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An ecological study of waterfowl habitat at Powell's slough, Utah Lake

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AN ECOLOGICAL STUDY OF WATERFOWL HABITAT AT POWELL'S SLOUGH, UTAH LAKE

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This thesis by L. Bruce Barnett is accepted in its present form by the Department of Zoology and Entomology of Brigham Young University as satisfying the thesis requirements for the degree of Master of Science.

Signed

7 May 1964
Date

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INTRODUCTION

Statement of the Problem

This study attempts to give a preliminary survey of the marsh habitat in Powell's Slough near Utah Lake. The following aspects are treated: seasonal waterfowl utilization of the slough, productivity of nesting waterfowl, description of the vegetation, invertebrate analysis, and analysis of environmental factors that may influence the habitat.

Review of the Literature

The earliest work on Powell's Slough was done by Cottam (1926) in his phyto-ecological study of Utah Lake. Besides a detailed history and geological study of the valley, he established the plant formations that are found there. At Powell's Slough he recognized four formations:

The Marsh Formation
  Pondweed Association
  Bulrush-Cattail Association
  Sedge Association
The Peat Bog Formation
  Sedge-Helenium Association
The Salt Marsh Formation
  Salt Grass Association
  Bunch Grass Association
The Sandy Beach Formation
  Marginal Swamp Beach Zone

Murphy (1951) studied the ecology of passerine birds wintering at Utah Lake on a marshy shore near Provo City airport. White (1963) studied the summer aquatic invertebrate populations at Mud Lake marsh. He also observed some waterfowl activities and the effect that cattle had upon nesting.

Harrison (personal communication, 1963) did extensive waterfowl census

work for the U. S. Fish and Wildlife Service from 1931 to 1944 at Powell's Slough, but unfortunately his reports were incorporated into summaries and then discarded. In general, his observations indicate that the area was utilized much more heavily by waterfowl then than now.

Some waterfowl studies that were made on the Bear River and Ogden Bay Refuges have been applicable to the present work. Nelson (1954) discussed the factors in the development and restoration of waterfowl habitat at Ogden Bay. At one of the Bear River marshes, Wingfield (1951) studied the nesting habits and productivity of four common species of ducks.

Description of the Study Area

Powell's Slough is located on the east side of Utah Lake about two and one half miles north of Provo River in Township 6 South, Range 2 East, S. L. B. & M., in parts of sections 19, 20, 29 and 30 (Fig. 1). The study area covers approximately 500 acres and is bounded on the west side by a lake beach ridge covered with cottonwoods and willows which separate the slough from the lake. There are two low spots in the ridge where the water from the slough has channeled through. The slough diminishes to the north where the land gradually rises. To the south it connects to a number of other marshy areas until the Provo Boat Harbor is reached. The east boundary is now marked by cultivated lands and fences that follow the top of a low escarpment that rises eight to ten feet above the slough. This has been established as the meander line by the 1874 government survey, and it divides the private property from the public domain.

The entire slough is fed by natural artesian springs. These give rise to small streams and a number of ponds which eventually drain into the lake through three main channels. The two channels in the southern part of the slough unite to form a common effluent which discharges approximately

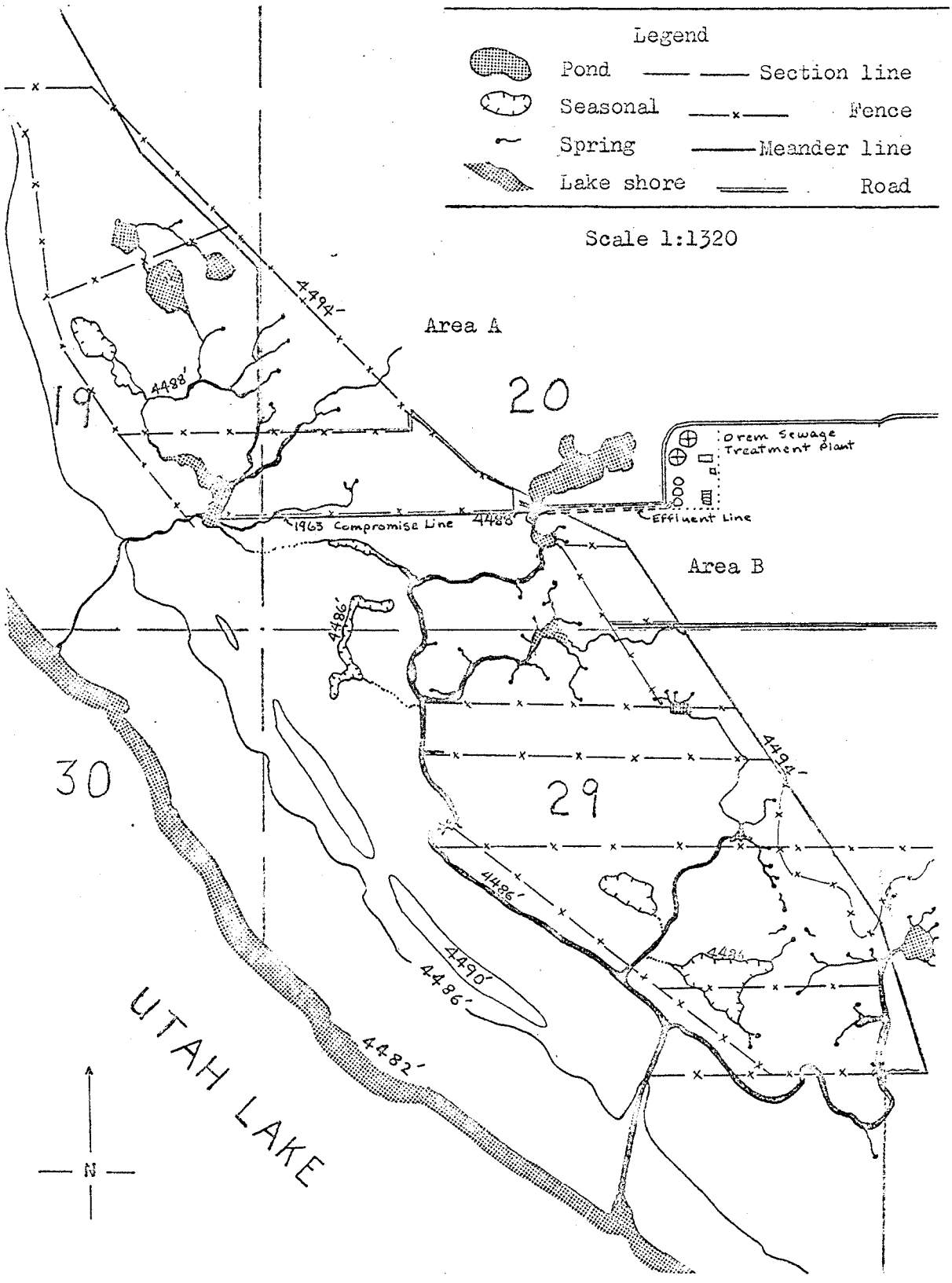

Fig. 1. Powell's Slough. T6S, R2E, Sec. 19, 20, 29, 30. SLB&M.

60 cubic feet per second of water in the spring and 30 cf/s in the fall. The north slough effluent discharges only about 0.5 to 0.24 cf/s. Excess irrigation water from the fields above the slough adds some water in the summer and the Orem City sewage disposal plant regularly adds 6 cf/s to the upper channel.

The natural artesian springs have given rise to one of the most interesting phenomena in this area, the peat bog formation. As described by Cottam (1926):

> The entire region is underlaid by an impervious hardpan, six inches to a foot in thickness, that makes drainage extremely poor, and artesian water which is forced up through breaks in the hardpan becomes permanently ponded and this marks the beginning of the upland bog. These ponds are soon surrounded by a vigorous community of sedges and grasses which steadily encroaches upon them until the open water is completely invaded. The pressure of the natural artesian spring remains sufficient to force the water up through the accumulating organic debris and the raised bogs finally result. Some of the older bogs have peat deposits exceeding 10 feet in thickness at their maximum depths, and they are characterized by an elevation several feet higher than the surrounding land. Usually at their summits artesian springs still pour out their clear, cold water that trickles down the side of the bog in deep, narrow trenches. (Fig. 2 and 3.)

That peat should form here is unusual, since it has generally been thought that an acid environment and acidic plants such as sphagnum moss need to be present (Kendeigh, 1961). The pH of the water is alkaline and apparently neutralizes the acidity of the decaying plants. Cottam (1926) attributed the formation of peat to the almost complete absence of oxygen and to the low temperatures of the artesian water which stops the natural decomposition of the plant remains. Table 1 gives some of the physical factors of the springs.

History of the Study Area

Powell's Slough was named for an early settler who owned the land. The slough was a favorite spot for fishing and hunting, especially water-

Fig. 2. A natural artesian spring in Powell's Slough, 1963

Fig. 3. The upland bog with a streamlet eminating from a spring. Note the elevation of the mound and the water cress marking the spring.

TABLE 1

PHYSICAL DATA OF SPRINGS IN POWELL'S SLOUGH.

	Cottam May, 1926	Barnett, 1963 July	October
Air temperature	22.5°C	26°C	15°C
Water temperature at 4 in.	12.9°C	13°C	13°C
Peat temperature at 1 ft.	17.7°C		
Peat temperature at 3 ft.	14.8°C		
pH of water	7.1 - 7.2	7.2 - 7.8	
Dissolved oxygen		0.58 - 0.75 cc/l (7-10% saturated)	

fowl. Black bass used the clear streams for spawning and in the 1920's a bass hatchery was operated there. Water was impounded by a wooden dam near the entrance of the main stream into Utah Lake, but it was washed out after a few years (Liddiard, Walter, personal communication, 1963).

After the Associated Water Users of the Salt Lake Valley dammed Utah Lake and began using it as a reservoir, the water levels fluctuated enough each spring, and especially in wet years, to form large ponds in the slough. One large, permanent pond existed at the north end on the boundary between sections 20 and 29. This drained directly west into Utah Lake, and boats were often rowed up onto the pond by duck hunters (Minor, Dean, personal communication, 1963). Johnson's Pond in the south end of the slough was also a good spot for hunting (Johnson, Nathan, personal communication, 1963).

The luxuriant plant growth that at one time existed along the bottom and shores of Utah Lake served as a filter to screen out sediments and kept the waters in the slough clear (Tanner, V. M., personal communication, 1963).

However, with the drought of the 1930's and the subsequent deterioration of the lake due to pollution, this cover was destroyed, and in the high flood of 1952 the water covered the entire slough and great quantities of silt were washed in and deposited. Johnson's Pond changed from three feet deep to six inches deep. The north pond was obliterated, and the water from Clegg's Pond and the springs in that area was forced southwest into the main stream. The north stream that flowed into Utah Lake was reduced to a width of two feet and a depth of six inches. Changes equally as great occurred in the marsh vegetation during those years. I was not able to find the following species of aquatic plants that had been reported by Cottam (1926): Potamogeton filiformis, P. praelongus, Batrachium trichophyllum, Ceratophyllum demersum, Sagittaria cuneata, S. arifolia, Alisma brevipes, and Sparganium simplex. Most of these are valuable waterfowl food plants.

During all these years the slough has been used increasingly as a pasture for livestock. Recently, several of the wet meadows were leveled and sown to grasses for hay and pasture.

Also of historical interest has been the development of the Orem City sewage treatment plant. Before 1959 most of the residents of that community had private means of sewage disposal, but some raw sewage was being dumped into Powell's Slough. In December, 1959, a one million dollar sewage treatment plant was installed near Clegg's Pond. It was designed to remove about 90% of the organic and bacterial pollution from the wastes of a population of 45,000 people (Orem Sewage Program, 1959). The effluent from this plant falls into the main stream of the slough and flows into the lake.

METHODS AND MATERIALS

Mapping

I was fortunate in having access to excellent aerial photographs, property surveys and topographic maps prepared by the State Fish and Game Department and loaned or given to me by Mr. LaVar Ware of this agency's regional office in Provo. I used a pantograph to reduce the aerial photograph to a scale of one inch to 1,320 feet. Acreage was then estimated using an Ott planimeter.

Ornithological Field Work

Sight identification was made of all birds, including waterfowl. These observations began February 15, 1963 and continued on a weekly basis until September, and then trips were made only once a month until December when the study ended. During the peak of nesting in May, June, and July, two to three trips a week were made and smaller areas covered each time for thorough checks of the nesting waterfowl. This was done by walking through the marshy areas and wet meadows to flush the hens from their nests. On June sixth and seventh, a rope was dragged between two people over most of the nesting areas to be sure that no nests had been missed. When a nest was found, it was checked and the data recorded on a form (Fig. 4). If the nest would be difficult to relocate, a colored ribbon was tied to the bulrushes about five feet to the north of the nest. The nests were rechecked about every two weeks as long as was necessary. The slough was divided into two areas, A and B, as an aid to field work. The 1963 Compromise Line (Fig. 1) that bisects the slough was the dividing line for this study, and

SPECIES:_____ NO._____

LOCATION:_____

COVER TYPE:_____ HEIGHT_____ DENSITY_____

NEST DESCRIPTION:_____ BOWER_____ MATERIALS_____

DISTANCE TO_____ AND NATURE OF NEAREST WATER_____

HEIGHT ABOVE GROUND_____ ABOVE WATER_____ WATER DEPTH_____

VISIT NO.	DATE	TIME	NO. EGGS	DOWN	PARASIT.	FLUSH DIST.	REMARKS

FATE OF NEST:

SUCCESSFUL:

_____ EGGS HATCHED

_____ EGGS INFERTILE

_____ EGGS, DEAD EMBRYOS

_____ EGGS, REMOVED BY_____

DESERTION CAUSED BY_____

DESTROYED BY_____

OTHER FATE_____

CONDITION OF NEST_____

COMMENTS; MAP

Fig. 4. Nesting data form

field work was generally done on different days in each area.

Vegetation Analysis

A plant collection was made in order to identify the species present and their relationship to or use by the waterfowl. The emphasis was placed on the plants of the marsh community. Dr. Stanley Welsh verified the identifications, and the collection was placed in the Brigham Young University Herbarium.

Analysis of Invertebrate Life and Physical Factors

Fourteen stations were selected in an attempt to check the variety of habitats found at Powell's Slough (Fig. 5 and Table 2). At each station the air and water temperatures were taken, water depth was measured and a sample was taken for the pH determination using a LaMotte colorimetric indicator. Water was also collected for a dissolved oxygen analysis using the Winkler method. A mud sample was obtained to determine soil salinity using a Wheatstone Bridge.

Since I was interested primarily in the invertebrates fed upon by ducklings, the benthic, neustonic and periphytonic organisms were the types studied. The bottom sample was taken by scooping up 500 milliliters (ca. 0.01 m^2) of material in a pan and then washing it through a number 40 brass screen. The swimming and clinging invertebrates were sampled in a semi-quantitative way using an aquatic dip net nine inches in diameter and passing it through the water, under and up against the plants or floating debris for a distance of approximately three feet (ca. 0.2 m^2). These samples were brought back to the laboratory, identified and counted. Determinations were made using Pennak (1953), and Chamberlin and Jones (1929). All of the material was recorded on an aquatic ecology field study form (Fig. 6).

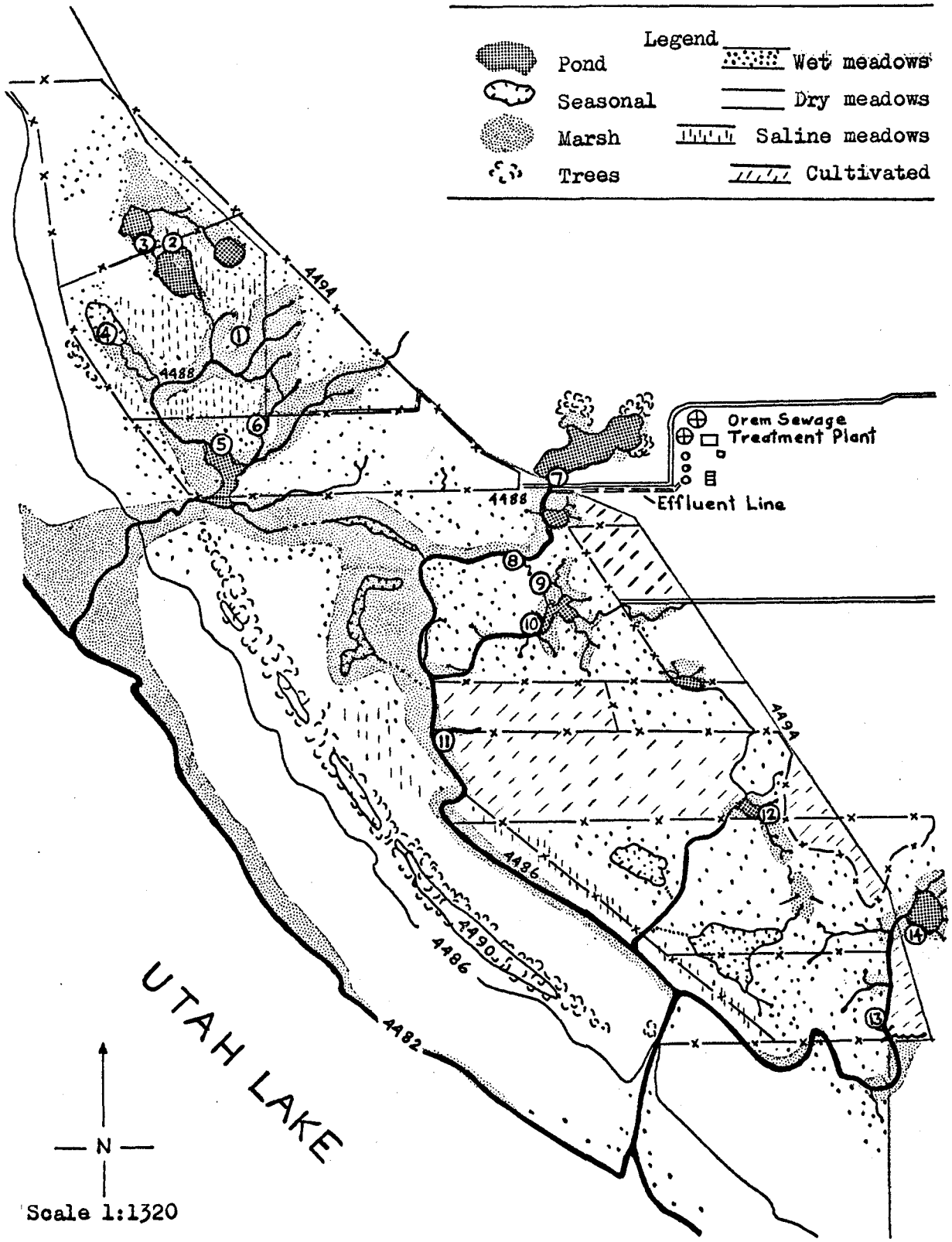

Fig. 5. Powell's Slough, 1963, showing the plant communities and the locations of the sampling stations.

TABLE 2

DESCRIPTION OF THE INVERTEBRATE SAMPLING STATIONS, POWELL'S SLOUGH, 1963

Station	Plant Type	Water	Depth cm	Bottom Composition
1 - marsh	emergent	clear	10-15	deep organic muck
2 - pond	floating	muddy	4-12	loam
3 - marsh	emergent	turbid	2-8	loam
4 - pond	submerged	turbid	0-20[a]	clay-loam
5 - pond	submerged	turbid	4-7	clay-loam
6 - stream	floating	clear	6-20	deep organic muck
7 - stream	submerged	clear	18-23	sand, gravel
8 - stream	emergent	turbid	15-30	deep organic muck
9 - spring	wet meadow	clear	26-35	peat
10 - pond	submerged	clear	24-35	loam
11 - stream	emergent	turbid	35-53	deep organic muck
12 - stream	submerged	clear	23-30	loam
13 - stream	floating	turbid	95-107	clay-loam
14 - pond	emergent	turbid	14-17	deep organic muck

[a]Dry during part of July and all of August.

DATE_____ TIME_____ AREA_____ STATION_____

TEMPERATURE: (AIR)_____ °C (WATER)_____ °C DEPTH_____

DISSOLVED O_2_____ ppm. _____ cc/l _____ % satur. pH_____

TURBIDITY_____ SALINITY_____

NOTES:_____

BIOCIES:_____ AMOUNT OF SAMPLE_____

ORGANISM: NUMBER/_____

BIOCIES:_____ AMOUNT OF SAMPLE_____

ORGANISM: NUMBER/_____

Fig. 6. Aquatic ecology field study form

RESULTS OF THE STUDY OF ENVIRONMENTAL FACTORS

Chemical and Physical Factors

An average of the data gathered at Powell's Slough is presented in Table 3. Water temperatures were moderate in the streams and remained uniform throughout the summer due to the inflow of subterranean waters. Water pH varied between 7.5 and 8.4 which is considered favorable for plant growth (Reid, 1961).

The amount of dissolved oxygen at the various stations was high enough to support life, except at station nine. The water from that small enclosed spring contained less than one part per million of dissolved oxygen which is insufficient for most organisms (Kendeigh, 1961). However, in a large open spring near-by, in which algae were growing, the dissolved oxygen was 2.6 ppm, and in a stream flowing from the peat bog it was 5.4 ppm (70% saturated). Although the artesian water was low in oxygen at its source, it rapidly absorbed enough, when coming into contact with air, to support a large population of invertebrates.

The sewage disposal plant so effectively removes organic wastes and reoxygenates the water, that the stream contained more oxygen below the effluent than above it. Synthetic detergents enter the stream unchanged, but apparently in low concentrations since carp were observed to congregate around the effluent. Concentrations of detergents exceeding 3 ppm are expected to be lethal to aquatic life, but more information is needed in this area (Henderson, et al., 1959). The invertebrate samples taken below the effluent contained the usual species, but in fewer numbers than at other

stations. Submerged aquatic plants were also absent from the stream for several hundred yards downstream.

TABLE 3

AVERAGE CHEMICAL AND PHYSICAL DATA FROM ALL STATIONS AT POWELL'S SLOUGH, JULY - AUGUST, 1963

Station	Time Visited (approx.)	Temperature °C Air	Temperature °C Water	Water Depth cm	Water pH	Dissolved Oxygen ppm	Soil Salinity[a] ppm
1	9 am	25°	23°	8	7.8	5.7	1,525
2	9:30	26°	26°	8	8.4	7.3	933
3	10 am	27°	24°	6	8.2	6.1	
4	10:30	27°	34°	10	7.6	13.1	1,515
5	11 am	27°	30°	6	8.4	12.7	2,622[b]
6	11:30	28°	28°	9	7.8	4.3	
7	9 am	22°	18°	26	7.7	4.4	394
8	9:30	26	19°	22	7.5	7.7	1,559
9	10 am	27°	13°	30	7.6	0.8	516
10	10:30	29°	21°	31	7.6	5.7	
11	11 am	29°	20°	44	8.1	6.7	1,285
12	11:30	30°	20°	26	7.5	5.4	24,000[c]
13	12:00	31°	25°	100	8.0	5.6	
14	12:30	31°	22°	15	7.6	5.2	

[a]One surface sample taken per station, November 28, 1963.
[b]Sample taken in a stand of saltgrass.
[c]Sample taken on a dry ridge encrusted with salt and dried Kochia.

Soil salinity samples taken in November showed most of the slough to be low in total salts at the time. The organic soils of the marshes and peat bogs averaged 0.12% total salts, and the loam, clay-loam, and sandy soils of the ponds averaged 0.09% total salts. These were taken in areas that were covered with water, and in which the typical marsh vegetation was growing well. There were no sterile salt playas in the slough, and the saltgrass meadows and dry ridges amounted to only about 28 acres.

During the summer of 1963, water level fluctuations varied in the different marshy areas of the slough. Ponds that were spring-fed dropped

from one fourth to one half of their high level, and seepage ponds, such as the one in the northwest of the slough (Station 4), completely dried up by August first. Much of the northeast marsh also dried up during June except for streams from the springs. These two marshes produced over 50% of the waterfowl nests. With the water gone, the nests were no longer protected and were open to attack by predators. This greatly reduced waterfowl productivity in area A. A number of low areas were flooded in the spring, but they did not support aquatic plants, nor were they utilized very much by waterfowl. These areas were characterized by large stands of cockleburs and wet meadow vegetation.

Good waterfowl habitat in the form of marshes or ponds amounted to only 20% of the slough. In comparison, Wingfield (1951) reported a water-land ratio of 1:2.5 acres at Knudson Marsh, Box Elder County, Utah, where productivity amounted to 5.3 nests per acre. I found a 1:24 acre water-land ratio at Powell's Slough, where productivity was one nest per 24 acres. The north end of the slough (area A) had a water-land ratio of 1:9 acres, and the south end (area B) had a ratio of 1:59.

Invertebrate Life

The presence of invertebrates was checked at each station in Powell's Slough during July and August (Table 4). Stations two, seven, ten and twelve contained the greatest total numbers of invertebrates. The amphipods and tendipedid (Chironomidae) larvae were the most common types collected. Corixids were most common around floating detritus. Tendipedid larvae were usually the dominant organisms in the mucky bottoms around the bulrushes. Station four, although it was dry during August, contained a rich invertebrate population when observed at other times of the year. Gastropods were especially abundant at this station. The greatest popula-

TABLE 4

MEAN NUMBER OF COMMON AQUATIC INVERTEBRATES PER SQUARE METER, POWELL'S SLOUGH, JULY - AUGUST, 1963

Station	Plant Type	Amphipod	Corixid	Tendipedid	Other Insects	Gastropod	Total
1	Emergent	42	22	203	7	127	402
2	Floating	308	793	188	277	118	1,687
3	Emergent	2	248	251	23	34	558
4	Submerged	0	0	0	321	341	663
5	Submerged	204	217	251	45	26	743
6	Floating	348	450	0	39	77	913
7	Submerged	1,060	1	1,493	2	0	2,558
8	Emergent	57	3	253	43	1	355
9	(Spring)	485	0	50	2	2	538
10	Submerged	2,005	12	593	55	140	2,805
11	Emergent	6	18	457	28	17	525
12	Submerged	1,013	5	1,275	41	6	2,339
13	Floating	265	38	411	85	9	805
14	Emergent	318	8	55	26	3	897
	Average:	449	134	437	65	58	1,143

tion of invertebrates occurred around submerged aquatic plants such as the pondweeds. The next most abundant population of invertebrates was found in floating duckweeds and algal mats. Emergent vegetation such as bulrushes and cattails contained the least amount. Waterfowl nesting was highest at stations where all three plant types were present and the invertebrate population was correspondingly high. There was little nesting in areas composed of emergent plants only where the invertebrates were few. Some nesting occured in meadows where the near-by water contained submerged and floating vegetation and an adequate supply of invertebrates was assured.

Plant Communities

The vegetation at Powell's Slough was grouped into four major communities according to the type of habitat and plant species present (Table 5).

This classification was used because of its relationship to waterfowl.

TABLE 5

PLANT COMMUNITIES AT POWELL'S SLOUGH WITH APPROXIMATE ACREAGE

Marsh Community	105
Emergent Marsh Type	85
Free Floating Aquatic Type Submerged Aquatic Type	20[a]
Wet Meadow Community	160
Dry Meadow Community	215
Saltgrass Type	28
Upland Weed and Herb Type	105
Cultivated Type	82
Deciduous Tree Community	20

[a]Equals total water area, hence is potential, not real.

The marsh community (Table 6) was the most valuable to waterfowl because of their nesting and feeding habits. Emergent plants such as the bulrushes were used by 75% of the breeding birds for cover and nesting. The seeds (achenes) are known to be a favorite food of ducks in the fall (Martin and Uhler, 1939). However, when hardstem bulrushes and cattails grew together in compact stands, waterfowl usually would not enter. The parts of the marsh where the vegetation was too thick for waterfowl production were along the north and west sides of the main stream from station seven to station eleven, and by stations three and five.

The free floating aquatic plants, while of little use for food themselves, served as a microhabitat for many invertebrates fed upon by ducklings. These plants were usually found in the springs and small ponds and around the bases of the bulrushes where some obstruction kept them from being swept away by the current.

TABLE 6

A LIST OF THE PLANTS FROM THE MARSH COMMUNITY AT POWELL'S SLOUGH, 1963

Common Name	Scientific Name	Abundance[a]	Cottam 1926
	SUBMERGED AQUATIC PLANTS		
Bladderwort	Utricularia minor	R	
Muskgrass	Chara sp.	O	*
Pondweed, horned	Zannichellia palustris	C	*
Pondweed, sago	Potamogeton pectinatus	R	
	FREE FLOATING AQUATIC PLANTS		
Duckweed, big	Spirodela polyrhiza	O	*
Duckweed, fern	Azolla caroliniana	O	*
Duckweed, little	Lemna minor	C	*
Liverwort	Riccia fluitans	R	
Liverwort	Ricciocarpus natans	O	
	EMERGENT AQUATIC PLANTS		
Bulrush, hardstem	Scirpus acutus	A	*
Bulrush, Olney's	Scirpus olneyi	A	*
Cattail	Typha latifolia	O	*
Cress, water	Rorippa nasturium-aquaticum	C	*
Marestail	Hippuris vulgaris	R	*
Water Parsnip	Berula erecta	O	*

[a]A-abundant, C-common, O-occasional, R-rare

Submerged aquatic plants are not common in the ponds and streams of Powell's Slough. The horned pondweed is most often seen, followed by muskgrass. The sago pondweed was present in a few streams where the bottom was firm. Few or no submerged aquatic plants would grow where the water was turbid due to the feeding activities of the carp. Cattle walking in the ponds would also stir up the mud. Submerged aquatic plants, especially the sago pondweed, are the most important waterfowl plant foods in the United States (Martin and Uhler, 1939).

The wet meadow community was dominated by the grasses and sedges (Table 7). Where open water was near, the waterfowl would use the tall grasses for nesting. The meadows were also extensively grazed by cattle. This community was characterized by the occasional innundation of water and damp soil which supported a luxuriant growth of vegetation. Most of the springs in these meadows were two to six feet higher than the surrounding ground owing to the accumulation of peat. The borders of the wet and dry meadows overlap, and as a result the plant list is somewhat arbitrary.

There were three types of dry meadows (Table 8): the saltgrass meadow from which most plants were excluded due to high soil salinity, the upland weed and herb type of meadow which contained most of the plant species in the dry meadow, and a special area, the cultivated grass meadow. The cultivated fields were reclaimed from both wet and dry meadow areas and planted to crops and grasses. Many of the grasses were escaping into surrounding fields. Waterfowl, especially the geese, foraged in the stubble after the hay was mowed. The dry meadows at Powell's Slough were not used for nesting, although ducks are known to use this type of habitat (Sowls, 1955, Kortright, 1943, Wingfield, 1951).

The deciduous tree community is located on the sandy beach ridge that separates the slough from the lake. It is dry and the trees are of mature proportions. The principle trees are cottonwoods, willows and box elders. Where the ridge is lower and the water table higher, dense stands of tamarisk are growing. Elsewhere in the slough, tamarisk and Russion olive occasionally grow on the dryer elevations. As far as I could determine, this community was not used by the waterfowl.

TABLE 7

A LIST OF PLANTS FROM THE WET MEADOW COMMUNITY AT POWELL'S SLOUGH, 1963

Common Name	Scientific Name	Abundance	Cottam 1926
Bedstraw	Galium tinctorum : G. trifidum	R	
Bittersweet	Solanum dulcamara	O	
Blue-eyed grass	Sisyrinchium angustifolium	O	*
Bulrush, common	Scirpus americanus	C	*
Buttercup	Ranunculus cymbalaria	C	*
Cinquefoil	? Potentilla pectinisecta	O	
Clover, sweet	Melilotus officinalis	C	
Clover, white	Trifolium repens	C	
Cocklebur	Xanthium italica = Now. X. strumarium	C	*
Cutgrass, rice	Leersia oryzoides	O	
Cyperus	? Cyperus erythrorhizos	R	
Dock	Rumex fueginus	C	*
Dock, curley	Rumex crispus	C	*
Eupatorium	Eupatorium maculatum	O	
Foxtail barley	Hordium jubatum	A	*
Goldenrod	Solidago canadensis	C	
Goldenrod	Solidago occidentalis	O	
Grass, rabbitfoot	Polypogon monspeliensis	C	
Grass, reed canary	Phalaris arundinacea	O	*
Indian paint brush	Castilleja exilis	C	*
Lovegrass, creeping	Eragrostis hypnoides	O	*
Medick, black	Medicago lupulina	C	
Monkey flower	Mimulus guttatus	C	*
Nettle, hedge	? Stachys palustris	C	
Nettle, stinging	Urtica gracilis	C	*
Orchid, hooded spiral	Spiranthes romanzoffiana	R	*
Plantain	Plantago major	C	*
Primrose, evening	Oenothera hookeri	R	*
Ragweed	Ambrosia elatior : A. artemisiifolia ?	C	*
Rush	Juncus torreyi	R	*
Rush, wire	Juncus balticus	C	
Sedge	Carex lanuginosa	C	
Sedge	Carex praegracilis	O	
Sedge, Nebraska	Carex nebraskensis	C	
Silver weed	Potentilla anserina	C	*
Smartweed	? Polygonum persicaria	O	
Smartweed, nodding	Polygonum lapathifolium	O	*
Sneezeweed	Helenium montanum : H. autumnale	C	*
Speedwell	Veronica americana	O	*
Speedwell	Veronica anagallis-aquatica	O	*
Spikerush	Eleocharis rostellata	C	*
Spikerush	? Eleocharis coloradensis	R	
Spikerush, pale	Eleocharis macrostachyas	C	
Thistle	Cirsium lanceolatum	C	*
Thistle, Canada	Cirsium arvense	A	
Verbena, blue	Verbena hastata	A	*

TABLE 8

A PARTIAL LIST OF PLANTS FROM THE DRY MEADOW COMMUNITY AT POWELL'S SLOUGH, 1963

Common Name	Scientific Name	Abundance	Cottam 1926
	SALINE MEADOWS		
Gray Molly	Kochia vestita	C	*
Saltgrass	Distichlis stricta	A	*
Saltwort	Glaux maritima	C	*
Seepweed	Suaeda depressa	O	*
	UPLAND WEEDS AND HERBS		
Aplopappus	Aplopappus lanceolatus = Haplopappus	O	
Aster	Aster adcendens = A. chilensis	O	*
Bee Flower	Cleome serrulata	R	
Bugleweed	Lycopus lucidus	O	*
Fleabane	Erigeron glabellus	O	
Fleabane	Erigeron loncophyllus	C	
Foxtail barley	Hordeum jubatum	C	*
Iva	Iva xanthifolia	C	
Mallow, prairie	Sidalcea oregana	O	
Scratchgrass	Muhlenbergia asperifolia	C	
Spearscale	Atriplex patula var. hastata	C	
Sunflower	Helianthus nuttalli	O	
Thistle	Cirsium scariosum	O	
Thistle, Russian	Salsola kali var. tenuifolia = S. kali	O	

Other Biotic Factors

Competition for the available water and light limited some plants from growing in certain areas of the slough. Plants such as cattails and hardstem bulrushes can force out smaller plants and annuals because of their vigorous rootstock and rank top growth (Nelson, 1954). This has resulted in these plants taking over about 50% of the marshy areas of the slough, and since waterfowl do not usually nest in such close vegetation, the marsh supports fewer nesting birds. As these thick stands of marsh plants die and fill in the marsh, plant succession is evident. Tall wet

meadow types, such as the stinging nettle, can be seen among the bulrushes.

Carp were found in every pond except at station four and in every stream except the small ones from the springs. Besides uprooting much of the aquatic vegetation, it is known that they create such turbid conditions in the water that sunlight is excluded and the submerged plants cannot exist (Martin and Uhler, 1939). This was obvious in comparing the ponds at stations two and four. The waterfowl preferred the clear water and the relative abundance of submerged aquatic plants at station four. The water was continuously turbid at the station two pond because the finely-divided soil particles of the bottom were easily stirred up by carp and cattle. As a result, very few submerged plants were in the water.

While cattle broke up dense stands of bulrushes with their grazing, they also destroyed six (28.5%) of the nests. Two nests were subsequently started in places that had been opened up by cattle, but they were unsuccessful. Most of the meadows were grazed; some so extensively as to keep the plant cover reduced to the ground level. Cattle were not as restricted in their grazing by the depth of the water as by the total depth of ooze and water. The peat bogs and deep oozy marshes generally were avoided by the cattle. One heifer became trapped in the ooze near station ten and drowned even though the water was only 20 centimeters deep.

During March and April some of the dense stands of dried bulrushes were burned at stations three, five and fourteen. This practice did not seem to benefit the waterfowl in any way since the rootstocks soon began to put forth their spring growth and became as thick as ever. This might have adversely affected nesting since mallards and Canada geese were beginning to nest the first week of April, and the fire destroyed some of the grassy margins of the marsh.

RESULTS OF WATERFOWL CENSUS

Seasonal Movement of Waterfowl at Powell's Slough

The seasonal migration of waterfowl is closely connected with weather conditions, and observations in any one year would not necessarily be indicative of the general trend. Figure 7 gives the average duck population trends in Utah over a five year period as a comparison. Since most migrating birds stay out on Utah Lake unless they are feeding or a storm forces them into the marsh, these observations made at Powell's Slough are not intended to give a complete picture of migration. Data of this kind also require daily observations since the birds are constantly moving.

Figure 8 shows the numbers of waterfowl that were observed in Powell's Slough during the visits made there in 1963. In the first part of February a small group of approximately 60 mallards, pintails and Canada geese were observed on the lake shore just south of the slough. They would come into the slough to feed or rest on the springs and streams that did not freeze over. These winter residents soon began pairing. About the first of March they were joined by cinnamon teal, green-winged teal, and a few shovellers along with more mallards and pintails. Those not already paired soon formed pair bonds, and cinnamon teal mating flights were particularly conspicuous over the slough. On March 30, the first gadwalls, American widgeons (Baldpates), and redheads were seen. A few ruddies, buffle-heads and lesser scaup appeared on April 17, and on April 24, some blue-winged teal were seen for the first time. Most waterfowl do not linger long in the spring, but continue their northern flight (Nelson, 1961), so that large concen-

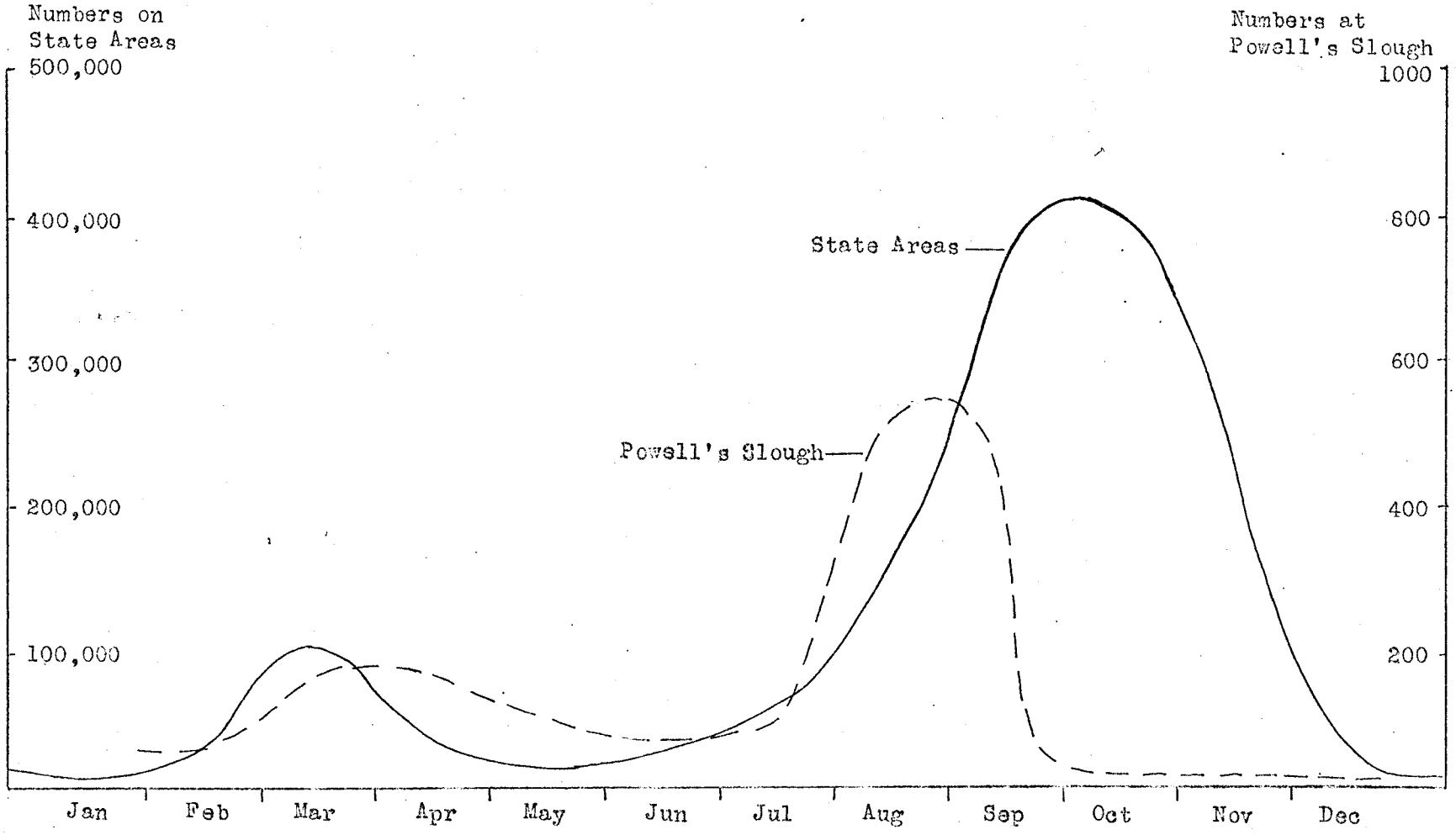

Fig. 7. Average duck populations on State Waterfowl Management Areas, 1947-1952 (Nelson, 1961) compared with duck populations at Powell's Slough, 1963.

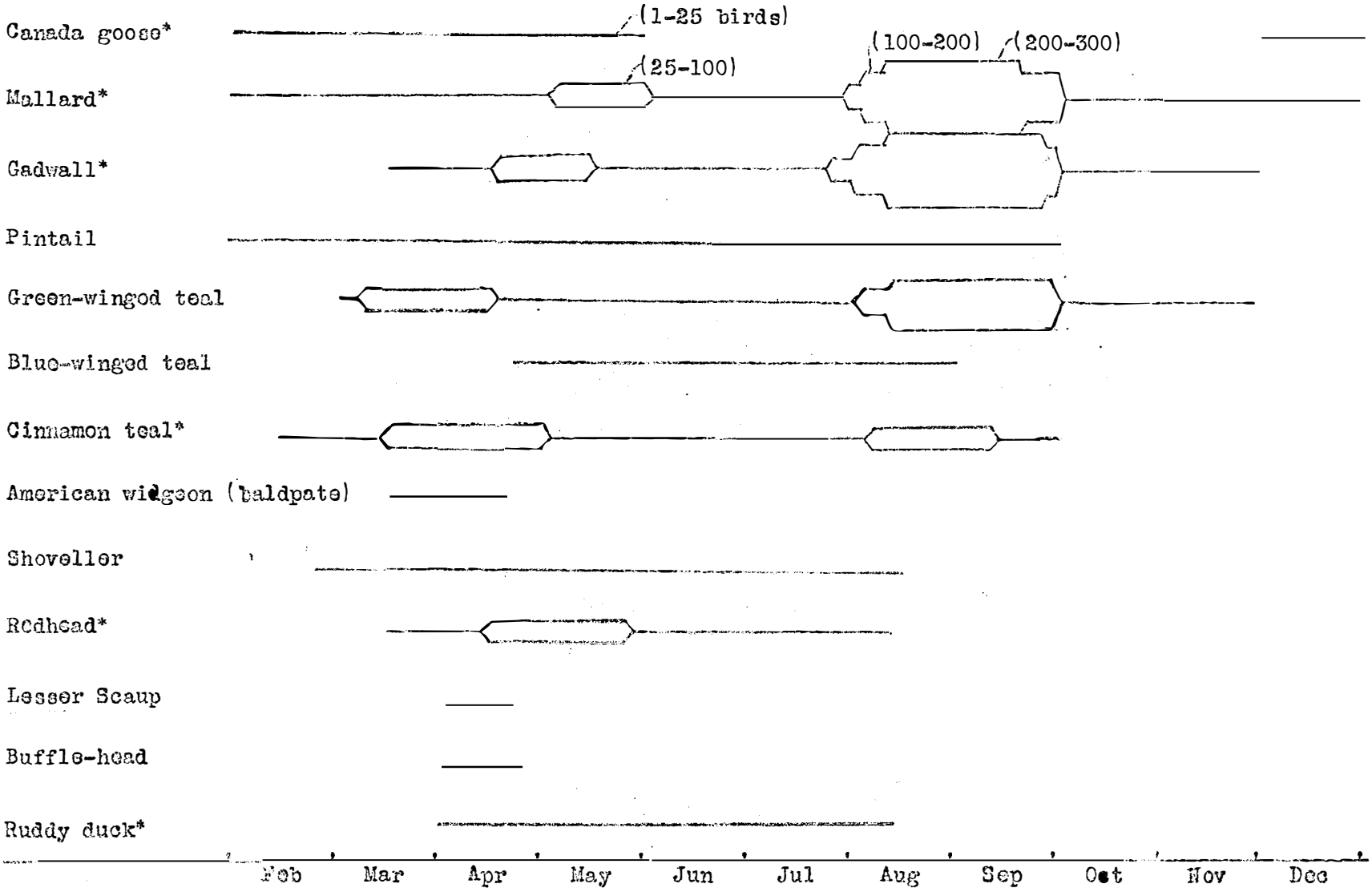

Fig. 8. Seasonal waterfowl utilization of Powell's Slough, 1963. (*Nested)

trations are seldom seen. None of the baldpates, lesser scaup, or bufflehead stayed here. Of those species that stayed during the summer, the Canada geese, mallards, gadwalls, cinnamon teal, redheads, and ruddy ducks were the only ones that nested. A few male pintails, shovellers, and blue-winged and green-winged teal were seen on the ponds occasionally.

The first waterfowl to leave Powell's Slough following nesting were the Canada geese in May. This was so early that I suspect the goslings were killed since they would not be ready to fly until September. The blue-winged teal, shovellers, redheads, ruddies, and cinnamon teal left the slough early in the fall, all being gone by September first.

Large concentrations of mallards, gadwalls, and green-winged teal began building up during August and September. At this time of the year the males were in eclipse plumage and resembled the females. After the opening of the hunting season on October first, the ducks were not seen much during the day in the slough. During October of this year there were few storms to drive the ducks south, and as a result the build-up of waterfowl during the fall migration period was smaller than usual. When the freeze-up came in December, the ducks migrated rapidly without stopping at the slough to feed. By the end of December there remained only a few geese and mallards.

All available water areas were utilized by the waterfowl during the spring migration. Ducks could be found in pairs on almost all of the ponds, wet meadow streams and the main streams draining into the lake. However, during the fall migration the ponds containing large stands of hardstem bulrushes were preferred over the streams. Several hundred ducks could be flushed from the bulrushes where they would be feeding.

Nesting Data

The results of the nesting study revealed a much lower productivity than had been anticipated in Powell's Slough. Approximately 120 man-hours were spent searching for nests over the marshy and wet meadow areas of the slough, and only 17 nests and four broods whose nests escaped detection were found, making a total of 21 nests (Fig. 9). Cinnamon teal and mallards were the most common species with eight and six nests respectively (Fig. 10). Other species included the Canada goose, redhead, and gadwall with two nests each, and one ruddy duck brood. This gives a nesting density of one nest per 24 acres for the entire 500 acre slough. However, since much of the area is not suitable for nesting, density can be calculated as one nest per eight acres of marsh. Seventeen nests were found in area A of the North marsh and only four in area B which contains 300 acres (Fig. 11). The greatest concentration of nests was four nests per acre on the northwest marsh in area of bulrushes and grasses.

The greatest distance from water that a nest was found was 12 feet. The average distance was two feet, and over half of the nests were built on island-like clumps of bulrushes or grasses in the water. Mallard nests were on the average two feet from the water, cinnamon teal 3.5 feet, and redhead nests one foot from the water. The one goose nest was found on top of a muskrat house, and the ruddy nested in an island of hardstem bulrushes in the middle of a pond.

The Olney's bulrush association was the preferred cover type used for nesting, followed by hardstem bulrushes and then various grasses and sedges typical of the wet meadows (Fig. 11). The mallards and cinnamon teal preferred the Olney's bulrush and the meadow, while the redheads and ruddies utilized only the hardstem bulrush. However, the nests were not located

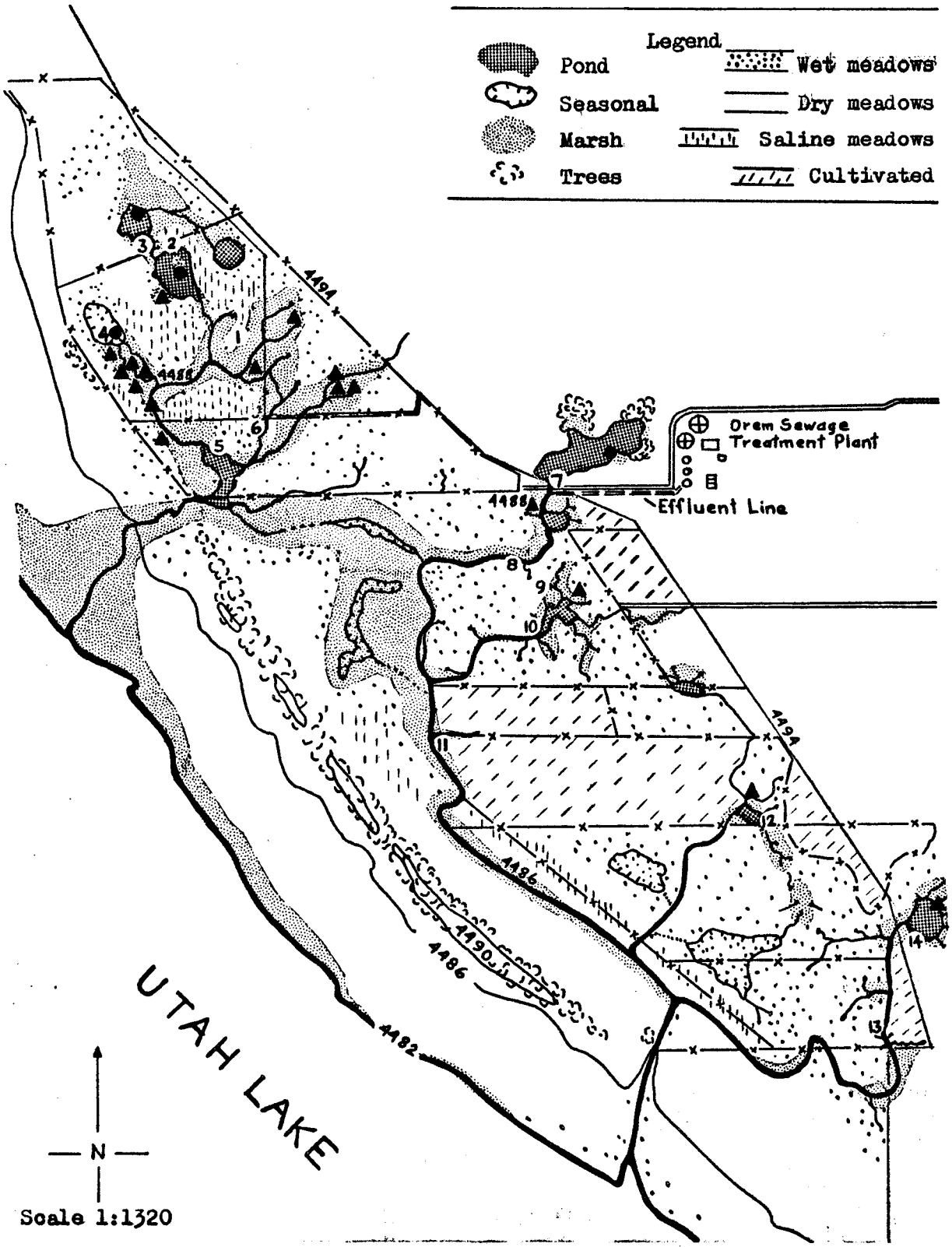

Fig. 9. Map of Powell's Slough showing the location of nests (▲) and broods (●), 1963.

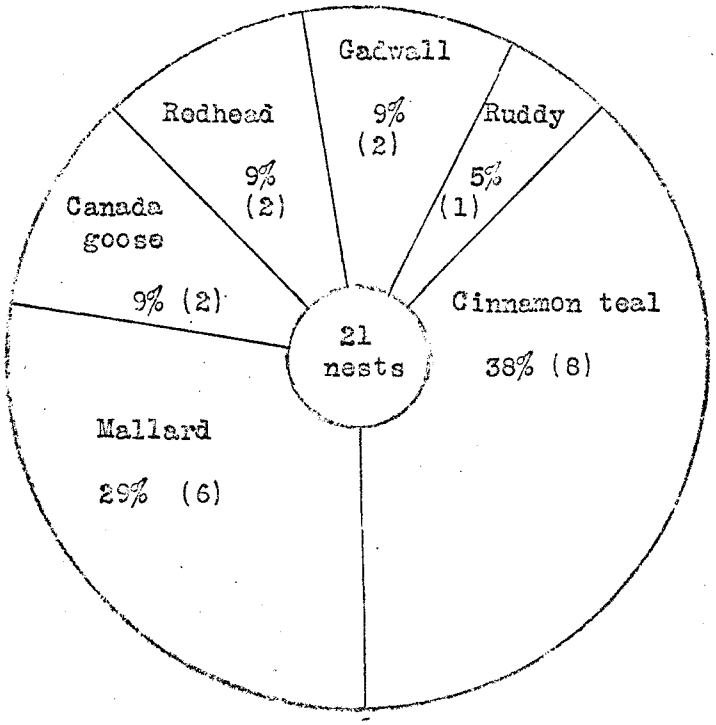

Fig. 10. Summarization of the nesting species for which nests or broods were found at Powell's Slough, 1963.

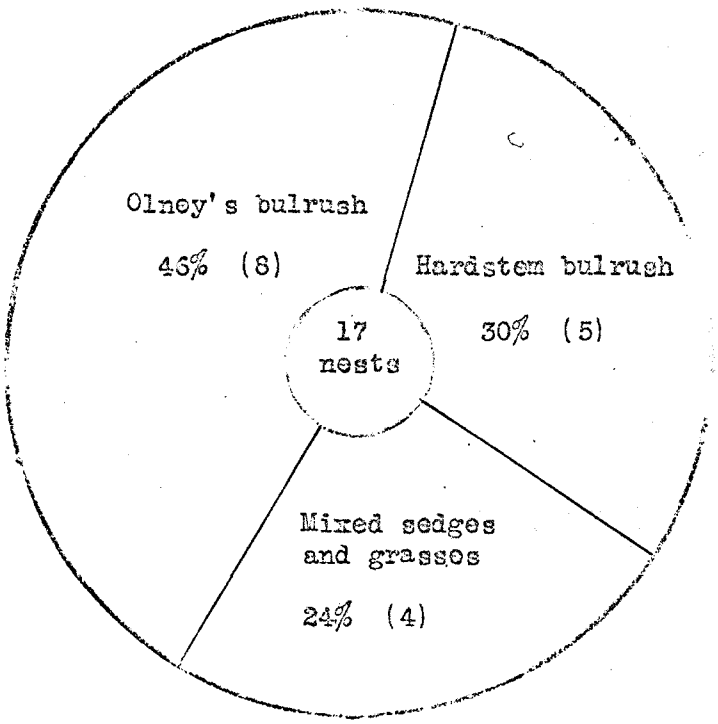

Fig. 11. Utilization of plant cover types by species for which nests were found at Powell's Slough.

in thick, tall stands of bulrushes, but in open areas and near the edges. Figure 12 shows a cinnamon teal nest in a habitat that was preferred, and figure 13 shows the poorest of the marsh cover types.

The nests were usually constructed of two parts: the bowl, and the bower or canopy over the nest. The former was usually constructed of dried grasses or bulrushes and lined with down. The amount of down gave an indication of the length of time the hen had been tending the nest (Wingfield, 1951). The bower was also made of dead vegetation, although by June new plant growth was also used. Dead clumps of Olney's bulrush made the best nests. The bent-over stems formed a strong, tight bower, and the bowl was naturally formed underneath (Fig. 16). Mallards generally concealed their nests the best, the teal's nests were only partially covered, and the redhead's nests were concealed the least.

The date of nest initiation was approximated by back-dating from the time the nest was found by counting the number of eggs present. This was accurate within a one to two week period as each area was rechecked that often during the nesting season. When broods were found, the average number of eggs for the species plus the average length of time of incubation (Kortright, 1943) was added together to determine the date of nest initiation. For example, the brood of ruddy ducklings was first seen on June 27 while in the downy stage. Back-dating 36 days gives the date of May 22 which is the latest possible date the nest could have been started, and it could have been several days sooner. Information on the initiation and fate of the nests was recorded bi-monthly, and the results are given in figure 14.

Nesting began during the second week of April. Two mallard and two Canada goose nests were observed at that time. The peak was reached during the first two weeks of May with four cinnamon teal and two mallard nests

Fig. 12. A preferred type of nesting habitat at Powell's Slough. A clump of grass or bulrushes on an island usually protected the nest from predators and cattle, and concealed it from view.

Fig. 13. Dense stands of hardstem bulrushes were least used by nesting waterfowl at Powell's Slough. They attracted migrating birds in the fall around the edges of ponds where the stands were open and they could feed.

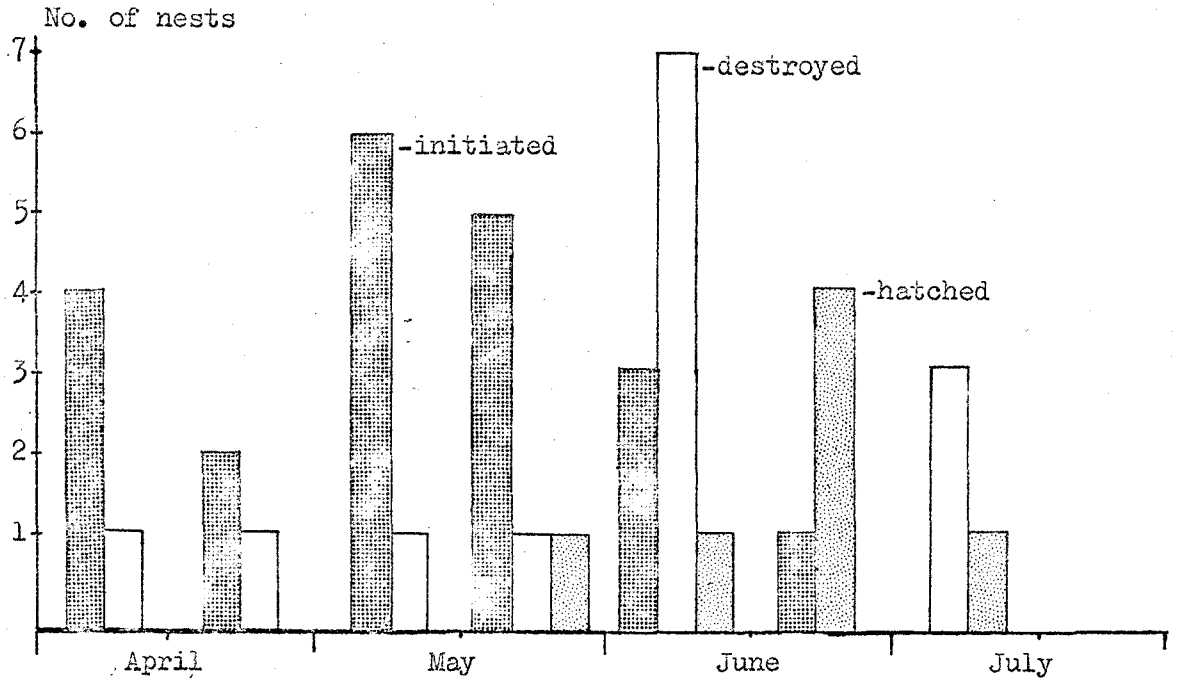

Fig. 14. Chronology of nest initiation, destruction, and hatching, Powell's Slough, 1963.

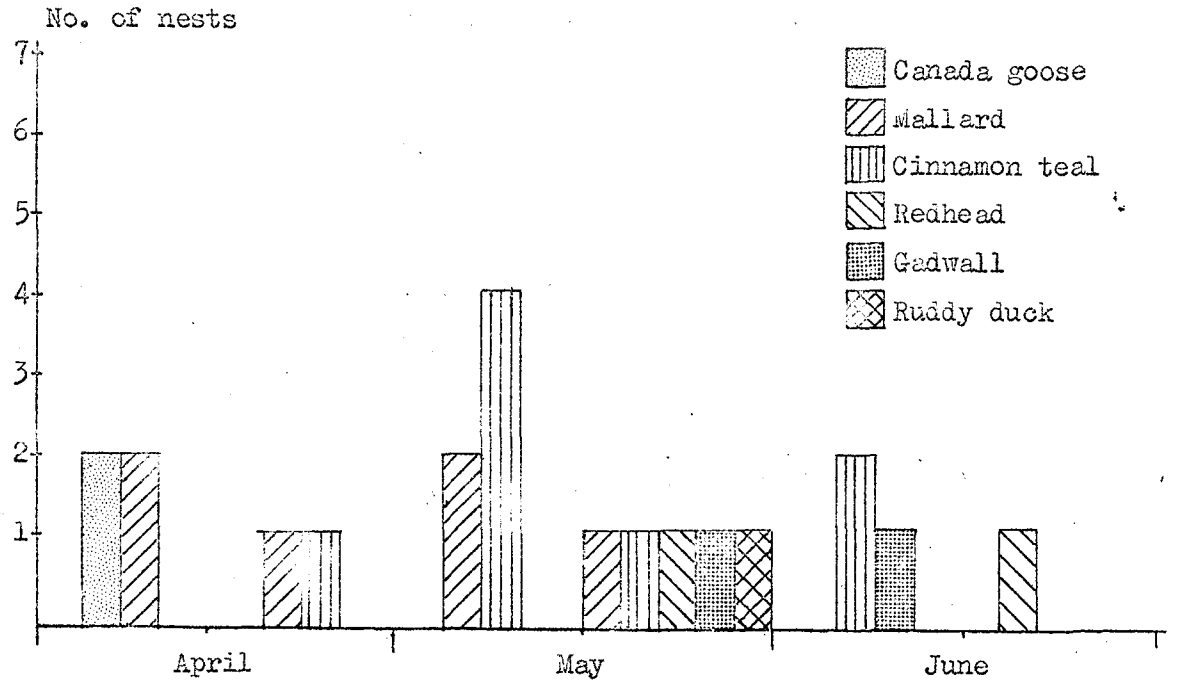

Fig. 15. Nesting chronology of waterfowl species starting nests at Powell's Slough, 1963.

starting (Fig. 15). Nest initiation ended in June indicating that very little second nesting was attempted. A mallard that began nesting about May 20 and laid only five eggs might have been a second attempt. There was no evidence of any other second nesting, which reduced the productivity of the slough considerably. Sowls (1955) reported that 10 to 50 percent of the successful nests at the Delta marsh were the result of renesting following early-season nest destruction.

There were only two cases of social parasitism where a bird laid an egg in another species' nest. This usually is quite common, especially with the redheads (Wingfield, 1951). A cinnamon teal nest was found on May 20 with ten teal eggs and two redhead eggs (Fig. 17). On June first, a second visit to a mallard nest revealed the addition of a small brown egg of some non-waterfowl species. In both cases the hens were still tending the nests. There was no evidence of abandonment of the nests due to parasitism.

Nesting success amounted to 33.5% or seven out of 21 nests that hatched. The Canada geese had 50% of the nests successful, the mallards 33%, the cinnamon teal 13%, and the redheads were unsuccessful in bringing off a hatch.

The causes of nest failures were primarily cattle destruction and predation (Fig. 18). The peak of nest destruction occured during the first week of June when nesting was at its highest. At the same time, some of the marsh dried up permitting terrestrial predators to reach the nests. Cattle were also turned loose to graze in the slough then. Unknown causes of nest failure could include human distrubance which would cause the hen to abandon the nest (Sowls, 1955), and destroyed nests where the cause was uncertain. The primary predator appeared to be the weasel because the destroyed nests were undisturbed and the egg shells were broken in from the small end of the egg

Fig. 16. The pond and marsh at station four, although drying up in August, was heavily used by both migrating and nesting waterfowl earlier in the spring.

Fig. 17. A cinnamon teal nest that was parasitized by a redhead. The bower of dried bulrushes was partially removed to see the nest better.

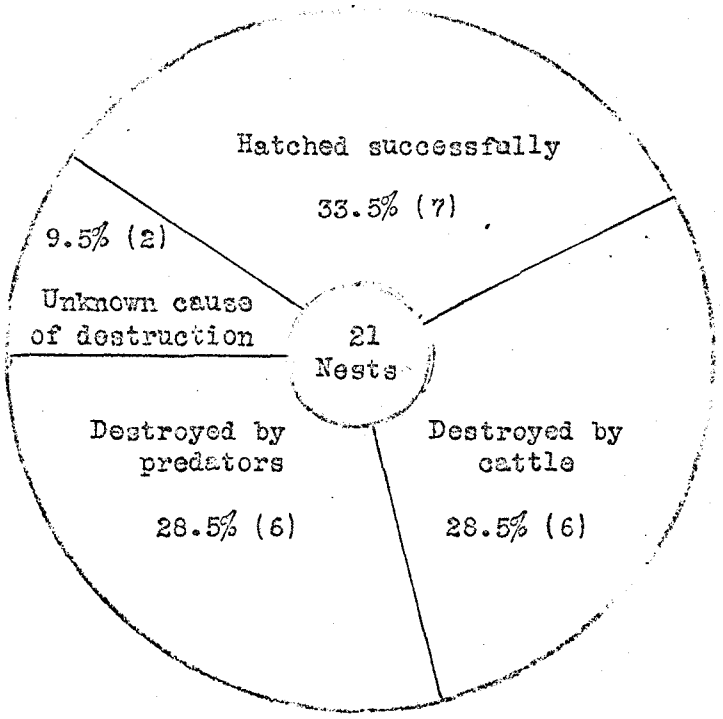

Fig. 18. Summarization of the fate of 21 nests or broods found at Powell's Slough, 1963.

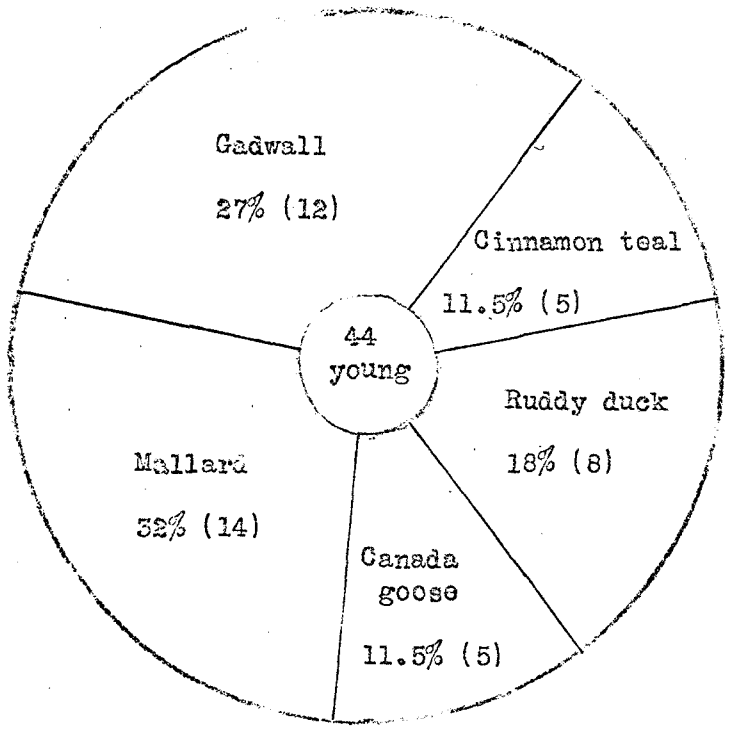

Fig. 19. Total number of young hatched by each species, both actual and estimated, at Powell's Slough.

and the broken fragments of the shell were small (Rearden, 1951). In one case the hen, a mallard, was also killed and eaten on the nest.

Total waterfowl production for 1963 at Powell's Slough amounted to 44 chicks known to have hatched (Fig. 19). This amounts to 0.073 per acre. Counting only the 105 acres of marsh and ponds, a productivity figure of 0.42 young per acre is obtained. Wingfield (1951) reported 14.9 young per acre at Knudson Marsh.

Besides the census kept on waterfowl, a record was also kept of some of the other species of birds seen in the slough (Fig. 20).

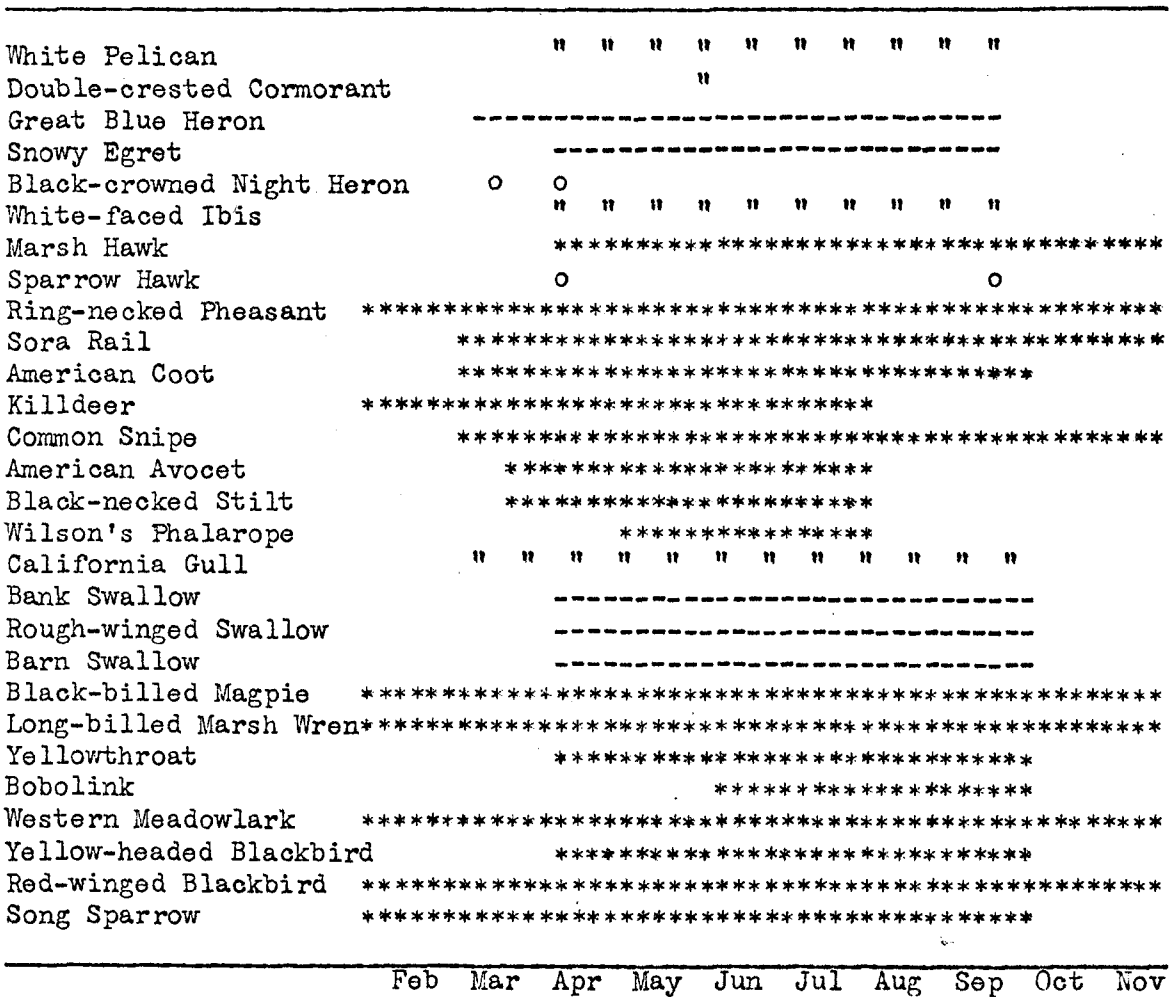

Fig. 20. A check list of the birds seen in Powell's Slough, 1963. (*) lives in slough, (-) common visitor, (o) rare visitor, (") seen overhead.

DISCUSSION

With the constant encroachment of agriculture upon wetlands, there has been a reduction in the availability of waterfowl habitat. This is one of the factors that has contributed to the decline of the waterfowl population as a whole and has even placed in jeopardy of extinction a number of species (American Ornithologists' Union, 1963). To counteract this trend there has been a movement among wildlife agencies and clubs to obtain title to wetlands and develop them into suitable habitats for waterfowl. Considerable development of this kind has been done on the Great Salt Lake Marshes at Bear River, Ogden Bay, and Farmington Bay. There is none, however, around Utah Lake, the largest freshwater lake in Utah.

The Utah Fish and Game Department leased an area on the east side of Utah Lake known as Powell's Slough from the federal government in December, 1961, and made plans to develop it as a wildlife management unit. However, legal action by the local farmers, who continue to graze their livestock in the area, has delayed this project.

The results of my study indicate that waterfowl productivity in Powell's Slough is quite low due primarily to the lack of habitat, although other factors also influence it. The temperature, pH, salinity, and dissolved oxygen of the water favor a good marsh habitat for nesting waterfowl. One of the limiting factors to waterfowl production is water depth and fluctuation. Lowering water levels during the spring in the north marsh allowed predators to reach the nests, and it eliminated the most-used nesting habitat from production early in the season. Ponds with water in them only a

few months in the spring do not support aquatic plants nor are they utilized by the waterfowl. The scarcity of permanent ponds and marshes due to the drainage pattern in the southern half of the slough (area B) makes it unattractive as a nesting area.

It was feared that the sewage effluent would pollute the water and thus lower the dissolved oxygen content, resulting in conditions favorable for the production of avian botulism. However, the disposal plant cleans the effluent of organic wastes and reoxygenates it before entering the slough, eliminating the danger of pollution except for synthetic detergents which are noticeable in the water. The reason why the stream contained fewer invertebrates and lacked submerged aquatic vegetation below the effluent was not determined, although several factors could be involved. Detergents are suspected, but the presence of invertebrates makes this seem unlikely. Carp destruction would account for some of it, and the oozy shifting bottom would make establishment difficult for anything but hardstem bulrushes and cattails.

Recent studies by Collias and Collias (1963) indicate that "the distribution of broods of ducklings is roughly correlated with the abundance of the invertebrates that apparently comprises the main food of many species of ducklings in their first week after hatching." Waterfowl in Powell's Slough favored nesting sites where invertebrates were abundant. However, while the population of invertebrates per square meter of water in the slough is adequate, the small proportion of wet areas does not afford much production.

Of the four major plant communities in Powell's Slough, the marsh is the most important to waterfowl for nesting, feeding, and cover. However, the marsh is deteriorating in several ways. Some of the submerged aquatic plants fed upon by waterfowl that were mentioned in earlier studies have

disappeared from the ponds and streams. About 50% of the marsh areas of the slough are covered with thick stands of hardstem bulrushes and cattails that are drying up due to plant succession and have smothered out the other aquatic plants. Because the bulrushes are so impenetrable, they are not utilized by waterfowl except around the margins where the stands are more open. Marsh succession is gradually changing these areas into wet meadows as the dead plants pile up and decay.

From the results of the waterfowl productivity study, one wonders if the slough can be used successfully as a waterfowl area. In its present condition it is probably producing more as a pasture for livestock, and would certainly require some changes to make it into an attractive habitat for waterfowl. A favorable habitat is necessary not only for nesting and rearing the young, but also for providing food and cover to attract migrating waterfowl from Utah Lake during the hunting season.

The Fish and Game Department plans to dam the main stream as it enters the lake in order to restore the marsh. Damming the stream and raising the water level three or four feet will innundate approximately half of the meadows in Area B. The numerous small islands and peninsulas created by the uneven shore lines will then provide a much more favorable habitat for waterfowl than would one large pond. Sowls (1955) has pointed out that the usefulness of a breeding area depends upon the proportion and distribution of nesting meadows and loafing and feeding waters. From the experience of Nelson (1954) at Ogden Bay, it also appears that a constant water level will have to be maintained for several years to allow the proper aquatic plants to become established. Of course, artificial propagation will greatly speed up this process.

In order to maintain the ponds and marshes, it will also be necessary to retard plant succession which, if left alone, will eventually bring

about the disappearance of the habitat and the return of the meadow (Kendeigh, 1961). Areas that are now in advance stages of succession will be covered by the rising water and should once again furnish good habitat.

Several undesirable factors should be eliminated or controlled for the sake of the habitat and the waterfowl. Cattle are causing much more harm than good when they destroy so many nests. Their grazing in the meadows also precludes extensive production of valuable duck food plants such as wild millet and smartweeds. Nelson (1954) reported a phenomenal growth of such plants following exclusion of cattle with the added result that the ducks began to nest in the protected areas.

It is important that the carp population be kept under control. Findings here and at Ogden Bay Refuge (Nelson, 1954) indicate that carp damage to aquatic plants can be severe if their numbers are unchecked. Control measures might also be considered against weasels because of their predation on waterfowl.

SUMMARY

A survey of waterfowl productivity and the environmental factors affecting it was conducted at Powell's Slough during 1963. Water temperature, pH, salinity, and dissolved oxygen was checked at 14 stations during July and August, and conditions were found to be favorable for a good habitat. The sewage disposal plant effluent apparently has no adverse affects on the habitat either. The 500 acre slough contains approximately 20 acres of ponds and 85 acres of marsh. Most of the slough is composed of wet meadows (160 acres) and dry or saline meadows (215 acres). The drying up of some of the ponds and marshes, plus the lack of marshy areas due to the natural drainage of the land were the most serious limiting factors to waterfowl productivity. About half of the marsh is drying up as the plants decay and fill it in, changing the habitat to a meadow community. Livestock grazed throughout most of the meadows and some of the marshes of the slough. They were responsible for the destruction of some of the nests, but were of some benefit in tramping down some of the dense stands of bulrushes. Carp were common in the streams and ponds, and their feeding activities kept the mud stirred up which is detrimental to aquatic plants.

Canada geese, mallards, and pintails wintering around Utah Lake used Powell's Slough for feeding and protection. In March and April migrating birds fed and rested on the ponds and streams, but did not stay long. A few pintails, green-winged and blue-winged teal, and shovellers stayed all summer, but did not nest in the slough. The species nesting were: Cinnamon teal (8), Mallard (6), Canada goose (2), Redhead (2), Gadwall (2),

and Ruddy duck (1). There were large flocks of ducks feeding in the bulrushes and on the ponds during September, but very few were seen during October and November of 1963.

There were 17 nests and four broods, whose nests I could not find, counted in the slough. Nesting density was one nest per 24 acres. There were 17 nests in the north marsh (area A), and four nests in the south (area B). Olney's bulrush was the preferred nesting cover with 46% of the nests built in dried clumps of it. 30% of the nests were in hardstem bulrushes and 24% in grasses and sedges. Hardstem bulrush was used by the redhead and ruddy ducks only if it was near open water and not too thick. The highest concentration of nests was four per acre in the northwest marsh.

Nesting began in April, reached a peak the first of May, and ended in June. There was very little second nesting due to a reduction in the nesting habitat. 33.5% of the nests hatched successfully. The mallards had 33%, the cinnamon teal 13%, and the redheads failed to hatch a single chick. Two broods of gadwall, one ruddy, and one Canada goose also represented successful nests. I counted 44 chicks that hatched out during this study. This is a total of one per two acres of marsh. Nesting failures were caused by cattle (43%), predators (43%), and unknown causes (14%). The weasel appeared to be the only predator.

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AN ECOLOGICAL STUDY OF WATERFOWL HABITAT AT POWELL'S SLOUGH, UTAH LAKE

An Abstract of

A Thesis

Presented to the

Department of Zoology and Entomology

Brigham Young University

In Partial Fulfillment

of the Requirement for the Degree

Master of Science

by

L. Bruce Barnett

May, 1964

ABSTRACT

Because of the potential that Powell's Slough near Utah Lake holds as a waterfowl area, an ecological study of the slough, and a census of the waterfowl was made during the spring and summer of 1963. The invertebrate life, plant communities, and several aquatic physical and chemical factors were analyzed.

The 500 acre slough contains approximately 105 acres of marshes and ponds, and 375 acres of meadows. There were 21 nesting pairs of waterfowl found giving a density of one nest per eight acres of marsh. Cattle grazing and weasel predation destroyed 14 of the nests, leaving the remaining nests to produce 44 chicks.

The limiting factors for waterfowl production were: lack of good marsh habitat, fluctuating water levels, and cattle and predator destruction of the nests. Deterioration of the habitat has resulted from: flooding and silting from Utah Lake, carp destruction of aquatic plants, plant succession filling in the marshes, and cattle grazing in the slough. Environmental conditions appear favorable for the establishment of a good waterfowl habitat if the streams leaving the slough could be dammed and the water levels controlled.

APPROVED:

May 7, 1964