

## BRIEF COMMUNICATIONS

## Deep-sea fishes qualify as endangered

A shift from shelf fisheries to the deep sea is exhausting late-maturing species that recover only slowly.

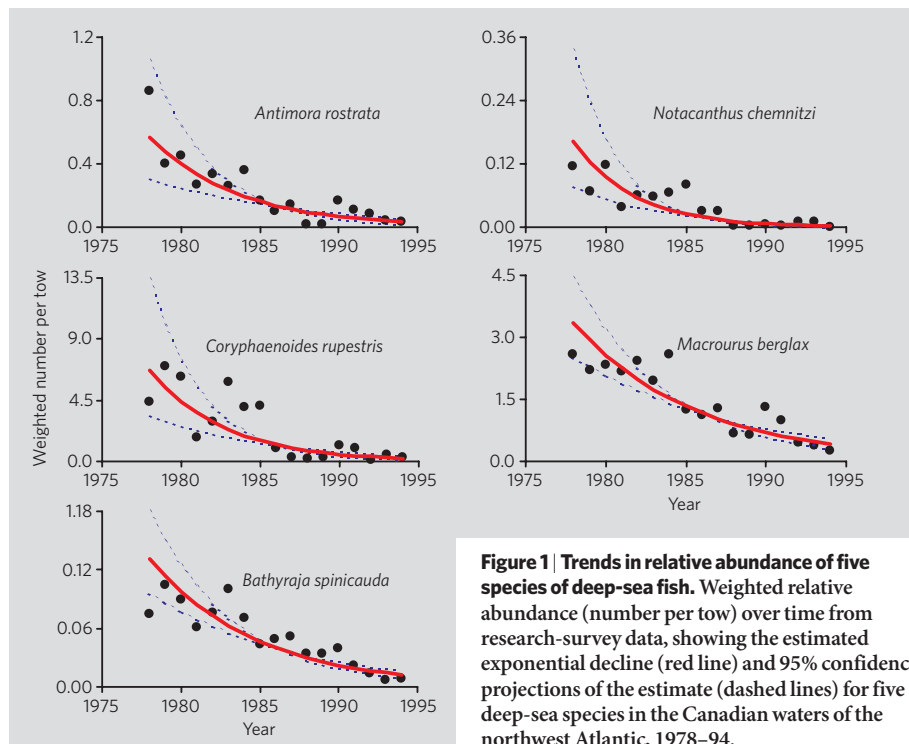
Criteria from the World Conservation Union<sup>1</sup> (IUCN) have been used to classify marine fish species as endangered since 1996, but deep-sea fish have not so far been evaluated — despite their vulnerability to aggressive deepwater fishing as a result of certain life-history traits<sup>2</sup>. Here we use research-survey data to show that five species of deep-sea fish have declined over a 17-year period in the Canadian waters of the northwest Atlantic to such an extent that they meet the IUCN criteria for being critically endangered. Our results indicate that urgent action is needed for the sustainable management of deep-sea fisheries.

At one time it was presumed from the vastness of the oceans that fishing would not drive species to extinction. There have, however, been recent sharp declines in the numbers of oceanic cod, sharks, rays, tuna, marlins, swordfish and sea turtles<sup>3–7</sup>. As the shelf fisheries in the northwest Atlantic began to collapse in the 1960s and 1970s, harvesting shifted to deep-sea fish species<sup>8</sup>, but many populations crashed within ten years because their recovery is so slow<sup>2,9</sup>.

Deep-sea fish are highly vulnerable to disturbance because of their late maturation, extreme longevity, low fecundity and slow growth<sup>2,9</sup>. Some deep-sea fish form spawning aggregations on seamounts and the sea floor, and this increases their susceptibility to overfishing<sup>2</sup>. Survey data collected over extended periods are limited so it has been difficult to determine the effects of deep-sea fishing on both target and by-catch species.

For our analysis, we chose five species that live on or near the bottom of the North Atlantic Ocean, on the continental slope. They range from the common to the rare: roundnose grenadier, *Coryphaenoides rupestris*; onion-eye grenadier, *Macrourus berglax*; blue hake, *Antimora rostrata*; spiny eel, *Notacanthus chemnitzii*; and spinytail skate, *Bathyraja spinicauda*. The species evaluated can live to 60 years of age, grow to more than 1 m in length, and mature in their late teens. *C. rupestris* and *M. berglax* have been commercially fished, and all five are taken as by-catch in fisheries that target Greenland halibut, *Reinhardtius hippoglossoides*, and redfish, *Sebastes* spp. None was taken in any substantial number, even as by-catch, before the 1970s.

We used catch data from standardized, research-trawl surveys in the Canadian waters of the northwest Atlantic Ocean over 1978–94



**Figure 1 | Trends in relative abundance of five species of deep-sea fish.** Weighted relative abundance (number per tow) over time from research-survey data, showing the estimated exponential decline (red line) and 95% confidence projections of the estimate (dashed lines) for five deep-sea species in the Canadian waters of the northwest Atlantic, 1978–94.

to determine declines in relative abundance and individual mean size (for details, see supplementary information). All species declined in relative abundance (Fig. 1): declines over the 17-year period were 87–98% and declines estimated for three generations, the IUCN benchmark, were 99–100% (see supplementary information). Survey data for an additional period (1995–2003) were obtained for *C. rupestris* and *M. berglax*. The overall declines in relative abundance for these two species over the 26-year period were 99.6% and 93.3%, respectively; estimated declines over three generations were 100% and 99.7%, respectively (see supplementary information).

According to the IUCN criteria, these five species of deep-sea fish qualify as critically endangered in the northwest Atlantic. The declines occurred on a timescale equal to, or slightly less than, a single generation of these species. All of the species apart from *N. chemnitzii* also declined by 25–57% in mean size over the 17-year period (see supplementary information). The survey data are not adequate for full assessment of the situation for other deep-sea fish species that may also be at risk. The largest deepwater skate in the northwest Atlantic — the barndoor skate *Dipturus laevis*

— was driven unnoticed almost to extinction<sup>6</sup>.

Scientific investigation lags behind the collapse of deep-sea fisheries<sup>8,9</sup>. Conservation measures are necessary and lack of knowledge must not delay appropriate initiatives, including the establishment of deep-sea protected areas.

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Supplementary information accompanies this communication on Nature's website.

Competing financial interests: declared none.  
doi:10.1038/439029a

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