American Alligator

The American alligator, *Alligator mississippiensis*, occurs throughout most of the southeastern United States. Alligators were once hunted primarily to produce leather products, which became fashionable in the late 1800s. Untold numbers of animals were killed during decades of unregulated hunting. Even after limited protection was put into effect in some areas in the mid-1900s, animals continued to be poached. As a result, alligator numbers were dramatically reduced and in some regions it was feared that local populations would go extinct. Federal legislation in the 1970s and 1980s, including the Endangered Species Act of 1973 and amendments to the Lacey Act in 1981, ensured the alligator's protection, and eventually its comeback. Today alligator numbers are estimated in the millions and they are common throughout most of their historic range.

The story of the American alligator, both tragedy and success, is similar to that of many of its close kin, the crocodiles. Worldwide there are 23 species of crocodilians; most were also hunted for food and skins, and by 1971 all crocodilians were endangered, threatened, or declining in numbers. Habitat destruction in many countries exacerbated the declines. But a combination of legislation, effective law enforcement, dedicated conservationists, and innovative sustainable yield harvesting programs reversed the decline for many species, despite continuing habitat loss. Since the 1970s 16 of the 23 crocodilian species have increased in population size. However, some species, such as the Chinese alligator, remain highly endangered in the wild.

The current federal protection status of the alligator remains as "threatened due to similarity of appearance" to endangered crocodiles (and products made from their skin). In some states alligators may be harvested using controlled hunts. Alligators are also bred and raised in captivity for the production of meat and skins, but most of the half million farmed alligators are hatched from eggs collected from the wild. The products from these tightly regulated wild harvests and alligator farms are now sold legally, providing important funds for the conservation of this species and its habitat.

Alligator Ecology

Habitat

Alligators live in fresh and brackish water habitats but will venture into salt water. Alligators inhabit swamps, tidal marshes, creeks and rivers, canals, ponds, lakes, and reservoirs. In some areas alligators do something that only a few species, such as humans and beavers, do—create wetland habitat. In marsh, sawgrass, and floodplain habitats gators sometimes create "gator holes," which provide a refuge for many other animals during dry periods. Alligators create the holes, which can be the size of a small backyard pool, using their snout, forefeet, and tail. Alligators are called a "keystone species" due to the strong influence they have on other species.

Alligator in a gator hole (photo by T.C. Glenn, SREL).

The habitat preferences of alligators depend somewhat on the size, age, and sex of the gator. Large adult male alligators generally prefer deep, open water during the entire active season. Large females also are found in open water during the breeding season, but then move to marshes and lake edges during the nesting season and after young have hatched. Smaller alligators (4-5 ft/1.2-1.5 m or less) typically occur in wetlands with relatively dense vegetation, which provides both a hiding place and good habitat for prey items.

Reproduction, nesting, & hatching

The time it takes for alligators to become mature, and thus able to reproduce, varies from population to population. Reproductive maturity in alligators is primarily related to body size, so the age at which an individual can breed depends on how fast it grows throughout its life. Both males and females tend to mature at about 6 feet (1.8 m) in length, but the size at which an alligator may successfully breed is also dependent upon social interactions among members of the population. The courtship and breeding season for alligators is generally from April through May, although there are some reports of autumn mating. Breeding occurs in open water. Body posturing, snout rubbing, water slapping, and bellowing are all part of the courtship process.

After mating, females construct shoreline mound nests made from vegetation, leaf litter, and mud. In June and July females lay 20-60 eggs in the nest and cover them with additional vegetation and debris. The temperature of the nest during the middle third of the incubation period determines the sex of the hatchlings. Constant incubation temperatures below 87.8°F (31°C) during this period produce only females, temperatures between 90.5 and 91.4°F (32.5-33°C) produce only males, and temperatures above 93.2°F (34°C) produce a high proportion of females. It generally takes a little more than two months for the embryos to develop and for hatchlings to emerge from the eggs. Eggs in alligator nests are often preyed upon by raccoons, opossums, skunks, pigs, and other nest predators. For example, in Florida it is considered "normal" if only 50% of the eggs escape predation and hatch. At hatching time the babies make a call that attracts the female. She uncovers the hatchlings in the nest by digging with her front feet and snout and may carry hatchlings in her mouth from the nest to the water's edge.

Hatchling gator hitching a ride on Mom.

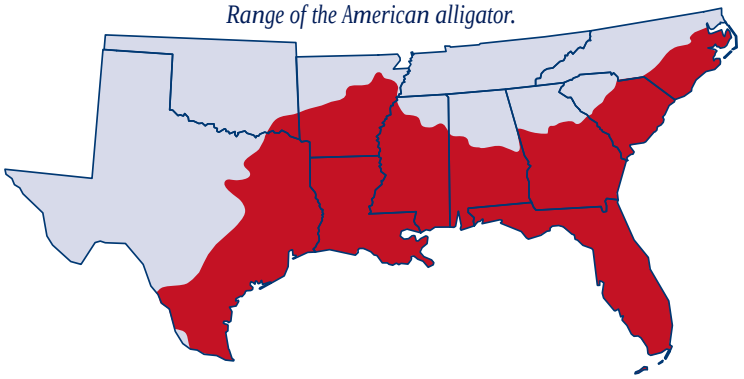
Most reptile species do very little "parenting," especially after the eggs have hatched. In contrast, female alligators will protect babies at all stages: eggs in the nest, hatchlings, and babies up to three years old. Hatchling gators generally stay together in a "pod" for 1-3 years, and make a call (presumably a distress call) to which females respond. Nonetheless, many hatchlings are preyed upon by a wide variety of animals, including large wading birds, snakes, bass, and even bullfrogs.

Feeding habits

The diet of alligators is quite varied, and is dependent upon the size of the gator. All gators, regardless of size, are primarily carnivores, although some plant material may incidentally be ingested. Hatchlings and young alligators eat insects, crayfish, snails and other invertebrates, small fish, and amphibians. At 5-6 ft long (1.5-1.8 m) alligators begin to feed more on large fish, turtles, snakes, waterfowl and wading birds, and small mammals. In addition to keen eyesight, hundreds of specialized pressure sensors on the snouts of gators help them locate prey in the water; these bumps are sensitive enough to detect ripples from a single drop of water. Because alligators are "cold blooded" their feeding activity is dependent on water temperature—gators will usually stop feeding if water temperatures are below approximately 70°F (21°C). Thus, alligators generally feed from late March/early April through October.

Growth & body size

Growth rates in young alligators vary from 4-14" (10-36 cm) per year, depending on



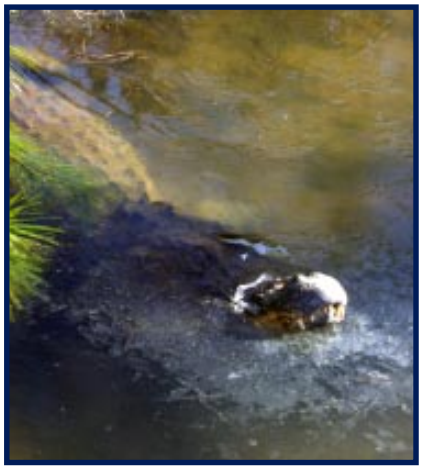
Range of the American alligator.

temperature, food resources of the habitat, and the animal's sex, size, and age. For example, juvenile alligators in some South Carolina populations average 7.5" (19 cm) of growth per year, while those in Louisiana may grow 12" (30.5 cm) per year. Because maturity is related to body size, this means that alligators in Louisiana may reach maturity earlier than those in South Carolina. As alligators get larger their growth rate slows, and once an alligator becomes reproductively mature its growth rate drops dramatically. Male alligators grow faster and larger than females. Females can attain approximately 9 ft (2.7 m) in length and 200+ lbs (91 kg). Males can grow to 13+ ft (4 m) and 500+ lbs (227 kg). The record alligator, taken on Marsh Island, Louisiana, was reported to be 19'2" long.

Interesting behaviors

For an animal with a maximum brain mass of less than ½ ounce (~10.5 grams), alligators demonstrate some interesting behaviors.

- In the temperate portions of their range, alligators construct dens (a cave-like structure in the bank of the waterway) where they remain dormant during winter months. Gators also exhibit "icing behavior" in response to extreme cold. Before a pond freezes, an adult will move to shallow water, place its nostrils (on the tip of the snout) out of the water, and let its snout become frozen into the ice. Hatchlings and juveniles may not be as successful at this, which may explain (in part) the limits to the range of the alligator.
- Humans can hear a wide variety of the sounds that alligators use to communicate, from coughing and hissing to distress yelps, hatching calls, and bellowing. In addition, alligators are one of many species of animals that communicate using sounds that we cannot hear. Humans hear sound in the range of 20-20,000 Hz (hertz; cycles per second), and some alligator vocalizations are below 20 Hz, in the infrasound range. Low frequency sound can travel very long distances.



An alligator exhibiting "icing" behavoir.

- Researchers who have used radiotransmitters to track alligators have learned that they have large home range sizes, with males using a larger area than females. Males move the most and have their largest home ranges during the breeding season, and females move the least and have their smallest ranges during the nesting season. Alligator home range size depends on many factors, including the location and type of habitat, but an adult male alligator may have a home range of more than 1,000 acres.
- Unique among reptiles, crocodilians have been observed bringing food to their young.

Alligator Research at SREL

The University of Georgia's Savannah River Ecology Laboratory (SREL) began conducting ecological studies on the newly created Savannah River Site (SRS) on the upper Coastal Plain of South Carolina in 1951. Studies of the American alligator on the SRS have increased our knowledge about its basic ecology and provided insights on the effects of industrial facilities on alligators. SREL's ongoing research, in collaboration with researchers from around the world, continues to lead to new discoveries about alligators and other crocodilians.

The SREL program of alligator research began in the late 1960s when nuclear production reactors were periodically discharging heated effluents into cooling reservoirs and streams on the SRS. The heated waters created unique gradients of water temperature never before experienced by alligators. As one example of a "thermal effect," alligators that inhabited the warm portions of the 2,840 acre (1,150 hectare) Par Pond reservoir were noted to bask less frequently, especially during cooler months, than gators in normal-temperature water. Research over the next decade documented the seasonal use of heated waters, particularly by larger males that moved into the warm waters and remained active during the winter months of the year. The prolonged active season of these larger male alligators seemed to put them out of

reproductive synchronization with females that remained in the cooler parts of the reservoir and entered typical winter dormancy. Researchers speculated that the altered male activity cycle may have caused a change in the timing of male reproduction, and made males incapable of breeding by the time females became active and ready to breed in the spring. Indeed, the early gator population at Par Pond had an unusually high proportion of adults (64%) and few juveniles, the pattern one might expect if females were not nesting and producing young. However, the same pattern might occur if males are more likely than females to colonize new aquatic habitats, resulting in a male-biased sex ratio with few adult females available for breeding. In 1974 there were 3.2 male alligators for every female, and only an estimated 15 females in all of Par Pond. Multiple possible causes for a single observed pattern illustrates why science can be so challenging!

By the mid-1980s the Par Pond alligator population had nearly doubled from 1974 estimates, to a total of almost 200 adults and juveniles (42%), with 24 adult females.

The American alligator (top) and American crocodile (right) are native to the U.S. The spectacled caiman (lower left) is established in parts of south Florida. Species are distinguished primarily by location (range and habitat), head shape, and teeth.

SREL scientists found themselves in a unique position in 1991, when Par Pond was lowered approximately 18 ft (5.5 m) while repairs were made to the dam. Radiotracking studies during the 3-year period of low water level showed that breeding females remained in the lowered reservoir and continued to nest successfully. However, survival of young from these nests was extremely low because the draw-down had denuded the reservoir shoreline of much of the emergent aquatic vegetation that newly hatched alligators need for protection from predators. Some adult alligators, primarily males, moved from Par Pond to nearby bodies of water. L-Lake, a new reservoir constructed in late 1985, is approximately 4 miles (6.4 km) from Par Pond. By 1988 alligators had not colonized the reservoir, but in the 1990s alligators began to take up residence in the new lake, although none were identified as known Par Pond animals. Researchers continue to study the colonization of L-Lake by alligators, which had reached a population size of several dozen (mostly adults) by the late 1990s.

SREL biologists have also used the technique of radiotelemetry to learn about alligator physiology. Radiotransmitters can be designed so that the pulse rate of the radio signal is dependent on temperature, simply meaning that the sound a biologist hears when tracking the animal is slower when cold and faster when warm. In the case of a large alligator, researchers attached one transmitter on a collar to the outside of the animal, and inserted one transmitter into the stomach, so that both the environmental temperature and body temperature were determined. Using these methods researchers studied the body temperature and behavior relationships of larger alligators as they faced cold weather in unheated reservoirs.

Similar techniques were used in other studies of the effects of thermal effluent from reactors. In addition to cooling reservoirs, three SRS streams received thermal effluent during periods of reactor operation. In the 1980s SREL researchers examined how hot water plumes in SRS streams affected alligators. At the time, alligators were still a federally listed endangered species in inland South Carolina, and the impact of hot water on alligators was of concern to the Department of Energy. Researchers had already determined that the critical thermal maximum (CTM), or the temperature at which alligators would overheat and die, was 100°F (38°C). Temperatures in parts of some SRS streams exceeded 104°F (40°C) when reactors were operating. How did alligators respond when water

Gator FACTS

Federal status

"Threatened due to similarity of appearance" to other crocodilian species

Size/age at maturity

6 ft./dependent on growth rates

Typical maximum size

males–13 to 14 feet,
females–9 to 10 feet

Largest SRS alligator

12'10" male that died in 1996

Weight

varies; adult males can be 500+ pounds

Longevity

40 or more years in the wild, record 66 years in captivity

Home range size

up to 2,000 acres for adult males

Hatchling size

8 to 10 inches

Clutch size

20–60 eggs

Incubation period

approximately 65 days

Teeth

74 to 80

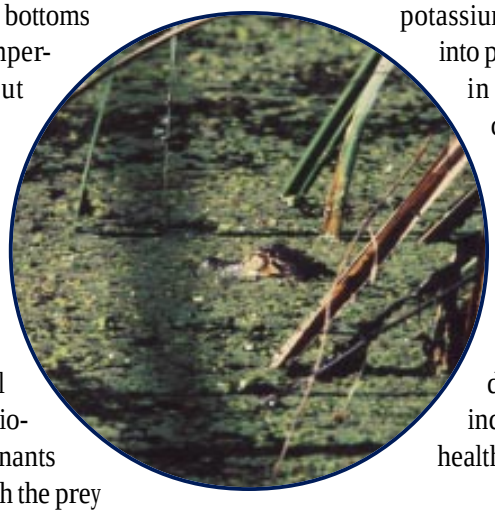
Name origin

Alligator is derived from the Spanish *el lagarto* which means "the lizard"; *mississippiensis* means "of or belonging to the Mississippi"

Ancestry

fossil records of crocodilian ancestors, archosaurs, are known from 225 million years ago; archosaurs are thought to have given rise to dinosaurs and birds

temperatures rose to such extremes? By using the combination of external and internal temperature-sensitive transmitters, researchers learned that alligators responded to thermal cues very rapidly, seeking cooler waters in coves, stream edges, or on stream bottoms once their body temperature reached about 91°F (33°C).



Like many wildlife species, alligators are vulnerable to environmental contaminants. Because alligators are top-level carnivores, they can bioaccumulate contaminants in their tissues through the prey items they ingest. Some environmental contaminants can be passed from female alligators to eggs, potentially adversely affecting the health of developing offspring. Scientists at SREL are studying maternal transfer of contaminants from females to their offspring. On the SRS, alligators nest in a swamp downstream from a coal-burning power plant. The swamp is contaminated with a variety of potentially toxic trace elements including arsenic, cadmium, and selenium (Se). Of these elements, selenium is of great concern because it readily bioaccumulates and causes developmental abnormalities when transferred from females to developing embryos. Monitoring efforts in the contaminated system revealed that adult female alligators accumulate Se and transfer significant quantities to their eggs. Concentrations of Se in eggs and hatchlings collected from the contaminated site are 3-5 times higher than levels from uncontaminated samples. Fortunately, the concentrations of Se do not appear high enough to adversely affect developing offspring; embryonic development, hatching success, and hatchling size all appear normal in clutches produced by female alligators nesting in the contaminated area.

Alligators from the Par Pond population have also been the subjects of contaminant studies. Elevated levels of the radioactive element radiocesium (^{137}Cs) occur in some portions of Par Pond as a result of reactor operations. Cesium-137 mimics elemental potassium when incorporated into plant and animal tissues; in animals it tends to concentrate in muscle tissue. SREL studies concluded that although some individuals had elevated levels of ^{137}Cs in their bodies, there were no detectable effects on individual or population health.

There is, however, reason for concern about human consumption of alligators due to a much more widely distributed environmental contaminant, mercury (Hg). Point-source pollution and atmospheric transport of this metal have resulted in many wildlife species having elevated Hg levels, even in "pristine" habitats. High Hg levels are common in wetland habitats and in top-level predators. Alligators are therefore prime candidates for exhibiting high Hg concentrations. Mercury levels in the tissues of SRS alligators, as well as those from other southeastern wetlands, have been analyzed. Although there are no national standards for Hg concentrations in reptile meat, if the same standards that are used for fish were applied to alligators (1 mg Hg/kg wet weight of tissue), then a high proportion of alligators from the Everglades, other areas of Florida, and the SRS would be considered unsafe for human consumption.

SREL scientists are also developing and using modern analytical and DNA techniques to learn about alligators and solve environmental problems. For example, researchers have developed microsatellite DNA loci for alligators, which are the same type of genetic markers used for paternity analyses or

human identification at crime scenes. Using these markers to determine paternity in alligators led to the discovery that about one-third of all gator nests contain offspring from multiple fathers. In addition, although there are many 8-10 ft (2.4-3 m) male alligators in the gator population on the SRS, only the few very large males (11+ ft; 3.4+ m) sire offspring. Finally, microsatellites have been used in investigations of the effects of contaminants, leading to the discovery that the Hg and low-levels of radioactive contamination in some alligators on the SRS are not resulting in increased mutation rates relative to gators from other populations. Continuing research will use these genetic markers to make more discoveries about the biology of alligators, solve other environmental problems, and even produce a map of the alligator genome.

Humans and Alligators

The recovery of alligator populations throughout the Southeast, combined with human population growth and encroachment on wetland habitats, has increased the likelihood of gator-human interactions. Even so, the fact remains that the probability of an alligator attacking a person is extremely low. The number of alligators throughout the range at any given point in time is probably more than three million animals, yet on the average there are fewer than 10 attacks per year. The majority of attacks have occurred in Florida, where there have been 11 fatalities during a 50-year period. Most attacks occur either because alligators have lost their natural fear of humans (due to being illegally fed by people and learning to associate humans with food) or because they are defending a territory. Humans can do several things to minimize the risk of attack:

- Do not feed alligators, thereby causing them to become accustomed to humans.
- Do not swim in areas (especially near heavily vegetated shorelines) where large (>6 feet) alligators are present, particularly at night/dusk when they are feeding.
- Do not attempt to capture alligators—it is dangerous and against the law.
- Do not approach an alligator nest or hatchlings.

The American alligator and some crocodile species are prime examples of the concept of "sustainable use." Sustainable use simply means that an organism is harvested at levels that can be continued indefinitely. The specifics of sustainable use programs vary among crocodilian species, and among populations within a species in different parts of its geographic range. For example, the harvesting program for alligators in Florida differs from programs in Louisiana and other southeastern states; even populations in different lakes within Florida are managed differently. The numbers of adult animals that can be killed, as well as the proportions of eggs and hatchlings that can be removed from the wild, are based on annual population trends. The end result is that the legal, regulated harvest of various life stages does not harm the population, and gator and croc populations can thrive even as humans use them commercially. In fact, many scientists believe that some crocodile species would be in far worse shape, and perhaps would have become extinct, if there were not a sustainable use management program for those species. Carefully managed sustained-yield harvest programs provide direct economic benefits to local people and communities, giving everyone an incentive to protect both the species and its habitat.

This brochure was produced by the Savannah River Ecology Laboratory Environmental Outreach Program, in support of Partners in Amphibian and Reptile Conservation (PARC; www.parcplace.org). Printing was sponsored by SREL (www.uga.edu/srel/), with additional program support from The Christensen Fund and the Department of Energy. Text by David E. Scott, I. Lehr Brisbin, Jr., Travis C. Glenn, and William A. Hopkins. Photographs by David E. Scott (except as noted). Layout and design by Laura L. Janecek.

The University of Georgia
Savannah River Ecology Laboratory

Partners in Amphibian and Reptile Conservation
PARC