by H. J. Post

Home range and breeding biology of the Shoveler

Canadian Wildlife Service Report Series Number 25

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Report Series Number 25

Environment Canada
Wildlife Service

Environnement Canada
Service de la Faune

Issued under the authority of the
Honourable Jack Davis, PC, MP
Minister of the Environment

Canadian Wildlife Service

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Price $1.50
Price subject to change
without notice
Information Canada
Catalogue No. CW65-8/25
Ottawa, 1974

Design: Gottschalk+Ash Ltd.

Printing:
Imprimerie Jacques-Cartier Inc.
Contract No. 02KX-KL-131-3-9133

Cover: A male Shoveler
Photo by R. Fyfe

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Acknowledgements

I am particularly indebted to Lawson Sugden of the Canadian Wildlife Service for his advice, field assistance and encouragement throughout this study. I also extend thanks to Jessop B. Low, Utah Cooperative Wildlife Research Unit, Utah State University, and to J. Bernard Gollop and Alex Dzubin, Canadian Wildlife Service, who offered guidance and helpful criticism; and to other persons who assisted in various ways.

I would like to thank George Freeman, Ducks Unlimited (Canada), for permission to use unpublished data and for field assistance.

The results of this study have been presented to the College of Graduate Studies, Utah State University, Logan, Utah, USA, in partial fulfillment of a Master of Science degree in Wildlife Resources.

The study area was selected with the generous co-operation of landowners J. Coldwell, H. Damen, G. Maunsell, K. Seitz, Miss J. Taylor and G. Van Verdegem.

I am thankful to the CWS for providing financial assistance and equipment for field work.

Perspective

Research on the breeding requirements of waterfowl and their utilization of habitat forms a basis for intelligent management. Such studies are timely because wetlands are progressively being reduced, while demands on waterfowl are increasing. Unless we preserve sufficient breeding habitat to accommodate them, the future of waterfowl may be threatened. It is critical, therefore, that knowledge of habitat capability in relation to the needs of breeding pairs be obtained, so that special effort can be made to insure preservation of the best habitat. The need to intensively study individual waterfowl species in various habitat types continues.

One species generally overlooked by ornithologists to date, but with an increasing potential value to the waterfowl harvest in the future, is the Common Shoveler (*Anas clypeata*). Therefore, this 4-year study of the home range and breeding biology of the Shoveler was undertaken.

Abstract

The breeding home ranges of eight colour-marked Shoveler (*Anas clypeata*) pairs which utilized irrigated grassland habitat near Strathmore, Alberta, each contained a "core area", a nest site, and several (3 to 13) "peripheral" ponds. Home ranges were between 20 and 128 acres in size, with a mean of 76 acres. Each core area was occupied 60 to 90 per cent of the time on the home range, and it appeared to supply basic requirements of food, loafing area and pair isolation.

Nesting sites consisted of a variety of cover species, mainly grasses, as far distant as two-thirds of a mile from the core areas.

Study during four breeding seasons indicated a definite tendency of mated female Shovelers and unpaired males to "home" to their former breeding or natal areas. The peak of spring arrival was approximately May 1. Settlement patterns during 3 years when breeding habitat was abundant, followed by a year with a drastic reduction in habitat, showed that Shoveler pairs became spaced upon the breeding habitat in an orderly manner, without crowding or an apparent increase in hostility. Thus, pair spacing on limited wetland habitat limits breeding pair densities.

Shoveler broods appeared during the first week of June and peaks of hatching were several weeks later. Moult in drakes first appeared in mid June, and within 3 weeks drakes had left the area.

Résumé

Chacune des aires d'habitation et de reproduction de huit couples de Canards souchets (*Anas Clypeata*), marqués à la teinture, qui s'étaient installés dans des prés irrigués, près de Strathmore (Alberta), comprenait une partie centrale, un emplacement de nidification et plusieurs étangs périphériques (de 3 à 13). L'étendue des aires d'habitation variait entre 20 et 128 acres, soit une moyenne de 76 acres. La partie centrale était occupée 60% à 90% du temps passé dans l'aire et elle semblait répondre aux besoins de base en ce qui a trait à l'alimentation, au repos et à l'isolement du couple. Les endroits de nidification consistaient en des types variés d'abris, composés principalement d'herbes, et leur éloignement de la partie centrale allait jusqu'à deux tiers de mille (1073 mètres).

Une étude qui s'est poursuivie au cours de quatre saisons de nidification a révélé une tendance certaine de la femelle appariée et du mâle solitaire à retourner à leur ancien aire de nidification ou aux lieux de leur naissance. C'est vers le 1er mai que l'arrivée printanière atteignit son point culminant. Les modes d'installation, enregistrés au cours de trois années où les habitats propices à la nidification étaient abondants et de l'année subséquente, marquée par une importante baisse du nombre d'habitats, ont démontré que les couples de Canards souchets se sont dispersés dans l'aire de reproduction d'une façon ordonnée, sans entassement ni augmentation apparente de l'hostilité. Ainsi, le dispersement, en cas de réduction de l'habitat, limite la concentration des couples reproducteurs.

Les canetons commencèrent leur apparition au cours de la première semaine de juin, mais les principales périodes d'éclosion n'ont eu lieu que plusieurs semaines plus tard. C'est vers la mi-juin que la mue se manifesta chez les mâles et, moins de trois semaines après, les mâles avaient quitté l'aire.

Introduction

The Common Shoveler (*Anas clypeata*)[1], is widespread throughout holarctic regions. In North America its breeding areas extend from the valleys of central Alaska, south to Oregon, eastward to Utah and Wisconsin, then northwesterly back to Alaska. Breeding density is highest on the countless shallow, very fertile wetlands of the central plains. Birds winter on fresh-water marshes and in low-lying river valleys of the coastal regions of California (Van Den Akker and Wilson, 1949), Mexico (Saunders, 1964) and the Atlantic Coast from Texas to South Carolina (Kortright, 1943).

Within each species' range, individuals of that species do not roam at random; each has a home region (Seton, 1909). This concept is applicable to all waterfowl during the breeding season. Migrational homing is directed toward a specific area — the home range — within which all breeding requirements are fulfilled (Sowls, 1955; Smith, 1955; Gates, 1962). From wintering grounds, female ducks tend to return to their former breeding or natal areas.

On prairie pothole country near Minnedosa, Manitoba, Dzubin (1955) found that before the onset of nesting each breeding pair of ducks selected a portion of the habitat, seldom more than 2 miles in length, and restricted its movements to that area throughout breeding. The size of these home ranges depended upon the mobility of each species and the type of habitat.

Hochbaum (1944) first described a duck's territory as a piece of terrain on which water, a loafing site, nesting cover and food were present; and about which the drake of a breeding pair established definite boundaries against sexually active birds of its own species. This definition has been proven too rigid (Sowls, 1955; Dzubin, 1955; Gates, 1958a; Lebret, 1961; Hori, 1963; McKinney, 1965a; Siegfried, 1965). Central areas of each home range are defended against intruders; peripheral areas may be shared with adjacent pairs. McKinney (1965a) believes that drakes' chasing activities bring about dispersion, and that home range size, level of hostility and pair bond strength govern whether or not the pattern is close to classical "territorialism". When hostility and defence do not appear dependent upon a fixed topographical location, the "mated-female-distance" concept (Conder, 1949) may be applicable. Hori (1963) supports this concept from observations of the Common Shoveler, and Siegfried (1965) states that it clearly operates in a closely related species, the Cape Shoveler (*Anas smithii*). Smith (1955) states that the zone of intolerance around breeding Pintail (*Anas acuta*) pairs represents a definite defence of space. Nevertheless, home range behaviour allows for sharing of some breeding requirements as well as assuring isolation so that individual pairs may proceed with reproduction in an orderly manner. The basic home range concepts of Hochbaum (1944), Sowls (1955) and Dzubin (1955) are discussed.

The breeding biology of the Shoveler is not well known. Girard (1939) briefly described the life history, and Hochbaum (1944) mentioned behaviour in general terms. Shovelers were included in Sowls' (1955) breeding ground study of five species of surface-feeding ducks near Delta, Manitoba. McKinney (1967) studied displays and breeding behaviour of captive Shovelers in large flight pens, and has provided detailed information on the behaviour of the species. Scattered information appears in accounts of other species.

Three objectives of my research were to study the movements of Shovelers using the home range concept, study the function of a Shoveler's home range, and study the breeding biology of Shovelers.

[1] Scientific nomenclature of waterfowl species from Delacour (1956).

The study area

The study area was located in the County of Wheatland, 2 miles north and 1 mile west of Strathmore (51°05′N, 113°18′W), a village situated 24 miles due east of Calgary, Alberta.

The land base consisted of dark brown soils of glacial till, providing conditions suitable for agriculture. The topography was low-sloping to gently rolling, dotted with numerous shallow basins (Fig. 1). The climate was cool temperate, without a wide range of fluctuating temperatures. Annual precipitation was approximately 13 inches, which fell mainly from May to July.

An unusual feature of the study area was its location within the Western Irrigation District — an area of approximately 50,000 acres under controlled irrigation to offset a shortage of water which normally occurs during summer. Consequently, water remained in many of the shallow depressions during summer, providing stock water for cattle and habitat for waterfowl (Fig. 2).

Figure 1. Aerial view of the Strathmore Study Area

Table 1
Land-use practices on the Strathmore Study Area, 1966 (slight variation in 1965, 1967 and 1968)

Surface cover	Acreage (approx.)	Per cent of total area
Pasture	1,797	66
Grain	389	14
Alfalfa	245	9
Summer fallow	60	2
Roads and farmyards	59	2
Brush and trees	49	2
Water	127	4.6
Total	2,726	99.6

The 4.25-square-mile study area was predominantly used for pasture (Table 1), most of which was efficiently managed by restrictive grazing and the provision of abundant stock water. The prairie grasses, herbs and scattered small shrubs furnished suitable cover for nesting ducks. On the more fertile land, cereal crops were cultivated and alfalfa was grown for winter feed.

A wide variety of marsh and aquatic plants grew in and around ponds (Append. 1). The low-sloping shorelines were open, except for a few restricted clusters of thick emergent species, largely cattail (*Typha latifolia*) and sedge (*Carex* spp.). Common species along pond margins were spike-rush (*Eleocharis macrostachya*) and spike-grass (*Distichlis stricta*); consequently loafing areas were abundant. Large portions of most ponds supported aquatics, mainly pondweeds (*Potamogeton pectinatus*, *P. pusillus*) and water-milfoil (*Myriophyllum exalbescens*), which provided food for waterfowl and cover for aquatic invertebrates.

Table 2
Types and distribution of water on the Strathmore Study Area, 1966

Pond type	Number	Size in acres: Range	Mean	Total	Percent of total water
Permanent	30	0.3–17.2	2.2	66	52
Semipermanent	74	0.2– 1.6	0.5	34	27
Surface water	±68	0.1– 5.4	0.5	27	21
Total	±172	0.1–17.2		127	100

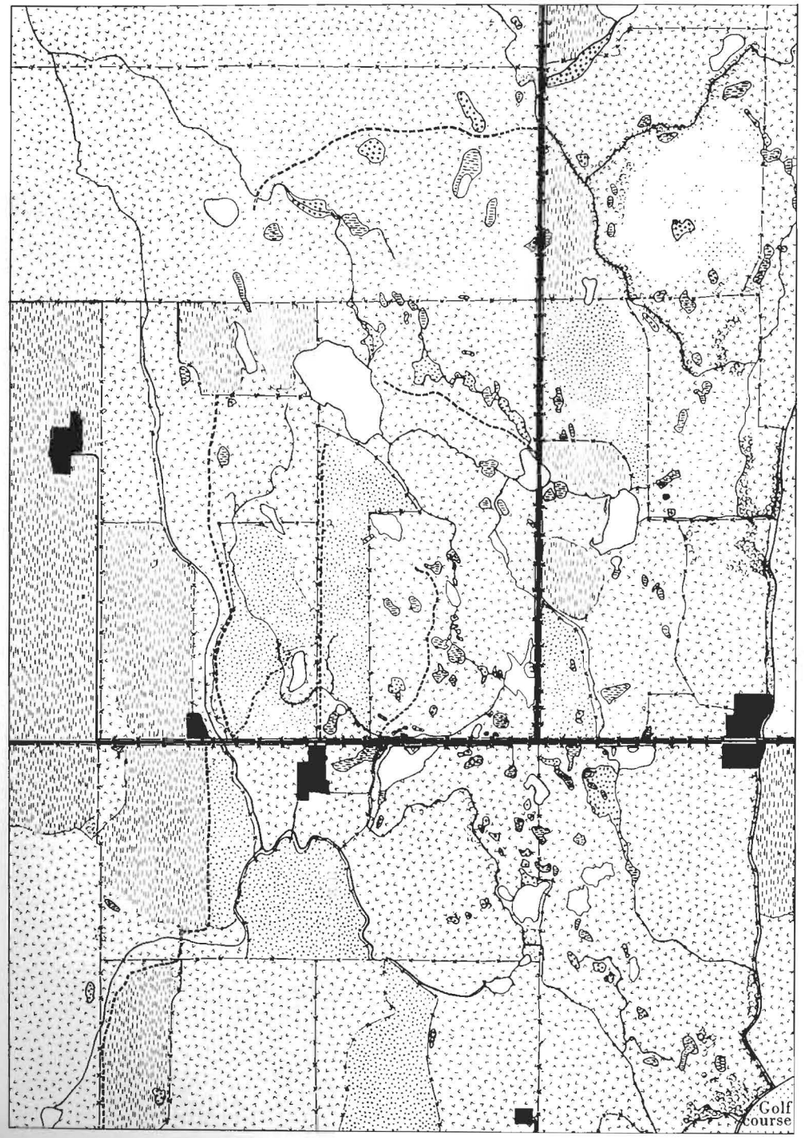
In summer, extensive areas of green algae and duckweed (*Lemna* spp.) occasionally developed, then subsided.

Ponds were numerous, but small in size. Nevertheless, irrigation water contributed toward their maintenance and consequently most ponds contained water until late summer. The maximum numbers and size of water areas classified are given in Table 2. Permanent ponds could be expected to remain indefinitely unless subjected to an exceptionally dry year during which additional irrigation water was not available. Semipermanent ponds, although containing typical marsh and aquatic vegetation, were susceptible to drying in mid or late summer during years of average precipitation. Surface water was essentially "sheet water" lying in shallow basins containing terrestrial vegetation, and remaining not longer than about one month in spring and for short periods following heavy rains.

A wide variety of invertebrates was found in abundance within most of 57 ponds sampled during May 1967.

Figure 2. Surface cover of the Shoveler study area

Figure 2



Water
- Permanent
- Semipermanent
- Surface
- Flowing

Vegetation
- Pasture
- Hay
- Cereal crops
- Brush and trees
- Summer fallow

Roads
- Section
- Field

- Fence
- Farmyard

Miles 0 1/8 1/4

Methods

Estimate of breeding pairs

Thorough searches for Shovelers in the study area were made at regular intervals during each breeding season, on foot, with the aid of binoculars and a 25-power spotting telescope. The number of breeding pairs was estimated on the basis of paired birds and solitary drakes (Evans and Black, 1956). Each solitary drake was assumed to represent a breeding pair, with the hen nesting.

Shoveler pairs resident on the area in 1965 were estimated from weekly censuses begun during the early nesting period in the third week of May and continued until mid July. The 1966 and 1967 breeding populations were measured similarly but census-taking terminated earlier. During those 2 years emphasis was also placed on the fluctuation in breeding pair numbers during the postmigration and prenesting periods. Thus, censuses were undertaken every 3 or 4 days from early April until late May and weekly thereafter. By the spring of 1968, many ponds had disappeared and water was scarce. For that reason, censuses were conducted weekly in May and once in mid June so that the settlement pattern and total number of breeding pairs could be compared with those of former years.

Counts were conducted so as to eliminate as many known sources of bias as possible (Diem and Lu, 1960). Care was taken to prevent the flushing of birds, thereby reducing the possibility of duplicate counts. Two or more censuses were usually taken during the selected days to help counteract any bias resulting from daily variation in waterfowl activities. Furthermore, counts were normally made in clear, calm weather.

The locations of all Shoveler sightings were plotted on maps. A series of sightings on particular ponds was used as a criterion for determining pair spacing. The total numbers of breeding Shoveler pairs resident on the area in 1965, 1966 and 1967 were estimated on the basis of maximum total pairs observed during at least three censuses. Resident breeding pairs in 1968 were estimated from eight censuses conducted after mid May. A minor correction to include several flocked pairs in the 1968 census totals was based upon knowledge of pond capacities to accommodate breeding pairs in the three previous years.

Identification and observation

The overall use of habitat by Shovelers is important, but of primary concern here is habitat use by individual breeding pairs. Therefore, Shoveler pairs were captured and colour-marked so that individuals could be identified and observed throughout the breeding season.

The first attempts to capture breeding pairs coincided with their establishment on the area, because earlier capture would likely have deterred settlement. Cannon-projectile nets were set along an open shoreline after a Shoveler pair, or pairs, was frequently seen loafing or feeding nearby. Periodic checking permitted the capture of any pairs found in front of the nets, and several pairs were carefully herded close to the nets to facilitate trapping. On one occasion a reluctant drake, whose mate was already marked, was readily lured within range and captured when he became very aggressive toward a stuffed specimen placed immediately in front of a net.

Nesting hens and flightless young were captured late in the breeding seasons of 1965 and 1966 with the speculation that some would "home" and provide additional marked birds for home range study. The hens, nest-trapped during late incubation with a manual trap similar to that described by Salyer (1962), were also observed, when possible, during the brood-rearing period. Juveniles approximately 6 weeks old were captured throughout the Strathmore District when drive-trapped or chased on land. They were then banded, colour-marked and released on ponds within the study area.

All captured birds were banded and colour-marked. A United States Fish and Wildlife Service (USFWS) numbered band and a coloured plastic nasal saddle (Sugden and Poston, 1968) were attached to each bird. Adult Shovelers were marked with variable bicoloured saddles (Fig. 3); juveniles were marked with white saddles in 1965 and orange saddles in 1966. Marked birds could be recognized with the aid of binoculars at distances beyond 100 yards.

Continuous observation of pairs was impossible; therefore conclusions about home range area and use were based on sample observations. A record of the location, activity, date, time and weather was kept for each sighting of a marked bird, including observations made during predetermined breeding pair censuses and during all travel on and adjacent to the study area. Such sightings were not necessarily random, however, because certain areas such as ponds along roads were observed more frequently. Furthermore, records were not always kept when birds were not located, although marked birds often were searched for until found. Home range boundaries were measured by the basic "regular polygon" method (Odum and Kuenzler, 1955). The extreme outermost points of observation were connected on a map forming a regular polygon; the area within was a home range.

Several pairs were studied intensively. A representative observation of daily activities during various breeding phases provided detailed information on home range use. Marked birds were followed and their activities recorded, minute by minute, for periods of not less than 3 hours, and on several occasions during most of the entire daylight period of approximately 17 hours.

Nesting, brood rearing and late summer distribution

Shoveler nests were located throughout the incubation period by dragging a 100-foot rope over nesting cover adjacent to ponds of high utilization, as well as over specific areas where hens were seen supposedly returning to nest sites (Sowls, 1955). Some hens were reluctant to flush, therefore several nests may have been overlooked. A number of nests were found incidental to my travelling about the area. In total, 15

Figure 3. Shoveler pair colour-marked with plastic nasal saddles

to 20 per cent of the estimated Shoveler nests were located.

After their nests had been found, incubating hens were disturbed as little as possible because of the increased risk of nest predation and desertion. Nest site measurements consisted of locating the nest in relation to the nearest known or assumed "core area", identifying the composition of nesting vegetation, and recording clutch size and the fate of the nest.

The Strathmore District was travelled widely. Shoveler broods which appeared throughout the breeding seasons were assigned, when first observed, to age classes according to criteria developed by Gollop and Marshall (1954); and the total number of ducklings in each was recorded. Hatching dates were estimated by backdating broods not older than Class IIb.

Three marked hens provided data on brood movement. The habitat adjacent to nests was intensively searched by two men and a trained Labrador retriever for at least several days following hatching, in an attempt to locate and observe marked hens with broods.

Each year several large water complexes within a 15-mile radius of the study area were checked periodically for marked birds and for a buildup of moulting flocks during the latter part of July and August. In late August 1966, one large water complex consisting of three lakes was surveyed from the air.

Spring arrival

The first Shovelers arrive annually in the Strathmore District prior to mid April. The earliest sightings during 1965, 1966 and 1967, were made between April 5 and 12. G. Freeman (pers. comm.) reported sightings between April 7 and 15 for the preceding 7 years. He observed that Shovelers arrived roughly 2 to 3 weeks later than the first Mallards (*Anas platyrhynchos*) and Pintails.

The progress of Shoveler arrival on the study area was closely observed in 1966 and 1967. Early migrants were subjected to frequent, intermittent periods of snow and freezing conditions. Water available to ducks was limited until late April, and early open water areas on several of the larger ponds or shallow depressions were utilized by flocks of 75 to 150 ducks. These were predominantly Mallards and Pintails, but included a few American Widgeon (*Anas americana*), Green-winged Teal (*Anas carolinensis*), Redheads (*Aythya americana*), and a small number of other species, including Shovelers. Several of the partially ice-free smaller ponds were soon occupied by a few scattered pairs and small flocks of Shovelers.

Shovelers travel in small isolated flocks during spring migration (Kortright, 1943; McKinney, 1965b). At the time of major population build-up on the study area, several large, shallow ponds within a few miles distant were utilized by loose flocks of 10 to 25 Shovelers, some in company with individuals and groups of other species. Hostilities were low despite Shoveler flock sex ratios ranging between 1:1 and 2:1 in favour of males. Presumably resident flocks soon dispersed to occupy the available water. Although most Shovelers travelled in small, isolated flocks during migration, some, especially early migrants, accompanied other species.

Hochbaum (1944), Sowls (1955) and others have noted that temperature influences waterfowl migrations. In April 1966 the sparse Shoveler population remained relatively stable during 2 weeks of cool, unsettled weather. However, on April 24, following three consecutive warmer days, Shoveler numbers rose rapidly to approximately one-half of those ultimately residing on the area (Append. 3). It is not known whether all birds were residents; nevertheless the main influx appeared well underway. An arctic air mass moved in the following afternoon, bringing a 4-day blizzard which halted migration completely. Ducks on the area remained relatively inactive, loafing near several limited patches of open water. There was no evidence of reverse migration during the abnormally severe weather. Immediately following the storm, Shovelers increased in number to the level of the eventual breeding population. Spacing was almost instantaneous, seldom with more than one or two Shoveler pairs on a pond at a given time.

Spring breakup and Shoveler arrival in 1967 differed slightly from the preceding year. The final surge of cool weather was somewhat less severe; nevertheless the mass influx of Shovelers was later and less pronounced (Append. 3 and 4).

The main influx of Shovelers apparently occurs at Strathmore after the weather begins to moderate in late April or early May. Upon arrival, all pairs have equal opportunity to assess and choose habitat. A wide selection of ponds is available in early May, with limited pair competition for preferred areas. Individual variation in timing of the reproductive cycle may account for a lack of synchronization in the drive to settle and establish breeding home ranges. Early nesting pairs may be subject to higher nesting losses as a result of unfavourable weather and poorer quality nesting cover, and therefore a period of settlement which forestalls nesting until favourable conditions persist can be advantageous.

Migrational homing

The annual return of wild birds to the area in which they nested the year before or where they were raised is called migrational homing (Sowls, 1955). In this study, evidence of migrational homing in Shovelers was obtained from returns of colour-marked birds (Table 3). An area of not less than 10 square miles surrounding the place of marking was thoroughly searched in successive years throughout the periods of spring migration and breeding. It was assumed that few, if any, markers were lost.

Table 3
Observed first-year migrational homing of Shovelers to the Strathmore Study Area, 1966–68

	Marked birds					Homing birds			
	Adult		Juvenile			Adult		Juvenile	
Year	F	M	F	M	Year	F	M	F	M
1965	6	6	24	35	1966	1	0	2	1
1966	8	5	92	99	1967	2	1	2	0
1967	6	8			1968	0	1		

This was based on the fact that of a sample of 24 hunting recoveries of Shovelers with similar markers, 23 were known to have retained markers for periods of 1.5 years or longer (Sugden and Poston, 1968). Birds that returned to the area with markers intact provided further indication of their effectiveness.

Recent published data on Shoveler survival were not available. Sowls (1955) estimated that the annual survival rate for Shovelers was between 31 and 51 per cent, based upon 89 band returns (55 the first year, 22 more in the second and 12 in successive years) for 1,087 Shovelers banded in Utah and reported by Van Den Akker and Wilson (1949). Assuming comparable or slightly lower survival rates for marked adult Shovelers on the study area, migrational homing and subsequent nesting was undertaken by at least 3 of the approximately 11 hens expected alive, or 30 per cent of those available for return. Furthermore, two hens colour-marked as breeding adults and one as a juvenile were next seen two breeding seasons later. They may well have returned for a brief period the intervening year, but because of some factor

(possibly habitat change or pair disturbance) may have left to breed elsewhere. Also, one female homing in 1966 was seen irregularly during a 2-day period before she and her mate disappeared on May 12. In 1965 a marked pair left the area during their egg laying period not long after a "group-rape" attempt on the hen, followed by the apparent destruction of the nest by predators shortly thereafter. Thus it was evident that not all ducks which attempt to settle on an area are successful.

On the basis of nesting hens, precise migrational homing to the study area (30 per cent) was less than that recorded by Sowls (1955) who marked 19 adult nesting hens and found that 8 returned. Subsequently, Sowls (1955) estimated the homing rate of Shovelers exceeded 50 per cent of the surviving birds.

Homing in juvenile hens apparently is less common than in adults. At least 4 of 116 juvenile females returned as yearlings. Using a dynamic life table (Hickey, 1952), I calculated first-year survival to be 18 per cent from a limited sample of 49 band returns (40 in the first year, 8 more the second year and 1 the third year) of 446 Shovelers banded as juveniles in the Strathmore area between 1958 and 1964 by G. Freeman, Ducks Unlimited (Canada). Thus, possibly a minimum of 20 per cent of the surviving juvenile females in my study returned to their natal area.

Two of the four returning juvenile hens became established several miles from the point of marking and release — which suggests that homing is not always precise. However, a stronger homing tendency may be expected under normal conditions. More than 95 per cent of the 116 marked juvenile hens were "planted" on the area while in the flightless stage (age classes II and III), and most remained there until autumn. With Wood Duck (*Aix sponsa*) transfers, McCabe (1947:108) found that "the point to which a duck returns is the place from which it leaves in autumn — the place where it learns to fly." But he also states, "there remains to be determined the minimum time required at a release point for birds to fix in their 'minds' so that they will return there the following spring." Vaught (1964) transplanted 377 flightless juvenile Blue-winged Teal (*Anas discors*) from Minnesota to Missouri and found no evidence of homing to the site of release.

Two of 19 adult drake Shovelers — of breeding age when marked — returned (Table 3). Only 1 of 134 juvenile Shoveler drakes returned. If previously described survival rates are applied, 25 per cent of adult drake and 8 per cent of juvenile drake Shovelers homed. It may be significant that all were unpaired on arrival. Thus, results show that males, too, are capable of homing but do so to a lesser degree than females. McKinney (1965a:93) states, "in most migrant ducks precise homing by males is thought to be a rare event, but there is little direct evidence since few males are banded on the breeding grounds." Sowls (1955) found that 2 of 185 male captive-reared juvenile ducks returned to their breeding areas the year following release. In addition, he collected a paired Mallard drake banded in the area the previous year. Sterling (1966) reports adult Pintail males exhibit a homing tendency toward moulting areas, and Erskine (1961) reports male Bufflehead (*Bucephala albeola*) home to wintering areas. Evidence from this study suggests migrational homing to breeding areas by unpaired male ducks may be more significant than previously believed.

Hochbaum (1944) suggested that adults arrive on the breeding ground before juveniles. However, this may not be true of Shovelers. When the main influx of Shovelers occurred in 1966, four marked birds were first observed in the following sequence: May 1, paired yearling female; May 2, unpaired yearling male; May 4, paired yearling female; and May 10, paired adult female. Both yearling females nested and their broods of nine ducklings each were first observed in mid June, less than 2 weeks following the first appearance of young and corresponding with the pronounced hatching peak of that year. However, Dane (1965), in a more conclusive study of Blue-winged Teal, found adults usually nest earlier than yearlings. The observed arrival sequence at Strathmore of marked birds in 1967 was: May 5, paired yearling female; May 8, unpaired adult male; May 14, paired adult female; and May 15, paired adult female. (Three later returns were excluded because the areas where the birds were sighted had not been regularly checked.)

Since most of the breeding population had arrived when the marked birds were first observed, it was apparent that any difference in arrival dates of adults and yearlings must be slight.

Pairing

Shovelers pair on the wintering grounds prior to migration (Chabreck, *cited by* McKinney, 1965b). However, pair bonds appeared weak on arrival at Strathmore. Mated birds often drifted some distance apart during their activities, although visual contact usually was maintained. Limited hostility in the form of occasional "head pumping" or short chases accompanied encounters between breeding pairs or unpaired drakes within flocks prior to dispersal. It was not until settlement upon a home range that a drake became intolerant of other drakes.

Several unpaired males accompanied the breeding populations on arrival. Fortunately, three had been marked in previous years. During early May 1966, a yearling drake, in close association with another unpaired drake, was observed using two large shallow ponds adjacent to the study area. Both birds participated in occasional behavioural encounters with other pairs before they disappeared approximately 1 week after arrival.

In 1967, an unpaired adult drake homed precisely to the home range he had occupied the previous year. (His mate of the previous year also was observed, 1 week later, re-paired and reoccupying the same home range.) This drake remained solitary and was not aggressive. About 2 weeks after arrival he mated, but as a result of a peculiar circumstance. A nearby pair was trapped and colour-marked, and this disturbance apparently disrupted its pair bond. The paired male remained in the vicinity of the trapping site. However, the female disappeared, and 2 days later was observed with the "homing" drake, while the original mate loafed close by. The rejected male remained close to the newly formed pair for about 6 days, with little hostility. He then apparently left the area. At this time, approximately 1 week after re-pairing, the hen began laying.

One of eight adult drakes marked in 1967 was observed to return in 1968. On arrival in early May, he intermingled with a scattered flock of Shovelers (four pairs and five unpaired males) on a 2-acre pond 0.5 miles south of the study area. The sex ratio of the group was very distorted; nevertheless, hostilities were low and the birds remained sociable. This drake was not sighted when the area was checked 1 week later; then during the following weekly search he was with a scattered flock 3.5 miles distant, on a shallow 25-acre pond bordering the study area. The next day he was regularly observed within his former home range, sharing a 1.9-acre pond with four Shoveler pairs. Hostilities were low, and only on occasion did this drake indicate his interest in sexual activity by "head pumping" upon the approach of paired birds. He was sighted again approximately 0.3 miles away on the second of two successive weekly checks of the area. It was apparent that this drake remained unsettled during May and possibly longer. Thus, not only yearling Shoveler drakes are known to remain unpaired (Kortright, 1943); adults, too, may form part of the surplus male population.

Unpaired drakes were not uncommon among Shoveler populations during the migration and postarrival periods. Similarly, Bellrose *et al.* (1961) have shown that there are more males than females in many species on their breeding grounds. Unpaired drakes may serve as replacements if pair bonds are disrupted, thus increasing the nesting potential of the breeding hen population.

Breeding populations

The breeding population of Shovelers was estimated to be 34 pairs in 1965, 38 pairs in 1966, and 50 pairs in 1967 (Append. 2–4). Small flocks of drakes were observed only occasionally; therefore it was assumed all birds bred and the sex ratio was even.

Pairs spread about the area upon arrival. As they settled on home ranges, each pair became more and more sedentary and intolerant of other Shovelers. Generally, pairs settled from 1 to 2 weeks after arrival; but not until nesting began did each pair centre its activities about a local pond or "core area" (see page 18).

In 1965, 1966 and 1967, there appeared to be more ponds available than Shovelers to use them. Thus, pond selection by pairs was undertaken in unoccupied areas. Water conditions were relatively stable, yet in successive years pair distribution varied and some ponds were used one year but not others. Evidence suggests that water permanence, along with accompanying pond characteristics such as the presence of invertebrates and vegetation, influences selection of ponds by Shoveler pairs.

There was much less water in 1968 than in 1965, 1966 or 1967. Consequently, ponds suitable for ducks were at a premium. The reduction in breeding habitat was attributed to a negligible spring runoff from a below average snowfall, the restricted supply of irrigation water, and a dry spring (4.8 inches of precipitation from April 1 to June 30, compared to an average of 6.8 inches annually during the years 1931 to 1967[2]).

Shovelers arrived at Strathmore on schedule in 1968, and the full complement of the breeding population appeared to be present on or about the study area during the first week of May. Dispersal to local ponds occurred to the extent that what wetland habitat existed was occupied by breeding pairs at a density comparable to that of previous years. However, presumably as a result of the overall shortage of habitat, two open shallow ponds 20 to 25 acres in

[2] Department of Transport. 1967. Annual meteorological summary for Calgary, Alberta. Meteorological Branch, Calgary.

Figure 4. Spring water conditions and breeding pair settlement of Shovelers on the Strathmore Study Area in 1968

size and situated less than 2 miles from the study area accommodated groups of Shovelers (Table 4) far exceeding former years when five to eight pairs normally occupied each. Daily activities on the large ponds consisted mainly of feeding or loafing, although occasional short flights were also observed. Approaching individuals were seldom aggressive toward each other, although low intensity "head pumping" did occur on occasion. When flushed, the Shovelers formed small flocks which flew short distances before attempting to return. As new ponds formed, a decrease in grouped Shovelers on the two large ponds accompanied an increase in the study area (Append. 5). Pairs dispersed to the smaller, scattered breeding ponds, many of which were formed as a result of irrigation water supplied in late May. Subsequently, numerous pairs did not establish home ranges or begin egg laying until the second week in June, later than in the three previous years.

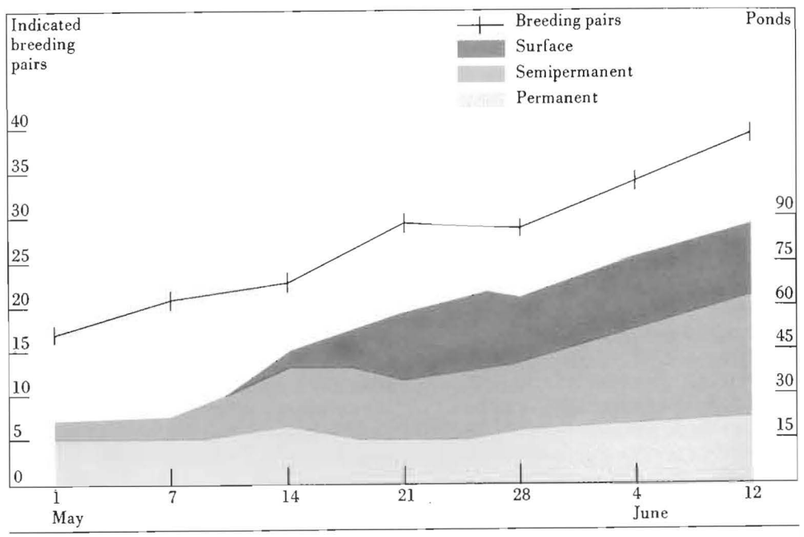
Drewien and Springer (1969:110) noted on the Waubay study area of South Dakota:

> Blue-winged Teal apparently responded to water conditions from late April through mid May. Variations in water conditions after this period did not appear to have as much effect. In 1951, 1957, and 1965, water conditions improved rapidly in late May or June, but Teal densities apparently had already stabilized and no appreciable increase in population occurred....

However, in the Redvers area of Saskatchewan, Stoudt (1971) found a mid season shift in waterfowl numbers, particularly increased Canvasback nesting, as habitat was created when water levels were improved by heavy rains between May 20 and June 10, 1963. Stoudt believed the sensitivity of waterfowl to rapidly improved conditions is influenced by both local and outside habitat conditions, and by the status and behaviour of the waterfowl species and populations themselves. Stoudt (1971:29) also states:

> It is quite possible that 70 per cent occupancy was at or near maximum density of ducks for the study area, assuming that territoriality or some other social phenomenon operates to regulate density of ducks.

Figure 4



The maximum population level for the Strathmore Study Area in 1968—carrying capacity—was realized because of the limitation of habitat. The influx of Shovelers to the study area apparently was deferred until breeding habitat became available, then pairs moved into the area in an orderly fashion (Fig. 4). Most ponds used in former years were, if extant, occupied by one or several pairs. A few ponds were used by small groups, although dispersal occurred prior to nesting. Nesting pairs isolated themselves from their neighbours; nevertheless there was no marked change in hostile attacks and aggressiveness from other years. As habitat became available, pairs moved onto it to settle. The mechanism which prevented crowding did not appear to be that of increased hostilities.

Distribution of the eventual breeding population of mid June 1968 of 38 pairs is illustrated in Figure 5. A comparison of Figure 5 with Figure 6 shows the change in conditions from the three previous years.

Table 4
Shoveler numbers on two ponds adjacent to the Strathmore Study Area, 1968

	Number of Shovelers			
	Pond 1		Pond 2	
Date	Pairs	Unpaired males	Pairs	Unpaired males
May 1	23	4	17	12
May 8	54	19	29	12
May 15	40	9	17	9
May 22	19	5	7	1
May 28	4	1	5	2
June 11	5	1	2	1

Figure 5. Distribution (core areas) of the Shoveler breeding population and water on the Strathmore Study Area in mid June, 1968

Figure 5

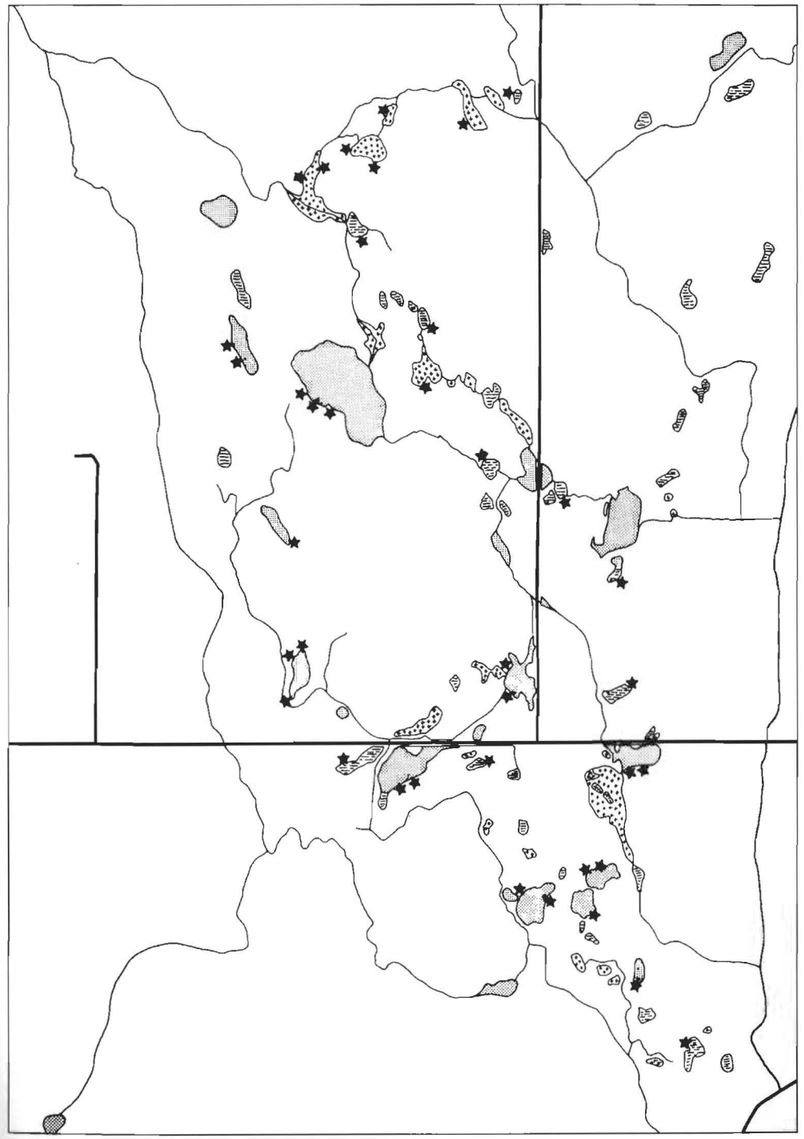
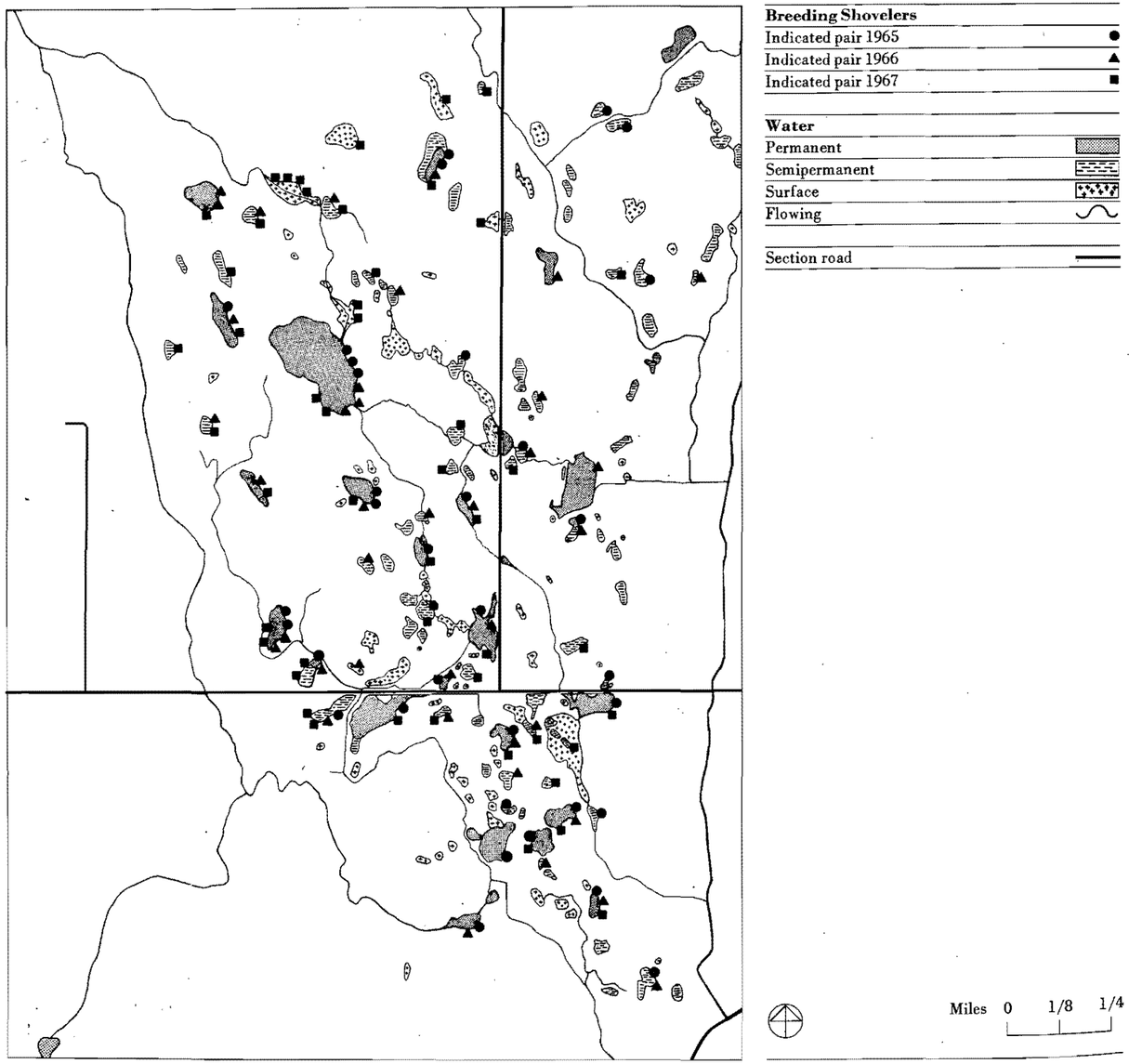


Figure 6. Distribution (core areas) of Shoveler breeding populations on the Strathmore Study Area, 1965–67

Figure 6



The postarrival period

Pair behaviour during the postarrival, nesting and brood rearing periods is described in sequence.

Postarrival activities

Few studies have provided information on postarrival movements, apart from the birds' known flights over nesting terrain. Dzubin (1955) found that a pair of Canvasbacks (*Aythya valisineria*) used an area as large as 2,560 acres, approximately twice the size of their eventual home range.

Gates (1962) found that, following arrival, Gadwalls (*Anas strepera*) grouped with other pairs in small flocks of up to 10 birds until the approach of nesting. He sighted all of six marked hens on areas more than 0.5 miles away from where they eventually nested. None were observed on the same area twice except on what later proved to be the breeding home range. Gates (1962: 49) states, "thus it appeared that resident hens were considerably more mobile during the postarrival period than after they settled down to begin nesting."

On arrival, Shoveler pairs dispersed over the available habitat close to where they eventually nested. Most pairs appeared unsettled and utilized numerous water areas, as if they were learning the habitat. As in Gadwalls (Gates, 1962), the tendency to occupy a home range including a core area did not become noticeable in the Shovelers until the approach of egg laying.

Shoveler mobility varied during postarrival. For example, pair F, which included an adult homing female, first appeared on May 14, 1967, several days later than most arrivals. The pair settled immediately and the hen started egg laying 1 week later. The pair used three ponds, all within the eventual home range area. In fact, during 14 hours of continuous observation I saw the pair use one pond more than 95 per cent of the time. The drake had the opportunity to chase off intruders on only three occasions, and did so each time. Drake G, an unpaired homing adult, was observed during a 2-week period before pairing (Append. 6). His movements were observed over at least 37 acres, and on several occasions he went well beyond this area. Another unpaired drake covered distances exceeding 3.5 miles before being observed on his former home range. Pair H, trapped 3 weeks prior to nesting, used ponds as far as 2 miles from its eventual home range, although it most frequently used ponds within or adjacent to the boundaries (Fig. 14). Two general areas were frequented until nesting, and on several occasions the pair was observed flying high en route between them. The pair's core area was seldom used during the postarrival period.

Individual variation in timing of the reproductive cycle, as well as habitat conditions, account for a lack of synchronization in settlement on home ranges for breeding. Normally, all Shovelers had arrived by the first week of May. Home range establishment and subsequent egg laying usually occurred 1 to 4 weeks thereafter.

Definition of home range

Hochbaum (1944) believed that at the beginning of egg laying each hen selected a small portion of the breeding marsh which contained all the breeding requirements—food, water and a loafing site, with nesting cover included or adjacent—and that the drake defended this unit area against others of the species for as long as the pair remained together. Hochbaum also believed that the nesting population of any breeding marsh is determined by the space required to provide isolation for each pair during copulation.

Sowls (1955) was critical of the concept of well-defined territories, and found that surface-feeding ducks residing on larger, more flexible areas often shared with other pairs of the same species. Sowls (1955:48) adopted the term "home range" as "the area within which a bird spends its period of isolation between the breakup of spring gregariousness following spring arrival and the reformation of fall gregariousness."

Dzubin (1955), using colour-marked birds, enlarged upon Sowls' findings. He defined home range as the area in which a

pair is most active during the breeding season; i.e., during the prenesting, nesting and incubation periods. This area includes the nest, feeding and loafing sites, and also a waiting area where the drake awaits the return of the female during incubation. Dzubin (1955:293) describes home range as:

> ...the sum total of all land and water areas utilized by the pair, including such areas the male and female may use individually from the time of initial settling on an area or prenesting period to the time the drake leaves for the molting grounds and the female hatches her brood. The last two events may not be simultaneous.

Home ranges, unlike territories, may overlap, providing for a sharing of resources. Nevertheless, each pair retains its seclusion by defending a restricted portion of habitat, somewhat variable in size, against others of the species. Dzubin believes each species of waterfowl may adapt its mobility to conditions at hand. Therefore, home ranges will vary in size in different habitats. Gates (1962) found Gadwalls occupied home ranges as described by Sowls (1955) and Dzubin (1955).

The component parts of a home range are a "core area" (Gates, 1958a), a nesting site, and at least several "peripheral" ponds. A core area is a restricted portion of habitat (a pond, section of a pond or several small adjacent ponds) containing loafing areas (the "waiting areas" of Dzubin, 1955) and feeding areas, within which the pair or drake regularly spends a large portion of time each day during the nesting period (from the onset of egg laying until the breaking of the pair bond or hatching, whichever occurs first). A core area resembles a territory, but differs in that its boundaries fluctuate with changes in the drake's hostility. This in turn is influenced by the "mood" (level of internal and external stimuli) of the individual drake, the chronology of the breeding cycle, and his location within the core area when intruders arrive. Peripheral ponds are not located within the core area, but are within the home range and are used by the pair either together or separately.

The home range

Detailed information was obtained on eight home ranges of Shoveler pairs, and somewhat less information on five others. Data are basically taken from observations shown in Append. 6. Measurements of home range have been estimated as follows: the "regular polygon" method (Odum and Kuenzler, 1955), describing an enclosed area; the range length—longest axis from a focal point; and the description of utilized ponds.

Shoveler home ranges were 20 to 128 acres in size, with a mean of 76 acres (Table 5). Each was delineated by peripheral ponds—seldom further than 0.7 miles from the core area. The spatial relationships of the components of home ranges are illustrated in Figures 7 to 14.

Research on home ranges has been done for a number of species. At Minnedosa, Manitoba, Dzubin (1955) found home range size to be in excess of 1,300 acres for a pair of Canvasbacks, 700 acres for a pair of Mallards, and 250 acres for a pair of Blue-winged Teal. Pond size and the pond permanence ratio in Dzubin's study area were similar to those in mine; however, water areas and accompanying breeding populations were more than twice as numerous. At Ogden Bay, Utah (Gates, 1962), Mallard and Pintail home ranges covered large areas of unknown expanse, whereas those of Shovelers, Cinnamon Teal (*Anas cyanoptera*), and Blue-winged Teal were estimated to be no larger than 20 acres. Five home ranges of Gadwalls varied between 34 and 87 acres in size, although some others were known to be larger. Gates could not detect differences in the habitat requirements of the six species studied; thus he suggested that this varied mobility may, in part, be the result of the innate behaviour of species.

Water area

Although, to date, total acreage has been used as the general unit of measurement for waterfowl home ranges, water area is of major importance. Utilization of each home range is restricted to water areas (Table 6) and their immediate vicinity, with the exception of the females' time on the nest. Thus, the quality and spacing of water on the habitat is critical.

The presence of water in home ranges A–H is illustrated in Table 7. Only core areas were used to any extent. Apparently, most pairs found all their requirements there and had little need for other ponds. Core areas, as such, were exclusive. Presumably each was established as a consequence of the drake's need to provide breeding isolation for the hen; also of his tendency to frequent a local "waiting" area to await the hen's return from the nest. Most core areas consisted of either permanent or semipermanent ponds. A number of ponds used as core areas in one or more years were not used in others. In 1967 and 1968 when demands on the habitat increased, a larger percentage of temporary water areas were used (Table 8). Utilization of semipermanent and surface waters increased as did breeding populations in 1965 to 1968; whereas the proportion of all permanent ponds used as core areas remained similar (52 to 65 per cent). Furthermore, evidence suggests a direct relationship may exist between the numbers and interspersion of the various water body types and the selection of core areas.

Table 5
Area and range length of Shoveler home ranges, Strathmore Study Area, 1965–67

Home range	Home range, acres: Drake	Home range, acres: Pair	Most distant sighting of drake from core area, yd
A	20	Unknown	250
B	128	110	825
C	75	14	625
D	97	81	800
E	54	32	575
F	106	26	1,350
G	87	37	1,225
H	39	39	825
Mean	76	48	810

Table 6
Distribution of drake activity within home ranges A–H (see Fig. 7–14), expressed as percentage use of ponds

Year	Drake	Pond number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1965	A	85*																						2
1965	B		90*				<1				<1													
1966	C			70*																				
1966	D				28*	7		1	3	1	1	7	5	1	<1	<1	<1				<1	7		
1966	E					65*						6						2	13	2			1	
1967	F						91*																	
1967	G				46*			4*	7*						2									
1967	H		81*				3																	

Year	Drake	Pond number 24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Unknown
1965	A	2	<1	1	4	1	1																		4
1965	B							<1	3	1	<1														4
1966	C																			10	13	1			6
1966	D														31*										7
1966	E																								11
1967	F										4	<1	<1	2											2
1967	G														11*	1	2	8	1				<1		18
1967	H														6									3	7

*Ponds used as core areas.

Any water area within the pair's home range may function as a peripheral pond when not occupied by another pair, and some ponds larger than 1.25 acres were used by several pairs at one time. These included permanent ponds, semipermanent ponds, shallow basins of surface water and slow-flowing irrigation water in wide channels. Use of peripheral water may be advantageous, although not essential. Pairs may fulfill a desire for flight exercise and a change in surroundings; and they may learn the whereabouts of neighbours, and areas to which they may flee in cases of emergency. Variations in maintenance activities within home ranges were not detected in fair weather. However, ducks used sheltered areas, including many small peripheral ponds with emergent vegetation, during windy, unsettled weather. Competition may prevent the use of peripheral ponds within individual home ranges; however, of 34 ponds believed unused in home ranges A–H (Table 7), only four ponds were situated within the core area of other pairs. Only a few temporary ponds disappeared during the nesting season, consequently changes in home range use attributed to habitat reduction were negligible.

Table 7
Total area and use of water within individual Shoveler drake home ranges, Strathmore Study Area, 1965–67

Home range of drake	Area, acres: Total	Area, acres: Water	Ponds: Core	Ponds: Peripheral	Ponds: Apparently unused	Per cent of water area used
A	20	9	1	7	1	65
B	128	18	1	6	5	56
C	75	15	1	3	2	93
D	97	14	2	13	7	71
E	54	7	1	5	2	91
F	106	9	1	4	2	96
G	87	6	4	6	9	61
H	39	8	1	3	6	55
Mean	76	11				73

Nest sites

Nests were rarely more than 100 yards from the core area, but the distance occasionally exceeded 0.5 miles. Nest sites were established at the beginning of egg laying, following settlement on the core area. Nesting

cover was abundant, although neither this nor the quality of cover appeared to influence nest site selection, and some nests were located in poor cover.

Sexual pursuits toward lone hens were minimized by the proximity of the mate. The drake in the core area insured the female's protection during periods of nest relief. Upon leaving the nest, hens flew directly to their core areas. They flew low, which reduced the opportunity for nearby drakes to proceed with sexual flights towards them. Although nest sites of hens F and G were more than 0.5 miles from their own core areas, direct flight routes to them were not close to ponds used as core areas by other Shoveler pairs. As nearby nesting cover was abundant, it was apparent that cover, *per se*, did not influence the distant location of the nest.

Maintenance activities

The hen moves about less during incubation than in the preceding breeding phases, presumably the result of her attraction to the nest site. Periods of nest relief, usually during the early morning or prior to dusk, were passed on core areas with few visits to nearby peripheral ponds. Hens fed actively, preened and bathed. Drakes were less active. Apparently the hen was responsible for movements of the pair, and the drake ranged where it desired only when alone.

Maintenance activities did not noticeably differ on any location within home ranges. Low-sloping shorelines with short or flattened vegetation used for loafing were plentiful. Feeding areas varied, although shallows containing submergent and surface vegetation were preferred (Fig. 15). Shovelers fed by: sifting food on or slightly below the water surface (the most common method), subsurface straining with head and neck submerged, and subsurface filtering with body position "tipping up". Each of 57 ponds sampled for invertebrates contained at least some areas where food was readily available. Bathing and preening were undertaken near feeding and loafing areas. Copulation, observed only a few times, was undertaken on core areas and once occurred on a shallow irrigation channel rarely used by Shovelers.

Table 8
Type and number of water areas used as core areas by Shoveler breeding populations at Strathmore, Alberta, 1965–68

	Water areas			
Year	Type	Number censused	Number used as core areas	No. of Shoveler pairs
1965	Permanent	28	18	28
	Semipermanent	72	11	11
	Surface	64±		
	Total	164±	29	39
1966	Permanent	28	18	22
	Semipermanent	72	15	15
	Surface	64±	1	1
	Total	164±	34	38
1967	Permanent	28	17	20
	Semipermanent	72	20	21
	Surface	64±	5	9
	Total	164±	42	50
1968	Permanent	23*	12	22
	Semipermanent	40	9	9
	Surface	23±	5	7
	Total	86±	26	38

*Five "permanent" ponds of 1965–67 dried in 1968, a consequence of extremely poor water conditions.

Table 9
Shoveler drake affinity for the home range

	Last sighting on the home range		Last sighting on the Strathmore Study Area
Drake	Date	Breeding phase	
A	6–13–65	Day brood hatched	July 9
B	7–03–65	Apparently nesting unsuccessful; pair together 33 days following first known nesting attempt	July 3
C	6–15–66	1 day after hatching of brood	June 17
D	7–01–66	Nest destruction 22nd day of incubation; pair bond observed intact 7 days later, male alone on 8th day	July 1
E	6–26–66	8 days after hatching of brood	June 26
F	6–20–67	Nest destruction approximately 23rd day of incubation; pair bond observed intact 2 days later	June 20
G	6–26–67	15th day of incubation	June 26
H	6–22–67	9th day of incubation	June 22

To clarify the extent and daily pattern of activities within a home range, marked drake F was observed during almost one entire daylight period under normal weather conditions (Fig. 16). The drake's breeding phase was mid-incubation (approximately 12th day) and the pair bond was intact. Since pairs were not observed to change their home range while pair bonds were intact, activities and behaviour are believed to be typical.

Each home range contained a core area, nesting cover and peripheral ponds—all components used during successful nesting and reproduction.

Home range overlap

Pairs prefer isolation during breeding, although home ranges may be shared to varying degrees by several neighbouring pairs (Fig. 17). This behaviour, in effect, provides for efficient use of available habitat. Conditions of sharing were: the use of "neutral" areas of nesting cover, the mutual use of peripheral ponds and the utilization of core areas in the absence of residents. Nests were usually near core areas although some were distant. However, should a nest be situated too near the core area of a neighbouring pair, the hen would be subject to harassment during periods of nest relief. Adjacent pairs may share peripheral ponds, within the mobility range of their respective core areas. However, each pair's strong attraction for the core area (occupied approximately 60 to 90 per cent of the daylight period) limits the use by other pairs of these specific areas as peripheral ponds. Similarly, it was evident that the total use of all peripheral ponds *per se* was less than the use of any core area. Territoriality on core areas was apparent, whereas aggression on peripheral ponds was a circumstance of the "individual-mated-distance" (Conder, 1949). Smith (1955) stated that in the Mallard, Gadwall, Shoveler and Cinnamon Teal, there is an area of intolerance around the breeding pair which moves as the pair moves. A pair establishes dominance when it is first to occupy a small pond which is not a core area, and other pairs are then discouraged from settling there. During flight, pairs were hesitant to approach occupied ponds from which they likely would be chased. However, ponds larger than 1.25 acres may support several pairs. Core areas functioned as isolated units wherein intruders were rejected by threats, fighting or aerial chasing. Only in the absence of residents were they available for use by others.

The strong pair bond is maintained to early incubation; thereafter its weakening is evident. Drake F was intolerant of others that attempted to enter his core area, but as mid-incubation approached he exerted fewer threats and chases. Subsequently, another pair also utilized the 1-acre pond as a core area. In effect, successive occupancy of habitat can result in accommodation of a larger number of breeding pairs. However, it did not appear to be a common occurrence.

McKinney (1965:96) says, "Among the *Anas* species which have been studied, the home ranges of Shoveler pairs probably overlap the least, as a result of the energetic chasing activities of paired males." It is true that Shovelers (except incubating hens) spend only a small proportion of time outside core areas. Nevertheless, if boundaries of individual home ranges are superimposed, overlap may in fact be comparable to that of other species (Fig. 17).

Affinity of drake for home range

Past studies indicate the pair bonds of Shovelers may remain intact until the last week of incubation (McKinney, 1965a; Sowls, 1955; Smith, 1955; Hochbaum, 1944; Girard, 1939). Drakes then leave for moulting lakes. On rare occasions, I observed pairs together until after hatching, as did Chura (1962), Smith (1955) and Munro (1945). Moreover, my observations of eight marked drakes with known breeding histories indicated that the Shoveler drake's pair bond duration and attachment to the home range may be for a longer period than previously believed (Table 9).

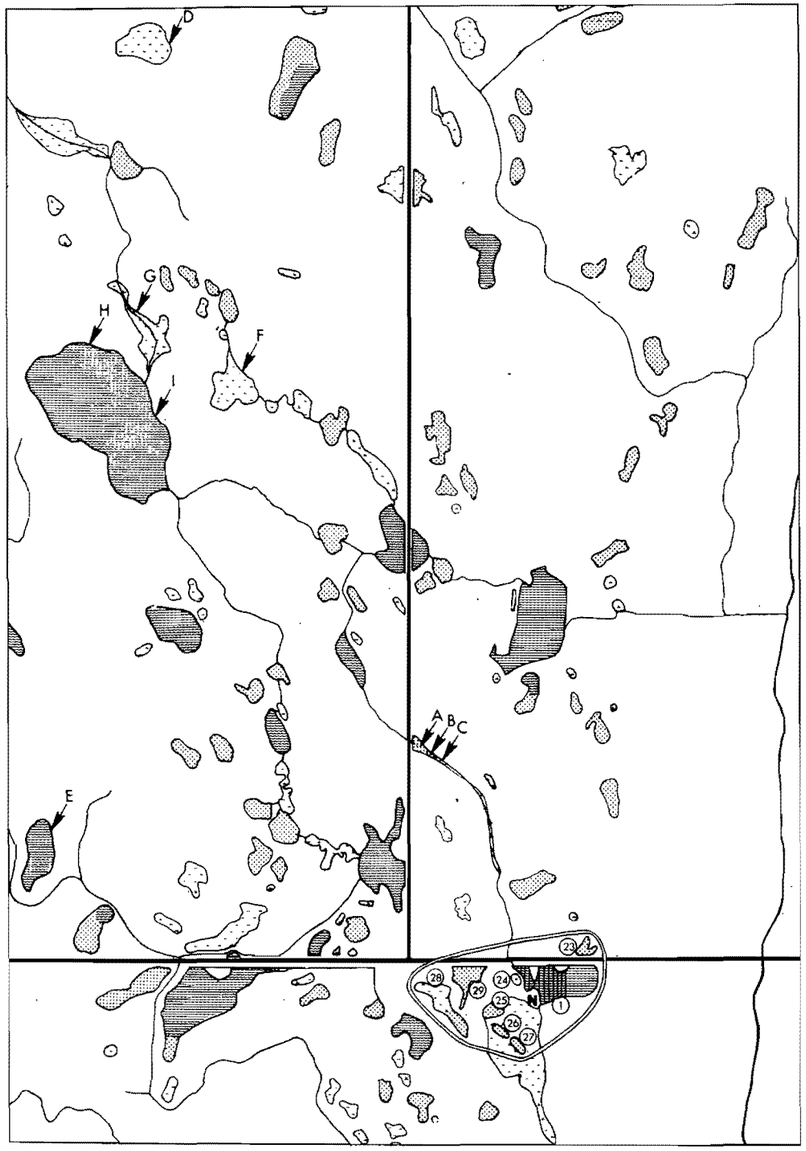
At the onset of nesting, each pair selected its home range, and specifically the core area. Mobility was most restricted once nesting began, and the drake awaited the return of the hen to the core area. Daily periods of nest relief were usually at regular times. Close association of the pair minimized harassment during periods when lone drakes were sexually active. Hens were seldom attacked while drakes were present to offer protection, an observation also reported by McKinney (1967). As incubation progressed, the drake's bond with his mate weakened and the pair was seldom seen together. The indifferent behaviour of hens suggested they, also, began to lose interest in their mates' presence. As hatching approached, drakes tended to increase their mobility. Consequently, the opportunities of meeting the hen were further reduced.

Maintenance of the pair bond and occupancy of the core area until late in the nesting cycle are functional in the promotion of renesting. If nesting is disrupted, a new clutch may be started as soon as the hen is physiologically capable of laying. The pair bonds of two marked pairs were intact when nest destruction occurred on the 22nd and 23rd days of incubation. These pairs were observed afterward on their core areas for 7 and 2 days respectively, but whether renesting occurred is unknown. Renesting intervals (Sowls, 1955) would extend to about 17 days, and it is doubtful these hens began laying as late as mid July.

The lengthy residence on a home range apparently creates an affinity within the individual to remain despite the eventual disruption of the pair bond. However, movements of drakes gradually widen, and with progressing stages of moult, movements are away from breeding areas, presumably to moulting lakes.

Figure 7. Home range of Shoveler pair A, 1965

Figure 7



Home range

Drake boundary	
Pair boundary	Unknown
Core area	
Nest	N
♂ Posthatching sightings	← A–I
Utilization reference (see table 6)	(26) etc., pond nos.

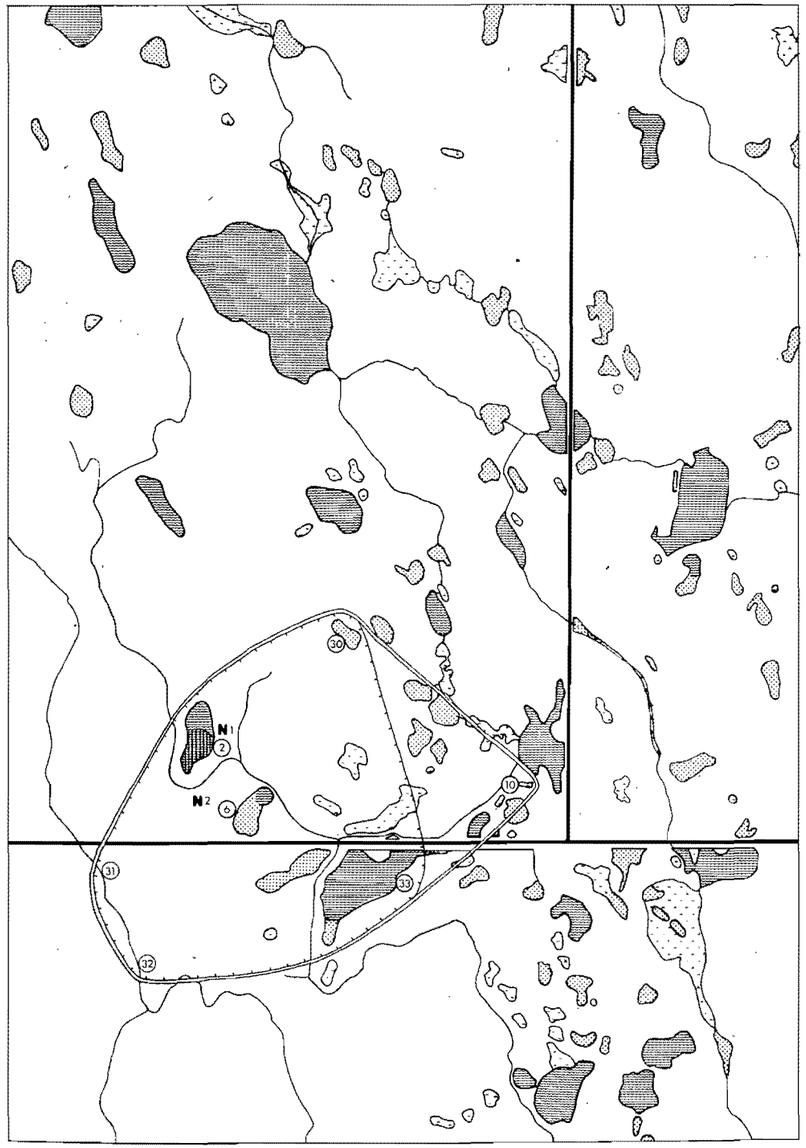
Water

Permanent	
Semipermanent	
Surface	
Flowing	
Section road	

Miles 0 1/8 1/4

Figure 8. Home range of Shoveler pair B, 1965

Figure 8



Home range

Drake boundary	
Pair boundary	
Core area	
Indicated nest	N_1, N_2
Utilization reference (see table 6)	(2) etc., pond nos.

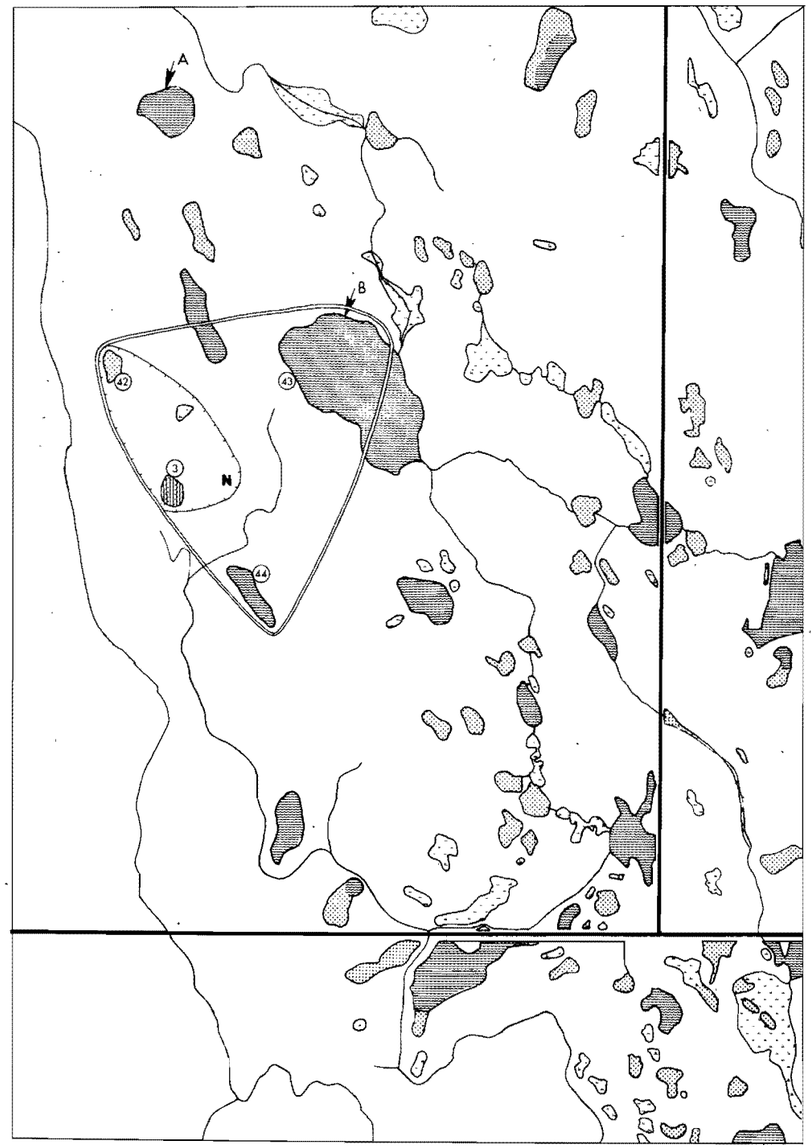
Water

Permanent	
Semipermanent	
Surface	
Flowing	
Section road	

Miles 0 1/8 1/4

Figure 9. Home range of Shoveler pair C, 1966

Figure 9



Home range

Drake boundary	
Pair boundary	
Core area	
Nest	N
♂ Posthatching sightings	←A–B
Utilization reference (see table 6)	③ etc., pond nos.

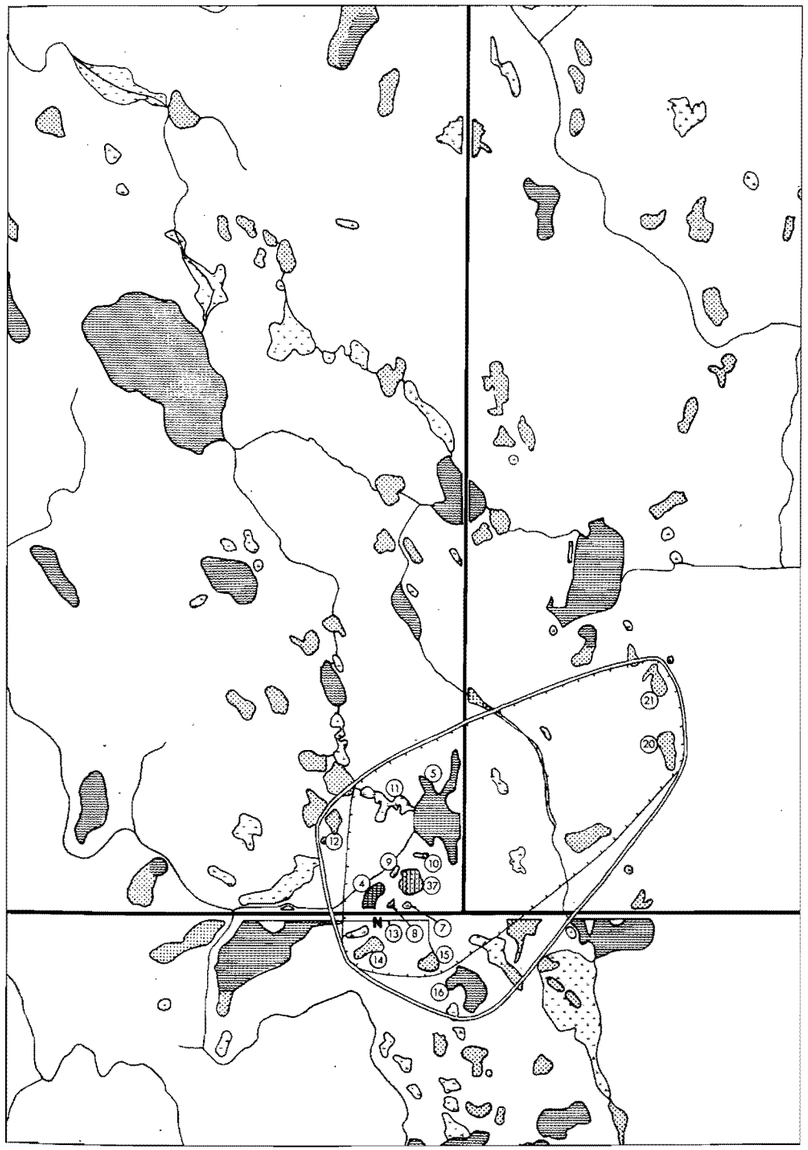
Water

Permanent	
Semipermanent	
Surface	
Flowing	
Section road	

Miles 0 1/8 1/4

Figure 10. Home range of Shoveler pair D, 1966

Figure 10



Home range

Drake boundary	
Pair boundary	
Core area	
Nest	N
Utilization reference (see table 6)	④ etc., pond nos.

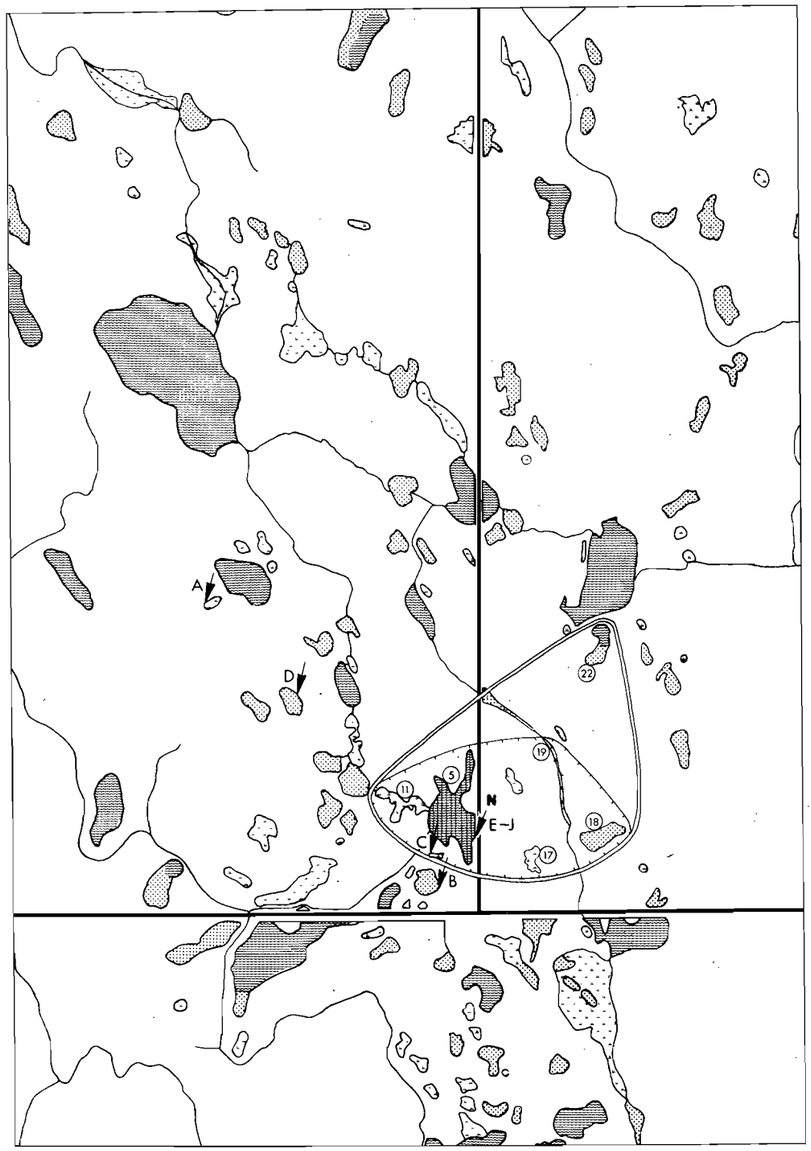
Water

Permanent	
Semipermanent	
Surface	
Flowing	
Section road	

Miles 0 1/8 1/4

Figure 11. Home range of Shoveler pair E, 1966

Figure 11



Home range
- Drake boundary
- Pair boundary
- Core area
- Nest — N
- ♂ Posthatching sightings — ← A–J
- Utilization reference (see table 6) — ⑰ etc., pond nos.

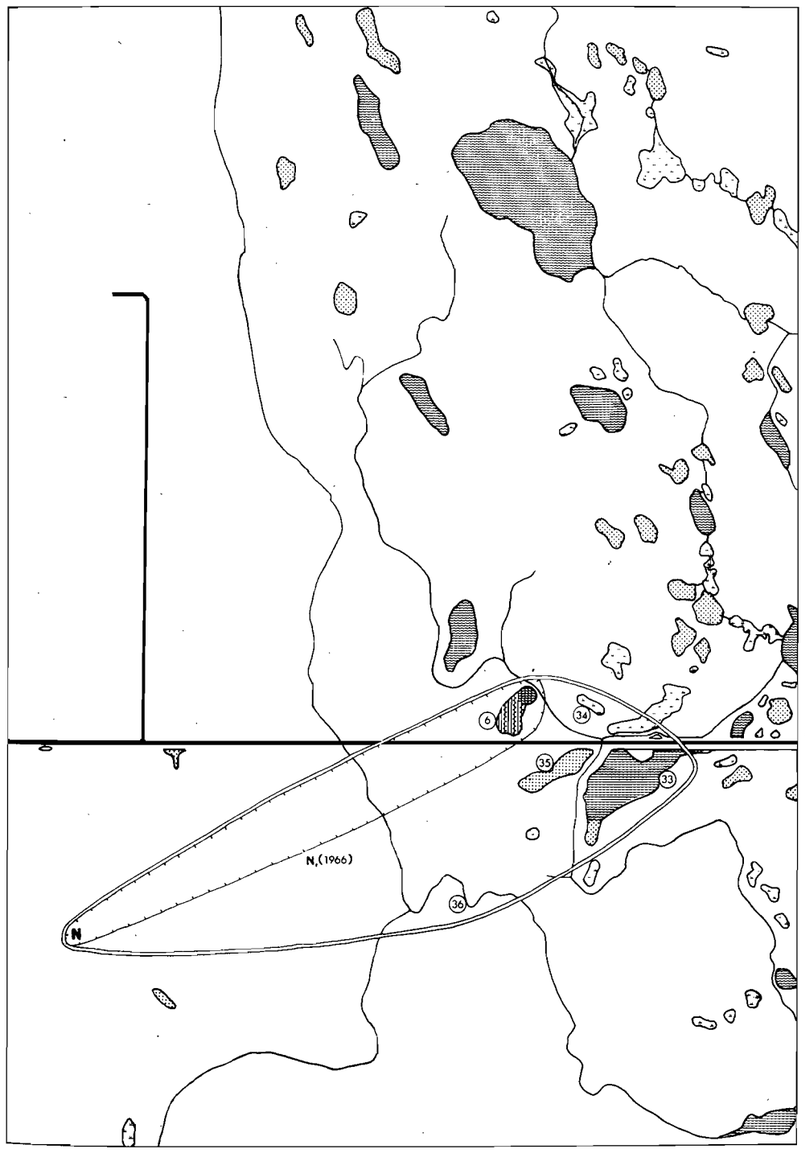
Water
- Permanent
- Semipermanent
- Surface
- Flowing

- Section road

Miles 0 1/8 1/4

Figure 12. Home range of Shoveler pair F, 1967

Figure 12



Home range
- Drake boundary
- Pair boundary
- Core area
- Nest — N

- Utilization reference (see table 6) — ㉝ etc., pond nos.

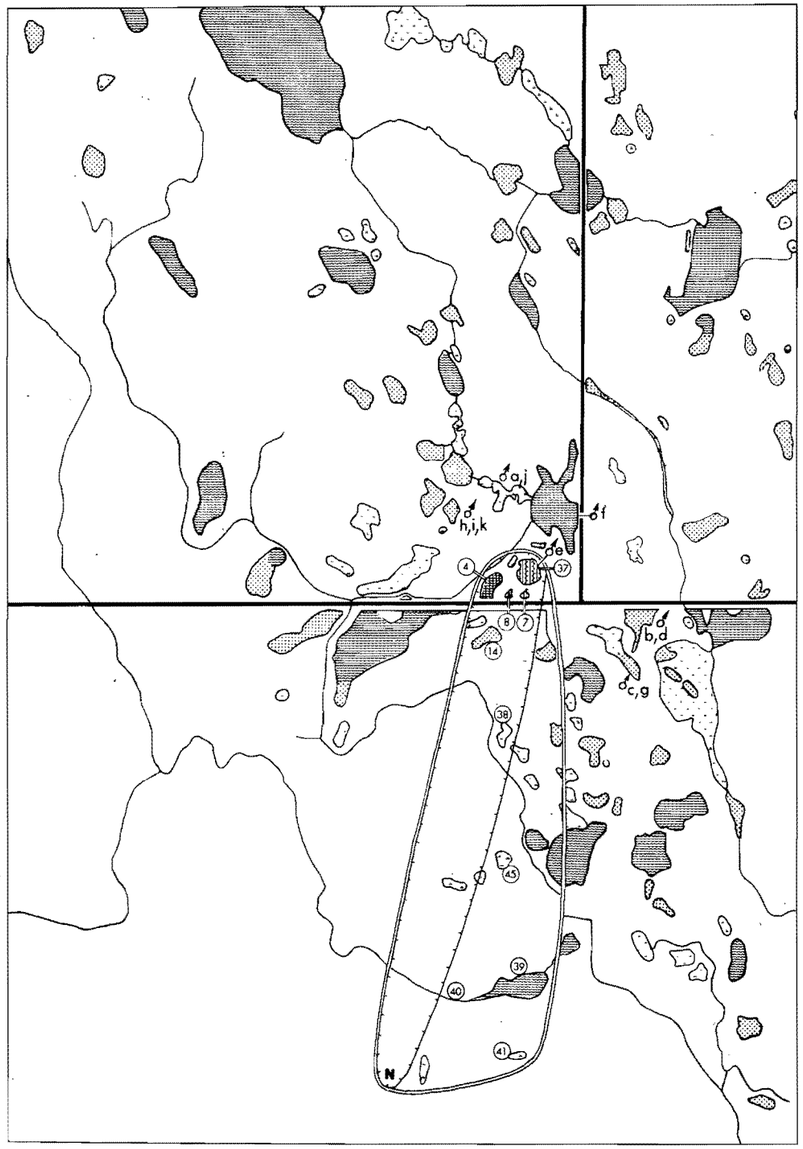
Water
- Permanent
- Semipermanent
- Surface
- Flowing

- Section road

Miles 0 1/8 1/4

Figure 13. Home range of Shoveler pair G, 1967

Figure 13



Home range
- Drake boundary
- Pair boundary
- Core area
- Nest N

Homing ♂, pre-pairing sightings ♂a–j

Utilization reference (see table 6) (41) etc., pond nos.

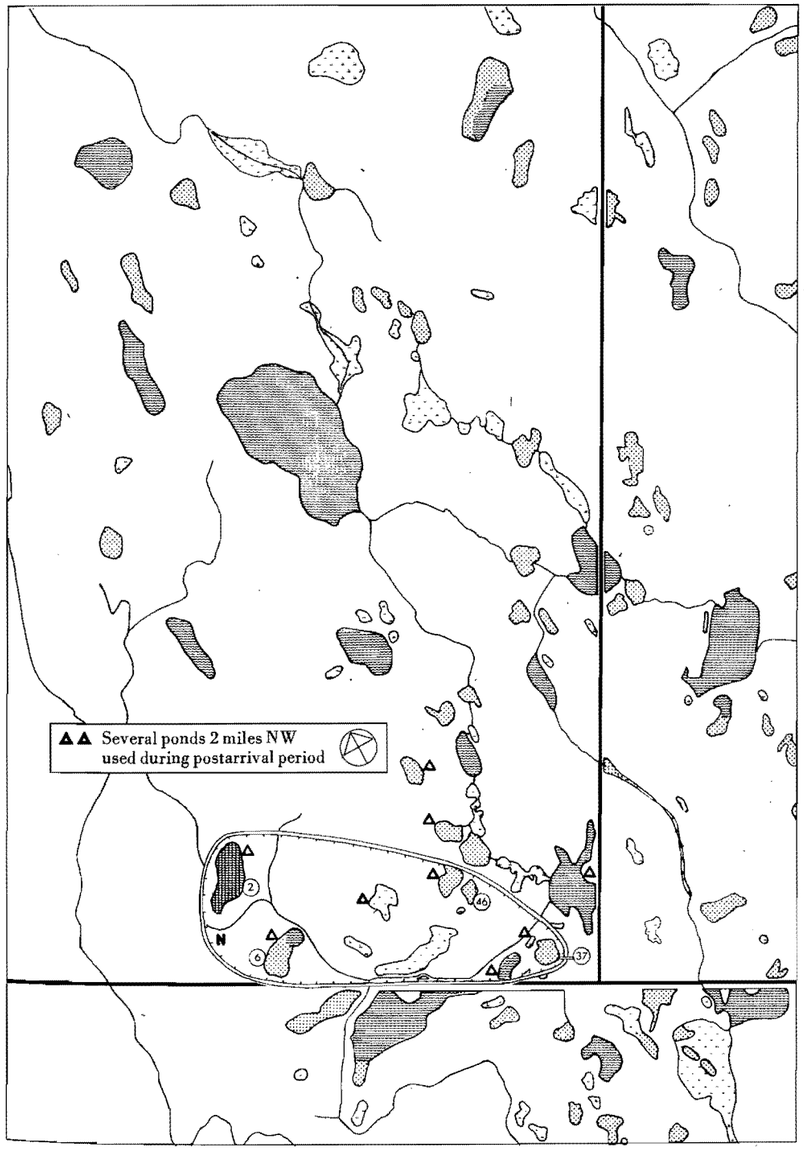
Water
- Permanent
- Semipermanent
- Surface
- Flowing

Section road

Miles 0 1/8 1/4

Figure 14. Home range of Shoveler pair H, 1967

Figure 14



Home range
- Drake boundary
- Pair boundary
- Core area
- Nest N

Pair sighting – postarrival ▲

Utilization reference (see table 6) (37) etc., pond nos.

Water
- Permanent
- Semipermanent
- Surface
- Flowing

Section road

Miles 0 1/8 1/4

Figure 15. A preferred Shoveler feeding area
Photo by J. Hatfield

Figure 16. Home range activities of drake F on one day during the mid-incubation period

Figure 16

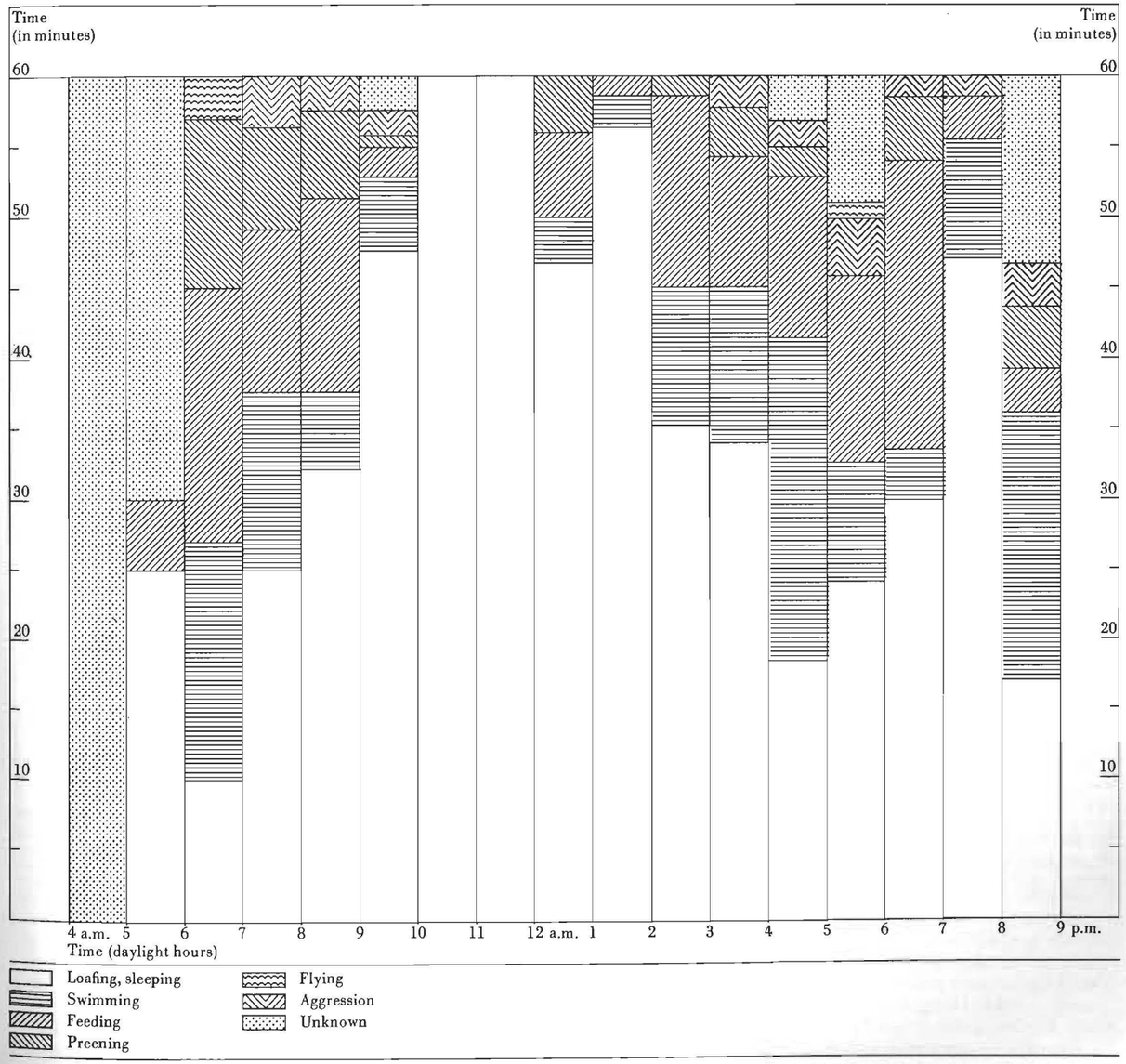
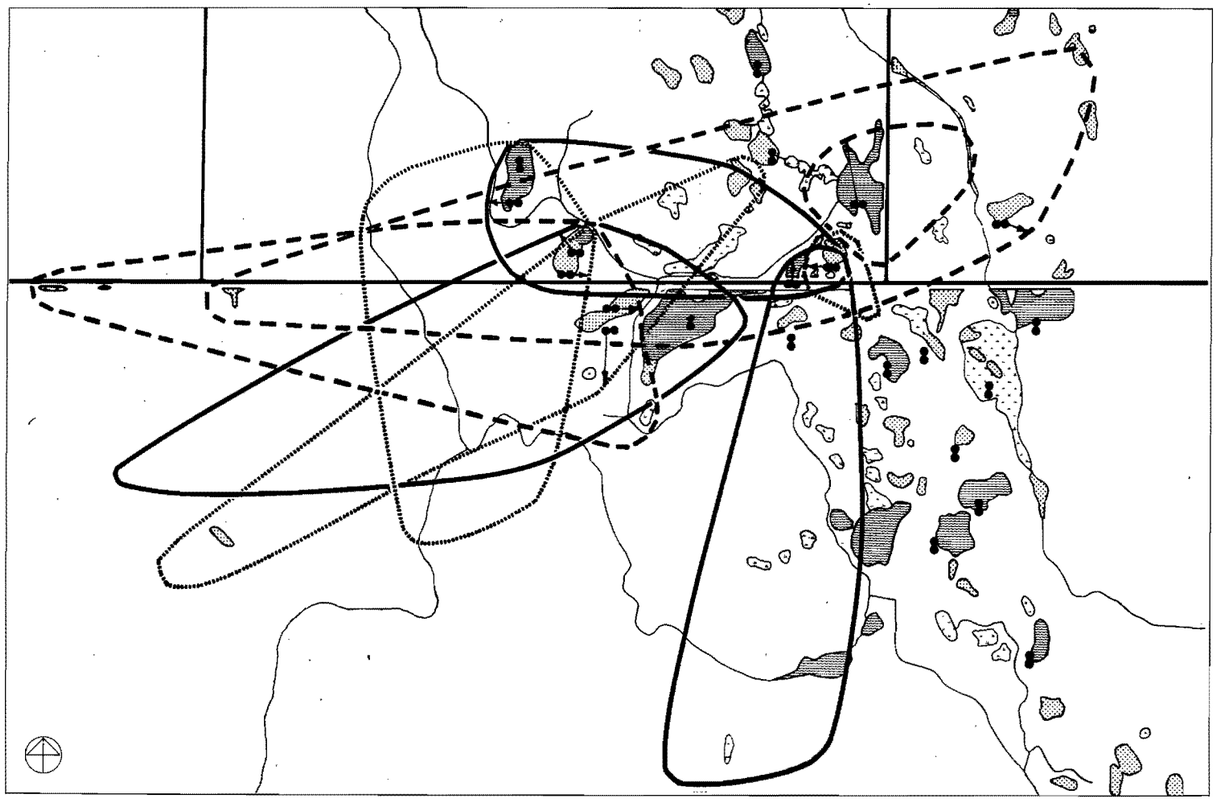


Figure 17. Known overlap of Shoveler home ranges, 1967

Figure 17



The nesting period

Nest site selection

The site of attachment, including not only the core area but perhaps the total home range, apparently is established prior to nest site selection. Preceding this period, pair mobility becomes restricted and ponds other than core ponds seldom are utilized. Pair bonds have strengthened by the time the hen selects the nest site. Several pairs observed flying to locations 50 to 150 yards from ponds were apparently in search of nest sites. Each hen probed and pecked at the vegetation as she walked. Each drake wandered in a wide area about his hen or remained relatively inactive.

At the time of nest initiation, vegetation appeared almost lifeless because new growth was still short, but fortunately the growth soon became functional for nest concealment. A variety of plant species were used for nesting. Pasture grasses were used most frequently. However, nests were also located in alfalfa (*Medicago sativa*), spike-rush, rush (*Juncus balticus*) and *Agropyron* spp. Nests were not found in grain fields or adjacent to brush or trees. Preference for any one type of cover was not evident.

Nest predation

The histories of 20 Shoveler nests located on the study area reveal that nest predation may have exceeded 50 per cent of the total nests (Table 10). Despite this, the numerous broods observed in the Strathmore District indicated that the outcome of nesting was favourable in overall productivity.

Crows (*Corvus brachyrhynchos*) and magpies (*Pica pica*), common residents on the area, nested in the brush and trees along the canals and ditches. They usually undertook their hunting activities on the nesting terrain as individuals or pairs, and usually at times when hens were flying to and from their nests. In addition, several small "nomadic" flocks of crows (probably non-breeders) were occasionally seen intensively searching areas of favourable nesting cover, and these contributed to the hazard of nest destruction.

Table 10
History of 20 Shoveler nests, Strathmore Study Area, 1965–68

Nest	Approximate date of initiation	Distance from water (indicated core area) (yd)	Clutch size (no. eggs)	Fate of nest
1	5–16–65	36	Incomplete: 5 (1/day)	Partially destroyed on May 21; completely destroyed on May 25
2	Unknown 1965	124	Unknown	Destroyed by avian predator on May 18
3	5–16–65	16	7	Hatched on June 8
4	5–27–65	67	6	Destroyed by predator approximately June 5
5	Unknown; laying on 6–2–65	17	Unknown; 2 eggshells found	Destroyed by predator on June 13
6	6–3–65	80	8 (1/day)	Destroyed by predator during mid-incubation
7	5–25–65	15	8	Death on hatching due to storm with continuous rainfall
8 (Hen A)	5–9–65	17 (33 yd to drake's main loafing site	10	Hatched approximately June 12
9	5–19–66	16	Incomplete; 5	Destroyed approximately May 21
10	5–22–66	104	6	Hatched on June 20 (1 addled egg)
11	6–5–66	29	Minimum of 5	Destroyed approximately June 15
12	6–9–66	27	13	Hatched approximately July 15
13	6–19–66	47	Incomplete	Destroyed as of June 23
14 (Hen C)	5–12–66	77*	9	Hatched on June 14
15 (Hen D)	5–23–66	19*	10 (1/day)	Destroyed by mammalian predator on June 23, the 22nd day of incubation
16 (Hen E)	5–16–66	42*	10	Hatched on June 18
17 (Hen F)	5–22–67	1100*	4	Destroyed on June 18
18 (Hen G)	6–2–67	1150*	9	Destroyed by predator as of July 3 (indirectly a result of cutting alfalfa used as nest cover)
19 (Hen H)	6–2–67	51*	11	Hatched on July 6
20	6–2–68	6	6	Unknown

*Distance from known core area.

Skunks (*Mephitus mephitus*) and long-tailed weasels (*Mustela frenata*) also were responsible for some nest loss.

Nest relocation followed by prolonged incubation

On June 19, 1965, following eight consecutive days of intermittent rainfall, a hen Shoveler was flushed from a nest containing eight eggs in approximately the 17th day of incubation. Although the nest and eggs were dry, the soil and vegetation surrounding the nest were soaked. Only one egg was resting in the saturated nest bowl when I revisited it on June 22. Close by, a newly constructed nest with neg-

ligible down contained seven eggs (Fig. 18). Confronted with rising water in the very shallow depression containing the nest, the hen's only alternatives were relocation to higher ground, elevation of the original nest or desertion of the clutch, and the hen apparently was in the process of moving her clutch to higher ground.

Nest buildup or relocation is not uncommon in diving ducks (Mendall, 1958; Low, 1945; Hochbaum, 1944). However, there are few accounts of surface-feeding dabbling ducks moving their nests. Oring (1964) reported that a hen Pintail and hen Mallard each moved nests from below nest traps and relocated on top of the netting. One hen Shoveler apparently reacted negatively to a nest trap, as the nest materials were scattered and desertion suggested. When the nest trap was removed, the hen resumed incubation. Sowls (1955) moved three eggs from a clutch of seven to a newly constructed nest 1 foot away from the original nest, and the Shoveler hen retrieved them. However, accounts of surface-feeding ducks relocating nests in response to changing weather conditions were not found in the literature.

A nest trap was set on June 23 and the hen was trapped and marked for study of brood movement. A USFWS leg band revealed this hen was raised on the area 3 years earlier. Hatching was expected on June 25, during 3 days of almost continual rainfall. On the afternoon of June 26, the rain-soaked nest was found to contain five almost completely pipped eggs with dead embryos, and three dead ducklings lay close by. Two of the ducklings were on the nest edge and one had moved 18 inches from the nest. After being flushed, the hen had stood alert in the field nearby; therefore I left the nest undisturbed. The hen soon returned to the nest and continued to incubate. She remained the next morning, despite what appeared to be the removal of one egg by a predator — remains were found 6 feet from the nest. The nest was visited again the following afternoon, June 28. The hen had apparently covered the nest before leaving the area. Thus, incubation was prolonged for approximately 2 days following the hatching and subsequent death of the young.

Table 11
Class I Shoveler broods observed, Strathmore, Alberta, 1965–67

Year	Age of broods: Subclass	Age of broods: Days	Number of broods	Size range	Median size	Mean brood size
1965	Ia	1– 6	7	7–13	9	9.7
	Ib	7–13	2	2– 6		
	Ic	14–17	8	3–11	9	8.6
1966	Ia	1– 6	18	1–14	10	9.3
	Ib	7–13	6	6–12	10	9.8
	Ic	14–17	3	8–11		9.0
1967	Ia	1– 6	21	1–13	8	8.0
	Ib	7–13	12	3–12	8	7.5
	Ic	14–17	8	4–10	7	7.1
Totals for 1965–67 inclusive	Ia	1– 6	46	1–14	9	8.8
	Ib	7–13	20	2–12	8	7.8
	Ic	14–17	19	3–11	8	8.0

Gates (1958b) reported that a Gadwall hen, incubating a clutch of five, hatched two young which were presumed to have died after leaving the nest. Eight days later the hen was observed incubating the three addled eggs, and she continued an additional 4 days before abandoning the nest. Thus, the hen's response to the incubation drive remains after hatching.

Hatching sequence

The hatching sequence of Shoveler broods as shown in Figure 19 was estimated from ageing broods in the field, ageing captured birds and known hatching dates.

Broods were first observed during the second week of June in all years. Hatching peaks, pronounced in the years of normal spring weather (1966 and 1967), were approximately June 10 to 20, followed by gradual declines to virtual completion of hatching by mid July. The 1965 hatching period extended throughout the summer, apparently as a consequence of cool and exceptionally wet weather (13.4 inches of precipitation from May through July, compared to an average of 7.9 inches for the same periods in 1931–67[3]). Possible explanations for the extended hatching period are that the cool, unfavourable weather caused a number of hens to postpone nesting attempts, and that the restricted growth of vegetation during early nesting exposed more nests to predation, resulting in renesting. Evans and Black (1956) also found the breeding season chronology highly variable, largely as a result of spring water conditions and temperatures.

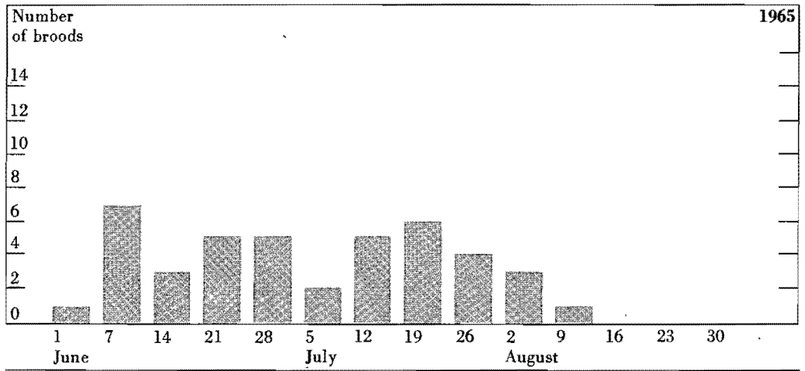
In this study, only indirect evidence suggested renesting occurred. Most clutches hatched in June; consequently clutches hatching in mid July or later were assumed the result of renesting, although some clutches hatching earlier cannot be overlooked as possible renests. The latest known clutch to hatch was on August 23, 1966 (estimated by back-dating a brood of two young Class IIa's with hen on September 12). Despite apparent nest loss, broods were numerous and production was favourable in all years. Nevertheless, the sizes of Class I broods, a function of clutch size, were by no means uniform (Table 11).

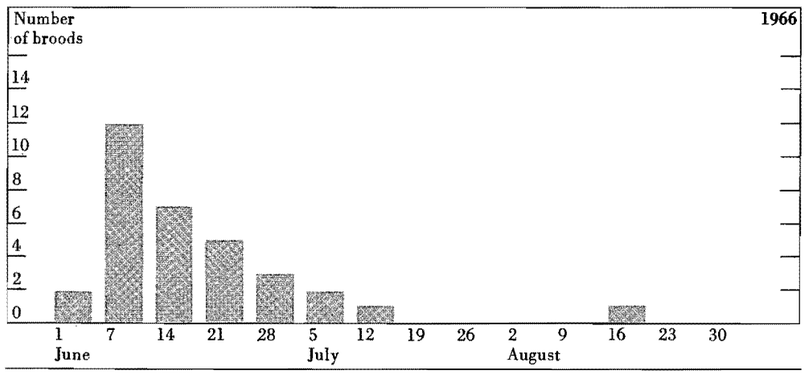
[3] Department of Transport. 1967. Annual meteorological summary for Calgary, Alberta. Meteorological Branch, Calgary.

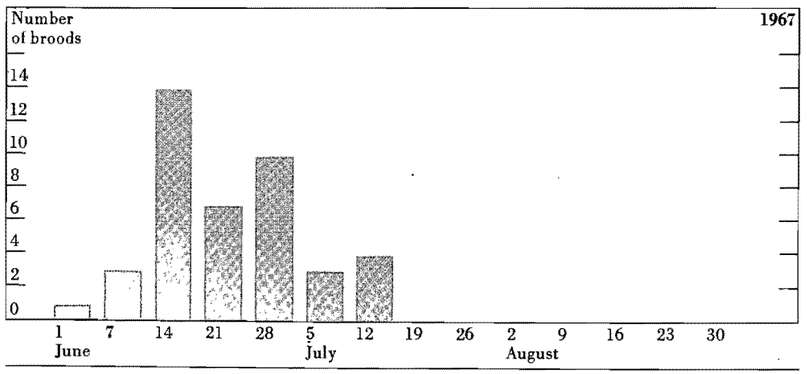
Figure 18. Newly constructed Shoveler nest adjacent to initial site

Figure 19. Hatching sequence of Shoveler broods, 1965–67

Figure 19







Age of broods	1965	1966	1967
Class I	22	28	42
Class II	20	5	–

The brood rearing period

Brood adoption

Brood adoption in waterfowl may happen on occasion (Hochbaum, 1944). Exceptionally large broods of diving ducks and geese suggest adoption but are more likely the result of brood combination, because usually more than one hen is present. However, very large broods of surface-feeding ducks are uncommon, probably because hens usually exercise hostility toward young other than their own. But it is unlikely the hen Gadwall which I observed with 21 Class Ib ducklings hatched such a large clutch, which implies a case of either adoption or "babysitting".

Repeated sightings of a positively identified hen with brood must be related back to brood size on hatching before one is certain of brood adoption. A marked Shoveler hen hatched a clutch of seven eggs on June 8, 1965. During the evening of June 13, this hen was sighted with a brood of 13 Class Ia ducklings. The hen and brood were actively feeding as a group, and soon after being approached they swam to shore and hid in the vegetation. Late the next afternoon, the hen and brood (now containing 12 ducklings) were at the same location, and the final sighting was during the evening of June 16. Thereafter, the hen and brood were not seen, despite frequent travel on the area as well as an intensive search of the immediate vicinity (0.5-mile radius) on June 22.

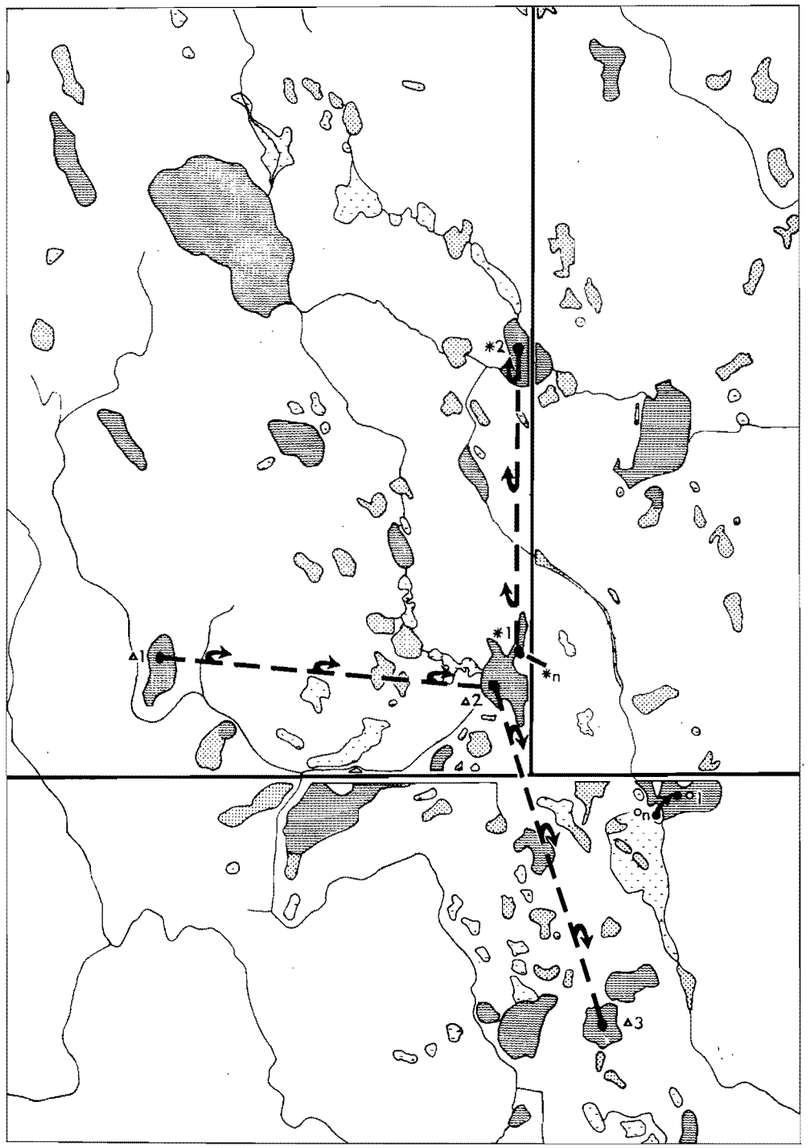
Brood movement

Nine marked hens hatched broods, but only three were sighted after their broods left the nests (Fig. 20). All three marked hens with their respective Class Ia broods were first sighted on their indicated core ponds adjacent to nests. (The core pond of marked hen(△)was apparent, although the nest was not located.) Thus hens, when leading newly hatched broods to water, were familiar with the surroundings during the period when their ducklings were most susceptible to death or injury. It was evident by repeated observation that broods in the study area seldom remained on one pond for longer than 7 to 10 days, with the exception of older broods of diving species. However, irrigation water flow and pond spacing may have facilitated or encouraged more movement of broods than normal.

Difficulty in locating and following marked broods with hens may be attributed to disturbances during nesting, namely my activities in nest-trapping hens and visiting nests, which may have caused some hens with broods to vacate the immediate area or seek cover upon the approach of strange objects. Improvement of radio-telemetry techniques would present more precise data on brood movements, especially if hens were marked prior to nesting. The pattern of brood movements in situations where nests and core ponds are far apart has yet to be investigated.

Figure 20. Movement of three marked Shoveler hens with broods

Figure 20



Brood	Date: Hatching	Date: Sighting(s)
○ n	June 8, 1965	
○ 1		June 13–16
△ –	June 14, 1966 (approx.)	
△ 1		June 17
△ 2		June 20–26
△ 3		June 29–July 13
* n	June 18, 1966	
* 1		June 18
* 2		June 30

Water
Permanent
Semipermanent
Surface
Flowing

Section road

Miles 0 1/8 1/4

The postbreeding period

Moult in drake Shovelers first became noticeable in early June, about the time of first hatching. This was evidenced by replacement of breast feathers. In mid June, moult in various stages was apparent on all individuals. The population decline generally began June 18 to 25 and continued until mid July, when all drakes had left the study area. Drakes became somewhat gregarious and occasionally groups of two to five were sighted after most of the breast feathers were replaced. One group of 12 drakes was sighted on June 23, 1966.

The moulting lakes of postbreeding birds from the study area remain unknown. Upon leaving the study area, the small sample of colour-marked drakes disappeared. Four lakes approximately 2 to 4 square miles in area and within a radius of 15 miles of the study area accommodated sizeable populations of moulting Shovelers and other species. It was common during the latter part of July and August for as many as 2,500 Shovelers to congregate on these lakes, although a small number may have been young birds. Two hundred Shovelers (20 per cent of the total duck flock), many in groups of five to seven birds, were observed feeding in shallow waters during an aerial survey of Namaka Lake, 12 miles southeast of the study area, on August 10, 1966. But only 10 Shovelers were sighted on August 21. Similarly, populations on other large lakes declined as fall approached, perhaps as a result of dispersal to smaller waters or early migration. Shovelers leaving the area were found to use migration routes and wintering areas shown in Append. 7.

Shovelers are important in the waterfowl harvest at Strathmore. Bob Adams, Alberta Provincial Fish and Wildlife Officer, conducted a survey within approximately a 10-mile radius of Strathmore throughout the hunting season of 1965, which began on September 24. A sample bag check of 324 successful hunters, randomly made while hunting, indicated that the three most heavily shot duck species were the Mallard (22 per cent), Lesser Scaup (*Aythya affinis*) (15 per cent), and Shoveler (12 per cent). Selective hunters, however, are known to overlook or discard Shovelers in favour of more preferred species if available. As bag limits of other species become more restrictive, the harvest and utilization of Shovelers will undoubtedly increase.

Recommendations for further study

Waterfowl biologists have yet to make precise evaluations of habitat characteristics — especially of wetland features attractive to ducks. Little is known of the relationships between physical and biological features of ponds and their effect on waterfowl use.

Further breeding ground studies are necessary to correlate duck use with pond characteristics. With limited data, Perret (n.d.) has suggested "habitat units" as a measure reducing the relationship of pond characteristics (shoreline, shoreline development, area, mean depth, and slope of basin) to a common denominator. Quantitative measurement of these factors and others (food resource, spacing of ponds and so on) should indicate what attracts waterfowl to use any given pond, provided waterfowl densities are below carrying capacity and pairs can select their habitat. For such a study, data would be needed on the numbers of all breeding pairs on a given area and the spacing of their core areas; a knowledge of previous waterfowl populations and water levels would be helpful.

To date, intensive measures for the acquisition and preservation of valuable waterfowl habitat, on a priority basis for production potential, are not fully implemented because the necessary criteria for identifying the best habitat remain unknown.

Summary

1. Migrating Shovelers first arrived at Strathmore before mid April, during intermittent snow and freezing conditions. Most of the breeding population did not appear until the first week of May, when the spring weather had begun to moderate.

2. Migrational homing was observed in hen Shovelers. Of the survivors, 30 per cent of adult hens and 25 per cent of juvenile hens were believed to have homed precisely to the study area and nested.

3. Three unpaired Shoveler males returned to the study area. Migrational homing to breeding areas by unpaired male ducks may be more prevalent than previously believed.

4. Differences in the arrival dates of adults and yearlings, if present, appeared slight.

5. Unpaired "surplus" drakes accompanying the breeding population may readily serve as replacements if pair bonds are broken.

6. Upon arrival, Shoveler pairs presumably set about learning the habitat, and ranged over distances occasionally exceeding 2 miles. The establishment of home ranges took place prior to the onset of egg laying, approximately 1 to 4 weeks after arrival. Pair activities then centred about local ponds.

7. Wetland habitat was seriously limited in 1968, and pairs moved onto the breeding area only as ponds became available. In this case, crowding did not occur on the breeding habitat.

8. The definition of home range set forth by Dzubin (1955) is applicable to Shovelers. Specifically, a home range refers to the area utilized by a breeding pair (as indicated by the drake's movement) from the onset of nesting (egg laying) until hatching, or until the desertion of local areas as a result of eventual pair bond breakage or unsuccessful nesting.

9. Eight home ranges, mapped and discussed in detail, had component parts consisting of a core area, a nesting site and at least several (3 to 13) peripheral ponds.

10. The size of the eight home ranges varied between 20 and 128 acres, with a mean of 76 acres; and the range lengths (most distant sighting points from core areas) covered distances of 250 to 1,350 yards with a mean of 810 yards. For most pairs, the location of the nest site did not influence the home range size.

11. Utilized ponds within home ranges varied between 4 and 15, and their importance to the home range concept has been emphasized.

12. Pairs had strong attractions for core areas and spent 60 to 90 per cent of their total time on them. Only one pair occupied a core area at a given time, although other Shovelers made use of it as a peripheral pond in their absence.

13. Maintenance activities of pairs did not noticeably vary on any area within the home range.

14. All home ranges studied overlapped with others, in fact some were found to be completely within the boundaries of others. The conditions of sharing were the use of "neutral" areas of nesting cover, mutual use of peripheral ponds, and utilization of core areas in the absence of their residents. The degree of overlap of Shoveler home range boundaries varied, but appeared to be comparable to that reported for other species.

15. The lengthy residence on the home range may create a desire within individuals to remain there. Drakes seldom leave before the brood hatches, even though the pair bond may no longer be intact.

16. Preference for a particular nesting cover was not clearly evident. A variety of plant species in varied locations were used.

17. Nest predation was high, but overall production was favourable.

18. One hen Shoveler relocated her nest in response to changing physical conditions. Furthermore, after hatching three ducklings — which died within a day — from a clutch of eight eggs, she retained an incubation drive over the remainder for 2 days.

19. Shoveler broods first appeared during the first week of June, and peaks of hatching were pronounced a few weeks later in years of normal spring weather. In 1965, a cool, wet spring influenced the hatching period and there was not a pronounced peak.

20. A marked hen adopted six Class Ia ducklings, in addition to her seven Class Ia's.

21. Some hens moved their broods to the core area upon leaving the nest. Hens with broods were not found to remain on any one pond continuously for longer than 7 to 10 days.

22. Evidence of moult in drakes appeared in mid June, and within several weeks drakes left the study area.

23. The Shoveler was prominent in the waterfowl hunting bag at Strathmore, and its importance in the future undoubtedly will increase.

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Appendices

Appendix 1
Marsh and aquatic plants collected on the Strathmore Study Area, 1965–68 (sample of 6 permanent and 4 semipermanent ponds)

Scientific name*	Common name*	No. of ponds
Marsh Plants		
Typhaceae		
Typha latifolia L.	Common cattail	6
Juncaginaceae		
Triglochin maritima L.	Arrow-grass	3
Gramineae		
Puccinellia Nuttalliana (Schultes) Hitchc.	Alkali-grass	4
Glyceria grandis S. Wats.	Manna-grass	6
Poa spp.	Meadow-grass	2
Distichlis stricta (Torr.) Rydb.	Spike-grass	2
Agropyron Smithii Rydb.	Agropyron	1
Hordeum jubatum L.	Squirrel-tail grass	7
Calamagrostis canadensis (Michx.) Nutt.	Blue-joint	4
Alopecurus aequalis Sobol.	Foxtail	2
Beckmannia syzigachne (Steud.) Fern.	Slough-grass	3
Cyperaceae		
Eleocharis acicularis (L.) R. & S.	Spike-rush	2
Eleocharis macrostachya Britt.	Spike-rush	9
Scirpus americanus Pers.	Three-square bulrush	4
Scirpus validus Vahl.	Soft-stem bulrush	5
Carex spp.	Sedge	9
Juncaceae		
Juncus balticus Willd.	Rush	7
Polygonaceae		
Polygonum amphibium L.	Water-smartweed	3
Rumex mexicanus Meisn.	Dock, sorrel	4
Hippuridaceae		
Hippurus vulgaris L.	Mare's-tail	2
Umbelliferae		
Cicuta bulbifera L.	Water-hemlock	2
Labiatae		
Mentha arvensis L.	Mint	1

cont'd.

Appendix 1, cont'd.

Aquatic Plants		
Chlorophyceae†	Green algae†	5
Zosteraceae		
Potamogeton pectinatus L.	Sago pondweed	5
Potamogeton pusillus L.	Small pondweed	5
Potamogeton Richardsonii (Ar. Benn.) Rydb.	Red-head pondweed	2
Zannichellia palustris L.	Horned pondweed	1
Alismataceae		
Sagittaria cuneata Sheldon	Arrowhead	2
Lemnaceae		
Lemna trisulca L.	Star duckweed	2
Lemna minor L.	Duckweed	4
Ceratophyllaceae		
Ceratophyllum demersum L.	Hornwort	1
Ranunculaceae		
Ranunculus spp.	Crowfoot, buttercup	2
Haloragaceae		
Myriophyllum exalbescens Fern.	Water-milfoil	6

*From Fernald (1950).
†From Fassett (1940).

Appendix 2
Censuses of Shovelers on the Strathmore Study Area, 1965

Date	Time start	Pairs	Lone males	Lone females	Grouped males	Indicated breeding pairs
May 21	0430	7	25	2	2	32
May 21	0830	16	16			32
May 21	1230	16	15			31
May 21	1630	21	6		2	27
May 28	0830	11	20			31
May 29	1730	21	13			34
June 4	0830	9	25			34
June 4	1600	10	23			33
June 11	0800	6	24			30
June 11	1630	11	18			29
June 19	1630	6	17		2	23
June 20	0800	4	19		2,2	23
June 27	0800	3	15	4*		18
July 2	0810	3†	17		2	20
July 9	1130	2	8	2†		10
July 17	1100‡					

*Brood accompanying each of 2 hens.
†Brood accompanying 1 hen.
‡Discontinued before completion.

Appendix 3
Censuses of Shovelers on the Strathmore Study Area, 1966

Date	Time start	Pairs	Lone males	Lone females	Grouped males	Indicated breeding pairs
April 5			1			1
April 7		1				1
April 10		2	1			3
April 13		2	2			4
April 14		4	3			7
April 17		2	2			4
April 18		2			2	2
April 21	1230	5	4			9
April 24	1230	14	5			19
April 27	1230	11	2			13
May 1	1230	31	7	1		38
May 4	0830	24	11			35
May 4	1230	21	11			32
May 7	1230	27	4			31
May 10	1330	33	8			41
May 14	0830	18	8			26
May 18	1430	23	9			32
May 20	0500	11	20		2	31

cont'd. on p. 45

Appendix 3, cont'd.

Date	Time start	Pairs	Lone males	Lone females	Grouped males	Indicated breeding pairs
May 20	0830	21	16			37
May 20	1300	24	12			36
May 20	1630	25	10			35
May 27	1700	15	23	1		38
June 3	1630	18	25			43
June 10	1630	19	18		2	37
June 11	0900	9	27			36
June 17	0900	5	33	1		38
June 25	0900	6*	22			28
July 1	0900		4			4
July 8	0930	2	1	2†		3

*Brood accompanying 1 hen.
†Brood accompanying each hen.

Appendix 4
Censuses of Shovelers on the Strathmore Study Area, 1967

Date	Time start	Pairs	Lone males	Lone females	Grouped males	Indicated breeding pairs
April 25		2				2
April 26		1				1
April 27		1				1
April 28		2				2
May 1		1				1
May 5	1230	15	2		2	17
May 8	1230	20	8			28
May 12	0830	19	9		2	28
May 16	1230	33	6			39
May 20	1300	38	13			51
May 24	0500	27	10		2	37
May 27	1300	34	16		3	50
June 1	1400	31	27			58
June 14	0930	5	41	1	5	46
June 22	1130	9	22		7	31

Appendix 5
Censuses of Shovelers on the Strathmore Study Area, 1968

Date	Time start	Pairs	Lone males	Lone females	Groups* Pairs	Groups* Males	Indicated breeding pairs
April 30	1230	12			2	3	19
					5	2	
May 1	1230	7			1	2	15
					1	2	
					2	3	
					4	2	
						2	
May 7	1230	15			4	1	19
						3	
May 8	0900	19			3	2	22
May 15	1230	16	2		1	1	23
					1	1	
					3	2	
					2	1	
May 16	1030	11	1		2	2	23
					3	1	
					2	1	
					5		
May 22	1230	16			2	1	28
					2	1	
					5	2	
					3	2	
May 23	1300	24	1		6		30
May 28	1500	24	1		2	1	26
						2	
May 29	1400	29	5		1	1	30
May 30	1030	16		1	2	2	26
					2	2	
					2	3	
					1	1	
					1	1	
					1	1	
June 11	1500	29	13				42
June 13	0800	3	32				35

*Each group is subdivided into the number of pairs and the number of unpaired males which comprise the group.

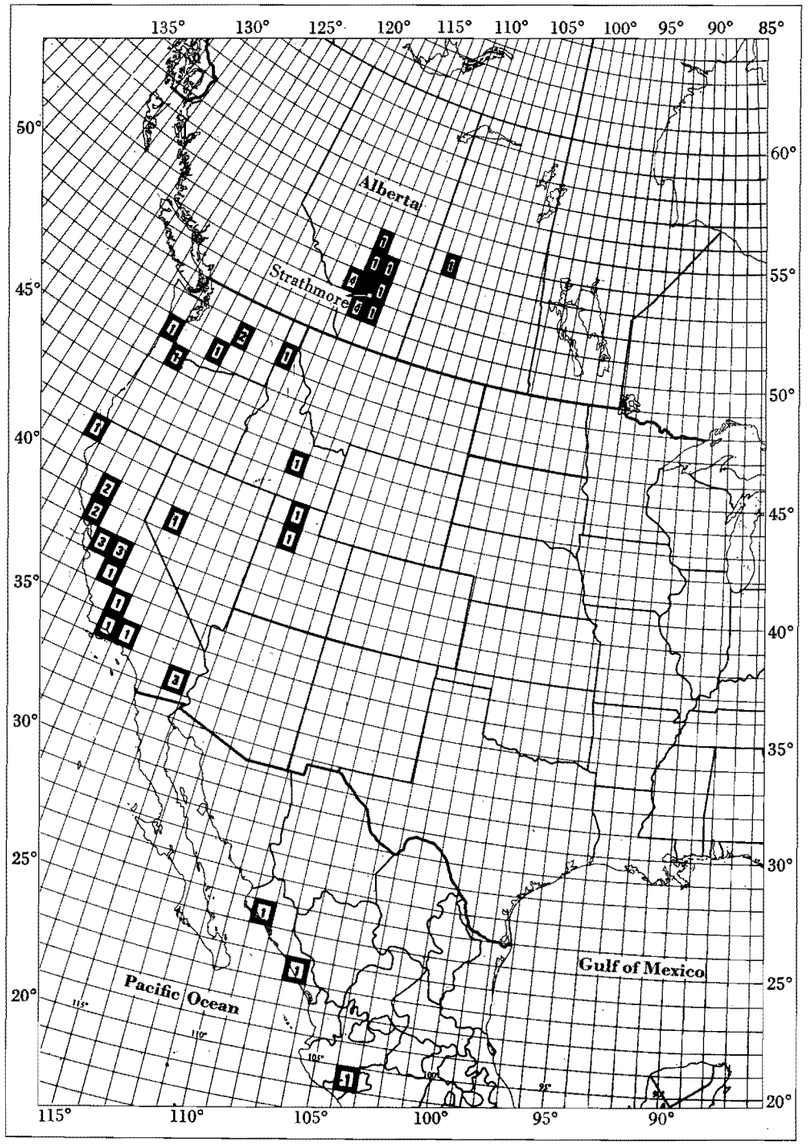
Appendix 6
Observations used for measurement of Shoveler home ranges A–H

Pair	Time of marking: Date	Time of marking: Breeding phase	Observations during breeding periods: Postarrival Dates	Postarrival No. casual obs.	Postarrival Hr total obs.	Nesting* Dates	Nesting* No. casual obs.	Nesting* Hr total obs.	Male posthatching Dates	Male posthatching No. casual obs.	Male posthatching Hr total obs.
A (male)	5–14–65	Laying				May 14–June 12	47	31	June 13–July 9		
B	5–19–65	Prelaying, settled		5		May 30–July 2	19	49.5	Unsuccessful early nesting		
C	5–16–66	Laying				May 16–June 14	29	6.5	June 15–17	2	
D	5–19–66	Prelaying, settled		3		May 23–June 23	80	6	June 23–July 1	10 (pair)‡	
E	5–19–66	Laying				May 20–June 18	47		June 18–20	10	
F (female)	5–14–67†	Arrival	May 14–21	10	14.5	May 22–June 18	82	31.5	June 18–20	7 (pair)‡	
(male)	6–2–67										
G (male)	5–8–67†	Unpaired	May 8–23	11					Male disappeared 15th day of incubation		
(female)	5–21–67	Prelaying, settled	May 23–June 1	17	2	June 2–26	74				
H	5–11–67	Prelaying, unsettled	May 11–June 1	31		June 2–22	22		Male disappeared 9th day of incubation		

*Extended to hatching, unless nest destruction or drake disappearance preceded.
†Bird marked the previous year; date refers to first sighting.
‡Following nest destruction.

Appendix 7. Direct banding recoveries (before April 1 of the next year) of 63 Shovelers (61 juvenile, 2 adult) banded at Strathmore, Alberta 1958–67. Eighteen birds were recovered in the banding block; the numerals in the shaded blocks indicate the numbers of birds recovered in these areas.

Appendix 7



Degree block of banding

Degree block of recoveries 0

Statute Miles 0 100 200 300

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