ABSTRACT

Intensive exploitation of seamounts in the Atlantic Ocean was initiated by Russia in the 1970s-1980s. Large-scale exploratory fisheries were conducted on the northern Mid-Atlantic Ridge (MAR), Corner and Rio-Grande Rises, South Azores and Madeira -Canary Island areas, the Vavilov, Walvis and South Antilic Ridges. As a result, seamounts with concentrations of roundnose grenadier, alfonsino, orange roughy, black scabbardfish, tusk, pelagic armorhead, horse mackerel, mackerel, and scabbardfish notothenids, patagonian toothfish and other species were found in some areas. The highest Russian annual catches in most seamount areas were between 1,000 and 10,000 t, with the exception of the MAR Madeira -Canary Island area catches (29,900 and 46,500 t). The total cumulative catch from the Atlantic seamounts amounted about 0.5 million tons. The history of fisheries indicates a vulnerability of fish stocks inhabiting the seamounts. The highest catches and fleet efficiency were observed during the first few years after the fishery beginning. Later on, these rates substantially decreased and remained low over a long period. In some cases even small catches caused lower density and stability of aggregations and consequently reduced catches. In some areas catches increased again after several years but they did not again reach the initial level. As a result of high fishing effort most of the stocks are severely depressed.

Keywords: Atlantic seamount areas, catches, fisheries, species, stocks, vulnerability.

INTRODUCTION

Intensive studies and exploitation on seamounts of the Atlantic Ocean were initiated by Russia in the 1970s-1980s. In the course of the exploratory fishing, seamounts with concentrations of fish and invertebrates were found (Figure 1), and commercial fisheries were developed in some areas.

Available historical data on Russian fisheries on Atlantic seamounts are summarized in this report. The purpose of the present paper is to sum up the results and to specify prospects for commercial use of fishery resources on Atlantic seamounts.
MATERIALS AND METHODS

A number of data sources have been used in compiling catch information for this work. Most details have come from the publications, fisheries statistics and data of Russian scientific research and exploratory cruises reports, and personal messages from masters of fishing vessels.

Following data were used as indices of the fishing intensity:
- Total annual catch.
- Annual catches for certain fishing targets (if relevant data are available).
- Mean annual fishing efficiency (if relevant data are available).

The most complete is statistical information for the period 1973-1992. For the subsequent decades information on fishery on seamounts is less reliable

RESULTS

There are ten seamount areas with aggregations of fish and invertebrates were exploited by Russian fleet in the Atlantic Ocean (Figure 1, Table 1). It has been reliably determined that commercial fisheries have been conducted on eight of them. Most of the areas were discovered by Russian research and exploratory vessels in the 1970-80s.

**Northern Mid-Atlantic Ridge**

The fishery on the Northern Mid-Atlantic Ridge (MAR) started in 1973, when dense concentrations of roundnose grenadier (*Coryphaenoides rupestris*) were discovered (Shibanov, Vinnichenko, 2008). The greatest annual catch (almost 30,000 t) in that area was taken in 1975 (Figure 2) and in subsequent years the catch varied from 2,800 to 22,800 t. In the last 15 years, there has been a sporadic fishery (annual catch estimated at 200–3,200 t). During the whole fishing period from 1973 to 2005, the total Russian catch of roundnose grenadier from the MAR comprised 208,100 t.

Roundnose grenadier aggregations may have occurred on 70 seamount peaks of the Ridge between 46–62° N (Figure 2) but only 30 of them were commercially important and subsequently exploited. The fishery is mainly conducted using pelagic trawls although on some seamounts it is possible to use bottom gear. Deepwater redfish (*Sebastes mentella*), orange roughy, black scabbardfish (*Aphanopus carbo*) and deepwater sharks are caught as bycatch in the fishery (Kemenov *et al.* 1979; Anon. 1988a,b; Anon. 1990).

In 1983-1987, during dives of the underwater-vehicle "Sever 2" aggregations of tusk (*Brosme brosme*) and northern wolffish (*Anarhichas denticulatus*) were observed on the MAR seamounts (Zaferman, Shestopal, 1991; Zaferman, Shestopal, 1996), and a bottom longlining fishery was developed (Prozorov et al., 1985). Catches of tusk were taken on 20 seamounts in the area between 51-57° N. In 1996-1997 a small fleet of Norwegian longliners had a short-lived fishery for tusk and 'giant' redfish (*Sebastes marinus*) on the Ridge. The fishery was mainly conducted with vertical longlines. Fishery in that area was resumed in 2005-2007 by Russian longliners with annual catches of 15-407 t (Vinnichenko, 2007, 2008).
Figure 1. Seamount areas discovered and exploited by Russian fleet in the Atlantic Ocean
Table 1. Summary data on Russian seamount fisheries in the Atlantic Ocean

<table>
<thead>
<tr>
<th>Area</th>
<th>Main species</th>
<th>Year of discovery</th>
<th>Quantity of fishable seamounts</th>
<th>Maximum catch/yr ('000 t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Mid Atlantic Ridge</td>
<td>Coryphaenoides rupestris</td>
<td>1973</td>
<td>34</td>
<td>29.9</td>
</tr>
<tr>
<td></td>
<td>Beryx splendens</td>
<td>1977</td>
<td>4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>Hoplostethus atlanticus</td>
<td>1979</td>
<td>5</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Epigonus telescopus</td>
<td>1981</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>Geryon affinis</td>
<td>1981</td>
<td>3</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Brosme brosme, Sebastes marinus*</td>
<td>1984</td>
<td>15</td>
<td>0.4</td>
</tr>
<tr>
<td>Corner Rise</td>
<td>Beryx splendens, Aphanopus carbo, Polyprion americanus,</td>
<td>1976</td>
<td>3</td>
<td>10.2</td>
</tr>
<tr>
<td></td>
<td>Geryon affinis</td>
<td>1983</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>South Azores seamounts</td>
<td>Trachurus picturatus, Scomber japonicus, Lepidopus caudatus</td>
<td>1970</td>
<td>9</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Beryx splendens</td>
<td>1976</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Geryon affinis</td>
<td>1981</td>
<td>3</td>
<td>n/a</td>
</tr>
<tr>
<td>Madeira - Canary Island area</td>
<td>Trachurus picturatus, Scomber japonicus, Lepidopus caudatus</td>
<td>1970</td>
<td>10</td>
<td>46.5</td>
</tr>
<tr>
<td>Vavilov Ridge</td>
<td>Beryx splendens, Epigonus denticulatus</td>
<td>1978</td>
<td>9</td>
<td>4.3</td>
</tr>
<tr>
<td>Walvis Ridge</td>
<td>Beryx splendens, Pentaceros richardsoni</td>
<td>1976</td>
<td>10</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>Jasus tristani, Decapterus macarellus, Emmelichthys nitidus</td>
<td>1968</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Maurolicus muelleri</td>
<td>1983</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td>Discovery seamounts</td>
<td>Beryx splendens, Pentaceros richardsoni, Epigonus telescopus,</td>
<td>1980</td>
<td>3</td>
<td>0.9</td>
</tr>
<tr>
<td>Rio-Grande Rise</td>
<td>Decapterus macarellus, Caranx spp., Seriola zonata</td>
<td>1982</td>
<td>3</td>
<td>n/a</td>
</tr>
<tr>
<td>Trinidad-Martin Vaz</td>
<td>Lepidonotothen macroptalmus, Notothenia kempi, Dissostichus eleginoides</td>
<td>1980</td>
<td>4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* - discovered by Norwegian fleet in 1996
n/a not available
In the North Azores section of MAR (42-46° N, Figure 1) the first catches of alfonsino (*Beryx splendens*) and scabbardfish (*Lepidopus caudatus*) were taken in 1976 (Vinnichenko 2002a). A commercial pelagic trawl fishery for alfonsino developed on "Spectr" seamount in 1977 and this and other seamounts were exploited in 1978 (700 t) and 1979 (1,100 t catch) (Figure 2). No commercial fishing took place during the 1980s but 9 exploratory and research cruises yielded about 1000 t of mixed deepwater species, mostly alfonsino, but also commercial catches of black cardinal fish (*Epigonus telescopus*) orange roughy, black scabbardfish and silver roughy (*Hoplostethus mediterrraneus*) (Vinnichenko, 2002a). Aggregations of deepwater crab (*Geryon affinis*) were observed, and it was thought harvesting by traps would be possible (Moskalenko, 1978; Zaferman, Sennikov, 1991). Studies to evaluate the possibility of longline fishing between 600 and 900 m were also carried out in the 1980s (Zaferman and Shestopal, 1991; Zaferman and...
Shestopal, 1996), with catches of longnose velvet dogfish (*Centroscymnus crepidater*) with blue antimora (*Antimora rostrata*), leafscale gulper shark (*Centrophorus squamosus*), birdbeak dogfish (*Deania calcea*) and false cat shark (*Pseudotriakis microdon*). Commercial fishing yielded 864 t in 1994, about 200 t in 1995 and 1000 t in 1996. In recent years there have been no indications of fishable concentrations of alfonsino (Shnar et al., 2005). Since the discovery of the seamounts in the North Azores area Russian vessels have taken more than 4000 t, mainly of alfonsino.

Oceanic redfish can also occur close to the bottom over seamounts of the MAR (60-62° N), where they can form aggregations in spring. In ICES Sub-areas XII and XIVb, where part of the MAR is located, several groups of ten thousand tones of redfish were taken Russian fleet by pelagic trawls in recent decade, but it was not possible to estimate the proportion of the catch, obtained from over the seamounts.

**Corner Rise**

Exploratory fishery on the Corner Rise seamounts (34-37° N, 47-53°W, Figure 1) began in 1976, when 3 seamounts with dense concentrations of deepwater fishes were found (Anon., 1988a; Anon., 1993). Catches in the first year consisted mainly of alfonsino, and totaled more than 10,000 t (Figure 2). Black scabbardfish, wreckfish, black cardinal fish, barrelfish (*Hyperoglyphe perciforma*), and silver roughy also occurred in catches. In the following year no stable aggregations were found in the area and the catch decreased to 800 t (Vinnichenko, 1997). Commercial activity resumed in 1987, with a catch of 2,300 t of predominantly alfonsino. The fishery then ceased until the mid 1990s (Figure 2) and then continued with variable effort levels until the end of the century. In recent years there has been no significant fishery in this area. Russian research vessels found no stable alfonsino aggregations in 2003-2004 (Shnar et al., 2005).

A potential pot fishery for deepwater crabs was identified (Zaferman and Sennikov, 1991), and longlining was attempted but catch rates of black dogfish (*Centroscyllium fabricii*), alfonsino and black scabbardfish were low.

The total cumulative catch taken by Russia on the Corner Rise has amounted to more than 21,000 t. Most of the catch was taken by pelagic trawl.

**South Azores area**

In the South Azores area (Figure 1) Russian fishery started in the early 1970s when some seamounts with aggregations of silver scabbard fish, horse-mackerel (*Trachurus picturatus*), mackerel (*Scomber japonicus*), sea-snipe (*Macrohamphosus gracilis*), alfonsino and black scabbardfish were found. Three seamounts fell within the 200 mile EEZ after 1977 and were no longer fished by the Russian fleet. Nine fishable seamounts were identified in international waters (Fomin et al., 1975; Bakanev et al., 1977; Vinnichenko, 2002a).

Highest catches were taken with both pelagic and bottom trawl gear during the first years of its operation (Figure 2), after which the fishery was conducted periodically (Samochvalov et al., 1981). The area was regularly investigated by research and exploratory vessels, but in most cases no stable fish aggregations were registered. Total Russian catches in this area throughout the whole period amounted to more than 28,000 t (Anon, 1984; Vinnichenko, 2002a).

The possibility for a fishery on deepwater crab with pots was determined during research in the 1980s (Zaferman and Sennikov, 1991), and development of a long-line fishery was also investigated (Zaferman and Shestopal, 1991). In the depth range of 250-680 m catches amounted to 454 kg per 1000 hooks and consisted mainly of blondnose six-gilled shark (*Heptranchias perlo*), and greater forkbeard (*Phycis blennoides*),
bluemouth (*Helicolenus dactiolopterus*), conger eel (*Conger conger*), alfonsino (*Beryx decadactylus*) and wreckfish.

According to anecdotal reports, some Russian commercial trawlers have operated periodically in the area in recent years, with catches of horse-mackerel, mackerel, alfonsino, sea-snipe and deep-bodied boarfish (*Antigonia capros*). More detailed information is not available, but fishable concentrations were found by Russian research vessels in 2003-2004 (Shnar et al., 2005)

**Madeira - Canary Island area**

The Madeira - Canary Island area lies off the coast of northwestern Africa between 17-37° N and 12-22°W (Figure 1). Here, 10 fishable seamounts are known. The Russian fishery began on Conception Seamount in 1970, and on the others in 1973-1974 (Fomin et al. 1975). The largest catches in this area occurred in the first few years with annual catches of 17,800 t to 46,500 t. When EEZs were established in 1977, the fishery continued intermittently on Josephine and Ampere seamounts, which are in international waters (Fomin et al. 1980; Vinnichenko and Khlopenyuk, 1983). Catches were over 10,000 t in 1974, but otherwise less than 3,000 t/yr (Figure 2).

The main target species in this area were horse mackerel, mackerel and silver scabbardfish. By-catch can comprised breams (family Sparidae), rotauge (*Erythrocles monody*), skipjack (*Katsuwonus pelamis*), albacore, yellowfin tuna (*Thunnus albacares*), bullet mackerel (*Auxis rochei*) and frigate mackerel (*A. thazard*) (Fomin et al., 1975; Vinnichenko and Khlopenyuk, 1983; Anon., 1988a; Vinnichenko, 1989; Vinnichenko, 1996). On some seamounts dense concentrations of sea-snipe formed periodically (Bakanev et al., 1977). The main fishing gear was pelagic trawl; although on some seamounts bottom trawl and purse seine were also used.

In 1984, on the Josephine and Ampere seamounts, a few settings of a bottom longline were made in the depth range of 100 m to 700 m. Catches per 1000 hooks varied from 38 kg to 104 kg and consisted mostly of different shark species (*Galeus melastomus*, *Deania calcea*, *Dalatias licha*, *Etmopterus spp.*), Serranidae, gurnard (Triglidae), conger, moray and greater fork beard (Zaferman and Shestopal, 1991).

**Vavilov Ridge**

The Vavilov Ridge is in the tropical zone of the Atlantic Ocean between 2-13° S, 6°W-2°E (Figure 1). Russian research vessels explored the region in 1978, and a commercial fishery developed on 6 seamounts (Anon. 1988a; Strogalev et al. 1989).

The most active fishery in the area was carried out in 1978, when 4,200 t of fish were caught (Figure 2). In the subsequent decade the area was repeatedly studied by exploratory vessels but stable concentrations were not generally found on the seamounts and there was no commercial fishery (Strogalev et al., 1989). The Russian fishery resumed in the second half of the 1990s.

The most important targets of the trawl fishery in the area are alfonsino and cardinal fish (*Epigonus denticulatus*). The exception is one seamount, where mackerel (*Scomber japonicus*), horse-mackerel (*Trachurus picturatus*) concentrations occur. Silver scabbardfish, round scad (*Decapterus longimanus*), yellow-fin tuna and skipjack are also found in trawl catches. On one of the seamounts, concentrations of crabs (species name is not known) were found and some catches were taken (Anon., 1988a; Strogalev et al., 1989).

**Walvis Ridge**
The Russian fishery in the Walvis Ridge area (20-34°S, 1-9°E, Figure 1) commenced in 1968 on the Valdivia Seamount. Data from Fomin (2002a) show that the commercial fleet operated in that area until 1973 but catch statistics for this period are lacking.

A few years later, exploratory vessels found 9 more fishable seamounts on the Ridge. The largest catch on the Ridge (6,200 t) was taken in 1976 after which catches rapidly declined and did not exceed 600 t until the end of the subsequent decade (Figure 2). In the last 15 years only occasional fishing was conducted (Fomin, 2002a). Data on catch statistics are lacking, however the total catch for this period did not exceed a few thousand tonnes.

Among the most commercially important species on the Ridge were alfonsino and pelagic armorhead (*Pentaceros richardsoni*), and to a lesser extent, barrel fishes (*Hyperoglyphe antarctica, Schedophilus ovalis*), scorpionfish (*Helicolenus tristanensis*), silver scabbardfish, escolar (*Ruvettus pretiosus*), rabbitfish (*Promethichthys promethus*) and orange roughy. An exception was the Vema Seamount located on the eastern margin of the Ridge, where catches were dominated by mackerel scad (*Decapterus macarellus*), redbait (*Emmelichthys nitidus*) and rubyfish (*Pagiogeneion rubiginosus*). The fishermem usually use pelagic trawls but on some seamounts bottom trawls were also used. Concentrations of shrimps (*Acanthephyra exigua, Oplphorus spinagus, Nematocatcinus longirostris*) and spiny lobster (*Panutirus echinatus*) were also found (Anon., 1983; Anon., 1988a; Fomin, 2002a).

**Trinidad-Martin Vaz**

The Trinidad-Martin Vaz seamounts (20-21° S, 36-39°W, Figure 1) were explored by Russian vessels in 1982. Bottom trawling took place on the 3 seamounts located in the western area (Anon., 1988a). Maximum catches were not exceed 3 t/tow and mainly consisted of jacks *Caranx* spp., mackerel scad, amber jack (*Seriola zonata*), *Sphyraena* spp., red snapper (*Lutjanus aya*), sea bass (*Paranthias furcifer*), wreckfish and coney *Cephalopholis fulva*.

**Rio-Grande Rise area**

Three commercial seamounts are known in the Rio-Grande Rise area (28-35° S, 20-38° W, Figure 1). The first fishery data were obtained in 1982 (Anon., 1988a; Zasef'skii, Pleteshkov, 1988). The catches from bottom trawls amounted to 5-12 t/tow but those from the pelagic trawl did not exceed 2 t. Apart from alfonsino, armorheads (*Pseudopentaceros richardsoni*), black cardinal fish and barrellfish were also caught. In the same year a new seamount was discovered, where pelagic trawl catches of alfonsino, with a bycatch of armorheads, cardinal fish and barrellfish amounted to 50 t. The total catch on both seamounts totalled more than 300 t. These seamounts were explored again in 1984 and 1985 as well, but no commercial catches were obtained.

The discovery of a third seamount resulted in a renewed fishery and in 2000-2002 catch in the area was estimated at between 300 and 600 t each year, with alfonsino being the dominant specie (Kakora, 2003; Kakora, 2005).

There are no available data after 2002.

**Discovery seamounts**

The Discovery seamounts are located between 41-44° S and 4° E - 3° W (Figure 1). In 1983, aggregations of mesopelagic pearlside, *Maurolicus muellerri*, were found on two seamounts, where catches of Russian exploratory vessel by pelagic trawl comprised 10-40 t per haul, and the total catch was about 350 t.
Between 1984 and 1987, density of the fish concentrations was noticeably lower and the catch per haul did not exceed 3-8 t. No commercial fishery for pearlsides has been established in the area.

**South Antilic Ridge**

The South Antilic Ridge is located between 53-62° S, 52-40° W (Figure 1). In late 1980 and early 1981, two seamounts were found by Russian exploratory vessel on the northwestern part of the area, and commercial catches of notothenids (*Lepidonotothen macrophthalmus, Patagonotothen ramsayi*) and Patagonian toothfish (*Dissostichus eleginoides*) were taken by bottom trawl (Anon. 1988a). In 1981, the total catch was about 1,200 t, which decreased to 200 t in 1983, and to 20 t in 1984.

In 1987, a new seamount was discovered near the South Orkney Islands. Bottom trawl catches totalled 255 t, and consisted of striped-eyed rockcod (*Lepidonotothen kempfi*) with bycatch of marbled rockcod (*Notothenia rossi marmorata*) and Patagonian toothfish. In 1989, the catch was about 200 t of notothenids.

**DISCUSSION**

The highest Russian annual catches in most areas were between 1000 and 12,000 t (Figure 2), with the exception of the Northern MAR and the Madeira-Canary Island area where the maximum annual catches reached 29,900 and 46,500 t respectively. The total Russian cumulative catch from the Atlantic seamounts amounts about 0.5 million t.

Russian statistical data analysis shows that fisheries on the seamounts have similar characteristics over most sea areas. The highest catches and fleet efficiency were typically observed during the first years of the fishery (Figure 2). Subsequently these rates substantially decreased (to the point of the total absence of catch) and remained low over a long periods. In some cases even small catches (in the range of 500-10,000 t) caused lower density and stability of aggregations and consequently reduced catches. In some areas catches increased again after several years but, as a rule, they did not reach the initial level (Figure 2).

The biology of fish and invertebrates inhabiting the seamounts is insufficiently explored, and the status of the stocks in most areas has not yet been estimated. In the recent decades there has been an abrupt decline in the available statistical data and of fishery investigations. Shortage or lack of investigations prevents an adequate assessment of the status of fish stocks on the seamounts. However some studies (Klimenko, 1983; Samokhvalov *et al.*, 1981; Zaferman, Shestopal, 1996; Vinnichenko, 1998; Shibanov, 1998; Vinnichenko, 2002a; Zakharov, 2003) suggest that the biomass of fish stocks on the seamounts is rather low and does not exceed several hundreds of thousand tonnes. Stock size and catch of different areas vary widely and apparently depend on the fish production on the seamounts, as well as on the number of seamounts in each area.

Results of fisheries indicate a vulnerability of most fish and invertebrates populations inhabiting the seamounts. As a rule, these stocks are comparatively low and highly susceptible to overfishing. This is particularly true for deepwater species with a retarded maturation and low fecundity (Vertunov, 1989; Vinnichenko, 2002b). On the other hand, some species (eg. pelagic fishes and alfonsino), which have a relatively short life history show quite a high ability to recover after the intensive fishery.

**CONCLUSIONS**

1. Limited biomass on seamounts does not allow large-scale fisheries to be conducted on a long-term sustainable basis. The allowable catch for these areas should be established assuming the existence of a discrete and a rather small stock on each seamount or on a group of adjacent seamounts.
2. As a result of intense fishery the fish stocks on the most seamounts areas are probably in a depressed state that will not permit significant increase of catch in these areas within the next few years.

3. In order to achieve effective and rational exploitation of fishery resources on seamounts, active support of international organizations, and regulating the fisheries on the high seas are required. Greater efforts are needed to obtain reliable statistical fishing data, more research is needed on the ecology of fish and invertebrate fauna on seamounts, stock structure, and precautionary guidelines to regulate fishing in the absence of any strict management measures.

REFERENCES


