About NUTRIA and their control

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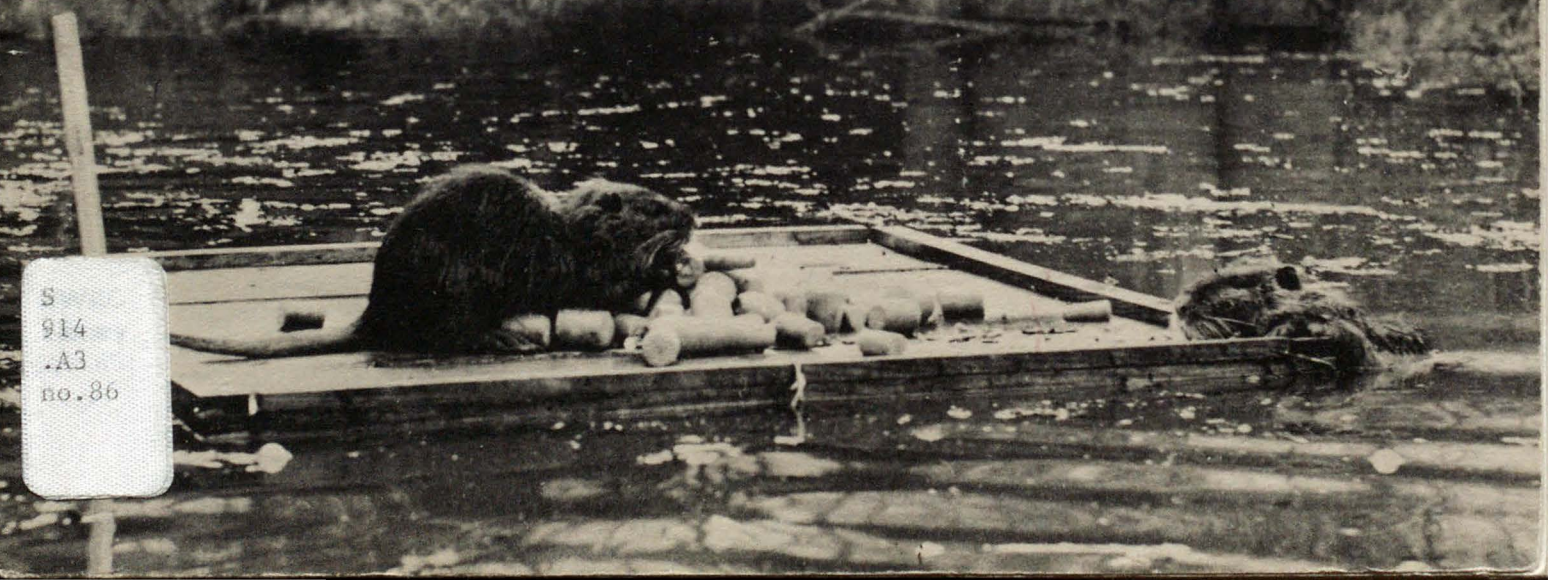

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About NUTRIA and their control

by

James Evans

Bureau of Sport Fisheries and Wildlife
Denver Wildlife Research Center

Illustrations by the Author

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This publication results from a combined effort of Denver research biologists assigned to the nutria project. The "we" commonly referred to specifically means myself, A. Lorin Ward, who directed the investigations, Roger D. Nass, who conducted the studies in Texas, and James O. Ells and Richard E. Griffith, Jr., who both assisted in the Louisiana studies.

Specific references to publications are omitted in the text, but our sources are listed in an Appendix. We have drawn freely on the wealth of information published by fellow biologists, as well as that gathered by other research personnel of the Bureau of Sport Fisheries and Wildlife—principally Earl J. Atwood, Van T. Harris, and the late Herbert L. Dozier, who all did early studies on Louisiana nutria. We are very grateful to all of them.

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Introduction

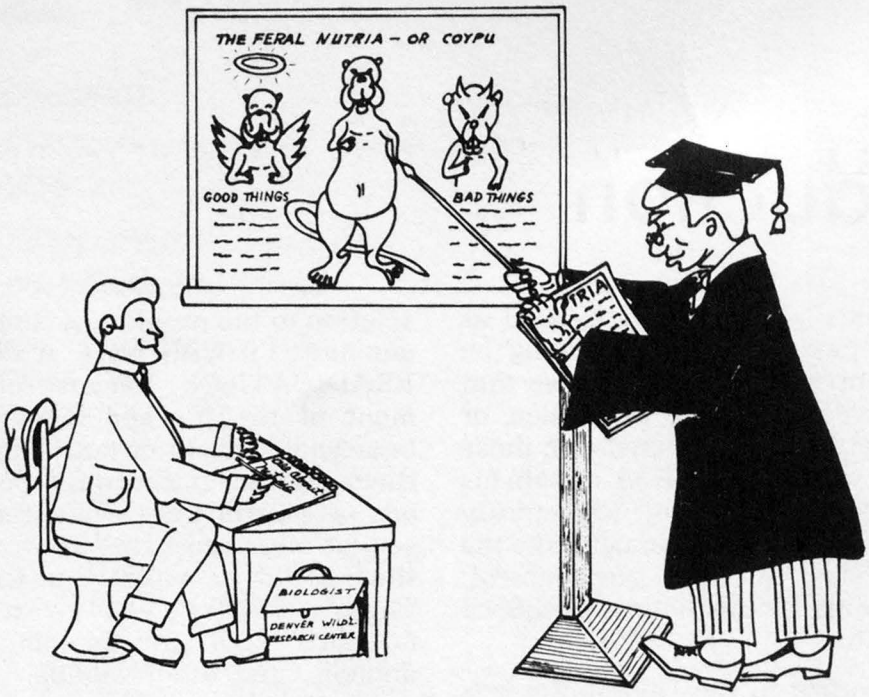
Wild animals are generally classed as beneficial or pest species, depending on the variable interests of man. Those that provide him with earnings, recreation, or enjoyment are considered beneficial; those that compete with him for food, or ruin his possessions or environment, are quickly dubbed pests. But all men do not have the same interests or the same environment, so many animals attain both a beneficial and a pest status.

The wild nutria in the United States is one of these animals with a dual nature. It is most numerous in the Gulf States, particularly in Louisiana and Texas, where the sale of nutria fur and meat in some years is a several-million-dollar industry. Although it is a valuable resource, it sometimes causes so much agricultural damage that it is also classified as a pest.

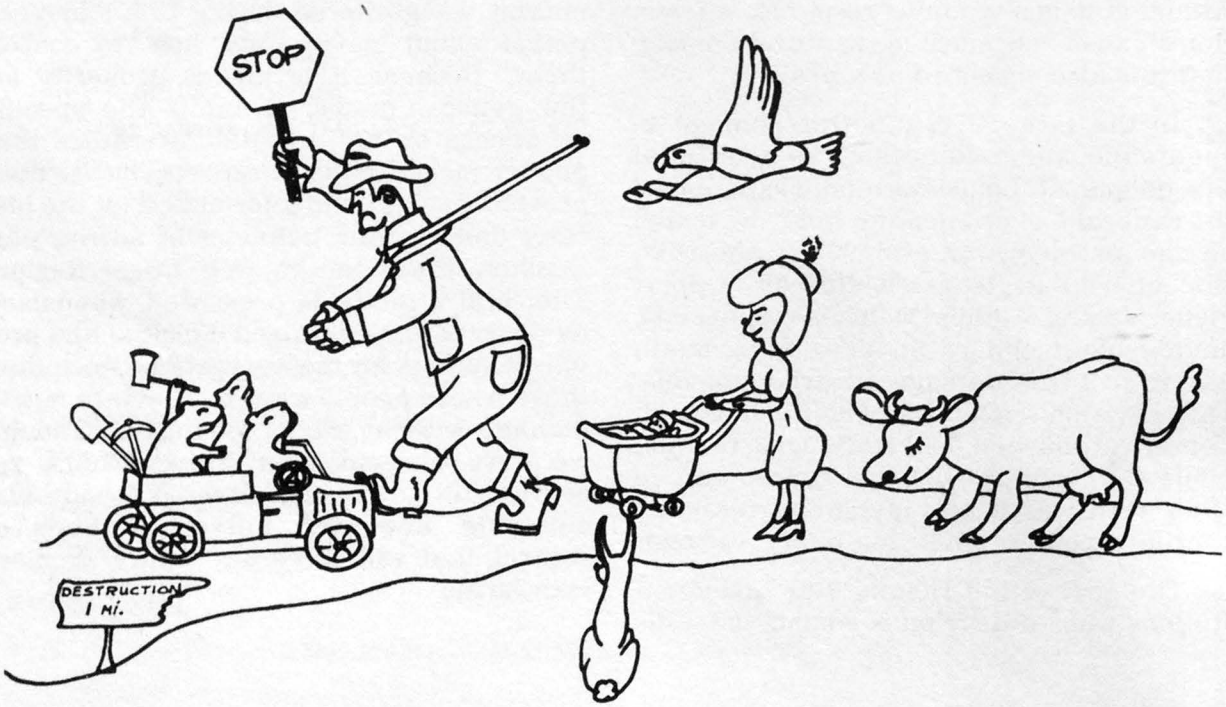
In the late 1950's, nutria damage to sugarcane and rice became so acute that the people of Louisiana and Texas asked the Federal Government for help. Research on the problem was assigned to the Division of Wildlife Research, Bureau of Sport Fisheries and Wildlife, which is responsible, among other things, for developing methods to control damage by wild animals. The Division's Denver Wildlife Research Center established field stations at Houma, Louisiana, and Beaumont, Texas, and in 1963 work was begun under congressional appropriation to fulfill this public request.

The goal of the Houma and Beaumont stations was to develop a sound, scientific solution to the problem of controlling nutria damage. IT WAS NOT A PROGRAM OF ERADICATION. Because of the involvement of the fur and meat industry, the beneficial aspects of nutria had to be continuously recognized when potential methods of control were evaluated. Especially sought were workable control procedures that could be readily used by laymen. These would have to be relatively selective for nutria and safe for humans, domestic animals, and other wildlife. In 1967, four years after our studies were begun, we had found methods to solve the current and immediately foreseeable problems of nutria damage.

This report presents much of the information we gathered during this four-year period about nutria and how to control them. Because it is meant primarily for the general public, it omits the specific references to the scientific literature that pepper most technical reports, but it does present background information on the history, biology, and behavior of nutria, particularly those in the Gulf Coast Region. The control methods presented, when used as directed, are safe and effective and provide solutions for most situations, including those where people want to alleviate nutria damage without killing the nutria. Though we were pleased with these results, research still continues, directed toward discovering new and better methods of control that will solve any future problem with nutria.



The Goal: To scientifically find out all about wild nutria—



— and then apply this knowledge to stop nutria damage by methods safe for humans, domestic animals, and wildlife.

The History of Nutria

Nutria were originally native to South America. The history of their life there and their introduction into Europe and North America is given in detail in several publications listed in Appendix C. Briefly, France had a few nutria ranches in the early 1880's, but the first extensive establishment of nutria farms was in South America in the early 1920's. This led to an expansion of the industry to Europe in the mid-1920's and to North America in the 1930's.

The first nutria for fur farming in North America were imported in 1899 from South America to Elizabeth Lake, California. Around this time, some zoos in Canada also imported nutria for display. These early pilgrims apparently were not successful in reproducing, and very little information is available on their eventual fate. The earliest record of successful reproduction by fur farm nutria came in 1927 from C. R. Partik, who had imported breeding stock from Germany for his Lantier, Quebec, fur farm. In Quebec City, La Forest reported successful reproduction in 1931—he had also imported nutria from Germany but did very little with them as a fur bearer.

In the United States, the 1930's were generally considered the boom years for establishing nutria ranches. Ranches were established in Washington, Oregon, and Michigan (early 1930's), New Mexico (mid-1930's), Louisiana and Ohio (1937), Utah (1939), and elsewhere.

Shortly after the boom years, World War II came and nutria farming virtually collapsed—poor reproduction, low fur prices, and competition with beaver pelts (also bringing low prices) were some of the causes. Dejected ranchers released their nutria or did nothing to recapture those that escaped because of inadequate holding facilities, storms, or floods. This is how our wild nutria populations started.

The 1930's were boom years for nutria ranching in the U.S.

Shortly after the boom, nutria ranches collapsed. Ranchers released their stock into the wild or permitted escapes.

The spread of nutria.

(1) It will probably never be known how far nutria would have dispersed in the U.S. if man had not helped.

(2) When ranch nutria escaped or were released, storms, floods, and hurricanes spread them.

(3) Fishermen, hunters, and trappers transplanted nutria in the early 1940's to improve ponds and marshes and provide a new source of fur.

(4) In the late 1940's, get-rich-quick artists promoted nutria as "weed cutters" for unwanted marsh plants, selling them to farmers and sportsmen in many states.

(5) State and Federal game departments also transplanted nutria in coastal and inland water areas to control vegetation and provide a new fur resource.

(6) Young nutria, which are very gentle, were picked up by the general public as pets. After messy experiences, people generally released them, sometimes many miles from where they were picked up.

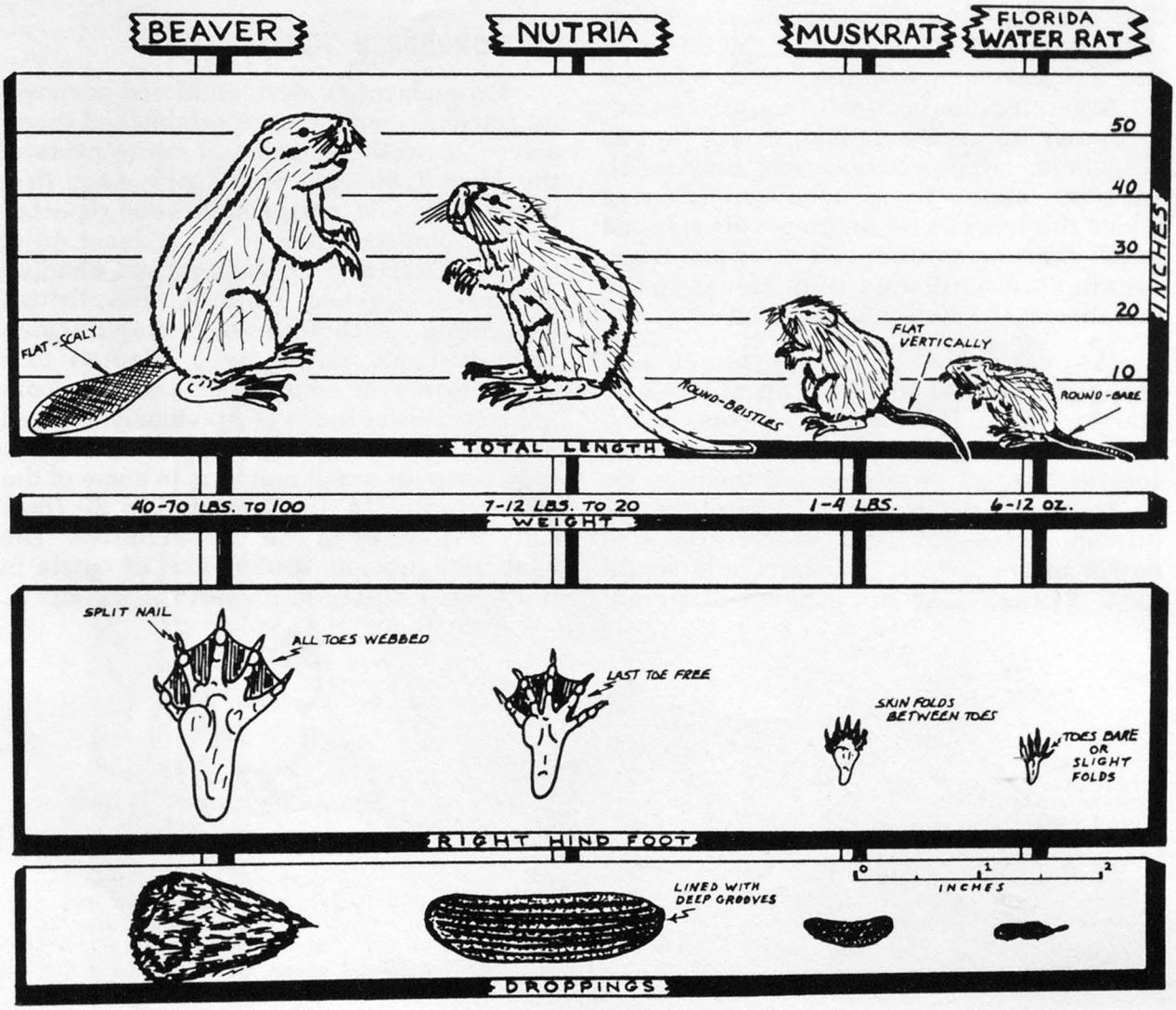
DISPERSAL

The origin of the Gulf Coast nutria population probably illustrates how wild nutria became established all over the country. Although nutria were first released in Louisiana marshes in the early 1930's near New Orleans, they were reportedly all recovered by trappers shortly afterward. The existing Gulf Coast nutria population dates back to 1937, when E. A. McIllhenny, the Tabasco Sauce millionnaire, released 13 Argentine fur farm nutria into a fenced-in marsh on Avery Island, Iberia Parish, Louisiana. Reproduction was successful. In 1939, about 12 escaped by burrowing under the fence, and another 150 escaped in 1940 during a storm-caused flood. These escapees established themselves in the marshes, reproduced, and spread.

As early as 1941, sportsmen and trappers were transplanting nutria into marshes from Port Arthur, Texas, to the Mississippi River in Louisiana; some were sold to hunters who released them as far away as North Carolina. A hurricane through Texas in 1941 widely scattered nutria in southwest Louisiana and southeast Texas. But the biggest dispersal occurred in the late 1940's, when get-rich-quick promoters selling nutria as "weed cutters" transplanted them throughout the southeast. State and federal agencies also transplanted nutria into Alabama, Arkansas, Georgia, Kentucky, Maryland Mississippi, and Oklahoma and inland in Louisiana and Texas.

OCCURRENCE TODAY

Through many accidental and purposeful releases, nutria have established themselves in wetland areas in many parts of the United States. Since they were first introduced, wild nutria have been reported at one time or another in at least 40 of the 50 states and at least three Canadian provinces—Quebec, Ontario, and British Columbia. Although some populations have died out, nutria have adapted to a wide variety of conditions, and they continue to persist in areas previously claimed as unsuitable for their existence. Although they occur in small numbers in some of the areas, nutria in 1966 existed in 20 (possibly 23) states in the United States. The past and present distribution of nutria in the United States is given in Appendix A.

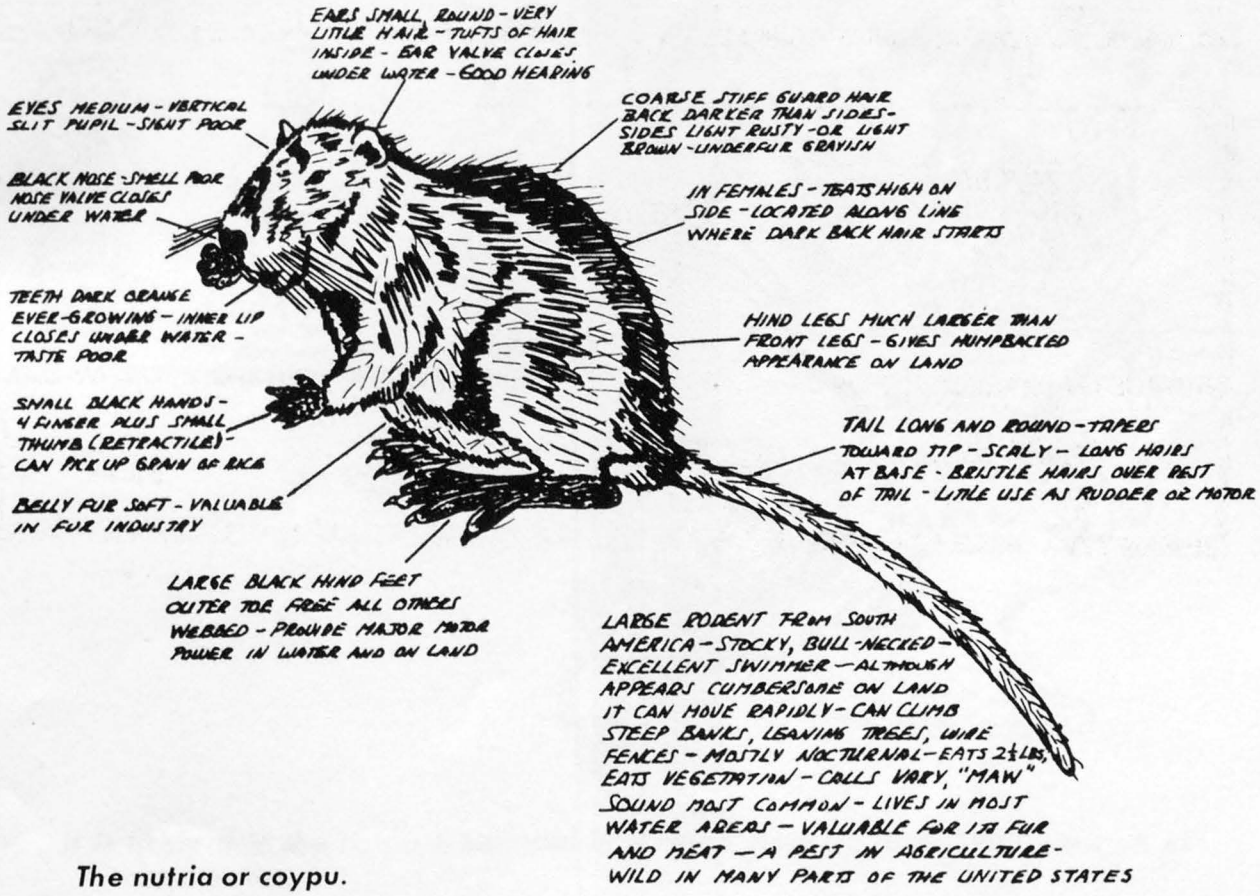

BEAVER
NUTRIA
MUSKRAT
FLORIDA WATER RAT
50
40
30
20
10
INCHES
FLAT - SCALY
ROUND - BRISTLES
FLAT VERTICALLY
ROUND - BARE
TOTAL LENGTH
40-70 LBS. TO 100
7-12 LBS. TO 20
1-4 LBS.
6-12 OZ.
WEIGHT
SPLIT NAIL
ALL TOES WEBBED
LAST TOE FREE
SKIN FOLDS BETWEEN TOES
TOES BARE OR SLIGHT FOLDS
RIGHT HIND FOOT
LINED WITH DEEP GROOVES
0
1
2
INCHES
DROPPINGS

What Are Nutria

Nutria are large, semi-aquatic rodents. They resemble beavers or muskrats but differ by having a long, round tail and webs between the inner four toes of their hind feet but not the fifth outer toe. Nutria are sometimes difficult to distinguish from these other animals in the water. In tooth patterns and other skull characteristics, however, nutria are more similar to porcupines, their closest wild relative in this country.

In North America, nutria are usually called just that—"nutria." This is also the name of the pelt in the fur industry and means "otter" in Spanish. Other names for the nutria in the United States are coypu, coypus, nutria-rat, South American beaver, and several unprintables, especially when they are doing damage. In England, they are called coypus or coypu-rats. To scientists everywhere they are known as *Myocastor coypus* in the family *Capromyidae* and order *Rodentia.*

The nutria is more closely related to the porcupine than any other North American animal.

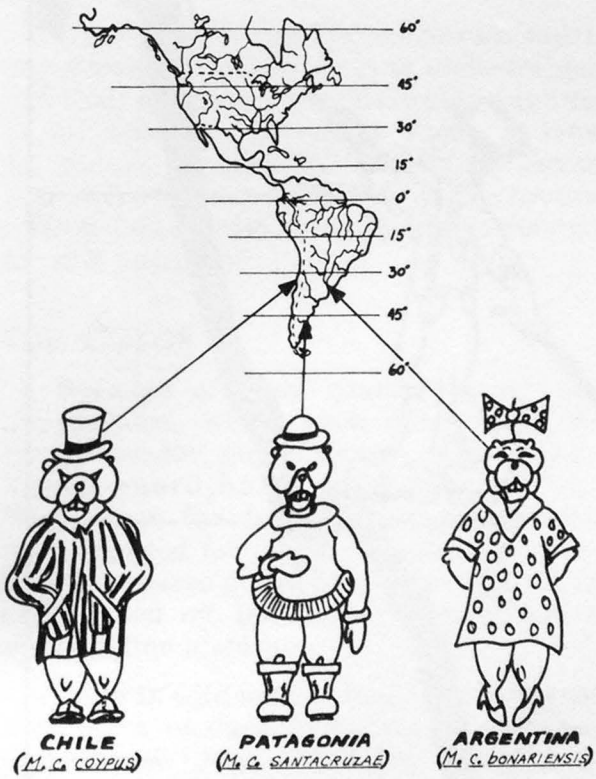


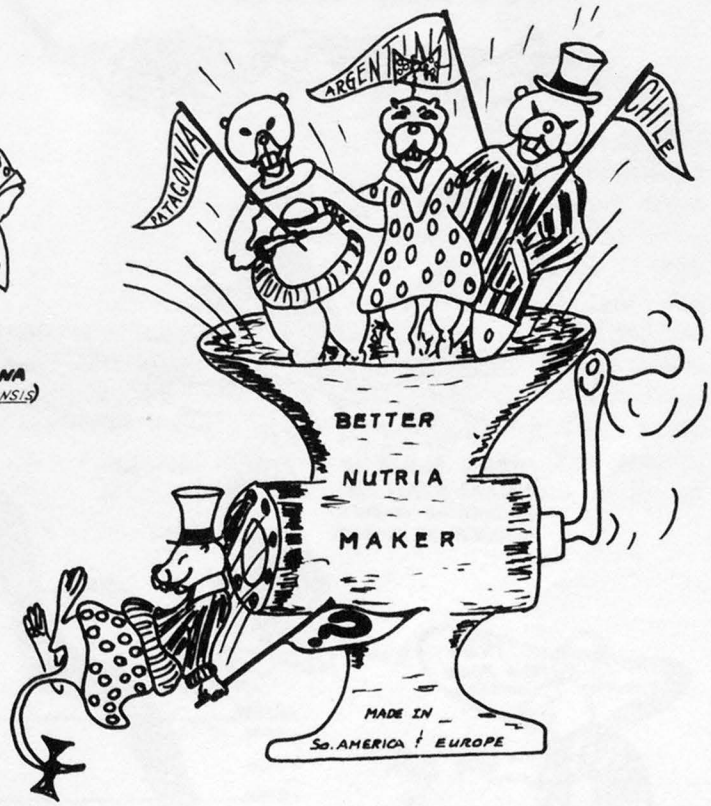
The nutria or coypu.

KINDS OF NUTRIA

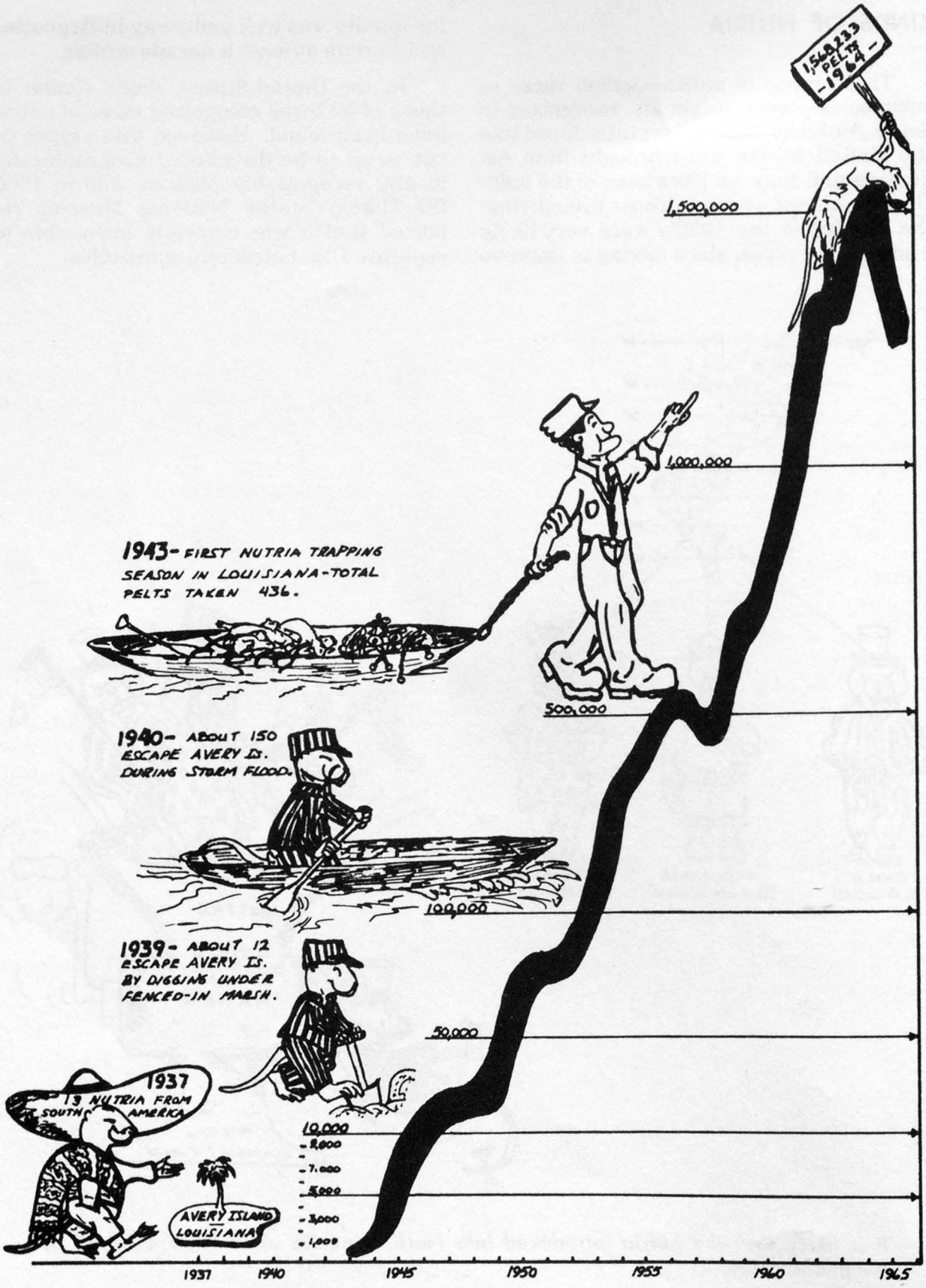
Three kinds of nutria—called races or subspecies—were originally recognized in South America. Those first introduced into the United States were brought from Argentina and may all have been of the mild-climate Argentine race. Those brought into the country in the 1930's were very likely a mixture of races, since mixing to improve fur quality was well underway in Argentina and Europe at least a decade earlier.

In the United States, skulls similar to those of all three recognized races of nutria have been found. However, these types do not seem to be distributed geographically in any recognizable pattern, and in 1966 the United States National Museum reported that it was currently impossible to separate U.S. nutria into subspecies.





It is likely that the nutria introduced into North America after 1900 were all of mixed races.


1,568,233 PELTS -1964-
1,500,000
1,000,000
500,000
100,000
50,000
10,000
9,000
7,000
5,000
3,000
1,000
1943- FIRST NUTRIA TRAPPING SEASON IN LOUISIANA-TOTAL PELTS TAKEN 436.
1940- ABOUT 150 ESCAPE AVERY IS. DURING STORM FLOOD.
1939- ABOUT 12 ESCAPE AVERY IS. BY DIGGING UNDER FENCED-IN MARSH.
1937
13 NUTRIA FROM SOUTH AMERICA
AVERY ISLAND LOUISIANA
1937
1940
1945
1950
1955
1960
1965

Nutria Fur Trapping

Over most of the United States, nutria are generally looked upon as undesirables, but they also have their desirable qualities as fur bearers. In recent years, at least 14 states, principally Louisiana, Texas, and Oregon, have cashed in on the several million dollars paid annually in this country for wild nutria fur.

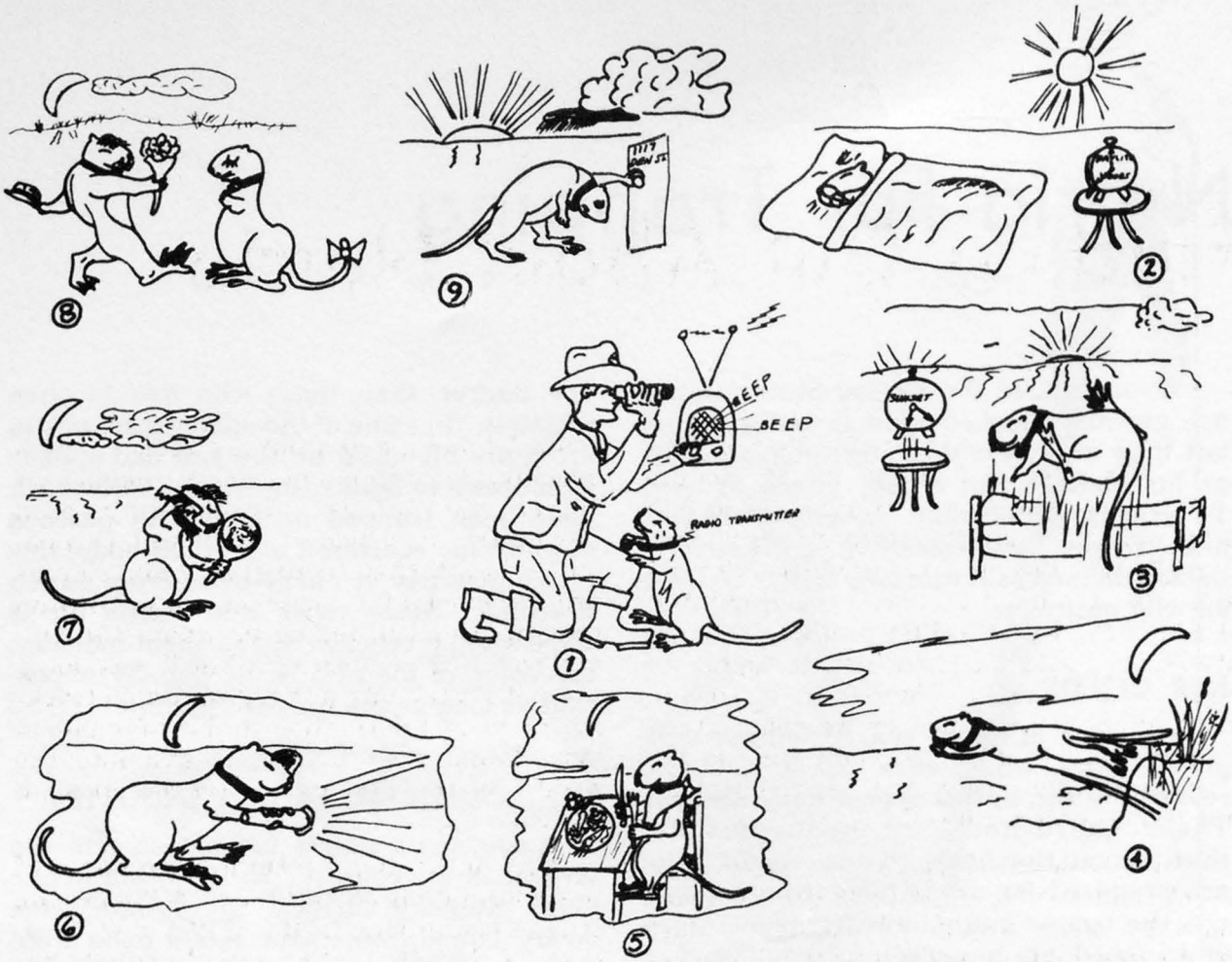
FUR COLOR

Because of their coarse, rather stiff guard hairs, which stick out beyond the rest of the fur, nutria appear quite shaggy. These guard hairs are the longest and thickest on the back. When nutria pelts are prepared for use in the garment industry, the coarse guard hairs are plucked out or trimmed off, leaving a fur composed of the soft, fine underhair.

Color in wild nutria varies considerably, from black or dark amber to a light rusty or brownish blond, depending on their environment and their ancestry. The back is usually darker than the sides and belly. In general, nutria who live in densely vegetated marshes, croplands, or swamps are darker than those who live in open marshes. In some of the open areas, nutria are quite bleached by the sun and appear light brown to light rusty blond. Wild nutria have been trapped or seen with patches of white fur scattered over their body; this is apparently a carry-over from ranch breeding. Since most wild nutria fur is dyed when it reaches the garment industry, the color of the pelt is not usually important as long as the quality is prime.

THE LOUISIANA NUTRIA INDUSTRY

Louisiana's nutria fur industry is the largest in the country. In 1945, within five years after the nutria's "big escape" from Avery Island, more than 8,500 pelts were taken by Louisiana trappers. By 1950 this figure had risen to 40,000 and in 1961 the average annual take was over a million pelts. In recent years, the sale of the pelts, mostly for trim and lining, and of the meat for mink and pet food has brought the state several million dollars a year. The annual income from nutria in Louisiana is listed in Appendix B.



A day in the life of a nutria.

(1) We used visual observation and radio tracking to find out how nutria in agricultural fields spend their day.

(2) Agricultural nutria spend most of the daylight hours resting.

(3) They start to become active at sunset.

(4) By nightfall, all of them are active. At this time, most can be found swimming in canals.

(5) They spend most of the night eating. They stop to eat many times, consuming 2½ to 3½ pounds of food a night.

(6) They also spend a lot of time just searching around.

(7) Nutria go through grooming and scratching routines. This is especially noticeable after swimming.

(8) When females are close to being in heat, nutria spend much of their time in courtship. Once the female is in heat, breeding is prompt.

(9) By dawn, most activity stops. By sun-up, all of it stops.

Finding Out About Nutria

While the nutria is an asset to the trapper, it is often a definite liability to the farmer. Our studies were planned to find ways of relieving the farmer's problems. In 1963 when we began, very little information was available on nutria in agricultural areas. Earlier studies made of marsh-dwelling nutria seemed not to apply to agricultural nutria. Therefore, we began by finding out as much as we could about the animals so that we could choose the best and easiest methods for controlling the damage they caused.

In this fact-finding process, we used a number of scientific methods that also are used by other wildlife researchers. Most of our information was obtained by observing animals that we had captured and released after marking them so that they could be identified from a distance. Periodically, we also caught some animals for closer examination. Tracking by radio telemetry—in which a small radio transmitter is attached to an animal and signals are received at a distance—was also an important tool in telling us where the animal was and suggesting what it was doing throughout the day and night. Radio tracking gave us information on how far nutria moved and also helped us evaluate the results of the various control methods we tested.

The following sections give some of the information we gathered. Although the studies were done in the Gulf Coast area, most of the information would apply to nutria anywhere in the United States.

What Nutria Are Like

PHYSICAL DEVELOPMENT

The average nutria is about 24 inches long, plus another 16 inches of tail. Nutria do not reach full growth until they are about one and a half years old, and some not until they are two and a half years old. On the Gulf Coast, a large male nutria may reach 20 pounds and a non-pregnant female about 18 pounds, but the average weight of most adults is not much over eight pounds. Fur-farm nutria and some pen-reared nutria may get up to 25 pounds, but wild nutria almost certainly never reach the 40-pound size reported by some trappers.

Nutria have fairly respectable life spans. Caged nutria have been known to live for 15 or 20 years, but the law of averages would probably catch up with most wild nutria before they survived that long. We estimated that most died within about two years.

CHARACTERISTICS AND HABITS

On land, nutria appear slow and cumbersome, usually ambling about in a rump-high, waddling gait. When frightened or disturbed, they can move quite rapidly in a waddling, bounding, or "belly-low" creeping gait. Nutria in the wild are quite adept at climbing high, steep banks, root entanglements, and gently sloping trees; they can also quite easily, and rapidly, climb over wire fences.

Although adept on land, nutria are more at home in the water. When undisturbed, they swim in a methodical, unhurried fashion with their head and most of their back out of the water and their tail floating free at the surface. In long-distance swims or when they are slightly disturbed, only their head appears out of the water. When frightened while on shore, they will usually hit the water with a resounding splash and either swim rapidly underwater for cover or simply stay submerged for awhile. We have held caged nutria underwater up to 14 minutes with no ill effects, but an excited animal in the wild would very likely be unable to stay submerged this long. Quite often when hiding in the water, nutria will keep only their nose and eyes or the upper part of their head out of the water. They can maintain perfect buoyancy with little or no body motion and can stay well hidden under very sparse vegetation.

Nutria sense danger primarily by hearing; they have relatively poor sight. Although they occasionally test the air for scent, smell apparently plays a very minor role in sensing danger.

Nutria have excellent hearing, but can't see or smell very well.

In general, wild nutria are not wary animals and appear relatively docile. However, in recent years, man's activities have eliminated many fearless nutria, so that the wariest animals were the most likely to survive and reproduce, passing on their wariness to their young. Even so, there are nutria that never seem to acquire this alertness, and remain indifferent toward man.

In our studies, both caged and wild nutria often seemed to go through periodic phases of extreme alertness, or viciousness, followed by periods of tameness. We were not able to define exactly what caused these changes. In general, nutria are not vicious animals when left alone and will try to escape rather than fight; but when captured or cornered, they can be quite aggressive and can inflict serious injury on man or dogs.

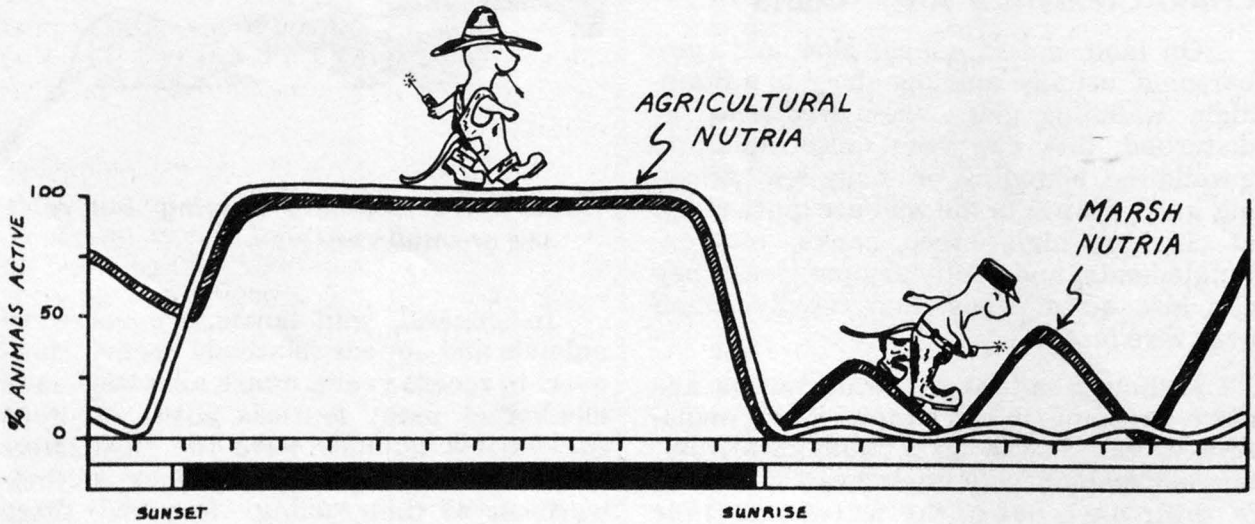
Females about to give birth and for about four to six weeks afterwards, at least in our studies, have almost always appeared in a "tranquilized" state of existence. They will freely allow handling of themselves and their young and offer no defense. However, a female will not accept either strange litters or other young mixed with her own. In our "mixing" studies, females would become vicious and fight young other than their own and would return to their tranquil state only after the strangers had been removed. We observed this both in pen studies and in the wild. About the time the young are weaned, the female will revert to her usual wildness and aggressively defend herself if attempts are made to handle her. In the wild, most females will readily abandon their young when approached by man or dogs but will return to them after the danger has passed.

GROOMING

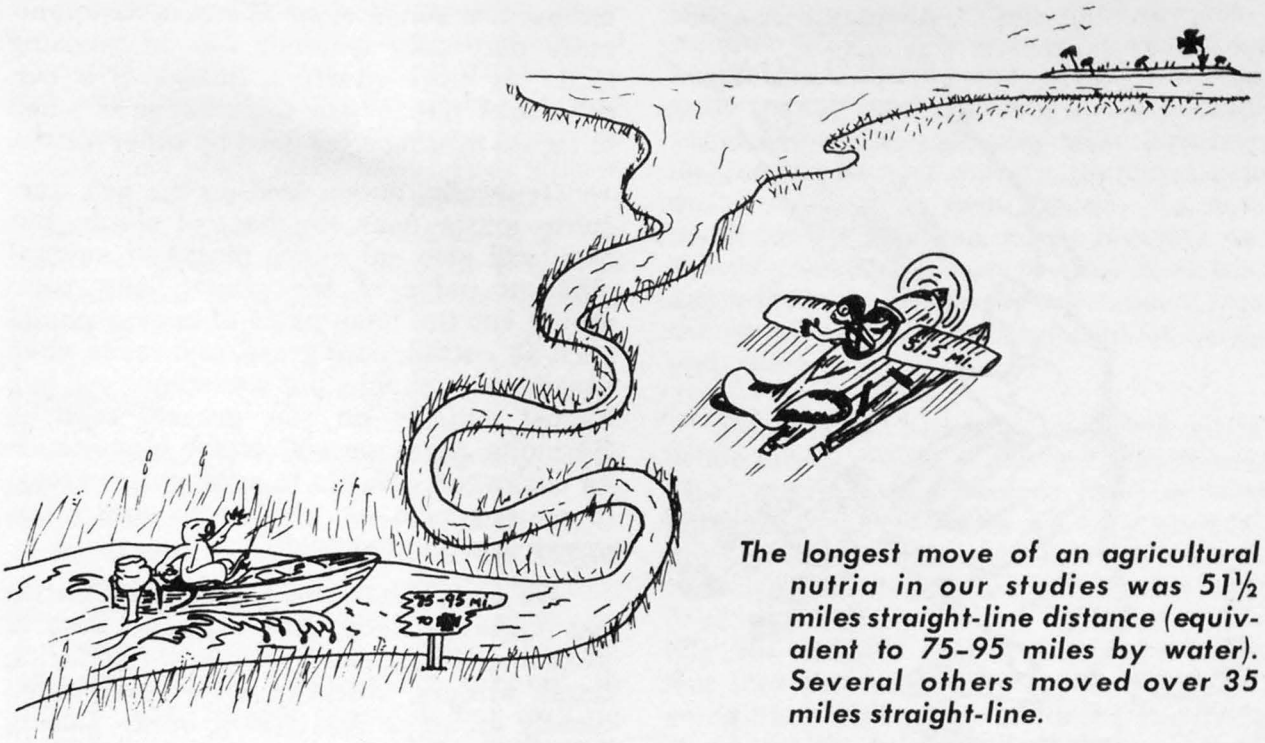
Nutria almost ritually scratch and groom themselves. They use their forepaws for both scratching and grooming; the hind feet, only for scratching. They do not use their tongue for grooming, but occasionally males will cleanse their genitals this way. Unlike beavers, nutria do not have a split toenail on the hind foot to use for grooming; instead, they use their free outer tow for combing themselves and cleaning their ears.

ACTIVITY

Nutria are primarily nocturnal animals. We found that when the food supply was good, as in agricultural areas in the summer, nutria spent the day resting, grooming, or in playful activity, and fed only at night. In the marshes and in agricultural areas during the winter, they fed at night, but also periodically during the daylight hours. This daytime feeding seemed to be prompted simply by hunger; when we gave supplemental food to nutria in agricultural areas in the winter, they went back to feeding only at night.



Radio-tracking studies showed that agricultural nutria rested during the daytime in summer but marsh nutria continued to feed off and on.



The longest move of an agricultural nutria in our studies was 51½ miles straight-line distance (equivalent to 75-95 miles by water). Several others moved over 35 miles straight-line.

Most nutria that live in agricultural areas do so only in the summer, coming in when the growing season starts and leaving again after harvest. In the sugarcane fields we studied, only about 10 percent actually made their home in the fields, and of these only about half lived there all year round. The summer residents appeared to be nomadic wanderers, but by radio tracking we found that most nutria had a home territory. Inside this was usually a "core" area where the nutria would spend most of its time, not leaving for days or even months. Nevertheless, these agricultural nutria moved much further in their lifetime than marsh nutria. Instead of the average 3600 feet reported by earlier biologists for marsh nutria, our cane-field nutria traveled an average maximum distance of almost three miles, and several moved over 35 miles. One footloose wanderer went 51½ miles! Rice-field nutria did not go as far as cane-field nutria, though they went further than marsh nutria. In the cane fields, males moved further than females; in rice fields, for some reason, the opposite was true.

FEEDING

Nutria are almost exclusively vegetarians. They have been reported to occasionally eat animal matter, primarily shellfish, in the United States and in other countries; but while we have observed them gnawing on mollusk shells, in pen studies we were unable to force nutria to eat any animal matter—live, cooked, or dried whole—and we never found animal remains in their stomachs.

Nutria eat about 2½ to 3½ pounds of food a day, consuming this amount in numerous feedings rather than at one time. Caged animals have lived without food up to 29 days, but it is doubtful that those in the wild could survive that long.

The feeding habits of nutria vary considerably. They feed while in the water, on surface or floating objects, or on land. They will graze on grass like cattle or clip upright plants like rabbits. Normally they feed by holding food items in their forepaws, either leaning forward while resting on their elbows or sitting in an upright

Nutria appear to be strictly vegetarian.

kangaroo-like position. With their remarkable bouyancy, they can also free-float for long periods, shoving floating plants into their mouth with their forepaws. Although nutria are reported to be able to feed underwater because of their "inner mouth cavity," we have never observed this behavior in either wild or penned animals. Nutria often pull up underwater vegetation with their forepaws or cut fine and coarse underwater plants with their front teeth, but they always seem to carry these foods to the surface to chew and swallow them. Nutria sometimes wash their food, but this normally does not happen until feeding has progressed well into the night.

Touch plays a major role in feeding. The nutria's sensitive and dextrous forepaws enable it to locate food items, pick up "handfuls" of plants or grain, or handle a single grain of rice or a stem of clover. Although nutria appear on occasion to be continuously smelling the food they are eating, the sense of smell and taste apparently play only a minor role in choosing food. At close quarters, though, it is evident that nutria use their sense of smell to locate feeding sites used by other nutria.

Generally, nutria feed on the soft, succulent parts near the base of plants, but they will also eat entire plants or several different parts of the plant. They commonly eat the base parts of coarse plants such as cattail, cord grass, and reeds when these are available, but sometimes will live almost entirely on soft grasses such as Bermuda grass or soft water plants such as duckweed. Nutria in agricultural areas, of course, also eat the weeds and crops growing in planted fields.

We found that the kind of food nutria eat varies a good deal with the time of year and the weather. In Louisiana during harsh winters, nutria in our studies relied mostly on roots and willow bark. During mild winters and during late winter and early spring, they grazed heavily on the flower heads and leaves of white clover. In late spring, bur clover and early spring grasses were added. In pasture and rice-growing areas, they grazed quite heavily on Bermuda grass and various legumes during middle and late summer. Cattail, sawgrass, and large sedges were eaten at all seasons of the year, and where these were the most common plants, the amount eaten stayed about the same regardless of the season.

PLATFORMS

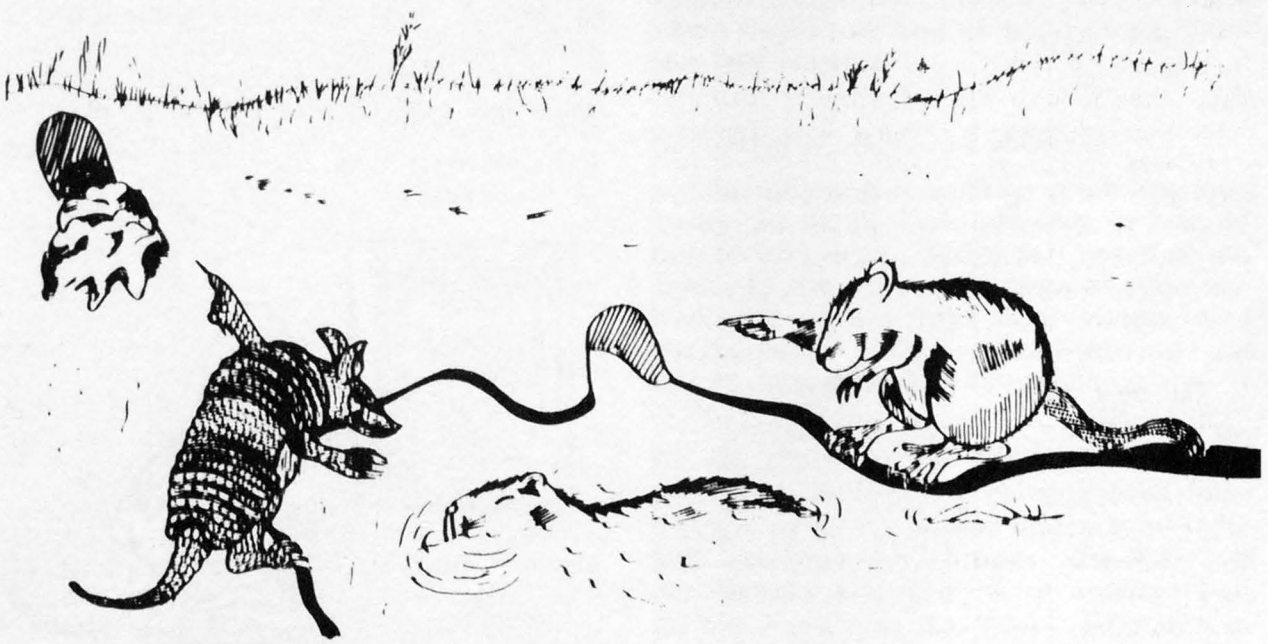
Nutria often build platforms of vegetation for feeding, resting, nesting, or hiding from danger or bad weather. Rather than say "build," perhaps we should say "accumulate," for most platforms appear to result from piles of uneaten plant parts at a favorite feeding site. Although nutria platforms in the southeast are quite large—some may be five or six feet across and used by several generations of nutria—they do not reach the massiveness of the nutria "lodges" reported in the Pacific Northwest and South America.

Generally, nutria platforms occur wherever nutria live or feed. They can be found in marshes or swamps, in pastures or agricultural fields, on stumps or in the root tangles of trees, on canal banks, or on and under man-made structures. They vary in size and density with the coarseness of the vegetation, and appear to consist of the most available vegetation in the area rather than a preferred type of building material.

BURROWS

Studies in the 1940's showed that marsh nutria made very few burrows. We found that during the summer, particularly in sugarcane fields, nutria make their home on the ground in dense vegetation, but that the rest of the time they are apt to use burrows. We found nutria burrows common wherever there was sloping ground—in banks and levees, spoil areas, rolling marshland, or even muskrat houses or beaver lodges. Nutria also made quite extensive use of existing burrows abandoned by armadillos, muskrats, or other nutria. Most nutria burrows were made in earth structures with a vertical or relatively sharp slope. They were the most common along banks and levees with dense vegetation, shrubs, and trees, and were quite rare in gently sloping banks without vegetation. Although they were generally located along water courses, we found some quite a distance from water. We even found nutria who had made burrows and reared young in a barn several miles from any waterway; they were free-loading from the water and feed troughs used for horses and cattle.

Burrows can be homes for single nutria, or for family groups of several generations. The burrows vary from simple, one-entrance, short tunnels to very complex units with several multi-level entrances, tunnels, and living compartments (to be used with different water levels). Normally the tunnels extend from four to six feet into the bank, but we found several going back 50 or even 150 feet. The living or resting compartments vary from small ledges (about a foot across) to large family units (three feet or more), and are either dirt-covered or overlaid with plant debris, apparently left from feeding, in which crude nests are formed.



Nutria can dig their own burrows, but often take over old burrows abandoned by armadillos, muskrats, or other nutria.

Reproduction

Wild nutria, like their fur-farm relatives, are generally very prolific animals, and have young throughout the year. But the conditions in the wild are not like the controlled conditions on fur farms. Many factors—the amount of food available, the kind of food, the weather, the prevalence of natural enemies and disease—all influence how many nutria will be born, how fast they will grow, and how many will survive.

SEXUAL MATURITY

The age at which nutria reach sexual maturity is variable, but it usually occurs well before they are full grown. On the Gulf Coast, they are reported to mature sexually at four months of age where the food supply is good, but not until about five or six months where it is poor. A study at Louisiana State University suggested that, although nutria could breed earlier, most of them do not do so until they are about eight months old.

Most nutria mature sexually when they are four to eight months old.

In our study, we found that the age of sexual maturity also differed between males and females and, for both sexes, between winter and summer. Young males born in early summer reached sexual maturity when they were four to six months old, but those born in early winter did not reach it until they were seven or eight months old. Females reached sexual maturity at four to six months during summer and mild winters but at five to seven months during severe winters. Scientists in England also report that nutria born in early winter take longer to reach sexual maturity. Apparently, the faster growth rate in the summer results from a better food supply.

Once nutria are sexually mature, they probably stay fertile. There have been some reports that nutria become sterile when their tail freezes off, but we found this was not true.

COURTSHIP AND BREEDING

Female nutria usually come into heat every 24 to 26 days and stay in heat for one to four days. Males can breed at any time. In the wild, most females come into heat one or two days after giving birth; we found that they also came into heat one or two days after they miscarried.

Courtship is common just before the female is in heat and consists of calls and sounds by both sexes, chasing each other on land or in the water, and playful fighting, wrestling, and biting. The male will occasionally squirt urine or seminal fluid on the female in courtship. Once the female is in heat, courtship is generally disregarded, or is very brief, and breeding is prompt.

Like most rodents, nutria do not mate for life. A female may breed with one or several males each time she comes in heat. Nutria breed almost anywhere, in or out of water. Breeding between littermates or between parents and their offspring is quite common, particularly in marsh areas and rice fields, where nutria tend to have close-knit communities, or colonies. In most agricultural areas this inbreeding is probably not too common except between littermates, because nutria there do not form colonies and there is an almost constant interchange of individuals in any particular area.

PREGNANCY AND BIRTH OF YOUNG

In our studies, over 85 percent of the sexually mature females we examined in Louisiana and Texas were pregnant, but we estimated that over half of the population never successfully produced young. Miscarriage of whole litters average 32 percent for the four years (1963-1966) and went as high as 45 percent in 1965, a particularly bad year. Miscarriage of only part of a litter averaged an additional 8 percent, and we found another 7 percent of the embryos were being absorbed by the mother's body. We estimated that, on the average, only 60 percent of the embryos survived to be born—only 47 percent in 1965. Miscarriage usually seemed to occur early in pregnancy, however. The number of developing embryos in females that were "obviously" pregnant averaged almost exactly the same as the number of young born per litter.

Successful pregnancy lasts about 130 days, although this period varies slightly. The young are born fully furred, with their eyes open, and are ready to swim shortly after drying off. Weights of newborn nutria vary, probably because of the mother's diet. Where food is plentiful and nutritious, they weigh about eight ounces; where it is scarce or not too nourishing, they weigh about six ounces.

Gulf Coast nutria have from one to nine young in a litter, although the first litter is generally smaller than later ones. In our studies in southern Louisiana, we found that the average litter was about four and a half young. Litters were larger in western Louisiana and eastern Texas—about five or six young—perhaps because of the higher-quality food in those areas. The sex ratio was always about fifty-fifty.

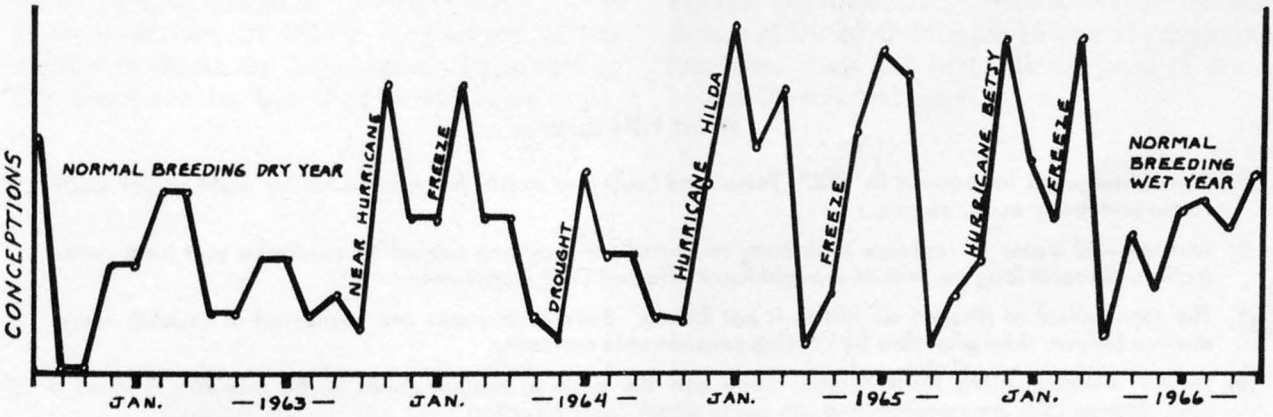
Female nutria may start producing milk as early as a week or two before giving birth, and continue for about six or eight weeks afterward. Most young are weaned at about five weeks, but some continue to nurse for a few weeks longer.

We estimated that over half the adult female nutria in central Louisiana never successfully had young.

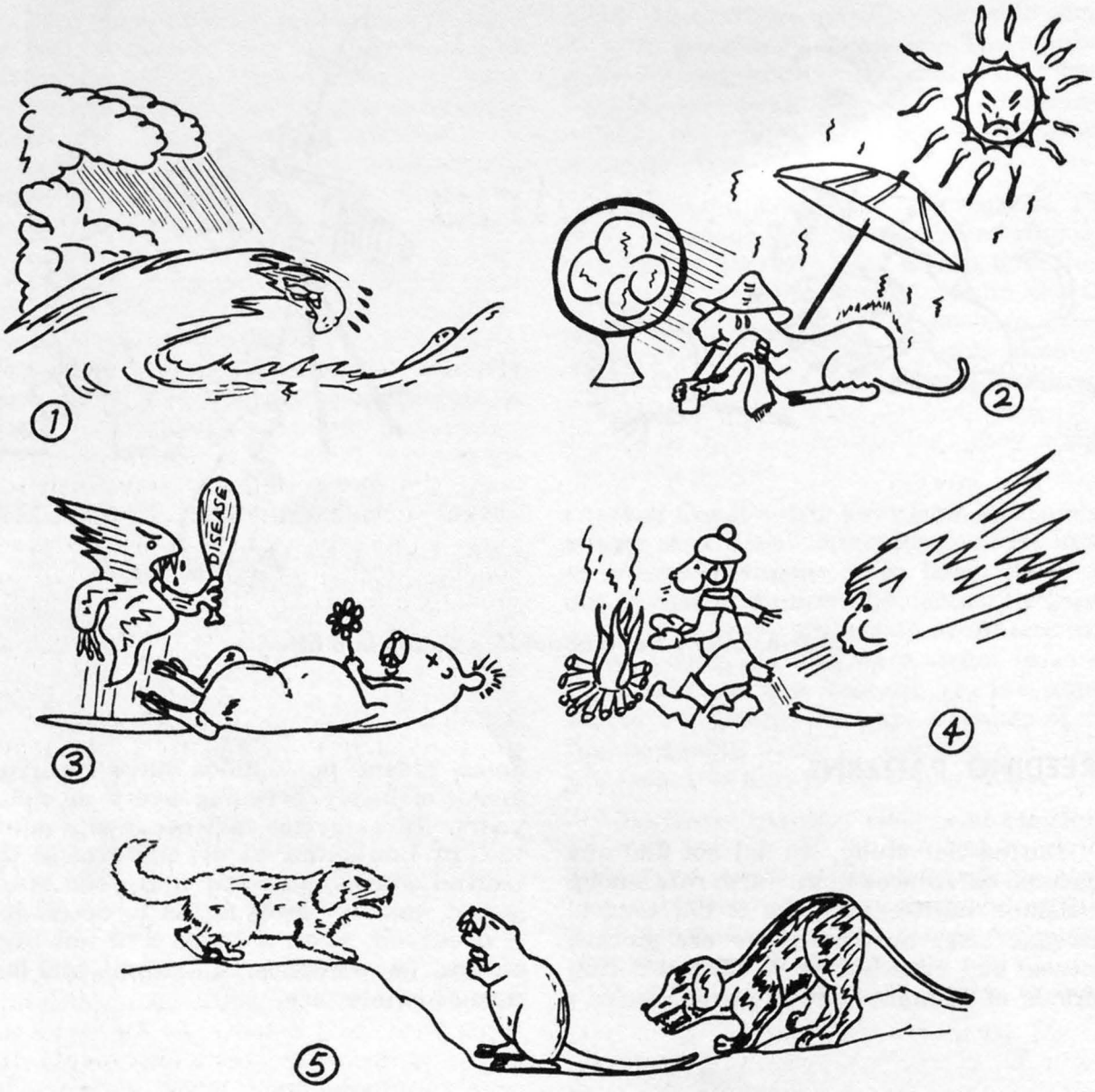
Nutria usually have about five young in a litter.

BREEDING PATTERNS

During our study, we did not find any seasonal differences in the birth rate among Louisiana nutria, although it did tend to increase after hurricanes, severe storms, freezes, and very hot weather, and during periods of drought (see the graph below). Some rodent populations have recurring peaks of heavy breeding every so many years. These cycles may occur with nutria too, in Louisiana or other parts of the United States, but our four-year study period was too short for us to detect it if it occurred, even if there had not been natural catastrophes like storms and hurricanes to interfere.



Breeding patterns are affected by weather. Mass breeding follows climatic catastrophes.



What kills nutria.

(1) Since they were introduced in 1937, Texas and Louisiana nutria have been hit by eight major hurricanes and many major storms.

(2) Nutria need water to regulate their body temperature; they are subject to sunstroke and heat prostration. Several long periods of drought have affected Gulf Coast nutria.

(3) The total effect of disease on nutria is not known. Several diseases are suspected of causing reproductive failure; they may also be causing considerable mortality.

(4) Winter weather often hurts nutria. They can die even in temperatures in the mid-30's if there is rain. Frozen tails are common and can cause death from infection.

(5) Dogs and cats, either pets or "wild," are the only animals that regularly prey on Gulf Coast nutria. Wild predatory animals may sometimes take nutria, but probably only young or weak ones.

Enemies of Nutria

Weather probably causes the greatest losses of nutria in the United States. Except for man, nutria have very few natural enemies; in the Gulf Coast area, domestic and wild dogs and cats are probably the worst. Although we did not see it in our studies, alligators, turtles, large snakes, large fish, and some birds of prey may occasionally take very young nutria or older animals that are sick or injured.

Not much is known about diseases of nutria. Leptospirosis has been reported in Louisiana nutria, and we also collected some animals with hemorrhagic septicemia and paratyphoid. All of these diseases can probably cause miscarriage or reproductive failure. Encephalitis is reported to kill a great many young nutria in South America; although the South American strain of the disease has not been widely recorded in the United States, our native nutria may be susceptible to strains that occur here.

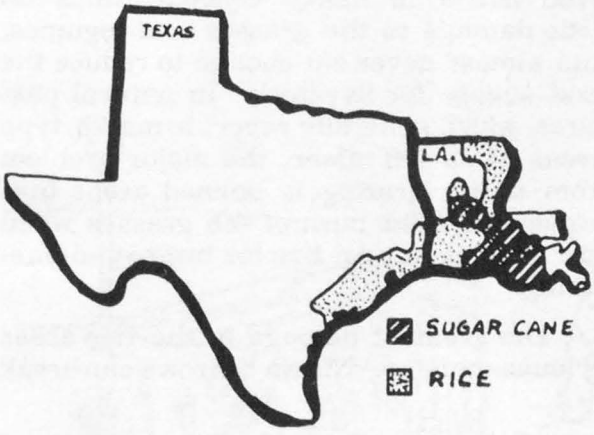
At least two internal parasites also occur in nutria. A roundworm with the mouth-filling name of *Strongyloides myopotami* occurs in 80 or 90 percent of the nutria in southern Louisiana. In addition, fur trappers in the Gulf Coast area occasionally pick up a rash called "nutria itch" from handling nutria. This is the same infection as "swimmer's itch" and is caused by a blood fluke called *Schistosoma mansoni*; the *Strongyloides* roundworm also causes a similar irritation. Both of these tiny organisms occur in the waters of coastal marshes as well as in nutria. Their immature forms can penetrate the human skin and cause an itching irritation accompanied by a severe rash on the hands, arms, and face. Care by a doctor is recommended for this condition, because the organisms may develop into adults inside humans. Fur farmers report that *Strongyloides myopotami* can greatly restrict nutria reproduction and cause mass mortality to young and old. It is not known how seriously the blood fluke affects nutria, but it probably is not doing them any good.

On top of these natural dangers, chlorinated hydrocarbon insecticides, which have often been used extensively for insect control in agricultural areas, may be affecting nutria reproduction. When we gave low doses of these chemicals to caged pregnant females, they all lost all or part of their litters by miscarriage.

The Damage Problem

Potentially, nutria can damage anything they can eat, gnaw, or dig into. Although some damage occurs in corn, grain sorghums, vegetables, ornamentals, tree plantings, road beds, and man-made wooden structures, the greatest losses are to sugarcane and rice.

The major areas where nutria do damage are the 224,000 acres of coastal sugarcane land and 186,000 acres of rice land in Louisiana, and almost all of the 425,000 acres of rice land in Texas. These areas are immediately adjacent to the marshes of the Gulf of Mexico. This region has the densest nutria population anywhere in the United States, and is abundantly laced with waterways, the nutria's favorite route of travel.



SUGARCANE

Louisiana's coastal sugarcane land is covered with narrow ridges that run along and into the swamps and marshes of the Gulf Coast Plain. Some of these ridges are 16 feet high or more, but rapidly fall to gently sloping land. The entire area is crisscrossed with bayous (natural waterways) and canals or ditches, all of which serve primarily as drainage and not irrigation systems. Since these systems are at or near sea level, they are subject to rapid flooding and considerable fluctuation in water level—up to six feet or more in as little as six hours.

In Louisiana, sugarcane is grown primarily from stalks of cane set out between August and mid-October. The small amount of growth that occurs before winter is killed back by freezing temperatures, and the root stalk remains dormant until early spring. Generally, growth begins in March and is greatest during June through mid-September. The sugarcane is harvested annually by mechanical cutters that leave the root stalks in the ground; harvest usually starts by mid-October and continues through most of December. Generally, three annual crops are harvested from one planting, after which the land is left fallow or planted to legumes or other crops for a year or more. Some fields are replanted to sugarcane after the three-year harvest and are out of production only one year out of four. Fields are rotated so that there is normally very little of a canefield system in which sugarcane is not being grown.

In sugarcane, more damage results from the nutria's habit of gnawing or cutting the stalks than from the actual amount of sugarcane they eat. In cane land that requires levee protection from flooding, nutria may also occasionally damage the levee itself; this type of damage is similar to that described for levee damage in rice areas.

The heaviest damage in sugarcane is during the summer growing season. Normally, the few nutria that spend the winter in the cane fields do very little damage except during severe winters when other foods are scarce. When winter damage happens, nutria will uproot the planted cane stalks, destroying all future growth of that stalk; in some cases this kind of damage may result in total loss of the three-year crop. Total loss also occurs if young

Nutria actually eat little sugarcane (perhaps two pounds an animal a night), but take this amount from many stalks, injuring or killing them all.

cane shoots are eaten back time and time again during the early growing season. Even if this does not kill the planted stalk, re-sprouting results in delayed growth of the cane. Mechanical harvesters, set to cut and pick up cane at desired heights, miss most of these retarded plants.

RICE

Coastal rice-growing areas are quite similar to sugarcane areas. They generally start next to the coastal marshes, but in eastern and central Louisiana they often touch much larger areas of swamp and marsh. The land is quite level except for natural levees and gentle rolling terrain near the large waterways. Canals, and some rivers, are used for both irrigation and drainage.

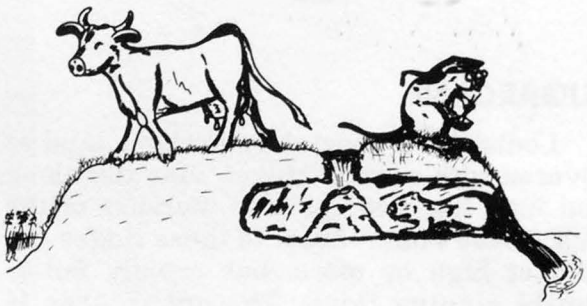
Rice is grown from seed planted on either dry or flooded fields, usually by airplane. The planting season runs from March through late June, but most seeding is done in April and May. During the two- or three-month growing season, these fields are flooded with about four to six inches of water, but they may be drained once or twice for fertilizing. Final draining is done just before harvest time.

Because several varieties of rice with different growth rates are grown, harvest time varies. Some rice is harvested as early as August, but the peak harvest is usually in September or early October and is normally completed by November. Rice is produced for one or two years or more on any one field, but because of field rotation, half to two-thirds of the total acreage in the rice area is usually out of production. A considerable amount of this acreage is flooded for wintering waterfowl, and in Louisiana in recent years many fallow fields have been left flooded throughout the year for crawfish production.

Most rice fields have rather few nutria, and severe damage occurs only in certain scattered areas. Nutria can destroy entire rice plants, but more often their constant grazing reduces the growth rate, resulting in a complete loss of grain at harvest time or rice of lowered quality because it is mixed with immature grains.

In improved riceland pasture areas, even nutria in heavy concentrations do little damage to the grasses and legumes, and almost never eat enough to reduce the food supply for livestock. In natural pastures, which generally revert to marsh-type areas when left alone, the major problem from nutria grazing is opened areas that prevent a solid burn of the grasses when the area is set on fire for improved pasturing.

The greatest damage in the rice areas is levee damage. Nutria burrows can break



In rice fields, nutria eat some rice, but more damage is done to the levees, mostly when cattle break through the tops of burrows.

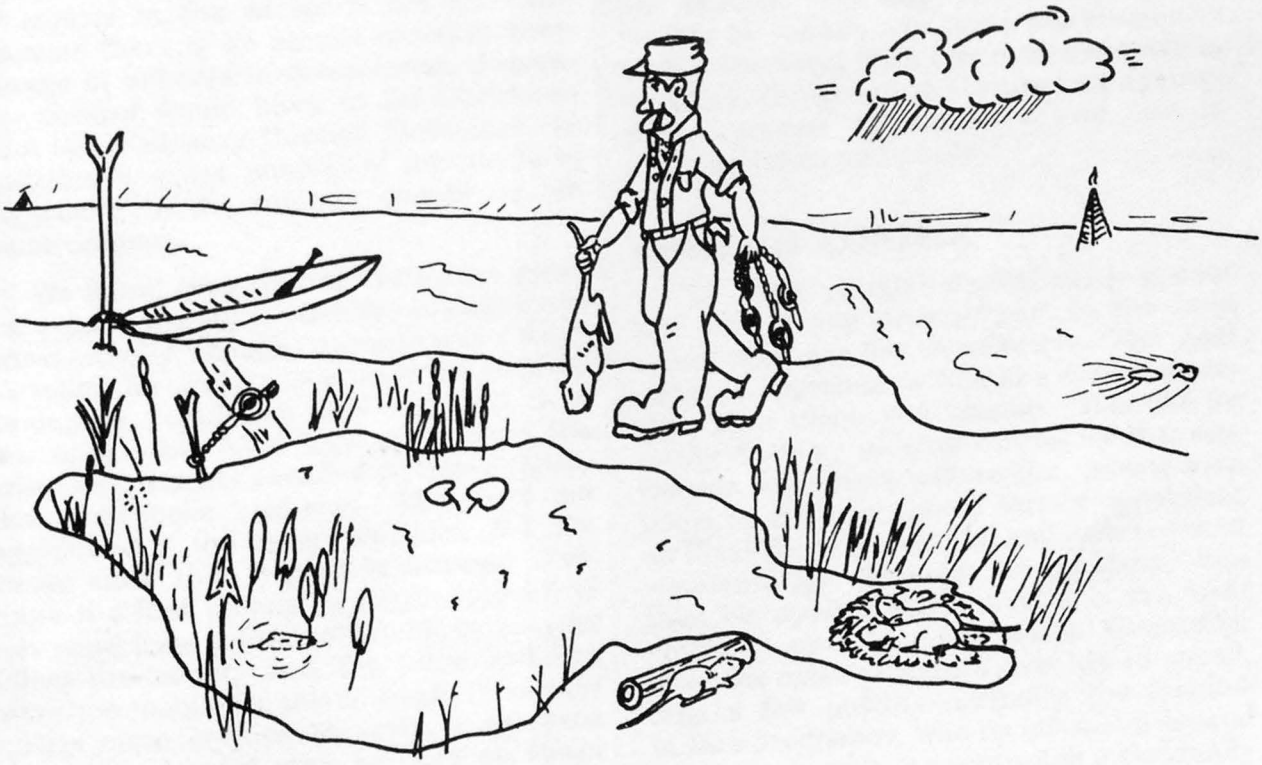
through the smaller levees that serve to divide fields and regulate the water level for small units of growing rice. Breaks in these field levees result in the water being lost from a unit or being reduced in several units below the level necessary for good weed control and proper growth of rice. This type of levee damage leads to reduced rice yields, delayed or uneven growth of the crop, or even complete loss.

Nutria burrows by themselves are usually too small to hurt major levees, although nutria sometimes enlarge burrow systems vacated by muskrats and end up breaking through the water-retention unit. However, more levee damage occurs when cattle, which are allowed to graze the harvested fields or pastures, step on the ground over a nutria burrow and break through. If these cave-ins are not refilled, they are eventually washed out by rain and wave action and cause breaks. This is particularly serious in Texas, where there is often a water quota and rice farms are on a waiting list. If water is lost, there can be a long waiting period before refill, which delays or prevents planting. If a break occurs during the growing season, the entire rice planting can be damaged or lost. Because the levees are so vital where water is scarce, they are under almost continuous and costly maintenance. Although this maintenance is required even without nutria, its cost increases substantially when a number of nutria are present.

WHY CONTROL?

The ideal solution to the nutria problem would be to take the animals for fur and meat before they damaged anything. Unfortunately, this has not been done, and may be impossible to do. The reasons are many, but primarily they concern the economics of the fur industry and the seasonal distribution of the nutria.

Nutria in the Texas rice fields congregate in a few water areas in the winter.



Not enough nutria are taken for fur and meat to alleviate damage, so additional control is necessary.

Trapping them at this time could substantially reduce the number ready to invade the fields in the spring. But trapping nutria is hard work, and the money offered for the pelts and meat in Texas has generally not been enough to offset the difficulties. Consequently, there have not been enough trappers in Texas rice fields to effectively reduce the nutria population.

Shooting nutria has also been ineffective. Since large nutria bring considerably more money for pelts and meat than small ones, most hunters tend to choose the larger animals. In addition, continuous shooting quickly kills off fearless nutria and leaves survivors that seldom expose themselves to the gun. The nutria left, a few wary individuals and a number of small ones capable of breeding when they are six or eight months old, are well able to sustain a population that causes damage.

In Louisiana, trapping and shooting nutria for fur and meat is more extensive than in Texas. However, the animals that damage agricultural areas are quite mobile and are most abundant during the spring, summer, and fall, when the fur is not prime and when meat spoils quickly. On the other hand, the wintering populations in these areas are generally quite low. Unfortunately, it takes twice as many man-hours and more than seven times as many traps to catch one agricultural nutria in the winter than to catch one marsh nutria. So, although agricultural nutria are larger and bring about nine cents more for their pelt and meat, there are not enough of them during good trapping months to offset the cost and effort involved.

For these reasons, shooting and trapping do not keep agricultural populations of nutria low enough to prevent damage, and other methods of control are necessary.

When, Where, and How to Control Nutria

WHEN TO CONTROL

Cane-field nutria are quite different from their relatives in the rice fields; those in sugarcane are periodic visitors, while those in rice fields tend to live there year-round. Therefore, the timing of direct control varies according to the crop being damaged.

In sugarcane fields, and in similar crop areas, control is best applied after damage has actually started—principally during the growing season. Preventing damage by control in the winter is not practical. Because there is an almost constant interchange of animals in these areas, preventive control would have to be continuous from late February through December. In addition, a great number of the nutria in sugarcane in the summer simply do not cause damage.

We found that control during the growing season was quite effective in sugarcane areas. Oddly enough, damage was always curtailed for the season once the original damaging population was removed from the area—this held true even when the area was quickly invaded by more nutria than had been removed. We could not explain why the later invaders did not cause more than negligible damage. Perhaps the first damaging nutria learned to eat cane from a few individuals by playing follow-the-leader, and the later invaders were too mobile for this to occur. The later nutria often seemed to settle in the area for only a brief stay or just meander through to end their summer travels back in the marsh. Whatever the reason, we were pleased to find that only the original damaging population needed to be controlled.

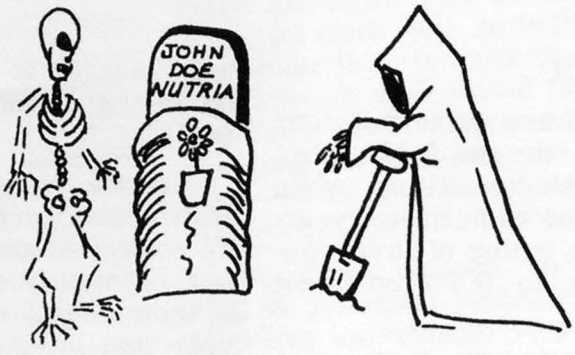
In rice areas, the situation is different. Nutria that are damaging the rice crop can be controlled during the growing season, but because the fields are flooded, most of them do not move much at this time of year and have to be dealt with as individuals rather than groups. Because of this, control is best applied during the winter months when the nutria are more mobile and tend to be concentrated in reservoirs and ditches. The objective of winter control is to reduce the local population to such a low level that few nutria are left to damage the crops the following spring. Winter control of nutria is also best in southern lakes and ponds.

WHERE TO CONTROL

The right place to control nutria is near the area being damaged or in the area where they are the most active. The most efficient approach is to make them congregate in a place you choose. This can be easily done by placing central feeding stations in convenient waterways. Nutria soon learn to become almost totally dependent on these feeding stations, and direct control —poisoning, shooting, or trapping—can then be applied against most of the local nutria at one time and place. Generally, after the main concentrations are removed, only a few nutria—normally the females in late pregnancy, who do not move around much—remain to be controlled individually in their home areas.

HOW TO CONTROL

Control of nutria damage can be direct or indirect. Direct control is designed to remove the animal (dead or alive) from the critical area—this includes poisoning, shooting, kill-trapping, and live-trapping. Indirect methods make an area unattractive to nutria so that they will not stay. In general, good farming practices—proper drainage, land grading, and vegetation control—all aid in making an area less attractive to nutria.



Chemical Control

When we began our studies in 1963, all kinds of chemicals were being used to control nutria damage. Many were potentially dangerous to humans and, the way they were used, quite often seemed to kill everything but nutria. It appeared inevitable that chemical warfare against nutria would continue no matter how dangerous or illegal it might be, so a great deal of our research was directed at finding a chemical that would be effective against nutria but safe for man, domestic animals, and other wildlife.

Of course, chemicals that can kill one type of animal can be potentially dangerous to others. To minimize the hazards, it is necessary to give careful attention to the way the chemical is used. In poisoning nutria, the animals we particularly had to watch for were muskrats (a valuable fur animal), rabbits (an important game species), and other wetland wildlife species such as ducks. In addition, we had to greatly reduce or eliminate the often unnoticed danger of secondary poisoning—this is what happens when a poisoned animal retains enough of the chemical in his body to, in turn, poison another animal that eats him. We were particularly concerned here with the potential danger to bald eagles and alligators, both of which are rare and endangered wildlife species, and to domestic minks, dogs, and cats, because of the great demand for nutria meat as mink and pet food.

MINIMIZING DANGERS

We tested numerous chemicals to see whether, and at what dose, they would kill caged nutria and muskrats. Those that showed potential as control agents were then tested for secondary poisoning: nutria that were poisoned and died were fed to ranch minks, dogs, cats, alligators, turtles, black vultures, and bald eagles. Any chemical that appeared likely to cause secondary poisoning was eliminated. The chemicals that remained were then tested against nutria in the wild. We used radio tracking to find out how effective they were and what dangers they presented. By putting radio transmitters on wild nutria, we determined what percentage were killed by the treatment (this represented the percentage killed in the whole population), and found what happened to the carcasses of those that died. Transmitters on muskrats indicated what the treatment did to the muskrat population.

Along with trying to find good control chemicals, we tried to protect other animals and birds by finding a bait they would not eat or a way of placing the bait so that they would not be attracted to it. We finally chose two-inch pieces of carrot as the baiting material. Nutria are very fond of carrots, and any pieces left over from a baiting program would not be very dangerous because they deteriorate within three to five days, becoming unappetizing even to nutria. The two-inch size is too big for waterfowl but small enough for most nutria to eat without leaving many pieces behind. To keep land animals from eating the bait, we placed it on floating feeding stations where only nutria and muskrats will normally feed. This left us with only one

animal to protect—the muskrat. Unfortunately, one of the really selective poisons for nutria that would not kill muskrats had to be eliminated because it showed high secondary poisoning to minks and dogs. The poison that was finally selected—zinc phosphide—could kill muskrats if they would eat it, but on the Gulf Coast at least, they rarely do.

ZINC PHOSPHIDE

Zinc phosphide, a highly concentrated poison that is very commonly used to control rodents in the United States, turned out to be the only chemical without serious disadvantages for controlling nutria. Its blackish color and strong phosphorous odor are safeguards against accidental consumption by humans and are also warning signals for some wildlife species. We found that carrots covered with 0.75 percent zinc phosphide and placed on small floating rafts would kill over 95 percent of the nutria, but very few muskrats, along a mile of waterway. In addition, secondary poisoning to mammals, birds, and reptiles was almost nil. Through testing, we found out that the zinc phosphide itself acts as an emetic—a substance that causes vomiting—and is tied up exclusively in the stomach contents of the poisoned nutria. Meat-eating animals that can vomit—minks, cats, dogs, eagles, vultures, snakes, and turtles—are relatively safe even if they eat the stomach contents of a poisoned nutria. Alligators, which cannot vomit, appear to be fairly safe because it takes a very high dose to kill them. Even without this built-in safeguard, there is little danger that the nutria meat sold for mink and pet food can ever poison animals because all the zinc phosphide is removed in the standard procedure of gutting the carcasses. All in all, then, zinc phosphide is a very effective chemical for nutria control and reasonably safe from accidental consumption by humans, domestic animals, and wildlife.

Using Zinc Phosphide

The procedures described here will give good results in controlling nutria, but only if the directions are followed carefully. In particular, prebaiting is necessary for good control, and the recommended size and placement of the bait are necessary for safety. The method was thoroughly tested and proved safe and effective in actual baiting programs under all conceivable conditions, including baiting near waterfowl, beaver lodges, and cattle. If it does not work, or if any animals besides nutria and possibly a few muskrats are killed, it will probably be the fault of the operator, not the fault of the bait or baiting procedures.

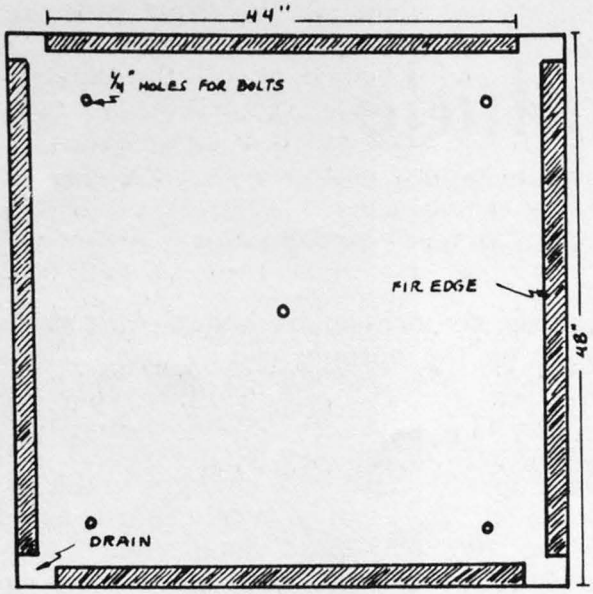
CHOOSING THE BAITING SITE

It is best to bait for nutria in waterways when at all possible. This is not only more effective but safer. Most of the time, the best baiting stations are floating rafts spaced a quarter to a half mile apart throughout the area of damage. These rafts are simple to make out of four-foot-square (or possibly four-by-eight-foot) pieces of exterior grade 3/4-inch plywood with styrofoam floats. They can be anchored to the bottom with a concrete block or tied to an object on the shore. The drawing on the next page shows construction details. Results are best when the top of the raft floats between one and four inches above the surface of the water.

When the nutria population or the waterway is very small, floating bait boards, six-inch-square boards with styrofoam on the bottom, can be used. These are also shown in the drawing. They are anchored through the center by a slender pole (reed or bamboo is convenient), and float up and down with changes in the water level. They can be evenly spaced about 50 to 100 feet apart along small waterways, or placed only near spots where nutria are active—runs, slides, burrows, or feeding areas.

Occasionally there are also natural sites surrounded by water where baiting can be done without danger to land animals. Small islands, hillocks, tree stumps, nutria platforms, or floating objects like logs are examples. (Homes of other animals, such as muskrat houses and beaver lodges, should be avoided, however.) If carrot pieces cannot be simply set out at these sites, they can often be tacked on with small nails.

If there are no suitable water sites at all, ground baiting can be considered as a last resort. It can also be used in mop-up operations if it is necessary to get the last few nutria that were not controlled by a regular baiting program. In ground baiting it is essential, not only for good control but for safety, to bait only at known areas of nutria activity such as runs and burrows. The carrot pieces should be placed directly next to these active areas; they are likely not to be accepted if they are actually placed in them.



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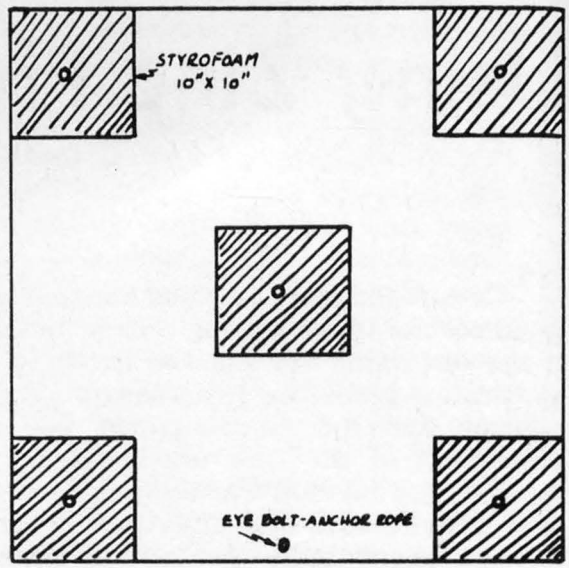
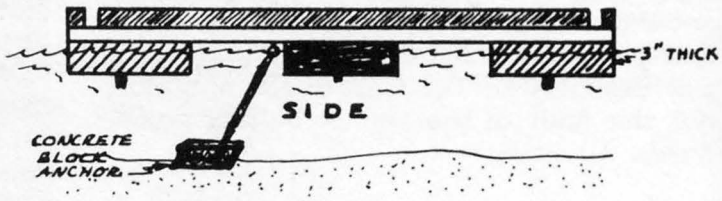
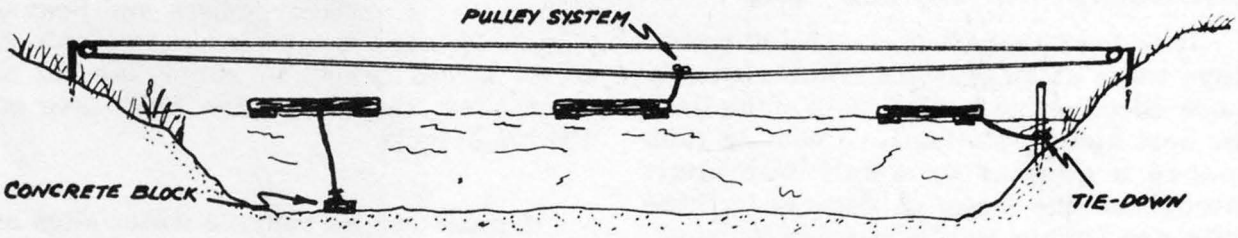


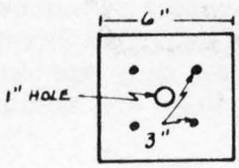
BOTTOM

How to make 4 x 4-foot styrofoam-floated rafts.





Rafts can be anchored in three ways.



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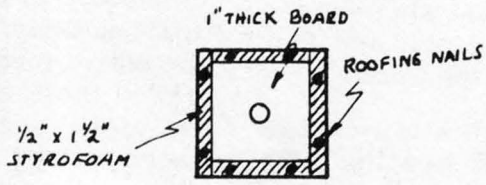

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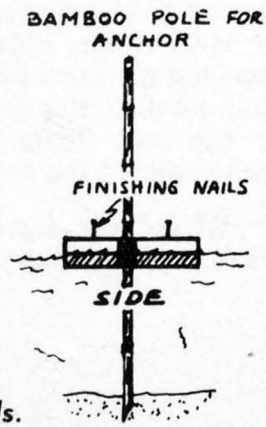


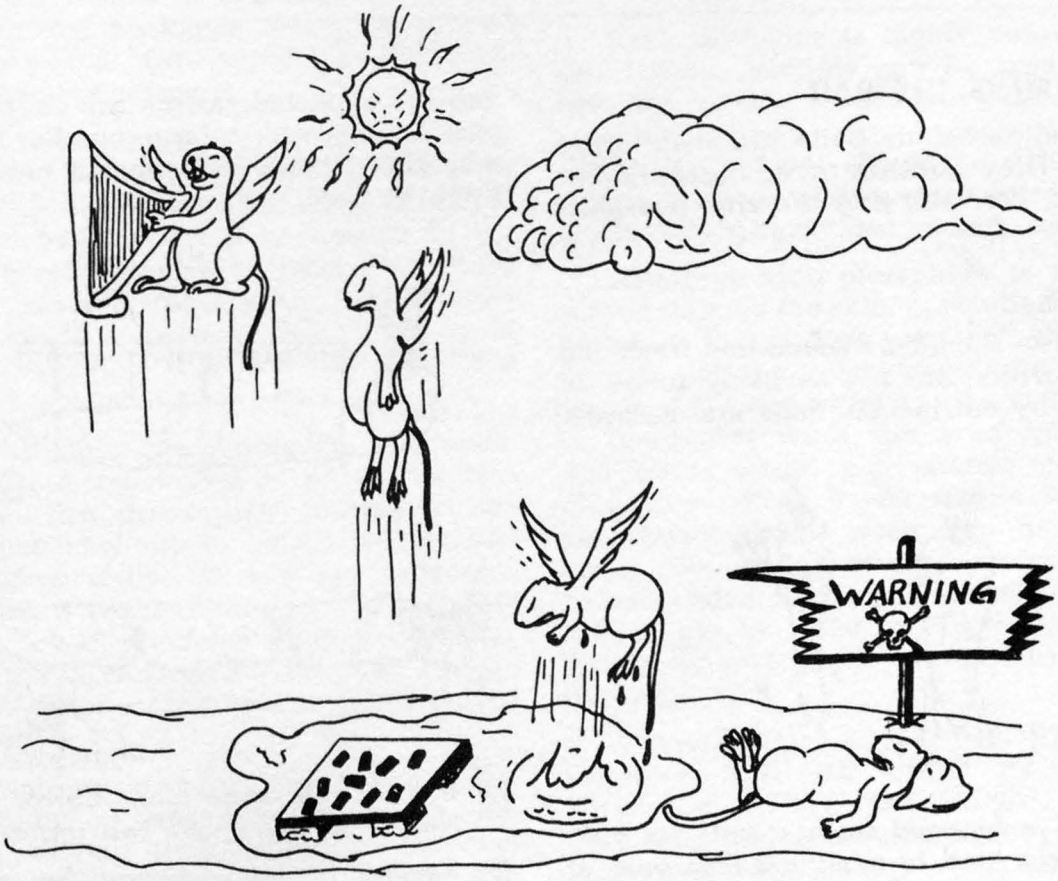
SIDE

How to make 6 x 6-inch styrofoam-floated bait boards.

PREBAITING

Prebaiting is possibly the most important step in nutria control, because it brings the nutria to the bait. In prebaiting, cut carrots coated with corn oil (like bait carrots but without the poison) are placed at the baiting stations in late afternoon. Nutria tend to group together for feeding, and if one nutria finds a new feeding spot, most of the other nutria in the area will soon join him. Generally, all the nutria that are going to be attracted by prebaiting will be at the baiting site by the third successive night, so the usual procedure is to put out unpoisoned carrots for two nights and poisoned carrots the third and fourth. If for some reason there is a break of over a week or so in this sequence, it will be necessary to start over again. Nutria eat only a small amount at a time, so for maximum drawing power it is not necessary to use more than 10 pounds of carrots per raft, four two-inch pieces of carrot per bait board, or two to five pieces of carrot at other water sites or on the ground for each night of prebaiting. Amounts of poisoned bait put out the third night are generally the same.

Prebaiting for two or three nights—



Is necessary for good kill of nutria with zinc phosphide bait.

The following table summarizes the steps in prebaiting and baiting for the different kinds of baiting stations:

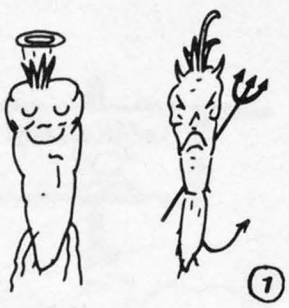
Baiting station	When to use	Where to use	Amount of prebait or bait per night	Number of nights of prebaiting	Number of nights of baiting
Four-foot-square raft	Many nutria; large waterways, lakes, and ponds	1/4 to 1/2 mile apart	10 pounds	2	2 or 3
Six-inch-square bait board	Few nutria; small waterways, ditches, burrow entrances	50 to 100 feet apart, or near active nutria sites	4 pieces	2	Until no more bait is taken
Miscellaneous natural sites surrounded by water	Few nutria; small waterways, lakes, and ponds	Near active nutria sites	A few pieces set out or tacked to objects	2	Until no more bait is taken
On the ground near active nutria sites	No feasible water sites, or in mop-up operations	Next to, but not in, active nutria sites	2 to 5 pieces	At least 2	Until no more bait is taken

PREPARING THE BAIT

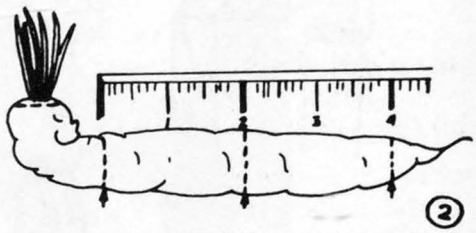
Zinc phosphide baits are easy to prepare. They contain three ingredients—carrots, corn oil, and the zinc phosphide itself.

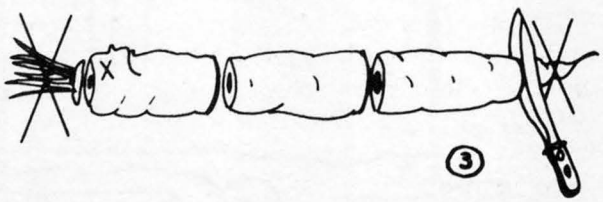
Carrots

These should be sound and fresh; old, limp carrots are not as likely to be accepted by nutria. The tops are discarded and the unpeeled carrots are cut into two-inch lengths with a large butcher knife or a hand vegetable cutter shortly before they are to be used.



(1) Use only good fresh carrots for bait. Nutria tend to avoid old limp ones or those with rotten spots.





(2) Bait size is important. Carrot pieces should all be about two inches long.

(3) Peeling is not necessary, but discard carrot tops and small ends.

Corn oil

The oil does not seem to either attract or repel nutria. It is put on the cut carrots to preserve their freshness and act as a glue for the zinc phosphide. We tried other substances for this purpose, but none worked as well. Other oils were not sticky enough to hold the zinc phosphide; latex "stickers" caused the poison to lose some of its effectiveness; and paraffin was chipped off the carrot by the nutria, carrying the poison with it. Therefore, only corn oil should be used and not a substitute.

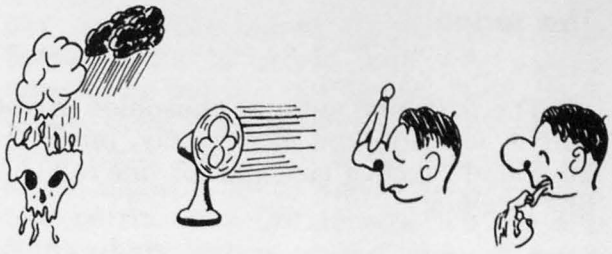
Zinc phosphide

The poison is a heavy, strong-smelling black powder. Information on sources of supply can be obtained through your local Wildlife Services district office (U.S. Bureau of Sport Fisheries and Wildlife) or through your county agent. It is sold as technical-grade material (about 94 percent pure) in 100-pound drums or occasionally in five- or ten-pound packages and costs around $2.00 a pound. One pound will treat about 130 pounds of carrots.

The amount of zinc phosphide in the bait—0.75 percent by weight—was chosen so that a single two-inch piece of carrot covered with it would be enough to kill the largest nutria ever recorded. Using more is not only unnecessary, but increases the hazards of baiting. Here, just as in taking medicine, it is not true that "if a little bit is good, a lot is better."

In handling zinc phosphide, it is essential to remember first of all that it is a poison. The precautions printed on the container label should always be read and followed carefully. As with any dangerous material, it should be stored only in tightly closed, clearly labeled containers out of the reach of children and animals. Always keep it dry, because moisture causes it to deteriorate.

Breathing of the dust or fumes of zinc phosphide can cause poisoning. As a safeguard, all bait should be mixed outdoors or in a well-ventilated area. Mixed bait or open containers of zinc phosphide should never be left inside a closed room or carried inside a closed vehicle. Since mixing is easy, it is best to prepare baits at the baiting sites.



Precautions: Keep zinc phosphide dry; it decomposes with moisture.

Mix only outdoors or in a well-ventilated area.

Avoid breathing dust or fumes.

Wash hands and arms thoroughly after mixing or handling bait; zinc phosphide is poisonous if swallowed.

Zinc phosphide is highly poisonous if swallowed. Victims can be treated by washing out the stomach or with emetics (substances that cause vomiting). Milk, oils, or fatty foods should be AVOIDED. As in all cases of suspected poisoning, a doctor should be notified immediately.

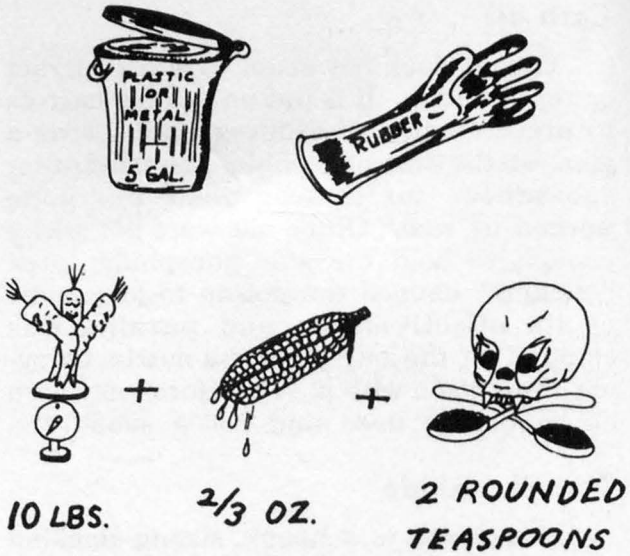
Although zinc phosphide is not absorbed through the skin, precautions should be taken that it does not touch your skin or your clothing, so that you do not carry traces of it away with you. If you do touch it, thoroughly wash the area with soap and warm water, and change clothes if necessary. Even if you do not touch it, you should always wash your hands and arms after mixing or handling bait. It is recommended that you wear long-sleeved rubber gloves when mixing bait; this is absolutely essential if you are stirring bait by hand.

WARNING: ZINC PHOSPHIDE SHOULD NOT BE USED IN VIOLATION OF STATE OR LOCAL LAWS. Your local Wildlife Services agent or county agent can tell you what regulations apply in your area.

The recipe

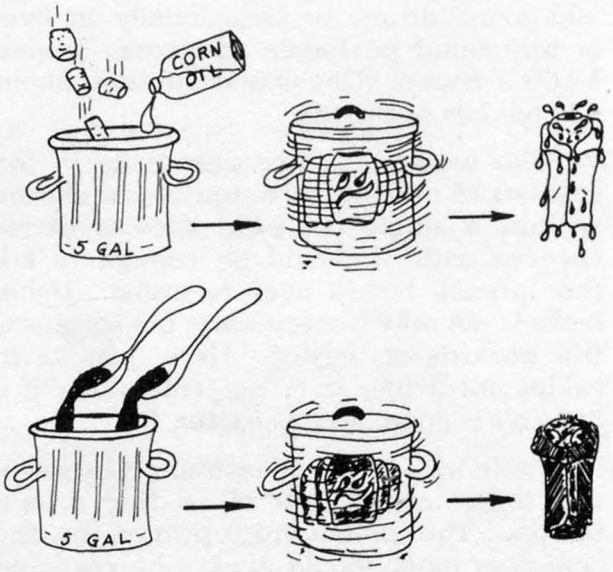
The 0.75 percent zinc phosphide carrot bait is usually, and most easily, mixed in 10-pound batches (enough for one raft) by this formula:

Materials	Amount
Unpeeled carrots cut in two-inch lengths	10 pounds
Corn oil	2/3 fluid ounce
Zinc phosphide (94 percent pure)	2 rounded teaspoons



What you need to mix bait—

Place the cut carrots in a five-gallon plastic or metal container. Add the oil and mix by stirring or by placing a lid on the container and shaking or tumbling until the carrots are all well coated with oil. Wearing rubber gloves, add the zinc phosphide and mix by stirring or shaking until the carrots are well covered. The finished carrots will be black.



And how to mix it.

If you intend to mix the bait at the baiting sites (this is recommended), you can cut the carrots, coat them with oil, and package them in 10-pound batches in plastic bags shortly beforehand. At the same time, measure out the zinc phosphide and fill small bottles or plastic bags with two rounded teaspoons each. Then simply carry along a five-gallon mixing container and mix the carrots with the poison at each site. If the final mixing is going to be done right away, it is also possible to mix the zinc phosphide with the oil in a small lid-covered jar, then carry this to the baiting site to mix with the carrots. However, if the mixture is left standing very long, the zinc phosphide will settle out, solidify, and will no longer spread.

Mixed bait needs to dry for at least an hour to be rain-proof. It should not be put out in the rain (or when rain is threatening) unless it has been thoroughly dried first in a well-ventilated area. Once the oil-zinc phosphide mixture is completely dry—a dull, sheenless gray—the carrot will stay poisonous until it deteriorates, regardless of the weather.

APPLYING THE BAIT

Although properly dried bait can be put out in the rain, it is not practical to try baiting in open water during high winds when there is continuous wave action day and night. During these periods, nutria move only very short distances, mostly along the shores and shallows, and very seldom venture out into deep water. It is best to wait until the water is calm before beginning a baiting program.

What happens during prebaiting will help you decide how to complete the baiting program. Examine the baiting sites after each night of prebaiting. If you see many signs of muskrats or other animals besides nutria, you should move operations to another site and start over. Muskrats can be detected by their droppings, which are smooth and not grooved like nutria droppings, and by their habit of nibbling only on the ends of carrots.

If you do not find any signs of other animals, see how much of the unpoisoned prebait has been eaten. This will not always indicate how much bait should be used, but it can help you make an intelligent guess. We developed the following rule of thumb for raft baiting:

1. When all, or almost all, of the prebait is eaten the second night, use 10 pounds of treated bait the third night.

2. When half to three-fourths of the prebait is eaten the second night, use five pounds of bait the third night.

3. When only a few pieces of bait are eaten, move the raft to another location and bait the original area with several six-inch-square bait boards (it is not necessary to repeat the prebaiting in the original location if you do not skip more than a night or two).

The amount of poisoned bait eaten the third night (the first night of baiting) will also help indicate how much bait to use the fourth night. For rafts, a rule of thumb similar to the one just given will help decide: If all or almost all the bait is eaten the third night, 10 pounds should be put out again the fourth night; if less than three-fourths is eaten, only five pounds need to be put out the fourth night. Generally, there will be some bait left over the third night and quite a bit left over the fourth night; it takes very little bait to kill one nutria. For the smaller baiting stations—bait boards, small natural water sites, and ground sites—the amount put out the third night should be put out again each subsequent night until essentially no more bait is taken. When the nutria population is large, this may take several nights.

AFTER BAITING

For safety to domestic animals and wildlife, it is essential to dispose of zinc phosphide bait and poisoned animals within two or three days after baiting. In areas where there are buzzards, many carcasses will be destroyed even before the next morning. The stomach, the skull, part of the skeleton, and an inside-out nutria pelt are all that a buzzard usually leaves behind. These remains, as well as all other partial or whole carcasses that can be found, should be deeply buried or cremated as added insurance against secondary poisoning. Left-over poisoned bait should be picked up from the baiting sites and deeply buried or otherwise disposed of so that animals cannot get to it.

INADVERTENT POISONING OF DOMESTIC OR WILD ANIMALS CAN OCCUR MAINLY THROUGH CARELESS BAIT PLACEMENT OR FAILURE TO DESTROY THE CARCASSES AND LEFT-OVER BAIT.

ESTIMATING THE KILL

Our studies indicated that baiting with zinc phosphide by the methods described here should kill 95 percent of the nutria in the immediate area and beyond; some radio-equipped nutria traveled over a mile to baiting stations. However, nutria poisoned in baiting programs are usually never seen. Our radio-tracking studies showed that only one out of every four poisoned nutria dies where the carcass can normally be found. Many die deep in dens or in dense vegetation, sink out of sight in the water, or are eaten by scavengers—turtles, crabs, or buzzards. So it is generally safe to assume that the kill has been good even if very few dead nutria are found.

The best way to tell that the baiting has been effective is the direct observation that the damage has stopped. A way to estimate the amount of reduction in nutria activity, and so in damage, is to put out untreated carrots the night after baiting has stopped and see how much is taken. For example, if 120 pounds of carrots were eaten the second night, during prebaiting, and only two pounds are eaten after baiting has stopped, the reduction in nutria activity, or damage, has been 98.3 percent. Another method can be used to estimate how many nutria were killed. Nutria eat between 0.29 and 0.41 pounds of poisoned carrots per night at baiting stations, or an average of 0.35 pounds. Dividing this figure into the amount of poisoned bait gone gives the number of animals that probably ate the bait and were killed. For example, if 30 pounds of poisoned bait were eaten, there were most likely 85 nutria killed ($30 \div 0.35$). It would be correct about 95 percent of the time to assume that between 73 and 104 were killed ($30 \div 0.41$ and $30 \div 0.29$).

Other Methods of Direct Control

Baiting with zinc phosphide is effective no matter what size the nutria population, but shooting, kill-trapping, and live-trapping are also good ways to reduce damage when the population is not too large.

SHOOTING

Shooting is an effective and sporty way of controlling nutria, either by itself (when it usually gives over 80 percent control) or in mop-up operations after other control measures. Unfortunately, it is most effective at night with an artificial light, a method illegal in most states even in damage-control situations. Night shooting of nutria is permitted in Texas, but has been illegal in Louisiana since 1964.

We have found the following methods of shooting the most effective. Night shooting has been included for those states where it is legal, and with the possibility in mind that other states may eventually legalize it. In all cases, however, remember to check your state and local game regulations to make sure the kind of shooting you want to do will not violate the law.

Raft shooting

As in baiting with zinc phosphide, cut carrots are put out for two nights on a four-foot-square raft to concentrate the nutria at a single location. Shooting is then done for the three following nights from about half to three-quarters of an hour after sunset until nine or ten o'clock at night. The raft is continuously lit by a spotlight; best results are obtained with a .22 caliber rifle directed from a vehicle or a blind on shore near the raft. All nutria seen on and around the raft should be shot. When there are high populations, the kill may average up to four or five animals an hour for the three nights. In order to repeat operations in the same area, it may be necessary to leave the waterway undisturbed for two or three weeks.

Boat shooting

Another good method, though requiring a bit more effort than shooting from a stationary vantage point on shore, is shooting nutria from a small boat with a .22 caliber rifle and a spotlight. On large, open water areas, a .410 gauge shotgun with number 4 shot can also be used, but a shotgun seems to frighten too many animals to be effective on the narrow waterways common in most agricultural areas. Boat shooting is best accomplished by slowly paddling a pirogue or canoe along primary canals or drainage ditches for three successive nights from about sunset to nine or ten o'clock at night. Average kill success is usually about four

or five nutria an hour. Nutria are seen in the light or are detected by their red-shining eyes or V-shaped wakes in the water (however, muskrats also leave V-shaped wakes). After dark, it is also possible to make a "maw" call to locate answering nutria, or to repeat the call to entice nutria to within a few feet of the boat. This low-pitched call, an imitation of the nutria feeding and assembly call, is hard to describe in words but not difficult to learn from someone who can make it, or from listening to nutria "talking" at night. "Maw" calling should not be used in the daytime; in agricultural areas at least, it seems to simply alert the nutria.

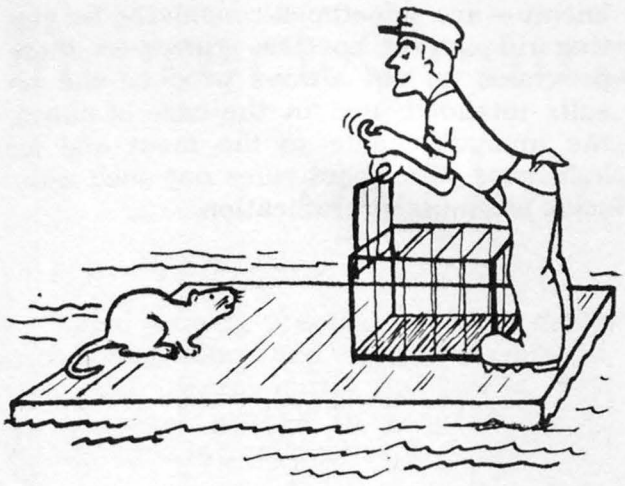
Bank shooting

Shooting on foot while slowly walking the banks of ditches and levees is quite effective for first-time hunts, but is limited to about the last hour before complete darkness. This method is not illegal like spotlight shooting at night, but usually kills off most of the unwary nutria the first hunt. When there are high populations, it is not unusual to kill 12 or 15 nutria an hour the first night of bank hunting, but this usually drops to no more than two an hour the second night and practically none the third. Where legal, it is also possible to slowly walk the bank after dark with a spotlight and shoot a fair number of nutria, but spotlight shooting on land is more effective from a stationary location on the bank. For about two hours after complete darkness, "maw" calling can be used to entice nutria to the spot.

KILL-TRAPPING

We found that No. 2 double-spring steel traps (jaw spread about 5¾ inches) were the best suited for trapping nutria. No. 3 traps (jaw spread about 7¼ inches) will work, but are cumbersome and cost about twice as much as No. 2 traps. Single-spring No. 1 traps (jaw spread about 4 inches) are suitable for muskrats, but a third to half of the nutria caught in them are able to pull free, usually leaving only their toes behind in the jaws. Trapping success can be increased by using cut carrots or sweet potatoes as "lead-ins" into the traps. Nutria normally pick up small items with their forepaws and large items with their teeth. Small pieces of carrot or sweet potato inside the trap or on the trip pan are suitable for trapping nutria by their forepaws, but larger pieces (one or two inches long) are best placed beside the trap and not inside the jaws because nutria picking them up with their teeth can often spring the trap without getting caught.

When nutria are all feeding together at a single location such as at a raft feeding station, steel traps can produce very favorable results. In a test in Louisiana in 1965, we tried trapping a 25-acre willow flooding without first setting up a raft and caught only one nutria for every 25 nights a trap was run (15 nutria in 25 traps run for 15 nights). When we put out two four-foot-square rafts with cut carrots and sweet potatoes for 14 nights to concentrate the nutria, trapping success was increased to one nutria every two and a half trap-nights (110 nutria in 20 traps run for 14 nights). During the same period, traps in the marsh around the willow area caught only one nutria every 34 trap-nights (62 nutria in 150 traps run for 14 nights). Trapping with rafts is also favorable in agricultural areas, particularly in Texas rice fields during the non-growing season.



LIVE-TRAPPING

Live-trapping for damage control is used mainly to transplant agricultural nutria to marsh areas where they naturally belong. It could also be used by the meat industry in the summer to transfer live animals to slaughtering places where the carcasses can immediately be refrigerated to prevent spoilage. Although bare or padded steel traps are also sometimes used to catch live nutria, this is not a humane method of transplanting animals because nutria caught in steel traps generally lose a leg from infection.

Though ordinary box-type wire live-traps (about 10 x 10 x 32 inches) can be set on land near areas of nutria activity, they are more effective when set four to eight at a time on raft feeding stations. Traps set on rafts have the additional advantages of catching fewer other animals and of not drowning the trapped animals when the water level rises. Other live-traps, such as the drop-door type, are also quite effective when placed on rafts. In general, it is possible to keep on live-trapping nutria on rafts as long as food is put out each night, but unless a large number of traps are put out, it may take a long time to remove the local population. As with other methods, a few nights of pre-baiting greatly increases success.

Nutria to be transplanted can be carried either in the live-traps or together in a large cage or strong box. In any case, they should be given food and shade, especially if they are to be held very long in hot weather, and should be released into their new home as soon as possible. Nutria can be released into an area like a marsh any time of day, but it is common sense to choose a spot as far as possible from the area they were removed from.

It is possible to transplant nutria without handling them by simply letting them crawl out of the live-traps they were caught in, but it is often more convenient to remove them yourself. Nutria are fairly large as rodents go and can bite quite effectively. The one really safe method of picking them up is by the tail within about six inches of the base. To remove a nutria from a live-trap, all that is necessary is to grab the tail and pull firmly and fast. Speed is essential because the nutria may grab the trap with its forepaws if it has time to realize what is going on. In letting go, simply place the animal near the ground.

INEFFECTIVE CONTROL METHODS

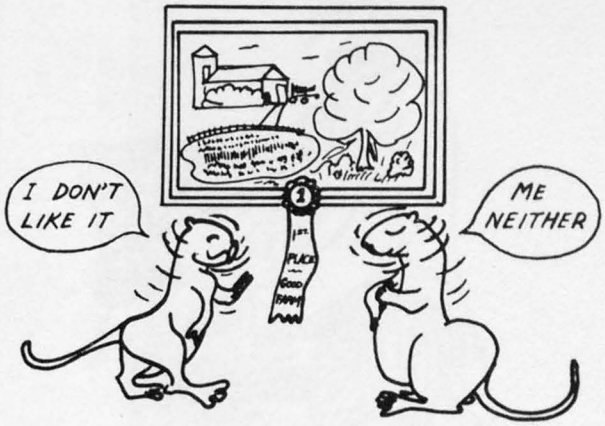
There are several good ways of controlling nutria, but perhaps a few methods that do not work should also be mentioned. First, as we have already pointed out, baiting with zinc phosphide will kill very few nutria if they are not first concentrated by prebaiting, or if control is attempted when there are high winds and rough water; the same is frequently true of shooting and trapping. Gases, including tear gas and poison gas bombs that are effective against some other rodents, are not effective against nutria. The only exception to this is carbon monoxide gas pumped directly into dens, but this is hardly a practical technique for large-scale control. Funnel traps and snares, whether activated by wire loops or springs, are not very effective for catching nutria, dead or alive. Walls, dams, and fences — even electrical fences — cannot seem to keep nutria out of large agricultural areas, and no chemical repellent has been found that will discourage

them from eating the plants once they are there.

Other, broader methods that attack the entire population—for example, introducing a new disease, parasite, or natural enemy—are sometimes considered for getting rid of pest species. However, these programs do not always produce the results intended; and in the case of nutria, the animal's value to the meat and fur industries just about rules out such wide-scale attempts at eradication.

Indirect Control of Nutria Damage

Good farming practices—proper drainage, land grading, and vegetation control—can help control nutria damage in most agricultural areas. In general, a well-farmed area is unattractive to nutria.



Good farming practices are not good for nutria.

DRAINING AND GRADING

Any drainage system that holds water is a potential highway and home-site for nutria. In rice fields, not much can be done to eliminate waterways, but several modifications are possible in sugarcane. In Louisiana, most sugarcane fields are drained by a system of quarter drains leading to lateral ditches that in turn drain into a primary canal or cross ditch. In addition, most corn, grain sorghum, and other crops, as well as some pasture land, are on renovated sugarcane fields that still retain this cane-field system of drainage. The ditches usually have steep banks and are dug deeper than necessary, so that water stands in them most of the year. Unless the soil is very poorly drained, it is usually possible to drain these ditches, modify their shape, or eliminate them entirely, leaving the land not only better for crop production but much less usable by nutria.

On well-drained soils, precision grading is the best and most permanent way of eliminating the smaller drainage ditches. It consists of leveling all the land to a gradual slope, which permits water to drain directly into a single primary canal or cross-ditch. This eliminates about 90 percent of the waterways, restricting nutria to the primary canal where they have less access to crops and can be more easily controlled. In one 174-acre sugarcane field we studied, 426 of the 494 nutria burrows we found (86 percent) were in field ditches; all of these would have been eliminated by precision grading.

Precision grading requires well-drained soil, but most soil types in the Louisiana sugarcane belt are suitable for improved drainage by V-ditching and crowning. This method eliminates only about 10 to 14 percent of the field ditches, but the gently sloping banks of those that are left make vegetation control easier and discourage nutria burrowing. In one of our studies, V-ditching and crowning eliminated over 30 nutria burrows in a 0.2-mile primary drainage canal, and no new burrows were made there in over three years of study. Grading the banks of levees in rice areas to make them gently sloping gives similar results.

VEGETATION CONTROL

Getting rid of unwanted brush, trees, and weeds eliminates much of the food and

cover used by nutria. Vegetation control is desirable all year, but is especially important in sugarcane areas during the early growing season because it discourages nutria that have wintered in the marshes from establishing homes in the fields. In clearing land, the cut vegetation should be burned or removed. Brush piles left on the ground or in ditches are made-to-order summer homes for nutria.

The Controversial Nutria

As has been pointed out, the nutria in the United States is at the same time a protected fur-bearer and a hunted pest. Because of man's variable interests, it has been a controversial animal on the Gulf Coast almost since it was introduced. Perhaps most of the controversy originated in the 1940's when nutria were widely promoted for vegetation control and as a valuable fur animal. Unfortunately, as weed cutters, nutria did not concentrate on the plants man wanted controlled, and they also proved disappointing as fur-bearers: skinning and pelt preparation were difficult at first, the market was variable and uncertain, and outlets for the pelts in many areas were either inaccessible to many trappers or non-existent. In addition, wherever nutria settled in large numbers they damaged crops or marsh plants, and some people suspected that they crowded out waterfowl or muskrats, an important native fur animal.

Although many state and federal biologists undertook studies over the years to find out exactly what good and what harm the nutria did, their work was often ignored; scientific research is slow and painstaking and seldom produces the quick and simple answers that people would like. Naturally, with few firm facts in circulation, the different groups concerned with nutria—sportsmen, trappers, fur and meat buyers, and farmers—reached their own conclusions about the animal's place in the scheme of things. Unfortunately, as too often happens, there were many one-sided individuals who characterized the nutria as solely beneficial or solely harmful regardless of the interests of others.

The change in the nutria's legal status in Louisiana over the years illustrates the different thinking about the animal that occurred as first one group and then another made its views known. (In Texas,

nutria have not been legally recognized as either outlawed or protected, although there are restrictions on importing them in quantity.) Louisiana opened its first official nutria trapping season during the 1943-44 fur season, only three years after the "big escape" from Avery Island. Catches and pelt prices remained good, and by 1946 the state recognized the nutria as a protected fur-bearer and put a ten-cent tax on each pelt. Soon, however, nutria increased and began ranging into rice and sugarcane fields and damaging crops and levees. Although the state provided control permits for nuisance animals, many landowners felt there was an unwarranted amount of red tape involved; nutria could move in and out of their fields before the permits could be obtained. In 1957, Hurricane Audrey pushed thousands of nutria inland, and damage increased. Irate farmers demanded pest status and unlimited control for this destructive animal. Recognizing the farmers' dilemma, the state placed the nutria on an "outlawed quadruped" list in July 1958, permitting

unlimited control in several coastal parishes where the most agricultural damage occurred. In other parishes where nutria remained protected, control permits were still available when there was damage. By 1963, with the spread of nutria and the spread of damage, the animal was classified as an outlaw in 17 coastal parishes in Louisiana.

At the same time, however, the market for nutria fur and meat was increasing, encouraged by the state and federal governments and enterprising private individuals. These groups felt that the nutria's outlaw status restrained its full market potential, and the Louisiana Wild Life and Fisheries Commission and the fur industry called for statewide legislation to protect it. Primarily through the instigation of the American Sugar Cane League and the Louisiana Wild Life and Fisheries Commission, the state recognized the dispute between the agricultural and fur industries, and a compromise was reached. In July 1964, the nutria was again given statewide recognition as a protected fur-bearer, but with the provision that when it was an agricultural nuisance it could be controlled whenever necessary in and near agricultural lands without control permits.

This compromise solution indicated that a healthy give-and-take attitude was beginning to develop among most of the people concerned with nutria. It may not be the end of the story, however. There are three major situations where people still disagree about the nutria—its influence in changing the marshlands, its effect on the muskrat, and its ability to cause major agricultural damage—and the disagreement could lead to further changes in the law. The following sections are a brief summary of the opinions people have, and what scientific research has shown, about nutria in these three situations.

CHANGES IN THE MARSH

Sportsmen, the fishermen and hunters who were among the first to distribute nutria, soon became some of the animal's greatest detractors. Fishermen wanted nutria introduced to control submerged vegetation; the nutria did control some plants, but generally the wrong ones. Fishermen became even more annoyed when nutria that were overcrowded or had a poor food supply began damaging boats and waterfront structures. There were even reports that nutria ate large numbers of fish (this is highly unlikely, as our studies showed). The duck hunter, on the other hand, found that nutria destroyed many of the tall marsh plants—the ones that offered him concealment and formed numerous small "potholes" where ducks concentrated. Even though the open marshes may have provided more food and acreage for waterfowl, the duck hunter wanted his marsh with the tall grass and potholes for the kind of hunting he was used to. Both fishermen and duck hunters were inclined to the view that, because the changes in the marsh took place soon after nutria were introduced, the nutria were entirely responsible for them.

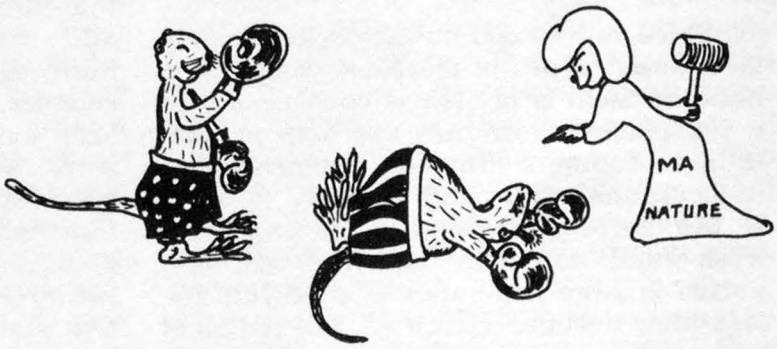
The fact is, however, that Louisiana's four million acres of coastal fresh-water and salt-water marshes have changed fairly often over the years. Some of the drastic changes have occurred since nutria became common marsh residents, but many others occurred earlier. For example, the hurricane in 1915 and severe drought in 1924-1925 played havoc with the coastal marshes before nutria were introduced, and a hurricane in 1941 coupled with severe damage to vegetation by muskrats in the 1940's caused major changes when the nutria population was still very small. The effects of the droughts of 1954, 1958-1960, and 1962-1965 can hardly be blamed on the nutria either. The overall changes in the marshlands in recent years are hard to assess, but scientific studies have shown that they were caused by a combination of such factors as flooding, drought, changes in water quality and salt content, industrialization, and increased building of canals, levees, and drainage systems. Apparently, even a high population of nutria plays only a very minor role in the overall changes in a marsh system.

Our studies and others have shown that it is only during abnormal conditions such as storms, drought, or marsh burning, when nutria lose their normal food supply, that they noticeably harm a marsh, mowing down above-water plants or stripping the bottom of underwater roots and tubers. This usually occurs only in isolated locations, since it is unusual to have a large nutria population and a widespread loss of their normal food supply at the same time over a large area. Under normal conditions, which is most of the time, nutria keep down the growth of many plants but do not completely wipe out any of them. It is true that nutria do not control many of the underwater plants that fishermen hate—coontail, bladderwort, algae, and some of the pondweeds—and they are usually of little help against floating plants such as hyacinth, alligator weed, water lily, and water lotus. But nutria that are not overcrowded or underfed can be very beneficial by controlling above-water plants like cattails, rushes, and sedges, and so creating more usable water surface and opening the way for plants more favored by waterfowl. In addition, nutria tend to avoid some of the better waterfowl foods such as smartweed, and are not very interested in wild millet or bulrushes. They normally do not eat enough of such plants as Delta duck-potato, duckweed, widgeon grass, and sago pondweed to seriously reduce the food supply for waterfowl. So it seems that, although nutria can directly or indirectly harm a marsh, their effects are rarely very pronounced, and in general the good they do probably outweighs the bad.

Nutria have been accused of knocking out the muskrat population—

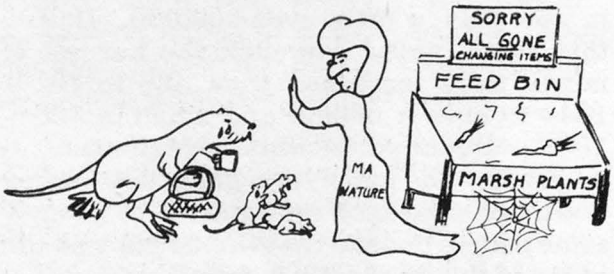
COMPETITION WITH MUSKRATS

In Louisiana, at least, trappers and many fur buyers prefer muskrats to nutria, mainly because many more muskrats can be handled for the time and effort expended. During the heyday of the Louisiana muskrat industry from 1939 to 1947, the usual harvest of muskrat pelts was between four and six million a year. But from the record high of over eight million pelts in the 1945-1946 season, the harvest has steadily declined; in 1964-1965 it was only a little over 200,000. During this same period, however, the harvest of nutria pelts increased from 436 in 1943-1944 to over a million and a half in 1964-1965. Because of this circumstantial evidence—one population going down when the other appeared and started to go up—some people believe that the nutria was the cause of the muskrat's downfall.



But actually Mother Nature was the culprit.

A number of state and federal biologists who have studied the problem have found no evidence that the decline in muskrats was directly related to the increase in nutria. For one thing, while nutria live in all kinds of marshes (and are the most numerous in fresh-water ones), muskrats on the Gulf Coast live mainly in certain kinds of salt-water marshes. During the years of large muskrat populations, about 85 percent of the muskrats in Louisiana lived in a quarter of the coastal marshlands—the quarter containing salt-water marshes covered with three-square grass. Since 1940, this type of marsh has been gradually changing or disappearing, mainly because of hurricanes, drought, industrialization, and damage by muskrats when they were too numerous for the available food supply. Not until 1966 did the three-square grass marsh show any signs of coming back over most of its original area. Many state biologists believe that once it is well established again, the large populations of muskrats will come back too.



Changes in the marsh due to nature have caused both muskrats and nutria to decline.

Since nutria and muskrats live mainly in different types of marshes, competition between them is of serious concern only in a few places where they are both present in large numbers. The only extensive area in Louisiana where this is likely to occur is the Terrebonne Marsh, the one large fresh-water marsh in the state that supported a large population of muskrats before their decline. (Even so, this marsh of a quarter million acres contained less than 3 percent of the state's muskrats.) When the muskrats declined in the Terrebonne Marsh, nutria were only beginning to settle there. Now nutria and muskrats are both well established, and competition is possible.

How serious competition can be between nutria and muskrats is open to different interpretations, and biologists have not always agreed even on the extent of direct physical conflict between the two species. Some have reported that the two were compatible with each other and lived in harmony in the same marsh, but others have implied that muskrats could kill young nutria if the nutria took over the muskrats' burrows, or that nutria would kill muskrats in competition for burrows or food. We conducted some studies of nutria and muskrats in pens and in the wild, using photography and radio-tracking to help us observe and record how the animals reacted to each other. In one study, we put equal numbers of nutria and muskrats of mixed ages and sexes together in four- by eight-foot pens. Each species established its own territory the first day; but even in these small quarters, fighting occurred only when territories were invaded, and occasionally during feeding. Although combat was fierce, it never lasted over a minute, and neither species suffered any visible injuries. In all of our field studies, we saw this kind of fighting in the wild only twice, and again it left no visible injuries. So, on the basis of our experience, we doubt that direct conflict between nutria and muskrats kills or even physically injures many animals in nature.

However, our investigations showed that nutria may interfere with muskrats in other ways. For example, in one study the burrowing and feeding activity of nutria completely destroyed four out of 14 muskrat lodges and heavily damaged seven more, three of them enough so that the muskrats abandoned them. This means that half the muskrats in the study were made homeless by nutria, though none of the seven seemed to be hurt by their eviction and all of them eventually built new lodges within 100 yards of their old ones. We did find, however, that females that

were pregnant or had litters maintained their lodges, even when damaged, until the young animals were old enough to go out on their own; this is contrary to the assumption of some biologists that nutria cause muskrats to desert their young, which eventually die.

Another way nutria can interfere with muskrats is competing with them for the high spots where marsh animals retreat for survival during floods. Incidentally, high populations of nutria can make this situation worse by "mowing" large open areas of a marsh and leaving it with no high vegetation to climb on during flooding. Since nutria and muskrats eat basically the same kind of food—marsh plants—there may also be serious competition for food when overpopulation or some catastrophe wipes out most of the normal food supply for one or the other. This never occurred during our studies, so we cannot judge how acute such competition might be or which species would be likely to fare the best.

When nutria and muskrats share a marsh in apparent harmony, there is usually a general upward trend in the muskrat population, but we found that removing the nutria often makes the muskrat population skyrocket. So it appears that, even though nutria rarely injure muskrats physically, the nutria's harassment and competition for food and territory are enough to keep the muskrat population from increasing at its normal potential. If this situation were widespread, it might be a serious concern for those who are looking forward to a resurgence in the muskrat industry. However, as we pointed out, nutria and muskrats usually choose to live in different marshes, and therefore the competition affects only a small percentage of the muskrats—in Louisiana, probably less than 10 percent. So the odds are that the muskrats, if they are going to come back in large numbers, will do so without serious interference from nutria, and that both species will continue to have their share in the Gulf Coast fur industry.

HOW MUCH DAMAGE

No one questions the fact that nutria in agricultural areas do damage, for it can be very evident. But how much the damage amounts to is disputed by most people involved, including the biologists studying the problem.

Although agricultural damage by nutria has been reported in many parts of the United States, most of it occurs in the rice and sugarcane fields of Texas and Louisiana. The value of sugar cane or rice lost to the most damaging populations of nutria has been estimated by various people to run anywhere from several thousand to over a million dollars annually. During our 1963-1966 studies, we never found really extensive sugarcane damage. However, the nutria population was declining at that time, and earlier reports, often substantiated by photographs, indicated that damage had been quite a bit higher a few years before. The sketchy studies made of the damage problem by biologists have shown that there are dozens of changeable factors—such as weather, food supply, cover, and man's activities—that govern the amount of damage nutria do. So it is as wrong to say, "Nutria left alone will always destroy everything in sight," as it is to say, "Nutria never damage enough of any crop to worry about." How much damage occurs in each situation has

to be decided more or less on its own merits.

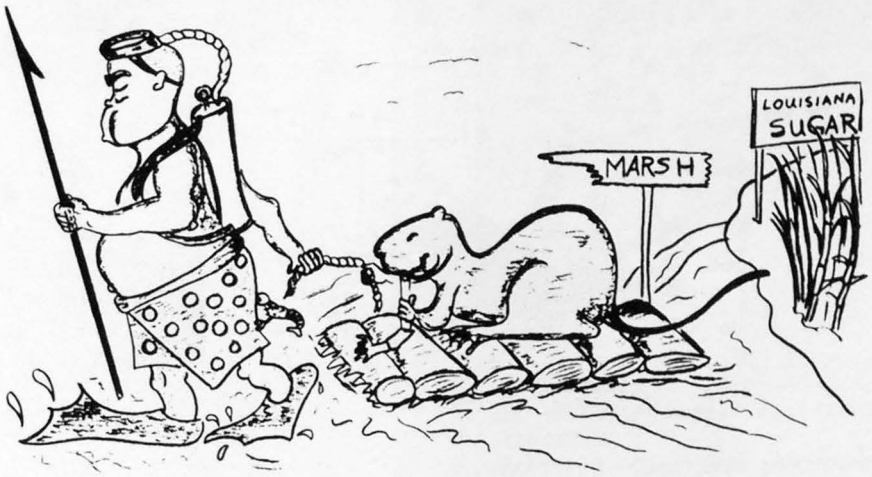
To calculate whether nutria are doing enough damage to warrant applying control measures, one has to know the market value of the plants lost so that he can balance it against the cost of the control program. But because it is so difficult to estimate crop losses accurately, most farmers rely on intuition (and human nature generally makes us overestimate damage to our own property). So, in a sense, it does not matter how much damage the nutria are actually doing, as long as the farmer thinks it is severe; he will apply control measures if he feels his crops are in danger. In previous years, before research was done on the problem, these control measures were likely to be anything that came to hand. They were often not very effective, and even more often were dangerous to most other animals, man included. Now, however, several good control methods are available, and people are more aware of the safeguards necessary in using them. This, along with the increasing tendency among farmers, agricultural advisory boards, and state and federal agencies to cooperate in setting up large, well-planned, and carefully balanced control programs, is making nutria control both safer and more economical. If nutria control becomes a routine part of sugarcane and rice growing, the amount of damage the nutria would do if uncontrolled becomes simply an academic question.

FINALLY

The nutria has its beneficial and its harmful aspects. If it is to be preserved at healthy population levels for those who want it but at the same time kept from interfering with those who do not, the people in the United States will sooner or later have to recognize both sides of its character and develop a "give a little, take a little" compromise attitude about the way it is to be managed. We hope that our studies, and this book, have helped give some of the information necessary for this to come about.

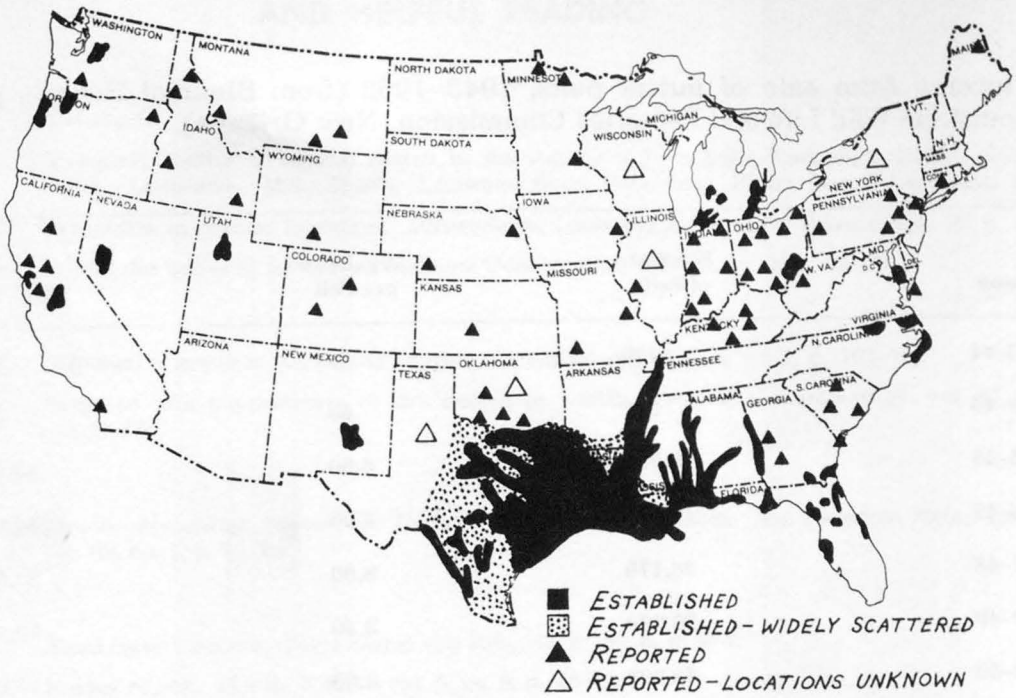
A full understanding of the nutria is necessary for sound management of this helpful and harmful animal.

Not all the questions are answered, of course. Studies are still continuing, with the hope that scientific research may someday show how to manage the Gulf Coast nutria so that it stays mainly in the marsh, as a valuable fur animal that opens the marsh vegetation without mowing it down, leaves the muskrat to go its own way, and never again invades the rice and sugarcane fields to do serious damage.

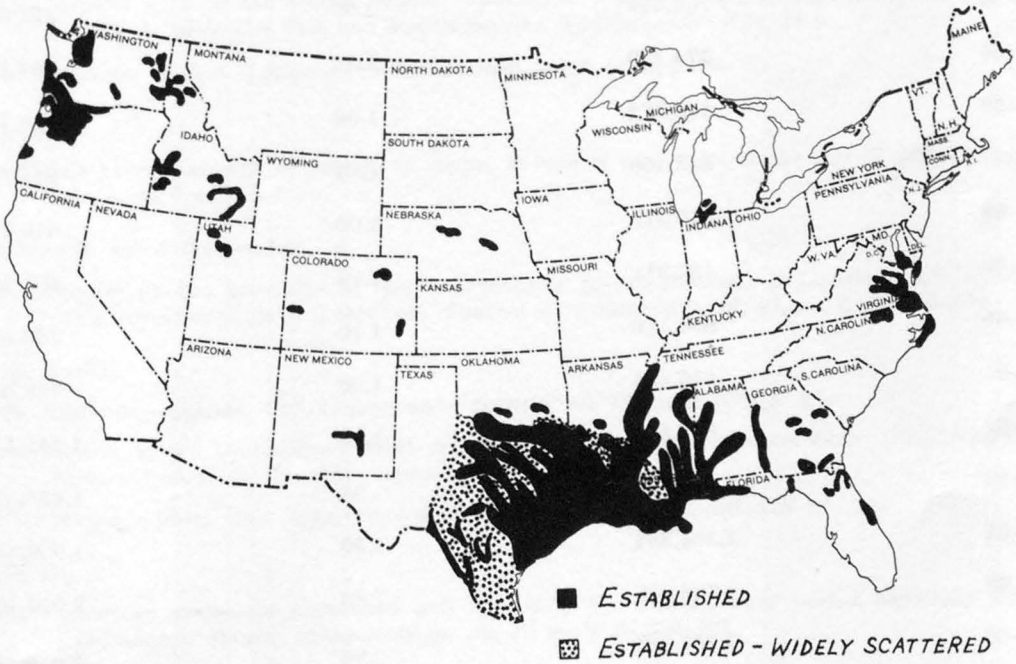


Scientific studies continue, aimed at keeping the nutria in the marsh where he belongs.

APPENDIX A. NUTRIA DISTRIBUTION IN THE UNITED STATES



Nutria distribution before 1966.



Nutria distribution in 1966.

APPENDIX B. NUTRIA HARVEST IN LOUISIANA

Annual income from sale of nutria pelts, 1943-1965 (from Biennial Reports published by the Louisiana Wild Life and Fisheries Commission, New Orleans).

Season	Number of Pelts	Avg. Price per Pelt	Total Value
1943-44	436	$ .50	$ 218.00
1944-45	902	.50	451.00
1945-46	8,784	5.00	43,920.00
1946-47	18,015	3.00	54,045.00
1947-48	28,176	3.00	84,528.00
1948-49	26,738	3.50	93,583.00
1949-50	38,988	3.00	116,964.00
1950-51	78,422	4.65	364,662.30
1951-52	77,966	2.00	155,932.00
1952-53	89,526	2.00	179,052.00
1953-54	160,654	2.00	321,308.00
1954-55	374,199	2.05	767,107.95
1955-56	418,772	1.00	418,772.00
1956-57	543,160	1.50	814,740.00
1957-58	510,679	1.00	510,679.00
1958-59	461,311	1.00	461,311.00
1959-60	694,110	1.10	763,521.00
1960-61	716,435	1.00	716,435.00
1961-62	912,890	1.25	1,141,112.50
1962-63	1,357,806	1.35	1,833,038.10
1963-64	1,304,267	1.50	1,956,400.50
1964-65	1,568,233	1.60	2,509,172.80
1965-66	1,257,385	2.90	3,646,416.50

APPENDIX C. BIBLIOGRAPHY: SOURCES OF INFORMATION AND HELPFUL READING

Adams, William H., Jr.

1956. Ecological studies of coastal marsh in the vicinity of Price Lake, Rockefeller Refuge, Cameron Parish, Louisiana. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 118 p.

1956. The nutria in coastal Louisiana. Proceedings, Louisiana Academy of Science, vol. 19, p. 28-41.

1957. Nutria: for better or for worse. Alabama Conservation, vol. 29, no. 1, p. 24-26.

Aliev, F. F.

1965. Dispersal of nutria in the USSR. Journal of Mammalogy, vol. 46, no. 1, p. 101-102.

1966. Enemies and competitors of the nutria in USSR. Journal of Mammalogy, vol. 47, no. 2, p. 353-355.

Allin, A. E.

1955. Nutria, *Myocastor coypus,* in Thunder Bay District, Ontario. The Canadian Field-Naturalist, vol. 69, no. 1, p. 25-26.

Anonymous

1950. Weed cutters deluxe. Texas Game and Fish, vol. 8, no. 8, p. 6-7.

1955. Roving rodent. Florida Wildlife, vol. 8, no. 9, p. 10-11, 41.

1959. Nutria are becoming crop enemy number one. Texas Game and Fish, vol. 17, no. 3, p. 29.

1962. Exotic animals threaten Oregon wildlife, game crops. Oregon State Game Commission Bulletin, vol. 17, no. 11, p. 7.

Ashbrook, Frank G.

1948. Nutrias grow in the United States. Journal of Wildlife Management, vol. 12, no. 1, p. 87-95. Reprinted: 1949, U.S. Fish and Wildlife Service, Wildlife Leaflet 319, 14 p.

1953. Muskrat—nutria. Louisiana Conservationist, vol. 5, no. 6, p. 16-17.

Atwood, Earl L.

1950. Life history studies of nutria, or coypu, in coastal Louisiana. Journal of Wildlife Management, vol. 14, no. 3, p. 249-265.

Babero, Bert B., and J. Warren Lee

1961. Studies on the helminths of nutria, *Myocastor coypus* (Molina), in Louisiana with check-list of other worm parasites from this host. Journal of Parasitology, vol. 47, no. 3, p. 378-390.

Bednarik, Karl E.

1955. And now—nutrias. Ohio Conservation Bulletin, vol. 19, no. 2, p. 2-3, 32.

1958. Nutria in the United States with management recommendations for Ohio. Ohio Department of Natural Resources, Game Management Publication 165, 22 p.

1961. Nutria in Ohio. Ohio Department of Natural Resources, Publication W-94, 2 p.

Boudelle, E.

1939. American mammals introduced into France in the contemporary period, especially *Myocastor* and *Ondatra.* Journal of Mammalogy, vol. 20, no. 3, p. 287-291.

Cabrera, Angel, and Jose Yepes.

1940. Historia Natural Ediar; Mamiferos sud-americanos (vida, costumbres y descripcion). Compania Argentina de Editores, Buenos Aires, 370 p. [For nutria, see plate XLVI, figure 1, and p. 227-228.]

Chabreck, Robert H.

1962. Daily activity of nutria in Louisiana. Journal of Mammalogy, vol. 43, no. 3, p. 337-344.

1964. The relation of cattle and cattle grazing to marsh wildlife and plants in Louisiana. Paper presented at the 18th Annual Conference, Southeastern Association of Game and Fish Commissioners, Clearwater, Florida, October 1964. [Mimeographed separate.]

Cooper, E. H.

1957. A special report on the nutria situation. Agricultural and Mechanical College of Texas, College Station, Texas, Texas Wildlife Bulletin 14.

Daspit, Armand P.

1947. Development of nutria in Louisiana. Louisiana Game, Fur and Fish, vol. 6, no. 1, p. 4.

1948. Louisiana fur industry. Louisiana Conservationist, vol. 1, no. 2, p. 17-18.

1950. Migrating nutria. Louisiana Conservationist, vol. 2, no. 5, p. 7-8.

Davis, R. A.

1955. The coypu. Discovery, vol. 16, no. 6, p. 237-239.

1956. The coypu. Agriculture (London), vol. 63, no. 3, p. 127-129.

1963. Feral coypus in Britain. Proceedings of the Association of Applied Biologists, Great Britain, vol. 51, p. 345-348.

Davis, R. A., and A. G. Jenson

1960. A note on the distribution of the coypu (*Myocastor coypus*) in Great Britain. Journal of Animal Ecology, vol. 29, no. 2, p. 397.

Davis, W. B.

1956. Nutrias can mean trouble. Texas Game and Fish, vol. 14, no. 6, p. 15, 23.

Dozier, Herbert L.

1951. The present status and future of nutria in the southeastern states. Paper presented at the 5th Annual Conference of the Southeastern Association of Game and Fish Commissioners, Gulfport, Mississippi, October 1951, 10 p. [Mimeographed separate.]

Dozier, Herbert L., and Frank G. Ashbrook

1950. Practical way to dry nutria pelts. Louisiana Conservationist, vol. 3, October, p. 16-18.

Draney, Virgil

1957. The controversial nutria. Utah Fish and Game Magazine, vol. 13, no. 7, p. 6-9.

Eagles, Darrell

1964. Nutria ranching in Canada—the biological and financial risks involved. Canadian Audubon Magazine, vol. 26, no. 3, p. 81-86.

Ehrlich, S.

1958. The biology of the nutria. Bamidgeh, vol. 10, no. 2, p. 36-43.

1958. The biology of the nutria. Bamidgeh, vol. 10, no. 3, p. 60-70.

Ensminger, Alan B.

1955. The economic status of nutria in Louisiana. Proceedings, 9th Annual Conference of the Southeastern Association of Game and Fish Commissioners, Daytona Beach, Florida, October 1955, p. 185-188.

Evans, James

1964. The nutria damage control research program. Paper presented at the 18th Annual Conference of the Southeastern Association of Game and Fish Commissioners, Clearwater, Florida, October 1964, 4 p. [Mimeographed separate.]

1968. Report co-author stresses rodenticides ruled out [excerpts from letter]. American Fur Breeder, vol. 41, no. 2, p. 36-37.

Evans, James, and A. Lorin Ward

1967. Secondary poisoning associated with anticoagulant-killed nutria. Journal of the American Veterinary Medical Association, vol. 151, no. 7, p. 856-861.

Fuller, Jefferson C., Jr.

1955. Four-legged weed cutter. South Carolina Wildlife, vol. 2, no. 2, p. 5, 23.

Gainey, Louis F.

1949. Comparative winter food habits of the muskrat and nutria in captivity. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana, 41 p.

Garner, Kenneth M.

1962. Nutritive values and digestibility of some wetland wildlife foods in Louisiana. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana, 90 p.

Glasgow, Leslie L.

1957. Nutria control in Louisiana. The Sugar Bulletin, vol. 36, no. 4, p. 57-59.

Glasgow, Leslie L., and Lavon A. McCollough

1963. Nutria for home use. Louisiana State University Agricultural Experiment Station, Circular 77, 20 p.

Glass, Bryan P., and Arthur F. Halloran

1961. Small mammals of the Wichita Mountains Wildlife Refuge, Oklahoma. Journal of Mammalogy, vol. 42, no. 2, p. 234-239.

Griffo, James V., Jr.

1957. The status of the nutria in Florida. The Quarterly Journal of the Florida Academy of Sciences, Tallahassee, vol. 20, no. 3, p. 209-215.

Guenther, Stanley E.

1950. Nutria. Washington State Game Department, Game Bulletin, vol. 2, no. 1, p. 5.

Gunderson, Harvey L.

1955. Nutria (*Myocastor coypus*) in Minnesota. Journal of Mammalogy, vol. 36, no. 3, p. 465.

Hale, James B.

1950. Nutria versus muskrat. Wisconsin Conservation Bulletin, vol. 15, no. 4, p. 15-16.

Harlan, James R.

1943. Iowa trappers catch South American coypu, or nutria. Iowa Conservation News (January 7, 1943). 1 p. [Mimeographed.]

Harris, Van T.

1956. The nutria as a wild fur mammal in Louisiana. Transactions of the 21st North American Wildlife Conference, p. 474-486.

Harris, Van T., and Fred Webert

1962. Nutria feeding activity and its effect on marsh vegetation in southwestern Louisiana. U.S. Fish and Wildlife Service, Special Scientific Report—Wildlife 64, 53 p.

Hodgson, Robert G.

1949. Farming nutria for profit. Fur Trade Journal of Canada, Toronto, 113 p.

1957. Now it's nutria. Fur Trade Journal of Canada, Toronto, 90 p.

Hoffmeister, Donald F.

1958. The future status of the nutria, fur bearing rodent in Illinois. Transactions of the Illinois State Academy of Science, vol. 51, no. 3-4, p. 48-50.

Hoffmeister, Donald F., and C. D. Kennedy

1947. The nutria, a South American rodent, in Kansas. Transactions of the Kansas Academy of Science, vol. 49, no. 4, p. 445-446.

Holdom, Martin W.

1944. Additional note on feral coypu. The Murrelet, vol. 25, no. 2, p. 30.

Hollister, N.

1914. Four new neotropical rodents. Proceedings of the Biological Society of Washington, vol. 27, p. 57-60.

Howard, Walter E.

1953. Nutria (*Myocastor coypus*) in California. Journal of Mammalogy, vol. 34, no. 4, p. 512-513.

Jellison, William L.

1946. Spotted skunk and feral nutria in Montana. Journal of Mammalogy, vol. 26, no. 4, p. 432.

Jones, J. Knox, Jr.

1957. Checklist of mammals of Nebraska. Transactions of the Kansas Academy of Science, vol. 60, no. 3, p. 273-282.

Kays, Carlos E.

1956. An ecological study with emphasis on nutria (*Myocastor coypus*) in the vicinity of Price Lake, Rockefeller Refuge, Cameron Parish, Louisiana. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana, 145 p.

1959. Present status of nutria in Kentucky. Kentucky Department of Fish and Wildlife, March 1959, 3 p. [Mimeographed.]

Kebbe, C. E.

1959. The nutria in Oregon. Oregon State Game Commission Bulletin, vol. 14, no. 4, p. 8.

Kimsey, Alden

1953. Nutria. Oklahoma Game and Fish News, vol. 9, no. 3, p. 10-11.

Kinsel, George V.

1958. The theory and practice of nutria raising. Fur Trade Journal of Canada, Toronto, 231 p.

Kyle, George

1958. The nutria needs hunting. Alabama Conservation, vol. 30, no. 3, p. 8-9, 22.

Larrison, Earl J.

1943. Feral coypus in the Pacific Northwest. The Murrelet, vol. 24, no. 1. p. 3-9.

Laurie, E. M. O.

1946. The coypu (*Myocastor coypus*) in Great Britain. Journal of Animal Ecology, vol. 15, no. 1, p. 22-34.

Long, W. R.

1966. Portrait of the Texas nutria. Texas Parks and Wildlife, vol. 24, no. 4, p. 18-19, 27.

Louisiana Department of Education

1955. How to skin and prepare nutria pelts. Louisiana Trade School, Natchitoches, Louisiana, 35 p.

Low, Jessop B.

1946. Nutria introduced in Utah marshlands near Salt Lake. Utah Fish and Game Bulletin, vol. 3, no. 4, p. 4-5.

Lowery, George H., Jr.

1943. Check-list of the mammals of Louisiana and adjacent waters. Louisiana State University Museum of Zoology, Occasional Paper 13, p. 213-257.

Lueth, Francis X.

1949. Meet Mr. and Mrs. Nutria. Alabama Conservation, vol. 20, no. 12, p. 4, 22.

1949. The first year of nutria investigations on the Mobile Delta. Paper presented at the 3rd Annual Meeting of the Southeastern Association of Game and Fish Commissioners, Nags Head, North Carolina, October 1949, 12 p. [Mineographed separate.]

Manville, Richard H.

1962. The nutria in the United States. U.S. Bureau of Sport Fisheries and Wildlife, Wildlife Leaflet 445, 4 p.

McCarthy, Jack

1967. Nutria—nuisance or necessity? Maryland Conservationist, vol. 44, no. 2, p. 17-19.

Newson, Robin M.

1966. Reproduction in the feral coypu (*Myocastor coypus*), p. 323-334. *In* Comparative Biology of Reproduction in Mammals, Symposia of the Zoological Society of London, no. 15.

Newson, R. M., and R. G. Holmes

1968. Some ectoparasites of the coypu (*Myocastor coypus*) in eastern England. Journal of Animal Ecology, vol. 37, no. 2, p. 471-481.

Norris, J. D.

1967. The control of coypus (*Myocastor coypus* Molina) by cage trapping. Journal of Applied Ecology, vol. 4, no. 1, p. 167-189.

1967. A campaign against feral coypus (*Myocastor coypus* Molina) in Great Britain. Journal of Applied Ecology, vol. 4, no. 1, p. 191-199.

O'Neil, Ted

1949. The muskrat in the Louisiana coastal marshes. Louisiana Department of Wild Life and Fisheries. 152 p.

1963. Louisiana's fur industry today. Louisiana Conservationist, vol. 15, nos. 1 & 2, p. 3-6.

1965. Fur future. Louisiana Conservationist, vol. 17, nos. 3 & 4, p. 14-17.

1966. Fur resources on the increase. Louisiana Conservationist, vol. 18, nos. 11 & 12, p. 3.

Osgood, Wilfred H.

1943. Mammals of Chile. Field Museum of Natural History, Zoological Series, vol. 30 [Museum publication No. 542], p. 131-134.

Page, Calvin A., Van T. Harris, and JoAnn Durand

1957. A survey of virus in nutria. Southwestern Louisiana Journal, vol. 1, no. 3, p. 207-210.

Parks, E. E., Kenneth M. Garner, and G. R. Abraham

1963. Reduction of nutria damage in sugarcane and other croplands in southern Louisiana. The Sugar Bulletin, vol. 41, no. 10, p. 133.

Parry, Elise A.

1939. The beaver rat neither beaver nor rat. Nature Magazine, vol. 32, no. 5, p. 256-258.

Petrides, George A.

1950. The nutria comes to Texas. Texas Game and Fish, vol. 8, no. 6, p. 4-5, 27.

Petrides, George A., and Daniel L. Leedy

1948. The nutria in Ohio. Journal of Mammalogy, vol. 29, no. 2, p. 182-183.

Popov, Boris H.

1949. The introduced fishes, game birds, and game and fur mammals of Utah. M.S. Thesis, Utah State Agricultural College, Logan, Utah, p. 166-172.

Popov, Boris H., and Jessop B. Low

1953. Game, fur animal and fish introductions into Utah. Utah Department of Fish and Game, Miscellaneous Publication 4. 85 p.

Prasad, H.

1960. Two new species of Coccidia of the coypu. Journal of Protozoology, vol. 7, no. 3, p. 207-210.

Roth, Earl E., W. V. Adams, G. E. Sanford, Betty Greer, and Patricia Mayeux

1962. *Leptospira paidjan* (bataviae serogroup) isolated from nutria in Louisiana. Public Health Reports, vol. 77, no. 7, p. 583-587.

Rawley, Edwin V.

1956. $$Nutria?? Utah Fish and Game Bulletin, vol 12, no. 4, p. 6-7.

Saveson, Irwin L.

1963. An efficient drainage system for sugarcane. U.S. Department of Agriculture Bulletin, Agricultural Research Service, publication ARS-41-72, 12 p.

Schacker, J. F.

1956. Parasites of Louisiana mammals with emphasis on nutria and otter. Department of Tropical Medicine and Public Health, Tulane University, New Orleans, Louisiana, 18 p. [Mimeographed.]

Skowron-Cendrzak, A.

1956. Sexual maturation and reproduction in *Myocastor coypus*. I. The oestrus cycle. Folia Biologica, vol. 4, no. 2, p. 119-138.

St. Amant, Lyle S.

1959. Louisiana wildlife inventory and management plan. Louisiana Wild Life and Fisheries Commission, 329 p.

Stanley, Hugh P., and Howard H. Hillemann

1960. Histology of the reproductive organs of nutria, *Myocastor coypus* (Molina). Journal of Morphology, vol. 106, no. 3, p. 277-299.

Sooter, Clarence A.

1943. Nutria good diver. Journal of Mammalogy, vol. 24, no. 4, p. 503-504.

Swank, Wendell G., and George A. Petrides

1954. Establishment and food habits of the nutria in Texas. Ecology, vol. 35, no. 2, p. 172-176.

Talbert, Rollo E.

1962. Control of nutria. Proceedings, Vertebrate Pest Control Conference, Sacramento, California, February 1962, p. 172-173. Reprinted: 1962, California Department of Agriculture Bulletin, vol. 51, no. 3, p. 156-157.

Thomas, Carl H.

1963. A preliminary report on the agricultural production of the red-swamp crawfish (*Procambarus clarkii*) (Girard) in Louisiana rice fields. Proceedings, 17th Annual Conference of the Southeastern Association of Game and Fish Commissioners, Hot Springs, Arkansas, September-October 1963, p. 180-186.

United States Fish and Wildlife Service

(Annually). Fur catch in the United States. U.S. Bureau of Sport Fisheries and Wildlife, Wildlife Leaflets, Washington, D.C.

1957. Nutrias in the United States. U.S. Bureau of Sport Fisheries and Wildlife, Wildlife Leaflet 389, 11 p.

Waldo, Ednard

1959. Louisiana fur outlook. Louisiana Conservationist, vol. 11, no. 12, p. 2-3.

1962. The Louisiana nutria story. Louisiana Wild Life and Fisheries Commission, New Orleans, 16 p.

Wallace, H. E.

1963. 1963 Florida nutria survey. Florida Game and Fresh Water Fish Commission, February 1963, 2 p. [Mimeographed.]

Williams, Bolton

1964. To catch a nutria. Texas Game and Fish, vol. 22, no. 1, p. 30.

Wilson, Everett D., and Andrew A. Dewees

1962. Body weights, adrenal weights and oestrous cycle of nutria. Journal of Mammalogy, vol. 43, no. 3, p. 362-364.

Wilson, Ken

1965. Nutria. Wildlife in North Carolina, vol. 29, no. 10, p. 26-27, 31.

Wingard, Bob

1957. Report on nutria. Pennsylvania Game News, vol. 28, no. 1, p. 56-58.

Yeager, Lee E.

1964. Fur and feathers, p. 313-322. *In* Waterfowl Tomorrow. U.S. Department of the Interior, Washington, D.C.

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