

# BAKO

Biodiversity Between Land and the Sea



*Life from Headwaters to the Coast*

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## Biodiversity Between Land and the Sea

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# SALTWATER CROCODILE

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The Saltwater Crocodile (*Crocodylus porosus*) is the largest of all crocodilian species, with mature males reaching 7-metre and weighing over a tonne. Male crocodilians can grow larger and often faster than females, although in their natural environment, they reach sexual maturity at the same age. The species is distributed from the western coast of India, to the Andaman and Nicobar archipelago, south-east Asia, and southward to northern Australia and south Pacific. Their habitat selections consist of coastal rivers and creeks, some hundreds of kilometers upstream from the sea. Sometimes, the species is encountered at sea, but usually just offshore, moving around coasts between rivers or to offshore islands in search of suitable habitat. Its tolerance of salt water has allowed it to occupy coastal waters and offshore islands and rivers that are subject to tidal impact in the region. Tidal habitats, like estuaries, attract Saltwater Crocodiles, on account of brackish conditions and an abundant supply of food sources, such as crabs, prawn, mammals and fish. These areas also offer protection from wind and allow for movement around the coast for new territory. They are also common in rivers under tidal influence where salinity ranges between 5–20%.



**Fig. 1.** Adult Saltwater Crocodile.

Within its native range, the Saltwater Crocodile is also known as the Estuarine or Indo-Pacific Crocodile or “Saltie”. The species name, *porosus*, refers to the ‘rugose’ and bumpy upper surface of the snout seen in large adults, meaning “full of callosities”.

The success of the species across its range is attributed largely to its heavily armoured skin, made of numerous large and small bony plates or osteoderms. The Saltwater crocodile has a broad and rounded snout, while its teeth are set in an irregular row, and possesses a tissue that can rise from the floor of the mouth to overlap a bony fold on the roof of the mouth; completely isolating its mouth from the pharynx. This enables the crocodile to keep its mouth open in the water without flooding its lungs and stomach. By this means, it can breathe through its valve nostrils even when its mouth is filled with water. The valves of the nostrils prevent flooding of the nasal tube when the animal is submerged.

The skin of the crocodile is covered with keratinized scales bearing a pore that is generally thought to be a sensory organ. High density of scales particularly on the upper and lower jaws can detect movement underwater. Crocodiles can choose to expose a minimum portion of their body with only eyes, ears and nostrils above water, while the bulk of the body remains submerged. Crocodiles can remain underwater for an extended period of time, concealing themselves from view. An average-sized crocodile can remain submerged for about 15 minutes per dive, but larger individual (> 4 m in length) can stay underwater for up to 2–3 hours. One of the reasons is due to the fact that larger crocodiles usually have higher amount of haemoglobin in their blood, than that does smaller individuals, that carry oxygen from their lungs to the rest of the body, while at the same time, are able to use its metabolic products, the bicarbonate ions, as the trigger to unload the oxygen they carry.

A large crocodile is strong enough to crush a turtle shell, a pig’s head or the skull of a fully-grown bovid with ease, and can draw a water buffalo weighing over a tonne into the water. When a Saltwater Crocodile hunts, it usually ambushes prey that comes close enough to the water edge. In the capture of prey, crocodiles are not sit-and-wait hunters as often reported but highly active and versatile ones. They move slowly in the water with only the nostrils and the top of the head visible above the surface. With a sudden sideways snap of the jaws, they can fish effectively. A crocodile snaps at its prey with a sideways movement of the jaws because its eyes are located on the lateral surface of its head. It can also attack by jumping entirely out of the water and can also come on land. Prey that is caught on land is often killed by drowning and then dismembered in the water, by a method called “death roll”,

a technique where it grabs onto an animal and then proceeds to roll to throw the animal off balance. Most animals, including human beings, are killed by its strong jaws, but drowning also occurs since the crocodile always drags its prey into the water. Its teeth are not suited for chewing, and a crocodile either eats the prey whole, or shakes the body of the prey vigorously until some of the flesh breaks away into smaller chunks before they are swallowed.

Crocodiles reproduce by internal fertilization. Males reach sexual maturity at around 16 years of age while females sexually mature at 10–12 years. Mating usually takes place during the wet season, when water levels are at their highest. Like most reptiles, the Saltwater Crocodiles lay eggs some five months after fertilization with a clutch size varying from 16 to over 80. The female selects the nesting site, and buries the eggs under a mound of leaves. She then remains on the nest or within its immediate vicinity, defending a fairly large territory for 75 to 106 days. Its incubation period is between 80–90 days. As in all crocodilians, the sex of the hatchlings is determined by temperature, where at 28–30°C, all hatchlings will be females while between 30–32°C, eggs will produce males. At 33°C or more, hatchlings are predominantly females or suffer mortality. While adult crocodiles are formidable animals with few natural threats, their eggs, hatchlings and juveniles are at risk. In the wild, an estimated 54% of hatchlings survive the first year. In terms of growth, the total length of a Saltwater Crocodile at hatching is about 29 cm, while after one year of age, it can reach 73 cm, in two years, its total length will be around 108 cm, and would be able to attain a total length of 170 cm in five years. The life span of any crocodilian is at least 25 years and probably exceeds 50 years.

Crocodiles are strictly carnivorous. For the first year of their lives, young Saltwater Crocodiles feed mainly on shrimps (Atyidae), crabs (Ocypodidae), insects and small fish, mostly of the family Hemiramphidae (the so-called ‘half-beaks’). As it grows, the amount of insect in its diet falls and turns to eating snails and larger fish, and thus the size of prey eaten are strongly bimodal: large numbers of small prey that consists mainly of crustaceans, and small numbers of large prey, consist mainly of rats. Small crocodiles are generalist feeders, while mid- and large-sized individuals specialize on particular prey items. Thus, the prey may include anything that they can outswim or ambush at the water edge and overpower. They include deer, cattles, flying foxes, crabs, turtles, dogs, and even human beings. Odd objects like chunks of wood, pebbles and even rocks are sometimes found in crocodile stomach. These are, however, not proof of accidental ingestion. Hard objects may be taken in as “gizzard stones” or gastroliths to help grind coarse food. The large chunks of food are reduced to digestible forms by the milling or churning action of the “gizzard stones” contained in crocodile stomachs that



are set in motion by regular contractions of the strong stomach muscles. These “gizzard stones” may also serve to stabilize a crocodile’s body. The “stones” lie in the stomach, below the centre of gravity and work as a counterpoise or ballast to the buoyant lungs.

Another behavioural adaptation that contributes to the success of crocodiles is basking. Reptiles have low metabolic rate and thus need to conserve energy. Crocodiles do this by raising their body temperature during basking. They come out of the water at sunrise and lie on the banks under the sun. When their bodies have warmed up, they would move into the shade or back into the water. By staying underwater at night, they conserve heat because water holds heat better than air. This direct use of solar energy enables large crocodiles to survive even when food is scarce.

Female crocodiles construct a meter high nest from vegetative matter, such as grass, bark and leaves. The area around the nest must offer seclusion, protection from flooding, a wallow and a quick path to the water. Small crocodiles are said to prefer upper mangrove section of rivers, a location undoubtedly related to the adjacent and extensive areas of grassland and shrubs well-suited for nesting. They also demonstrated a significant preference for brackish water. It has been reported that this species favours brackish waters, due to the presence of prawns, a favoured food. Juvenile crocodiles were found to feed on crustaceans and insects, and migrate upstream from their nesting sites, though movements were not correlated with salinity factors. This, however, may need further clarification since abundance of main food source, consisting of tiny shrimps, particularly of the genus *Penaeus* are seasonal, and may be affected by changes in water salinity.

Smaller juveniles show preferences for warmer waters, ranging from 31–35°C while feeding, and 25–30°C while fasting. Large crocodiles do however seem to be more wide ranging and may be more inclined to enter freshwater swamps than smaller crocodiles. Inland freshwater environments such as rivers, lakes, billabongs and creeks offer a constant supply of freshwater, which crocodiles need to drink, but during the dry season they move back to permanent water areas close to the coast. Saltwater Crocodile do not swim much but they drift following ocean current. Because of their size, heavy



**Fig. 2.** Young Saltwater Crocodile.

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armour and powerful biting power, mature crocodiles are immune to attack by most predator in its habitat except humans. Hatchlings that are 20-cm, on the other hand, are prone to attacks by many other predators, such as otters, large birds, fish and even adult crocodiles.

A law concerning catching of crocodiles existed during the reign of the Rajah Brookes in Sarawak in the 19th century. Those who killed crocodiles were required to bring the skin to the department concerned, as evidence for which the Government paid 36 cents for each foot of skin. In this manner, the Government encouraged the local inhabitants to catch more, thus causing significant decline in the crocodile populations. Prior to, and during the Second World War, crocodile hunting was reported to be rampant throughout Borneo, including Sarawak. At that time, the crocodile skin was not considered an important commercial product for the leather industry, instead the meat was of high demand for food by Japanese soldiers. It was at the end of the war that companies started buying any type of animal skin that was useable, with the highest price offered for crocodile skin. Those of high quality were exported. As a result, many worked actively to catch crocodiles. The exploitative activity eventually lead to the general assumption that the Saltwater Crocodiles in south-east Asia are endangered.

A number of surveys for crocodiles have been conducted in recent years, using spotlights from moving boat, that indicate that populations have remarkably increased along certain rivers, as compared to data obtained in the 1980's. Surveys at Sungei Bako show mean densities of 11 individuals per km, while Sungei Sebelak in central Sarawak supported about 10 individuals per km. The increase in its population is thought to be largely due to the enforcement of the legislation that restricted hunting and trading of crocodiles from the wild.

Crocodiles are both feared and respected by the indigenous people of Sarawak. A belief prevalent among many indigenous people, particularly the Ibans, the Malays, the Orang Ulu and the Bidayuh is that crocodiles become predators of humans only when harassed. On the other hand, many of them also believe that crocodiles share a common ancestor with humans, and refrain from hunting them.

Management strategy for include the establishment of crocodile removal zones, monitoring of populations in selected rivers where there are high number of encounters, as well as the development of crocodiles as economic resources. The latter category includes ecotourism, such as crocodile-watch activities along Sungei Santubong. Significantly, it also includes the issuance of permits that allow locals to hunt and harvest, as well as explore the potential for ranching and farming of these often feared denizens of the rivers of Sarawak.