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DUCK BROOD BEHAVIOR AT THE SENEY NATIONAL WILDLIFE REFUGE

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Abstract: Daily observations of duck broods living undisturbed in their natural environment and unaware of an observer's presence were made during the summer of 1950 and 1951 at a 20-acre marsh in the Seney National Wildlife Refuge on the Upper Peninsula of Michigan. Observations were made of duck broods of the following species: blue-winged teal (*Anas discors*), black duck (*Anas rubripes*), wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), hooded merganser (*Lophodytes cucullatus*), ring-necked duck (*Aythya collaris*), and American widgeon (*Mareca americana*). The latter two species were the most numerous, with the others represented by one or two broods only. Favorable loafing spots were so much in demand that competition existed among broods for their use. Although these spots were defended by the hen occupying them, she and her ducklings were sometimes driven off by other brood hens. No instance was ever observed of a widgeon hen driving a ring-necked duck family off a mound, but several instances of the reverse were seen. The female and her brood usually left the loafing mound together after completing their period of sleep, although sometimes the hen left while the ducklings were still asleep, to return either before they had awakened or after they had gone. Similarly, hens often left their broods while they were feeding, to return after an absence of 15-75 minutes. While thus temporarily abandoned, the young usually continued their leisurely foraging through the marsh. The duck broods exercised a considerable degree of mobility in their movements into and out of the study area; the overall length of time individual duck broods used the marsh varied widely. Methods of escape used by duck broods when frightened varied among the different species observed. With the exception of the widgeon, most brood hens usually tolerated the close approach of other adult ducks, provided they made no threatening move toward the young. The widgeons were conspicuous for their belligerence toward all ducklings that attempted to join their broods. In contrast was the behavior of the ring-necked duck and wood duck, which either tolerated or adopted young of other species into their broods. Loafing sites were extremely important in the daily activities of duck broods: it is quite probable that the number of such loafing spots in a marsh, suitable in all other respects for brood rearing, has a limiting influence on both the number of broods using the marsh and on the length of time they remain in it. Although no duck nests were found in the area immediately surrounding the study marsh, many of the broods first appeared there as downy young, indicating that rearing habitat need not necessarily include nesting sites. When existing rearing marshes become overcrowded, confusion prevails among broods, resulting in lowered duckling survival. Under such conditions, establishment of additional small rearing marshes is recommended. For the study area, the maximum concentration of broods occurred July 18, 1950, when 15 broods, representing 0.75 brood/acre, were tallied; and 9 widgeon broods was the highest number of broods of a single species seen there during 1 day. There appeared to be no conflict between the ducks and the deer (*Odocoileus virginianus*), beaver (*Castor canadensis*), and muskrats (*Ondatra zibethicus*) which also inhabited the marsh. The mink (*Mustela vison*), however, was shown to be a potentially important predator.

This paper is the outcome of two summers of field work devoted to a study of waterfowl behavior in a 20-acre marsh during the brood-rearing period. Its purposes are (1) to record the normal daily activities of duck broods in their natural environment when undisturbed by human

interference or experiments, and (2) to show how knowledge of brood behavior of the various species can be translated into useful waterfowl management practices.

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Fig. 1. Aerial view looking south of 20-acre study marsh showing its location between E Pool in the foreground and C Pool in the middle background. Note how the marsh is a topographically self-contained unit, encircled by a dike, tree-covered ridges, and two old beaver dams. Circles mark location of two tree platforms.



Fig. 2. Aerial view of study marsh looking north. E Pool is in the background. Circles mark location of the two tree platforms.



Fig. 3. West end of study marsh. The open character of the marsh, excellent interspersion of sedge and water, and sparseness of vegetative growth are evident. Note trails of duck broods and other animals, such as beaver and muskrat, through the *Brasenia*. Arrow indicates tree platform at west end.



Fig. 4. Zone of open water and dead brush in southeastern part of marsh. View looking across marsh toward northwest. West end platform tree indicated by arrow.

dean emeritus, and Warren W. Chase for their constant encouragement and continuing interest and to Howard L. Mendall and Louis A. Krumholz for their critical reading of the manuscript. Sincere appreciation is also due the U. S. Bureau of Sport Fisheries and Wildlife and C. J. Henry, formerly Seney Refuge manager, for unfailing courtesy and cooperation in making available the facilities of the Seney National Wildlife Refuge, where this study was undertaken.

STUDY METHODS

Selection of Study Area

A small marsh (Figs. 1, 2, 3, 4) of approximately 20 acres, shown by the writer's previous work (Beard 1953) at the Seney National Wildlife Refuge to be excellent brood-rearing habitat and highly productive of ducklings, was selected for intensive observation throughout the brood period in 2 years (1950 and 1951). There were several other features that made it ideal for the purposes of the study. It was situated between two large open water impoundments: E Pool (491 acres) to the north and C Pool (271 acres) to the south.

Water depth in both pools averaged 3 feet, and both had an abundant supply of desirable submersed aquatic plants. The only emergent vegetation present occurred as an occasional sparse fringe along the shoreline. The study area was separated from these open water bodies by a series of encircling dikes, ridges, and beaver dams, which had produced a topographically self-contained unit. In addition, it was small enough and so shaped that almost all of it could be seen from vantage points at either the east (Fig. 5) or west end (Fig. 6). The emergent aquatic vegetation was sufficiently sparse so that movements of duck broods could be followed with reasonable facility throughout the marsh. And, finally, because its location within the refuge was far enough away from the main traveled dike roads and public access areas, it was almost completely free from disturbance by either people or vehicles.

Description of Study Area

The ridges that bordered the marsh were covered with scattered red pine (*Pinus resinosa*), jack pine (*Pinus banksiana*), white spruce (*Picea glauca*), and white birch (*Betula papyrifera*), while the dike



Fig. 5. Flat mud loafing bar at east end of marsh. View looking toward west. Note open water and dead brush and mat of *Brasenia*.



Fig. 6. Close-up of west end mud mound. Note duck feathers in foreground.

and two old beaver dams that completed the encirclement of the area were fringed with a thick growth of tag alder (*Alnus rugosa*). The marginal vegetation consisted of cattail (*Typha latifolia*) and various sedges and grasses typical of such a location. The emergent aquatic plant was largely a fine sedge (*Carex lasiocarpa*) which grew in small patches of sparse to medium density, well interspersed with open water (Fig. 7). In the eastern quarter, the sedge was replaced by dead brush clumps and large areas of open water. A luxuriant and abundant growth of watershield (*Brasenia schreberi*) covered more than three-quarters of the entire surface of the marsh. The most common submersed aquatic plants included, in addition to the watershield, various species of pondweeds (*Potamogeton* spp.), elodea (*Elodea canadensis*), and bladderwort (*Utricularia* spp.). The depth of water within the marsh ranged from 2.5 feet in the open water zone in the eastern quarter to 1 foot, with an average of approximately 1.5 feet throughout most of the marsh. (For a more detailed description of this area, see Beard 1953.)

Techniques of Observation

In 1949 an observation platform was built 30 feet high in a red pine at the west

end of the marsh, and, in 1950, an additional platform was erected in a jack pine at the east end (Fig. 8). These platforms made it possible not only to see duck broods that could not have been spotted from ground level, but also to follow their movements throughout the marsh. Equally important, it was possible from these vantage points to observe the broods without alarming them, since ordinarily they were unaware of anyone on the platforms.

From June 16–August 22, 1950, and from June 14–August 22, 1951, observations were made almost daily at the study marsh. In addition, observations were made of all duck broods wherever encountered throughout the refuge. Since the broods were most active from daylight until about 10:00 AM, Eastern Standard Time,² most of the field work was done during those hours, although a few observations were made during the afternoon and early evening. Both Hochbaum (1944: 97) and Mendall (1958:131) stated that the periods of greatest activity among duck broods were during the early morning and evening hours. A typical observation day began at 5:30 AM and ended 5 hours later. Eight-power binoculars and a

² Eastern Standard is the time used throughout this paper.

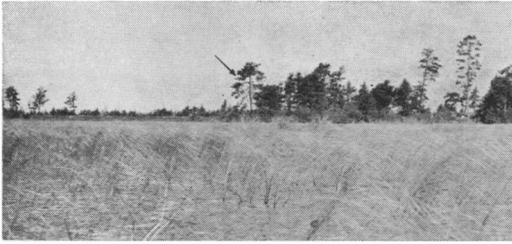


Fig. 7. Predominant emergent in the study marsh is *Carex lasiocarpa*, which does not form tussocks, but whose stems form beds of the sedge-meadow type, growing in this marsh in stands of sparse density. Note *Brasenia*, which blankets almost the entire marsh. West end platform tree indicated by arrow.

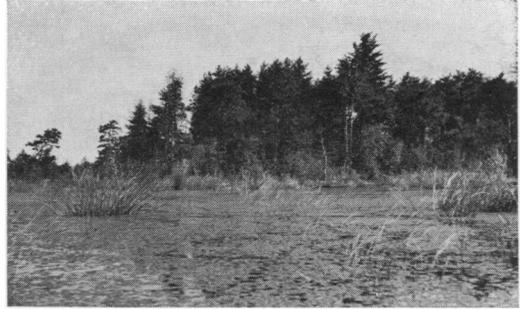


Fig. 8. Platform in jack pine tree at northeast corner of marsh. Note surface mat of *Brasenia* and clumps of dead brush.

20-power spotting telescope were used.

All brood movements and activities were timed and recorded in detail. Broods were identified as to species, number of young, and age-class. The U. S. Bureau of Sport Fisheries and Wildlife system of designating ducklings up to 2 weeks old as Class I, 2-6 weeks as Class II, and 6 weeks to flyers as Class III was followed throughout this study.³ In a majority of instances, it was possible to identify individual broods with reasonable certainty, though it is readily admitted that since no broods were color-banded or otherwise marked, identification could not actually be proved, and a few errors might have been made, especially among the many American widgeon and ring-necked duck broods. The number of young, the progressive change in age-class, plus behavior mannerisms such as regularity of use of same spot for loafing and sleeping each day, however, all helped establish brood identity. In addition, a record was kept of the earliest date the first brood of each species appeared in the marsh, as well as the latest date that

the last brood of each species was seen there. These have been tabulated in Table 1. The number of different broods and the total number of observations of each species occurring in the marsh are listed in Table 2. Widgeon and ring-necked duck were by far the most numerous, with the other species represented only by one or two broods each.

An attempt was made to determine the average size of the broods for each species that occurred in the study area. Significant volume of data was obtained, however, only for the widgeon and ring-necked duck. Brood sizes for these two species, along with comparative figures from other waterfowl workers, are tabulated in Table 3.

ACTIVITY AND BEHAVIOR OF BROODS

Feeding

Feeding consumed nearly three-fourths of the total time during which the broods were observed. The duration of individual feeding periods showed wide variation ranging from 15 to 315 minutes, but the average length fell between 40 minutes for the blue-winged teal and 105 minutes for the wood duck (Table 4). Mendall (1958:133) found that a ring-necked duck family "may spend as much as 45 minutes feeding and resting in a single feed bed."

³ This system lacks the greater refinement by species and groups of the classification worked out by Gollop and Marshall (1954) but was the only one available at the time this study was made.

Table 1. Earliest and latest dates for duck broods in marsh for 1950 and 1951.

BROOD SPECIES	FIRST DATE SEEN	AGE-CLASS OF BROOD	LAST DATE SEEN	AGE-CLASS OF BROOD
Black duck	June 16, 1950	Downy	August 4, 1950	III
	June 25, 1951	III	June 25, 1951	III
Mallard	June 29, 1950	II	July 3, 1950	II
	June 14, 1951	I	June 22, 1951	I
Blue-winged teal	July 6, 1950	Downy	August 11, 1950	III
Wood duck	June 17, 1950	Downy	August 3, 1950	III
	June 22, 1951	Downy	August 17, 1951	III
Hooded merganser	June 23, 1950	I	August 4, 1950	III
	June 14, 1951	I	July 23, 1951	III
American widgeon	July 1, 1950	Downy	August 22, 1950	III
	June 18, 1951	Downy	August 17, 1951	III
Ring-necked duck	June 28, 1950	Downy	July 28, 1950	II
	June 21, 1951	Downy	July 25, 1951	II

The feeding method differed somewhat among ducklings of the various species, and, to a lesser extent, among ducklings of different age-classes of the same species. Young wood ducks fed in a most lively manner. They darted swiftly over the water in all directions chasing insects, or they swam along more slowly, energetically dabbling and skimming the surface of the water with their bills. Most characteristic was their remarkable agility in jumping to get insects clinging to the sedges. As these young wood ducks grew older, they obtained more of their food by dabbling. As they increased in size, they were able to reach many of the insects on the sedges simply by stretching their necks. When this failed, however, they did not hesitate to jump, and it was very common to see young ducks, almost able to fly, jumping 8–10 inches out of the water for insects high on a sedge stem. This habit of jumping to obtain food appeared to be more strongly developed in wood duck young than in ducklings of the other species observed.

Young hooded mergansers were vigorous feeders, too, though their method was quite different. When feeding, they swam with just their heads under water or, frequently, with their entire bodies com-

pletely submersed with only the rippling of the water above to indicate their presence. Other times they resorted to diving. They swam rapidly, moving in spurts, first in one direction, then in another, chasing minnows that presumably constituted their food. When they found a school of fish, the entire brood concentrated on the spot and stayed there several minutes, churning up the water with their splashing, diving, and underwater feeding. While hooded merganser ducklings were in the downy or Class I classification, their dives were shallow and of short duration, but as they grew older, the dives increased in depth and length of time.

Table 2. Number of broods and number of brood observations in study marsh for 1950 and 1951.

BROOD SPECIES	TOTAL NUMBER OF OBSERVATIONS		TOTAL MINIMUM NUMBER OF DIFFERENT BROODS	
	1950	1951	1950	1951
Black duck	5	1	5	1
Mallard	3	5	1	2
Blue-winged teal	10	—	1	—
Wood duck	21	22	1	1
Hooded merganser	26	16	1	2
American widgeon	77	71	21	14
Ring-necked duck	30	35	8	10
Totals	172	150	38	30

Table 3. Brood sizes of ring-necked duck and American widgeon broods.

REPORTED BY	LOCATION	AVERAGE SIZE OF BROODS—CLASS I	NUMBER OF RECORDS	AVERAGE SIZE OF BROODS—CLASS II	NUMBER OF RECORDS	AVERAGE SIZE OF BROODS—CLASS III	NUMBER OF RECORDS
Ring-necked Duck							
Wright (1954:48)	New Brunswick	6.6	39	5.7	20	5.3	18
Mendall (1958:139)	Maine	7.0	488	6.0	361	5.2	141
Beard (present study)	Michigan	7.3	38	4.6	28	—	—
American Widgeon							
Munro (1949:296)	British Columbia	7.0*	10	6.2*	75	5.2*	14
		(June)		(July)		(August)	
Evans et al. (1952:36)	Manitoba	6.4	15	5.0	4	5.0	4
Beard (present study)	Michigan	7.6	23	5.8	16	4.6	11

* In his study of the American widgeon, Munro classified the broods by months instead of age-classes. It is probable that a substantial number of his June, July, and August records correspond to age-class I, II, and III, respectively.

American widgeon ducklings were industrious and extremely thorough in their feeding. They were essentially dabblers and surface gleaners. While feeding, widgeon broods moved very slowly through the marsh. It appeared as though no part of the water surface in their path escaped their concentrated attention. Their feeding was so vigorous that the noise of their bills sucking in the water could be heard for a considerable distance. When passing through the marsh sedges and rushes, the young stretched or occasionally jumped to obtain insects. Sometimes they skittered or darted along the surface of the water in their chase after food. On one occasion, I observed tiny ducklings (about 2 weeks old) making short shallow dives amidst much splashing and skittering about. In general, however, widgeon broods moved slowly and rather deliberately through the marsh, dabbling and gleaning along the water surface with characteristic thoroughness. When the young were half grown (4 weeks or more), they began tipping for food in addition to surface dabbling.

The feeding habits of mallards and blue-winged teal were similar to those of the widgeon. These ducklings were surface

gleaners and vigorous dabblers, too, but in their feeding they darted and skittered first in one direction, then in another, in contrast to the intensive coverage and methodical thoroughness of the widgeon. Blue-winged teal young reached up and stretched to obtain food otherwise unobtainable on the sedges above them, but seldom resorted to jumping. Mallard young, on the other hand, frequently jumped the full length of their bodies to reach food, but with nowhere the frequency or vigor of young wood ducks. Although the young of these two species scattered rather widely when feeding, they moved through the marsh as a unit, maintaining contact with one another in response to some type of visual or auditory stimulus. Collias and Collias (1956:391) found, in a series of experiments conducted at the Delta Waterfowl Research Station in Manitoba, that broods show a strong tendency to keep together regardless of whether the hen is present and that this cohesion is maintained "in part by means of the contentment notes [uttered by the ducklings], which therefore function as contact notes." Mallard ducklings when feeding often spread out abreast of each other. When half grown (about 4

Table 4. Duration of feeding and sleeping periods during morning activities of duck broods.

SPECIES	FEEDING				SLEEPING			
	Number of Observations	Duration (minutes)		Average Duration	Number of Observations	Duration (minutes)		Average Duration
		Minimum	Maximum			Minimum	Maximum	
Wood duck	19	15	210	105	5	45	60	48
Mallard	3	30	105	60	2	20	20	20
Blue-winged teal	6	15	75	40	6	15	90	51
Hooded merganser	9	30	150	76	4	30	90	45
Ring-necked duck	41	15	315	96	26*	5	120	50
American widgeon	30	15	165	65	17†	15	105	44

* 10 of the 26 observations were for 1 hour or more.

† 7 of the 17 observations were for 1 hour or more.

weeks), these ducklings commenced tipping for their food.

Ring-necked duck broods fed both by dabbling and by diving. Downy and early Class I ducklings obtained most of their food from the water surface. They were extremely quick and agile in their movements, darting and skittering over the water in all directions, jumping to reach insects on the marsh sedges. Occasionally they made shallow dives of very short duration—not more than 8 seconds. However, by the time they were 2 weeks old, they began to feed more and more by diving, so that when they were about half grown (3–4 weeks old), they had switched almost completely to this method of feeding, and their dives were approaching the 15-second average duration of adults. Mendall (1958:132) observed similar development in the diving habits of ring-necked ducklings.

There was little significant difference in the behavior of the hens of the various species as they accompanied their feeding broods through the marsh. The ducklings, spread out rather widely, usually preceded the hen, which followed slowly, very much on the alert, though she frequently interrupted her watchfulness to dabble very briefly for food as she moved along. Sometimes she dropped behind the ducklings for

1 or 2 minutes, occasionally to feed or preen but more often to remain motionless, with no relaxation of her constant vigilance, before slowly moving on to overtake her brood, which she never allowed to get very far ahead. The widgeon, blue-winged teal, and ring-necked hens, in particular, did this, with the latter often making stops of 2–3 minutes duration. The ring-necked hen usually did not feed at all as she accompanied her brood through the marsh. When the ducklings stopped and began to feed, she normally sat quietly to one side, maintaining constant watch. It was only when they had finished feeding and had settled down nearby to rest that she would begin to dive for food. Similar observations on the feeding behavior of ring-necked brood hens were given by Mendall (1958:133). As the ducklings grew older, all the hens relaxed some of their vigilance and fed more frequently. Ordinarily, the hens were silent as they moved through the marsh with their broods. Exceptions to this were the widgeon and, to a lesser extent, the blue-winged teal, which commonly uttered an intermittent soft quacking.

Sleeping and Loafing

Duration and Frequency of Sleeping Periods.—Sleeping accounted for about

one-fourth of the total time that the ducklings were under observation (Table 4). The duration of the individual sleeping period, while showing considerable range from a short catnap of 5 minutes to a prolonged sleep of 2 hours, averaged between 45 and 50 minutes. In the cases of the ring-necked duck and the widgeon, for which the greatest number of observations were made, out of 26 observed sleeping periods for the former, 10 were of 1 hour or more; and out of 17 periods for the latter, 7 were of more than an hour.

Usually the broods slept only once during a typical morning's observation period. When broods slept more than once during such a period, the total time for the combined sleeping periods ranged from 50 to 110 minutes, with an average of 83 minutes.

Types of Sites Used for Sleeping and Loafing.—The duck broods used a rather wide variety of sites in the study marsh for sleeping and loafing. A floating log, sedge tussocks, bases of dead brush clumps, a low mud beaver dam, sedge vegetation bordering the marsh, snags, and even yellow water lily pads were used. But by far the most favored sites were two small mud bars and an area of open water and dead brush.

The two mud bars, one at the east end and one at the west end of the marsh, were low-lying mounds about 3 feet long and 2 feet wide, probably the remains of old muskrat houses or flattened sedge tussocks from which the sedges had long since disappeared. The east bar, about 100 feet from the edge of the marsh, was in an open water area free from emergent sedges and dead brush. The west one, however, was surrounded by sedges and clumps of dead brush. It was not quite so flattened as the east mound but rose above the water surface about 6 or 8 inches. Bennett (1938:55) listed old rotted-down

muskrat houses as favorite resting and roosting sites for duck broods, as did Hochbaum (1944:10). The open water zone in the eastern quarter of the study area was covered almost completely with a blanket of water shield leaves but was unbroken by any type of emergent vegetation except for a scattering of dead brush clumps.

Use of Mud Bars for Sleeping and Loafing.—Both mud bars were used at one time or another by duck broods of all species in the marsh, but the widgeon, ring-necked duck, blue-winged teal, and hooded merganser used them most frequently. On numerous occasions they were occupied at different times during the same day by different duck broods. For example, on the morning of July 20, 1951, the east mound was used as follows: 7:20–8:05 ring-necked brood; 9:00–9:55 widgeon brood; 9:55–10:30 ring-necked brood.

In fact, so popular were these two mud bar loafing sites, that, as shown by several observations, there was actual competition among the various duck broods for their possession. On June 28, 1950, a female hooded merganser and 9 Class I ducklings and a female wood duck and her 12 Class I young were feeding in the center of the marsh. At about the same time both family units began to move in the general direction of the west mound. As they neared the loafing spot and it became obvious they were headed for the same place, both broods, spurred on by the females, increased their rate of progress, so that by the time they were within 100 feet of the mound they were swimming very rapidly. The hooded merganser reached the mound first, and the ducklings, without the customary preliminary bathing, took instant possession. The wood ducks continued past the mound and shortly afterwards commenced feeding.

On several occasions, broods swam directly to one of the mounds already occupied by another female and her young. It appeared certain from the directness of their course through the marsh that the mud bar was their destination, and had it not already been occupied they would probably have used it themselves. Sometimes these broods just swam on past. Other times they settled down to sleep in the water at the base of the occupied loafing spot. For example, a female widgeon and five Class III young swam directly from the low beaver dam at the east end of the marsh to the east loafing mound, which was already occupied by a widgeon and her brood of five Class III ducklings. There they bathed for a minute, went completely around the mound, then returned to the dam, where they fed a moment, turned, and once again swam back to the mound. This time they gathered into a compact group and settled down to sleep about 15 feet from the mound. The hen and ducklings already in possession paid little attention to them.

Sometimes, however, the outcome was not so peaceful, and the intruding hen successfully drove the original possessors away. An observation made July 20, 1951, showed the ring-necked duck as the successful aggressor. A widgeon and her five Class III young had been sleeping on the east mound since 9:00 A.M. A ring-neck and her nine Class II ducklings began to move in the direction of the mound from a distance of 200 yards away. Eight of the young fell behind and commenced feeding. The female and one duckling continued on toward the mound until they reached a small area of open water (free from *Brasenia*) about 50 feet from the mound. There the female stopped and bathed. This allowed the eight ducklings almost to catch up to her. Then she and the other

duckling swam around to the north side of the mound. There they stopped, and the female looked directly at the widgeon and her brood for several minutes. The hen widgeon was preening and paid no attention to the ring-necked duck.

Suddenly, without warning, the ring-neck lowered head and neck in the usual threat position, opened her bill, and spurted across the 15 or 20 feet that separated her from the loafing mound. She rushed onto the mound and headed directly toward the female widgeon. The latter leaped at least 5 feet into the air. The young widgeons left the loafing site immediately, as did their hen. However, one duckling was a little slower than the others, and as it went past the ring-neck, the latter nipped it with her bill. She even followed it back into the water. At this, the hen widgeon turned and rushed the ring-necked duck. There was a brief flurry of wings and water, which resulted in the ring-neck releasing the young widgeon. Then widgeon and brood swam away.

Meanwhile, the eight ring-necked ducklings, sitting quietly together, had remained a short distance (approximately 60 feet) from the disputed loafing spot. The moment the hen widgeon and her brood were successfully dislodged by the ring-neck, the eight young ring-necks moved leisurely toward the mound, feeding as they went. They stopped to bathe for a minute or two. Then, with one accord and in single file, they approached the mound directly. Within the last few yards of their destination they put on a little extra spurt, and one by one scurried up onto the bar, joining the hen ring-neck and duckling already there. After preening a few minutes, the hen and her reunited brood of nine settled down and slept 35 minutes before leaving.

Use of Sites Other Than Mounds for Sleeping and Loafing.—The open water-

Table 5. Frequency of use of loafing sites by duck broods for 1950 and 1951 combined.

LOAFING SITES	NUMBER OF TIMES USED
Open water and dead brush zone— (east end of marsh)	28
East mud bar	26
West mud mound	14
Flattened sedge tussock	5
Floating log	5
Mud beaver dam	5
Lily leaves	5
Sedge growth at periphery of marsh	4
Dead brush hummock	1

dead brush area in the southeastern part of the marsh was the favored loafing spot of ring-necked and, to a lesser extent, of widgeon ducklings. This area was large enough so that it was a common occurrence for two broods of ring-necked ducks and occasionally a widgeon brood to be sleeping or loafing in it at the same time.

Sedge vegetation bordering the edge of the marsh, small tussocks of sedge within the marsh, a low beaver dam, and a floating log were all used occasionally and rather indiscriminately by the various duck broods.

With but two exceptions, no clear preference for any site by any species or any age-class was indicated. The ring-necked broods favored the open water-dead brush area and the mud bars in the open water, and they avoided dry land sites, such as the sedge growth of the marsh edge. The diving habits of this species easily explained this preference. The use of floating leaves of the yellow water lily and water shield was restricted to very young ducklings, since the lily pads could not support the weight of older ducklings.

The use of the various loafing sites in the marsh by the duck broods for 1950 and 1951 combined is summarized in Table 5.

Regularity of Use of Loafing Sites.—Individual duck broods showed a marked

tendency to use the same loafing spots each day they were in the marsh. This was true for almost all the broods for which a sufficient number of consecutive observations of individual broods could be made. One of the most striking examples of this involved a brood of 12 blue-winged teal, which was observed from July 18 through August 1, 1950. During that entire time, the brood used only the east mound. On two occasions, it came into the marsh, swam directly to the east bar, slept there, and then left the marsh immediately after its sleeping period.

Twice a brood of five widgeon probably would have slept on the east loafing site which they had been using rather regularly, if it had not been already occupied by a ring-necked brood. In each case, the widgeons settled down to sleep close by, and when the ring-necked family left the mound, they swam over and took possession of it.

Except within a general range of 2-3 hours, duck broods did not sleep at the same time each day. During the morning hours, the broods usually had at least one sleeping period, with others throughout the rest of the day, but there was almost no evidence of any rigid adherence to a timetable. A similar conclusion was reached by Hochbaum (1944:97), who stated "I have not been able to deduce any fixed schedule of daily brood activities in the Canvasback." Mendall (1958:131) said "They [ring-necked broods] feed frequently and they rest frequently, and these periods are scattered throughout the entire period of daylight, with little evidence of fixed routines."

Approach to Loafing Sites.—Whenever a duck brood headed for a loafing spot (especially the east or west mound), its progress through the marsh became direct, rapid, and purposeful. So invariable was

this behavior, that the brood's course and final destination could be quite accurately predicted. The hen usually led the young, which followed in single file, and she set so rapid a pace that the ducklings often had to skitter over the water to keep up. Rarely, she pressed close behind them. This change in the tempo of travel closely resembles that described by Mendall (1958: 133) for ring-necked families when moving across open water.

Upon reaching the loafing sites, the hen and her brood commonly bathed quite energetically for several minutes before climbing out of the water. I noted that they sought openings free from the *Brasenia* mat that blanketed most of the open water, no doubt to avoid becoming tangled in the luxuriant growth of stems and leaves. When they had finished bathing, usually the hen climbed out first, followed by the ducklings, which ran right up onto the mound. If they were in the early Class I stage and the mound was steep (like the west mound), they frequently fell off backwards and had to make several attempts before gaining the top. Or, if they had chosen to sleep on a log, there was much falling off and climbing back again before all the young succeeded in balancing.

Occasionally, after leading the young to the mound, the hen would remain in the water at its base, either bathing and preening or sitting alert and motionless, watching for any possible danger. Then, after 3–10 minutes, she would join her ducklings, which were already asleep.

Brooding of Young.—On two occasions hens were observed brooding their young. At 8:15 AM, July 3, 1950, a hen ring-neck flew into the marsh to rejoin her 12 downy ducklings which had been feeding, and they all gradually worked their way over to the west mound, which they quickly as-

cended, helping themselves up by flapping their tiny wings. Once on top, they preened actively for several minutes before settling down in a compact group. The female stood astride them, dropped her wings to the ground, and then carefully lowered herself over the young, completely covering them. Three-quarters of an hour later when the female stood up for a few minutes and preened a bit, the young ducklings were seen all still sleeping beneath her. While brooding the young, the hen slept with her head turned back on her shoulder and her bill under the scapulars. Twenty minutes later she awoke, stretched, and left the mound. The young followed, jumping off one at a time, each making a faint splash as it hit the water.

Defense of Loafing Sites.—At least in the case of widgeons, the defense of a loafing mound was not so vigorous when the intruder was of the same species as when the interloper was of a different species. Frequently after some display of intimidation and hostility, the challenge for the loafing spot ended with both the original possessors and the intruders peacefully occupying the mound at the same time.

On August 17, 1951, a widgeon and her four Class III young were sleeping on the east mound. A second brood of the same species (one female and three Class III young), which had been sleeping nearby at the base of some dead brush in open water for 1 hour and 40 minutes, swam up to the loafing site. For several minutes this brood remained motionless, just staring at the brood on the mound. Suddenly the female lowered head and neck into a threatening position and climbed onto the mud bar. One of the ducklings already on the mound jumped into the water. The rest of the brood, with lowered heads and necks, stood their ground. At this, the

duckling which had jumped off returned. Then the three young of the intruding brood ascended the mound, and in a few minutes the threatening postures were abandoned and all nine began preening. After 5 minutes, however, the brood which had first been on the loafing spot left and swam 20 feet or so away, where it settled down in the open water and slept.

While several observations already described have shown widgeon broods successfully driven from their loafing sites by ring-necked duck broods, no observations were ever made of widgeons either attempting to dislodge ring-necks from their mounds or of successfully defending their own when attacked by ring-necks.

Behavior on the Loafing Site.—All species of duck broods exhibited much the same behavior while occupying the loafing mounds. Sometimes the female climbed onto the mound, followed by the young either immediately afterwards or after an interval of a few minutes; other times it was the young which occupied the mound first and the hen which followed. Once on the loafing site, the hen and ducklings almost invariably spent several minutes preening before settling down to sleep. The preening was probably a necessary aftermath of the bathing which both the female and young almost always did before occupying the loafing spot.

In general, the female and her brood left the mound at the same time, after completing their period of sleep. Sometimes, however, the hen left the loafing spot while her brood was asleep and returned either while it was still sleeping or after it had awakened and left the mound. An example of the hen returning while her brood still slept was observed on June 28, 1950, at 7:30 A.M. A female hooded merganser and her 12 Class I young swam over to the west loafing mound. After the

brood had preened a few minutes, the hen flew off, leaving the marsh. The young continued preening a short time, then huddled in a compact group and slept. After 15 minutes the female reappeared, swam up to the mound, preened, climbed out of the water, continued preening, then settled down next to her young and slept. Ten minutes later she and her brood left the mound.

A typical illustration of a female leaving her sleeping brood and returning after it had awakened and left the loafing spot was noted on July 21, 1950. At 7:20 a blue-winged teal and her brood of 12 Class II young climbed onto the east mound and within 5 minutes were all asleep. Twenty minutes later the female left. Ten minutes after that (7:55) the young swam over to the east bank of the marsh where they began feeding. Fifteen minutes later quacking was heard, and the hen came flying over the marsh from the west, landing at the base of the east mound. She climbed onto the vacant loafing spot, quacked once or twice, and stayed there several minutes. Her young, which were busily feeding about 125 yards away, paid no apparent attention to her. She then flew toward her brood, landed, and began swimming toward them, quacking occasionally. Still the young continued feeding, but after several minutes the hen reached the brood, and then they all moved off together busily feeding.

Competition with Turtles for Loafing Sites.—Competition for loafing sites was occasionally noted between ducks and painted turtles (*Chrysemys picta*). The turtles frequently took complete possession of the mud bars. Usually, however, duck broods and turtles shared these spots with mutual tolerance. Ring-necks, widgeons, hooded mergansers, and wood ducks were observed occupying mounds simultaneously

with from one to nine painted turtles. A similar observation was made by Bennett (1938:64), who stated, "Often the turtles [Bell's painted turtle (*Chrysemys picta bellii*)] were observed on muskrat houses sunning themselves side by side with young and adult teal. But it was not found that this turtle interfered in any way with the well being of the Blue-winged Teal."

Occasionally some slight signs of antagonism were observed. On June 23, 1950, a female wood duck and her 12 Class I young and 2 Class I hooded mergansers were sleeping on the west mound. The ducklings were crowded together in several small groups spread out over the small bar. A painted turtle started to crawl slowly up the mound directly toward one of the duckling groups. The hen wood duck paid no attention to the turtle, but two ducklings directly in its path lowered their heads, stretched out their necks in a threatening manner, and opened their bills a couple of times as though hissing. This had no effect on the turtle, and the young made no further attempts to frighten it away. Shortly afterwards, a second painted turtle joined the first, and both moved toward one of the young ducklings which was by itself at one end of the bar. At that, this one scurried away and joined the other ducklings. The two turtles remained on the vacated end of the mound.

Mobility of Duck Broods

The number of duck broods using the study marsh changed almost daily. This indicated a considerable degree of mobility of hens and ducklings and much movement back and forth between the marsh and adjacent open water pools. Studies by Evans et al. (1952:24), Hochbaum (1944:104), Bennett (1938:52), and Sowls (1955:144) established the high degree of mobility of hens and ducklings. Evans listed in

order of degree of mobility the following species: pintail, canvasback, mallard, red-head, blue-winged teal, American widgeon, and ruddy duck. Actual ingress and egress were not, however, seen very often.

There was a marked tendency for particular spots to be favored for entering or leaving the marsh. For example, during a 2-week period a female blue-winged teal and her 12 young were seen leaving the marsh three times, entering it once, and entering and leaving it on the same day once. On each of these occasions the teal always left or entered the marsh at the center of the low sedge-grown mud beaver dam at the east end of the study area. Black duck, mallard, and wood duck broods were also seen to cross at this spot. Apparently, it served as a natural travel-way between the study area and the pool beyond it.

When a female and brood were about to leave, their manner of movement changed completely from that used in feeding or just casual wandering; they moved as they did when they headed for loafing spots. The pace set was rapid and steady, whether the female preceded or followed the single file of ducklings. There was no darting out of line or lagging behind to feed. Sometimes when shore was reached, the young and female crossed over immediately with no hesitation. At other times, however, the female would pause and remain quietly on the alert, while the young moved in and out among the sedge tussocks growing at the edge. After a minute or two, the female herded the young together and purposefully guided them along the shore to the crossing runway, where they scurried out of the water and disappeared in the sedges.

On July 11, 1950, the observer surprised a ring-neck and her brood of nine downy young at the very moment they reached

Table 6. Observed instances of duck broods leaving and/or entering marsh.

SPECIES	COMPOSITION OF BROOD	DATE	LEAVE MARSH	ENTER MARSH	ENTER AND LEAVE MARSH
Black duck	8 young (III)	August 4, 1950		X	
	9 young (III)	June 25, 1951	X		
Mallard	12 young (I)	June 19, 1951	X		
Blue-winged teal	12 young (I)	July 18, 1950		X	
	12 young (II)	July 20, 1950	X		
	12 young (III)	July 25, 1950	X		
	12 young (III)	July 28, 1950			X
American widgeon	12 young (III)	August 1, 1950	X		
	5 young (II)	July 20, 1950	X		
	6 young (III)	August 1, 1950	X		
	4 young (III)	August 6, 1950		X	
Wood duck	12 young (II)	July 6, 1950	X		
	7 young (III)	July 20, 1950	X		
	7 young (III)	July 28, 1950			X
Ring-necked duck	9 downy young	July 11, 1950		X	
Hooded merganser	6 young (I)	June 27, 1951	X		
	12 young (I)	July 1, 1950	X		
Totals			11	4	2

the shore of E Pool at the base of the narrow ridge separating this impoundment from the study marsh. Unquestionably the female would have led the ducklings (which appeared to be only 2 or 3 days old) up over the ridge and down into the marsh, had she not been startled. Mobility at an early age was indicated and also the value for brood rearing of the study marsh in contrast to a large open water impoundment. Mendall (1958:134) recorded ring-necked broods 1-2 weeks of age leaving their nesting marshes and traveling distances up to 3 miles to reach more favorable areas.

The overall length of time individual duck broods stayed in the marsh varied widely, ranging from 1 day to 8 weeks, though within this time broods might leave the marsh for short periods.

Observations made of brood movements into and out of the marsh are listed in Table 6, and the duration of use of the marsh by certain individual duck broods is summarized in Table 7.

Escape Behavior of Broods

The methods of escape used by duck broods when frightened varied among the different species. In general, the dabbling ducks (black duck, mallard, blue-winged teal, widgeon, and wood duck) relied for safety upon the speed with which they could reach the concealment afforded by the nearest emergent vegetation. The young ducklings of these species, trying to use their wings to help hasten their escape, usually skittered across the surface of the water, churning up a wake. As they grew older, they did less skittering and relied instead upon rapid but quiet swimming to enable them to reach the safety of the nearest vegetation.

The typical escape reaction of the female blue-winged teal or wood duck was to drive their young ahead of them or, more often, to lead the young, closely bunched, as quickly as possible into the concealing cover of the nearest sedge, where they all disappeared from sight. These maneuvers were accompanied by the noise of the

Table 7. Duration of use of marsh by specific duck broods.

SPECIES	DATE OF FIRST OBSERVATION	DATE OF LAST OBSERVATION	DURATION	AVERAGE DURATION—1950	AVERAGE DURATION—1951
Mallard	June 29, 1950	July 3, 1950	5 days	5 days	9 days
	June 14, 1951	June 22, 1951	9 days		
Wood duck	June 17, 1950	August 3, 1950	48 days	48 days	57 days
	June 22, 1951	August 17, 1951	57 days		
Blue-winged teal	July 6, 1950	August 11, 1950	37 days	37 days	
American widgeon	July 7, 1950	July 25, 1950	19 days	23.4 days	30.6 days
	July 7, 1950	July 20, 1950	14 days		
	July 15, 1950	August 22, 1950	39 days		
	July 21, 1950	August 22, 1950	33 days		
	August 7, 1950	August 18, 1950	12 days		
	June 19, 1951	July 28, 1951	40 days		
	July 3, 1951	August 9, 1951	38 days		
	July 3, 1951	August 17, 1951	46 days		
	July 17, 1951	July 28, 1951	12 days		
	August 1, 1951	August 17, 1951	17 days		
Ring-necked duck	July 1, 1950	July 21, 1950	21 days	13 days	13 days
	July 7, 1950	July 21, 1950	15 days		
	July 11, 1950	July 28, 1950	18 days		
	July 15, 1950	July 21, 1950	7 days		
	July 25, 1950	July 28, 1950	4 days		
	June 21, 1951	July 3, 1951	13 days		
	July 3, 1951	July 20, 1951	18 days		
	July 10, 1951	July 25, 1951	16 days		
	July 16, 1951	July 20, 1951	5 days		
Hooded merganser	June 23, 1950	August 4, 1950	42 days	42 days	18.5 days
	June 14, 1951	June 22, 1951	9 days		
	June 25, 1951	July 23, 1951	28 days		

ducklings skittering (if they were in the early Class I stage), the squeaking of the hen wood duck, or the high-pitched quacking of the hen blue-winged teal.

This evasive type of action of the blue-winged teal and her brood agrees with Hochbaum's (1944:106-107) account of the first phase of a blue-winged teal's escape behavior. However, the subsequent injury feigning he describes was not observed, except in connection with the hen's defense of her young from the attack of a mink as described later (page 517); not seen, either, was the injury feigning of the wood duck described by A. B. Eastman (1915), quoted by Bent (1923:164). Another reference ("Mr. Manly Hardy in his manuscript notes sent to Major Bendire"),

quoted by Bent (1923:164), stated that a wood duck hen, when surprised by human intruders, flew away, while her half-grown ducklings ran into the tall grass. It is apparent that escape behavior is variable and is conditioned by many factors, including age of young, broodiness of individual hen, and proximity and kind of danger.

Sometimes a widgeon hen and brood used an evasive method of escape, with the female almost always croaking loudly. Only if the young were nearly full grown was a widgeon female silent while leading her young to safety; characteristically she remained behind, croaking continuously, while the young hurried to the nearest cover. Sometimes she stayed but a few

moments before flying a short distance to catch up with the brood. More often she remained behind for as many as 15–20 minutes. At such times she either sat in one spot or flew short distances back and forth, always returning to face the intruder. This behavior is very similar to that noted by Munro (1949:296–297).

The widgeon female was, without question, the noisiest of any of the seven species observed in the marsh. So prone were widgeon hens to croak when alarmed that they frequently commenced their guttural quacking before they had been observed, thereby attracting attention to themselves and their broods; if they had remained silent, they might have escaped detection. An example of this occurred July 10, 1951. Loud croaking by a female widgeon, hitherto unseen, instantly announced her presence in the marsh. The duck, highly agitated, swam nervously back and forth right in front of the observer, who remained motionless on the dike. Twice the hen flew directly toward the intruder, dropping back into the water just below where the latter was standing. For a full 30 minutes, the hen, croaking incessantly, continued this behavior. Gradually, however, she subsided and her loud croaks became shorter, much softer, and on a higher pitch. As her alarm decreased, she drank and twice preened briefly. Finally, her croaking ceased completely, and shortly afterwards, she silently swam off in the marsh and disappeared from sight. The observer, suspecting the presence of a brood, quickly and noiselessly moved ahead a few yards to gain a better view. In a very few minutes, this same hen was seen quietly swimming along, followed by her brood of four Class II young, which had remained successfully hidden from sight during the entire 30-minute protective display of the hen. A somewhat simi-

lar observation was given by Nelson (1887), cited by Bent (1923:92).

Black duck and mallard hens were much the same in their escape behavior. While their ducklings scattered for cover, they generally remained behind and began a loud and vigorous quacking. Instead of making short flights or remaining motionless, they usually put on a realistic display of injury feigning.

The behavior of a female black duck with five Class II ducklings when startled by the observer's sudden approach well illustrates this species' usual escape behavior. The young peeped and skittered toward the closest marsh cover, with the female loudly quacking behind them. As soon as they were 100 yards away, she turned and flew back to within 25 feet of the observer. Then she began violently propelling herself by her wings through the water, at the same time opening her bill, but emitting no sound. Back and forth she flapped through the water at a distance of 25–50 feet from the observer. After about 10 minutes of this, she began flying short distances of perhaps 100 or so yards, returning each time to plop into the marsh as though fatally injured. Ten minutes later she quieted down a bit, but remained close by and very much on the alert. After a moment or two of preening, she resumed her loud quacking and commenced flying short distances out over the marsh, landing and then swimming back to within 20 feet of the observer, who throughout the entire episode remained standing motionless at the spot where she was first seen by the hen. These short flights were repeated many times. Finally the quacking became less continuous, the flights farther away, and after 30 minutes ceased altogether.

Similar observations of injury feigning by black duck hens in defense of their young were recorded by both Forbush

(1925:198) and Bent (1923:55). Injury feigning by mallard hens as described by Bent (1923:39) and Munro (1943:242–243) also agrees closely with that observed in the present study.

In contrast to the species discussed above, a ring-necked duck hen and brood, when frightened, did not normally seek the nearest marsh vegetation for safety. Instead, they endeavored to put considerable distance as quickly as possible between themselves and the cause for their alarm. Typically, a ring-necked hen led her young, either bunched tightly together or in close single file, away from danger across the open water or open marsh. Rarely, the young preceded the female. Their pace was very rapid, but steady. Sometimes, the hen was silent; at other times she croaked intermittently.

An observation made July 11, 1950, is an illustration of this. A female with nine downy young was surprised at very close range. The hen made no sound, nor did she flap her wings. Instead, she silently sank down into the water, until only her head, neck, and the mere top of her back remained above the water. Then she and her young quietly and swiftly moved off toward the center of the pool. One of the ducklings climbed onto her back and rode there for a minute or two. The rest of the young were all bunched together, following close to her. Several times she dived, usually coming up right by the brood. If, however, she surfaced a little distance away, the young immediately skittered over to her. When hen and brood were several hundred yards away, the hen resumed her normal alert posture on the water and continued leading her brood away.

Occasionally, a female ring-necked duck used escape methods similar to those of a hen widgeon. For example, on July 12, 1950, a ring-neck with a brood of 10 Class

I young was surprised very close to shore in the open water impoundment just north of the study marsh. The ducklings set up a loud peeping and skittered away a short distance across the open water before calming down, bunching up, and swimming rapidly out of sight. The female, croaking loudly, flew a short way after the young, then immediately flew back, landed at the base of the dike, and, still croaking, remained there for approximately 5 minutes. She then flew off in the direction taken by the ducklings, but a few minutes later, still croaking, she returned. This time she remained only a few minutes before finally flying away toward where the ducklings had disappeared from sight.

This is in marked contrast to what Mendall (1958:128) observed. He stated that the usual escape behavior of ring-necked broods was more like that of dabbling ducks than that of most divers. He found that the ducklings, at the first sign of danger, headed for the closest marsh cover, where they remained until called out by the hen. The hen either remained hidden with them or stayed out in the open water and staged an injury-feigning performance which in Mendall's words "is the most intense and persistent that I have observed among any waterfowl in the northeast." He further said (1958:126), "Her [the ring-necked hen's] act of injury-feigning is much more persistent than that of the black duck and even exceeds the endeavor put on by the blue-winged teal." He did note, however (1958:128), that when surprised in open water away from cover, ring-necks would dive and disperse widely, but added, "It is not the usual reaction." It is puzzling that there should be such marked difference in the escape action of ring-necks as observed by Mendall in Maine and as described in the present study in Michigan.

The escape behavior of the hooded mer-

ganser was similar in many ways to that of the ring-necked duck. A female hooded merganser, when seeking to escape threatened danger, usually led her brood as quickly as possible across open water, relying for safety on distance rather than on concealment in the marsh vegetation. Sometimes, she was silent but at other times she croaked intermittently. The young usually followed along in single file, though now and then they had to skitter a bit to keep up with her. Occasionally the hen and the young resorted to a combination of swimming, skittering, and shallow diving in their escape efforts. E. A. Samuels (1883), quoted by Bent (1923:26), recorded that if the danger was at close range, the hen hooded merganser resorted to injury feigning, while the young dived and swam underwater toward the nearest cover; otherwise, the hen merely swam rapidly away, followed closely by her brood.

Relationship between Hen and Ducklings

Rearing of Broods by Females.—Female ducks, at least of the seven species studied, assumed entire care of the broods. With but one exception, adult males were never seen accompanying the hens and ducklings. In fact, for the duration of the brood season, they virtually disappeared completely from the study marsh.

The exception occurred on June 25, 1951, when a pair of ring-necked ducks, the hen croaking loudly, flew into the marsh and landed in the general vicinity of a brood of six downy ring-necked ducklings, which had been feeding by themselves and peeping. When the female reached the young she stopped for a minute or two, waiting until the drake had caught up to them. Then, as one family unit, they all proceeded slowly through the marsh, female

in the lead followed by the young with the male in the rear.

When the hen stopped, he stopped. Sometimes he fell behind several feet. Once when swimming rapidly to catch up with the brood, one of the young skittered ahead a bit as though to get out of his way, but that was the only sign of possible antagonism displayed toward him. The female appeared to pay no attention to him at all. When she finally stopped and the young spread out to feed, the drake stopped a few feet away. In contrast with the female which remained motionless and constantly on the alert, he moved about short distances, dabbling as he went. At length he flushed and flew off, leaving the marsh. The total time he had spent with the brood since flying in with the hen had been 17 minutes. A similar observation of drake ring-necks accompanying hens with broods of downy ducklings was recorded by Mendall (1958:68).

Strength of Bond between Hen and Ducklings.—The strength of the bond between the hen and her brood was governed primarily by two factors: (1) the stage in the annual reproductive cycle reached by the hen and (2) the age of the ducklings. In general, the younger the brood, the stronger the bond. It is possible, too, that this varied somewhat among the different species. When the ducklings were small, the hen usually kept them bunched together quite closely and prevented them from straying very far. Collias and Collias (1956:390–391), in their experimental work at the Delta Waterfowl Research Station on various phases of duckling behavior, found that an “important factor in the development of the response of following the parent is the social facilitation of this response through the presence of other members of the brood.” Through their experiments they were able to demonstrate that very

young ducklings could be induced to follow slightly older ducklings that had been previously trained to follow a human person. This suggested the "important role of leadership among ducklings in nature." Collias and Collias postulated, "The first ducklings to hatch are not only older but probably have developed a stronger tendency to follow the mother than is true of the last ducklings to hatch" and concluded, "The attachment of the ducklings to one another will, therefore, help the laggards to maintain contact with the mother through the intermediacy of the better followers, until the response of following has become fully developed in these youngest ducklings."

During the present study several observations suggested that the hen was aware if part of her brood was missing. For instance, a female widgeon and a Class I duckling swam over to the east loafing mound, climbed out, and preened. After a minute or two, the hen began a loud croaking and left the mound, swimming about 50 feet away. Instantly, the other 12 of her brood came skittering out of the marsh vegetation to meet her. Whereupon she turned, swam back to the mound with her brood, and one by one they all climbed out and joined the one duckling which had remained.

Another example suggesting that the hen could tell when some of her ducklings were missing occurred July 6, 1950, when a female wood duck was seen leading her brood of 11 Class II young from the east end of the marsh across its entire length to the foot of the dike on the northwest side, almost directly under the observer's tree platform. When she reached this point, she waited quietly at the base of the dike for several minutes. By that time the brood, which had scattered somewhat during the long trip across the marsh, had reassembled

about her. The moment the eleventh duckling arrived, she turned and led them all single file right up over the steep sandy dike bank and down into the pool on the other side.

Mr. Manly Hardy in his notes sent to Major Bendire as quoted in Bent (1923:164) described an incident in which a hen wood duck returned to round up her scattered brood, and concluded, "It was plain that she could count enough to know if one was missing. . . ." Hochbaum (1944:98) expressed current opinion, however, when he said, in describing canvasback and redhead hens driving away ducklings not their own, "Such behavior suggests that although the hen cannot count her brood, she can distinguish her own ducklings from strangers."

In addition to the hen's constant vigilance, which was especially keen with very young ducklings, she guided and controlled them by an almost constant soft calling. To this the young gave instant heed, as was commonly observed among most of the species found in the study area. For example, when a brood of 12 Class I wood ducks scattered a bit too widely while feeding, the hen began to squeak softly, and the young immediately converged about her. Similarly, when seven young black ducks spread out more than about 40 yards along the sedge-covered edge of the marsh, the female quacked softly, and the young swam over to her at once. Comparable observations on the use of calling by the hen to direct her ducklings were made by Bennett (1938:54), Hochbaum (1944:107-108), Sowls (1955:143-145), and Mendall (1958:126, 128).

Weakening of Bond between Hen and Brood.—As the ducklings grew older and as the hen advanced along her annual reproductive cycle, the bond between brood and hen gradually weakened. This was

shown in several ways. First, the female ceased the almost constant soft calling used to guide the very young ducklings. Secondly, she no longer attempted to maintain the tightly bunched brood formation, but instead, allowed the young to move about the marsh in smaller groups of two, three, or four individuals. And, finally, the young ranged increasingly greater distances in their feeding. The female still maintained her alert watch over the brood, but now she relaxed at times and indulged in more feeding and preening herself. She continued to "call in" the young from time to time, and they obeyed her calls. And whenever danger threatened or she wished to lead the ducklings elsewhere in the marsh, they all assembled about her and moved off as one brood unit.

By the time the young were 5 weeks or more old, they were becoming increasingly independent of the female. They continued to swim and feed in the marsh in small groups and only rarely assembled as a full brood. Sometimes they responded to the hen's calls; sometimes they didn't. These observations agree with Bennett's findings for the blue-winged teal (1938:54) and with the observations of Mendall (1958:131), who said, referring to ring-necks, "Among early hatched broods, dispersal of ducklings is usually piecemeal and progressive. One by one, the young leave the rest of the family, joining other groups of flying young or occasionally shifting for themselves. There is noticeable variation in this respect."

An observation made on July 26, 1951, illustrates the weakening of the bond between hen and young. Four Class III widgeon ducklings went to sleep in the water at the base of a clump of dead brush. Fifteen minutes later a female widgeon, croaking loudly, flew into the area. She landed nearby and remained motionless

but continued calling. All four widgeon young had awakened the moment she flew into the marsh, but they made no noise nor showed any inclination to leave the brush clump and join the female. After 3 minutes, she ceased quacking and flew off to another part of the marsh. The four ducklings went back to sleep but after half an hour woke up, left the brush clump, and commenced feeding. Several hours later they and the hen (presumably the same hen they had responded to earlier) were seen moving through the marsh together.

Dissolution of Bond between Hen and Brood.—Eventually the bond between the hen and brood ceased to exist, and the young were on their own. It appeared that the females left the study area completely, for no broodless hens were seen in the marsh during the postbrood period. If any had remained, it is doubtful if they could have gone undetected because of the sparseness of the emergent vegetation.

This is contrary to Hochbaum (1944:122), who believed that most hens pass the flightless period on the marshes where they nested. He also said, however (1944:121), "There is evidence that some females leave the marshes where they have nested, and move to other areas, to molt the wing." He included American widgeon as one of the species that did this. Mendall (1958:149-150) likewise found that most female ring-necked ducks on his study areas passed through the entire molting period in or near the breeding marshes. He added, however, that exceptions to this were "hens that nested in small marshes or sloughs and moved a short distance to larger areas as the flightless period approached." Hochbaum (1944:122-123), attempting to determine the special characteristics of a molting marsh, concluded that in addition to an abundant supply of aquatic food plants, ample protective cover, permanent supply

of water and isolation, another requirement may be large size. It may well be that the main reasons the brood hens did not remain in the Michigan study area to pass their flightless period were (1) the emergent vegetation was not sufficiently dense to afford adequate protective cover and (2) it was too small to be acceptable as a molting marsh.

The final and complete breakup of the brood-hen bond usually occurred when the young were in Class III: 7-8 weeks old, or just about the time they began to fly.

Although black duck, mallard, widgeon, and blue-winged teal females accompanying Class III ducklings were commonly seen, it was equally common to see the same-aged young of these species without the females swimming about in the marsh either singly or in small groups, foraging for themselves as self-sufficient individuals, no longer members of a brood. Munro (1949:298), in writing about the American widgeon, said, "Females accompany their broods until the young are nearly full-grown, sometimes after they have reached the flying stage." Whether the young leave the hen, as they become progressively more independent, or the hen abandons the brood, as the flightless period of her molt approaches, has not been clearly determined. Apparently there is much variation in this respect among waterfowl.

In the case of the hooded merganser and wood duck broods under observation in the study marsh, this dissolution of the brood-hen relationship occurred considerably earlier. For example, as early as July 7, 1950, a female hooded merganser flew into the marsh and began croaking loudly in an effort to call together her brood, which she had left earlier. Although she landed in the general vicinity of the young and maintained a constant loud croaking, the four Class II young (about 5 weeks old) kept

right on feeding where they were and paid no attention to her whatsoever. Although she finally joined them about 10 minutes later, their lack of response to her calling was clear indication of the weakening of the brood ties. In fact, it was only 4 days later that the female left the area, and the young ducklings were seen thereafter in small groups, swimming, feeding, and loafing in the marsh completely on their own. Mendall (1958:130) also observed what appeared to be abandonment of hooded merganser broods by the hen.

Similarly, Class II young wood ducks (about 5 weeks old) were abandoned by their hen in 1950 by July 15 and in 1951 by July 17. These young hooded merganser and wood duck ducklings remained in the study marsh until full grown and appeared to have no difficulty in taking care of themselves.

Temporary Absences of Females from Broods.—As was the case when the young were sleeping on loafing mounds, hens frequently left their broods for short periods, ranging from 15 minutes to an hour and a quarter. Broods of all ages, from downy young to almost full grown, were thus temporarily deserted. These ducklings usually continued feeding and dabbling as they moved slowly through the marsh. Occasionally they paused for a few minutes to rest. And sometimes the youngest ones maintained a rather constant peeping.

The manner in which the female re-joined the ducklings was generally similar for all the species present in the study marsh. On July 7, 1950, at 7:05 AM, a female wood duck was heard squeaking as she flew into the marsh from out over the large impoundment to the north. As soon as she landed, she continued her loud squeaking, adding a low "chuck-chuck" call several times. Five young Class II wood ducks immediately began a loud

peeping and swam from another part of the marsh toward the female. As soon as they reached the hen, she stopped squeaking.

Sometimes the young were not so prompt in their response—as, for example, on August 1, 1951, when four Class II widgeon ducklings were watched feeding and occasionally peeping while moving through the marsh. After an hour, the female, croaking loudly, flew into the marsh. The young continued their feeding and peeping, but made no attempt to move in the direction of the female who had landed 200 yards away. The hen then flew three times, each time a bit closer to the brood, pausing between flights for 2 or 3 minutes. Both the female and the ducklings maintained their constant calling. On the last lap, the hen landed right by the brood; whereupon the ducklings ceased peeping and, turning, moved off, feeding as a brood unit once again.

A hen was usually reunited with her brood within 5 or 10 minutes after returning to the vicinity. Whenever this time was exceeded to any appreciable extent, it was usually a good indication that the bond between the brood and hen was weakening.

Once in a while, when returning to the marsh, the hen tried to claim the wrong brood, and sometimes the young responded to the wrong female. For example, a female widgeon was heard to croak several times while still out of sight and away from the marsh. Immediately three Class I widgeon ducklings, which had been swimming about, began a loud peeping. In a few moments, the female flew in and landed about 30 feet from the young. She began to croak, and the young continued peeping. The female and the young moved together, with the female doing most of the moving. But when she got within several yards of the ducklings, they

skittered rapidly away. The female quickly pursued them, but there was no suggestion of violence in her action. As she chased them, she separated one from the other two. Three times she followed the one duckling, until after the third time, it allowed her to reach it and didn't swim away. Then the female started after the other two which were close by. They skittered away with the female right after them. When she paused to feed for a moment, the first duckling left her and rejoined the other two a short distance away. Finally, the female flew off and the three young resumed their leisurely feeding. This whole episode lasted 5 minutes.

Several times it was noticed that when a hen left her own brood and flew low over unattended young of the same species, these latter ducklings peeped for a moment or two while the female was overhead.

Tolerance

It was difficult to predict the amount of tolerance a hen with a brood would show to other ducks, either old or young, that approached her and her young. It appeared as though some species, such as the widgeon, were naturally more intolerant than others. Studies of tolerance among ducklings made at the Delta Waterfowl Research Station by Collias and Collias (1956) demonstrated that redhead ducklings were dominant over canvasback ducklings. They also showed that the redhead ducklings exhibited more intraspecific tolerance than did the canvasbacks, which were the subordinate species (with reference to the redheads). Other experiments showed that mallard ducklings dominated and were intolerant of pintails. Collias and Collias concluded from these and related experiments that (1) the dominance order, regardless of species, shows no consistent parallel to differences in sex or weight, and

(2) the aggressive behavior of ducklings and their brood hen toward other hens and ducklings probably helps to maintain the brood size within manageable limits.

Behavior of Brood Hens Toward Broodless Adult Ducks.—Whereas most brood hens would usually tolerate the close approach of other adult ducks (regardless of species), *provided* they made no threatening move toward the young, widgeons commonly drove away such intruders. The following example is typical of the widgeon's behavior. Two adult widgeons flew into the marsh and landed close by another widgeon and her brood of six Class II young. Although the newcomers made no hostile move toward the ducklings, the brood hen, nevertheless, immediately charged across the water toward one of the intruders in a threatening manner, with head and neck lowered and bill opened. She succeeded in driving away one of the intruders a short distance. Then she turned and went after the second, which she forced to fly away. By this time the first intruder was close to one of her young, so the hen rushed it again and chased it over the water, trying to nip at its tail feathers until it, too, finally left the marsh. Then the female flapped her wings several times and returned to her young.

The behavior of a ring-necked duck with a brood was in contrast to the belligerence of the widgeon. For example, two adult mallards flew into the marsh and landed close by a ring-neck and her eight Class I ducklings. The mallards swam right through the brood and close to the female, but she did not threaten them or try to chase them away. She merely remained motionless and on the alert and even resumed diving while the two mallards were still quite close. One of the ring-necked ducklings did skitter away from the mal-

lards, but not because of any antagonistic action on their part.

The usual outcome of the continuing presence of adult ducks in the close vicinity of hens with broods was that sooner or later they made some move, intentional or otherwise, which aroused the brood hen's antagonism. This, without exception, resulted in the brood hen's instantly rushing the intruding ducks and attempting to drive them away. For example, a female hooded merganser landed in the marsh in a small opening already occupied by a ring-necked duck and her one young. The hooded merganser appeared to chase the ring-necked duckling, which immediately skittered away. Instantly, the ring-necked hen turned upon the intruder, forcing her to retreat. After that, each, keeping to her own part of the opening, began to preen and loaf.

Behavior of Brood Hens Toward Stray Ducklings.—The widgeon brood hen was conspicuous for her belligerence not only toward adult ducks but also toward any and all ducklings that attempted to join her brood. Sixteen different instances were recorded of ducklings being driven away by widgeon hens; in all but one case, the unwanted ducklings were widgeons.

It is possible, however, that this large number of observations of widgeons driving away young of their own species was not solely the reflection of a greater degree of intolerance on the part of that species. It might also have been owing in part to the higher number of broods of that species present in the marsh at the same time, with the resulting greater opportunities for confusion and mix-up among the widgeon broods. Yet it is interesting that although the ring-necked ducks in 1951 had 10 broods to the widgeons' 14, and in 1950 had 8 to the widgeons' 21, no display of antagonism by a female ring-necked duck

to any ring-necked duckling was ever seen. Mendall (1958:135), however, noted, "Under most conditions, hen ring-necks are aggressive in driving away the young of some other female."

Typical of this type of behavior is the following example. A widgeon left her brood of eight Class I young resting on a mud tussock to drive away a widgeon duckling which had been quietly sitting in the water close by. A few minutes later when the brood left the mound, the unwanted duckling tagged along. Instantly the hen rushed toward the duckling, scattering her own young in all directions. The unfortunate youngster quickly dived to escape her attacks, but she remained on the spot, relentlessly jabbing and pecking at it every time it surfaced. Finally, she gathered her scattered brood together and they moved on. The duckling made one more attempt to join the brood, but was immediately chased away by the female.

Yet in spite of this determination on the part of the widgeon hen to repulse any young not her own, it was noticed that if the young persevered in their attempts and could survive the first three or four attacks of the female, they very frequently were accepted into the brood and were no longer molested by the hen.

The behavior exhibited by the ring-necked duck and the wood duck toward ducklings of other species was quite different. Instances were observed of hens of these two species tolerating the presence in their own broods of young that did not belong to them. Sometimes this was on a temporary basis, as in the case of three Class II widgeon young remaining unmolested for about an hour and a quarter with a ring-necked hen and brood until the three ducklings left to rejoin their own hen. This agrees with the observations of Mendall (1958:135), who found that the ring-

neck was tolerant to broods of other species. Other times, tolerance meant a permanent acceptance, as illustrated by 2 Class I hooded mergansers which stayed for approximately 2 weeks with a wood duck and her 14 ducklings until the brood bond was broken and the young abandoned by the hen.

Behavior of Hens with Broods Toward Other Hens with Broods.—Often during the height of the rearing season when as many as 10 or 12 different broods were in the study marsh at the same time, it was inevitable that the broods and their hens should come close to each other or even intermingle. Ordinarily there was no antagonism shown by either brood hen during these encounters, regardless of whether the broods were the same or different species. The broods, usually feeding as they slowly moved along, kept on their way and soon were by themselves again. Mendall (1958:135) made similar observations. He found that there was no friction among ring-necks when broods were feeding or traveling close to one another. He further stated, "When 2 broods are feeding near each other, the young may become intermingled for a few minutes at a time, yet whenever 1 or both of the broods start to travel away, segregation into the respective groups appears to be immediate."

Sometimes one or two of the young were delayed by the presence of the other broods, but they usually had little difficulty in catching up with their own brood. For example, after a female widgeon and brood of 15 Class I young had mingled with a ring-necked hen and her brood of 9 Class I young, 5 of the widgeon ducklings became separated from their own brood. However, skittering over the water in their haste to catch up, they rejoined it by the time it was about 100 yards away. This suggests one way in which ducklings less

fortunate in "catching up" might have become permanently separated from their broods.

As might have been expected, the wid-geon hen did occasionally display some antagonism toward the other hens and their broods during some of these encounters. Most of any belligerence that was shown during these brood mix-ups appeared to be directed toward the young, rather than toward the hens.

Relationship of Duck Broods to Other Wildlife

In addition to the ducks, many other forms of wildlife inhabited the study marsh. White-tailed deer fed regularly on its aquatic plants, and beaver and muskrats lived there. Between these animals and the ducks there appeared to be neither conflict nor competition of any kind. On the contrary, the presence of the beaver and muskrat was distinctly beneficial to the waterfowl, for their feeding habits helped maintain the marsh vegetation in a desirable semiopen state and their feeding platforms and houses provided excellent loafing mounds. In fact, the preservation of the marsh itself as habitat suitable for rearing duck broods depended upon the continued presence of beaver in the marsh, since they ensured the proper maintenance of the all-important water levels (Beard 1953). Hochbaum (1944:10) called attention to the important role of the muskrat in the ecology of the marsh, both by its feeding habits, which kept the vegetation opened up, and by the building of lodges, which provided excellent loafing spots for ducks. The presence of muskrats would be harmful to waterfowl, however, if they were allowed to increase beyond the carrying capacity of the marsh. An overpopulation of muskrats normally results in rapid deterioration of their habitat through "eat-outs" and destruction of the emergent

vegetation. Innumerable observations were made of ducks and duck broods swimming and feeding without concern or excitement in close proximity to deer, beaver, and muskrat. Only very rarely was any sign of fear or antagonism seen.

In a different category, however, was the mink. Female ducks were seen defending their broods against attacks by this well-known predator on two different occasions. On July 6, 1950, a wood duck and her seven Class II young were leisurely swimming and feeding among the sedge clumps along the shore. Suddenly the hen commenced a loud and frantic squeaking, beat her wings, and rushed back and forth through the sedges, driving her young out of the vegetation and away from the shore. Seconds later, a large mink came racing through the tall grasses toward the water and bounded across a small opening between two sedge clumps. The female kept up her squeaking for some time, even after she had led her young far from the danger zone.

On another occasion a female blue-winged teal and her brood of 12 Class II ducklings were spread out rather widely in the marsh as they busily fed. A mink swam from shore in the direction of the brood. Instantly the female left the young about 30 feet away and with loud quacking flew right to the mink, where she plummeted down into the water and began flopping on the surface as though badly injured. The mink spurted toward her with vicious speed, but the female flushed just ahead of him and flew a short distance still further from the young before dropping down again. This was repeated several times before the mink gave up the chase. The young, meanwhile, had frozen wherever they happened to be when the attack began and remained there motionless at least 5 minutes, before they

gradually resumed their moving about and feeding. The female stayed close to the shore where the mink had disappeared for about 15 minutes before she finally stopped quacking and rejoined her young.

Arthur Hawkins (quoted both by Sowls 1955:149 and Mendall 1958:129) described similar behavior on the part of a female mallard in defending her brood from the attack of a mink. There was a difference, however, in the way the ducklings of the two species reacted. The young mallards, bunched together, made a "wild dash across the ditch" to get away; whereas, the blue-winged teal ducklings remained absolutely motionless wherever they happened to be for the duration of the danger.

Occasionally a marsh hawk (*Circus cyaneus*) flew over the marsh. Ordinarily this produced no effect whatsoever on the ducks and broods there. Bennett (1938:64-66) noted, "Usually the mother teal guided her young into nearby cover at the approach of a Marsh Hawk. Often the intruder made a low sweep, as if to retrieve a duckling, but not once did the author witness a kill." He concluded that depredation by this bird was negligible, probably due to the abundance of more accessible prey and the hawk's inability to catch the ducks. Sowls (1955:119-121) in analyzing the contents of pellets collected around marsh hawk nests found that ducklings, as well as adult and juvenile coots, were occasionally taken by the marsh hawk.

A bald eagle (*Haliaeetus leucocephalus*) flying over the marsh, however, produced a marked reaction among the ducks. On August 17, 1951, a widgeon brood of four Class III ducklings was busily preening on the east loafing mound, while the female sat at the base. Suddenly she became alert and motionless. The young, too, rose up on the mound and sat still, with heads

stretched upward. The female quickly swam to a sparse clump of sedge growing about 30 feet from the mound; whereupon the young instantly left the mound and in single file swam there also. All sat quietly for 5 minutes before returning to the loafing mound. The cause for their alarm was a bald eagle which had flown over the area. As the eagle continued on its way across the marsh out over the pool to the south, a half dozen or so ducks, quacking loudly, flushed and flew off.

Mendall (1958:129) described similar behavior in his study of the ring-necked duck. He noted, "If caught in open water with an eagle overhead, the female quickly leads her brood to the nearest cover, making repeated dives if the eagle swoops low. If in a channel or pothole when a bird of prey is spotted, the female herds her young into the edge of emergent vegetation and the entire group remains motionless until the danger has passed." He concluded that the reaction of ring-necked families to potential danger as represented by the bald eagle was apparently based on experience. He stated, "Apparently, if the family has once been harassed by birds of prey, they become very wary of them. If, however, they have not been molested by these birds, they show no fear of them Some individual eagles constantly harass or attack ducks, while others apparently have no interest in them." Wright (1954:52-53) recorded seeing on several occasions ducks swimming "directly under a Bald Eagle sitting on an overhanging branch, and, although both appeared to see the other, the ducks showed no alarm and the eagle paid no attention to them."

Ducks were sometimes annoyed by red-winged blackbirds (*Agelaius phoeniceus*), which followed them persistently, continually diving at them in an apparent attempt to peck their heads. A probable explana-

tion for this is that the ducks, while traveling through the marsh, sometimes inadvertently approached a blackbird's nest too closely, thereby flushing the bird, which immediately attempted to drive away the intruder. Even birds the size of the Canada goose were not immune from these persistent attacks. Pied-billed grebes (*Podilymbus podiceps*) were very aggressive in defense of their nest territory and drove away any ducks that happened to trespass upon it. This belligerence was not one-sided, for the ducks usually did not allow the grebes to get too close to the ducklings.

RELATION OF DUCK BROOD STUDY TO WATERFOWL MANAGEMENT

The daily observations made during this 2-year field study of duck broods *living undisturbed in their natural environment and probably unaware of the presence of a human observer* established certain facts which can profitably be used in waterfowl management efforts.

1. Loafing sites are very important in the daily activities of a duck brood. Flattened muskrat houses and low mud bars or mounds were shown to be the type of site highly favored by duck broods. That the demand for these was great was well proven by the competition for them that existed. It seems logical to infer from this that probably the number of desirable loafing spots in a marsh, suitable in all other respects for brood rearing, has a definite limiting influence both on the number of broods using the marsh and on the length of time they stay in it. In fact, the availability of loafing spots possibly limits the carrying capacity of the marsh during peak periods of use. In most instances management should find it practical to provide artificial loafing spots in those marshes in which they are lacking,

but which otherwise are suitable for brood rearing.

Hochbaum (1944:59-61) stressed the importance of loafing spots for dabbling ducks. He said, "A loafing spot is seemingly an indispensable factor in the territorial requirements of all river ducks. In these species every territory includes some spit of mud, protruding boulder, Muskrat house, stretch of beach, or mat of reeds upon which the pair can rest out of water." He said further, "The importance of the loafing spot is further demonstrated when one is created artificially where there was none before." He cited the case of providing two 8-foot logs where there had been no suitable loafing spots and their immediate occupancy by two pairs of ducks. Sowls (1955:149, 159) likewise underscored the importance of loafing spots and concluded that they must be considered in any management plan. He observed that dry loafing places, such as small hummocks, are "important to the young ducks and are a necessary part of any rearing ground." Furthermore, he found that loafing logs and platforms artificially provided for breeding-season adults were used extensively by broods as loafing sites. Bennett (1938:55) similarly observed in his blue-winged teal study that the hen and her brood made use of various types of loafing spots both by day and night as well as during stormy weather.

2. There is considerable mobility of duck broods. An intensive hunt was made of all the land directly surrounding the study marsh, and no duck nests were found in either 1950 or 1951. However, the first broods of all but mallard and hooded merganser broods in 1950 and mallard, hooded merganser, and black duck broods in 1951 appeared in the marsh as downy young. This means that all broods observed in the marsh, even broods of downy

Table 8. Maximum known concentrations of broods in 20-acre study marsh.

NUMBER OF BROODS	SPECIES	DATE	BROODS/ACRE
Maximum Number of Broods (single species)			
3	Black duck	June 27, 1950	0.15
3	Mallard	June 14, 1951	0.15
9	American widgeon	July 18, 1950	0.45
3	Ring-necked duck	Almost daily during July, 1950 and 1951	0.15
Maximum Number of Broods (all species)			
5	1 hooded merganser, 1 wood duck, 1 ring-necked duck, 1 American widgeon, 1 blue-winged teal	July 6, 1950	0.25
15	1 hooded merganser, 1 wood duck,* 1 blue-winged teal, 3 ring-necked duck, 9 American widgeon	July 18, 1950	0.75
9	1 hooded merganser,* 1 wood duck,* 2 ring-necked duck, 4 American widgeon, 1 blue-winged teal	July 28, 1950	0.45
6	1 black duck, 1 hooded merganser, 1 wood duck, 3 ring-necked duck	June 25, 1951	0.30
8	1 hooded merganser,* 1 wood duck, 2 ring-necked duck, 4 American widgeon	July 3, 1951	0.40
9	1 hooded merganser,* 1 wood duck,* 3 ring-necked duck, 4 American widgeon	July 20, 1951	0.45

* Broods deserted by hens.

young, will travel to reach habitat favorable for brood rearing; also that rearing habitat need not necessarily include nesting sites. Evans et al. (1952:40-41) found that nesting may be done in areas used neither for territory nor for brood rearing. They concluded, "The data furnished by both diving ducks and river ducks indicate that the nesting site often bears no relation to the potholes used by the breeding birds for other activities nor to potholes used for brood rearing."

3. Overcrowding of rearing marshes is detrimental to maximum duckling survival. A marsh which combines all the desirable factors for brood-rearing habitat to the nearly optimum extent as did the study area receives a heavy influx of duck broods during the height of the brood season. Sometimes this concentration is so great, that, as was the case with widgeons in

1951, confusion prevails among the broods. This leads to mix-ups among broods, to strife between brood hens, and to straying by ducklings from their own brood, and possibly to loss of ducklings if they are driven away from other broods. In this connection it is interesting to note that through their experimental studies Collias and Collias (1956:398) found, "In general, aggression did not occur in relation to food competition but was often observed when one bird was moving about and disturbing resting birds, and aggressions could readily be provoked by moderately crowding the birds."

The establishment of many well-protected, small marshes (averaging between 10 and 20 acres), with all the requisite factors for optimum brood-rearing habitat (Beard 1953) and strategic location, would help reduce crowding in the rearing

marshes already existing, would lessen the interbrood conflicts, and would permit a larger number of ducks to rear their young under favorable conditions, thereby helping to ensure a higher degree of survival among the young.

Maximum concentrations of broods both by species and by date have been tabulated in Table 8. The highest concentration of broods occurred on July 18, 1950, when 15 broods, representing 0.75 brood per acre, were tallied in the marsh. On the same date, nine broods of widgeon were counted. This was the greatest number of broods of a single species seen in the marsh during 1 day. Evans et al. (1952:33) made a similar tabulation for their Minnedosa study area in Manitoba. Their brood/acre figures were considerably higher than those obtained in the present study, but the great difference between the two areas should be considered in making any comparison. One 20-acre marsh situated on the fringe of waterfowl-producing territory is quite different from the Minnedosa area, which is located in the heartland of the continental "duck factory" and consists of 127 potholes of varying types, averaging in size from 5.6 to 0.23 acres.

4. The hen and her brood were shown to exist harmoniously in the same marsh with deer, beaver, and muskrat. The mink, however, was shown to be a real threat. The use of trapping whenever the mink population should appear to be excessive and out of balance with its environment would be desirable in order to prevent too many ducklings from being lost to this predator.

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