REPORT OF THE REGIONAL WORKSHOP ON THE STANDARD OPERATING PROCEDURE AND DEVELOPMENT/IMPROVEMENT OF SAMPLING GEARS FOR THE DEEP-SEA RESOURCE EXPLORATION

Samutprakarn, Thailand, 26-28 May 2009

TD/RP/171

Preparation and distribution of this document

The Report of the Regional Workshop on Standard Operating Procedure and Development/ Improvement of Sampling Gears for the Deep-Sea Resource Exploration was prepared by the Coastal Fisheries Technology Division of the Training Department of the Southeast Asian Fisheries Development Center (SEAFDEC). The Document is distributed to the participants and resource persons of the Workshop, SEAFDEC Member Countries, SEAFDEC Departments and concerned institutions/organizations.

BIBLIOGRAPHIC CITATION

SEAFDEC. 2009. Report of the Regional Regional Workshop on Standard Operating Procedure and Development/Improvement of Sampling Gears for the Deep-Sea Resource Exploration. Southeast Asian Fisheries Development Center, Training Department, Thailand, TD/RP/171: 300 pp.

SEAFDEC Training Department
P.O. Box 97
Phrasamutchedi
SAMUT PRAKAN 10290
Thailand

CONTENTS

PART I

CONTENTS

PART II

Presentations

REPORT OF THE
REGIONAL WORKSHOP ON THE STANDARD OPERATING PROCEDURE AND DEVELOPMENT/IMPROVEMENT OF SAMPLING GEARS FOR THE DEEP-SEA RESOURCE EXPLORATION

26-28 May 2009
SEAFDEC Training Department, Thailand

I. INTRODUCTION AND OPENING OF THE MEETING

1. The Regional Workshop on the Standard Operating Procedure and Development/ Improvement of Sampling Gears for the Deep-Sea Resource Exploration was organized by the SEAFDEC Training Department in Thailand from 26 to 28 May 2009. The Workshop was attended by fishing gear technologists, marine capture fisheries experts, and representatives from Brunei Darussalam, Indonesia, Japan, Malaysia, Myanmar, Philippines, Thailand, and Vietnam as well as from the SEAFDEC Secretariat, Training Department, and Marine Fishery Resources Development and Management Department. The List of Participants appears as Annex 1.

2. The Secretary-General of SEAFDEC, Dr. Siri Ekmaharaj in his Opening Address, welcomed the participants and thanked them for their participation in the Workshop. He briefed the participants on the efforts of SEAFDEC in conducting deep-sea fishery resources survey in the EEZs of the countries in Southeast Asia in order to explore new potential fishing grounds. He added that the Workshop is convened in order to address the need to formulate and develop the Standard Operating Procedures (SOP) for deep-sea resources exploration in the Southeast Asian waters. After coaxing the participants to exchange their experiences and views on their respective activities and initiatives related to deep-sea fishery resources surveys which could contribute to the improvement of sampling gears and methods for deep-sea resources, he declared the Regional Workshop opened. His Opening Address appears as Annex 2.

3. The Chairman of the Workshop, Dr. Worawit Wanchana, SEAFDEC Training Department, briefed the participants on the background as well as on the rationale and objectives of the Workshop. He reiterated that aside from developing the Standard Operating Procedures, the Workshop would also serve as an avenue for the improvement of deep-sea resources sampling gears that could be used by the countries in the region in their respective deep-sea fishery resources exploration and surveys. Moreover, the Workshop is also envisaged to formulate future plan of activities on deep-sea fishery resources exploration at the regional and national levels.

4. The agenda which appears as Annex 3 was adopted.

II. SHARING OF EXPERIENCES ON DEEP-SEA RESOURCES RESEARCH AND SURVEY

2.1 Technical Requirements and Prerequisites for Deep-Sea Exploration

5. An overview of the technology development for deep-sea exploration was presented by Dr. Yoshiki Matsushita (Annex 4), Resource Person from the Faculty of Fisheries of Nagasaki University, Japan. At the onset, Dr. Matsushita defined "deep-sea areas" as those marine environments that occur beyond the continental shelf with average depth of approximately 200 m, and added that in the Southeast Asian region, the known deep-sea areas are found in Brunei Darussalam at 200-500 m depth, in the west coast of Luzon in the Philippines at 200-1000 m depth, in the Visayan Sea also in the Philippines at 150-500 m depth, and in the Andaman Sea of Myanmar at 150 to 400 m depth. He also cited some examples of deep-sea fishing in Japan such as the gillnet fishing in the Okhotsk high sea, pot fishing in the Sea of Japan, longline in the East China Sea, vertical line gear in Eastern Japan, and otter trawl off Hokkaido.

6. In outlining the industrial technology development in deep-sea fisheries in Japan, Dr. Matsushita cited that seabed mapping tool for the fishing industry has already been advanced and that an auto-trawl system to lock-on deep-sea target has already been adopted. Specifically, he summarized the considerations for deep-sea operation using gillnets, lines and pots that include the fact that gillnets and longlines are low-energy

consumption fishing methods, that small-scale gillnet/longline fishing practices are low-cost fisheries but on a large-scale could be labor intensive, and that mechanization and using stronger net haulers are required.

7. As regards otter trawl, he advocated that the trawl winch must be powerful enough as the trawl could be very heavy. Thus, otter trawl operation needs improvement of the deck's machinery used in setting and towing the gear, and hauling the gear and catch. In loading large quantities of heavy gear, Dr. Matsushita prescribed that safety onboard should be the main focus.

8. As regards the development of research technologies, Dr. Matsushita evoked the need for habitat mapping considering that deep-sea exploration for fishing requires understanding of the physical and biological characteristics of the seafloor habitats. He defined "habitat" as referring to the environment necessary to support, directly or indirectly, the living process of the resident organisms. The physical characteristics of the seafloor habitats could be perceived through bathymetry using echo-sounder, multi-beam sonar, side-scan sonar, etc. In addition, the substrate type could be determined by sampling with the use of grab or dredge, video recording techniques, analyzing the multi-beam sonar backscatter, etc. Physical parameters such as temperature, flow condition, etc. could be monitored using various conventional instruments.

9. In understanding the biological characteristics, Dr. Matsushita suggested the need to conduct sampling or remote monitoring, considering that techniques in scientific sampling of fisheries is similar to commercial fishing gears although typically scaled down in terms of size. He cited that passive sampling (hook and line, gillnets and pots) are preferred as these are relatively simple in terms of design, construction and use; involve less machineries; relatively abundant and are available; environment dependent; and are selective gears.

10. In conclusion, Dr. Matsushita highlighted on the factors that should be given attention in deep-sea exploration such as the vulnerability of the deep-sea stocks and conservation of the habitat. Deep-sea stocks generally reach late maturation, possess extreme longevity but with low fecundity and slow growth. In order to conserve the habitat, efforts should be made to minimize the negative effect of fishing to habitat specifically to the biogenic habitat. He added that one consideration necessary for deep-sea exploration is the ecosystem approach to fisheries which has been promoted by FAO. The ecosystem approach to fisheries is an extension of the conventional fisheries management that recognizes more explicitly the interdependence between human and ecosystem health and the need to maintain ecosystem productivity for the present and future generations.

2.2 Experiences and Lessons Learned from Regional/National Initiatives/Programs Related to Deep-Sea Exploration

Regional Fishing Trials and Resources Survey

(1) Deep-sea fisheries resources survey experience in Andaman Sea (1975-1995) (Annex 5)

11. The results of the deep-sea fishery resources surveys of the Andaman Sea from 1975 to 1995 were presented by Mr. Aussanee Manprasit of SEAFDEC/TD. Within the period of more than 10 years, six major resources surveys have been conducted in the area. The Demersal Fishery Resources Survey was conducted in March 1975 using the R.V. Fisheries Research No. II of Department of Fisheries Thailand in 200-500 m depth using bottom trawl with mesh size of 30 mm at the cod-end. The results indicated an average catch of 175 kg/hr with a maximum catch of 586 kg/hr, comprising 75 species of fish of which 12-15 species were unknown, 30 species of shrimps, and 5-6 species of squid and crab. The main catch comprised fishes (*Chloropthalmus corniger, Synagrops malaynus*), shrimps (*Heterocapus laevigatus, H. ensifer*), and spiny lobster (*Puerulus sewelli*).

12. In February 1976, the Deep Sea Shrimp Resources Survey was carried out in 300-500 m depth using the R.V. Fisheries Research No. II of DOF. The survey fishing gear used was deep-sea pot (prism shape, mesh size of 15 mm, emersion time of 8 hours). The maximum total catch was 8.8 kg/pot, of which shrimps (*Heterocapus loseigatus, H. ensifer*) accounted for 0.9 kg/pot. Results also indicated that at depth of 400 m could be a good fishing ground for the shrimps.

13. From August to September 1987, the Training Cruise and Demersal Fishery Resources Survey/Bottom Topography Survey of Andaman Sea was conducted in 200-1000 m depth using the M.V. Paknam and bottom trawl with mesh size of 40 mm at the cod-end. The total catch was 150-300 kg/hr, and the topography indicated slope at 200-300 m and over 500 m, flat at 350-500 m, and that the most appropriate area for bottom trawl could be at 350-450 m depth.

14. The Resource Survey and Training Cruise was conducted from January to March 1988 in 100-250 m depth using the M.V. Platoo with bottom vertical long line (BVL). The catch comprises snapper, grouper, spiny dogfish (*Squalus* spp.). In February 1990, another Resource Survey and Training Cruise was conducted in 200-400 m depth using the M.V. Paknam and deep-sea pot (hemispherical shape, mesh size of 30 mm, and emersion time of 12-14 hrs). Shrimp species (*Heterocapus siboge, H. lepidus*) were abundant at 300-400 m depth. Another Resource Survey and Training Cruise was conducted in March 1994 in 150-250 m depth using the M.V. SEAFDEC and deep-sea pots (hemispherical shape, mesh size of 30 cm) and BVL. The main catch comprised deep sea shrimps, hag fish, rat tail, conger eel, etc.

15. During the discussion, it was explained that deep-sea shrimp fisheries could be developed in Thai as well as in Myanmar waters in the Andaman Sea, however the use of good and efficient gear is necessary. Although resources are available, marketing could be a problem since deep-sea shrimps could be expensive compared with other shrimps. Moreover, the spiny lobster resources in the Myanmar waters of the Andaman Sea could have already recovered after a huge exploitation sometime in 1994 by foreign vessels.

16. Furthermore, bottom trawl should not be used in the Andaman Sea because other species could be caught which are not useful, although could still be used as fish meal. The use of trap or BVL to select the catch should therefore be promoted.

(2) Fishing Trials and Resources Survey Using the M.V. SEAFDEC 2 (2004-present) (<u>Annex 6</u>)

17. The results of the fishing trials and resources survey using the M.V. SEAFDEC 2 were reported by Mr. Nakaret Yasook of SEAFDEC/TD. The sampling equipments used were bottom otter trawl, beam trawl, trap, and the Isaac-Kidd Mid-Water Trawl (IKMT). The survey stations were located in the Andaman Sea and waters off Brunei Darussalam.

18. For the bottom otter trawl, the depth of operation was 120 m in the Andaman Sea and 100-160 m in Brunei Darussalam waters. With 2 operations in the Andaman Sea and 16 operations in Brunei Darussalam waters, the CPUE was 260 kg/hr and 101 kg/hr, respectively. Beam trawl was used at 70-80 m depth in the Andaman Sea and after 3 operations the CPUE was 4.02 kg/hr. In Brunei Darussalam waters, after 21 beam trawl operations, the CPUE was 4.74 kg/hr. Trap was used at 80-160 m depth in the Andaman Sea giving a CPUE of 2.96 kg/trap.

19. In the discussion, it was emphasized that for deep-sea explorations, the size of boat and power as well as the gear to be used should be considered. Moreover, the efficiency of the gear should also be taken into consideration, as well as the resources and the target species.

(3) Results of Bottom Trawl Survey at the Continental Slope in the Northern East China Sea (<u>Annex 7</u>)

20. The result of the bottom trawl survey at the continental slope in the Northern East China Sea conducted by the Seikai National Fisheries Research Institute in Nagasaki, Japan was presented by Dr. Yoshinobu Konishi. For the exploitation of new demersal fish resources and fishing grounds, the survey was conducted using commercial bottom trawl fishing boats, in order to evaluate the targeted area as fishing ground and the abundance of economically important fish for commercial fisheries. The bottom paired trawl boat had acoustic instruments onboard for towing such as side-scan sonar to detect bottom materials, e.g. rocky area muddy areas; and echo sounder in the boats to detect the vertical profiles of the sea bottom and determine the sea depth.

21. The survey period was from 21 July until 16 August 2008 in 23 stations where a total of 3 to 4 net hauls/day/station was conducted with 2 hours towing time/net. The net height and width at towing is about 4-5 m, 30 m, respectively. When fishes were caught only the marketable fishes were sorted on board while the

unmarketable were discarded. The quantity of fishes caught per haul was estimated by the number of fish trays for each sorted and unsorted species. The body length for 50 specimens of each selected species captured was measured by sampling from 2-3 hauls/day. Trays with sorted fishes were stored in chilled room (around 0ºC) and landed on a fish market for auction once a week.

22. Net shootings were done after searching the trawlable area with the aid of the sonar and typical echo sounders. During the survey, 84 hauls including 2 hauls in night time were conducted. Four of the 84 hauls encountered net trouble when the compound rope got entangled at the sea bottom, however adjustment of the speed of the fishing boats and trawl winch solved the problem. In some stations, net haul in the same depth zone was difficult when hauling track infringed across the zone. The number of net hauls in four depth zones was: 19 in 200 m zone; 33 in 300 m zone; 28 in 400 m zone; and 3 in 500 m zone. In some stations, a large gap (> 100 m) between the minimum and maximum sea depths occurred at hauling.

23. The results indicated that the total catch was dominated by common squid (7.0% of total catch) followed by sea perch (6.6%), Japanese splitfin (6.0%), rockfish (5.5%), rosy sea bass (4.8%), mirror dory (4.8%), and other species. Of the estimated whole catch landed of 45,517 kg valued at about 4.4 million Japanese Yen, the discards comprised about 42.2% (19,099 kg). The total catch of the best nine species accounted for about 43% of the whole catch landed. Among the catch landed, the deep-sea shrimp, deep-sea smelt, blackedge greeneye and some rattails have never been landed at the Nagasaki Fish Market before, hence the market prices of such species except for the deep sea shrimp were quite low.

24. In conclusion, Dr. Konishi recommended that the continental slope area surveyed could be considered potential fishing ground for the commercial bottom paired trawl fishing boats from the point of view of net operation. In addition, deep-sea shrimp is a potential fisheries resource in the area and should therefore be investigated in terms of ecological aspects for sustainable yield. He continued that when the unfamiliar species may get higher market prices, the deep-sea area where the resources is exploited could be a possible fishing ground for such species from the point of view of profitable and sustainable fisheries.

National Resources Survey related to Deep-Sea Resources Exploration

(1) Brunei Darussalam (Annex 8)

25. The EEZ of Brunei Darussalam has been divided into four zones, namely: zone 1 from 0-3 nm; zone 2 from 3-20 nm; zone 3 from 20-45 nm; and zone 4 from 45-200 nm. The offshore area which covers about 75% of the country's territorial waters, is located in zone 4, and is largely rough with plenty of deep troughs > 3000 m depths. The area at 100-200 m depth is a very narrow strip (about 2 nm^2) and is approximately 40 nm from the shoreline. The bottom type is generally muddy on the western side and rocky on the eastern side. The continental slope creeps sharply from the 200 m depth up to about 3,000 m depth of the sea floor towards the Palawan trough that ends in Brunei waters.

26. Deep-sea surveys have been carried out to assess and determine the fisheries potential of the offshore marine areas of Brunei Darussalam from the continental edge onwards for sustainable fisheries development. Specifically, the deep water surveys aimed to assess the ecological resources including the demersal as well as pelagic fishery resources in the area covered in zone 4 and to achieve sustainable development of these resources through proper management using scientific data generated through the systematic surveys.

27. Thus, in order to assess the fisheries potential in the offshore areas of Brunei Darussalam, collaborative research surveys with SEAFDEC were conducted since 2004 to date at depths ranging from 100 to 3,000 m of the country's EEZ using the M.V. SEAFDEC 2. In addition, annual surveys have also been carried out regularly by the country's Department of Fisheries in the continental shelf areas at depth of less than100 m. The results of the oceanographic survey revealed healthy and normal condition of the country's marine environment while the acoustic data manifested the abundance of large pelagic species and other benthic resources.

28. In addition, trial fishing in the country's EEZ was also conducted onboard Japanese commercial fishing boats in 2000 and 2001 using tuna longline, bottom gillnet, squid jigs and pots. As a result, a total of 8.41 mt of fish were caught by longline comprising mainly the yellow-fin tuna, big-eye tuna, blue marlin,

dorado, and sharks. With relatively short history of quantitative and systematic fisheries research especially in the offshore areas, the results of the collaborative surveys using the M.V. SEAFDEC 2 had provided the most recent information necessary for the rational management of the demersal and pelagic resources of the offshore areas of Brunei Darussalam

(2) Indonesia (Annex 9)

29. Considering that 2/3 of Indonesian region is covered by water, the country's deep-sea region is the waters beyond the jurisdiction line of 12 nm from shoreline, including the Indonesian EEZ and international seawaters deeper than 200 m or beyond the continental shelf. Deep-sea fishery resources surveys were conducted from 1972 to 2008 to locate the unexploited stocks of fishes and prawns in the waters of the outer continental shelf and slope, and identify the species with commercial potential and evaluate their distribution. The initial deepsea trawl survey in Indian Ocean was conducted in 1972 by Korean RV Oh Dae San (1126.59 GT) covered South of Java with depths ranging from 20-290 m, while the survey by Korean RV Tae Baek San (309.85 GT) in 1975 covered 50-200 m in Western of South Sumatra and Southern Java. In 1991 and 1993, a deep-sea exploration survey By RV Baruna Jaya-1 (700 GT) was conducted in Arafura Sea using the otter trawl and beam trawl with mesh size of 1.0 inch at the cod-end. The main aims of the surveys were locate unexploited stocks of fishes and prawns in the waters of the outer continental shelf and slope, to identify species with commercial potential, and to evaluate species disribution. The depth range to be covered between 200 m and 1000 m.

30. Moreover, deep-sea bottom longline (BLL) survey using M/V Ural, a Russian fishing vessel conducted in 2004 in the continental shelf and slope areas of the Arafura Sea at depths ranging from 30 to 700 m.. Results of the BLL survey in the Arafura Sea revealed that more than 75% of the resources consisted of red snappers, groupers, sharks, and rays. On the other hand, results of the deep-sea trawl surveys in the Indian Ocean exhibited about 305 species belonging to about 98 families dominated by the Ophidiidae (38.3% of the toital catch), Plesiobatidae (20.3%), Acropomatidae (6.2%), Trichiuridae (5.7%), and Myctopidae (5.5%). The highest CPUE of the dominant species was obtained in depths ranging from 750 to 1000 m.

(3) Malaysia (Annex 10)

31. The total area of the EEZ of Malaysia is 548,800 km^2, of which 46% or approximately 250,000 km^2 is the combined EEZ of Sarawak, Sabah and the Federal Territory of Labuan. The first fishery resources survey in the EEZ of Malaysia was conducted from 1985 to 1987 followed by the second survey from 1996 to 1997, with the aim of estimating the demersal and semi-pelagic/pelagic biomass and potentials. The two surveys covered areas in the west and east coast of Peninsular Malaysia as well as in the South China Sea area of Sarawak and Sabah. A third survey was conducted in 2004-2005 off the EEZ of Sarawak with the objective of assessing the fishery resources in the area of 30 nm offshore, which have been exploited by deep-sea fishing vessels.

32. In 2005, a survey in the untrawlable area within 180 m depth was carried out in Sarawak waters using the M.V. SEAFDEC 2, in order to assess the fish stock and the resources in the untrawlable area. In addition, two tuna resource surveys were also conducted in the waters of Labuan and Sarawak in 2008.

33. Results from the first, second and third surveys in the EEZ of Malaysia showed total catch rates of 85.60, 120.25 and 96.49, respectively with the catch rates of the demersal fishes at 44.80, 109.65, and 82.43 kg/hr, respectively. Specifically in the third survey at 92-185 m depth stratum, the total catch was dominated by *Priachantus macracanthus* (15.47 kg/hr), *Saurida tumbil* (2.15 kg/hr), *Saurida longimanus* (1.80 kg/hr), *Loligo duvaucelli* (1.57 kg/hr), and *Decapterus kurroides* (1.57 kg/hr).

34. The survey in the untrawlable area in Sarawak waters using the M.V. SEAFDEC 2 was conducted in three sub-areas using the bottom vertical longline (BVL) and traps. The average catch by the BVL was about 18 kg/station comprising 26 species from 18 families. On the other hand, the average catch by traps was about 3.5 kg/100 traps comprising 39 species from 21 families. In the first tuna survey, yellow-fin tuna, blue

marlin and snake mackerel were caught. In the second tuna survey, 44 yellow-fin tunas, *Gempylus serpens*, lancetfish (*Alepisaurus ferox*) and *Coryphaena hippurus* were caught.

(4) Myanmar (Annex 11)

35. The coastline of the Union of Myanmar which is about 3,000 km, forms several large estuaries, delta system and numerous offshore islands, and is rich in aquatic resources. The country's continental shelf covers 228,751 km^2 and its territorial fishing area is within 12 nm from the shore with an EEZ that covers 200 nm offshore. The total fisheries water of Myanmar is 486,000 km^2. Myanmar has three coastal regions: Rakhine coastal region (about 740 km); Ayeyarwaddy Delta region (about 460 km); and Tanintharyi coastal region (about 1,200 km).

36. At least seven fishery resources surveys have been conducted in Myanmar waters from 1979 to 2009. In 1979-80, a survey was conducted under the UNDP/FAO project in order to estimate the marine fish biomass in the EEZ of Myanmar as well as in the continental shelf. As a result, it was estimated that 1.8 million mt (1 and 0.8 million mt of demersal and pelagic fish, respectively) were available in Myanmar.

37. Shrimp resources surveys were also conducted. The first in 1982 was conducted in 60 m depth range in Rakhine area which indicated that about 4,379 mt of shrimp in 5,102 nm^2 was available. In 1985, deep-sea survey was conducted resulting in an average catch rate of 31.18 kg/hr. The Thai-Myanmar joint survey also indicated a mean catch of 31.6 kg/hr. In 1990, a joint Myanmar-Thai fishery exploratory survey was conducted in the waters of Myanmar. The result indicated an overall catch rate of 183.67 kg/hr with about 80% 0f the catch comprising the economically important fishes and about 20% were trash fish. The highest catch rate was 1473 kg/hr which was obtained at depth of 105 m.

38. In 2002, a joint Myanmar-India oceanographic survey was conducted in the Bay of Bengal and Andaman Sea to study the marine plankton distribution, benthos, chemical and mineral contents of the sea water. In 2004 and 2007, an oceanographic and fishery resources surveys were conducted in Myanmar waters using the M.V. SEAFDEC 2 to study the catch composition, species composition, length frequency and oceanographic parameters in the area. In addition, in 2007 a joint ecosystem-based deep-sea survey was conducted in the Bay of Bengal using the M.V. SEAFDEC 2 using gill net, longline, and automatic squid jigging.

39. In January 2009, a demersal fishery resources survey in untrawlable fishing ground in Rakhine area was conducted using the M.V. SEAFDEC 2 to investigate the potential resources of some economically important species, and to carry out trials of appropriate/responsible fishing gears and practices for harvesting fishery resources from the untrawlable grounds. The main fish species caught were: *Scolopis monogramma, Nemipterus japonicus, Lethrinus* sp., *Lutjanus erythropterus, Cephalopholis argus, Cephalopholis formosa*, etc.

(5) The Philippines (Annex 12)

40. The Philippines has a long history of deep-sea explorations that spans over two centuries. From 1799 to 2011, about 18 deep-sea resource surveys were conducted in the Philippine waters. Lately, surveys of the deep-water benthic fauna in the Philippine waters were conducted and dubbed as Aurora 2007 and Lumiwan 2008.

41. In addition, SEAFDEC/TD in collaboration with the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) conducted the deep-sea fishery resources survey on the continental shelf/slopes at Lingayen Gulf (located on the northwestern Luzon of the Philippines) where the depth ranges from 200 to 1000 m using the training and research vessel the M.V. DA-BFAR, from 11 to 25 May 2008. The survey aimed to investigate the existing fishery resources and search for potential fishery resources in the country's EEZ. The survey used three main sampling gears: bottom trawl, deep-sea beam trawl, and deep-sea trap. In order that the SEAFDEC Member Countries could gain the most benefit from the activity, the Shipboard Training Workshop on Deep-Sea Fisheries Resources Research and Survey was simultaneously conducted onboard the M.V. DA-BFAR which was participated in by scientists and researchers from Brunei Darussalam, Indonesia, Japan, Malaysia, Philippines, Thailand, and Vietnam.

42. Dubbed as Lingayen 2008, the deep-sea exploratory survey of the continental slopes of Lingayen Gulf covered a total of 15 sampling stations consisting of 11 beam trawl, 3 deep-sea trap, and one otter trawl operations. The results indicated that samples caught by the beam trawl manifested high diversity. The results also confirmed the prevalence of pandalid shrimp species in deep-sea areas (400-600 m deep) and that their distribution beyond 800 m may be limited. The pandalid shrimp could therefore be considered as the most promising resource for developing into deep-sea based fisheries. However, in order to protect the vulnerability of such resource from over-exploitation, an in-depth feasibility study and stock assessment should be conducted before dissemination of information on the fishery resource to the fishers.

(6) Thailand (Annex 13 and Annex 14)

43. A resource exploration and demersal surveys have been conducted in the Andaman Sea of Thailand from 2005 to 2008. Using BVL and deep-sea trap, the major fish species caught were snappers, groupers, sharks, lobsters, etc.

44. The Thai-Danish Biodiversity Project mainly aimed to enhance understanding on the diversity of benthos at depths down to 1,000 m deep within the EEZ of Thailand. A total of 114 stations were sampled at depths ranging from 20 to 1,020 m using the Olsen box corer, Smith-McIntyre grab, Ockelmann detritus sledge, Pearcy-Rothlisberg epibenthic sledge, triangular sledge, heavy rectangular sledge, beam trawl, 2-m Agassiz trawl, otter trawl, and baited traps. A brief summary of the outcome of the scientific cooperation program on marine biodiversity in the Andaman Sea (Thai-Danish Biodiversity Project) was reported. The project was divided into: (1) Biodiversity and biomass of demersal invertebrates on the shelf of the Andaman Sea off Phuket (BIOSHELF), and (2) Biodiversity and biomass of demersal invertebrates in the deep waters beyond the shelf of the Andaman Sea off Phuket (BIODEEP). Results have exhibited at least 185 species of polychaetes, 43 of which are apparently new species. In addition, the survey also found 162 species of crustaceans, 54 of which are apparently new species.

(7) Vietnam (Annex 15)

45. For management purposes, the marine waters of Vietnam have been divided into four areas, namely: Tonkin Gulf, Central, Southeast, and Southwest. The coastal areas have depth ranging from 0 to 100 m, offshore areas from 100 to 200 m, and > 200 m are considered deep-sea areas. Five deep-sea surveys were conducted in Vietnam from 1978 to 2007, The Viet-Xo joint surveys were conducted from 1978 to 1988 using the otter trawl; the ALMRV Phase 1 from 1996 to 1997 also using the otter trawl; the ALMRV Phase 2 from 2000 to 2005 also using the otter trawl; the ALMRV Phase 2 in 2002 using trap and bottom longline; and the continental slope surveys from 2005 to 2007 using the M.V. SEAFDEC 2 and sampling gears such as bottom longline, BVL, traps and pots.

46. Specifically, the results of the trial fishing in the continental slope showed catch belonging to 134 species from 68 families, while that of the surveys indicated catch comprising 186 species from 81 families. Vietnam still needs further studies on resource assessment of its deep-sea waters, deep-sea species identification, deep-sea ecology, and gear improvement/development for deep sea fisheries as well as technology transfer.

III. CLARIFICATION ON THE STANDARD OPERATING PROCEDURE

3.1 Challenges for Assessment of Deep-Sea Resources

47. The simple tools for deep-sea fisheries stock assessment were presented by Dr. Mala Supongpan (Annex 16), Advisor from the Department of Fisheries of Thailand. The tools are useful for the estimation of initial population size and catchability coefficient from the fishing catch and effort; for analyzing the sustainable yield from surveys; and for parameter estimation.

48. The parameters needed in fish stock assessment include length-weight, growth, mortality and data on production as well as catch and effort, production and biomass. Two methods of estimating the initial population size (or virgin stock) of deep-sea stock could be applied, namely: Leslie's Method involves

plotting the catch per unit effort against the cumulative catch over a period of time, and from the resulting straight line, the initial population and catchability could be estimated; and DeLury's Method which involves computing the logarithm of the catch per unit effort to be plotted against the cumulative effort, and the fitted straight line yields the values of the statistics.

49. The main sources of data for stock assessment are the surveys carried out by research vessels. The survey data can be used in stock assessment in two ways: for monitoring at regular intervals the indices of stock abundance, and to obtain the estimates of absolute abundance possibly at one instant time and usually in advance of intense exploitation. She stressed that monitoring survey conducted at regular intervals (maintained constantly year by year) could provide the index of abundance that is free from difficulties caused by possible changes in the catchability coefficient.

50. Moreover, the definition of the terms commonly used in stock assessment were restated in order to understand the formula being used in estimating the initial population, estimation of total mortality, biomass estimation, and sustainable yield estimation. Thus, catchability refers to the 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 computing the population, in which case it is called the catchability coefficient.

51. Furthermore, availability denotes the fraction of a fish population which loves in regions where it is susceptible to fishing during a given fishing season, where such fraction receives recruits from or become mingled with the non-available part of the stock at other seasons or in other times. Three key parameters were also presented, including:

- *Catch per unit of effort* (CPUE) is the catch of fish (in number or in weight) taken by a defined unit of fishing effort.
- *Biomass* is the weight of a fish stock or of some defined portion of it.
- *Fishing effort* is the total fishing gear in use for a specified period of time so that when two or more kinds of gears are used, they must be adjusted to some standard type.

52. During the discussion, it was noted that since the two methods for estimating the initial population size could be used for the management of less mobile species but may not be applicable for migratory species, it was recommended that the migration pattern of the target species (deep-sea species) should also be studied and that all biological data during the survey should be recorded. In addition, it was also suggested that the gear performance should also be considered.

3.2 Interpretation of Terms: Scope of Deep-Sea Area, Deep-Sea Sampling Gears, Indicators for Deep-Sea Resources Survey, and Indicators for the Impact of Fishing to Ecosystem

53. In order to have a common understanding for the Standard Operating Procedure, the scope of the deep-sea area was defined, the deep-sea fisheries resources sampling gears standardized, and the indicators for deep-sea resources surveys as well as the indicators to evaluate the impact of fishing to the ecosystem were established. FAO considered deepwater fisheries as those fisheries that occur beyond the continental shelf/slope break which typically occurs at about 200 m, and the current technology limit of such fisheries is about 2,000 m. Considering such factors as topography of the waters of Southeast Asia, the ecosystem, capability of research operations and activities of fishermen, and biology of the target species, it was agreed that the scope of deep-sea area in the context of Southeast Asia, should be from the continental shelf down to more than 200 m could be considered deep-sea area.

54. Moreover, in considering also the relationships with the water column or sea floor, deep-sea fisheries resources could include demersal species which are close to, or in contact with, the sea floor most of the time, and benthopelagic[1] species that are associated with the sea floor, without excluding the deep scattering layer.

---

[1] Relating to, living on, or occurring on the bottom or mid-waters of a body of water, feeding on benthic and free swimming organisms.

55. During the discussion, it was agreed that the deep-sea fishery resources sampling gears could include: *beam trawl*, *bottom trawl*, *mid-water trawl*, *agassiz trawl*, *demersal longline*, *vertical longline*, *traps/pots*, *bottom gill net*, and *rectangular dredge*. However, for trawlable area, the priority gear to be used should be trawl, while for untrawlable area the priority gears could include the demersal longline, vertical longline, trap, pot or bottom gillnet.

56. The regional guidelines on the use of indicators for the sustainable development and management of capture fisheries in Southeast Asia provides that *fisheries indicators* are generally referred to as practical tools to support management of fisheries; and that *fisheries indicators* provide information on status and trend of fisheries and resources that can support decision-making process. Guided by such framework, it was agreed that the resource indicators for capture fisheries management could include: CPUE (or CPUA as the case may be), catch composition, number of species caught, average landing size (average catch size), and size of mature resource.

57. Furthermore, the following units to be used for the indicators were agreed upon while the equipment and apparatus for deep-sea resource exploration were also standardized.

Fishing gear	Indicator	Unit
Trawl	CPUE	kg/hr
	CPUA	kg/km^2
Line:	CPUE	kg/1000 hooks
BVL, VL		and/or no/1000 hooks
Trap/pot	CPUE	kg/100 traps
		and/or no/100 traps
Bottom gill net	CPUE	kg/km net

58. Based on the FAO Guidelines for the management of deep-sea fisheries in the high seas, it was agreed that the indicators for the impact of fishing to the ecosystem could include: uniqueness or rarity, functional significance of the habitat, fragility, life history traits, and structural complexity. Moreover, it was also agreed that a networking should be established with biologists, the academe, museum reference collectors, etc. in order to compare and standardize data collected from resources surveys using such standard indicators.

59. After discussing the Draft Standard Operating Procedure (SOP) on Deep-Sea Resources Exploration in Southeast Asian Region (Annex 17**),** it was agreed that the Second Draft would be finalized incorporating the inputs from the Workshop, after which the Second Draft SOP would be circulated as soon as possible to all Workshop participants for further comments within a period of one month. As soon as the comments are collated and incorporated into the Second Draft, the final Draft SOP would be finalized for discussion again among the experts.

3.3 Standardization of the Specific Procedures for the Operation of Sampling Gears and Data Collection

Draft of the Construction and Materials of the Deep-Sea Sampling Gears of the M.V. SEAFDEC 2

60. The detailed construction design and materials for deep-sea sampling gears of the M.V. SEAFDEC 2 focusing on the major gears for deep-sea exploration, namely: otter board trawl, beam trawl, trap and bottom longline (Annex 18) were presented. The draft construction and materials for otter board trawl, beam trawl, trap and bottom longline were compared with the SOP for the M.V. SEAFDEC 2 (Annex 19) for possible improvement of the sampling gears for deep-sea exploration.

61. In the standardization of the deep-sea survey sampling gears, the catch efficiency, catch consistency and relative abundance should be considered. Once optimum data are arrived at, there would be no need to further improve the gears. Thus, improvement should be limited once the efficient gear has been developed.

62. Moreover, in the improvement of the gears, the impact of the gears to the sea bottom and the ecosystem should be taken into consideration considering that these concerns have are being discussed in the international arena. However, it was also suggested that for the deep-sea exploration to be carried out by the respective countries, data from trawl survey could still be used as this is considered the most efficient gear for the purpose. Results of such explorations could be compiled and analyzed in order to promote the most efficient gear for deep-sea fisheries. Furthermore, the possibility of using the respective fishing vessels of the countries in the region during the sampling operations in addition to the use of the M.V. SEAFDEC 2 should also be explored.

63. In order to finalize the draft construction and materials which would be used as guide during future surveys to be conducted in the SEAFDEC Member Countries, the participants were asked to continue communicating with SEAFDEC/TD and provide further comments within a period of one month. Once inputs are received, SEAFDEC/TD will finalize the draft and circulate the revised draft again for confirmation and later for publication as the SOP for deep-sea survey sampling gears.

IV. DEVELOPMENT OF ACTION PLAN FOR DEEP-SEA FISHERY RESOURCES EXPLORATION/SURVEY

Identification of the requirements for future actions at regional/national levels with respect to the future support for deep-sea resources exploration/survey

64. Based on the discussions during the Workshop, a number of needs to further promote deep-seas exploration were identified that include:

- understanding the stock/habitat and its assessment;
- establishment of regional and national network to share information and exchange of experts and facilities;
- further improvement and restructuring of the SOPs considering their applicability and usage as minimum requirements for scientists involved in the deep-sea explorations;
- development of more simple sampling gears for effective collection of deep scattering layer (DSL) organisms;
- exploring the meso-pelagic resources using gillnet;
- standardization of deep-sea sampling gears; and
- sustainable design of the beam trawl to make this more applicable to the Member Countries considering the different topography of the deep-sea areas and types of national vessels.

65. Considering the needs to further promote deep-sea exploration raised during the Workshop, the following programs/initiatives were proposed and agreed upon:

- joint survey (countries and SEAFDEC using the M.V. SEAFDEC 2 or national vessels);
- technical support and services (with SEAFDEC providing the technical services);
- template of survey report (to be developed by SEAFDEC in collaboration with the Member Countries); and
- sharing of information (SEAFDEC serving as the main node).

(details are showed in Annex 19)

66. Moreover, the Member Countries were also encouraged to make full use of the M.V. SEAFDEC 2 in their respective deep-sea exploration activities.

Development of appropriate regional/national program/initiative for future exploration/survey

67. In order to foster and strengthen future collaboration in deep-sea exploration, some concerns need to be addressed such as lack of technological information, insufficient funding, effective sharing of data, major findings and information as well as the availability of the M.V. SEAFDEC 2.

68. After the discussion, the Workshop considered the Regional Plan of Activities for 2010 and onwards on Deep-Sea Fishery Resources Exploration in the Southeast Asian Region (Annex 20).

Recommendations on the action plan for the utilization of the M.V. SEAFDEC 2 for deep-sea exploration/survey

69. After identifying their requirements for deep-sea exploration, the representatives from the Member Countries agreed to avail of the M.V. SEAFDEC 2 in their surveys, considering that the vessel is equipped with the necessary gears, equipments and apparatus.

V. RECOMMENDATIONS AND CONCLUSIONS

70. The Workshop recommended that SEAFDEC should serve as a center of excellence for deep-sea exploration and surveys, and the center of information exchange and dissemination. In this regard, SEAFDEC/TD would compile the relevant and necessary data and information. In addition, in order to that concerned researchers and scientists of the Member Countries could be updated on the progress and development of respective countries' deep-sea exploration activities, a deep-sea forum could be convened every two years. It was also suggested that the participants in the Workshop should serve as Deep-Sea Resource Persons and should make sure that communications with SEAFDEC should be sustained in order to improve their national efforts in deep-sea exploration.

VI. CLOSING OF THE REGIONAL WORKSHOP

71. The SEAFDEC Deputy Secretary-General and Trust Fund Program Manager thanked the participants for their active participation in the Workshop. The Workshop has served as an avenue for the exploration of the deep-sea fishery resources and investigation of the appropriate fishing gears to be used during such exploration and survey. He also commended the participants for exchanging experiences and views with regards to their deep-sea exploration activities which lead to the development of a regional plan of action, and thanked the resource persons for providing the necessary technical inputs. After assuring the Workshop that SEAFDEC would find ways and means to initiate the implementation of the regional Plan of Action on Deep-Sea Resources Exploration as endorsed during the Workshop, he declared the Regional Workshop closed.

Annex 1

List of Participants and Resource Persons

Country Representative

BRUNEI DARUSSALAM

Mr. Matzaini Haji Juna
Fisheries Officer
Fisheries Department, Ministry of Industry and Primary Resources
Brunei Darussalam
Tel: 673-2772787
Fax: 673-2770065
Email: matzaini.juna@fisheries.gov.bn

INDONESIA

Mr. Bambang Sumiono
Scientist - Chief of Demersal & Shrimp Divisions
Research Institute for Marine Fisheries (RIMF)
Jalan Muarabaru Ujung
Jakarta 14440, Indonesia
Tel 62-21-6602044
Fax 62-21-6605912
Email: bsumiono@yahoo.co.id

JAPAN

Dr. Yoshiki Matsushita
Associate Professor
Nagasaki University
1-14 Bunkyo, Nagasaki 852-8521
Nagasaki, Japan
Tel: 81-95-8192803
Fax: 81-95-8192803
Email: yoshiki@nagasaki-u.ac.jp

MYANMAR

Mr. Aung Htay Oo
Senior Fishery Officer (Research)
Marine Resources Conservation Unit,
Department of Fisheries, Myanmar
No. 133, Inwa Road,20th Lane,6th Qtx ,South Okkalapa
P.O, Yangon, Myanmar
Tel: 95-01-680748
Email: aunghtyoo21@gmail.com

MALAYSIA

Mr. Sallehudin bin Jamon
Researcher
Aquatic Ecosystem Research Center
FRI-Kg.Acheh,D.O.F Malaysia
32000, Sitiawan Perak, Malaysia
Tel: 605-6914752
Fax: 605-6914742
Email: sallehudin_jamon@dof.gov.my

THE PHILIPPINES

Mr. Rafael Ramiscal
Supervising Aquaculturist
BFAR, PCA Bldg, Elliptical Road Quozon City,
The Philippines
Tel: 632-9294296,632-9296668
Fax: 632-9296668
Email: rv_ram55@yahoo.com

THAILAND

Mr. Pisanu Siripitrakool
Fisheries Biologist
Deep Sea Fisheries Research and Technology Development Institute
Kasetsart University Campus, Chatuchak,
Bangkok 10900, THAILAND
Tel: 0-2562-0533,08-1554-3707
Fax: 0-2562-0533
Email: PISANUS_BORG@hotmail.com

VIETNAM

Mr. Nguyen Viet Nghia
Head of Department
Department of Marine Fisheries Resources,
Research Institute for Marine Fisheries
170 Le Lai Street, Hai Phong City, Vietnam
Tel: 84-313-768764
Fax: 84-313-836812
Email: nvnghia@rimf.org.vn

SEAFDEC/MFRDMD

Mr. Sharum Yusof
Research Officer
SEAFDEC_MFRDMD
Chendering Fisheries Garden 21080 Kuala Terengganu Malaysia
Tel: 609-6171543
Fax: 609-6175136
Email: sharum@mfrdmd.org.my

Resource Persons

JAPAN

Dr. Yoshinobu Konishi
Special Advisor
Tel: 81-95-883-6704
Fax: 81-95-883-6704
Email: ykoni@gmail.com

Thailand

Dr. Mala Supongphan
Consultant on Marine Fisheries, Department of Fisheries Thailand
378 yak 16, Moo Baan Suan Luang, Onnut 17, Sukhumvit 77,
Bangkok 10250, THAILAND
Tel: 66-2 3002716, 66-8 56499654
Email: m.supongpan@yahoo.com,m.supongpan@gmail.com

Department of Marine and Coastal Resources

Dr. Charatsee Aungtonya
Senior Marine biologist
Phuket Marine Biological Center
P.O. Box 60, Phuket 8300, Thailand
Tel: 66-7 6391128, 6391507
Fax: 66-7 6391127
Email: charatsee@yahoo.com

SEAFDEC Secretariat (SEC)

Dr. Somboon Siriraksophon
Policy and Program Coordinator

SEAFDEC Secretariat
P.O.Box 1046 Kasetsart Post Office
Bangkok 10903 Thailand
Tel: 66-2 9406326, 9406327
Fax: 66-2 9406336
Email: somboon@seafdec.org

SEAFDEC Training Department

Mr. Aussanee Munprasit
Assistant the Training Department Chief/Technical
SEAFDEC Traning Department
P.O. Box 97 Phrasamutchedi, Samutprakan 10290, Thailand
Tel: 66-2 4256100
Fax: 66-2 4256110
Email: aussanee@seafdec.org

Mr. Suppachai Ananpongsuk
Fishing Gear Technologist and Administrative Division Head
Email: suppachai@seafdec.org

Mr. Isara Chanrachkij
Expert and Fishing Gear Specialist
Email: isara@seafdec.org

Technical Organizing Members

SEAFDEC Training Department (TD)

Dr. Worawit Wanchana
Fishing Gear Technologist and Head of Marine Capture Fisheries Division
SEAFDEC Training Department
P.O. Box 97 Phrasamutchedi, Samutprakan 10290, Thailand
Tel: 66-2 4256100
Fax: 66-2 4256110
Email: worawit@seafdec.org

Mr. Narong Ruangsivakul
Fishing Gear Technologist
Email: narong@seafdec.org

Mr. Nakaret Yasook
Fishing Gear Technologist
Email: nakaret@seafdec.org

Mr. Sayan Promjinda
Fishing Gear Technologist
Email: sayan@seafdec.org

Ms. Penchan Laongmanee
Fishing Ground and Fishery Oceanography Section Head
Email: penchan@seafdec.org

Dr. Natinee Sukramongkol
Fishery Oceanographer
Email: natinee@seafdec.org

Secretariat of the Workshop

SEAFDEC/TD

Ms. Nathacha Sornvaree
Administrative Officer
SEAFDEC Traning Department
P.O. Box 97 Phrasamutchedi, Samutprakan 10290, Thailand
Tel: 66-2 4256100
Fax: 66-2 4256110
Email: natha@seafdec.org

Reporter of the Workshop

SEAFDEC/SEC

Mrs. Virgiia Sulit
Senior Editor
SEAFDEC Secretariat
P.O Box 1046, Kasetsart Post Office
Bangkok 10903, THAILAND
Tel: 66-2 6406328
Fax: 66-2 9406336
Email: sulit@seafdec.org

Observers

SEAFDEC/SEC

Mr. Akito Sato
Position Assistant Trust Fund Manager
SEAFDEC Secretariat
P.O.Box 1046 Kasetsart Post Office
Bangkok 10903 Thailand
Tel: 66-2 9406326, 9406327
Fax: 66-2 9406336
Email: sato@seafdec.org

Ms. Hiromi Iwasaki
Secretary to Deputy Secretary
SEAFDEC Secretariat
P.O.Box 1046 Kasetsart Post Office
Bangkok 10903 Thailand
Tel: 66-2 9406326, 9406327
Fax: 66-2 9406336
Email: iwasaki@seafdec.org

SEAFDEC/TD

Mr. Weerasak Yingyuad
Fisheries Resources Enhancement Scientist
SEAFDEC Traning Department
P.O. Box 97 Phrasamutchedi, Samutprakan 10290, Thailand
Tel: 66-2 4256100
Fax: 66-2 4256110
Email weerasak@seafdec.org

Kasetsart University

Dr. Anukorn Boutson
Lecturer
Kasetsart University, Department of marine science
50 Paholyothin Rd.Ladyaw Jatujak, Bangkok 10900, THAILAND
Tel: 66-2 5797610 ext. 230, 66-8 18090338

Fax 66-2 5614287
Email: ffisakb@ku.ac.th, anukornb@yahoo.com

Mr. Charuay Sukhsangchan
Lecturer
Kasetsart University, Department of marine science
50 Paholyothin Rd.Ladyaw Jatujak, Bangkok 10900, THAILAND
Tel: 66-2 5797610
Fax 66-2 5614281
Email: charuay44@hotmail.com

Eastern marine Fisheries Research and Development Center – Department of Fisheries Thailand

Mr. Bundit Yangphonkhan
Fisheries Biologist
Eastern marine Fisheries Research and Development Center
2 Moo 2 Pae District Muang, Rayong, 21160, THAILAND
Tel: 66-38 651764
Fax: 66-38 651763
Email: b_pong_1980@hotmail.com

Mr. Krisada Thongsila
Fisheries Biologist
Email: ktda2519@yahoo.com

Annex 2

WELCOME REMARKS

by DR. SIRI EKMAHARAJ

SECRETARY-GENERAL
SOUTHEAST ASEAN FISHERIES DEVELOPMENT CENTER

Dr. Yoshiki Matsushita, Nagasaki University,
Dr. Yoshinobu Konishi, Fishery Research Agency of Japan,
Dr. Mala Supongpan, Department of Fishery of Thailand,
Dr. Charatsee Aungtonya, Phuket Marine Biological Center,
Delegates from the SEAFDEC Member Countries, Brunei Darussalam,
Indonesia, Malaysia, Myanmar, Philippines, Vietnam and Thailand
Colleagues from SEAFDEC Secretariat, Training Department, and Marine Fishery
Resources Development and Management Department
Ladies and Gentlemen, good morning.

It is my pleasure to welcome you all to the Regional Workshop on the Standard Operating Procedure and Development/Improvement of Sampling Gears for the Deep-Sea Resource Exploration. For those who come from aboard, let me also welcome you to Bangkok and Samutprakarn. And let me thank you for participating in this Workshop.

In the view of fishery policy maker in searching for new fishery resources in the deep water areas or deep-sea as a consequence of the depletion of the coastal fisheries resources in the Southeast Asian Countries. Those depletion was also reduces the supply of sea food materials to many fish processing industries in the region and reduces the food supply for the global level. Therefore, the deep-sea sea fishery resources survey in the EEZ of the Southeast Asian Region were initiated with the aim to explore potential fishing ground and assess the stock in deep-sea areas.

We are gathering in here for challenging of sustainable exploration of the fishery resources for further sustainable development and management of the deep-sea fishery resources. With that, understanding on the deep-sea ecosystem and its resources as well as the impact to such resources from fisheries is required.

In this connection, SEAFDEC is organizing this Workshop to encourage our Member Countries on deep-sea sea resources exploration on the continental shelf/slope of their respective EEZ waters, and to support the national resources surveys of the member countries by advising them on the use of improved fishing gear and methods for deep-sea fish samplings using the M.V. SEAFDEC2 and/or national research vessel.

During this Workshop, the SOP for deep-sea fishery resources exploration and further development/improvement of the appropriate samplings gears will be developed, which is useful for the possibility of developing other fishing gear for sustainable development and management of the deep-sea sea fisheries in the region. During this Workshop we would also like to identify the needs for future program and activities on the deep-sea fishery resource survey to be regional effort to effectively support the food security and sustainable development of the fishery sector for our region.

Before I end my opening remarks, I wish the workshop full success and achievements. I also wish to take this opportunity to express my sincere thanks to all resource persons and participants in sharing your expertise, experiences, and idea for these significant undertaking. With that note, I now declare the Workshop on the Standard Operating Procedure and Development/Improvement of Sampling Gears for the Deep-Sea Resource Exploration open.

I thank you again for your kind cooperation and support and look forward to a fruitful workshop.

Thank you very much.

Annex 3

Agenda of the Workshop

1. Opening and Introduction
2. Sharing Experiences on Deep-sea Resources Research and Survey
   - 2.1 Technical Requirements and Prerequisites for Deep-sea Exploration
   - 2.2 Experiences and Lessons Learned from Regional/National Initiatives/Programs Related to the Deep-sea Exploration
     - 2.2.1 Regional Fishing Trials and Resources Survey by SEAFDEC/TD
     - 2.2.2 Results and Experiences from the Deep-sea Research Survey in the Continental Slope of the East China Sea
     - 2.2.3 National Resources Survey related to the Deep-sea Exploration – Brunei
     - 2.2.4 National Resources Survey Related to the Deep-sea Exploration – Indonesia
     - 2.2.5 National Resources Survey Related to the Deep-sea Exploration – Malaysia
     - 2.2.6 National Resources Survey Related to the Deep-sea Exploration – Myanmar
     - 2.2.7 National Resources Survey Related to the Deep-sea Exploration – Philippines
     - 2.2.8 National Resources Survey Related to the Deep-sea Exploration – Thailand/DOF
     - 2.2.9 National Resources Survey Related to the Deep-sea Exploration – Thailand/DMCR
     - 2.2.10 National Resources Survey Related to the Deep-sea Exploration – Vietnam
3. Clarification on the Standard Operating Procedure (SOP)
   - 3.1 Challenges for assessment of deep-sea resources – knowledge on the stock assessment application tools
   - 3.2 Interpretation of terms – scope of deep-sea area, deep-sea sampling gears, indicators for deep-sea resources survey, and indicator for the impact of fishing to ecosystem
   - 3.3 Standardization of the specific procedures for the operation of sampling gears and data collection
4. Development of Action Plan for Deep-sea Fishery Resources Exploration/Survey
5. Recommendation and Conclusion
6. Closing

Regional Workshop on the Standard Operation Procedure and Development/Improvement of Sampling Gear for the Deep-Sea Resources Exploration

Overview of technology development for deep-sea exploration

Yoshiki Matsushita, Ph.D.
Faculty of Fisheries, Nagasaki University
長崎大学
NAGASAKI UNIVERSITY

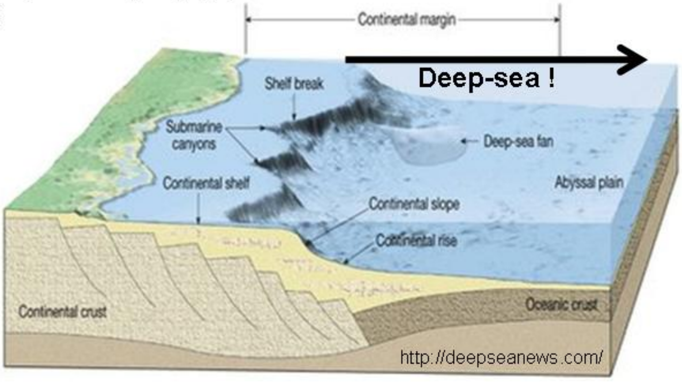
Contents of presentation

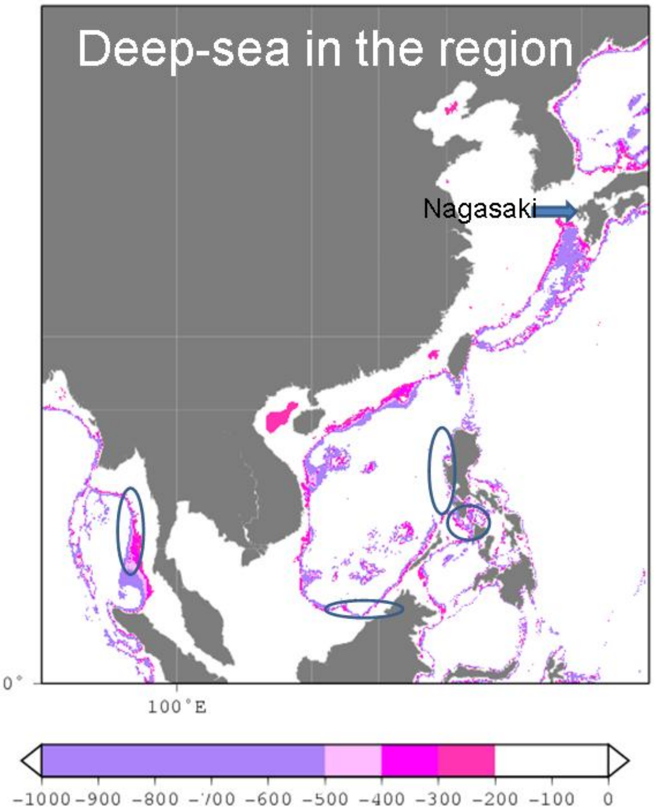
- Outline of deep-sea fishing exploration in Japan
- Industrial technologies
- Research technologies
- Current issues in deep-sea exploration

Before starting a story…

- Definition of “Deep-sea”

The deep sea represents those marine environments that occur beyond the continental shelf. The average depth at which this occurs is appro



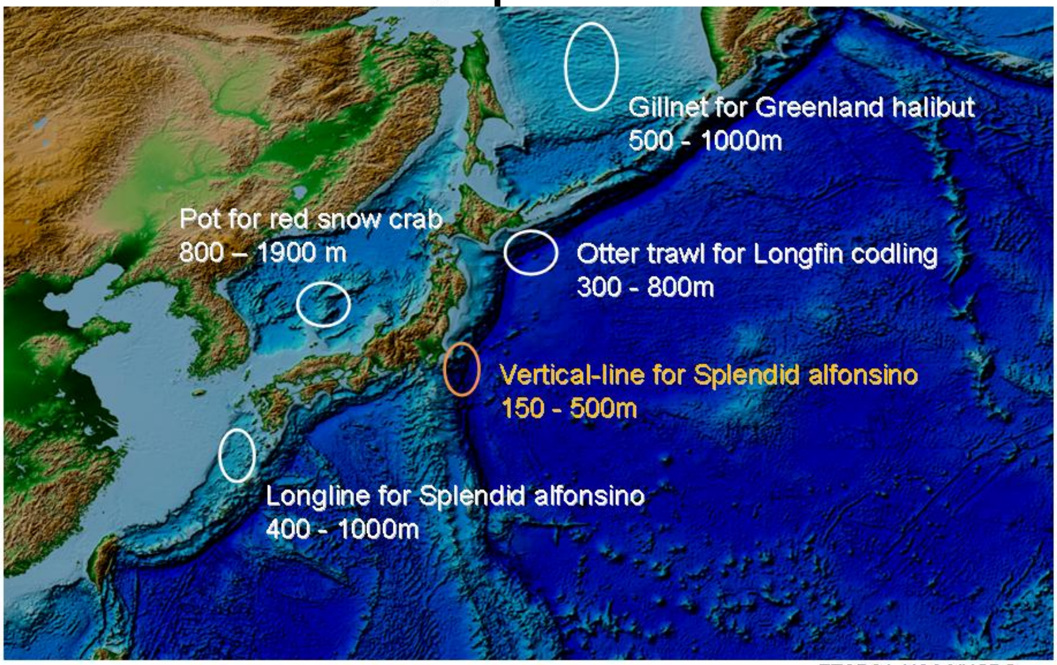


In the region….

Brunei Darussalam
200-500 m
West Coast of Luzon , Philippines
200-1000 m
Visayan Sea, Philippines
150-500 m
Andaman Sea, Myanmar
150-400 m

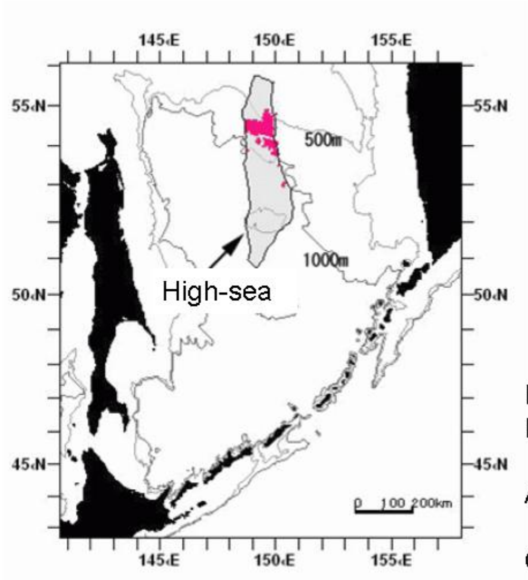
ETOPO2, NOAA/NGDC

Examples of deep-sea fishing in Japan



ETOPO1, NOAA/NGDC

Gillnet in Okhotsk high sea



Greenland halibut
Reinhardtius hippoglossoides

500-700 mm

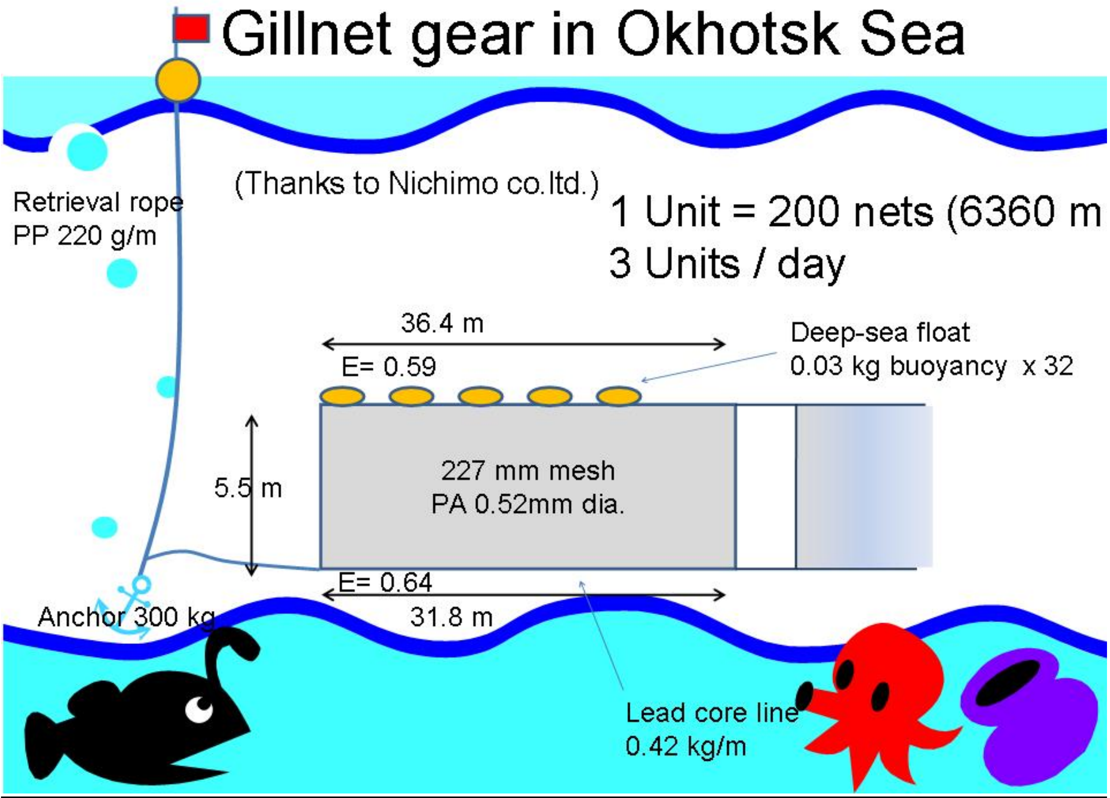
Experimentally started with permission by Hokkaido local government in 1986

After 2000, a government licensed fishery

Only 2 boats operating so far

http://kokushi.job.affrc.go.jp/H20/H20_61S.html


Same type of vessel used for deep-sea gillnetting
160 – 184 GRT
15 crews
25 – 45 days cruise
http://atom.ryoshi.net/menu2.html


Gillnet gear in Okhotsk Sea
(Thanks to Nichimo co.ltd.)
1 Unit = 200 nets (6360 m
3 Units / day
Retrieval rope
PP 220 g/m
36.4 m
E= 0.59
Deep-sea float
0.03 kg buoyancy x 32
5.5 m
227 mm mesh
PA 0.52mm dia.
E= 0.64
31.8 m
Anchor 300 kg
Lead core line
0.42 kg/m

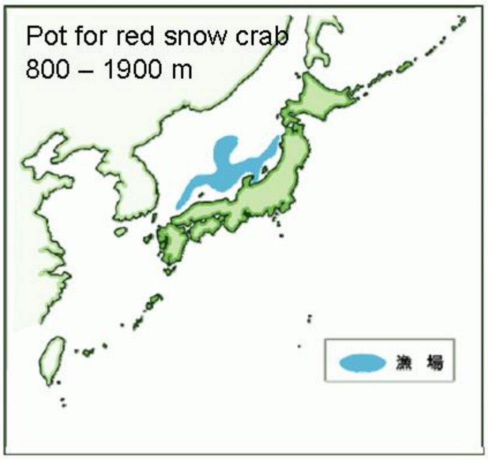
Amount of Gillnet gear in Okhotsk Se

Parts in 1 unit	Material	Dia. (mm	Lengt h(m)	No. used	Total weight in	Total weight in
Retrieval rope	PP	11	1200	2	528	-48
Float line	PP	5	7272	1	91	-8
Floats	ABS	-	-	6400	80	-192
Lead line	resin	11	6363	1	2672	2370
Netting	PP +	0.52	-	-	122	15
Anchor	lead	-	-	2	600	525
Total					4093	2662

iron

Some values are intended to be underestimated, as those physical specifications are unidentifi

Pot fishing in Sea of Japan



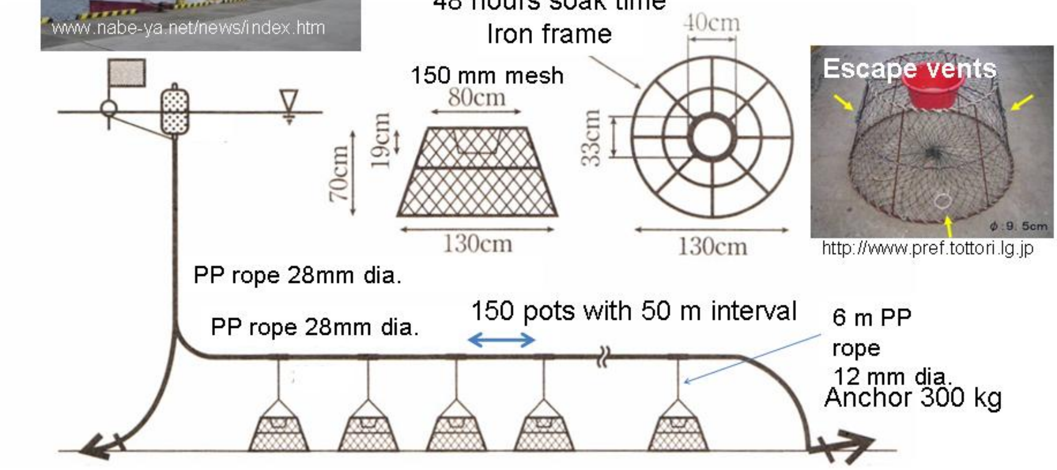
Red snow crab
Chionoecetes japonicus
Most captured ground fish
in Sea of Japan

Explored in 1941 by deep-sea gillnetting and shifted to pot fishing in 1964.
A government licensed fishery

http://abchan.job.affrc.go.jp/digests20/

Pot fishing gear in Sea of Japan

Typically, 120 GRT
10 crews
10 days cruise
Max. 9 units (1350 pots) can be soaked
48 hours soak time

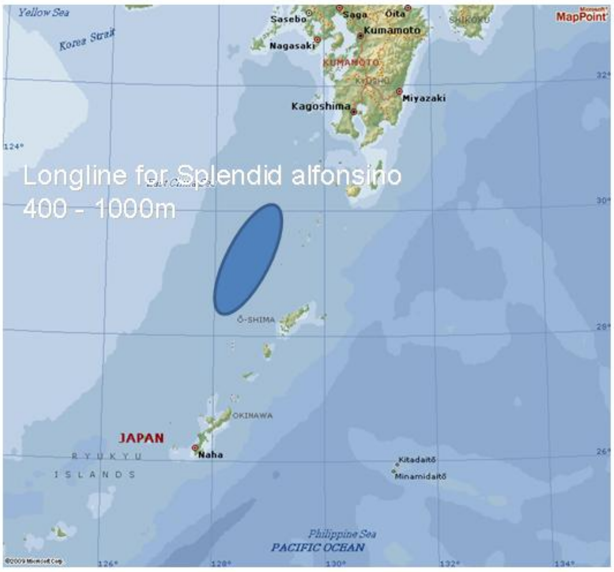


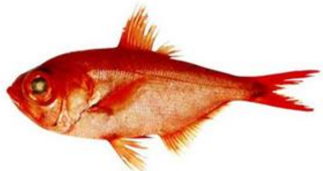
Amount of pot gear in Sea of Japan

Parts in 1 unit	Material	Dia. (mm	Lengt h(m)	No. used	Total weight in	Total weight in
Retrieval rope	PP	28	3000	1	1065	-105
Main line	PP	28	7500	1	2663	-263
Branch line	PP	12	6	150	59	-6
Pot	Iron +	-	-	150	2250	1969
Anchor	PE	-	-	2	600	525
Total					6637	2120

Some values are intended to be underestimated, as those physical specifications are unidentifi

Longline in East China Sea





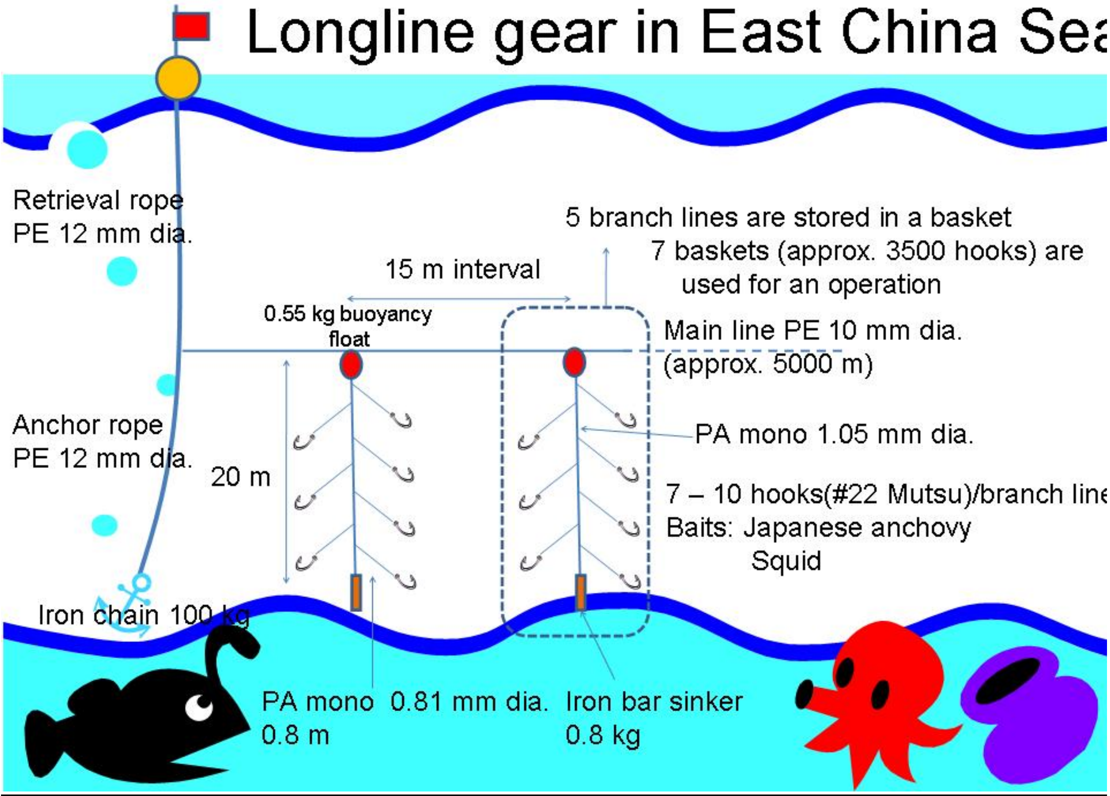
Splendid alfonsino
Beryx splendens

Widely distributed in the Atlantic and in the western Pacific, Japan, Australia and New Zealand (Woods and Sonoda, 1973).

A government licensed fishery

http://jamarc.fra.affrc.go.jp/

Longline gear in East China Sea



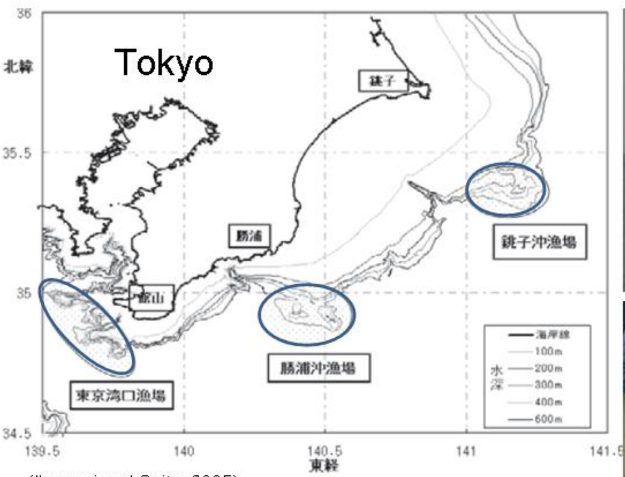
Amount of Longline gear in East China Sea

Parts	Material	Dia. (mm	Length(m)	No. used	Total weight in	Total weight in
Retrieval rope	PP	12	1000	2	130	-14
Anchor rope	PP	12	20	2	3	-0
Main line	PP	10	5000	1	238	-26
Branch line	PA	1.05	20	35	69	7
Leader line	mono	0.81	0.8	3500	163	16
Hook	PA			3500	7	6
Weight	mono			35	28	25
Midwater float	Iron	114		35	10	-19
Anchor	Iron			2	200	175
Total					848	170

resin
Iron

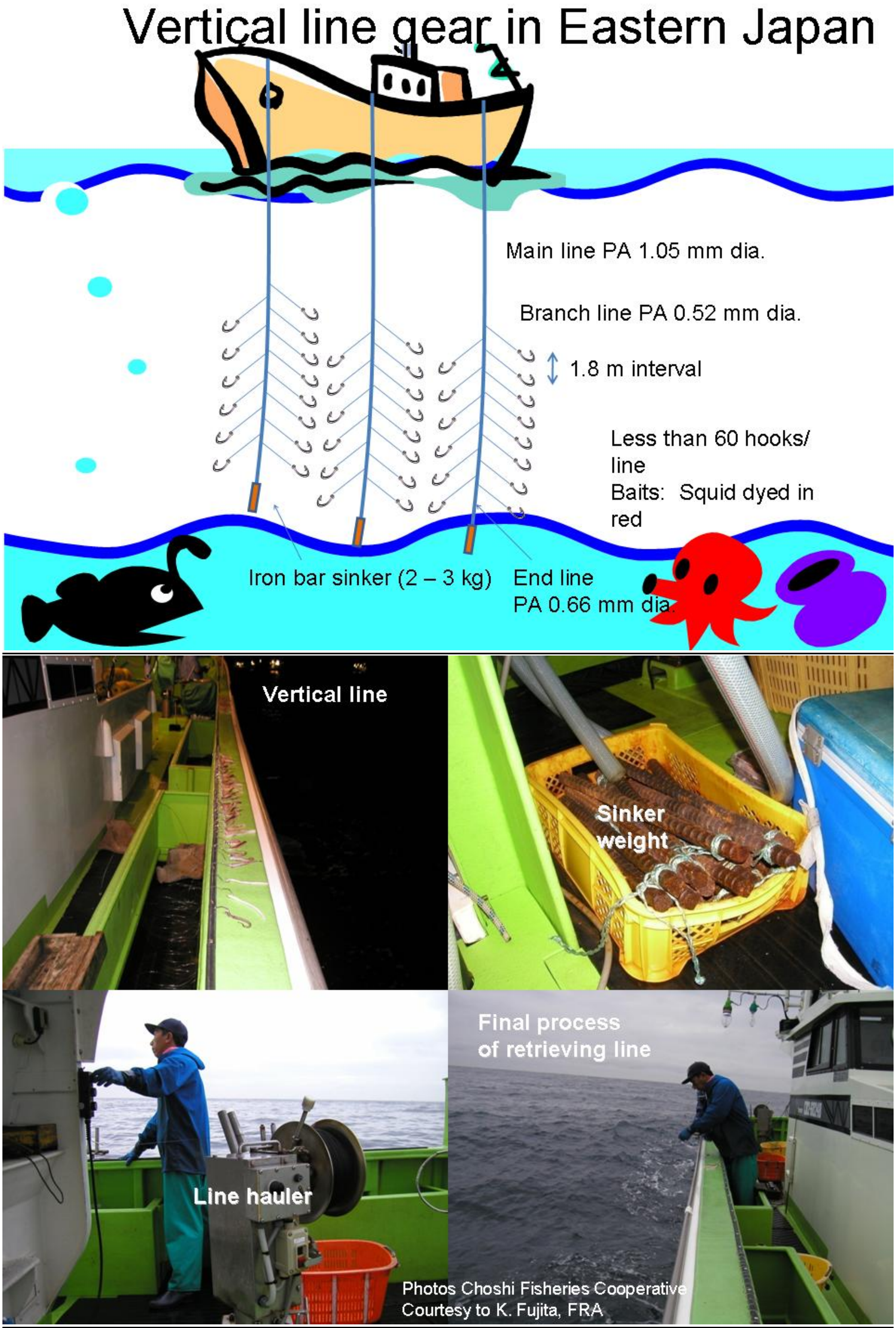
Some values are intended to be underestimated, as those physical specifications are unidentified

Vertical-line for Splendid alfonsino



(Ikegami and Saito, 2005)

Vertical-line for Splendid alfonsino
150 - 500m


Vertical line gear in Eastern Japan
Main line PA 1.05 mm dia.
Branch line PA 0.52 mm dia.
1.8 m interval
Less than 60 hooks/ line
Baits: Squid dyed in red
Iron bar sinker (2 – 3 kg)
End line PA 0.66 mm dia.
Vertical line
Sinker weight
Line hauler
Final process of retrieving line
Photos Choshi Fisheries Cooperative
Courtesy to K. Fujita, FRA

Vertical line gear in Eastern Japan
(Case in Chiba Prefecture)

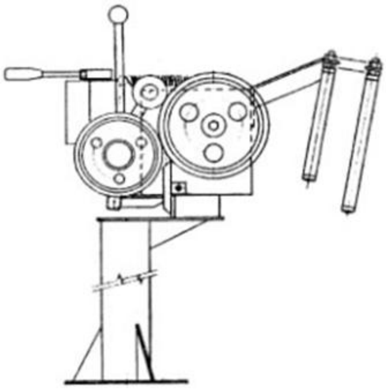
Voluntary regulation

- Minimum landing size 22 – 25 cm
- Night fishing prohibited
- Driftlines prohibited
- Max. 30 – 150 hooks/ line
- No. of lines less than No. of crew (+1)
- Bait limitations
- Fixed day off
- Closed season

Consideration for deep-sea operation using gillnets/lines/pots

- Gillnet and longline are low energy consumption fishing methods (e.g. fuel/fish, Endal 1979, also pots…)
- Small scale gillnet/longline fishing are low-cost fisheries, but on a large scale, they are labor intensive fishing methods.
- Mechanization, especially stronger net haulers are required.

Line hauler



Electronic hauler: DC 24 V
30 - 65 m/min.
Max. 80 kg
Speed controllable

Hydraulic hauler: 100 m/min.
Max. 160 kg
Speed controllable

http://www.shinnikkai.co.jp/

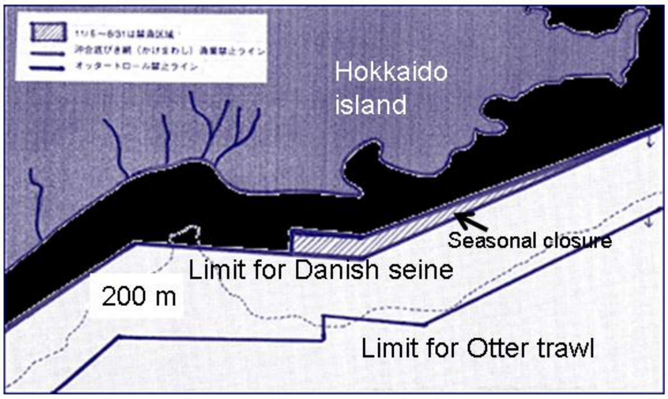
Net hauler

Electronic hauler: DC 24 V
15 - 30 m/min.
Max. 120 kg

Hydraulic hauler: 40 m/min.
Max. 500 kg

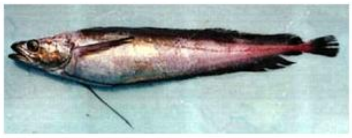
http://www.yanmar.co.jp/prod/marine

Otter trawl off Hokkaido



Zoned for coastal, Danish seine and otter trawl fisheries by depths

Walleye pollack
Theragra chalcogramma
200 – 300 m



Longfin codling
Laemonema longipes
300 – 800 m

Longfin codling was explored as a substitute for walleye pollack in 1990s. Used for Surimi products. A government licensed fishery

http://abchan.job.affrc.go.jp/digests20/

Otter trawl off Hokkaido

www.suisan-kushiro.com/

Typical otter trawler
Main engine: 1325 kW
15 crews
1 – 2 days cruise

Parts	Weight in air (kg)		Weight in water (kg)	
	Pollack	Longfin codling	Pollack	Longfin codling
Net	550	600	-44	-48
Floats	265	265	-640	-640
Ground rope	2982	3071	991	1038
Rigs	800	800	703	703
Otter boards	5840	2920	4600	4600
Warps	**3374** (@700m)	**7712** (@1600m	**2952**	**6748**
Total	13811	18288	**8562**	**12401**

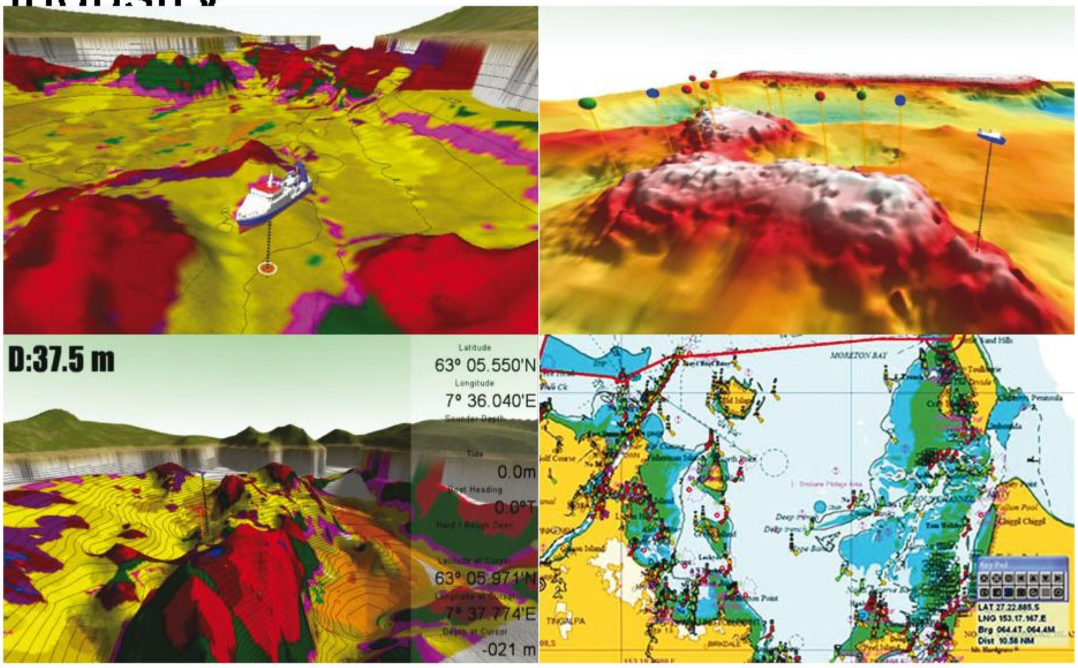
Warp length / Depth = 3 - 4 at 150 – 300 m
= 2 at 300 - 800 m

Some values are intended to be underestimated, as those physical specifications are unidentified

As shown in examples,

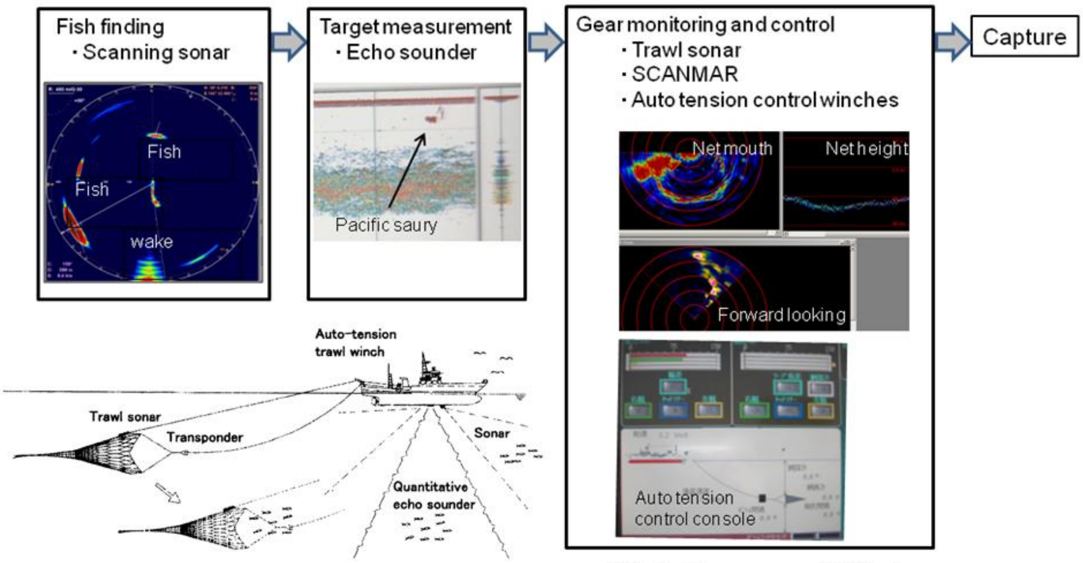
- Gears are thick, heavy, and large amount
- Operation needs improvement of the deck's machinery (setting, hauling, and transporting gears and fish)
- Loading large quantities of heavy gear relates to **safety** issues

Sea bed mapping tool for fishing industry



http://www.piscatus.co.nz

Auto-trawl system to lock-on deep-sea target



RV Hokko-maru, FRA, Japan

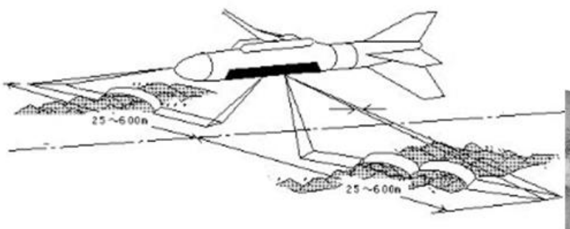
Research technologies: Habitat mapping

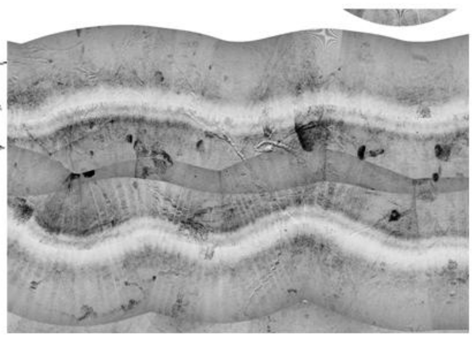
- Deep-sea exploration for fishing requires understanding physical and biological characteristics of seafloor habitats (Habitat mapping).

- “Habitat” refers the environment necessary to support, directly or indirectly, the life process of the resident organisms

Physical characteristics-1

- Bathymetry; Echo sounding, multi-beam sonar, sidescan-sonar, etc.

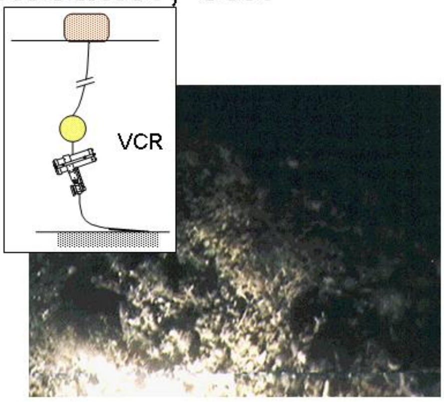




Physical characteristics-2

- Substrate type; sampling using grab or dredge, video techniques, analysis of multi-beam sonar backscatter, etc.

Watanabe and Kitagawa, 2003



Physical characteristics-3

- Temperature, Flow condition, etc…
  Various traditional and state-of-art instruments….

Biological characteristics: sampling or remote monitoring (e.g. acoustics)

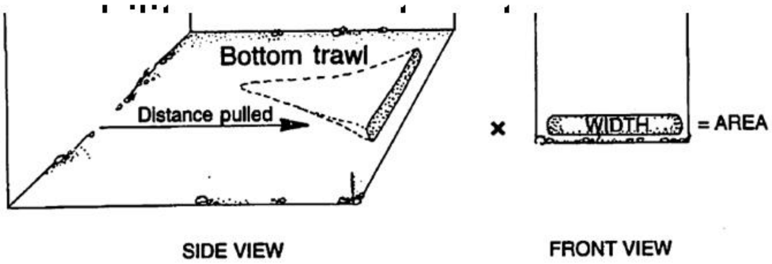
- Techniques used in scientific sampling of fisheries are similar to commercial fishing gears, but typically scaled down in size.

Passive sampling: Hook & line, gillnets, pots

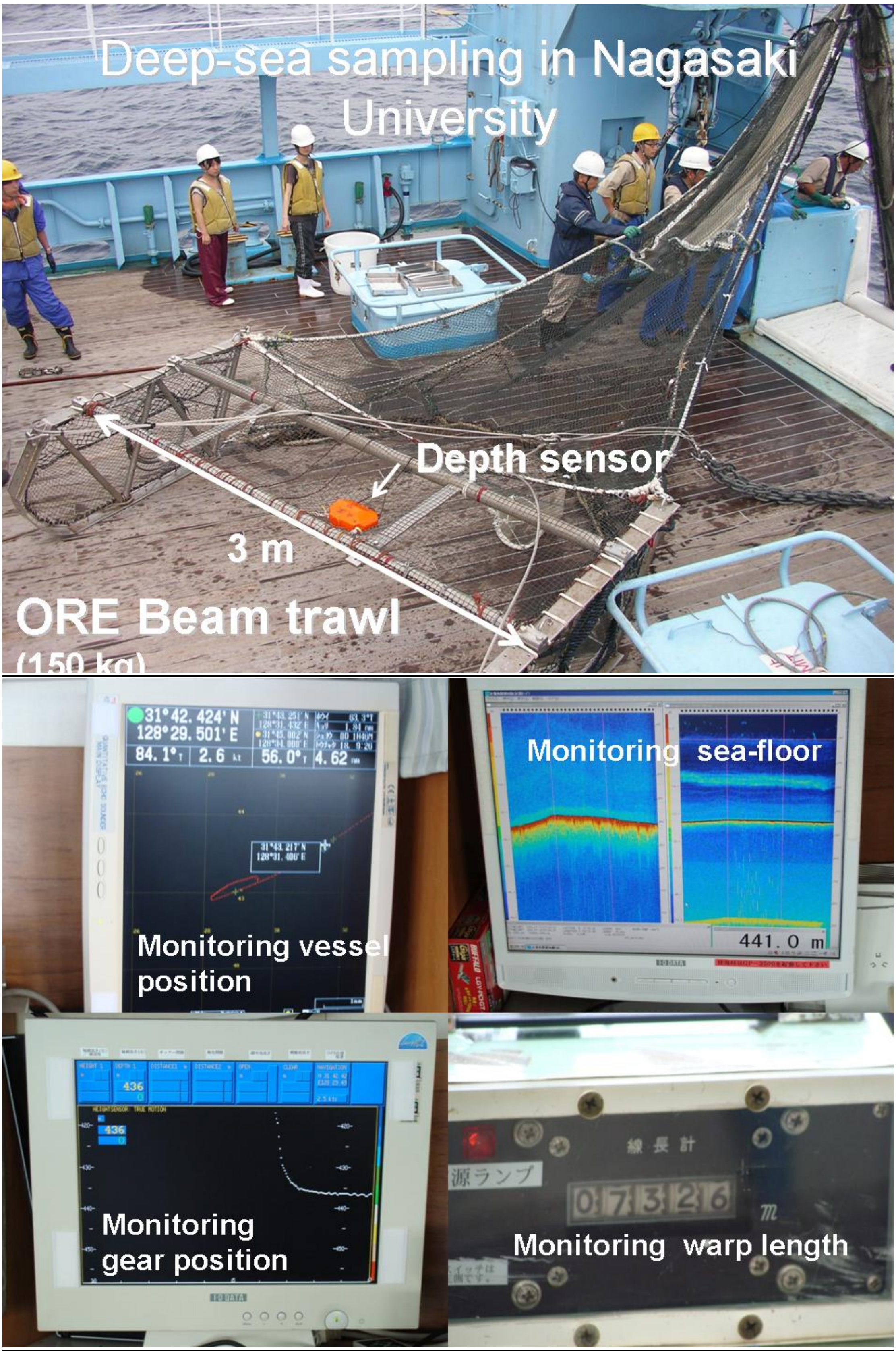
- Relatively simple in design, construction, and use
- less machineries
- relative abundance available
- environment dependent
- selectivity

Active sampling: towed gears

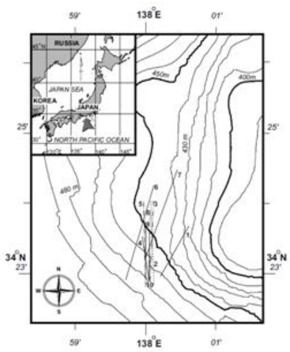
- Accurate sampling effort (e.g. geometric space, operated duration) => better index of abundance
- Samplings are mobile in space and time
- Larger sample size increase statistical precision
- Bu
- Se



Hayes, et al. 1996


Deep-sea sampling in Nagasaki University
Depth sensor
3 m
ORE Beam trawl
(150 kg)
31°42.424'N
128°29.501'E
84.1°
2.6
56.0°
4.62
Monitoring vessel position
Monitoring sea-floor
441.0 m
436
Monitoring gear position
線長計
源ランプ
07326
m
Monitoring warp length

Change in sampling performance of beam trawl by speed and opening (Yeh and Ohta, 2002)



(a) Demersal fish

	3m 1.5 kt	3m 0.8 kt	2m 1.5 kt	*F*	*P*
Density (ind. 1000 m^{-2})	3.11 ± 0.24	2.36 ± 0.22	1.60 ± 0.17	41.79	***
Biomass (kg 1000 m^{-2})	1.24 ± 0.14	0.85 ± 0.07	0.80 ± 0.06	17.79	**
Shannon index, *H'*	1.74 ± 0.23	1.75 ± 0.21	1.16 ± 0.29	6.16	*
Shannon evenness, *E*	0.74 ± 0.10	0.88 ± 0.06	0.91 ± 0.03	5.83	*
Simpson index, 1-D	0.75 ± 0.09	0.83 ± 0.07	0.75 ± 0.10	0.81	ns

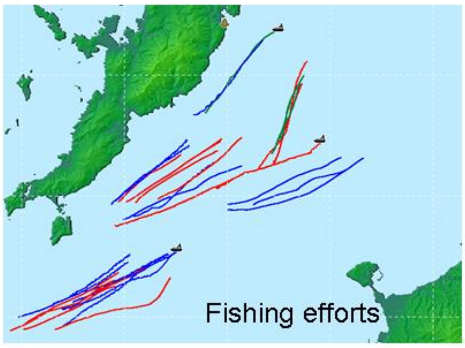
(b) Decapod crustaceans

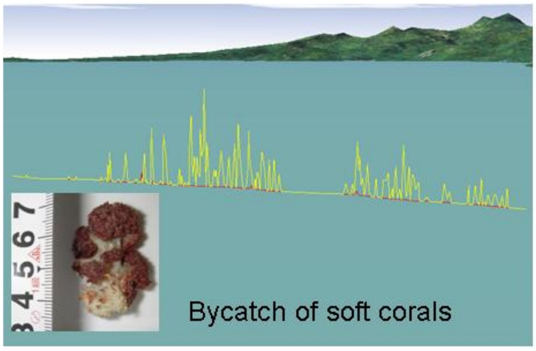
	3m 1.5 kt	3m 0.8 kt	2m 1.5 kt	*F*	*P*
Density (ind. 1000 m^{-2})	2.94 ± 0.99	3.75 ± 0.86	4.53 ± 0.99	2.40	ns
Shannon index, *H'*	1.37 ± 0.33	1.71 ± 0.33	1.29 ± 0.52	0.98	ns
Shannon evenness, *E*	0.71 ± 0.05	0.77 ± 0.09	0.55 ± 0.14	4.41	ns
Simpson index, 1-D	0.68 ± 0.07	0.76 ± 0.10	0.56 ± 0.21	1.56	ns

ns: not significant; *: $0.01 < P < 0.05$; **: $0.001 < P < 0.01$; ***: $P < 0.001$; $F(0.05,2,7) = 4.74$.
All data show as Mean ± SD.

Geographic Information System (GIS)

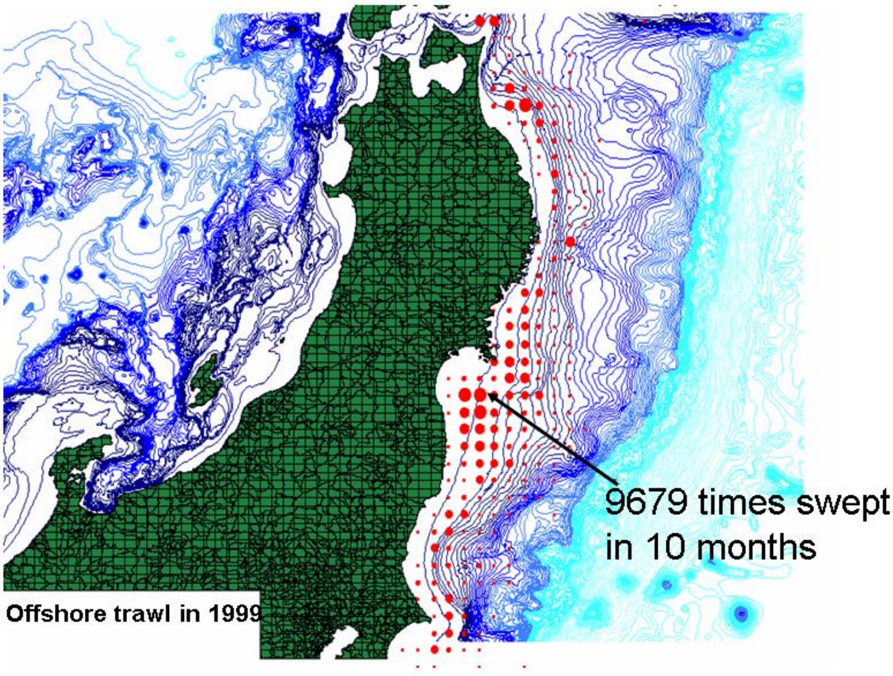
- GIS allows the user to consider relations of plural factors.
- Almost standard way to represent geo-spatial data (e.g. bathymetry, substrate, current, catch and effort, etc.).





Free software available: e.g. GLASS GIS, GMT, Google Eart

Monitoring and mapping fishing efforts



Attention for deep-sea exploration

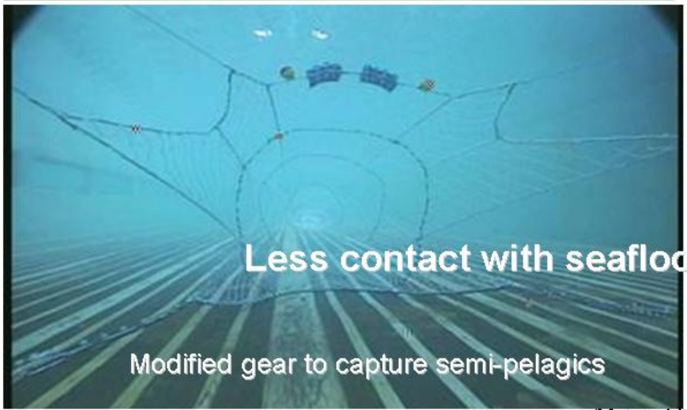
- **Vulnerability of deep-sea stocks**
  Generally, late maturation, extreme longevity, low fecundity and slow growth
- **Conservation of habitat**
  Minimize negative effect of fishing to habitat, especially, for biogenic habitat.

We reviewed 283 reports on habitat impacts of fishing

- **Negative impacts to organisms**: Short and long term effects, chronic effects to target and other organisms in the habitat
- **Negative impacts to seafloor**: Change of geographical features
- **Sediment suspension**: Turbidity increase, seabed erosion, Change in organic matter balance
- **Gear modification** : Light weight gear, Less contact or contactless gear

---

Gear modification: Example of trawl gear



(Matsushita et al. 2006)

Consideration from various angles is necessary to explore deep-sea

- Ecosystem Approach to Fisheries (FAO, 2003)

  An extension of conventional fisheries management recognizing more explicitly the interdependence between human and ecosystem health and need to maintain ecosystems productivity for present and future generations.


Thank you for your attention , ARIGATOU!

Deep Sea Fisheries Resources Survey Experience in Andaman Sea 1975-1995

By

Aussanee Manprasit

SEAFDEC/TD

March 1975

R.V. Fisheries Research No. II/DOF

GT - 380 T

Hp - 1,000 Ps

Deep sea demersal resource survey by bottom trawl

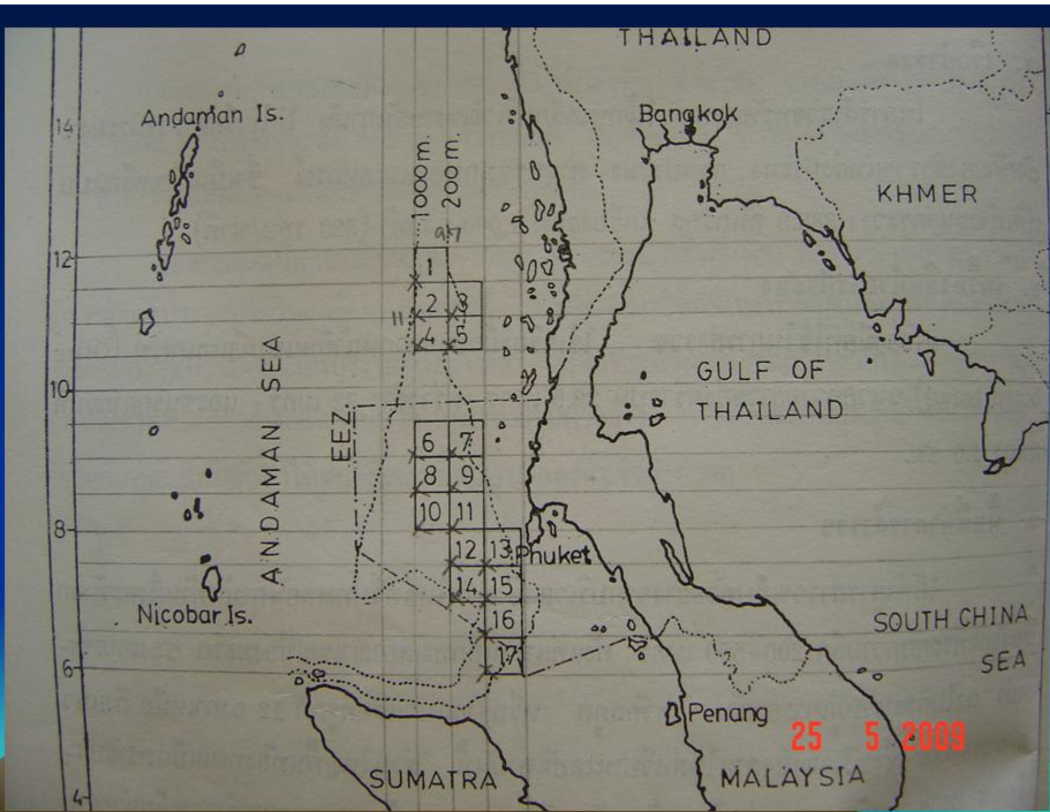
Trawl net

Japanese type with 22-32 head rope and ground rope and 30 mm mesh size at cod-end

Fishing ground

200-500 meter depth,

latitude 6 °N - 12°N



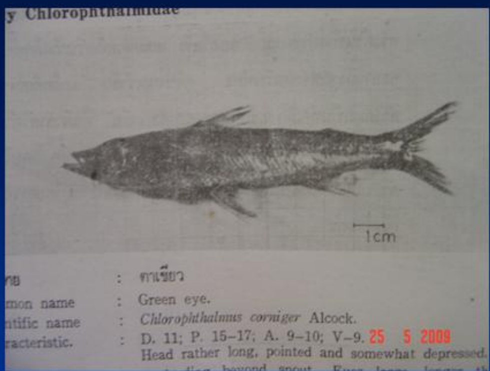


Photo. 1 Deep-sea lobster (Spiny lobster), 7/9/'87 at a depth of 400 metres in the Andaman Sea.

Results

Average catch 175 kgs./hrs.
Maximum catch 586 kgs./hrs.
75 species of fish, 12-15 unknown samples
30 species of Shrimp
5-6 species of Squid and Crab

Main catch

- Fish *Chloropthalmus Corniger, Synagrops malaynus*
- Shrimp *Heterocapus laevigatus, H. ensifer*
- Spiny lobster *Puerulus sewelli*

... และอื่น ๆ ซึ่งจากการวิเคราะห์
ชนิดแล้วมีดังต่อไปนี้

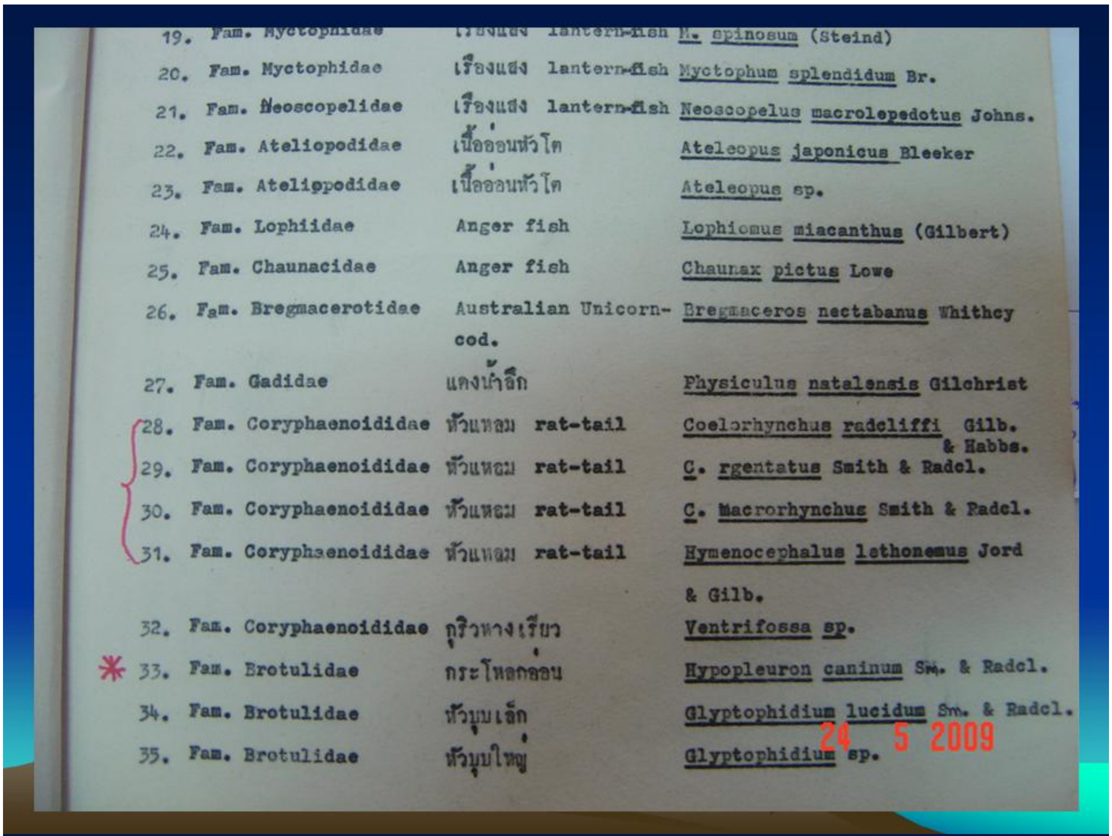
พวกปลา

1. Fam. Muraenesocidae	Arabian Pike-eel	Muraenesox cinerius(Forskål)
2. Fam. Nettastomidae	หลดน้ำลึก หลดเผือก	Venefica proboscides(Vaitlan
3. Fam. Congridae	sea conger	Gongrellus anaco(Schlegel
4. Fam. Congridae	Conger eel	Congrellus roosendaali
5. Fam. Congridae	"	Ariosoma balcarica(de la Roch
6. Fam. Ophichthyidae	yellow-fin snake eel	Brachysomophis (Brachysomophis) cirhoocheilus (Blks.
7. Fam. Nemichthyidae	ปากนกยาง snipe-eel	Nemichthys scolopacius Richardson
8. Fam. Sternoptychidae	แป้นเขี้ยว	Argyropelecus olfersi (Cuvier)
9. Fam. Astronesthidae	ดำเขี้ยวยาว	Astronesthes cyaneas (Brauer)
10. Fam. Astronesthidae	ดำเขี้ยวหนวดทอง	Astronesthes niger Richardson

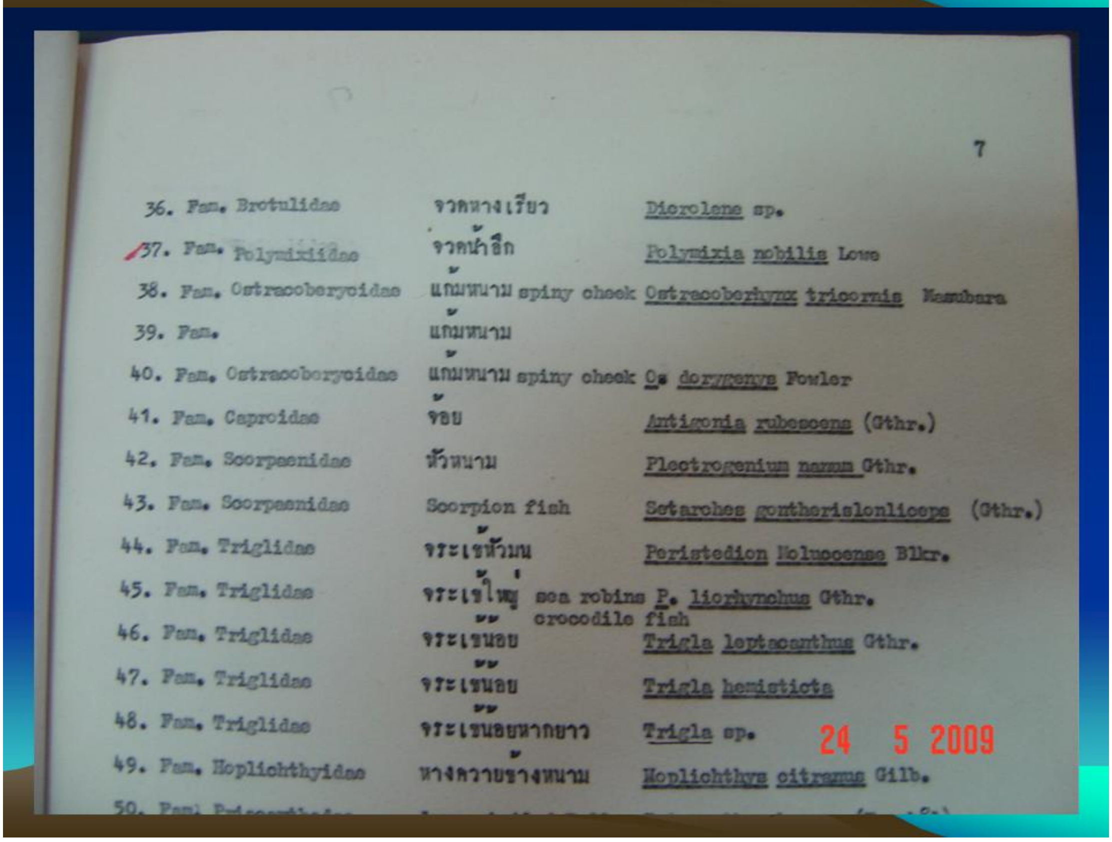
24 5 2009

11. Fam. Astronesthidae	เรืองแสงเขี้ยวยาว	Astronesthes lucifer Gilb.
12. Fam. Chauiodontidae	เขี้ยวยาว	Chauliodus sloani Bl. Schn.
13. Fam. Alepocephalidae	หน้าดำ	Alepocephalus bicolor Alc.
14. Fam. Synodontidae	ปากคมปากแหลม	Synodus sp.
15. Fam. Harpodontidae	Giassy Bombay duck	Harpodon translucent Savillkent
16. Fam. Chloropthalmidae	ตาเขียว (green eye)	Chloropthalmus corniger Alc.
17. Fam. Palalepidae	อินทรียาว naked barracudene	Lestidium nudum Gilbert
18. Fam. Myctophidae	เรืองแสง lantern-fish	Myctophum caeruleum Klunz
19. Fam. Myctophidae	เรืองแสง lantern-fish	M. spinosum (Steind)
20. Fam. Myctophidae	เรืองแสง lantern-fish	Myctophum splendidum Br.
21. Fam. Neoscopelidae	เรืองแสง lantern-fish	Neoscopelus macrolepidotus John
22. Fam. Ateliopodidae	เนื้ออ่อนหัวโต	Ateleopus japonicus Bleeker
23. Fam. Ateliopodidae	เนื้ออ่อนหัวโต	Ateleopus sp.

24 5 2009



19. Fam. Myctophidae	เรืองแสง lantern-fish	M. spinosum (Steind)
20. Fam. Myctophidae	เรืองแสง lantern-fish	Myctophum splendidum Br.
21. Fam. Neoscopelidae	เรืองแสง lantern-fish	Neoscopelus macrolepedotus Johns.
22. Fam. Ateliopodidae	เนื้ออ่อนหัวโต	Ateleopus japonicus Bleeker
23. Fam. Ateliopodidae	เนื้ออ่อนหัวโต	Ateleopus sp.
24. Fam. Lophiidae	Anger fish	Lophiomus miacanthus (Gilbert)
25. Fam. Chaunacidae	Anger fish	Chaunax pictus Lowe
26. Fam. Bregmacerotidae	Australian Unicorn-cod.	Bregmaceros nectabanus Whithcy
27. Fam. Gadidae	แดงน้ำลึก	Physiculus natalensis Gilchrist
28. Fam. Coryphaenoididae	หัวแหลม rat-tail	Coelorhynchus radcliffi Gilb. & Habbs.
29. Fam. Coryphaenoididae	หัวแหลม rat-tail	C. rgentatus Smith & Radcl.
30. Fam. Coryphaenoididae	หัวแหลม rat-tail	C. Macrorhynchus Smith & Radcl.
31. Fam. Coryphaenoididae	หัวแหลม rat-tail	Hymenocephalus lethonemus Jord & Gilb.
32. Fam. Coryphaenoididae	กุริวหางเรียว	Ventrifossa sp.
* 33. Fam. Brotulidae	กระโหลกอ่อน	Hypopleuron caninum Sm. & Radcl.
34. Fam. Brotulidae	หัวบุบเล็ก	Glyptophidium lucidum Sm. & Radcl.
35. Fam. Brotulidae	หัวบุบใหญ่	Glyptophidium sp.



7

36. Fam. Brotulidae	จวดหางเรียว	Dicrolene sp.
37. Fam. Polymixiidae	จวดน้ำลึก	Polymixia nobilis Lowe
38. Fam. Ostracoberycidae	แก้มหนาม spiny cheek	Ostracoberhynx tricornis Masubara
39. Fam.	แก้มหนาม	
40. Fam. Ostracoberycidae	แก้มหนาม spiny cheek	Os dorygenys Fowler
41. Fam. Caproidae	จ้อย	Antigonia rubescens (Gthr.)
42. Fam. Scorpaenidae	หัวหนาม	Plectrogenium nanum Gthr.
43. Fam. Scorpaenidae	Scorpion fish	Setarches guntherislonliceps (Gthr.)
44. Fam. Triglidae	จระเข้หัวมน	Peristedion Moluccense Blkr.
45. Fam. Triglidae	จระเข้ใหญ่ sea robins crocodile fish	P. liorhynchus Gthr.
46. Fam. Triglidae	จระเข้น้อย	Trigla leptacanthus Gthr.
47. Fam. Triglidae	จระเข้น้อย	Trigla hemisticta
48. Fam. Triglidae	จระเข้น้อยหางยาว	Trigla sp.
49. Fam. Hoplichthyidae	หางควายช้างหนาม	Hoplichthys citrinus Gilb.

46. Fam. Triglidae	จระเข้น้อย	Trigla leptacanthus Gthr.
47. Fam. Triglidae	จระเข้น้อย	Trigla hemisticta
48. Fam. Triglidae	จระเข้น้อยหางยาว	Trigla sp.
49. Fam. Hoplichthyidae	หางควายข้างหนาม	Hoplichthys citrамus Gilb.
50. Fam. Priacanthedae	Lunar-tailed Bulls -eye	Priacanthus hamrus (Forskål)
51. Fam. Apogonidae	อมไข่น้ำลึก	Synagrops malayanus M. Weber
52. Fam. Apogonidae	ตาโตเกล็ดใหญ่	S. japonicus Steindachner
53. Fam. Apogonidae	อมไข่น้ำลึก	Acropoma sp.
54. Fam. Bramidae	pygmy pomfret, rays's bream	Collybus drachme Snyder
55. Fam. Lutjanidae	ทรายน้ำลึก	Pristipomoides argyrogrammicus (Valenciennes)
56. Fam. Champsodontidae	sabre-gills	Champsodon capensis Regan
57. Fam. Bembropsidae	หางควายน้ำลึก	Bembrop caudimacular Steindachner
58. Fam. Bembropsidae	หางควายน้ำลึก	Bembrop sp.
*59. Fam. Gempylidae	อินทรีเขี้ยว Snake mackerels	Epinnula orientalis Gilchrist & Van. Bonde
60. Fam. Gempylidae	อินทรีเขี้ยว snake	Jordanidia prometheoides (Bl.)

24 5 2009

70. Fam. Triacanthodidae	วัวปากยาว	Halimochirurgus alcocki M.Weber
71. Fam. Dalatiidae	Alligator shark, Prickle shark, spiny shark, Brambles.	Echinorhinus brucus (Bonnaterri)
72. Fam. Heptranchidae	Seven-gills shark	Hetranchias perlo (Bonnaterer)
73. Fam. Scyliorhinidae (or Catulidae)	ฉลามแคระ dog fish	Halaelurus hispidus
74. Fam. Squalidae	spiny dog fish	Squalus fernandinus Molinaeus
75. Fam. Squalidae	Piked dog fish, Spiky Jack Lentern shark Lentern shark	Etmopterus spinax (Linn.)

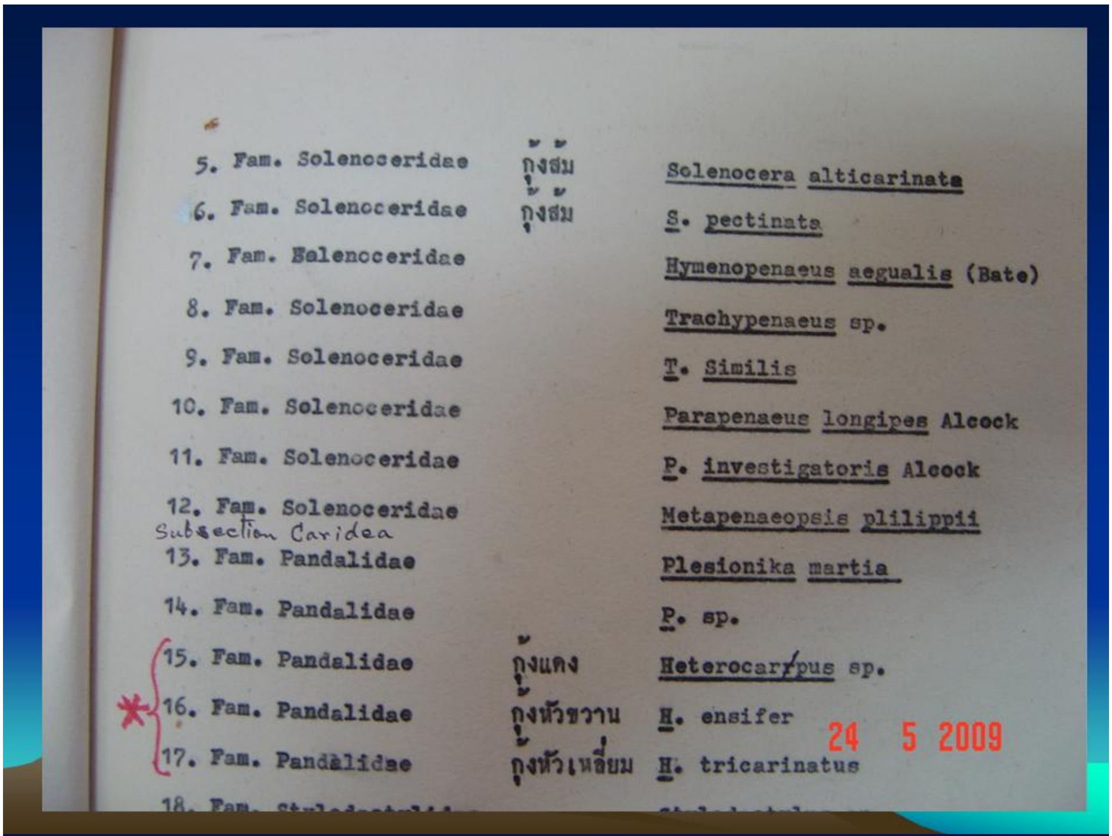
นอกจากนี้ที่ยังเหลืออีก 9-10 ชนิดที่ยังไม่สามารถวิเคราะห์ออกมาได้ เนื่องจากเอกสารประกอบการวิเคราะห์นั้น เราจะได้พยายามต่อไป

พวกกุ้ง

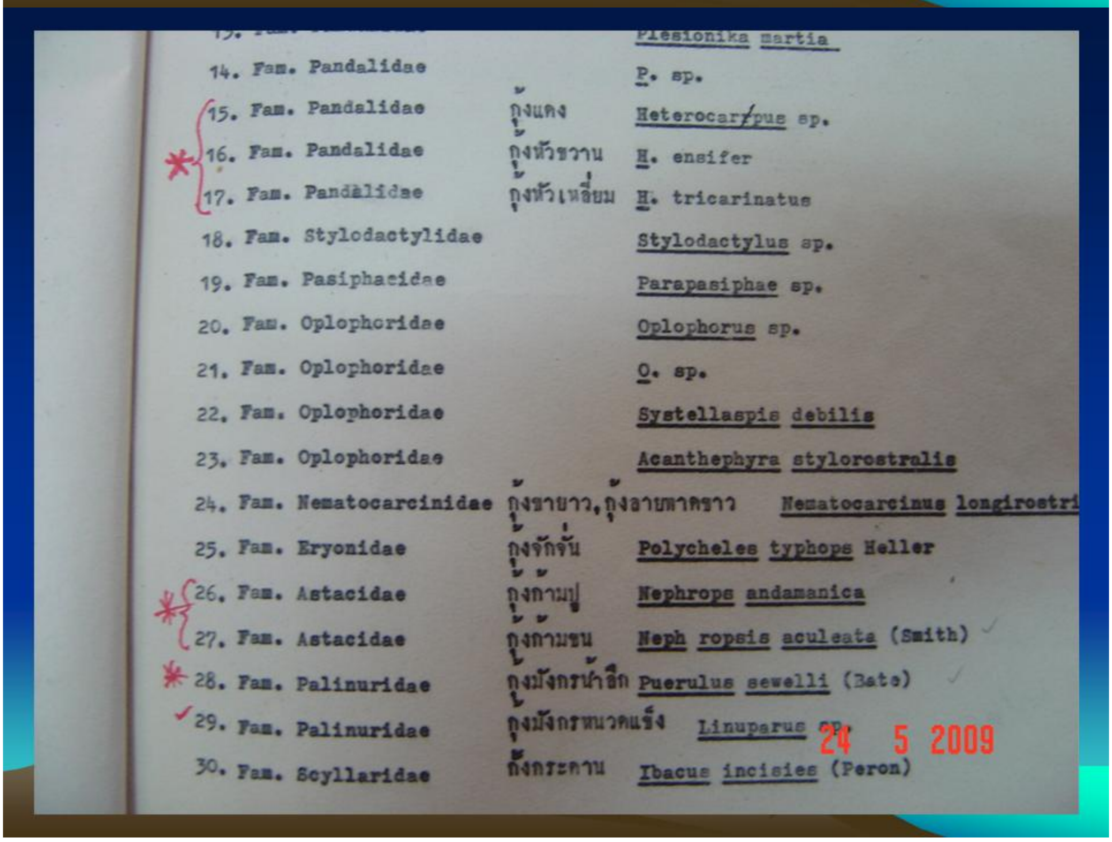
Subsection Stenopodidea

1. Fam. Stenopodidae		Stenopus hispidus Aristeus virilis (Bate 1881)
Subsection Panaeidea 2. Fam. Aristaeidae	~~stot~~ stout red shrimp	Aristaeus virillis (Bate) Syn. A. tomentosus
3. Fam. Aristaeidae	กุ้งแดงใหญ่	Aristeomopha rostridentata (Bate)
4. Fam. Aristaeidae	กุ้งแดงใหญ่	A. foliacea (Risso)

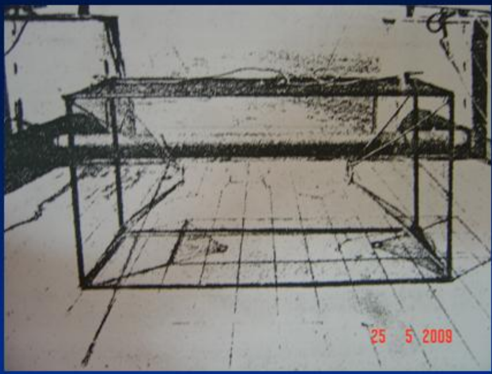
24 5 2009

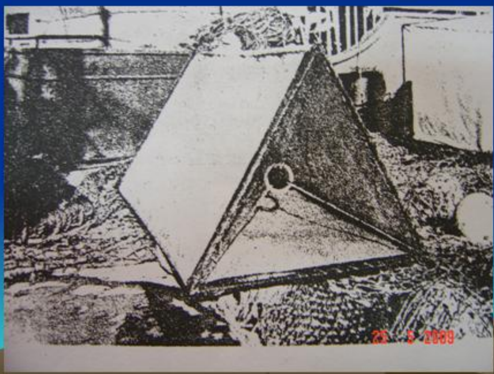


5. Fam. Solenoceridae	กุ้งส้ม	Solenocera altricarinata
6. Fam. Solenoceridae	กุ้งส้ม	S. pectinata
7. Fam. Solenoceridae		Hymenopenaeus aegualis (Bate)
8. Fam. Solenoceridae		Trachypenaeus sp.
9. Fam. Solenoceridae		T. Similis
10. Fam. Solenoceridae		Parapenaeus longipes Alcock
11. Fam. Solenoceridae		P. investigatoris Alcock
12. Fam. Solenoceridae		Metapenaeopsis plilippii
Subsection Caridea		
13. Fam. Pandalidae		Plesionika martia
14. Fam. Pandalidae		P. sp.
15. Fam. Pandalidae	กุ้งแดง	Heterocarpus sp.
* 16. Fam. Pandalidae	กุ้งหัวขวาน	H. ensifer
17. Fam. Pandalidae	กุ้งหัวเหลี่ยม	H. tricarinatus



14. Fam. Pandalidae		P. sp.
15. Fam. Pandalidae	กุ้งแดง	Heterocarpus sp.
* 16. Fam. Pandalidae	กุ้งหัวขวาน	H. ensifer
17. Fam. Pandalidae	กุ้งหัวเหลี่ยม	H. tricarinatus
18. Fam. Stylodactylidae		Stylodactylus sp.
19. Fam. Pasiphaeidae		Parapasiphae sp.
20. Fam. Oplophoridae		Oplophorus sp.
21. Fam. Oplophoridae		O. sp.
22. Fam. Oplophoridae		Systellaspis debilis
23. Fam. Oplophoridae		Acanthephyra stylorostralis
24. Fam. Nematocarcinidae	กุ้งขายาว,กุ้งลายพาดขาว	Nematocarcinus longirostri
25. Fam. Eryonidae	กุ้งจักจั่น	Polycheles typhops Heller
* 26. Fam. Astacidae	กุ้งก้ามปู	Nephrops andamanica
27. Fam. Astacidae	กุ้งก้ามขน	Neph ropsis aculeata (Smith)
* 28. Fam. Palinuridae	กุ้งมังกรน้ำลึก	Puerulus sewelli (Bate)
✓ 29. Fam. Palinuridae	กุ้งมังกรหนวดแข็ง	Linuparus sp.
30. Fam. Scyllaridae	กั้งกระดาน	Ibacus incisies (Peron)





February 1976

R.V. Fisheries Research No. II/DOF

Deep sea demersal resource survey by deep sea pot

Pot

Deep Sea Pot Rectangular, Prism shape 60 x 60 x 120 cm. mesh size 15 mm. 58 pots, Emersion time 8 hrs. (6 – 18 hrs.)

Fishing ground

300-500 meter depth,

latitude 7 °N - 10°N

Results

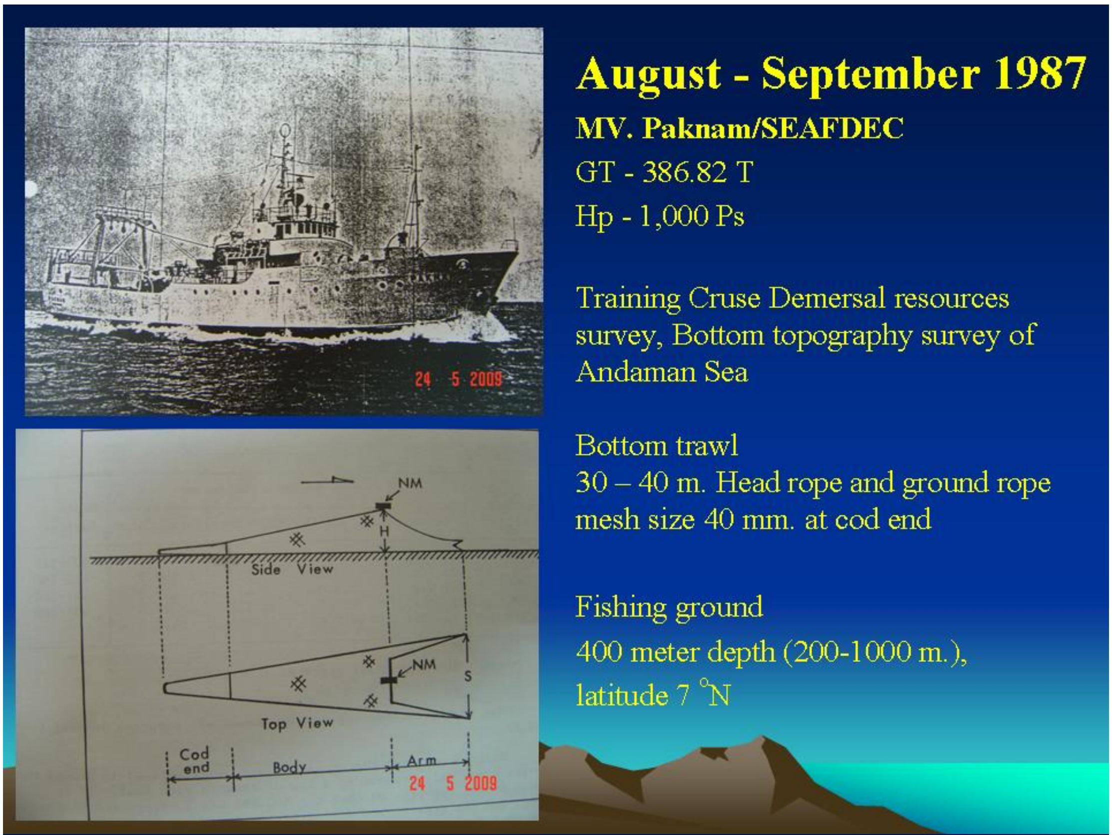
Catch Total Max. 8.8 kg./t

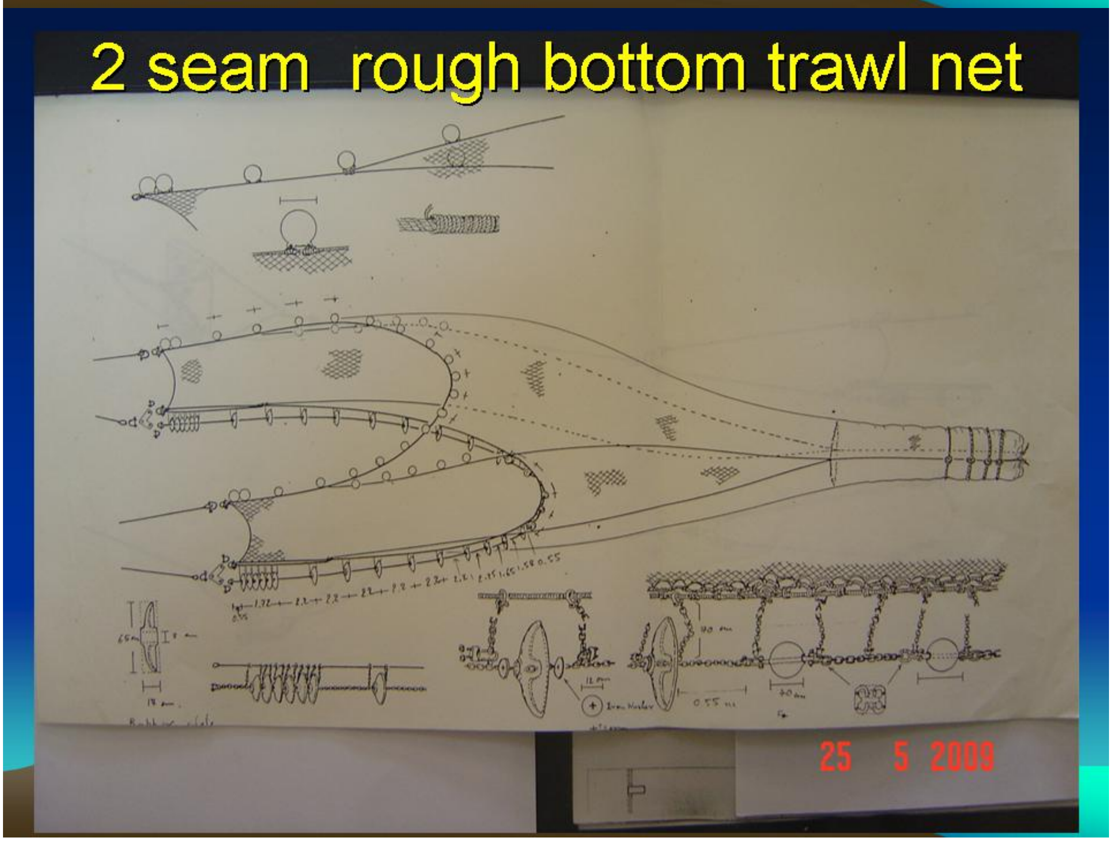
Shrimp 0.9 kg./t

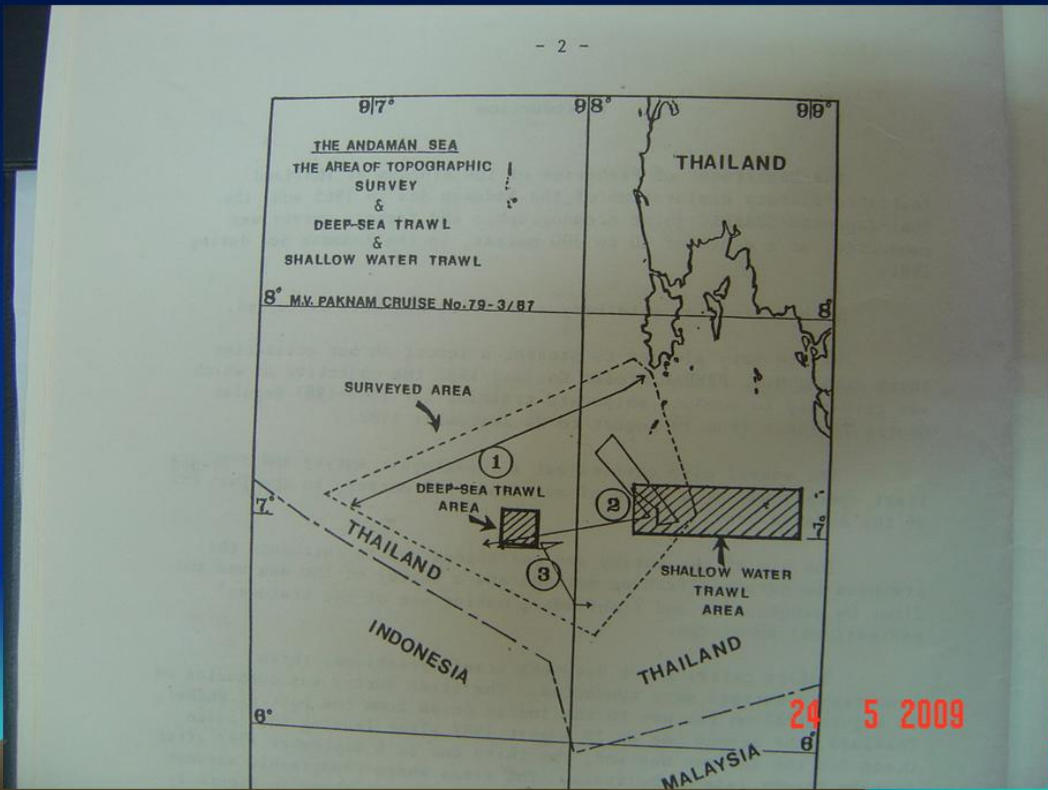
H. loseigatus

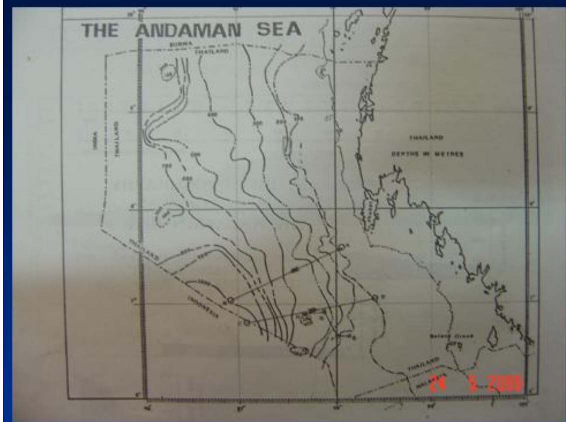
H. ensifer

Good Fishing ground ~ 400 m.


24 5 2009
NM
H
Side View
NM
S
Top View
Cod end
Body
Arm
24 5 2009
August - September 1987
MV. Paknam/SEAFDEC
GT - 386.82 T
Hp - 1,000 Ps
Training Cruse Demersal resources survey, Bottom topography survey of Andaman Sea
Bottom trawl
30 – 40 m. Head rope and ground rope mesh size 40 mm. at cod end
Fishing ground
400 meter depth (200-1000 m.),
latitude 7 °N


2 seam rough bottom trawl net
25 5 2009





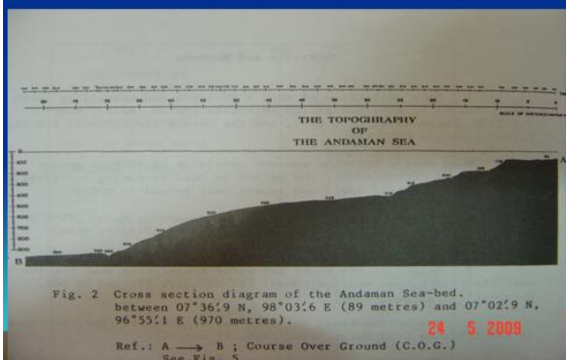
Topography Survey

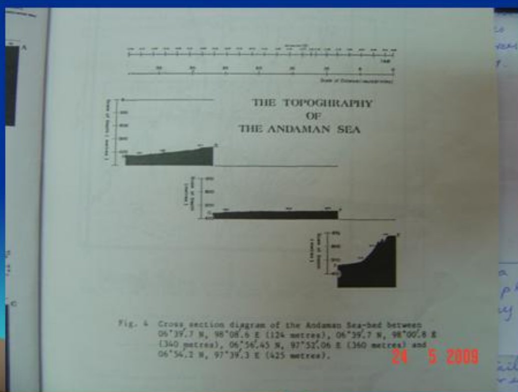
200 – 350 slope

350 – 500 smooth (flab)

500 over slope

350 – 450 most appropriate for bottom trawl

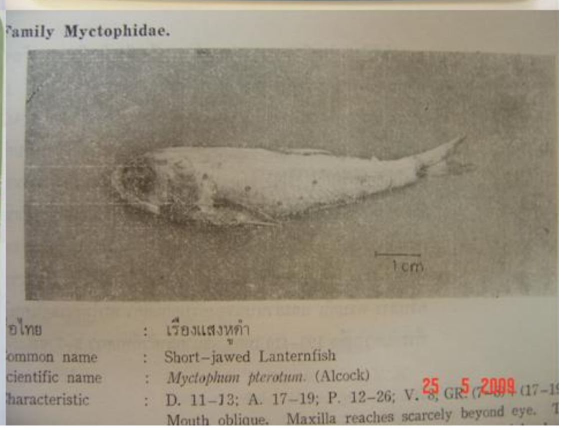


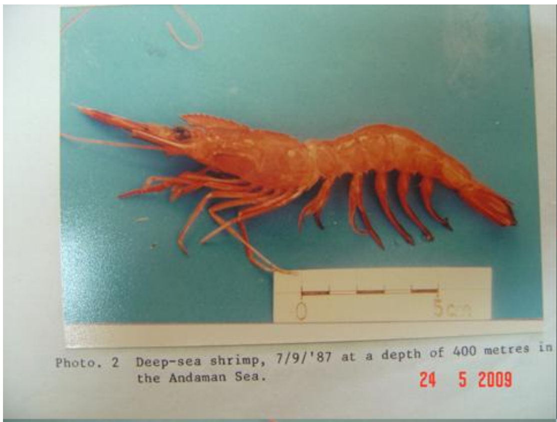



Results
Catch
150 – 300 kg./hrs. of deep sea fish and shrimp
New species of deep sea crab had found
Dairoides seafdeci
- 14 -
Photo. 3 Catch on deck, deep-sea shrimp was the dominant species
C


0
5cm


0
5cm


Family Myctophidae.
1 cm
ชื่อไทย : เรืองแสงหูดำ
Common name : Short–jawed Lanternfish
Scientific name : Myctophum pterotum (Alcock)
Characteristic : D. 11–13; A. 17–19; P. 12–26; V. 8; GR.
Mouth oblique. Maxilla reaches scarcely beyond eye.


0 5cm
Photo. 2 Deep-sea shrimp, 7/9/'87 at a depth of 400 metres in the Andaman Sea.
24 5 2009

0 5cm
24 5 2009

0 5cm
24 5 2009

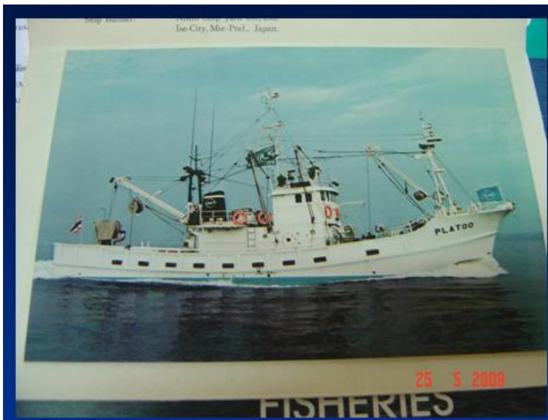
5 10cm
Photo. 1 Deep-sea lobster (Spiny lobster), 7/9/'87 at a depth of 400 metres in the Andaman Sea.
24 5 2009

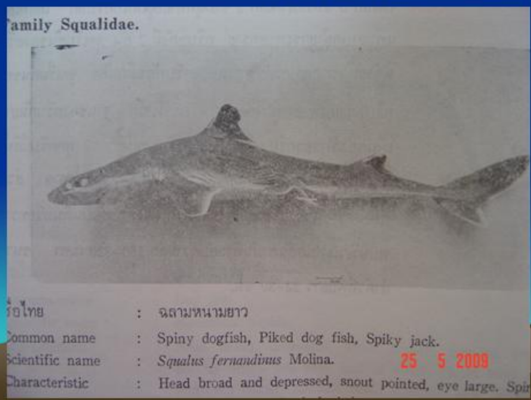
0 5cm
24 5 2009

0 5cm
24 5 2009

0 5cm
24 5 2009

0 5cm
24 5 2009





January - March 1988

M.V. Platoo/SEAFDEC

GT - 67 T

Hp – 500 Ps

Resource Survey and Training Cruise
Bottom Vertical long line (BVL)

Fishing ground

100-250 meter depth,

latitude 6 °N - 7°N

Catch

Snapper, Grouper, Spiny dogfish (Squalus spp.)

February 1990

MV. Paknam/SEAFDEC

GT - 386.82 T

Hp - 1,000 Ps

Resource Survey and Training Cruise

Pot

Deep Sea Pot Hemispherical shape

Dia. 100 cm. mesh size 30 mm. 30 – 90 pic/l ET. 12 – 14 hrs.

Fishing ground

200 - 400 meter depth

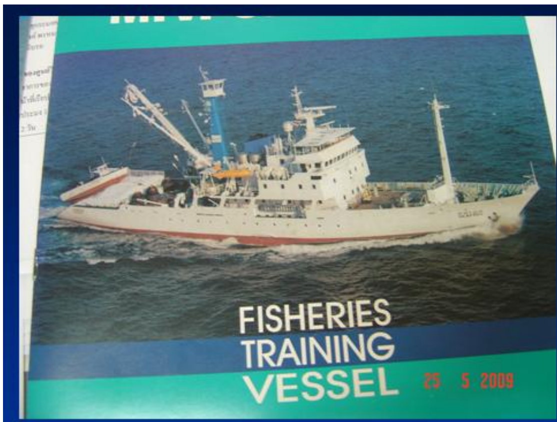
latitude 6 °N - 9 °N

Catch

Shrimp caught at most appropriate 300-400 m.

Heterocapus siboge

H. lepidus



March 1994

M.V. SEAFDEC/SEAFDEC

GT – 1,178 T

Hp – 2,800 Ps

Resources Survey and Training Cruise

Deep Sea Pot and BVL

Pot

Hemispherical shape

dia 80, 150 cm. mesh size 30, 120 mm.

Fishing ground

150-250 meter depth,

latitude 6 °N - 9°N

Results

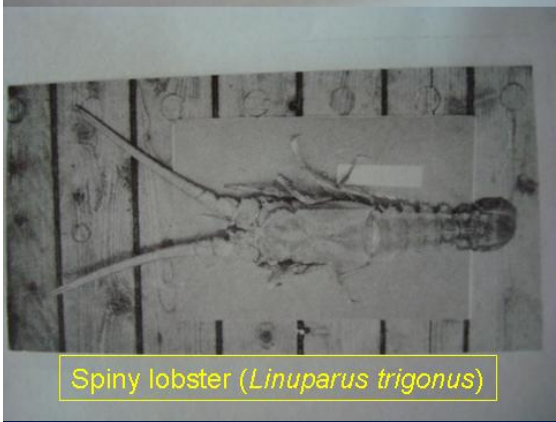
Catch

Deep Sea shrimp

Hag fish.

Rat tail

Conger eel



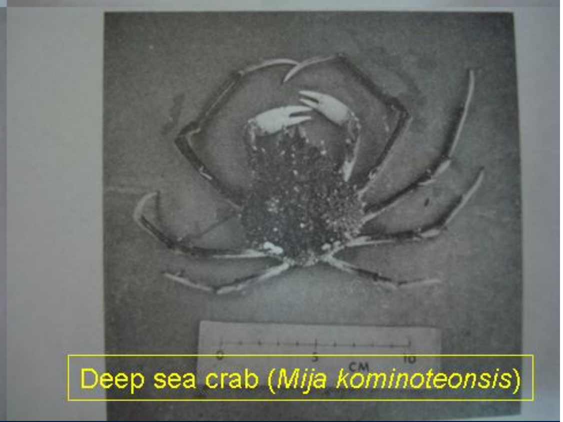


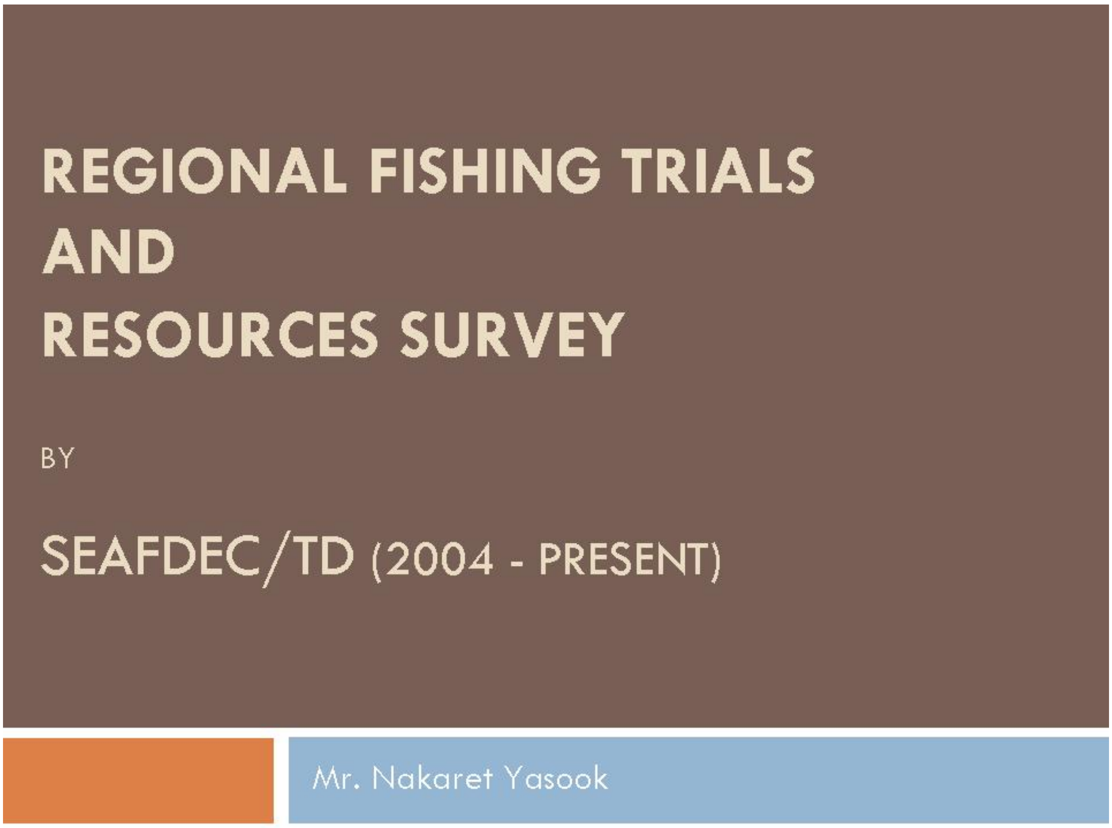
Table of Deep Sea Fisheries Survey Experience in Andaman Sea 1975-1955

Month/Year	Survey Vessel	Depth (m)	Location	Survey Fishing Gear	Objective	Result
March **1975**	"	200 – 500	6° N – 12° N	Bottom trawler 22/32 m. Head rope and Ground rope, mesh size 30 mm. at cod end	Demersal Fisheries Resources Survey	"
February **1976**	**R.V. Fisheries Research No. II/DOF** GT - 380 T Hp - 1,000 Ps	300 – 500	7° N – 10° N	Deep Sea Pot Rectangular, Prism shape 60 x 60 x 120 cm. mesh size 15 mm. 58 pots, Emersion time – 8 hrs. (6 – 18 hrs.)	Deep Sea Shrimp Resources Survey	**Catch** Total Max. 8.8 kg./t Shrimp 0.9 kg./t *H. loseigatus* *H. ensifer* Good Fishing ground ~ 400 m.

Table of Deep Sea Fisheries Survey Experience in Andaman Sea 1975-1955 (Cont.)

Month/Year	Survey Vessel	Depth (m)	Location	Survey Fishing Gear	Objective	Result
August – September **1987**	**M.V. Paknam/SEAFDEC** GT - 386.82 T Hp - 1,000 Ps	400 m. (200 – 1,000 m.)	7º N	Bottom trawl 30 – 40 m. Head rope and ground rope mesh size 40 mm. at cod end	Training Cruse Demersal resources survey, Bottom topography survey of Andaman Sea	**Catch** 150 – 300 kg./hrs. Topography -200 – 350 slope -350 – 500 smooth (flab) -500 over slope -350 – 450 most appropriate for bottom trawl
January - March **1988**	"	100 – 250	6º N – 7º N	Bottom Vertical long line (BVL)	Resource Survey and Training Cruise	Snapper, Grouper, Spiny dogfish (Squalus spp.)
February **1990**	**M.V. Paknam/SEAFDEC** GT - 386.8 T Hp - 1,000 Ps	200 – 400	6º N – 9º N	Deep Sea Pot Hemispherical shape Dia. 100 cm. mesh size 30 mm. 30 – 90 pic/l ET. 12 – 14 hrs.	Resource Survey and Training Cruise	**Catch** Shrimp caught at most appropriate 300- 400 m. *Heterocapus siboge* *H. lepidus*
March **1994**	**M.V. SEAFDEC/SEAFDEC** GT – 1,178 T Hp – 2,800 Ps	150 – 250	6º N – 9º N	Deep Sea Pot and BVL Hemispherical shape Dia. 80, 150 cm. mesh size 30, 120 mm.	Resources Survey and Training Cruise	Deep Sea shrimp -Hag fish -Rat ail -Conger eel

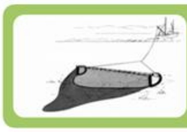
Thank You

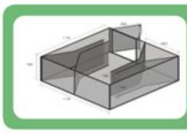

REGIONAL FISHING TRIALS
AND
RESOURCES SURVEY
BY
SEAFDEC/TD (2004 - PRESENT)
Mr. Nakaret Yasook

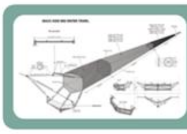

M.V.SEAFDEC2 Cruise No.
24-2/2007 Andaman Sea, Thailand
15 March – 23 April 2007 (1st sea trial for deep sea bottom otter trawl, trap)
28-1/2008 Andaman Sea, Thailand
3 March – 4 April 2008 (1st sea trial for beam trawl and IKMT)
29-2/2008 Brunei Waters, Brunei Darussalam
4 June – 5 July 2008 (Bottom otter trawl, Beam trawl, IKMT)
30-3/2008 Andaman Sea, Thailand
24 November – 25 December 2008 (IKMT)
31-1/2009 Brunei Waters, Brunei Darussalam
6 March – 11 April 2009 (Bottom otter trawl, Beam trawl, IKMT)

Sampling Equipment


Bottom Otter Trawl


Beam Trawl

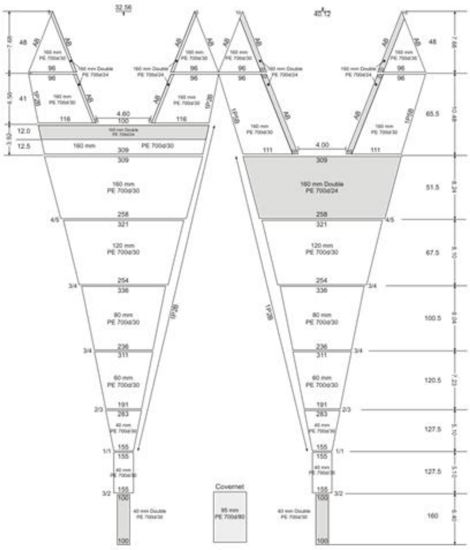

Trap

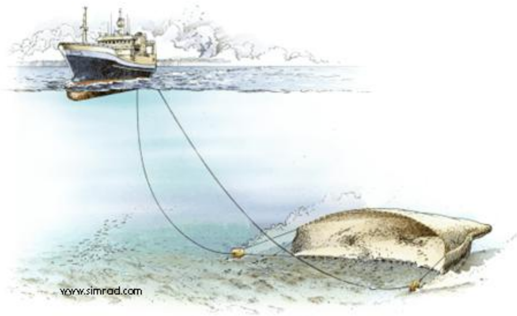

Isaacs-Kidd Mid-Water Trawl (IKMT)

Survey stations

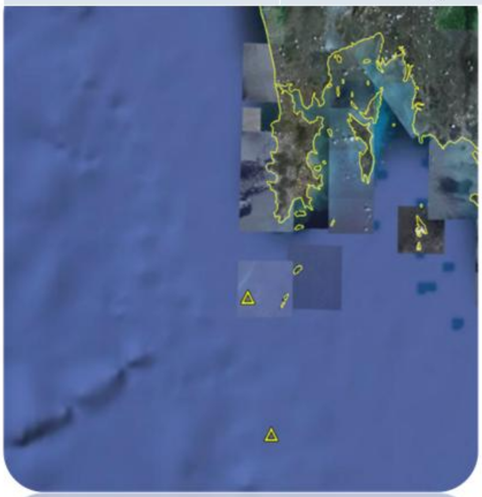
Bottom Otter Trawl

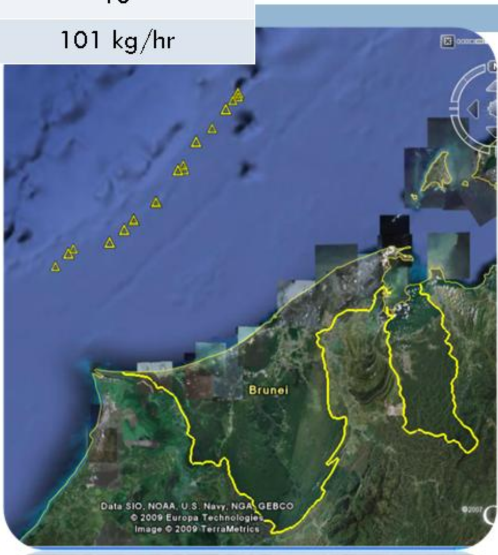
Thai Bottom Trawl (High Opening)



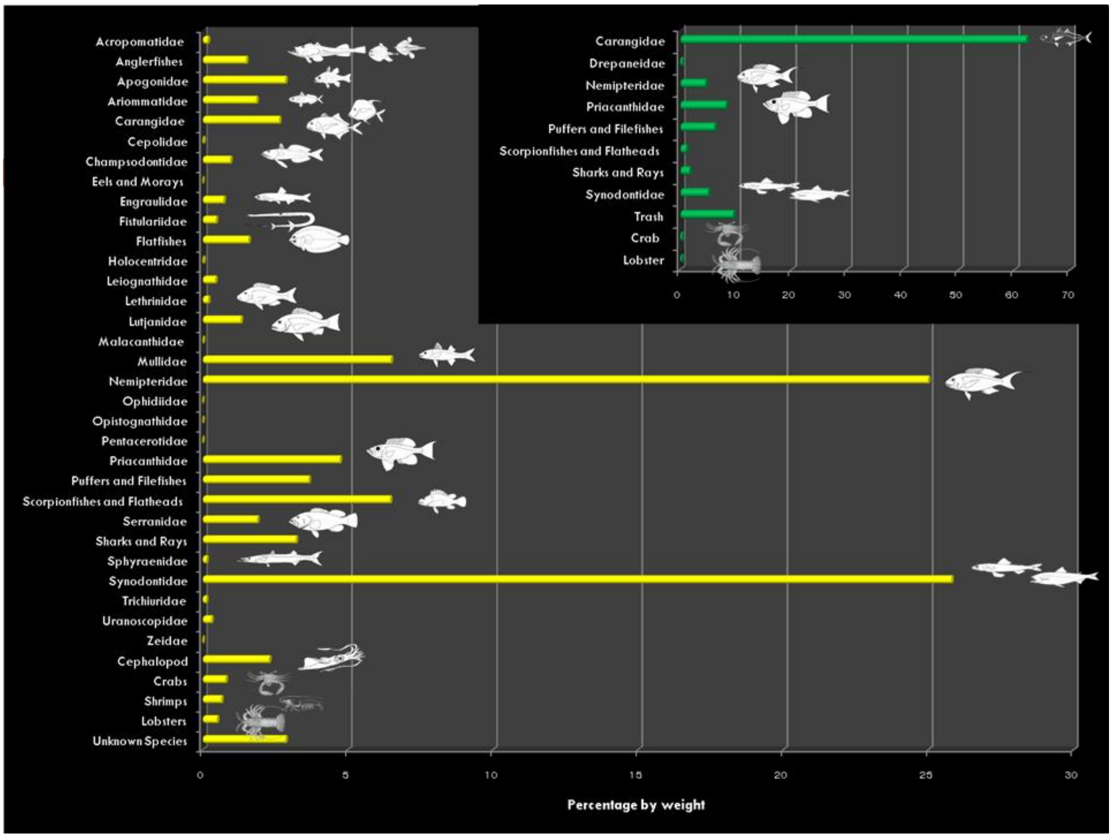


	Andaman Sea	Brunei Waters
Depth of operation	120 m	100 – 160 m
Number of operation	2	18
CPUE	260 kg/hr	101 kg/hr

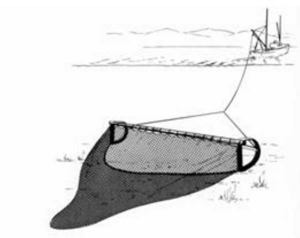




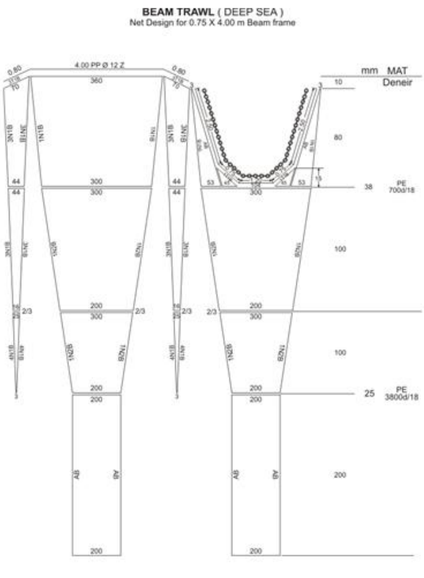
Bottom otter trawl

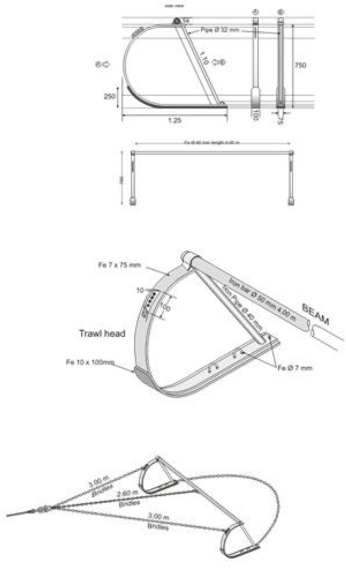


Beam Trawl

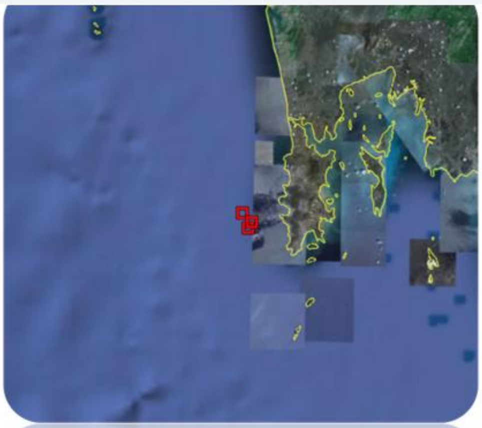


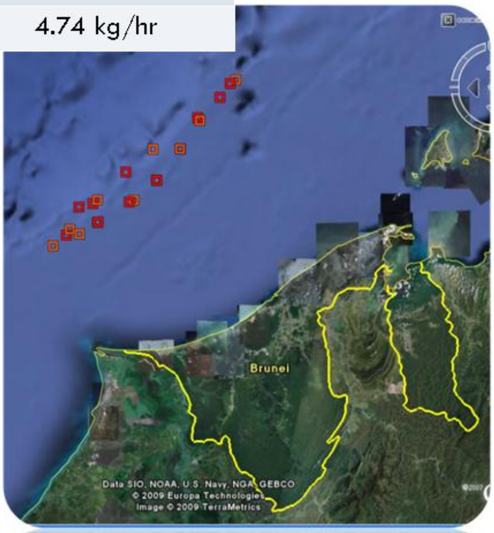
http://research.usm.maine.edu



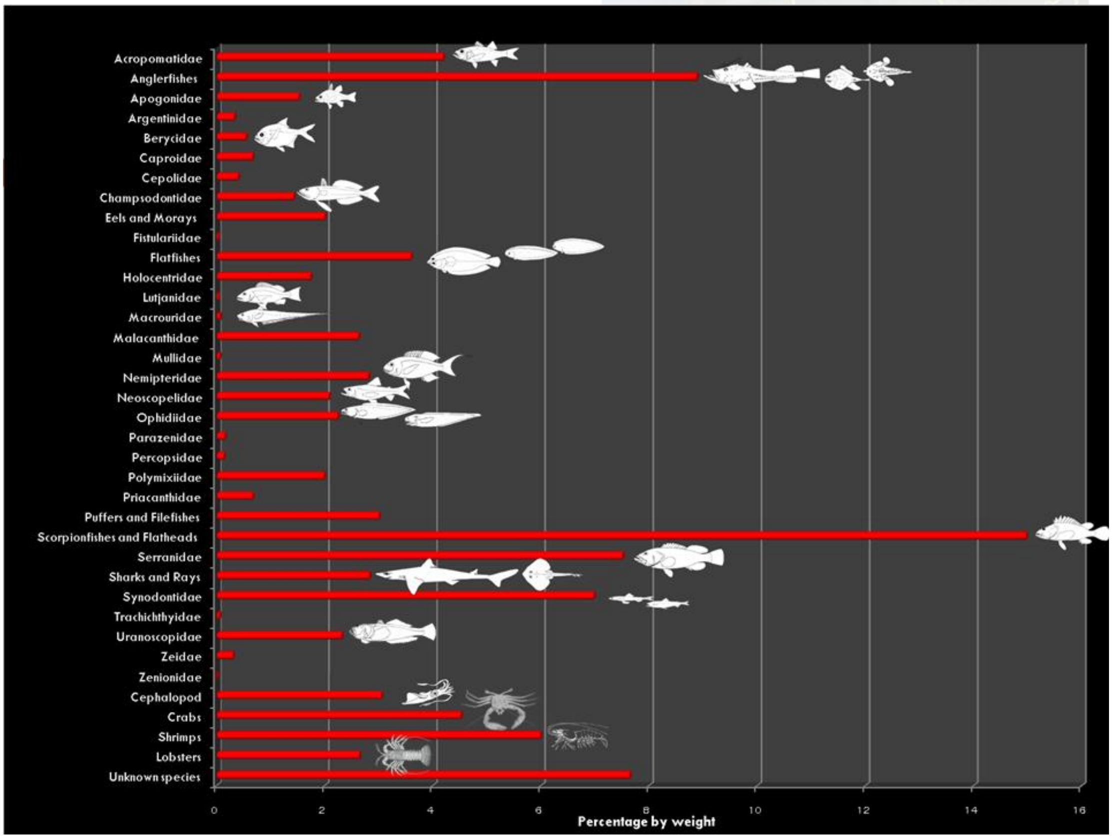


	Andaman Sea	Brunei Waters
Depth of operation	70 - 80 m	100 – 370 m
Beam length	2 m	4 m
Number of operation	3	21
CPUE	4.02 kg/hr	4.74 kg/hr

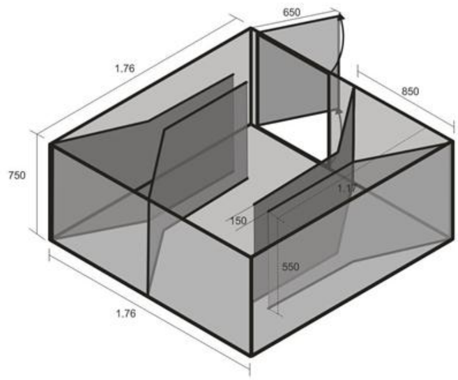




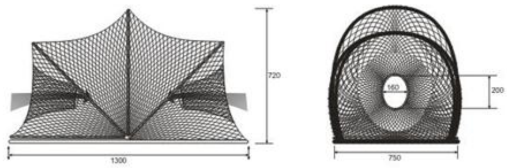
Beam trawl



Trap

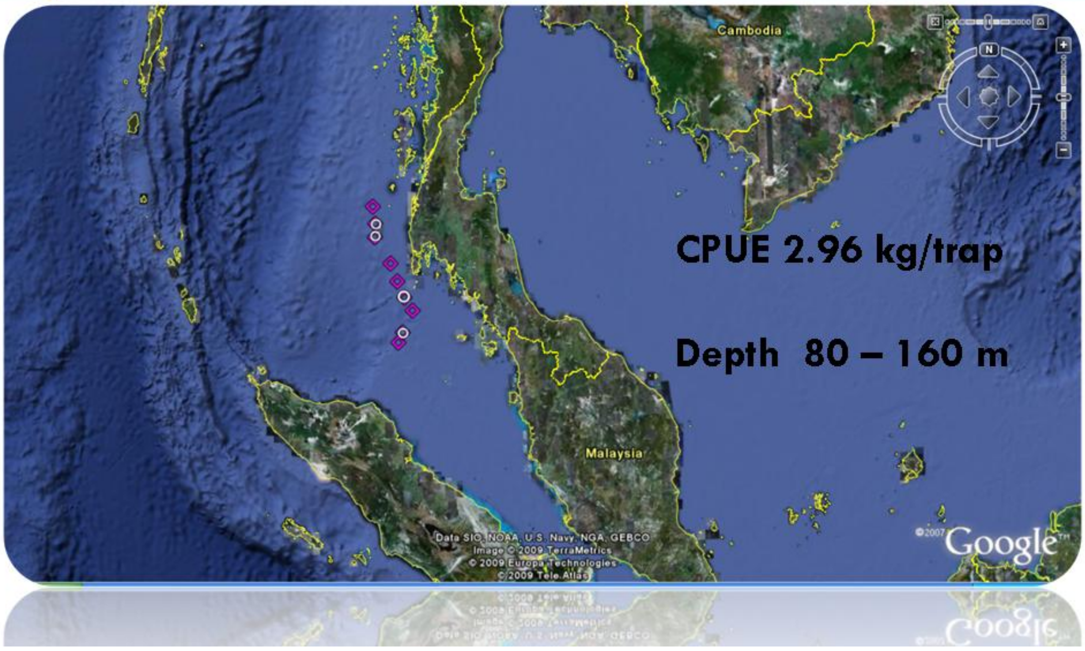


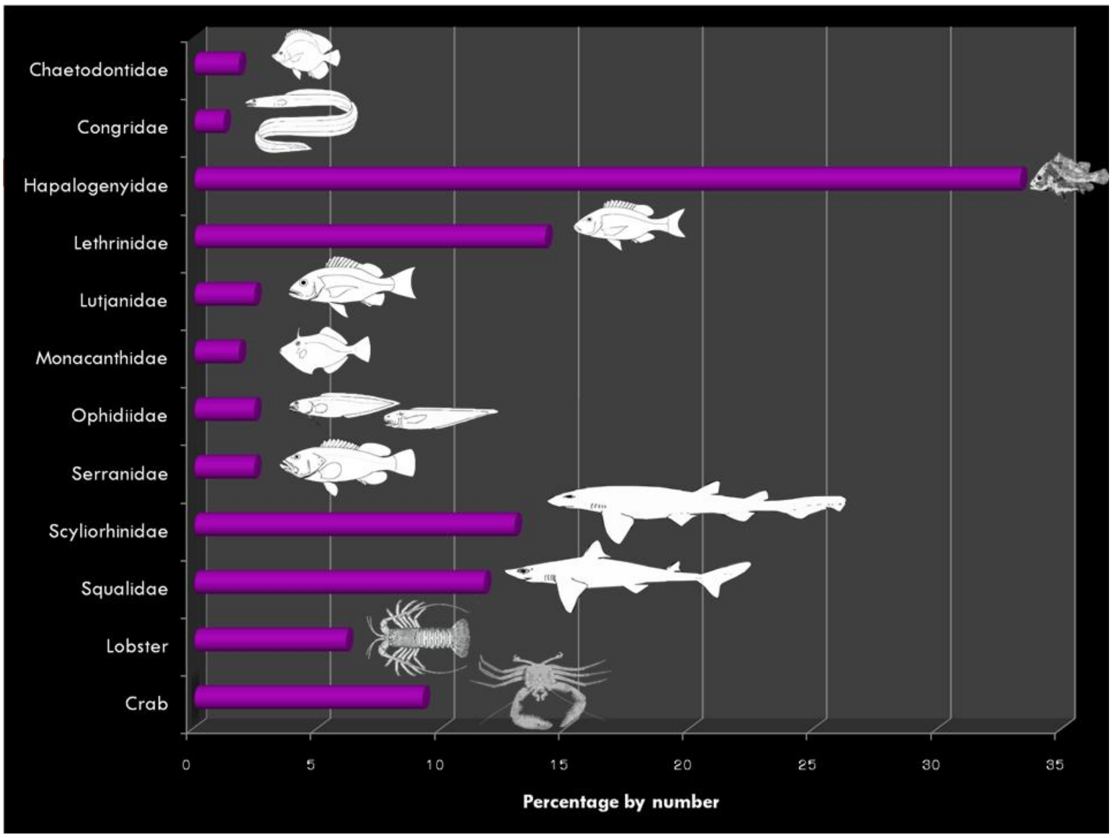
Giant fish trap (DOF)



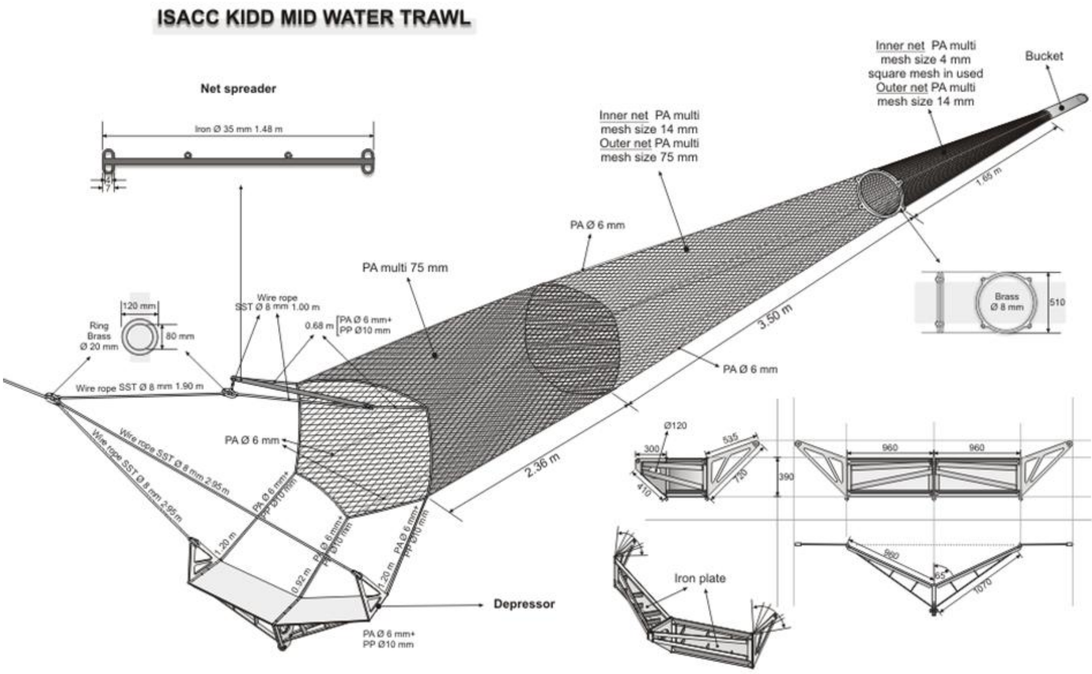
Collapsible fish trap

Trap operation stations





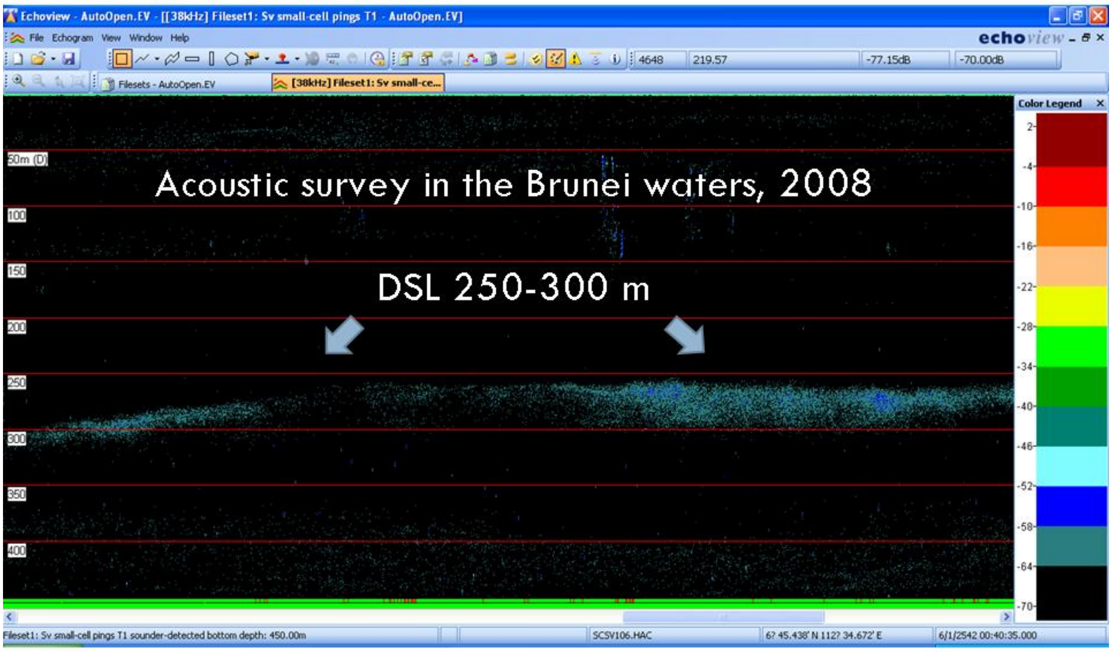
Isacc-Kidd Mid-Water Trawl



	Andaman Sea	Brunei Waters
Depth of operation	25 - 350 m	160 – 470 m
Number of operation	8	13

IKMT

DSL by Scientific Echo sounder

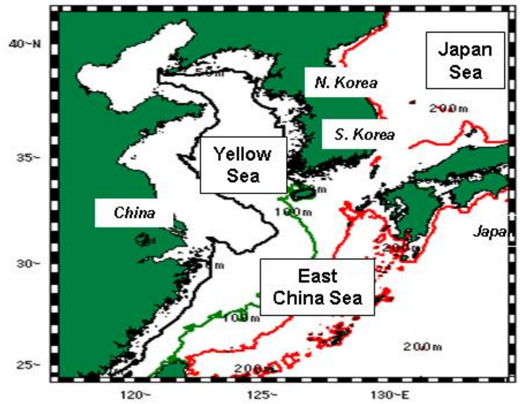


Active organisms live in DSL

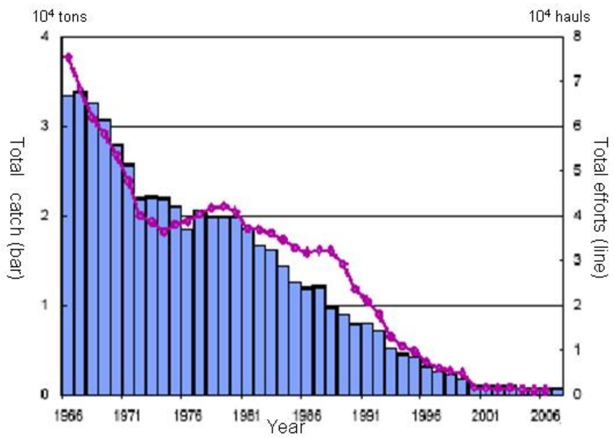
	Equipment	Depth of operation (m)	Number of operation	CPUE
Andaman Sea	Bottom otter trawl	120	2	260 kg/hr
	Beam trawl (2 m beam length)	70-80	3	4.02 kg/hr
	Trap	80-160	9	2.96 kg/trap
	IKMT	25-350	8	-
Brunei Waters	Bottom otter trawl	100-160	18	101 kg/hr
	Beam trawl (4 m beam length)	100-370	21	4.74 kg/hr
	IKMT	160 - 470	13	-

Results of bottom trawl survey at the continental slope in the northern East China Sea

Yoshinobu KONISHI
(Former Seikai National Fisheries Research Institute)
Sayan PROMJINDA
(SEAFDEC - Training Department)



Objectives of the survey



Annual trends of total catch and effort of the Japanese bottom trawl fishery in the ECS and Yellow Sea from 1966 to 2007.

Exploitation of new demersal fish resources and fishing grounds

- **To evaluate the targeted area as the fishing ground and economically important fish richness for the commercial fishery**

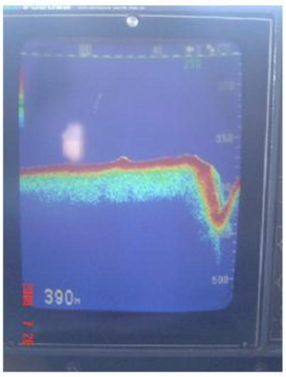
The fishery licensed by Minister of Agriculture, Forestry and Fisheries has being conducted in the continental shelf sea area.

Commercial bottom - trawl fishing boats chartered for the survey

Pair bottom trawl boat

- 162 gross tons
- 33.5 m (length)
- 7.5 m (width)
- 950 HP (main engine)

* 10 boats (5 pairs) and 1 transporting boat have been working in last four years.



Acoustic Instruments for Net-Tow Operation

Side Looking Sonar (main boat)

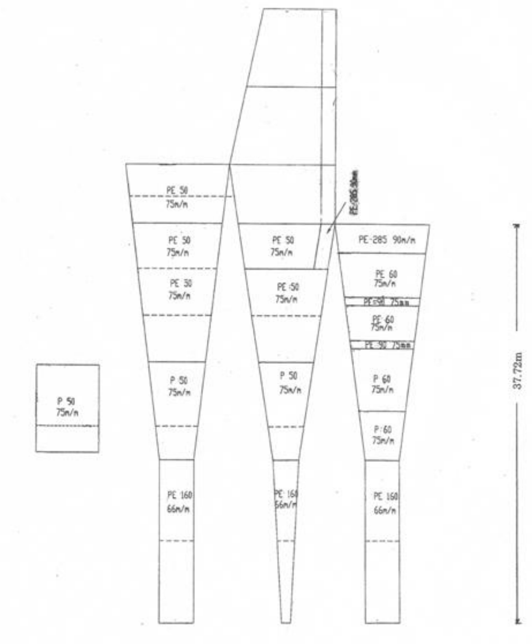
- Detector for bottom materials (exp. rock area in red color, muddy area in yellow color)

Echo Sounder (both boats)

- Detector for vertical profiles of sea bottom & sea depth

* Two instruments above are used to detect trawlable area prior to shooting of net
* Main boat has an image monitor of echo sounder of the other boat

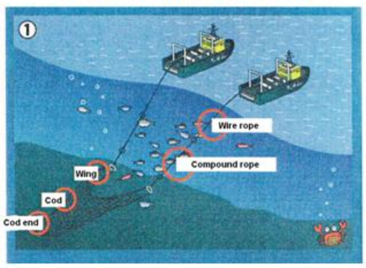
Bottom trawl net for two-boat haul



- Side length of cod net : 37.72 m
- Mesh size
  - Cod end : 66 mm
  - Cover net : 56 mm

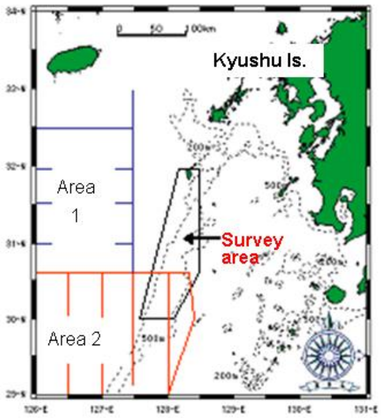
Net operation of the chartered fishing boat

Shooting & Towing



Hauling

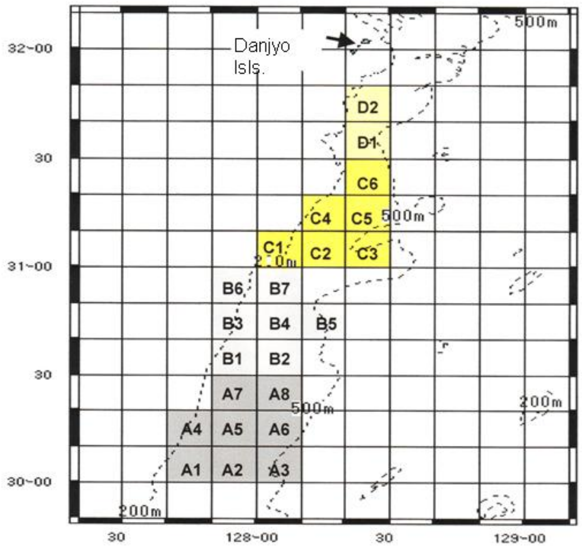
- Wire rope length : 1,500 m
- Compound rope length : 100 m
- Towing time : 2 hrs/haul
- Ship speed at towing : ca. 3 kt /h
- Distance between both boats at towing: ca. 450 – 480 m
- Opening size of the net at towing:
  height (4 – 5 m)
  distance between wing nets of both sides (ca. 30 m)



Area 1 & 2: communal fishing grounds between Japan and China

Methods

Survey area



- **Survey period: 21 Jul. – 16 Aug. 2008**
- **23 sub-areas in the survey area**
- **Area of each sub-area: 10´long. X 10´lat.**
- **3 to 4 net hauls/day/sub-area in daytime**
- **2 hrs haul/station**

Handling of fishes captured

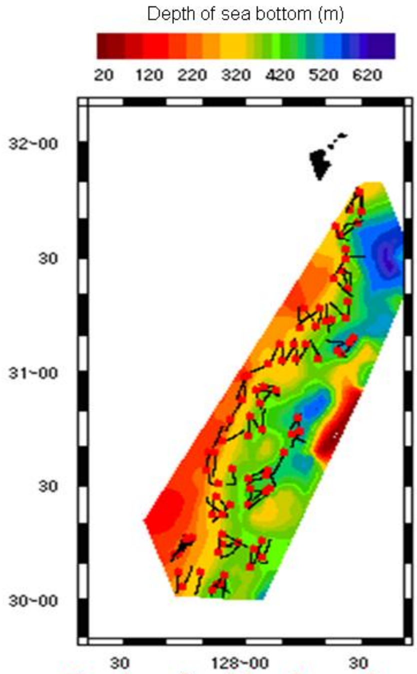
- Only marketable fishes were sorted on board.
- The unmarketable were thrown away on board.
- Total weight of capture fishes in each haul were estimated by the number of fish trays for each species sorted and the unsorted.
- When a tray is not fully occupied, the weight of fishes in the tray is measured with an electric balance on board.
- Body length for maximum 50 specimens of each selected species captured were measured by punching for 2 to 3 hauls/day .
- Trays with sorted fishes were stored in chilled room (around 0℃) and landed on a fish market for auction every one week.

Sorting table in lower deck

Electric balance

Chilled room

Landed fish trays in the market



Tracks of net hauls and topography of sea bottom

Black lines and red circles indicate net track and starting point of net haul respectively.

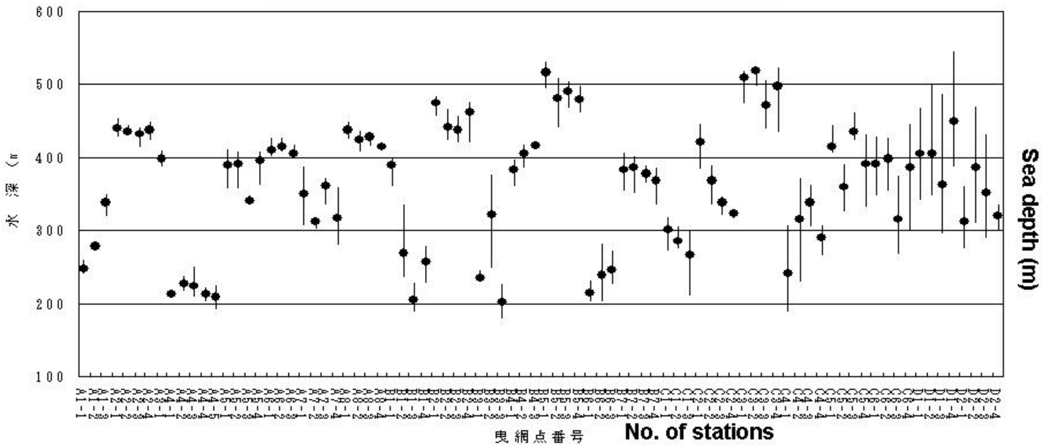
Results

Net hauls conducted - 1

- Net shootings were done after searching trawlable area with aid of the Side Looking Sonar and normal echo sounders.
- 84 net hauls including 2 hauls in night-time were conducted.
- 4 of 84 hauls had a net trouble such as catch of sea bottom by compound rope, but adjustment of speeds of fishing boat and trawl winch resolved them.
- Net haul in the same depth zone was difficult in some stations where hauling track sometimes traced across the zone or turned.

The topography was figured on the basis of 6283 data sets of ship position by GPS and sea depth by echo sounder with GIS software.

Net hauls conducted - 2



Sea depth change during net hauling in each station

Upper and lower tips of bar: minimum and maximum depth; solid circle: average depth

No. of net hauls in sea depth zones

- 200 m: 19
- 400 m: 28
- 300 m: 33
- 500 m: 3

In some stations large gap (>100m) between min. and max. sea depths at hauling appeared.

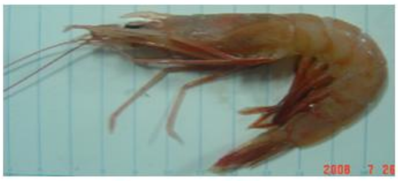
Estimated total catch for each landed species - 1

Species	Catch (kg)	%
Common squid	3,197	7.0
Seaperch	2,990	6.6
Japanese splitfin	2,732	6.0
Rockfish	2,518	5.5
Rosy seabass	2,182	4.8
Mirror dory	2,175	4.8
Blackspotted gurnard	1,348	3.0
Indian driftfish	1,212	2.7
Deep sea shrimp	1,003	2.2
Rattails	885	1.9
Deepsea smelt	790	1.7
Other fishes	748	1.6
Octopus	540	1.2

Landed fishes (1)

Common squid
Todarodes pacificus

Japanese splitfin
Synagrops japonicus



Deep sea shrimp
Haliporoides sibogae

Seaperch
Malakichthys wakiyae

Mirror dory
Zenopsis nebulosa

Rattail
Caelorichus sp.

Rosy seabass
Doederleinia berycoides

Rockfish
Helicolenus ferorovi

Blackspotted gurnard
Pterygotrigla hemisticta

Deepsea smelt
Glossanodon semifasciatus

Estimated total catch for each landed species - 2

Species	Catch (kg)	%
Silver chimaera	521	1.1
Gnomefish	518	1.1
Silver eye	514	1.1
Gurnards	378	0.8
Japanese lobster	314	0.7
Armoured cusk	281	0.6
Coffinfish	240	0.5
Deepwater scorpionfish	159	0.3
Stargazer	139	0.3
Channel scabbardfish	135	0.3
Blackedge greeneye	128	0.3
Watchman prawn	105	0.2
Scorpionfish	104	0.2

Landed fishes – (2)


Silver chimaera
Chimaera phantasma


Gnomefish
Scombrops boops


Silver eye
Polymixia japonica


Stargazer
Xenocephalus elongatus


Coffinfish
Chaunax abei


Deepwater scorpionfish
Setarches guentheri


Japanese lobster
Metanephrops sagamiensis


Chanenel scabbardfish
Evoxymetopon taeniatus


Japanese lobster
Cervimunida princeps


Scorpionfish
Scorpaena neglecta

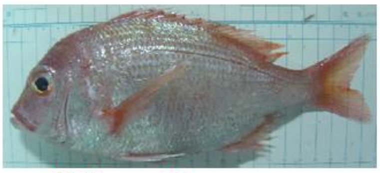

Blackedge greeneye
Chlorophthalmus acutifrons


Armoured cusk
Hoplobrotula armata

Estimated total catch for each landed species - 3

Species	Catch (kg)	%
Yellow sea bream	94	0.2
Goosefish	92	0.2
Japanese armorhead	70	0.2
Daggertooth pike conger	66	0.1
Cuttlefish	64	0.1
Slender frostfish	62	0.1
Other deepsea shrimp	54	0.1
Longfinned bullseye	39	0.1
Japanese gissu	11	0.0
Japanese angelshark	8	0.0
Red sea bream	2	0.0
Unlanded fishes (discards)	19,099	42.2
Whole total catch	45,517	100.0

Landed fishes – (3)


Yellow sea bream
Dentex tumifrons


Japanese armorhead
Pentacerous japonicus

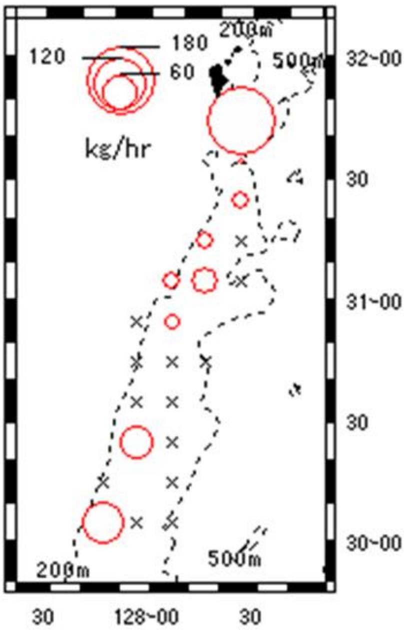

Goosefish
Lophius litulon


Daggertooth conger pike
Muraenesox cinereus

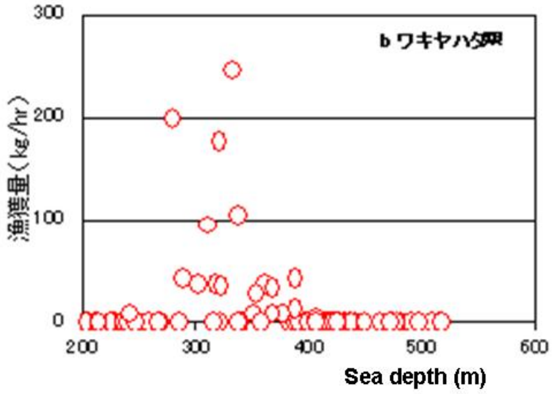

Longfinned bullseye
Cookeolus japonicus


Japanese gissu
Pterothrissus gissu

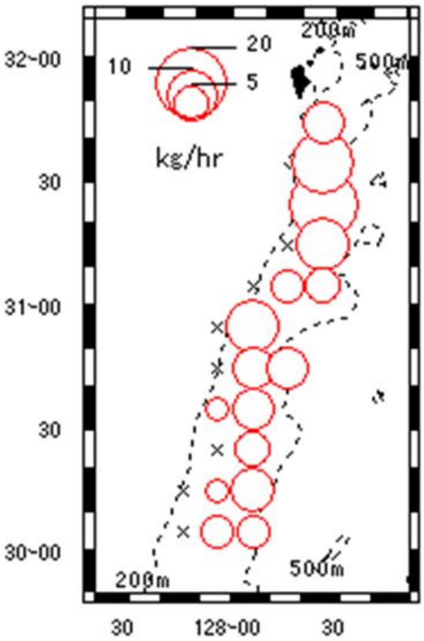
Distribution and capturing sea-depth zone - 1



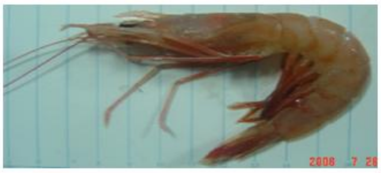
Seaperch
Malakichthys wakiyae

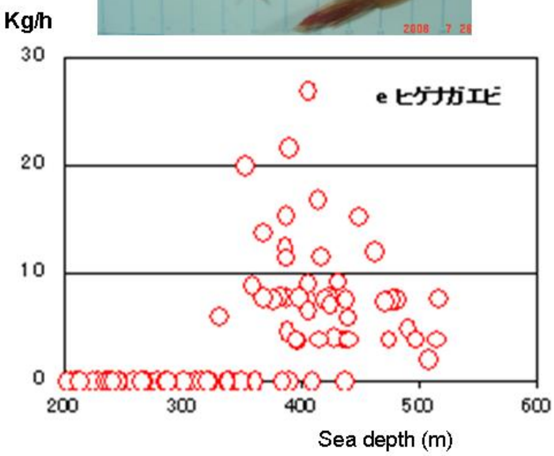


Distribution and capturing sea-depth zone - 2

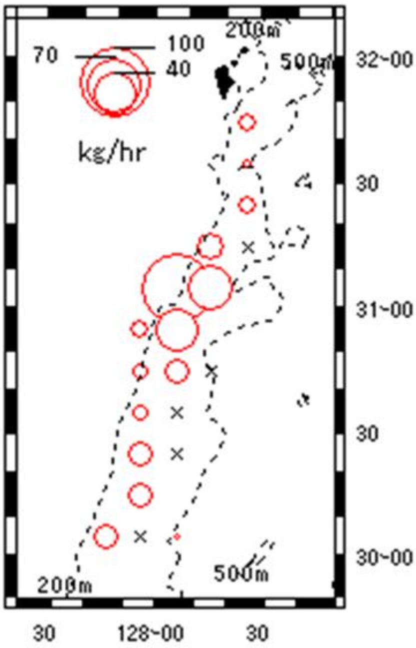


Deep sea shrimp
Haliporoides sibogae



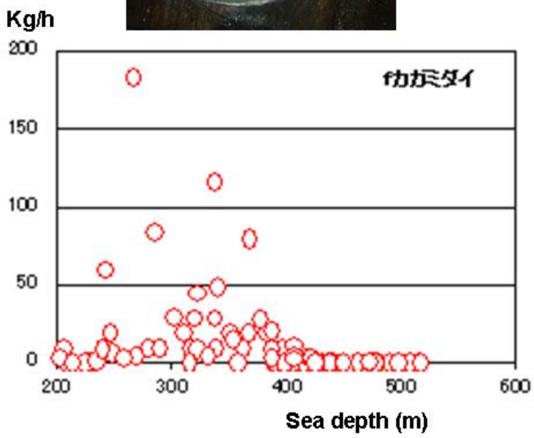


Distribution and capturing sea-depth zone - 3

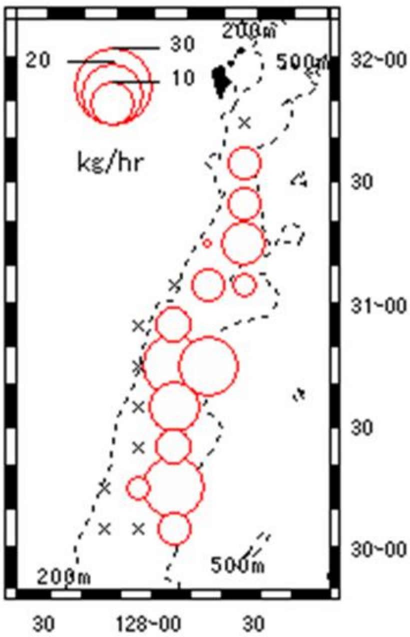


Mirror dory

Zenopsis nebulosa

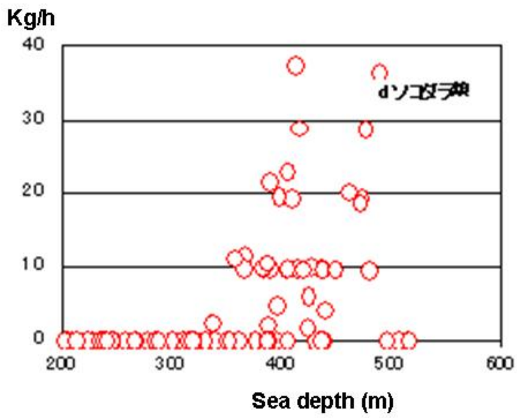


Distribution and capturing sea-depth zone - 4

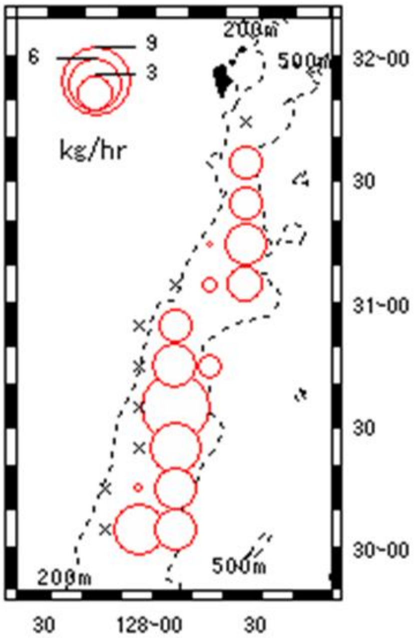


Rattails

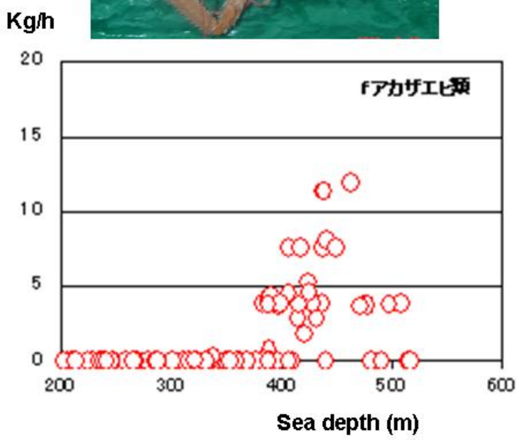
Macrouridae spp.



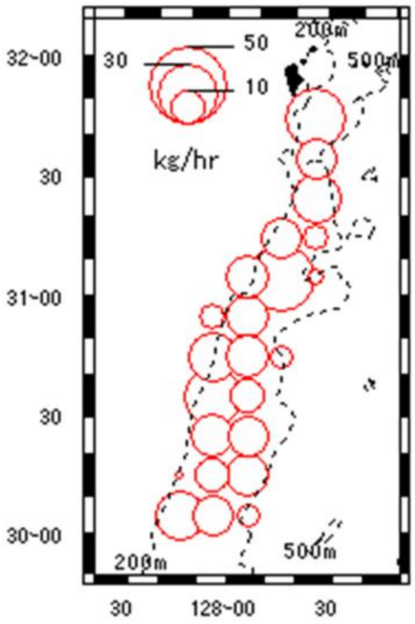
Distribution and capturing sea-depth zone - 5



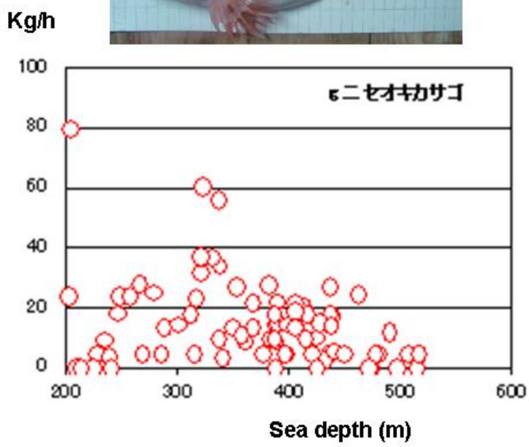
Japanese lobster
Metanephrops sagamiensis



Distribution and capturing sea-depth zone - 6



Rockfish
Helicolenus ferorovi



Distribution, abundance, capturing sea depth and maximum catch per hour for 15 selected species

Species	Major capturing area			Capturing sea depth (m)	Maximum catch (kg/h)
	North	Middle	South		
Blackedge greeneye	++	+		200-400 (300)	20
Seaperch	++	+	+	200-400 (300)	248
Silver eye	++	++	+	300-500 (300)	30
Deep sea shrimps	++	++	+	300-500 (400)	27
Armoured cusk	+	++	+	200-400	69
Mirror dory	+	++	+	200-400 (300)	124
Rosy seabass	+	++	+	200-400 (300)	77
Gnomefish	+	++	+	200-400	20
Blackspotted gurnard	+	++	++	200-300 (200)	88
Common squid	+	++	++	200-500 (300)	130
Rattails	+	++	++	300-500 (400)	37
Deepsea smelt		+	++	200-400 (300)	205
Japanese splitfin	+	+	++	300-500 (400)	89
Japanese lobster	+	+	++	400-500 (400)	12
Rockfish	++	++	++	200-500 (200-300)	30

( ): major capturing sea depth; North: 31° 10'- 31° 50'; Middle: 30° 40' - 31° 10'; South: 30° 00' - 31° 40'

Unit price and catch in value of selected species landed on the Nagasaki Fish Market - 1

Species	Unit price (JPY/kg)	Catch in value (JPY)
Rosy seabass	854	1,785,100
Rockfish	190	511,100
Seaperch	180	387,700
Japanese lobster	1,352	354,000
Deep sea shrimps	388	346,200
Common squid	79	275,600
Others	147	209,300
Gnomefish	283	127,600
Armoured cusk	548	122,500
Mirror dory	45	91,300
Blackspotted gurnard	48	55,100

Species in red color are not familiar in the fish market

Unit price and catch in value of selected species landed on the Nagasaki Fish Market - 2

Species	Unit price (JPY/kg)	Catch in value (JPY)
Searobin	80	37,300
Silver chimaera	129	30,000
Indian driftfish	30	28,000
Silver eye	49	22,900
Deepsea smelts	40	18,300
Japanese splitfin	30	18,200
Rattails	25	13,800
Blackedged greeneye	43	5,800
Whatchman prawn	63	4,000
Coffinfish	50	3,500
Whole total catch		4,447,300

Species in red color are not familiar in the fish market

Conclusions - 1

1) 84 net hauls were conducted in the continental slope of the northern East China Sea with a paired commercial bottom-trawl fishing boat from 22 July to 16 August 2008.
2) Net troubles such as catch of rock by net rope were quite small in number in spite of rough sea bottom topography in the survey area.
3) Estimated whole total catch including the discard (42% of total catch) was 45,517 kg.
4) The largest catch in quantity landed was common squid and follows seaperch, Japanese splitfin, rockfish, rosy seabass and so on. Total catch of the top 9 species occupied about 43% of the whole landed.

Conclusions - 2

5) 29 species of fish, 3 crustacean and 3 cephalopoda were landed on the Nagasaki Fish Market. Whole total catch in value was 4,447,300 JPY.
6) Of which 93% was occupied by the top 9 species, namely rosy seabass, rockfish, seaperch, Japanese lobster, deep-sea shrimp, common squid, others, gnomefish and armoured cusk.
7) Since deep sea shrimp, deepsea smelt, balckedge greeneye and some rattails have never been landed in the Nagasaki Fish Market, market prices of those except deep sea shrimp were quite low (these are in high or reasonable market price in other region).

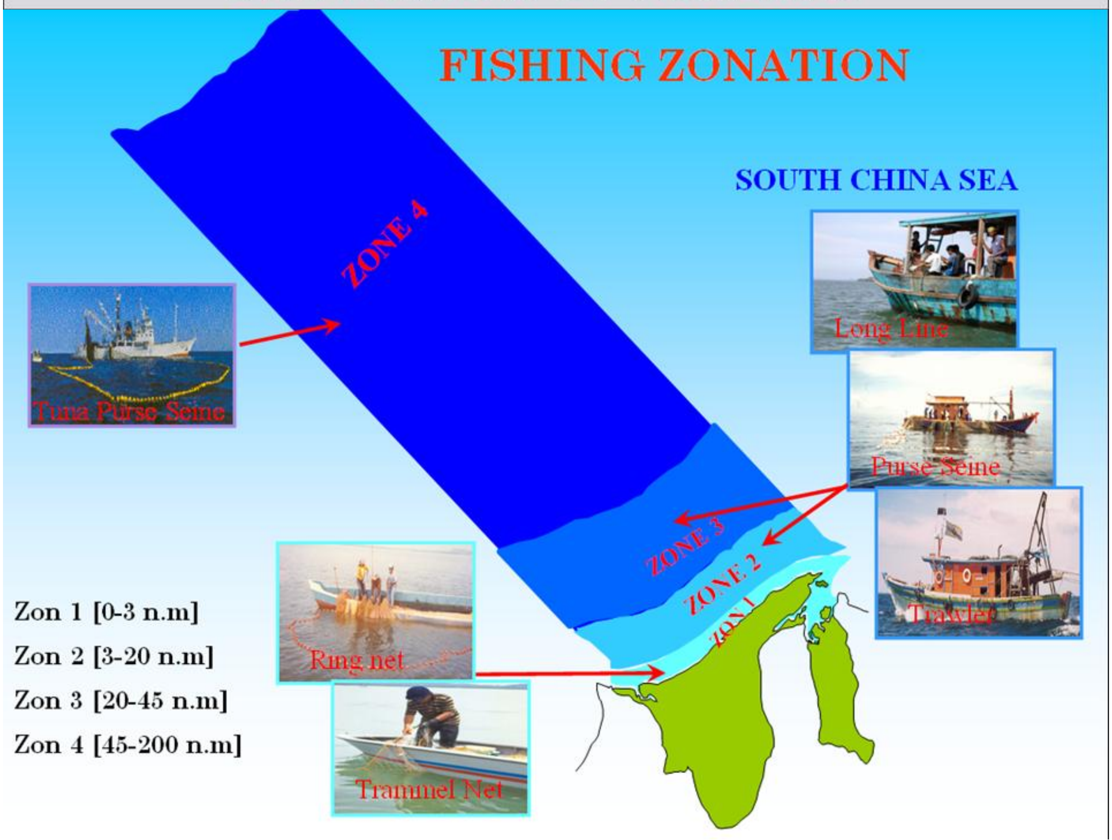
Conclusions - 3

8) The continental slope area surveyed is possible fishing ground for the commercial pair bottom trawl fishing boat from view point of net operation.
9) Deep sea shrimp is possible new fisheries resources in the area, and should be investigated on ecological aspect for sustainable yield.
10) If the unfamiliar species above in Nagasaki Fish Market get high or reasonable market price, the sea area is possible fishing ground from view point of profitable fishery.

*** The lowest profit line of the Japanese commercial pair bottom trawl fishery in the East China is about 1.5 million JPY/day.**


Thank you for your attention
ミドリフサアンコウの三味揚げ
（ミドリフサアンコウ）
平成調理師研究会
(株)メモリード　稲佐会堂
赤ムツ押寿司
(赤ムツ)
平成調理師研究会
Dishes with unfamiliar f
at the taste party


OFFSHORE RESOURCES
BRUNEI DARUSSALAM
PRESENTED BY
MATZAINI HAJI JUNA
DEPARTMENT OF FISHERIES


FISHING ZONATION
SOUTH CHINA SEA
ZONE 4
Tuna Purse Seine
Long Line
Purse Seine
Trawler
ZONE 3
ZONE 2
Ring net
Trammel Net
Zon 1 [0-3 n.m]
Zon 2 [3-20 n.m]
Zon 3 [20-45 n.m]
Zon 4 [45-200 n.m]

CHARACTERISTIC OF OFFSHORE AREA

- Offshore area covers ~75% of the territorial Waters also known as Zone 4;
- Physical features: largely rough with plenty of deep troughs and depth of > 3,000m.
- The 100-200 meter depth is a very narrow strip (about 2 nm) forming the continental edge with an area of about 120 nm^2 and 40 nm from the shoreline The bottom type is generally muddy on the western side, and rocky on the eastern side.
- The continental slope creeps sharply from the 200 m depth up to about 3,000 m depth of the sea floor towards the Palawan trough that ends in Brunei waters.

INTRODUCTION – DEEP WATER SURVEY

- The survey is in line with the goal of the Department of Fisheries to assess and determine the fisheries potential of the offshelf marine areas of Brunei Darussalam from the continental edge onwards for sustainable fisheries development.

- Aims to provide the most recent information on the deep water demersal marine resources of Brunei Darussalam

OBJECTIVES– DEEP WATER SURVEY

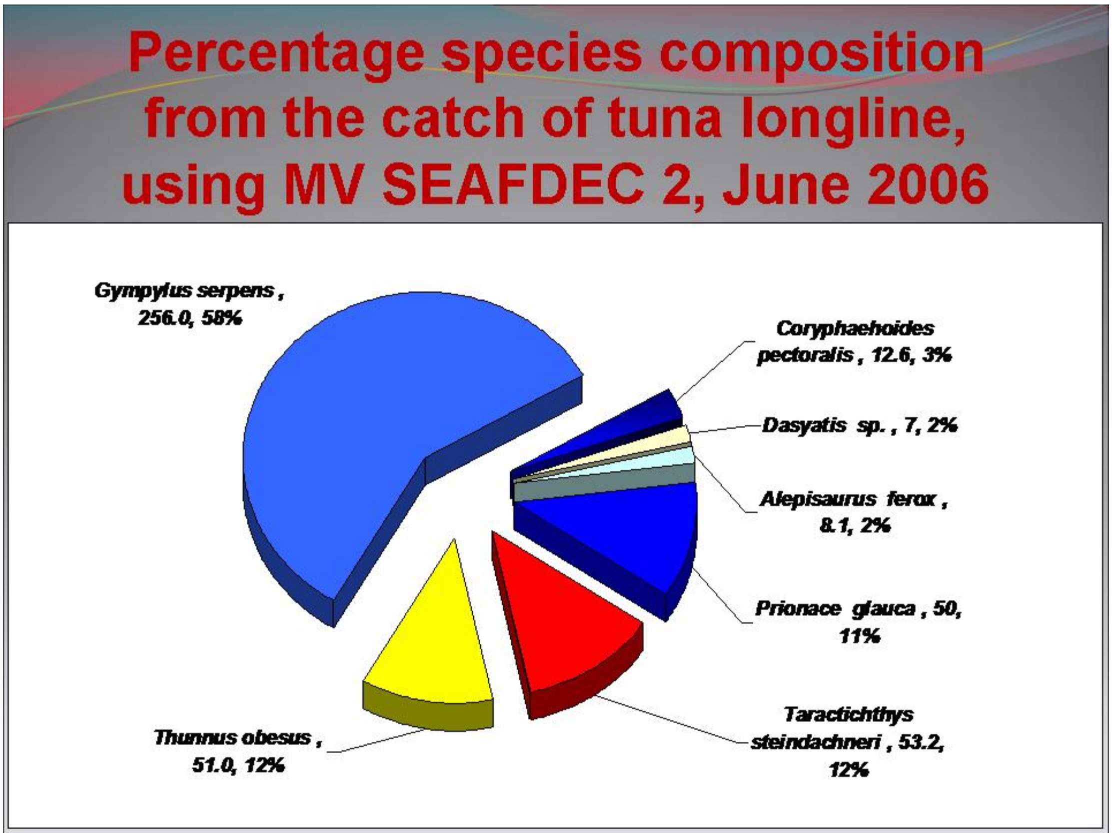
- The main objective of the survey this time is to assess ecological resources including both the **deep demersal and pelagic fisheries resources** in the area that covers zone 4 and to achieve sustainable development of these resources through proper management via the use of scientific data generated by the systematic surveys.

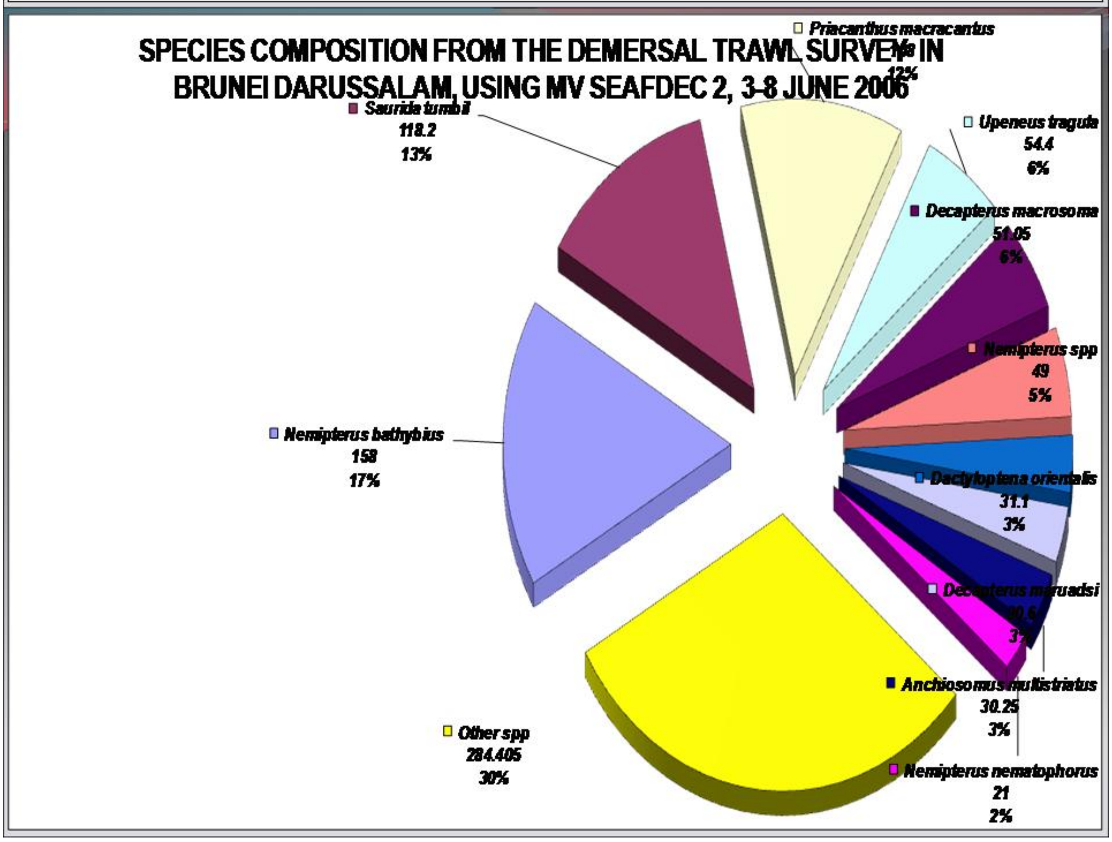
- To assess the health of the marine environment of the demersal and pelagic fish stocks in the offshelf marine areas by conducting oceanographic survey simultaneously with the demersal and pelagic surveys

RESEARCH SURVEY AND RESULTS

- To assess the fisheries potential in the offshore areas of Brunei Darussalam, collaborative research surveys with SEAFDEC were conducted from 2004-2006 at depths from 100 to 3,000 m of the EEZ
- Annual surveys have been carried out regularly by Department on the shelf areas at depths of less than 100 m.

- Key results:
- Oceanographic data reveals healthy and normal conditions of the marine environment
- Acoustic data revealed the abundance of large pelagics and other benthic resources


Percentage species composition from the catch of tuna longline, using MV SEAFDEC 2, June 2006
Gympylus serpens , 256.0, 58%
Coryphaehoides pectoralis , 12.6, 3%
Dasyatis sp. , 7, 2%
Alepisaurus ferox , 8.1, 2%
Prionace glauca , 50, 11%
Taractichthys steindachneri , 53.2, 12%
Thunnus obesus , 51.0, 12%


SPECIES COMPOSITION FROM THE DEMERSAL TRAWL SURVEY IN BRUNEI DARUSSALAM, USING MV SEAFDEC 2, 3-8 JUNE 2006
Priacanthus macracantus
12%
Saurida tumbil
118.2
13%
Upeneus tragula
54.4
6%
Decapterus macrosoma
51.05
6%
Nemipterus spp
49
5%
Nemipterus bathybius
158
17%
Dactyloptena orientalis
31.1
3%
Anchiosomus multistriatus
30.25
3%
Other spp
284.405
30%
Nemipterus nematophorus
21
2%

Sampling stations covered for the deep bottom trawl survey, June 2008

RESEARCH SURVEY AND RESULTS - 2008

Deep-water otter-board trawl

- Survey and indicates the fish density along the continental slope ranging from 0.63 to 1.53 mt/km2 among the valid hauls with an average of about **1.18 mt/km2**.
- The value is slightly lower than the value obtained in the 2006 survey at 1.21 mt/km2.
- The species composition from the deep-water demersal trawl is dominated by the lizard fish, *Saurida tumbil* and nemipterids with 15% and 12 % respectively of the total catch. The catch composition is almost similar with the 2006 survey.

Sampling stations for the beam trawl survey – June 2008

RESEARCH SURVEY AND RESULTS - 2008

- The beam trawl survey on the other hand resulted in a lower density of fish at **0.64 mt/km2** mainly due to a smaller sampling gear coverage.

- The species composition of the beam trawl is analyzed according to the sampling depths. The species composition of the 105-163 meter depth is almost similar with the demersal trawl catch composition.

RESEARCH SURVEY AND RESULTS - 2008

The species composition from the lower continental slope from the 215-374m depth stations were almost entirely different consisting of deep-water fishes that were dominated by silverbelly seaperch at 12.4%. It is followed by other deep water species including lantern fish and beardfish at 9.8% and 9.7% respectively.

- Surprisingly, a significant amount of deep water **shrimps and** crustaceans (7.0%) were found in the 215-374 m depth catch. It includes *Heterocarpus sp, Plesionika sp., Parahempomadus sp., and Metanephrops sp to name a few.*
- These rare species were also found in the deep waters of the neighboring countries like the Philippines, Malaysia and Indonesia.

DEEP WATER SHRIMP

Plesionika sp.

Parahempomadus sp.

Metanephrops sp.1

Heterocarpus sp

Experimental fishing/joint ventures

- Trial fishing in Brunei's EEZ on board the Japanese commercial fishing boats in 2000 and 2001. Gears used were tuna longline, bottom-set gillnet, squid jigs and pots;

- Key Results :
- A total of 8.41 mt of fish were caught by longline comprising of yellowfiin tuna, bigeye tuna, blue marlin Dorado and sharks

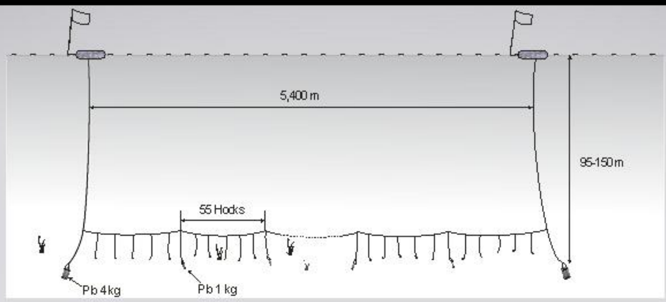
Current commercial fishing

- Currently, 2 licenses for tuna long line and 2 tuna purse seiners are available for the exploration of the offshore areas; the vessel specification is restricted to those vessels with capacity between 150-200 GT and with the engine power between 600-800 hp. Such fishing venture offer had been open since 2000 however to date, there are still no takers.

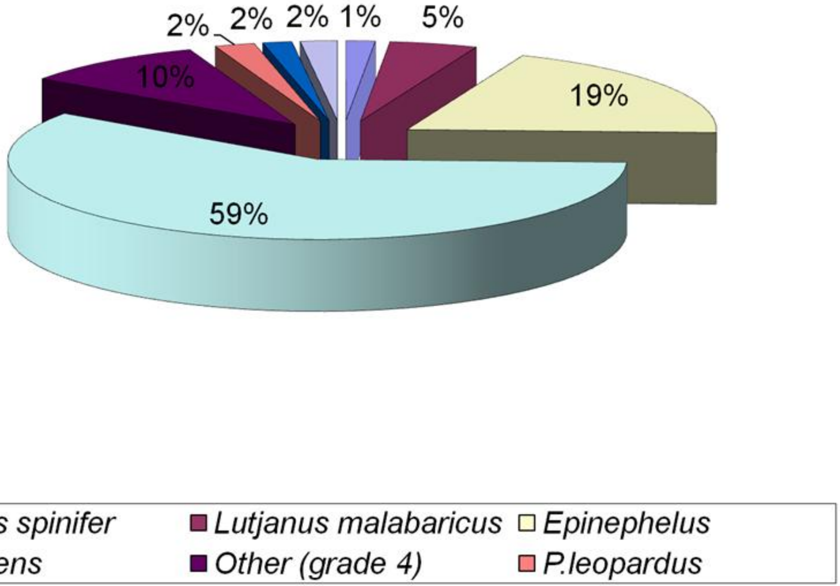
- 3 licenses for bottom longline operator, operated from the depth of 76- 215 meter.

- Small scale fishing – hook and line.

COMMERCIAL FISHING - LONGLINER



SPECIES CAUGHT BY BOTTOM SET LONGLINE (100-150 M DEPTH) - 2008



CONCLUSION

- Brunei Darussalam has a relatively short history of quantitative and systematic fisheries research especially in the offshelf areas as evidenced by the paucity of published works. Therefore the surveys with MV SEFADEC 2 aim to provide the most recent information that is needed in the rational management of the demersal and pelagic resources of the offshore areas.

- Valuable oceanographic data were generated to validate previous information collected in the past to determine any changes that can influence the plankton and fish biomass of the marine resources.

RECOMMENDATION

- It is important to do resource assessment procedures together with oceanografic and marine environment assessment includes the use of hydroacoustic system, the ICTD oceanographic sampler and Bongo plankton net determine any changes that can influence the plankton and fish biomass of the marine resources.


THANK YOU
© 2001 National Geographic Society. All rights reserved.
nationalgeographic.com

DEEPSEA DEMERSAL AND PRAWN RESOURCES EXPLORATION SURVEYS IN INDONESIA

Bambang Sumiono
Research Institute for Marine Fisheries
Jalan Muarabaru Ujung, Jakarta-14440, Indonesia
email bsumiono@yahoo.co.id

INTRODUCTION

Approximately two third of the Indonesia region, or about 5.8 million km^2 is covered by water. Located in the tropics, the Indonesian waters are regarded as one of the highest biodiversity region in the world. This region with its natural resource potentials, however, it has been given little attention by previuos administrations to be one of the bases for its national development. Data and information on marine resources and its environmental condition, their potentials and its utilizations are in high demand to be used as basic for decision making process for government policy, marine industries and other related marine activities. Currently, the data and information on the above mentioned matters are scanty and should be up dated especially for marine fisheries. This condition becomes more critical in the deepsea region, although this region occupies approximatelly 40 % of the Indonesian seawaters. Furthermore, attention from existing institutions and respective agencies on deepsea region are at the lower end of their priorities. The deepsea region is defined as the seawaters beyond the jurisdiction line of 12 nautical miles from the coastline, i.e. including the Indonesian Economic Exclusive Zone (IEEZ) and international seawaters, and/or the seawaters with a depth of more than 200 m or beyond the continental shelf.

Exploitation of fishery resources has benefited the country and its people. Some of resources in the depth region less than 200 m has been studied and exploited. On the other hand, the deepsea resources are still underutilized. Many fishery resources in coastal or shallow waters in the region appear to have been heavily exploited. Some stocks, especially demersal fish resources in shallow waters are believed to have been over exploited, and many small pelagic fish resources are in the state of fully exploited. This paper give an information on the species found, their distribution and their biology of the deepsea demersal and prawn based on exploratory research in the waters of Indonesia

RESEARCH

One of the challenge and opportunity research on the fishery is the ability of science and technology for exploiting and developing of new commodities or frontier commodities as an alternative utilization of marine fishery resources in the future. Deepsea demersal and prawn is one of the resources has not been utilized yet as quickly as those in tropical neighbouring countries. Indonesia is expected to have significant contribution in the development of deepsea fishery resources, particularly in the Pacific and Indian Ocean region. Judging the above rationale, research needed should have the accountability and sustainability in order to support the development and management strategies of their fisheries. The application of inconventional technology which stress the fishing method and acoustic method are very much needed. This technique is suitable for deepsea resources exploration and their environment.

On the other hand, the lack of the adequate information on this resources create difficulties to make fuller utilization of the fish resources. Particular the deepsea demersal and prawns lack a clear identification of their resources and even almost unknown and unexploited. From this realities, some joint research effort were carried out by the marine research institute of government of Indonesia with other institutes/agencies from other countries. The main areas of the research were Indian Ocean, Arafura Sea and Timor Sea.

1. Indian Ocean

Deepsea trawl surveys were first initiated on the Indian Ocean subareas of south off Java in 1972 and 1975 with assistance from Fisheries Research and Development Agency Office of Fisheries, Busan, Korea, under a bilateral agreement (Anonymous, 1973; Anonymous, 1975).

During 1979-1981, the joint exploratory fishing and stock assessment for demersal fish were carried out by the Government of Indonesia, The Federal Republic of Germany, the Commonwealth of Australia and the FAO/UNDP as Coordinating Agency through the Jetindofish Project. The survey area covered Indian Ocean sub areas of South off Lombok Island to Eastern off Timor in the main depth between 50m to 200m (Lohmeyer, 1982).

Pelagic and bottom trawl, surveys were conducted in the Northern and Western Sumatera waters by aggreement between the Government of Indonesia and the FAO/SCSDEVPRO. The surveys were carried out from August 6 to 30, 1980 by using RV Fridtjof Nansen (491.81 GT)(Aglen *et al*., 1982).

During the 2004 and 2005, Research Institute for Marine Fisheries (RIMF) of the Government of Indonesia had in association with Overseas Fishery Cooperation Foundation (OFCF) of Japan assisted in surveying the deepsea fishery resources in the waters deeper than 200 m in the Indian Ocean. Investigation during 2004 of the South off Java and west off Sumatera gave a bathymetry of the area to know the actual depth and bottom topography of the area, and an exploratory fishing with deepsea trawl to know the kind and distribution of the resources. In 2005 an assessment of the deepsea trawl –fish stock of South off Java and off South Sumatera was implemented. The fish trawling provided additional information on the species distribution and size of the stocks; biological and morphometric data were also collected (Anonymous, 2006).

2. Banda Sea and Arafura Sea

Deepsea bottom trawl and beam trawl surveys for demersal fish and prawn resources were conducted in the eastern part of Indonesia mainly in the Banda Sea and Arafura Sea in 1992 and 1993. The research vessel Baruna Jaya-I (700 GT) of Agency for The Assessment and Application of Technology, Indonesia was used in this survey.

(Sumiono & Iskandar, 1993; Soselisa *et al*., 1993; Wudianto & Barus, 1993; Sumiono, 2001). The main aims of both surveys were locate unexploited stocks of fishes and prawns in the waters of the outer continental shelf and slope, to identify species with commercial potential, and to evaluate species disribution. The depth range to be covered between 200 m and 1000 m.

Research on fishing technique of deepsea trap was conducted in both areas during February to March 1993. The aim of the research was to obtain the efficient fishing technique and the performance of the traps in the waters (Amin *et al*., 1993).

Investigation of bottom longline fishing in 2000-2004 of the Arafura Sea continental slope demersal stocks gave a first estimate of the catch composition and hook rate of some groupers and snappers. The fishing ground and fishing operation during investigation carried out in the depth between 50-200 m (Badrudin *et al*., 2004; Badrudin *et al*., 2005)

3. Timor Sea

Following the promising catches of commercial deepsea demersal fish and prawn resources by CSIRO Australia off the North West Shelf in 1982-1983 (Davis & Ward, 1984; Phillips & Jernakoff, 1991) and Jetindofish Cruises in 1980-1981 (Lohmeyer, 1982), a survey in the Indonesian Economic Exclusive Zone (IEEZ) was made in February-March 1993 by RV Baruna Jaya-I (700 GT). The survey was conducted in slope waters between 200 m to 1000 m deep extending from Timor trench at about 125^{o}35' - 127^{o}24'E and 10^{o}16'- 09^{o}37'S (Sumiono & Iskandar, 1993; Soselisa *et al*., 1993; Wudianto & Barus, 1993).

FISHING

1. Deepsea Trawl

The initial trawl survey in Indian Ocean was conducted in 1972 by RV Oh Dae San (1126.59 GT) covered 20-290 m deep. The size for each otter board was 3.4 m x 2.2 m, weight in the air 2300 kgs. All trawl surveys were carried out with an otter trawl net with a cod-end mesh size of 1.75 inch, headrope of 50 m and ground rope of 63 m. In usual fishing operation, the lengths of the warp were 3.1- 3.2 times of the depth at 100 - 300 m and 2.5 - 2.6 times in the depth of more than 300 m. Net heigt was measured by the echo record of foodrope or lower panel of the net. Towing speed was measured by ship's speed meter in bridge and the trawling speed was regulated between 2.5 to 3.5 knots.

The head rope lengths of the nets used during survey by RV Tae Baek San (309.85 GT) in the sub areas of Western South Sumatera and Southern Java was 45 m and the ground rope was 49.5 m for the type of 148 feet net, and 43 m of the head rope and 47.0 m of ground rope for the type of 130 feet net. The otter boards were flat plate type and each size 2.29 m x 1.23 m for both type of the net. The average trawling time per haul was one hour. Meanwhile the bottom trawl used by RV Fridtjof Nansen (491

GT) in the sub area of Western Sumatera had footrope of 47 m in length with opening width of about 6 m.

Deepsea exploration survey in the Indian Ocean sub areas of Southern Java and Western Sumatera during 2004 and 2005 were used trawl net 6 seam type with head rope of 31.6 m and ground rope of 37.4 m. Fishing was conducted during daytime. The net was towed for 30 minute at about 2 knots.

Beam trawl already used for fishing in the Arafura and Timor Sea. The mouth of beam trawl was 4.15 m with material used of the net was PA meshed of 12-15 mm. According to Wudianto & Barus (1993), three important factors determined the successful haul of beam trawl, i.e. the weigt of sinker, the length of warp and vessel’s speed.

2. Deepsea bottom long line

Bottom long line fisheries (BLL) in the continental shelf area of the Arafura Sea has been practised and developed since the last two decades. But bottom long lining in the slope area seemed to be unusual fishing operation for most Indonesian fishers as this fishing activity facing a relatively higher risks of fishing gear lost.

In search of new resources and fishing grounds, the Research Center for Capture Fisheries in collaboration with a private fishing company based in Jakarta carried out an exploratory bottom long lining survey in the Arafura Sea covering both the continental shelf flat and slope areas and a wide range of depth started from around 30 m to approximately 700 m. BLL fishing activities were carried out in the continental shelf area of the Arafura Sea, using M/V Ural, a Russian fishing vessel chartered by the Indonesian fishing company based in Jakarta. The activity was carried out in May-July 2004. Fishing gear used was bottom long line with the number of hook between 6900 to more than 11000 hooks, with the distance between hooks was about one meter. The setting time will last some hours and therefore the number of setting was only once per-day. BLL was randomly set covering the bottom area of both the continental shelf part which relatively flat bottom conditions and the slope part of the Arafura Sea.

3. Traps

There is little available literature regarding the exploitation of deepsea by the use of traps. In 1993, the trap fishing exploratories in the Arafura sea and Timor sea were accomplished aboard the R.V. Baruna Jaya-I. Three types of trap operated were folding trap, cylindrical trap, and trapezoid trap. Towing and hauling were carried out in the stern. Towing time for 30 traps about 6 minutes and the vessel speed about 3 knots. Soaking time was about 24 hours. Traps were set along transects by allowing the vessel to drift with the current and/or wind. Those traps were simultaneously operated with interval of 18 m. The result shows that the type of cylindrical and folding traps were more suitable for catching deepsea prawns instead of trapezoid trap (Barus & Wudianto, 1993). Scad, mackerel or head of tuna was used as bait of the trap (Amin *et al.*, 1993). Catch rates of the depsea prawn were still very low, i.e. 10.6 kg/30 trap/day and was dominated by *Heterocarpus woodmasoni*. Chub mackerel bait seems to be effective for prawn and demersal fish

SPECIES FOUND

1. Stock Assessment Method

The entire catch of trawl was sorted into respective species immadiately after retrieving the net and was counted and weighted by species. When a large quantity was caught, total weight was determined firstly. Next, a suitable small portion was taken rhandomly as asplit sample. The split sample was sorted into species to be measured and counted, than was raised to the total catch. The data were recorded in the fishing log sheet. Length frequency data for the important species of fish, prawn and other biota collected should be recorded. Length-weight data and some biological observation were also recorded.

Estimation of stock density and standing stock size in the trawl survey was carried out by using the swept area method following (Saeger *et al.*, 1976; Sparre & Venema,). The assumption that the constant mouth openning of the trawl was 50% of the head rope length and escapement factor was 75%. The swept area method was calculate the size of the stock density of the fish. This method assumes that the catch per unit effort is proportional to the stock density within an area. Indicated stock density (D) for each trawl is D = catch in kg / (swept area in km x C), where C = catchability coefficient.

Catch rate in the BLL fisheries also known as hook rate, provides one of the stock abundance index reflecting fish stock density. Catch rate was obtained from the number of catch per setting per 100 hooks (Gulland, 1983).

Species identifications were done following Nakabo (2000), Gloerfelt-Tarp & Kailola (1985) and (Carpenter & Niem, 1999; 2001a; 2001b;2001c).

2. Catch Rate and Catch Compositions

2.1 Deepsea trawl

Marine resources which are still less exploited are those in deep waters of Indian Ocean and other part of Indonesia. Resource surveys have been conducted in various part of the Indian Ocean (Anonymous, 1973; Aglen *et al.*, 1981; Lohmeyer, *1982*). The result indicates that density of demersal stock in Indian Ocean is lower that of the Java Sea and the fish density tend to increase toward the coast. Concentration of crustacean was detected by R.V. Oh Dae San of being *Solenocera prominentis* at depth of 210 m in the South of Central Java. Lohmeyer (1982) found relatifely large amount of shrimp at depth of 200-300 m. According to Anonymous (1985), Australian scientist was able to locate concentration of deepsea prawn (Scampi, *Metanephrops* spp.) at the depth of 300-500 m of Northwest Australia which become commercial operation although in limited amount.

Deepsea prawn survey in the Arafura sea and Timor Seas showed that the highest stock density of 1.97 tons/km^2 was occurred in the depth ranging between 400-400 m and the lowest of 0.28 tons/km^2 in the depth ranging from 700-800 m. Based on geographical distribution, catch rates of Caridean prawn and marine lobsters i.e. *Aristeus virilis*, *Heterocarpus woodmasoni*, and *Metanephrops sibogae* ("Scampi") tend to decrease from Arafura sea to Timor sea, but *Aristeomorpha foliacea* tend to increase (Sumiono & Iskandar, 1993). Stock density estimation of demersal fish in the depth between 200-1000 m were in Arafura sea sub area of Tanimbar 0.475 tons/km^2 and ZEEI of Timor Sea 0.294 tons/km^2. Four families that were dominant in total catch were Macrouridae, Myctophidae, Ophidiidae and Alepocephalidae (Soselisa *et al*., 1993).

The last survey (2005) in the Indian Ocean sub area of Southern Java showed that the catch composition of deepsea demersal fish were dominated by family of Ophidiidae (38.2 % of total catch), Plesiobatidae (20.3 %), Acropomatidae (6.2 %), and Trichiuridae (5.7%). Based on geographical distribution, *Trichiurus lepturus*, *Plesiobatis* sp. *and Lamprogrammus niger* are widespread in the southern Java. The main concentrations of genera Trichiurus and Plesiobatis were in the sub area of Cilacap-Yogyakarta in the depth between 200-500m. Meanwhile, the genera Lamprogrammus distributed in the area of Yogyakarta-Pacitan in the depth between 500-750 m. Catch rates analyses shown the highest density of 13,6 kg/km^2 occurred in the depth ranging between 750-1000 m and the lowest of 1,7 kg/km^2 in the depth ranging of 500-750 m. The highest relative abundance (CPUE) of major species by depth was 629.4 kg for *Lamprogrammus niger* in the depth of 200-500 m, and the lowest number of 36 kg for *Trichiurus lepturus* in the depth of 500-750 m (Sumiono, 2009).

Analysis of fish resources in the sub areas of Western Sumatera indicated that the lowest density of about 0.08 tons/km^2 was observed in the depth zone of 751-1000 m in the waters of the north-western part of Simeuleu and the highest density of 17.7 tons/km^2 was occurred in the depth zone 500-750 m in the waters of the western part off Banda Aceh. The most importance species in term of numbers were the lantern-fish, *Diaphus sp.1*, the rat-tails macrourid, *Caelorinchus divergens,* the neoscopelids, *Neoscopelus macrolepidotus*, the spinyfins, *Diretmoides pauciradiatus*, the alepocephalid, *Bajacalifornia erimorensis* and the trachichthyds *Haplostetus crassispinus* (Badrudin *et al.*, 2006).

2.2 Deepsea Bottom Long Line

BLL survey in the Arafura sea showed that the total number of hooks used in the flat area was almost one and half times higher than in the slope area, while the overall total catch in the slope area was almost four times higher than the catch obtained in the flat area. The overall total catch in the slope area was about 16,9 kgs (approx. 17.0 tons) while the catch in the flat area was only 4.5 tons. Similarly, the catch rate in the slope of about 1.3 tonnes was more than four and half times higher that the catch rate in the flat area which was only about 0.28 tons. Higher variation of catch/setting in the flat area was occurred, while in the slope area was relatively lower.

From this composition data it can be concluded that more than 75% of bottom long line catches consisted of red snappers, groupers and sharks & rays. The most dominated red snappers species found in the catch were goldband snappers, *Pristipomoides spp*. (*P. multidens* and *P. typus*), red snappers, *Lutjanus spp*., jobfish (*Etelis carbunculus*), john snapper (*L. johni*) and emperor red snapper (*L. sebae*), while groupers consisted of *Epinephelus microdon, E. amblycephalus, E. maculatus,* and *E. retouti*. (Badrudin *et al.*, 2005)

REFFERENCES

Aglen,A., L. Foyn, O.R. Godo, S.Myklevoll & O.J. Ostvedt. 1981. A Survey of the Marine Fish Resources of the North and West Coast of Sumatera, August 1980. Institute of Marine Research , Bergen: 55p.

Amin, E.M., Sudjianto & A. A.Widodo. 1993. Research on Fishing Technique of Deepsea Trap. Journal of Marine Fisheries Research. RIMF, Jakarta (77) : 54-71 (In Indonesian, Abstract in English).

Anonymous, 1973. Report of the Exploratory Operations of Trawl in the Gulf of Siam and Java Sea. Fisheries Research and Development Agency. Office of Fisheries. Busan, Korea. June 1973: 131p.

Anonymous, 1975. Investigation for the Unexploited Fishing Ground in the Adjacent Sea to Indonesia. Fisheries Research and Development Agency. Busan, Korea. March 1975: 82p.

Anonymous. 1985. Licences for Scampi off North-West Australia. Australian Fisheries,44 (3):14p.

Anonymous. 2006. The Japan-Indonesia Deep-Sea Fishery Resources Joint Exploration Project. November , 2005. Project Report. OFCF – RIMF : 151 p

Badrudin, B. Sumiono & S. Nurhakim. 2004. Hook Rates and Composition of Bottom Longline Catches in the Waters of the Arafura Sea. Indonesian Fisheries Research Journal. AMFR. MMAF. Vol 10 (1) : 9-14

Badrudin, N.N. Wiadnyana & B. Wibowo., 2005. Deep-water Exploratory Bottom Long Lining in the Waters of the Arafura Sea. Indonesian Fisheries Research Journal. MFR. MMAF. Vol. 11 (1) : 41-46.

Badrudin, Wudianto, N.N. Wiadnyana & S. Nurhakim. 2006. Deepsea Fish Resources Potential and Diversity in the Waters of Western Sumatera of the Eastern Indian Ocean. Indonesian Fisheries Research Journal. MFR. MMAF : 25 p (Mimeo)

Barus, H.R & Wudianto. 1993. Research on Some Type of Traps for Deepsea Shrimp Fishing. Journal of Marine Fisheries Research. RIMF, Jakarta (77) : 42-53 (In Indonesian, Abstract in English).

Carpenter, K.E. & V.H. Niem (Eds.). 1999. The Living Marine Reources of The Western Central Pacific. Volume 3. Batoid Fishes, Chimaeras and Bony Fishes Part 1 (Elopidae to Linophrynidae). FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organization of The United Nations. Rome.

Carpenter, K.E. & V.H. Niem (Eds.). 2001a. The living Marine Reources of the Western Central Pacific. Volume 4. Bony Fishes Part 2 (Mugillidae to Carangidae) FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organization of The United Nations. Rome.

Carpenter, K.E. & V.H. Niem (Eds.). 2001b. The Living Marine Reources of the Western Central Pacific. Volume 5. Bony Fishes Part 3 (Menidae to Pomacentridae) FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organization of The United Nations. Rome.

Carpenter, K.E. & V.H. Niem (Eds.). 2001c. The Living Marine Reources of the Western Central Pacific. Volume 6. Bony Fishes Part 4 (Labridae to Latimeriidae) Estuarine Crocodiles, Sea turtles, Sea Snakes and Marine Mammals. FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organization of The United Nations. Rome.

Davis, T.L.O. & T.J.Ward. 1984. CSIRO Finds Two New Scampi Ground off the Northwest Shelf. Australian Fisheries Vol. 43 (8): 64p.

Gloerfelt-Tarp, T. & P. Kailola., 1985. Trawled Fish of the Southern Indonesia and Northern Australia. ADAB –GTZ-DGF Indonesia : 406p.

Gulland, J.A., 1993. Fish Stock Assessment. A Manual of Basic Methods. John Wiley & Sons.

Lohmeyer,U.P. 1982. Joint Eastern Tropical Indian Ocean Fishery Survey. Summary Report Module II. Directorate General of Fisheries, Indonesia: 143p.

Nakabo, T. 2000. Fishes of Japan with Pictorial Keys to the Species. Second Edition. Tokai University Press. 2-28-4, Tomigaya, Shibuya-ku, Tokyo.

Phillips,B & P. Jernakoff. 1991. The Northwest Slope Trawl Fishery. What Future Does It Have?. Aust.Fish. Vol. 50 (7): 18-20.

Saeger, J., P.Martosubroto & D.Pauly. 1976. First Report of the Indonesian-German Demersal Fisheries Project (Results of a Trawl Survey in the Sunda Shelf Areas). Special Report. Contrib. of the Dem.Fish.Project. No.1, 1976. Mar.Fish. Res.Inst. Jakarta : 46 p.

Shindo, S. 1973. General review of the trawl fishery and the demersal fish stock of the South China Sea. FAO Fish.Tech.Pap. (120): 49 p.

Soselisa, J, R. Rustam & Badrudin. 1993. Distribution and Potential of the Demersal Deepsea Fishes Resources in the Waters of Kai, Tanimbar and Timor Sea. Journal of Marine Fisheries Research. RIMF, Jakarta (77) : 27-32 (In Indonesian, Abstract in English).

Sparre, P. & S.C.Venema. 1992. Introduction to Tropical Fish Stock Assesment. Part I. Manual. FAO Fish. Tech. Pap. No. 306/1.

Sumiono, B & B.Iskandar PS. 1993. Distribution and Stock Density of Deepwater Prawn in the Weters of Tanimbar and Timor Sea. Journal of Marine Fisheries Research. RIMF, Jakarta (77) : 1-15 (In Indonesian, Abstract in English).

Sumiono, B. 2002. Deepwater Prawn: Biological aspect and distribution in the eastern Indonesian waters. Journal of Indonesia Marine and Fisheries Science. Special Edition: Crustacea. Bogor Agricultural Institute. Vol.II (2): 25-33. (In Indonesian, Abstract in English).

Sumiono, B. 2009. Distribution and Stock Density of Deepsea Fish Resources in the Waters of South off Java. Paper Presented at the Symposium of WOC, Manado, Indonesia 11-15 May, 2009.

Wudianto & H.R. Barus. 1993. Deepsea Shrimp Fishing with Beam Trawl. Journal of Marine Fisheries Research. RIMF, Jakarta (77) : 92-106 (In Indonesian, Abstract in English)

DEEPSEA DEMERSAL AND PRAWN RESOURCES EXPLORATION SURVEYS IN INDONESIA

Bambang Sumiono

Research Institute for Marine Fisheries

Jakarta, Indonesia

2009

Introduction

- Approx. 2/3 of the Indonesia region is covered by water.
- One of the challenge and opportunity research on the fishery biology is the ability of science and technology for exploiting and developing of new commodities or frontier commodities as an alternative utilization of marine fishery resources in the future.
- Deepwater demersal & prawn are the resources have not been utilized yet as quickly as those in tropical neighbouring countries.
- The deepsea region is defined as the seawaters beyond the jurisdiction line of 12 nautical miles from the coastline, i.e. including the Indonesian Economic Exclusive Zone (IEEZ) and international seawaters, and/or the seawaters with a depth of more than 200 m or beyond the continental shelf.

Deepsea trawl survey for fish and prawn resources were conducted in Indonesia :

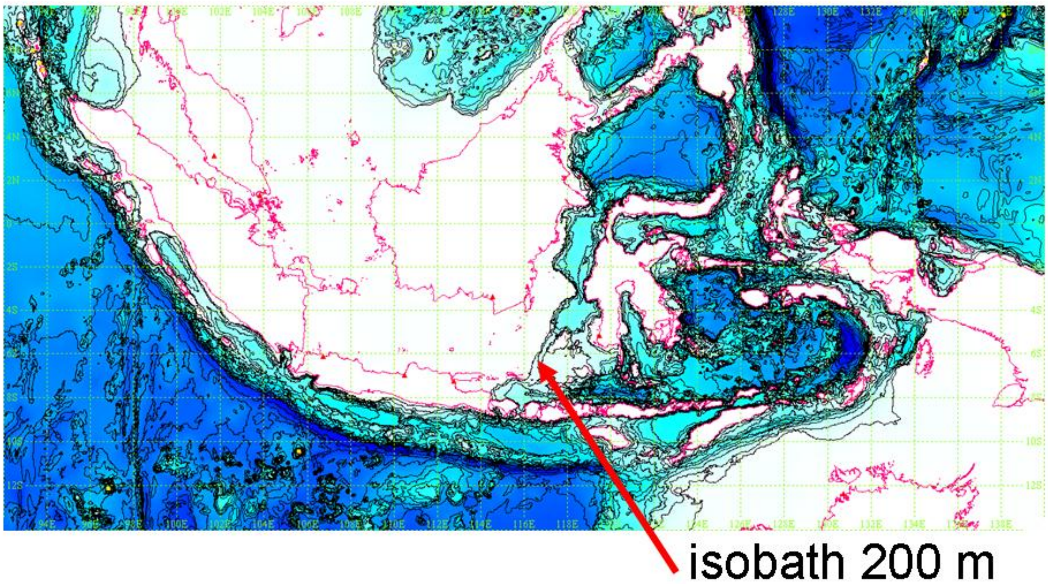
Eastern Ina → Banda Sea, Kei, Aru, Tanimbar, South Papua, Timor Sea

Western Ina → West Sumatera, South Java

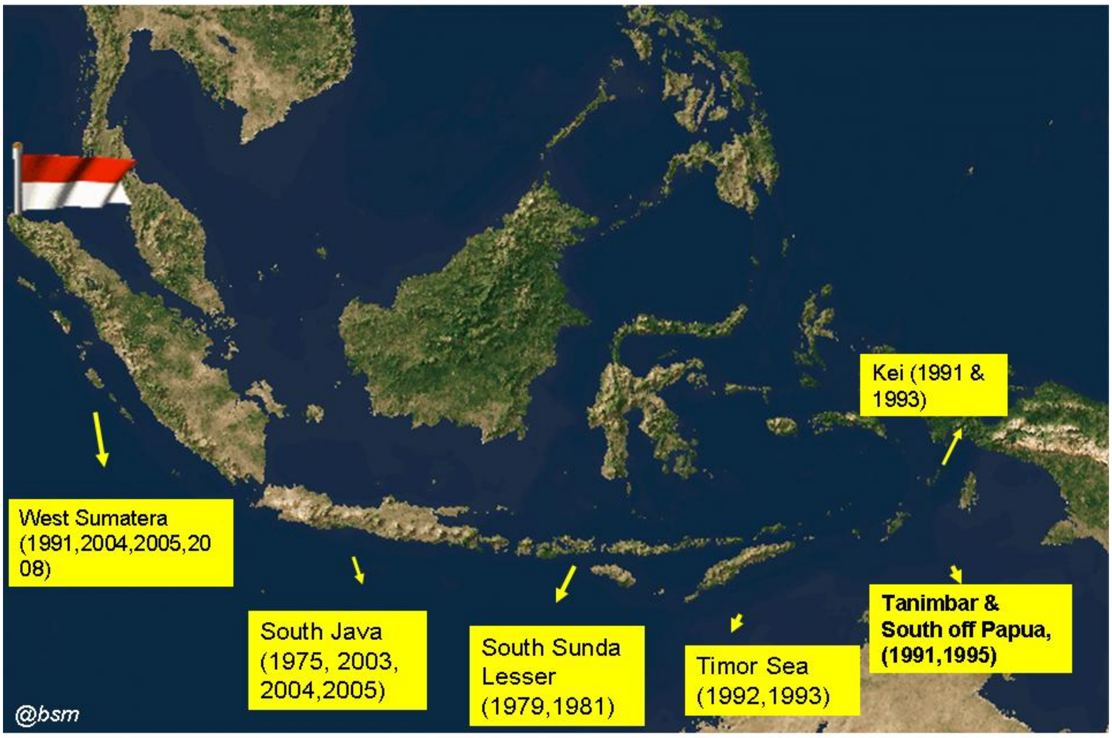
The main aims of the surveys

1. to locate unexploited stocks of fishes and prawns in the waters of the outer continental shelf and slope
1. to identify species with commercial potential, and to evaluate species disribution.

Deepsea (> 200 m) around Indonesia



Survey area for demersal deepsea fishery in Indonesia



DEEPSEA TRAWL

- **1972** → RV Oh Dae San (1126.59 GT) covered 20-290 m deep.
- The size for each otter board was 3.4 m x 2.2 m, weight in the air 2300 kgs
- The length of HR = 50 m and GR = 63 m
- The lengths of the warp were 3.1- 3.2 times of the depth at 100 - 300 m and 2.5 - 2.6 times in the depth of more than 300 m.
- Net heigt was measured by the echo record of foodrope or lower panel of the net. Towing speed →between 2.5 to 3.5 knots.

- **1975** → RV Tae Baek San (309.85 GT) covered 50-200m in the Western South Sumatera and Southern Java
- The otter boards were flat plate type and each size 2.29 m x 1.23 m
- The length of HR = 45 m and GR = 49.5 m (type of 148 feet net), and HR=43 m
- GR = 47.0 m (type of 130 feet net).
- The av. trawling time = one hour.

- **1991 & 1993** → survey in the Arafura Sea by RV Baruna Jaya-1 (700 GT).
- HR = 18.8m ; GR = 21.74 m
- Cod-end mesh size = 1 inch
- The size for each otter board = 1.8 m x 0.8 m
- Beam trawl with the mouth of beam was 4.15 m. Material used of the net was PA meshed of 12-15 mm.

- **2004 & 2005** → survey in the Indian Ocean by RV Baruna Jaya-4 (1200 GT)
- Using trawl net 6 seam type with HR = 31.6 m; GR = 37.4 m.
- Fishing was conducted during daytime.
- The net was towed for 30 minute at about 2 knots.

DEEPSEA BLL

- **2004** →BLL fisheries in the continental shelf & slope areas of the Arafura Sea
- Covering both the continental shelf flat and slope areas and depth ranging between 30 m to approx. 700 m.
- By using of M/V Ural (1200 GT), a Russian fishing vessel
  The number of hook between 6900 - 11000 hooks, with the distance between hooks was about 1 m.
- The number of setting was once per-day.

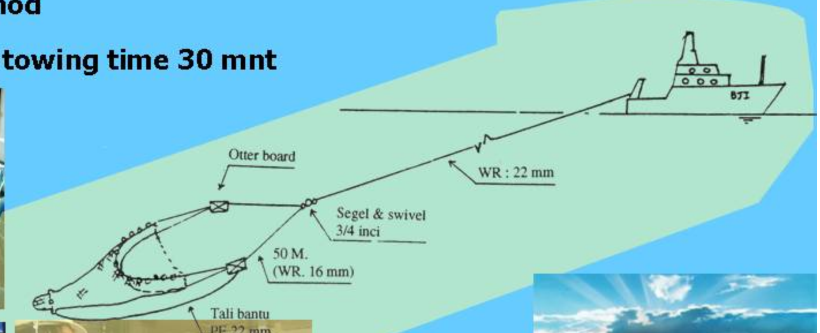
TRAPS

- **1993** → trap fishing exploratories in the Arafura sea and Timor by R.V Baruna Jaya-I. Three types of trap operated were folding trap, cylindrical trap, and trapezoid trap
- Towing time about 6 minutes and the vessel speed about 3 knots. Soaking time was about 24 hours

METHODOLOGY

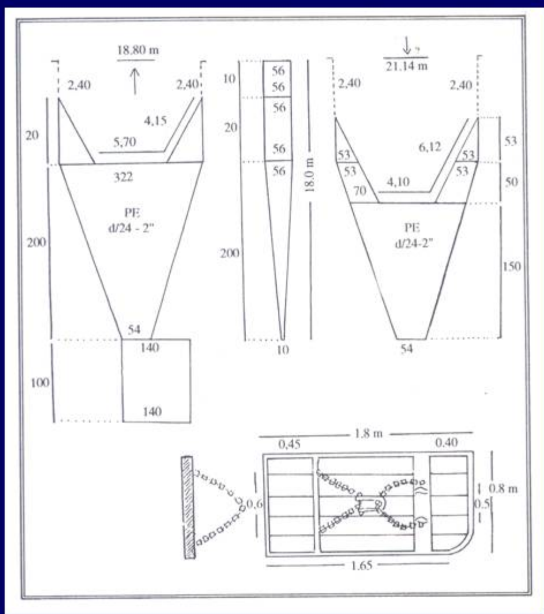
1. Resource abundance

- **RV Baruna Jaya-IV (1200 GT)**
- **Deepwater trawl**
- **Swept area method**
- **Daylight fishing, towing time 30 mnt**



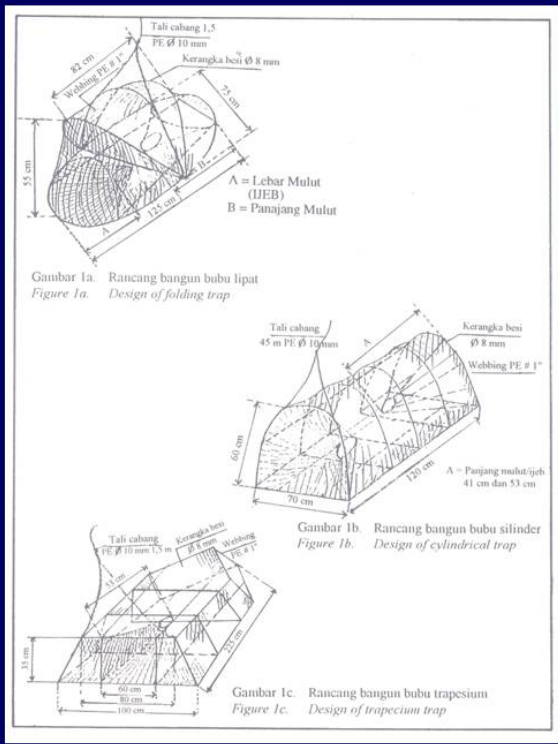
2. Biological research

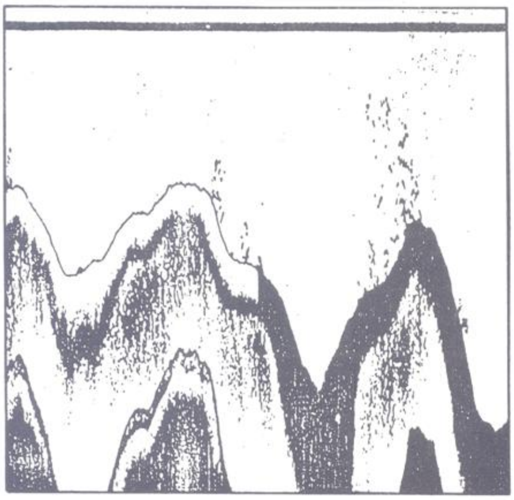
- For dominant species in the catch, take 100 individuals randomly and measure their L-W
- For potential target species, select 20 individuals randomly for detailed measurements (L-W, stomach cont., maturity stage)
- Every species caught is to be recorded in an electronic media with a digital camera.



Design of deepsea trawl operated in the Arafura Sea

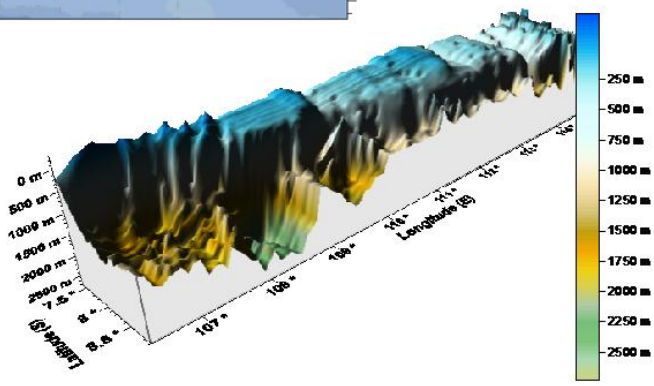
Design of trap operated in the Arafura Sea and Timor Sea





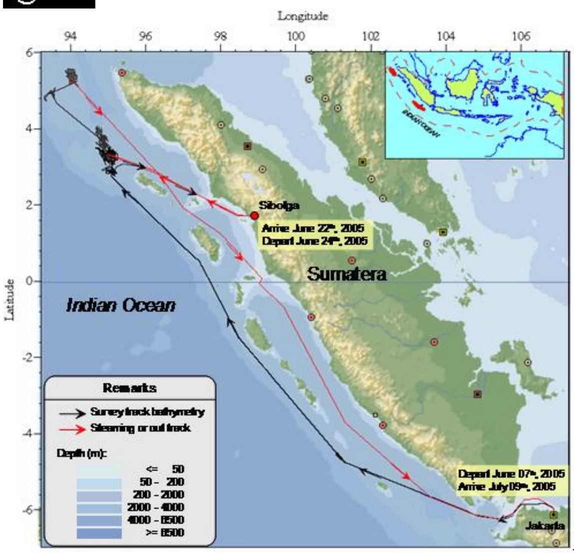
Topography of the bottom sea around Tanimbar, Arafura Sea

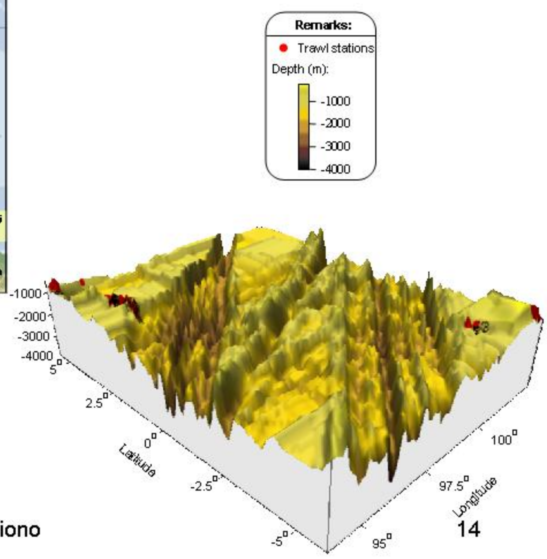
Cruise track during survey in the waters of south off Java, May-June 2005



Bottom of the topography

@bsm





bsumiono 14

BLL Fisheries – Arafura Sea

- Total number of hooks used in the flat area → 1.5 times higher than in the slope area Total catch in the slope area → 4 times higher than in the flat area (approx. 17.0 tons ~ 4.5 tons)
- More than 75% of BLL consisted of red snappers, groupers, sharks & rays.
- The most dominated red snappers → goldband snappers, *Pristipomoides spp.* (*P. multidens* and *P. typus*), red snappers, *Lutjanus spp.*, jobfish (*Etelis carbunculus*), john snapper (*L. johni*) and emperor red snapper (*L. sebae*), while groupers consisted of *Epinephelus microdon*, *E. amblycephalus*, *E. maculatus*, and *E. retouti*. (Badrudin *et al.*, 2005)

Deepsea trawl – Indian Ocean

SPECIES & CATCH COMPOSITION

- About 305 species belonging of about 98 families were identified from the catches within 52 times of trawl operation.

- The highest CPUE of dominant species in the depth of 750 – 1000 m

The ten dominated fish group recorded during the survey

Familiy	Tot catch (kg)	Av.	% of total catch
1. Ophidiidae	4,336	83.4	38.3
2. Plesiobatidae	2,304	44.3	20.3
3. Acropomatidae	700	13.5	6.2
4. Trichiuridae	642	12.4	5.7
5. Myctopidae	624	12.0	5.5
6. Macrouridae	514	9.9	4.5
7. Chimaeridae	351	6.8	3.1
8. Hexatrygonidae	306	5.9	2.7
9. Centrophoridae	258	4.9	2.3
10.Rajidae	222	4.3	1.9
Others (88 fam.)	1,122	21.6	9.9
Total Demersal	11,328	217.9	100.0

1


2


3


4


5


6


CATCH RATES & STOCK DENSITIES

- Catch rate provide one of the index of abundance of fish resources.
- the lowest total catch rate = 10.0 kg/hr was occurred in the depth range between 680-700m.
- the highest total catch rate = 2,095.0 kg/hr was occurred in the depth range between 911-926m

Summary of the catch rates	
Items	Quantity
Total no. of trawl station	52
Minimum catch rate (kg/hr)	10.0
Maximum catch rate (kg/hr)	2095.0
Average of catch rate (kg/hr)	227.18
Standard deviation	352.14
Coefficient of variation (%)	155

The relatively high variation in catch rate indicate that the distribution of deepsea fish resources in this area during the survey periods was somewhat forming cluster. This was likely due to the occurring differences in the depth contour and bottom substrate

Some of species has commercial value and marketable in Japan :

- *Beryx splendens* (family Berycidae, Japan: *kinme*),
- *Doederleina berycoides* (family Acropomatidae),
- *Diretmoides pauciradiatus* (family Diretmidae, Japan: *nakamuraginme*),
- *Haplostethus crassipinus* (family Trachichthyidae, Japan: *hiuchi red*),
- *Haplostethus rubellopterus* (Japan: *hiuchi black*)
- *Trichiurus lepturus* (family Trichiuridae, Japan: *tachiuo*).

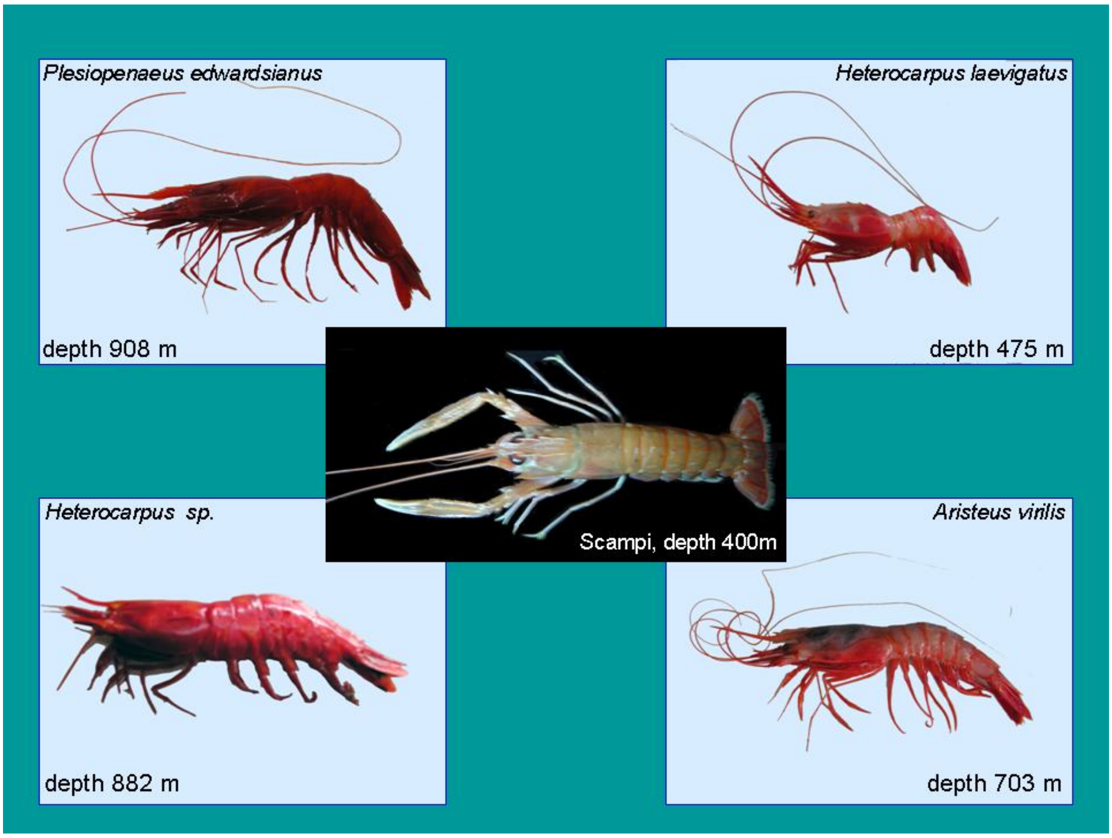
→ widely distributed in the de ... m. E *plendens*, there was found c ... harr bank off Cilacap in the deptl

Hoplostetus sp.
depth 760 m

Hoplostethus melanopus
depth 882 m

Beryx splendens
depth 795 m

Diretmoides pauciradiatus
depth 519



Survey activities

bsumiono 22


Thank You
@bsm

Deep-Sea Resources Research and Survey in Malaysia Water Area.

By
Sallehudin Jamon

Aquatic Ecosystem Research Center, Department of Fisheries Malaysia, 32000 Sitiawan Perak, Malaysia.

1.0 Introductions

The fisheries sector is an important sector in the Malaysia national economy. Beside providing the main source of protein, this sector provides employment for about 80,000 fisher folk (Annual Fisheries Statistic, 1996). The implementation of the Malaysia Exclusive Economic Zone (EEZ) in 1981, extended the fishing grounds beyond traditional area. The state of Sarawak, Sabah and Federal Territory Labuan are separated from Peninsular Malaysia by the South China Sea and have a combines EEZ of approximately 250,000 km^2. This is 46% of the total EEZ area of Malaysia at 548,800km2 and the EEZ of Sarawak is the largest within Sabah and Federal Territory Labuan, which is at 160,000km^2.

The first fisheries resources survey in the EEZ of Malaysia was conducted from 1985-1987 (Anon, 1988). The second survey was carried out from 1996-1997 (Anon, 1998). K.K Manchong from Fisheries Research Institute, Sarawak Branch, based at Bintawa, Kuching Sarawak was deployed to do the sampling in the second survey while R.V.RASTRELLIGER was used in first survey. The objectives of both survey is to estimate the demersal and semi pelagic/pelagic fish biomass and potential in the waters of the Malaysian EEZ, covering the west and east coast of Peninsular Malaysia, as well as in the South China Sea area off Sarawak and Sabah. The results from the surveys provided the Department of Fisheries with baseline resource information for the formulation of the development plan for offshore fisheries. The third survey was conducted in 2004-2005 off EEZ Sarawak water area also using K.K. Manchong. The main objective of the third survey was to assess the resource of the area more than 30nm offshore, which has been exploited by deep sea vessels.

In the year 2005, a survey in the untrawlable area within 180 meter depth were conducted in Sarawak water and this survey was carried out using MV SEAFDEC 2, a research vessel owned by the South East Asia Development Center based at SEAFDEC Training Department, Bangkok, Thailand. Beside the EEZ survey, two tuna survey in Sabah and Sarawak water were conducted in 2008 using the KP2 YELLOWFIN vessel owned by the National Agriculture Training Council (NATC).

2.0 Material and Methods

2.1 First and Second EEZ Survey

The area surveyed extended seaward is beyond the territorial limit of 12 nm from the coast. The area is divided into Sub-areas, I, II and III and each sub-area was divided into depth strata i.e Stratum 1 from 10-30 fathoms (18-55m), Stratum II from 30-50 fathoms (56-91m) and Stratum III from 50-100 fathoms (92-185m). The first and second survey used the same division during EEZ survey.

2.1.1 Research Vessel and Fishing Gear

The research vessel R.V. RASTRELLIGER was deployed for the first survey while K.K MANCHONG, was deployed for second survey. Fishing operation using the standard bottom trawl net was carried out during the surveye. Each trawl haul was of one-hour duration and trawling speed of four knot maintained throughout.

Figure 1 : Research vessel, K.K. Manchong, a stern-trawler with gross capacity of 150 GRT and powered by 90 HP engine was used during research in Malaysia EEZ water.

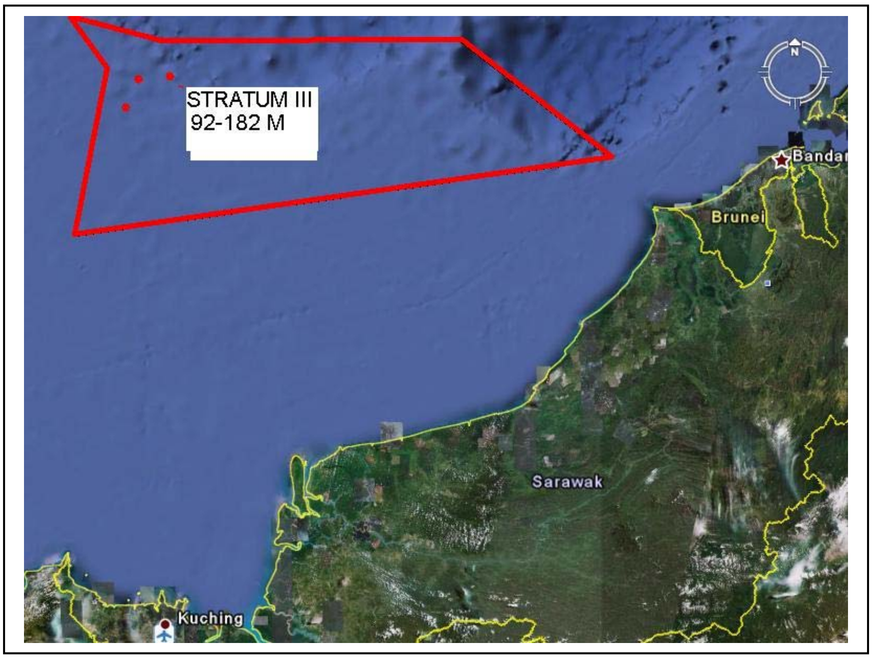


Figure 2: Map of the coast of Sarawak showing the Sub-area III and Depth strata

2.2. Third Resource Survey

The surveyed area was beyond the 12 nm line from shore to the 100 fathom depth contour off the coast Sarawak. The division of the survey area into stratum followed the standard procedure used in earlier demersal fish surveys (Anon. 1998).

2.2.1 Research Vessel and Fishing Gear

The trawl net of K.K. MANCHONG from the FRI Sarawak Branch, based at Bintawa Kuching Sarawak was deployed to do the sampling. Each trawl was of one-hour duration and a trawling speed of four knot was maintained throughout.

2.3 Fourth Resource Survey (Untrawlable survey)

This survey focused on the untrawlable area in Sarawak waters which have been identified in previous studies. The areas are either covered by a rocky and hard coral seabed, or deeper than the normally trawlable depth of local trawler or sloping toward the continental slope.

2.3.1 Research Vessel and Fishing Gear

The survey was carried out using MV SEAFDEC2, that was equipped with the latest navigational and oceanographic equipments and was able to operate various types of fishing gears including bottom vertical longline (BVL), traps and deep-water trawl net, all of which were used in this survey.

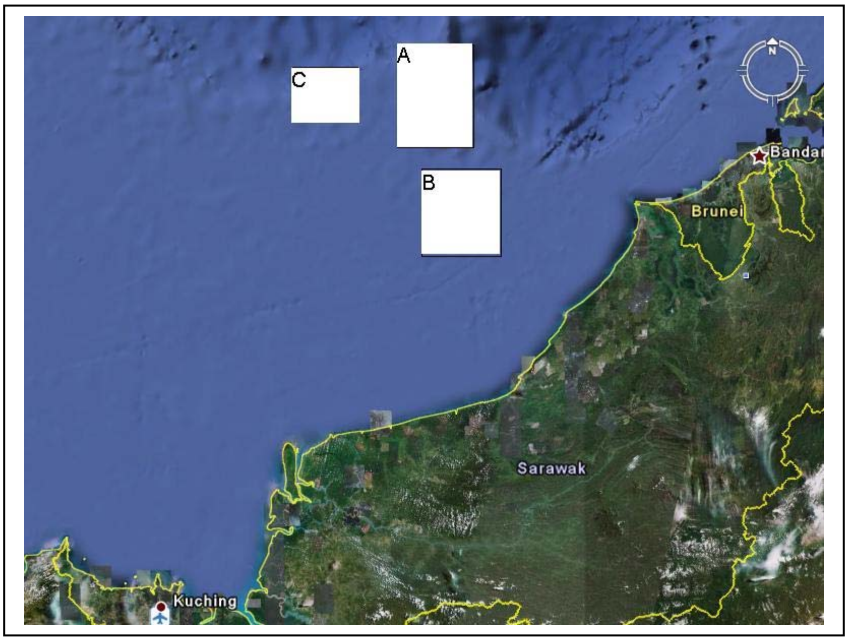


Figure 3: Sampling areas representing Sub-area A, B and C rock and coral seabed and areas of near continental slope of Sarawak water.

2.4 Fifth survey (Tuna Survey)

Two survey in the South China Sea area were carried out in 2008. The first survey was conducted in the northern Mangalum's Island, about 30 nautical miles from Labuan. The second survey was carried out at the Gugusan Beting Patinggi Ali or South Luconia Shoal area which was 70 nautical miles from Labuan. The objective of the survey was to assess the resources of tuna in Sabah and Sarawak Waters.

Figure 4 . Survey tuna areas representing station 1 and 2 in Labuan and Sarawak waters

2.4.1 Research Vessel and Fishing Gear

The survey was carried out using KP2 Yellowfin vessel owned by the National Agriculture Training Council (NATC). The tuna longline were used during the survey.

3.0 Results and Discussions

3.1.0 Resource Research Survey

Table 1 shows the abundance in terms of catch rate from the three different surveys in the depth stratum III (50-100 ftm 92-185 m).

Table 1 : Comparison of catch rates (kg/hr) of demersal fish between 1987, 1998, 2004/2005 surveys conducted in Malaysian EEZ off Sarawak

Depth Stratum	**1987 R.V. RASTRELLIGER Cod End mesh size = 50 nm**			**1998 K.K. MANCHONG Cod End mesh size = 38 mm**			**2004/2005 K.K. MANCHONG Cod End mesh size = 38 mm**		
	Demersal	Trash	Total	Demersal	Trash	Total	Demersal	Trash	Total
III 50-100ftm (92-185m	44.80	40.80	85.60	109.65	10.60	120.25	82.43	14.06	96.49

The survey in 1998 and 2004/2005 used a trawl net with a cod-end mesh size of 38 mm while in early survey a trawl net with cod-end mesh size 50 mm was used. An average catch rate of 82.43 kg/hr of demersal fish was obtained during the third survey, declined 24% from the second survey. Stratum III with 92-185 meter depth was dominated (beside trash fish)by fish species such as *Priachantus macracanthus* (15.47kg/hr), *Saurida tumbil* (2.15kg/hr), *Saurida longimanus* (1.80kg/hr), *loligo duvaucelli* (1.57kg/hr) and *Decapterus kurroides* (1.57kg/hr).

3.2.0 Untrawlable Survey

3.2.1 Traps

Table 2. The list of average catch and the common commercial species catch by traps by sub-area of Sarawak waters

Sub-Area	Average Catch	Common Commercial species	No. of Species	No. of Families
A	3.7kg/100traps	*Chrybdis spp*. (40.37%) *Squalus megalops* (21.10%) *Dentex fumitron* (10.33%)	39	21
B	3.2kg/100traps	*Chrybdis spp*. (42.76%) *Nemipterus spp* (6.02%) *Ephinephalus spp* (0.86%)		

The majority of the catches by traps were from Family Portunidae (crab) that are commonly found in the coral seabed. The presence of *Charybdis spp.* in almost all of the stations indicate the wide distribution of *Charybdis spp.* in the fishing ground of hard coral seabed found in Sarawak waters.

3.2.2 Bottom Vertical Longline (BVL)

Table 3. The list of average catch and the common commercial species catch by BVL by sub-area of Sarawak water.

Sub-Area	Average Catch	Common Commercial species	No. of Species	No. of Families
A	12.66kg/stations	*Pristimomoides multidens (28%)* *Squalus megalops (20.41%)* *Mustelus manazo (9.22%)* *Dentex fumitron (8.29%)* *Gymnocranius griseus (7.11%)*	26	18
B	23.24kg/stations	*Arius thallasinus (21.52%)* *Lutjanus malabaricus (11.84%)* *Pristimomoides multidens (4.84%)*		

The catches of the bottom vertical longline (BVL) from rocky and hard coral grounds of sub-areas A and B showed the presence of highly diverse fish species in

Sarawak waters. Some of the commercial species such as Family Nemipteridae, Portunidae and Muraenidae are rarely found in Peninsular Malaysia waters. Most of the catches from BVL were large individuals weighing up to 8 kg.

3.2.3 Trawl Net

Table . List of five most abundant species by depth strata in the untrawlable area of Sub-area C of Sarawak waters

Stratum	**130-140 m**		**Stratum**	**150-160 m**		**Stratum**	**170-180 m**	
	Kg/h	**%**		**Kg/h**	**%**		**Kg/h**	**%**
Species			**Species**			**Species**		
Saurida wanieso	3.95	17.38	*Rexea prometheoides*	24.06	47.20	*Rexea prometheoides*	4.90	12.73
Lophiomus setigurus	3.87	17.03	*Malakichtys elegans*	6.57	12.89	*Hyperoglyphe sp*	4.71	12.24
Squalus megalops	3.50	15.41	*Hyperoglyphe sp*	3.48	6.83	*Priachantus macracanthus*	3.65	9.47
Loligo chinensis	2.75	12.11	*Priachantus macracanthus*	2.80	5.49	*Loligo chinensis*	2.71	7.04
Priachantus macracanthus	2.58	11.36	*Lophiomus setigurus*	2.0	3.92	*Lophiomus setigurus*	2.25	5.85

The species composition of the catch by bottom trawl net in sub-area C indicated the presence of deep sea fish species such as *Lophiomus spp*. (Ghost shark) and *Malakichthys elegens.*

3.3.0 Tuna Survey

3.3.1 First Survey

During the first survey, a Yellowfin tuna weighing 42 kg was caught and apart from that 18kg marlin and snake mackerel *Gempylus serpens* belonging to the Family Gempylidae were also caught by tuna longline

3.3.2 Second Survey

During second survey, 44 young yellowfin tunas with size between 0.5kg to 3.8kg were caught by trolling activities in payao area. Other species caught by longline were from Family Gempylidae (*Gempylus serpens*), lancetfish from Family Alepisauridae (*Alepisaurus ferox*) and Family Corphaenidae (*Coryphaena hippurus*).

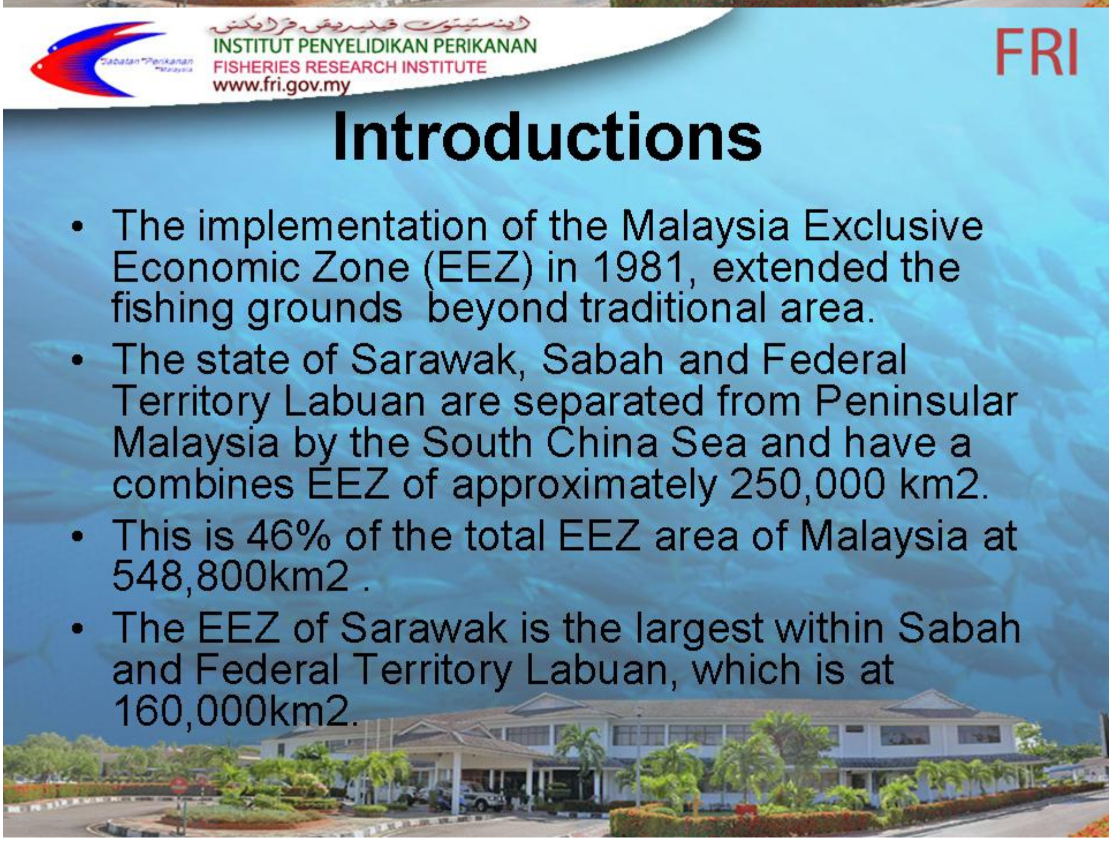
4.0 Conclusion

More studies should be carried out to assess the size of fish stocks in deep sea water and enhancing the technical know how of the research vessel or local fishermen on feasible fishing gears. Mastering the operation of deep sea fishing gear is important in order to develop the capture fisheries in deep-sea water area.

Acknowledgement

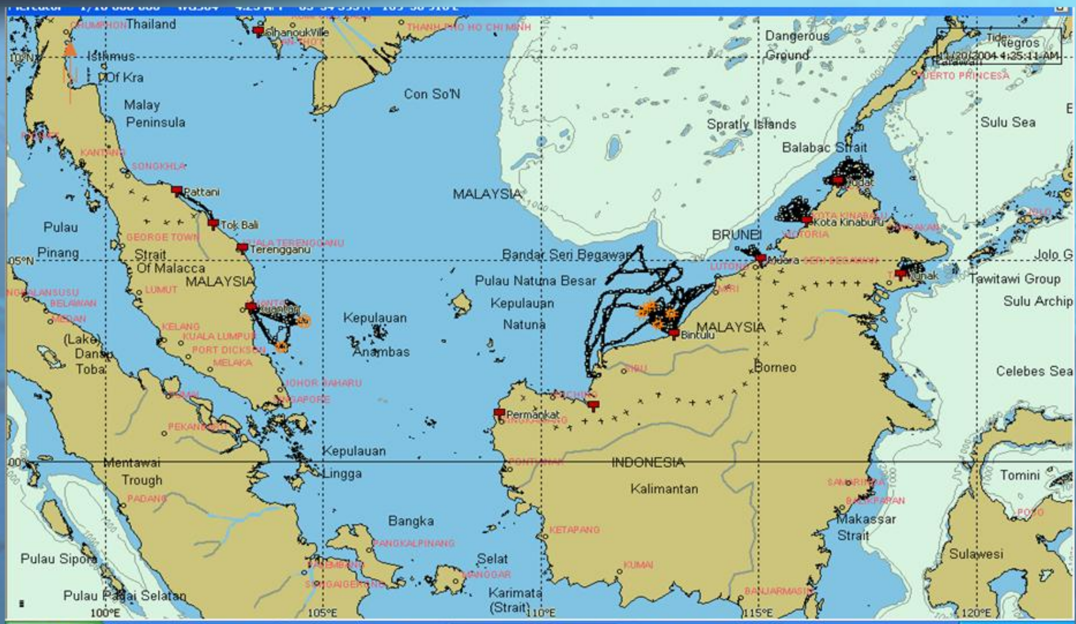
The authors would like to thank to the Director General of Fisheries Malaysia, Y. Bhg. Dato' Junaidi bin Che Ayub, for permission in publishing this paper. Also express gratitude to Mr. Raja Mohammad Noordin Raja Omar Director of FRI and Ms. Hjh Mahyam Mohd Isa Director of SEAFDEC-MFRDMD, for permission to attending this workshop.


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
Deep-Sea Resources Research and Survey in Malaysia Water Area
REGIONAL WORKSHOP ON STANDARD OPERATION PROCEDURE AND DEVELOPMEN/IMPROVEMENT OF SAMPLING GEARS FOR THE DEEP SEA RESOURCES EXPLORATION 25-28 MAY 2009,
SAMUT PRAKAN THAILAND


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
Introductions
• The implementation of the Malaysia Exclusive Economic Zone (EEZ) in 1981, extended the fishing grounds beyond traditional area.
• The state of Sarawak, Sabah and Federal Territory Labuan are separated from Peninsular Malaysia by the South China Sea and have a combines EEZ of approximately 250,000 km2.
• This is 46% of the total EEZ area of Malaysia at 548,800km2 .
• The EEZ of Sarawak is the largest within Sabah and Federal Territory Labuan, which is at 160,000km2.

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my

FRI



INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my

FRI

Introductions

- The first fisheries resources survey in the EEZ of Malaysia was conducted from 1985-1987 (R.V.RASTRELLIGER)
- The second survey was carried out from 1996-1997 (K.K.MANCHONG)
- The objectives of both survey is to estimate the demersal and semi pelagic/pelagic fish biomass and potential in the waters of the Malaysian EEZ,
- covering the west and east coast of Peninsular Malaysia, as well as in the South China Sea area off Sarawak and Sabah.
- The third survey was conducted in 2004-2005 off EEZ Sarawak water area also using K.K. Manchong.
- The main objective of the third survey was to assess the resource of the area more than 30nm offshore, which has been exploited by deep sea vessels.

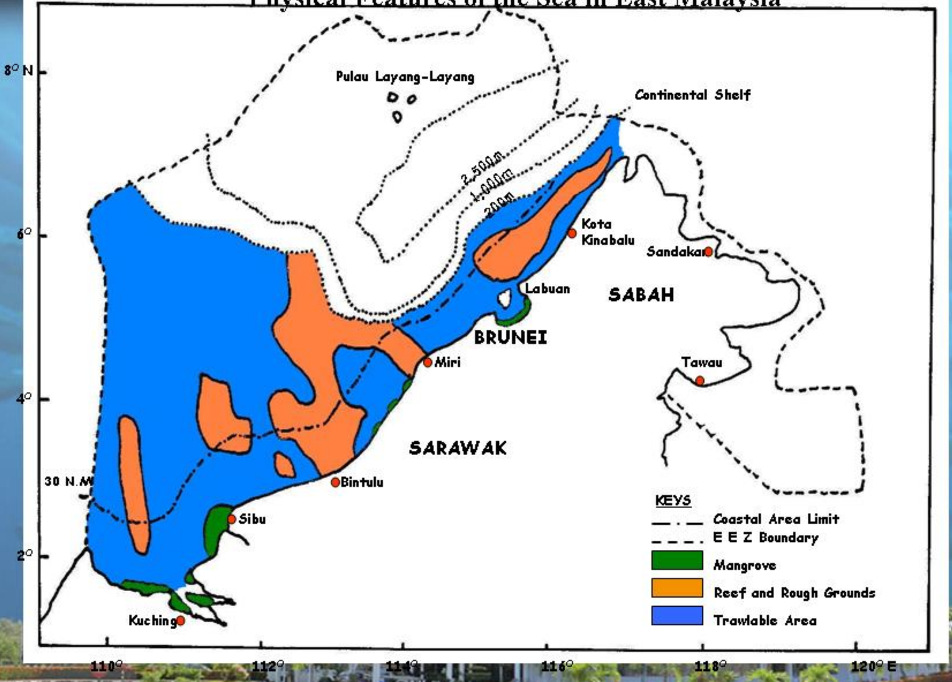
INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Introductions

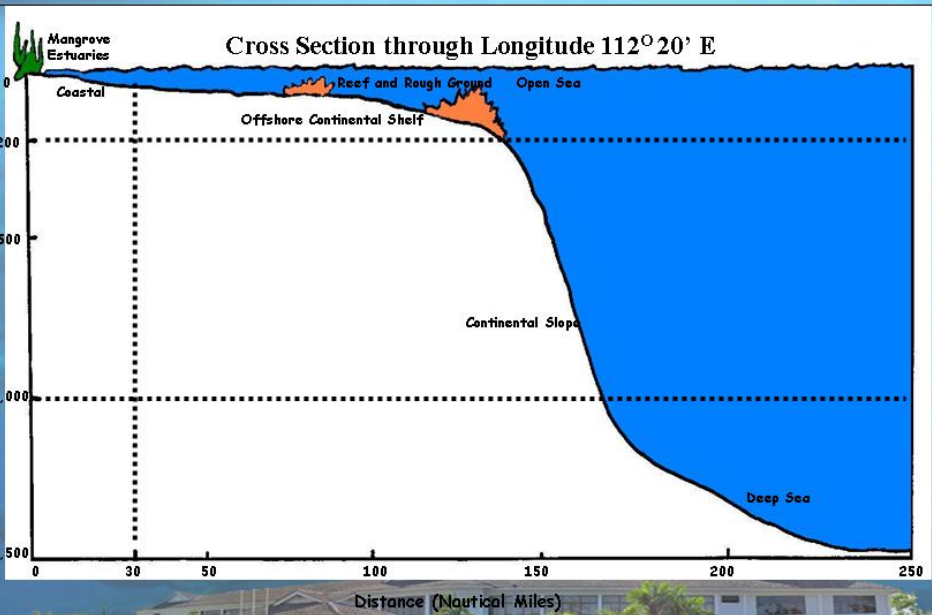
- In the year 2005, a survey in the untrawlable area within 180 meter depth were conducted in Sarawak water and this survey was carried out using MV SEAFDEC 2,
- The objective of this survey is to assess the fish stock and resources in untrawlable area.
- Beside the EEZ survey, two tuna surveys in Sabah and Sarawak water were conducted in 2008 using the KP2 YELLOWFIN vessel owned by the National Agriculture Training Council (NATC).
- The objective of the tuna survey was to assess the resources of tuna in Sabah and Sarawak Waters.

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Physical Features of the Sea in East Malaysia



INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI



INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

1st,2nd and 3rd Surveys

- The area surveyed extended seaward is beyond the territorial limit of 12 nm from the coast.
- The area is divided into Sub-areas, I, II and III and each sub-area was divided into depth strata i.e Stratum 1 from 10-30 fathoms (18-55m), Stratum II from 30-50 fathoms (56-91m) and Stratum III from 50-100 fathoms (92-185m).
- The first, second & third surveys used the same division during EEZ survey
- The research vessel R.V. RASTRELLIGER was deployed for the first survey while
- K.K MANCHONG, was deployed for second and third survey

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Map of the coast of Sarawak showing the Sub-area III and Depth strata (K.K Manchong)

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Research vessel, K.K. Manchong, a stern-trawler with gross capacity of 150 GRT and powered by 90 HP engine was used during research in Malaysia EEZ water.

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Comparison of catch rates (kg/hr) of demersal fish between 1st, 2nd and 3rd surveys conducted in Malaysian EEZ off Sarawak

Depth Stratum	1987 R.V. RASTRELLIGER Cod End mesh size = 50 mm			1998 K.K. MANCHONG Cod End mesh size = 38 mm			2004/2005 K.K. MANCHONG Cod End mesh size = 38 mm		
	Dem	Trash	Total	Dem	Trash	Total	Dem	Trash	Total
III 50-100ftm (92-185m)	44.80	40.80	85.60	109.65	10.60	120.25	82.43	14.06	96.49

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

3rd survey
Stratum III with 92-185 meter depth was dominated (beside trash fish) by fish species such as

- *Priachantus macracanthus* (15.47kg/hr),
- *Saurida tumbil* (2.15kg/hr),
- *Saurida longimanus* (1.80kg/hr),
- *Loligo duvaucelli* (1.57kg/hr) and
- *Decapterus kurroides* (1.57kg/hr).

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Fourth Resource Survey (Untrawlable survey)

- This survey focused on the untrawlable area in Sarawak waters
- The areas are either covered by a rocky and hard coral seabed, or deeper than the normally trawlable depth of local trawler or sloping toward the continental slope.
- The survey was carried out using MV SEAFDEC2, that was equipped with the latest navigational and oceanographic equipments and was able to operate various types of fishing gears including bottom vertical longline (BVL), traps and deep-water trawl net.

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Sampling areas representing Sub-area A, B and C rock and coral seabed and areas of near continental slope of Sarawak water. (M.V Seafdec 2)

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

The list of average catch and the common commercial species catch by BVL by sub-area of Sarawak water

Sub Area	Average Catch (kg/stations)	Common Commercial species	No. of Sps	No. of Families
A	12.66	*Pristimomoides multidens (28%)* *Squalus megalops (20.41%)* *Mustelus manazo (9.22%)* *Dentex fumitron (8.29%)* *Gymnocranius griseus (7.11%)*	26	18
B	23.24	*Arius thallasinus (21.52%)* *Lutjanus malabaricus (11.84%)* *Pristimomoides multidens (4.84%)*		

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

The list of average catch and the common commercial species catch by traps by sub-area of Sarawak waters

Sub Area	Average Catch	Common Commercial species	No. of Species	No. of Families
A	3.7kg/100traps	*Chrybdis spp*. (40.37%) *Squalus megalops* (21.10%) *Dentex fumitron* (10.33%)	39	21
B	3.2kg/100traps	*Chrybdis spp*. (42.76%) *Nemipterus spp* (6.02%) *Ephinephalus spp* (0.86%)		

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

List of five most abundant species by depth strata in the untrawlable area of Sub-area C of Sarawak waters

(Trawl Net)

Stratum	130-140 m		Stratum	150-160 m		Stratum	170-180 m	
	Kg/h	%		Kg/h	%		Kg/h	%
Species			Species			Species		
Saurida wanieso	3.95	17.38	*Rexea prometheoides*	24.06	47.20	*Rexea prometheoides*	4.90	12.73
Lophiomus setigurus	3.87	17.03	*Malakichtys elegans*	6.57	12.89	*Hyperoglyphe sp*	4.71	12.24
Squalus megalops	3.50	15.41	*Hyperoglyphe sp*	3.48	6.83	*Priachantus macracanthus*	3.65	9.47
Loligo chinensis	2.75	12.11	*Priachantus macracanthus*	2.80	5.49	*Loligo chinensis*	2.71	7.04
Priachantus macracanthus	2.58	11.36	*Lophiomus setigurus*	2.0	3.92	*Lophiomus setigurus*	2.25	5.85

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Fifth survey (Tuna Survey)

- Two survey in the South China Sea area were carried out in 2008.
- The first survey was conducted in the northern Mangalum's Island, about 30 nautical miles from Labuan.
- The second survey was carried out at the Gugusan Beting Patinggi Ali or South Luconia Shoal area which was 70 nautical miles from Labuan.
- The tuna longline were used during the survey. .

INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

Survey tuna areas representing survey 1 and 2 in Labuan and Sarawak waters

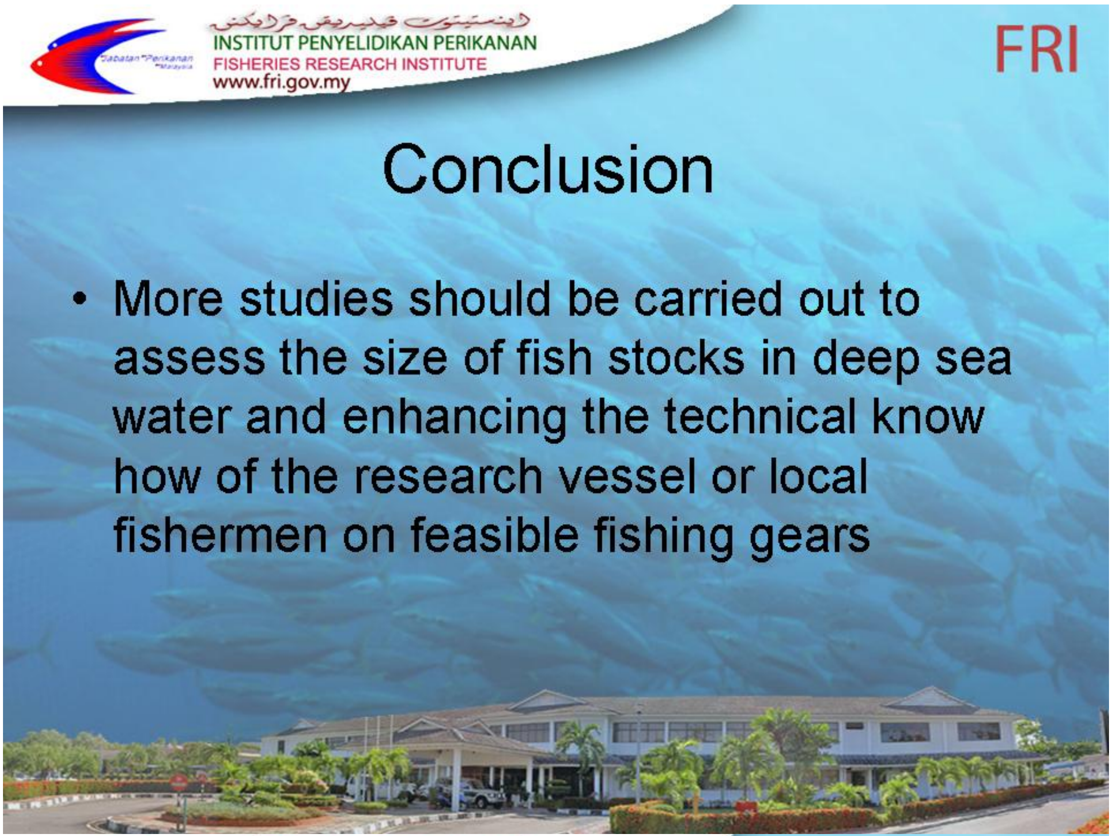
INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI

- First Survey
- Yellowfin tuna weighing 42 kg
  Marlin 18kg and
  Snake mackerel *Gempylus serpens* belonging to the Family Gempylidae

- Second Survey
- 44 young yellowfin tunas with size between 0.5kg to 3.8kg were caught by trolling activities in payao area. *Gempylus serpens*,
  Lancetfish from Family Alepisauridae (*Alepisaurus ferox*) and
  Coryphaena hippurus Family Corphaenidae .


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
Yellowfin Tuna 42kg & Marlin 18 kg


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
young yellowfin
Gempylus serpens/ Snake mackerel
Alepisaurus ferox/ lancetfish
Coryphaena hippurus/ Belitong


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
Conclusion
• More studies should be carried out to assess the size of fish stocks in deep sea water and enhancing the technical know how of the research vessel or local fishermen on feasible fishing gears


INSTITUT PENYELIDIKAN PERIKANAN
FISHERIES RESEARCH INSTITUTE
www.fri.gov.my
FRI
Thank You

STATUS OF DEEP SEA SURVEY IN MYANMAR

Aung Htay Oo
Senior Fishery Officer
Fishery Resources Conservation Unit, R & D
Department of Fisheries

Introduction

Union of Myanmar has a long coastline of nearly 3000 kilometers which can be divided into three coastal regions. The Rakhine coastal region (from the mouth of the Naff River to Mawtin point, about 740 km) the Ayeyarwaddy Delta and the Gulf of Moattama (Martaban) coastal region (from Mawtin point to the gulf of Moattama, about 460 km) and the Taninthayi coastal region (from Gulf of Moattama to the mouth of the Packchan River, about 1200 km in the Bay of Bengal and the Andaman Sea.

Coastline of Myanmar formed several large estuarine, Delta systems and numerous offshore islands, Myanmar possesses a considerable diversity of coastal habitats, including coral reefs, mangroves, sandy beaches and mudflats. The coastal zone is a very diverse array of ecosystem, coral reef, sea grass bed, mud and sand flats, mangroves, bays, estuaries and sandy and sandy rocky shores. In addition, there are two major islands grouping, the Moscos Island in the north and the Mergui (Myeik) Archipelago in Tanintharyi, which consists of over 800 islands.

Rakhine state is situated in the westernmost part of the nation. Boarding with the Chin state in the North and Magway division. Bago division and Ayeyarwaddy division in the East and facing Bay of Bengal in the west. It is located between Latitude 17° 30′ North and 21° 30′ North and East Longitude 92° 10′ East and 94° 50′ East. The area of the Rakhine state is 22852.68 sq.km.

The Rakhine state is located in tropical monsoon region. Temperatures never rise or fall extreme ly as it is a coastal region. The average temperature of Sittway in May the hottest month of the year is 84° F (29° Celsius) and in January the coldest month of the year is 70°F (21°C). Rakhine state gets a lot of rain annually as the north-west monsoon wind blows from the sea almost right angle to the Yoma (Mountain range). Rakhine state gets the rain from storm that formed in the Bay of Bengal. Annual rainfall at the Thandwe is 221 inches, Kyaukphyu is 186 inches, and Sittway 203 inches. Torrential rainfall and tidal wave rise from the sea when cyclones that are formed in the Bay of Bengal enter Rakhine state, causing proper damages and flooded sea water in the low land area. Though the storm appears mostly in early and later period of rainy season, they sometimes appear in the mid rainy season.

There are fishing industries in Sittway, Kyaukphyu, Thandwe (lonetha) and Andrew bay. Most of the catch (fishes and shrimps) is transported directly to Yangon. Some are exported. The state own pearl culture station is situated on Apawye island near Thandwe. Sun dried fish and sundried salt are produced along the coast. Thandwe produced sundried Indian anchovy *Stolephorus indicus* species a lot and Spanish mackerel *Scomberomorus commerson* as well.

The previous deep sea surveys in Myanmar

In 1968, Jone & Bonnergi conducted the deep sea survey in 200 meter depth range, they estimated that 775 000 tonnes of demersal fish and 800 000 tonnes of pelagic fishes. Mr Shomura estimated that 625 000 tonnes of demersal fish in 200 meter depth line. Prasad and other researchers conducted survey and found that 326 000 tonnes of demersal fishes and

400,000 tonnes of pelagic fishes, and total 726 000 tonnes as MSY in 1970. Gulland also estimated 625,000 tonnes of demersal fishes in 1972. Then, Narr et al estimated based on the production of carbon per sq meter is 0.630 gm, the fish biomass is 1,512,000 tonnes in 1973. Again in 1977, Menon conducted the survey and estimated the 783,000 tonnes of demersal fish and 729,000 tonnes of pelagic fishes. In 1979-80, the FAO/UNDP conducted deep sea survey in Myanmar water with RV-Dr. Fridtjof Nansen using acoustic survey and modern equipments and estimated there were 750,000 to 800,000 tonnes of demersal fishes and 620,000 to 1,330,000 tonnes of pelagic fishes. So the MSY of that biomass has 200,000 tonnes of demersal fishes and 500,000 tonnes of pelagic fishes, totally 1.05 million metric ton as MSY.

In 1982, Dr. John Tarbit conducted the shrimp resources survey activities till 60 meter depth range in Rakhine area. They estimayed that there are 4370 metric tones of shrimps in 5102 sq miles water between 17° to 20° North Latitude.

In 1985, the department of fisheries conducted deep sea survey by 533 shrimp trawler; average mean catch of shrimp is 31.18 kg/hr. Then, the Thai-Myannar joint survey was conducted deep sea survey, mean catch rate was 31.6 kilogram/hr.

Later on the DOF of Myanmar and Southeast Asian Fisheries Development Center SEAFDEC conducted two times partial deep sea survey in our water in 2004 and 2007.

Since 2006, Southeast Asian Fisheries Development Center SEAFDEC had conducted demersal fishery resources living in Un-trawlable fishing grounds in Southeast Asian waters using SEAFDEC 2 and using other research vessels in collaboration with member countries. This aims to evaluate on the potential resources of economically important species in the un-trawlable areas. The survey area will be focused in the EEZ of member countries and/ or trans-bordering areas particularly in the un-trawlable fishing grounds.

Rakhine fishing grounds of Myanmar is one of the target survey area which is still lacking the information about the species diversity. it characteristics is narrow continental shelf with rocky area. It is therefore not suitable for trawlers but there is still a possible or other fishing gear such as bottom vertical long line. It is envisaged that the survey result will be analyzed together with data collected from other un-trawlable areas in the region.

The objective of the survey

- to investigate the potential resources of some economically important species on the un-trawlable ground at the Rakhine fishing ground of Myanmar using bottom long-line; and
- to introduce and carry out trial of the appropriated/ responsible fishing gears and practices for harvesting of fisheries resources on the un-trawlable grounds.

Materials and methods

Fishing gears:	bottom vertical long-line (Fig: 1) 360 hooks/ stations (20 baskets)
Bait:	squids
Immersions time:	2 hrs
No. of stations:	10 stations.
Survey area:	rocky area of Rakhine fishing ground (Fig. 4 table.1)
Topography survey:	portable echo sounder
Fishing vessels:	2 local fishing boats

Period: 23rd to 30th January 2009

Fishing port: Thandwe

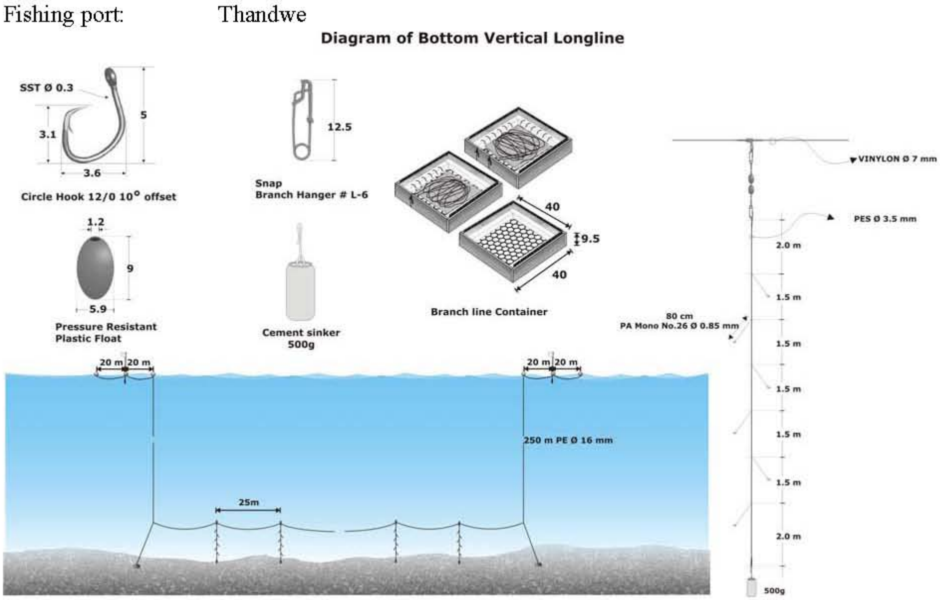


Fig. 1. Diagram of bottom vertical long-line

Participants:

From Southeast Asian Fisheries Development Center SEAFDEC /TD

1. Ms. Penchan Laongmanee — Coordinator
2. Mr. Sayan Promjinda — Team member
3. Mr. Narong Ruandsivakul — Team member
4. Mr. Nakaret Yasook — Team member
5. Mr. Aussawin Buachuay — Team member
6. Mr. Suchart Kitsamut — Team member
7. Mr. Tana Rangjoy — Team member

From department of Fisheries, Myanmar

1. Mr. Khin Maung Soe — Coordinator
2. Mr. Aung Htay Oo — Taxonomist
3. Mr. Khin Maung Thein — Team member
4. Mr. Kyaw Naing Htwe — Team member
5. Mr. Min Khine — Team member

Local fishermen

10 local fishermen join on board rental board.

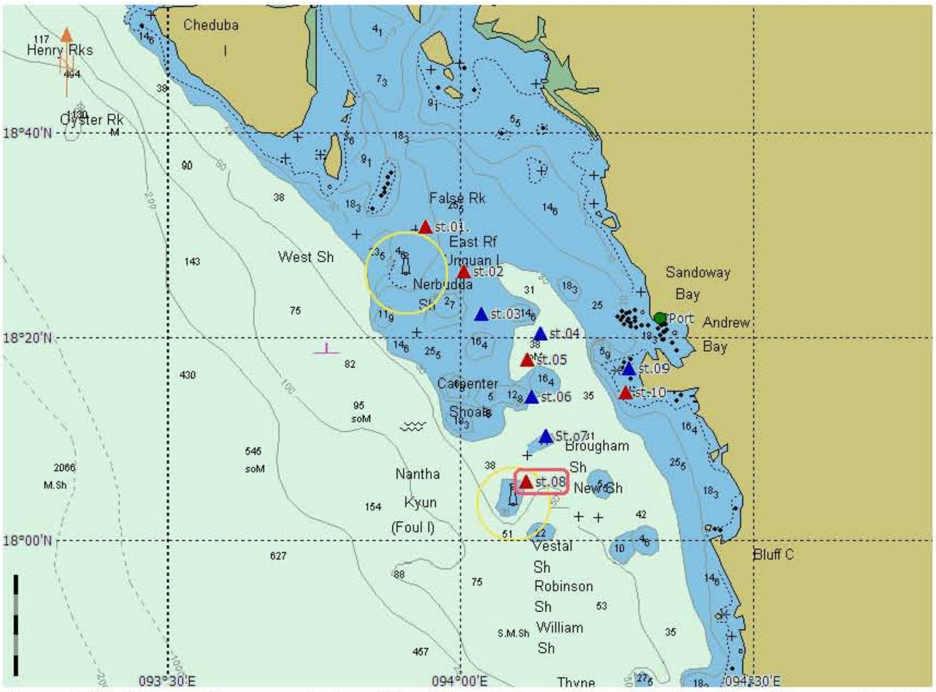


Figure 4. Fishing position map (red and blue triangle is position of boat no.1 and 2 respectively)

Daily performance note

23-1-2009	Afternoon about 3: leave for Thandwe by high-way bus (4 persons)
24-1-2009	7:30 am arrived Thandwe, stay at LintharOo hotel, arrangement for survey
25-1-2009	Preparation of the fishing gears and necessary thing such as battery, winch etc, and sea trail for testing handheld GPS and echo-sounder. Then we discussed to reschedule the activities. The average speed of two rental boats (ferry boats) is about 4 knots. There is no communication equipment on board therefore we have to rearrange the fishing ground to be rocky area that travel time is not more than 4 hr from fishing port. Another problem is the survey team could not travel to Gwa area, because of bridge collapsed on the way to Gwa.
26-30 January 2009	The two survey teams leave fishing port at 5:00 am, the detail fishing grounds information are showed in table 1. Before each operation, bottom topography was surveyed for suitable fishing ground (rocky area) using portable echo sounder. The fishing positions are showed in fig. 4. Catch them were identified and measured length and weight at the accommodation as report in table 2. After fishing operation of potential fishery resources survey as well as demonstration bottom long line to local fishermen, all fishing gears then were give to bottom long line fishermen.

Table 1. Partial information of survey for Demersal fishery resources in un-trawlable area in Rakhine fishing ground.

St no	Date	Number of hook used	Total catch (number)	Total catch weight (kg)	Hook rate	CPUE pc/1000 hooks
1	26-1-2009	396	2	2.45	0.51	5.05
2	26-1-2009	378	4	1.32	1.06	10.58
3	27-1-2009	360	2	0.70	0.56	5.56
4	27-1-2009	396	16	5.74	4.04	40.40
5	28-1-2009	360	0	0.00	0.00	0.00
6	28-1-2009	378	7	2.81	1.85	18.52
7	29-1-2009	366	10	4.58	2.73	27.32
8	29-1-2009	270	2	4.5	0.74	7.41
9	30-1-2009	378	2	0.36	0.53	5.29
10	30-1-2009	270	0	0.00	0.00	0.00

Table. 2. List of the species caught from Rakhine survey areas (26-30 January 2009)

Date	St no	Species	Common name	TL (cm)	FL (cm)	Wt (g)	BD (cm)	HL (cm)	sex
27-1-09	1	*Scolopsis monogramma*	Monocle bream	35	26.5	350	9	7.5	F
		Psudobalistes flavimarginatus	Yellowmargin trigger fish	44	-	2100	20	13.5	F
26-1-09	2	*Lagocephalus wheeleri*	Puffer fish	15.5	14	70	-	-	F
			Moray eel	126	-	750	-	-	M
			Moray eel	77	-	250	-	-	M
			Moray eel	68.5	-	250	-	-	F
27-1-09	3	*Cephalopholis Formosa*	Bluelined grouper	26	-	240	7.5	8.5	F
		Lethrinus sp.	Emperor	34.2	31.8	455	8.5	10.5	M
26-1-09	4		Moray eel	92.5	-	500	-	-	M
			Moray eel	75.5	-	291	-	-	F
			Moray eel	104	-	610	-	-	M
			Moray eel	94.5	-	500	-	-	M
			Moray eel	71	-	250	-	-	F
			Moray eel	75.5	-	291	-	-	F
			Moray eel	84	-	410	-	-	F
			Moray eel	67	-	190	-	-	F
			Moray eel	99	-	580	-	-	M
			Moray eel	74..5	-	260	-	-	F
			Moray eel	76	-	270	-	-	F
			Moray eel	100	-	510	-	-	M
			Moray eel	93	-	450	-	-	M
		Seriolina nigrofasiata	Blackbanded trevally	27	23.5	270	6.5	6.3	M
		Pomadasys hasta	Silver grunt	24		250	7.5	7	F

		Lagocephalus wheeleri	Puffer fish	16	14	100	-	-	F
28-1-09	6	*Nemipterus japonicas*	Japanese threadfin bream	18.5	17	90	5	4.6	-
		Nemipterus japonicas	Japanese threadfin bream	22.5	20	144	6	6	-
		Lutjanus erythropterus	Crimson snapper	30	-	423	10	8.7	-
			Moray eel	104	-	690	-	-	-
			Moray eel	67.5	-	190	-	-	-
			Moray eel	102.5	-	510	-	-	-
			Moray eel	56	-	130	-	-	-
29-1-09	7	*Arius sp.*	Sea catfish	44	36	740	7.5	10	M
		Arius sp.	Sea catfish	39.5	31	460	6	8.5	M
			Moray eel	67.5	-	200	-	-	M
			Moray eel	101	-	530	-	-	F
			Moray eel	65	-	165	-	-	M
			Moray eel	110	-	690	-	-	F
			Moray eel	92-	-	450	-	-	F
			Moray eel	63	-	180	-	-	M
			Moray eel	111	-	560	-	-	F
			Moray eel	109	-	600	-	-	F
29-1-09	8		Moray eel	107	-	604	-	-	M
		Arothron stellatus	Starry toad fish	53.5	-	3900	18	16	M
30-1-09	9	*Cephalopholis Formosa*	Bluelined grouper	25.9	-	240	8	8.3	M
		Cephalopholis argus	Blue spotted grouper	19.8	-	120	6.7	7	M

In Rakhine area, the major fishing gears used are small purse seine operate by two boats, light boat and seine boat. About 18 crews on those two boats. Fishing activity is only one night at sea, leave from landing site at about 17:00 pm and come back in the early morning. Crew is searching for the fish school by the experience eye in the night time, then luring light to aggregate fish before net shooting. Generally fishermen operate only one or two time per night. Fishing ground of small purse seine is about five nautical miles from shore (about 1.5 hr travel time).

Fishing season

The fishing season in this area is six month due to strong wind and wave that is influence of south west monsoon. Average catch of small purse seiner is about 200 viss (320 kg/season/boat). Catch that was observed on 30th January are king mackerel, black pomfret, frigate tuna, anchovy, mackerel, wolf herring, squid, etc.

Most of the catches then were dry under sun light for sending to Yangon and some were directly export to China. Only few good quality fish was daily transport to Yangon due to the inconvenient of transportation.

The other fishing gears that were observed are gill net, hand line and bottom long line. They more utilized pelagic then demersal resources.

Fishing village observation

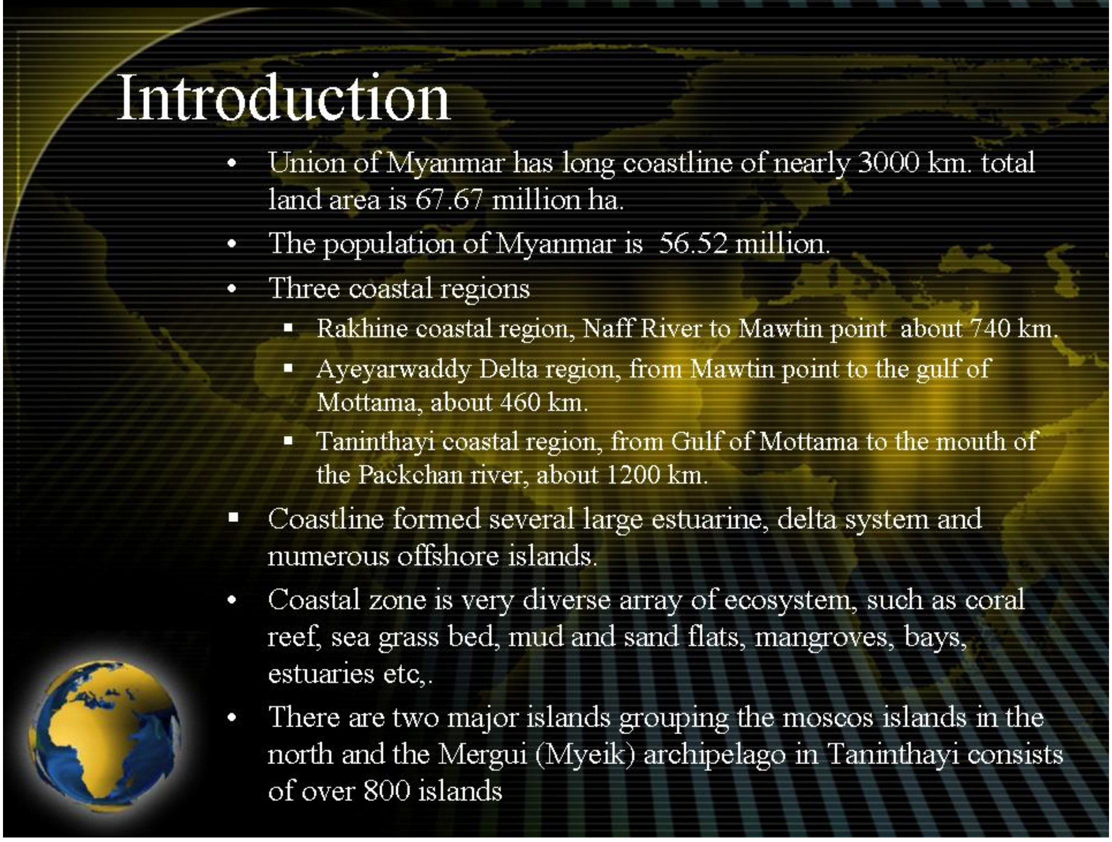
When the fishing boats went to the sea for survey, there is a time to observe the fishing village. There are fishing villages or fishing communities along the coastline called "jade-taw". Sand

beaches along the coast, the fishing boats are loading the catch and young villagers carried the catch by buckets. And some are preparation for sun dried small fishes (most are anchovy). After finished the survey activities, all the member of the survey team have a chance to visit the fishing village jade-taw.
Survey team observed the local purse seine net construction at the workshop of the leader called U Nyi Lay Gyi and the morning activities of the village. There are the many labors for sun dried fish processing house. It can observed the process for the sun dried fish.
The interesting information from discussion with leader local fisherman called Mr. Nyi Lay Gyi who observed that the high abundance streaked spine foot in this area is 10 years cycle.

The findings for future

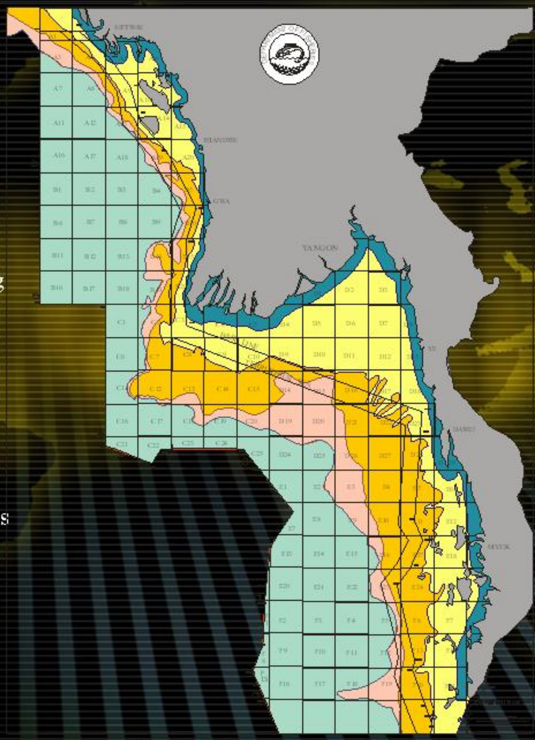
- The fishing time gap between (local fishermen and survey team) the nature of longliners and purse seiner local fishermen went out for fishing at evening time, came back early morning and the survey team use to go out sea at early morning finishing and came back evening time.
- Selected hook size, may be reduced amount of catch
- The capability of the fishing vessels, two of the using boats are ferry boats and the problem is they could not go out enough the depth range.
- Need to collect more parameters such as water temperature, salinity, etc,.
- Need to conduct more detail survey in Rakhine area collaboration with Southeast Asian Fisheries Development Center using MV-SEAFDEC 2


Status of Deep Sea Fishery survey in Myanmar
Aung Htay Oo
Senior Fishery Officer
Marine Fisheries Conservation Unit, DOF.
aunghtayoo21@gmail.com


Introduction
• Union of Myanmar has long coastline of nearly 3000 km. total land area is 67.67 million ha.
• The population of Myanmar is 56.52 million.
• Three coastal regions
▪ Rakhine coastal region, Naff River to Mawtin point about 740 km.
▪ Ayeyarwaddy Delta region, from Mawtin point to the gulf of Mottama, about 460 km.
▪ Taninthayi coastal region, from Gulf of Mottama to the mouth of the Packchan river, about 1200 km.
▪ Coastline formed several large estuarine, delta system and numerous offshore islands.
• Coastal zone is very diverse array of ecosystem, such as coral reef, sea grass bed, mud and sand flats, mangroves, bays, estuaries etc,.
• There are two major islands grouping the moscos islands in the north and the Mergui (Myeik) archipelago in Taninthayi consists of over 800 islands

Contin:

- Union of Myanmar, with an area of 676,577 sq kilometer
- A long coastline nearly 3000 kilo meter from border with Bangladesh to Northern-most Taninthayi division.
- Rich in aquatic resources
- Total swamp area is 0.5 million hectares serving as spawning, nursery and feeding grounds for near shore aquatic and brackish water fauna
- Continental shelf covers 228,751 sq kilometers
- The territorial fishing zone is within 12 nautical miles from baseline
- The EEZ covers 200 nautical off shore from baseline
- Myanmar fisheries water including EEZ is 486,000 sq kilometer



Rakhine state

- Situated in the westernmost part of the nation
- Boarding with Chin state in North and Magway division. Bago and Ayeyarwaddy division in the east and facing Bay of Bangal in the west.
- The area of Rakhine state is 22852.68 sq km.
- Located in tropical monsoon region, temperature never rise or fall extremely.
- Average temperature in Sittwe in May the hottest month of the year is 84º F (29º C), in January the coldest month of the years is 70ºF (21ºC)
- Rakhine gets a lot of rain annually as the north-west monsoon wind blows from the sea.
- Annual rain fall at Thandwe is 221 inches.

Rakhine state (contin:)

- Kyauk-Phyu gets 186 inches, Sittway get 203 inches.
- Torrential rainfall and tidal wave rise from sea when cyclones that are formed in the Bay of Bengal, enter Rakhine state, causing proper damages and flooded sea water in the low land area.
- Though the storm appears mostly in early and late period of rainy season. Sometime appear in the mid rainy season.

Rakhine state (contin:)

- There are fishing industries in Sittway, Kyaukphyu, Thandwe and Andrew bay.
- Most of the catch is transported to Yangon directly.
- State own pearl culture station is situated on Apawye island near Thandwe.
- Sun dried fish and salt are produced along the coast, produced sundried indian anchovy *Stolephorus indicus* and spanish mackerel *Scomberomorus commerson* as well.

Previous surveys

Analyzer	Year	Reference	Demersal (ton)	Pelagic (ton)	Total
Jone, S & Baner Ji, S.K	1968	review of the living resources of central Indian Ocean Proc. of Symp. In 200 mtr depth range.	775,000	800,000	1,575,000
Somura, R. S.	1969	Area review on living resources of the world's ocean FAO fish Circ. (109.10.Rev-1) in 200 meter depth line.	625,000	-	-
Prasad, R et al	1970	A quantitative assessment of potential fishery resources of Indian ocean & adjoining seas	326,000	400,000	726,000[a] it seem to be MSY
Gulland, J. A	1972	The fishery resources of the Indian Ocean	625,000	-	-
Narr et al	1973	estimated based on the production of carbon per square meter is 0.630 gm			1,512,000 tonnes
Menon, M.D	1977	Plan proposal for PPFC for development in the marine fisheries sector	783,000	729,000	1,512,000[b]

b= Menon and PPFC team analyzed the trawl catch data of PPFC for 1975-77 and c alculated standing stock of demersal fish for Burmese shelf area.

UNDP/FAO Project BUR/77/003

- In 1979-80, the research vessel "Dr. Fridtjof Nenson" conducted survey in Myanmar water.
- The objectives of the project, to which these survey were expected to contribute
  - To make an estimate of marine fish biomass with the EEZ of Myanmar and in particular, over its continental shelf.
- Survey methods
  - Acoustic estimation of biomass of demersal and pelagic fish.
  - Estimation by Trawl fishing for identification and sampling and for assessment of catch rates.
  - Recording types of bottom samples, hydrographical profiles form coast to 500 mtr depths for temperature, salinity and oxygen.
- As a result, 1.0 million metric ton of pelagic fish and 0.8 million metric tons of demersal fish are exists as biomass in Myanmar.

Shrimp resource survey

- In 1982, Dr. John Tarbit conducted the shrimp resources survey till 60 mtr depth range in Rakhine area.
- Estimated that 4370 metric tones of shrimp in 5102 sq miles water between 17° to 20° North latitude.
- In 1985, DOF conducted deep sea survey by 533 shrimp trawler, mean catch rate is 31.18 kg/hr
- Then, Thai-Myanmar joint survey was conducted as well and mean catch is 31.6 kg/hr.
- Then, DOF of Myanmar and SEAFDEC conducted two time partial deep sea survey in Myanmar in 2004 and 2007.

FRTV- Chulabhorn

In 1990, Joint Myanmar-Thai fishery exploratory Survey has been conducted in Myanmar water

Research operation with FRTV- Chulabhorn

Fishery Biological survey, Acoustic survey and

Oceanographic survey were carried out.

The result of overall catch rate was 183.67 kg/hr with about 79.94%of economically important fish and 20.06% of trash fish.

A complete classification of 65 families and 226 species were identified from trawl catch.

The highest catch rate observed was 1,473 kg/hr which was obtained at the depth of 105.0 mtr at station No-2 in Delta area.

Myanmar-India oceanographic survey

- In 2002, the joint Myanmar-India oceanographic survey was conducted in Bay of Bengal and Andaman sea.
- To study the marine plankton distribution, benthos, chemical and mineral content of the sea water etc;
- This survey was supported by National Institute of Oceanography
- The survey team from Indian scientists and Myanmar scientists lead by Dr. Swe Thwin who is professor of marine science from University of Mawlamyein.

The activities of SEAFDEC 2 in Myanmar water

•In 2004 and 2007, the oceanographic survey and fishery survey was conduc ted in Myanmar water.

• FRTV-SEAFDEC 2 from Southeast Asia Fisheries Development Center (SEAFDEC)

•Survey team scientists from departm ent of Fisheries (Thailand) and Fisher y scientists from Department of Fisheri es Myanmar.

•Studied the catch composition, speci es composition, length frequency and oceanographic parameters.

Jointed Ecosystem based deep sea survey in bay of Bengal

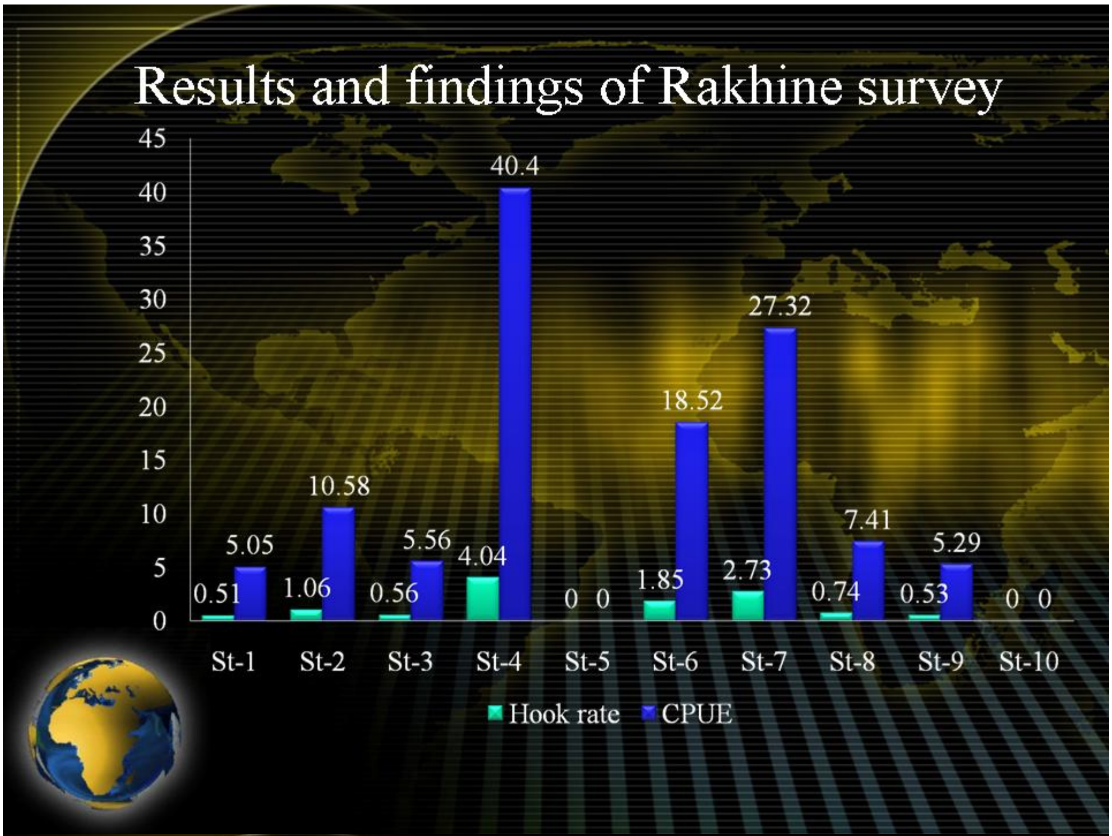
- In 2007, the ecosystem based deep sea survey and fishery survey was conducted in Sri Lanka, India and Myanmar water.
- using FRTV-SEAFDEC from Southeast Asia Fisheries Development Center (SEAFDEC)
- Survey team scientists from India, Sri Lanka, Nepal, Bangladesh, DOF of Thailand, SEAFDEC and Myanmar.
- The fishing gears used are gillnet, long line, and automatic squid jigging.
- Studied the catch composition, species composition, length frequency and oceanographic parameters and many sub-projects.

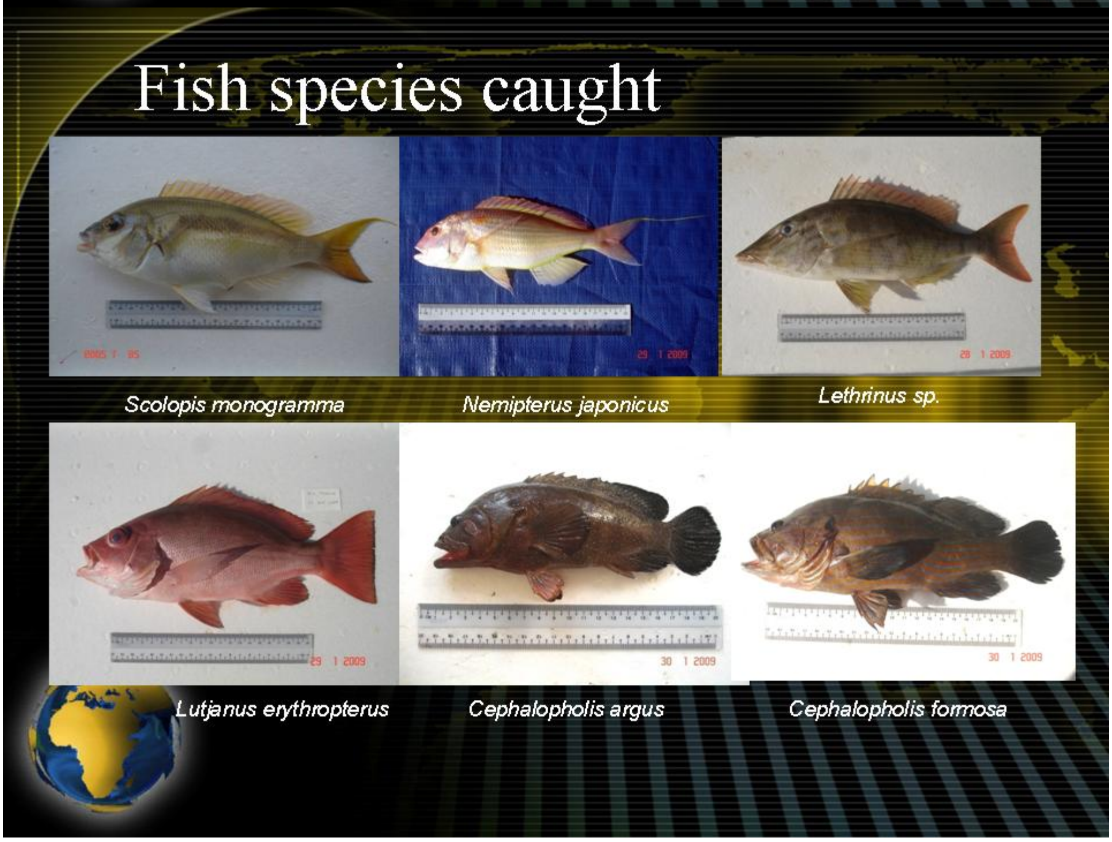
Demersal fishery resource survey in untrawlable fishing ground at Rakhine in January 2009.

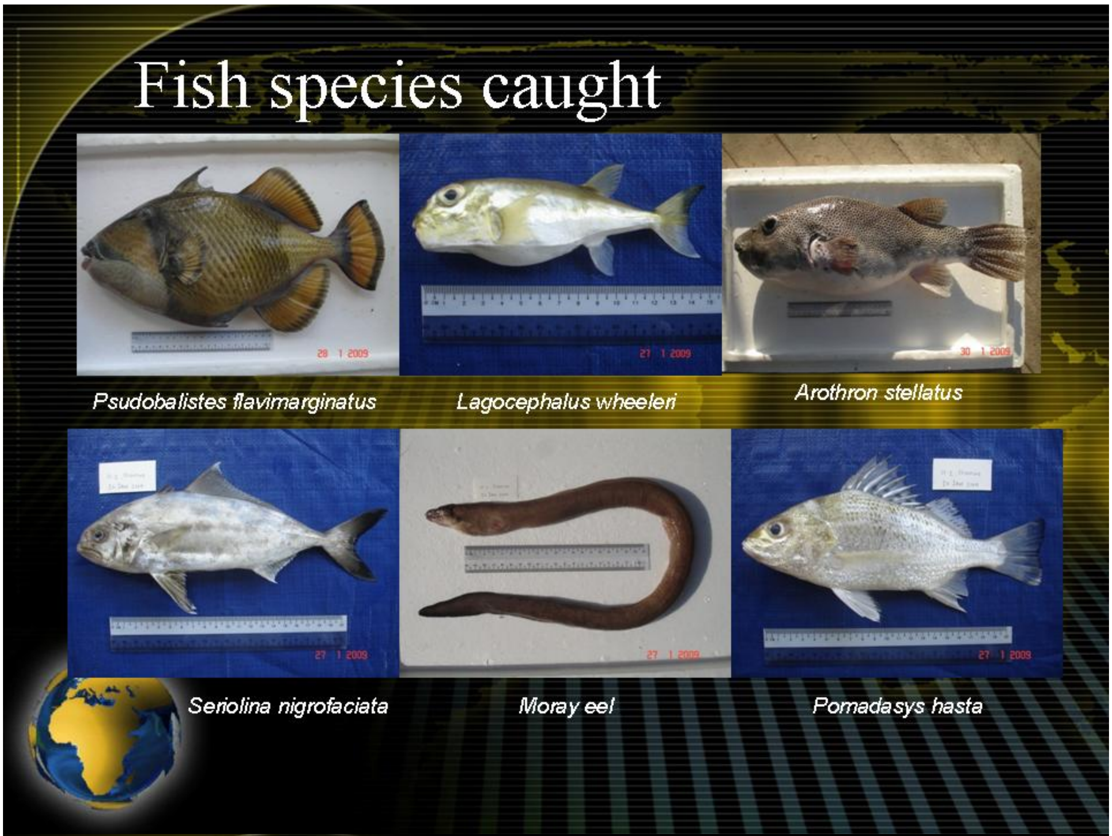
- The objectives
  - To investigate the potential resources of some economically important species.
  - To introduce and carry out trial of appropriate/ responsible fishing gears and practice for harvesting of fisheries resources on the untrawlable grounds.

Material and method

- Fishing gear: Bottom vertical long line
- Bait : squids
- Immersion time : 2 hr
- No of St: 10 stations
- Topography survey : portable echo sounder
- Fishing boats: 2 local fishing boats (photos)
- Researchers from SEAFDEC and DOF Myanmar.
- 10 local fishermen joined on board


Results and findings of Rakhine survey
45
40
35
30
25
20
15
10
5
0
0.51
5.05
1.06
10.58
0.56
5.56
4.04
40.4
0 0
1.85
18.52
2.73
27.32
0.74
7.41
0.53
5.29
0 0
St-1
St-2
St-3
St-4
St-5
St-6
St-7
St-8
St-9
St-10
Hook rate
CPUE

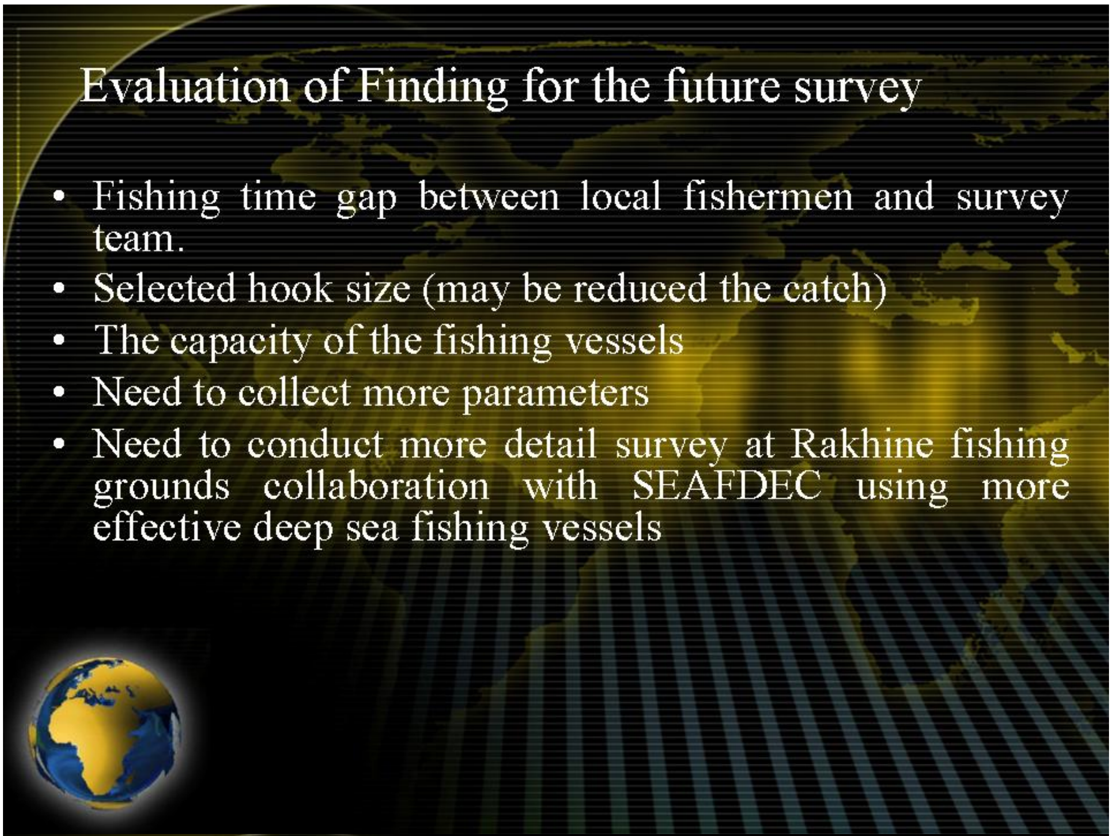

Fish species caught
Scolopis monogramma
Nemipterus japonicus
Lethrinus sp.
Lutjanus erythropterus
Cephalopholis argus
Cephalopholis formosa

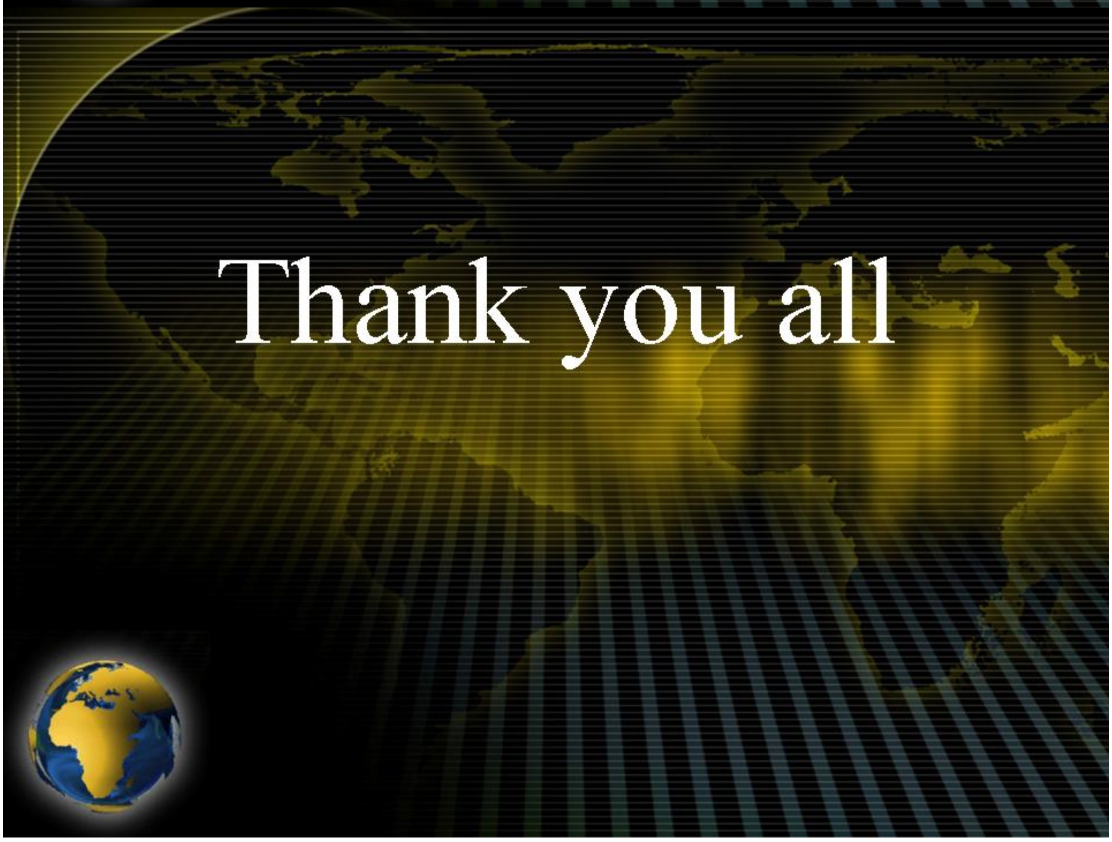

Fish species caught
Psudobalistes flavimarginatus
Lagocephalus wheeleri
Arothron stellatus
Seriolina nigrofaciata
Moray eel
Pomadasys hasta


Fish species caught
Arius sp

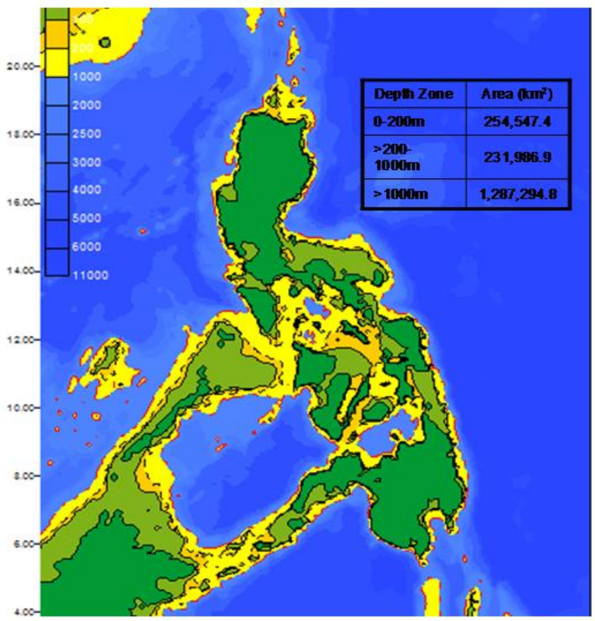

Observation of Fisheries activities of Rakhine area


Providing fishing gears to the local fishermen


Evaluation of Finding for the future survey
• Fishing time gap between local fishermen and survey team.
• Selected hook size (may be reduced the catch)
• The capacity of the fishing vessels
• Need to collect more parameters
• Need to conduct more detail survey at Rakhine fishing grounds collaboration with SEAFDEC using more effective deep sea fishing vessels


Thank you all

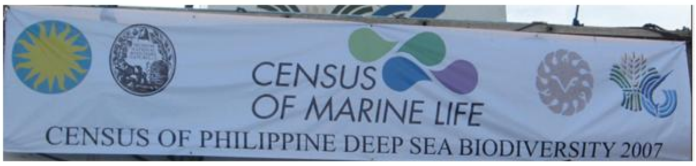
DEEP WATER AREAS



Year	Deep Sea exploration
1799-1817	H Samarang Exploration
1839-1843	HMS Erebus and Terror exploration
1857-1858	Navarra Exploration
1873-1876	Challenger Exploration
1907-1910	Siboga and Albatross
1907--1912	Planet Expedition
1927	Emden Expedition
1929	RSS Dana II expedition
1930	HMS Villebrord Snellius expedition
1940's	Cape Johnson Exploration
1948	Exploratory surveys for deepwater sharks
1950's	Exploratory surveys for a living fossil crustacean in Verde Passage
1951	Galathea expedition
1992	Resource and ecological assessment of Ormoc Bay
1996-1997	Survey of non-traditional invertebrate stocks in Panay Gulf
1998	Deepwater survey of Marinduque
2000	Deepwater survey off mindoro
2001	Deepwater survey in Davao Gulf

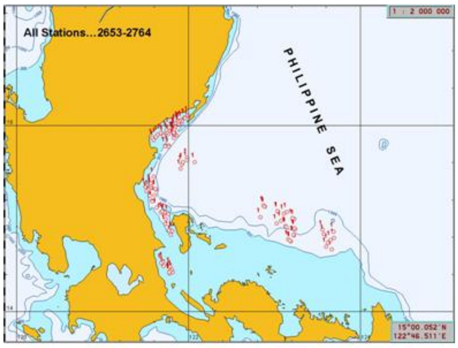
Survey of Deep-Water Benthic Fauna

2005-2008

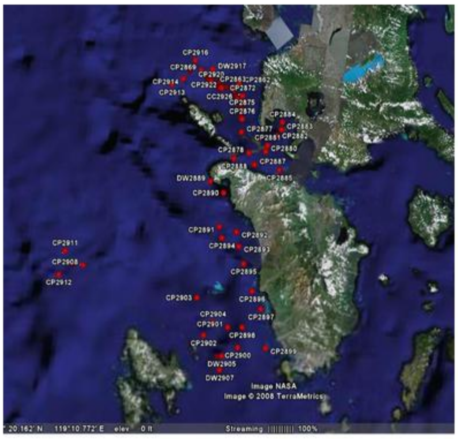


Survey of Deep-Water Benthic Fauna

AURORA 2007



LUMIWAN 2008



RESULTS TRAWLING

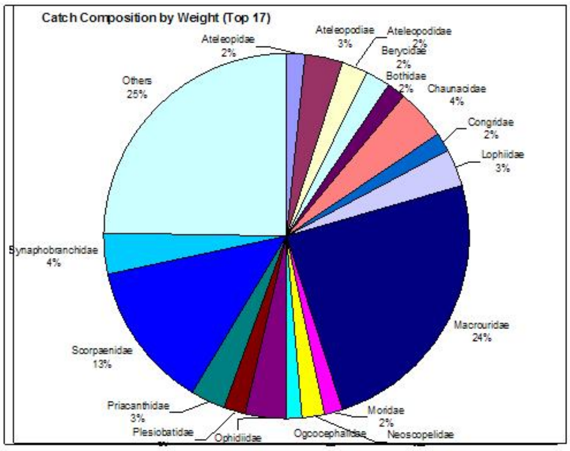
Shrimps and Lobsters Species Collected, LUMIWAN 2008 Expedition

Family	Genus	Species
ARISTEIDAE	Parahempomadus	vaubani
ARISTEIDAE	Acantephyra	armata
ARISTEIDAE	Aristaemorpha	sp
ARISTEIDAE	Aristeus	virilis
NEMATOCARCINIDAE	Netatocarcinus	sp
NEPHROPIDAE	Metanephrops	sinensis
NEPHROPIDAE	Metanephrops	thomsoni
NEPHROPIDAE	Nephropsis	stewarti
NEPHROPIDAE	Metanephrops	australiansis
PANDALIDAE	Plesionika	grandis
PANDALIDAE	Plesionika	indica
PANDALIDAE	Plesionika	lephosis
PANDALIDAE	Plesionika	semilaevis

Family	Genus	Species
PANDALIDAE	Plesionika	sp
PANDALIDAE	Heterocarpus	dorsalis
PANDALIDAE	Heterocarpus	gibbosus
PANDALIDAE	Heterocarpus	hayashii
PANDALIDAE	Heterocarpus	sibugue
PANDALIDAE	Heterocarpus	tricarinatus
PANDALIDAE	Heterocarpus	woodmasonii
PENAEIDAE	Parapenaeus	investigatoris
PENAEIDAE	Parapenaeus	sextuberlatus
PENAEIDAE	Penaeopsis	sp
PENAEIDAE	Metapenaeopsis	sp
SOLENOCERIDAE	Haliopinoides	sibugue
SOLENOCERIDAE	Hymenopenaeus	aequis

6 – Families 14 – Genus 26 – Species

Fish Composition



Note: 61 stations had only been analyzed for ID out of 68 (excluding 4 otter trawl drags)

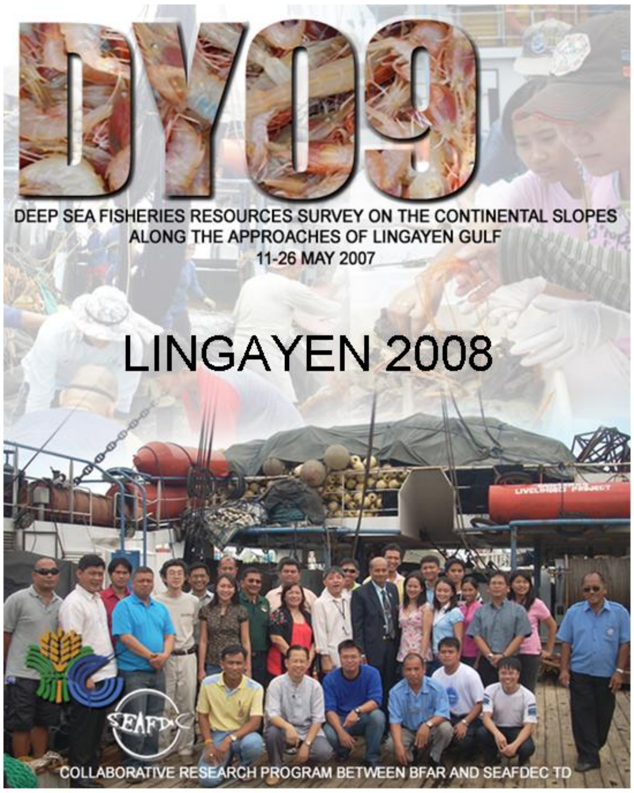
Notably…

16% by number & 24% by weight (Macrouridae)

8% by number & 13% by weight (Scorpaenidae)

11% by number (Acropomatidae)

4% by number & 4% by weight (Ophidiidae))



DEEP SEA SURVEY SAMPLING GEARS

BEAM TRAWL

OTTER TRAWL

TRAP

SAMPLING STATIONS

BEAM TRAWL STATIONS

Date	Stn Code	Stn Number	Depth_range (m)
13-May-08	BTR	512	Briddle line was cut
13-May-08	BTR	513	400-600
14-May-08	BTR	514	>1000
14-May-08	BTR	515	200-400
20-May-08	BTR	517	200-400
20-May-08	BTR	518	400-600
20-May-08	BTR	519	600-800
20-May-08	BTR	520	600-800
20-May-08	BTR	522	600-800
21-May-08	BTR	523	800-1000
21-May-08	BTR	524	400-600

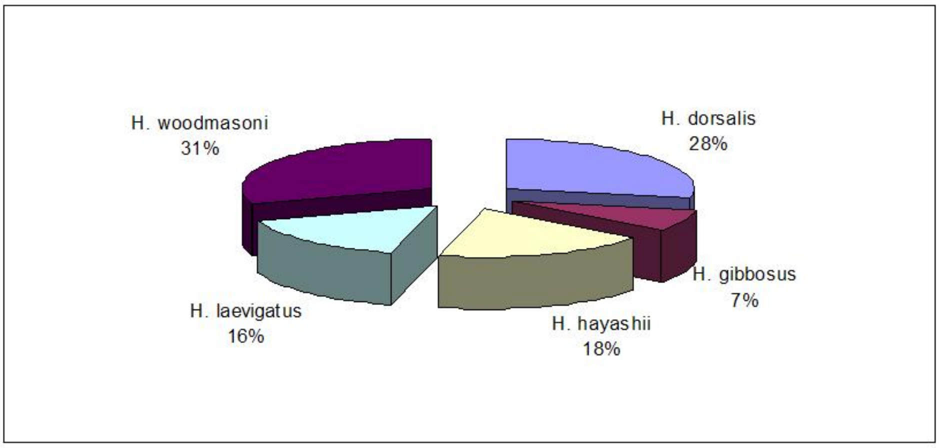
DEEP SEA TRAP STATION

Date	Stn Code	Stn #	Depth_range (m)
14-15 May-08	TRA	511	200-400
20-21 May-08	TRA	516	200-400
21-22 May-08	TRA	521	600-800

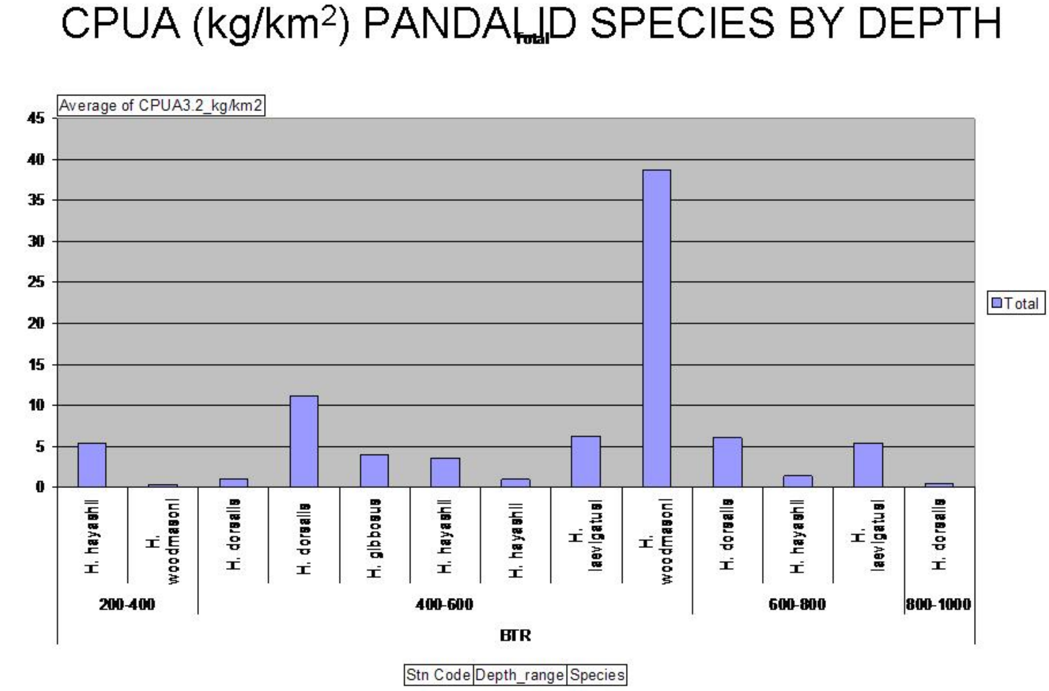
METHODS

- Beam trawl - the swept area method to estimate the catch-per-unit-area (CPUA)
- CPUA = C/A where C is the total catch for the particular station
- The fraction of the biomass in the effective path swept which was actually retained by the beam trawl was estimated as CPUA*0.5
- stratified CPUA and biomass according to depth, to account difference of distribution according to depth
- For trap, CPUE (g/trap/hour).

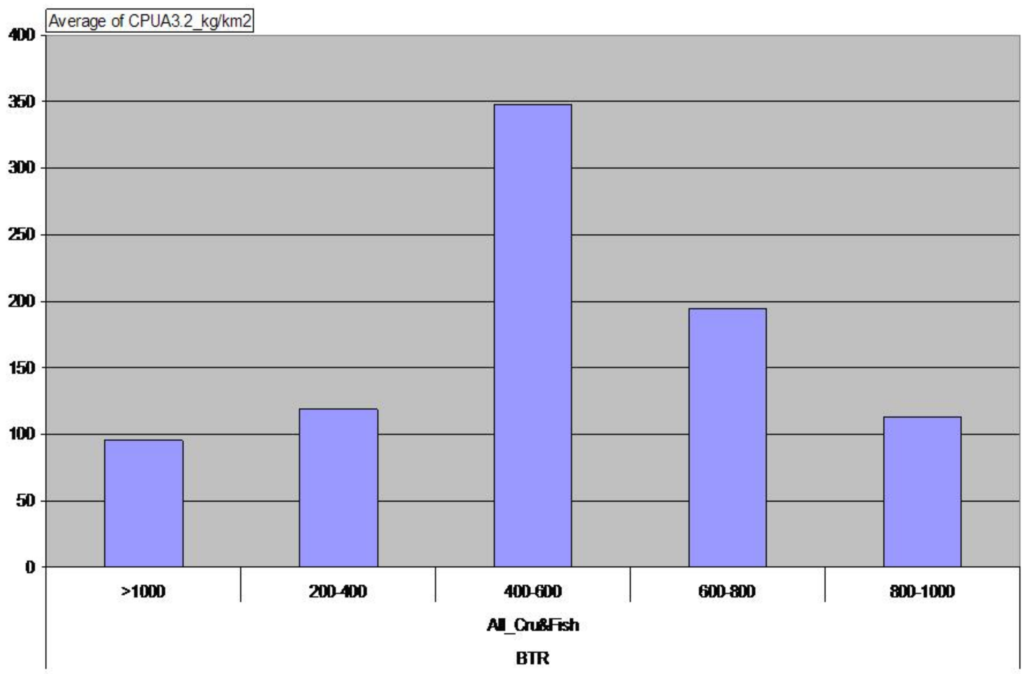
RELATIVE ABUNDANCE OF PANDALID SPECIES, BEAM TRAWL



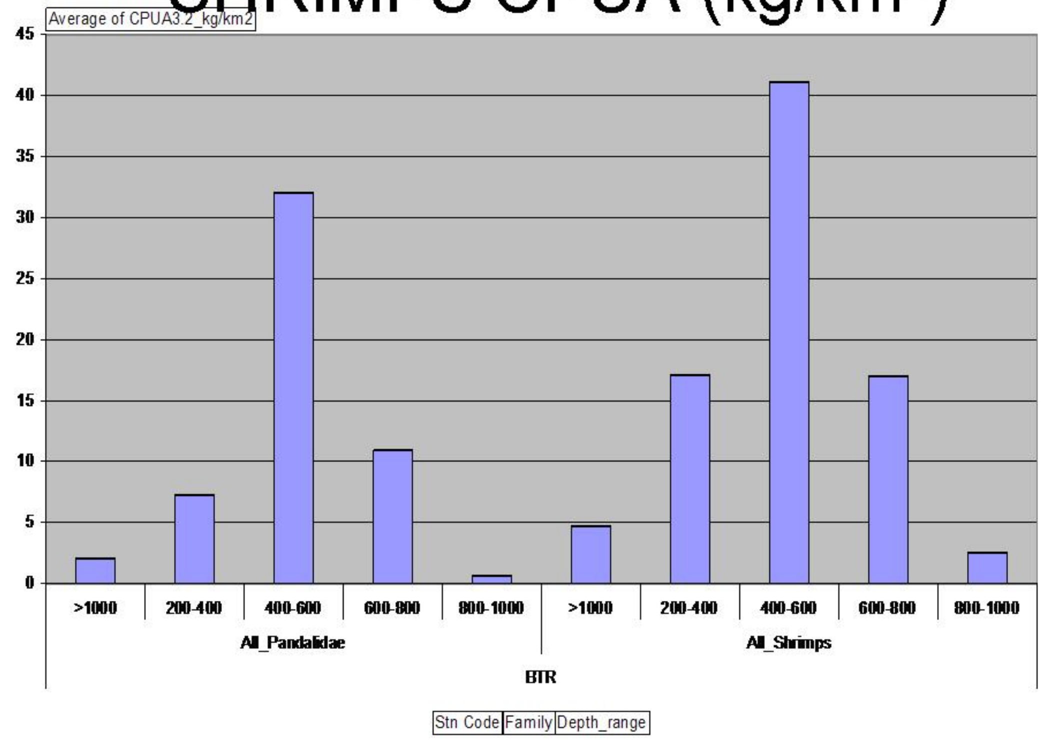
CPUA (kg/km^2) PANDALID SPECIES BY DEPTH

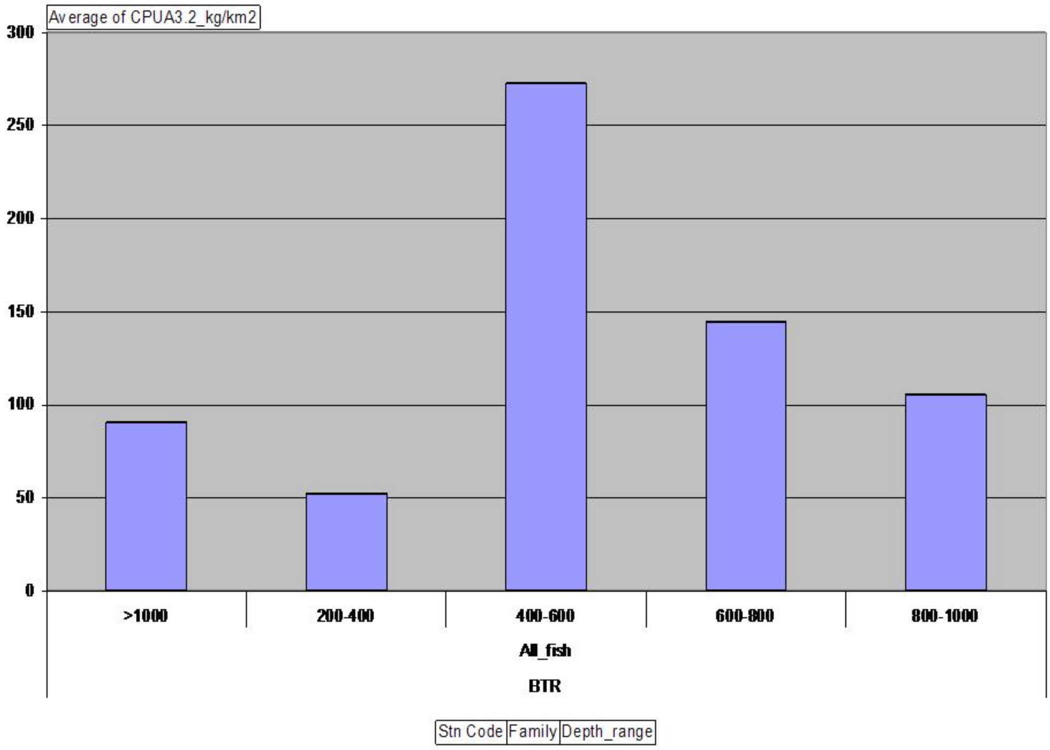


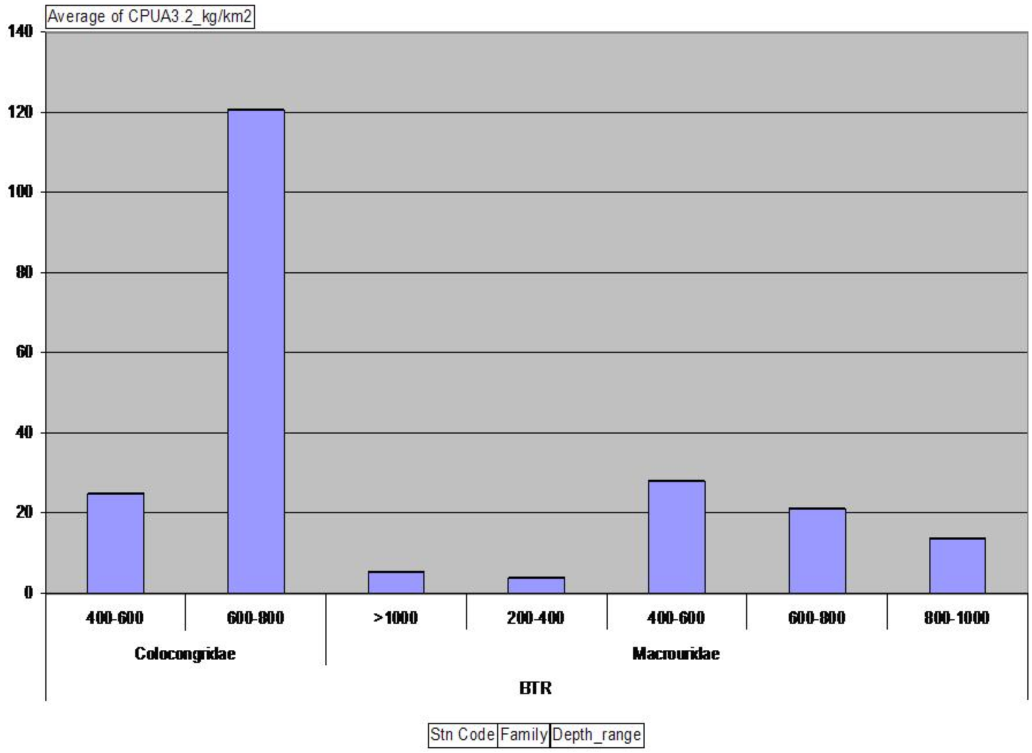
TOTAL CPUA (kg/km^2)

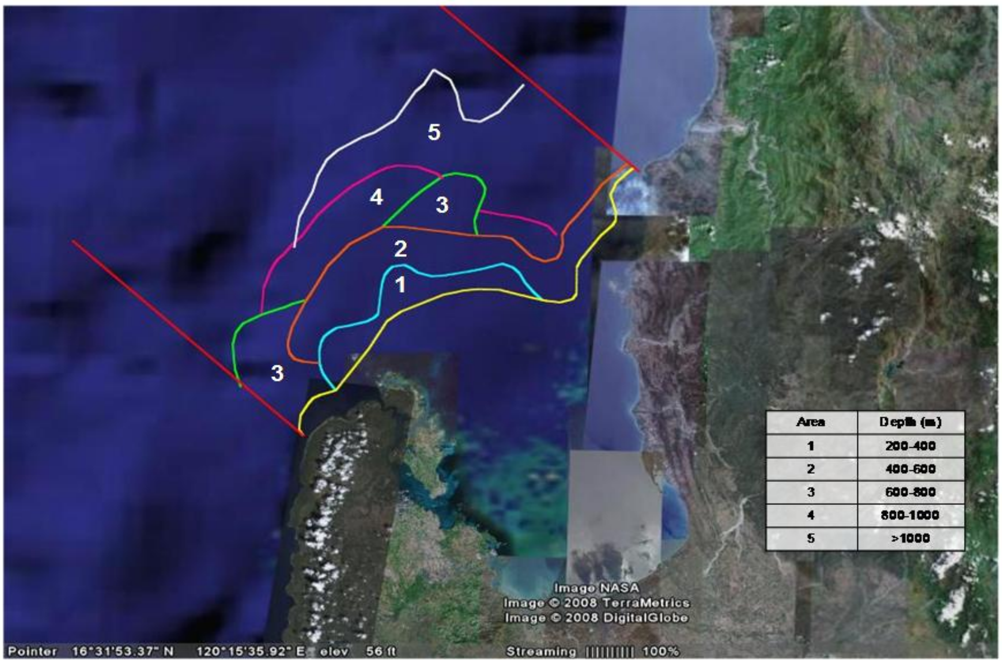


SHRIMPS CPUA (kg/km^2)





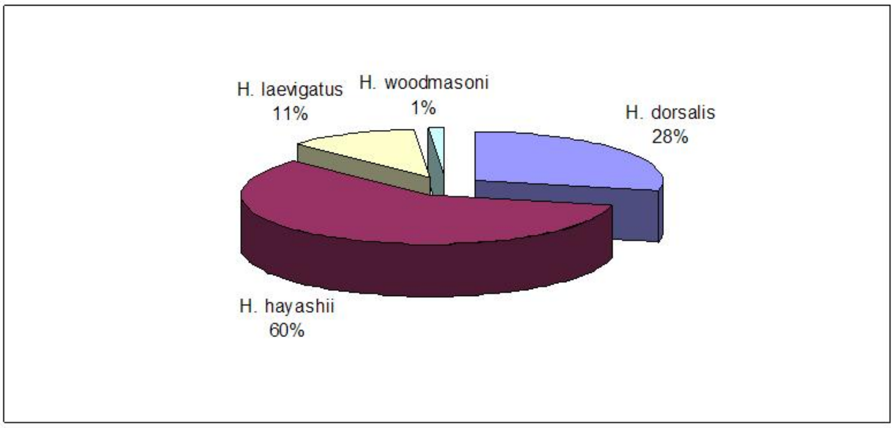

Average of CPUA3.2_kg/km2
140
120
100
80
60
40
20
0
400-600
600-800
>1000
200-400
400-600
600-800
800-1000
Colocongridae
Macrouridae
BTR
Stn Code
Family
Depth_range

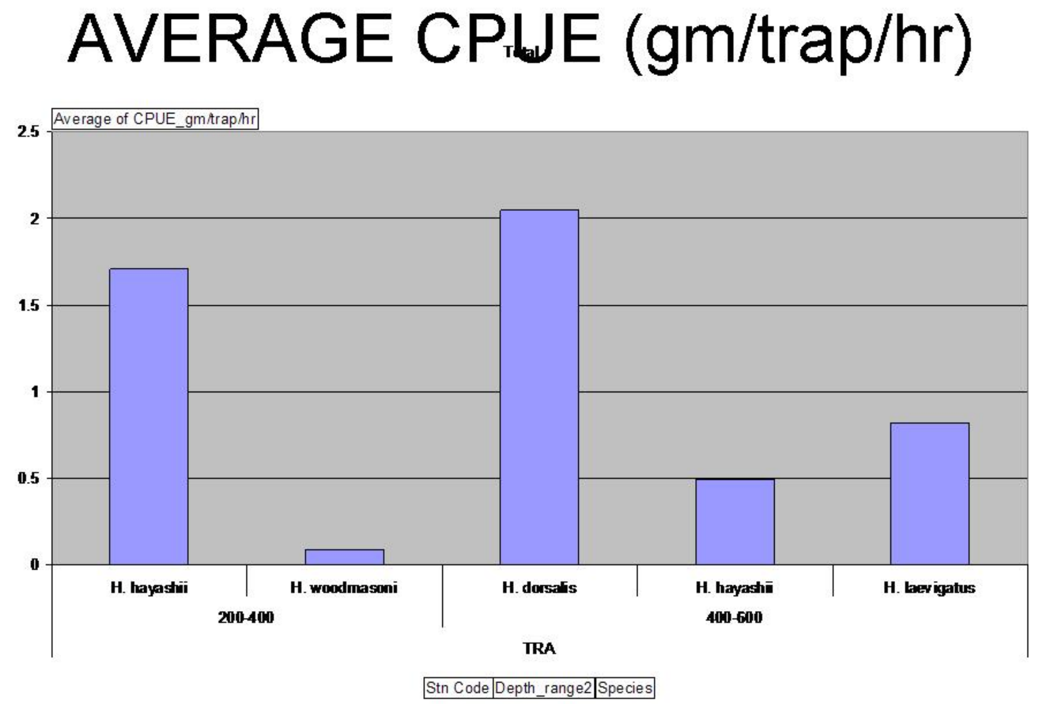

5
4
3
2
1
3
Area
Depth (m)
1
200-400
2
400-600
3
600-800
4
800-1000
5
>1000
Image NASA
Image © 2008 TerraMetrics
Image © 2008 DigitalGlobe
Pointer 16°31'53.37" N 120°15'35.92" E elev 56 ft
Streaming |||||||||| 100%

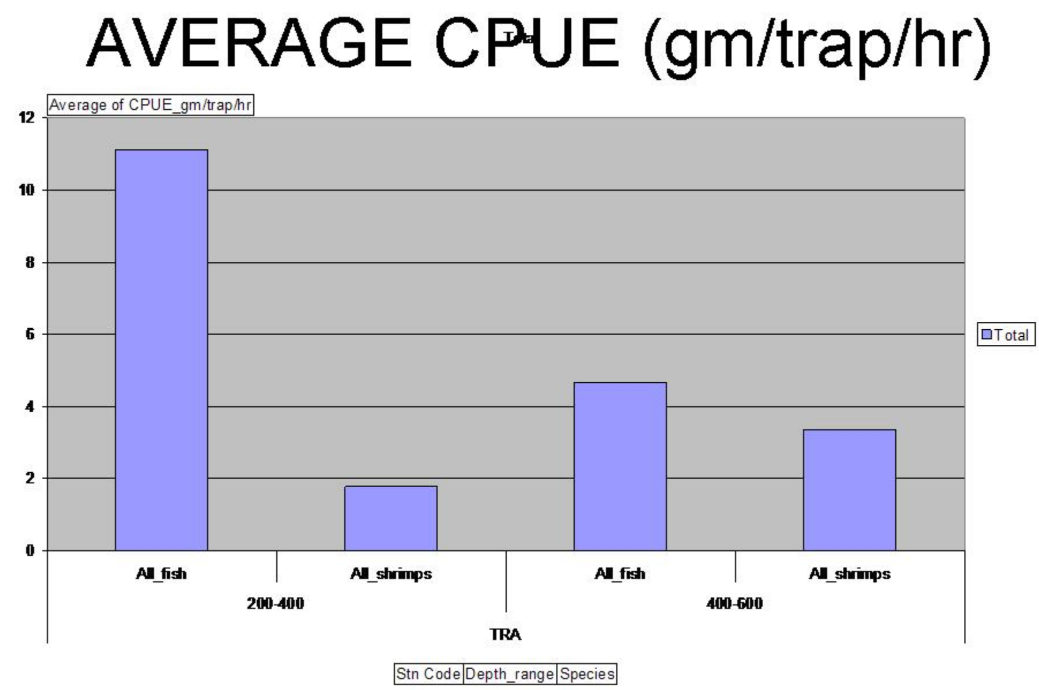
BIOMASS ESTIMATES

Depth	Total area (km^2)	BIOMASS_(tons)						
		Cru&Fish	All_Cru	All_Fish	Pandalid	All_Shrimps	Macrouridae	Colocongridae
200-400	253.81	60.242	33.645	26.597	3.694	8.683	1.921	0.000
400-600	604.52	339.924	76.540	263.385	29.679	43.343	28.116	30.042
600-800	395.47	153.460	39.249	114.211	8.615	13.448	16.696	95.405
800-1000	408.84	92.690	6.558	86.132	0.510	2.040	11.295	0.000
>1000	905.15	172.650	8.950	163.699	3.769	8.479	9.422	0.000
Total	2567.80	818.966	164.943	654.023	46.267	75.994	67.450	125.447

RELATIVE ABUNDANCE OF PANDALID SPECIES, TRAPS




AVERAGE CPUE (gm/trap/hr)
Total
Average of CPUE_gm/trap/hr
2.5
2
1.5
1
0.5
0
H. hayashii
H. woodmasoni
H. dorsalis
H. hayashii
H. laevigatus
200-400
400-600
TRA
Stn Code
Depth_range2
Species


AVERAGE CPUE (gm/trap/hr)
Average of CPUE_gm/trap/hr
12
10
8
6
4
2
0
All_fish
All_shrimps
All_fish
All_shrimps
200-400
400-600
TRA
Total
Stn Code
Depth_range
Species


05/14/2008

SUMMARY/RECOMMENDATIONS

- Pandalid shrimps were dominant and perhaps the most significant to fisheries (mainly *Heterocarpus dorsalis*, *H. woodmasoni*, H*. hayashii* and *H. laevigatus*
- Pandalid shrimps were caught at sampling depths 200m to 800m but was most abundant at 400-600m; distribution beyond 1000m possibly limited.
- CPUA for fish and crustaceans particularly pandalid shrimps was highest at 400-600m.

SUMMARY/RECOMMENDATIONS

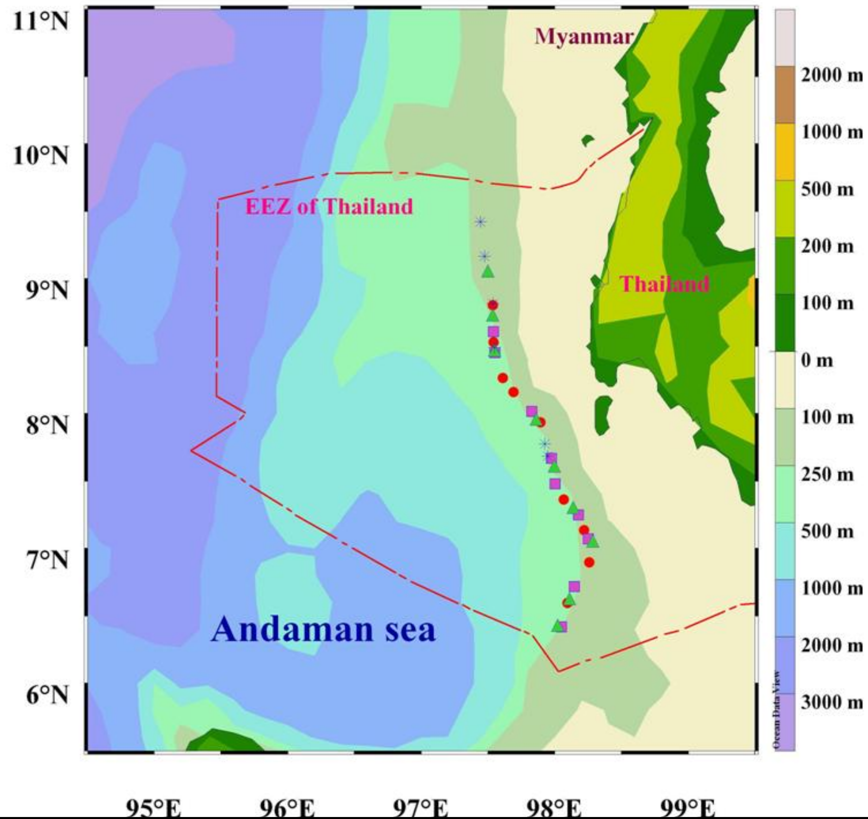
- Estimated total biomass :
  - Fish and crustaceans - 819 tons
  - Pandalid shrimps - 46 tons
- Embarking on a fishery based on above deep sea species should be done carefully following thorough feasibility and assessment studies.

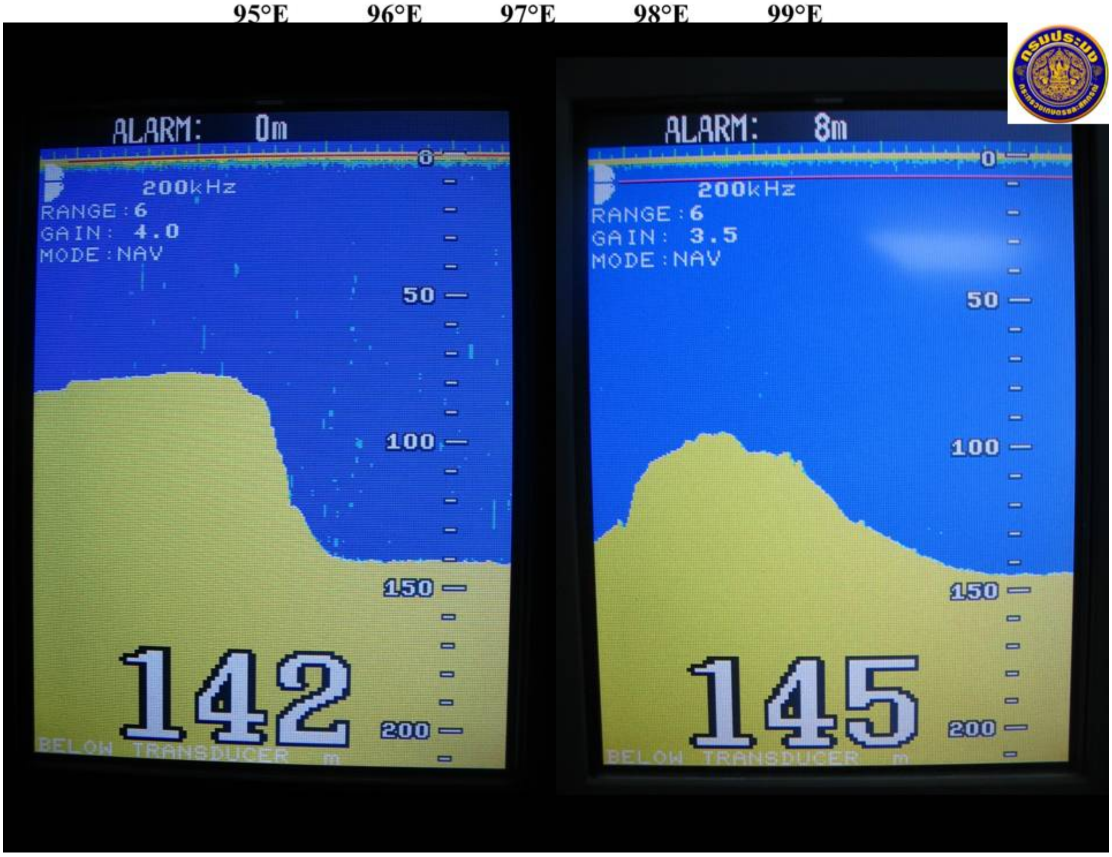
SUMMARY/RECOMMENDATIONS

- Implement pilot deep sea shrimp trap fishery
- Modify current trap design to improve efficiency.
- Use smaller shrimp trawl net.

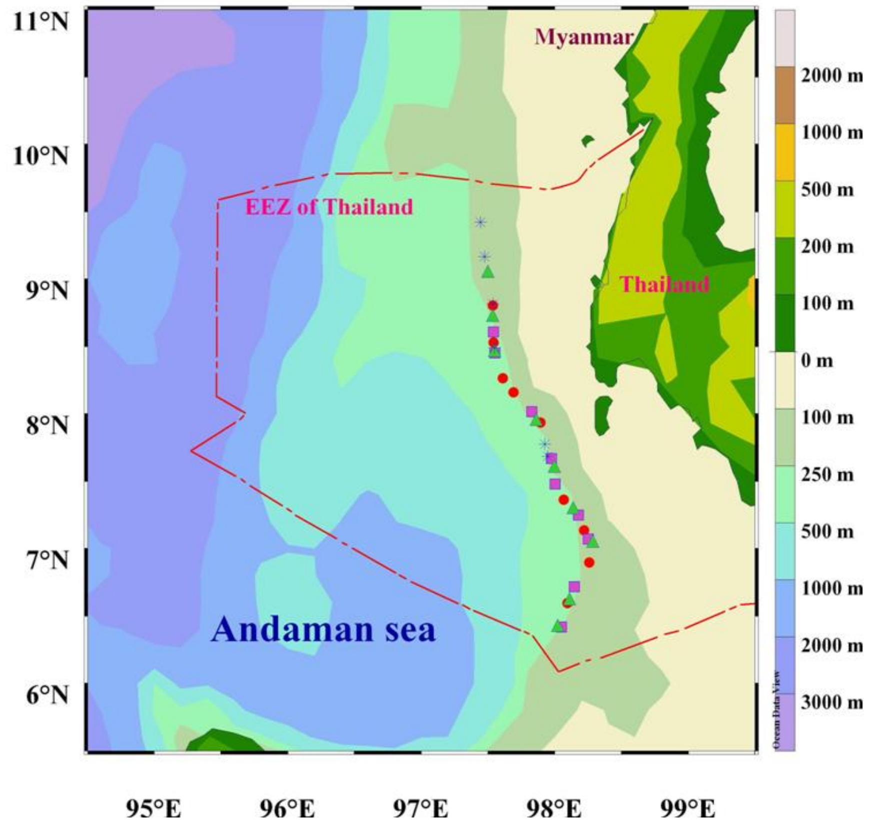
Outline

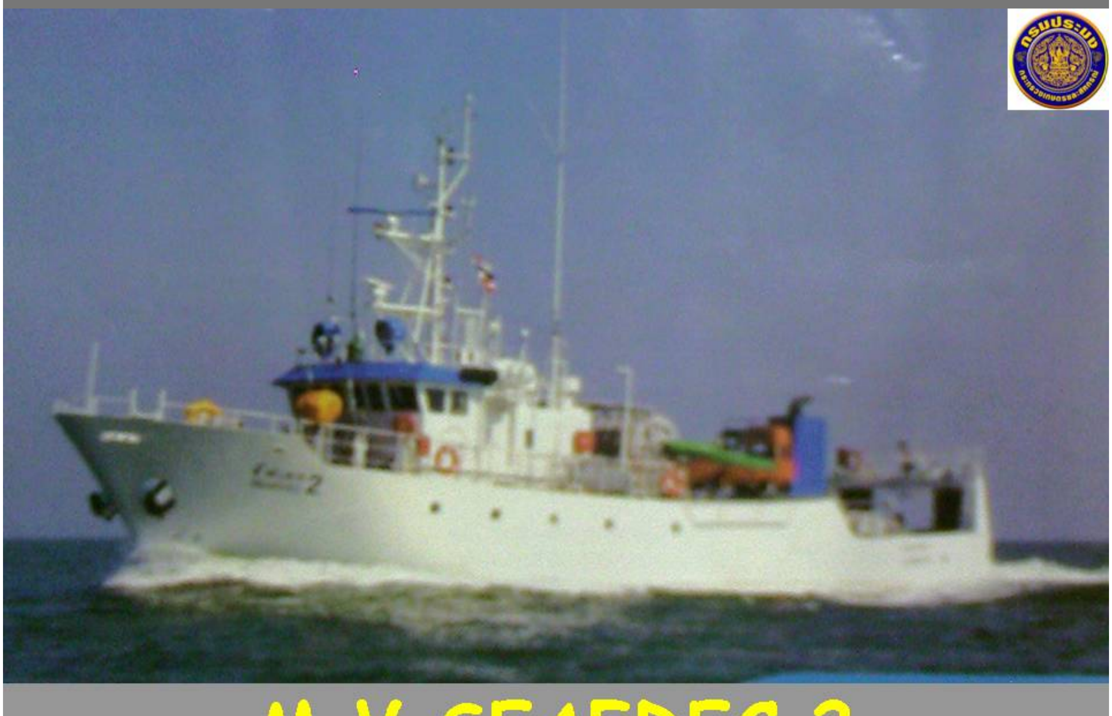
- Thai EEZ in Andaman sea
- Area of Resource Exploration in Andaman sea
- Up-to-date Resource Exploration during 2005-2008


11°N
10°N
9°N
8°N
7°N
6°N
95°E
96°E
97°E
98°E
99°E
Myanmar
Thailand
EEZ of Thailand
Andaman sea
2000 m
1000 m
500 m
200 m
100 m
0 m
100 m
250 m
500 m
1000 m
2000 m
3000 m
Ocean Data View

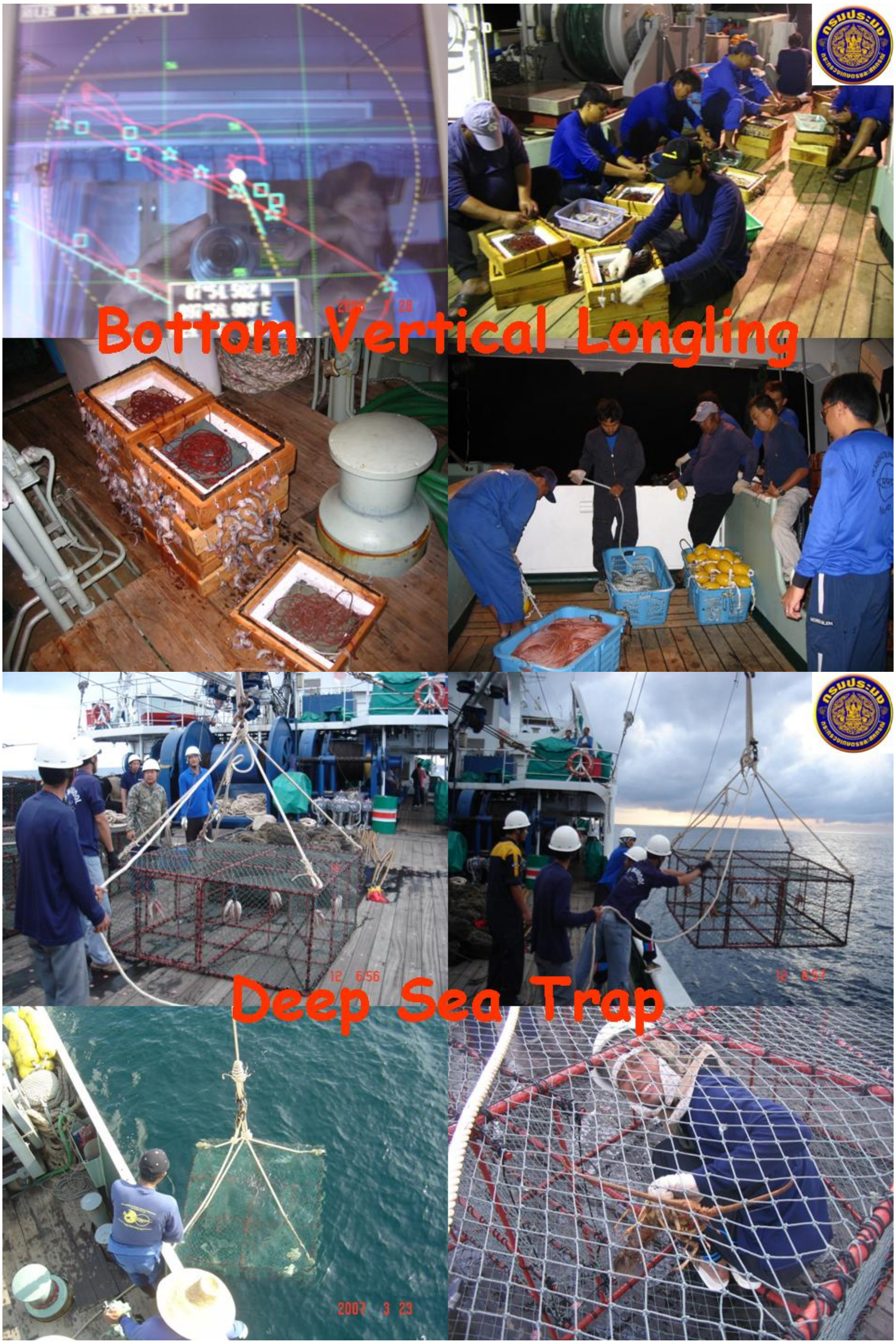

ALARM: 0m
200kHz
RANGE:6
GAIN: 4.0
MODE:NAV
0
50
100
150
200
142
BELOW TRANSDUCER m
ALARM: 8m
200kHz
RANGE:6
GAIN: 3.5
MODE:NAV
0
50
100
150
200
145
BELOW TRANSDUCER m

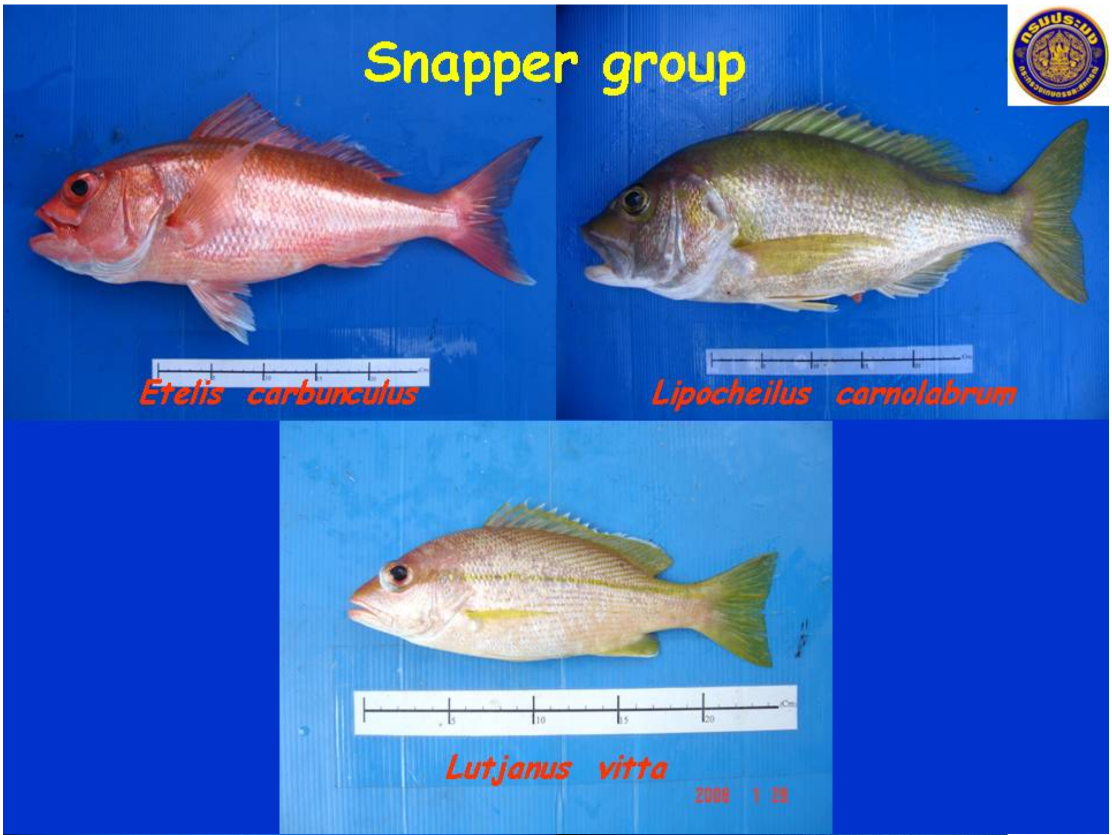
The Resource Exploration on Demersal Survey during 2005-2008

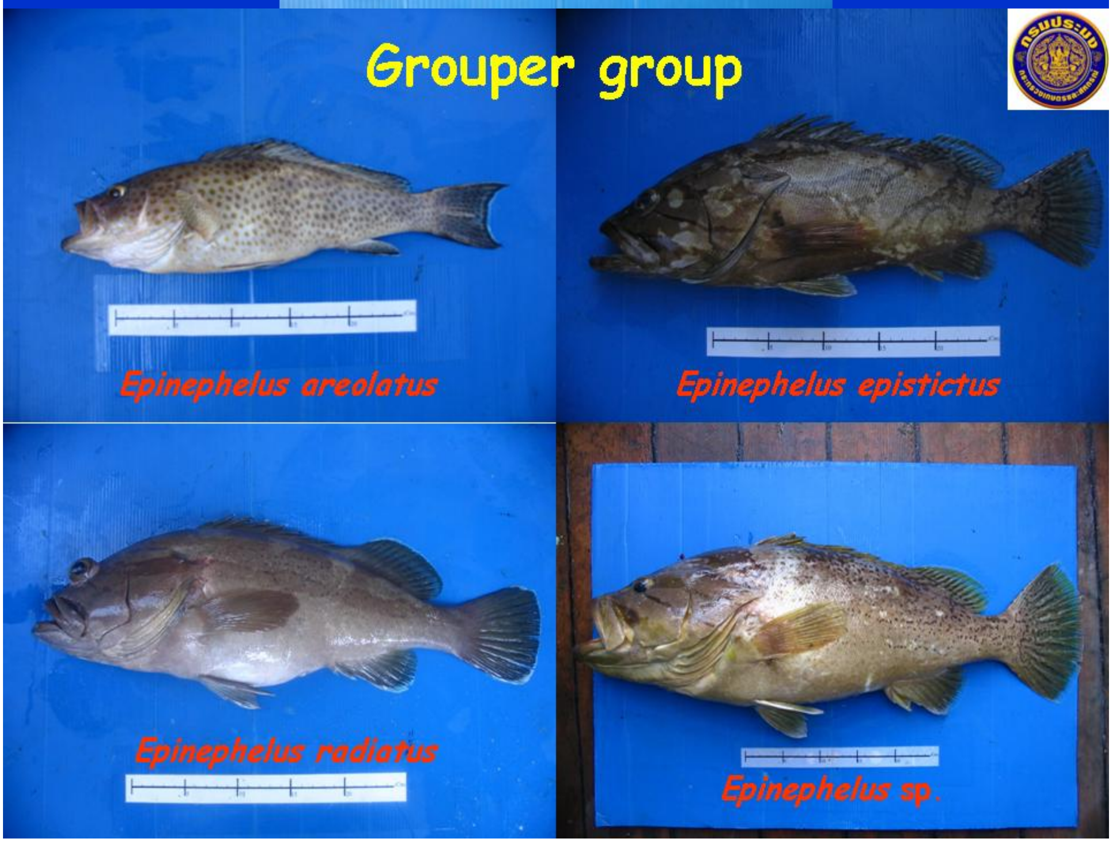


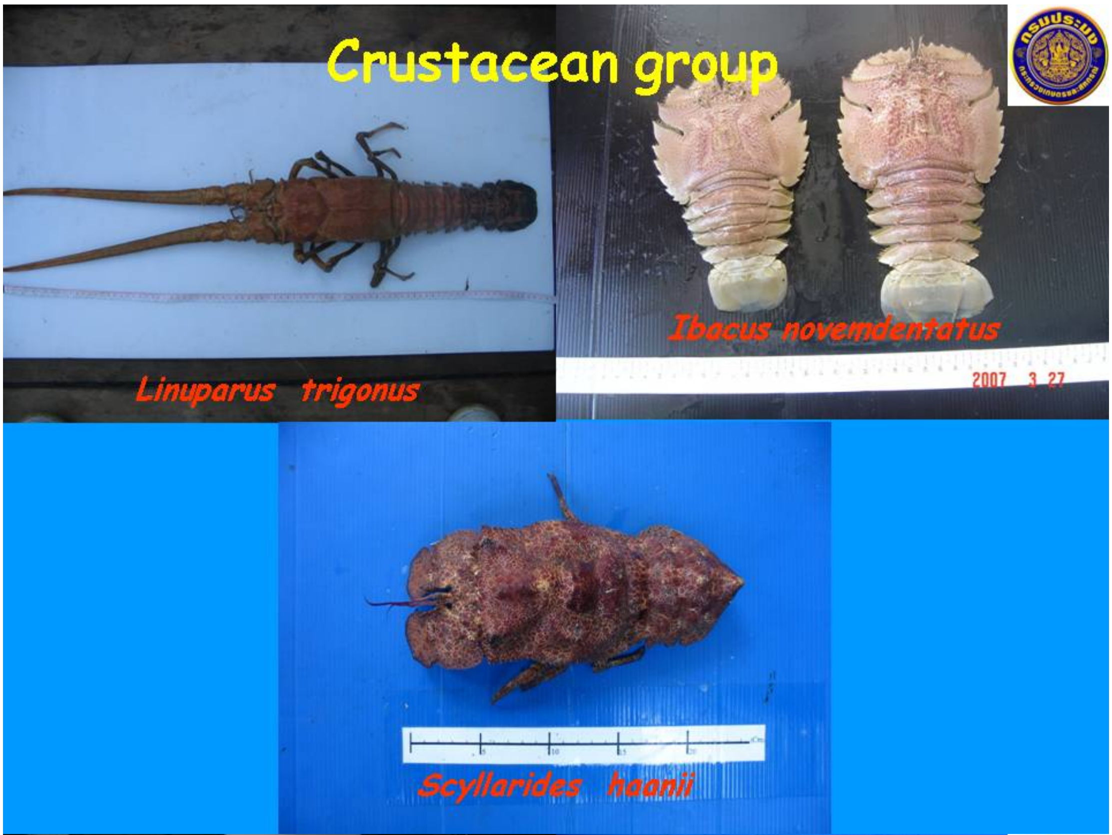


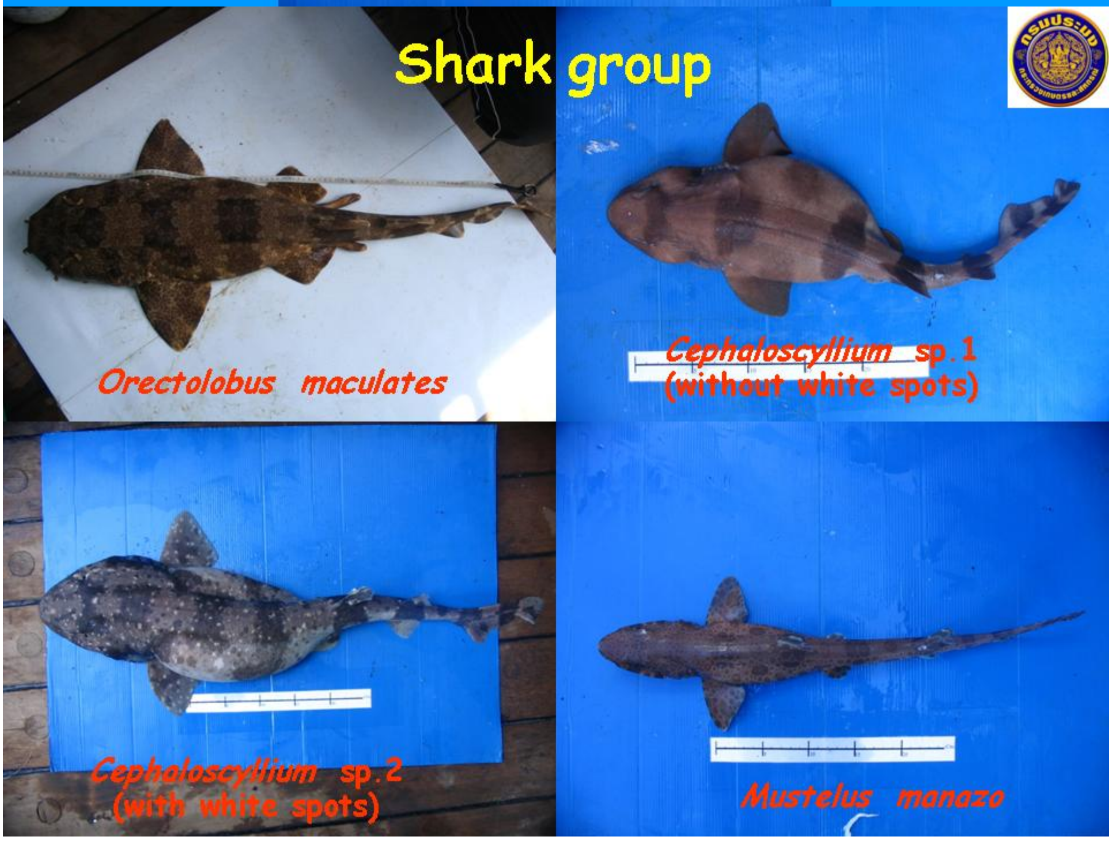
M.V.SEAFDEC 2


Bottom Vertical Longling
Deep Sea Trap

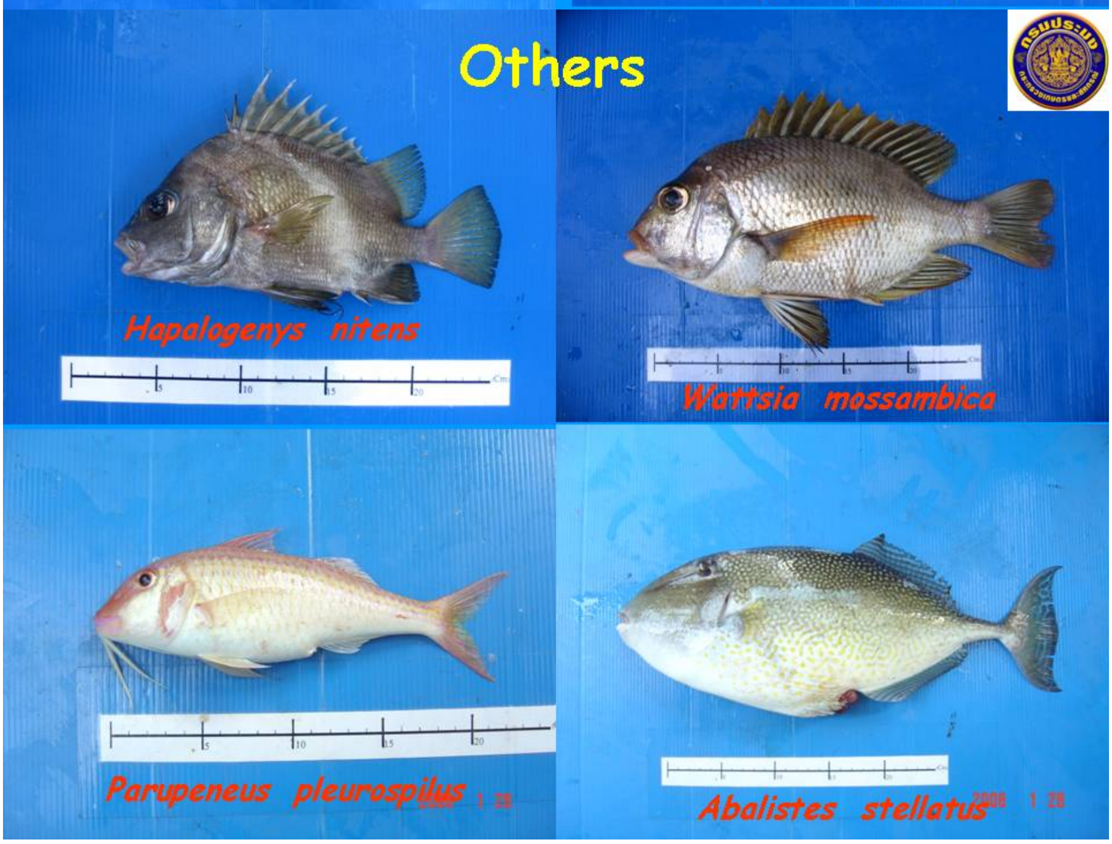

Snapper group
Etelis carbunculus
Lipocheilus carnolabrum
Lutjanus vitta


Grouper group
Epinephelus areolatus
Epinephelus epistictus
Epinephelus radiatus
Epinephelus sp.

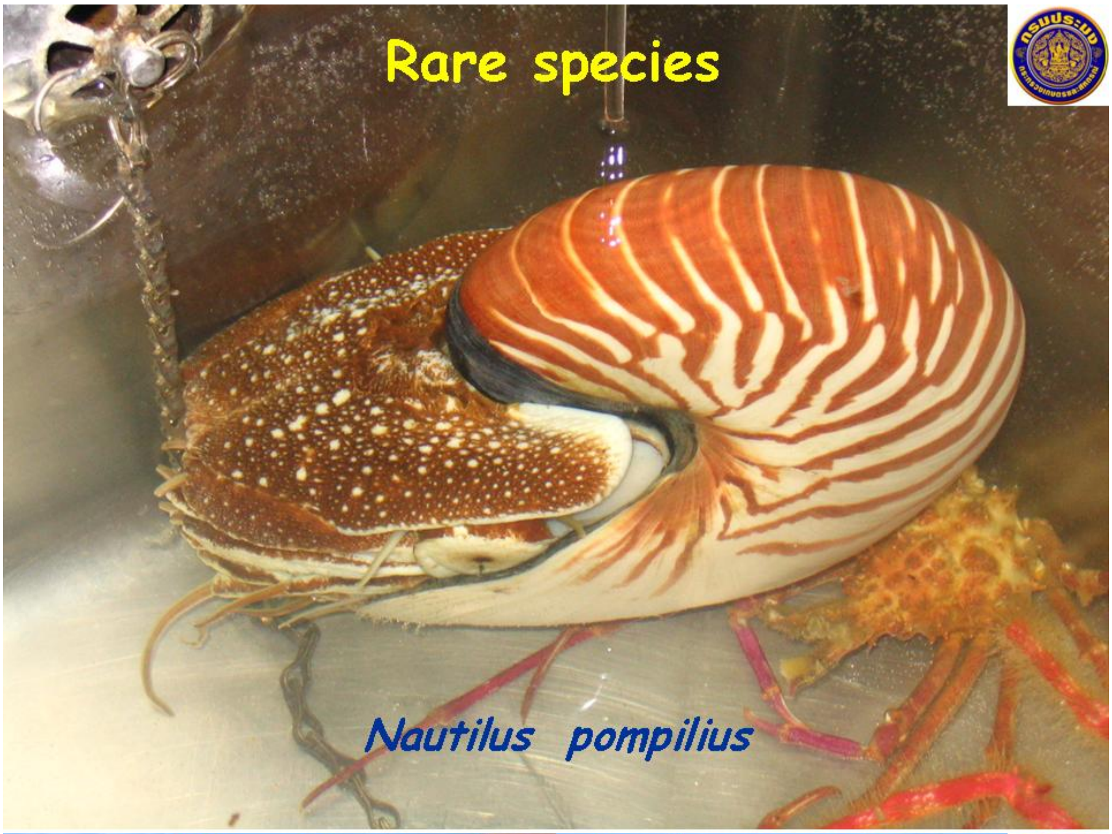

Crustacean group
Linuparus trigonus
Ibacus novemdentatus
2007 3 27
Scyllarides haanii


Shark group
Orectolobus maculates
Cephaloscyllium sp.1
(without white spots)
Cephaloscyllium sp.2
(with white spots)
Mustelus manazo


Others
Gymnothorax sp.
Conger myriaste
Brotula multibarbata
Satyrichthys sp.


Others
Hapalogenys nitens
Wattsia mossambica
Parupeneus pleurospilus
Abalistes stellatus


Others
Pandalidae sp.
Lithodes longispina
Charybdis natator
Charybdis sp.
HOSE
BOX


Rare species
Nautilus pompilius


New Record in Andaman Sea
Hexanchus nakamurai

Conclusion

- Economic catch.
- Area of exploration survey.
- Area of continental shelf in Andaman sea.
- Fishing gear.

Recommendation

- Conduct the research survey to promote local fisherman in the future.
- The development and modification for higher efficiency of sampling gear.

Recommendation

- Research vessel and sampling equipment need careful consideration.

Thank you
For
Your Attention

Phuket mar. biol. Cent. Res. Bull. **63:** 53–76 (2000)

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

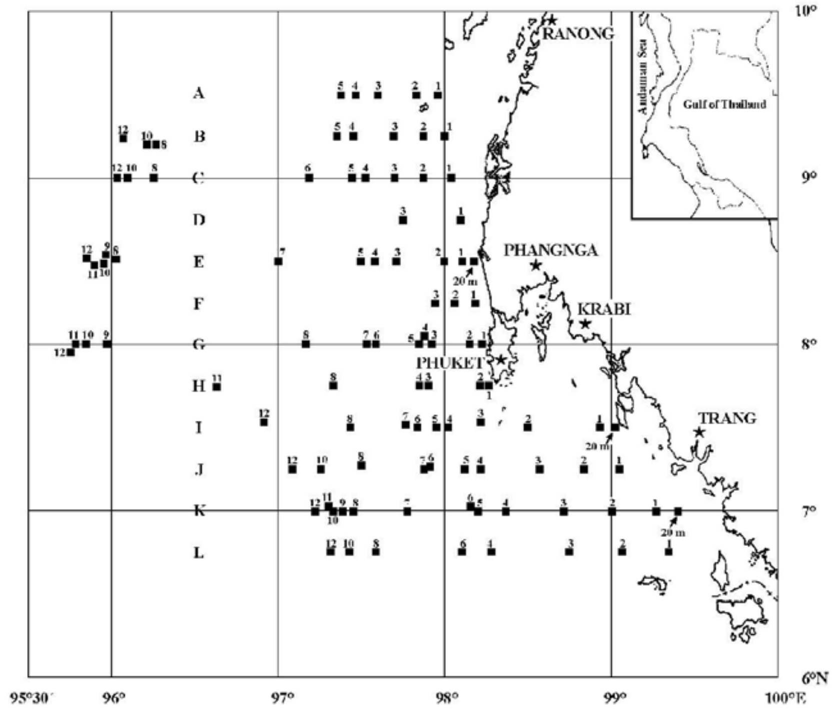


Figure 1 Location of BIOSHELF stations in the Andaman Sea during 1996–2000. A–L = Transect lines. Numbers indicate sampling points along transect lines.

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).

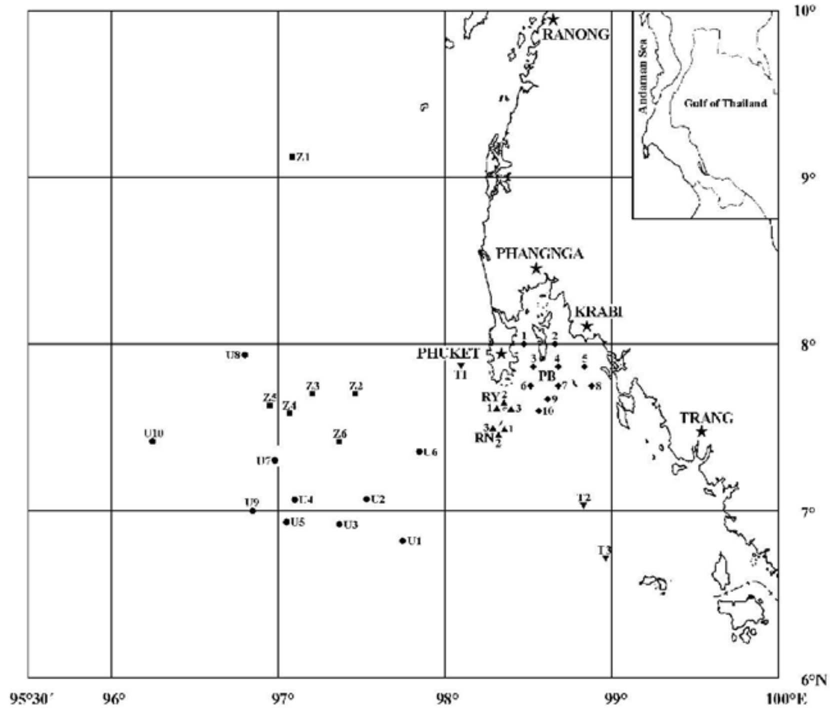


Figure 3 Location of additional stations in the Andaman Sea during 1996–2000. Designations of sampling stations are described in the text.

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.

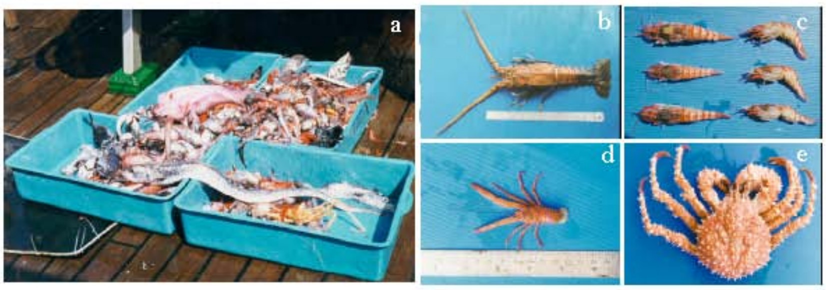


Figure 6 Some samples collected during the cruises: a. samples from the otter trawl; b. Palinuridae; c. Glyphocrangonidae; d. Galatheidae; e. Majidae.

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.

ACKNOWLEDGEMENTS

We thank Mr. Praween Limpsaichol, the director of the Phuket Marine Biological Center, and DANIDA for supporting this project. We would like to express our appreciation to Dr. Jens Peter Thomson, Dr. Thomas Kiørboe, Dr. Claus Nielsen, and Mr. Somchai Bussarawit for their advice and encouragement regarding the project. Sincere thanks are given to Mr. Sombat Poovachiranon (PMBC) and Dr. Danny Eibye-Jacobson (ZMUC, during his visit at PMBC), for their helpful comments, and to Ms. Marie Eiland for providing a photograph of the Pearcy-Rothlisberg sledge. We also wish to thank all SSA and JSA, the crews of the 'R/V Chakratong Tongyai' and the staff of the Marine Biodiversity Research Sub-division, especially Ms. Vararin Vongpanich, Mr. Sahet Autsaha, and Ms. Teunchai Srisawat, for their assistance during field work. A map of the study site was drawn by Mr. Patairat Singdam (PMBC artist) for which we are also grateful.

REFERENCES

Aungtonya, C. and J. Hylleberg. 1998. Check list of sublittoral molluscs, with nine new records for the Andaman Sea. Phuket mar. biol. Cent. Spec. Publ. **18**(2): 317–322.

Brattegard, T. and J.H. Fossaa, 1991: Replicability of an epibenthic sampler. Journal of the Marine Biological Association UK **71**: 153–166.

Bussarawit, S. 1995. Molluscs from the marine national parks: Surin and Lepae Island, Andaman Sea, Thailand. Phuket mar. biol. Cent. Spec. Publ. **15**: 119–126.

Carr, D. 1991. Distribution of bivalves and gastropods in Phang-nga Bay, South Thailand. Phuket mar. biol. Cent. Res. Bull. **56**: 11–22.

Chantrapornsyl, S. 1996. The first record of a pygmy killer whale (*Feresa attenuata*) from Thailand. Phuket mar. biol. Cent. Res. Bull. **61**: 29–37.

Chatanathawej, B and S. Bussarawit. 1987. Quatitative survey of the macrobenthic fauna along the west coast of Thailand in the Andaman Sea. Phuket mar. biol. Cent. Res. Bull. **47**: 1–23.

Eleftheriou, A. and N.A. Holme. 1984. Macrofauna Techniques. In: Holme, N.A. and A.D. McIntyre (eds.). Methods fro the study of marine benthos. Blackwell Scientific Publications, London, 387 pp.

Hylleberg, J. and A. Nateewathana. 1991a. Polychaetes of Thailand. Spionidae (Part 1): *Prionospio* of the *steenstrupi* group with description of eight new species from the Andaman Sea. Phuket mar. biol. Cent. Res. Bull. **55**: 1–32.

Hylleberg, J. A. Nateewathana. 1991b. Morphology, internal anatomy, and biometrics of the cephalopod *Idiosepius biserialis* Voss, 1962. A new record for the Andaman Sea. Phuket mar. biol. Cent. Res. Bull. **56**: 1–9.

Janekarn, V. and T. Kiørboe. Temporal and spatial distribution of fish larvae and their environmental biology in Phang-nga Bay, Thailand. Phuket mar. biol. Cent. Res. Bull. **56**: 23–40.

Nateewathana, A. 1990. Andaman Sea type-species deposited in the Reference Collection of PMBC and other collections, with notes on how to obtain material for taxonomic studies. Phuket mar. biol. Cent. Res. Bull. **54:** 65–74.

Nateewathana, A. 1995. New records of oceanic squids from Thai waters, the Andaman Sea. Phuket mar. biol. Cent. Res. Bull. **60**: 1–19.

Nateewathana, A. 1997. The Sepiolidae (Cephalopoda) of the Andaman Sea, Thailand, with description cf. *Euprymna hyllebergi* sp.nov. Phuket mar. biol. Cent. Spec. Publ. **17**(2): 465–481.

Nateewathana, A. 1998. A new record of the cuttlefish *Metasepia tullbergi* (Appellöf, 1886) (Sepiidae: Cephalopoda), Gulf of Thailand. Phuket mar. biol. Cent. Spec. Publ. **18**(2): 323–329.

Nateewathana, A. and M.D. Norman. 1999. On three new species of Ocellate octopuses (Cephalopoda: Octopoda) from Thai waters. Phuket mar. biol. Cent. Spec. Publ. **19**(2): 445–462.

Randall, J.E. and U. Satapoomin. 1999. *Archamia ataenia*, a new species of cardinalfish (Perciformes: Apogonidae) from the Andaman Sea and Mentawai Islands. Phuket mar. biol. Cent. Res. Bull. **62**: 1–8.

Seidenfaden, G., T. Smitin and and G. Thorson. 1968. Report on the fifth Thai-Danish Expedition 1996. The Natural History bulletin of the Siam Society **22**: 245–261.

Sirimontraporn, P. and S. Bussarawit. 1993. Two new records of fishes from the Andaman Sea. Phuket mar. biol. Cent. Spec. Publ. **12**: 93–95.

Manuscript received: 10 October 2000; accepted: 19 November 2000

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	009°30′N	097°57′E	-	-	43	-	sand with shell fragments	S. Bussarawit &C. Aungtonya
	OS	18/04/1996	009°30′N	097°58′E	009°29′N	097°58′E	42	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	18/02/1998	009°30′N	097°57′E	009°30′N	097°56′E	46	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	18/04/1996	009°32′N	097°58′E	009°30′N	097°58′E	40	-	ND	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	009°30′N	097°56′E	009°30′N	097°55′E	49	-	ND	S. Bussarawit & C. Aungtonya
	T	18/04/1996	009°30′N	097°57′E	009°33′N	097°56′E	43	-	ND	S. Bussarawit & C. Aungtonya
A2	BC	18/04/1996	009°30′N	097°51′E	-	-	61	-	sandy mud, fine sand & shell fragments	S. Bussarawit & C. Aungtonya
	OS	18/04/1996	009°32′N	097°50′E	009°30′N	097°51′E	66	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	18/02/1998	009°29′N	097°52′E	009°30′N	097°51′E	61	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	18/04/1996	009°34′N	097°49′E	009°32′N	097°50′E	70	-	ND	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	009°30′N	097°53′E	009°30′N	097°52′E	59	-	ND	S. Bussarawit & C. Aungtonya
	T	18/04/1996	009°31′N	097°51′E	009°34′N	097°49′E	64	-	ND	S. Bussarawit & C. Aungtonya
	T	18/02/1998	009°27′N	097°52′E	009°26′N	097°50′E	63	-	ND	S. Bussarawit & C. Aungtonya
A3	BC	19/04/1996	009°30′N	097°38′E	-	-	82	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	19/04/1996	009°30′N	097°38′E	009°31′N	097°38′E	83	-	sandy mud	S. Bussarawit & C. Aungtonya
	TD	19/04/1996	009°31′N	097°38′E	009°33′N	097°38′E	87	-	ND	S. Bussarawit & C. Aungtonya
	T	19/04/1996	009°33′N	097°38′E	009°29′N	097°38′E	83	-	ND	S. Bussarawit & C. Aungtonya
A4	BC	19/04/1996	009°30′N	097°28′E	-	-	116	-	coarse sand	S. Bussarawit & C. Aungtonya
A5	BC	19/04/1996	009°29′N	097°22′E	-	-	204	-	rock	S. Bussarawit & C. Aungtonya
	TD	19/04/1996	009°28′N	097°22′E	009°28′N	097°23′E	196	-	ND	S. Bussarawit & C. Aungtonya
B1	OS	17/02/1998	009°14′N	098°00′E	009°14′N	098°00′E	45	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	009°15′N	098°02′E	009°15′N	098°03′E	43	-	ND	S. Bussarawit & C. Aungtonya
B2	OS	17/02/1998	009°15′N	097°54′E	009°15′N	097°52′E	58	-	sand	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	009°15′N	097°54′E	009°15′N	097°52′E	61	-	ND	S. Bussarawit & C. Aungtonya
B3	TD	18/02/1998	009°15′N	097°42′E	009°15′N	097°42′E	80	-	ND	S. Bussarawit & C. Aungtonya
B4	RD	02/02/2000	009°15′N	097°28′E	009°15′N	097°28′E	96	92	ND	C. Aungtonya & V. Vongpanich
B5	RD	02/02/2000	009°15′N	097°22′E	009°15′N	097°22′E	200	204	ND	C. Aungtonya & V. Vongpanich
B8	G	11/02/1999	009°12′N	096°17′E	-	-	500	-	sand	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	009°12′N	096°17′E	009°12′N	096°17′E	516	500	sand	S. Bussarawit & C. Aungtonya
	T	11/02/1999	009°10′N	096°18′E	009°09′N	096°16′E	489	504	ND	S. Bussarawit & C. Aungtonya
B10	G	11/02/1999	009°13′N	096°14′E	-	-	689	-	sand	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	009°13′N	096°12′E	009°13′N	096°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	009°11 'N	096°12 'E	009°10 'N	096°14 'E	689	549	ND	S. Bussarawit & C. Aungtonya
B12	G	10/02/1999	009°14 'N	096°06 'E	-	-	940	-	mud	S. Bussarawit & C. Aungtonya
	OS	11/02/1999	009°13 'N	096°06 'E	009°13 'N	096°06 'E	908	933	sand	S. Bussarawit & C. Aungtonya
C1	BC	20/04/1996	009°00 'N	098°03 'E	-	-	40	-	muddy sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	009°01 'N	098°03 'E	009°01 'N	098°03 'E	39	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	17/02/1998	009°00 'N	098°02 'E	009°00 'N	098°03 'E	41	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	20/04/1996	009°02 'N	098°03 'E	009°02 'N	098°03 'E	39	-	ND	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	009°00 'N	098°02 'E	009°00 'N	098°01 'E	43	-	ND	S. Bussarawit & C. Aungtonya
	T	20/04/1996	009°02 'N	098°03 'E	008°59 'N	098°03 'E	40	-	ND	S. Bussarawit & C. Aungtonya
C2	BC	20/04/1996	009°00 'N	097°53 'E	-	-	65	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	009°00 'N	097°53 'E	009°01 'N	097°53 'E	64	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	17/02/1998	009°00 'N	097°56 'E	009°00 'N	097°57 'E	60	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	20/04/1996	009°02 'N	097°53 'E	009°02 'N	097°53 'E	64	-	ND	S. Bussarawit & C. Aungtonya
	TD	17/02/1998	009°00 'N	097°55 'E	009°00 'N	097°56 'E	61	-	ND	S. Bussarawit & C. Aungtonya
	RD	01/02/2000	009°00 'N	097°55 'E	009°00 'N	097°55 'E	60	60	ND	C. Aungtonya & V. Vongpanich
	AT	01/02/2000	009°00 'N	097°54 'E	009°02 'N	097°53 'E	62	64	ND	C. Aungtonya & V. Vongpanich
	T	20/04/1996	009°01 'N	097°53 'E	008°59 'N	097°53 'E	64	-	ND	S. Bussarawit & C. Aungtonya
	T	17/02/1998	009°00 'N	097°48 'E	009°01 'N	097°50 'E	70	-	ND	S. Bussarawit & C. Aungtonya
C3	BC	20/04/1996	009°00 'N	097°43 'E	-	-	79	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	20/04/1996	009°00 'N	097°43 'E	008°59 'N	097°43 'E	80	-	fine sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	18/02/1998	009°00 'N	097°43 'E	009°00 'N	097°42 'E	79	-	ND	S. Bussarawit & C. Aungtonya
	T	20/04/1996	009°00 'N	097°43 'E	009°03 'N	097°43 'E	81	-	ND	S. Bussarawit & C. Aungtonya
C4	BC	21/04/1996	009°00 'N	097°30 'E	-	-	129	-	sandy mud	S. Bussarawit & C. Aungtonya
	AT	02/02/2000	009°00 'N	097°31 'E	009°01 'N	097°29 'E	110	164	ND	C. Aungtonya & V. Vongpanich
	T	21/04/1996	009°00 'N	097°30 'E	008°58 'N	097°30 'E	126	-	ND	S. Bussarawit & C. Aungtonya
C5	BC	21/04/1996	009°00 'N	097°26 'E	-	-	200	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	21/04/1996	009°01 'N	097°27 'E	009°00 'N	097°28 'E	191	-	ND	S. Bussarawit & C. Aungtonya
	AT	02/02/2000	009°00 'N	097°25 'E	009°00 'N	097°23 'E	215	230	ND	C. Aungtonya & V. Vongpanich
C6	RD	02/02/2000	009°00 'N	097°11 'E	009°00 'N	097°11 'E	311	311	ND	C. Aungtonya & V. Vongpanich
C8	G	03/02/2000	009°00 'N	096°17 'E	-	-	480	-	sand	C. Aungtonya & V. Vongpanich
	HS	03/02/2000	009°00 'N	096°14 'E	009°00 'N	096°14 'E	475	473	ND	C. Aungtonya & V. Vongpanich
	AT	03/02/2000	009°00 'N	096°15 'E	009°00 'N	096°13 'E	478	480	ND	C. Aungtonya & V. Vongpanich
C10	G	04/02/2000	009°00 'N	096°09 'E	-	-	684	-	mud	C. Aungtonya & V. Vongpanich
	RD	04/02/2000	009°01 'N	096°08 'E	009°01 'N	096°08 'E	709	722	ND	C. Aungtonya & V. Vongpanich
	AT	04/02/2000	008°59 'N	096°08 'E	008°56 'N	096°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	009°00 'N	096°04 'E	-	-	936	-	sand	C. Aungtonya & V. Vongpanich
	OS	05/02/2000	008°56 'N	096°02 'E	008°56 'N	096°02 'E	933	928	sand	C. Aungtonya & V. Vongpanich
	AT	04/02/2000	008°59 'N	096°03 'E	008°56 'N	096°01 'E	930	962	ND	C. Aungtonya & V. Vongpanich
D1	TD	19/02/1998	008°45 'N	098°05 'E	008°45 'N	098°05 'E	38	-	ND	S. Bussarawit & C. Aungtonya
D3	OS	19/02/1998	008°45 'N	097°43 'E	008°45 'N	097°42 'E	80	-	sand	S. Bussarawit & C. Aungtonya
	TD	19/02/1998	008°45 'N	097°42 'E	008°45 'N	097°43 'E	80	-	ND	S. Bussarawit & C. Aungtonya
E 20 m	BC	22/04/1996	008°30 'N	098°12 'E	-	-	21	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	008°30 'N	098°12 'E	008°30 'N	098°12 'E	20	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	008°29 'N	098°12 'E	008°29 'N	098°12 'E	20	-	ND	S. Bussarawit & C. Aungtonya
E1	BC	22/04/1996	008°30 'N	098°06 'E	-	-	42	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	008°30 'N	098°06 'E	008°30 'N	098°07 'E	41	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	008°30 'N	098°06 'E	008°29 'N	098°07 'E	38	-	ND	S. Bussarawit & C. Aungtonya
E2	BC	22/04/1996	008°30 'N	098°00 'E	-	-	63	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	008°31 'N	098°00 'E	008°30 'N	098°00 'E	60	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	008°30 'N	098°00 'E	008°30 'N	098°00 'E	60	-	ND	S. Bussarawit & C. Aungtonya
E3	BC	22/04/1996	008°31 'N	097°46 'E	-	-	81	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	22/04/1996	008°30 'N	097°46 'E	008°31 'N	097°46 'E	81	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1996	008°32 'N	097°46 'E	008°31 'N	097°46 'E	79	-	ND	S. Bussarawit & C. Aungtonya
E4	BC	21/04/1996	008°30 'N	097°33 'E	-	-	74	-	sand and gravel	S. Bussarawit & C. Aungtonya
	TD	21/04/1996	008°30 'N	097°33 'E	008°30 'N	097°34 'E	74	-	ND	S. Bussarawit & C. Aungtonya
E5	BC	21/04/1996	008°30 'N	097°30 'E	-	-	227	-	rock	S. Bussarawit & C. Aungtonya
	G	08/02/2000	008°30 'N	097°30 'E	-	-	228	-	rock	C. Aungtonya & V. Vongpanich
	TD	08/02/2000	008°30 'N	097°30 'E	008°30 'N	097°31 'E	225	228	ND	C. Aungtonya & V. Vongpanich
E7	G	08/02/2000	008°30 'N	097°00 'E	-	-	450	-	sand and gravel	C. Aungtonya & V. Vongpanich
	TD	08/02/2000	008°29 'N	097°00 'E	008°29 'N	097°00 'E	452	453	ND	C. Aungtonya & V. Vongpanich
	AT	08/02/2000	008°30 'N	097°01 'E	008°29 'N	097°03 'E	449	446	ND	C. Aungtonya & V. Vongpanich
	T	08/02/2000	008°30 'N	097°08 'E	008°30 'N	097°08 'E	436	443	ND	C. Aungtonya & V. Vongpanich
	T	09/02/2000	008°30 'N	097°07 'E	008°29 'N	097°04 'E	435	444	ND	C. Aungtonya & V. Vongpanich
E8	G	05/02/1999	008°32 'N	096°02 'E	-	-	488	-	muddy sand	S. Bussarawit & C. Aungtonya
	G	06/02/2000	008°30 'N	096°01 'E	-	-	498	-	sand	C. Aungtonya & V. Vongpanich
	OS	06/02/1999	008°28 'N	096°06 'E	008°28 'N	096°05 'E	483	482	sand	S. Bussarawit & C. Aungtonya
	RD	06/02/2000	008°25 'N	096°01 'E	008°25 'N	096°01 'E	500	500	ND	C. Aungtonya & V. Vongpanich
	T	06/02/1999	008°32 'N	096°04 'E	008°31 'N	096°07 'E	488	478	ND	S. Bussarawit & C. Aungtonya
E9	T	05/02/1999	008°30 'N	095°58 'E	008°28 'N	095°58 'E	649	550	ND	S. Bussarawit & C. Aungtonya
E10	G	05/02/1999	008°32 'N	095°57 'E	-	-	685	-	sand and coral	S. Bussarawit & C. Aungtonya
	OS	05/02/1999	008°29 'N	095°56 'E	008°29 'N	095°56 'E	684	720	ND	S. Bussarawit & C. Aungtonya

Appendix 1 (continued.)

Station	Gear	Date	Start Point Lat.	Start Point Long.	End Point Lat.	End Point Long.	Depth (m) Start	Depth (m) End	Type of sediment	Collector
	AT	05/02/2000	008°31 'N	095°57 'E	008°33 'N	095°57 'E	707	664	ND	C. Aungtonya & V. Vongpanich
E11	TD	04/02/1999	008°31 'N	095°54 'E	008°30 'N	095°54 'E	842	867	ND	S. Bussarawit & C. Aungtonya
	AT	05/02/2000	008°28 'N	095°53 'E	008°24 'N	095°52 'E	864	800	ND	C. Aungtonya & V. Vongpanich
E12	G	04/02/1999	008°29 'N	095°52 'E	-	-	918	-	ND	S. Bussarawit & C. Aungtonya
F1	OS	16/02/1998	008°15 'N	098°10 'E	008°15 'N	098°10 'E	43	-	sand	S. Bussarawit & C. Aungtonya
	TD	16/02/1998	008°15 'N	098°12 'E	008°15 'N	098°12 'E	36	-	ND	S. Bussarawit & C. Aungtonya
F2	OS	16/02/1998	008°15 'N	098°03 'E	008°15 'N	098°02 'E	66	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	16/02/1998	008°15 'N	098°04 'E	008°15 'N	098°03 'E	59	-	ND	S. Bussarawit & C. Aungtonya
F3	TD	16/02/1998	008°15 'N	097°58 'E	008°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 Lat.	Start Point Long.	End Point Lat.	End Point Long.	Depth (m) Start	Depth (m) End	Type of sediment	Collector
	TD	03/05/1996	007°29 ′N	098°56 ′E	007°29 ′N	098°56 ′E	40	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	007°30 ′N	098°54 ′E	007°30 ′N	098°55 ′E	43	-	ND	S. Bussarawit & C. Aungtonya
I2	BC	01/05/1996	007°30 ′N	098°30 ′E	-	-	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	BC	03/05/1996	007°30 ′N	098°29 ′E	-	-	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	03/05/1996	007°30 ′N	098°29 ′E	007°30 ′N	098°29 ′E	60	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	22/02/1998	007°30 ′N	098°30 ′E	007°30 ′N	098°30 ′E	59	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	05/12/1998	007°29 ′N	098°30 ′E	007°29 ′N	098°30 ′E	64	-	ND	S. Bussarawit
	HS	26/02/2000	007°30 ′N	098°29 ′E	007°30 ′N	098°29 ′E	61	61	ND	C. Aungtonya & V. Vongpanich
	TD	01/05/1996	007°30 ′N	098°31 ′E	007°30 ′N	098°30 ′E	59	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	007°31 ′N	098°30 ′E	007°30 ′N	098°30 ′E	58	-	ND	S. Bussarawit & C. Aungtonya
	TD	05/12/1998	007°28 ′N	098°31 ′E	007°29 ′N	098°30 ′E	65	-	ND	S. Bussarawit
	AT	26/02/2000	007°30 ′N	098°29 ′E	007°31 ′N	098°27 ′E	60	62	ND	C. Aungtonya & V. Vongpanich
	T	05/12/1998	007°30 ′N	098°30 ′E	007°30 ′N	098°28 ′E	61	-	ND	S. Bussarawit
	T	22/02/1998	007°30 ′N	098°31 ′E	007°29 ′N	098°35 ′E	59	-	ND	S. Bussarawit & C. Aungtonya
I3-I2	OS	22/02/1998	007°33 ′N	098°19 ′E	007°33 ′N	098°19 ′E	55	-	ND	S. Bussarawit & C. Aungtonya
I3	BC	02/05/1996	007°30 ′N	098°10 ′E	-	-	79	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	G	15/11/1999	007°30 ′N	098°15 ′E	-	-	66	-	sand	C. Aungtonya & V. Vongpanich
	OS	01/12/1998	007°34 ′N	098°13 ′E	007°34 ′N	098°13 ′E	77	-	ND	S. Bussarawit
	OS	02/12/1998	007°35 ′N	098°14 ′E	007°34 ′N	098°13 ′E	73	-	ND	S. Bussarawit
	HS	08/11/1999	007°29 ′N	098°14 ′E	007°29 ′N	098°14 ′E	67	66	ND	C. Aungtonya & V. Vongpanich
	TD	02/05/1996	007°30 ′N	098°10 ′E	007°30 ′N	098°11 ′E	78	-	ND	S. Bussarawit & C. Aungtonya
	TD	01/12/1998	007°35 ′N	098°12 ′E	007°34 ′N	098°13 ′E	77	-	ND	S. Bussarawit
	TD	02/12/1998	007°34 ′N	098°14 ′E	007°34 ′N	098°13 ′E	75	-	ND	S. Bussarawit
	BT	01/12/1998	007°34 ′N	098°14 ′E	007°35 ′N	098°15 ′E	69	-	ND	S. Bussarawit
	BT	02/12/1998	007°32 ′N	098°13 ′E	007°30 ′N	098°12 ′E	83	-	ND	S. Bussarawit
I4	G	16/02/2000	007°31 ′N	098°01 ′E	-	-	125	-	sand with shell fragments	C. Aungtonya & V. Vongpanich
	HS	17/02/2000	007°30 ′N	098°01 ′E	007°30 ′N	098°01 ′E	118	118	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	08/11/1999	007°30 ′N	098°02 ′E	007°30 ′N	098°01 ′E	122	137	ND	C. Aungtonya & V. Vongpanich
	TD	16/02/2000	007°30 ′N	098°01 ′E	007°30 ′N	098°01 ′E	120	117	ND	C. Aungtonya & V. Vongpanich
	RD	08/11/1999	007°30 ′N	098°01 ′E	007°30 ′N	098°01 ′E	120	107	ND	C. Aungtonya & V. Vongpanich
	AT	16/02/2000	007°30 ′N	098°01 ′E	007°31 ′N	098°00 ′E	122	156	ND	C. Aungtonya & V. Vongpanich
I5	TD	29/01/1999	007°32 ′N	097°56 ′E	007°32 ′N	097°56 ′E	190	209	ND	S. Bussarawit & C. Aungtonya
	TD	16/02/2000	007°30 ′N	097°58 ′E	007°30 ′N	097°58 ′E	194	193	ND	C. Aungtonya & V. Vongpanich
	RD	09/11/1999	007°30 ′N	097°57 ′E	007°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	007°27 'N	097°49 'E	007°27 'N	097°49 'E	298	300	ND	S. Bussarawit & C. Aungtonya
	RD	09/11/1999	007°30 'N	097°50 'E	007°30 'N	097°50 'E	299	301	ND	C. Aungtonya & V. Vongpanich
	AT	09/11/1999	007°30 'N	097°50 'E	007°31 'N	097°51 'E	300	284	ND	C. Aungtonya & V. Vongpanich
I7	RD	09/11/1999	007°31 'N	097°46 'E	007°31 'N	097°46 'E	427	424	ND	C. Aungtonya & V. Vongpanich
I8	G	09/11/1999	007°30 'N	097°26 'E	-	-	502		mud	C. Aungtonya & V. Vongpanich
	HS	09/11/1999	007°30 'N	097°26 'E	007°30 'N	097°25 'E	504	507	mud	C. Aungtonya & V. Vongpanich
I12	G	25/01/1999	007°32 'N	096°54 'E	-	-	916	-	mud	S. Bussarawit & C. Aungtonya
	OS	25/01/1999	007°32 'N	096°56 'E	007°32 'N	096°56 'E	928	880	mud	S. Bussarawit & C. Aungtonya
J1	BC	04/05/1996	007°15 'N	099°03 'E	-	-	43	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	007°16 'N	099°03 'E	007°16 'N	099°03 'E	42	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	007°15 'N	099°04 'E	007°15 'N	099°04 'E	39	-	sandy mud with shell fragments	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	007°15 'N	099°03 'E	007°15 'N	099°03 'E	41	41	shells	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	007°15 'N	099°03 'E	007°16 'N	099°03 'E	42	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	007°15 'N	099°03 'E	007°15 'N	099°03 'E	42	-	ND	S. Bussarawit & C. Aungtonya
	AT	27/02/2000	007°15 'N	099°03 'E	007°15 'N	099°04 'E	43	40	ND	C. Aungtonya & V. Vongpanich
J2	BC	04/05/1996	007°15 'N	098°50 'E	-	-	62	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	007°15 'N	098°51 'E	007°15 'N	098°51 'E	61	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	007°15 'N	098°48 'E	007°15 'N	098°48 'E	63	-	soft mud	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	007°15 'N	098°51 'E	007°15 'N	098°51 'E	60	59	sandy mud	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	007°15 'N	098°51 'E	007°15 'N	098°51 'E	62	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	007°15 'N	098°48 'E	007°15 'N	098°48 'E	63	-	ND	S. Bussarawit & C. Aungtonya
	AT	27/02/2000	007°15 'N	098°49 'E	007°16 'N	098°51 'E	62	58	ND	C. Aungtonya & V. Vongpanich
	T	23/02/1998	007°16 'N	098°49 'E	007°16 'N	098°54 'E	62	-	ND	S. Bussarawit & C. Aungtonya
J3	BC	04/05/1996	007°15 'N	098°34 'E	-	-	79	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	04/05/1996	007°15 'N	098°36 'E	007°16 'N	098°36 'E	79	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	23/02/1998	007°15 'N	098°36 'E	007°16 'N	098°36 'E	77	-	fine sand	S. Bussarawit & C. Aungtonya
	HS	26/02/2000	007°15 'N	098°35 'E	007°15 'N	098°35 'E	78	78	sand	C. Aungtonya & V. Vongpanich
	TD	04/05/1996	007°15 'N	098°35 'E	007°15 'N	098°36 'E	79	-	ND	S. Bussarawit & C. Aungtonya
	TD	23/02/1998	007°15 'N	098°35 'E	007°15 'N	098°36 'E	78	-	ND	S. Bussarawit & C. Aungtonya
	AT	26/02/2000	007°15 'N	098°35 'E	007°12 'N	098°34 'E	79	79	ND	C. Aungtonya & V. Vongpanich
J48-47	T	23/02/1998	007°14 'N	098°37 'E	007°16 'N	098°42 'E	76	-	ND	S. Bussarawit & C. Aungtonya
J4	TD	01/03/2000	007°15 'N	098°14 'E	007°15 'N	098°14 'E	89	90	ND	C. Aungtonya & V. Vongpanich
	AT	01/03/2000	007°15 'N	098°12 'E	007°16 'N	098°13 'E	87	89	ND	C. Aungtonya & V. Vongpanich
J5	TD	01/03/2000	007°15 'N	098°07 'E	007°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	007°16 'N	097°55 'E	-	-	330	-	rock	C. Aungtonya & V. Vongpanich
	TD	17/02/2000	007°15 'N	097°55 'E	007°15 'N	097°56 'E	304	315	ND	C. Aungtonya & V. Vongpanich
J7	TD	02/12/1998	007°16 'N	097°53 'E	007°15 'N	097°53 'E	342	-	ND	S. Bussarawit
	AT	17/02/2000	007°15 'N	097°53 'E	007°16 'N	097°52 'E	356	360	ND	C. Aungtonya & V. Vongpanich
J8	BC	18/02/2000	007°16 'N	097°31 'E	-	-	489	-	sand	C. Aungtonya & V. Vongpanich
	G	27/01/1999	007°20 'N	097°29 'E	-	-	501	-	mud	S. Bussarawit & C. Aungtonya
	G	18/02/2000	007°15 'N	097°31 'E	-	-	488	-	sand	C. Aungtonya & V. Vongpanich
	OS	18/02/2000	007°15 'N	097°30 'E	007°15 'N	097°30 'E	495	490	mud	C. Aungtonya & V. Vongpanich
	TD	18/02/2000	007°15 'N	097°30 'E	007°15 'N	097°31 'E	493	490	ND	C. Aungtonya & V. Vongpanich
	AT	18/02/2000	007°15 'N	097°30 'E	007°15 'N	097°32 'E	490	479	ND	C. Aungtonya & V. Vongpanich
	T	27/01/1999	007°21 'N	097°26 'E	007°20 'N	097°25 'E	520	531	ND	S. Bussarawit & C. Aungtonya
	T	18/02/2000	007°15 'N	097°33 'E	007°15 'N	097°30 'E	473	494	ND	C. Aungtonya & V. Vongpanich
J10	BC	19/02/2000	007°15 'N	097°16 'E	-	-	668	-	mud	C. Aungtonya & V. Vongpanich
	G	28/01/1999	007°17 'N	097°15 'E	-	-	656	-	mud	S. Bussarawit & C. Aungtonya
	OS	19/02/2000	007°15 'N	097°16 'E	007°15 'N	097°16 'E	668	669	muddy sand	C. Aungtonya & V. Vongpanich
	TD	19/02/2000	007°15 'N	097°16 'E	007°15 'N	097°16 'E	660	663	ND	C. Aungtonya & V. Vongpanich
	AT	19/02/2000	007°15 'N	097°15 'E	007°14 'N	097°15 'E	689	687	ND	C. Aungtonya & V. Vongpanich
	T	28/01/1999	007°20 'N	097°14 'E	007°22 'N	097°13 'E	655	651	ND	S. Bussarawit & C. Aungtonya
	T	19/02/2000	007°15 'N	097°16 'E	007°15 'N	097°14 'E	662	696	ND	C. Aungtonya & V. Vongpanich
J12	BC	20/02/2000	007°15 'N	097°05 'E	-	-	924	-	muddy sand	C. Aungtonya & V. Vongpanich
	OS	20/02/2000	007°15 'N	097°07 'E	007°15 'N	097°07 'E	896	896	sand	C. Aungtonya & V. Vongpanich
	AT	20/02/2000	007°16 'N	097°03 'E	007°16 'N	097°05 'E	944	912	ND	C. Aungtonya & V. Vongpanich
K 20 m	BC	06/05/1996	007°00 'N	099°24 'E	-	-	21	-	mud with shell fragments	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	007°00 'N	099°24 'E	007°00 'N	099°24 'E	22	-	mud with shell fragments	S. Bussarawit & C. Aungtonya
	TD	06/05/1996	007°00 'N	099°24 'E	007°00 'N	099°24 'E	20	-	ND	S. Bussarawit & C. Aungtonya
K1	BC	06/05/1996	007°00 'N	099°16 'E	-	-	43	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	007°00 'N	099°15 'E	007°00 'N	099°14 'E	45	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	007°00 'N	099°16 'E	007°00 'N	099°15 'E	41	-	soft mud	S. Bussarawit & C. Aungtonya
	HS	27/02/2000	007°00 'N	099°16 'E	007°00 'N	099°16 'E	43	42	mud with shell fragments	C. Aungtonya & V. Vongpanich
	TD	06/05/1996	007°00 'N	099°16 'E	007°00 'N	099°15 'E	44	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	007°00 'N	099°15 'E	007°00 'N	099°16 'E	42	-	ND	S. Bussarawit & C. Aungtonya
K2	BC	06/05/1996	007°00 'N	098°59 'E	-	-	63	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	007°00 'N	099°00 'E	007°01 'N	099°00 'E	60	-	soft mud	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	007°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	007°00 'N	098°59 'E	007°00 'N	098°59 'E	64	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	007°00 'N	099°04 'E	007°00 'N	099°04 'E	55	-	ND	S. Bussarawit & C. Aungtonya
	T	24/02/1998	007°00 'N	099°04 'E	007°01 'N	099°08 'E	52	-	ND	S. Bussarawit & C. Aungtonya
K3	BC	05/05/1996	007°00 'N	098°41 'E	-	-	83	-	sandy mud	S. Bussarawit & C. Aungtonya
	OS	05/05/1996	006°59 'N	098°42 'E	006°59 'N	098°42 'E	82	-	sandy mud	S. Bussarawit & C. Aungtonya
	HS	29/02/2000	007°02 'N	098°43 'E	007°02 'N	098°43 'E	81	81	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	05/05/1996	007°00 'N	098°42 'E	007°00 'N	098°42 'E	83	-	ND	S. Bussarawit & C. Aungtonya
	AT	29/02/2000	007°00 'N	098°41 'E	007°01 'N	098°43 'E	83	81	ND	C. Aungtonya & V. Vongpanich
K4	BC	07/05/1996	007°00 'N	098°21 'E	-	-	105	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	G	15/11/1999	006°59 'N	098°21 'E	-	-	103	-	mud with shell fragments	C. Aungtonya & V. Vongpanich
	HS	29/02/2000	007°00 'N	098°20 'E	007°00 'N	098°20 'E	108	110	mud with shell fragments	C. Aungtonya & V. Vongpanich
	TD	15/11/1999	006°59 'N	098°20 'E	006°59 'N	098°20 'E	107	109	ND	C. Aungtonya & V. Vongpanich
	AT	23/02/2000	007°00 'N	098°21 'E	006°59 'N	098°21 'E	104	101	ND	C. Aungtonya & V. Vongpanich
	T	23/02/2000	007°01 'N	098°19 'E	007°05 'N	098°18 'E	119	116	ND	C. Aungtonya & V. Vongpanich
K5	BC	07/05/1996	007°00 'N	098°12 'E	-	-	220	-	gravel	S. Bussarawit & C. Aungtonya
	HS	01/03/2000	007°00 'N	098°12 'E	007°00 'N	098°12 'E	217	217	sand with shell fragments	C. Aungtonya & V. Vongpanich
K6	T	01/03/2000	007°02 'N	098°10 'E	007°04 'N	098°09 'E	277	288	ND	C. Aungtonya & V. Vongpanich
K7	RD	18/11/1999	007°01 'N	097°46 'E	007°01 'N	097°46 'E	389	389	ND	C. Aungtonya & V. Vongpanich
K8	G	17/11/1999	007°00 'N	097°25 'E	-	-	540	-	mud	C. Aungtonya & V. Vongpanich
	HS	18/11/1999	007°01 'N	097°29 'E	007°01 'N	097°29 'E	504	504	mud	C. Aungtonya & V. Vongpanich
	AT	17/11/1999	007°00 'N	097°26 'E	007°01 'N	097°28 'E	556	520	ND	C. Aungtonya & V. Vongpanich
K9	G	16/11/1999	007°00 'N	097°22 'E	-	-	640	-	mud	C. Aungtonya & V. Vongpanich
K10	G	17/11/1999	006°59 'N	097°20 'E	-	-	712	-	mud	C. Aungtonya & V. Vongpanich
	AT	17/11/1999	007°01 'N	097°20 'E	007°03 'N	097°20 'E	690	684	ND	C. Aungtonya & V. Vongpanich
K11	HS	17/11/1999	007°02 'N	097°18 'E	007°02 'N	097°18 'E	760	764	mud	C. Aungtonya & V. Vongpanich
	AT	16/11/1999	007°00 'N	097°18 'E	007°00 'N	097°21 'E	828	684	ND	C. Aungtonya & V. Vongpanich
K12	BC	20/02/2000	007°00 'N	097°14 'E	-	-	940	-	mud	C. Aungtonya & V. Vongpanich
L1	BC	06/05/1996	006°45 'N	099°21 'E	-	-	38	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	OS	06/05/1996	006°46 'N	099°21 'E	006°46 'N	099°21 'E	38	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	OS	24/02/1998	006°49 'N	099°21 'E	006°48 'N	099°21 'E	39	-	sandy mud with shell franments	S. Bussarawit & C. Aungtonya
	HS	28/02/2000	006°45 'N	099°21 'E	006°45 'N	099°21 'E	38	38	sand with shell fragments	C. Aungtonya & V. Vongpanich
	TD	06/05/1996	006°45 'N	099°21 'E	006°45 'N	099°21 'E	38	-	ND	S. Bussarawit & C. Aungtonya
	TD	24/02/1998	006°49 'N	099°21 'E	006°49 'N	099°21 'E	39	-	ND	S. Bussarawit & C. Aungtonya
	AT	28/02/2000	006°45 'N	099°21 'E	006°46 'N	099°19 'E	39	41	ND	C. Aungtonya & V. Vongpanich

Apendix 1 (continued.)

Station	Gear	Date	Start Point Lat.	Start Point Long.	End Point Lat.	End Point Long.	Depth (m) Start	Depth (m) End	Type of sediment	Collector
	T	25/02/1998	006°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	007°26 'N	098°18 'E	007°26 'N	098°18 'E	75	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°26 'N	098°18 'E	007°26 'N	098°18 'E	74	-	ND	S. Bussarawit & C. Aungtonya
RN3	BC	08/05/1996	007°30 'N	098°17 'E	-	-	72	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	007°30 'N	098°17 'E	007°30 'N	098°17 'E	72	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°30 'N	098°18 'E	007°31 'N	098°18 'E	70	-	ND	S. Bussarawit & C. Aungtonya
RY1	BC	08/05/1996	007°36 'N	098°19 'E	-	-	55	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	007°37 'N	098°20 'E	007°37 'N	098°20 'E	55	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	22/02/1998	007°35 'N	098°16 'E	007°34 'N	098°17 'E	68	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°36 'N	098°19 'E	007°37 'N	098°20 'E	55	-	ND	S. Bussarawit & C. Aungtonya
	TD	22/02/1998	007°35 'N	098°16 'E	007°35 'N	098°16 'E	70	-	ND	S. Bussarawit & C. Aungtonya
	BT	01/12/1998	007°37 'N	098°15 'E	007°36 'N	098°13 'E	67	-	ND	S. Bussarawit
	T	02/12/1998	007°37 'N	098°16 'E	007°38 'N	098°17 'E	71	-	ND	S. Bussarawit
RY2	BC	08/05/1996	007°39 'N	098°23 'E	-	-	45	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	007°40 'N	098°24 'E	007°39 'N	098°24 'E	44	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°39 'N	098°24 'E	007°38 'N	098°24 'E	43	-	ND	S. Bussarawit & C. Aungtonya
RY3	BC	08/05/1996	007°36 'N	098°25 'E	-	-	49	-	muddy sand	S. Bussarawit & C. Aungtonya
	OS	08/05/1996	007°36 'N	098°25 'E	007°35 'N	098°26 'E	50	-	muddy sand	S. Bussarawit & C. Aungtonya
	TD	08/05/1996	007°35 'N	098°26 'E	007°35 'N	098°26 'E	52	-	ND	S. Bussarawit & C. Aungtonya
PB1	BC	23/04/1997	008°00 'N	098°29 'E	-	-	19	-	sand with shell fragments	S. Bussarawit
	OS	23/04/1997	008°00 'N	098°29 'E	008°00 'N	098°29 'E	17	-	sand with shell fragments	S. Bussarawit
	TD	23/04/1997	007°59 'N	098°29 'E	007°59 'N	098°29 'E	14	-	ND	S. Bussarawit
PB2	BC	22/04/1997	008°00 'N	098°39 'E	-	-	17	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	007°59 'N	098°39 'E	007°58 'N	098°39 'E	20	-	sand with shell fragments	S. Bussarawit
	TD	22/04/1997	008°00 'N	098°38 'E	007°59 'N	098°39 'E	15	-	ND	S. Bussarawit
PB3	BC	23/04/1997	007°51 'N	098°32 'E	-	-	22	-	sand with shell fragments	S. Bussarawit
	OS	23/04/1997	007°51 'N	098°31 'E	007°52 'N	098°31 'E	20	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	007°51 'N	098°34 'E	007°51 'N	098°34 'E	28	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	OS	27/02/1998	007°48 'N	098°31 'E	007°48 'N	098°30 'E	24	-	ND	S. Bussarawit & C. Aungtonya
	OS	04/12/1998	007°49 'N	098°31 'E	007°49 'N	098°31 'E	22	-	ND	S. Bussarawit
	TD	23/04/1997	007°52 'N	098°31 'E	007°52 'N	098°30 'E	22	-	ND	S. Bussarawit
	TD	21/02/1998	007°51 'N	098°32 'E	007°51 'N	098°33 'E	33	-	ND	S. Bussarawit & C. Aungtonya
	TD	04/12/1998	007°48 'N	098°31 'E	007°49 'N	098°31 'E	20	-	ND	S. Bussarawit
	T	21/04/1997	007°48 'N	098°28 'E	007°49 'N	098°32 'E	21	-	ND	S. Bussarawit
	T	04/12/1998	007°48 'N	098°29 'E	007°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	007°51 'N	098°37 'E	007°51 'N	098°39 'E	21	-	ND	S. Bussarawit & C. Aungtonya
	T	04/12/1998	007°51 'N	098°38 'E	007°49 'N	098°40 'E	22	-	ND	S. Bussarawit
PB4	BC	22/04/1997	007°52 'N	098°41 'E	-	-	32	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	007°52 'N	098°41 'E	007°52 'N	098°41 'E	31	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	007°52 'N	098°41 'E	007°52 'N	098°42 'E	29	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	007°52 'N	098°41 'E	007°52 'N	098°42 'E	33	-	ND	S. Bussarawit
	TD	21/02/1998	007°52 'N	098°40 'E	007°52 'N	098°41 'E	29	-	ND	S. Bussarawit & C. Aungtonya
PB5	BC	22/04/1997	007°52 'N	098°48 'E	-	-	21	-	sand with shell fragments	S. Bussarawit
PB6	BC	22/04/1997	007°45 'N	098°32 'E	-	-	30	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	007°45 'N	098°32 'E	007°45 'N	098°32 'E	30	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	007°43 'N	098°33 'E	007°44 'N	098°33 'E	37	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	007°46 'N	098°31 'E	007°47 'N	098°31 'E	27	-	ND	S. Bussarawit
	TD	21/02/1998	007°44 'N	098°33 'E	007°44 'N	098°32 'E	34	-	ND	S. Bussarawit & C. Aungtonya
	T	27/02/1998	007°45 'N	098°36 'E	007°47 'N	098°34 'E	24			S. Bussarawit & C. Aungtonya
PB7	BC	22/04/1997	007°45 'N	098°41 'E	-	-	29	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	007°45 'N	098°41 'E	007°45 'N	098°41 'E	32	-	sand with shell fragments	S. Bussarawit
	OS	21/02/1998	007°44 'N	098°41 'E	007°44 'N	098°41 'E	32	-	sand with shell fragments	S. Bussarawit & C. Aungtonya
	TD	22/04/1997	007°45 'N	098°40 'E	007°45 'N	098°40 'E	30	-	ND	S. Bussarawit
	TD	21/02/1998	007°45 'N	098°42 'E	007°44 'N	098°41 'E	30	-	ND	S. Bussarawit & C. Aungtonya
	T	21/02/1998	007°44 'N	098°40 'E	007°43 'N	098°36 'E	32	-	ND	S. Bussarawit & C. Aungtonya
PB8	BC	22/04/1997	007°45 'N	098°52 'E	-	-	19	-	sand with shell fragments	S. Bussarawit
	OS	22/04/1997	007°45 'N	098°51 'E	007°44 'N	098°51 'E	19	-	sand with shell fragments	S. Bussarawit
	TD	22/04/1997	007°44 'N	098°51 'E	007°44 'N	098°50 'E	22	-	ND	S. Bussarawit
PB9	TD	05/12/1998	007°40 'N	098°37 'E	007°39 'N	098°37 'E	36	-	ND	S. Bussarawit
PB10	OS	05/12/1998	007°36 'N	098°34 'E	007°36 'N	098°34 'E	41	-	ND	S. Bussarawit
	T	05/12/1998	007°36 'N	098°34 'E	007°32 'N	098°33 'E	44	-	ND	S. Bussarawit
U1	G	19/04/1997	006°49 'N	097°45 'E	-	-	400	-	sandy mud	S. Bussarawit
	OS	19/04/1997	006°46 'N	097°44 'E	006°46 'N	097°44 'E	416	-	sandy mud	S. Bussarawit
	TD	19/04/1997	006°48 'N	097°45 'E	006°46 'N	097°44 'E	402	-	ND	S. Bussarawit
U2	G	18/04/1997	007°03 'N	097°32 'E	-	-	476	-	sandy mud	S. Bussarawit
	TD	18/04/1997	007°04 'N	097°31 'E	007°05 'N	097°31 'E	476	-	ND	S. Bussarawit
U3	G	17/04/1997	006°55 'N	097°22 'E	-	-	669	-	soft mud	S. Bussarawit
	TD	17/04/1997	006°57 'N	097°22 'E	006°56 'N	097°21 'E	651	-	ND	S. Bussarawit
U4	G	15/04/1997	007°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	007°07 'N	097°04 'E	-	-	965		mud	S. Bussarawit & C. Aungtonya
	G	16/11/1999	007°06 'N	097°04 'E	-	-	964		mud	C. Aungtonya & V. Vongpanich
	OS	28/01/1999	007°06 'N	097°05 'E	007°06 'N	097°05 'E	960	960	mud	S. Bussarawit & C. Aungtonya
	AT	16/11/1999	007°07 'N	097°03 'E	007°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 Lat.	Start Point Long.	End Point Lat.	End Point Long.	Depth (m) Start	Depth (m) End	Type of sediment	Collector
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

Phuket Marine Biological Center Special Publication 31: 75–81 (2008)

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

'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.

Phuket Marine Biological Center Special Publication 31: 75–81 (2008)

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

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,

REFERENCES

Alcock, A. 1902: A naturalist in Indian Seas or, four years with The Royal Indian Marine survey ship 'Investigator'. J. Murray, London, 328 p.

Ananpongsuk, S. 1989. Report on some offshore demersal resources of the Andaman Sea. Training Department, Southeast Asian Fisheries Development Center. Research Paper Series No. 20, 30 p.

Aungtonya, C., S. Thaipal and O. Tendal 2000: A preliminary report on the Thai-Danish BIOSHELF surveys (1996–2000) of the West Coast of Thailand, Andean Sea. Phuket marine biological Center Research Bulletin **63**: 53–76.

Chatanathawej, B. and S. Bussarawit. 1987: Quantitative survey of the macrobenthic fauna along the west coast of Thailand in the Andaman Sea. Phuket marine biological Center Research Bulletin **47**: 1–23.

Hylleberg, J. 2001: Biodiversity studies at Phuket Marine Biological Center (PMBC): Polychaetes, Sipunculans, Amphipods, Echinoderms and Molluscs. pp. 48-49. **In:** Centenary Celebration of Thai-Danish Co-operation in Biodiversity. Queen Sirikit Botanical Garden, Chiang Mai, Thailand,10-11 February 2001. 71 p.

Muus, B. 1964: A new quantitative sampler for meiobenthos. Ophelia **1**: 209–216.

Nishida, T. and K. Sivasubramaniam. 1986: Atlas of deep water demersal fishery resources in the Bay of Bengal. Bay of Bengal Programme. Marine Fishery Resources Management, Colombo. 49 p.

Pokapun, W., J. Tantivala and A. Munprasit. 1983. Some deep-sea fishes in the Andama Sea. Exploratory Fishing Division, Department of Fisheries, Bangkok Thailand. No. 14, 70 p.

Rice, A.L. 1986: British oceanographic vessels 1800–1950. The Ray Society, London, vol 157: 1–193.

Sewell, R.B.S. 1925. Geographic and oceanographic research in Indian waters. Part I. The geography of the Andaman Sea basin. Memoirs of the Asiatic Society of Bengal **9**: 1–26.

Sewell, R.B.S. 1954. Deep–sea oceanographic exploration in Indian waters. The Journal of the Bombay Natural History Society **50**: 705–717.

Takahashi K. and N. Ruangsivakul. 1983: A comprehensive study on the oceanographic conditions of trawl fishing grounds in the Andaman Sea off the southwest coast of Thailand. Training Department, Southeast Asian Fisheries Development Center. Current Technical Paper **23**: 148–182.

Seidenfaden, G., T. Smitinand and G. Thorson. 1968. Report on the Fifth Thai-Danish Expedition 1966. Natural History Bulletin of the Siam Society **22:** 245–261.

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

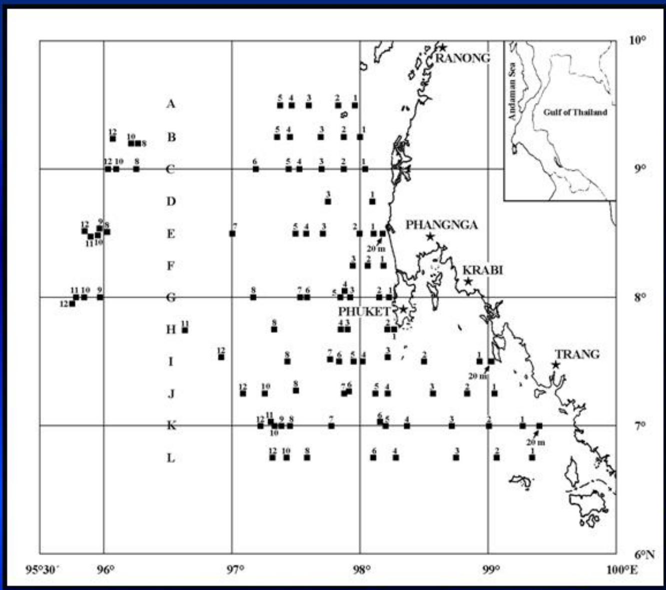
136 stations in the Thai EEZ : BIOSHELF and BIODEEP
20 – 1,020 m

"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

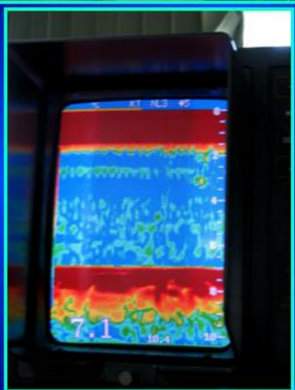
				No. of used times							
	No. of sampling station	min. depth (m)	max. depth (m)	Box corer	Smith-McIntyre grab	Ockel-mann sledge	Rothlisberg-Pearcy epibenthic sledge	Trian-gular dredge	Rectan-gular dredge	Agassiz trawl	Otter trawl
Cruise 1996	5	191	233	5	–	–	×	3	×	×	–
Cruise 1997	12	324	1,020	2	12	4	×	9	×	×	–
Cruise 1998	1	–	342	–	–	–	×	1	×	×	–
Cruise 1999 (Jan–Feb.)	20	192	965	–	7	10	×	4	×	×	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

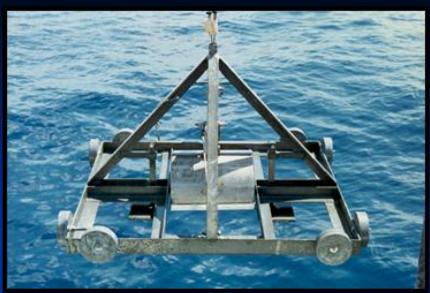
The box corer

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

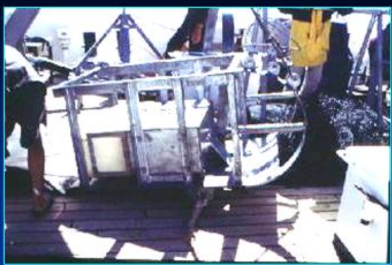
Ockelmann Sledge

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.

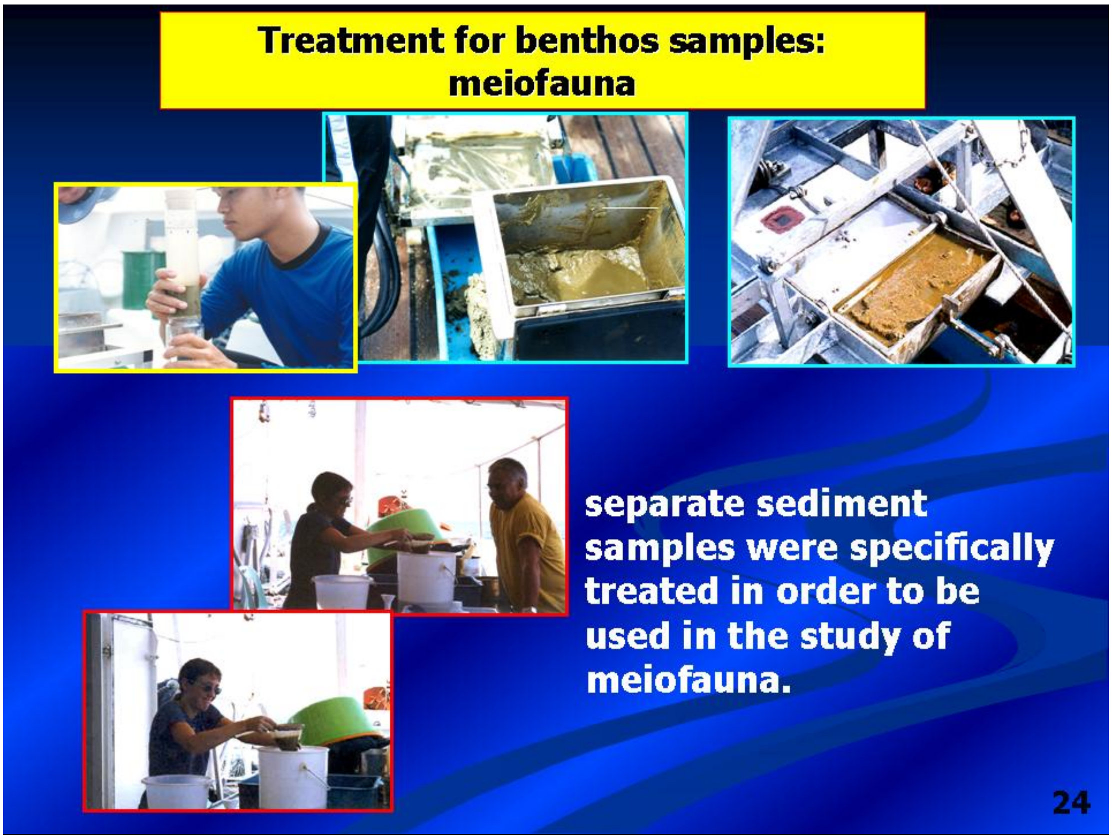
The plankton net bag has a mesh size of 0.5 mm and is 4 m long. The terminal plastic cylinder, which is 10 cm in diameter and 30 cm long, can be screwed off. For protection of the net underside a thick rubber sheet is mounted on the lower rear end of the frame.

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

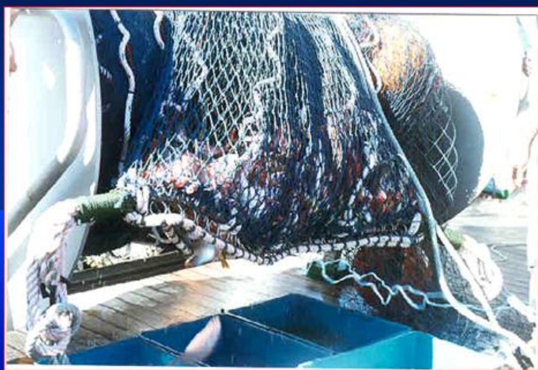
This gear is a rustfree steel tube construction, locally build after suggestions on dimensions by Associate Professor Ole Tendal.

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

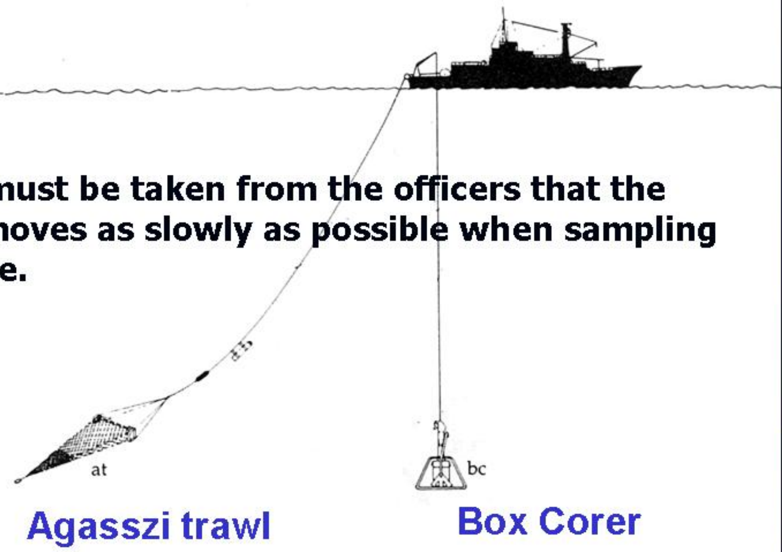
1. In some areas work has been difficult because of very rugged bottoms. Although rather poor both in species and specimens there is a special fauna in these areas, and it must be sampled. It is inevitable that some gear will be damaged, destroyed or totally lost during work in this kind of environment.

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

Care must be taken from the officers that the ship moves as slowly as possible when sampling is done.



wires condition & sampling gear

13

Treatment of fish and large invertebrate samples

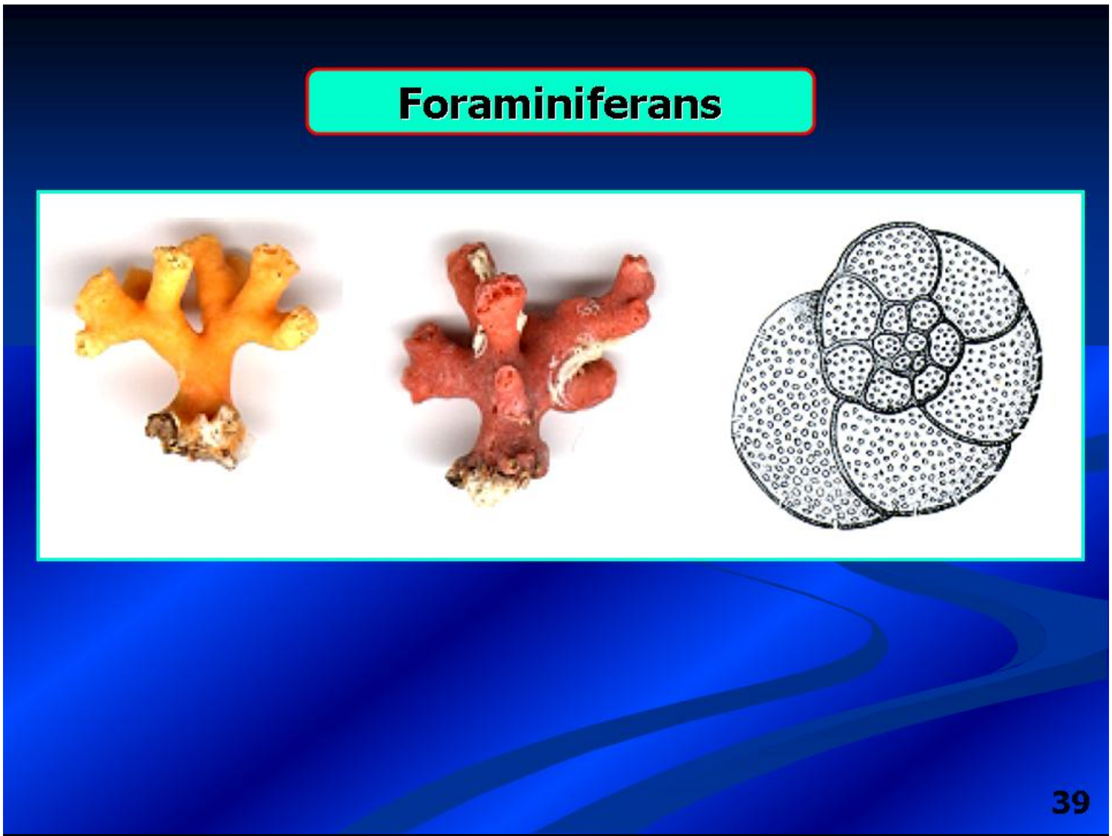
Samples were roughly sorted on deck and fixed in 10% buffered formalin.

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

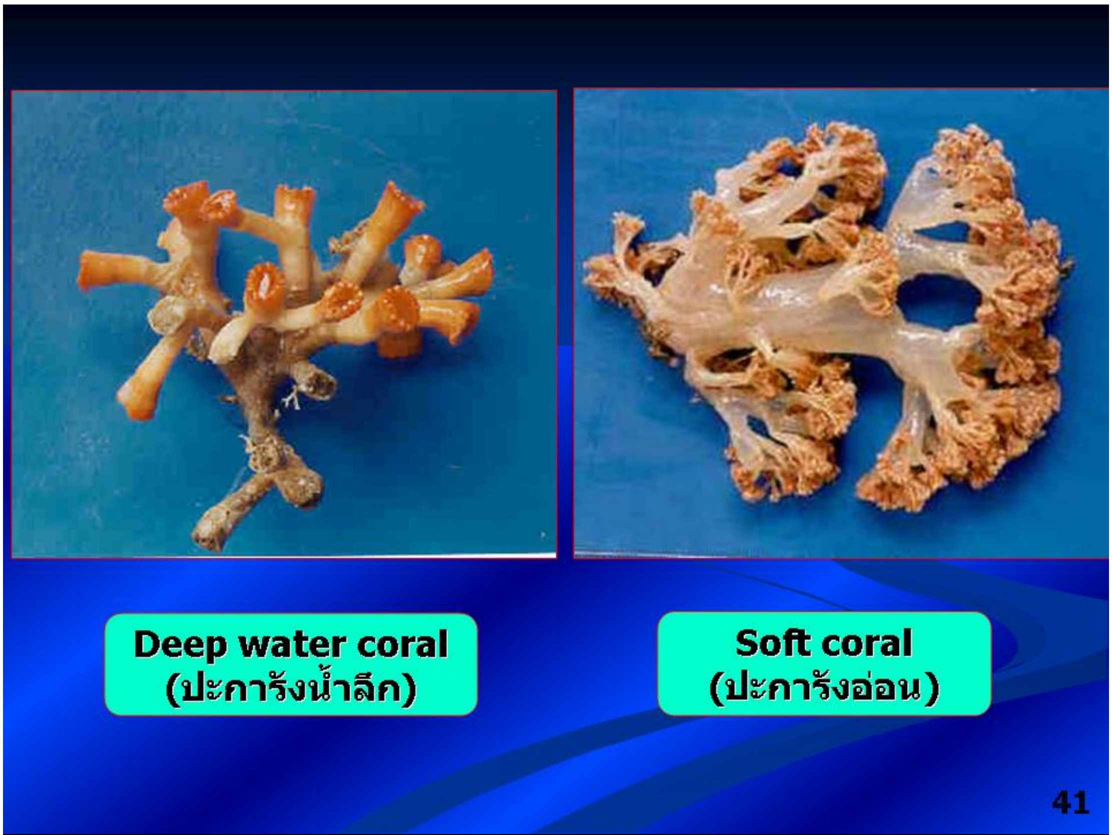
37

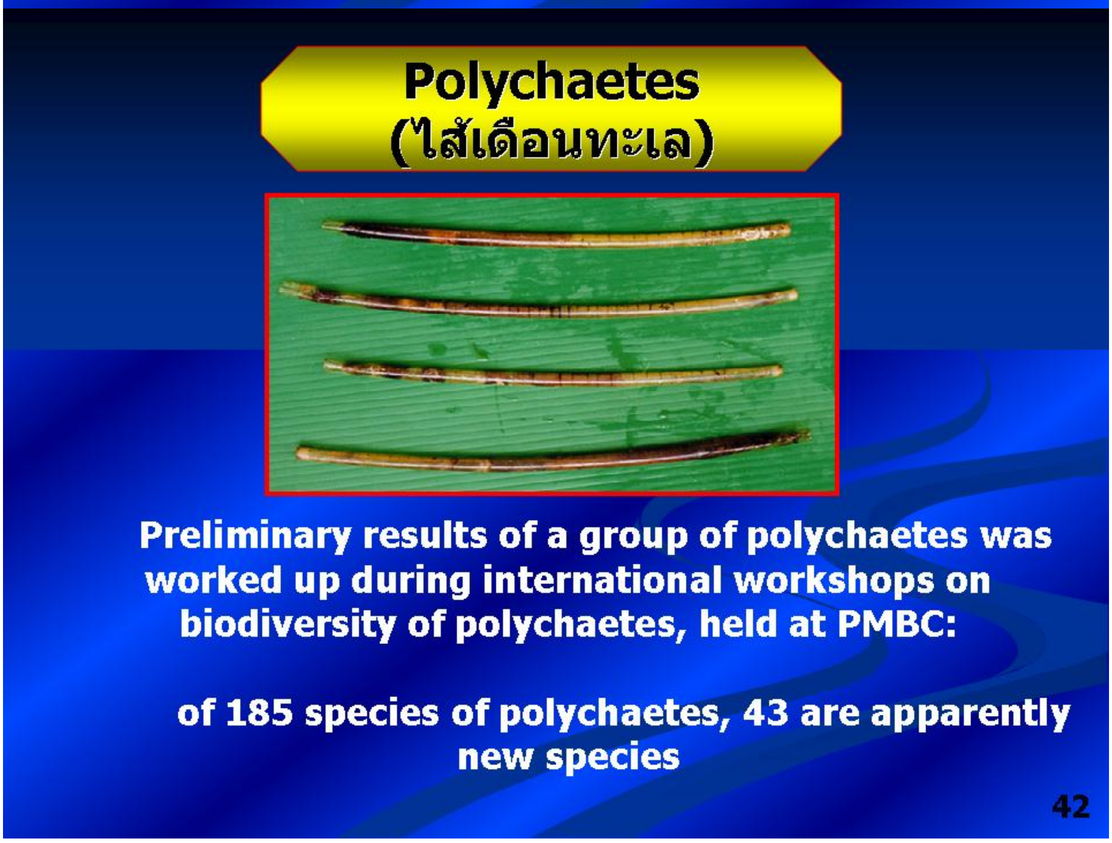
Fauna

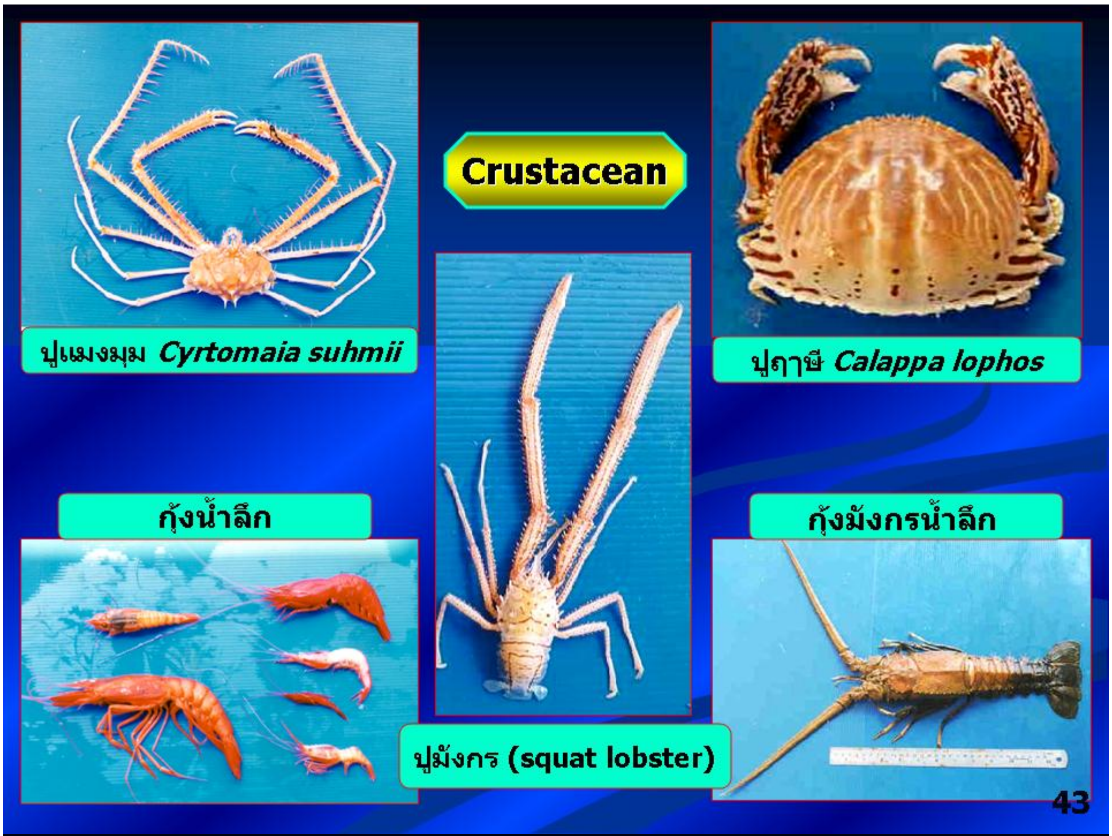
38

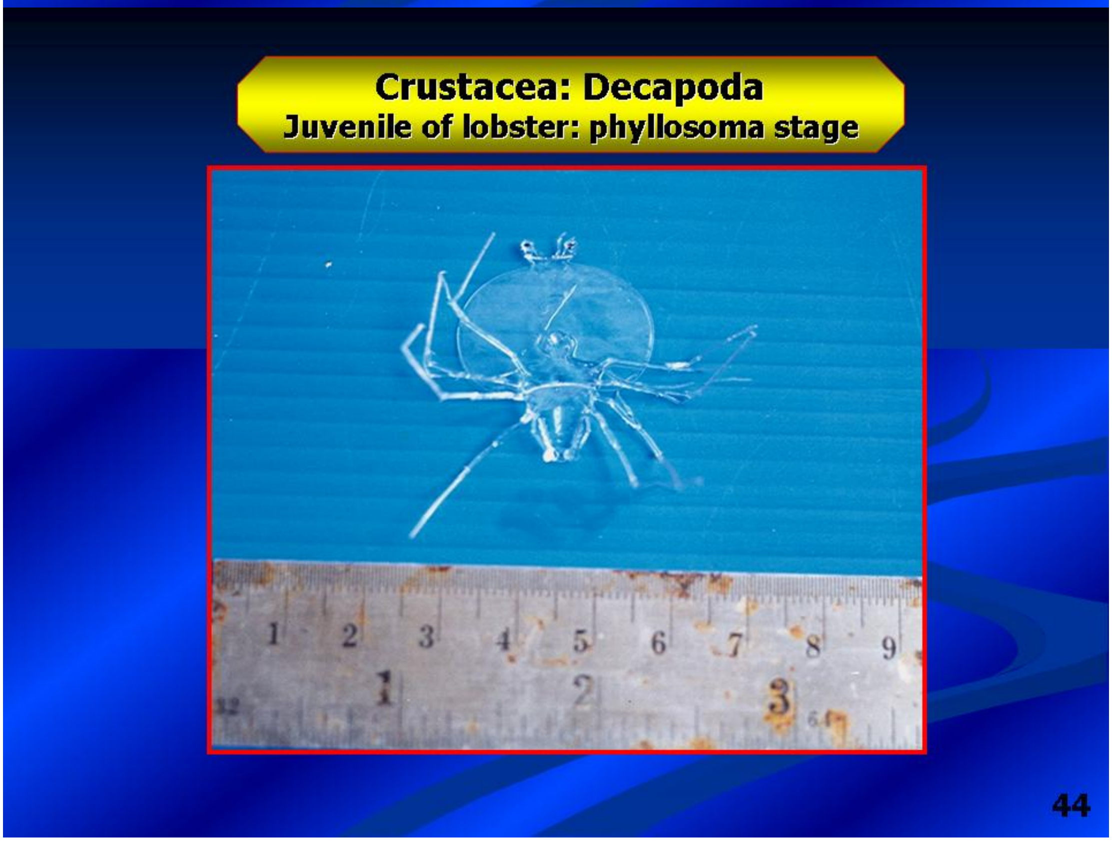

Foraminiferans
39

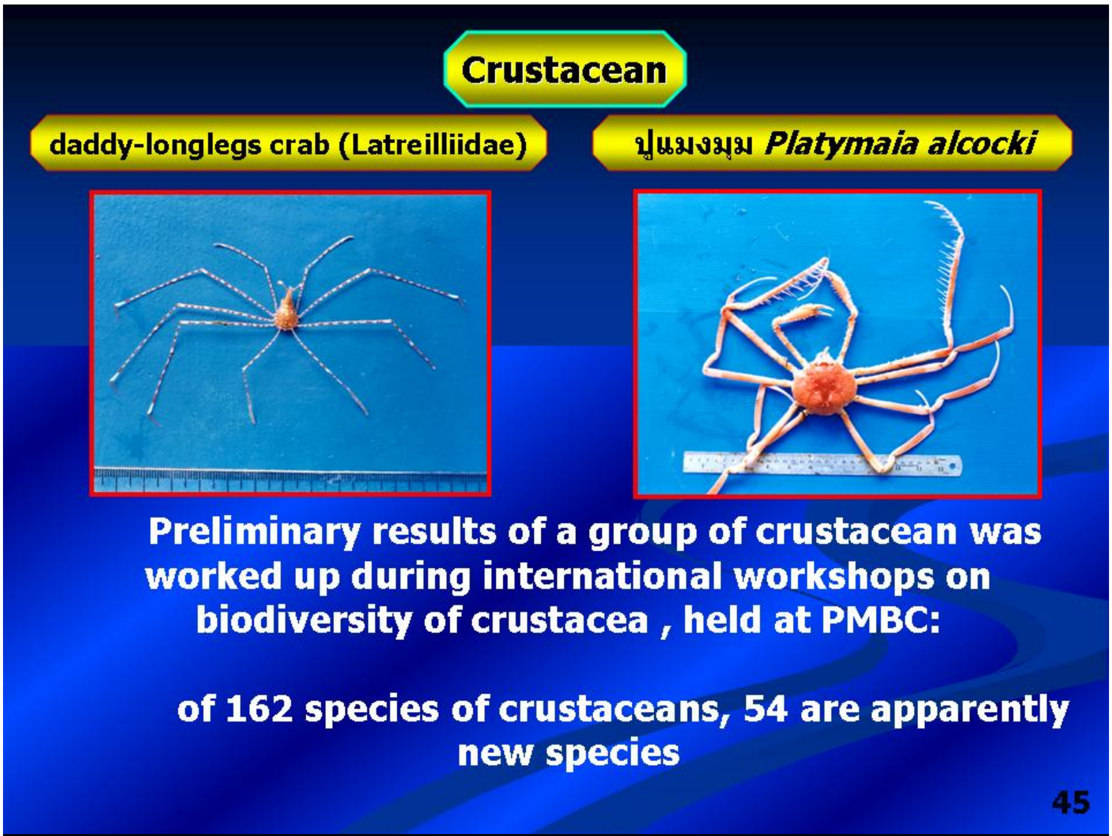

Sea sponges / Porifera (ฟองน้ำ)
40


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
กุ้งมังกรน้ำลึก
ปูมังกร (squat lobster)
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.
แนะนำตัวอย่างอ้างอิง
Bathynomus lowryi (Bruce and Bussarawit, 2004)
แมลงสาบทะเลยักษ์ แห่งท้องทะเลอันดามัน
46


Crustacea: Stomatopoda
กั้งกระดาน (Scyllaridae)
กั้งตั๊กแตน
47

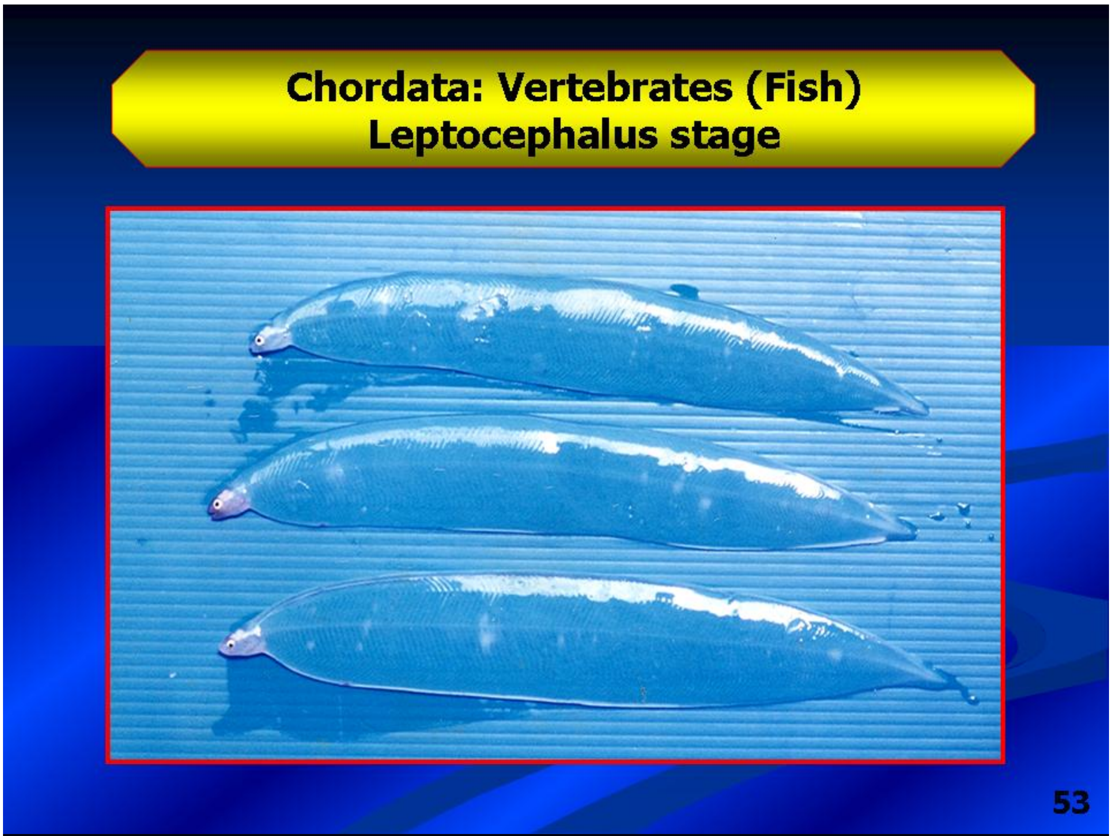

Bryozoa
ลูกถักทะเล
48


ดาวทะเล
อีแปะทะเล
เม่นทะเล
ดาวขนนก
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
Proceedings of the International Workshop on
the Crustacea of the Andaman Sea
Part 1
A Thai - Danish Scientific Cooperation Program
Proceedings of the International Workshop on
the Crustacea of the Andaman Sea
Part 2
A Thai - Danish Scientific Cooperation Program
Proceedings of the International Workshop on
the Polychaetes of the Andaman Sea
June–August 1997
A Thai-Danish Scientific Cooperation Program
Proceedings of the SCP Concluding Conference on
the Thai - Danish Scientific Cooperation Program
20 - 22 February 2001
A Thai - Danish Cooperation Program
54

References

Aungtonya, C., S. Thaipal and O.S. Tendal. 2000. A preliminary report on the Thai-Danish BIOSHELF surveys (1996–2000) of the West Coast of Thailand, Andean Sea. Phuket marine biological Center Research Bulletin 63: 53–76.

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.

55

ACKNOWLEDGEMENTS

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

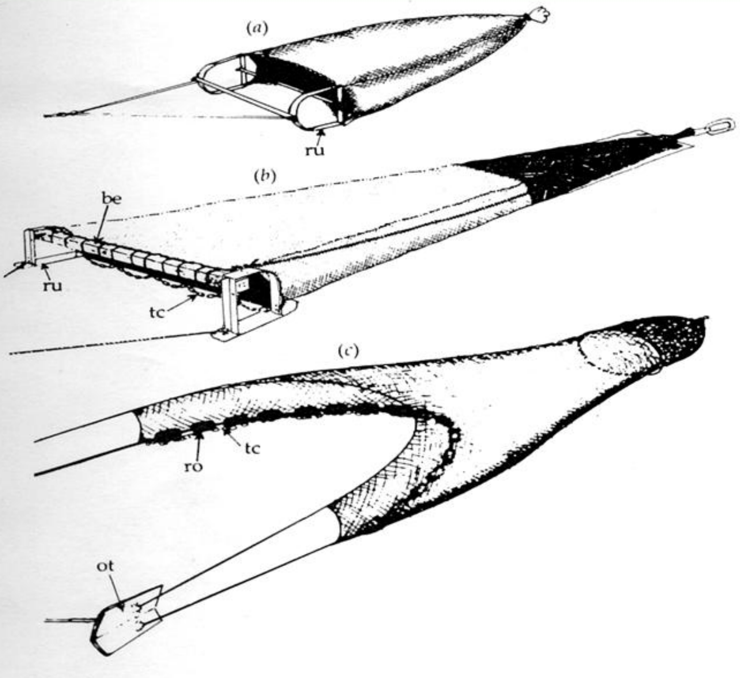


Fig. 3.9. Different bottom trawls drawn roughly to scale. (*a*) 3-m wide Agassiz trawl with: (*b*) large 6-m wide beam trawl operated in recent French studies; (*c*) semiballoon otter trawl (OTSB). ru, metal runner; be, timber beam; tc, tickler chain; ro, rubber rollers on trawl foot rope; ot, steel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

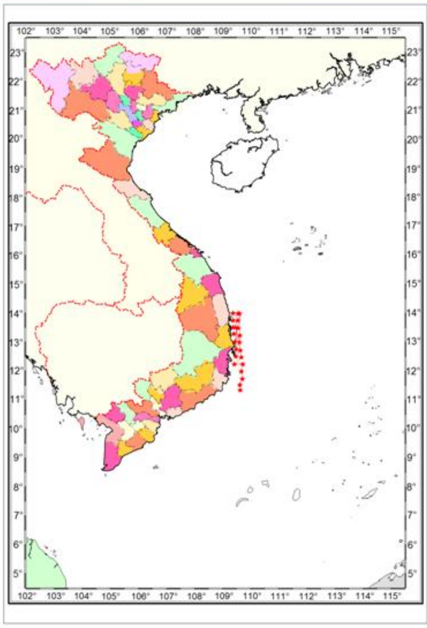
ALMRV PHASE 2 (2000-2005): supported by DANIDA

- 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

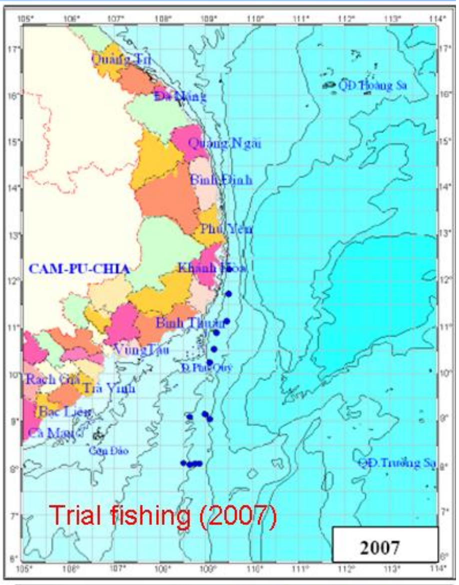
- Gear used: Trap and bottom longline
- Period: 2002
- Numbers of trip: 1 trips
- Numbers of station: 28 stations
- Numbers of station in deep sea area: 28 stations



Related deep-sea surveys

Continental slope surveys (2005-2007)

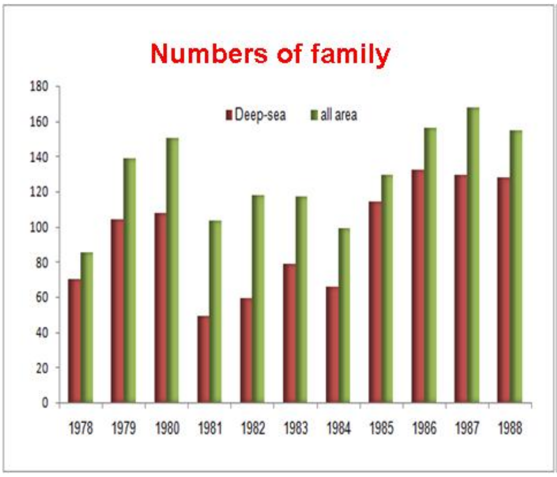
- Gear used: Bottom longline, BVL, traps, pots
- Period: 2005-2007
- Vessel: M/V SEAFDEC 2, commercial boats
- Surveys: 2 surveys
- Trial fishing: 3 surveys

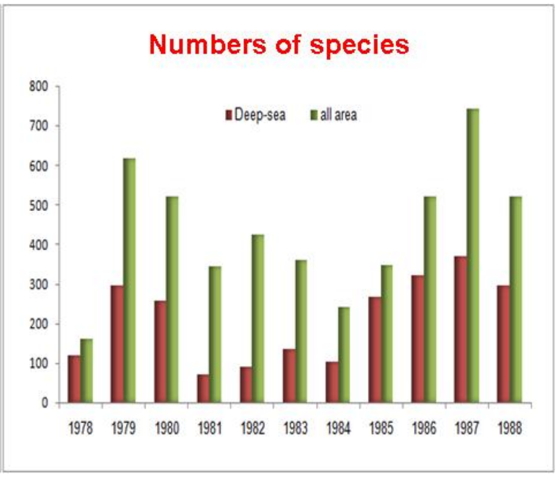


Results

Viet-Xo Joint surveys (1978-1988)

Species composition

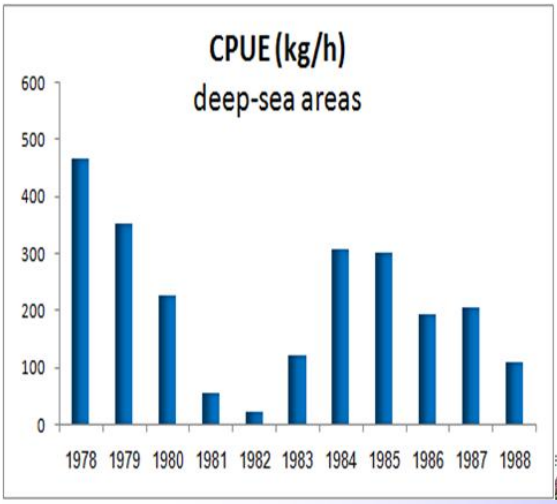


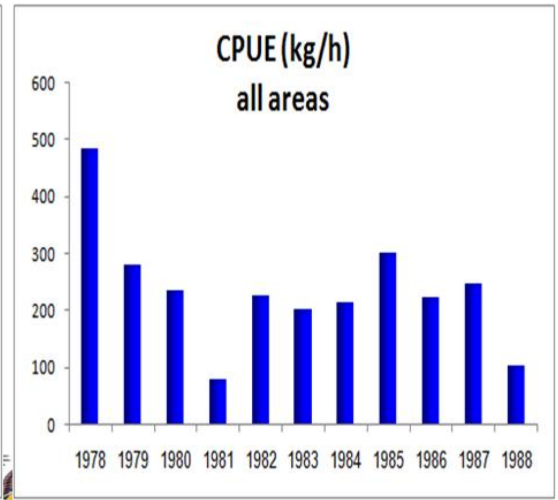


Results (cont')

Viet-Xo Joint surveys (1978-1988)

Catch rate

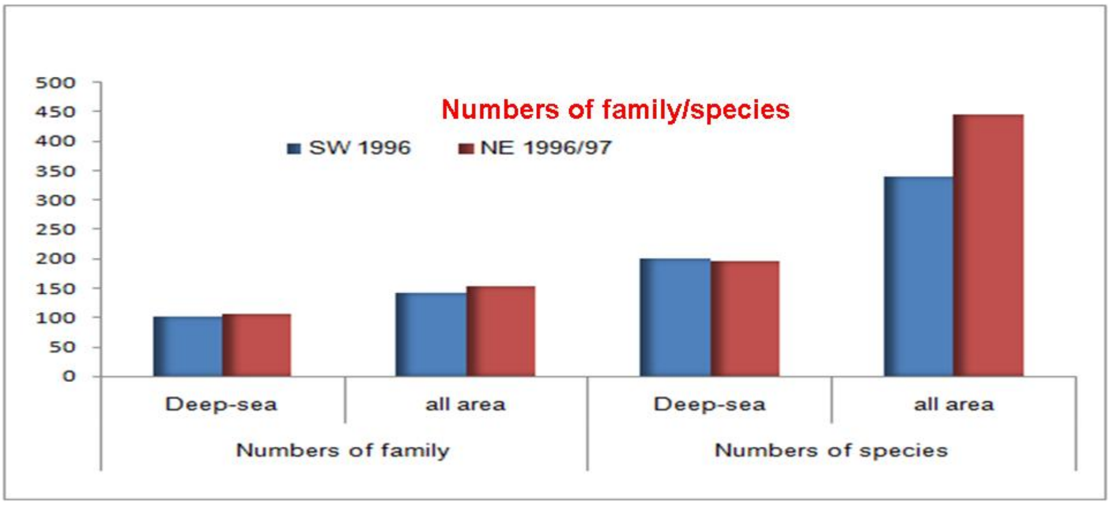




Results (cont')

ALMRV PHASE 1 surveys (1996-1997)

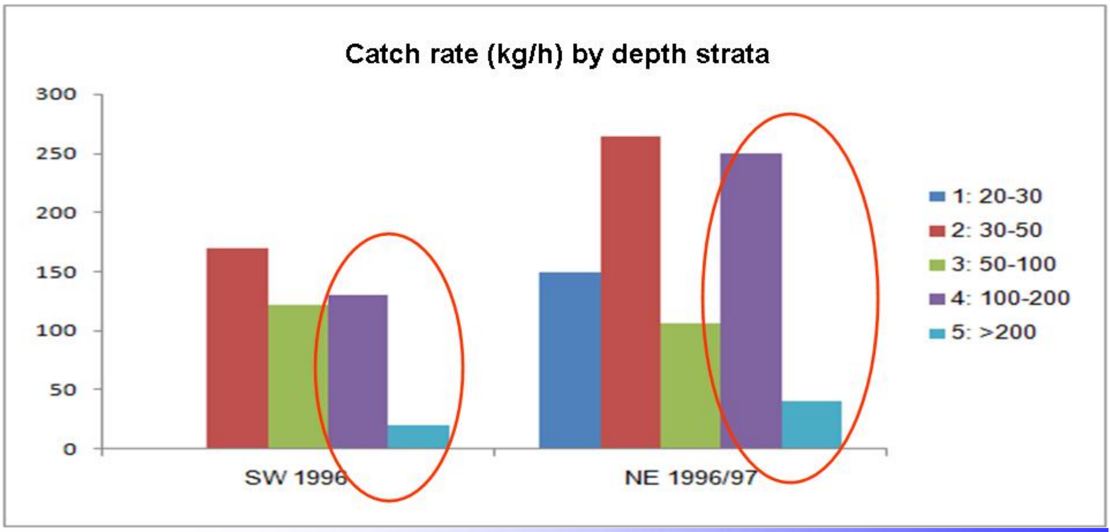
Species composition



Results (cont')

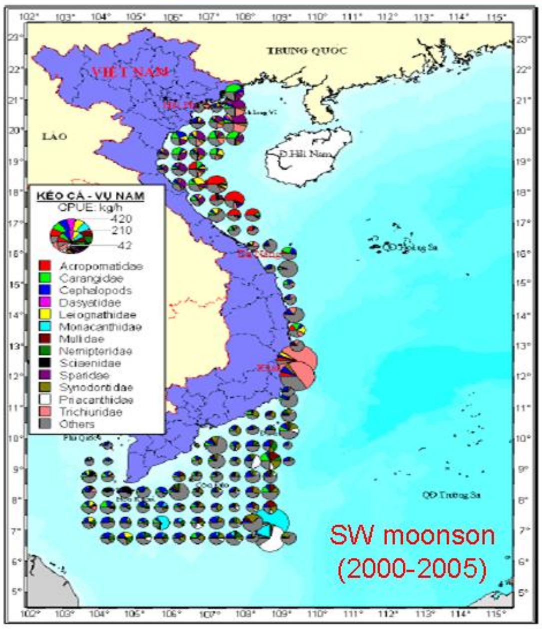
ALMRV PHASE 1 surveys (1996-1997)

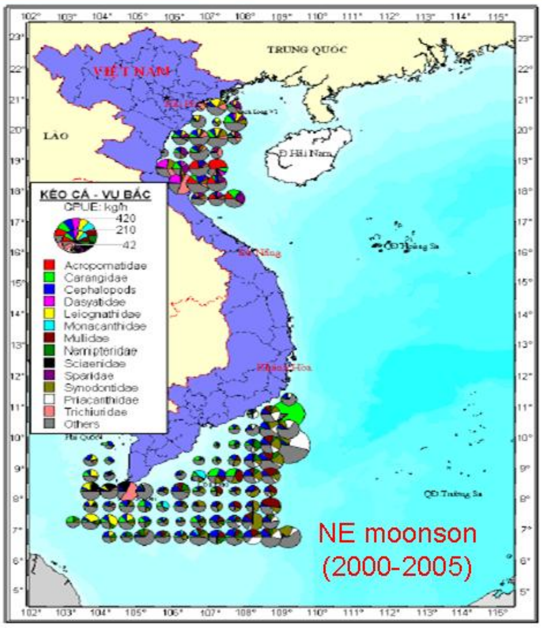
Catch rate (kg/h)



Results (cont')

ALMRV PHASE 2 surveys (2000-2005)

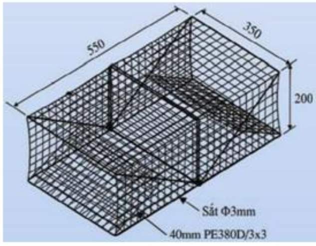


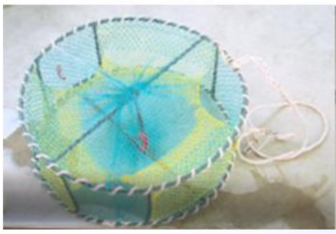


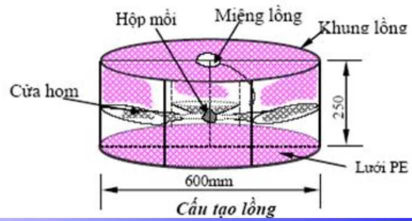
Results (cont')

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

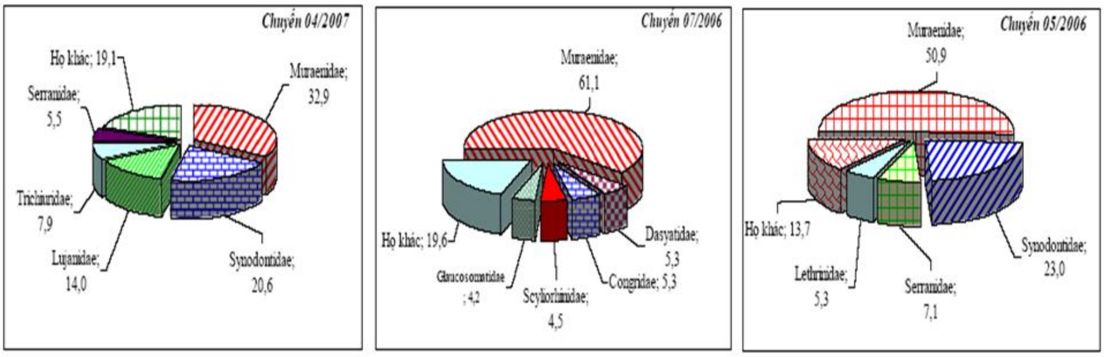
- Trial fishing (2006-2007)

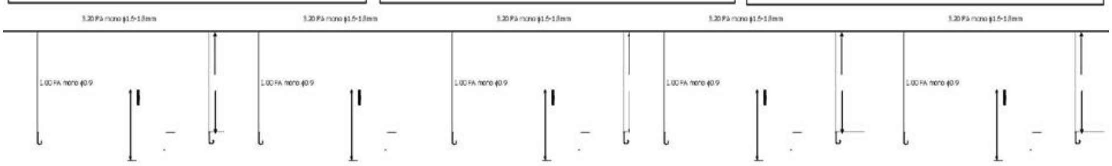
Gear type	*Family/species*	*May 06*	*Jul 06*	*Apr 07*	*All*
Bottom longline	Family	13	22	22	34
	Species	22	35	37	71
Eel pot	Family	2	1	4	5
	Species	3	1	7	9
Cylinder swim. crab trap	Family	12	13	12	25
	Species	18	19	17	40
Rectangular swim. crab trap	Family	6		9	11
	Species	8		13	20
Grouper trap (soft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

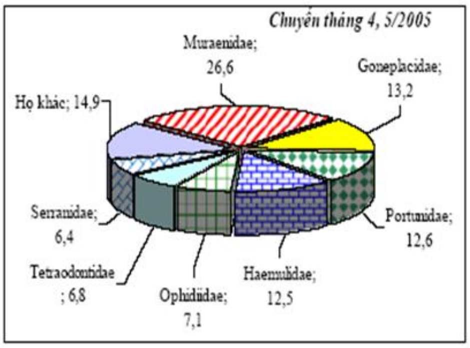


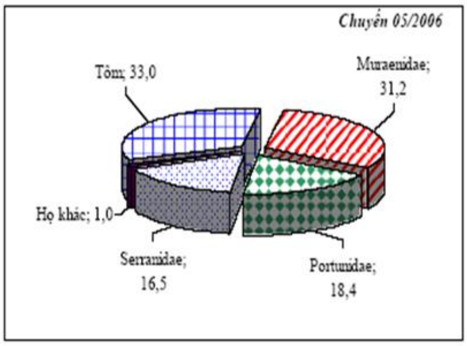


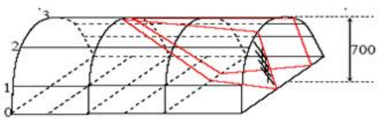
Results (cont')

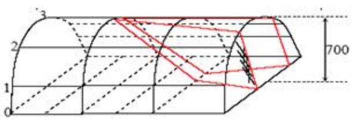
Continental slope surveys (2005-2007)

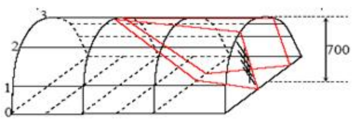
*) Grouper trap (soft cover)







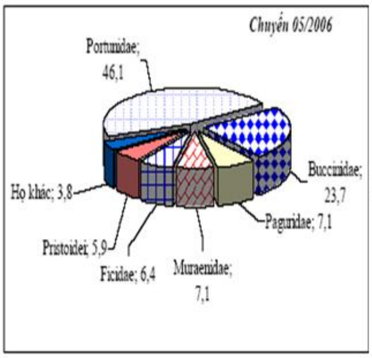


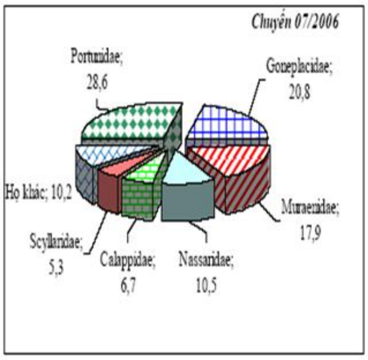


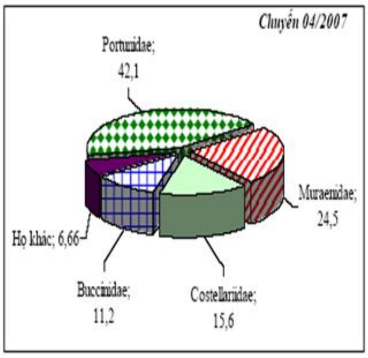
Results (cont')

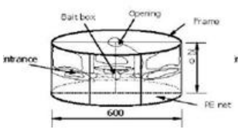
Continental slope surveys (2005-2007)

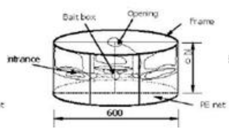
*) Cylinder swim. crab trap

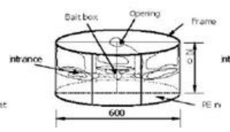


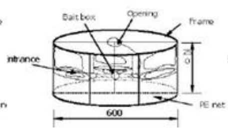


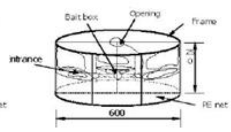








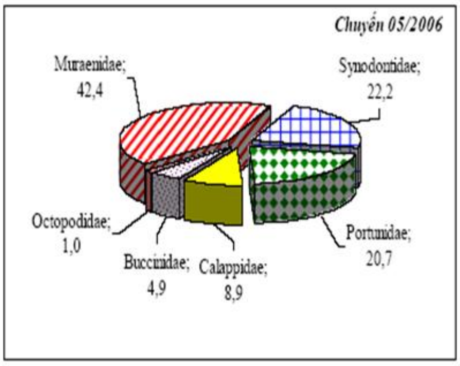


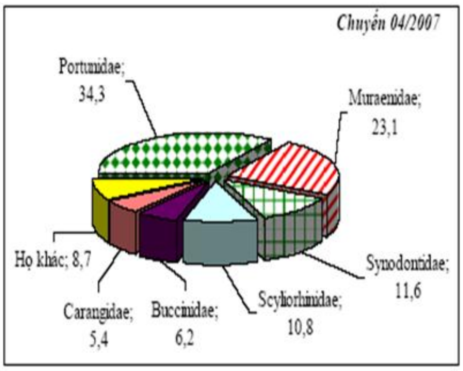


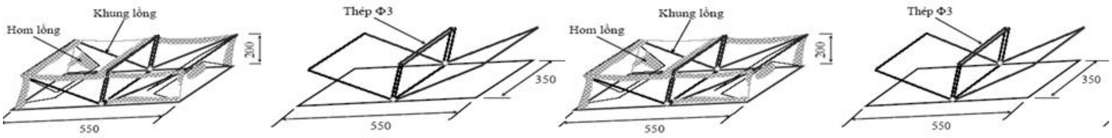
Results (cont')

Continental slope surveys (2005-2007)

*) Rectangular swim. crab trap



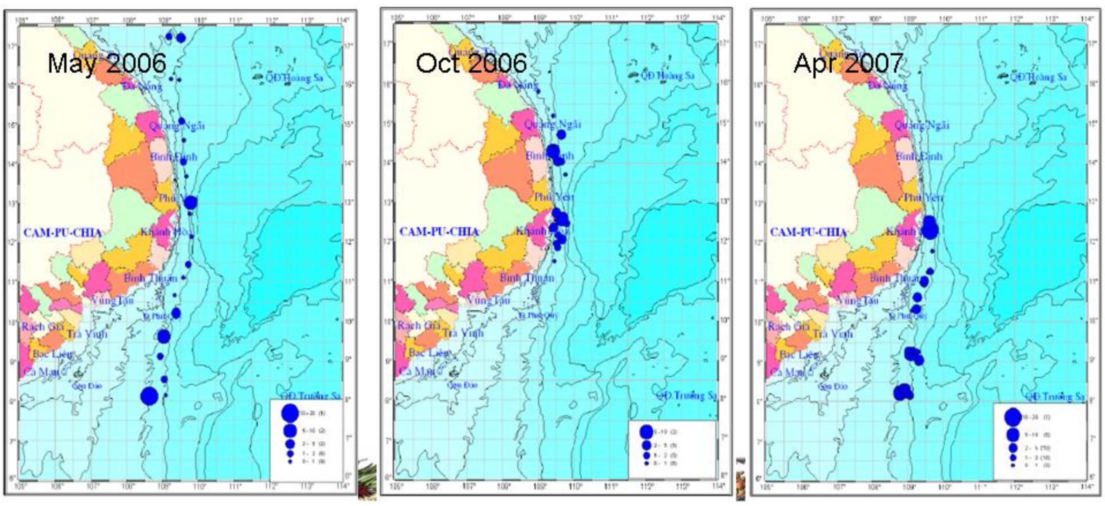




Results (cont')

Continental slope surveys (2005-2007)

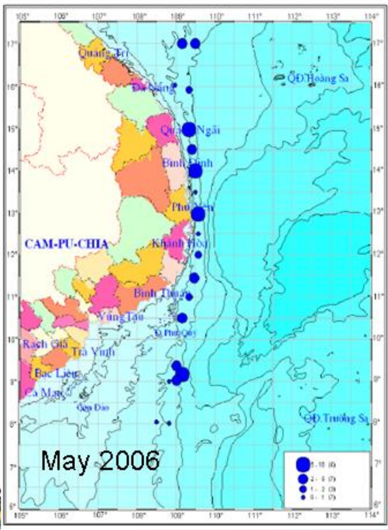
*) Bottom longline

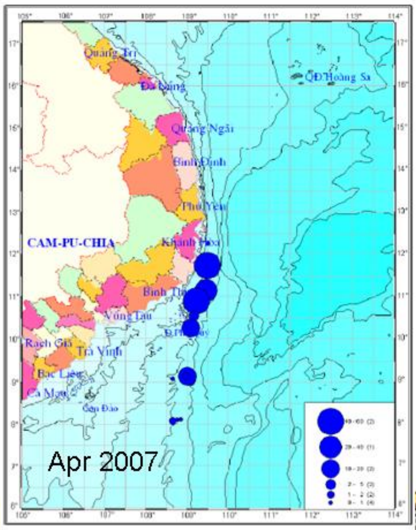


Results (cont')

Continental slope surveys (2005-2007)

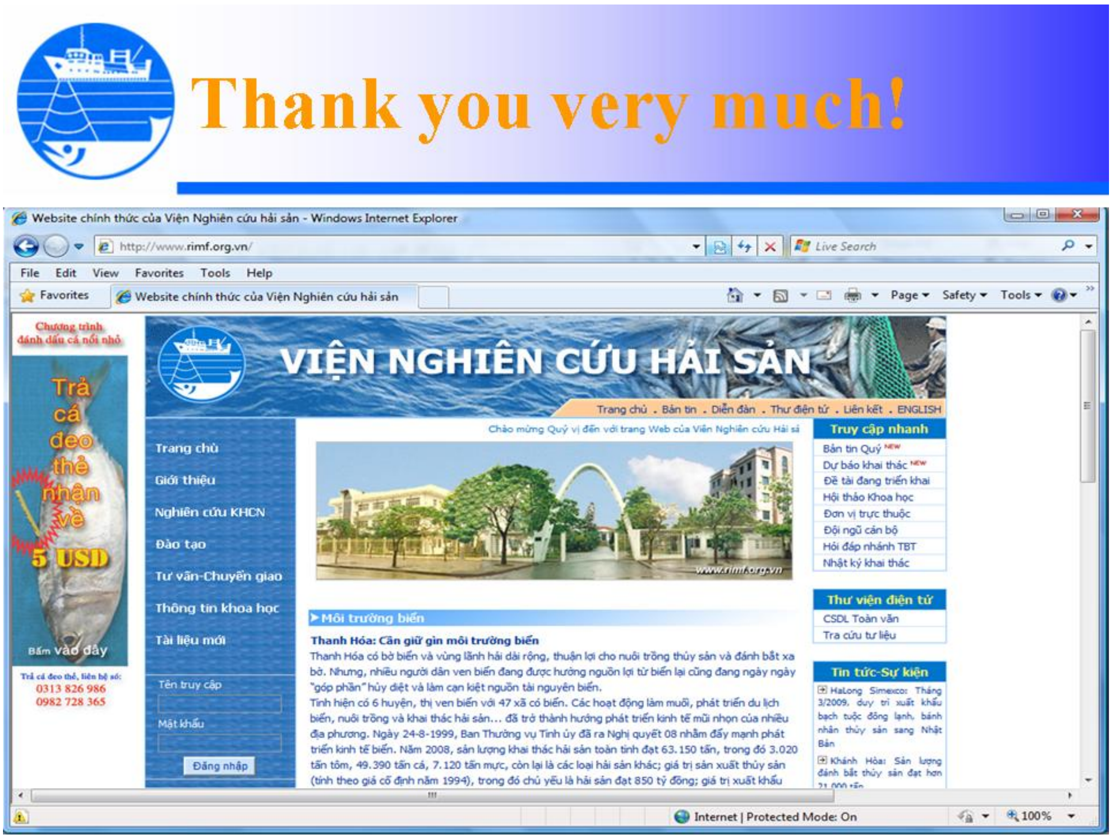
*) Eel pots





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!
Website chính thức của Viện Nghiên cứu hải sản - Windows Internet Explorer
http://www.rimf.org.vn/
File Edit View Favorites Tools Help
Favorites
Website chính thức của Viện Nghiên cứu hải sản
Chương trình đánh dấu cá nổi nhỏ
Trả cá đeo thẻ nhận về 5 USD
Bấm vào đây
Trả cá đeo thẻ, liên hệ số: 0313 826 986 0982 728 365
VIỆN NGHIÊN CỨU HẢI SẢN
Trang chủ . Bản tin . Diễn đàn . Thư điện tử . Liên kết . ENGLISH
Trang chủ
Giới thiệu
Nghiên cứu KHCN
Đào tạo
Tư vấn-Chuyển giao
Thông tin khoa học
Tài liệu mới
Tên truy cập
Mật khẩu
Đăng nhập
www.rimf.org.vn
Môi trường biển
Thanh Hóa: Cần giữ gìn môi trường biển
Truy cập nhanh
Bản tin Quý
Dự báo khai thác
Đề tài đang triển khai
Hội thảo Khoa học
Đơn vị trực thuộc
Đội ngũ cán bộ
Hỏi đáp nhánh TBT
Nhật ký khai thác
Thư viện điện tử
CSDL Toàn văn
Tra cứu tư liệu
Tin tức-Sự kiện
Internet | Protected Mode: On
100%

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:

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

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

$$C_t = qN_0 - qK_t \qquad ....5$$

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:

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

Or,

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

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

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

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

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

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

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

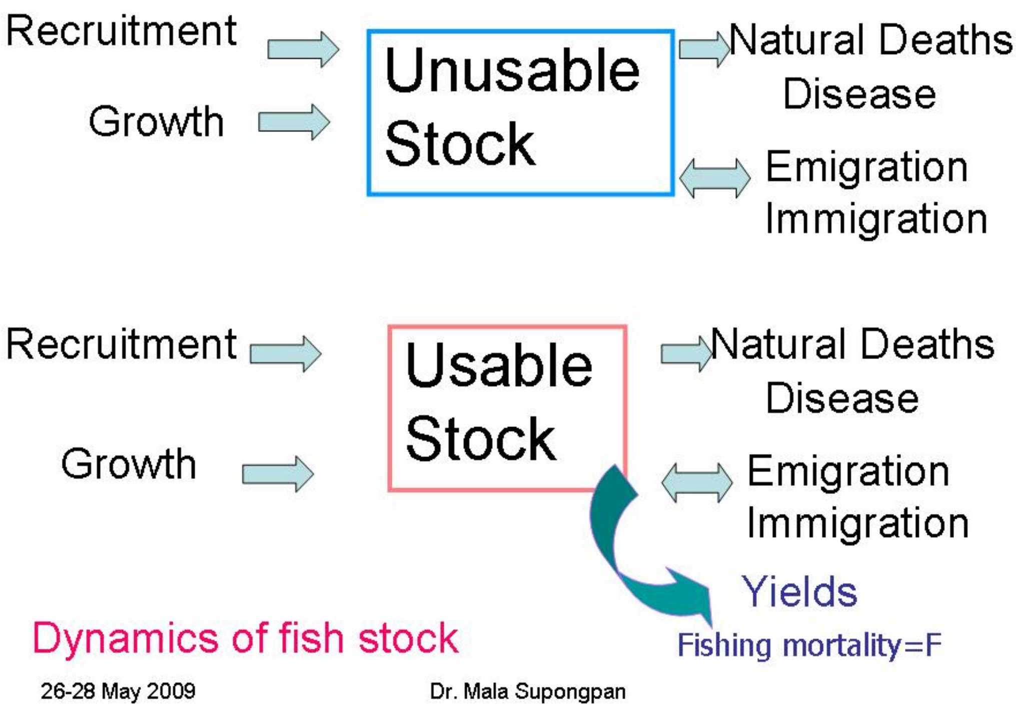
DuLury $q = 0.01394, N_0 = 1150.42$ $\ln\frac{C_t}{f_t} = \ln(qN_0) - qE_t$

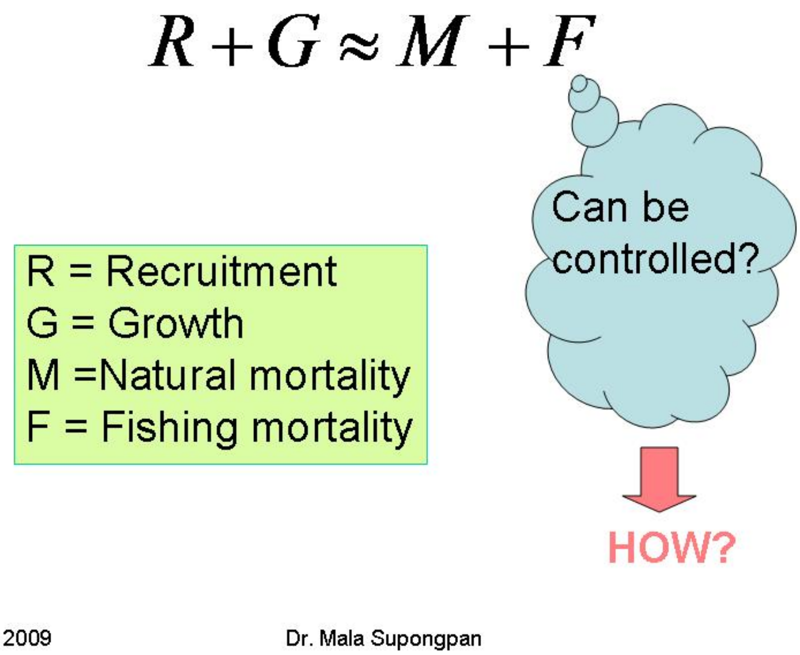
Exercise 2

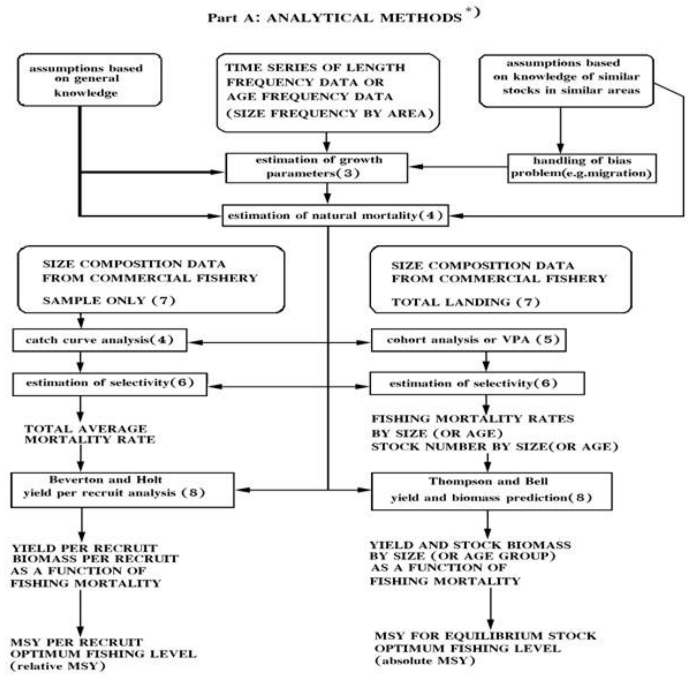
Find the Z value from CPUE data given:

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		

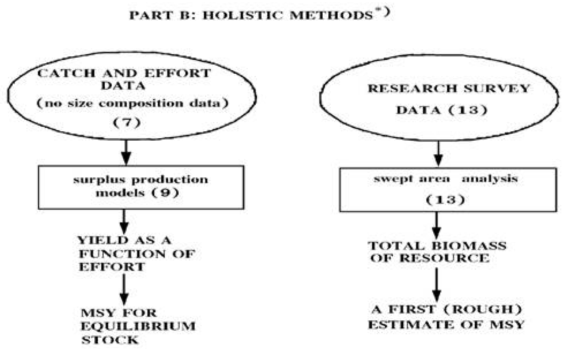
$$\frac{1}{t2 - t1} \ln\left(\frac{CPUE(t1)}{CPUE(t2)}\right) = Z$$


Recruitment
Growth
Unusable Stock
Natural Deaths
Disease
Emigration
Immigration
Recruitment
Growth
Usable Stock
Natural Deaths
Disease
Emigration
Immigration
Yields
Fishing mortality=F
Dynamics of fish stock
26-28 May 2009
Dr. Mala Supongpan


$R + G \approx M + F$
R = Recruitment
G = Growth
M =Natural mortality
F = Fishing mortality
Can be controlled?
HOW?
26-28 May 2009
Dr. Mala Supongpan



รูป 1.8.1A ลำดับขั้นตอนการประเมินสต๊อกสัตว์น้ำ
และการลำดับหัวข้อเรื่องในคู่มือ



รูป 1.8.1B ลำดับขั้นตอนการประเมินสต๊อกสัตว์น้ำ
และการลำดับหัวข้อเรื่องในคู่มือ

*) สัญญลักษณ์ที่ใช้มีดังนี้

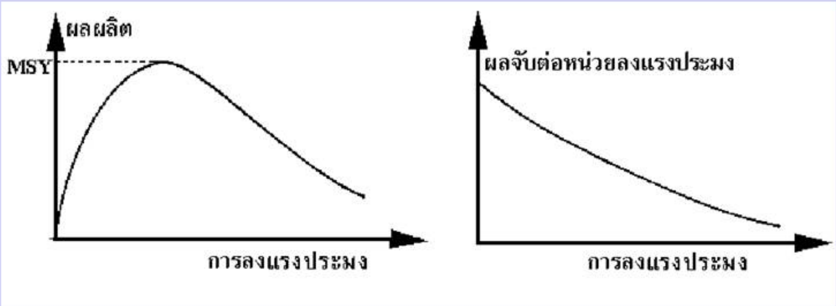
(วงรี) : ข้อมูลนำเข้าหรือสมมุติฐาน

(สี่เหลี่ยม) : การประมวลข้อมูลโดยใช้โมเดล

ข้อความที่ไม่มีกรอบและเขียนด้วยตัวอักษรใหญ่ : ผลที่ได้จากการประมวลข้อมูล ผลที่ได้จากขั้นตอนหนึ่ง และใช้เป็นข้อมูลนำเข้าในการประมวลผลขั้นต่อไป

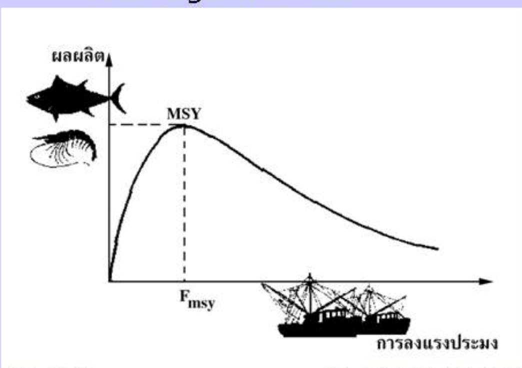
(n) : ตัวเลขในวงเล็บคือ เลขที่บท ที่มีทฤษฎีที่เกี่ยวข้อง

→ : ทิศทางการเคลื่อนที่ของข้อมูล



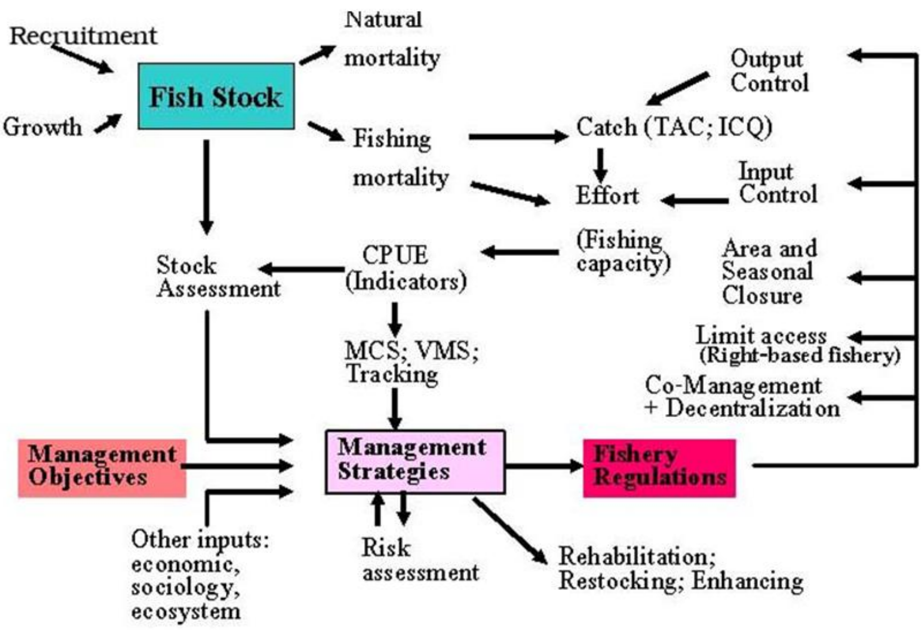
Yield against effort

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

26-28 May 2009 Dr. Mala Supongpan

Parameters for fish stock assessment

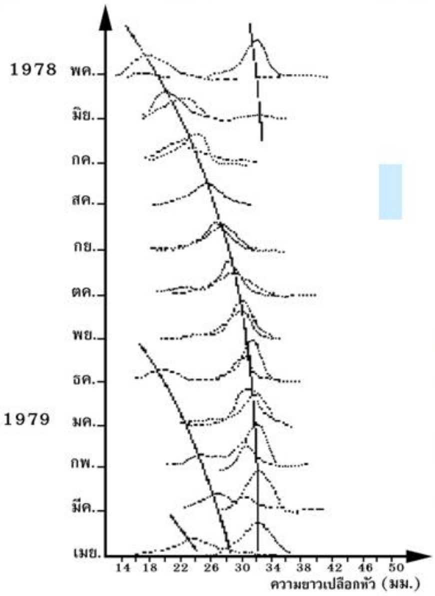
1. Length-weight $a, b, L_t, W_t, \bar{L}, \bar{W}$
2. Growth parameter $K, t_0, L_\infty, W_\infty, R$
3. Mortality Z, F, M, q

And data on production

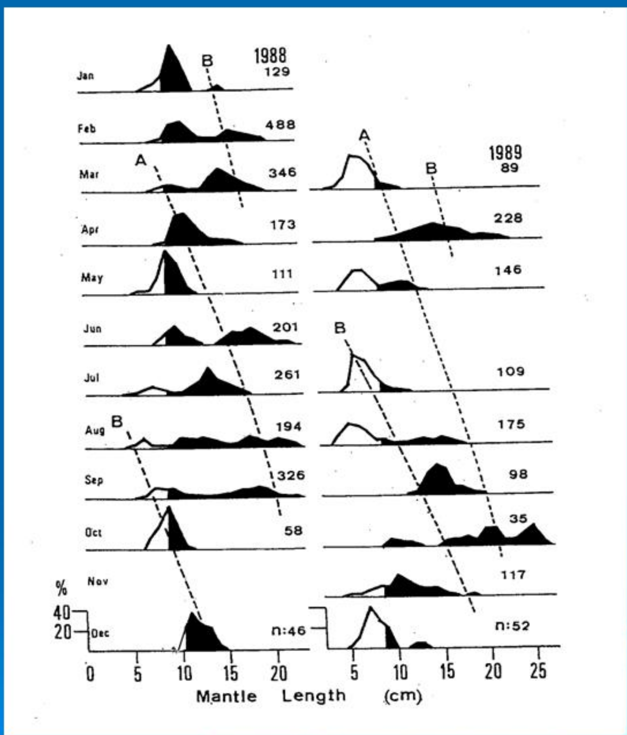
Catch and effort, production and biomass

26-28 May 2009 Dr. Mala Supongpan

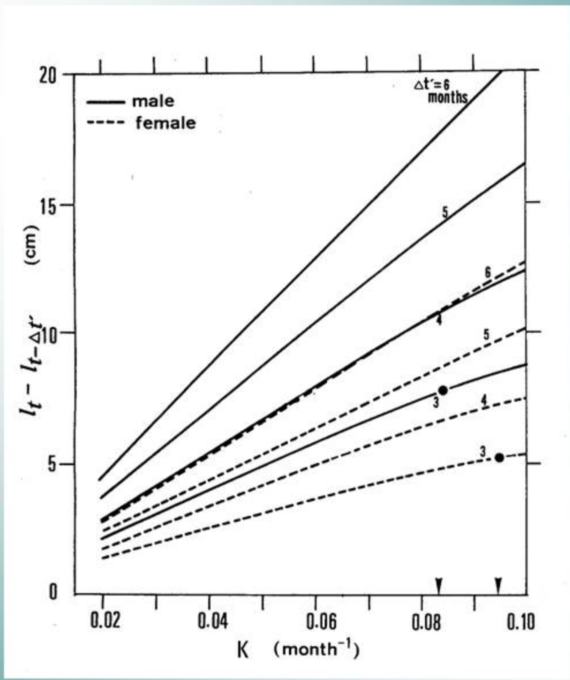
Modal Progression Analysis



26-28 May 2009 Dr. Mala Supongpan



26-28 May 2009 Dr. Mala Supongpan



26-28 May 2009 Dr. Mala Supongpan

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+

26-28 May 2009 Dr. Mala Supongpan

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

26-28 May 2009 Dr. Mala Supongpan

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

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

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

$$CPUE(t)=qN_t$$

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

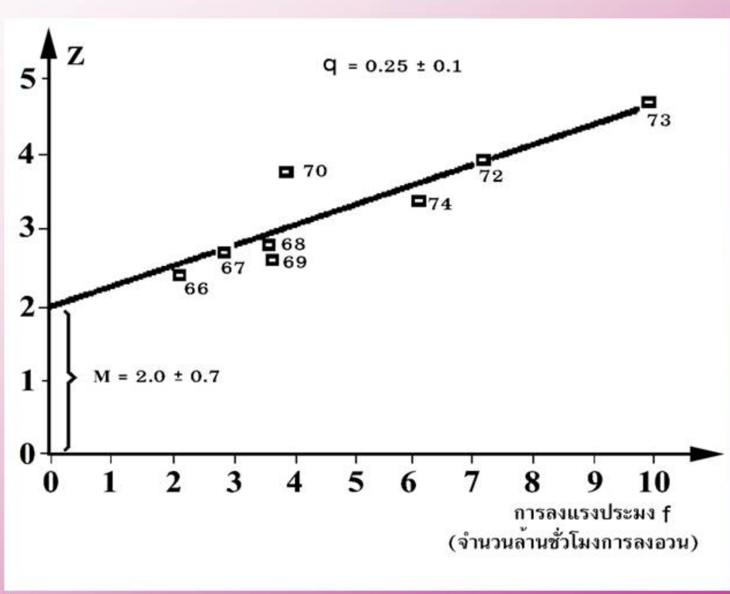
From above equations, then gives:

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

26-28 May 2009 Dr. Mala Supongpan

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/ km^2)*

A = total area (km^2) (101,384 km^2)

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

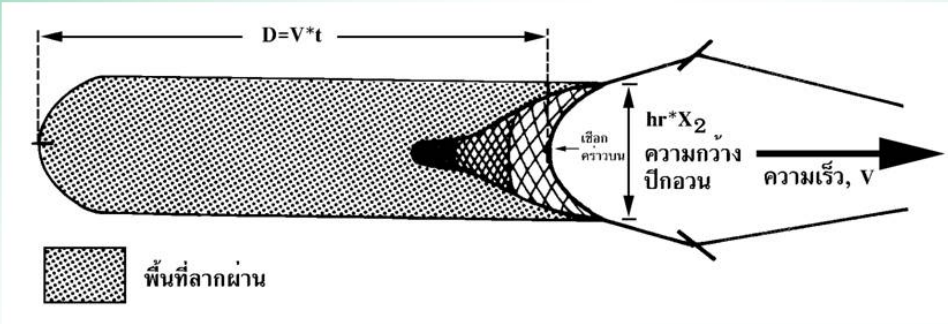
{ D= (V*t) = 2.5*1}
h (head rope) (= 39 m)
$X_2 = 0.5$

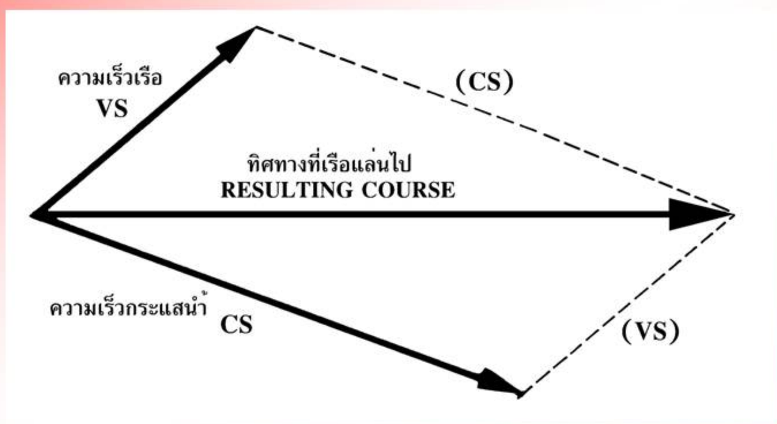
a = (2.5*1.852) * (0.039*0.5) = 0.090285

X_1 = 0.5

$X_2 = 0.5$

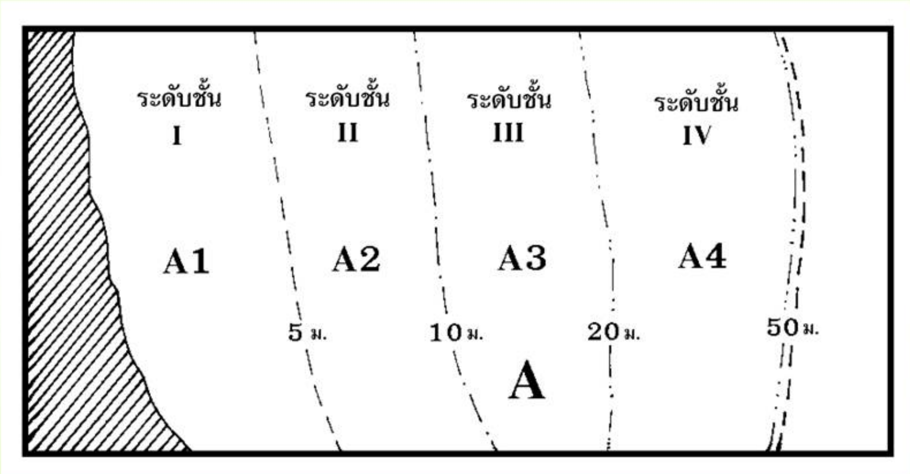
Swept area to estimate biomass





26-28 May 2009 Dr. Mala Supongpan

Survey strata by depth



26-28 May 2009 Dr. Mala Supongpan

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 $Y = FB$

26-28 May 2009 Dr. Mala Supongpan

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.

26-28 May 2009 Dr. Mala Supongpan

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.

26-28 May 2009 Dr. Mala Supongpan

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. no.	Date	Shooting				Hauling				Immersion time	Thermocline m/°C	TD No.1 m/°C	TD No.8/10 m/°C	Number of hook	Total catch (number)	Total catch weight(kg)	Hook rate (%)	CPUE pcs./ 1000 hook
			Start		Finish		Start		Finish									
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

TD/XX/XXX MAY 2009

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)**.

<u>Recommendation for the fishing method of;</u>

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

Aparre, P., Venema, S.C. 1992. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper No.306.1, Rev.1. Rome, FAO. 376 p.

EPA, 2003. Standard Operating Procedure for Meteorological Data Aboard the R/V Lake Guardian LG300, Revision 02, February 2003. 3 p.

SEAFDEC, 2004. M.V. SEAFDEC 2 Standard Operating Procedures (Revised edition). SEAFDEC/TD 93 p.

FAO, 2007. Guidance for Preparing Standard Operating Procedures (SOPs), EPA QA/G-6. U.S. Washington, DC. Office of Environmental Protection Agency, Cincinnati, OH. 55 p.

FAO, 2008. Report of the FAO Workshop on Vulnerable Ecosystems and Destructive Fishing in Deep-sea Fisheries. Rome, 26–29 June 2007. FAO Fisheries Report. No. 829. Rome, FAO. 2008. 18 p.

FAO, 2008. Report of the Expert Consultation on International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. Bangkok, 11-14 September 2007. FAO Fisheries Report. No. 855. Rome, FAO. 39 p.

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

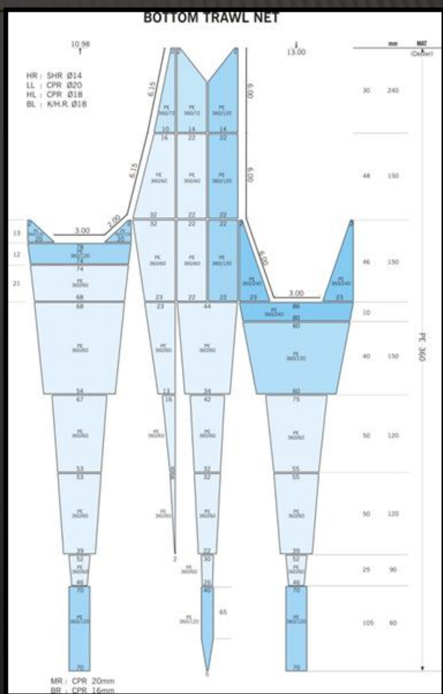
Capture Fisheries Technology Division
Southeast Asian Fisheries Development Center
Training Department

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.



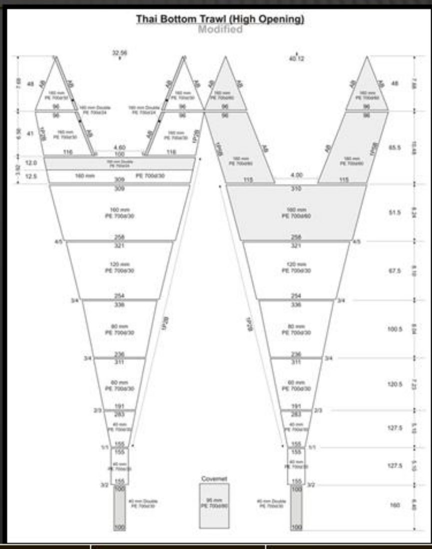
Otter board trawl

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.



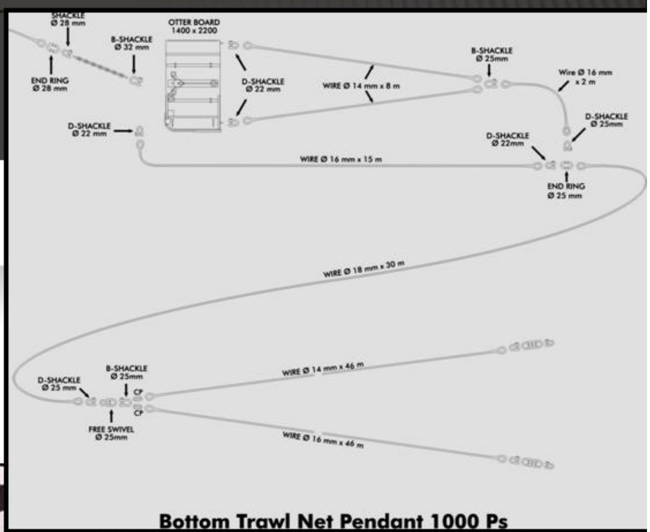
Type of net	Ground rope(length)	Head rope(length)	Net body (length)	Net opening (m)	Wing spread (m)
2 seam	40.12	32.56	66.37	4-10	10-20
4 seam	37	31.6	40.55	2.5-3.0	20-24

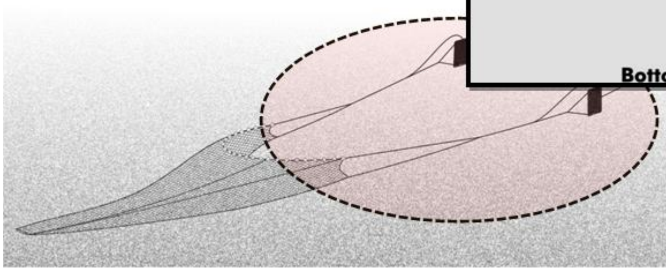
Otter board trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Otter board and Net Pendant

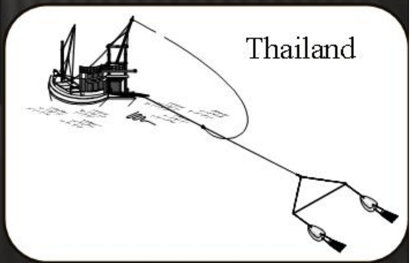
- Rectangular iron otter board 1.40 x 2.20 m
- Sweep line is 30 m length
- Upper and lower net pendant 50 m





BEAM TRAWL

Beam trawl category



Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

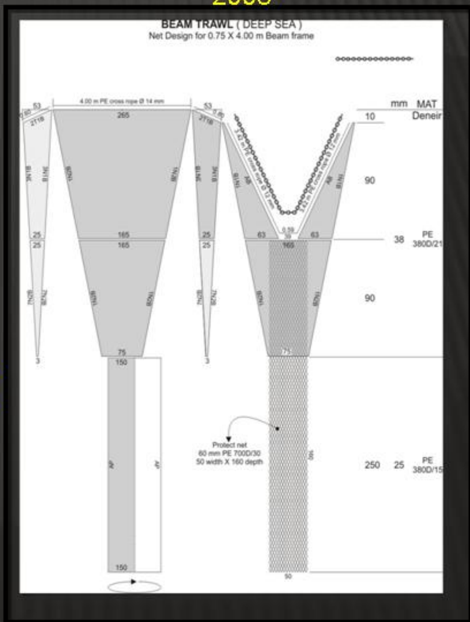
Net design

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



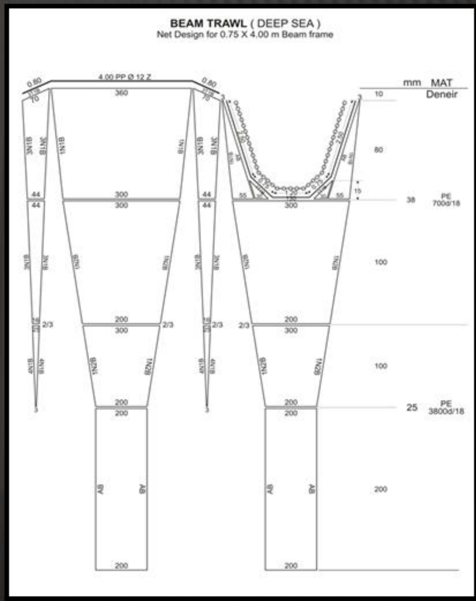
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Net design

2009

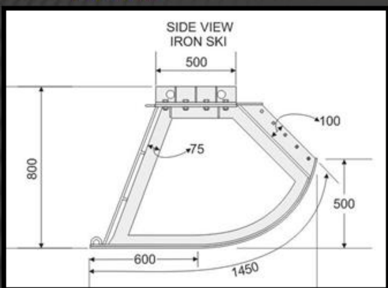
M.V. SEAFDEC 2 Modification
- Frame : 4 meter
- Head rope 4 m (Length)
- Ground rope 8.7 m
- PE 700 d/18, 380 d/18
- Mesh size 40 mm / 25 mm
- Net body is 15.1 m length

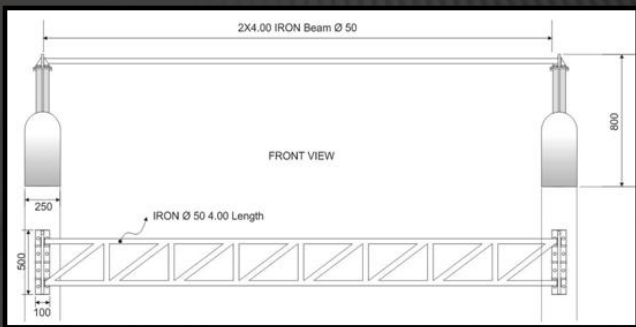


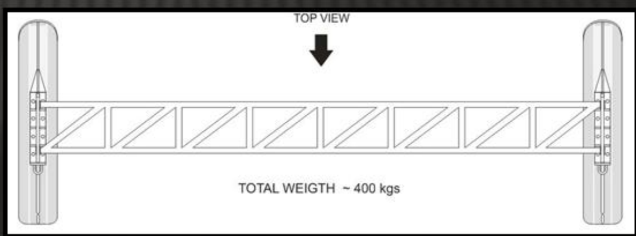
Beam trawl

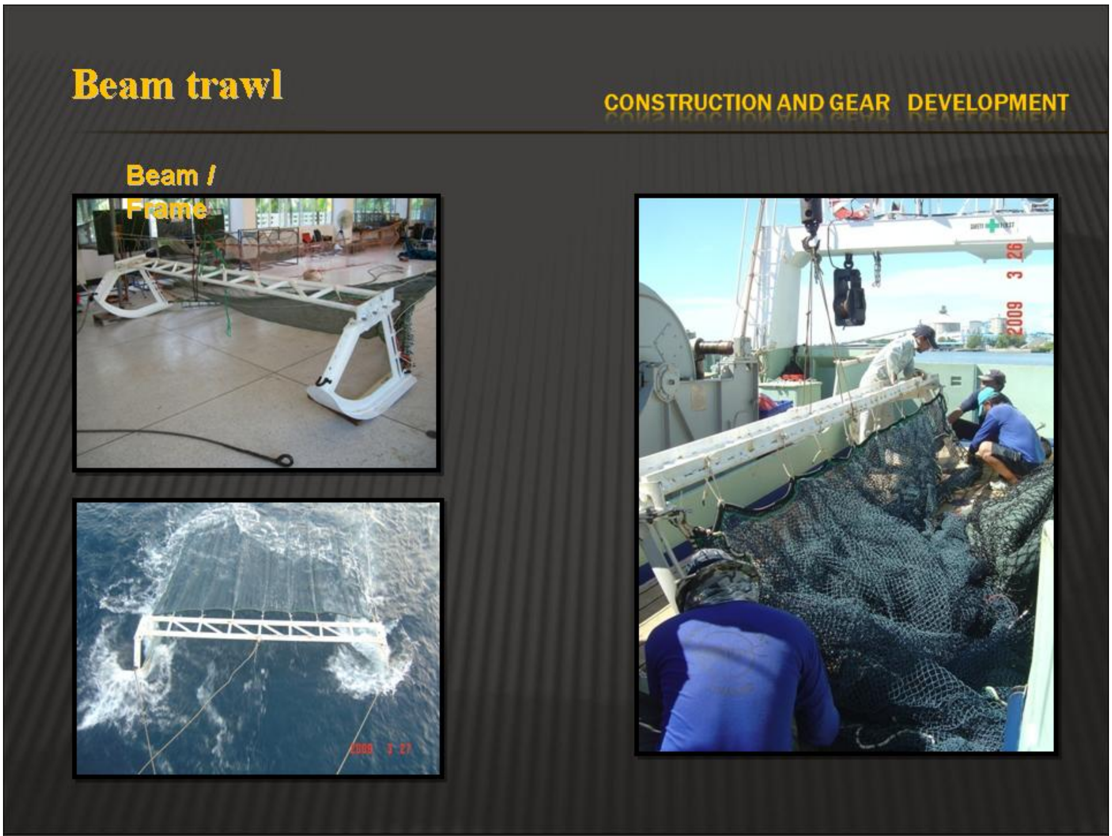
CONSTRUCTION AND GEAR DEVELOPMENT

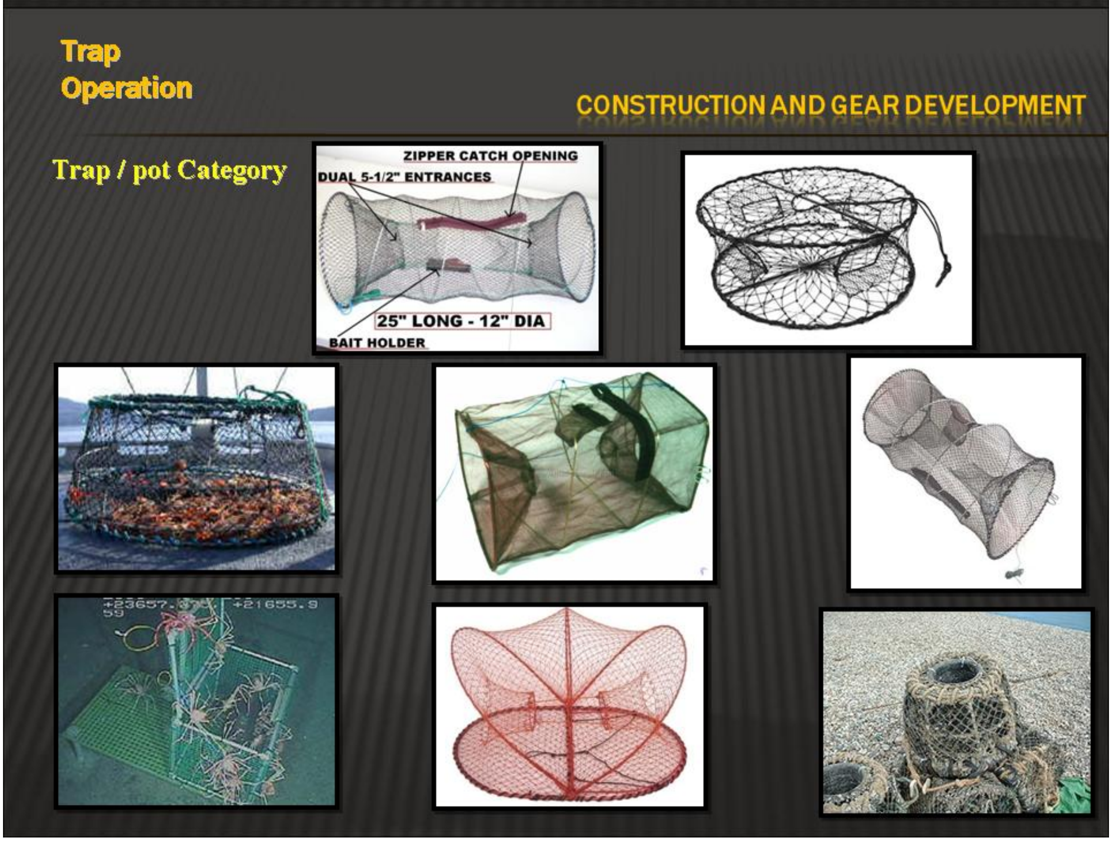
Beam / Frame








Beam trawl
CONSTRUCTION AND GEAR DEVELOPMENT
Beam / Frame

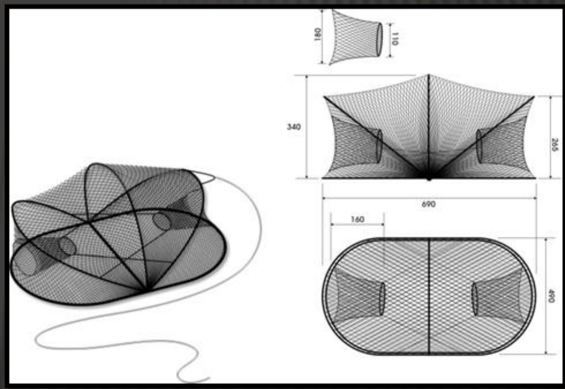

Trap Operation
CONSTRUCTION AND GEAR DEVELOPMENT
Trap / pot Category
ZIPPER CATCH OPENING
DUAL 5-1/2" ENTRANCES
25" LONG - 12" DIA
BAIT HOLDER

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible Lobster trap



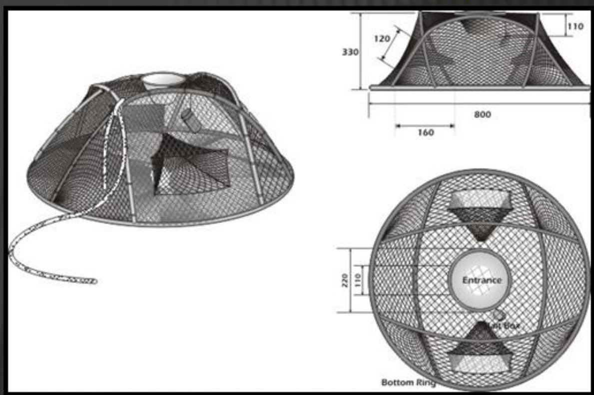
Target species : Lobster and Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Deep sea shrimp pot



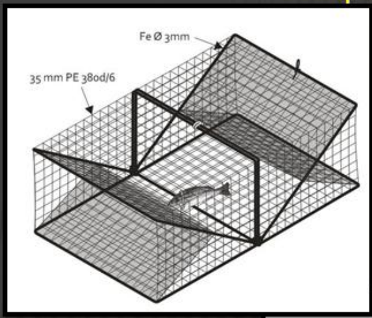
Target species : Shrimp

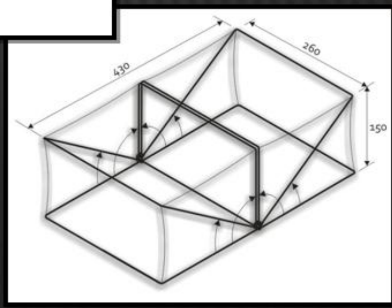
Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible crap trap





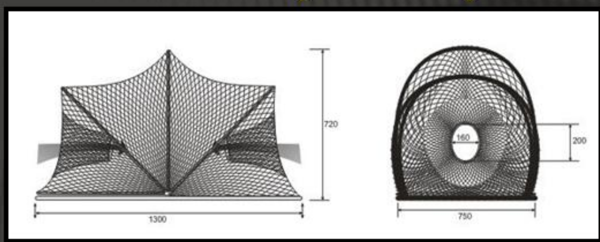
Target species : Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible fish trap



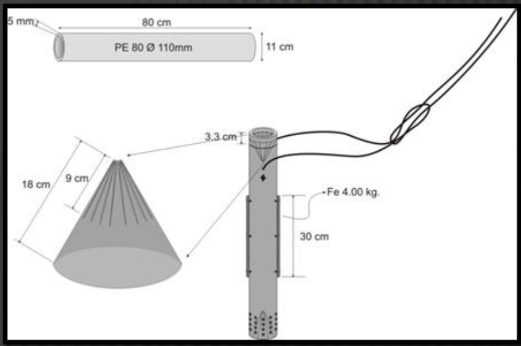
Target species : Fish and Lobster

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

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

Eel trap



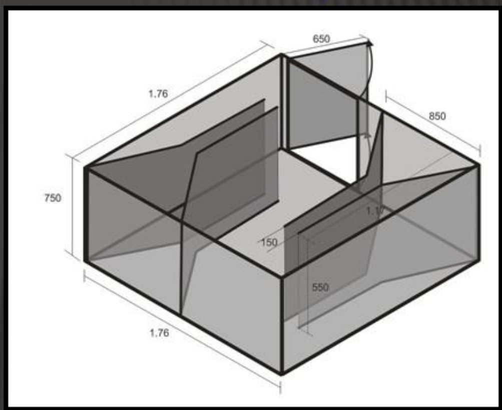
Target species : Eel

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Giant Fish trap



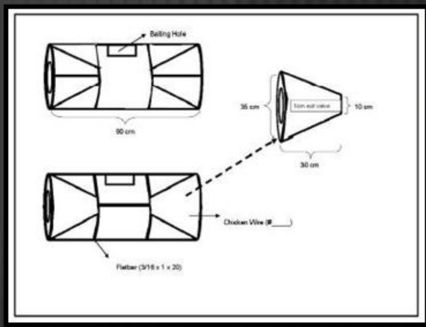
Target species : Fish

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

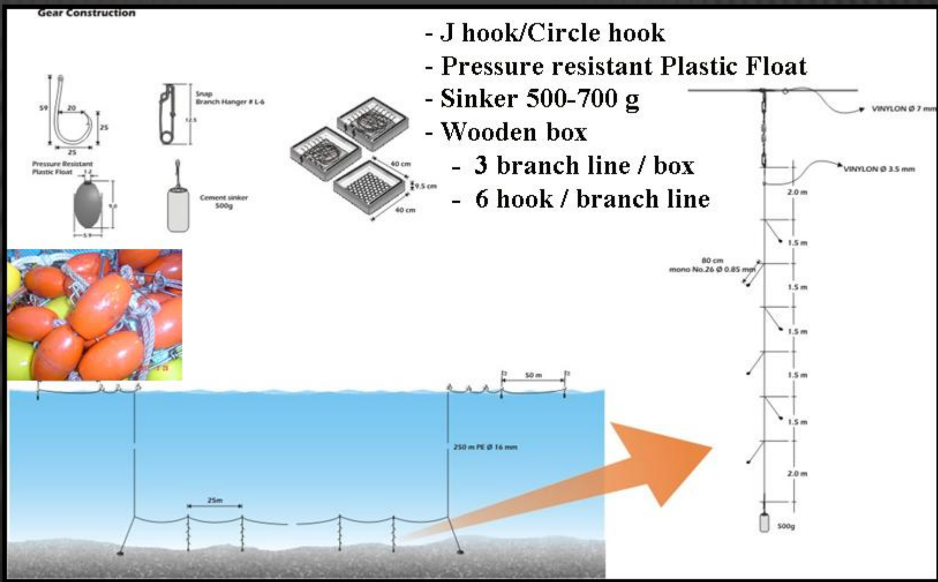
CONSTRUCTION AND GEAR DEVELOPMENT

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. SEAFDEC2

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. SEAFDEC2

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

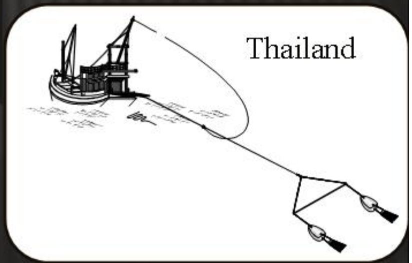
If the malfunctioning or lost of gear, main line usually found entangled with under water rocky during hauling operation.

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

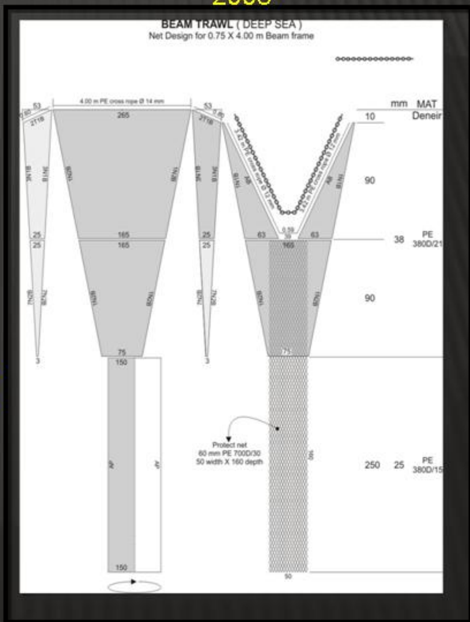
Net design

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



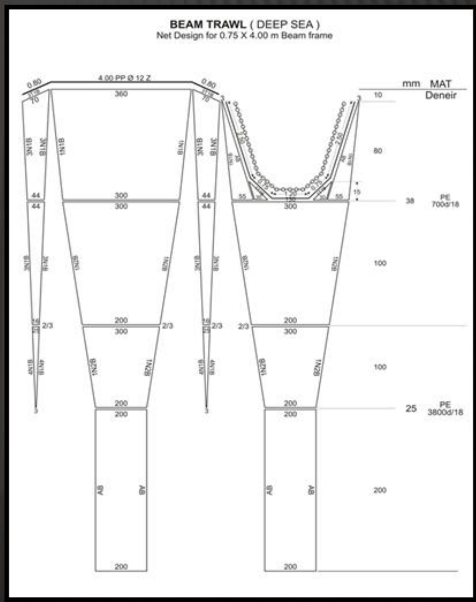
Beam trawl

CONSTRUCTION AND GEAR DEVELOPMENT

Net design

2009

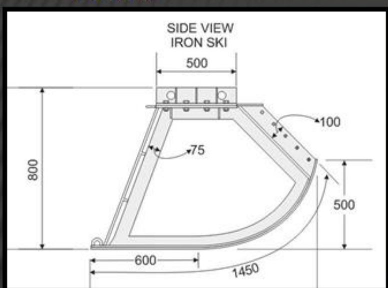
M.V. SEAFDEC 2 Modification
- Frame : 4 meter
- Head rope 4 m (Length)
- Ground rope 8.7 m
- PE 700 d/18, 380 d/18
- Mesh size 40 mm / 25 mm
- Net body is 15.1 m length

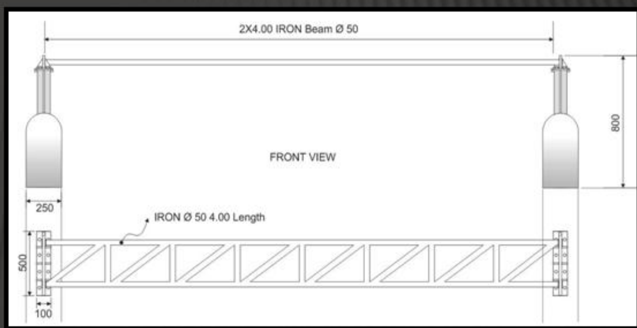


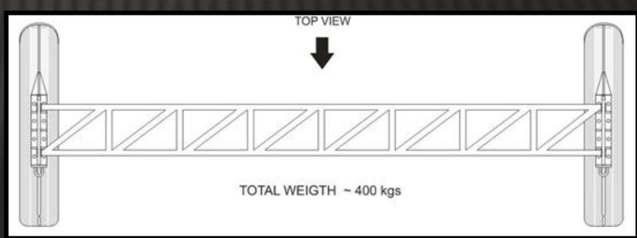
Beam trawl

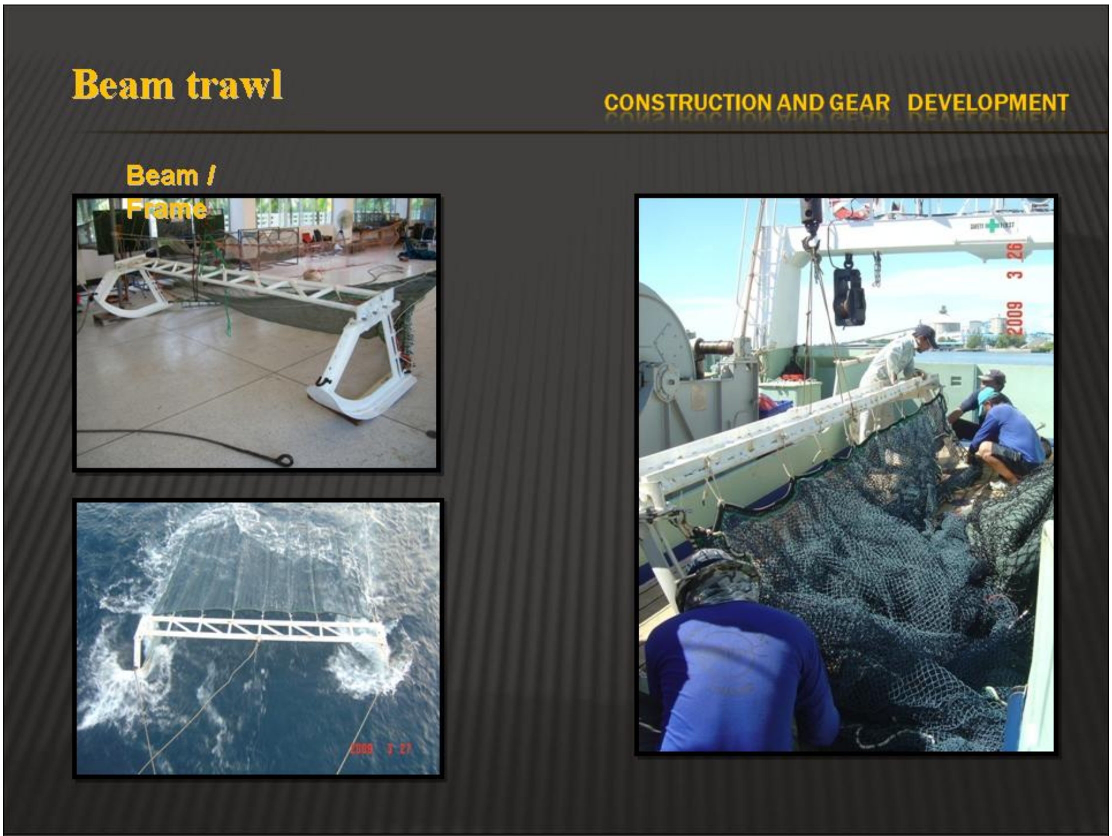
CONSTRUCTION AND GEAR DEVELOPMENT

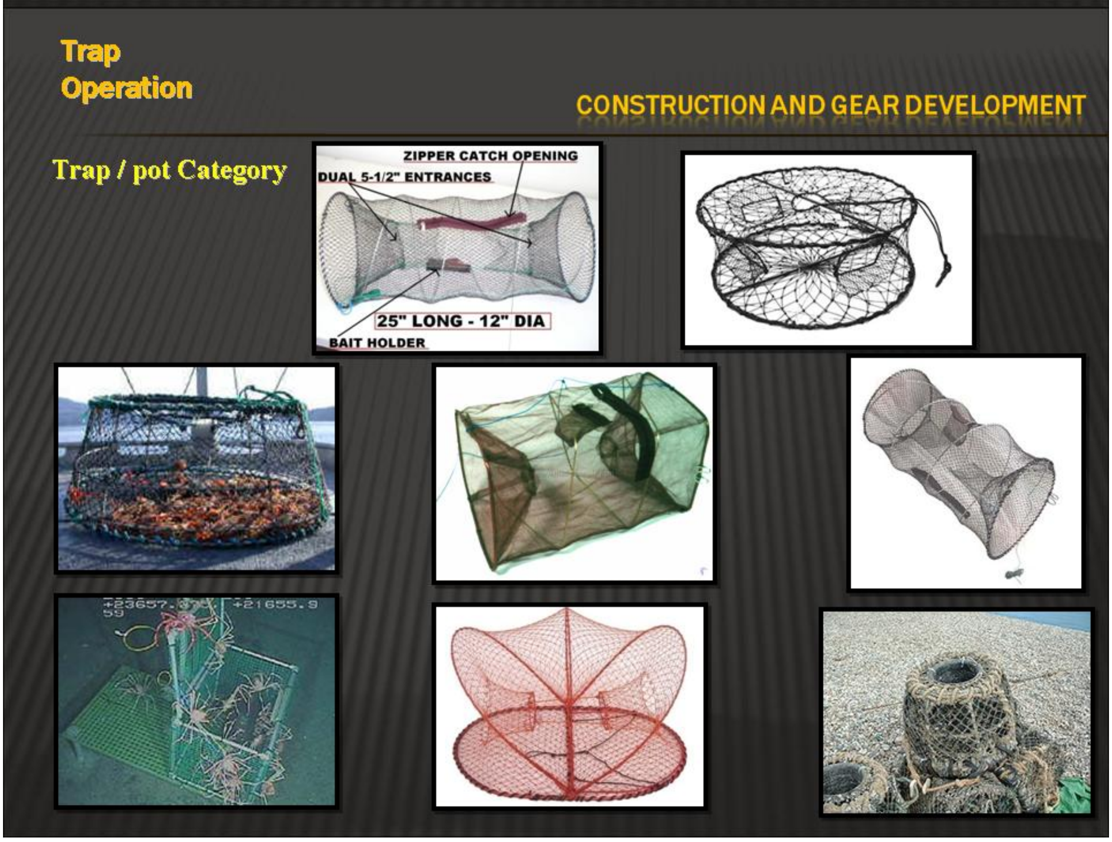
Beam / Frame








Beam trawl
CONSTRUCTION AND GEAR DEVELOPMENT
Beam / Frame

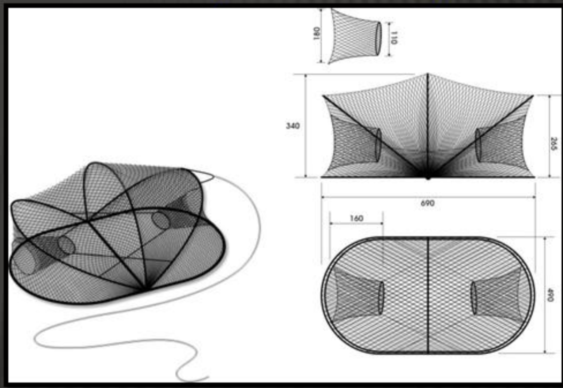

Trap Operation
CONSTRUCTION AND GEAR DEVELOPMENT
Trap / pot Category
ZIPPER CATCH OPENING
DUAL 5-1/2" ENTRANCES
25" LONG - 12" DIA
BAIT HOLDER

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible Lobster trap



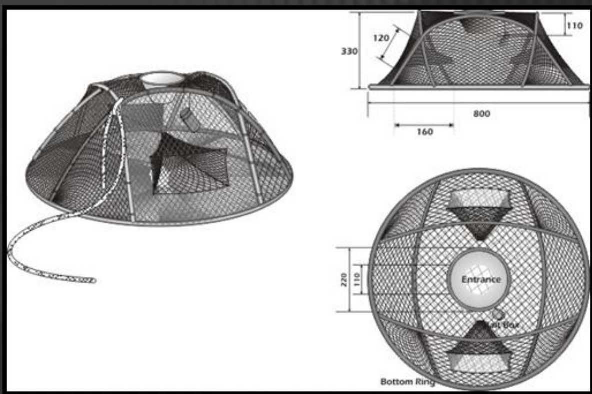
Target species : Lobster and Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Deep sea shrimp pot



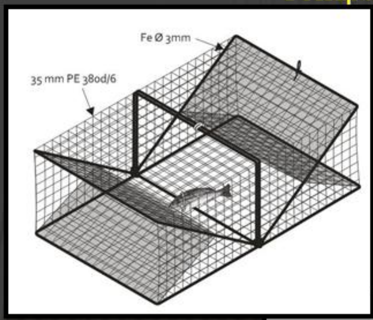
Target species : Shrimp

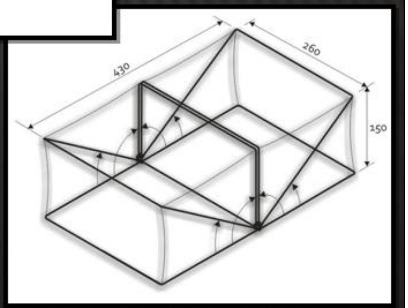
Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible crap trap





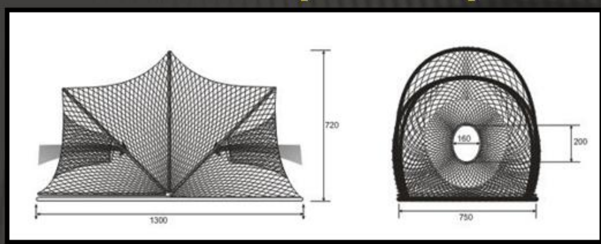
Target species : Crab

Trap Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Collapsible fish trap



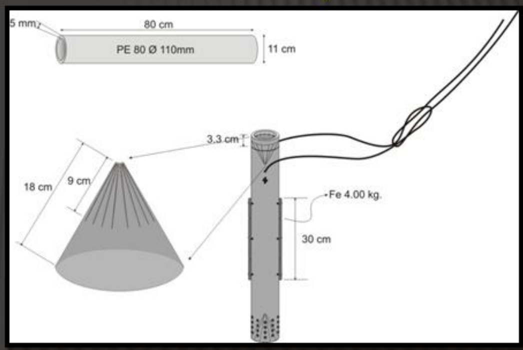
Target species : Fish and Lobster

Trap
Operation

CONSTRUCTION AND GEAR DEVELOPMENT

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

Eel trap



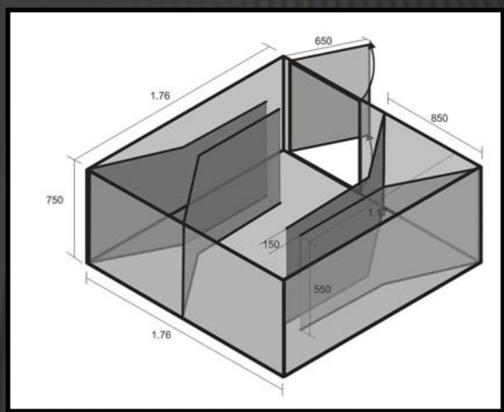
Target species : Eel

Trap
Operation

CONSTRUCTION AND GEAR DEVELOPMENT

Trap used on M.V.SEAFDEC 2

Giant Fish trap



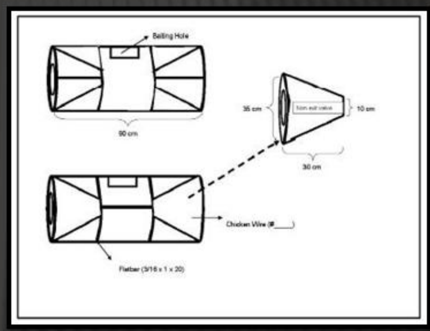
Target species : Fish

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

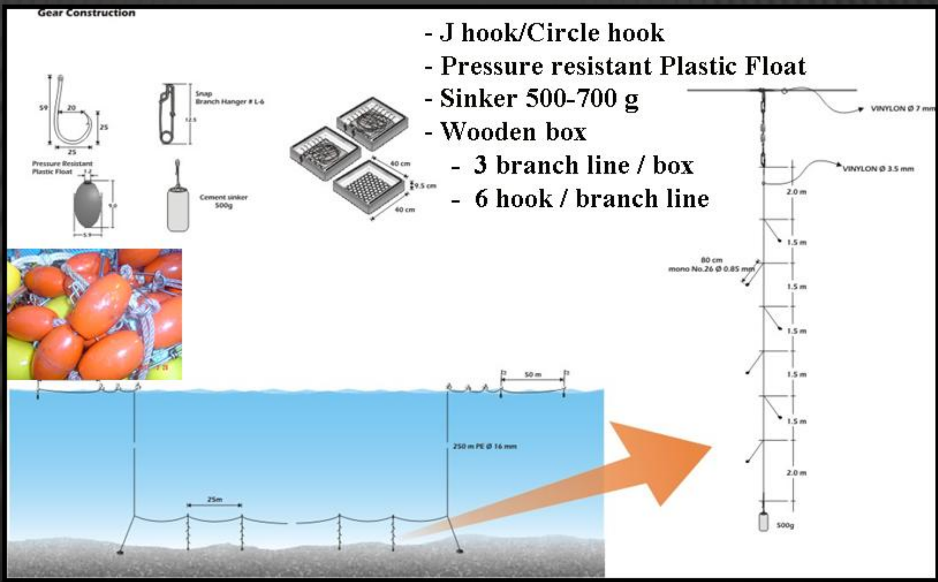
CONSTRUCTION AND GEAR DEVELOPMENT

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. SEAFDEC 2

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. SEAFDEC 2

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

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