# Status of marine species and habitats

Stuart Banks

Charles Darwin Foundation

The driving questions for research in marine conservation remain: How has and will the human presence in Galapagos change natural ecosystem processes? And how do we achieve a sustainable multi-use Marine Reserve that maintains biodiversity and endemism and hence its unique status as a natural resource, while at the same time permit responsible use of these resources for fisheries, tourism, science, and education? Marine Reserve managers worldwide face these same questions, yet few places of comparable size harbor such a unique confluence of marine species of differing biogeographic affinities, such rich and inspiring natural seascapes, a hugely dynamic biophysical environment, and at the same time have undergone such rapid development of human activities.

Even after decades of exploration, the Galapagos Marine Reserve (GMR) continues to reveal new mysteries. Now, with novel satellite and sensor technology, we are beginning to understand how to follow and predict how marine ecosystems change under strong climatic pressures such as El Niño. With climate change a global issue, Galapagos may experience more frequent El Niño/Southern Oscillation (ENSO) effects. New species previously hidden in deep waters and others believed to be extinct can now be revealed by remote deep water exploration vehicles. Monitoring frameworks for marine species and the subtidal marine ecosystem provide us with a wealth of new information regarding the composition of Galapagos coastal communities, yet much work remains to ensure a timely flow of information to an effective participatory decision-making forum. Complex interactions arising from the juxtaposition of cold and warm current systems, extractive fisheries, and non extractive tourism activities emphasize the importance of making informed management decisions based upon the best and most recent scientific advice available.

## IUCN evaluation of marine groups

Early red listing by the IUCN focused on charismatic groups and those obviously impacted by human activity on a global scale, such as whales, pinnipeds, and more recently marine reptiles and sharks (Fig. 1, Table 1). Despite their importance, little attention was given to the many important subtidal habitat-forming species such as corals and macroalgae. These species are heavily impacted by ENSO events and their subsequent recovery most likely compromised by rapid human development in the coastal zone. A red listing process was initiated in 2006 for these groups, and a further fish evaluation is planned for 2007.

A review of Galapagos marine groups includes 25 species not yet accepted on the IUCN Red List (Table 1, Fig. 2). Of these 25, 80% have already been reviewed by experts for inclusion in 2007. Of the 57 species already incorporated into the Red List, 41% are categorized as threatened: Vulnerable (VU), Endangered (EN), or Critically Endangered (CR).

> According to the IUCN Red List, 40% of the marine species evaluated to date are threatened.

**Table 1.** Number of marine species listed in IUCN threat categories by marine group.

| Marine group | No. species on Red List as of 2006 | No. species submitted for inclusion |
|---|---|---|
| Marine Birds | 5 | |
| Cetaceans | 15 | |
| Fish | 6 | 2 |
| Molluscs | 2 | |
| Pinnipeds | 2 | |
| Rays | 5 | |
| Marine reptiles | 5 | |
| Sharks | 17 | |
| Echinoderms | | 2 |
| Corals | | 4 |
| Macroalgae | | 16 |
| Crustaceans | | 1 |
| **Total** | **57** | **25** |

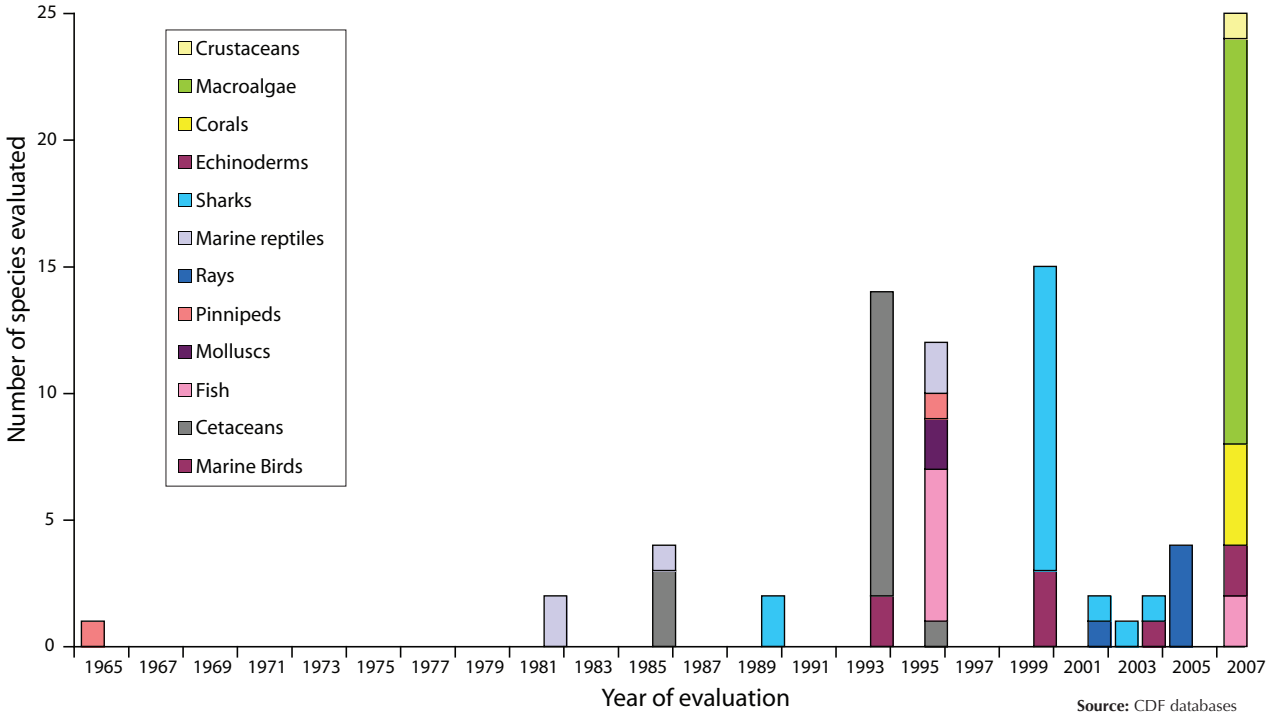
**Source:** CDF databases

**Table 2.** Marine species in IUCN Red List by threat category.

| | | | Threat Category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Species listed | EX | CR | EN | VU | NT | LC | DD |
| 2006 | Species | 57 | — | 3 | 6 | 14 | 5 | 17 | 12 |
| | Percent | | — | 5% | 11% | 25% | 9% | 30% | 21% |
| | | Species submitted for inclusion | EX | CR | EN | VU | NT | LC | DD |
| 2006 | Species | 25 | — | 13 | 3 | 9 | — | — | — |

**Source:** CDF databases

**Figure 1.** Marine groups evaluated in recent years (data for 2007 were recently submitted)




**Source:** CDF databases

**Figure 2.** Marine species of the GMR evaluated by IUCN threat categories

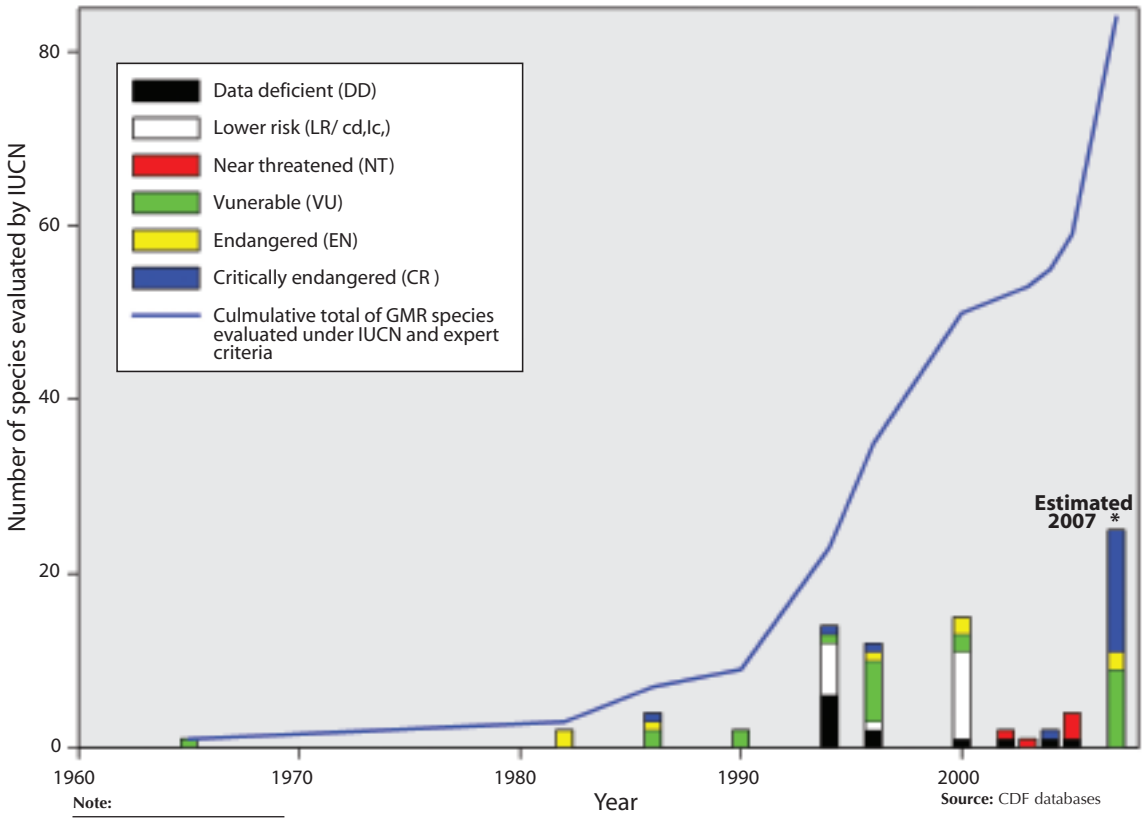



Figure includes threatened species reviewed in 2006 for Red List inclusion in 2007.

## Threatened marine species

The marine species listed in Annex 1 are the most threatened coastal marine species in the GMR. These species are particularly sensitive to stress due to climatic events and human activities. Endangered species that visit the GMR but are seldom observed (such as the great white shark) are not included. The data cover marine birds and some other vertebrates that form colonies on land but spend the majority of their life in the marine environment. Annex 2 includes all species evaluated as Data Deficient and for which further research and monitoring are required.

## Population data for threatened species and reasons for their decline

All species listed in Table 2 have experienced severe declines or have very restricted distributions. El Niño events have strongly affected the majority of resident marine species, particularly the coral and macroalgae communities, both of which include important habitat-forming species upon which many other species depend.

Bleaching of reef corals and strong swells led to a >97% reduction in abundance, although the colonies that remain are still relatively widespread and show signs of recovery in some areas. Certainly thermal and physical wave stress on large intertidal algae has driven several species collected from the early 1930s and later, such as *Bifurcia galapagensis,* to Critically Endangered status and possibly to Extinction. Reconstruction of past climate suggests that strong climatic events have altered marine subtidal and intertidal habitats in Galapagos for hundreds if not thousands of years. In contrast, the greatly increased human activity in the coastal zone over the last 40 years is unprecedented in the islands evolutionary history.

Overfishing of key predators, such as bacalao and lobster, has likely impacted the top-down control of habitat engineers such as urchins, which today form extensive barrens encrusted with coralline algae

Corals and macroalgae are important habitat-forming species that have been severely impacted by El Niño; the evaluation of their threat status began in recent years.

throughout the archipelago, compromising the natural recovery of other species while breaking down the foundation of old corals. The magnificent scallop, *Nodipecten magnificus*, is now only found in parts of western Isabela and Fernandina, having been fished as incidental catch after being already heavily affected during strong El Niño events. Threatened solitary corals, such as *Tubastrea taguensis*, that were formerly widespread are now only found in small pockets of cold water. Many migratory species, such as marine turtles and pelagic sharks, are still threatened by industrial fishing activities outside of the GMR and illegal fishing activities within the Reserve.

As global warming scenarios predict more frequent and stronger El Niños, an increase in sea level, acidification of the world's oceans, and possible changes in current patterns, the only thing that is certain is that change will occur. How we respond and adapt in the face of that change over the coming decades will likely determine the extinction or survival of many threatened and endemic species.

Marine turtles and pelagic sharks continue to be highly threatened species primarily due to illegal fishing activities in the GMR.

## Key habitats

More than 80% of the near coastal subtidal and intertidal habitat is rocky reef, fringed by soft bottom sediments that host distinct species assemblages that change with the often dramatic bathymetry and oceanographic environment. In the open waters, strong currents scour the islands, forming productive fronts, eddies, and submarine channels that affect species' distribution and recruitment patterns. Few areas of similar size harbor such a rich diversity of habitat where productive coastal waters and the fringes interact with open and deep water systems, volcanic submarine hotspots, mangrove-fringed bays, fragmented coral reefs, sand flats, and thick algal beds (Table 3).

Some dark, deep-water habitats below 30 m appear as calm as protected coastal mangroves or lagoons and harbor species previously believed to be extinct. Others are dominated by localized upwelling, which encourages endemism of cold-water species and provides a constant influx of nutrients into the coastal fringe. Strong currents tearing past vertical walls produce some of the greatest biological turnover of filter feeders in any system, while attracting large pelagic visitors, such as sharks and consequently tourists. The habitats reflect the unique placement of the islands on the equator and the currents that surround them - particularly those associated with cold water upwelling and hydrothermally active hot spots. This great diversity of near-shore and off-shore habitats in a relatively confined area generates an astounding biological panorama.

Although all habitats in Galapagos are influenced by the interplay between El Niño events and human use, highly productive habitats that are of particular importance have been damaged since the El Niño of 1982/83. Macroalgae beds forming important nursery habitat for many species and coral reef communities were prevalent across the archipelago 40 years ago, whereas today they are greatly reduced (to <5% of their historical range) and restricted to localities in the far north and west of the archipelago and a few fragments elsewhere. Today the prevalent habitat across subtidal rocky reefs is urchin barrens, with biogenic sediments from deteriorated coral reefs, which change the physical and biotic environment. These areas, as well as habitats for which little information exists (such as sea mounts and soft bottom sediments), have been targeted as a priority for conservation measures. With the development of subtidal monitoring over the last seven years, the species inventory for the GMR is greatly improved and now includes those rare and newly discovered species and the habitats that they depend upon to survive (Table 4).

Macroalgae beds, abundant in the GMR 40 years ago, are perhaps the marine habitat that is most threatened. Today, the remaining 5% of the original beds are restricted to a few sites.

**Table 3.** Habitat types within the Galapagos Marine Reserve.

| Type of habitat or community | Area covered (estimated area or percent of coastline) | Status |
|---|---|---|
| Rocky intertidal | >80% | Stable |
| Rocky subtidal reef | > 80% | Stable |
| Soft bottom sediments | < 20% | Stable |
| Vertical walls | > 50 significant walls | Stable |
| Coral communities | < 500 m extensions in Wolf and Darwin, elsewhere fragmented | Fragmented, low |
| Macroalgae beds | <15% of the coast | Predominant in the west coasts of Isabela and Fernandina Low – medium |
| Mangroves | Approximately 5800 ha | Stable |
| Sandy beaches | Approximately 460 ha | Stable |
| Coastal lagoons | Approximately 285 ha | Unknown |
| Open water pelagic | Approximately 127,000 km$^2$ | Stable |
| Seamounts | Approximately 1,400 km$^2$ | Stable |
| Hydrothermal vents | Baseline data not available | Unknown |
| Abyssal plain (> 3000 m depth) | Approximately 26,000 km$^2$ | Stable |
| Galapagos shelf and platform (>100 - 3000 m) | Approximately 17,000 km$^2$ | Stable |

**Source:** CDF databases

**Table 4.** New and rediscovered marine species in the Galapagos Marine Reserve.

| Year | Group | Species | Island registered |
|---|---|---|---|
| 2004 | Anemone | *Anthopleura mariscali* | Pinzón, Santa Cruz, South Plaza, Sin Nombre |
| 2004 | Bivalve | *Nodipecten magnificus* | Fernandina, Isabela, Genovesa |
| 2006 | Coral | *Leptoseris sp.* | Darwin |
| 2006 | Coral | *Pavona duerdeni.* | Santa Cruz |
| 2004 | Damselfish | *Nexilosus latifrons* | Fernandina, Isabela |
| 2006 | Fish | *Kathetostoma averruncus* | Santa Cruz |
| 2005 | Gorgonia | *Heterogorgia hickmani* | Floreana |
| 2005 | Gorgonia | *Pacifigorgia symbiotica* | Darwin |
| 2004 | Gorgonia | *Pacifigorgia damperi* | Darwin , Wolf |
| 2004 | Gorgonia | *Pacifigorgia rubripunctata* | Central archipelago |
| 2004 | Hermatypic coral | *Leptoseris scabra* | Wolf, Darwin |
| 2003 | Hermatypic coral | *Gardineroseris planulata* | Wolf, Darwin |
| 2006 | Hydroid | *Nemalecium lighti* | Wolf |
| 2004 | Macroalgae (kelp) | *Eisenia galapagensis* | Isabela, Fernandina |
| 2007 | Macroalgae (kelp) | *Desmeretia ligulata* | Isabela |
| 2006 | Octacoral (sea pen) | *Ptilosarcus sp.* | Wolf |
| 2006 | Octacoral (sea pen) | *Virgularia galapagensis* | Santiago |
| 2006 | Octacoral (sea pen) | *Cavernulina cf. darwini* | Santiago |
| 2004 | Pinniped | *Mirounga leonina* | Isabela |
| 2004 | Ray | *Raya veléis* | Isabela |
| 2004 | Ray | *Torpedo tremens* | Isabela |
| 2002 | Sea star | *Heliaster cumingii* | Isabela, Santa Cruz |
| 2004 | Sea star | *Pauli ahorrida* | Isabela, Santa Cruz |
| 2004 | Sea star | *Coronoaster marchenus* | Fernandina |
| 2002 | Sea star | *Acanthaster planki* | Darwin |
| 2005 | Shark | *Bythaelurus sp.* | Isabela |
| 2002 | Slipper lobster | *Parribacus scarlatinus.* | Wolf, Darwin, Pinzón, Isabela, Genovesa |
| 2004 | Solitary coral | *Tubastraea taguensis* | Isabela |
| 2004 | Solitary coral | *Tubastraea faulkneri* | Isabela |
| 2004 | Solitary coral | *Tubastraea floreana* | Floreana |
| 2000 | Solitary coral | *Rhizopsammia wellingtoni* | Santa Cruz |
| 2003 | Solitary coral | *Astrangia brownii* | Floreana, Isabela |

**Source:** CDF databases

**Annex 1.** Threatened marine species on the Red List or submitted in 2006 for evaluation, by category.

| Species | Scientific Name | GLPS Expert Advice Status | Year of evaluation | Principal threat |
|---|---|---|---|---|
| Galapagos petrel | *Pterodroma phaeopygia* | CR | 1994 | Fisheries and predation by introduced species |
| Hawksbill turtle | *Eretmochelys imbricata* | CR | 1996 | Fisheries bycatch |
| Leatherback turtle | *Dermochelys coriacea* | CR | 1986 | Fisheries bycatch |
| Black-spotted damselfish | *Azurina eupalama* | CR* | 2007 | El Niño |
| Twenty-four-rayed sun star | *Heliaster solaris* | CR* | 2007 | El Niño |
| Elongate heart urchin | *Clypeaster elongatus* | CR* | 2007 | Unknown process |
| Wellington's coral | *Rhizopsammia Wellington* | CR* | 2007 | El Niño |
| Floreana coral | *Tubastraea floreana* | CR* | 2007 | El Niño |
| Tagus cup coral | *Tubastraea taguensis* | CR* | 2007 | El Niño |
| Galapagos stringweed | *Bifurcaria galapagensis* | CR* | 2007 | Overgrazing |
| Tropical acidweed | *Desmarestia tropica* | CR* | 2007 | El Niño, climate change, overgrazing |
| Brown alga | *Glossophora galapagensis* | CR* | 2007 | El Niño, climate change, overgrazing |
| Brown alga | *Spatoglossum schmittii* | CR* | 2007 | El Niño, climate change, overgrazing |
| Red alga | *Gracilaria skottsbergii* | CR* | 2007 | El Niño, climate change, overgrazing |
| Red alga | *Galaxaura barbata* | CR* | 2007 | El Niño, climate change, overgrazing |
| Red alga | *Phycodrina elegans* | CR* | 2007 | El Niño, climate change, overgrazing |
| Blue whale | *Balaenoptera musculus* | EN | 1986 | International fisheries |
| Galapagos penguin | *Spheniscus mendiculus* | EN | 2000 | El Niño and predation by introduced species |
| Flightless cormorant | *Phalacrocorax harrisi* | EN | 2000 | El Niño and predation by introduced species |
| Green turtle | *Chelonia mydas* | EN | 1982 | Fisheries and predation by introduced species |
| Olive ridley turtle | *Lepidochelys olivacea* | EN | 1982 | Fisheries bycatch |
| Magnificent scallop | *Nodipecten magnificus* | EN | 1996 | Fisheries and El Niño, climate change |
| String sargassum | *Sargassum setifolium* | EN* | 2007 | Overgrazing |
| Brown alga | *Dictyota major* | EN* | 2007 | Overgrazing |
| Galapagos kelp | *Eisenia galapagensis* | EN* | 2007 | El Niño, climate change, overgrazing |
| Galapagos sea lion | *Zalophus wollebaeki* | VU | 1996 | El Niño, overfishing of food source, disease, |
| Galapagos fur seal | *Arctocephalus galapagoensis* | VU | 1965 | El Niño, overfishing of food source, disease |
| Sperm whale | *Physeter macrocephalus* | VU | 1996 | Fisheries |
| Humpback whale | *Megaptera novaeangliae* | VU | 1986 | Fisheries |
| Lava gull | *Larus fuliginosus* | VU | 1994 | Unknown |
| Waved albatross | *Phoebastria irrorata* | VU | 2000 | Fisheries |
| Marine iguana | *Amblyrhynchus cristatus* | VU | 1996 | El Niño and predation by introduced species |
| Whale shark | *Rhincodon typus* | VU | 1990 | Fisheries |
| Oceanic whitetip shark | *Carcharhinus longimanus* | VU | 2000 | Fisheries |
| Bacalao or sailfin grouper | *Mycteroperca olfax* | VU | 1996 | Fisheries |
| Bigeye tuna | *Thunnus obesus* | VU | 1996 | Fisheries |
| Seahorse | *Hippocampus ingens Pacific* | VU | 1996 | Fisheries |
| Mystery goby | *Chriolepis tagusi* | VU* | 2007 | Unknown process |
| Cartago crab | *Hexapanopeus cartagoensis* | VU* | 2007 | Unknown process |
| Isabela coral | *Polycyathus isabelae* | VU* | 2007 | El Niño |
| Galapagos rocksnail | *Neorapana grandis* | VU* | 1996 | El Niño |
| Red alga | *Galaxaura intermedia* | VU* | 2007 | El Niño, climate change, overgrazing |
| Red alga | *Laurencia oppositoclada* | VU* | 2007 | Overgrazing |
| Red alga | *Myriogramme kylinii* | VU* | 2007 | Overgrazing |
| Red alga | *Pseudolaingia hancockii* | VU* | 2007 | Overgrazing |
| Red alga | *Acrosorium papenfussii* | VU* | 2007 | El Niño, climate change, overgrazing |
| Red alga | *Schizymenia ecuadoreana* | VU* | 2007 | El Niño, climate change, overgrazing |

Symbols Legend: **CR** = Critically Endangered, **EN** = Endangered, **VU** = Vulnerable.

**Source:** CDF databases

**Note:** * Species submitted for the IUCN Red List inclusion in 2007 according to scientific criteria from Galapagos experts.

**Annex 2.** Species on the IUCN Red Listed evaluated as being Data Deficient.

| Marine Group | Year added to the Red List | Year Evaluated | Common Name | Scientific Name |
|---|---|---|---|---|
| Cetaceans | 1994 | 1994 | Pygmy killer whale | *Feresa attenuata* |
| Cetaceans | 1994 | 1994 | Fraser's dolphin | *Lagenodelphis hosei* |
| Cetaceans | 1994 | 1994 | Blainville's beaked whale | *Mesoplodon densirostris* |
| Cetaceans | 1994 | 1994 | Ginkgo-toothed beaked whale | *Mesoplodon ginkgodens* |
| Cetaceans | 1994 | 1994 | Rough toothed dolphin | *Steno bredanensis* |
| Cetaceans | 1994 | 1994 | Cuvier's beaked whale | *Ziphius cavirostris* |
| Fish | 1994 | 1996 | Albacore tuna | *Thunnus alalunga* |
| Fish | 1994 | 1996 | Swordfish | *Xiphias gladius* |
| Rays | 2001 | 2005 | Longtail stingray | *Dasyatis longa* |
| Sharks | 2001 | 2002 | Thresher shark | *Alopias vulpinus* |
| Sharks | 2001 | 2004 | Longnose catshark | *Apristurus kampae* |
| Sharks | 1994 | 2000 | Great hammerhead | *Sphyrna mokarran* |

**Source:** CDF databases