BROADBILL SWORDFISH: STATUS OF WORLD FISHERIES

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Longline fisheries targeting swordfish in the Australian Fishing Zone (AFZ) off eastern and western Australia have developed rapidly in recent years. As a result of prospects for continued expansion in Australia, fishing permits to operate in Australia's Eastern Tuna and Billfish Fishery and Western Tuna and Billfish Fishery are increasing in value at a rapid rate. New and larger boats are entering the fishery and investment in the fishery has increased dramatically without an understanding of the impact of present levels of fishing effort. Several swordfish fisheries in other parts of the world, however, have shown an initial rapid expansion and then declined, prompting concern over the species' ability to support intensive harvesting. Views on swordfish status are polarised between the fishing industry and conservation groups, with scientists in the middle ground. Conservation groups, for example, instigated a boycott of swordfish in restaurants in the United States and are calling for a complete ban on longline fishing.

In response to the rapid increase of Australia's swordfish fishery, the Bureau of Rural Sciences (BRS) undertook a review of the world's swordfish fisheries (Ward and Elscot 2000). The report consists of a summary of biological characteristics of swordfish that are relevant to stock assessment and fishery management, an overview of the world's swordfish fisheries, detailed reviews of six swordfish fisheries and a comparison of the six fisheries. The main body of the report consists of detailed 'case studies' of one developing swordfish fishery (eastern Australia) and five established fisheries-fisheries that have passed an historical peak in catch levels. For each fishery, its history, catch levels and the geographical and seasonal distribution of fishing activities and catches are described. To help comparison between fisheries, the types of boats used, their fishing gear and fishing practices are described. Data collection, research and stock assessment are examined. Under the heading of 'management' the report details fishery management institutions, their objectives, management measures, bycatch and fishery interaction issues and advice needs. The future prospects for each swordfish fishery are examined and general conclusions about swordfish fisheries are developed. The summary from the report is provided below.

REFERENCES

Ward, P. and Elscot, S. 2000. Broadbill swordfish: Status of world fisheries. Bureau of Rural Sciences, Canberra, Australia. 208 pp.

SUMMARY

Coastal nations depend on swordfish

Swordfish are a high value catch that represent an increasingly important source of revenue to many coastal nations in the Pacific and Indian oceans, e.g., Australia and La Réunion. Optimistic that they can continue to increase swordfish catches, fishers are purchasing fishing permits and investing in new, larger boats to fish for swordfish. However, several swordfish fisheries in other parts of the world have shown initial, rapid expansion, then declined, prompting concern over the species' ability to support intensive harvesting. We examine established fisheries for swordfish to identify lessons for the assessment and management of developing swordfish fisheries, like Australia's.

Swordfish differ from other species

Like other billfish and tuna, swordfish are highly fecund, migratory fish that grow quickly in their early years and become apex predators. Tuna and billfish are truly oceanic and they are difficult to study. Swordfish have a wider geographical distribution (50°N–50°S) than other billfish and tuna. They routinely move between surface waters and great depths where they tolerate extreme cold (~5°C). They do not form schools. Results of recent research suggest that the Pacific Ocean is comprised of several, semi-independent stocks of swordfish (a northern stock, a south-western stock and two or three eastern Pacific stocks). Swordfish move with prevailing currents and use their highly developed sight to stalk prey. Female swordfish grow faster and live longer than males. They reach their maximum size (usually ~350 kg) at about 15 years of age. Male and female swordfish have different distributions depending on size.

Early activities take large females

Swordfish fishing started as nearshore subsistence activities in subtropical areas, thousands of years ago. The early fishing involved harpooning large, female swordfish as they were basking at the sea surface. Large swordfish are also a prized catch of recreational anglers, although in most areas gamefishing activities tend to focus on other billfish, such as blue marlin. Anecdotal reports suggest that large swordfish were more abundant when commercial fishing commenced in the 1800s than they are in many areas now. Swordfish fisheries changed dramatically when fishers upgraded to monofilament driftnet and longline fishing gear in the 1980s.

Failure to contain fleet overcapacity

Distant-water longliners started to target swordfish early in the 1950s. They typically spend several months at sea and freeze their catches. In the 1960s many distant-water longliners started targeting sashimi tuna, such as yellowfin. In the mid-1980s fishers realised the potential for smaller (10–25 m) longliners to make shorter fishing trips, store tuna and swordfish on ice and airfreight the fish to distant markets. Unit prices paid for fresh-chilled swordfish in the United States and Europe are generally lower than those paid for sashimi tuna in Japan. However, boats can undertake longer fishing trips for fresh-chilled swordfish because it has good storage qualities and its price is less sensitive to product quality. Fresh-chill longline fleets quickly developed in many of the world's ports. Driftnet boats also target swordfish and distant-water tuna longliners take a substantial bycatch of swordfish. During the 1980s and 1990s longliners and driftnet boats increased swordfish catches to high levels.

Examples of rapid expansion in swordfish catches:

Area	Initial annual catch (t)	Peak annual catch (t)	Period of increase (yrs)
Mediterranean	5 000	20 000	11
North Atlantic	12 000	21 000	9
South Atlantic	5 000	21 000	15
Chile	500	7 000	6
Hawaii	300	6 000	3
North-west Pacific	2 000	5 000	3

In each area fishing effort continued to expand for several years after the peak in catches, highlighting the inability of fishery managers to control growing overcapacity in the fleets.

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Fisheries expand geographically

Fresh-chill longline fisheries for swordfish exhibit a development pattern where the risk-takers in the fleet progressively move further offshore, initially taking high catch rates. Other longliners follow and the fleet ranges further offshore for longer trips, tolerating more extreme weather conditions. Hawaii-based longliners, for example, regularly make trips of more than 30 days. They venture 1000–2000 nm from port and average about 250 days at sea per year. Such expansion shows the potential for increases in effort in other fresh-chilled fisheries like Australia's. To allow informed decisions on economic efficiency, fishers and fishery managers require an understanding of the limits that distance and boat size place on the commercial feasibility of swordfish fisheries.

Expansion conceals declines

The introduction of longline gear increased swordfish catch levels and resulted in the expansion of fishing into offshore waters and to lower latitudes where small, juvenile swordfish were typically more abundant. The expansion of fishing grounds also broadened the size range of swordfish in catches. However, expansion often concealed declines in swordfish abundance and degradation of size composition on the original fishing grounds.

Flexibility hampers management

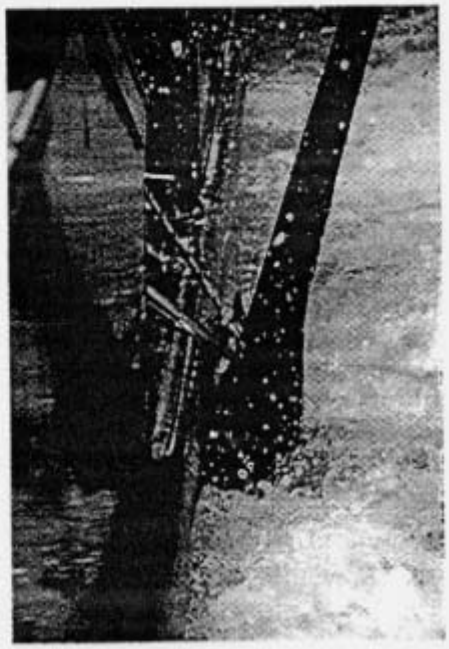
Longliners are able to switch between target species (e.g., from targeting swordfish to sashimi tuna) or to relocate to distant ports in response to declining prices, poor catch rates or the imposition of management regulations. Many of Spain's swordfish longliners, for example, started to target tuna or shark or relocated to the South Atlantic when swordfish catch rates declined in the North Atlantic. Fishery managers need to establish measures that encompass the ability of longliners to switch between target species and to relocate to distant areas.

Prone to local depletion

Within populations a proportion of the swordfish associate with underwater features, such as banks and seamounts. Such features were often the focus of fisheries when they first began to develop. Modern longliners are potentially capable of removing the 'resident' components of swordfish populations at a greater rate than growth and immigration can replace them. Swordfish may thus be inclined to local depletion around underwater features.

Fishing removes large swordfish

Very large swordfish (250–500 kg) were most abundant when commercial fishing began to develop in the 1800s. In the Mediterranean the size composition of catches has declined so that the fishery now relies almost exclusively on one-, two- and three-year-old swordfish. The size at maturity is smaller in the Mediterranean than in other fisheries (it might be a characteristic of the Mediterranean stock or it might have declined there in response to increased exploitation). However, swordfish are remarkably fast-growing in their early years and, in the Mediterranean, seem to support relatively heavy fishing pressure.



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No stock collapse apparent

There is no clear evidence of swordfish stocks or their fisheries collapsing from overfishing. Their broad distribution combined with prolonged spawning periods might contribute to the apparent resilience of swordfish stocks to intensive harvesting. Nonetheless, inadequate scientific advice and fishery management are failing to realise the considerable economic benefits that would be derived from optimum use of the swordfish resources. Three fisheries—the Mediterranean, South Atlantic and North Atlantic—have been fished at levels that are above the estimated maximum sustainable yield (MSY). It is unclear whether the combined effects of harpoon, driftnet and longline fishing or juvenile catches by longline alone were the main cause of the decline in the parent stocks. Swordfish abundance in the North Atlantic has shown a continuous decline since about 1980 with the stock eventually falling below the estimated optimum level. Catch rates declined during 1990–96 and there were fewer older-age swordfish in the population. The most recent (1999) assessment suggested that the decline in abundance has slowed and that there were strong recruitments of young swordfish in 1997 and 1998. The status of swordfish in the South Atlantic is more uncertain. There, swordfish catches are believed to have been above the maximum sustainable yield in most years since 1989. In the Mediterranean the number of new recruits produced in 1994 was estimated to be 10–20 per cent of that which an unfished stock would have produced. The fishery's reliance on small swordfish and the fluctuations in recruitment reflect significant reductions in the size of the parent stock.

Regional management has lacked power

Swordfish are a highly migratory species. Nations and regional organisations have not been particularly successful in managing swordfish fisheries. They have been unable to establish the necessary data collection and research programs early in the fishery's development. They have allowed fleets to overcapitalise and have not always implemented restraints recommended by scientific advisers. Where restraints have been imposed, they have proved inappropriate (e.g., size restrictions) or difficult to enforce (e.g., quotas). The North Atlantic stock seems to have recovered quickly in response to the application of strict management action. Apart from those cooperating in the International Commission for the Conservation of Atlantic Tunas (ICCAT), however, most nations have taken unilateral approaches, attempting independently to research and manage

Special research needs

The unique biology of swordfish requires complex age and spatially structured stock assessment models. Swordfish stock assessment needs knowledge of stock structure and mixing, age and growth and natural mortality. Tag–recapture experiments are often used to obtain such information for other marine fish. However, swordfish are notoriously difficult to tag. New technology 'archival' and 'pop-up' tags might provide information on swordfish movement and behaviour.

Swordfish distribution and abundance are closely linked to ocean temperature and productivity. Knowledge of inter-annual variability in swordfish abundance, the effects of broad-scale oceanographic events, like El Niño, and changes in ocean productivity might aid the interpretation of catch rates and the management of several swordfish fisheries, such as those off Chile and Australia.

The accuracy of stock assessments depends on data quality and coverage. A recent analysis suggests that size may be a more sensitive indicator of swordfish stock status than catch rates. For most swordfish fisheries, stock assessment relies on programs that sample catches when they are landed at ports. However, female swordfish grow faster than males and the size and sex composition of swordfish catches vary considerably between areas and seasonally. Longliners that supply United States markets often discard small and damaged swordfish, creating further gaps in the data collected through port sampling. Consequently, swordfish stock assessment requires a detailed breakdown of catches by location, size and sex that can only be gathered by at-sea programs.

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swordfish within their waters. In the Mediterranean there is virtually no coordination of regulations; neither is there an overall limit on fishing effort or catch levels. Several nations have inadequate enforcement arrangements and many fleets do not to comply with those regulations. In the Atlantic, ICCAT has no regulatory authority and member nations are not legally bound to accept its recommendations. Several members have ignored the national quotas allocated by ICCAT and catches have regularly exceeded the total allowable catch, thereby contributing to the continuing decline of the South Atlantic swordfish stock and, in the past, the North Atlantic stock. Nations that have developing swordfish fisheries need to cooperate in regional approaches to fishery management and assessment.

Mostly an incidental catch of tuna longliners

Globally, swordfish catches are increasing. More than half of the world's swordfish is taken as an incidental catch of longliners targeting tuna. Most of that swordfish catch is frozen and sold for low prices. Bycatch presents problems to fishery management and assessment. With stock assessment, it is difficult to collect catch, effort and size composition data on bycatch species and it is difficult to control catches of bycatch species when the fishery is targeting other species. Japan's longliners, for example, do not target swordfish in the North Atlantic. They are, however, the second largest harvester of swordfish there, landing more than ten per cent of the total catch.

Control effort before expansion commences

Several nations have managed their swordfish fisheries by limiting the entry of new participants. Yet, inadequate support measures (e.g., boat size limits) for limited entry regulations have often allowed latent effort to build up in the fishery. Limited entry has not restrained fishing effort because fishers have been able to upgrade to larger fishing boats, set more fishing gear or spend more days at sea. Longliners were able to leave the North Atlantic swordfish fisheries before they were restrained by management regulations. Many nations have been unable or unwilling to prevent the relocation of their fleets to new areas. An important lesson from our review is the need to put in place mechanisms to control fishing effort *before* expansion commences and to activate those measures in a precautionary manner.

Six lessons for developing fisheries

1. **Control fishing effort.** Catch rates and average size will not be maintained at initial levels. Without controls, fishing effort will expand and overshoot the optimum level.
2. **Control geographical expansion.** The fishery will expand to a size that threatens the commercial viability of boats comprising the fleet.
3. **Establish appropriate data collection programs.** Swordfish are different to tuna; stock assessment requires more robust size-monitoring and at-sea programs to collect data on the sex composition of swordfish catches.
4. **Take a multispecies approach.** Management and research must deal with the ability of longliners to switch between target species in response to fluctuations in abundance and price.
5. **Monitor and mitigate bycatch.** Fishing affects other components of pelagic ecosystems that swordfish depend on. Environmental concerns over bycatch may also damage markets and attract harsh regulation.
6. **Adopt a regional approach.** Modern longliners are able to relocate to distant areas. Nations must work together through appropriate regional bodies to effectively manage and assess highly migratory species like swordfish.

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External influences determine catches

Swordfish is a global commodity. Markets in Europe and the United States tend to dictate swordfish prices. Catch levels declined in the 1970s in response to mercury restrictions in the United States and Canada, then increased when the restrictions were eased. In 1998 swordfish prices fell in response to a restaurant boycott and oversupply of the United States market. Further health restrictions or fluctuations in global demand will directly influence the commercial viability of many swordfish fisheries. A significant decline in the value of the United States dollar, for instance, might suddenly make several developing swordfish fisheries unprofitable.

Concern over shark

Longliners that target swordfish often take large, incidental catches of shark, particularly blue shark. Finning—the practice of removing the shark's fins and discarding the carcass—is common in many swordfish fisheries. The wastage associated with finning and the broader effects of longlining on shark populations are a growing concern to fishery managers and the wider public. Fishery managers require reliable estimates of the catch levels of shark and the status of shark populations. Simple techniques, such as the use of monofilament leaders, might also be available to mitigate shark bycatch.

Environmental concerns drive management

There is scant information about the catch levels of other bycatch species because observers are rarely placed on longliners targeting swordfish. Compared with longlining for tuna, swordfish longlining is more likely to interact with marine wildlife, such as seabird, seal and turtle, because it usually involves shallow-sets beginning in the late afternoon, at high latitudes where those species are often active. Many fishing nations have agreed to the Food and Agriculture Organization (FAO) International Plan of Action to reduce the incidental take of seabird by longline. At a national level, fishery managers are also responding to concern over the bycatch of seabird and other species in swordfish fisheries. The potential for incidental catches of seal and turtle, for instance, resulted in significant area closures around the Hawaiian Islands. Fishing for swordfish in the pelagic environment is simultaneously taking predators, competitors and prey. There is little understanding of fishing's effects on the wider ecosystem. Those effects will, in turn, affect swordfish population dynamics. In addition to robust assessments of swordfish status, the fisheries need multispecies assessments and ecosystem approaches to their management.

Unexploited resources in southern hemisphere

Swordfish distribution is closely linked to ocean temperature and the abundance of prey species. Deep-sea bathymetry and oceanographic conditions suggest that there may be unexploited or lightly exploited resources of swordfish in several locations of the southern hemisphere: the south-eastern Indian Ocean, southern Tasman Sea, across the subtropical convergence zone of the South Pacific and associated with seamounts and banks south of French Polynesia, Fiji and Tonga. Feasibility fishing is required to evaluate the resources of those unfished areas. The development of commercially feasible fisheries in unfished areas will also depend on the proximity of fishing grounds to ports and airfreighting links and markets.