

## Fishing threatens ‘shark of the Antarctic’

*In Brief:* A predator fish known as the “shark of the Antarctic” appears to be in a decline correlated to commercial fishing, according to three recent peer-reviewed publications. The predator is the Antarctic toothfish, one of two species marketed as Chilean sea bass. Data from 39 years of sampling in the Ross Sea show declines in size and abundance that coincide with the start of fishing for the species, in the late 1990s. The authors argue that this fishery could disrupt the entire Ross Sea food web because it targets large toothfish, which produce more offspring and play a very different ecological role than younger, smaller fish. The authors call for increased monitoring and for a marine protected area (MPA) to protect large toothfish and the broader ecosystem.

### Background: The “shark of the Antarctic”

The Antarctic toothfish is the only fish among the suite of predators in the Southern Ocean. It grows up to two meters in length, lives up to 50 years, and is the major predator on fish, an ecological role often played by sharks in warmer ecosystems. The Ross Sea, a bay in the Antarctic coast south of New Zealand, is an important feeding area for the species and home to a uniquely intact food web that includes seals, penguins, and killer whales. Along with the Patagonian toothfish, found in warmer waters, the Antarctic toothfish is one of two species marketed in industrialized countries as Chilean sea bass.

As with sharks, toothfish feeding habits change with age. Juveniles and younger adults generally stay close to the ocean floor and eat small prey, such as shrimp. When they grow to about one meter long, they become buoyant, allowing them to hunt near the surface and prey on larger fish, such as silverfish. (In very rare cases they may also eat Adélie penguins).

Toothfish reproduce slowly, and spawning is a mysterious process that has never been observed. They are thought to swim thousands of kilometers north to spawn near seamounts in the dead of winter. It is hypothesized that the buoyancy of larger adults also lets them spawn near the surface, where prey for their young is abundant.

Commercial fishing for Antarctic toothfish in the Ross Sea began in 1997. Catch peaked at 3,200 tonnes in 2005, then declined slightly.

### Past changes are linked to fishing

In two publications, the authors report on data on Antarctic toothfish in the Ross Sea. Three observations suggest that fishing has affected the toothfish population:

- *There are fewer big fish.* The size of the biggest toothfish caught at McMurdo Sound, in the southern Ross Sea, declined starting in the 1990s, according to the first study (Ainley *et al.*, 2012a). This reversed an increase that began in the mid-1970s (see figure on next page). The



A diver with a large adult Antarctic toothfish under the ice of McMurdo Sound. Credit: Rob Robbins

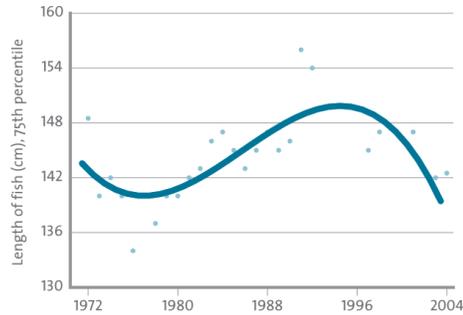
75th percentile of length—that is, the length of the individual fish that was longer than 75 percent of the population in a given year—went from a peak of 156 centimeters (about 61 inches) in 1991 to a low of 142 centimeters (about 56 inches) in 2003. This decline was statistically significant.



Map of Ross Sea showing McMurdo Sound.

 FISHING ACTIVITY, 2009–2011

**Biggest fish getting smaller, and fish getting harder to catch:** (left) Dots show the 75th percentile of length—that is, the length of the fish that was longer than 75% of the population in a given year—for Antarctic toothfish caught at McMurdo Sound. The curve shows the best statistical fit to the data. (right) Line shows the average number of Antarctic toothfish caught for every 10 hooks in each year at McMurdo Sound. This “catch per unit effort” is a measure of fish abundance. Source: Adapted from Ainley *et al.* (2012a)



— *Fish are harder to catch.* The authors also found a precipitous decline in “catch per unit effort,” which tends to correlate with fish biomass, starting in 2000. Catch declined from more than one toothfish for every 10 baited hooks to less than one fish per 100 hooks in three of the four most recent years.

— *Toothfish predators have declined, but competitors have increased.* A second study (Ainley & Ballard, 2012) looked at the frequency of visits to the southwestern Ross Sea by two types of killer whale between 2002 and 2011. Visits by the type of whale that eats seals did not change, but visits by the type that eats large toothfish declined by about 10 percent each year from 2003 through 2011. Meanwhile, the population of penguins, which compete with toothfish for silverfish, has increased. All of this suggests a decline in large toothfish.

### Future changes could disrupt the Ross Sea food web

In the third publication (Ainley *et al.* 2012b), the authors argue that current fishing practices pose serious risks to the Ross Sea, possibly the world’s most untouched marine ecosystem. Current management, based on “maximum sustainable yield,” assumes that removing the largest fish frees smaller ones from competition and cannibalism, allowing

them to grow more quickly. In theory, this results in a sustainable surplus.

However, this has rarely been demonstrated in long-lived, slow-growing fish like toothfish. Moreover, removing large toothfish will not increase growth of fish less than one meter in length, which eat different food and live in different habitats. Even though a 2009 stock assessment suggests the toothfish biomass is healthy, the removal of large fish may not be. The authors argue that it will reduce reproductive capacity, since large fish are believed to produce more offspring.

Current management could also trigger broader ecosystem changes, just as fishing for sharks and other predators has elsewhere. For example, the authors speculate that removal of large toothfish could lead to an increase in silverfish, their main prey. Silverfish might then seasonally deplete the krill population, which is the basis of the food web and crucial to Adélie penguins and many other species.

Because of such risks, the authors recommend increased monitoring by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), with the goal of detecting ecosystem changes before it is too late. They also recommend closing large parts of the Ross Sea to fishing, perhaps with a marine protected area (MPA). This is the only way to protect the largest toothfish, since the longlines used in the fishery are not size-selective.

### Citations

Ainley, D. G., Nur, N., Eastman, J. T., Ballard, G., Parkinson, C. L., Evans, C. W. and DeVries, A. L. 2012a. Decadal trends in abundance, size and condition of Antarctic toothfish in McMurdo Sound, Antarctica, 1972–2011. *Fish and Fisheries*. doi: 10.1111/j.1467-2979.2012.00474.x

Ainley, D.G. and Ballard, G. 2012. Trophic Interactions and Population Trends of Killer Whales (*Orcinus orca*) in the Southern Ross Sea. *Aquatic Mammals*. 38(2): 153-160. doi: 10.1578/AM.38.2.2012.153

Ainley, D., C. Brooks, and J. Eastman. 2012b. Unnatural selection of the Antarctic toothfish in the Ross Sea, Antarctica. In: *Protection of the Three Poles*. F. Huettmann (ed). Springer (Tokyo, Japan). doi: 10.1007/978-4-431-54006-9\_3



LENFEST  
OCEAN  
PROGRAM

Lenfest Ocean Program was established in 2004 by the Lenfest Foundation and is managed by The Pew Charitable Trusts

www.LenfestOcean.org  
Email: info@lenfestocean.org  
Twitter handle: @LenfestOcean