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Texas Agricultural Extension Service

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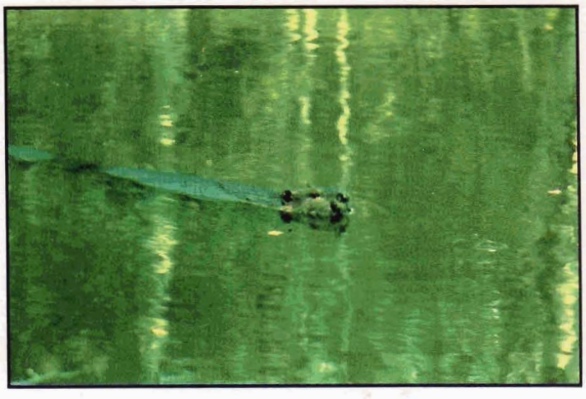
Identifying and Managing Aquatic Rodents in Texas: Beaver, Nutria and Muskrats



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Cover Photos

Top left: Beaver

Top right: Beaver

Bottom left: Muskrat

Bottom right: Nutria

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Identifying and Managing Aquatic Rodents in Texas: Beaver, Nutria and Muskrats

Dale A. Wade and Charles W. Ramsey*

Beaver *(Castor canadensis),* nutria *(Myocastor coypu)* and muskrats *(Ondatra zibethica)* are important furbearing animals in Texas. All three species are semi-aquatic rodents that utilize similar habitat and are somewhat similar in general habits and appearance. They may simultaneously inhabit the same lakes, marshes and streams, but they differ substantially in size and specific habits.

Beaver are the largest native rodents in North America; some adults weigh more than 100 pounds. Nutria are native to South America and were brought into the United States about 50 years ago; adults may weigh as much as 20 to 25 pounds. Muskrats also are native to North America; adults commonly weigh from 2 to 4 pounds.

These species are valuable as furbearers and have positive effects on the environment. However, they may also cause substantial economic or other losses. In order to manage these species in Texas it is necessary to understand their ecology and damage, as well as methods of control. The following discussion considers the species in order of their general importance in Texas.

BEAVER

General History

The history of the beaver in North America is a lengthy one, with the earliest evidence of beaver occurring in Pleistocene deposits. It is believed that beaver occupied streams in North America for thousands of years before the first European settlers arrived, and probably attained a population level which filled available habitat. Climatic conditions and plant succession, with their influence upon the amount and quality of habitat, undoubtedly caused some population fluctuations. Seton (1900) estimated that in primitive times there were some 60,000,000 beaver in North America.

The Indians killed beaver for food and used their skins for clothing; they captured beaver with snares, nets and deadfalls. This harvesting of beaver had little effect on the total population, and could be considered simply a part of the natural environmental pressures upon wildlife in general. However, the coming of white men dramatically changed the factors which influenced beaver populations. The invasion of North America by Europeans not only altered natural conditions, but also caused the Indians to modify their ideas and practices. Beaver pelts became important in the fashion markets of Europe and many beaver were killed to satisfy this demand. The early fur trade depended almost entirely upon Indians who gave furs in trade for whatever products the whites had to offer. But this system failed to supply enough beaver pelts to satisfy demand, so the era of the "white trapper" or "mountain man" came into being. Between 1800 and 1850, the major explorations in western North America were made largely to discover new areas for trapping beaver.

About midway through this 50-year period, steel leghold traps were invented. These traps enabled trappers to operate with much greater efficiency at a time when fur demand was reaching its peak. The extirpation of beaver from much of their original habitat followed shortly and by 1850, when the whims of fashion decreed that silk hats should be the successor to beaver hats, the scarcity of beaver had become noticeable. Trappers were going farther into headwater areas, were staying longer and were returning with fewer pelts. By the late 1850s, beaver populations in most of the American West had been severely depleted.

Even the low pelt prices common after 1850 did not end the exploitation of beaver. Trappers who knew no

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other way of life continued to eke out a living by selling pelts for whatever the market would bring, and beaver populations continued to dwindle through the last half of the 19th century. The low point probably was reached sometime between 1890 and 1900.

About 1900 most western states began protecting beaver. From that time to the present, because of protection and transplants, beaver populations have increased. Since much of the original beaver habitat has been altered, it is not likely that the total beaver population will again reach the level present before European settlement of North America. Nonetheless, in some areas beaver populations may exceed pristine levels because of the favorable habitat created by land management practices.

Texas History

Historical references to the early fur trade generally emphasize the Rocky Mountains and other western areas, with little mention of the beaver harvest and fur trade in Texas. Yet, Texas beaver were nearly extinct by 1900, primarily because of the fur trade. Beginning in 1925, beaver were protected by Texas laws and regulations and their harvest was controlled. Beaver that caused damage were commonly live-trapped and transplanted to other areas. There isn't much information on the number of beaver transplanted within Texas or brought in from other states, but records do show numerous transplants from 1939 to 1961 and there were many that were not recorded (Texas Parks & Wildlife Department, unpublished data, Fig. 1). These were generally

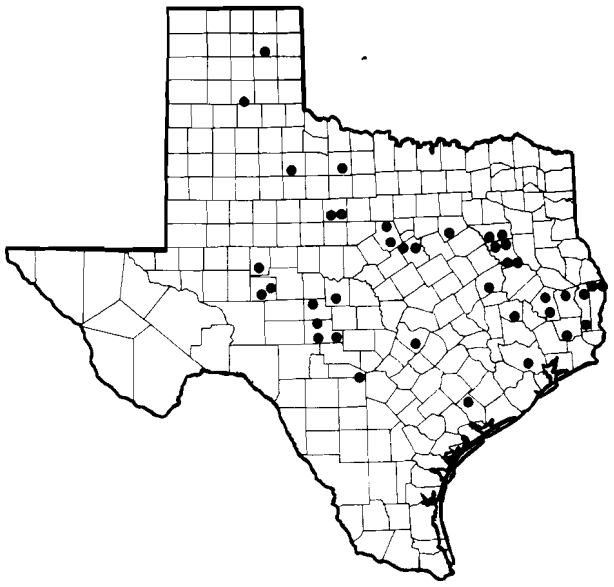


Figure 1. Beaver transplants recorded by the Texas Parks & Wildlife Department, 1939–73. (47 transplants; 229 beaver)

Source: TPWD, Austin; January 7, 1984

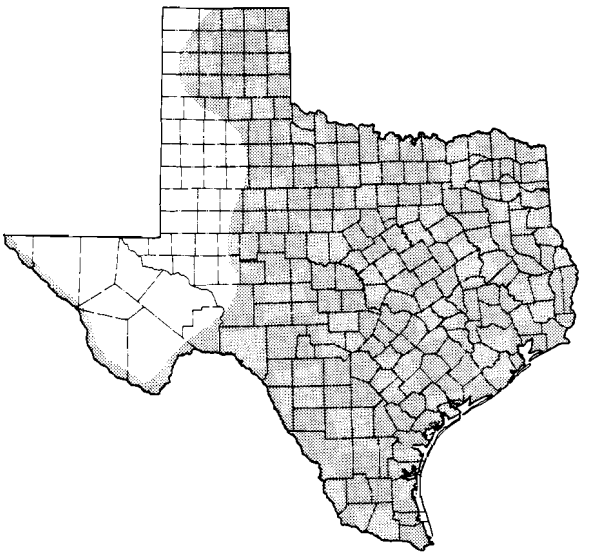


Figure 2. Beaver distribution, 1984.

successful and both protection and transplanting contributed to a relatively rapid increase in the Texas beaver population. By the mid 1960s there were many complaints of beaver damage in Texas and transplanting to protect beaver was no longer considered necessary. As damage complaints increased, restrictions on "taking" beaver were gradually reduced. At present, beaver populations are quite high. Damage is serious in many areas, particularly the eastern half of Texas, and removal of beaver for damage control is legal throughout the year.

Consistently high fur prices would stimulate beaver harvest and contribute to population control. However, beaver fur prices have been erratic and relatively low for several decades (see Tables 1–3, pp. 42–44). It is often claimed that beaver pelts from warm southern climates are of lower quality than those from cold northern climates. Whether or not this is true, the result of the claim is that lower prices are paid for southern furs and harvesting of southern beaver often is not profitable to trappers. As a consequence, beaver continue to increase in numbers and extend their range into urban and rural areas in western and northern Texas. Beaver are now present in most areas of Texas except in parts of the Trans-Pecos, the High Plains and the Panhandle (Fig. 2).

Description

Beaver are semi-aquatic furbearing animals and the largest of all North American rodents. Mature beaver normally weigh 40 to 60 pounds; occasionally large adults may reach 100 pounds or more. Average adults are 25 to 30 inches long from the nose to the base of the paddle-shaped tail. The flat, scaly tail is 6 to 8 inches wide and 10 to 12 inches long on adults. It is both useful

and unusual. It is used as a rudder and for propulsion in swimming, and is slapped against the water surface as a danger signal. On land, a beaver uses its tail as a brace when cutting trees and for balance when holding or carrying material with its front feet and legs.

Beaver have large, fully-webbed hind feet which provide the major propulsion in swimming and good support on soft, muddy surfaces. The three outer toes of the hind foot have thick, blunt nails; the two inner toes curve toward the body and have sharp nails. The second of these toes has a split nail and is thought to be used for grooming their fur. Beaver have five toes with strong claws on each front foot. Their front feet are dextrous, well-adapted for digging and are used to hold and manipulate material. The front feet are small, have no webs and are used very little in swimming.

Beaver have short, stout legs that are specialized for work and swimming but poorly adapted for running. Beaver are slow and awkward on land but swift and graceful in water. Therefore, they rarely travel far from water unless forced by drouth, a need for food or a search for new territory.

The eyes, ears, nose and mouth of beaver are highly specialized for their aquatic life. The eyes are set high on the head and allow vision above water while the beaver is almost totally submerged. Beaver also appear to see well under water. Although their ears are small, their hearing is good. Both ears and nostrils have valves that close under water. Their sense of smell is well developed. Beaver have large, paired incisors (front teeth) that are orange to brown on the front surfaces. The beaver's lips can be closed behind the incisors so that the teeth can be used under water. Beaver have sixteen large molar teeth—four on either side of the upper and lower jaws; these are used for grinding vegetation. As in many other rodent species, the incisors grow continually throughout life and beaver must keep them worn back by daily use. The front surface of the incisors is extremely hard but the teeth become progressively softer toward the back. As a result, the back wears down more rapidly than the front and the incisors are kept chisel-shaped, sharp and efficient by constant growth and wear.

Beaver have a soft, dense undercoat of fur protected by long, coarse guard hairs. Their fur appears golden to dark brown on the back, shading to a lighter color on the belly. There are occasional albino beaver. Beaver carefully groom and condition their fur with oil from a pair of anal glands which empty into the cloaca, the external ventral opening (between the tail and the hind legs) of the intestines and the reproductive and urinary tracts. This oil, along with oil from glands in the skin, normally prevents beaver from becoming wet at the skin surface.

In addition to the paired oil glands, both male and female beaver have a pair of scent glands called "castor sacs" or "castors." These are anterior to the oil glands and empty into the cloaca. The product of these castors and the urine which enters them is a yellow liquid called castoreum. Castoreum is deposited at scent mounds by adult beaver, possibly as a territorial marker and/or for identification of sex and reproductive condition. The odor is readily detected by humans and is not unpleasant. The oil gland secretions also are chemical signals to other beaver.

Determination of Sex

There are no visible external differences between male and female beaver except late in gestation and during lactation, when the female exhibits four ventral teats between and just behind the front legs. At other times the teats are not readily visible. The simplest way to sex beaver when teats are not visible is to palpate for the baculum (penis bone), which is about 1 inch long in adult males and is easily located on most male beaver. This is done by feeling externally on the underside of the beaver. The baculum is midway between the pelvis and cloaca; if it is not present, the beaver can be assumed to be female.

Biology and Behavior

The beaver is one of the few mammals other than man which is capable of modifying habitat to suit its needs. Beaver often inhabit natural ponds, lakes or streams that supply sufficient water for their safety. But often beaver must provide their own impoundments for adequate water depth. Beaver are highly skilled in building dams of sticks, stones, mud and other materials to maintain a constant water level. They exhibit an unusual degree of engineering skill in choosing dam locations. Usually, one dam is built to provide the water impoundment for the main lodge in a colony; one or several secondary dams may be built to provide safe travel routes and aid in transporting tree limbs and other vegetation. Beaver also commonly build or dig canals to aid in transporting vegetation to the home pond.

In Texas, beaver often live in dens (burrows) in stream or lake banks, or may dig simple bank dens as temporary living quarters when establishing new colonies. However, in some instances a lodge is constructed for living quarters. A lodge is usually dome-shaped, built of sticks and mud, with a large interior chamber above the water line. Lodges may be built entirely on land, but usually have one side against the bank; some are completely surrounded by water. The entrances, normally two or more, are under water. Beaver burrows and lodge entrances are usually at least 12 inches in diameter and some are much larger. The interior chamber may be 3 feet high and several feet in diameter.

Colony and Family

A beaver colony consists of a small group of animals occupying the same area or areas, such as a portion of a lake, a section of stream or a series of ponds on a drainage. The colony maintains communal dams and uses the same food source. Typically, the colony is a family unit which includes the parents and their offspring of the previous and current years.

Family size and age class composition vary among colonies. Reported averages for family size range from three to eight. Fur trapping, predation, habitat quality and other influences on individual survival distort family composition. For example, in 22 studies the average percentage of adults in observed colonies ranged from 15 to 61 percent.

Beaver within a colony may occupy several bank dens or lodges. The male parent often takes up quarters away from the home lodge or den when the young are born. The yearlings begin extending their range to other dens and lodges, although they continue to use the home lodge until they disperse as 2-year-olds.

In northern climates, beaver must keep their dams in good repair to have adequate water depth, and must establish a food cache to last through the winter. The food cache consists of a large pile of green tree limbs anchored to the bottom of the home pond where they can be reached when the pond is frozen over. Food caches may not be necessary in most areas of Texas where ponds do not freeze, but caches are common in some of these areas as well.

Colony members seem to stay within their boundaries unless a lack of food or water, or habitat saturation, forces them to migrate elsewhere. The progeny are allowed to remain until about 2 years of age when they either begin to disperse or are driven out by the parents. Beaver trappers generally believe that 2-year-olds may be killed by the parents if they refuse to leave. Dispersal is important in reducing population pressures and social stress, and may also be a primary means of preventing inbreeding. Young adults leaving to establish new colonies may have to travel long distances to find suitable unoccupied sites.

Movements and Dispersal

The pattern of daily movement centers, for the most part, around the lodge and pond. Beaver are primarily nocturnal and do most of their feeding and dam construction at dusk and after dark. Beaver activity outside the lodge is much greater just before dark and in the early morning hours after daybreak.

Seasonal movements of beaver vary greatly by sex and age classes. The female parent in the colony is relatively sedentary throughout the year. She is occupied with care of the young during the spring and summer. Little if any migratory movement by beaver occurs during late fall and winter. Certain conditions may force colonies or even the entire population along a stream to migrate. Flooding or depletion of the food supply are the most common causes of such large migrations.

The coming of spring brings high water and the birth of the new litter. Then 2-year-old beaver disperse from the home colony. These animals may spend the entire summer roaming about and not settle at any specific location before early fall. The location finally chosen for winter quarters may be adjacent to the parent colony or it may be on an entirely different stream drainage, depending on habitat conditions and competition for territory by other beaver. Dispersal distances vary considerably but average between 5 and 6 miles from the natal colony. During the dispersal period, 2-year-olds attempt to locate mates. If successful, they mate the following winter.

Reproduction

Beaver normally become sexually mature after they leave the home colony. This may be partly due to the social structure of beaver colonies, which tends to inhibit sexual maturation of the young. Normally, only the dominant female (usually the largest and the oldest in the colony) comes into estrus and breeds. There may be similar repression of young males by the dominant male. Dispersal permits sexual behavior to develop. Thus, if favorable habitat and good food supplies cause less dispersal and larger colonies, there may be less reproduction by young adults. This may partially explain the later maturity of beaver in the southern states. Likewise, limited food supplies and/or poor habitat which force more rapid dispersal of juvenile beaver may contribute to early breeding.

Beaver are normally monogamous and produce only one litter per year in northern states. Breeding in cold northern states normally occurs from January to March, although some may breed earlier or later. Research and reports from wildlife management field staffs indicate that breeding may occur throughout the year in Texas, with a major peak in winter. These data suggest that it is possible for females to produce more than one litter per year, although this has not been confirmed.

Gestation Period and Litter Size

Reports indicate that the gestation period for beaver ranges from 98 to 128 days with 100 to 105 days being the most common.

Litter size depends upon the age and size of the female and the quantity and quality of the food supply. Litters contain one to nine kits with the average being three or four. Larger litters seem to be borne by large females in their prime (4 to 6 years) and are common in good habitat.

Beaver kits weigh about 1 pound at birth, although in large litters they may be smaller. In appearance they are miniatures of their parents, with a color range from light brown to nearly black. Kits grow rapidly and begin taking solid food in 2 to 4 weeks. By 6 months of age they normally weigh 8 to 10 pounds.

Mortality and Life Expectancy

Beaver have a relatively long life span for wild animals. Most do not live more than 10 years, but some may live 20 years or more.

Beaver have few natural enemies because of their aquatic habitat and behavior. River otter *(Lutra canadensis)* and mink *(Mustela vison)* occasionally prey on

beaver kits. Coyotes *(Canis latrans)*, wolves *(Canis lupus)*, bears *(Ursus arctos* and *Ursus americanus)*, wolverines *(Gulo luscus)*, lynx *(Lynx canadensis)*, bobcats *(Lynx rufus)*, mountain lions *(Felis concolor)* and alligators *(Alligator mississippiensis)* are among the larger predators that will prey on beaver if the opportunity occurs. However, beaver rarely travel far from water and are relatively safe from most predators. In addition, adults are capable of putting up a strong defense when necessary. Natural predation in Texas probably has little effect on beaver populations.

Other than occasional outbreaks of tularemia, the major cause of beaver mortality is the annual harvest for fur and damage control. Data indicate that beaver can maintain or increase their populations with an annual harvest of 30 to 40 percent. Thus, it should not be surprising that their populations and range in Texas are rapidly expanding, since current fur prices offer little incentive for harvest and damage control efforts are limited.

Parasites and Diseases

Beaver appear to be less affected by diseases and parasites than many other wild species. They do harbor several external and internal parasite species which normally have little effect on beaver populations. Screwworms occasionally have been reported in beaver, normally as a result of wounds.

Tularemia, a bacterial disease caused by *Francisella tularensis,* may have caused several epidemics that killed many beaver in the Rocky Mountains and northern states. Its importance in Texas is not known, but it is probably not significant at present. Tularemia can be transmitted to humans through bites by insect vectors or infected animals or by handling animals or carcasses which are infected. The organism is believed to enter through small abrasions or wounds in the skin. Tularemia has been found in many wild animals, but it is relatively rare in humans in North America. Most human cases have occurred through exposure to infected rabbits, rodents or carnivores.

Giardiasis is a disease caused by a protozoan parasite *(Giardia lamblia)* carried by many animal species, including beaver. Beaver do not appear to be severely affected by the organism. However, in some states parasites excreted by infected beaver appear to have contaminated water sources and caused outbreaks of the disease in humans. Beaver infected with *Giardia* have been found in water impoundments in Texas, but the extent of infestation in Texas is not known. Besides beaver, a variety of mammals, birds, reptiles, amphibians and fishes also are known to harbor this organism.

Benefits of Beaver

Beaver dams create ponds that contribute to the stabilization of water tables and help reduce rapid run off from rain. Dams also help to reduce soil erosion, since much of the silt suspended in running water is deposited in the quiet pools impounded by beaver dams. These ponds create a habitat beneficial to many plants and animals and contribute to a diversity of plant communities.

Beaver ponds are excellent sites for observing wildlife behavior. Many varieties of plants and animals are found in the beaver pond ecosystem. The principles of wildlife management and the behavior of animal species can be learned by observing life in and near a beaver pond. Beaver ponds also provide recreation such as fishing and hunting; and of course they have great aesthetic value.

Harvest of beaver pelts often has been a significant source of income, but their fur value fluctuates greatly with fashion demands. As a consequence, this benefit is often more potential than real. However, beaver ponds do provide habitat for other furbearers whose harvest values are significant.

Beaver castoreum is a common ingredient of trappers' lures used to attract furbearers. It is also used extensively in the manufacture of perfumes and other cosmetics.

Beaver meat is good to eat and once was an important source of food in some areas of North America. It is comparable in protein value to other red meats and is highly palatable. Although rarely used for human food in Texas, it is an excellent source of protein for dogs.

In general, beaver are considered beneficial where they do not compete with people for the use of land, water and trees; however, when fur values are low their populations increase and the damage they cause to roads, crops, pasture and timber may become severe.

Legal Status

Beaver are legally classified as furbearing animals under Texas statute. Management of furbearers is regulated by the Texas Parks and Wildlife Department (TPWD) under the "Parks and Wildlife Code, Subtitle C. Fur-bearing Animals." Excerpts from Chapter 71 appropriate to wildlife damage control follow:

71.001 Definitions
(8) "Take" means the act of snaring, trapping, shooting, killing, or capturing by any means and includes an attempt to take.

(9) "Carcass" means the body of a dead fur-bearing animal, with or without the hide attached.

(10) "Depredation" means the loss of or damage to agricultural crops, livestock, poultry, or personal property.

(11) "Pelt" means the untanned, green or dried hide or skin of a fur-bearing animal, whether or not the hide or skin is attached to the carcass.

71.0011 Application
This chapter applies to fur-bearing animals in each county except those populations on the state's list of endangered fish and wildlife.

71.002 Proclamations
(a) The commission by proclamation may regulate the taking, possession, propagation, transportation, exportation, importation, sale, and offering for sale of fur-bearing animals, pelts, and carcasses as the commission considers necessary to manage fur-bearing animals or to protect human health or property.

(b) A proclamation of the commission under this chapter may also provide for:
(1) . . . .
(2) . . . .
(3) the periods of time when it is lawful to take, possess, sell, purchase, or transport fur-bearing animals, pelts, and carcasses;
(4) catch and possession limits for fur-bearing animals and pelts; and
(5) the means, methods, and manner that are, and places in which it is, lawful to take or possess fur-bearing animals, pelts, or carcasses.

71.004 Prohibited Acts
(a) No person may take, sell, purchase, or possess a fur-bearing animal, pelt, or carcass in this state, except as provided by proclamation of the commission. This chapter does not prohibit a landowner or his agent from taking a fur-bearing animal causing depredation on that person's land. No person may possess a fur-bearing animal taken for depredation purposes except as authorized by proclamation of the commission.

Regulatory proclamations are issued yearly and information on current provisions should be obtained from game wardens or TPWD offices.

Management and Control of Beaver

Although the TPWD is responsible for managing beaver as furbearers, there are other agencies which may have specific interests and responsibilities at various times. These include the Texas Department of Health, which is responsible for dealing with potential or known health hazards caused by wild animals, and the USDA Soil Conservation Service (SCS), which is responsible for constructing and/or managing many water impoundments in Texas. The SCS often is forced to request beaver control when beaver cause damage by burrowing into dams or by blocking overflow structures and spillways. Information on designing spillways and structures to reduce beaver damage is available from SCS offices.

Federal, state, county and municipal agencies concerned with highway and road maintenance also may request beaver control to correct flooding, blocking of culverts and similar problems caused by beaver dams. The Texas Soil and Water Conservation Districts, Water Quality Board and Forest Service also have certain interests which may be affected by beaver. These agencies inform the public about health hazards or damage caused by beaver and other wildlife species.

Other than the TPWD, the Texas Rodent and Predatory Animal Control Service (TRPACS) is the state agency most heavily involved in beaver control. The TRPACS was established by state law and operates under a cooperative agreement between the USDA Animal and Plant Health Inspection Service, the Texas Agricultural Extension Service, and the Texas Animal Damage Control Association.

The primary responsibility of the TRPACS is to aid in preventing or controlling wildlife damage, particularly by carnivores, lagomorphs, rodents and birds. The TRPACS has cooperative agreements with and conducts damage control programs in approximately 140 of Texas' 254 counties. In addition, the TRPACS conducts educational programs throughout much of the state to aid landowners and others in correcting damage problems. However, the increasing beaver damage in Texas now demands more control than the TRPACS can provide. As a consequence, a major part of the control effort must be provided by people directly affected by beaver damage.

Their large population increases have caused Texas beaver to become a major pest species in many areas. Since trapping and relocating beaver from damage areas does not effectively reduce the damage problem, most beaver removed from damage sites are disposed of immediately.

Beaver management should be based upon an understanding of their population levels and dynamics, the expected level of the fur harvest, the vulnerability of beaver to excessive harvest, and their propensity to cause damage in some circumstances. There should be flexibility in harvest and control programs so that these factors can be integrated into management.

Further information on the benefits and control of beaver, nutria and muskrats can be supplied by the following agencies:

Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Texas Rodent and Predatory Animal Control Service
P.O. Box 9037
Guilbeau Station
San Antonio, Texas 78204

Texas Agricultural Extension Service
Room 111, Nagle Hall
Texas A&M University
College Station, Texas 77843-2258

Beaver Damage

Beaver damage varies in severity but is serious in many areas of eastern and central Texas.

Damage in urban areas includes the cutting or girdling of ornamental trees and shrubs and burrowing which undermines yards and walkways. Beaver dams may cause flooding of walks and roadways. Damage to shade trees and other ornamentals may be severe in parks, golf courses and greenbelts. Beaver often burrow into and destroy the styrofoam and other flotation materials used to support dock and boat houses.

In rural areas, beaver may dam drainage ditches and canals, plug drain pipes and construct dams on small streams. This frequently leads to flooding of roads, pastures, and crop and timber lands, and may cause extensive economic loss. Beaver often move into stock ponds where they burrow into the banks or dams and frequently cause washouts which destroy the dams and ponds. Beaver also may feed extensively on sorghum, corn, soybeans and other crops adjacent to streams and ponds.

Damming of streams sometimes increases the number of aquatic snakes, including the water snakes (*Natrix* spp.) and the poisonous cottonmouth *(Agkistrodon piscivorus)*.

Beaver ponds and flooded areas provide habitat for mosquitoes and may reduce the effectiveness of mosquito control efforts. This would have the greatest effect in urban communities, but also may be significant in rural areas.

The potential problem of the protozoan disease Giardiasis was described earlier.

Distinguishing Beaver, Nutria and Muskrat Damage

Since beaver damage can be confused with damage caused by nutria and muskrats, it is important to accurately identify the species involved. It may be necessary to secure the help of experienced people in doing so. Beaver and nutria damage can be quite similar, and may occur simultaneously at the same location. Both species burrow into pond banks and earthen dams and damage the styrofoam floats of docks and boat houses. Because large nutria can be the same size as small beaver, their burrow openings may be similar in size. However, typical beaver tracks are both different and larger than those of nutria, and are much larger than muskrat tracks (Fig. 3).

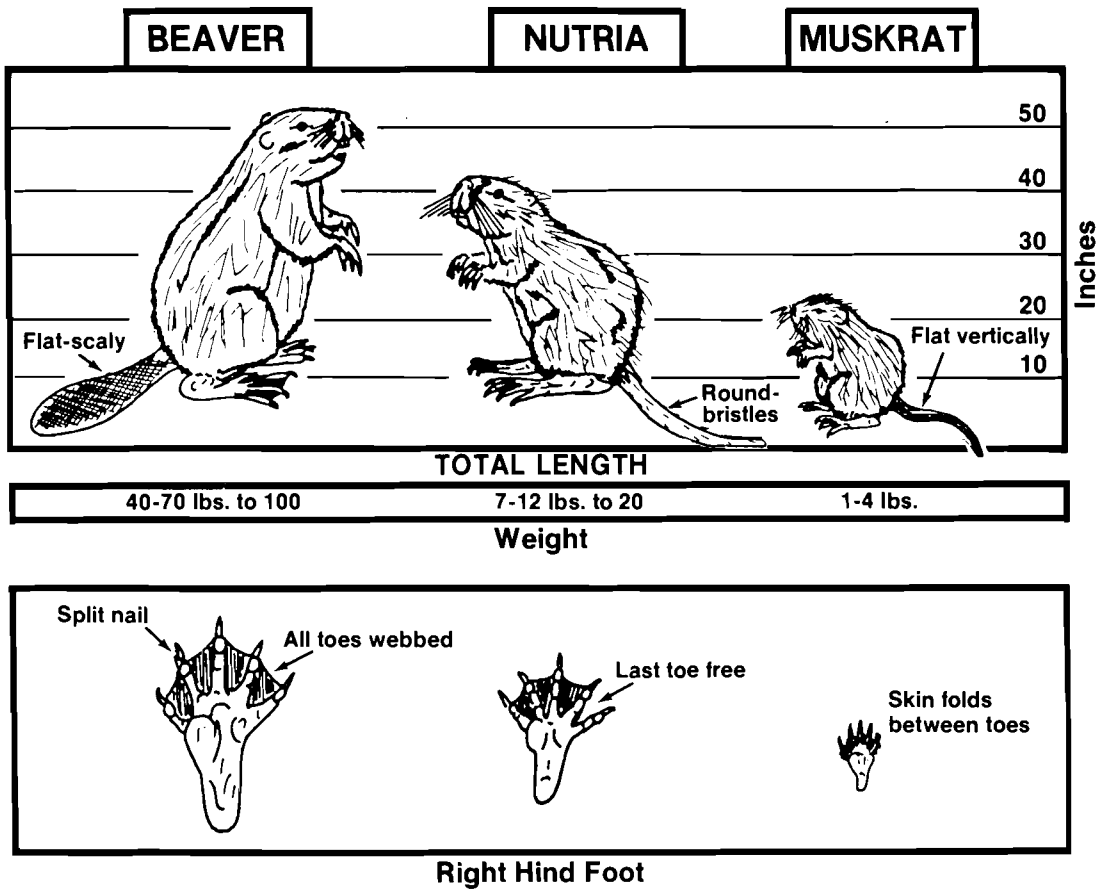


Figure 3. Comparison of beaver, nutria and muskrat

By sitting quietly near ponds in the early morning or at dusk, it is often possible to identify each of the species present as they move about. Brief descriptions of nutria and muskrats and their food habits, behavior and "signs" are included elsewhere in this publication to aid in identification.

Typical beaver damage includes the cutting or girdling of trees and shrubs and flooding caused by the dams they build. Beaver use mud, rocks, sticks, fence posts, tree limbs, corn stalks and other types of vegetation to build their dams. They also use these materials to plug drain pipes, irrigation gates and other structures in water impoundments. Beaver commonly dam across culverts, canals, ditches and bridges. However, beaver also live in the banks of large lakes and impoundments where their dams are not needed to maintain water levels. In these instances, it is necessary to observe the animals, their tracks or cuttings in order to identify them.

Nutria and muskrats do not construct dams, nor do they plug drainage pipes, ditches and canals. Also, beaver leave chips at their feeding areas, both on land and in water; nutria and muskrats do not. Since both beaver and nutria peel twigs with their incisors to feed on the inner bark, the width of tooth marks, droppings and other signs usually are helpful in determining which species is responsible.

Damage Prevention and Control

In addition to identifying the species causing damage, it is necessary to determine the degree of damage and compare this to the probable cost of control. Also, any benefits from the presence of beaver or other wild species should be considered. Examples include fur values, water storage in beaver ponds, and habitat for waterfowl and other animals. If ponds are created close to human residences, such benefits might be outweighed by the increased number of undesirable animal species such as mosquitoes and venomous snakes. If, after all these factors have been assessed, the decision to control the beaver population is made, there are several possible methods. Repellent and/or exclusion methods are sometimes successful; however, where beaver must be removed it is usually necessary to remove all of them in order to control damage effectively.

Exclusion

Individual trees or shrubs can be protected by fencing or wrapping them with hardware cloth. Ornamental plots, culverts, drains and small ponds can be fenced to exclude beaver by using netwire with small mesh. This approach may be feasible for homes, small parks and golf courses in suburban areas, but it is rarely practical where beaver damage is extensive. Also, damage may become so persistent, even in suburban areas, that beaver removal is necessary. Beaver also can be excluded by constructing concrete spillways and canal walls.

Cultural Methods

It may be necessary to control water levels even where beaver and their ponds are desirable. This can be done by installing three-log drains in beaver dams to limit water depth and flooding. Lowering of pond levels usually exposes mud flats which can be seeded to Japanese millet to improve habitat and food supplies for waterfowl, particularly ducks.

It is sometimes possible to alter the beaver habitat near fish ponds or other reservoirs to prevent beaver from moving in or to encourage them to move out. Clearing out trees and shrubs near ponds and planting crops no closer than 100 yards from streams or ponds usually will prevent beaver from moving in and may persuade them to leave. Eliminating food supplies and aquatic habitat are probably the only cultural methods that have significant effects on beaver.

It may be possible, particularly in marginal habitat, to persuade beaver to move out of an area by daily destroying their dams and removing sticks, limbs and other dam construction materials. However, this is often impossible or impractical and, if forced to move, beaver may be even more troublesome in the next location they choose. Also, if beaver are abundant they will continually reinvade suitable habitat.

The stocking of large alligators to control beaver populations has been attempted in several locations, but without notable success. Alligators have been present in southern beaver ponds for a number of years without controlling beaver. Moreover, alligators are a definite hazard to humans and other animals.

Chemical Methods

The use of chemicals in wildlife damage control is strongly government regulated. The Federal Insecticide, Fungicide, and Rodenticide Act, known as FIFRA, is the federal law which regulates all pesticide use. A pesticide is defined by law as any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. The act is administered and enforced by the Environmental Protection Agency (EPA).

Pesticides sold, offered for sale, distributed or delivered for transportation or transported within the state must be registered with the Texas Department of Agriculture and the EPA. Federal law requires EPA to classify each use of a pesticide as either "restricted" or "general," based on considerations of potential hazard to the applicator or other persons and the possibility of unreasonable adverse effect on the environment. A restricted-use pesticide may be used only by or under the direct supervision of a certified applicator. Most toxicants used in wildlife damage control are classified as "restricted."

The Texas Pesticide Control Act requires the certification of applicators and the Texas Department of Agriculture (TDA) is responsible for the certification.

Among federal and state requirements is the provision that use inconsistent with the label directions is a violation of the law and may subject the user to penalties.

Further information on pesticide use may be obtained from TDA and your county Extension agent.

Frightening Agents and Repellents. Beaver are wary of humans and will restrict their activities to nighttime hours if harassed, but rarely are attempts to frighten them effective in forcing them to move on, or in preventing damage.

Some chemicals have been reported to repel beaver, but none are registered by EPA and TDA for this purpose. Research may someday develop effective repellents.

Reproduction Inhibitors. Some chemicals have been shown to inhibit reproduction in captive beaver, but at present there is no way to get a chemical into wild beaver. Extensive research would be necessary to develop application methods and to have chemical reproduction inhibitors registered.

Toxicants and Fumigants. There has been some research to develop safe, effective and practical toxic baits and den fumigants. Fumigants sometimes kill beaver in burrows. Also, some baits are effective in killing captive beaver but have not been effective in field testing. To be effective, research must develop toxic baits which are: 1) relatively selective; 2) readily acceptable to beaver; and 3) easy to use. No fumigants or toxic baits are yet registered by the EPA or TDA for beaver control.

Shooting

Shooting can be an effective beaver control method where firearms can be used safely. When beaver dams are removed, the ponds are lowered and den entrances are exposed; beaver can then be flushed from bank dens and lodges by trained dogs and shot as they emerge. This method can be hazardous to dogs, however, because of the venomous snakes around beaver ponds. A more common method when few beaver are involved is to sit quietly in concealment and shoot beaver on ponds as they swim about during early morning and evening hours. Depending on the range, either a high-powered rifle or a shotgun with large shot should be used. Low power .22 caliber rimfire rifles and small birdshot in shotguns are not adequate for shooting beaver.

If night shooting is allowed, a spotlight (200,000 to 300,000 candle power) and shotgun can be highly effective under some conditions; however, a Texas Parks and Wildlife Department warden should be contacted for specific information prior to using this method. Red light, produced by using a red lens on the spotlight, frightens beaver less and permits more effective night hunting. A 12-gauge shotgun with large shot (BB or No. 4 buck) is probably the best choice for night shooting, but effective shotgun range is limited to about 50 yards even with large shot. Beaver become wary quite rapidly when hunted with firearms; therefore, this method may be only partially successful.

One must be extremely careful with firearms, particularly when shooting into or over water, because bullets or shot pellets can ricochet easily from the water surface and travel long distances. Extreme caution must be exercised to prevent danger to property, nontarget animals, livestock and humans when firearms are used. Also, any permits necessary should be secured before attempting to control beaver by shooting. The TPWD can provide information on specific regulations which govern control of depredating wildlife.

Trapping

There are a variety of traps effective for capturing beaver. These include the Hancock or Bailey "suitcase-type" livetraps, leghold and conibear-type traps, and wire cable snares. In many situations, trapping is the most effective, practical and environmentally safe method of control. The effectiveness of traps for beaver control depends on the trapper's knowledge of beaver habits, his ability to read beaver sign, the use of proper traps for each situation and correct trap placement. Nearly anyone with trapping experience and some outdoor knowledge can become an effective beaver trapper. In areas where beaver are common and have not been exposed to traps, trapping can be quite successful. Additional expertise and improved techniques can be attained through trapping experience.

Livetraps. Livetrapping of beaver is relatively easy if only a few are involved. However, if beaver are to be moved alive there must be acceptable release sites for them, and relatively few people now are interested in receiving such transplants. Beaver will not remain where they are released unless the habitat and water supply are suitable; otherwise they may simply move into areas where they are not wanted. Moving beaver into areas where populations already exist causes intense competition which also may cause them to move elsewhere. Without suitable habitat, transplanted beaver may have a poor survival rate.

There are other problems with livetrapping. Bailey and Hancock livetraps are quite expensive, cumbersome, bulky and hard to conceal. These traps have powerful springs which can injure people. Like other traps, they may be stolen or destroyed by people opposed to trapping. Thus, there should be strong local support of beaver control in order for livetrapping to be effective. Because of these factors, livetrapping and transplanting of beaver may not be a sound economic or biological method even though it is legal.

Leghold Traps. Steel leghold traps can be highly effective in catching beaver but their use requires knowledge and skill. In size and jawspread these traps should not be smaller than the equivalent of No. 4 longspring or coilspring traps and should be in good mechanical condition. Leghold traps should be used with a weight and slide lock wire or other mechanism to ensure rapid drowning of trapped beaver.

The placement of these traps is important. They usually are placed slightly under water at the water's edge, with the pan, jaws and springs covered lightly with leaves or mud and pressed gently into the mud. For this set, there must be a cavity under the pan so that when the beaver's foot hits the pan it will trip and allow the jaws to

close. Traps should be placed slightly off-center on the beaver trail or run to ensure catching them by the foot or leg. With some experience, beaver trappers learn to make sets that will catch beaver by the hind foot rather than the front, which is much smaller and easier to twist off or pull out. When leghold traps without drowning sets are used beaver may escape.

Trappers have developed several methods of making drowning sets with leghold traps. One of the simplest and most practical uses a slide wire attached to a stake on shore, with a heavy weight attached to the other end and placed in deep water. As an alternative, the wire can be staked to the bottom in water 3 feet deep or deeper. The other end of the wire is threaded through a hole in one end of a small piece of angle iron; the trap chain is attached to a hole in the other end of the angle iron. The upper end of the wire is then attached to a tree or stake driven into the bank and the trap is set in the slide or run.

When the beaver is caught in the trap it immediately dives back into deeper water. The angle iron lock slides down the wire and will not slide back up, thus preventing the beaver from coming up for air. If a beaver is not drowned, trappers should be prepared to dispatch it with a .22 caliber bullet as quickly as possible.

The leghold trap set in bank dens or feeding burrows is effective, especially for trapping young beaver. This set can be placed under water at the edge of the hole where the beaver first turns upward to enter the burrow.

The use of castoreum scent or freshly cut cottonwood, ash, willow or sweetgum limbs as bait may help attract beaver to leghold trap sets. Scent or bait is especially helpful around scent mounds and on slides down the bank or dam.

To increase trapping success, it is sometimes best to make several sets in slides and runs near dams and feeding areas. In some situations, the combined use of conibear-type traps, other traps and snares will shorten trapping time and more rapidly control beaver damage.

Conibear-type Traps. Although not all trappers will agree, the conibear-type trap (with 10-inch jaw spread) may be the most effective beaver trap in most situations. It was designed primarily for underwater use; in fact, the TPWD has specific restrictions on the use of such traps out of water. This is the trap most commonly used by professionals and fur trappers. The trap kills a beaver almost instantly and, when properly set, prevents escape regardless of the beaver's size. It is equally effective in deep and shallow water.

When setting this trap, some people employ a device called "setting tongs." Others use a piece of ⅜- or ½-inch diameter rope. Many people who use these traps extensively use only their hands, but regardless of the technique used, one must be extremely careful to avoid injury from the powerful springs.

Early models of this trap came with round, steel safety coils, which were dangerous unless properly used while setting and placing the trap. These coils are not necessary to safely set the trap. The two safety hooks, one on each spring, must be carefully positioned and held in place as each spring is compressed and during trap placement. On newer traps, an additional safety catch (not attached to the springs) is included for extra precaution against accidental spring release. Once the trap is in place, the last step before leaving a set is to lift the safety hook attached to each spring, then slide the hook back from the trap jaws and toward the spring eye while making sure to keep hands and feet safely away from the center of the trap. If the extra (unattached) safety catch is employed, it should be removed before removing those attached to the springs to prevent the extra catch from interfering with movement of the safety hooks.

The conibear trap is easiest to set while on solid ground. Once the springs are compressed and both safety hooks are in place, the trap can be safely carried to the set location for proper placement. Before the trap is placed, stakes must be selected to hold the trap in place. Suitable wooden stakes 1 to 2 inches in diameter can be found around most beaver ponds and dams. As beaver feed they leave many tree limbs in pieces 2 to 4 feet long. At least two strong stakes, preferably straight and without forks or snags, should be placed through the trap spring eyes and into the mud to anchor the trap. These stakes should be dry wood so that beaver won't cut them off for food. Additional stakes may be useful between the arms of each spring to help hold the trap in place. Do *not* place stakes on the outside of the spring arms since they will prevent the trap from closing properly. In addition to holding the trap in place, stakes also help to guide beaver into the trap. Stakes also are useful for holding "dive-sticks" at or just beneath the water surface. It is best for the chain and ring attached to one spring eye to be staked or attached with wire to another stake to avoid loss of the trap. Where traps are placed in deep water sets, the chains should be tied with wire to a solid object on shore or above the water surface to prevent trap loss.

A variety of sets can be made with conibear traps, such as dam sets, slide sets, lodge sets, bank den sets, run or trail sets, under-log/dive sets, pole sets, sets under the ice, deep water sets, drain pipe sets and others depending on the trapper's ingenuity and capability. In most ponds, beaver can be trapped with sets in dams, lodge or bank dens, runs, dives, or slides where beaver enter the water from feeding areas. Beaver swim mostly at the surface or along the bottom of a pond in runs. In shallow ponds, these runs are used for traveling from lodges or dens to the dam and feeding areas. The bottoms of these runs are good trap set locations.

To locate underwater dive holes and runs, it may be necessary to wade the pond. Choose a good stake or walking staff to help locate deep holes or runs, to prevent stepping into them and to ward off curious snakes. In older beaver ponds, particularly in bottomland swamps, it is common to find runs and lodges or den entrances scoured out 2 or 3 feet deep in the pond bottom.

Another effective trap location is the dam itself. Cutting out a vertical section of a beaver dam and lowering the water level will cause beaver to repair the break the following night. It is best to break the dam early in the day, allow the water level to drop and set traps in the

evening before beaver become active. If traps are set as soon as the dam is broken, they may be above the water level by evening or they may be tripped or blocked by debris flowing through the water.

The best trap sets at a broken dam are 12 to 18 inches in front of the dam in the moving water. Stakes and debris placed on both sides of the trap help to guide beaver into the trap jaws. It is best to set the trigger in the first notch of the trap dog to help prevent moving debris from tripping the trap. The trigger wires can be bent outward, or the trigger can be set to one side if necessary, to help reduce problems with debris or to assist in selective trapping for larger beaver. This also may prevent turtles from tripping traps.

Snares. Wire cable snares have not been extensively used in Texas but can be extremely useful in taking beaver. Snares are effective when set where beaver slides enter the water, at den entrances, in feeding areas, on land or water trails, and in water sites where beaver dive under logs or other obstructions.

NUTRIA

Nutria are native to South America and were successfully established in North America in the early 1930s as a new furbearing species. Many were released into Louisiana marshes. A hurricane in 1941 aided in scattering nutria through southwest Louisiana and southeast Texas. However, the greatest dispersal occurred in the late 1940s, when nutria were promoted for stocking "fur ranches" and as a quick and easy means of aquatic weed control. Neither of these concepts was accurate, but the nutria remained and many were released when "nutria ranching" failed. Today nutria are found over most of the eastern two-thirds of Texas (Fig. 4) and in many other states.

Description

Nutria are large, stocky, brown-furred rodents that resemble large rats. They are semiaquatic like beaver, but instead of broad, flat tails, nutria have long, round, scaly tails sparsely covered with bristles. Nutria have webs between the inner four toes of their hind feet, but not between the fourth and fifth (outer) toes. Their small, black, unwebbed front feet are much smaller than their hind feet. They have large front teeth which range from yellow to dark orange.

The average nutria is about 24 inches long, with about a 16-inch tail. Nutria do not reach full growth before they are 1½ to 2½ years old. A large male may weigh 25 pounds and a non-pregnant female about 18 pounds, but most adults weigh about 10 pounds.

Behavior

Nutria are relatively docile. They are not especially aggressive or wary and when disturbed usually try to escape rather than fight. But when captured or cornered their bites can cause serious injury.

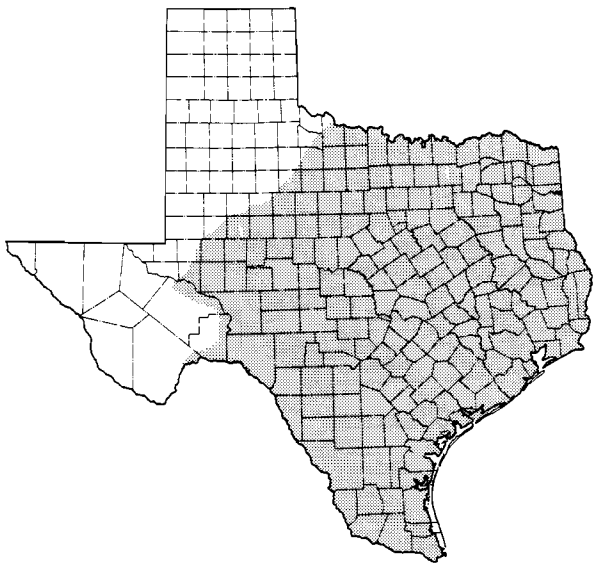


Figure 4. Nutria distribution, 1984.

Nutria scratch and groom themselves ritually. The forepaws are used for scratching and grooming and the free outer toes of the hind feet are used for combing themselves and cleaning their ears.

Nutria feed and are most active at night, but they also feed periodically during daylight hours, as prompted by hunger.

Reproduction

Nutria mature sexually at about 4 months of age where the food supply is good, but not until about 5 to 6 months of age where it is poor. However, most nutria do not breed until they are about 8 months old.

Under good conditions nutria have a high reproductive rate, and the female can produce two litters per year. Litter size varies from one to nine young; the average number is five. Resorptions of embryos and miscarriages are common, so only about half of all females successfully produce young during a given year.

Female nutria usually come in estrus every 24 to 26 days and stay in heat for 1 to 4 days. Estrus begins within a day or two after giving birth or after miscarriage. Males are fertile and capable of breeding throughout the year.

Courtship occurs just before the female is in estrus and is evidenced by chasing, playful fighting, wrestling, biting and calls made by both sexes. Once the female is in heat, courtship is discontinued and breeding is prompt.

Nutria do not mate for life. A female may breed with one or several males each time she comes in heat. Nutria will breed both in and out of the water.

Gestation and Litter Size

The gestation period is about 130 days. The young are born fully furred with their eyes open, and are able to swim shortly after birth. Newborn nutria weigh from 6 to 8 ounces.

The female's teats are high on the side, along the line where the dark back hair begins. This allows the young to nurse while both mother and young are in the water. Most young are weaned at about 5 weeks of age.

Habitat

Nutria prefer a semi-aquatic habitat in swamps and marshes and along the shores of rivers and lakes. When hiding in the water, a nutria often keeps only its nose, eyes and the upper part of its head out of the water. Nutria can float with little or no body motion and can stay well hidden under sparse vegetation.

The nutria appears slow and clumsy on land because its legs are scarcely long enough to keep its large body off the ground. But when frightened it can move quite rapidly. Nutria easily climb high, steep banks, root entanglements, gently sloping trees and wire fences.

Nutria often build platforms of vegetation for feeding, resting, nesting and hiding from danger or bad weather. Most platforms appear to result from piles of uneaten plant material at a favorite feeding site. These platforms occur wherever nutria live and feed.

During the summer nutria may make their homes on the ground in dense vegetation, but the rest of the year they use burrows. Burrows are commonly located wherever there is sloping ground such as banks and levees, spoil areas or rolling marshland. Burrows are most common along banks with dense vegetation and are rare in gently sloping banks without vegetation. Nutria often use burrows abandoned by armadillos *(Dasypus novemcinctus)*, muskrats or other nutria. In marshes, they may construct lodges of vegetation similar to but larger than those built by muskrats.

A burrow may house a single nutria or a family group of several generations. Burrows vary from simple, one entrance burrows with short tunnels to very complex units having several multi-level entrances, tunnels and living compartments. The tunnels normally extend from 4 to 6 feet into the bank, but some may be as long as 50 to 150 feet.

Nutria are found in agricultural areas primarily during the summer. They come in when the growing season starts and leave again after harvest. Although nutria travel an average maximum distance of about 3 miles, some have reportedly traveled 30 to 50 miles.

Food Habits

Nutria are almost exclusively vegetarians. Their dextrous forepaws enable them to locate food items, pick up handfuls of plants or grain, or handle a single grain of rice. They eat about 2½ to 3½ pounds of food per day. Feeding habits of nutria vary considerably. They feed while in the water, on floating objects or on land. They will graze on grass like cattle and clip upright plants like rabbits.

Nutria seem to prefer the soft, succulent parts near the bases of plants, especially when eating coarse plants such as cattail, cord grass and reeds. They also can live almost entirely on grasses such as bermudagrass, or soft water plants such as duckweed. In agricultural areas they eat the weeds and crops growing in planted fields. They will readily eat all root crops except white potatoes.

Legal Status

Nutria are classified as furbearing animals under Texas statute. (See p. 7 for the legal status of furbearers.) Regulatory proclamations are issued yearly and information on current provisions should be obtained from game wardens or TPWD offices.

Nutria Damage

As mentioned previously, nutria damage may resemble beaver damage in some instances. Burrows in pond banks, dams and boat dock flotation materials are examples. In other cases, nutria and muskrat damage may be similar despite the difference in the size of these species. For example, both nutria and muskrats graze on rice fields. Therefore, careful examination of burrows, tracks, droppings and other evidence may be necessary to identify the animals. In some instances, both species may be involved.

Nutria droppings are distinctly marked with deep, parallel grooves extending the length of the scat. Scats are cylindrical, approximately 2 inches long and ½ inch in diameter.

Nutria frequently feed on corn and other grains, vegetable crops, tree seedlings and ornamental shrubs. They also damage wood buildings, boat docks, road beds, earthern dams and other structures. However, their greatest damage is to sugarcane and rice fields in the Gulf Coast. In this area there are relatively high nutria populations and many waterways they can travel, such as bayous and canals.

Nutria cause more damage to sugarcane by gnawing on or cutting stalks during the summer growing season than by the amount they actually eat. In winter their damage is usually due to a scarcity of other food. Nutria feeding may destroy part or all of the crop. Nutria burrows may damage levees built to protect sugarcane from flooding. This can result in the loss of crops and the need for costly levee repairs.

Nutria grazing in rice fields disrupts plant growth, reduces grain yield and lowers crop quality. However, damage to levees may be the most serious loss. Burrows may affect control of water levels in rice and cause reduced yield or loss of the crop. Furthermore, breaks in levees are expensive to repair. In some places crayfish are grown in flooded fields, and loss of water caused by levee breaks can severely damage crayfish production.

(continued on p. 35)

Illustrated Field Guide

The following pictorial review illustrates the general biology and behavior of beaver, nutria and muskrats, as well as their habitat, the kinds of damage they cause and various damage control methods.

It is necessary to understand both the benefits of these species and the economic costs of their damage in order to make wise management decisions. Correct identification of the species also is essential for accurate assessment of damage and selection of appropriate control methods.

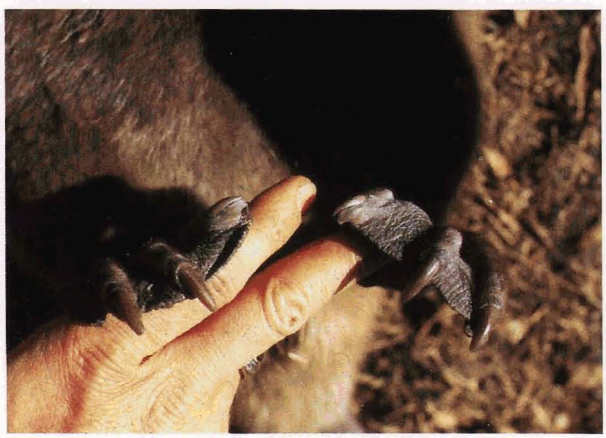
Photographs for the Field Guide were contributed by the following agencies and individuals:

Texas Agricultural Extension Service
Texas Rodent and Predatory Animal Control Service
Texas Parks and Wildlife Department
U.S. Fish and Wildlife Service

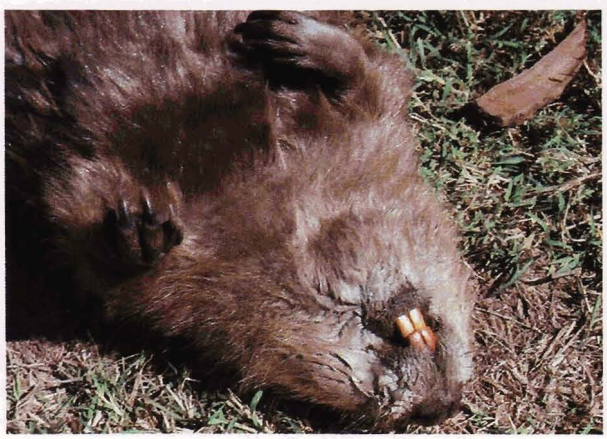
Kirk E. Gustad
Mark E. Mapston
James E. Miller
Bill Patterson
Randy M. Smith
Rick L. Sramek

Beaver are the largest native rodents in North America. Some weigh more than 100 pounds, although the average adult weighs from 40 to 60 pounds. Beaver are found throughout much of Texas.

Average adult beaver are 20 to 30 inches in length with a broad, paddle-shaped tail about 10 to 12 inches long. They are golden to dark brown in color with long, coarse guard hairs and a soft, dense undercoat of fur.



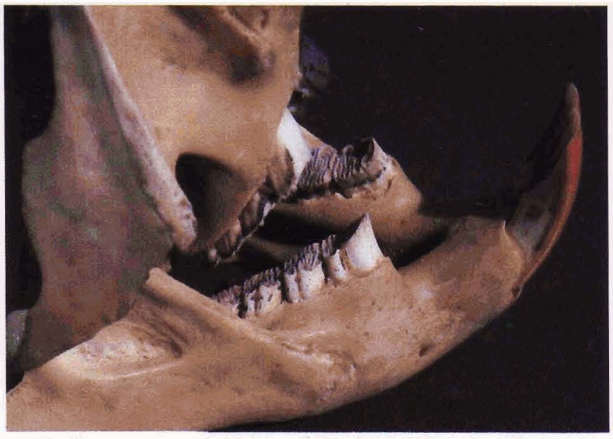
Beaver have large, fully-webbed hind feet with strong claws that provide good support in mud and propulsion for swimming.



Beaver have small, dextrous front feet with claws on each toe.

Beaver are highly adapted to aquatic life. Their eyes are near the tops of their skulls to allow good vision when swimming, and their ears and nostrils have valves that close when under water.

Beaver have large, paired, chisel-shaped incisors (front teeth) which grow throughout life. They are kept sharp and efficient by daily use in cutting wood and bark.



Beaver grind their food with four large molar teeth on either side of the upper and lower jaws.

Beaver have a single ventral opening, the cloaca, to the intestinal, urinary and reproductive tracts.

The paired castor and oil glands also empty into the cloaca. The oil glands are behind the lateral to the cloaca. The castor glands are in front of and lateral to the cloaca. The penis of the male beaver is between the castor glands.

Female beaver have four teats and mammary glands in back of the front legs. These are visible late in gestation and during lactation.

Beaver fetuses are miniatures of the adults. Normally there are three or four young in a litter.

Beaver require water impoundments to meet their biological needs, and, when necessary, are adept at building dams like this one to ensure a constant water supply.

In addition to the primary dam, several secondary dams may be built to maintain water levels. These beaver ponds often improve habitat and reduce soil erosion.

Beaver also construct canals to provide safe travel routes and aid in transporting tree limbs for food and building material.

In shallow water, beaver dig underwater trenches called "runs" which allow them to swim in safety under the surface.

Normally, beaver utilize trees and other vegetation close to their ponds whenever possible.

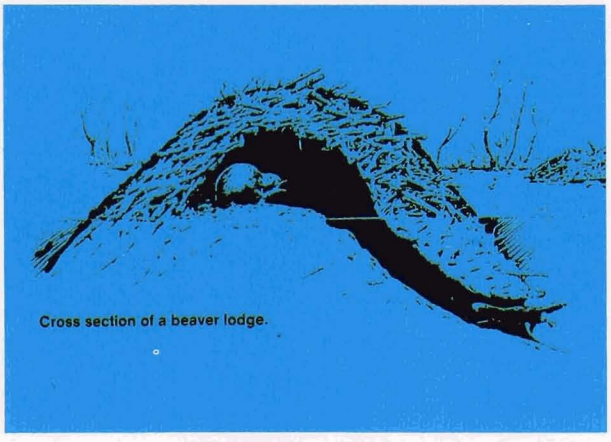
When beaver must travel on land to secure their food, they establish trails that show extensive use.

Beaver trails are especially evident where the animals enter and leave the water. These entry points are called "slides."

Beaver may live in bank dens if streams or lakes provide a permanent water supply.

In many areas, particularly in northern states, beaver construct lodges of sticks and mud for living quarters. These may be along the shoreline as shown here.

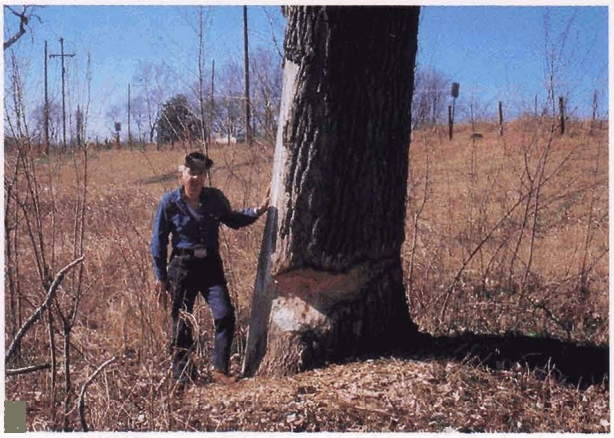
Beaver lodges often are some distance from the shoreline and surrounded by open water.



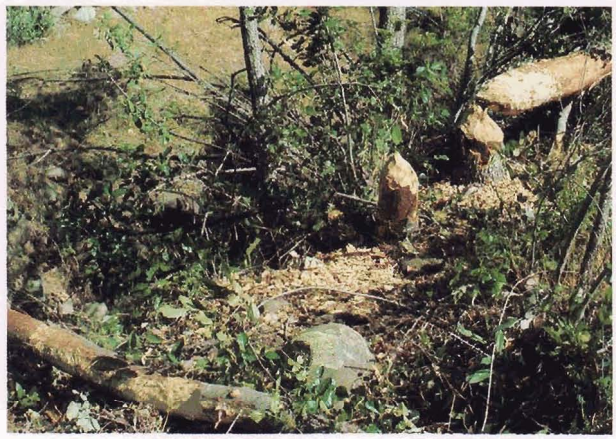
All beaver dams and lodges have underwater entrances and interior chambers above the water level.

Interior chambers are several feet across and up to 3 feet high inside.

Beaver fell trees to feed on the inner layers of bark. They generally prefer small trees but may fell trees up to 2 feet in diameter.



In many cases, beaver girdle large trees and cause them to die.



Beaver leave many wood chips and teeth marks when cutting trees and feeding on land.

They also leave many chips and peeled limbs in the water.

Beaver cut these grapevines for food and to use in building a dam.

Beaver mark their territories by depositing scent on small mounds of mud and vegetation along the shoreline.

As a consequence of low fur prices and other factors, beaver harvests have declined and their populations have increased and spread, often causing significant damage.

Beaver Damage

This timber was flooded and killed by a beaver pond.

This cropland was flooded by a beaver pond.

Pastures often are flooded by beaver ponds.

A bridge opening, dammed by beaver, caused flooding of the roadway.

Roadway flooding often occurs near beaver ponds.

These beaver tunnels are in a man-made dam built to impound water. Such tunnels commonly cause failure of dams, loss of water and costly repairs.

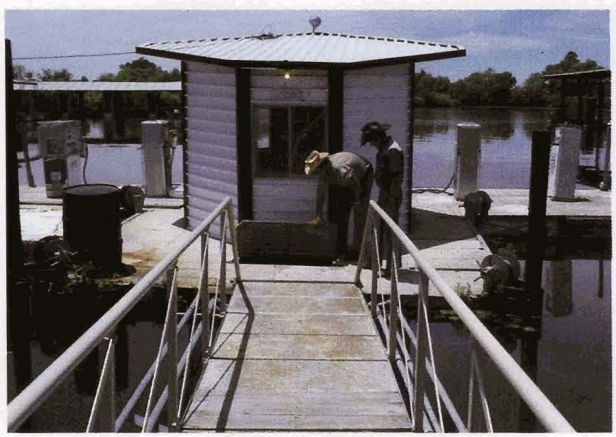
Beaver often plug overflow tubes in water impoundments, causing washouts and flooding.

Beaver interfered with crop irrigation by plugging this headgate with sticks and mud.

Beaver frequently cut fruit and shade trees and ornamental shrubs in urban and rural areas. This is a pear tree killed by beaver.

Beaver tunnels under walkways and houses, as shown here, can cause major structural damage if the tunnels collapse.

This type of beaver damage to styrofoam and wood supports under boat houses and docks is a frequent reason for complaints from marinas.

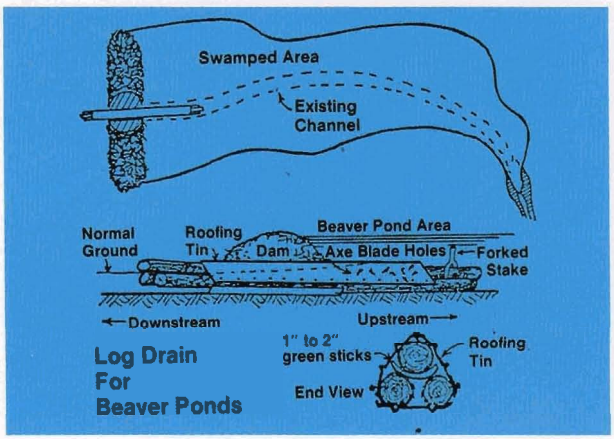


Damage to the flotation supports cause the houses and docks to tilt or sink; repairs are quite expensive.

Beaver ponds provide habitat for many aquatic and semi-aquatic animals. Some of them, like this cottonmouth, may not be desirable, particularly in urban areas. Snakes also present a significant hazard to beaver trappers.

Beaver can be carriers of an intestinal parasite, *Giardia lamblia*, which causes illness in people. Contamination of water supplies with this parasite, through improper sewage disposal, could become a signficant problem in Texas as it has in some other states.

Drains for Beaver Ponds



Flooding by beaver ponds sometimes can be controlled by installing drains in the dams. This is the typical arrangement for a "3-log drain."

Plastic pipe drains have been used successfully to control water levels in some beaver ponds.

Beaver Damage Control

If ponds can be drained entirely by tube systems, beaver can be forced to move away. If total removal is necessary, draining of ponds permits effective use of other control methods.

Although stocking of alligators has been suggested for beaver control, trials have not been highly successful. Also, alligators present a hazard to people and other animals.

When small plots are subject to beaver damage, trees and shrubs can be wrapped with wire mesh to protect them.

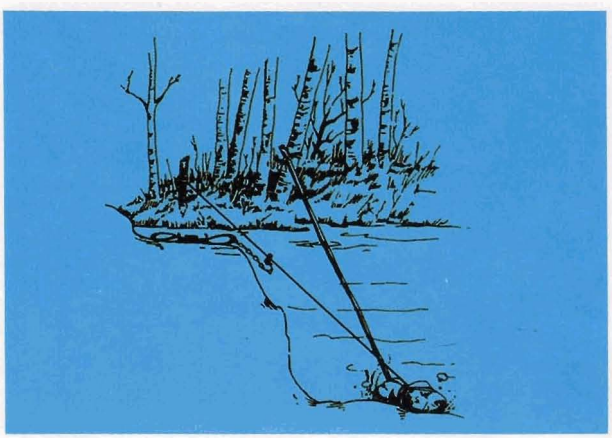
In some instances, small-mesh netwire fencing can be used to protect ornamental plots, gardens, culverts and drains.

Beaver Damage Control: Trapping

Beaver can be captured with cage type livetraps, as shown here, for release in other locations.

However, this is appropriate only where more beaver are desired and acceptable release sites are available.

In addition to livetraps, beaver can be captured with leghold or body-gripping conibear-type traps.



Leghold traps should be staked with a long chain and weight or with the chain attached to a slide wire so that beaver can go to deep water and drown rapidly.

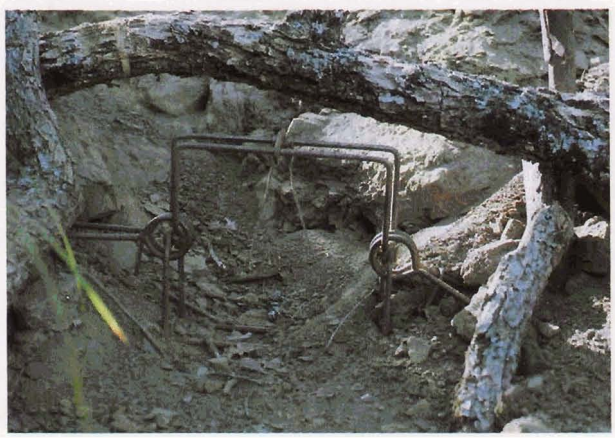
The angled slide wire lock holds the chain at the bottom of the pond.

Leghold traps can be set under the water surface at slides as shown here. For beaver, Number 4 size traps are better than smaller traps.

Fresh green twigs can be used to attract beaver over leghold traps. This is a "bait stick" set with the trap under the water surface.

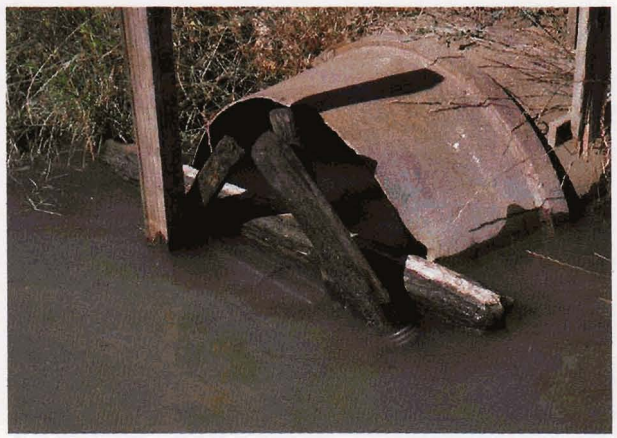
"Scent mound" sets also are effective on beaver. A small amount of beaver castoreum is placed on a mound of mud and vegetation at the edge of the pond to attract beaver over the trap.

Because of their powerful springs, body-gripping conibear-type traps can cause severe injuries to people and pets. They must be used with extreme caution.



While conibear traps are effective in land sets, as shown here, they are hazardous and may not be legal. In many states, including Texas, their use in land sets is restricted or prohibited by law.

Conibear traps can be set in beaver slides in underwater runs and at breaks in beaver dams. The "dive stick" above the trap guides beaver through the trap frame.



Conibear traps are especially effective where beaver travel through culverts and in shallow runs.

If necessary, beaver dams can be broken and conibear traps set in front of the break to capture beaver after the water level drops.

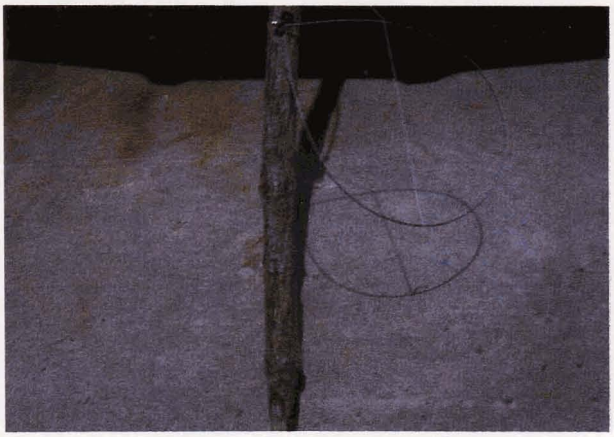
The setting of traps after the dam is broken should be delayed so that debris does not interfere with the traps.

Beaver Damage Control: Snaring

Trappers working in deep water often wear chest-high waders. Caution must be exercised to avoid drowning accidents which can occur when waders fill with water. Also, hypothermia is a potential hazard under these conditions.

Wire cable snares are less commonly used than traps, but can be quite effective in capturing beaver when set in a beaver trail to a feeding area.

This snare is set in a water trail between ponds used by beaver.



Snares also can be attached to dry wood stakes for placement in burrow entrances. The cable should be anchored solidly on shore with wire or chain.

Beaver Damage Control: Shooting

Where it is legal and safe, shooting in early morning and late evening with a high-powered rifle or a 12-gauge shotgun can be effective in removing beaver. To be successful, the hunter should be concealed or remain quiet and motionless.

Beaver can be effectively hunted at night with the use of a red light, which does not seem to alarm them. Spotlights of 200,000 to 300,000 candlepower with red lenses are available at many hardware and sporting goods stores.

A 12-gauge shotgun with large shot (Number 4 buck or BB shot) is recommended. The effective range of the shot usually is less than 50 yards.

Beaver furs can be a valuable resource. They should be salvaged during the fur season when they have value.

Nutria are semi-aquatic rodents that were introduced into the United States from South America. Many escaped from fur farms or were deliberately released and they are now present in many states.

Adult nutria normally weigh about 10 to 12 pounds, although some may reach 25 pounds or more. They have round, sparsely haired tails.

The forepaws are small and the hind feet are partially webbed.

The mammary glands are high on the sides of female nutria, in constrast to our native rodents.

Nutria commonly live in single burrows in stream banks and on land.

In some instances, small groups of nutria live in communal burrows with multiple entrances.

Nutria Damage

Nutria damage may be confused with that caused by beaver and muskrats. They may feed on bark from small trees as beaver do or in rice and other crops like muskrats. This photo shows typical nutria damage to rice.

When nutria leave ponds to feed, they trample grass and other crops and often cause substantial damage.

The most serious nutria damage occurs when their burrows cause breaks in dikes and, as a consequence, flooding and loss of water.

Nutria, like beaver, also burrow into styrofoam flotation blocks in marinas.

Nutria Damage Control

If possible and practical, burning crop residues in the fall can help reduce habitat for nutria and concentrate them in smaller areas to make control more effective.

Keeping dams and levees in good condition also helps prevent nutria damage by reducing habitat and eliminating burrows available to nutria.

Nutria can be captured with baited livetraps set in feeding areas and at burrows. However, their release in other locations is not desirable.

Leghold traps in sizes 3 or 4 can be set under the water surface, as shown here, where nutria enter and leave the water. They should be set so that nutria drown quickly.

Conibear traps (size No. 330 or No. 220) set in burrow openings are highly effective for capturing nutria.

Wire cable snares set in burrow openings or in land trails, as shown here, also are effective.

Nutria can be hunted, like beaver, at night with the aid of a red light. They also can be hunted during early morning and late evening hours. The shotgun and shot should be similar to those used for beaver.

Under certain conditions toxic baits can be used in nutria control. Baiting rafts are commonly used for prebaiting and placing the toxic bait. This procedure must conform to all laws and regulations which govern the use of pesticides.

Muskrat Biology

Muskrats are much smaller than beaver, are golden to dark brown in color, and weigh about 2 to 4 pounds. Muskrats are common in East Texas and along rivers in West Texas.

Muskrats have laterally-flattened, nearly hairless tails and partially webbed hind feet.

Muskrats often live in bank burrows.

In marshy areas and in northern states many muskrats use vegetation to construct lodges. An indication of muskrat numbers can be gained from the number of lodges present.

Muskrat Damage

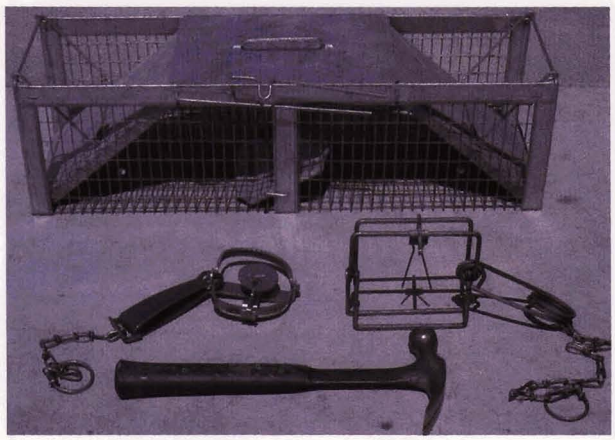
Muskrats may cut and damage crops as in this rice field.

However, the most serious damage occurs when their burrows destroy levees and dikes. This may result in loss of water needed for rice, crayfish and catfish production, and require costly repairs.

It may be necessary to install concrete aprons around headgates and tubes to prevent muskrats from burrowing next to them.

Some control of muskrats can be accomplished by burning the straw after crops are harvested to limit their habitat.

Where only a few muskrats are present, it is possible to control them by shooting them with a rifle or shotgun as they swim about.



The most common method of muskrat control is trapping with cage-type, leghold or conibear-type traps.

Small cage traps can be set at underwater burrow entrances. However, these are bulky and not highly efficient.

Leghold traps in sizes 0 to 1½ are effective when set under the water surface at burrow entrances and on trails at the water's edge.

A conibear-type trap is probably the best choice for trapping muskrats. These should be set in burrow entrances, usually just under the water surface.

During the fur season, muskrat populations usually are concentrated. Trapping efficiency and fur harvesting are increased under these conditions.

Nutria Damage Control

Except for man, nutria have very few natural enemies. In the Gulf Coast area, domestic and wild dogs and cats are the main predators. Others include the same carnivores which attack beaver. However, carnivores probably do little to control nutria populations. Drought and cold weather probably cause the greatest losses of nutria. Nutria are not well adapted to cold and may starve or freeze during severe winters, even in Central Texas. At times, diseases appear to affect nutria populations, although the causes are not well known. Roundworms *(Strongyloides myopotami)* and blood flukes may be significant causes of mortality. Fur trappers on the Gulf Coast occasionally report a rash called "nutria itch" (caused by the blood flukes) which results from handling nutria.

Farming practices such as draining fields and ponds, building gentle slopes on levees and dams and reducing cover can limit nutria habitat. Still, it is often necessary to control nutria.

Cage-type livetraps and leghold traps can be used to capture nutria, but are less efficient than conibear-type traps. Conibear traps set in burrow entrances and underwater runs are highly effective. Conibear-type traps used for beaver (No. 330 or equivalent), or the next smaller size (No. 220 or equivalent), are the best traps for nutria control.

Wire cable snares also can be used to capture nutria in the same type of sets used for beaver; however, they are not commonly used in nutria control.

Where hunting nutria is legal, shooting them during morning and evening hours, or at night with a spotlight, can be useful. Nutria may become wary if hunted extensively and shooting may not be completely effective. Laws and regulations should be checked prior to hunting.

Toxic baits, if registered and legal for use, can be effective for rapid reduction of populations. It is necessary to prebait sites with untreated bait to establish adequate feeding patterns before using toxic baits. Legality of toxic baits should be determined prior to use. (See Chemical Methods, p. 10.) State game wardens, county Extension agents and professional damage control personnel can provide information on laws, regulations and the use of toxic baits. There are other sources of information on baiting and other control methods (Evans 1970, 1983 and Kuhn 1974).

MUSKRATS

Muskrats are furbearers native to much of North America. They also have been introduced into some areas where they were not native, including parts of California and other states. In Texas, they appear to be most common in marshy areas of the Eastern Gulf Coast, in East Texas, along the Red River into the Panhandle, along the Pecos River, and in the Rio Grande above Big Bend National Park. They are not found in most of central and west Texas (Fig. 5) because of the lack of suitable wetlands.

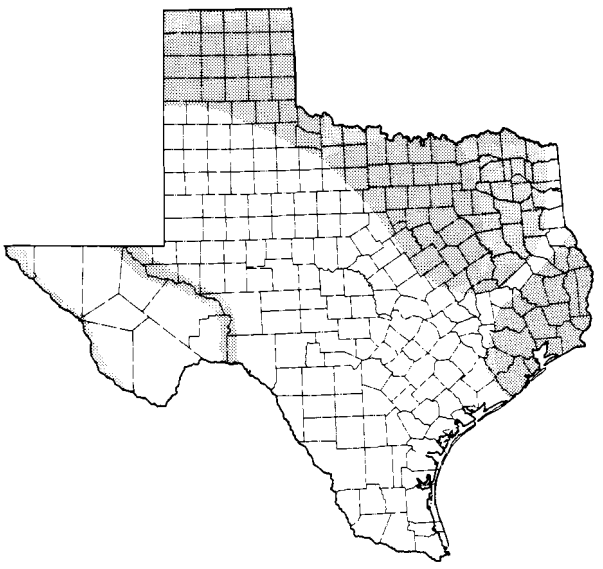


Figure 5. Muskrat distribution, 1984.

Description

The name "muskrat" refers to the strong, musky odor of secretions from the animals' rectal scent glands and to their rat-like appearance. They are stocky, robust, semi-aquatic rodents that resemble beaver but are much smaller. The average weight of adults is about 2½ pounds although some reach 4 pounds. The body, including the tail, is 20 to 25 inches long. The tail is 9 to 11 inches long, laterally flattened, scaly and nearly naked. The forepaws are small and the hind feet are partially webbed. The eyes and ears are small. Muskrats have dense underfur protected by long guard hairs and vary from golden brown to nearly black on the back and head. Their bellies are light brown or silver gray. Occasionally, albino and black muskrats occur.

Reproduction

Muskrats normally mature at about 8 to 10 months of age and some may breed during the first year. They have a high reproduction rate and a short gestation period of 28 to 30 days. Three or four litters can be produced annually under good conditions. Litters average five to eight young with a range of one to thirteen; however, neonatal mortality reduces the number of young which are weaned and on their own at about 4 weeks of age.

Historically, muskrats have provided one of the most valuable fur resources in North America, including the southeastern United States. However, like various other wild species, their populations can vary substantially be-

cause of habitat change, weather and other factors. Populations may reach extremely high levels and then drop precipitously as a consequence of drouth, starvation and/or diseases.

Legal Status

Muskrats are legally classified as furbearing animals under Texas statute. (See p. 7 for the legal status of furbearers.) Regulatory proclamations are issued yearly and information on current provisions should be obtained from game wardens or TPWD offices. The TPWD can provide specific information on provisions of the code and other regulations.

Muskrat Damage

Muskrats are not a major problem in Texas, but they can cause significant damage if high population levels exist. Most muskrat damage occurs where dams and levees are required for agricultural operations such as catfish and crayfish farming or rice production. Muskrat burrows in levees frequently cause washouts or loss of water. The subsequent loss of crops and rebuilding of dams and levees can be extremely costly. Muskrats sometimes cut crops but this is not usually a major loss.

Muskrat burrows are much smaller than those made by nutria and beaver; normally they are only 6 to 8 inches in diameter. Muskrat tracks and droppings are different and much smaller than those of nutria and beaver.

Muskrat Damage Control

Some carnivores, including raptors, prey extensively on muskrats. Great horned owls and mink are probably the most common of these. Other carnivores take muskrats as the opportunity comes, but usually do not limit their populations.

Muskrats may best be controlled by trapping them for their furs. Where this is not feasible, or when damage occurs outside the fur season, other approaches may be necessary.

Some control can be achieved by altering their habitat. This might including draining small ponds and cutting vegetation near waterways and rice fields. However, since vegetation is essential to preventing soil erosion this method should be used with caution. Draining rice fields and burning the straw can help to concentrate muskrat populations in small areas. This normally is done during the fall and coincides with the onset of the fur harvest season. As a consequence, trapping efforts can be much more efficient and productive.

To control small muskrat populations, such as those in farm ponds, shooting during early morning and evening hours may be effective. However, caution is always essential in the use of firearms for this purpose.

Trapping is the most common and effective method of muskrat control. Small cage or "stove pipe" live traps and sizes No. 1 or 1½ leghold traps can be used, but the small conibear-type trap (Size No. 110 or equivalent) is probably the most useful. Conibear-type traps set in burrow entrances and runways used by muskrats are highly effective. However, much time and effort are required to reduce high muskrat populations by trapping.

Toxic baits, if registered and legal for use, can be effective in population control, but extended application may be necessary to significantly reduce muskrat numbers. The legality of toxic baits should be determined before they are used (see Chemical Methods, p. 10).

Further information on muskrat control can be found in the following references: California Department of Agriculture (1958); Clark (1975); Miller (1972, 1974, 1983); and Wade (1978).

MAKING WILDLIFE CONTROL DECISIONS

In managing land and wildlife resources, it is important to recognize that the abundance and diversity of wildlife are indicators of a healthy environment. However, the presence of abundant wildlife may, in some circumstances, cause problems for individuals or groups which outweigh the benefits of wildlife to them. Beaver flooding timber, geese grazing winter pastures, squirrels chewing electrical wires, and robins roosting in frontyard trees are examples of significant wildlife damage situations. Though the species are desirable, their damage is not.

Objectives of wildlife damage control include the protection of: human health and safety; livestock and crops; urban and industrial facilities; rangelands and forests; and wildlife. Since no environmental changes can be made in isolation, mitigating wildlife damage requires a balancing of the positive and negative impacts from each course of action.

Management of wildlife in all situations, including damage control, requires knowledge of ecological principles and integration of the impacts of various activities on the land. There are no quick fixes. The particular circumstances of a situation must guide the selection of control methods.

REFERENCES

Beaver

Almand, J. D. 1966. *Beaver Control,* Circular 565, Cooperative Extension Service, University of Georgia, Athens, 4 pp.

Arner, D. H. and J. H. Dubose. 1978. The economic impact of increased forest and farmland beaver damage in Mississippi, Water Resources Institute, Mississippi State University, 41 pp.

Arner, D. H. and J. S. Dubose. 1979. The impact of the beaver on the environment and economics in the southeastern United States, *Proceedings: Fourteenth International Wildlife Congress,* pp. 241–247.

Baccus, J. T. 1971. The mammals of Baylor County, Texas, Texas Journal of Science 22 (2–3): 177–185.

Bailey, V. 1905. Biological survey of Texas, North American Fauna 25: 1–222.

Baker, R. H. 1956. Remarks on the former distribution of animals in Eastern Texas, Texas Journal of Science 8 (3): 356–359.

Belovsky, G. E. 1984. Summer diet optimization by beaver, The American Midland Naturalist 111 (2): 209–222.

Brown, M. K. Two old beaver from the Adirondacks, New York Fish and Game Journal 22 (1).

Buech, R. R. 1983. Modification of the Bailey livetrap for beaver, Wildlife Society Bulletin 11 (1): 66–68.

Buech, R. R. 1984. Ontogeny and diurnal cycle of fecal reingestation in the North American beaver *(Castor canadensis).* Journal of Mammalogy 65 (2): 347–350.

Buech, R. R. 1985. Beaver in water impoundments: understanding a problem of water-level management. In: *Water Impoundments for Wildlife: A Habitat Management Workshop,* General Technical Report NC-100, USDA-Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota, pp. 95–105.

Bullock, J. F. and D. H. Arner. 1985. Beaver damage to nonimpounded timber in Mississippi, Southern Journal of Applied Forestry 9 (3): 137–140.

Burt, W. H. and R. P. Grossenheider. 1964. *A Field Guide to the Mammals,* Houghton Mifflin Co., Boston, 284 pp.

Byford, J. L. 1974. *Beaver in Tennessee: Control, Utilization and Management,* Publication 687, Agricultural Extension Service, University of Tennessee, Knoxville, 15 pp.

Calahane, V. H. 1961. *Mammals of North America,* The MacMillan Co., New York, pp: 452–462.

Cleland, R. G. 1950. *This Reckless Breed of Men: The Trappers and Fur Traders of the Southwest,* Alfred A. Knopf, Publisher, New York, 361 pp.

Couch, L. K. 1942. *Trapping and Transplanting Live Beaver,* Conservation Bulletin 30, U.S. Department of the Interior, Fish & Wildlife Service, Washington, D.C. 20 pp.

Davis, W. B. 1940. Critical notes on Texas beaver, Journal of Mammalogy 21: 84–86.

Davis, W. B. 1974. *The Mammals of Texas,* Bulletin 41, Texas Parks & Wildlife Department, Austin, pp. 189–190.

Denney, R. N. 1952. *A Summary of North American Beaver Management 1946–1948,* Current Report No. 28, Colorado Game & Fish Department, Denver, 58 pp.

Forbus, K. and F. Allen. 1981. Southern Beaver Control, Georgia Forest Research Paper No. 23, 10 pp.

Grasse, J. E. and E. F. Putnam. 1955. *Beaver Management and Ecology in Wyoming,* Bulletin No. 6, Second Edition, Wyoming Game & Fish Commission, Cheyenne, 75 pp.

Hall, E. R. 1981. *The Mammals of North America,* Volume II, Second Edition, John Wiley and Sons, New York, pp. 601–605.

Hay, K. G. and W. H. Rutherford. 1956. *A Guide to Beaver Trapping and Pelting,* Technical Bulletin No. 3, Department of Game & Fish, Denver, Colorado, 21 pp.

Henry, D. B. and T. A. Bookhout. 1969. Productivity of beavers in Northeastern Ohio, Journal of Wildlife Management 33 (4): 927–932.

Hill, E. P. 1974. *Trapping Beaver and Processing Their Fur,* Cooperative Wildlife Research Unit, Auburn University, Auburn, Alabama, 11 pp.

Hill, E. P. 1976. Control methods for nuisance beaver in the Southeastern United States, *Proceedings: Seventh Vertebrate Pest Control Conference*, Monterey, California, University of California, Davis, pp. 85–98.

Hill, E. P. 1982. Beaver, In: *Wild Mammals of North America*, J. A. Chapman and G. A. Feldhamer (Editors), Johns Hopkins University Press, Baltimore, Chapter 14, pp. 256–281.

Ingle-Sidorowiez, H. M. 1982. Beaver increase in Ontario: result of changing environment, Mammalia 46 (2):167–175.

Kennelly, J. J. 1983. Evaluation of induced sterility for beaver *(Castor canadensis)* management problems, *Proceedings: First Eastern Wildlife Damage Control Conference*, Cornell University, Ithaca, New York, pp. 169–175.

Larson, J. S. and F. C. Van Nostrand. 1968. An evaluation of beaver aging techniques, Journal of Wildlife Management 32 (1): 99–103.

Leege, T. A. 1968. Natural movements of beaver in southeastern Idaho, Journal of Wildlife Management 32 (4): 973–976.

Loven, J. E. 1986. Reported beaver damage and control methods used in Texas. *Proceedings: Great Plains Wildlife Damage Control Workshop* 7:145–151.

Lyons, P. J. 1975. Productivity and population structure of western Massachusetts beaver, *Transactions: N.E. Section, Wildlife Society* 36:176–187.

McCarley, H. 1959. The mammals of Eastern Texas, Texas Journal of Science 11 (4):385–426.

Miller, J. E. 1971. *Beaver: Friend or Foe?*, Circular 539, Agricultural Extension Service, University of Arkansas, Little Rock, 15 pp.

Miller, J. E. 1983. Control of beaver damage, *Proceedings, First Eastern Wildlife Damage Control Conference*, Cornell University, Ithaca, New York, pp. 177–183.

Miller, J. E. 1983. Beavers, In: *Prevention and Control of Wildlife Damage*, R. M. Timm (Editor), Cooperative Extension Service, University of Nebraska, Lincoln, pp. B-1 to B-11.

Muller-Schwarze, D. and S. Heckman. 1980. The social role of scent marking in beaver *(Castor canadensis)*, Journal of Chemical Ecology 6 (1):81–95.

Novak, M. 1977. Determining the average size and composition of beaver families, Journal of Wildlife Management 41 (4): 751–754.

Owen, C. N., Adams, D. L. and Wigley, T. B. 1984. Inefficacy of a deer repellent on beavers, Wildlife Society Bulletin 12:405–408.

Parsons, G. R. 1975. Effects of a 4-year closure of the trapping season for beaver in eastern Warren County, New York, New York Fish and Game Journal 22 (1): 57–61.

Parsons, G. and M. Brown. 1978. Effect of a four-year closure of trapping season for beaver in Fulton County, New York, New York Fish and Game Journal 25 (1):23–30.

Payne, N. F. 1980. Trapline management of Newfoundland beaver, Wildlife Society Bulletin 8 (2):110–117.

Payne, N. F. 1984. Reproductive rates of beaver in Newfoundland, Journal of Wildlife Management 48 (3): 912–917.

Roblee, K. J. 1983. A wire mesh culvert for use in controlling water levels at nuisance beaver sites, *Proceedings: First Eastern Wildlife Damage Control Conference*, Cornell University, Ithaca, New York, pp. 167–168.

Roberts, T. H. and Arner, D. H. 1984. Food habits of beaver in East-Central Mississippi, Journal of Wildlife Management 48 (4):1414–1419.

Rutherford, W. H. 1964. *The Beaver in Colorado*, Technical Publication No. 17, Colorado Game, Fish and Parks Department, Denver, 49 pp.

Schmidly, D. J. 1984. *The Furbearers of Texas*, Texas Parks and Wildlife Dept., Austin, Texas, Bulletin No. 111, 55 pp.

Schwille, E. M. 1986. Beaver problems associated with conservation activities. *Proceedings: Great Plains Wildlife Damage Control Workshop* 7:49–51.

Soulen, G. H. 1942. Food habits of Texas beaver as related to the state restoration program, MS thesis, Agricultural and Mechanical College of Texas, College Station, 88 pp.

Stains, H. J. 1979. Primeness in North American furbearers, Wildlife Society Bulletin 7 (2):120–124.

Svendsen, G. E. 1980. Patterns of scent-mounding in a population of beaver *(Castor canadensis)*, Journal of Chemical Ecology 6 (1):133–148.

U.S. Fish & Wildlife Service. 1985. *Paiute Cutthroat Trout Recovery Plan,* Endangered Species Technical Bulletin, 10 (7): 5–6.

von Oettingen, S. L. 1982. A survey of beaver in central Massachusetts for *Giardia lamblia,* M.S. thesis, University of Massachusetts, Amherst, 58 pp.

Walro, J. M. and G. E. Svendsen. 1982. Castor sacs and anal glands of the North American beaver *(Castor canadensis),* Journal of Chemical Ecology 8 (5): 809–819.

Weaver, K. M., D. H. Arner, C. Mason and J. J. Hartley. 1985. A guide to using snares in beaver capture, Southern Journal of Applied Forestry (3): 141–146.

Weber, D. J. 1971. *The Taos Trappers: The Fur Trade in the Far Southwest, 1540–1846,* University of Oklahoma Press, Norman, 263 pp.

Wigley, T. B. Jr. 1981. A model of beaver damage and control, Ph.D. Dissertation, Mississippi State University, Mississippi State, 141 pp.

Wigley, T. B., T. H. Roberts and D. H. Arner. 1983. Reproductive characteristics of beaver in Mississippi, Journal of Wildlife Management 47 (4): 1172–1177.

Wire, F. B. and A. B. Hatch. 1943. Administration of beaver in the western United States, Journal of Wildlife Management 7 (1): 81–92.

Woodward, D. K. 1983. Beaver management in the Southeastern United States: review and update, *Proceedings: First Eastern Wildlife Damage Control Conference,* Cornell University, Ithaca, New York, pp. 163–165.

Diseases

Ament, M. E. 1972. Diagnosis and treatment of giardiasis, Journal of Pediatrics 80 (4) Part I: 633–637.

Beach, R. and W. F. McCulloch. 1986. Incidence of significance of *Giardia lamblia* (Lambl) in Texas beaver populations. *Proceedings: Great Plains Wildlife Damage Control Workshop* 7: 152–164.

California State Department of Health. 1977. A Manual for the Control of Communicable Diseases in California, California State Department of Health, Sacramento, pp. 176–178, 460–462.

Center for Disease Control. 1980. Waterborne Giardiasis—California, Colorado, Oregon, Pennsylvania, Morbidity and Mortality Weekly Report 29 (11): 121–123.

Center for Disease Control. 1983. Outbreak of diarrheal illness associated with a natural disaster—Utah, Morbidity and Mortality Weekly Report 32 (50): 662–664.

Craun, G. F. 1979. Waterborne giardiasis in the United States: A review, American Journal of Public Health 69 (8): 817–819.

Elliott, S., E. G. Long, A. L. Truant and J. H. Smith. 1981. Parasitic infections encountered on the Texas Gulf Coast, Texas Medicine 77: 45–46.

Frost, F., B. Plan and B. Liechty. 1980. *Giardia* prevalence in commercially trapped mammals, Journal of Environmental Health 42 (5): 245–249.

Meyer, E. A. and E. L. Jarroll. 1980. Reviews and commentary: giardiasis, American Journal of Epidemiology 111 (1): 1–12.

U.S. Department of Health and Human Services. 1983. Water-Related Disease Outbreaks Surveillance, *Annual Summary 1982,* Center for Disease Control, Atlanta, Georgia, 7 pp.

von Oettingen, S. L. 1982. A survey of beaver in central Massachusetts for *Giardia lamblia,* M.S. Thesis, University of Massachusetts, Amherst, 58 pp.

Nutria

Adams, W. H. 1956. The nutria in coastal Louisiana. *Proceedings: Louisiana Academy of Science* 19: 28–41.

Ashbrook, F. G. 1948. Nutrias grow in the United States, Journal of Wildlife Management 12 (1): 87–95.

Atwood, E. L. 1950. Life history studies of nutria, or coypu, in coastal Louisiana, Journal of Wildlife Management 14 (3): 249–265.

Brown, L. N. 1975. Ecological relationships and breeding biology of the nutria, *(Myocastor coypu)* in the Tampa, Florida, area, Journal of Mammalogy 56(4): 928–930.

Daspit, A. P. 1947. Development of nutria in few years since its introduction in Louisiana has been virtually phenomenal, Louisiana Game, Fur and Fish 6 (1): 4.

Evans, J. 1970. *About Nutria and Their Control,* Resource Publication No. 86, Bureau of Sport Fisheries and Wildlife, U.S. Department of the Interior, Denver, Colorado, 65 pp.

Evans, J. 1983. Nutria, In: *Prevention and Control of Wildlife Damage,* R. M. Timm, Editor, Cooperative Extension Service, University of Nebraska, Lincoln, pp. B-61 to B-70.

Gosling, L. M. 1981. The effect of cold weather on success in trapping feral coypus *(Myocastor coypu)*, Journal of Applied Ecology 18 (2): 467–470.

Hale, J. B. 1950. Nutria versus muskrat. Wisconsin Conservation Bulletin (April): 15–16.

Harris, V. T. 1956. The nutria as a wild fur mammal in Louisiana. *Transactions: North American Wildlife Conference* 21:474–485.

Hoffmeister, D. F. 1958. The future status of the nutria, fur-bearing rodent in Illinois, *Transactions: Illinois State Academy of Science* 51 (3–4): 48–50.

Kuhn, L. W. and E. P. Peloquin. 1974. Oregon's nutria problem, *Proceedings: Sixth Vertebrate Pest Conference,* Anaheim, California, University of California, Davis, pp. 101–105.

Kyle, G. 1958. The nutria needs hunting, Alabama Conservation 30 (3): 8–9, 22.

LaVoie, G. F. and F. Schitosky, Jr. 1973. Nutria damage to sugar cane—a 5-year appraisal, Sugar Bulletin, October: 13–14.

Ramsey, C. W. 1975. Nutria *(Myocastor coypu)*, Fact Sheet L-1363, Texas Agricultural Extension Service, Texas A&M University, College Station, 2 pp.

Schitosky, F., Jr., J. Evans and G. K. LaVoie. 1972. Status and Control of nutria in California, *Proceedings: Fifth Vertebrate Pest Conference,* Fresno, California, University of California, Davis, pp. 15–17.

Simpson, T. R. and W. G. Swank. 1980. Trap avoidance by marked nutria: a problem in population estimation, *Proceedings: Annual Conference,* Southeast Association of Fish & Wildlife Agencies 33: 11–14.

Swank, W. G. and G. A. Petrides. 1954. Establishment and food habits of the nutria in Texas, Ecology 35: 172–176.

U.S. Fish & Wildlife Service. 1957. *Nutria in the United States,* U.S. Department of the Interior, Washington, D.C., Leaflet 389, 11 pp.

Willner, G. R., J. A. Chapman and D. Pursley. 1979. *Reproduction, Physiological Responses, Food Habits, and Abundance of Nutria on Maryland Marshes,* Wildlife Monograph No. 65, The Wildlife Society, Washington, D.C., 43 pp.

Wilson, E. D. and A. A. Dewees. 1962. Body weights, adrenal weights and oestrous cycles of nutria, Journal of Mammalogy 43 (3): 362–364.

Muskrats

Bellrose, F. C. and J. B. Low. 1943. The influence of flood and low water levels on the survival of muskrats, Journal of Wildlife Management 24:173–184.

Clark, D. O. (Editor). 1975. Muskrat: biology, legal status, control materials and directions for use, In: *Vertebrate Pest Control Handbook,* California Department of Food and Agriculture, Sacramento, pp. 516–1 to 516–3.

Clark, W. R., K. L. Johnson and R. T. Clay. 1984. Survival and Harvest Rates of Muskrats on Pool 9, Upper Mississippi River, Project Report, U.S. Fish & Wildlife Service, Winona, Minnesota, 19 pp.

Clay, R. T. 1983. Population Characteristics and Habitat of Muskrats on Pool-9 of the Upper Mississippi River, M.S. Thesis, Iowa State University, Ames, 73 pp.

Clay, R. T. and W. R. Clark. 1985. Demography of muskrats on the upper Mississippi River, Journal of Wildlife Management 49 (4): 883–890.

Craven, S. C. 1984. Unusual damage caused by muskrats, *Ondatra zibethica,* Canadian Field-Naturalist 98(1): 55–56.

Dorney, R. S. and A. J. Rusch. 1953. *Muskrat Growth and Litter Production,* Wisconsin Conservation Department, Technical Wildlife Bulletin No. 8, 32 pp.

Errington, P. L., R. J. Siglin and R. C. Clark. 1963. The decline of a muskrat population, Journal of Wildlife Management 25: 154–159.

Errington, P. L. 1963. *Muskrat Populations,* Iowa State University Press, Ames, 665 pp.

Lay, D. W. and T. O'Neil. 1942. Muskrats on the Texas Coast, Journal of Wildlife Management 6 (4): 301–311.

McCabe, T. R. 1983. Muskrat population levels and vegetation utilization: a basis for an index, Ph.D. Thesis, Utah State University, Logan, 110 pp.

Miller, J. E. 1972. Muskrat and beaver control, *Proceedings: National Extension Wildlife Workshop,* Estes Park, Colorado, Colorado State University, Fort Collins, pp. 35–37.

Miller, J. E. 1974. Muskrat control and damage prevention, *Proceedings: Sixth Vertebrate Pest Conference,* Anaheim, California, University of California, Davis, pp. 85–89.

Miller, J. E. 1983. Muskrats, In: *Prevention and Control of Wildlife Damage,* R. M. Timm (Editor), Cooperative Extension Service, University of Nebraska, Lincoln, pp. B-51 to B-59.

Neal, T. J. 1966. A comparison of two muskrat populations, Iowa State Journal of Science 43: 193–210.

Perry, H. R. 1982. Muskrats, In: *Wild Mammals of North America,* Baltimore, Maryland, J. A. Chapman and G. A. Feldhamer (Editors), Johns Hopkins University Press, pp. 282–325.

Proulx, G. and F. F. Gilbert. 1984. Estimating muskrat population trends by house counts, Journal of Wildlife Management 48 (3): pp 917–922.

Wade, D. A. 1978. Muskrats and Damage Control, Leaflet 21043, Cooperative Extension Service, University of California, Davis, 8 pp.

Appendix A

Table 1. Estimated Texas Fur Harvest by Species During the 1977–1984 Fur Seasons.

Species	Estimated number harvested [1,2]						
	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84
Raccoon	569,492	518,593	465,145	402,864	403,464	409,078	287,022
Opossum	200,285	238,437	401,340	261,087	184,960	175,934	118,687
Ringtail	128,758	132,751	90,420	69,145	76,747	63,039	44,642
Red Fox	—	10,342	6,955	7,226	6,849	5,532	4,511
Gray Fox	64,585	49,589	44,330	29,778	31,407	44,887	37,270
Bobcat	22,900	18,262	17,994	13,581	13,962	14,562	17,062
Coyote	94,482	91,258	105,797	64,989	60,356	60,122	42,029
Civet	1,449	4,389	5,105	3,399	2,312	2,416	2,751
Skunk	13,446	94,083	109,605	95,296	79,733	79,247	62,631
Badger	3,400	3,077	5,339	2,952	1,785	1,698	1,293
Nutria	29,795	21,645	17,973	34,586	21,836	51,080	21,179
Mink	3,480	3,036	2,459	4,330	2,754	4,599	3,906
Beaver	2,702	—	—	2,193	2,547	3,239	2,613
Otter	190	—	—	—	585	361	770
Muskrat	4,551	—	—	—	—	—	—
Swift Fox	959	—	—	—	—	308	—
Kit Fox	204	—	—	—	—	899	—
Total	**1,137,678**	**1,185,462**	**1,272,462**	**991,426**	**889,297**	**917,001**	**646,330**

[1] Estimates for 1977–78 were based on Fur Dealer's Monthly Reports, all other estimates are based on mail questionnaire surveys of trapper's license holders.

[2] Estimates represent statistical calculations of the most likely harvest; actual harvest levels may be as much as 30 percent above or below these values.

Source:
Special Reports: Texas Fur Harvest Summaries, 1981–82 and 1983–84 Fur Seasons, Texas Parks & Wildlife Department, Austin, Texas

Table 2. Average Fur Prices to Texas Trappers (1977–84).

Species	Average price						
	1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84
Raccoon	$16.00	$25.50	$20.00	$11.00	$14.40	$13.50	$12.25
Opossum	1.75	2.50	2.50	1.50	1.25	.50	.50
Ringtail	7.50	7.50	5.75	7.25	8.00	3.25	2.50
Red Fox	40.00	45.00	45.00	17.00	35.00	27.00	28.50
Gray Fox	28.50	35.00	35.00	26.00	22.50	20.00	24.75
Bobcat	55.00	85.00	65.00	65.00	55.00	38.75	40.00
Coyote	20.00	22.50	15.75	19.50	13.00	13.25	6.00
Civet	12.00	2.50	2.50	4.25	3.00	2.00	2.00
Skunk	1.50	2.00	3.00	2.00	1.00	1.00	1.00
Badger	5.00	5.00	6.25	5.25	2.00	2.00	2.75
Nutria	6.50	7.25	8.75	8.75	4.00	1.75	1.25
Mink							
Male	12.00	14.00	14.00	12.00	16.00	11.00	9.50
Female	6.00	7.50	7.50	6.00	8.00	6.00	5.75
Beaver	7.00	9.00	7.50	5.75	2.50	3.50	4.00
Otter	28.00	40.00	40.00	28.00	25.00	17.00	9.00
Muskrat	5.50	6.25	7.25	7.25	3.00	—	2.50

Source:
Special Reports: Texas Fur Harvest Summaries, 1981–82 and 1983–84 Fur Seasons, Texas Parks & Wildlife Department, Austin, Texas

Table 3. Estimated Total Value of Fur Harvest to Texas Trappers (1977–82 fur seasons).

Species	Fur value ($) 1977–78	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84
Raccoon	10,387,536	16,530,152	11,628,625	4,431,504	5,850,228	5,522,554	3,516,019
Opossum	396,564	745,116	1,254,188	391,631	231,200	87,969	59,344
Ringtail	1,098,234	1,244,541	649,894	501,301	613,976	204,876	111,605
Fox (Red & Gray)	2,219,366	2,751,256	2,330,656	897,070	946,373	1,047,606	1,050,996
Bobcat	1,470,180	1,940,338	409,364	822,765	767,910	564,278	681,040
Coyote	2,210,880	2,566,631	2,082,878	1,267,286	784,628	796,616	252,174
Civet	20,681	13,716	41,711	14,446	6,936	4,832	5,502
Skunk	23,598	235,208	411,019	190,592	79,733	79,247	62,631
Badger	20,298	19,213	41,711	15,498	3,570	3,396	3,556
Nutria	230,434	196,158	—	302,627	87,344	89,390	26,474
Mink	26,539	40,796	33,042	38,970	33,048	39,092	29,295
Beaver	19,781	—	—	12,610	6,368	11,337	10,452
Otter	6,228	—	—	—	14,625	6,137	6,930
Total	**$18,160,099**	**$26,283,143**	**$18,883,088**	**$8,886,300**	**$9,425,939**	**$8,457,330**	**$5,816,018**

Source:
Special Reports: Texas Fur Harvest Summaries, 1981–82 and 1983–84 Fur Seasons, Texas Parks & Wildlife Department, Austin, Texas

Appendix B

BEAVER TRANSPLANTS

1939

Jasper County	4
Hardin County	6
Walker County	4
Newton County	3
Total	17

Source: Llano River

1940–41

Anderson County	9
Armstrong County	7
Baylor County	4
McCulloch County	6
Robertson County	9
Sterling County	5
Total	40

Source: 21 trapped in Panhandle; 19 trapped in Llano River.
(Foard County—4, Randall County —6. Source unknown)

1941–42

Calhoun County	4
Jackson County	5
Henderson County	4
Roberts County	6
Morris County	5
Polk County	4
Tyler County	5
Titus County	5
Total	38

Source: Llano River

1942–43

King County	6
Tyler County	1
Newton County	6
Total	13

Source: Unknown

1944–45

Travis County	8
Total	8

Source: Unknown
(Callahan and Coleman Counties—2. Source unknown)

1947–48

Bosque County	4
Ellis County	3
Shackelford County	3
Total	10

Source: Unknown

1948–49

Anderson County	5
Erath County	1
Shackelford County	9
Total	15

Source: Unknown

1949–50

Anderson County	8
Henderson County	8
Irion County	11
Leon County	1
Polk County	3
Tyler County	5
Total	36

Source: 24 from Louisiana; 5 from Wheeler County; 6 from Llano River; 1 from Leon County.

1950–51

Jasper County	11
Irion County	3
Total	14

Source: 11 from Alabama; 3 from source unknown.

1951–52

Menard County	2
Total	2

Source: Unknown

1952–53

Anderson County	4
Erath County	7
Total	11

Source: Randall County

1954–55

Bandera County	2
Kimble County	1
Total	3

Source: Llano River

1956–57

Kimble County	3
Total	3

Source: Kimble County

1957–58

Bosque County	5
Total	5

Source: 4 from Polk County; 1 from Randall County.

1958–59

Harris County	2
Kimble County	2
Total	4

Source: 2 from Red River County; 2 from Kimble County.

1960–61

Presidio County	6
Total	6

Source: Presidio County

1972–73

Newton County	4
Total	4

Source: Henderson County.

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