesting on Egg Island in Great Salt Lake during the banding years from 1939 to 1942. After 1088 gulls had been banded in 1940, it was estimated that about one in ten or twelve of the young birds bore bands. There were perhaps 10,000 young birds on the island, a conservative estimate. In 1941, after banding of 1500 gulls was completed, it was estimated that 9 out of 10 young on the island were banded. This indicated a very great reduction in number from 10,000 in 1940 to 1700 in 1941 had taken place. In 1942, about 1500 or 40 per cent of the young gulls were banded, indicating a total crop of 3750 young birds on the island.

At the time of the low numbers of young on Egg Island in 1941, new colonies were established on artificial islands in Farmington Bay about 20 miles east of Egg Island, and the colony on Rock Island in Utah Lake was reported to be much larger than usual, containing about 15 or 16 thousand young gulls. A few years later, during the nesting seasons of 1945 and 1946, unusually high water in Utah Lake inundated Rock Island where the gulls had previously nested for many years, and they moved their nesting activities to artificial dikes at the Geneva Steel Plant near Utah Lake but the numbers there are not known.

SUBSPECIATION

The patterns of distribution of the populations of the Western Gull (*L. o. occidentalis* and *L. o. wymani*) revealed by these studies suggest a partial isolating mechanism that could well contribute to the observed divergence and resultant subspeciation. Figures 4, 5, 8 and 9 show the population of the southern race (*wymani*) to be more or less sedentary with little movement northward and the northern race, although much more mobile within its range, shows little tendency to move southward into the area inhabited by the southern race. More data are needed from colonies located between those where banding occurred, for example, from Point Lobos, where the northernmost breeding colony of *wymani* is located and from the Farallon Islands, where the southernmost breeding colony of *L. o. occidentalis* is located.

The tendency of these gulls to remain in a restricted area reduces chances for interbreeding between the two racial populations, and this may be accentuated by the geographic location of available nesting sites. It is conceivable that climatic conditions, gaps in the breeding range, sedentariness of populations, and perhaps food supply attractions might all contribute toward an isolating mechanism that would lead to racial divergence.

The question arises why racial divergences have not developed in the other two species studied. The dispersing population of wintering California Gulls coming from the interior covers the area occupied by both subspecies of the Western Gull, but no isolating mechanism separating one contingent from another has been found for the California Gull. From the banding returns, it becomes evident that birds from the various interior breeding colonies all occupy the same wintering ranges. Sight records reported by Laidlaw O. Williams and others have established the fact that birds from different colonies have been seen along the coast in the same flocks. Presumably this mixing of birds from the various breeding colonies tends to prevent isolation. It might operate in two ways: when such mixed flocks return inland to breed, presumably the flock will go to a given nesting site and mixing on the breeding grounds will be accomplished. The other alternative is that they might pair off in the mixed flocks before they leave the coast. This needs further investigation.

In the Glaucous-winged Gull, the birds are more or less landlocked on the interior waterways between Vancouver Island and the mainland. Few of them appear to escape this barrier; but if they do, they seem to go long distances in their travels. Presumably, those that travel afar eventually come back to the known breeding grounds. Available evidence does not point to any isolating mechanism.

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