THE COLONIZATION OF ARTIFICIAL NESTING

STRUCTURES BY WILD MALLARD AND BLACK DUCKS

(Anas p. platyrhynchos and A. rubripes tristis)

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TABLE OF CONTENTS

PAGE

Acknowledgements ii

List of Tables v

List of Figures vi

INTRODUCTION 1

Objectives 2

Literature Review 3

Location and Duration of the Study 7

EXPERIMENTATION 8

Design and Location of Artificial Nesting Structures 8

Breeding Waterfowl Population 9

Criteria Used in Counts 11

Observation of Territorial Pairs 12

Nesting Pair Densities 14

Artificial Nesting Structure Utilization 15

Rate of Utilization 15

Utilization by Wood Ducks 18

Pattern of Utilization 19

Nesting Behavior 19

Trapping and Banding of Ducklings 22

Candling Method 22

Trapping and Banding Method 23

Area Brood Production 27

Trapping of Hens 29

PAGE

DISCUSSION AND CONCLUSIONS 31

SUMMARY 40

LITERATURE CITED 44

LIST OF TABLES

TABLE PAGE

I. Utilization of Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1964 47

II. Utilization of Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1965 48

III. Utilization of Nesting Structures on the Winous Point Marsh, Ottawa County, Ohio, 1965 49

IV. Summary of Clutch Data for the Winous Point and Ottawa Club Marshes, Ottawa and Sandusky Counties, Ohio, 1964 and 1965 50

LIST OF FIGURES

FIGURE PAGE

1. Locations of Nesting Structures on General Study Area 51
2. Metal Nesting Structure 52
3. Grass-Poultry Wire Nesting Structure 53
4. Mallard and Black Duck Breeding Population on the Winous Point Marsh, Ottawa County, Ohio, 1964 54
5. Mallard and Black Duck Breeding Population on the Winous Point and Ottawa Marshes, Ottawa and Sandusky Counties, Ohio, 1965 55
6. Deteriorated Grass-Poultry Wire Nesting Structure Containing Deserted Mallard Nest 56
7. Cover Map of the Latamore Unit on the Winous Point Marsh, Ottawa County, Ohio, 1965 57
8. Cavity of Grass-Poultry Wire Nesting Structure Containing Wood Duck Nest 58
9. Map Showing the Locations of Active Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1964 . . . 59
10. Map Showing the Locations Active Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1965 60
11. Comparison of the Peak Period of Territoriality and the Date of Nest Initiation in Artificial Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1964 . . . 61
12. Comparison of Peak Period of Territoriality and Date of Nest Initiation in Artificial Nesting Structures on the Ottawa and Winous Point Marshes, Sandusky and Ottawa Counties, Ohio, 1965 62

FIGURE PAGE

13. Active Mallard Nest in Structure Surrounded by Catch Pen 63

14. Patagial Tag on Wing of Captive Juvenile Mallard 64

15. Captive Juvenile Mallard with Hole Punched in the Web of the Foot 65

16. Mallard Ducklings in Catch Pen Shortly After Leaving Nest in Artificial Structure 66

17. Nest Trap Used in Capturing Structure Nesting Hens during 1965 67

INTRODUCTION

The waterfowl of North America are being increasingly subjected to a wide variety of decimating hardships as a resulting side-effect of an expanding human population. Chief among these hardships is the constant reduction of essential waterfowl habitat, especially nesting habitat. Although in certain rare cases migratory habitat and nesting habitat are being created where none existed before and previously drained marsh areas are being restored, the economic and social pressures common to an expanding urbanized and industrialized human population are prohibitive to such ventures. The only alternative available, if the waterfowl of the continent are to continue to exist at a population level consistent with a biologically sound harvest, is a program of intensive management on those waterfowl areas now in existence. Methods and techniques must be developed which will bring about greater productivity on those areas.

One such method consistent with a program of intensive management which has been receiving an increasing amount of attention from the biologist and the layman alike is the artificial nesting structure. Since a natural, or wild, nesting population of waterfowl is ecologically an inseparable part of a larger biotic community, productivity of waterfowl in such communities is under the constant influence of natural decimating factors. Nest predation, concentrated primarily but not exclusively on ground nesting species, constitutes one of the chief factors reducing waterfowl production on most marsh areas. Although predator control would seem to be the logical solution to such a problem, the reduction of a predator population in a given area to a level low enough to have a significant and beneficial influence on nesting waterfowl is usually economically and ecologically impractical. The utilization of aerial, predator-proof nesting structures by a large segment of a local ground nesting population would rneder those waterfowl relatively free from a major decimating factor, thus increasing productivity.

Although ground nesting species are known to nest in aerial structures of varying design, the factor, or combination of factors, underlying this utilization is unknown. Learning of some form is believed to be involved. It has been suggested that the process of imprinting may determine the nest site which a neonate female will choose upon maturation. This study centers around the possible role played by imprinting in the selection of nest sites by wild mallard (*Anas p. platyrhynchos*) and black ducks (*Anas rubripes tristis*) and the feasibility of establishing a colony or strain of these species which will nest in aerial nesting structures in preference to the natural and vulnerable ground nest site.

Objectives

(1) To determine the proportion of wild mallard and black duck ducklings hatched in artificial nesting structures that return to nest in similar structures.

(2) To determine the utilization and rate of increased use of artificial structures by wild mallard and black ducks.

Literature Review

The concept of imprinting was first set forth by Konrad Lorenz (1937), although some work relating to the phenomenon had been performed earlier by Spalding (1873) and James (1890). According to Lorenz, a neonate bird possesses an innate behavior pattern, or innate perceptory pattern, which at the time of hatching lacks a triggering stimulus, or releaser. Within a short period of time following hatching, a releaser, or unconditioned stimulus, is fitted to the innate behavior pattern resulting in a specific unconditioned response. The releaser stimulus from that time onward and under the appropriate conditions, or circumstances, will continue to act as an unconditioned stimulus, thus releasing the appropriate behavioral response. In other words, the phenomenon once established is irreversible. The process of fitting the releaser to the innate behavior pattern, or the "key" to the "lock", was referred to by Lorenz (1937) as "Pragung", or imprinting. In addition to being confined to a very definite period of a bird's life, the critical period, and supposedly being irreversible, the imprinting phenomenon is characterized by the fact that the process of acquiring a releaser stimulus may be completed long before the response itself becomes established.

One of the most intensively studied aspects of the imprinting phenomenon is that of the following response displayed by the young of nidifugous species. Upon hatching, such young birds have an innate tendency to follow the first animate object, the releaser, with which they are confronted and to avoid all subsequent animate objects. Among mallard ducks the hen represents the releaser of the following response for the members of her brood by means of both visual and auditory stimuli (Gottlieb, 1963, 1965; Klopfer, 1959). Once the stimulus-response bond has been formed, the ducklings will continue to follow the hen throughout their juvenile period. The hen is also believed to serve as the initial releaser in the courtship behavior of the drake duckling. The duckling, upon maturing and upon acquiring the correct physiological condition associated with mate selection, responds by an inherited display pattern to a hen, the secondary releaser, which resembles the maternal hen.

The acquisition of habitat or environmental affinities by means of imprinting has also been suggested (Thorpe, 1945; Tinbergen, 1948; Svardson, 1949; Klopfer, 1963, 1964; Hess, 1964; Wecker, 1964). Hanson (1960) found that the offspring of captive mallard hens which were hatched in artificial nesting structures showed a significant tendency to nest in such sites when compared with captive incubator hatched mallards.

As stated by Lorenz (1937), imprinting must take place within a relatively short period early in the life of the individual, if it is to occur. This short span of time is commonly referred to as the critical, or sensitive, period. However, within the critical period an optimal time exists for a given species during which maximum imprinting takes place. The optimal time for mallard ducklings for the following response was between 13 and 16 hours (Ramsay and Hess, 1954) after hatching.

The critical period was terminated by the fear response between 24 and 28 hours. Although Ramsay and Hess (1954) list fear as the factor responsible for the termination of the critical period, various investigators have advanced other theories to account for this termination. Kaufman and Hinde (1961) categorized these theories, in addition to that of fearfulness, in the following manner: (1) the end of sensitivity resulting from the maturation of the individual; (2) the inhibition of imprintability due to the effects of socialization; (3) the end of a low state of anxiety.

Lorenz (1937) also stated that once the releaser stimulus had been fitted to the innate behavior pattern, the bond was irreversible, or, in other words, another releaser cannot trigger the same innate bahavior pattern. However, Hinde, Thorpe, and Vince (1956) found that generalization, or an interchange of releaser objects, took place in their investigation of the following response among coots (Fulica atra) and moorhens (Gallinula chloropus). From this observation they concluded that imprinting was similar to other froms of learning and thus it was not irreversible. Similar observations were made by Cofoid and Honig (1961) and Gottlieb (1961).

Movement on the part of the imprinting object was originally believed to be an essential factor in the initiation of the following response. However, Smith (1960) and Smith and Hoyes (1961) have demonstrated that the following response can also be initiated by simulated movement referred to as visual, or retinal, flicker. This effect is produced by the movement of a black and white pattern across the subject's field of vision. James (1959, 1960a,b) used intermittent light to achieve the same effect. However, Gray (1960) observed that chicks could be imprinted to motionless geometric figures and concluded that neither motion nor visual flicker was a required condition for imprinting and that an object prominently displayed in the subject's visual field could serve as an imprinting stimulus.

Hess (1959) observed that the strength of imprinting shown by ducklings was equal to the amount of energy expended by the ducklings in reaching the imprinting object. He referred to this relationship as the Law of Effort. However, Sluckin (1965), in reviewing some previous work, stated that chicks restricted in their movements in reaching the imprinting stimulus performed as well in trials as did a control group which had been allowed complete freedom.

Considerable controversy exists among various investigators concerning the question of whether imprinting is a special form of learning unique in itself or whether it is a form of association learning. Hinde et al. (1956) expressed the view that imprinting is basically the same as other types of learning. The existence of a critical period was considered by Klopfer (1961) to be the characteristic separating imprinting from other forms of learning. However, he also stated that "intermediate processes link imprinting to conventional types of learning." Hess (1964) took a position similar to that of Klopfer (1961). Hess (1964) also distinguished between imprinting and association learning on the basis of the time of exposure and the influence exerted by that exposure on the later behavior of the subject. In association learning, the object, or material, most recently learned has the greatest effect on the subject's behavior. In the case of imprinting the object to which the subject is first exposed exerts the greatest influence on that individual's behavior. Thus, the primacy of the learning exposure serves to distinguish imprinting from association learning.

Location and Duration of the Study

The study was conducted on the Winous Point Club and the Ottawa Shooting Club Marshes during the 1964 and 1965 nesting seasons. Both marshes are located near the southwestern end of Lake Erie on Sandusky Bay in the area where the Sandusky River enters Mud Creek Bay (Fig. 1). The Winous Point Club Marsh is situated on both the north and south sides of Sandusky and Mud Creek Bays in Ottawa and Sandusky Counties, Ohio. The portion of the Ottawa Club Marsh used in the study is situated on the south side of Sandusky Bay in Sandusky County, Ohio.

EXPERIMENTATION

Design and Location of Artificial Nesting Structures

Two types of artificial nesting structures, both cylindrical in their basic design, were used in the study: an all metal structure (Fig. 2) and a grass-poultry wire structure (Fig. 3). The metal nesting structure was constructed from a 2-ft section of 12-inch 24 gauge galvanized furnace pipe. The section of furnace pipe was fastened by means of bolts to a 7-ft length of traffic sign post. A predator guard consisting of a 38 x 9-inch section of 24 gauge sheet metal was also attached to the post. Both the furnace pipe and the predator guard were coated with gun-metal paint and wood shavings to reduce glare. Approximately half of the structures were coated with duck-boat paint (color of dead marsh vegetation) before the beginning of the 1965 season.

Hardware cloth baffles 6 inches in height were soldered inside the furnace pipe at a distance of 5 inches from either end. The baffles served a dual purpose: retaining the nesting material within the structure and positioning the nesting hen near the center of the cylinder so as to decrease the possibility of detection by avian predators. Perches made from 3 x 1-inch furring strips were also attached to the structures as a means of making the nesting structures more attractive to potential nesting hens. Straw was provided as nesting material during the 1964 season; during the 1965 season, native grass, primarily blue joint grass (*Calamagrostis canadensis* Nutt.)[1], underlaid by approximately 2 inches of

[1]Nomenclature according to Fernald (1950)

dirt was used as nesting material. The cost of construction for this type of nesting structure was approximately $4.70.

The design of the grass-poultry wire structure used in the study was a modification of a structure design developed by Francis Uhler (1959) at the Patuxent Wildlife Research Center, Laurel, Maryland. The design of this nesting structure consisted of a 3 x 1-ft cylinder of heavy-duty poultry, or fur farm, wire attached by means of staples to a 3-ft section of 2 x 4-inch pine board. Another cylinder of light-weight poultry wire was placed around the first cylinder and stapled to the pine board. The space between the two cylinders was then packed tightly with blue joint grass. A 15-inch length of 1 inch pipe which had been welded to the center of a 2 x 2 x 1/4-inch steel plate was bolted to the bottom of the board. The cylinder and attached length of 1-inch pipe were mounted on an 8-ft section of 1-1/2-inch pipe by inserting the smaller pipe into the larger pipe. A 2-inch bolt was placed in holes drilled through both pipes to prevent the nesting structure from being turned by the wind. All of the grass-poultry wire structures were erected over open water. The supporting posts of approximately two-thirds of the grass-wire nesting structures located on the Ottawa Club Marsh were given a coating of Tanglefoot as a predator deterrent. The grass-wire nesting structures were constructed at an estimated cost of $6.75 each.

Two hundred eighty-one metal nesting structures were erected on the Winous Point Marsh during the latter half of March and the first week of April, 1964 (see Fig. 1). Whenever possible, the structures were located over open water in sheltered areas near, but not in, stands of vegetation. The work was accomplished by using an outboard-powered 12-ft skiff equipped with a 5-ft square plywood sheet bolted to the bow as a work platform; a smaller boat carrying additional nesting structures was towed behind. An army "weasel" was used in erecting the structures on several occasions when ice made travel by boat impossible. This type of nesting structure was erected on a total of approximately 1185 acres of marshland at an average density of one nesting structure per 4.86 acres. The destruction by ice of most of the structures located in the wide expanses of open water decreased the average nesting structure density in 1965 to one structure per 5.86 acres.

During the winter and spring of 1961-1962, 100 grass-poultry wire nesting structures were erected on approximately 544 acres of the Ottawa Club Marsh. The structure density was one structure per 5.44 acres. Destruction of some of the structures by ice during the winters of 1963-1964 and 1964-1965 reduced structure densities during the nesting seasons of 1964 and 1965 to one structure per 5.85 and 6.04 acres, respectively.

In addition to the metal nesting structures located on the Winous Point Marsh, 18 grass-poultry wire structures, which had been erected in 1958, were repaired during 1965 and made available to nesting waterfowl. The density of these nesting structures was approximately one structure to 6 or 7 acres.

Breeding Waterfowl Population

Breeding pair counts were conducted on a 562-acre tract of the Winous Point Marsh during 1964 and 1965. A similar count was conducted during 1965 on a 524-acre tract of the Ottawa Club Marsh. The estimates of the breeding population derived from those counts were used to evaluate the influence of pair density on nesting structure utilization.

Criteria used in counts.--With regard to the nature of territoriality among ducks, Hochbaum (1944) made the following remarks:

> At the time the pair is ready to nest it takes title to a small water area of the breeding marsh--a pothole, the corner of a slough, or a portion of bay edge. Day after day, as long as drake and hen remain together as a pair, they may be found on this water area. Here the drake and hen loaf and preen together, and here the drake waits for his hen while she is occupied on the nest. Here the drake serves his hen. The water area occupied by the pair is the 'territory'....
>
> . . . .
>
> The water area occupied by a pair of nesting ducks is defended by the drake; he establishes definite boundaries against the intrusion of other sexually active birds of his own species.
>
> . . . .
>
> Any water area will not serve as territory. A territory is a specialized piece of terrain in which four components must exist together: water, loafing spot, nesting cover (adjacent or nearby), and food....

Although the concept of territorial behavior advanced by Hochbaum (1944) has been found to vary somewhat under more intensive investigation (Sowls, 1955), the general pattern of territoriality can be used as a valuable method of estimating breeding populations. Territorial pairs can be distinguished from nonbreeding or transient pairs by their characteristic behavior: (1) Pairs occupying territory tend to isolate themselves from other members of their own species as opposed to transient pairs which usually remain in small flocks; (2) Upon being flushed from their established territory, territorial pairs are reluctant to leave the area and usually either fly only a short distance before landing, or circle the area until the source of the disturbance has passed (transient pairs, upon being flushed, usually fly away in a more or less straight line until lost from view); (3) The drake of a territorial pair defends his territory against invading pairs of his own species (the defending drake characteristically pursues the hen of the invading pair); (4) The hen of a mallard or black duck pair gives a characteristic quack upon sensing danger. The above distinguishing forms of behavior were adhered to closely in all counts made during the present study.

All of the areas for which the counts were conducted on the Winous Point and Ottawa Club Marshes were impounded by a network of dikes, thus ensuring a relatively constant water level throughout the period during which the counts were conducted. The elevated nature of the dikes was conducive to maximum visibility of the count area. Pair counts were conducted during the early morning hours at weekly intervals. However, in order to avoid inclement weather and thus secure comparable count data, territorial pair counts were postponed one or two days on several occasions.

Observation of territorial pairs.--The peak of the spring migration on the southwestern Lake Erie Marshes normally occurs during the third week of March. The migration of 1964 peaked the week of March 19 through March 26. However, during the 1965 migration, a cold wave occurred during the latter half of March, causing the Sandusky and Mud Creek Bays and the surrounding marshland to be covered with ice and snow. As a result, the migration was slowed and the onset of the breeding season was delayed by approximately one week.

On March 29, 1965, a large flock of ducks, geese, and swans was observed concentrated around a large body of open water on the otherwise frozen area south of Sandusky and Mud Creek Bays. Isolated pairs of mallard and black ducks were scattered about on the ice, on snow covered muskrat houses, and on beds of emergent vegetation.

By March 30, the weather began to warm and the ice gradually began to break up, forming holes of open water throughout the Marsh and Bay areas. On several occasions, mallard and black duck hens could be heard to give a loud, sharp series of territorial quacks. Hochbaum (1944) states that this particular call may serve to release the defense behavior of the drake once the hen has made her selection of a territorial area. This call differs from the quack given by a hen when she and her drake are flushed from their territory in that it consists of one loud, sharp quack followed by a series of progressively lower quacks uttered at an increasing frequency, whereas the latter call is a series of loud quacks uttered at a more of less even frequency.

Definite territorial behavior on the part of both mallard and black ducks was observed for the first time during 1965 on March 31. In addition to several observations of rather distinct territorality, many more pairs expressing weaker forms of territorial behavior were observed, indicating that the major portion of the breeding population would soon be defending territory and searching for nests.

Territorial behavior extended from the latter days of March until mid-June. Nesting hens, therefore, were found incubating as late as the first week of July. During 1964, the breeding pair counts indicated at least two nesting attempts were made (Fig. 4). However, during the 1965 nesting season, the occurrence of renesting was not nearly as evident (see Fig. 5).

Small groups of two to four mallard drakes were observed on the marsh during the first week of May, 1965. On several occasions when small groups of mallard drakes were flushed, one or more of the drakes expressed territoriality as indicated by his reluctance to leave the area. These drakes usually circled the area, giving their characteristic call. Obviously, the physio-psychological condition necessary for intense territorial behavior was beginning to wane, resulting in a lower tendency for isolation and a growing tendency for gregariousness. As the month of May progressed, still larger groups of drakes became common sights on the marsh. On June 13, a flock of two or three hundred mallard and black ducks, mostly drakes, was observed.

Nesting pair densities.--The estimates of the breeding population for the nesting seasons of 1964 and 1965 were based on the assumption that at least 85 per cent of the territorial pairs were visible at the time the weekly counts were conducted. The estimates were based solely upon the number of pairs visible during the peak period of territorial activity. Although the possibility exists that several late nesting pairs did establish territories following the peak period, such pairs were few. They were not used to supplement the peak count since such pairs could not be distinguished from renesting pairs or pairs defending two or more territorial areas (see Sowls, 1955, p.53). Even though the late nesting pairs were not included in the count and, therefore, contributed towards an error in the final population estimate, any attempt to supplement the numbers observed during the peak period with observations of supposedly late nesting pairs would have resulted in an equal or even greater source of error.

In 1964, 61 pairs of mallard and black ducks (53 mallard, 8 black duck) composed the breeding population on the 562-acre Winous Point count area. This estimate was based on the number of pairs observed during the peak period of territorial activity which occurred during the month April 13 and 20. The density was one pair per 9.2 acres. During 1965, counts were conducted on both the 562-acre tract of the Winous Point Marsh and the 424-acre tract of the Ottawa Club Marsh. The density of the pairs observed during the peak period of territoriality for the week of April 19 through 26 was one pair per 13.7 acres (34 mallard, 7 black duck) and one pair per 12.8 acres (28 mallard, 5 black duck), respectively. The average density for both areas was one pair per 13.4 acres. From a comparison of the 1964 and 1965 population estimates, a decrease of approximately 33 per cent in the local mallard and black duck population was observed. Bednarik[1] observed a similar decrease in the 1965 breeding population on the Magee Marsh in western Ottawa County, Ohio.

Artificial Nesting Structure Utilization

Rate of utilization.--No utilization of the metal nesting structures was observed in either the 1964 or the 1965 nesting season. The observation of a well formed nest depression in one structure during 1965 served as the only indication that these structures were inspected as possible nest sites. A hollow had been formed in the blue joint grass nesting material and a small depression had been scratched out in the dirt beneath the grass, both typical of the nest initiation behavior displayed by ground nesting species. No eggs or down was found in the nest, indicating the hen had deserted the site for some unknown reason

1 Personal communication.

or reasons. Similar depressions were formed in the nesting material of the grass-wire structures located adjacent to active structures. In the case of the metal nesting structure, the hen probably established a nest on a nearby dike or spoil bank, although the location of such a nest is unknown.

Forty-one grass-wire nesting structures were utilized during 1964 and 1965 on both the Ottawa and Winous Point Marshes (see Tables I, II, and III). Thirteen of these structures were located on the Ottawa Club Marsh during 1964 (11 mallard, 2 wood duck, Aix sponsa); fifteen structures (14 mallard, 1 wood duck) were active on the Ottawa Club Marsh in 1965; thirteen structures (12 mallard, 1 black duck) were located on the Winous Point Marsh during 1965. The rates of utilization by mallard and black duck in those structures located on the Ottawa Club Marsh during 1964 and 1965, based on the number of structures utilized divided by the number of structures available, were 11.8 and 15.5 per cent, respectively. The rate of utilization by these two species on the Winous Point Marsh during 1965 was 72.2 per cent. A summary of the hatching success, average clutch size, and the number of ducklings produced is given in Table IV.

During the nesting season of 1964, mallard hens attempted to establish nests in a group of deteriorated grass-wire structures which were erected on the 84-acre Latamore Unit of the Winous Point Marsh (see Fig. 1) in 1958. In most cases only a handful of pulverized nesting material remained between the two cylinders of poultry wire. Yet, the hens repeatedly attempted to lay and to incubate clutches in such structures with nothing more than down in most cases to hold the eggs in place. The high winds common to the area during the spring made such nests impossible to maintain and eventually brought about desertion (see Fig. 6). Five nests of this type were found within the 84-acre area.

During 1965, the nesting structures on this unit were repaired; eleven structures (10 mallard, 1 black duck) were utilized out of a total of 13 available, or a utilization rate of 84.6 per cent. An additional structure was observed to contain 6 eggs; however, a hen was never observed in the structure, leading to the belief that the structure may have served as a drop nest. Nineteen metal structures were located in the area, usually in close proximity to the grass-wire structures, but, as mentioned above, none was utilized. The utilization of the grass-wire structures on this area of 84 acres represents a density of one active nest per 7.6 acres. Active nesting structures have been noted on this area since their erection in 1958. The preference of the hens for structures, especially in a deteriorated state as during 1964, in an area containing more than adequate nesting cover (see Fig. 7) suggests that imprinting may play a role in utilization.

Another approach which can be used in evaluating structure utilization is a comparison of the pair density on an area with the density of active nesting structures on that area. This approach assumes that all or a major portion of the pairs on territory in a given area will nest within the limits of that area. Although this assumption is not completely valid since a pair need not necessarily establish a nest within their territory, this approach does provide a more logical means of evaluation than is provided by a comparison of the number of structures available with the number of structures utilized.

During 1964, the rate of utilization on the Ottawa Club Marsh based on the latter method was 11.8 per cent. However, when the estimated pair density of one pair per 9.2 acres is compared with the active nesting structure density of one active structure per 49.4 acres in the following manner,

$$\frac{9.2 \text{ A/pair}}{49.4 \text{ A/active structure}} = \frac{x}{100}$$

the rate of utilization was 18.6 per cent. During 1965, the rates of utilization were 15.2 per cent and 32.9 per cent, respectively. Therefore, only a relatively small portion of the breeding pairs present on the Ottawa Marsh during 1964 and 1965 was responsible for the utilization of the structures. The rate of utilization on the 84-acre Latamore Unit of the Winous Point Marsh during the 1965 nesting season based on a comparison of the number of structures available and the number of structures actually utilized was 84.6 per cent. A comparison of the pair density and the density of active nesting structures,

$$\frac{6.0 \text{ A/pair}}{6.46 \text{ A/active structure}} = \frac{x}{100}$$

indicates that the rate of utilization was 92.8 per cent. In this case, both methods indicate a high rate of utilization.

Utilization by wood ducks.--The utilization by wood ducks of the well-lighted, open-ended grass-wire structures on the Ottawa Club Marsh during 1964 and 1965 represents a sharp contrast with the poorly lighted cavities usually chosen by this species as a nesting site (see Fig. 8). All three wood duck nests were located in structures having generous amounts of blue joint grass as nesting material. The depressions formed in the nesting material ranged from approximately 6 to 7 inches in depth.

Thus, the depth of the depression may have modified to some degree the amount of light reaching the incubating hen and, thereby, rendered the nest site and the additional light more tolerable. Only one of the three structures was located near a wooded area where natural cavities were available as nest sites. The remaining two structures were located one-fourth to one-half mile from the nearest wooded area. All of the structures were located over open water.

Pattern of utilization.--A comparison of the nesting structures utilized during 1964 and 1965 on the Ottawa Club Marsh (see Figs. 9 and 10) shows that certain structures were active during both years. Six structures were used as nest sites by mallard hens during 1964 and 1965; two additional structures, number 9 and number 31, were used by wood ducks during 1964 and by mallards during 1965. One nest, number 55, was active in 1962, 1963 (Thompson, 1964), 1964 and 1965. The utilization of the same structures over a series of nesting seasons suggests that homing by the hens or their offspring may take place. Homing is also suggested by the clumping-effect observed on the maps of active structures for 1964 and 1965. Thompson's (1964) map of active structures on the same area for the 1962 and 1963 nesting seasons also shows clumping to some degree.

Nesting Behavior

On several occasions during both 1964 and 1965, mallard pairs were observed inspecting the grass-wire structures as possible nest site locations. The inspection was usually performed from atop the structure by both the hen and the drake. Both could be seen walking back and forth atop the structure and peering from time to time into the cavity of the structure. The hen then entered the cavity for a closer inspection of the actual nest site.

Although the structures involved in these observations were occupied shortly thereafterwards by mallard hens which are assumed to be the same hens observed earlier, at least several structures or other sites are probably inspected before a final site is chosen. Many structures located adjacent to active structures were found to contain depressions formed in the nesting material, suggesting that the hen had inspected several nests before beginning to lay. Although these structures seemed identical to the structures chosen for the actual nest sites, obviously the failure of the hens to utilize them as nest sites was due to the absence of one or more necessary characteristics. Perhaps the hen may by sensitive to certain microclimatic conditions existing within the structure cavity itself or within the immediate environment.

Hens began establishing their clutches shortly after choosing their nest sites, probably on the same day that the choice was made. While laying their clutches, hens were on the nest only during the morning hours. Drakes usually accompanied their hens to the nests and remained near the structure, sometimes at the very base of the structure post, during the time the hen stayed on the nest.

As mentioned earlier, perches were placed on a portion of the structures to make them more attractive to potential nesting hens. However, after observing the hens enter and leave the structures, perches seemed unnecessary and not contributory to the attractiveness of the structure.

Hens upon returning to the nest after periods of inattentiveness usually land in the water in the general area of the structure, swim to within a short distance of the nest, and make a short flight to the entrance of the structure. On one occasion, a mallard, who was cautiously inspecting her nest after an earlier and unsuccessful trapping attempt, swam in circles around the structure and made numerous short, vertical hovering flights to a height of several feet above the structure. After making more than a dozen short flights of this type, she hovered momentarily before the entrance of the structure and then flew directly into the cavity to her nest. In other situations, such as when structures are located on or near mud flats or near dense stands of vegetation, the hen may land first on the structure, survey the area and the nest briefly, and then enter the nest cavity. The absence of a perch on a nesting structure does not make that structure less attractive or less likely to be utilized when compared with structures having perches.

The drakes associated with the nesting structures displayed definite territorial defense of the structure areas. All pairs of mallard and black ducks entering the immediate area of the structures were vigorously pursued by the defending drakes. The size and shape of the defended areas adjacent to the structures varied somewhat according to the proximity of stands of vegetation, dikes, or other barriers which would tend to increase visual isolation and, in turn, increase the number of pairs occupying a given unit of marshalnd. The average area defended in the vicinity of the nesting structure was 300 to 400 ft in diameter, although variation in territorial size and shape does take place. When two or more structures are located closer together than 300 or 400 ft, the probability of both being utilized simultaneously is significantly decreased.

However, additional structures within a given territorial area may be occupied later in the nesting season by renesting pairs after the territoriality associated with the first nest has waned, or has come to an end.

The dates on which the majority of the nests in structures were initiated coincide with the peak period of territoriality (Fig. 11 and 12). However, renesting or perhaps first nesting attempts during the month of May in both 1964 and 1965 accounted for a portion of the total utilization.

Trapping and Banding of Ducklings

To investigate the importance of natal experience, or imprinting, in nest site selection by wild mallard and black ducks, the ducklings hatched in the artificial nesting structures during the 1964 nesting season were trapped and banded as they left the nest. The presence of banded hens nesting in artificial structures during the 1965 season would be considered as an indication that nest site imprinting does occur.

Candling method.--The nesting structures were inspected at approximately three week intervals by walking the dikes surrounding structure units or by using a boat. Hens occupying the structures could be observed without difficulty with the aid of binoculars or a spotting scope; the smooth, rounded lines of the hen's head contrasted sharply with the nesting material (Fig. 13). Upon locating an active structure, the nest was inspected from a boat or by wading.

To synchronize the trapping and banding operations with the time of hatching, the eggs were candled using the field candler and candling technique developed by Weller (1956). The candling device consisted of an 8-inch length of automobile radiator tubing; sunlight was used as the source of illumination. Owing to the opaque nature of the contents of the egg after 1-1/2 to 2 weeks of incubation, the hatching date could in some cases be estimated to within one or two days when the hen was located before the clutch was complete; a second inspection of the nest was then made later at an interval of a week to ten days. The stage of incubation was then derived from the difference in the number of eggs present during the second inspection, allowing one day for each additional egg added to the clutch.

Care had to be exercised not to unduly excite the hen during the early stages of incubation and thus run the risk of bringing about nest desertion. If the nest could not be inspected while the hen was absent, she was flushed from the nest. A special effort was made not to remain at the nest site more than a few minutes after flushing the hen. In spite of these precautions, several hens deserted their nests. Tolerance toward human intrusion varied greatly from hen to hen independent of the stage of incubation at the time of inspection. Hens nesting for the first time and hens renesting following recent nest predation might be more intolerant than others toward human intrusion.

Trapping and banding method.--A 35 x 3-ft circular catch pen constructed from 1/4-inch mesh hardware cloth was set up around active nests after the hen was estimated to have been incubating for approximately two and one-half to three weeks (Fig. 13). A section of approximately 6 inches at the top of the hardware cloth was bent inward at 120 degrees from the perpendicular in order to prevent the mallard ducklings from escaping by climbing the sides of the pen, however slight the possibility. The catch pens set up around active wood duck structures were equipped with a 6-inch wide strip of sheet metal along the inner perimeter of the pen 8 to 12 inches above the water. On one occasion, three wood ducklings were found wedged in a gap between the sheet metal and the hardware cloth. Had the metal guard not been in place, the ducklings would undoubtedly have escaped.

Although the catch pens were not set up until the hen was well into the incubation period, the hen's reaction to the catch pen varied widely. Usually the hens remained in the general area while the catch pen was being set up, often flying around the area from time to time. The hen usually returned to the nest two or three hours after the investigator's departure. However, on two occasions the hens did not return even though they were well into the incubation period at the time of the disturbance.

Two inspection trips were made daily, early morning and evening, after the catch pens had been set up in order to prevent the ducklings from remaining in the catch pen for too long a period after leaving the nest. Several ducklings drowned or died of exposure following their exit from the nest as a result of the cold, inclement weather and the realtively high waves created by the accompanying winds. The susceptibility of the ducklings to drowning or to exposure correlates with the span of time the duckling has spent between hatching and leaving the nest. The exodus of the hen and her brood from the nest may be prompted by the increased activity of the stronger, earlier hatched members of the brood, as suggested by Gottlieb (1965), thus forcing the weaker, late hatched members to leave the nest before recovering from the exhausting ordeal of hatching.

A small mesh dip-net was used to capture the ducklings once they had jumped from the structure to the catch pen. Upon being netted, the ducklings were placed in a gallon bucket, banded, and returned to the catch pen.

Banding was accomplished by attaching a size no. 1 monel metal self-piercing tag to the patagial membrane (Fig. 14). Holes were also punched in the webs of the feet as a secondary means of identification. The permanency of the two methods was tested on captive day-old mallard ducklings. While the patagial tags remained in place throughout the juvenile, subadult, and adult stages, the holes punched in the webs of the feet varied in their conspicuousness and permanency. The holes appeared to increase in size as the duckling's foot increased in size up to the first or second week, apparently due to the wearing away of dead tissue around the hole. Thereafter, the hole tended to decrease in size to a point where it either remained open or closed completely leaving a not too easily discernible scar, thus reducing the value of this banding method (Fig. 15).

Immediately after being banded, the ducklings were returned one by one to the catch pen. At this time when the ducklings reached the water, they remained motionless instead of retreating from the investigator and joining any other brood members which may have been present in the pen. Movement and subsequent retreat was obtained by splashing the water near the duckling. This behavior suggests that a state of fearfulness had not yet developed.

When the complete brood had been banded, they were released as a unit from the pen where they could then be picked up by the hen. The decision to release the brood as a unit was made to prevent the hen from leaving the area with one or two ducklings and deserting the remainder of the brood before the banding operations were completed. A total of 73 mallard and 13 wood ducklings was banded and released.

In mos t cases the hen remained in the general area during the banding operations. One particular hen remained for a short time after the investigator's approach within a distance of 5 ft from the catch pen, swimming back and forth and uttering a low, soft, whistle-like call in an attempt to lure the ducklings away from the pen. The ducklings, apparently responding to the call and the movement of the hen, remained in a close unit vainly attempting to force their way from the pen (Fig. 16). The ducklings gave their characteristic distress call while in the pen.

Another hen remained on the nest incubating an infertile egg after the ducklings had left the nest. The hen remained on the nest until the investigator entered the catch pen to capture the ducklings. The sight and the sound of the ducklings moving from the nest to the water apparently were not sufficient stimuli to terminate the incubating behavior of the hen.

Usually, the hens left the nest area upon the approach of the investigator and began to quack and to display the broken wing behavior or to fly in wide circles around the structure and ducklings. The hens characteristically disappeared for short intervals into the surrounding vegetation. The disappearance of the hen into the vegetation usually coincided with the gradual cessation of the distress calls by the ducklings as they were placed one by one into the bucket. The flights became more frequent again upon the release of the ducklings from the bucket.

Upon being released from the catch pen, the ducklings moved as a close unit towards the calling hen, if the hen happened to be in the immediate vicinity at that particular time. If no hen was present at the moment of release, the ducklings moved collectively away from the nest in a rather random manner.

One hen, observed flying around the structure site during the banding activities, landed in the water on the opposite side of the catch pen from which her ducklings had been released. She then assumed the "sneak position", that is, she extended her head, neck, and body out flat against the surface of the water, and slowly and widely circled the structure and pen. Although the hen was not heard to call to the ducklings at that time, the ducklings directed their attention to her, perhaps as the result of her movement alone, and swam in her direction. The hen, still in the "sneak position", swam to a dike approximately 150 ft from the structure. From this location the hen waited for the brood, then 10 to 15 ft away, to join her. The hen and brood were last seen 150 yards east of the structure following closely along the base of a dike.

Area Brood Production

Brood counts were conducted during 1964 on an area of approximately 300 acres of the Winous Point Marsh. The count area consisted of a transect of the marshland north of Sandusky and Mud Creek Bays. The area included all types of marsh vegetation; no attempt was made to include only vegetation types favored by broods. The counts were conducted during the early morning and evening hours at bi-weekly intervals beginning in mid-May and extending through and including the first week of July. During the entire count period, eight individual broods, seven mallard broods and one black duck brood, were sighted. Stated on an acreage basis, one brood was sighted for every 37.4 acres of marshland included in the count area.

During this same nesting season, 11 active nesting structures were located on the Ottawa Club Marsh. Although only eight hens were successful in hatching their clutches, all 11 of the hens probably would have been successful in the absence of the human interference necessitated by this study. Therefore, using the 11 nests as the number of broods which could have been produced on 544 acres, the production can be listed as one brood per 49.4 acres of marshland.

From the data gathered by Andrews (1952) in a nesting study conducted on the Winous Point Marsh during 1951 and 1952, nest predation accounted for the loss of 65 per cent of the 115 nests inspected. Even though the area has changed somewhat in the past 13 years, the rate of nest predation at present is considered to be at least as high or higher than his estimate.

Since the origin of the broods sighted on the Winous Point Marsh is unknown and the proportion of the breeding population involved in the production of those broods is also unknown, a direct comparison cannot be made between natural and structure brood production. However, with the estimated predation of 65 per cent or higher on ground nests, it is assumed that the production per acre and per breeding pair is greater in nesting structures than in ground nests.

Trapping of Hens

To determine if the ducklings banded during the 1964 nesting season returned to nest in artificial nest structures, or, in other words, to determine whether natal experience influences nest site selection, the hens nesting in structures during the 1965 season were trapped on the nest and inspected for wing tags.

A trap was designed which could be mounted on top of the nesting structure and which would, when triggered, close off both ends of the nest cylinder by means of two round net covered doors powered by rat trap springs (Fig. 17). The trap was triggered by means of a string at a distance ranging from 150 to 200 ft. A 3 x 18-inch section of fur pen wire was attached at each end of the nesting structure; the wire was cut in such a way as to provide small projecting hooks on which the netting of the door would catch upon closing. This device prevented the hen from forcing her way out of the doors once the trap had been triggered. The trapped hen was then forced into an extra long dip-net where she was held and inspected for bands. Leg bands were placed on all hens before they were released for future reference.

Since the trap was designed specifically for this study and had not been tested in the field prior to the 1965 nesting season, several malfunctions took place. The major problem was the accidental triggering of the trap by the hens as they inspected the trap following their return to the nest. On several occasions, nest desertion took place when the traps were accidentally triggered by the hens. After several hens were observed sitting atop the structures on which the traps had been triggered, it was assumed that the weight of the hen landing on the doors was sufficient to trigger the trap. This defect was corrected by placing a brace beneath each door which would support the weight of the hen and, thus, prevent the trap from being triggered.

Although an attempt was not made to trap the hens until they were in the last week of incubation, the tolerance of the hen to the presence of the trap varied in the same manner as did the tolerance toward the catch pen during the banding phase of the study in 1964. Two hens deserted after the trap was mounted on the nesting structure. In general, however, the hen's maternal instinct, or broodiness, was strong enough to overcome her reaction to the trap and to cause her to return to the nest. The ordeal of being trapped, forced into the dip-net, and inspected for identifying marks was not sufficient to cause desertion. Only on one occasion did a hen not return to the nest following trapping.

From the total of 26 mallards, 1 black duck, and 1 wood duck utilizing the structures on the Winous Point and Ottawa Club Marshes, 17 mallards and 1 wood duck were trapped and inspected for bands. The black duck was deliberately not trapped. No wing tags or other marks were found on the hens.

DISCUSSION AND CONCLUSIONS

Although imprinting is generally defined as a form of learning, occurring during the early stages of an organism's life, the exact nature of this learning process is unknown Probably the most significant obstacle standing in the way of obtaining a more complete understanding of this phenomenon is the tendency for most investigators to view imprinting as one general phenomenon without qualifying their observations as to the species involved or the behavior pattern being established. The factors underlying social imprinting may be completely different from those influencing environmental imprinting, even within the same species. The nature of the stimulus, the conditions under which the stimulus-response relationships develop, the time element involved, and the permanency of the bond between stimulus and response undoubtedly vary according to the species and aspect of imprinting phenomenon involved.

The present study has involved one aspect of environmental imprinting, that of nest site selection. Yet, since most of the work relating to the phenomenon of imprinting has concerned social imprinting and not environmental imprinting, most of the standards which can be applied to the observations made during this study are those derived from studies of social imprinting, namely the following response. Therefore, any conclusions based on such standards can be made only with certain limitations.

One school of thought concerning the concept of imprinting derived from investigations of the following response dictates that the releaser must be a moving object. In addition to movement on the part of the imprinting object, Hess (1959) in his Law of Effort maintains that the strength of imprinting is dependent upon the effort exerted by the subject in reaching the imprinting object. Since the nesting structure is an inanimate object and since no effort is expended by the ducklings in reaching the structure as Hess' Law requires, the role of the nesting structure as an imprinting object is dubious. However, other investigators (Gray, 1960; James, 1959) suggest that a stationary object can serve as a releaser. If this is the case, the nesting structure might then function as an imprinting object.

Laboratory work dealing with the following response has shown that the critical period for mallard ducklings is terminated between 24 and 28 hours (Ramsay and Hess, 1954). However, an optimal time ranging from 13 to 16 hours has been found to occur within the critical period. During this optimal period of 13 to 16 hours, maximum imprinting has been found to occur as measured by the number of individuals imprinted and the strength of imprinting displayed by those individuals. The ducklings hatched in the nesting structures are estimated to have remained in the nest for an interval ranging between 12 and 24 hours. Therefore, if nest site imprinting does occur and if the optimal period derived from the study of the following response can be applied to environmental imprinting, the ducklings are assumed to have received an adequate exposure to the nesting structures.

Sluckin and Salzen (1961) and Guiton (1961) have suggested that previous imprinting experience tends to inhibit subsequent imprinting of the subject to new objects. Kaufman and Hinde (1961) listed socialization as one possible factor bringing about the termination or the inhibition of imprintability. During the period that the ducklings are estimated to have spent in the cavity of the nesting structure, socialization, or the imprinting of brood members to one another, may possibly have taken place. The initial stages of the formation of a familial bond between the hen and her brood undoubtedly took place during this interval. The question of whether social imprinting can interfere with or enhance nest site imprinting is open to speculation.

The concept of imprinting as originally advanced by Lorenz (1937) was characterized by the irreversible nature of the bond between the releaser and the behavioral response. However, the investigation of the following response among coots and moorhens by Hinde et al. (1956) indicates that generalization, or the interchange of releaser objects which trigger a specific response, can take place. This investigation as well as the work of other investigators (Cofoid and Honig, 1961; Gottlieb, 1961) suggests that the imprinting process may not be completely irreversible. If nest site imprinting did occur among the structure ducklings, nest site generalization cannot be ruled out as one of the possible reasons behind the failure of the investigator to find banded individuals among the hens nesting in structures during 1965. Thus, hens nesting for the first time may have established nests in sites other than in structures due to an interchange of releaser stimuli.

Generalization may be prompted by the interplay of environmental stimuli, or releasers, and the internal, or physiological, motivation of the hen. Svardson (1949) stated that the mechanism by which a bird chooses a territory or nest site centers around its recognition of the appropriate environmental stimuli necessary for the release of certain innate behavior patterns associated with reproduction. Once reaching a given threshold, the summation of the appropriate environmental releasers causes the bird to select a territory or nest site with a minimum of internal motivation. However, if the appropriate environmental stimuli are deficient or lacking, the physiological condition of the bird eventually compels her to choose a territory or nest site of a suboptimal quality.

If generalization occurred in the case of the banded hens during 1965, it may have been in response to a deficiency of the appropriate environmental stimuli to which the hens were imprinted at the 1964 structure nest sites. Since the study area contained many more structures than were actually utilized, the likelihood of a hen not finding a nest site having the necessary releaser stimuli would seem remote. However, it is possible that the nest site releasers to which the hen may have been imprinted are not possessed by all of the structures.

Although the identity of these releaser stimuli is unknown, a portion of the releasers involved in nest site selection may possibly be of a microclimatic nature. The structure's location and its resulting proximity to dikes, stands of vegetation, and to open water areas may impart to it a certain combination of physical conditions, such as temperature and humidity, which may be found only in several other structures on the marsh. The natal nest site would then determine the combination of microclimatic releasers which a hen would seek when choosing a nest site. The clumping-effect noted for active nesting structures during 1964 and 1965 (Fig. 9 and 10) would tend to support the idea of microclimates in or near the various structures.

If this is the case, the number of structures available as possible nest sites would be reduced. This number might be further reduced by the utilization of otherwise acceptable structures by the maternal hen thereby excluding the offspring from those structures. Hens produced during nesting seasons prior to the 1964 season might also exclude first year hens from using those structures. The utilization of the same structures over a period of several years tends to support the idea of a definite preference for certain structures by either the maternal hen or her offspring. Examination of the estimated dates of structure nest initiation for 1965 (Tables II and III) shows a tendency for the nests in structures which were utilized in 1964 to have been initiated slightly earlier than nests in structures not having a history of utilization. First year hens might also be excluded from acceptable structures since they tend to establish their nests later than experienced hens.

Hanson (1960) suggested that the height of the structure above the surrounding marsh vegetation may be an important factor affecting utilization. If height is a releaser influencing nest site selection, similar nesting situations may be found on the vegetation-covered dikes located throughout the study area. Muskrat houses may possibly serve the same function. Hens nesting for the first time and being excluded from acceptable structures by the maternal hen or other experienced hens may possibly establish nests on dikes due to a similarity in releaser stimuli. This similarity in height between dikes and structures may account in part for the initial use of the structures when they were first erected on the study area.

The utilization of the deteriorated structures on the Winous

Point Marsh during 1964 could be classified as the ultimate in suboptimal nesting conditions. Here again height, perhaps height alone, above the surrounding marshland may have played a role in utilization. However, conditioning of the hen to this particular type of nest site situation resulting from several previous and successful nestings in such a structure may have brought about these seemingly abnormal nesting attempts. Conditioning coupled with the physiological drive to nest may have compelled the hen to attempt establishing a nest even though the structure had fallen into disrepair. However, the initial use of the structure may have been prompted by either imprinting of the hen to a similar structure or some other site possessing similar releasing stimuli.

Hanson (1960) in his study of nest site selection among captive mallards found that ducks which had been hatched in structures but allowed to spend the remainder of their juvenile period (65 days) in exposure to natural nesting cover tended to establish a greater number of ground nests than structure hatched hens which had been removed from the area immediately after hatching. However, the hen exposed to vegetation (imprinted-conditioned group) established fewer ground nests, or more nests in structures, than did a control group hatched in an incubator. Hanson (1960) suggested that the imprinted-conditioned group may have left the nest before the period of imprintability had been terminated and, therefore, had been imprinted to a natural nesting cover. All or a portion of the wild mallard ducklings hatched in structures during the present study may also have left the nest before the termination of the period of imprintability. Therefore, it is conceivable that such ducklings would find nesting sites on dikes just as acceptable as structure nest sites.

As mentioned above, the hypothesized role played by imprinting in nesting structure utilization, based on the return and utilization of the nesting structures by banded, structure hatched yearling hens, has not been supported by the results of this study. No banded individuals were recovered among the 17 mallard hens trapped from the total of 26 hens of this species utilizing nesting structures during 1965. The small number of ducklings banded during 1964 coupled with a high rate of juvenile mortality, and the inability of the investigator to capture all of the hens nesting in structures undoubtedly contributed to the results obtained.

Although the banding returns fail to show a relationship between imprinting and utilization, other observations made during the course of the study do not totally exclude this possibility. Intraspecific pressures indirectly exerted between the hens through territoriality or through a difference in time of nest initiation possibly combine with nest site imprinting in influencing the particular site a hen will choose for ner nest. Simple social facilitation may in part explain the clumping-effect on the Ottawa Marsh and the high rate of utilization on the Latamore Unit of the Winous Point Marsh. No single factor is believed to play a decisive role; utilization is probably dependent upon the interplay of several factors.

The establishment of a colony, or strain, of wild mallard and black ducks which would nest by preference in artificial structures has been set as a possible management goal. Such a colony which would include a major segment of a local breeding population could conceivably be established, but it could be established only if the factors governing utilization can be determined and manipulated to provide the optimum in nesting conditions. Based on the observations of structure utilization on the Ottawa Club Marsh, the desired goal of colonization of a major portion of the structures located on a breeding marsh by a major segment of the breeding population cannot be obtained if the structures are located in a random manner.

With the objective of obtaining a higher rate of utilization in mind, an attempt should be made to obtain more information concerning the releasers associated with active structure nests. A comparison of the physical factors present at newly established ground and structure nest sites, for example, humidity, temperature, wind velocity, etc., may yield valuable information pertaining to utilization.

From the data given by Thompson (1964) the rates of utilization were 2 per cent in 1962 and 11.2 per cent in 1963. The rates of utilization for 1964 and 1965 were 11.8 per cent and 15.5 per cent respectively. These data covering four years of utilization show a slight increase during 1963 over 1962. Another small increase was noted during 1965 over 1964, but this increase was probably exaggerated due to a decrease in the number of available structures. Therefore, the rate of utilization appears to have reached its maximum level for the existing set of conditions.

Observations of drakes defending areas containing active nesting structures suggests that structure utilization may be enhanced by improving the area adjacent to nesting structures to attract and hold territorial pairs. Although probably not all pairs nest within defended areas, a portion of the pairs on the study area were observed to do so. The high rate of utilization on the 84-acre Latamore Unit of the Winous Point Marsh probably can be attributed in part to the high breeding pair density found there. The visual isolation resulting from the criss-crossing pattern of dikes and the high level of interspersion between emergent vegetation and water areas undoubtedly contributes to the area's relatively high density of breeding pairs. Therefore, a significant increase in the rate of utilization might possibly be obtained by increasing visual isolation on structure areas and by the addition of loafing spots adjacent to the nesting structures.

Due to the absence of a complete understanding of the factors governing structure utilization by mallard and black ducks and the low levels of utilization obtained as a result, the potential of this management method might possibly be overlooked. However, the presence of nesting structures on a breeding marsh even with relatively low levels of utilization can be considered as a contribution to local brood production. Since nesting structures render nests and the potential broods which they represent free from most predation, one hen nesting in a structure is comparable in terms of production to several ground nesting birds.

SUMMARY

This study was undertaken to investigate the role played by the process of imprinting in the selection of nesting sites by wild mallard and black ducks. The major objective involved the determination of the proportion of the ducklings of these two species hatched in artificial nesting structures that returned to nest in similar structures. Additional emphasis was placed on determining the increased rate of utilization of artificial structures by these two species of waterfowl.

The study was conducted on the Winous Point Shooting Club and the Ottawa Shooting Club Marshes during the 1964 and 1965 nesting seasons. Both marshes are located near the southwestern end of Lake Erie on Sandusky Bay in the area where the Sandusky River enters Mud Creek Bay in Sandusky and Ottawa Counties, Ohio.

Two hundred eighty-one metal nesting structures were erected on 1185 acres of the Winous Point Marsh during 1964 at a density of one structure per 4.86 acres. Destruction of a portion of these structures by ice reduced the density during the 1965 season to one structure per 5.86 acres. Ninety three grass-poultry wire nesting structures were present on 544 acres of the Ottawa Club Marsh during 1964. The structure density at that time was one structure per 5.85 acres. Ice destruction reduced the structure density during 1965 to one structure per 6.04 acres. Eighteen grass-poultry wire structures on the Winous Point Marsh were repaired and made available to nesting waterfowl during 1965 at a density of one structure per 6 or 7 acres.

Breeding pair counts were conducted on the Winous Point Marsh

during 1964 and 1965 and on the Ottawa Club Marsh during 1965. Mallard and black duck breeding pair densities on the Winous Point Marsh were one pair per 9.2 acres during 1964 and one pair per 13.7 acres during 1965. The breeding pair density on the Ottawa Club Marsh during 1965 was one pair per 12.8 acres. The local breeding population underwent a decrease of approximately 33 per cent during 1965 as compared to 1964.

No utilization of the metal nesting structures was observed during the 1964 and 1965 nesting seasons. Forty-one grass-poultry wire nesting structures were utilized (37 mallard, 1 black duck, and 3 wood ducks) during 1964 and 1965 on the Winous Point and Ottawa Club Marshes. The rates of utilization during 1964 and 1965 based on the number of active nesting structures divided by the total number of nesting structures available on the Ottawa Club Marsh were 11.8 and 15.5 per cent respectively. The rate of utilization on the Winous Point Marsh was 72.2 per cent.

During 1964, mallard hens attempted to establish nests in a group of deteriorated grass-poultry wire structures originally erected on the Winous Point Marsh in 1958. Since little or no nesting material remained in the structures, all such nests were unsuccessful. These seemingly abnormal nesting attempts can probably be attributed to conditioning resulting from previously successful nesting attempts in such structures coupled with the physiological drive of the hen to establish a nest. The initial use of these structures may have been the result of imprinting to similar structures or to a similar nest site situation.

A portion of the structures located on the Ottawa Club Marsh were utilized by mallard hens during both 1964 and 1965 nesting seasons. One structure was occupied by a mallard hen during 1962, 1963, 1964, and 1965.

The utilization of the same structures over a series of nesting seasons suggests that imprinting may be involved. The tendency towards the clumping of active structures also suggests that imprinting may be involved and the subsequent homing of the structure hatched offspring may occur.

To investigate the importance of imprinting in nest site selection, the ducklings hatched in nesting structures during 1964 were banded by means of a size no. 1 monel metal tag attached to the patagial membrane and by web punching. Seventy-three mallard and 13 wood duck ducklings were banded and released. All hens nesting in structures during 1965 were trapped and inspected for marks which would indicate a structure origin. Seventeen mallard hens and one wood duck hen were trapped. No hens carrying patagial tags or web punch holes were recovered.

Brood counts were conducted during 1964 on an area of approximately 300 acres of the Winous Point Marsh. Ground nesting hens accounted for the production of eight individual broods (seven mallard and one black duck) or one brood per 37.4 acres of marshland included in the count area. Structure nesting hens on the Ottawa Club Marsh during 1964 potentially could have produced 11 broods or one brood per 49.4 acres. Production on the Winous Point and Ottawa Club Marsh is not directly comparable since the origin of the broods sighted and the proportion of the breeding population involved in the production of those broods are unknown. However, based on earlier studies of nest predation on ground nesting waterfowl conducted on the Winous Point Marsh, structure brood production appears to be slightly higher in terms of the number of broods produced per breeding pair per acre.

Although the results of the study fail to support the hypothesized role played by imprinting in nest site selection, the phenomenon of imprinting cannot be completely ruled out as a factor influencing utilization. Intraspecific pressures indirectly exerted between the hens through territoriality or through a difference in the time of nest initiation possibly combine with nest site imprinting in the determination of the particular site a hen will choose for her nest. The management goal of the colonization of a major portion of the nesting structures present on an area by a major segment of a breeding population appears to be feasible. However, this goal can be attained only if the factors governing utilization are known and manipulated to make the utilization of a given nesting structure a certainty rather than a matter of chance.

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Table I. Utilization of Nesting Structures on The Ottawa Club Marsh, Sandusky County, Ohio, 1964.

Structure No.	Species	Clutch size	Utilization Period	Fate of Clutch
55	Mallard	11	4/6-5/13*	10 hatched; 1 infertile
84	Mallard	11	4/7-5/14*	11-complete hatch
22	Mallard	10	4/10-5/16*	9 hatched; 1 pipped
54	Mallard	10	4/14-5/20*	9 hatched; 1 pipped
12	Mallard	11	4/14-5/21*	11-complete hatch
4	Mallard	11	4/17-5/24*	10 hatched; 1 infertile
85	Mallard	10	4/24**	Desertion
20	Mallard	7	4/26**	Desertion
9	Wood Duck	10 (9 wood duck, 1 mallard)	5/1-6/9	5 wood ducks hatched; 4 infertile; 1 mallard 6/4
11	Mallard	10	5/1**	Desertion
51	Mallard	9	5/10-6/5*	9-complete hatch
31	Wood Duck	12	5/19-6/30*	12-complete hatch
86	Mallard	11	5/26-7/2*	11-complete hatch

* Utilization period based on hatching date

** Estimated utilization period

Table II. Utilization of Nesting Strucutres on the Ottawa Club Marsh, Sandusky County, Ohio, 1965.

Structure No.	Species	Clutch size	Estimated Date of Nest Initiation	Fate of Clutch
55*	Mallard	11	4/8	9 hatched; 2 infertile
4*	Mallard	11	4/15	10 hatched; 1 infertile
51*	Mallard	11	4/15	11-complete hatch
84*	Mallard	11	4/13	10 hatched; 1 infertile
86*	Mallard	13	4/8	13-complete hatch
9**	Mallard	12	4/22	12-complete hatch
31**	Mallard	8	4/22	8-complete hatch
60	Mallard	9	4/28	Desertion-trap failure
54*	Mallard	12	4/30	12-complete hatch
90	Mallard	--	5/1	complete hatch
49	Mallard	4 (Incomplete clutch)	5/7	Predation
7	Mallard	10	5/7	10-complete hatch
95	Wood Duck	11	5/8	10 hatched; 1 pipped
98	Mallard	11	5/8	10 hatched; 1 infertile
Colony***	Mallard	9	5/9	Desertion

* Structures utilized during 1964

** Structures utilized by wood ducks during 1964

*** One of cluster of 4 structures

Table III. Utilization of Nesting Structures on the Winous Point Marsh, Ottawa County, Ohio, 1965

Structure No.	Species	Clutch Size	Estimated Date of Nest Initiation	Fate of Clutch
6 Latamore	Mallard	11	4/7	11-Complete hatch
9 Latamore	Mallard	12	4/12	Desertion
10 Latamore	Mallard	11	4/16	Desertion
8 Latamore	Mallard	11	4/20	11-Complete hatch
12 Latamore	Mallard	--	4/20	Complete hatch
13 Latamore	Mallard	10	4/20	Did not hatch; pipped
1 Latamore	Black Duck	11	4/20	9 hatched; 1 pipped; 1 unpipped
14 Bunker Hill	Mallard	7 Incomplete Clutch	4/20	Predation
2 Latamore	Mallard	9	4/23	Desertion
11 Latamore	Mallard	9	4/29	Desertion-trap failure
5 Latamore	Mallard	13 mallard; 1 woodduck	4/29	13-Complete mallard hatch
7 Latamore	Mallard	10	5/6	10-Complete hatch
15 North Marsh	Mallard	10	5/7	10-Complete hatch
4 Latamore	Mallard	6	5/16	Possible dump nest

Table IV. Summary of Clutch Data for the Winous Point and Ottawa Club Marshes, Ottawa and Sandusky Counties, Ohio, 1964 and 1965

Date	Species	Clutch Size	Hatchability	No. Ducklings Produced
		OTTAWA MARSH		
1964	Mallard	10.4 (10 nests)	95.2% (8 nests)	80 (8 nests)
1964	Wood Duck	10.5 (2 nests)	81.0% (2 nests)	17 (2 nests)
1965	Mallard	10.7 (12 nests)	95.2% (10 nests)	105 (10 nests)
1965	Wood Duck	11.0 (1 nest)	91.0% (1 nest)	10 (1 nest)
		WINOUS POINT MARSH		
1965	Mallard	10.6 (11 nests)	96.9% (6 nests)	64 (6 nests)

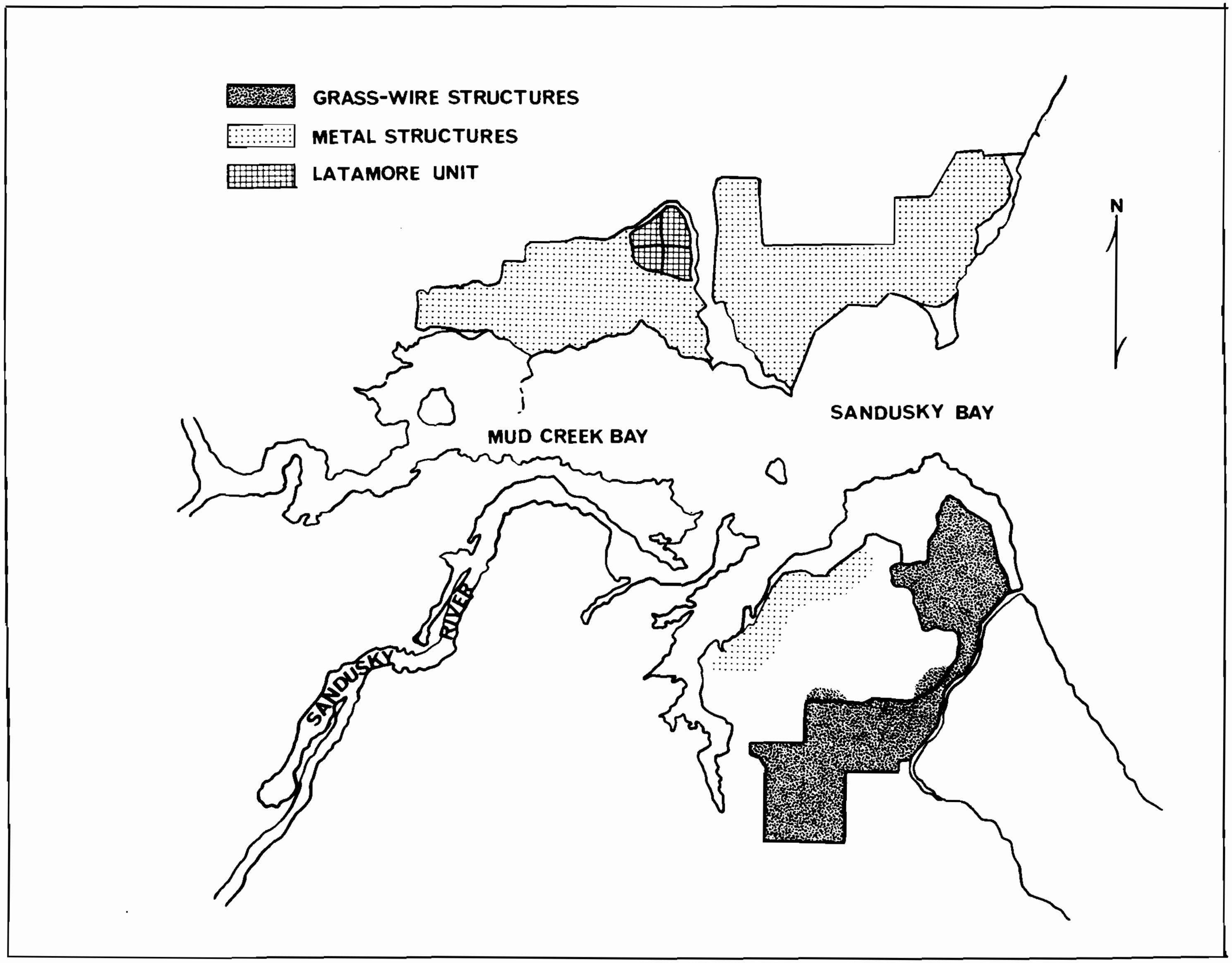

Figure 1. Location of Nesting Structure Types on General Study Area.

Figure 2. Metal Nesting Structure.

Figure 3. Grass-Poultry Wire Nesting Structure.

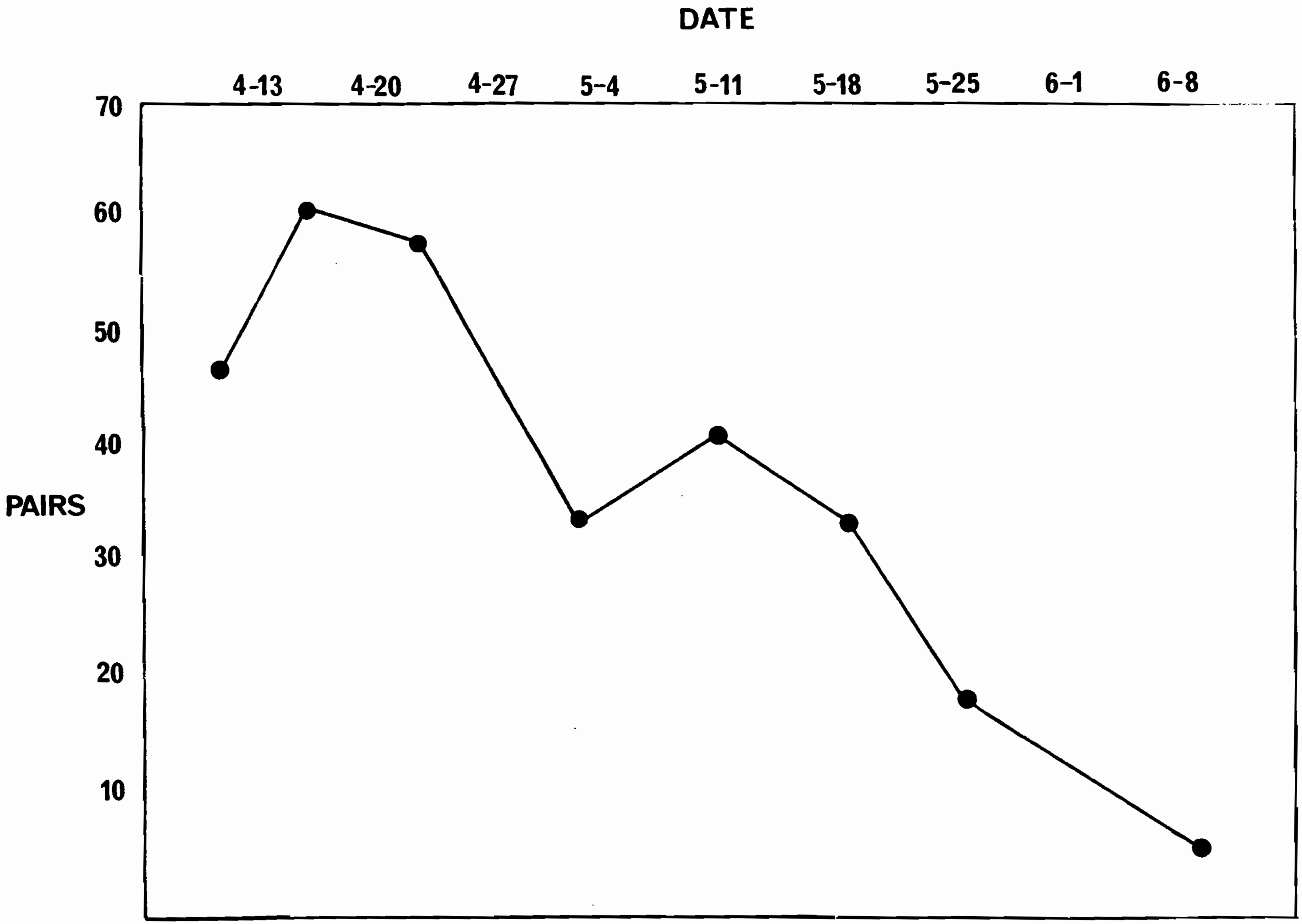

Figure 4. Mallard and Black Duck Breeding Population on the Winous Point Marsh, Ottawa County, Ohio, 1964.

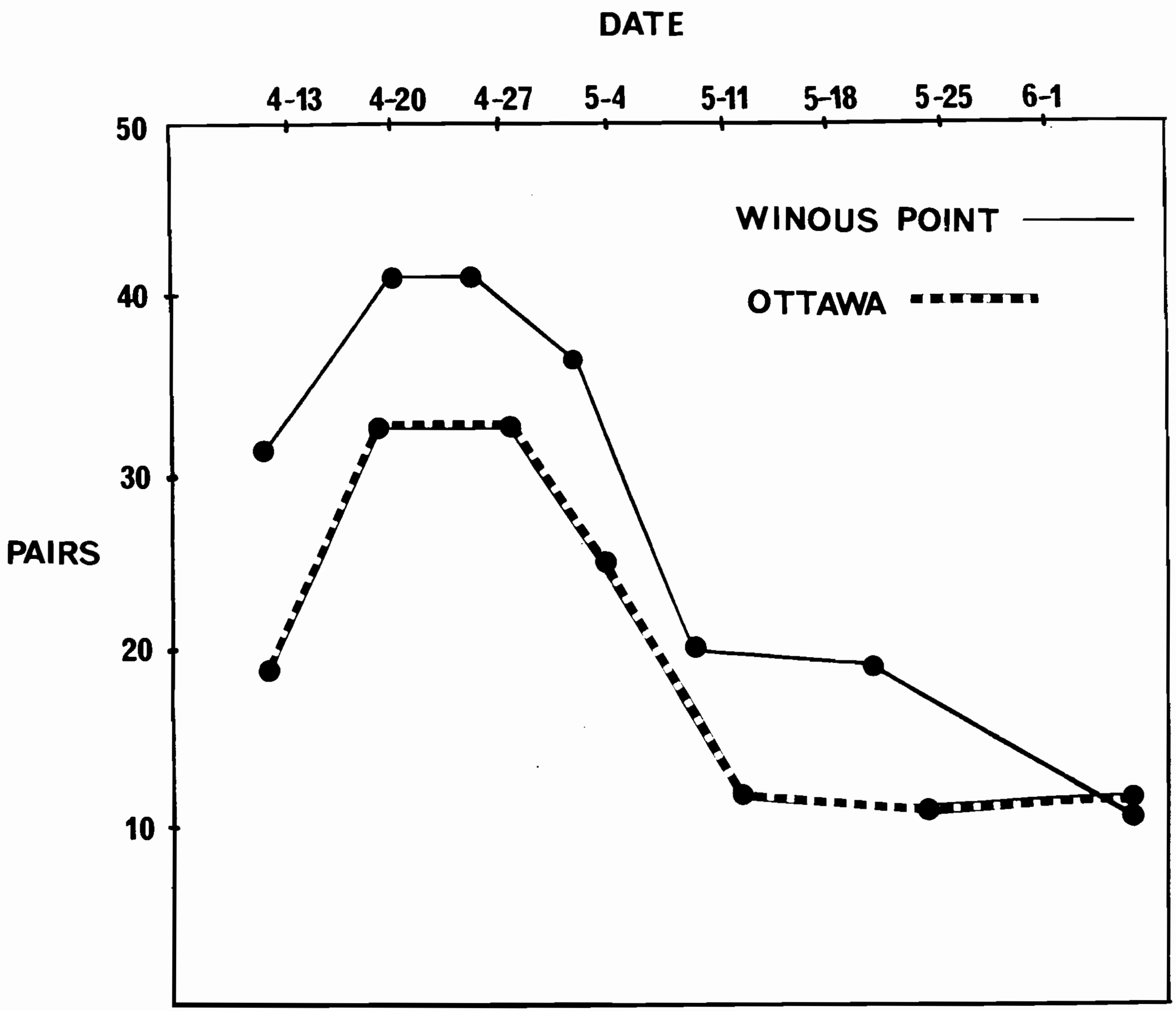

Figure 5. Mallard and Black Duck Breeding Population on the Winous Point and Ottawa Marshes, Ottawa and Sandusky Counties, Ohio, 1965.

Figure 6. Deteriorated Grass-Poultry Wire Nesting Structure Containing Deserted Mallard Nest.

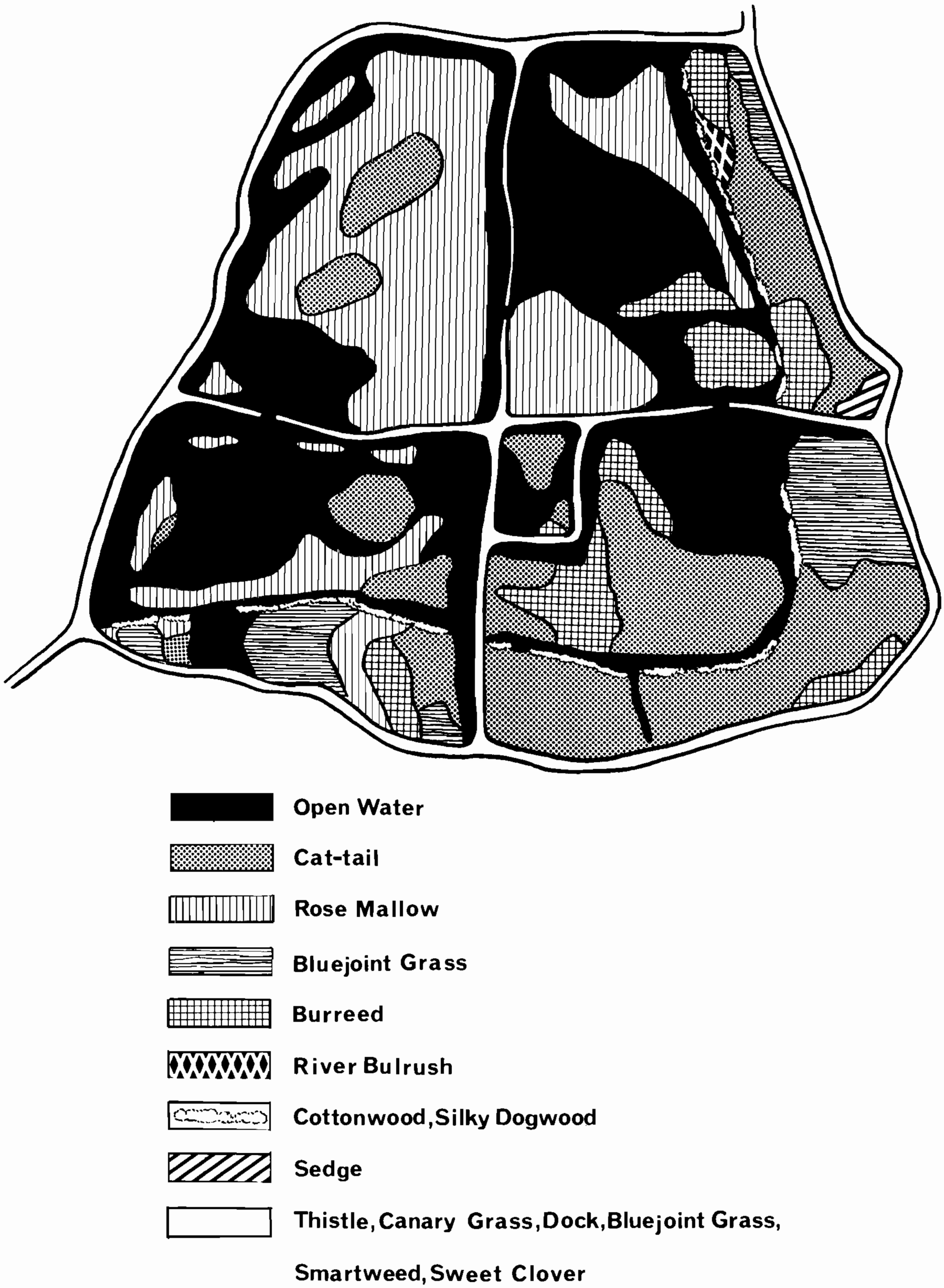

Figure 7. Cover Map of the Latamore Unit on the Winous Point Marsh, Ottawa County, Ohio, 1965.

Figure 8. Cavity of Grass-Poultry Wire Nesting Structure Containing Wood Duck Nest.

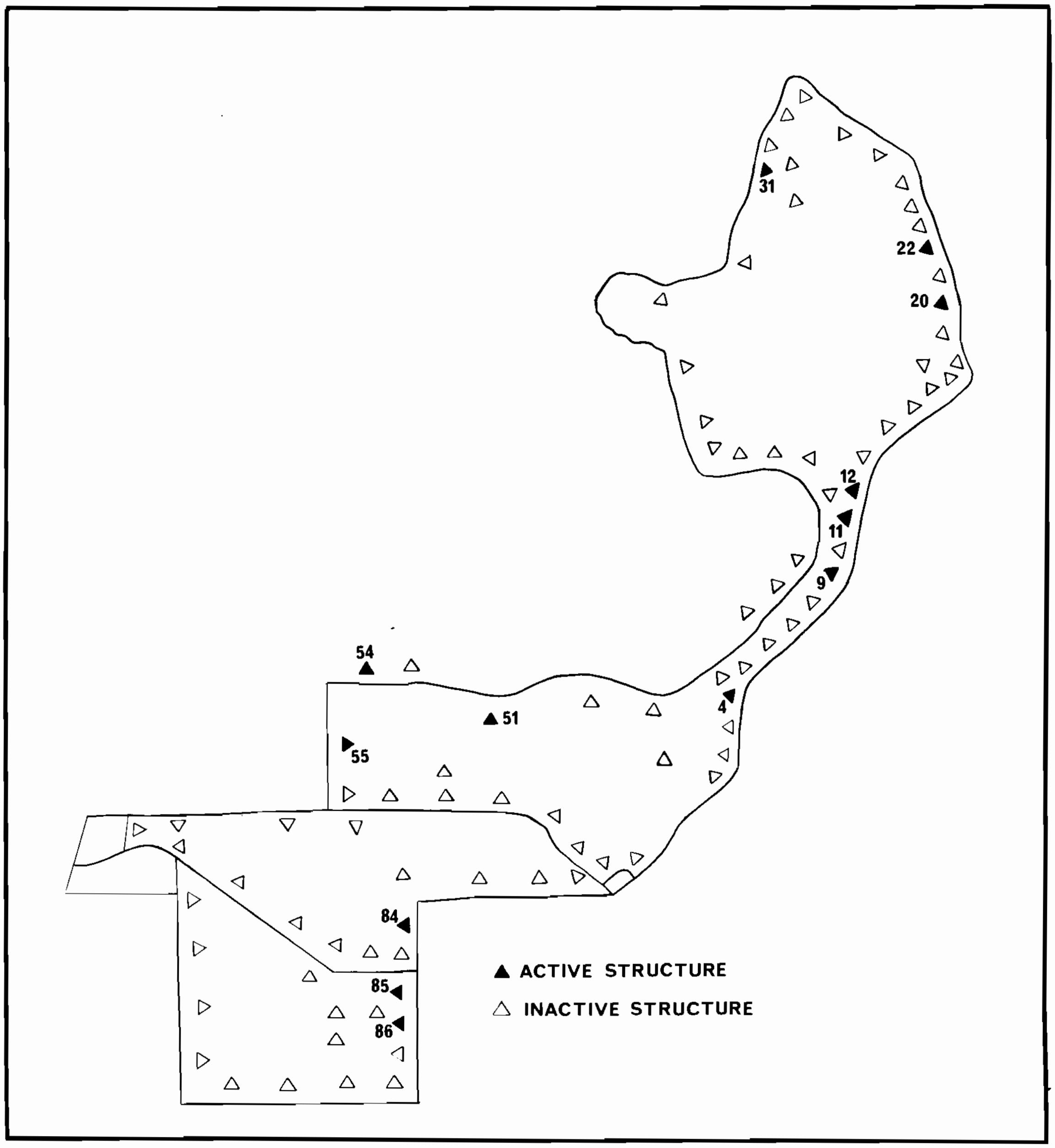

Figure 9. Map Showing the Locations of Active Nesting Structures on the Ottawa Club Marsh. Sandusky County, Ohio, 1964

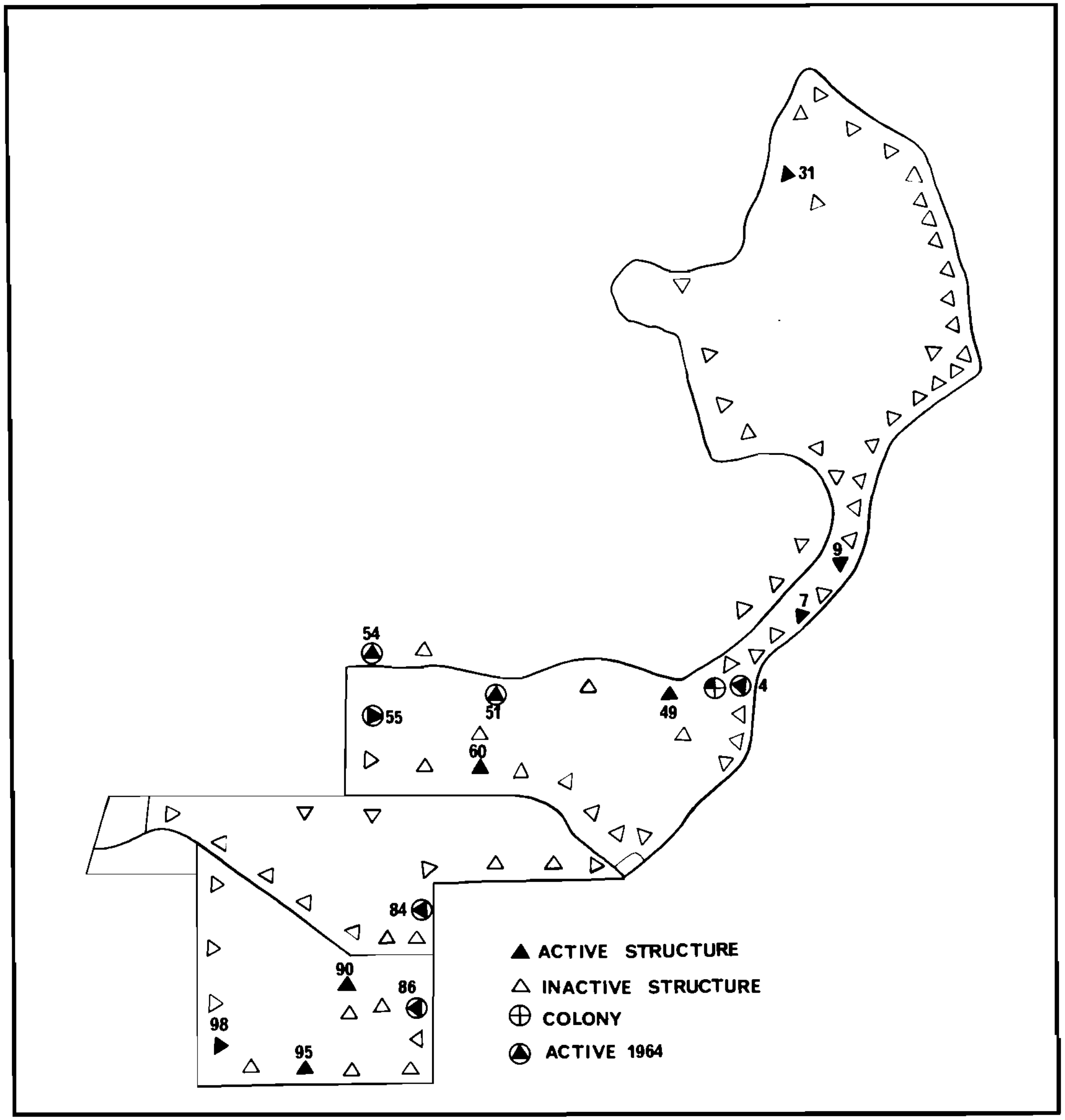

Figure 10. Locations of Active Nesting Structures on the Ottawa Club Marsh, Sandusky County, Ohio, 1965.

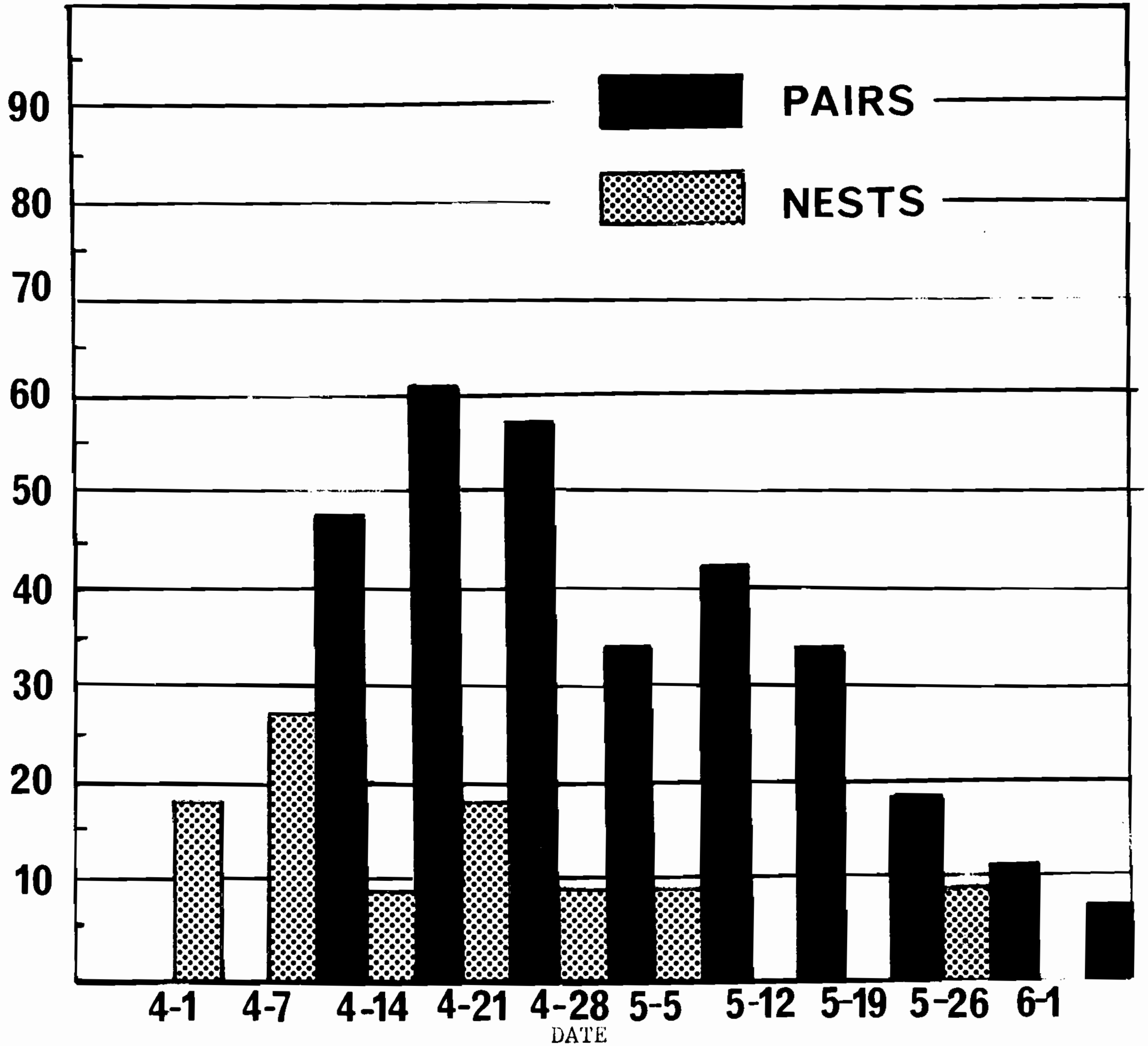

Figure 11. Comparison of the Peak Period of territoriality and the Date of Nest Initiation in Artificial Nesting Structures (stated as the percentage for a given period of the total structures [illegible] Sandusky County, Ohio, 1964.

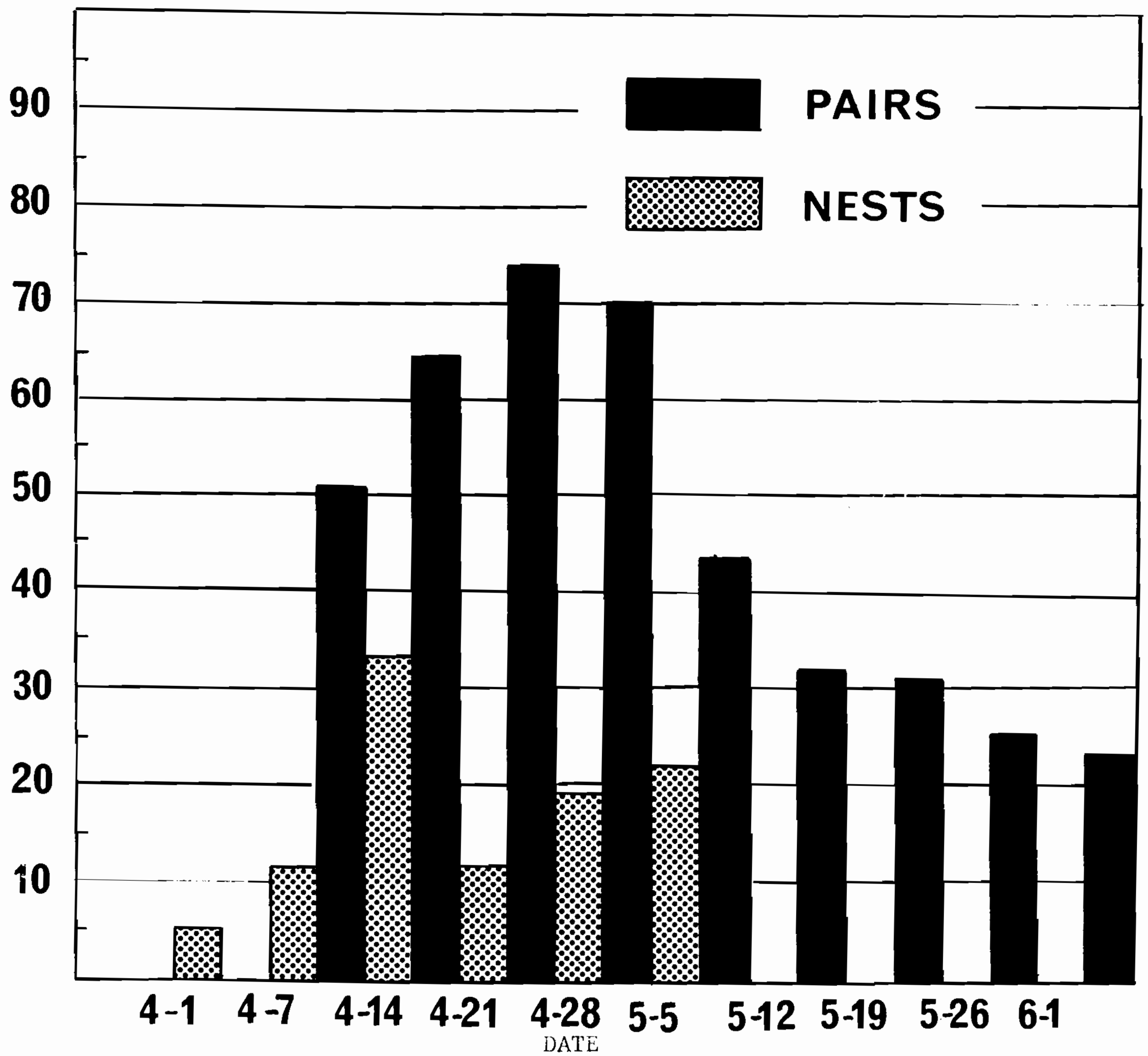

Figure 12. Comparison of the Peak Period of Territoriality and the Date of Nest Initiation in Artificial Nesting Structures (stated as the percentage for a given period of the total structures utilized) on the Ottawa and Winous Point Marshes, Sandusky and Ottawa Counties, Ohio, 1965.

Figure 13. Active Mallard Nest in Structure Surrounded by Catch Pen.

Figure 14. Patagial Tag on Wing of Captive Juvenile Mallard.

Figure 15. Captive Juvenile Mallard with Hole Punched in the Web of the Foot.

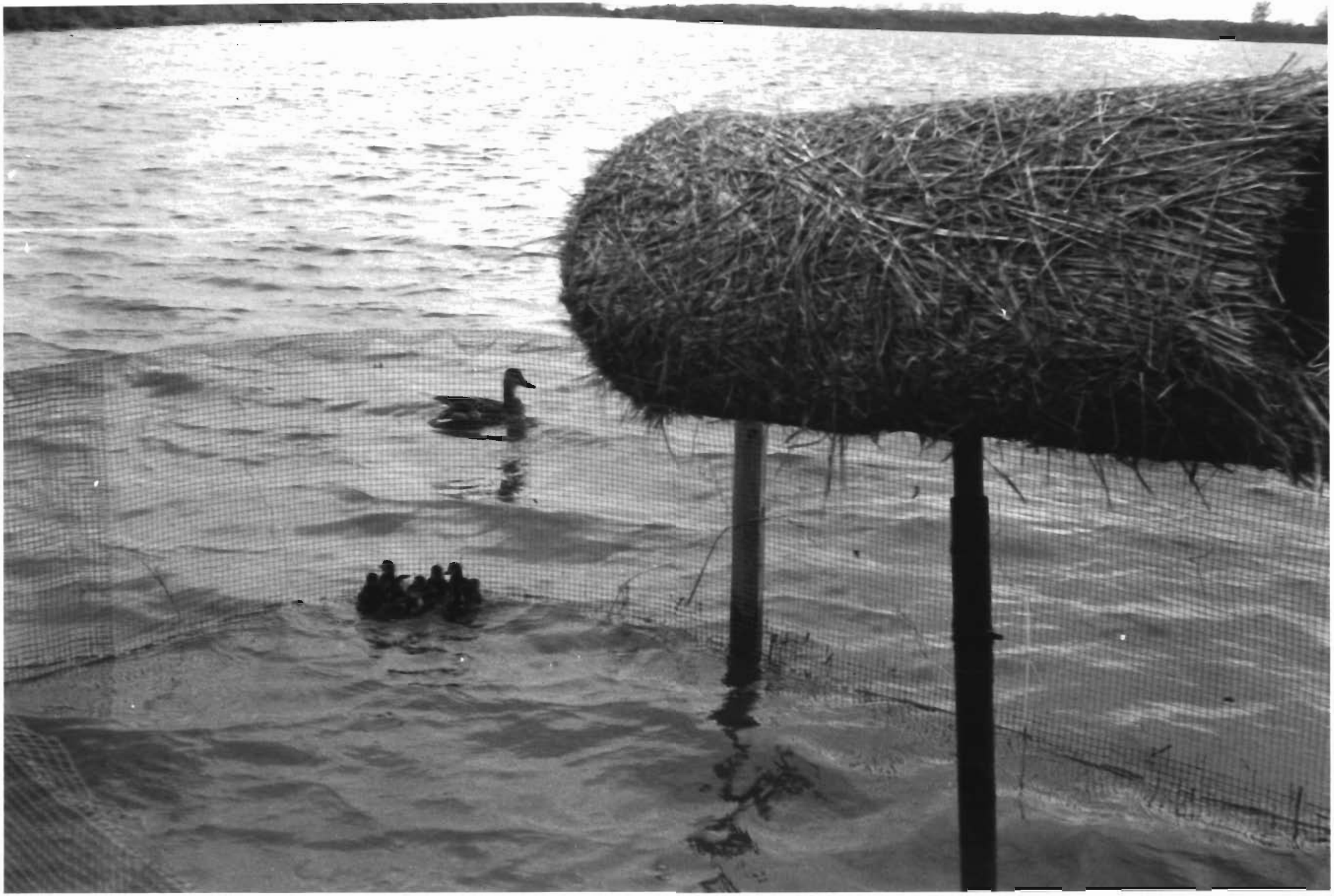

Figure 16. Mallard Ducklings in Catch Pen Shortly After Leaving Nest in Artificial Structure.

Figure 17. Nest Trap Used in Capturing Structure Nesting Hens During 1965.