ECOLOGY OF NESTING WATERFOWL
IN THE MISSOURI COTEAU OF
SOUTHERN SASKATCHEWAN

A Thesis

Presented to

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In Partial Fulfillment

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Master of Science

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by

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Figure 1

The Missouri Coteau twelve miles north of Johnstone Lake, Saskatchewan.
Aerial photograph from two thousand feet.

May, 1949.

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INTRODUCTION

Foreword

Expanding populations, more leisure time and increased standards of living since World War II, have resulted in an ever increasing demand in the United States and Canada for outdoor recreation in the form of hunting and fishing.

Carhart (1951), writing in Sports Afield magazine and referring to the United States alone, states that 7,846,168 fishing licenses and 7,505,258 hunting licenses were sold in 1943 in all states. By 1949 the annual sale had increased to 15,478,570 fishing licenses and 12,758,698 hunting licenses. An analysis of 1947 expenditures, based on a questionnaire sent to two thousand sportsmen in all walks of life, showed that sportsmen spent directly and indirectly almost four billion dollars on their sport that year. This was greater than all sales by retail drug stores; more than double all retail liquor sales; four times the business in jewellery stores, and more than the income of all gasoline filling stations. Whether free public hunting and fishing in the American and Canadian tradition can be maintained for this army of hunters and fishers is the problem facing wildlife administrators today.

Ducks and geese are particularly prized as game. The number of sportsmen hunting waterfowl based on duck stamps sold, (required of all duck hunters in the United States over 16 years of age), increased from 635,001 in 1935 to 1,383,629 in 1943 and to 2,127,598 in 1948. Sales declined to 1,903,644 in 1951 (official releases of the United States Fish and Wildlife Service). Waterfowl hunting has increased in Canada in a like manner.

Cottam (1947) regards the waterfowl resource as representing a capitalized investment of one and a half billion dollars, and estimates that 300 million dollars are spent each year harvesting the annual waterfowl surplus. This appraisal makes no allowance for the value of the meat obtained, nor for the aesthetic values which are very real yet cannot be expressed in dollars.

Paradoxically, as the demand for more waterfowl increases the means of maintaining even the present population decrease. As the human population of the continent expands, more land is needed for farming and other activities. Marshes and other wet lands are drained destroying the only habitat in which waterfowl can exist. Cottam (loc. cit.) states that by 1920, 100 million acres of waterfowl habitat in the United States had been destroyed as such, and that this destruction had continued, though at a somewhat reduced pace. Bennett (1938), discussing the state of Iowa, shows that between 1900 and 1938 the duck producing habitat was reduced from six million acres to about 50 thousand.

In Canada a similar situation is developing. In Alberta, Saskatchewan and Manitoba, there were 3,600,000 acres under cultivation in 1900. By 1930 this had increased to 33,156,000 acres, and by 1947 to nearly 43,500,000 (Day 1949). This great expansion was by no means all the result of drainage, but the impact upon the waterfowl population was almost the same as if it had been. Thousands of small prairie sloughs and potholes which were originally surrounded by native prairie are now cultivated to the water's edge. All that remains of the original waterfowl habitat is the water, and that only in abnormally wet years.

Apart from the lore of the duck hunter no one knew very much about waterfowl, or made much effort to learn more, until the drought of the mid-thirties focused attention upon the dwindling flights. Since that time, and particularily during the last decade when an attempt has been made to manage the resource on a continental basis, there has been a tremendous increase in waterfowl research.

Emphasis was first laid on census and census techniques. It was imperative to find out how many waterfowl there were so that regulations could be designed to protect the birds from extinction,and at the same time to permit some hunting if at all possible. By far the major portion of expenditures on waterfowl in both Canada and the United States, (apart from the refuges operated by the United States Fish and Wildlife Service in the United States), is still, by necessity, on the census phase of the work.

Basic waterfowl research is increasing however. Many State Game Departments now employ waterfowl biologists to investigate local problems. The work of the Illinois Natural History Survey has been particularly outstanding. Special investigations by the United States Fish and Wildlife Service both in the United States and Canada during the last 15 years have added greatly to our knowledge of the ecology of nesting waterfowl. The intensive study of botulism at the Bear River Marshes in Utah is also noteworthy. Establishment of the Delta Waterfowl Research Station at

Delta, Manitoba for the specific purpose of basic research in waterfowl, and for training waterfowl biologists, was a tremendous stride forward. The North-eastern Research Station at Fredericton, New Brunswick was set up for a similar purpose.

Ducks Unlimited, financed by the voluntary contributions of United States duck hunters, has, since its inception in 1938, spent over three million dollars to increase and maintain waterfowl breeding areas in Western Canada.

Previous Work

Although there have been many investigations in recent years into the ecology of nesting waterfowl these have been conducted in areas quite different ecologically from that discussed in this paper.

Bennett (1938), and Low (1945), deal with the ecology of the blue-winged teals and redheads in Iowa. Kalmbach (1937) reports on investigations into crow-waterfowl relationships in the transition zone, or aspen grove area, of Saskatchewan, and the edge of the coniferous forest in Alberta. Kalmbach (1938) gives data on waterfowl breeding populations for the years 1936 and 1937 on the Lower Souris Refuge in North Dakota, but like Hochbaum's work on the Delta Marsh in Manitoba (1944), and that of Williams and Marshall in Utah (1938), these observations relate to breeding populations on large marsh areas.

Furniss (1935), (1938), deals with an area more closely resembling that which will be discussed. But although he studied waterfowl on a series of small water bodies, his study area "on the dividing line between the typical Canadian and Transition Life Zones", Furniss (1935), is quite different ecologically from the Missouri Coteau. Evans (1949), and Kiel (1949), (1950), studied nesting populations and reproductive success in the Minnedosa pothole area of Manitoba. Although the water areas differ physically and ecologically from those of the study area in the Missouri Coteau, interesting comparisons can be made.

Scope of the Present Work

Waterfowl range the length and breadth of this continent and into South America. Since this is so, it is beyond any individual to study the complete ecology of even one of the many species of waterfowl classed as game. Each investigator must work out the ecology of that part of the life cycle spent in his own small area, and contribute his findings to the general problem. The work herein reported adds a little more to the general knowledge of nesting waterfowl.

The original objective was to discover how broods of flightless ducklings react to drought. Specifically how far they can, or will, walk to water, and how successful they are in their search for it. The study area was selected in this particular section of the Missouri Coteau because it was known to have a good duck breeding population in normal years and to be subject to drought. During the three years of intensive study water conditions were excellent, and there was no opportunity to learn how waterfowl would react to drought. Brood census work however gives valuable information on this point.

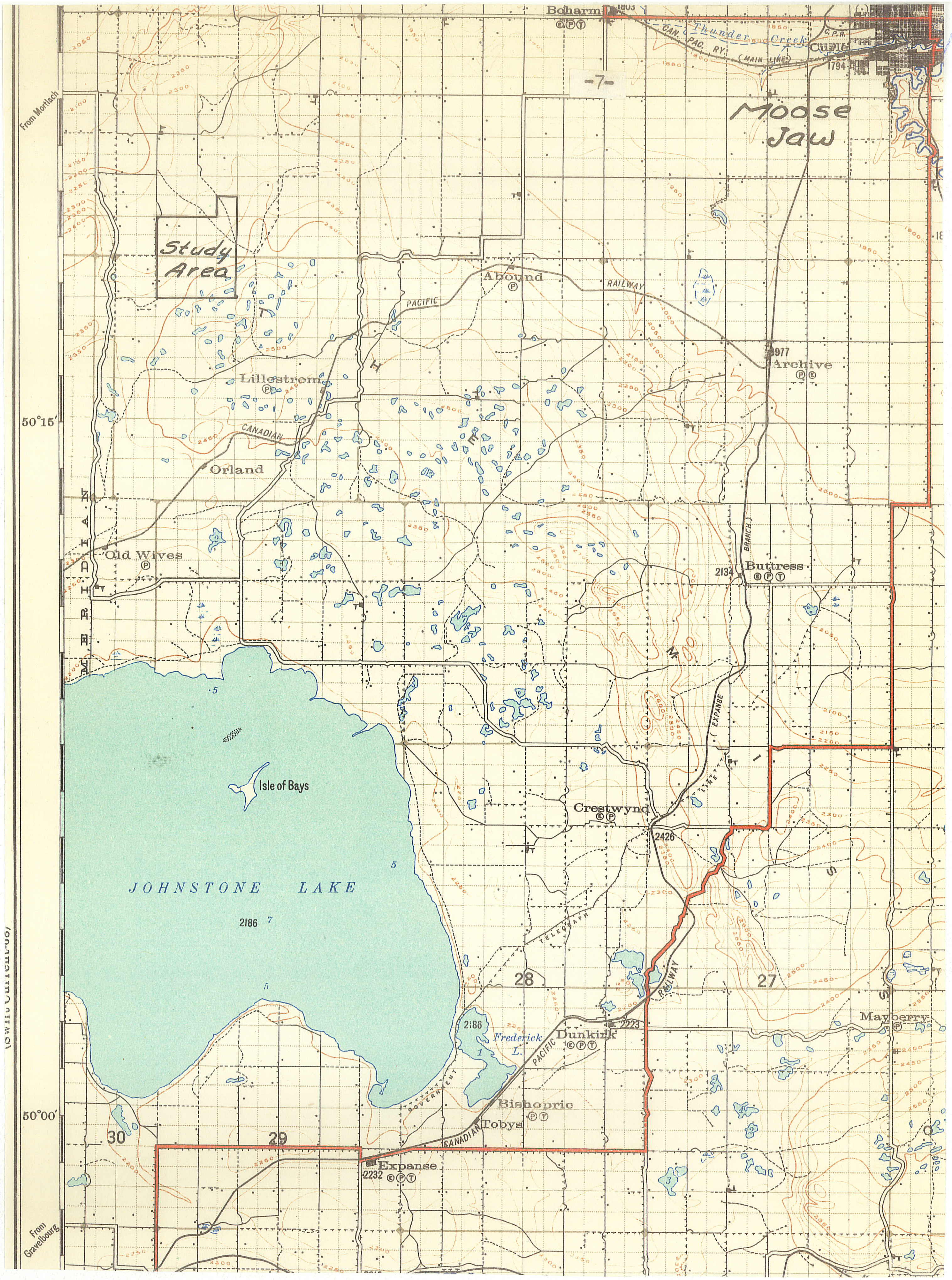
In the course of the investigation it was necessary to census the nesting population, find nests, and search for broods. It was apparent that these observations were important in themselves, and the investigation soon expanded into a study of the ecology of waterfowl in the area, of which, in the end, the original objective became a minor part.

The investigation is preliminary in that the data obtained and the conclusions drawn are mostly of an observational nature. Many interesting opportunities for intensive research on specific aspects of the problem were revealed. For instance, <u>why</u> are some water areas occupied and others not, and <u>what</u> factors are responsible for the differences in plant communities between water areas. These problems are only two of many that were most enticing but beyond the scope of this enquiry. One had to be content to discover that a condition existed while the reasons for it could only be surmised and relegated to more intensive research.

The work was conducted under the auspicies of Ducks Unlimited (Canada). The general plan and field supervision were the responsibility of the author. The field work was carried out in 1947 and 1948 by Lloyd Sutton, then an undergraduate from the University of Manitoba. Sutton prepared the map of the area. In 1949 the area was practically dry in the spring and after a preliminary survey in early May work was discontinued. Dave Peterson, also an undergraduate from the University of Manitoba, continued the field work in 1950. The 1951 data were collected by the author. All botanical data, compilations, summaries and conclusions are his.

Figure 2

Map showing the location of the study area.


Boharm
Moose Jaw
Study Area
Thunder Creek
CAN. PAC. RY. (MAIN LINE)
Abound
PACIFIC
RAILWAY
CANADIAN
Lillestrom
Orland
Old Wives
Archive
Buttress
EXPANSE
BRANCH
Crestwynd
2426
Isle of Bays
JOHNSTONE LAKE
2186
TELEGRAPH
RAILWAY
28
27
Frederick L.
Dunkirk
2223
Mayberry
Bishopric
Tobys
GOVERNMENT
CANADIAN
Expanse
2232
30
29
50°15′
50°00′
From Morlach
From Gravelbourg
MERIDIAN

THE AREA

General

The Missouri Coteau is a prominent topographical feature of the western plains. This great terminal moraine stretching north-west from the International Boundary south of Weyburn, Saskatchewan, to a point about thirty-five miles west of Prince Albert, marks the beginning of the third prairie steppe. Along its more southerly extension the escarpment rises abruptly two hundred to five hundred feet above the plain to the east. To the north it is less well defined.

The relief is described in the Soil Survey of Saskatchewan as follows:

> "The topography is characterized by a pronounced "wavy" relief; even on the undulating phases the local relief is usually sufficient to produce a succession of low knolls, long smooth intermediate slopes and shallow undrained depressions or sloughs. On rolling phases the above type of relief is accentuated, forming the knob and kettle topography typical of morainic deposits." (Figure 1)

The undulating phases are cultivated but knob and kettle areas are utilized as grazing land. The numerous water bodies and uncultivated conditions in knob and kettle areas make them very attractive to water-fowl about to nest.

Location and Description of Study Area

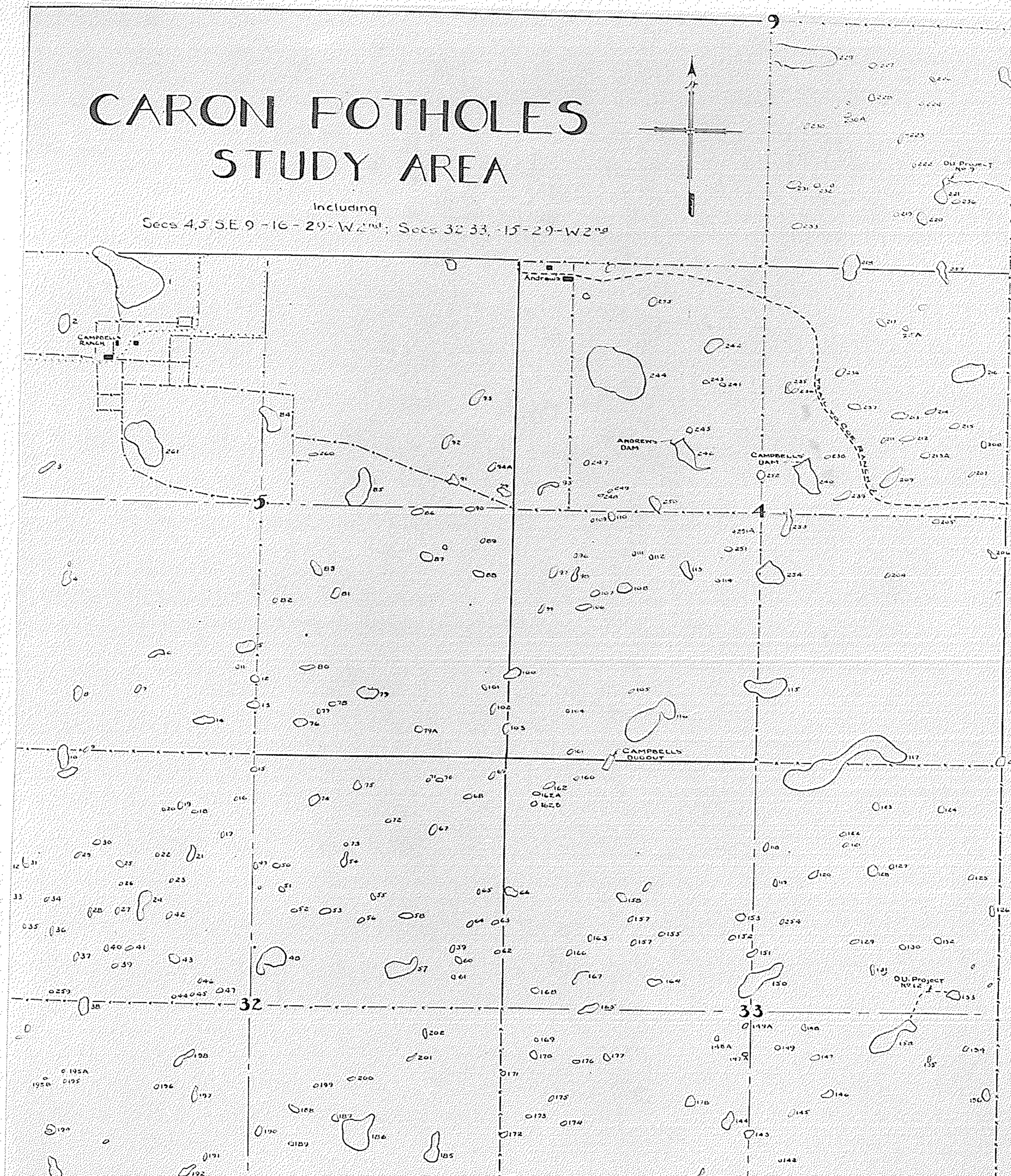
The study area comprised four and one quarter square miles of a knob and kettle area approximately twenty miles west of the city of Moose Jaw (Figure 2). Specifically, sections 4 and 5 and the south east quarter of 9 in township 16, range 29 west of the second meridian, and sections 32 and 33 in township 15 of the same range (Figures 3 and 4).

Figure 3

Aerial photograph of study area. Looking south-east over Campbell's Ranch. May 19, 1950.

Figure 4

Map of study area.


CARON FOTHOLES
STUDY AREA
Including
Secs 4,5 S.E.9 - 16 - 29 - W2nd; Secs 32 33, - 15 - 29 - W2nd
CAMPBELLS RANCH
Andrews
ANDREWS DAM
CAMPBELLS' DAM
CAMPBELLS DUGOUT
D.U. Project No. 2
5
4
9
32
33

The Soil Survey of Saskatchewan places this area in the Brown Soil Zone and classifies it ecologically as "Mixed Prairie-Western Section". The location is actually on the extreme eastern edge of the Brown Soil Zone since the boundary with the Dark Brown Soils follows the edge of the Coteau ten miles to the east. The soil is a clay loam which has been developed on glacial till. The stony hillsides are further indication of glacial origin. The study area is a sample of a total of 2,038,600 acres of similar soil type and topography .

With the exception of the west half of section five, which is somewhat less rugged, the entire study area is used for grazing. The steep relief results in a high rate of run-off and since drainage has not developed the water collects in the many depressions between the hills. The hillsides support only a rather sparse growth. The prairie crocus (Pulsatilla ludoviciana) is a conspicuous feature of the vernal aspect with moss phlox (Phlox Hoodii) dominant on the dry hill tops. Spear grass (Stipa spp.), blue grama grass (Bouteloua gracilis) and sage (Artemisia spp.) are co-dominants on the hillsides (Fig. 5). Some water areas support a partial ring of aspen (Populus tremuloides) usually on the north side of the pond sheltered by a hill. Willow (Salix sp.) bunches are frequently found in similar situations. Extensive communities of snowberry (Symphoricarpos occidentalis) occur on the northern slopes of the hills, where moisture conditions are better, in shallow ravines where the snow is held in the spring, and on the edges of many of the water areas. Silverberry, (Elaeagnus commutata) frequently occurs with the snowberry as do thick

Figure 5. Typical hillside mid-August. Dominated by sage and spear grass. August 18, 1950.

Figure 6. "Buckbrush" - mixed snowberry and silverberry in the foreground, wild rose at water's edge. Snowberry extending up the shallow draws where snow lies late in the spring. Used as nesting cover by several species of ducks.

Pothole 139, June 26, 1950.

tangles of wild rose (Rosa spp.). Communities of snowberry or mixed communities of snowberry and silverberry or wild rose are known locally as "buckbrush" (Fig. 6).

Classification of Water Areas

The study area contains 261 separate water bodies. From the beginning it was apparent that these could be divided on the basis of annual longevity and floral composition into three groups, potholes, sloughs and hay sloughs.

"Pothole" is a precise geological term which has been absorbed into the language of waterfowl workers without any attempt at precise definition. It is applied to any water area up to fifty acres in size so long as such water areas are closely grouped. The term "Pothole Area" is applied to the district where such a condition occurs. In this work the term pothole is used to describe a specific type of water area.

The typical pothole is a basin-shaped depression usually less than a half acre in size (Figs. 7 and 8). After a normal spring run-off many of these small "catch basins", which occur at any elevation in the hills, contain as much as three feet of water. Loss of water is rapid however, and by August 1st, even in years of normal precipitation, between one third and one half are dry.(Fig.58). The vegetation is that of a fresh water environment. Although the emergent dominant varies between potholes it will be either bur-reed (Sparganium eurycarpum) or water parsnip (Sium cicutaefolium) in the deeper areas, and carex (Carex spp.), spike-rush

Figure 7. Typical pothole. Vernal aspect. One-eighth acre in size. Seldom used as territorial water by nesting pairs. Contains about three feet of water.

Pond 99. May 19, 1950.

Figure 8. Pond 99. Late summer. Overgrown with bur reed and water parsnip. Contains about eighteen inches of water. Broods are almost never found in such situations.

August 19, 1950.

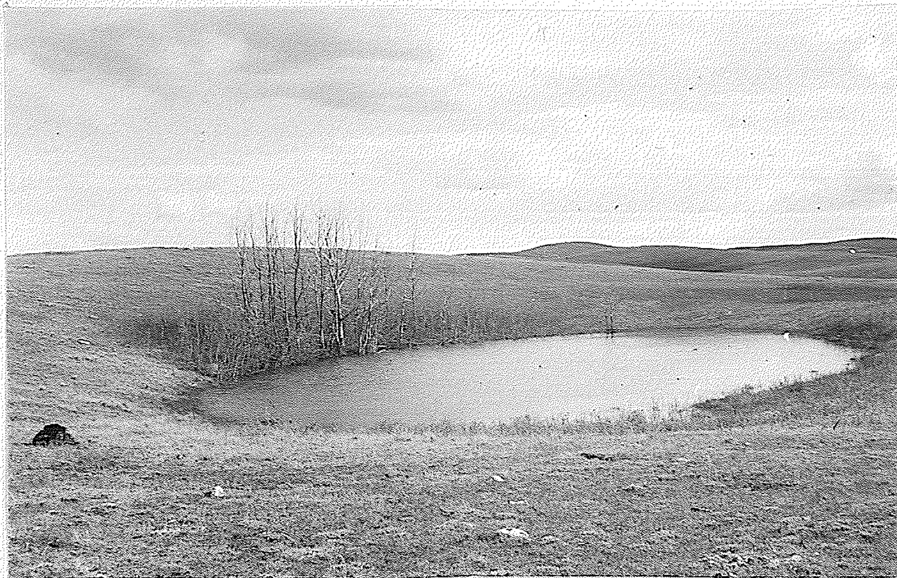


Figure 9. Shallow pothole. Vernal aspect.. A quarter acre in size. Water is about eighteen inches deep. Note gauge in pond. Very seldom used by waterfowl.
Pond 50. May 25, 1950.

Figure 10. Pond 50. Dry August 8th.
August 20, 1950.

Figure 11. Shallow half-acre potholes. Vernal aspect. Used sparingly by nesting waterfowl. Water about a foot deep. Ponds 81 and 83. May 25, 1950.

Figure 12. Ponds 81 and 83. Late summer. Both overgrown by dense spikerush. Pond 83 dry, other contains a few inches of water. Broods are almost never found in such situations. August 20, 1950.

(<u>Eleocharis spp.</u>) or marsh smartweed (<u>Polygonum sp.</u>) where the water dries up early in the season. In such situations the pothole is usually completely overgrown. Floating and submerged aquatics include yellow water buttercups (<u>Ranunculus sp.</u>) and white water buttercups (<u>Batrachium sp.</u>), smartweeds (<u>Polygonum spp.</u>) and duckweeds (<u>Lemnae minor and Lemnae trisulca</u>). Water plantain (<u>Alisma spp.</u>) and arrow head (<u>Sagittaria cuneata</u>) occur occasionally. Growth is usually quite dense in potholes and the roots form a solid mat making wading relatively easy.

The study area contains 208 potholes. As with most classifications there are exceptions. Some very small areas which hold only a few inches of water in the spring and are dry very early in the season have been recorded as potholes, even though they lack the characteristic vegetation as described above (Figs. 9 and 10). Some quite large, but very shallow areas, which are also dry early in the season have been classified as potholes on the basis of vegetation (Figs. 11 and 12).

Sloughs occur up to about three acres in size. Two distinct types are found. The so called "Alkali" slough and the hay slough. These are readily identified by their characteristic vegetation.

The local term "Alkali" slough results from the deposit of white salt which appears along the edge of the drying mud during low water. "Saline" slough is a better term, few of these sloughs are very alkaline.

Dominant emergent plants in sloughs are hard stem bulrush (<u>Scirpus</u>

Figure 13. Sloughs 107 and 108. Vernal aspect. One-quarter and one-half acre in size. Emergent growth of previous year broken down and covered by high water. Depth about three feet. These areas always contain territorial pairs.

May 19, 1950.

Figure 14. Sloughs 107 and 108. Late summer. Outer margin of alkali bulrush; inner ring of hard stem bulrush. Such areas almost always contain broods.

August 20, 1950.

Figure 15

Slough 150. Late summer. This area always contains territorial pairs in the spring and broods during the brood season. The emergent plant is alkali bulrush. The water depth about three feet.

August 20, 1950.

acutus) and alkali bulrush (Scirpus paludosus). These emergents often form concentric rings of vegetation around the sloughs, the alkali bulrush occupying the shallow shoreward zone (Figs. 13, 14 and 15). True aquatics include sago pondweed (Potamogeton pectinatus), musk grass (Chara sp.), and horned pondweed (Zannichellia palustris). The bottoms of "alkali" sloughs are invariably soft and mucky, making wading very difficult. In the years spent in the area none held more than three feet of water. However, in some cases the rock-rimmed shorelines indicated that at one time, since the recession of the glacier, the water had been much deeper. Twenty-eight water bodies classified as sloughs are found in the area.

Hay sloughs are open water areas until about June 15th, (Figure 16), after which they become completely overgrown with whitetop grass (Scolochloa festucacea)(Figure 17) which, as the name implies, is cut for hay in drier years. On the shallow edges, sedges (Carex spp.) are frequently found in an almost pure community. The water may be as deep as three feet. The thickest growth is found, however, in areas which are most likely to dry up during the summer (Figs. 18 and 19). During 1950 and 1951 water levels have been continuously high in some hay sloughs and the stand is becoming progressively thinner. Old residents claim, on the basis of experience, that these areas will revert to bulrush. This is difficult to believe, since bulrush is unlikely to ecesize under high water conditions. The growth of whitetop is usually so dense that all other plants, except duckweeds, are eliminated. Where deeper water has opened out the cover the characteristic pothole aquatics appear, namely water buttercups and smart-

Figure 16. Hay slough number 1. Vernal aspect. Always used by several territorial pairs. Water about four feet deep.

May 19, 1950.

Figure 17. Hay slough number 1. Late summer. Overgrown by whitetop grass. Small areas of open water in middle. Always contains broods. Water still about three feet deep.

August 20, 1950.

Figure 18. Hay slough. Vernal aspect. Whitetop grass just appearing. Water about eighteen inches deep. Used annually by territorial pairs.

Pond 84. May 19, 1950.

Figure 19. As above, late spring. Completely overgrown by Carex and whitetop grass. Still contains about eighteen inches of water. Broods are almost never found in such situations, particularly as the water becomes shallower. Comparison with Figure 18 illustrates the very rapid growth of these emergent plants.

June 27, 1950.

weeds, indicating a fresh water condition. Twenty-five hay sloughs were found in the area.

Water Supply

The water areas are replenished each year by melting snow. A good run-off depends upon three factors, a saturated soil condition the previous fall, hard frozen so that losses to the soil by percolation are minimized, at least an average snowfall, and a delayed but rapid spring break-up. An above normal snowfall sometimes produces less run-off than one much lighter if daylight thawing and night freezing continues over a long period of time. Losses to a relatively dry soil are high under these conditions. Losses to sublimation are also said to be considerable.

There are no precipitation records for the study area. However the Saskatchewan Soil Survey gives the annual precipitation at the town of Caron, which is located on the flat about eight miles north, as 13.79 inches. It is probably somewhat higher in the hills where the study area is located. Much of the precipitation falls as rain during the spring months and is a significant factor in prolonging the existence of the water areas.

The actual amount of rain which falls however, may not be the most important factor. Significant rainfall is usually associated with the passage of warm or cold fronts. Unsettled weather, with above normal relative humidity and generally lower temperatures, often persists for several days, effectively reducing evaporation and thus prolonging the existence of temporary ponds.

Relative Longevity of Ecological Types

Ranchers, long resident in the area, report that in dry years the sloughs are the last to go dry. Reference to Figure 58 confirms this. Thus on August 15th, 1947, 64 per cent of the potholes and 45 per cent of the hay sloughs were dry but only 10 per cent of the sloughs. In 1948 the percentages on the same date were, 48, 52 and 19 and in 1950, 56, 12 and 4 (one slough only).

Many potholes begin the spring season with water depths as great or greater than some of the sloughs. Yet by the first of August the water in many of these potholes has disappeared. If we assume that evaporation rates are similar then some other factor must operate to reduce the water levels in the potholes more rapidly than in the sloughs. Their relative locations appears to supply the answer. Almost without exception potholes are found at higher elevations on the hillsides and on the benches between them. The sloughs on the other hand occupy the lowest elevations in the area. It is probable that there is a high seepage loss from potholes, while the levels of the sloughs are supported by ground water. To obtain information on this point markers were placed in typical potholes on the hillsides and in adjacent sloughs. The losses to six potholes from May 23rd to August 15th were 16.25, 18.25, 13.75, 17.75, 15,25 and 13.75 inches. During the same period three sloughs lost only 14.25, 10.5 and 13 inches respectively, while a large hay slough lost 9.5 inches. Losses to percolation vary of course with the permeability of the pond bottom. Potholes are usually more heavily overgrown with emergent plants than sloughs. Whether the difference in transpiration is great enough to affect the relative water loss is not known. Alkali sloughs are more open to wind action than potholes, which are usually contained in deep pockets in the hillsides, and should lose more water to evaporation.

There is then a significant difference in the rate of water loss between potholes and sloughs. This is believed due to percolation losses from potholes which do not occur in sloughs until late in the season when the water table itself has fallen.

Considerable space has been given to the difference in rates of water loss between sloughs and potholes and the probable reasons for it. This factor is important in deciding on a development program for such an area. The problem will be discussed further under the heading "Development Plan for the Area".

Relation of Total Dissolved Solids to Characteristics of Sloughs and Potholes

Constant leaching of soluble salts downward from the potholes into the ground water accounts for the fresh water vegetation which characterizes them. Such waters percolating downward through the soil to the water table carry an increasing quantity of dissolved salts which finally reach the sloughs through the ground water.

To confirm the fresh water condition of the potholes, samples from sloughs and potholes were analyzed for total dissolved solids. Samples from four typical potholes contained total dissolved solids ranging from 1,600 to 4,000 parts per million, the average being 2,187. Samples from five sloughs ranged from 3,200 to 42,300 parts per million and averaged 19,820. The samples were taken in May. By August these concentrations would be greatly increased by evaporation. The slough which contained the greatest amount of dissolved solids, (42,300 p.p.m.) appears to exceed the tolerance limit of even most halophytes by late summer. It supports only a narrow margin of alkali bulrush. Even the extremely salt tolerant sago pondweed is absent.

No water samples from hay sloughs were analyzed but the vegetation indicates a fresh water condition. Whitetop grass is never found in sloughs.

Vertebrates Other than Waterfowl

The following list of birds and mammals found in the area is not intended to be complete. It includes only those in the community whose activities might have some direct affect on waterfowl. Sub specific names are from Peterson's "A Field Guide to the Birds" and from Soper (1946).

Birds

Crow (*Corvus brachyrhynchos*). Common, nesting in aspen and willow bunches around water bodies.

Magpie (*Pica pica*). Fairly common, nesting in willow bunches around water bodies.

Hen Hawk (*Buteo spp.*). One or two pairs on the study area in each year.

Marsh Hawk (*Circus hudsonius*). Fairly common. A nest found in thick snowberry.

American Coot (Fulica americana). Common. Nesting in both hay and "alkali sloughs".

Sora Rail (Porzana carolina). Common, could be flushed from almost any hay slough or overgrown pothole.

Horned Grebe (Colymbus auritus). Fairly common. Several pairs nesting on the area each year.

Eared Grebe (Colymbus nigricollis californicus). Rare.

American Bittern (Botaurus lentiginosus). Occasional. More common in recent years.

Mammals

Franklin Ground Squirrel (Citellus franklinii). Occasional. Said to be common in some years but was never so during the years of the investigation.

Richardson Ground Squirrel (Citellus richardsonii richardsonii). Fairly common but not nearly so abundant as in 1940.

Muskrat (Ondatra zibethica cinnamomina). Fairly common, confined to deeper sloughs and artificial impoundments.

Porcupine (Erethizon dorsatum epixanthum). Occasional, common in some years. Found in thick snowberry patches.

Coyote (Canis latrans nabracensis). Common.

Badger (Taxidea taxus taxus). Fairly common.

Skunk (Mephitis mephitis hudsonica). Occasional.

Weasel (Mustela frenata longicauda). Reported by Soper to range through the plains but not observed in the study area.

FIELD TECHNIQUES

The Weekly Census

Weekly counts of ducks on the study area were made from May 20th to August 28th in 1947, May 5th to August 10th in 1948 and May 22nd to June 19th in 1950. One count was made May 20th to 22nd in 1951, and brood counts on June 22nd to 26th inclusive, and August 15th to 17th inclusive.

Counts were made from the hills surrounding the ponds. Care was taken not to disturb the birds to prevent recounting on adjacent ponds. Since ducks are relatively tame during the territorial phase of the breeding cycle this was not difficult, and it is believed that the weekly counts were quite accurate. After the middle of June the ponds were carefully searched for marked and unmarked females with broods.

The ducks observed were recorded as pairs, single males or flocks. Pairs and single males were assumed to represent potential breeding birds (Hochbaum 1944). The refinement of recording single drakes and groups of drakes separately was not used until the 1948 season. Consequently the data for 1947 are not strictly comparable with those of subsequent years. This will be dealt with more fully in the section on Nesting Populations.

Location and Recording of Nests

The area was methodically searched for nests. The snowberry patches were worked back and forth at short intervals and the grassy borders of each water area thoroughly covered. Intensive nest searches were carried on during the short periods when two men were available, otherwise the observer worked alone.

Nests found were given a number and the species, type of cover, number of eggs, distance from nearest water etc. recorded (Figure 20). The nest was visited at regular intervals until it was established that the complete clutch of eggs had been laid. The hatching date was then estimated by allowing about twenty days from the dropping of the last egg. The nest was not revisited until just before hatching, at which time an attempt was made to nest trap and mark the female. Trapping was delayed until this later date to try to decrease desertion by taking advantage of the close attachment of the female to the nest during the last days of incubation.

Data were kept on the success of each nest and, if unsuccessful, an attempt was made to identify the agent responsible.

The original plan included a study of territorialism and the relation of the female, nest and brood, to the original territory. It soon became apparent that the many water bodies in the area made such a study impractical so it was discontinued.

Trapping and Marking Nesting Females

Females were trapped on the nest using either a hoop trap, Figures 21 and 22, or a box trap with a sliding front, Figure 23. Capturing waterfowl by means of nest traps is believed to have originated with the late R. D. Harris while employed by Ducks Unlimited (Canada) on the Big Grass Marsh in Manitoba. T. R. Randall evolved the hoop type trap while banding in Southern Alberta. The technique is also described by Sowls (1949). The

Figure 20

RECORD OF MARKED FEMALE

Species..Female Number........................

1. Markings

Left Wing..

Right Wing...

No. of Eggs in Nest when marked..

Date marked..

Band number..

Remarks..

2. Nest

Date located.....................................No. of Eggs.............

No. of eggs in completed clutch..

Cover..

Distance from nearest water..

Slough.............Pothole.............Size...................

Description..

Dry at time of hatching?.....................................

Distance from territorial water...

Slough.............Pothole.............Size...................

Description..

Dry at time of hatching?.....................................

Remarks re above...

....

Male still on territory when nest located..

When was territory abandoned?..

3. Success

Date hatched..............................No. of young hatched........

Date destroyed or deserted................Cause.........................

Renest?...

Male still present on territory..

Were waters referred to in (2) still in existence?.....................

4. Brood

Date first located......................No. of young present........

Nearest water...........................Territorial water............

If other: Slough.............Pothole.............Size...............

Distance covered to water....................................

Time (if known) to cover distance...........................

SUBSEQUENT OBSERVATIONS

Date	Location	Distance From Last Location	Number of Young Present	Reason for Movement if Apparent - also Remarks re Development of Brood, etc.

Figure 21. Hoop trap set over pintail nest.
May 21, 1947.

Figure 22. Hoop trap dropped on pintail nest.
May 21, 1947.

The box trap with the sliding front panel is believed to be original with Sutton.

Either of these traps was set over the duck's nest. The hoop trap was secured by a pin driven into the ground. The foreward edge was then propped up by a stick so that the female could return to her nest. A long cord was fastened to the stick and stretched out on the ground to a point beyond the normal flushing distance of the female. To be safe at least 150 feet of cord was used. The operator then left the area returning several hours later to drop the trap. If the female had not returned, or was not caught, the trap was not reset if the hour was late so that she would not be kept from her nest overnight and the eggs chilled. The box trap was operated in a similar manner, the front panel being dropped by means of a pull string. It was considered superior in heavy snowberry since it was unnecessary to clear away so much of the cover in order to set it.

Some females were very difficult to catch if the first attempt failed. Some were never caught. It was found helpful to tie a stone to the forward edge of the hoop trap to increase the rate of fall and to hold the edge of the trap more firmly on the ground when a duck had been caught. In pulling a trap the string had to be grabbed and pulled instantly. A gradual tightening would almost invariably flush the bird before the trap fell. Traps in heavy cover, and particularly box traps, must be set so that the female can reach her nest along her accustomed path. Otherwise she may be a long time in returning or may desert. One would expect the sudden fall of the trap to panic the hen to the point where she would accidently break her eggs. This very seldom occurred. In most instances she appeared to be trying to protect the eggs by holding the trap away from them.

Wadkins (1948) briefly discusses the history of marking birds and mammals for later identification. Data are given on the suitability of a series of dyes using a number of different solvents. Sowls (1949) reports the use of "Aeroplane dope" to mark nesting females at Delta Manitoba. In 1947 the females trapped in this study were marked with artists' oils diluted with carbon tetrachloride. Although on original application the color was quite intense fading was rapid. The longest record for this marking to be visible was thirty-nine days. There were several observations of thirty days. Four colors, red, yellow, black and white applied to wings or tail (Figure 24) were found to give sufficient combinations to identify the number of ducks which it was expected would be trapped, since females of different species could be marked identically. The birds were banded with standard United States Fish and Wildlife Service bands at the same time.

During the winter of 1947--1948 experiments were carried out with marking lacquer provided by the Sherwin-Williams Company of Winnipeg. Red, yellow, black and white lacquer was applied to stretched wings of ducks collected during the hunting season. These wings were exposed to the

Figure 23. Box trap set over pintail nest in heavy snowberry.

June 16, 1947.

Figure 24. Female pintail marked, banded and ready for release.

May 11, 1948.

elements during the latter part of the winter and spring. Little fading occurred so this lacquer was adopted to replace the artists' oils and used in the field in 1948 and 1950.

In 1948 the longest period from marking to last observation was thirty-seven days with several other sightings as long as four weeks. Heavy nest losses reduced the number of hens marked in 1950 and only two were relocated, one after twenty-four days and the other after twenty-two. The latter female was sighted on three different occasions. Nineteen days after marking it was noted that the colors had "faded" badly. The disappearance of the color was more likely due to the activity of the female than to fading of the color itself. Lacquer covers the feathers but dries quickly forming a coating with little penetration. If the hen worked at it with her bill she could probably chip it off gradually. This is likely what occurred.

Brood Counts and Location of Marked Females

In 1947 and 1948 systematic searches were made of each water area to locate marked broods. No attempt was made to carry out a complete brood census though the broods seen during the search for marked females and during the weekly census were recorded. These data cannot be used to estimate total brood productions since all the water areas were not waded and "beaten out", nor was the whole area covered at the one time. This is essential if anything approaching the total number of broods is to be located.

In 1950 the scope of the work was expanded and a definite attempt made to correlate the estimated breeding population and the number of broods produced. A complete brood census was carried out on June 25th, 26th and 27th to count the early broods and another count on August 17th, 18th and 19th for late nesters. These counts were spaced far enough apart so that the early broods would be on the wing before the second count was made. Only flightless broods were counted. Counts made in 1951 were similarly spaced. Due to heavy cover it was impossible in most instances to count the number of ducklings per brood accurately. The census was of broods not ducklings. Females which by their characteristic "feigning action" indicated a brood nearby, were counted as broods, even though the brood itself was not seen.

THE NESTING POPULATION

General

The number of pairs of ducks nesting in the area each year from 1947 to 1951 inclusive, (excepting 1949), are given in Table 1. The 1951 data are based on one count only, those for other years on weekly counts made during the nesting season. Due to the emergent growth, counts of territorial pairs are not accurate after about June 25th, and data obtained past this date are not used.

The nesting populations given in Table 1 are not completely accurate since they do not take into account the "turn over" in nesting populations. It is difficult to establish the total number of nesting pairs using the area since they may have used it at different times. Table 1 gives the number of nesting pairs on the study area when the population was at its maximum. Since the mating and nesting season extends over a considerable period, drakes which abandoned their territories before the maximum was reached, and late nesters which may have occupied territories after the counts were discontinued, would not be included. The data for pintails (*Anas acuta tzitzihoa*) and mallards (*Anas platyrhynchos platyrhynchos*) are affected the most, since in these species the period of territorial occupancy by the drake is short once the hen begins to incubate. Blue-winged teal (*Anas discors*), shoveller (*Anas clypeata*) and baldpate (*Anas americana*) drakes remain on territory much longer, and total nesting population figures for these species should be quite accurate.

The actual counts themselves are accurate only within limits.

TABLE I

NUMBER OF NESTING PAIRS[1]

Species	1947	1948	1950	1951[2]
Blue-winged Teal	71 (24.4)[3]	114 (38.9)	68 (25.3)	90 (28.0)
Shoveller	59 (20.2)	47 (15.9)	41 (15.5)	52 (16.1)
Gadwall	40 (13.7)	25 (8.4)	28 (10.6)	33 (10.2)
Pintail	39 (13.0)	27 (9.1)	34 (12.8)	57 (17.7)
Baldpate	33 (11.3)	24 (8.1)	24 (8.6)	24 (7.4)
Mallard	27 (9.2)	40 (13.5)	39 (14.7)	34 (10.5)
Lesser Scaup	10 (3.4)	10 (3.3)	12 (4.5)	4 (1.2)
Ruddy	5 (1.7)	1 (.3)	6 (2.2)	4 (1.2)
Canvasback	4 (1.2)	0	2 (.7)	8 (2.4)
Redhead	2 (.6)	5 (1.6)	9 (3.3)	10 (3.1)
Green-winged Teal	2 (.6)	2 (.6)	1 (.3)	5 (1.5)
Total	292	295	264	321
Pairs / sq. mile	68	69	62	75
Per cent Anatinae (Surface Feeders)	92.8	94.5	89.0	91.9

1 Lone females observed were counted as breeding pairs and were added to the data obtained from the graphs to arrive at these figures. This accounts for the slight discrepancy when compared with the graphs.

2 Based on one count only.

3 Percent of total.

Double counting certainly occurred in some instances and all lone drakes may not have represented breeding pairs. In some cases novice drakes may have been included as territorial males (Hochbaum 1944 P. 70). Changes in the number of pairs or single drakes of less than five units are probably not significant.

A single count of pairs and single drakes does not give a reliable census of the actual number of nesting pairs on an area due to the difficulty of separating migrants from the resident breeding population. Such a distinction can be made on small areas by observing the behavior of the birds, (Hochbaum 1944), but on a study area over four square miles in extent containing 261 water bodies, such an approach was impractical, particularly when the population estimate was only part of the problem. It was necessary therefore to deal with mass data.

To obtain a complete picture of the population during the territorial phase of the nesting season, graphs were prepared for each species on which frequency polygons were drawn for the number of pairs seen on each weekly count, for the number of single drakes apparently on territory, and also for the total breeding population. By studying these graphs a decision was reached on the size of the nesting population of each species. Lynch (1947) graphed single drakes and pairs to appraise the success of nesting pairs in various habitats.

Analysis of a Theoretical Population

Figure 25 shows the changes which would take place in numbers and composition in a theoretical population of nesting ducks, of a single species, in an area such as the one under discussion. The graph is based on the nesting and territorial behavior of waterfowl. The abscissa gives the dates on which the counts were made; the ordinate the number of paired ducks or single males counted on each census date. Since most lone drakes at this time of the year may logically be expected to have a mate on a nest nearby, they are assumed to represent breeding pairs. A third frequency polygon, called the "pair equivalent polygon", is therefore drawn which is the sum of the observed pairs and the lone drakes, and represents the total potential nesting population on the area.

From Figure 25, it can be seen that on May 1st there were ten pairs of ducks on the area and two lone drakes. By May 14th there were forty pairs on the area and four lone drakes. However on May 21st this was reduced to twenty-five pairs and five drakes and from this date on there was a steady decrease in pairs during the remainder of the census period.

At what date on the pair equivalent polygon can we say that the population became stable? What point represents the true breeding population? The clue is provided by single drakes. The peak of May 14th was caused by the passage of paired migrants, for with the decrease in pairs between May 14th and May 21st there was no corresponding increase in single drakes, which would have maintained the pair equivalent polygon at the high level of May 14th. Between May 21st and May 28th there is a

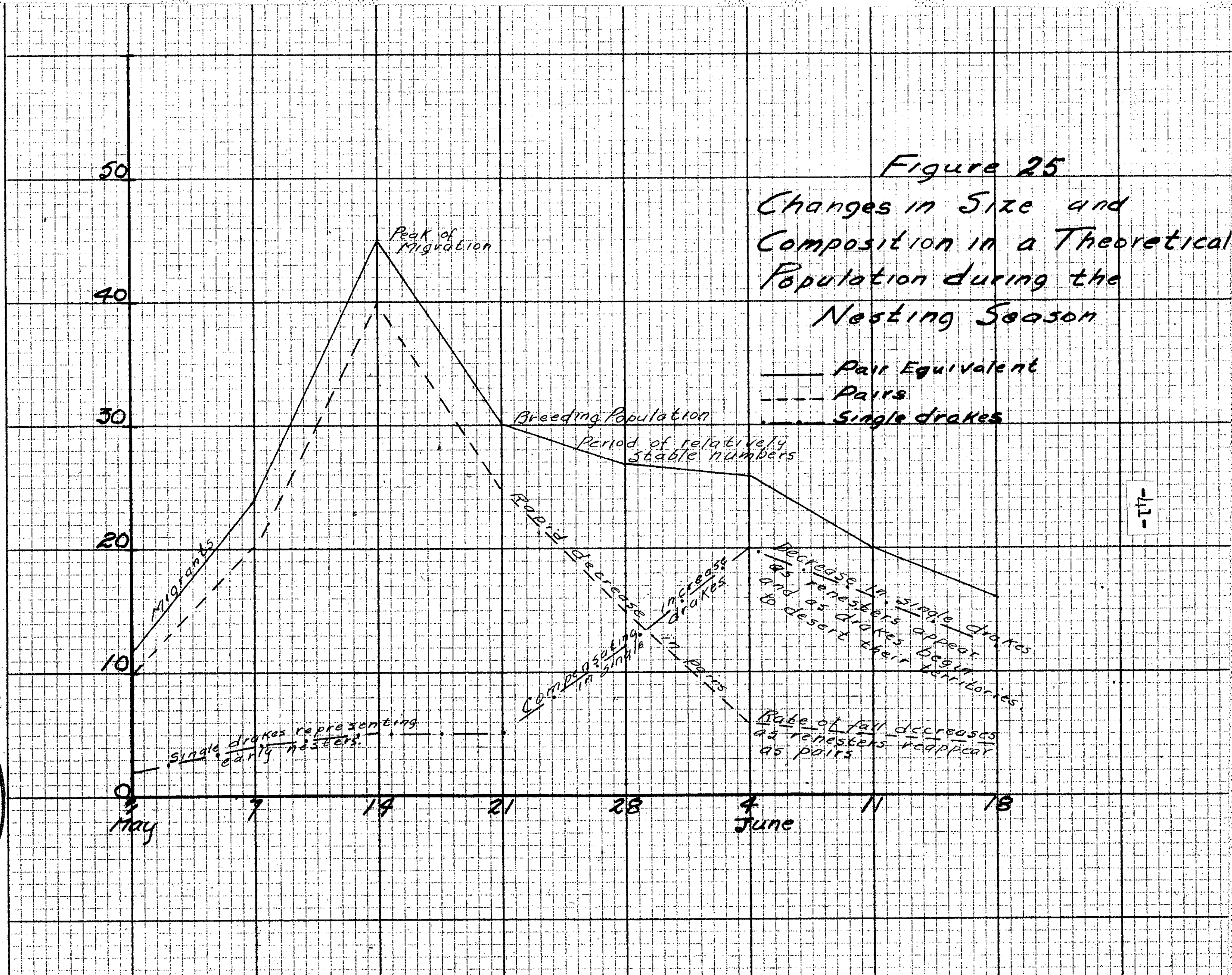


Figure 25
Changes in Size and Composition in a Theoretical Population during the Nesting Season

further reduction in the number of paired birds, but this is matched by a corresponding increase in single drakes, as the hens spend less and less time on the territory, and as a result the pair equivalent polygon is reduced very little below May 21st. At this point migration is finished, the population is stable, and nesting has become general. Complicating factors of course appear when graphs are plotted from field data as the next few pages will reveal. However, with Figure 25 as a guide, the graphs can be interpreted satisfactorily. The slight discrepancies between the number of breeding pairs as indicated on the graphs and that shown in Table 1 is due to the inclusion of lone females, presumably off the nest, in the total breeding population figure.

The best field data available are those of 1948, for that year an observer was in the field early enough to record the migration of the blue-winged teals and shovellers, although it was still too late for the early nesting pintails and mallards.

Blue-Winged Teal Nesting Populations

Figure 26 is for the 1948 blue-winged teal population and comes close to conforming to the theoretical population illustrated by Figure 25. On May 5th the count showed fifty-five pairs of blue-winged teals on the area and one lone drake. By May 20th the number of pairs had increased to 107 and the lone drakes to three. May 27th saw a sharp increase in the number of lone drakes to twenty-three, but the number of pairs only decreased by nine. It is believed that the pair polygon was supported by the continuing migration of mated pairs. On June 4th, the number of pairs

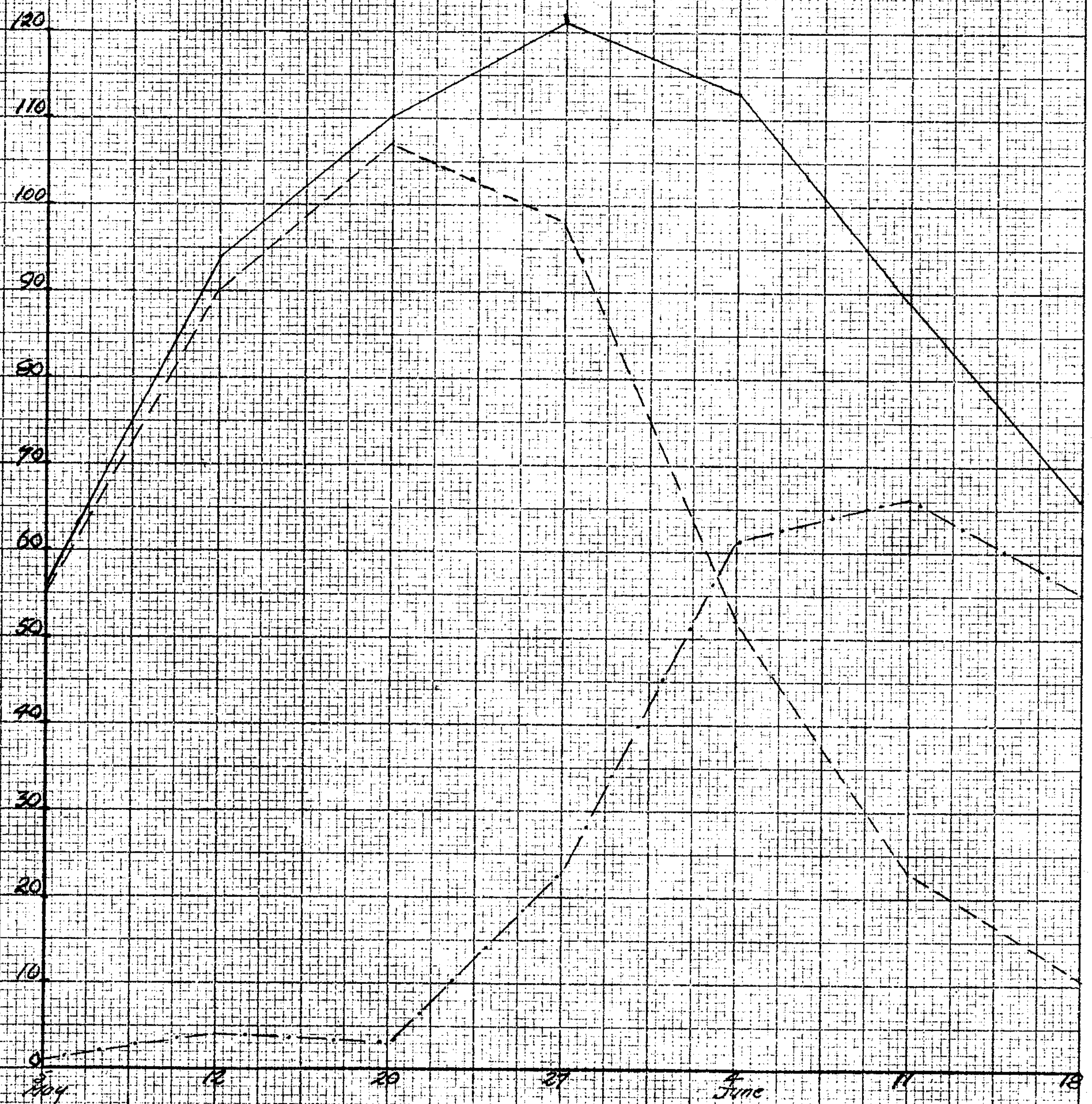


Figure 26
Blue-Winged Teals
1948

had declined by forty-six while the lone drakes increased by thirty-eight, indicating that general nesting had begun and that the population June 4th was stable. After June 4th the number of pairs continued to decrease whereas there was only a slight further increase of lone drakes and then a continued reduction. This was due to abandonment of territories by drakes, their aggregation into flocks, and departure for larger waters on which to undergo the moult. It may have also been due, in part, to the re-establishment of pairs after the destruction of first nesting attempts. The population on June 4th is believed to have been the true nesting population.

Reference to the nesting data confirms the above interpretation of the blue-winged teal graph. The observer was active in the area from May4th and although twenty-two mallard and pintail nests had been located by the 24th of the month, no blue-winged teal nests were found until that date. Thirteen nests were found during the next two weeks with clutches complete or almost complete, indicating that incubation was underway during the weeks of May 20th to June 4th, the period of great decrease in mated pairs.

The graph illustrating the 1950 data for blue-winged teals, Figure 27, is incomplete due to delay in getting into the field. Fortunately 1950 was a year when migration was late, and more of the story is available than would normally be the case.

The number of mated pairs decreased from seventy-five on May 22nd to twenty-five on June 5th. During this period the number of single drakes increased only from eight to twenty-four. This indicates that many of the

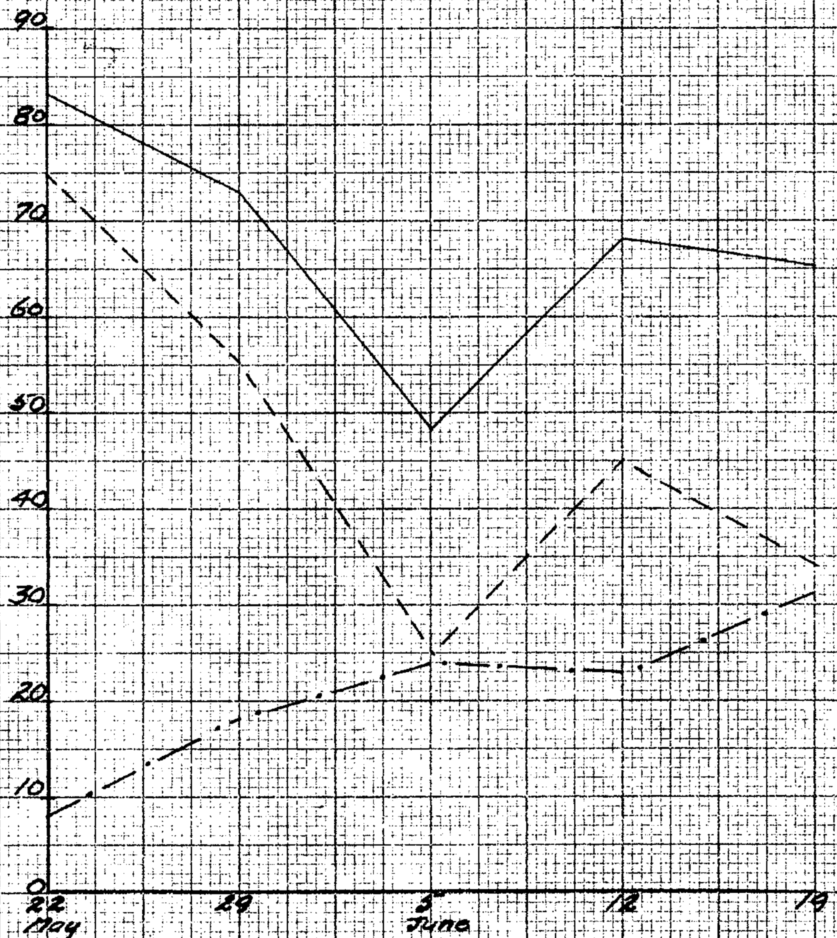


Figure 27
Blue Winged Teals
1950

blue-winged teals on the area May 22nd were migrants, and had passed on by June 5th. A further influx of pairs into the area occurred between June 5th and 12th, augmenting the early population already nesting. Part of the increase in pairs between these two dates may be accounted for by the loss of early nests and the reappearance of nesting birds in pairs. The levelling off of the polygon for single males between June 5th and June 12th indicates this, though by this date some of the early nesting drakes would begin to abandon their territories. After June 12th the population became stable and further decreases in pairs were adequately matched by increases in single drakes. The June 12th census was taken as the nesting population for this species.

The 1950 nesting population reached its maximum, according to the graph, approximately eight days later than in 1948. This is supported by other evidence. The first blue-winged teals were not seen in the study area in 1950 until May 7th, whereas in 1948 they were already abundant on May 5th. First nests of blue-winged teal were located during the week of May 24th to June 1st in 1948, but not until the week of June 7th to 14th in 1950. The data for broods also provides evidence. The June count located no blue-winged teal broods in 1950 whereas in 1951, when migration was more normal, thirteen broods were recorded.

The 1947 graph for blue-winged teals, Figure 28, has been left to the last because it conforms least to that of the theoretical population. This is because in 1947 single drakes were not recorded separately from flocks of drakes, or from groups of drakes forming courting parties.

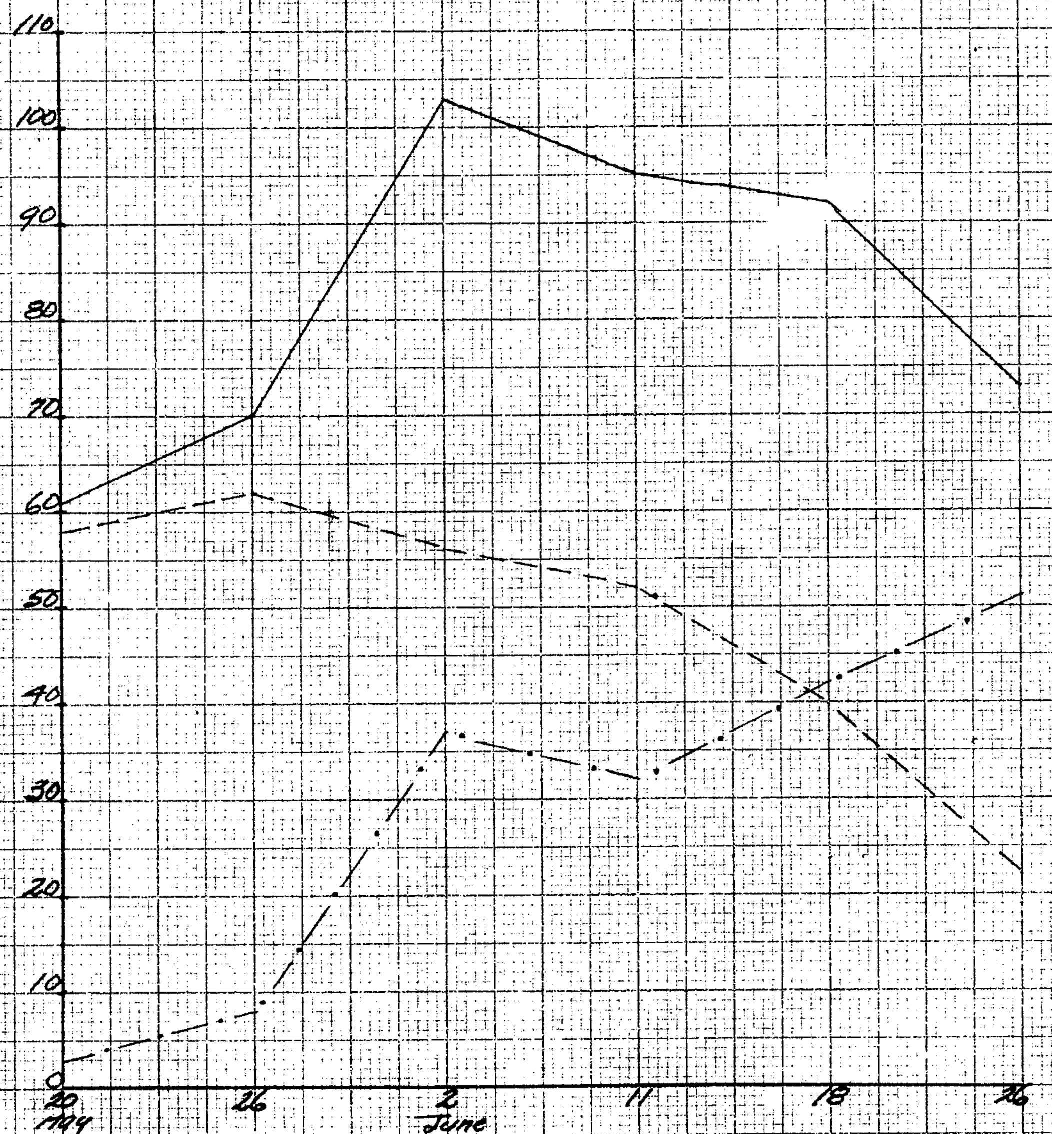


Figure 28
Blue Winged Teals
1947

The frequency polygon plotted for drakes therefore represents all drakes on the area not just territorial birds. The distortion produced is most evident in the 1947 graphs for mallards and pintails (Figures 32 and 35). Here an influx of drakes of both species in early June, (presumably post-breeding birds), having no connection with the resident breeding population, completely destroyed the normal configuration of the frequency polygons.

The 1947 graph for the blue-winged teals indicates that the main migration passed through the area prior to May 20th. There is a slight increase in pairs up to May 26th, but not enough to be significant. It seems likely that the population on May 26th was a stable one since the decrease in pairs each week from then on was at a uniform rate, indicating that nesting and incubation were under way. The frequency polygon for the drakes confirms this, except that it is distorted by what must have been an influx of unmated drakes between May 26th and June 2nd. The selection of the date on which the population may be said to have become stable is therefore somewhat arbitrary, since the corroborating evidence which would have been supplied by the data from the drake polygon was masked by this influx. The May 26th point on the pair equivalent polygon was taken as the 1947 nesting population.

Shoveller Nesting Populations

Shovellers are very similar to blue-winged teals in territorial behavior, the drake remaining on territory for a relatively long time after the hen has begun to incubate (Hochbaum 1944). Graphs for this species therefore give good data on the number of nesting pairs using the area.

The 1947, 1948, and 1950 data are graphed in Figures 29, 30 and 31. Interpretation of the 1947 graph is again difficult due to the distortion of the drake polygon. However the steady decline in pairs from May 26th supported by the increase in single drakes, (although distorted by an influx of unmated birds as in the 1947 data for the blue-winged teals), justifies the selection of this date as the beginning of the period of stable numbers. The 1948 graph is good and there is no hesitation in selecting May 20th as the beginning of the stable period. As previously stated, in 1950 migration was delayed. This is apparent in the shoveller graph for that year. The thirty-five pairs of shovellers on the area on May 22nd apparently included many migrants, since this number was reduced to thirteen pairs on May 29th with no corresponding increase in lone drakes. Another wave of migrants came into the area between May 29th and June 5th, many of which remained to nest. The point on the pair equivalent polygon for June 5th is believed to represent the true nesting population. The disproportionate increase in drakes on June 19th cannot be accounted for.

Mallard Nesting Populations

Data on the number of pintails and mallards which nested in the area are not as reliable as those for the other species. This is because the

Figure 29
Shovellers 1947

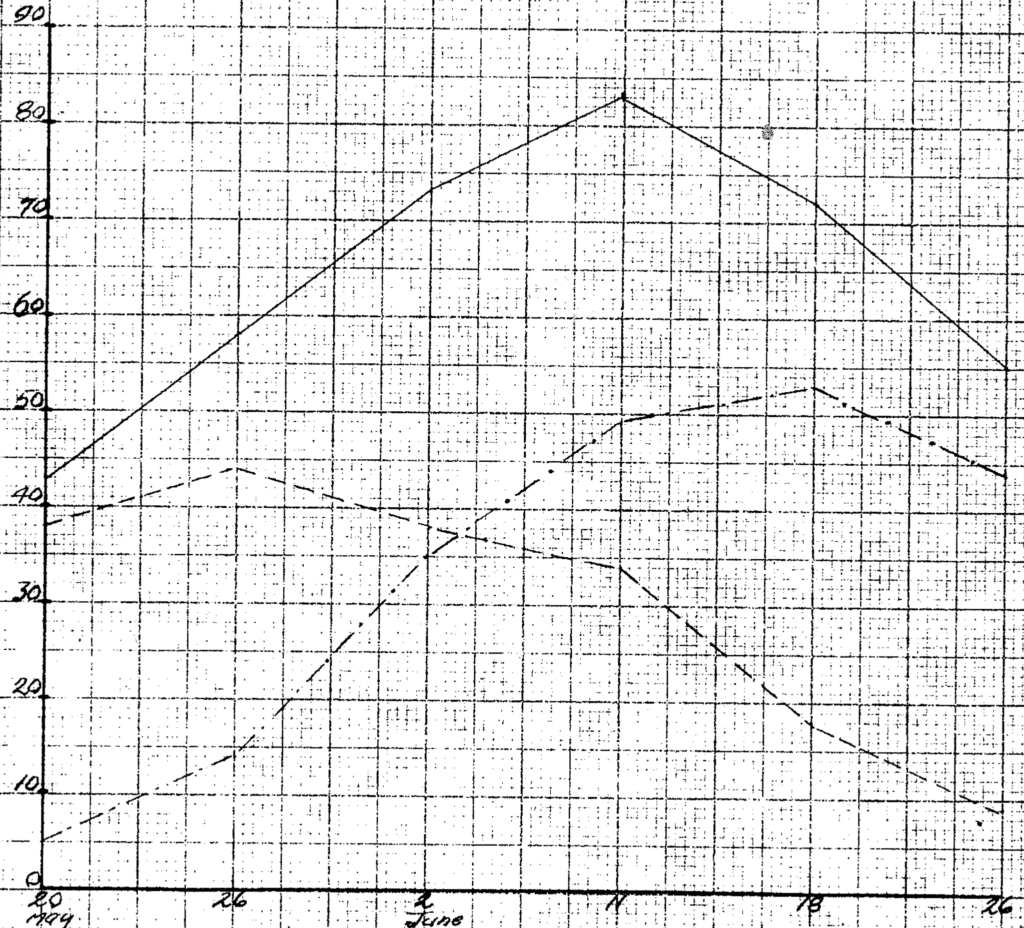


Figure 30
Shovellers 1948

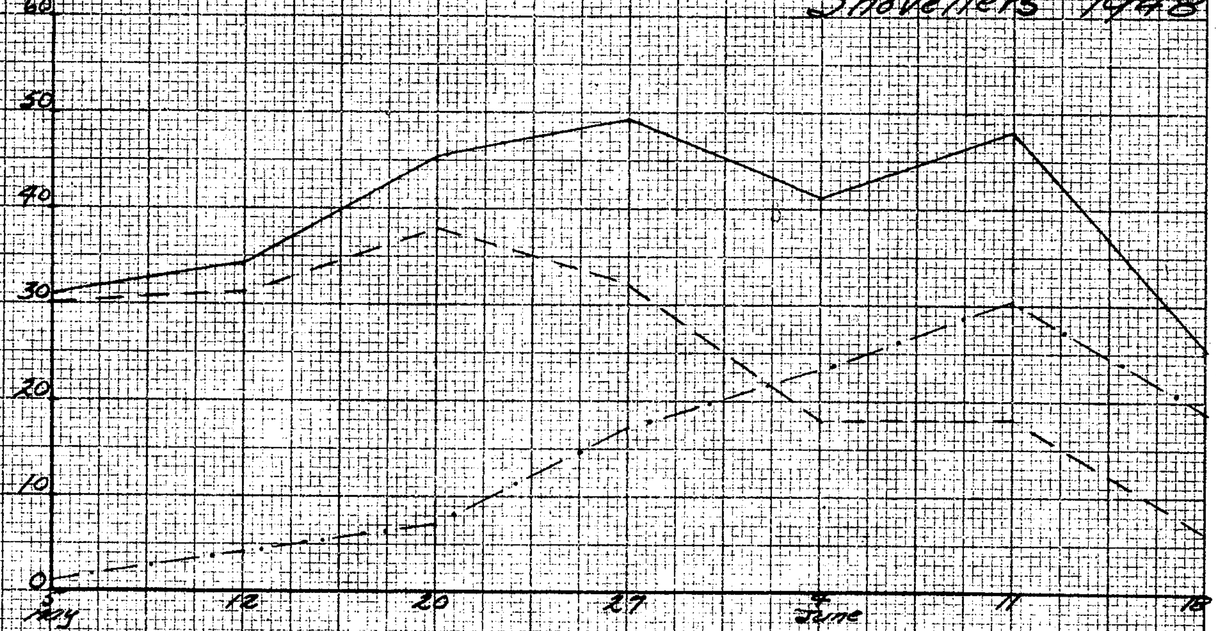
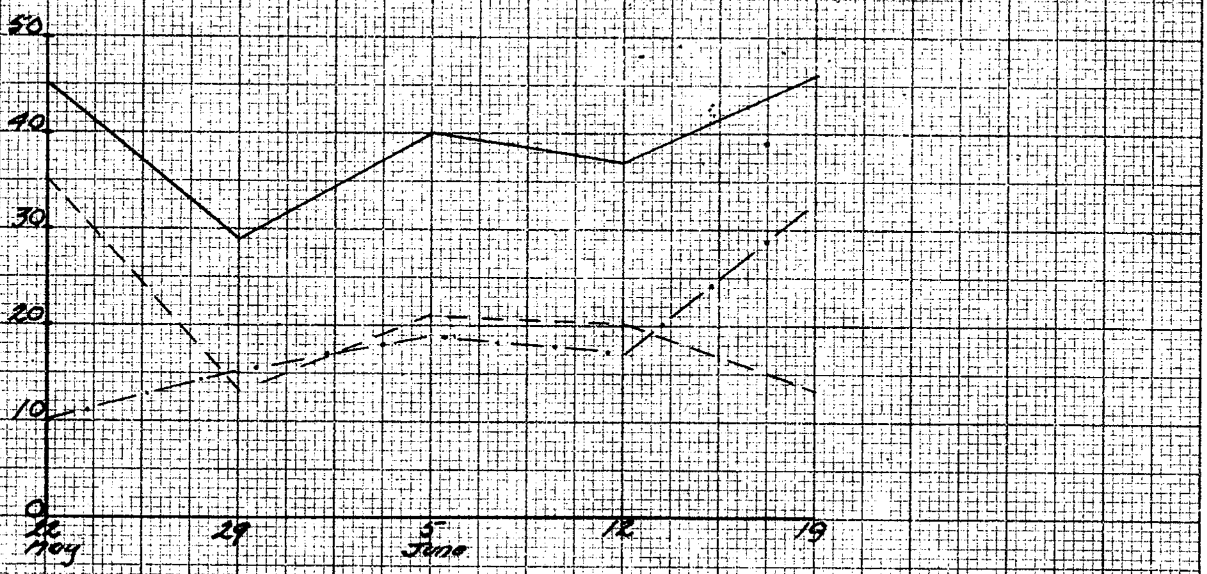


Figure 31
Shovellers 1950



period of territorial occupancy is relatively short in these species and a larger proportion of the earliest arrivals may have already deserted their territories before later migrants arrive. It was also impossible to get an observer into the field soon enough to record early population changes.

The 1948 data are the best for these early nesting species. Even so the nesting season was underway before the first count was taken on May 5th.

Between May 5th and 12th, 1948, the number of mallard pairs decreased, Figure 33, and the polygon representing pairs crossed the single drake polygon during this period. Reference to the graphs for blue-winged teals and shovellers, shows that this "cross over" takes place shortly after the nesting population becomes stabilized. The best we can do is assume that the May 5th population is as close to the actual nesting population as it is possible to come. The single drake polygon shows no increase in harmony with the decline in the number of pairs. This is no doubt due to the short period of territorial occupancy, the departure of drakes from their territories just about balancing the appearance of lone drakes as their hens began incubation. The peak reached by the single drakes on May 20th cannot be explained on any logical ground. There was no decline in mated pairs to compensate for it. The uniform number of pairs on the area from May 12th to May 27th can be explained however, by the destruction of the first nests and the return of females to their mates. This is confirmed by the nest data which shows that of twenty-five mallard nests under

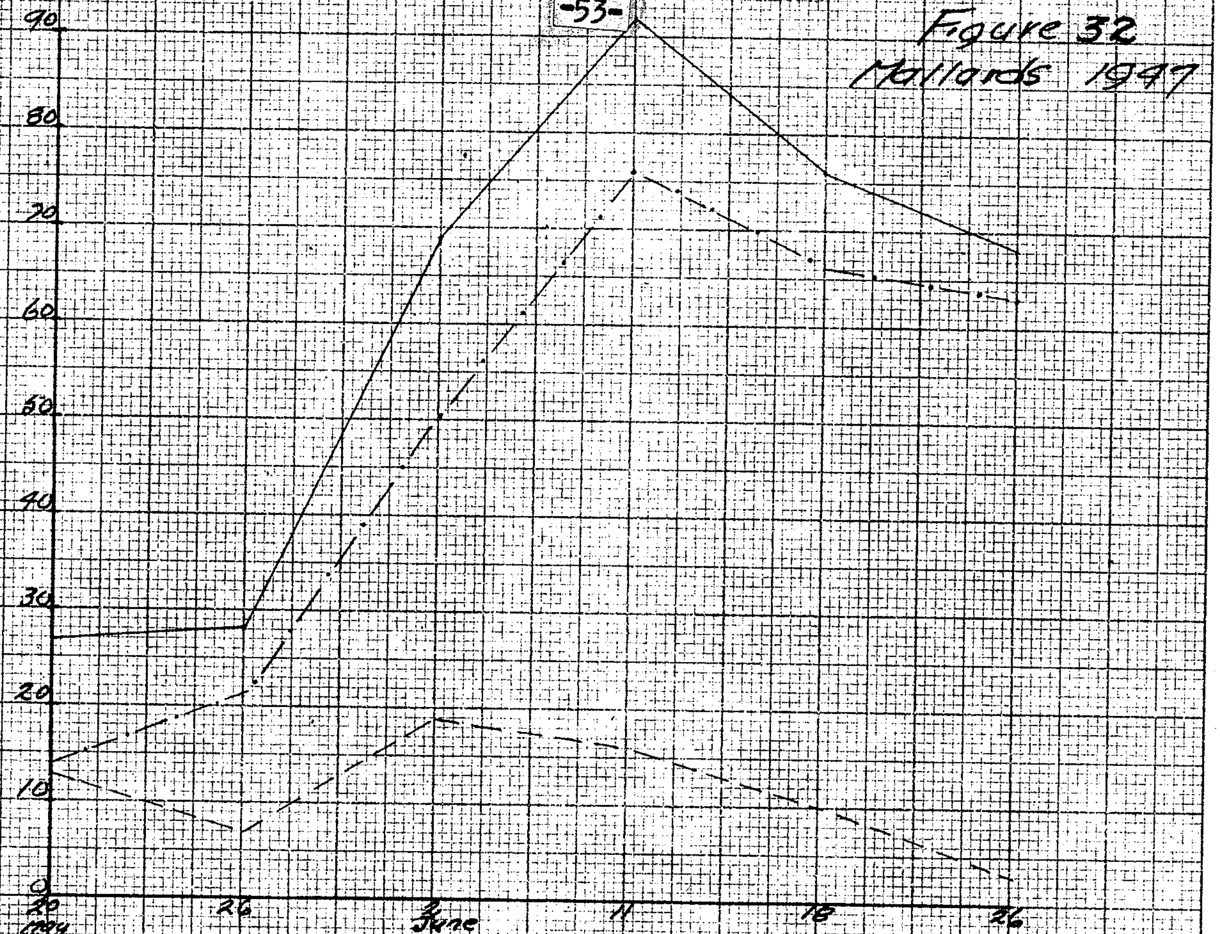


Figure 32
Mallards 1947

Figure 33
Mallards 1948

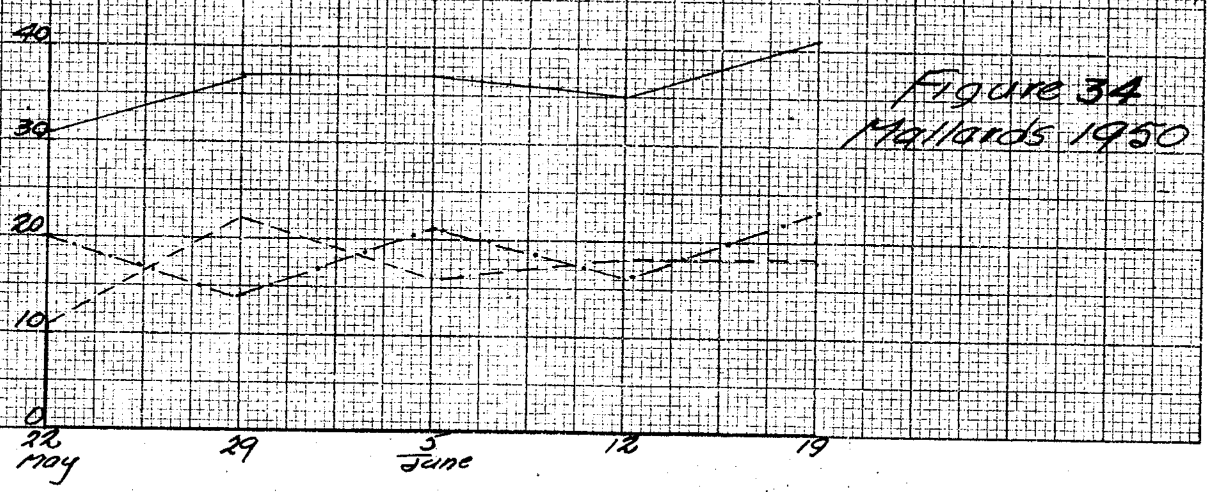


Figure 34
Mallards 1950

observation during that time twelve were destroyed by predation or deserted.

The 1947 data for mallards, Figure 32, are of course, distorted by the failure to distinguish in the records between single drakes and aggregations. This distortion is evident in the rapid increase in drakes between May 26th and June 11th, to numbers far beyond the original breeding population. The count on May 20th appears to have been taken just after the crossing of the pair and drake polygons and the population at this date is accepted as the stable one. Between May 20th and 26th the decline in pairs and resulting increase in drakes gives the graph a normal appearance. The increase in the number of pairs between May 26th and June 2nd was likely caused by nest destruction and the reforming of pairs.

The early nesting season for mallards in 1950 seems to have been almost a complete failure. This is indicated by the graph, Figure 34, and is further confirmed by the record of wholesale nest destruction and the absence of broods on the late June brood census. Referring to the graph it will be seen that the pair and single drake polygons crossed four times during the five weekly counts, indicating a condition where pairs were re-forming in numbers equal to the females commencing incubation, while the population remained stable at about thirty-seven nesting pairs.

Nesting data confirm this heavy loss of mallard nests. During the period May 29th to June 19th, of thirteen mallard nests under observation ten were destroyed or deserted. The brood census in late June, which is the height of the normal mallard brood season, located only three broods on the area.

<u>Pintail Nesting Populations</u>

The pintail graphs for the three years are very similar to those of the mallards. The 1947 graph, Figure 35, shows three successive influxes of drakes on June 2nd, 11th, and 26th which had no relationship with the resident population. The nesting population for that year is estimated to have been about forty-five pairs, as shown on the pair equivalent polygon for May 20th. The cross over of the polygons for the pairs and single drakes took place prior to May 20th.

The 1948 graph for pintails, Figure 36, indicates that the greater part of an early migration of pintails were already nesting on May 5th for even on this early date single drakes already exceeded the pairs. The graph suggests heavy nest losses resulting in the reforming of pairs at a rate equal to the beginning of incubation by other females. The relative positions of the single drakes and pairs remained unchanged until June 4th, after which date the graph assumes something of the normal configuration. The nesting data show that these nest losses did occur. Out of twenty-six nests under observation ten were destroyed during the period May 5th to June 18th. From the graph the nesting population was estimated at twenty-five pairs. Judging from the number of nests found, (Table 11), this estimate is too low but there are no data on which to base a higher estimate. It must also be remembered that the period under consideration is sufficiently long for second and even third nesting attempts of an individual hen to have been discovered.

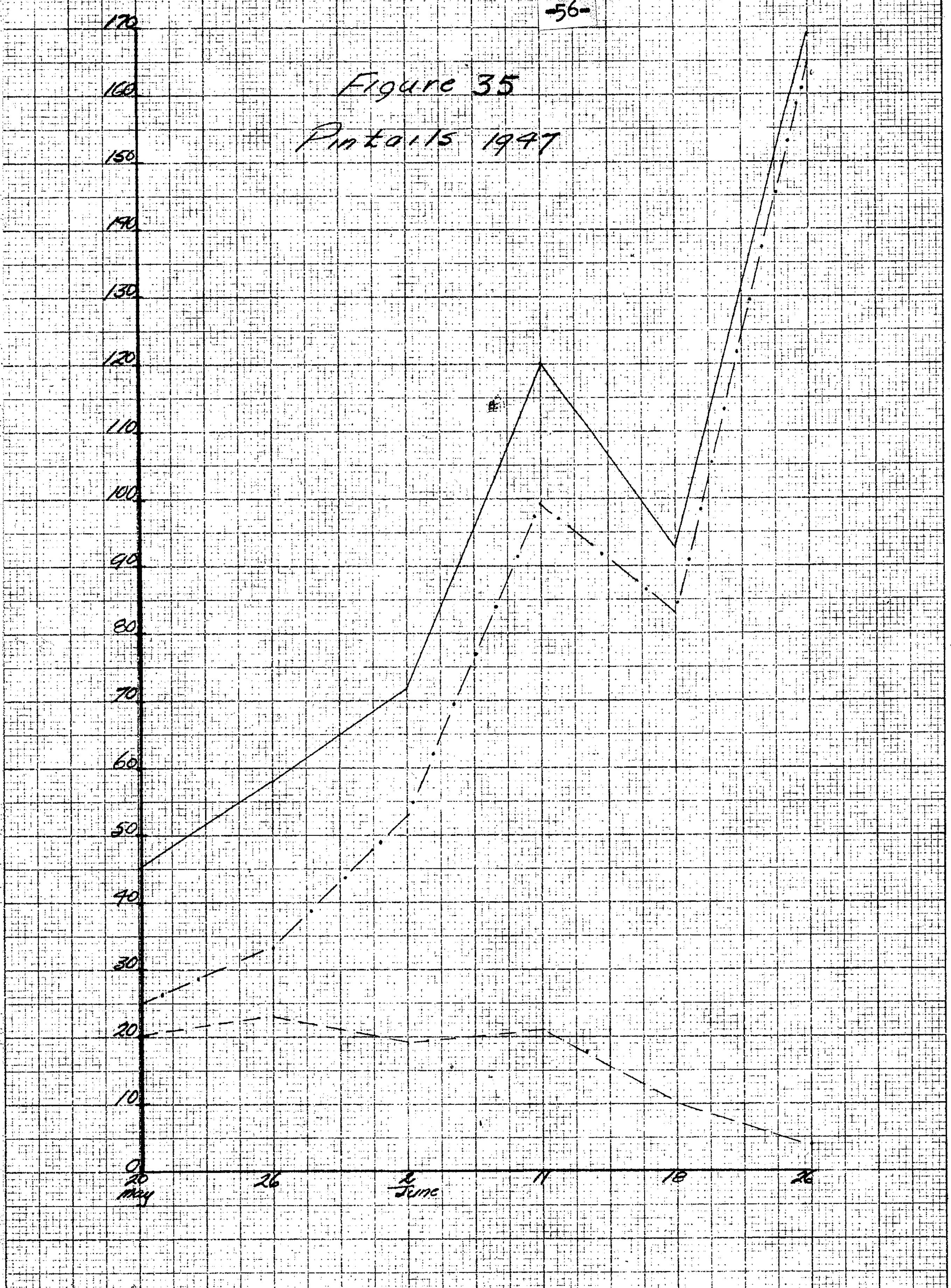


Figure 35
Pintails 1947
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
20
May
26
2
June
11
18
26

Figure 36
Pintails 1948

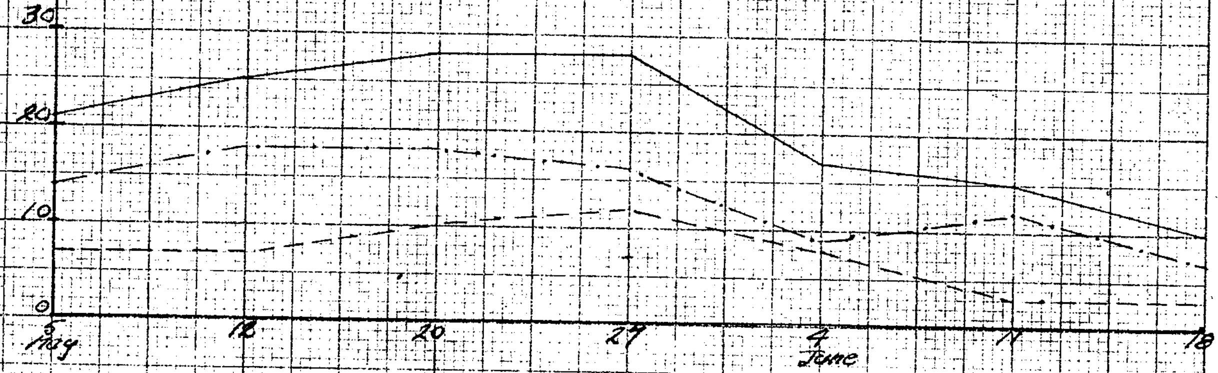
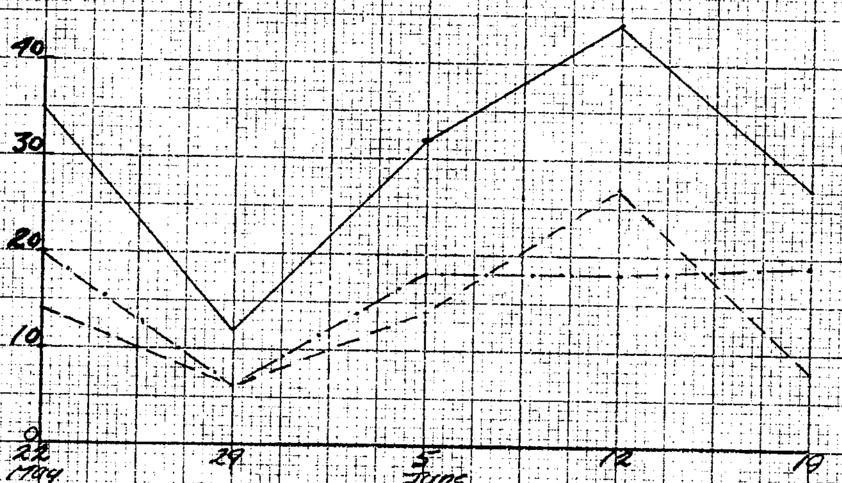


Figure 37
Pintails 1950



The 1950 graph for pintails, Figure 37, is noteworthy for the rapid increase in the number of mated pairs from May 29th to June 12th and particularly between June 5th and June 12th. Earlier in the season this upward surge and rapid fall-off without a corresponding increase in single drakes would be accounted for by the northward migration but at such a late date this seems unlikely. On May 22nd about half the pintails were apparently incubating since the population was about evenly divided between pairs and lone drakes and the total nesting population on the area, as shown by the pair equivalent polygon was thirty-five pairs. Single drakes already exceeded paired birds in the population. Both categories and particularly the single drakes, had greatly decreased by the May 29 census. Between that date and June 5th there was a considerable influx of breeding pairs into the area which apparently began to nest almost immediately. This movement supported the pair polygon at the June 5th census and also increased the number of single drakes considerably beyond the number observed on May 29th. That many of these immigrants remained to nest is evident since the single drake polygon shows no sign of a downward trend from June 5th to June 19th as it would normally do, unless the females of mated pairs were continually commencing to nest and incubate, leaving the drake alone on his territory most of the time. Another factor was also operating on the two polygons. Nests were being destroyed by predation, (of twelve nests under observation seven were destroyed during this period), and at least some of these females would reappear as pairs. This should, of course, have reduced the single drakes on the area but did not do so, again indicating that the nesting population had been augmented. However, part of the June 12th influx did not remain to nest. Had they done so the disappearance of nineteen pairs between June 12th and 17th would have bent the single drake polygon upward perceptibly during this period, even though at that time of the year the drakes would have been abandoning their territories freely.

It is then, extremely difficult to decide how many pintails nested in the study area in 1950. The polygon for single drakes indicates at least eighteen pairs. If we accept all the June 12th influx as nesters the population would be a maximum of forty-four pairs. Since we know that at least some of the influx did not stay to nest the best that can be done is to assume that the nesting population was about thirty pairs in June. There is no way of determining accurately how many pair used the area in early May.

From whence came this large influx of paired pintails so late in the season? There are two possible explanations. It could have been a late migration, though this seems unlikely at such a late date even in a backward season, or it could have resulted from heavy losses of first nests in surrounding areas. The latter seems the more logical explanation. Colls (1950, pp. 39--40) refers to unsuccessful nesting of pintails and mallards in 1950.

Baldpate Nesting Populations

The data for baldpates will not be discussed in detail. The graphs for the three years are presented in Figures 38, 39 and 40. Baldpate drakes like blue-winged teals and shovellers remain long on territory after the female begins to nest, and are the drakes most frequently seen

Figure 38
Baldpates 1947

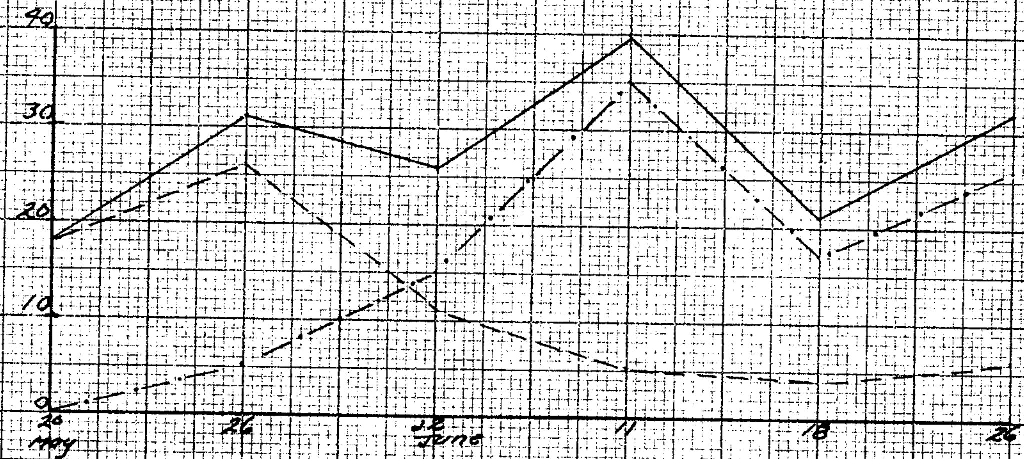


Figure 39
Baldpates 1948

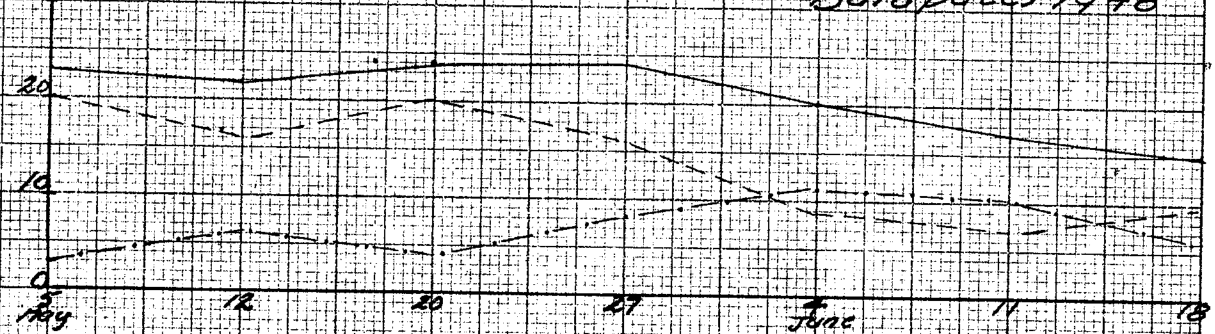
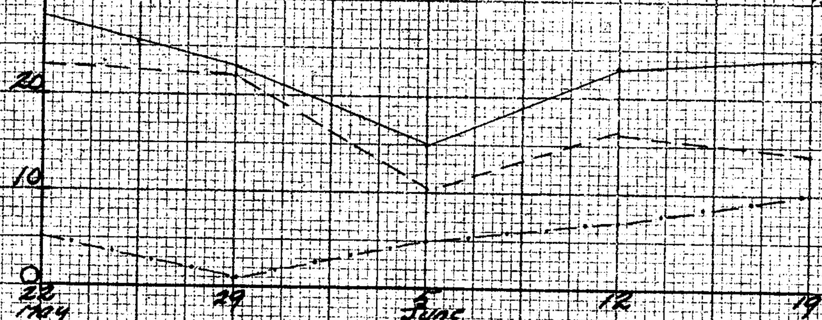


Figure 40
Baldpates 1950



with the female and brood. The 1947 graph is, as with the other species discussed, distorted by the failure to categorize the drakes observed. It can be interpretated however without too much difficulty. The 1950 graph reflects again the late nesting season and migration, into the area between June 5th and 12th.

Gadwall Nesting Populations

Gadwalls (Anas streperus) are late nesters. The first nests of this species found were on June 7th in 1947, June 8th in 1948 and June 9th in 1950. The graphs for 1947, Figure 41, and 1948, Figure 42, show migration into and through the study area until a late date with the population stabilized June 18th in 1947 and June 4th in 1948. In 1950, Figure 43, the gadwall nesting population appears to have stabilized about May 29th and the nesting season to have progressed normally during the period of observation.

Lesser Scaup Nesting Populations

Of the important game diving ducks of the genus Aythya only the lesser scaup (Aythya affinis) nests in sufficient numbers in the area to supply data for graphs. This species is a late nester as Figures 44, 45 and 46 for 1947, 1948 and 1950 reveal. The 1947 data are confused by the excess males which characterize this species and it can only be estimated that about ten pairs nested on the area. Migration is nicely shown by the 1948 graph with stabilization again at about ten pairs on June 4th. The 1950 nesting population was apparently about twelve pairs.

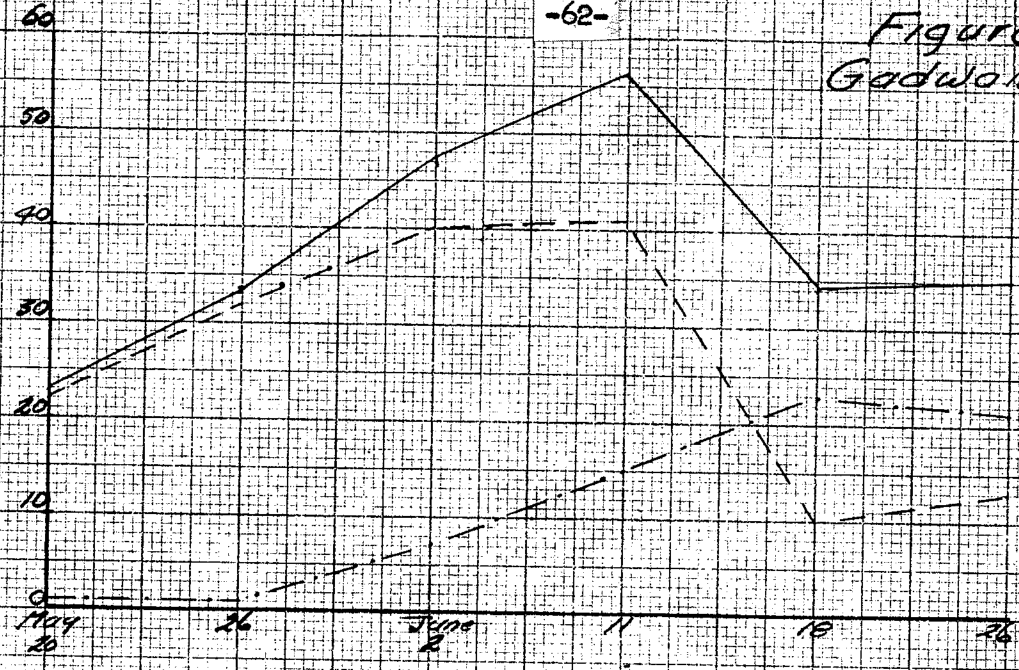


Figure 41
Gadwalls 1947

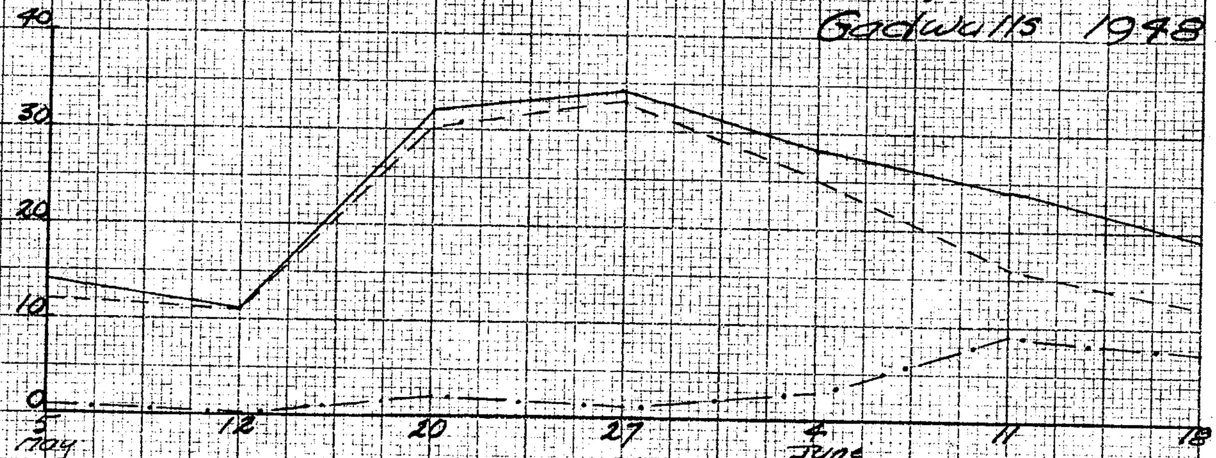


Figure 42
Gadwalls 1948

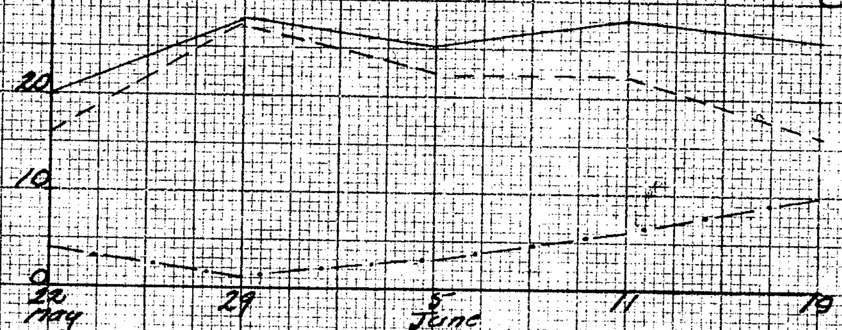


Figure 43
Gadwalls 1950

Figure 44
Lesser Scaups 1947

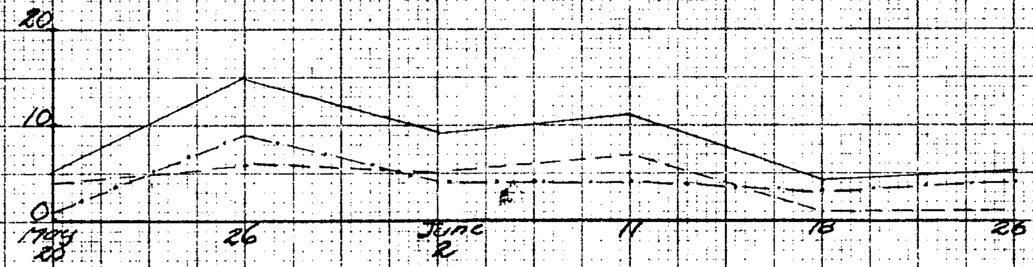


Figure 45
Lesser Scaups 1948

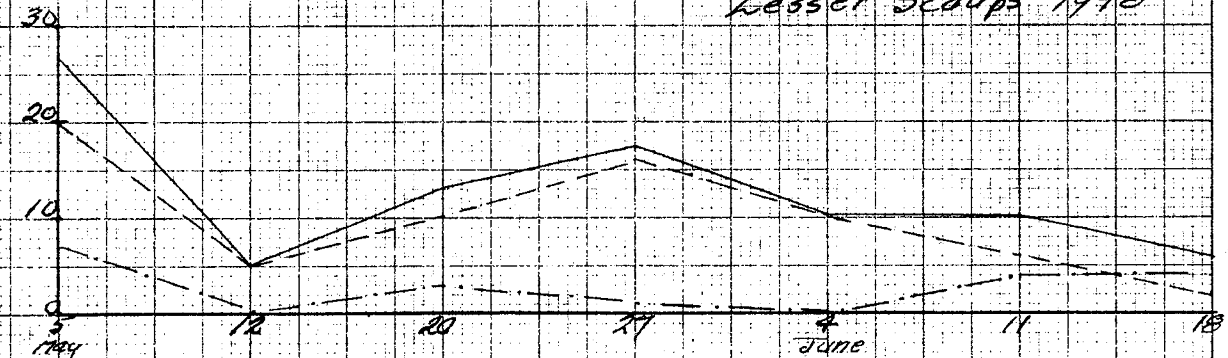
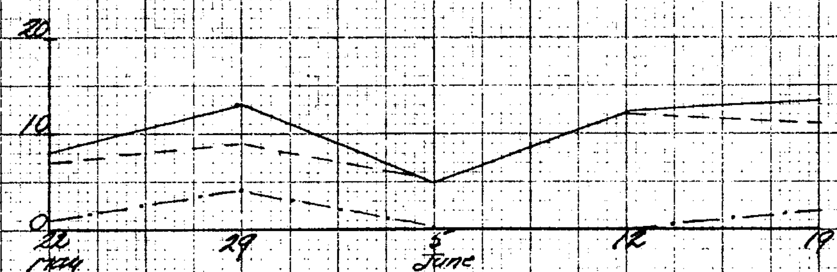


Figure 46
Lesser Scaups 1950



The 1951 Nesting Populations

After examining the data for 1947, 1948 and 1950, it is evident that the single count made May 20th to 22nd in 1951 while interesting and important is not as accurate as those of previous years. Although the date was perhaps the best that could be selected it was too late for the mallard and pintail and probably too early for the gadwalls and perhaps also the blue-winged teals. One census gives just one small part of a very complex picture.

Total Nesting Populations and Comparative Data

The nesting population expressed in number of pairs per square mile is given at the bottom of Table 1. It would be interesting to compare these results with those of other workers but unfortunately most authors reporting detailed investigations of this sort have expressed their results in pairs per mile of shoreline or acre of water, Hochbaum (1944), or in nests per acre of cover, Bennett (1938), Low (1945). Furniss (1938) gives the average nesting population for 1935 and 1936 combined and also for 1937. Since his area comprised twenty quarter sections the per square mile combined average for 1935 and 1936 would be 200 pairs, and 221 in 1938. It seems obvious that Furniss confused migrants with the resident nesting population. Both his technique and results confirm this.

The best comparative data are contained in the annual reports of the United States Fish and Wildlife Service, (Waterfowl Populations and Breeding Conditions). These reports are a compilation of the work done by all agencies cooperating in waterfowl research in Canada and have been issued yearly beginning with 1947.

In 1947 a sample of the Missouri Coteau obtained by roadside transect gave a population of 34.7 pair per square mile, in 1948 a transect through similar habitat showed 55.7 pair per square mile. These populations are somewhat smaller than those obtained on the study area namely 68 pair per square mile in 1947 and 69 in 1948.

Kiel (1950) gives data on pothole nesting populations in the vicinity of Minnedosa, Manitoba. While these water areas are located in the aspen parklands and differ physically and ecologically from those of the Coteau area, (chiefly in being larger and mostly with emergent vegetation), a comparison is interesting. Kiel found 43.8 nesting pairs per square mile. It should be noted that reflecting the larger number of water areas which support emergent vegetation the population included large numbers of canvasbacks (*Aythya valisineria*) and redheads (*Aythya americana*). Evans (1949), studied one and a half square miles of the same area intensively in the previous year, and found a nesting population of 88 pairs per square mile.

Table 1 also shows that the nesting population was composed almost entirely of surface feeding species (*Anatinae*). With the exception of lesser scaups the number of diving species (*Aythyinae*) is insignificant. Although most of the sloughs support good growths of round stem bulrush, which appear to provide suitable nesting sites for canvasbacks and redheads, few nests of these species have been found. Failure to use the area may be due to the smallness of the water bodies. Lack of large adjacent lake or marsh areas to attract and hold spring migrants of these species, which would subsequently spread out into the sloughs to nest, is probably also an important factor (Low 1945).

Furniss (1938) found numbers of canvasbacks and redheads nesting in his area. All but twelve of his 83 water areas were larger than one acre, six were six acres or larger, and two were twelve acres. In the study area only eight ponds were larger than one acre and the biggest only three acres. If size alone is concerned the critical point apparently lies between these extremes.

Blue-winged teals and shovellers were the most abundant nesting species except in 1951 when the pintails outnumbered shovellers. While these species were the most abundant it must be remembered that due to the longer period the drakes remain on territory, and because they are later nesters, a more accurate count of their numbers was obtained. The order of abundance is likely correct but undoubtedly more mallards and pintails used the area than were recorded.

NESTS AND NESTING SUCCESS

General

Table II gives the number of nests of each species found. A wide discrepancy, except for mallards and pintails, was found between the estimated nesting populations and the number of nests located.

Mallard and pintail nests were relatively easy to find due to their preference for buckbrush nesting cover (Figures 6, 47 and 48). The value of buckbrush for nesting cover is further illustrated by the large percentage of baldpate and gadwall nests which were found in it. Table III, gives the cover preferences for the common species nesting in the areas.

Acceptable nesting cover for shovellers and blue-winged teals however covered a much greater area since these species nested in grass almost exclusively. They are, moreover, inclined to sit very close and sometimes are actually stepped on before they will flush. This is particularly true during the last week of incubation. Had more than one man been available and a rope dragged around the water areas, (Bennett 1938), more of these nests would, no doubt, have been found. A well trained hunting dog would also have been a decided asset. While most of the buckbrush patches in the study area were covered several times all of the grass nesting cover could not be covered even once, although the immediate edges of most of the water areas were searched (Figure 49).

Nesting Success

Overall nesting success was only 37 per cent as Table II reveals. This was found by most investigators. Kalmbach (1939) summarized the results

TABLE II

REPRODUCTIVE SUCCESS

BASED ON NESTS

Species		Number of Nesting Pairs	Number Nests Located	Number of Successful Nests	Per cent of Nests Successful	Per cent of Total Nests Successful
Blue-winged Teal	1947	71	10	3	30	
	1948	114	21	7	33 1/3	26
	1950	68	7	-	0	
Shoveller	1947	59	14	7	50	
	1948	47	8	5	71 *	51 *
	1950	41	6	2	33	
Gadwall	1947	40	10	4	40	
	1948	25	11	2	29 *	29 *
	1950	28	4	0	0	
Pintail	1947	38	20	9	47 *	
	1948	27	26	13	50	43 *
	1950	34	13	3	23	
Baldpate	1947	33	9	6	66 2/3	
	1948	24	6	1	17	53
	1950	24	2	2	100	
Mallard	1947	27	18	9	53*	
	1948	40	43	11	27 *	28 *
	1950	39	16	1	6	
Lesser Scaup	1947	10	-	-	-	
	1948	10	2	2	100	
	1950	12	1	0	0	
Ruddy	1947	5	2	1	50	
	1948	1	-	-	-	
	1950	6	-	-	-	
Canvasback	1947	4	-	-	-	
	1948	0	-	-	-	
	1950	2	0	0	0	
Redhead	1947	2	-	-	-	
	1948	5	1	0	0	
	1950	9	-	-	-	

Continued

TABLE II (continued)

REPRODUCTIVE SUCCESS

BASED ON NESTS

Species		Number of Nesting Pairs	Number Nests Located	Number of Successful Nests	Per cent of Nests Successful	Per cent of Total Nests Successful
Green-winged Teal	1947	2	1	-	-	
	1948	2	2	1	50	
	1950	1	2	1	50	
Totals	1947	291	84	39	48 *	
	1948	295	120	42	38 *	37 *
	1950	264	51	9	17 *	

* Adjusted for nests whose histories were not completed. See Table IV.

TABLE III

NESTING COVER PREFERENCES

Species	Number of Nests	Cover Types					
		Buckbrush[1]	Grass[2] and Buckbrush	Grass	Weeds	Stubble	Other
Blue-winged Teal	37	-	7 (18.9)[3]	29 (78.4)	1 (2.7)	-	
Shoveller	28	-	15 (53.6)	13 (46.4)	-	-	
Gadwall	25	23 (92.0)	-	1 (4.0)	1 (4.0)	-	
Pintail	59	32 (54.4)	12 (20.3)	10 (16.9)	2 (3.4)	3 (5.1)	
Baldpate	17	16 (94.1)	-	1 (5.9)	-	-	
Mallard	77	66 (85.7)	1 (1.3)	4 (5.2)	4 (5.2)	1 (1.3)	One on rock pile
Total	243	137	35	58	8	4	1

1 "Buckbrush" is a local name for thick patches of snowberry or mixtures of snowberry, silverberry and wild rose.

2 Grass and buckbrush refers to a situation where the two occurred together. A condition possible only where buckbrush is sparse.

3 Percent of total nests.

Figure 47. Thick snowberry preferred nesting cover for mallards.

May 12, 1948.

Figure 48. Mallard nest found in thick snowberry shown in Figure 47.

May 12, 1948.

Figure 49

Thick grass on pothole edge. Nesting cover for blue-winged teals and shovellers.

June, 1950.

of twenty-two studies of waterfowl nesting success including two dealing with Canada geese (Branta canadensis canadensis). The histories of 7,600 nests comprising thirteen species of ducks and Canada geese, gave an average success of 60 per cent. Kalmbach's studies in Canada (Kalmbach 1937) made at the southern edge of the aspen parkland in Saskatchewan, and on the southern fringe of the coniferous forest in Alberta, showed that in 1934 and 1935 of a total of 512 nests 49 per cent were successful. Furniss (1938) found that in the pothole area just south of Prince Albert, Saskatchewan, (which he describes as being on the dividing line between the typical Canadian and Transition Life Zones), 73.17 per cent of the duck nests under observation in 1935 were successful and 74.33 per cent in 1937. His data are not strictly comparable since many of his nests were over water where success was higher. Kalmbach's studies on the Lower Souris Refuge in South Dakota (Kalmbach 1938) which is somewhat similar ecologically to the study area show a nesting success of 54.4 per cent in 1936 and 69.3 per cent in 1937. The 1937 figure was influenced, however, by control efforts directed against the skunks. Kalmbach (1939) considered that a 60 per cent hatch was what might be called normal and that management should be able to increase this to 70 per cent.

It is evident from the above that the hatching success found in the study area, 1947--46 per cent, 1948--35 per cent and 1950--17 per cent, was below what was called normal by Kalmbach. The lowest success reported by Kalmbach in his summation was 36 per cent by Bennett in 1935 for six species of ducks nesting in Iowa. Sowls (1948) gives data on 206 nests under observation at Delta Marsh in Manitoba. Here, in spite of the inclusion of overwater nests success was still only 35 per cent. In California Earl, (1950), reports a success of slightly over 50 per cent for nesting mallards.

Causes of Nest Failure

The causes of nest failures are given in Table lV. Establishment of these causes is one of the most difficult problems of nesting studies. The observers were instructed not to charge the destruction of a nest against a predator unless they were sure of their identification. This accounts for the large number of destructions where the agent was not identified.

One of the most baffling aspects of this phase of the study was the identification of the animal shown in Table lV as "Unidentified Animal". The work of this predator was so characteristic that the nests which it destroyed could be easily identified.

In 1947 this animal was not an important nest predator, but in 1948 it was responsible for 37 per cent of the total nests destroyed and for 50 per cent of the mallard nests alone. Mallards suffered heaviest because most of their nests were located in buckbrush where this predator was active. Typically a nest so destroyed was found in the following condition. The side was torn out and never more than two or three of the eggs eaten.

TABLE IV

CAUSES FOR NEST FAILURES

Species		Number of Nests Located	Number of Nest Failures	Destroyed: Crows	Destroyed: Stock	Destroyed: Unidentified Animal	Destroyed: Undetermined Agent	Deserted: Cause Unknown	Deserted: Activities of Investigator	Other	Fate Undetermined
Blue-winged Teal	1947	10	7	4			1	1	1	-	-
	1948	21	14	3	1	3		4	2	1 Female killed	
	1950	7	7	1			2	1	2	1 Run over by truck	
Sheveller	1947	14	7	2	-	-	3	1	1		
	1948	8	2	-	-	-	1	1	-		1
	1950	6	4	1	-	-	3	-	-		
Gadwall	1947	10	6	-	-	1	2	3	-		
	1948	11	5	-	-	3	1	-	1		4
	1950	4	4	-	-	1	2	-	1		
Pintail	1947	20	10	2	1	1	4	-	2		1
	1948	26	13	1	1	2	4	1	1	3 Females killed	
	1950	13	10	3	-	-	5	-	-	2 Nests by coyote	
Baldpate	1947	9	3	1	1	-	1	-	-		
	1948	6	5	-	-	3	-	-	-	1 Killed by tractor	-
	1950	2	0	-	-	-	-	-	-	1 Killed by cat	
Mallard	1947	18	8	2	-	-	1	2	3		1
	1948	43	30	-	1	15	7	3	3	1 Killed by discing	2
	1950	16	15	4	-	2	5	1	2	1 Female killed	

TABLE IV (continued)

CAUSES FOR NEST FAILURES

Species		Number of Nests Located	Number of Nest Failures	Destroyed				Deserted		Other	Fate Undetermined
				Crows	Stock	Unidentified Animal	Undetermined Agent	Cause Unknown	Activities of Investigator		
Lesser Scaup	1947	0	-	-	-	-	-	-	-		
	1948	2	0	-	-	-	-	-	-		-
	1950	1	1	-	-	-	-	-	1		
Ruddy	1947	2	1	-	1	-	-	-	-		
Redhead	1948	1	-	-	-	-	-	-	-		1
Green-winged Teal	1947	1	1	-	-	-	1	-	-		
	1948	2	1	-	-	-	-	-	-	1 Killed by cat	
	1950	2	1	1	-	-	-	-	-		
Totals	1947	84	43	11	3	2	13	7	7	-	2
	1948	120	70	4	3	26	13	9	7	8	8
	1950	51	42	10	-	3	17	2	6	4	-

The remainder were usually found within a yard of the nest and partially buried. Shallow digging was always found around the nest site. Because consistently so few eggs were eaten, the larger nest predators, skunks, coyotes and possibly badgers and porcupines, were eliminated and it was finally decided that the agent responsible must be the Franklin ground squirrel. The Richardson ground squirrel was not found back in the pasture where the loss was taking place. Sooter (1946) found that coyotes on two occasions buried uneaten eggs near destroyed nests, but in every other instance all eggs were consumed. The eggs were buried in a dog-like manner while the animal responsible in the study area disturbed only a relatively small area. The fact that so few eggs were eaten at each nest further eliminated the coyote, which Sooter showed to be capable of consuming a clutch of eggs without difficulty when hungry. The disturbing factor is, however, that only one Franklin ground squirrel was seen in three years of field work. Since the nests destroyed were all in buckbrush, the heavy growth afforded excellent concealment, and the noisy passage of an observer through it may have given ample warning of his approach.

Sowls (1948) discusses the status of this rodent as a predator on waterfowl nests and gives data on the life history. He states that Franklin ground squirrels spend 90 per cent of their lives in the burrow. Strong winds are particularly annoying to them causing them to remain underground during days that are otherwise favorable. The study area is plagued by wind, particularly during the spring months. As a result ground squirrels may have been active only early in the morning before the wind began to blow, and before the investigator was in the field.

Unsolicited corroborating evidence was volunteered by a local rancher who stated, during a general conversation about ducks, that the "grey ground squirrels" destroy a large number of nests in some years. Toward the end of the 1948 season a dummy nest was built in the buckbrush and surrounded by steel traps to catch the agent for positive identification. The attempt was not successful, though if it had been pursued with sufficient vigor it should have provided the answer.

Crows were important destroyers of duck nests in 1947 and 1950 but not in 1948.

Desertion was responsible for 32 per cent of nest failures in 1947, 23 per cent in 1948 and 19 per cent in 1950. Although in 1947 and 1948 only about one half of the desertions were charged to the investigator directly, it is probable that he was responsible for at least some of those listed as unknown. It was difficult to determine exactly why a duck deserted her nest unless it occured right after she had been trapped and marked. In some instances where the female was flushed from the nest and the eggs covered by the investigator it was possible to state definitely that she had not returned to the nest. It is surprising that more females did not desert after being trapped and marked. Waiting until the nest was almost ready to hatch before attempting to catch the female was doubtlessly important in reducing the number of desertions.

Many investigators studying nests of both waterfowl and upland game species have raised the question of whether results so obtained are a true index of nesting success. Certainly once a nest has been found and examined it is no longer a "natural" nest. One would suppose that this interference would increase the likelihood of subsequent destruction. Kalmbach (1937) quotes Stoddard, (whose work with bob-white quail is regarded as a model nesting study), as coming to the conclusion that in thickly settled country, where there are a profusion of trails and tracks made by human beings and domestic animals, that predators have little to gain by following them with the hope of finding food. He observed also (Stoddard) that success was even higher in the group of nests visited repeatedly, than in those whose histories had been terminated when discovered. It should be noted however, that destroyed nests are usually easier to find than those which have hatched successfully. Stoddard admitted that in unsettled country human tracks might be such a novelty that trailing by predators would lead to increased destruction.

In this connection it is interesting to note that Sutton on one occasion observed a coyote following his trail and saw him discover two nests as a result. From the few nests that were definitely assumed destroyed by coyotes this may not have been of frequent occurrence, though the large number of nests destroyed for which no agent was definitely identified may have contained nests destroyed by this animal.

It seemed that discovery of a nest in buckbrush in 1948 did predispose it to predation. In many instances destruction took place within a very short time, often as short as twenty four hours. Since most of the nests so located were assumed to be destroyed by ground squirrels there was apparently some connection between disturbance of the nest and its subsequent destruction by this predator.

The writer believes that due to the nature of the study, which required much disturbance of the nesting cover in order to trap the female, and to the relative inexperience of the investigators, particularly in 1950, that the nests under observation were conditioned, and that the per- cent success was less than that which would have obtained under natural conditions.

Relative Nesting Success

Nesting success by species is also given in Table 11. Relative success among the six most abundant species was found to vary greatly from year to year. Thus the mallard, second in the scale of success in 1947, was in fifth position in 1948, and the baldpate dropped from first position in 1947 to last in 1948. These changes were due to heavy predation by Franklin ground squirrels as previously described. Mallards, baldpates and gadwalls through their preference for heavy buckbrush nesting cover were most affected. Shovellers and blue-winged teals, almost exclusively grass nesters, were not affected and were more successful than in the previous year. Pintails, although losing a number of nests located in buckbrush, maintained a nesting success almost equal to that of 1947 because of their acceptance of other cover. General disaster overtook the whole population in the early part of the 1950 nesting season. As previously mentioned this abnormal early failure was characteristic of that year all across the prairies.

Renesting

Sowls (1949) has discussed renesting in surface feeding ducks after destruction of the nest and reports thirteen of sixty six hens under observation renested. He further suggests that the true number was probably greater. Four renesting attempts were recorded during this study. In 1947, out of ten marked females whose nests were destroyed, two, a mallard and a pintail, were found renesting, and in 1948 two renesting attempts out of eighteen marked females were located. Considering that the study area was surrounded by similar habitat to which there may have been considerably leakage and that no special effort was made to locate renests, the discovery of two of these renests in 1947 supports Sowls data and suggests that many females may try again when the first or even the second nest is lost.

Details of these renesting attempts are of interest. On July first 1947 a marked mallard was found renesting approximately three quarters of a mile from the first nest. The first nest of seven eggs had been destroyed between June 7th and 10th at which time incubation was almost complete. Allowing one day for each of the ten eggs found in the new nest indicates that the first egg of the second clutch was laid about June 22nd or between twelve and fifteen days after destruction of the first nest. This record confirms Sowls' observation that second nests do not necessarily contain fewer eggs.

While the data on this mallard demonstrates that the reproductive cycle can be turned back even when nesting has proceeded to the point where incubation is almost complete, the record of a renesting pintail in 1948 is even more remarkable. This nest was destroyed on May 27th in the morning of which the eggs had been "<u>well pipped</u>". The female was discovered two hundred yards away from the former nest on June 18th with a new set of eight eggs. Assuming destruction to have occurred on May 27th this hen was able to begin laying on or before June 10th, somewhere within fourteen days after the first nest was destroyed. The identification of these two birds was confirmed by retrapping and checking the band numbers.

BROODS AND REPRODUCTIVE SUCCESS

General

A simpler method of determining the reproductive success of a waterfowl nesting population is to deal directly with broods. By so doing complicating factors of human intrusion, renesting etc. are avoided, and one deals with the end product directly; the number of broods produced.

This method cannot be used in all habitats, large marshes with much emergent vegetation for instance, but the study area is admirably suited for it. Here the water areas are small, and while some are overgrown with whitetop and carex and others support a dense periphery of round stem bulrush, these can be "beaten out" by one or two persons and most of the broods found. Due to the heavy, though low cover, it is seldom possible to count the number of ducklings in a brood and be sure that one has seen them all. In many instances the brood is never seen and the female by her characteristic "feigning" action is the only evidence that a brood is present. Such females were recorded as broods.

Due to the length of the brood season two counts were necessary, one at the end of June to record the early nesting pintails and mallards and another during the first week of August for the later nesting species, the blue-winged teals, shovellers, gadwalls, and renesters. Since surface feeding ducks are able to fly between six to eight weeks after hatching there was little danger of double counting for broods able to fly were not counted. The June and August counts were summed to obtain the total production.

The number of broods counted is always the minimum of those present. There is no doubt that some broods are missed even when an area is thoroughly worked. This likely occurs most frequently in the August counts because at this time many broods are almost full grown and the hen has left them. With no hen to betray their presence and with their acknowledged skill in hiding some of these are missed.

Table V summarizes the brood data collected during the three years of intensive study and includes that of 1951 when field work was confined to one population count and two brood counts.

These data require some explanation. No total brood counts were made in 1947 and 1948. Broods were recorded during the weekly census but the areas were not "worked out" in a search for broods. In arriving at the number of broods for these years the largest number seen on any weekly census was taken. This method was the only one available and the number of broods shown in the table is obviously too low for late and early broods would not appear. Also, in 1947, "feigning females" were not recorded as broods. This further reduced the figure for that year.

Table V also compares the estimated number of breeding pairs with the number of broods produced from them. For the reasons given above the 1947 and 1948 data are not of much significance. The 1950 data however are only subject to such inaccuracies as missed broods, movements of broods into and out of the study area and to mistakes in appraising the breeding

TABLE V

REPRODUCTIVE SUCCESS

BASED ON BROODS

Species	Year	Estimated Breeding Populations	Broods Produced	Per cent Success
Blue-winged Teal	1947	71	19	27
	1948	114	24	21
	1950	68	20	29
	1951	90	39	43
Shoveller	1947	59	8	14
	1948	47	8	19
	1950	41	17	41
	1951	52	19	37
Gadwall	1947	40	9	22
	1948	25	9	36
	1950	28	12	43
	1951	33	11	33
Pintail	1947	39	6	16
	1948	27	14	52
	1950	34	10	29
	1951	57	28	49
Baldpate	1947	33	7	21
	1948	24	10	42
	1950	24	19	79
	1951	24	12	50
Mallard	1947	27	6	22
	1948	40	5	12
	1950	39	13	33 1/3
	1951	34	10	29
Lesser Scaup	1947	10	0	0
	1948	10	2	20
	1950	12	4	25
	1951	4	7	[illegible]
Ruddy	1947	5	2	-
	1948	1	1	-
	1950	6	1	-
	1951	4	4	-

TABLE V (continued)

REPRODUCTIVE SUCCESS

BASED ON BROODS

Species		Estimated Breeding Populations	Broods Produced	Per cent Success
Canvasback	1947	4	1	-
	1948	0	0	-
	1950	2	0	-
	1951	8	1	-
Redhead	1947	2	0	-
	1948	5	0	-
	1950	9	2	-
	1951	10	2	-
Green-winged Teal	1947	2	0	-
	1948	2	1	-
	1950	1	2	-
	1951	5	2	-
Unidentified	1947	-	-	-
	1948	-	-	-
	1950	-	10 *	-
	1951	-	15 *	-
Totals	1947	292	58	20
	1948	295	74	26
	1950	264	110 (25.8 per sq.mi.)	42
	1951	321	150 (35.3 per sq.mi.)	47

* Broods listed as unidentified were massed on an artificial impoundment without attendant hens and separation into broods was impossible. These rafts were composed mostly of blue-winged teals, shovellers, gadwalls, and scaups. The total number was divided by six (the long term average brood) and recorded as broods.

population. Missed broods have been discussed. Evidence will be presented later to show that there was considerable movement of broods from one water area to another. Since the habitat outside the area was essentially similar, there is no reason to suppose that there was any great unidirectional movement into or out of the study area. The 1951 data suffer from one additional source of error. The population estimate was based upon only one count, even though the count was taken when at least a part of the breeding pintail and mallard population were in evidence and after the later migrating species should have passed on.

With these reservations in mind we can proceed to a discussion of the reproductive success of the population as indicated by the number of broods produced.

Comparison of Nesting and Reproductive Success

Due to the severe limitations placed upon them in 1947 and 1948 data will not be discussed. Those for 1950 however show that the population was in the end more successful than what the nesting data indicated. This must have been because the nests under observation were either not representative, i.e. they were conditioned by the observer, or to renesting on a large scale. Probably both factors were involved.

Comparison of Tables 11 and V shows that blue-winged teals were unsuccessful in all nests under observation in 1950 but that brood counts gave a 29 per cent reproductive success for the population. Shovellers had a nesting success of 33 1/3 per cent (though based on only six nests), and a brood success of 41 per cent. Too few gadwall nests were found in 1950 to be significant but this species had a brood success of 43 per cent. The pintails did not improve their position much, nesting success being 23 per cent and brood success only 29 per cent. Mallards, however showed an increase from a nesting success of only 6 per cent to a brood success of 33 1/3 per cent. Nesting data for baldpates were too few to be of significance but the brood success of 79 per cent indicates a very successful season.

Relative Reproductive Success

Relative reproductive success by species as presented in Table V is conditioned by the relative ease with which broods are seen. There is some indication that blue-winged teal broods are more easily flushed and counted than those of pintails and mallards. Agreement among fieldmen on this point however is not complete. Accepting this possible error we can see that according to Table V baldpates were the most successful species in 1950 followed by the gadwalls, shovellers, mallards, bluw-winged teals and pintails. Blue-winged teals and pintails, were equally successful.

There are no nesting data for 1951 but Table V gives the per cent success on the basis of brood counts. Baldpates were again the most succéssful followed by pintails, blue-winged teals, shovellers, gadwalls and mallards. It is apparent that relative success varied from year to year. Thus the pintails had a very poor year in 1950 but were quite successful in 1951. Similarily mallards were, in the end, quite successful in 1950, but were least successful of all species in 1951. The few pairs of nesting lesser scaups were only 25 per cent successful in 1950. The discrepancy in the 1951 data, (more broods were found than the estimated number of nesting pairs), probably stems from the inadequacy of the one count of nesting pairs made that year.

Overall Reproductive Success and Comparative Data

The overall success of the nesting population is given at the bottom of Table V. The data for 1947 and 1948 are invalid for reasons previously discussed, those for 1950 and 1951 have meaning. Since the population estimate is based on ample data the 1950 figure, (42 per cent), should accurately represent the per cent success for that year. The 1951 success, (47 per cent), may be a little low due to only one nesting pair count being taken, although comparison with populations of previous years does not show any species to be present in sufficient numbers to suggest a migration wave. Some broods may have been missed because the August count was delayed until the 15th of the month. Blue-winged teal broods hatched immediately after the June count could have been on the wing by the time of the August count.

Evans (1949) shows the reproductive success, on a one and a half square mile study area in the Minnedosa potholes in Manitoba, which was studied intensively, to have been 56 per cent. The physical and ecological differences between the two areas were pointed out in the discussion on nesting populations.

Production per square mile in 1950 was 2 5.8 broods and 35.3 in 1951 (Table V). Colls (1950), gives the average brood production for Saskatchewan in that year as 0.9 broods per square mile, and Smith (1950) reports 0.39 broods per square mile for the brown soil zone of Alberta, (the Short Grass Prairie), and 1.17 broods per square mile for the dark brown soils of the Mixed Prairie. It is obvious that the study area is preferred habitat and that production was much above the provincial average. It is less, however, than that reported by Evans in 1949 for his study area in the Minnedosa potholes where 49.8 broods per square mile were produced.

Hawkins (personal letter), states that " Corrected mallard age ratios based on extensive bag checks in Illinois from 1939 to 1951, show that an average of 2.4 flying young were produced per adult female. Juveniles made up about 46 per cent of the fall population, 1939--1950." If we assume the average mallard brood on the study area contained six ducklings, (the long term mid July average), then 2.0 ducklings were produced for each mallard female in 1950 and 1.78 in 1951. This is less than the long term average given by Hawkins.

Since several species are involved an overall comparison of the success of the breeding population with Hawkins' data for mallards is probably invalid but is nevertheless interesting. Based on an average brood size of six the overall reproductive success was 2.45 ducklings per female in 1950 and 2.8 in 1951. To be comparable the assumption is of course made that all six ducklings reached the flying stage. The fall flight, had the population remained as a unit, which of course it did not, would have been 56 per cent juvenile in 1950 and 58 per cent in 1951. In spite of heavy losses to nests and to other factors, the original population therefore more than reproduced itself.

Banding records show that ducks are physiologically relatively long lived. The life span of one individual may extend through several breeding seasons. This being the case the reproductive success found in this study should maintain the population at a high level. Unfortunately ecological longevity, defined by Bodenheimer (1938), as "...the empirical average longevity of the individuals of a population under given conditions." and quoted by Allee, Emerson et al, (1949), is much less. Whether waterfowl even with their great reproductive potential, can maintain themselves before the increasing ecological pressures created by man is an open question.

Brood Movements

Records of marked broods show them to be very active, moving frequently from pond to pond. Table Vl gives data on the number of marked females with broods located, and the distance travelled between sightings.

Except for gadwall 64, which in 1947 moved a newly hatched brood one half mile in twenty-four hours, there is nothing particularly significant about these movements other than the fact that they occur. The observations are too far apart to give any information on the speed of travel etc. Broods, except for those newly hatched, were never seen on land in transit between ponds. It is believed that such movements must have taken place in the late evening or very early morning when the

TABLE VI

MOVEMENT OF MARKED BROODS

Female	Date Hatched	Date Brood Located	Distance Travelled	Date Re-located	Distance Travelled	Date Re-located	Dist. Trav'd.
		1947					
# 24 Baldpate	June 28-July 2	July 25	$1\frac{1}{2}$ miles	(out of area)			
# 36 Shoveller	July 7	July 16	200 yards	July 23	250 yds.		
# 49 Mallard	June 28-July 4	July 10	500 yards				
# 50 Shoveller	June 30	July 10	400 yards	July 12	$\frac{3}{4}$ mi.	July 17	$\frac{1}{2}$ mi.
# 61 Baldpate	July 6	July 16	$\frac{1}{2}$ mile	July 25	$\frac{1}{2}$ mi.		
# 62 Mallard	July 7-July 12	Aug. 1	$\frac{1}{2}$ mile				
# 64 Gadwall	July 5	July 11	750 yards	July 21	35 yds.		
# 67 Gadwall	July 6	July 7	$\frac{1}{2}$ mile				
# 71 Pintail	July 10	July 30	250 yards	Aug. 1	100 yds.		
# 73 Mallard	July 23	July 25	100 yards				
# 79 Shoveller	July 10	July 25	250 yards				
		1948					
# 15 Pintail	May 31	June 28	$\frac{1}{2}$ mile				
# 19 Mallard	May 29	June 10	500 yards	June 18	Same location		
# 22 Pintail	May 23	June 25	$\frac{1}{2}$ mile				
# 28 Mallard	June 2	June 18	$\frac{1}{2}$ mile				
# 31 Pintail	May 29	June 4	1 mile	June 25	600 yds.		
# 34 Pintail	May 30	June 22	$\frac{3}{4}$ mile				
# 45 Pintail	June 2	June 17	$\frac{3}{4}$ mile	June 21	700 yds.		
# 84 Shoveller	?	July 19	$1\frac{3}{4}$ mile				
# 95 Green-winged Teal	?	July 19	$\frac{1}{4}$ mile				
#113 Lesser Scaup	July 9	July 9	9 yards				
#119 Lesser Scaup	July 19	Aug. 3	$\frac{3}{4}$ mile				
#120 Gadwall	July 26	July 26	100 yards				

Continued

TABLE VI (continued)

MOVEMENTS OF MARKED BROODS

Female	Date Hatched	Date Brood Located	Distance Travelled	Date Re-located	Distance Travelled	Date Re-located	Dist. Trav'd.
		1950					
# 4 Pintail	May 29-June 1	June 2	75 yards				
# 63 Shoveller	July 24	July 24	25 yards	July 29	½ mile	Aug. 11	20 yds.

observer was not in the field.

The reason for these movements is not apparent. Sometimes a brood abandoned a pond for one, which to human eyes at least, was no better and in many cases was actually inferior. Because a brood was found on a certain pond does not of course indicate a preference since it may have been occupying the pond only in transit.

Indirect evidence of brood movements was abundant. Studies of population records for each water body reveals the appearance of broods on many areas where no pairs of that species were recorded. Disappearances of broods from areas where they were previously recorded were also numerous.

Evans (1949), working in the Minnedosa potholes in Manitoba, marked ducklings while still in the shell, (using a hypodermic needle and aniline dyes of low toxicity), in order to follow brood movements subsequent to hatching. He also found broods to be quite mobile although the maximum movement recorded was only .84 miles, while in the study area it was one and three quarter miles with another record of one and a half miles (Table V1).

Evans believed size and escape cover to be important factors in determining the use of water areas by broods. Use of the water areas in the study area by broods will be further discussed under the section "Waterfowl Utilization of the Area".

WATERFOWL UTILIZATION OF THE AREA

General

Figure 50 gives the size distribution of the water areas by ecological type, i.e. potholes, sloughs and hay sloughs. Where the line is broken the ecological type did not occur in that particular size class. In Figures 51 and 52 the use of these areas by nesting pairs, on the basis of per cent occupancy, by size and ecological type, is illustrated.

"Occupancy" must be defined. The four weekly counts beginning with the May 20th census and ending June 12th for the years 1947, 1948 and 1950 were carefully analyzed. These dates were chosen because the 1947 data were available only for that period and the nesting population was close to a maximum during that time. The number of times each pothole, slough and hay slough of each size class was occupied by ducks on the four consecutive census dates for each of the three years was computed. A water body found occupied more than once, during this period was considered as occupied from a seasonal standpoint. The presence of ducks on an area on only one occasion was assumed to be chance rather than true occupancy. Two observations were considered to be borderline but, the pond was listed as occupied. This increased the number of occupied one eighth and one quarter acre potholes considerably. The number of hay sloughs was also considerably increased but there was little affect on the sloughs except in 1950.

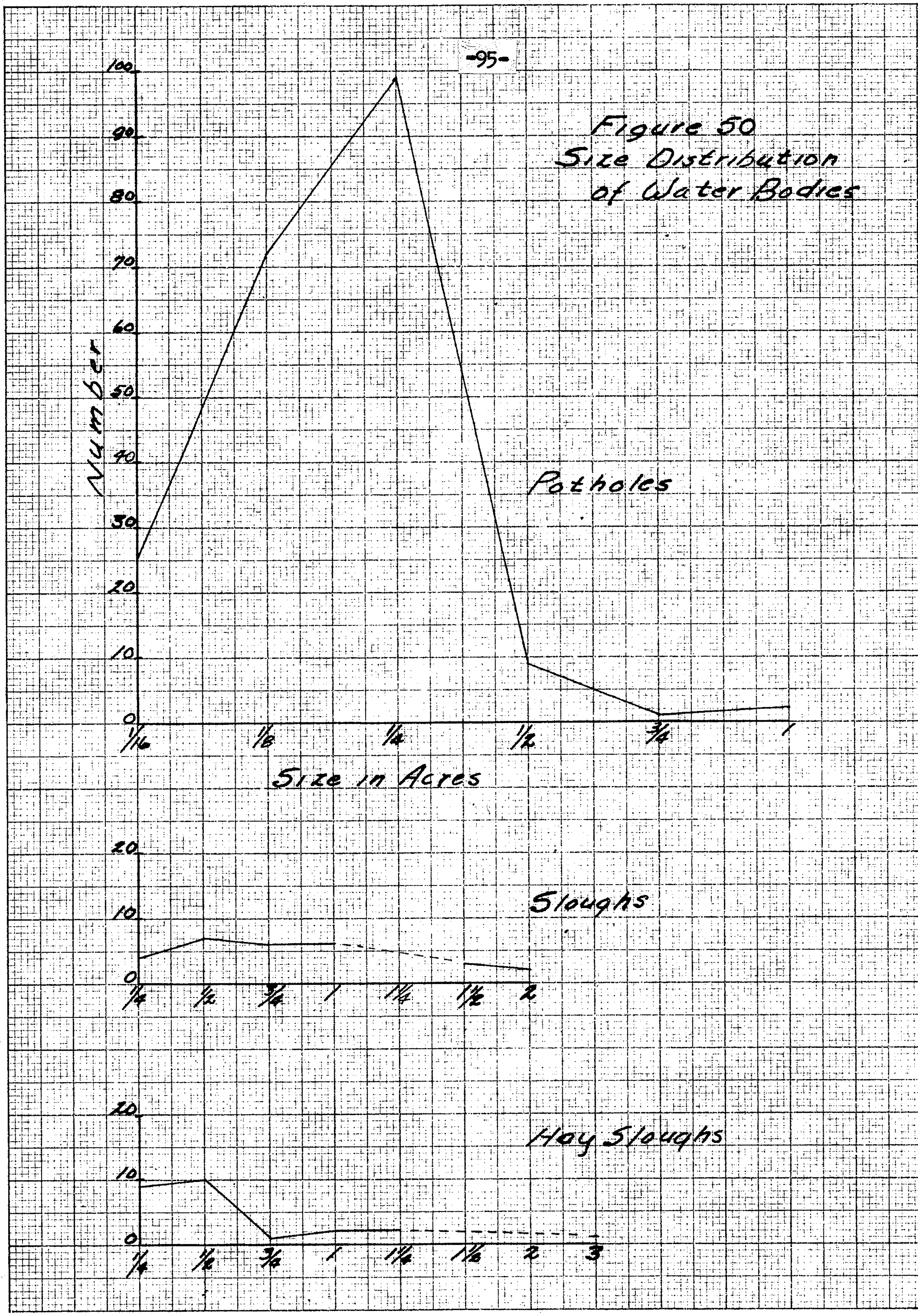


Figure 50
Size Distribution
of Water Bodies
Number
100
90
80
70
60
50
40
30
20
10
0
Potholes
1/16
1/8
1/4
1/2
3/4
1
Size in Acres
20
10
0
Sloughs
1/4
1/2
3/4
1
1 1/4
1 1/2
2
20
10
0
Hay Sloughs
1/4
1/2
3/4
1
1 1/4
1 1/2
2
3

<u>Utilization by Nesting Waterfowl on the Basis of Size</u>

Figures 51 and 52 show that size is important in determining whether a water area is occupied. Figure 51, illustrates the increase in occupancy of potholes with size. The increase in occupancy between one eighth and one quarter acre potholes is particularly significant since these existed on the area is somewhat similar numbers, 72 for the former and 99 for the latter. Since there was only one three quarter acre and two one acre potholes their complete occupation is not significant.

Evidence corroborating the importance of size as a determinant of occupancy is found, if we consider potholes with only two occupancies as unoccupied from a seasonal standpoint. Reduction in per cent occupancy is very great in sixteenth, eighth and quarter acre potholes indicating that the status of many of these areas is doubtful. There is little difference in one half acre potholes, the occupancy of which is firmly established by three and mostly four observed occupancies. There is no change in the status of the three quarter and one acre areas.

Whether size itself is limiting, or some other factor which varies with it, must be considered. To produce conclusive evidence on this point would require a thorough investigation of the physical and biotic factors of each water area. Such an investigation was beyond the scope of this work, but offers an attractive field for further study.

That size itself may be the determining factor in occupancy is suggested by Figure 52 which shows the per-cent occupancy of sloughs and hay sloughs

Figure 51
Occupancy of Potholes
by Territorial Pairs

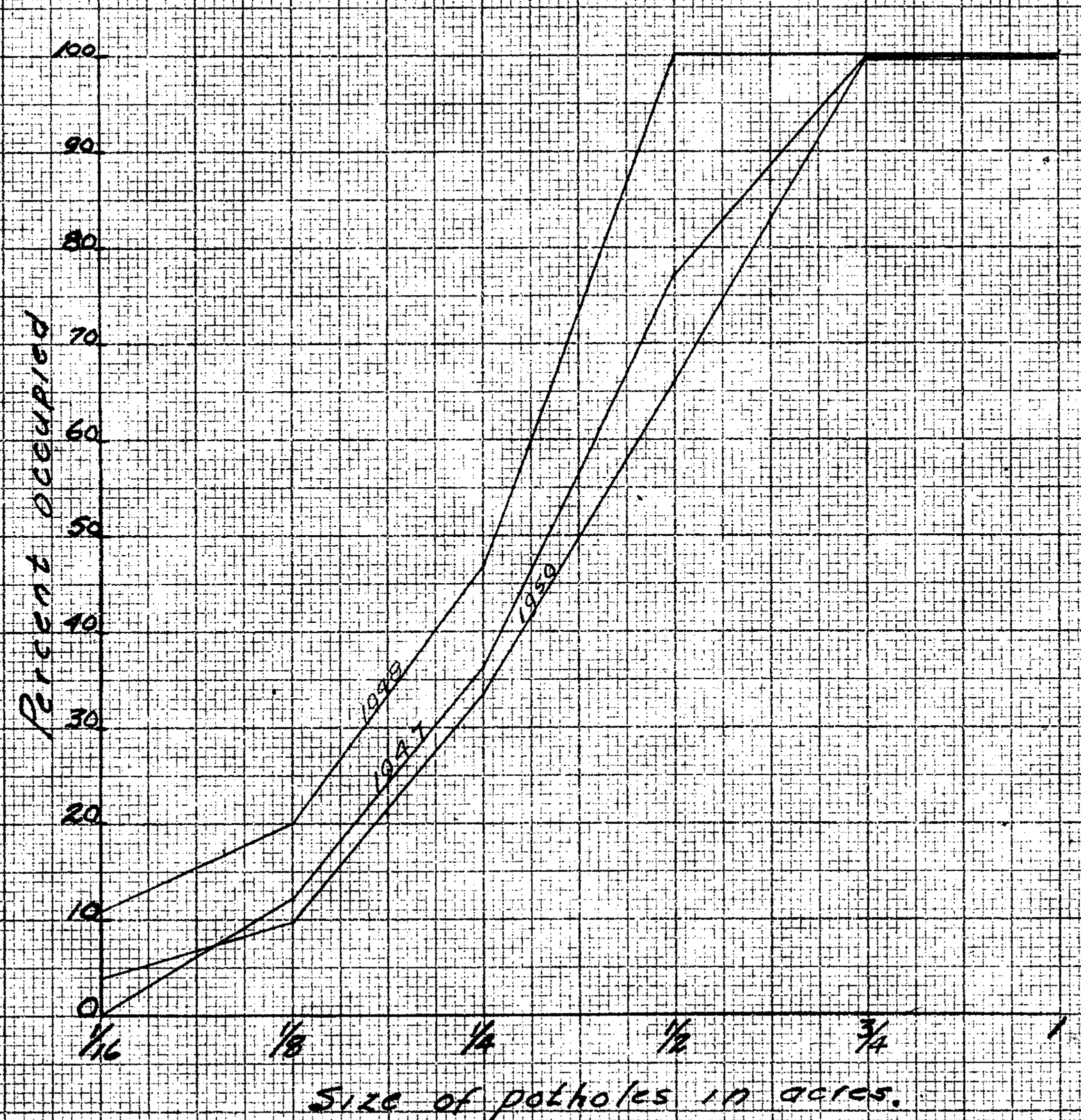
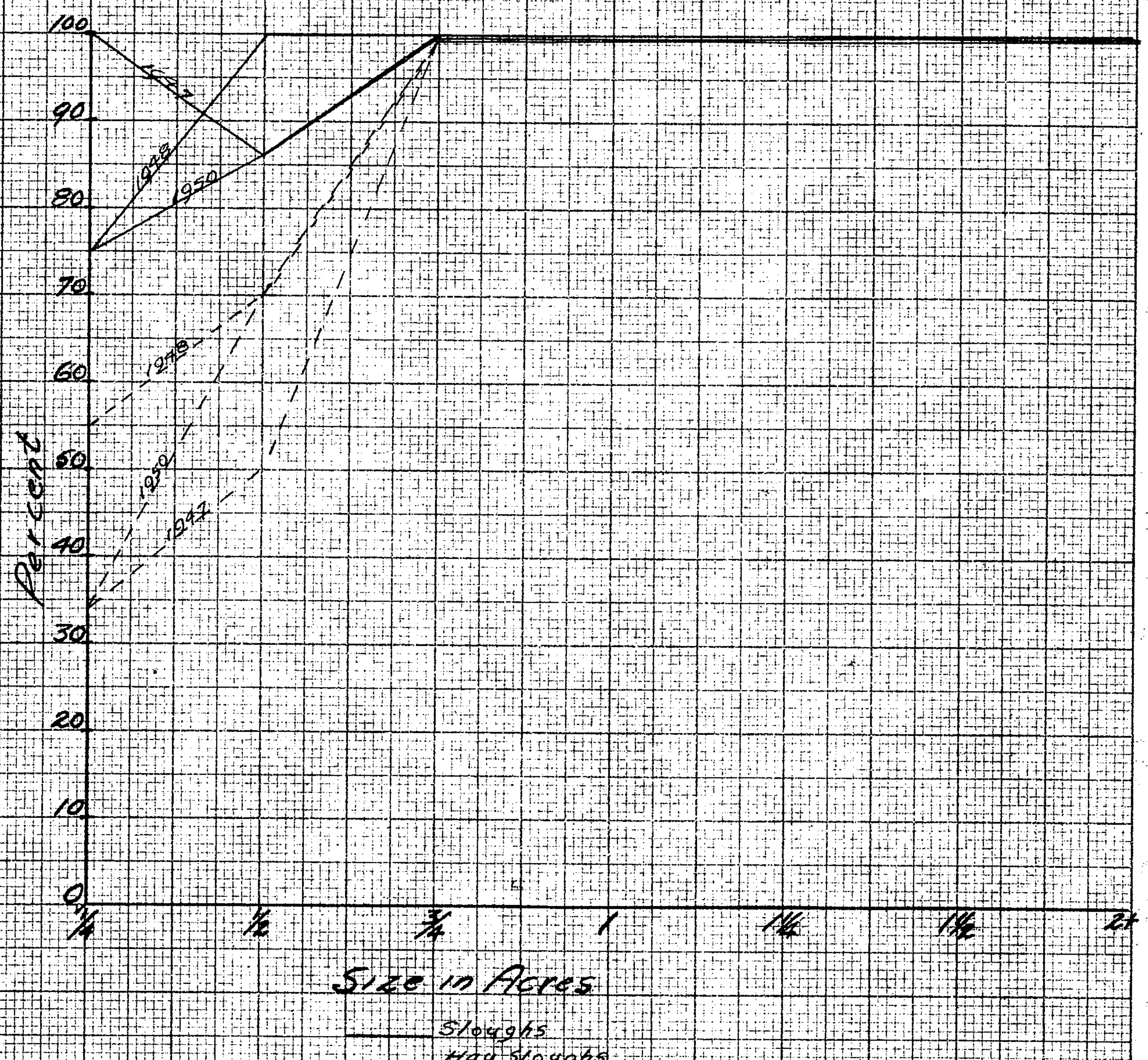


Figure 52
Occupancy of Sloughs
and
Hay Sloughs
by
Territorial Pairs



by size. It can be seen that here too the smaller size classes are least utilized. This is particularly true of hay sloughs, and would be emphasised if we considered that hay sloughs which contained ducks on only two of the four annual observations as unoccupied from a seasonal standpoint. Such an analysis would however make little difference in the per-cent occupancy of the sloughs. These areas apparently are so attractive to waterfowl that size is a secondary consideration and most occupancies are firmly established by three or four observations. Occupancy of the slough areas would have been close to 100 per cent had it not been necessary to include under this category two one half acre and one one quarter acre artificial impoundments, which lack some of the distinctive characteristics of typical sloughs and were not as attractive to nesting ducks. Since there were only four quarter acre sloughs the curve for 1948 and 1950 is displaced disproportionately by the one slough of that size unoccupied in those years.

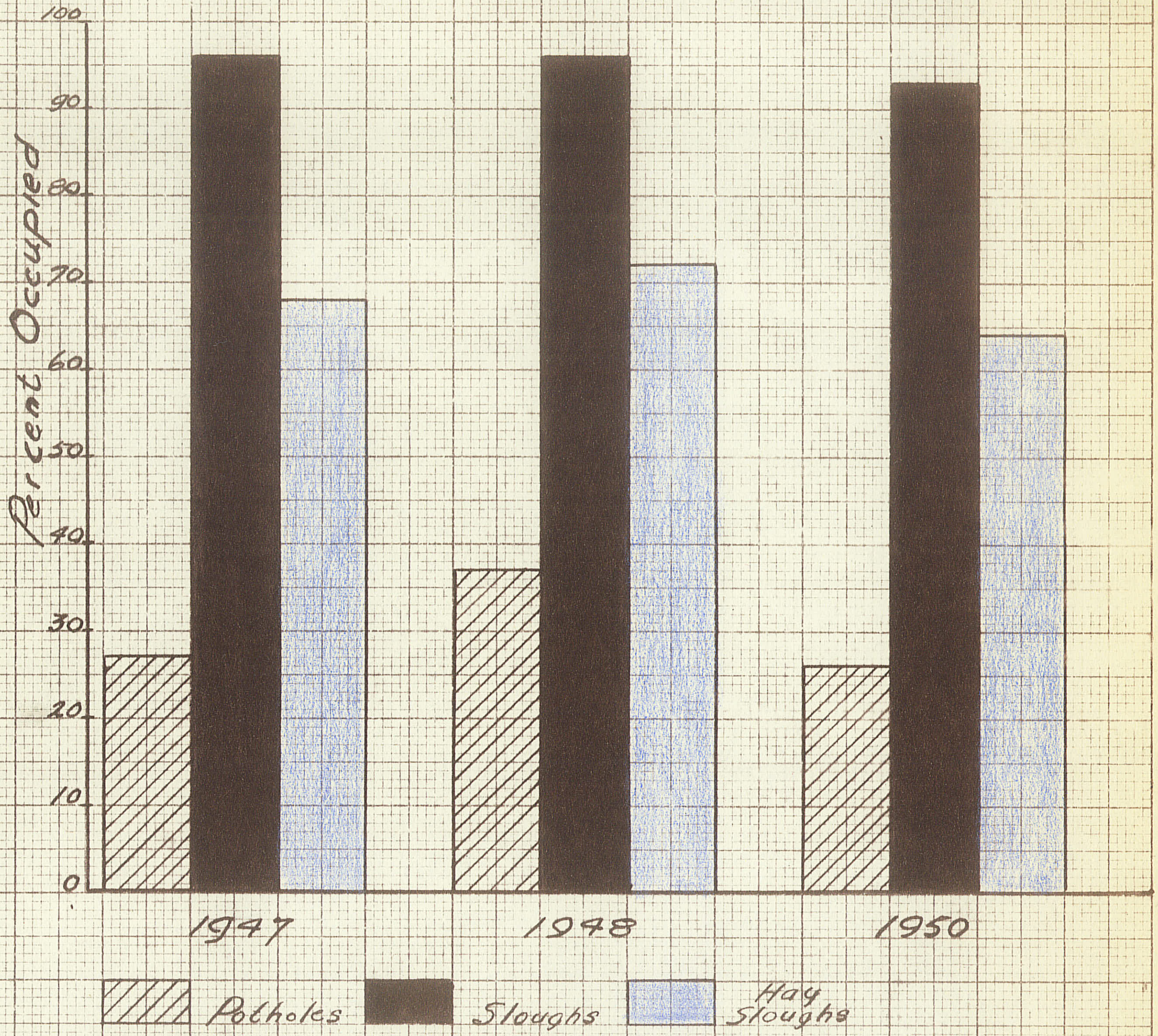
From Figures 51 and 52 it is readily apparent that sloughs are preferred habitat almost all being occupied in each of the three years. Hay sloughs were occupied to a lesser degree and potholes least of all. Actually the difference in occupancy is somewhat minimized in these graphs. Since there were only 28 sloughs and 25 hay sloughs contrasted with 208 potholes, the affect of one slough or hay slough being unoccupied has a disproportionate affect on the percentage occupancy.

Utilization by Nesting Waterfowl on the Basis of Ecological Type

Figure 53 gives a direct comparison of the relative use of potholes, sloughs and hay sloughs by nesting waterfowl. This comparison is also based on per-cent occupancy as previously described. The histogram shows a similar pattern of relative occupancy each year. Sloughs are clearly preferred habitat while a relatively small percentage of potholes are occupied. Hay sloughs are intermediate.

The 1950 nesting population was the smallest during the three years of intensive study. The 1947 and 1948 populations were almost the same--about thirty pairs in excess of 1950. One would expect that since sloughs appear to be preferred habitat that the fewer number of nesting pairs would be almost wholly reflected in the occupancy of potholes. Comparison of the 1948 and 1950 data in Figure 53 gives this impression but those of 1947 do not confirm it. It is apparent that a greater proportion of the nesting population used the slough areas in 1947 as compared with 1948, although in both years the occupancy rating was the same. The 1950 data shows a decrease in per cent occupancy of sloughs. There must have also been a decrease in the number of nesting ducks using them. The same thing is probably true of hay sloughs, and to a lesser extent, potholes. It is probable that even with a very low population that at least some of the potholes would be occupied. Figure 51 is interesting in this connection. Here it can be seen that the reduction in the occupancy of potholes in 1950 took place in all size classes below three quarters of an acre,

Figure 53
Percentage Utilization
of
Potholes Sloughs and Hay Sloughs
by
Territorial Pairs



not just in the lower size classes as one might expect. Surprisingly, sixteenth acre potholes showed the highest occupancy of any year, and one half acre areas the lowest.

Utilization by Broods

In discussing the use of the water area types by broods it is necessary to introduce a fourth category, artificial impoundments. In previous discussions these three areas were included with the sloughs. However their importance to broods is such that a special catagory must be created for them, since the relative importance of slough areas to broods would otherwise be distorted.

Two of these areas were created by small dams, Campbell's Dam and Andrew's Dam (See Figure 3). The third (D.U. Project No. 9) was developed by draining several water areas into one. Ecologically these impoundments are closer to potholes than sloughs and it was only on the basis of longevity that they were included with the latter.

Figure 54 contrasts the use of the four types of water areas by broods. The histograms are based on the 1950 June 25th, 26th, and 27th, and August 17th, 18th and 19th brood counts, and on counts made June 22nd to 26th inclusive, and August 15th, 16th and 17th in 1951, and show the per cent of the total number of broods on the area which were found on each habitat type. The data and resulting figure for the June 1950 census are not believed to be representative since the season was abnormally late and only seven broods were seen. Previous reference has been made to this late season.

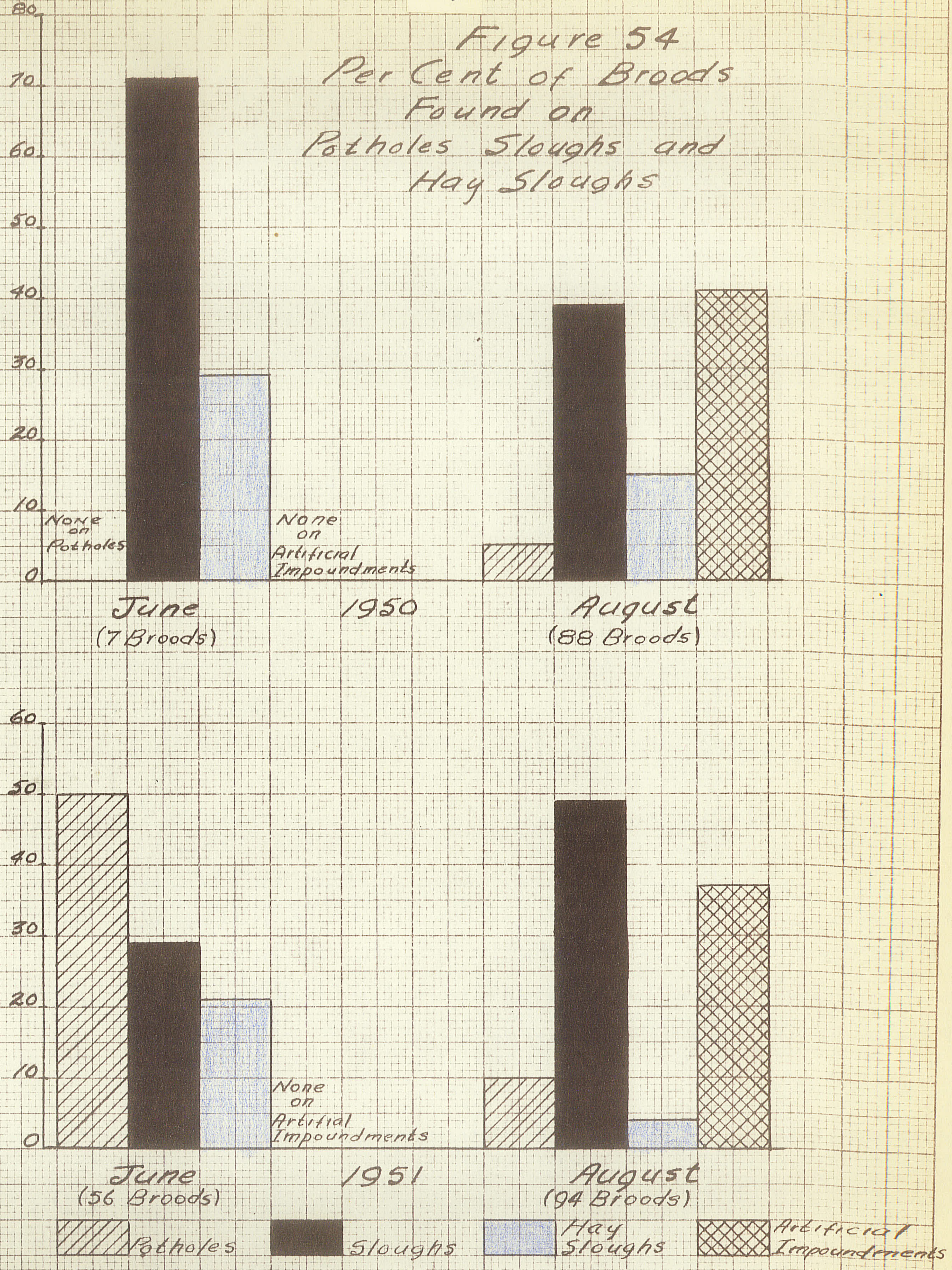


Figure 54
Per Cent of Broods
Found on
Potholes Sloughs and
Hay Sloughs
80
70
60
50
40
30
20
10
0
None on Potholes
None on Artificial Impoundments
June
(7 Broods)
1950
August
(88 Broods)
60
50
40
30
20
10
0
None on Artifial Impoundments
June
(56 Broods)
1951
August
(94 Broods)
Potholes
Sloughs
Hay Sloughs
Artificial Impoundments

Many potholes contain waterfowl broods in a normal year as the 1951 data indicates. This is because waterfowl nest all over the area and in June many newly hatched broods are found on what may be the nearest water to the nest. Such broods have not yet had time to exercise a preference. The preference of broods for slough type areas and artificial impoundments is clearly shown by the August census for both years. In 1950 although 111 potholes still contained water only 4 per cent of the broods were found on them and only 10 per cent of the broods were found on the 91 potholes still in existence in August 1951. The sloughs in August 1950 contained 39 per cent of the broods and the artificial impoundments 41 per cent or a total of 80 per cent. In August 1951, 49 per cent of the broods were on the sloughs and 37 per cent on the artificial impoundments, a total of 86 per cent. Furniss (1935) shows that the number of water areas occupied increases with size but makes no distinction between ecological types.

Reference to Figures 55, 56 and 57, which are the population records for these three artificial impoundments for 1950, illustrates that although they have little attraction for nesting ducks or June broods there is a large movement of broods to them in July and August, even though other water is abundant on the area.

We can only surmise why these impoundments are so attractive to broods. As previously mentioned they are ecologically closer to potholes, which have a very low occupancy, than to sloughs. The two dams were built in 1947 and

Figure 55
Population Record - 1950

Pond No.- 240 - Campbells Dam

Date	Mallard	Pin-tail	B.W. Teal	Shov.	Bald.	Gad-wall	G.W. Teal	L. Scaup	Canvas-back	Redhead	Ruddy
				Nesting Pair Census							
May 22			5 pr.				1 pr.	2 pr.		1 pr.	1 ♂
May 29	Nil										
June 5			5 ♂		1 ♂						
June 12	2 ♂		1 pr. 1 ♂		1 pr.						
June 19			3 pr. 1 ♂	1 pr.		2 ♂		2 pr.		1 pr.	1 pr. 4 ♂
				Brood Counts							
July 24		2			3						
July 31			3	1	1					1	
Aug. 2		1	5	1	2	1		3	(Also raft of 55 ducklings of various species.)		
Aug. 7			2	2	1	1		2		1	1
Aug. 14	Raft of 110 birds (mostly Shovellers and Blue-winged Teal, but Baldpates, Gadwall, Lesser Scaup, and Redheads present.)										
Aug. 19			1	1				1		1	(Raft of 85 ducklings of various species.)

Figure 56

Population Record - 1950

Pond No.- 246 - - - Andrews Dam

Date	Mallard	Pin-tail	B.W. Teal	Shov.	Bald.	Gad-wall	G.W. Teal	L. Scaup	Canvas-back	Redhead	Ruddy
Nesting Pair Census											
May 22	Nil										
May 29	Nil										
June 5			1♂	1♂							
June 12	Nil										
June 19	Nil										
Brood Counts											
July 26				1	1	1					
July 31		1	1	1		1					
Aug. 7			1		1						
Aug. 14		1	1	2		2		1	(Raft of various	74 birds species.)	of
Aug. 19			1	1		1		1		1	(Raft of 45 birds of various species.)

Figure 57
Population Record - 1950

Pond No.- 221 - D.U. Project # 9

Date	Mallard	Pin-tail	B.W. Teal	Shov.	Bald.	Gad-wall	G.W. Teal	L. Scaup	Canvas-back	Redhead	Ruddy
Nesting Pair Census											
May 22	Nil										
May 29	Nil										
June 5	1 ♂					1 pr.					
June 12											
June 19											
Brood Counts											
July 24		1		1	1						
Aug. 7					1			1			
Aug. 14			1	1	2	1		1			1
Aug. 19			1	2	1			1			1

and the drainage project in 1940. Campbell's Dam is now developing a narrow shoreline vegetation of whitetop grass, burreed, and cattail. Heavy grazing seems to have prevented a similar development on Andrew's Dam. The drainage project is almost a typical pothole except that the water is about six feet deep. A marginal growth of carex, spikerush and the occasional clump of bulrush is established, but is nowhere dense or wide enough to provide concealment for broods. The same is true of the shoreline vegetation at Campbell's Dam.

These three areas are all small. The two dams impound one half acre of water each and the drainage project one quarter acre. The major difference between them and ordinary potholes is in depth. The water is approximately six feet deep at the face of the dams and becomes progressively shallower upstream. The drainage project is bowl shaped with a maximum depth of six feet. These areas present poorer feeding conditions than ordinary potholes since most of the bottom is beyond the depth to which surface feeding ducks can reach. There are no extensive beds of aquatic plants which provide food at the surface. It appears that broods must move to these areas because of the greater depth of water even though feeding conditions are apparently better in neighboring sloughs and potholes. This movement to deepest water may be part of a behavior pattern developed through long time occupancy of a region where drought in many years forces such behavior. Deeper water may also have a survival value beyond that of drought. While the areas offer no concealment the ducks are masters in their own environment and coyotes and similar predators have little chance of catching them except on shore.

Occupancy of hay sloughs by broods is low in June and still lower in August, as Figure 54 shows. This appears to be due to two things, the complete dominance of whitetop grass which prevents the growth of true aquatic plants other than the duck weeds, and the dense growth, which makes it very difficult for ducklings, or even adult ducks, to force their way through. Hay sloughs seldom contain ducks (Figure 19) unless there is at least some open water.

The seasonal use of the study area by waterfowl appears then to follow this pattern. Pairs of ducks about to nest and seeking territories find their requirements best met by slough type areas but also find the larger hay sloughs attractive during the period of open water in the spring (Figure 16). Potholes are also used. The usuage increasing quite rapidly with size. Broods present on the area in June make considerable use of potholes and hay sloughs, probably due to the high percentage of newly hatched broods, which is mentioned above, have not as yet had time to exercise a preference. Also many hay sloughs at this time of the year are not so heavily overgrown as they will be later in the season and offer young broods abundant escape cover and animal food. Late July and early August is characterized by a distinct movement of broods from potholes and hay sloughs to sloughs and the open water of artificial impoundments.

<u>Annual Return of Nesting Females</u>

It has been popular belief for some time, that waterfowl return to the same area to nest year after year. Hochbaum (1944) gives some indirect evidence of this and later (1946) touches on the subject again. Sowles (1949) reports the return of a shoveller hen to his study area in 1948 which had been banded there the previous year. Unpublished data on ducks banded by Ducks Unlimited (Canada) shows many instances of female ducks retrapped in the same area on subsequent years.

This investigation indicates a substantial return of females to the same area to nest. Thirty-nine females were banded at the nest in 1947. Of these, three were reported killed during the hunting season leaving a maximum of thirty-six available to return the following year. Six of these females were retrapped in 1948 indicating a return of at least 17 per cent. No doubt the per cent return was considerably greater, since it is unlikely that losses to the original thirty-nine females were confined to the three birds reported by hunters. It is also unlikely that all the birds returning were trapped. Bellrose and Chase (1950) analyzed the data for a large number of mallards banded in Illinois and showed an average annual loss in female mallards of 46.68 per cent. If we accept this figure as also valid for the area under discussion and as applying to all species banded, only twenty-one females would still be alive to return. The return would thereby be increased to at least 29 per cent. It is interesting to note that a baldpate returning in 1948 nested within three yards of the 1947 site and a mallard within five yards.

One female pintail banded in 1948 was retrapped on the area in 1950. This low return is due to the fact that the females banded in 1947 and 1948 were probably reduced to very few numbers by three and two years mortality respectively. Also in 1949 the area was dry early in the season and few ducks nested. This may have broken the nesting tradition. The 1950 nesting population may have been composed almost entirely of first year nesters without established traditions. Large scale bandings of both nesting adults and young of the year would solve many of these interesting problems.

While the evidence is strong that we are here dealing with a population unit, which nest in the area each year, there are too few returns to give evidence of a common wintering ground. Table V11 gives the returns for the females banded during the investigations. It is interesting to note that three of the returns are from the Pacific Flyway. It was expected that the population would be Mississippi or Central Flyway birds.

TABLE VII

RETURNS FROM FEMALES BANDED

1947, 1948, 1950

Species	Number Banded	Returns	Date and Place
Pintail	25	1	California, Dec. 31/47
Mallard	26	1 1	Saskatchewan, Oct. 14/48 Oregon, Oct. 23/49
Baldpate	7	none reported	-
Gadwall	12	1	Manitoba, Oct. 10/47
Blue-winged Teal	15	none reported	-
Shoveller	21	1	California, 1947
Green-winged Teal	2	none reported	-
Lesser Scaup	2	none reported	-

DEVELOPMENT PLAN FOR THE AREA

General

Previous sections have shown this part of the Missouri Coteau to support a heavy nesting population in years when spring water is abundant. It has further been shown that reproductive success compares favorably with other areas. The knob and kettle areas of the Missouri Coteau are, then, extremely valuable to waterfowl. It is important that the present ecological conditions be maintained and if possible improved.

The Predation Factor

Most sportsmen's groups upon reviewing the section on "Nests and Nesting Success" would be quick to advocate predator control campaigns in spite of the wide spread belief of biologists that such programs are both ineffective and ill advised. Wiser minds will refer to the section on "Broods and Reproductive Success" which shows that by the end of the nesting season the population was in a thrifty condition, and the juvenile component what might be considered satisfactory for the species, under primitive conditions at least. The high reproductive potential of waterfowl resulting from early maturity, longevity, fertility, and ability to renest, dictates heavy mortality at some stage in the life cycle. In view of this, the low success of nests is not surprising; admitting, of course, that success was lower than would have occurred had the nests not been "conditioned" by the activities of the observer. To increase the production of ducks by predator control in this area means an adjustment of the whole complex animal community. An adjustment which man has seldom been able to make successfully on either ecological or financial grounds.

The Land Use Factor

Management plans often suggest changes in land use. This is not necessary here. The area remains largely in its primitive condition except that cattle have replaced bison and antelope. Such rugged terrain can be used only for grazing.

Ranching and the production of waterfowl are not antagonistic in this area. The numerous water bodies which provide habitat for waterfowl also disperse grazing, and bring about maximum range utilization. Abundance of water and dispersal of grazing prevents the over use of water areas, which results in trampled shorelines and destruction of emergent plants and adjacent upland cover. The intrusion of sage, as shown in Figure 5, indicates overgrazing. While this is probably true of dry hillsides, where almost any grazing is overgrazing, it has no affect upon waterfowl. Figure 49 shows the abundance of grassy nesting cover surrounding most water areas and in other figures the many extensive communities of snowberry or buckbrush, which are a conspicuous feature of the landscape, can be seen. Grazing could be considerably intensified without adversely affecting the area from a waterfowl standpoint.

The Water Factor

Unfortunately, although the knob and kettle areas of the Missouri Coteau are excellent range land and provide ideal duck nesting habitat, the essential component, water, is the least secure. Except for artificial impoundments there is seldom any carry over from the previous year and both cattle and ducks are dependent on the spring runoff for water.

To waterfowl returning in the spring the area can present one of three situations. The ponds can be filled to the point where the water will last all season; partially filled so that the whole area, after enticing the ducks to nest, will be dry by early summer, or they can be almost all dry and the greater number of migrants will pass on. The amount of precipitation will of course have both a direct and indirect affect on the longevity of the water areas. For the season to be ~~considered~~ successful from a duck production standpoint it was considered essential for sufficient water to last until August 15th.

Nothing of course can be done which will affect the spring levels of the ponds. If there is abundant water the duck crop is secure, if there is none the birds will nest elsewhere. It is the in between situation, where the water disappears in mid-summer with disasterous results to broods still unable to fly, which contains the possibility of improvement.

To ascertain how often this situation exists it was necessary to review the history of water levels in the study area. Since there are no written records, and the human memory is notoriously frail, the runoff data for the nearest stream, Moose Jaw Creek, were used and correlated with known spring conditions in the area from 1946 to 1950. The assumption was made that the co-relation found during this period could be used to establish what water conditions had been in the study area in the past. The known longevity of the water areas during the period was also

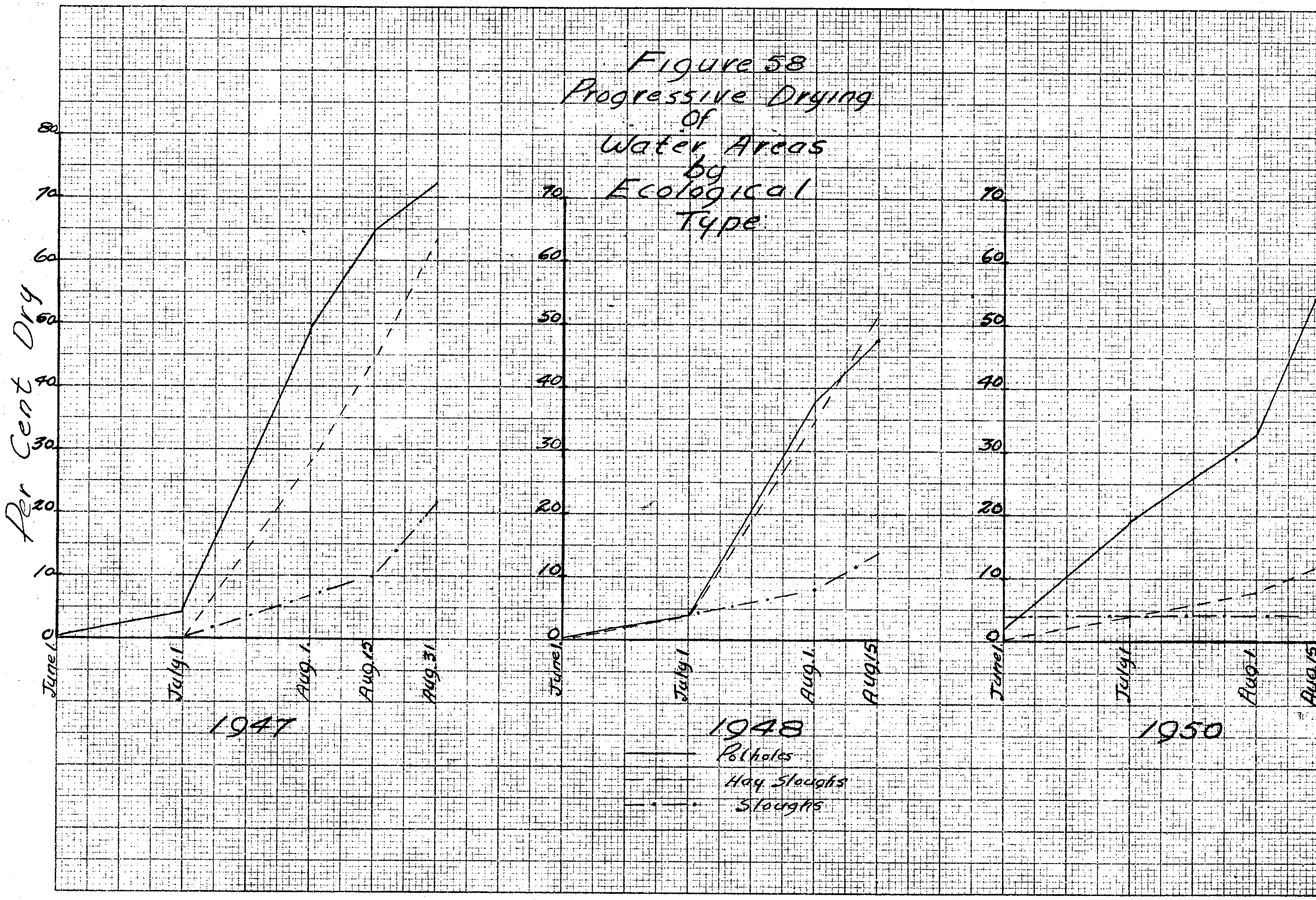
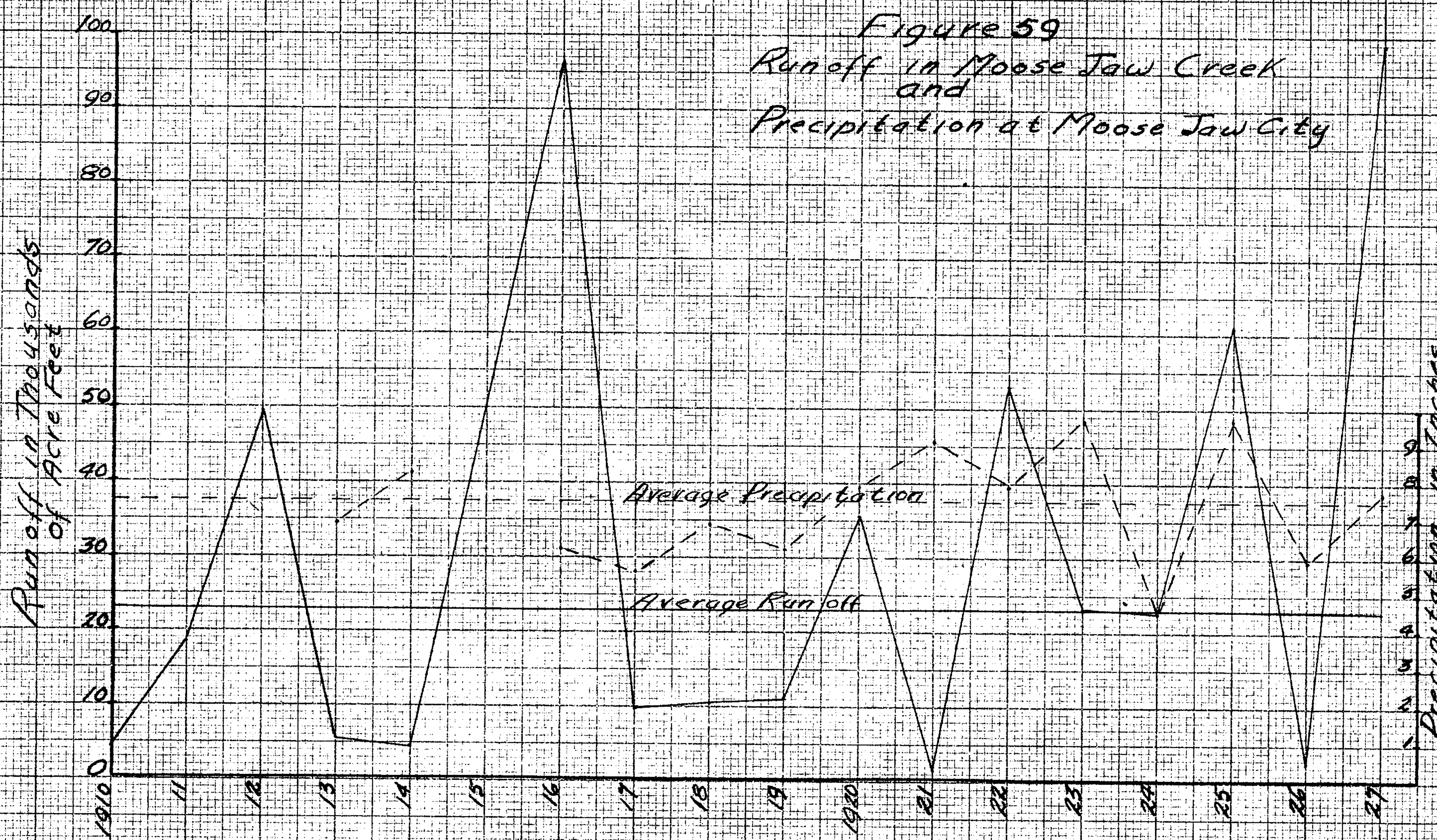


Figure 58
Progressive Drying
of
Water Areas
by
Ecological
Type

Figure 59
Runoff in Moose Jaw Creek
and
Precipitation at Moose Jaw City



Runoff in Moose Jaw Creek March to June Inclusive
Precipitation in Inches April to July Inclusive

(Continued)

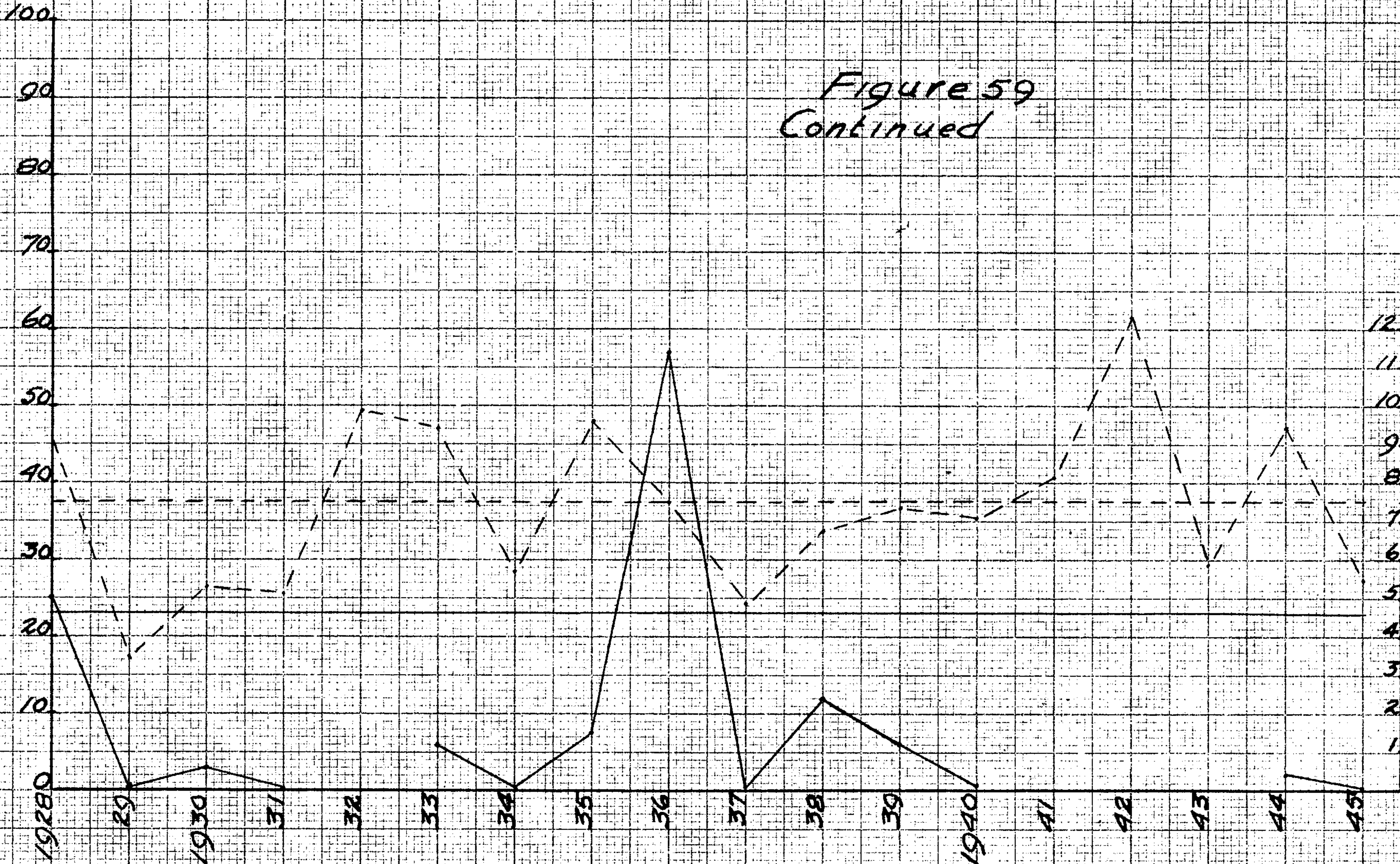


Figure 59
Continued

(Continued)

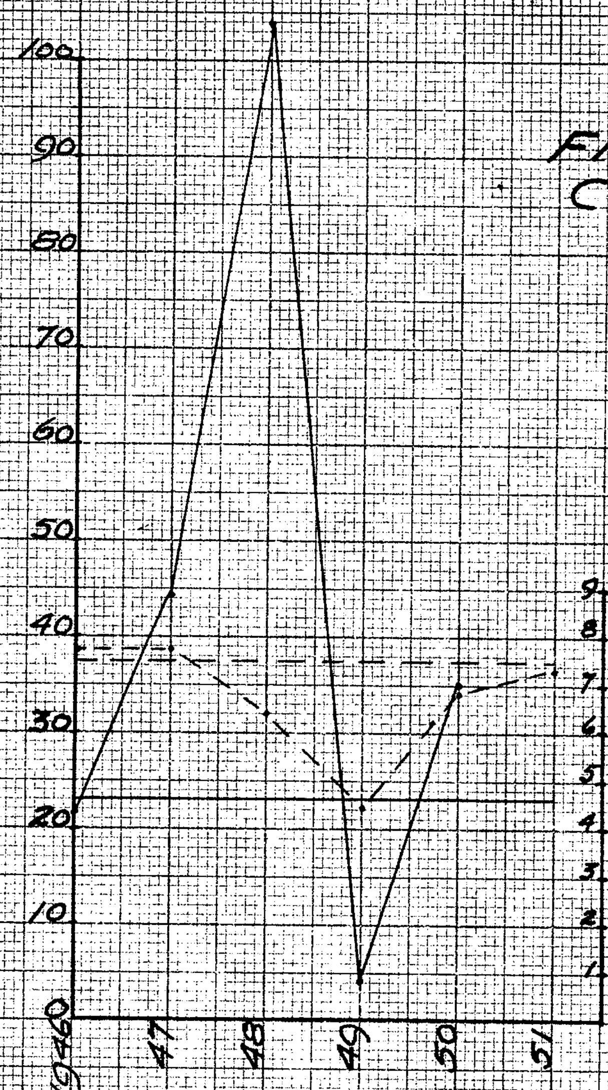


Figure 59
Concluded

correlated with the precipitation from April to July inclusive.

The runoff in Moose Jaw Creek in acre feet from March to June inclusive is shown in Figure 59. The long term average runoff is also shown.

Moose Jaw Creek skirts the eastern edge of the Coteau from its origin in Ibsen Lake near the town of Yellowgrass to the city of Moose Jaw. Tributaries from the southern part of the Coteau supply most of the water but the last large stream joins about twenty-five miles south of Moose Jaw. Consequently the runoff figures are more valid for the Coteau, forty miles south east of the study area, than for the study area itself. It is admitted that in some years there may be significant differences in snowfall and runoff conditions in two areas so situated. However, since frontal storms cover such broad areas in their passage, it is believed that significant differences would be the exception, and that the two areas would be generally similar.

The records extend back to 1910 and are complete except for 1932 and for 1941 to 1943 inclusive. In 1944 the location of the guaging station was moved about twenty five miles upstream. The data after this date are therefore not completely comparable to those prior to 1940. However no large tributaries join the creek between the two stations, and it is believed that the small difference due to local runoff would not significantly affect the co-relation.

The total precipitation from April to July inclusive and the long term average for the same months is also shown in Figure 59. The nearest meteorological station is at Moose Jaw about twenty miles to the east and the data for this station were used. Since the study area is about five hundred feet higher than the city of Moose Jaw, the true precipitation may be a little higher due to the upslope affect.

Two weeks were spent in the study area in early July 1946. At this time only a few ponds still held water and it was estimated that the area would be almost completely dry by August first. That spring the runoff in Moose Jaw Creek was about 22,000 acre feet, just slightly below the long time average. Precipitation to the end of June was 3.59 inches. In July 4.10 inches of rain fell bringing the total for the four month period to just slightly above the long term average. Except for artificial impoundments the area was reported to be dry on August first.

In 1947 runoff in Moose Jaw Creek was 44,000 acre feet and the precipitation from April to July inclusive 7.76 inches. This combination of runoff and precipitation produced the situation shown for 1947 in Figure 58. Sixty-five per cent of the potholes, 44 per cent of the hay sloughs, and 10 per cent of the sloughs were dry by August 15th, but there was abundant water in the area to carry the ducks through to the flying stage. Conditions were similar on August 15th, 1948, although more areas contained water, reflecting the record runoff of 109,000 acre feet that year. These areas remained in existence in spite of below normal precipitation during the period.

Hot dry weather continued through August and September in 1948. As a result by freeze-up the study area was almost dry. Runoff in Moose Jaw Creek in 1949 amounted to only 9,000 acre feet, and on May 4th only 76 (or 25 per cent), of the ponds contained water. It was estimated that many of these would last only two weeks. The area was reported almost completely dry except for artificial impoundments by July 1st. Although water conditions were very poor in the spring of 1949 a census carried out May 4th indicated that almost a normal population of mallards and pintails had established territories and were beginning to nest. It is unfortunate that the ultimate fate of these nesting attempts is unknown.

In 1950 the runoff in Moose Jaw Creek was 35,000 acre feet and the precipitation 6.94 inches. This combination produced the situation shown in Figure 58 when 55 per cent of the potholes, 12 per cent of the hay sloughs and 4 per cent of the sloughs were dry on August 15th. There was more water in the area on August first 1950 than in either 1947 or 1948, although in those years runoff was greater. Precipitation in 1947 also exceeded that of 1950, and in 1948 it was about the same. These discrepancies are probably due to the inadequacy of precipitation as a measure of weather conditions as they affect evaporation. Cloudy days without rain, average temperatures, and most important the amount of wind, would all tend to distort the relationship. Data on the runoff for 1951 are not available, but it is known to have been well above normal and comparable to to 1948. Water was still abundant in the area on August 15th.

It is obvious that the spring runoff is the factor which determines how much water the ponds will contain in the spring, and how many will still contain water by August first. Weather from April to the end of July has an important modifying influence, of which the amount of precipitation is at least a partial expression.

From the 1946 data it is apparent that a runoff in Moose Jaw Creek of 22,000 acre feet indicates a condition of water shortage in the study area, where, in spite of above normal precipitation, the whole area is dry by August first. In 1950 however, when the runoff in Moose Jaw Creek was 35,000 acre feet, there was sufficient water in the area to maintain good water conditions to August 15th even though precipitation was a little below normal. The critical point therefore lies somewhere between 22,000 and 35,000 acre feet of runoff, and is assumed to be, for purposes of analysis, 29,000 acre feet. It should be noted that this is above the long term average runoff.

An analysis of the annual spring runoff in Moose Jaw Creek, (Figure 59), since 1910, for the thirty-eight years for which data are available shows that only in twelve years, (including 1951), was runoff above what might be called the "safe level" of 29,000 acre feet. During each of these years the amount of precipitation, though sometimes slightly below normal, confirms the likelihood of a good "duck year". It is interesting to note that four of these "good duck years" have occurred since 1946. In fourteen years the runoff has been between 5,000 and 29,000 acre feet, indicating a hazardous condition for waterfowl similar to that of 1946 and 1949. In most of these years the small runoff has been followed by below normal precipitation. The area has been almost completely dry in the spring in eleven years, when runoff has been below the 1949 level of 4,000 acre feet, and would attract few nesting ducks. In some years the precipitation has been above normal following a spring of almost no runoff, but this would have little affect on the condition of the area.

Conclusion

From the above it can be appreciated that, although this section of the Missouri Coteau is highly desirable duck breeding habitat, in the long term view, productivity is severely curtailed in about two out of three years due to lack of water. Assuming that the past is a mirror of the future it seems safe to conclude that this condition will continue.

There is no way in which management can influence runoff of precipitation, but it seems that artificial impoundments of sufficient depth to withstand years of low runoff have a real value here. This investigation has shown quite conclusively that there is a definite movement of still flightless duck broods to sloughs and the deeper water of artificial impoundments in late July and August, even in years when other water is abundant.

Such "salvage areas" can be developed by several different means.

The construction of deep dugouts in the bottoms of the deepest sloughs should provide water for broods until they are able to fly. The usual type of dugout however, with steep sides and deep water, offers little in the way of food or feeding areas to shallow feeding ducks. The small area of water which can be produced by this means is also an undesirable feature.

Dams on shallow draws where at least six feet of water can be held at the dam face, and a minimum of one half acre of water impounded, seem to be the best solution. Such areas provide shallow water at the upstream end and for at least a narrow zone along the shores. They provide a situation where both aquatic and emergent plants can develop. Such areas would last through at least one season when there was no runoff, (both Campbell's and Andrew's dams contained water all through 1949 when the rest of the area was dry), and with a favorable interspersion of wet and dry years, might never be dry. They could not of course survive a drought such as occurred from 1929 to 1940 (Figure 59).

The draining of several water areas into one is also a sound method of creating suitable salvage areas. At least six feet of water should be provided. The pond shown in Figure 3 as D.U. No. 9 has never been dry since it was built in 1940 in spite of low runoff in 1944, 1945 and 1949. Such areas provide more shallow water than dugouts and also have the possibility of developing both marsh and aquatic vegetation.

In selecting the type of development to provide "salvage ponds" for a specific breeding area the first choice should be between dams or drainage projects. There is little to choose between the two from the standpoint of habitat so the choice becomes one of economics. Dugouts should be built only as a last resort.

The investigation has shown that duck broods are highly mobile, and the concentration of broods on sloughs and artificial impoundments indicates that they have the ability to locate and move to what appears to be preferred habitat. In view of this, it seems that one salvage area per quarter section, (four to the square mile), should be sufficient to salvage the ducklings in an area. If the areas developed are exceptionally small, more may be required.

This program is economically feasible because the cost of such small dams is small and maintenance low. Drainage projects have the additional advantage of requiring no maintenance. Thus although such areas may actually be required only two out of three years their construction is warranted.

Further development of this program on a large scale calls for reconnaisance of the entire Missouri Coteau to ascertain where tracts of habitat similar to the study area exist. Knob and kettle areas, and other lands which can only be used for grazing, are the only waterfowl habitats on the prairies which are safe from the advances of agriculture. The development of such areas for waterfowl production is completely in accord with present land use. It presents the opportunity for wise expenditure of funds to increase and perpetuate the continental waterfowl.

SUMMARY

(1) The ecology of nesting waterfowl on a four and one-quarter square mile area in the Missouri Coteau of Southern Saskatchewan was studied intensively in 1947, 1947 and 1950, and on a reduced scale in 1951.

(2) The study area contained 261 water areas. These were classified as potholes, sloughs or hay sloughs on the basis of the associated flora and secondarily on size and longevity.

(3) The nesting population was composed almost entirely of surface feeding species, (Anatinae). The population per square mile was 68 pairs in 1947, 69 in 1948, 62 in 1950 and 75 in 1951. These populations were greatly in excess of the provincial average and are only exceeded by Evans' data (1949) for the Minnedosa Potholes in Manitoba.

(4) Forty-eight percent of the nests under observation were successful in 1947, 38 percent in 1948 and 17 percent in 1950. Overall success for the three years was 37 percent. The success in 1948 compares favorably with the results of most workers in other areas, but in subsequent years, and overall, the success was relatively low. There was evidence of considerable renesting.

(5) Brood counts made in 1950 and 1951 showed that final reproductive success was greater than that indicated by nesting studies. Forty-two percent of the nesting pairs produced broods in 1950 and 47 percent in 1951. The production per square mile was 25.8 broods in 1950 and 35.3 in 1951. This is well above the provincial average but the percent success is somewhat less than that found in the Minnedosa

Potholes in Manitoba in 1949. Reproduction in 1950 was considered adequate to ensure a return of nesting ducks to the area in 1951 at least equal to the 1950 population. Reproduction in 1951 should have been sufficient to effect an increase in 1952.

(6) Slough type areas were found to be of greatest value to waterfowl during both territorial and brooding phases of the reproductive cycle. Hay sloughs were used by territorial pairs during the early spring before the emergent grasses became too thick. Brood use was almost all confined to the early part of the brood season. Utilization of potholes was lowest of all, but was found to increase with size. Artificial impoundments were not very attractive to nesting ducks, but were used to a very high degree by late summer broods. The number of banded females retrapped in the area in years subsequent to banding, indicates a definite return to the same area to nest.

(7) Evidence is presented to show that the limiting factor on waterfowl production in this area in two out of three years is water. For reproduction to be satisfactory sufficient water to carry the duck crop through to the flight stage must be available until at least August 15th. The amount of spring runoff largely determines what conditions will be on August 15th. Precipitation and associated weather conditions have an important modifying influence.

(8) It is concluded that the construction of artificial impoundments of sufficient depth to last through dry seasons will materially increase the number of ducks produced in areas such as this. Dams on

shallow draws, or the drainage of several potholes into one, produce better waterfowl habitat than dugouts, which should be constructed only as a last resort. The mobility of duck broods was found to be such that four strategically placed developments per square mile would provide adequate salvage areas.

(9) A program to develop the Missouri Coteau for greater waterfowl production, as outline above, is recommended. This to involve first a biological reconnaissance of the knob and kettle areas of the Coteau which are now adequately mapped, and then initiation of a construction program where water conditions and land use warrant.

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