and cottontails; corn, browntopmillet, smartweeds for wild ducks. These are the specific high-quality foods which agriculture can provide for wildlife better than unaided nature usually does. However, they all cost money; they use a part of the farmer's land; and they require his patience, intelligent planning, and his labor. *Farmers do not provide enough of these foods to support good wildlife populations under a "free hunting" economy.*

Water is necessary for most species. Ducks, geese, turkeys, and doves drink water daily; squirrels and deer use it less frequently. Water is a peculiar necessity to help ducks swallow their food; field grain and other seeds are highly attractive to them when flooded with a few inches of water. Farm ponds provide water for fishes.

Cover is a peculiar problem in the South. Usually it is insufficient only on improved pastures or overgrazed range. Often we have *too much cover* on the ground, burying food under leaves and stems, making the summer heat unbearable, and harboring parasites such as redbugs and ticks instead of nutritious insects, such as crickets and grasshoppers. Excess cover must be removed frequently (1 to 3 years) by grazing, mowing, cutting, cultivation, or controlled fire. Multiflora rose is one of the better cover plants for cottontails and for several species of songbirds.

Most of our huntable wildlife is fed, sheltered, and watered on farm and ranch lands. When we have more wildlife, it will be produced on the same lands. The farmer is no enemy! Neither is he any sucker. He needs encouragement, not abuse.

Every state in the Southeast concerns itself with finding successful means to assure a productive farm program for wildlife. This has been our joint anxiety for the past 15 years. A summary of our experience indicates the need for modern wildlife attitudes, and a broadening of our technical land management practices.

The Soil Conservation Service provides technical assistance through Soil Conservation Districts to help farmers plan for wildlife food, water, and cover. In the Southeast, State Game and Fish Commissions encourage quail and rabbit management on farms by furnishing lespedeza, multiflora rose, and annual seed mixtures to demonstrate the value of farmland management for game. These combined efforts however are not enough. The individual hunter, it appears, will have to make wildlife management profitable on the farm where he wishes to hunt.

These are facts regarding the relationship of agriculture to fish and wildlife. The educational and informational efforts of all wildlife and agricultural organizations might well be directed toward helping hunters, fishermen and wildlife workers understand them.

HURRICANE DAMAGE TO ROCKEFELLER REFUGE

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INTRODUCTION

This paper is concerned with the effects of Hurricane "Audrey" upon the animal life, marsh habitat, levees and installations on Rockefeller Refuge. Rockefeller Refuge is a state owned and maintained wildlife refuge and game preserve consisting of some 84,000 acres of marshland that extends northward

from its 26.5 miles of Gulf shoreline in Southwest Louisiana. The refuge is under the jurisdiction of the Louisiana Wildlife and Fisheries Commission, Refuge Division, headed by Mr. Richard K. Yancey. The refuge is closed to hunting and trespassing and the only outside activity permitted is the normal development work of oil companies.

Rockefeller Refuge was in the direct path of Hurricane "Audrey" and its wildlife populations, habitats and man-made improvements suffered extensively and in many areas, total losses. While hurricane preparedness in a coastal marshland must be limited in scope it seems advisable that development planning be done while fully cognizant of the hurricane potential.

In many instances, animal wildlife losses directly related to the storm exceeded fifty percent of pre-storm populations. Habitats were subjected to extreme high water and salinity conditions. Man-made control installations received damages that critically reduced their effectiveness, while refuge operation and maintenance facilities were almost completely destroyed.

PRE-STORM STATUS OF ROCKEFELLER REFUGE

Habitats and Control Installations

Approximately two-thirds of the refuge is located in Cameron Parish and the eastern one-third is in Vermilion Parish. The refuge is comprised of marshland ranging from a freshwater marsh lying adjacent to the Grand Chenier ridge complex, which is a stranded beach ridge located seven miles inland from the Gulf of Mexico, to a salt marsh back of the present day beach. Gulf water has access to the marsh through one canal and six tidal channels. The average tidal fluctuation is one foot. These uncontrolled saltwater inlets in past years have done much to salt out and also, cause excessive drainage in some stands of fresh to brackish marsh plants such as sawgrass (*Cladium jamaicense*), bull whip (*Scirpus californicus*), cattail (*Typha spp.*), roseau cane (*Phragmites communis*), olneyi three square (*Scirpus olneyi*), and leafy three square (*Scirpus robustus*). These stands have not been completely replaced and as a result large open areas of barren marsh exist. The dominant plants on the refuge at this time are the salt tolerant species such as wiregrass (*Spartina patens*), salt meadow grass (*Distichlis spicata*), oyster grass (*Spartina alterniflora*), and the less salt tolerant bull tongue (*Sagittaria lancifolia*).

Prior to the storm there were approximately 18,000 acres of fresh to brackish water impoundments that had been constructed during 1954 to 1956. Most of the impoundments had been flooded during the past year with maximum water depths ranging from 10 to 24 inches. This flooded condition had given rise to the growth of some aquatic plants, the more abundant ones being waterhysop (*Bacopa monnieria*), widgeon grass (*Ruppia maritima*), southern najas (*Najas guadalupensis*), bladder wort (*Utricularia vulgaris*), and duckweed (*Lemna minor*).

During the past fifteen years there has been a great deal of oil development work done in the marshes of southwest Louisiana. As a result, there is at the present time approximately forty-five (45) producing gas and oil wells on the refuge with more locations set for future work. It is from these wells that the monies used for development, management, and research are derived.

Canals dug by the oil companies opened up large tracts of marshland and thus created new problems in management and development. A major problem of the past has been saltwater intrusion from neglected or abandoned canals. It is now required that canal spoil banks be maintained by the leasing oil companies. The development program has benefitted from existing canals in one way, in that in most areas it was possible to utilize these same canals and levees for impounded habitats.

An important part of the development program at Rockefeller Refuge is dependent upon the 93 miles of canal and impoundment levees being effective as water retainers. That is, the levees must maintain adequate height and thickness to prevent water losses from seepage and levee overflow. The high organic content of marsh soils and the presence of the water table at or near the surface makes levee construction and maintenance difficult and costly. Marsh conditions and the development program objectives dictated the levee specifications and as a result it was essential that many levees be constructed to an initial height of six feet above the marsh level with a base width exceeding

60 feet. This seemingly excessive levee size was necessary to offset levee losses resulting from shrinkage, settlement, and erosion.

As each marsh area was enclosed by levees, water control structures were designed to control the pool stage in each impoundment according to refuge habitat needs. Impoundment structures were 36-inch metal gravity drain lines, each with overflow funnels set at pre-determined pool stages. Each structure was also equipped with manually operated headgates for complete or partial impoundment drainage. The headgates and overflow funnels were placed 50 feet inside the impoundments to eliminate the possibility of seepage at the structure. Creosote timber walkways were constructed from the levees to the headgates for easy access. The drain lines were laid under the levees at marsh level and drained into canals. The outlets on saltwater canals were provided with flap gates. Adequate structures were provided to enable each impoundment to be drained in a 14-day period.

In order to maintain the controlled marsh habitat program and keep it compatible with oil field development; one field utilizing a freshwater canal system and one a saltwater system, it was necessary to construct large concrete control structures, two at the junction of a freshwater-saltwater system and one in a tidal stream having a direct influence on a freshwater system. These structures incorporated undercanal siphons as well as manually operated gates designed to allow boat passage. The structures have three or four gates and each gate is ten feet wide with a sill depth of minus nine feet mean sea level.

Each structure's foundation is of reinforced concrete piling anchored in firm Pleistocene clays. The sill is metal interlocking sheet piling capped with a reinforced concrete slab. Wings of each structure extend 20 feet into existing canal levees or earthen embankments which in turn reach outward 70 feet from the tidal stream bank.

Wildlife Usage

The most abundant animals on the refuge are nutria. This fur-bearing animal has been trapped heavily in localized areas on the refuge in past years but to very little avail as a control measure. They are vegetative eating animals and are helpful to some extent in controlling plants in the impoundments. The nutria feeds mainly on the stems of vegetation above the ground surface. As the plant grows only the basal part of the stem is used. This feeding habit leaves most of the plant that the nutria feeds upon unused. In the more dense stands of large marsh plants such as roseau, bullwhip, cattail, and hogcane (*Spartina cynosuroides*), feeding activities lead to quite an accumulation of debris in the stand.

At the time of the storm the refuge supported a large number of nesting purple and Florida gallinules, king rails, mottle ducks, boat-tailed grackles, least bitterns, little green herons and various other birds.

There was an abundance of alligators on the refuge, ranging in sizes from one foot up to about eleven feet. These reptiles had built large nests of grass and mud on the levees and could be seen near the nests at any time. In the past years most of the alligators had nested in the marsh proper but due to the presence of the large freshwater canals, levees and the flooded marsh conditions that existed they were utilizing the sides and tops of the levees for nesting sites.

Deer were moving into the eastern end of the refuge and using the large levees for resting and feeding areas. Prior to the construction of these levees there was very little range for deer on the refuge due to the lack of resting sites.

There was a normal population of other marsh animals such as raccoons, mink, and otter as well as birds such as herons, egrets, a variety of shore birds, gulls, and terns. There was an abundance of alligator garfish, mullet and mosquito killfish.

HURRICANE DAMAGE

Habitats and Control Installations

At the height of the hurricane, winds were well over 100 miles per hour and saltwater from the Gulf was 9 to 12 feet deep on the refuge. Some of this water was trapped in the impoundments for several weeks before it was flushed out by rain water. This condition has caused a great decrease in the amount

of waterfowl and other game food plants for the coming season. The less salt tolerant plants such as bullwhip have been damaged and some stands may be destroyed by the saltwater. The wave action and current may have helped to some degree in that it removed a lot of dead and partly decomposed vegetation, thus getting rid of some of the build-up on the floor of the impoundments. This factor is one of the major problems in management of shallow water impoundments.

Unimpounded marsh areas will exhibit very little damage from the saltwater. This can be explained that first, this region received excessive rainfall in the weeks prior to and after the hurricane and secondly, drainage conditions on the refuge facilitate drainage, and also channels watershed drainage from the North through selected outlets.

The tangible damages incurred by the storm was the destruction of buildings and damage to the water control installations. At the time of the storm there were six residence houses, one guest house, office and laboratory building, one steel boat house and workshop (210′ x 60′), three utility buildings, a radio building with a 300′ tower and 17 trapping camps on the refuge. Two of the residence houses were built on pilings with the floor level ten feet above sea level. These buildings suffered the least amount of damage; however, there was about $5,000.00 damage to each. The large boat house suffered extensive damage in that sheets of tin were blown off, some of the steel beams were bent and the wooden wharfs washed away. At the main headquarters site, two residence houses, the guest house, utility buildings, and radio house were destroyed while the office and laboratory building were badly damaged. Of the total layout in buildings, the two residences on pilings, the office and laboratory, and boat house are all that can be repaired. Only one trapping camp is left in the marsh and it was damaged to the point that it would cost almost as much to repair as to build a new one.

The levee damage was principally breaks in impoundment levees that began as the water rose and engulfed the entire area. The breaks greatly enlarged as the water rapidly receded and drained from the level full impoundments. Some side collapse and slumping of the levees resulting from the rapid fall of water was noted. Wave wash was slight due to the rapid rise in water. Levees exhibiting good grass coverage suffered little or no damage.

The impoundment water control structures themselves were undamaged although most of the walkways and platforms were swept away. The large concrete control structures *per se* were undamaged. However, each was washed around at the point where the concrete wings were covered with earthen material. Each area washed was about six feet in width and was over ten feet in depth. Here too, the greatest washing occurred as the water rushed back into the Gulf.

Wildlife Losses

Wildlife losses appear staggering when first examined but upon clear analysis in light of the species involved we must concede that the losses are relative and that normal habitat populations should be restored in a few years. Of the smaller and more selective or less adaptable animals, approximately 60 percent mortality is estimated, this applies to nutria, muskrat, raccoon, rabbit, and deer. Mink and otter losses were considerably less.

All the nests of animals and birds were swept away by the hurricane waters. This is easily understood when we remember the 100 miles per hour winds and 11 feet of water over the marsh. There was a tremendous amount of wave action and current which kept dislocating the animals from any shelter or cover they might be lucky enough to find.

During the height of the storm countless numbers of nutria, snakes, gallinules, and other animals were trying to find refuge from the wind and water. Several raccoons were observed trying to climb trees and get upon drifting vegetation but with very little luck. Mink made out quite well during the storm and several have been observed since. One alligator hunter claims to have seen approximately 100 mink during a night's hunt about five days after the storm.

A few mottle ducks were seen during the height of the storm and a few afterwards. They were not trying to fly and appeared to be making out very well in the water and on the drift. The best indication of the bird mortality is the large number of carcasses found after the storm. Of over 200 dead birds

observed in a relatively restricted area on drifts of vegetation and in debris of houses that had broken apart, 95 percent were gallinules and rails.

A large percentage of the alligators that were on the refuge were swept along with the current and a few were found dead after the storm. One seven foot 'gator was killed in the kitchen of a house the next day. Many of the alligators that were moved off the refuge, thus losing its protection, were killed by alligator hunters. Although first indications were that the alligators suffered comparable losses to the other wildlife, it now appears that their losses were not excessive.

The after effects of the storm can probably best be described by pointing out that the refuge will be set back about two years in the planned development and management of the area. There will undoubtedly be a big decrease in the number of wintering waterfowl on the refuge, however, at the present time there is an abundance of blue winged teal and pintails. It is evident that the trapping success will be greatly decreased for the next few years until populations of muskrat and nutria build back up.

The future plans are to develop this large tract of marshland into an ideal wintering area for waterfowl and to produce as much other game and fur-bearing animals as possible, plus carry on a full load of marsh research. Plans have been made to construct low level wiers in most of the inlets within the next year. This will eliminate the daily fluctuation of the water level and reduce the salinity of the natural marsh ponds, thus increasing the productivity of these ponds for waterfowl and other forms of animal life.

SUMMARY

Rockefeller Refuge, an 84,000-acre tract of marshland, was in the direct path of Hurricane "Audrey" and suffered an unknown amount of monetary damage, a loss of well over half of its game population, and one employee, Mr. D. A. Bertrand, his wife, and three-year-old grandson.

The trapping activity on the refuge will be reduced until the population of nutria build back up.

Most of the levees were damaged to some extent, however, where there was any vegetative cover on the levees they did not wash excessively. The most satisfactory levee cover in this area appears to be bermuda grass or St. Augustine grass.

Water control structures must be functional in design and compatible in utility with the surrounding marsh environs.

The survival of the two buildings constructed on pilings indicates that future houses should be constructed in a similar manner in this exposed coastal section of Louisiana.

COTURNIX OR JAPANESE QUAIL INVESTIGATIONS IN THE UNITED STATES

(A Progress Report—October, 1957)

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The name of a bird, the Coturnix or Japanese quail (*Coturnix coturnix* japonica)*, was of little concern to workers in the wildlife field less than three years ago. Today the name Coturnix signifies one of the most interesting programs ever to sway the field of wildlife management since early in the century.

This paper is a partial coverage of some 1957 work that is in progress in several states working with the Coturnix quail. It covers some of the present

* Some vernacular names of the Japanese or Coturnix quail are: Common quail; Stubble quail; Eastern Common quail; Asiatic quail; Japanese grey quail; Red-throated quail; Japanese migratory quail; King quail; Japanese King quail.