Australia's fishing zone ~ vast and largely unknown

Australia's north-west shelf, the shallow sea-bed extending 100 km and more off the Western Australian coast north of Exmouth Gulf, has captured a lot of attention in recent years as a promising source of natural gas and, perhaps, oil. Less well known is the fact that it is also one of the country's richest fishing grounds.

Poling for southern bluefin tuna off Australia.

In 1974, Taiwanese trawlers landed about 40 000 tonnes of fish in this area, and a similar quantity from adjoining sections of continental shelf in the Timor and Arafura Seas. This was their biggest catch so far, but during the 1970s the Taiwanese haul from these waters has generally exceeded the total Australian fish catch (which was about 47 500 tonnes in 1978–79).

The entire north-west shelf and large portions of the Timor and Arafura Seas lie within the 200-nautical-mile Australian fishing zone, which was proclaimed on November 1 last year. It replaces the 12-mile 'declared fishing zone', and gives Australia jurisdiction over an area of ocean about the same size as its land area. The country's claim over this huge area follows international agreement that coastal nations have the right to control the resources within 200 miles of their shores.

Under the legislation establishing the Australian fishing zone, foreign fishermen can operate inside it only if they are licensed to do so and if they comply with terms and conditions of access (relating to permitted catch size, provision of information about catches, etc.) determined by Australia. Access to the north-west and northern shelf fisheries has been granted to the Taiwanese fishing interests, subject to various conditions, one of which is that illegal clam-gathering in the Great Barrier Reef region ceases.

Access to the 200-mile zone has also been granted to Japanese long-line tuna fishermen. Like the Taiwanese, most of them operate in fishing areas that are not being exploited by Australians. The government's policy, in line with the international agreement reached at the United Nations conference on the law of the sea, is to let foreign fishing fleets operate in fisheries that are not fully exploited by Australians and are not likely to be in the near future.

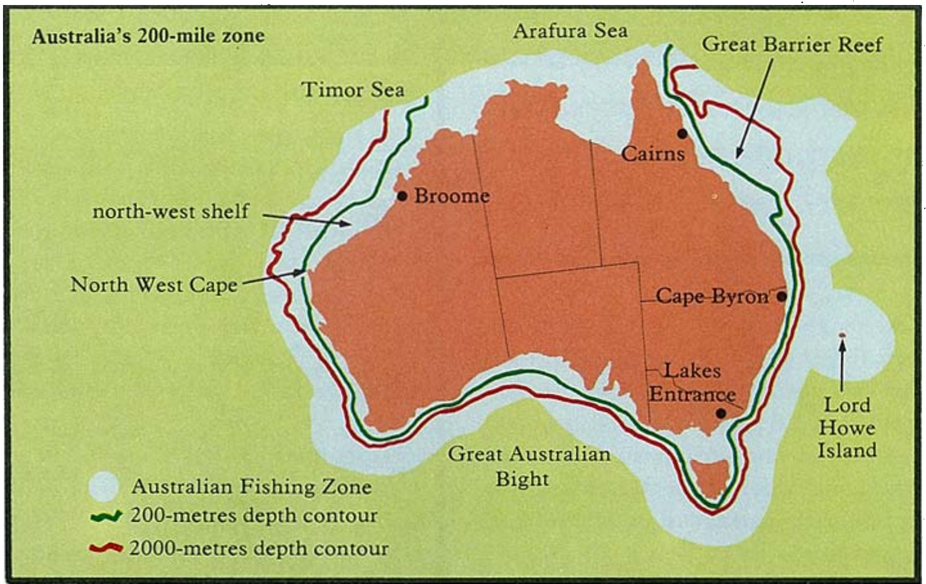
Countries claiming 200-mile fishing zones are obliged, under the agreement, to see that their fisheries are managed in a way that ensures the resources are effectively utilized but are not damaged by overfishing. This means they should allow access to fisheries they are not exploiting or planning to exploit themselves. It also means that catch limits must be set in accordance with the capacity of each fishery. Operations have to be monitored, to ensure that the limits are complied with and to determine whether these should be raised or lowered in the light of fishing experience.

To set catch limits likely to match reasonably closely the maximum yield of fish that can be sustained indefinitely, a great deal needs to be known about a fishery. One essential is a good estimate of total fish numbers. Equally necessary is information about the biology of the fish to be caught — their reproductive habits, growth rates, natural mortality rates, food preferences, and so on. Ecological information giving an understanding of the interactions of these species with others that share the same areas of ocean is also needed.

Very little of this information now exists about the fish of Australia's 200-mile zone. To help fill the information gap, the federal government has substantially increased its funding of fisheries research since 1978. For the CSIRO Division of Fisheries and Oceanography, this means that the number of staff engaged on fisheries-related work will more than double. Eight new scientists and support staff have joined the Division this year and another ten are now being recruited.

Funds have also been provided to allow the chartering for 5 years of a 53-metre research vessel, the *Soela*. It replaces the 28-metre *Courageous*, used by the Division for the past 3 years. The *Soela* has room for more scientists on board, can operate in deeper water, is faster, and can accommodate better research facilities (see the box on page 30). It began its first research cruise last December off Western Australia.

It gives Australia jurisdiction over an area of ocean about the same size as its land area.



Additional sections of the zone surround Norfolk, Macquarie, Heard, Cocos, and Christmas Islands.

On board the *Courageous* — preparing for a pelagic trawl.

A load of sponges and other things brought up from the bottom of the Great Australian Bight by *Courageous*.

Three teams

The Division is setting up three fisheries research teams: one to operate in tropical waters (north of North West Cape in the west and Cape Byron in the east), the second concerned with temperate fisheries, and the third to gather information on fish, such as tuna, that are highly migratory.

The tropical team's main initial concern will be with the fisheries exploited by the Taiwanese off the north-western coast. This research will be carried out in conjunction with a survey of the fisheries of the easern Indian Ocean being sponsored by the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP). It involves collaboration with Indonesian and West German researchers.

Teams led by Dr Keith Sainsbury of the Division of Fisheries and Oceanography spent 3 months in 1978 and 4½ months last year in the area on *Courageous*. They will return this year for 4 months on *Soela*.

One of their aims is to gather information about the multitude of bottom-dwelling (demersal) species taken by the Taiwanese. This work involves carrying out sample trawls, identifying the fish (not an easy task, as a single trawl can bring up more than 100 species), and examining them to discover what they eat, their reproductive status, and their age.

The scientists are also monitoring the distribution of schools of pelagic fish (the mid-water and surface species), using echo-sounding techniques. Mid-water trawls provide samples of these fish for study.

Information is being gathered on plankton, nutrient concentrations, and variations in ocean temperatures and salinity — all factors that affect the fish populations.

An upwelling?

For a long time it has been known that some form of nutrient enrichment occurs periodically in north-west-shelf waters. This has aroused speculation that the shelf may be the site of an upwelling of nutrient-rich water from the ocean bottom. Upwellings produce some of the world's biggest concentrations of fish — for example, the huge anchovetta fishery off Peru — and a general lack of them is probably a major reason why the sea around Australia is not nearly as rich in fish as some of the world's oceans.

The federal government has substantially increased its funding of fisheries research since 1978.

Although the north-west-shelf nutrient enrichment is far from dramatic, it must have a substantial influence on fish populations. Because of this, it is important to find out what processes are involved, and whether the degree and timing of enrichment vary significantly from year to year.

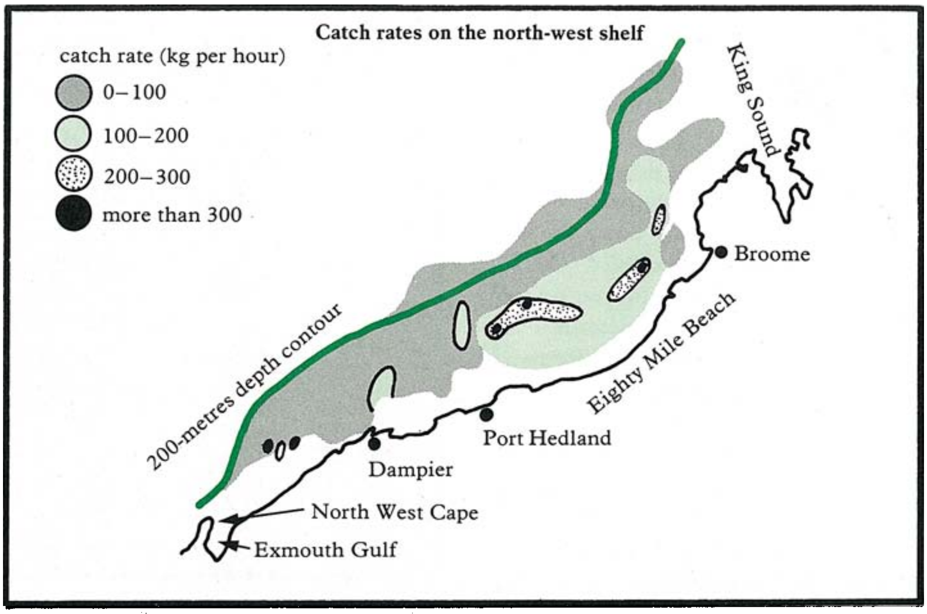
The Division is planning a detailed study of the physical oceanography of the region for 1982, and the answers may emerge from that. Dr Sainsbury's studies so far lead him to believe that no substantial upwelling occurs, but possibly small, localized, short-lived ones do. Other possible contributors to the enrichment include mangrove areas and other nutrient-rich coastal plant communities, and water swept south from upwellings that are known to occur further north.

Wherever the nutrients come from, the unusual density structure of the water helps make them available to the organisms that put them to use. Dr Sainsbury and his colleagues have found that for half of the year — from May to October — there is virtually no variation in water density with depth over much of the shelf. The result is that nutrients can move freely between the bottom and surface; they are not trapped in the lower water layers. Normally, differences in density effectively separate different ocean levels, except for short periods in spring and autumn.

Tropical variety

The scientists' trawls over the shelf brought up a huge variety of fish species, but most fall into six main types, all of them tropical. Probably only one of these, trevally, is known to most Australian fish-eaters. The others are sea perch, emperor fish, threadfin, lizard fish, and goatfish; and most, except the lizard fish, are also very good table fish.

Trawling beyond the shelf edge, at depths of 240–320 m, the team came up with a quite different range of species, most of them normally thought of as temperate-water fish. They included gummy shark, John dory, ghost shark, star gazer fish, and armoured gurnard.



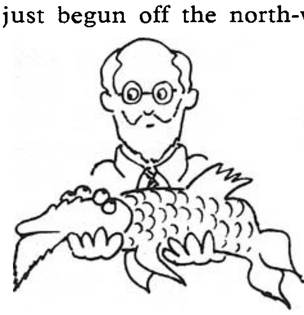
The map shows catch rates from demersal trawls by *Courageous* in May, June, and July 1978. The low rates west of Port Hedland contrast with results obtained by Japanese researchers in the early 1960s. Intensive trawling since 1970 may have reduced fish numbers in that area.

As one of its main aims, the research seeks to discover enough about the distribution of fish to enable groups of coexisting species to be defined. This has to be done before the interactions between species can be studied. If the likely impact of fishing on particular species is to be determined, information is also needed on matters such as where the fish breed and whether the juveniles inhabit the same areas as the adults, the age at which fish can begin to reproduce, and the age distribution of the population.

The Taiwanese trawlers working off the north-western coast take a wide range of species. They probably exert a more general pressure on the fish communities than a fishing operation aimed at the Australian market would, as such an operation would probably concentrate on a few popular species. Obviously, different types of fishing have different effects on a population, and the impact of any one type can only be predicted if the species interactions are understood.

The scientists use computer models to describe these interactions; they feed in data on population sizes, what eats what, how much food is available to the whole community, reproduction rates, and so on. But, however well a model seems to work, a great deal of information is needed to validate it.

Collection of information has really only just begun off the north-western



The *Soela*, CSIRO's new research vessel.

coast, and Dr Sainsbury believes it will be a long time before anybody feels very confident about any calculations of the effects of fishing operations there. A clear conclusion is that, at least for the present, catch limits should be set conservatively.

Estimates differ

In 1976, Professor H. Liu of the National Taiwan University put forward 336 000 tonnes as an estimate of the potential annual fish yield from the north-west shelf, and about one million tonnes for all of Australia's tropical north-western waters. Dr Sainsbury's initial investigations lead him to believe these figures are much too high.

One reason for this is that Professor Liu based his calculations on the catch of the Taiwanese fleet in a limited shelf area that the CSIRO research cruises have

The big money-earners are not fish

The most valuable products of Australia's fisheries are crustaceans rather than fish. The biggest money-earner in 1978–79 was the prawn catch, which totalled 21 500 tonnes and brought in an estimated \$97 million. Next was the 15 700-tonne lobster catch — mainly the renowned western rock lobster — which brought in about \$77 million. The year's tuna catch, by contrast, was valued at only \$5 million.

While virtually all the fish caught off Australia are sold on the home market, by far the bulk of both the prawn and lobster hauls is exported. The prawns mainly go to Japan and the lobsters to the United States. Scallops and abalone are also mainly sold overseas.

The prawn, lobster, scallop, and abalone fisheries are now regarded as fully exploited, and management measures have been introduced to prevent fishing pressure increasing beyond present levels. Demersal fisheries located near Australia's large population centres are also thought to be generally yielding at about the maximum sustainable level. On the eastern coast, their products include the familiar snapper, whiting, flathead, and morwong. Consideration is being given to the need for management controls in some of these fisheries.

Further out to sea and away from the population centres, much more information is needed before anything very definite can be said about the potential yield of most fisheries (as indicated in the main article). Squid, found mainly at the edge of the continental shelf, has emerged recently as a possible substan-

tial export-earner. The federal and State governments approved joint Australian–Japanese feasibility fishing projects involving 68 squid boats operating off South Australia, Victoria, and Tasmania during 1978–79. Twenty boats operated in 1977–78 and six the year before. Clearly, there is optimism about the prospects for a big harvest of this mollusc.

shown has a higher-than-average fish density. Also important is that the CSIRO data on the age of fish differ substantially from assumptions the professor used in deriving his yield estimates.

The age of tropical fish is difficult to determine, but the CSIRO team believe that methods developed at the Division's Cronulla headquarters give reasonably accurate answers. Professor Liu assumed that the natural mortality and reproduction rates in unfished ocean were such that only 5% of all fish were older than 3 years and the average age was 1 year. The CSIRO data for fish caught from the *Courageous* indicate, on the other hand, that the average age of commercially important species is greater than 1 year, despite the fact that heavy fishing pressure through the 1970s has almost certainly reduced it.

Dr Sainsbury calculates that these two factors alone could bring the sustainable fish yield down to less than one-third of Professor Liu's figure. He thinks other factors probably reduce it even further, perhaps to about 70 000 tonnes per year for the north-west shelf. This is still, however, a very substantial yield.

The CSIRO team recorded its highest catch rates at depths of less than 150 m off Eighty Mile Beach, between Port Hedland and Broome.

Unlike Japanese researchers who worked in the area between 1962 and 1966, they did not find particularly rich fishing grounds between Dampier and Port Hedland — in fact most of the experimental trawls in that region gave very low catch rates. The Japanese reported large quantities of sponge over this area of sea bed, whereas *Courageous* found it smooth and devoid of sponges. It seems possible that intensive trawling in that part of the north-west shelf since 1970 has substantially altered the sea-bed habitat and reduced populations of bottom-dwelling fish there. Further research should reveal whether this has in fact happened.

As well as collecting data from its own research cruises, the CSIRO team obtains fish for study and catch records from a pilot Korean fishing venture in the area that is looking at the prospects of supplying the Australian market. It also obtains the fishing returns of the Taiwanese trawlers. Piecing together a satisfactory picture of the fish of the tropical shelf will be a long and painstaking process.

Temperate fisheries

One of the main aims of the temperate fisheries research group is to develop a better understanding of the effects of fishing operations by comparing data collected from areas subjected to differing fishing pressures and from unfished areas. They plan to gather information in heavily exploited fishing grounds off south-eastern Australia, in the Great Australian Bight, which has been subjected to large but sporadic trawling operations, and in undeveloped fishing grounds around Tasmania.

In the past few years, the Division has used *Courageous* to study the Great Australian Bight fishery. Other temperate-water research has mainly concentrated on jack mackerel, a pelagic species found off the southern, south-eastern, and south-western coasts. More recently studies have begun of squid, which is an important component of temperate pelagic ecosystems and may soon be fished in significant quantities.

The work in the Bight, involving cruises by *Courageous* in 1978 and 1979, has confirmed that the shelf there, despite its vast size (it extends 100–200 km from the shore), could support only a

Piecing together a satisfactory picture of the fish of the tropical shelf will be a long and painstaking process.

fairly modest trawling industry. Dr Garrey Maxwell, leader of the research team, thinks that one reason for the low fish population may be the virtual absence of run-off from the arid land bordering the Bight — the input of nutrients from the land is negligible.

Tuna boats at Port Lincoln, S.A.

The first investigation into the prospects for trawling there was made in 1909, and further research data were gathered in the 1950s and 1960s. Successive trawling ventures have been launched in the area, but all have failed — usually for marketing and economic reasons. The latest, a joint Australian–British venture employing the three largest trawling vessels seen up to then in Australian waters, wound up last year.

Despite this history of failure, Dr Maxwell believes the shelf could support a modest demersal fishing operation taking perhaps 3000 tonnes of fish a year. This compares with an annual demersal catch of about 10 000 tonnes off the New South Wales coast. The research confirmed the finding of previous researchers and fishermen that the best areas for trawling are at the edge of the continental shelf, where it begins to drop away from a depth of about 100 m. Information collected on species distribution, the age of fish, and breeding areas will help in assessment of the effects of any future trawling operations on fish populations and in the setting of catch limits.

A good prospect

Jack mackerel is a fish with the potential to support a much bigger fishing operation than would be possible in the trawling grounds of the Bight. A preliminary, and conservative, estimate by Dr Maxwell and his colleagues is that 20 000 tonnes of the fish could be taken safely each year around south-eastern Australia.

No jack mackerel fishing operation exists now. However, in the summer of 1973–74 four boats operating off Tasmania landed 6000 tonnes for a fish-protein concentrate factory at Triabunna on the island's eastern coast. Problems on shore, not a lack of fish, led to the collapse of this venture.

Jack mackerel is not considered a good table fish in Australia, but is highly valued as such in Japan and is suitable for canning. Although some has been canned here, probably the best prospect for its use within Australia is as the basis for a fish-meal industry — at present, most of the fish-meal used here is imported.

Working from the *Courageous*, the CSIRO scientists have used echo-sounding techniques to track and study schools of jack mackerel; one school can contain 100 tonnes or more of fish. They are also looking at two other species, present in smaller numbers, that gather in schools. These are the pilchard, a small fish used mainly for fish-meal, and the blue mackerel, a good table fish that is related to the mackerel species fished in the Northern Hemisphere.

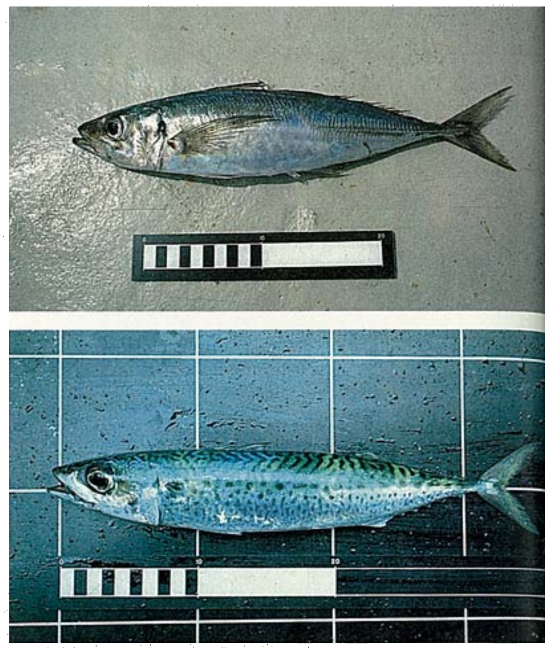
Large schools of jack mackerel appear off the southern New South Wales coast in late winter and early spring. Off south-eastern Tasmania, the biggest concentrations have been sighted 6 months later — during autumn and early winter. This and other evidence suggests that the fish migrate southwards during the summer, keeping to water with a temperature of about 17°C. An offshore migration into deeper, cooler water may also occur.

Whether the movement of surface schools reflects what is happening in the whole population remains to be determined. Evidence from sonar experiments suggests that substantial numbers spend their time in deep-water groups that cannot be seen from the surface.

The research aims at finding out how jack mackerel are distributed at different times of the year and the factors, such as water temperature and food availability, that determine this. In the Great Australian Bight, sampling from the *Courageous* in 1978 brought in large numbers of jack mackerel and blue mackerel, but few pilchard. The following year, pilchard were taken in large numbers, but no jack mackerel were caught. Presumably different conditions favour each species, but what these conditions are remains to be discovered. The studies aim at developing an understanding of the environmental factors that determine the seasonal distribution of the fish.

The Australian salmon

Much more is known about two other important pelagic fish, the Australian salmon and the southern bluefin tuna. The Australian salmon is not a true salmon; it acquired its name through mis-



Jack mackerel, top, and blue mackerel. Substantial catches of jack mackerel seem possible off southern Australia.

taken early identification. Actually it is a distant relative of species such as snapper, tailor, and trevally. It forms schools close inshore around Australia's southern seaboard, and some 3000–6000 tonnes are netted each year, mainly from beaches. Most of it finds its way into cans.

Two subspecies exist, the eastern and western. A decline in the catch of the western subspecies off Western Australia since the late 1960s prompted the setting up of a research program — involving CSIRO, the Western Australian Department of Fisheries and Wildlife, and the South Australian Department of Agriculture and Fisheries — aimed at determining the causes.

Earlier research had shown that the western subspecies spawns only off south-western Western Australia. The larvae drift eastwards across the Great Australian Bight and young fish are found right around the coast to points as far east as Lakes Entrance, Vic. Then, as the fish grow older, there is a general movement back towards the spawning grounds.

A possibility that the researchers wanted to investigate was that increased catches in South Australia since 1966 could be reducing the Western Australian catch. To determine the pattern of movement back to the spawning grounds, they tagged and released more than 9000 young fish in South Australian and Western Australian waters in 1975 and 1976, and sought the cooperation of fishermen in returning the tags together with information about where the fish were caught and their size. Although tags are expected to keep coming in for another year or two, the information to date suggests that young fish from western parts of the Bight, rather than from the South Australian fishing areas, are the ones that mainly find their way to the Western Australian fishery.

If this is confirmed, another explanation for the decline in the Western Australian catch will have to be sought. Dr Clive Stanley, leader of the CSIRO team involved in the study, suspects that changes in surface currents that carry salmon eggs and larvae away from the spawning area may be responsible. Changes in current systems are reflected in changes in salinity in the ocean. As records of this exist, information about past currents can be derived.

The fish are usually 3–4 years old when they are caught. Hence, it could be expected that currents likely to carry large numbers of eggs and larvae to the areas along the southern coast where juvenile fish are found would correlate well with a good catch 3–4 years later. The scientists are examining the data to see whether such a correlation exists.

Australia's tuna fishery

Southern bluefin tuna is the fish landed in greatest quantities by Australian fishermen. The tuna fleet of about 60 boats, working mainly off the New South Wales, South Australian, and Western Australian coasts, landed 10 700 tonnes in 1978–79, about the average catch for recent years. Virtually the whole catch is canned for consumption in Australia, although export markets are developing.

The Division of Fisheries and Oceanography has put a lot of effort into

Unloading southern bluefin tuna.

studying this fish during the past 20 years, and its biology and habits are now better understood than those of all other tuna. Much of the knowledge has come from a big tagging program: tags have been inserted in some 67 000 tuna, and about 8000 have been returned with information about where the fish were caught. One was recovered 14 years after the fish was tagged.

Tagging provides information not only on the movements of fish in the ocean but also on growth rates, longevity, and other aspects of the fish's biology. But this method of acquiring information can only be used with species that are being caught in large numbers. Another important source of data is catch sampling. This provides information on the age distribution of fish in the catch, from which very useful data on reproduction and mortality rates can be derived.

The general picture that has emerged is that southern bluefin tuna spawn only in the Indian Ocean south of Java; the young fish then gradually move southwards until they reach latitudes of up to 48° South, when some head off the east

The biology and habits of the southern bluefin tuna are now better understood than those of all other tuna.

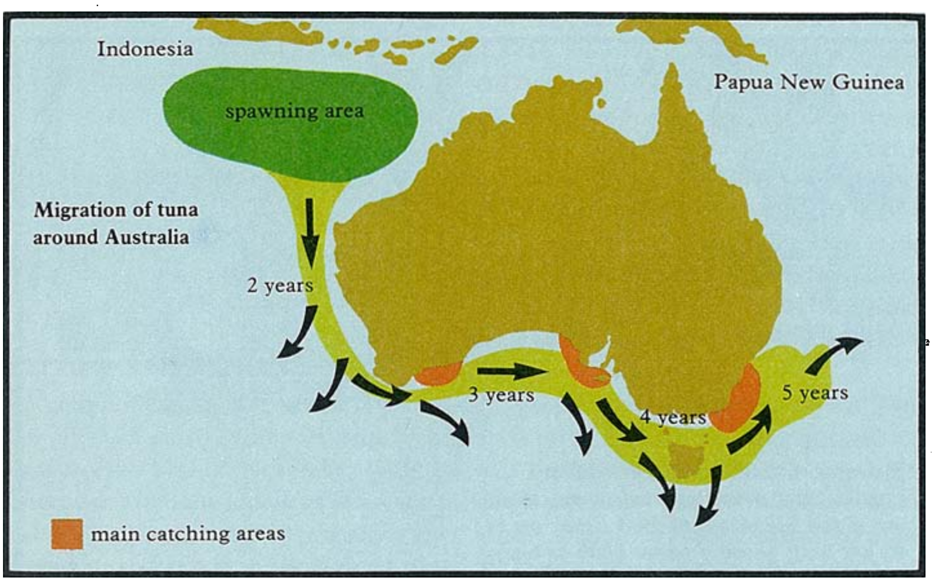
and others to the west (see the map). This means that, around Australia, fish off Western Australia are about 2 years old, around the south of the continent they are 3–4 years old, and off the New South Wales coast they are usually about 5 years old. These are the fish that the Australian tuna boats, mostly using the live-bait and pole-fishing method, take from surface schools. Light aircraft are sometimes used to spot the schools.

The Japanese catch

Japanese fishing boats take southern bluefin tuna over wide areas of the Indian, Southern, and Pacific Oceans. Their catch includes older fish than those taken by the Australian fleet. They use the long-line fishing method, setting and hauling the lines, up to 80 km long and bearing some 2000 hooks, once a day. They catch about 20 000 tonnes a year.

Since 1962, when tuna-fishing began on a substantial scale off Australia, a gradual rise in the Australian catch has coincided with a falling trend in the Japanese catch. Dr Garth Murphy, who leads CSIRO's tuna research, concludes from his study of the catch data that this may not be a coincidence — by taking some of the younger fish the Australian fleet is reducing the numbers of older fish available to the Japanese.

He believes the effect is probably small, however, partly because only a portion of the younger fish population finds its way into the areas fished by the Australian fleet. Also, from data on the age distribution of the fish landed and on growth rates, he has calculated that no substantial change has occurred in the number of very young fish in the tuna population over the years. This suggests that the current total fishing rate is not big enough to reduce the number of fish spawned each year.



The map shows the general migration pattern for southern bluefin tuna off Australia and the typical ages of fish in different areas. Some fish head west across the Indian Ocean rather than east around southern Australia.

M.V. *Soela* — a bigger and better research ship

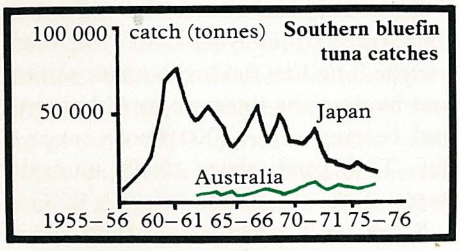
'I think it's going to transform our operations.' That's the comment of Dr Garth Murphy, leader of CSIRO's fisheries research program, on the 53-metre research vessel *Soela*. The Division of Fisheries and Oceanography has chartered the ship for 5 years, with an option for another 2 years, and expects it to spend about 200 days each year out in the 200-mile zone gathering data.

Built in West Germany in 1965, *Soela* started life as a stern trawler operating in the North Sea. More recently it has been used for oil exploration in the Red Sea. The Division plans to use it for both fisheries research and its associated oceanographic investigations. For fisheries work, it replaces the 28-metre *Courageous*, which, since 1975, has made 52 research cruises off New South Wales and Tasmania, around the Great Australian Bight, and off Western Australia.

One of *Soela*'s main advantages over *Courageous* is greater power and speed; it can cruise at about 13 knots, compared with 8 knots for *Courageous*. This is important for reasons besides the obvious one of reducing the time spent travelling to research areas. Some fish are fast swimmers, and the scientists sometimes found, during trawls with *Courageous*, that fish were able to swim out of the moving net. This could result in an imbalance in favour of slow swimmers in the samples brought on board for study. They expect *Soela*'s extra speed to overcome this problem.

Soela is equipped for both bottom (demersal) and mid-water (pelagic) trawls, and for finding fish and estimating their numbers using sonar and other techniques. It also has an extensive range of equipment for oceanographic measurements (of temperature, salinity, surface chlorophyll level, etc.). On the main deck and below are biological and chemical laboratories, an electronics operations room that contains computer facilities and an electronics laboratory, and a library and draughting room.

Soela can accommodate twelve scientists on a cruise, compared with a maximum of six on *Courageous*. Air-conditioning is provided, so that work can proceed under reasonable conditions in all parts of the 200-mile zone — from the Antarctic waters around Macquarie Island to the tropical north. It can operate at sea for 30 days between calls to port for reprovisioning.



Australia's catch has gradually risen over the years, while Japan's has fallen.

Skipjack tuna

Southern bluefin tuna is one of the species in which the new CSIRO research team concerned with highly migratory fish will take an interest. It is regarded at present as being fully exploited. The skipjack tuna, by contrast, is hardly fished at all in Australian waters, and research aims at working out what size catch could be taken within the 200-mile limit. Dr Murphy says that the limited information available indicates that a yield as great as 50 000 tonnes a year may prove possible.

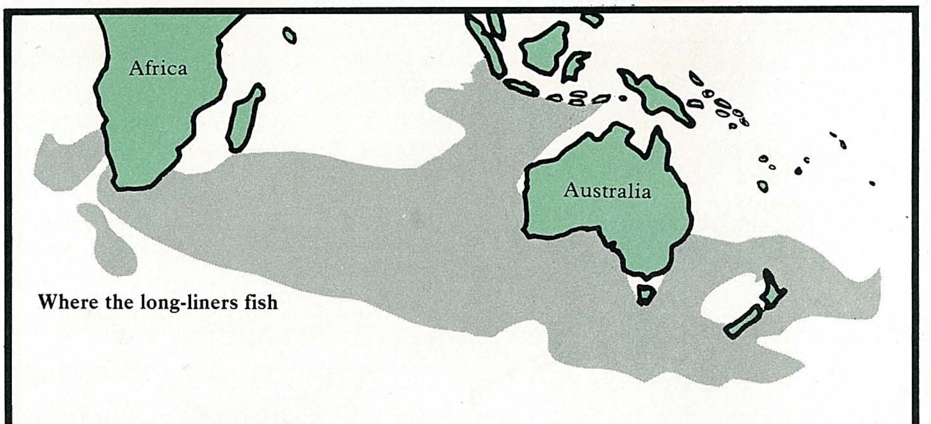
The skipjack is smaller than the southern bluefin, but when canned the two species are virtually indistinguishable. Not much is known about the migration patterns of this fish. Whether, as in the case of the bluefin, there is just one widely dispersed population remains to be determined.

The South Pacific Commission has recently organized a tagging program to try to find out some of the answers. Results to date show that the fish can travel long distances: a specimen tagged off Jervis Bay turned up at the Solomon Islands 3 months later, and fish tagged in Fiji have been recovered off New Zealand, which now has a substantial skipjack tuna fishery.

Late last year a 72-metre American purse-seiner, twice the size of the biggest fishing vessel registered in Australia, began fishing for skipjack off the New South Wales coast. Its aim is to test the feasibility of establishing a commercial skipjack tuna fishery off eastern Australia.

This is one of a number of feasibility fishing projects recently approved by the federal government. (The Korean venture on the north-west shelf, mentioned earlier, is another.) Involving collaboration between Australian and foreign fishing interests, they are limited to a maximum of 2 years. These projects are intended to provide, quickly, assessments of the extent of unknown or little-known resources in the 200-mile zone and of the commercial viability of harvesting them.

The catch data that the feasibility fishing ventures supply will be of considerable value to fisheries' researchers. Scientists working from a research vessel can learn much about the biology and ecology of fish populations, but some information, including reliable estimates of fish numbers, can usually only be obtained from study of the results of fishing operations.



Japanese fishermen catch southern bluefin tuna over this vast ocean area, using the long-line method (lines up to 80 km long bearing some 2000 hooks).

With both an expanded research effort and feasibility fishing now under way, the job of filling the many gaps that exist in knowledge of the fish around Australia should move along more quickly. The new fishing zone is enormous, however, and there is a great deal to be learnt.

Robert Lehane

More about the topic

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Decline in W.A. salmon catch. C. A. Stanley. *Australian Fisheries*, 1979, **38**(3), 14–17.

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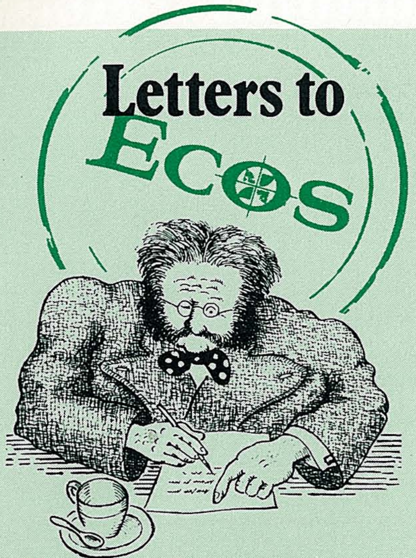

This is our first 'letters to the editor' section. We plan to make it a regular feature of the magazine, and look forward to hearing from readers.

In selecting letters for publication, preference will be given to those dealing with research topics covered in *Ecos* — providing additional information or commenting on conclusions reached in articles. However, letters on other matters in the area of science and the environment are also welcome.

Please keep letters as short as possible. They should be written with the general *Ecos* readership rather than a specialist audience in mind.

The address for letters is: The Editor, *Ecos*, P.O. Box 225, Dickson, A.C.T. 2602.

Barrow Island oil

My compliments on the article 'Australian oil — an elusive resource' which appears in *Ecos* No. 22, November 1979. It is because I find the article so interesting that I take the opportunity to make a few comments relevant to the origin and migration of hydrocarbons in regard to Barrow Island.

The article is a useful summary of hydrocarbon research work. However, because of its general nature, it does not indicate the great complexity of such studies, nor the differences of opinion which exist between scientists about some of the processes involved in the formation and migration of hydrocarbons. For instance, there is a relationship between the effects of time *vis a vis* temperature and/or pressure in the generation of hydrocarbons from a source rock, which means that oil can be generated at much lower temperatures than the 130°C given in the article.

In the discussion of Barrow Island, oil reservoirs at 1000 m and 2000 m are referred to. These are respectively accumulations in Winning Group rocks (including the Windalia Sandstone, the main reservoir on Barrow Island), and in the deeper Barrow Formation. The Barrow Formation is underlain by the Dingo Claystone. Geological mapping shows that these rock units are buried to greater depths (and attain higher temperatures) offshore to the west of Barrow Island.

Several scientists and institutions have received rock and oil samples (and financial support for research) from Wapet. These include CSIRO, the Western Australian Institute of Technology (WAIT), and our own laboratories at Chevron Oil Field Research Company, La Habra, California. WAIT researchers consider it most likely that the Windalia oil was sourced from the Winning Group (e.g. see Woodhouse, G., Ph.D. Thesis, Murdoch Univ., 1979; CSIRO scientists consider it more likely that it was sourced from older sediments.

The relatively shallow (1000 m) Windalia oil is naphthenic–aromatic, with a relatively low proportion of straight-chain paraffins; thus as indicated in the article it has the general character of an oil that has been modified by bacterial attack. However, even for this aspect the various chemical analyses that have been carried out, and the geological data, are not conclusive. There are differences of opinion between the three groups of workers who have studied the oil in most detail not only about to what degree the Windalia oil may have been biodegraded, but whether it has been biodegraded at all.

Our integration of all available geochemical and geological data for the Barrow Sub-basin shows that both the Winning Group, and the older rocks of the lower Barrow Formation and Dingo Claystone, could have sourced the Windalia (1000 m) oil. In our geological studies involved in the search for hydrocarbon accumulations we have to take both possibilities into account. We consider that the accumulation in the lower Barrow Formation (2000 m) was sourced by rocks of the lower Barrow Group and Dingo Claystone.

Additionally, it should be noted that in the search for deeper oil accumulations we have drilled three very deep wells on Barrow Island (at a cost of $15 million). The deepest of these wells was Barrow Deep No. 1, which reached a total depth of 4650 m in 1973; after encountering abnormal formation pressures in the Dingo Claystone it penetrated a limited, non-commercial gas/condensate reservoir below 3000 m and formation pressures in excess of 10 000 p.s.i. We consider that these three wells drilled the source rocks, or their lateral equivalents, for both the 1000 m and 2000 m oil accumulations on the island. Also, with the drilling of these wells, our follow-up studies, and our knowledge of the habitat of oil worldwide, we conclude that there is very little likelihood of encountering oil accumulations at even greater depths on Barrow Island.

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