bably infertile, for the next morning when I visited the nest I found that it had not hatched.

These observations show that the incubation period of this clutch was from ten to eleven days, probably 250 to 255 hours to be more exact; for although I noticed that the last fertile egg had hatched at 4:20 in the afternoon of the tenth day, I was not sure but that this might have occurred earlier in the day, since I did not scare the mother from the nest at the time of my morning visit.

This concluded my observations on the activities of this one family. I may add, however, that I have never seen a male Dickcissel feeding the fledglings and dare say that further observations will show that he takes no part in any of the drudgeries connected with domestic life. He merely looks after the general safety of his family and compells his mate to do all the work, while he encourages her by his presence and song.

University of Oklahoma, Norman, Oklahoma.

FURTHER OBSERVATIONS ON THE HABITS AND BEHAVIOR OF THE HERRING GULL.

BY R. M. STRONG.

Plate XXXVI.

I. INTRODUCTION.

This paper gives the results of observations made since my publications on the same subject in 1914.[1] In July and August, 1917, I was located at the University of Michigan Biological Station. During this period, I had a student working on the behavior of juvenal Herring Gulls.

A few days after the work at the Biological Station was started I read in 'Science'(4) the recommendation of the Committee on Zoology of the National Research Council that the problem of "utilization of gulls and other aquatic birds in locating submarines be studied." It at once occurred to me that I ought to consider

[1] The Auk, 1914, pp. 22 and 178.

this recommendation, and I accordingly gave a good deal of attention to it during several following months. It may seem at this time to have been a very unpromising effort, but it must be remembered that the submarine problem was then appalling. No successful methods for either the detection or the destruction of submarines had been devised. So desperate was the situation that the British advised the study of the habits, even of sea lions, as well as of sea birds, along with a number of other topics in a general program of broad inquiry.

It seemed to me that Gulls, to be of any use in the vast area of submarine activities, would have to be trained to some extent. I, therefore, decided that their docility and capacity for training should be studied, also their habits as bearing upon the problem.

I am greatly indebted to Captain Robert E. Ellsworth of Michigan Patrol Boat No. 4 for a considerable amount of data given in this paper and for numerous courtesies while a guest on his boat. Acknowledgments are also due to the Honorable John Baird of the Michigan Public Domain for his authorization of my expeditions with Captain Ellsworth. The work at the University of Michigan Biological Station required facilities kindly made available by Professor George R. La Rue, the director. He was also with us on two of the trips.

The first expedition with Captain Ellsworth began at Cheboygan, Michigan, August 4, 1917. Various islands in Potagannissing Bay were visited. The trip was extended through the channels and lakes collectively known as St. Mary's River. A second expedition was made during June 19 to 22, 1919, to the Beaver Islands, and a third to Gull Island near Thunder Bay, Lake Huron, July 16, 1920.

The Gulls used in the experimental work were obtained on a short trip to Goose Island, July 8, 1917.

II. HABITAT.

The general geographical distribution of the Herring Gull has been known for many years, but the literature has contained little concerning the local distribution of this bird. I was interested in determining where individual Gulls spend their time and why. It has not been practicable to follow the activities of any single

individuals for an entire day, but I have collected data concerning the location of groups.

By far the most important factor in determining the location of Gulls appears to be the food supply. In recent years on the Great Lakes, at least, the most reliable or abundant sources of food have been connected with human activities. It is my judgment that they also determine the abundance of these birds more than any other factors. On our 1917 cruise, we found very few Gulls on bodies of water not used much for navigation, but they were abundant along the ship courses and about harbors. For a number of years I have found non-breeding Gulls collected mostly about harbors, large vessels (especially passenger boats on their course when not many miles out from a harbor), and about fisheries. It is not an uncommon sight to see good perching places, such as posts and piles of an abandoned wharf, occupied by Gulls.

Enough young are raised to the flying stage each year in my judgment to make a greater increase in the Gull population than is maintained. The supply of food is not unlimited and many a Gull must face starvation.

Heavy storms, especially during the winter months, may scatter dead fish along the beach at points remote from harbors and ship courses. At such times considerable numbers of Gulls leave the ship courses temporarily. During the period when navigation is closed, on account of ice, this is especially true.

In the spring, there is a general movement northward, and by the end of April only stragglers are to be found in the latitude of Chicago. The number of these stragglers seemed to be larger, however, during the past season or two. Both the winter and summer distributions cover a large range of latitude. It would be interesting to determine whether individuals wintering as far south as the Gulf of Mexico breed farther south than individuals with a more northern winter habitat. It is possible that some individuals may not migrate at all. It is furthermore conceivable that some strains or colonies of Herring Gulls may be non-migrating.

As has been stated earlier in this paper, it has not been practicable to follow all of the activities of individual Gulls for even a single day, but the following observations probably tell most of the story except for nocturnal activities which were discussed in previous papers.

It has been my privilege to observe these birds daily for periods of two to six weeks a number of summers on Little Traverse Bay, and especially at Harbor Springs and Harbor Point, Michigan. From our summer home porch, Gulls are almost constantly observable, while there is daylight, at fish weirs less than one half mile away. A number of Gulls may be seen at all hours of the day unless disturbed, usually standing or sitting on the group of piles that at one time supported a low dock at Harbor Springs.

Among the first sounds at daybreak are the "challenge" cries of Gulls at the fish weirs mentioned above. As twilight comes on, the Gulls about the Harbor gather in a large flock and fly off up the bay, presumably to some roosting place.

I have never ascertained whether any of these Gulls about Harbor Point and Harbor Springs were breeding, though many of them were adults. Certainly, however, they spent a large amount of time standing on the piles and fish weir poles looking for an occasional fish or any food that might turn up. Occasionally, they were seen in flight during the day, especially in stormy weather or when disturbed by intruders.

III. NOTES ON BREEDING HABITS.

(A.) *The time of laying and hatching.*—For some years, I have been interested in obtaining data concerning the time of laying, but it has not been practicable for me to visit Gull breeding places early enough to get records of the first laying. Nests with fresh eggs may be found well into July, but it is probable that so late a nesting is due to previous attempts having been failures.

Though the data available are not so complete as is desirable, there is evidence of a correlation between seasonal conditions and the time of breeding. This conclusion is supported more by observations on the stage of development of the young than by records of early laying. It is, of course, impossible to determine the time of laying by simply observing eggs in nests. Full sets may be fresh or nearly ready to hatch, involving an uncertainity of over three weeks.

Nests, with one or two eggs only, do not furnish reliable data because the eggs may be sterile or considerably incubated, as I

have found by testing. Only close observation of marked nests on successive days can establish the time of laying exactly.

Though the data given below are subject to such limitations as have been indicated in the two preceding paragraphs, they are of interest in showing that eggs had been laid by the dates indicated.

From Captain Ellsworth, I received the following records made at Gull Island, Lake Huron, May 23, 1919.

3 nests with 4 eggs	198 nests with 2 eggs
260 " " 3 "	144 " empty
3 nests with young	

I have never myself seen a set of four Herring Gull eggs.

It is clear that some eggs are laid in April because the incubation period is about 26 days. The age of the young was not estimated, but even if they were just hatched, they must have come from eggs laid in April, an earlier record than I have had. However, the season should open earlier for this colony than for most of the other colonies.

Captain Ellsworth wrote that there were "several thousand Gulls in vicinity of the island" that had "not commenced to nest." He found eleven Great Blue Heron nests.

(B.) *List of breeding places.*—Breeding colonies of Gulls have existed recently and presumably during the past summer on islands as follows.

Lake Michigan
- Gravel Island, Garden Island } near Green Bay
- Squaw, Gull, Pismire } Beaver Islands group
- Fisherman's Island—near Charlevoix, Michigan
- Sister Islands, Strawberry Islands, Hat Island } in Green Bay

Lake Huron
- Gull Island—near Alpena, Michigan
- Goose Island—Chenaux Islands group
- Several or more islands in Potagannissing Bay

Lake Superior
- Gull Island near Marquette, Michigan
- Huron Islands

Caribou Islands
Grand Portal Island
Grand Island
Various other islands not known to me

(C.) *Breeding period vicissitudes.*—We found remains of a number of Gulls which had met a tragic end. In each case a fish hook was caught in some part of the mouth, gullet, or stomach with a short piece of line entangled in bushes, tree branches, and sometimes weed stems. According to Captain Ellsworth, these Gulls had eaten floating bait attached to lines which had been torn loose from trawls by storms.

During the season of 1917, I obtained evidence that various colonies in Potagannissing Bay and the one at Goose Island suffered from egg poaching. Furthermore, a great storm May 22 to 24 combined with high water destroyed a great number of eggs of Herring Gulls and Terns. During an ordinary winter, much ice accumulates in the region of the Gull breeding places on the Great Lakes. This breaks up late, some springs, and presumably retards early breeding. On the other hand, after a mild winter such as that of 1918–19, the region of the more southern colonies does not become ice-bound. Early records are to be expected under such conditions.

While in Potagannissing Bay, we made visits to a majority of the islands on the American side of the boundary line. We found small colonies of Herring Gulls at several of these islands and some nests and broken shells. The birds were all wild and in spite of considerable searching, I was unable to find a single young Gull. The water was high, and we were told that it was eighteen inches above normal. We were informed that high water and severe storms, especially one May 22 and 24, had destroyed great numbers of eggs of Gulls and Terns. I saw many evidences of this statement being true, for instance submerged nests. I was also informed that a great deal of egg poaching by Indians had taken place.

IV. BEHAVIOR.

(A.) *Docility.*—To be capable of training, there must be some degree of docility. An intractable Gull would be useless where control is required. I was, therefore, especially interested during

the summer of 1917 when the problem of submarine detection was on my mind, in ascertaining how docile the Herring Gull may become. It was also important to learn how quickly and easily docility might be developed.

My experience with a Gull captured when adult, as well as with wild birds of other species, was entirely against wasting any time in attempts to train adult Gulls. Furthermore, it is, of course, vastly easier to capture Gulls while they are in the nestling stage. We, therefore, concentrated our attention on the young in studying capacity for training.

At a fisherman's home on Shaw Island in Potagannissing Bay, we saw three juvenal Herring Gulls which had been taken when in the down plumage stage and were, at this date, August 5, flying like adults. They were splendid specimens and they were as tame as chickens become under careful treatment. They took food from the hand even from us strangers, though a little shy of us. These birds were in the habit of flying away a considerable distance, but they returned regularly for the night and they were about the yard at times during the day.

Our young Gulls at the Biological Station became so tame in a few days that it was necessary to step carefully, when entering the enclosure in which they were confined, to avoid stepping on them. I, therefore, concluded that we need have no concern about the problem of docility.

(B.) *Adaptability.*—Intimately connected with docility is capacity for adaptation to new conditions. In fact this must exist to some extent if a wild animal is to become docile. Adaptability, of course, involves something more than just docility. A wild bird which has learned that men may not molest it must also be able to recognize new conditions, such as the man with a gun and changes in food supply.

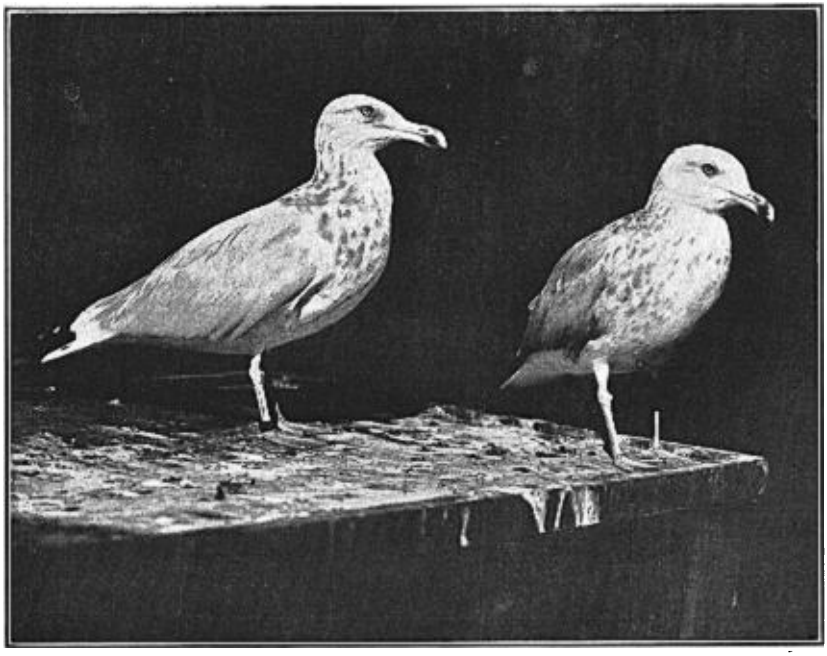
I have discussed adaptability under the topic of modifiability in behavior in previous papers, and I have little to add in the way of new observations.

During the early summer of 1921, long rafts of logs were regularly towed past our summer home at Harbor Point, Michigan, one each day in the early evening. I noticed Gulls in the vicinity of the rear of one of these rafts and with the aid of power 8 field glasses

was able to count them and even determine the approximate age of immature Gulls. There were about thirty altogether. The Gulls were actually perched on the raft with only a few occasionally in flight not many feet away. This number appeared to be, at least approximately, constant each day. I even recognized the same proportions of immatures of different ages. I got in the habit of looking for what I called the Gull express.

As the raft approached the town of Harbor Springs on its way to the saw mill, the Gulls would rise more or less together and fly away, apparently to their roosting place. I was informed by the crew of the tug towing the raft that these Gulls gathered daily towards noon about the raft at the time it was due to start for the afternoon trip to Harbor Springs. So far as I could learn, these raft trips had not occurred in other summers. So this behavior must have been developed that summer. It appeared from the testimony of the crew, and from my observations with the field glasses, that fishes were being caught in the water alongside the raft at and near the rear end. I would occasionally see movements of the Gulls which supported the statements of the crew.

(C.) *Application to problem of submarine detection.*—Many people apparently speculated on the possible use of sea birds in detecting submarines. One man had a scheme for interesting wild Gulls in submarines by scattering food from a submerged submarine. It was my judgment, however, that the chances of Gulls being in the vicinity of a ship about to be attacked by a submarine were too small. A large number of these attacks occurred at great distances from shore, whereas Gulls are found mostly near shore. I, therefore, decided that the Gulls should, if possible, be taken with the ship to be released in regions of danger. The scheme involved capturing the nestling Gulls in large numbers and giving them the attention necessary for the docility and devotion to their quarters that I believed possible for them. It was, of course, assumed that the birds would take advantage of release and fly out on the water in short trips, returning eventually to their home on the ship. Their alertness for objects in the water was depended upon for their success in locating a submarine. By careful watching, it was thought that variations in their



Photos by R. M. Strong

1. CAPTIVE HERRING GULLS HATCHED SPRING, 1911. PHOTOGRAPHED OCTOBER 19, 1913.
2. GULL CAGE AT DOUGLAS LAKE, AUGUST, 1917.

movements would at least suggest that an unusual object was in the water that ought to be avoided or at least kept in mind. It was realized, of course, that a submarine is most of the time too deeply submerged to be visible, but I was also informed that it approaches the surface when about to attack and this would, of course, be the critical time when the Gulls could be most useful.

It must be admitted that the chances of success were limited, to say the least. Nevertheless, I was informed that if the method were successful to the extent of locating just one submarine in time to save a great ship, the result would more than justify the effort and relatively small financial outlay.

The observations at Shaw Island of the tame Gulls not kept captive, the evidence of some capacity for training, and the raft performance all encouraged me in what may seem now to have been a slim chance. Very efficient methods for detection of submarines were developed about the time this scheme was under consideration, and there was, therefore, no raid on the colonies I had located.

The following notes are added verbatim from my records. They indicate how easy it is to manage the nestling Gulls.

"July 8, 1917, landed at Goose Island about 11:40 A. M., and left at 1:30 P. M. Saw many empty nests on beach especially on west side of island in northern half. Nests also back under cedar trees. Only 1 egg seen. Juvenal Gulls very hard to find. All seen were taken, i. e., seven. None of these were very old. Possibly none were more than one week—certainly not more than two weeks old. They were quiet for two hours or so in the basket but made a little noise at times on way from Mackinac Island—the hunger cry and a call of disturbance similar. I placed them under a crate that night. The next morning about 6:15, I fed them for the first time on small dead fish four to six inches long, picked up on the beach. I held the fish before the beak of each bird. It was grabbed as a stick might be in the same position. Then I shoved the fish down the throat of the bird who swallowed it readily though struggling some, naturally, when I was pushing the fish. One bird after being released regurgitated the fish. I then placed all the birds in the crate and dropped a few fishes on the ground inside, where they were picked up at once and swal-

lowed. Two had a tug of war. At the next feeding, about three hours later, I simply dropped the fishes on the ground and they were picked up and swallowed at once with much contention and tugging. On July 11, fish were placed in a pan inside the crate. The Gulls ate greedily and immediately, but the instinct to take food from the beak apparently was responsible for numerous tussles over fish when plenty were in the pan. The same thing had been noticed when fish were dropped on the ground. Apparently the smaller Gulls were less inclined to take food from the pan than the larger, as might be expected. The smaller Gulls would sometimes not take, at once, as much food as they needed, apparently waiting to take it from the beak of another or from my hand. They would do the latter, although backing off with a little fear. The birds seemed very tame."

"July 12. Gulls transferred at 1 P. M., to 1st unit of large cage. They appeared to enjoy their space and indulged in a sort of dance, jumping from both feet simultaneously and flapping wings. They also yawned a good deal in the sun. About 6 P. M. the labyrinth was placed in their cage, and a few minutes later food in a pan was placed in section 3 in sight from entrance. Some of the Gulls at once entered and others followed—all feeding voraciously as usual."

V. IMMATURE BIRD POPULATION.

For some years I have been struck with an apparent scarcity of Herring Gulls in plumages intermediate to the juvenal and adult stages. During the fall and winter, large number of juvenal Gulls are to be seen, but I do not often see Gulls in their second and third years. I had very few records until June, 1919, when I saw a number at these ages in the vicinity of Harbor Springs, Michigan. They were in the usual habitat for non-breeding Gulls, i. e., about harbors, fish weirs, and about vessels.

However, I counted only four immature birds at the above ages in a flock frequenting piles of a wharf ruin at Harbor Springs. The numbers were as follows: fifty-two adults, two in their third year, two in their second, and twenty juvenals. This count was made August 21, 1921.

It is true that these intermediate stages, especially the third year, are easily overlooked. Nevertheless, I am familiar with their appearance as the result of rearing Herring Gulls from the nestling stage to the adult, and I have had many opportunities to look for them.

VI. PARASITATION.

During the summer of 1917, some interesting observations were made on conditions of parasitation, especially by Dr. La Rue. So far as I know, these have not been published. I shall refer only to those features which bear upon Gull habits.

In planning the experimental work with nestlings, I thought I could solve the food problem by utilizing numerous small dead fishes which were almost daily swept up on the beach of Douglas Lake near the Biological Station by waves.

The little Gulls enjoyed this food greatly, and it was certainly the simplest method available, then, for obtaining their food. However, in the course of about two weeks, all of the Gulls became badly infested with parasites, especially Trematodes, and all but one died. It was eventually found that the worm causing most of the trouble occurs in another stage in one species of fish which appeared very frequently in the food. I was informed that fish in the Great Lakes do not often have this parasite.

I have seen relatively few Gulls about Douglas Lake or any other small inland lakes, and I do not know that these were breeding. This fact may account for the health of nestlings at their breeding places.

VII. NOTES ON SOARING FLIGHT.

At every good opportunity, I have continued to watch soaring Gulls, always puzzled concerning certain features of their marvelous performances. It is a common idea, even among some distinguished scientific men that the soaring so well described by Brewster[5] is done only in the wake of vessels and that so-called streamline currents are always used. I have seen Herring Gulls soaring with the wind in all directions with reference to their course, when no ship was in sight. I have watched soaring Gulls from ships for several years with this point especially in mind. Never

have I seen the soaring without a wind and the stronger the breeze, the better has been the soaring. Furthermore, the best displays have been with head to beam winds. The Gulls have soared at all points with reference to the ship, sometimes within 15 ft. of where I stood on the top deck, again 100 yards or more in front, to the side, or to the rear.

It is true that they are more often just behind the ship or in the vicinity of the stern, but I am convinced that this is because food is best discovered there, rather than for any air current advantage. It has also been maintained that an upward component involving an oblique air movement is necessary. For a number of years, I have tried, by rather crude methods, perhaps, to get evidence concerning this conception. I have watched the flapping of ship pennants when Gulls were soaring, often within several feet of them. I have held my handkerchief in the breeze, and I have observed the direction taken by the ship's smoke.

As a result of these observations, I am of the opinion that the Herring Gull often soars in horizontal winds, where there is no significant upward component.

On the morning of July 14, 1920, I was on the steamship Manitou near the northern end of Lake Michigan on the way to Harbor Springs, Michigan. We had a strong north wind which, because of our changing course, was at first a head wind but gradually became a beam wind. During this period a considerable number of Gulls accompanied us, soaring most of the time at varying distances and altitudes, but always facing into the wind. The boat was making about 16 miles an hour, and the Gulls kept up with us even when our course was at right angles to the wind. They sailed in a direction at *right angles to their bodies,* often at least 200 ft. to windward and frequently, at least that distance above the water.

I was unable to detect any differences in their wing body, or head positions from the positions occupied in a head wind. How the lateral course was maintained appeared inexplicable.

All of this time the ship's smoke was swept rapidly over and against the water. I could have more easily credited the wind with a downward rather than an upward component. The atmospheric conditions (anticyclonic) were furthermore such as

would involve downward rather than upward currents. On another occasion in the late afternoon, there was a waning westerly wind with patches of smooth water. I was astonished at the amount of soaring in so light a breeze. As the breeze became still weaker, altitude was lost and the soaring degenerated into gliding which also ceased when a flat calm ensued. I was unable to rule out the possibility of upward currents of air, but if there were any, they could not have been strong.

Loyala University School of Medicine, Chicago.

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EXPLANATION OF PLATE.

Two Gulls in their third autumnal plumage are shown in Fig. 1. The mottling of the head, neck and breast is noticeable. The beak color has not made any significant progress towards the adult condition.

This cage (Fig. 2) was constructed in sections six feet square which were used for the top, as well as for the sides and ends. These sections are easily assembled, and they are convenient where it is desirable to have the cage stored when not in use.

THE HERRING GULLS OF LAKE CHAMPLAIN.

BY LIEUT. L. R. WOLFE, U. S. A.

Plate XXXVII.

UPON several occasions it had been rumored to me by local residents that the ever present Gulls nested somewhere on small islands in Lake Champlain. An examination of all available publications failed to give me very much information. Mr. A. C. Bent in his well known book states that, "In 1888, Mr. A. H. Jordan found a few pairs breeding on an island in Lake Champlain." I could find no other reference to the Herring