REPTILES, AMPHIBIANS, ETC.

F-1  Alligators  Allan R. Woodward and Dennis N. David
F-7  Crayfish    James F. Fowler, Wendell Lorio, and Greg Lutz
F-9  Frogs and Toads  Paul E. Moler
F-13 Salamanders  James L. Byford
F-15 Snakes, Nonpoisonous  James L. Byford
F-21 Rattlesnakes  Walter E. Howard
F-27 Turtles     James F. Fowler and Jimmy L. Avery
**ALLIGATORS**

**Damage Prevention and Control Methods**

**Exclusion**

Bulkheads along edges of lakes and waterways.

Wire mesh fences.

**Habitat Modification**

Minimize emergent vegetation.

Drain ponds and borrow pits where appropriate and permitted.

**Frightening**

Prodding or other harassment can increase wariness.

Hunting pressure increases wariness and avoidance of people.

**Repellents**

None are registered.

**Toxicants**

None are registered.

**Fumigants**

None are registered.

**Trapping**

Baited hooks and trip-snare traps are most effective.

**Shooting**

Hunt during the day or night with rifles or crossbows.

**Other Methods**

Hunt with detachable-head harpoons or handheld, breakaway pole snares.

Capture with snatch hooks or tongs.

**Identification**

The American alligator (*Alligator mississippiensis*, Fig. 1) is the most common of two crocodilians native to the United States and is one of 22 crocodilian species worldwide. The other native crocodilian is the American crocodile (*Crocodylus acutus*). Caimans (*Caiman spp.*), imported from Central and South America, are occasionally released in the United States and can survive and reproduce in Florida. The American alligator is distinguished from the American crocodile and caiman by its more rounded snout and black and yellow-white coloration. American crocodiles and caimans are olive-brown in color and have more pointed snouts. American alligators and crocodiles are similar in physical size, whereas caimans are 40% smaller.
Range

The American alligator is found in wetlands throughout the coastal plain of the southeastern United States. Viable alligator populations are found in Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. The northern range is limited by low winter temperatures. Alligators are rarely found south of the Rio Grande drainage. Alligators prefer fresh water but also inhabit brackish water and occasionally venture into salt water. American crocodiles are scarce and, in the United States, are only found in the warmer coastal waters of Florida, south of Tampa and Miami. Caimans rarely survive winters north of central Florida and reproduce only in southernmost Florida.

Habitat

Alligators can be found in almost any type of fresh water, but population densities are greatest in wetlands with an abundant food supply and adjacent marsh habitat for nesting. In Texas, Louisiana, and South Carolina, the highest densities are found in highly productive coastal impoundments. In Florida, highest densities occur in nutrient-enriched lakes and marshes. Coastal and inland marshes maintain the highest alligator densities in Georgia, Alabama, and Mississippi. Alligators commonly inhabit urban wetlands (canals, lagoons, ponds, impoundments, and streams) throughout their range.

Food Habits

Alligators are exclusively carnivorous and prey upon whatever creatures are most available. Juvenile alligators (less than 4 feet [1.2 m]) eat crustaceans, snails, and small fish; subadults (4 to 6 feet [1.2 to 1.8 m]) eat mostly fish, crustaceans, small mammals, and birds; and adults (greater than 6 feet [1.8 m]) eat fish, mammals, turtles, birds, and other alligators. Diets are range-dependent; in Louisiana coastal marshes, adult alligators feed primarily on nutria (Myocastor coypus), whereas in Florida and northern Louisiana, rough fish and turtles comprise most of the diet. Recent studies in Florida and Louisiana indicate that cannibalism is common among alligators. Alligators readily take domestic dogs and cats. In rural areas, larger alligators take calves, foals, goats, hogs, domestic waterfowl, and occasionally, full-grown cattle and horses.

General Biology, Reproduction, and Behavior

Alligators are ecotothermic — they rely on external sources of heat to maintain body temperature. They are most active at warmer temperatures and prefer 82° to 92°F (28° to 33°C). They stop feeding when ambient temperature drops below 70°F (21°C) and become dormant below 55°F (13°C).

Alligators are among the largest animals in North America. Males can attain a size of more than 14 feet (4.3 m) and 1,000 pounds (473 kg). Females can exceed 10 feet (3.1 m) and 250 pounds (116 kg). Alligators of both sexes become sexually mature when they attain a length of 6 to 7 feet (1.8 to 2.1 m), but their full reproductive capacity is not realized until females and males are at least 7 feet (2.1 m) and 8 feet (2.4 m) long, respectively.

Alligators begin courtship in April throughout most of their range and breed in late May and early June. Females lay a single clutch of 30 to 50 eggs in a mound of vegetation from early June to mid-July. Nests average about 2 feet (0.6 m) in height and 5 feet (1.5 m) in diameter. Nests are constructed of the predominant surrounding vegetation, which is commonly cordgrass (Spartina spp.), sawgrass (Cladium jamaicense), cattail (Typha spp.), giant reed (Phragmites spp.), other marsh grasses, peat, pine needles, and/or soil. Females tend their nests and sometimes defend them against intruders, including humans. Eggs normally take 65 days to complete incubation. In late August to early September, 9 to 10-inch (23 to 25-cm) hatchlings are liberated from the nest by the female. She may defend her hatchlings against intruders and stay with them for up to 1 year, but gradually loses her affinity for them as the next breeding season approaches.

Growth rates of alligators are variable and dependent on diet, temperature, and sex. Alligators take 7 to 10 years to reach 6 feet (1.8 m) in Louisiana, 9 to 14 years in Florida, and up to 16 years in North Carolina. When maintained on farms under ideal temperature and nutrition, alligators can reach a length of 6 feet (1.8 m) in 3 years.

Alligators are not normally aggressive toward humans, but aberrant behavior occasionally occurs. Alligators can and will attack humans and cause serious injury or death. Most attacks are characterized by a single bite and release with resulting puncture wounds. Single bites are usually made by smaller alligators (less than 8 feet [2.4 m]) and result in an immediate release, possibly because they were unsure of their intended prey. One-third of the attacks, however, involve repeated bites, major injury, and sometimes death. Serious and repeated attacks are normally made by alligators greater than 8 feet in length and are most likely the result of chase and feeding behavior. Unprovoked attacks by alligators smaller than 5 feet (1.5 m) in length are rare.

Contrary to popular belief, few attacks can be attributed to wounded or territorial alligators or females defending their nests or young. Necropsies of alligators that have attacked humans have shown that most are healthy and well-nourished. It is unlikely that alligator attacks are related to territorial defense. When defending a territory, alligators display, vocalize, and normally approach on the surface of the water where they can be more intimidating. In most serious alligator attacks, victims were unaware of the alligator prior to the attack. Female alligators frequently defend their nest and young, but there have been no confirmed reports of humans being bitten by protective females. Brooding females typically try to intimidate intruders by displaying and hissing before attacking.
Alligators quickly become conditioned to humans, especially when food is involved. Feeding-habituated alligators lose their fear of humans and can be dangerous to unsuspecting humans, especially children. Many aggressive or “fearless” alligators have to be removed each year following feeding by humans. Ponds and waterways at golf courses and high-density housing create a similar problem when alligators become accustomed to living near people.

**Damage and Damage Identification**

Damage by alligators is usually limited to injuries or death to humans or domestic animals. Most alligator bites occur in Florida, which has documented approximately 140 unprovoked attacks from 1972 to 1991, or about 7 per year. Since 1972, 5 deaths have been positively attributed to alligators. Historically, nonfatal attacks have also been documented in South Carolina (8), Louisiana (2), Texas (1), Georgia (1), and Alabama (1).

Alligators inflict damage with their sharp, cone-shaped teeth and powerful jaws. Bites are characterized by puncture wounds and/or torn flesh. Alligators, like other crocodilians that take large prey, prefer to seize an appendage and twist it off by spinning. Many serious injuries have involved badly damaged and broken arms on humans and legs on animals. Sometimes alligators bite or eat previously drowned persons. Coroners can usually determine whether a person drowned before or after being bitten. Stories of alligators breaking the legs of full-grown men with their tails are unfounded.

Alligators sometimes excavate extensive burrows or dens for refuges from cold temperatures, drought, and predators (other alligators and humans). Burrowing by alligators can damage dikes in impoundments.

**Legal Status**

The American alligator is federally classified as “threatened due to similarity of appearance” to other endangered and threatened crocodilians. This provides federal protection for alligators but allows state-approved management and control programs. Alligators can be legally taken only by individuals with proper licenses or permits. Florida, Louisiana, Georgia, South Carolina, and Texas have problem or nuisance alligator control programs that allow permitted hunters to kill or facilitate the removal of nuisance alligators. Other states use state wildlife officials to remove problem animals.

**Damage Prevention and Control Methods**

**Exclusion**

Alligators are most dangerous in water or at the water’s edge. They occasionally make overland forays in search of new habitat, mates, or prey. Concrete or wooden bulkheads that are a minimum of 3 feet (1 m) above the high water mark will repel alligators along waterways and lakes. Alligators have been documented to climb 5-foot (1.5-m) chain-link fences to get at dogs. Fences at least 5 feet high with 4-inch (10-cm) mesh will effectively exclude larger alligators if the top of the fence is angled outward.

**Habitat Modification**

Elimination of wetlands will eradicate alligators because they depend on water for cover, food, and temperature regulation. Most modifications of wetlands, however, are unlawful and would adversely affect other wildlife. Elimination of emergent vegetation can reduce alligator densities by reducing cover. Check with appropriate conservation authorities before modifying any wetlands.

**Frightening**

Aversive conditioning using sticks to prod “tame” alligators and rough handling of captured alligators have been attempted in several areas with limited success. Hunting pressure appears to be the most effective means of increasing alligator wariness and may be responsible for limiting the incidence of alligator attacks in Florida, despite increasing human and alligator populations. The historically low attack rate in Louisiana is attributed to a history of intense hunting.

**Repellents**

None are registered.

**Toxicants**

None are registered.

**Trapping**

Alligators can be readily trapped because they are attracted to baits. A baited hook is the simplest method and is used in Louisiana as a general harvest method and in Florida to remove nuisance alligators. Hooks are rigged by embedding a large fish hook (12/0 forged) in bait (nutria, fish, beef lungs, and chicken are popular) and suspended from a tree limb or pole about 2 feet (0.6 m) above the surface of the water. The bait should be set closer to the water to catch smaller alligators. To increase success, baited hooks should be set in the evening and left overnight during the primary feeding time of alligators. Once swallowed, the hook lodges in the alligator’s stomach and the alligator is retrieved with the attached rope. This method can kill or otherwise injure alligators and is not suitable for alligators that are to be translocated. Hooked alligators are most effectively killed by a shot to the brain with a small caliber (.22) rifle. Powerheads (“bangsticks”) can also be used to kill alligators, but should only be used with the barrel under water and according to manufacturer recommendations.

Trip-snare traps (Fig. 2) are more complicated and somewhat less effective than are set hooks but do not injure or kill alligators. An alligator is attracted to the bait and, because of the placement of the guide boards, is forced to enter from the end of the trap with the snare. The alligator puts its head through the self-locking snare (No. 3, 72-inch [1.84-m]; see Supplies and Materials), seize the bait, and releases the trigger mechanism as it pulls the bait. The surgical tubing contracts and locks the snare on the alligator. These
Traps can be modified as floating sets. A variation of the trip-snare trap can be set on alligator trails and rigged to trip by the weight of the alligator (see Mazzotti and Brandt 1988).

Wire box traps have been used effectively to trap alligators. Heavy nets have been used with limited success to capture alligators and crocodiles at basking sites.

**Translocation**

Translocation of problem alligators was practiced extensively during the 1970s with limited success. Alligators, especially larger ones, tended to return to their original capture sites after being moved. These alligators not only caused problems during their return trip but frequently required subsequent capture and translocation. Translocation is not recommended unless areas with depleted alligator populations are available for release of problem animals.

**Shooting**

Next to baited hooks, shooting is probably the most effective means of removing alligators. Alligators can be shot during the day or at night, and should be shot in the brain case with a sufficiently powerful rifle (.243 caliber and larger) for an efficient and humane kill. Firearms, however, present public safety problems in most nuisance alligator settings. Furthermore, alligators sink almost immediately after dying and may be difficult to recover (by gaffs or snatch hooks) in areas with currents or dense submergent plants. This method may make confirmation of a kill difficult and may compromise the commercial value of the alligator. Crossbows with lines attached to barbed bolts work fairly well at short distances but should only be used to kill alligators.

**Other Methods**

Detachable-head harpoons (Fig. 3a, b) with attached lines have been used effectively to harvest nuisance alligators. A harpoon assembly (Fig. 3a) is attached to a 10- to 12-foot (3- to 3.5-m) wooden pole. The harpoon is thrust at the alligator and, after the tip penetrates the skin, withdrawn, leaving the tip embedded under the alligator’s skin (Fig. 3b). As tension is placed on the retrieval line, the off-center attachment location of the cable causes the tip to rotate into a position parallel to the skin of the alligator, providing a secure attachment to the alligator. Harpoons are less effective than firearms, but the attached line helps to ensure the recovery of the alligator.

Snatch hooks are weighted multitine hooks on fishing line that can be cast over an alligator’s back and embedded in its skin. The size of hooks and the line strength should be suited to the size of the alligator; small alligators can be caught with standard light fishing gear while large alligators require 10/0 hooks, a 100-pound test line, and a heavy-duty fishing rod. Heavy hooks with nylon line can be hand-cast for larger alligators. After the hook penetrates the alligator’s skin, the line must be kept tight to prevent the hook from falling out. Alligators frequently roll after being snagged and become entangled in the line. This entanglement permits a more effective recovery. Snatch hooks work well during the day and at night, provided that vegetation is minimal.

Handheld poles with self-locking
snares (sizes No. 2 and 3; Fig. 4) can be used effectively to capture unwary alligators at night. For smaller (less than 6 feet [1.8 m]) alligators, snares can be affixed to a pole with a hose clamp. For adult alligators, snares should be rigged to “break away” from the pole by attaching the snare to the pole with thin (1/2-inch [1-cm] wide) duct tape (Fig. 4). The tape or clamps allow the snare to be maneuvered and are designed to release after the snare is locked. Carefully place the snare around the alligator’s neck, then jerk the pole and/or retrieval line to set the locking snare. A nylon retrieval rope should always be fastened to the snare and the rope secured to a boat or other heavy object.

For alligators less than 6 feet (1.8 m) long, commercially available catch poles (Fig. 5; see Supplies and Materials) can be used. Snake tongs (Fig. 6, see Supplies and Materials) are effective for catching alligators less than 2 feet (0.6 m) long.

Avoidance

Measures can be taken to avoid confrontations with alligators and substantially reduce the probability of attacks. Avoid swimming or participating in water activities in areas with large alligators. Avoid water activities at dusk and at night during the warmer months when alligators are most active. Alligators can quickly surge at least 5 feet (1.5 m) onto the shore to seize prey, so care should be taken when at the water’s edge. Do not feed alligators. Avoid approaching nests and capturing young (<2 feet [0.6 m]) alligators.

Economics of Damage and Control

Alligators can cause injuries and death to humans, livestock, and pets. All alligator bites require medical treatment and serious bites may require hospitalization. Infections can result from alligator bites, particularly from the Aeromonas spp. bacteria.

Lawsuits that arise from findings of negligence on the part of a private
Acknowledgments

We thank William Brownlee, Texas Parks and Wildlife Department; Ted Joanen, Louisiana Department of Wildlife and Fisheries; Steve Ruckel, Georgia Department of Natural Resources; Thomas Swayngham, South Carolina Department of Wildlife and Marine Resources; and Paul Moler and Michael Jennings, Florida Game and Fresh Water Fish Commission for providing information on their respective states and for reviewing this chapter. We also thank Thomas Murphy and Philip Wilkinson, South Carolina Department of Wildlife and Marine Resources, for providing diagrams of the trip-snare trap.

For Additional Information


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owner or governmental agency responsible for an attack site can lead to significant economic liability.

In Florida, approximately 15% of the alligator complaints are due to fear of pet losses and, to a lesser extent, livestock losses. Losses of livestock other than domestic waterfowl, however, are uncommon and difficult to verify. Levees damaged by alligator burrows or dens may require repair.

Alligators are valuable for their skin and meat. An average-sized nuisance alligator typically yields 8 feet (2.4 m) of skin and 30 pounds (13.5 kg) of boneless meat with a wholesale value of $390 (at $30 per foot for skins and $5 per pound for meat). Other products such as skulls, teeth, fat, and organs can be sold, but account for less than 10% of the value of an alligator. Nuisance alligator control programs in several states use the sale of alligator skins to offset costs of removal and administration.

Florida has the most pressing nuisance alligator problem and currently harvests about 4,000 alligators per year. Nuisance alligator harvests also occur in Louisiana (600), Georgia (400), South Carolina (250), and Texas (50).
Crayfish, also called crawfish, crawcrab, crab, stonecrab, crawdad, creekcrab, and other local names, are native to fresh waters on all continents except Africa, where they have been widely introduced. There are over 400 species in the family Astacidae worldwide, and approximately 300 species in the United States. In size, shape, and color, the variation is extremely wide among species. The detailed life histories and habits of all species of crayfish are beyond the scope of this handbook.

Damage Prevention and Control Methods

Exclusion
Not practical.

Cultural Methods
Deep tillage destroys burrows and generally results in lower populations.

Drainage of rice irrigation systems and fields during fall and winter months reduces populations.

Repellents
None are registered.

Toxicants
None are registered. Check individual state regulations for Special Local Needs registrations 24(c).

Approved turf insecticides used for insect pest control will also control crayfish in lawn and turf areas.

Fumigants
None are registered. Check state regulations for Special Local Needs registrations 24(c).

Trapping
Not effective in eliminating populations. May be used in capturing crayfish for bait or food.
Crayfish are economically important in a number of states for use as fish bait and for human consumption. In Louisiana, the crayfish is a major economic crop and comprises the second largest aquaculture industry in North America. Over 130,000 acres (56,000 ha) are devoted solely to crayfish culture.

**Damage**

Most damage associated with crayfish is the result of crayfish burrowing in home lawns. Burrows created by burrowing species of crayfish are damaging to turf areas and may be hazardous to mowing machinery. Newly planted rice fields may be damaged by foraging crayfish where local populations are high.

Crayfish populations in commercial baitfish ponds can reduce reproduction by feeding on the eggs of the baitfish as they are deposited on spawning mats. During pond harvest, crayfish caught in the nets injure and destroy baitfish as they are being harvested for market.

Unwanted populations of crayfish have been established in the wild because of the release of bait crayfish. Some populations have reached extremely high levels. Crayfish can reduce game fish populations by preying on eggs and fry. They also can degrade habitat by destroying aquatic vegetation.

**Legal Status**

Crayfish may be protected by law in some states. Harvest of crayfish may also be regulated by state wildlife conservation agencies. In areas where damage occurs, control measures are generally unrestricted. Check with your local agricultural or wildlife authorities before initiating control. Unwanted populations of crayfish have resulted in regulations against the use of crayfish as bait in some northern lakes.

**Damage Prevention and Control Methods**

**Cultural Methods**

Deep cultivation helps reduce burrowing crayfish populations in rice fields and other grain crops. Drainage of rice irrigation canals and fallow fields during fall and winter is also helpful in reducing crayfish populations in these areas.

High populations of crayfish are generally associated with years of high rainfall. Unseasonably dry weather conditions usually reduce crayfish numbers.

Rapid drainage of baitfish ponds during early spring helps eliminate crayfish by exposing them to predators before burrowing activities begin. Principal predators include snakes, raccoons, mink, otter, skunks, bass, catfish, ibis, and herons.

**Toxicants**

There are no General Use Pesticides registered for crayfish control. In some states, however, Special Local Needs registration under section 24(c) of FIFRA have been established for certain insecticides for burrow treatment. Toxicants, where legal, may be used at any time of the year when crayfish are active, but best results are obtained in early fall when adults are in their burrows. To be effective, applications of toxic chemicals must reach the water in the burrows. Additional treatments may be necessary where burrows in dikes or dams open at the bottom into a pond or stream.

**Fumigants**

None are federally registered for crayfish control. Check with your local wildlife or agricultural agency for Special Local Needs registrations.

**Trapping**

Wire cage traps, baited with fish, chicken, or other meat can be used to capture crayfish, but they are not cost-effective in damage control situations.

**Acknowledgments**

Figure 1 by Emily Oseas Routman.

**For Additional Information**


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Damage Prevention and Control Methods

Exclusion
Seal all openings 3/16 inch (0.5 cm) or larger to exclude frogs.

A frogproof fence can be used for nonclimbing species, but will be ineffective against treefrogs and a few related species.

On fish farms, mesh tenting over ponds will serve to exclude frogs as well as birds and other predators.

Habitat Modification
Around hatchery ponds, keep vegetation closely mown and remove emergent vegetation and other types of cover.

Frightening
Not applicable.

Repellents
None are registered.

Toxicants
None are registered.

Fumigants
None are registered.

Trapping
Funnel traps.

Capture
Capture by hand or gig at night.

Egg masses may be removed with a fine-meshed net.

Shooting
Allowed in some states, but often not safe in areas requiring control.
Some states permit shooting only during daylight hours.
Identification

Frogs and toads are amphibians with four legs and no tail. They may have skin that is smooth and moist or dry and warty, but they have no scales or claws. The front legs are short, but the hind legs are muscular and elongated for hopping or jumping. The popular distinction between frogs and toads is somewhat artificial; basically, toads are a particular group of frogs. Throughout this chapter, the term frog will be used to include toads. North American frogs range in body size from the 11/16-inch (1.7-cm) little grass frog to the 8-inch (20-cm) bullfrog.

Range

At least 85 species of frogs are native to the United States, and there are three well-established exotic species. There is no part of the country that is not home to at least a few species.

Habitat

Frogs occur in almost all nonmarine habitats. “True” frogs (genus Rana) and treefrogs predominate in the more humid east. In the drier Great Plains and western regions, toads and spadefoots are typically more numerous. Whereas some species are seldom found far from permanent water, others return to water only seasonally to breed. Some desert species spend most of their time beneath ground, venturing to the surface only following rains.

Food Habits

Most frogs have a two-phased life cycle, including an aquatic larval form (tadpole) and a terrestrial or semi-aquatic adult form. Tadpoles are primarily herbivorous, feeding on algae and decaying organic matter. Adults, on the other hand, are carnivorous, consuming almost any prey that can be overpowered. Although the diet consists primarily of insects, crayfish, and other invertebrates, larger frogs occasionally take snakes, other frogs, fish, mice, and small birds. In natural habitats, fish usually comprise less than 5% of the diet of the bullfrog. On fish farms, as many as 30% of bullfrogs have been found to contain fish.

General Biology, Reproduction, and Behavior

Although some species spend most of their adult lives away from water, most frogs native to North America must return to water to lay eggs. Some species breed during the cooler winter and spring months, whereas others breed during the warmer months. Following rain, males begin calling from breeding sites. Each species has its own distinctive call, and females respond only to the calls of their own species. Several recordings of frog calls are available, and four are listed at the end of this chapter.

Eggs are fertilized by the male as they are released by the female. Hatching occurs a few days later. The aquatic tadpole stage may last as little as 2 to 3 weeks in some species of spadefoots or as long as 2 years in some northern populations of bullfrogs.

Frogs are typically most active at night. Some species aggregate around artificial lights and feed on the insects attracted there. Frogs are an important component of the vertebrate food chain and are consumed by a variety of predators, including fish, snakes, turtles, wading birds, raptors, skunks, and raccoons. Individuals of many species may live 12 to 15 years, but life expectancy is much shorter in the wild.

Damage

The greatest potential for economic damage is at fish farms and hatcheries. Tadpoles compete for food intended for fish, and adult bullfrogs may actually feed on the fish. Losses are said to be high at some fish farms. One study suggested that the mere presence of high densities of tadpoles retarded reproduction of fish. Although the bullfrog is native to most of the eastern United States, its introduction to portions of the west has seriously affected some native species. In at least some cases, these introductions may have resulted from the unintentional release of tadpoles during fish-stocking programs. Considerable labor is required to separate tadpoles from loads of fry.

Only in rare instances do frogs cause any significant damage. Some species (toads, for example) produce skin secretions that are toxic if ingested. This does not normally present a problem for people, and pets usually learn to avoid such frogs. A few species (giant toad, Colorado River toad) produce especially copious or toxic secretions, and there have been cases in which dogs have died after biting them.

The noise sometimes produced by large breeding choruses of frogs following heavy rains can be annoying to humans. These aggregations usually last only a few days, however, and seldom warrant control. Similarly, complaints sometimes arise when large numbers of young frogs leave the ponds en masse, but the frogs disperse quickly, and the “problem” will take care of itself in a few days.

Legal Status

Laws pertaining to frogs vary from state to state. Some rare species (for example, Houston toad, Wyoming toad, Pine Barrens treefrog) may be fully protected under federal or state laws. Seasons and bag limits may apply to other species (bullfrogs, for example). Permits to remove frogs that are causing damage are available in some states. Contact your state wildlife department to determine the legal status of frogs in your area.

Damage Prevention and Control Methods

Exclusion

The effectiveness of exclusion depends in part on the species involved. Most species responsible for potential or real damage can be effectively excluded from limited areas. Giant toads (south-
ern Florida, extreme southern Texas) or Colorado River toads (southern Arizona, extreme southeastern California) can be excluded from pet enclosures by placing a strip of 1/8-inch (0.3-cm) mesh hardware cloth along the outside base of the perimeter fence. The hardware cloth should be buried at least 4 inches (10 cm) in the ground and should extend to a height of at least 20 inches (50 cm). A similar exclusion fence can be used to control breeding aggregations of nonclimbing species in small, urban stormwater detention basins or to exclude these species from small hatchery ponds. Although treefrogs and some related species will readily climb such a fence, most treefrogs normally breed in seasonal, fish-free waters. In addition, their eggs and tadpoles are readily eaten by fish, so they do not usually present a significant problem on fish farms.

**Habitat Modification**
Keep the shoreline of ponds free of emergent vegetation to minimize cover for adult frogs and allow predators to assist in control. Efforts to directly remove adult frogs at night will also be facilitated.

**Frightening**
Not applicable.

**Repellents**
None are registered.

**Toxicants**
None are registered.

**Fumigants**
None are registered.

**Trapping**
Place funnel traps along the base of a perimeter fence. Toads may also be trapped by burying several 5-gallon (19-l) buckets flush with the ground surface beneath an overhead light. Toads attracted by the insects drawn to the light will fall into the buckets and be unable to escape.

**Caution:** traps may capture other non-target species, including snakes, turtles, and small mammals.

**Capture**
Frogs can be located at night by the reflection of their eyes in the beam of a headlamp. They can be collected by gig or hand. Captured frogs may be eaten, or where allowed by law, sold to provide additional economic returns. Check with your state wildlife agency regarding seasons, bag limits, legal methods of take, and restrictions on sale.

**Shooting**
Although shooting is allowable in some states, it is not safe in some areas requiring control.

**Economics of Damage and Control**
Frogs eat many insect pests. With the exception of fish farms, control measures for frogs are seldom warranted and, in most cases, should be discouraged. On fish farms, the economic damage depends in part on the unit value of the fish produced. Corse and Metter (1980) provided data suggesting that a 350-pond farm that produced goldfish might sustain $42,000 in annual losses to bullfrogs, whereas the same facility might sustain only $12,600 in losses if it produced golden shiners, a less valuable species. It follows that losses might be still higher on farms specializing in valuable aquarium fishes.
SALAMANDERS

Identification

Salamanders are smooth-skinned amphibians with no skin covering such as scales, hair, or feathers. They do not have claws. Adult salamanders can be distinguished from frogs and toads by the presence of a tail and by the nearly equal size of their front and hind limbs. Most salamanders are moist or slimy to the touch, which is a good way to distinguish them from lizards, which are dry.

The waterdog, which is completely aquatic (water living), can be recognized by its featherlike external gills.

Damage Prevention and Control Methods

Exclusion

All openings 1/4 inch (0.6 cm) and larger should be sealed to exclude salamanders.

Habitat Modification

Remove all items that lie close to the ground in damp areas, such as lumber or woodpiles.

Frightening

Not applicable.

Repellents

None are registered.

Toxicants

None are registered.

Fumigants

Not applicable.

Trapping

Not applicable.

Shooting

Not applicable.
Range

There are several dozen kinds of salamanders found in the United States, but most occur only in parts of one or several states. Because salamanders are so dependent on specific habitat conditions, their movements are limited and home ranges are usually very small.

Habitat

Salamanders depend on water and moisture for their existence. Because they do not have a skin covering, they dehydrate rapidly in dry environments. The larvae spend the first part of their lives in water. After the larval form changes to the adult form, most salamanders leave the water and live in moist areas on land. They can usually be found under logs, under rocks, near streams, and in other areas where the ground is moist and shaded from the sun.

Food Habits

All salamanders are predators. They commonly eat insects, slugs, earthworms, and other invertebrates. Some eat leeches, tiny mollusks, crustaceans, and frogs’ eggs. As aquatic larvae, they typically eat aquatic invertebrates, but some may even be cannibalistic.

Behavior

Salamanders generally are active when there is no sunshine—at night or on cloudy, rainy days. On sunny days they generally hide in moist areas, such as under stones and logs. Since salamanders are mostly nocturnal (active at night), they are seldom seen by people.

Damage

Salamanders do not cause damage to people or property. Occasionally, they frighten people who are not familiar with them. None have a poisonous bite.

Legal Status

Salamanders are protected in most states, as are other nongame animals. In some areas, they may be legally taken to use as bait for fishing, but in most areas they are completely protected. Some salamanders are on state lists of threatened and endangered species.

Damage Prevention and Control Methods

Exclusion

Salamanders generally do not enter buildings. On occasion, they may be found in a damp basement, if the basement stays moist most of the time and there are items lying close to the damp floor. In such cases, all openings 1/4 inch (0.6 cm) and larger should be sealed to exclude salamanders. Check for openings around the corners of doors and windows, water pipes, and electric service entrances. Holes in masonry foundations (poured concrete and concrete blocks or bricks) should be sealed with mortar. Openings in wood should be sealed with fine mesh (1/8-inch [0.3-cm]) hardware cloth and/or sheet metal.

Habitat Modification

In situations where salamanders are inside buildings, steps should be taken to dry out the basement area (see a construction specialist for this) or remove objects from the floor of damp basements where salamanders can hide. Keep areas outside of buildings free from objects that salamanders can hide under—lumber, sticks, old boards, or firewood. If such items are off the ground (stacked on runners) the soil underneath can dry, making the area unattractive to salamanders.

Frightening

Not applicable.

Repellents

None are registered.

Toxicants

None are registered.

Economics of Damage and Control

As mentioned earlier, salamanders are completely harmless. They do not have a poisonous bite and cause no hazard to people, except perhaps frightening them. They cause no damage to personal property. Therefore, expense toward control of salamanders is not justified. Most methods required to remove salamanders are inexpensive and are consistent with good grooming of the yard and home environment.

Acknowledgments

Figure 1 by Emily Oseas Routman.

For Additional Information


NONPOISONOUS SNAKES

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Fig. 1. Bullsnake (gopher snake), Pituophis melanoleucus

Damage Prevention and Control Methods

Exclusion
Seal all openings (1/4 inch [0.6 cm] and larger) with mortar, 1/8-inch (0.3-cm) hardware cloth, sheet metal, or steel wool.

A snake-proof fence can be used to exclude snakes.

Habitat Modification
Reduce rodent populations.

Keep all vegetation closely mowed; remove bushes, shrubs, rocks, boards, firewood, and debris lying close to the ground, especially around buildings.

Alter all sites that provide cool, damp, dark habitat for snakes.

Frightening
Not applicable.

Repellents
Several snake repellents have been promoted, but none are consistently effective.

Toxicants
None are registered.

Fumigants
None are registered.

Trapping
A funnel trap with drift fences can be used.

Shooting
Nonpoisonous snakes are protected by law in most states and indiscriminate killing is illegal. Shooting or clubbing is effective, however, where it is allowed, with permission from the state wildlife agency.

Other Methods

Remove snakes from inside buildings by placing piles of damp burlap bags or towels in areas where snakes have been seen. After snakes have been attracted, remove the bags and snake(s) from the building.

Glue boards can be used to capture snakes found inside houses or other buildings. Once caught, the snake and board can be taken outside. The snake can be released unharmed by pouring vegetable oil on it (the oil counteracts the adhesive).

Since nonpoisonous snakes are completely harmless, control programs for them are not necessary. Learn how to distinguish between poisonous and nonpoisonous snakes in your area.
Identification

Of the many kinds of snakes found in the United States, only the following are harmful: rattlesnakes, copperheads, cottonmouths, coral snakes, and sea snakes. The latter group lives only in the oceans. All poisonous snakes, except coral snakes and sea snakes, belong in a group called pit vipers. There are three ways to distinguish between pit vipers and nonpoisonous snakes in the United States:

(1) All pit vipers have a deep pit on each side of the head, midway between the eye and the nostril. Nonpoisonous snakes do not have these pits.

(2) On the underside of the tail of pit vipers, scales go all the way across in one row (except on the very tip of the tail, which may have two rows in some cases). On the underside of the tail of all nonpoisonous snakes, scales are in two rows all the way from the vent of the snake to the tip of the tail (Fig. 2). The shed skin of a snake shows the same characteristics.

(3) The pupil of pit vipers is vertically elliptical (egg-shaped). In very bright light, the pupil may be almost a vertical line, due to extreme contraction to shut out light. The pupil of nonpoisonous snakes is perfectly round (Fig. 3).

The poisonous coral snake is ringed with red, yellow, and black, with red and yellow rings touching. Nonpoisonous mimics of the coral snake (such as the scarlet king snake) have red and yellow rings, separated by black rings. A helpful saying to memorize is: “Red on yellow, kill a fellow; red on black, friend of Jack.”

Range

Some species of nonpoisonous snakes occur throughout several states, but the majority have only limited ranges.

Habitat

Snakes are not very mobile, and even though some are fairly adaptable, most have specific habitat requirements. Some live underground (these are mostly small in size), and some have eyes shielded by scales of the head. Others, such as green snakes, live primarily in trees. One group spends its entire life in the oceans. In general, snakes like cool, damp, dark areas where they can find food. The following are areas around the home that seem to be attractive to snakes: firewood stacked directly on the ground; old lumber piles; junk piles; flower beds with heavy mulch; gardens; unkempt basements; shrubbery growing against foundations; barn lofts—especially where stored feed attracts rodents; attics in houses where there is a rodent or bat problem; stream banks; pond banks where there are boards, innertubes, tires, planks, and other items lying on the bank; unmowed lawns; and abandoned lots and fields.

Food Habits

All snakes are predators, and the different species eat many different kinds of food. Rat snakes eat primarily rodents (such as rats, mice, and chipmunks), bird eggs, and baby birds. King snakes eat other snakes, as well as rodents, young birds, and bird eggs. Some snakes, such as green snakes, eat primarily insects. Some small snakes, such as earth snakes and worm snakes, eat earthworms, slugs, and salamanders. Water snakes eat primarily frogs, fish, and tadpoles.

General Biology, Reproduction, and Behavior

Snakes are specialized animals, having elongated bodies and no legs. They have no ears, externally or internally, and no eyelids, except for a protective window beneath which the eye moves. The organs of the body are elongated. Snakes have a long, forked tongue,
which helps them smell. Gaseous particles from odors are picked up by the tongue and inserted into the two-holed organ, called the Jacobson’s Organ, at the roof of the mouth.

The two halves of the lower jaw are not fused, but are connected by a ligament to each other. They are also loosely connected so the snake can swallow food much larger than its head. Because snakes are cold-blooded and not very active, one meal may last them several weeks. Also, because they are cold-blooded, they may hibernate during cold weather months or aestivate during hot summer months when the climate is severe. In either case, they consume little or no food during these times. Some snakes lay eggs, some hatch their eggs inside the body, and some give live birth. The young of copperheads, rattlesnakes, and cottonmouths are born alive.

Nonpoisonous snakes are harmless to humans. In most cases, a snake will crawl away when approached if it feels it can reach cover safely. No snakes charge or attack people, with the exception of the racers, which occasionally bluff by advancing toward an intruder. Racers will retreat rapidly, however, if challenged. Snakes react only when cornered. Different species react in different ways, playing dead by turning over on the back, hissing, opening the mouth in a menacing manner, coiling, and striking and biting if necessary.

Damage and Damage Identification

A nonpoisonous snake bite has no venom and can do no more harm than frighten the victim. After being bitten several thousand times by nonpoisonous snakes, the author and his students have never suffered any adverse reaction, and no treatment was ever used. The only harm nonpoisonous snakes can cause is frightening people who are not familiar with them. A bite from a poisonous snake, however, causes an almost immediate reaction—swelling, tissue turning a dark blue-black, a tingling sensation, and nausea. If none of these is observed or felt, the bite was from a nonpoisonous snake. Also, bites from one of the pit vipers (copperheads, rattlesnakes, and cottonmouths) will reveal two fang marks, in addition to teeth marks. All snakes have teeth; only pit vipers have fangs. North American pit vipers have only two rows of teeth on top and two on the bottom, whereas nonpoisonous snakes have four on top and four on the bottom.

Legal Status

In most states, snakes are considered nongame wildlife and are protected by state law unless they are about to cause personal or property damage. Therefore, snakes should not be indiscriminately killed. Some species are listed on federal and/or state threatened and endangered species lists.

Damage Prevention and Control Methods

Exclusion

Snakes enter houses, barns and other buildings when habitat conditions are suitable inside the buildings. They are particularly attracted to rodents and insects as well as cool, damp, dark areas often associated with buildings. All openings 1/4 inch (0.6 cm) and larger should be sealed to exclude snakes. Check the corners of doors and windows, as well as around water pipe and electrical service entrances. Holes in masonry foundations (poured concrete and concrete blocks or bricks) should be sealed with mortar to exclude snakes. Holes in wooden buildings can be sealed with fine mesh (1/8-inch [0.3-cm]) hardware cloth or sheet metal.

In some cases, the homeowner may get peace of mind by constructing a snakeproof fence around the home or yard (Fig. 4). A properly constructed snakeproof fence will keep out all poisonous snakes and most harmless snakes (some nonpoisonous snakes are fairly good climbers). The cost of fencing a whole yard may be high, but it costs little to enclose a play space for children too young to recognize dangerous snakes. The following design is taken from information from the US Fish and Wildlife Service.

The fence should be made of heavy galvanized hardware cloth, 36 inches (91 cm) wide with a 1/4-inch (0.6-cm) mesh. The lower edge should be buried 6 inches (15 cm) in the ground, and the fence should be slanted outward from the bottom to the top at a 30° angle (Fig. 5). Place supporting stakes inside the fence and make sure that any gate is tightly fitted. Gates should swing inward because of the outward slope of the fence. A 36-inch (91-cm) vertical fence with a 12-inch (30-cm) lip at the top, facing outside and angled downward at a 30° angle would probably work as well. Any opening under the fence should be firmly filled—concrete is preferable. Mow all vegetation just outside the fence, for snakes might...
Toxicants
None are registered.

Fumigants
There are no legal fumigants to kill snakes. Moreover, because most snakes do not burrow, using fumigants in underground burrows is not a feasible method of control. In the past, pest control operators have completely encased houses with plastic and fumigated at tremendous expense to the homeowner (several thousand dollars). This is not a reasonable control method for nonpoisonous snakes since the animals being killed are completely harmless.

Trapping
One method reported by researchers to catch snakes involves a funnel trap with drift fences constructed of 1/4-inch or 1/2-inch (0.6- or 1.3-cm) mesh hardware cloth erected 2 feet (0.6 m) high and 25 feet (7.5 m) long. Posts for drift fences should be on the back side of the fence. These fences guide animals into the funnel end of the trap (Fig. 6).

Shooting
Nonpoisonous snakes are protected by law in most states, and indiscriminate killing is illegal. Shooting or clubbing is extremely effective in states where it is allowed and will soon eliminate the snake population. Permission may be required from the local state wildlife agency.

Other Methods
It is not difficult to remove snakes from inside a house or other buildings. Place piles of damp burlap bags or towels in areas where snakes have been seen or are likely to be found. Cover each pile with a dry burlap bag or towel to slow evaporation. Snakes are attracted to damp, cool, dark areas such as these piles. After the bags or towels have been out for a couple of weeks, completely remove them with a large scoop shovel during the middle of the day when snakes are likely to be inside or underneath.

Repellents
Several repellents have been used in the past, but none has been consistently effective. Currently Dr. T’s® Snake-A-Way® is registered for the control of rattlesnakes and the checkered garter snake, but is apparently not effective against most species of snakes. Active ingredients include sulfur and naphthalene. Band applications around the area to be protected are recommended.
(61 x 41 cm) to make a glue patch at least 7 x 12 inches (15 to 30 cm). Place the board against a wall where snakes are likely to travel. Snakes become stuck when they try to cross the board. Do not place the board near any object (pipes or beams) that the snake can use for leverage in attempting to free itself. A hole drilled through the plywood board will allow removal of the board and the entrapped snake with a long stick or hooked pole. Animals trapped in the glue can be removed with the aid of vegetable oil, which counteracts the adhesive.

Do not use glue boards outdoors or in any location where they are likely to catch pets or nontarget wildlife. The glue can be quite messy and is hard to remove from animals.

Economics of Damage and Control

As mentioned earlier, nonpoisonous snakes are completely harmless and cause no damage, except occasionally frightening people. Therefore, no expense toward control of nonpoisonous snakes is justified. Most methods to remove snakes are inexpensive, except for the snake-proof fence, which can be quite expensive.

Acknowledgments

Appreciation is expressed to the US Fish and Wildlife Service for some of the information presented in this chapter, particularly the design of the snake-proof fence.

Figures 1 through 3 by Emily Oseas Routman.
Figures 4 through 6 by Jill Sack Johnson.

For Additional Information


Editors

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Damage Prevention and Control Methods*

Exclusion
Construct a snake-proof fence around areas of human activity.
Seal entrances to buildings and structures.

Habitat Modification
Eliminate shelter for snakes.
Control rodents; they attract snakes.

Repellents
None are available.

Toxicants
None are available.

Fumigants
Generally not effective in dens.

Trapping
Effective in some situations when properly placed.
Glue boards are useful in removing rattlesnakes from buildings.

Shooting
Effective where safe.

Other Methods
Organized snake hunts may be successful in spring or early summer.

Snake Bite
Wear protective clothing and be careful when climbing and walking.
If a bite occurs, keep the victim calm, warm, and reassured. Seek medical attention immediately.

Introduction
Rattlesnakes are distinctly American serpents. They all have a jointed rattle at the tip of the tail, except for one rare species on an island off the Mexican coast. This chapter concerns the genus Crotalus, of the pit viper family Crotalidae, suborder Serpentes. Since snakes evolved from lizards, both groups make up the order Squamata.

This article describes the characteristics of the common species of rattlesnakes that belong to the genus Crotalus. These include the eastern diamondback, (C. adamanteus); the western diamond (back) rattlesnake, (C. atrox); the red diamond rattlesnake, (C. ruber); the Mohave rattlesnake, (C. scutulatus); the sidewinder, (C. ceraster); timber rattlesnake, (C. horridus); three subspecies of the western rattlesnake, (C. viridis); the prairie rattlesnake (C. v. viridis); the Great Basin rattlesnake (C. v. lutosus); and the Pacific rattlesnake (C. v. oreganus).

*Information pertains to other poisonous snakes.
There are 15 species of rattlesnakes in the United States and 25 in Mexico. Other front-fanged poisonous snakes of the Crotalidae family, which are not included in this discussion, are the massasauga and pigmy rattlesnakes, both of the genus *Sistrurus*. Also not included are two snakes that do not have rattles, hence are not called rattlesnakes: the water moccasin or cottonmouth, and the copperhead, both of the genus *Agkistrodon*. Two other genera of poisonous snakes in North America are coral snakes (*Micrurus* and *Micruroides*) of the family *Elapidae*.

**Identification**

Rattlesnakes are usually identified by their warning rattle — a hiss or buzz — made by the rattle at the tip of their tails. A rattlesnake is born with a button, or rattler, and acquires a new rattle section each time it molts. Rattlesnakes also are distinguished by having rather flattened, triangular heads. The heads of all *Crotalus* rattlesnakes are about twice as wide as their necks. Only pit vipers possess this head configuration; coral snakes do not.

Rattlesnakes belong to the pit viper family Crotalidae, so named because all possess visible loreal pits, or lateral heat sensory organs, between eye and nostril on each side of the head (Fig. 2). These heat sensory pits are not present in true vipers, which do not occur in the Western Hemisphere. The facial pits enable rattlesnakes to seek out and strike, even in darkness, warm objects such as small animal prey, as well as larger animals that could be a threat. The vertically elliptical eye pupils, or “cat eyes,” are also a characteristic of rattlesnakes (Fig. 2). Identifying a dead rattler whose rattles are missing can be done by looking at the snake’s scales on the underside in the short region between the vent and the tip of the tail. If the scales are divided down the center, the snake is harmless. The scales on rattlesnakes are not divided.

Rattlesnakes come in a great variety of colors, depending on the species and stage of molt. Most rattlers are various shades of brown, tan, yellow, gray, black, chalky white, dull red, and olive green. Many have diamond, chevron, or blotched markings on their backs and sides.

**Range and Habitat**

Rattlesnakes occur only in North and South America and range from sea level to perhaps 11,000 feet (over 3,000 m) in California and 14,000 feet (4,000 m) in Mexico, although they are not abundant at the higher elevations. They are found throughout the Great Plains region and most of the United States, from deserts to dense forests and from sea level to fairly high mountains. They need good cover so they can retreat from the sun. Rattles are common in rough terrain and wherever rodents are abundant.

**Food Habits**

Young or small species of rodents comprise the bulk of the food supply for most rattlesnakes. Larger rattlers may capture and consume squirrels, prairie dogs, wood rats, cottontails, and young jackrabbits. Occasionally, even small carnivores like weasels and skunks are taken. Ground-nesting birds and bird eggs can also make up an appreciable amount of the diet of some rattlers. Lizards are frequently taken by rattlers, especially in the Southwest. The smaller species of rattlesnakes and young rattlesnakes regularly feed on lizards and amphibians. Rattlesnakes consume about 40% of their own body weight each year. Many prey are killed but not eaten by rattlesnakes because they are too large or cannot be tracked after being struck. One male rattler captured in the field had consumed 123% of its weight, but young rattlers frequently die due to lack of food. Domestically raised rattlesnakes will survive when fed only once a year, but in the field, snakes usually feed more than once, depending on the size of prey consumed. A snake may kill several prey, one after another, and of different species. When rodents and rabbits are struck, the prey is immediately released. The snake then uses its tongue to track the prey to where it has died.

Digestion is quite slow and usually no bones remain in the feces, called “scats.” Hair, feathers, and sometimes teeth, however, can usually be identified in scats. Rattlesnakes use very little energy except when active, and they probably are active for less than 10% of their lives. They are not very active unless food is scarce. They store much fat in their bodies, which can last them for long periods.

**General Biology, Reproduction, and Behavior**

When a rattlesnake strikes its prey or enemy, the paired fangs unfold from the roof of its mouth. Prior to the completion of the forward strike motion, the fangs become fully erect at the outer tip of the upper jaw. The erectile fangs are hollow and work like hypodermic needles to inject a modified saliva, the venom, into the prey. Rattlesnakes can regulate the amount of venom they inject when they strike.
Mature fangs generally are shed several times a season. They may become embedded in the prey and may even be swallowed with the prey. When one mature fang in a pair is lost, it will soon be replaced by another functional mature fang. A series of developing fangs are located directly behind one another in the same sheath at the rear and outer tip of the mouth (Fig. 3). If a newly replaced fang is artificially removed, it may require weeks or longer before another replacement will be fully effective. One fang can function, however, while the other in the pair is being replaced. Fangs that get stuck in a person’s boot are not very dangerous; they cannot contain much venom since they serve only as a hollow needle. The external opening of the hollow fang is a groove on the outside of the fang, set slightly back from the tip to prevent it from becoming plugged by tissue from the prey (Fig. 3).

Rattlesnakes cannot spit venom, but the impact of a strike against an object can squeeze the venom gland, located in the roof of the mouth, and venom may be squirited. This can happen when a rattler strikes the end of a stick pointed at it, or the wire mesh of a snake trap. The venom is released involuntarily if sufficient pressure is exerted, as occurs when venom is artificially “milked” from live snakes. Such venom is dangerous only if it gets into an open wound. Always wear protective clothing when handling rattlesnakes.

Female rattlesnakes are ovoviviparous. That is, they produce eggs that are retained, grow, and hatch internally. The young of most species of rattlesnakes are 6 to 8 inches (15 to 20 cm) when born. They are born with a single rattle or button, fangs, and venom. They can strike within minutes, but being so small, they are not very dangerous. Average broods consist of 5 to 12 young, but sometimes twice as many may be produced.

The breeding season lasts about 2 months in the spring when the snakes emerge from hibernation. Sperm is thought to survive in the female as long as a year. During summer, pregnant females usually do not feed, so few are ever captured that contain eggs about to hatch. The young are born in the fall. Most rattlesnakes are mature in 3 years, but may require more time in northerly areas. Rattlesnakes may not produce young every year.

The sex of a rattlesnake is not easy to determine. Even though the tail of the rattlesnake (the distance between the vent and the rattles) is quite short, it is much longer in males than in females of the same size. The paired hemipenes of male snakes are not visible except during mating, when one of these paired hollow organs is turned inside out and extruded from the cloaca. If both are extruded artificially, they appear like two forked, stumpy legs.

Snakes never close their eyes, since they have no eyelids. They are deaf, but can detect vibrations. They have a good sense of smell and vision, and their forked tongues transport microscopic particles from the environment to sensory cells in pits at the roof of the mouth. A rattlesnake uses these pits to track prey it has struck and to gather information about its environment.

Snakes have a large number of ribs and vertebrae with ball-and-socket joints. Each rib is joined to one of the scales on the snake’s underside. The snake accomplishes its smooth flowing glide by hooking the ground with its scales, which are then given a backward push from the ribs. Rattlesnakes often look much larger when seen live than after they have been killed. This happens because their right lung extends almost the full length of the tubular body, and when the snakes inhale they can appear much fatter and more threatening. The expulsion of the air can produce a hiss.

Rattlesnakes, like other snakes, periodically shed their skin. When the new skin underneath is formed, the snake rubs its snout against a stone, twig, or rough surface until a hole is worn through. After it works its head free,
the snake contracts its muscles rhythmically, pushing, pulling, and rubbing, until it can crawl out of the old skin, which peels off like an inverted stocking. Each molt produces a new rattle. Some rattles usually break off from older snakes. Even if no rattles have been lost, they do not indicate exact age because several rattles may be produced in one season.

Even though the optimum temperature for rattlesnakes is around 77° to 89°F (25° to 32°C), the greatest period of activity is spring, when they come out of hibernation and are seeking food. If lizards are active, be alert for rattlesnakes. The activity period for rattlers can vary from about 10 months or so in warm southern regions to perhaps less than 5 months in the north and at high elevations. Depending upon availability of good, dry denning sites below the frost line, rattlesnakes may hibernate alone or in small numbers. However, sometimes they den in large groups of several hundred in abandoned prairie dog burrows or rock caverns, where they lie torpid in groups or “balls.” All dens must be deep enough so the temperature is not affected by occasional warm days. If not, the snakes might emerge too early in spring only to become sluggish and vulnerable should the weather again turn cold. Since snakes are cold-blooded animals and their body temperature is altered by air temperature, refrigeration makes them sluggish and easy to handle for displaying.

Rattlesnakes usually see humans before humans see them, or they detect soil vibrations made by walking. They coil for protection, but they can strike only from a third to a half of their body length. Rattles rely on surprise to strike prey. Once a prey has been struck, but not killed, it is unlikely that it will be struck again. Experienced rodents and dogs can evade rattlesnake strikes.

Rattlesnakes may appear quite aggressive if exposed to warm sunshine. Since they have no effective cooling mechanism, they may die from heat stroke if kept in the sun on a hot day much longer than 15 or 20 minutes.

If a rattlesnake has just been killed by cutting off its head, it can still bare its fangs and bite. The heat sensory pits will still be functioning, and the warmth of a hand will activate the striking reflex. The head cannot strike, but it can bite and inflict venom. The reflex no longer exists after a few minutes, or as long as an hour or more if it is cool, as rigor mortis sets in.

**Damage and Damage Identification**

The greatest danger to humans from rattlesnakes is that small children may be struck while rolling and tumbling in the grass. Only about 1,000 people are bitten and less than a dozen people die from rattlesnake venom each year in the United States. Nevertheless, it is a most unpleasant experience to be struck. The venom, a toxic enzyme synthesized in the snake’s venom glands, causes tissue damage, as it tends to quickly tenderize its prey. When known to be abundant, rattlesnakes detract from the enjoyment of outdoor activities. The human fear of rattlesnakes is much greater than the hazard, however, and many harmless snakes inadvertently get killed as a result. Death from a rattlesnake bite is rare and the chance of being bitten in the field is extremely small.

Experienced livestock operators and farmers usually can identify rattlesnake bites on people or on livestock without much difficulty, even if they did not witness the strike. A rattlesnake bite results in almost immediate swelling, darkening of tissue to a dark blue-black color, a tingling sensation, and nausea. Bites will also reveal two fang marks in addition to other teeth marks (all snakes have teeth; only pit vipers have fangs too). Rattlesnakes often bite livestock on the nose or head as the animals attempt to investigate them. Sheep, in particular, may crowd together in shaded areas near water during midday. As a consequence, they also frequently are bitten on the legs or lower body when pushed close to snakes. Fang marks and tissue discoloration that follows in the major blood vessels from the bite area are usually apparent on livestock that are bitten (see Wade and Bowns 1982, pages 32 and 34 in the Damage Identification section of this book).

**Legal Status**

Most species of rattlesnakes are not considered threatened or endangered. Since they are potentially dangerous, there has not been much support for protecting them except in national parks and preserves. However, since there are state and local restrictions, contact local wildlife agencies for more information.

**Damage Prevention and Control Methods**

An occasional single poisonous snake can be destroyed if one has enough determination. In areas where the habitat is favorable for rattlesnakes, copperheads, or water moccasins, a significant reduction in their population density may be difficult. In snake country, most people learn to “keep their eyes open” and be cautious.

**Exclusion**

When feasible, the most effective way for a homeowner to protect a child’s play area from rattlesnakes is to construct a rattlesnake-proof fence around it. The fencing must be tight. If wire mesh is used, it should be 1/4-inch (0.6-cm) mesh and about 3 feet (1 m) high. Bury the bottom 3 or 4 inches (8 or 10 cm) or bend outward 3 or more inches of the base of the wire to discourage other animals from digging under the fence. Put the stakes on the inside and install a gate that is tight-fitting at the sides and bottom, equipped with a self-closing spring. The benefit of the fence will be lost if wood, junk, or thick vegetation accumulates against the outside of the fence. Vegetation that has ground-level foliage also provides attractive hiding places for rattlesnakes, so it should be removed or properly pruned. Tight-fitting doors will prevent snakes from entering outbuildings. The foundations of all buildings should be sealed or tightly screened with 1/4-inch (0.6-cm) wire mesh to keep out snakes.
**Habitat Modification**

It is always desirable to use nonlethal biological means of control when feasible. Although good quantified data are not available to evaluate the effectiveness of removing the prey of snakes, effective, sustained rodent control will reduce the attractiveness of a rural residence or other facility to rattlesnakes. Snakes will not remain in habitat made less favorable for them. Hiding places under buildings, piles of debris, or dense vegetation should be removed. Hay barns and feed storage areas that encourage rodents will attract rattles.

**Frightening**

No methods are known that will frighten rattlesnakes. Sounds certainly will not work because snakes are deaf.

**Repellents**

Many potential snake repellents have been researched, only to be found ineffective. All species of snakes are likely to cross a strip of repellent substance if they want to get to the other side.

Dr. T's™ Snake-A-Way®, a mixture of sulphur-naphthalene, has been registered by EPA; however, its registration in California was denied as of July 1991, because required data was not submitted. A Y-shaped laboratory enclosure that provided rattlers with a choice of crawling into a tunnel with odor or one free of odor showed they usually chose the passage free of odor. No field test data is available. To be of practical use, the odor of a snake repellent must not be too objectionable to people.

**Toxicants**

No effective toxicant is registered for the control of rattlesnakes. When rodents were poisoned with various rodenticides and then fed to rattlesnakes, the snakes were not affected. Apparently, digestion is too slow for the toxicants to have an effect on snakes.

**Fumigants**

It may be possible to kill rattlesnakes in burrows and rock dens with toxic gas, although this is not a very practical method. Calcium cyanide is a chemical frequently recommended, but no lethal gas has had good success because snakes have such a slow rate of metabolism, especially when in hibernation. In addition, susceptible non-target species in the burrows or dens may become victims.

In the spring and early summer, when hibernating snakes are about to emerge, gasoline poured down a burrow or into a den will drive the snakes out. As the snakes exit they can be clubbed, shot, or captured alive with snake tongs that secure a snake at its neck. If transported in a bag, tie the top securely. Many snake hunters push a hose down a burrow and after listening to confirm that rattlesnakes are present, pour 1 to 2 ounces (30 to 60 ml) of gasoline into a funnel on the hose and then blow on the hose. This technique seems quite effective for seasonally reducing rattlesnake numbers, but it may be lethal to nontarget animals including nonpoisonous and beneficial snakes. To be effective, community-wide campaigns should extend over several days, since many snakes may escape into holes or crevices. Snake hunters should wear protective clothing such as pants, heavy gloves, and boots.

**Trapping**

Various combinations of fencing and traps at known rattlesnake dens can be very successful if one is trying to collect rattlesnakes, because in some localities several hundred rattlesnakes may occupy the same den. If all but one opening can be blocked, it is then quite simple to pipe or otherwise channel the emerging rattlesnakes into a large oil drum or other receptacle. If it is not possible to find all den openings, inward-sloping drift fences of 1/4-inch (0.6-cm) hardware cloth mesh, 1 or 2 feet (0.5 m) high, with fish-type funnel traps (Fig. 4) will suffice. The inward sloping funnel makes it difficult for the snakes to escape. If a wooden nestbox is attached to one side of these traps, the snakes will usually hide in the box and not spend as much time trying to escape. Drift-fence funnel traps also catch many other animals. Therefore, this control method requires daily inspection and usually is not very practical except at dens.

Glue boards are useful for trapping rattlesnakes that are in or under buildings (Knight 1986). To trap rattlesnakes, use a plywood board approximately 24 x 16 inches (61 x 41 cm). Securely tack a 6 x 12-inch (15 x 30-cm) rodent glue trap (or use bulk glue to make a similar-sized glue patch) to the plywood (Fig. 5). Place the board against a wall, as this is where snakes are likely to travel. The rattlesnake will become stuck while attempting to cross the board. Do not place the board near any objects (pipes, beams) that the snake can use for leverage in attempting to free itself.
The best protection for humans when traveling in snake country is common sense in choosing protective foot and leg wear. When climbing, one should beware of putting a hand up over rocks. Rattlesnakes might be waiting there for a rodent, and the warmth in a hand may cause the snake to strike reflexively. Care should be taken at night, when snakes are more active, and the chance of stepping on a snake is greater. Fortunately, rattlesnakes try to avoid people.

The best first aid for a poisonous snake bite is to seek immediate medical care and to keep the victim calm, warm, and reassured. Do not drink alcohol or use ice, cold packs, or freon spray to treat the snake bite or cut the wound, as was once recommended. If a victim of snake bite is several hours from a car and medical aid, apply a light constricting cloth or other band on the bitten limb, 2 to 4 inches (5 to 10 cm) from the bite and between bite and heart. Make sure it is not as tight as a tourniquet. It should be easy to insert a finger under the band. Loosen it if swelling occurs. Apply suction at the wound for at least 3/4 of an hour by mouth (if no mouth sores), or with a snake bite kit, but again, only if medical assistance is several hours away.

The causes of human death from rattlesnake venom are varied, but usually occur from extended hypotension and cardiopulmonary arrest. Usually within a few minutes after being struck the victim will experience pain and swelling at the wound site. The greatest economic loss to humans from rattlesnakes comes from the number of domestic livestock and pets that are killed. Horses and cattle are most frequently struck in the head while grazing. Some have claimed that rattlesnakes benefit ranchers by the number of rodents they eat, but current predator-prey theory discounts this. It is very doubtful that snakes have much effect on the density of rodents.

The commercial value of rattlesnakes consists of the venom, rattles, skins and, to a limited degree, the meat.

**Acknowledgments**

Figures 1 through 3 by Emily Oseas Routman.

Figures 4 and 5 by Jill Sack Johnson.

**For Additional Information**


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TURTLES

Fig. 1. Eastern box turtle, Terrapene carolina

Damage Prevention and Control Methods

Exclusion
Generally not practical. Small areas can be fenced.

Cultural Methods
Routine drainage of fish ponds generally results in lower populations.
Keep levees mowed to make aquaculture ponds less attractive to turtles.
Drain rice irrigation systems during late summer to reduce populations prior to spring planting.

Repellents
None are registered.

Toxicants
None are registered.

Fumigants
None are registered.

Fishing
Hook and line with bait.
Snag pole.

Trapping
Can be effective at certain times and places.

Shooting
Can be used to reduce populations of turtles. Check for local restrictions before discharging firearms. Some states prohibit the shooting of turtles in ponds and lakes.

Identification and Range

Turtles occur on all continents except Antarctica. Over 240 species occur worldwide but turtles are most abundant in eastern North America. Most turtles have good field characteristics that are visible and can be easily identified. Some species, however, require close examination of the shields on the plastron (underside shell) for a positive identification.
General Biology, Reproduction, and Behavior

Any permanent body of water is a potential home for turtles. Some species will also tolerate brackish water, but the sea turtles are the only true saltwater species.

Unlike most other turtles, including soft-shells, snapping turtles rarely bask. Turtles feed on a combination of plant and animal material that includes items such as aquatic weeds, crayfish, carrion, insects, fish, and other small organisms. The diet of snapping turtles, however, usually includes a relatively high proportion of fish. They are relatively aggressive predators, occasionally known to take fish off fish stringers.

All turtles reproduce by laying eggs in early spring. Hatching begins in late summer and extends into the fall, depending on summer temperatures associated with the climate of the range. During winter, turtles usually bury themselves in soft mud or sand in shallow water with only the eyes and snout exposed.

Turtles are easy prey for a number of predator species such as alligators, otters, raccoons, and bears. Humans are probably the greatest threat to turtle populations, particularly for the most commercial species, such as snappers and soft-shells.

Damage

Turtles are seldom a pest to people. Turtles are very beneficial and of economic importance, except in certain areas such as waterfowl sanctuaries, aquaculture facilities, and rice fields in the south. Indiscriminate destruction of turtles is strongly discouraged, and every effort should be made to ensure that local populations are not exterminated unless it can be clearly demonstrated that they are undesirable.

Some species of pond and marsh turtles are occasional economic pests in rice fields in the south. Their feeding activity on young rice often results in significant yield reductions in local areas.

In farm ponds, turtles undoubtedly compete with fish for natural food sources such as crayfish and insects. Turtles, however, are valuable because they kill diseased and weakened fish, and clean up dead or decaying animal matter.

In commercial aquaculture production ponds, turtles can eat fish that are being grown. They also eat fish food. Aquaculture ponds are not the preferred habitat of turtles, however. The heavy clay soils required for pond construction are not conducive to the turtles’ laying of eggs.

Legal Status

Most turtles are not protected by state laws. Licenses usually are required for commercial fishing and sale of turtles. Before taking turtles, contact a state wildlife or conservation agency representative for legal status.

There were two turtles listed by the US Fish and Wildlife Service as endangered or threatened species as of December 1992. The desert tortoise was listed as threatened everywhere except for a population in Arizona. Its historic range is Arizona, California, Nevada, and Utah. The gopher tortoise was listed as threatened wherever found west of the Mobile and Tombigbee rivers in Alabama, Mississippi, and Louisiana. Its historic range is Alabama, Florida, Georgia, Louisiana, Mississippi, and South Carolina.

Five freshwater turtles were listed by the US Fish and Wildlife Service as endangered or threatened species as of December 1992. The Alabama red-bellied turtle and the flattened musk turtle were listed as endangered and threatened, respectively. Alabama is the historic range of both species. The ringed sawback turtle is threatened in its historic range of Louisiana and Mississippi. The yellow-blotched map turtle is threatened in its historic range of Mississippi. The Plymouth red-bellied turtle is endangered in its historic range of Massachusetts.

Additional species under review include the alligator snapping turtle, bog turtles, and the western tortoises.

Damage Prevention and Control Methods

Cultural Methods

The best control for box, pond, and marsh turtles in rice fields is to drain irrigation canals and fallow fields during winter months. Without a permanent water source year-round, these species do not reach large enough populations to become a serious economic problem.

Ponds that are used for the production of channel catfish or other finfish are routinely harvested by seining. The seining process will also capture turtles. Farmers can control turtle populations by moving these captured turtles to their natural habitats.

Repellents, Toxicants, and Fumigants

None are registered.

Trapping

Since turtles generally are not a pest to people, control measures are limited primarily to trapping. Trapping can be used quite effectively to reduce local populations of these species where damage occurs.

The best place to trap turtles is in the quiet water areas of streams and ponds, or in the shallow water of lakes. Soft-bottom areas near aquatic vegetation are excellent spots.

The best seasons for trapping are spring, summer, and early fall. Most turtles hibernate through the winter, except in the extreme south, and do not feed, making trapping ineffective. Methods of trapping are described for various types of turtles in the following sections.

Traps should be baited with fresh fish or red meat. Catfish heads and cut carp are regarded as two of the best baits available for trapping turtles. Baits should be suspended in traps on a bait hook or placed in bait containers.
for maximum effectiveness. In areas where turtle populations are high, it is often necessary to check traps two or three times per day and add fresh bait, since turtles are capable of consuming large quantities of bait rather quickly.

**Snapping and Soft-Shell Turtles.**
While snapping turtles are in hibernation, they often can be taken in quantities from spring holes and old muskrat holes, under old logs, and in soft bottoms of waterways. Turtle collectors rely on their hunting instincts and experience to locate hibernating turtles. When one is found, it pays to explore the surrounding area carefully because snappers often hibernate together. The method for capture, known as “noodling” or “snagging,” requires a stout hook. One end of an iron rod is bent to form a hook and sharpened; the other end of the rod is used for probing into the mud or soil to locate the turtles. The hunter probes about in the mud bottom until a turtle is located (which feels much like a piece of wood) and then pulls it out with the hook. Turtles are inactive during the winter and offer little resistance to capture, although the landing of large ones may be difficult even for experienced hunters.

Snappers and soft-shelled turtles are sometimes taken on set lines baited with cut fish or other fresh meat. One recommended device is made by tying 4 or 5 feet (1.2 or 1.5 m) of line to a stout flexible pole, 6 to 8 feet (1.8 to 2.4 m) long. About 12 inches (30.5 cm) of No. 16 steel wire is placed between the line and the hook, preferably a stout hook about 1 inch (2.5 cm) across between barb and shaft. The end of the pole is pushed into the bank far enough to make it secure at an angle that will hold the bait a few inches (cm) above the bottom.

Snappers and soft-shelled turtles may also be taken readily in baited fyke or hoop nets (Fig. 2). These barrel-shaped traps may sometimes be purchased on the market or made from 3-inch (7.6-cm) square mesh of No. 24 nylon seine twine. The trap should be 4 to 6 feet (1.2 to 1.8 m) long from front to back hoop. The three to five hoops per trap

Fig. 2. Hoop net turtle trap.
should be 30 inches (76 cm) in diameter, made of wood or 6-gauge steel wire with welded joints. The funnel-shaped mouth should be 18 inches (46 cm) deep from the front hoop to the opening inside. The entrance opening of the funnel should be 1 inch x 20 inches (2.5 x 51 cm). The corners of the opening are tied by twine to the middle hoop. The rear or "box" end may be closed with a purse string. After the hoops have been installed, the net should be treated with a preservative of tanbark, cooper oleate, tar, or asphalt. To keep the trap extended, stretchers of wood or steel wire, about 9 gauge or larger, are fastened along each side.

Coarse mesh poultry wire may be substituted for the twine. If this is done, the frame will be approximately 30 inches (76 cm) square. The shape and dimensions of the entrance as specified should be the same in all traps, as it is easily negotiated by the turtles. The dimensions of the trap may be altered for ease of transportation. A door may be installed in the top to facilitate baiting and removal of turtles. Entrance funnels may be placed on each end if desired.

Fyke or hoop turtle traps should be set with the tops of the hoops just out of the water. This will permit the turtles to obtain air and lessen their struggles to escape, and will enable other turtles to enter the trap more freely. It is necessary to set traps this way if the turtles are to be taken alive. Traps set in streams must be anchored. If the water is too deep for the top of the trap to be out of the water, short logs can be lashed to each side to float the trap. Turtles enter more readily when the mouth of the trap is set downstream.

**Box, Pond, and Marsh Turtles.**

Because of their habits, these species must be captured with methods different from those for snapping and soft-shelled turtles. They cannot be taken in numbers during the winter, like snappers, because they do not congregate in their hibernating places. In the summer some species are gregarious, crowding together in numbers on projecting logs and banks. By taking
advantage of this fact, these basking species may be taken by trapping in a box sunk in a place the turtles are using. The turtles crawl up onto the top of the box to bask in the sun, and many of them fall into the trap (Fig. 3).

The top frame of the box may be constructed from discarded telephone poles, imperfect ties, or logs about 8 inches (20 cm) in diameter. Old natural unpainted wood is preferred. The logs are mitered at each end to fit together, and the inside enclosure made to measure 2 to 3 feet (61 to 91 cm) square. About half of each log from the top center to the inside under center is lined with zinc or galvanized metal. Turtles that have dropped into the trap are unable to climb over the zinc or galvanized metal covering. From the outside water edge to the top of each log, cleats can be nailed or the logs made rough, so turtles can easily climb on top. Galvanized mesh wire can be fastened to the logs with staples, hooks, or wire to form a wire basket fitting the opening between the logs. One-inch (2.5-cm) mesh is about right if all sizes of turtles are to be trapped. If only larger specimens are sought, however, a 3-inch (7.6-cm) mesh can be used. The trap should be fastened to a stump or some other permanent anchor.

Some trappers prefer to use bait; others leave the traps unbaited. For the capture of snapping and soft-shelled turtles, the trap can be modified by installing funnel-like entrances on one or two sides as described for the hoop traps.

Another type of trap consists of a box with an inclined board leading up to it. The turtles climb up on the board to bask and drop off into the box. Figure 4 shows the same trap with pivotal boards placed so that turtles crawling out on the boards overbalance on the terminal end and are dropped into the box.

**Economics of Damage and Control**

Three groups of turtles are of economic importance in North America. They include the snapping turtles; the box, pond, and marsh turtles; and the soft-shelled turtles. Snapping turtles are trapped for human consumption and are being considered for aquaculture. Red-eared turtles are cultured for the foreign pet trade. Soft-shell turtles are also trapped for human consumption.

Damage is typically of little economic concern, but may be a problem in rice and aquacultural production.

**Acknowledgments**

Figure 1 from C. W. Schwartz: Wildlife Drawings (1980), Missouri Department of Conservation, Jefferson City.

Figures 2 through 4 from Wildlife Damage Control Handbook (1969), Kansas State University, Manhattan. Adapted by Emily Oseas Routman.

**For Additional Information**


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