THE SOCIAL ORGANIZATION OF A MALLARD POPULATION IN NORTHERN IOWA

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Dale Dean Humburg

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ABSTRACT

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POPULATION IN NORTHERN IOWA

By

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Breeding activity of mallards (*Anas platyrhynchos*) was studied during 1974 and 1975 on Ventura Marsh in North Central Iowa. Over the two years, 134 drakes and 22 hens were captured and marked. The marked and unmarked birds on the study area were monitored by ground counts, fixed-point observations, radio telemetry locations and observation of remating activity of marked hens losing nests at mid-incubation. A large number of mallards arrived on the study area in late March and early April of each year. Sex ratios of mallards spaced on breeding areas averaged 53.5 percent drakes while 58 percent of the transient mallards feeding in fields and loafing on larger water areas were drakes. Numbers of mallards observed during fixed-point observations and the number of pairs estimated from a modified Lincoln Index were found to decline after the initial influx and remained relatively constant over the breeding season. Limitations in numbers of breeding birds and time spent on the marsh appear to result from pursuit flights. Sixty-four marked drakes, observed at least once with a hen, spent an average of 17.6 days on the marsh while 70 drakes not seen with hens averaged 1.3 days on the area.

There was a continual turnover of lone drakes on the study area throughout the breeding season. Delayed breeding or emigration appears to occur if the pair or single drake does not obtain a space on the breeding marsh. The nests of 22 marked hens were destroyed between day 10 and 17 of incubation and their subsequent remating activity was monitored. Four (18 percent) of the 22 hens left the study area and three (14 percent) did not remate after nest loss. Fifteen (68 percent) of the hens remated. Of the 11 identified rematings, 8 (73 percent) were observed to return to their original drake and the remaining 3 (27 percent) changed drakes after losing their nest. With nest destruction at an average of 14 days into incubation, remating with the original drake was the most frequent choice by mallard hens.

THE SOCIAL ORGANIZATION OF A MALLARD POPULATION IN NORTHERN IOWA

By

Dale Dean Humburg

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DEDICATED TO THE MEMORY OF

TERRY WILLSON

1946 - 1975

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INTRODUCTION

The return of mallards (*Anas platyrhynchos*) to breeding areas each year has been accepted as a predictable event in the annual breeding cycle of the species. The social organization of a breeding population in relation to the reproductive strategy of mallards is not clearly understood. A variety of studies concerning courtship behavior, interaction between pairs and nesting provide a base for a general model of mallard mate selection and nesting (Fig. 1).

The pair is the fundamental unit when considering mallard reproduction. Weidman and Darley (1971) reviewed the range of attitudes among investigators concerning the role of the mallard male and female in display and courtship. They concluded that the female is an essential element in directing display and that social display promotes pair formation, which occurs for the most part before spring migration (Hawkins *in* Hochbaum 1944:121 and Weller 1965). Hochbaum (1944:16) and Sowls (1955:21) reflected the general acceptance by biologists that most mallards are paired upon arrival in the spring at breeding areas. Lebret (1961) defined a pair as a hen and a drake that maintain a close proximity when together and when the paired drake defends the female from other mallards.

Interaction between pairs in the form of pursuit flights (three-bird-flights) is described by Dzubin (1957), McKinney (1965) and Titman (1973). This behavior is believed to be responsible for the

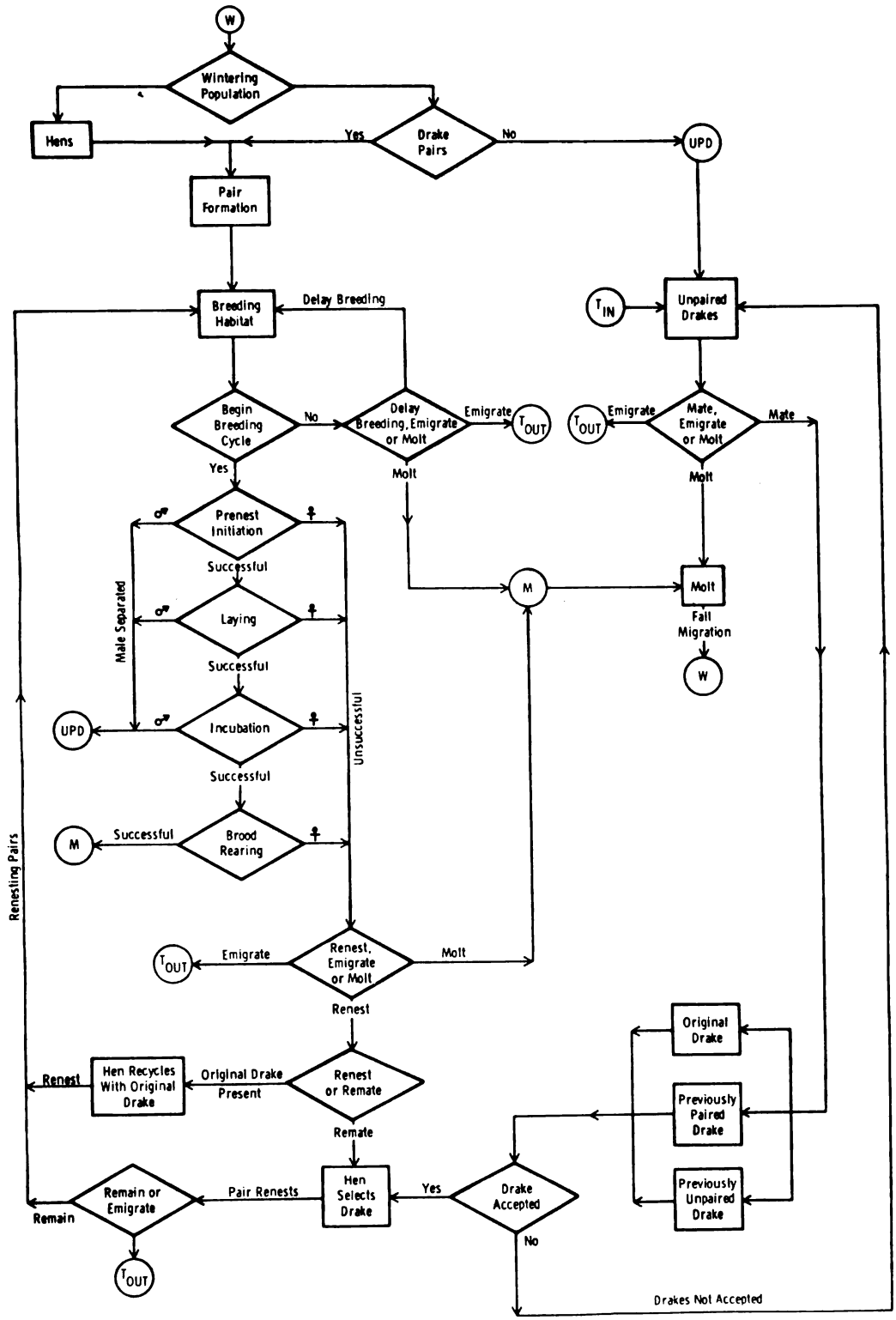

Figure 1. A model describing the relationship between various components of mallard population on a breeding marsh. Rectangles represent events and/or components and diamond shaped figures represent points where more than one alternative exists. Circles connect the wintering population (W), unpaired drakes (UPD), transients (T) and the molting component (M) to other events and components.

spacing of breeding pairs. The ultimate consequence appears to be a lessened competition for breeding requisites and dispersion of nests as an anti-predator mechanism. Those pairs unable to enter a breeding system may attempt to nest in sub-optimal habitat, emigrate to other systems, delay the breeding effort or molt.

During the reproductive effort drakes are observed with hens on breeding areas through laying and for an average of eight days into incubation according to Lebret (1961). Dzubin (1955) reported drakes present in the vicinity of nests until day 16 of incubation. Unless the nest is destroyed or abandoned, the hen continues incubating until the eggs hatch. Nest destruction, which appears to be a limiting factor in the annual production of mallards, has been reported by Dzubin and Gollop (1972) to range from 22 to 73 percent depending upon the area studied, condition of nesting cover, predator populations, water levels, weather and degree of human disturbance. Because of high losses of first nests, renesting, reported to be as high as 77 percent (Keith 1961), is presumed to play an important role in maintaining annual production in breeding populations of mallards. Since a pair bond is a necessary requisite to successful culmination of laying and incubation of the clutch (Dzubin 1970), hens losing nests probably will not renest without remating even though fertile eggs can be layed up to 17 days after insemination (Elder and Weller 1954). Hens attempting renests could select a drake from a variety of sources, including the original mate, drakes originally paired with another female and previously unpaired drakes. Although little data are available concerning the breeding activity of unpaired drakes, Titman (1973:41) observed marked unpaired males for at least a short

time in localized areas on a breeding marsh. Titman speculated that there may be a selective advantage for an unpaired drake to be available for breeding with renesting hens. Elder and Weller (1954) suggested that the unpaired drake segment is essential to high productivity by supplying mates for renesting hens. Aldrich (1973) also suggested that unpaired drakes may be important but he also suggested that they may be harmful to production by harrassing nesting hens.

Investigations by Bellrose (1961) have shown that sex ratios of mallards generally favor drakes and range from 40 to 70 percent drakes depending upon latitude, season and method of data collection. The percentage of drake mallards appears to be increasing since 1970 (Bellrose 1976:230). Some biologists have advocated utilization of the supposed excess drake supply. Dzubin (1970) suggested that biological justification for harvest of surplus drakes may exist if no difference exists between drakes and hens in the time it takes to mature sexually, if surplus drakes have no significance in providing mates for renesting hens and if harvest of hens would not also increase with increased drake harvest. With the advent of the point system of waterfowl regulations, which allows for the harvest of apparent surplus drakes, controversy has arisen among technical people concerning the biological implication that increased drake harvest could have on mallard production.

This study was designed to describe the structure and relationships between various components (Fig. 1) of a mallard breeding population on a breeding area. Specifically, an attempt was made to

describe the breeding activity of drake and hen mallards relative to the nesting cycle of hens unsuccessful in their initial nesting attempt.

STUDY AREA

The study area consisted of Ventura Marsh, a state-owned wetland (Fig. 2) and the surrounding area located in Cerro Gordo and Hancock Counties in north central Iowa. The 450 acre marsh, located at the west end of a 3,600 acre glacial lake, consists of about 40 percent emergent vegetation which is made up mostly of sedges (*Carex* spp.), cattail (*Typha* spp.) and bullrush (*Scirpus* spp.). Annual fluctuations in water levels of about 6 to 12 inches also promote the growth of various species of annual plants. Uplands utilized by nesting mallards and blue-winged teal (*Anas discors*), consist of 300 acres owned by the state adjacent to the marsh and surrounding alfalfa (*Medicago sativa*) fields planted by private land owners. The majority of private land area consists of corn, soybeans and pasture acreage.

There are few large permanent marshes in North Iowa, though semi-permanent water areas less than one acre in size attract and hold breeding mallards. The majority of ground work was conducted on Ventura Marsh and small water areas within 1 1/2 miles. Larger breeding marshes are located further than ten miles from Ventura as suggested by Dzubin (1970) allowing for a relatively isolated study area. Aerial telemetry work was conducted within a ten mile radius of Ventura Marsh and over major water areas within 30 miles.

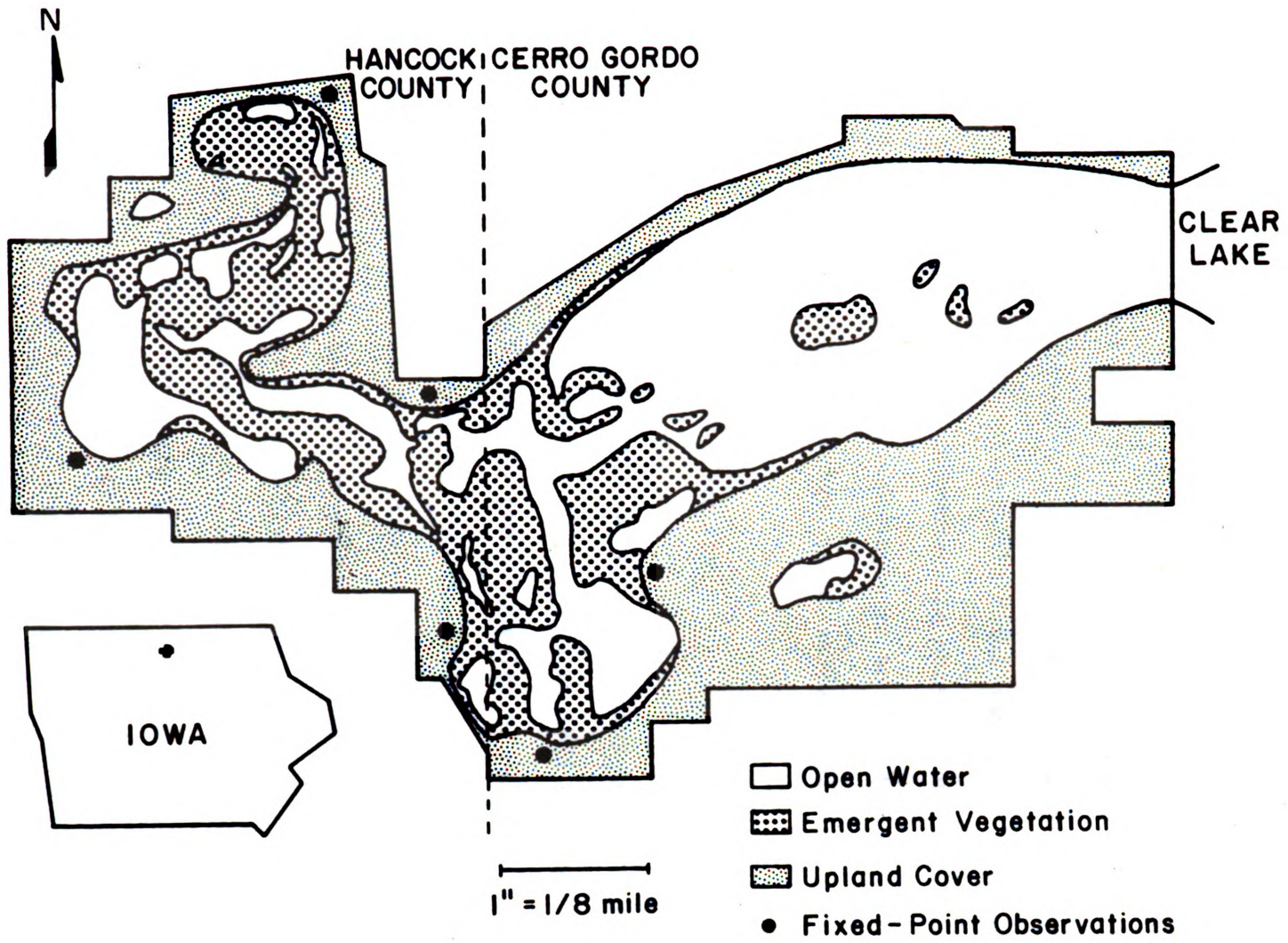

Figure 2. The Ventura Marsh study area.

MATERIALS AND METHODS

Field work began each year in March with the initial influx of mallards into the area. Throughout the breeding season, weekly counts were made on Ventura Marsh to estimate the total number of mallards present on the marsh. A series of systematic observations were also made on Ventura Marsh and the surrounding area to record the activities of mallards marked with nasal saddles, paint and/or telemeters.

Trapping and Marking

Modified clover-leaf traps utilizing a live decoy hen were used to capture drakes. Eleven traps in 1974 and 13 in 1975 were spaced over the areas in the marsh used by breeding pairs of mallards. The traps were checked each morning and evening. All of the drakes and about one-half the hens were captured in this manner over the two seasons. Hens were also captured on nests. A rope drag was used to locate nests in the uplands and along the marsh edge. Over-water nests were located by checking nest baskets and searching floating vegetation and muskrat houses. Hens were trapped on the nest in early incubation with a bail trap similar to that designed by W. H. Thornsbury and described in Doty and Lee (1974). One egg was taken from incubated nests and the age of the embryo was determined according to the technique developed by Prince *et al.* (1968). All clutches were back-dated to determine the date of nest initiation (Sowls 1955:82).

All captured mallards were banded with U. S. Fish and Wildlife Service bands and marked with poly-vinyl nasal saddles which were marked with a combination of letters and numbers to allow for individual identification. Different color nasal tabs were used on drakes and hens in each season. Fluorescent paint in different combinations was sprayed on the undersides of wings and on the tail which allowed for identification of birds in flight. Several light coats, which were allowed to dry between applications were used for color marking. This did not appear to impair flight. Selected drakes and most hens captured were also equipped with a radio transmitter package similar to that described by Dwyer (1972).

Trapping resulted in the marking of 8 hens and 69 drakes in 1974 and 14 hens and 63 drakes in 1975 (Table 1). The trapping success for the hen decoy trap averaged .19 ducks per trap day during 457 trap days in 1974 and .16 ducks per trap day during 474 trap days in 1975. Seven hens and eight drakes in 1974 and 14 hens and 5 drakes in 1975 were equipped with radio transmitters. Four hens and two drakes marked in 1974 were observed again on the study area in 1975. After the first week of trapping, an average of 35 and 40 percent of the total mallards observed on the study area during the 1974 and 1975 seasons were marked.

Observations

Systematic counts of the population plus observations of marked and unmarked birds began in late March and continued through June. Spotting scopes and binoculars were used to facilitate sighting and

Table 1. Number of mallards marked with nasal saddles and/or radio transmitters on Ventura Marsh in 1974 and 1975.

	Females			Males		
Year	Number Marked	Number Returned From Previous Year	Total	Number Marked	Number Returned From Previous Year	Total
1974	8	---	8(7)	69	---	69(8)
1975	14	4	18(14)	63	2	65(5)

identification of marked nasal saddles and paint combinations. For telemetric observation, hand-held antennas and those attached to a vehicle or an airplane were used.

Ground Counts

Total numbers of mallards on the marsh were estimated by ground counts (see Dzubin 1969b) which were initiated each year in late April and conducted on a weekly basis beginning at 0800 hours. During each count, the entire marsh was covered, usually by four people, two in boats and two walking the marsh edge. The counts were categorized into the number of birds observed as pairs, lone drakes, single hens and groups of two or more drakes.

Fixed-Point Observations

Mallard activity and numbers on the marsh were also measured with hourly fixed-point observations. An attempt was made to observe activity on Ventura Marsh from six different locations during all daylight hours by five-day periods. Observations were made on all marked and unmarked mallards and an attempt was made not to recount the same individual within an hourly observation period. Activity observed was categorized into locomotor, feeding, social behaviors and comfort movements and when possible location, duration and intensity was described. All hens observed with broods during fixed-point observations were recorded. From these observations we were able to calculate the total number of mallards seen per hour. Observations of marked birds throughout the breeding season allowed us to determine the number of days they spent on the area and breeding

status of individual mallards. The number of days marked drakes were observed to be paired with hens, as defined by Lebret (1961), will be referred to as a pair sequence in this study.

Remating Activity

The drake paired with an incubating female was identified by flushing the hen and determining the identity of the male that joined her in flight. Nests were destroyed around 14 days into incubation and the subsequent remating activity of the hens was monitored. Hens were located daily and any association with drakes was recorded. Renesting activity and subsequent nest success was determined. Aerial telemetric searching for radioed hens leaving the study area was conducted within a 10 mile radius and over large water areas within 30 miles. At least one flight per week was made throughout the breeding season in search of birds that were no longer present on the study area.

Statistical Analysis

Standard statistical procedures (mean, variance, t-test and correlation) were employed according to methods outlined by Snedecor and Cochran (1967). Randomness of reobservation of marked drakes was calculated according to the method used by Leslie *in* Southwood (1966:77). Randomness is determined by a comparison of actual and expected variance by Chi-square of individuals observed during subsequent five-day periods after capture.

RESULTS

Population Observations

Hourly fixed-point observations were initiated when mallards returned to Ventura Marsh in late March in 1974 and early April in 1975 (Fig. 3). Each year, the greatest number of birds observed per hour occurred soon after spring arrival. Thereafter numbers declined and remained fairly constant after 20 April averaging 8.7 ± 3.5 mallards per hour in 1974 and 10.6 ± 3.2 mallards per hour in 1975. A total of 78 and 84 mallards were counted in 1974 and 1975 respectively, when the first ground counts were initiated in late April. In contrast to the fixed-point observations, numbers of mallards observed during ground counts continued to decline throughout the season.

In 1975, the sex ratio of individual flocks of mallards on fields and large water areas within 15 miles of Ventura Marsh was recorded. The sex ratios ranged from 126 to 154 drakes:100 hens and averaged 58 percent drakes (n=5,695). During the same period, we found sex ratios of mallards spaced on breeding areas to average 115 drakes:100 hens (53.5 percent drakes).

Marked Drake and Pair Observations

Trapping began in early April of each year and about 75 percent of the drakes were trapped by 1 May (Fig. 4). Although 64 marked drakes

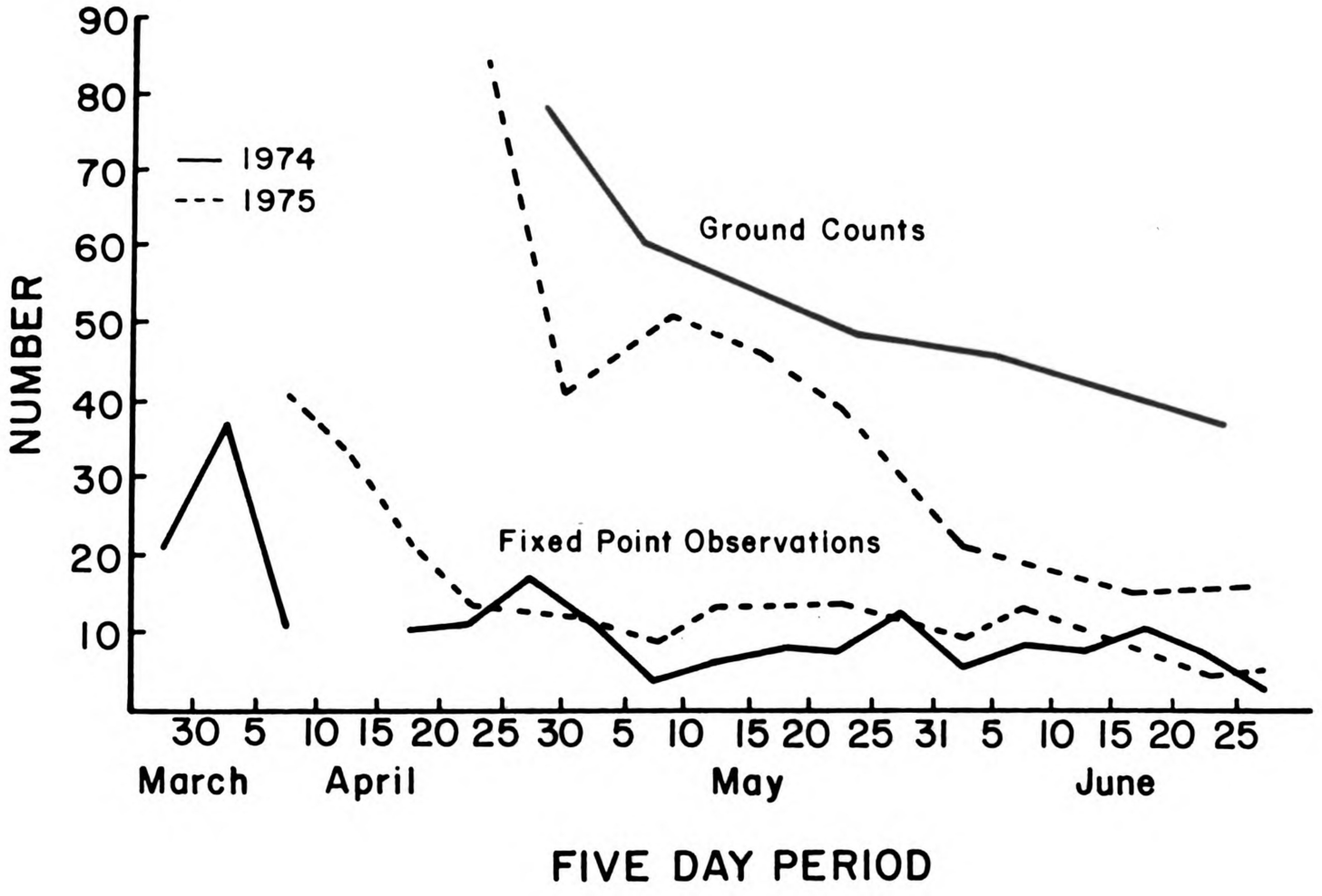

Figure 3. Total number of mallards seen during ground counts and number observed per hour per five day period during fixed-point observations on Ventura Marsh in 1974 and 1975.

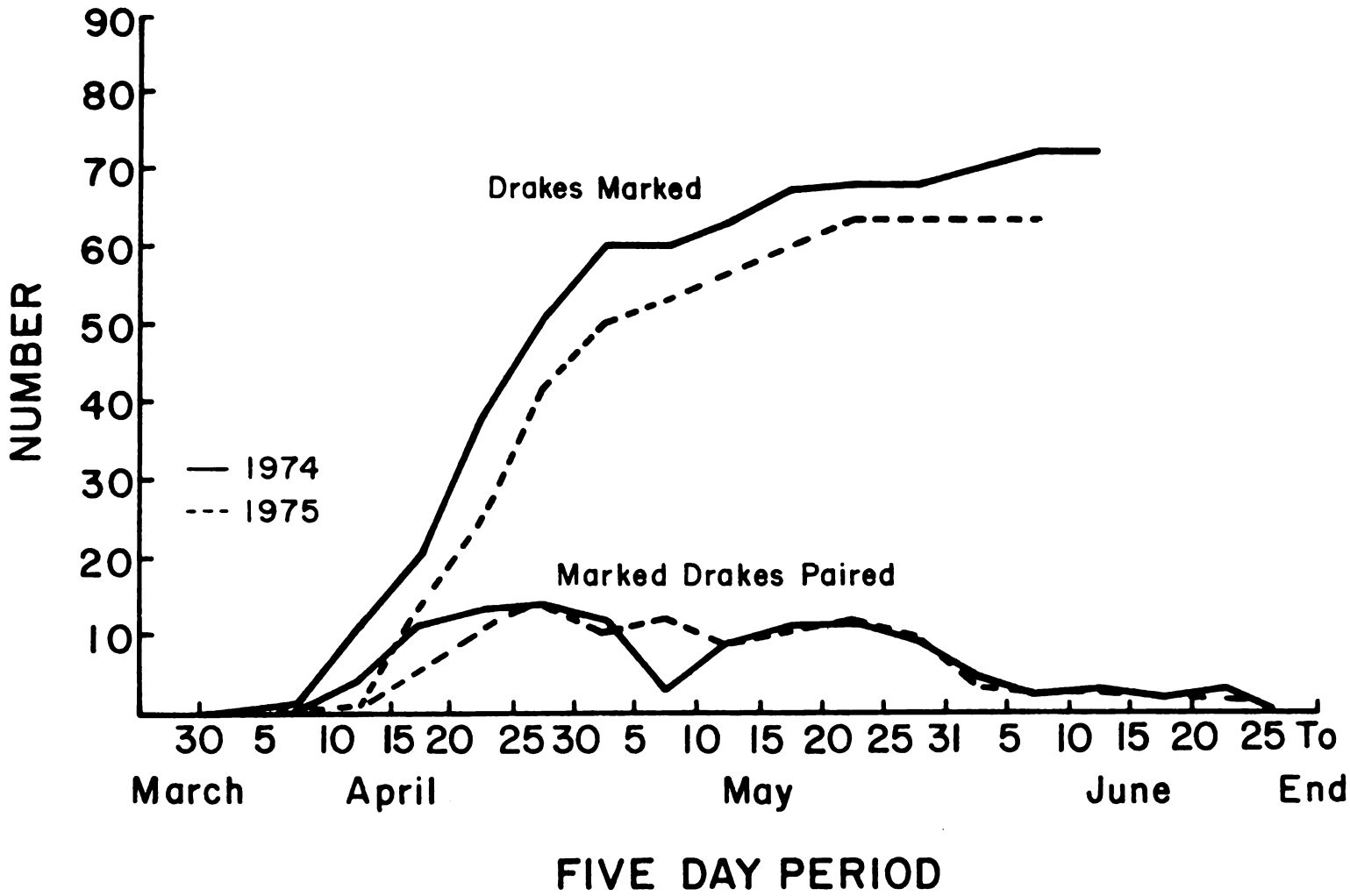

Figure 4. Cummulative number of drake mallards marked and number of marked drakes known to be paired and present on Ventura Marsh per five day period in 1974 and 1975.

were observed in a pair sequence during the two years, less than 14 were observed during any five-day period. An average of 10.3 ± 3.4 and 11.0 ± 1.6 marked drakes in 1974 and 1975, respectively, were observed to be paired during the eight periods following 20 April. The trend between the number of marked drakes and the total number of mallards observed per hour during fixed-point observations appears to be similar (Fig. 3 and 4). Although the ground counts and cumulative number of drakes marked suggest that a large number of mallards are potentially available to the area, the actual number of birds present and visible on the marsh remains at a lower and relatively constant level.

From the information collected on marked pairs, I was able to estimate the total number of pairs on the area during a five-day period with the aid of the following modified Lincoln Index:

$$N = MC/R$$

Where:

N = Estimated number of pairs present during a five-day period
M = Number of marked drakes known to be paired and present during a five-day period
C = Total number of single drakes plus pairs observed during a five-day period
R = Number of marked single drakes plus pairs observed during a five-day period

Although pairs were present on the area by late March and early April, no pair estimates can be calculated until after trapping and marking began, around 15 April. From 20 April to 31 May, the estimated number of pairs averaged 37.9 ± 15.7 in 1974 and 32.6 ± 15.6 in 1975 (Fig. 5). The number of indicated pairs (pairs plus lone drakes) calculated from ground counts are included as an independent check for comparison with

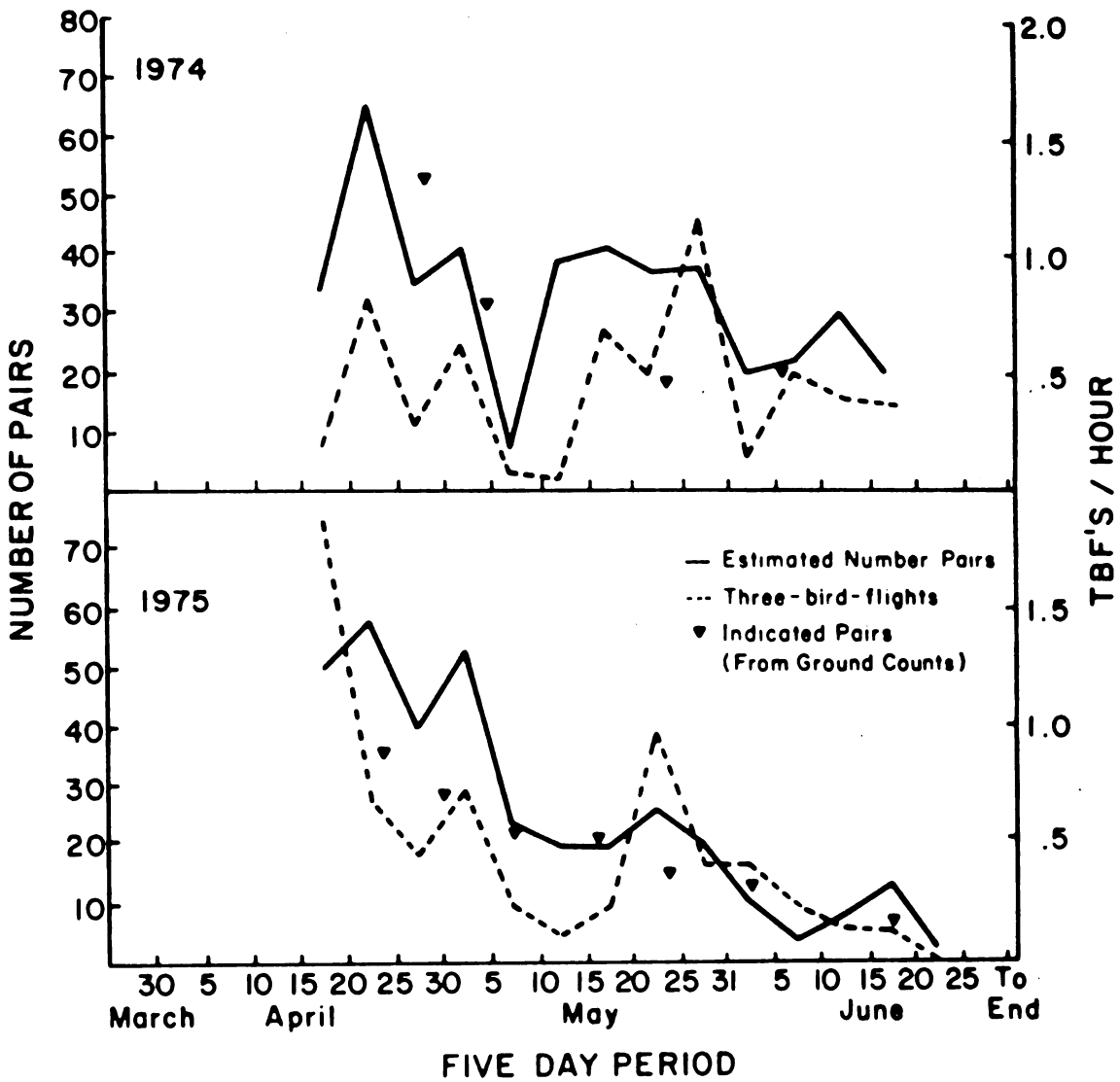

Figure 5. Total number of mallards estimated to be present compared to the number of indicated pairs as determined from ground counts and the mean number of three-bird-flights (TBF's) per hour on Ventura Marsh in 1974 and 1975.

estimated pairs. The counts and pair estimates were significantly correlated ($r=0.67$, 9 df, $P<.05$). The number of pairs appeared to gradually decline as the season progressed. The abrupt drop in the number of pairs between 5 and 10 May 1974 was probably due to birds dispersing to surface water outside the study area created during a week of increased rainfall. The total number of marked pairs and the average proportion of marked individuals on the area can be expanded to give an estimate of the total number of pairs on Ventura Marsh for the season by using the modified Lincoln Index. From this calculation, I estimated that at least 70 pairs could have utilized the system each year.

The number of three-bird flights per hour was calculated from the fixed-point observations (Fig. 5). We observed a range of 0.04 to 1.88 flights per hour over the two years. The number of estimated pairs and the number of flights were compared and found to be significantly correlated ($r=0.61$, 25 df, $P<.05$).

Over the two year study, 134 drakes were captured and marked. Forty-eight percent (64) were observed in at least one pair sequence with a hen for an average of 10.4 ± 8.2 days (Table 2). Eleven percent (15) of the males were observed in at least two pair sequences and 2 males were observed in 3 pair sequences. The second pair sequences averaged 6.9 ± 6.9 days in length and there was a significant decrease ($P<.01$) in the time individual drakes spent in first contrasted with second pair sequences. Over the two years, three of eight drakes were known to be paired with two different hens during the season. Chronologically, 76 percent of the 64 first pair sequences were initiated before 10 May while 87 percent of the second pair sequences did not occur until after 20 May.

Table 2. Number of times marked drake mallards were paired with females and number of consecutive days the drakes were observed with the hens per sequence on Ventura Marsh, Iowa in 1974 and 1975.

	Number of Pair Sequences		
	One	Two	Three
Number of drakes	64	15	2
Mean time (days)	10.4 ± 8.2	6.9 ± 6.9	1,8

The length of time that paired drakes were observed on the study area proved to be significantly different than what would be expected randomly. Marked drakes, which were observed at least part of the time with hens, spent an average of 17.5 ± 11.8 and 17.8 ± 13.7 total days on the area during the 1974 and 1975 seasons, respectively (Fig. 6). Of the 64 marked drakes which were observed with a hen, 20 percent (13) were observed as single drakes before they were observed in a pair sequence.

Marked drakes, which were never observed with a hen, were not contacted on the study area for more days than what would be expected randomly. Fifty-seven percent of the drakes (39) in 1974 and 52 percent (31) in 1975 were not observed with a hen after they were captured and marked. Those drakes were observed for an average of 1.2 ± 2.1 and 1.3 ± 1.2 days during the 1974 and 1975 seasons, respectively (Fig. 7). During the 14 periods following 15 April I observed an average of 6.1 ± 4.5 unpaired drakes in 1974 and 6.7 ± 4.8 drakes in 1975 during any one five-day period.

Nesting and Remating

The chronology of mallard nesting activity was determined by back-dating nests and class Ia broods (Gollop and Marshall 1954) to date of nest initiation (Sowls 1955:82). Nests were initiated between 5 April and 15 June in 1974 and 15 April and 10 June in 1975. Fifty percent of the nests were initiated by 30 April and 5 May in 1974 and 1975, respectively (Fig. 8). According to the project design, five nests in 1974 and six in 1975 were destroyed at mid-incubation. Nests

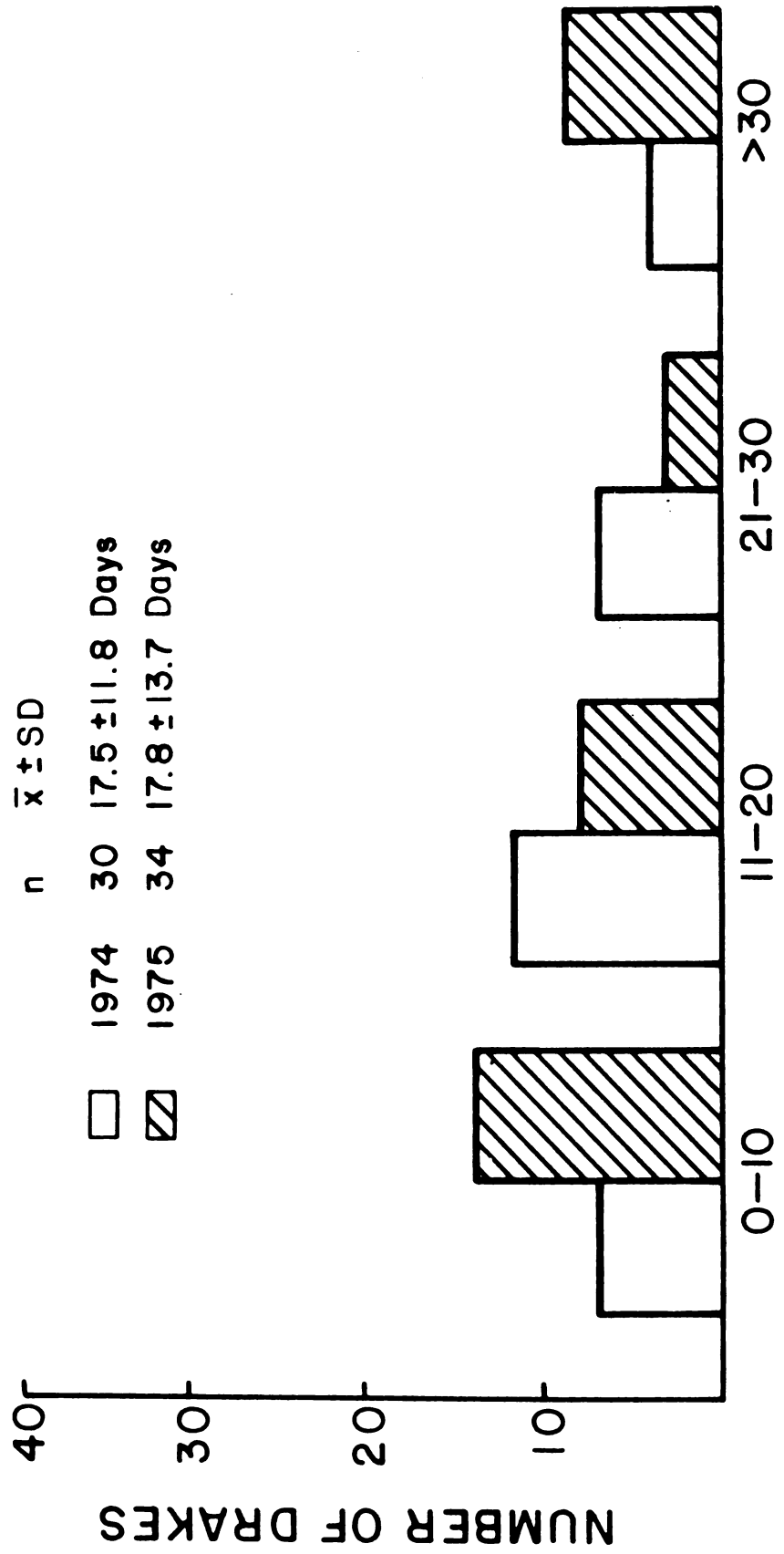

Figure 6. Number of days marked drake mallards, seen with hens, were observed on Ventura Marsh in 1974 and 1975.

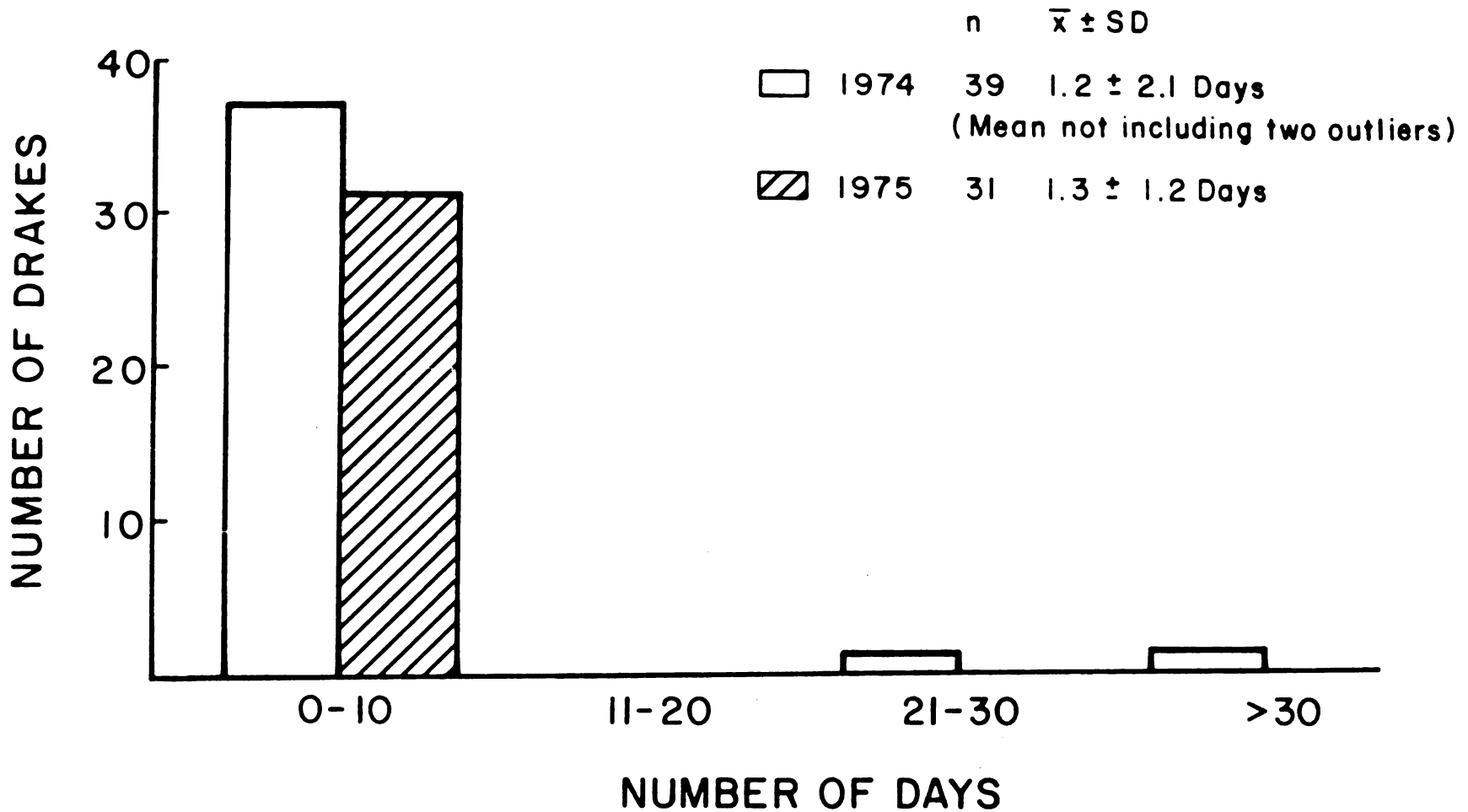

Figure 7. Number of days marked drake mallards, not seen with hens, were observed on Ventura Marsh in 1974 and 1975. This includes 22 drakes not observed after capture.

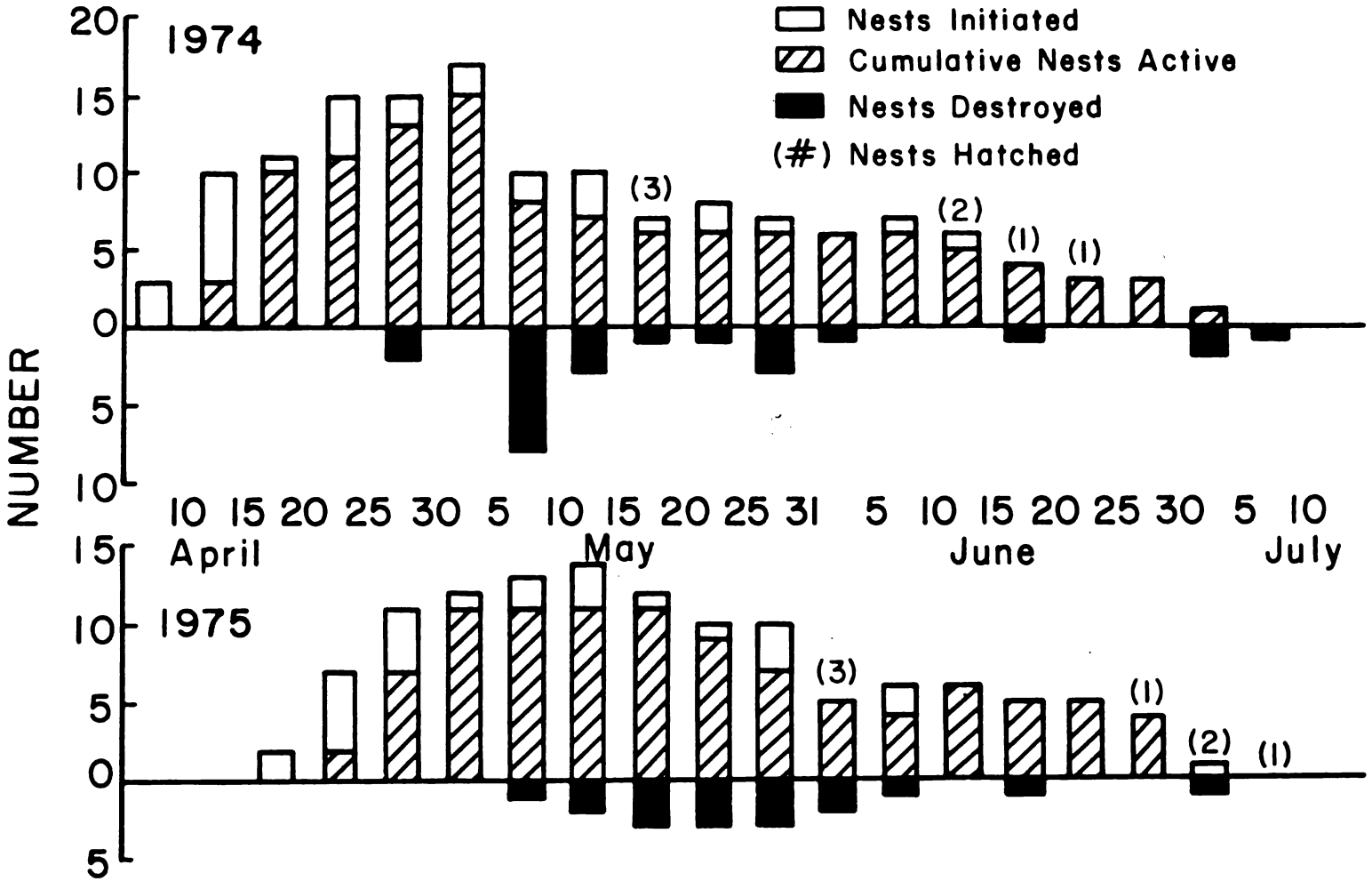

Figure 8. The chronology and status of 30 and 25 nesting attempts observed on Ventura Marsh during 1974 and 1975, respectively.

lost due to depredation and weather are included with those destroyed according to design. The large number of nests lost between 5 and 10 May in 1974 are believed to be the result of wet and cold weather during that period. This loss of nests corresponds to the abnormal drop in the number of pairs during the same period (Fig. 5).

The nests of 22 marked mallard hens were destroyed both naturally and by design between day 10 and day 17 of incubation during 1974 and 1975 (Table 3). Each hen was equipped with a working telemeter at the time of nest destruction. The hens were located daily and their consort was identified if one was present. Four hens (18 percent) emigrated from the study area after the nest was destroyed and were not located by aerial radio-location attempts within 30 miles of the study area. Three hens (14 percent) remained on the study area after nest loss but were not again observed with a drake. Fifteen hens (68 percent) were observed again with a drake of which four (18 percent) were with unmarked drakes both before and after nest loss. Of the 11 identified remating sequences, hens returned to their original drake 73 percent (8) of the time. The remaining 27 percent (3), were observed to remate with a different drake. Two of these three drakes were marked one of which had been previously paired and one not before observed with a hen. The third hen was observed with an unmarked drake in her second pair sequence.

Table 3. Breeding activity of hen mallards after destruction of nest between day 10 and 17 of incubation.[a]

Year	Observed With a Drake			Observed Without a Drake	Not Observed on Study Area	Total
	Previous Mate	New Mate	Unknown			
1974	2[a]	2	1	1	1	7
1975	6	1[a]	3	2	3	15
Total	8	3	4	3	4	22

[a]Data from observation of two females with nest depredated before day six of incubation are included.

DISCUSSION

A large influx of mallards was observed in late March and early April. During this period an average of 88 percent of the mallards were paired. This is consistent with the 90 percent paired mallards reported by Weller (1965) on wintering areas and also agrees with the general concensus among biologists that most mallards arrive paired in the spring. A sex ratio of 52.8 percent drakes was observed for spaced mallards on wetlands near Kindersley, Saskatchewan (Dzubin 1969a) which is similar to 53.5 percent drakes which were observed on Ventura Marsh. As expected, mallards on breeding areas show a sex ratio of near 50:50. Considering the data collected on migrants, which showed a marked disparity of 58 percent drakes, it appears that a significant sex ratio difference may actually exist.

After nesting pairs were established on the marsh, the number of individuals observed remained relatively constant throughout the breeding season. Dzubin (1969a), in discussing carrying capacity for pothole habitats suggested that for low to intermediate population levels of mallards, chases and avoidance are responsible for limiting the abundance of pairs on a specific area. In this study, the number of pairs and the number of pursuit flights were positively correlated. Since pair interaction increased when a greater number of birds were present, it appears that spacing mechanisms, in the form of pursuit flights, were important on Ventura Marsh. Our information appears to

be consistent with the idea that an upper limit exists on the density of pairs and the time mallards spend on the area. In this study, there were two times as many paired as unpaired drakes on the marsh throughout the season. Paired drakes were observed for an average of 16 days longer than unpaired drakes. A continuous turnover of lone drakes was observed on Ventura Marsh throughout the breeding season.

Because an upper limit of pairs appears to exist, some pairs may be unable to enter a particular breeding system. Those pairs may attempt to nest in sub-optimal habitats, emigrate to other areas or delay the breeding effort. These factors plus the possibility of late influxes of migrant and drought displaced pairs suggested by Dzubin (1969b) are probably responsible for the turnover of mallards observed on breeding areas. Delayed breeding was observed in at least three marked pairs. These pairs, which had a hen equipped with an active transmitter, did not attempt to nest for two to three weeks after they were first observed. The number of pairs which used the system and the turnover of pairs during the season could not be directly enumerated. I estimated with the aid of a modified Lincoln Index that at least 70 pairs could have utilized the marsh during each breeding season.

In addition to the effects of population turnover, hens that lose nests and renest, further confound the understanding of mallard breeding systems. Besides the new pairs entering a system, renesting pairs probably account for a large proportion of the pairs utilizing breeding areas later in the season. The number of hens losing nests and the incidence of renesting has been documented by Keith (1961), Coulter and Miller (1968) and Dzubin and Gollop (1972). Little field

data are available, however, concerning the remating activity of hens thwarted in initial nesting attempts. Observations of specific hens after nest loss showed that they obtained a mate in a variety of ways. The large majority (73 percent) of hens returned to their original drake. This suggests that paired drakes may be available for remating at least until mid-incubation. Less common (27 percent) was the incidence of hens changing drakes after nest loss.

The observations of marked drakes suggests there is flexibility in their remating activity. Although the majority of drakes were involved in one pair sequence, 23 percent were also observed in two or three pair sequences. Though the hens with marked drakes were usually not marked, 38 percent (3) of the drakes were known to have paired with different hens for the second or third pair sequence. Several drakes were involved in more than one pair sequence and some drakes paired with two different hens during the same breeding season. Twenty percent of the marked paired drakes were observed for a period of time on the marsh without a hen before they were observed in a pair sequence. None of these drakes were seen in more than one sequence as a paired drake. This suggests that a certain proportion of the drakes arrive unpaired in the spring and a limited number are successful in mating with a hen later in the breeding season.

The ability of breeding hen mallards to exploit a variety of options in securing a mate appears to be one characteristic of the mallard reproductive strategy. The hen, which needs a drake for insemination and perhaps to secure a space on the breeding marsh, has a number of alternatives available for remating after nest destruction. In this study, renesting hens most commonly remated

with their original drake. Less common in occurrence were hens remating with drakes previously paired to another female or hens remating with previously unpaired drakes. Other hens did not remate or emigrated from the area following the loss of the nest. Over the season, it appeared that an upper limit was imposed on the number of pairs utilizing the breeding area at one time. A turnover of individuals and the resultant temporal spacing appeared to allow for a large number of pairs to use the marsh over the season. There was also a constant supply of unpaired drakes, present for short periods, on Ventura Marsh throughout the breeding season. Although the surplus drake components appear to be available for breeding, they do not appear to interfer or disrupt the breeders in the system. The actual number of surplus males moving through a breeding marsh would appear to be directly related to the number of surplus males in the migrant population. Additional work under varying population densities, changes in sex ratios, different habitats and location within the breeding range is needed to determine the range of conditions that exist and that would not adversely influence mallard productivity.

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