CRUISE REPORT ON RESEARCH ACTIVITY

M.V.SEAFDEC 2 Cruise No. 28-1/2008

3 March – 4 April 2008

Fishery Resources Survey in the Andaman Sea of Thailand

TD/RP/117

This report is base on preliminary data

For readers who may need data in the report, please contact to:

Southeast Asian Fisheries Development Center
Training Department
PO. BOX 97 Phrasamutchedi
Samut Prakan, 10290
THAILAND
Tel: 662-4256100
Fax: 662-4256110
E-mail: td@seafdec.org

I. Cruise summary

Cruise no.: MV.SEAFDEC2 No.28-1/2008

Period: 3 March – 4 April 2008 (31 days)

Area: The Andaman Sea: Similan Island and the EEZ of Thai Waters

Port of call: Phuket, Thailand

Objective:

1) Whale sighting survey (during cruising between TD and Andaman Sea)

2) Deployment of Tuna FADs (included fishing ground survey)

3) Fishing Trials on Deep Sea Beam Trawl and IKMT (after completion the main activities)

Main activity:

1) ACDP Mooring (upload) and re-deployment
2) Oceanographic survey by ICTD
3) Water samplings
4) Plankton survey by horizontal and vertical samplings
5) Sediment samplings from Box-Core, (alternative gears: Gravity core)
6) Biosonic experiments during the 1st Leg (option)

II. List of personal on board

Ship personals

No.	Name	Position
1	Mr. Tossaporn Sukhapindha	Captain
2	Mr. Veerachai Chettasumon	Chief engineer
3	Mr. Suren Pruksarat	Second officer
4	Mr. Somphote Vudthipanyo	Third officer
5	Mr. Komson Sangphuek	Second engineer
6	Mr. Somyos Pronprasert	Fishing Assistant
7	Mr. Anuruk Loog-on	Boatswain
8	Mr. Pradit Kui-prasert	Steerman
9	Mr. Tana Rungjoy	Steerman
10	Mr. Plew Shodok	Oiler
11	Mr. Boontarin Wara-in	“
12	Mr. Watchara Panasri	“
13	Mr. Saichol Kornnoom	Cook
14	Mr. Somsak Phangkumhuk	Ship's boy

Researchers from SEAFDEC/TD[1], PMBC[2] and PSU[3]

No.	Name	Responsibility	Period of duty
1	Mr. Sayan Promjinda[1]	Chief scientist	3-29/03/2008
2	Ms. Natinee Sukramongkol[1]	Researcher	11-29/03/2008
3	Mr. Suthipong Thanasarnsakorn[1]	Researcher	9-10,26-29/03/2008
4	Mr. Apinan Taladon[1]	Researcher	9-10/29/03/2008
5	Mr. Thaweesak Timkrab[1]	Researcher	9-10/03/2008
6	Mr. Nakaret Yasook[1]	Researcher	26/03-4/04/2008
7	Mr. Suchart Kitsamut[1]	Assistant Researcher	26-29/03/2008
8	Mr. Chatchai Chaithanawisut[1]	Assistant Researcher	9-10/03/2008
1	Dr. Suree Satapoomin[2]	Researcher	11-18/03/2008
2	Ms. Vararin Vongpanich[2]	Researcher	11-18/03/2008
3	Ms. Jiraporn Charoenvattaporn[2]	Researcher	11-18/03/2008
4	Mr. Supasit Boonpienpol[2]	Researcher	11-18/03/2008
5	Mr. Santi Ratthakarn[2]	Researcher	11-18/03/2008
6	Miss Daroonwan Sakuna[2]	Researcher	11-18, 20-25/03/2008
7	Miss Aeumporn Sakna[2]	Researcher	11-18, 20-25/03/2008
8	Mr. Tripop Thingmong[2]	Researcher	11-18/03/2008
9	Mr.Isman Madsit[2]	Researcher	11-18/03/2008
10	Dr.Claudio Richter (Mr.) [2]	Researcher	11-18/03/2008
11	Miss Laura Fillinger[2]	Researcher	11-18/03/2008
12	Dr.Penjai Sompongchaiyakul[3]	Researcher	20-25/03/2008
13	Miss Saisiri Chaichana[3]	Researcher	20-25/03/2008
14	Mr.Danai Tipmanee[3]	Researcher	20-25/03/2008
15	Miss Pornpan JanJang[3]	Researcher	20-25/03/2008
16	Miss Ann Noowong[2]	Researcher	20-25/03/2008
17	Mr. Lui, Hon-Kit[3]	Researcher	20-25/03/2008
18	Mr. Yeh, Chun-Hung[3]	Researcher	20-25/03/2008

[1]Southeast Asian Fisheries Development Center, Training Department, Phrasamutchedi, Samutprakarn Thailand
[2]Phuket Marine Biological Center, Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment of Thailand
[3]Prince Songkla University, Faculty of Environmental Management, Hadyai, Songkla, Thailand

II. Research activities of M.V. SEAFDEC2

<u>Session I</u>: 9 to 11 March 2008
<u>Deployment of Tuna FADs:</u>

Date	Time	Activities	Remark
9 Mar 08	1615	Leave Phuket for Tuna FADs setting areas	
10 Mar 08	0700	Arrived area for setting Tuna FADs,	
	0725-0830	Setting Tuna FADs No. 1 , depth 956 m	L08°14′.90N λ095°48′.50E
	0940-1000	Setting Tuna FADs No. 2 , depth 948 m	L08°14′.90N λ095°48′.70E
	1135-1145	Setting Tuna FADs No. 3 , depth 955 m	L08°14′.90N λ095°48′.60E
	1200-1510	Searching for FADs, the position of FADs No. 2 L08°15′.20N λ095°48′.30E No. 3 L08°15′.20N λ095°48′.40E	
	1530	Leave to Phuket	

Session II: 11-17 March 2008
Ocean – Reef Coupling :

Date	Time	Activities	Remark
11 Mar 08	1800	Leave Phuket for Ko Miang	
12 Mar 08	0650-1026	Retrieved ADCP , depth 178 m	L08°35′.22N λ097°32′.02E
	1138-1208	Oceanographic survey at Station No.22 - CTD and water sampling, Depth 262 m	L08°34′.23N λ097°21′.53E
	 1235-1355 1358-1518 1632-1648 1658-1730	Oceanographic survey at Station No.23 - CTD and water sampling, Depth 318 m - Vandorn , depth 350 m - Neuston net , depth 318 m - Bongo net, depth 317 m	L08°34′.2N λ097°17′.6E – L08°34′.2N λ097°17′.4E
13 Mar 08	 0805-0847 0938-1010 1015-1035 1040-1110	Oceanographic survey at Station No.21 - CTD and water sampling, Depth 189 m - Zoo pump , depth 201 m - Neuston net , depth 210 m - Bongo net, depth 210 m	L08°34′.16 λ097°25.55E – L08°34′.70 λ097°25′.43E
	1143-1202	Oceanographic survey at Station No.20 - CTD and water sampling, Depth 183 m	L08°34′.33 λ097°27′.40E
	1225-1245 1249-1311 1318-1348 1353-1410 1425-1640	Oceanographic survey at Station No.19 - CTD and water sampling, Depth 198 m - Zoo pump , depth 199 m - Bongo net, depth 199 m - Neuston net , depth 199 m - Biosonic survey	L08°34′.20 λ097°29.50E – L08°35′.30 λ097°28′.90E L08°35′.70 λ 097°28.40E – L08°34′.58 λ 097°38′.26 E
14 Mar 08	 0737-0750 0820-0843 0853-0905 0914-0944	 Oceanographic survey at Station No.18 - CTD and water sampling, Depth 181 m - Vandorn, depth 186 m - Neuston net , depth 185 m - Bongo net, depth 185 m	L08°34′.20 λ 097°31.30E – L08°34′.61 λ 097°31′75 E
14 Mar 08	 1005-1015 1020-1033 1117-1150 1153-1213	Oceanographic survey at Station No.17 - CTD and water sampling, Depth 78.5 m - Vandorn , depth 77.8 m - Bongo net, depth 78.5 m - Neuston net, depth 76.5 m	L08°34′.16 λ 097°33.64E – L08°35′.15 λ 097°33′78 E
	1225-1235	Oceanographic survey at Station No.16 - CTD, Depth 77 m	L08°34′.20N λ 097°33′.80E
	1245-1258	Oceanographic survey at Station No.15 - CTD and water sampling, Depth 74 m	L08°34′.10 λ 097°34′.60 E
	1322-1328	Oceanographic survey at Station No.14 - CTD, Depth 75 m	L08°34′.10N λ 097°35′.50E
	 1338-1348 1350-1420	Oceanographic survey at Station No.13 - CTD and water sampling, Depth 75 m - Grab (Smith Macintyre), Depth 75 m	L08°34′.20 λ 097°35.50E – L08°34′.20 λ 097°35′50 E
	1430-1437	Oceanographic survey at Station No.12 - CTD, Depth 74 m	L08°34′.20 λ 097°35′80 E
	1448-1516	Oceanographic survey at Station No.13 - Grab (Smith Macintyre), Depth 75 m	L08°34.20N λ 097°36′.50E

Date	Time	Activities	Remark
15 Mar 08	 0704-0714 0715-0728 0730-0757 0801-0831 0837-0852	Oceanographic survey at Station No.01 - CTD and water sampling, Depth 80 m - Vandorn, depth 79.6 m - Grab, depth 80.7 m - Bongo net, depth 79.9 m - Neuston net , depth 79.5 m	L08°34′.16 λ 097°48.64 – L08°34′.43 λ 097°48′25 E
	 0909-0918 0921-0946	Oceanographic survey at Station No.02 - CTD and water sampling, Depth 80 m - Grab, depth 80.7 m	L08°34′.23 λ 097°46.54 – L08°34′.23 λ 097°46′54 E
	 1004-1012 1015-1041 1043-1108 1116-1146 1151-1210	Oceanographic survey at Station No.03 - CTD and water sampling, Depth 76 m - Vandorn, depth 77.5 m - Grab, depth 76.5 m - Bongo net, depth 75 m - Neuston net, depth 76 m	L08°34′.20N λ097°44′.30E – L08°34′.25N λ097°44′.47 E
	 1225-1238 1241-1306	Oceanographic survey at Station No.04 - CTD and water sampling, Depth 78 m - Grab, depth 78 m	L08°34′.20N λ097°44′.30E – L08°34′.10N λ097°42′.40 E
	 1322-1335 1338-1347 1352-1415 1422-1458 1500-1520	Oceanographic survey at Station No.05 - CTD and water sampling, Depth 71 m - Vandorn, depth 71 m - Grab, depth 69 m - Bongo net, depth 70 m - Neuston net, depth 89 m	L08°34′.20N λ097°40′.50E – L08°34′.60N λ097°40′.30 E
	1536-1544	Oceanographic survey at Station No.06 - CTD and water sampling, Depth 72 m	L08°34′.10N λ097°39′.50E
16 Mar 08	 0710-0718 0722-0730 0738-0757	Oceanographic survey at Station No.07 - CTD and water sampling, Depth 32.8 m - Vandorn, depth 34 m - Grab, depth 37 m	L08°34′.51N λ097°38′.29E – L08°34′.64N λ097°38′.31 E
	0814-0823	Oceanographic survey at Station No.08 - CTD, depth 72.2 m	L08°34′.13N λ097°37′.53E
	 0858-0844 0847-0852 0905-0925 0928-0958 1003-1020	Oceanographic survey at Station No.09 - CTD and water sampling, Depth 72.8 m - Vandorn, depth 72.6 m - Grab, depth 71.1 m - Bongo net, depth 72.4 m - Neuston net , depth 72 m	L08°34′.05N λ097°36′.61 E – L08°34′.20N λ097°36′.87 E
	1030-1035	Oceanographic survey at Station No.10 - CTD, Depth 72.2 m	L08°34′.20N λ097°36′.87E
	1051-1100	Oceanographic survey at Station No.11 - CTD, Water sampling ,Depth 73.8 m - Vandon, depth 72.4 m	L08°34′.19N λ097°36′.53E- L08°34′.15N λ097°36′.30E
	1815	Proceed to Station No. 19	
	 1920-1940 1944-2018	Oceanographic survey at Station No.19 - Neuston net, depth 199 m - Bongo net, depth 72.4 m	L08°34′.20N λ097°29′.50E- L08°34′.10N λ097°29′.40E
	 2041-2115 2119-2136	Oceanographic survey at Station No.17 - Bongo net, depth 90 m - Neuston net, depth 135 m	L08°34′.20N λ097°33.10E- L08°34′.10N λ097°32′.83E

Date	Time	Activities	Remark
17 Mar 08	0800-0808	Oceanographic survey at Station No.11 - Grab, depth 73 m	L08°34′.10N λ097°36′.40E
	0830-0840	Oceanographic survey at Station No.17 - Grab, depth 79.5	L08°34′.27N λ097°33′.52E
	0904-0924	Oceanographic survey at continental shelf - Grab, depth 92 – 125 m	L08°34′.24N λ097°32′.80E
	0957-1011	Oceanographic survey at Station No.18 - Copepod sampling, depth 188 m	L08°34′.11N λ097°31′.55E
	1025-1040	Oceanographic survey at Station No.19 - Copepod sampling, depth 198 m	L08°34′.17N λ097°29′.58E
	1100-1118	Oceanographic survey at Station No.21 - Copepod sampling, depth 188 m	L08°34′.15N λ097°25′.60E
	1139-1156	Oceanographic survey at Station No.22 - CTD, depth 260 m	L08°34′.25N λ097°21′.65E
	1222-1248	Oceanographic survey at Station No.23 - CTD, depth 317 m	L08°34′.20N λ097°17′.40E

<u>Session III</u>: 19 – 23 March 2008
: Investigation of Biogeochemical Processes

Date	Time	Activities	Remark
19 Mar 08	1745	Leave Phuket for Station No. 1	
20 Mar 08	0704-0819	Oceanographic survey at Station No.01 - CTD and water sampling, Depth 286 m	L07°09′.90N λ098°00′.20E
	0907-0923	Oceanographic survey at Station No.01A - CTD, Depth 376 m	L07°10′.03N λ097°50′.36E
	1002-1127	Oceanographic survey at Station No.02 - CTD and water sampling, Depth 428 m	L07°09′.90N λ097°40′.06E
	1225-1243	Oceanographic survey at Station No.02A - CTD, Depth 500 m	L07°09′.90N λ097°30′.10E
	1333-1420	Oceanographic survey at Station No.03 - CTD and water sampling, Depth 635 m - Vandorn	L07°09′.90N λ097°19′.80E
20 Mar 08	1510-1527	Oceanographic survey at Station No.03A - CTD, Depth 896 m	L07°09′.80N λ097°10′.10E
	1620-1710	Oceanographic survey at Station No.04 - CTD and water sampling, Depth 969 m - Vandorn, depth 970 m	L07°09′.90N λ096°59′.70E
	1803-1817	Oceanographic survey at Station No.04A - CTD, Depth 985 m	L07°09′.97N λ096°49′.75E
21 Mar 08	0631-0720	Oceanographic survey at Station No.05 - CTD and water sampling, Depth 1,020 m - Vandorn, Depth 1,020 m	L07°10′.00N λ096°39′.80E
	0827-0843	Oceanographic survey at Station No.05A - CTD, Depth 1,146 m	L07°09′.78N λ096°29′.70E
	0945-1030	Oceanographic survey at Station No.06 - CTD and water sampling, Depth 1,096 m - Vandorn , Depth 1,097 m	L07°09′.85N λ096°19′.25E
	1050 1750	Proceeded to FADs setting area Observed FADs	

	1800	Proceeded to Station No. 7	
Date	**Time**	**Activities**	**Remark**
22 Mar 08	0629-0719	Oceanographic survey at Station No.07 - CTD and water sampling, Depth 772 m - Vandorn, 752 m	L08°29′.70N λ095°55′.30E
	0832-0847	Oceanographic survey at Station No.07A - CTD, Depth 483 m	L08°30′.02N λ096°08′.77E
	0954-1016	Oceanographic survey at Station No.08 - CTD and water sampling, Depth 480 m	L08°29′.81N λ096°19′.41E
	1113-1129	Oceanographic survey at Station No.08A - CTD, Depth 496 m	L08°29′.93N λ096°29′.27E
	1225-1250	Oceanographic survey at Station No.09 - CTD and water sampling, Depth 496 m	L08°29′.90N λ096°39′.50E
	1348-1414	Oceanographic survey at Station No.09A - CTD, Depth 477 m	L08°29′.90N λ096°59′.60E
	1512-1536	Oceanographic survey at Station No.10 - CTD and water sampling, Depth 457 m	L08°29′.90N λ096°59′.60E
	1638-1653	Oceanographic survey at Station No.10 A - CTD, Depth 435 m	L08°30′.02N λ096°08′.77E
23 Mar 08	0630-0649	Oceanographic survey at Station No.11 - CTD and water sampling, Depth 258 m	L08°29′.90N λ097°19′.90E
	0750-0800	Oceanographic survey at Station No.11A - CTD, Depth 235 m	L08°30′.04N λ097°29′.98E
	0856-0916	Oceanographic survey at Station No.12 - CTD and water sampling, Depth 50 m - Grap, Depth 48.7 m	L08°29′.90N λ097°37′.94E
	1014-1030	Oceanographic survey at Station No.12A - CTD, Depth 79.1 m - Grap, Depth 79.1 m	L08°29′.98N λ097°50′.08E
	1130-1149	Oceanographic survey at Station No.13 - CTD and water sampling, Depth 64.1 m - Grap, Depth 64 m	L08°27′.60N λ098°01′.40E
	1235-1245	Oceanographic survey at Station No.14 - Grap, Vandorn Depth 58 m	L08°22′.40N λ098°03′.20E
	1330-1337	Oceanographic survey at Station No.15 - Grap, Vandorn Depth 56 m	L08°14′.80N λ098°05′.90E
23 Mar 08	1420-1428	Oceanographic survey at Station No.16 - Grap, Vandorn Depth 55 m	L08°17′.10N λ098°08′.70E
	1513-1520	Oceanographic survey at Station No.17 - Grap, Vandorn Depth 57 m	L07°59′.60N λ098°11′.30E
	1606-1612	Oceanographic survey at Station No.18 - Grap, Vandorn Depth 55 m	L07°51′.90N λ098°14′.10E
	1700-1704	Oceanographic survey at Station No.19 - Grap, Vandorn Depth 38 m	L07°44′15N λ098°16′.81E

<u>Session IV</u> : 27 to 29 March 2008
<u>:Fishing trial on Deep sea beam trawl and IKMTs:</u>

Date	Time	Activities	Remark
27 Mar 08	0900	Leave Phuket for beam trawl fishing ground	
	1000-1025	1st Beam Trawl Fishing Trial	L07°51′.89N λ098°10′.22E
	1200-1255	2nd Beam Trawl Fishing Trial	L07°50′.60N λ098°09′.70E
	1135-1145	3rd Beam Trawl Fishing Trial	L08°14′.90N λ095°48′.60E
	1200-1510	4th Beam Trawl Fishing Trial	
		1st IKMT Fishing Trial	L08°34.96 N λ095°50′.47 E
		2nd IKMT Fishing Trial	L 08°13.75 N λ095°53′.27 E
		3rd IKMT Fishing Trial	L 08°13.28 N λ095°55′.97 E
		4th IKMT Fishing Trial	L 08°11.22 N λ096°10′.50 E
28 Mar 08		5th IKMT Fishing Trial	L 07°55.90 N λ097°51′.90 E
		6th IKMT Fishing Trial	L 07°54.10 N λ097°53′.90 E
29 Mar 08			
		Leave fishing ground for Phuket	

III. Fishing Activities and trials

1. Fish Aggregating Device (FAD) for the development of pelagic fishing ground in the Andaman Sea (in Thai)

Objectives:

1) To study and collecting the fundamental data for fulfill the development of the tuna fishing ground (friendly to environment) in the Andaman Sea of Thailand

2) To study and developing the buoy and aggregating device for deep sea fishing ground

3) To extend the knowledge and techniques on FADs construction and installation to the technical staffs and concerns

4) To study and collecting the information on fish species included other marine life living in the fish aggregation device

1.1 Background:

The development of the pelagic fishing ground has been initiated in the Andaman Sea of Thailand as a consequence of the depletion of the tuna and other pelagic fishery resources in the Southeast Asian Region included the Indian Ocean and the Western Pacific Ocean due to the heavy exploitation and over-fishing in those areas. The study on the developing of the pelagic fishing ground using the fish aggregation devices (FAD) in the areas those have potential had been initiated by the Fishery Engineering Section/ Capture Fishery Technology Division, SEAFDEC/TD. Three sets of FADs were constructed and installed in the EEZ Waters of the Andaman Sea of Thailand under the concept on environmental friendly fisheries. The interaction between the pelagic fishes and the aggregating device including the fishing ground condition were study in order to fulfill the development of the compatible buoy and aggregating device for deep sea fishing ground. Moreover, the contribution on the fishing technique on handline and/or pole and line included the technology on fish handling would also distribute to the local fishermen in the next process.

1.2 Materials and methods

Iron FADs (capsule shape) construction

- Concrete buoy size 65 x 65 x 50 cm (211 liter) with a hoop made from the rubber tire (Figure 1a and 1b).
- Floating buoy (capsule shape as shown in figure 2) made from ¼ inch thickness metal with diameter 40 cm and total length 3 m. Two hoops attached to the lower part of buoy for connect to the main rope. Tiller was attached to the opposite side of the main.
- Polyurethane Styrofoam filled inside the floating buoy for maintain the buoyancy for long term submersion (Figure 3a and 3b).

Figure 1a

Figure 1b

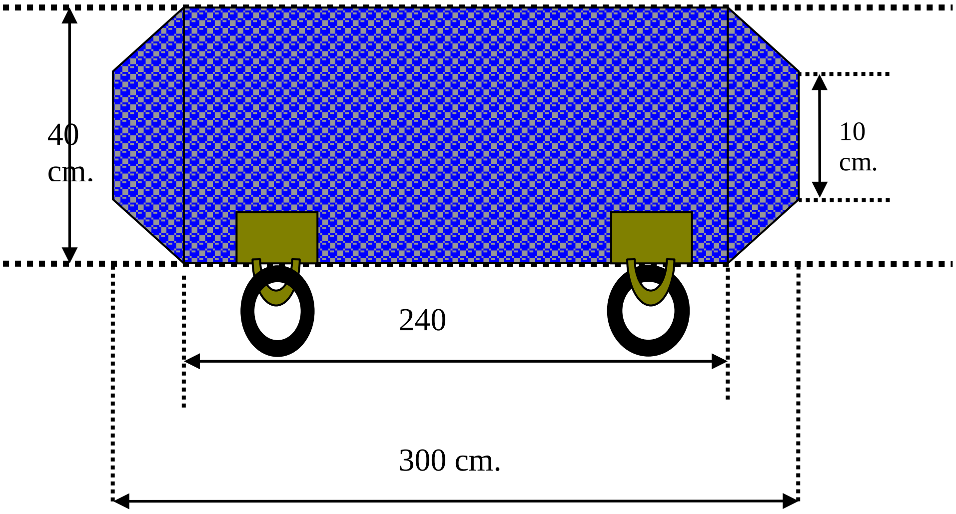

Figure 2. Floating buoy diagram.

Figure 3a

Figure 3b

Four strings FADs (jelly-fish shape) construction

- Round shape buoy diameter 15 cm for 80 pieces separated into 4 strings (20 buoys per line) interval 2 m between two buoys (Figure 4a and 4b).

- Galvanized iron size ½ inches in round shape diameter 1 m for six pieces. Interval between each galvanized ring is 8 m for maintain the cylindrical shape after submersion.

- Polyethylene rope size 14 mm for tide the buoy.

Figure 4a

Figure 4b

Tufts and lines

- Tuft line (diameter 24 mm) length 120 m attached to the buoy (Figure 5a and 5b).
- Bunch of tufts made from rope diameter 20 mm and length 2 m for 40 pieces.
- Distance between each tuft is 3 m to avoid entangle.

Figure 5a

Figure 5b

Main rope

- Polyethylene rope size 24 mm (maximum tension 5,000 Kg-f) total length 900 m
- 120 m length will set for the tuft rope and 780 m for main rope.

Installation

- Three sets of FADs were prepared for the present installation; there are 1 set of strings FADs (cylindrical shape) and 2 sets of Iron FADs (capsule shape) (Figure 6).
- The fishing ground for setting the FADs in the present study is between 900 and 950 m in the western of Andaman Sea of Thailand.
- The distance between each FADs is 150 m in triangle position.
- The FADs are submerging under the sea surface about 30-50 m depth.
- Combined the depth of the submerged FADs and the depth of the tuft lines, thus the actual depth of the FADs will be between 140 and 170 m.

Observed buoy

- Due to the FADs are submerged at about 50 m depth under the sea surface thus, a single buoy (purse seine buoy were used in the present study) was tied to the FADs and left floating at the sea surface in order to made a convenient observation on FADs.

.

Figure 6. The installation.

1.3 Results

The first set of FADs (strings type) was setting on 10th March 2007 (0730) hrs at latitude 08º 14’N and longitude 095º 48’ E. The second set of FADs (capsule shape) at 150 m far from the position of strings type FADs. The third FADs (capsule shape) were set at 150 m as far as the first and the second FADs (Figure 7).

The observation activities were conducted in the first time during 27-30 March 2008 aboard M/V SEAFDEC 2. The observation had been made at the position of FADS number two (latitude 08º 14’ N; longitude 095º 48’E) and found that the FAD was in the satisfied position and condition (Figure 7).

The checking on fish species was conduct using trawling lines and hand lines at the FADs setting area. The fish species caught during the observation are the dolphin fish, skipjack tuna, and juvenile yellowfin tuna (Figure 8). Moreover, there were fish schools at the FADs observed by eye.

1.4 Summary

- The first FAD setting (strings jelly-fish type) was unable to observed by hydro-acoustic equipment. However, considered of the water pressure resistant of the buoy.
- Among three setting FADs, the FAD number two (capsule shape) was in the best position.
- The position of those three FADs was easy to observe by the school of birds and fishes at the sea surface.
- Setting of the FADs in group may cause the trouble on setting the FADs as the first FAD those set against the current was unable to observed.
- Observation of FADs needed the skill on the using of the hydro-acoustic equipments and/or knowledge and training on using the hydro-acoustic equipments to the engineering staffs may useful to the results of the study.

Figure 7.

Figure 8.

2. Deep sea Beam trawl

2.1. Area of the sea trial

The fishing trial of beam trawl fishing operations, were conducted in western part of Phuket Island .Depth of the fishing ground sounded by echo sounder was between 80 m to 183 m. The position is viewed by the chart. (Figure 9.)

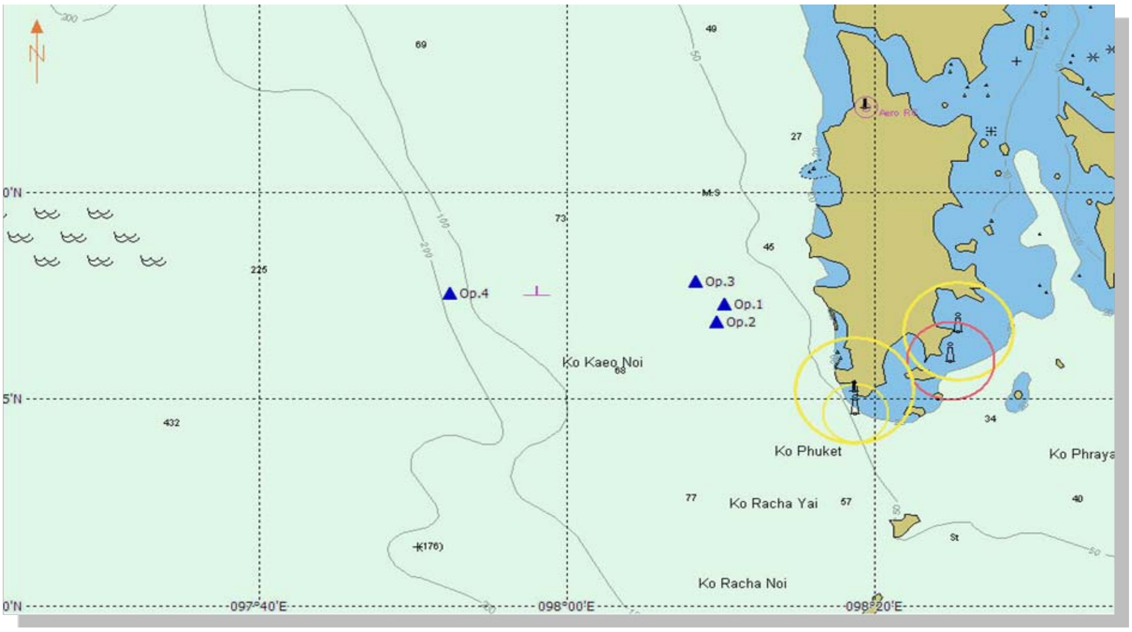

Figure 9. The stations of deep sea fishing trial operation.

2.2. Beam trawl net for MV SEAFDEC2

SEAFDEC design of deep sea beam trawl gear and its net were developed and modified from the fisherman in the Northern part and Northeast of the European water. The design is suitable for M.V.SEAFDEC 2 and other research vessels for deep sea fauna samplings in particularly deep sea shrimps and bottom fishes.

Figure 2 shows the details of net. Head rope and ground ropes are made from Z-twist Polypropylene rope, diameter 12 mm. Length of head rope is 2 m. and ground rope length is 4.40 m. The wing parts and square part are made from polyethylene net, twine size 380d/21 and mesh size is 38 mm. Belly part is composed from polyethylene net, twine size 380d/18 mesh size is 38 mm and twine size 380d/18 mesh size 25 mm respectively. The cod end piece is made from polyethylene net, twine size 380d/18 with mesh size 25 mm. There are not any lacing lines on the both side of net. Cover net at the cod end is made from polyethylene net, twine size 700d/30. 44 pieces of diameter 6 mm STT hoop sinkers are attached at the ground rope and tickler chains 9-10 kg in weight. Head line is attached with beam by tied cords. Chain matrices are rigged between the beam are 3.3 m in length and 9 mm of diameter.

Towing warp is duty heavy chains diameter 9 mm, 3 m length. Details of the deep sea beam trawl design, construction and chain arrangements and its operation are in Figure 3 and 5. The net of Beam trawl were designed and modified for two size of frame in 2 m. and 4 m. respectively (Figure 10-14).

2.3. Fishing operations

Four fishing operations had conducted during this fishing trial on 27 March 2008. Beam trawl fishing trials were conducted only in the daytime. Also shrimp species always bury themselves under the muddy in the daytime. So that daytime operations are the most appropriate period for fishing trial (Figure 15-16). Towing time of operations was 30 minute - 1 hour. The second and third operations the underwater camera were attached at the beam for observe the sea bottom and the ground rope characteristic, so the towing time in second and third operations were only 30 minute for safety the equipment (Figure 17-19).

The towing line was released 1.5 – 2.5 times of the sea depth. In the forth operation to released the warp ~2.5 time (450m) of sea depth (183m) , in order to prevent the beam trawl to the rock bottom or coral caused damage of towing line in the forth operation. Shooting speed was 2 – 3 knots in every operations, high towing speed make the beam and ground rope rise up at the surface of sea bottom. In case the sea bottom is rock and coral the towing speed should be reduce to 1.5-2 knots, and be able to reduce the damage of the trawl net.

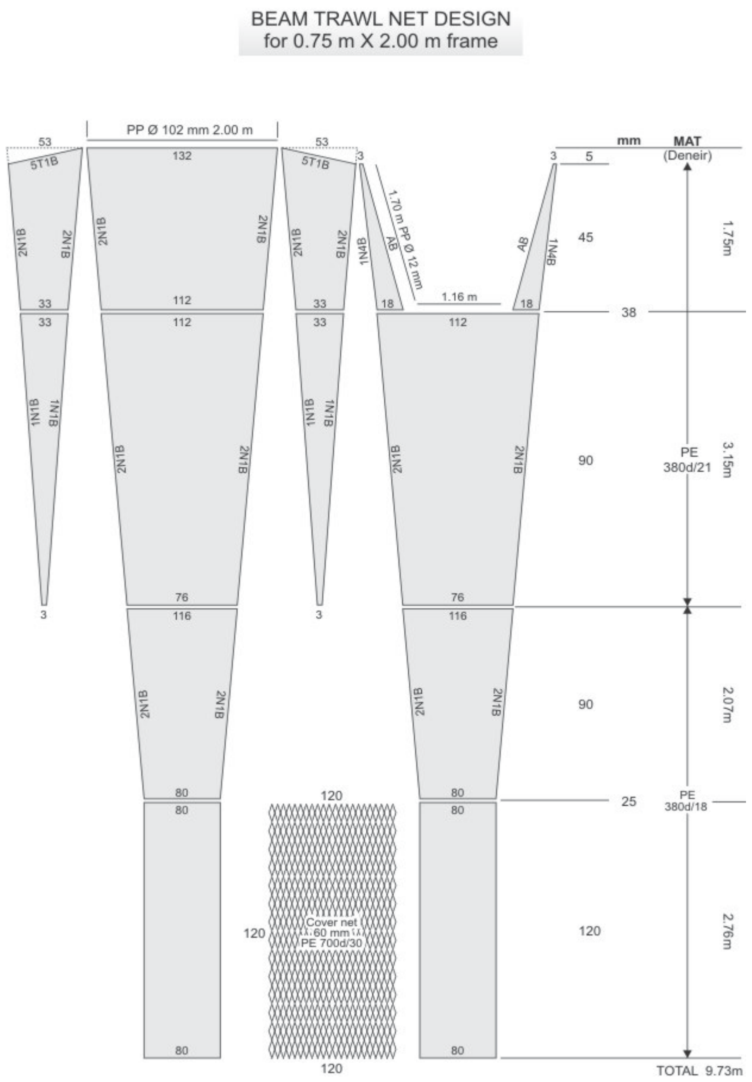

Figure 10. Monograph of fishing net for Deep sea beam trawl (2m beam).

Figure 11. Beam structure.

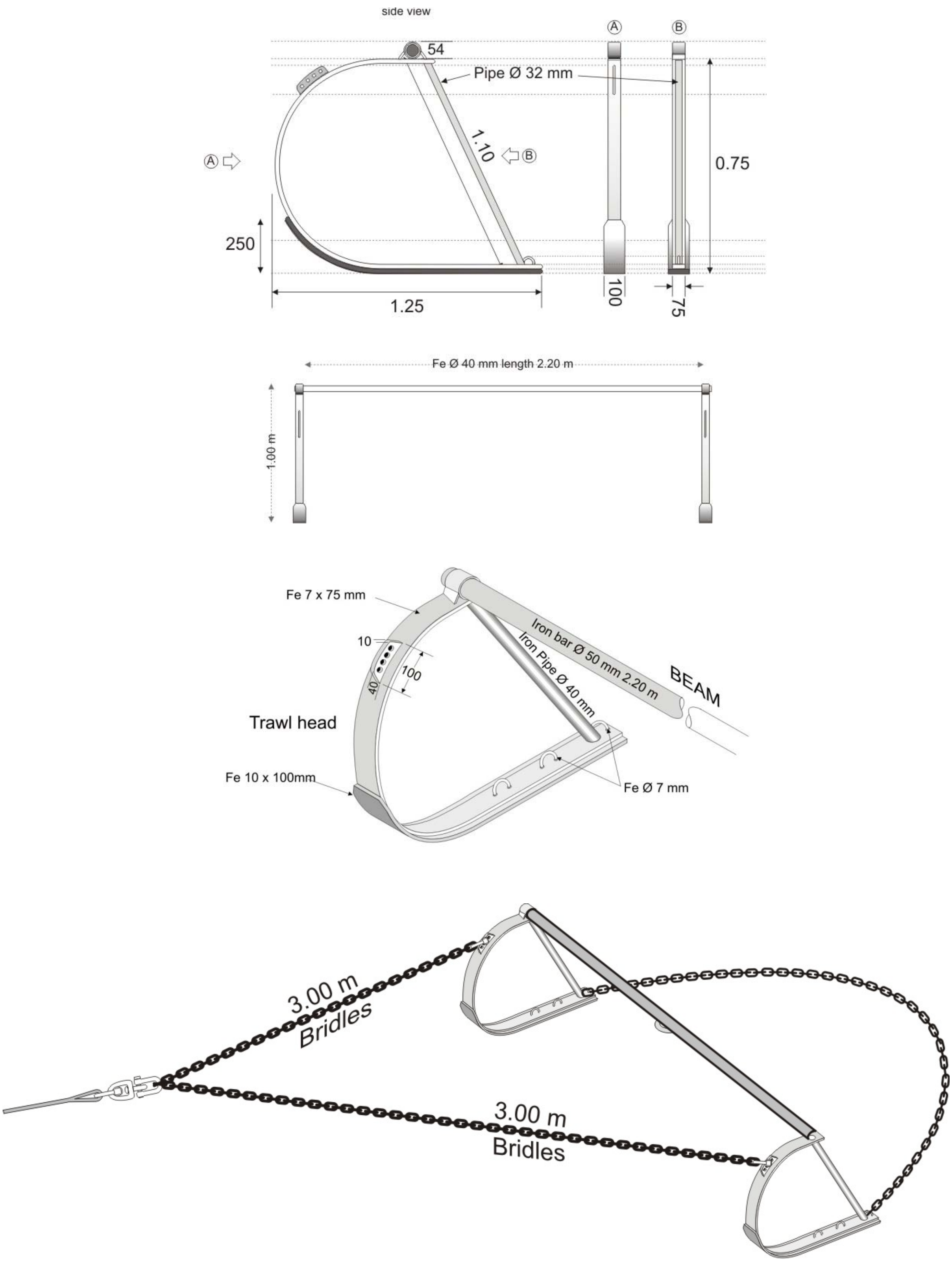

Figure 12. Design of the Deep sea beam trawl and towing chain arrangements**.**

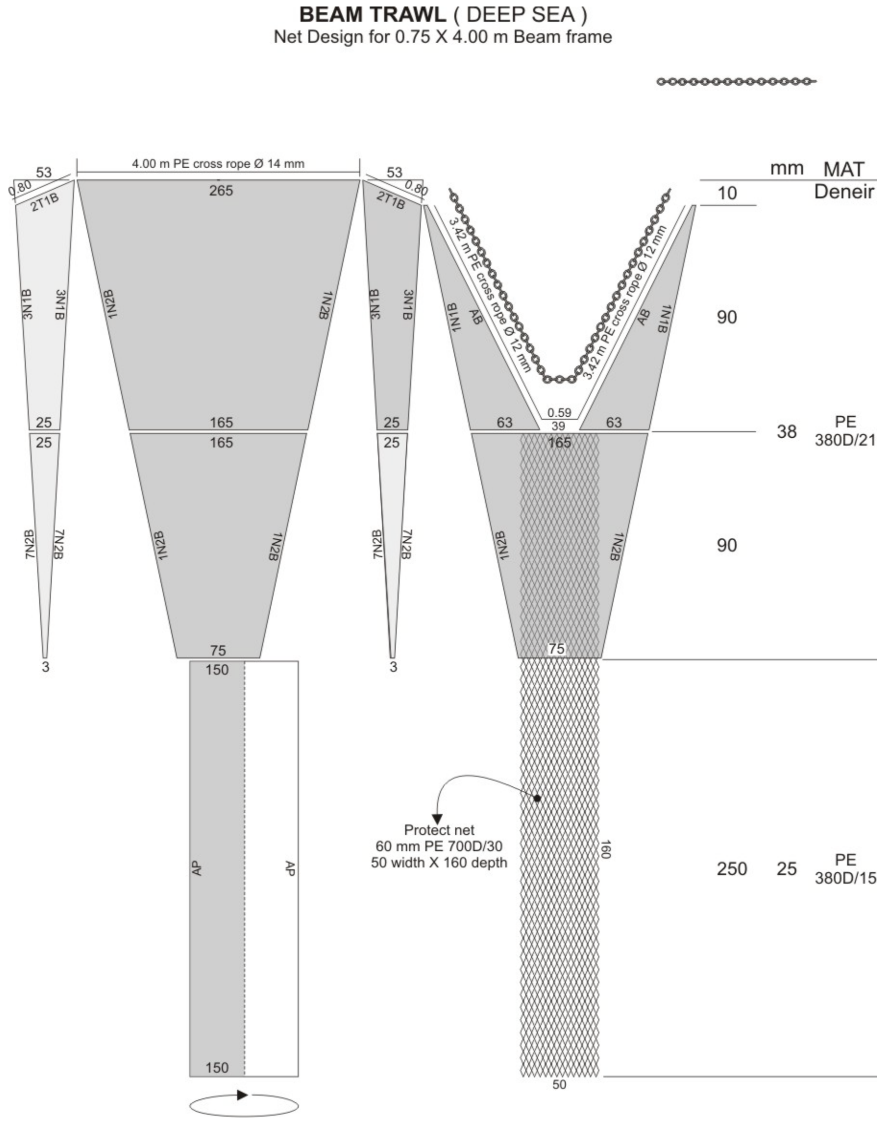

Figure 13. Monograph of fishing net for Deep sea beam trawl (4m beam).

Figure 14. Trawl net construction.

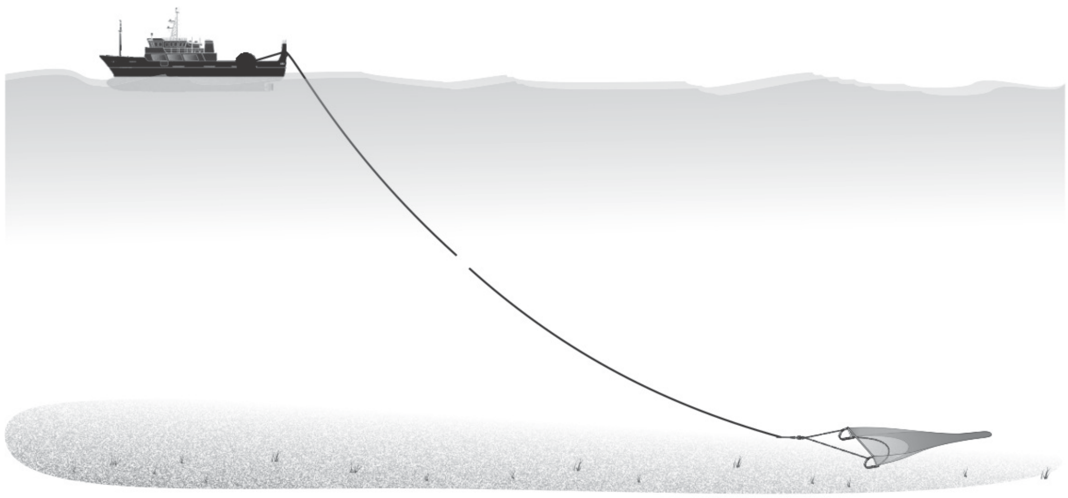

Figure 15. The overall diagram of deep sea beam trawl gear and its operation.

Figure 16. Fishing trials of Beam Trawl on M.V. SEAFDEC2.

Figure 17. Install underwater camera at beam.

Figure 18. The picture from underwater camera, the trickle chain at sea bottom

Figure 19. The picture from underwater camera, the ski at sea bottom

2.4. Results of resource survey

Four operations of deep sea fishing trial were conducted in 2 zone of sea depth. First operation to third operation were performed in shallow area (60 – 85m) and in the forth operation to operated in deep sea area (175 – 185m). The towing time in first operation was so long for adjust the ship speed and the towing line suitably.

Table 1. Fishing information of beam trawl fishing trials.

Op. No	**Ship speed (kt)**	**Towing time**	**Sea depth(m)**	**Warp length (m)**	**Total catch in weight(kg)**	**CPUE (Kg/hr)**
1	2.5	55 mn.	73	200	6.72	7.33
2	2.0	30 mn.	80	180	1.47	2.94
3	2.3	30 mn.	82	140	1.27	2.54
4	2.7-3.8	~ 40 mn.	183	450	Was loosed	-
	Total	2.35 hrs.			9.46	4.02

Total catch from 4 fishing operations, 2.35 hrs towing time, was 9.46 kilograms and CPUE was 4.02 kilograms per hour. The mostly of the samples were sea urchins and sea stars, some of fish sample from the family follow as Apogonidae, Lophiidae, Paralichthyidae, Synodontidae, Bothidae Nemipteridae: Synanceiidae, Batrachoididae, Pinguipedidae, Cephalopod, Shrimp and Crab (Figure 20).

Figure 20. Catches from the beam trawl fishing trials.

3. Isaacs-Kidd Mid-Water Trawl (IKMT)

3.1. Materials and methods

Isaacs-Kidd mid-water trawl (IKMT) is an oceanography tool used to collect bathypelagic biological specimens larger than those taken by standard plankton nets (Figure 21). The IKMT is a long, round net approximately 6.50 m long, with a series of hoops decreasing in size extending from the mouth of the net to the rear (cod) end, which measures an additional 2 m in length. The hoops maintain the shape of the net during towing. The mouth of the net is 1.75 m wide by 1.30 m high, and is attached to a V-shaped, rigid diving vane. The outer net of IKMT is PA multifilament ∅ 1 mm, mesh side 75 mm and the inner net is PA multifilament (knotless) ∅ 0.5 mm, mesh size 16 mm. Cod end part used the plankton net mesh size 1 mm and cover with PA multifilament ∅ 1 mm, mesh side 19 mm net. All bridles are SST wire ∅ 8 mm. The net spreader is iron ∅ 35 mm with approximately 1.50 m length.

The trial operations on Isaccs-Kidd Mid-Water Trawl (IKMT) were conducted for the living organisms collecting at the deep-scattering layer with towing speed between 1.8 – 3.3 knots and approximated towing time of 30 – 60 minute. To make sample collection easier, the IKMT is always used in conjunction with echo-sounders, which provide a target area for sampling. Partial details of IKMT operation are in table 2 and figure 22.

Table 2. Partial details of IKMT operation included the shooting position depth of capture and the scattering depth.

Operation No.	Latitude	Longitude	Depth of capture (m)	Remark
1	08°_34.96 N	095°_50.47 E	25 – 30	Scattering layer 25 – 30 m
2	08°_13.75 N	095°_53.27 E	25	Scattering layer 25 – 30 m
3	08°_13.28 N	095°_55.97 E	350	Scattering layer 290 – 400 m
4	08°_11.22 N	096°_10.50 E	120 – 140	19:15 Scattering layer 130 m 19:40 Scattering layer 70 – 100 m
5	07°_55.90 N	097°_51.90 E	25	06:30 Scattering layer 10 – 30 m 06:40 Scattering layer separate to 2 layers
6	07°_54.10 N	097°_53.90 E	30	Scattering layer 19 – 40 m

Before start the operation, the essential information of weather and oceanographic condition are collected, in addition the target area and scattering layer could be detected by the scientific echo-sounder (Furuno FQ80) before and during the operation (see figure 23).

Thus, all of the acoustic equipments onboard that have the same or nearest frequency of scientific echo-sounder must be turn off to prevent the noise problem.

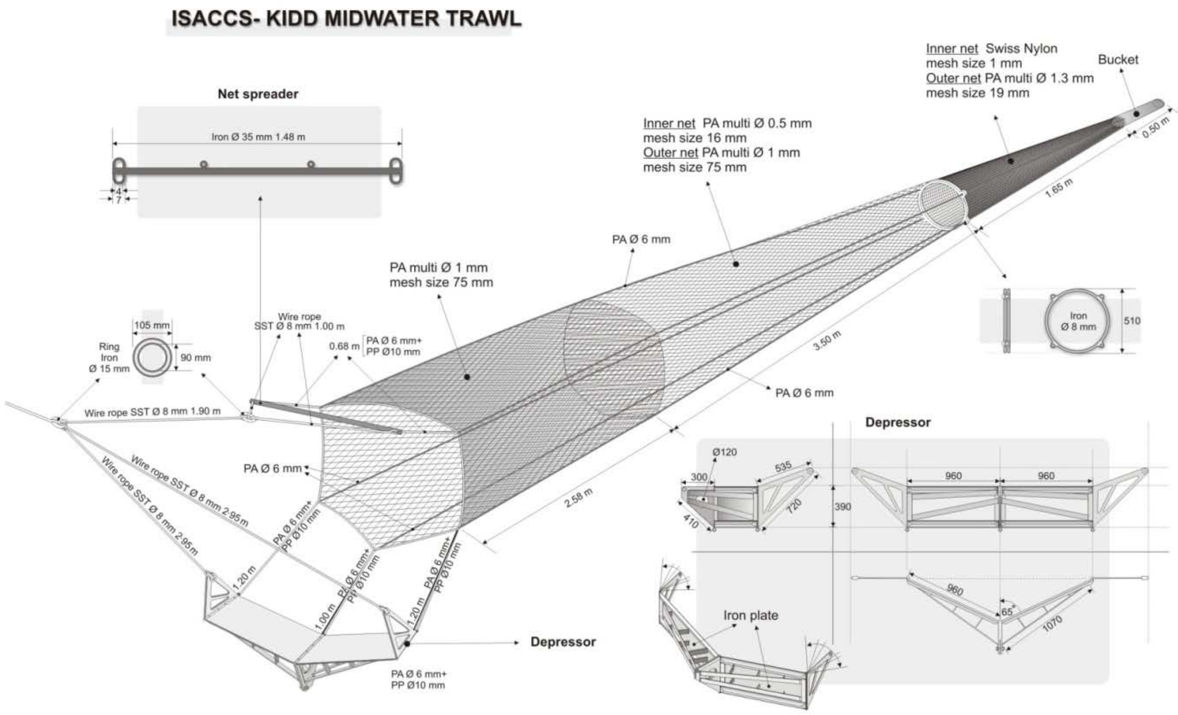

Figure 21. Diagram of Isaacs-Kidd mid-water trawl (IKMT)

3.2. Results

All sample that collected by IKMT were preserved with formalin 10% solution and some living organism in the scattering layer was shown in figure 24.

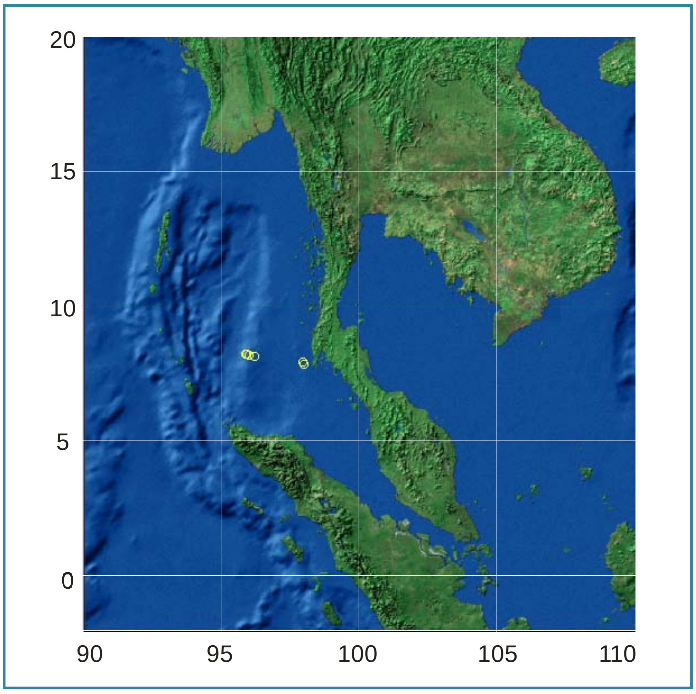

Figure 22. Operation position of Isaccs-Kidd Midwater trawl (IKMT)

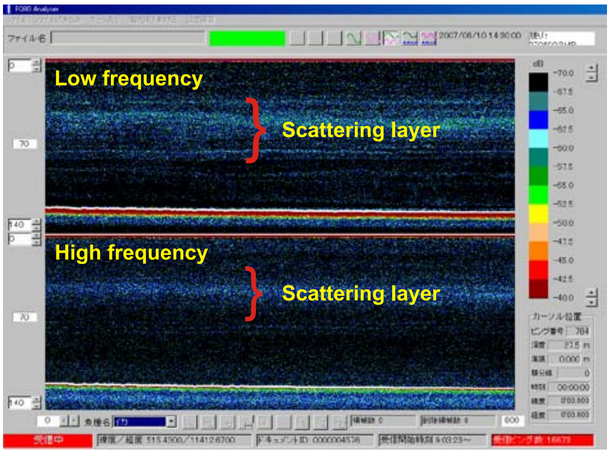

Figure 23. The target area and scattering layer were detected by the scientific echo-sounder (Furuno FQ80) before and during the operation

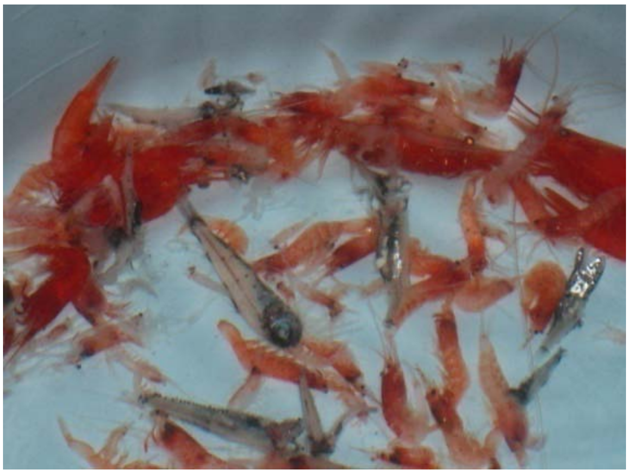

Figure 24. The sample active organism live in scattering layer

IV. Oceanographic survey

There are 32 and 25 oceanographic stations conducted in leg I and leg II, respectively (Figure 25-26). Partial details of the survey and environmental condition of each station had shown in table 3 and 4 respectively. The materials and methods of the oceanographic survey were conduced as follow;

Physical and chemical oceanography

The iCTD was deployed from the sea surface to approximately 5 meter above the sea bottom and the maximum depth of 400 meter at the station deeper than 500 meter. Physical and chemical characteristic of water including conductivity, temperature, depth, dissolved oxygen, pH, and PAR was measuring using SeaBird 911 CTD and Thermosalinograph with Fluorometer (TSG-Fluorometer). All iCTD data were average into every 1 meter interval. Data in each station were divided into down cast and up cast (Figure 27-28).

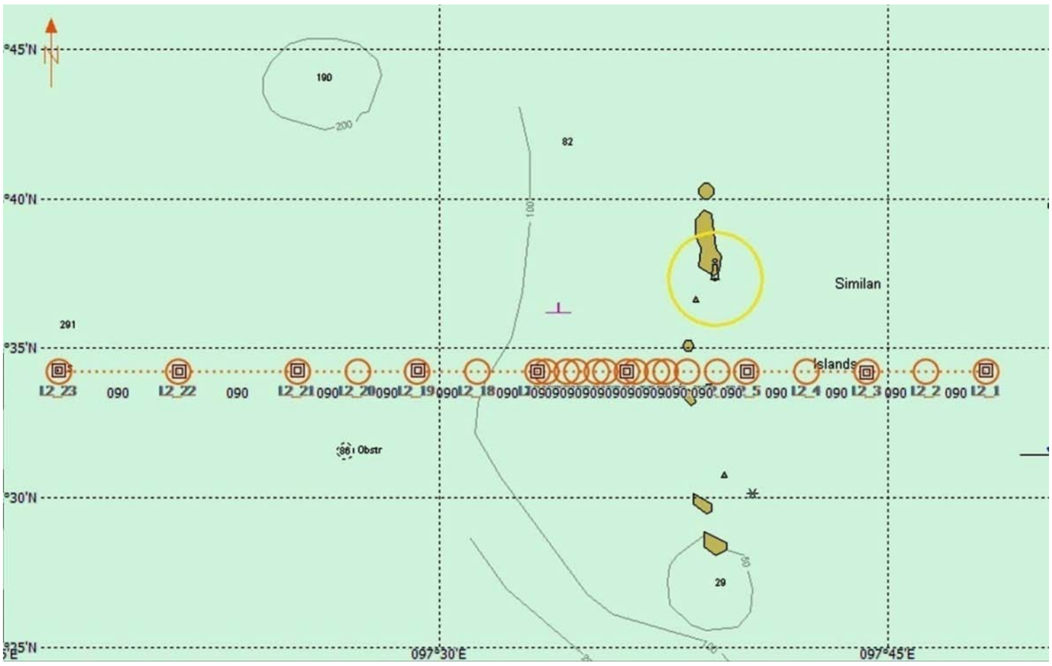

Figure 25. Map of the oceanographic stations at the Similan Island on leg I.

Figure 26. Map of the oceanographic stations in the Andaman Sea on leg II.

TSG – Fluorometer were operated along the cruise track of M.V.SEAFDEC 2 to measure the temperature and chlorophyll a. The system was designed to pump water from approximately 5 meter below the sea surface continuously. The data were average every 6 second. Operating summary had shown in table 3.

During retrieving the iCTD, Carousel Water Sample comprised with the Niskin Bottles which is a part of CTD system were used for collecting water samples from standard depth (Table 3). The water sample was analyzed aboard on the dissolved oxygen, alkalinity, pH, and chlorophyll a. Another process such as nutrient and heavy metal in sea water was further process after bring back to the laboratory of PMBC and PSU.

Biological oceanography

Marine biology was conducted on the zooplankton, phytoplankton and fish larval. The 45 cm diameter bongo frames were attached with the net mesh size of 1000 µm and 500 µm, respectively. A flow meter was attached at the aperture of net to measure the water volume passing through the net. Bongo net was oblique tow with ship speed approximately 1-2 knots. Angle of towing cable was maintained at 45 ^{o}. Towing depth was observed using Net SONDE (depth meter). Towing time for downward and upward was 15 minute each. The samples were preserved in 5% buffered formalin and seawater immediately. Partial details of Bongo net operation are in table 3.

Fish larvae and juvenile was also collected using the Neuston net. The 75 cm long, square shape frame with net mesh size 1000 µm. The operation was conducted after the bongo net operation with the towing time approximately 15 minute at the sea surface. The details of the Neuston net operation are in table 3.

Preliminary analysis of oceanographic parameters

The profiles of temperature, salinity, dissolved oxygen and pH from the oceanographic stations were plotted and shown in figure 27 for leg I and in figure 28 for leg II. Data from each station had shown the similar pattern except the pH data. The vertical plotted of the temperature, salinity, and dissolved oxygen along the survey track of leg I and II were shown in figure 29 and 30.

Along the continental shelf stations (BVL operation), the surface temperature was found lower than the offshore stations. Those of dissolved oxygen concentration at station no. 2, 3 and 6 was also lower than others.

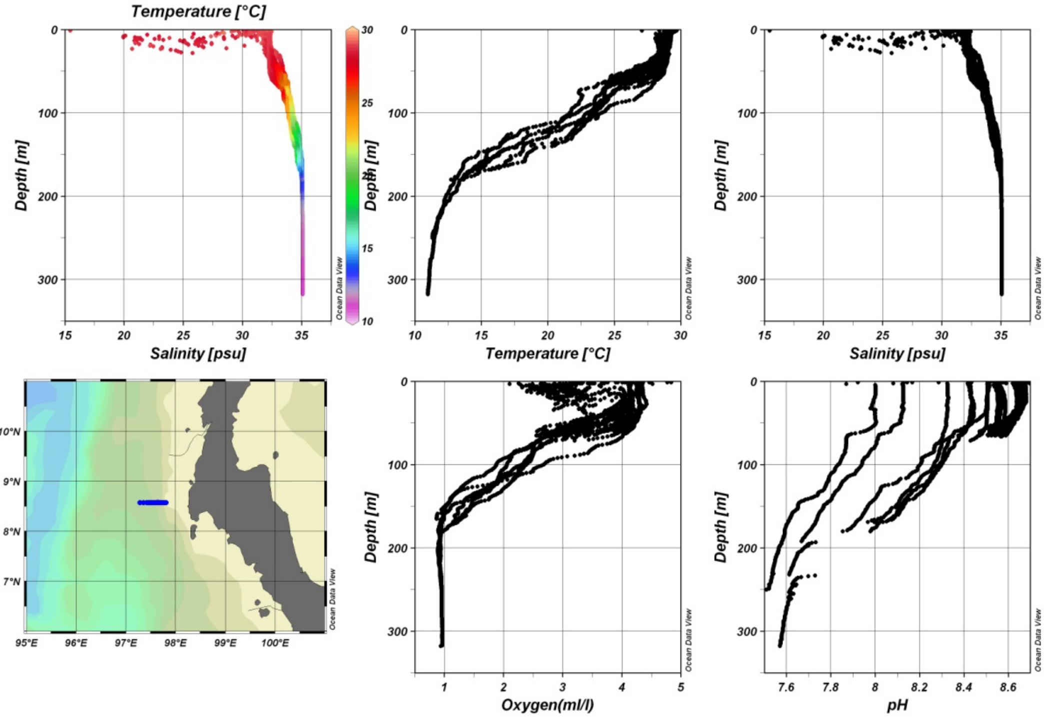

Figure 27. Profile of temperature (°C), salinity (psu), dissolved oxygen (ml/l), and pH of oceanographic stations in leg I.

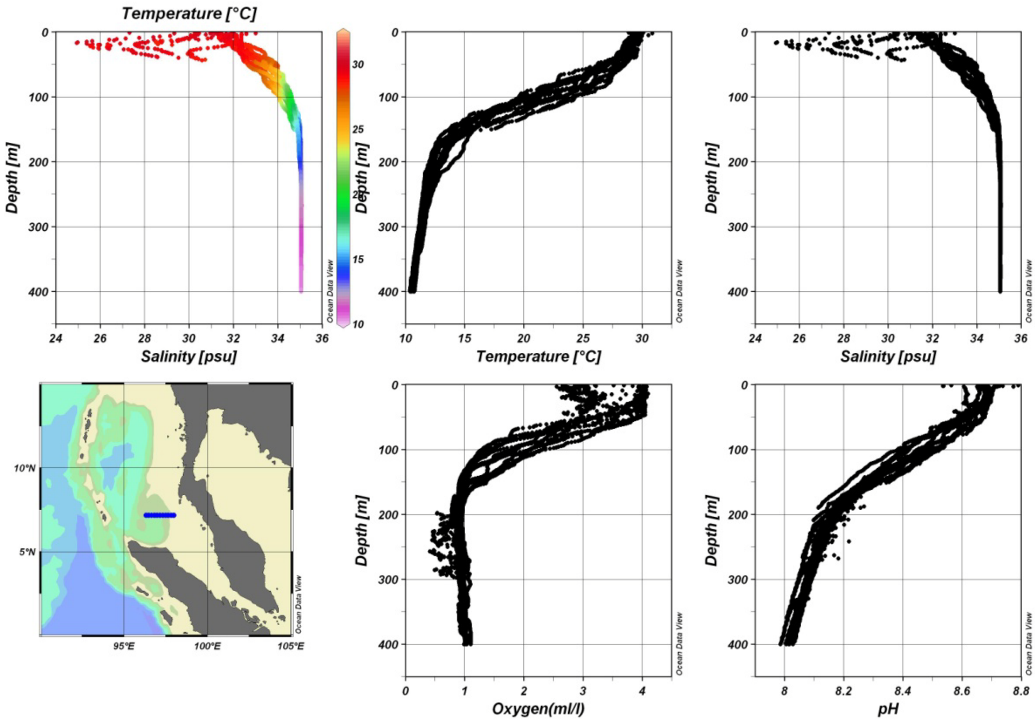

Figure 28. Profile of temperature (°C), salinity (psu), dissolved oxygen (ml/l), and pH of oceanographic stations in leg II.

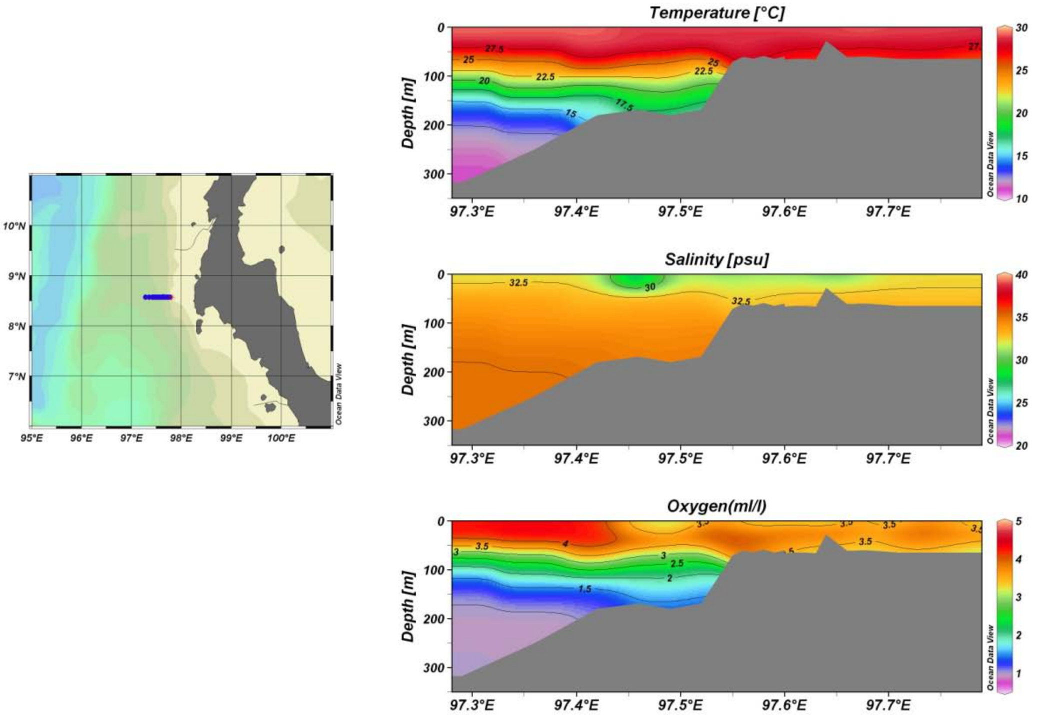

Figure 29. Vertical plot along the survey track at Similan Island of temperature (°c), salinity and dissolved oxygen (ml/l) at leg I.

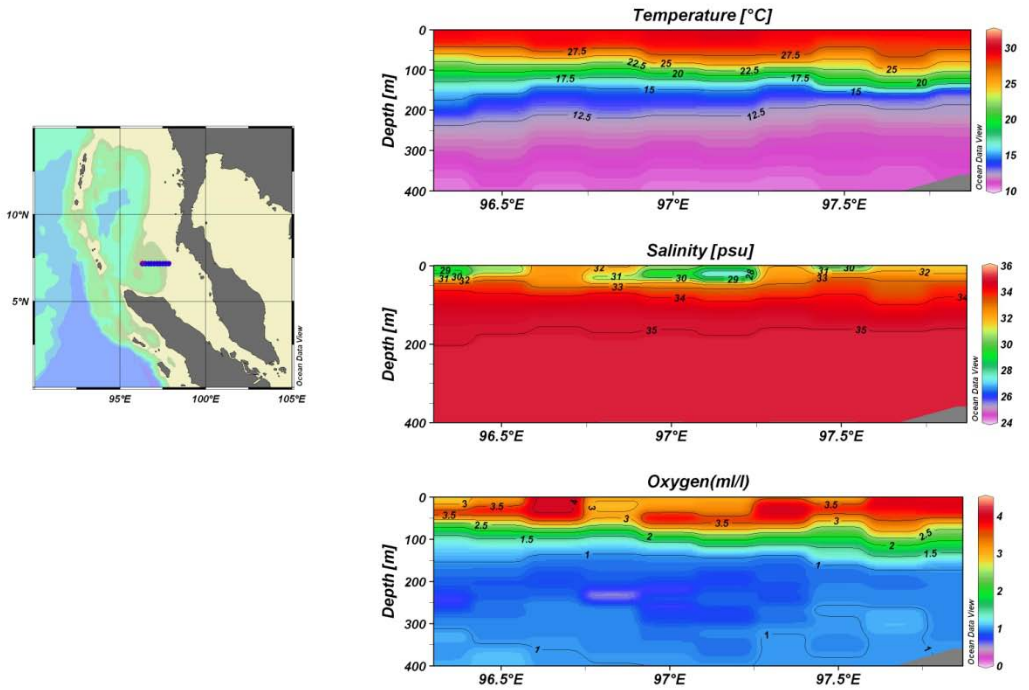

Figure 30. Vertical plot along the survey track at Similan Island of temperature (°c), salinity and dissolved oxygen (ml/l) at leg II.

Table 3. Partial detail of oceanographic stations

Station no	Date	Start	Finish	Position		Bottom Depth (m)	CTD	TSG	Bongo net					Neuston net			Niskin bottle (depth, m)	Smith McIntyre Grab (depth of collecting, m)
				Latitude	Longitude		file name	file name	Towing depth (m)	Start Time	Towing period (min)	Flowmeter rev. 1000µm	Flowmeter rev. 500µm	Start Time	Towing period (min)	Flowmeter rev.		
L2-22	12-Mar-08	11:44	12:08	08° 34.18´N	097°21.51´E	262	s2d28L2-22	2008-03-12 Similan-L2-22	-	-	-	-	-	-	-	-	230, 210, 180, 160, 120, 90, 60, 40, 30, 20, 10, 0	
L2-23	12-Mar-08	12:50	13:10	08° 34.24´N	097° 17.56´E	318	s2d28L2-23	2008-03-12 L2-22 to 23	-	-	-	-	-	-	-	-	280, 240, 200, 160, 120, 90, 70, 50, 30, 20, 10, 0	
L2-23A	12-Mar-08	13:22	13:40	08° 34.25´N	097° 17.26´E	319	s2d28L2-23A	-	-	-	-	-	-	-	-	-	-	
L2-23B	12-Mar-08	15:20	15:34	08° 34.57´N	097° 16.39´E	351	s2d28L2-23B	-	70	16:58	32	5964	6167	16:31	16	2753	280, 160, 30	
L2-21	13-Mar-08	08:29	04:46	08° 34.48´N	097° 25.49´E	199	s2d28L2-21	2008-03-13 L2-21 to 20	-	-	-	-	-	-	-	-	160, 130, 100, 80, 70, 60, 50, 40, 30, 20, 10, 4	-
L2-21A	13-Mar-08	09:12	09:23	08° 34.47´N	097° 25.54´E	198	s2d28L2-21A	-	125	10:40	30	4288	4896	10:17	15	4316	4, 30, 160	-
L2-20	13-Mar-08	11:43	11:59	08° 34.32´N	097° 27.42´E	183	s2d28L2-20	-	-	-	-	-	-	-	-	-	150, 120, 100, 80, 70, 60, 50, 40, 30, 20, 10, 4	-
L2-19	13-Mar-08	12:25	12:44	08° 34.30´N	097° 29.50´E	198	s2d28L2-19	-	110	13:18	30	5163	4990	13:53	16	3310	160, 130, 100, 85, 75, 75, 65, 55, 45, 30, 20, 10, 4	-
L2-18	14-Mar-08	07:37	07:52	08° 34.19´N	097° 31.38´E	181	s2d28L2-18	2008-03-14 Similan-L2-18	120	09:14	29	4872	4757	08:53	15	4847	150, 120, 100, 80, 70, 60, 50, 40, 30, 20, 10, 4	-
L2-17	14-Mar-08	10:05	10:14	08° 34.16´N	097° 33.65´E	78.5	s2d28L2-17	-	65	11:17	30	5355	5235	11:53	19	5265	65, 50, 40, 30, 20, 10, 4	-
L2-16	14-Mar-08	12:27	12:34	08° 34.22´N	097° 33.85´E	76.1	s2d28L2-16	-	-	-	-	-	-	-	-	-	-	-
L2-15	14-Mar-08	12:48	12:56	08° 34.21´N	097° 34.65´E	75	s2d28L2-15	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-14	14-Mar-08	13:21	13:27	08° 34.18´N	097° 34.95´E	74.5	s2d28L2-14	-	-	-	-	-	-	-	-	-	-	-
L2-13	14-Mar-08	13:40	13:47	08° 34.20´N	097° 35.50´E	75	s2d28L2-13	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-12	14-Mar-08	14:30	14:36	08° 34.21´N	097° 35.89´E	73.3	s2d28L2-12	-	-	-	-	-	-	-	-	-	-	-
L2-01	15-Mar-08	07:04	07:12	08° 34.17´N	097° 48.64´E	78.5	s2d28L2-01	2008-03-15 Similan-L2-01	50	08:01	30	5727	5575	08:37	15	3895	65, 50, 40, 30, 20, 10, 4	-
L2-02	15-Mar-08	09:08	09:16	08° 34.23´N	097° 46.54´E	79.6	s2d28L2-02	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-03	15-Mar-08	10:04	10:12	08° 34.19´N	097° 44.32´E	76.2	s2d28L2-03	-	50	11:16	30	6179	5528	11:51	16	4651	65, 50, 40, 30, 20, 10, 4	-
L2-04	15-Mar-08	12:28	12:38	08° 34.20´N	097° 42.55´E	76.9	s2d28L2-04	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-05	15-Mar-08	13:22	13:34	08° 34.19´N	097° 40.52´E	70.9	s2d28L2-05	-	45	14:21	30	6612	6217	15:01	16	4162	60, 50, 45, 35, 25, 10, 4	-
L2-06	15-Mar-08	15:35	15:43	08° 34.18´N	097° 39.55´E	72.8	s2d28L2-06	-	-	-	-	-	-	-	-	-	60, 50, 40, 30, 20, 10, 4	-
L2-07	16-Mar-08	07:09	07:17	08° 34.54´N	097° 38.31´E	32.8	s2d28L2-07	-	-	-	-	-	-	-	-	-	25, 20, 15, 10, 4	-
L2-08	16-Mar-08	08:12	08:21	08° 34.15´N	097° 37.55´E	71.6	s2d28L2-08	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-09	16-Mar-08	08:33	08:42	08° 34.20´N	097° 37.20´E	73.1	s2d28L2-09	-	50	09:28	30			10:04	16		65, 55, 45, 35, 20, 10, 4	-
L2-10	16-Mar-08	10:28	10:36	08° 34.20´N	097° 36.89´E	71.9	s2d28L2-10	-	-	-	-	-	-	-	-	-	-	-
L2-11	16-Mar-08	10:50	10:59	08° 34.19´N	097° 36.54´E	72.7	s2d28L2-11	-	-	-	-	-	-	-	-	-	65, 50, 40, 30, 20, 10, 4	-
L2-18	16-Mar-08	19:21	20:15	08° 34.10´N	097° 29.40´E	200	s2d28L2-22	-	110	19:44	31	-	-	19:21	15	-	-	-
L2-17	16-Mar-08	20:41	21:35	08° 34.20´N	097° 33.10´E	90-113	-	-	65	20:41	32	-	-	21:18	15	-	-	-
L2-11	17-Mar-08	08:02	08:08	08° 34.19´N	097° 36.48´E	73.3	-	2008-03-17 Similan-L2-11to23	-	-	-	-	-	-	-	-	-	73.3
L2-19 to 22	17-Mar-08	08:32	08:49	08° 34.27´N	097° 35.53´E	79.8	-	-	-	-	-	-	-	-	-	-	-	100, 92
L2-22A	17-Mar-08	11:38	11:56	08° 34.26´N	097° 21.65´E	260	-	-	-	-	-	-	-	-	-	-	-	-
L2-23C	17-Mar-08	12:23	12:42	08° 34.29´N	097° 17.46´E	317	s2d28L2-23C	-	-	-	-	-	-	-	-	-	-	-

Table 3. Partial detail of oceanographic stations (cont.)

Station no	Date	Start	Finish	Position		Bottom Depth (m)	CTD	TSG	Bongo net					Neuston net			Niskin bottle (depth, m)	Smith McIntyre Grab (depth of collecting, m)
									Towing depth (m)	Start Time	Towing period (min)	Flowmeter rev.		Start Time	Towing period (min)	owmeter revolutio		
				Latitude	Longitude		file name	file name				1000µm	500µm			1000µm		
01	20-Mar-08	07:03	07:24	07° 09.90´N	098° 00.20´E	287.5	s2d2801	2008-03-20 01 to 02	-	-	-	-	-	-	-	-	275, 250, 200, 125, 100, 75, 60, 40, 30, 20, 10, 4	-
01-1	20-Mar-08	08:03	08:17	07° 10.00´N	097° 59.50´E	288	s2d2801-1	-	-	-	-	-	-	-	-	-	270, 125, 60	-
01A	20-Mar-08	09:07	09:22	07° 10.04´N	097° 50.38´E	376	s2d2801A	-	-	-	-	-	-	-	-	-	-	-
02	20-Mar-08	10:17	10:38	07° 09.90´N	097° 40.07´E	427	s2d2802	2008-03-20 02 to 03	-	-	-	-	-	-	-	-	410, 300, 200, 150, 100, 60, 50, 40, 30, 20, 10, 4	-
02A	20-Mar-08	12:25	12:41	07° 09.90´N	097° 30.18´E	500	s2d2802A	-	-	-	-	-	-	-	-	-	-	-
03	20-Mar-08	13:34	13:56	07° 09.92´N	097° 19.82´E	635	s2d2803	2008-03-20 03 to 04	-	-	-	-	-	-	-	-	400, 300, 200, 125, 60, 35, 20, 10, 4	-
03A	20-Mar-08	15:11	15:25	07° 09.85´N	097° 10.19´E	896	s2d2803A	-	-	-	-	-	-	-	-	-	-	-
04	20-Mar-08	16:22	16:43	07° 09.81´N	096° 59.78´E	969	s2d2804	2008-03-20 04 to 05	-	-	-	-	-	-	-	-	400, 300, 200, 150, 75, 35, 20, 10, 4	-
04A	20-Mar-08	18:01	18:16	07° 09.56´N	096° 49.78´E	984	s2d2804A	-	-	-	-	-	-	-	-	-	-	-
05	21-Mar-08	06:31	06:52	07° 10.01´N	096° 39.75´E	1,020	s2d2805	2008-03-20 05 to 06	-	-	-	-	-	-	-	-	400, 300, 200, 150, 75, 50, 30, 10, 4	-
05A	21-Mar-08	08:27	08:42	07° 09.86´N	096° 29.69´E	1,148	s2d2805A	-	-	-	-	-	-	-	-	-	-	-
06	21-Mar-08	09:44	10:02	07° 09.85´N	096° 19.52´E	1,098	s2d2806	2008-03-20 06 to 07	-	-	-	-	-	-	-	-	400, 300, 200, 150, 75, 35, 20, 10, 4	-
07	22-Mar-08	06:28	06:50	08° 29.75´N	095° 55.29´E	768	s2d2807	2008-03-20 07 to 08	-	-	-	-	-	-	-	-	400, 300, 200, 100, 75, 60, 40, 20, 4	-
07A	22-Mar-08	08:31	08:46	08° 30.03´N	096° 08.79´E	483	s2d2807A	-	-	-	-	-	-	-	-	-	-	-
08	22-Mar-08	09:53	10:15	08° 29.82´N	096° 19.42´E	480	s2d2808	2008-03-20 08 to 09	-	-	-	-	-	-	-	-	450, 300, 200, 150, 100, 60, 30, 20, 10, 4	-
08A	22-Mar-08	11:12	11:28	08° 29.93´N	096° 29.78´E	495	s2d2808A	-	-	-	-	-	-	-	-	-	-	-
09	22-Mar-08	12:25	12:49	08° 29.98´N	096° 39.55´E	496	s2d2809	2008-03-20 09 to 10	-	-	-	-	-	-	-	-	450, 300, 200, 125, 100, 75, 45, 25, 10, 4	-
09A	22-Mar-08	13:49	14:12	08° 29.97´N	096° 49.54´E	477	s2d2809A	-	-	-	-	-	-	-	-	-	-	-
10	22-Mar-08	15:14	15:36	08° 29.97´N	096° 59.65´E	457	s2d2810	2008-03-20 10 to 11	-	-	-	-	-	-	-	-	440, 300, 200, 160, 100, 75, 50, 30, 10, 4	-
10A	22-Mar-08	16:37	16:52	08° 29.99´N	097° 09.78´E	435	s2d2810A	-	-	-	-	-	-	-	-	-	-	-
11	23-Mar-08	06:29	06:49	08° 30.00´N	097° 19.84´E	257	s2d2811	2008-03-20 11 to 12	-	-	-	-	-	-	-	-	240, 175, 150, 120, 80, 50, 30, 10, 4	-
11A	23-Mar-08	07:48	08:00	08° 30.03´N	097° 29.99´E	235	s2d2811A	-	-	-	-	-	-	-	-	-	-	-
12	23-Mar-08	08:55	09:06	08° 29.86´N	097° 39.91´E	49.3	s2d2812	2008-03-20 12 to 13	-	-	-	-	-	-	-	-	40, 37, 30, 23, 20, 10, 4	-
12A	23-Mar-08	10:22	10:30	08° 29.97´N	097° 50.10´E	79.1	s2d2812A	-	-	-	-	-	-	-	-	-	-	-
13	23-Mar-08	11:30	11:39	08° 30.01´N	098° 00.37´E	63.9	s2d2813	2008-03-20 13 to 14	-	-	-	-	-	-	-	-	55, 40, 20, 10, 4	-
14	23-Mar-08	12:37	12:45	08° 02.47´N	098° 02.95´E	58.7	-	2008-03-20 14 to 15	-	-	-	-	-	-	-	-	4 M (VANDORN)	58.7
15	23-Mar-08	13:29	13:37	08° 14.87´N	098° 05.94´E	56	-	2008-03-20 15 to 16	-	-	-	-	-	-	-	-	5 M (VANDORN)	56
16	23-Mar-08	14:22	14:28	08° 07.18´N	098° 08.68´E	55	-	2008-03-20 16 to 17	-	-	-	-	-	-	-	-	6 M (VANDORN)	55
17	23-Mar-08	15:13	15:18	07° 59.71´N	098° 11.33´E	56.6	-	2008-03-20 17 to 18	-	-	-	-	-	-	-	-	7 M (VANDORN)	56.6
18	23-Mar-08	16:08	16:14	07° 51.91´N	098° 14.13´E	54.8	-	2008-03-20 18 to 19	-	-	-	-	-	-	-	-	8 M (VANDORN)	54.8
19	23-Mar-08	16:59	17:04	07° 44.15´N	098° 16.82´E	38.4	-	2008-03-23 19 to HKT	-	-	-	-	-	-	-	-	9 M (VANDORN)	38.4

Table 4. Environmental condition during oceanographic survey

Station No	Position		Wind		Air					Sea Surface	Current					
											Surface		25 m		50 m	
	Latitude	Longitude	Spd. (Knt)	Dir.	Temp (°C)	Press	Humidity	Weather	Sea stage	Temp (°C)	Spd.(Knt)	Dir	Spd.(Knt)	Dir	Spd.(Knt)	Dir
L2-22	08° 34.18´N	097°21.51´E	2.0	090	30.8	1014	72	bc	calm	29.6	0.6	082	0.8	089	0.4	092
L2-23	08° 34.24´N	097° 17.56´E	2.0	088	31.0	1013.5	67	bc	calm	29.7	0.1	021	0.2	142	0.2	237
L2-23A	08° 34.25´N	097° 17.26´E	-	-	-	-	-	c	calm	-	-	-	-	-	-	-
L2-23B	08° 34.57´N	097° 16.39´E	-	-	-	-	-	bc	calm	-	-	-	-	-	-	-
L2-21	08° 34.48´N	097° 25.49´E	4.0	070	29.0	1014	78	bc	calm	29.3	0.7	067	0.6	065	1.0	038
L2-21A	08° 34.47´N	097° 25.54´E	-	-	-	-	-	bc	calm	-	-	-	-	-	-	-
L2-20	08° 34.32´N	097° 27.42´E	3.0	110	29.8	1013.5	72	bc	calm	29.5	0.8	331	0.6	341	0.8	339
L2-19	08° 34.30´N	097° 29.50´E	8.0	110	28.9	1012.5	72	c	slight	29.5	1.2	001	1.3	008	1.0	009
L2-18	08° 34.19´N	097° 31.38´E	10	100	29.4	1013.5	85	bc	calm	28.8	1.8	022	1.6	021	1.3	029
L2-17	08° 34.16´N	097° 33.65´E	4.0	090	29.5	1015.5	72	bc	calm	28.8	0.7	031	0.8	042	0.7	052
L2-16	08° 34.22´N	097° 33.85´E	5.0	070	30.4	1015	72	bc	calm	28.9	1.0	052	1.1	050	0.8	050
L2-15	08° 34.21´N	097° 34.65´E	4.0	070	29.1	1013	65	bc	calm	29.1	0.9	045	0.9	067	0.7	062
L2-14	08° 34.18´N	097° 34.95´E	4.0	060	29.4	1012	72	bc	calm	29.2	0.6	064	0.6	068	0.5	031
L2-13	08° 34.20´N	097° 35.50´E	2.0	020	30.4	1012	73	bc	calm	29.3	0.4	071	0.3	063	0.3	041
L2-12	08° 34.21´N	097° 35.89´E	2.0	030	33.4	1011	63	bc	calm	28.9	1.3	-	-	-	-	-
L2-01	08° 34.17´N	097° 48.64´E	5.0	120	28.1	1013	77	bc	calm	28.9	0.2	051	0.3	187	0.1	114
L2-02	08° 34.23´N	097° 46.54´E	2.0	060	29.8	1014.5	66	bc	calm	29.1	0.3	002	0.3	095	0.2	283
L2-03	08° 34.19´N	097° 44.32´E	0.5	060	29.54	1014	72	bc	calm	29.2	0.3	013	0.2	295	0.1	268
L2-04	08° 34.20´N	097° 42.55´E	1.0	090	30.4	1012.5	66	bc	calm	29.3	0.5	194	0.3	150	0.3	196
L2-05	08° 34.19´N	097° 40.52´E	2.0	180	31.1	1010	67	bc	calm	29.6	0.5	197	0.6	151	0.2	150
L2-06	08° 34.18´N	097° 39.55´E	2.0	140	31.3	1010	66	bc	calm	29.6	0.2	255	0.4	187	0.0	147
L2-07	08° 34.54´N	097° 38.31´E	6.0	120	28.9	1011.5	76	bc	calm	28.0	0.1	236	0.3	112	0.1	311
L2-08	08° 34.15´N	097° 37.55´E	5.0	060	29.5	1013	60	bc	calm	29.1	0.1	117	0.3	172	0.1	008
L2-09	08° 34.20´N	097° 37.20´E	5.0	060	29.5	1013	60	bc	calm	29.1	0.1	117	0.3	172	0.1	008
L2-10	08° 34.20´N	097° 36.89´E	4.0	030	30.3	1013.5	72	bc	calm	29.1	0.4	211	0.1	165	0.4	151
L2-11	08° 34.19´N	097° 36.54´E	1.0	090	29.6	1013.5	72	bc	calm	29.2	0.8	265	0.4	285	0.3	148
L2-18	08° 34.10´N	097° 29.40´E	3.0	000	30.0	1015.0	78	bc	calm	29.3	0.2	320	0.2	102	0.3	204
L2-17	08° 34.20´N	097° 33.10´E	4.0	010	30.5	1011	78	bc	calm	29.3	0.3	204	0.3	276	0.1	172
L2-11	08° 34.19´N	097° 36.48´E	2.0	090	29.1	1011.5	66	bc	calm	29.2	0.2	085	0.2	249	0.1	177
L2-19 to 22	08° 34.27´N	097° 35.53´E	3.0	090	29.9	1012	67	bc	calm	29.1	0.1	064	0.5	325	0.4	275
L2-22A	08° 34.26´N	097° 21.65´E	3.0	050	29.7	1012	78	bc	calm	29.2	1.4	042	1.2	040	1.4	049
L2-23C	08° 34.29´N	097° 17.46´E	4.0	050	29.2	1011	72	c	slight	29.4	4.5	034	0.4	042	0.5	067

Table 4. Environmental condition during oceanographic survey (cont.)

Station	Position		Wind		Air					Sea Surface	Current					
											Surface		25 m		50 m	
No	Latitude	Longitude	Spd. (Knt)	Dir.	Temp (°C)	Press	Humidity	Weather	Sea stage	Temp (°C)	Spd.(Knt)	Dir	Spd.(Knt)	Dir	Spd.(Knt)	Dir
01	07° 09.90´N	098° 00.20´E	2.0	140	29.1	1010	85	c	calm	29.2	0.9	286	0.8	279	-	-
01-1	07° 10.00´N	097° 59.50´E	3.0	130	30.9	1011	78	c	calm	29.2	0.9	282	0.9	286	0.7	314
01A	07° 10.04´N	097° 50.38´E	2.0	170	30.5	1012	79	c	calm	29.3	1.2	28.9	0.9	301	0.8	291
02	07° 09.90´N	097° 40.07´E	1.0	180	30.7	1012	72	c	calm	29.6	0.5	032	0.7	046	0.8	047
02A	07° 09.90´N	097° 30.18´E	1.0	160	31.8	1012	67	c	calm	30.1	0.2	300	0.4	289	0.4	292
03	07° 09.92´N	097° 19.82´E	2.0	190	32.3	1010	67	c	calm	29.7	0.9	261	0.9	262	0.6	283
03A	07° 09.85´N	097° 10.19´E	2.0	270	30.8	1009.5	73	c	calm	31.0	0.9	250	0.9	289	0.7	397
04	07° 09.81´N	096° 59.78´E	0.0	120	30.7	1009	75	c	calm	29.8	0.3	278	0.4	302	0.3	015
04A	07° 09.56´N	096° 49.78´E	0.0	090	30.4	1009	75	c	calm	29.5	2.0	271	2.0	274	1.6	271
05	07° 10.01´N	096° 39.75´E	2.0	350	29.2	1011	85	c	calm	29.3	0.3	124	0.2	045	0.3	196
05A	07° 09.86´N	096° 29.69´E	1.0	270	29.9	1012.5	73	c	calm	29.4	0.6	183	0.8	166	0.3	223
06	07° 09.85´N	096° 19.52´E	1.0	090	31.1	1013.5	63	c	calm	29.7	1.1	197	1.0	175	0.8	183
07	08° 29.75´N	095° 55.29´E	6.0	020	29.6	1011	85	c	calm	20	1.2	102	1.5	098	1.1	135
07A	08° 30.03´N	096° 08.79´E	11.0	120	23.9	1014	91	r	slight	29.2	0.9	186	0.9	179	0.8	184
08	08° 29.82´N	096° 19.42´E	4.0	300	25.4	1013.5	92	c	slight	29	1.0	125	0.9	123	1.0	132
08A	08° 29.93´N	096° 29.78´E	2.0	350	27.6	1013	85	c	calm	29.6	1.1	163	1.1	180	1.3	177
09	08° 29.98´N	096° 39.55´E	4.0	010	29.9	1012.5	78	c	slight	29.7	0.4	171	0.2	154	0.9	149
09A	08° 29.97´N	096° 49.54´E	2.0	120	30.0	1011	79	c	slight	30.1	1.0	098	0.8	091	1.0	079
10	08° 29.97´N	096° 59.65´E	6.0	120	29.7	1010	72	c	calm	30.1	0.4	153	0.5	149	0.3	181
10A	08° 29.99´N	097° 09.78´E	2.0	180	30	1009	72	c	calm	29.8	0.9	145	0.9	140	0.7	145
11	08° 30.00´N	097° 19.84´E	2.0	160	29.4	1011	85	c	calm	28.7	0.3	324	0.3	340	0.6	351
11A	08° 30.03´N	097° 29.99´E	1.0	110	29.3	1013	85	c	calm	29.6	0.8	027	1.1	020	0.9	040
12	08° 29.86´N	097° 39.91´E	2.0	130	29.2	1014	79	c	calm	29.5	0.4	000	0.2	358	-	-
12A	08° 29.97´N	097° 50.10´E	3.0	150	29.5	1014.5	78	c	calm	29.8	0.4	197	0.3	172	0.2	083
13	08° 30.01´N	098° 00.37´E	1.0	180	30.4	1013.5	73	c	calm	30.4	0.6	193	0.6	191	-	-