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SOME ASPECTS OF INDIVIDUAL DISTRIBUTION IN THE CAPE COD TERN COLONIES¹

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FOR the past decade, personnel from the Austin Ornithological Research Station has made each nesting season a detailed and fairly comprehensive study of the colonies of terns nesting on Cape Cod, Massachusetts. These are composed of three species, Common (*Sterna hirundo*), Roseate (*Sterna dougalli*) and Arctic (*Sterna paradisaea*) which breed together, the proportion of each species varying on the several nesting sites. It is with the conjoined nesting of these three species this article deals, due consideration being given always to the variations in behaviour which these species exhibit. In this interim of ten years, ending with 1939, there have been banded 25,375 adults and 132,567 chicks. 10,919 banded birds have returned. This work appears to show that:

THE TERN COLONIES ON CAPE COD FORM A DISTINCT, CONCRETE GROUP WHICH IS SELF-SUSTAINING AND FREE FROM ASSOCIATION WITH OTHER GROUPS DURING THE NESTING SEASON.

Within a circle of a 25 mile radius are the colonies of nesting terns which we think of as the Cape Cod group (see map). They are scattered over the Cape, from Provincetown at the tip, along the ocean front on the east side to the Cape Cod canal on the south, and along the bay side on the west as far as Plymouth. Their locations and sizes have been described in preceding papers; some are large, others very small.

Other colonies of nesting terns begin in contiguity with the Cape group and extend to the north and the south along the Atlantic seaboard. Aside from a few birds of the year, no tern banded on the Cape has been recovered to the north; and only one known to be from a northern site taken on the Cape. Immediately to the south is a cluster of tern colonies centered around Martha's Vineyard.

¹Contribution number 35 by the Austin Ornithological Research Station.



Map of Cape Cod and surroundings with key to localities mentioned in the text.

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| 1—Austin Ornithological Research Station. | 10—Nauset Marsh. |
| 2—Tern Island. | 11—Little Sipson Island. |
| 3—North Point. | 12—Egg Island. |
| 4—Jeremys Point. | 13—Plymouth Beach. |
| 5—Pamet Point. | 14—Ram Island. |
| 6—Billingsgate Island. | 15—Penikese Island. |
| 7—Hopkins Island. | 16—Weepecket Island. |
| 8—Stoney Island. | 17—Muskeget Island. |
| 9—Nauset Point. | 18—Cotuit. |

They comprise a group which in make-up, site occupancy and behaviour corresponds closely to the one domiciled on the Cape, and appears to be quite as much a distinct entity.

Of the 10,919 banded adults trapped on the Cape, only 80 were birds banded in the Vineyard colonies; only 15 Cape individuals

have been captured in the Vineyard locality. Of these 95 birds, 80 have been banded while chicks before the homing instinct had been definitely stimulated into functioning by habit. The remaining fifteen represent the inevitable minute shifting which must occur in all species.

No tern should be considered allied to any colony or group until after its first nesting. The homing instinct, so far as this behaviour is concerned, does not function actively until the individual bird has successfully completed its first breeding. Our statistics show that three-fourths of the chicks returning for their first nesting, settle on the site where they were hatched. This is due more to some sort of group association than to pure homing instinct on the part of the individual bird. When in May a considerable number of adults which have been well established on one site elect to nest elsewhere, they are usually accompanied by a corresponding percentage of the first returned birds which should have sited where they had been reared. Since our chick banding and adult trapping have not yet resulted in the identification of family relationships, we must assume that this cohesion is a group affair rather than one of parentage. Usually these seasonal nesting site diversions are followed the next year by a return of the older birds to their usual rookery, while the first nesters of the previous year have a tendency to remain on the new site. Possibly the homing instinct has more than a geographical background.

It is known that in recent years a deterioration has been taking place in the amount and desirability of the nesting territory of the Vineyard group as well as a numerical shrinkage of its content. Yet there has been no corresponding increase in the number of birds from this group taken on the Cape. Ram Island, the site of a large colony, is as near some of the Cape units geographically as it is those of the Vineyard group, yet trapping done there shows it to belong definitely to the latter. Also the interchange of its members with those of the Cape is much smaller than it is with even the more distant colonies in the Vineyard group. It is significant that trapping done late in the season has not disclosed one re-nesting bird which emigrated from one group into the other although there have been several wholesale site transferences within the groups themselves.

These findings, in conjunction with a great amount of less striking but confirmatory evidence, show the Cape Cod group of tern colonies to be a closely knit, self-sustaining unit, free from any functioning association with neighboring colonies or groups. It has sufficient adaptability, as a whole, to accomplish these readjustments to environmental changes which the individual colonies are unable to make for themselves. Since much less work, especially adult trapping, has been done in the Vineyard colonies, insufficient data are available to determine beyond doubt that it is as distinctive an entity. Nevertheless, enough facts have been obtained, duplicating exactly, as far as they go, those by which the existence of the Cape

Cod association has been indicated, to be reasonably sure of the homogeneity.

It is improbable that this group formation is simply a local occurrence. All individuals comprising each of the species of terns of the Atlantic coast are morphologically identical, and there exists no variations in the ecology of their nesting sites sufficient to result in the establishment of so distinctive a behaviour pattern for the tenants of only one small stretch of the coast. Neither has there been an isolation of any of the groups which would encourage a sharp divergence from a common habit. Aside from the formation of these aggregations, terns are essentially non-communistic. The only gain accruing from group formation is possibly the much greater consistency of incubation and brooding which some unknown factor engenders in a large colony. If numbers alone were the desideratum, there would be no reason for limiting cohesion to the extent of the grouping found to prevail; the Vineyard group would abandon the attempt to carry on under adverse conditions and amalgamate with the Cape group on its far more suitable site.

No better explanation having been discovered for this grouping, the suggestion is ventured that it may be due to some behaviour pattern which developed from habit and has been made compelling by continued experience.

MAINTENANCE OF THE CAPE GROUP AS AN ENTITY EQUALIZES
THE ACCOMPLISHMENTS AND FAILURES OF ITS COMPONENT
COLONIES.

The Cape Cod group comprises the colonies (see map) from Plymouth beach eastward on the north, from Cotuit eastward on the south. They all radiate out from Tern Island where, at present, breeds the Chatham colony which not only has always been the largest of all on the Cape, but which is actually the nucleus or parent colony from which all the other Cape Cod colonies originated.

Formerly domiciled on North Point, this Chatham colony moved to Tern Island in 1918 when erosion converted a peninsula into this island, affording the colony a security from depredation not existing at North Point. So we must visualize this colony not as a site, but rather as an aggregation of terns which, although at the moment occupying Tern Island, may relocate elsewhere if adequate determining cause occurs, as it has before. Birds hatched here have been taken in all the other Cape colonies. Likewise birds hatched in each of the others have been taken nesting in this colony. The history of the whole Cape Cod group shows that its prosperity, measured in units of five years, corresponds roughly with the welfare and reproductive success of the Chatham colony.

The other colonies, if we think back over a considerable period of time, must formerly have been larger and more flourishing than they are now. The verity of this is asserted by residents who were familiar with the status of the "mackerel gulls" fifty and seventy-

five years ago. When plumage-hunters subsequently reduced the number of terns along the coast to a small minimum, the larger colonies suffered the most. The small groups, in ratio to their size, experienced comparatively smaller depletion not only because they were molested less but also because their losses were replaced by escapes from larger sites. When persecution ceased around the turn of the century, the Chatham colony still remained the largest. Since the reproductive accomplishment of a colony increases geometrically in proportion to its size, the Chatham colony made the quickest and greatest comeback to assume its present key position in the Cape group.

There must be undetected differences in the many sites, occupied and unoccupied, scattered over the Cape, which to human observation appear to be identical. If all sites offered ecologically equal nesting territory there would tend to be an even distribution of the composite Cape population through them, environment being the most potent of all the factors which play a part in the rise and fall of tern colonies. Second in importance is the tendency of terns to ally themselves into persistent aggregations of varying size, the individuals comprising any one of these acting in concert when important behaviour matters such as emigration and colony location occur. Third is the homing habit, which induces birds to return to previously occupied rookeries. When the Cape terns started their comeback the influence of these three factors necessarily determined the rapid up-building of such a key colony as the one now at Tern Island.

All tern colonies are cyclic in size and prosperity. This is brought about far less by the instincts and behaviour of the birds themselves than by the changing ecology of the nesting sites resulting from occupancy, and alterations by the elements. In the early nineteen-thirties the Chatham colony had passed its cyclic peak with Tern Island as its site and had begun to disintegrate. Ultimately it would have emigrated elsewhere as an entity had not reclamation work done there restored it to its former prosperity. (Austin, 1934.)

The size of all the Cape colonies varies from year to year and usually from time to time during each season as the result of ecological changes not due to occupancy. During the last ten years disaster has come to several of the colonies; the dispersal of the Billingsgate group by the washing away of its site; the erosion of Egg Island, this year almost complete; elimination by vegetation of Hopkins Island; of Jeremeys Point by predators; Rocky Island by human trespass; and Nauset Marsh by inundation. But all these mishaps have resulted simply in a redistribution of the inhabitants of each of these into the other colonies or the temporary formation of new colonies as at North Point in 1933, Jeremeys Point in 1938 and 1939. This past year, when a rat invasion again disrupted the Tern Island nesting, a large section of the colony disappeared. After much search it was found, in company with individuals dispossessed

from other sites in the Cape circle, forming part of a recently mushrooming colony at Plymouth Beach. This Plymouth site, always comparatively lightly populated and for years non-productive, this year yielded a larger chick production and survival than any other Cape colony, even Tern Island. Another constructive occurrence has been the rebuilding of Billingsgate Island sufficiently to support some five hundred pairs of birds.

Aside from the usual death of some of its adult members and the addition in July of maturing chicks, for the last ten years the aggregate population of the Cape Cod group has remained practically unchanged in spite of the almost complete dissolution of some of the colonies and the augmentation of others. If in one or two years there is a drop below the average for the decade, there follows immediately a duplicating rise. These variations do not harmonize with intercolonial shifts in population; rather they correspond accurately to the number of chicks matured the preceding third and fourth years. Accordingly, since these fluctuations do not effect the size of the group as a whole, there is indicated an inherent ability of the aggregation so to adjust its various tenures that the survival of its numerical content is assured.

A SUCCESSFUL TERN COLONY IS BUILT AROUND AN ESSENTIAL
NUCLEUS OF SEXUALLY EFFICIENT INDIVIDUALS BETWEEN FOUR
AND TEN YEARS OF AGE.

They form not simply a nucleus but the important body of the colony, and it is on their greater fertility and more faithful carrying out the duties of incubation and chick raising that the success of a nesting depends. Other conditions equal, the achievement of a colony appears to be in direct ratio to the number of such individuals present. In pairs of the sexes, they carry on the details of breeding unassisted by other members of the colony, for at no time have more than two breeding individuals been trapped on a given nest.

The total chick yield of a colony is found to correspond roughly to the contribution of this group of individuals. This applies as much to the aggregate of seasons as it does to any one, for the group of sexually efficient individuals returns more persistently to the site than do the other elements in the colony's make-up, and they are far more resistant to changes inviting emigration. Augmenting them are birds breeding for the first or second time, mature birds from decadent sites and colonies in the process of breaking up, and some individuals whose failure to develop sufficiently the homing habit results in their nesting erratically from year to year in different rookeries.

In the large colonies, seldom in the small ones, are non-breeding birds whose presence is simply the continuation or resumption of preceding association with the colony. They do not participate in the sexual part of reproduction, in no way aid breeding pairs or the colony as a whole. They are simply hangers-on whose migration was

motivated more by habit than by endocrine stimulation. Occasionally some few of these, as the result of an adolescent, only slightly developed or an erratic sex instinct, will be found attempting to duplicate some part of the procreative procedure, but this, like so many other things terns have been reported as doing, is individual rather than characteristic of the species as a whole, inefficient and usually misconstrued.

The aggregate of these several types constitutes a definite, self-efficient unit in the Cape Cod group carrying on, probably free from contact with, certainly without assistance from the other colonies.

Once established for the year, the only changes occurring in this general make-up of a colony are those emigrations or accessions following events which have interrupted successful breeding there or elsewhere. Otherwise the population remains stable for the first three-quarters of a season. Then there is a marked increase from the addition of chicks newly able to fly. As maturity warrants, the chicks leave the nesting site and scatter to nearby beaches in company with their parents, where they are observed being fed and further educated. Thus the colony dwindles rapidly to late and renesting pairs. The sectors first depopulated are those where the older, virile group nested.

IN TERNS, A HOMING BEHAVIOUR PATTERN IS WELL DEVELOPED
AND INCREASES WITH AGE.

Annual trapping of the members of the Cape Cod group shows a fixed tendency for all its members to return not only to the Cape itself, but to the same colony. First indicated by some adult trapping started after several years of chick banding, it increased in conclusiveness as this procedure became more comprehensive, especially after the banding of individuals already adult members of the colony. With only birds banded as chicks for a source it would be necessary for many years to elapse before a sufficient percentage of the population could have been banded to furnish data adequate for correct conclusions. Approximately only five percent of banded chicks survive to become full-fledged breeding adult their fourth year. The mortality rate of adults rises consistently after two years of sexual maturity (Austin, 1938), so that, theoretically, a complete turnover of the adult population requires twenty years. In reality it occurs probably once in from ten to fifteen years, the greatest age of breeding birds taken being sixteen years.

When trapping adults in large numbers began in 1932, after thousands of chicks had been banded annually for the preceding ten years and a comparatively few adults the preceding four, of 1,319 adult terns trapped, only 80 or 6 per cent bore bands, and only 46 or 3.9 per cent had been banded while chicks. Each successive year the percentage of returns has increased, until in 1939 of 5,462 adults trapped on Tern Island, 2,761 or 49 per cent were returns. It is more cogent that only 574 of these returns, or 10 per

cent of the whole, were banded as chicks, while 79 per cent of the returns, or 39 per cent of the whole, were banded as adults.

By trapping its adult members, the bulk of a colony is banded more rapidly. It is not practically possible, and certainly inimical to its welfare to attempt trapping in a season more than 30 per cent of the adults in a colony such as Tern Island, hence the slow rise in the percentage of banded takes. But the best picture of the movements of terns both within the group and within the colony is delineated by those birds which have been captured in from two to five different seasons.

After making carefully estimated allowances for annual ecological changes in the sites, for seasonal variations in the size of colonies, for the amount of trapping done in them and other modifying factors, it is found that the percentage of returns found in the colonies duplicates closely that for the group as a whole.

A statistical analysis of the returns of terns banded as adults shows that 75 per cent of them have come back to the sites where they were trapped for the first time. Either on their way north from their wintering grounds in the tropics, or during the subsequent week or two spent by them off shore from their breeding sites, they sort out and amalgamate into groups made up largely of the identical individuals of which they had been composed the preceding season. If individuals had re-nested the year before on other than the primary site, usually they reappear in the group with which they had nested first. These features of their alignment when they land on the rookeries are shown by the results of the earliest trapping of the year done over courtship scoop-holes and nests containing a single newly laid egg. If environmental conditions are propitious they remain, nest and breed on the site. The older members arrive earliest and this first trapping, started immediately after nesting has begun, yields a higher percentage of returns than do the subsequent takes. Of these earliest nesters invariably over 90 per cent are individuals which had been trapped on the same site before.

Young birds returned for their first nesting exhibit a decided preference for the site of their nativity. Of all birds banded as chicks and trapped for the first time between the ages of two and four years, 81 per cent were taken where they had been hatched. Some arrive early with the maturer birds which usually proceed to nest promptly. The youngest, by reason of a weaker procreative urge, constitute a considerable part of the large flocks which for the first week or ten days are strung along the site's shore-lines. Then they amalgamate with the others on the upland and begin egg-laying, selecting territory in the more desirable localities not pre-empted by their elders, or if concentration compels, nesting elsewhere on the site.

Nest locations and local concentrations vary in a colony from season to season to a degree commensurate with changes in the character of the terrain. As the result of reclamation work at Tern

Island, not only was a large tract, formerly useless for nesting by reason of overgrowth, converted into ideal terrain, but also the contours of densely populated areas were altered much by leveling and by a thinning out of their vegetation. At once nest concentration decreased; individual territories became larger; there was a more even distribution of breeding birds over the whole island. When the entire island had been trapped over, it was found that the old birds had remained where they had been previous years while the younger members of the flock had scattered out into the newly made territory. The size of the colony as a whole increased to what had been its peak before its cyclic decline, the increment consisting largely of birds of two categories: first, more numerous, were first-time nesters which were induced to locate by the abundance of ideal territory; the second were individuals returning for the third or fourth times, which had been banded here as adults then taken on other sites during Tern Island's decline. These last were not taken in the newer territory, but usually on that part of the site where they had nested formerly.

The homing pattern functions with progressively increasing cogency as the birds increase in age. Of nearly 2,000 terns banded as adults which have returned from two to five times within a period of nine years, 92 per cent were taken on their banding site the year of their latest capture, whereas of birds returned for the first time after having been banded as adults, never have more than 80 per cent been taken on the site of banding.

This trend to return to the previously occupied site alone can account for the tenacity with which the older birds will return to nest on sites which by reason of progressively increased unsuitability are eventually abandoned. This has occurred at Hopkins Island, ten years ago the home of a flourishing colony of Arctic Terns, but now so completely overgrown by bushes that no suitable nesting terrain remains, yet even this year a few pairs of its very old inhabitants nested there, on territory they would not have occupied elsewhere. Likewise, at Stoney Island, up to the present time a few persistent birds have continued nesting there even though for several years adequate incubation has been made impossible by constant traffic.

Individuals who have established a definite connection with a site and subsequently nest elsewhere one or more subsequent seasons, exhibit a trend, if they are dispossessed from the later location, to return to the original breeding-ground. In 1934 and 1935, a newly formed colony of three or four hundred birds bred on Little Sipson Island. Like all young colonies, it was composed of individuals from many and diverse rookeries grouped around a nucleus of birds from Tern Island. Predation disrupted this colony to almost complete abandonment of the site. In 1938 and 1939, 53 of the adults trapped at Little Sipson in 1934 and 1935 were taken in other localities. Of these, 39 or 74 per cent had returned to the place they had been captured before having emigrated to Little Sipson.

In 1933 Tern Island, the Cape's parent and largest colony, was disrupted by a rat invasion and abandoned shortly after mid-season by its entire population. Its restoration the following winter and spring to an ideal terrain free from predators doubled its former size in the 1934 nesting with an obviously corresponding shrinkage of other populations. That year, in a desire to enhance conservation, no adult trapping was done on that island. In 1935, of the 443 returns taken there, 69 per cent were individuals formerly members of the Tern Island colony. Egg Island, between 1931 and 1936 the second largest colony, has eroded so rapidly in three years that in 1939, with maximum occupancy of available nesting terrain, intensive trapping of the surviving tenants yielded only 372 takes. In 1938 and 1939, 412 former incumbents of this site were captured elsewhere and of these, 340 or 80 per cent were found at Tern Island, from which the progenitors of the Egg Island flock sprang. The persistence of this inherent and potent homing tendency over more than one generation is suggested by the regularity, with which for the duration of its known existence, the Chatham colony has built up when its nesting conditions are ideal.

Fidelity to a site is well illustrated by the following: In 1936, over a span of eleven days, 1,000 mature adults were banded in a small sector of the most densely populated, longest and most consistently occupied part of Tern Island. Since then, 517 of these have been recaptured in the Cape Cod colonies; 503 or 97 per cent of them at Tern Island itself. The other 14, trapped on three sites, were all taken after the end of June, some late in July, so it is probable they were renesting birds, especially since they were accompanied by birds from Tern Island and other sites known, by having been trapped earlier elsewhere, to be renesting. Six of the 14 have been retaken at Tern Island subsequent years; none elsewhere. Further, 159, or 30 per cent of the 517 have been retrapped yearly at Tern Island either two or three times in the three elapsed years; not one has been taken a second time elsewhere. This occurrence has been duplicated repeatedly by similar groups of banded adults at Tern Island and other breeding grounds. In fact, when changes in the environment and other influencing occurrences have not taken place to vary the norm of a nesting, it has been found that a large percentage of any given set of individuals will be taken from year to year in the same colony.

This paramount tendency of terns to return yearly to the sites with which they have been associated, is more closely focused and directed quite as impellingly on not only the same small sector of the site, but even the exact location of the preceding nesting. In field work, daily are affixed in a small sector of the site from 50 to 250 bands serially numbered. When this same sector is trapped subsequent years from 10 to 50 per cent of these birds are recaptured. This occurs too frequently to be either an artifact or a coincidence. At Tern Island on June 7th, 1939, were taken 28 of the 128 birds

banded in the same area June 14th, 1938; June 16th, 1939, 25 of the 102 banded June 20th, 1938, and so ad infinitum.

Once domiciled to the degree of chick hatching, a tern exhibits a compelling tendency to return, subsequent years, to the exact site of its former nest or its close proximity, this impulse being augmented by each additional tenancy.

In 1932, when incubation time was being studied, at Tern Island several quadrates were taped out. The tenanting adults were trapped and their band number together with the exact location of their nests in the quadrates recorded on maps. For specific identification out of hand, a few of them in one quadrate were additionally marked with colored celluloid bands. In June, 1935, one of these color-banded birds was taken on the site of this particular quadrate. A sufficient amount of the tape marking the nearby angle of the quadrate was uncovered to fix the present location of the bird's nest in relation to the angle. Reference to the old map showed that the same bird had nested in exactly the same spot in 1932. Many corroborating occurrences, equally unequivocal, can be detailed. Even in small groups nesting on large sites affording a myriad of electives, the clutches of specific birds will be found consecutive seasons close to the same clump of dusty-miller or beach grass. This preference for an exact site is shown more commonly by Arctic than by Common Terns, possibly because, constituting a very small fraction of the Cape's population, their nests are more consistently observed. The annual close contact over a period of years with the same many thousand birds has developed the opinion that, in a broad way, the behaviour of many terns is as individual and characteristic as is that of humans, and this applies to their reactions to human intrusion on their territory. In several of the colonies are exact spots where invasion always subjects the trespassers to a swooping attack of most unusual ferocity and persistence which facilitates identification of the bird and its nest. Capture of the tern shows it to be the same individual which seasonally nests on the identical area.

As the tern becomes older, either this urge or a more developed sense of location leads it to accept marked intervening changes in the physical characteristics of its old home-site so that it nests as near its former tenure as the alterations permit. The younger the bird the less is its toleration of environmental changes so that commonly terns are trapped in different parts of the nesting ground their first two nestings. Fidelity to the site and to their clutches is less constant in the young breeders; they react more promptly to predation, human intrusion and food shortages so that they are the birds first found to be re-nesting, usually having elected to do so in a different colony.

RENESTING IS COMMON, EFFICACIOUS AND FOLLOWS FIXED LINES.

Although terns rear but one brood yearly, individuals commonly

renew when their initial attempt at reproduction has been thwarted. In a season, most frustrated individuals will make a second effort to breed but never a third. Under most conditions, failure is greater than in the first try; under others, the success exceeds the primary endeavor. The latter occurred in 1939 at Plymouth where a colony, 50 per cent of which were reneesting birds, achieved a high peak of chick maturing. Also at Billingsgate in 1938 and 1939 where in July, following the egg obliteration by high tides, the colony reneested on the same site, hatched and matured a percentage of chicks greater than the average for a first laying. The distribution and behaviour of reneesting birds follow fixed patterns depending on the following factors: the time the first nesting fails, the age of the colony, the percentage of the membership of a colony involved, the causative agent and the age of the individual.

Since reneesting is solely a bird's reaction to the gonadal stimulation which does not end until its chick has attained complete independence, and since this stimulation begins to wane progressively about the time the chicks have or would have hatched, it is obvious that the earlier in a season the thwarting occurs the more surely and promptly relaying takes place, and is carried to a successful conclusion. For the same reason, late reneesting is less efficacious unless some environmental factor or some habit is substituted for endocrine stimulation to prolong adequate incubation. In illustration of the first is the chick-maturing success achieved by birds reneesting late in highly successful colonies; of the second is the Billingsgate accomplishment narrated above, which has occurred for five years with increasing proficiency. For physiological reasons, chick-loss is far less commonly followed by reneesting than is egg-loss. Human intrusion is increased enormously after July first, likewise the inroads of predators.

In old and well established colonies with a preponderance of individuals of the greatest reproductive efficiency, the trend is toward prompt reneesting on the site. The flock will emigrate only after prolonged and excessive depredation. But a young colony will react promptly and adversely to spoliation which would have no unhappy sequence in the former. The newly established but prosperous colony of 1,000 birds at Jeremeys Point immediately deserted the site in a body when 50 of its most efficient breeders were wantonly shot.

Small colonies usually withstand a far greater amount of despoiling than do others. In those composed of from 50 to 100 breeding pairs, especially if the nests are located widely apart, as high as 80 per cent of the nests may be destroyed without abandonment of the remainder. The defeat of 25 per cent of Tern Island's 15,000 to 20,000 birds always results in extensive emigration.

The percentage of a colony's population involved when mishaps occur, by reason of the trend toward the maintenance of group adherence, determines the resulting reaction. When only a few birds

are involved, usually they relay elsewhere on the site; if the number is great, usually they emigrate in a body to another site, preferably one with which many of them have had previous nesting association. At such times the *emigrés* are accompanied by a considerable number of individuals whose clutches were intact. Such an exodus occurred from Tern Island to Egg Island in 1936 and from Tern Island to Plymouth Beach in 1939.

The agencies which terminate first nestings prematurely, on the Cape, in the order of their importance, are human interference, the inroad of rats, tidal inundation, meteorological inclemency, and predation by owls, skunks, foxes and weasels. In a general way, terns will react far less promptly and radically to depredation by their natural enemies than to that by man and his concomitant rats. In spite of annual inundation by high-course tides, a colony returned seasonally to Nauset Marsh, was washed out each June by high-course tides, but promptly re-nested there until the constant presence of people dislodged it. In 1938 and 1939 Great Horned Owls killed several hundred of the more mature birds at Tern Island without causing any departure of other nesting pairs, while at Egg Island the considerable annual toll taken by Short-eared Owls never disturbed the peace of that colony. Once a typical weasel killing occurred at Pamet Point without interrupting incubation in the vicinity of the casualties. The advent of rats, always gluttonous, prolific and cunning, results in damage so great and demoralizing that wholesale abandonment of the site commonly ensues. A severe rat invasion in 1932 and 1933 resulted in the hegira from Tern Island by June 15th of its entire colony with almost no reproductive accomplishment. The conscious aversion of terns to rats is shown by the unwillingness of old members of this flock, when thus molested, to re-nest on the site as is customary. Usually it requires a week or two of rat pillage to disrupt a large colony but when in 1938 at North Point a single rat in two days destroyed a dozen clutches in a colony of 250 birds nesting on a small dune, the whole group immediately departed to re-nest on Tern Island. The casual visitation of colonies by curious people and those having a real interest does no appreciable harm; it is such persecution as the destruction in a single day of the entire laying of 3,000 birds at Billingsgate Island in 1929, and the collection of eggs into several piles each of more than a bushel at Tern Island in 1935, that result in emigration. Equally injurious is such continuous interruption of egg incubation and the feeding and brooding of chicks by bathers, campers and picnickers as has defeated North Point, Egg Island and Plymouth Beach on occasions. Strangely, terns thus frustrated usually re-nest on the same site.

The older a bird is, the more times it has nested on a site or with a colony the more loathe it is to depart after a nesting mishap. Correlation of available data appears to show that this action, in small colonies, is due essentially to site-attachment, in large ones

to group-adherence. When the few individuals which are always thwarted in all colonies relay, the older ones commonly do so on some other unoccupied part of the rookery, never in the same nest; the very young emigrate, scattering out at random into the other colonies.

When, as frequently occurs, two or more of these various factors are combined, the reneesting individual follows the course which would have been its reaction to the most compelling of the factors if it existed alone.

When the reason is sought for these things which we have learned that terns do, such as the formation of groups and colonies, the homing and the reneesting, it appears probable that the sex-induced urge to procreate is the only instinct involved. This instinct is primary and continues to be the starting-point for each nesting, but it is most elementary and once effectual it plays no role in shaping the responses made by individual terns. The entire pattern has been developed by habit with experience modifying only to the small degree compatible with the very low intelligence of terns.

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BIRD BANDING IN THE LAST FIVE YEARS¹

By O. A. STEVENS

THE annual reports in Bird Banding Notes are always received from the Biological Survey with great interest by the coöperators. While there is a certain amount of rivalry to see who has banded the largest numbers, I believe the greatest interest is to see the grand total and the numbers of certain species in which the operator has a special interest. Personally, I have been interested to see the number of stations which have passed my own mark during the last ten years. In 1928 I was seventeenth on the list, the highest number being then 5,707. Since then I have dropped to about fiftieth place while the first place is now headed by 28,845.

Five years have passed since I undertook to present a survey of the distribution of the banding stations,² and it has seemed worth while to repeat the study for indications of progress during that period. A comparison of the reports for the years ending June 30, 1934 and 1939 shows the following summaries.

<i>Number Banded</i>	<i>Number of Stations</i>		<i>Birds Banded</i>	
	<i>1934</i>	<i>1939</i>	<i>1934</i>	<i>1939</i>
More than 1000.....	64	102	159,438	320,272
From 800 to 1000.....	13	19	11,700	17,100
From 500 to 800.....	19	59	12,350	38,350
From 300 to 500.....	55	58	22,000	23,000
From 200 to 300.....	46	64	11,500	16,000
From 100 to 200.....	100	106	15,000	15,900
From 1 to 100.....	—	—	43,029 ³	5,826
Totals.....	297	408	275,017	436,648

It will be observed that the chief gain was made in the larger stations. The 500 to 800 group also had a material increase in numbers, the others remaining about the same. By charting on a map of the United States the totals for the various states as in the earlier article according to groupings, over 5,000, 1,000 to 5,000, 100 to 1,000 and none over 100, the gains are seen to be well distributed. Only Idaho, Nevada, and Rhode Island now remain blank. Washington, Wyoming, Nebraska, Kentucky, Alabama,

¹ Acknowledgment is made to the Works Progress Administration for aid in assembling data
² *Bird Banding*, 6: 25-28, 1935.

³ See correction in *Bird-Banding*, 7 : 84, 1936.