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By

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Pittman–Robertson Project 77-R

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To the many sportsmen's clubs which participated in the exploratory phases of the program and especially to the Badger State Sportsmen's Club of La Crosse and the Marathon Rod and Gun Club of Wausau for assistance during the major period of large-scale releases, a sincere thank you for helping to complete various phases of this study.

Edited by Ruth L. Hine

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ABSTRACT

The Conservation Department, largely as a result of sportsmen's interest, established a trial project to investigate artificial mallard propagation under Wisconsin conditions. The production of young birds, selection of suitable release sites, recovery of banded birds, field observations on behavior and the determination of the cost of artificial propagation were the major problems studied in order to furnish basic information to game administrators, sportsmen and wildlife technicians.

During the years 1949–1953, a total of 10,371 hand-reared mallards was produced from matings of domestic and wild mallards. A high degree of wildness was maintained in the breeding flock through constant use of wild drakes as breeders. Egg production was, therefore, more limited than if more domestic-type birds were used. The birds were released at about four weeks of age at Horicon, La Crosse (Goose Island), and Wausau, generally on well-known and heavily hunted public hunting grounds. Some releases were made on refuge areas. In this study, it cost $2.04 to produce a thirty-day-old mallard duckling.

Approximately 27 per cent of the birds released were recovered. The bulk of the releases were bagged by hunters in the first year of release and within twenty miles of the release site.

Of the total number of banded birds released, about the same proportion of hand-reared mallards and wild mallards were recovered by hunters. However, here the similarity between hand-reared and wild mallards ends. Even though the hand-reared birds had the benefit of being associated with thousands of wild ducks, they were considerably more vulnerable to hunting. A higher percentage of them were shot in the vicinity of the release site and during the first year of release, especially on opening week-end. The stocked mallards did not fear man, as did the wild mallards, and hand-reared birds were more sedentary than the wild birds. The tameness and sedentary habits of the hand-reared mallards, which apparently resulted from the favorable association with man during the rearing period, contributed significantly to the high vulnerability of the stocked birds to the gun.

Since the bulk of the stocked birds were killed during the first hunting season following release, it appears obvious then, that pre-hunting season mallard stocking is essentially stocking for the gun. However, hand-reared mallards made up only 1–2 per cent of the total season's waterfowl bag at the release sites and immediate vicinity. Artificial propagation as a state-wide waterfowl management practice

would require liberation of about 155,000 mallards to increase the estimated Wisconsin duck kill by only 10 per cent.

At the present time there are reasonably good supplies of wild ducks on some of the existing waterfowl areas. The problem of providing more ducks seems to be one of making additional existing wetland areas more attractive for breeding and migrant waterfowl and to restore and create more areas to attract wild ducks for a longer period of time, rather than to artificially and temporarily supply shooting through stocking.

INTRODUCTION

In the world of waterfowl, the people responsible for the management and perpetuation of these birds have attempted, by their actions and in their thinking, to stay a step or two in front of the sportsmen who are seeking outdoor recreation or meat for the table. As is the case with many other wildlife species, management has developed along three main lines: protection, artificial propagation, and habitat management. The activities and interests of the sportsmen have followed a parallel course. In many instances it is a moot question as to which group does the leading. Frequently the management practices have arisen at the request of sportsmen. In some cases the needs for management were not recognized soon enough or the requests were received too late to be of value in benefiting waterfowl.

From the turn of the century to the early 1930's, various waterfowl hunting restrictions were established: prohibiting spring shooting, baiting, and use of live decoys; limiting the size of shotguns to 10 gauge or smaller; allowing only 3 shells; reducing bag limits; and many others. By 1940, after some of the restrictive measures had been in force for a decade or more, it became obvious that the waterfowl populations were continuing to decline. While protection still seemed to be a part of the answer to the restoration of the continenal waterfowl populations, the knowledge gained in habitat management on some of the famous waterfowl concentration areas seemed to offer more and better possibilities. The result was an expansion of the refuge program, including both acquisition and development of waterfowl habitat by the state and federal agencies concerned.

Following World War II, the number of waterfowl hunters increased considerably, while modern farming machinery and various types of reclamation projects greatly aided in the rapid and final elimination of many wetland areas. This continual loss and/or deterioration in

quality of wetland areas resulted in greater hunting pressure on the remaining waterfowl habitat. Many hunters wanted more ducks on certain wetlands. Considerable interest was aroused by the success of artificial propagation of some upland game-bird species, and the possibility of applying the technique to waterfowl to increase local and flyway populations seemed logical to some sportsmen. Increasing numbers of inquiries were received by state and federal agencies requesting information and assistance for carrying out a large-scale duck-propagation program.

Artificial propagation basically serves two functions: (1) on vacant range it is the way to start an initial breeding stock, and (2) on overshot range it is a possible way of supplementing deficient breeding stock (Leopold, 1933). The problem in Wisconsin was principally one of overshot range. The interested public wanted to increase local breeding populations by stocking and thereby have more birds to shoot during the legal open season. In 1946, only limited information on the artificial propagation of ducks was available. Specific information for making recommendations to Wisconsin sportsmen's organizations was lacking. There were, however, two sources of general information available: (1) the published literature from studies in artificial duck propagation carried out prior to 1946, or before our study was initiated, and (2) the incomplete results of scattered releases of hand-reared ducks made at various times in the past in Wisconsin.

Review of the Literature Preceding This Study (Before 1946)

An examination of the literature showed that artificial propagation is one of the oldest of game management techniques, particularly with respect to birds. Maxwell (1913) commented that it was sometime after 1800 before the practice of rearing pheasants became at all well known in England; but he pointed to the early history of mallard propagation in that country by reference to a letter of 1631 accompanying a delivery of 200 eggs for propagation in connection with the sport of hawking.

In the United States, artificial propagation was slow to develop, probably because of the wealth of native game. It was not until the close of the 19th century that serious consideration was given to propagation as a means of supplementing dwindling huntable game populations. The first state game farm was established in Illinois in 1905 (Leopold, 1933). Following World War I and continuing through the early 1940's, many states jumped on the bandwagon of artificial propagation in an attempt to build up native game populations.

Efforts were directed principally toward upland birds, including the introduction of a number of exotic species. Waterfowl received relatively little attention.

In the early 1930's a few states attempted to propagate mallards on a small scale. An analysis of band recoveries was used as a means of evaluating the releases. Lincoln (1934) analyzed the band recoveries from 3,500 hand-reared mallards released in the states of California, New York, Pennsylvania and Connecticut, and reported that the recovery rate of 1.5 per cent of the pen-reared mallards was considerably lower than the 12 per cent which he found for wild-banded mallards. Errington and Albert (1936) obtained equally poor results, an approximately one per cent recovery, from releases of 350 hand-reared mallards in Iowa. New York studies by Benson (Foley, 1954b) disclosed a recovery rate of 8 per cent. Also, as for the other studies cited above, the majority of recoveries occurred during the first year at the release site or in its immediate vicinity. Pirnie (1935) reported that Michigan released over 2,000 hand-reared mallards in 1933. These were wing-clipped adults liberated in the spring of the year on refuge areas in the hope that some would nest and produce young. A small number were subsequently shot by hunters.

Generally, the results of these studies pointed up the poor survival of the released birds and a lack of migratory behavior. None of these early reports contained information on the cost of releasing hand-reared mallards as a further means of evaluating the practice.

Early Mallard Releases in Wisconsin

Although exact records are lacking, there were a number of releases of hand-reared mallards made in Wisconsin, principally by sportsmen's organizations. In the early 1930's, several hundred "top-quality" mallards were reared from selected domestic hens mated with wild drakes at the Moon Lake State Game Farm at Kewaskum, Wisconsin. The birds were released in mid-August on some of the lakes and marshes in southern Wisconsin. The reported recovery from one group of approximately 200 birds was close to 50 per cent the first year, with all but four of the recoveries occurring in Wisconsin. Observations made at that time indicated that the birds were so tame that hunters had little difficulty in shooting them on the water (Ralph C. Hopkins, unpublished).

About 1932, approximately 1,000 mallards were reared, banded and released on Horicon Marsh, principally as part of a restoration project conducted by the Izaak Walton League. No banding records are avail-

able, but observations made by Wisconsin Conservation Department field men disclosed that the farthest most of these birds moved was to the nearest farm yard.

Truax (1952) referred to a nationally advertisied "Duck Liberation Day" at Horicon Marsh in April, 1935. This event was also in connection with Izaak Walton League activities. No banding records are available on the released birds.

* * *

In view of the lack of a complete evaluation of artificial duck propagation, sound recommendations could not be made on the subject to Wisconsin sportsmen's clubs. The Conservation Department, largely as a result of Sportsmen's interest, decided to establish a trial project to invesitgate artificial duck propagation under Wisconsin conditions. The study was conducted between 1946 and 1953 by the waterfowl management research project with cooperative assistance from several sportsmen's organizations. The study was designed to furnish basic information for game administrators, sportsmen and wildlife technicians. The mallard was selected as the species to work with because it is a common breeder in Wisconsin, and because this species is more readily adapted to artificial propagation than any other species of wild duck.

OBJECTIVES

The major objective of this study was to design and initiate an experimental project to secure detailed information on the hand-rearing of mallards for stocking under Wisconsin conditions. (At no time during the course of this study was there a state-sponsored mallard propagation PROGRAM similar to the state cooperative pheasant-rearing program. This project was strictly an experimental study for the purpose of securing information on which to base future recommendations.)

This experimental project included the following aspects:

a. Developing an experimental plant, where mallards could be held and reared.
b. Acquiring and maintaining suitable breeding stock.
c. Determining the number of young to be produced annually for release and for holding as future breeding stock.
d. Selecting suitable release sites and methods of release.
e. Determining methods for checking hunters to secure band recovery data.

f. Making field observations on behavior, movements and vulnerability to hunting.
g. Determining, with the aid of cost accountants, the cost of producing hand-reared mallards.

Minor objectives explored as a result of having large samples of birds available were to determine the value of a refuge as a release site for hand-reared mallards and to test the effect of feeding a synthetic estrogenic hormone to hand-reared mallards which were released.

Data secured on the above objectives were used to determine the feasibility of having a large-scale mallard-rearing project as a statewide, state-sponsored waterfowl management practice, or as a constructive project for sportsmen's organizations. An analysis of hand-reared mallard banding data, a comparison of hand-reared and wild mallard band recoveries, and a detailed cost analysis provide the bulk of the factual material used in making this evaluation report.

PROCEDURES

The hand-reared mallard project, although started in 1946, did not have adequate facilities and did not develop suitable techniques for large-scale releases until 1949. Experiments between 1946 and 1949, using a variety of production and release methods, sportsmen's club cooperators and release sites, provided the essential information needed to enlarge the project and standardize procedures. Therefore, in 1949 three release sites were selected on the basis of habitat type, location with respect to important waterfowl migratory flight lanes, and interest and rearing facilities of the cooperating sportsmen's organizations. Headquarters during the entire study period were maintained at the Wisconsin Conservation Department station on the Horicon Marsh. Personnel from the Horicon station maintained the Horicon Marsh propagation unit, and assisted with the rearing, banding, and releasing of birds by the cooperating organizations. All records used in this report were maintained and are on file at Horicon. The major portion of this report is based on data from three permanent stations and for the years 1949 through 1953.

The common names of plants and animals were used in this report to facilitate reading. The scientific names appear in Appendix B.

Study Areas

Horicon Marsh. Lying in the upper reaches of the Rock River in north–central Dodge County, the marsh is 14 miles long and 3 to 4 miles wide, a total of 31,540 acres. The northern two-thirds of the

Horicon Marsh: Hand-reared mallards raised in the Horicon propagation unit were released on the marsh, primarily on the state-owned portion. Here there is a combination of open water, productive marsh covered by an average of 2 feet of water, and semi-dry marsh with scatteretd blocks of uplands.

marsh is maintained as a U.S. Fish and Wildlife Service waterfowl refuge or management area. A dike, completed on the federal portion in 1950, maintains up to 4 feet of water over approximately 12,000 acres which are in a flowage-like condition. The remainder of the area is semi-dry marsh, except for approximately 1,500 acres of tillable agricultural land.

The southern one-third is managed by the Wisconsin Conservation Department and serves partly as a public hunting and fishing grounds and partly as a waterfowl refuge. Approximately 3,000 acres are closed to waterfowl hunting at all times. Truax (1952) described the 10,857-acre state area as 5 per cent open water, 6,000 acres of productive marsh covered by an average of 2 feet of water, and the remainder as semi-dry marsh with scattered blocks of uplands. Conditions are similar

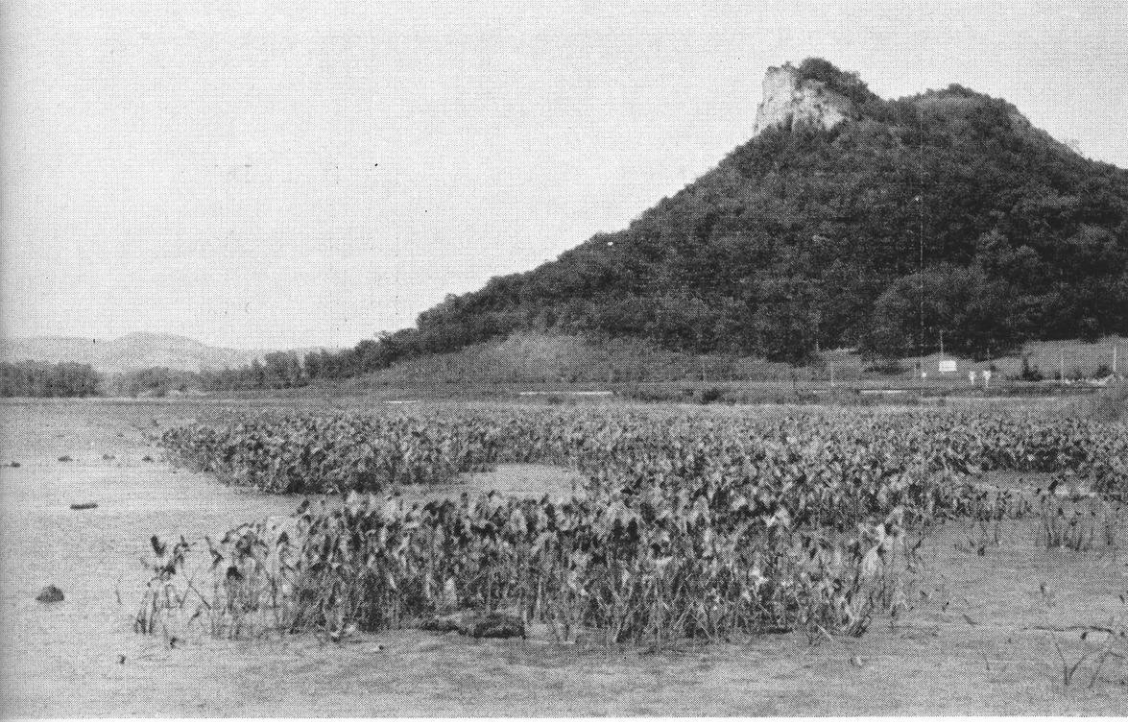
today. Dominant emergent vegetation consists of common and narrow-leaved cattail, river and hard-stem bulrush, giant bur reed and blue-joint. Scattered throughout the state area are 36 islands, ranging in size from one to 160 acres. Dominant vegetation on the islands ranges from scattered growths of willow and aspen to mature hardwoods. Dredged ditches and their spoilbanks, some from the drainage era of the early 1900's and the remainder from recent experiments in muskrat management, help to further break up the marshy area. These ditches, old deep burns in the peat, muskrat eatouts, and shallow open-water areas are choked with desirable aquatic plants and provide an adequate interspersion of water, food, and cover for waterfowl.

Most of the hand-reared-mallard releases on Horicon Marsh were made on the state-operated public hunting grounds. Part of the birds released in 1950 and 1953 were liberated on the state-operated refuge on the southern end of the marsh and at various points deep in the federal refuge.

Goose Island. The Goose Island rearing site is located on a formerly farmed, 400-acre island in the Upper Mississippi River National Wildlife Refuge located approximately six miles south of the city of La Crosse, Wisconsin. The major portion of the releases of hand-reared mallards were made in the immediate vicinity of Goose Island and within a five-mile radius north and south of the island. The general aquatic habitat of the island-spattered river bottom consists of a number of species of arrowhead, bulrush, smartweed, and bur reed as the dominant emergents; duckweed, and pondweeds as the dominant floating species; and coontail as the dominant submerged species. Many of the islands are covered with medium density stands of lowland hardwoods. The entire Mississippi River area is subject to severe flooding in spring and occasionally in summer and fall.

Of the 87,411 acres of the Upper Mississippi River Refuge bordering Wisconsin along six counties, the U.S. Fish and Wildlife Service maintains 30,052 acres for public hunting grounds and 4,518 acres in two units as refuge in the Goose Island area (La Crosse and Vernon counties, Wisconsin). Releases of hand-reared mallards were made in both the public hunting and refuge areas.

Wausau. Birds reared at the Wausau station from 1949 through 1951 were released on flowages of or flowages immediately adjacent to the Wisconsin River in Marathon County, Wisconsin. Drawdowns involved in electric-power production on these flowages are frequent, the waters are stained brown, and aquatic plant growth for food and escape cover is very limited. Zimmerman (1953) made an aquatic



Goose Island, Mississippi River: Releases of birds reared on Goose Island were made in river bottom habitat consisting mainly of duck potato, bulrush, smartweed, and bur reed as the dominant emergents; duckweed and pondweed as the dominant floating species; and coontail as the dominant submerged plant.

Little Eau Pleine River: Type of habitat used for release of birds reared at the Wausau station in 1953. Duck potato and sedges are growing along the banks; shallow pockets of water extending back from the river contained sparse growths of duckweed.

habitat survey on the Big Eau Pleine flowage in 1941 and DuBay flowage in 1943. He described the Eau Pleine as a "biological desert as far as plant life is concerned"; and as "another good example showing that water areas created as storage basins do not necessarily create good habitat for wildlife." This area has changed very little to date. The DuBay flowage closely resembles the Eau Pleine flowage.

In 1952 over half of the releases in Marathon County were made on the large flowages, the remainder on isolated marshes. In 1953 all of the birds were released along the marshy edges of the Little Eau Pleine River, approximately two miles south of the Big Eau Pleine flowage. Sedges were the dominant aquatic vegetation type along the little Eau Pleine River.

Breeding Stock

The selection of a breeding flock poses a problem in any artificial propagation program. No recommended procedures for selecting mallards existed in the late 1940's. The Delta Waterfowl Research Station in Manitoba usually does not hold breeders, but annually collects wild duck eggs from nests located in natural habitat and hatches them in incubators. The New York Conservation Department developed its own strain of mallards through selective inbreeding. The ultimate choice in the Wisconsin mallard studies was to select females from an ordinary game-farm stock, the type usually available to sportsmen's organizations, for mating with wild-trapped drakes. From young of these matings, immature females were selected and held for mating the next year with new wild-trapped drakes. At the termination of this study in 1953, birds resulting from matings of fifth-year crosses with wild drakes were released.

Separate breeding flocks were maintained at the three Wisconsin release sites from 1949 through 1951, after which all breeders were maintained at Horicon. Cooperating organizations thereafter received day-old ducklings for rearing and release. The breeders at Horicon were maintained on a 5-acre pond in an 11-acre enclosure during the nonbreeding season. Drakes were trapped in late August and September, wing-clipped and released on the pond. The immature females to be used as breeders during the following year were held in covered pens until their primary wing feathers were fully developed. They were then wing-clipped and released on the pond. About April 1, the breeding flock was rounded up, carefully screened for culls, and confined to 25-by-75-foot breeding pens through the first week in June. At the termination of the egg-laying period, the spent breeders, both males and females, were liberated at one of the major release sites.

Food, in the form of commercial poultry pellets, and water were supplied daily.

The sex ratios of the ducks confined in breeding enclosures during this study varied from one male per three females to one male per six females in each pen without any marked difference in the hatching success (see Table 1). Peyton (1949) stated that in duck flocks, from five to eight females can be mated to one drake, although most commercial producers prefer five. Studies by Holm (1953) in New York showed that hand-reared mallards produced equally well using sex ratios of one male per three females and one male per five females.

Egg Production

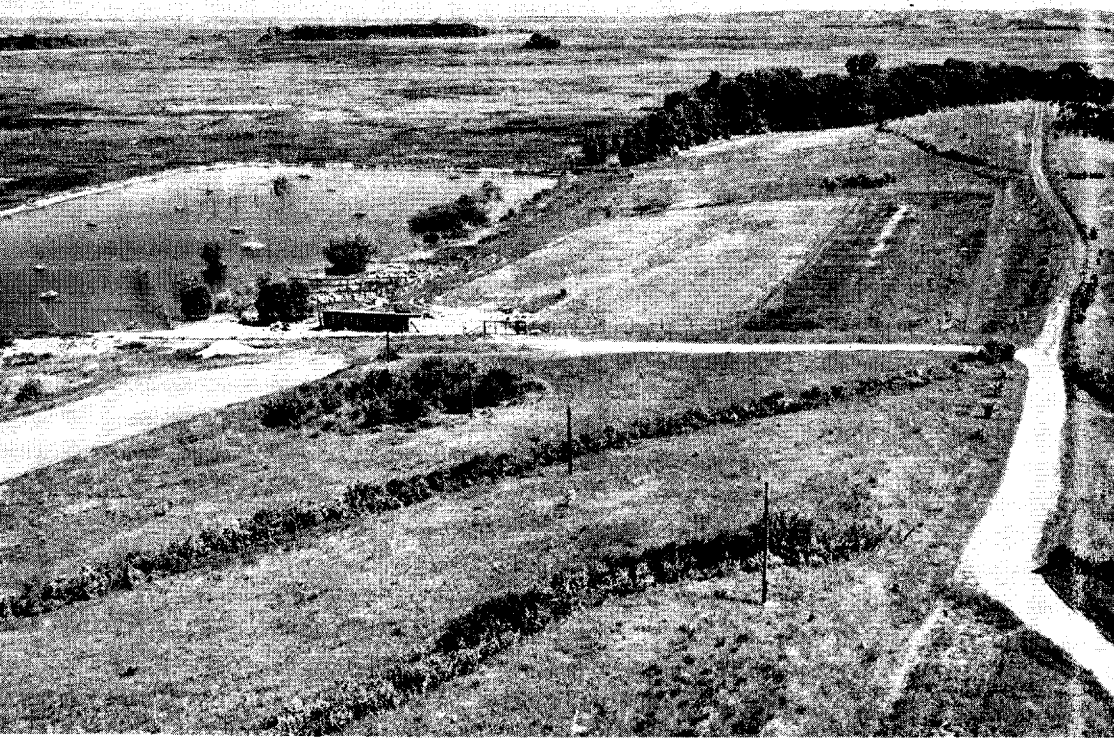
Tepee-type, wood, laying shelters were used in the breeding pens with marsh hay provided for nesting material. Eggs were gathered daily, usually about 10:00 a.m., and were stored in egg crates in a barn basement. Crated eggs were turned daily prior to shipment for incubation. All eggs were transported to the hatchery via automobile or railroad express. The length of time the eggs were held prior to incubation varied from 4 days to 24 days, depending on the rate of laying. The bulk of the eggs were not held longer than 8 days. Egg production was recorded daily for later study.

Hatching

Eggs were hatched by commercial hatcheries, except in 1949 when the eggs were hatched at the Experimental Game and Fur Farm, Poynette. Forced-draft incubators and automatic turning devices were used each year. Daily cold-water spraying of the eggs with a garden hose was an added technique from 1950 through 1953. All eggs were candled after ten days of incubation. Those eggs showing no development were assumed to be infertile and were taken out of the incubator. Representative samples of eggs not hatched at the end of the incubation period were broken and the stage of development of the embryo recorded.

Rearing

Ducklings hatched by the various hatcheries were shipped by express to cooperating clubs at La Crosse and Wausau, usually arriving at their destination within 24 to 48 hours after hatching. Ducklings for rearing at Horicon were picked up directly at the hatchery. For the first ten days, ducklings were held indoors in pens equipped with brooders maintained at 95° F. Feed was a commercial starter pellet. Litter was changed daily or as needed. Water was available at all times.



Propagation unit at the Horicon Marsh Wildlife Area Headquarters.

At the end of ten days the ducklings were transferred to large outdoor holding pens for rearing to four weeks of age. Commercial grower pellets and water were supplied daily. Shelters were provided for protection against storms and for shade. Predatory control was maintained at all rearing sites. Whenever possible, dead ducklings were removed from the pens and were subjected to pathological examination.

Hormone Treatment

In 1950 and 1951, a portion of the Horicon hand-reared ducks were fed a special diet containing a synthetic estrogenic homone, dienestrol diacetate, in an attempt to test its effect on survival and mortality. In this experiment, one-half of the birds were fed pellets which were specially treated with 50 parts per million dienestrol diacetate dissolved in soybean oil. The other half of the birds, acting as controls, were fed the same diet except for the hormone. The birds were fed in this way for two weeks, during the third and fourth weeks of age.

Releasing

All releases of immature birds were made at the age of four to five weeks. The birds were sexed by cloacal examination, banded with U.S.

Fish and Wildlife Service aluminum leg bands and crated for distribution. Releases were made directly from crates in scattered groups of 6 to 15 birds each in suitable areas in the vicinity of the rearing stations. Releases in refuges and on public hunting grounds were recorded by band numbers for later identification.

Banding Data

The waterfowl research project maintained hunter-bag-check stations at the Horicon Marsh and Goose Island release sites for all or part of each hunting season during the entire course of this study. These stations, while not specifically maintained to obtain band recoveries, provided an excellent source for securing recovery data. Band recoveries used in this report were also submitted voluntarily by hunters not contacted through the bag-check stations. All of the Wausau recoveries are of the voluntary type.

Wild mallards were trapped and banded at Horicon Marsh from July through September for three years, 1949–1951. Recoveries from these wild-banded mallards provided data which were used for comparative purposes to help evaluate the Wisconsin-type hand-reared mallard. Although it is realized that most of the wild-trapped mallards were probably not produced locally (on Horicon Marsh), those trapped in July, August, and September were subjected to the same environmental conditions as the hand-reared mallards released in those months. A comparison, therefore, was made between Wisconsin wild-trapped and hand-reared mallards where banding by years and months corresponded. General comments are also offered from an examination of other Wisconsin mallard bandings and from other studies.

Because of the large volume of band recoveries obtained in the course of this study, it was found advisable to analyze them using the International Business Machine system. All band reports received up to March 1, 1954, were included in the analysis. A few subsequent reports received up to August 1, 1956, were utilized in the calculation of mortality rates.

Cost Analysis

The economics involved in this project were explored as a major aspect in the evaluation of artificial mallard propagation. Standard accounting procedures, as approved by the Finance Division of the Wisconsin Conservation Department, were employed. The costs of the physical plant, annual operating expenses, and administrative expenses were included in the analysis. Expenses for banding and releasing operations were not included.

RESULTS AND DISCUSSION

Production and Rearing

Egg Production

A basic problem in the Wisconsin mallard-propagation study was the selection of a technique which would give the greatest possible egg production and still maintain a high level of quality in the young produced. Leopold (1933) referred to two techniques for the propagation of birds: (1) artificially increasing the breeding potential by removal of the eggs, either daily or just before completion of the clutch, and (2) the confining of wing-clipped adults to large natural holding pens where they are allowed to nest and rear their young in a semi-wild condition. Through trial and error, we selected the first technique as being the most productive, in terms of investments in both money and labor, and in birds released in the field. The quality of the mallards used in this study was maintained by eliminating birds which were not similar in physical appearance (in shape and color) to that of wild mallards.

Table 1 presents a summary of the available data on egg production, fertility, and hatchability from the breeding flock maintained at Horicon. The egg production of the Wisconsin hand-reared mallards never averaged more than 22 eggs per female in any year of this study. This is in sharp contrast to a report on rearing mallards by Hunter and Scholes (1954) in which it is stated that from 50 to 90 eggs per duck (hen) can be expected depending upon the treatment (use of artificial lights) given during the winter and spring. Leopold (1933) stated that hen mallards (domestic?) have laid up to 40 eggs per season. Holm (1953), in studies with New York game-farm mallards which had been selectively inbred, found an average of 43 eggs per female. With wild mallards hatched in New York from eggs gathered at Delta, Manitoba, he obtained an average of 12 eggs per female. Holm estimated that only 50 per cent of these wild mallard hens were laying eggs and attributed the lower production of the laying birds to a greater degree of wildness. The Wisconsin mallards were never held in confinement until egg production stopped, but only until the hens started incubating. Although not presented here, the egg production data for each year show that there was a normal distribution pattern of egg laying, with a peak in the first ten days of May and a gradual tapering off through the first week in June. From Table 1 it is also seen that the breeders were held in the breeding pens for at least seven weeks, except in 1950 when a quota was met. Because the breeders

TABLE 1

Production, Fertility and Hatchability of Eggs from the Mallard Breeding Flock at Horicon, 1949–1953

	1949	1950	1951	1952	1953	Mean
Number of females	168	153	138	185	246	184 [1]
Egg-laying days	66	41	58	51	59	58 [1]
Number of eggs	2,829	2,092	2,640	4,064	4,396	3,482 [1]
Eggs per female	16.8	13.7	19.1	21.1	17.9	18.9 [1]
Per cent fertility [2]	81.5	77.1	87.8	82.8	81.8	80.2
Per cent hatchability [3]	11.4	89.9	77.6	77.8	82.1	81.0 [4]
Adult Sex ratio male:female	1:5.6	1:5.1	1:2.9	1:2.9	1:3.3	1:3.6

[1]The 1950 figure was excluded from the mean value because a quota of only 2,100 eggs was produced by the breeders prior to their release. More eggs would have been laid if the birds had been held longer.

[2]Per cent fertility—the number of eggs showing embryonic development whether hatching or not, divided by the total number of eggs laid.

[3]Per cent hatchability—the number of eggs hatching divided by the number of fertile eggs.

[4]The mean per cent hatchability excludes the 1949 data because the techniques used were different from all other years and resulted in a low hatch despite high fertility.

were held for this period of time, we believe that maximum egg production was obtained. The implication from these data is that the Wisconsin-type mallard, if egg laying is related to the degree of wildness as implied by Holm, is more wild than the selectively inbred, game-farm mallard used in the New York studies, and less wild than the Delta-type mallard.

Although all of the fluctuations in the egg-laying curves (not shown in this report) could not be attributed to variations in daily precipitation and temperature, it may be stated that egg production decreased following cold, cloudy days or nights during which any appreciable amount of precipitation fell, and when the daily minimum temperature fell below 35° F. The decreases were of no great magnitude except during periods of heavy and/or prolonged rainfall or when below-freezing temperatures prevailed for the greater part of a 24-hour period. Egg production decreased 20–25 per cent during these times but resumed a normal rate within a day or two.

Fertility

Figure 1 is based on the values given in Table 1 on fertility and hatchability, with the addition of the 1948 data. The 1948 data were included to demonstrate how fertility can be influenced by the degree

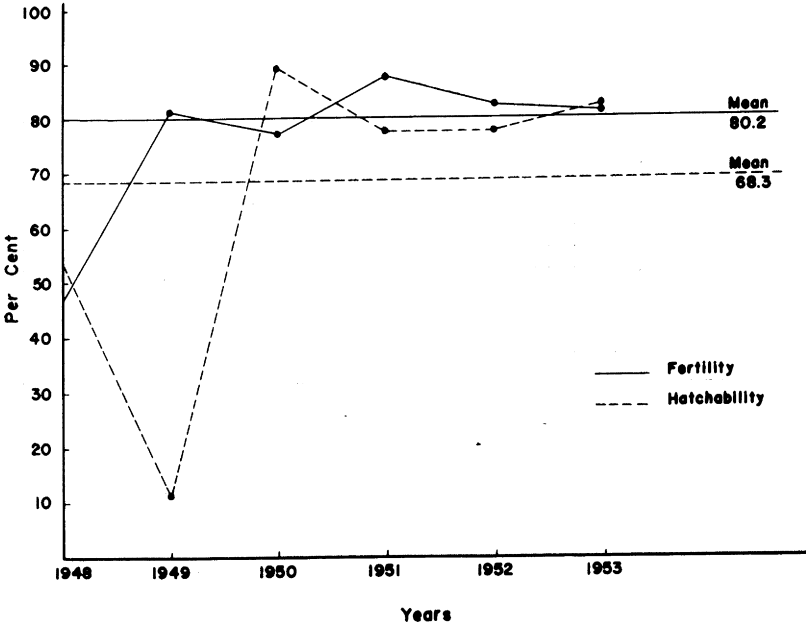


Figure 1. Fertility and hatchability of hand-reared mallard eggs from the Horicon breeding flock, 1948–1953.

to which the mallard breeding stock accepts life in pens. From the figure, we see that the 1948 egg fertility was noticeably lower than in other years. This low fertility was probably due to the physiological condition of the breeding stock. Due to unforeseen circumstances it was necessary to purchase new females and trap wild drakes for breeding stock in the spring of 1948. The confinement of these birds to the breeding pens without a conditioning period, particularly the spring-trapped males, apparently upset their breeding physiology or psychology to the extent that their natural breeding capacities were inhibited. Fertility was below 50 per cent for the first half of the 1948 breeding season while the birds adjusted to their new surroundings. The fertility during the remainder of the season was near the 80 per cent average for the entire study period. In all probability, the low fertility in the first half of the breeding season, as determined by candling after 10 days incubation, was due to sterile eggs rather than early embryonic mortality. A search of the literature failed to reveal a figure on hand-reared-mallard egg fertility for comparative purposes.

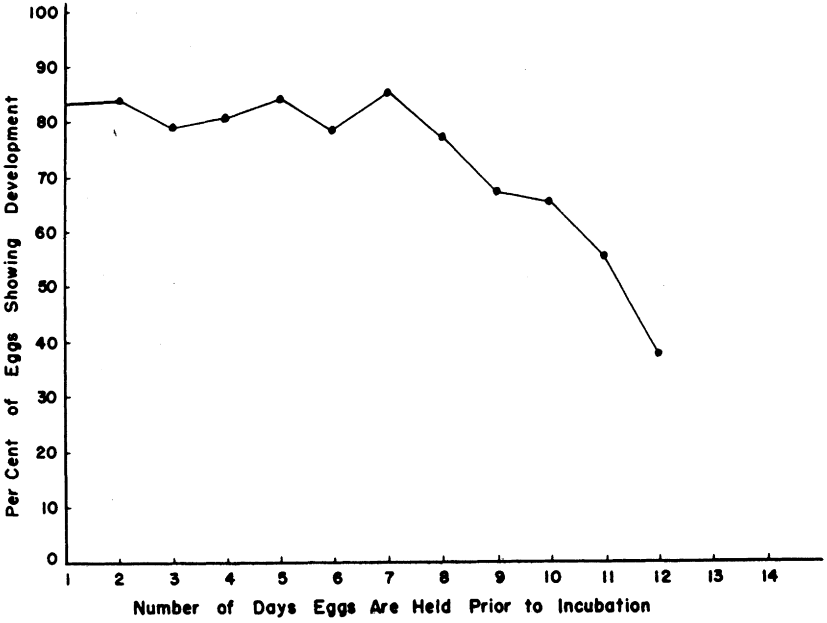


Figure 2. The relationship between the length of time eggs are stored prior to incubation and embryonic development. (Based on 4,228 eggs from 1949 and 1950.)

Hatchability

In a nontechnical publication covering the major aspects of artificial waterfowl propagation from the commercial viewpoint, Peyton (1950) wrote: "Duck and goose eggs do not stand storage as well as chicken and turkey eggs. They hold up fairly well for the first 8 or 10 days under good conditions (storage temperature of 45 to 55° with ample humidity), then are apt to fall off rapidly in hatchability." Moran (1925) found that unincubated chicken eggs could be stored up to 15 days at 46 to 60° F. with 90 to 100 per cent hatchability. After 17 to 20 days of storage, hatchability dropped off rapidly. This indicates that hatchability depends to a large degree on the length of time in which the fertilized ovum remains viable.

In an attempt to determine the effect on viability according to the length of time eggs are held prior to incubation, the 1949 and 1950 egg-production data were combined, and the percentage of eggs showing development was plotted in Figure 2. It is readily apparent that viability drops off sharply after the eggs are stored more than seven days. From the number of copulations observed in the breeding pens,

most of the eggs should have been fertile when laid. Apparently there is some change taking place in the egg after the seventh day of storage which results in the death of the embryo. Poultrymen are aware of this fact, and there is also a possibility that this phenomenon may occur in wild ducks, for a number of species are capable of laying clutches of 12 or more eggs. Certainly these are points in egg handling technique and nesting studies which need further study. In view of the loss of viability after seven days of storage, eggs to be incubated artificially should not be held more than seven days if maximum hatchability is desired.

The question arises: "What is the effect of freezing temperatures on viability or early embryonic mortality?" Peyton (1950) wrote that storage of duck eggs for one-half day at 32° F. does not hurt the eggs; but three or four days at that temperature will. Moran (1925) determined that unincubated chicken eggs could be exposed to a temperature of 33.5° F. with a 70 to 100 per cent hatch after 113 hours and no hatch after 237 hours. English (1941) found that unincubated pheasant eggs could be exposed to temperature as low as 10° F. for three periods of one and one-half to two hours on alternate days without appreciable loss of viability. In our Wisconsin studies, no mallard eggs were exposed to temperatures below 32° F. for longer than 12 hours during any period. Observations made on the adult breeders in the pens indicated that the majority of the eggs were laid at night or in the early morning and that several hens laid in the same nest thereby warming up the eggs already laid. Under the conditions of the Wisconsin hand-reared-mallard study, we concluded that low temperatures had no important effect on egg viability.

In the Wisconsin project in 1948, fertility was relatively low, but hatchability of all fertile eggs fairly high, although below average (Figure 1). This success in hatching is attributed to the technical experience of personnel of the State Game Farm at Poynette, Wisconsin gained through many years of handling the incubation of native and exotic game-bird eggs. A small commercial hatchery was hired to do the incubating in 1949 and even though the fertility was very high, hatchability was disastrously low. Although a forced-draft incubator was used, most of the eggs were not hatched successfully, evidently due to poor incubation techniques. From 1950 through 1953, a very high level of hatchability was obtained by personnel of the Fox River Valley Game Farm using a forced-draft incubator and an added technique of daily cold-water spraying of all eggs. The water spraying was adopted to prevent excessive dehydration which could cause the ducklings to

stick to the shell and consequently be unable to rotate and properly pip the shell at hatching time. The apparent success of this technique is shown in Table 2 by the decrease in the per cent of fertile eggs which did not hatch in the years 1950 through 1953 as compared to 1949, and also by the reduction in the percentage of ducklings lost during the final week of development.

The results of the egg-production phases of this study indicate that if a propagation project is established in which artificial incubation is to be used, an experienced hatchery should be employed to insure the highest possible success.

TABLE 2

The Per Cent of Total Eggs Fertile but not Hatching and the Age of Embryos Dying During Development

Year	Total Eggs Laid	Per Cent of Total Eggs Fertile But Not Hatching	Per Cent of Embryos Dying During Various Stages of Development			
			1st week	2nd week	3rd week	4th week
1949	2,829	72.2	7.7	18.2	31.6	42.5
1950	2,092	7.8	3.1	19.0	42.9	35.0
1951	2,640	20.7	5.5	35.5	31.8	27.2
1952	4,064	18.4	13.1	38.0	33.6	15.3
1953	4,396	14.7	16.6	67.6	4.8	11.0
Average[1]	3,298	15.4	9.5	40.0	28.2	22.5

[1]1949 data excluded because of difference in incubation techniques.

Rearing Losses and Pathology

The rearing losses sustained from the time of hatching to release amounted to 15 per cent for all stations. The major sources of losses were overcrowding under brooders, predators, disease, and lightning. A number of autopsies were performed by Kenneth G. Flakas on dead ducklings as a precaution in preventing outbreaks of disease in the rearing pens. The findings from these autopsies showed that *Salmonella* sp. (not *S. pullorum*) and *Aspergillus* sp. were the principal disease organisms. In seeking the source of the infestation, the *Salmonella* was found to originate in the water supply. The use of a commercial disinfectant (Sulmet) in the water immediately stopped the losses. The *Aspergillus* and an unidentified fungus were found to be living in the damp, ground-up corncobs used as litter under the brooders. Substitution of wood shavings eliminated further losses.

The importance of leucocytozoon disease *(Leucocytozoon anatis)* as a cause of heavy losses in young wild ducks in black fly (*Simulium venustum)* areas in Michigan was pointed out by O'Roke (1934). A number of New York workers (Kutz, Mason and Taber, 1948; Foley and Taber, 1951), who have made recent attempts to establish mallard breeding populations in a number of areas in that state, have suggested that leucocytozoon disease may be responsible for the failure of some of their releases of hand-reared mallards.

In relation to the leucocytozoon disease and Wisconsin hand-reared mallards, the Wausau-released birds pose an interesting problem. For all practical purposes, the Wausau release areas are essentially in heavily wooded areas, with a minimum of agricultural and marshy land. The presence of a leucocytozoon parasite was not established since no studies were carried out in the area. However, studies on wild-trapped ducks of several species made at Horicon Marsh (Flakas, 1951) showed a fairly high incidence of leucocytozoon, ranging from 6 per cent for mallards (97 birds) to 43 per cent for black ducks (30 birds). With such an incidence in a nonwooded area like Horicon, it seems likely that an even higher potential exists in the Wausau area. This in part may account for the extremely poor survival obtained from this release area.

Weights

Nelson and Martin (1953) pointed out that weight may serve as an important indicator of abnormal conditions such as disease and malnutrition, and as a criterion in habitat evaluation. From the standpoint of game management, subsequent weights taken at the release site probably indicate the suitability of the environment and the adaptability of the hand-reared mallards to this environment. If a large portion of the released birds are reported recovered and weights of released birds taken during the first hunting season are approximately the same or greater than those for wild mallards, then the environment must be supplying the necessary food and cover requirements for normal development and survival. Table 3 presents the hand-reared mallard weights available from Horicon Marsh, and weights of other types of mallards from a number of sources.

From a comparison of the weight of the Wisconsin hand-reared mallard at release age with that of birds of similar age in Southwick's (1953) study of hand-reared wild mallards, one might suspect that the domestic characteristic of excessive weight was being maintained to a considerable degree in the Wisconsin birds. However, the mean weights

TABLE 3

Mean Weights of Some Hand-Reared and Wild Mallards[1]

Type	Source	Number in Sample	Sex	Age	Mean Weight (lbs.)	Range
Hand-reared (wild eggs)	Delta, Manitoba; Southwick (1953)	6	?	5 weeks	1.0 ±0.12	-------
Hand-reared	Wisconsin	93	male	4–5 weeks	1.4 ±0.33	0.4–2.2
Wild	Illinois; Bellrose and Hawkins (1957)	730	male	immature	2.59 ±0.01	-------
Wild	Wisconsin	729	male	immature	2.7	1.4–3.8
Hand-reared	Wisconsin	102	male	immature	2.6 ±0.27	1.8–3.4
Wild	Illinois; Bellrose and Hawkins (1947)	671	female	immature	2.28 ±0.01	-------
Wild	Wisconsin	719	female	immature	2.4	1.1–3.8
Hand-reared	Wisconsin	41	female	immature	2.3 ±0.25	1.8–3.0

[1]The weights of the birds listed in the table were secured during any one of the following operations: at the time of release, when trapping and banding, and at hunter-check stations.

of Wisconsin hand-reared birds taken from 4 to 15 weeks after release show a very favorable comparison with immature Wisconsin wild mallards (unpublished data) and those weighed by Bellrose and Hawkins (1947). The average fall weight for the immature Wisconsin hand-reared birds was attained by the age of 10 weeks in the majority of cases and occasionally in 8 weeks. Wisconsin hand-reared mallards released on Horicon Marsh during the months of June, July, and August, on the basis of weight, are in excellent physical condition by the opening of the waterfowl hunting season in October and at least in weight do not differ markedly from the wild-type mallard at this time.

Behavior

Although detailed behavior studies were not a part of this project, a few observations concerning the behavior of the birds, as influenced by the rearing conditions, seem pertinent. Two behavioral aspects are considered here, imprinting and acquired behavior.

The subject of "imprinting"—a term generally used to describe the learning behavior of a bird or animal as influenced by factors which occur during its first few hours or days of life—is frequently associated with the hand-rearing of ducks. Supposedly, the association with man during the early life of the ducklings leaves an impression on the "memory" of the birds. Lorenz (1937) distinguishes imprinting from acquired behavior in that (1) it occurs very rapidly; (2) it occurs only in a very limited part of the animal's life; and (3) it is irreversible or at least difficult to eliminate. Ramsey and Hess (1954) determined that the critical age in imprinting in mallard ducklings was at the age of 13 to 16 hours and that no imprinting occurred beyond 24–28 hours of age. Boyd (1954) suggested from studies on mallards in England that imprinting was not important in mallards. In the Wisconsin studies, techniques for handling hatched young were not set up to have birds shipped from the hatcheries to the rearing stations within the 13- to 16-hour critical imprinting period, and usually not within a 36-hour period. On the basis of this information, we conclude that the behavior of the released ducklings as influenced by the association with man in the Wisconsin studies was not imprinting in its strictest sense.

However, association with man during the Wisconsin studies did result in the ducklings acquiring certain behavioral characteristics. Unquestionably the daily feeding and watering of the birds during the rearing period resulted in the ducklings learning that man was not to be feared. Observations made prior to the opening of the waterfowl hunting season (in early October) revealed that some groups of the

released mallards could be approached within a few feet by boat on the release sites. The birds obviously were sedentary and tame and did not fear man. These factors could result in the birds being very vulnerable to the gun in the hunting season. Data presented later in this report, in the section on band recoveries, also indicate that the sedentary habits and tame behavior of the released mallards are the most important factors affecting the mortality of the Wisconsin hand-reared birds.

Survival, Movements, and Mortality

The principal means used to evaluate the Wisconsin hand-reared mallard project was the analysis of the band-recovery data. From these data it is possible to determine what happens to the birds in terms of survival, movements, and mortality. In the presentation of the banding data, a number of terms are used for which definitions are given below together with a few explanatory remarks. Whenever possible, the definitions are based on those given in the "Manual for Bird Banders" issued by the U.S. Fish and Wildlife Service.

BAND RECOVERY: A report of any dead banded bird. (The bulk of these birds are shot in the hunting season.)

BAND RECAPTURE: A report of any previously banded bird which was recaptured alive and released. (No trapping stations were maintained at the release sites to secure recapture data on the hand-reared birds.)

LOCAL RECOVERY OR RECAPTURE: A band recovery or recapture from Wisconsin or Minnesota within a 20-mile radius of the Goose Island release site.

FOREIGN RECOVERY OR RECAPTURE: A band recovery or recapture from outside Wisconsin and in Minnesota beyond the 20-mile radius from the Goose Island release site.

FIRST-YEAR PERIOD: A band recovery or recapture occurring at any time from release until the end of the first hunting season in the Mississippi Flyway (which usually occurs about January 10).

SUBSEQUENT PERIOD: A band recovery or recapture reported at any time after the first-year period.

IMMATURE: Any bird from the recent breeding season identified through cloacal examination and/or by tail-feather characteristics. This applies to both hand-reared and wild mallards.

ADULT: Any bird not identified as an immature. In this study, the only adults released were the breeders used for egg

production. These adults were released each year at the termination of egg laying.

RECOVERY RATE: The total number of bands reported recovered divided by the total number of banded birds released.

MORTALITY RATE: The percentage of birds alive at the start of a year that die in that year.

$$\frac{\text{Number dying in a given time interval}}{\text{Number alive at the start of that interval}}$$

The banding analysis deals primarily with immature birds, although the band recoveries from the released adult breeders will be discussed briefly in a separate section. The recovery and mortality rates presented in this report are "calculated rates" based on recovery data gathered essentially through 1953. They are subject to slight changes in subsequent years as additional recoveries are received.

Review of Literature Available After 1946

After the initiation of the Wisconsin studies in 1946, several papers appeared dealing with artificial mallard propagation. Höhn (1948), in analyzing recoveries for the European race of mallard, concluded that there was no reason to assume a difference existed in survival between wild and hand-reared mallards. This conclusion was based on 271 (not necessarily all) wild and 557 hand-reared band recoveries, obtained almost entirely by shooting. First-year mortality rates for both groups of birds, banded as juveniles, was 89 per cent. Hickey (1952a), after considering the ease with which *imprinting* is reported to occur in waterfowl, thought it pertinent to re-examine Höhn's data. Arranging the data to fit into a dynamic life table, Hickey found no difference in the first-year mortality rates for wild (89 per cent) and hand-reared (88 per cent) mallards, but showed that as adults, the known hand-reared birds had a 100 per cent mortality by the end of the second year as compared to 58 per cent by the end of the fifth year for wild mallards.

Hickey (1952a) also examined samples of hand-reared-mallard recoveries from various sources and for all years through 1938 in the U.S. Fish and Wildlife Service files at the Patuxent Research Refuge in Laurel, Maryland. His conclusions were that:

The per cent shot during the first year of life did not vary with the month of banding (June, July, or August).

The percentage of recoveries of birds shot differed markedly in the first year (82 per cent) from that of a small sample of wild-reared birds (68 per cent).

The hand-reared mallards may not attain an adult survival rate equal to the wild-reared mallard until the third year of life. By that time only 5 per cent of those reported were still alive.

The New York Conservation Department has made a number of studies directed at establishing and improving local mallard breeding populations through stocking hand-reared birds (Benson, 1939; Mason, 1947; Kutz, Mason and Taber, 1948; Darrow, 1949; Taber, 1949; Foley and Taber, 1951; Wells, 1951; Holm, 1953; Foley, 1954a, 1954b). They feel that their mallard breeding population has been successfully established in New York State as a result of their hand-reared releases. The comment has been made in some reports, however, that the major contribution of their releases has been to improve local hunting opportunities during the fall immediately following release (Taber, 1949; Foley and Taber, 1951). This is evident from an examination of their band-recovery data. The recovery rate was approximately 13 per cent, with 71 to 98 per cent of the recoveries occurring within 0 to 50 miles of the release sites during the first hunting season.

Brakhage (1953) compared the migration and mortality of mallards, pintails, redheads, and canvasbacks hand-reared from wild eggs with that of wild birds trapped at Delta, Manitoba. His conclusions were that the wild and hand-reared birds had similar migrational and homing tendencies, but that hand-reared birds were much more vulnerable to local hunting and had a consistently higher mortality rate. He concluded that artificial propagation with hand-reared birds from wild eggs should not be recommended as a management technique.

The Pennsylvania Game Commission at the present time has established a mallard-rearing project that dwarfs any previously reported study. Started in 1951, production zoomed to 7,100 birds in 1953 and 8,500 birds in 1954. According to a preliminary report (McGill, 1954), the reported recovery rate was approximately 14 per cent.

In none of the recent studies is there any mention of the cost of production of the released birds.

Presented in Table 4 is a summary of some banding and recovery data for the major studies on hand-reared mallards. Data from the early studies and from the Wisconsin studies described in this report are presented for comparative purposes.

Number Banded and Recovered

Table 5 presents the total number of band reports whether recaptures or recoveries for birds released at the major sites in the Wisconsin

TABLE 4

A Summary of Banding and Recovery Data for Major Hand-Reared Mallard Studies, 1934–1954

Type Bird [1]	Location	Number Banded	Recovered		Per Cent Reported 1st Year [2]	Minimum Per Cent Recovered Within 50 Miles	Source and Year
			No.	Per Cent			
HR	Iowa	350	3	1	0	100	Errington and Albert, 1936
HR	N. Y., Penn., Conn., Calif.	3,500	-----	1.5	-----	-----	Lincoln, 1934
HR	England	-----	557	-----	89	-----	Höhn, 1948
HR	Pennsylvania	15,600	-----	14.0	-----	-----	McGill, 1954
NY	New York	336	14	4	100	71	Foley, 1954b
NY	New York	426	30	7	87	97	Foley and Taber, 1952
NY	New York	160	-----	8	-----	-----	Foley, 1954b
NY	New York	250	32	13	100	82	Taber, 1949
NY	New York	773	141	18	95	98	Foley and Taber, 1951
NY	New York	-----	921	-----	78	-----	Mason, 1947
W	New York	244	14	6	100	64	Foley, 1954b
W	Delta, Manitoba	2,007	204	10	91	49	Brakhage, 1953
NY x W	New York	221	18	8	100	61	Foley, 1954b
W x D	Wisconsin	10,731	2,791	26.9	94.3	84.6	This Study

[1]HR—Hand-reared mallard of unknown genetic origin.

NY—Hand-reared mallard of domestic stock, selectively inbred to closely resemble the wild mallard in physical appearance. Known as New York mallard.

W—Mallard hatched from a wild egg, but hand-reared.

NYxW—Hand-reared mallard hybrid resulting from cross of New York and hand-reared mallard reared from wild egg.

WxD—Hand-reared mallard hybrid resulting from cross of wild mallard and domestic mallard.

[2]The figures in this column are an approximation of the bird's first-year mortality rate, largely due to shooting. These figures will be reduced slightly in later years as more recoveries occur. Also, since immature mallards are more vulnerable to gunning than are adults, these calculated mortality rates have a bias which tend to make them high.

studies. The reports represent approximately 27 per cent of the birds released. From a review of the literature on previous studies of hand-reared mallards (Table 4), the reported recovery rate has ranged from one per cent (Lincoln, 1934; Errington and Albert, 1936) to 14 per cent (McGill, 1954). The recovery rate in the Wisconsin studies was approximately twice as great as that reported in any previous study.

In examining the data for individual banding stations in Table 5 the question rises as to why the Horicon and Goose Island areas have three times as many bands reported as the Wausau station. There are two reasons for this difference:

1. Except for the refuge releases, all the Horicon and Goose Island releases were made on well-known and heavily hunted public hunting and fishing grounds. The Wausau releases were not made on heavily hunted areas. The purely mathematical chance of a bird being shot was many times less for the Wausau releases.

2. There were hunter-bag-check stations maintained at the Horicon and Goose Island release areas and none at the Wausau release sites. Although these bag checks varied in intensity and duration with a resulting influence on the total number of band recoveries within years, approximately 47 per cent of the Horicon and 64 per cent of the Goose Island recoveries were obtained by the hunter-check method. As Kabat, Kozlik, Thompson and Wagner (1955) pointed out in evaluating Wisconsin pheasant-banding studies, the more intensive the checking method, the higher the band recoveries.

Table 5 also shows that there is a greater recovery rate for immature males than females. This difference is statistically significant. Why the males have a higher recovery rate is open to speculation. On the basis of hunter-bag-check information from Horicon Marsh for the years 1946 through 1953, there does not appear to be a selection, by hunters, of wild drake mallards (see Wisconsin Waterfowl Research Project 6–R Reports, Wisconsin Wildlife Research, Vols. 5–12). In fact, it would be difficult to determine the sex of some of the immature hand-reared mallards in flight because they would not be in complete adult plumage by the opening of the hunting season in early October. Cartwright (1945) and Murdy (1954) have suggested that in adult birds, males disperse more, and when pairing off for nesting merely go where the females lead them. Since the immature males are probably not paired in the early fall of their first year, they may move around more than the females with the result that there is a greater chance for them to be shot by hunters. There is also the possibility that the males are responding to a physiological condition similar to that causing

TABLE 5

Recoveries of Immature Male and Female Hand-Reared Mallards Banded in Wisconsin, 1949–1953[1]

Year	HORICON			GOOSE ISLAND			WAUSAU			TOTAL ALL STATIONS		
	Number Banded	Recovered No.	Per Cent	Number Banded	Recovered No.	Per Cent	Number Banded	Recovered No.	Per Cent	Number Banded	Recovered No.	Per Cent
1949												
Male	260	115	44	385	92	24	175	10	6	820	217	27
Female	19	12	63	412	127	31	191	7	4	622	146	24
1950												
Male	778	251	32	506	102	20	20	8	40	1,304	361	27.7
Female	564	149	26	508	99	20	14	3	21	1,086	251	23.1
1951												
Male	1,061	357	33.6	314	115	37	88	16	18	1,463	488	33.4
Female	699	178	26	362	126	35	69	11	16	1,130	315	27.9
1952												
Male	0	0	0	916	346	38	183	25	14	1,099	371	33.8
Female	0	0	0	658	202	31	200	20	10	858	222	26
1953												
Male	372	62	17	656	187	29	85	2	2	1,113	251	22.6
Female	236	45	21	514	124	24	126	0	0	876	169	19
Summary												
Male	2,471	785	31.8	2,777	842	30.3	551	61	11.1	5,799	1,688	29.1[2]
Female	1,518	384	25.3	2,454	678	27.6	600	41	6.8	4,572	1,103	24.1
Total	3,989	1,169	29.3	5,231	1,520	29.1	1,151	102	8.9	10,371	2,791	26.9

[1]Birds recaptured and recovered through February, 1954, are included in this table.
[2]Chi square test shows a significant difference at the 99 per cent confidence level from the total value for females.

the fall courtship display in prairie grouse and ruffed grouse, and the fall crowing of pheasants.

Hormone Experiments

Included in the totals presented in Table 5 but presented separately in Table 6 are the results of the hormone-feeding experiments conducted in 1950 and 1951. Thompson (1952) reported that the addition of one part per 10,000 of dienestrol diacetate in the diet of game-farm pheasant cocks released on public hunting grounds resulted in a 34 per cent recovery rate, in contrast to 29 per cent for similar untreated birds. In the experiment with hand-reared mallards, one-half of the birds were fed a diet containing 50 parts of dienestrol diacetate (dissolved in soybean oil) per 1,000,000 units of commercial poultry pellets. The other half of the birds served as controls.

As can be seen from Table 6, the hormone feeding did not significantly alter the total number of recoveries or the first-year mortality rate at the level of hormone fed. During the remainder of this study, it was not possible to explore further, at higher levels of feeding, the effects of dienestrol diacetate on survival and mortality. Since the percentage recovered and mortality rates for the hormone-treated birds are of approximately the same magnitude as for the nonhormone-treated (control) birds, the remaining tables in this report include data from both groups.

TABLE 6

Recovery Rate and First-Year Mortality Rate of Hormone and Control Groups of Hand-Reared Mallards[1]

	HORMONE			CONTROL		
Sex	No. Banded	Recovery Rate	First-Year Mortality Rate[2]	No. Banded	Recovery Rate	First-Year Mortality Rate[2]
Male	501	31%	86%	484	33%	92%
Female	489	27%	87%	421	27%	82%
Total	990	29%	86%	905	30%	87%

[1]A synthetic estrogenic hormone, dienestrol diacetate, dissolved in soybean oil was used.

[2]Since the total number of recoveries may increase slightly in the years subsequent to this calculation, the values for first-year mortality rates calculated here may be subject to a (slight) final revision downward. This would not, however, affect conclusions based on the comparisons shown here.

Types of Recoveries

The band reports analyzed in this study were obtained from a variety of sources, but largely by shooting during the hunting season. The major categories represented in the 2,797 band reports (Table 7) are shooting (2,743 recoveries), recaptures (10 re-trapped and released), killed in furbearer traps (16 recoveries), predator kills (6 recoveries), unknown cause of death (22 recoveries). The hunting season (shot-type) recovery for the Wisconsin studies, representing 98 per cent of all the bands reported, is even higher than the 92 per cent found by Mason (1947) in his analysis of New York hand-reared mallard data. Of the birds killed in furbearer traps, all but one occurred at the Horicon Marsh where an intensive muskrat share-trapping program is carried out by the State Conservation Department and the U.S. Fish and Wildlife Service.

Because there are so few recoveries from any type other than those reported shot by hunters, only the hunting-season recoveries will be considered in the remaining tables and discussion.

Interval of Time from Banding to Recovery

The hunting-season recoveries were examined for the interval of time, in years, from banding to recovery (Table 8). On the basis of the combined data from all stations, the first-year recoveries represented a very high 94.3 per cent of the 2,737 total shot-type recoveries analyzed. Station-to-station comparisons, although not completely valid, do reflect somewhat the conditions of the environment at the release sites. The relatively lower percentage of first-year recoveries for Horicon (90.8 per cent of all Horicon recoveries) in all probability reflects the lack of a complete freeze-up which allows some of the birds to remain over winter. The birds that remain are not subjected to further gunning pressure that would have occurred had they migrated down the flyway. There is also a possibility that some of the Horicon birds did not leave the refuge areas in which they were released until final freeze-up after the close of the Wisconsin hunting season and that at this time they joined the captive flock maintained at the state headquarters on Horicon Marsh where water remains open all winter. For all practical purposes, complete freeze-up occurs at the Goose Island and Wausau release sites. This means that the birds surviving the Wisconsin hunting season at these latitudes are forced to migrate south from the release areas or die. However, they need not go very far south for there are fair numbers of wintering waterfowl at several areas in southern Wisconsin.

TABLE 7

Major Types of Recoveries for Immature Hand-Reared Mallards Banded in Wisconsin, 1949–1953

Station	Shot (Hunting Season)			Retrap and Release		Fur-trap Kill		Predator Kill		Unknown		Total		
	Male	Female	Sex?	Male	Female	Male	Female	Male	Female	Male	Feamle	Male	Female	Sex?
Horicon														
Number reported	755	365	3	7	3	7	8	4	2	12	6	785	384	3
Per cent of total for each sex	96	95	100	1	1	1	2	1	1	1	1	100	100	100
Total number of male, female, sex?		1,123			10		15		6		18		1,172	
Per cent of total		95.8			0.9		1.3		0.7		1.5		100	
Goose Island														
Number reported	838	677	2	0	0	1	0	0	0	3	1	842	678	2
Per cent of total for each sex	99.5	99.9	100	0	0	0.1	0	0	0	0.4	0.1	100	100	100
Total number of male, female, sex?		1,517			0		1		0		4		1,522	
Per cent of total		99.7			0		0		0		0.3		100	
Wausau														
Number reported	61	41	1	0	0	0	0	0	0	0	0	61	41	1
Per cent of total for each sex	100	100	100	0	0	0	0	0	0	0	0	100	100	100
Total number of male, female, sex?		103			0		0		0		0		103	
Per cent of total		100			0		0		0		0		100	
All Stations														
Number reported	1,654	1,083	6	7	3	8	8	4	2	15	7	1,688	1,103	6
Per cent of total for each sex	98	98.2	100	0.4	0.3	0.5	0.7	0.2	0.2	0.9	0.6	100	100	100
Total number of male, female, sex?		2,743			10		16		6		22		2,797	
Per cent of total		98.1			0.3		0.6		0.2		0.8		100	

TABLE 8

Hunting-Season Recoveries of Immature Hand-Reared Mallards Banded in Wisconsin, 1949–1953[1]

Station	1st Year		2nd Year		3rd Year		4th Year		5th Year		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Horicon												
Number reported	700	317	42	40	8	6	5	2	0	0	755	365
Per cent of total for each sex	93	87	5	11	1	1	1	1	0	0	100	100
Total number	1,017		82		14		7		0		1,120	
Per cent	90.8		7.3		1.3		0.6		0		100	
Goose Island												
Number reported	810	654	23	17	4	3	1	3	0	0	838	677
Per cent of total for each sex	96	97	3	3	1	0.5	0	0.5	0	0	100	101
Total number	1,464		40		7		4		0		1,515	
Per cent	96.6		2.6		0.5		0.3		0		100	
Wausau												
Number reported	60	41	1	0	0	0	0	0	0	0	61	41
Per cent of total for each sex	98	100	2	0	0	0	0	0	0	0	100	100
Total number	101		1		0		0		0		102	
Per cent	99		1		0		0		0		100	
All Stations												
Number reported	1,570	1,012	66	57	12	9	6	5	0	0	1,654	1,083
Per cent of total for each sex	94.9	93.4	4.0	5.3	0.7	0.8	0.4	0.5	0	0		
Total number	2,582		123		21		11		0		2,737	
Per cent	94.3		4.5		0.8		0.4		0		100	

[1]Not included on this table are six hunting season recoveries for birds of unknown sex.

The large per cent of first year recoveries in combination with a high total recovery rate for the Horicon and Goose Island stations further emphasizes the heavy gunning pressure and the more intensive methods used to secure band recoveries. The lower total recovery and high per cent of first-year recoveries for the Wausau birds indicate poor first-year survival and high vulnerability of the surviving birds. Poor survival could be due to lower quality pen-rearing conditions and poorer habitat at the release sites. The higher vulnerability probably was due to the greater association with man at the rearing site.

Location of Recovery

The geographic distributions of the first-year and subsequent hand-reared-mallard band recoveries from this study are presented in Appendix A, Figures 4–8. The high degree of vulnerability, as shown by the first-year mortality rate, is probably also reflected in the distribution of the recoveries inside and outside of Wisconsin. The series of maps showing the first-year recoveries (Appendix A, Fig. 4–6) readily illustrate this tendency. The bulk of the recoveries occurred within the county or a 20-mile radius of the release point.

Jahn (unpublished data) determined, through an intensive statewide waterfowl migration survey, that there are four major migratory flight lanes in Wisconsin (Appendix A, Fig. 11). Fall waterfowl migrations in Wisconsin, although occurring on a broad front, tend to funnel down major river valleys and along the Lake Michigan shore. Over 98 per cent of all band recoveries occurred in the counties through which the important migratory flight lanes pass. Apparently, the hand-reared mallards migrate from the release areas in a rather random pattern but upon intersecting one of these flight lanes there is a tendency for the birds to follow its course. The direction of the migration is usually southerly but a few birds did move north. This phenomenon of late-summer northerly movement occurs in immature wild birds as well.

Radius of Recovery

In conjunction with the location of a recovery, those occurring at specified distances from the release sites are presented in Table 9. Because of its proximity to the State of Minnesota, the Goose Island station posed a problem in defining a "local" recovery. From observations made on the fall stubble-feeding flights of wild ducks in the vicinity of Horicon Marsh, it was determined that the majority of daily movements to and from the area were included within a 20-mile radius of the marsh. Therefore, arbitrarily included as occurring at the Goose Island release site, were those recoveries occurring in Minnesota within

a 20-mile radius of the Goose Island station. Movements at the Goose Island release sites were more likely to occur on an elongated axis, up and down the Mississippi River, rather than inland.

Eighty-seven per cent of the first-year recoveries occurred within the 20-mile radius of all the release sites. The degree of recovery within prescribed distances from the release sites has been thoroughly investigated in a number of other studies on hand-reared mallards. To sum up these findings (also see Table 4), from 78 to 100 per cent of all recoveries occurred the first year, and of these, 61 to 100 per cent occurred within 50 miles of the release site.

In this study, 40 per cent of all the subsequent recoveries occurred in the 0- to 20-mile radius. This is understandable for the Horicon station because some of the birds can overwinter in the vicinity of Horicon. Such, however, is not true for the Goose Island area. The relatively high subsequent recovery rate at the release sites does not necessarily mean that the birds "home" to the release sites. If a larger per cent of the returning birds were females, homing might be suspected. This was not the case. There is, apparently, some attraction for the birds at the release site during the fall migration period. A possibility may be the protection offered by the refuge areas in the vicinity. If ducks tend to return annually to the same areas during fall migration as Crissey (1955) has speculated, then the high number of subsequent recoveries occuring within the 0- to 20-mile radius is not surprising.

Of interest in relation to the Goose Island station is the distribution of the recoveries beyond the 20-mile radius (Table 9). Approximately twice as many first-year and subsequent recoveries occurred in Minnesota as in Wisconsin. Although the bulk of the recoveries for both states occurred along the Mississippi River, more interior recoveries were reported from Minnesota. Possibly the more extensive inland aquatic habitat in Minnesota may be attracting more of these ducks. In relation to this westward drift from Wisconsin, it should be pointed out that the same pattern also exists for wild ducks banded in the fall in northern Wisconsin in the years 1946 through 1949 (unpublished data).

Because the first-year recoveries occurring within 0 to 20 miles of the release site were so great, we suspected that most of these recoveries occurred at the release site itself. It was possible to attack this problem at the Horicon station by determining the portion of voluntary recoveries that occurred directly on Horicon Marsh as compared to those occurring in surrounding areas. For all practical pur-

TABLE 9

Recoveries Occurring at Specified Distances from the Release Sites for Immature Hand-Reared Mallards Banded in Wisconsin, 1949–1953[1]

Station	Number of Recoveries	Per Cent of Each Sample: Wisconsin Recoveries 0–20 Miles	20–40 Miles	40–60 Miles	60–100 Miles	Over 100 Miles	Total	Foreign	Total
Horicon									
First-year	1,015	86.1	4.3	3.3	0.5	0.2	94.4	5.6	100
Subsequent	102	43	7	5	3	4	62	38	100
Subtotal	1,117	82.1	4.6	3.5	0.7	0.5	91.4	8.6	100
Wausau									
First-year	101	83	5	3	4	3	98	2	100
Subsequent	1	0	0	0	0	0	0	100	100
Subtotal	102	81	5	3	4	3	96	4	100
		Wisconsin 0–20	Wisconsin All Others	Minnesota 0–20	Minnesota All Others				
Goose Island[2]									
First-year	1,464	84.1	2.5	4.3	5.1			4	100
Subsequent	51	35	12	1.0	20			31	99
Subtotal	1,515	82.4	2.8	4.2	5.7			4.9	100
		0–20 Miles	All Other Wisconsin Plus Goose Island in Minnesota						
All Stations									
First-year	2,580	87.1	8.3					4.6	100
Subsequent	154	40	23					36	99
Total	2,734	84.6	9.1					6.3	100

[1]Not included in this table because of unknown location of recovery area are: one subsequent and two first-year recoveries from the Horicon banded birds.

[2]The Goose Island release sites were located on the Mississippi River between Minnesota and Wisconsin. Therefore, the area available for recovery was considered as approximately equal for comparative purposes.

poses, recoveries occurring within 0 to 10 miles of the release site represented the Horicon Marsh. Beyond the 10-mile radius but within the 0- to 20-mile radius, are four fairly good, large-sized waterfowl concentration areas. These are Beaver Dam Lake, Fox Lake, Lake Sinissippi, and Lake Maria (Fig. 3). From the 479 first-year voluntary recoveries occurring in the 0- to 20-mile radius, 93 per cent of these occurred within the 0- to 10-mile radius, or at the Horicon Marsh proper. There was no difference existing in the recovery rates between sexes. Although this refinement could not be made for other release sites, the data serve to emphasize the sedentary behavior and the extremely high vulnerability of the hand-reared mallard at the release site.

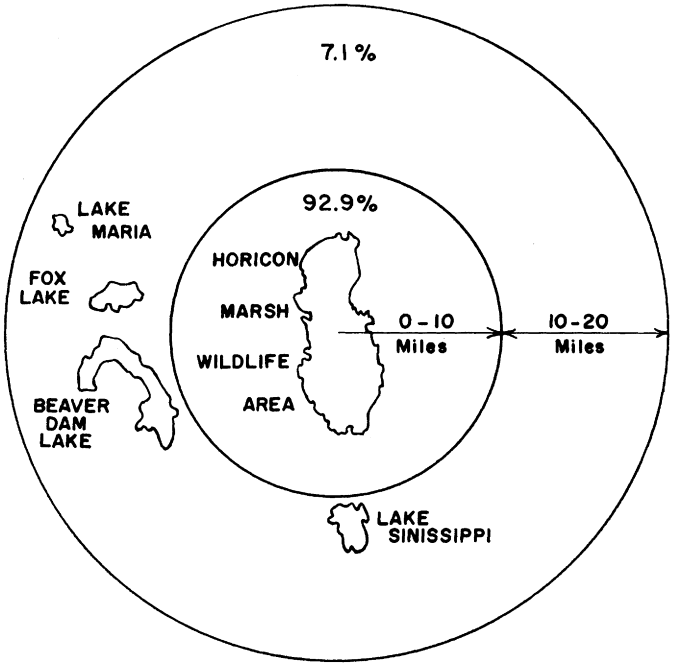


Figure 3. The percentage of 479 voluntary, first-year, hunting season recoveries occurring at given distances from Horicon Marsh.

Variation in Recovery by Month of Banding

In a large-scale artificial-propagation project in which hatching and releasing occurs over several months, there will be a considerable difference in the age of the birds by the opening date of the waterfowl

hunting season. The fact that immature birds of a huntable species are more vulnerable to the gun than adults has been suggested many times by the consistently higher immature mortality rates. There is also the possibility that immatures exhibit a difference in vulnerability in the first year of life depending on their age in months at the time of the

TABLE 10

Band Recoveries and Mortality Rates of Immature Hand-Reared Mallards for each Month of Banding[1]

	June	July	August	Sept. & Oct.	Total
Number banded	1,602	4,896	2,249	82	8,829
Per cent recovered	27.2	24.9	32.0	37.0	27.2
Calculated first-year mortality rate	95.6	91.2	98.5	100.0	94.3
Per cent first-year recoveries taken within 0–20 miles	82.6	83.4	95.4	100.0	93.8

[1]Excludes the known refuge-released birds.

hunting season. This hypothesis was tested by examining the band recoveries occurring for each month of banding. These data are given in Table 10.

Hickey (1952a), in examining samples of hand-reared mallards in the national banding files, stated that "the percentage shot during the first year of life did not vary with the month of banding (June, July, and August)." In the much larger series of Wisconsin data, as the age of released birds decreased with respect to the period of time from hatching to the opening of the hunting season, there was an increase in the recovery rate, an increase in the calculated first-year mortality rate, and an increase in the percentage of the first-year recoveries in the vicinity of the release sites. Kabat *et al.* (1955) found in an evaluation of Wisconsin pheasant stocking that the nearer the stocking period was to the opening of hunting, the higher the rate of recovery. They pointed out, however, that the increased costs of holding pheasants longer before release may nullify the eventual dollars and cents values of the higher recovery rate of later releases. This would undoubtedly also be true of a duck-propagation program.

There are several reasons why the older birds (early releases) may appear to be less vulnerable in the hunting season. They have a longer period of time to adjust to their environment. They also have a longer time to associate with wild ducks. There is also the possibility that

the early releases may move farther away from the release sites before shooting starts and hence would not be subjected to the heavy hunting pressure at the release sites or the intensive methods used there to secure band recoveries.

Refuge and Public Hunting Grounds Releases

In conjunction with the regular releasing of hand-reared mallards, groups of birds were released simultaneously in refuge areas and on public hunting grounds. At the Horicon and Goose Island stations, the objective was to test the value of a large (1,500 acres or more) refuge as a release site. If a refuge protected the birds from the initial blasts at the opening of the waterfowl hunting season and prolonged or even reduced the over-all kill, then refuge releases might well become a standard technique for future stocking programs. Because the value of a refuge in relation to this type of project is of primary importance in the first year of release, only the first-year recoveries have been examined in detail.

Data in Table 11 indicate that refuges, as release areas, are of value in reducing the percentage recovered in the first year, in lowering the recovery rate in the vicinity of the release site, and in distributing the recoveries over a greater portion of the hunting season. Refuge releases also resulted in a greater percentage of first year foreign recoveries. This may or may not be a desirable characteristic, depending on the objective of the project. Because refuge releases resulted in a 40 per cent lower first-year recovery rate, when compared to public-hunting-grounds releases, more birds may survive to nest in subsequent years. On the other hand, the foreign recoveries are made by persons not contributing financially to the program. The birds shot in other states are an unavoidable financial loss to a project stressing stocking for local shooting purposes. Regardless of whether the birds are shot by hunters the first year, or return north to nest in later years, there is a greater contribution to the flyway population through refuge releases than through public-hunting-grounds releases.

Refuges may serve another function by offering a differential degree of protection to different-aged immature mallards. As was shown in Table 10, birds released in June and July, which were older when the hunting season opened, were less vulnerable than birds released in August or later. On the basis of this information, an examination was made of the refuge and public-hunting-ground releases for the major months of banding (June, July, and August) in relation to months of recovery during the hunting season. These data (Table 12) show that

TABLE 11

First-Year Local and Foreign Recoveries for Immature Hand-Reared Mallards Released in Refuge and Public Hunting Areas

	Refuge	Public Hunting Grounds
Number banded	1,545	1,425
First-year recovery rate	20%	28%
Per cent of recoveries within 0–20 miles:		
Opening weekend	45 (55) [1]	57 (64) [1]
Balance of October	17 (20)	19 (22)
November	20 (25)	12 (14)
Sub-total	82 (100)	88 (100)
Per cent Wisconsin recoveries over 20 miles:	2	4
Per cent foreign recoveries:		
October	9 (56)	7 (79)
November	3 (20)	1 (15)
December	3 (16)	0.5 (3)
January	1 (8)	0.5 (3)
Sub-total	16 (100)	9 (100)
Grand total	100%	101%

[1]Figures in parentheses indicate the per cent for each time period within the sub-totals.

refuges offer protection for August-released birds which are the youngest and most vulnerable.

Releases of Wisconsin hand-reared mallards in refuge areas, particularly the late-hatching groups, definitely resulted in a lower rate of recovery as compared to public-hunting-grounds releases.

Fate of Released Adult Breeders

The hand-reared-mallard breeding stock of each year was released at the termination of egg laying, and new breeders acquired for the next year as described under the section of techniques. The adult breeders were released on refuge areas. An attempt was made to determine the fate of these breeders through banding. Because of the circumstances surrounding their breeding activities, no precise comparisons could be made between the recovery data for the adult breeders and the immature hand-reared and wild mallards. In the first place, the adult breeders were wing-clipped to insure their staying in the breeding pens. At the time of their release in early June, there were still several weeks before they completed the postnuptial molt. The

TABLE 12

First-Year Monthly Hunting-Season Recoveries for Immature Hand-Reared Mallards Released in Different Months on Refuges and Public Hunting Areas

	Month Released			Three-Month Total
	June	July	August	
Refuge				
Number banded	362	1,014	168	1,544[1]
First-year recovery rate	22%	16%	17%	17%
Per cent of first year recovery by month				
October	82	70	45	71
November	13	25	45	23
December	5	5	10	6
Total	100	100	100	100
Public Hunting Grounds				
Number banded	321	831	271	1,423[1]
First-year recovery rate	31%	23%	28%	26%
Per cent of first-year recovery by month				
October	91	81	83	84
November	8	18	17	15
December	1	1	0	1
Total	100	100	100	100

[1]These values appear also in Table 11 and differ slightly because a few recoveries could not be classified into all categories.

power of flight was not regained until completion of the molt. Actually, these females had never experienced unlimited flight because they were held in covered pens as immatures until the primary flight feathers were developed, then wing-clipped and released in the 11-acre breeding enclosure. The males, however, were wild birds and had known true flight. Wing-clipped birds would definitely be at a disadvantage regardless of the time or place of release. Furthermore, the released birds had just completed an extended breeding period which was much more exhausting than that normally experienced by wild birds. The physiological strain resulting from being held for 50 to 60 days in the breeding pens undoubtedly lowered the general physical condition of these birds a great deal.

New York studies by Mason (1947) demonstrated that there was no difference in the mortality rates for hand-reared mallards whether released as adults or immatures. Even though the Wisconsin adult

breeders were wing-clipped when released, they did survive and were recovered at approximately the same rate as the immature Wisconsin hand-reared mallards released under much more optimal conditions (Table 13). It is obvious that despite the severe handicaps imposed by the breeding season, the adult birds survived and gained the power of flight in reasonably good numbers following the postbreeding-season molt.

TABLE 13

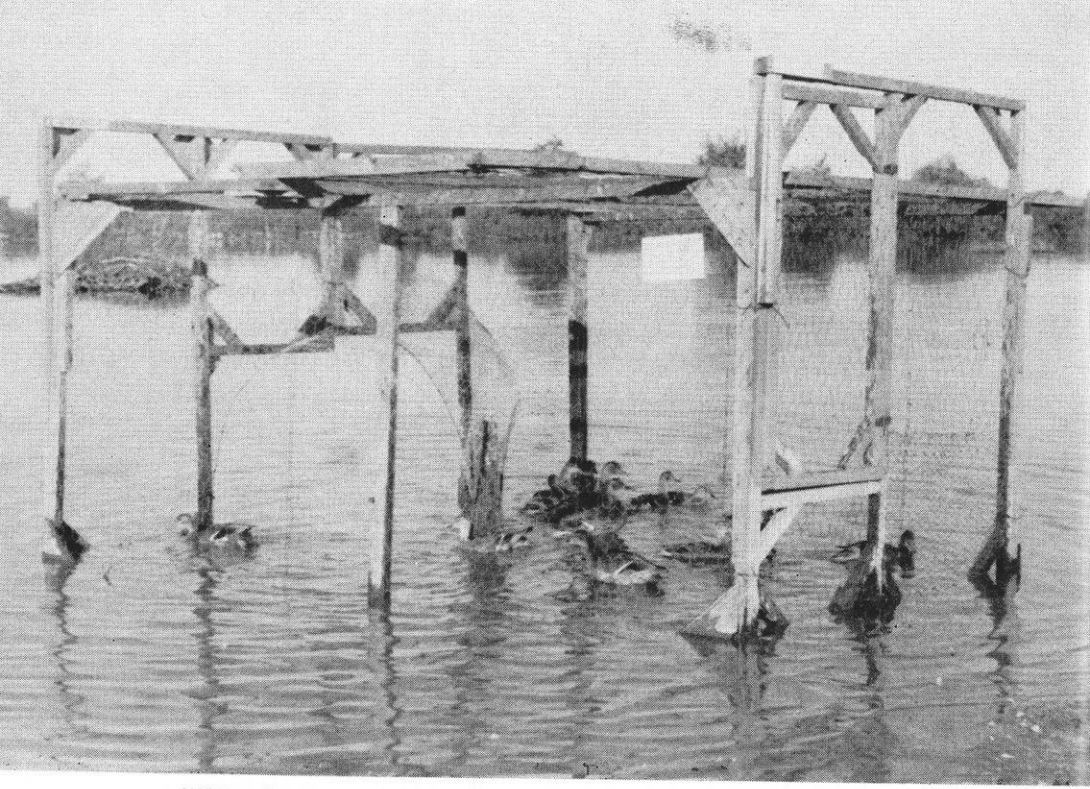
Banding Statistics Concerning Some of the Adult Mallards Used as Breeders, 1950 through 1953

	Adult Male (Wild)		Adult Female (Hand-Reared)	
	No.	Per Cent	No.	Per Cent
Total banded	82	---	677	---
Total recovered	14	17	206	30
Hunting-season recoveries	14	100	192	92
1st year	14	100	189	98
2nd year	0	0	3	2
All other years	0	0	0	0
Recovered at release site	13	93	183	95
Foreign recoveries (all years)	1	---	7	---
Time of First-Year Hunting-Season Recoveries:				
Opening weekend	9	64	117	62
Remainder of October	2	14	33	18
November	2	14	27	14
December	0	0	1	1
Unknown date	1	7	11	6
Total	14	99	189	101

A Comparison With Wild Mallards

In making the comparisons of wild and hand-reared mallards, only the immature wild-mallard hunting-season recoveries from birds banded at Horicon Marsh from July through September for the years 1949 through 1951 are considered. The hand-reared mallard recoveries are from the entire Wisconsin study period of 1949 through 1953.

There is no significant difference in the percentage of the bands recovered for immature wild and hand-reared mallards, 23 per cent and 26 per cent respectively (Table 14). These results are considerably higher and the difference between them is much smaller than the 10.1 per cent for hand-reared mallards hatched from wild eggs and the 15.8 per cent for wild mallards as found by Brakhage (1953) at Delta, Manitoba. The similarity in total recovery is, however, the only



Wild mallards were trapped at Horicon Marsh from July through September. Band recoveries from these birds provided important comparative information which aided in the evaluation of the hand-reared mallard program.

similarity between the two types of Wisconsin birds. The hand-reared mallard shows a much higher percentage of recovery in every other category of comparison except, of course, in the subsequent recovery rate. That the hand-reared mallards are considerably more vulnerable to hunting is shown in the comparisons of the first-year recovery rates and in the percentage of recoveries that occurred in the 0- to 20-mile radius. The hand-reared mallards were recovered at a 47 per cent greater rate the first year and a 77 per cent greater rate in the 0- to 20-mile radius.

Table 15 presents the recoveries by years. The fact that a known minimum of approximately 50 per cent of all the first-year hand-reared-mallard recoveries occurred on the opening weekend of the hunting season—a rate almost two times greater than that for wild mallards—may be explained by the birds' attitude toward humans. Observations made at the release sites showed that some of the hand-reared birds, even beyond flying age, had little fear of man or boat. This would probably be true whether the bird had remained or moved off the release sites. The lack of fear of man and consequently higher vulnerability of hand-reared mallards to hunting emphasizes the value of wild

TABLE 14

A Comparison of Some Hunting-Season Band-Recovery Statistics for Immature Hand-Reared and Wild Mallards Banded in Wisconsin from 1949 to 1953

	All H-R Mallards	Horicon H-R Mallards	Horicon Wild Mallards
Number recovered	2,737	1,120	214
Per cent recovered	26	28	23
First-year recovery rate	25	26	17
Subsequent recovery rate	1	2	6
Per cent recovered in Wisconsin	91	91	62
Of first-year birds	95	94	79
Of subsequent-year birds	63	61	45
Per cent recovered in 0–20 miles	84	82	43
Of first-year birds	87	86	49
Of subsequent-year birds	40	43	20

adult "training" that immature wild mallards receive during the rearing period.

Boyd (1954), in a detailed analysis of recoveries of mallards banded in England, observed that the high vulnerability of British hand-reared mallards was affected by (1) the shooting pressure at the release site, (2) the amount of local movement, and (3) the lack of migration in the usual sense. He concluded that the high mortality of the hand-reared mallards was due to their *sedentary* habits; "reared for shooting they get shot; reared with protection, they survive exceptionally well." Observations on Wisconsin hand-reared mallards in general agree with Boyd's findings.

Migration, however, did take place in a normal manner in Wisconsin hand-reared mallards. This difference in migration is probably due to the fact that Boyd's studies were conducted in a climate suitable for birds to remain throughout the year while in Wisconsin most water areas freeze over and force the birds to migrate. The high first-year mortality rate of the Wisconsin hand-reared mallards was due partly to their sedentary behavior and to local hunting pressure but primarily to the tameness of the birds acquired through rearing.

The figures in Table 15 also emphasize the scarcity of subsequent recoveries for hand-reared mallards. Bellrose and Chase (1950) pointed out that subsequent recoveries are dependent upon two factors (1) the number of birds left alive to be bagged and (2) the shooting pressure.

TABLE 15

Distribution of Hunting-Season Recoveries of Immature Hand-Reared and Wild Mallards 1949 to 1953

	No. of Band Recoveries	Percentage Distribution in Years Following Release						
		1st		2nd	3rd	4th	5th	Total
		Opening Weekend	Total					
All Stations (Hand-reared)	2,737	48.0	94.3	4.5	0.8	0.4	0.0	100.0
Horicon (Hand-reared)	1,120	50.0	90.8	7.3	1.3	0.6	0.0	100.0
Horicon (Wild)	214	27	77	16	5	1	1	100

Jahn and Bell (unpublished) compiled some hunting-pressure statistics for Horicon Marsh which showed that the hunting pressure more than doubled on the area during the period 1949 through 1953. Opening-day hunting pressure in each year was the greatest for any single day of the entire hunting season. On this day almost every acre of the approximate 5,500 acres of good marsh land available to waterfowl was covered by one or more hunters. The trend in increased hunting pressure has occurred at the other release sites as well. This information indicates why so many hand-reared mallards released on the public hunting grounds in Wisconsin are shot on opening weekend.

In addition, reward-band studies on wild mallards at Horicon Marsh, where hunter-check stations were also maintained, showed that reward-banded birds were reported at a 2.8 times greater rate than were regular-banded birds. When it is considered that (1) a greater recovery of hand-reared mallards may be occurring than is actually recorded, (2) they are subject to heavy hunting pressure at the release sites, and (3) crippling loss is taking place, it is surprising that there are as many subsequent recoveries as do exist for hand-reared mallards.

Another means of comparing hand-reared and wild mallards lies in the determination of migration patterns. The location of hunting-season recoveries is shown in Appendix A, Figures 4–10. The distribution of recoveries, both state-wide and on a flyway basis, shows close correlation for the hand-reared and wild mallards.

In Table 16, the first-year and subsequent recoveries are presented by flyways, with 100 per cent of the wild mallard and 99.6 per cent of the hand-reared-mallard first-year recoveries occurring in the Mississippi Flyway. Brakhage (1953) found similar results for first-year recoveries of hand-reared birds hatched from wild eggs and wild mallards banded as immatures at Delta, Manitoba. There is a slight difference in the distribution pattern for first-year and subsequent recoveries for both wild and hand-reared birds, particularly with respect to the out-of-state recoveries (see Appendix A, Figures 4–10). This is to be expected since the subsequent recoveries are from adult birds that may have migrated into Canada for the breeding season. Although not presented in this report, the data show that there were no marked differences in the patterns of recovery between sexes. The females were as inclined to migrate north as were the males.

On the basis of comparative mortality rates for each year, Hickey (1952a) showed that hand-reared mallards had an apparently greater first-year mortality rate and that they did not reach a wild-mallard rate until the third year of life, at which time only 5 per cent of those

TABLE 16

Occurrence of Band Recoveries of Immature Wild and Hand-Reared Mallards in the Continental Waterfowl Flyways

	Recoveries by Flyway						Total Number
	Mississippi		Central		Atlantic		
	No.	%	No.	%	No.	%	
Wild mallard							
First year	164	100	0	----	0	---	164
Subsequent	44	90	5	10	0	---	49
Total	208	98	5	2	0	---	213
Hand-reared mallard							
First year	2,579	99.6	2	0.1	8	0.3	2,589
Subsequent	141	93	7	5	3	2	151
Total	2,720	99.2	9	0.4	11	0.4	2,740

reported remained alive. Table 17 compares the calculated mortality rates for Wisconsin wild and hand-reared mallards. It is highly probable that the differences in the calculated first-year mortality rates are due to the much higher vulnerability of the immature hand-reared mallards to hunting. In the Wisconsin studies, adult mortality rates were similar for both groups of birds. In fact, the adult hand-reared-mallard mortality rate was similar to the wild-mallard rate in the second year of life. Survival after the second year was about 4 per cent of those reported alive at the start.

Hickey (1952b), in examining continent-wide samples of wild mallards in the U.S. Fish and Wildlife Service files, grouped the recoveries on a north-south gradient, and demonstrated that differences exist in adult and immature hunting mortality for the months of the hunting season. Adult mortality occurred in a unimodal distribution pattern with a peak in November of 44 per cent, while immature mortality occurred in a pattern heavily skewed toward September and October, which accounted for 45 per cent of the total reported loss.

The monthly distribution of hunting-season recoveries for Wisconsin wild and hand-reared mallards is presented in Table 18. From an examination of these data it is evident that both types of Wisconsin birds were much more vulnerable in October, both as adults and immatures. Direct comparisons with Hickey's data are not valid because of different banding periods, and the absence of any September gunning pressure in the United States during the period of our study. In addition to the subjection of the immature birds to hunting for the first time in their lives and the adults again after a nine-month period, the two other factors which probably account for the skewed distribution in the Wisconsin data, are (1) the very heavy hunting pressure on Horicon Marsh and Goose Island, particularly on opening weekend, and (2) the presence of hunter-bag-check stations at these release sites as a means of securing additional band recoveries. It is also evident from Table 18, that the immature hand-reared birds are more vulnerable in October than immature wild mallards, that both types of immature birds are more vulnerable than the adults, and that the hand-reared birds surviving to the adult stage apparently have learned to react to hunting in a fashion similar to adult wild mallards.

Nesting Behavior

There were a number of nesting recaptures of hand-reared mallards recorded in the vicinity of the Horicon rearing station that seem worthy of discussion. At the time this project was conducted, there was no

TABLE 17

Mortality Rates for Wild and Hand-Reared Mallards Banded as Immatures in Wisconsin from 1949–1953 and Recovered in the Years 1949–1955 Inclusive[1]

Age Interval (Years)	Banded Birds Available	Number Recovered	Number Recovered (Shot) Per 1000 Banded Birds Available for Study	Number Alive at Start of each Age Interval (Per 1000 Banded)	Mortality Rate
Wild Mallards					
0–1	958	166	173	231	75%
1–2	958	32	33	58	
2–3	958	12	13	25	
3–4	958	8	8	12	58%[2]
4–5	958	4	4	4	
5–6	414	0			
6–7	144	0			
Hand-reared Mallards					
0–1	10,371	2,585	249	273	91.4%
1–2	10,371	146	14	24	60 %
2–3	10,371	43	4	10	
3–4	8,382	25	3	6	
4–5	6,425	10	2	3	52 %[2]
5–6	3,832	3	1	1	
6–7	1,442	0	0	0	

56%[2]

[1]The mortality rates calculated in this table include the 1949–1953 data from the IBM analysis, and in addition, 8 wild and 75 hand-reared mallard recoveries received from the 1954 and the 1955 waterfowl hunting seasons. Because a few additional recoveries may still occur, the first-year mortality rates calculated here may be reduced slightly in future years.

[2]Adult mortality rates.

practical technique available for conducting an extensive nesting study on areas of many square miles of waterfowl nesting habitat. Therefore, no special efforts were directed toward finding nests of hand-reared mallards at the release sites. However, 17 nests of banded females, 15 of which were originally released at Horicon Marsh, were found incidental to other activities. The question immediately arises: Do any of these nesting records indicate "homing"?

If the generally accepted theory of homing requires that there must be a movement away from the release site and a return to that site in some subsequent migration period, then these nesting records do not necessarily constitute homing, although it cannot be ruled out entirely. As pointed out previously, there is not a complete freeze-up of waters in the vicinity of Horicon. Consequently, some hand-reared birds could spend the entire winter in the vicinity. A small number of released birds were known to have wintered with the Horicon captive flock. The nests which were found, and from which the females were captured to read the band numbers, were the obvious ones located around buildings or in the 11-acre enclosure. There is a very strong probability that these nests were from birds that had wintered with the captive flock or in the immediate vicinity.

The nesting records are of value because they indicate that some of the hand-reared mallards are capable of nesting and rearing young outside the 11-acre enclosure (in areas where blue-winged teal and wild mallard nests have also been found). Of the 17 hand-reared nests found, 12 were from females banded the previous year, one was from a female banded two years previously and four were from females banded three years previously. Two nests were from females used as breeders at Horicon; these two were released as adults at Goose Island and returned to Horicon to nest the following year.

The 15 nesting females also demonstrated to some extent the acquired behavior of the acceptance of man in their immediate evironment. The nests that were found were in poorly selected sites along the edges of buildings or fence lines. One nest was under the steps of the front door of the main office of the Horicon state headquarters through which many people passed daily. Some of the other nests, because they were poorly concealed, were eventually subjected to predation. Perhaps the choice of poor nest sites and the lack of wariness, even as adults, indicates the highly vulnerable nature of this type of bird to all decimating factors.

TABLE 18

Monthly Frequency of Hunting-Season Mortality for Adult and Immature Hand-Reared and Wild Mallards[1]

	Number of Recoveries	Per Cent of Recoveries by Months					Total
		Sept.	Oct.	Nov.	Dec.	Jan.	
Recovered as immatures							
Hand-reared							
Wisconsin (1949–1953)	2,111	0	79	19	2	0	100
Wild-trapped							
Wisconsin (1949–1953)	140	0	71	23	6	0	100
U. S. and Canada (1925–1946)[2]	610	11	33	34	19	3	100
Recovered as adults							
Hand-reared							
Wisconsin (1950–1953)	136	1	51	31	9	8	100
Wild-trapped							
Wisconsin (1950–1953)	42	0	55	31	9	5	100
Mississippi Valley (1939–1947)[2]	3,033	6	31	36	22	5	100

[1]The term adult in this table refers to the age of the birds at the time recovered. The Wisconsin birds were originally banded as immatures, but the recovery occurred after September 1 of the year following release.

[2]From Hickey, 1952b. The hunting seasons during this period opened in September much more frequently than in recent years.

Cost

Table 19 presents the cost of production for the Horicon rearing station for the year 1952. It cost $2.04 to produce a 30-day-old mallard duckling. We realize that a large-scale project might reduce the cost per bird under the various headings in Table 19. Kabat *et al.* (1955) reported that in Wisconsin 10- to 12-week-old summer-released pheasants could be put in the field for approximately $1 ($0.97–$1.13) per bird. However, the pheasant program in Wisconsin is a large-scale operation, with approximately 250,000 birds produced annually.

Since we recognize that the cost of mallard production is related to the number of eggs produced per female, we are faced with a peculiar situation. In our studies, the average egg production per female was 18 and never exceeded 22 in any one year. If egg production per female is related to the degree of wildness maintained in the breeding flock, as suggested by Holm (1953), greater egg production could be obtained but at the sacrifice of genetic quality. In fact, there would probably have to be a substitution of more domestic-type birds as breeders. Increasing the size of the breeding flock probably would not substantially decrease the cost of maintaining each breeder if the annual average egg production remained in the vicinity of 18 eggs per female. When one considers that costs of production are dependent on total egg production, the constant use of new wild drakes as breeders does not seem to be an economical practice.

Although the chance of recovering the $1 pheasant in Wisconsin is very good—the average hunting season recovery for four years was 51 per cent—this is not as true for the $2.04 mallards. At least 6.3 per cent of all the recoveries occurred beyond the boundaries of Wisconsin, and an additional 4.3 per cent of the local Goose Island recoveries were in the 0- to 20-mile radius in Minnesota. When one considers the number of unreported bands (between 2 and 3 times the reported recovery away from checking stations), this becomes a sizable loss to the Wisconsin hunter who is financing the project.

If a high level of wildness in the breeding flock results in more birds migrating and being shot by out-of-state hunters who do not contribute financially to the project, possibly the other extreme should be considered in which there is less wildness in the breeders, more eggs per female, and more birds taken at the release sites. With the latter situation, the cost per bird recovered should be less to the sponsoring organization, although the quality of shooting could be expected to be more comparable to that offered by mallards in a barnyard.

TABLE 19

A Summary of the Costs of Propagating Mallard Ducks at the Horicon Rearing Station in 1952[1]

	Breeding	Hatching	Rearing
Feed	$ 857.02		$ 208.40
Labor	1,074.50	$ 525.00	612.50
Trapping males	87.25		
Incubation service		324.16	
Breeding costs applied to egg costs		1,859.08	
Sub-total	$2,018.77	$2,708.24	$ 820.90
Administration share	297.60	148.80	173.60
Depreciation of physical equipment		365.54	
Maintenance of equipment and grounds		200.00	
Grand total	$2,316.37	$3,422.58	$ 994.50
No. birds used as divisor[2]	300	2,634	1,350
Cost to hold each breeder	$ 7.72		
Cost to produce a day-old duckling		$ 1.30	
Cost to rear a duckling for 30 days			$ 0.74
Cost to produce 30-day-old duckling			2.04

[1]Based on facilities for handling 300 adult breeders year-round and rearing 1,500 ducklings for the period June 1 through August 15.

[2]A 10 per cent rearing loss occurred this year, hence only 1,350 birds were used as the divisor under the column "rearing".

EVALUATION AND MANAGEMENT IMPLICATIONS

This evaluation of the artificial propagation of mallards under Wisconsin conditions was made to determine the feasibility of a large-scale mallard-rearing project as a state-wide, state-sponsored waterfowl management practice or as a constructive project for sportsmen's organizations. When this project was initiated in 1946, we knew that mallards could be raised in large numbers in suitable pens. While we also knew that the stocked birds could increase hunting opportunities or supplement local breeding populations, we did not know if either contribution could be significant or economically justifiable.

Contribution of the Stocked Mallard

Mallards which are reared and released in Wisconsin can potentially have two values: (1) to increase hunting opportunities and (2) to increase or re-establish local breeding populations of wild mallards.

Hunting Opportunities

In general, the greatest value of prehunting-season-stocked birds is in the hunting opportunities offered to sportsmen. It is this aspect of mallard stocking which is best evaluated from our data.

The maximum benefit to the hunters from the stocked birds would be realized if all the birds released were bagged. However, a 100 per cent recovery rate does not occur with birds released in the wild. In this study 27 per cent of the birds released were reported recovered. The maximum number of banded birds which were recovered can be calculated. Reward-band studies on wild mallards at Horicon Marsh show that at least 2.8 times as many banded birds are taken (shot) as are reported by hunters. In our studies it would not be valid to apply the 2.8 correction factor directly to the reported 27 per cent recovery rate because so many of the band recoveries were secured through personal contacts of Conservation Department personnel with hunters. A more reliable corrected recovery rate is obtained by subtracting the number of recoveries obtained through hunter bag checks from the total recoveries, multiplying the difference, which is the number of voluntary recoveries, by 2.8 and then adding this product to the number of recoveries obtained from bag checks. Use of these procedures on the hand-reared mallard data results in a calculated recovery rate of 48 per cent. Of the 48 per cent, 47 per cent are recovered by shooting. It is obvious, then, that 53 out of every 100 stocked mallards are lost due to other mortality factors, such as lack of physical adaptation, predators, crippling losses from hunting and other causes.

Applying the recovery statistics obtained in this study to every 100 mallards released, then for the calculated 48 mallards recovered, 44 are first-year hunting-season recoveries, three are subsequent hunting-season recoveries, and one is a recovery representing all other types of mortality (one of the 53 birds lost to crippling and all the non-hunting mortality factors). Despite the fact that there is extremely heavy hunting pressure at the release sites, less than half of the stocked birds were bagged by hunters. This means that in a release of 10,000 birds, 4,700 birds would be bagged by hunters, and 5,300 birds would be lost to crippling and other mortality factors. And in rounded figures, of the 4,700 birds recovered by hunters, 3,900 would be taken in the vicinity of the release sites in the first year and 100 in subsequent years, 300 recovered in other Wisconsin areas in all years, and 400 recovered in areas outside Wisconsin.

In our opinion, the calculated total recovery by shooting of 47 per cent represents a poor investment. And, it occurred despite the fact that these releases were made in some of the best waterfowl hunting habitat in Wisconsin. Releases in less desirable habitat probably would result in even fewer birds being bagged by hunters and more birds being lost to other mortality factors.

We estimate on the basis of reported kill and hunter check data that annually the hand-reared mallards made up only 1 to 2 per cent of the total season's waterfowl bag at the release sites and in their immediate vicinity. Both the Horicon Marsh and Goose Island release areas annually attract peak populations of over 50,000 ducks in the fall, and consequently these areas have some of the heaviest hunting pressure in the state. Even though the stocked mallards had the benefit of being associated with thousands of wild ducks, the majority of the birds were recovered the first hunting season at the release site.

From the above discussion it is clear that the bulk (94 per cent) of the stocked birds recovered are killed during the first hunting season following release. It is obvious, then, that prehunting-season mallard stocking is essentially stocking for the gun.

If Wisconsin were to initiate large-scale mallard stocking, how much would it cost to stock enough mallards to increase the state-wide duck kill by a significant margin? According to voluntary hunter reports, the estimated annual duck kill during the course of this study (1949–1953) averaged 670,000 birds (Otis Bersing, unpublished data). If we assume (1) that 670,000 ducks is an average kill, (2) that 43 out of every 100 birds stocked are recovered by shooting in Wisconsin, and (3) that the cost of each released bird was $2.04, then it would require that

Waterfowl bagged by hunters were examined at hunter-check stations maintained during the hunting season at Horicon Marsh and Goose Island. These stations provided an excellent means for recovering banded birds.

approximately 155,800 mallards be released at an approximate cost of $318,000 to increase the state-wide kill 10 per cent, 311,600 mallards at a cost of $636,000 to increase the kill 20 per cent, and so on. The figures cited in the above examples will vary with (1) the precision of the estimates of 670,000 as the average state duck kill; (2) the suitability of release areas in sustaining ducks during their period of growth; (3) the attractiveness of the release areas in helping to hold

birds within the state; (4) local variations in hunting pressure and crippling losses. Reduction in the cost of increasing the state-wide kill even 10 per cent would require a considerably higher recovery rate or a lower cost of production per bird. These could be effected if (1) the type of birds released were similar to the birds reared for commercial shooting areas where pen-reared mallards pass over hunters as they fly from feeding areas to water areas and (2) by establishing a rearing program involving cooperators similar to the day-old-pheasant-chick program in which sportsmen's clubs received free pheasant chicks and feed from the state but use club labor and equipment for maintenance and rearing. But even with this type of program, the cost appears to be staggering for the benefits received.

Breeding Contributions

To contribute to a waterfowl breeding population, the stocked mallards must survive from the time of fall release to the following spring breeding season and produce young.

No specific attention was directed toward completely evaluating that portion of the surviving released birds which bred. However, from figures secured in these studies, calculated estimates can be made which indicate the magnitude of duckling production that can be expected from a given number of released birds. As was shown earlier in this report, an estimated 48 mallards out of each 100 released are recovered by one means or another. Of these 48 mallards, 47 are recovered through shooting, with 44 of the recoveries occurring during the first hunting season following release. Therefore, from three to four mallards, out of every 48 which we have estimated as reported, survive to breed in a subsequent year. We must assume, however, that the 52 unreported birds out of every 100 released (100 — 48 = 52) are dying and surviving at the same rate as the 48 recovered birds. On this basis, an additional 3 to 4 birds survive after the first hunting season so that for every 100 birds released, there are between 6 and 8 potential breeders. Thus in a total of 10,000 released mallards composed of equal sexes, an anticipated 600 to 800 birds should survive to breed. Assuming that these birds (1) will account for 300 to 400 pairs regardless of whether they mate with wild mallards or as hand-reared mallard pairs, (2) that they experience a 55 per cent breeding success comparable to wild mallards (Hickey 1952a), and (3) that each pair successfully rears 7 young (Hickey 1952a), the total production would be between 1,155 and 1,540 ducklings from the original release of 10,000 hand-reared mallards.

If the above production were actually realized, what portion could be expected to occur in the vicinity of the release sites? In this study, 40 per cent of the subsequent recoveries, which would be the birds contributing to production, occurred at the release sites. As was pointed out previously, this was not interpreted as "homing" because of the possibility of some birds remaining over winter and the tendency of ducks in migration to stop at the same areas year after year. However, if all of the birds contributing to the 40 per cent subsequent recovery at or in the vicinity of the release sites actually bred there, then from 462 to 616 ducklings will be produced by the survivors of the original 10,000 mallards stocked at the release sites. It must be emphasized that the above calculations are of a theoretical nature and that field data are not available to substantiate all of the figures. However, the potential breeding contribution which can be expected from the stocked mallards is a "best estimate" and provides the only satisfactory working base available at present for the evaluation of this phase of artificial propagation.

The relatively low egg production of the breeding stock used in this study was one of the main factors in the high production costs. Therefore, consideration will be given here to the contribution that the hand-reared mallard might make to a breeding population if egg production were increased. In order to accomplish this, there would have to be greater egg production per female. While this would decrease the cost of the bird stocked, it would not increase the breeding population significantly, because: (1) greater egg production per female undoubtedly would be obtained at the sacrifice of wildness in potential breeders; (2) the standards of rearing would be lower with a larger program; (3) many release areas would be of poorer quality than those used in the present study, and consequently there would probably be lower survival; (4) production of more domestic-type birds would undoubtedly result in less birds surviving to the hunting season and in a greater first-year harvest of surviving birds.

Our conclusion is that summer and early fall (prehunting season) stocking has only a limited value (obtained at great cost) as a technique for improving local breeding populations of mallards.

The stocking of adults in spring might be a technique to re-establish or build up local mallard breeding populations at suitable sites. As yet, no thorough study of the stocking of mallards in the spring has been made. However, it must be realized that stocking in spring can only be successful if the aquatic habitat into which the birds are

introduced provides food and cover for survival and is suitable for breeding waterfowl. Birds stocked in unsuitable habitat will have low breeding success and because of the high hunting pressure on any area where waterfowl are concentrated, a large portion of the birds can be expected to be killed the first year. Also if the habitat is suitable it will already be producing birds, and adding pen-reared breeders may decrease the potential of the local wild breeders.

Need for Mallard Stocking

Even if a mallard stocking program were feasible, and the survival and cost figures given in this report indicate that it is highly questionable, the basic consideration should not be whether the cost justifies the result, but rather whether there is a *need* for stocking mallards in Wisconsin at this time, either on a state-wide basis or as a local sportsmen's club project. At the present time, due to Wisconsin's fairly favorable location in relation to fall migratory flights of waterfowl, there are reasonably good supplies of wild ducks on many of the existing waterfowl areas. The problem seems to be one of making the presently existing areas more attractive for both breeding and migrant waterfowl and to restore or create more areas to attract and hold wild ducks for a longer period of time, rather than to artificially and temporarily supply shooting through stocking.

Admittedly, there is a need for group-participation activities for sportsmen's clubs. Mallard stocking on this basis poses several problems, despite the apparent ease with which such projects can be established. As a club project, the type of program carried on in this study seems to offer too low a return on the investment. In a number of other states, pen-reared mallards have become a part of the program offered by commercial shooting areas. From a club viewpoint, this has some merit since a greater recovery can be expected on the number of birds reared. There is little point in clubs maintaining wildness in the released birds only to have them migrate from the release areas to be shot by some hunter not financially supporting the program. Another consideration a club faces is the possible attraction of wild ducks to the release areas due to the stocked birds acting as decoys which creates the problem of "illegal hunting". To avoid this confusion in shooting stocked mallards, Peyton has suggested substitution of muscovy ducks where commercial shooting practices conflict with state and federal regulations (Hopkins, 1955).

* * *

To many people, artificial propagation, as well as adequate protection and habitat improvement, were the management tools through which desirable waterfowl populations could be maintained. While we believe that the problems of waterfowl management are much more complex, we did investigate artificial propagation as a desirable practice and at the same time carried out a management program of protection and habitat improvement on many suitable wetland areas in Wisconsin.

As this study and other published studies have shown, the stocked birds do not have the characteristics necessary for maintaining desirable wild waterfowl populations. Regardless of genetic quality, the association with man in the rearing process results in a highly vulnerable behavior pattern in the stocked birds, with respect both to natural and hunting-season mortality factors.

SUMMARY AND CONCLUSIONS

1. This report was based on field studies in Wisconsin from the years 1946 through 1953, although the major share of the data are from the years 1949 through 1953. During the years 1949–1953, a total of 10,371 hand-reared mallards resulting from domestic and wild mallard matings were reared and released at approximately 4 weeks of age. The evaluation of mallard propagation and prehunting-

season stocking in Wisconsin was based primarily upon: (1) a comparison with the previously published studies on hand-reared mallards, (2) an analysis of 2,791 hand-reared mallard band reports from the 10,371 birds banded in the years 1949–1953, (3) a comparison with wild mallards banded in Wisconsin during the same years of the hand-reared mallard releases, and (4) a detailed cost analysis of the Wisconsin hand-reared mallard project.

2. Egg production in the Wisconsin hand-reared mallards was apparently limited by the high degree of wildness maintained in the breeding flock through the constant use of wild drakes as breeders. Egg production per female reported in other studies using more domestic-type birds was at least twice as great as for this study.
3. The maximum hatchability of mallard eggs was obtained in incubators when the eggs were stored not longer than 7 or 8 days prior to incubation and by spraying the incubating eggs with water each day.
4. Duckling rearing losses averaged 15 per cent.
5. Weights of stocked mallards taken at various times prior to and during the hunting season compared favorably with those of wild mallards.
6. The analysis of the hand-reared mallard banding data revealed:
   (1) A total of approximately 27 per cent of the birds released were recovered. The great majority of these were bagged by hunters. This is almost twice as great as found in any previously reported study. However, this greater recovery rate may be explained in part by the very heavy hunting pressure at the Horicon and Goose Island release sites and by the hunter bag checks which were used as a method of supplementing voluntary reports in obtaining band-recovery data.
   (2) Immature males were recovered at a significantly higher rate than immature females.
   (3) The feeding of a ration containing a synthetic estrogenic hormone, dienestrol diacetate, at the rate of 50 parts per million had no apparent effect on the recovery rate.
   (4) The first-year recoveries represented 94 per cent of all the bands reported.
   (5) Within a 20-mile radius of the release sites, 87 per cent of the first-year and 40 per cent of the subsequent recoveries occurred.
   (6) The younger the released immature mallards were with respect to the opening of the hunting season, the higher the recovery

rate and the percentage of the recoveries occurring in the vicinity of the release sites.

(7) The use of large (1,500 acres or more) waterfowl refuges as release areas for hand-reared mallards in Wisconsin resulted in a lower first-year recovery, a wider geographic distribution of recoveries, and a more uniform distribution of recoveries throughout the hunting season.

(8) The wing-clipped adult breeders, released after the egg-production period, were recovered at approximately the same rate as the immatures.

7. The comparison of hand-reared and wild-mallard band-recovery data on birds banded and released revealed:

(1) Approximately the same total recovery rates, 27 and 23 per cent respectively;

(2) A much greater hand-reared mallard first-year recovery rate, 25 and 17 per cent respectively;

(3) A much greater hand-reared mallard recovery in the vicinity of the release site, 84 and 43 per cent respectively;

(4) A much greater hand-reared mallard recovery occurring on the opening weekend of the waterfowl hunting season, 48 and 27 per cent respectively;

(5) A much greater hand-reared mallard calculated first-year mortality rate, 91 and 75 per cent respectively, and similar calculated adult mortality rates, 56 and 58 per cent respectively;

(6) Approximately the same migration patterns.

8. Band recoveries and observations in the field disclosed that the stocked mallards did not fear man as did wild mallards and that the hand-reared birds were more sedentary than banded samples of wild mallards. The tameness and sedentary habits of the hand-reared mallards, which apparently resulted from the favorable association with man during the rearing period, contributed significantly to the high vulnerability of the stocked birds to the gun.

9. Seventeen nests of banded hand-reared mallard hens were found at Horicon, indicating that at least some of the birds surviving the hunting season are capable of mating, nesting, and rearing young. However, the contribution to the breeding population, whether flyway or local, is limited because (1) so few birds survive to become breeders and (2) the females surviving to breed apparently lack the secretive behavior in nest-site selection that is so necessary for successful nesting in the wild.

10. In this study, the cost per released immature (30-day-old) bird amounted to $2.04. This cost figure, however, will vary with the type of bird reared for release and the magnitude of the program.
11. In this study, it was calculated that 48 out of every 100 stocked mallards were recovered. The waterfowl hunter accounted for 47 of these recoveries, 44 of which occurred in the year of release and 38 in the vicinity of the release sites.
12. The potential contribution of mallards stocked in Wisconsin to the breeding population was calculated to be from 6 to 8 breeders (male and female) per 100 birds released. When so few birds survive to breed, prehunting-season stocking of mallards does not appear either economically or biologically justifiable as a technique for increasing local breeding populations.
13. In recognizing that mallard stocking, as carried on in this study, results in stocking for the gun, artificial propagation as a state-wide waterfowl management practice would require in an average year the liberation of approximately 155,000 mallards to increase the estimated Wisconsin duck kill by only 10 per cent.
14. At the present time there are reasonably good supplies of wild ducks on many of the existing waterfowl areas. The problem seems to be one of making additional existing wetland areas more attractive for breeding and migrant waterfowl and to restore and create more areas to attract wild ducks for a longer period of time, rather than to artificially and temporarily supply shooting through stocking.

APPENDIX A

LOCATIONS OF HAND-REARED AND WILD MALLARD BAND RECOVERIES

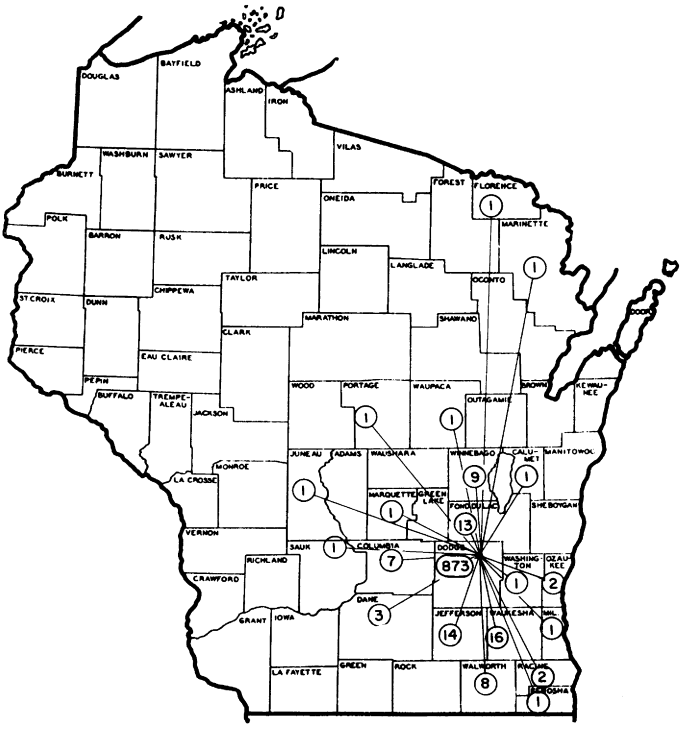
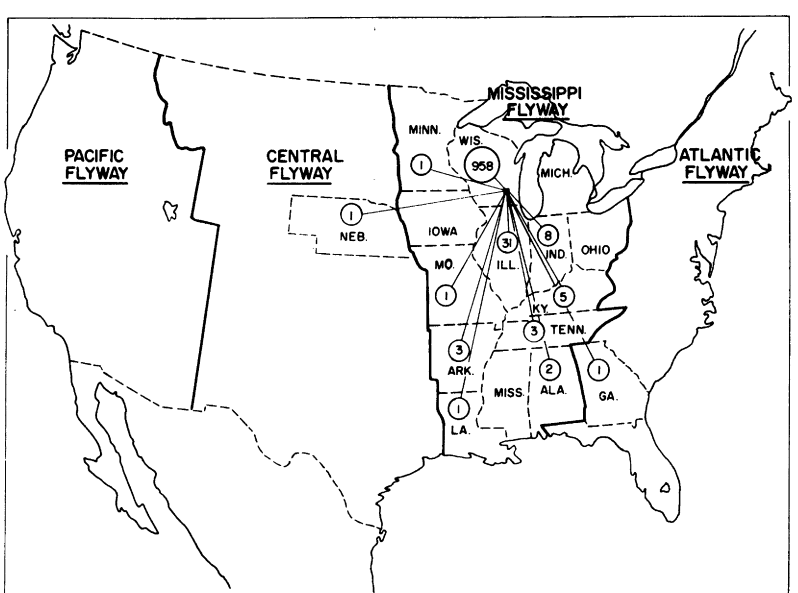


Figure 4. Location of first-year hunting-season recoveries of hand-reared mallards banded at Horicon.



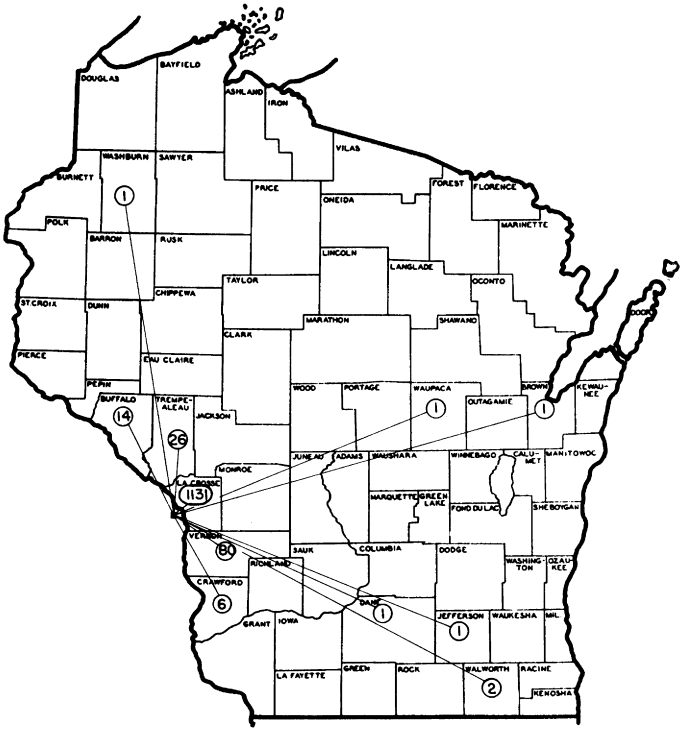
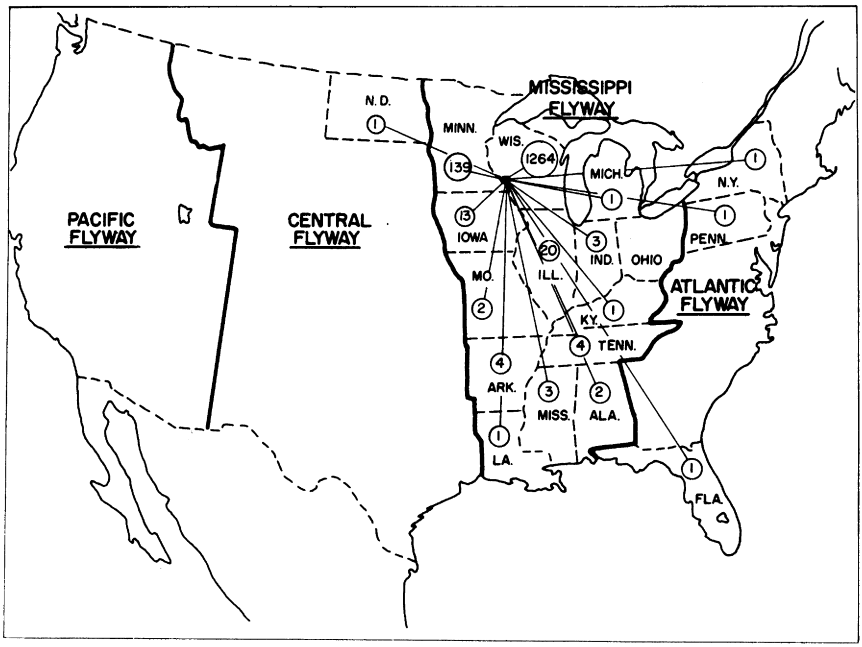


Figure 5. Location of first-year hunting-season recoveries of hand-reared mallards banded at Goose Island.



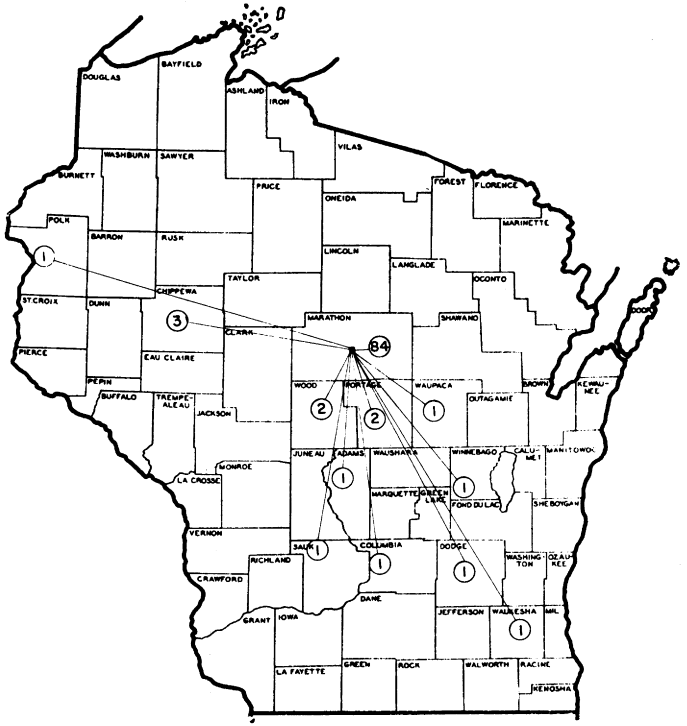
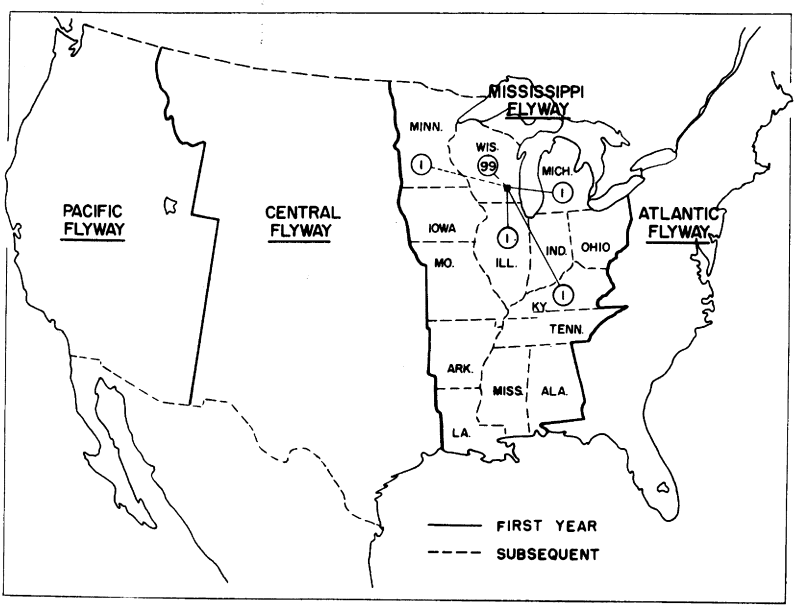


Figure 6. Location of first-year hunting-season recoveries (and the one subsequent recovery) of hand-reared mallards banded at Wausau.



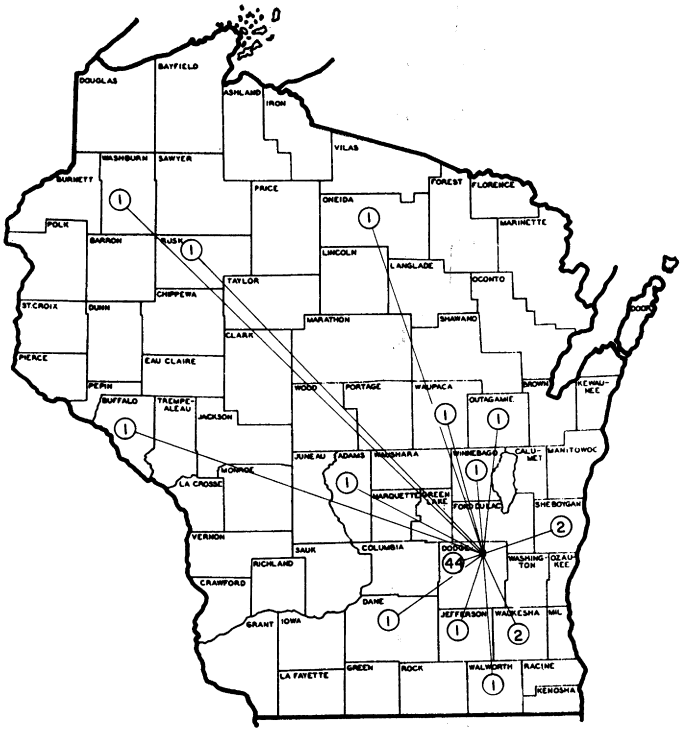
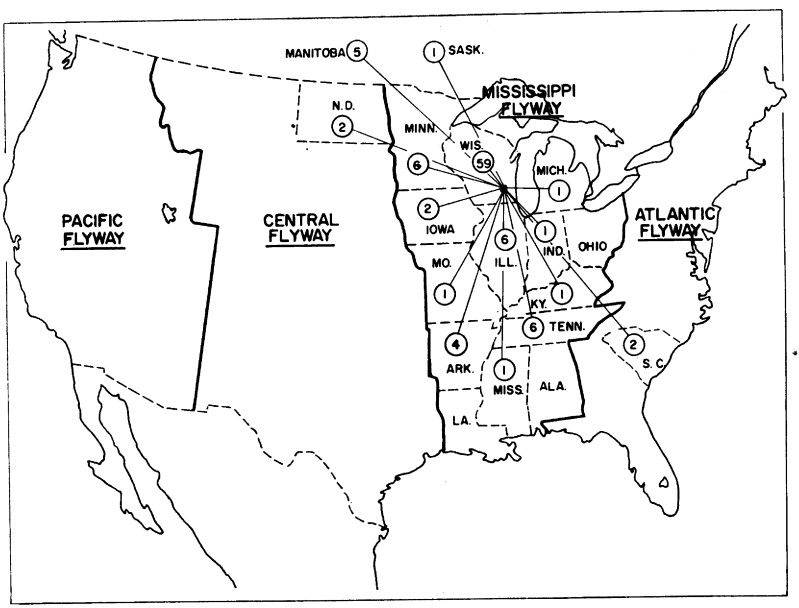


Figure 7. Location of subsequent hunting-season recoveries of hand-reared mallards banded at Horicon.



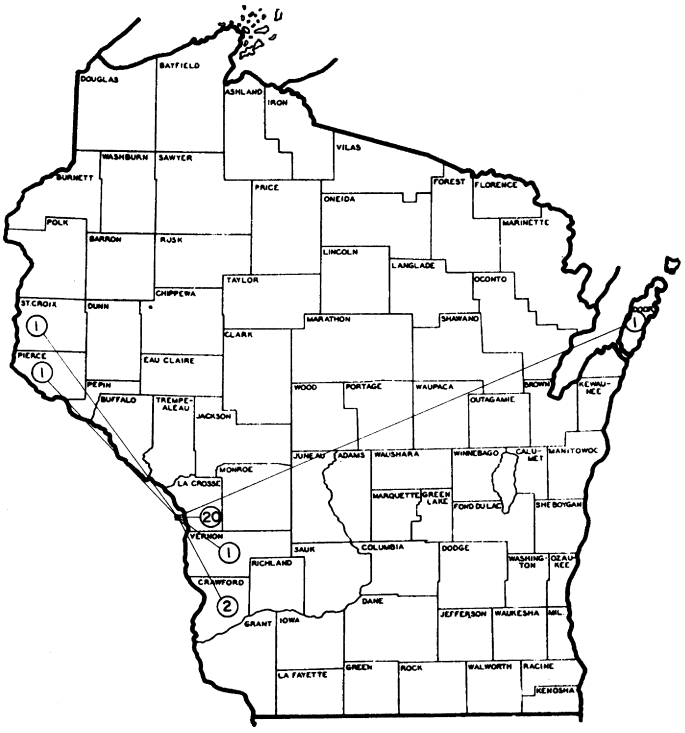
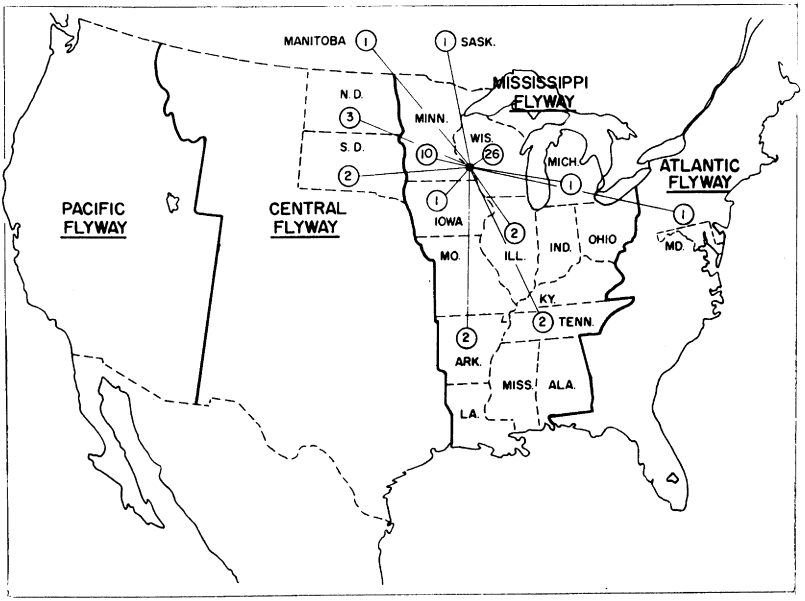


Figure 8. Location of subsequent hunting-season recoveries of hand-reared mallards banded at Goose Island.



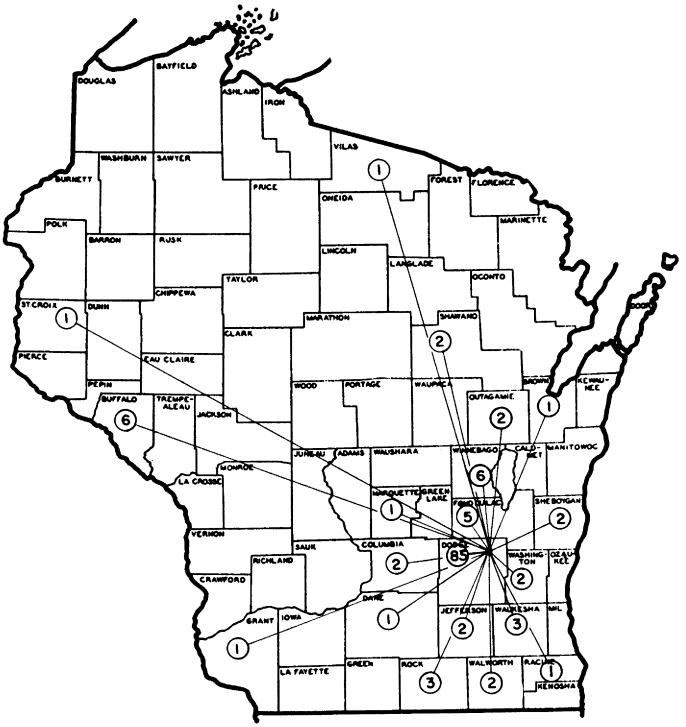


Figure 9. Location of first-year hunting-season recoveries of wild mallards banded at Horicon. (There were six additional recoveries in Wisconsin with county locations unknown.)

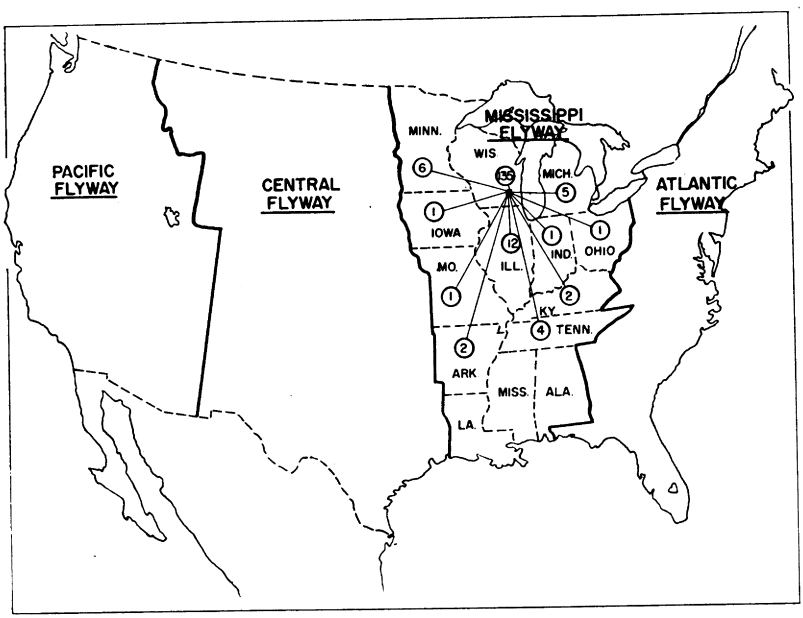
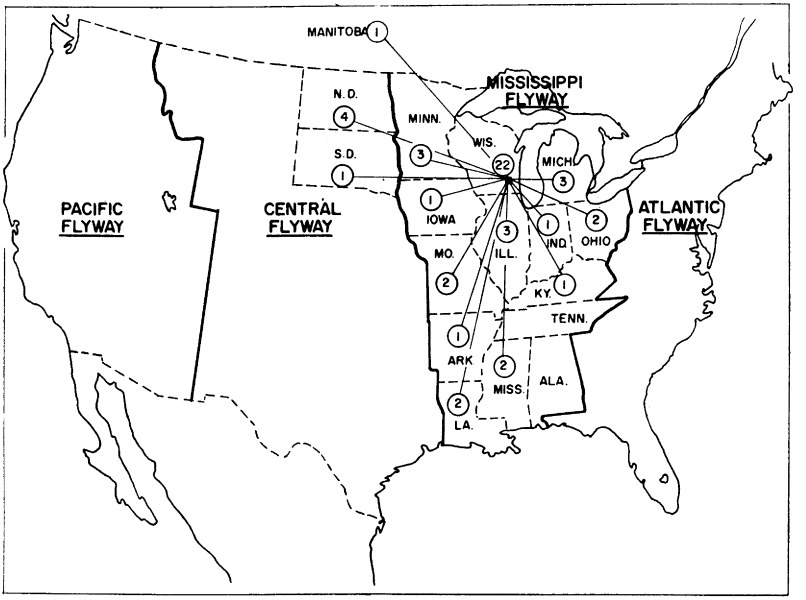


Figure 10. Location of subsequent hunting-season recoveries of wild mallards banded at Horicon.



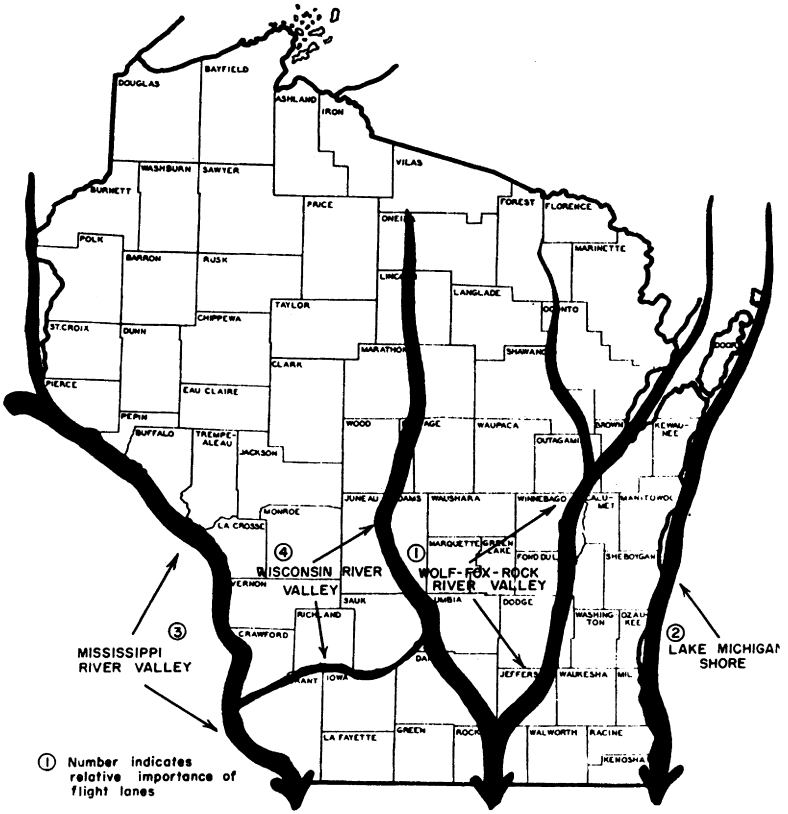


Figure 11. Major fall waterfowl migratory flight lanes in Wisconsin.

APPENDIX B

COMMON AND SCIENTIFIC NAMES OF PLANTS AND ANIMALS USED IN THIS REPORT

PLANTS

Common Name	Scientific Name
Arrowhead	*Sagittaria* sp.
Aspen, quaking	*Populus tremuloides*
Bluejoint	*Calamagrostis canadensis*
Bulrush, hardstem	*Scirpus acutus*
Bulrush, river	*Scirpus fluviatilis*
Bur reed, giant	*Sparganium eurycarpum*
Cattail, common	*Typha latifolia*
Cattail, narrowleaf	*Typha angustifolia*
Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna* sp.
Duckweed	*Spirodela polyrhiza*
Pondweed	*Potamogeton* sp.
Sedge	*Carex* sp.
Smartweed	*Polygonum* sp.
Willow	*Salix* sp.

BIRDS

Blue-winged Teal	*Anas discors*
Canvasback	*Aythya valisineris*
Mallard	*Anas phatyrhynchos*
Pheasant	*Phasianus colchicus*
Pintail	*Anas acuta*
Redhead	*Aythya americana*
Ruffed Grouse	*Bonasa umbellus*

MAMMALS

Muskrat	*Ondatra zibethica*

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