ECOLOGICAL STUDIES ON THREE LAKES AND A MARSH IN ALLEGAN COUNTY, MICHIGAN

Thesis for the Degree of M. S.

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ECOLOGICAL STUDIES ON THREE LAKES AND A MARSH IN ALLEGAN COUNTY, MICHIGAN

By

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Gratitude is here expressed to the Game Division of the Michigan Department of Conservation for providing equipment and expenses to make this study possible. Grateful acknowledgment for many favors is also made to Mr. B. T. Ostenson of the Zoology Department of Michigan State College, under whose guidance the study was made; to Dr. H. R. Hunt, head, and Mr. J. W. Stack of the Department of Zoology, and to Dr. H. T. Darlington of the Department of Botany of Michigan State College.

For records of developments on the area I am indebted to the Federal Resettlement Administration; for analyses and descriptions of the lakes to the Institute for Fisheries Research at Ann Arbor, Michigan. This investigation benefited greatly from the services of Mr. F. W. Stuewer and Mr. H. S. Orwoll who assisted in the field work and gave valuable field records.

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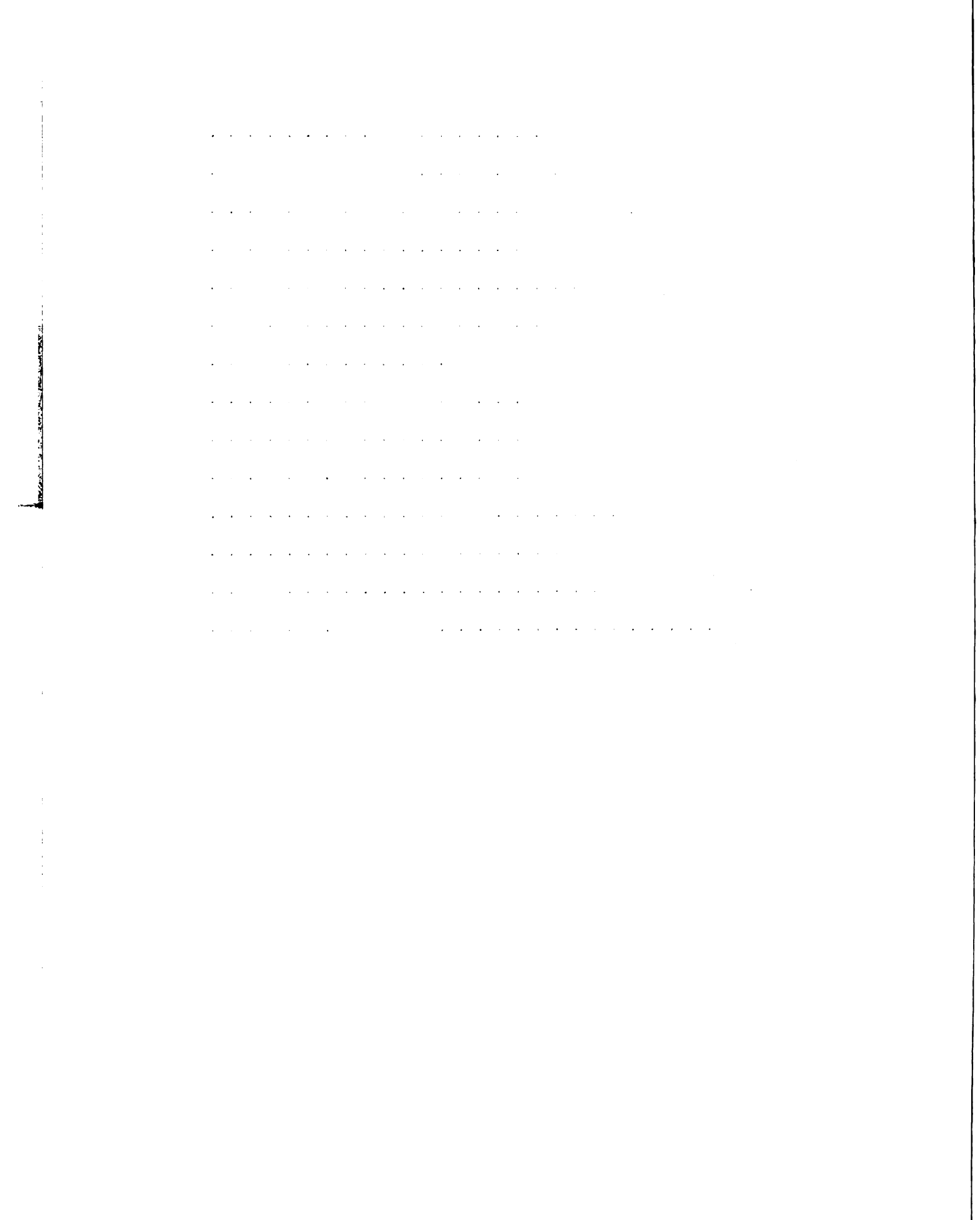

INTRODUCTION

The problem of utilizing submarginal lands has confronted the American agricultural leaders for some time. During the last decade several movements have been inaugurated to convert large areas of land which are unsuitable for agricultural purposes into areas which might serve the American public by means other than agriculture. Some areas have been set aside as game refuges or wildlife sanctuaries, others have been developed into recreational areas, and some are being used as research areas.

This study was made on one of the areas which has been taken over by the Federal Resettlement Administration which is now operating as the Farm Security Administration. The area is a combined waterfowl refuge and research or experimental area. It offers an excellent opportunity for life history studies of certain birds and other classes of animals as well as for investigations concerning aquatic plants--both native and introduced. This paper, however, will treat the area from an ecological standpoint--life histories being only incidental.

The work was made possible by the Michigan Conservation Department and the Federal Resettlement Administration. Expenses were furnished by the Game Division of the Conservation Department while equipment was furnished both by the Resettlement Administration and the Game Division. The field work was done under the supervision of Mr. B. T. Ostenson of the Zoology Department of Michigan State College. Graduate credit was received for the field work in the area from the Graduate School of Michigan State College.

The studies on the area consisted of a survey of aquatic plants, the use of the area by waterfowl, possible improvements for developing the area, and the ecological relationships between the animals and the various habitats. No systematic field technique was worked out or adhered to. The studies were made by taking trips throughout the area by automobile, boat, and on foot. By this means the entire territory was quite completely covered. Field notes were taken daily, all observations pertaining to wildlife--both plant and animal--being recorded. Pictures of various habitats and other items of interest were taken. When working on the aquatic plants, specimens of each species were collected and preserved for future use and reference.

The work for the summer began on June 23, 1937 and continued until September 1, 1937.

For this paper, the accounts of aquatic plantings, waterfowl plantings, and work previously done on the area have been taken from the records of the Federal Resettlement Administration and are used by permission.

PART I THE AREA

The area included in this study is approximately 3000 acres in extent. It is located in Clyde Township, Allegan County, Michigan. It includes most of sections 25, 26, 27, 34, 35, and 36. The most extensive work was done on the Bravo Marsh, an artificial marsh of about 1500 acres lying near the town of Bravo and occupying part of sections 26, 27, 34, and 35, and on the following lakes: Ely Lake in section 26, Little Tom Lake in section 26, and Crooked Lake in sections 25 and 36. The area is for the most part uninhabited by man, hence offering an opportunity to study natural conditions unaffected by agriculture and other human activities at the present time.

PHYSIOGRAPHY AND SOILS

The area studied represents a sandy lake bed of glacial origin. The entire region is comparatively level except for occasional hollows and ridges probably caused by wind action. The hollows are not drained and are at present occupied by shallow undrained bog lakes. There is a slight drainage of the marsh to the west.

The soil is chiefly Plainfield Sand (Fippin & Rice, 1901). The water-holding power of the soil is low and the land is unsuitable for farming. In the region of the Bravo Marsh is a layer of hardpan which lies at varying depths beneath the surface. This renders the soil wet in places where the ground water can not escape. Farming was attempted in this locality but much of the soil is poorly drained and the remainder is too dry.

Map 1. Detailed cover map of the Waterfowl Area previous to reflooding. Taken from Federal Resettlement Administration map made in 1935.

Legend:

O	Red and white oak
P	Aspen or poplar
MO	Maple, oak, beech, basswood, and white ash
W	White pine
E	Elm, ash, soft maple
Em	Elm, ash, soft maple, beech, and yellow birch
St	Tamarack
Wl	Willow
Gr	Upland grasses
Gs	Sedge
Fc	Cropped land
Fp	Pasture
Fg	Abandoned crop land
Ll	Leatherleaf

Map 2. Map of same area after reflooding showing approximate boundaries of Bravo Marsh and reformation of Crooked Lake. Position of the dike and spill-ways are shown in Bravo Marsh. General cover types are indicated in red.

Legend:

H	Oak uplands--containing scattered black cherry, beech, sugar maple, bitternut hickory, and white pine
P	Chiefly aspen and willows; scattered elm, silver maple, beech, yellow birch, white ash, tamarack, black cherry, and blue-berry

Both types are subject to considerable variation depending upon environmental factors.

Vegetation in the marsh and lakes has been discussed in the text.

Map 1. Detailed cover map of the Waterford Area previous to reflooding. Taken from Federal Resettlement Administration map made in 19[illegible].

Legend:

O Red and white oak
P Aspen or poplar
MO Maple, oak, beech, basswood, and white ash
W White pine
E Elm, ash, soft maple
Ea Elm, ash, soft maple, beech, and yellow birch
Lt Tamarack
Wl Willow
Gr Upland grasses
Gs Sedge
Fc Cropped land
Fp Pasture
Fa Abandoned crop land
Ll Leatherleaf

Map 2. Map of same area after reflooding showing approximate boundaries of Bravo Marsh and reformation of Crooked Lake. Position of the dike and spill-ways are shown in Bravo Marsh. General cover types are indicated in red.

Legend:

H Oak uplands--containing scattered black cherry, beech, sugar maple, butternut hickory, and white pine
L Chiefly aspen and willows; scattered elm, silver maple, beech, yellow birch, white ash, tamarack, black cherry, and blue-berry

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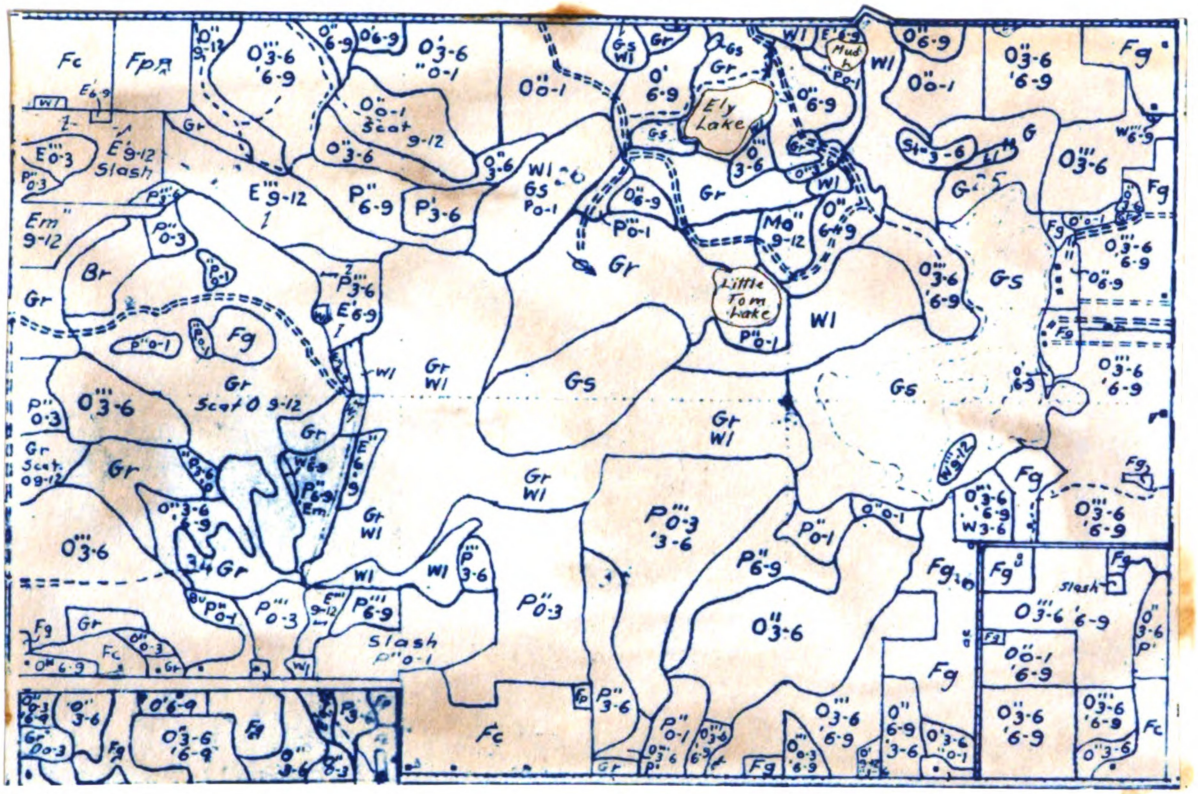
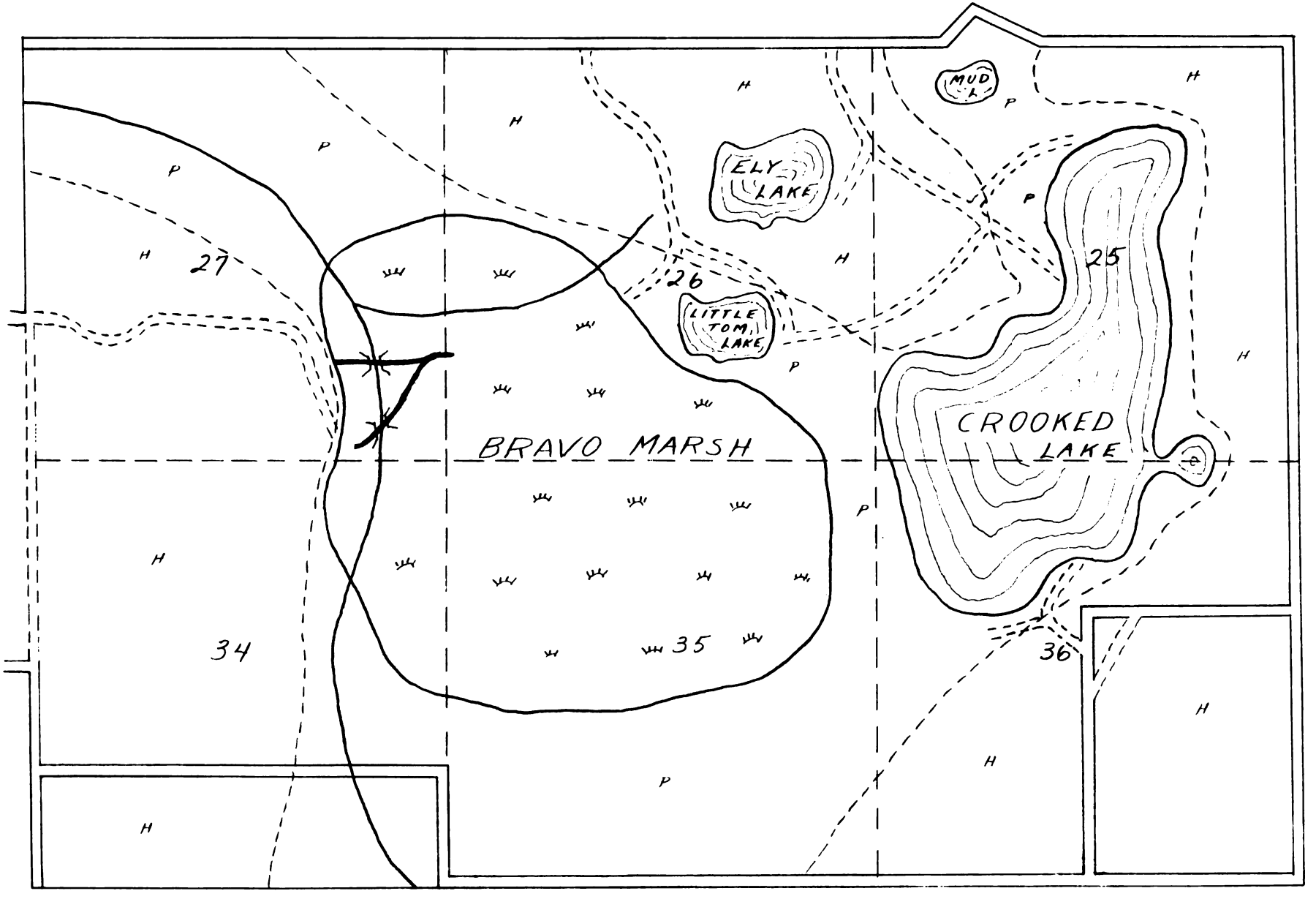


Map 1. Scale: 2 inches = 1 mile



Map 2. Scale: 3 inches = 1 mile.

CLIMATE

Allegan County has an average growing season of from 140 to 150 days. The average date of the last killing frost is May 5 to 10. The first killing frost occurs about October 8. Annual precipitation is usually between 30 and 35 inches. The mean annual temperature at Allegan is 48.4° F.

The summer of 1937 had more than the average rainfall. The precipitation during the months of June, July, and August was 12.83 inches as compared with an average of 9.43 inches for the same three months. The above data have been obtained from the Federal Weather Bureau at East Lansing.

RECENT HISTORY

According to local residents, the area formerly served as a resting place for waterfowl during the migrating season. The lakes are reputed to have harbored several hundred ducks at a single time during heavy migrations. They were also fairly good fishing lakes, but apparently intensive fishing has nearly exhausted the supply and at present fish are caught in comparatively small numbers. No artificial propagation has been practiced.

Several years ago the farmers of the community dug drainage ditches in the western portion of the area in an attempt to use the land for agricultural purposes. The marsh was completely drained as well as was Crooked Lake, with the exception of a few small "holes". Crooked Lake prior to that time was only 6 feet deep at its deepest

point. The lake bed consisted of a mucky peat and was not workable. One farmer's tractor is said to have disappeared in the muck. The marsh, after being drained, did not yield enough to make farming profitable, so farming practices were discontinued. The water levels in Little Tom and Ely Lakes were only slightly affected by the drainage.

In the spring of 1936 the Federal Resettlement Administration obtained possession of the area and began developing it into an area which, it was hoped, would be suitable for a waterfowl refuge. The first step in the development was to restore and, if possible, to raise the water table higher than it had been previously. This was accomplished by means of a dike built along the west side of the Bravo Marsh as the natural drainage was in this direction. A spill-way was built in the dike at a level which was considered desirable. This raised the water level to a point slightly higher than it had been previously.

Artificial pools with sandy sloping banks were constructed to provide resting grounds for the waterfowl. Three bodies of water in the area, containing inadequate food supply and cover for waterfowl, were planted with a variety of aquatic plants. This, it was hoped, would render the area a favorable site for a refuge. The plants chosen were those which are known to be most desirable for food and cover. All of the plants were obtained from nearby sources. Mallards were planted, having first been wing-clipped to insure their staying on the area. Nothing had been done since that time in the way of checking the results of the above developments.

Figure 1. A series of artificial pools in the Bravo Marsh. Ducks were frequently found resting here.

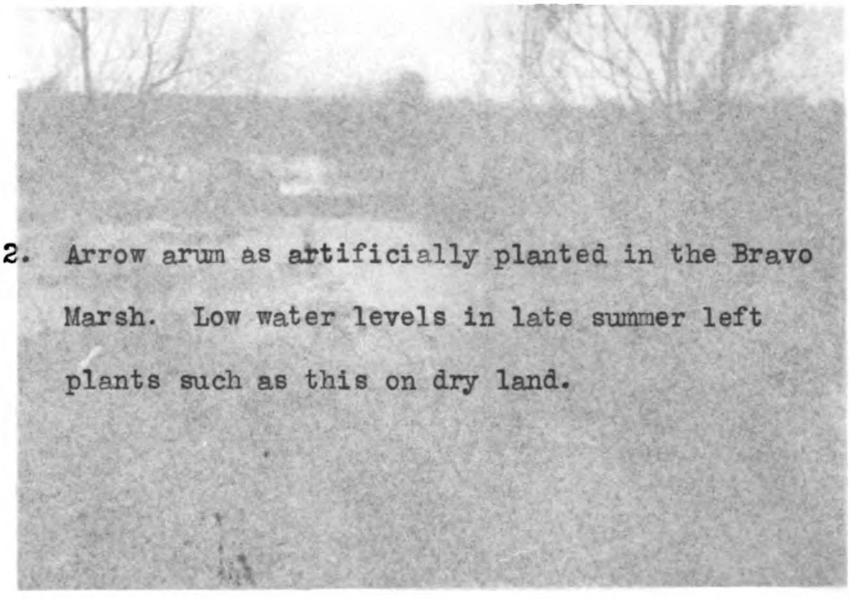


Figure 2. Arrow arum as artificially planted in the Bravo Marsh. Low water levels in late summer left plants such as this on dry land.

Figure 1. A series of artificial pools in the Truro Marsh.
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plants much be this on dry land.

Figure 1.

Figure 2.

VEGETATION

The area, except for the attempted farming of the Bravo Marsh, has not undergone any recent changes as a result of mans' activities. Hence, it may be called a prisere. Inasmuch as the lowest stage of this natural succession is open water, it is considered a hydrosere. The lakes are undrained and consequently contain a large percentage of organic acids, giving the soil a tendency toward physiological dryness. This results in the growth of plants which exhibit xerophytic characteristics.

In this discussion, the three lakes and the marsh will be treated as separate ecological units.

Ely Lake:

This lake is a small body of water measuring approximately 1700 by 940 feet and covering about 18 acres. The shoals are wide--75 to 100 feet--and shallow. There is no true drop-off. The maximum depth is 16 feet. Acidity determinations show a pH. of 6.3.

The lake is located in an area which formerly provided extensive resting grounds for a large number of waterfowl. Before the recent plantings it was almost wholly lacking in aquatic vegetation, the only species present being small amounts of pickerel-weed (Pontederia cordata), white water lily (Nymphaea odorata), and sedges (Carex spp.). The reasons for this lack of aquatic growth are difficult to determine, but frequent fires over the entire surrounding area may have had some effect. It is also possible that conditions preventing growth at present have existed for some time. Various tests showed the water and soil to be acid in most places but not noticeably more so than other lakes and streams

nearby which support vigorous growths of aquatic vegetation. Ely Lake gives a pH. test of 6.3 while Little Tom Lake, which contains an abundance of plant growth, has a pH. of 6.1. On the belief that valuable food and cover plants could be established here if once given a start, a number of hardy species were collected and transplanted here. In planting this lake, which normally supported considerable fish life, such cover plants as yellow water lily (Nymphozanthus advenus) were used extensively, as well as those which benefit chiefly waterfowl. The varieties and quantities of vegetation planted are summarized in the following:

Ely Lake

No.	Species of Plant	Amount Planted	Source of Supply
1.	Pickerel-weed (Pontederia cordata)	1149 plants	Round Lake
2.	Duck potato (Sagittaria latifolia)	6196 "	Swan Cr. Marshes
3.	Giant bur-reed (Sparganium eurycarpum)	5793 "	" " "
4.	Yellow water lily (Nymphozanthus advenus)	2321 "	Little Tom Lake
5.	Arrow arum (Peltandra virginica)	50 "	Kalamazoo R. Flats
6.	Bulrush (Scirpus sp.)	682 "	Round Lake
7.	White water lily (Nymphaea odorata)	93 "	" "
8.	Water shield (Brasenia Schreberi)	1½ bu.	
9.	Cattail (Typha latifolia)	734 plants	Swan Cr. Flats
10.	Water smartweed (Polygonum amphibium)	30 bu.	Round Lake
11.	Bushy pondweed (Naias flexilis)	51½ bu.	" "
12.	Sedges (Carex spp.)	24 plants	
13.	Sago pondweed (Potamogeton pectinatus)	2 bu.	Kalamazoo River
14.	Large floating-leaved pondweed (Potamogeton amplifolius)	147 bu.	Round Lake
15.	Grass-leaved pondweed (Potamogeton compressus)	8½ bu.	Upper Scott Lake
16.	Small floating-leaved pondweed (Potamogeton sp.)	53½ bu.	Little Tom Lake
17.	Robbin's pondweed (Potamogeton Robbinsii)	11 bu.	Upper Scott Lake
18.	Wild celery (Vallisneria americana)	52½ bu.	Upper and Lower Scott Lakes

Present Status:

The lake at present apparently supports very little more vegetation than it did previously. There is no well defined zonation of plants, except for a border of sedges (Carex), bur-reeds (Sparganium), and a few cattails (Typha).

Some distance from the shore are scattered groups of plants consisting of mixtures of pickerel weed (Pontederia), yellow water lily (Nymphozanthus), white water lily (Nymphaea), water smartweed (Polygonum), arrow arum (Peltandra), bladderwort (Utricularia), and a few pondweeds (Potamogeton). The land around the lake is occupied by a mixture of red and white oaks (Quercus borealis maxima and Q. alba).

Little Tom Lake:

This is a small lake measuring about 1100 by 975 feet and covers an area of 17.4 acres. The shoals are from 50 to 75 feet wide. There is an abrupt drop-off. The maximum depth is 12 feet. The water has a pH. of 6.1.

This body of water supports abundant aquatic vegetation. Consequently no aquatic plantings were made by the Federal Resettlement Administration. The lake represents an entirely natural plant succession as found in undrained bog lakes. The various stages of succession are quite clearly defined and will be described briefly.

The deeper central portion of the lake does not, as far as could be determined, support any bottom plant life. The soil in this region, however, is a pulpy peat and should be able to support vegetation.

The plant zones occur in nearly perfect concentric rings around the margin of the lake and occupy the lake bottom less than 6 feet under water. The shoals are rather wide, giving considerable territory for plant growth. The zones will be described in order beginning with the innermost.

A submerged stage forming a ring averaging about 10 feet in width occurs at the edge of the shoal. Its chief constituents are Chara and bladderwort (Utricularia intermedia). These plants are rooted in the bottom mud. A pondweed identified as Potamogeton Oakesianus is found on the shoreward side of this zone and continues into the next zone.

This next zone might be called a floating stage or a zone of Nymphozanthus; it extends 20 to 25 feet shoreward. The soil is a fibrous peat and lies 3 to 4 feet under water. The yellow water lily (Nymphozanthus) is the most abundant and characteristic plant of this zone. Growing with it as subordinate species are white water lily (Nymphaea), water shield (Brasenia), and the pond weed described in the preceding zone.

Next is a very narrow zone of sedges (Carex). It contains also pipewort (Eriocaulon septangulare) and bur-reeds (Sparganium). Scattered throughout this and the preceding zones are sparse stands of Chara which is ordinarily found to be a pioneer in the succession, and is located in the submerged stage (Weaver & Clements 1929). Its presence in scattered stands can not be explained satisfactorily.

The next zone occupies the shore of the lake and is found on soil formed by the decaying vegetations of the previous stages. On the south side of the lake is the east extremity of the Bravo Marsh. The shore here is formed by vegetation growing out from the slight ridge separating the lake from the marsh. The mat of vegetation is dense

enough to support a man's weight but it quakes very noticeably. It is composed of sedges (Carex spp.), loosestrife (Decodon verticillatus) , cattail (Typha latifolia), leather leaf (Chamaedaphne calyculata), pitcher plant (Sarracenia purpurea), willows (Salix spp.), and grasses. The ridge is occupied by black cherry (Prunus serotina), aspen (Populus tremuloides), and tamarack (Larix laricina). The north and east shores are higher, and here this zone is very narrow where present. The higher land is occupied by red and white oaks (Quercus borealis maxima and Q. alba), sugar maple (Acer saccharum), beech (Fagus grandifolia), and white ash (Fraxinus americana). The west side of the lake continues as a tall grass marsh and runs into the Bravo Marsh to the south and into the higher oak region on the north.

Crooked Lake:

This lake at the time the Resettlement Administration took charge was nearly depleted of its water supply due to drainage. The few "holes" left in the lake bottom, however, supported an abundant aquatic vegetation. The soil varies from peat to a rich muck. Since the construction of the dike at the west end of the Bravo Marsh, the water level has been raised so that the lake is as large and as deep as it had been previously--about 6 feet maximum depth and covering roughly 500 acres. Because of the variety of plants already present, only those plants which were thought to be the best possible food and cover were planted. Following is the summary of the plantings in this lake:

Crooked Lake

No.	Species of Plant	Amount Planted	Source of Supply
1.	Duck potato (Sagittaria latifolia)	7667 plants	Swan Cr. Flats
2.	Giant bur-reed (Sparganium eurycarpum)	3927 "	" " "
3.	Small bur-reed (Sparganium sp.)	713 "	" " "
4.	Sedges (Carex sp.)	236 "	" " "
5.	Blue flag (Iris versicolor)	184 "	" " "
6.	Cattail (Typha latifolia)	579 "	" " "
7.	Bulrushes (Scirpus)	775 "	Swan Cr. & Round L.
8.	White water lily (Nymphaea odorata)	23 "	Round Lake
9.	Arrow arum (Peltandra virginica)	1034 "	Lower Scott Lake
10.	Wild celery (Vallisneria americana)	95½ bu.	" " "
11.	Duckweed (Lemna minor and Spirodela polyrhiza)	1½ bu.	" " "
12.	Pale smartweed (Polygonum sp.)	4 bu.	Kalamazoo River
13.	Celery-leaved pondweed (Potamogeton epihydrus)	4 bu.	Kalamazoo River

Present Status:

The lake supports abundant aquatic vegetation. Zonation, however, is not clearly defined inasmuch as the lake is very large and rather shallow throughout. The youthful condition of the lake at present probably accounts, to an appreciable extent, for the lack of zonation. The percentage of open water is comparatively small. The bottom, being at a maximum depth of 6 feet, supports vegetation which is able to rise to the surface. The open water existing at present can be expected to disappear in a few years as the vegetation has more time to become dispersed.

The most abundant species in the lake are yellow water lily (Nymphozanthus) and pickerel-weed (Pontederia). In midsummer these plants present a dense mat of green foliage covering the larger part of the surface and give the lake a very characteristic aspect. In the month of August the vegetation made navigation by boat almost impossible in many places. Plants occurring with yellow water lily and pickerel weed are:

white water lily (Nymphaea), which is common in the northern part of the lake but rare in the southern portion; water shield (Brasenia Schreberi), which is abundant and occurs in several places forming dense pure stands; water smartweed (Polygonum amphibium), which is relatively scarce; and Potamogeton Oakesianus.

A submerged stage is not present as such but plants ordinarily belonging in this habitat are found throughout the lake. Of these probably the most abundant is the mermaid weed (Proserpinaca palustris). This plant is present in exceedingly dense growths and extends upward to within 6 inches or a foot from the surface. The reddish-brown leaves give a peculiar tint to the water due to the reflection of sunlight. These groups, therefore, can often be distinguished from considerable distances.

Other submerged plants found are bladderwort (Utricularia intermedia), which occurs rather sparsely but consistently throughout the lake, and sphagnum moss (Sphagnum), which grows in a few restricted localities.

The sedge-meadow habitat is well developed on the southeast shore of the lake but is not clearly defined in the remaining portion. As a result of the recent drainage, the shore line and the shallower portion of the lake became dry and favored the growth of terrestial weeds and grasses. Trees, such as cherry and poplar, began growth. Two shrubs--Spiraea alba and Spiraea tomentosa--became abundant. When reflooded these plants died but still remain in place as dead stubs. They give the shore line a characteristic appearance. Sedges, however, are coming in and very likely will become the dominant form. Pipewort

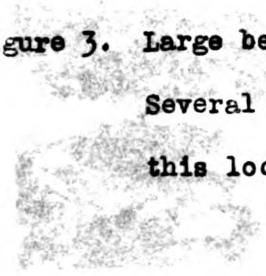

Figure 3. Large bed of yellow water lilies in Crooked Lake. Several Pied-billed Grebe nests were found in this location.

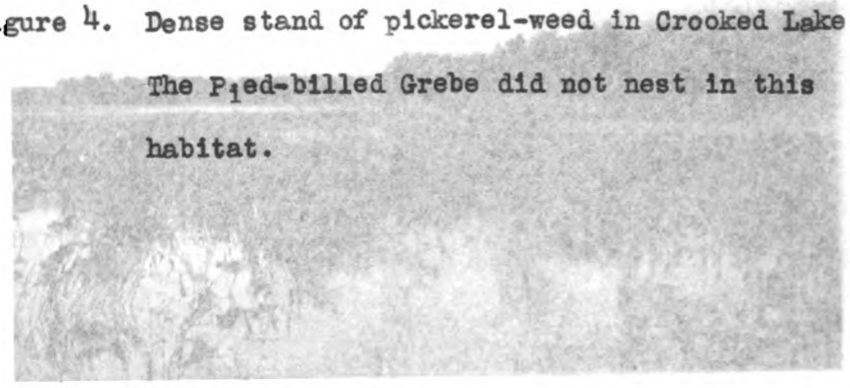

Figure 4. Dense stand of pickerel-weed in Crooked Lake. The Pied-billed Grebe did not nest in this habitat.

Figure 3. Large bed of yellow water lilies in Crowned Lake. Several Pied-billed Grebe nests were found in this location.

Figure 4. Dense stand of pickerel-weed in Crowned Lake. The Pied-billed Grebe did not nest in this habitat.

Figure 3.

Figure 4.

(Eriocaulon septangulare) has also penetrated into this habitat and has become quite abundant. Cattail and bulrushes are being established in small restricted areas.

The shore is occupied by various combinations of plants, apparently depending upon the water content of the soil. On the northern and northeast shore is found a "blue berry bog" composed of two species--Vaccinium pennsylvanicum and V. corymbosum. These occur on a large flat area, only slightly above the shoreline. Leather leaf (Chamaedaphne) and buttonbush (Cephalanthus occidentalis) are present here as subordinate species. Beyond this a narrow zone of poplar and cherry is found before the land rises rather abruptly and is occupied by a mixture of red and white oaks.

The eastern shore rises almost immediately to the oak uplands. There is a dense growth of white pine (Pinus strobus) on the south shore. A zone of loosestrife (Decodon verticillatus) about 8 feet wide occurs in shallow water between the white pine and a sudden drop-off. Immediately beyond this is a dense growth of yellow water lily and pickerel weed. The soil giving growth to the white pine and loosestrife is saturated with water. Small depressions contain open water. The white pine are large, averaging 10 to 12 inches in diameter. This formation is peculiar inasmuch as white pine growths are not ordinarily found on soil saturated with organic acids. Possibly these trees began growth as an edaphic formation before the lake appeared. Since the development of the lake, the trees may exist but not grow to any appreciable extent. No cross-sections of trunks were obtainable, however, to substantiate this theory. It is very evident that the group has not been reproducing

for a considerable time because very few trees with a diameter of less than 8 inches are found. The theory presented would indicate that the lake is of rather recent origin. This would not allow for the deep layer of muck and peat which exists in the lake bottom. However, it seems possible that as this layer was being formed, the water level was much lower than it is at present. This would account for drier soil at the time of formation where the shore of the lake now is and also make the invasion of the water into the white pine stand relatively recent. The roots of the trees may, since their growth began, have prevented erosion by wind, thus accounting for the sudden drop-off just beyond their outer margin.

Bravo Marsh:

This is a large marsh which is, for the most part, artificial. It occupies a level region with a very slight drainage to the west. In the southwest corner is an old drain coming in from the south. The dike built along the west side of the marsh has held enough water to flood the area near the dike quite completely. Water becomes less abundant toward the east, and in the east half the only water existing is in the artificial holes and pools which were made by the Resettlement Administration. Before the plantings by the Resettlement Administration little or no aquatic vegetation existed except for tall marsh grasses in the drainage-way. In the west side of the marsh there was considerable tree growth--chiefly black cherry and aspen; these trees are now standing in the water. The area now constituting the east part of the marsh had grown up to weeds, scattered cherry and poplar, and blue-berries (Vaccinium) in a few of the damper places.

The soil is sandy but is underlain by a layer of hardpan which holds the water near the surface, the level depending, of course, on the variability in the depth of the layer.

Of the three areas artificially planted, this offered the best possibilities for development, and consequently the most extensive work was done here. Moreover, most of the planting could be done on dry land or very shallow water. Plantings were made as follows:

Bravo Marsh

No.	Species of Plant	Amount Planted	Source of Supply
1.	Pickerel-weed (*Pontederia cordata*)	3360 plants	Round Lake & Osterhout Lake
2.	Yellow water lily (*Nymphozanthus advenus*)	5575 "	Little Tom Lake Osterhout Lake Kalamazoo River
3.	White water lily (*Nymphaea odorata*)	1292 "	Round Lake
4.	Water shield (*Brasenia Schreberi*)	15½ bu.	Round Lake
5.	Arrow arum (*Peltandra virginica*)	3173 plants	Lower Scott Lake
6.	Bur-reed (*Sparganium eurycarpum*)	13702 "	Swan Cr. Flats
7.	Small bur-reed (*Sparganium*)	1200 "	" " "
8.	Cattail (*Typha latifolia*)	1230 "	" " "
9.	Bulrushes (*Scirpus*)	4302 "	Round Lake Swan Cr. Flats Osterhout Lake
10.	Square-stemmed spike rush (*Scirpus americanus*)	57 "	" "
11.	Blue flag (*Iris versicolor*)	140 "	Black River
12.	Water smartweed (*Polygonum amphibium*)	24 bu.	Round Lake
13.	Duck potato (*Sagittaria latifolia*)	4593 plants	Swan Cr. Flats Kalamazoo R. Flats Black River
14.	Sedges (*Carex* spp.)	205 "	Swan Cr. Flats
15.	Duckweed (*Lemna minor* and *Spirodela polyrhiza*	2 bu.	Kalamazoo R. Flats
16.	Chara or Musk grass (*Chara*)	½ bu.	Lower Scott Lake
17.	Bushy pondweed (*Najas flexilis*)	3 bu.	Round Lake
18.	Large floating-leaved pondweed (*Potamogeton amplifolius*)	8 bu.	Round Lake
19.	Celery-leaved pondweed (*Potamogeton epihydrus*)	1½ bu.	Kalamazoo River
20.	Elodea (*Elodea canadensis*)	½ bu.	Lower Scott Lake
21.	Wild celery (*Vallisneria americana*)	124 bu.	Lower Scott Lake

Present Status:

The marsh is too young to show any well-defined ecological successions of higher plants. Some of the plants which were placed there artificially have become established. Most of these are in the deeper water--2 to 3 feet--in the western edge along the dike. The following plants are spreading from their places of original introduction: yellow water lily (Nymphozanthus), water shield (Brasenia), bur-reed (Sparganium), blue flag (Iris), sedges (Carex), duckweed (Spirodela and Lemna), water smartweed (Polygonum) , Elodea and Potamogeton amplifolius. The duckweeds have become very abundant and cover large portions of the surface of the water.

These plants are existing but do not seem to be reproducing; arrow arum (Peltandra), duck potato (Sagittaria), bushy pondweed (Najas), and wild celery (Vallisneria).

A few species have been introduced into the area by some natural means. They were not present originally, and were not planted, but now exist. It is expected that they will spread and assume their position in the natural ecological succession. The plants are: mud plantain (Heteranthera dubia), coontail (Ceratophyllum demersum), and pondweeds (Potamogeton americanus, P. Oakesianus, and P. zosteriformis).

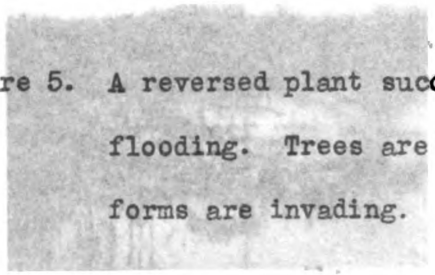

Figure 5. A reversed plant succession at Bravo Marsh due to flooding. Trees are being killed while aquatic forms are invading.

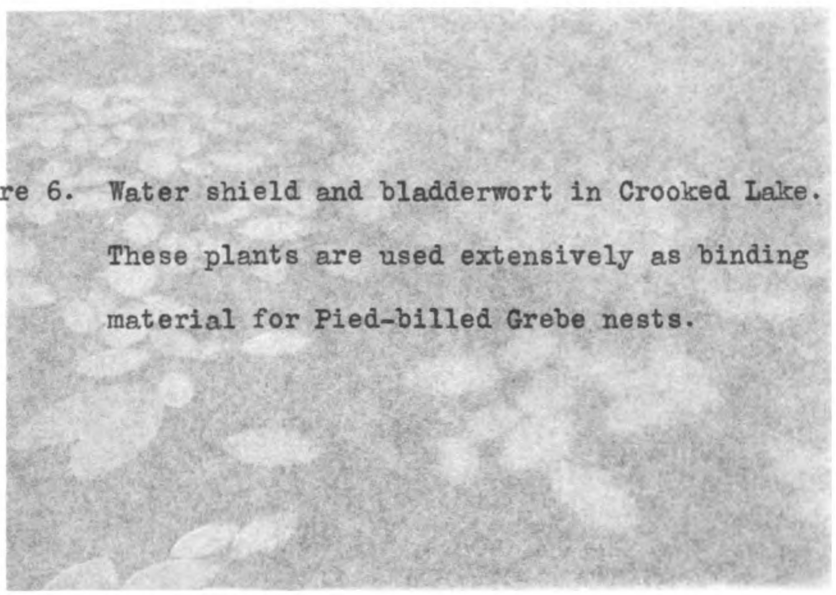

Figure 6. Water shield and bladderwort in Crooked Lake. These plants are used extensively as binding material for Pied-billed Grebe nests.

Figure 5. A reversed plant succession at Provo Marsh due to flooding. Trees are being killed while aquatic forms are invading.

Figure 6. Water shield and bladderwort in Crooked Lake. These plants are used extensively as binding material for Pied-billed Grebe nests.

Figure 5.

Figure 6.

PART II THE ANIMAL LIFE OF THE AREA

Inasmuch as this study deals primarily with water areas, the vertebrate fauna consists mainly of aquatic forms. Other types will be described only insofar as they relate ecologically to the aquatic fauna.

POPULATIONS

Waterfowl:

In this report, the term "waterfowl" will be used in reference to game species such as ducks and geese. Forms other than these will be included in "Other Birds".

One of the purposes of the study, as originally planned, was to investigate the nesting situation with special attention to nesting conditions and the approximate number of waterfowl which used the area as a nesting site. The nesting season was nearly completed, however, before the study started. Consequently the only information on the extent to which the area was used for nesting was the number of broods of young observed. This does not take into account the nests that may have been destroyed or the mortality of the young previous to the time that the study began. Therefore any figure which might be given to represent the pairs of nesting waterfowl would probably be subject to considerable error.

The portion of the area which contained the best natural habitats and upon which most of the artificial development took place is the Bravo Marsh. It contains drainage ditches, artificial pools, tall grass, open water, and heavily wooded areas along the border. These various types of habitats allow for nesting, feeding areas, and

resting grounds. The drainage ditches contain considerable vegetation in the form of rushes, sedges, and small trees, particularly willow and aspen. They are used quite extensively by the waterfowl. The artificial ponds are of various sizes and shapes. Some of them are merely holes dug in the ground varying in size from 10 to 25 feet square. The sides of some of these pools are perpendicular to the horizontal. Others are constructed with gently sloping banks, providing as nearly as possible a lakeshore habitat which is supposedly an important factor in attracting waterfowl. The aquatic plantings in these pools have not had a chance, as yet, to become very well established. Consequently food and cover are lacking and the small holes do not seem especially attractive as resting grounds.

The wooded borders were formed as the result of the flooding of the region by means of the dike. The trees extend out into the water for some distance along the west side of the marsh, providing shade and cover on some of the deeper waters. Female ducks were often seen with their broods swimming among the trees in this part of the area. Nesting conditions on the shore seemed rather favorable although no nests were found. This is not surprising when the time of the study is considered.

There are no accurate census methods for determining the number of waterfowl nesting on an area. The largest number of separate broods observed at any one time is the best available means of estimating the population of nesting females. Trips were made to the area at all times of the day, some at sunrise, others in the forenoon, early afternoon, and shortly before sundown. The largest number of broods of Mallards (Anas p. platyrhynchos) seen on a single trip and known to be separate

broods is four. At least two pairs of Black Ducks (Anas rubripes tristis) and two pairs of Blue-winged Teal (Querquedula discors) are known to have nested on the area and raised the young successfully--at least until half to three-fourths grown. One pair of Green-winged Teal (Nettion carolinense) was observed but no young were ever seen. Judging from this information and the number of ducks present throughout the summer, it would seem that not over 15 pairs of ducks used the Bravo Marsh as a nesting site.

Crooked Lake apparently does not serve as a favorable nesting place for waterfowl. During April, 1937, the Resettlement Administration banded and released 60 Mallards on the lake. The birds were obtained from the Mason Game Farm (this is under the direction and supervision of the Game Division of the Michigan State Conservation Department) and were wing-clipped before being released. One pair of Black Ducks and two pairs of Mallards are known to have nested on the area. It is presumed, but does not necessarily follow, that the Mallards were of the planted group. One female Green-winged Teal was observed with nine young on the lake.

During the first part of the summer, waterfowl on Crooked Lake were rather scarce. Food and cover, however, were plentiful. In the latter part of July and the first part of August the numbers began to increase. At the same time the population began to decrease at the Bravo Marsh due to its drying up. Hence it is quite likely that there was a general movement of the waterfowl from the marsh to the lake which is only a half a mile distant, and possibly additional birds came in from other areas.

Nesting conditions on Crooked Lake are rather poor. Much of the lake has a very marshy border. Cottages occupy a large percentage of the dry shore, the small remainder being wooded and providing favorable nesting sites. The water level is also a factor in the development of this lake into a suitable nesting region. The level is constant through the nesting season but dropped between 2½ and 3 feet from July 15 to September 1.

Other Birds:

The entire area serves as a nesting ground for many other birds besides ducks. In the Bravo Marsh the following birds are known to have nested during the spring and summer: Spotted Sandpiper (Actitis macularia), Killdeer (Oxyechus vociferus vociferus), Eastern Red-wing (Adelaius p. phoeniceus), Kingbird (Tyrannus tyrannus), and Pied-billed Grebe (Podilymbus p. podiceps). Other birds observed on the area are: Green Heron (Butorides v. viriscens), Marsh Hawk (Circus hudsonius), Pectoral Sandpiper (Pisobia melanota), Virginia Rail (Rallus l. limicola), and Crow (Corvus b. brachyrhynchos).

Crooked Lake served as a nesting place for many Pied-billed Grebes and Black Terns (Chlidonias nigra surinamensis). Seventeen grebe nests were located and contained an average of 6.8 eggs. The nests were of two types--the floating type and those built on the semi-solid muskrat houses. The former were in the majority. These nests were built with old, dead vegetation--particularly stems and leaves of the water lilies. These were complexly interwoven to form a mass which floated on the surface. Some living plants were included to keep the nest in position. Fifteen nests of the floating type were observed. The remaining two were located on old muskrat houses which rose slightly above the

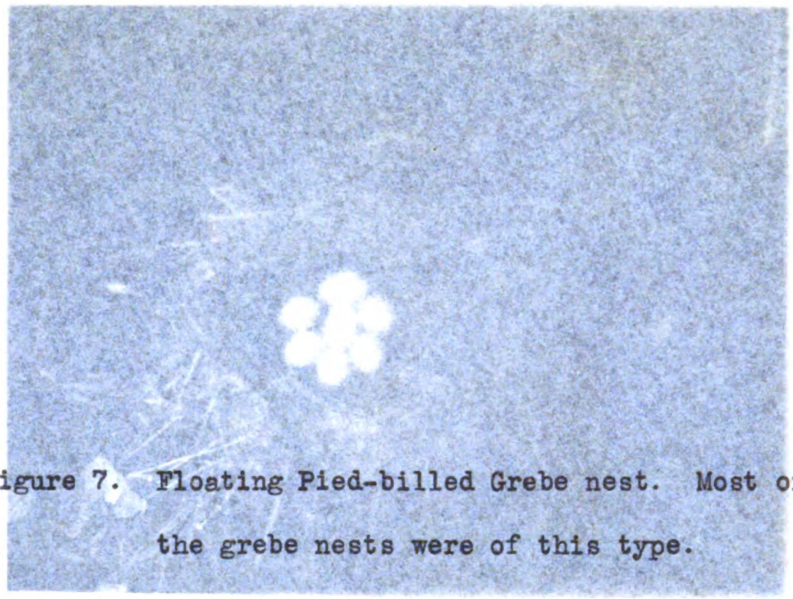

Figure 7. Floating Pied-billed Grebe nest. Most of the grebe nests were of this type.

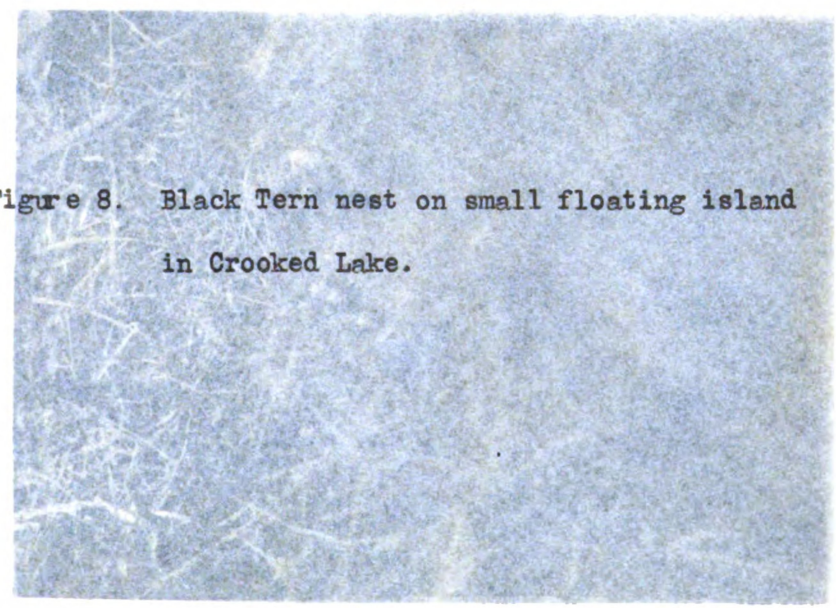

Figure 8. Black Tern nest on small floating island in Crooked Lake.

Figure 7. Floating Pied-billed Grebe nest. Most of the grebe nests were of this type.

Figure 8. Black Tern nest on small floating island in Crooked Lake.

Figure 7.

Figure 8.

surface of the water. The nests in every case were covered when found. The bird upon leaving the nest pulls the vegetation up over the eggs so they can not be seen unless uncovered. The eggs under these conditions are warmed by the sun, allowing the adult to spend much of the day away from the nest.

Young grebes were in evidence throughout the summer. There were young on the lake when the first trip was made on June 23. The last nest observed with eggs was on July 27. A trip to the nest on July 29 showed that the eggs had hatched.

Nine Black Tern nests were observed. Five of them were built on the grebe nests after the latter had hatched. The others were located on old muskrat houses and other piles of old vegetation in the lake. None of them were successful, each being destroyed before hatching.

Two Least Bittern (Ixobrychus e. exilis) nests were found in the tall grasses on the west side of Crooked Lake. The eggs in both were hatching on the same day, July 7. The nests were revisited on July 12 with intentions of banding the young. Both were empty. It is doubtful that the young were able to fly at that age although no signs of disturbance could be seen.

A single Coot (Fulica a. americana) was observed on Crooked Lake on three different occasions. Whether or not it was the same bird, of course, is not known. In each case the bird flew to the Bravo Marsh.

Several Long-billed Marsh Wrens' (Telmatodytes p. palustris) nests were located. The female bird showed signs of excitement, indicating that either the nest or young might be nearby. This bird has the

unique habit of building several "dummy" nests and those were the only ones that could be located.

Other birds observed nesting about Crooked Lake were Eastern Kingbird (Tyrannus tyrannus) and the Eastern Red-wing (Adelaius p. phoeniceus).

Mammals:

Mammalian life in the lakes was limited to the muskrat (Ondatra z. zibethica). This species was found in both Crooked Lake and the Bravo Marsh. Several old houses occurred in the lake, whereas there were none in the marsh. Muskrat activity was not noticeable until August, when they began cutting off reeds and cattails and concentrating them in suitable places for houses. A trip to the area in October, however, found the water level lowered to such an extent that the houses which were begun in August were then on dry land some distance from the water. No evidence of the animals could be found at that time.

Other mammals present around the borders of the lakes are the white-tailed deer (Odocoileus virginianus borealis), skunk (Mephitis nigra), cottontail rabbit (Sylvilagus floridanus mearnsii), and the fox squirrel (Scirus niger rufiventer). No deer were observed but their presence was indicated by numerous fresh tracks.

Amphibians and Reptiles:

Amphibians are represented on the area by a large number of individuals belonging to but a few species. Of the frogs, the green frog (Rana clamitans) is undoubtedly the most abundant. The leopard-frog (Rana pipiens) and wood-frog (Rana cantabrigensis) are present

in limited numbers. Both the Fowler's toad (Bufo fowleri) and American toad (Bufo americanus) are found, with Fowler's out-numbering the American. During the first part of the summer tadpoles were very numerous in the west side of Bravo Marsh. They were very large and thought to be tadpoles of the green frog (Rana clamitans). No records of salamanders were obtained.

As far as could be determined, reptiles are restricted to the water-snake (Natrix s. sipedon), Blanding's turtle (Emys blandingii), and the western painted turtle (Chrysemys bellii marginata).

ANIMAL INTERRELATIONS

Ignoring the invertebrates, the animal life on the area is not particularly complex. In comparison with terrestial habitats, the aquatic plant societies act as host to a relatively small number of animal species. There seems to be no outstanding conflict between various forms as far as habitats are concerned. Since the study took place in the summer, other seasonal interrelationships can not be discussed.

Habitat Relations:

In this discussion an attempt will be made to portray the outstanding and rather constant affinities that certain forms exhibit for a particular habitat.

Ducks:

As mentioned previously, the work began too late to study nesting of ducks. Mallards and Blacks were frequently seen feeding among the yellow water lilies and pickerel-weeds. In the Bravo Marsh the artificial pools served as resting grounds during the cooler parts of the day.

Pied-billed Grebe:

This form was restricted in its nesting range on the area to the floating vegetation and the few on muskrat houses. Yellow water lilies seemed to take preference over other plants. A few nests were found in a mixture of the lilies and pickerel-weed but none were observed in the pure stands of pickerel-weed. It is probable that the foliage of this plant is too rigid to permit using it for nests. In addition, the stands are very dense and practically no other vegetation occurs with the pickerel-weed. Some finer fibrous material seems to be necessary to

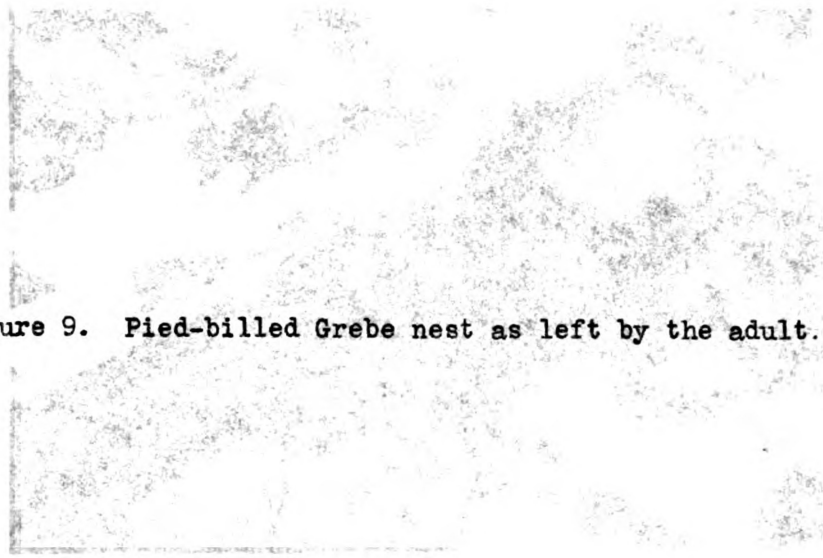

Figure 9. Pied-billed Grebe nest as left by the adult.

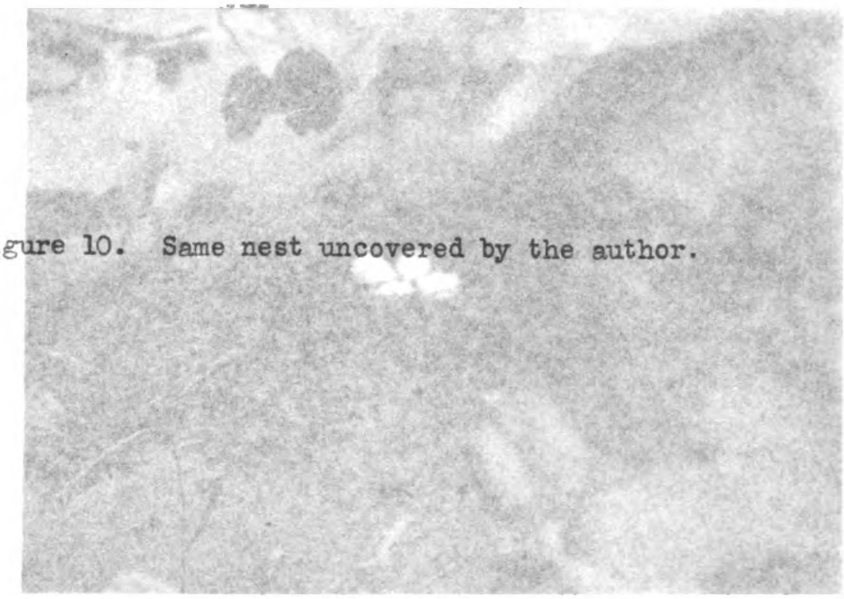

Figure 10. Same nest uncovered by the author.

Figure 9. Pied-billed Grebe nest as left by the adult

Figure 10. Same nest uncovered by the author.

Figure 9.

Figure 10.

hold coarser materials together. Bladderwort (Utricularia) is often used, and the absence of this plant in the pickerel-weed beds may account for the failure of the grebes to nest there.

This habitat offers in addition to good nesting conditions, excellent cover for both adult and young grebes. There birds have superior diving ability, as well as the ability to sink gradually while swimming. They may return to the surface behind some vegetation and at a considerable distance from their point of disappearance.

Black Tern:

The Black Tern (Chlidonias nigra surinamensis) is found to nest in the same habitat as the Pied-billed Grebe. Old muskrat houses and other piles of vegetation are used more extensively as nesting material by the tern. The nests are in slightly drier situations than those of the Pied-billed Grebe.

Least Bittern:

Two nests of the Least Bittern (Ixobrychus e. exilis) were located on Crooked Lake. Each consisted of a saucer-shaped platform built on broken down reeds and sedges. They were placed about 8 inches above the water and were about 50 feet apart. Sedge material was the chief constituent used in building. The eggs numbered 4 in one nest and 5 in the other. They were unspotted and pale blue in color. In size they are slightly smaller than the eggs of the Ring-necked Pheasant, being approximately 1.2 by .9 inches. The nests were not covered.

Long-billed Marsh Wren:

In the tall grasses along the west side of Crooked Lake were found the nests of the Long-billed Marsh Wren (Telmatodytes p. palustris).

They were composed of vegetable matter interwoven in the natural grasses and were globular to oval in shape. The entrance to the nest was a small hole on one side and was usually quite inconspicuous. Barrows (1912) describes the actions of the animal very well: "The bird is continually rambling about among the grass stems, climbing to the tops of the reeds and cattails, and occasionally fluttering a few yards upward into the air, uttering his peculiar sputtering song and then dropping back out of sight in the reeds".

Eastern Red-wing:

The Eastern Red-wing (Adelaius p. phoeniceus) was restricted in its nesting to the low shrubs which occurred about the border of the open water in both Crooked Lake and the Bravo Marsh. Four nests were observed. Young in three of the nests were banded with U. S. Biological Survey bands. The adults fed quite generally on the fruit and seeds of the yellow water lily.

Eastern Kingbird:

This bird showed a preference for nesting above the water. Three nests were seen, each of them being placed in a dead tree and between three and four feet above open water. The bird is more often thought of as being strictly a land bird but the same unusual aquatic habit of nesting has been observed by R. W. Chaney (Barrows 1912).

Great Blue Heron:

These large birds were often seen wading in the sedges where most of their feeding was done. They stand perfectly still for some time at the border of the plant growth or in open water within the zone of sedges. This bird is reputed to be wary and suspicious (Taverner 1934)

Figure 11. Sedge-meadow habitat at Crooked Lake. The Least Bittern and Long-billed Marsh Wren used this habitat for nesting.

Figure 12. Long-billed Marsh Wren nest.

Figure 11. Sedge-meadow habitat at Crooked Lake. The lower

Bittern and Long-billed Marsh Wren used this

habitat for nesting.

Figure 12. Long-billed Marsh Wren nest.

Figure 11.

Figure 12.

but it was found that when feeding, it was possible to get within 15 or 20 feet of them in a boat. On some occasions the birds would slowly walk away while at other times they would fly for a short distance and continue feeding. It was difficult to observe the food which they were taking. It is probable that the chief food was frogs since there was an abundance of frogs in this sedge habitat.

Insects:

Very little work was done on the insect life of the area but their presence could not be overlooked in the large beds of Lemna and Spirodela. These plants act as host and protection to a multitude of small aquatic insects. M. B. Scotland (1934) points out the importance of this stage of succession as affecting the animal life. The insects are preyed upon by larger forms, and they in turn by still larger. It is found also that these small plants are used to a great extent as material for cases of the caddis fly larvae.

It is evident that this stage in the succession acts as a favorable site for the location of amphibian eggs. During the first part of the summer tadpoles were present in exceedingly great numbers. When walking along the dike the water seemed to be "boiling" due to the numbers of tadpoles swimming about in the duckweeds. The mat of green vegetation serves as a good protection from bird predators. In addition, the marsh is relatively young and there has been very little opportunity for larger forms, which might prey upon the tadpoles, to invade the area.

It is thought by Scotland (1934) that the tadpoles, together with the insects, aid in the pollination and dispersion of the duckweeds.

Activity Relations:

As mentioned previously, there seems to be little conflict between animal forms of this particular area. This condition probably is due to the fact that the animals are not brought in contact with each other. In most cases the nesting habits differ, feeding habits do not overlap, and predation among resident forms seems only occasional. There are, however, certain observations that would indicate conflict between some of the species.

Considerable time was spent trying to determine an ecological relationship between the Black Tern and the Pied-billed Grebe. At one time a tern was seen hovering very low, occasionally swooping down as though it were attacking something. Then closer examination showed a grebe on a nest and seemingly fighting back. This continued for a period of about five minutes. The grebe, apparently noticing the boat, quickly covered up the nest and dove into the water. The tern did nothing to the nest but flew away and did not return. Upon examination of the nest seven grebe eggs were found. The nest was revisited daily and the eggs hatched five days later. In this connection, it is noteworthy that this is the only grebe ever observed on the nest. It is quite likely that the struggle took much of the bird's attention and she did not notice the boat approaching as readily as she would have ordinarily.

On another occasion a nest was found containing one tern egg and two grebe eggs. The nest was watched but no attention was ever given it by either of the birds. It finally collapsed due to the decay of the vegetation. As a result, no definite relationship could be

determined. The terns did interfere with life history studies of the grebe. Their constant "crying" overhead made it impossible to conceal one's presence. This may account for the fact that only one grebe was observed on the nest because the terns definitely announce approaching danger.

On the shore of Crooked Lake there was considerable evidence of predation and destruction of turtle nests. The work looked like that of skunks. No count was made as to the number of nests rooted up, but throughout the summer there must have been at least 20 of them destroyed.

There is one relationship which is questionable since it is based on a single observation. A Black Tern's nest containing three eggs had been visited daily for several days. Once when approaching the nest, located on an old, low muskrat house, a turtle was seen on top of the house. The turtle slid off into the water and upon examination it was found that the eggs were gone. The shallow nest seemed undisturbed but no trace of the eggs remained. This may have been only incidental but it is interesting to note that of the nine tern nests under observation, all of them were destroyed before hatching. Possibly turtles may be a factor affecting mortality of the Black Tern nests.

The feeding of the Great Blue Heron upon frogs and possibly small fish in the sedge habitat has been previously described.

SUMMARY AND CONCLUSIONS

SUMMARY

The purpose of this study is to determine the plant and animal successions as they occur in a recently flooded area. The area studied represents an old glacial lake bed. It includes several small lakes and a large marsh. The topography is very level throughout except for the shallow lakes. The soil is unsuitable for agriculture.

Vegetation

The study of the vegetation is concerned chiefly with the plants in the lakes and their immediate borders. The lakes vary considerably as far as plant and animal life are concerned and are considered separate ecological units.

Ely Lake is a small lake which contains very little plant and animal life. Environmental conditions are similar to the other lakes and there is no apparent reason for this difference. The aquatic plantings of the Federal Resettlement Administration did not survive and spread whereas in the other regions the plantings were quite successful.

Plant life is very abundant in Little Tom Lake. The various stages of succession are quite clearly defined and form concentric rings around the lake. The stages occur in order from the center as follows: open water, a submerged stage, a floating stage, a zone of sedges, and the shore habitats which are variable. The south shore is a quaking bog, the north and east shores rise rather abruptly to a mixed hardwood upland, whereas the west side continues as a tall grass marsh. The lake is fairly good for fishing. Bird and mammal life is relatively scarce.

Crooked Lake is a large shallow body and supports an enormous quantity of aquatic vegetation. Since the vegetation in its present stage is comparatively young, zonation of plants is very incomplete. Bird life on the lake is plentiful. Food and cover conditions for waterfowl are good but there is an obvious lack of favorable nesting conditions. Life history studies were made on the Pied-billed Grebe and the Black Tern.

The Bravo Marsh is an artificial marsh of about 1500 acres. Aquatic plantings have been made and in addition, several plants have come in from unknown sources.

Animal Life:

The animal life has been discussed from the standpoints of abundance, habitat, and activity relations. The study took place in the summer, so seasonal activity and fluctuations can not be discussed. No accurate censuses were made of the animal populations but throughout the course of the study the relative abundance of various forms was noted.

The number of waterfowl nesting on the area was estimated by counting the number of separate broods of young observed. In the Bravo Marsh the following ducks are known to have nested: Mallard Duck, Black Duck, and Blue-winged Teal. Mallards, Blacks, and Green-winged Teal were found to nest on Crooked Lake. In addition to the waterfowl, the following birds nested on the area: Spotted Sandpiper, Killdeer, Eastern Red-wing, Eastern Kingbird, Pied-billed Grebe, Least Bittern, Long-billed Marsh Wren, and Black Tern. The muskrat is the only mammal which is known to be active in the lakes. Other mammals present are the white-tailed deer, skunk, cottontail rabbit, and the fox squirrel. Amphibians and reptiles are represented by a large number of individuals but relatively few species.

Animal relations have been divided into habitat and activity relations. Certain forms exhibit a strong affinity for definite habitats. Activity relations are not particularly complex inasmuch as the different species occupy different habitats and there are not enough individuals of any one species to cause a noticeable conflict.

The Pied-billed Grebe nested chiefly in the floating vegetation. A preference for the yellow water lily or a mixture of the water lily and pickerel-weed seemed evident. The Black Tern occupied the same habitat as the grebe but nested in drier situations. Two Least Bittern nests were found in the sedge-meadow habitat at Crooked Lake, whereas the Long-billed Marsh Wren nested in the taller grasses. The duckweed beds in the Bravo Marsh harbored many insects. Tadpoles were also abundant. The mat of green vegetation seemed to serve as a good protection for these forms.

A conflict was indicated between the Black Tern and the Pied-billed Grebe but intensive studies gave no definite conclusions. The terns used the old grebe nests and in one case a nest containing both kinds of eggs was found. A tern which seemed to be fighting with a nesting grebe was observed on one occasion. Skunks were quite active in digging up turtle nests on the shore of Crooked Lake. A possible predation of the turtle on the Black Tern was suggested by the fact that a turtle was found on an old muskrat house which had been the site of a tern's nest. Upon examination the nest was present but no trace of the eggs could be found.

In general it might be said that the reflooding has added to the value of the area. The Bravo Marsh has been greatly enlarged and by other artificial changes has been made attractive for waterfowl, particularly in the migrating season. Crooked Lake has been brought back to its former

status. Vegetation has again become abundant and the lake serves as a resting place for ducks as well as a nesting site for several other species of birds. Little Tom and Ely Lakes were little affected by the reflooding.

CONCLUSIONS

Whether or not the restoration of the Waterfowl Area has been, or will be, a success cannot be definitely determined from a two months study. From these records and observations, however, some idea as to the value of the project can be obtained.

The aquatic plantings have added much to the area to make it attractive to, and usable by, the waterfowl. Since all of the plants were obtained from nearby sources, the only cost involved being the labor, the plantings may be considered practical. In order to maintain the growth of these species, the water level must be held constant. This seems to be the greatest difficulty on the area. The source of water supply is not constant and consequently during a dry season evaporation over such a large area will tend to lower the water level to a greater degree than many of the aquatic plants can tolerate.

It is doubtful whether the plantings served the purpose intended. Neither waterfowl nor other birds were attracted to the region in considerable numbers for nesting. Most of our waterfowl normally breed farther north. Only a small percentage of the area is suitable for breeding by such important species as mallards and black ducks. Though game bird populations may not be increased by the project, yet the region may provide opportunities for useful experimentation.

The Bravo Marsh is at present a waterfowl refuge and should continue as such. It provides an excellent opportunity for the waterfowl to "stop off and rest". A trip was made to the marsh rather early in the migrating season and a goodly number of ducks were found on the area. Crooked Lake is near enough to take care of the overflow from the marsh and will probably provide fairly good hunting. This adds to the value of the project.

Ely Lake has been developed into a recreational area and probably will serve the public better in that way than it would as a waterfowl habitat. The aquatic plantings in this lake were of no avail and there are very few native plants present. Very little insect life is in evidence and fish life is scarce. The reason for this is not known. The Institute for Fisheries Research conducted a study of the lake, considering plant and animal life, acidity, and various other factors. There seems to be nothing in their report that would explain the lack of life in this lake.

Crooked Lake offers opportunity for more detailed life history studies on the Least Bittern, Black Tern, Pied-billed Grebe, and any possible ecological relationships.

If the area is to be developed, some sort of management program is required. Problems such as predator control, disease, planting of duck foods, and maintenance of the water level will have to be considered. The area offers an excellent opportunity for banding birds during the spring and fall migrations, studies on individual breeding and nesting activities, and further studies regarding the plant and animal successions.

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CHECK-LIST OF VERTEBRATES

All of the species listed here were observed in the Bravo Marsh, on the lakes, or in their immediate vicinity. No particular effort was made to study forms other then the more or less aquatic species and those which are directly connected with a marsh or lake type of habitat. A total of 5 amphibians, 4 reptiles, 33 birds, and 6 mammals have been recorded.

Class AMPHIBIA

Bufo americanus Holbrook	American toad
Bufo fowleri Garman	Fowler toad
Rana cantabrigensis Baird	Wood frog
Rana clamitans Latreille	Green frog
Rana pipiens Schreber	Leopard frog

Class REPTILIA

Thamnophis s. sirtalis (Linne)	Common garter snake
Natrix s. sipedon (Linne)	Water snake
Chrysemys bellii marginata (Agassiz)	Western painted turtle
Emys blandingii (Holbrook)	Blanding turtle

Class AVES

Podilymbus p. podiceps (Linne)	Pied-billed Grebe
Chlidonias nigra surinamensis (Gmelin)	Black Tern

Anas p. platyrhynchos Linne	Common Mallard
Anas rubripes tristis Brewster	Common Black Duck
Querquedula discors (Linne)	Blue-winged Teal
Nettion carolinense (Gmelin)	Green-winged Teal
Botaurus lentiginosus (Montagu)	American Bittern
Ixobrychus e. exilis (Gmelin)	Eastern Least Bittern
Butorides v. virescens (Linne)	Eastern Green Heron
Ardea h. herodias Linne	Great Blue Heron
Rallus l. limicola Vieillot	Virginia Rail
Fulica a. americana Gmelin	American Coot
Actitis macularia (Linne)	Spotted Sandpiper
Pisobia melanotos (Vieillot)	Pectoral Sandpiper
Oxyechus v. vociferus (Linne)	Killdeer
Zenaidura macroura carolinensis (Linne)	Eastern Mourning Dove
Circus hudsonius (Linne)	Marsh Hawk
Megaceryle a. alcyon (Linne)	Eastern Belted Kingfisher
Melanerpes erythrocephalus (Linne)	Red-headed Woodpecker
Tyrannus tyrannus (Linne)	Eastern Kingbird
Cyanocitta c. cristata (Linne)	Northern Blue Jay
Corvus b. brachyrhynchus Brehm	Eastern Crow
Agelaius p. phoeniceus (Linne)	Eastern Red-wing
Sturnella m. magna (Linne)	Eastern Meadowlark
Sturnus v. vulgaris (Linne)	Starling
Melospiza m. melodia (Wilson)	Eastern Song Sparrow
Richmondena c. cardinalis (Linne)	Eastern Cardinal

Passer d. domesticus (Linne)	English Sparrow
Stelgidopteryx ruficollis serripennis (Audubon)	Rough-winged Swallow
Toxostoma rufum (Linne)	Brown Thrasher
Telmatodytes p. palustris (Wilson)	Long-billed Marsh Wren
Sitta c. carolinensis Latham	White-breasted Nuthatch
Turdus m. migratorius (Linne)	Eastern Robin
Sialia s. sialis (Linne)	Eastern Bluebird

Class MAMMALIA

Ondatra z. zibethica (Linne)	Muskrat
Mephitis nigra Peale and Beauvois	Eastern Skunk
Sylvilagus floridanus mearnsii (Allen)	Cottontail rabbit
Sciurus hudsonicus loquax Bangs	Southern red squirrel
Odocoileus virginianus borealis (Miller)	White-tailed deer
Procyon l. lotor (Linne)	Raccoon