Tuna fishing and a review of payaos in the Philippines

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Abstract

Payao is a traditional concept, which has been successfully commercialized to increase the landings of several species valuable to the country's export and local industries. It has become one of the most important developments in pelagic fishing that significantly contributed to increased tuna production and expansion of purse seine and other fishing gears. The introduction of the payao in tuna fishing in 1975 triggered the rapid development of the tuna and small pelagic fishery. With limited management schemes and strategies, however, unstable tuna and tuna-like species production was experienced in the 1980s and 1990s.

In this paper, the evolution and development of the payao with emphasis on the technological aspect are reviewed. The present practices and techniques of payao in various parts of the country, including its structure, ownership, distribution, and fishing operations are discussed. Monitoring results of purse seine/ringnet operations including handline using payao in Celebes Sea and Western Luzon are presented to compare fishing styles and techniques, payao designs and species caught. The fishing gears in various regions of the country for harvesting payao are enumerated and discussed. The inshore and offshore payaos in terms of sea depth, location, designs, fishing methods and catch composition are also compared. Fishing companies and fisherfolk associations involved in payao operation are presented to determine extent of utilization and involvement in the municipal and commercial sectors of the fishing industry. The issues and problems concerning the use of payao, and its biological, economic impact as well as management aspect are presented. Recommendations are given for future research and actions.

Introduction

Location

The Philippines are an archipelago composed of more than 7,000 islands bounded on the east by the Pacific Ocean, on the west by the South China Sea, in the south by the Celebes Sea and Bornean waters and in the north by Taiwan (fig. 1). The territorial waters as defined in the 1898 Treaty of Paris had an area of about 1,666,000 square kilometres (sq. km).

With the promulgation of the Exclusive Economic Zone and the Unclos, the territorial marine area increased to 2,200,000 square kilometres. The coastal and oceanic areas are 266,000 sq. km and 1,934,000 sq. km, respectively. The coastline is 17,460 km while the shelf area (up to 200 m deep) is 184,600 sq. km (BFAR, 1998).

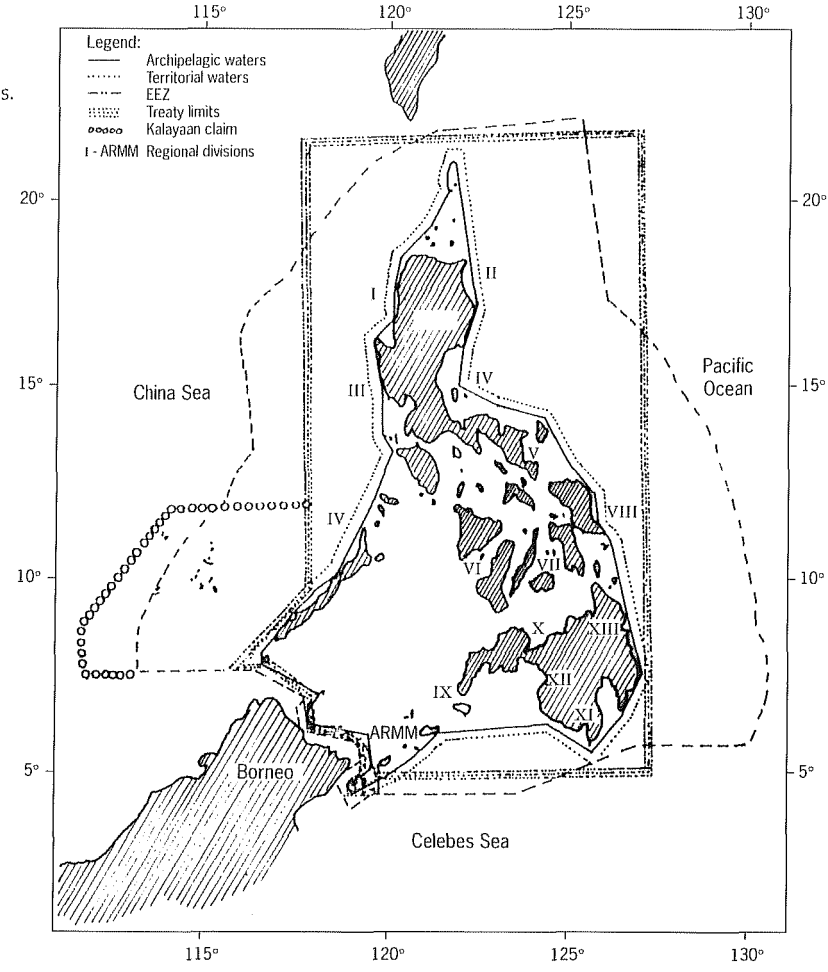


Figure 1
Philippine territorial waters.

Fisheries sector

The fisheries industry is classified into commercial, municipal and aquaculture fisheries. Commercial fisheries include capture fishing operations using vessels of over 3 gross tons while municipal fisheries include capture using boats of 3 gross tons or less including other forms of fishing not involving the use of water craft. Aquaculture involves fish culture activities in marine and inland waters.

Out of the 940,533 mt commercial production in 1998, the major species caught were roundscad and Indian sardines contributing 22.2% and 17.4%, respectively. West Palawan waters, South Sulu Sea and Visayan Sea produced about 54.69% of the total commercial production.

There were 3,216 registered commercial boats with Regions IV, XI, VI and IX having the most number. The major species caught by the marine municipal sector are frigate tuna and fimbriated sardines contributing 12.8% of the 891,146 mt catch in 1998. Visayan Sea, Moro Gulf and East Sulu Sea shared respectively 11.28%, 9.41% and 9.10% of the catch. In the latest census of 1985, there were 464,395 log sets with Regions IX, IV, V, and VII having the most registered number.

Fish production

In 1998, the total fish production was 2,791,163 mt, of which 33.7% came from the commercial fisheries, 31.9% from the municipal fisheries, and 34.4% from the aquaculture sector (tab. 1).

Table 1 - Total fish production by sector, 1998.

Sector	Quantity (mt)	%	Value in billion pesos	%
Aquaculture	959484	34.4	25.9	30.6
Municipal fisheries	891146	31.9	29.0	34.3
Commercial fisheries	940533	33.7	29.7	35.1
Total	2791163	100.0	84.6	100.0

Source: BFAR, 1998.

The Philippines' fish production comes from fifteen different regions. (tab. 2). The highest productions are found in Regions IV, IX, XI, VI, and ARMM. However, in Region IV, the production is not based totally from various fishing grounds productivity but on fish landed in the biggest fishport in Navotas, Rizal.

Table 2 - Fish production, by sector and region, 1998 (in tons).

Region	Total	Commercial	Municipal	Aquaculture	% share to total
CAR	1145	0	258	887	0,04
I	43892	1963	23553	18376	1,57
II	23870	8413	13473	1984	0,86
III	112732	10383	11656	90693	4,04
IV	811924	330405	262091	219428	29,09
V	113317	23883	73058	16376	4,06
VI	308840	112824	127284	68732	11,06
VII	135506	62446	41273	31787	4,85
VIII	69058	28733	36026	4299	2,47
IX	418974	188289	113670	117015	15,01
X	37960	19590	16220	2150	1,36
XI	167182	104581	47101	15500	5,99
XII	27583	9637	9976	7970	0,99
XIII	69199	4669	61359	3171	2,48
ARMM	449981	34717	54148	361116	16,12
Total	2791163	940533	891146	959484	100,00

Source: BFAR, 1998.

Tuna resources

The tuna fishery is one of the most important marine fisheries in terms of volume and value of landings. In 1997, tuna contributed about 121,090 t from the municipal sector and 191,416 t from the commercial sector. In 1998, tuna in fresh/chilled/frozen, smoked and canned forms topped the fish exports to 99,461 t for about US$ 204,703,000.00 (FOB value) or 7.9 billion pesos. The major destinations were Japan, Thailand, USA, South Africa, etc. (BFAR, 1998).

The local tuna fishery consists of six major species, namely; the yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye tuna (*Thunnus obesus*), bullet tuna (*Auxis rochei*), eastern little tuna or "kawa-kawa" (*Euthynnus affinis*), and frigate tuna (*Auxis thazard*). It is also classified into inshore or limited-range species and oceanic-highly migratory species. Most of the tuna catch is derived from small-scale fishing using handlines and gillnets and commercial scale ringnetting and purse seining in conjunction with payaos. Tuna are found throughout the archipelago at different sizes but fishing activities are concentrated in Moro Gulf, Davao Gulf, Celebes Sea, Sulu Sea, east coast of Samar and Western Luzon. One of the traditional fishing ground is the "Dangerous Grounds" of the Central South China Sea where purse seiners operate during the summer months.

Under the Philippine Tuna Research Project (1992-1995), catches by gears used for tuna fishing from 18 landing sites were monitored for a period of 18 months. It indicates a total of 14 tuna and tuna-like species of the family Scombridae (tab. 3).

There are 21 tuna species recorded in the Philippines, four belong to the large tunas (yellowfin, bigeye, albacore and skipjack): six species to the small tunas (frigate, bullet, "kawa-kawa", longtail, bonito and Indian mackerel) and three to the seerfishes (Spanish mackerel, dogtooth tuna and shark mackerel). Other catches include the families; Istiophoridae (billfishes such as marlins), Coryphaenidae (dolphinfishes), Carangidae (jacks and travalles), Balistidae (triggerfishes), Carcharhinidae (sharks), Clupeidae (sardines), Engraulidae (anchovies) and the *Loligo* spp. (squid). Fishing gears monitored include at least ten different types which have been classified as major gears (purse seine, ringnet and handline) and minor gears (bagnet, gillnet, mini-longline, troll line, multiple handline and fish corral (tab. 4).

Table 3 - Catch composition of tuna fishing gears.

Scientific name	Common name	Local name	Code
A. Scombridae	Tunas and Mackerels	Tangigue and Bariles	
1. Tunas and Bonitos	Tuna and tuna-like		
Thunnus albacares	Yellowfin	Bariles	YFT
Thunnus obesus	Bigeye	Buldog	BET
Thunnus tongol	Longtail		LOT
Thunnus alalunga	Albacore	Albakora	ALB
Katsuwonus pelamis	Skipjack	Tambakol	SKJ
Euthynnus affinis	Kawa-kawa	Katchorita	KAW
Auxis rochei	Bullet tuna	Tulingan	BLT
Auxis thazard	Frigate tuna	Tulingan	FRI
Sarda orientalis	Striped bonito		
Rastrelliger brachysoma	Short mackerel	Hasa-hasa	RAS
Rastrelliger kanagurta	Indian mackerel	Alumahan	RAS
2. Seerfishes			
Scomberomorus commerson	Barred Spanish mackerel	Tanguigui	SEE
Gymnosarda unicolor	Dog-tooth tuna	Tanguigui	COM
Grammatorcynus bicarinatus	Shark mackerel	Tanguigui bato	
B. Istiophoridae	Billfishes		BIL
Makaira mazara	Indo-Pacific blue marlin	Malasugui	BLE
M. indica	Black marlin	Malasugui	BLK
C. Coryphaenidae	Dolphinfishes		
Coryphaena hippurus	Dolphinfish	Dorado	DLF
D. Carangidae	Jacks and Travalles	Talakitok/kabalyas	
Decapterus spp.	Roundscad	Galunggong	RSC
Elagatis bipinnula	Rainbow runner	Salmon	RRU
E. Others			OTH
Carcharhinidae	Shark	Pating	SHK
Dasyatidae	Stingray	Pagi	STR
Mobulidae	Manta ray	Salanga	MAN
Sphyraenidae	Barracuda	Torsillo	BAR
Balistidae	Triggerfish	Papakol	TRI
Carangidae	Jack	Talakitok	CAR
Clupeidae	Sardine/Herring	Tamban	SAR
Engraulidae	Anchovy	Dilis	ANC
Loligo spp.	Squid	Pusit	SQD

Source: Philippine Tuna Research Project (1992-1994).

Table 4 - Landing (t) of different gears used for tuna fishing at the 19 landing sites monitored by PTRP* in 1993.

	Major Gears				Minor Gears						
Landing Sites	Handline	Purse seine	Ringnet	Bagnet	Drift gillnet	Mini longline	Troll line	Multiple handline	Gillnet	Fish corral	Total
Zambales											
Matalvis		1468.5	389.0								1857.5
Masinloc	538.7										538.7
Matain	87.7		0.8								88.5
Subic	504.7	7.6	33.5							0.1	545.9
Quezon										0.2	0.2
Atimonan	231.0	9.7	78.4	77.5					9,8		406.4
Palawan											
Pier	354.9										354.9
Liberty	87.6										87.6
Quito			0.3			15.7					16.0
Tandag, Surigao											
Kalipayan	322.3										322.3
Santan	353.4										353.4
Zamboanga City											
Labuan	2.9		223.0		253.2		11.3	6.6			497.0
Baliwasan			634.3								634.3
Rio Hondo	119.5										119.5
Lig Marine		7328.9									7328.9
Permex		4041.2									4041.2
Pagadian City											
Sta. Lucia	702.4		16.2	27.0							745.6
Tukuran	24.3	4221.7	4.4								4250.4
Gen. Santos City											
Lion Beach	6456.5										6456.5
Calumpang		11615.2	14813.1								26428.3
Total	9785.9	28692.8	16193.0	104.5	253.2	15.7	11.3	6.6	9.8	0.3	55073.1

* PTRP: Pilippine Tuna Research Project.

The payao

Features

Payao is a Fish Aggregating Device being used by the artisanal/small-scale and industrial Filipino fishermen. It is used mainly to attract free-schooling tunas and small pelagics (sardines, scad, mackerel, etc.). It consists of four functional parts: the floating, anchoring, mooring and the attractant sections. It is distinguished from one another through the materials being used in the floating section and distance of installation. The selection for their use depends upon the preference of the fishermen, price and availability of the materials in the locality.

Inshore municipal payaos are installed within the 15-km area which is the jurisdiction of the municipal or local government units while offshore payaos are installed beyond the 15-km from the shoreline and in deeper waters. In 1981, about 2,000 payaos were deployed in Western Luzon, Sibuyan Sea, Western Antique, Sulu Sea, Bohol Sea, Davao Gulf

and Moro Gulf. At present, Philippine payaos are estimated to be around 4,000 to 5,000 units both in inshore, offshore, high seas, and waters of other countries where Philippine fishing boats are allowed to operate.

Types

The "arong" evolved from the shallow fish shelter locally termed "tangkal" and "bonbon". Figure 2 shows a vertical and horizontal bundled bamboos tied together by rattan or interior rubber of tyres. It is anchored in the sea floor by means of boulders or big stones covered with nets, sacks and woven rattan baskets. The original anchor line is made of rattan or sliced exterior of rubber tyres twisted and joined together but nowadays by polyethylene rope while the mooring section is concrete cement. It is mostly installed in shallow areas (20 to 200 m) where pelagic fishes are known to be abundant. During daytime, fishes are harvested by handlines. At night-time, it is lighted with gas lamps and harvested by handline, gillnet, liftnet and surrounding net. The "arong" is estimated to cost from US$ 50 to US$ 500 depending on sea depth and materials.

The payao which is set in deeper waters has many variations depending on the type of the float. Figure 3 describes the types and parts of bamboo, rectangular-steel, galvanized-drum and bamboo-pontoon combination payaos. The anchor line section usually consists of wire

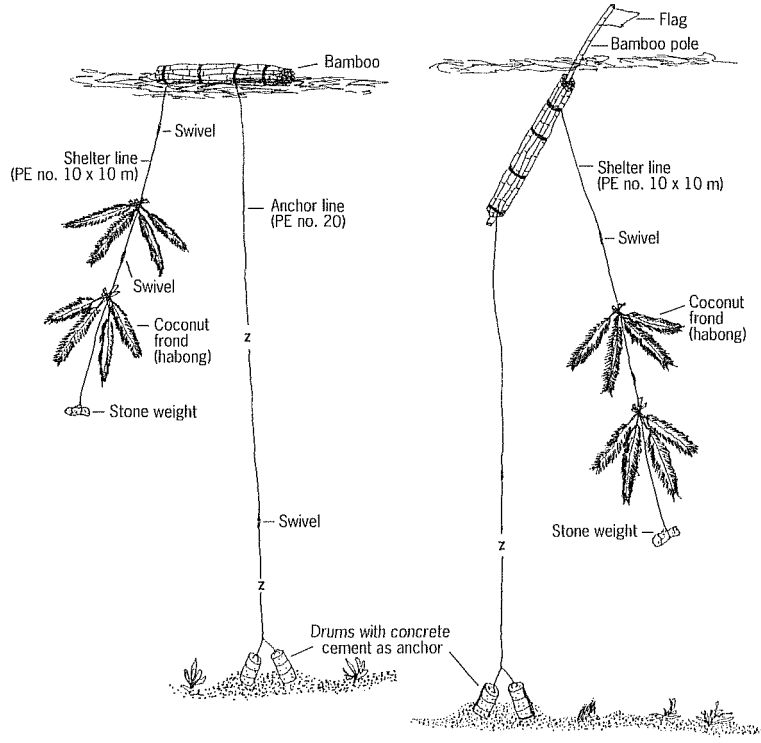
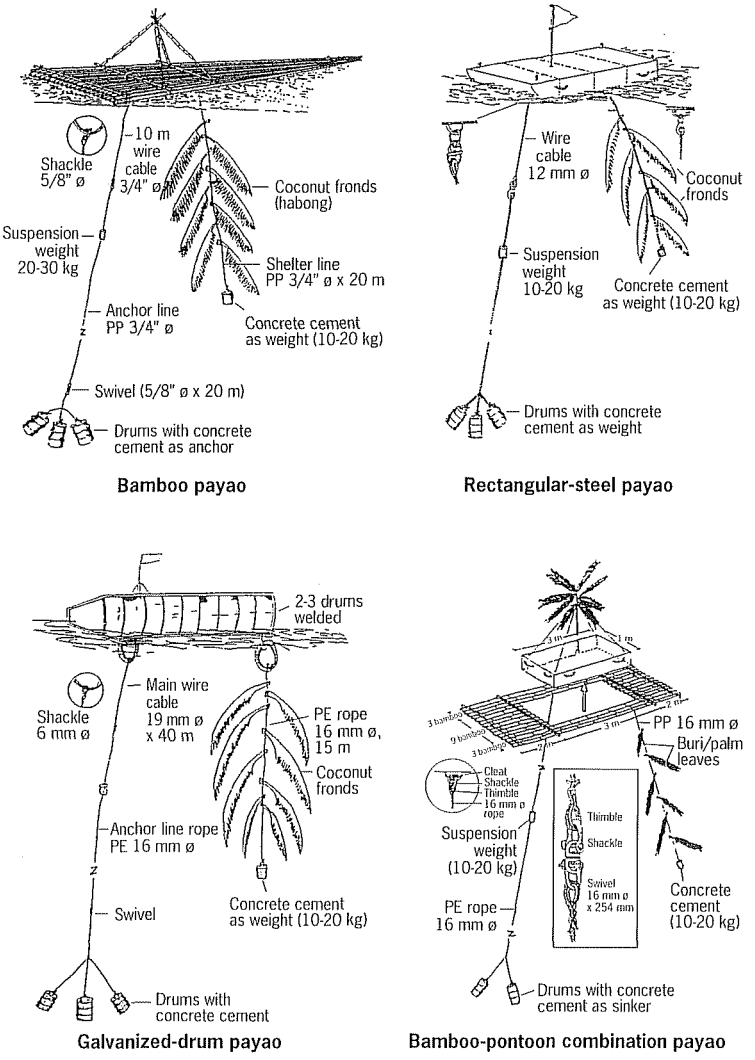


Figure 2
Bundled horizontal-vertical bamboo payao.

cable near the floater and the mooring drums, swivels, suspension weight and the polypropylene or polyethylene rope. The suspension weight prevents the floating of the slack rope during low tide since the anchor line sea depth ratio is 1.2:1. The mooring section is made of one to eight concrete 200 l capacity cemented drum depending on sea depth. The attractant section is made of coconut/palm leaves tied to a rope and hung to the float. The depth of the sea ranges from 300 m to 5,000 m. The price is estimated from US$ 700 to US$ 3,000 depending on the diameter, length and material of the anchor line. In most deep-sea payaos, a galvanized chain, wire cable, or iron rod is connected to the upper portion of the anchor line near the floater to prevent other fishermen in cutting the line.

Figure 3
Types of payao.



Ownership

Municipal payaos are usually owned by small-scale fishermen or group of fishermen who formed cooperative or association. They are installed near the seashore, adjacent to their villages or nearby waters for easy monitoring and provide safeguarding from vandals. In some regions, the payaos owned by associations are harvested by the big companies at sharing of 25:75% of the catch. However, in offshore waters payao are owned by the ringnetters and purse seiners companies. Depending on the number of catchers, they can operate 30 to 50 units. The fishing companies allow that small-scale fishermen operate their fishing lines, and in return, monitor the payao for the presence of school and prevent other fishermen in destroying the units.

Regional distribution

Figure 4 shows the distribution of payaos by region. In region I, the galvanized-drum payao is the most commonly installed off north-western Luzon at 20 to 50 nautical miles away from the shore. However, some companies are using the bamboo and pontoon payaos. In Region III, galvanized-drum payao is also installed on the western part of Zambales at about 20 to 40 nautical miles from the shore. The distance is becoming farther offshore due to unscrupulous fishermen. In Region IV, payaos are distributed off western Bataan and Palawan while arongs are set off western Batangas and Mindoro Strait. In the Visayas or Central Philippines, (Regions VI, and VII), arongs are found in Negros Strait, Cebu Strait, Camotes Sea, Bohol Sea, Samar Sea, Visayan Sea, Carigara Bay, Leyte Gulf and Sulu Sea. They are set in shallow waters from 50 m to 300 m deep. Eastern Visayas (Region VIII) has also raft-type and galvanized-drum payaos with peak season of harvest during the southwest monsoon (June-October). The eastern Samar and Leyte waters provide a good fishing activity. In Mindanao (Regions IX, X, XI, XII and ARMM), the major payao areas are Davao Gulf, Moro Gulf, Celebes Sea and South Sulu Sea using the cylindrical-drum payao.

Harvesting methods and techniques

Commercial tuna fishing started in the Philippines as early as the 1930s but it was only in 1974 when the United Nations Food and Agriculture Organization brought in two experimental purse seining vessels to test the viability of tuna fishing in Philippine waters that a breakthrough was made. It was during this period that the effectiveness of payao for aggregating tuna and small pelagics was discovered by the Filipinos. Figure 5 presents the fishing gears for harvesting tuna associated with payao. The handline is used extensively in Regions I, III, IV, VII, VIII, IX, XI and XII while troll line is used solely in Regions I and VII. Bagnet using payao is traditionally found in Region XI while ringnet and purse seine are widely used in all Regions.

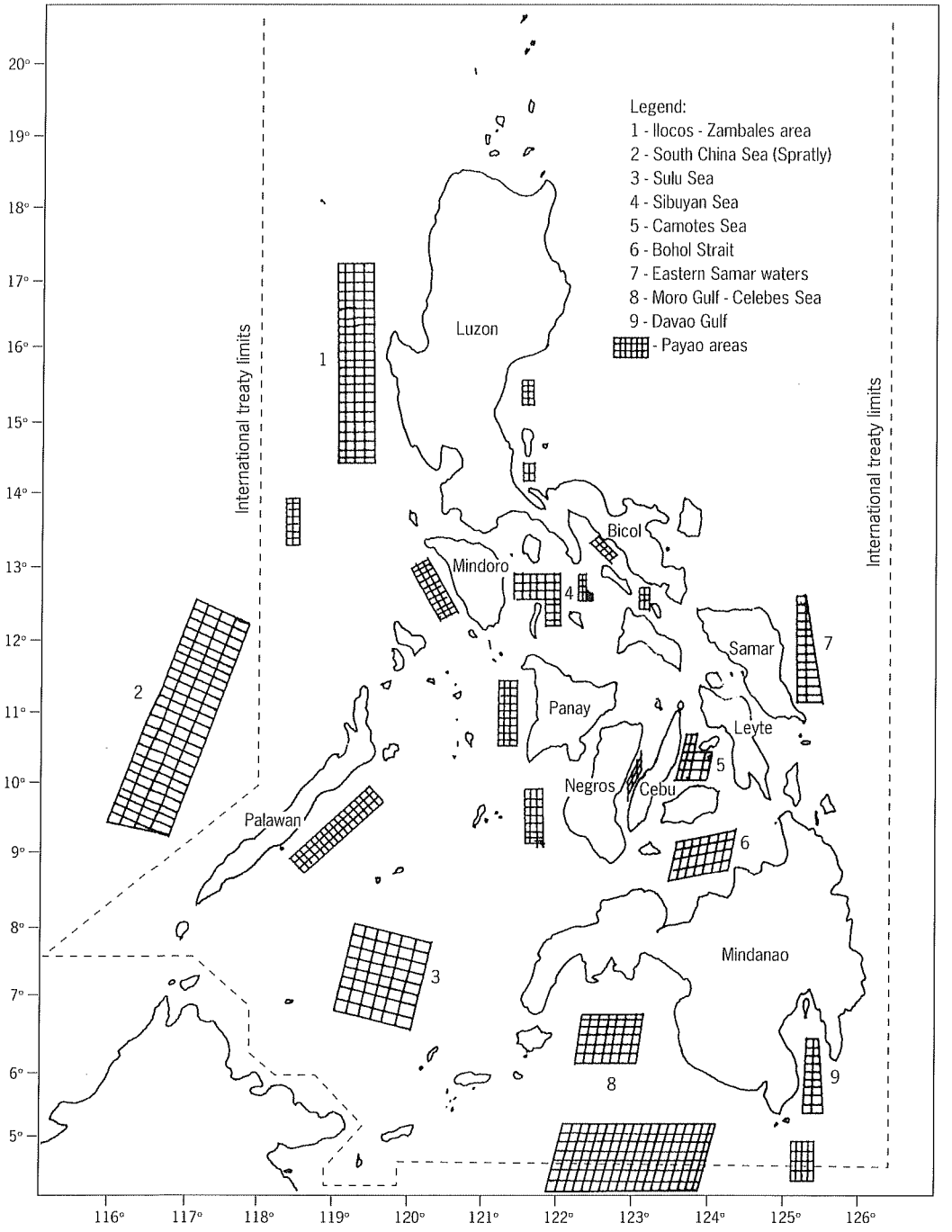


Figure 4 - Payao areas in the Philippine waters.

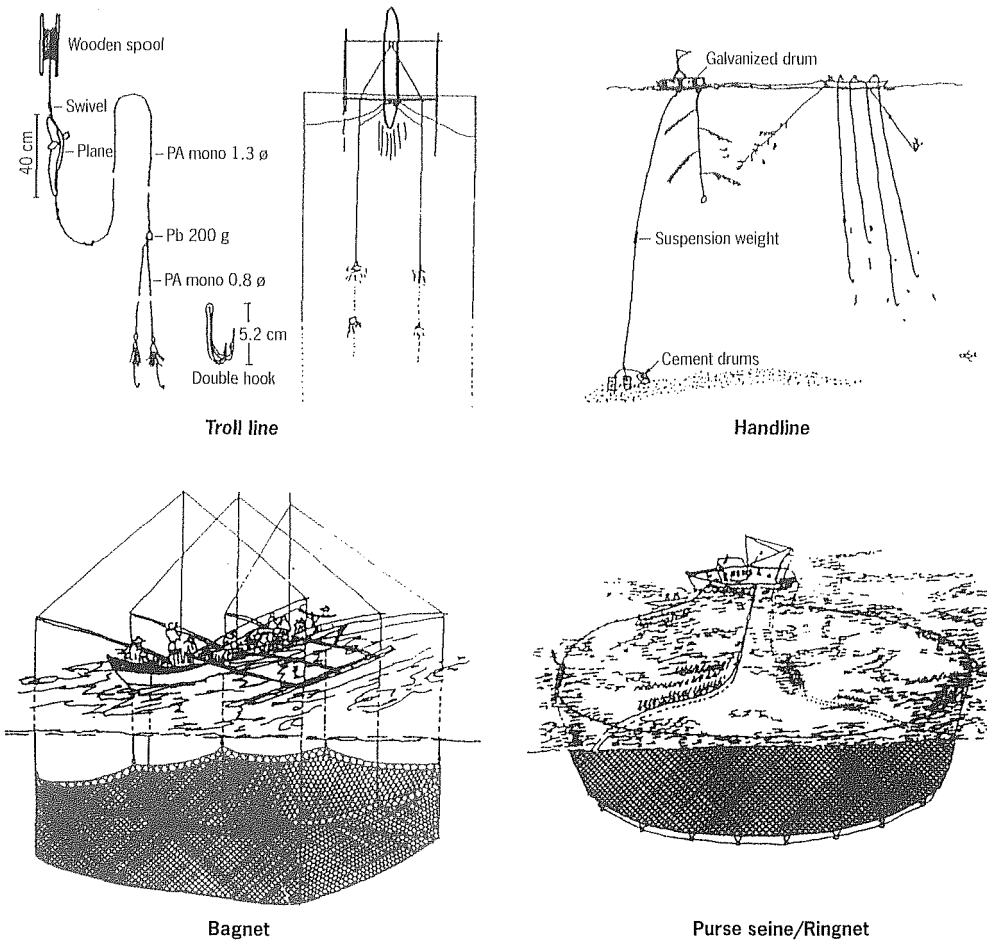


Figure 5
Tuna fishing gears associated with payao.

The techniques for ringnet/purse seine in Zambales waters, Celebes Sea, and international waters vary with the operation of the payao. Handline fishing in Celebes Sea is unique compared to other areas.

Ringnet/purse seine operation in Zambales-Ilocos coast

The 2.5 pc galvanized drum of about 2.5 metres long is mostly used with the bamboo type as alternate floater. Peak fishing is seasonal and occuring during the northeast monsoon from November to May. Payaos are set about 20 to 50 nautical miles from the shore at 500 to 3,000 fathoms deep. Two whole drums are welded together with the third drum cut into two pc. to shape like a torpedo. The torpedo-shaped drum reduces the effect of wind and waves. Payaos are patrolled by "ranger bancas" and the unit with fish schools are lighted during the night. At midnight, the mother boat or catcher boat is called and arrives in the designated position before dawn.

Divers, often called "human echosounders" dive underneath the payao and estimate the volume of the school. With a good estimation, the light boat detached the floater with the habong towing to a distance where it is surrounded by the mother boat. Shooting of the net starts with two fishermen jumping overboard with one end of the net. As soon as the fishermen and the mother boat meet, the fishermen throw the floatline and purse line on board ready for pursing. At this juncture, a tom weight or "lingote" is dropped along the purse line. The fishing operation lasts until 6am or 7 am and the boat reaches the homeport at noon, ready for the fish delivery to the market by means of insulated trucks or vans.

The "floater" technique

Before the payao is surrounded by the catcher boat, the whole drum or floater is detached from the anchor line where its end is provided by a float or buoy. The drum float together with the "habong" or attractant is towed away by the lightboat. Simultaneously, the catcher boat tows the buoy with the anchor line to a distance to avoid entanglement. Finally, the catcher boat surrounds the lightboat together with the floater. Surrounding takes about 3 to 5 min, pursing another 30 min, and hauling the net from 40 min to one hour depending on the sea conditions. Brailing of the catch takes about 30 min to one hour.

The "habong" technique

The "habong" or the attractant only is being detached and towed by the "ranger boat" or light boat away from the floater. At a designated area, the light boat with the "habong" is surrounded by the catcher boat until operation is completed. The "habong" is returned to the floater after the operation.

Purse seine operation in Celebes Sea

Majority of the purse seiners in General Santos and Davao, southern Mindanao operate in Celebes Sea, Moro Gulf, and adjacent waters. One fleet usually consists of a catcher boat, three lightboats, two carriers and 40 to 50 payao units.

The "single payao" technique

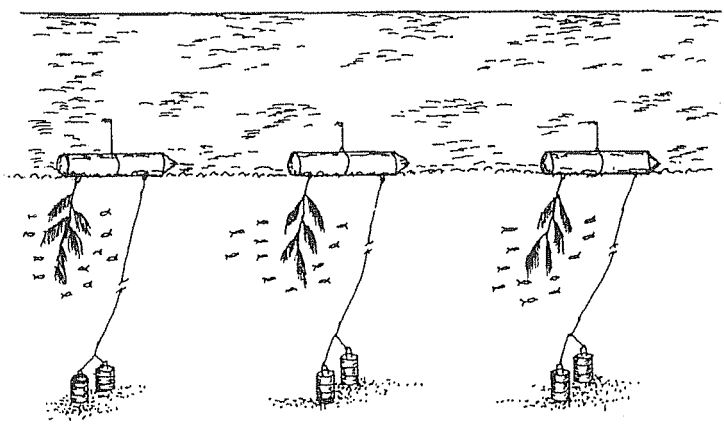
During the time when fish schools are abundant both inside the Philippines' territory and adjacent waters, the single-payao operation is being applied. A single payao is lighted for the night. At dawn, it is surrounded by the catcher boat until tuna and other small pelagics are hauled on board. The average catch rate ranges from 10 to 15 tons per night operation.

The "terminal" technique

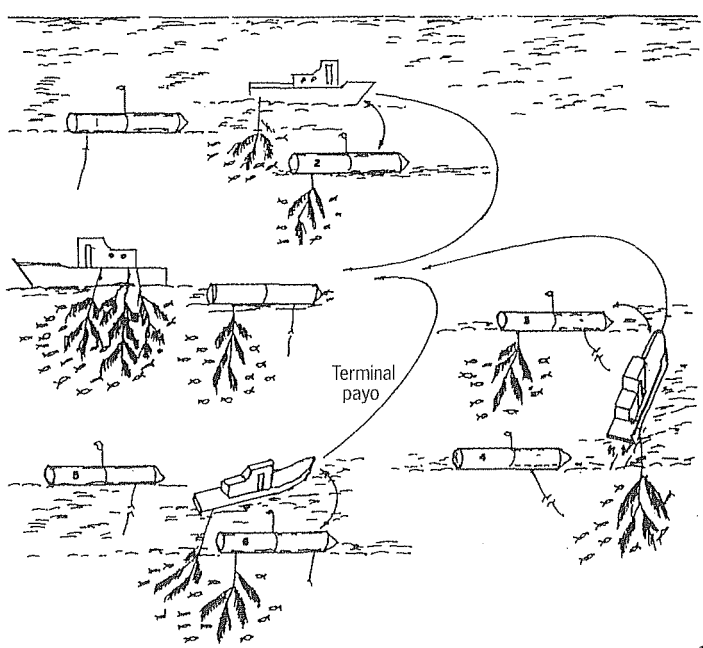
With the declining catch, the fishermen devise a technique where seven to nine payaos' attractants (habongs) are combined during the day.

Usually, the payaos are three or four nautical miles distant. The experience of other companies for the installation of payaos is from 8 to 10 nautical miles. After assigning the position of the terminal payao, the lightboats proceed to the adjacent payaos and firstly combine two payaos' "habong" and tow them to the terminal payao. The "habong" of other payaos are also brought to the terminal. Before leaving the floater, a new set of "habong" is tied. It was observed that the schools follow the "habong", hence increasing the catch per unit effort. The terminal is lighted at night to maximize the attracting efficiency (fig. 6). At dawn, it is surrounded by the catcher boat. The new technique in harvesting several payaos is already being done in Celebes Sea by the General Santos fishing companies and in adjacent waters frequented by Navotas/Malabon companies.

Figure 6
Terminal technique in purse seining.



Payao at Celebes Sea is approximately 3-4 nautical miles at depth of 3,000 to 4,000 metres



Purse seine fishing in international waters

International waters include other countries territorial waters where fishing agreements exist. Presently, there are about five fishing companies from Navotas/Malabon, Metro Manila, Zamboanga City and General Santos City which are operating in international waters. These are mostly tuna purse seiners using payaos, floating logs and setting their nets in open waters. The cylindrical-steel payao is the type of floater being used with their depth ranges from 1,000 to 4,000 fathoms. The purse seiners go fishing farther to seek for better fishing grounds in order to harvest enough volume to sustain their operations.

Hook-and-line fishing in Celebes Sea

Hook-and-line fishermen are the source of "sashimi" tuna in General Santos City and Davao City. The tuna caught are distributed to other parts of the country particularly Metro Manila. A large portion of the catch are exported to Hong Kong, Taiwan and Japan. Tuna handlining is one of the important fishing methods for capturing big tunas and is very popular in southern Mindanao. The outriggered banca measures 17 m by 1.5 m by 1.4 m (LBD) with about 3 to 10 gross tonnage. At the fishing ground where payaos are present, the fishermen release their small handlines baited with silk cloth to catch small-sized fish such as salmonettes, roundscad, tuna and squid to serve as baits.

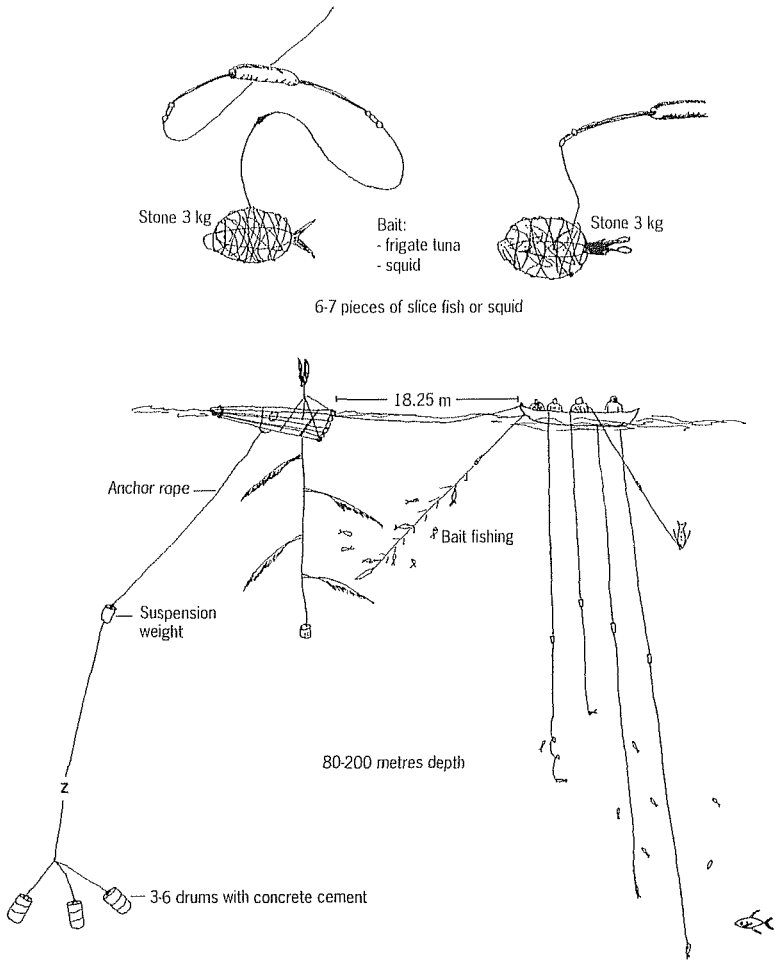
The "stone weight" technique

Figure 7 shows the major innovation introduced by the local fishermen. It is the coiling together of the baited hook in a stone weighing 1 to 3 kg using a 2-metre secondary main line. It is then dropped near the payao until it reaches the swimming layer of the tuna while the line is suddenly pulled to release the stone. At this depth, fishermen jerk their lines frequently to attract tuna bites. The observed swimming layer of tuna under payao ranges from 80 m to 200 m depth and fishermen must adjust their lines to this depth. Although, the stone acts as additional weight and increases the sinking speed of the hook, the effect to the fishing ground might have a negative impact to the tuna fishery in particular and the fishing area in general.

The "squid-ink" technique

Another baiting technique is putting a squid or octopus ink ("shabu-shabu") inside a small plastic bag together with the bait. The position of the plastic bag is located at the tipmost portion of the hookbarb for easy bursting upon jerking of the line. Tuna species are attracted to the black clouds of water as they think there is abundance of squids.

Figure 7
Stone-weight technique in tuna handlining.



Impact on tuna fisheries

The introduction of "arong" and payao did not provide all positive effect to the fishery resources and sustainable profit to the fishermen. In relation to the gears used, the devices attracted juvenile tunas and small pelagics. The harvesting led to the uncontrolled catches of juveniles which affect the recruitment patterns of the various species.
The Philippine waters are known as spawning areas of tuna; hence, the juveniles stayed in the fishery, attracted by the "arong" and payao, and finally caught by various fishing gears. Most of the mesh sizes are considered fine-meshed nets (less than 3 centimetres). The distribution of the tuna fisheries shows that small tunas dominate the catch. About 90% of the skipjack landed are at size 16 cm (juvenile migrates at about 30 cm and left Philippine waters at 60 centimetres). Yellowfin in the 60-110 cm range are not abundantly found in the country. The "arong" and payao truly increase the total catch of tunas and small

pelagics due to the attracting efficiency of the payao. However, the introduction of payaos had some negative economic impact to the tuna fishing industry and small-scale fisherfolk after years of good harvest. Tuna production increased from less than 10,000 t in 1972 to 125,000 t in 1976 when the payao was introduced to tuna fishing. In 1997, the total tuna production was 312,506 t comprising of frigate/bullet, yellowfin/bigeye, skipjack and "kawa-kawa" (tab. 5). However, the positive impact resulted for the artisanal or small-scale fishermen to sustain their catch, and the handline fishermen in General Santos City establish an export market of tuna "sashimi" while the purse seiners contributed to the sustained operation of tuna canneries and processing plants as well as the boom of related industries in southern Mindanao.

Table 5 - Annual total landings (t) of tunas in the Philippines (1970-1997).

Year/Species	FRI/BLT	YFT/BET	SKJ	KAW	Total
1970		1685	122	7247	9054
1971		3775	225	4246	8246
1972		1856	131	7253	9240
1973	3201	6865	1463	11071	22600
1974	2247	11415	2761	8915	25338
1975	3396	9694	3181	5288	21559
1976	28328	44478	29714	23004	125524
1977	43007	63059	55090	54744	215900
1978	45937	37225	32586	21953	137701
1979	79909	49224	45084	23094	197311
1980	96874	48023	31180	24733	200810
1981	78248	56176	38439	30891	203754
1982	67363	51922	50795	46524	216604
1983	74219	62036	57151	48880	242286
1984	80305	58924	44671	41899	225799
1985	95726	64293	60536	41060	261615
1986	87225	59510	77031	42445	266211
1987	98032	51809	73751	46934	270526
1988	107498	57650	58156	56337	279641
1989	117545	62146	64654	57899	302244
1990	88801	81103	99705	43762	313371
1991	93236	95594	102394	47850	339074
1992	125655	45026	83179	31943	285803
1993	110266	38083	68065	21714	238128
1994	109866	63179	84560	29669	287274
1995	88426	60957	110111	27308	286802
1996	88969	61280	110004	24345	284598
1997	108494	67342	110097	26573	312506
Total	1922773	1314329	1494836	857581	5589519
Average	76910.92	46940.32	53387.00	30627.89	

Source: Bureau of Agriculture Statistics (BAS), Fisheries Statistics, 1970-1997.

Management

The increasing and continuous use of "arong" and payao in the territorial waters should be an area of concern for both the Philippines and other countries using the technology. The uncontrolled capture of juvenile tunas should be provided with proper solution to make tuna fishing sustainable in the region. It has been recognized that international cooperation through a regional agreement should be done for the effective utilization of the highly migratory species. The multi-high level conference relating to straddling and migratory stocks should be concretized and the creation of a regional body is recommended. The use of payaos is contributory to the removal of juveniles of tuna from the stocks. With this situation, the government must regulate the tuna fishery by looking at the effect of payaos and other harvest methods in order to ensure the sustainable productivity of the tuna fishery.

Recommendations

- A system of monitoring catch, effort, size composition, oceanographic and biological data should be implemented on fishery resources associated with payao to improve understanding of the population and fishery dynamics involving the device and management of tuna stocks.
- The potential impact of payao and the fishing gears to the fishery resources and environment should be given priority in research. The results of the studies will serve as basis in the formulation of policies for the sustainable viability of the tuna resource and continuous utilization of the payao for both inshore and offshore waters.
- At the same time, since many countries are using FADs, concerted and effective monitoring is necessary to check or counteract reported detrimental effect of payao on juvenile tuna catch. Among the suggested measures are the use of big mesh-size nets and proper spacing of FADs.

Bibliographic references

Aprieto V.L., 1979. Philippine tuna management on marine environment and extended maritime jurisdictions: transnational environment and resource management in Southeast Asian Seas. East-West Center Environment and Policy Institute, Honolulu, Hawaii, 38-50.

Aprieto V.L., 1991. Payao, tuna aggregating device in the Philippines. *In:* Symposium on artificial reef and Fish Aggregating Devices as tools for the management and enhancement of marine fishery resources. Indo-Pacific Fishery Commission, Colombo, Sri Lanka, 14-17 May 1990, RAPA-FAO-UN 1991/11, 14-15.

Aprieto V.L., 1991. Philippine tuna fisheries: yellowfin and skipjack. University of the Philippines Press, 251 p.

ASEAN/SF/88/GEN/7, 1998. Report on the training-study tour on fishing with payao. ASEAN/UNDP/FAO regional small-scale coastal fisheries development project, 87 p.

BAS, 1970-1997. Bureau of Agriculture Statistics. Fisheries Statistics.

BFAR, 1998. Fisheries profile. Bureau of Fisheries and Aquatic Resources, Quezon City, Philippines, 51 p.

Dickson J.O., Pastoral P.C., 1995. Technology advances and problems on the use of payao in tuna fishing. *In:* 4th World Tuna Trade Conference, 25-27 October 1995, Metro Manila, Philippines, 165-172.

Dickson J.O., 1993. Deep-sea Fish Aggregating Devices for commercial fisheries in the Philippines. INFOFISH Int., (4), 51-56.

Hallier J.-P., 1995. Tropical tuna fishing with purse seine and log. INFOFISH Int., (4), 53-58.

Malig J.B., de Jesus A.S., Dickson J.O., 1991. Deep-sea Fish Aggregating Devices in the Philippines. *In:* Symposium on artificial reef and Fish Aggregating Devices as tools for the management and enhancement of marine fishery resources. Indo-Pacific Fishery Commission, Colombo, Sri Lanka, 14-17 May 1990, RAPA-FAO-UN 1991/11, 214-228.

Pauly D., Floyd J.M., 1984. Smaller-size tuna around the Philippines-can Fish Aggregating Devices be blamed? INFOFISH Mark. Dig., 5, 25-27.

Primex, 1993. Philippine Tuna Research Project (PTRP). Final Report. Pacific Innovation and Management Components, Inc., Manila Luxury Condominium, Pasig, Metro Manila, Philippines.