UTILIZATION OF AVAILABLE FOODS BY DIVING DUCKS ON APALACHEE BAY, FLORIDA

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ABSTRACT

A study designed to determine the vegetative composition and production of that portion of Apalachee Bay, Florida, included within the St. Marks National Wildlife Refuge was carried out in 1964. Gizzards and gullets of fourteen diving ducks were subsequently collected in order to correlate feeding activities with available foods. Greater scaup consumed large quantities of animal foods. Redheads consumed considerably more vegetative material than animal, and showed a predilection for shoalgrass. Shoalgrass constituted 67.9 per cent of the total volume of all foods consumed by diving ducks. Turtlegrass and manateegrass, two other species which occur commonly in the bay, apparently are of little value as waterfowl foods in this area. Vegetative production data was correlated with food habits to determine the approximate carrying capacity of the study area in waterfowl use days, and to ascertain the percentage utilization of the standing crop of vegetation by waterfowl during the 1964-65 over wintering period.

INTRODUCTION

Apalachee Bay is an important wintering area for waterfowl on the Gulf coast, especially for redheads (*Aythya americana*). Its importance is emphasized by the fact that 80-85 per cent of the St. Marks National Wildlife Refuge wintering duck population normally utilizes that portion of the bay closed to the hunting of waterfowl by Executive Order (Gidden, 1965). During the 1964-65 overwintering period peaks of 50,000 redheads, 5,000 scaup (*Aythya affinis* and *A. marila*), 1,000 buffleheads (*Bucephala albeola*), and 1,000 red-breasted mergansers (*Mergus serrator*) were noted on the bay. Appreciable numbers of puddle ducks and Canada geese (*Branta canadensis*) also use the bay.

Because of its high value to waterfowl a study of Apalachee Bay was initiated in 1964. The primary objectives of this study were to: (1) determine the composition and production of aquatic vegetation; (2) ascertain dietary patterns of diving ducks; and (3) determine the approximate carrying capacity in waterfowl use days.

DESCRIPTION OF STUDY AREA

Apalachee Bay is located approximately twenty-five miles south of Tallahassee, Florida. The study area was composed of that portion of the bay closed to the hunting of migratory waterfowl by Executive Order. This area encompasses 31,500 acres and is delineated in Figure 1. Water depths range from 0 to 8′ at low tide over most of the bay, with dredged channels being appreciably deeper. The salinity fluctuates considerably and is directly influenced by influxes of fresh water from the St. Marks, East, Pinhook, and Aucilla rivers as well as West Goose and Stoney Bayou Creeks. At the time of vegetation sampling in 1964 salinities ranged from 20 to 56 per cent of sea strength over the study area. Bay bottom soils are variable, ranging from fine hard sands to soft mucks.

MATERIALS AND METHODS

Vegetation sampling was completed during July, 1964. Modified oyster tongs, which collected a foot-square sample, were used to physically collect the aquatic vegetation. Four hundred and seventy-two samples were systematically collected at 110′ intervals along five transect lines totalling 9.83 miles (Fig. 1). Following collection the samples were washed thoroughly and separated by species. Excess water was removed and the volume of each determined by water displacement. Factors for

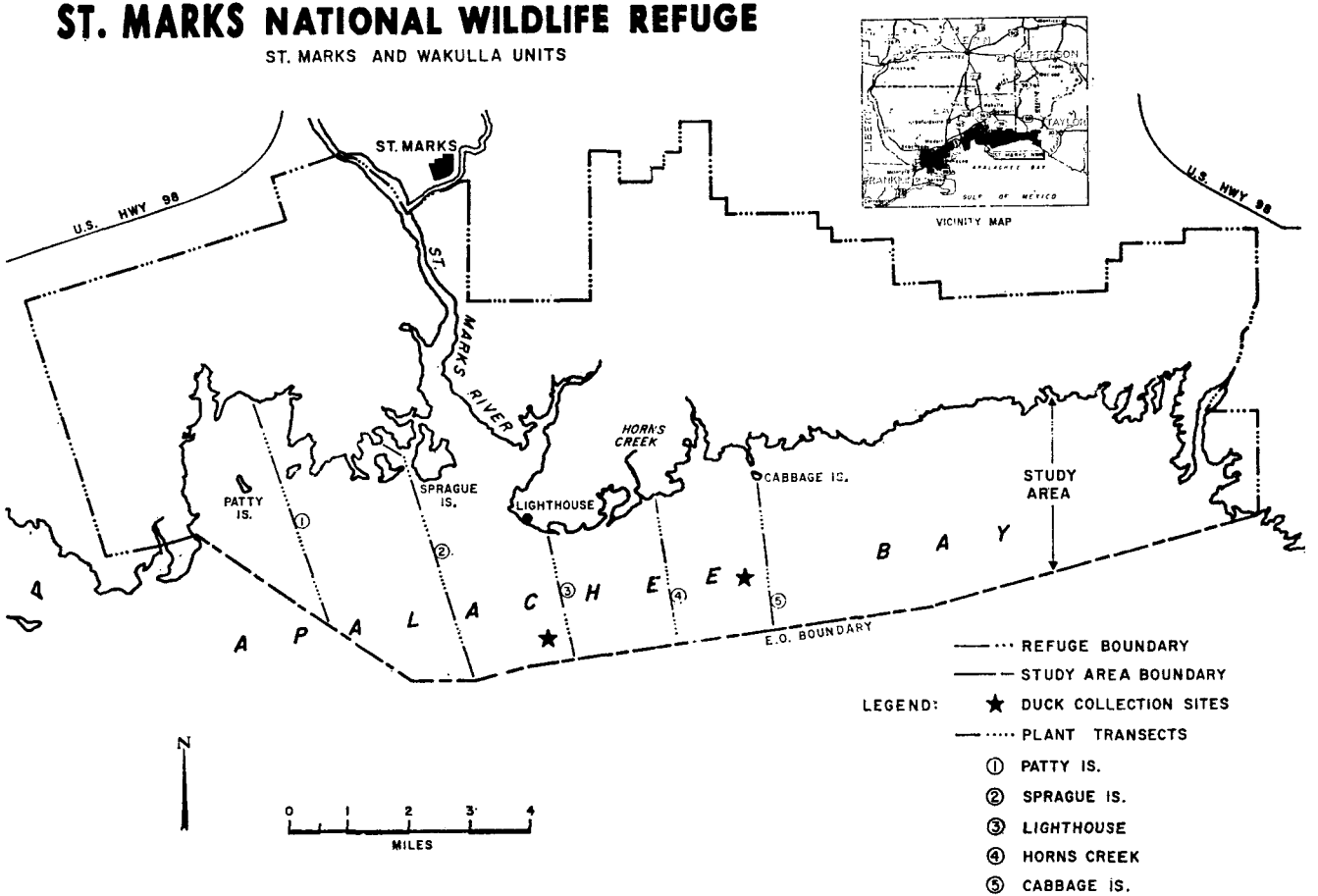

FIG I. LOCATION OF STUDY AREA, PLANT TRANSECTS, AND DUCK COLLECTION SITES, IN APALACHEE BAY, ST. MARKS N.W.R. FLORIDA.

converting volumetric data to dry weight were determined for the vascular plants by oven drying known volumes of each species for 24 hours.

The collection of waterfowl for food habits analysis proved to be extremely difficult and the total sample is somewhat less than that desired. Fourteen duck gizzards and gullets were secured for analysis. The sample consisted of a redhead collected in 1964, and nine redheads and four greater scaup collected in March, 1966. Of the latter thirteen birds, five redheads were collected near the south end of the Lighthouse vegetation transect and the remainder near the Cabbage Island transect (Fig. 1).

Standard laboratory techniques were utilized in analyzing gizzards, and in identifying their contents. The volume of each item of food was determined by water displacement; frequency of occurrence was computed on a percentage basis. The amount of grit in each gizzard was measured; however, this item has been excluded from the presentation of data.

RESULTS

Available Plant Foods

Five species of vascular plants and six species of algae were recorded from the aquatic transects. Table I summarizes frequency of occurrence and volumetric data from the five transects.

TABLE I

SUMMARY OF DATA FROM FIVE AQUATIC VEGETATION TRANSECTS, APALACHEE BAY, FLORIDA, JULY, 1964

Species	% Freq. Occur.	% Species Comp.
Turtlegrass (*Thalassia testudinum*)	70.9	59.3
Manateegrass (*Cymodocea manatorum*)	42.1	16.9
Shoalgrass (*Diplanthera Wrightii*)	63.1	6.9
Widgeongrass (*Ruppia maritima*)	14.0	4.1
Halophila engelmannii	13.6	.5
Algae (*Digenea simplex*)	37.7	10.7
Algae (*Sargassum fluitans*)	4.2	1.1
Other algae*	6.6	.5
Bare bottom	8.9	—
	TOTAL	100.0

* Includes *Acetabularia farlowii, Caulerpa prolifera, Gracilaria blodgettii,* and *Udotea conglutinata.*

Total production was determined by first obtaining the average of dry weight material (in grams) by species per square foot sample and multiplying this figure by 43,560. This figure was then converted to pounds and multiplied by 31,500 to determine total production for the area closed by Executive Order. Algae were excluded from total production computations as this group proved to be negligible in value as waterfowl food. Table II reflects production data for the five vascular plants recorded from the bay.

TABLE II

PRODUCTION OF VASCULAR PLANTS IN E. O. CLOSED AREA OF APALACHEE BAY, ST. MARKS REFUGE, JULY, 1964

Species	Avg. Dry Wt./Sample (in grams)	Lbs./Acre	Total Production (Lbs.)
Turtlegrass (*Thalassia testudinum*)	5.69	546.43	17,212,545
Manateegrass (*Cymodocea manatorum*)	1.76	169.02	5,324,130
Shoalgrass (*Diplanthera Wrightii*)	.68	65.30	2,056,950
Widgeongrass (*Ruppia maritima*)	.36	34.57	1,088,955
Halophila engelmannii	.04	3.84	120,960
Totals	8.53	819.16	25,803,540

These data indicate that the total dry weight tonnage of the standing crop of vascular plants in July was approximately 12,902 for the 31,500-acre study area. The quantity of submergent vegetation available to waterfowl in the fall was undoubtedly greater than this figure as all species should have put on additional growth between the time of sampling and the arrival of waterfowl. This would appear to be a tremendous food resource; however, of the five species represented, only shoalgrass (*Diplanthera Wrightii*) and widgeongrass (*Ruppia maritima*) are known to be readily accepted by waterfowl. The total available tonnage of these two species in 1964 was approximately 1,573.

Diving Duck Food Habits

Two plant foods and 22 animal foods were recorded from the 14 gizzards and gullets examined (Table III). Of these, only the two plant foods and seven animal foods constituted more than .5 per cent of the total volume. Plant foods yielded 68.5 per cent of the total volume and animal foods 31.5 per cent.

TABLE III

FOODS APPEARING IN 14 DIVING DUCK GIZZARDS AND GULLETS FROM APALACHEE BAY, ST. MARKS NATIONAL WILDLIFE REFUGE

FOOD ITEM	Per Cent Volume		% Freq. Occur.	
Plant Foods	68.5		78.5	
Shoalgrass (*Diplanthera Wrightii*)		67.9		78.5
Manateegrass (*Cymodocea manatorum*)		.6		7.1
Animal Foods	31.5		100.0	
Greedy dove-shell (*Anachis avara*)		8.1		42.9
Variable dwarf olive (*Olivella mutica*)		7.5		92.9
Variable nassa (*Nassarius ambiguus*)		6.2		71.4
Atlantic modulus (*Modulus modulus*)		4.1		21.4
Mud crab (*Rithropanopeus* sp.)		2.8		14.3
Common Atlantic marginella (*Prunum apicinum*)		1.6		7.1
Fly-specked cerith (*Cerithium muscarum*)		.6		28.6
Atlantic cones (*Conus* sp.)		.2		14.3
Punctate mangelia (*Kurtziella limonitella*)		.2		7.1
Teardrop marginella (*Cypraeolina hadria*)		.1		42.9
Chesnels rissoina (*Rissoina chesneli*)		.1		28.6
Lunar dove shell (*Mitrella lunata*)		Trace		7.1
Costate horn shell (*Cerithidea costata*)		Trace		7.1
Pyram shell (*Pyramidella* sp.)		Trace		21.4
Scorched mussel (*Brachidontes exustus*)		Trace		14.3
Brown gem clam (*Parastarte triquetra*)		Trace		7.1
Barrel-bubble (*Acteocina candei*)		Trace		7.1
Ceriths (*Cerithium* sp.)		Trace		7.1
Snail (*Sayella hemphilli*)		Trace		7.1
Paper mussel (*Amygdalum papyria*)		Trace		7.1
Impressed odostome (*Odostomia impressa*)		Trace		7.1
Horned shells (*Cerithidea* sp.)		Trace		7.1
Total		100.0		

Shoalgrass was the most important food item as it constituted 67.9 per cent of the total volume and appeared in 78.5 per cent of the tracts examined. Leaves, stems, and rootstocks were consumed, with some preference indicated for the latter portion. Manateegrass (*Cymodocea manatorum*) was of little significance as it represented only .6 per cent of the total volume and was recorded from a single redhead.

Gastropods comprised 28.7 per cent of the total volume and occurred in all tracts examined. By volume, the most important members of this group were greedy dove-shells (*Anachis avara*) 8.1 per cent; variable dwarf olives (*Olivella mutica*) 7.5 per cent; variable nassas (*Nassarius ambiguus*) 6.2 per cent; Atlantic modulus (*Modulus modulus*)

4.1 per cent; and common Atlantic marginellas (*Prunum apicinum*) 1.6 per cent. Pelecypods represented only a trace of the total volume and occurred in 13.3 per cent of the tracts. Mud crabs (*Rithropanopeus* sp.) occurred twice and comprised 2.8 per cent of the total volume.

The data are broken down in Tables IV and V to separately reflect the feeding habits of redheads and greater scaup in the bay.

TABLE IV
FOODS OF 10 REDHEADS, APALACHEE BAY, ST. MARKS NATIONAL WILDLIFE REFUGE, 1964-66.

FOOD ITEM	Per Cent Volume		% Freq. Occur.	
Plant Foods	86.0		100.0	
Shoalgrass (*Diplanthera Wrightii*)		85.3		100.0
Manateegrass (*Cymodocea manatorum*)		.7		10.0
Animal Foods	14.0		100.0	
Variable dwarf olive (*Olivella mutica*)		9.2		100.0
Common Atlantic marginella (*Prunum apicinum*)		2.0		10.0
Variable nassa (*Nassarius ambiguus*)		1.0		70.0
Greedy dove-shell (*Anachis avara*)		1.0		30.0
Atlantic cone shell (*Conus* sp.)		.3		20.0
Fly-specked cerith (*Cerithium muscarum*)		.3		30.0
Teardrop marginella (*Cypraeolina hadria*)		.1		60.0
Chesnels rissoina (*Rissoina chesneli*)		.1		40.0
Costate horn shell (*Cerithidea costata*)		Trace		10.0
Pyram shell (*Pyramidella* sp.)		Trace		30.0
Impressed odostome (*Odostomia impressa*)		Trace		10.0
Horn shells (*Cerithidea* sp.)		Trace		10.0
Ceriths (*Cerithium* sp.)		Trace		10.0
Scorched mussel (*Brachidontes exustus*)		Trace		20.0
Barrel-bubble (*Acteocina candei*)		Trace		10.0
Brown gem clam (*Parastarte triquetra*)		Trace		10.0
Snail (*Sayella hemphilli*)		Trace		10.0
Paper Mussel (*Amygdalum papyria*)		Trace		10.0
Total		100.0		

These limited data indicate that redheads rely heavily upon shoalgrass as it represented 85.3 per cent of the total volume of all foods and occurred in all 10 samples (Table IV). Animal foods comprised only 14.0 per cent of the total volume, but were noted in all tracts examined. Of the animal foods, variable dwarf olives, Atlantic marginellas, variable nassas, and greedy dove-shells were consumed in the largest quantities. Other species of gastropods appeared fairly frequently, but were unimportant volumetrically.

TABLE V
FOODS OF FOUR GREATER SCAUP, APALACHEE BAY, ST. MARKS NATIONAL WILDLIFE REFUGE, 1966

FOOD ITEM	Per Cent Volume		% Freq. Occur.	
Plant Foods	1.0		25.0	
Shoalgrass (*Diplanthera Wrightii*)		1.0		25.0
Animal Foods	99.0		100.0	
Greedy dove-shell (*Anachis avara*)		35.4		75.0
Variable Nassa (*Nassarius ambiguus*)		26.3		75.0
Atlantic modulus (*Modulus modulus*)		20.0		75.0
Mud crab (*Rithropanopeus* sp.)		13.8		50.0
Fly-specked cerith (*Cerithium muscarum*)		1.7		25.0
Punctate mangelia (*Kurtziella limonitella*)		.9		25.0
Variable dwarf olive (*Olivella mutica*)		.7		75.0
Lunar dove shell (*Mitrella lunata*)		.2		25.0
Total		100.0		

Greater Scaup relied almost entirely upon animal foods as they represented 99.0 per cent of the total volume and occurred in all four samples (Table V). Shoalgrass was recorded from one specimen, but it constituted only 1.0 per cent of the total volume. Of the animal forms, gastropods comprised 85.2 per cent of the total volume and mud crabs 13.8 per cent. No pelecypods were noted in greater scaup tracts.

Relationship of Food Habits to Available Foods

In an effort to relate foods consumed with availability the thirteen 1966 samples were taken from flocks known to have spent a considerable period of time in the vicinity of the collection site immediately prior to shooting.

Five redheads were collected from a flock of two hundred on a shoal about two miles south of the St. Marks Lighthouse. Shoalgrass was the only plant food recorded from this sample. It had been consumed by all five ducks, and constituted 89.7 per cent of the total volume. Seven gastropods represented 10.3 per cent of the total volume with the most important of these being variable dwarf olives (6.9 per cent) and common Atlantic marginellas (2.3 per cent). Four other gastropods and three pelecypods were present in trace amounts.

Vegetation sampling in the general vicinity of the collection site revealed that shoalgrass, manateegrass, and turtlegrass (*Thalassia testudinum*) were present in fairly equal abundance with lesser quantities of *Halophila engelmannii* present. The fact that the redheads had consumed large quantities of shoalgrass, but no manateegrass, turtlegrass or *Halophila*, indicates a probable predilection for shoalgrass.

Four redheads and four greater scaup were collected in an area extending 1½-2 miles south of Cabbage Island, in the general vicinity of the Cabbage Island plant transect. Vegetation in this area consisted of abundant manateegrass, algae (*Digenea simplex*), and turtlegrass; shoalgrass common; and scattered *Halophila engelmannii, Sargassum fluitans*, and miscellaneous algae. Ducks collected in this area had fed heavily on animal forms, as this group comprised 82.4 per cent of the total volume. Greedy dove shells (29.2 per cent), variable nassas (21.2 per cent), Atlantic modulus (14.9 per cent), and mud crabs were the most important volumetrically. Shoalgrass was the only plant food recorded despite the greater abundance of manateegrass and turtlegrass. It represented 17.6 per cent of the total volume and appeared in 62.5 per cent of the tracts. The data further substantiates some preference for shoalgrass.

DISCUSSION

It is difficult to determine the waterfowl carrying capacity of the Apalachee Bay study area mainly because we do not know what percentage of the standing crop of vegetation can be harvested each year without damaging the overall stand. Some workers feel that 60-70 per cent of the standing crop may be harvested each year without adverse effects. I personally feel that we can safely permit a 50 per cent harvest and possibly more.

The questionable value of turtlegrass and manateegrass as a food resource also complicates the determination of carrying capacity. The limited data presented in this paper indicates that shoalgrass is highly preferred over both species, as manateegrass occurred in only one sample and turtlegrass was not recorded. Turtlegrass is consumed occasionally by waterfowl. A baldpate (*Mareca americana*) collected in the bay in 1965 contained a turtlegrass leaf fragment as well as a limited quantity of manateegrass (unpublished data). Ninety-one gizzards collected on the Chassahowitzka Refuge (69 dabblers; 20 divers; and two mergansers) did not contain turtlegrass, despite its relative abundance in the more saline waters of the refuge (Stieglitz, 1966). In the latter study manateegrass comprised only 0.2 per cent of the total volume and occurred in 2.2 per cent of the gizzards while shoalgrass constituted 18.9 per cent of the total volume and occurred in 20.9 per cent of the samples. Manateegrass and shoalgrass were consumed by both divers and dabblers at Chassahowitzka.

Possibly the tough leaves of turtlegrass are unpalatable to waterfowl and this species is ignored in favor of more palatable plants such as shoalgrass and widgeongrass. The question remains to be answered as to whether waterfowl would utilize turtlegrass and manateegrass to a significant degree if they were the only plant foods available.

Widgeongrass was not recorded from the gizzards examined; however, this is a reflection of sampling bias rather than non-use by ducks. The value of widgeongrass as a waterfowl food is generally accepted and has been well documented in several studies (Cottam, 1939; Martin and Uhler, 1939; Quay and Critcher, 1962). Widgeongrass is most abundant in Apalachee Bay in the shallower areas, and is associated with medium to deep muck bottoms west of the St. Marks River. Its distribution is also influenced by salinity variations. None of the divers collected in this study were taken in areas vegetated by widgeongrass, but general observations indicate that it is heavily utilized.

If only highly preferred waterfowl food plants are considered (shoalgrass and widgeongrass), the July, 1964 production was 99.87 pounds per acre (dry weight) or 3,145,905 pounds for the area closed by Executive Order. If manateegrass is included, a total production of 8,470,035 pounds is indicated. This is a conservative estimate in relation to the amount of food that must be available to waterfowl in the fall for two reasons: (1) all species undoubtedly put on additional growth between July and the onset of cold weather in the fall; and (2) the sampling device was not completely efficient in collecting all vegetation within the plot to sampled, e.g., in some cases the rootstocks were not collected in their entirety, particularly on hard sand bottoms.

Several factors must be considered in converting plant production figures to waterfowl carrying capacity. The question of how much food is consumed per duck or goose per day is of utmost importance. Jordan (1953) found that mallards had daily intakes of .20 lb. on a diet of corn and small grains. This is the equivalent of approximately 7.8 per cent of dry weight food per wet body weight. Studies by Holm and Scott (1954) revealed that a group of mallards, redheads, pintails, and gadwalls consumed the equivalent of 11 per cent of their wet body weight in food (dry weight) each day. Longcore and Cornwell (1964) found that canvasbacks and lesser scaup consumed only two-three per cent of their body weight in dry weight food on a diet of wild celery, *Elodea, Heteranthera, Myriophyllum,* coontail, and invertebrates. Most studies reported increased food intake with decreased temperatures. Considering previous studies and work accomplished at the Patuxent Wildlife Research Center, Sincock (1962) concluded that a fair estimate of the average daily consumption of food (dry weight) for waterfowl is 10 per cent of the wet body weight. Sincock's conclusion appears to be valid, and will be used in relating available foods to waterfowl carrying capacity on Apalachee Bay.

Redheads contribute the bulk of the waterfowl use of the bay and their wet body weight will be used in duck food consumption computations. Kortwright (1942) listed the average weights of male and female redheads as 2 lbs. 8 oz. and 2 lbs. 4 oz., respectively. The average of these two figures is about 2.4 pounds. Using this weight as a base, the average intake of dry weight food per day would be .24 pound for ducks. Assuming an average weight of eight pounds for geese, each goose use day represents a requirement for .8 pound of dry weight food.

A portion of the food requirements would be supplied by animal forms, for which production and availability data is lacking. The gizzards and gullets examined in this study contained 68.5 per cent plant material and 31.5 per cent animal material. The examination of 91 gizzards (representing dabblers, divers and mergansers), collected in brackish situations on the Chassahowitzka Refuge, indicated that 62.9 per cent of the total food volume was composed of plant foods and 37.1 per cent animal foods (Stieglitz, 1966). The Chassahowitzka study also revealed that 72.3 per cent of the total volume of 20 diving duck gizzards (15 lesser scaup, two ringnecks, one redhead, and one canvasback) examined was comprised of animal foods. This is somewhat in

agreement with the present study which indicated that 99.0 per cent of the food consumed by greater scaup was of animal origin. Cottam (1939) reported an intake of 53.48 per cent of animal foods by greater scaup, 40.45 per cent by lesser scaup, and 10.34 per cent by redheads. Unfortunately, Cottam's data represent numerous collection sites and it is not known how many specimens were collected in habitats similar to Apalachee Bay. Redheads far outnumber all other waterfowl wintering on the bay. Our limited sample indicates that their diet was composed of 86 per cent plant foods and 14 per cent animal foods. Some species found in lesser numbers on the bay, e.g., mergansers, goldeneyes, and buffleheads, are known to feed heavily on animal forms. Dabblers feed on both plant and animal forms, but vegetative materials are preferred.

Assuming 20 per cent of the food of all ducks using the bay is animal, the average intake of plant food is estimated as about 0.19 lb. dry weight per duck use day. Using this assumption the estimated 4,264,000 duck use days supported by the bay during the 1964-65 season represented a consumption of 810,000 pounds (dry weight) of plant foods. If 75 per cent of the 339,388 goose use days recorded by the refuge during the 1964-65 season represented bay use, and assuming their diet to be entirely of plant origin, an additional 203,500 pounds of food would have been consumed. If these assumptions are correct a total of 1,013,500 pounds of the standing crop of submergent vegetation available in the fall of 1964 was consumed by wintering waterfowl. If goose food preferences are similar to those of ducks, i.e., if essentially only shoalgrass and widgeongrass are consumed, approximately 32.3 per cent of the standing crop of these two species was harvested by all waterfowl. Actually, the harvest was probably somewhat lower as the diving ducks undoubtedly secure some of their food outside of the study area.

Based on a 50 per cent allowable harvest of shoalgrass and widgeongrass, the closed area of the bay could have supported 7,199,000 duck use days in addition to normal goose use of 254,500 days in the fall of 1964. On the basis of a 60 per cent harvest of the standing crop a carrying capacity of 8,862,700 duck use days is indicated under 1964 conditions. If manateegrass is included, a potential carrying capacity of 20,682,000 duck use days and 254,500 goose use days was existent on the basis of a 50% harvest of the standing crop.

SUMMARY

1. The submergent vegetation within that portion of Apalachee Bay included in the study area was sampled by means of modified oyster tongs. Four hundred and seventy two foot-square samples were collected along five transects totalling 9.83 miles. Five species of vascular plants and six species of algae were collected.

2. Species composition and frequency of occurrence data is presented for all species. In addition, total production data is presented for the vascular plants. On a production basis, turtlegrass was the most abundant plant, followed in decreasing order by manateegrass, shoalgrass, widgeongrass, and *Halophila engelmannii.* Total production (dry weight) of these five species in 1964 was estimated to be 25,803,540 pounds.

3. Gizzards and gullets from ten redheads and four greater scaup were collected for food habits analyses. Two plant and 22 animal foods were recorded. Plant foods comprised 68.5 per cent of the total volume and animal foods 31.5 per cent. The most important food item in the diet of redheads was shoalgrass which constituted 67.9 per cent of the total volume for this species. Ninety-nine per cent of the total volume of the greater scaup sample was composed of animal foods. A predilection for shoalgrass was indicated. Manateegrass, turtlegrass, and *Halophila* apparently receive little use by waterfowl.

4. The vegetative production data were expanded in order to estimate waterfowl carrying capacity for the study area. Based on an allowable harvest of 50 per cent of the standing crop of shoalgrass and widgeongrass an estimated carrying capacity of 7,199,000 duck use days and 254,500 goose use days existed in the fall of 1964. Recorded waterfowl use removed an estimated 32.3 per cent of the standing crop.

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A COTTONTAIL RABBIT LENS GROWTH CURVE FROM ALABAMA [1]

By EDWARD P. HILL III

INTRODUCTION

Use of the eye lens in aging cottontail rabbits (*Sylvilagus floridanus*) was first reported by Lord (1959). Numerous other investigations have dealt with the application of this technique. Curves, more or less refined than those for the cottontail, have been used by Dudzinski and Mykytowycz (1961) working with rabbits (*Oryctolagus Cuniculus*) in Australia, Kolenosky and Miller (1962) working with pronghorn antelope (*Antilocapra americana*), Bauer et al. (1964) working with the fur seal (*Callorhinus ursinus*), Beale (1962) working with the fox squirrel (*Sciurus niger*), Montgomery (1963) and Sanderson (1961) working with raccoons (*Procyon lotor*) and Friend and Severinghaus (1966) working with white tailed deer (*Odocoileus virginianus*). Friend (1965) made a thorough investigation of factors causing variation in the technique.

More recently, Rongstad (1966) presented a growth curve with confidence limits for cottontails of Southern Wisconsin. On finding Wisconsin cottontail lenses heavier than those reported by Lord (1959)

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