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

SEAFDEC Training Department

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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) (Annex 6)

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 (Annex 7)

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

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Annex 2

WELCOME REMARKS

by DR. SIRI EKMAHARAJ

SECRETARY-GENERAL
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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