EXPLOITATION PATTERNS IN SEAMOUNT FISHERIES: A PRELIMARY ANALYSIS

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ABSTRACT

Serious stock depletion on continental shelves helped create new pressure for alternative fishing grounds. In particular, seamounts were among those 'newly' targeted ecosystems that have been intensively fished since the second half of the 20th century. But what are the seamount fisheries? How have their catches changed in recent years? Can we map where these catches are taken? This paper describes the progress of this work. Most seamount species are also found on the continental slope, making the allocation of reported catches to specific seamounts difficult. Thus, future mapping of landings will require species distributions that allow proportioning of catches between slope areas and those taken on seamounts. Catches of fishes identified as mostly occurring on seamounts only began in 1967, initially with the Orange roughy fishery. The catches of these species have only continued because new seamounts with harvestable stocks were discovered as fisheries collapsed, and because new stocks or species were targeted. A pattern of successive rapid development and decline is evident. While the percent of fisheries that collapsed is somewhat similar for seamount species and those not associated with seamounts, it is obvious that those fisheries that are based on species found only on seamounts have collapsed with greater frequency and had poorer recovery. This points towards the conclusion that not only seamount fisheries, but deep-water trawling in general, may not be sustainable in the long term.

INTRODUCTION

Arguably, the expansion of commercial fisheries into deepwater areas, especially those outside the jurisdiction of current management agencies, is one of the most worrying developments in recent years. The life-history of many of the species exploited in these environments makes them particularly susceptible to overfishing and serial depletion (Morato et al., this volume). Already there is considerable evidence that many of these fisheries are more similar to 'mining' operations than to sustainable fisheries (Hopper, 1995; Merret and Haedrich, 1997), with targeted fish stocks showing signs of overexploitation within a short period from the beginning of the fishery. This has been the case for the Orange roughy (*Hoplostethus atlanticus*) fishery off the waters of New Zealand (Clark, 1999; Clack et al., 2000), Australia (Lack, 2003), Namibia (Boyer et al., 2001; Branch, 2001), and the North Atlantic (Branch, 2001), the pelagic armorhead (*Pseudopentaceros wheeleri*) fishery over seamounts in international waters off Hawaii (Sasaki, 1986; Humphreys and Moffitt, 1999), the blue ling (*Molva dipterygia*) fishery in the North Atlantic (Bergstad et al., 2003) and Alfonsino (*Beryx splendens*), Roundnose grenadier (*Coryphaenoides rupestris*) fisheries in the Mid Atlantic Ridge (Vinnichenko, 2002) and Giant redfish (*Sebastes marinus*) fishery in international waters close to Iceland (Hareide et al., 2001). To those investing in these fisheries, the low productivity of stocks, the high logistic costs, and their unregulated, 'gold rush' performance must represent a considerable risk. However, the high prices obtained for species such as 'Chilean seabass', i.e., the Patagonian toothfish (*Dissostichus eleginoides*), especially in the restaurant markets of America, offset losses. Over recent years more and more of the deep ocean bottom has been fished and these include areas with seamounts (Pauly et al., 2003).

Seamount fisheries have recently deserved much attention mainly because of their increased importance and recognized impact on these ecosystems. Information on seamounts fisheries, however, is very sparse, and it is difficult to make a distinction between deep-water fishing activities in general and those occurring on seamounts. Moreover, fish species living on seamounts are also known to occur on other habitats, such as continental slope, and landings statistics are not spatially allocated, making it difficult to make an estimate of the total fisheries occurring on seamounts worldwide. Nevertheless, seamount fisheries are usually assumed to be economically important.

But what are seamount fisheries? How have their catches changed in recent years? Can we map where these catches are taken? To complete these tasks requires that we identify which species are associated with seamounts (see Stocks, this vol.; Froese and Sampang, this vol.), either exclusively or otherwise so that we can then examine their landings to date. Once we describe their global distributions with regard to the locations of seamounts (see Kitchingman and Lai, this vol.) we can construct maps of where they were taken. This report will describe the progress of this work.

METHODS

Identifying seamount associated fishes

An analysis of the published works describing the association of fish species with seamounts (Froese and Sampang, this vol.; Morato et al., this vol.) and continental slopes was used to construct a list of fish species with commercial value that occur on seamounts (Appendix 1). It must be recognized that in most cases species, associated with seamounts are or, at least were, associated with the continental slopes of many countries and not exclusively with seamounts (e.g. Tracey et al., 2004). In several cases the abundance of these species on the slope has diminished with fishing such that today they are recognized as predominantly 'seamount' species. It would, however, appear that there are comparatively few commercial fish species that are found almost exclusively on seamounts.

Global Catch Data Sources

The *Sea Around Us* project (SAUP) has constructed a global database of fisheries catches sourced from a number of agencies, regional and national, in addition to data made available by FAO (Watson et al., 2004). Using rule-based methods, and databases of the global distribution of species, as well as the fishing patterns of reporting countries, this project has mapped otherwise vaguely described catch data on a system of 180,000 spatial cells measuring 30 minutes of longitude by 30 minutes of latitude.

Analyzing Patterns of Collapse and Recovery

We examined the catch trajectories for each reported species and other taxonomic units in the SAUP catch database (http://www.seaaroundus.org/). Fisheries were defined as any reported taxa within a large marine ecosystem (Sherman et al., 1990) for which a cumulative catch of at least 100 tonnes was reported since 1950. Most reached their maximum annual catch before the end of the time series that extends from 1950 to 2001 inclusive. In all series where a maximum occurred, it was examined to find out whether the catch had collapsed, which we defined, following Froese and Pauly (2003), as reduction in any one year to 10% or less than the maximum. The number of years between the year of the maximum and that of the collapse was calculated, as were the percent annual catches of the maximum that was reached 5 years, 10 years and 15 years following the collapse. The latter were used as an estimate of fishery recovery.

RESULTS AND DISCUSSION

Seamount associated fishes and their catches

The list of commercial fish species occurring on seamounts is surprisingly long (Appendix 1). Most species are also found on the continental slope, making the allocation of reported catches to specific seamounts difficult. Though there is some documented harvest of invertebrates, e.g., corals (Anon., 1999), associated with seamounts, it is very difficult at present to distinguish the dependence of commercial invertebrates on seamounts. Therefore we have limited our analyses to fishes. Future mapping of landings will require species distributions that allow proportioning of catches between slope areas and those taken on seamounts. Given the rapid depletion of some coastal stocks this partitioning will have to make some assumptions of the relative abundance in both areas through time. This work is underway but will need to be revised by experts with specific knowledge of seamount areas.

Based on FAO data, we infer that present landings of the slope and seamount-associated fishes in Appendix 1 presently stagnate at around 15 million t. Our examination of the distribution of species contributing to these catches suggests that species with a strong presence on continental slope, in relative close proximity to the fishing ports of industrialized countries, notably in the North Atlantic and North Pacific, would have supplied the overwhelming bulk of the earliest catches. Those catches reported in more recent years, however, appear to consist to an increasing extent of species taken from seamounts (including those shown in Figure 1). Unfortunately there is a significant illegal catch of some species, notably Chilean seabass (i.e., Patagonian toothfish, *Dissostichus eleginoides*), so that the true landings, in recent years, would likely be higher than what has been reported to FAO from member countries. In fact, the illegal, 'pirate', catch of this species may be as much as four time the officially reported catch. (http://www.traffic.org/toothfish), and most of this is consumed in North America and Asia. Overall, we assume that the fraction of landings taken from remote seamounts compared to continental slope areas will continue to increase for some species (as also suggested in Pauly et al. 2003), at least until their stocks collapse.

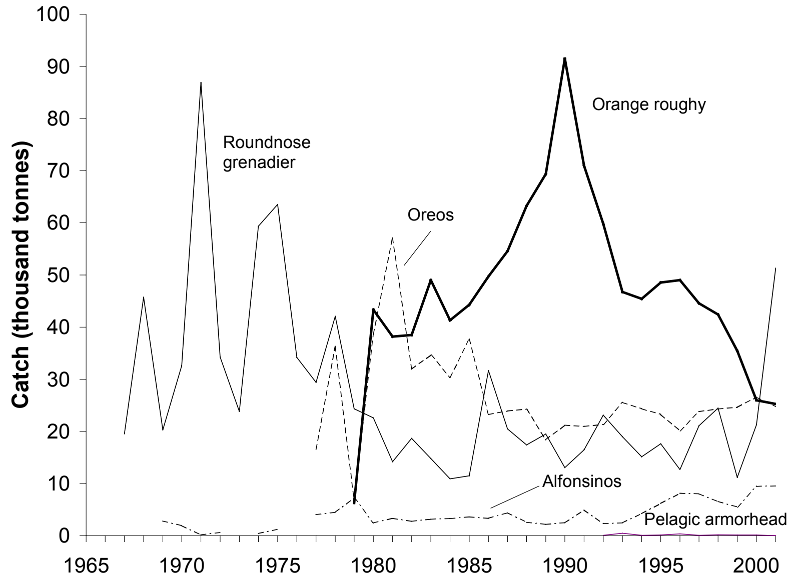

Figure 1. Sequence of catches in five seamount species, with the high variability documenting their lack of sustainability (see text).

Composition of seamount associated fish catches (1950-2001)

Figure 1 shows the catch composition from 1950 to 2001 of fishes identified as mostly occurring on seamounts (as subset of seamount associated species listed in Appendix 1). Catches of these species only began in 1967, initially with the Orange roughy fishery. The graph shows that the catches of these species has only been maintained because new seamounts with unexploited stocks were being discovered and because new species became targeted. A pattern of successive rapid development and decline is evident.

Collapse and Recovery of seamount associated fisheries

Table 1 compares the collapse and recover of non-seamount fisheries (Non-SM) with those of seamount associated (SM) and seamount only (SM Only, i.e., those species usually associated only with seamounts). While the percentage of fisheries that collapsed is somewhat similar for seamount associated species and those not associated with seamounts, it is obvious that those fisheries that rely on species found only on seamounts have collapsed with greater frequency. In addition, the latter fisheries took less than half the time between the year the maximum landings were reported until they collapsed (dropped to <10% of the maximum). This took less than four years on average for directed seamount fisheries. Following collapse the recovery of the fishery, as indicated by the percent of the maximum catch that was obtained 5, 10 and 15 years after the collapse, was also worse for directed seamount fisheries.

This points towards the question whether non-only seamount fisheries, but also deep-water trawling in general, may or may not be sustainable in the long term (Clark, 2001). Recently, several scientific studies (e.g. Hopper, 1995; Merrett and Haedrich, 1997; Moore, 1999; Moore and Mace, 1999; Probert, 1999; Roberts, 2002), and environmental NGOs (WWF and TRAFFIC, Lack et al., 2003; IUCN), and governments (New Zealand, Australia, Canada) have strongly advocated an urgent need for implementation of fishing regulations for deepwater fisheries, the establishment of marine reserves, and/or ban of deepwater trawl in what have been considered a very sensitive habitat, the seamounts (see also Alder and Wood, this vol.).

Table 1. Comparison of the collapse and recovery of non-seamount fisheries (Non-SM), those based on seamount associated fisheries (SM), and those based on species usually only found on seamounts (SM Only). Note that here, a 'fishery' is defined by one catch series, representing the same taxon, within the same Large Marine Ecosystem (see LME definitions and catch data in http://www.seaaroundus.org/).

Fishery Type*	% collapsed	Years post Max. to collapse	5 yrs post collapse (% max)	10 yrs post collapse (% max)	15 yrs post collapse (% max)
Non-SM	46	8.2	13.3	12.9	13.0
SM	49	7.9	14.1	12.2	14
SM Only	64	3.5	12.7	7.6	8.4

FUTURE WORK

In order to map the catch of seamount associated fishes using the procedures used by the Sea Around Us Project (Watson et al., 2004) it is first necessary to construct distributions for these species. As discussed previously this is challenging as it must recognize that for some species, their abundance on the slope has declined significantly in recent years, leaving only fisheries on isolated seamounts, i.e., in high seas areas. Once these distributions have been constructed, they can be used to guide catch allocations and maps of catches can be constructed such as those found at http://seaaroundus.org/globalcatch/viewer.htm.

CONCLUSION

The quantification, mapping and evaluation of seamount fisheries are a immediate needs. Many species identified have life histories that place them at great risk (see Morato et al., this vol.), especially in the cooler, relatively low productive waters of the world's southern oceans. Many of these fisheries are outside the current management mandate of any country (Alder and Wood, this vol.). 'Pirate' fleets roam these areas with relatively impunity and the sustainability of the resource is not of great interest to them. Scoping this problem must be a priority before these resources, and the ecosystems upon which they depend, are compromised.

APPENDICES

The list of commercial fish species occurring on seamounts is surprisingly long and is presented in the following appendices:

1. Commercial fish taxa associated with seamounts

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