AUSTRALIA'S SALTWATER CROCODILE: A THREAT OR A PROMISE?

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As crocodile and human populations collide, Australians debate management for preservation or profit.

ERIC HOFFMAN

When cattleman Hilton Graham stepped from his boat onto the shore of a swamp in the Northern Territory, he was literally walking into the crux of the crocodile conservation dilemma facing Australia. The water behind him exploded. Turning, Graham had one glimpse down the gullet of a huge crocodile a split-second before its jaws slammed shut on him. The crocodile folded him at the waist and held his entire back, hips, and upper legs in rows of spikelike teeth. Graham gasped to his thirteen-year-old companion, "Help me or I'm a goner!"

Peta Lynne Mann grabbed Graham's hand and dug her heels into the slippery bank. The crocodile dragged Graham and Mann into the swamp. The reptile rolled over and banged Graham on the bottom in an attempt to drown him. This maneuver, known as the "death roll," preludes tearing off the limbs and gulping the victim down. Somehow, Mann stayed close. When the crocodile momentarily loosened its grip, she tugged Graham free. The two made it back to the bank where they successfully fought off the crocodile. Graham lapsed into unconsciousness with internal injuries, a crushed arm, and bloody divots in his back and legs. He lived, and Mann received a national award for heroism from Queen Elizabeth.

When this attack occurred seven years ago, it was seen as an isolated incident. In many parts of Australia's tropics, large saltwater crocodiles (*Crocodylus porosus*) were seen so seldom that their presence was no longer taken seriously. However, Graham's experience turned out to be a

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forewarning. Saltwater crocodiles are making a comeback from endangered-species status. Their population resurgence poses a management challenge that pits protection of the animals in the wild against concern for human safety.

The saltwater crocodile is the largest, most aggressive, most territorial crocodile in the world. Adults often weigh a ton or more and measure between 15 and 21 feet long. Only the Nile crocodile compares in size to the saltwater crocodile. Mature American alligators usually weigh 425 pounds and measure 11 feet.

Because of their ability to survive in both saltwater and freshwater, saltwater crocodiles are the most widely distributed crocodile. Although they rarely take to the open ocean, they have turned up in surprising places. Recently a wayward saltwater crocodile scrambled ashore on the South Pacific island of Ponape, 1,000 miles from the nearest known population of its kind. Though never as numerous as American alligators, Nile crocodiles, or South American caymans, saltwater croc-

Crocodylus porosus *lurks among the water-weeds (left). Above, a large specimen has caught its lunch in the swamp. Saltwater crocodiles' only criterion for a good meal is being able to catch it.*

These teeth belong to a 17-foot crocodile which is now being mounted for display at the Australian Museum in Sydney. Grahame Webb estimates the animal's age at sixty to eighty years. While most crocodile teeth are white, Webb attributes the unusual coloration to tannins in the water where the animal lived, relatively immobile and unable to feed regularly. This croc was killed after it developed a habit of attacking boats (below).

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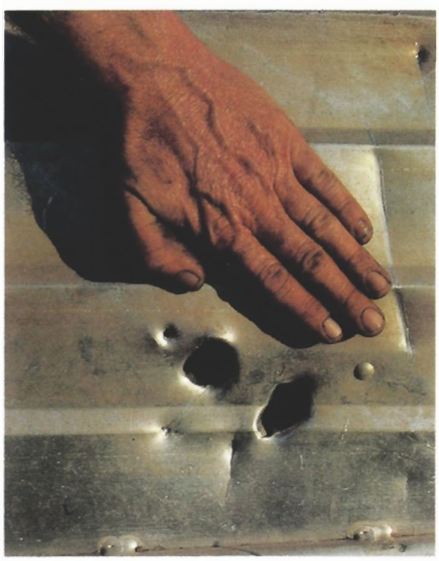

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odiles were once plentiful in India, Southeast Asia, and Pacific island archipelagos. Today the largest populations are found in northern Australia and parts of Papua New Guinea.

Dr. Laurie Taplin, as a University of Sydney postgraduate student, found glands in salties' mouths which expel salt and allow the reptiles to maintain a healthy metabolic balance. This explains how they are able to survive in salt water. The discovery has far-reaching ramifications. Says Taplin, "The popular thinking was that crocodiles had a terrestrial ancestor. These salt-excreting glands raise the possibility that crocodiles actually had a marine ancestor similar to *porosus*." This would imply that saltwater crocodiles are the most primitive species of crocodile alive today.

As the crocodile population in Australia has grown, chance meetings of salties and people have become increasingly frequent. In the past two years, 300 saltwater crocodiles were removed from Darwin Harbor because they posed a threat to sunbathers, boaters, and swimmers. "Sweetheart," a particularly pugnacious old male that had staked out a section of the Finniss River near Darwin, made a habit of biting the propeller shafts of passing small boats, flipping the crafts, and dumping the occupants into the river. It is believed Sweetheart saw small boats as interlopers into his territory. After scuttling a boat Sweetheart politely allowed the terrified fishermen to swim to the riverbank without eating them.

The fishermen victimized by Sweetheart were the lucky ones. Within the last two years a deck hand on a trawler was killed by a 15-foot saltie when she attempted to swim back to her vessel after her skiff developed engine trouble. A canoeist was capsized by a large crocodile and dragged to the bottom before escaping with near-fatal injuries. A man swimming in the MacArthur River was eaten—except for his legs. And, on the Daintree River in northern Queensland, neighbors watched Beryl Wruck vanish, in a mud-spewing swish of a giant tail, as she was wading in knee-deep water.

To avenge her death, Wruck's boyfriend and local citizens spent weeks shooting every large crocodile they could find. Even though saltwater crocodiles are a protected species in Queensland no arrests were made. The Wruck incident exposed a loophole in Queensland law, which states: "A person who kills an Estuarine Crocodile when he believes on reasonable grounds that the crocodile . . . is likely to cause injury to a person is not guilty of an offense." Since nobody knew which crocodile had killed Wruck, all large crocodiles became suspect. Tour boat operators on the Daintree now report that crocodiles are hard to find.

Put in perspective, the chances of being devoured or injured by a saltwater crocodile in Australia's tropics are relatively small, about one-fourth as likely as succumbing in a traffic accident. More unsettling is the fact that the animals causing the problems don't appear to be starving or "rogues," but merely representative of the growing numbers of large crocodiles whose only criterion for a good meal is being able to catch it.

So far, urbanized Australians and their elected representatives favor continued conservation efforts. Nonetheless, rural

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In the past two years, 300 crocodiles have been removed from the mangrove swamps adjoining Darwin Harbor because the animals posed a threat to sunbathers, boaters, and swimmers.

Australians and vacationers are beginning to realize that such activities as sunbathing, swimming, and light boat use are no longer safe. After Wruck's death one rural Queensland politician even called for a "crocodile-free constituency."

Taplin, now the most knowledgeable crocodile expert working in the National Parks and Wildlife Service in Queensland, thinks a fearful public can force ill-conceived public policy. "Already people in management positions find themselves being asked to make immediate decisions without the benefit of research," he says. "The last thing we need is another human mortality." In general, the authorities in Queensland are less well disposed toward conservation of saltwater crocodiles than are their counterparts in the Northern Territory and Western Australia.

Illustration by Paula McKenzie

The range of saltwater crocodiles in Australia is shown in black.

G. D. Anderson/Australasian Nature Transparencies

SALTWATER CROCODILES were hunted for commercial hide export from 1946 until 1972, when their depressed numbers earned them an Appendix I listing in the Convention of International Trade in Endangered Species (CITES). An Appendix I designation is reserved for the most threatened species, and prohibits all international trade of animals taken from the wild, or their products. Salties' hides are the most sought after in the world both because they are easily tanned and because the scales are uniformly small in size, which is a value in the reptile skin market.

Salties can live seventy years. Those that have survived the hunting era are generally very wary. However, hatchlings born in the 1970s are now adults—having reached maturity at twelve to fifteen years of age—and some have shown a disquieting boldness towards people.

The increased number of crocodiles plying the northern waterways guarantees more croc/human confrontations in the future. Dr. Grahame Webb, the resident expert on crocodilian matters at the Conservation Commission of the Northern Territory, estimates the number of salties in the Northern Territory at 50,000. Sightings have increased in Queensland and Western Australia as well, but population studies haven't been completed in either state. It is believed the northern Territory holds most of Australia's salties.

While numbers of crocodiles have increased dramatically in the past fifteen years, human populations within the crocodile habitat have grown sevenfold. In 1946, when commercial hunting began and most saltie habitats were in a pristine state, tourism to the Northern Territory was nearly nonexistent and only 20,000 people lived in the "Top End." Today there are 140,000 residents, and the yearly growth rate is 3 percent. Some 280,000 tourists visit the Northern Territory annually. Prime recreational areas include the freshwater swamps, rivers, beaches, and billabongs (standing areas of freshwater) where the salties reside.

In Queensland there are 2.5 million people, with increasing numbers moving to crocodile habitats in the coastal areas of the tropical north. Tourism, which is principally aimed at the Great Barrier Reef, also attracts a million people annually to the coast. By comparison, Western Australia is sparsely populated. Aborigines, who live along river systems, only occasionally report incidents involving crocodiles.

So far the Northern Territory is the only state to address the management dilemma posed by these demographic changes. Webb, who has studied both salties and Australia's smaller, less aggressive freshwater crocodiles (*Crocodylus johnstoni*) for fifteen years, has approached the challenge from an innovative point of view.

"Management decisions should lead to realistic, long-term conservation programs that are both feasible and acceptable to the public," Webb declares. "These should include flexibility, thinning or restocking when necessary, and providing economic incentives. Some harvesting would enhance the overall economic value of the species. Webb believes that the

Salt-excreting glands in the mouths of Crocodylus porosus *allow the reptiles to live in both saltwater and freshwater habitats.*

views, fears, and values of the people who live around crocodiles have to be taken into consideration and addressed. He asks, "How else can the support of residents be incorporated into a management plan?"

To get the current program underway required all of Webb's talents and contributions from many other scientists. Over a hundred people, two universities, and four wildlife agencies were involved in the formulation of the commision's plan for salties. As with any species, an intelligent management plan could not be devised until the basic biology and ecology was understood. Little has been known about salties until the last ten years.

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THE CROCODILES' greatest concentrations are found in freshwater swamps in the tidal-river systems throughout northern Australia. They're also at home in mangroves, rivers, billabongs, and along coastal beaches, if there are sufficient food sources.

The younger crocodiles eat insects, shrimp, crustaceans, small rodents, turtles, fish, and carrion. The bigger crocodiles become adept at snatching larger game: waterfowl, other crocodiles, kangeroos, wild pigs, and even cattle and horses.

Like all crocodiles, salties play a wait-and-watch game with their prey. Relying on their difficult-to-detect aquatic profile of only nostrils and eyes poking above the surface, they can often draw near their intended victims undetected. At the right distance, they explode onto their prey and gulp it down—if possible. For bigger prey, such as cattle, they will usually wait for an animal to begin drinking. In its attack, the saltie usually grabs the animal's head, twists violently and pulls the animal off balance. The crocodile then drags the prey to deeper water and drowns it.

Because of their ferociousness, saltwater crocodiles pose a very real threat to people. Ted Joanen, who has headed up the conservation effort for American alligators in Louisiana, feels Australia's saltwater crocodiles are scarier than America's alligators. "Salties are like great white sharks in their aggressiveness and attitude towards man. They are also incredibly fast—three times as fast as an alligator. An alligator is a timid creature by comparison." In fact, the saltie's aggressive nature may be a prerequisite for survival in an uncompromising and often unpredictable environment.

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A metal cylinder facilitates the removal of a crocodile's stomach contents (top). This animal's recent diet included the tag from a cow's ear (above).

Saltwater crocodile habitat is typified by tropical climate and distinct wet and dry seasons. In northern Australia during the summer monsoons, rivers often overflow their banks, replenishing freshwater swamps and inundating vast plains. This allows for dispersal of the crocodile population and gives them greater access to prey. On the other hand, the winter is dry and the river courses shrink in size, restricting the crocodiles' mobility and compressing their hunting areas in the river systems. Depending on the intensity and duration of the dry season, competition for space and food can be fierce.

It wouldn't qualify as romantic behavior for most observers, but salties do court each other. There's a great deal of chin rubbing and submissive behavior by the female before mating. Courting and mating activities that start at the end of the dry season add to the level of ferocity. Mature males become more aggressive and territorial, creating additional hazards for

HOME ON THE SWAMP WITH GRAHAME WEBB

George Sack

Dr. Grahame Webb could be the real Crocodile Dundee. Nobody knows saltwater crocodiles better than Webb does, nor has anyone risked his own mortality in front of their jaws as audaciously as he has. His novel *Nununmari* is being made into a full-length film, *Dark Age*, that will be released this year. The novel contains characters close to Webb's heart: a 30-foot saltwater crocodile that eludes and terrorizes those who try to kill it, an aborigine elder who appreciates salties and knows more about them than white men do, and a good guy scientist whose irreverent attitude towards bureaucracy is remarkably like Webb's. The book is a page-turner, and action-packed.

Webb's seventy scientific papers on both species of Australian crocodiles may be less entertaining than his novel, but they are no less impressive. U.S. biologist Ted Joanen, a member of the International Union for the Conservation of Nature's Crocodile Specialist Group, describes Webb as "one of the most dynamic and brilliant scientists I've known. The thoroughness of his work has resulted in deep admiration for his talents." With characteristic modesty about his scientific credentials, Webb says, "I consider myself extremely fortunate to get paid for something like studying crocodiles."

Webb's methods of study often involve peril to life and limb. He has captured around 5,000 crocodiles and visited 500 nests. Routinely called in by authorities to help capture problem crocodiles, he usually shows up wearing thongs, shorts, and a T-shirt. Typically he'll survey a huge crocodile that has been baited into a net-trap, drop two nooses around its snout and announce, "It's a two-Toyota croc!"—which means it will take two four-wheel-drive vehicles to drag the reptile from the swamp. A half hour later Webb has tied the crocodile to the vehicles, towed it up a bank, and winched it into a cattle truck.

Webb recalls the time "I damn near donated my body to saltie conservation." He and two companions climbed out on a tree limb overhanging the Tomkinson River in hopes of locating a 13-foot crocodile whose telemetry equipment needed checking. "You might say the bloody croc got the drop on us," says Webb. The crocodile and three scientists spied each other at the same instant, but before Webb and his companions could get down from the tree and up the river bank to safety, the crocodile positioned itself in the water directly underneath their perch. "We sat there like the Three Stooges. We weren't safe where we were and descending was an even worse alternative." Webb and his companions found yelling and throwing a stick in the crocodile's direction didn't help either.

Finally, the crocodile launched itself

Webb's associates collect eggs from a nest under supervision of a wary mother crocodile.

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A large crocodile is caught in one of Webb's rope traps (top) and measured (below). This animal caused problems in a populated area and was removed to a crocodile ranch

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at the trio. Its mouth slammed shut on the limb just inches under their feet, tearing off bark. And then he dropped back in the water and was gone.

Some of the risks Webb takes are more his own doing. He frequently wades to nests—his only weapon the oar from his aluminum boat. He claims he's just doing his job. "Crocs do attract some scientists who wear leopard underwear and carry a rubber knife in their teeth," he allows, "but that's not my style. I wade in because it's the only way to reach some nests." Without visiting nests he could not collect data on his latest project: determining the relationship between temperature and sex in a developing egg.

Webb must know what he's doing—he's still alive. "I'm deeply respectful and know what to expect from salties," says Webb, as he and Charlie Manolis drop from the boat into hip-deep swamp. "The trick is to be super cautious." Working back to back, Webb and Manolis poke their oars along the bottom to locate the female that may explode towards them at any moment. "Give her a stiff bump on the snout; she'll leave. It works every time," Webb explains as he peers at the bright green swamp grasses and murky water for some sign of the crocodile's movement.

Webb moves gingerly. He finds the female and jabs her. The swirl caused by her tail signals she's departed. Webb moves in, lifts the concealing twigs off the nest, measures the eggs and takes temperature readings at different spots. Manolis keeps vigil nearby with oar at the ready. Webb works fast and leaves the nest as he found it.

Back on board the boat, he seems genuinely embarrassed when he's asked to explain the inch-wide scars on his leg. "It's only happened once," he says apologetically. "I could feel the croc, but I thought she was cane grass under the water. By the time I realized what I was standing on it was too late." The thirty- nine-year-old Webb sighs, "I guess I'm slowing down a little."

He turns his boat towards home. The swamp seems empty, but crocodile eyes poking just above the surface are no doubt watching the intruders' departure. With the sweep of an arm Webb declares, "This is saltie paradise, just like it was a million years ago."

It's his paradise too.

—E.H.

Graham Webb

A female crocodile guards her nest, surrounded by eggshells. A small hatchling can be seen behind her.

smaller crocodiles.

Nesting takes place in the wet season, and nests are always near water. Building the nest, guarding it, and looking after the hatchlings are the female's chores. Typically she stacks mud, reeds, and swamp plants into a pile until it pokes up out of the swamp, in a mound about a yard across. She lays about fifty eggs and buries them a few inches under the surface. Sunshine and the heat produced by the nest's composting vegetation incubate the eggs. Surprisingly, the offspring's sex is not determined at the time the egg is fertilized. Slight fluctuations in the nest's temperature during incubation determine the eventual sex of a crocodile—a phenomenon that also occurs in sea-going turtles.

As the female guards her nest, she often keeps a donut-shaped channel cleared around it. This moat discourages marauding wild pigs and egg-snatching monitor lizards. Any animal approaching a nest quickly discovers just how fast a saltie can move. A full grown saltie has the power to launch its entire body out of the water from a floating position. The female protects her hatchlings for two months before leaving them to fend for themselves.

Yet even a fearless mother can't guarantee her young's survival. Seventy-five percent of the eggs do not survive hatching. Most often, flooding accounts for their demise. It is estimated that fewer than 3 percent of the hatchlings reach maturity.

During the late 1960s and 1970s just finding a freshwater swamp where they could build a nest became difficult for many crocodiles. The reason, scientists learned, was that feral Asian water buffalo (*Bubalus bubalis*) were destroying fragile freshwater swamps. With their bucket-sized hooves the animals cut channels through wetlands, allowing the mats of vegetation used by crocodiles for nesting to float free. In many cases, swamps were emptied altogether, destroying large tracts of nesting habitat. Indirectly, humans, who introduced the buffalo as a meat source at the turn of the century, caused the problem.

WEBB, WHO HAS authored thirty technical papers on salties, collected all available information on the species before outlining the Northern Territory's management plan. His most challenging hurdle was downgrading the endangered species classification of the saltwater crocodile to permit more flexibility in managing the population. Webb and biologists Charlie Manolis, Goff Letts, and Peter Whitehead made a formal proposal to CITES, the International Union for the Conservation of Nature (IUCN), and the Australian Council of Nature Conservation Ministers (CONCOM) all of which had to approve the Northern Territory's plan, if it were ever to be implemented.

The Webb team proposal rejected preservation philosophy and questioned the validity of the scientific evidence upon which much of the existing policies had been based. Instead of maintaining the prevailing preservationist philosophy, which advocated very little human interference with salties and ignored public concerns, the proposal addressed public safety directly and suggested manipulating crocodile populations. It also suggested that economic utilization of crocodiles would best serve the species in the long term. Team member Manolis says, "Successful management must incorporate options that minimize risk to people, garner public support, and allow the species to prosper."

Webb never believed salties belonged on the Appendix I list in the first place. "The two figures most commonly cited were 1,000,000 crocodiles as a pristine population and only 15,500 as today's viable population," he says. "The more I looked at these demographic studies I realized something was wrong."

So, the team reinterpreted the original population models. Through interviews with former commerical crocodile hunt-

The Australian "goanna," or monitor lizard (Varanus gouldii) *is the major predator of saltwater crocodile eggs and hatchlings (top). A hatchling emerges from its shell (below). Seventy-five percent of crocodile eggs do not survive hatching, and fewer than three percent of the hatchlings reach maturity.*

ers and hide exporters, they reconstructed the total number of crocodiles hunted and eventually arrived at an entirely new set of numbers. "We concluded that roughly 250,000 crocs comprised the pre-European population and that there are at least 50,000 salties in the Northern Territory today," Webb states. "For one thing, the original models didn't adequately take into account the high densities of crocs still living in the freshwater swamps."

In Queensland, Taplin concurs that "a great number of crocs in small tidal rivers were not included in the original population models."

This radically different demographic picture of salties ruffled feathers in the Australian academic community, where the first studies had originated, and the

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Wild water buffalo trampling the swamplands threaten the saltwater crocodile with loss of habitat. The edge of Melacca Swamp, Australia's richest breeding habitat for salties, shows extensive damage by buffalo (below). In another part of this same swamp (opposite page), researchers patrol for nests.

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debate has gone public through magazine articles by Webb and preservationist Harry Messel, who did the original demographic work. The preservationists imply that the Conservation Commission of the Northern Territory is motivated by exploitation of the species and that salties are threatened by extinction; Webb paints a picture of a reptile safe from extinction, but in need of innovative management. In fact, the polarity of these views may have clouded the public's understanding of the issue.

Controversy aside, saltwater crocodiles were downgraded to Appendix II of CITES in 1986. The new listing allows limited trade in crocodile products and gives the Conservation Commission of the Northern Territory the management options Webb advocates. Australian authorities at the federal level (CONCOM) subsequently approved the new comprehensive management plan for the Northern Territory. The management plan takes a three-pronged approach: public safety, which includes public education and removing "problem" animals from recreational areas; increasing and maintaining healthy crocodile habitat; and controlled economic use of salties.

Commercial utilization of salties has been the most controversial plank of the Conservation Commission's management plan. Though market prices fluctuate, the skin of a six-footer is valued at about $250 and its meat is worth about $70. Some scientists fear that an emphasis on ranching may some day erode the government's commitment to protecting wild salties.

Permits have been granted for three commercial ranching operations, and the first hides are expected to be exported this year, pending changes in Commonwealth law. The ranches have been stocked with crocodiles that have been removed from recreational areas and with eggs taken

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from nests known to experience annual losses due to flooding. The ranches, which hold about 4,000 crocodiles, are also obligated to supply crocodiles for restocking in the wild if necessary.

Webb believes that an economic value for crocodiles will ultimately help wild populations. "In the future, the Conservation Commission may tell a cattle rancher that he can harvest a percentage of the crocs on his land annually for their skins. The rancher will begin to look at crocs as an asset and keep them out of harm's way from prospective poachers and fishermen," he says. He might even start to think about conserving swamps he might otherwise drain for stock use."

According to Webb, "Ranchers who see the crocodile as an unwanted menace will begin to see it as the goose that laid the golden egg. Ranching creates proponents for crocs in a sector of society that commonly would be disinterested, or even hostile towards the species. And a tightly monitored ranching situation that assures humane treatment, combined with a tagging system of skins being readied for export, would guarantee against excesses," he continues.

Habitat improvement was begun in the Northern Territory before the management plan was approved. Some 60 percent of saltwater crocodile habitats are on aboriginal lands or in national parks where they are largely protected. Recently, Melacca Swamp, 20 square kilometers of primary saltic nesting area located on the southern border of Arnhem Land, has been purchased by the Conservation Commission, which fenced the area to keep water buffalo out. Crocodiles benefited when buffalo and wild cattle populations were greatly reduced under the bovine disease control program initiated in 1983. The program was begun to protect domestic cattle, but expanded when more was learned about how the feral buffalo destroy crocodile nesting areas. As a result, freshwater swamps have recovered in many areas.

Meanwhile, public education efforts appear to be making a difference. Rangers from the Conservation Commission of the Northern Territory give talks to school children; a wider audience is reached through television and radio spots; warning signs are tacked up throughout the Northern Territory near waters inhabited by crocodiles.

Webb is certain the educational effort helps. "The more people know about crocs, the greater the chances for coexistence without harm to humans," he says. Webb points to changing attitudes towards crocodiles in communities where they have attacked people as further evidence of the success of the Northern Territory's educational effort. "In Queensland when Wruck was killed, the shoot-everything mentality prevailed. But when a bloke was eaten on the MacArthur River in the Northern Territory, the only people who responded to the call to capture the killer croc were the authorities. The local townspeople expressed the view that anyone swimming in a croc-infested river ought to know better."

Eric Hoffman