FACTORS AFFECTING HOME
RANGE OF MALLARD PAIRS

A THESIS
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

JUNE 1976

MASTER

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ABSTRACT: Certain habitat and social factors were investigated for their effect on home range size of mallard (Anas platyrhynchos) pairs breeding in a forested region of north-central Minnesota during the spring of 1971-72. Data from 31 radio-marked hens and drakes were used, but primary emphasis was placed on 8 pairs (5 with both members of the pair marked). Pairs were radio-tracked on river marsh areas, river channels, and large sand lakes to provide comparative data for evaluating home range size differences. Home ranges varied from an average of 53 ha for pairs using primarily river habitat to 871 ha for pairs using only large sand lakes. River and lake shorelines varied considerably in species and density of vegetation. Interaction between pairs as well as density of flocked males appeared to be influenced by these habitat differences with resultant effects on home range sizes.

INTRODUCTION

Home ranges of breeding waterfowl are frequently described in the literature (e.g., Dzubin 1955, Gates 1962, Drewien 1967, Coulter and Miller 1968, Gilmer 1971, Poston 1974, Derrickson 1975, Gilmer et al. 1975); however, many of the ecological and sociological factors influencing home range size need further investigation. Dzubin (1955:296) indicated the basic scientific need for research on the relationships between environmental factors and waterfowl behavior by noting that intensive studies of home ranges in differing habitats should lead to a broader understanding of the biology and ecology of each species of duck. This study deals with some effects of habitat and social behavior on home range size of mallard pairs breeding in a lake-forest region containing varied habitat complexes.

Home range size could be affected by a multitude of factors interacting in a complex manner with considerable individual variation in bird reaction to these influences. Wetland density and availability, population density and degree of intrapopulation interaction, distribution of food resources, loafing sites, and nesting cover, sex and breeding status of the individual, chronology of the nesting history, and general physical and biotic characteristics of the habitat have all been explored to some extent in the literature as factors relating to intraspecies variation in home range. Intrapopulation interaction as affected by physical and biotic characteristics of the habitat, fulfillment of night roosting requirements as related to habitat, and renesting, repairing and male flocking aspects of the breeding cycle are potential factors influencing home range which are investigated in this paper.

This study was part of a cooperative project between the University of Minnesota and the Northern Prairie Wildlife Research Center, U.S. Fish and Wildlife Service. Funds were also provided by the U.S. Atomic Energy Commission, C00-1332-122.

Team effort was essential to the success of the field work. L. M. Cowardin, I. J. Ball, R. E. Kirby, and R. S. Stott provided enthusiastic assistance throughout the study and their efforts are sincerely appreciated. D. S. Gilmer provided assistance and suggestions in many aspects of the project.

I am grateful to J. R. Tester, my adviser, for his encouragement and guidance throughout the study. L. M. Cowardin, J. R. Tester, D. B. Siniff, and D. S. Gilmer provided helpful criticism of the thesis. D. H. Johnson assisted with statistical analysis and D. A. Davenport helped

with computer analysis. The engineering staff, Cedar Creek Bioelectronics Laboratory, University of Minnesota constructed and maintained telemetry equipment.

My wife, Sharon, assisted in drawing of maps and graphs as well as providing cheerful encouragement and tolerance.

I am grateful to the residents of the study area for their friendly interest.

STUDY AREA

The study was conducted near the headwaters of the Mississippi River at the western edge of the Chippewa National Forest, 18 km east of Bemidji, Minnesota. Telemetry locations were obtained within an 18-km² area around the river. According to Cowardin and Johnson's (1973) classification the habitats represented in the area include the following wetland complexes: sand lakes, river marsh, river channel, intermediate lakes, bog lakes, and nonpermanent wetlands (Fig. 1). Nonpermanent wetlands farther than 100 m from a lake or river shoreline were designated interior wetlands while those closer than 100 m were called adjacent wetlands. Areas designated as river marsh contained more than 50 percent emergent vegetation.

Shoreline lengths for the two major wetland complexes are sand lake 21.7 km, and river channel 5.1 km. Thirty-seven percent of the total shoreline is a floating mat of vegetation consisting primarily of sedges (Carex lasiocarpa, C. aquatilis, C. lacustris), blue-joint (Calamagrostis canadensis), willows (Salix spp.), and speckled alder (Alnus rugosa). Other shorelines consist of sand and rock beaches, overhanging upland brush, and residential areas. Fifteen resorts occupy these shorelines and recreational use is obvious with the beginning of fishing season around

LEGEND

SHORELINE BOG MATS
 ADJACENT WETLANDS
 INTERIOR WETLANDS
 INTERMEDIATE LAKES
 BOG LAKES
 SAND LAKES
 RIVER MARSHES
 RIVER CHANNELS
 TRAPPING SITES

KILOMETERS

SCALE

Fig. 1. Study area map indicating distribution of lakes, river areas, bog mats, nonpermanent wetlands, and trapping sites.

May 15th. River marsh areas contained 62.0 ha consisting primarily of floating mat vegetation and emergent stands of phragmites (Phragmites communis) and cattail (Typha spp.). Adjacent nonpermanent wetlands averaged 0.6 ha and had a density of one wetland per 1.6 km of lake shoreline. Total interior nonpermanent wetland area was 38.6 ha.

METHODS

Data were gathered during April through July of 1971 and 1972 as part of a 5 year biotelemetry study concerning the breeding ecology of mallards and wood ducks (Aix sponsa) in the Chippewa National Forest (Ball 1971, 1973; Ball et al. 1975; Gilmer 1971; Gilmer et al. 1974, 1975; Cowardin and Johnson 1973). Ball (1971:3) defined interior segments of the study area as including all small lakes (< 500 ha) and wetlands outside of the Mississippi River flowage (including large chain lakes). Gilmer (1971) and Gilmer et al. (1975) reported on the initial breeding pair study concerned primarily with home range and habitat use of mallard pairs using predominantly these small interior water areas outside the river flowage. For this study data were collected on mallard pair use of river channel, river marsh, and large (> 2500 ha) sand lake complexes on the Mississippi flowage.

An attempt was made to trap equal numbers of birds among the three major complex types (Fig. 1). Small cannon nets (Dill and Thornsberry 1950, Miller 1957) proved most effective in capturing pairs on the river-channel and sand-lake areas while nightlighting accounted for all individuals caught in river marsh areas.

Birds were banded and equipped with breast-mounted transmitters (Gilmer et al. 1974). Ball (1971, 1973) and Gilmer (1971) give additional

descriptions of all electronic equipment and tracking techniques used in this study. Radio fixes were mostly obtained from a boat equipped with a yagi antenna and locations were coded with an eight-digit X-Y coordinate overlay on maps derived from aerial photographs. Duck locations were keyed to habitat through the use of digitized maps (Gilmer et al. 1973) which delineated the habitat stand - an area of relatively uniform physical and botanical characteristics. Habitat use was then assigned to complex type and community type, which is a group of stands with similar botanical and physical characteristics (Cowardin and Johnson 1973).

Since most of the pairs were conditioned to boat traffic on the river and lakes, behavioral observations were frequently obtained (45 percent of all locations) on undisturbed birds. Numerous efforts were made to continually observe individual marked pairs for long periods during daylight hours. Nighttime activity (sunset to sunrise) was monitored with an automatic device that recorded the presence of a radio-marked bird (Gilmer et al. 1971).

Home range sizes were calculated using the minimum area method described by Odum and Kuenzler (1955). Habitat use was based on the proportion of all locations in a particular community for each hen. Availability was determined by the proportion of community type in the home range. On nest locations were not considered in the habitat analysis.

RESULTS AND DISCUSSION

Eighteen hens and 13 drakes were radio-marked during two breeding seasons. In eight cases both members of the pair were marked. A total of 3738 radio locations were obtained from 31 instrumented ducks. Seventeen hundred of these locations included a visual observation.

Behavioral data for radio-marked birds were supplemented by 2650 observations of unmarked mallards. Radio-marked hens attempted 19 known nests, 5 of which were renests.

HOME RANGE

To eliminate some of the variation in home range size attributed to inadequate sampling, restrictions were placed on individuals selected for analysis. Only those hens with more than 100 locations, at least one month tracking history, and one or more known nesting attempts were selected. Any radio-marked drake paired to one of the above hens was also included. Thirteen individuals (five marked pairs plus three hens) having a mean tracking rate of 7.2 fixes per day per bird remained for analysis.

The mean home range for eight hens was 540 ha (40-1440 ha); the average for five drakes was somewhat larger at 620 ha (70-1140 ha). Five combined hen and drake home ranges were less than 100 ha while six exceeded 750 ha. Only two home ranges were between these limits. The scarcity of mid-range sizes and the large difference between small and large home ranges were obvious.

Mallard hens using mainly interior areas were found by Gilmer et al. (1975:786) to have a mean home range of 210 ha while drakes had a mean of 240 ha. The smallest was 66 ha and the largest 760 ha. Obvious differences existed between interior mallard home ranges and those of mallards using river and large lake complexes. Six mallards in this study had home ranges considerably larger than the interior mallard's largest. Derrickson (1975:13) found that home ranges of pintail (Anas acuta) hens, considered a highly mobile duck, averaged 480 ha, somewhat smaller than the average for mallard hens (546 ha) in this study. Differences

in mobility of mallards between parklands, grasslands and forested habitats (Gilmer 1971) not only exist, but also appear to be present within different types of forested habitat. The need for further comparisons of mallard home ranges and the identification of factors that may influence the size of home ranges in forested regions is apparent.

HABITAT EFFECTS

The diversity of wetland complexes on the study area was ideally suited to the investigation of differences in habitat use and availability, and other habitat characteristics, which might help explain some of the large variation in home range size. Potential masking of the effects of habitat on home range size existed for four hens because of an obvious shift from river channel use to river marsh or large sand lake use. Since the river channel was the first habitat to become ice-free in the spring, it is probable that high population densities forced some pairs to shift home ranges as more habitat became available when the ice thawed. Large sand lake areas became ice-free as much as one month after pairs arrived on the river. One pair's shift in home range appeared to be directly associated with the thaw on a large lake. Another pair did not shift away from use of river channel until after the hen's first nest loss. There was no apparent reason for the timing of the shift by the other two pairs, but it is possible that gradual spacing effects similar to those described by McKinney (1965) could have been a factor.

Since 4 of the 8 hen's home ranges were divided into two segments based on this pronounced shift in use of a complex type, twelve partial home ranges (all of these are partial in the sense that they do not include the total breeding home range) remained for habitat analysis.

The partial home ranges defined here are not used in the same context as SOWLS (1955:48) definition which included the total area used by the pair during the breeding season. Habitat effects should influence size of both partial and total breeding home ranges.

Two home ranges are discussed separately because of atypical habitat use which did not fit the classification and; therefore, could not be compared to habitat use of other hens. One of these hens intensively used a small boat harbor which was ice-free at least one week earlier than the large lake it bordered. Normally these locations would be considered as sand lake-residential shoreline but could not be classified as such with the lake ice-locked. This hen nested successfully early in the season and had a small home range (80 ha) that included a segment of the river channel and the small harbor. The other atypical hen was located 40 percent of the time in one stand bordering a river mouth and the sand lake it entered making it unclear whether to classify her locations as lake or river habitat.

To facilitate comparisons, the remaining 10 home ranges were divided into three groups by maximizing variation of percent wetland complex use and home range size between groups. Size is significantly correlated ($P < .01$) with percent use of river areas and the breakdown of groups is apparent (Fig. 2). The three groups are: (1) pairs that had small home ranges ($\bar{X}=53$ ha) and used predominantly river marsh (63 percent), (2) pairs that had intermediate home ranges ($\bar{X}=347$ ha) and used predominantly river channel (57 percent), and (3) pairs that had large home ranges ($\bar{X}=871$ ha) and used primarily sand lake (66 percent). Obvious differences

Fig. 2. Regression of home range sizes on percent river use (river channel and river marsh combined). Breakdown of groups is noted: (○ = large HRs and low river use, □ = intermediate HR size and intermediate river use, * = small HRS and high river use).

in habitat use and home range size suggest the need for further comparisons based on wetland communities present in the home range and their differential use.

Differences in community use and availability among the home range size groups were apparent (Fig. 3). Use of nonpermanent interior wetlands was low in all groups although they constituted 23 percent of the total wetland area (excluding open water) in the large home ranges. Nonpermanent wetlands were not used by pairs with small home ranges. Pairs with large home ranges showed a preference (percent use greater than availability) for nonpermanent wetlands; however, only those wetlands adjacent to the shoreline of a sand lake were used extensively. Cattail stands and bog mat shoreline accounted for 69 percent of the use by pairs with small home ranges; whereas, bog mat shoreline alone was used 46 percent of the time in intermediate home ranges. Shoreline stands containing overhanging brush were preferred in small home ranges but avoided in the other groups. Sand beach appeared to be avoided by all groups although when in association with an adjacent wetland (sand bar-pond) it was highly preferred by pairs with large home ranges.

The degree of isolation afforded a pair was one habitat characteristic examined for possible effects on home range size. References to seclusion, isolation, avoidance, and intolerance are made by Barclay (1970), McKinney (1965), Titman (1973), Dzubin (1957), and others in describing mallard pair behavior in relation to other mallard pairs or extra males during the breeding season. Barclay (1970:3) felt that social structure may be a factor affecting habitat use. Hochbaum (1944:75) noted that chasing of other pairs and larger territories were more common in habitats such as lake shores where birds were readily visible.

Fig. 3. Changes in mean percent use and percent availability of community types between different home range size groups. Community types are grouped by concealment value. Community types are nonpermanent wetlands: 1a = interior wetlands, 1b = adjacent wetlands; emergent aquatics: 18 = phragmites; 21 = cattail. Shoreline types are: 32 = deep/shallow marsh, 33 = bog mat, 36 = overhanging brush, 37 = steep bank, 83 = emergent aquatic-bog mat, 31 = sand or gravel beach, 34 = sand bar-shrub swamp, 35 = sand bar-pond, 38 = rock beach, 39 = residential (Cowardin and Johnson 1973:10-11).

Community types were grouped on the basis of concealment value and differences in use and availability between groups were related to home range size (Fig. 3). Classification of types according to degree of concealment was determined by the percent visual observations obtained from radio-marked birds in the different community types. Sand bar types, rock beaches, and residential shorelines (largely sand beach) were considered as being low concealment types. Over 50 percent of the total use by pairs with large home ranges was in low concealment communities, while pairs with intermediate home ranges seemed to avoid these communities. Communities providing the most isolation (cattail, bog mat shoreline, and overhanging brush shoreline) accounted for almost 90 percent of the use by pairs with small home ranges but only 17 percent of the use in large home ranges. Pairs with intermediate size home ranges used such communities 60 percent of the time.

If pairs seek isolation from other pairs or from drake encounters, it is not readily apparent why birds using large home ranges appear to prefer nonconcealing types. Table 1 indicates that these pairs predominantly use sand lakes, but also use river-channel and river-marsh areas to a small degree. Most of the availability of high concealing types in large home ranges is present in these river areas. However, river-marsh and river-channel areas were not extensive. This created the potential for competition with river pairs for the isolating qualities of these complexes. Competition through pair encounters could result in a spacing phenomenon with some pair use being shifted toward the less desirable sand lakes. Apparent preference for community types with low

concealment on sand lakes could be nothing more than an artifact resulting from suppression of preferential tendencies for community types with high concealment in river areas.

Few pairs restricted their use to only one complex type; however, one pair used only a river-marsh area while another pair used only sand lake (with adjacent wetlands). Probably a whole continuum of proportion of river use exists between these two extremes. McKinney (1965) suggests pair encounters can bring about dispersion of various kinds. One expression of dispersion may be the temporal spacing of pairs between these complex types. Numerous instances were recorded where as many as three pairs would utilize the same segment of lake or river shoreline by spacing their use during different times of the day.

This discussion does not imply that concealment value is the sole habitat characteristic affecting home range size. Other factors such as intense competition for highly preferred stands because of their productivity or desirability as a loafing site or roosting site could be important. The most use for any given community in relation to its availability was found in the large home range group for the sand bar-pond type. Small available acreages that are highly preferred increase the chances of pair encounters in competition for these areas with resultant temporal dispersion. Pairs with large home ranges tended to use a smaller proportion (19 percent) of the total number of stands available to them (45 percent stand use for pairs with small home ranges). Low use of total stands available could reflect a high degree of home range overlap with other pairs. Home range overlap would be obvious in areas with pronounced temporal spacing of pair use. McKinney (1965:8) reported more overlapping ranges among mobile species.

Little quantitative data were obtained relating attractiveness of habitat to preferred feeding areas or loafing sites. Intense use of sand bar-pond communities may be influenced by this attractiveness. Many of the ponds associated with these sand bars were extremely small (<1 ha) but appeared to have high numbers of invertebrates, especially mosquito larvae. Cline (1965:93) observed mallard pairs feeding extensively on mosquito larvae in some of the smallest woodland ponds in northern Minnesota. The sand bar-pond community may be highly preferred because of the association of a rich food source in close proximity to a desirable loafing site on the sand bar. Density of ponds adjacent to sand bars was low (<1 per km of shoreline) which could be reflected in the large home range size of lake pairs. Numerous authors have suggested the influence quality and distribution of habitat could have on home range size.

A high proportion (56 percent) of the home ranges of pairs using sand lakes was open water contributing significantly to the large size of these home ranges. Pairs did not establish their home range on segments of a lake shoreline, but instead, included whole portions of the lake. Opposite shorelines were often one kilometer apart. Although lake configuration indirectly influenced home range size, other factors determined use of both shores of the large lake instead of restricting use to one side or the other which would have greatly reduced home range size.

Preference for nighttime roosting sites appeared to be an important factor to some pairs in determining home range. River marsh areas received heavy use as nighttime roosting sites in all groups (63 percent). Differences in daytime-nighttime use of river marsh areas for the three

groups of home ranges were (1) day = 63 percent, night = 67 percent; (2) day = 14 percent, night = 83 percent; (3) day = 6 percent, night = 40 percent for small, medium, and large home ranges, respectively. An obvious shift to river marsh areas during night was apparent for pairs with medium and large home ranges. Depending on the location of the day home range, shifts to river marsh areas at night could significantly affect home range size (Fig. 4). Gilmer et al. (1971) reported that mallard pairs made high use of lake shorelines for roosting sites, but this was in areas where river habitat was not available. Drewien and Springer (1969:114) indicated that blue-winged teal (Anas discors) pairs roosted in ponds having residual vegetative cover in patchy stands. Deltaic areas of river marshes contained similar patchy cover and appeared to be primary roosting sites for many pairs (Fig. 4). During spring, near the peak period of nesting activities, as many as seven pairs of mallards were flushed from a 50 meter long deltaic floating mat during nightlighting operations. Radio-marked pairs in the height of nesting activity were seen in these roosting flocks. Evidently isolation or defense of any form of territory was not required by some breeding pairs at night. Fifteen duck-nights (a duck-night involved monitoring of one duck from dusk to dawn) of automatic monitoring showed very little activity indicating that once pairs settled down there was little movement or conflict with other pairs.

Habitat use in relation to availability is summarized for all pairs in Table 2 and is compared to Gilmer's et al. (1975:784) study of mallard pairs using interior areas. Interior mallards used significantly more nonpermanent water areas. Isolation or concealment benefits from use of

Fig. 4. Locations of night-day use by hen 5255 for three weeks. Use symbol size is approximately proportional to percentages of night and day locations, respectively.

this type of small pond in woodland habitat are obvious and may reflect in the smaller mean home range sizes (210 ha for 8 hens in interior areas versus 546 ha for 8 hens in lake and river areas). Gilmer (1971) reported that timber and shrub cover around wetlands and lakes may reduce encounters between pairs using these habitats. Interior mallard pairs preferred sand bar-pond, deep/shallow marsh, and bog mat communities as did lake and river pairs, but used sand beach and overhanging brush communities more in relation to availability. Little use and availability of emergent aquatics, such as phragmites and cattail stands, by interior mallards may have been offset by high use and availability of small nonpermanent wetlands.

BEHAVIOR

Numerous authors (e.g., Dzubin 1955, Gates 1962, Derrickson 1975, Gilmer et al. 1975) have observed differential mobility of hens during various periods of the nesting season. Most of these studies reported decreasing mobility from prenesting through incubation although they provided little information concerning renesting effects on mobility. Sowl's (1955:132-133) defined the period of time between destruction of one nest and the laying of the first egg in the second nest as the renesting interval. Five renesting hens were examined for mobility differences relating to the renesting interval (Table 3). Both hens with the longest renesting intervals appeared to use a higher proportion of the total breeding home range during this period. These hens also had a larger home range during the renesting interval than during either the 1st or 2nd nesting periods. Hen 5200, with a renesting interval of

six days, used only 16 percent of her total breeding home range at this time. This hen was tracked for the longest period of time prior to the initiation of her 1st nest. The large pre-nesting home range partly accounted for the small portion of the total breeding home range used during the renesting interval. Four out of 5 hens had larger home ranges during the 2nd nesting period than the first but were generally tracked for a longer time during the 2nd nesting attempt. Mean distance between renests was 1323 meters. Sowls (1955:137) found mean distances between 15 pintail renests to be 258 m. Distances between renests, variations in mobility related to duration of the renesting interval, and differences in home range size between 1st and 2nd nesting periods indicated that renesting may have an impact on home range size. Previous reference to a hen shifting use of complex types after destruction of her 1st nest seems to also indicate the effect renesting can have on the home range.

One radio-marked hen repaired 3 days after the disappearance of her radio-marked drake from the study area. The home range size of 52 ha for 5 days prior to repairing increased to 144 ha for the 5 days immediately following the first observation of the hen with a new drake. Some stabilization in mobility of the new pair appeared to develop the 2nd 5 day period after repairing when the home range size decreased to a more typical 42 ha for this hen. Repairing in this instance caused a shift in home range and significantly affected the size (109 ha to 302 ha). Another hen suspected of repairing showed even a greater increase in home range size (41 ha to 554 ha) for the 5 day period immediately following apparent repairing. This last difference may be exaggerated due to unequal samples (17 versus 90 locations) for the two periods.

Repairing of a hen may be followed by an unstable period of high mobility as the new pair adjusts to each other's movement strategies and to those of surrounding pairs.

Gilmer (1975:787) reported that drakes from interior areas shifted their use to large lakes, often in the company of other males, once the hen began incubation. Some of these larger lakes were the same areas investigated in this study. Flocked males became increasingly apparent on large lake shorelines as the breeding season progressed. Undoubtedly some of these drakes came not only from interior areas but also from river-channel and river-marsh areas. All lone and flocked drake observations (marked and unmarked) were analyzed for percent use of large lakes. Lone drakes were observed on large lakes 27 percent of the time versus 55 percent for flocked drakes.

Of four marked drakes paired to marked hens, two began flocking when the hen was laying, one was observed in flocks when the hen was 19 days into incubation of the first nest, and the fourth drake flocked when the hen was laying in the first nest and again during early incubation of the renest. All drakes departed the study area to molt but remained in flocks for at least 10 days prior to departure. During this time, they also remained paired to hens until sometime during the last week prior to departure. Two drakes were paired to hens 2 days before leaving.

Once drakes began to flock, activities often became extensive resulting in high frequencies of movements and considerable home range increases. One radio-marked drake had a cumulative home range size of 799 ha compared to 80 ha for the hen. The drake's home range more than doubled during the first week of the hen's incubation and increased

another 223 ha after initiation of consistent flocking with other drakes. Activity of this drake expanded primarily on lake areas. Dzubin (1955:286) found that a drake mallard's home range increased once incubation began. Other radio-marked drakes did not show such a pronounced increase in mobility as incubation progressed or pair bonds deteriorated. Differences in mobility of drakes appeared to be related to whether their pair home range was originally on large lakes or to the stage of the breeding season at which pair bond deterioration occurred.

Titman (1973:139-140) reported increasing lengths of pursuit flights with rape attempts more obvious later in the breeding season. McKinney (1965:101) noted that drakes characteristically participate in attempted rape flights when the pair bond is weakening. An influx of male mallards into a given wetland complex such as large lakes could affect activities of pairs using these same areas. Increased chasing of paired hens may contribute to the larger home range sizes observed on sand lakes.

CONCLUSION

Home range sizes of mallard pairs varied considerably among different wetland complexes. Numerous habitat and social factors probably affected this phenomenon in a highly complex interacting manner. Home range size appeared to be strongly related to isolation afforded the pair by the habitat although a possible direct association between the productivity or quality of a habitat and its concealment value may affect the significance of this relationship. Distribution of habitat obviously would influence home range size. A high density of evenly distributed and highly productive wetland units would not necessarily limit home range size if habitat providing isolation was not available. Pair densities, the incidence of

flocked males, and other social factors present in these areas would also affect the final impact of the habitat factors on home range size.

Large home range sizes characteristic of pairs using sand lakes probably did not reflect optimum conditions for mobility of a breeding pair. Lack of isolation coupled with a high density of flocked drakes could be causative factors which might ultimately affect reproduction according to Dzubin's (1969:156) hypothesis pertaining to overdispersal of nests into suboptimal habitat. Although this hypothesis was meant for high pair densities a similar effect may result in areas experiencing a high influx of extra drakes and/or in areas affording little pair isolation. Extensive overlap of home ranges caused by low distribution of highly preferred sites for feeding, loafing, and nighttime roosting may also be related to large home ranges on sand lakes. Desirability of sand bar-pond areas for feeding, loafing, and isolation was an important example. Small home ranges of pairs using river marshes indicated that these areas could accommodate high densities of breeding pairs.

Large lakes and rivers are common in the northern forests of the Lake States and Canada. Creation and preservation of small water areas adjacent to lake shorelines may increase the value of lake habitat to breeding pairs. River marsh areas and shorelines with extensive cover could support high pair densities and should be protected from destructive practices related to shoreline development.

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TABLE 1. Mean availability and use of wetland complexes by mallards grouped according to home range size.

COMPLEX TYPE	Home Range Size Group					
	$\bar{X} = 53 \text{ ha}^a$		$\bar{X} = 347 \text{ ha}$		$\bar{X} = 871 \text{ ha}$	
	Available ^b	use ^c	Available	use	Available	use
Nonpermanent wetlands	5	tr	17	9	33	16
Bog lakes	0	0	0	0	2	2
Intermediate lakes	0	0	6	8	2	2
Sand lakes	12	3	20	8	42	66
River channel	20	35	20	57	8	5
River marsh	63	62	37	18	13	9
Total	100	100	100	100	100	100

^a Mean home range size

^b Percentages of total wetland complex area (excluding open water)

^c Percentages of total fixes

Table 2. Summary of mean availability and use of community types by mallard pairs using predominantly river channel, river marsh, and sand lake complexes compared to mallard pairs using predominantly nonpermanent wetlands, intermediate lakes, and small sand lake.

Community	Lake and river pairs		Interior pairs	
	Available ^b	Use ^c	Available	Use ^a
Nonpermanent water ^d				
Interior	13	2	--	--
Adjacent	5	6	--	--
Total	18	8	64	50
Lakeshore				
Sand-gravel	4	3	6	10
Deep/shallow marsh	3	6	4	8
Bog mat	21	31	5	9
Sand bar-shrub swamp	6	4	2	2
Sand bar-pond				
Overhanging ^e brush	1	6	1	4
Steep bank	9	8	5	10
Rock and boulder	2	3	tr	1
Residential	7	2	3	5
Total	54	65	36	50
Emergent-bog mat ^f	7	2	--	--
Emergent aquatics ^g				
Phragmites	6	6	--	--
Cattail	14	14	--	--
Total	20	20	6	tr
Emersed aquatics	--	--	4	1

^a Data used from Gilmer et al. (1975)

^b Percentages of total community acreage

^c Percentages of total fixes

^d Not divided into subcategories by Gilmer et al.

^e Not present in interior areas

^f Not present in interior areas

^g Classified differently by Gilmer et al.

TABLE 3. Home range size variation for 5 renesting hens between different periods of the nesting season. Period length, distance between renests, overall cumulative home range sizes and overall tracking periods are also given.

Hen Identification	1st Nesting Period			Renesting Interval		2nd Nesting Period			Overall	
	Home range area ^a	Days	Stage Destroyed	Home range area	Days	Home range area	Days	Distance Between renests ^b	Home range area	Tracking period
5147	3.7	5	Early inc.	7.4	12	13.2	12	547.1	76	4/29-6/2
5200 ^c	97.4	15	Early inc.	63.2	6	257.8	37	3203.2	997.7	4/19-7/9
5222	82.0	19	Late inc.	114.3	19	5.79	18	1340.8	223	5/17-7/12
5256	6.2	8	Late laying	18	9	27.2	29	82	32.6	4/29-6/13
5259	92.5	10	Early inc.	181	17	111.9	23	1443	389.6	5/6-6/24

^a Home range size given in hectares

^b Distance between renests given in meters

^c Tracked for 11 days prior to her first nest attempt - home range size for this prenesting period was 950 ha (95% of her total breeding home range).