

101

# WHERE WATERS RUN BEAVERS

Paul Strong



**NORTHWORD**  
WILDLIFE SERIES

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NorthWord Press, Inc.  
5900 Green Oak Drive  
Minnetonka, MN 55343  
1-800-328-3895

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Book design by Amy J. Quamme

#### Library of Congress Cataloging-in-Publication Data

Strong, Paul I. V.

Beavers : where waters run / by Paul Strong.

p. cm.—(NorthWord wildlife series)

Includes bibliographical references.

ISBN 1-55971-580-4 (sc)

I. American beaver. I. Title. II. Series.

QL737.R632S78 1997

599.37—dc21

96-46824

Printed in Singapore



## Meet the Beaver

Like many people who spend a lot of time on rivers and lakes, I thought I knew a lot about beavers. After all, what was there to know? They build dams, construct lodges in which to spend the winter, and cut down trees to feed on the bark. Whenever they saw me in my canoe, they slapped their tails on the water to warn all of the other beavers nearby. Little did I know as a youngster growing up on a lake in central Maine that my path in life would cause me to learn far more about beavers than I ever thought imaginable and that I would learn many of these things in a place far more famous for rattlesnakes and cactus than for northern lights and moose.

I moved from Maine to north-central Oklahoma in search of a Master's degree in wildlife ecology figuring that I would conduct a field research study on a species typical of the Great Plains such as jackrabbits or prairie dogs. Instead, I wound up spending a year in Big Bend National Park, Texas, studying beavers that inhabited the Rio Grande on the Mexican border. Until that time, I wouldn't have guessed that beavers could be found south of the Mason-Dixon line, much less on a slow-moving, silt-laden river winding its way through the heart of the Chihuahuan Desert.

Since that time, I have had beavers on my mind as I have

lived and traveled through Maine and the Great Lakes states. And while I now think I know something about these creatures, I also realize that this intensively studied animal, by scientist, fur trapper, and nature observer alike, remains an alluring and mysterious work of Nature.

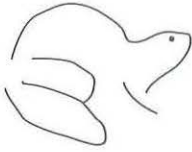
## T h e R a t ' s C o u s i n

The beaver is a rodent, which means it is closely related to rats, mice, and squirrels. Rodents in general are not held in high esteem. We trap and poison them to keep them away from our stores of food. They are carriers of diseases like the virus that caused the bubonic plague across Europe in the Middle Ages and the more recently discovered Hanta virus. They damage our homes, gnawing at wood and sometimes chewing through electrical wiring. Rodents make us think of small and furtive creatures that scurry across our floors in the night and keep us awake as they run across the ceiling or in the walls.

Although most rodents are small, they found an unfilled niche in some parts of the world which allowed a few species to evolve large body sizes and adapt to an aquatic way of life. The beaver is the second largest species of rodent in the world today exceeded only by the South American capybara, or water hog as it is known locally.

Beavers are truly enormous when viewed in context of their far more familiar and smaller cousin the mouse. While a mouse living comfortably in your attic may attain a weight of an ounce or two, an adult Canadian beaver may weigh as much as ninety pounds. Weights of beavers vary greatly across their North American range with smaller beavers living in the extreme southern areas.

Some of the largest beavers ever recorded were caught in Wisconsin, which is near the center of the beaver's range and provides some of its best habitat. In 1952, trappers working rivers and streams in southwestern Wisconsin brought in beavers weighing between eighty and eighty-seven pounds. The record for the



## A Place to Call Home

The only constants that can be used to describe beaver habitat are water and trees. Just about everything else varies a great deal, and even the kinds of water and trees can be quite different. This shouldn't be all that unexpected for a creature that inhabits areas from the Arctic Circle to the Gulf of Mexico and from the desert Southwest to the Maine north woods. The ability to survive across a range of environmental conditions is a testament to the flexibility of the habits of beavers and their advantage over other creatures in being able to modify their environment for their own good.

The heart of beaver range in North America is in the aspen dominated forests of the Great Lake states and southern Canada. There, they find their favorite foods and a myriad of lakes, rivers, streams, and other wetlands. In the headwaters area of the Mississippi River in north-central Minnesota, there exists an enormous complex of freshwater habitats of all kinds and sizes. It is not nearly as well known as the Everglades of Florida, but is equally impressive in its own right. In virtually every pond, lake, river, and stream, there is a family of beavers. This area probably holds one of the densest concentrations of beavers in the world.



Excellent habitat for beavers also exists in New England and parts of eastern Canada. High mountain streams of the Rocky Mountains are what come to mind when many people think of “classic” beaver habitat. While many beavers find the mile-high elevation to their liking, the steep, fast-running streams present a challenge to beavers trying to create a stable environment. Similar conditions along the Pacific Northwest coast limit the success of beavers, but they have figured out ways to survive there as well.

The central part of the eastern United States is good, but not excellent, habitat for beavers. There are a limited number of lakes, but a wealth of rivers and streams. The slow-moving, murky rivers and wetlands of the Southeast are surprisingly good



beaver habitat. Although it doesn't conjure up the romantic notion of mountain men trapping beaver in cold, clear streams, the Southeast has more than its share of beavers, particularly those which have adapted to the river life.

Perhaps the most surprising habitat exploited by beavers is the remote web of large rivers and their tributaries in the desert Southwest. A person on a raft trip through the Grand Canyon or floating a stretch of the Rio Grande in Big Bend National Park is in far better beaver habitat than they might think. While beavers occupying these large rivers generally don't build dams or lodges, they find a way to eke out a living in the cool floodplains where the adjacent desert may be only a few yards away.

Beavers were one of the keys to the exploration and settle-





ment of the North American wilderness, but they are not creatures that require solitude to survive. In fact, beavers and people live remarkably close together in many areas. Man-made ponds sometimes support a family or a transient beaver passing through, especially if they are connected to a stream or river system by a drainage ditch. Roadside ditches have become commonly used habitat for beavers unable to compete successfully for the prime habitats.

A stream flowing through a farmer's field in central Michigan may support a beaver family if there is a nearby woodlot or trees along the stream bank. A small lake in Ontario ringed with summer homes may also have a beaver colony with different designs on the trees planted and cared for in the lakeshore yards of the human residents. Irrigation ditches in Tennessee might suit a bachelor beaver just fine for a time while he is looking for a better place to start a home and family.

And often, what doesn't look like potential beaver habitat to us can look surprisingly good after a dam is built to raise the water level and after a series of canals are dug to reach the nearby trees. Leave it to the beavers to turn a low-rent district into high-priced real estate on the beaver market.

by the tail to the water while it held onto the branches. He reasoned that this accounted for why some beaver hunters took beavers that had hairless backs.

While this account is creative and amusing, a beaver actually works singly and grabs the butt end of a branch in its mouth and drags it to the side. Well worn paths between the water and the cutting area are evidence of the repeated dragging that takes place after a tree has been cut down. Some of these paths are used over the course of an entire ice-free season and may be worn a foot or deeper into the earth. On the Rio Grande, where there were often wide sandbars between the river and the forest, I watched for signs of drag marks at the water's edge and followed the marks back to the forest and into the trees. The beavers were sometimes dragging branches and small trees fifty or more yards from the interior forest to the edge, and then another one or two hundred feet across the widest sandbars, a testament to their powerful jaws, necks, and legs—and to their persistence.

All in all, Nature's lumberjack is an efficient, if not perfect, tree-feller. Unlike their human counterparts, however, they are feller, limber, skidder, and debarker all in one.

## D e n s   a n d   L o d g e s

More than any other animal, save humans, beavers are able to modify their environment to serve their own needs. Their ability to build complex structures, establish travel networks, and manipulate water levels is unparalleled.

Beavers live either in a den in the earth or in a lodge constructed of branches and mud. Lodges are preferred housing in all situations, but sometimes are not feasible to construct. Beavers living along large rivers which flood frequently or in areas where there are few trees live in bank dens.

Bank dens, or burrows as they are sometimes called, are constructed by digging into the bank with the forepaws and kicking dirt out with the back feet. Den entrances are underwater and the tunnel is dug at a slightly upward angle until it is above water



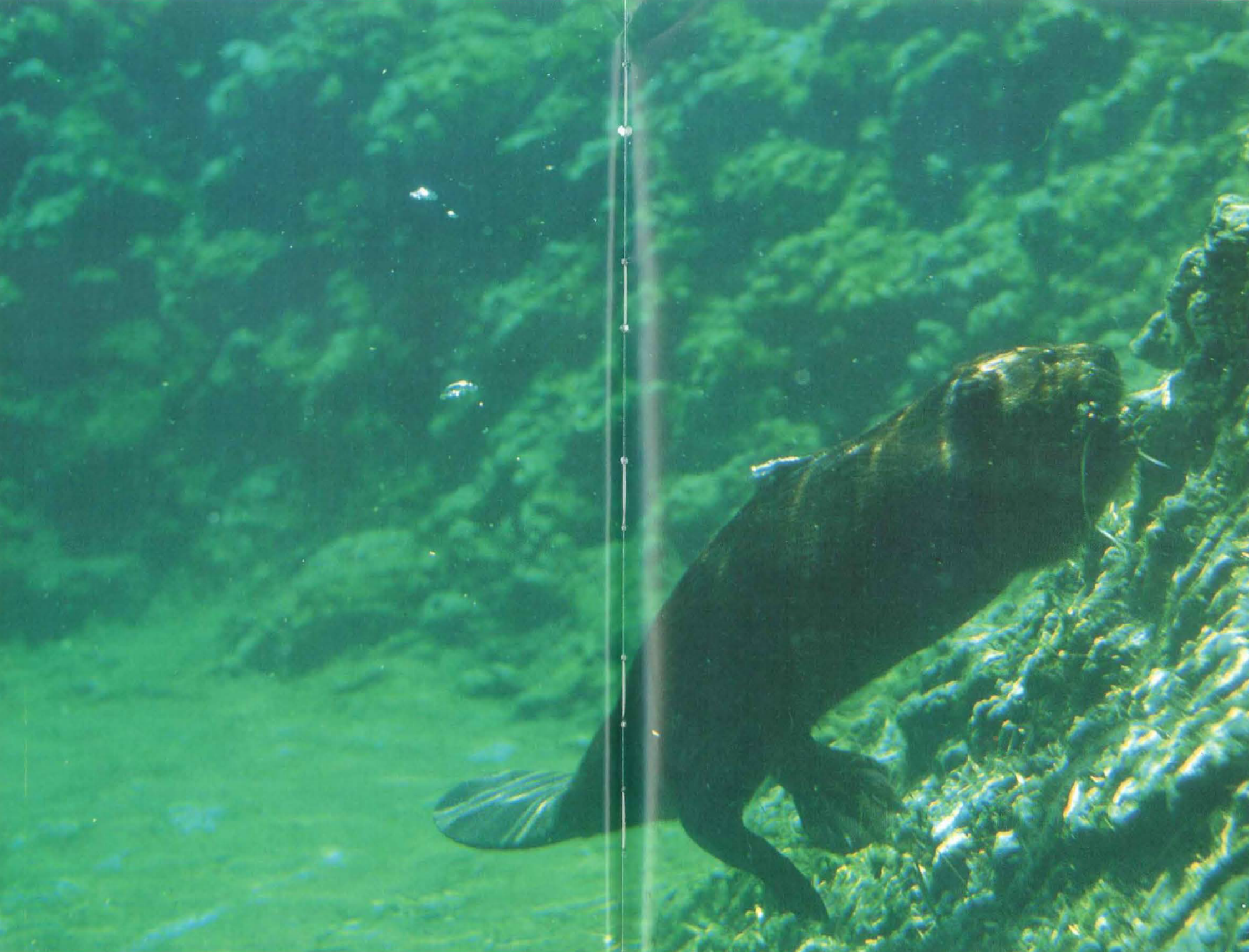
level. Then, a larger chamber is hollowed out of the bank. The chambers are sometimes associated with a tangle of tree roots which provide additional stability to the living quarters.

Burrows vary in length. I found some on the Rio Grande which were just six feet back into the bank. Others continue twenty or thirty feet into the bank before opening into the living chamber. The chambers also vary in size. Bank burrows built by bachelor beavers are small. Families living in bank burrows year-round sometimes construct several large chambers at the end of the same tunnel.

Beavers living in lodges usually have several bank dens in the colony. They get used as high water or low water refuges and also are places to hide away from the lodge. Their most creative use is as air pockets during the winter. Beavers swimming under the ice can lengthen their time away from the lodge by swimming to a bank den to get a fresh breath of air. Beavers also breathe from air

A beaver lodge can be six feet high and thirty feet across.

Next pages: Beavers collect mud from the bottom of the pond to put on the lodge.



pockets trapped under the ice. They also have been observed exhaling the air from their lungs, allowing it to rise to the ice in a bubble, and then reinhaling it—the bubble presumably containing new oxygen gained by passing through the water.

Lodges may be the final step on the evolutionary ladder of housing development for beavers. Watching the process of lodge building reveals that preliminary steps are identical to those of burrow excavation. The differences are that the tunnel is cut through the surface of the ground and that sticks and mud are added to the top.

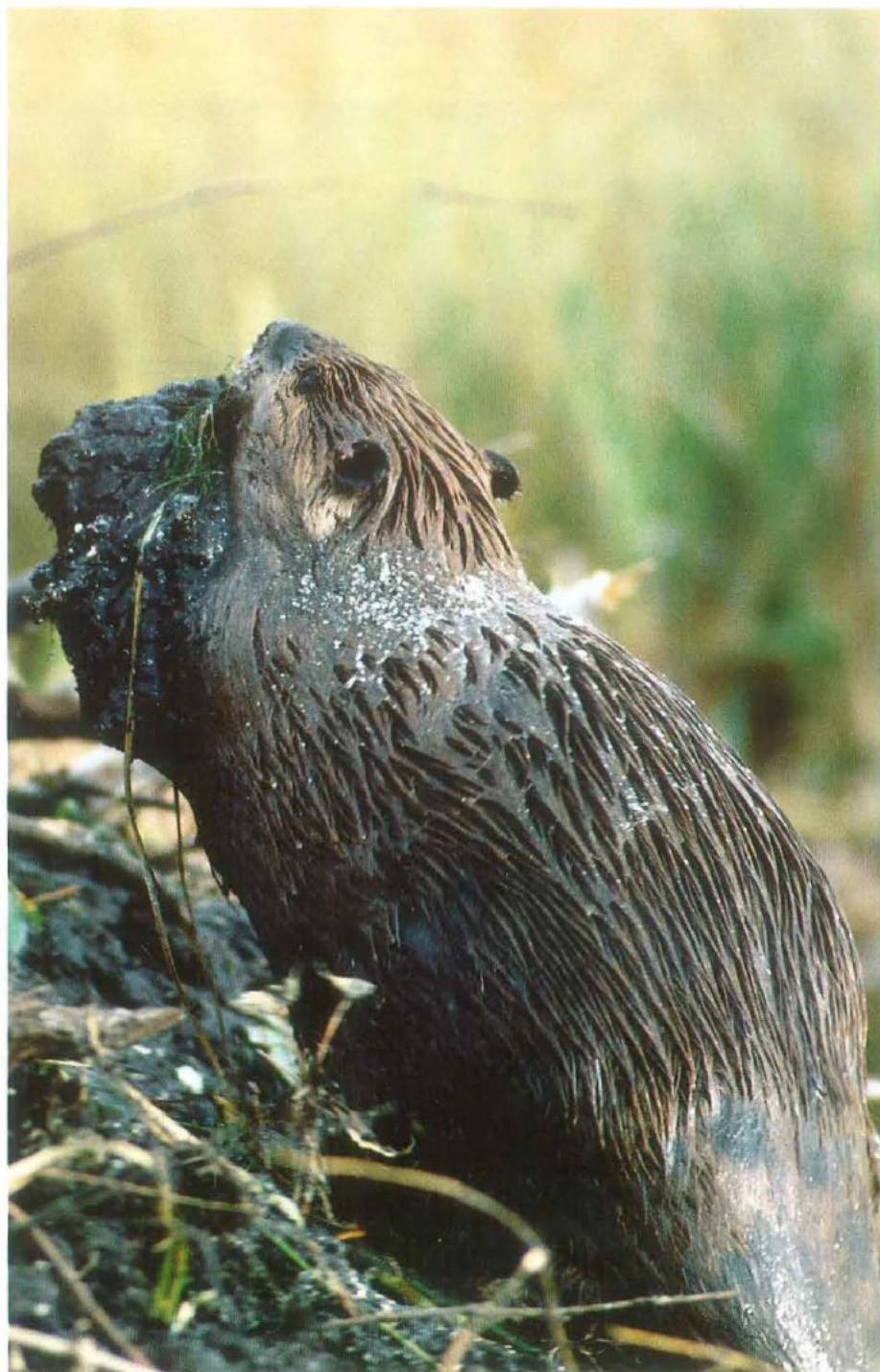
New lodge construction can occur at any time during the ice-free season as beavers establish new colonies. However, beavers in established colonies begin to build new lodges and maintain old lodges in the late summer and early fall.

Most colonies have several lodges in various degrees of repair. One is clearly the main lodge to be used in the winter, but all of them may receive a little home improvement now and then. New lodges are built to take advantage of a small movement in the activity center of the colony or to replace a damaged lodge or one that is no longer inhabitable.

Once a tunnel has been constructed and has broken through to the surface, the colony members start piling sticks on top of the hole. It has been commonly thought that beavers place the sticks in a manner that creates a chamber at the bottom. However, close observations reveal no such strategy. Instead, a beaver works from the tunnel and cuts away portions of branches to create the living space.

Mud is brought in through the tunnel and piled next to the escape hole to create a low feeding platform. This is the spot where beavers entering the lodge stop to dry their fur, feed on a branch, and groom. Most lodges also have a slightly higher level which is kept dry and is often carpeted with wood shavings. The beavers sleep on the upper levels. The inside chamber of a lodge can be up to five feet across and two feet high.

Once sticks are in place on the outside of the lodge, the colony members start plastering the outside with mud. They carry the mud up under their chins with their forepaws and walk upright on their legs up the side of the lodge. Mud is poked into



An armful of mud held against the chest is destined to be used to waterproof and insulate the lodge.

most nooks and crannies except for the top few feet. This small unplastered area serves as a vent and allows for air exchange in the lodge.

During winter, the mud freezes solid and provides adequate insulation so that the inside of the lodge is above freezing, heated exclusively by the body heat of the inhabitants. Spring and summer rains wash some of the mud off the lodges, which means steady employment for the colony every fall.

Adults do most of the work on the lodges although all age classes participate. Kits generally bring sticks to the lodge and don't carry mud. Females do a bit more lodge maintenance than males.

Single beavers also build lodges. Their lodges tend to be a little smaller, but you can't always judge the number of beavers in a lodge by its size. Nor can you judge the number of beavers in a colony by the number of lodges they maintain. Like people, some beaver families prefer more room than others.

Some of the largest beaver lodges have been found in the Great Lakes states and in eastern Canada. Heights above the water have exceeded ten feet and distances across the base have been forty to fifty feet.

There may be more than one entrance to a lodge and some lodges have more than one chamber. One well-known nature writer and photographer tried to swim into a beaver lodge by following an underwater tunnel. He got in around fifteen feet without reaching the living chamber and nearly got stuck as he tried to turn around.

Lodges found associated with the bank may appear to be islands. When a lodge is built on top of a bank tunnel, the colony may also be raising water levels with a dam. Sometimes, the rise in water level isolates the lodge from shore making it less vulnerable to potential predators. In other cases, beavers build lodges starting them away from shore. They push sticks into the mud and pile other sticks on top of them. Then, they cut out the chambers and the entrances from below.

Beaver homes range from the efficiency apartments found in bachelor beavers' bank burrows to high-rent penthouses which are the island lodges with multiple chambers. A colony usually





has several of each within their home range, alternating between them throughout the seasons and years.

## D a m s

While beavers have developed abilities as lumberjacks and architects, they are best when it comes to constructing elaborate water control projects. They build dams to raise water levels and then cut canals, make plunge holes, dig underwater aqueducts, and dredge channels into the bottom of ponds.



Damming the flow of moving water is the strongest instinct a beaver seems to have outside of eating and procreating. The sound of running water alone spurs a beaver to action. Beavers will dam anything from a spring to a fast-running stream. They are unable to harness the largest rivers, but are very creative in using mid-stream boulders and islands to anchor dams that span larger and faster flowing rivers than one might think possible.

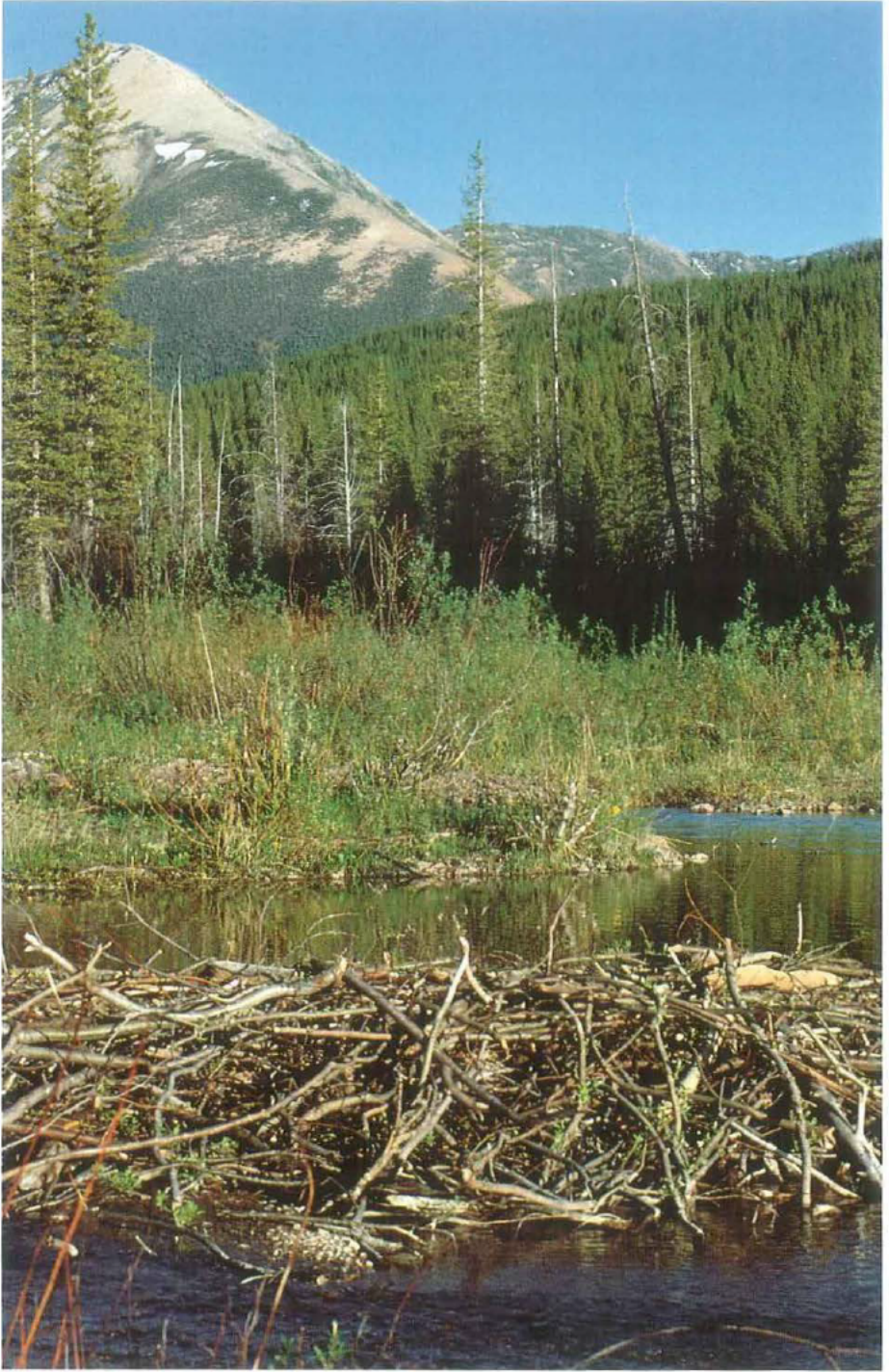
Beavers, like most people, seem to desire stability in their lives. The stability they seek the most is the water level of their colony site. Lakes and most ponds provide a stable water environment and beavers rarely construct dams on them. When they do, they usually pick a spot on the outlet stream.



Rivers and streams have fluctuating water levels and also have a limited amount of safe foraging habitat. Dams built on these water bodies raise the water level so that streamside vegetation is flooded and food is accessible without leaving the water. Stabilization of the water level allows a lodge to be built along the river bank where it would otherwise be washed away.

I have seen beaver dams all over North America and can attest to the fact that they will build a dam on every body of running water on which they are physically able to do so. Dams are noticeably absent only on large rivers and steep, fast-moving streams where spring snow melt produces raging torrents.

Even though the beavers I studied on the Rio Grande could



not get a dam across the main channel of the river, I discovered an area in Big Bend National Park next to the river where small springs created a marsh-like environment. The beavers occupying that stretch of river constructed a small dam across the area where the marsh drained into the big river. Their dam raised the water level in the marsh and allowed them to move safely to gather food.

While many people have seen beaver dams, few have observed beavers constructing or maintaining them. Beavers do most of their work at night and only dedicated researchers, trappers, and amateur naturalists have shown the patience to sit up after dark to watch Nature's engineer at work.

One of the first activities of a colony of beavers moving into a new area is to construct a dam. Most dam-building occurs in early spring and late summer, with a couple of months of intense activity in each season.

While human engineers carefully select sites for their dams so that costs are kept low, dam stability is high, and results are predictable, beavers seem to have a more haphazard approach. Some beaver dams appear to be in an ideal location while others are located in an area where they are difficult to construct and don't provide maximum benefit. In these cases, there often is a far better location nearby. Scientists believe that beavers learn through experience and that older beavers may make better selections than younger animals.

Beavers respond to both the sound and the feel of running water and often choose locations for dams that are close to places where the water is running fastest and making the most noise. On a number of trout streams I have fished in northern Wisconsin, I have found dams in places where the river had narrowed and was running noisily over exposed rocks.

Such exposed rocks may also provide a strong base for the dam. Dams are sometimes built in a curved or zig-zag fashion to take advantage of instream boulders and rocks.

Beavers typically start dam construction by pushing up a narrow ridge of mud and gravel all the way across the stream. If the current is so strong that this is impractical, they begin by anchoring sticks in the substrate. Beavers will often eat the



bark off small sticks before using them in the dam so no food goes to waste.

It may take a number of tries and certainly requires concerted efforts to establish the base. With the base started, they add sticks and rocks as they gradually build up the dam from the bottom. The entire dam from one side of the river to the other is raised uniformly, perhaps to keep the pressure of the running water even across the structure.

Adults initiate most dams, but are aided in construction by all but the youngest colony members. Beavers add sticks to the dam by pushing them into the existing structure using their powerful jaw and neck muscles. The result is a strong latticework. Small rocks are often pushed or carried across the pond to the dam where they are placed near the base or sometimes in the

body of the dam.

Once the dam's crest is above water level, mud is added to restrict flow through the network of sticks and rocks. The mud is usually daubed on the upstream side of the dam so that the water forces the mud into the inner crevices. Eventually, the last leaks are filled and the dam holds back almost all of the water.

As water backs up behind the dam, it floods a large area. Typically, the water finds another channel and flows past the dam to the side. In these cases, the beavers will build additional small dams to capture that water flow and to increase the efficiency of their main structure.

On slow-moving streams, a dam may be so well constructed that virtually no water escapes and the downstream section goes dry. More commonly, enough water escapes through cracks in the dam to keep the water level downstream at an acceptable level for fish and other stream creatures. Sometimes, beavers build secondary dams to back up water against the downstream side of the main dam so that the pressure of the water on the upstream side is partially counterbalanced.

Dams take on all shapes and sizes. Some are small with narrow crests that can't be walked across without getting wet feet. Others have wide, stable crests that actually serve as travelways for a variety of creatures which prefer to cross streams with dry feet.

Dams are usually fairly straight across although some are bowed downstream because the stream flow pushed material as the dam was being built. Others have an upstream curve which is a hydrologically superior design.

The desire to build dams across running water is so strong that beavers will use any material they have available. I have seen and read about beaver dams made from cornstalks when no woody building materials were nearby.

There is no register of the largest and longest beaver dams, but people who wander the woods and canoe streams and rivers bring back tales of some monsters. Trappers provide most of the examples. Some dams span hundreds of yards and a few are over ten feet tall from their base to their crest.

One might think a simple structure of sticks and mud would

not have much strength. I have learned from experience, however, that this is not the case. On several occasions I have tried to pull sticks out of dams when temporarily stalled by water backed up across a woods road. The first few sticks come out easily and water starts to flow over the crest. Sticks farther down on the dam come out with far more difficulty, if at all. Standing on the upstream side of the dam in rubber boots while pulling at sticks reminds one of how much force running water has and just how strong a dam has to be to hold it all back.

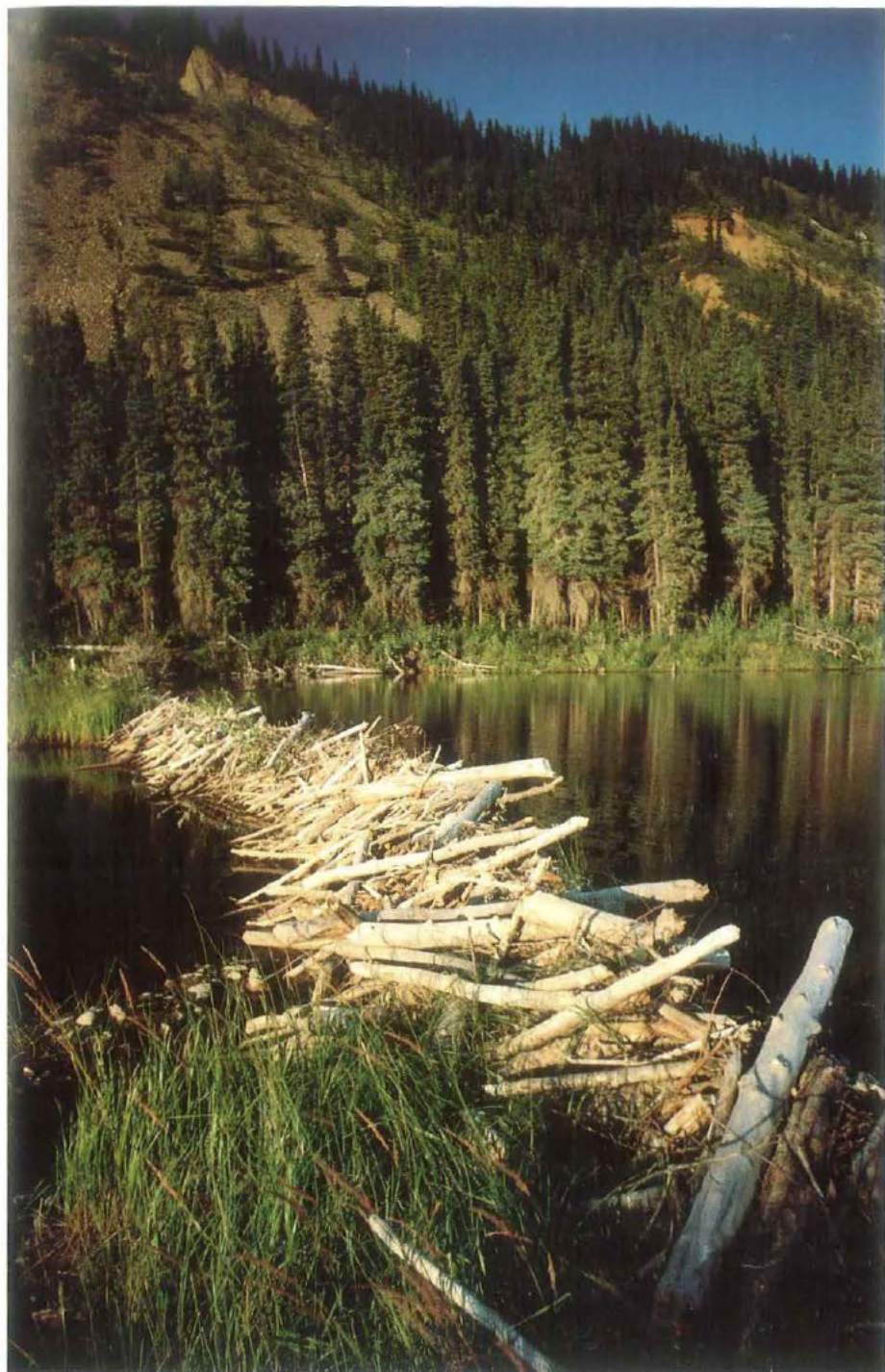
Unfortunately, I have had to continue removing sticks even after this realization, so that the force of the water itself would pull at the sticks and start to wash out the structure. This is not a safe practice, as I learned one day in northern Maine. I had driven on a woods road to get to my study site where I was conducting a loon research project. I was disappointed to find a beaver dam across a low water crossing in the road which had created a pool some six feet deep where I wanted to drive. I started to pull sticks out as I fought the black flies and no-see-ums.

The water started to flow through the first break I made so I moved to one side and started to make another breach. That break in the dam caused that side to quickly fall apart and I barely escaped back to the side where I left my truck without getting washed downstream. I thought the water level would drop quickly, but there was so much water stored behind the dam that it subsided slowly. I grew impatient and ventured out onto the dam once more to create another break. It fell apart under my weight and I stumbled into the upstream pool where I fell and got soaked, but avoided being swept away in the current by sheer luck alone.

A beaver dam is a wonder to behold, but like all structures, it requires maintenance to survive. Beavers regularly conduct inspections of their work to patch leaks and shore up weak spots. Adult males frequently conduct detailed inspections of the entire dam which may last five minutes or more. Casual inspections taking less than a minute are conducted more frequently.

The actions of humans, flood events, and the continued force of water eat away at the dam. Small holes in the dam are repaired by bringing up mud from the bottom and by pulling materials





Beaver dams are sometimes marvels of engineering.



from the sides of the breaks. Medium-sized breaks require more effort. Beavers often swim into the hole to block the flow of the water and pull branches into the hole from the sides of the break. They then back out of the hole and push mud into the hole to seal it.

Large breaks in dams require greater efforts. In these cases, new materials are brought to the dam and jammed into the sides of the break until a latticework is established. Smaller sticks, rocks and mud are added until the job is finished. All colony members may assist in the reconstruction of a breached dam when it threatens to drop water levels to an unacceptable level. The adult male and female frequently rearrange sticks placed by younger animals reinforcing the idea that beavers learn the best construction principles through experience.

Most beavers typically overcompensate when there is a break. They often add materials to the crest even though water is not flowing over the top of the dam. They seem to be driven by the need to quiet the sound of running water and may build and build to the top even when the water is leaking through the middle of the dam.

On the other hand, some beavers may not repair or add to a dam even if water is pouring over its top. Apparently, these beavers try to regulate the water level to their best advantage and will not blindly add to a dam when the result will flood a lodge or den.

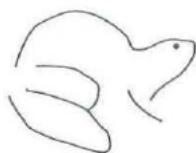
Beavers occasionally create holes in dams to allow some water to escape during floods or when they want to bring the water level in the pond down a bit. They typically cut a hole about the diameter of their body through the dam and repair it when the level is acceptable.

### C a n a l s , C h a n n e l s , a n d P l u n g e H o l e s

Lodges and dams are the most obvious structures built by beavers. Less well known, yet equally magnificent in their own right are the series of canals, channels, and plunge holes built in some beaver colonies.

Beavers like to create a network of regular travelways to aid in their movement underwater and on land. Most beaver ponds have at least one shallow channel cut into the bottom substrate and many have a complex network.

The channels generally are extensions from the lodge entrances to heavily used areas such as food caches, dams, and feeding or scent marking activity areas. From above, they resemble a spider web of channels across the bottom of the pond. The channels serve as underwater route markers, particularly in iron-stained waters with poor visibility. Additionally, they lend more depth to the pond when ice freezes thick. Beavers dredge these channels frequently, much like humans dredge shipping channels



## Food Habits

An animal weighing fifty or more pounds, spending much of its time in the water, and sometimes living in cold climates, needs a lot of calories to keep its internal engine running. The beaver, unfortunately, doesn't have easily digestible, high-calorie options on its menu. Instead, it must eat vegetation containing high amounts of cellulose, which is notoriously difficult to digest and from which to extract calories.

The beaver makes up for calorie-poor food by choosing from its limited menu carefully and by eating and eating and eating.

Beavers and their food habits have been studied all over North America and Europe. Researchers have documented the use of hundreds of different kinds of plants. In just one study of beavers in Alabama, Master's student Philip Wilkinson listed fifty-three species of trees and non-woody plants used by beaver over just one-and-a-half years of study.

Tree bark is the primary food of beavers throughout most of their range during the fall and winter. Leaves, twigs, and buds are used during the spring and summer. Spring and summer also provide a great variety of herbaceous plants which are far more easy to digest than bark. Thus, summer does not provide a great challenge for acquiring nutritional foods because many soft plants



grow in and along lakes, rivers, and streams.

With such a variety of plants to choose from in any one area and an equally diverse range across North America, it is difficult to identify favored summer foods. However, some that are used commonly include cattail, arrowhead, pondweed, smartweed, milfoil, pond lily and a variety of sedges. Beavers are particularly fond of the starchy roots of cattails and pond lilies. They also sample some seemingly less likely fare including nettles, blackberry, and the gritty stems of bulrushes.

During the summer months, I noticed beavers on the Rio Grande digging at riverbanks where sedges were growing. They left the above-ground stems, but ate the roots. Similarly, they ate the roots of species of reeds or canes which grew in thick stands along most of the river. Beavers have been noticed dining on large mats of algae or pond scum which they swim into and pull together with their forepaws. Although it didn't occur to me when I observed it, other biologists have likened it to the eating of spaghetti.

Beavers will eat herbaceous vegetation as long as it is available into the autumn. This varies, of course, across their range. In the North, herbaceous plants are available for just a month or two. On the southern end of the range, herbaceous plants may be available for over half the year. Some colonies even survive the winter by digging up and eating the rhizomes and tubers of pond lilies. Eventually, however, in most colonies beavers turn their attention to trees.

Bark is not a highly nutritious food because it contains a number of chemicals designed to repel potential diners. As a tree gets older, its bark on the trunk and the larger branches becomes cork-like in texture. Beavers prefer the thin, smooth bark growing on seedlings, saplings, and the small branches of large trees. When saplings are available, beavers prefer to cut them down and eat their bark. Large trees are cut down to get at the small branches. Not surprisingly, only when food becomes scarce in an area will bark from large branches and the trunk be eaten.

Dozens of species of trees grow in riparian areas in North America. Yet the beaver is well known for its affinity for just a handful. Whenever they are present, aspens, cottonwoods, and



willows are the preferred foods. Maples, alder, and sweet gum are frequently reported to be commonly used as well.

Aspen, cottonwood, and willow are pioneer species which readily recolonize burned over, logged, or flooded areas and they are abundant in many riparian and adjacent areas. They also respond to being cut down by resprouting from the roots. In many ways, they are ideal beaver foods. Aspen bark is particularly nutritious because some photosynthesis takes place in the bark as well as in the leaves. Eventually, however, repeated cutting kills the plant and beavers are forced to eat less favored foods or to move on to a different area.

Across the Upper Midwest where aspen is common, I have seen thousands of acres of forest next to lakeshores and rivers in which beavers have selectively felled the aspen trees leaving only



the pines and birches. The areas inevitably become choked with hazel brush which apparently doesn't compare favorably for the beaver's palate.

Aspen, being primarily a northern or high elevation tree, was absent from my study area on the Rio Grande. Several species of willow grew fairly commonly in isolated patches along the floodplain. Cottonwood, which had once been common, was very rare, having been replaced by an aggressive exotic species called tamarisk or salt cedar. Beavers there ate willow most frequently. In fact, every willow stand on the river had a beaver colony associated with it.





The remaining cottonwoods were mostly large, old trees growing a hundred yards or more back from the river. There weren't nearly enough of them in any one area to support a beaver colony for very long. Because they were so far back from the river's edge, it was dangerous for beavers to walk to them and spend time gnawing at their large trunks. However, during floods which reduced the distance between the water and the cottonwoods, I found signs of fresh chewing at most of the sites. I took this as an indication that beavers preferred cottonwoods over willows, but wouldn't risk predation to cut them down unless they were close to the water's edge.



In areas where aspens, cottonwoods, or willows, are not available, beavers turn to other trees. They generally avoid pines and other softwoods which have sticky resins in their bark, but they do occasionally show up on the food list from research studies. Oaks and other hardwood trees seem to be starvation foods.

It is always risky to attribute the felling of trees to food because trees are also used to make lodges and dams. However, on the Rio Grande, where neither dams nor lodges were built, every tree that was cut down was probably used for food. Tamarisk was the only softwood there and it was used only when willows were scarce and then, only small seedlings and saplings were cut down. Tamarisk is a species that has been in the area less than a hundred years, indicating the beaver's ability to adapt to a new food.

I found beavers felling a dozen or so tree species, one of which would have been the last on my list had I been predicting. In one beaver colony near the town of Boquillas, Mexico, I

discovered beavers cutting down and peeling the bark off a tree called “catclaw acacia,” so named because of the long, sturdy thorns growing on its trunk and branches. The thorns looked as if they had been neatly clipped off, probably with a quick (and careful!) nip of the incisors.

## D i g e s t i o n

Like all animals that eat green or woody vegetation, beavers have evolved a digestive system to deal with the high amounts of cellulose. Many animals that eat vegetation are large-bodied and have large stomachs and intestines providing for slow processing of the food. Beavers do not have exceptionally large stomachs. However, they do have a large pouched digestive organ called a cecum, and a cardiogastric gland, a somewhat unique organ which produces highly acidic juices that drain into the stomach. Only koalas and wombats, two other mammals about the size of beavers which have a vegetarian diet, have a similar gland.

Beavers make use of foods with lots of cellulose using two adaptations—bacteria in their cecum and the reingestion of their feces. The bacteria allow beavers to break down about one third of the cellulose in a meal which stays in the digestive tract for at least a couple of days. Beavers then capture some of the remaining cellulose by sending it through the system again.

Beavers reingest some of their feces to give the digestive system another chance at breaking down more cellulose. Although not commonly observed, reingestion of feces is fairly common among small mammals that eat a lot of vegetation.

A fairly inefficient digestive system and some foods that aren't all that nutritious means that a beaver has to eat a lot. Captive beavers have maintained weight on one-and-a-half to two pounds of aspen bark a day. A typical one-inch-diameter aspen tree, which takes five or six years to grow, has about three pounds of bark on it. An acre of aspen trees this size produces about three tons of bark or enough to feed a large colony of ten beavers for about a year.