individuals. It is suggested that the latter possibility is the more probable one since habitat conditions (drought) were such that buildups did not occur in the lower flyway. Coots prefer shallow fresh water areas occupied by dense stands of aquatic vegetation and where such is found in the lower flyway high wintering populations result. Under drought conditions such areas are reduced in size and number and this normally is reflected in a lower number of wintering coots.

The peak flyway population of 1,700,000 coots was recorded during the mid-October inventory and represented a 25% increase over 1955. By January 15th the coot population had declined to 172,000 and these birds were found largely in Louisiana (58%), Alabama (15%), Arkansas (13%), and Tennessee (9%).

For three years now the coot migration has been one of the most regular as to timing and distribution of flights. As suggested in the 1955 inventory report management could apply this information to regulate the coot kill by setting seasons to conform to the flight or to miss the flight as desired. It even appears that a differential harvest of coots could be accomplished in portions of the flyway if desired by use of selected opening dates.

FOOD HABITS OF WILD DUCKS IN THE RICE-MARSH TRANSITION AREA OF LOUISIANA

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INTRODUCTION

Several papers have been published on the food habits of wild ducks taken in widely scattered areas of the Gulf Coast. The general Gulf Coast area was summarized by Martin and Uhler (1939) in their study of 2,101 stomachs from 38 locations. Singleton (1953) analyzed 1,017 stomachs from the Texas Coast. These included 293 from the upper coast, 502 from the central coast, 120 from the lower coast, and 102 from inland lakes.

The present study is based on material obtained from hunting clubs in Cameron and Vermilion Parishes, Louisiana, from the fall of 1954 through the hunting season, January, 1957. The area considered in this paper is much smaller than the areas covered by Martin and Uhler or by Singleton. The points of collection are in one of the major waterfowl wintering grounds on the Gulf Coast.

The original objective was to study only *gullet* material from selected hunting sites within the area. The first season's collections showed heavy usage of the seeds from rice fields and fallow rice fields, although the collection locations were several miles from the rice growing area. It then seemed advisable to collect *stomachs* to supplement the gullet material and attempt a correlation of gullet studies with stomach studies as had been done by others (lit. cit.). It was felt that this was necessary since gullet material reflects recent consumption and stomach material may distort the food importance of some hard seeded plants. Both the gullet and stomach were taken from the same bird wherever possible. For this study the gullet material was anything contained in the area between the proventriculus and the mouth, and the stomach included the proventriculus and gizzard.

DESCRIPTION OF THE AREA

The collection areas were located in the Gulf Coast Marsh Resource Area and is classified as fresh marsh. The vegetative conditions have probably changed some from the original as a result of water control. Structures, such as control gates and levees, have been installed to insure having water on the areas in the fall of the year. The fall is usually dry through the middle of November in this portion of Louisiana.

The areas where collections were made include good stands of emergent plants, including *Scirpus, Cladium, Zizaniopsis, Sagiteria, Eleocharis,* and *Echinochloa.* These communities are interspaced with open water areas which produced sub-

merged plants such as *Utricularia, Chara, Nymphaea, Nymphoides, Najas, Potamogeton,* and *Brasenia.*

Many of the above-named plants are usually considered important duck foods. However, ducks taken from these areas during this study did not reflect heavy usage of marsh plants. Instead, rice and plants associated with its culture dominated the sample. Red rice, barnyardgrass, and junglerice are annuals which volunteer in and around fields being farmed for commercial rice. All of them are considered pests by the rice grower. With the exception of domestic rice, the same plants plus brownseed paspalum, signalgrass, and snow-on-the-prairie are common volunteer plants in fallow rice fields. In rice culture the field is farmed to rice only one out of every three or four years. The field is then either left idle or put into improved grasses and legumes for pasture.

This study indicates that ducks in the area studied were feeding primarily in rice lands, then flying 5 to 30 miles—perhaps more—to loafing grounds in the marshes.

RESULTS

The analyses of 106 duck gullets that includes mallards, pintails, gadwalls, blue and green-wing teal is shown in Table I.

TABLE I

MAJOR FOOD PLANTS OF 106 DUCKS FROM CAMERON AND VERMILION PARISHES LOUISIANA, 1954-1957

	Times Used	*Volume %*
Rice (domestic)	52	20.6
Brownseed Paspalum	56	19.0
Junglerice	49	18.3
Barnyardgrass	36	10.8
Knotgrass	9	5.6
Red Rice	32	3.9
Beakrush	4	3.5
Coast Cockspur	10	2.8
Water Paspalum	4	2.0
Squarestem Spikesedge	2	1.9
Signalgrass	15	1.9
Snails	17	1.9
Flatsedge	4	1.7
Insects	15	1.6
Common Spikesedge	3	1.1
Fall Panicum	8	.7
Snow-on-the-Prairie	12	.7
Sawgrass	3	.5
Watershield	1	trace

The percent of rice used was not as high as was shown by Singleton (1951, 1953), but is considerably higher than shown by Martin and Uhler (1939). Red rice was separated from domestic rice in the present study since it is a pest plant. This was not done by Singleton or Martin and Uhler. The combined percent for both plants would be 24.5%. The times used would be some higher, but not a combination of the two since some gullets contained both varieties of rice.

Table I shows a marked increase in use of plants considered pests in rice and idle rice fields. Williams (1956) listed junglerice, barnyardgrass, red rice, knotgrass, water paspalum, flatsedges, and spikesedges as weeds in rice culture. These same plants plus brownseed paspalum, signalgrass, fall panicum, and snow-on-the-prairie also grow profusely in idle rice fields.

The 82 duck stomachs showed about the same proportion of rice, brownseed paspalum, junglerice, barnyardgrass, and some less important seeds occurred in 85 duck stomachs as compared to the gullets. Three plants apparently are distorted in stomach analyses due to the hardness of the seed. These plants are sawgrass, squarestem spikesedge, and watershield. The difference between frequency of their occurrence in gullets and stomachs is shown in Table II.

TABLE II

OCCURRENCE OF SAWGRASS, SQUARESTEM SPIKESEDGE AND WATERSHIELD IN DUCK GULLETS AND STOMACHS

		Sawgrass		*Squarestem Spikesedge*		*Watershield*	
Ducks	*Number*	*Time Used*	*% of Total*	*Time Used*	*% of Total*	*Time Used*	*% of Total*
Mallard	91 gullets	3	3*	2	2	1	2
	63 stomachs	48	76*	40	63	20	32
Pintail	14 gullets	1	7	1	7	..	..
	8 stomachs	4	50	5	6	..	..
Teal†	16 gullets	0	0	1	6	..	..
	13 stomachs	4	30	4	30	..	..

* By volume mallard gullets held a "trace" while stomachs averaged 12% sawgrass.
† Bluewing and greenwing combined.

The occurrence of sawgrass was also checked by volumetric comparison between gullet and stomach analyses. Three mallard gullets represented 1%, trace, and 1%, respectively. Their companion stomachs were 2%, 6% and 10%. Three pintail gullets averaged 7% sawgrass as against an average of 17% in their stomachs. Thus, stomach analyses may be expected to exaggerate daily consumption of some hard seeded plants from 2 to 10 times (or even more), whether measured by volume or frequency.

Hard seeds may well be used, however, to supplement grit in the grinding of food. This area of the Gulf Coast is generally deficient in sand, gravel and other grit material.

MANAGEMENT SIGNIFICANCE

Additional losses in natural marsh habitat due to oil activity, deep boat channels, industrialization, drainage and others can be expected. However, the development and management of rice and pasture lands can be expected to more than compensate for this loss.

Another factor to be considered is the low production of natural food plants. Singleton (1951) reported yields of what he considered to be 10 of the better seed producing plants for waterfowl. The maximum production was 910 pounds per acre; however, the average yields of the ten plants were only 369 pounds per acre. Six of these plants fell below the average. Four fell below the minimum amount of waste rice following harvest operations.

Rice fields feed ducks better than natural marshes. Rice farmers generally consider that one to three barrels (barrel = 162 pounds) of rice per acre are lost in the harvest operation. This was borne out in a check made in Cameron Parish by the author where three fields were checked following harvest operations. The seed on the ground following combining was 160, 320 and 347 pounds per acre, respectively. Only domestic rice was checked since most rice field weeds had shattered prior to rice harvest.

To be available for ducks to feed on, most seeds need to be in water. It is simple to restore water on a rice field following harvest. The levees are in place and only dirt plugs or simple water control structures are needed to hold water on the land. A dependable source of water such as a well, bayou, reservoir, or irrigation canal is necessary to assure water for flooding when needed. Water should be kept on the field until March or early April to make food available to ducks all winter and thus send the ducks north to their breeding grounds in good flesh.

There is some indication that weeds are less abundant in a rice crop following heavy duck feeding. This point, however, needs further investigation.

Some of the management possibilities from the landowners' and hunters' standpoint were demonstrated by Edward Leger, a Vermilion Parish rice farmer. For the past several years, he has flooded his rice field following harvest each fall. Water was held on the field from only one to six inches deep. He kept a kill record for the 1955-56 season. Two or three hunters hunted every morning of the season. The season was split. Results are shown in Table III.

TABLE III

DUCK KILL* IN ED. LEGER'S FLOODED† RICE STUBBLE FIELD
VERMILION PARISH, LA.

	First Half	*Second Half*
Season Days	25	25
Number of Hunters	2-3	2-3
Number of Days no Ducks Killed	2	3
Total Ducks Killed	145	182
Percent Mallards	90	90
Percent Teal and Spoonbill	10 (all Teal)	10

* All birds killed from one three-man blind.
† Forty (40) acres rice stubble flooded.

The rules followed are simple: (1) Keep the field flooded; (2) Take no more than the daily legal limit for the party; (3) Hunt from opening until 10 A. M. with no P. M. shooting; and (4) Be sure the birds are within range before shooting.

The field was kept flooded until late March so the birds could use the area after the hunting season.

The best ways to feed ducks with agricultural lands are being studied and successfully carried on by Soil Conservation Service Biologists in South Carolina, Georgia, Florida, Tennessee, Arkansas, Mississippi and Texas as well as in Louisiana. Agriculturally fed ducks are usually fat, but marsh fed ducks are often in poor flesh by February and March.

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CONCLUSION

1. Waterfowl food plants are listed in Table IV as "Choice" and "Less Attractive" for the species shown. They were selected on the basis of volume and occurrence. Duck foods must have the ability to "attract" ducks at the same time they are nutritionally favorable.

TABLE IV

WATERFOWL PLANT FOODS

Gadwall	(9)*	*Choice:* Cockspur (coast); Junglerice. *Less Attractive:* Sawgrass.
Mallard	(155)*	*Choice:* Barnyardgrass; Junglerice; Paspalum (brownseed, knotweed and seashore); Rice. *Less Attractive:* Beakrush (horned); Bulrush (saltmarsh, softstem); Cockspur (coast); Croton (woolly); Flatsedge (fragrant); Snow-on-the-Prairie; Giantcutgrass; Naiad; Panicum (fall); Paspalum (hairyseed, Longtom, seashore); Pickerelweed; Pondweed (leafy); Rosemallow; Rush, Ryegrass; Saltgrass (seashore); Sawgrass; Signalgrass; Smartweed Puerto Rico and swamp); Spikesedge (common, Gulfcoast, jointed,

* Number of gullets and stomachs examined.

TABLE IV—*Continued*

WATERFOWL PLANT FOODS

		squarestem); Stonewort; Waterlily (dotleaf, American); Waterprimrose; Watershield and Dodder.
Pintail	(18)*	*Choice:* Barnyardgrass; Junglerice; Panicum (fall); Paspalum (brownseed, knotweed); and Rice. *Less Attractive:* Bulrush (California); Flatsedge (odoratus); Fimbry (globe); Snow-on-the-Prairie; Mudplantain; Paspalum (Florida, longtom); Rose-mallow (common); and Sawgrass.
Teal, Bluewing	(7)*	*Choice:* Junglerice and Stonewort. *Less Attractive:* spikesedge (dwarf, squarestem).
Teal, Greenwing	(12)*	*Choice:* Barnyardgrass; Junglerice, Paspalum (brownseed); Rice; Stonewort; and Dodder. *Less Attractive:* Bulrush (California); Paspalum (longtom); Sawgrass; and Signalgrass.

2. Ducks depend heavily upon agricultural lands for food. Opportunities for the management of rice and idle rice fields to produce duck food are extensive throughout the rice growing area of the Gulf Coast. Even without special management the rice growing area in most cases is producing duck foods in excess of that produced by comparable acreages of natural marsh lands. Management techniques of corn, browntopmillet and smartweeds, in addition to rice and idle rice fields, are being used by Soil Conservation Service technicians assisting farmers in Soil Conservation Districts to increase the amount of food to predictable amounts.

3. There appears to have been changes in food habits of ducks since the studies made by Martin and Uhler (1939) and by Singleton (1951). The birds are feeding more on the weed seeds in rice and idle rice fields than was shown by Singleton (1951). This might be based in part upon the fact that rice acreages have been reduced due to acreage control and more idle acres are growing weeds and grasses.

4. Stomach analyses of ducks may exaggerate some hard seeded plants from 2 to 10 times their daily consumption. Although they may be of minor importance as food, they may be important as a supplement to grit in an area where natural grit is deficient.

DUCKFOOD STUDIES

LIST OF PLANTS—STANDARDIZED PLANT NAMES (1942)

Common Name	*Latin Name*
arrowhead	*Sagittaria* sp.
barnyardgrass	*Echinochloa crusgalli*
beakrush, horned	*Rhynchospora corniculata*
browntopmillet	*Panicum remosum*
bulrush, California	*Scirpus californicus*
bulrush, saltmarsh	*Scirpus robustus*
bulrush, softstem	*Scirpus validus*
cockspur, coast	*Echinochloa walteri*
croton, woolly	*Croton capitatus*
dodder	*Cuscuta* sp.
fescue, meadow	*Festuca elatior*
fimbry, globe	*Fimbristyles miliacea*
flatsedge, fragrant	*Cyperus odoratus*
giantcutgrass	*Zizaniopsis miliacea*
junglerice	*Echinochloa colonum*
mudplantain, blue	*Heteranthera limosa*
naiad, southern	*Naias guadalupensis*
panicum, fall	*Panicum dichotomiflorum*
paspalum, water	*Paspalum hydrophyllum*
paspalum, Florida	*Paspalum floridanum*
papsalum, hairyseed	*Paspalum pubiflorum*
paspalum, knotweed	*Paspalum distichum*
paspalum, longtom	*Paspalum lividum*

LIST OF PLANTS—STANDARDIZED PLANT NAMES (1942)

Common Name	*Latin Name*
paspalum, seashore	*Paspalum vaginatum*
pickerel weed	*Pontederia cordata*
pondweed, leafy	*Pontamogeton foliosus*
rice, common domestic	*Oryza sativa*
rice, red	*Oryza sativa* var.
rosemallow, common	*Hibiscus palustris*
saltgrass, seashore	*Distichlis spicata*
sawgrass	*Cladium jamaicensis*
signalgrass	*Brachiaria platyphylla*
smartweed, Puerto Rico	*Polygonum portoricense*
smartweed, swamp	*Polygonum hydropiperoides*
snow-on-the-prairie	*Euphorbia bicolor*
spikesedge, common	*Eleocharis palustris*
spikesedge, dwarf	*Eleocharis parvula*
spikesedge, Gulfcoast	*Eleocharis cellulosa*
spikesedge, jointed	*Eleocharis equistoides*
spikesedge, squarestem	*Eleocharis quadrangulatus*
stonewort	*Chara* sp.
waterlily, dotleaf	*Nymphaes ampla*
waterlily, American	*Nymphaes odorata*
waterprimrose, floating	*Jussiaea diffusa*
watershield	*Brasenia schreberi*

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CLIPPING STUDY TECHNIQUES IN MARSH ECOLOGY INVESTIGATIONS

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INTRODUCTION

A variety of field study techniques are being employed in the investigation of the northern and central Everglades aquatic plant communities. These include permanent quadrats, belt and line transects, association transects, clipping study quadrats, and transect sample plot methods. Each of these procedures is utilized to serve a specific need. This paper describes the latter two of the aforementioned procedures and discusses some of the problems involved in designing these study methods.