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A PRELIMINARY REPORT ON THE THAI-DANISH BIOSHELF SURVEYS (1996–2000) OF THE WEST COAST OF THAILAND, ANDAMAN SEA

Charatsee Aungtonya[1], Santisuk Thaipal[1], and Ole Tendal[2]

[1]Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand
(Email:pmbcnet@phuket.ksc.co.th)
[2]Zoological Museum, University of Copenhagen, Copenhagen, Denmark
(Email:OSTendal@zmuc.ku.dk)

ABSTRACT

The project 'Biodiversity of the Andaman Sea Shelf (BIOSHELF)' attempted to cover the west coast of Thailand, from the Burmese border in the north to the Malaysian border in the south. The objective of the project, during 1996–2000, was to expand our general knowledge of the diversity of benthos at depths down to 1000 m within the Thai Economic Exclusive Zone (EEZ). Ninety-eight stations from twelve transects were sampled at depths of 40–900 m, with an extra sixteen stations in the Thai EEZ and three near-shore stations, ten stations from Phang-nga Bay, three stations near Racha Yai Island, and three stations near Racha Noi Island. Materials were collected using the following equipment—Olsen box corer, Smith-McIntyre grab, Ockelmann detritus sledge, Pearcy-Rothlisberg epibenthic sledge, triangular dredge, heavy rectangular dredge, beam trawl, 2 m Agassiz trawl, otter trawl, and baited traps. Samples of polychaetes, crustaceans, molluscs, and fishes are currently being worked up. Some recent BIOSHELF material will be distributed to various specialists. The remaining material will be studied in greater detail in the future. This interim report gives an itinerary of the cruises and addresses progress, problems, comments and future plans for activities conducted under the BIOSHELF Project.

INTRODUCTION

The Andaman Sea is part of the Bay of Bengal, the eastern Indian Ocean, and covers about 800000 km^2. The Thai Economic Exclusive Zone (EEZ) comprises roughly 140000 km^2, of which about three quarters lies within the 1000 m depth contour, and the rest has maximum depths of 2400 m. The slope is somewhat unusual, as it falls towards deeper water from the shelf break at about 200 m depth but has a further sharp step around 700 m depth, a phenomenon which is most strongly pronounced in the northern region.

Taxonomic studies on the marine fauna along the west coast of Thailand are scattered and inadequate. The fauna of the sandy and muddy bottoms was first investigated by the Fifth Thai-Danish Expedition in 1966, using the research vessel 'M/S Dhanarajata' (Seidenfaden *et al.*, 1968). The expedition was successful in its scientific research programme, the training of groups of young Thai marine biologists, and in the creation of the nucleus for a comprehensive marine fauna reference collection for the later erected Phuket Marine Biological Center (PMBC). However, only depths down to about 80 m were surveyed. Surveys at greater depths were conducted later, aiming at the evaluation of natural resources, *e.g.*, the Thai-Japanese Joint Oceanographic and Fisheries Survey in 1981 at depths of 30–300 m, and topographic studies and deep sea trawling in 1987 and 1989 by the Southeast Asian Fisheries Development Center (SEAFDEC) at depths of 100–400 m.

In the last ten years, a number of other surveys have been carried out, but most of these studies were confined to the biodiversity of marine national parks, coral reef ecosystems, and offshore islands (*e.g.*, Carr, 1991; Janekarn and Kiørboe, 1991; Bussarawit, 1995). A number of new species and new records were reported and described, and type specimens have been deposited at the Reference Collection, Phuket Marine Biological Center (*e.g.*, Nateewathana, 1990, 1995, 1997, 1998; Hylleberg and Nateewathana, 1991a, 1991b; Sirimontraporn and Bussarawit, 1993; Chantrapornsyl, 1996; Nateewathana and Norman, 1999; Randall and Satapoomin, 1999;).

The Biodiversity of the Andaman Sea Shelf (BIOSHELF) Project during 1996–2000 has been supported by the Scientific Cooperation Programme (SCP) between Denmark and Thailand in connection with the supply of the marine research vessel 'R/V Chakratong Tongyai' from DANIDA to PMBC. The Chief Technical Advisor (CTA) of the SCP programme is Dr. Jens Peter Thomson. The BIOSHELF Project was carried out in cooperation with the Zoological Museum (ZMUC), University of Copenhagen, Denmark, which has collaborated with PMBC since 1966, and which has provided many of the senior scientific advisers (SSA) and junior scientific advisers (JSA). The leader of the BIOSHELF Thai Scientists is Mr. Somchai Bussarawit, head of the Marine Biodiversity Research Sub-division, and the leader of the BIOSHELF Danish Scientists is Dr. Claus Nielsen.

The objective of the project is to expand our general knowledge of the diversity of benthos at depths down to 1000 m within the Thai EEZ and to provide additional specimens to be deposited in the PMBC Reference Collection. Apart from knowledge gained about the species present in the entire area, this information can be applied in the future sustainable use of yet undiscovered commercial species. In all cases, the results will be needed in studies of food chains and food availability in deep water, which also constitute major issues in fisheries biology. This report give a detailed itinerary of the cruises and addresses progress, problems, comments and future plans on activities conducted under the BIOSHELF Project.

MATERIALS AND METHODS

The study area

The west coast area of Thailand extends over approximately 740 km (6°30′–9°30′N; 97°30′–100°00′E) (Janekarn and Kiørboe, 1991) with many islands of which Phuket is the largest. The BIOSHELF Project attempted to cover this entire area, from the Burmese border in the north to the Malaysian border in the south, inside the 1000 m depth contour.

Twelve transect lines were established across the shelf running perpendicular to the coast and parallel to latitudes (A–L, Fig. 1). Along each transect 12 stations were fixed at lines of approximate depths of 40, 60, 80, 100, 200, 300, 400, 500, 600, 700, 800, and 900 m.

Sampling methods

Topography and bottom type were judged from the echo-sounder image and sampling gear was chosen accordingly. Quantitative samples from soft bottom were collected with an Olsen box corer or a Smith-McIntyre grab (Fig. 2). Animals from the bottom surface and the uppermost layers of the sediment were collected with an Ockelmann sledge (frame = 2 m in length and 1 m in width), and the hyperbenthic fauna was sampled with a modified Pearcy-Rothlisberg epibenthic sledge, which most often also takes a certain amount of sediment (Brattegard and Fossaa, 1991). The samples were carefully sieved through 2 mm and 1 mm mesh screens. All material retained by these screens was fixed in 10% buffered formalin. In the cruises of 1999 and 2000, separate sediment samples were specifically treated in order to be used in the study of meiofauna. Foraminifera samples were collected during the cruise of 2000. A beam trawl was used for sampling shrimps, prawns and flatfish (Eleftheriou and Holme, 1984). For the catch of large, scattered invertebrates a 2 m wide Agassiz trawl was used. A otter trawl was used to catch demersal fishes.

On hard bottoms sampling was done with a triangular dredge or a heavy rectangular dredge. Baited traps consisting of a PVC pipe, 30 cm in length and 10 cm in diameter, were used to catch small demersal crustaceans, particularly isopods. Three traps were set on a rope which was lowered

to the bottom by a weight. The traps were placed on the bottom and at 2 and 10 m above the bottom.

RESULTS AND DISCUSSION

Topography and bottom type

In the northern part of the area, from Ranong to Takua-pa in Phang-nga, the shelf is relatively narrow, dominated by sand and shell fragments down to a depth of 80–100 m. Below this depth, down to about 400 m the substrate is mostly gravel and rock. At depths of 500–900 m there is a rather steep slope, with a sand and mud substrate.

In the southern region, from Takua-pa in Phang-nga to Satun, the shelf is wide and dominated by sand, shell fragments, and mud down to about 200 m. Between 200–400 m there is a steep slope dominated by gravel and rock. The bottom becomes rather flat at about 500 m, and at about 700 m turns into a steep slope, dominated by sand and mud, which continues to at least 1000 m depth. Between 500 and 900 m depths, the sediment is characterized by a very high content of pelagic foraminiferan tests.

Samples of sediment, gravel, and rock were collected and sent to the Marine Mineral Resources

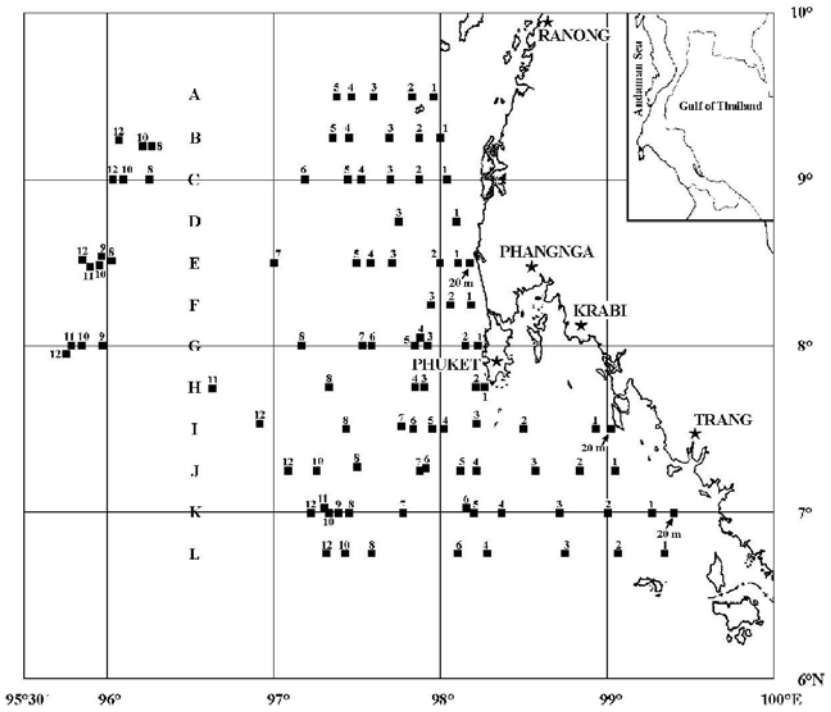

Figure 1 Location of BIOSHELF stations in the Andaman Sea during 1996–2000. A–L = Transect lines. Numbers indicate sampling points along transect lines.

Figure 2 Sampling gear: a. Olsen box corer (BC); b. Smith-McIntyre grab (G); c. Ockelmann sledge (OS); d. Pierce-Rothlisberg hyperbenthic sledge (HS); e. triangular dredge (TD); f. rectangular dredge (RD); g. beam trawl (BT); h. Agassiz trawl (AT); i. otter trawl (T); j. baited trap (Trap).

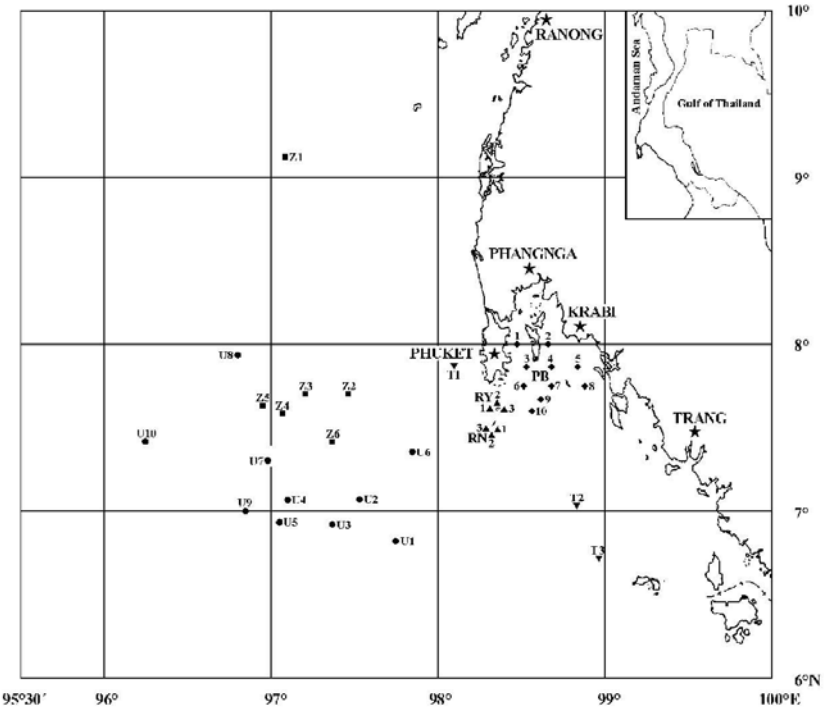

Figure 3 Location of additional stations in the Andaman Sea during 1996–2000. Designations of sampling stations are described in the text.

Section, Department of Mineral Resources, for chemical investigation. Such chemical information will be useful for future surveys of mineral resources in the Andaman Sea.

Sampling stations

Ninety-eight stations were sampled from the twelve transects (Fig. 1). Due to unsuitable bottom type some of the planned stations could not be sampled, but extra stations were added at 20 m depth along transects E, I, and K.

Additionally ten stations (U1–U10) in 1997 and six stations (Z1–Z6) in 1999 were chosen randomly at depths of 300 to 1,000 m in the Thai EEZ (Fig. 3). Three near-shore stations, (T1–T3) were sampled in 1998. Ten stations from Phang-nga Bay (PB1–PB10), three stations near Racha Yai Island (RY1–RY3) and three stations near Racha Noi Island (RN1–RN3) were also chosen for study as areas of particular interest. At present, the mouth of the Phang-nga Bay is under consideration for development into an industrial area as part of the Upper South Development Project. Finally, samples were also collected from Cape Panwa, PMBC, along the beach of Phuket Island, and the small islands around Phuket by visiting scientists (Fig. 4).

Cruise operation

Six main BIOSHELF cruises and a number of

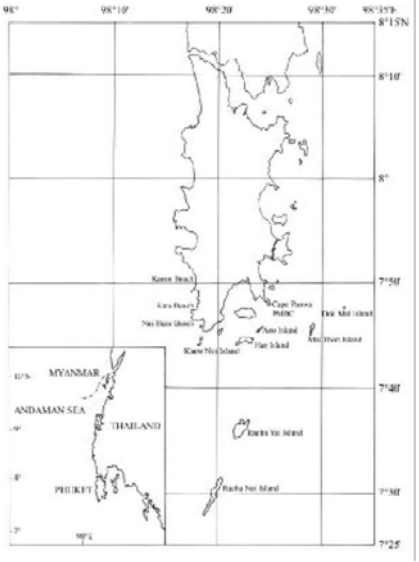

Figure 4 Location of stations around the Southern part of Phuket Island during 1996–2000.

additional cruises were conducted in the Thai EEZ of the Andaman Sea during 1996–2000. Leading and participating marine biologists in these cruises are listed below. The detailed itinerary, including sampling gear, and sediment type recorded at each sampling station is given in Appendix 1.

The first BIOSHELF cruise was conducted by Mr. Somchai Bussarawit and Ms. Charatsee Aungtonya in April and May 1996. Three stations were sampled near Racha Yai Island (RY1–RY3), and three stations were sampled near Racha Noi Island (RN1–RN3).

The second BIOSHELF cruise was conducted by Mr. Somchai Bussarawit in April 1997. A few BIOSHELF stations and additional samples (U1–U10) were chosen randomly at depths of 300 to 1,000 m. Eight stations were sampled in Phang-nga Bay (PB1–PB8).

Supplementary crustacean material was collected by using an Ockelmann sledge (frame = 0.6m in length and 0.5m in width) in November 1997 (stations NBA: Hae Island–Racha Yai Island, NBB: Racha Yai Island–Kaew Noi Island, NBC: Mai Thon Island–Racha Yai Island, and NBD: Hae Island–Mai-Thon Island). This trip was conducted using a long-tail boat and led by Dr. Niel Bruce (SSA) and Ms. Grete Dinesen (JSA) from ZMUC; specimens collected were studied during the International Workshop on Crustaceans in 1998.

The third BIOSHELF cruise was conducted by Mr. Somchai Bussarawit and Ms. Charatsee Aungtonya in February 1998. A few samples were collected at Racha Yai Island, and in Phang-nga Bay with additional samples from near-shore stations (T1–T2).

A test cruise for sampling gear was organized by Mr. Somchai Bussarawit in December 1998. A few BIOSHELF samples were collected with additional samples at two stations in Phang-nga Bay (PB9–PB10) and a near-shore station (T3).

A supplementary cruise was organized by Dr. Matz Berggren (SSA) during the International Workshop on Crustaceans in December 1998, and was conducted aboard the Coastal Research Vessel 'R/V Boonlert Phasuk'. SCUBA gear was used and samples were taken at the Racha Islands and from the waters around Phuket Island.

The fourth BIOSHELF cruise was conducted by Mr. Somchai Bussarawit, Ms. Charatsee Aungtonya, and Ms. Vararin Vongpanich in January and February 1999. Danish scientists from ZMUC, Dr. Ole Tendal (SSA) and Dr. Danny Eibye-Jacobsen (SSA), participated in the cruise in order to advise the Thai marine biologists and the crew concerning methods of sampling and types of sampling gear. Six additional stations (Z1–Z6) were sampled randomly at depths of 300 to 700 m in the Thai EEZ.

The fifth BIOSHELF cruise was conducted by Ms. Charatsee Aungtonya, Ms. Vararin Vongpanich, and Mr. Santisuk Thaipal in November 1999. Danish scientists from ZMUC, Dr. Ole Tendal (SSA) and Ms. Marie Eiland (JSA), participated in the cruise in order to train groups of young Thai marine biologists and crew members in the use of new sampling gear and to further familiarize them with sample treatment. Supplementary crustacean material was collected with baited traps when the vessel was anchored.

The sixth BIOSHELF cruise was conducted by Ms. Charatsee Aungtonya, Ms. Vararin Vongpanich, and Mr. Santisuk Thaipal in February 2000. Dr. Ole Tendal (SSA), Dr. Danny Eibye-Jacobsen (SSA) and Mr. Tom Schiøtte (JSA), all from ZMUC, and Dr. Tomas Cedhagen (SSA), from the Department of Marine Ecology, Aarhus University, participated in the cruise to assist in training groups of young Thai marine biologists in methods of collection and in the working-up of material of particular faunal groups. Supplementary crustacean material was collected with baited traps when the vessel was anchored.

BIOSHELF fauna

Animals collected were sorted on board into broad taxonomic groups (Fig. 5 and Fig. 6). A number of photographs were taken of fresh specimens before they were fixed in 10% buffered formalin. All material was brought back to the PMBC Reference Collection for detailed studies, including sorting, identification and data analysis.

Size and character of the samples was very variable. A general pattern emerged with a narrow zone, rich in large bathyal invertebrates between 500 and 700 m all along the slope. The catches contained sponges of both the classes Hexactinellida and Demospongiae, pennatulaceans belonging to the genus *Umbellula,* solitary corals of the genus *Caryophyllia* and related genera, stalked crinoids of the genus *Saracrinus,* gigantic isopods of the genus *Bathyonomus*, asteroids, ophiuroids and holothuroids.

Sorting of material was carried out by the staff of the Marine Biodiversity Research Sub-division. Mr. Somchai Bussarawit worked up the echinoderms and shrimps, Ms. Charatsee Aungtonya the polychaetes, Ms. Vararin Vongpanich the molluscs, and Mr. Santisuk the fishes. There are about 50 families of polychaetes in the waters off the west coast of Thailand. Most of the

Figure 5 Sorting material in the field.

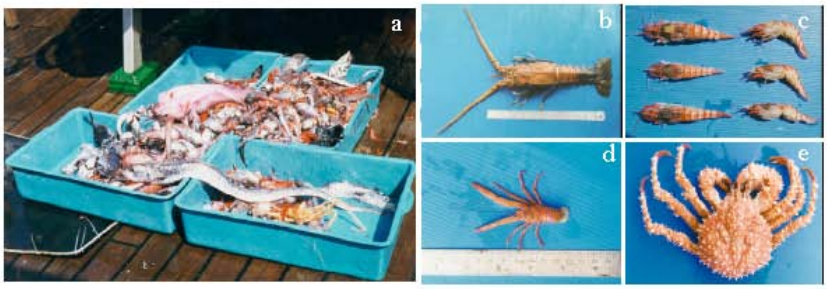

Figure 6 Some samples collected during the cruises: a. samples from the otter trawl; b. Palinuridae; c. Glyphocrangonidae; d. Galatheidae; e. Majidae.

polychaete material from 1996–1997 has been studied at the PMBC-DANIDA International Workshop on Polychaetes. The workshop was held at the PMBC during June-August 1997 and was led by Dr. Danny Eibye-Jacobsen (SSA) and Mr. Torben Kristensen (JSA), both ZMUC. Twelve participants from 6 countries (Denmark, USA, Sweden, Norway, Australia and Thailand) took part.

Part of the crustacean material from 1996–1998 has been studied during the International Workshop on Crustaceans. The workshop was held at the PMBC in November–December 1998, and was lead by Dr. Matz Berggren (SSA, Kristineberg Marine Research Station, Sweden), Dr. Niel Bruce (SSA, Department of Primary Industries, Australia), Ms. Grete Dinesen (JSA, Department of Marine Ecology, University of Aarhus, Denmark), and Mr. Teunis Jensen (JSA, ZMUC) in cooperation with the Marine Biodiversity Research Sub-division, with 22 participants from Thailand, Denmark, Singapore, Australia, Sweden, U.S.A., and Ireland. Work on this material is continuing at the home institutions of these and a number of other specialists not present at the workshop.

A planned international workshop on molluscs was cancelled, However, Dr. R.N. Kilburn, Natal Museum, South Africa, was invited to work up the collected material with Ms. Vararin Vongpanich in July 2000. The current knowledge of the group off the Thai Andaman coast can be summarized as follows. Mollusca comprises Gastropoda with 49 families, Bivalvia with 38 families, Scaphopoda with 2 families, and Polyplacophora with 1 family. Samples which were collected using a triangular dredge on the 1996 cruise have already been studied. Nine new records were found from the area (Aungtonya and Hylleberg, 1998). From recent work on fishes, 5 families in 4 order of Chondrichthyes and 50 families in 16 orders of Osteichthyes have been recorded.

Material from other taxonomic groups is currently being handled by various specialists, *e.g.*, meiofauna samples with Prof. Reinhardt Møbjerg Kristensen, ZMUC, and Foraminifera samples with Dr. Tomas Cedhagen from the University of Aarhus, Denmark.

Other parts of the recently collected BIOSHELF material representing selected groups will be distributed to various specialists. The remaining material will be studied in greater detail in the future. The results will be published in the Phuket Marine Biological Center Research Bulletin, PMBC Special Publications, and in relevant international journals. Information will also be presented at international and national conferences and workshops.

Problems

Scheduled to finish this year, the BIOSHELF Project has achieved its goal of sampling benthic fauna on the entire shelf of the Thai Andaman Sea. However, in some areas work has been difficult because of the high topography of the bottom. Although rather poor, both in species and specimens there is a special fauna in these areas, and it must be sampled. It may turn out to have a special composition because the living conditions are obviously harsh, particularly with respect to hydrological forces and food supply. It is inevitable that some gear will be damaged, destroyed or totally lost during work in this kind of environment.

Comments and future plans

(i) A box corer was provided for the first cruise in 1996, and a Smith-McIntyre grab was borrowed from another institute and used on cruises in 1997. Such gear was not used in 1998. A new Smith-McIntyre grab was made and used in cruises 1999–2000 but there seemed to be a technical problem in the structure of the gear, as there was no success in sampling the sediment. The grab has been modified but the problem has not been solved. The box corer was the alternative gear in the cruise during 2000 for some stations. The beam trawl was used only in the cruise of December 1998. The Pearcy-Rothlisberg epibenthic sledge and the Agassiz trawl were new and used during the cruises of 1999–2000. The poor quality of the net used in the epibenthic sledge was such that the gear could be used only for a limited number of hauls. Both the frame and the net of the Agassiz trawl were often damaged due to the deployment of the gear on rugged bottoms. Re-sampling in some stations with the gears mentioned is highly desirable in order to complete the future goals of

the project. The grab must be modified or replaced before new sampling can take place. A reserve net for the epibenthic sledge and a least three Agassiz trawls should be available on the vessel and these should be made from good quality netting.

(ii) Many animal groups from the BIOSHELF cruise have not been worked up. They can be studied at PMBC, or the Center can consider requests for loans of material to be mailed abroad to interested specialists.

(iii) Young Thai biologists should be trained in taxonomic work with some groups of animals, in connection with exchange of scientists between the PMBC Reference Collection and other museums/institutions and in collaboration with the specialists in question, if possible.

(iv) The sediments of the west coast of Thailand are affected by changes of winds and currents (Chatanathawej and Bussarawit, 1987). Grain size composition and organic content of the sediment at depths up to 70 m was previously studied by Chatanathawej and Bussarawit (1987). Mud and very fine sand dominated the northern region, and the sediment in the southern region was mostly mud, sand, and shell fractions. The overall pattern of median grain size was found to be rather similar between surveys conducted in 1982 and 1983. However, some differences are apparent, indicating temporal changes in sediment composition on the sea bottom. Future studies on grain size composition should include investigations on temporal changes in sediment composition and its relationship to macrofauna abundance.

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Appendix 1 Detailed itinerary of the cruises during the period of 1996–2000. Abbreviation:- BC: Olsen box corer; G: Smith-McIntyre grab; OS: Ockelmann sledge; HS: Pierce-Rothlisberg hyperbenthic sledge; TD: triangular dredge; RD: rectangular dredge; BT: beam trawl; AT: Agassiz trawl; T: otter trawl; Trap: baited trap; and ND: no data collected

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
A1	BC	18/04/1996	09°30′N	97°57′E	-	-	43	-	sand with shell fragments	S. Bussarawit &C. Aungtonya
	OS	18/04/1996	09°30′N	97°58′E	09°29′N	97°58′E	42	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	18/02/1998	09°30′N	97°57′E	09°30′N	97°56′E	46	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	18/04/1996	09°32′N	97°58′E	09°30′N	97°58′E	40	-	ND	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	09°30′N	97°56′E	09°30′N	97°55′E	49	-	ND	S. Bussarawit & C. Aungtonya
	T	18/04/1996	09°30′N	97°57′E	09°33′N	97°56′E	43	-	ND	S. Bussarawit & C. Aungtonya
A2	BC	18/04/1996	09°30′N	97°51′E	-	-	61	-	sandy mud, fine sand & shell fragments	S. Bussarawit & C. Aungtonya
	OS	18/04/1996	09°32′N	97°50′E	09°30′N	97°51′E	66	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	18/02/1998	09°29′N	97°52′E	09°30′N	97°51′E	61	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	18/04/1996	09°34′N	97°49′E	09°32′N	97°50′E	70	-	ND	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	09°30′N	97°53′E	09°30′N	97°52′E	59	-	ND	S. Bussarawit & C. Aungtonya
	T	18/04/1996	09°31′N	97°51′E	09°34′N	97°49′E	64	-	ND	S. Bussarawit & C. Aungtonya
	T	18/02/1998	09°27′N	97°52′E	09°26′N	97°50′E	63	-	ND	S. Bussarawit & C. Aungtonya
A3	BC	19/04/1996	09°30′N	97°38′E	-	-	82	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	19/04/1996	09°30′N	97°38′E	09°31′N	97°38′E	83	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	19/04/1996	09°31′N	97°38′E	09°33′N	97°38′E	87	-	ND	S. Bussarawit & C. Aungtonya
	T	19/04/1996	09°33′N	97°38′E	09°29′N	97°38′E	83	-	ND	S. Bussarawit & C. Aungtonya
A4	BC	19/04/1996	09°30′N	97°28′E	-	-	116	-	coarse sand	S. Bussarawit & C. Aungtonya
A5	BC	19/04/1996	09°29 ′N	97°22 ′E	-	-	204	-	rock	S. Bussarawit & C. Aungtonya
	TD	19/04/1996	09°28 ′N	97°22 ′E	09°28 ′N	97°23 ′E	196	-	ND	S. Bussarawit & C. Aungtonya
B1	OS	17/02/1998	09°14 ′N	98°00 ′E	09°14 ′N	98°00 ′E	45	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	09°15 ′N	98°02 ′E	09°15 ′N	98°03 ′E	43	-	ND	S. Bussarawit & C. Aungtonya
B2	OS	17/02/1998	09°15 ′N	97°54 ′E	09°15 ′N	97°52 ′E	58	-	sand	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	09°15 ′N	97°54 ′E	09°15 ′N	97°52 ′E	61	-	ND	S. Bussarawit & C. Aungtonya
B3	TD	18/02/1998	09°15 ′N	97°42 ′E	09°15 ′N	97°42 ′E	80	-	ND	S. Bussarawit & C. Aungtonya
B4	RD	02/02/2000	09°15 ′N	97°28 ′E	09°15 ′N	97°28 ′E	96	92	ND	C. Aungtonya & V. Vongpanich
B5	RD	02/02/2000	09°15 ′N	97°22 ′E	09°15 ′N	97°22 ′E	200	204	ND	C. Aungtonya & V. Vongpanich
B8	G	11/02/1999	09°12 ′N	96°17 ′E	-	-	500	-	sand	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	09°12 ′N	96°17 ′E	09°12 ′N	96°17 ′E	516	500	sand	S. Bussarawit & C. Aungtonya
	T	11/02/1999	09°10 ′N	96°18 ′E	09°09 ′N	96°16 ′E	489	504	ND	S. Bussarawit & C. Aungtonya
B10	G	11/02/1999	09°13 ′N	96°14 ′E	-	-	689	-	sand	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	09°13 ′N	96°12 ′E	09°13 ′N	96°12 ′E	687	691	sand	S. Bussarawit & C. Aungtonya

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	T	11/02/1999	09°11 ′N	96°12 ′E	09°10 ′N	96°14 ′E	689	549	ND	S. Bussarawit & C. Aungtonya
B12	G	10/02/1999	09°14 ′N	96°06 ′E	-	-	940	-	mud	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	09°13 ′N	96°06 ′E	09°13 ′N	96°06 ′E	908	933	sand	S. Bussarawit & C. Aungtonya
C1	BC	20/04/1996	09°00 ′N	98°03 ′E	-	-	40	-	muddy sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	09°01 ′N	98°03 ′E	09°01 ′N	98°03 ′E	39	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	17/02/1998	09°00 ′N	98°02 ′E	09°00 ′N	98°03 ′E	41	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	20/04/1996	09°02 ′N	98°03 ′E	09°02 ′N	98°03 ′E	39	-	ND	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	09°00 ′N	98°02 ′E	09°00 ′N	98°01 ′E	43	-	ND	S. Bussarawit & C. Aungtonya
	T	20/04/1996	09°02 ′N	98°03 ′E	08°59 ′N	98°03 ′E	40	-	ND	S. Bussarawit & C. Aungtonya
C2	BC	20/04/1996	09°00 ′N	97°53 ′E	-	-	65	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	09°00 ′N	97°53 ′E	09°01 ′N	97°53 ′E	64	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	17/02/1998	09°00 ′N	97°56 ′E	09°00 ′N	97°57 ′E	60	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	20/04/1996	09°02 ′N	97°53 ′E	09°02 ′N	97°53 ′E	64	-	ND	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	09°00 ′N	97°55 ′E	09°00 ′N	97°56 ′E	61	-	ND	S. Bussarawit & C. Aungtonya
	RD	01/02/2000	09°00 ′N	97°55 ′E	09°00 ′N	97°55 ′E	60	60	ND	C. Aungtonya & V. Vongpanich
	AT	01/02/2000	09°00 ′N	97°54 ′E	09°02 ′N	97°53 ′E	62	64	ND	C. Aungtonya & V. Vongpanich
	T	20/04/1996	09°01 ′N	97°53 ′E	08°59 ′N	97°53 ′E	64	-	ND	S. Bussarawit & C. Aungtonya
	T	17/02/1998	09°00 ′N	97°48 ′E	09°01 ′N	97°50 ′E	70	-	ND	S. Bussarawit & C. Aungtonya
C3	BC	20/04/1996	09°00 ′N	97°43 ′E	-	-	79	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	09°00 ′N	97°43 ′E	08°59 ′N	97°43 ′E	80	-	fine sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	09°00 ′N	97°43 ′E	09°00 ′N	97°42 ′E	79	-	ND	S. Bussarawit & C. Aungtonya
	T	20/04/1996	09°00 ′N	97°43 ′E	09°03 ′N	97°43 ′E	81	-	ND	S. Bussarawit & C. Aungtonya
C4	BC	21/04/1996	09°00 ′N	97°30 ′E	-	-	129	-	sandy mud	S. Bussarawit & C. Aungtonya
	AT	02/02/2000	09°00 ′N	97°31 ′E	09°01 ′N	97°29 ′E	110	164	ND	C. Aungtonya & V. Vongpanich
	T	21/04/1996	09°00 ′N	97°30 ′E	08°58 ′N	97°30 ′E	126	-	ND	S. Bussarawit & C. Aungtonya
C5	BC	21/04/1996	09°00 ′N	97°26 ′E	-	-	200	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	21/04/1996	09°01 ′N	97°27 ′E	09°00 ′N	97°28 ′E	191	-	ND	S. Bussarawit & C. Aungtonya
	AT	02/02/2000	09°00 ′N	97°25 ′E	09°00 ′N	97°23 ′E	215	230	ND	C. Aungtonya & V. Vongpanich
C6	RD	02/02/2000	09°00 ′N	97°11 ′E	09°00 ′N	97°11 ′E	311	311	ND	C. Aungtonya & V. Vongpanich
C8	G	03/02/2000	09°00 ′N	96°17 ′E	-	-	480	-	sand	C. Aungtonya & V. Vongpanich
	HS	03/02/2000	09°00 ′N	96°14 ′E	09°00 ′N	96°14 ′E	475	473	ND	C. Aungtonya & V. Vongpanich
	AT	03/02/2000	09°00 ′N	96°15 ′E	09°00 ′N	96°13 ′E	478	480	ND	C. Aungtonya & V. Vongpanich
C10	G	04/02/2000	09°00 ′N	96°09 ′E	-	-	684	-	mud	C. Aungtonya & V. Vongpanich
	RD	04/02/2000	09°01 ′N	96°08 ′E	09°01 ′N	96°08 ′E	709	722	ND	C. Aungtonya & V. Vongpanich
	AT	04/02/2000	08°59 ′N	96°08 ′E	08°56 ′N	96°08 ′E	691	684	ND	C. Aungtonya & V. Vongpanich

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
C12	G	04/02/2000	09°00 ′N	096°04 ′E	-	-	936	-	sand	C. Aungtonya & V. Vongpanich
	OS	05/02/2000	08°56 ′N	096°02 ′E	08°56 ′N	096°02 ′E	933	928	sand	C. Aungtonya & V. Vongpanich
	AT	04/02/2000	08°59 ′N	096°03 ′E	08°56 ′N	096°01 ′E	930	962	ND	C. Aungtonya & V. Vongpanich
D1	TD	19/02/1998	08°45 ′N	098°05 ′E	08°45 ′N	098°05 ′E	38	-	ND	S. Bussarawit & C. Aungtonya
D3	OS	19/02/1998	08°45 ′N	097°43 ′E	08°45 ′N	097°42 ′E	80	-	sand	S. Bussarawit & C. Aungtonya
	TD	19/02/1998	08°45 ′N	097°42 ′E	08°45 ′N	097°43 ′E	80	-	ND	S. Bussarawit & C. Aungtonya
E 20 m	BC	22/04/1996	08°30 ′N	098°12 ′E	-	-	21	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	08°30 ′N	098°12 ′E	08°30 ′N	098°12 ′E	20	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	08°29 ′N	098°12 ′E	08°29 ′N	098°12 ′E	20	-	ND	S. Bussarawit & C. Aungtonya
E1	BC	22/04/1996	08°30 ′N	098°06 ′E	-	-	42	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	08°30 ′N	098°06 ′E	08°30 ′N	098°07 ′E	41	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	08°30 ′N	098°06 ′E	08°29 ′N	098°07 ′E	38	-	ND	S. Bussarawit & C. Aungtonya
E2	BC	22/04/1996	08°30 ′N	098°00 ′E	-	-	63	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	08°31 ′N	098°00 ′E	08°30 ′N	098°00 ′E	60	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	08°30 ′N	098°00 ′E	08°30 ′N	098°00 ′E	60	-	ND	S. Bussarawit & C. Aungtonya
E3	BC	22/04/1996	08°31 ′N	097°46 ′E	-	-	81	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	08°30 ′N	097°46 ′E	08°31 ′N	097°46 ′E	81	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	08°32 ′N	097°46 ′E	08°31 ′N	097°46 ′E	79	-	ND	S. Bussarawit & C. Aungtonya
E4	BC	21/04/1996	08°30 ′N	097°33 ′E	-	-	74	-	sand and gravel	S. Bussarawit & C. Aungtonya
	TD	21/04/1996	08°30 ′N	097°33 ′E	08°30 ′N	097°34 ′E	74	-	ND	S. Bussarawit & C. Aungtonya
E5	BC	21/04/1996	08°30 ′N	097°30 ′E	-	-	227	-	rock	S. Bussarawit & C. Aungtonya
	G	08/02/2000	08°30 ′N	097°30 ′E	-	-	228	-	rock	C. Aungtonya & V. Vongpanich
	TD	08/02/2000	08°30 ′N	097°30 ′E	08°30 ′N	097°31 ′E	225	228	ND	C. Aungtonya & V. Vongpanich
E7	G	08/02/2000	08°30 ′N	097°00 ′E	-	-	450	-	sand and gravel	C. Aungtonya & V. Vongpanich
	TD	08/02/2000	08°29 ′N	097°00 ′E	08°29 ′N	097°00 ′E	452	453	ND	C. Aungtonya & V. Vongpanich
	AT	08/02/2000	08°30 ′N	097°01 ′E	08°29 ′N	097°03 ′E	449	446	ND	C. Aungtonya & V. Vongpanich
	T	08/02/2000	08°30 ′N	097°08 ′E	08°30 ′N	097°08 ′E	436	443	ND	C. Aungtonya & V. Vongpanich
	T	09/02/2000	08°30 ′N	097°07 ′E	08°29 ′N	097°04 ′E	435	444	ND	C. Aungtonya & V. Vongpanich
E8	G	05/02/1999	08°32 ′N	096°02 ′E	-	-	488	-	muddy sand	S. Bussarawit & C. Aungtonya
	G	06/02/2000	08°30 ′N	096°01 ′E	-	-	498	-	sand	C. Aungtonya & V. Vongpanich
	OS	06/02/1999	08°28 ′N	096°06 ′E	08°28 ′N	096°05 ′E	483	482	sand	S. Bussarawit & C. Aungtonya
	RD	06/02/2000	08°25 ′N	096°01 ′E	08°25 ′N	096°01 ′E	500	500	ND	C. Aungtonya & V. Vongpanich
	T	06/02/1999	08°32 ′N	096°04 ′E	08°31 ′N	096°07 ′E	488	478	ND	S. Bussarawit & C. Aungtonya
E9	T	05/02/1999	08°30 ′N	095°58 ′E	08°28 ′N	095°58 ′E	649	550	ND	S. Bussarawit & C. Aungtonya
E10	G	05/02/1999	08°32 ′N	095°57 ′E	-	-	685	-	sand and coral	S. Bussarawit & C. Aungtonya
	OS	05/02/1999	08°29 ′N	095°56 ′E	08°29 ′N	095°56 ′E	684	720	ND	S. Bussarawit & C. Aungtonya

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	AT	05/02/2000	08°31 'N	095°57 'E	08°33 'N	095°57 'E	707	664	ND	C. Aungtonya & V. Vongpanich
E11	TD	04/02/1999	08°31 'N	095°54 'E	08°30 'N	095°54 'E	842	867	ND	S. Bussarawit & C. Aungtonya
	AT	05/02/2000	08°28 'N	095°53 'E	08°24 'N	095°52 'E	864	800	ND	C. Aungtonya & V. Vongpanich
E12	G	04/02/1999	08°29 'N	095°52 'E	-	-	918	-	ND	S. Bussarawit & C. Aungtonya
F1	OS	16/02/1998	08°15 'N	098°10 'E	08°15 'N	098°10 'E	43	-	sand	S. Bussarawit & C. Aungtonya
	TD	16/02/1998	08°15 'N	098°12 'E	08°15 'N	098°12 'E	36	-	ND	S. Bussarawit & C. Aungtonya
F2	OS	16/02/1998	08°15 'N	098°03 'E	08°15 'N	098°02 'E	66	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	16/02/1998	08°15 'N	098°04 'E	08°15 'N	098°03 'E	59	-	ND	S. Bussarawit & C. Aungtonya
F3	TD	16/02/1998	08°15 'N	097°58 'E	08°15 'N	097°57 'E	78	-	ND	S. Bussarawit & C. Aungtonya
G1	BC	24/04/1996	008°00 'N	098°14 'E	-	-	42	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	24/04/1996	008°00 'N	098°14 'E	007°59 'N	098°14 'E	43	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	20/02/1998	008°00 'N	098°12 'E	007°59 'N	098°12 'E	49	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	24/04/1996	007°59 'N	098°14 'E	007°59 'N	098°14 'E	43	-	ND	S. Bussarawit & C. Aungtonya
	TD	20/02/1998	008°00 'N	098°13 'E	008°00 'N	098°12 'E	46	-	ND	S. Bussarawit & C. Aungtonya
G2	BC	23/04/1996	008°00 'N	098°10 'E	-	-	63	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	23/04/1996	008°00 'N	098°10 'E	008°00 'N	098°10 'E	63	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	20/02/1998	007°59 'N	098°08 'E	007°59 'N	098°07 'E	72	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	23/04/1996	008°01 'N	098°10 'E	008°01 'N	098°10 'E	61	-	ND	S. Bussarawit & C. Aungtonya
	TD	20/02/1998	007°59 'N	098°09 'E	007°59 'N	098°08 'E	68	-	ND	S. Bussarawit & C. Aungtonya
G3	BC	23/04/1996	008°00 'N	097°54 'E	-	-	76	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	23/04/1996	008°00 'N	097°54 'E	008°01 'N	097°54 'E	77	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	20/02/1998	007°58 'N	098°02 'E	007°57 'N	098°03 'E	79	-	ND	S. Bussarawit & C. Aungtonya
G4	G	10/02/2000	008°03 'N	097°49 'E	-	-	140	-	sand	C. Aungtonya & V. Vongpanich
	TD	10/02/2000	008°03 'N	097°48 'E	008°03 'N	097°48 'E	151	151	ND	C. Aungtonya & V. Vongpanich
	AT	10/02/2000	008°04 'N	097°47 'E	008°03 'N	097°48 'E	173	158	ND	C. Aungtonya & V. Vongpanich
G5	BC	23/04/1996	008°00 'N	097°48 'E	-	-	233	-	coarse sand and gravel	S. Bussarawit & C. Aungtonya
	G	10/02/2000	008°00 'N	097°47 'E	-	-	247	-	rock	C. Aungtonya & V. Vongpanich
	TD	23/04/1996	008°00 'N	097°48 'E	008°00 'N	097°48 'E	220	-	ND	S. Bussarawit & C. Aungtonya
	TD	10/02/2000	008°00 'N	097°48 'E	008°00 'N	097°47 'E	236	242	ND	C. Aungtonya & V. Vongpanich
G6	G	20/11/1999	008°00 'N	097°34 'E	-	-	344	-	mud	C. Aungtonya & V. Vongpanich
	TD	20/11/1999	008°00 'N	097°35 'E	008°00 'N	097°35 'E	280	292	ND	C. Aungtonya & V. Vongpanich
	RD	20/11/1999	008°00 'N	097°35 'E	008°00 'N	097°35 'E	262	262	ND	C. Aungtonya & V. Vongpanich
	AT	20/11/1999	008°01 'N	097°34 'E	008°01 'N	097°33 'E	276	290	ND	C. Aungtonya & V. Vongpanich
G7	RD	20/11/1999	008°00 'N	097°32 'E	007°59 'N	097°33 'E	408	408	ND	C. Aungtonya & V. Vongpanich

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
G8	G	20/11/1999	008°00 ′N	097°14 ′E	-	-	483	-	muddy sand	C. Aungtonya & V. Vongpanich
	G	09/02/2000	008°01 ′N	097°09 ′E	-	-	498	-	ND	C. Aungtonya & V. Vongpanich
	HS	20/11/1999	008°00 ′N	097°12 ′E	008°00 ′N	097°12 ′E	488	488	muddy sand	C. Aungtonya & V. Vongpanich
	TD	09/02/2000	008°00 ′N	097°08 ′E	008°00 ′N	097°08 ′E	500	504	ND	C. Aungtonya & V. Vongpanich
	AT	09/02/2000	008°00 ′N	097°11 ′E	008°00 ′N	097°13 ′E	495	488	ND	C. Aungtonya & V. Vongpanich
	T	20/11/1999	008°00 ′N	097°06 ′E	008°00 ′N	097°04 ′E	508	518	ND	C. Aungtonya & V. Vongpanich
G9	G	07/02/2000	008°00 ′N	095°59 ′E	-	-	548	-	sand	C. Aungtonya & V. Vongpanich
	TD	07/02/2000	008°00 ′N	095°54 ′E	008°00 ′N	095°54 ′E	560	560	ND	C. Aungtonya & V. Vongpanich
G10	G	07/02/2000	008°00 ′N	095°50 ′E	-	-	680	-	sand	C. Aungtonya & V. Vongpanich
G11	G	06/02/2000	008°00 ′N	095°47 ′E	-	-	808.0	-	sand	C. Aungtonya & V. Vongpanich
G12	G	06/02/2000	007°57 ′N	095°46 ′E	-	-	872	-	sand	C. Aungtonya & V. Vongpanich
H1	BC	09/05/1996	007°45 ′N	098°16 ′E	-	-	32	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	09/05/1996	007°45 ′N	098°16 ′E	007°44 ′N	098°17 ′E	31	-	mud	S. Bussarawit & C. Aungtonya
	OS	20/02/1998	007°46 ′N	098°16 ′E	007°46 ′N	098°16 ′E	40	-	soft mud	S. Bussarawit & C. Aungtonya
	TD	09/05/1996	007°44 ′N	098°17 ′E	007°44 ′N	098°17 ′E	32	-	ND	S. Bussarawit & C. Aungtonya
H2	BC	09/05/1996	007°45 ′N	098°15 ′E	-	-	59	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	09/05/1996	007°45 ′N	098°15 ′E	007°44 ′N	098°16 ′E	56	-	soft mud	S. Bussarawit & C. Aungtonya
	TD	09/05/1996	007°44 ′N	098°16 ′E	007°43 ′N	098°16 ′E	60	-	ND	S. Bussarawit & C. Aungtonya
	TD	20/02/1998	007°46 ′N	098°14 ′E	007°46 ′N	098°15 ′E	57	-	ND	S. Bussarawit & C. Aungtonya
H3	BC	09/05/1996	007°45 ′N	097°58 ′E	-	-	70	-	coarse sand	S. Bussarawit & C. Aungtonya
	TD	09/05/1996	007°46 ′N	097°58 ′E	007°45 ′N	097°59 ′E	71	-	ND	S. Bussarawit & C. Aungtonya
	T	08/04/1997	007°46 ′N	097°58 ′E	007°45 ′N	097°57 ′E	80	-	ND	S. Bussarawit
H4	BC	09/05/1996	007°45 ′N	097°56 ′E	-	-	139	-	coarse sand with shell fragments	S. Bussarawit & C. Aungtonya
H8	G	10/04/1997	007°45 ′N	097°20 ′E	-	-	493	-	soft mud	S. Bussarawit
	OS	10/04/1997	007°45 ′N	097°20 ′E	007°46 ′N	097°19 ′E	493	-	sand	S. Bussarawit
	TD	10/04/1997	007°45 ′N	097°20 ′E	007°46 ′N	097°19 ′E	493	-	ND	S. Bussarawit
H11	G	16/04/1997	007°44 ′N	096°38 ′E	-	-	820	-	soft mud	S. Bussarawit
	OS	16/04/1997	007°44 ′N	096°38 ′E	007°42 ′N	096°38 ′E	822	-	soft mud	S. Bussarawit
I 20 m	BC	03/05/1996	007°30 ′N	099°01 ′E	-	-	21	-	mud	S. Bussarawit & C. Aungtonya
	OS	03/05/1996	007°30 ′N	099°01 ′E	007°30 ′N	099°01 ′E	21	-	mud	S. Bussarawit & C. Aungtonya
	TD	03/05/1996	007°30 ′N	099°01 ′E	007°30 ′N	099°01 ′E	21	-	ND	S. Bussarawit & C. Aungtonya
I1	BC	03/05/1996	007°30 ′N	098°57 ′E	-	-	38	-	mud	S. Bussarawit & C. Aungtonya
	OS	03/05/1996	007°30 ′N	098°57 ′E	007°30 ′N	098°57 ′E	38	-	mud	S. Bussarawit & C. Aungtonya
	OS	22/02/1998	007°30 ′N	098°55 ′E	007°30 ′N	098°56 ′E	42	-	mud	S. Bussarawit & C. Aungtonya

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	TD	03/05/1996	07°29′N	098°56′E	07°29′N	098°56′E	40	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	07°30′N	098°54′E	07°30′N	098°55′E	43	-	ND	S. Bussarawit & C. Aungtonya
I2	BC	01/05/1996	07°30′N	098°30′E	-	-	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	BC	03/05/1996	07°30′N	098°29′E	-	-	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	03/05/1996	07°30′N	098°29′E	07°30′N	098°29′E	60	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	22/02/1998	07°30′N	098°30′E	07°30′N	098°30′E	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	05/12/1998	07°29′N	098°30′E	07°29′N	098°30′E	64	-	ND	S. Bussarawit
	HS	26/02/2000	07°30′N	098°29′E	07°30′N	098°29′E	61	61	ND	C. Aungtonya & V. Vongpanich
	TD	01/05/1996	07°30′N	098°31′E	07°30′N	098°30′E	59	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	07°31′N	098°30′E	07°30′N	098°30′E	58	-	ND	S. Bussarawit & C. Aungtonya
	TD	05/12/1998	07°28′N	098°31′E	07°29′N	098°30′E	65	-	ND	S. Bussarawit
	AT	26/02/2000	07°30′N	098°29′E	07°31′N	098°27′E	60	62	ND	C. Aungtonya & V. Vongpanich
	T	05/12/1998	07°30′N	098°30′E	07°30′N	098°28′E	61	-	ND	S. Bussarawit
	T	22/02/1998	07°30′N	098°31′E	07°29′N	098°35′E	59	-	ND	S. Bussarawit & C. Aungtonya
I3-I2	OS	22/02/1998	07°33′N	098°19′E	07°33′N	098°19′E	55	-	ND	S. Bussarawit & C. Aungtonya
I3	BC	02/05/1996	07°30′N	098°10′E	-	-	79	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	G	15/11/1999	07°30′N	098°15′E	-	-	66	-	sand	C. Aungtonya & V. Vongpanich
	OS	01/12/1998	07°34′N	098°13′E	07°34′N	098°13′E	77	-	ND	S. Bussarawit
	OS	02/12/1998	07°35′N	098°14′E	07°34′N	098°13′E	73	-	ND	S. Bussarawit
	HS	08/11/1999	07°29′N	098°14′E	07°29′N	098°14′E	67	66	ND	C. Aungtonya & V. Vongpanich
	TD	02/05/1996	07°30′N	098°10′E	07°30′N	098°11′E	78	-	ND	S. Bussarawit & C. Aungtonya
	TD	01/12/1998	07°35′N	098°12′E	07°34′N	098°13′E	77	-	ND	S. Bussarawit
	TD	02/12/1998	07°34′N	098°14′E	07°34′N	098°13′E	75	-	ND	S. Bussarawit
	BT	01/12/1998	07°34′N	098°14′E	07°35′N	098°15′E	69	-	ND	S. Bussarawit
	BT	02/12/1998	07°32′N	098°13′E	07°30′N	098°12′E	83	-	ND	S. Bussarawit
I4	G	16/02/2000	07°31′N	098°01′E	-	-	125	-	sand with shell fragments	C. Aungtonya & V. Vongpanich
	HS	17/02/2000	07°30′N	098°01′E	07°30′N	098°01′E	118	118	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	08/11/1999	07°30′N	098°02′E	07°30′N	098°01′E	122	137	ND	C. Aungtonya & V. Vongpanich
	TD	16/02/2000	07°30′N	098°01′E	07°30′N	098°01′E	120	117	ND	C. Aungtonya & V. Vongpanich
	RD	08/11/1999	07°30′N	098°01′E	07°30′N	098°01′E	120	107	ND	C. Aungtonya & V. Vongpanich
	AT	16/02/2000	07°30′N	098°01′E	07°31′N	098°00′E	122	156	ND	C. Aungtonya & V. Vongpanich
I5	TD	29/01/1999	07°32′N	097°56′E	07°32′N	097°56′E	190	209	ND	S. Bussarawit & C. Aungtonya
	TD	16/02/2000	07°30′N	097°58′E	07°30′N	097°58′E	194	193	ND	C. Aungtonya & V. Vongpanich
	RD	09/11/1999	07°30′N	097°57′E	07°30′N	097°56′E	220	222	ND	C. Aungtonya & V. Vongpanich

Appendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
I6	TD	29/01/1999	07°27 ′N	097°49 ′E	07°27 ′N	097°49 ′E	298	300	ND	S. Bussarawit & C. Aungtonya
	RD	09/11/1999	07°30 ′N	097°50 ′E	07°30 ′N	097°50 ′E	299	301	ND	C. Aungtonya & V. Vongpanich
	AT	09/11/1999	07°30 ′N	097°50 ′E	07°31 ′N	097°51 ′E	300	284	ND	C. Aungtonya & V. Vongpanich
I7	RD	09/11/1999	07°31 ′N	097°46 ′E	07°31 ′N	097°46 ′E	427	424	ND	C. Aungtonya & V. Vongpanich
I8	G	09/11/1999	07°30 ′N	097°26 ′E	-	-	502		mud	C. Aungtonya & V. Vongpanich
	HS	09/11/1999	07°30 ′N	097°26 ′E	07°30 ′N	097°25 ′E	504	507	mud	C. Aungtonya & V. Vongpanich
I12	G	25/01/1999	07°32 ′N	096°54 ′E	-	-	916	-	mud	S. Bussarawit & C. Aungtonya
	OS	25/01/1999	07°32 ′N	096°56 ′E	07°32 ′N	096°56 ′E	928	880	mud	S. Bussarawit & C. Aungtonya
J1	BC	04/05/1996	07°15 ′N	099°03 ′E	-	-	43	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	07°16 ′N	099°03 ′E	07°16 ′N	099°03 ′E	42	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	07°15 ′N	099°04 ′E	07°15 ′N	099°04 ′E	39	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	07°15 ′N	099°03 ′E	07°15 ′N	099°03 ′E	41	41	shells	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	07°15 ′N	099°03 ′E	07°16 ′N	099°03 ′E	42	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	07°15 ′N	099°03 ′E	07°15 ′N	099°03 ′E	42	-	ND	S. Bussarawit & C. Aungtonya
	AT	27/02/2000	07°15 ′N	099°03 ′E	07°15 ′N	099°04 ′E	43	40	ND	C. Aungtonya & V. Vongpanich
J2	BC	04/05/1996	07°15 ′N	098°50 ′E	-	-	62	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	07°15 ′N	098°51 ′E	07°15 ′N	098°51 ′E	61	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	07°15 ′N	098°48 ′E	07°15 ′N	098°48 ′E	63	-	soft mud	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	07°15 ′N	098°51 ′E	07°15 ′N	098°51 ′E	60	59	sandy mud	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	07°15 ′N	098°51 ′E	07°15 ′N	098°51 ′E	62	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	07°15 ′N	098°48 ′E	07°15 ′N	098°48 ′E	63	-	ND	S. Bussarawit & C. Aungtonya
	AT	27/02/2000	07°15 ′N	098°49 ′E	07°16 ′N	098°51 ′E	62	58	ND	C. Aungtonya & V. Vongpanich
	T	23/02/1998	07°16 ′N	098°49 ′E	07°16 ′N	098°54 ′E	62	-	ND	S. Bussarawit & C. Aungtonya
J3	BC	04/05/1996	07°15 ′N	098°34 ′E	-	-	79	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	07°15 ′N	098°36 ′E	07°16 ′N	098°36 ′E	79	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	07°15 ′N	098°36 ′E	07°16 ′N	098°36 ′E	77	-	fine sand	S. Bussarawit & C. Aungtonya
	HS	26/02/2000	07°15 ′N	098°35 ′E	07°15 ′N	098°35 ′E	78	78	sand	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	07°15 ′N	098°35 ′E	07°15 ′N	098°36 ′E	79	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	07°15 ′N	098°35 ′E	07°15 ′N	098°36 ′E	78	-	ND	S. Bussarawit & C. Aungtonya
	AT	26/02/2000	07°15 ′N	098°35 ′E	07°12 ′N	098°34 ′E	79	79	ND	C. Aungtonya & V. Vongpanich
J48-47	T	23/02/1998	07°14 ′N	098°37 ′E	07°16 ′N	098°42 ′E	76	-	ND	S. Bussarawit & C. Aungtonya
J4	TD	01/03/2000	07°15 ′N	098°14 ′E	07°15 ′N	098°14 ′E	89	90	ND	C. Aungtonya & V. Vongpanich
	AT	01/03/2000	07°15 ′N	098°12 ′E	07°16 ′N	098°13 ′E	87	89	ND	C. Aungtonya & V. Vongpanich
J5	TD	01/03/2000	07°15 ′N	098°07 ′E	07°15 ′N	098°07 ′E	217	216	ND	C. Aungtonya & V. Vongpanich

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
J6	G	17/02/2000	07°16 'N	97°55 'E	-	-	330	-	rock	C. Aungtonya & V. Vongpanich
	TD	17/02/2000	07°15 'N	97°55 'E	07°15 'N	97°56 'E	304	315	ND	C. Aungtonya & V. Vongpanich
J7	TD	02/12/1998	07°16 'N	97°53 'E	07°15 'N	97°53 'E	342	-	ND	S. Bussarawit
	AT	17/02/2000	07°15 'N	97°53 'E	07°16 'N	97°52 'E	356	360	ND	C. Aungtonya & V. Vongpanich
J8	BC	18/02/2000	07°16 'N	97°31 'E	-	-	489	-	sand	C. Aungtonya & V. Vongpanich
	G	27/01/1999	07°20 'N	97°29 'E	-	-	501	-	mud	S. Bussarawit & C. Aungtonya
	G	18/02/2000	07°15 'N	97°31 'E	-	-	488	-	sand	C. Aungtonya & V. Vongpanich
	OS	18/02/2000	07°15 'N	97°30 'E	07°15 'N	97°30 'E	495	490	mud	C. Aungtonya & V. Vongpanich
	TD	18/02/2000	07°15 'N	97°30 'E	07°15 'N	97°31 'E	493	490	ND	C. Aungtonya & V. Vongpanich
	AT	18/02/2000	07°15 'N	97°30 'E	07°15 'N	97°32 'E	490	479	ND	C. Aungtonya & V. Vongpanich
	T	27/01/1999	07°21 'N	97°26 'E	07°20 'N	97°25 'E	520	531	ND	S. Bussarawit & C. Aungtonya
	T	18/02/2000	07°15 'N	97°33 'E	07°15 'N	97°30 'E	473	494	ND	C. Aungtonya & V. Vongpanich
J10	BC	19/02/2000	07°15 'N	97°16 'E	-	-	668	-	mud	C. Aungtonya & V. Vongpanich
	G	28/01/1999	07°17 'N	97°15 'E	-	-	656	-	mud	S. Bussarawit & C. Aungtonya
	OS	19/02/2000	07°15 'N	97°16 'E	07°15 'N	97°16 'E	668	669	muddy sand	C. Aungtonya & V. Vongpanich
	TD	19/02/2000	07°15 'N	97°16 'E	07°15 'N	97°16 'E	660	663	ND	C. Aungtonya & V. Vongpanich
	AT	19/02/2000	07°15 'N	97°15 'E	07°14 'N	97°15 'E	689	687	ND	C. Aungtonya & V. Vongpanich
	T	28/01/1999	07°20 'N	97°14 'E	07°22 'N	97°13 'E	655	651	ND	S. Bussarawit & C. Aungtonya
	T	19/02/2000	07°15 'N	97°16 'E	07°15 'N	97°14 'E	662	696	ND	C. Aungtonya & V. Vongpanich
J12	BC	20/02/2000	07°15 'N	97°05 'E	-	-	924	-	muddy sand	C. Aungtonya & V. Vongpanich
	OS	20/02/2000	07°15 'N	97°07 'E	07°15 'N	97°07 'E	896	896	sand	C. Aungtonya & V. Vongpanich
	AT	20/02/2000	07°16 'N	97°03 'E	07°16 'N	97°05 'E	944	912	ND	C. Aungtonya & V. Vongpanich
K 20 m	BC	06/05/1996	07°00 'N	099°24 'E	-	-	21	-	mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	07°00 'N	099°24 'E	07°00 'N	099°24 'E	22	-	mud with shell fragments	S. Bussarawit & C. Aungtonya
	TD	06/05/1996	07°00 'N	099°24 'E	07°00 'N	099°24 'E	20	-	ND	S. Bussarawit & C. Aungtonya
K1	BC	06/05/1996	07°00 'N	099°16 'E	-	-	43	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	07°00 'N	099°15 'E	07°00 'N	099°14 'E	45	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	07°00 'N	099°16 'E	07°00 'N	099°15 'E	41	-	soft mud	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	07°00 'N	099°16 'E	07°00 'N	099°16 'E	43	42	mud with shell fragments	C. Aungtonya & V. Vongpanich
	TD	06/05/1996	07°00 'N	099°16 'E	07°00 'N	099°15 'E	44	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	07°00 'N	099°15 'E	07°00 'N	099°16 'E	42	-	ND	S. Bussarawit & C. Aungtonya
K2	BC	06/05/1996	07°00 'N	098°59 'E	-	-	63	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	07°00 'N	099°00 'E	07°01 'N	099°00 'E	60	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	07°00 'N	099°04 'E	006°59 'N	099°04 'E	53	-	soft mud	S. Bussarawit & C. Aungtonya

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	TD	06/05/1996	00700 ′N	09859 ′E	00700 ′N	09859 ′E	64	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	00700 ′N	09904 ′E	00700 ′N	09904 ′E	55	-	ND	S. Bussarawit & C. Aungtonya
	T	24/02/1998	00700 ′N	09904 ′E	00701 ′N	09908 ′E	52	-	ND	S. Bussarawit & C. Aungtonya
K3	BC	05/05/1996	00700 ′N	09841 ′E	-	-	83	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	05/05/1996	00659 ′N	09842 ′E	00659 ′N	09842 ′E	82	-	sandy mud	S. Bussarawit & C. Aungtonya
	HS	29/02/2000	00702 ′N	09843 ′E	00702 ′N	09843 ′E	81	81	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	05/05/1996	00700 ′N	09842 ′E	00700 ′N	09842 ′E	83	-	ND	S. Bussarawit & C. Aungtonya
	AT	29/02/2000	00700 ′N	09841 ′E	00701 ′N	09843 ′E	83	81	ND	C. Aungtonya & V. Vongpanich
K4	BC	07/05/1996	00700 ′N	09821 ′E	-	-	105	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	G	15/11/1999	00659 ′N	09821 ′E	-	-	103	-	mud with shell fragments	C. Aungtonya & V. Vongpanich
	HS	29/02/2000	00700 ′N	09820 ′E	00700 ′N	09820 ′E	108	110	mud with shell fragments	C. Aungtonya & V. Vongpanich
	TD	15/11/1999	00659 ′N	09820 ′E	00659 ′N	09820 ′E	107	109	ND	C. Aungtonya & V. Vongpanich
	AT	23/02/2000	00700 ′N	09821 ′E	00659 ′N	09821 ′E	104	101	ND	C. Aungtonya & V. Vongpanich
	T	23/02/2000	00701 ′N	09819 ′E	00705 ′N	09818 ′E	119	116	ND	C. Aungtonya & V. Vongpanich
K5	BC	07/05/1996	00700 ′N	09812 ′E	-	-	220	-	gravel	S. Bussarawit & C. Aungtonya
	HS	01/03/2000	00700 ′N	09812 ′E	00700 ′N	09812 ′E	217	217	sand with shell fragments	C. Aungtonya & V. Vongpanich
K6	T	01/03/2000	00702 ′N	09810 ′E	00704 ′N	09809 ′E	277	288	ND	C. Aungtonya & V. Vongpanich
K7	RD	18/11/1999	00701 ′N	09746 ′E	00701 ′N	09746 ′E	389	389	ND	C. Aungtonya & V. Vongpanich
K8	G	17/11/1999	00700 ′N	09725 ′E	-	-	540	-	mud	C. Aungtonya & V. Vongpanich
	HS	18/11/1999	00701 ′N	09729 ′E	00701 ′N	09729 ′E	504	504	mud	C. Aungtonya & V. Vongpanich
	AT	17/11/1999	00700 ′N	09726 ′E	00701 ′N	09728 ′E	556	520	ND	C. Aungtonya & V. Vongpanich
K9	G	16/11/1999	00700 ′N	09722 ′E	-	-	640	-	mud	C. Aungtonya & V. Vongpanich
K10	G	17/11/1999	00659 ′N	09720 ′E	-	-	712	-	mud	C. Aungtonya & V. Vongpanich
	AT	17/11/1999	00701 ′N	09720 ′E	00703 ′N	09720 ′E	690	684	ND	C. Aungtonya & V. Vongpanich
K11	HS	17/11/1999	00702 ′N	09718 ′E	00702 ′N	09718 ′E	760	764	mud	C. Aungtonya & V. Vongpanich
	AT	16/11/1999	00700 ′N	09718 ′E	00700 ′N	09721 ′E	828	684	ND	C. Aungtonya & V. Vongpanich
K12	BC	20/02/2000	00700 ′N	09714 ′E	-	-	940	-	mud	C. Aungtonya & V. Vongpanich
L1	BC	06/05/1996	00645 ′N	09921 ′E	-	-	38	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	00646 ′N	09921 ′E	00646 ′N	09921 ′E	38	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	00649 ′N	09921 ′E	00648 ′N	09921 ′E	39	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	HS	28/02/2000	00645 ′N	09921 ′E	00645 ′N	09921 ′E	38	38	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	06/05/1996	00645 ′N	09921 ′E	00645 ′N	09921 ′E	38	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	00649 ′N	09921 ′E	00649 ′N	09921 ′E	39	-	ND	S. Bussarawit & C. Aungtonya
	AT	28/02/2000	00645 ′N	09921 ′E	00646 ′N	09919 ′E	39	41	ND	C. Aungtonya & V. Vongpanich

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	T	25/02/1998	06°45 ′N	099°18 ′E	006°46 ′N	099°16 ′E	47			
L2	BC	05/05/1996	006°46 ′N	099°04 ′E	-	-	59	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	05/05/1996	006°44 ′N	099°05 ′E	006°44 ′N	099°05 ′E	56	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	25/02/1998	006°43 ′N	099°03 ′E	006°43 ′N	099°04 ′E	61	-	soft mud	S. Bussarawit & C. Aungtonya
	HS	28/02/2000	006°45 ′N	099°02 ′E	006°45 ′N	099°02 ′E	63	64	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	05/05/1996	006°45 ′N	099°04 ′E	006°45 ′N	099°05 ′E	59	-	ND	S. Bussarawit & C. Aungtonya
	TD	25/02/1998	006°44 ′N	099°04 ′E	006°43 ′N	099°03 ′E	59	-	ND	S. Bussarawit & C. Aungtonya
	AT	28/02/2000	006°45 ′N	099°04 ′E	006°45 ′N	099°02 ′E	59	63	ND	C. Aungtonya & V. Vongpanich
L3	BC	05/05/1996	006°45 ′N	098°45 ′E	-	-	83	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	05/05/1996	006°46 ′N	098°45 ′E	006°46 ′N	098°45 ′E	83	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	HS	29/02/2000	006°45 ′N	098°45 ′E	006°45 ′N	098°45 ′E	82	81	sandy mud with shell fragments	C. Aungtonya & V. Vongpanich
	TD	05/05/1996	006°45 ′N	098°45 ′E	006°46 ′N	098°45 ′E	83	-	ND	S. Bussarawit & C. Aungtonya
	AT	29/02/2000	006°45 ′N	098°43 ′E	006°46 ′N	098°41 ′E	83	84	ND	C. Aungtonya & V. Vongpanich
L4	TD	23/02/2000	006°45 ′N	098°17 ′E	006°45 ′N	098°17 ′E	118	118	ND	C. Aungtonya & V. Vongpanich
	AT	23/02/2000	006°45 ′N	098°18 ′E	006°44 ′N	098°19 ′E	113	109	ND	C. Aungtonya & V. Vongpanich
L6	BC	23/02/2000	006°45 ′N	098°07 ′E	-	-	300	-	mud with shell fragments	C. Aungtonya & V. Vongpanich
	OS	23/02/2000	006°45 ′N	098°04 ′E	006°45 ′N	098°04 ′E	317	317	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	23/02/2000	006°45 ′N	098°02 ′E	006°45 ′N	098°02 ′E	320	321	ND	C. Aungtonya & V. Vongpanich
	AT	23/02/2000	006°45 ′N	098°06 ′E	006°44 ′N	098°05 ′E	303	313	ND	C. Aungtonya & V. Vongpanich
L8	BC	22/02/2000	006°45 ′N	097°34 ′E	-	-	512	-	mud	C. Aungtonya & V. Vongpanich
	OS	22/02/2000	006°45 ′N	097°35 ′E	006°45 ′N	097°35 ′E	503	503	mud	C. Aungtonya & V. Vongpanich
	AT	22/02/2000	006°45 ′N	097°36 ′E	006°44 ′N	097°34 ′E	482	507	ND	C. Aungtonya & V. Vongpanich
	T	22/02/2000	006°46 ′N	097°33 ′E	006°44 ′N	097°35 ′E	513	501	ND	C. Aungtonya & V. Vongpanich
L10	BC	22/02/2000	006°45 ′N	097°24 ′E	-	-	699	-	mud	C. Aungtonya & V. Vongpanich
	OS	21/02/2000	006°44 ′N	097°25 ′E	006°44 ′N	097°24 ′E	690	693	ND	C. Aungtonya & V. Vongpanich
	OS	22/02/2000	006°43 ′N	097°25 ′E	006°43 ′N	097°25 ′E	675	677	mud	C. Aungtonya & V. Vongpanich
	AT	21/02/2000	006°45 ′N	097°23 ′E	006°44 ′N	097°26 ′E	707	651	ND	C. Aungtonya & V. Vongpanich
L12	BC	21/02/2000	006°45 ′N	097°18 ′E	-	-	918	-	mud	C. Aungtonya & V. Vongpanich
	OS	21/02/2000	006°45 ′N	097°20 ′E	006°45 ′N	097°20 ′E	860	860	mud	C. Aungtonya & V. Vongpanich
	AT	21/02/2000	006°45 ′N	097°18 ′E	006°45 ′N	097°16 ′E	940	988	ND	C. Aungtonya & V. Vongpanich
RN1	BC	08/05/1996	007°30 ′N	098°22 ′E	-	-	63	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	007°30 ′N	098°22 ′E	007°29 ′N	098°22 ′E	64	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°30 ′N	098°22 ′E	007°30 ′N	098°22 ′E	63	-	ND	S. Bussarawit & C. Aungtonya
RN2	BC	08/05/1996	007°26 ′N	098°19 ′E	-	-	75	-	sand with shell fragments	S. Bussarawit & C. Aungtonya

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	OS	08/05/1996	07°26 ′N	098°18 ′E	07°26 ′N	098°18 ′E	75	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	07°26 ′N	098°18 ′E	07°26 ′N	098°18 ′E	74	-	ND	S. Bussarawit & C. Aungtonya
RN3	BC	08/05/1996	07°30 ′N	098°17 ′E	-	-	72	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	07°30 ′N	098°17 ′E	07°30 ′N	098°17 ′E	72	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	07°30 ′N	098°18 ′E	07°31 ′N	098°18 ′E	70	-	ND	S. Bussarawit & C. Aungtonya
RY1	BC	08/05/1996	07°36 ′N	098°19 ′E	-	-	55	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	07°37 ′N	098°20 ′E	07°37 ′N	098°20 ′E	55	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	22/02/1998	07°35 ′N	098°16 ′E	07°34 ′N	098°17 ′E	68	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	07°36 ′N	098°19 ′E	07°37 ′N	098°20 ′E	55	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	07°35 ′N	098°16 ′E	07°35 ′N	098°16 ′E	70	-	ND	S. Bussarawit & C. Aungtonya
	BT	01/12/1998	07°37 ′N	098°15 ′E	07°36 ′N	098°13 ′E	67	-	ND	S. Bussarawit
	T	02/12/1998	07°37 ′N	098°16 ′E	07°38 ′N	098°17 ′E	71	-	ND	S. Bussarawit
RY2	BC	08/05/1996	07°39 ′N	098°23 ′E	-	-	45	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	07°40 ′N	098°24 ′E	07°39 ′N	098°24 ′E	44	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	07°39 ′N	098°24 ′E	07°38 ′N	098°24 ′E	43	-	ND	S. Bussarawit & C. Aungtonya
RY3	BC	08/05/1996	07°36 ′N	098°25 ′E	-	-	49	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	07°36 ′N	098°25 ′E	07°35 ′N	098°26 ′E	50	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	07°35 ′N	098°26 ′E	07°35 ′N	098°26 ′E	52	-	ND	S. Bussarawit & C. Aungtonya
PB1	BC	23/04/1997	08°00 ′N	098°29 ′E	-	-	19	-	sand with shell fragments	S. Bussarawit
	OS	23/04/1997	08°00 ′N	098°29 ′E	08°00 ′N	098°29 ′E	17	-	sand with shell fragments	S. Bussarawit
	TD	23/04/1997	07°59 ′N	098°29 ′E	07°59 ′N	098°29 ′E	14	-	ND	S. Bussarawit
PB2	BC	22/04/1997	08°00 ′N	098°39 ′E	-	-	17	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	07°59 ′N	098°39 ′E	07°58 ′N	098°39 ′E	20	-	sand with shell fragments	S. Bussarawit
	TD	22/04/1997	08°00 ′N	098°38 ′E	07°59 ′N	098°39 ′E	15	-	ND	S. Bussarawit
PB3	BC	23/04/1997	07°51 ′N	098°32 ′E	-	-	22	-	sand with shell fragments	S. Bussarawit
	OS	23/04/1997	07°51 ′N	098°31 ′E	07°52 ′N	098°31 ′E	20	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	07°51 ′N	098°34 ′E	07°51 ′N	098°34 ′E	28	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	27/02/1998	07°48 ′N	098°31 ′E	07°48 ′N	098°30 ′E	24	-	ND	S. Bussarawit & C. Aungtonya
	OS	04/12/1998	07°49 ′N	098°31 ′E	07°49 ′N	098°31 ′E	22	-	ND	S. Bussarawit
	TD	23/04/1997	07°52 ′N	098°31 ′E	07°52 ′N	098°30 ′E	22	-	ND	S. Bussarawit
	TD	21/02/1998	07°51 ′N	098°32 ′E	07°51 ′N	098°33 ′E	33	-	ND	S. Bussarawit & C. Aungtonya
	TD	04/12/1998	07°48 ′N	098°31 ′E	07°49 ′N	098°31 ′E	20	-	ND	S. Bussarawit
	T	21/04/1997	07°48 ′N	098°28 ′E	07°49 ′N	098°32 ′E	21	-	ND	S. Bussarawit
	T	04/12/1998	07°48 ′N	098°29 ′E	07°49 ′N	098°31 ′E	22	-	ND	S. Bussarawit

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
PB3-PB4	T	21/02/1998	07°51 'N	098°37 'E	07°51 'N	098°39 'E	21	-	ND	S. Bussarawit & C. Aungtonya
	T	04/12/1998	07°51 'N	098°38 'E	07°49 'N	098°40 'E	22	-	ND	S. Bussarawit
PB4	BC	22/04/1997	07°52 'N	098°41 'E	-	-	32	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	07°52 'N	098°41 'E	07°52 'N	098°41 'E	31	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	07°52 'N	098°41 'E	07°52 'N	098°42 'E	29	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	07°52 'N	098°41 'E	07°52 'N	098°42 'E	33	-	ND	S. Bussarawit
	TD	21/02/1998	07°52 'N	098°40 'E	07°52 'N	098°41 'E	29	-	ND	S. Bussarawit & C. Aungtonya
PB5	BC	22/04/1997	07°52 'N	098°48 'E	-	-	21	-	sand with shell fragments	S. Bussarawit
PB6	BC	22/04/1997	07°45 'N	098°32 'E	-	-	30	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	07°45 'N	098°32 'E	07°45 'N	098°32 'E	30	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	07°43 'N	098°33 'E	07°44 'N	098°33 'E	37	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	07°46 'N	098°31 'E	07°47 'N	098°31 'E	27	-	ND	S. Bussarawit
	TD	21/02/1998	07°44 'N	098°33 'E	07°44 'N	098°32 'E	34	-	ND	S. Bussarawit & C. Aungtonya
	T	27/02/1998	07°45 'N	098°36 'E	07°47 'N	098°34 'E	24			S. Bussarawit & C. Aungtonya
PB7	BC	22/04/1997	07°45 'N	098°41 'E	-	-	29	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	07°45 'N	098°41 'E	07°45 'N	098°41 'E	32	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	07°44 'N	098°41 'E	07°44 'N	098°41 'E	32	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	07°45 'N	098°40 'E	07°45 'N	098°40 'E	30	-	ND	S. Bussarawit
	TD	21/02/1998	07°45 'N	098°42 'E	07°44 'N	098°41 'E	30	-	ND	S. Bussarawit & C. Aungtonya
	T	21/02/1998	07°44 'N	098°40 'E	07°43 'N	098°36 'E	32	-	ND	S. Bussarawit & C. Aungtonya
PB8	BC	22/04/1997	07°45 'N	098°52 'E	-	-	19	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	07°45 'N	098°51 'E	07°44 'N	098°51 'E	19	-	sand with shell fragments	S. Bussarawit
	TD	22/04/1997	07°44 'N	098°51 'E	07°44 'N	098°50 'E	22	-	ND	S. Bussarawit
PB9	TD	05/12/1998	07°40 'N	098°37 'E	07°39 'N	098°37 'E	36	-	ND	S. Bussarawit
PB10	OS	05/12/1998	07°36 'N	098°34 'E	07°36 'N	098°34 'E	41	-	ND	S. Bussarawit
	T	05/12/1998	07°36 'N	098°34 'E	07°32 'N	098°33 'E	44	-	ND	S. Bussarawit
U1	G	19/04/1997	06°49 'N	097°45 'E	-	-	400	-	sandy mud	S. Bussarawit
	OS	19/04/1997	06°46 'N	097°44 'E	06°46 'N	097°44 'E	416	-	sandy mud	S. Bussarawit
	TD	19/04/1997	06°48 'N	097°45 'E	06°46 'N	097°44 'E	402	-	ND	S. Bussarawit
U2	G	18/04/1997	07°03 'N	097°32 'E	-	-	476	-	sandy mud	S. Bussarawit
	TD	18/04/1997	07°04 'N	097°31 'E	07°05 'N	097°31 'E	476	-	ND	S. Bussarawit
U3	G	17/04/1997	06°55 'N	097°22 'E	-	-	669	-	soft mud	S. Bussarawit
	TD	17/04/1997	06°57 'N	097°22 'E	06°56 'N	097°21 'E	651	-	ND	S. Bussarawit
U4	G	15/04/1997	07°02 'N	097°08 'E	-	-	989		soft mud	S. Bussarawit

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
	G	28/01/1999	00°07 ′N	097°04 ′E	-	-	965		mud	S. Bussarawit & C. Aungtonya
	G	16/11/1999	00°06 ′N	097°04 ′E	-	-	964		mud	C. Aungtonya & V. Vongpanich
	OS	28/01/1999	00°06 ′N	097°05 ′E	00°06 ′N	097°05 ′E	960	960	mud	S. Bussarawit & C. Aungtonya
	AT	16/11/1999	00°07 ′N	097°03 ′E	00°07 ′N	097°01 ′E	967	964	ND	C. Aungtonya & V. Vongpanich
U5	G	15/04/1997	006°56 ′N	097°03 ′E	-	-	1020	-	soft mud	S. Bussarawit
U6	BC	09/04/1997	007°21 ′N	097°51 ′E	-	-	324	-	rock	S. Bussarawit
	G	09/04/1997	007°21 ′N	097°50 ′E	-	-	324	-	rock	S. Bussarawit
	TD	09/04/1997	007°21 ′N	097°51 ′E	007°20 ′N	097°50 ′E	324	-	ND	S. Bussarawit
U7	G	13/04/1997	007°19 ′N	096°59 ′E	-	-	929	-	soft mud	S. Bussarawit
	TD	13/04/1997	007°16 ′N	096°59 ′E	007°15 ′N	096°59 ′E	935	-	ND	S. Bussarawit
U8	G	11/04/1997	007°56 ′N	096°48 ′E	-	-	640	-	soft mud	S. Bussarawit
	TD	11/04/1997	007°55 ′N	096°47 ′E	007°53 ′N	096°46 ′E	643	-	ND	S. Bussarawit
U9	G	14/04/1997	007°00 ′N	096°51 ′E	-	-	1020	-	soft mud	S. Bussarawit
	OS	14/04/1997	007°00 ′N	096°51 ′E	007°00 ′N	096°52 ′E	1020	-	soft mud	S. Bussarawit
	TD	14/04/1997	006°59 ′N	096°54 ′E	006°58 ′N	096°56 ′E	1020	-	ND	S. Bussarawit
U10	BC	12/04/1997	007°25 ′N	096°15 ′E	-	-	880	-	soft mud	S. Bussarawit
	G	12/04/1997	007°25 ′N	096°15 ′E	-	-	879	-	soft mud	S. Bussarawit
	TD	12/04/1997	007°25 ′N	096°18 ′E	007°25 ′N	096°20 ′E	878	-	ND	S. Bussarawit
T1	OS	24/02/1998	007°02 ′N	098°50 ′E	007°01 ′N	098°50 ′E	75	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	007°02 ′N	098°49 ′E	007°02 ′N	098°50 ′E	76	-	ND	S. Bussarawit & C. Aungtonya
T2	OS	25/02/1998	006°43 ′N	098°57 ′E	006°44 ′N	098°57 ′E	72	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	TD	25/02/1998	006°43 ′N	098°58 ′E	006°43 ′N	098°57 ′E	71	-	ND	S. Bussarawit & C. Aungtonya
T3	T	03/12/1998	007°52 ′N	098°06 ′E	007°50 ′N	098°06 ′E	68	-	ND	S. Bussarawit
Z1	G	10/02/1999	009°07 ′N	097°05 ′E	-	-	360	-	gravel	S. Bussarawit & C. Aungtonya
	TD	10/02/1999	009°07 ′N	097°05 ′E	009°06 ′N	097°06 ′E	358	356	ND	S. Bussarawit & C. Aungtonya
Z2	G	23/01/1999	007°42 ′N	097°28 ′E	-	-	467	-	sand	S. Bussarawit & C. Aungtonya
	OS	24/01/1999	007°42 ′N	097°29 ′E	007°42 ′N	097°29 ′E	458	480	sand	S. Bussarawit & C. Aungtonya
	T	23/01/1999	007°42 ′N	097°28 ′E	007°42 ′N	097°31 ′E	464	464	ND	S. Bussarawit & C. Aungtonya
Z3	T	24/01/1999	007°42 ′N	097°20 ′E	007°42 ′N	097°18 ′E	493	322	ND	S. Bussarawit & C. Aungtonya
Z4	OS	25/01/1999	007°35 ′N	097°06 ′E	007°35 ′N	097°07 ′E	620	610	mud	S. Bussarawit & C. Aungtonya
	T	25/01/1999	007°34 ′N	097°03 ′E	007°35 ′N	097°04 ′E	660	633	ND	S. Bussarawit & C. Aungtonya
Z5	G	24/01/1999	007°38 ′N	096°57 ′E	-	-	713	-	mud	S. Bussarawit & C. Aungtonya
Z6	OS	27/01/1999	007°25 ′N	097°22 ′E	007°25 ′N	097°21 ′E	541	551	mud	S. Bussarawit & C. Aungtonya

Apendix 1 (continued.)

Station	Gear	Date	Start Point		End Point		Depth (m)		Type of sediment	Collector
			Lat.	Long.	Lat.	Long.	Start	End		
Supplementary crustacean material:										
NBA	OS	23/11/1997	007°37 ′N	098°17 ′E	-	-	50	-	coarse sand	N. Bruce & G. Dinesen
NBB	OS	27/11/1997	007°40 ′N	098°20 ′E	-	-	60	-	coarse sand	N. Bruce & G. Dinesen
NBC	OS	03/12/1997	007°43 ′N	098°24 ′E	-	-	45	-	coarse sand	N. Bruce & G. Dinesen
NBD	OS	09/12/1997	007°44 ′N	098°24 ′E	-	-	40	-	coarse sand	N. Bruce & G. Dinesen
Aeo Island (NW bay)	SCUBA	26/11/1998	007°45 ′N	098°24 ′E	-	-	max. Depth 6 m.		ND	A. Myers, J. Lowry, R. Evans,M. Huggett, M. Storey, P. Davie, and G. Dinesen
Dok Mai Island	SCUBA	04/12/1998	007°47 ′N	098°32 ′E	-	-	max. Depth 25 m.		ND	same as above
Hae Island (north bay)	SCUBA	02/11/1998	007°45 ′N	098°23 ′E	-	-	max. Depth 8.5 m		ND	same as above
Hae Island (south bay)	SCUBA	09/12/1998	007°44 ′N	098°22 ′E	-	-	max. Depth 12 m.		ND	same as above
Hae Island (north bay)	SCUBA	09/12/1998	007°45 ′N	098°23 ′E	-	-	max. Depth 10 m.		ND	same as above
Racha Yai Island (south point)	SCUBA	05/12/1998	007°35 ′N	098°21 ′E	-	-	max. Depth 30 m.		ND	same as above
Racha Yai Island (NW bay)	SCUBA	05/12/1998	007°36 ′N	098°22 ′E	-	-	max. Depth 12 m.		ND	same as above
Racha Noi Island (south bay)	SCUBA	14/12/1998	007°28 ′N	098°18 ′E	-	-	max. Depth 25 m.		ND	same as above
Racha Noi Island (NW bay)	SCUBA	14/12/1998	007°27 ′N	098°18 ′E	-	-	max. Depth 15 m.		ND	same as above
Racha Noi Island	Trap	08/11/1999	007°31 ′N	098°20 ′E	-	-	47	-	ND	C. Aungtonya & V. Vongpanich
about 30 mile from south of Racha Noi Island	Trap	15/11/1999	007°00 ′N	098°25 ′E	-	-	75	-	ND	C. Aungtonya & V. Vongpanich
Ta Chai Island	Trap	02/02/2000	009°04 ′N	097°48 ′E	-	-	45	-	ND	C. Aungtonya & V. Vongpanich
Hin Dang Island	Trap	26/02/2000	007°09 ′N	098°50 ′E	-	-	65	-	ND	C. Aungtonya & V. Vongpanich
Adang Island	Trap	27/02/2000	006°30 ′N	099°18 ′E	-	-	22	-	ND	C. Aungtonya & V. Vongpanich
Bu Tang Island	Trap	28/02/2000	006°31 ′N	099°09 ′E	-	-	46	-	ND	C. Aungtonya & V. Vongpanich

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SUMMARY OF THE THAI-DANISH BIODIVERSITY PROJECT ON THE ANDAMAN SEA CONTINENTAL SHELF AND SLOPE (1996–2000)

Somchai Bussarawit[1], Ole SecherTendal[2], Claus Nielsen[2] and Arne Redsted Rasmussen[3]

[1]*Phuket Marine Biological Center, Phuket, Thailand*
[2]*Zoological Museum, University of Copenhagen, Denmark*
[3]*Royal Academy of Fine Arts, School of Conservation, Denmark*

ABSTRACT: The scientific cooperation programme on marine biodiversity in the Andaman Sea shelf and slope was conducted in connection with the supply of a marine research vessel by Danida, Ministry of Foreign Affairs, Denmark to Phuket Marine Biological Center, Department of Fisheries, Thailand during 1996–2000. A total of 114 stations from 12 transects were sampled at depths ranging from 20 to 1,020 m, including additional diving sampling. The activities included Thai, Danish and other international participants and experts; a national training course and workshop on starch gel electrophoresis, plus a national workshop on cladistics and phylogeny. Three international workshops on the biology of sea snakes, on biodiversity of polychaetes and on biodiversity of crustacea in the Andaman Sea were held. At least 200 new species of polychaetes and crustaceans were discovered and described from the collected materials under the SCP programme. The biodiversity research study of the collected deep water fauna will be published in a special volume including vertebrates and invertebrates. To replace the Danida supported programme (1996–2000) in the future a Danced project (2002–2006) with emphasis on marine biodiversity is discussed together with a plan to promote PMBC as a Center of Excellence for marine biodiversity research, education and training in the region.

INTRODUCTION

Knowledge of the diversity of organisms and communities is the foundation for understanding the structure and function of marine communities. Knowledge of the species is fundamental to work on predicting the role of human-mediated and natural processes that might change the oceanic ecosystem. Adequate understanding of what creates and maintains biological diversity must be the scientific underpinning for political decisions regarding pollutant and waste disposal, habitat alteration, fisheries management and the preservation of threatened or endangered species. However, data on biodiversity patterns and their causes are lacking for most marine ecosystems, and the inability, at this time, to provide this information to policy makers has profound implications for the conservation of marine life.

The Andaman Sea is undersampled and underdescribed in terms of biological diversity. There are large numbers of undescribed species in familiar environments, such as coral reefs and the pelagic zone, and there are environments like the continental slope, which are so undersampled, that scarely any knowledge exists.

The Biodiversity of the Andaman Sea Continental Shelf and Slope (BIOSHELF) project during 1996–2000 has been supported by the Scientific Cooperation Programme (SCP) between Denmark and Thailand in connection with the supply of the marine research vessel R/V "Chakratong Tongyai" from Danida to Phuket Marine Biological Center, Department of

Fisheries, Thailand.

The objectives of the project are to expand the general knowledge of the biodiversity of benthic fauna at depths down to 1,000 m within the Thai EEZ and to provide additional specimens to be deposited in the PMBC Reference Collection.

Background

The Andaman Sea and the project goals

The Andaman Sea is a closed basin with depths down to about 4,000 m, with the deepest connection to the Indian Ocean at 1,300–1,400 m between the Nicobar Islands and Sumatra. Covering roughly 800,000 km² and being at maximum about 600 km wide the sea is completely divided into the Exclusive Economic Zones of India, Myanmar, Thailand, Malaysia and Indonesia, and represents an obvious goal for future regional co-operative work in oceanographic sciences. The deepest part is within the Indian EEZ. The Thai EEZ, which has a maximum depth of about 2,400 m, covers roughly 110,000 km², of which 94,000 lie between 100 and 600 m depth (Nishida and Sivasubramaniam 1986).

With the establishment of the Phuket Marine Biological Center in 1971 the Department of Fisheries and the Thai community got first hand access to information on the biocomplexity of local benthic ecosystems, such as coral reefs, mangroves and sea grass beds as well as on hydrography, productivity and other subjects. From the onset, most biological projects investigated species and communities in shallow water bottoms (<100 m depth), where most of the commercial fishery activity takes place. Interest in deep-water benthos came later, prompted by the extension of the EEZ and the search for exploitable demersal populations. Facilities for more comprehensive biodiversity studies came about with the inauguration of a new building for the Reference Collection at PMBC in 1983. With the delivery in November 1995 of the Danish-built R/V "Chakratong Tongyai" a modern research vessel of suitable size and capacity for work all over the Andaman EEZ was put at disposal for the PMBC, potentially adding new dimensions in regional scientific and educational efforts.

In connection with the supply of the research vessel, the 5-years Thai-Danish Cooperation Project 1996–2000 was formulated and launched. The Reference Collection Subdivision got responsibility for two individual benthos projects:

A. Biodiversity and Biomass of Demersal Invertebrates on the Shelf of the Andaman Sea off Phuket (BIOSHELF).

B. Biodiversity and Biomass of Demersal Invertebrates in deep Water beyond the Shelf of the Andaman Sea off Phuket (BIODEEP).

During the first cruise of 1999 it became evident that due to technical difficulties it was not possible to work in the deepest parts of the EEZ. The co-operation partners then agreed to concentrate the open sea efforts to the areas down to the 1,000 m depth contour. Because of the special topography of the shelf edge region it was decided to consider investigation of this and the upper part of the slope as an extension of the BIOSHELF project. When future economic circumstances allow for it a BIODEEP project in the part of the EEZ deeper than 1,000 m should be formulated and carried though by the Reference Collection.

The immediate objectives of BIOSHELF, as formulated in the contract of 1996 between The Zoological Museum (University of Copenhagen) and Danida, are to improve the knowledge of the structure, diversity and biomass of the benthic invertebrate communities on the margin (originally:shelf) of the Andaman Sea east of the 1,000 m (originally: 100 m) depth contour. Particular emphasis is on:

- A future assessment of potential fisheries resources,
- An examination of the geographical distribution of the biomes of invertebrates according to depth and type of sediment, and
- An examination of the biodiversity of invertebrates according to depth and type of sediment.

Early investigations of the bottom fauna of the Andaman Sea

Only a few of the renowned expeditions visited parts of the Andaman Sea, viz. the Austrian

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'Novara' (1857–1859), the German 'Valdivia' (1898–99) and the Danish 'Dana' (1928–30) and 'Galathea' (1950–52). They took few and scattered samples, adding only little to the knowledge of the fauna as a whole. More comprehensive sampling, mainly in Indian (around the Andaman Islands) and Burmese waters, was made between 1874 and 1925 by the two Royal Indian Marine ships both named 'Investigator', under the leadership of "the surgeon-naturalist"(Alcock, 1902; Rice, 1986; Sewell, 1954), but still the accounts of the bottom fauna were scarce and no proper regional picture emerged. A general view on the origin and distribution of the fauna was presented by the "surgeon-naturalist" R.B.S. Sewell, who filled this post from 1910 to 1925, when in a review of the supposed tertiary–quaternary development of the Andaman Sea and its connections to other seas he concluded (1925, p. 22): "These various channels have permitted the entry into the basin of the rich shallow-water fauna of both Indian and Pacific Oceans, whereas the deep fauna must have been derived from ancestors capable of living in moderate depths of less than 800–900 fathoms, who had already succeeded in establishing themselves in the Bay of Bengal, or else by recent migration of shallow water forms downwards into the deep waters of the basin."

Investigations in the Thai EEZ prior to the BIOSHELF programme

The first comprehensive invertebrate biodiversity study on invertebrates along the Thai coast of the Andaman Sea was initiated through Thai-Danish cooperation after the Second Worldwar. While the first four expeditions under the cooperation programme were largely limited to botanical work, the Fifth Thai-Danish Expedition in 1966 included marine sampling from the Burmese border in the north to the Malaysian border in the south. The expedition had at its disposal the research vessel "Dhanarajata", and during January and February close to 600 samples were taken from the shoreline to 80 m depth. The main gear for macrofauna was the Smith-McIntyre grab of 1/10 m^2 (420 samples), the contents of which were washed through a 2 mm sieve. At each sampling locality ten grabs were taken, supplemented by 2 Muus-sampler ("the mouse-trap", Muus, 1964) samples of 150 cm^2 for meiofauna. To these quantitative samples were added 30 triangle dredge samples, 30 trawl catches and nearly 40 shore-collected stations (Seidenfaden *et al.*, 1968).

The preliminary main conclusions were: 1) As to number of species, the Thai Andaman coast is one of the richest known. 2) The majority of these species are members of the epifauna. 3) Sandy–muddy bottoms are inhabited by a large number of species each represented by only a few specimens. 4) The biomass (wet weight) is low compared to Northern waters. 5) Sandy bottoms are markedly richer both in species and individuals than muddy bottoms. 6) There are indications that the productivity along the coast is comparatively low. 7) The numbers of animals decrease with increasing depth, a tendency evident from about 10 m depth (Seidenfaden *et al.*, 1968).

After the establishment of the Phuket Marine Biological Center Reference Collection, Biodiversity studies were continued, especially during 1980s (literature list in Aungtonya *et al.*, 2000, Hylleberg, 2001), including a quantitative programme (Chatanathawej and Bussarawit, 1987). In deeper waters, a few investigations have been performed down to about 400 m. They partly aim at potential natural resources, which for the invertebrates include species of prawns and deep-sea lobsters such as appeared in the Bay of Bengal Programme (Nishida and Sivasubramaniam, 1986), and at oceanographic conditions on fishing grounds in the Thai-Japanese Joint Oceanographic and Fisheries Survey in 1981 (Takahashi and Ruangsivakul, 1983) and the Southeast Asian Fisheries Development Center (SEAFDEC) studied in 1987 (Ananpongsuk, 1989).

Cruise activities

Quantitative and qualitative samples have been taken during 7 BIOSHELF cruises (see Aungtonya *et al.*, 2000 for station list). The actual operation days of the R/V "Chakratong Tongyai" during the five years were:

Cruise 1996; 16 Apr.–10 May 1996 (21 days)

Cruise 1997; 8–23 Apr. 1997 (26 days)
Cruise 1998;16–28 Feb. 1998 (13 days), 1–5 Dec.1998 (5 days)
Cruise 1999; 22 Jan.–13 Feb. 1999 (23 days), 8–21 Nov. 1999 (14 days)

During the cruises the following types of gear were used in each year:

Gears	Years				
	1996	1997	1998	1999	2000
Olsen box corer	x	x			x
Smith-McIntyre grab		x		x	x
Ockelmann sledge	x	x	x	x	x
Pierce-Rothlisberg hyperbenthic sledge				x	x
Triangular dredge	x	x	x	x	x
Rectangular dredge				x	x
Beam trawl			x		
Agassiz trawl				x	x
Otter trawl	x	x	x	x	x

Cooperative staff
Reference Collection, Phuket Marine Biological Center:
Mr. Somchai Bussarawit, Chief of Reference Collection Unit
Ms. Charatsee Aungtonya, Marine Biologist
Ms. Vararin Vongpanich, Marine Biologist
Mr. Santisuk Thaipal, Marine Biologist
Ms. Ratchanee Sirivejhabandhu, Technical Curator
Ms Teunjai Srisawad, Technical Assistant
Ms. Nittaya Thaiklang, Technical Assistant
Mr. Sahet Utsaha, Worker
Mr. Patairat Singdom, Artist
Ms. Duangjan Srisuwan, Database Assistant
Dr. Andrew Davison, Database Consultant

Senior Scientific Assistants (SSA):
Dr. Danny Eibye-Jacobsen, Zoological Museum, Copenhagen, Denmark
Dr. Niel L. Bruce, Primary Industry Department, Queensland, Australia
Dr. Matz Berggren, Kristineberg Marine Station, Gothenburg, Sweden
Dr. Ole Secher Tendal, Zoological Museum, Copenhagen, Denmark
Dr. Tomas Cedhagen, Department of Marine Ecology, Aarhus University, Denmark
Dr. Arne Redsted Rasmussen, Royal Academy of Fine Arts, Copenhagen, Denmark

Junior Scientific Assistants (JSA):
Dr. Monica Niklasson, Department of Marine Ecology, Aarhus University
Ms. Grete Dinesen, BIOCONSULT, Denmark
Mr. Torben Kristensen, Zoological Museum, Copenhagen, Denmark
Mr. Teunis Jansen, Zoological Museum, Copenhagen, Denmark
Mr. Tom Schiotte, Zoological Museum, Copenhagen, Denmark
Ms Marie Eiland, Zoological Museum, Copenhagen, Denmark

Training Courses and Workshops

1. Training Course and Workshop on Starch Gel Electrophoresis. Place: Phuket Marine Biological Center, Duration: 13–18 October 1996.

2. Workshop on Cladistics and Phylogeny. Place: Phuket Marine Biological Center, Duration: 18–22 December 1996.

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International Workshops

1. International Workshop on Biodiversity of Polychaetes in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 1 June–31 August 1997.

2. International Workshop on Biodiversity of Crustaceans in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 20 November–20 December 1998.

3. International Workshop on Biology of Sea Snakes in the Andaman Sea Place: Phuket Marine Biological Center, Duration: 18–22 January 1998.

Additional manuscripts for publication in PMBC Research Bulletin

The SCP collected samples of polychaetes and crustaceans during 1999–2000 which will be studied by the previous group of experts and are planned to be published in the regular Phuket Marine Biological Center Research Bulletin.

The Database of the Reference Collection

The Reference Collection database was set up with support from Danida by hiring staff (Dr. Andrew Davison, computer consultant, Asia Institute of Technology, Bangkok, and Dungjan Srisawad, database staff), which started from September 1997. The project activities covered a 2 years period terminating in August 1999. The computerized database of the contents in the PMBC Reference Collection (RC) with information about scientific name and individual specimens is updated and register catalogues of all groups are planned to be published on a regular basis in PMBC Research Bulletin.

Academic education

MSc scholarship

Ms. Vararin Vongpanich was funded by Danida to study for a Master of Science in the International Program on Marine Science, Aarhus University, Denmark, for 2 years during February 1997- January 1999. She did the thesis study under supervision of Assoc. Prof. Jorgen Hylleberg on the topic "Systematics of the bivalve mollusc family Mactridae".

PhD scholarship

Mr. Somchai Bussarawit was funded by Danida to study for a PhD in the International Programme on Marine Sciences at Aarhus University, Denmark, under supervision of Assoc. Prof. Dr. Tomas Cedhagen enrolled from 1 September till 31 August 2002. A total of 12 months travel to Denmark was supported by the Danida Fellowship Center for mandatory courses and supervision. The thesis topic was "Systematics of Oysters (Family Ostreidae and Gryphaeidae) of Thailand (Gulf of Thailand and the Andaman Sea).

Ms. Charatsee Aungtonya was funded by Danida to study for a PhD in the University of Copenhagen, Denmark, under the supervision of Dr. Danny Eibye-Jacobsen, Zoological Museum, enrolled from 1 March 2000 till February 2003. A total of 12 months travel to Denmark was supported by the Danida Fellowship Center for mandatory courses and supervision. The thesis topic was "The phylogeny and systematics of Sigalionidae (Annelida; Polychaeta) with a taxonomic study of the species found in the Andaman Sea of Thailand".

Regional Danida project on Sea snakes

Sea snakes are the most common and widely spread poisonous reptiles in the world. Sea snakes occur in the tropical and subtropical areas of the Indian Ocean and in the Pacific Ocean, with most species concentrated in the Bengal Bay, the Indo-Malaysia area, the China Sea, Indonesia and the Australian region. Most species are found in shallow waters around islands, mouths of rivers and along coastlines. Sea snakes are related to terrestrial elapids (e.g. cobra, mamba coral snakes, and Australian poison snakes) and are called proteroglyph snakes because of the position of the fang in front of the maxillary bone.

The investigation of the venom of sea snakes using "LD50" toxicity tests shows that sea snakes have one of the most poisonous venom's found in snakes. The typical victim is a fisherman, sorting out fish from a bag-net, or on board a trawling boat or using a pull-net in a river mouth. Although we know that sea snakes can be very numerous locally and that sea snake bites occur

frequently, our knowledge about the biology and epidemiology is very limited.

Research on monovalent and polyvalent serum against snakebite shows that only monovalent serum neutralises the venom effectively. It is therefore of great importance that the species can be distinguished from each other during serum production and during the treatment of a victim.

Sea snakes have been collected and used commercially over the last 70 years. In the Philippines some populations have disappeared since the early 80 because of overexploitation and in most areas of the Indian and the Pacific Oceans snake fisheries are not reported on in the literature and are beyond control of local governments.

Goal

To solve some of the above mentioned problems a collaborative project was started in 1996 with cross-disciplinary scientists from Great Britain, India, Indonesia, Philippines and Thailand (PMBC); later on also scientists from Cambodia and Vietnam participated. The main goals were to produce a monograph on sea snakes, to get the necessary knowledge on taxonomy and biology to produce serum against bite, and to obtain a sustainable exploitation of the sea snakes.

In co-operation with partners from the involved institutions sea snake specimens have been collected and examined in Cambodia, India, Indonesia, Philippines and Thailand. Lectures on sea snake biology for students at local universities have been given together with partners. Local reference collections have been started, and sea snake literature is now available in the institutes of the collaborative partners together with identification guides, including slides. To get an idea about incidence of sea snake bites local hospitals have been contacted and the information has been gathered.

Future cooperation project in marine biodiversity under Danced (2002-2006)

The updated Danced assistance to Thailand (letter dated 21 February 2001) specifies priority areas for the new country programme 2002–2006 (CP III). One of the four priorities listed is "Protection of biodiversity".

Projects so far have e.g. targeted on the Convention on Biological Diversity, the Convention on International Trade of Endangered Species (CITES) and the Ramsar Convention. Danced proposes a focused thematic approach with specific emphasis on implementation of the Convention on Biological Diversity; the Ramsar Convention; the Washington Convention and giving priority to regional co-operation on international conventions. This includes development of policies and regulations as well as implementation of obligations; and sector integration. Support to implementation of international conventions and agreements have high Danced priority as emphasized by the Danish Parliament. Many ecosystems are under threat in Thailand and full implementation of a range of international conventions is still lacking. One example is the Biodiversity Convention signed by Thailand in 1992 but not yet ratified after 9 years.

The PMBC Reference Collection unit plan to propose activities under future Danced support projects as follows;

1. Biodiversity research and monitoring of marine fauna and flora of the Andaman Sea coast of Thailand with emphasis on important groups in different habitats, such as coral reefs, mangroves, seagrass beds, sandy beaches, muddy beaches, rocky shores, soft bottoms, hard bottoms, and deep water fauna.
2. Expand PMBC Reference Collection which was donated by Danida in 1983 on occasion of Ratanakosin Bicentenial Celebration to be a Center of Excellence of marine reference materials and research and monitoring training for the region.
3. Organize training courses on marine biodiversity research for the next generation and public by PMBC staff.
4. Arrange workshops on marine biodiversity on different taxonomic groups including genetic biodiversity research for young biologists in Thailand and in the region by inviting international experts as resource persons.
5. Capacity building for young marine biodiversity biologists in Thailand, Denmark and network

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countries in the Asean region under Danced/ Danida cooperative project.

6. Launch a biodiversity media and poster campaign for protection information, sustainable use and conservation.

ACKNOWLEDGEMENTS

We would like to thank Danida and PMBC for supporting the BIOSHELF project and organizing the SCP closing conference in February 2001. Thanks to all participants and experts who participated in the SCP cruises onboard R/V "Chakratong Tongyai" and the coastal research vessel "Boonlert Phasuk" and/or in the workshops. A special thank to Monica Niklasson, Danny Eibye-Jacobsen, Niel Bruce, Matz Berggren, Charatsee Aungtonya and the staff of the Reference Collection; without their support the activity under the BIOSHELF project would not have been successful,

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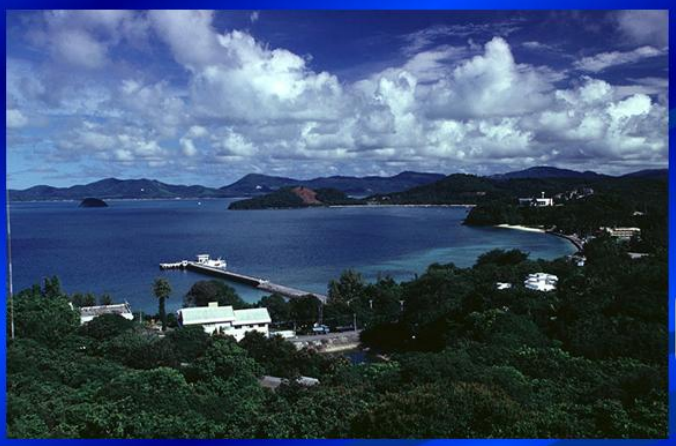
Phuket Marine Biological Center (PMBC)

Department of Marine and Coastal Resources
Ministry of Natural Resources and Environment



Charatsee Aungtonya

1

Experiences and Lessons Learned:

The Thai-Danish Biodiversity Project on the Andaman Sea continental shelf and slope 1996–2000

2

Scientific Cooperation Programme (SCP) between Denmark and Thailand

The research vessel is used for research and survey in oceanography and marine living resources, including marine biodiversity and endangered species.

Chakratong Tongyai R/V (38.4 m; GT 464) provided by Danish Government in 1995

3

The project on marine biodiversity in the Andaman Sea continental shelf and slope

Zoological Museum, Copenhagen University, Denmark, and the Reference Collection Subdivision, PMBC

– Biodiversity and biomass of demersal invertebrates on the shelf of the Andaman Sea off Phuket or BIOSHELF.

– Biodiversity and biomass of demersal invertebrates in deep water beyond the shelf of the Andaman Sea off Phuket or BIODEEP.

4

Project cooperation

PMBC: the Reference Collection staff
the crew of the R/V Chakratong Tongyai

Denmark : Copenhagen University, and Aarhus University
- Senior Scientific Assistants (or SSA)
- Junior Scientific Assistants (or JSA)

- to assist in methods of collection
- to train groups of young Thai marine biologists and crew members in the use of new sampling gear
- to further familiarize them with sample treatment and in the working-up of material of particular groups

5

1.
Dr. Somchai Bussarawit , Chief of Reference Collection Unit, PMBC (left)
Danish scientists from ZMUC:
- Associate Prof. Ole Tendal (SSA), an expert on Sea sponges, corals, molluscs, deep sea, and invasive species (middle) and
- Associate Prof. Danny Eibye-Jacobson (SSA) , an expert on Polychaete worms, brittle stars, sea urchins, and sea cucumbers (right)

2.
Mr. Tom Schiøtte (JSA) (right)

3.
Danish scientists from Aarhus University :
Associate Prof. Tomas Cedhagen (SSA) , an expert on foraminifera (middle)

6

Project activities

- Cruise activities:
  - Sampling methods
  - Treatment for benthos samples/fish and large invertebrate samples)
- Fauna study, e.g., international workshops :
  - workshop on biodiversity of polychaetes
  - workshop on biodiversity of crustacea

  etc.
- Other activities, e.g., national training courses and workshops :
  - workshop on cladistics and phylogeny

  etc.

7

Cruise activities

quantitative and qualitative samples : 6 main cruises

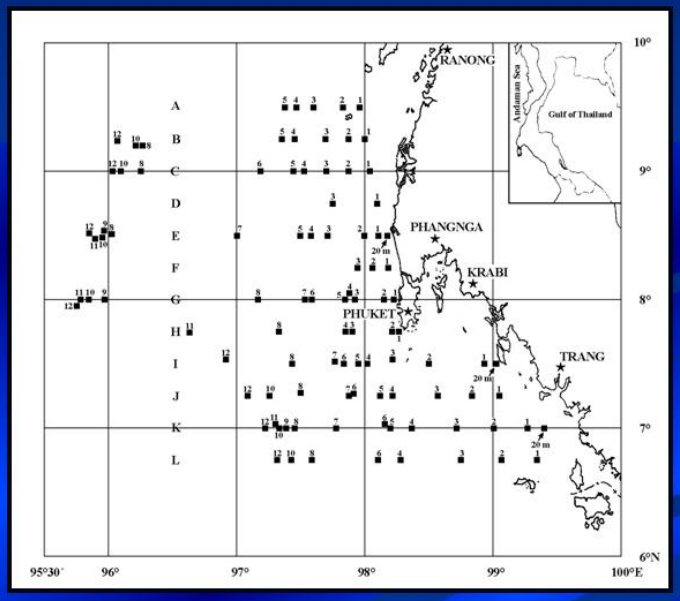
136 stations in the Thai EEZ : BIOSHELF and BIODEEP
20 – 1,020 m

"Summary of the Thai-Danish Biodiversity Project on the Andaman Sea continental shelf and slope"

- The Andaman Sea and the project goals
- Early investigations of the bottom fauna of the Andaman Sea
- Investigations in the Thai EEZ prior to the BIOSHELF programme.

8

Study area: cover the west coast of Thailand from the Burmese border in the north to the Malaysian border in the south



the project goals:

– to gain more basic knowledge of the diversity of benthos at depths down to 1000 m within the Thai Economic Exclusive Zone (or the Thai EEZ)

– to provide additional specimens to be deposited in the PMBC Reference Collection.

9

Deep-water surveys 1996–2000

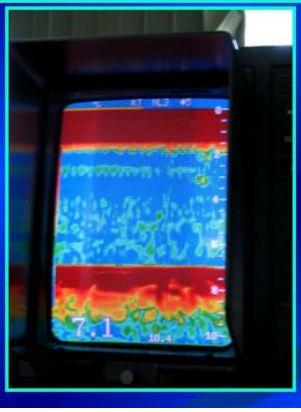
				No. of used times							
	No. of sampling station	min. depth (m)	max. depth (m)	Box corer	Smith-McIntyre grab	Ockel-mann sledge	Rothlisberg-Pearcy epibenthic sledge	Trian-gular dredge	Rectan-gular dredge	Agassiz trawl	Otter trawl
Cruise 1996	5	191	233	5	–	–	X	3	X	X	–
Cruise 1997	12	324	1,020	2	12	4	X	9	X	X	–
Cruise 1998	1	–	342	–	–	–	X	1	X	X	–
Cruise 1999 (Jan–Feb.)	20	192	965	–	7	10	X	4	X	X	4
Cruise 1999 (Nov.)	13	220	967	–	7	–	4	1	6	6	–
Cruise 2000 (Feb–March)	31	193	988	8	14	9	1	11	–	16	6

10

Sampling gears on deck of R/V Charkratong Tongyai
Rothlisberg-Pearcy epibenthic sledge, Agassiz trawl,
and Otter trawl

11

Echo-sounder & bottom type



Red = hard substratum
Green = soft substratum

12

Soft-bottom

14

"Olausen" or "Olsen" box corer

- quantitative gear
- penetration depth is 40 cm

15

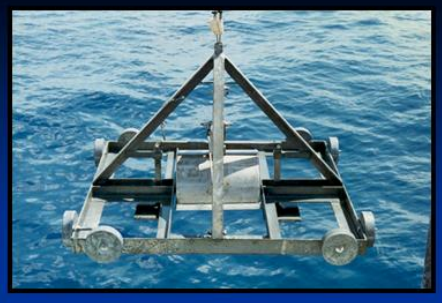
The box corer

The 600 cm^2 box corer is from KC Denmark Research Equipment.

The frame is made of square galvanized steel tube. Mounting, releaser, shovel, wires and sampling boxes are of stainless steel.

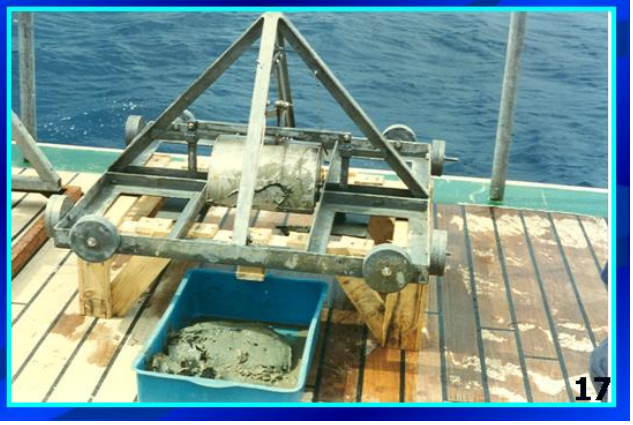
The fully mounted gear measures 210 cm in height and 110 cm in width. The area of the sampling box is 29 x 20,7 cm (~600 cm^2).

16



Smith-McIntyre Grab

- quantitative gear
- maximum penetration depth is 20 cm.



17

Smith-McIntyre Grab

A modified version of the 0.1 m^2 Smith-McIntyre grab, made by Duncan and Associates, Cumbria, UK was used on soft and sandy bottoms during the first cruises.

During the later cruises 2 locally built copies were on board. One of them closed but did not take any sample. The other worked tolerably well, but on the last cruise also that one failed.

The above-mentioned modifications concern the release mechanism and the mounting in a kind of frame.

18

Ockelmann Sledge

to collect animals from the bottom surface and the uppermost layers of the sediment

19

Ockelmann Sledge

The sledge is from KC Denmark Research Equipment. The model used has a frame of 5 mm aluminium, which is 2 m long, 1 m wide and 17 cm high. It has a protective canvas sheet on both large sides. The 2 m long and 1 m wide plankton net bag is of 0.5 mm mesh size.

The weight and balance can be regulated by adding up to 10 kg of lead weights on each side.

The sledge should always be used with a weak link on the drag wire, and a security wire attached to the rear end of one of the runners to pull the sledge free if fastened to an obstacle on the bottom.

20

Rothlisberg-Pearcy epibenthic sledge

- to collect the hyperbenthic fauna.
- samples are in principle taken at 6–36 cm above the bottom, but front turbulence results in the interspersion of some mud and near-bottom water.

21

Rothlisberg-Pearcy epibenthic sledge

A locally build sledge made of 8 and 10 mm rustfree steel. The very solid frame is 90 cm wide, 70 cm high and 1.2 m long. It has 2 curved steel pieces on the sides of the front for drag wire attachment, with a choice of three positions in 3 pairs of "eyes". The two 30 cm broad runners on the underside are spaced 30 cm. An "eye" for a security wire is inserted on top back. The box carrying and suspending the net measures 70 x 30 x 75 cm and is fixed inside the frame with screws, 6 cm above the bottom. The front end of the box is provided with a door that, by the action of a hinged "foot", opens at ground contact and closes when the gear leaves the bottom.

The plankton net bag has a mesh size of 0.5 mm and is 4 m long. The terminal plastic cylinder, which is 10 cm in diameter and 30 cm long, can be screwed off. For protection of the net underside a thick rubber sheet is mounted on the lower rear end of the frame.

22

Treatment for benthos samples: macrofauna

The samples were carefully sieved through 2 mm and 1 mm mesh screens. All material retained by these screens was fixed in 10% buffered formalin.

23

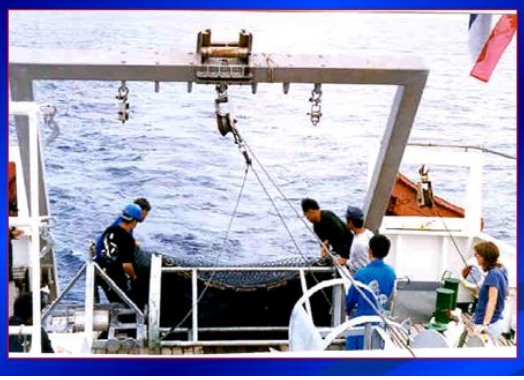
Treatment for benthos samples: meiofauna

separate sediment samples were specifically treated in order to be used in the study of meiofauna.

24

Agasszi trawl

- It is one of the best tools in deep-water and deep-sea investigation.
- 2 m wide Agassiz trawl was used for the catch of large, scattered invertebrates.



25

2 m wide Agassiz trawl

This gear is a rustfree steel tube construction, locally build after suggestions on dimensions by Associate Professor Ole Tendal.

The frame is 2 m wide, 1 m high, and 1,20 m long. The double netbag is 4 m long, with outer net of 4 cm meshes and inner net of 1.5 cm meshes.

The net bag is fastened with shackles, so it is easy to change in case of damage. The net bag opening is provided with small runners of plastic on rope. Because of the symmetrical construction it does not matter which side runs on the bottom surface, and for this reason many scientists prefer the Agassiz trawl to other small trawl types in deep-water investigations.

26

Otter trawl

Otter trawl was used to catch demersal fishes.

27

Otter trawl

The boards used measure 1.30 x 1.0 m, and are marked US-68.

The trawl is 20 m wide in the opening and about 30 m long.

The general net mesh size is 4 cm, and of the inner net 1.5 cm, with a cod end mesh size of 5 mm.

28

Some samples collected with Otter trawl

29

Hard-bottom

30

Triangular dredge

Simple and cheap

It is well suited for use on rough and uneven bottoms.

31

Triangular dredge

Locally produced after original from KC Denmark Research Equipment. The frame is made of 20 mm rustfree steel, or common steel. The side length is 90 cm, with 100 cm long arms.

The net bag is of 20 mm mesh size and 2 m long, with an inner net of mesh size 10 mm in the lower end. A protection rubber sheet is fastened on one side, and to ensure that this side faces the bottom plastic floats are tied to the opposite corner. The net bag is attached to a frame that can easily be screwed out and changed if damage has occurred.

During operation a "security link" can be applied; it is constructed by only one of the three arms being hooked on to the ship's wire, while the other two are fastened to the first one with a few turns of nylon string. The idea is that when the gear is drawn over the bottom and fastens on some obstacle, the strings are broken and the direction of the drag changes a little, whereby the triangle is hoped to jump free.

32

Rectangular dredge

The gear has been widely used both on rough and even bottom types.

33

Rectangular dredge

Locally made of 8 mm rustfree steel, in two versions. In both cases the frame is 70 cm wide and 40 cm high, but one version is 40 cm, the other 20 cm long.

The double 2 m long net bag has mesh size 4 cm in the outer bag, and 10 mm in the inner bag. The net is mounted on a metal frame, fastened with screws; it is easy to change in case of damage to the net bag.

An "eye" for a security wire is mounted near the rear end of the frame.

34

Baited trap

collected small demersal crustaceans, particularly isopods, when the vessel was anchored.

- consist of a PVC pipe, 30 cm in length and 10 cm in diameter.
- three traps were set on a rope which was lowered to the bottom by a weight.
- traps were placed at the bottom and 2 and 10 m above the bottom.

35

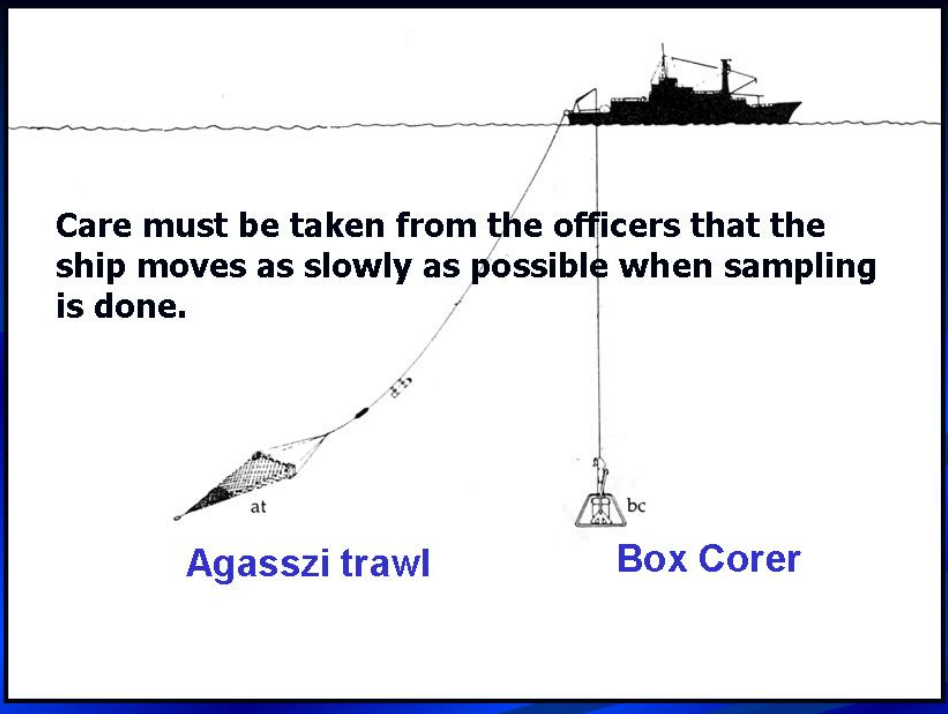
Sampling Problems & Comments

1. In some areas work has been difficult because of very rugged bottoms. Although rather poor both in species and specimens there is a special fauna in these areas, and it must be sampled. It is inevitable that some gear will be damaged, destroyed or totally lost during work in this kind of environment.

2. More sampling of hyperbenthic fauna at different localities and a few selected cases of sampling both night and day are needed to indicate the localities sample.

3. Future studies on grain size composition should be included investigations on temporal changes in sediment composition and its relationship to macrofauna abundance.

36



wires condition & sampling gear

13

Treatment of fish and large invertebrate samples

Samples were roughly sorted on deck and fixed in 10% buffered formalin.

Fine sorting and transfer to 70% alcohol were done at the Reference Collection.

37

Fauna

38

Foraminiferans

39

Sea sponges / Porifera (ฟองน้ำ)

40

Deep water coral
(ปะการังน้ำลึก)

Soft coral
(ปะการังอ่อน)

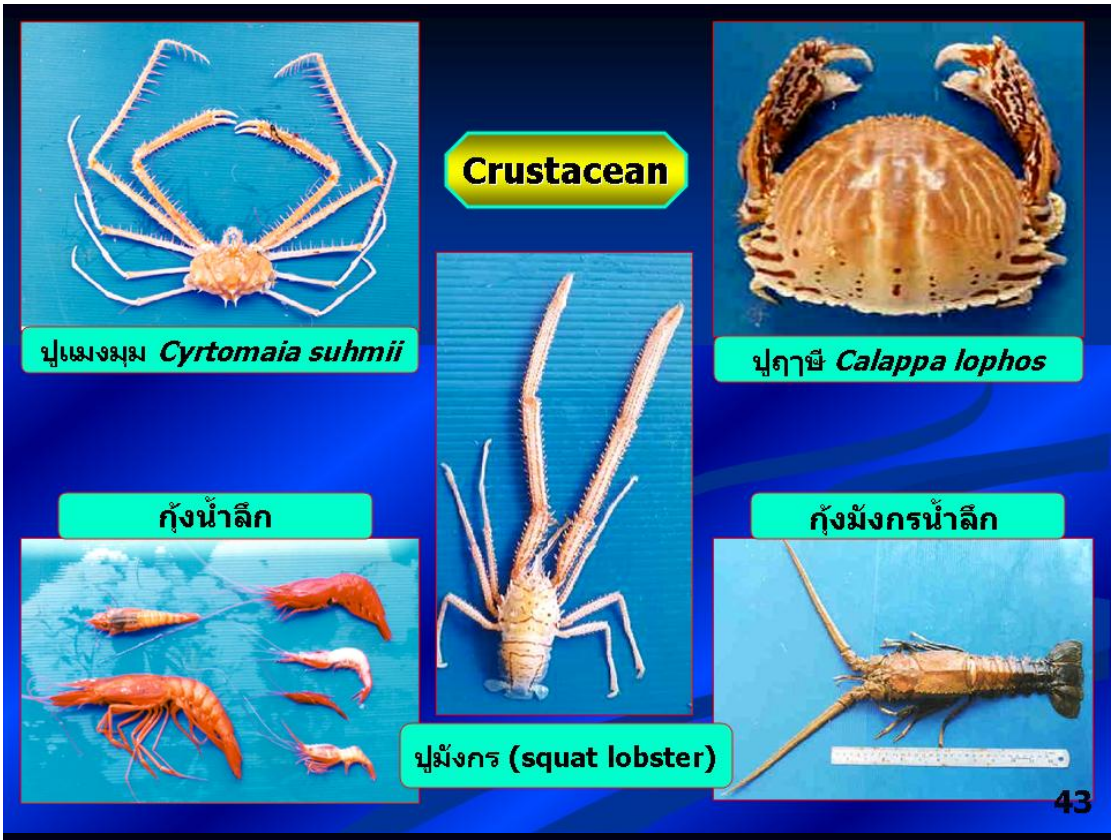
41

Polychaetes
(ไส้เดือนทะเล)

Preliminary results of a group of polychaetes was worked up during international workshops on biodiversity of polychaetes, held at PMBC:

of 185 species of polychaetes, 43 are apparently new species

42

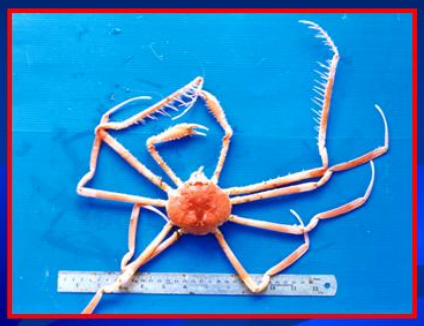

Crustacean
ปูแมงมุม Cyrtomaia suhmii
ปูฤาษี Calappa lophos
กุ้งน้ำลึก
ปูมังกร (squat lobster)
กุ้งมังกรน้ำลึก
43


Crustacea: Decapoda
Juvenile of lobster: phyllosoma stage
44

Crustacean

daddy-longlegs crab (Latreilliidae)

ปูแมงมุม *Platymaia alcocki*



Preliminary results of a group of crustacean was worked up during international workshops on biodiversity of crustacea , held at PMBC:

of 162 species of crustaceans, 54 are apparently new species

45

Crustacea: Isopoda

แมงสาบทะเลยักษ์

***Bathynomus lowryi* sp. nov.**

46

Crustacea: Stomatopoda

กั้งกระดาน (Scyllaridae)

กั้งตั๊กแตน

47

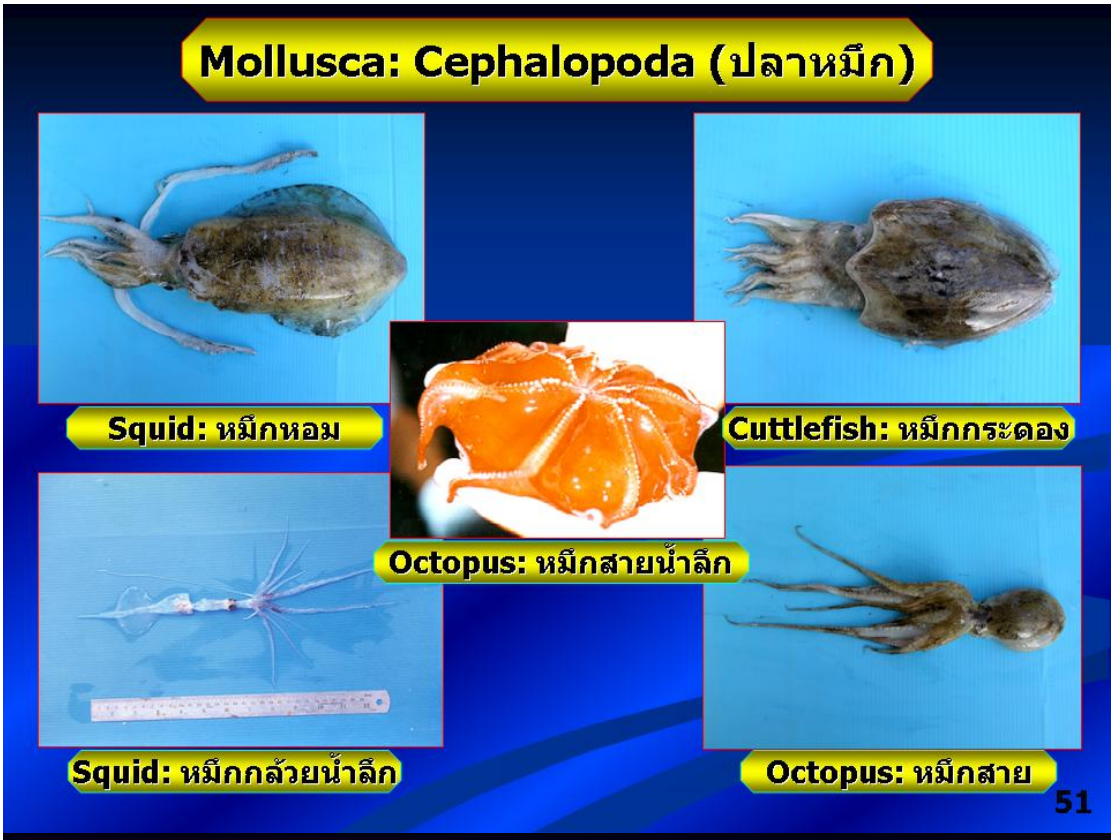
Bryozoa

ลูกถักทะเล

48


ดาวทะเล
ดาวขนนก
อีแปะทะเล
เม่นทะเล
พลับพลึงทะเล
ดาวตะกร้า
Echinodermata
ปลิงทะเล
49


Mollusca: Bivalvia (หอยสองฝา)
50

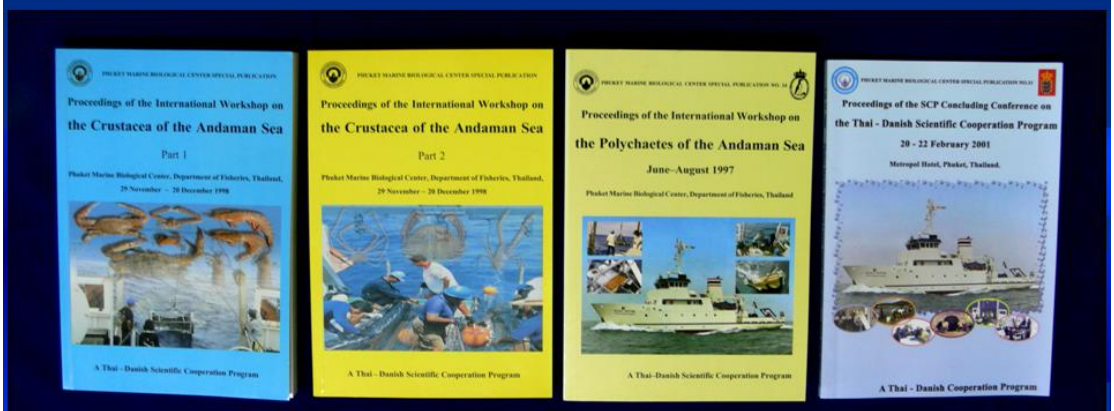

Mollusca: Cephalopoda (ปลาหมึก)
Squid: หมึกหอม
Cuttlefish: หมึกกระดอง
Octopus: หมึกสายน้ำลึก
Squid: หมึกกล้วยน้ำลึก
Octopus: หมึกสาย
51


Chordata: Vertebrates
Deep-water Fishes
ปลาลิ้นควาย
52

Chordata: Vertebrates (Fish)
Leptocephalus stage

53

Scientific publications



54

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Bussarawit, S., O.S. Tendal, C. Nielsen, and A.R. Rasmussen. 2008. Summary of the Thai-Danish Biodiversity Project on the Andaman Sea continental shelf and slope. Phuket Marine Biological Center Special Publication 31: 75–81.

Tendal, O.S., C. Aungtonya, and S. Bussarawit. (in manuscript). Gear, Sampling, sample treatment and some observation from the Thai-Danish BIOSHELF surveys 1996–2000 in the Andaman Sea.

Tendal, O.S., S. Bussarawit & C. Aungtonya. 2002. On the Thai-Danish Scientific Cooperation Programme and the deep-water fauna of the Andaman Sea continental margin. – Deep-Sea Newsletter 31: 10–11.

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I would like to thanks SEAFDEC and JTF for inviting and financial support.

A special thanks to Associate Prof. Ole Tendal (SSA) for useful information and his indefatigable efforts in this project.

56

Beam trawl

It works very well in shallow water

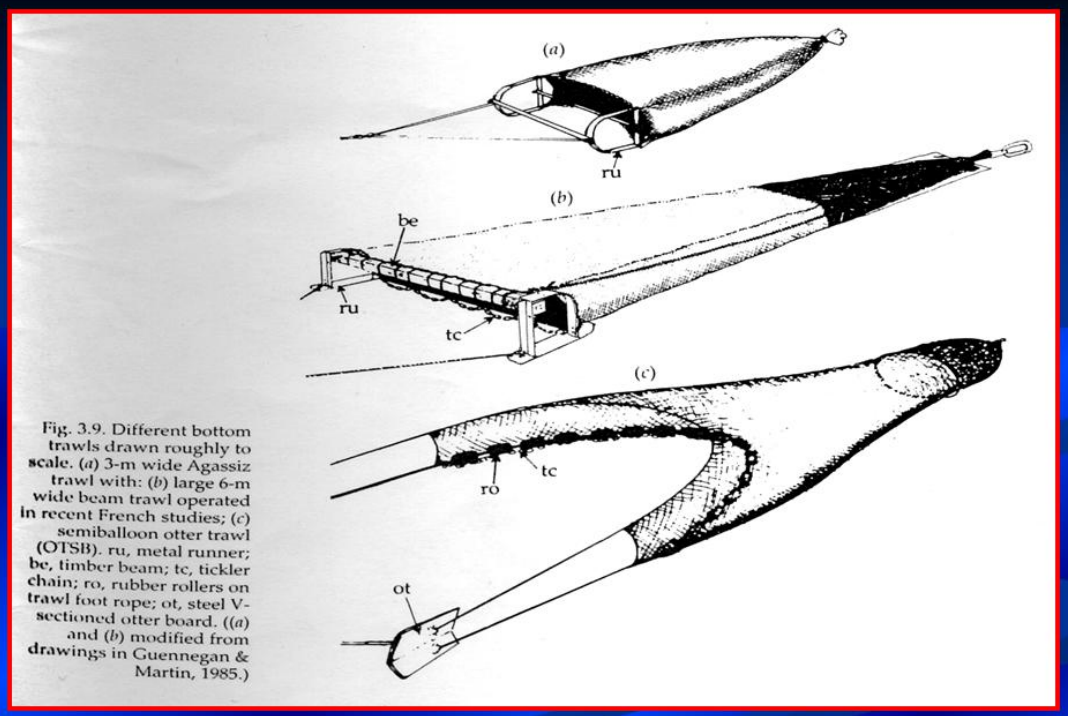


Fig. 3.9. Different bottom trawls drawn roughly to scale. (*a*) 3-m wide Agassiz trawl with: (*b*) large 6-m wide beam trawl operated in recent French studies; (*c*) semiballoon otter trawl (OTSB). ru, metal runner; be, timber beam; tc, tickler chain; ro, rubber rollers on trawl foot rope; ot, steel V-sectioned otter board. ((*a*) and (*b*) modified from drawings in Guennegan & Martin, 1985.)

Agasszi trawl, Beam trawl, Otter trawl

RESEARCH INSTITUTE FOR MARINE FISHERIES
170 Le Lai, Hai Phong City, Viet Nam

Country Report

Status of resources surveys related to the deep-sea exploration in Vietnam

Regional Workshop on the Standard Operation Procedure and Development / Improvement of Sampling Gears for the Deep-sea Resources Exploration
Bangkok, 26 - 28 May 2009

Nguyen Viet Nghia
Research Institute for Marine Fisheries
170 Le Lai, Hai Phong City
Viet Nam

Introduction

- Vietnam locates in the Southeast Asia, with:
  - Long coastal line: 3,260km
  - Exclusive economic zone (EEZ): over 1 million km^2
  - Large deep-sea area
- The Fishery plays an important role in the economics
  - provided about 40% animal protein in the Vietnamese diet,
  - created jobs for totally over 4 million laborers
  - contributed about 4% of the GDP (2004)
- High fishing pressure leads to over-exploitation of the resources, especially in coastal areas.
- It is needed to develop offshore fisheries

⇨ Deep-sea fisheries is a possible choice!

Bathymetry profiles

Management Area	
(All the marine waters of Vietnam is devided into 4 areas for the management purposes)	1. Tonkin Gulf
	2. Central
	3. Southeast
	4. Southwest
Depth strata	
▪ 0-20 m	Near-shore areas
▪ 20-30 m	
▪ 30-50 m	
▪ 50-100 m	
▪ 100-200 m	Off-shore areas (Considered as deep-sea areas)
▪ >200 m	

Related deep-sea surveys

Viet-Xo Joint surveys (1978-1988)

- Gear used: Otter trawl
- Numbers of vessel: 22 vessels, with 31 trips
- Numbers of station: 4,412 stations (deep sea: 1,312 stations)

YEAR	1978		1979		1980		1981		1982		1983		1984		1985		1986		1987		1988		Total	
VESSEL / AREA	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all	deep	all
AELITA			68	542																			68	542
E/V ANTIYA											32	92	3	3									35	95
E/V ELSK			119	436																			119	436
E/V GERAKL											15	147							76	113			91	260
E/V KALPER	91	122																					91	122
E/V KIZIVETE																					103	193	103	193
E/V MUXTICHI																	40	64	4	67			44	131
E/V MYSDALNI																			66	163			66	163
E/V MYX DALN																			27	121			27	121
E/V OCHAKOV													15	16			91	151					106	167
E/V OMEGA															77	126							77	126
E/V SHANTAR															49	54	24	24					73	78
E/V TRUD										77														77
E/V UGLEKAME													18	51									18	51
E/V VOZROJDE					13	72																	13	72
E/V YALTA			34	257																			34	257
E/V ZAVETINS							15	327		7													15	334
MARLIN					6	46		13															6	59
MILOGRADOVO									24	205													24	205
NAUKA			28	208	148	225																	176	433
SEMMEN VOLKO			31	132	95	327																	126	459
TIMASHEVSK										31														31
Grand Total	91	122	280	1575	262	670	15	340	24	320	47	239	36	70	126	180	155	239	173	464	103	193	1312	4412

Related deep-sea surveys

ALMRV PHASE 1 (1996-1997): supported by DANIDA

- Gear used: Otter trawl
- Period: 1996 – 1997
- Vessel: HA LONG 408 B
- Numbers of trip: 2 trips
- Station: 292 stations (in deep sea area: 63 stations)

ALMRV PHASE 2 (2000-2005): supported by DANIDA

- Gear used: Otter trawl
- Period: 2000-2005
- Numbers of trip: 14 trips
- Numbers of station: 894 stations (in deep sea area: 91 stations)

Related deep-sea surveys

ALMRV PHASE 2 (2000-2005): supported by DANIDA

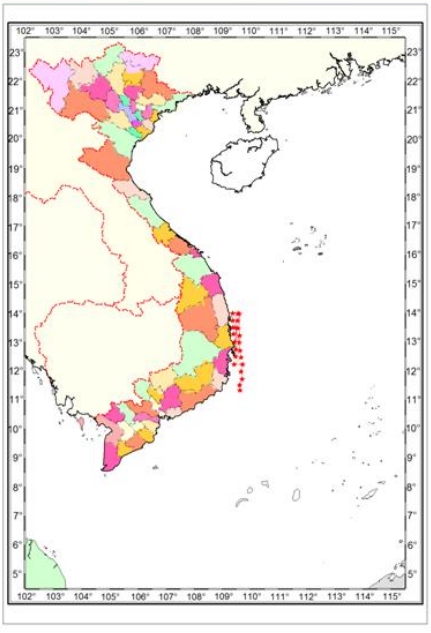
•Gear used: Trap and bottom longline

•Period: 2002

•Numbers of trip: 1 trips

•Numbers of station: 28 stations

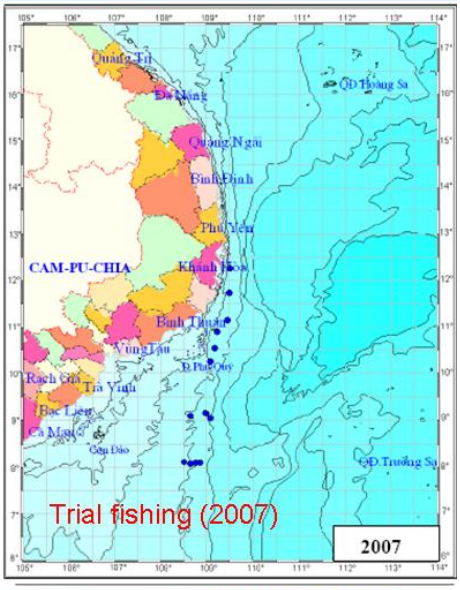
•Numbers of station in deep sea area: 28 stations



Related deep-sea surveys

Continental slope surveys (2005-2007)

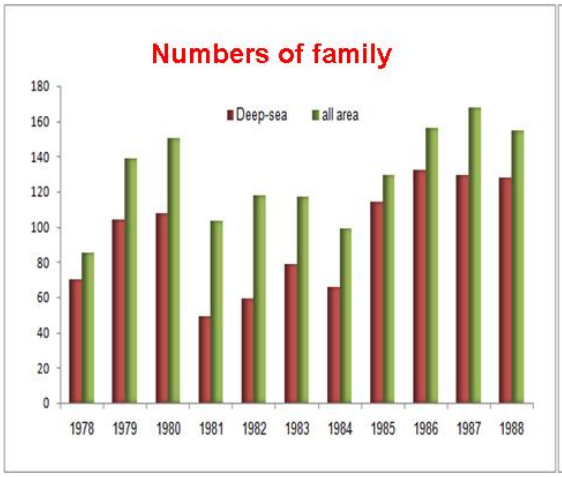
- Gear used: Bottom longline, BVL, traps, pots
- Period: 2005-2007
- Vessel: M/V SEAFDEC 2, commercial boats
- Surveys: 2 surveys
- Trial fishing: 3 surveys

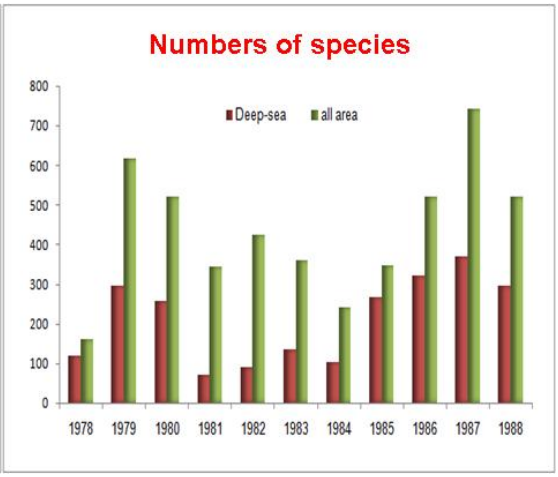


Results

Viet-Xo Joint surveys (1978-1988)

Species composition

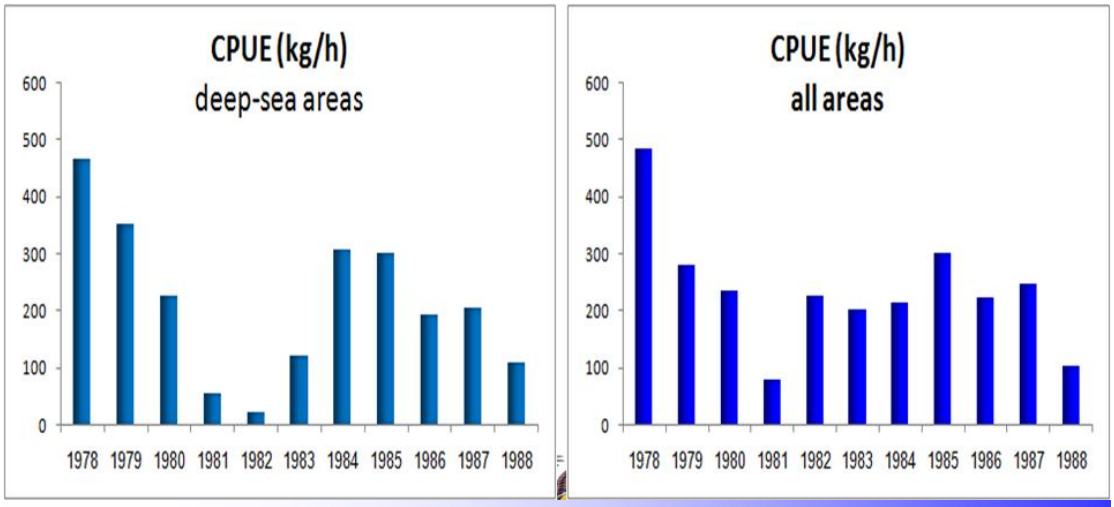




Results (cont')

Viet-Xo Joint surveys (1978-1988)

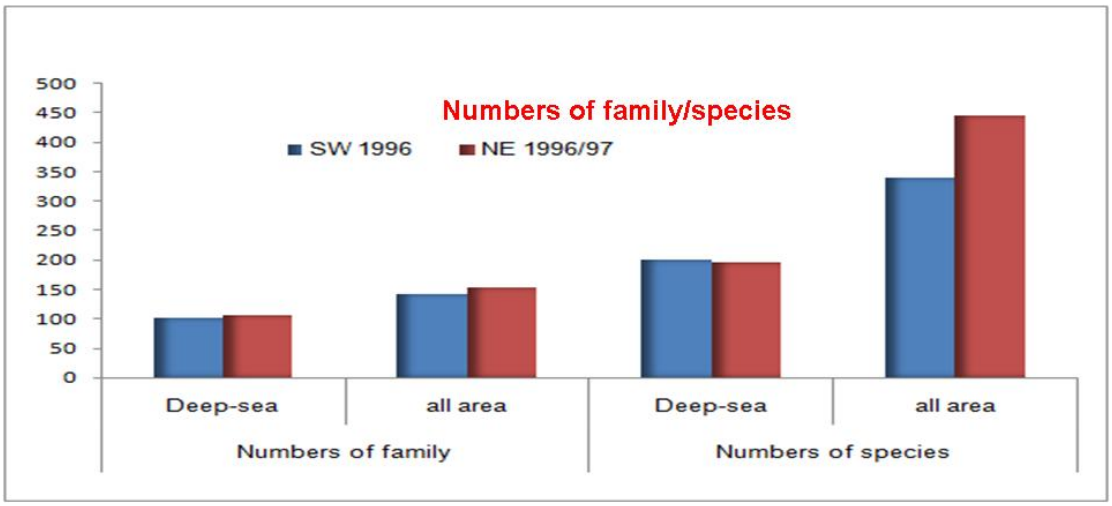
Catch rate



Results (cont')

ALMRV PHASE 1 surveys (1996-1997)

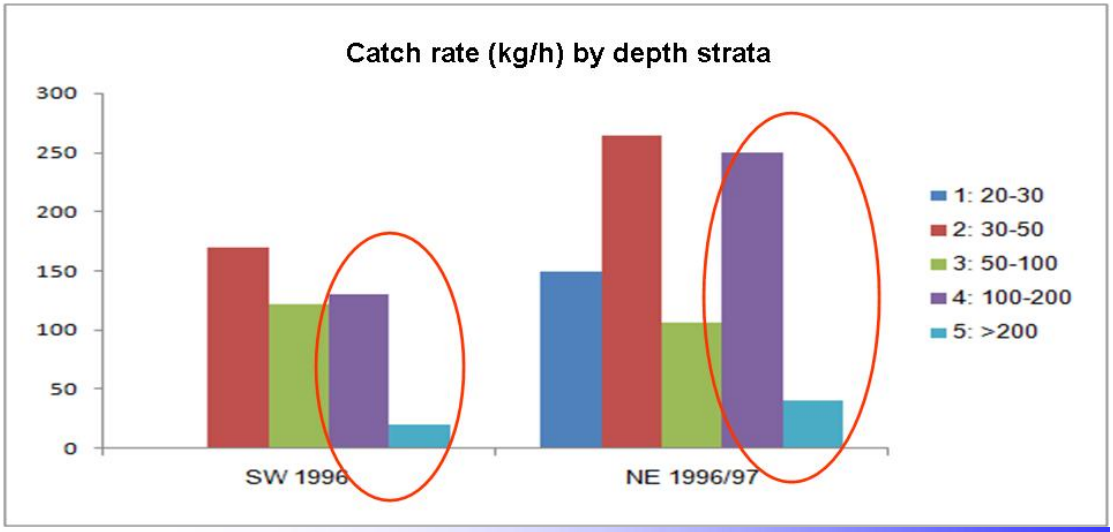
Species composition



Results (cont')

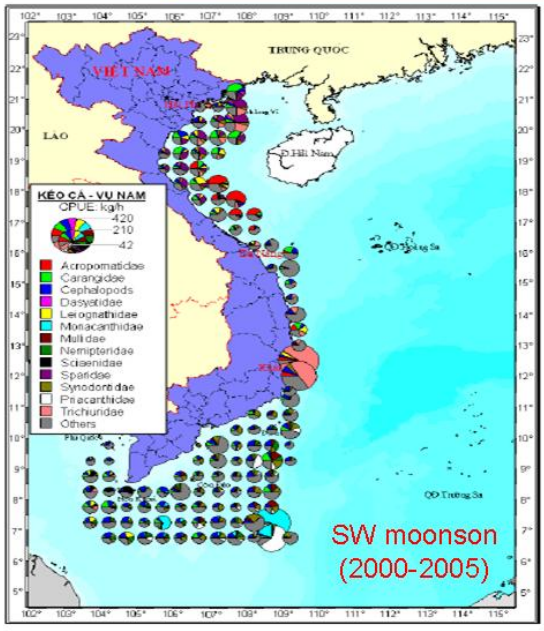
ALMRV PHASE 1 surveys (1996-1997)

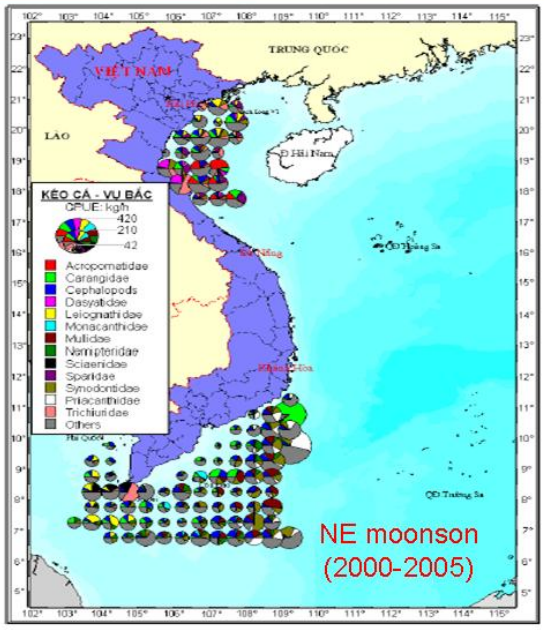
Catch rate (kg/h)



Results (cont')

ALMRV PHASE 2 surveys (2000-2005)

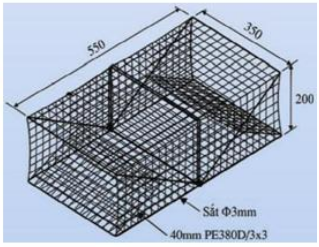


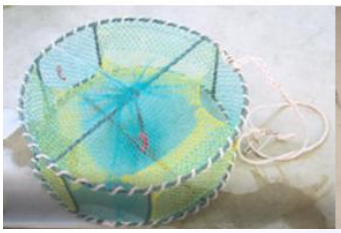


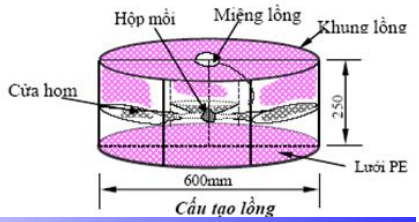
Results (cont')

Continental slope surveys (2005-2007)

- Species composition







Results (cont')

Continental slope surveys (2005-2007)

Species composition

- Surveys (2005-2006)

Gear type	*Family/species*	*2005*	*2006*	*All*
Vertical Bottom Longline	Family	19	20	26
	Species	26	42	56
Bottom Longline	Family	26	21	35
	Species	47	27	64
Eel pots	Family	4	7	9
	Species	8	7	14
Cylinder swim. crab trap	Family	20	19	32
	Species	33	25	49
Rectangular swim. crab trap	Family		10	10
	Species		12	12
Lồng ghẹ mái vòm	Family		41	41
	Species		50	50
Grouper trap (solid cover)	Family	10		10
	Species	14		14
Grouper trap (soft cover)	Family	13		13
	Species	15		15
Total	**Family**	**67**	**51**	**81**
	Species	**131**	**91**	**186**

Results (cont')

Continental slope surveys (2005-2007)

Species composition

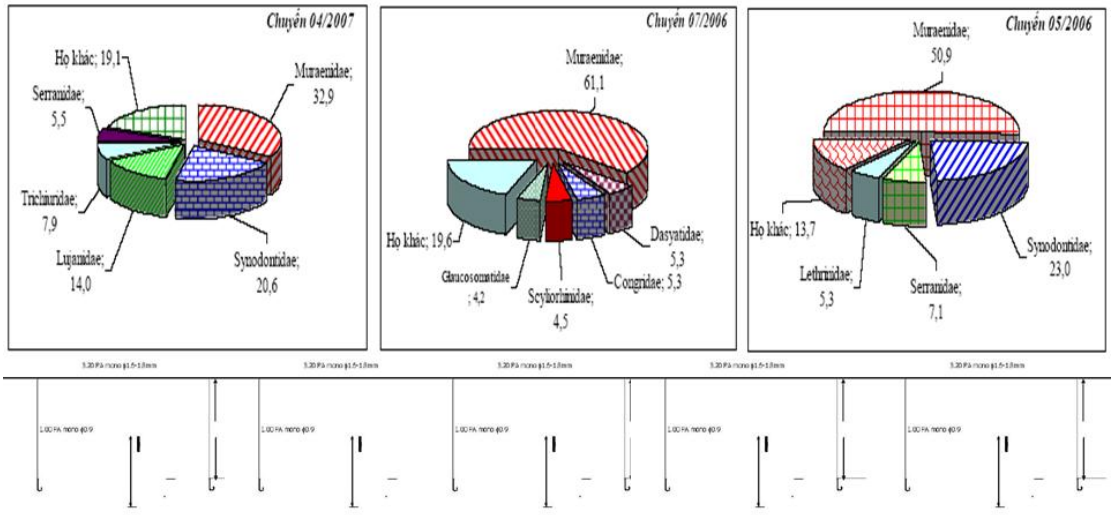
- Trial fishing (2006-2007)

Gear type	*Family/species*	*May 06*	*Jul 06*	*Apr 07*	*All*
Bottom longline	Family	13	22	22	34
	Species	22	35	37	71
Eel pot	Family	2	1	4	5
	Species	3	1	7	9
Cylinder swim. crab trap	Family	12	13	12	25
	Species	18	19	17	40
Rectangular swim. crab trap	Family	6		9	11
	Species	8		13	20
Grouper trap (soft cover)	Family	6	0		6
	Species	8	0		8
Tổng	**Family**	**32**	**40**	**37**	**68**
	Species	**55**	**59**	**58**	**134**

Results (cont')

Continental slope surveys (2005-2007)

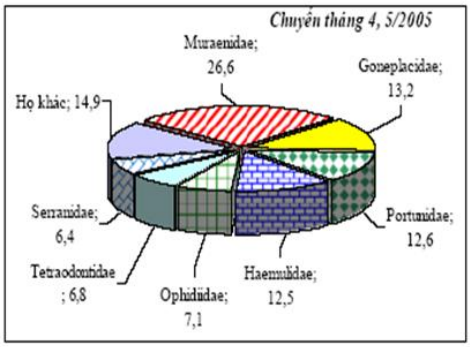
*) Bottom longline

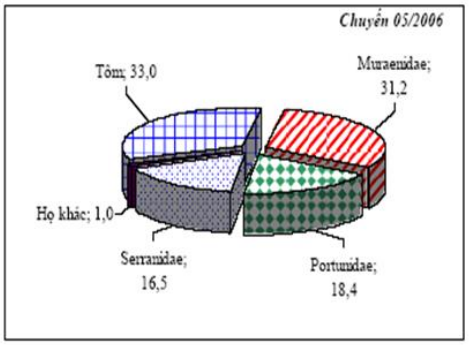


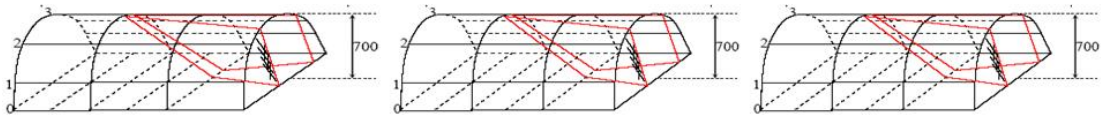
Results (cont')

Continental slope surveys (2005-2007)

*) Grouper trap (soft cover)



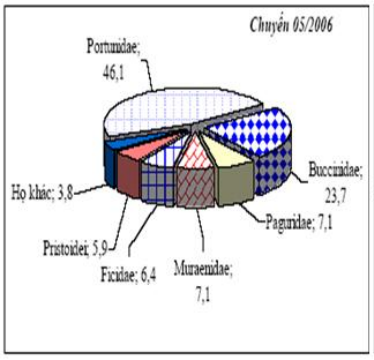


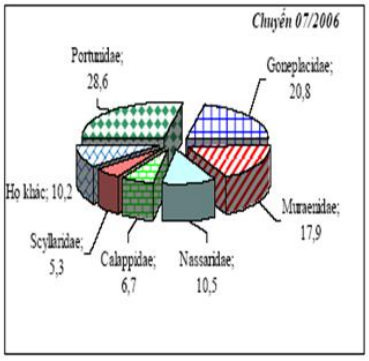


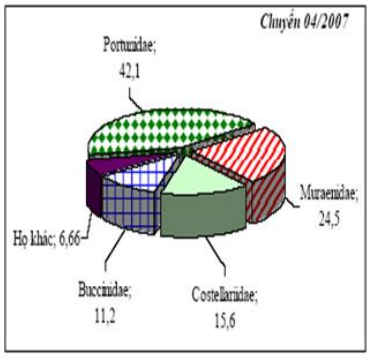
Results (cont')

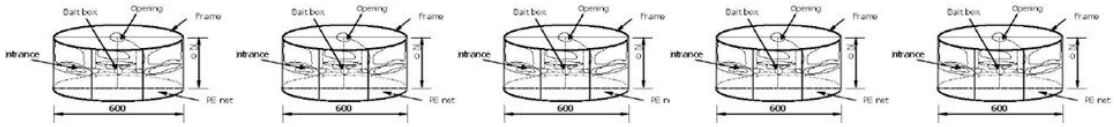
Continental slope surveys (2005-2007)

*) Cylinder swim. crab trap





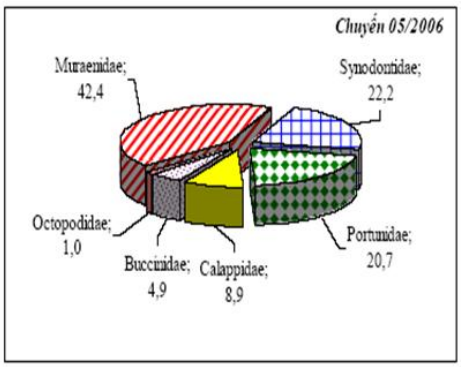


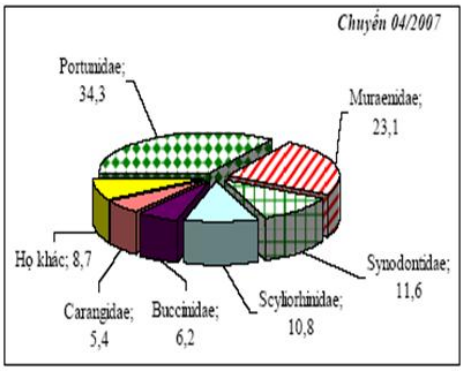


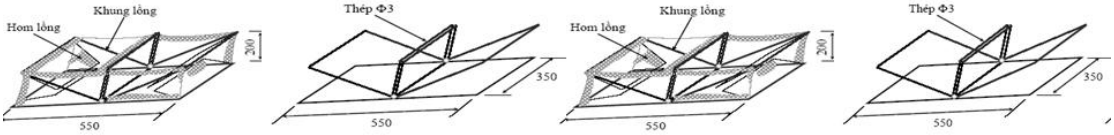
Results (cont')

Continental slope surveys (2005-2007)

*) Rectangular swim. crab trap



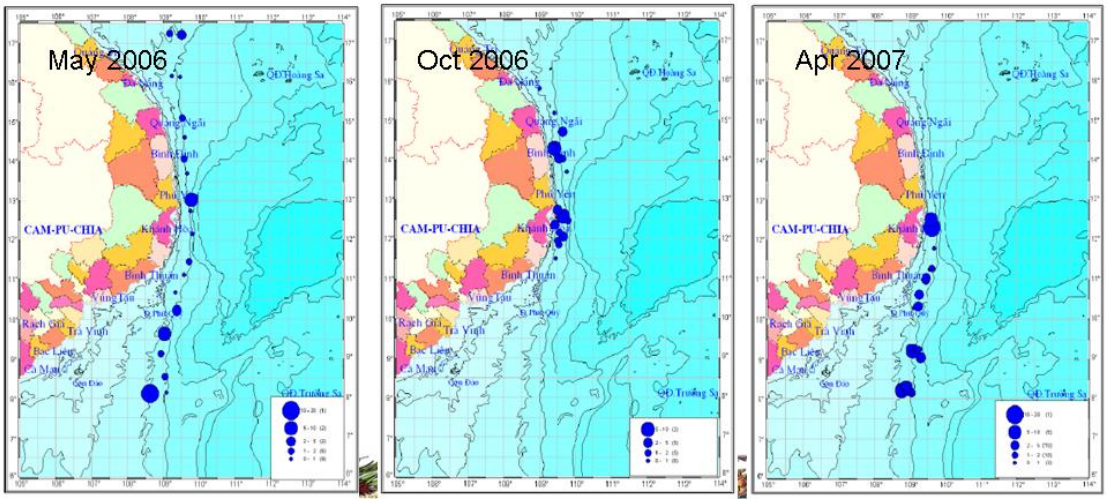




Results (cont')

Continental slope surveys (2005-2007)

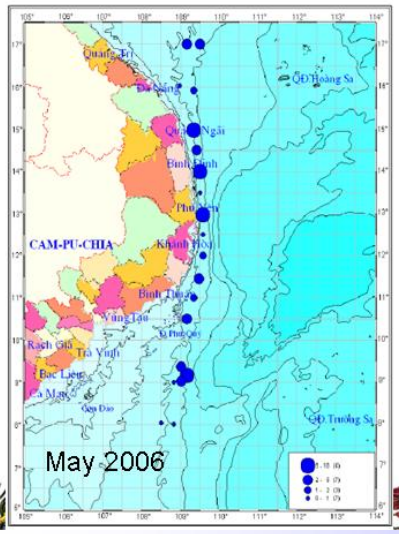
*) Bottom longline

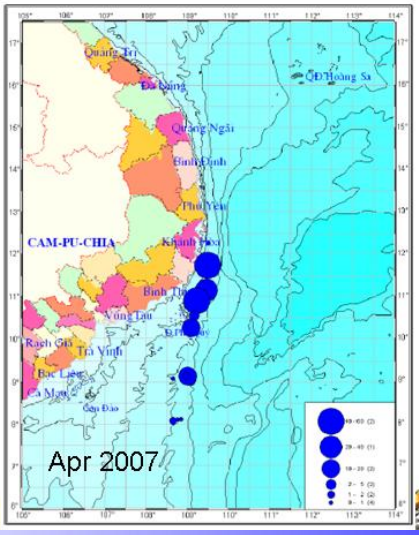


Results (cont')

Continental slope surveys (2005-2007)

*) Eel pots





Future needs

- Collaboration with SEAFDEC and countries on:
  - Resources assessments of deep-sea waters
  - Deep-sea species identification
  - Deep-sea ecology
  - Gear improvement/development for deep-sea fisheries
  - Technology transfer

Thank you very much!

I. Estimation of initial popualtion size and catchability coefficient from the fishing success to catch or effort

1.1 Principles of fishing success methods

General and historical. The method is applicable when a population is fished until enough, fish are removed to reduce significantly the catch per unit effort, the latter being considered proportional to stock present. For example, if removal of 10 tons of fish reduces $\frac{C}{f}$ by a quarter, the original stock is estimated as $\frac{10}{0.25}$ or 40 tons. Instead of estimating $\frac{C}{f}$ only at the start and finish of the experiment, a series of estimates is usually made. That is, a number of points are used to determine the rate of decrease of $\frac{C}{f}$, and hence of the stock.The reason is that variables such as weather, which affect vulnerability, tend to make single estimates of $\frac{C}{f}$ unreliable for this purpose.

Types of computation and symbols. The procedures and computation in common use are of two main types. The first, introduced by Leslie and Davis (1939), involves plotting catch per unit effort against cumulative catch over a period of time; from the resulting straight line, initial population and catchability can be estimated. In the second method, first described by DeLury in 1947, the logarithm of catch per unit effort is plotted against cumulative effort, and the fitted straight line yields the same statistics. Both methods can be improved by a minor change suggested by Braaton (1969), and are described here in that form. The concept and symbols to be employed are as follows:

N_0 Original population size

N_t mean population surviving during time interval t

C_t catch taken during time interval t

K_t cumulative catch to the start of interval t plus half of that taken during the interval

C total catch ($\sum C_t$)

q catchability-the fraction of the population taken by 1 unit of fishing effort (k) of DeLury

P $(1-q)$; the complement of catchability

f_t fishing effort during time interval t

E_t cumulative fishing effort up to the start of interval t plus half of that during the interval

f total fishing effort for the whole period of the experiment (E of DuLury)

$\frac{C}{f}$ catch per unit effort during the interval t (C_t of DeLury)

1.2 Population estimates from the relation of fishing success to catch already taken - Leslie's method.

General case. By definition, catch per unit of effort during time interval t is equal catchability multiplied by mean population present during the interval; that is

$$\frac{C_t}{f_t} = qN_t \qquad \text{.....1}$$

The population at time K_t fish have been caught is equal to the original population less K_t:

$$N_t = N_0 - K_t \qquad \text{.....2}$$

From 1 and 2 :

$$\frac{C_t}{f_t} = qN_0 - qK_t \qquad \text{.....3}$$

Equation 3 indicates that catch per unit effort during interval t plotted against the cumulative catch K_t should give a straight line whose slope is the catchability, q.

Also, the X-axis intercept is an estimate of the original population N_0, since it represents the cumulative catch if $\frac{C}{f}$ and thus the population also, were to be reduced to zero by fishing. The Y-axis intercept is the product of the original population N_0, and the catchability q. Confidence limits for the estimate of N_0 can be calculated using equation 4. Upper and lower limits of confidence for any level of probability (P) are the roots of the equation:

$$N^2(q^2 - t_p^2 S_{yx}^2 c_{22}) - 2(q^2 N_0 - t_p^2 S_{yx}^2 c_{12})N + (q^2 N_0^2 - t_p^2 S_{yx}^2 C_{11}) = 0 \qquad \text{.....4}$$

Where

$$c_{11} = \frac{\sum X^2}{n\sum X^2}$$

$$c_{12} = \frac{\sum X}{n\sum X^2}$$

$$c_{22} = \frac{1}{\sum X^2}$$

$t_p =$ the t value corresponding to a given population P for $n-2$ degree of fredom, found from a t-table e.g. Snedecore's table 3.8.

$n =$ the number of days of fishing.

Special case. A special case of the Leslie method occurs when equal units of effort are used to make the successive catches, so the latter can be plotted directly against cumulative catch

$$C_t = qN_0 - qK_t \qquad \text{.....5}$$

This situation has been studied by Hayne (1949), Moran (1951), and Zippen (1956).

In fitting a line to equation 5, the statistic weighting should be

$$\frac{1}{N_0 - K_t} \qquad \text{.....6}$$

Where N_0 is a preliminary estimate obtained by eye.

A comparative weighting formula for the general situation (Eq. 3) would be

$$\frac{f_t}{N_0 - K_t} \qquad \text{.....7}$$

Effect of variability. It appears that an ordinary predictive regression line fitted to express eq. 5 or 6 will provide unbiased estimates of q and N_0 only if there is no error in K_t. That is, the catch must be completely reliable, for practical purposes. When this is so, all the variability lies in $\frac{C_t}{f_t}$ and the predictive regression is also the functional one. In many situations this is the actual state of affairs. If not, however, an estimate of catchability will tend to be too small and the initial population too large.

1.3 Population estimates from the relation of fishing success to cumulative fishing effort – DeLury's method.

General case. Eq. 1 can be written in the form:

$$\frac{C_t}{f_t} = qN_0(\frac{N_t}{N_0}) \qquad \text{.....8}$$

Or,

$$\ln\frac{C_t}{f_t} = \ln(qN_0) + \ln(\frac{N_t}{N_0}) \qquad \text{.....9}$$

When the fraction of the stock taken by a unit of effort is small- for example, 0.02 or or less - it can be used as an exponential index to show the fraction of stock remaining after E_t units have been expended:

$$\frac{N_t}{N_0} = e^{qEt} \qquad \text{.....10}$$

Substituting Eq. 10 in Eq. 9

$$\ln \frac{C_t}{f_t} = \ln(qN_0) - qE_t \qquad \text{.....11}$$

Systematic errors in fishing success methods

Inconstant catchability is perhaps the greatest potential source of error in applying methods estimation based on secular change in catch per unit effort. Many popupation have been found not to be amendable to this treatment, eigther because catchability varies with seasonal change in environment conditions or the fish's reaction, or because individual fish differ in vulnerability and those more vulnalable are more quickly removed. Either effect may produce changes in catch per unit effort which cannot be distinguished from those produced by changed abundance.

Less seious, but of widespread occurrence, is day-to-day or other short-term variation in catchability. Usually this merely increase the scatter of points along the line of the graph. Occasionally, it may be possible to relate it to other measurable factors and make appropriate adjustments.

Obviously recruitment and natural mortality, or immigration and emigration, can introduce serious error into Leslie or DuLury calculations, unless opposed tendencies happen to be in balance.

II. Sustainable yield from surveys

2.1 Methods and objectives of surveys

Apart from the commercial fishery, the other main sources of data in stock assessment are surveys carried out by research or similar vessels. The details of how surveys should be carried out, and the data from them collected and analysed are described in a number of FAO manuals. For the present it is only important to note what types of information can be provided from surveys that will be useful in stock assessment and to outline brieftly the advantages and disadvantages of the different methods of surveying by which this information can be collected.

Survey data can be used in stock assessment into main ways: first, for monitoring, that is to provide at regular intervals (most convenient annually) indices of stock abundance; second, to produce estimates of absolute abundance, possibly at only instant of time, and most usually in advance of intense exploitation.

As CPUE data from some parts of the commercial fishery usuaully provides the most convenient index of stock abundant, but for some stocks there may be no CPUE data that is satisfactory. This may be because, over a wide range of stock sizes, the observed CPUE is only weakly related to stock sizes or change in fishing power, change in species preference. A monitoring survey repeated at regular intervals, in which the methods used are maintained constant from year to year, will provide an index of abundance that is free of difficulties caused by possible changes in the catchability coefficient q

Surveys that can produce absolute estimates of stock abundance introduce a new type of information into assessment work. The ability to use these estmates, in combination with data of total catch, to provide estimates of fishing mortality in absolute terms clearly makes such of analysis of mortality rates much simpler. In addition, estimates of total stock abundance, combined with estimates of natural mortality or other measures of turnover rate, can provide the first approximations to the potential yield from the stock.

2.2 Estimating sustainable yield from surveys

The data from surveys will usually be used together with data from other sources to carry out assessments. Survey data can also be used more directly to make assessments. Several types of survey give estimates of total biomass. This estimate is interesting, but seldom exactly what the fishery administrator or planner wants to know; he usually needs to know how much can be caught each year. This quantity is clearly related to biomass, or standing stock; other thing being equal, the bigger the biomass the bigger the sustainable yield. Further, the ratio of sustainable yield to biomass must be connected with the turn over rates (growth and mortality rates) of the species concerned. For a given biomass the sustainable yield from a long-lived species will be less than that from a short-lived species.

This suggests that, for surveys of unexploited stock, the sustainable yield may be estimated by an expression of the form

$$Y_{\max} = aMB_{\infty} \qquad \text{.....12}$$

Where B_{∞} = unexploited biomass, and M = natural mortality. Theorectical considerations suggest that the value of a is likely to be around 0.5 or somewhat less, so that a convenient expression for the sustainable yield is

$$Y_{\max} = 0.5MB_{\infty} \qquad \text{.....13}$$

Practical applications of this formula have shown that in general it gives useful results. It is obvoiusly approximate, and should not be considered as a substitute for more detailed assessments. At the same time it is one of the few methods that can be readily used before fishing begins, and in particular at the moment when plans are being drawn up to start exploitation of a stock. At this time a rough estimate (accurate to within say 50%) is all that is required.

Apart from estimates of biomass, application of this method requires estimates of M. If the biomass is obtained by trawl or other fishing surveys, then samples from the catch can be used. Otherwise rough estimates of natural mortality can be obtained by comparison with known values for similar species. These estimates will inevitably be rough, but in most cases sufficient.

When the unexploited stock is fishing, the biomass will reduce, while the total mortality has been increased. This suggest that a suitable modified formula would be

$$Y_{\max} = 0.5ZB \qquad \text{.....14}$$

Where Z is total mortality coefficient ($F+M$)

This is convenient if the total mortality can be estimated. For some stocks though, the best estimate of mortality may still be that of natural mortality secured

from comparison with other species or stocks. For these, a better form is obtained by noting that $ZB = (F+M)B$ and the catch $Y = FB$

Therefore we can write

$$Y_{\max} = 0.5(Y + MB) \qquad \text{.....15}$$

In view of all the economic and social uncertainties in start up a new fishery, let alone the biological ones, realistic plans for the initial development will seldom aim to catch more than a fraction of the estimated sustainable yield. As these plans are put into effect, and effort increases, then there will be opportunities to make assessments by other, more precise methods. [Recent studies suggest that putting a = 0.5 gives too high values of potential yield and a more conservative value around 0.3 would be better].

III. Parameter estimation

3.1 Natural mortality estimation

There are many methods to estimate natural mortality, although thery are mostly rather difficult to apply. Relationship between natural mortality and survival rate is expessed as

$$S = e^{-M}$$

$$N_t = R.e^{(-Z_{(t-t_R)})} \Rightarrow \frac{N_t}{N_0} = e^{(-Z_{(t-t0)})}$$

When no fishing, $Z = M$ $\quad S = e^{-M} = \frac{N_t}{N_0}$

$$M = -\ln S = -\ln(\frac{N_t}{N_0})$$

3.2 Total mortality estimation

When CPUEs data are available, the total mortality rate (or total mortality coefficient, Z can be obtained by using formula:

$$\frac{1}{t2-t1}\ln\left(\frac{CPUE(t1)}{CPUE(t2)}\right) = Z$$

.....

Exercise 1

Data from Table, find the q (catchability) and N_0 (initial population) using Leslie and De Lury methods.

1	2	3	4	5	6	7	8
Day	C_t	$C_t/2$	K_t	f_t	E_t	$\frac{C_t}{f_t}$	$\ln(\frac{C_t}{f_t})$
1	131	65.5	65.5	7	3.5		
2	69	34.5	165.5	7	10.5		
3	99	49.5	249.5	7	17.5		
4	78			7	24.5		
5	56			7	31.5		
6	76			7	38.5		
7	49			7	45.5		
8	42			7	52.5		
9	63			7	59.5		
10	47			7	66.5		
Total				70			

(165.5 = 65.5+65.5+34.5)

Leslie $q = 0.01525, N_0 = 1077.51$ $\frac{C_t}{f_t} = qN_0 - qK_t$

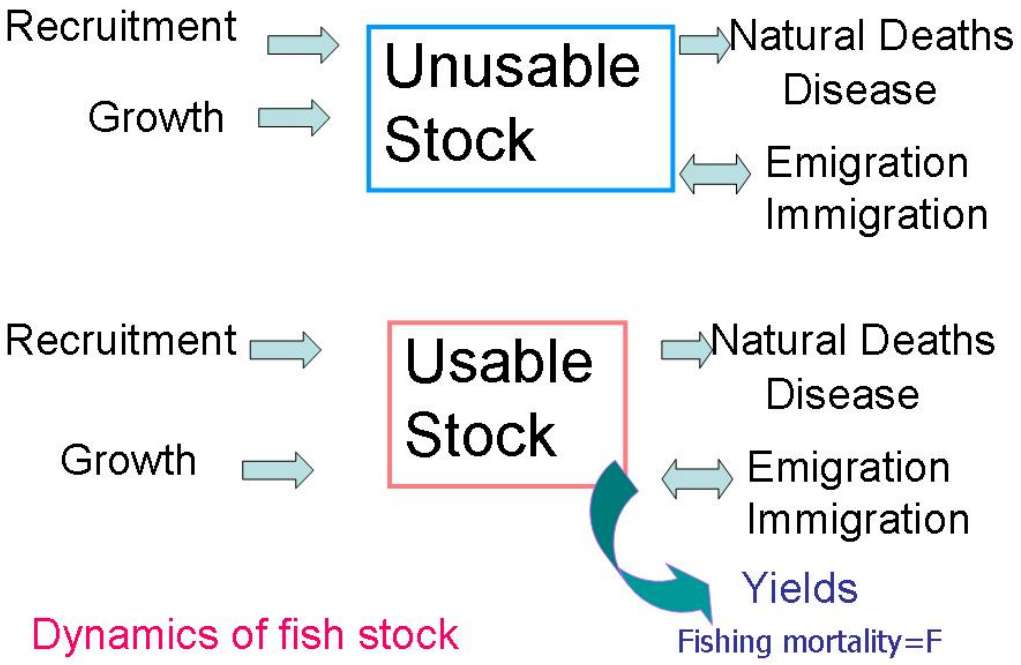
DuLury $q = 0.01394, N_0 = 1150.42$ $\ln\frac{C_t}{f_t} = \ln(qN_0) - qE_t$

Exercise 2

Find the Z value from CPUE data given:

t_1	t_2	$t_2 - t_1$	$\frac{1}{t_2 - t_1}$	$CPUE_{t1}$	$CPUE_{t2}$	$\ln \frac{CPUE_{t1}}{CPUE_{t2}}$
10 Nov 97	12 Nov 97	2	0.5	8.08	31.37	
14 Nov 97	16 Nov 97	2	0.5	31.37	13.73	
18 Nov 97	20 Nov 97	2	0.5	13.73	39.39	
		2	0.5	39.39	9.8	
		2	0.5	9.8	17.65	
		2	0.5	17.65	3.85	
		2	0.5	3.85	7.84	
		2	0.5	7.84	0	
		2	0.5	0	7.69	
		2	0.5	7.69	9.62	
		2	0.5	9.62	9.9	
		2	0.5	9.9		

$$\frac{1}{t2 - t1} \ln\left(\frac{CPUE(t1)}{CPUE(t2)}\right) = Z$$



$$R + G \approx M + F$$

R = Recruitment
G = Growth
M =Natural mortality
F = Fishing mortality

Can be controlled?

HOW?

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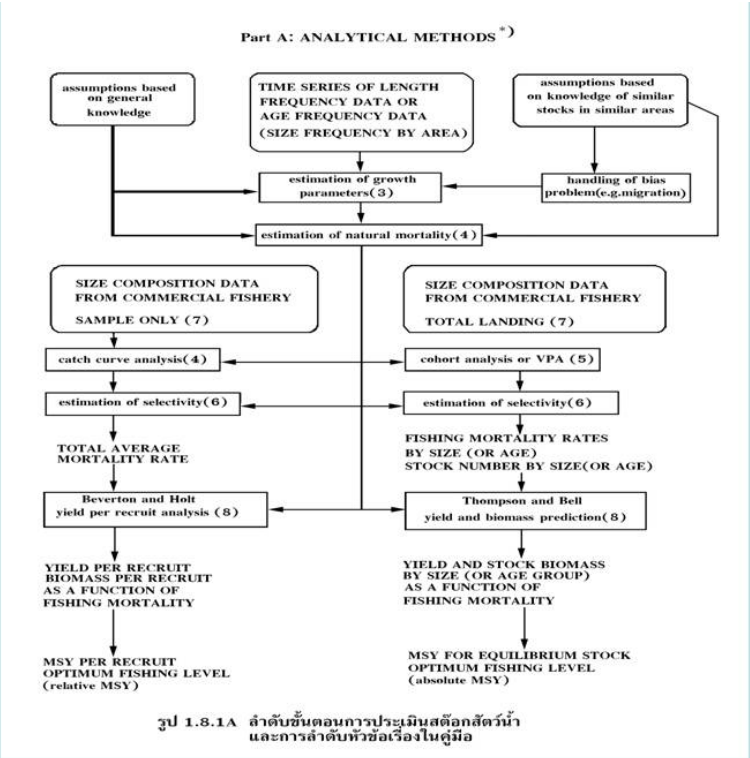
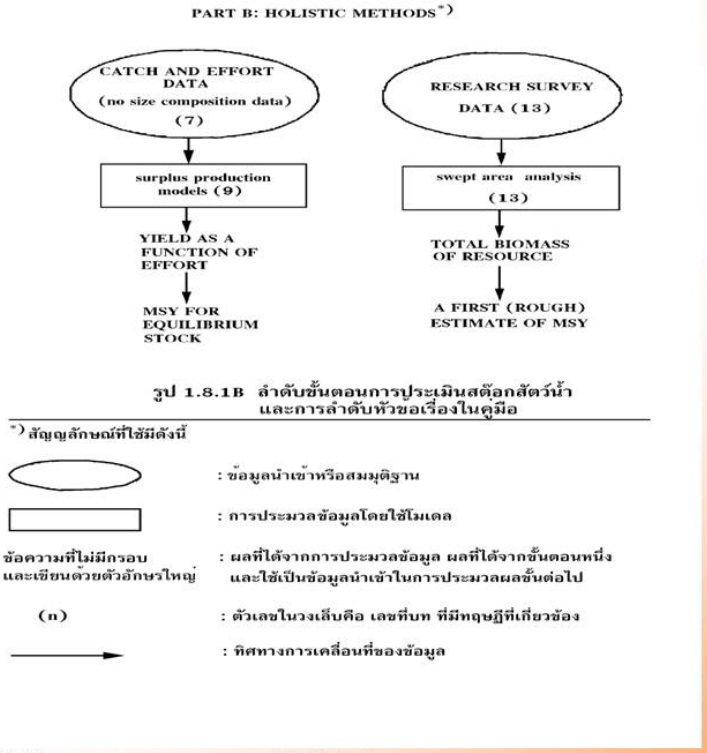


รูป 1.8.1A ลำดับขั้นตอนการประเมินสต๊อกสัตว์น้ำ และการลำดับหัวข้อเรื่องในคู่มือ



รูป 1.8.1B ลำดับขั้นตอนการประเมินสต๊อกสัตว์น้ำ และการลำดับหัวขอเรื่องในคูมือ

*) สัญญลักษณ์ที่ใช้มีดังนี้

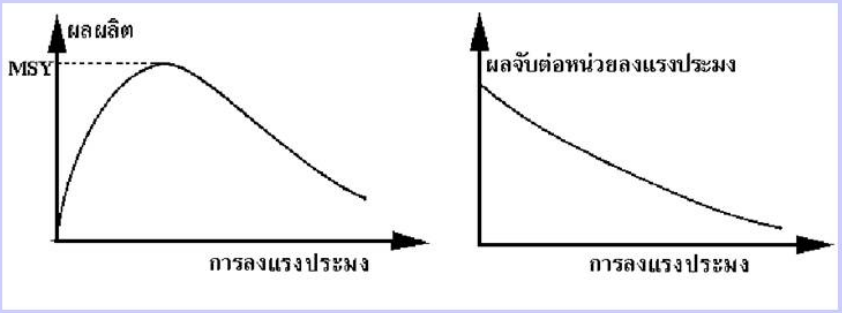
: ข้อมูลนำเข้าหรือสมมุติฐาน

: การประมวลข้อมูลโดยใช้โมเดล

ข้อความที่ไม่มีกรอบและเขียนด้วยตัวอักษรใหญ่ : ผลที่ได้จากการประมวลข้อมูล ผลที่ได้จากขั้นตอนหนึ่งและใช้เป็นข้อมูลนำเข้าในการประมวลผลขั้นต่อไป

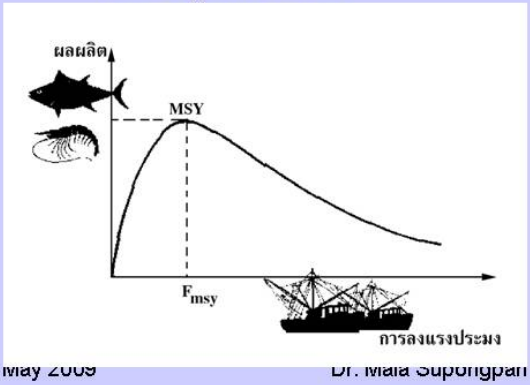
(n) : ตัวเลขในวงเล็บคือ เลขที่บท ที่มีทฤษฎีที่เกี่ยวข้อง

: ทิศทางการเคลื่อนที่ของข้อมูล



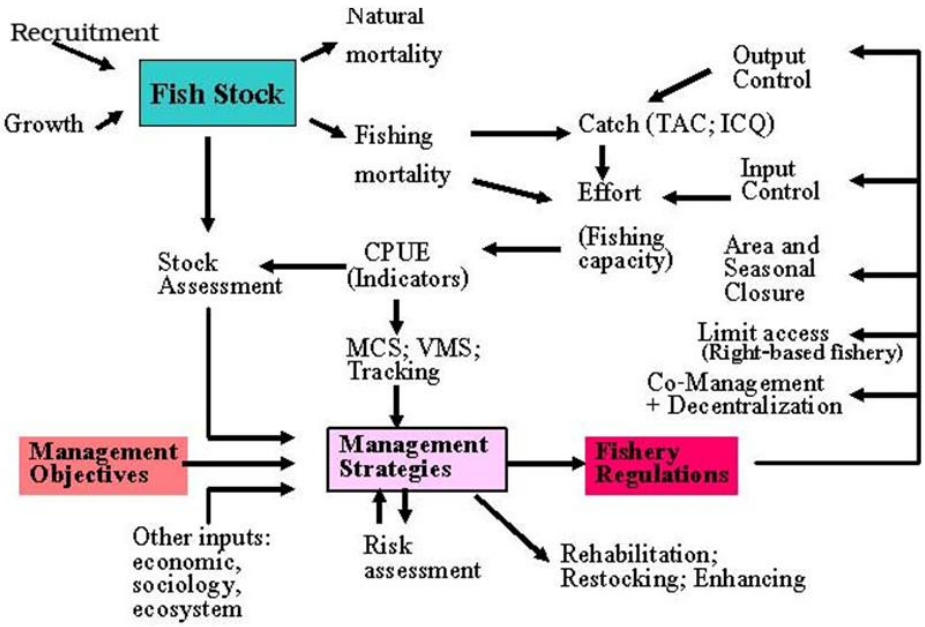
Yield against effort

CPUE against effort



Analytical methods

Holistic methods



Management Objectives and Strategies

The fish stock assessment needs:

- Catches, Species and Sizes composition
- Abundance
- Biomass estimation
- Analytical methods and Holistic methods
- Parameter estimation (recruitment, growth, mortality-natural mortality, fishing mortality and total mortality)
- Catch and effort data from statistic record (time series)
- Population size and catchability
- Using catch per unit effort to find original population size and catchability

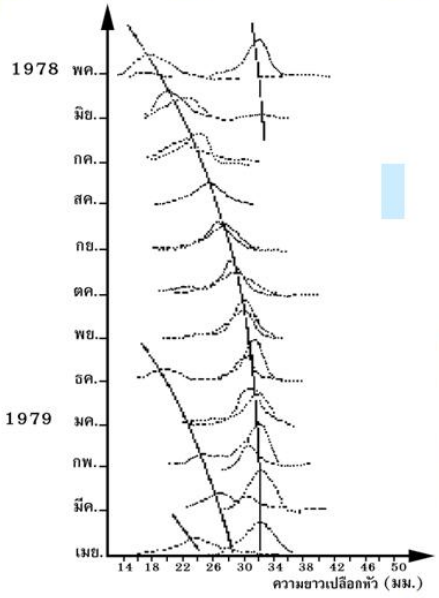
Parameters for fish stock assessment

1. Length-weight $a, b, L_t, W_t, \bar{L}, \bar{W}$
2. Growth parameter $K, t_0, L_\infty, W_\infty, R$
3. Mortality Z, F, M, q

And data on production

Catch and effort, production and biomass

Modal Progression Analysis



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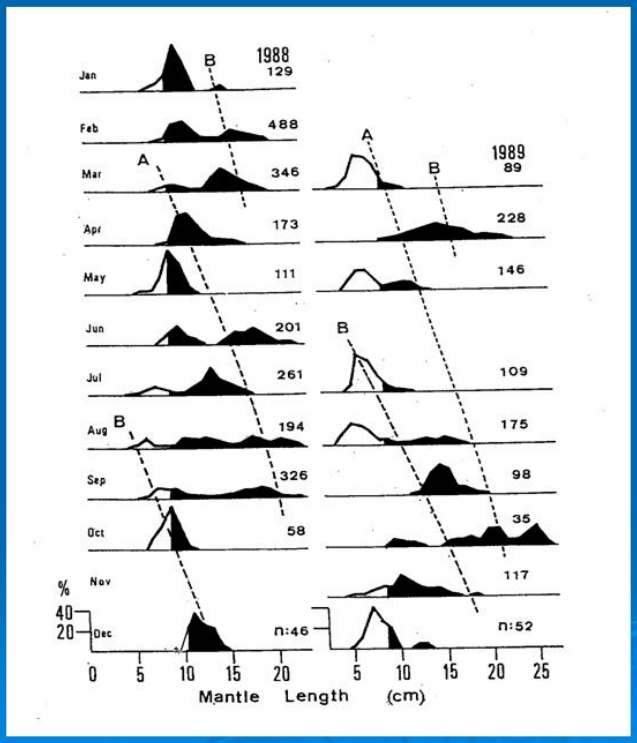

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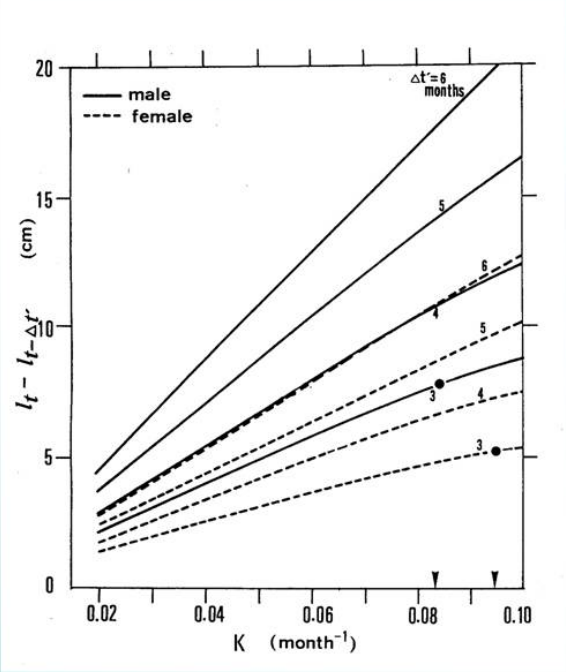


For virgin stock or limited data

1. Estimation of initial population size and catchability coefficient from the fishing success to catch or effort

N_0 Original population size (Roughly virgin stock size)

q catchability ⟺ Z=M+F, Z=M+qf, F=qf

Leslie's method $\frac{C_t}{f_t} = qN_0 - qK_t$ Cumulative catch+

DeLury's method $\ln\frac{C_t}{f_t} = \ln(qN_0) - qE_t$ Cumulative effort+

2. Estimation of Z using CPUE data

$$\frac{1}{t2-t1}\ln\left(\frac{CPUE(t1)}{CPUE(t2)}\right)=Z$$

3. Natural mortality estimation

When no fishing $S=e^{-M}=\frac{N_t}{N_0}$

$$M=-\ln S=-\ln\left(\frac{N_t}{N_0}\right)$$

4. Fishing mortality estimation

F=Z-M

Estimation of total mortality (Z)

1. CPUE data
2. Catch curve based on length composition data
3. Cumulative catch curve based on length composition data
4. Beverton and Holt's Z equation
5. Plot Z on effort

1. Estimate Z from CPUE data

$$N_{t2}=N_{t1}*e^{(-Z(t2-t1))}$$

$$\frac{1}{t2-t1}\ln\left(\frac{N_{t1}}{N_{t2}}\right)=Z$$

$$CPUE(t)=qN_t$$

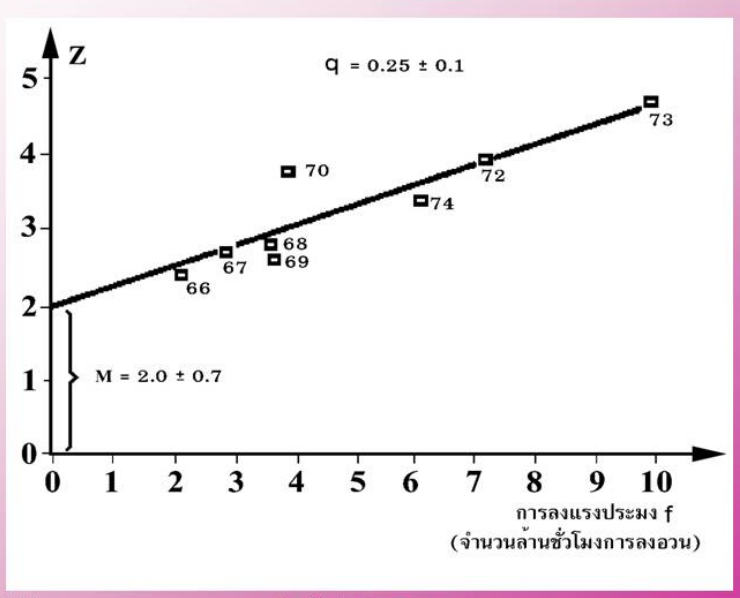
$$\frac{N_{t1}}{N_{t2}}=\frac{qN_{t1}}{qN_{t2}}=\frac{CPUE\ (t1)}{CPUE\ (t2)}$$

From above equations, then gives:

$$\frac{1}{t2-t1}\ln\left(\frac{CPUE\ (t1)}{CPUE\ (t2)}\right)=Z$$ *

Plot Z against effort to estimate F and M

$Z = M + q*f$ $F = Z - M$



Biomass estimation

$$B = CPUE * A / a * X_1$$

B = *Biomass (tons/ km²)*

A = total area (km²) (101,384 km²)

a = Swept Area = $D*h*X_2$

{ D= (V*t) = 2.5*1}

h (head rope) (= 39 m)

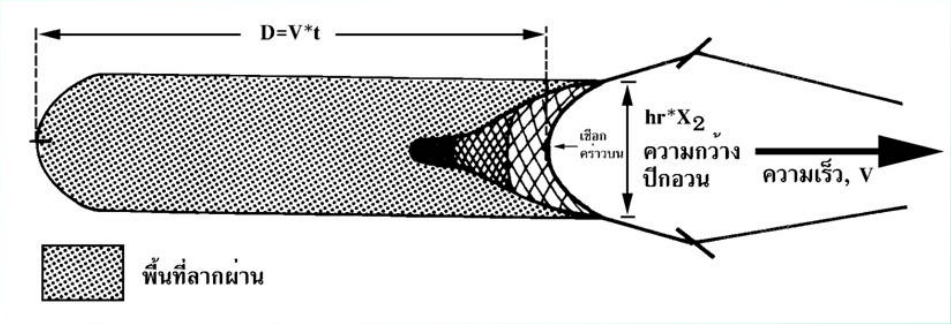
$X_2 = 0.5$

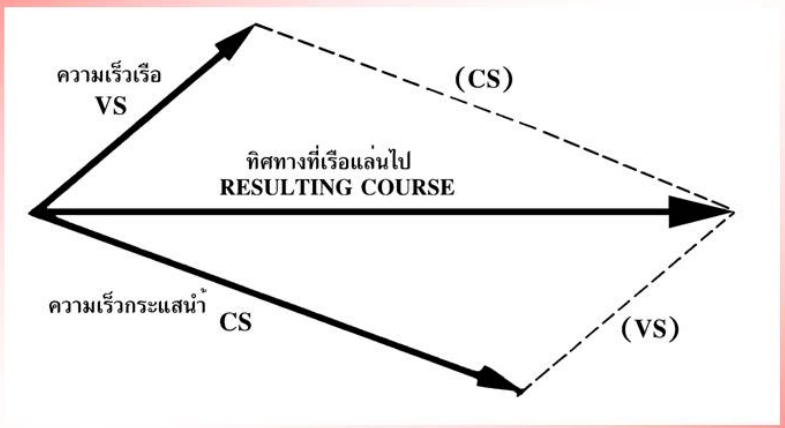
a = (2.5*1.852) * (0.039*0.5) = 0.090285

$X_1 = 0.5$

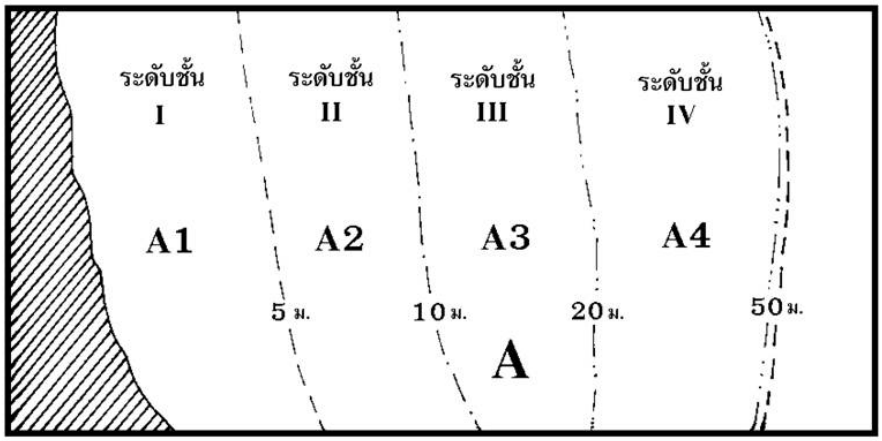
$X_2 = 0.5$

Swept area to estimate biomass





Survey strata by depth



Sustainable yield estimation

$Y_{max} = aMB_{\infty}$ Virgin biomass B_{∞}

For conservation, a- should be=0.3

$Y_{max} = 0.5MB_{\infty}$

$Y_{max} = 0.3MB_{\infty}$

$Y_{max} = 0.5ZB$

$Y_{max} = 0.5(Y + MB)$ *ZB = (F+M)B* and the catch *Y = FB*

Definition

Catchability (q): A fraction of a fish stock which is caught by a defined unit of the fishing effort. When the unit is small enough that it catches only a small part of the stock-0.01 or less-it can be used As an instantaneous rate in computating population change. Also called catchability coeffifient.

Availability:

The fraction of a fish population which lives in regions where it is susceptible to fishing during a given fishing season. This fraction receives recruits from or become mingled with the non-available part of the stock at other seasons, or in other years.

Catch per unit of effort (CPUE):

The catch of fish, in number or in weight, taken by a defined unit of fishing effort.

Also called Catch per effort, fishing success, availability.

Biomass:

The weight of a fish stock, or of some defined portion of it.

Fishing effort:

The total fishing gear in use for a specified period of time. When two or more kinds of gear are used, they must be adjusted to some standard type.

References

Gulland, J.A. 1983. Fish stock assessment. (FAO/Wiley series on food and agriculture; v. 1), 223 pp.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations, pp.151-155.

Exercises 1 and 2

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

St.		Shooting				Hauling				Immersion	Thermocline	TD No.1	TD No.8/10	Number	Total catch	Total catch	Hook rate	CPUE
no.	Date	Start		Finish		Start		Finish		time	m/°C	m/°C	m/°C	of hook	(number)	weight(kg)	(%)	pcs./ 1000 hook
5	10-11/Nov/07	Time	1820	Time	1936	Time	0720	Time	1010	13 hrs.	47-250 m			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 minute	28-10°C	60m/27.5°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	40-215 m			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 minute	28.5-12.6°C	60m/27.°C	130m/20°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.	50-180 m			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 minute	28.5-15.25°C	50m/27.°C	200m/16°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.	70-250 m			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 minute	28.3-12.8°C	60m/28.°C	150m/20°C					
		Long	094°59'.70E	Long	094°52'.90 E	Long	094°45'.70 E	Long	094°49'.40 E									
14	17-18/Nov/07	Time	1731	Time	1847	Time	0646	Time	1005	14 hrs.	50-220 m			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 minute	28.5-13.3°C	40m/28.0°C	80m/26°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.	50-240 m			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 minute	28.4-12.4°C	50m/27.5°C	80m/26°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.	22-280 m			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 minute	28.3-11.7°C	40m/27.5°C	80m/26°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.	50-240 m			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	01 minute	28.4-12.4°C	80m/23.0°C	300m/12°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.	47-220 m			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	09 minute	27.8-12.5°C	85m/21.5°C	230m/13°C					
		Long	088°28'.30E	Long	088°18'.50 E	Long	088°22'.10 E	Long	088°32'.20 E									
29	28-29/Nov/07	Time	1803	Time	1921	Time	0702	Time	1000	13 hrs.	30-200 m			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 minute	28.9-13.8°C	N/R	200m/13°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.	40-270 m			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 minute	28.2-12.4°C	60m/24.5°C	190m/15°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.	N / R			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 minute		70m/22.5°C	250m/12°C					
		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.	45-200 m			303	3	37.7	0.99	**9.90**
			11°29'.60 N		11°26'.250 N		11°22'.50 N		11°25'.50 N									
		Lat		Lat		Lat		Lat		22 minute	28.2-14.2°C	60m/23.0°C	240m/13°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**
														1,863	**17**	**514**	**0.91**	**9.13**

Draft for Preparing Standard Operating Procedures (SOPs)

On Deep-Sea Resources Exploration In Southeast Asian Region

TABLE OF CONTENTS

A. PURPOSE AND APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to establish a uniform procedure for deep-sea resources exploration on the continental shelf and slopes in the Southeast Asian Region for the analysis of the potential of resources in the deep sea areas. The procedures outlined in this SOP are applicable to all Regional Deep Sea Exploration Program who attempted and/or conducted the research on the deep-sea resources in those areas.

B. TERMS AND DEFINITIONS

Terms and definitions of the following items are waiting from the conclusion of **Agenda 3.2**

1. Scope of deep-sea area
2. Deep-sea sampling gears
3. Indicator for the deep-sea resources survey
4. Indicator for the impact of fishing to the eco-system

C. STANDARD EQUIPMENTS AND APPARATUS

1. Standard equipments (Details of this item will follow the conclusion of **Agenda 3.2**)
   a. Sampling/Fishing gears

Gears	Point to be Considered	
	Advantage Point	Impact
Bottom Trawl	Its operating characteristic can be altered for use on various types of bottom and for many species of fishes	- The area impacted is a function of the width of the trawl and the distance it is towed - The otter boards scar the seabed, and the trawl sweep only smooth the seabed removing small bedforms that are regenerated in a relatively short period of time - On hard bottom, trawls will roll-over the larger rocks, and scrape off attached, emergent, epibenthic organisms including sponges and corals

(continue next page)

(Continued)

Gears	Point to be Considered	
	Advantage Point	Impact
Traps	Aquatic animals can enter the gear voluntarily	- If traps are lost on the seabed, they will ghost fish - Large number of traps on the seabed has a larger footprint than a longline, and several traps are attached together the mainline will encounter and entangle hard and soft corals on the seabed
Bottom longline	Considered fixed and passive gear because once deployed the gear does not move and the fish voluntarily takes the hook	The impact to seabed of this gear is minimal as only the anchor touches the bottom
Gill net	Shellfish and large fish are easily entangled in bottom set enmeshing gear	On soft substrates the effects will be minimal, while on hard bottoms with attached, the nets will tangle with corals and other organisms and remove them from the seabed

b. Hydro-acoustic apparatus

Hydro-acoustic apparatus	Techniques	Output
Echo sounder	Fixed-location techniques use stationary transducers to monitor passing fish and bottom depth	- Evaluate fish biomass and spatial distributions - Bottom topography
Scientific echo sounder for fishery research applications	Scientific Single and Multibeam Echo Sounders	- Real time echo integration and target strength analysis in an unlimited number of layers - Storage of raw data for replay or analysis in one of several post-processing software packages

c. Oceanography apparatus

Parameter	Equipment apparatus	Topic to study
Physical oceanography	iCTD with auxiliary sensors (Dissolved oxygen, pH, Chlorophyll fluorometer, PAR)	Real-time oceanographic data (e.g., temperature, salinity, dissolved oxygen, chlorophyll concentration, etc.)
Water sampling	Niskin bottles water sampler	Primary productivity, Environmental studies
	Van Dorn water sampler	
Plankton sampling	Bongo net attached with zooplankton net and larvae net	Species composition and diversity, distribution, abundance, of zooplankton and larval fishes

D. DATA RECORD

1. Hydro-Acoustic and Oceanography

a. Survey should identify areas of fishing/sampling operation such as the bottom depth along the survey track of each fishing operation.

b. The vessels can continuously save depth information from the echo-sounders giving bathymetry along the cruise track.

c. Oceanography at the location of each fishing event, and other oceanographic information considered relevant to the fishing area should be collected during the fishing.

2. Fishing Activity

a. The data should be collected according to the operational characteristics of each fishing method (e.g., each individual for trawl, each set for traps or setting, soak and hauling times for bottom longline) which include fishing location, depth of fishing, date and time at the start and end of every haul. An example of fishing logsheet of M.V. SEAFDEC 2 are given in Annex I.

b. Direct fishing effort during the exploratory those appropriate to each fishing method should be collected (e.g., haul-by-haul catch, catch per effort by

total catch and by species, haul-by-haul length frequency of common species) to evaluate the fishery potential and the ecological relationships among harvested, dependent and related populations and the likelihood of adverse impacts.

c. The spatial details on the navigation and environment condition should be collected such as weather and sea condition, wind and current speed and direction, barometric pressure, humidity.

3. Catch Data

a. Volume of catch should be measured (in whole kilogram) and entered onto logsheet.

b. The catches should be identifying to the lowest taxonomic level and the data of length, weight, sex of fish, and/or maturation and fecundity should be collected.

c. The sufficient data to facilitate effective stock assessment (when required) and assess impact on the ecosystem should include the catch by species both target and non-target, retained and discarded.

d. Distribution, abundance, and species composition, should be documented for an estimate of the fishery's potential yield.

4. Benthic Habitat Data

a. Data should be collected on all aspects of the biology and ecology of the benthic fauna found in the survey areas.

b. The communities that composed of dense benthic or emergent fauna e.g., sponge ground (e.g., sponge dominated communities); invertebrates (e.g., hydroids and bryozoans) should be documented for measure the effects of fisheries to the ecosystem.

E. PROCEDURAL STEPS

1. Location selection

a. The survey is focus on the area which covered within the boundaries described from the present workshop (Descriptions of the proposed deep-sea area are waiting from the conclusion of **Agenda 3.2**).

b. The location selection will verify by the grid size 30 X 30 minute (Annex II-Map of the study area). Any location within the grid that meets the depth requirements will be determined as the survey stations.

c. The survey stations will randomly determined on the stratified depth areas (zone).

d. At each survey station where the sampling takes place, the station will be determined by global positioning system (GPS) in latitude/longitude in decimal minutes.

e. Mapping of fishing area should be based on haul-by-haul information.

2. Sampling/Fishing Operation

A variety of fishing methods will be employed for different targeted based on the primary habitats such as hard bottom, soft bottom, and rocky/un-trawlable bottom. An example of sampling/fishing gears description and method of M.V. SEAFDEC 2 are given in Annex III (waiting from the conclusion of **Agenda 3.3)**.

Recommendation for the fishing method of;

Bottom trawl: e.g., towing period should be at least ??? minute

Traps:

Bottom longline:

Gill net:

3. Sorting the catch and sub-sampling

a. The catch should be transferred to the designated sorting area on deck.

b. The entire catch should be sorted in order to ensure that rarer species are properly accounted. The aim is to obtain abundance data (and biomass, when required) for each taxa in the catch.

c. Sub-sampling (FAO, 1992) should be made for each of the highly numerous species or large catches. The purpose of sub-sampling is to obtain an accurate estimate of abundance of the catch which achieved by fully sorting one or more sub-sampling of known catch volume.

d. It is not acceptable to discard any portion of the catch that has not been sorted.

4. Species identification

a. During the sorting individual taxa into separate container, it may more convenient to temporarily sort taxa by higher taxonomic groups, such as Family (e.g. Paguridae – hermit crabs), order (e.g. Octopoda – Octopuses), Class (e.g. Bivalvia – bivalves), Phylum (e.g. Bryozoa) etc. These can then be taken into the wet-lab for more rigorous identify.

b. When the entire catch has been sorted, each taxa should be identified to the lowest taxonomic level practicable in the field.

5. Data record

See item D. DATA RECORD

6. Labeling

a. The identity, date, depth of capture, operation number, cruise info should be labeled on the bucket or container and put together with the sample those preserved in formalin or alcohol resolution.

7. Photography and preservation

a. Collection of deep-sea fauna should be documented by photography of the fresh specimens and preservation of rare or uncommon species for further confirmation and study.

8. Data Reporting and Networks
    a. All data collected should be report and made available for further purpose of scientific analyses
    b. Database and network

F. REFERENCES

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FAO, 2008. Report of the workshop on Data and Knowledge in Deep-Sea Fisheries in the High Seas. Rome, 5-7 November 2007. FAO Fisheries Report. No. 860. Rome, FAO. 15 p.

DRAFT OF THE CONSTRUCTION AND MATERIALS OF THE DEEP-SEA SAMPLING GEARS OF M.V. SEAFDEC 2

Otter board trawl
Beam trawl
Trap
Bottom long line

Sayan Promjinda

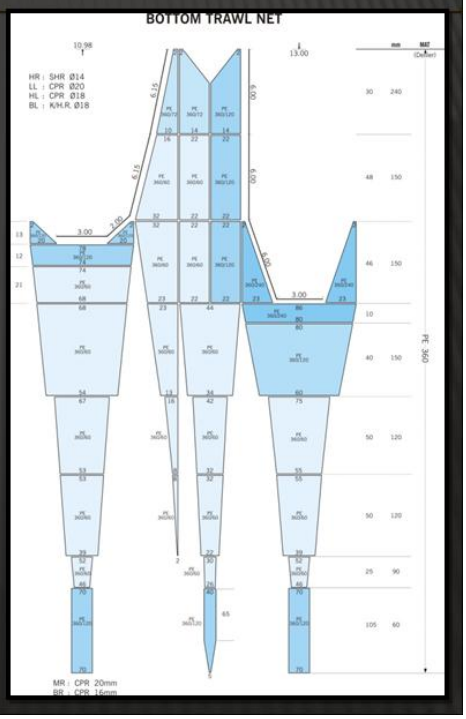
Capture Fisheries Technology Division
Southeast Asian Fisheries Development Center
Training Department

Otter board trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Trawl Net design 2004-2007

- 4 seams trawl.
- Ground rope is 37 m. length
- Head rope is 31.6 m length.
- Net body is 40.55 m length.
- Ground rope is suitable for soft bottom.
- Cod end part is 1 inch mesh size and make by polyethylene knotless net.
- Net opening is about 2.5-3.0 m height and 20-24 m wing spread.



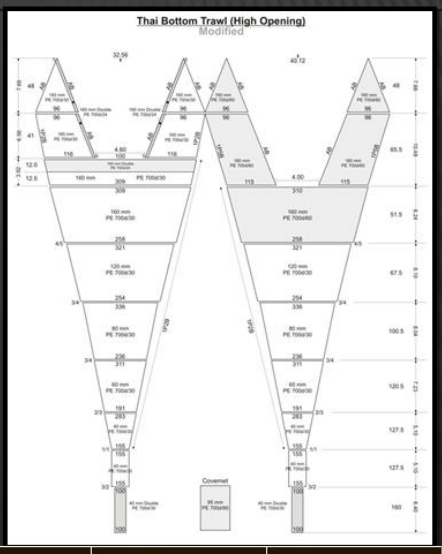
Otter board trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Trawl Net design

2007-2009

-2 seams trawl.
- Ground rope is 40.12 m with length
- Head rope of 32.56 m length.
- Net body is 66.37 m length.
- Ground rope is suitable for soft bottom.
- Cod end part is 40 mm double mesh size made by polyethylene PE 700d/30.
- Net opening is about 4-10 m height and 10-20 m wing spread.



Type of net	Ground rope(length)	Head rope(length)	Net body (length)	Net opening (m)	Wing spread (m)
2 seam	40.12	32.56	66.37	4-10	10-20
4 seam	37	31.6	40.55	2.5-3.0	20-24

Otter board trawl

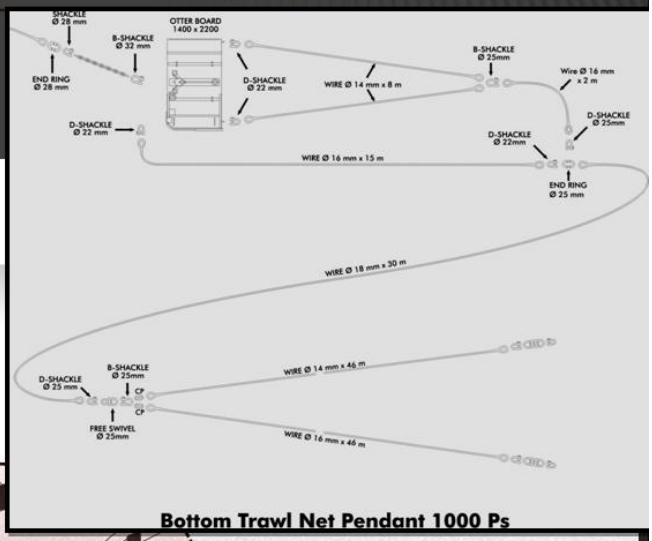
CONSTRUCTION AND GEAR DEVELOPMENT

Otter board and Net Pendant

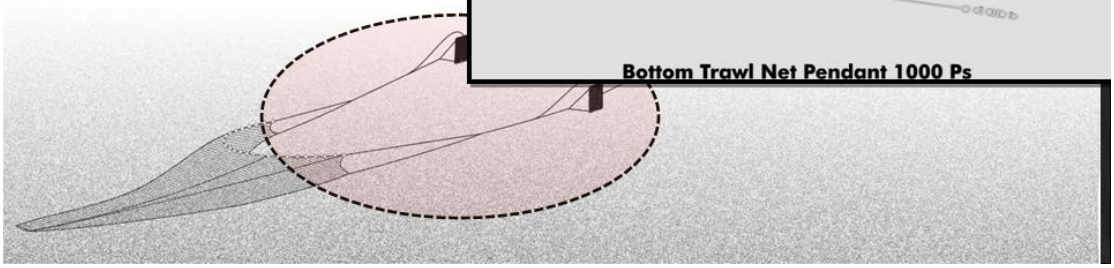
- Rectangular iron otter board 1.40 x 2.20 m

- Sweep line is 30 m length

- Upper and lower net pendant 50 m

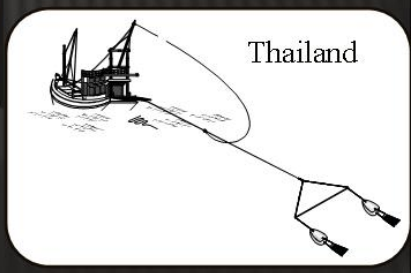


Bottom Trawl Net Pendant 1000 Ps



BEAM TRAWL

Beam trawl category



Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

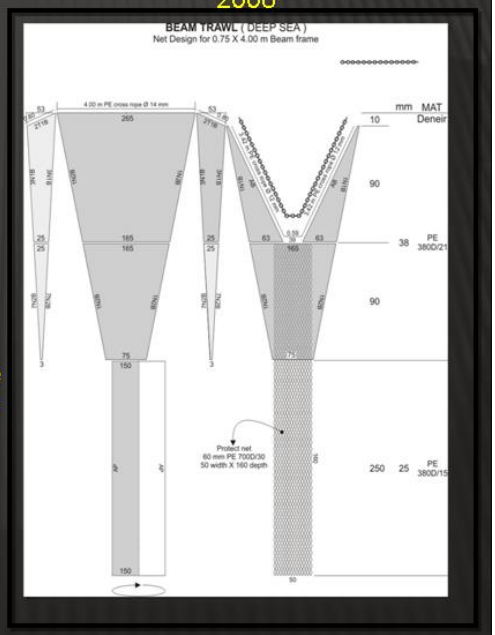
Net design

M.V. SEAFDEC 2 Modification
- **Frame : 4 meter**
- **Head rope 4 m (Length)**
- **Ground rope 7.4 m**
- **PE 380 d/21, 380 d/15**
- **Mesh size 38 mm / 25 mm**
- **Net body is 13.47 m length**

Demerit

Net body and Cod end is narrow, the logged get in side the net it will made the beam turnover or tilt to one side when hauling

2008



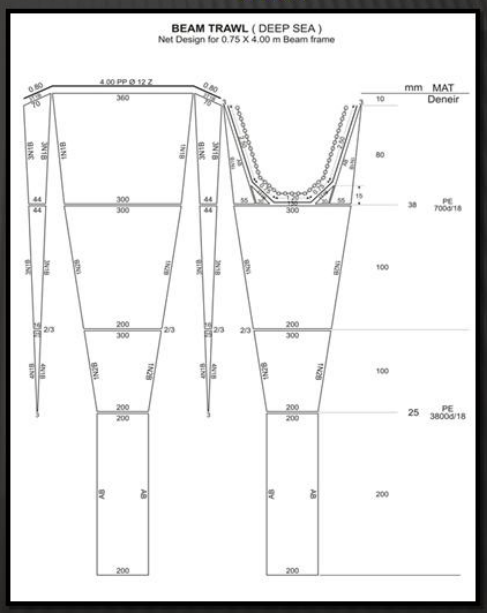
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Net design

2009

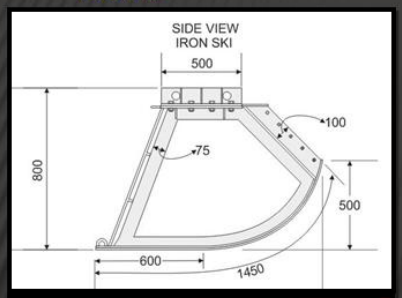
M.V. SEAFDEC 2 Modification
- Frame : 4 meter
- Head rope 4 m (Length)
- Ground rope 8.7 m
- PE 700 d/18, 380 d/18
- Mesh size 40 mm / 25 mm
- Net body is 15.1 m length

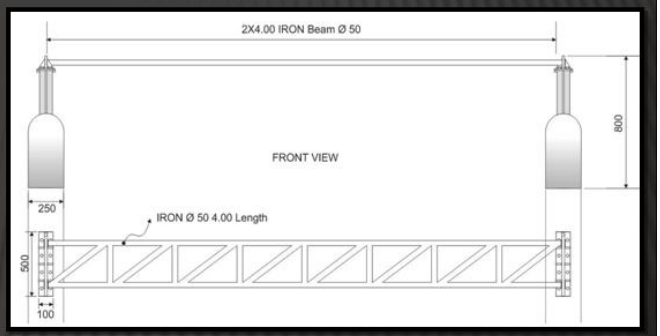


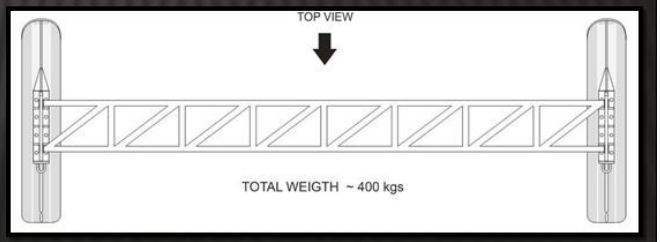
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Beam / Frame



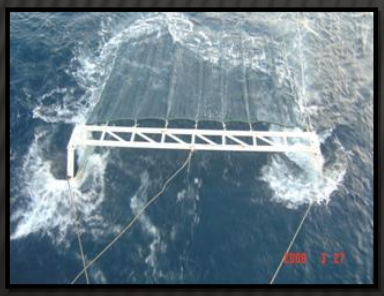




Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

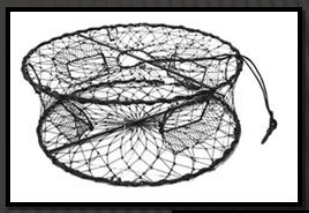
Beam / Frame

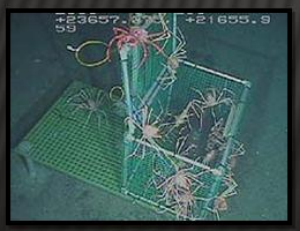


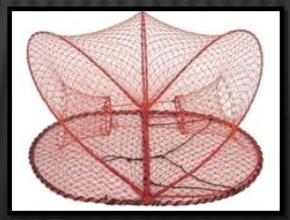
Trap Operation

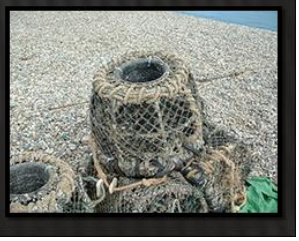
CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category







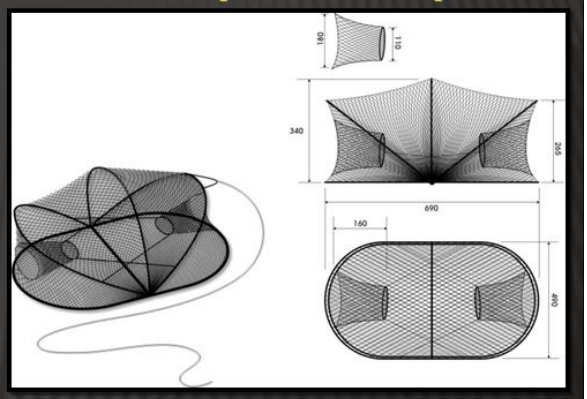


Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible Lobster trap



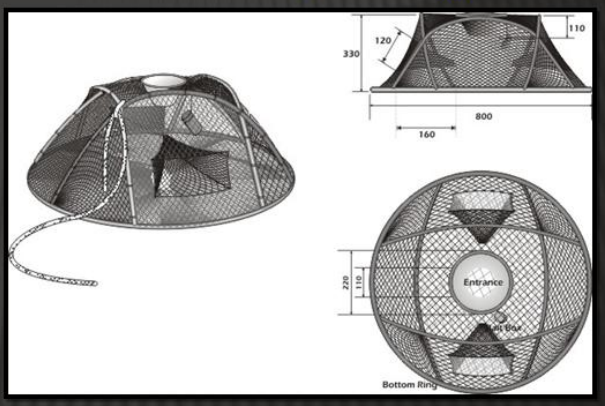
Target species : Lobster and Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Deep sea shrimp pot



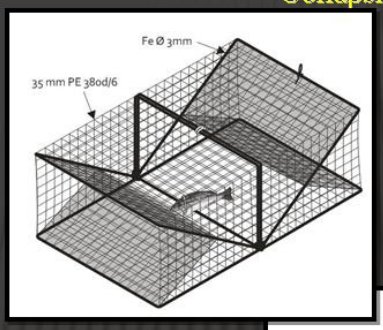
Target species : Shrimp

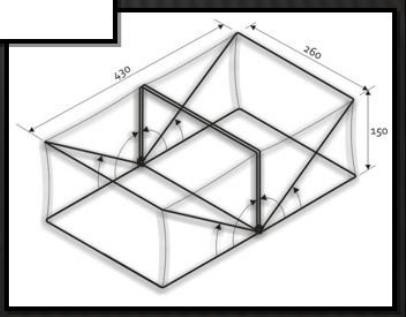
Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible crap trap





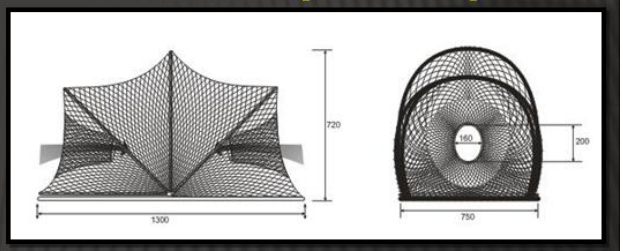
Target species : Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible fish trap



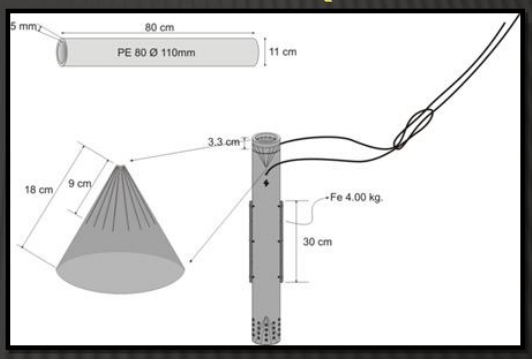
Target species : Fish and Lobster

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category used on M.V.SEAFDEC 2

Eel trap



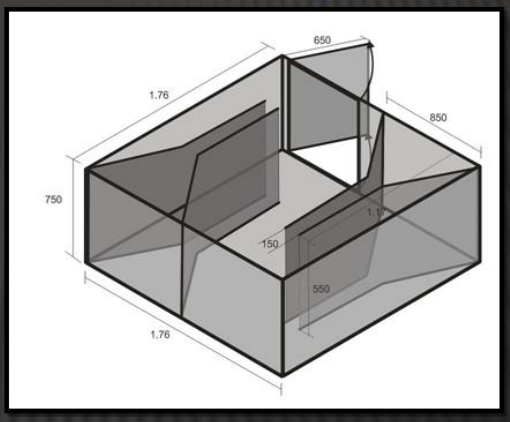
Target species : Eel

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Giant Fish trap



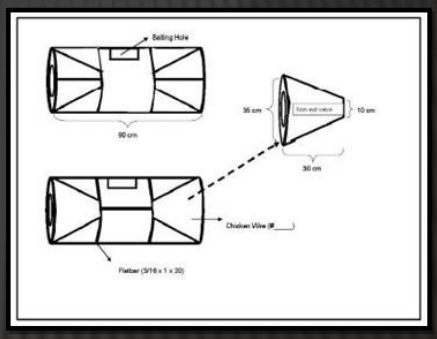
Target species : Fish

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category used on M.V.SEAFDEC 2

Under construction



Target species : Shrimp and Fish

Bottom long line Operation

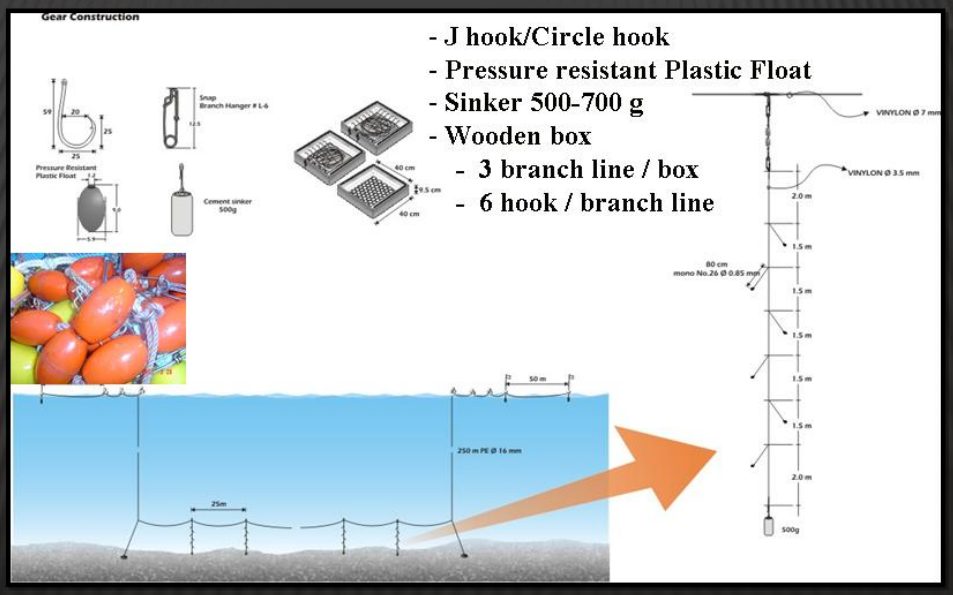
CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories

Bottom long line Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories



Bottom long line Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories

-Mainline at least, shall be contained 60 branch line

- At least 500 hooks shall be deployed in an operation

- Number of hook per branch line must be constant in each operation

- Number of hook should be constant in every operation

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Fishing operation preparation

Bottom condition is detected before start fishing operation by using essential fishing finder or echo sounder and essential information or weather and oceanographic condition are collected, in order to select and plot the proper ground for the fishing operation and

Period of Fishing operation

Otter board and beam trawl / Trap

Daytime and night time

Bottom long line

Should be conducted in twilight time or daytime

Bait selection (Trap / Bottom long line)

Trap

Bait shall be minced and put in the perforated bait box or meshed bag to allow the odor to escape or to use the whole fish hang in the trap/pot

Bait in each trap/pot shall be similar in type and quantity

Bottom long line

Bait type and cutting size of bait shall be similar in every operation in a research cruise except there is any experiment on such topic

Local bait found in fishing ground is the first priority to be used

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Towing time (Otter board and Beam trawl)

1 hour or shall be designed whilst the process of research survey planning

Immersion time

Trap

Immersion time of the gear shall be at least 6 hours and not exceed 72 hours.

Bottom long line

Immersion time of the gear shall be at least 2 hours and not exceed 6 hours.

Depth of operation

Otter board trawl

The maximum depth in not more than 500 m, (According to the towing warp length, 1500 m.)

Beam trawl

The maximum depth in not more than 600 m, (According to the towing warp length, 1500 m.)

Trap

According to length of buoy line, depth of capture shall be less than 500 meters.

Record the depth of the fishing ground in depth range.

Bottom long line

Depth of water between 100 – 350 meter.

Rocky bottom, hard coral ground is preferred.

Record the depth of the fishing ground in depth range.

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC2

Speed of operation

Otter board trawl

Towing speed is constant at 3-4 knots and recommend not to adjust towing speed during fishing operation excepted for the recovery of malfunction gear.

Beam trawl

Towing speed is constant at 2.5-3.5 knots and recommend not to adjust towing speed during fishing operation excepted for the recovery of malfunction gear.

Shooting speed (Trap / Bottom long line)

Shooting course shall be recorded in unit of 'degree' with three digit places.

Speed measurement

Shooting speed shall be recorded from average speed over ground during shooting.

Recording unit of speed shall be in 'knot'

Warp length

Otter board trawl

Warp length is released 3-5 times of the sea depth.

Beam trawl

Warp length is released 1.5-2.5 times of the sea depth

The warp length is recorded when the brake of trawl winch is fastened and warp length is measured by unit of meter(m) Recommend not to adjust towing warp during fishing operation except for the malfunction of gear or operation is occurred

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC2

Towing direction (Otter board / Beam trawl)

Towing shall be straight direction and recommend to avoid changing of towing direction except the towing direction is obstructed by some object.

Monitoring Device (Otter board)

Net depth shall be detected by depth sensor; SCANMAR measurement is unit of meter

Net spreading shall be detected by distance sensor; SCANMAR

Measurement is unit of meter

In order to calculate the sweeping area, Clinometers shall be used to check the spreading of otter board by measure the warp angle using, the calculation shall be compared with the information by distance sensor.

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Information Recording

Otter board / Beam trawl

The recording of **Starting fishing** time and fishing position

Start recording the towing time and fishing position when the trawl net/ beam/skies reaches at the sea bottom or when the brake of trawl winch is fastened

The recording of **Finishing fishing** time and fishing position

Recording the finishing of towing time and position when the trawl net/ beam/skies is lifted form the sea bottom or when start hauling the trawl warp

Trap / Bottom long line

The recording of Start shooting time and fishing position

Start shooting time is the time when any part of the gear reaches the sea.

The recording of Finish shooting time and fishing position

Finish shooting time is the time when the last part of the gear shot overboard.

The recording of start hauling time and fishing position

Start hauling time is the time when operator hauled any part of gear on board.

The recording of finish hauling time and fishing position

Finish hauling time is the time when operator hauled all part of gear on board

The recording of Fishing position

Fishing position shall be recorded by using the GPS (Global Positioning System) or equally accurate navigation system for position measurement and

Position recording by unit of Latitude and Longitude

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Gear malfunction

Otter board / Beam trawl

If the malfunctioning of gear or operation is occurred trawl fishing operation should be cancelled and re-operate in the same area

Trap / Bottom long line

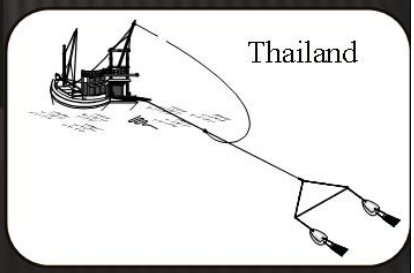
If the malfunctioning or lost of gear, main line usually found entangled with under water rocky during hauling operation.

Details of entangling and lost of trap / branch line shall be recorded numbers

Record the malfunction of the gear of operation in to the Fishing log sheet

BEAM TRAWL

Beam trawl category



Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

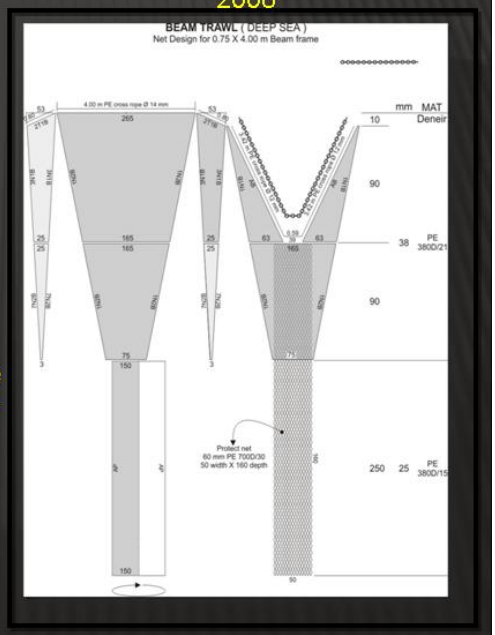
Net design

M.V. SEAFDEC 2 Modification
- **Frame : 4 meter**
- **Head rope 4 m (Length)**
- **Ground rope 7.4 m**
- **PE 380 d/21, 380 d/15**
- **Mesh size 38 mm / 25 mm**
- **Net body is 13.47 m length**

Demerit

Net body and Cod end is narrow, the logged get in side the net it will made the beam turnover or tilt to one side when hauling

2008



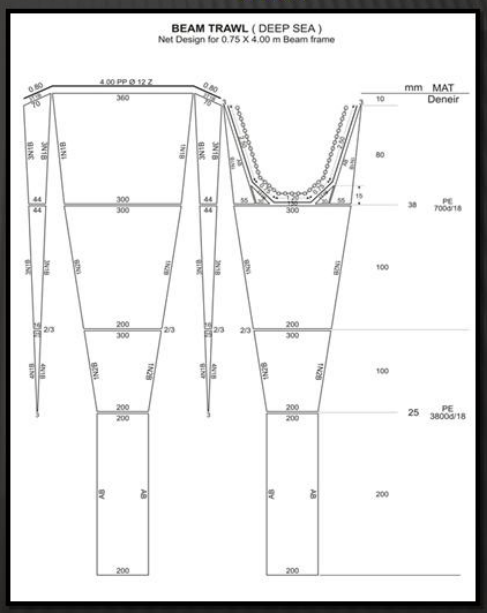
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Net design

2009

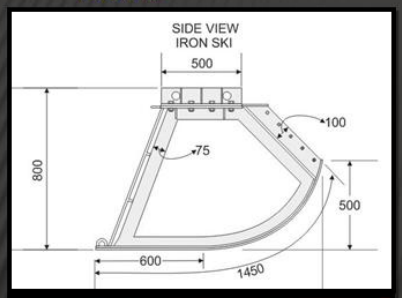
M.V. SEAFDEC 2 Modification
- Frame : 4 meter
- Head rope 4 m (Length)
- Ground rope 8.7 m
- PE 700 d/18, 380 d/18
- Mesh size 40 mm / 25 mm
- Net body is 15.1 m length

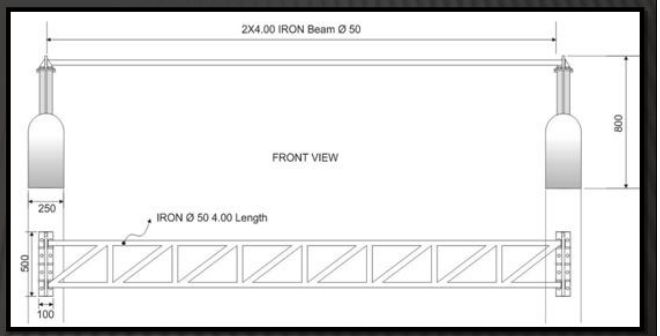


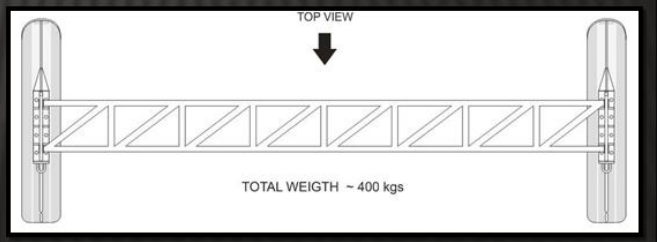
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Beam / Frame



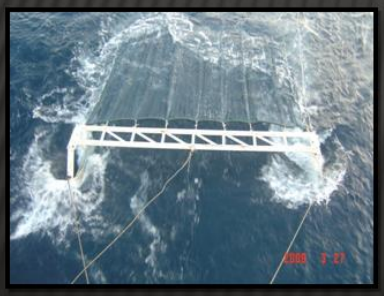




Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

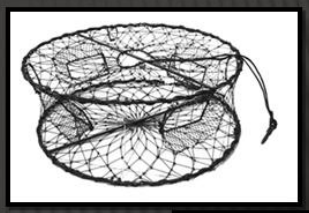
Beam / Frame

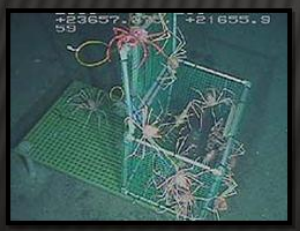


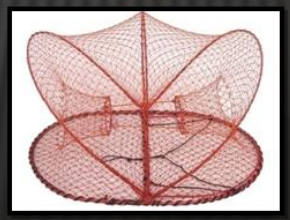
Trap Operation

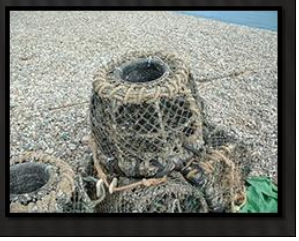
CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category







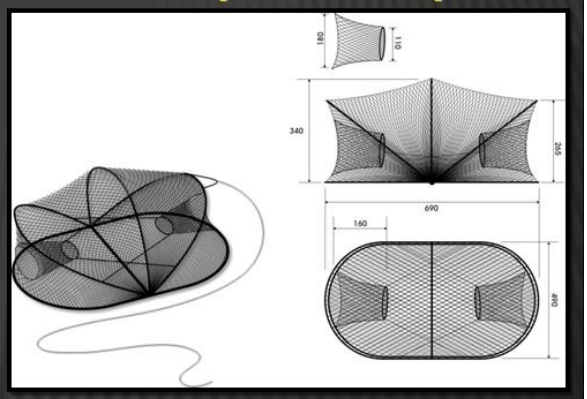


Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible Lobster trap



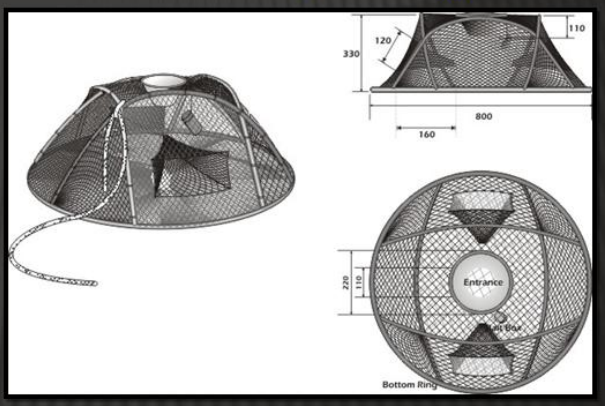
Target species : Lobster and Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Deep sea shrimp pot



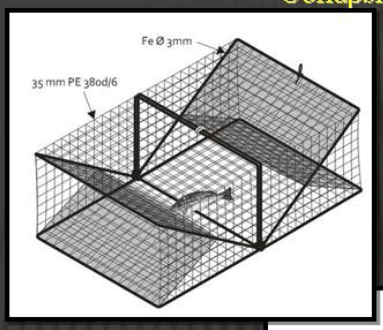
Target species : Shrimp

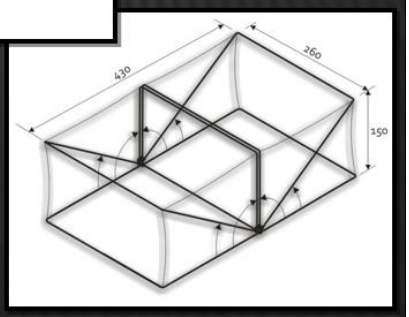
Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible crap trap





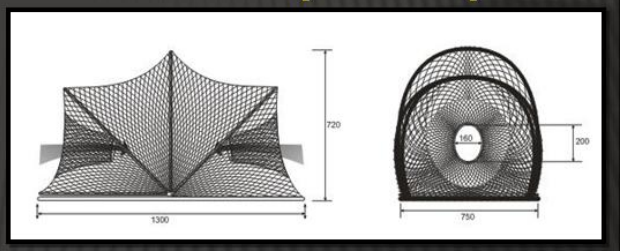
Target species : Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible fish trap



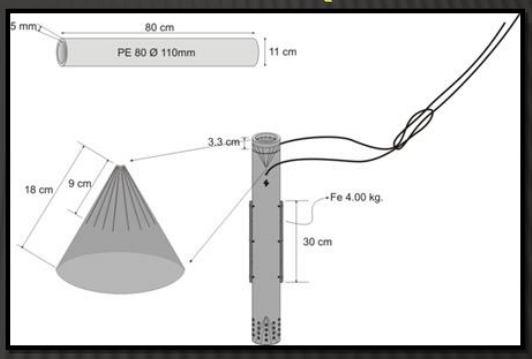
Target species : Fish and Lobster

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category used on M.V.SEAFDEC 2

Eel trap



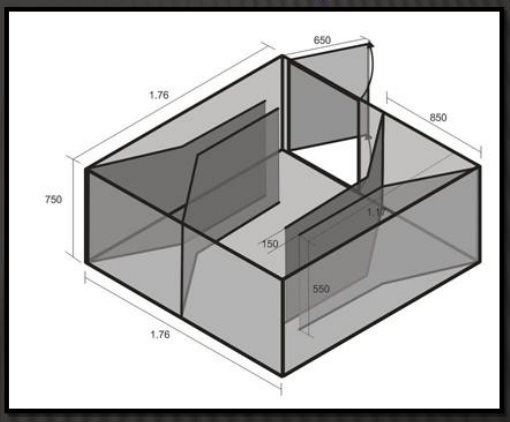
Target species : Eel

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Giant Fish trap



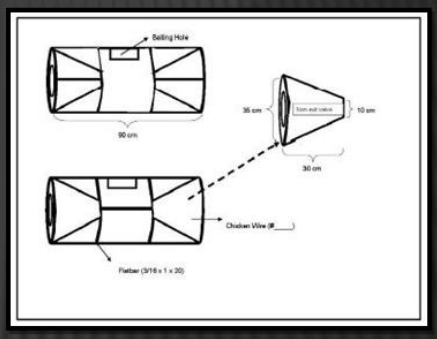
Target species : Fish

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap / pot Category used on M.V.SEAFDEC 2

Under construction



Target species : Shrimp and Fish

Bottom long line Operation

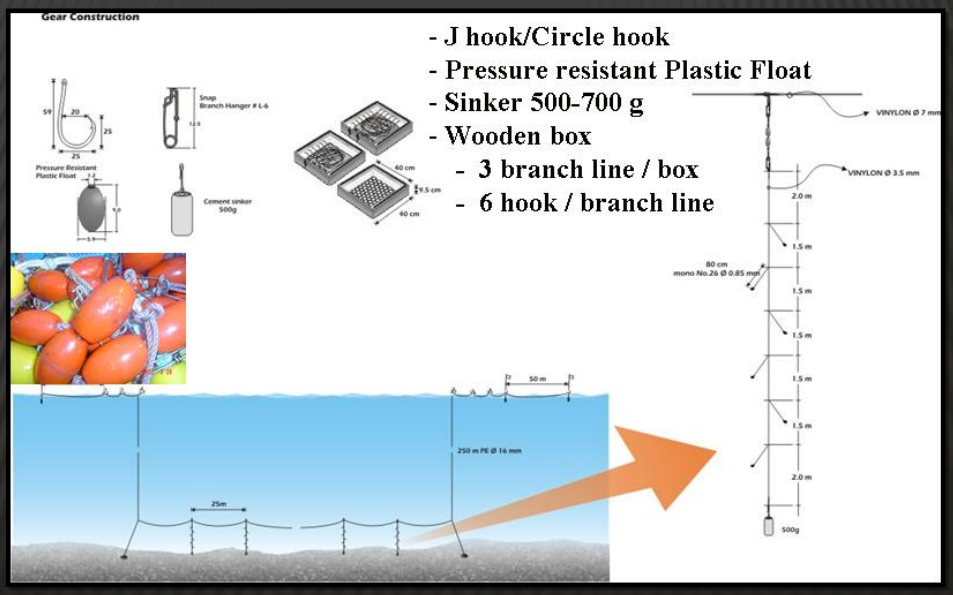
CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories

Bottom long line Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories



Bottom long line Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Bottom vertical long line and their accessories

-Mainline at least, shall be contained 60 branch line

- At least 500 hooks shall be deployed in an operation

- Number of hook per branch line must be constant in each operation

- Number of hook should be constant in every operation

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Fishing operation preparation

Bottom condition is detected before start fishing operation by using essential fishing finder or echo sounder and essential information or weather and oceanographic condition are collected, in order to select and plot the proper ground for the fishing operation and

Period of Fishing operation

Otter board and beam trawl / Trap

Daytime and night time

Bottom long line

Should be conducted in twilight time or daytime

Bait selection (Trap / Bottom long line)

Trap

Bait shall be minced and put in the perforated bait box or meshed bag to allow the odor to escape or to use the whole fish hang in the trap/pot

Bait in each trap/pot shall be similar in type and quantity

Bottom long line

Bait type and cutting size of bait shall be similar in every operation in a research cruise except there is any experiment on such topic

Local bait found in fishing ground is the first priority to be used

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Towing time (Otter board and Beam trawl)

1 hour or shall be designed whilst the process of research survey planning

Immersion time

Trap

Immersion time of the gear shall be at least 6 hours and not exceed 72 hours.

Bottom long line

Immersion time of the gear shall be at least 2 hours and not exceed 6 hours.

Depth of operation

Otter board trawl

The maximum depth in not more than 500 m, (According to the towing warp length, 1500 m.)

Beam trawl

The maximum depth in not more than 600 m, (According to the towing warp length, 1500 m.)

Trap

According to length of buoy line, depth of capture shall be less than 500 meters.

Record the depth of the fishing ground in depth range.

Bottom long line

Depth of water between 100 – 350 meter.

Rocky bottom, hard coral ground is preferred.

Record the depth of the fishing ground in depth range.

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC2

Speed of operation

Otter board trawl

Towing speed is constant at 3-4 knots and recommend not to adjust towing speed during fishing operation excepted for the recovery of malfunction gear.

Beam trawl

Towing speed is constant at 2.5-3.5 knots and recommend not to adjust towing speed during fishing operation excepted for the recovery of malfunction gear.

Shooting speed (Trap / Bottom long line)

Shooting course shall be recorded in unit of 'degree' with three digit places.

Speed measurement

Shooting speed shall be recorded from average speed over ground during shooting.

Recording unit of speed shall be in 'knot'

Warp length

Otter board trawl

Warp length is released 3-5 times of the sea depth.

Beam trawl

Warp length is released 1.5-2.5 times of the sea depth

The warp length is recorded when the brake of trawl winch is fastened and warp length is measured by unit of meter(m) Recommend not to adjust towing warp during fishing operation except for the malfunction of gear or operation is occurred

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC2

Towing direction (Otter board / Beam trawl)

Towing shall be straight direction and recommend to avoid changing of towing direction except the towing direction is obstructed by some object.

Monitoring Device (Otter board)

Net depth shall be detected by depth sensor; SCANMAR measurement is unit of meter

Net spreading shall be detected by distance sensor; SCANMAR

Measurement is unit of meter

In order to calculate the sweeping area, Clinometers shall be used to check the spreading of otter board by measure the warp angle using, the calculation shall be compared with the information by distance sensor.

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Information Recording

Otter board / Beam trawl

The recording of **Starting fishing** time and fishing position

Start recording the towing time and fishing position when the trawl net/ beam/skies reaches at the sea bottom or when the brake of trawl winch is fastened

The recording of **Finishing fishing** time and fishing position

Recording the finishing of towing time and position when the trawl net/ beam/skies is lifted form the sea bottom or when start hauling the trawl warp

Trap / Bottom long line

The recording of Start shooting time and fishing position

Start shooting time is the time when any part of the gear reaches the sea.

The recording of Finish shooting time and fishing position

Finish shooting time is the time when the last part of the gear shot overboard.

The recording of start hauling time and fishing position

Start hauling time is the time when operator hauled any part of gear on board.

The recording of finish hauling time and fishing position

Finish hauling time is the time when operator hauled all part of gear on board

The recording of Fishing position

Fishing position shall be recorded by using the GPS (Global Positioning System) or equally accurate navigation system for position measurement and

Position recording by unit of Latitude and Longitude

STANDARD OPERATING PROCEDURES FOR M.V. SEAFDEC 2

Gear malfunction

Otter board / Beam trawl

If the malfunctioning of gear or operation is occurred trawl fishing operation should be cancelled and re-operate in the same area

Trap / Bottom long line

If the malfunctioning or lost of gear, main line usually found entangled with under water rocky during hauling operation.

Details of entangling and lost of trap / branch line shall be recorded numbers

Record the malfunction of the gear of operation in to the Fishing log sheet

Annex 19

Programs/Initiatives proposed for future improvement of the deep-sea resource exploration in SEA region

Programs/Initiatives	Merits	Existing Facilities/Agencies	Activities
Joint Survey	Safe cost, sharing of facilities, experts, etc.	1. MV SEAFDEC 2 2. National Research Vessels	1. Formulation of regional survey program for deep-sea exploration 2. Regional inventory of research vessels, including their facilities 3. List of possible support to the national activities related to the deep-sea exploration (e.g. ASEAN, DANIDA, Japan, etc.)
Technical Support and Services	Facilitating the process of conducting the survey (i.e.g selection of survey equipments, sampling gears, research vessels)	1. FRA (Japan) 2. SEAFDEC/TD 3. SEAFDEC/MFRDMD 4. BFAR (Philippines) 5. DMCR (Thailand)	Information availability - biological characteristics of species - physical characteristics of seabed - etc.
Template of the Survey Report	Support and facilitate further compilation of the results from the surveys	SEAFDEC	1. Structure and content of the report 2. Template for data input, processing and analysis - Stock estimation (catchability, sustainable yield estimation, biomass estimation, natural mortality, fishing mortality, CPUE, etc.) - Species distribution in the survey area (finding sheet, regional mapping of the deep-sea species, etc.)
Sharing of Information	Support future human and institutional capacity building, knowledge transfer, development of commercial deep-sea fisheries.	SEAFDEC	1. Establishment of sharing mechanism and also its updating for: - Mapping of the seabed characteristic of deep-sea in SEA waters - Mapping of deep-sea resources in SEA waters - Availability of research vessels and facilities in SEA countries 2. Establishment of a regional center of excellence for the deep-sea fishery resources exploration in SEA waters

Annex 20

Regional Plan of Activities for 2010 and Onward – Deepsea Fishery Resources Exploration in the Southeast Asian Region

Group of Activity	2010 Plan	3-Year Plan (2011~2013)	Ultimate Goal
Supporting of Deep-sea Fishery Resources Exploration	- Participation in the actual survey by MV SEAFDEC2: Brunei - Participation in the actual Survey by National Research Vessels	- Information collection and/or study on the cost and benefits for the deep-sea fishery resources utilization, considering sustainable development and management of deep-sea fishery, through o The support of actual survey using MV SEAFDEC and/or other research vessels o Review of report, documents, information, etc. o Participation in the relevant events	- Understanding fishery resources availability in deep-sea areas on the continental shelf/slope in the SEA - Information package, including o Selected deep-sea catch species o Study report on the cost and benefits for deep-sea exploitation in SEA
Deep-sea Ecosystem and Impact from Deep-sea Fisheries	- Organization of the Regional Expert Consultation on the Deep-sea Ecosystem and Impact from Deep-sea Fisheries - Information collection on deep-sea ecosystem and impact from deep-sea fisheries on the continental shelf/slope in SEA o Research activity during the actual cruise survey o Review of reports from research surveys carried out in SEA region, regional and national programs/activities o Participation in the relevant events	- Organization of series of Regional Expert Consultation on the Deep-sea Fishery Resources - Continue collect information on deep-sea ecosystem on the continental shelf/slope in SEA through: o The support of actual survey using MV SEAFDEC and/or other research vessels o Review of reports from research surveys carried out in SEA region, regional and national programs/activities o Participation in the relevant events	- Information update/available: o Deep-sea ecosystem in the continental shelf/slope in SEA o Study report on the impact of deep-sea fisheries on the deep-sea ecosystem/habitat

Development/Improvement of Deep-sea Sampling Gears/Technology	- Fishing trails during the actual survey in the areas of continental shelf/slope in SEA - Consultation with fishing gear experts for improvement of fishing gear (if possible)	- Organization of the expert consultation on development/improvement of sampling gear for deep-sea fishery resource exploration	- Regional SOP for Deep-sea Fishing Gear and Technology
HRD Programs on Deep-sea Fishery Resources Exploration	- Organization of the onsite training program on deep-sea fishery resource exploration in SEAFDEC Member Countries	- Organization of onsite training program on deep-sea fishery resources exploration - Organization of the regional training program on deep-sea fishery resources exploration	- Human capacity building for the deep-sea fishery resources, including the area of: fishing gear, deep-sea fish species, deep-sea ecosystem, etc. - Development of the regional/national training program and its package on deep-sea fishery resource exploration
Information Dissemination	- Reporting of all outputs from the project, including reports of the survey, SOP of sampling gear, SOP of deep-sea fishery resource survey in SEA - Disseminate information through website	- Information dissemination to SEAFDEC Member Countries and other relevant agencies	- Establishment/publication of set of information on deep-sea fishery resource exploration in SEA, including: o Deep-sea catch species o Training course/programs o Etc