

Large Pelagic Fishery Resource Survey using Pelagic Longline in the Bay of Bengal

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Abstract

The fishery research vessel, M.V. SEAFDEC, of the Southeast Asian Fisheries Development Center (SEAFDEC) collaborated with the BIMSTEC member countries was conducted a survey using pelagic longline with thirteen fishing operations to investigate the potential of large pelagic fishery resources in the Bay of Bengal within 3 areas during 5 November to 4 December 2007.

The mainline of pelagic longline was made from nylon monofilament in the reel system. Number of hook deployed in each station varied from 303-520, the hook operation depth was between 40-300 m. Shooting gear was done at dusk, baits using were round scads, milk fish and Indian mackerel then the gear was retrieved in the next morning. Total catch were weighing 1,754.65 kg and 77 numbers. Identified seventeen species belonged to 16 genera and 12 families were caught during the survey. Main catch, by weight and number, were swordfish (*Xiphias gladius*) 650.0 kg (37.044%), 21 individuals followed by bigeye thresher shark (*Alopias superciliosus*) 641.0 kg (36.531%), 11 individuals and yellowfin tuna (*Thunnus albacares*) 75.0 kg (4.274%), 3 individuals. The overall average catch rate was 1.23% (individuals/100 hooks). The highest catch rate 3.94% was found at station 12 at latitude 12°30'.30 N longitude 094°59'.70E. The catch rate of swordfish was quite high comparing to commercial longline fleet. This suggests the prominent potential yield of swordfish in this surveyed area whilst the tuna is low.

Keywords : Bay of Bengal, pelagic longline, large pelagic fishery

Introduction

The Bay of Bengal is a bay that forms the northeastern part of the Indian Ocean. It occupies an area of 2,172,000 km², 2,090 km long and 1,600 km wide with an average depth of more than 2,600 m. It resembles a triangle in shape, and is bordered by India and Sri Lanka to the West, Bangladesh and the Indian state of west Bengal to the North (where the name comes from), and Myanmar, southern part of Thailand and the Andaman Sea and Nicobar Islands to the East. Its southern boundary extends as an imaginary line from Dondra Head at the southern end of Sri Lanka to the northern tip of Sumatra. The Bay of Bengal is

full of biological diversity, diverging amongst coral reefs, estuaries, fish spawning and nursery areas, and mangroves. The Bay of Bengal is one of the world's 64 largest marine ecosystems. Marlin, barracuda, skipjack tuna, (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), Indo-Pacific humpbacked dolphin (*Sousa chinensis*), and Bryde's whale (*Balaenoptera edeni*) are a few of the marine animals living in the Bay of Bengal ecosystem (http://en.wikipedia.org/wiki/Bay_of_Bengal).

The FAO 10 years trend showed a steady increased in catch from 1.4 million tons in 1990 to 2.2 million tons in 1999. The average catch was 2 million tons. This tropical region has a relatively great marine biodiversity that was reflected in the catch composition. There was a high catch percentage for miscellaneous coastal fishes and pelagic fishes (tuna, yellowfin tuna, bigeye tuna and skipjack tuna) (FAO, 2003). Catch trends were quite diverse and it was difficult to identify a pattern due to the fact that there is inadequate information on the status of the fishery resources and their exploitations. Despite a steady rise in total landings since the 1950s, there were signs that the harvest levels may not be sustainable, especially with regarded to tuna fishing in the Maldives, Malaysia, Andaman coast of Thailand and Sri Lanka. Ecological changes in the estuaries and coastal areas have not yet affected total production trends (Dwivedi, 1993).

The Ecosystem-Based Fishery Management in the Bay of Bengal is a collaborative survey project of the BIMSTEC member countries (Bangladesh, India, Myanmar, Sri Lanka, Nepal and Thailand) aims to manage the fishery resources in the Bay of Bengal. This project is collaborated among member countries and Thailand takes a lead country in research surveys. In line with the concept of the project, it is incorporated to settle 17 sub-projects. The large pelagic fishery resource survey using pelagic longline is one of the sub-projects to investigate its potential yield and resources in the Bay of Bengal.

Materials and Methods

1. Fishery Research Vessel

The fishery research vessel, M.V. SEAFDEC, of the Southeast Asian Fisheries Development Center (SEAFDEC) was deployed in the proposed survey areas throughout the survey period.

2. Fishing Gear

The pelagic longline gear was used for the exploration of large pelagic species. The gear was composed of nylon monofilament mainline (4.0 mm diameter). The mainline was stored in a 2.0 meter-winch mainline reel which was driven by hydraulic power. The total length of mainline stored in the reel was about 70,000 m. The branch line, which was made of 2.0 mm nylon monofilament, was attached to the mainline by stainless steel snap clip. Total length of each branch line was 12 m. One tuna hook was attached to the branch line by aluminum sleeve at the end. One 40 g lead sinker was attached at 1.5 m above the hook. The distance between each branch line was maintained at 40 m. A PVC float (300 mm diameter) with single eye was attached to a 25 m long nylon rope (5 mm diameter) known as float line which was further attached to the mainline gear after every 15-20 hooks (which is called one basket). Two temperature-depth recorders (TDR) were also attached to the mainline gear (one at the beginning and the other at the middle portion of the basket) so as to ascertain the actual depth of the hook and the sea water temperature at that depth. About 500 hooks were operated in each pelagic longline (PLL) operation. While deploying the gear both ends of the mainline

were attached with radio buoy and flag pole with light buoy for easy location of the line. The sketch of the PLL gear accessories are depicted in fig.1.

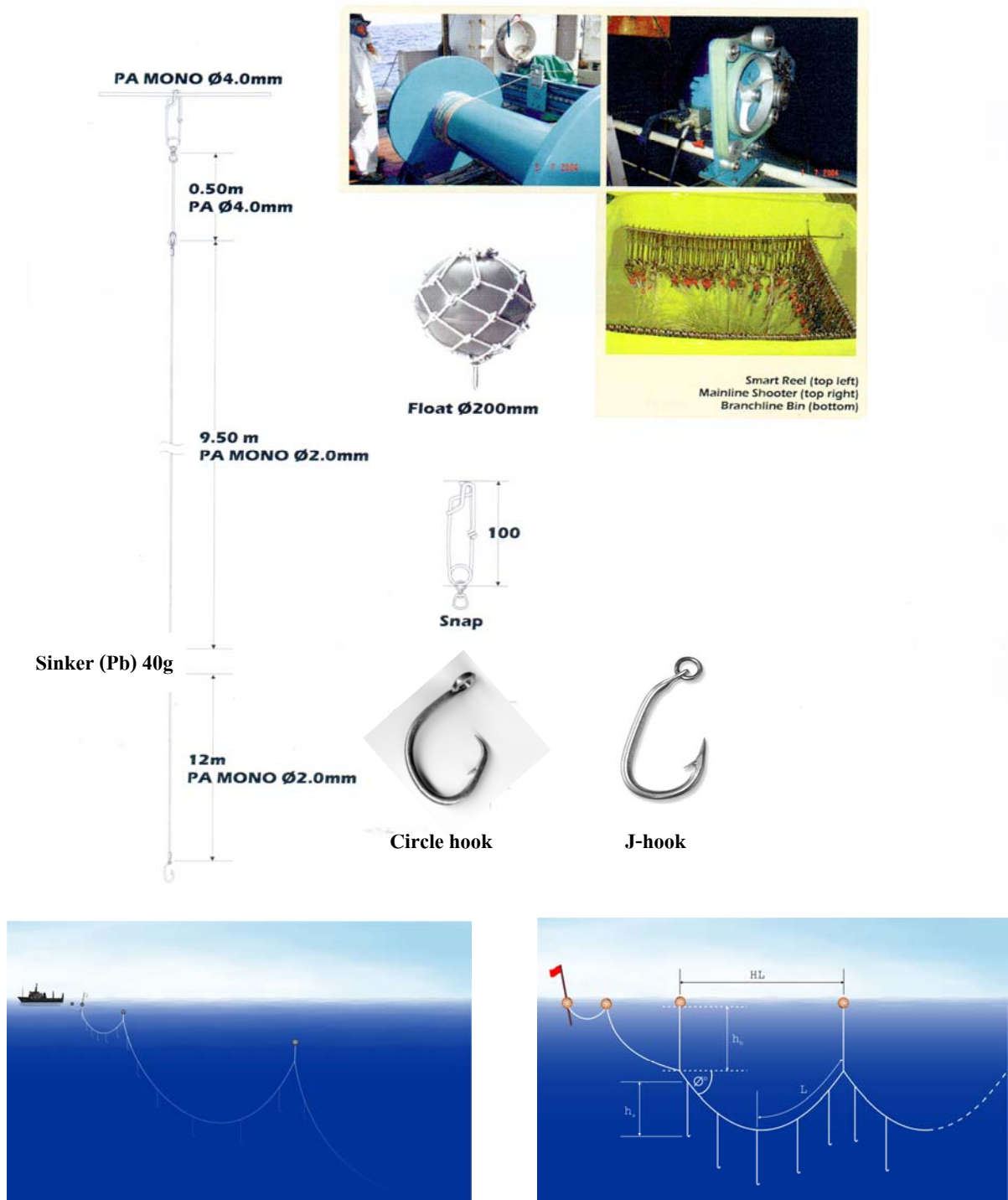


Figure 1 Accessories of pelagic longline gear and construction.

3. Survey Area

The survey areas

Area A: latitude 16°N-19°N, longitude 88°E-91°E

Area B: latitude 09°N-14°N, longitude 82°E-85°E

Area C: latitude 10°N-12°N, longitude 95°E-97°E

4. Survey Period

The pelagic longline survey was conducted within 18 different stations in three designated areas during 5 November to 4 December 2007.

5. Fishing Activity

Shooting operation was at dusk. Three different types of baits i.e., round scad (*Decapterus* sp.), milk fish (*Chanos chanos*) and Indian mackerel (*Rastrelliger kanagurta*) were used to mask the hook. Bait sizes were approximately 8-10 individuals per kilogram. Baitfish was hooked at the end of its skull to secure it fastened with the hook. Two types of tuna hooks were used during the survey operations i.e., 3.6 Sun tuna hook (known as 'J'hook) and stainless steel circle hook (No.14). Line shooter speed was calculated in relation to the vessel speed in order to maintain the mainline sac at proper fishing depth. From the temperature depth recorder (TDR) operated in every operation, the depth of the hook and temperature were recorded. The shooting of the PLL was done during the evening hours whereas the hauling of the line was carried out in the next day morning. The immersion time for the gear was more than 13 hours. After hauling the gear, the catch was identified up to species level and the morphometric characteristics (length and weight) of each specimen were measured on board. Oceanographic condition of each station was also observed using ICTD and recorded in oceanographic logsheet.

Results

Thirteen fishing operations were carried out during the survey. The survey was mutually defined as area A: latitude 16°N-19°N and longitude 88°E-91°E (5 stations), area B: latitude 9°N-14°N and longitude 82°E-85°E (4 stations), area C: latitude 10°N-12°N and longitude 95°E-97°E (4 stations) as shown in fig.2. The depth of the sea at the survey stations varied between 1,128 m and 3,525 m. About 303 to 520 hooks were used in each PLL operation and hook depth varied between 40-300 m. Total numbers of 6,277 hooks were deployed over the survey areas. The mainline length ranging 13,004 m to 21,897 m was paid out in all PLL operations.

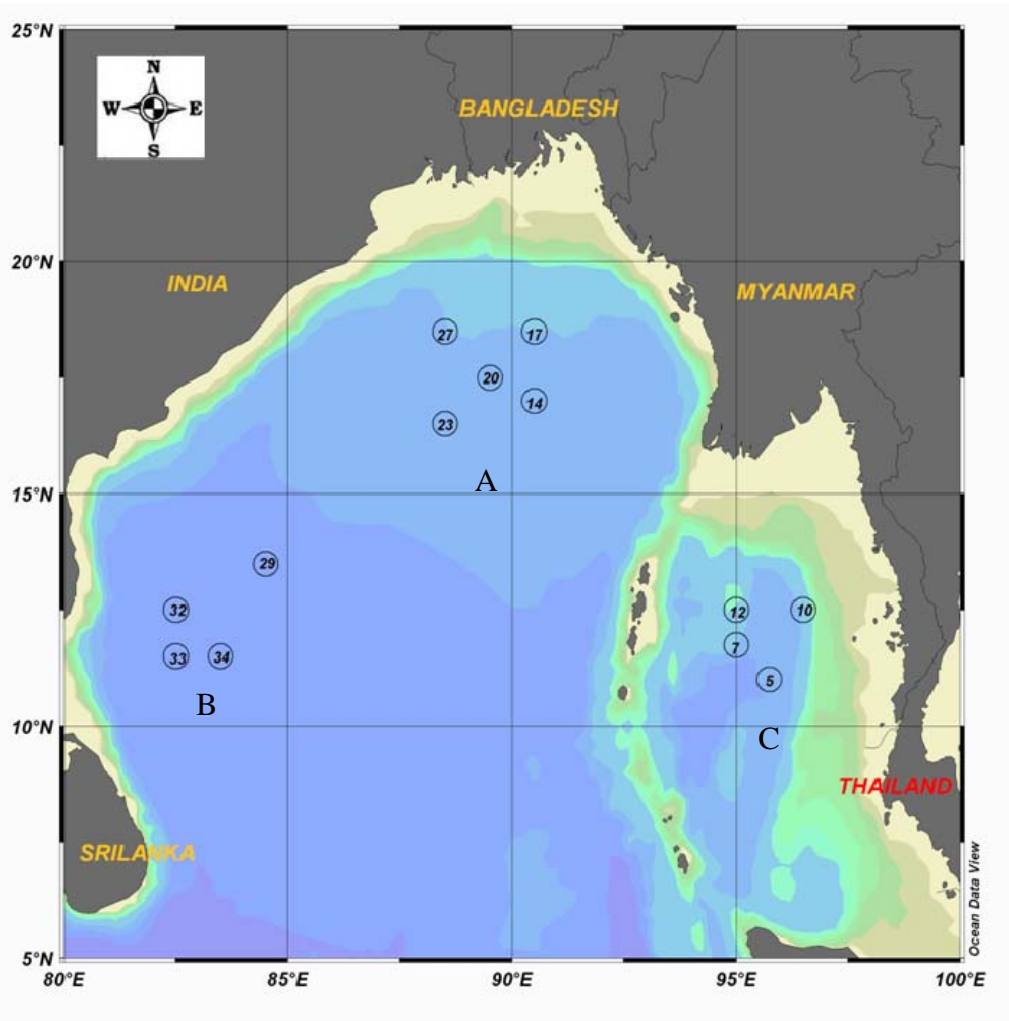


Figure 2 Map depicting the survey stations of pelagic longline.

The details of the results were summarized in table 1 and 2. A total of 77 numbers weighing about 1,754.65 kg were caught during the survey. The catch was identified into 12 families, 16 genera and 17 species. The species caught were yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), black marlin (*Makaira indica*), pelagic thresher shark (*Alopias pelagicus*), bigeye thresher shark (*Alopias superciliosus*), longnose houndshark (*Iago garricki*), silky shark (*Carcharhinus falciformis*), tiger shark (*Galeocerdo cuveri*), pelagic stingray (*Pteroplatytrygon violacea*), lancet fish (*Alepisaurus ferox*), great barracuda (*Sphyreana barracuda*), giant trevally (*Caranx ignobilis*), dolphinfish (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), roudi escolar (*Promethichthys prometheus*), snake mackerel (*Gempylus serpens*) and escolar (*Lepidocybium flavobrunneum*). Regarding to the catch by station, the highest catch of 16 numbers weighing 362.0 kg was obtained at the station 7 in area C.

Table 1 Results of the pelagic longline operation.

Area Station	Position		Sea depth	Hook depth	Total	Total catch	Tuna	Swordfish	Shark	Others	
	Latitude	Longitude	(m)	(m)	hooks	No./kg	No./kg	No./kg	No./kg	No./kg	
C	5	11°05'.80 N	095°41'.80E	2513	60-200	495	4/6.85	0	0	0	4/6.85
	7	11°46'.00 N	094°58'.90E	2841	60-130	510	16/362.00	1/2	4/221	3/117	8/22
	10	12°34'.30 N	096°26'.70E	1128	50-220	510	7/285.60	0	2/102	3/173	2/10.6
	12	12°30'.30 N	094°59'.70E	200-1418	60-150	330	13/309.10	0	7/264	2/24	4/21.1
A	14	16°55'.60 N	090°25'.90E	2535	40-80	510	5/107.40	2/73	1/30	1/3.3	1/1.1
	17	18°31'.10 N	090°26'.70E	2005	50-80	510	9/79.10	0	0	6/61.4	3/17.7
	20	17°31'.50 N	089°28'.20E	2249	40-80	519	2/52.50	0	0	1/40	1/12.5
	23	16°30'.70 N	088°24'.50E	2633	80-300	510	4/38.60	0	1/26	0	3/12.6
	27	18°30'.40 N	088°28'.30E	2082	80-230	520	0/0.00	0	0	0	0
	29	13°30'.00 N	084°30'.1E	3221	60-200	520	4/186.50	0	1/11.5	3/175	0
B	32	12°32'.90 N	082°24'.90E	3425	60-190	520	5/167.80	0	2/24	2/139	1/4.8
	33	11°31'.80 N	082°26'.10E	3525	70-250	520	5/121.50	0	2/17.5	2/101	1/3
	34	11°29'.60 N	083°28'.10E	3470	60-240	303	3/37.70	0	2/34	1/3.7	0
					6,277	77/1,754.65	3/75	22/730	24/837.4	28/112.25	

Species inventory:

Tuna; yellowfin tuna (*Thunnus albacares*)
 Swordfish; swordfish (*Xiphias gladius*), black marlin (*Makaira indica*)
 Shark; thresher shark (*Alopias pelagicus*), bigeye thresher shark (*Alopias superciliosus*), longnose houndshark (*Iago garricki*), silky shark (*Carcharhinus falciformis*), tiger shark (*Galeocerdo cuveri*)
 Others; pelagic stingray (*Pteroplatytrygon violacea*), lancet fish (*Alepisaurus ferox*), great barracuda (*Sphyreana barracuda*), giant trevally (*Caranx ignobilis*), dolphinfish (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), roudi escolar (*Promethichthys prometheus*), snake mackerel (*Gempylus serpens*), escolar (*Lepidocybium flavobrunneum*)

Table 2 Species list of fishes caught by pelagic longline separated by area.

No.	Family	Scientific Name	Area			Remark
			A	B	C	
1	Dasyatidae	<i>Pteroplatytrygon violacea</i>	/*		/	
2	Alopiidae	<i>Alopias pelagicus</i>			/	
3	Alopiidae	<i>Alopias Superciliosus</i>		/	/	
4	Triakidae	<i>Iago garricki</i>	/			
5	Carcharhinidae	<i>Carcharhinus falciformis</i>	/	/	/	
6	Carcharhinidae	<i>Galeocerdo cuvieri</i>			/	Escape
7	Alepisauridae	<i>Alepisaurus ferox</i>	/	/		
8	Sphyrnidae	<i>Sphyrna baracuda</i>	/	/		
9	Carangidae	<i>Caranx ignobilis</i>			/	
10	Coryphaenidae	<i>Coryphaena hippurus</i>	/		/	
11	Istiophoridae	<i>Istiophorus platypterus</i>	/			
12	Istiophoridae	<i>Makaira indica</i>			/	
13	Xiphiidae	<i>Xiphias gladius</i>	/	/	/	
14	Scombridae	<i>Thunnus albacares</i>	/		/	
15	Gempylidae	<i>Promethichthys prometheus</i>			/	
16	Gempylidae	<i>Gempylus serpens</i>	/		/	
17	Gempylidae	<i>Lepidocybium flavobrunneum</i>			/	

/* occur

The station wise catch composition and the average size were shown in table 3 and 4 respectively. From table 3 it showed that swordfish dominated the catch by weight 650.0 kg (37.044%) followed by bigeye thresher shark 641.0 kg (36.531%), silky shark 130.3 kg (7.426%) and yellowfin tuna 75.0 kg (4.274%). From table 4 it appeared that swordfish also dominated the catch by number and, likewise, followed by bigeye thresher and silky shark. It was rather disappointing that only 3 individuals of yellowfin tuna were obtained throughout the survey period. The fork length of yellowfin tuna ranged from 52-140 cm with an average length 109.7 cm and weighing about 2-38 kg with an average weight 25 kg. The size of swordfish ranged by weight from 5-100 kg with an average weight 30.95 kg, and the total length ranging 129-295 cm with an average length 170.3 cm. Only one black marlin with total length 276 cm and weight about 80 kg was caught during this survey.

Table 3 Station-wise and species-wise average weight (kg) obtained by pelagic longline.

Scientific name	Stations														%	Average	min.	max	
	5	7	10	12	14	17	20	23	27	29	32	33	34	Total					
<i>Pteroplatytrygon violacea</i>	2.50	2.20	9.50	3.00				10.60							27.80	1.5844	4.6333	2.20	9.50
<i>Alopias pelagicus</i>		34.00													34.00	1.9377	34.0000	34.00	34.00
<i>Alopias superciliosus</i>		53.00	173.00						175.00	139.00	101.00				641.00	36.5315	58.2727	31.00	100.00
<i>Iago garricki</i>						2.10									2.10	0.1197	2.1000	2.10	2.10
<i>Carcharhinus falciformis</i>				24.00	3.30	59.30	40.00						3.70		130.30	7.4260	13.3000	3.30	40.00
<i>Galeocerdo cuveri</i>		30.00													30.00	1.7097	30.0000	30.00	30.00
<i>Alepisaurus ferox</i>								2.00				3.00			5.00	0.2850	2.5000	2.00	3.00
<i>Sphyreana barracuda</i>						3.90					4.80				8.70	0.4958	43.5000	39.00	48.00
<i>Caranx ignobilis</i>				15.60											15.60	0.8891	7.8000	7.60	8.00
<i>Coryphaena hippurus</i>				2.50		13.00									15.50	0.8834	7.7500	2.50	13.00
<i>Istiophorus platyurus</i>							12.50								12.50	0.7124	12.5000	12.50	12.50
<i>Makaira indica</i>			80.00												80.00	4.5593	80.0000	80.00	80.00
<i>Xiphias gladius</i>		221.00	22.00	264.00	30.00		26.00		11.50	24.00	17.50	34.00			650.00	37.0444	30.9524	5.00	100.00
<i>Thunnus albacares</i>		2.00			73.00										75.00	4.2744	25.0000	2.00	38.00
<i>Promethichthys prometheus</i>		1.60													1.60	0.0912	1.6000	1.60	1.60
<i>Gempylus serpens</i>	2.70	4.20	1.10		1.10	0.80									9.90	0.5642	1.1750	0.80	1.50
<i>Lepidocybium flavobrunneum</i>	1.65	14.00													15.65	0.8919	3.9125	1.50	6.50
Total	6.85	362.00	285.60	309.10	107.40	79.10	52.50	38.60	0.00	186.50	167.80	121.50	37.70	1,754.65	100.0000	22.7877	0.80	100.00	

Table 4 Station-wise and species-wise average length (cm) obtained by pelagic longline.

Scientific name	Stations														No.	Average	min.	max	
	5	7	10	12	14	17	20	23	27	29	32	33	34	Total					
<i>Pteroplatytrygon violacea</i>	98.0	94.0	133.0	100.0				222.0							647.0	6	107.8	94.0	133.0
<i>Alopias pelagicus</i>		256.0													256.0	1	256.0	256.0	256.0
<i>Alopias superciliosus</i>		276.0	801.0						827.0	573.0	482.0				2,959.0	11	269.0	205.0	329.0
<i>Iago garricki</i>						80.0									80.0	1	80.0	80.0	80.0
<i>Carcharhinus falciformis</i>				252.0	85.0	571.0	178.0				93.6				1,179.6	10	118.0	85.0	178.0
<i>Galeocerdo cuveri</i>		0.0													0.0	1	0.0	0.0	0.0
<i>Alepisaurus ferox</i>								120.0				135.0			255.0	2	127.5	120.0	135.0
<i>Sphyreana baracuda</i>						88.0					88.5				176.5	2	88.3	88.0	88.5
<i>Caranx ignobilis</i>				184.0											184.0	2	92.0	92.0	92.0
<i>Coryphaena hippurus</i>				80.0		135.0									215.0	2	107.5	80.0	135.0
<i>Istiophorus platyurus</i>							194.0								194.0	1	194.0	194.0	194.0
<i>Makaira indica</i>			276.0												276.0	1	276.0	276.0	276.0
<i>Xiphias gladius</i>		1,012.0	212.0	954.0	215.0			210.0	162.0	160.0	297.0	354.0			3,576.0	21	170.3	129.0	295.0
<i>Thunnus albacares</i>		52.0			277.0										329.0	3	109.7	52.0	140.0
<i>Promethichthys prometheus</i>		76.0													76.0	1	76.0	76.0	76.0
<i>Gempylus serpens</i>	214.0	305.0	97.0		102.0	96.0									814.0	8	101.8	96.0	111.0
<i>Lepidocybium flavobrunneum</i>	60.9	239.0													299.9	4	75.0	60.0	92.0

Table 5 Catch and catch rate in each station.

Area	Station	No. of hook	Catch (No./kg)				Catch rate (No./kg/100 hooks)			
			Total	Tuna	Swordfish	Shark	Total	Tuna	Swordfish	Shark
	5	495	4/6.85	0	0	0	0.81/1.38	0	0	0
C	7	510	16/362.00	½	4/221	3/117	3.14/70.98	0.20/0.39	0.78/43.33	0.59/22.94
	10	510	7/285.60	0	2/102	3/173	1.37/56.00	0	0.39/20.00	0.59/33.92
	12	330	13/309.10	0	7/264	2/24	3.94/93.67	0	2.12/80.00	0.61/7.27
	Sub-total	1,845	40/963.50	½	13/587	8/314	2.17/52.22	0.05/0.11	0.70/31.82	0.43/17.02
	14	510	5/107.40	2/73	1/30	1/3.3	0.98/21.06	0.39/14.31	0.20/5.88	0.20/0.65
	17	510	9/79.10	0	0	6/61.4	1.76/15.51	0	0	1.18/12.04
A	20	519	2/52.50	0	0	1/40	0.39/10.16	0	0	0.19/7.71
	23	510	4/38.60	0	1/26	0	0.78/7.57	0	0.20/5.10	0
	27	520	0/0.00	0	0	0	0	0	0	0
	Sub-total	2,569	20/2,77.60	2/73	2/56	8/104.7	0.78/10.81	0.08/2.84	0.08/2.18	0.31/4.08
	29	520	4/186.50	0	1/11.5	3/175	0.77/35.87	0	0.19/2.21	0.58/33.65
B	32	520	5/167.80	0	2/24	2/139	0.96/32.27	0	0.38/4.62	0.38/26.73
	33	520	5/121.50	0	2/17.5	2/101	0.96/23.37	0	0.38/3.37	0.38/19.42
	34	303	3/37.70	0	2/34	1/3.7	0.99/12.44	0	0.66/11.22	0.33/1.22
	Sub-total	1,863	17/513.50	0	7/87	8/418.7	0.91/27.56	0	0.38/4.67	0.43/22.47
Total	6,277	77/1,754.65	3/75	22/730	24/837.4	1.23/27.95	0.05/1.19	0.35/11.63	0.38/13.34	

Table 6 Catch result and data of temperature and depth in each station.

St. no.	Date	Shooting				Hauling				Immersion time	Sea depth (m)	Thermocline m/°C	TD No.1 m/°C	TD No.8/10 m/°C	Number of hook	Total catch (number)	Total catch weight(kg)	Hook rate (%)	CPUE inds./ 1000 hooks				
		Start Time	Finish Time	Start lat.	Finish lat.	Start Time	Finish Time	Start lat.	Finish lat.														
5	10-11/Nov/07	Time	1820	Time	1936	Time	0720	Time	1010	13 hrs.	2,513	47-250 m	60m/27.5°C		495	4	6.9	0.81	8.08				
		lat.	11°05'.80 N	lat.	11°07'.10 N	lat.	11°11'.90 N	lat.	11°14'.00 N	50 min		28-10°C	200m/14°C										
		long.	095°41'.80E	long.	095°33'.10 E	long.	095°41'.90 E	long.	095°33'.70 E														
7	11-12/Nov/07	Time	1820	Time	1942	Time	0612	Time	0924	12 hrs.	2,841	40-215 m	60m/27.°C	130m/20°C	510	16	362.5	3.14	31.37				
		lat.	11°46'.00 N	lat.	11°51'.00 N	lat.	11°57'.20 N	lat.	11°55'.70 N	47 min		28.5-12.6°C											
		long.	094°58'.90E	long.	095°07'.10 E	long.	095°00'.80 E	long.	094°52'.30 E														
10	13-14/Nov/07	Time	1746	Time	1912	Time	0613	Time	1220	14 hrs.	1,128	50-180 m	50m/27.°C	200m/16°C	510	7	285.6	1.37	13.73				
		lat.	12°34'.30 N	lat.	12°42'.40 N	lat.	12°47'.20 N	lat.	12°43'.90 N	41 min		28.5-15.25°C											
		long.	096°26'.70E	long.	096°20'.00 E	long.	096°18'.80 E	long.	096°19'.50 E														
12	15-16/Nov/07	Time	1731	Time	1823	Time	0612	Time	0906	14 hrs.	200-1,418	70-250 m	60m/28.°C	150m/20°C	330	13	309.1	3.94	39.39				
		lat.	12°30'.30 N	lat.	12°30'.30 N	lat.	12°32'.70 N	lat.	12°33'.30 N	36 min		28.3-12.8°C											
		long.	094°59'.70E	long.	094°52'.90 E	long.	094°45'.70 E	long.	094°49'.40 E														
															1,845	40	964.1	2.17	21.68				
14	17-18/Nov/07	Time	1731	Time	1847	Time	0646	Time	1005	14 hrs.	2,353	50-220 m	40m/28.0°C	80m/26°C	510	5	107.4	0.98	9.80				
		lat.	16°55'.60 N	lat.	16°46'.70 N	lat.	16°53'.60 N	lat.	17°00'.10 N	35 min		28.5-13.3°C											
		long.	090°25'.90E	long.	090°21'.10 E	long.	090°13'.80 E	long.	090°16'.60 E														
17	19-20/Nov/07	Time	1732	Time	1847	Time	0645	Time	1015	14 hrs.	2,005	50-240 m	50m/27.5°C	80m/26°C	510	9	79.1	1.76	17.65				
		lat.	18°31'.10 N	lat.	18°23'.00 N	lat.	18°22'.10 N	lat.	18°23'.40 N	21 min		28.4-12.4°C											
		long.	090°26'.70E	long.	090°26'.40 E	long.	090°34'.70 E	long.	090°38'.60 E														
20	21-22/Nov/07	Time	1800	Time	1920	Time	0645	Time	1030	13 hrs.	2,249	22-280 m	40m/27.5°C	80m/26°C	519	2	52.5	0.39	3.85				
		lat.	17°31'.50 N	lat.	17°24'.80 N	lat.	17°25'.50 N	lat.	17°31'.80 N	57 min		28.3-11.7°C											
		long.	089°28'.20E	long.	089°24'.60 E	long.	089°25'.70 E	long.	089°31'.20 E														
23	23-24/Nov/07	Time	1731	Time	1910	Time	0645	Time	1027	14 hrs.	2,633	50-240 m	80m/23.0°C	300m/12°C	510	4	38.6	0.78	7.84				
		lat.	16°30'.70 N	lat.	16°22'.10 N	lat.	16°21'.10 N	lat.	16°27'.90 N	1 min		28.4-12.4°C											
		long.	088°24'.50E	long.	088°20'.30 E	long.	088°16'.10 E	long.	088°16'.90 E														
27	25-26/Nov/07	Time	1730	Time	1850	Time	0654	Time	0957	14 hrs.	2,082	47-220 m	85m/21.5°C	230m/13°C	520	0	0.0	0.00	0.00				
		lat.	18°30'.40 N	lat.	18°28'.90 N	lat.	18°31'.70 N	lat.	18°33'.70 N	9 min		27.8-12.5°C											
		long.	088°28'.30E	long.	088°18'.50 E	long.	088°22'.10 E	long.	088°32'.20 E														
															2,569	20	277.6	0.78	7.79				

Table 6 (Cont.)

St. no.	Date	Shooting				Hauling				Immersion time	Sea depth (m)	Thermocline m/°C	TD No.1 m/°C	TD No.8/10 m/°C	Number of hook	Total catch (number)	Total catch weight(kg)	Hook rate (%)	CPUE inds./ 1000 hooks
		Start	Finish	Start	Finish	Start	Finish	Start	Finish										
29	28-29/Nov/07	Time	1803	Time	1921	Time	0702	Time	1000	13 hrs.	3,221	30-200 m	N/R	200m/13°C	520	4	186.5	0.77	7.69
		lat.	13°30'.00 N	lat.	13°24'.80 N	lat.	13°24'.40 N	lat.	13°29'.00 N	49 min	28.9-13.8°C								
		long.	084°30'.1E	long.	084°22'.20 E	long.	084°29'.60 E	long.	084°38'.20 E										
32	1-2/Dec/07	Time	1827	Time	1954	Time	0718	Time	1023	13 hrs.	3,425	40-270 m	60m/24.5°C	190m/15°C	520	5	167.8	0.96	9.62
		lat.	12°32'.90 N	lat.	12°30'.40 N	lat.	12°34'.40 N	lat.	12°37'.50 N	49 min	28.2-12.4°C								
		long.	082°24'.90 E	long.	082°15'.70 E	long.	082°19'.90 E	long.	082°29'.50 E										
33	2-3/Dec/07	Time	1800	Time	1919	Time	0712	Time	1123	14 hrs.	3,528	N / R	70m/22.5°C	250m/12°C	520	5	121.5	0.96	9.62
		lat.	11°31'.80 N	lat.	11°32'.50 N	lat.	13°37'.70 N	lat.	11°35'.50 N	39 min									
		long.	082°26'.10 E	long.	082°17'.00 E	long.	082°21'.40 E	long.	082°19'.80 E										
34	3-4/Dec/07	Time	1828	Time	1916	Time	0710	Time	0855	13 hrs.	3,470	45-200 m	60m/23.0°C	240m/13°C	303	3	37.7	0.99	9.90
		lat.	11°29'.60 N	lat.	11°26'.250 N	lat.	11°22'.50 N	lat.	11°25'.50 N	22 min	28.2-14.2°C								
		long.	083°28'.10 E	long.	083°24'.40 E	long.	083°13'.70 E	long.	083°15'.20 E										
															1,863	17	513.5	0.91	9.13
															6,277	77	1,755	1.23	12.27

Discussion and Conclusion

From the catch result, considering the catch rate or hooking rate (individuals/100 hooks) in table 5 and 6, it was found that the highest hooking rate 3.94% (individuals/100 hooks) was at station 12 whilst the highest catch was obtained at station 7 with 16 individuals of fish (362.0 kg). Looking over station 7 and 12 which were in area C and showed the best catch result during the survey, catch composition of these two stations were mostly swordfish aggregated 11 individuals from a total of 29 individuals and contributed 72.28% to the total catch weight. An overall average hooking rate of 1.23% was obtained during the survey, out of which the average hooking rate of yellowfin tuna, swordfish and sharks were 0.05%, 0.35% and 0.38% respectively. The area wise aggregated hooking rate appeared that area C ranked on the top with 2.17% followed by area B 0.91% and area A 0.78%. One yellowfin tuna was caught from area C at latitude 11°N longitude 94°E and two from area A at latitude 16°N longitude 90°E.

Regarding to the catch composition, swordfish dominated the total catch with 650.0 kg by weight (37.044%) followed by bigeye thresher 641.0 kg (36.531%), silky shark 130.3 kg (7.426%) and yellowfin tuna 75.0 kg (4.274%). When consider to the catch in number, it was apparent that swordfish also came out on the top followed by bigeye thresher and silky shark. Takahashi *et al.*(2005) and Brill *et al.*(2005) found that swordfish swim in could water (3-6°C) during daytime at depth of up to 650 m and migrate vertically to stay near the warmer surface water (21-26°C) at night. By integrated consideration the catch results and the physical property of the sea on the temperature and depth, it was found that the temperature at hook depth for swordfish was between 20-28°C which covered the temperature range of their diurnal migration behavior.

Referring to Poison and Taquet (2000) CPUE (catch per unit effort = individuals/1000 hooks) from French's commercial swordfish longline fleet that operated over 4 million hooks in the southwest Indian Ocean each year, CPUE declined continuously from 16 in 1994 to 8 number of fish per 1,000 hooks in 1999. When comparing to the catch result in this survey area, especially at station 7 and 12, the CPUE of swordfish, which were 7.8 and 21.2 respectively, it indicated the high potential yield for swordfish longline fishing. For tunas, it was apparent that there were only 3 individuals (total weight 75 kg) of yellowfin tuna caught during the survey period, at station 7 and 14. Catch rate for tuna was only 0.05% which was similar to result of the last survey by SEAFDEC in the Andaman Sea, in November 2004. That survey deployed a total of 3,871 hooks in 7 fishing operations and two individuals tunas were caught weighing 45 kg and 64 kg. The catch rate was also reported 0.05% (Prajakjitt, 2004). During the year 1987-1990 tuna resource surveys using tuna longline in the eastern Indian Ocean were conducted, the results showed the total catches 12,169.6 kg were obtained from 69,949 hooks and the CPUE of total catch was 8.93 individuals/1,000 hooks. Thus tunas were dominant species which constituted 52.16% of the total catch. The CPUE of tunas was 4.64 of which 3.04 belonging to yellowfin tuna (Tantivala, 1991).

From thirteen fishing operations in this survey it may be too few operations to conclude that tunas are less abundant in this area. RV Chulabhorn of the Department of Fisheries, Thailand, has been surveyed tuna resource in the Andaman Sea within the the EEZ of Thailand in December 1999. The survey using tuna longline deployed totally 3,360 hooks in 7 stations and 27 individuals of yellowfin tuna were caught with total weight 775 kg. The average catch rate was 0.80% to the total (Uttayamakul, 2001). Thus this information confirms the distribution of yellowfin tuna in the Andaman Sea however it may be low season in December.

For further research survey, daytime fishing operation and increasing number of hook line per basket in order to cover wider range of fishing depth are suggested to ascertain about the abundance of tuna resource in the Bay of Bengal.

References

- Brill, R. W., K. A. Bigelow, M. K. Musyl, K. A. Fritsches and E. J. Warrant. 2005. Bigeye tuna (*Thunnus obesus*) behavior and physiology and their relevance to stock assessments and fishery biology. International Commission for the Conservation of Atlantic Tunas (ICCAT). Collective Volume of Scientific Papers ICCT. 57(2):142-161.
- FAO. 2003. Trends in oceanic captures and clustering of large marine ecosystem - 2 studies based on the FAO capture database. FAO fisheries technical paper 435. FAO. 71 pp.
- Dwivedi, S. W. 1993. Long-term variability in the food chains, biomass yield and oceanography of the Bay of Bengal ecosystem. **In:** Sherman, K., L. M. Alexander and B. D. Gold. (eds.). Large Marine Ecosystem: Stress, Mitigation and Sustainability. AAAS Press, Washington D. C., USA. p. 43-52.
- Poison, F. and M. Toquet. 2000. French Swordfish Longline Fishery in Southwest Indian Ocean. **In:** Preliminary result from the PRR Program. WPB 00-06 IOTC Proceedings no.3. IOTC. p. 169-201.
- Prajakjitt, P. 2004. Large pelagic fish survey in the Andaman Sea using pelagic longline. Preliminary results on the large pelagic fishery resources survey in the Andaman Sea. TD/RES/99 SEAFDEC. p. 102-112.
- Takahashi, M., H. Okamura, K. Yokawa and M. Okazaki. 2005. Swimming behavior and migration of a swordfish recorded by archival tag. CSIRO Publishing Marine Freshwater Research. Australia. 54(4):527-534.
- Tantivala, C. and T. Panniem. 1991. Tuna resources exploratory fishing survey by tuna longline in the Eastern Indian Ocean. Oceanic Fisheries Division, Department of Fisheries, Thailand. 32 pp.
- Uttayamakul, W. 2001. Longline fishing: An alternative for responsible fishing in Andaman Sea. Oceanic Fisheries Division, Department of Fisheries, Bangkok, Thailand. 44 pp.