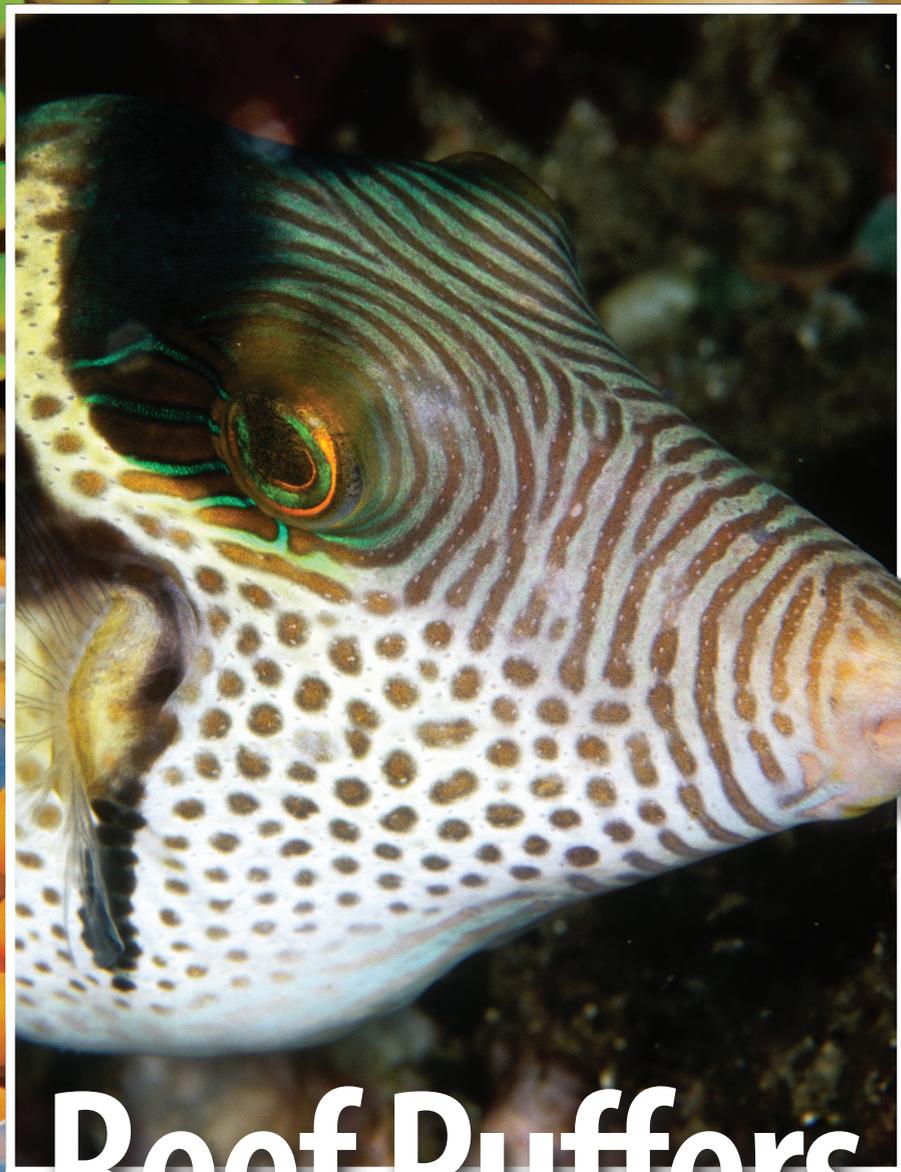




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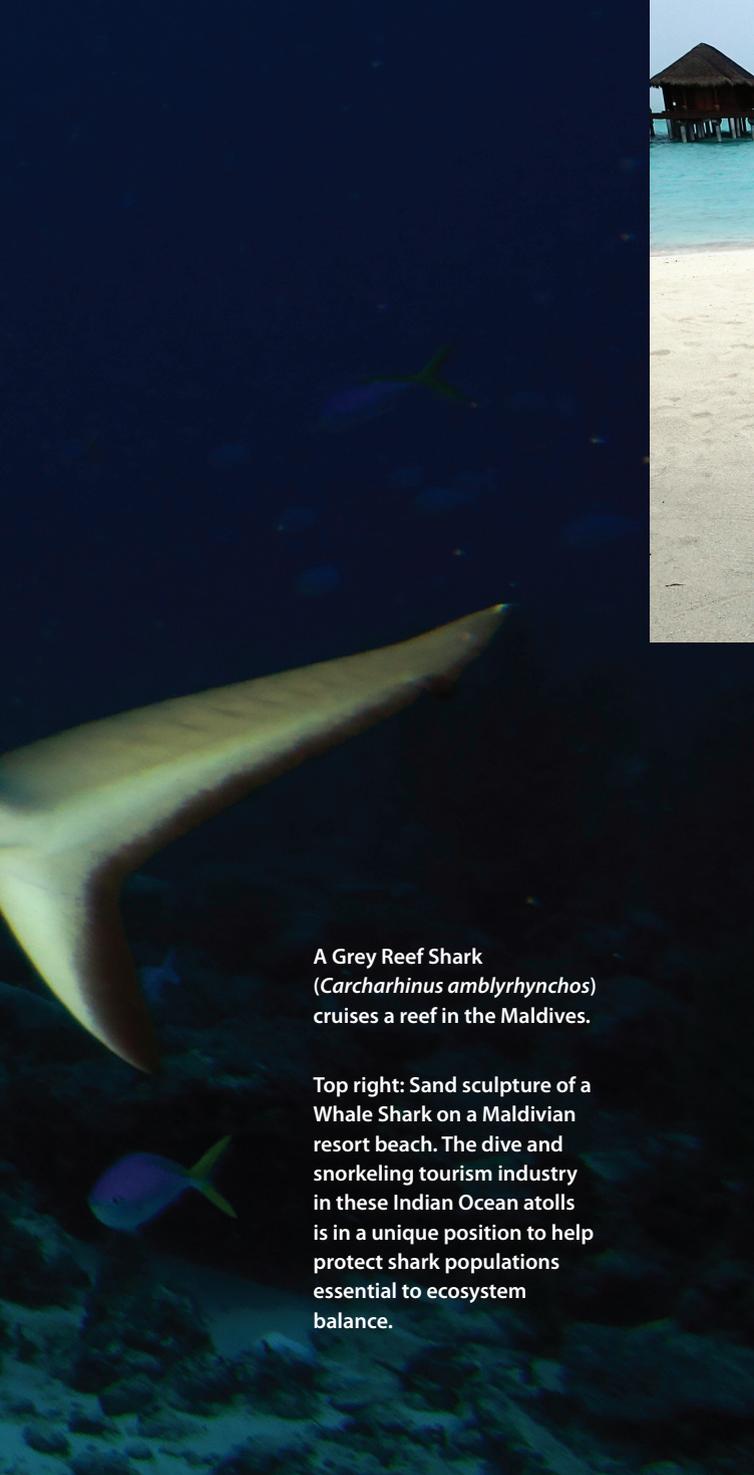
GEORGIA COWARD & ANDREW BRUCKNER, PH.D.



A Shark in the Sea: Worth 100 in Your Soup

Sharks were gliding silently through our oceans long before the dinosaurs made their relatively brief appearance on Earth. They have been evolving for more than 400 million years, surviving all five mass extinctions to become the most successful of all fishes. Although most people are aware only of a handful of large, charismatic species, there are more than 500 described species of shark. In fact, sharks are found in all five oceans and have adapted to occupy a variety of niches and environmental conditions. They can survive at great depth, manage salinity fluctuations, and cope with extreme temperature shifts.

ALL: A. BRUCKNER, PH.D.



A Grey Reef Shark (*Carcharhinus amblyrhynchos*) cruises a reef in the Maldives.

Top right: Sand sculpture of a Whale Shark on a Maldivian resort beach. The dive and snorkeling tourism industry in these Indian Ocean atolls is in a unique position to help protect shark populations essential to ecosystem balance.

Among the most highly adapted are the Greenland Shark (*Somniosus microcephalus*), which swims in icy Arctic waters down to 7,198 feet (2,194 m), and the Bull Shark (*Carcharhinus leucas*), which is found in full-salinity sea water and in freshwater rivers several thousand miles from the ocean. Sharks vary remarkably in size, from the tiny 8-inch (20-cm) Dwarf Lantern Shark (*Etmopterus perryi*) to the enormous 40-foot (12-m) Whale Shark (*Rhincodon typus*).

All sharks are carnivores, yet they feed on a variety of prey in diverse ways. There are filter-feeders that eat plankton (Whale and Basking Sharks [*Cetorhinus maximus*]); bottom-feeders that consume large snails and



octopus (Tawny Nurse Sharks, *Nebrius ferrugineus*); and suction crushers (Carpet Sharks or Wobbegongs [Orectolobidae] that eat mostly shrimp, lobsters, squid, crabs, and even coral. Most common are raptorial feeders, such as the Great White Shark (*Carcharodon carcharias*), which prefer fishes, marine mammals, and other large prey.

Many species are apex predators, situated at the top of the oceanic food web, although some small-bodied species occupy lower trophic levels. Sharks have evolved perfectly for a predatory lifestyle. They have slender, torpedo-shaped bodies built for speed and swift directional changes, a lightweight cartilaginous skeleton, a lipid-filled liver for buoyancy, and six highly refined senses—smell, hearing, touch, taste, and electroreception—which they use to hunt prey.

Electroreception is perhaps a shark's most unique sense. If you ever see a shark up close, you will notice small pores on its head and snout. These pores, known as "ampullae of Lorenzini," form an internal network of gel-filled canals and are used to detect weak electrical fields (for example, muscle contractions) emitted by prey in distress. The ampullae receive these signals and transmit them through the canals, where they hit nerve bundles and send a signal that alerts the brain to a possible meal. The lateral line that extends the length of a shark's body similarly detects tiny changes and vibrations in the surrounding water through stimulation of a series of nerves. This enables a shark to perceive the exact location of its prey. Some sharks also use electroreceptors to sense changes in temperature and to navigate the globe by tracking Earth's electromagnetic field.

KEYSTONE PREDATORS

Sharks perform critical roles in their ecosystems. As generalist predators, they are responsible for maintaining the species below them in the food chain. They help by removing weak and sick animals and culling over-abundant populations to balance the ecosystem and ensure species diversity. Sharks are "keystone" species, and their



A Reef Shark, *Carcharhinus perezii*, patrolling a reef in the Caribbean Sea.



The largest fish in the ocean—the enigmatic Whale Shark (*Rhincodon typus*).

Despite their existence in our oceans for hundreds of millions of years and their critical role in ecosystem health, sharks are under increasing threat from human activities. Their populations have declined by over 50 percent since the 1950s. Every year, around 1.4 million tons (estimated to represent between 63 million and 273 million animals) are killed for their fins, considered a delicacy in Asia. The fins have little flavor of their own, but are used in shark fin soup to add texture and as a status symbol (chicken or other stock provides the flavor). A bowl of shark fin soup ranges in price from \$0.60 to a whopping \$250 US.

Until recently, the Maldives had one of the largest shark fisheries in the world. Annual landings fluctuated between 1,212.5 tons (1,100 metric tons or MT) and 2,204.6 tons (2,000 MT), and by 2005 had climbed to over 2,866 tons (2,600 MT). This unsustainable fishery caused rapid declines in shark populations and cascading effects on the ecosystem, as well as direct conflicts with the tourism industry. Tourism contributes over 30 percent of the Maldives' gross domestic product, much of it from snorkeling and diving to view sharks and other megafauna. By 2009, populations of most shark species had collapsed, and this led to a total ban on shark fishing in 2010. The Maldives is now one of the largest shark sanctuaries in the world, covering 353,743 square miles (916,189 km²), but these species have been slow to recover.

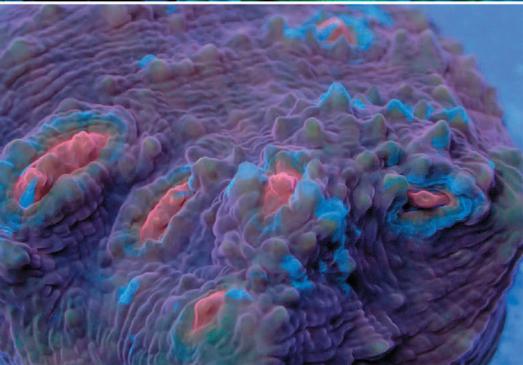
removal by fishing can cause dramatic cascading effects throughout an ecosystem. This is particularly relevant for a coral reef, an ecosystem that must function in total balance and where slight changes in community assemblages can have significant and rapid consequences.

Many shark species rely on coral reef ecosystems for part or all of their life cycles. In the Maldives, where we are working, 16 shark species use the coral reefs for protection, resting, cleaning, feeding, and/or breeding, including the large, magnificent Whale Sharks that regularly visit reefs to feed on plankton blooms. In fact, these islands have one of the largest resident Whale Shark populations: more than 200 individuals have been documented in Maldivian waters. This makes the Maldives one of the best places to see a shark up close.

The life-history characteristics of sharks, notably their advanced age at sexual maturity, low reproductive output, and slow growth rate, make them increasingly susceptible to overfishing. Many species don't reach sexual



Scalloped Hammerheads (*Sphyrna lewini*).



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A Tawny Nurse Shark (*Nebrius ferrugineus*) seeks refuge under a ledge.



An exciting and unusual encounter in the Maldives: meeting a young Leopard Shark (*Stegostoma fasciatum*).



A 4-foot (1.2-m) Whitetip Reef Shark (*Triaenodon obesus*) looks for crustaceans.

maturity for over 7 years (and some take 30 years), have a gestation period exceeding 12 months, and reproduce only once every few years. Sanctuaries like the Maldives provide a refuge where shark populations can rebound while still creating revenue opportunities for the local tourism industry. However, these sanctuaries and fishing bans only work when they are effectively enforced. Illegal shark fishing, including finning of Whale Sharks, does still occur in the Maldives, and prosecution is challenging—there is a lot of ocean and few patrol boats, so enforcement is reliant on reporting by local communities, divers, and resorts.

A NEW THREAT: INSTANT ISLANDS

Sharks in the Maldives are now facing a new threat: the development boom. The Maldives comprise just one percent dry land, and available real estate cannot keep pace with the more than 70 resorts that are expected to open in the next few years. Hence, land reclamation is at a peak, with islands popping up out of nowhere every few weeks. Sand is continually being piled onto reefs, causing devastation to the surrounding ecosystem and the animals that rely upon it. Sand extraction is also commonly practiced on resort islands to compensate for the monsoonal shifting of sand. Every day, large floating, non-selective machines pump tons of sand from shallow lagoons directly onto the sandy shores in order to satisfy beach-goers and their desire to snap Instagram photos.

But these shallow, crystal-clear lagoons are also of interest to Coral Reef CPR, because many act as critical nursery grounds for juvenile reef sharks. These immature sharks, some under a foot (30 cm) long, cruise the shoreline in less than a foot of water. Around some islands, dozens of species occur. The lagoons protect the young sharks from predators and offer a remarkable opportunity for unsuspecting tourists to see juvenile sharks in the wild. Our team is working to identify the locations of these key nursery areas throughout the Maldives, as this will help document the rate at which shark populations are rebounding. We will also use this information to determine the efficacy of the 2010 fishing ban and help protect these critical nursery areas from future development.

Ironically, the conflict between tourism and commercial shark harvesting led to the shark fishery ban seven years ago, but the rapidly growing tourism industry has now become the biggest threat to the sharks in the Maldives. Sharks are critical to the health of the coral reefs, especially now that reefs in the Maldives have undergone severe changes over the past five years due to Crown of Thorns Starfish outbreaks and the 2016 bleaching event.

Economically speaking, a shark in the ocean is worth 100 times more than one killed for its fins and meat. Seeing a shark in the wild is among the most exciting and unforgettable experiences you can have in the ocean, and the Maldivian coral reefs are some of the best places to do that. Sharks have survived millions of years of changing climate and mass extinction events. They have truly earned their place in the ocean. It is now up to us to do all we can to ensure that they survive.



Georgia Coward is a fishery biologist and program manager at Coral Reef CPR. **Andrew Bruckner, Ph.D.**, is an ecologist and directs the Coral Reef CPR program.

ON THE INTERNET

Learn more about shark and coral reef conservation projects on our Coral Reef CPR website, www.coralreefcpr.org, and our Facebook page, www.facebook.com/coralreefcpr.