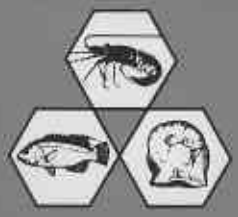

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Potential for the Development of a Tuna Industry in North West Australian Waters

BY

J. P. ROBINS

PERTH
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FISHERIES DEPARTMENT

108 Adelaide Terrace

PERTH

R E P O R T N O. 80

POTENTIAL FOR DEVELOPMENT OF A TUNA INDUSTRY IN NORTH WEST AUSTRALIAN WATERS

BY

J P ROBINS

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POTENTIAL FOR DEVELOPMENT OF A TUNA INDUSTRY IN NORTH WEST AUSTRALIAN WATERS

J P Robins

Fisheries Department, 108 Adelaide Terrace
Perth, Western Australia

Abstract

Information available on the abundance of tuna off north west Australia, gathered on surveys by both ship and aircraft, is presented in order to identify opportunities for the sourcing of raw material for the Western Australian tuna canning industry. Identification of the constraints and potential for industry development of these resources is made focusing on the area considered most favourable, types of vessels used, fishing methods and strategies required for the development of such resources in the event that there is some identified prospect of viable commercial development.

INTRODUCTION

Concentration on the capture of southern bluefin tuna along the south coast of Western Australia by the commercial fleet until 1984, when a quota on catch of that species was effected, militated against expansion of effort into the more northern areas of the State where stocks of other tuna species occur. The problem of paucity of information on abundance of desired species of tuna in the area as well as logistical problems relating to ports with suitable unloading and freezing facilities and the relatively high transport costs to Perth, have acted as deterrents to any development of a tuna fishing industry in the north west region of the State.

SURVEYS FOR TUNA OFF THE NORWEST COAST

Since December 1942 various types of surveys to determine the availability of tuna stocks off the north west coast (ie. from Shark Bay to the Western Australian - Northern Territory border) have been made by Commonwealth and Western Australian State governments and private companies. These surveys have been carried out by both plane and vessels.

The results from numerous surveys of the area under consideration show that the following tuna species occur: southern bluefin (Thunnus maccoyii), northern bluefin (Thunnus tonggol), yellowfin (Thunnus albacares), skipjack (striped tuna) (Katsuwonus pelamis), mackerel tuna (Euthynnus affinis) and dogtooth tuna (Gymnosarda unicolor).

The following survey summaries are listed chronologically:

Aerial spotting

During the period December 1942 to May 1943, and in the later half of 1945, Mr Stanley Fowler of the C S I R Division of Fisheries undertook aerial spotting surveys in the area from the Western Australian/South Australian border to Truscott Air Base in the far north of Western Australia when he accompanied R A A F planes on surveillance flights. Unfortunately no detailed analysis of sightings were published but a report of his impressions of the tuna potential off north west Australia

was made to a Western Australian Fisheries Inspectors meeting in 1944. From this report the following points emerge:

(i) most of the tuna observed had been found broadly from North West Cape to a few miles north of Broome to a distance no more than 50 miles offshore;

(ii) species of tuna identified in this area were northern bluefin and mackerel tuna and maybe a further species (not specified);

(iii) with the information available the peak of the tuna season occurred during the winter months (his flights did not cover the area at all times of the year);

(iv) baitfish (herring and hardyheads) occurred in large schools during March and April;

(v) schools of tuna were seen under conditions which should render possible their capture by both purse seine and livebait and pole methods, but Fowler was inclined to favour the latter method.

M.V. "Isobel" Cruise

During the period July to December 1945 the M.V. "Isobel", chartered by C.S.I.R investigated the near shore area from Fremantle to King Sound and return to Geraldton. All tuna were trolled by line and species taken were yellowfin, northern bluefin, striped tuna and mackerel tuna. No yellowfin were taken between North West Cape and King Sound. Only 54 tuna were taken for 240 hours' trolling with two lines; 25 in the area from just south of Shark Bay to North West Cape (7 yellowfin, 12 northern bluefin, 2 mackerel tuna, 4 striped tuna) - 102 hours' trolling; 29 trolled in the area from North West Cape to Cape Leveque (16 northern bluefin and 13 mackerel tuna) - 138 hours' trolling.

F.R.V. "Warreen" Cruise

During the period 6 August to late October 1949 the F.R.V. "Wareen" (C S I R) investigated the area from North West Cape to south of Timor. This cruise trolled 24 tuna (7 northern bluefin, 17 mackerel tuna) (Serventy, 1950).

Aerial Spotting

During the period December 1966 to February 1968 the Western Australian Department of Fisheries and Wildlife undertook aerial spotting surveys in the area from Fremantle to Wyndham and return. Results of the survey were published in Report 17, Department Fisheries and Wildlife, Western Australia. The objective of this survey and a follow-up survey in 1973/74 was:-

> *to collect background information on distribution and relative abundance which could be used at a later date when research and industry were in a position to prosecute surveys by vessels with the intention of commercial exploitation of the tuna stocks off the coast of Western Australia.*

F.V. "Estelle Star" Cruise

During the period 12 July to 15 August 1967 the F.V. "Estelle Star", under charter to Department of Fisheries and Wildlife, investigated the area from North West Cape to Scott Reef. The "Estelle Star" was a successful livebait and pole vessel which operated in the bluefin fishery in the Eastern States. During the survey period 41 tuna were trolled (3 yellowfin, 14 northern bluefin, 5 striped tuna, 19 mackerel tuna). The catch results on this cruise would not appear encouraging for development of a successful livebait and pole operation at this time of the year. Most fish caught and schools sighted were mackerel tuna except in the Scott Reef area where schools of striped tuna of good size and yellowfin were sighted. No attempt was made to catch tuna with livebait and pole.

F.V. "Torbay" Cruise

During the period 18 January to 13 March 1971 the F.V. "Torbay", under charter to Department of Fisheries and Wildlife investigated the area from 50 miles west of North West Cape to Dampier Archipelago and offshore to the edge of the Continental Shelf. A total number of 42 days were worked during which time 298 schools of tuna were sighted (93 of mackerel tuna, 155 striped tuna, 9 mixed mackerel and striped tuna, 41 unidentified). The number of tuna trolled was 17 (12 mackerel tuna, 2 striped tuna, 2 yellowfin and 1 northern bluefin).

Aerial Spotting

During the period August 1973 to August 1974 the Department of Fisheries and Wildlife undertook aerial spotting surveys mainly in continental shelf waters in the area from Fremantle to Admiralty Gulf. The results of this survey were combined with the survey undertaken from 1966 to 1968 and presented by Robins (1975a).

A total of 3,636 schools of tuna were sighted during these two surveys. For the purpose of analysis of data the coastline was divided into five areas, viz., Wyndham to Broome (Area A), Broome to Port Hedland (Area B), Port Hedland to Onslow (Area C), Onslow to Carnarvon (Area D), Carnarvon to Fremantle (Area E). The number of schools sighted per "effective hour" flown in each area for the year was 7.45 (in A), 5.47 (in B), 11.62 (in C), 6.19 (in D) and 1.24 (in E).

Further, the schools were categorised by size and fish size within the school. The divisions within each category were small, medium and large. A small school contained less than 5 tonnes of fish, a medium school contained between 5 and 10 tonnes, and a large school contained greater than 10 tonnes. A small fish weighed less than 7kg, a medium fish between 7kg and 18kg and a large fish weighed greater than 18kg. The sizes of the schools in each category expressed as a percentage were: small (67.8%), medium (22.6%), large (9.6%). Fish sizes within the schools were: small (45%), medium (51%), large (4%).

The critical question of species composition of the schools could not be given with any precision. However, a subjective assessment based mainly on fish size composition of the schools and a knowledge of the biology of

the various species was that the large fish were probably mostly yellowfin (perhaps a few northern bluefin), the medium fish were probably yellowfin, northern bluefin with some skipjack and mackerel tuna and the small sized fish were any of the four species.

F.V. "Western Star" Cruise

During the period August 1973 and August 1974 (except for November and December 1973) the F.V. "Western Star", under a joint State/Commonwealth charter investigated the area between Cape Naturaliste and Broome. The results in brief are summarised in Tables 1(a), 1(b) and 1(c) and were given in detail by Robins (1975b).

F.V. "Janet D" Cruise

During the period 14 April to 26 June 1975 the F.V. "Janet D", operating privately, investigated the area between Fremantle and North West Cape. During this period the vessel spent 25¼ days steaming. "Janet D" was a purse seiner built originally to catch jack mackerel off Tasmania. The net used in the survey was a mackerel purse seine. During the course of the cruise 46 tuna were trolled (19 yellowfin, 21 striped tuna and 6 mackerel tuna); 61 schools of tuna were sighted of which 58 were small schools of small fish, one a small school with medium sized fish and two large schools of small fish.

Seven purse seine sets were made. Three were made on small schools of striped tuna resulting in a catch of 58 fish, and two on pilchards resulting in a catch of 200 pilchards. A further two sets were made resulting in foul up and net damage. A subsequent attempt to mend the net resulted in total loss of net due to unexpected bad weather and the method of handling the net for repair.

F.V. "Maria Luisa"

During the period 1 August to 13 August 1975 the F.V. "Maria Luisa", operating privately, investigated the area between Geraldton and Port Hedland. "Maria Luisa" was a purse seiner. No tuna were trolled, but 35 schools were sighted (27 small schools of small fish, 8 medium sized schools of small fish). The purse net was not used.

Aerial Spotting

During the period 11 July to 27 July 1977 an observer from the Department of Fisheries and Wildlife accompanied the W A Museum on whale spotting flights in the Shark Bay and offshore area. During this period a total of 356+ schools of tuna, and 627+ bait schools were sighted. It was estimated that a fairly large proportion of these schools were either small or medium sized schools and the size of the fish within the schools ranged between 11 and 13 kg and that they were composed of both yellowfin and northern bluefin tuna.

F.V. "Altrev"

The F.V. "Altrev", under charter to Department of Fisheries and Wildlife, undertook three cruises to investigate the tuna potential in Shark Bay. The dates of the cruises were from:-

(a) 17 May to 6 July 1978;
(b) 18 July to 31 July 1978; and
(c) 3 August to 7 September 1978.

Results from cruises:-

(a) Investigations throughout Shark Bay yielded 266 yellowfin (av.wt. 17.3kg) and 677 northern bluefin (av.wt. 11.3kg) from 32 days at sea.

(b) Areas investigated were:

(i) Western Ground for three days resulting in a catch of 13 northern bluefin, 1 yellowfin and 1 striped tuna. Six small schools of striped tuna were sighted;

(ii) West Peron area for one day from Cape Peron to Dampier Reef. No fish were taken but 1 small school of striped tuna was sighted;

(iii) Denham Sound area for three days resulting in a

catch of 394 northern bluefin (av. wt. 12.4kg) poled in 6½ hours, using dead bait (pilchards). No schools were sighted.

(c) The areas investigated were West Cape Peron and Denham Sound and near Koks Island resulting in a catch of 151 northern bluefin (av.wt. 12.5kg), 11 yellowfin (av.wt. 18.8kg), 2 striped tuna (av.wt. 3.3kg) and 3 mackerel tuna (av.wt. 6.8kg). Twenty-one schools were sighted of which two were identified as yellowfin.

F.V. "Spunky"

During the period from 31 July to 3 September 1978 the F.V. "Spunky", operating privately, investigated Shark Bay, mainly near West Peron and Denham Sound. The catch was 20,000kg of northern bluefin and 180kg of yellowfin (3 fish) in 15 days. Another vessel (F.V. "Amanda D") made similar catches during this period.

F.V. "Lee Cheng"

During the period from 13 June to 10 August 1979 the F.V. "Lee Cheng", operating privately, investigated the Shark Bay area. No catch was reported but 17 schools were sighted. Estimates of school size ranged to 30 tonnes.

F.V. "Helen M"

However, this net, even when increased in length, was still too small for the turning circle of the "Frontier" and as a result most fish encircled escaped the net before the "gate" could be closed. The number of sets made was 6 with two productive shots (1 x 500kg of mackerel tuna, 1 x 2 tonnes of skipjack north of Barrow Island).

F.V. "Frontier"

During the period 22 April to 18 June 1979, the F.V. "Frontier", operating privately with assistance from the Department of Fisheries and Wildlife investigated the area from Albany to Broome. The "Frontier" was a large (60m) American super purse seiner and used a net with a 98 fathoms fishing depth. This net was unsatisfactory for use in continental shelf waters and the Department lent its purse seine (with a specified depth of 23.5 fathoms, but which actually fished deeper) to the seiner.

During the period 31 May 1980 to 5 December 1980 the F.V. "Helen M" was chartered by the Department of Fisheries and Wildlife to investigate livebait potential along the west coast. One test fishing exercise using livebait (anchovies and small herring) resulted in a catch of 3.5 tonnes of striped tuna in three hours by two polers near Dampier Reef, Shark Bay.

F.V. "Kerrisma"

In July 1985 the F.V. "Kerrisma", operating privately, investigated an area near the northern entrance to Shark Bay. Large schools of 4-6kg northern bluefin were reported off Quobba Point on July 14, estimated at many hundreds of tonnes. On 24 July an estimated 800 tonnes were recorded in a feeding frenzy near Darwin Reef. The fish taken by jig averaged 5.4kg in weight. Because of his apparent inability to capture a large quantity of these fish by poling (with dead bait) and trolling, the skipper suggested that either gillnetting or a shallow-fishing purse seine net be tried.

Of all the surveys carried out in W.A. waters the aerial surveys come closest to a "resource appraisal" survey. However aerial surveys lack the critical information on species composition of schools sighted. In an attempt to overcome this problem dual surveys by air and sea were carried out in 1967 by F.V. "Estelle Star" and in 1973-74 by F.V. "Western Star". On both occasions species composition and abundance could not be determined.

METHODS OF FISHING FOR TUNA

The principal methods of fishing for tuna are purse seining, pole and line fishing, longlining, trolling and gillnetting. All of these methods have been used to catch tuna, some very much more than others in the waters around Australia.

(1) Purse seine.

Purse seining (in association with livebait and pole vessels to keep the tuna schools in position whilst the purse net is shot around the school) is used for southern bluefin tuna and occasional catches of skipjack tuna. The method is commonly used in New South Wales and South Australia.

Purse seining is the most efficient method of catching surface schools of tuna in large quantities but requires high capital input in terms of vessel, fishing gear, fuel, crew's wages and, generally, a spotting plane.

To operate commercially on a low unit value resource the purse seiner has to catch tuna in large quantities and to operate successfully needs fishermen with a good working knowledge and experience of vessel and gear.

(2) Pole and line

Pole and line fishing with live or dead bait, to catch southern bluefin tuna and to a limited extent skipjack, is used in New South Wales, South Australia and Western Australia.

Pole and line fishing had been the popular commercial method of catching southern bluefin in Australian waters until purse seining commenced in the late 1970's. The method depends on finding a school by sighting at the surface, trolling or by echo-sounding and then "chumming" a school to the vessel where the pole fishermen can catch them. If the fish bite freely many can be caught in a short period

of time, but on many occasions fish become "dodge" and move away from the vessel.

The use of water sprays can frequently induce the tuna to bite more freely. This method of fishing, depending on vessel size and sophistication, is relatively cheap, when compared to the capitalisation and running costs of a purse seining operation.

Live bait studies by the Fisheries Department (unpublished data) show that there are live bait resources along the north west coast, especially good in the Shark Bay region, which can be used in the live bait and pole method of fishing. Both small herrings and anchovy are available.

Dead bait and pole fishing for tuna in Shark Bay has been carried out successfully on yellowfin and northern bluefin, and the livebait and pole method has also been successfully demonstrated in the capture of skipjack.

(3) Gillnetting

Gillnet test fishing for skipjack has occurred off the south east Victorian coast and gillnetting for northern bluefin by Taiwanese off northern Australia was a common method until recently.

Successful capture of skipjack by gillnets was demonstrated off the S.E. coast of Victoria in the early 1960's (Temple, 1963(a)(b)), but for various reasons was not developed further. The Taiwanese gillnetters operating within the Australian Fishing Zone off northern Australia captured northern bluefin as a significant part of their total catch. This fishing has now ceased off Australia.

The annual tonnages taken ranged between 410 tonnes in 1975 to about 4,770 tonnes in 1977. The average length of net used by the Taiwanese increased from about 8.2km (1980) to 13.5km (1984) and some vessels used up to 18km of net (Lyle & Read, 1985).

These nets were made of multifilament nylon with mesh sizes

ranging between 150mm (6") and 170mm (6.7"), and fitted with floats attached directly to the headline of the net whereas previously a float line and a float were used in the net construction.

The Taiwanese method of gillnetting is labour intensive and the catch weight of northern bluefin/set ranged from 176kg to 751kg, or when expressed as kg/km/set, ranged from 20kg to 56kg.

Except for several catches in excess of one tonne and one in excess of five tonnes of northern bluefin, Australian gillnetters working out of Darwin with nets ranging in length from 600 to 1,500m, report that only sporadic low catches of tuna are made.

Experimental fishing with a larger mesh size gillnet in the Shark Bay area may show that it is a useful adjunct method to pole and line fishing.

(4) Trolling.

Trolling is used in all States. This method is useful for determining species occurrence in an area but does not produce catches of economic significance.

(5) Longlining.

Longlining for larger sized tuna has occurred off the east coast of Australia and more recently off the coast of Western Australia, for the Japanese sashimi market.

The gear catches high quality but a low quantity of tuna and it is inappropriate for discussion in this report, except to mention that the results of the analysis of Japanese catch data on yellowfin showed that this species is available throughout the year in the area bordered by longitudes 110°-115°E and latitudes 20°-25°S (ie. from north of North West Cape to Shark Bay).

(6) Handlining.

Handlining has also been tried, for example in Shark Bay and wide off the Queensland north coast by the Japanese.

This is generally considered a somewhat crude method of tuna capture but operates quite well in Shark Bay, mainly because of the northern bluefin's feeding behaviour. The tuna follow the trawlers, feeding on fish which escape through the meshes of the trawl net and trash fish which is discarded over the ship's side by the trawler's crew when sorting a catch of prawns from a trawl.

In summary, but bearing in mind that one of the objectives of this report is to identify opportunities for the sourcing of raw material for the Western Australia canning industry which requires large volume of product, it is clear that the only two fishing methods which could satisfy this volume requirement are purse seining and/or pole and line fishing using live and dead bait.

CONSTRAINTS

Desired species

From the evidence gathered by both exploratory survey vessels and observations of schools of tuna from the air, it appears that the area from North West Cape to the north is dominated by skipjack (small size), yellowfin (small size) and mackerel tuna (not a marketable tuna). On the other hand it has been shown that there is a resource within Shark Bay, of both yellowfin and northern bluefin, of ideal size, which could be exploited for the canning market. Striped tuna of a size acceptable for canning (ie. 4kg) also occur in this area and it has been demonstrated that they can be caught by the livebait and pole method of fishing.

The sizes of the northern bluefin caught in Shark Bay range from 72cm to 118cm with a modal value of 93cm. Weights range from 6kg to 25.5kg with a modal value of 12.5kg.

The sizes of the yellowfin range from 86cm to 141cm with a modal value of 95cm. Weights range from 12kg to 59kg with a modal value of 18kg.

Subsequent to the "Altrev" cruise in 1978 no further tuna investigations have been made in Shark Bay but catches taken by handline from prawning vessels show that tuna, both northern bluefin and yellowfin (combined in the catch statistics from prawning vessels within Shark Bay) are readily taken during the prawning season which extends from March to October. The greatest catches were taken in the period from May to September inclusive. Unfortunately no effort figures are available, but in both the 1983 and 1984 seasons, 134 tonnes were caught by handlining from up to 19 vessels (Table 2).

Fishing Methods

(a) Purse seining. From observations of the attempts to purse seine for tuna off the Western Australian coast it is clear that there were several problems which must in future be solved before further attempts at purse seining are attempted.

These problems are:

(i) the vessel must be a suitable purse seine vessel ie. a vessel built for the job;

(ii) the net(s) to be used must be designed to suit the depths of water to be fished;

(iii) the fishing skipper and crew must be fully experienced in carrying out a purse seine operation.

In hindsight F.V. "Western Star" did not satisfy (i) and (iii); F.V. "Frontier" did not satisfy (ii); F.V. "Janet D" did not properly satisfy both (ii) and (iii).

Most fish schools sighted from the air have occurred within the 100 metres isobath and if purse seining is considered to be the method of capture to be used in the area between Shark Bay and North West Cape, careful consideration must be given to the choice of net(s) design(s) as well as being sure that (i) and (iii) are fulfilled.

A purse seiner is helped immeasurably to find fish by the assistance of a spotter plane. This observation also applies to livebait and pole vessels.

(b) Live/dead bait and pole fishing. The only documented accounts of dead bait and pole fishing in the northern area are those of F.V. "Altrev" (under charter to investigate live or dead bait and poling for tuna in Shark Bay in 1978) and F.V. "Spunky" (rock lobster boat) in 1978. During 56 days of investigation, F.V. "Altrev" caught 20 tonnes of northern bluefin and yellowfin, whilst F.V. "Spunky" caught 20 tonnes of northern bluefin, using dead bait and pole, in 15 days' fishing.

Even though it has been stated quite frequently that the northern bluefin is extremely shy of hook and lure, the older age groups of northern bluefin frequenting Shark Bay can be caught by this method quite successfully.

Livebait schools are abundant in Shark Bay and are available for at least 6 months of the year (from February to August). The oily herring is the most abundant species but another species present, the southern anchovy, is a better livebait.

The two main constraints related to the fishing operation would be:-

(i) the irregular procurement of livebait due to wind and tide conditions (dead bait could be readily substituted if needed in a small-sized operation); and

(ii) the somewhat crude technique of dead bait fishing.

Refinement of fishing technique, which would include the use of overside sprays, would probably improve the catches significantly.

Weather (wind) Conditions

White (1978) analysed all 9am and 3pm wind speed data for Broome, Port Hedland, Karratha, Learmonth, Carnarvon and Geraldton and by applying a "sighting efficiency" factor (derived from Robins, 1975a) was able to calculate the number of "effective sighting days" per month for each of

the areas A, B, C, D and E respectively (Table 3). In my opinion the "effective sighting days" would equilibrate with fishing days.

Logistics

If a decision is made that the area extending from Shark Bay to North West Cape should be the initial area in which to attempt to develop a tuna fishery then some of the constraints on logistics of operation are removed. These relate to port facilities (wharves, unloading, fuelling), product storage and freight costs.

With the information presented on the apparent availability of tuna in the north west, I consider it would be unwise to initiate a tuna fishing enterprise in any area other than the Shark Bay area; Carnarvon is in a better logistic situation than Exmouth.

FISHING STRATEGIES

If a decision is made to proceed to exploit the known catchable populations of tuna in Shark Bay, the next decision to be made will be on the best method of capture.

It is considered that the water depths (up to 12 fathoms) are too shallow in which to use a standard construction tuna purse seine net ie. a net with a headline: stretched depth ratio of 10:1. Expert advice will be required to determine the feasibility of constructing an efficient purse or ring net to fish in such shallow waters. If it is determined that such a net could not be used in such shallow water depths, but that a purse seiner is still required, then it will have to operate in deeper offshore waters where the information on fish occurrence is poor.

Alternatively, if live/dead bait and pole fishing is determined to be the better initial method of fishing then tuna production of some significance could be obtained immediately from within the Bay. Extension of fishing activities to waters outside Shark Bay will surely follow.

The season could extend from April to September before weather conditions deteriorate to the extent that fewer days per month (9 to 12) could be fished effectively during the period October to March (see Table 3).

From analysis of data, held by the Fisheries Department, it is shown that the southern section of Shark Bay is dominated by schools of large northern bluefin tuna, the middle ground has about equal quantities of both northern bluefin and yellowfin whilst the area between Koks Island and Point Quobba is dominated by yellowfin; targeting on one particular species is not an important factor.

When fishing for tuna the following aids to fishing are considered essential or desirable

(1) Aerial spotting. Aerial spotting for schools of tuna is considered to be mandatory in the initial stages of development.

(2) Satellite imagery. Satellite imagery information on sea surface temperatures and eddy systems in the region will become more important as the fishery develops.

(3) Suitable radar.

(4) Sonar. A sonar system which helps to determine fish school size and depth position.

CONCLUSIONS

(1) Analysis of catch results from all surveys indicates that Shark Bay and environs is most likely to produce tuna immediately for use by the canning industry. This area holds populations of good sized northern bluefin and yellowfin tuna which are readily accessible and vulnerable to the pole and line method of fishing.

(2) It is very doubtful that purse seining for tuna within Shark Bay is feasible, but will probably be used in deeper waters outside Shark Bay as the fishery develops.

(3) The fishing season in Shark Bay should extend, at least, from April to September.

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TABLE 1(a) SUMMARY OF CATCH RESULTS - BY MONTH

F.V. "WESTERN STAR" AUG 1973 - AUG 1974 (EXCLUDING NOV & DEC 1973)

Month/Yr	Area	Hours Steamed/ Trolled	Days	No. of Schools Sighted	Mackerel Tuna	SPECIES TROLLED: Southern Bluefin	Northern Bluefin	Yellowfin	Skipjack
Aug '73	D	35.1	3	3	1	0	1	0	0
Sept	C	94.5	9	39	9	0	0	0	0
	D	32.65	5	33	0	0	0	0	0
Oct	B	40.0	3	12	4	2	2	0	3
	C	122.5	11	54	6	0	4	0	0
	D	4.5	1	0	0	0	0	0	0
Nov Dec		OFF CHARTER (Refit & Leave)							
Jan '74	E	144.25	16	9	0	2	0	1	0
Feb	E	135.25	13	3	0	16	0	1	4
March	E	131.50	13	13	0	13	0	0	3
April	D	143.84	14	83	3	2	0	7	79
	E	57.5	5	3	0	0	0	0	0
May	D	117.75	15	49	1	1	1	15	78
June	C	20.5	2	6	0	0	0	0	15
	D	213.84	24	28	8	0	0	28	54
July	A	34.50	3	22	9	0	0	33	3
	B	16.25	2	25	2	0	0	25	1
	C	38.25	4	2	26	0	0	3	0
	D	15.00	2	0	0	0	0	0	0
Aug	A	17.75	2	17	1	0	0	0	2
	B	25.58	3	22	10	0	0	3	2
	C	96.00	9	20	21	0	0	1	6
	D	20.33	3	0	2	0	0	1	0
TOTALS		1,557.34	162	443	103	36	8	118	250

Note: Purse seine net shot 12 times during survey.
2 trial shots; 7 foul shots; 2 shots caught small quantity of (i) mackerel tuna, (ii) skipjack or striped tuna; 1 "dry" shot.

TABLE 1(b) SUMMARY OF CATCH RESULTS - BY AREA
F.V. "WESTERN STAR" AUG 1973 - AUG 1974 (EXCLUDING NOV & DEC 1973)

Area	Hours Trolled	Days	No. of Schools	No. Schools Per Hour	SPECIES TROLLED							
					MT	SBT	NBT	Yellow-fin	Skip-jack	Total Fish	Catch/Hr (3 lines)	Catch/H (1 line)
A	52.25	5	39	0.75	10	0	0	33	5	48	0.92	0.31
B	81.83	8	59	0.72	16	2	2	28	6	54	0.66	0.22
C	406.85	35	121	0.30	63	0	5	4	21	93	0.23	0.08
D	547.91	67	196	0.36	14	3	1	51	211	280	0.51	0.17
E	468.50	47	28	0.06	0	31	0	2	7	40	0.09	0.03
	1,557.34	162	443	0.28	103	36	8	118	250	515	0.33	0.11

TABLE 1(c) MEAN WEIGHT (kg) AND WEIGHT RANGE of 3 TUNA SPECIES TAKEN, BY TROLLING, DURING F.V. "WESTERN STAR" CRUISES

Area	A		B		C		D		E	
Species	$\bar{m}$	Range (kg)	$\bar{m}$	Range (kg)	$\bar{m}$	Range (kg)	$\bar{m}$	Range (kg)	$\bar{m}$	Range (kg)
Striped Tuna	2.43	1.6-3.6	2.45	2.0-2.9	2.31	1.4-3.2	3.21	0.7-11	4.4	2.7-5.4
Northern Bluefin	-	-	1.4	1.4	1.9	1.6-2.7	3.6	3.6	-	-
Yellowfin	2.69	2.4.-3.7	2.49	2.0-7.7	2.7	2.5-3.0	4.25	0.7-12	3.6	3.6

N.B. 79 Striped Tuna taken by purse seine had a mean weight of 1.23kg and ranged from 0.7kg to 4.0kg.

TABLE 2 TUNA PRODUCTION (kg) BY TRAWLERS IN SHARK BAY

Month	Year 1983 kg	1983 No. vessels landing	1984 kg	1984 No. vessels landing
Jan	NF	NF**	NF	NF
Feb	NF	NF	NF	NF
March	4,335	NA*	693	7
April	6,405	"	10,129	16
May	5,378	"	2,777	8
June	21,893	"	15,864	17
July	16,255	"	20,268	18
August	38,962	"	63,069	19
Sept	40,247	"	17,843	16
Oct	556	NA	4,291	13
Nov	NF	NF	NF	NF
Dec	NF	NF	NF	NF
	134,031		134,934	

* Not Available
** No Fishing

TABLE 3 DAYS PER MONTH THAT CONDITIONS ARE SUITABLE FOR VISUAL SIGHTINGS OF TUNA SCHOOLS

Year	Month	Area A Wyndham to Broome	B Broome to Port Hedland	C Port Hedland to Onslow	D Onslow to Carnarvon	E Carnarvon to Fremantle
1966	Dec	18.0	12.7	16.8	9.2	10.4
1967	Jan	17.1	16.0	12.7	9.2	6.9
1967	Feb	17.5	19.0	14.8	12.4	8.4
1967	March	10.4	15.9	11.8	12.4	10.0
1967	April	24.9	16.4	17.4	18.4	14.0
1967	May	26.4	18.2	15.8	21.0	15.6
1967	June	26.4	13.0	13.2	21.9	18.2
1967	July	20.8	11.0	17.8	23.5	17.7
1967	Aug	20.2	15.4	14.5	16.5	14.0
1967	Sept	13.4	12.0	12.5	15.1	14.8
1967	Oct	17.4	10.3	9.7	9.9	8.7
1967	Nov	8.6	10.1	8.3	9.5	8.0
1967	Dec	18.0	12.7	16.8	9.2	10.4
	Av.	18.7	14.4	14.3	16.0	13.1
	% Days/ Month	61.5	47.4	47.0	52.6	43.1