THE ECOLOGY OF WILD DUCKS IN TWO CENTRAL MICHIGAN IMPOUNDMENT MARSHES

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Frederick James Ignatoski

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THE ECOLOGY OF WILD DUCKS IN TWO
CENTRAL MICHIGAN IMPOUNDMENT MARSHES

By

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INTRODUCTION

The two areas used during this study are located near Houghton Lake in central Michigan. The Dead Stream Impoundment, also known as the Muskegon River flooding or Reedsburg backwater, Michigan's first combination waterfowl-fishing-recreation impoundment, was developed in 1938. The other area, known as the Houghton Lake Flats Flooding, or "Pike Marsh", was developed in 1964 to serve wild ducks and to increase spawning of the Northern Pike (*Esox lucius*).

The Dead Stream Area

The Dead Stream-Muskegon Impoundment floods about six miles of meandering river valley, and has long been known for its excellent fishing and hunting; and the flooding has attracted nesting Ospreys, Bald Eagles and Great Blue Herons. A number of studies have been done at this area, starting back in 1939 when cover mapping was done by Ben Jenkins (1939). Later, studies of waterfowl and plant succession were done by Norcross (1952) and Di Angelo (1953).

However, active management was delayed until 1964, when a "drawdown" (the controlled lowering of water levels) was tried to "rejuvenate" the marsh, hopefully to create more suitable habitat for wild ducks. Also, at that time, 42,720 feet of channel and 273 "potholes" were dug by dragline to create openings across the denser marsh to provide nesting spots and loafing islands (Figure 1). The new islands were seeded with brome grass, rye, and Chewing's fescue. Also, 13 one-chain sample strips were sprayed with "Dalapon" at the rate of ten pounds per acre to provide openings across dense stands

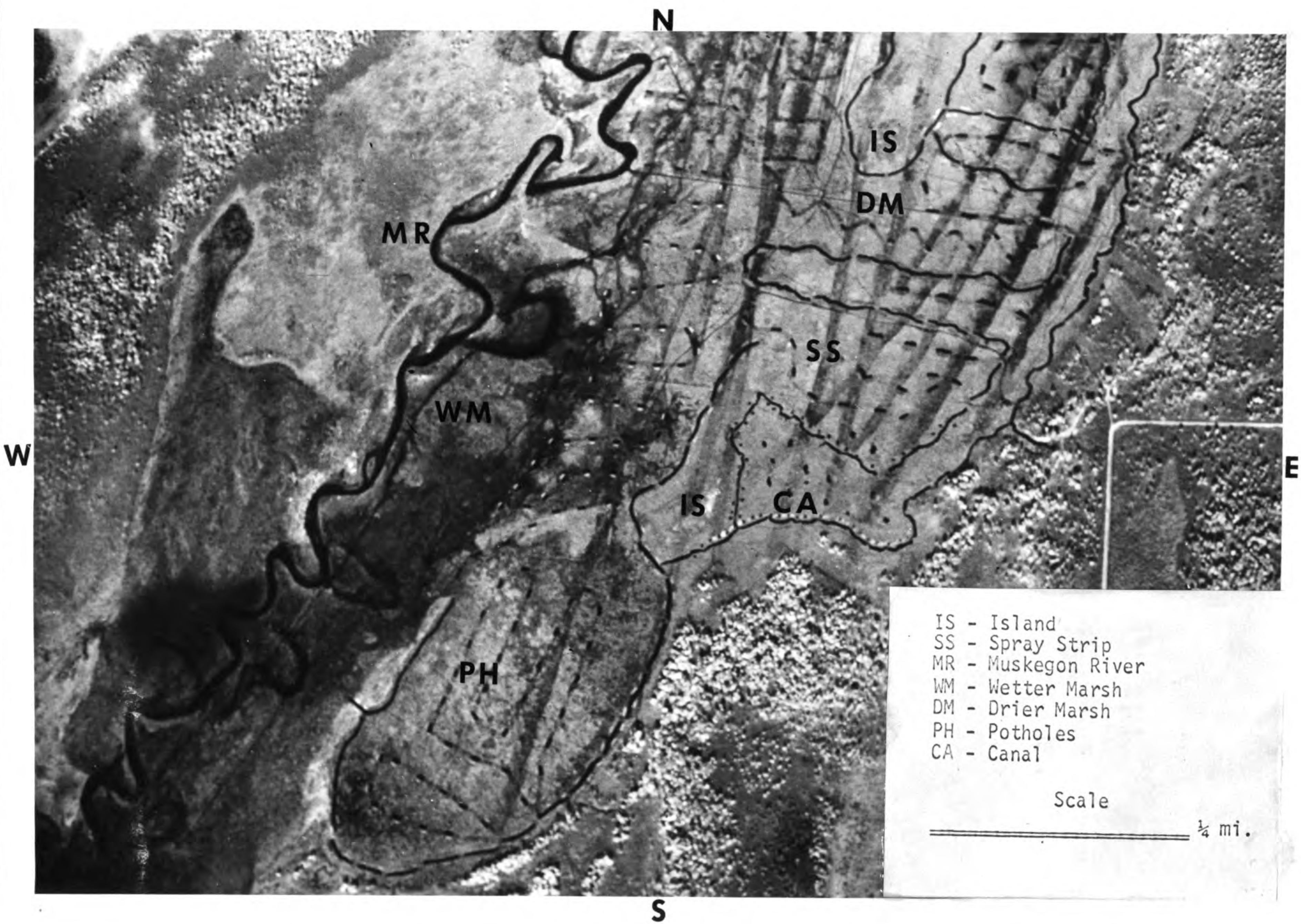

Figure 1. T[illegible] tral area of the [illegible] S[illegible] Impou[illegible]. (October 13, 19[illegible])

of sedges. The blasting of 83 potholes (12' by 3' by 60') with amonium nitrate was also part of the new management program. Trees and brush were clear-cut from islands to improve nesting conditions (Figure 1). Figure 1 also shows the meandering Muskegon River and adjacent to it the wetter part of the marsh (darker area on photograph). The drier area (lighter area on photograph), where most management work was done, lacks water during extensive dry periods, except for ditches and "potholes".

The Houghton Lake Flats Flooding, or Pike Marsh

Houghton Lake, Michigan's largest inland lake, has undergone drastic changes in the last fifteen to twenty years, as have many other Michigan lakes. Most shallow marsh edges, which formerly provided spawning habitat for Northern Pike, are now all but gone, due to the growing development of resorts. Therefore, in the spring of 1964, the Michigan Department of Conservation developed the Houghton Lake Flats Flooding (also called the Pike Marsh area) primarily to create new spawning habitat for Northern Pike and also to attract nesting waterfowl.

This area of land, located at the west side of Houghton Lake, is bordered by two major highways (Figure 2). Draglines were used to dike the north and south ends, and to dredge the series of canals feeding into the main ditch. This was done primarily to supply travel lanes for the pike fry, when water levels are lowered. Also, along these canals, "ponds" were dug to give more open area for waterfowl (along the two southernmost canals, Figure 2). Later, the draglines were used to dig more small ponds along the other canals.

Figure 2. The Pike Marsh. (October 13, 1965)

These lanes greatly facilitated the author's duckboat travel for marsh observations and surveys.

The aims of this study were to provide information on the ecology of waterfowl in terms of duck food and cover at the two nearby impoundments, based on: (1) an analysis of the plant communities of each area, and comparing duck brood use; (2) finding the most-used and preferred foods of ducks in the Pike Marsh - an area lacking many of the "quality" foods; (3) taking aquatic insect samples in the Pike Marsh to determine availability to wild ducks; and (4) determining whether the selection of seeds or invertebrates was related to caloric value.

Waterfowl ecology studies carried out by Bennett (1938), Munro (1943), Mendall (1949), Swank (1949), and Keith (1960) have all provided valuable information. However, little has been done to determine the actual role which foods or vegetation play in determining waterfowl productivity - a major objective of my study.

MATERIALS AND METHODS

Vegetation Sampling

Vegetation was sampled, in July of 1965 and 1966, in the Pike Marsh, by establishing random milacre plots throughout the marsh every ½ to 4½ chains. These figures were arrived at by substituting from the table of random numbers ½ chain for each number, ex: 1 = ½ chain. At each plot, all woody vegetation (Salix) was counted as stems at water level, but herbaceous vegetation (Carex) was counted by taking two square-foot samples from the upper right hand corner of each plot; and again, all stems were counted at water level. Some herbaceous vegetation was present in such small quantities as to permit an entire count. From these plots, data on density, frequency, and coverage could be determined and used in analyzing the composition of the community.

In the Dead Stream, 3 one-hundred foot transects were set out to obtain figures on the types of vegetation present and the percent of species composition. This was done by counting the stems touching the transect line. These data were used mainly to have some idea of the vegetation in relation to brood abundance, not to determine a detailed makeup of the marsh.

Aquatic Insect Samples

Aquatic insect samples were taken as described by Gerking (1962). Using this method, ten randomly chosen sites were sampled every 2½ weeks, from June 15 through October 30, with an Ekman dredge (225 cm^2). Each sample was put in a waterproof plastic bag and taken into the lab to be sorted through three U. S. Standard sieves, 3360, 1160 and 500 microns. The use of sucrose flotation was also applied in sorting. For further information on this sampling method, refer to Gerking (1962). Identification of insects was made according to Usinger (1963).

The sample size was the minimum in which to receive some statistical information, while the time between samples was considered to be a maximum in which one could observe population changes in insect life. Time was a factor in sampling, and a more comprehensive study would have to be carried out to secure data of greater statistical validity.

Brood Census Method

The determination of the number of broods using areas of such size is usually a very difficult and time-consuming project. I thought the best technique at this time was one proposed by Bennett (1965).

Using his method, one or two individuals, observing for one-half hour at each of six predetermined sites located in and around the marsh, can get a fairly accurate brood estimate, with only three days observation. At these sites, data on the species of duck, age class and number per brood are recorded, whenever possible. The canals provided good observations, since the ducks used these openings in travel (Figure 3). Then, using the following equations, I estimated the number of broods.

Figure 3. Blue-winged Teal brood using the type of canal which also facilitated the travel for the Northern Pike fry and the author.

$$x = \frac{b}{\log 10 \, (n+1)}$$

$$n = \frac{x \log 10^e}{dB/dN}$$

$$N = \frac{.43429 \, x}{.008}$$

Total Broods (B) = $x \log_{10} N$

B = estimated total broods

b = number of different broods seen

n = total broods sighted

N = theoretical estimated total brood sighting necessary to see all the broods

For further information on the development of the equations and the limitation of this method, refer to Bennett (1965).

Duck Gullet and Gizzard Analyses

In analyzing waterfowl for foods taken in the Pike Marsh, I used the gizzard, proventriculus and gullet of each specimen. Of the 53 ducks analyzed during the summer and fall, 15 were from duck trapping casualties, 28 were donated by hunters, and only ten were taken under a United States Fish and Wildlife permit. Twenty-seven of the ducks used were Mallards and Black Ducks, and 26 were Blue-winged Teal; and no duck under a 2b class (mostly feathered ducklings) were taken. Most ducks were collected in early morning, although some were taken in midday and evening to observe any change in diet.

The contents of each "stomach" was first washed into a 250-milliliter beaker and any floating seeds or insects were taken out. The remaining materials were then filtered and all soft-bodied insects were removed, so as not to destroy them by heat. The residue was placed in an oven at 50 c. for one-half hour to dry. The material was then screened and the seeds sorted. This was done first by eye and then by use of a disecting microscope. Samples of organic material were also placed under a high-powered microscope for possible identification of algae (Prescott 1950). I collected seed plants from the marsh and classified them according to Fassett (1940). This collection was then used as a reference in classifying all seeds found in the "stomachs". The Munscher seed collection (Cornell University) was also very helpful.

In analyzing the stomach contents, I followed the method outlined by Keith (1960), in which percentage volume, percentage occurrence, importance value, and preference rating were obtained for each food species. Percentage volume is the percentage of seed (in milliliters) compared to the total amount of organic material. Percentage occurrence is the percentage of ducks which had the material.

The use of these figures individually would not give a clear account of waterfowl use, for percentage volume could be misleading if one duck had a large volume of seed, or if in the case of percentage occurrence one could have small amounts of seed in many ducks. Therefore, the products of the two previous figures (called "importance value") is used to help minimize the error of either figure. Preference rating is then obtained by dividing the percentage availability of each seed into the importance value. Percentage availability of seeds was taken into account in the milacre plots and aquatic insect samples.

Caloric Analysis of Duck Foods

In selecting a method for obtaining the caloric values of duck foods, I took into account the limited size of many samples and the time it would take for analysis. The bomb calorimeter, which is the most widely used instrument, proved to have two weaknesses: (1) only a few samples can be analyzed in one day, and (2) a relatively large volume of seed is needed for each analysis. Therefore, I used the organic analysis by dichromate oxidation, as proposed by Maciolek (1962). Maciolek stated that data taken by this method varies only by ±5 percent, when compared to the bomb calorimeter.

By use of this method, one can obtain results from 20 to 30 samples a day, with only 20 to 30 milligrams of material. This proved very beneficial, since large quantities of some seeds were not available.

Caloric values are obtained by determining the amount of oxygen consumed from the potassium dichromate. The material being tested is placed in a 30-milliliter flask, with five milliliters of potassium dichromate and ten milliliters sulfuric acid, and placed in a boiling water bath for three hours, after which the solution is titrated with ferrous sulfate. Then, by use of the following formulas, one can obtain the caloric value for each material.

Oxygen consumed (O. C.)

$$\text{O.C.} = \frac{\text{(reagent blank titer-sample titer) x N ferrous solution x 8}}{\text{Amount of material}}$$

Gram calories gm. cal. = O. C. in mg. x 3.4

3.4 = Kcal/g. O_2 in crude protein, lipid, carbohydrate

For further details on the derivation and procedures of this method were reported by Maciolek (1962).

RESULTS

Vegetative Samples

The vegetation data, taken in July, 1965, from 70 milacre plots were analyzed in terms of frequency, density, and cover. The frequency is plotted (Figure 4) according to the Raunkier classification, in which the vegetation is divided into five groups: A - those plants found in zero to 20 percent of the plots; B - 21 to 40; C - 41 to 60; D - 61 to 80; and E - 81 to 100 percent. The category for each plant species can be seen in Table 1.

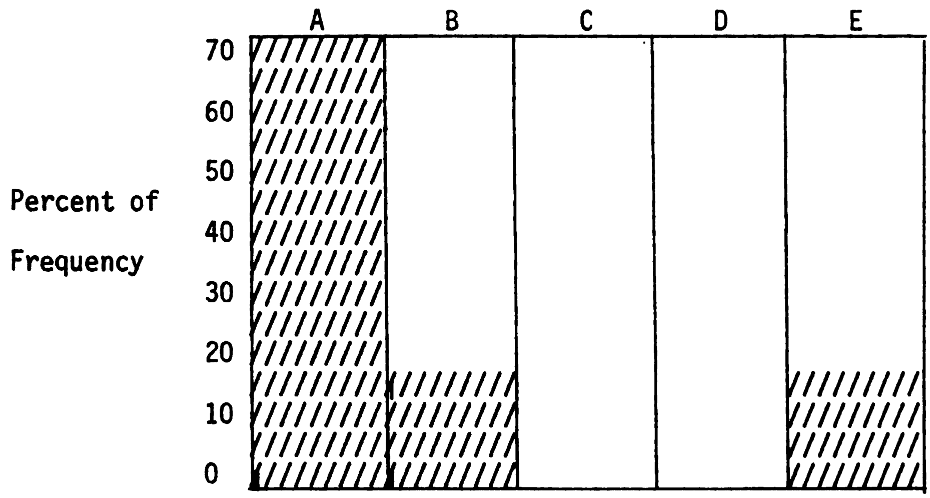

Figure 4. Frequency expressed as a percentage of plants found per milacre plot in Houghton Lake Flats Flooding.

Frequency indicates a very homogeneous community by having few individuals in columns B, C, and D, although using frequency only, as a criterion for determining structure, is not very useful (Oosting 1940).

"Nearest neighbor" results, according to Evans, et al. (1954), along with the milacre plots, indicated a non-random or a clumped com-

Table 1

Statistical data on the plant species found in Houghton Lake Flats Flooding in July of 1965.

Species	n Plots	$\bar{x}$ Mean	$\frac{2s\bar{x}}{\bar{x}}$ 95% Confidence limits of the mean	Total Plots Available	Total Stems	Stems per acre	Percent of cover	Frequency
Herbaceous								
Carex oligosperma	140	12.12	18.64%	16,988,400	205,899,408	527,947	89%	E
Carex & Scirpus sp.	1401	2.30	40.00%	16,988,400	39,903,436	102,316		B
Calamagrostis canadensis	140	2.29	52.40%	16,988,400	38,903,436	99,752	10%	A
Eleocharis palustris	140	1.84	57.61%	16,988,400	31,258,560	80,150		A
Iris versicolor	70	0.84	150.00%	390,000	327,600	840		A
Rubus hispida	70	0.17	111.11%	390,000	105,300	270		A
Utricularia vulgaris	70	0.11	200.00%	390,000	42,900	110	1%	A
Typha latifolia	70	0.07	457.14%	390,000	27,300	70		A
Polygonum amphibium	70	0.07	142.85%	390,000	27,300	70		A
Rumex verticillatus	70	0.03	400.00%	390,000	11,700	30		A
Woody								
Salix sp.	70	7.66	0.08%	390,000	2,987,400	7,660	92.76%	E
Spirea alba	70	2.97	46.46%	390,000	1,158,300	2,970	6.89%	B
Chamaedaphne calyculata	70	1.47	93.87%	390,000	573,300	1,470	0.35%	A
Betula pumila	70	0.03	400.00%	390,000	11,700	30		A

munity, with a homogeneous structure. Table 1 shows the species composition and statistical methods used in obtaining results. Valid statistical information was achieved in the sedges (Carex sp.), willow (Salix sp.), and to some extent bluejoint (Calamagrostic canadensis), spike rush (Eleocharis palustris) and spirea (Spirea alba).

The wide range of error with the remaining plant species is due to the small numbers in which they were present. Some of these plants represent new species, which are just invading the area, such as bladderwort (Utricularia vulgaris), smartweed (Polygonum amphibium), dock (Rumex verticillatus), spike rush, cattail (Typha latifolia), and duck potato (Sagittaria latifolia). These final three plants appeared on the newly disturbed sandy or barren soil area exposed by ditching (Figure 5).

In August, 1965, six months after flooding, samples from an area, adjacent to the west side of the Pike Marsh, showed 70.83 percent more sedges and 46.84 percent more bluejoint, as compared to the flooded area. This initial loss was not as severe as it may appear, since the original vegetation probably was much too thick for good duck use; and a mean of 12 stems per square foot of sedge (Carex sp.) provided excellent cover. However, the July,1966 studies revealed no statistical differences in vegetation in the second year of flooding. The square-foot samples taken in July,1966 revealed a mean of 14.2 stems of sedge (Carex sp.) per square foot, but with 95 percent confidence limit no significant change took place from the previous mean of 12 stems per square foot. The same was true for bluejoint, 3.1 stems per square foot, and other sedges (Scirpus sp.) were 2.9 stems per square foot at

Figure 5. The establishment of cattail and spike rush on an area scalped by the dragline.

this time; but, again, no significant difference was observed. The remaining plants could not be compared, due to their presence in small numbers.

From the author's observations, there was no die-off of willow, spirea, leatherleaf (Chamaedaphne calyculata), low birch (Betula pumila), and blue flag (Iris versicolor) during the second year of flooding. Tag alder (Alnus rugosa), which was present but not found in sampling, suffered a die-off of 63 percent due to flooding. Although no statistical difference could be observed during the second year of flooding, some changes were taking place in the disturbed ditch area. Bladderwort and algae were the only plants found during the first year of flooding; but, in the second year large amounts of duck potato and pondweeds (Potamogeton gramineus and Potamogeton confervoides) had invaded the area, allowing for additional food selection by waterfowl.

The results of the 3 one-hundred-foot transects at the Dead Stream Flooding revealed a very different community. Each species is represented in terms of percent of total vegetation and percent of emergent, floating, or submergent vegetation (Table 2). One can see from these data that the area differs considerably from the Pike Marsh, and that it contains some excellent waterfowl plants, such as burreed (Sparganium spp.), wildrice (Zizania aquatica), soft rush (Juncus effusus), and pondweeds (Potamogeton spp.), also observed by Norcross (1952). Since the sampling was not extensive, some plant species, which occurred in small or scattered areas, were not found.

Table 2

Transect data of vegetation from the Dead Stream in August, 1965, expressed as percent of total vegetation and the percent each plant provided as emergent, floating or submergent growths.

Species	Common Name	Total percent of vegetation	Percent of Emergent
	Emergent		
Sparganium spp.	Burreed	37.66	61.75
Eleocharis spp.	Spike Rush	5.66	9.29
Juncus effusus	Soft Rush	6.00	9.84
Zizania aquatica	Wildrice	4.66	7.65
Pontederia cordata	Pickeral Weed	1.33	2.18
Typha latifolia	Cattail	3.66	6.01
Sagittaria latifolia	Duck Potato	0.66	1.09
Carex & Scirpus spp.	Sedge	1.33	2.19
	Floating		
Nuphar variegatum & Nymphea odorata	Water Lily	24.00	48.00
Potamogeton spp.	Pondweed	26.00	52.00
	Submergent		
Myriophyllum spp.	Water Milfoil	49.00	79.89
Utricularia vulgaris	Bladderwort	12.33	20.11

Insect Samples

Ekman dredge samples from June 15 through October 30, 1965 in the Pike Marsh, are graphed in relation to the number of insects and time (Figure 6). A peak occurred between July 15 and August 1, mostly due to hatching eggs, and then steadily declined, possibly due to predation by Giant Water-Bugs (Belostomatidae), Predacious Diving-Beetles (Dytiscidae), Water-Scorpions (Nepidae), Back-Swimmers (Notonectidae), and Dragonfly larva (Odonata). The loss was mainly of Water-Boatmen (Corixidae), which made up over one-half of the insect life through August. In October, more Damselfly (Odonata) and Midge (Chironomidae) larvae were found, but no significant differences were found from September 1 through October 15. The water-boatmen, damselflies and midges made up 80 percent of the insect life; and eight other insect families made up the remaining population.

Insects in terms of biomass or calories might give a more ideal picture of the actual role they play in the aquatic environment (Odum 1959). However, since the ducks sampled made only a limited use of aquatic insects, these were not emphasized. No invnetory of insects was made in 1966, because of limited use by ducks and their great abundance.

Duck Brood Censuses

With the data obtained from the six observation sites and using the equation previously described, a minimum estimate of 44 broods of duck used the Pike Marsh flooding during the first week of July, 1965.

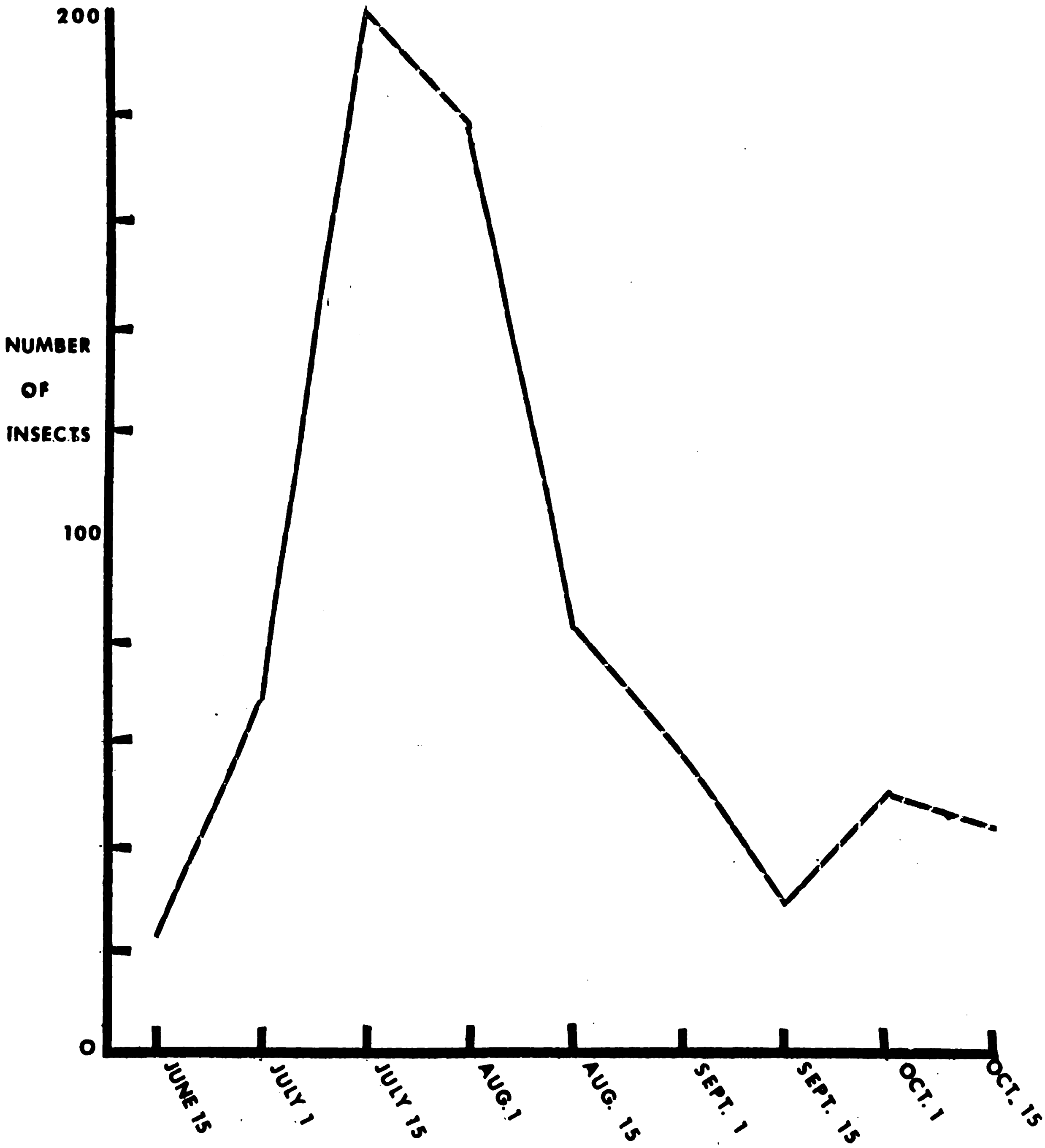

Figure 6. Total number of aquatic insects per ten Ekman dredge samples in relation to season, in the Pike Marsh.

$$x = \frac{26}{\text{Log } 10\ (51+1)} \qquad N = 824.6109$$

$$x = 15.19 \qquad B = 15.19 \times 2.92$$

$$N = \frac{.43429 \times 15.19}{.008} \qquad B = 44$$

I believe this figure to be reasonably accurate because from personal observations throughout the marsh in June and July, I knew of 38 different duck broods using the area. I am also sure I did not see all the ducks using the 390-acre flooding. Broods identified were: 16 Mallard, 12 Blue-winged Teal, 7 Black Duck, and one each of Greenwing, Woodduck, and Goldeneye. The 1966 duck brood census, done in a similar manner, again indicated 44 broods of waterfowl.

Brood surveys in the Dead Stream Flooding were done in a like manner, and covered about 350 acres. Most of the 24 broods of waterfowl found there in 1965 were Blue-winged Teal (eight) and Mallard (six). Done in a similar manner, the 1966 calculated brood estimate was 16 broods of ducks using the area.

There is no way to distinguish between local and migrant ducks, unless marked. Therefore, the first week of July was considered to be the optimum time to take the brood census, since the majority of the ducks would be hatched and in a flightless condition.

Duck "Stomach" Analyses

It is very difficult to obtain information on feeding habits of wild ducks. Much of the data reported in the past was from gizzard analyses only; and, due to the persistance of hard seeds for long periods of time, and the speedy breakdown of plants and soft-bodied insects, an accurate picture is seldom received from a gizzard sample. A gullet sample shows chiefly what the duck was eating at the time of collection or death. Using "gullets" only would be impossible, due to the large number of ducks needed to obtain adequate data, since many gullets are empty. But by using both the gullet and gizzard, some reliable information can be obtained.

The data were analyzed (Figures 7 and 8) according to food species importance and preference values.

These data attempt only to show waterfowl use of the Pike Marsh, and to find just what waterfowl were selecting from an area lacking species which usually are rated as "good" duck foods.

My Mallard and Black Duck "importance values" agree with those of McAtee (1918) and Mendall (1949), in which sedges and smartweeds are the most used seeds; and that animal life, like snails (Helisoma), play an important role in the waterfowl diet (Figure 7). Blue-winged Teal data by Mabbott (1920) and Bennett (1938) also pointed out that sedges were the most commonly used food. The Mallard and Black Duck used more animal food than the Blue-winged Teal; but the Blue-winged Teal made greater use of sphagnum capsules. No other statistical differences in use could be detected.

Lee et al. (1964) stated that waterfowl are opportunists and feed upon food readily available. I think this would be true to some extent, but the preference ratings do point out that they are also selective in feeding. Preference was also reported by Pirnie, when three Lesser Scaups, shot while feeding on a wild celery bed, had eaten only snails (Pirnie 1935).

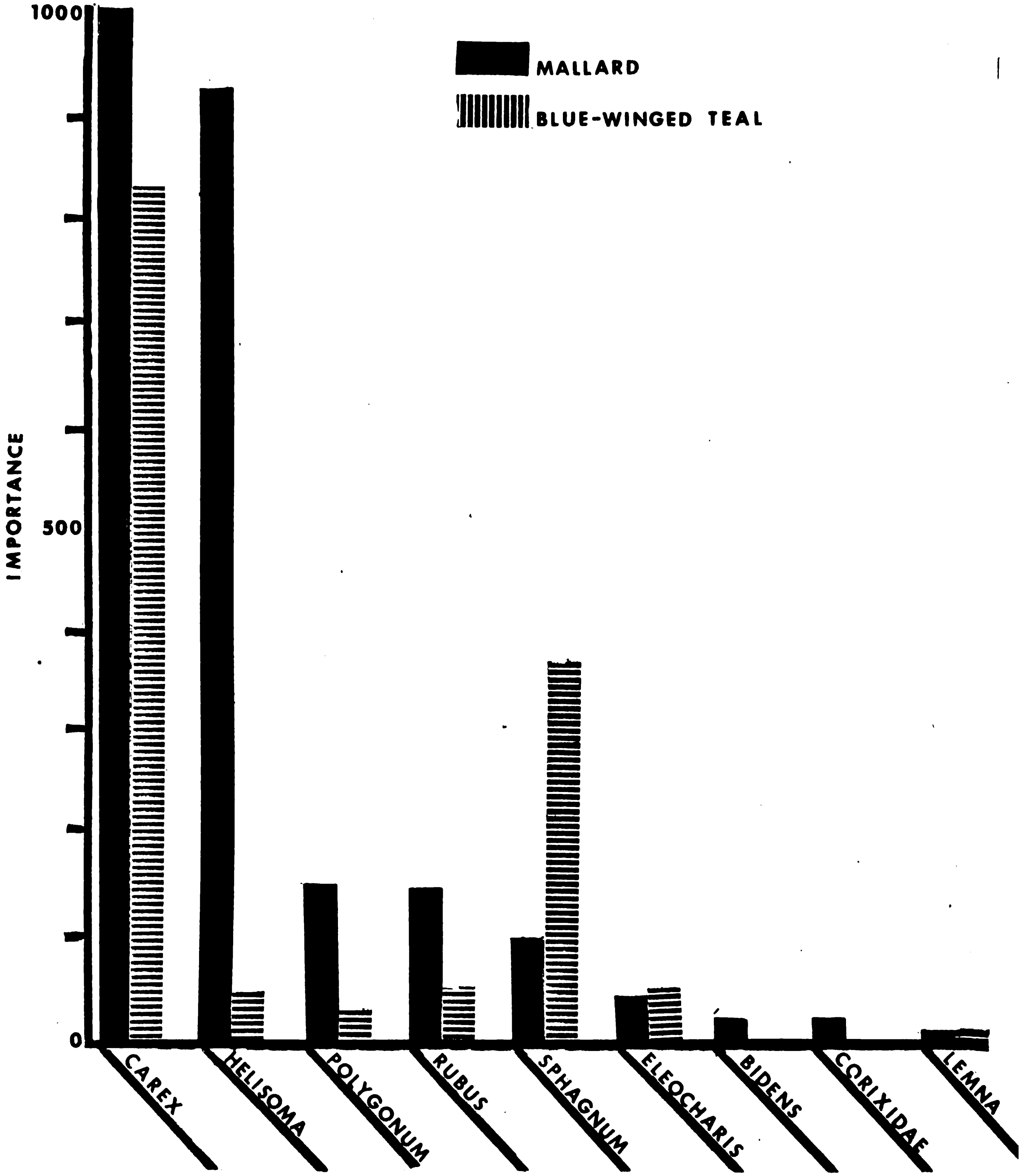

Figure 7. Importance values for seeds and animal foods found in ducks taken in the Pike Marsh.

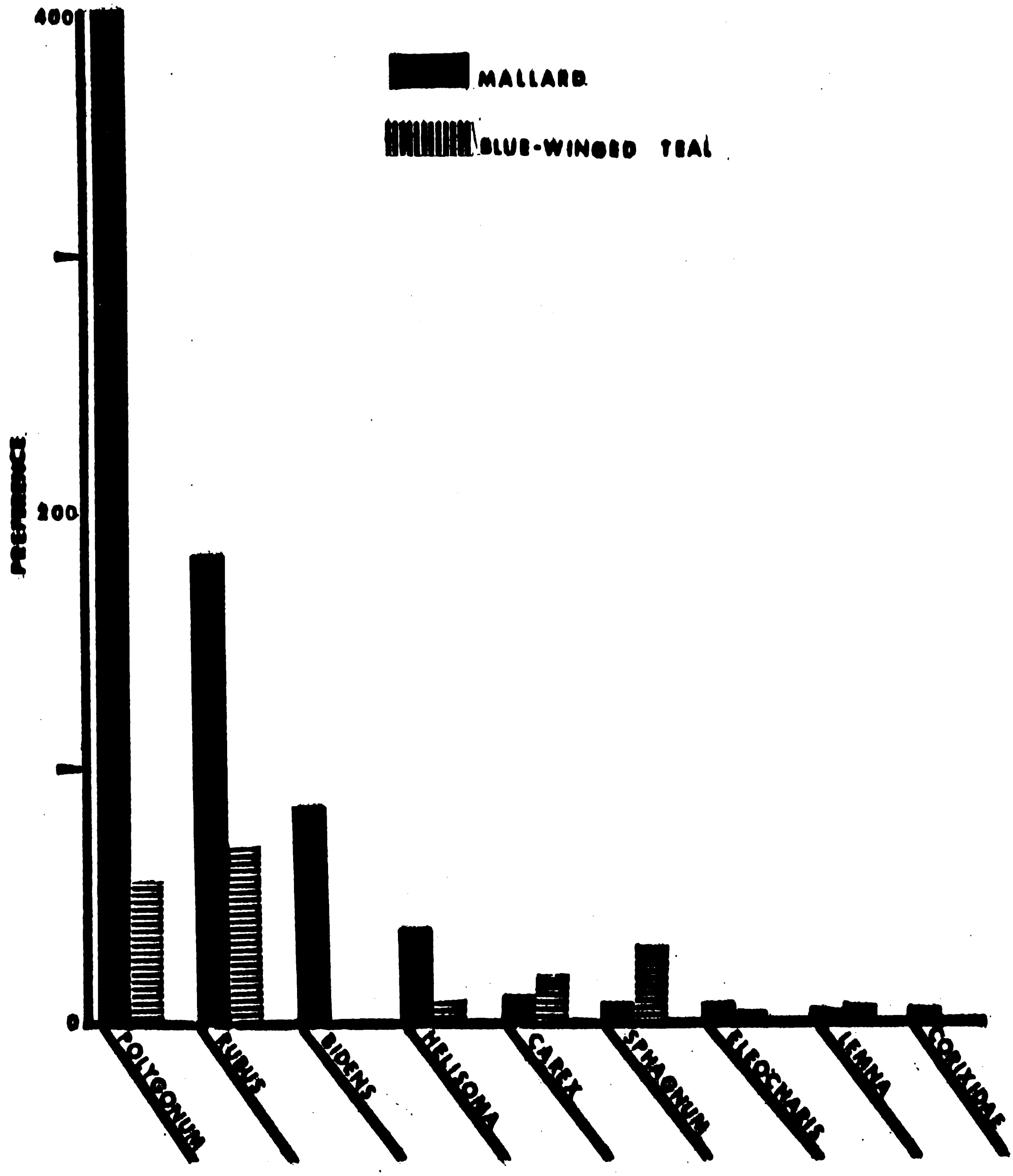

Figure 8. Preference values for seeds and animal foods consumed by waterfowl taken in the Pike Marsh.

Other individuals, such as Munro (1943), Martin and Uhler (1939), Bellrose and Anderson (1943), and Korschgen (1955) have also indicated food preferences, which depend on area and season of year. Data gathered by these workers have proved that smartweeds, cutgrass, corn, millet, pondweeds, and bulrushes are very important foods for waterfowl.

The Mallard and Black Duck differed statistically from Blue-winged Teal in their preferences for smartweed, raspberry (*Rubus* sp.), and snails (Figure 8). Smartweed and snails have long been known as excellent foods for waterfowl, but not the raspberry. However, Mendall (1948) showed "Rubus" as a food used by Black Ducks in Maine. This suggests that different areas provide different preference foods, depending on the plant and animal life available. No other differences were observed, either because both species of duck used the food in nearly equal amounts; or both made little use of a food, so as not to provide adequate data.

Some seed plants, such as blue flag and water plantain (*Alisma plantago*), which were obviously available but not found in a duck, suggests that there are certain foods which waterfowl obviously omit or make little use of. Microscope studies revealed algae present in almost every "stomach", with *Microspora* sp. making up 95 percent of the algae found. Exact volume of this alga could not be measured and, since it occurred in large blooms, it could not be determined whether this item was selected by the ducks or taken in accidentally while feeding. Regardless of means of ingestion, algae may add to the nutritional value of the diet.

Due to the scarcity of ducks in the Dead Stream area, no specimens were taken there during the spring or summer; and only six were available from the hunting season. Examination of stomach contents showed burreed, pondweed, and bulrushes the most commonly eaten seeds. This was not surprising, since these seeds were readily available, and are known to be used widely by waterfowl in northern Michigan (Pirnie 1935).

In the spring of 1965, so as not to disturb potential breeding birds or reduce productivity, only eight waterfowl were collected in the Pike Marsh. From examination of these gullets and gizzards, snails proved to be the most important food, both in volume and numbers taken. Coulter (1955), in a spring food study in Maine, found the seeds of sedges and burreed as the most used food, and reported no heavy use or selection of animal foods.

Caloric Food Values

The caloric value of waterfowl foods as determined by the dichromate analysis can be seen in Table 3. These data pointed out that the caloric values of most seeds range relatively close, from 4.5 to 5.7 K-cal. Animal food, such as snails and aquatic insects, range slightly higher than the seeds, from 5.5 to 6.6 K-cal, with duckweed (*Lemna* sp.) the lowest, 2.90 K-cal. Since the actual "efficiency" of waterfowl on each of these seeds is unknown, it would be impossible to say with any certainty that preferences can be based on caloric value alone.

Animal foods have a higher value than seeds, yet only snails were heavily used by the Mallards and Black Ducks. Water-boatmen, which had the highest value, and duckweed the lowest value, both had low use and poor preference ratings in the few examples studied.

Table 3

Caloric values of seeds and adult insects available to waterfowl in Houghton Lake Flats and the Dead Stream.

Houghton Lake Flats			Dead Stream		
Species	Common Name	Caloric Value	Species	Common Name	Caloric Value
Corixidae	Water-Boatmen	6.6 K-cal	Corixidae	Water-Boatmen	6.6 K-cal
Eleocharis palustris	Spike Rush	5.7 K-cal	*Eleocharis palustris*	Spike Rush	5.7 K-cal
Helisoma	Snail	5.5 K-cal	*Helisoma*	Snail	5.5 K-cal
Rubus hispida	Raspberry	5.53 K-cal	*Sparganium eurycarpum*	Burreed	5.03 K-cal
Carex spp.	Sedge	5.01 K-cal	*Carex spp.*	Sedge	5.01 K-cal
Polygonum amphibium	Smartweed	4.62 K-cal	*Zizania aquatica*	Wildrice	4.88-5.01 K-cal
Sphagnum spp.	Sphagnum spores	3.8 K-cal	*Sagittaria latifolia*	Duck Potato	4.7 K-cal
Lemna spp.	Duckweed	2.9 K-cal	*Polygonum smphibium*	Smartweed	4.62 K-cal
			Phalaris arundinacea	Reed Canary	4.5 K-cal
			Echinochloa spp.	Millet	4.17 K-cal

DISCUSSION

Comparing two communities in relation to waterfowl ecology in terms of food and cover is a very complex proposition, since it includes the changes in vegetation and other environmental influences, as well as the behavior of ducks themselves. However, the author has tried to obtain the results from the methods known to him, and has tried to evaluate them objectively. Sampling communities calls for a decision as to the size and time for samples which are needed to achieve reasonably accurate and meaningful data.

The Pike Marsh habitat was sampled in July of both years, when broods were making greatest use of the area, and when most fruits could be found on the plant life. These data showed good statistical validity on plants present in large quantities. However, it would be impossible to obtain sufficient data on plants newly invading the area, or those present in small quantities.

Data obtained from the 70 milacre plots in the Pike Marsh, during the first and second year of flooding, revealed a monotype community of sedges and willow, with scattered bluejoint, blue flag, spirea, and leatherleaf, along with newly invading aquatic plants such as water smartweed, cattail, duck potato, bladderwort, pondweeds and spike rush, with no significant differences in two years of flooding, except in the disturbed ditches.

The Dead Stream Flooding consisted of many different kinds of emergent, floating and submergent vegetation such as burreed, wildrice, pondweeds and bulrushes, all of which are known to contribute to waterfowl diets (McAtee 1918, Pirnie 1935, Bennett 1938). My observations revealed large stands of sedges with scattered bluejoint, smartweed and duck potato. These also were observed by Norcross (1952).

Duck brood inventories estimated a minimum of 44 broods of duck in 1965, and the same in 1966, in the Pike Marsh flooding, as compared to 24 and 16 in the Dead Stream area for these same years. The accuracy of the calculated brood estimates on the Pike Marsh is confirmed by many personal observations of flightless ducks during June, and July of both years.

The Dead Stream area poses a greater problem, since much of the area is dense, emergent vegetation; and observations are very difficult to make. Even the duck banding program tried in 1965 was of little help in estimating the number of broods.

Therefore, if this area of the Dead Stream had significantly fewer broods of duck, it could be concluded that a single factor, or a combination of them, must influence the brood use in each waterfowl area. These factors being: (1) the lack of woody vegetation might have been restricting waterfowl use, since the Dead Stream had the same aquatic plants as in the Pike Marsh, plus many others, but lacked the woody shrubs of willows and spirea; and (2) since predation can have a great effect on a nesting population, raccoon and other predators in the Dead Stream may have affected the duck brood population there.

The Pike Marsh was given a complete drawdown at the end of the 1965 duck season, in November; but even with the reflooding in early March, no shortage of animal foods has been observed in June, July and August, when most duck broods use the area. This could be accounted for since many insects overwinter as adults and can fly into the area in early spring, to mate and lay their eggs. Also, insects may be pumped into the area from Houghton Lake while flooding, and since all ditches maintain water throughout the year, insects may disperse into the shallow water after flooding.

The stomach analyses of 53 ducks from the Pike Marsh revealed that food plays no determining role in attracting breeding waterfowl. The ducks used mostly sedge seeds and snails, but seemingly preferred such foods as smartweed and dewberry seeds. This is nothing out of the ordinary, since previous food studies by McAtee (1918), Pirnie (1935), Martin (1938), and Mendall (1948) have all indicated the importance of various seeds in the wild duck's diet.

The Dead Stream provided these same aquatic plants plus wildrice, burreed, pondweed, and others, which are excellent duck foods. Therefore, if food supplied determine waterfowl production and brood use, more or at least as many broods should be using the Dead Stream area.

Another test was conducted in the spring of 1966, when corn was added at the Pike Marsh, with the hope of attracting breeding pairs. Four ducks (two Mallard, two Blue-winged Teal) were collected near the baited area, but only snails and sedge seeds were found in their gullets. It is possible they didn't find the corn, didn't have time to eat it, or did not care for it. Therefore, even though some ducks probably used the corn, it failed to attract large concentrations, since no more than four ducks were ever seen in the general area at one observation. Pirnie observed a situation on Houghton Lake where an area baited in May, was passed over by Lesser Scaups; but on

Wintergreen Lake, near Battle Creek, Michigan, Redheads found and used an offering of wheat in less than one hour!

My results indicated no selection of seeds or animal life according to caloric value; and the caloric values of the seeds most used or preferred differ little from those that seemingly were overlooked. However, it may be possible that certain foods provide an essential nutrient or vitamin, no matter how low or high the calories. A more detailed study on the percentage of fats, protein, carbohydrates and possible vitamins of each seed should be conducted along with isotope feeding, so as to determine the actual roles of plant and animal foods in diet. This type of study may explain why some ducks chose one food over another.

Management

In looking at these area changes from a management standpoint, each plays an important role for waterfowl. The Pike Marsh, evidently, serves as a duck rearing marsh, but in order to maintain this for waterfowl and Northern Pike, the following management procedures may be necessary:

(1) Regulate water level by pumping in 18 inches of water in early spring, March 1st, for pike spawning and waterfowl use.

(2) Drawdown 12 inches just after the pike spawn to return adults into the lake and prevent loss of ducklings; and bring water back to original level.

(3) Drawdown around June 1st, to release pike fry into the lake; then return water to 12 inch-level.

(4) Drawdown around August 15, to prevent loss of grasses needed for pike spawning; this will also prevent the loss of shrubby woody vegetation such as willow and spirea. This type of management should retard the open pond succession, as observed in the Dead Horse Impoundment of once similar vegetation (Figure 9). However, by fluctuating water levels, this type of habitat can be avoided.

(5) If hunting is desired, water can be returned into the marsh prior to hunting season.

It has been observed that this type of management will permit good brood production and pike spawning. However, it will be conceded that some aspects will be subject to alteration, depending on future ecological changes.

Figure 9. The Dead Horse Flooding, developed in 1962, in Missaukee Co., Michigan, illustrating the loss of willow and emergent vegetation due to prolonged high water, and resulting in poor waterfowl production and use.

SUMMARY

The objectives of this study were to provide information on the ecology of wild ducks, relating to food and vegetative type in two central Michigan impoundments.

Houghton Lake Flats, or Pike Marsh, is a 390-acre area, which serves as a Northern Pike spawning habitat and a waterfowl nesting area in the early spring. The Pike Marsh community is a monotype, consisting mainly of sedge and willow. The Dead Stream, however, is a diverse community of emergent, floating and submergent aquatic vegetation.

Brood surveys in two successive years revealed a minimum of 44 broods of duck using the Pike Marsh, while the Dead Stream data showed 24 broods in 1965 and 16 in 1966. However, brood counts on the Dead Stream were very difficult, due to the dense stands of emergent vegetation; but the figure for this area is not too greatly underestimated, since a duck banding program in the Dead Stream in 1965 was not nearly as successful as in the Pike Marsh area.

The greater population on the Pike Marsh, as compared to the Dead Stream, could be explained in two ways: (1) The shrubby, woody vegetation, which was so much more abundant in the Pike Marsh, was more condusive to nesting waterfowl. This could be possible, since, in early spring, most herbaceous cover is gone and only the woody shrubs are erect to give cover. (2) Predation by raccoon and other predators in the Dead Stream could have caused a reduction in nesting birds and broods.

The invasion of aquatic insects in the Pike Marsh is large enough each spring to produce a population of substantial numbers, so as not to cause a shortage of animal food to the newly hatched ducklings. Food studies of 53 wild duck gizzards and gullets during the summer and fall in the Pike Marsh established the fact that sedge seeds and snails were the most used foods, and smartweed and dewberry the most preferred, all of which are known to be used by waterfowl. Since these foods were also available at the Dead Stream, along with wildrice, pondweeds and burreed, all being excellent duck foods, it was concluded that food was not a major factor in holding breeding waterfowl. This was also observed in a spring food study, when an area baited with corn was little used, and no increase in ducks could be observed. It is possible the ducks did not find the corn; or they just did not use it.

The caloric values of seeds and invertebrates, known to be used by wild ducks, differ little from those seeds which were seemingly overlooked. Therefore, no selection of seeds or animal life was made according to caloric value. But further studies must be carried out to determine the actual role of each food in the diet, since each food could provide an essential nutrient, regardless of caloric value.

In conclusion, each area plays an important role to waterfowl. An area such as the Pike Marsh, can be used to benefit both Northern Pike and waterfowl; and the Dead Stream, to provide a feeding and loafing site for local and migrating waterfowl, plus serve as a brood production area.

A management program can be set up for the Pike Marsh, to maintain habitat for Northern Pike spawning and wild duck rearing, as was observed from the results of the second year of flooding. By fluctuating the water level at the right time, both pike and ducks can benefit. It is thought that this controlled lowering of water levels will retard the open pond succession, which has been detrimental to most flooded areas.

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