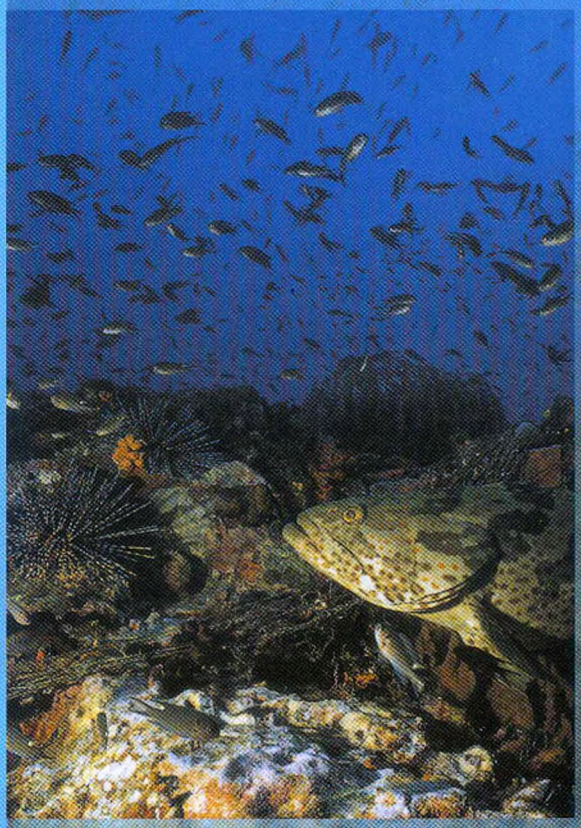
PROCEEDINGS OF

THE 1ST REGIONAL WORKSHOP ON ENHANCING COASTAL RESOURCES :

Artificial Reefs, Stationary Fishing Gear Design and Construction and Marine Protected Areas, 30 September-3 October 2003, Thailand



Organized by
Training Department (TD)
Southeast Asian Fisheries Development Center (SEAFDEC)

Southeast Asian Fisheries Development Center

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote fisheries development in Southeast Asia.

Objectives

SEAFDEC aims specifically to develop fishery potentials in the region through training, research and information services in order to improve food supply through rational utilization of fisheries resources in the region.

Functions

To achieve its objectives the Center has the following functions :

1) To offer training courses, and to organize workshops and seminars, in fishing technology, marine engineering, extension methodology, post-harvest technology, and aquaculture;

2) To conduct research and development in fishing gear technology, fishing ground surveys, post-harvest technology and aquaculture, to examine problems related to the handling of fish at sea and quality control, and to undertake studies on the fisheries resources in the region; and

3) To arrange for the transfer of technology to the countries in the region and to make available the printed and non-printed media, which include the publication of statistical bullentins for the exchange and dissemination related to fisheries and aquaculture development.

Membership

SEAFDEC membership is open to all Southeast Asian Countries. The Member Countries of SEAFDEC at present are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

Proceedings of the 1st Regional Workshop on

Enhancing Coastal Resources : Artificial Reefs, Stationary Fishing Gear Design and Construction and Marine Protected Areas

30 September - 3 October 2003
Thailand

Organized by
Training Department (TD)
Southeast Asian Fisheries Development Center (SEAFDEC)

in Collaboration with
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FOREWORD

There is growing awareness that the coastal fisheries of Southeast Asia are highly significant in terms of the number of people participating in them, the total catch and their economics, social and environment impacts. However, based on current demand for fisheries and our understanding of the status of many fish stocks, many coastal fish species are scarce. Further, resource scarcities will likely continue in the future.

Coastal fisheries have some peculiarities which hold regardless whether the fisheries are in developed or developing countries. The major historical peculiarities were due to the common property and free entry nature of most of the world's fisheries leading to a tendency towards overexploitation of resources, a tendency which was first explained by a biological model of fish population growth. Later, economic variables were introduced to this biological model and the resultant bio-economic model exerted significant influences on fisheries resource management.

However, the application of these approaches to fisheries management in Southeast Asia have been confounded by the tropical and multi-species, multi-fishing gear nature of our regional fisheries. It is now well recognized, especially in the context of Southeast Asia's complex coastal fisheries, that in order to be successful coastal fisheries management needs to become more innovative and specific to fisheries issues at the local level. This is especially the case as the contribution of coastal fisheries to regional food security and employment has become increasingly apparent in recent years.

The need to reconcile regional fisheries issues with emerging frameworks for the management of coastal fisheries certainly requires the development of innovative and practical approaches to fisheries management, such as resource enhancement through the use of artificial reefs and restocking. It has been with this mindset that the Southeast Asian Fisheries Development Center has developed an ongoing project aimed at developing regional capacity to design and implement resource enhancement activities for the long-term sustainability of our fisheries resources.

A multitude of resource enhancement activities can be used in fisheries resource management. However, in most parts of our diverse region, resource enhancement is in its infancy and understudied (as compared to other approaches to fisheries resource management). Acknowledging the various advantages and disadvantages of different approaches to resource enhancement is critical if it is to be effectively applied in Southeast Asia.

This compilation of papers provides a clear and comprehensive overview of the state of resource enhancement in Southeast Asia. I take great pleasure in congratulating the presenters for their erudite papers and excellent contributions to this valuable part of fisheries resource management in our region.

Niwes Ruangpanit
Secretary-General and
Chief of the Training Department
SEAFDEC

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REPORT OF THE REGIONAL WORKSHOP ON ENHANCING COASTAL RESOURCES: ARTIFICIAL REEFS, STATIONARY FISHING GEAR DESIGN AND CONSTRUCTION AND MARINE PROTECTED AREAS

SEAFDEC/TD, Samut Prakan, Thailand
30 September - 3 October 2003

I. INTRODUCTION

1. Considering that the quality of coastal and inshore ecosystems has deteriorated significantly as a result of continued and increasing human activities. These areas are critical to a broad range of aquatic organisms during their life cycles including spawning, nursery areas and feeding zones and many of these species are of economic importance. The areas serve as important sources of recruitment to, and the sustainability of, commercial fisheries. It is suggested that the productivity of these ecosystems can be enhanced through human intervention leading to improved livelihoods for coastal communities.

2. The Workshop on Enhancing Coastal Resources: Artificial Reefs, Stationary Fishing Gear Design and Construction and Marine Protected Areas was organized by SEAFDEC Training Department from 30 September to 3 October 2003, SEAFDEC/TD, Samut prakan Thailand.

3. The Workshop was attended by representatives from the ASEAN and SEAFDEC Member Countries namely Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. The Workshop also attended by resource persons from CHARM, Reef management Int. SEAFDEC/SEC, SEAFDEC/AQD, SEAFDEC/MFRDMD, and SEAFDEC/TD The list of participants appears as Appendix A.

4. The objectives of the Workshop were to review the existing regional and national programs/projects related to resource enhancement; to discuss on resource enhancement issue; to promote the establishment of a technical supporting group for working as resource persons/coordinator of the issues related to resource enhancement; to evaluate, promote and encourage the use of ARs and SFG for coastal resources enhancement in light of environment; and to work in close cooperation with Southeast Asian member countries through technical assistance in research and development program for resource enhancement such as the use of ARs and SFG.

II. OPENING OF THE WORKSHOP

5. Mr. Niwes Ruangpanit welcomed the participants to the Workshop. He outlined the several threats to the well-being of the coastal resources and habitats. He stressed on the importance of enhancement of coastal resources through a number of approaches and tools and wished that the Workshop could exchange views and experience to develop directions for the promotion of coastal resource enhancement. He then declared the Workshop open. His opening statement appears as Appendix B.

6. The agenda of the Workshop, which appears as Appendix C was adopted.

III. COUNTRY PAPERS: OVERVIEW OF COUNTRY POLICIES, PROGRAMS AND EXPERIENCES WITH ARTIFICIAL REEFS, STATIONARY FISHING GEAR AND ESTABLISHMENT OF MARINE PROTECTED AREAS

(Chair Person: Dr. Yuttana T.)

3.1 Brunei Darussalam

7. Mr. Idris Haji Abd. Hamid from Brunei Darussalam made a presentation on the topic. He briefly explained the objectives and development of artificial reefs that have been conducted in Brunei Darussalam over the last 10 years. He further explained the sites for ARs and results from installation. However, he explained that there is no stationary fishing gears promoted for fish aggregation and for reef organisms building. He explained two MPAs – Selirong Isaland and Pelong Rocks that have been integrated under the 8th National Development Plan and in the process of staring in 2003.

Discussion

8. With regards to the CPUE study in ARs, it was clarified that CPUE of the study area was 15 to 20 while after the study was 60 to 70 kg by using hand lines.

9. All off shore construction including oil rigs are restricted from fishing activities. At the moment there is no study on impact of used oil rigs on fishery resources.

10. Regarding the monitoring of reefs, there are regular on-going dive checking for rig reefs.

3.2 Cambodia

11. Mr. Suy Serywath from Cambodia made a presentation on the topic (CP 01). He explained that there is currently no ARs, and SFGs, for resource conservation in the coastal areas. He explained the existing legislation and government policy to promote conservation of natural resources and coastal development. He outlined existing projects related to coastal zone started in 1997. These include community-based on natural resources management, protection of natural resources and so on.

12. With regard to MPAs, Mr. Serywath explained that an MPA was established in 2002 at Koh Rong supported by UNEP. The MPA will be supported by community-based natural resources management.

3.3 Indonesia

13. Mr. Parlinggoman Tampubolon from Indonesia made a presentation on the topic. He briefly explained the government plan and policy to promote coastal development and management including various designs of AR modules.

3.4 Malaysia

14. Mr. Sukarno bin Wagiman from Malaysia made a presentation on the topic (CP 02). He briefly presented his country policy and plan related to ARs and SFGs as well as establishment of MPAs and action taken to protect marine resources and actions to be done. He outlined the development of fisheries management legislation that have been developed since 1894 until 1985 in the development, conservation and management of maritime and fisheries. He explained the development of ARs since 1975 to mitigate impacts and loss of habitats duet to destructions and to increase marine resources. At the moment there are 99 ARS sites scattering around the country. He explained the development of SFGs using set nets that have been replaced with more effective gear. There are currently SFGs available for recreational purposes. As for MPAs and marine parks as management tools, there is in place the policy and plan to promote the area for conservation of marine resources. Under the Fisheries Act 1985, MPAs was developed as an approach to regulate fishing while marine parks is promoted for no take zone. He concluded by suggesting.

3.5 Myanmar

15. Mr. Soe Thu from Myanmar made a presentation on the topic (CP 03). The country is not currently implementing ARs and SFGs while MPAs in at the beginning stage.

3.6 Philippines

16. Mr. Pierre Easter made a presentation on the topic (CP 04) with emphasis on ARs. He outlined factors attributing to the destruction and depletion of the coral reefs in the Philippines leading by illegal fishing from dynamite and destructive fishing practices such as trawls and push nets. He introduced plan and activities of an innovative coral reef management and regeneration program entitled "The Coral Gardening and Reef rehabilitation Project in Tangalan, Aklan) initiated by Bureau of Fisheries and Aquatic Resources (BFAR) to ensure proper conservation and management of coral reefs in the country with the objective to rehabilitate the damage destructed reefs. He highlighted the importance of the project in response to the declining resources of coral reefs, objectives, various criteria for appropriate site selection, program activities, and their current results.

17. Mr. Benebert R. Fernando made a presentation on the topic (CP 05) with emphasis on SFGs. He introduced the set net fishery as a SFG. There are at the moment about 60 units of set net that have been adopted in the Philippines. The fishing gear catches only tuna and tuna like species and was introduced and technically transferred to fishermen for coastal community operation. He outlined various advantages of set net fishing stressing on the nature of this type of fishing gear as a kind of ARs, environment-friendly, and selectivity of catch. He stressed on the importance to strike balance objectives and benefits of environment, economic and social aspects for the conservation and management of coastal zones.

18. In discussion, with regard to ARs and linkages with CBM in the Philippines, it was clarified that municipalities have right to management their coastal resources within 3 NM. In addition, Fisheries and Resource Management Council (FARMC) has the mandate to monitor overall implementation of coastal resources management throughout the country.

19. With regard to the large number of MPAs and marine reserves implemented all over the country, however, it was clarified that only limited number of experiences are well managed. This has led to the need for proper management of these initiatives in the future.

20. With respect to the set net fishery, the Workshop was informed that social acceptance of technology was found as the major obstacle in the promotion of this type of fishery.

3.7 Singapore

21. Ms. Elsie Wong Lih Shiuan made a presentation on the topic (CP 06). Singapore is basically promoting on re-stocking for Singapore river to increase resident fish number and promote game fishing as well as ARs. There is no national policies or agencies managing coral reefs and reef resources. SFGs are currently not promoted to avoid obstacles of navigation pathways around the country. She explained the national strategies and plan for restoration of reefs using Reef Enhancement Unit (REU).

22. In discussion, with regard to the stability of REU against strong wave action, it was clarified that the unit is secured with iron sticks at the level of 3-5 m. and experience no collapse problems.

23. In response to the inquiry on justification of the project where there is already natural growth of reef in the country, it was clarified that the project focuses on developing areas for eco-tourism by moving the REU to the target areas.

24. In response to the question related to materials used with REU, it was clarified that the reasons for using sand and calcium carbonate for REU because they are generally found in normal coral and may enhance succession performance of coral reef. However, further studies need to be conducted to investigate the issue.

3.8 Thailand

25. Mr. Anucha Songjitsawat made a presentation on the topic (CP 07). He briefly explained the current status of coastal and marine resources that have been declining over the years. He outlined the objectives and activities related to ARs, SFGs and MPAs including marine sanctuaries conducted in Thailand. He stressed on the planned collaborative project with SEAFDEC on the use of set net as a measures for conservation and management of coastal resources.

26. Regarding to MPAs in Thailand, it was clarified that fishing in the MPA is not allowed.

3.9 Vietnam

27. Mr. Nguyen van Nguyen made a presentation on the topic (CP 08). He outlined the current national activities and experiences related to MPA system and national parks in Vietnam. As for ARs, the country is in the initial implementation stage and there is no real ARs in place yet. Regarding SFGs, Vietnam has some practices of SFGs particularly set nets in MPA. But validity of SFGs as a conservation and management tool is still questioning and should be further investigated.

28. In discussion, Trash fish in set nets, there is simply incidence.

29. It was clarified that MPAs is not no-take reserve but it is part of MPAs. There is evidence proved that MPAs could be an effective tool for conservation and management of coastal resources. It was suggested that appropriateness of SFGs as a tool for conservation and management should be investigated. In addition, it was also suggested that information related to ARs in the Member Countries should be compiled. Cooperation from the Member Countries is envisaged.

30. In the overall conclusion of the country papers, the Workshop took note of the following synthesis of the country situation.

- All participating countries have in place the national legislation, policy and plan including resource enhancement activities to promote conservation and management of marine resources. This is except in Singapore where the country has no national policies or agencies managing coral reefs and reef resources.
- With regards to resource enhancement activities, most of participating countries have promoted ARs, SFGs and MPAs as approaches towards conservation and management of coastal resources.
  - Cambodia, and Myanmar are currently promoting only MPAs but with intention to expand to other potential measures.
  - Singapore is basically promoting only re-stocking to increase resident fish number and promote game fishing as well as ARs. SFGs in Singapore are currently not promoted as it is considered obstacles for navigation pathways.
  - Vietnam is in the initial stage for implementing ARs.
- Resource enhancement activities of the implementing countries generally focus on the following objectives:
  - To mitigate impacts and loss of habitats due to natural and man-made destructions;
  - To enhance marine productivity and biodiversity of coastal resources;
  - To provide physical obstruction against invasion of trawlers into coastal areas;
  - To provide productive and alternative near shore fishing areas to small-scale fishermen; and
  - To promote sustainable livelihoods such as eco-tourism and small-scale selective fishing in the use of coastal marine resources.

- Issues and Considerations for Future Actions
  - o Common understanding on purpose of resource enhancement tools particularly MPAs – (regulated fishing) VS protection (no taking)
  - o Definitions of terms used in resource enhancement measures/activities and their context/implications for conservation and management purposes (ARs VS FADs, MPAs VS Marine Parks and Sanctuaries, etc.)
  - o Directions and needs for supporting research, legislation and tools (ARs, SFGs, MPAs and so on) for resource enhancement
- Durability and appropriate formation and installation of AR modules
- Studies on appropriateness and effectiveness different AR modules
- SFGs as a resource enhancement tool for conservation and management purposes for coastal resources?
  - o Regional source of information including and system to facilitate information and experience sharing including guidelines for resource enhancement promotion
  - o Balancing objectives and benefits of environment, economic and social aspects for the conservation and management policy and plan for coastal development
  - o Guidelines for criteria, conducting indicators and impact assessment of resource enhancement activities
  - o Integrating resource enhancement into innovative management plan, strategies and approaches for sustainable utilization of coastal areas
- Management framework
- Resource use pattern in the resource enhancement areas
- Involvement of communities and fishers
  - o Resource enhancement is not the only solution – needs for other measures (i.e. stock enhancement, management measures, etc.) to supplement conservation and management of coastal resources

IV. REVIEW OF EXISTING RESOURCE ENHANCEMENT PROJECTS

(Chair Person: Mr. Bundit C.)

4.1 SEAFDEC initiatives and activities related to fishery resource enhancement

(Dr. Yuttana T. and Dr. Wenresti G. Gallardo)

31. Dr. Yuttana Theparoonrat and Dr. Wenresti G. Gallardo made presentations on the topics (EP 01 and EP 02) focusing on resource enhancement through ARs and SFGs and stock enhancement programs, respectively. Dr. Yuttana reviewed issues, conclusion and recommendations reached at the 2001 Millennium Conference on Fish for the People related to the issues of ARs, re-stocking, marine parks, management measures such as seasonal closure both area and seasons, etc. He stressed on the linkages between resource enhancement activities and integrated coastal fisheries management with particular emphasis on decentralized right-based fisheries.

32. Dr. Yuttana introduced the project on resource enhancement as a follow-up activity to assist the Member Countries to implement the outcome of the Millennium Conference. The project information includes objectives, activities namely 1) survey and data collection on environmental studies, 2) workshop on ARs and SFGs, 3) regional training course on resource enhancement. He briefly explained the progress of the project that has been made in 2002 namely reviewing existing ARs and other resource enhancement projects in the ASEAN countries, attending international conference in Kobe (resource and stock enhancement) and Himi (set net) in Japan to enhance capacity of project staff, identification of a project site in Thailand, coordination with FADs study in Lankawi, Malaysia, LBCRM-PD project in Chumporn, Thailand, and set net project in Rayong, Thailand.

33. As for 2003, the first activity has been conducted covering oceanographic survey, fisheries biology survey, and fishing survey.

He outlined the planned collaborative project on artificial reefs in collaboration with LBCRM-PD project in Chumporn, Thailand.

34. Dr. Gallardo presented stock enhancement project implemented by AQD under the regular program. He stress on outcome of the Millennium Conference to promote seed release programs in areas considered feasible particularly in localities operating with in regime of right-based fisheries. Current focused species for stock enhancement program are abalone, top shell, window-pane shell, giant clams, and seahorses. He briefly explained the program activities covering research on seed production; tagging/ permanent marking (for monitoring and evaluation through artificial feeding, genetic characterization, etc.); packing and transportation methods; assessment of potential sites for stock enhancement; and release, monitoring and evaluation methods. As for training and information the program also focuses on training, workshop and publication.

35. With regards to the assessment of potential sites, Dr. Gallardo pointed out some criteria that have been developed for site selection namely release habitat for the species, source of food, existing stock, potential predators, and protection from poachers.

36. In discussion, (SEC) commented that TD's project could look into possibility to develop activities accommodating requirement for other Member Countries besides Thailand. While sea ranching and restocking of AQD should sharpen the objectives to address either commercial purposes or conservation and management purposes.

37. In response to the comments on the purpose of activities, it was clarified that activities should be promoted together with right-based fisheries regime to ensure effective resource enhancement activities.

38. With regard to the species selection for restocking, it was suggested that fast growing species including fish species should be focused to fasten the re-stocking process. In response, it was explained that ecology and biology of target fish species should be thoroughly investigated before conducting restocking activities. It is likely appropriate for fin-fishes that only less migratory species or species with home instinct should be given priority rather than highly migratory ones. AQD requested the Workshop to provide suggestions for species selection to further develop future activities on restocking activities.

39. It was also suggested that linkage between the project and other related projects such as coastal resource management and right-based fisheries should be clarified and promoted.

V. FISHERY RESOURCE ENHANCEMENT: POTENTIALS AND CONSIDERATIONS

(Chair Person: Mr. Bundit C)

5.1 Potentials of ARs, SFGs and other man-made constructions for resource enhancement: lessons from Japan

(EP 03) (Dr. Vicharn Ingsrisawang)

40. Dr. Vicharn briefly introduced the background and purposes of ARs for fishery management purpose. He introduced formation and care of fishing grounds in connection with the use of ARs. He explained the linkages and interactions among behavior of aquatic animals, environment and ARs.

41. In discussion, once ARs is proved economically and ecologically viable, ARs is introduced to a community.

42. Japan is a rich country and located in temperate zone, different characteristics of ARs need to be carefully determined. In this connection, it was clarified that instead of high cost AR modules, it was clarified that tyres could also be used but because of durability and potential toxic from tyres. These should be taken into consideration as well as other material for ARs model, it should be considered

for the long term use. In Japan, use of tyres is forbidden due to effects to environment. As for the techniques for installation and formation of ARs, it was pointed out that environmental characteristics in Japan and SEA are different and should be taken into consideration for future promotion of ARs in SEA.

43. Dr. Vichan also point out that to make it acceptable for the community, it should be the study on both negative and positive effect before and after installation of ARs in that area.

Resource enhancement aspects of stationary fishing gear in Southeast Asia (Mr. Aussanee Munprasit)

44. Mr. Aussanee presented a collaborative project on set net for the development of sustainable coastal fisheries management promoted by SEAFDEC, EMDEC/DOF, and Mae Ramphueng Beach Fisher's Group. He introduced the development of SFGs that starting by the use of coastal stake traps, which were replaced by a more modern and advance fishing technology such as trawls, push nets, light fishing. He pointed out the principles of the use of set net for developing sustainable management for coastal fisheries highlighting that the gear is meant for a group operation as a management tool not for individual fishermen for catch harvesting only. The gear also promotes ownership of the local fishers; providing ARs for coastal resources; etc. He explained the reasons that stake traps are not feasible at present due to lack of wood materials in locality. This has led to the development of rope set net, which is environment-friendly.

45. Mr. Aussanee outlined the objectives of the project emphasizing on the joint management of fisheries, reducing conflicts among fishers, and enhancing coastal resources. He explained the project activities starting from on-shore and sea survey (socio-economic, fishing gear, oceanographic and other environmental parameters), fisher forming and training, and monitoring and evaluation.

46. In discussion, it was pointed out that set nets if attract fish, it would be considered as FADs not resource enhancement except the case that it attract breeders for target fish as spawning grounds. It was further pointed out that SFGs could provide shelter for fishes and tool for fishing but whether it is served as resource enhancement tool, there is no clear scientific prove.

47. It was further pointed out that due careful consideration should be ensured when introducing new fishing gear in any area. In addition, aquaculture facilities could also provide shelter for fishes.

5.2 Re-stocking (EP 04)
(Dr. Wenresti G. Gallardo)

48. Dr. Gallardo outlined the resource management strategies emphasizing on fishing control, establishment of marine protected areas, modification or rehabilitation of habitats, release of hatchery-reproduced seeds (stock enhancement). He also outlined the components of stock enhancement, which include hatchery production, habitat improvement and protection, proper release and monitoring strategies and harvest regulations. He provided distinction between stock enhancement and sea ranching. Stock enhancement refers to "stocking of hatchery-produced seeds for the public good without the intention of benefiting an exclusive user group." While sea ranching refers to "releasing hatchery-produced seeds into their natural habitat with the intention of being harvested by the releasing party or agency."

49. Dr. Gallardo briefly explained some development towards stock enhancement including constraints and failures in the promotion. He stated that until mid to late 1990s, stock enhancement was recognized as one of the important tool for fishery management. He introduced major issues in stock enhancement and important considerations in stock enhancement should be taken into account. He further introduced principles of stock enhancement from target species selection,

developing a management plan, identifying released hatchery fish and assessing stocking impacts, and so on.

50. In discussion, it was pointed out in promoting resource enhancement in the SEA, the following should be emphasized and considered:

- Since most countries in the region have established hatchery infrastructure, hatcheries should be maximized not only for aquaculture but also stock enhancement activities.
- Resource enhancement is socially desirable and recognized. This could lead to support from public.

It should however be noted that:

- Most successful cases are in temperate countries. Experience in tropical countries like in SEA where fisheries are multi-gear and species have been unsuccessful. Different approaches and techniques need to be developed.
- Successful stock enhancement activities require decentralization of management functions/responsibilities and right-based fisheries in place and functioning.
- Stock enhancement is generally costly particularly for seed production, supporting empirical research, monitoring and evaluation. There is a substantial need for developing indicators for success or impact assessment to show evidence of impact of stock enhancement to natural resources as it is normally required by policy-makers.
- There is a need for techniques applicable for tropical fisheries in SEA.

5.3 Resource enhancement through Marine Protected Areas: Promises and limitations (Dr. Theo Ebbers)

51. Dr. Ebbers clarified the term MPAs widely used and recognized in the region emphasizing on its management functions. He introduced the purpose, usage and benefits of MPAs as no-take zone, which will give benefits in term of enhancing resources outside MPAs in response to the conservation and management purposes. He pointed out some considerations for and potential contribution from the introduction of MPAs.

52. In discussion, cost effectiveness between ARs and MPAs, it was pointed out that both approaches need proper management while ARs require huge investment compared to MPAs.

53. Site selection and defining for MPAs, it was suggested that MPAs should cover an entire area with due consideration of balance of MPAs and other fishing areas. MPAs and ARs can be a complimentary tools for conservation and management of fisheries.

54. In the overall conclusion of the potentials and considerations of fishery resource enhancement, the Workshop took note of the following synthesis:

- Resource management strategies particularly on issues and considerations in stock enhancement presented by Dr. Gallardo from AQD was a good starting point to explore appropriate approaches for resource enhancement for SEA countries.
- All resource enhancement activities (ARs, SFGs, aquaculture facilities (cage culture, mollusk farms, etc.), MPAs, stock enhancement) have to be combined with integrated management framework (decentralization of management functions/ responsibilities and right-based fisheries) including with due consideration on involvement and participation of community and fishers (sense of ownership, local cooperation, relevance to local needs).
- Differences in environmental, economic and social situation of fisheries in Japan and other temperate countries compared to SEA need to be fully taken into consideration for future promotion of resource enhancement activities in SEA.
- Need to compile information and experience as well as to develop approaches and techniques applicable/viable for SEA countries.
- Resource and stock enhancement activities are generally costly. There is a need to develop practical indicators for success or

impact assessment to show evidence for environmental, socio-economic and resources impacts of resource/stock enhancement activities to natural resources. This will help convincing support from policy-makers and public.

- There should be careful investigation of implication of any SFGs to be used as resource enhancement tool for conservation and management purposes not for fish luring or FADs or simply be shelter for fishes.
- For the community acceptable, the study on both negative and positive effect before and after installation of ARs is necessary.

VI. FISHERY RESOURCE ENHANCEMENT: CASE STUDIES

(Chair Person: Dr. Somboon S. and Mr. Suppachai Ananpongsuk)

6.1 The Marine Park Management in Malaysia (EP 05) (Mr. Zulkifli)

55. Mr. Zulkifli presented background of the establishment of marine parks in Malaysia in response to the degradation of coastal marine resources. He stressed on the objectives as well as permitted and prohibited activities in marine parks. He outlined major issues pertaining to marine parks and their impacts to environment and resources.

56. In discussion, regarding establishment of marine parks, it was commented that the responsible agencies are not always fishery related agency but involving various agencies except in Malaysia. In response to the marine parks set up, it was clarified that it is not necessary in island areas.

57. Regarding the impact to highly migratory fish species, it was clarified that if the marine parks are established properly, enhancement impact on migratory fish resources can be recognized. A combination of marine parks (no fishing allowed) and MPAs (only traditional fishing is allowed) is proved to enhance abundance of coastal marine resources.

58. Regarding to the inquiry on 2 NM as the boundary of marine parks, it was clarified that coral reefs exist within 1 NM. and 1 NM. is considered as a buffer zone. There is in place legislation for establishment of marine parks.

6.2 Experiences and Initiatives in Coral Reef Protection in Indonesia (Mr. Roderick Schipper)

59. Mr. Schipper briefly explained the background of the topic with particular emphasis on impacts of blast fishing to coastal marine resource use. He briefly introduced the Reef Management International (RMI) whose capacity has been well developed in reef management. He presented a blast fishing detection using acoustic localization techniques as part of studies for reef management detailing detection principles, modeling, system set-up and testing, etc.

60. In discussion, it was clarified that the cost of the minimum system is manageable. The system can be placed also in islands as sound travels through island. It was pointed out that the core issue of conservation and management is willingness and seriousness of responsible agencies to implement strict law enforcement and management. Regarding the requirement for maintenance, it was clarified that system services are always made available. In addition, it was pointed out that bouys if removed or blown-up, system will be no longer working.

6.3 Management of Marine Protected Areas: Experiences in the Philippines (EP 06) (Mr. Pierre Easter L. Velasco)

61. Mr. Velasco made a presentation on establishment of marine reserve and fish sanctuaries in the Philippines. He pointed out problems and issues in the establishment of marine reserves and fish sanctuaries in the Philippines emphasizing on lack of willingness and financial supports, coordination and involvement of other government agencies. He pointed out that effectiveness of a marine reserve is closely tied to the traditional resource

use patterns of the local people. He explained the site selection criteria focusing on the involvement of community, Fisheries and Resources Management Council (FARMC) and Local Government Units (LGU).

62. Mr. Velasco briefly explained the procedure for the establishment of marine reserves. He explained the management framework to support the marine reserves both regulatory and non-regulatory techniques.

63. In discussion, cost implication should include cost to establish the system as well as cost for follow-up activities. In response to the comments, it was clarified that introduction of marine reserves is a cost sharing between BFAR and LGU. BFAR is responsible for system establishment and LGU is for follow-up activities.

64. With regard to 400 sites of marine reserves that have been established and promoted by private organizations, LGUs, and academe, but only 37 sites were found successful. This to a large extent depends on various factors such as site selection, management plan, etc.

6.4 Regional Action Plan (RAP) to Strengthen a Resilient Network of Effective MPAs in Southeast Asia (Mr. Abdul Halim)

65. Mr. Halim made a presentation promoted by World Commission on Protected Areas – Southeast Asian Marine Working Group (WCPA-SEA Marine) under the IUCN. He referred the marine reserves as strict no-take zones while MPAs include utilization zones and no-take reserves. He presented the objectives and the RAP's 10-year Goals. He further explained the MPA themes.

66. In response to the inquiry regarding linkages with WCPA and other initiatives such as International Coral Reef Initiatives (ICRI), it was clarified that WCPA seeks to harmonize efforts and actions to promote MPAs including reef management.

6.5 Artificial Reef Projects in Thailand (EP 07) (Mr. Kornwit Jankusol)

67. Mr. Kornwit made a presentration on the objectives for ARs constructions, the ARs site selection, he gave some example of ARs constructions and ended the presentation with the development of small scale areas of ARs constructions. A video was showed on the used, plans and activities of ARs construction in Thailand

68. In responded to the question of site selection for ARs construction in Thailand, it is based on the requests that made by the fisher-folk in the areas. Issue that need to be considered is the length from shore to set the ARs.

6.6 Artificial Reef Projects in Malaysia (EP 08)

69. Mr. Abdul Razak Bin Latun made a presentation on the objectives of building ARs in Malaysia, activities for building ARs which under the projects of MFRDMD , site selection criterias, materials and constructions of ARs, (tyre reefs, boat reefs, concrete reefs, PVC reefs, which target on the habitat for the fish, monitoring by make the observation of the reefs, the status of ARs program in Malaysia.

70. In discussion the terminology of ARs-for conservation and FADs-for fishing was clearly given, including the supporting research for future cooperation.

6.7 Artificial Reef projects in Mediterranean (Mr. Yves Henocque)

Mr. Yves briefly explained on the Main purposes of ARs, Marine Reserve and Marine Fisheries Reserve. Made some considerations on the design and participation of MPAs, the supporting researches for the monitoring on the biomass. And there should be the regional cooperative among the region countries.

71. In the overall conclusion of the case studies on fishery resource enhancement, the Workshop took note of the following synthesis:

- Issues for further clarifications:
  - o Clear purposes and goals for resource enhancement in relation to conservation and management of FISHERIES
  - o Institutional arrangement
  - o Planning and design of resource enhancement in a comprehensive management system
  - o Awareness building, capacity building, community empowerment
  - o Effective law enforcement, coordination, monitoring and evaluation
  - o Allowable resource utilization patterns (i.e. fisheries, tourism, etc.)
  - o Sustainable financing
- Issue and Considerations for Future Actions
  - o Cost benefit analysis
  - o Standard Supporting research
- Clarification and implication of terms related to resource enhancement activities (marine parks, marine reserves, MPAs) should be clarified especially implication to fisheries
- Due coordination of efforts by various agencies in the promotion of any resource enhancement activities should be considered.
- Need for integration of resource enhancement activities into comprehensive management strategies and plan for coastal development
- Combination of resource enhancement activities (marine parks, MPAs, etc.) could provide complementary effects to conservation and management of coastal marine resources.
- Technology development for conservation and management tools is an area for future consideration. However, applicability, relevance to local needs and capacity to adopt technology should be considered.
- Regional specificities, situation, tradition and value should be fully taken into consideration in development resource enhancement activities and supporting management systems.
- Adaptive management approaches mobilizing local ecological knowledge.

VII. TOWARDS REGIONAL POLICIES AND STRATEGIES FOR RESOURCE ENHANCEMENT: POSSIBILITIES FOR FUTURE ACTIONS

(Chair Person: Mr. Suriyan Vichitlekarn)

7.1 Introduction to working session: Considerations for future activities for promoting sustainable fishery resource enhancement approaches in the region

(Mr. Suriyan Vichitlekarn.)

72. Mr. Suriyan briefly explained on the objectives and goals of the working sessions, the guidelines for group discussion, as well as the expectation output of the discussions that need to be considered as the conclusion and recommendation of the workshop. Then he divided the participants into two groups based on their responsibilities/works, each group had a single representative from one country.

7.2 Working Group Sessions:

1. Bio-physical considerations for the implementation and promotion of fishery resource enhancement programs and projects in Southeast Asia (see table 1)
2. Socio-economic and policy considerations for the implementation and promotion of fishery resource enhancement programs and projects in Southeast Asia (see table 2)

VIII. CONCLUSION AND RECOMMENDATIONS FOR THE FURTHER PROMOTION OF FISHERY RESOURCE ENHANCEMENT IN THE REGION (Chair person: Dr. Yuttana Theparoonrat)

73. Overall conclusion and recommendations

o The Workshop supported the compilation of data and information in order to establish Database and GIS works of Artificial Reefs in Southeast Asian Region. The national representatives attended the Workshop agreed to provide the requested data and information by one month after the Workshop.

o The Workshop supported the establishment of technical expert group on resource enhancement and network for data and information sharing.

o It was suggested that the regional understanding of the existing terms that have been developed in the Regional Guidelines for Responsible Fisheries could be used as a basis to establish common understanding.

o Optimum combination among the resource enhancement strategies could be used for the plan of actions in each particular situation.

o The workshop made the clarification for the following issues:

• Resource Enhancement: Combination of conservation measures and responsible modifications of coastal habitats aimed at sustainable fishery production.

• SFGs: Results from further studies should be used for determining the potential of resource enhancement effect of SFGs.

• ARs are for habitat recovery/ conservation.

• Stationary fishing gear: Passive/ non-mobile fishing gear which could be used for increasing/recovering/enhancing the existing marine resources in its area.

o Following issues to be discussed

• Supporting group for resource enhancement

• Developing the regional guild lines for the implementation of resource enhancement strategies.

• Database on the resource enhancement programs/projects in the region.

IX. CLOSING OF THE WORKSHOP

73. The SEAFDEC Dupery secretary-general, Mr. Junichiro Okamoto on behalf of the Workshop organizer expressed his appreciation for all valuable contributed, and shared experiences though the presentations and discussion which has made the Workshop a great success of future action on Enhancing of Coastal Resource Resources, and then he declared the Workshop close (Appendix D)

Table 1 Bio-physical considerations for the implementation and promotion of fishery resource enhancement programs and projects in Southeast Asia.

Outcome of Group Discussion

Resource Enhancement Strategies	Issues	Actions
MPAs	Potential reduction or loss of the traditional fishing areas	- Provide alternatives fishing areas, ARs/FADs for fishing activities. - Provide alternative incomes. - Reviews on MPAs considered being successful to be adopted for fisheries benefits.
	Balance between natural resource conservation and fishery benefits.	- Study on MPA impact on fishery resource. - Identification of critical habitats/areas for important commercial marine species. - Establish specific MPAs for particular purposes.
	Can MPAs replace conventional fisheries resource management?	- Identify the optimum combination of MPAs and other management tools.
Stock enhancement	Availability and suitability of habitats/carrying capacity.	- Proper site assessment.
	Bio-diversity and genetic conservation	- Use breeders from the targeted release site. - Make sure the natural stocks are not displaced. - Study on impact on resource ecological system interaction with released species.
	Disease introduction	- Don't release unhealthy animals.
	Target species selection	- Carefully select appropriate species, following recommended selection criteria.
ARs/FADs	Is the high density of fish in AR sites/ FADs actually fishery recruitment or merely aggregating effect of the reef?	- Study/research on the efficacy of the ARs/FADs deployment on the fish and other marine organisms in natural reef. - Develop regional guidelines for the establishment of ARs and FADs.

Table 2 Socio-economic and policy considerations for the implementation and promotion of fishery resource enhancement programs and projects in Southeast Asia

Items	Issues	Actions
1	Resource depletion	• Identify causes of resource depletion in order to clarify appropriate marine and coastal resource management tools.
2	Lack of awareness and education	• Enhance/improve sense of ownership, sustainable resource use and implication for responsibilities. • Promote stakeholder participatory approach to resource management.
3	Conflicts	• Strengthen fisher's organizations and other resource user groups. • Clarify roles, functions and responsibilities of agencies concerned under the existing legal framework. • Promote regional collaborative framework for management of marine and coastal resources.
4	Law and Enforcement	• Harmonize law enforcement activities for integrated coastal management. • Enhance/improve awareness of fishers on existing laws, regulations and policy.
5	Ownership	• Define roles and responsibilities of agencies and community concerned. • Promote right-based resource use scheme. • Enhance sense of community ownership on management initiatives.
6	Definition and classification	• Further clarify the existing regional terminology of ARs, MPAs, FADs, SFGs, etc. with the focus on resource enhancement. • Clarify their implications to resource conservation and management.
7	Data and information	• Coordinate and compile/share existing data and information on status of the resources and management plans. • Design and implement monitoring program to evaluate management options.
8	Stock enhancement	• Considered as a complementary tool to resource enhancement and need to be further explored.

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OPENING ADDRESS

MR. NIWES RUANGPANIT
Secretary-General and Chief of the Training Department
Southeast AsianFisheries Development Center (SEAFDEC)

Mr. Deputy secretary General, Distingruished guests, participants and observers, ladies and gentlemen. Good morning to you all.

Firstly, I offer you a most cordial welcome here to the Training Department of SEAFDEC and thank you to you all for finding the time to participate in discussions on what has become a most important aspect of fisheries.

To borrow the words of the famous politician Winston Churchill, there is a "wind of change" blowing through the fishing industry, a change brought about by the pronounced reduction in the quantity of landed catches that has prompted the need to find out why the quantities have reduced. All of you here today are knowledgeable about the reasons, each with a viewpoint developed in your own countries and based upon the needs of your countries.

However different the circumstances of the fisheries in our various countries, the return on applied effort are falling, the reasons have a common thread, which is that of poor recruitment of resources. If the fish are not allowed to breed in relative peace there will be fewer fish to catch. Moreover, as the returns fall so the fishing effort increases, thus, we are in a spiral of diminishing returns. A further indication of the danger to our fishing industry is reflected in the degradation of the reefs, the breeding grounds that represent fish for the future. It is arguable whether mechanical damage due to fishing, industrial pollution or global warming causes the blanching and dying of the reefs. Whatever the reason it is happening, and it is happening on a global scale.

We can rectify the pattern of degradation quite readily, but what is the impact of what we do? This is what we are here to discuss. What are the best ways to encourage resource enhancement? Each of you will have your own ideas and the purpose of this workshop is to share experience and find common ground that reduces fishing effort in the breeding grounds and encourages the natural enhancement of the resources.

I hope that this workshop can promote ideas and thinking that will be an answer to the problems that fisheries face today. Thank you all for coming here and I hope your discussions will be fruitful and enlightening.

Thank you.

PROVISIONAL AGENDA AND TIMETABLE

Background

The quality of coastal and inshore ecosystems has deteriorated significantly as a result of continued and increasing human activities. These areas are critical to a broad range of aquatic organisms during their life cycles including spawning, nursery areas and feeding zones and many of these species are of economic importance. The areas serve as important sources of recruitment to, and the sustainability of, commercial fisheries. It is suggested that the productivity of these ecosystems can be enhanced through human intervention leading to improved livelihoods for coastal communities.

In many areas, the introduction of man-made structures, including Artificail Reefs (ARs), Aquaculture Facilities, Breakwaters, Statioanry Fishing Gear (SFG) and Jetties are shown to enhance local populations of aquatic organisms, provided that there are sfficient numbers of structures to have a significant and positive impact on ecosystem productivity and that they are integrated into coastal zone management regimes. These structures can enhance fisheries resources. To optimize the results of such initiatives, careful impact assessment and planning procedures are required.

Re-stocking may be an effective component in the enhancement of marine resources in inshore waters. Juveniles and seeds produced by hatcheries or collected form the wild in others areas will be removes rapidly from the ecosystem by destructive fishing gears such as push nets or small-mesh trawl nets. Furtheremore, in order to retain the relaeased stocks within the immediate vicinity and minimize losses through out-migration, suitable habitat must be available to them. Therefore, habitat restoration and/or enhancement and establishment of exclusive fishing right may be necessary prerequisities for any marine restocking exercises.

Immediate action is required to prevent further loss of habitat and damage to fish stocks. A range of effective community-level mechanisms must be developed to assist fishers to restore habitats and rebuild stocks. These mechanisms are likely to be specific to different stocks and habitats. Habitat creation and the establishment of ARs, the use of fish attraction devices and redator removal all has potential in the region.

Objectives

1. To review the existing regional and national program/projects related to resource enhancement.
2. To discuss on resource enhancement issues.
3. To promote the establishment of a technical supporting group for working as resource persons/coordinator of the issues related to resource enhancement.
4. To evaluate, promote and encourage the use of ARs and SFG for coastal resources enhancement i light of environment.
5. To work in close cooperation with Southeast Asian member countries through technical assistance in research and development program for resource enhancement such as the use of ARs and SFG.

Workshop Programme

DATE/TIME	PROGRAMME
30 September 2003 (Tuesday)	
08:00 - 09:00	Registration
09:00 - 09:30	Opening
09:30 - 09:45	Refreshment break
10:00 - 10:15	Country Paper of Brunei Darussalam
10:15 - 10:30	Country Paper of Cambodia
10:30 - 10:45	Country Paper of Indonesia
10:45 - 11:00	Country Paper of Malaysia
11:00 - 11:15	Country Paper of Myanmar
11:15 - 11:30	Country Paper of the Philippines
11:30 - 11:45	Country Paper of Singapore
11:45 - 14:00	Lunch Break
14:00 - 14:15	Country Paper of Thailand
14:15 - 14:30	Country Paper of Vietnam
14:30 - 14:45	Refreshment break
	1. Review of existing resource enhancement projects (Chair Person : Mr. Bundit C.)
14:45 - 16:00	1.1 SEAFDEC initiatives and activities related to fishery resource enhancement (Dr. Yuttana T. and Dr. Wenresti G. Gallardo)
1 October 2003 (Wednesday)	
	2. Fishery resource enhancement: Potentials and considerations (Chair Person : Mr. Bundit C.)
09:00 - 09:30	2.1 Potentials of ARs, SFGs and other man-made construction for resource enhancement: lessons from Japan (Dr. Vicharn Ingsrisawang)
09:30 - 10:00	2.2 Resource enhancement aspects of stationary fishing gear in Southeast Asia (Mr. Aussanee Munprasit)
10:00 - 10:15	Refreshment break
10:15 - 10:45	2.3 Re-stocking (Dr. Wenresti G. Gallardo)
10:45 - 11:15	2.4 Resource enhancement through Marine Protected Areas: Promises and limitations (Dr. Theo Ebbers)
11:15 - 11:45	Conclusion
	3. Fishery Resource Enhancement : Case Studies (Chair Person : Dr. Somboon S.)
11:45 - 12:00	3.1 The Marine park Management in Malaysia (Mr. Zulkifli Talib)
12:00 - 14:00	Lunch break

DATE/TIME	PROGRAMME
14:00 - 14:30	3.2 Experience and Initiatives in Coral Reef Protection in Indonesia (Mr. Roderick Schipper) 3.3 Management of Marine Protected Areas: Experience in the Philippines (resource person from the philippines)
15:00 - 15:15	Refreshment break
15:15 - 15:45	3.4 Regional Action Plan to Strengthen a Resilient Network of Effecitve MPAS in SEA (Mr. Abdul Halim) 3.5 Artificial Reef Projects in Thailand (Mr. Kornwit Jankusol)
2 October 2003 (Thursday)	
	Fishery Resource Enhancement: Case Studies (Continue) **(Chair Person: Mr. Suppachai Ananpongsuk)**
09:00 - 09:30	3.6 Artificial Reef Projects in Malaysia
09:30 - 10:00	3.7 Artificial Reef Projects in Vietnam
10:00 - 10:15	Refreshment break
10:15 - 10:45	3.8 Artificial Reef Projects in Mediterranean (Mr. Yves Henocque)
10:45 - 12:00	Fishing Village and mangrove area observation trip
12:00 - 14:00	Lunch break
14:00 - 21:00	Excursion/shopping
3 October 2003 (Friday)	
	4. Towards Regional Policies and strategies for Resource Enhancement: Possibilities for future actions **(Chair Person : Mr. Suriyan Vichitlekarn)**
09:00 - 09:15	4.1 Introduction to working session : Considerations for future activities for promoting sustainable fishery resource enhancement approaches in the region (Mr. Suriyan Vichitlekarn)
09:15 - 12:00	Working Group Sessions: 1. Bio-physical considerations for the implementation and promotion of fishery resource enhancement programs and projects in Souteast Asia 2. Socio-economic and policy considerations for the implementation and promotion of fishery resource enhancement programs and projects in Southeas Asia
12:00 - 14:00	Lunch break
14:00 - 15:30	**5. Conclusion and recommendations for the further promotion of fishery resource enhancement in the region** **(Chair person : Dr. Yuttana Theparoonrat)**
15:30 - 15:45	Refreshment break
15:45 - 16:30	Closing

CLOSING ADDRESS

MR. JUNICHIRO OKAMOTO
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The time has come now when we must say good-bye to our participants, contributors and the silent minority who have listened. All here have learned to some degree the various views that have been put forward, but it must also be emphasized that resource enhancement and restocking, artificial reefs and habitats and fish attracting devices are only a part, an important part certainly, but only a part of coastal fisheries management. The most important factor in what we do is to enhance the sense of environmental responsibility and we must be certain that whatever we put into the sea to encourage the availability of fish does not have an adverse impact either in the short or long-term.

It must be recognized that anything done to provide habitats, or to prevent the fishermen from catching their fish will be offset by the ingenuity of the fishermen. For example, will the introduction of ARs encourage the use of methods that have two purposes, one to catch fish by illegal methods and two, to destroy the underwater structure that is the refuge for the fish? The facts are that we are undertaking Coastal Management and this should be carried out with an element of enforcement. It is understood that enforcement is not an acceptable term to use, but coastal management of itself implies some form of monitoring and protection.

Enough of the doom and gloom, I want to thank you all for your contribution to this workshop, for the presentations and for the subsequent discussions. For the wisdom that has been brought to the meeting and expounded for all to hear, and for the experiences that have been described and shared.

Now it is time to hope that when you return to your various countries that you have been given food for thought and a foundation upon which to build the future of coastal fisheries management in your countries. As you leave here, you take with you our gratitude for your contribution and that your return journeys to your homes and loved ones will be safe and expedient.

Thank you all for your attention.

LIST OF DOCUMENTS

Country papers

SEAFDEC/ECR-1/CP 01	Review of Coastal Zone Management in Fisheries of Cambodia (Suy Serywath and Rous Chhanty)
SEAFDEC/ECR-1/CP 02	Overview on Country Policies, Programs Experiences with Artificial Reefs, Stationary Fishing Gear and Establishment of Marine Protected Areas in Malaysia (Sukarno bin Wagiman and Abdul Khalil bin Abdul Karim and Abd. Razak bin Latun)
SEAFDEC/ECR-1/CP 03	Country Paper of Myanmar (Soe Thu and Myint Soe)
SEAFDEC/ECR-1/CP 04	Coral Garden & Reef Rehabilitation Project, the Establishment of Marine Reserves and Fish Sanctuaries of the Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines (Alma C. Dickson and Pieer Easter L. Velasco)
SEAFDEC/ECR-1/CP 05	Set Net Fishery (Lanbakled), the Philippines (Alma C. Dickson and Pieer Easter L. Velasco)
SEAFDEC/ECR-1/CP 06	Artificial Reefs & Marine Re-Stocking Efforts in Singapore (L.S. Wong and L.M. Chou)
SEAFDEC/ECR-1/CP 07	A Country Report for the Workshop on Artificial Reef and Stationary Fishing Gear Design and Construction and Marine Protected Area in Thailand (Anucha Songjitsawat)
SEAFDEC/ECR-1/CP 08	A Country Report of Vietnam (Nguyen Van Nguyen and Tran Duc Hap)

Experience Papers

SEAFDEC/ECR-1/EP 01	SEAFDEC Initiatives and Activities Related to Fishery Resource Enhancement (Yuttana Theparoonrat, Ph.D.)
SEAFDEC/ECR-1/EP 02	Stock Enhancement Program of SEAFDEC Aquaculture Department (Wenresti G. Gallardo, Ph.D.)
SEAFDEC/ECR-1/EP 03	Resource-Cultivation Fisheries by Artificial reefs (Vicharn Ingsrisawang, Ph.D.)
SEAFDEC/ECR-1/EP 04	Resource Enhancement Strategies and Stock Enhancement Principles (Wenresti G. Gallardo, Ph.D.)
SEAFDEC/ECR-1/EP 05	Marine Parks Malaysia-Management Strategy (Zulklifli bin Talib, et al)
SEAFDEC/ECR-1/EP 06	Etablishment Marine Reserve and Fish Sanctuaries in the Philippines (Pierre Easter L. Velasco)
SEAFDEC/ECR-1/EP 07	Artificial Reefs Construction Project in Thailand

Country papers

REVIEW OF COASTAL ZONE MANAGEMENT IN FISHERIES OF CAMBODIA

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■ BACKGROUND

Cambodia is one of countries located in Indochina, in which covers area of 181035 km^2 and shares its 2428 km land border with Thailand on the north-west, Lao PDR on the northeast and Vietnam on the east and south. Extending of 435 km at southwest of Cambodia along the Gulf of Thailand, the coastal zone contains extensive forest, bays and beaches with several offshore islands.

Marine fisheries of Cambodia is considered a crucial resource for the local people's consumption, while the population increase, poor management, lack of law enforcement and uneducated it puts much more pressure to these natural resources. In addition the relevant institutions cooperated to manage marine resources in sustainable use. The Ministry of Environment and Fisheries of Department under the Ministry of Agriculture, Forestry and Fisheries had carried out to manage and save natural resources in the coastal zone by creating the Protected Areas, Community based natural resources management, strengthening law and law enforcement.

Although natural resource management at the coastal zone of Cambodia seems to be lack if compared inland fisheries or fresh water fisheries, that 13 Protected Areas called "fish sanctuary" were established by the Department of Fisheries at the end of civil war in 1979. The fish sanctuaries had been established in the Tonle Sap great lack, Mekong system including the deep hold reserve on the mainstream between Kratie and Khone Falls. These sanctuaries are to preserve inland fish brood stock for spawning and nursing from one flooding season to next one. Fisheries law 'KRET-CHHBAB/33 Kra. Char/9 March 1987 on Fishery Management in Cambodia" is strictly forbidden of all fisheries activities in fish sanctuary except scientific research conduct by the Department of Fisheries with special permission. While, the Department of Fisheries under the Ministry of Agriculture, Forestry and Fisheries have protected of inundated forest within the Tonle Sap, River, Lack, National park and mangroves forests along the coast where the fish ground, fish sanctuaries and diver habitat or aquatic species nursery function located and had also prohibited on activities to destroy ecosystem as well cutting flooding forest and mangroves.

The Ministry of Environment (MoE) has conducted 23 Protected Areas to conserve all wild life including fish and their habitat but it is not designed as fish sanctuaries, in this case, the MoE protected areas contribute to localize fisheries productivities by maintaining river, lake and coastal habitat. There are seven of the MoE protected areas are associated with major natural water systems, four Protected area with marine ecosystems and three other with fresh water ecosystems. Also, the Ministry of Agriculture, Forestry and Fisheries has recently established the Siru Crane Reserve at Ang Tropeang Thmor which is a significant wetland and fisheries center.

On the first of November 1993, the Royal Degree concerning Creation and Designation of Protected Areas was established. This define four National Parks within the coastal areas (Ream Phnom Boko, Botum Sakor and Kep) and part of fifth (Kirirom) altogether covering of 366,250 ha, and one wildlife sanctuary and part of a second (Peam Krasob and Phnom Samkos) with altogether cover area of 357,500 ha, and a multiple use area (Dang Peng) covers area of 27,700 ha.

Coastal zone management established by MoE and Ministry of urbanization and planning focus only on the development of infrastructure, encouraging standard of living and use of natural resources in sustainable. The MoE had conducted several researches on social economic survey including pilot projects.

Fishery of Cambodia plays a very important role for food supply to people. The fish production is dominated by the fresh water fish production, while the marine productivities were considered when the natural stock of fresh water fish declined. According to statistic of DoF in 2001 shown that the marine production is 42,000 tons compared to inland fisheries 385,000 tons.

There are many types of small-scale and large scale (commercial scale) fishing gears were used in Cambodia water. The small-scale fishing gears were used for household consumption and size the gears are small. While the most of the fisherman used small-scale fishing gears they are pourers, the large scale fishing gears were used by the businessmen. The construction of the household fishing gear is depending on their purpose. Most hand made fishing gears were made by using natural resources it's called stationary fishing gear.

When most of coastal zone management was concerned the survey only on social economic and livelihood of local people in coastal zone by the MoE; the DoF under The Ministry of Agriculture, Forestry and Fisheries, had cooperated with United Nation Environment Program (UNEP) to conducted the survey under water resources. Coral Reefs and Seagrass play a crucial for nursing ground, sanctuaries function for aquatics resource and integrated biodiversity, however, it is very little known about these ecosystem due to lack of research. Furthermore, the sites of the coral reefs and seagrass have been not completely identified. According to the small survey, coral reefs have been observed to occur in many locations in coastal water of Cambodia, generally around the inshore islands and in some rocky areas. In Shihanoukville, coral reefs have grown around most of the islands and estuaries in Koh Rong and Koh Rong Sonlem Group and the other island in Kompong Sam bay. Artificial reefs have been not implemented yet in the coastal water of Cambodia.

In cooperation between DoF with ICRAN under UNEP, the Marine Protected Areas (MPA) in Koh Rong and Rong Sonlem group of Kompong Som Bay, was established in 2002, it is under implementing activities. The coral reef and ecosystem in this area were concerned to manage in sustainable use for people depending on community based natural resource management.

■ OVERVIEWS LEGISLATION OF CAMBODIA

1. National Policy

There is no national policy specifying the development, use and management of specific natural resources in the coastal zone, especially coral reef and sea grass. However, the national program to rehabilitate and develop Cambodia has implication for development and management of the coastal zone. The national program reflects a policy based on a process of legal reform, established of a legal framework based on democracy and a market economy. It is also sets the framework for national policy in all sector related in Cambodia's coastal zone.

The Five-year socio-economic Development Plan (1998-2002) considers environmental protection to an equally important element to develop the country. This plans also emphasis the need to alleviate poverty and improve quality of life of rural communities. In addition to the general national policy, there are some important sectoral policy related to the management of fisheries, coastal resources and coastal environment.

1.1 Fisheries Policy

The mandate of DoF is to manage fisheries sector. The main element related to marine fisheries is:

• Provide job opportunities and improve livelihood of people in rural communities;

• To provide the access to and distribution of fisheries benefits include export earning

• To extend the institutional responsibilities of fisheries management to the fishing communities

• To improve the protection of fisheries resources in sustainable way

• To encourage the integration of fisheries resource management with rural development in fishing communities.

Local communities and authorities are now working together to management fisheries resources in the coastal of Cambodia. One objective is to designate zone that should be reserved for conservation as well as those to be kept open for sustainable use.

1.2 Industrial Sector Policy

The policies of the industrial sector are defined as follows:

• To ensure the development of industry on political, economic and social stability in order to reduce the trade gap;

• To develop an industrial base to maximize the benefits of the existing natural resources, attracting greater foreign investment, promoting technology transfer and stimulating human resource development;

• To support the goals of the Ministry of Education and other agencies in developing vocational training centers to provide trained personnel for industrial development;

• To increase effectiveness, competitiveness and modernization of industry within the context of a free market economy;

• To support national economic and social development through effective industries, by creating added value to natural resources, sustainability of economic development, job opportunities and thereby upgrading the living standard of the people;

• To develop a Petroleum Training Institute and a training institute in the mines and geology sector; and

• To develop agro-manufacturing and food processing industries to support the agriculture sector.

1.3 Tourism Policy

Regarding to the management of tourism, the Ministry of Tourism (MoT) has set up the following tourism policy:

• To increase foreign exchange earnings;

• To increase and encourage investment in all areas of torism;

• To create employment opportunities for local people;

• To enhance and preserve the national cultural heritage; and

• To develop and conserve the physical and environmental resources in the coastal areas.

1.4 Policy of the Ministry of Public Work and Transportation

The main objective of Transport development includes the following policies:

• To upgrade the port facilities and infrastructure of Phnom Penh and Sihanoukville ports;

• To reconstruct the southern and northern railway branches; and

• To develop Phnom Penh and Sihanoukville ports as dry ports in order to accommodate future growths in traffic demand, especially with reference to container traffic.

1.5 Environmental Policy

The objectives of this policy are based on the Law on Environmental Protection and Natural Resource Management and the National Program to Rehabilitate and Develop Cambodia.

• To implement the national policy or national programs;

• To protect the environment from the effects of economic development;

• To conserve the environment by creating of protected areas;

• To ensure the development and implementation of laws and sub-decrees on

environmental conservation and protection of the coastal environment;

- To prepare and implement national and regional action plans through inter-agency coordination; and
- To ensure sustainable economic development activities in order to promote economic, social and political stability.

According to the unclear policy or responsibilities at ministerial levels, it may be difficult for departments or local authorities to define their own responsibilities or functions. However, the uncertain situation exists despite the fact that the National Environmental Action Plan (NEAP) was prepared by representatives from the following Ministries:

- Agriculture Forestry Fisheries
- Tourism
- Industry Mines and Energy
- Environment
- Rural Development and
- Public work and transportation

2. National Legislation Framework

2.1 Constitution of Cambodia

The National Assembly adopted the Constitution of Cambodia on 22 September 1993. It is the supreme law of the land and all other legislative texts have to strictly conform to this. "The Government of Cambodia must protect the environment and maintain ecological balance (Article 59 of the Constitution).

The Constitution refers three levels of power – legislative, executive and judicial. Legislative power has 120 members of the National Assembly who are elected for a term of five years by universal adult suffrage. The Royal Government of Cambodia is known as executive power. The head of the judiciary branch is the Supreme Council of the Magistracy.

2.2 Fisheries Law

There is under draft of new fisheries law under supported by World Bank project. However, the Fisheries Law No. 33, passed in 1987 is still in the enforcement, which defines fisheries and categorizes fishing areas. It states that all entities or persons who fish in either freshwater or seawater must contribute to the state, except fishing for household subsistence. Fisheries exploitation and aquaculture in fishing areas are permitted but must be determined by regulations of the government of Cambodia.

The Fisheries Law aims at being sustainable of exploitation of Cambodia's freshwater and marine fisheries resources. This law includes provisions addressing access control, gear restrictions, closed seasons and the designation of fish sanctuaries and also supports to the management of fisheries, coastal resources and the coastal environment in Cambodia as well as all types of inland waters. The management and administration of Coastal Fisheries of Cambodia is also mentioned in Fisheries Law, which includes the following:

- Fishery resources are comprised of living animals and plants found in the fisheries domain (Chapter 1, Article 1). Marine fisheries domain extends from the coastline to the outer boundary of the EEz. Fisheries domain is the property of the state.
- Chapter 3, Article 22 of this law mentioned that fishery exploitation, aquaculture and processing in Cambodia's marine fisheries are allowed upon government permission except for small-scale family fishing small-scale family fishing gear and other fishing gear permitted in the marine fisheries domain of Cambodia must be defined by the proclamation of the Ministry of Agriculture. However this law was not directly mentioned about the coral or sea grass management within marine water.
- Commercial fishing group or enterprise must obtain the following additional licenses: a fishing boat or vessel incense allowing them to operate in the sea, which to be issued by the fisheries authority after technical control, and a license from the police for administrative control (Chapter 3, Article 23).
- The fishing activities of foreigners in Cambodia's marine fisheries domain must have the approval of the Council of Ministers (Chapter 3, Article 24).

• Fishers who are permitted in the marine fisheries domain must respect the order or act mentioned on the fishing license. Records must be kept on the daily catch of fish and other organisms, and reporting this monthly to the provincial municipal fisheries authority (Chapter 3, Article 25).

• All kinds of fishing gear, extending across a stream, inlet or navigable channel of coastal zones, must have a free space of one-third of its width during low tide to enable the navigation of vessels (Chapter 3, Article 26).

• Trawling in shallow water (less than 20 m) is prohibited, except where special permission is granted by the Department of fisheries for scientific research (Chapter 3, Article 28).

• Fishing in Cambodia by using electric fishing gear and all kinds of explosive or modern fishing gear, which are not mentioned in the Proclamation of the Ministry of Agriculture, are absolutely prohibited (Chapter 3, Article 29).

2.3 Forestry Law

The Forestry Management Law No. 35 was passed in June 1988, which defined as all types of forests and states that forests are divided into forest concessions and protected forests. Limitation of forest boundaries and forest uses are to be determined by a sub-decree. All sectors of society are obliged to protect the forests. Taxes of exploitation of forests must be paid to the government otherwise the logging operation are not allowed. Hunting of all species of animals is also prohibited.

2.4 Tourism Law

Royal Decree on the Establishment of the Ministry of Tourism was established on 24 January 1996. Its mission is to provide direction and encourage the development of the tourism industry in the Kingdom of Cambodia.

Sub-decree on the Organization and Functioning of the Ministry of Tourism

It was issued on 5 August 1997. It defines the administrative structure of the MoT and its role and duty in tourism management. The organizational structure is composed of central and local administrations. The main responsibilities of the Ministry especially related to coastal tourism management are:

• To define the tourism policy and strategies and to prepare plans for tourism development;

• To encourage tourism investment in accordance with the national strategies;

• To develop and manage the tourism industry;

• To direct and administer other services related to tourism;

• To direct, control and maintain natural and artificial recreational resorts, tourism areas and tourism zoning in the Kingdom;

• To study proposals for establishing, recognizing and controlling private schools and professional training for the tourism sector;

• To promote tourism locally and overseas;

• To appoint tourism representatives in various countries in cooperation with the Ministry of Foreign Affairs and International Cooperation;

• To sign contracts that relate to tourism upon government approval;

• To issue operating permits for tourism firms, agencies and guides;

• To control tourism services and other tourism related activities; and

• To conduct tourism inspection.

With regard to issuing licenses, there are various declarations such as:

• Circular on the Licensing of Travel Agencies, 1994;

• Declaration on the Licensing of Tourist Guides, 1996;

• Declaration on the Licensing of Tourist Boats, 1996;

- Declaration on the Licensing of Tourist Vehicles, 1996;
- Declaration on the Licensing of Hotel and Guest Houses, 1996;
- Declaration on the Licensing of Resorts, 1996;
- Declaration on the Licensing of Catering Establishments, 1996; and
- Declaration on the Licensing of Massage Parlors, 1996.

2.5 Environmental Law

Law on Environmental Protection and Natural Resource Management

One of the national government's priorities is the development of environmental legislation. Law on Environmental Protection and Natural Resource Management is the first law specifically concerned with environment, which was adopted by the National Assembly on 24 December 1996. It is can be considered as the framework for subsequent sectoral laws, sub-decrees and regulations for environmental protection and natural resources management.

The Law does not attempt to establish specific environmental management systems or standards. Rather, these tasks must be implemented by subordinate legal instruments. The main objectives of this law are to protect, manage and enhance the environment and to promote sustainable socioeconomic development. This law described the general legal framework of environmental protection, conservation and management of natural resources including coastal zone and marine resources.

The important objectives in this law are as follows:

- EIAs must be conducted for all projects and economic activities that might affect the environment (Article 6, Chapter 3);
- To conserve, develop, manage and use natural resources in being sustainable way (Article 8, Chapter 4);
- To protect the coastal environment through the identification of pollutants, toxic and hazardous substances (Chapter 5);
- To prepare national and regional plans for environmental protection and natural resources management (Chapter 2); and
- To suppress any acts which abuse the environment, in conformity with the "polluter pays" principles. Those who violate this law are to be fined and/or jailed in accordance with the degree of the violation.

Sub-decree on the Organization and Functioning of the Ministry of Environment

The Sub-decree on the Organization and Functioning of the MoE was ratified by the Council of Ministers in late 1997. Accordingly, the Royal Government of Cambodia gives the Ministry the authority to supervise and manage the environment in the Kingdom.

Royal Decree on the Creation and Designation of Protected Areas

Protected area management was mandated under the Royal Decree on the Creation and Designation of Protected Areas on 1 November 1993. There are 23 protected areas designated in the country and some of these protected areas are found along the coastline of Cambodia.

The MOE is currently preparing a proposal for a Sub-decree on Protected Areas Management. The purpose of this sub-decree is to implement the Law on Environmental Protection and Natural Resource Management and to implement the Royal Decree of 1 November 1993. At present, the MoE faces major management problems in the designated protected areas, especially in preventing violations such as illegal logging and hunting.

Sub-decree on Water Pollution Control

A Draft Sub-decree on Water Pollution Control is under review by the MoE. The purpose of this sub-decree is to control effluent discharge into water bodies and set standards for water quality.

Sub-decree on Environmental Impact Assessment (EIA)

EIA provisions are incorporated in the Law on Environmental Protection and

Natural Resource Management. The draft sub-decree specifies the following environmental review process: screening, initial EIA and full-scale EIA.

As specified in the Law on Environmental Protection and Natural Resource Management, this review process applies to proposed, existing and on going projects and activities by both public and private sectors.

Where there is no requirement for an EIA, the Ministry will require the proponent to enter into an agreement to comply with any conditions set in the Ministry's initial evaluation as a precondition of granting any license or permit.

2.6 Transportation Law

In order to ensure safety in as well as develop other modes of transport, the MPWT has issued many laws and declarations, some of which are also related to maritime transport in the coastal zone.

- *Sub-decree on Private Transportation Services Passed in 1991 by state council No. 13*
- Declaration on the Management of Vehicles and Inland Waterways Transportation issued in 1993 by Ministry of Public work and Transportation
- Common Circular on Overloaded Trucks, Especially Logging Trucks issued by MPWT, MAFF, Financial and Economics in February 1995
- Declaration on Ship Construction by MWPT in 1995
- Declaration on Issuing Business Licenses for Tourist Boats Issued by MOT in 1996.
- *Sub-decree on River Navigation issued by councl of Minister in 1986.*
- *Draft Declaration with Respect to the Act of Registration of Merchant Ships by GDT and MWTP in 1995.*
- *Declaration No. 018 on Overloaded Ferries, Riverboats and Sea-going Vessels by MWTP in August 1995.*

2.7 Land Law

The Constitution provides that only Cambodia citizens or entities have the right to own land. The State of Cambodia's National Assembly passed the Land Law on 10 August 1992 and it is now being enforced. This law prescribes the management of land and the system of property rights such as state or private property. Private property rights in fisheries and forest reserves, however, are not provided.

2.8 Law on Land Management, Urbanization and construction

This Law was passed by the National Assembly and came into effect on 24 May 1994. It aims to promote the improvement of urban and rural areas in order to ensure sustainable development throughout out the Kingdom.

2.9 Law on Investment

The Law on Investment governs all investment projects initiated by investors who are Cambodian citizens and/or foreigners within the Kingdom of Cambodia. The National Assembly of the Kingdom of Cambodia adopted this law in August 1994 during the session of the first legislature.

2.10 Labor Law

This law governs all agreements between employees and employers who are Cambodian citizens and/or foreigners within the territory of the Kingdom of Cambodia. This Law was adopted by the National Assembly on January 1997 during the extraordinary session of the seventh legislature.

2.11 Industry Law

Law on Mineral Exploitation and Mining

The Law on Mineral Exploitation and Mining is still a draft and relates to the management and monitoring of mineral resources and mineral exploitation. It sets provisions for the sustainable development of the mining sector with the objective of improving the national economy but prevents natural resources depletion.

Sub-Decree on Industrial and Handicraft Management and Monitoring

This sub-decree is still a draft and relates to the management and monitoring of handicraft industries. It intends to promote sustainable development in the industry, improve the national economy and prevent harmful industrial impacts on the environment. The sub-decree was written in 1995.

Draft Industrial Zone Act

This act provides, written in 1995, for the development of the industrial zones in the Kingdom of Cambodia. It also aims to promote economic development in the industrial sector while maintaining environmental protection.

■ PROJECT ACTIVITIES IN COASTAL ZONE OF CAMBODIA

Natural resource management in coastal of Cambodia started in 1997 when the MoE cooperated with institution relevance including NGOs funded by DANIDA. The Coastal Zone Management (CZM) plays a very important role manage marine resource in sustainable use. In order to promote livelihood of the local lived in coastal area, there are some projects including pilot project were implemented in various place in province/ municipality along the coastline of Cambodia. However, the project focus one the social and management in order to encourage and promote living condition of the local people. The objectives of the project as below:

- To investigated the ecological impact of the destructive fishing and coral collection
- To suggest management strategy to stop or regulate the destruction of coral reef
- Infrastructure: capacity and socio-economic assessment
- Assist local authorities to develop and maintain a monitoring program to track changes in specific habitats
- Contribute to the development of coastal management strategies.

Therefore, from the purpose of the project and through the activities we got some out put as below:

- A functional policies and inst. Framework for CZM
- Planning and integrated of Environmental management strategy at national and provincial levels including CZM action plans
- An approach for stakeholder participation in CZM process
- Standardized for collecting, analyzing and disseminating coastal inform
- Productive pilot projects with community-based management
- Pilot projects on waste management and monitoring
- Provincial working group coordinate, negotiate, plan and management
- Incorporate into existing institutional framework
- Physical framework plans for all four coastal provinces
- Guideline for community-base management
- Awareness raising

REAM National Park is one of five pilot projects located in Sihanoukville. The purpose of the pilot project is to improved living condition for local community fisheries trough patrolling as a mean to increase income from fishing, testing potentials of crab fattening as an additional income for household, enhanced public awareness on the environmental protection and improved community participation; and alternative livelihood possibility explored.

Based on natural resources management, this project shown the sign improving the natural resource and living condition as well. Reducing of environmental degradation is much appreciated; particularly the illegal activities as fishing and cutting mangrove forest in the pilot areas were reduced. Decreasing illegal fishing activities by the end of 2002 is 20-30% and the same as 50-60% for illegal cutting mangrove forests. Participating of stakeholders conducted regularly to solve any issues. Moreover, the cooperation between authority and community play very crucial in order to manage their natural resources in sustainable use.

■ STATIONARY FISHING GEARS

Introduction

There are many types of fishing gears used in Cambodia water. In order to tax from the Fishing activities the gears were classified into small-scale and large scale (commercial scale fishing gear), these gears are distinguished by the capacity of boat engines and size of fishing gears. In other hand, the fishing gears were divided into two groups is mobile (active) fishing gear and stationary (passive) fishing gear. The passive gears were made from the net and bamboo or small tree in different size.

1. Trap (Khmer name *Lop*)

There are many types of traps in Cambodia water. These gears are constructed from bamboo and small trees as born and covered by net. They also are operated with bamboo-fender and the small tree as born and covered by net. They also are operated with bamboo-fender and the production for their household consumption.

Crap traps (Khmer name *Lop Kdam*) were previously constructed from bamboo and now it's can made from the net. They keep trash fish inside trap and put in seagrass or estuaries where they considered as a good place to get crab.

Fish traps (Khmer name *Lop Trey*) were constructed by bamboo in various sizes. Generally, they operated in associated with bamboo-feder.

Squid traps (Khmer name Lop Meuk) are operated in associated with aquid eagge, which are used for attraction. However, the data recorded by the DoF could not be separated by type of traps.

2. Gill net (Khmer name *Mong Peak*)

There also many types of gill net with various sizes can be used in Cambodia water. They catch different species and body sizes of the fish while the fish pass through it. These fishing gears were introduced in Cambodia along time ago and they are operated in the shallow or inshore water.

Mackerel gill net (Khmer name *Mong Trey Kamong*)

This fishing gear is specifically designed. It is used to catch pelagic fish especially mackerel, which comprises more than 80-90% of the total catch. According to the Fisheries Law of Cambodia (Khmer called *Kret Chhbab Lek* 33 *Kra. Chor*), which was signed and came into force on 09th March 1987, Article 27 mackerel fishing is prohibited every year from 15 January to 31 March because this is the spawning period for mackerel. In Cambodia, one fisherman has at least two types of the fishing gears, so they can change to another fishery during the closed season. This fishing gear is used only the fishermen who live in Sihanoukville municipality and Koh Kong province (Table. 2).

Scomberomorus gill net (Khmer name Mong Trey Beka)

This gill net is widely distributed in Sihanoukville and Koh Kong province (Tab. 16). One fishing boat has from 1 to 10 km of net depending on the size of the boat. For boats with engines from 10 to 90 HP, gill nets with a height of 9 m are used, whereas boats with engines bigger than 90 HP, use nets with a height of 18 m. On the bottom the gill nets are anchored or weighted and they are used to catch various pelagic fish species. The main fish species caught by this gill net are *Scomberomorus*, scads and shack.

Shrimp gill net or Trammel net (Khmer name *Mong Bang Kear*)

Trammel nets are widely used throughout Cambodian sea and more used in Sihanoukville and Koh Kong province (Tab. 4). This gear has a special design and consists of two or tree layers of different mesh size. For example trammel net tree layers, the layers 1 and 3 have a mesh size from 8 to 10 cm and layer 2 has a mesh size from 3.8 to 4.2 cm. This fishing gear is used for capture of mixed fishes but the most important is demersal fish because it is weighted to the bottom. It catches mainly shrimp, catfish and silver and black pomfrets.

Crab gill net (Khmer name *Mong Kdam*)

This is another type of gill net with various mesh sizes, which is operated in the shallow or inshore water like other gill nets and is weighted at the bottom. It is used to capture of mixed fishes but the most important is demersal fish, and especially crab. They have mesh sizes around 4-10 cm according to the depth or zone for fishing. Nets used in the shallow water have mesh sizes from 4 to 8 cm and 80% of the nets had a mesh size of 6 cm; 80-95% of the total catch is crabs. For deeper water (inshore) a mesh size of 8-10 cm is used and 80-90% of the catch is crabs.

Clupea gill net (Khmer name Mong Trey Kbork)

This is yet another type of gill net with various mesh sizes, which is operated in the shallow or inshore waters like other gill nets. It has a mesh size of 3.5 cm and is used to capture demersal fish especially Clupea. One fishing boat has from 150 to 200 m of this gill net and it is used all year round. It is used more for the fishermen who live in Sihanoukville (Tab. 6).

■ MARINE PROTECTED AREAS

Marine Protected area was established in 2002, which implemented by DoF and funded by ICRAND project under the United Nation Environment Program in Koh Rong site of Sihanoukville. It is the beginning time for activities that focus on protection and management the area of sea in which spawning ground, feeding grounds and nursing grounds for marine living resources to ensure their long-term viability and to maintain genetic diversity. Moreover, to promote compliance with MPA regulation by increasing income for local fishers trough enhancement of local fisheries, training of alternative livelihood, and promote of eco-tourism, and protecting coral reef and other diversity within the MPA.

1. Location of Koh Rong group

Koh Rong groups is in Mittapeap district about 28 Km from International Sea Port at the west of Sihanoukville. There are 5 villages in Mittapeap district, they are Preksvay, Deum Thkorv, Koh Touch, Koh Rong Sonlem and Soksan village.

2. Socio-economic status

There are 5 villages belong to Koh Rong Commune, Mittapeap District of Sihanoukville. Koh Rong commune just approve to be a commune, during 2000. One of the 5 villages (Sok San village) is still un-legislation.

The vast majority of the people in Koh Rong MPAs are fishing (70%) for their livelihood. The others grow rain season rice (rice field 100 ha) and farming (300 ha: coconut, mango, jack fruit, corn, water melon, banana, etc.) about 20% and 10% is goods sellers.

The standard living of the stakeholders are rich (Wooden house with tile roof, engine boat, TV, radio, etc.) is 16%, medium (Wooden house with tile roof and wall, engine boat but in-dept, radio, etc.) is 30 and poor (cottage, non-engine boat, no land) is 54%. There are only 3 primary schools with 8 classes, and Koh Toch village have no school for children. No health center in this areas, no doctors. There are 8 wells, but some are run out of water during dry season. No infrastructure: route, electricity, transportation, etc.

Men are the main actors in fishing, but most of the women are free and stay home during day time. The traditional roles in house-works, on rice field, in animal husbandry, in marketing and some time mend fishing tool. However, the women influence in decision making at both household and village levels are significant.

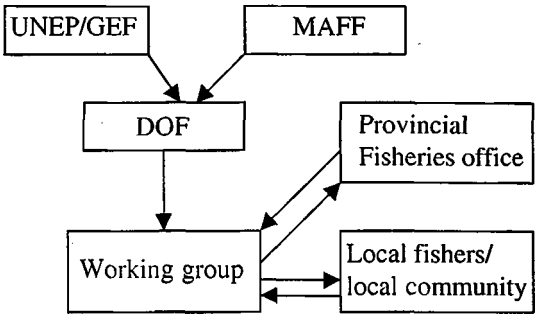
Problem and challenges faced by this community include minor internal fishing conflicts, large amount of external fishing conflicts, increase in number of fishermen, poverty and indeptness, passive attitude and lack of unified force (in particular, women and the poorest), lack of others skills in alternatives, no boundary delimitation of fishing grounds for community and the trawlers, lack of knowledge of habitat observation (coral reef, sea-grasses, mangrove and coordinate to protect endangered species (sea turtle, dugong) such lack of regular control of competent agencies over fishing abuses and poor responses from local authorities in the same regard.

3. Management authority

Management authority in the Koh Rong site had varied from regime to regime due to the civil war was toured in this country. In 1960s and 1970s, the site was managed or governed by two authorities Sihanoukvill International Sea Port and the Navy. There are no people lived in Koh Rong site in Khmer Rouge period (1975-79). This site is under controlling by Pol Pot authority and there are no fishing activities. In 1979 to 200, Koh Rong site had governed by Navy authority of Cambodia Government for five miles around islands. Since 2000, Koh Rong site became a new district (Meattapeap district) in Sihnoukville and it had been managed by Sihnoukville governor cooperation with Navy authority.

The Department of Fisheries is the principle government agency responsible for management of living aquatic resource in the Marine Protected Area at Koh Rong Site. The working group (Unit) of DoF, will cooperated with local authority, commune, local fishers, NGOs and relevance institutions to manage and conserve the resources. At the future the Koh Rong site will employ some rangers, an admitrative assistant and a manager. The structure of Marine Protected Area in Koh Rong site was organized as below:

Flow chart of management structure for Marine Protected Areas



■ CONCLUSION

Through the review of the existing legislation, the law enforcement in coastal zone of Cambodia based on the infrastructure and development in coastline in order to promote standard of living for local people. It is quite lack of law enforcement in marine fisheries and other ecosystem. Under water resources, as coral reefs and seagrass is very little known as a nursing ground, sanctuaries and food for marine species.

The uses of fishing gears are rapid increasing year by year due to population are also increased. Therefore, management of fisheries activities in coastal zone area is more need and fisheries law (CHBAB 33 kra) should be updated to follow up the changing of real context.

Marine Protected Areas plays a very important role in order to save natural marine resources as well as using natural resource in sustainable. The community natural based management is one of the duties to restore and manage resources, and cooperation from relevance institutions and NGOs is necessary needed to strengthen and provide alternatives or experiences.

Table 1. The statistic of traps (Crap trap, Fish trap and squid trap) use in sea of Cambodia (Unit = Number)

Province/Municipality	1997	1998	1999	2000	2001
Kep	200	1,000	500	11,550	10,000
Kampot	2,303	1,745	1,745	1,745	6,175
Sihanoukville	1,620	1,420	2,300	2,080	2,080
Koh Kong	19,077	19,077	29,415	35,874	48,000
Total	**23,200**	**23,242**	**33,960**	**51,249**	**66,255**

Source: DOF 2002

Table 2. Data of mackerel gill net use in the coastal area of Cambodia (Unit = m)

Province/Municipality1	1997	1998	1999	2000	2001
Kep	-	-	-	-	-
Kampot	-	-	-	-	-
Sihanoukville	17,620	26,900	84,600	64,700	64,700
Koh Kong	113,600	113,600	113,600	113,600	-
Total	**131,220**	**140,500**	**198,200**	**178,300**	**64,700**

Source: DOF 2002

Table 3. Data of Scomberomorus gill net use in the coastal area of Cambodia (Unit = m)

Province/Municipality1	1997	1998	1999	2000	2001
Kep	-	-	-	-	-
Kampot	-	8,700	-	-	-
Sihanoukville	43,800	45,800	86,600	100,000	100,000
Koh Kong	23,000	30,500	53,500	48,000	84,000
Total	**66,800**	**85,000**	**140,100**	**148,000**	**184,000**

Source: DOF 2002

Table 4. Data of shrimp gill net or trammel net use in the coastal area of Cambodia (Unit = m)

Province/Municipality1	1997	1998	1999	2000	2001
Kep	300	1,000	1,000	2,000	1,200
Kampot	10,500	9,750	4,100	4,100	27,100
Sihanoukville	145,700	145,700	121,900	104,900	104,900
Koh Kong	312,600	312,600	869,055	542,890	190,000
Total	**469,100**	**469,050**	**996,055**	**653,890**	**323,200**

Source: DOF 2002

Table 5. Data of crab net use in Cambodian waters (Unit = m)

Province/Municipality1	1997	1998	1999	2000	2001
Kep	500	20,000	10,000	10,000	10,000
Kampot	10,900	24,200	40,755	27,600	27,600
Sihanoukville	87,500	87,500	219,500	204,000	225,000
Koh Kong	294,300	294,300	268,290	719,770	372,600
Total	**393,200**	**426,000**	**538,545**	**961,370**	**635,200**

Source: DOF 2002

Table 6. The statistic of Clupea gill net used in Cambodia sea (Unit = m)

Province/Municipality1	1997	1998	1999	2000	2001
Kep	-	-	-	2,500	-
Kampot	-	-	5,700	7,600	7,600
Sihanoukville	15,900	15,900	19,900	19,900	19,900
Koh Kong	8,000	8,000	8,000	8,000	-
Total	**23,900**	**23,900**	**33,600**	**38,000**	**27,500**

Source: DOF 2002

Table 7. Number of Villages and population in Koh Rong Site

No.	Village Name			Population	
	Koh Rong	**Koh Rong Sanlem**	**No. of family**	**No. of People**	**No. of women**
1	Koh Roch	-	90	329	203
2	Deam Tkov*	-	59	335	162
3	Prek svay	-	101	499	361
4	Sok San**	-	51	244	52
5	-	Koh Rong Sanlem	51	259	129
			352	**1666**	**907**

* Deam Tkov ville is the Commune Head Quarter of Kon Rong

** Sok San village is under registration

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OVERVIEW ON COUNTRY POLICIES, PROGRAMS EXPERIENCES WITH ARTIFICIAL REEFS, STATIONARY FISHING GEAR ESTABLISHMENT OF MARINE PROTECTED AREAS IN MALAYSIA

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Abstract

Marine environments are typically strongly linked to the mixing of water masses and, in coastal areas they are greatly influenced by rivers and land runoff. A marine area can also be strongly influenced by activities in distant areas including those on land and at sea. Artificial reef developments is part of the government programme in Malaysia for habitat enhancement and rehabilitation, and artisanal fishing ground. A total of 99 artificial reefs have been constructed from various materials such as tires, fabricated concrete blocks and cylinders, sunken boats and PVC pipes. Another 221 artificial reefs have also been deployed in coastal waters to provide fishing ground specifically for traditional fishermen. In 1983, the Government of Malaysia initiated the establishment of Marine Parks in Peninsular Malaysia for the conservation of living marine resources. To date, waters of 2 nautical miles off the shores of 40 islands in Peninsular Malaysia have been gazetted as marine parks of Malaysia under the Fisheries Act 1985. These 40 islands are grouped into 5 marine parks and a comprehensive management plan was developed to cater for them. These plans were adopted for the day-to-day management of particular marine parks. Current management issues in these marine parks are the impacts of fisheries and tourism. All fishery activities within the marine park waters are prohibited.

■ INTRODUCTION

As a sovereign nation, Malaysia has proclaimed its 47,000 square miles Territorial waters and 113,000 square miles EEZ in April 1980; and thus, by the provision given under the United Nation Convention On The Law Of The Sea (UNCLOS), Malaysia has exercised its right as a coastal state and as a 'Straits State' depending on one's orientation. The coastal waters is a very important fishing ground for about 84,500 fishermen working on 31,800 fishing vessels (Anon, 2002). This fishing activity was producing 1.2 millions tones of fish with about 80% of the fish landed coming from coastal waters. Edible marine organisms have been and are still the main protein source in the diet of the people in Malaysia. With a per capita consumption of fish of about 39.5 kg. And an increasing population, the demand for fish is expected to increase in the future.

One of the most important goods derived from the marine ecosystem functions is food for human consumption. The diverse marine habitats support fishing and its related industries as one of the major food production industry in Malaysia. Fishing industries in Malaysia during the last decade have undergone changes through several eras of management regime to regulate its open access and common property nature. The fishing industries in Malaysia started with the management regime of the Colonial Fisheries Unit in 1894 under the British Government (Department of Fisheries 1994). During the early colonial period and the pre independence (1894-1950), there were no clear fisheries management objectives and plans other than: 1) regulating the fisheries activities; 2) economic performance and 3) equity or social needs. During the Post-Independence (1951-1970) and early years of the New Economic Policy (1971-1990), the Colonial Fisheries laws were replaced with the Fisheries Act of

1963, which provided a more comprehensive legal framework to manage the fisheries in Malaysian waters. Marine fish resources have declined considerably over the past decade, particularly in inshore waters, due to the increased intensity of fishery activity. Then, fish aggregating devices and artificial reefs have been found to be popular forms of fisheries resource enhancement and management tool in this country. Some traditional fishermen in the East Coast of Peninsular Malaysia practiced this activity since the early 1900's (Hung, 1990). This was practiced by sinking derelict wooden boats, bundle of trees branches, twigs and rocks.

Malaysian marine protected areas were first established in 1983 and they are new compared to other marine parks in the other parts of the world for examples in Caribbean and Australia. This paper overviews the states of development of artificial reefs and marine protected areas and the experience gained by Malaysia on the use and management of artificial reefs and marine protected areas.

■ ARTIFICIAL REEFS

Artificial reef developments from part of the government's programmes in Malaysia for habitat enhancements and rehabilitation's, and artisanal fishing ground. The decline in fisheries resources is reflected in the annual catch data on the demersal resources off the east coast of Peninsular Malaysia. The catch rates of demersal fish monitored from commercial fishing boats, in 1988 were 280 kg. Hr- 1 have gradually decreased in 1994, to 180 kg. Hr $^{-1}$ (Anon, 1994). The high composition of trash fish in the catch of trawl nets also serves as an indication of marine living resources depletion. In 1994, the trash fish composition was 55% compared to only 32.9% in 1987 (Ibrahim *per. Comm)*

Accordingly, in 1975, as a step towards alleviating the problem of declining fisheries resources and helping in the rehabilitation of marine habitat, the Department of Fisheries initiated artificial reef construction. The principle objective in the construction of artificial reef are to generate the recovery of fishery stocks, or to mitigate some of the impacts or losses related to coastal development projects or to increase the fisheries resources and diversity of colonizing organisms thereby improving the catches. As such, fishing in the artificial sites is prohibited.

At present in Peninsular Malaysia, a total of 99 artificial reefs have been constructed from various materials such as tires, fabricated concrete blocks and cylinders, sunken boats and PVC pipes. The government had spent a total budget of RM 23.16 millions, since 1986. Clearly, an artificial reef provides better fishing ground for artisanal fishermen and protection of habitats from destruction by trawlers. It was indicated that the fish catch-per-unit-effort (kg. Per personhour) in Malaysian artificial reef was 8.7 to 20.72, and 0.78 in areas without artificial reef (Omar, *et al.*, 1994; Sukarno *et al.*, 1994)

Additionally, there are another 221 artificial reefs that have been deployed in coastal waters to provide fishing ground specifically for traditional fishermen. This initiative was started only in 1983 under the Fisheries Development Authority Malaysia with the total cost of RM24 millions.

■ STATIONARY FISHING GEAR (SET NET)

The fisheries sector still plays an important role in providing fish as a source of food and protein. Contributed about 1.54% to GDP and provide direct employment both in the capture fishery and aquaculture. An increase in the number of vessel, fishing gears together with sustainable management of the resource, it would give a positive contribution to fisheries sector in the future. There was an increase in the number of licensed fishing gears in 2001 by 28.1% as compared to the previous year (Anon, 2002). However, the use of stationary fishing gear (set net) in Malaysia is no longer practiced. Stationary fishing gear was popular during the pre 70's but with the introduction of more efficient gears, set net have taken a back seat among the fishing communities. Though the subsidiary scheme that was introduced in the 70's, fishermen were

given aids in improving their methods of catching fish. The drift nets replaced the set nets quickly but since the active gears such as trawl net and purse seine more preferable.

■ MARINE PROTECTED AREA

However, in the early stage of the fisheries development under the Fisheries Act of 1963, the fisheries management objectives linger around maximizing sustainable yields (MSY), maximizing economic return, maintaining employment, ensuring the equitable distribution of wealth and maintaining the living standard of those involved in the fishery. The importance of the dynamics of the effective fishing effort, 'other resource users', the marine habitats, the ecology and the terrestrial environment especially the offshore islands and the coastal areas were given less emphasis. As a result, we see that the coastal waters (of islands and the mainland) in the Peninsular Malaysia have been subjected to prolong and tremendous pressure due to the social and economic reasons as predefined in the fisheries management objectives.

Nevertheless, the Fisheries Act of 1963 provided regulations to regulate fisheries exploitation through a very strict 'limited entry' or 'input' management regime. Among others, the regulations provided for restriction of some fishing areas which is the initial stage towards the marine protected area (MPA) management approaches, the impetus for MPA's came much later.

Though not defined as MPA's per se, the water areas of less then three miles of any state of West Malaysia and of Pulau Langkawi and Pulau Bidan in Kedah; Pulau Pinang; Pulau Pangkor in Perak; Pulau Ketam in Selangor; Paulau Tioman in Pahang; and Pulau Redang and Pulau Perhentian in Terengganu were restricted to trawl fishing and fishing with purse seine nets but not to fishing using traditional appliances (Fisheries (Maritime) Regulations 1967). The numbers of islands were later increased to include Pulau Perak, Pulau Jarak, Pulau Pisang, Pulau Aur, Pulau Berhala, Pulau Tenggol and Pulau Yu Besar in 1980 while the restricted water areas increased from three to five nautical miles from the shoreline of all State of West Malaysia and the above-mentioned islands. Some of the island mentioned above were later gazetted as Marine Parks of Malaysia. Under the New Fisheries Policy 1982-1983, 'restricted fishing area' were expanded and clearly defined to four fishing zones as follows (Anon, 1983);

Zone A - within five nautical miles from shoreline, reserved for traditional owner operator vessels;

Zone B - Five nautical miles and above from the shoreline for commercial gear of owner operator vessels below 39.9 GRT (Gross Registered Tonnage);

Zone C1- 12 nautical miles and above from the shoreline for commercial gears operating with vessel 40.0 GRT and above;

Zone C2- 30 nautical miles and above from the shoreline for commercial gears operating with vessel 70.0 GRT and above;

The essence of these water areas restriction aim mainly for resource distribution (equity sharing) and minimizing conflict among fishers using various fishing appliances and at the same time met the requirement of MPA's as adopted by IUCN at its 17th General Assembly in 1988 (Gubbay, 1995). These requirements include among others, area protection, conservation and sustainable use of the ecosystems and its resources especially in zone A where the areas are protected from the commercial gears – the trawler and the purse seiner (Figure 1).

The use of marine protected areas management has been widely promoted by the Department of Fisheries as a sole 'steward' since the early 80s. Realizing the need to enhance fisheries resources, steps to establish MPA were taken seriously as one of the management tool.

Through the Department of Fisheries Malaysia has been established for more than 100 years, the development of marine parks took place only at the beginning of early 1980's. Due to the inadequacy of the Fisheries Act of 1963, the potential identified water

bodies were first gazetted as the Fisheries Protected Area (1983-1985) before they were regazetted as the Marine Parks of Malaysia in 1994 under the Fisheries Act of 1985.

Establishment of Marine Parks

The first national park in Malaysia was established in 1925 but parks have been limited to mainland terrestrial areas and not include the sea areas. The islands within Peninsular Malaysia have received minimum attention under the National Park Act 1980. The initiative for the conservation of the marine assets in the form to marine park was largely due to the direction of the Prime Minister of Malaysia in 1983. However, the marine park proposal, requirement and management were much earlier as 1975 (Langham, 1976 and Lulofs, 1977). Like many other developing countries, legal and conservation measures have been slow in implementing in Malaysia, resulting in the destruction of potential good sites for marine parks.

In addition to the mentioned marine parks, three state parks (12 islands) in Sabah, one national park in Sarawak (4 islands), and three marine protected areas in Sarawak were gazetted to protect coastal and marine ecosystem.

Objectives of the Marine Park Establishment

The Objectives of the establishment of marine parks in Malaysia are:

1. To afford special protection to the aquatic flora and fauna and to protect, preserve and manage the natural breeding grounds and habitat of aquatic life with particular regards to species of rare or endangered flora and fauna;
2. To allow for the natural regeneration of aquatic life where such life has been depleted;
3. To promote scientific study and research;
4. To preserve and enhance and other undamaged state and productivity of the environment; and
5. To regulate sectional and other to avoid irresistible damage to the environment.

The objectives of the marine research programme is to direct activities to provide baseline information for the development of a management plan, promote education of marine parks and to apply the research knowledge to achieve management plan.

Legislation and Management

In Peninsular Malaysia, marine parks have been administered by the Department of Fisheries, Ministry of Agriculture since 1983, and all the responsibilities for marine parks establishment and management have now been incorporated into the Fisheries Act 1985. The coral reef management in Malaysia is discussed in De Silva (1984), and De Silva and Ridzwan (1983). The state government has jurisdiction over land (including islands) and its resources and foreshore including the waters up to 3 miles from the low water mark. The federal government has jurisdiction over all estuaries and marine living resources. Such jurisdictional division will hamper the concept of integrated marine parks management unless machinery is established in order to allow consultation or joint management on the same interest. The Fisheries Act 1985 covers all aspects of fishing and prohibits the use of dynamite and other destructive fishing methods.

The marine parks are administered by the Department of Fisheries under the Fisheries Act 1985 Part IX-Marine Parks and Marine Reserve (Sections 41-45) (Anon, 1985). As marine parks, the concerned water body is given the statute of no take zone after many years of conflicting uses. The administration of navigation and shipping remains with the Department of Transport, within the framework of regulations established for management of each particular marine park. Accordingly, A Notional Advisory Council on Marine Parks (NACMP) has been established. The council consists of representatives from federal and state governments, non-government organizations (NGO) such as World Wildlife Fund (WWF),

Malayan Nature Society and Malaysian Marine Science Society (Anon, 1993). The NACMP advises the Minister of Agriculture on any matters relating the marine park areas.

To date 40 offshore islands and the surrounding marine waters have been identified and established as marine parks and state parks under the Fisheries Act 1985. These islands are grouped into five marine parks, which located off the coast of Kedah, Terengganu, Pahang, Johor and Labuan (Figure 2).

The establishment of MPAs in Malaysia meets the need to manage and to conserve marine biodiversity as spelled out in the National Policy on the Biological Diversity (NPB). The NPB, which was officiated in 1998 act as a primary document to guide biodiversity conservation effort in the country. Nevertheless, the existence of several policies, legislations and protection of marine resources directly or indirectly, reflect the concern and priority given to sustain the marine resources.

The conservation efforts are made possible through legislations and guidelines that include the Fisheries Act, 1985; Control of Development in the Coastal Zone, 1987; Guidelines on Erosion Control for Development Projects in the Coastal Zone, 1997; National Ecotourism Plan, 1997; and guidelines for development planning in the Coastal Zone; 1997 to mention a few. Furthermore, the Department of Fisheries Malaysia is in the process of formulating a new marine parks regulation. This regulation will encompass a wide range of provision from day to day activities to the regulation of uses and user.

■ ACTIONS TAKEN TO PROTECT THE MARINE RESOURCES

Malaysia's coastline of 4675 km. comprises primarily of mud flat and sandy beaches. Most of the islands support coral reefs. Most of the populations live in the coastal zone, which is also the center of economic activities. The effective implementation of marine resources and environments at the state and federal levels requires a system of laws and an effective institutional mechanism for planning, regulation and enforcement of existing and new developments. Three of these laws that have profoundly influenced marine resources/ environment are the Fisheries Act (1985), the Environmental Quality Act (1985) and the Environmental Impact Assessment Order (1987). Ultimate jurisdiction over marine living resources is with the Department of Fisheries. The Fisheries Act, 1985 covers all aspects of fishing, marine park management, sea turtle conservation, artificial reefs construction and explosive and toxicant fishing methods prohibitions. The Environmental Impacts Assessment (EIA) order, lists development activities such as resort and recreational facilities or clearing of mangrove swamps that require mandatory EIA reports to be submitted for prior approval by the Department of Environment. The government to streamline planning practices has also introduced administrative guidelines.

An integrated management plan for marine parks has been formulated in order to strengthen the management and enforcement within the park. The concept of marine park management in Malaysia is to incorporate zoned areas so that sensitive habitats are protected from destructive activities (Looi, 1993). Zoning in marine park is implemented to keep people out of sensitive, valuable or recuperating and habitats where necessary to limit the impacts of visitors on the resources. The marine park management plan incorporates the following zones;

- Core zone – covers all the coral reef areas. Activities within this zone will be controlled. Collecting and fishing will be prohibited.
- Buffer zone – safeguard areas around the core zones to the core.
- Reserve zone – maintains undamaged wilderness area for retention of a gene pool in this zone.
- Scientific zone – researches pristine areas by ecologically sound techniques
- Preservation zone – closes damaged reef areas for rehabilitation or regeneration of resources.

- Recreational zone – allows controlled recreational activities.

The Department of Fisheries Malaysia is responsible for law enforcement and public safety within the boundaries. Under the Fisheries Act (1985), the rules and regulations had total prohibition against the collection of marine organisms and also prohibition against fishing within the designated areas. Four management and visitor centers have been built which are responsible for management and control of the parks.

■ WHAT NEED TO BE DONE?

The fishery industry in Malaysia situation is by no means typical. Throughout the tropics, human populations are growing and growing at a high rate. However, coral reef and reef fishes are probably reaching critically low levels. A better integrated management plans with better enforcement and interpretation programmes has to be designed. For artificial reefs and marine protected areas to be successful as a tool for coping with the marine resources and environment degradation and depletion, public interpretation, education and awareness about the function and importance of marine environment are needed. Furthermore, more scientific research and study should be encouraged in order to gain knowledge for the development of a better management plan and to resolve management issues. Ehrlich and Dailey, (1993) described and supported the use of science in perceiving the natural resources problem, understanding their mechanism and strategically assessing options for their solution. The following research needs can be identified; scientific evaluation of alternative option for mitigating anthropogenic influences and restoration of habitats, and scientific evaluation of success or failure of management plan and strategies such as marine protected areas, marine parks, fishing zoning, artificial reefs and other marine ecosystems.

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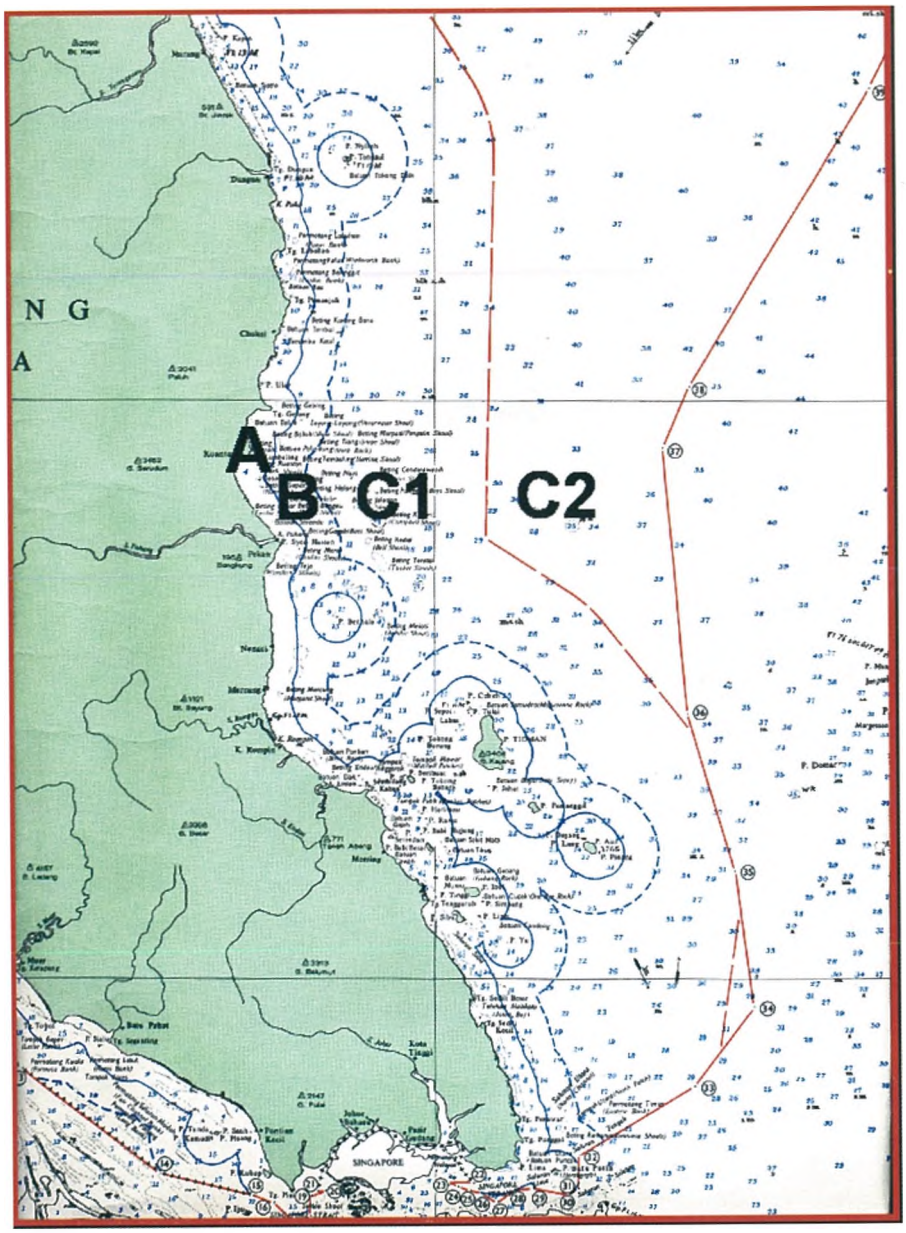

Figure 1. Restricted fishing areas which were defined into four zones (Source; Department of Fisheries Malaysia)

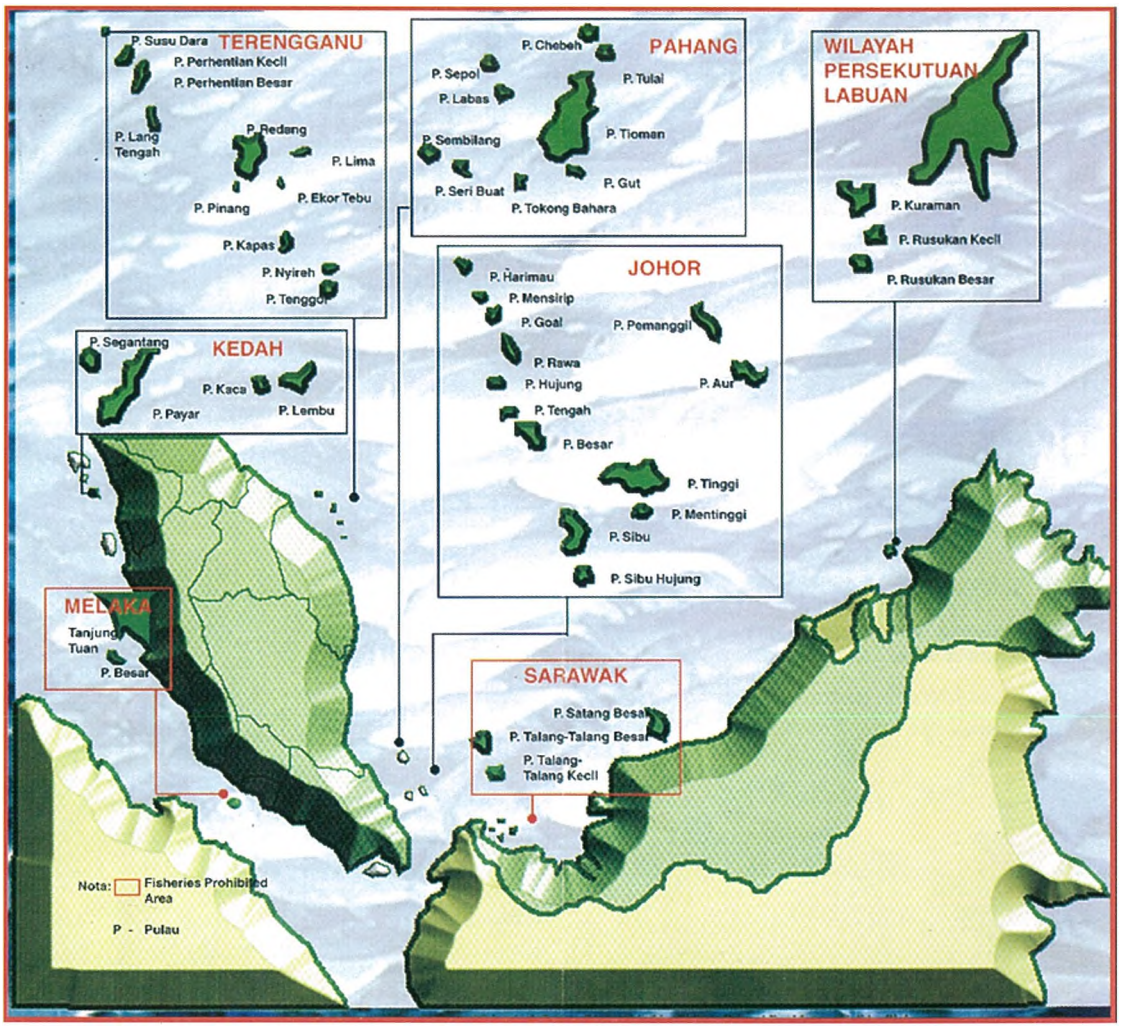

Figure 2. Location of the Marine Parks in Malaysia (Source; Department of Fisheries Malaysia)

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COUNTRY PAPER OF MYANMAR

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■ INTRODUCTION

Small-scale fisheries contribute over 95% to the total national catch. All fishing activities, with the exception of operation carried out by D.O.F. (Myanmar Fisheries Enterprise) are referred to small-scale fishing activities. This report is primarily concerned with marine fisheries, particularly, with the traditional small-scale coastal fisheries. However, frequent references are made to other sectors of fisheries, such as freshwater fisheries and off-shore fisheries in order to put the small-scale sector in a proper perspective.

Fish is an important of the daily protein in take (80%) of the population about (51 million) of Myanmar. The main role of fisheries in Myanmar is provider of food as well as employment. Average annual production for the last 5 years amounts to 763, 720 m .t. In which marine fisheries accounts for 529, 320 m .t (78%) per capita consumption of fish is 18.5 kg (1993-94). The freshwater fisheries provide 22% of the total catch. The consumer preference is still for freshwater fish which causes the high price of this commodity, on the other hand, the marine fish is available at much lower price, it is steadily growing.

Small-scale marine fisheries have great potential for further developments. Inspite of having a considerable levels of increased production from small-scale sectors, investments have been mainly, directed towards the development of industrial fisheries and aquaculture. Even then, investment if these two sectors have not attained a significant increases in the levels of production.

The low productivity of small-scale fisheries in Myanmar is attributed to the use of primitive fishing gears and methods. Priority should be given in the development of boat design, construction, fishing gear and methods. Other factors, associated with the low productivity of his sector is shortage of fishing gears and equipments such as net, rope, twine, engine spear part and fuel. Myanmar still lacks manufacture of fishing equipments within the country, mainly relying on imports. With the manufacture of fishing materials and equipments locally, if sufficiently supply cheaper and higher grade of materials and availabel to fishermen, production could be boost substantially in small-scale castors.

Export product amounted to 96, 740 m .t with the value of US$ 120.6 million was realized during 1994-95. It has upward trend of exporting. The prospect of small-scale fisheries development in Myanmar is certainly bright since the resource potential is available and a huge market waiting on the doorstep because of the big gap between demand and supply of fish in the international markets.

■ STRUCTURE OF FISHERY MANAGEMENT SYSTEM

Ministry of Livestock and Fisheries took the responsibilities for the development of fisheries in Myanmar. There are three Department, one Enterprise and one Beekeeping Division. Two Departments are directly concerned with fisheries. They are Directorate of Livestock and Fisheries Department, and Department of Fisheries.

The Directorate of Livestock and Fisheries is directly responsible to the Minister and co-ordinates, supervises, monitors and evaluates the manual performance of the department and enterprise. This Department also gives advises on formulation of projects and foreign economic relation. Department of Fisheries is responsible for the management of fisheries, conservation of resources, providing extension service, conduction research, and compilation of the national statistics in fisheries.

As the population is booming day by day the exploitation of aquatic resources is naturally getting inters as well. Moreover current high export demand for shrimp prawns and certain species of fish is major course of pressure leading to over investment in fisheries.

In the future the demand for fish will exceed potential supplies creating over exploitation subject to this, effective appropriate management measures are required to promote the objective for optimum utilization of aquatic resources.

Management should be conceived and understood not as a constraint upon national exploitation, but as an essential tool for the sound, sustained development of fisheries. Hence, management of fisheries is an integral part of the development process. There is a need to introduce effective management mechanisms at all stages and particularly at the beginning of fisheries development rather than wait until the effect of over fishing have begun to be felt.

The setting of that objective should be based on assessment of the fishery resources available, existing technology, market to be served, social and economic conditions, the potential impact of other economic activities, and other relevant factors, including foreign operation, where applicable. The objective, it appears, is to provide a legislative framework for a fisheries management system, and to ensure, as far as possible, that both the fishery people and responsible authority concerned perform their roles within that frame work. Thus new impetus has come a new and broader view of the role of law in fisheries management of all renewable natural aquatic resources.

The economy of the Union of Myanmar, under centrally plenned economic system in the part, has been changed into a market-oriented system since 1988. The Government had envisaged such policy objective as exploitation of abundant resources of the country with a view to catering to the needs of the national in the first instance and exporting whatever surplus available. Furthermore the extension of Myanmar Jurisdiction to 200 nautical miles according to UN Convention on Law of the Sea also present a new and unprecedented opportunity to reap the full benefit of the living aquatic resources. At the same time attention has been drawn to the potential roles of inland water fisheries and aquaculture as food supplies within the overall socioeconomic context of national development

In this respect a reassessment of strategies and policies for fisheries development and management from time to time need to take full account of the present and potential contribution from marine fisheries as well as from inland water fisheries and aquaculture.

In order to fulfill the need, the DOF, playing major roles in fishery management, is conducing acquisition and analyzing of information implementation of fishery policy and design and exercising of management measure and the continuous evaluation of management activities.

Obviously, the DOF always conduct the management and conservation of aquatic resources, licensing, surveillance and enforcement of existing fisheries law as its main responsibilities. To render assistance and to support the effort exerted by DOF on fishery management the government has promulgated four fisheries laws, namely.

The law Relating to the Fishing Rights of Foreign Fishing Vessel, Myanmar Marine Fisheries Law, Freshwater Fisheries Law Relating to Aquaculture.

■ FISHERIES RESOURCES

Myanmar has a long coastline that stretches approximately from 21' N to 10' N over a distance of 1,800 km. With its large number of estuaries and islands, a total coastline will be close to 3,000 km. The continental shelf (0-200) depth covers and area of 225.000 km^2

Since the total investments in the marine fisheries sectors were considerable, it was felt that at least the rough estimate of marine fisheries resources should be obtained, so that the risk of over investment and consequent financial failure could be avoided.

With a view to identification of new fishing grounds, stock and efficient means of their exploitation "Marine Fisheries Resources Survey and Exploratory Fishing Project" was carried out with the assistance of F.A.O during 1979-83. Project activities consisted of acoustic/experimental fishing surveys with R.V. Dr. Fridtjof Nansan and trawl surveys with a vessel from Myanmar contribution.

The coast line of Myanmar has been divided into 3 sub-areas to represent main ecological division.

1. The Rakhie (Arakan) coast : Bordering with Bangladesh in the north, a narrow shelf areas, a few islets down to 16.00 Lat. N. (Maw din point)

2. The Areyawady (Irrawaddy) 16.00 Lat. N (Maw din point) area : shelf area between 16.00 and 13.30 'Lat. N Dawei (Tavoy point)

3. The Tanintharyi (Tenasserim) cost : From 13 .30" Lat. To 10 .00' Lat. N, Kawthanung (Victoria point) border with Thailand. This division has been initiated during acoustic surveys

Later, trawl survey also has followed the same division

Estimate of small pelagic fish such as sardine (Nga kone nyo), shub mackerel (pla tu) and herring (zin bya) has been recorded a standing stock of about one million m.t, out of which about half a million m .t was considered a yearly maximum sustainable yield (M.S.Y.). It was found that biomass (standing stock) at pre-monsoon was about twice as high as during post-monsoon season.

Demersal fish resource (Trawling surveys)

The four appraisal surveys of demarsal fish resources were conducted off the Myanmar continental shelf during 1981-83. The results of these trawl surveys are furnished below.

Regarding demersal fish resource, namely, snapper (Nga Parr Ni), thread fin/ Indian salmon (ka ku yan) and croaker (poke thin) their standing stock was about 800,000 m .t from these about 550,000 m .t was exploitable as maximum sustainable yield (M.S.Y). Thus, a total of about 1.05 million m .t could be harvested as yearly (m .s .y) for the whole shelf areas.

Shrimp resources

The most extensive shrimp surveys were conducted with the assistance of O.D.A (U.K) off the Rakhine coastal in 1981-82. An annual standing stock of 4,370 m .t of shrimp was estimated in the surveys area of 14,700 km^3

Although shrimp surveys were also conducted off the Ayeyarwady and Tanintharyi with FAO in 1981-82, the standing stock could not be calculated due to inadequate trawls hauls. Considering Myanmar sea conditions, yield per unit area, an assumption has been made and estamated a standing stock of 4,000 m.t for Ayeyarwady and 5,000 m.t for Tanintharyi, totaling 13,000 m.t of shrimps for all regions.

Hilsa resource

Hilsa is very important pelagic fish resource, contributing to the national economy by small-scale fishermen. It is distributed widely entire coast of Myanmar as well as in the inland waters. The fish takes anadromous migration through the river system, particularly, Ayeyarwady river complex for spawning.

Two species of hilsa are observed namely, in *Tenualosa toil* is common and *Tenualosa ilisha* is mostly countributed in Ayeyarwady and Rakhine areas.

Fishing season off the delta is from September to March, with two peak seasons namely, August and September. The most effective fishing gear for this species is encircling gill nets.

Bombay duck resource

Dried fish is favorite item in the daily diet of Myanmar people. There is a kind of fish, exclusively exploit for making dried fish, called Bombay duck *(Harpodon nehereus)*. According to the record from the previous surveys, conducted in the yeare of 1980, it was known that the estimated standing stock of this single species was 42,000 m.t

Reef fisheries resources

Reef fishery is usually associated with rocky or coralline areas in which nature of topography restricted the use of trawls or drift nets.

Common reef fishes occurring in Myanmar reef waters are snapper, group, sea bream, large size horse mackerel, oyster, sea cucumber, jellyfish, spiny lobster and sea urchin. Standing stock of reef fishery is not known however, there are very good habitat all along the coast.

Crab resource

Crab resource is another potential of Myanmar. Although Myanmar people are not very much prefer crab than fish in old days, crab resources are now become important item in fish trade, because of newly open market economic policy, which was laid down by the Myanmar government in last ten year. The two main species are mud crab (*Scylla serrata*) and sand crab (*Portunus pelagicus*). The main habitat areas for mud crab are mangrove forest in the coastal areas. The crabs are mainly caught by bamboo traps with bait in a depth range of 1 to 3 meters near the mangrove forest. The resource is believed to be substantial.

■ FISHING GEARS

The fishing methods in small scale fisheries comprised of "fixed engine" (i.e. trap and basket) lift nets, stake nets and cast nets in the on-shore fisheries, gill nets, drift nets, small shore-seines, set nets, hooks and cast net in the in-shore fisheries sector. The fishing in the small-scale fisheries have mainly, based on passive fishing techniques, fish being caught by luring or by chance. The most important and active fishing gear is encircling gill nets used for exploiting Hilsa species.

The small-scale fisheries sectors have succeeded to some extent to increasing production due to mechanization of the craft and introduction of synthetic imported fishing nets.

Encircling gill net for hilsa

This fishing gear is only use to exploite hilsa species. The fishing season for hilsa species in the Tanintharyi coastal areas is round about July and inthe in-shore grounds off the Ayeyarwady is from September to March with two peak seasons of rivering spawning migration, August and October.

Large type drife gill net for hilsa

Season for fishing by this fishing gear is from September, October to April, May. Even in off-season about 25% of fishing vessels go out for fishing. These nets operate not only for Hilsa but also for Spanish mackerel and pomfret.

Small gill net for miscellaneous fish

Major species caught by small type of drift net are silver pomfret, Spanish mackerel, thread fin or India salmon, herring, cat fish, horse mackerel, pike conger, rays and sharks. From August to April are the fishing seasons for these gears with the best season in September to November.

Trammel gill net for shrimp

This type of fishing is targeting exclusively for the shrimp in the in-shore fishing grounds. Fishing season is from June to November with the peak seasons August and September; it is associated with shoaling habit of the white shrimp in the rainy season. Since the price of shrimp is higher than fish, the trammel gill net is very popular among the small-scale fishermen and they use to operate throughout the year.

Bottom gill net

This type of fishing is operated in the mid water and at the bottom to catch shark, large size mackerel and thread fin, large size sea bass. This type of fishing gear is very popular around Ayeyarwady delta areas and Nothern Tanintharyi areas.

River gill net

This type of fishing gear is popular along the reverie areas, catching hilsa, croaker and mango fish.

Tiger mouth net (Kyarr pa zat)

There are two types of tiger mouth nets. The small tiger mouth is 45' long with the mouth width of 18'. While in large tiger mouth is 75' long and 21' wide. Small type operate in the rivers and the large types operate in the in-shore area usually (4) miles away from near shore.

Main season of tiger mouth net is from August to April and the best season is October to December. Major fishing areas are off the Ayeyarwady delta and around Myeik archipelago. Species caught by tiger mouth nets consists of small pomfret, ribbon fish and a good quantity of juvenile shrimp and fish.

A good catch of one operation of lager mouth net has tield about 1.5 mt.

Long line fishing

Many fishermen have taken up to long line fishing since the cost of fishing gear is relatively low. It is also very popular along the whole coastal areas of Myanmar.

Fishing season is from October (End of Buddhist lent period) to February. Species caught by this fishing method mainly consist of Indian salmon or threadfin (Ka Ku yan), large croaker (Ka tha Myin), catfish (nga yaung) conger eel (nga shwe) and shark (nga mann) Average catch is 10-30 kg per operation.

■ MANAGEMENT MEASURES

One of the goals of fisheries management is to achieve sustainable coastal fisheries. In order to achieve this goal, various management strategies have been formulated and implemented to control fishing effort and promote rehabilitation and conservation of marine resources and marine ecosystems. These meaures include:

• State and Division-wise direct limitation of fishing effort through proper licensing of the fishing gear and fishing vessels. A person desiring to carry out inshore fishery shall apply for license to the Officer-in charge of the Department of the respective Township in the prescribed application form. THe effectiveness of the fisheries licensing procedure is 1st April to 31st March of next year

• Nursery areas are identified and they have been protected and managed as reserved fishing areas to ensure survival of juveniles of commercially important fish species. These areas have been gazette as closed fishing area for three months (June to August). These are one fishing ground in Rakhine, four fishing grounds in Ayeyarwady, two fishing grounds in the Mon, and three fishing grounds in Tanintharyi region.

• Strict law enforcement on fishing activities in Myanmar's fishery waters, is carried out by a number of department's, namely Myanmar Navy, Myanmar Coast guard, Department of fisheries, Customs Department, and Myanmar Police Force, and these department address the problem of illegal fishing.

• Rehabilitation of resources through the use of artificial reefs and coral replanting program; have not yet been established in Myanmar Coastal zones. Although the conditiion of the Myanmar coastal zones are still in intact and not yet threatened as to establish an artificial reef, the authorities of the Department of the Fisheries has determined to apply artificial reefs in specific area for the conservation and rehabilitation of resources.

Closed are

To conserve the juveniles fish and shrimp to avoide conflate between the artisanal fishermen and the trawler, Rakhine coast five mile from the shore line, For Ayeyarwady and Taninthayi coast ten miles from shore line. The trawler will not allowed to fishing in those areas.

Closed Season

June, July and August, the three months are closed season. That season most of the juveniles come back to the mangrove area (feeding ground). The fishing boats must stoop fishing operation.

Limitation of Mesh Size and License System

As the major portion of marine product came from artisinal fishermen, it is important to fulfill needs of small scale and indigenous fishermen by increasing the income, improving their lives and those of their families, as well as their environment. Accordingly, this zoning of fishing is entirely based on policy of protecting our local fisheries. Under these circumstances the Department of Fisheries gives first priority to local fishermen by permitting them to operate in all aonce. In addition to this and as declared in the Territorial Sea and Maritime Zone Law the waters between the baseline and the coast are reserved entirely for local fishermen.

The rapid increases in demand for quality marine products significantly accelerated momentum on shrimp and other demersal resources exploitation, resulting in resource use conflict and violence between trawlers and small-scale fishermen. To ensure a more equitable exploitation and distribution of resources and to support the sustainability of small scale artisanal fisheries, efforts have been made by DOF by limiting the size and engine power of fishing boats in inshore areas. For effective management and control the DOF also determines the type of fishery, volume of business method of fishing, species of fish permitted to exploit, size of fish, fishing implement and fishing ground and these condition are attached to all fishing license.

Minimum mesh size and minimum catch able size for main economic fish species have been established based on Rule of expansion and protectiono f fishery resources. For instance, the mesh size on fish trawl codends is not allowed smaller than 2.5 inches and 2 inches for the shrimp trawl codends. The large mesh drift net, the minimum mesh size shall be 8 inches and for small mesh drift net are 3.5 inches mesh size.

Prohibition of fishing gear

Under "Law Relating to The Fishing Rights of Foreign Fishing Vessels" and "Myanmar Marine Fisheries Law" and related regulations, fishing gear that is destructive to the environment and the fisheries resources are banned. These gears includes pair trawl fishing, electric fishing, fishing using poisons, chemicals and explosives, push net, Purse seine net less than 1 inch mesh size, for trawl net cod-end mesh size less than 2 inches, trammel gill net for less than 1.5 inches mesh size etc.

■ CONSERVATION OF RESOURCES

Conservation of marine resources has always been the primary concern of the Department. Marine Park and Marine Reserves as well as fisheries protected area have been established under Fisheries Laws, as one of the Department's management measures. This is essential to protect, conserve and manage in perpetuity the marine environment in order that it remains undamaged for future generation. Public awareness of the need to protect the corals and other marine flora and fauna in the waters surrounding the islands off the coast is being promoted to ensure their conservation. Recently, Lampi island of Tanintharyi coast have been gazetted as Marine park and Marine Reserve. The waters around the island area also have been announced as fisheries protected areas, shereby collection of marine fauna and flora is prohibited. Fishing in fisheries protected areas is prohibited unless specifically licensed to do so.

■ REQUIREMENT FOR DEVELOPMENT OF FISHERIES

1. Assess the potential of marine and coastal living resources including under-utilized and unutilized stock and species; develop methodologies and take measures for their conservation and sustainable use; and undertake studies on maximum stustainable yields of different fish species.

2. Encourage research and develop long-term monitoring programmes database and information sharing with international conservation communities for technical and logistic support.

3. Develop and implement strategies for the sustainable use of marine living resources, taking into account the special needs and interests of small-scale artisanal fishermen, local community and indigenous people to meet nutritional and other development needs, integrate small-scale fisheries development in marine and coastal planning taking into account their interest and, where appropriate, encourage representation of fishermen, small-scale fish workers, women, local communities and indigenous people.

For fisheries development augment the national effort to support fisheris development in the country, we need asssistance from international fisheries related agencies such as FAO, NACA, BOBP and SEAFDEC. Apart from the government's in fisheries development, International or regional collaboration is needed in the following areas;

a. assessment of fishery resources

b.development of appropriate technology.

c. training of skilled manpower

d. identification and preparation of projects

e. financing of commercial operation

Region	Surface are Covered mk²	Standing took		Average Standing stock	M.S.Y. m .t
		Pre-monsoon	Post-monsoon		
Rakhine	39,000	170,000	180,000	175,000	87,500
Ayeyawady	118,000	640,000	370,000	505,000	252,500
Tanintharyi	72,000	520,000	70,000	295,000	147,500
Total	229,000	1,330,000	620,000	975,000	487,500

Fig. 1 Pelagic fish resources (Acoustic surveys) Acoustic estimate of total standing stock and M.S.Y on the Myanmar shelf area 1979-80

Region	Depth range (m)	Surface area (km2)	Standing stock		Average Standing	M.S.Y m.t
			Pre-monsoon	Post-monsoon		
Rakhine Coast	0-50	20,130	103,200	240,100	171,650	121,195
"	51-100	14,000	14,000	97,100	55,550	39,222
"	101-200	38,700	38,700	36,600	37,650	26,583
Sub total		72,830	155,900	373,800	264,850	187,000
Ayeyawady	0-50	60,891	276,900	168,700	222,800	158,170
"	51-100	28,592	37,700	61,000	49,350	35,037
"	101,200	15,884	16,500	12,500	14,500	10,293
Sub total		105,367	331,100	242,200	286,650	203,500
Tanintharyi	0-50	31,723	155,600	113,700	134,650	92,036
"	51-100	35,732	97,900	76,200	7,050	59,501
"	101-200	17,246	14,100	9,200	11,650	7,963
Sub total		84,701	267,600	199,100	233,350	159,500
Grand total		262,898	754,600	815,100	784,850	550,000

Fig. 2 The results of trawl surveys were conducted off the Myanmar continental shelf

CORAL GARDEN & REEF REHABILITATION PROJECT, THE ESTABLISHMENT OF MARINE RESERVES AND FISH SANTUARIES OF THE BUREAU OF FISHERIES AND AQUATIC RESOURCES (BFAR) IN THE PHILIPPINES

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ABSTRACT

The vastness of the Philippine waters provides significant supply of food and protein as well as opportunities for development for commercial and municipal fisheries. The utilization of such immense marine resource should be geared along sustainability not only for survival, but also to the country's increasing population, environmental degradation, and the state's commitment to the Global competitiveness archetype. The establishment of non-fishing areas in marine protected areas would double fish catch in 5 years (Roberts, 2002).

■ INTRODUCTION

The Philippines Marine Resources envelops a total area of 220,000 hectares (including the Exclusive Economic Zone), consisting of 193,400,000 hectares of oceanic or off-shore waters, and 27, 000 sq. km. of coral reef areas. At present, destructive/illegal fishing, pollution, sedimentation and other anthropogenic activities mainly cause the destruction and depletion of the coral reefs. 476,900 metric tons valued at P 13.3 billion are lost from illegal fishing activities every year such as poaching by foreign fishing vessels which resulted to the loss of around 80,000 metric tons of fish and other aquatic products valued at P 2.23 billion and coral reef destruction of 396,900 metric tons valued at P11.07 billion pesos. To date, only 4 percent of the coral reefs in the Philippines remain in excellent condition and 70 percent of which are at high risk from human activities. On the other hand, worldwide concern has been raised in order to save, manage, and protect the fast diminishing coral reef resource.

The Bureau of Fisheries and Aquatic Resources (BFAR) launched an innovative coral reef management and regeneration program: The Coral Gardening and Reef Rehabilitation Project in Tangalan, Aklan, the initial implementing strategy for sustainable fisheries management. The Program seeks to promote alternative livelihood to reduce community pressure on the reefs through "green" coral aquaculture. The BFAR with the LGU of Tangalan, Akalan has identified and delineated the 10 ha. site/area for the said coral rehabilitation and marine resource conservation and protection project. In addition to the 13 identified sites of the NFARMC (National Fisheries and Aquatic Resource Management Council), the BFAR-CO has identified 26 sites from ARMM (Autonomous Region of Muslim Mindanao) and 21 from BFAR-RFO 2. Overall, 60 sites/ areas has been identified which needs prioritization and assessment as basis for introducing management interventions. To date, over 400 marine reserves and fish sanctuaries have been established all over the country with a total area of 8,313.90 has.

■ SIGNIFICANCE OF THE PROJECT

The Nationwide implementation of the establishment of Marine reserves and sanctuaries will protect the coral reefs from further degradation and destruction due to illegal and destructive fishing activities, pollution, sedimentation and human activities. Coastal and Municipal Fisheries has declined its production, from a peak of 1,070,195 (million) m.t. in 1988 to only 924,466 (33.4%) m.t. in 1997. Furthermore, 476,900 metric tons

valued at P 13.31 Billion pesos are lost to illegal fishing activities. This is broken down as follows: poaching by foreign fishing vessels at 80,000 metric tons valued at 2.23 Billion pesos; and coral reef destruction due to blast and cyanide fishing at 396,900 metric tons valued at P 11.07 Billion pesos.

"Coral Garden and Reef Rehabilitation Project of the BFAR"

The BFAR SCUBA Divers Task Force in cooperation with the LGU of Tangalan, Aklan, and the BFAR-NMFDC launched the First of its kind ***Coral Garden and Reef Rehabilitation Project*** to rehabilitate, manage and protect the said Coral Reef by establishing a Marine Reserve and deploy ARs in the said Municipality which, upon its successful implementation shall be intended in other priority areas.

A survey conducted by the BFAR SCUBA Divers Task Force yielded 12.09% of live corals in Puntod reef is (table 1), an alarming decline compared to the previous survey conducted by SEAFDEC (1998), which registered 58.4% live coral cover. Furthermore, dead corals registered at 27.62, a distressing increase compared to 12.8% as recorded by SEAFDEC (1998).

Table 1. Percent Cover of Major Benthic Lifeform Categories in Puntod Reef, Tangalan, Aklan

Lifeform Categories	Percent Cover (%)
Live Corals	12.09
Dead Corals	27.62
Algae	1.545
Other Fauna	8.287
Abiotics	50.43

The grim scenario of the coral reef of Tangalan, Aklan calls for immediate intervention. The rapid rate of destruction/degradation will ultimately wipe out the coral reefs by the time the year-ends.

The BFAR SCUBA Divers Task Force, Tangalan, Aklan LGU, and the BFAR-NMFDC is charged to rehabilitate, manage and protect the said Coral Reef by establishing a Marine Reserve and deploy ARs in the said site in Brgy. Jawili, Tangalan, Aklan.

Another Twelve (12) sites all over the country have also been identified by the BFAR that needs immediate intervention. The alarming rate of decline and diminishing of fish caught and coral reef species respectively has raised the concern of both the stakeholders and LGUs of the provinces and municipalities but such undertakings though a priority concern on resource conservation and management are at stake in view of the absence of funding requirements, hence the need for grants in aid to support its successful implementation.

■ OBJECTIVES:

General

1. To conserve and initiate the rehabilitation of damaged reefs in the fish sanctuary in the Philippines initially in Puntod Reef, Tangalan, Aklan
2. To uplift the standard of living conditions of the fisherfolk in the local fishing communities

Specific Objectives

1. To concentrate marine organisms to allow for more efficient but selective and regulated fishing activities
2. To protect small/juvenile organisms and nursery areas from destructive fishing activities
3. Increase the natural productivity eventually by supplying new habitats for sessile or permanently attached organisms and by allowing the establishment of an associated food chain
4. To create habitats and stimulate natural reefs for desired target species
5. Restore dead or degraded coral reefs
6. Generate income through tourism
7. To educate the primary stakeholders in the local fishing communities in Tangalan, Aklan about coral reef conservation and rehabilitation and build their capabilities to monitor and manage their coral reef resources.

■ DESCRIPTION OF THE PROJECT

The Bureau of Fisheries and Aquatic Resources (BFAR) has formed and organized the BFAR SCUBA Divers Task Force with a primary purpose to monitor, manage, safeguard the Coral Reef Resources of the Philippines and to establish Marine Reserves and Fish Sanctuaries. Initially it will implement the Coral Garden and Reef Rehabilitation Project in Tangalan, Aklan to be followed by other areas upon availability of funding and technical support to pursue said activities. The components of the Project are as follows:

Artificial Reefs

Fifty (50) modules or eight hundred (800) of concrete building blocks (1 module=16 units, 2m x 0.20m x 0.15m) will serve as artificial reefs. The artificial reefs will be installed/sited within the marine park/ sanctuaries. The installation will be conducted on fine weather condition; water current is moderate, and good visibility.

1. An ocular survey was conducted to identify suitable/viable sites/area for the installation of Artificial Reef modules/units. The Manta Tow method was utilized in the survey to facilitate a fast and reliable assessment of the reef.

2. The Identified site will be marked with buoys based on the recorded coordinates in the initial survey conducted last Aug. 2-8, 2002.

3. The total area of the proposed LGU marine sanctuary is 370 hectare and is 5.13 kilometers from Casa Blanca, Brgy. Jawili, Tangalan, Aklan. Furthermore, the proposed BFAR Coral Garden has a total area of 15.36 ha. and lies in Puntod-Tungod reef (11? 49.00 N, 122? 16.30 E). Visibility is relatively good and adequate sunlight penetrates to the bottom in all parts of the reef. It was observed though, that a strong surface current surges in the later part of the day.

Coral Fragmentation

The one-square meter quadrant shall be the basic experimental unit because it is retractable and because ecological processes taking place on this scale can be readily interpreted using human scales of perception. It is also easy to replicate.

1. At least three (3) colonies of coral species will be transplanted to each experimental unit. The particular species to be used will depend on what is available for surrounding reef patches. Colonies form different species will be randomly within each experimental unit.

2. Coral Fragments (will be introduced into selected sites by transporting them in well-aerated water filled containers on-board a banca. Whenever possible, whole colonies rather portions of colonies, will be used. These will be attached to a firm substrate by cement or by tying with plastic coated wires.

Colonies harboring obvious signs of disease will not be transplanted

3. Growth and survival of the fragments will be assessed periodically (once in every 4 months)

4. Survival will be assessed by counting the nos. of remaining healthy coral colonies and dividing the nos. by the original nos. of coral colonies at the start of the experiment

5. Recruitment of reef fishes and other invertebrates into the patches created by the coral transplants will also be observed

6. Indicators/criteria of success in rehabilitation efforts with the proposed project will be:

6.1 Survival and significant growth of the transplanted coral colonies

6.2 Absence of damage to the source patches from which coral transplants are obtained

6.3 Significant enhancement of the diversity and abundance of fish and other invertebrates

Site Selection

The selection of the proposed coral garden site/area were based on the following criteria:

1. At least 500m away from natural reefs

2. Near an alternative food source (i.e. sea grass beds)

3. Constructed on a barren and stable substrate area of flat or gently sloping bottom of relatively good visibility.

4. At depths of 15m to 25m, protected form wave action but still accessible to local fishermen.

5. If coastal management project is already on going, or if site is a successful marine protected area

6. Absence of sources of chronic damage to reefs. Otherwise, reef rehabilitation will not succeed.

7. Relatively protected from wave action

8. Deployment of Artificial reefs (AR's) may be considered in areas where there is no stable substrate available

9. Accessible and manageable to the fisherfolk/stakeholders

Survey and Assessment

A survey of the proposed site will be conducted using the Line Intercept Transect Method (LIT). This will determine the condition/status of the marine benthos communities (English et. al. 1997). Furthermore, the results of the survey will help stakeholders determine the appropriate actions and formulate ordinances, guidelines, etc. in the protection, management, and conservation of the marine sanctuaries and MPAs with the recommendation of the BFAR. In addition, a global positioning system (GPS) will be used to identify and delineate the proposed areas. The BFAR SCUBA Divers Task Force is charged to undertake such duty as well as the trained NGOs.

Marine Researves and Fish Sanctuaries

Fisheries of all kinds in the country are near or have surpassed sustainable levels of catch. Most of the over-fished are high-value fishes and the volume and economic importance of such are declining. In some cases where fish catch volume is high, composition has changed to a lower-value of catch because of the changes in the ecological make-up of fishery. The BFAR and the Local Government units have deemed it important to establish marine reserves and fish sanctuaries to rehabilitate, regenerate, manage and protect the remaining fishery and marine resources.

Site Selection

" Provided however, that in the Municipal waters, the concerned LGU in consultation with the FARMCs may establish fishery refuge and sanctuaries: The FARMCs may also recommend fishery refuge and sanctuaries: Provided, further, that at least fifteen percent (15%)where applicable of the total coastal areas in each municipality shall be identified, based on the best available scientific data and in consultation with the Department, and automatically designated as fish sanctuaries by the LGUs in consultation with the concerned FARMCs"

Section of R.A. 8550 otherwise known as **"The Fisheries Philippine Fisheries Code of 1998"**

Social Criteria

1. Site should be identified/ recommended by the communityt/FARMC/ LGU as validated/assessed by the DA-BFAR office to facilitate a well coordinated and fully supported by the fisherfolk/stakeholders

2. Should be accessible and manageable to the community

3. Existing Fisherfolk Organizations, B/MFARMCs and active involvement of the LGUs in the proposed site

Ecological Criteria

1. Preferably the proposed site site has mangrove stands, seagrass beds, or corals of no less than twenty percent (20%) live hard coral cover and drop off of slope no less than twenty-two degrees (20^{o})

2. Should be away from river banks, creek, ports, shipyard landing or grounding area of boats and run-off of no less than (2) kilometers

3. Should be away from fish corrals and other fixed structures and the like; fishing gears of no less than (2) kilometer distance

4. Presence of endangered or threatened species in the porposed site is preferable

5. The site should be diversified with no less than thirty (30) species of fish, 15 families and 550 individuals per 500 sq. m

6. Should have a good water quality free from *E. coli,* heavy metals and other pollutants with horizontal visibility of no less than seven (7) meters.

7. Water depth should be from zero to no more than two hundred (200) meters

Economic Criteria

1. Should be outside the duly designated navigational lanes and not a landing or docking area

2. Abutting and adjacent land area should not be classified as industrial zone.

An area (10 ha.) with heavily depleted demersal/benthic fish stocks, coral, and coral reef species will be delineated using a Global Positioning System (GPS). Local Government Units (LGUs) will be encouraged to formulate Municipal Ordinances with the BFAR recommendation and technical assistance to enact and strengthen the protection, conservation and management of the Marine Sanctuary.

Marker buoys will be installed to delineate the identified sites for the proposed marine reserves and sanctuaries. Fifty (50) units of marker buoys (30 cm diameter, orange sphere, 8 mm thick) will be used.

■ EDUCATIONAL CAMPAIGN

Educational campaigns on coral reef conservation, management, and protection as well as the management of the marine reserves/sanctuaries will be the main topics/ subject in the said campaign. These seminars/ trainings will be conducted with the stakeholders and LGUs based from the identified sites/areas by the BFAR. In addition, issues on coastal resource management will also be tackled.

■ FLOATING LABORATORY

The Laboratory is vital in the conduct of research and coral transportation on site. The Laboratory is designed for "mobility," a working area for coral transportation and propagation, a guardhouse and a diving platform.

■ LABORATORY

The Construction of a 50 sq. m. Laboratory with coral nursery tanks is fundamental in the research, conduct of experiments, and propagation of corals. The Laboratory construction includes 12 aerated tanks for coral acclimatization and propagation.

■ SERVICE BOATS

A 25-ft multi purpose boat, equipped with navigational equipments and GPS will be used in the transport of coral fragments for transplantation, monitoring, and SCUBA Diving activities.

■ ALTERNATIVE LIVELIHOOD PROJECTS

6 units of 4m x 5m fish cage will be provided for fisherfolk displaced from their fishing ground as a consequence in the establishment of marine reserves/sanctuaries and the coral rehabilitation project. Seminar and hands-on training on the culture of high-value fish produce will be provided for by the BFAR. Revenues from this endeavor will be shared by the affected fisherfolk.

■ OTHER PORPOSED PROJECT SITES

Out of the 60 sites identified, hereunder are the 12 priority sites based on the recommendation of the NFARMC and the BFAR-RFOs. The fisherfolk and LGUs who are willing to support the projects and those areas not covered by the Fisheries Resource Management Project (FRMP) but needs funding assistance for implemetation in the near future.

Province	Municipality
1. Aparri	
2. Bataan	Mariveles, Samal
3. Bulacan	
4. Catanduanes	
5. Guimaras	Buenavista
6. Antique	Semirara
7. Cebu	Daanbantayan
8. Southern Leyte	Quatro Islas
9. Zamboanga del Norte	
10. Cagayan	Rizal, Sibuco
11. Camiguin (Reg. IX)	Baguio Pt., Camiguin
12. Sarangani (Cotabato City)	San Vicente, Sumnanga Minanga, Maligay

SET NET FISHERY
(LAMBAKLAD)

Alma C. Dickson, Pierre Easter L. Velasco
Bureau of Fisheries and Aquatic Resources, Philippines

■ DESCRIPTION

Philippines, like Japan is an archipelago endowed with numerous bays, gulfs and coves that are essential requisites for set nets. The set net is a typical "passive" gear in contrast to such an aggressive or active type of fishing gear such as trawl and boat seines.

One of the most feasible type of set net is the Lambaklad. Lambaklad is a Japanese (Otoshi-Ami) type of set net that consists of several parts, namely: the bag, the slope (outer and inner), the playground and the leader. Each of these parts has its own role in trapping the fish. The leader blocks the path of the school of migratory fish that lead them to the playground. From the playground, fish enters the outer slope by means of the pointer nettings. As the fish passes through the slope, it enters the inner slope or non-return valve dropping into the bag where they are trapped and hauled for the catch. This design effectively confines fish and enables hauling only in a small box chamber to harvest them. This is the major category of set net which is popularly used today in Japan and encounters proliferation in the Philippines. *Otoshi*, a Japanese word means trapping down and *Ami* means a net.

Lambaklad is considered as one of the most viable and durable fishing methods used for catching first class highly migratory fishes such as tuna and tuna-like species i.e. yellow fin, skipjack, marlin, Spanish mackerel, caranx sp., crevalle and other migratory fishes. Its fishing operation is very economical and not fuel-consuming. It is a passive and seasonal gear due to the effect of monsoon wind. Likewise, the net could be removed at sea during unfavorable weather condition especially during typhoon months.

This gear is set in the strategic coastal areas, which are considered migration paths of pelagic fishes. They are set in coves and in bays preferably in areas where there are moderate currents and observed as feeding ground of migrating species. It could be set from 20 to 45 meters deep. The life span of the fishing materials will last for 5 to 7 years.

The environment to support set net (Lambaklad) is unique not only in the Philippines and Japan, where it originated but must also be available all over the world. ***Hence, there is no reason that the techical transfer for Lambaklad fishery is doubtful in other countries***. Since set net fishing mainly depends on environmental factors, the technology is applicable in waters wherever the situation is favorable to develop in many parts of coastal waters over the world.

■ ADVANTAGES OF A LAMBAKLAD

Lambaklad have some advantages compared to other types of fishing gear. The following are the advantages:

1. Passive type of gear : the gear is stationary and is anchored at the bottom. It is a "wait and see" type of fishery operated to catch only incoming fishes.
2. Good Quality of Catch : can be preserved in the net for a number of days waiting for good market price as being alive and fresh and near to the market.
3. Durable life of materials : incresed life span of the gear due to the advent of synthetic materials from jute.
4. Seedlings for Aquaculture : fishes caught alive could be reared in tanks, cages and ponds e.g. yellow tail, red sesa bream, etc. for marine fish cultivation.

5. Shorter Working Time : fishermen can attend to other businesses after 2-3 hours of hauling in a day and with the mechanization of the boat, the working time and labor cost is reduced.

6. Less Fuel Consumption : as compared to trawl and other types of fishing gear, fishermen do not go too far from shore to scout a school of fish.

7. Preserves the Marine Resources : being a selective and passive gear, it can only fish coming to it with much less possibility of overfishing.

■ AREAS OF OPERATION

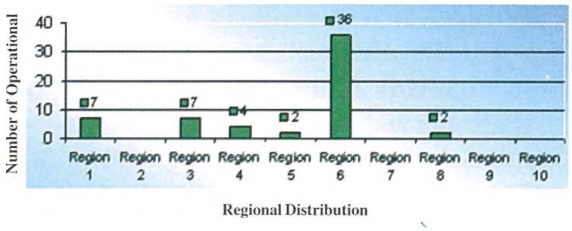

Fig. 1 Status of Operational Lambaklad Projects in the Philippines

There are fifty-four (58) lambaklad units presently operating in all regions (Figure 1) of the Philippines. It is broken down of as follows: Antique 19 units; Aklan 17 units; Camarines Province 2 units; Ilocos Province 7 units; Leyte - units; Mindoro - units and Zambales 7 units.

■ ON-GOING LAMBAKLAD CONSTRUCTION

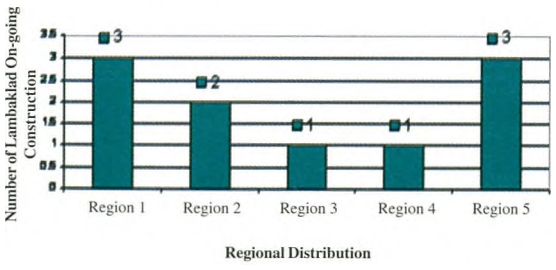

Fig. 2 Regional Distribution of Lambaklad on-going Construction

Figure 2 shows that in a total of ten that are on-going construction, three are done at Regions 1 and 6, two are at Region 5 and one each for Regions 4 and 5. It is expected that this number of Lambaklad undergoing construction will grow due to enormous requests from different Regional Offices nationawide for Lambaklad Project.

■ AREAS SURVEYED/PROPOSED SITES

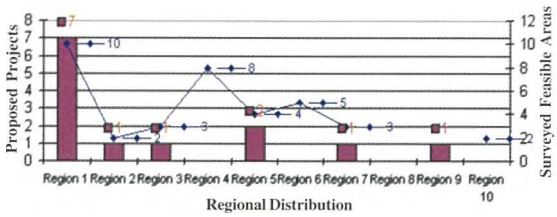

Fig. 3 Lambaklad Data on surveyed Sites and Surveyed Feasible Areas

Figure 3 shows the data on the regional distribution of Proposed Projects and the actual Surveyed Feasible Areas in the Philippine. Furtheremore, it shows that among the proposed seven (7) projects at Region 1, ten (10) areas were found out to be feasible while one (1) proposed project at region 2 and 2 sites were found out to be feasible.

It is interesting to note that no project was propsed in regions IV and VI but were found out to have eight (8) and five (5) surveyed feasible areas respectively.

To date, there are eleven (11) proposed projects while 35 areas in the Philippines were found out feasible.

■ IMPORTANCE/BENEFITS

Economic Benefits

The implementation of the project will introduce a community-based livelihood program, the direct beneficiaries of which are the residents of the area. The lambaklad net fishing will provide regular source of extra

income and additional employment opportunities to the fisherfolks. Better quality of local fish supply will increase with lesser lives' risk considering that it is a coastal type of fishing. Increase trade with other communities and other economic activities will generate more revenue to the community and the government.

Social Benefits

Cooperative participation in the conceptualization of the project is recognized and highly encouraged. Dialogue is conducted with the representative from the cooperative with the local residents to final solution of the proposed project site. It is also through this dialogue that the fishemen encourage to a cooperative to push with the project.

Fisherfolks/Cooperative and Fishermen Association are integrated of the project. Their direct and active participation in the project is imperative to insure availability as envisioned that through direct technology transfer and management training fisherfolks cooperators, the project will be replicated in the future.

As development effect, the quality of life of the fisherfolk organization will improve. Being a community-based project, their involvement and participation in the cooperative effort will be heightened. The cooperative will thus be strengthened. Its capability will be increased and more services will be rendered for more community development endeavors.

Environment Aspect

The introduction of a new, efficient and environment-friendly fishing method shall boost production and will eventually provide an alternative measure against illegal and highly destructive fishing methods such as dynamite and cyanide poisoning. The set net (lambaklad) being stationary will serve as buffer or fence against incursion of large commercial fishing vessels in the municipal waters. The fisherfolks cooperators will naturally act as protectors in the nearby vicinity of the project so as to ensure viability and sustainability of their livelihood. Marine resources will be protected and will be regenerated. The gear also helps in conserving fishes thus serving as sanctuary for small and juvenile species.

■ INVESTMENT/INCOME

Investments (Depth: 25 meters)

A. Materials and Equipments/Labor	**P 1,280,437.90**
- one set of otoshi-ami (complete)	812,798.00
- two units of woodenhauling boat	80,000.00
- two units service boat (outriggered)	100,000.00
- two units o steel buoy (rectangular)	80,000.00
- one unit Fishermen Quarter	60,000.00
B. Labor	
- Hiring of 18 skilled net menders at P 170.00/day for 30 days construction	91,000.00
- Hiring of technical supervisor in the Survey site, gear designing and Construction and installation 5%	56,639.90
C. Operating Expenses	**P 280,559.60**
- Fuel and Lube-oil	10,000.00
- Repair and maintenance	15,000.00
- Municipal Permit	15,000.00
- Annual depreciation	226,559.60
- Fish Handling	14,000.00
D. Estimated Gross Income (8 monts)	**P 1,260,000.00**
- Average catch/day 100 kgs. At P60.00/kg. For 210 days (fishing operation)	
E. Estimated Net Income	**P 979,440.40**
- 65% institutional share	636,636.26
- 35% Fishermen share	342,804.14

F. Return of Investment

$$\textbf{R.O.I.} = \frac{\text{Net Return}}{\text{Investments}} \times 100 = \frac{636{,}636.26}{1{,}280{,}437.90} \times 100 = \mathbf{49.72\%}$$

$$\textbf{Payback Period} = \frac{\text{Investment}}{\text{Institutional share}} = \frac{1{,}280{,}437.90}{636{,}636.26} = \mathbf{2\ years}$$

EXPERIENCES FROM OTHER AREAS

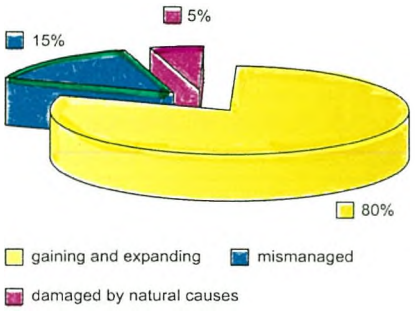

Fig 4. Over all evaluation on Lambaklad Operators in 1995

Figure 4 shows the over-all evaluation on Lambaklad Operators in 1995. It was found out that 80% of the total installed projects were gaining and expanding, 15% are mismanaged and 5% are damaged by natural calamities. As a recent development, Lambaklad units can now be installed facing an open sea such as South China Sea as experience in the Ilocos Region and Zambales Coast.

Through the monitoring of BFAR with regards to the operation and production of lambaklad projects thus having an average yield of 200 kgs. per day. In other observation, payback period takes five (5) months of operation, having a maximum production of 25 tons per day in Antique; 14 tons/day in Zambales; 13 tons/day in Aklan; 6 tons/day in Vigan. For an over-all evaluation in 1995 on Lambaklad operators.

RECOMMENDATIONS

1. Technology transfer on this field of Fishing Industry must be encourage and intensified.

2. Continuous dissemination of information and educate the lambaklad beneficiaries.

3. Scientific studies should be conducte in future development of the Lambaklad fishery industry.

4. The optimistic matterialization of proportainately large capital for Lambaklad investment will stimulate new projects by investors to boost the Lambaklad fishing business. Therefore, it is strongly recommended that soft expanded loans be liberalized. Flexible loan programs should be sustained by the goverment to go hand in hand with technology and ecological policies.

Table 1. Criteria applied to decide dimensions of various positions of Set net.

FIG.	POSITIONS	*CRITERIA TO DECIDE DIMENSIONS*
A	Front entrance width	1.0 ~ 2.0 (1.5 in average) x water depth, W.
B	Back entrance width	0 ~ 100% (50 ~ 60% in average) of the front entrance width, A, or may have no back entrance.
C	Buffer stop panel	Its length is equivalent to a sum of the widths of front entrance, A and back entrance, B.
D	Entrance flap length	30 ~ 40% (1/3 in average) of breadth of net, H.
E	Entrance flap opening (width between off- shore ends of entrance flaps)	70~85 of the entrance width, A+B.
F	Playground side panel	The length is 0.8~1.8 (0.9 in average) x W.
G	End stopper panel of playground	The length is 0.6~1.3 (0.8 in average) x W.
H	Breadth of net	0.9~2.2 (1.5 in average) x W, being narrow in a deep fishing ground and broad, in shallow
I	Waist of net (intermediate breadth at the end of panel of box chamber)	0.6~1.4 (1.0 in average) x W
J	Outer slope funnel	The length is 1.2 ~ 1.9 (1.5 in average of 20 degrees)
K	Incline of outer slope funnel (angle between funnel floor and seabed)	12~25 degrees with an average of 20 degrees.
L	Hauling section (width of slope funnel at end panel of box chamber)	The width is 0.6~0.8 the waist of net, I, basically.
M	Inner slope funnel	The length is 0.8 x width between outer slope funnel ends, L, or 1/3 of the length of box trap chamber
N	Height of slope funnel floor at the waist.	0.3~0.7 (0.5 in average) x W
O	Distance between base floats and end stopper panel	0.5 x W basically or relatively constant to be 20~30 m.
P	Box Chamber	The length is 1.1~3.3 (2.0 in average) x W. It could be as long as 3.0 x W in strong current fishing ground.
Q	Bunt end	The length is the same as that of the net hauling boat.

A: Front Entrance
B: Back Entrance
C: Buffer Stop Panel
D: Entrance Flap
E: Entrance Flap Width
F: Off-shore side Panel
G: End Stopper Panel
H: Breadth of Net
I: Waist of Net
J: Outer Slope Funnel
K: Incline of Outer Slope Funnel
L: Outer Slope Funnel
M: Inner Slope Funnel
N: Height of Slope Funnel Floor at the Waist
O: Distance between Base Floats and End Stopper Panel
P: Box Chamber
Q: Bunt End
R: King Base Float
S: Van Base Float
W: Water Depth

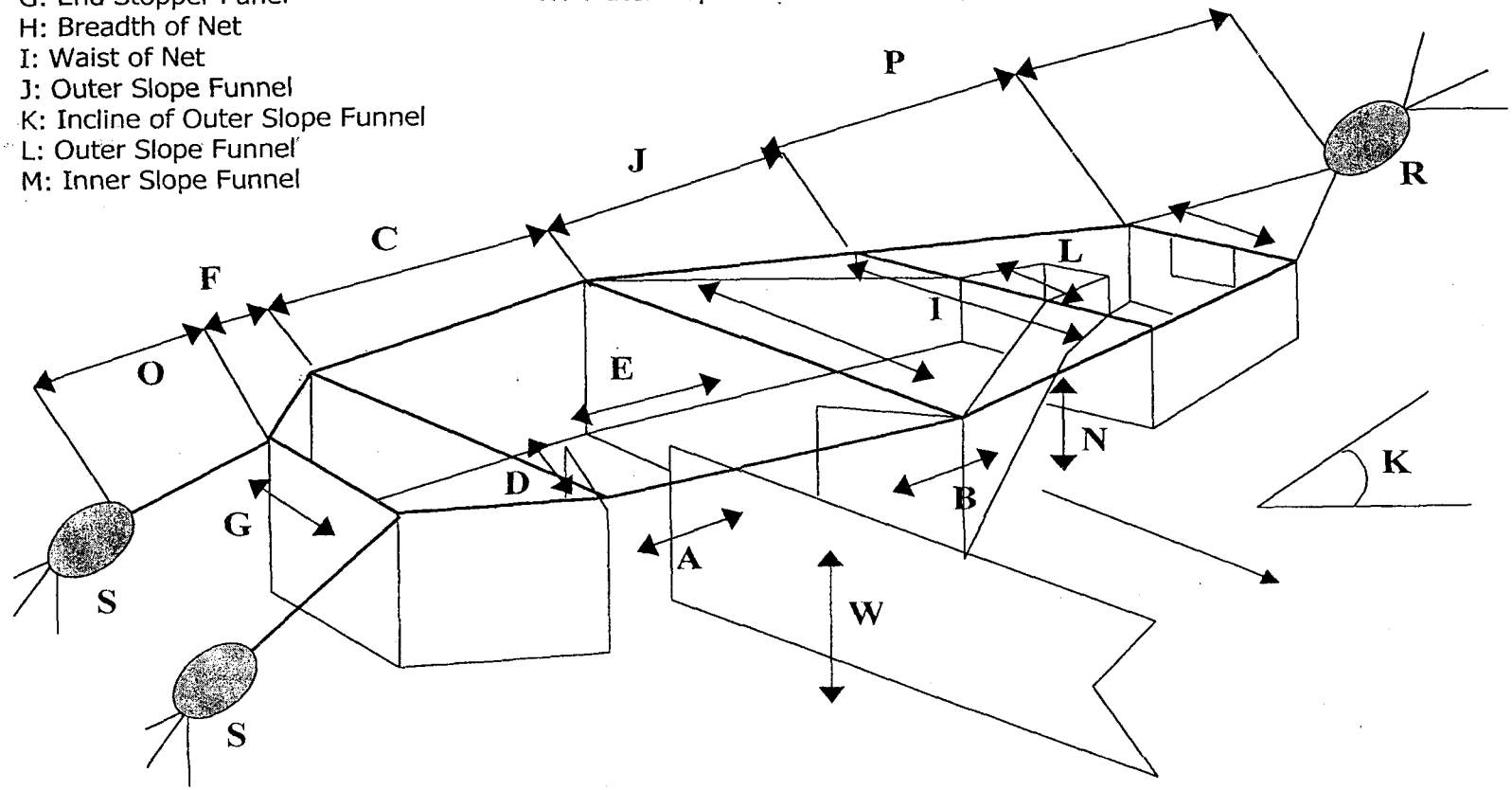

Figure 5) Names of the Parts of Set Net, *Otoshi- Ami*

ESTIMATED BILL OF MATERIALS FOR 30 METERS DEEP SET NET

1. Nettings: (200 MD x 100 m B/R PA)

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
210/ 36 X 11 K	Bale	1	30,763.20	30,763.20
210/ 36 X 7 K	Bales	6	24,629.80	147,778.80
210/ 36 X 5 K	Bales	7	29,770.00	208,390.00
210/ 36 X 4 K	Bales	5		
210/ 45 X 3 K	Bales	4	28,431.00	113,724.00
210/ 45 X 2 K	Bales	4	29,770.00	119,080.00
SUB- TOTAL				***619,736.00***

2. Ropes (medium Laid, PP) 220 meters

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
40 mm	rolls	2	13,260.00	26,520.00
30 mm	rolls	3	10,774.00	32,322.00
24 mm	rolls	18	5,024.00	90,432.00
18 mm	rolls	10	3,465.00	34,650.00
14 mm	rolls	12	1,787.50	21,450.00
7 mm	rolls	80	487.00	38,960.00
SUB- TOTAL				***244,334.00***

3. Knitting Twine (PA br)

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
210/36	spools	50	123.50	6,175.00
210/42	spools	30	123.50	3,705.00
210/45	spools	20	123.50	2,470.00
SUB- TOTAL				***12,350.00***

4. Floats and Sinkers

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
Y- 80	pcs.	70	117.00	8,190.00
Y- 30	pcs.	150	53.00	7,950.00
Plastic Floats 15" dia	pcs.	150	715.00	107,250.00
#8 pb (50 kgs. / box)	box	8	1,885.00	15,080.00
Stone/ Boulders	tons	80		
SUB- TOTAL				***138,470.00***

5. Accessories

Flatboat				
24' x 4' x 2'	unit	2	32,500.00	65,000.00
Main Buoy				
8' x 4' x 2'	unit	2	30,000.00	60,000.00
Pump Boat	unit	1	100,000.00	100,000.00
16 HP Engine		1	65,000.00	65,000.00
Fishermen's Quarter	unit	1	60,000.00	60,000.00
SUB- TOTAL				***350,000.00***

Labor Cost: 30 % of the Materials and Equipments **374253.06**

Allowance for Contingencies: 10 % **124751.02**

ESTIMATED BILL OF MATERIALS FOR 35 METERS DEEP SET NET

1. Nettings: (200 MD x 100 m B/R PA)

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
210/ 36 X 11 K	Bale	1	30,763.20	30,763.20
210/ 36 X 7 K	Bales	5	24,629.80	123,149.00
210/ 36 X 5 K	Bales	7	29,770.00	208,390.00
210/ 45 X 3 K	Bales	7	28,431.00	199,017.00
210/ 45 X 2 K	Bales	4	29,770.00	119,080.00
SUB- TOTAL				***680,399.20***

2. Ropes (medium Laid, PP) 220 meters

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
40 mm	rolls	1	13,260.00	13,260.00
36 mm	rolls	3	10,774.00	32,322.00
24 mm	rolls	16	5,024.00	80,384.00
14 mm	rolls	12	1,787.50	21,450.00
7 mm	rolls	60	487.00	29,220.00
4 mm	rolls	20	280.00	5,600.00
SUB- TOTAL				***182,236.00***

3. Knitting Twine (PA br)

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
210/36	spools	50	123.50	6,175.00
210/45	spools	30	123.50	3,705.00
SUB- TOTAL				***9,880.00***

4. Floats

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
Y- 80	pcs.	70	117.00	8,190.00
Y- 30	pcs.	130	53.00	6,890.00
Synthetic Float	pcs.	130	715.00	92,950.00
#8 pb (50 kgs. / box)	box	9	1,885.00	16,965.00
SUB- TOTAL				***124,995.00***

5. Accessories

Flatboat				
24' x 4' x 2'	unit	2	32,500.00	65,000.00
Main Buoy				
8' x 4' x 2'	unit	2	30,000.00	60,000.00
One unit Pump Boat				
16 HP Engine		1	65,000.00	65,000.00
Fishermen's Quarter	unit	1	60,000.00	60,000.00
SUB- TOTAL				***250,000.00***

Labor Cost: 30 % of the Materials and Equipments **374253.06**

Allowance for Contingencies: 10 % **124751.02**

GRAND TOTAL 1,746,514.28

ARTIFICIAL REEFS & MARINE RE-STOCKING EFFORTS IN SINGAPORE

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■ INTRODUCTION

The Republic of Singapore consists of a main island and over 60 small offshore islands with fringing and patch reefs. It has a combined land area of approximately 660 km^2, and its territorial waters cover 630 km^2. The human population of 3.9 million gives a high density of 5,900 persons per km^2 (Anon, 2000). Its marine environment continues to be an important resource, playing an important role in economic growth and prosperity. The marine environment has undergone tremendous change over the years, and now supports one of the world's busiest ports and one of the largest oil refining centres. Close to 60% of the total coral reef areas have been lost through foreshore reclamation (Chou, 1995; Chou & Goh, 1998).

In Singapore's highly urbanised society, fishing and collecting from reefs and other coastal areas, either from aquarium trade or for subsistence, declined steadily since the 1980s. Records are not available of coral reef fish harvested from reefs, as reef fisheries is practically non-existent. Boat-operated commercial fishing is prohibited in territorial waters due to limited space and risk to navigational safety. Local fish catch comes mainly from the diminishing numbers of licensed commercial palisade trap operations and local production from marine aquaculture (Chou, 2002). Thus, with the declining numbers, Singapore does not have any extensive monitoring programmes for fish re-stocking and stationary fishing gear.

Illegal collection of corals and other reef invertebrates stopped with stronger enforcement by the Police Coast Guard in the 1990s. Effective regulatory measures prevent marine pollution. The greatest impact however, is the high sediment load generated by land reclamation, the regular dredging of rivers and shipping lanes, and the dumping of these material out at sea. In the past three decades, the high sedimentation levels generated by these activities have reduced the abundance but not the diversity of the coral reef life-forms (Hsu & Chou, 1991). Coral growth zone is reduced to shallower depths. Higher diversity of hermatypic corals is found at the 3m depth compared to the 10m depth (Chou, 1991). There were organised efforts on enhancing the marine resources in the past two decades through artificial reef programmes. These include concrete blocks and tyre modules as artificial reef structures in the 1980s (Chua & Chou, 1994; Chou, 1991) and the present project using fibreglass structures (Loh & Chou, 2002).

■ STATIONARY FISHING GEAR & RE-STOCKING

Coastal fisheries production of 40,000 tonnes annually declined drastically since the late 1940s, due to increased shipping activities, loss of original coastal habitats and fishing grounds to land reclamation, and better alternative employment opportunities. Palisade traps ("kelongs") which were located at the nearshore were phased out particularly along the southern coast as they posed a threat to navigational safety (Chou & Chan, 2001). The use of simple fish traps such as the "bubu" has decreased over the years. Coastal aquaculture practices have shifted from traditional to intensive systems while mariculture, using floating net cages, has been actively promoted.

In 1977, the Singapore Government initiated a 10-year River Clean-up programme to improve the water quality of the Singapore River to transform the riverbanks into beautiful parks and walkways with clean river water. The fauna returned to the river after the water quality improved. The Primary Production Department (the now Agri-Food & Veterinary Authority) launched a 10-year stocking programme in 1986, with the aim to enhance the fish population. The stocked fish would establish as resident fish and promote game fishing (Lee & Low, 1991). Over 80,000 seabass (*Lates calcarifer*), 8,500 cherry snappers (*Oreochromis niloticus*) and 630,000 banana shrimp (*Penaeus merguiensis*) were released into the river as stock.

Khin & Chou (1991) studied the effects of stocking in the river during the period April 1986 – October 1988. They speculated that seabass and banana shrimps might have established their ecological niche. Further investigations revealed that only seabass had established well in the river but not the snappers and banana shrimps (Lee & Low, 1991). Seabass had also been found to have a preference for the artificial seagrass, which Lee & Low (1991) speculated made a good ecological niche for the stocked seabass. However, due to multi-sectoral conflicts in the use of the site, follow-up work was shelved. Besides these studies, there were no other re-stocking efforts, except a giant clam re-stocking research currently conducted by the Tropical Marine Science Institute of the National University of Singapore.

■ MARINE PROTECTED AREA & POLICIES

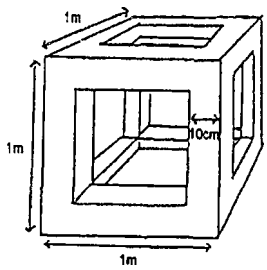
Among the nature reserve areas in Singapore, only Sungei Buloh Wetlands Reserve (SNWR) and Labrador Nature Reserve are coastal related nature areas. However, as far as marine protected areas are concerned, there are none in Singapore. There are no national policies on coral reefs and neither is there a government agency with the distinct responsibility of managing reef resources. Although Labrador is a rocky shore, only the beach and terrestrial area are under the jurisdiction of National Parks Board.

The protection and conservation of fisheries are regulated by the Fisheries Act (Chapter 111). The Act has strict prohibitions on the use of poisons or explosives, as well as trawl net fishing.

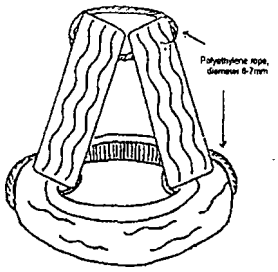
■ ARTIFICIAL REEFS

Since the 1960s, intensive development of the coastal areas in Singapore has resulted in the degradation of the coral reef ecosystem. Several sites were identified for artificial reef establishment. Pre-establishment surveys were conducted to assess the site potential. Reef resources (Hsu & Chou, 1991 ar13), the fish fauna (Lim & Chou, 1991), physical parameters (Hsu & Chou, 1987), etc of several sites were assessed to determine the site potential of establishing artificial reefs, prior to the study. Of the initial seven sites selected for artificial reefs, Hsu & Chou (1987) revealed that Cyrene reefs, Terumbu Jarat, Terumbu Pempang and Terumbu Bemban were suitable for the establishment of artificial reef. In Hsu & Chou's (1991) later studies, Terumbu Bemban was found to have the highest percentage live coral cover (65.88%), as well as the largest average size of coral colonies, while Pulau Semakau has the lowest average live coral cover, diversity and average coral colony size. Cyrene Reefs has the highest diversity, with 28 genera. The fish species recorded at the sites were generally small, and were mostly pomacentrids and labrids (Lim & Chou, 1991).

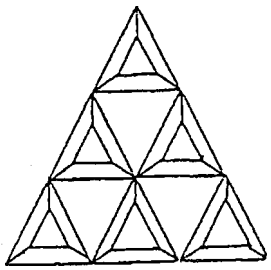
In mid-1989, the first artificial reef was launched in the southern islands of Singapore, under the ASEAN-US Coastal Resources Management Project (Chua & Chou, 1994; Chou, 1991), using of hollow concrete cubes and tyres-pyramids modules (Fig 1). The artificial structures were established on the sea floor, at 15m, adjacent to a natural patch reef (Terumbu Pempang Tengah) west of Pulau Hantu. This is an attempt to restore and enhance the fish communities of degraded reefs.



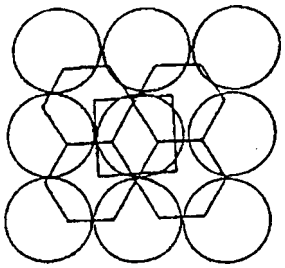
A. Single hollow concrete frame module



B. Subunit of three tyres of the tyre-pyramid module



C. Side view of the tyre-pyramid module



D. Plan view of the tyre-pyramid

Figure 1. Structure and design of hollow concrete module (A) and tyre pyramids (B to D) used in constructing the artificial reefs.

Since the artificial reef establishment, observations showed that a layer of filamentous algae grew over the surface of materials within the first few weeks. Subsequently, a myriad of encrusting organisms such as hydroids, tunicates, barnacles, etc settled and grew on the concrete modules but not on the tyre modules (Han *et al*, 1994).

Initial fish community surveys showed a total of 37 and 32 fish species recorded over a period of 1.5 years at the concrete and tyre reefs respectively (Chua & Chou, 1994). Fish community surveys conducted between September 1989 to January 1996 at the concrete and tyre reefs indicated significant increase in fish abundance and species richness (Low & Chou, 1999). A total of 68 species from 26 families were recorded at both artificial reefs – 55 species (22 families) at the concrete and 48 species (24 families) at the tyre reef.

In general, both concrete and tyre artificial reefs contributed towards an increased fish population. However, the fish communities of both artificial reefs appeared to reach a state of equilibrium by the seventh year after establishment, based on increasing species evenness and the absence of additional new species (Low & Chou, 1999).

Low & Chou (1999) also found that fish abundance, density and size is higher at the concrete reef than at the tyre reef. Several authors have reported that fishes prefer to have hole sizes similar to their body sizes (Hixon & Beets, 1989; Randall, 1963; Shulman, 1984) and Low & Chou (1999) ascertained this. Adult batfish (*Platax*) and snappers have been observed to take residence at the concrete modules while the juvenile stages of various fishes preferred the tyre reef, which have smaller holes.

Artificial reefs of this magnitude can only benefit the fish community, not the coral reefs as Singapore reefs do not extend to depths of 15m due to high sedimentation levels and low light penetration. Should artificial reefs be used as reef restoration tools in Singapore, structures must be designed for shallow reef areas.

In April 2001, National University of Singapore (NUS) and Singapore Tourism Board (STB) established a research collaboration to use artificial reefs to promote coastal tourism. As Singapore reefs are shallow, fringing and not extending any deeper than 10m (Lim *et al*, 1990), the previous concrete and tyre artificial reefs are unsuitable and inconvenient. A specially fabricated artificial unit, called Reef Enhancement Unit (REU) was designed and used (Fig 2) (Loh & Chou, 2002). The REUs are made of fibreglass impregnated with sand and calcium carbonate to roughen the exterior surface and provide coral recruits with suitable settlement substrate. The REU is light enough for divers to handle in the water and easy to manoeuvre, which allows the REUs to be moved to the exact location rather than dropped randomly overboard.

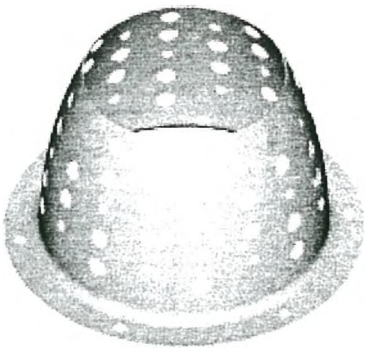


Figure 2. A schematic diagram of Reef Enhancing Unit (REU).

Seventy-six REUs were deployed at a depth of 3m, at three sites, one at Raffles Lighthouse and two at St John's Island. Surveys of flora and fauna settlement on the unit exterior were conducted using modified Line Intersect Transect. Over the one-year study, the percentage cover of algal assemblage exceeded 90% for all three sites in the first month. Gradually, other organisms such as ascidians, coralline algae, hydroids, bryozoans grew on the units. By the 9th month of REU deployment, coral recruits were detected growing on the REUs. Results gathered from this preliminary study showed that fibreglass is a viable alternative material for artificial reefs. In addition, artificial substrates can provide the stable surfaces which corals need to recruit on (Chou & Lim, 1986).

Currently, the artificial reef project using REUs is in its second phase, under a collaboration with Sentosa Development Corporation (SDC). This two-year study will further investigate the dynamics of REUs and reef rehabilitation to maximise their effectiveness.

In comparison, tyres and concrete structures are more suitable materials for artificial reef structures deployed at greater depths for fish community enhancement purposes. The REUs are better suited for reef rehabilitation, particularly in shallow reefs areas. Artificial reefs must be part of programmes to manage fishing effort and resources, to obtain an overall positive effect. If properly planned, executed and managed, artificial reef programmes can enhance the marine environment in the long term (Chou, 1997).

■ BEYOND ARTIFICIAL REEFS

Having artificial reefs in the waters is not sufficient if it is an isolated attempt. The ultimate goal in reef restoration would be a concerted effort for all related marine resource enhancement programmes to tie in with coral reef rehabilitation. The effectiveness of the REUs can be maximised with better understanding of the most appropriate deployment period, such as to coincide unit deployment with the local coral spawning events. Guest (2002) confirmed that coral spawning events occurred in March or April with a smaller event in October. Efforts were made to tie in REU deployment with the mass spawning event.

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A COUNTRY REPORT FOR THE WORKSHOP ON ARTIFICIAL REEF AND STATIONARY FISHING GEAR DESIGN AND CONSTRUCTION AND MARINE ROTECTED AREA IN THAILAND

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■ INTRODUCTION

The rapid development of the commercial trawling and purse seining fleet resulted in extreme economic hardship for small-scale fishermen who could no longer compete for scarce fishing resources. A great numbers of them changed to alternative fishing practices such as near-shored push nets and fine mesh cod-end trawlers. Such gears are destructive both the resources themselves and their habitats. Since juvenile fish and shrimps were also taken by these activities even in high percentage, recruitment of high-value, market-size fish into the fisheries was unfortunately reduced. The Government has, therefore, undertaken various tasks to diminish numbers of the push-nets and trawls.

As Thailand realized its problems associated the capture fisheries occurring not only in the Gulf of Thailand but also in the Andaman Sea, many management programs and conservation measurements were implemented by the Department of Fisheries to enhance the national resources. As well as other management and conservation mechanisms, such programs as installation of artificial reefs, introduction of stationary gears and proclamation of marine Sanctuaries or protected area are highly expected as the most effective strategies of resource enhancement.

■ GEOGRAPHIC FEATURES

Thailand is situated between 5°- 21° N, 95° - 106° E in the Southeast Asian Peninsula. It covers a terrestrial area of 513, 115 km2, bordering Myanmar to the West and Northwest, Laos to o the North and Northeast, Cambodia to the East, and Malaysia to the South. The country has an extensive inland water surface area of 5,300 km^2 and a shoreline of 2,614 km, 1,874 km of which borders the northern and western reaches of the Gulf of Thailand, whereas 740 km face the Andaman Sea making 420,280 km^2 of coastal areas.

The Gulf of Thailand can be classified as a shallow semi-enclosed sea with limited, wind-driven water circulation and a low rate of exchange with the adjacent South China Sea. Its average depth is 45 m with a maximum depth of 85 m located in a central basin. The fishing area is about 252,000 km^2. The Andaman Sea is located on western coast of Southern Thailand. It is an open area adjacent to deep oceanic waters of the Indian Ocean. The Andaman Sea of Thailand provides about 126,000 km^2 fishing area for Thai fishermen.

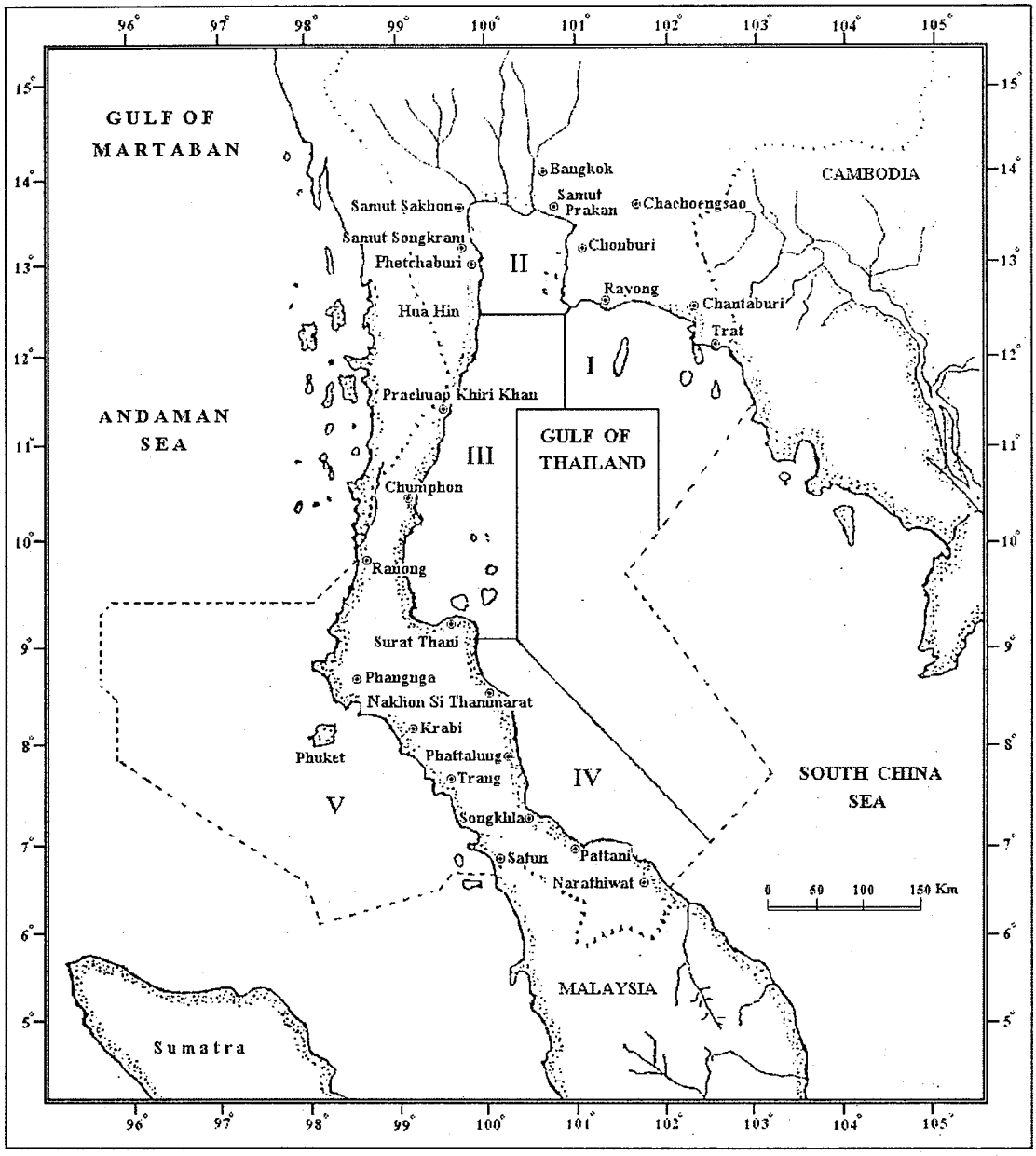

Fig. 1 Coastal areas of Thailand and limits of fishing areas (—) and the Thai EEZ (Economical Exclusive Zone) (-----)

Area I Eastern Gulf:	Trat, Chantaburi, Rayong
Area II Inner Gulf:	Chonburi, Chachoengsao, Samut Prakan, Bangkok, Samut Songkram, Samut Sakhon, Phetchaburi
Area III Central Gulf:	Prachaup Khiri Khan, Chumphon, Surat Thani
Area IV Southern Gulf:	Nakhon Si Thammarat, Phattalung, Songkhla, Phattani, Narathiwat
Area V Andaman Sea:	Ranong, Phangnga, Phuket, Krabi, Trang, Satun

Culturally and administratively, Thailand divides into 6 regions, 76 provinces and 787 districts. The total area of brackish waters in Thailand is approvimately 259 km2 of mangrove swamps, tidal land and lagoon, most of them are suitable for brackish water fish culture. There are 24 coastal provinces that can be divided into 5 fishing zones. The Eastern Gulf covers 3 provinces (Area I), the Inner Gulf covers 7 provinces located around Bangkok (Area II), the Central Gulf covers 3 provinces (Area III), the Southern Gulf covers 5 provinces (Area IV), and the 6 provinces facing the Andaman Sea Coast (Area V) (National Statistical Office, 1997).

Like other countries in the Southeast Asia, Thailand is also influenced by tropical monsoons that are clearly defined the wet and dry seasons. During May to September, the Southwest Monsoon brings heavy rainfalls to the country. Typhoons and depressions sometimes occur bringing low moisture, cooler winds over the country, featuring the cool season.

■ FISHERY RESOURCE ENHANCEMENT

Artificial reefs

The Department of Fisheries has implemented the artificial reef program as a fulfillment of the Small-Scale Fisheries Development Project. This program should serve the following objectives:

1. Providing habitats and shelters for juvenile fish, increasing in yields of food fish and reducing the juvenile fish component of trash fish landings;

2. Providing substrates for primary and secondary productions that are food sources of the higher levels of food web;

3. Providing physical obstructions against invasion of trawlers into nursery grounds, thereby potentially increasing overall production of the Gulf and provide a resolution to conflicts between the small-scale and commercial fishermen; and

4. Facilitating the small-scale fishermen to access the fishing grounds for income with little fishing effort.

Since 1978, hundreds of artificial reefs have been constructed at the depth of 4-18 m along the coast of the Gulf of Thailand and in the Andaman Sea. They are composed of used tyres, open concrete pipes, open concrete cubes and open concrete pyramids, each covering different areas between 3.0 km2 to 50.0 km2. Among the criteria of selecting a suitable site for artificial reef installation, an agreement from the Habour Department and the Royal Thai Navy is required to secure the marine transport.

The Department of Fisheries has regularly managed to evaluate the benefit of artificial reefs. So far, it was often reported that the artificial reefs became alternative grounds for small-scale fisheries. Traps and hand-lines are commonly used in the reef areas, occasionally gill nets and trammel nets are working nearby. Economically important fish as grouper *(Epinephelus spp.)*, snappers *(lutjanus spp)*, rabbit fish and parrot fish are usually caught by those gears.

Artificial reefs are considerably popular among Thai fishermen, especially the small-scale fishermen, who usually ask for extension of the projects from their own communities or associations or even from the NGOs. Besides collaborations and good management, in fact, researches on suitable materials and techniques are still needed in order to improve the durability and reduce deterioration or sinking rate of materials, for example.

The artificial reef program would be a long-term engagement, which is expected to play a key role in future fisheries development of Thailand.

Stationary gears (Set net)

Stationary fishing gears or set nets known as stake traps used to be very common in Thailand in the past. The Government did not promote these gears because they are fixed to one place for so long time and need large coastal areas for installation and operation, and that might hinder the navigation, as well. To possess or operate a net set of such gears requires special permission and seemed to be impossible. Since 1960, as the trawls were first introduced to Thailand and became very popular among Thai fishermen in only short time, numbers of stake traps were rapidly reduced.

As the fishing resources were severely exploited and their habitats were destroyed particularly by the trawls, similar to artificial

reefs, the set nets are accounted to enhance restocking of the marine resources.

The pioneer project on set-net, entitled "Introduction of Set-Net Fishing to develop Sustainable Coastal Fisheries Management", was approved in April 2003. This project is being conducted in collaboration of the SEAFDEC/TC, Department of Fisheries (by Eastern Marine Fisheries Research and Development Center 9EMDEC) and Rayong Provincial Fisheries Office) and the local fishermen in the project site of Mae Rumphung Beach, Ban Phe, Rayong Province.

The following objectives should serve this proposed project:

1. To reduce fishing pressure on coastal fishery resources through introduction of set-net as a passive fishing gear.
2. To alleviate fishing competition in the congested fishing ground by organizing collective fishing operation in set-net through the pilot project.
3. To develop common policy concept of fishery management for fishing gear occupying wide fishing ground such as set-net through the pilot project.

To accomplish the project the following activities were accounted:

1. Project site selection and grouping fishermen on the coastal of the Gulf of Thailand.
2. Fishing gear construction, installation, operation and maintenance will be conducted at the site and fishermen training on set-net fishing will also carried out at the same time.
3. Monitoring on impact of set-net installation to the coastal fishery resources and fishing ground condition will be carried out.
4. Technical seminar at national level will be held in order to evaluate the project from public idea.

Now the construction of set-net is nearly finished and installation of the gear should be completely done in October this year. Financially, the project is supported by the Trust Fund-I Program.

Marine sanctuaries or protected areas

In terms of fisheries management, in general, the near-shored areas within the 3-km boundary from shorelines are protected for spawning and nursing grounds of the juvenile fish and shellfish. This zone is, however, open for some small-scaled fisheries. Legislation under Fisheries Acts implemented in Thailand include 3 significant measures. They are: (1) limited fishing gears, (2) closed seasons, and (3) closed areas.

Limited Fishing gears: is concentrated on the control number of trawlers and push nets by 3 mechanisms of licensing issued in September 1982:

1.1 New fishing licenses for all types of trawlers and push nets are not to be issued:

1.2 Fishing licenses for other types of fisheries are not be permitted to be transferred or utilized to operate trawlers and push nets; and

1.3 Only the licenses and navigation certificates of the holders of the license/ certificate for the preceding year are to be renewed and transfer of these licenses to another person cannot be allowed or negotiated under any circumstances, except as in instance of family inheritance.

These measures are not effective since the authority to control is distributed in 2 agencies, i.e. fishing boat registration for navigation certificate is the responsibility of Harbour Department while Department of Fisheries issues fishing license. This creates the gaps because fishermen can operate with other type of gear not mentioned in the fishing license. The review of this legal practice has not been complemented until presently.

Closed seasons: which was issued in November 1984. By this regulation, a conservation area of approximately 26,400 km2 was declared in the Gulf of Thailand to protect several commercially exploited species of demersal and pelagic fish during their spawning and breeding seasons from 15 February to 15 May. This regulation prohibited fishing by all types and sizes of trawlers (with the exception of beam trawlers), all types of purse seines (except for anchovy purse seines operating in the day time during 15 February to 31 March only) and gillnets with less than 4.7 cm mesh

size, along the coastline of Prachuap Khirikhan, Chumphon and Surat Thani provinces, as well as Khanom district in Nakhon Sri Thammaratprovince, in central western Gulf of Thailand. These measures yielded quite encouraging results. The total annual catch of Rastrelliger spp., which is the target species, is reported to be gradually increased.

Closed areas: concentrates on the prohibition of using trawl and push net within 3 km from shore was issued on July 1972. This aims to conserve the juvenile fish and shrimps from being heavily exploited. Anyhow, some small-size trawllers (14 meters) always break the rule searching for valuable small shrimps.

In terms of marine parks, sanctuaries or protected areas for other purposes (non-fisheries) such as tourism and recreations, the Department of Forestry is also responsible for. The Fisheries Acts, the Forestry Acts and its supporting regulations are mainly enforced by the Provincial and District Administration, with, occasionally, assistance from the water police and the Royal Thai Navy. The enforcement faces numerous problems, particularly in the marine capture sector, due to the independent nature of most fishermen, lack of patrol craft and the small penalties usually imposed (for example, the fine for fishing with an unlicensed gear is set at three times the annual license fee). Although many fisheries officers attempt to enforce the regulations, it is considered that inability to prosecute the regulations has led to a lack of respect for the law. It is known that most fishermen profess knowledge of the regulation, but they often ignore them. These are also problems of inequality in enforcement effort between provinces and between individuals within provinces.

As the nation needs to develop its social and economic structures, a great numbers of development projects are proposed and conducted. These also include the intensive use of coastal areas that often causes not only domestic but also industrial pollution, which are eventually transferred to the marine environment. Any fisheries management and conservation program could hardly get success, so long the pollution exists.

■ INTERNATIONAL ORGANIZATIONS RELATING FISHERIES MANAGMENT OF THAILAND

Thailand is the member of the following organizations: the Southeast Asian Fisheries Development Center (SEAFDEC), Association of Southeast Asian Nations (ASEAN), Asia-Pacific Economic Cooperation (APEC), Asia-Pacific Fishery Commission (APFIC), Food and Agriculture Organization/Regional Office for Asia and Pacific (FAO/RAPA)

■ CONCLUSION

Fishery resource enhancement should be nationalized or globalized that requires a great deal of responsibility and cooperation not only from the fishermen or the authorities, but everybody must incorporate within the program. Nowadays nobody could say yet, which of the present programs and measures implemented in fishery management and conservation policy determines the best effective manipulation for resource enhancement. Further tasks must be done and we all have to work hard and sincerely to approach the expected target.

COUNTRY REPORT OF VIETNAM

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■ MPA SYSTEM

Marine conservation starts late in Vietnam compared to other countries. At the moment there is only one MPA (Hon Mun) available. Another one (Cu Lao Cham) is being setup and expected to start in the next year. However, the plan for establishment of a system of MPA has been setup and put into effect.

The idea to establish an MPA system started in 1999 when scientists collected biodiversity data to select sites for conservation. In the first proposal, about 30 sites were proposed. After many revisions, some 14 sites were finally accepted and ranked by level of priority. They cover most of the hight diversity areas. Vietnam becomes one of a few countries establishing MPA in a system.

Following this plan, in 2000, the first MPA in Vietnam was established in the central of Vietnam, referred as the pilot MPA Hon Mun, funded by World Bank, IUCN and ADB. After two years running it has shown some signals of recovery of fish population in the MPA. The project operators claim that the establishment of such MPA is somewhat late in terms of ability for the recover of resources as they are exhaust. If is were established earlier, it would be less difficult and needs shorter time to recover the resources. This is a valuable lesson for the conservation process in Vietnam. The process must be pushed forwards, before it is too late.

The second MPA is now being setup in Cu Lao Cham (also in the central of Vietnam). This is a part of the project called "supporting the MPA system in Vietnam" supported by Danida which aims to motivate the establishment of the MPA system in Vietnam.

There are also two other small local marine protected sites created by local government in cooperation with NGOs in Ran Trao (60 km to the north of Hon Mun MPA) and Phu Long (in North) set up by local governments. In addition, three other national terrestrial parks Con Dao (in the south), Bai Tu Long and Cat Ba (both in Halong Bay) also take care of marine areas within or surrounding them. However, they do not focus much on marine resources due to the limit in human resource and budget. Under the planning of Vietnam, many other MPAs are expected to be established in near future.

■ ARTIFICIAL REEFS

The establishment of artificial reefs strongly depends on the conservation process. As this process is moving slowly, the application of artificial reef is also slowly in Vietnam. At the moment, there has not been a real artificial reef in Vietnam. The only functioning MPA (Hon Hun) does not use artificial reefs because they have other choices cheaper than artificial reefs: protect and let the reef self-recovering.

Early this year, a testing artificial reef was setup at the local protected site Ran Trao (in the central). Numbers of concrete tanks with holes were laid on seabed. But up to now, no data on the development of the reef available yet and the success of the work is still uncertain.

In recent years, artificial reef is strongly motivated by Research Institute for Marine Fisheries. It is now creating an artificial reef in Halong Bay in an attempt to check the possibility of recovery of the reef and proper methods in building artificial reefs in this high turbidity area. Concrete tanks of different shapes with holes are being laid on the degraded reefs (fig. 1).

As the MPA system is being setup, artificial reef is expected to play important roles in the conservation process, particularly in areas where reefs are unable to self-recover.

■ STATIONARY FISHING GEARS

There are various types of stationary fishing gears being operated in Vietnam waters, including set nets, traps... They are used in diverse ways to catch migrating fishes (tuna and mackerel), reef species (grouper, lobster, eel...) or trash fish in estuaries or tidal flats... Of those, set nets are the most comon one. They are applied in various types of waters like shallow estuary, tidal flats, lagoons and reefs. Among them, some are friendly with resources some are not.

Around Hon Mun MPA there are 5 set nets within buffer zones and core zones. They are designed to catch migrating tuna and mackerel. The nets have existed for more than 200 years, playing an important role in the fishing industry of the area as they create huge amount of income to local communities. The annual production is about 100-65 tons/net/year, giving the to tall values of about 200-1000 millions VND (15,000-66,000 USD/net/year). These high selectivity-fishing gears seem to be friendly with resources. However, when the MPA is established, a question is raised whether or not these set nets should be removed. Since then, the existence of these set nets become continuous source of conflict between fishermen, authorities and MPA project staffs. The MPA staffs want to remove the set nets away from the MPA as they are considered to harm/disturb the MPA. On the other hand, fishermen argue that, fishes being caught are pelagic and not related to the resources of the MPA while it provides huge amount of income for local people.

Other type of set net in Tam Giang lagoon in Thua Thien-Hue province (northern central Vietnam) is a disaster for the resources of this huge lagoon. Hear laid thousands of set nets (3009 set nets in 1995), in the total area of 210 km^2 of the lagoon (fig. 2). The situation becomes worse and worse as more set nets are added day by day. This seriously affects the resources, pushing the resources to an unrecoverable situation. In 2001, these nets occupied some 50% of the total area of the lagoon (May be much more this year). This means, there are few chances for the organisms to recruit in this lagoon and in distant future, the whole special lagoon will be empty due to this kind of stationary fishing gears.

Besides, this type of fishing also affects many other waters, particularly estuaries and tidal flats with very small mesh size. All of these force us to consider carefully in saying: encourage stationary fishing gears.

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3) Long, N., Khang, N.V., Hai, V.D. and Bundit C., 2002. Part IV. Vietnam. In: Narong R. & Somboon S. (eds): Fishing gears and methods in Southeast Asia. SEAFDEC 2002. Figure 1. Design and construction of concrete tanks used for artificial reefs in Halong Bay, Vietnam

Experience papers

SEAFDEC INITIATIVES AND ACTIVITIES RELATED TO FISHERY RESOURCE ENHANCEMENT

Dr. Yuttana Theparoonrat
SEAFDEC Training Department

■ INTRODUCTION/BACKGROUND

Reference to/linkages with items of the Resolution and Plan of Action adopted at the 2001 Millenium Conferences. The quality of coastal and inshore ecosystems has deteriorated significntly as a result of continued and increasing human activities. These areas are critical to a broad range of aquatic organisms during their life cycles including spawning, nursery areas and feeding zones and many of these species are of economic importance. The areas serve as important sources of recruitment to, and the sustainability of, commercial fisheries. It is suggested that the productivity of these ecosystems can be enhanced through human intervention leading to improved livelihoods for coastal communities.

In many areas, the introduction of man-made structures, including artificial reefs, aquaculture facilities, breakwaters, stationary nets and jetties are shown to enhance local populations of aquatic organisms, provided that there are sufficient numbers of structures to have a significant and positive impact on ecosystem productivity and that they are integrated into coastal zone management regimes. These structures can enhance fisheries resources. To optimize the results of such initiatives, careful impact assessment and planning procedures are required.

Re-stocking may be an effective component in the enhancement of marine resources in inshore waters. Juveniles and seeds produced by hatcheries or collected from the wild and others areas will be removes rapidly from the ecosystem by destructive fishing gears such as push nets or small-mesh trawl nets. Furthermore, in order to retain the released stocks within the immediate vicinity and minimize losses through our-migration, suitable habitat must be available to them. Therefore, habitat restoration and/or enhancement and establishment of exclusive fishing right may be necessary prerequisites for any marine restocking exercises.

Immediate action is required to prevent further loss of habitat and damage to fish stocks. A range of effective community-level mechanisms must be developed to assist fishers to restore habitats and rebuild stocks. These mechanisms are likely to be specific to different stocks and habitats. Habitat creation and the establishment of artificial reefs, the use of fish attraction devices and predator removal all has potential in the region.

■ CONCLUSION AND RECOMMENDATIONS FORM ASEAN-SEAFDEC MILLENIUM CONFERENCE, BANGKOK 2001

Conclusion

Considering current levels of degradation of aquatic environments within the ASEAN region, it is projected that the productivity of fisheries will decline. This in turn will lead to a reduced supply of fish and hence its level of contribution to local food security. Various strategies to enhance the resource base can be initiated by the countries in the region. Coastal areas, specifically the inshore waters, are highly important to the replenishment of aquatic resources. They provide critical habitat for spawning and nurseries for many species, particularly a large number of commercially important fish species. Government resource enhancement efforts should focus on:

1) integrated installation of artificial habitats in inshore water with careful pre-assessment of environment and socio-economic impact;

2) Re-stocking exercises with careful assessment of economic feasibility and environmental impact;

3) the establishment of Marine Parks to protect fragile ecosystems; and

4) develop management practices to effect seasonal closures of spawning areas in accordance with management requirements.

Recommendations

In order to enhance the fisheries resources the following recommendations are made:

1. Take measures to restore critical inshore habitats, which have been extensively degraded by various human activities.

2. Assess the feasibility and environmental impact of artificial reefs and other man-made structures in inshore waters with respect to resource enhancement and coastal zone management objectives.

3. Promote re-stocking activities (seed release programs) from hatchery-produced stocks and/or wild collected sources in areas where they are considered to be feasible, particular localities operating within a regime of rights-based fisheries.

4. Further encourage a culture-based fisheries program in inland waters where favourable exploitation patterns and traditional management mechanisms prevail.

5. Enhance marine engineering capabilities to address the physical constraints in the construction, installation and placement of resource enhancement structures.

6. Note that the implementation of rights-based fisheries, more specifically exclusive fishing rights, and the enhancement of inshore habitat by expanded Ars are prerequisites for the successful implementation of a re-stocking program.

7. Conduct research on the released species' potential recapture rate and impact on the ecosystem.

8. Ensure optimal recapture of the released stock through effective management measures, including predator control.

9. Develop marine parks in limited areas such as coral reefs to protect fragile coastal ecosystems, given that the establishment of marine protected areas is not feasible in the region due to their negative social impacts and enforcement problems.

10. Promote the seasonal closure of specific areas to protest spawners and juveniles of certain commercial-valued species under rights-based fisheries management, as an alternative measure to marine protected areas.

■ RESOURCES ENHANCEMENT PROJECT OUTLINE

1. Objective

1. To optimize the use of inshore waters through resource enhancement programs.

2. To enhance the fisheries resources by artificial reefs, stationare fishing gear and aqua-culture facilities (e.g. oyster culture)

3. To assess the feasibility and environmental impact of artificial reefs, stationary fishing gear and aqua-culture facilities.

4. To enhance marine engineering of artificial reef construction and installation,

5. To developing human resources for the implementation of resource enhancement programs.

6. To promote right-based fisheries management concepts to local fishers.

2. Project Description

The program is composed of three main activities as;

Activities 1. Survey and data collection on environmental studies on Artificial Reefs, Set Net and Marine Cage Culture project site, (Chumphon Province, Thailand and Malaysia) in cooperation with Management of Sustainable Coastal Fisheries Program.

Activities 2. Workshop on Artificial Reefs and Stationary Fishing Gear (Set Net) Design and Construction and Marine Protected Area.

Activities 3. Preparatory work for Training Regional short-term Training Course

in Resource Enhancement Methodologies.

3. Proposed Activities

3.1. Survey and data collection on environmental studies on Artificial Reefs, Marine Cage Culture project site.

3.1.1 On site survey in Chumphon Province, Thailand

3.1.2 On site survey in Lankawi, Malaysia

3.1.3 Set net fishing introduction, Thailand

3.2. Workshop on Artificial Reefs and Stationary Fishing Gear (Set net) Design and Construction and Marine Protected Area.

3.3. Preparatory work for training Regional short-term Training Course in Resource Enhancement Methodologies.

3.4. Marine Ranching and Stock Enhancement.

3.5. Production of Extension Package on Resources Enhancement.

■ RESOURCES ENHANCEMENT PROJECT, ACHIEVEMENT 2002

TD in collaboration with ASEAN and SEAFDEC member countries conducted Resources Enhancement project in a selected member country as a case study. This project is designed to integrated installation of artificial habitats in inshore waters with careful pre-assessment of environmental and socio-economic impact.

In the year 2002, project proposal and planning as well as core working group were carry out. Review of existing Artificial Reefs and Resources Enhancement project in the ASEAN countries is under investigated. A TD technical staff was attended the Second International Symposium on Stock Enhancement and Sea Ranching, Kobe, February 2002 for project information collection. The identification of project site selection for artificial reefs study is under investigated and discussion for find out a suitable location with DOF Thailand. The area of Chumporn province southern part of Thailand was selected. Department of Fisheries, Thailand propose to install artificial reefs at Chumporn around April 2003. The workshop on Artificial Reefs is plan to conduct during the end of 2002 at TD.

■ PROPOSED RESOURCES ENHANCEMENT PROGRAM FOR THE YEAR 2003

1. Survey and data collection on environmental studies on Artificial reefs, Set net and Marine cage culture project sites *(Jan. – Dec. 2003)*.

1.1 On site survey in Chumporn, Thailand

1.2 On site survey in Lankawi, Malaysia

1.3 Set net fishing introduction

2. Workshop on artificial reefs and stationary fishing gear (Set net) design and construction and marine protected area. (In collaboration with AQD) *(Nov. 2003)*.

3. Preparatory work for training regional short-term training course in Resources Enhancement Methodologies. *(Sep. 2003)*.

4. Marine Ranching and Stock Enhancement (collaboration with AQD). *(Jan. - Dec. 2003)*.

5. Production of extension package on Resources Enhancement. *(Jan. – Dec. 2003)*.

Detail of propose resource enhancement project activities on 2003

Date	Activities	Venue
Feb. 2003	NOAA-SEAFDEC Workshop on Marine Protected Area	TD
17-21 Mar. 2003	Training/Workshop on Artificial Reefs and Stationary Fishing Gear (Set net) Design and Construction	TD
7-11 Apr. 2003	Environmental survey studies on Artificial Reefs, Set net and Marine Cage Culture project site	Chumporn Thailand
5-30 May 2003	Regional short-term Training Course in Resource Enhancement Methodologies.	TD
19-30 May 2003	Installation of Artificial Reefs	Chumporn Thailand
Jun.-Jul. 2003	Set net design and construction	TD
Aug. 2003	Environmental survey studies on Artificial Reefs, Set net and Marine Cage Culture project site. (3 months after installation)	Chumporn Thailand
Sep. 2003	Set Net installation	Chumporn Thailand
Nov. 2003	Environmental survey studies on Artificial Reefs, Set net and Marine Cage Culture project site (6 months after installation)	Chumporn Thailand
Apr.-Dec. 2003	Analysis of data of environmental condition and fishing operation	TD
Jan.-Dec. 2003	Production of Extension Package on Resources Enhancement	TD
Dec. 2003	Environmental survey studies on FADs in Langawee Island Malaysia (Joint Project with CBFM)	Langawee Island

Proposed items of environmental survey studies on Artificial Reefs project site

Oceanographic Survey

- Water Current, Speed/Direction (Current Meter)
- Water Quality, Oxygen, Neutrient (Water Sampling)
- Sedimentation (Smit McIntyre grap)

Fisheries Biology Survey

- Benthos (Smit McIntyre grap, Drege)
- Phytoplankton, Zooplankton (Plankton Net)
- Fish Larvae (Lavae Net)
- Hydro-acoustic survey (Echo-sounder)
- Fish species and behavior observation (Under-water camera)

Fishing Survey

- Trammel net
- Surface Gill Net
- Fish Trap
- Squid Trap
- Crab Trap
- Shrimp Trawl Net
- Trawl net

Fisheries Department of Thailand Artificial Reefs Project for 2003

Project Number : 46-16-07
Location : Moo 2, Banborsamrong, Pakklong Village, Pratew District, Chumporn Province
Area : 1.0 x 1.0 kilometer
Water Depth : 11.0-16.0 meter
Bottom : Muddy sand
Dist. From Shore : 4.9-5.8 kilometer
Material : Concrete 1.5x1.5x1.5 meter, 875 pieces
Position : A. Lat. 10-49.00 N, Long. 99-28.85 E
B. Lat. 10-49.00 N, Long. 99-29.35 E
C. Lat. 10-48.50 N, Long. 99-28.70 E
D. Lat. 10-48.50 N, Long. 99-28.20 E
Budget : 3,000,000.- Baht

Project Number : 46-16-08
Location : Moo 6, Bonrai, Pakklong Village, Pratew District, Chumporn Province
Area : 0.5x2.0 kilometer
Water Depth : 9.5-11.0 meter
Bottom : Muddy sand
Dist. From Shore : 3.0-4.5 kilometer
Material : Concrete 1.5x1.5x1.5 meter, 875 pieces
Position : A. Lat. 10-48.20 N, Long. 99-28.05 E
B. Lat. 10-48.20 N, Long. 99-28.30 E
C. Lat. 10-47.20 N, Long. 99-27.00 E
D. Lat. 10-47.20 N, Long. 99-26.75
Budget : 3,000,000.- Baht

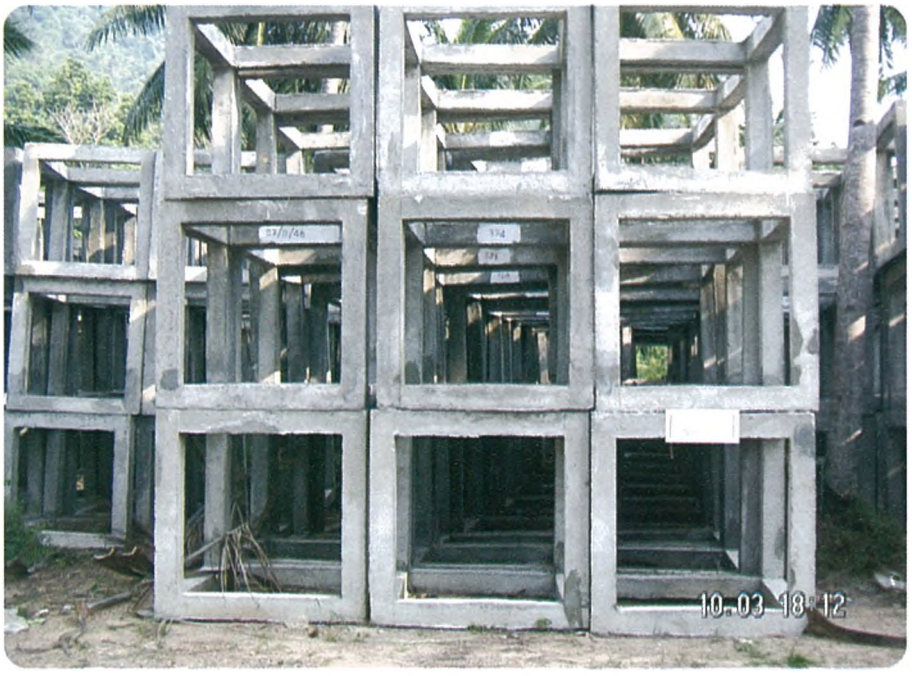

Figure 1. Concrete box type artificial reefs

ANNEX I

Views of National Seminar on Resource Enhancement

Issues	Views of National Seminar
➢ Releasing hatchery reared juveniles into natural habitat	
Malaysia	Very much welcome but doubtful of its success, unless fishers are given the responsibility to manage by area
Thailand	Protection should be expanded Spawning ground in the management framework
➢ Inadequate or absence of baseline data	
Indonesia	- Need a technical study on the availability of seed - Inventory program in each area
Malaysia	Decline in demersal as well as other important resource was supported
• What major species has severely declined in the selected area and what is the catch history of the species?	
Cambodia	Slipper lobsters, Silver pomfret fishes, Grouper fishes, Dugong, Mud crab, Shark, Sea-cucumber and other invertebrate that live in Coral Reef.
Malaysia	It is very difficult to ascertain. Request study to be conducted by the authority
Myanmar	Brood stock industry is to be set up. Brood stock management technology is to be imparted in the regions.
Philippines	- Needs further research and proper transfer of technology to end-users
Thailand	High demand from fishers of grouper fry for cage culture. High price for lobster, abalone and pomfret for export and domestic consumption
Vietnam	Some high-value shrimp species (black-tiger shrimp..., mollucs (pearl oyster, abalone,....)
• Where can spawners of the desired species be caught and what is the status of the technology to breed them in captivity?	
Cambodia	Slipper lobsters, Silver pomfret fishes, Grouper fishes, Dugong, Mud crab, Shark, Sea-cucumber and other invertebrate that live in Coral Reef.
Indonesia	Inventory program in term of finding-out the local specific species
Malaysia	Need to identify species
Philippines	Strengthening of the National Stock Assessment Program
Vietnam	Inshore area of Vietnam, above mentioned kinds are caught. Current breeding technology for sea fishes and other species (excluded shrimp) is limited
• Others?	
Cambodia	Have no experience and technology for breeding of marine species
➢ **No available guidelines on release strategies**	
Thailand	Standard effective guideline should be established
• How can the critical number and stage for stocking to make an impact be determined?	
Cambodia	Have no experiences
Indonesia	Need a guidance and extension program to introduce and understanding by the local community
Malaysia	Need to identify species and area for stocking
Vietnam	Initial number is qualitative. It's necessary to have study program
➢ **Impact of release on the local fish stock**	
Thailand	MCS for Pollution from rivers to sea should be seriously implemented
Vietnam	Initial number and inadequate
• What information is available on the use and impact of the desired species for stock enhancement in other areas?	

Vietnam	Initial number and inadequate
• What information is available on the use and impact of the desired species for stock enhancement in other area?	
Cambodia	Have no research studies and other in vestigation to proof. So we should be studies and research fisheries biology of fishes that going to release.
Indonesia	- Need a guidance and extension program to introduce and understanding by the local community - Regular meeting with the representative of institutions involve should be conducted.
Philippine	Conduct impact studies of the desired species
➢ **Impact on biodiversity**	
Malaysia	Not well understood
• What studies have been made on possible effect of hatchery-bred stocks on the biodiversity and on the genetic structure of the local stock?	
Cambodia	Have no research have been done
Indonesia	The study's result should be published and informed to the local level
Malaysia	Only aware that certain species have become extinct or disappeared over time
Philippines	Study the long-term effects on biodiversity and genetic structure
Vietnam	It's necessary to study immediately
➢ **Cost and benefits** • How much will the stocking program cost and how will the benefits be measured?	
Cambodia	Have no research or other study done but we Should be studies on: - Natural stock - Biology - Socio-economic and fisheries economic
Indonesia	Stocking program should also be carried out by the user in order to maintain the resources from extinction by fishing
Malaysia	Need to identify species
Philippines	Aquaculture concern
Vietnam	Releasing shrimp seed available 2 Mill USD/1Bill… Seed P5 and mollusk seeds (pearl oyster, abalone,…), sea horse, milk fis, sea turtle and fresh water fish species (cap fish, pilatia, big head fish, cat fish, black grass fish,
➢ **Responsibility over stock enhancement**	
Malaysia	Supportive but needs assistance in monitoring and surveillance
• How can the stock enhancement activities be privatized in conjunction with rights-based fisheries?	
Cambodia	In order to improve stock enhancement we should be strengthening on exercise of fisheries law and enforcement of fisheries management
Indonesia	The local government through the community might play the role in term of enhancing the resources
Philippines	Aquaculture concern
Vietnam	Government need to regulate appropriate fishing time and location Hatchery and Nursery Center have responsibility to release a certain proportion of hatchery reared juveniles into natural habitant and to contribute to resource recreating Fund. Enhancement of educating, communication to response new resources recreating Government support partly to these activities

• Others?	
Indonesia	- Customary law could be used to maintain the stock - The traditional fishing gear should be identified and inventory
Use of AR (conventional and non conventional) as a tool of fisheries management	
Myanmar	AR to be introduced in near future. AR should be major components in coast fisheries management activities
Vietnam	It's necessary to implement some experiments
Are AR cost effective in managing fisheries?	
Cambodia	Artificial Reefs cost are more effectiveness in managing fisheries
Indonesia	- Need move justification on the coral's trade - Need an inventory program on the coral reef area in Indonesian waters
Malaysia	Cost effective in terms of income, but not in management
Philippines	• Useful if management plan is formulated • Establishment of ARs should be made with a management plan
Thailand	Local community ownership of ARs should protect the damage of ARs. There are problems on evaluation due to too many ARs have been installed
How useful are AR in preventing trawlers and push netters operating in the coastal waters?	
Cambodia	Artificial Reefs are useful in preventing trawlers and push netters operation in the prohibit area
Indonesia	- All fishing gear (trawls modification) should be banned - Guarantee that trawler only operates in the right area.
Malaysia	Very useful
Myanmar	Although AR are not yet implemented in our waters, most of the fishermen, especially drift users and long line users, believe that AR will be preventing trawlers and push netters, which operating in the coastal waters and destroyed their nets and their livelihood very often. Because of these fishing vessels, not only fishing gears of small-scale fishermen are destroyed but also natural habitats and juveniles of fish and shrimp are destroyed. For this reasons small-scale fishermen from the coastal areas have suggested to implement AR for fisheries management
Philippines	ARs are deterrent to trawling and push netters
Thailand	No technical evaluation on this aspect to prove its useful
Vietnam	Well preventing bottom trawlers in coastal waters
• How are the location and number of ARs determined to rationalize their use?	
Cambodia	Artificial Reefs are useful in preventing trawlers and push netters operation in the prohibit area.
Malaysia	Currently no guidelines. Hence need guidelines to avoid conflicts.
Myanmar	Technology cooperation and technology transfer from the ASEAN-SEAFDEC countries, which have good experience and technology in this field, are needed to implement ARs successfully in the future
Philippine	• LGUs to strictly follow the guidelines and enact municipal ordinance to legitimize Ars
Thailand	Control/management the fisheries in ARs should be considered to prevent over fishing
• Is present legislative framework and support adequate to establish and manage AR?	
Indonesia	- Need a strong coordination among the institutions involved - Participating the stake holder in Artificial reef program
Thailand	No, the legislative framework and support should be settle and should be responsible by the Local Community Organizations

• Others?	
Thailand	The use of ARs for tourism will be one incentive for local people in taking care of their ARs.
➢ Engineering capabilities for the deployment of AR • Is present knowledge and skill in design and construction adequate?	
Cambodia	None but we should be train them
Indonesia	- Another program, e.g. awareness program should also be considered as a part of Artificial reef program - Personal capability and skill should be considered, while using the new technology
Myanmar	Technology cooperation and technology transfer from ASEAN-SEAFDEC member countries and International organizations is needed
Philippines	• Adequate, however there is a need to provide guidelines re:establishment
Thailand	It is very important to improve the structure of ARs in corresponding to the environment and resource nature Local technology e.g. mussel farm can be used as ARs, it is proved to be one of the resource enhancement and being use as management tool.
Vietnam	Can follow and meet demand of knowledge and skill in the region

STOCK ENHANCEMENT PROGRAM OF SEAFDEC AQUACULTURE DEPARTMENT

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■ BACKGROUND

Stock enhancement is one of SEAFDEC Aquaculture Department's four regular programs that are focused on addressing urgent issues in aquaculture in Southeast Asia. SEAFDEC/AQD formally started its stock enhancement program in September 2000 but as an activity, it had its start in 1991 as part of the Community Fishery-Management Project undertaken in Malalison Island, Culasi, Antique (west central Philippines). The importance of stock enhancement was articulated as early as 1969 in the Kyoto Declaration on Aquaculture (Sections 17 and 18) and was affirmed in 2000 in the Bangkok Declaration and Strategy for Aquaculture Development (Sections 3.9 and 3.10) and then 2001 during the ASEAN-SEAFDEC Conference on Sustainable Fisheries for the New Millennium. One of the ten-point recommendations in the Millennium Conference reads: "Promote re-stocking activities (seed release programs) from hatcher-produced stocks and/or wild collected sources in areas where they are considered to the feasible, particularly in localities operating within a regime of rights-based fisheries."

■ PROGRAM COMPONENTS

The stock enhancement program of SEAFDEC/AQD has two research components:

1) Adaptation and refinement of breeding and hatcher production techniques of appropriate species for stock enhancement

The breeding component brings together previous works on the propagation of the abalone (*Haliotis asinina*), top shell (*Trochus niloticus*), window-pane oyster (*Placuna placenta*), and seahorses (*Hippocampus barbouri and H.kuda*). Other species such as grouper and siganid which have developed hatchery technologies are being evaluated for their suitability for stock enhancement.

2) Development of strategies for release and stock enhancement of appropriate species Research studies are aimed at determining the optimum release method, animal size, season, habitat and density that will result in high survival, growth and reproduction of the released animal

The stock enhancement program also has training and information components such as:

1) Seminar and training on stock enhancement for fishers, local government units and non-government organizations.

2) Production of information materials such as flyers to enhance people's awareness of stock enhancement efforts.

■ ABALONE

Abalone is a high value species of gastropod mollusk that inhabits rocky and coral reefs. Its large "foot" is one big muscle that is sold either frozen or canned and is highly prized in Chinese cuisine. Due to its high market demand, over-harvesting from the wild could result in its depletion, thus, stock enhancement in protected areas is necessary.

SEAFDEC /AQD started its research on abalone in 1993 with the aim of developing and refining hatchery and grow-out culture techniques. With the development of hatchery technology, abalone juveniles can now be mass produced. For stock enhancement purposes, juveniles are 'diet-tagged' by feeding them with artificial diet for 3-4 weeks followed by seaweed-feeding. The bluish-green shell band produced through artificial diet feeding serves as a permanent marker of hatchery-produced abalone when released to the wild. Efforts are also being made to produce and release first generation offspring of wild spawners from the release sites to maintain genetic integrity of natural stocks.

SEAFDEC/AQD researchers have evaluated potential stock enhancement sites in Panay and Negros Islands and have selected Sagay Marine Reserve in Negros Occidental as pilot stock enhancement site. Preliminary releases of hatchery-produced abalones in Sagay Marine Reserve have produced encouraging results. This research aimed at determining the optimum release size, habitat, season and density will be continued with funding support from the International Foundation for Science (IFS).

■ TOP SHELL

The top shell, *Trochus niloticus*, is another highly valuable gastropod mollusk. Its mother-of-pearl shell is used in the manufacture of buttons and other shellcrafts. The uncontrolled harvesting of top shell from the wild has resulted in the decline of natural stocks.

SEAFDEC/AQD started its research on top shell in 2000 with some broodstock obtained from Iris Marine Development Corporation which operated a Trochus hatchery in Palawan. SEAFDEC/AQD reared these broodstock and was successful in inducing them to spawn (see SPC Trochus Information Bulletin #9, p. 14). Thousands of juveniles have been produced and diet-tagged in preparation for release. Last February 2003, more than 3,000 top shell juveniles were brought to Palawan for release in a marine sanctuary in Binduyan, Puerto Princess. The initial release was carried out by the participants of the training course on Fish Sanctuary and Trochus Shell Resources Management conducted by the BFAR-Fisheries Resource Management Project (FRMP) in Palawan. SEAFDEC continues its efforts to refine the seed production techniques to enable mass production of seeds for stock enhancement.

■ WINDOW-PANE SHELL

The window-pane shell Placuna placenta is a bivalve mollusk whose shells are used as lampshades and other shellcrafts marketed locally and internationally. The reported decline in natural stocks prompted SEAFDEC/AQD to resume its research on the species in 1990 SEAFDEC/AQD researchers have succeeded in propagating the species in the hatchery. The Juveniles can be nursed to larger sizes in tanks so they can survive better in nature once released. Initial attempts gave also been made to restock the depleted beds along the Gulf of Panay by releasing both immature and breeding stocks collected from a neighboring island Close collaboration with the concerned local government has also resulted in the Closure of The stock enhanced area to all forms of gathering so that a viable breeding population can be established. However, with the discovery of the juveniles by the fisherfolk, gathering was difficult to control. Closer cooperation of the fisherfolk and local government and the establishment of a permanent protected area are necessary so that a breeding population will always be available to repopulate the area.

■ GIANT CLAM

SEAFDEC/AQD is collaborating with the Marine Science Institute of the University of the Philippines (UP MSI) in the restocking of giant clams *Tridacna* spp. UP MSI is distributing hatchery-produced giant clam juveniles to various parts of the Philippines in efforts to save and enhance the stocks of this endangered species. SEAFDEC/AQD received *Tridacna gigas* juveniles from UP MSI in October 2001 and these were reared in tank and ocean nurseries and then restocked in coral reefs in SEAFDEC/AQD's Igang Marine Substation in Guimaras Island. Restocked giant clams are growing well and the remaining giant clams in cages will be restocked in other protected areas such as Sagay Marine Reserve in Negros Occidental.

■ SEAHORSE

Commanding a good price either in live form for the aquarium or in dried form for traditional Chinese medicine, seahorse gathering in the Philippines and other parts of Southeast Asia is a good supplemental livelihood activity. However, since uncontrolled gathering will deplete the natural stocks, seed production and stock enhancement techniques should be developed, coupled with other conservation measures.

Seahorse research at SEAFDEC/AQD started in 1996. Seahorse juveniles have been produced so that SEAFDEC/AQD now has at least second generation hatchery-bred animals in captivity. Sites are now being assessed where seahorse juveniles may eventually be stocked.

Program Proposal

SEA RANCHING AND STOCK ENHANCEMENT PROGRAM FOR FOOD SECURITY IN SOUTHEAST ASIA

■ BACKGROUND/RATIONAL

Overfishing, destructive fishing methods, and weak low enforcement are among the major causes of the decline of fishery resources, resulting in food insufficiency. There is a need to increase fish supply and augment income for increasing human population. Releasing hatchery-produced seeds into protected areas is one method of resource or stock enhancement. The Kyoto Declaration on Aquaculture (Sections 17 & 18). The Bangkok Declaration and Strategy for Aquaculture Development (Sections 3.9 and 3.10) and The ASEAN-SEAFDEC Conference on Sustainable Fisheries for the New Millennium held in Bangkok, Thailand on November 2001 recognized that sea ranching and stock enhancement have the potential to increase fish supplies. The Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region includes restocking of commercially important fish species as part of resource enhancement programs. Southeast Asian countries can learn from other countries with developed technologies for sea ranching and stock enhancement, and adopt and develop these for local species with high commercial value.

■ SPECIFIC OBJECTIVES

1. To assess the past and present sea ranching and stock enhancement strategies and programs in southeast Asia, Japan, US, Europe and other countries

2. To develop and verify ecologically sound strategies for sea ranching and stock enhancement of suitable species of mollusks, crustaceans, and fishes.

3. To assess the economic feasibility and acceptability of developed technologies.

4. To transfer developed and verified sea ranching and stock enhancement strategies to SEAFDEC member Countries

METHODS/DESCRIPTION

The program will use hatchery technologies developed at SEAFDEC/AQD and elsewhere for many species of mollusks, crustaceans, and fishes. It will have the following projects and activities:

1. A workshop to assess the state-of-the-art of sea ranching and stock enhancement. Experts from other countries will be invited.

2. Research and development of strategies for mass production of quality seeds, sea ranching and stock enhancement of suitable species. Technology should be research-based and shall include socioeconomic considerations (i.e. social acceptability and economic viability).

3. Verification of developed technologies for sea ranching and stock enhancement through pilot testing.

4. Training and information on developed and verified technologies for sea ranching and stock enhancement.

■ DURATION

5 years (2004-2008)

■ SCHEDULE OF ACTIVITIES

2004 – Workshop to assess existing technologies and identify suitable species for sea ranching and stock enhancement in Southeast Asian region

2005-2008

Research studies:

A. Quality Seed Production

1. Screening of suitable species for sea ranching and stock enhancement.

2. Seed quality improvement and health management.

3. Genetic management and characteri zation of wild and hatchery-produced Stocks

4. Behavioral conditioning (predator avoidance, food search etc.)

B. Release and stock enhancement strategies

1. Appropriate marking or tagging methods

2. Resource and ecological assessment of potential sites

3. Habitat protection and rehabilitation, etc.

4. Experimental releases to develop effective release strategies (optimum release size, season, habitat, and stocking density)

5. Released stock management strategies

6. Evaluation of stock enhancement effectiveness

C. Socio-economics

1. Economics of producing and releasing seeds for stock enhancement

2. Socioeconomic indicators of suitable sites for sea ranching and stock enhancement

3. Social acceptability of sea ranching and stock enhancement strategies

4. Management strategies for increasing and maintaining stocks

D. Technology verification

1. Pilot testing of sea ranching and stock enhancement technologies developed Recently in AQD (e.g. abalone) and in other countries

2. Monitoring and evaluation of the effectiveness of sea ranching and stock enhancement.

2006 – Workshop to evaluate developed technologies

Continue research and verification studies.

2007 – Production of manuals and information materials

Continue research & verification studies

2008 – Conduct of training programs for SEAFDEC Member Countries

■ BUDGET

Year	Amount (US Dollars)
2003	110,000
2004	120,000
2005	130,000
2006	140,000
2007	150,000

■ EXPECTED OUTPUT

1. Socially acceptable and economically viable sea ranching and stock enhancement strategies (e.g. habitat protection/rehabilitation, release of hatchery-produced Juveniles, co-management of resources).

2. Manuals and other information materials on sea ranching and stock enhancement.

3. Training modules on sea ranching and stock enhancement.

4. Trained staff of government fisheries agencies on methods of sea ranching and stock enhancement.

RESOURCE-CULTIVATION FISHERIES BY ARTIFICIAL REEFS

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■ RESOURCE-CULTIVATION FISHERIES

Maritime countries make special effort to promote resource-cultivation fisheries. Figure 1 shows the resource cultivation fisheries based on biology and environmental engineering. Fisheries engineering deals with various techniques such as mass production of artificial seeding, formation and improvement of spawning and nursery grounds, development of fishing grounds, and the promotion of resource-cultivation technique.

■ FISHERIES ENGINEERING

Fisheries engineering technique aims to promote the resource-cultivation fisheries. It achieves this goal by means of environmental engineering, but it is not merely a study of dynamics. Rather, it is an academic field which encompasses a wide range of studies and activities such as (1) the study on the behavior of marine life, their response to environments (2) the identification, formation and control of environments in which marine life proliferates (3) hydraulics designs to enhance accident prevention and required function, after identifying optimum propagation conditions.

Example

If a certain type of fish tends to avoid a water mass with mixed water temperature and salinity (i.e. at certain density), the movement of water mass can be calculated and we can analyze fishways by applying the laws of physics.

Although the dynamic design of fisheries facilities is an area covered by marine engineering, little practical experience has been obtained so far in water depth of 200

meters or more. In some cases, we do not even have the knowledge of the basic design conditions.

The fourth subject the fisheries engineering deals with is (4) construction technology for marine structures. Here again, however, adequate technology has not been developed and we are faced with a new challenge such as the use of the continental shelf and shallow areas for aquaculture and fish farming.

■ FORMATIONAND CARE OF FISHING GROUNDS

Development of fishing grounds involves the engineering works listed below:

1. Formation and care of productive fishing grounds.
2. Formation and care of aquaculture.
3. Formation and care of fisheries propagation grounds.

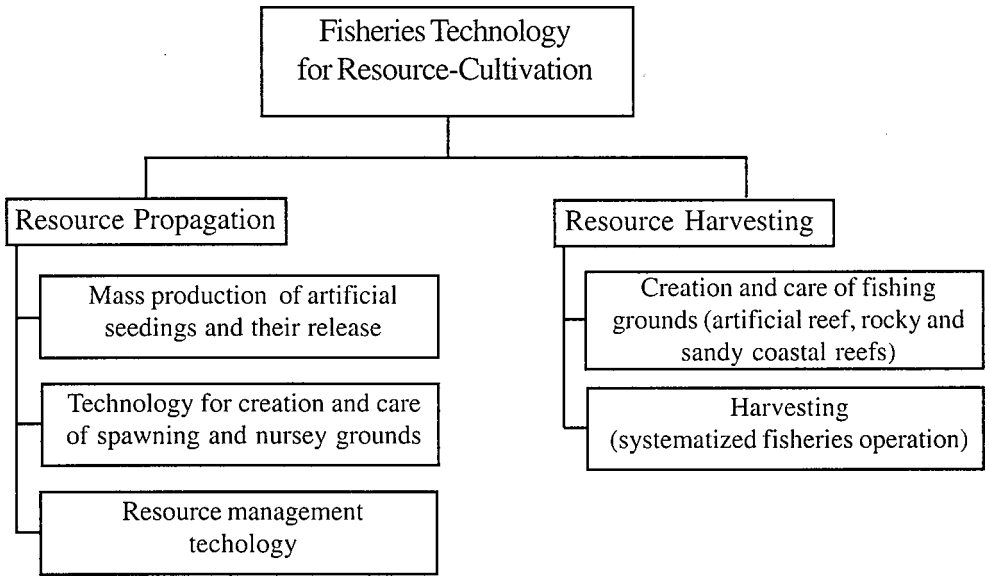


Fig. 1 Resource-Cultivation Fisheries

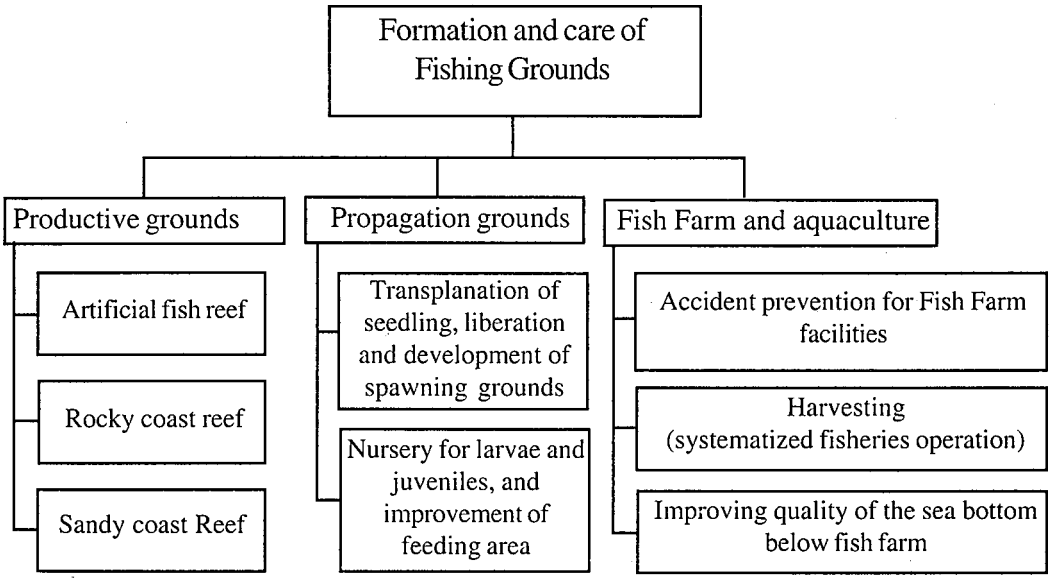


Fig. 2 Type of artificial habitats

Formation and care of productive fishing grounds

A "productive fishing ground" is an efficiently managed area, created for the purpose of increasing the harvest. It is also an area which allows us to cultivate resources and some example of productive habitats are artificial fish reefs, rocky and sandy coast reefs. Detailed descriptions of these structures will be made in the nex t section.

We can create productive fishing grounds by artificial means which emulate natural ones. It is one area that fisheries engineering address and it has trememdous potential for future development. It is likely that fisheries engineering in the future will evolve by incorporating new equipment and functions and by promoting "maring ranching" and systematiazed fisheries.

Formation and care of aquaculture

The term "aquaculture" includes sea surfaces as well as inland waters. Both artificial and natural feeding are practiced at these man-made habitats. Sea-surface aquaculture needs protective facilities to fend off waves. It is also important to secure a good flow of seawater in these habitats in order to keep the culture environments clean.

When culturing fish and shellfish in pond, leaks or other inland waters, the control of water quality and bottom grounds is quite an important subject. Accident prevention and improvement of facilities are also necessary, but these aspects are not discussed in this paper.

Formation and care of fisheries propagation

In essence, fisheries propagation technology is the application of artificial means to natural life history of target fish and shellfish species to enhance their propagation, and thus increase their catch. Most aquatic organisms spawn millions of eggs, but only a fraction of hatched spawn grows to aulthood. The highest mortality occurs immediately following birth. It is know that larvae and juveniles which survive the initial "high risk" periods usually grow into adult fish.

It is know from the existence of the "dominant year class" that a generation which has show an exceptionally high spawning rate wil later from a very large population. this shows the importance of early care in the very begining stage of larval growth.

Fig. 3 shows various methods used to increase larval propagation. The technique employed for mann production of artificl seding comes from biological engineering.

Resource-management technology is based on accurate resource forecasts and technology that allows efficent harvesting. Environmental control technology is equivalent to "artificial propagation ground formation technology", illustrated in Fig. 2, and involves such civil engineering works as the formation of artificial tidal basin, water ways, development of sand coast and rock reef seaweed beds, and the formation of propagation reefs and artificial inlet.

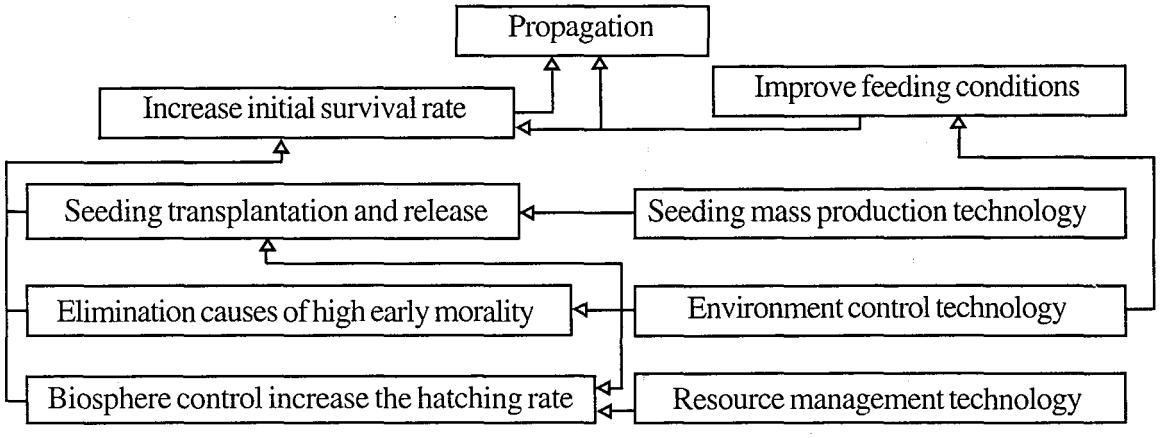


Fig. 3 Larval propagation and Required Technology

■ ARTIFICIAL FISH REEFS

Function

Artificial fish reefs protect and propagate fish populations and thus, contribute to increasing catch and efficiency in fisheries operations. In forming artificial fish reefs, we take advantage of behavioral characteristics of fish such as their tendency to aggregate in and around natural fish reefs and sunken ships.

Reef with widely varied topography are attractive habitats for various species of fish. When we look at the behavior of fish, they show certain taxis, or natural guided movements in response to a stimulus. Examples of various forms of taxis are listed in Fig. 4.

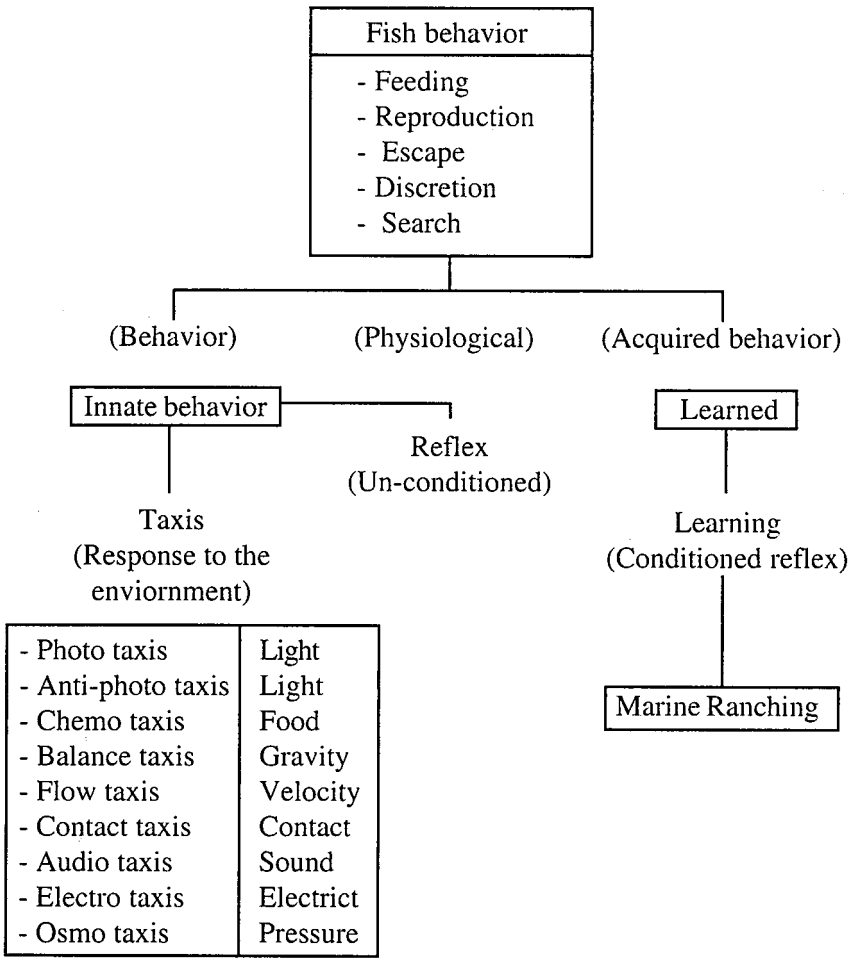


Fig. 4 Environmental stimuli and fish behavior

Animal behavior is triggered by natural intuitive impulses and displayed when its sense organs are stimulated. There are various froms of taxis, e.g. photo taxis caused by fish's sensitivity to light, chemo taxis triggered by the small of chemical components in the feed, balance taxis a fish intuitively keeps its abdomen down, but this may be interpreted as its anti photo taxis, and flow taxis cause by animal sense of action. Animals determine their body position in relation to the direction of surrounding objects or thier line in reference to the position or movement of the other objects), audio taxis, in which animals respond to certain sounds. (This behavior characteristic can be used in acoustic conditioning of fishes).

Intuitive behavior is a set of inborn behavioral patterns triggered by inner and outer conditions and including such activities as feeding, reproduction, escape, imitation and research. Reflexes are quick, either innate or learned reactions. An innate reaction to any stimulus is known as an unconditional reflex. The learned reactions are called conditional reflexes.

School of fish congregate in and around fish reefs because of their taxis and intuition. In designing the structure of a fish reef, it is important to know the functions of the sense organs of fish. In an effort to create environments attractive to fish, fisheries engineering takes advantage of these behavioral patterns of fish.

Reaction to fish reefs differs from fish to fish. Although there are no quantitative definitions, the tendency of fish to gather around a fish reef is well-known and is called "reef affinity".

By means of the relative positions that fishes maintain within the reef, they are classified into 3 to 5 categories. But is should be noted that such relative positions, and therefore, fish classification based on them, change with different stage of growth.

Type I : The fish keeps a part or most of its body in close contact with the reef.

Type II The fish does not directly come in contact with the reef, but the school swims around a reef or positions itself in the sea bottom around reef. (example: Red sea-bream, parrot bass, flounder, sole, blanquillo)

Type III : The fish swims close to the sea surface or in the intermediary waters far and away from fish reefs. (example: Yellow tails, skipjack, mackerels).

Structure

The most important issue in artificial reef design is how to make the best use of the target fish's taxis. For fish that gather around a reef, spacing is an important concern because they select habitats according to their body size. For example, Type I fishes such as hata and rockfish, which show contact-taxis, will need space and clearance of all sizes.

As for the Type II fishs, their photo taxis behavior is stimulted line by vision and their audiotaxis is activated by the lateral line. For them, the best clearance size is between 1.5 to 2 meters, then the fish can continuosly keep objects in view. Fish eye are true spheres and can see quite a wide range, as far as 150 degrees around the eye, but due to very poor resolution, their depth of vision is only about 1 m.

Therefore, an ideal fish reef for Type I and II in other words, bottom fishes, must have space and clearance of various size, all preferably under 2 m. Many fish leave the reef at night when their vision deteriorates. Those remaining in the reef area position themselves by sensing the differences in water pressure caused by turbulence in the flow, which in turn, is cause by physical structures of the reef. The minimum requirements for driving fish way from turbulence caused by the members of the reef are shown in the following equation.

$$Bu > 100 \text{ (Unit : cm, sec)} \qquad (1)$$

where, B is the width of the member and u is the flow rate. If the flow rate is $u = 5$ cm/s, then the width of the member, B, must be 20 cm. When the flow rate increases, for example during the tidal flow, fish with small swimming capacity move to the downstream of the reef. If down stream flow velocity is shown by u', and the upstream velocity by u, then the following equation holds true:

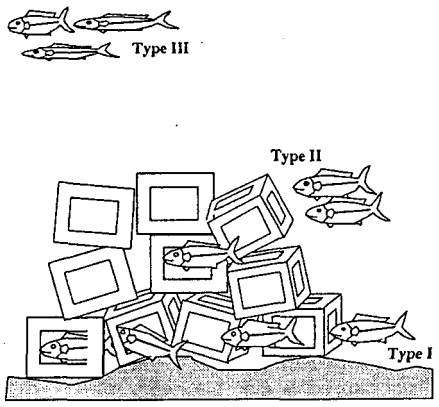


Fig. 5 Structure of fish reefs and fish types

$$u' = u\ (1\text{-}C_D A/2S) \quad (2)$$

where, C_D is the drag coefficient of the fish reef and A is the actual projected area where fluid pressure is applied, S is the area of the upstream flow tube that corresponds to the flow line of the hind-steam formed by the entire reef. S is about the same as the nominal projected area of the entrie fish reef, and this area includes all the internal areas including space (see Fig. 6)

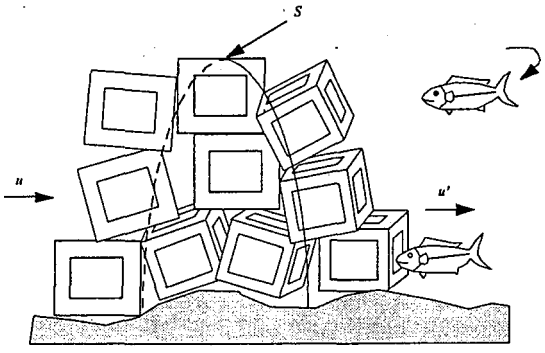


Fig. 6 Flow velocity behind a fish reefs

Exercise 1: As shown in Fig. 7, an artificial reef has been made by stacking 13 cubic reef units 1.5 m. in dimension. If the upstream flow rate is u = 1.0 m/s, what is the downstream flow rate, u'? The drag coefficient CP is 2.0 when the total fluid pressure is expressed by the projected area.

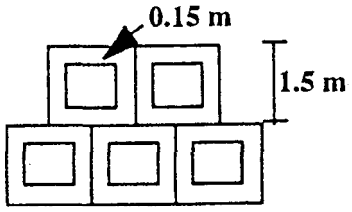


Fig. 7 Flow rates around cubic reef units

Answer : From equation (2)

$$u' = 1.0\left[1 - \frac{2 \times 5(1.5^2 - 1.2^2)}{2 \times 5 \times 1.5^2}\right] = 0.64 m/s$$

Active fish, e.g. those looking for food, usually locate themselves in the upstream tide around the reef. Therefore, artificial reefs must have a structure which ensures good tidal flos through them.

In summary, artificial fish reefs targeted at bottom fishes (Type I, II) must have various spaces no larger than 2m apart, having the width of the member obtained by equation (1), and intermediate sea areas. The reef must have sufficient height, and must be able to interrupt the water flow and create fluid noises. Interruption of flow and fluid noise can be calculated from equations (1) and (2).

In the case of pelagic fish (Type III), it is important to place artificial reefs in the surface and intermediate sea areas. The reef must have sufficient height, and must be able to interrupt the water flow and create fluid noises. Interruption of flow and fluid noise can be calculated from equations (1) and (2).

Fig. 8 shows the height of a turbulent flow in reference to the reef height/water depth ratio. The graph has been prepared by estimating the heights of turblent flows from the records of fish sounders. In this figure, we can see that turbulent flows develop rapidly to about 80% of the water depth if the height of the reef is about one tenth (10%) of the water depth. Turbulent flows do not develop as readily when the reef height exceeds 10% of the depth.

From Fig. 8, we can conclude that the optimal height of an artifical reef for Type III fishes is about one tenth of the depth of water. Sometimes the flow conditions at the bottom of the sea reach upper layers. One example is shown by the topographic wave. When density gradually increases from the surface to the bottom, and if there is only a mild flow, artificial reefs located at the sea bottom create topographic waves, a type of internal wave, as shown in Fig. 9. Topographic waves frequently develop when the reef height/water depth ratio is 1/10, and when the Froude number F = 0.09. The Froude number is defined by the following equation.

$$\left.\begin{aligned} F_r &= \frac{u}{\sqrt{egh'}} \\ \varepsilon &= \frac{\rho_2 - \rho_1}{\rho^2} \end{aligned}\right\} \qquad (3)$$

where, u is the flow rate, g is the acceleration of gravity, h is the water depth and are the density of sea water depth, ρ is water density of sea water at the top and bottom.

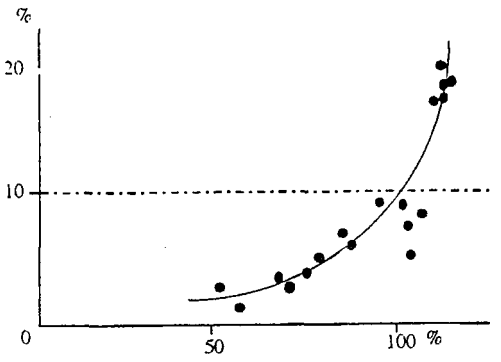


Fig. 8 Correlation bet when height of reef and height of turbulent flow.

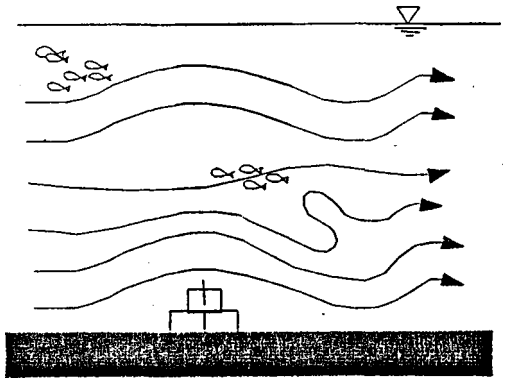
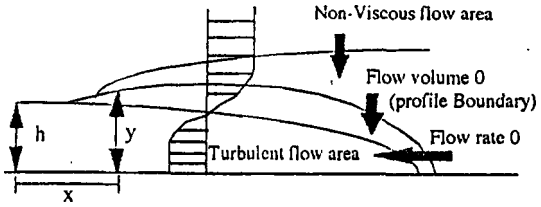


Fig. 9 Formation of topographic waves by an artificial reef.

At a maximum flow rate, Fr > 0.32 (=1/π), the topographic wave will be pushed back and the area behind the reef will have flows as shown in Fig. 10. This is proved by the movement of pelagic fish to deeper waters during bad weather.



The correspondence between topographic wave and type III fishes has been assumed by this writer and has not yet been proven. But obtaining data from research in the sea itself is quite difficult. By applying my assumptions, we can use the following criteria to determine reef location:

If Fr < 0.31, a submerged reef is better

If Fr > 0.31, a suspended reef is more desirable.

Construction

An artificial reef must be laid out as shown in Fig. 11. The terms used in artificial reef construction are defined as follows:

Fish reef unit : The single, smallest unit structure used for constructing an artificial fish reef.

Unit fish reef: The smallest fish reef created by placing one of more fish reef units together.

Fish reef group: An artificial reef created more than two interrelated fish reef units.

Fish reef zone: An expansive area containing more than two fish reef groups.

Unit fish reef

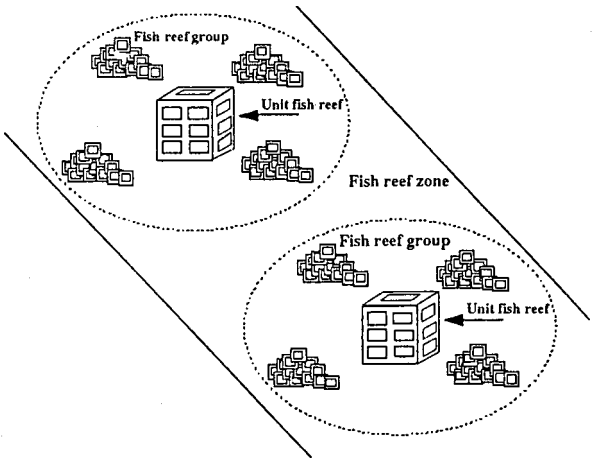
When we make an artificial fish reef, sometimes a single reef unit suffices to supplement the naturally existing ones. But on other occasions, several reef units are used. The purpose decides the functions of an articial reef.

A standard fishing ground size is approx. 400 m^3 and this criteria is used for determining the size of an artificial reef. But actually, the size varies with the construction accuracy at different depths, purpose of the reef, location, characteriestics of target fishes, sea area environments, the operating efficiency of fishermen and other factors.

For Type I fish, the nominal volume (m^3) is an important factor, while enveloped surface area and height are important, respectively, for Type II and Type III fishes. For reefs targeted at Type II and Type III, we can obtain a maximum enveloped surface area if the reefs are scattered. But if they are placed too far apart, fish gathering efficiency will drop because of decreased stimulus.

A distribution area within 20 times the projected area is considered desirable. Even in this case, however, it is not necessary to make the reef any higher than 5 m. When Type III fish are targeted, the reef height should be about one tenth of depth of water, but here again, the features of the particular sea area and the ease of construction method must be taken into consideration.

A fishing ground created by a unit fishing reef is about 200 meters wide from the edge of the reef, for Type I and II fishes and 300 meters in the case of Type III fish. Past research has shown that the distance between adjacent reefs, in which fishes can detect and migrate back and forth, is about 1 km.



Here is a partical example in determining the distribution of a fish reef, which ideally, should be within 20 times the projected area of the reef.

Exercise 1

Suppose a unit fish reef J is formed with cubic reef units with dimensions of **a**. The distribution radius r can be obtained from the following equation, when the unit reef surface area is S:

$$\left.\begin{aligned} s &= \frac{J}{a^3} \times a^2 \times 20 = \frac{2J}{a} \\ r &= \sqrt{\frac{20J}{\pi a}} \end{aligned}\right\} \quad (5)$$

For example is a cubic reef of $J = 400$ m^3. a = 1.5 m. is used then S=5333 m^2. and r = 41 m. This is the maximum size of an efficient reef, so a good fishing ground cannot be created by any distribution area greater than this. In other words, a good artificial reef can be obtainaed if J = 400 m^3, or by an accumulation of 119 cubic reefs in an area of 82 m. in diameter.

When you look at the size of unit fish reef from a construction viewpoint, the size of a unit reef Ju, and a arequired number of Nu, then the possible distribution range Rc can be obtained as follows:

$$\left.\begin{aligned} Ju &= \frac{\pi a r_c^2}{20} \geq 400m^3 \\ Nu &= \frac{\pi a r_c^2}{20a^2} \geq \frac{400m^3}{a^3} \end{aligned}\right\} \quad (6)$$

Exercise 2.

When you are given a cubic reef of a = 1.5 m., and asked to construct with an accuracy of rc = 50 m, then what is the required size of the unit fish reef?

$$Ju = \frac{\pi 1.5 \times 50^2}{20} \geq 600 m^3$$

$$Nu = \frac{3.14 \times 50^2}{20 \times 1.5^2} \geq 175$$

By using the above equations, you will need 175 cubic reefs. However, construction accuracy usually deteriorates with depth, therefore, the size of the unit reef usually become larger with increasing water depth.

Fish reef group

A fish group is an artificially created fishing ground made of several interrelated fish reef unit which have been laid out to attain maximum effect. When designing a fish reef group, it is important to note that the type of fish reef must match the fishing methods, angling, line haul, or sill net fishing. Using data such as estimates on increase in resources and volume of fish attracted to the reef, we aim at increasing daily catch per boat.

Artificial fish reef habitats are expected to increase the population of Type I fish, while an increase in Type II fish resources is also likely because reefs will contribute to the proliferation of plankton and benthos. We can achieve betters results by tying reef formation to artificial seedling release and construction of propagation grounds.

For Type III fishes, we can design various combination of unit fish reefs based on the estimated volume of fish attracted to them. In determining the distance between adjacent reefs, in achieving an effective fishing ground.

An effective distance is 400 m. for Type I and II, and 600 m. for Type III. These figure are obtained by doubling the figure 200 m. and 300 m., which are known to be effective congregation ranges for Type I, II and III, respectively.

Before constructing fish reef unit, the correlation between fish movements and water mass in a particular area must be studied to maximize the effect. In addition, adequate space must be secured for fishing operations.

Fishways are determined by releasing tagged fish or by tracing fish equipped with Bingers sounders, movement of water mass by checking water temperature and salinity, thermographics created by remote sensing, water color graphic analysis, and by behavioral analysis of internal waves as well as checking existing fishing rounds. Artificial reef must be placed in a way that they will intercept presumed fishways. Fig. 12 shows example of fish reef unit layouts.

Fish reef zone

In a fish reef zone, reef Unit and reef groups are placed one after another for maximum effect. The most important factors in fish reef zone installation are such that 1) they do not cause a drastic decrease in fish population density, 2) Create a series of fishing grounds which can be used one after another in conjunction with seasonal migration of various fish species.

In terms of fish population density, fishing grounds must have sufficient space between them so that a drop in the population at one fishing ground will not effect other areas. In other words, they must be spaced far enough apart to prevent migration of fish from one area to another. It is desirable for two adjacent fish reefs to be separated by more than twice the fish's perceptible distance.

The range of fish perception varies with the fish type and with currents. In an investigation conducted in Niigata Prefecture, Japan, the perception range of flounder was about 100 m. According to other research conducted in Shimane, it was 600 m. for red sea-breams.

The direction in which these fish reef zones are oriented is decided by considering such factors as the movement of water mass, estimated through physical and chemical investigations, and the assumed movement of the target fish based on biological research.

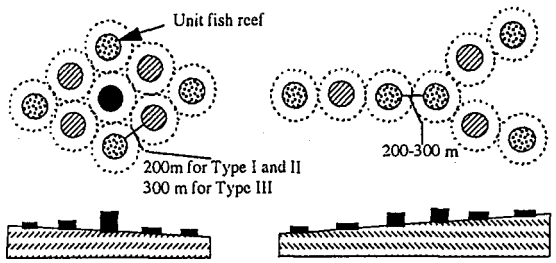


Fig. 12 Fish reef group creates by effective installation of unit fish reefs

Location of artificial fish reefs

When selecting a sea area suitable for farming artificial habitat, we must analyze the result of basic research and select areas assure can when fishing efficiency. It must be an area that enable fishermen to operate most effectively.

1) Target mrine life and location of fish reef

It is important to check the selected area for its suitability as a habitat for the target fish, and then, to check if it intercepts any fishway. An investigation of physical conditions such as water temperature, salinity and depth, is necessary to make sure that they are satisfactory for various stage areas which will benefit greatly from the installation of artificial reefs.

For Type I fish, since artificial reefs are most likely to enlarge their habitats, areas with good distribution and places which allow easy seedling release should be selected.

For Type II fish, area with good larvae distribution and those intercepting fishways of adult fish are more suitable.

For Type III fish, we must select sea areas which are part of fishways of adult fish.

In order to find the best location for installing artificial reef, we must know the distribution of the existing fishing grouds, conduct catch investigations as well as seedling release experiments. Needless to say, it is important to select an area which will easily allow future improvement or expansion.

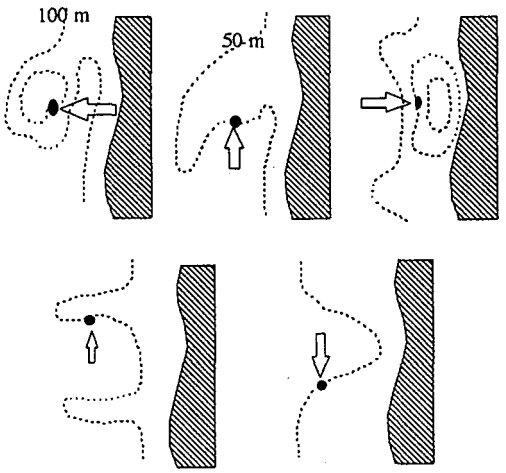


Fig. 13 Geographical features suited for reef installation

2) Physical and chemical conditions and location of fish reefs

Sea bottom features that are most suitable for artificial reef installation are those with good distribution and a wide variety of banks, seahills, basins, depressions, ridges, sea valleys and the like. In other words, they are areas which contain geographical features resembling islands, capes, bays and inlet on the water surface. Areas rich in geographical indentations support tremedous variety, for example, in terms of current flow rates, current direction, internal tides, internal waves, upwellings, etc. Artificial reefs must enhance these natural features and contribute to the propagation or congregation of fish.

When building artificial reefs along expansive sandy coasts, you must select a depth that would satisfy all biological conditions. Generally speaking, a good location is a semiflat area on the sloping side of a shelf. Whe building an artificial reef, it is desirable to select an area provided with many kinds of sea currents. For Type I fish, an area close to upwells with good supply of plankton and benthos is naturally suitable for purpose. For Type II fish, the movement of water masses must be considered, in addition to the volume of available feed, areas with little fluctuation in water temperature, salinity and tidal difference is considered better. For example, an area where internal tides and

waves merge makes a a good fishing ground.

Since Type III fish are sensitive to water mass movement, and hardly leave a water mass unless to feed or reproduce, it is only natural that larger water masses are better suited for artificial reefs aimed at Type III fish.

Isothermal variation lines indicate how long a certain water mass will remain in a aparticular sea area. They can be obtained by continuously measuring water temperature, for example, for two weeks or a month, and ascertaining difference in temperature. If line are far apart, the water mass is supposed to be large with stable water temperature and quality. Therefore, it is ideal for building an artificial ree. On the other hand, closely packed lines are an indication of rapid and violent changes in water masses, so in such areas, we can expect that Type III fish will not stay for a a long time.

In terms of the quality of the sea bottom, the volume of organic feed, such as benthos and detritus, the currents and flow dynamics need to be considered. The feed condition is of particular important for Type I and Type II fish.

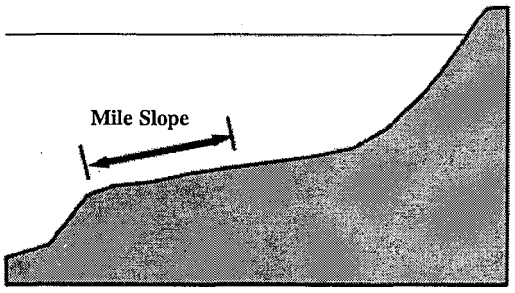


Fig. 14 Semi-flat sedimentation area suited for reef installation.

Estimate of effect on the catch

Potential increases in catch can be estimated by the amount of seedling released, farming conditions, actual catch and volume of uncaught fish, mortality and fish gathering effects of fish reefs. For particular purposes, fish catch effect is estimated by using the data of earlier, similar works, experimentally submerged reefs, of the catch volume in similar sea areas.

The reef's effect in attracting fish differs with the type of fish that are dealt with, e.g. Type I, II or III. Potential catch is estimate in the following manner, if the area developed by building artificial reefs is considerably larger than the measurable area (in which the catch is already known and can easily be measured.)

For Type I fish, an increase in the habitat leads to an increase in catch, so potential catch grows in proportion to the overall size of the the artificially created reef. The catch effect of Type III fish will increase in proportion to the area of the newly created reef, if the size of their schools passing that particular area is sufficiently large. In the case of Type II fish, the amount of plankton, benthos and other feed supply conditions are an important factor.

Fig. 15 show the time required for a fish reef to become operative. For Type I, the required time is equal to the time period needed for natural growth of larvae into adulthood, while Type III will show immediate results. Type II requires a time period womewhere between Type I and Type III.

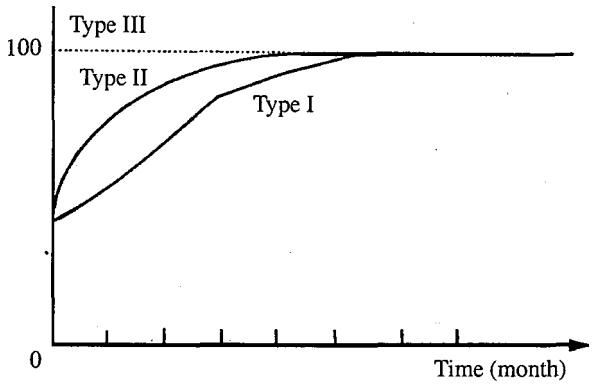


Fig. 15 Shows the time required for a fish reef to become operative.

RESOURCE ENHANCEMENT STRATEGIES AND STOCK ENHANCEMENT PRINCIPLES

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■ RESOURCE ENHANCEMENT STRATEGIES

1. Regulation or control of fishing activities through legislation

- Regulation of fishing season
- Prohibition on the use of specific fishing gears
- Regulation of harvestable size
- Prohibition of specific fishing areas

2. Establishment of marine sanctuaries or protected areas

- Likely to be the only effective means of replenishing a fishery where there are no resources to establish hatchery infrastructure
- Provides a base population whose excess recruits will spill out to colonize fished areas

3. Prevention of degradation of the environment

- Pollution control
- Mangrove reforestation

4. Modification or rehabilitation of habitats

- Deployment of artificial reefs
- Seaweed reforestation or afforestation

5. Transplantation of stocks

- Preferably of breeding adults from unprotected to protected areas
- A means of establishing a breeding population in an area whose native population is scarce such that gamete fertilization is almost nil

Release of hatchery-produced seeds (stock enhancement)

- A means of artificial recruitment to supplement or enhance existing stocks; potentially much more rapid than natural stock recovery and could be self-sustaining if the seed reproduce before harvest

■ DEFINITIONS OF STOCK ENHANCEMENT

- Activities aimed at maintaining or sustaining the productivity of marine and freshwater bodies through the production and stocking of seeds and the maintenance and development of fishing grounds (Regionalization of the Code of Conduct for Responsible Fisheries – Aquaculture Development, 2001).
- A process whereby the abundance of free-living juveniles is supplemented by the release of juveniles reared in hatcheries or captured elsewhere e.g., in offshore oceanic areas (Munro and Bell, 1997).
- Stocking of hatchery-produced seed for the public good without the intention of benefiting an exclusive user group (Bannister et al., 1991)
- Replenishment of wild stocks (Leber, 1999)

Propagation of resource organisms and/or modification of natural habitat and environmental conditions for recovery of depleted stocks and also for increased production from the natural grounds (Shokita et al., 1991).

■ MAJOR ISSUES IN STOCK ENHANCEMENT

1. Risk of disease introduction or increase in the wild fishery
2. Risk to the genetic integrity of the wild fishery
3. Consequences to aquaculture of genetic risk minimization
4. Resource sharing (stock and water)
5. Compliance issues

■ IMPORTANT CONSIDERATION IN STOCK ENHANCEMENT

1. Ecological – availability of food and niches; biodiversity conservation (no displacement of wild individuals); no introduction of pathogens
2. Genetic – preservation of genetic diversity of natural stocks
3. Social – resource-use conflicts, property rights, harvesting regulation, etc.
4. Economic – costs and benefits

■ PRINCIPLES OF STOCK ENHANCEMENT

1. Prioritize and select target species

- Define and rank criteria
- Consult community and local experts
- Get consensus

The choice of species depends on a combination of economic and social factors and biological characteristics. The most obvious choices are:

1. Highly desirable and valuable species
2. Early life stages should be amenable to being caught from the wild or reared in hatcheries, en masse, at viable cost

Important biological attributes

A. Hatchery production

1. Ability to spawn in captivity
2. Ease of larval rearing (e.g. non-cannibalistic behavior)

B. Release into the wild

1. Rapid adoption of behavior promoting survival in the wild
2. Fast growth
3. Relatively low natural mortality
4. Narrow habitat preferences
5. Minimal propensity to migrate (low mobility)
6. High fecundity

Protocol for species selection involving the community (Leber, 1994)

1. Initial workshop – to define and rank selection criteria in order of importance
2. Community survey – to solicit opinions on the selection criteria and generate a list of possible species for stock enhancement
3. Interviews with local experts – to rank each candidate species with regard to each selection criterion
4. Second workshop – to discuss the results of the quantitative species selection process and to seek consensus.

2. Develop a management plan for the species

- Goals and objectives should be clearly defined and understood prior to implementation (What is the population being enhanced? Can it be geographically defined?)
- Genetic structure of wild stocks should be identified and managed according to the objectives of the enhancement
- The following assumptions and expectations should be considered:
  - Post-release survival
  - Interactions with wild stocks
  - Long-term fitness
  - Disease

3. Use genetic resource management to avoid deleterious genetic effects

- Genetic monitoring prior to, during and after enhancement
- Collection of broodstock from the population into which hatchery-produced juveniles will be released

• Proper use of a sufficiently large and representative broodstock population and spawning protocols

• Regular replacement of broodstock

4. Practice disease and health managment

• Determine maximum acceptable levels of infection and parasites in the hatchery populations based on healthy wild population levels

• Screening for viral/bacterial infection and parasites prior to release

• No release of unhealthy seeds

5. Consider ecological, biological & life-history patterns when forming bjectives & tactics

• Ecological factors affect survival, growth, dispersal and reproduction:

- Biotic factors: predators, food availability, accessibility of critical habitat, environmental carrying capacity
- Abiotic factors: temperature, salinity

• Physiological and behavioral deficits in hatchery-reared fish can strongly reduce survival in the wild

- Swimming ability
- Feeding behavior
- Predator avoidance
- Schooling
- Habitat selection

6. Identify released hatchery fish and assess stocking impacts

• Tagging and marking systems should be reliable

• Evaluate if released hatchery fish increased abundance without displacing wild individuals

Tags appropriate for stock enhancement

1. Able to mark small individuals
2. Detectable in all subsequent life-history stages, especially the adult
3. Unique to the local population,
4. Suitable for identification of individuals or cohorts from multiple releases
5. Inexpensive to apply and detect
6. Transmitted to subsequent generations (or in other instances not transmitted)
7. Harmless to the tagged organism and subsequent consumer
8. Acceptable to the public

7. Use an empirical process to define optimum release strategies

• Conduct experimental releases to determine optimum

- Size at release
- Release season
- Release habitat
- Release magnitude

8. Define quantitative measurements of success

Example: Hatchery release will provide at least 20% increase in annual landings of top shells

Factors affecting the success of stock enhancement

A. Fitness of hatchery-reared juveniles
   1. Reduced tolerance to stress
   2. Increased vulnerability to predation

B. Release strategies
   1. Size at release
   2. Release season
   3. Release habitat
   4. Stocking density

Reasons for stocking failures

1. Failure to anticipate the impact of planted species on the native species
2. Failure to consider the suitability of the stocking material to the receiving aquatic systems
3. Failure to include habitat protection and/or enhancement as a consistent management technique
4. Failure to consider the quality of the stocking material

5. Faulty stocking techniques

Three basic information needed to measure the success of stock enhancement programs:

1. Rate of recovery of the released individuals
2. Cost of producing the additional juveniles
3. Unit value of the harvested animal

Four ways to assess the contribution of cultured juveniles to wild stocks:

1. The proportion of released animals in the commercial catch
2. The survival rate of released individuals at the time of first harvest
3. The ratio of cultured juveniles to the estimated recruitment from the wild stock
4. Increases in total catch following enhancement

Factors that determine the economic viability of stock-enhancement systems:

1. Cost of producing the additional juveniles
2. Magnitude of the increased production resulting from enhancement
3. Value of the additional production

9. Identify economic and policy objectives

- Estimate costs and benefits
- Develop economic models to predict the value of enhancement
- Educate the public and policy makers on the need and benefits of a responsible approach of stock enhancement
- Use co-management approach wherein there is sharing of responsibilities or management functions among government agencies, community, and other sectors

10. Use adaptive management

- Continuing assessment process that allows improvement overtime
- Continued use of the nine principles to ensure an efficient and wise use of a natural resource

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MARINE PARKS MALAYSIA–MANAGEMENT STRATEGY

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ABSTRACT

The coral reef is one of the most and productive ecosystems in the world. It provides a variety of resources and services and thus needs to be protected. The Marine Parks Malaysia was established with the objectives of conservation and protection as well as education. The Department of Fisheries has been given the task of managing the Marine Parks Malaysia as its establishment comes under the purview of the Fishery Act 1985. In its effort to manage the Marine Parks Malaysia sustainable the Department of Fisheries has to overcome several issues related to marine protected areas. Having a multi tiered governing structure has somehow added to the complexity of managing the Marine Parks Malaysia. With the Department of Fisheries having only powers within the waters of the marine parks, issues regarding terrestrial developments need to be addressed jointly with the relevant authorities. Other issues that needed attention are with regards to the conflict of use of the Malaysia for tourism and the tack of awareness among the public regarding the importance of the marine environment. The Marine Parks Malaysia also provide sites for long term research to understand marine ecosystems and ecosystem services in developing sustainable management and to explore and evaluate options for new forms of use. Other than these issues the Department of Fisheries also strives to overcome operational and management issues in terms of capacity building and sustainable financing.

■ INTRODUCTION

Coral reefs are among the most biologically diverse ecosystem on the planet. It is also sometimes known as the 'Rain forest of the sea' due to its highly productive biological diversity. Coral reefs cover over 1 million square km worldwide. A single reef is capable of supporting habitats for hundreds of fish species and other related living animals and plants. Though it covers less than 25% percent of the oven surface area, coral reefs provide protection and food security as well as livelihood to millions of the world's coastal community.

Though the coastal waters are rich fishing grounds there is a general consensus that the fishery resources in these grounds are currently intensively exploited (Ibrahim, 1987, DRM 1994, MoA 1994). Sheppard, (1992) showed that there is a steep decline in the fish catch per unit population from 1970 to 1990. In order to overcome or at the least, sustain the situation, there is a need for a sustainable resource management, rational development policy and management approach.

Other important symptoms in the decline in the fishery sector that indicate the need for better marine environment management are the fact that fishers are fishing for smaller and lower-value species. This is further aggravated by the fact that the fishers have to fish further from home bases and the destruction or degradation of fish habitats in coastal areas. This paper will discuss the management strategies taken up by the Department of Fisheries Malaysia as a primary government agency to manage, protect and conserve the living marine resources by way of establishing MPA's particularly the Marine Parks of Malaysia.

■ SETTING UP OF THE MARINE PARK

Proper management of the marine environment has increased its current and potential range of uses. The marine environment has been seen as a source of providing new industries such as tourism and even medical with the development of new forms of drugs from marine resources. Like fisheries, unless these uses are managed sustainable, they can threaten, change and destroy the very processes that they depend on.

Though parks and reserve were established as early as in 1925 (Jasmi, 1996), they were confined only to land areas. It was only in 1983, steps were taken to initiate for the conservation of the natural marine habitats in the form of marine parks and marine reserve(Ch'ng, 1990). In the initial stage only waters around Pulau Redang, Terengganu were gazetted. This was followed in 1985 by the gazettement, under the Fisheries Act 1963, of water areas surrounding 21 islands in Terengganu (including Pulau Redang), Kedah, Pahang and Johor as Fisheries Prohibited Area.

The Fisheries Act of 1963 was later replaced by the Fisheries Act of 1985 to cater for the rapid expansion of the fishing industries and for the management, protection and conservation of marine habitats and other living marine resources such as corals, marine mammals and turtles. Under the Fisheries Act of 1985, a provision for the establishment of marine park or marine reserve was made under Part IX – Marine Parks And Marine Reserve (Sections 41 – 45).

■ OBJECTIVES OF THE MARINE PARKS

In order to fulfil the need for a more sustainable marine resource the Marine Parks Malaysia was set up to meet the following objectives:

1. To conserve and protect biological diversity of marine community and its habitats;
2. To upgrade and conserve the natural habitats of endangered species of aquatic life;
3. To establish specific management zone for the conservation of aquatic flora and fauna; and
4. To establish zones of recreational use consistent with the carrying capacity of the area.

■ SIZE OF THE MARINE PARKS MALAYSIA

The size of a Marine Protected Area depends on what is there that needs to be conserved, Though much as been said about the size of protected areas, the Marine Parks Malaysia is thus defined as an area of 2 nautical miles measured from the lowest watermark of is lands that has been gazette as marine parks. To date a total of 40 islands have been gazetted as marine parks as seen in Appendix 1.

■ REGULATIONS PERTAINING TO THE MARINE PARKS MALAYSIA

For the Marine Parks Malaysia to be effectively managed there need to be in place a set of regulations in order to govern them. As such the do's and don'ts revolves around making sure that the Marine Parks Malaysia is always kept in the best state of health. Activities that are of destructive in nature are not allowed while activities that are of non-destructive in nature are encouraged. The Marine Parks Malaysia is therefore a no take zone within the confines of the marine park areas.

■ MANAGEMENT OF MARINE PARKS MALAYSIA

In an effort to provide continuous protection of resources within the Marine Parks the Department of Fisheries Malaysia set up several marine parks centres. At present there are 7 centres with the latest being the centres on Pulau Perhentian, which went operational in April 2003. See Appendix 2.

■ IDENTIFYING ISSUES IN MARINE PARKS MALAYSIA

The Marine Parks Malaysia is very new and young as compared to other marine parks in the world, thus there are plenty of things to do and learn. It has only been more than 10 years since the first marine park in Malaysia was first established, thus it is not unusual that issues that plagued other marine parks are also felt here. Though there appears to be a non exhaustive list of issues and problems, among those that have been identified are:

Institutional Arrangement

The challenge to manage the fragile marine resources wisely, to attain sustainable development and to protect the environment, habitats and the resources should not be address in isolation (Thomas, 1996). These must be pursued by quarters (scientist, economist, policy maker), social institution (NGOs) and the most importantly by public consciousness and willingness to pay/accept.

The structure of governance in Malaysia is based on a three-tier system structure around the Federal, State and the Local Government. While the structure of the tiered system appears simple, actual implementation is more complicated and complex and usually involves a combination of several governance levels and a myriad of policies, legislation, bylaws and guidelines (MIMA, unpub.). As such, the administration and management of landmass, water body and biodiversity in marine parks of Malaysia involved in one way or another all level of government. Failure of implementation at any level may causes adverse effect on the environment and the complexity of the institution framework and jurisdictions make management difficult.

Policy and legislative framework must take into consideration the needs, roles and functions of all relevant authorities, relevant organizations and local communities as to ensure that the resources in the resources in the marine parks have the necessary policy and legal protection for its sustainability.

Development Integrated Management Approaches

The institutional and legal issues coupled with the revolutionary development of marine parks uses have added to the management complexities. The existing marine parks objectives and policies need to be augmented and strengthened in order to meet demands from 'new users'. Management decision must justify not only in terms of benefits to the environment, but also in terms of public accountability and support.

Effective management will have to involve integrated planning and management of both land and sea and must be co-managed by the State, Federal and the public. In states where there is in existence a State Park or Development Board, a Joint Technical Committee will be established to foresee and facilitate management and conservation issues. Such joint committees have been planned in the near future between the Department of Fisheries and Tioman Development Authority; and between the Department of Fisheries and the Johor State parks. Other similar co management committees can be stimulated via the Marine Parks Advisory Committee at every State where marine parks are established.

Lack of awareness

Awareness on environmental issues, especially on marine related issues among the stakeholders that need to be increased. The low information base and lack of knowledge on the resources available and the importance of conserving these resources were identified as major underlying causes of the immediate threats to marine biodiversity (Vidisha *et al.*, 2000).

Marine Parks Malaysia recognised the importance of people management through communication. An informed community will promote the conservation and sustainable use of the marine parks assets and help to ensure marine parks meets its obligations under the national policy. More awareness campaigns are being brought about in order to facilitate the stakeholders to fully understand the idea of the marine parks.

Research

Our knowledge on the resources and the potential yields are limited by the degree of uncertainty of natural life processes. Inadequate information put resource managers in a difficult position. More often than not management is undertaken with any available data with the hope of minimizing risk,

Research within the Marine Parks Malaysia is encouraged, as this will add to the prevailing data on the parks. As a marine protected area (MPA) the Marine Parks Malaysia provide broad benefits as sites for reference in long term research to understand marine ecosystems and ecosystem services, to develop and evaluate techniques for verifiably sustainable management and to explore and evaluate options for new forms of use. In many coastal areas the ecosystems are highly degraded. These degraded areas are now the focus of attempts to restore the original services, such as healthy fisheries and research and exploration in biological diversity, which is still lacking in Malaysia.

Other examples of the economic value of maintaining biodiversity lie in the discovery of medical drugs and other valuable chemicals from marine plants and animals.

The Marine Parks Malaysia as protected areas can provide sits for repeated field surveys by over many years that can provide good information about long term change that cannot be obtained in any other way. This also has the advantage that by collecting and analyzing a particular year's data, it is likely to provide a good understanding of change in comparison to earlier years. It is also possible to inform managers in future decision making about marine environments and resources.

e. Tourism

When the marine parks were set up, the main objectives were conservation and education. With the increasing interest in marine nature tourism, more and more tourists are now looking at the sea for their enjoyment as such; the marine park soon became targets by the tourism industry. Marine Parks of Malaysia experienced an upsurge of visitors in recent years as shown in Appendix 3. Tourism is a globally competitive activity that depends on repeats businesses, positive word-of-mouth recommendation and marketing but is vulnerable to fashion cycles and negative reports by customers.

The quality of the natural environment is important for the setting and the activities, yet coastal and marine tourism areas are vulnerable to hasty and inappropriate development with consequent beach erosion and beach and water pollution. Unmanaged or inadequately managed visitation can lead to rapid resource and site degradation and a decline in visitor numbers. However, though the management of the marine parks is motivated by the philosophy of conservation and protection, of late there has been an increasing pressure to manage the people and the activities generated by them.

Sustainable financing

Maintaining a 'clean', healthy and sustained MPA is not cheap. When natural resources are depleted, there's often a hidden cost. The Government of Malaysia provided all the financial aliocation for management and development programs through the Five Years Malaysian Plan and the Marine Parks Trust Fund set up in 1987. To date, the Government had spent more than RM 21.6 million (approximate USD 5.68 million) on the development of marine parks centres and the acquisition of surveillance boats. The Government of Malaysia is also committed to maintain the management and conservation cost which include emolument for the staffs, allowances, maintenance of assets and equipment, petrol, diesel and other conservation activities which total up to nearly an average of RM 2.0-2.6 million yearly.

In view of the increasing number of visitors and an ever increasing cost, Marine Parks Malaysia must develop new but sustainable use of the environment and at the same time adequately meet financial obligation. There is a need to manage the marine parks profitably and thus create a revolving fund. This has been spurred by the

increase willingness to pay for leisure and recreational services. Thus, with proper planning and implementation, tourist development can bring significant financial benefit to the marine parks and subsides the management and development cost required. As such, the payment of the 'Conservation Charge' for entrance to the Marine Parks Malaysia was enforced beginning January 1999 in Marine Parks of Kedah, March 1999 in Terengganu and June 1999 in Pahang and Johor. The fee charged is RM5.00 (USD 1.32) for adults and RM2.50 (UAD 0.65) for children, student and pensioner.

The collection from the 'conservation charge' when it was first introduced was around RM 840,000 and in 2003 the collection was about RM 1.2 million. The conservation charge has managed to generate some income into the Marine Parks Trust Fund that was set up but still far from being sustainable in order to support the management and developmental cost needed to run the Marine Parks Malaysia. Co financing by other organisations in implementing projects in the Marine Parks Malaysia is welcomed and there has been great interest generated among the private sector.

Training and education and capacity building

Since ignorance is a major factor in human damage to coastal and marine environments, marine environments, marine protected areas can play a role in education. Reflecting a long-term commitment to establish and strengthen human resource and institutional capabilities, Marine Parks Malaysia recognises the importance of improving knowledge and skill, managerial capacity and experiences, enterprise development, scientific and technical know-how of the government personnel and the stakeholders.

The Marine Parks Malaysia play an important role in the training of resource management staff involved in policy development and implementation of a wide range of activities in coastal and marine areas. Courses being run at the marine parks can provide a valuable introduction and contribute to understanding and implementation of measures to achieve sustainability and maintain ecosystem processes. Most of these courses are in a way to improve in the capacity building of the staffs and to create awareness among the public. They play an increasing role in developing community understanding and demand for sustainable management of their marine environment.

The marine park centres also play an important role in tourism through providing training and support for local people involved in the industry. The centres themselves often provide an attraction for visitors seeking local knowledge of the area.

Fisheries Benefits

Within the fishing communities, few people understand how marine ecosystems function, how fish develop, how fishing and pollution affect the ecosystem that produces the fish and how to avoid damage or how to sustain fisheries for the future. This should not stop them from reaping the benefits of the marine parks. It is hoped that the Marine Parks Malaysia can benefit the fishing industry and community by;

Providing a spill over of an exploited species

Fish tagging studies show that fish species move out of a marine protected area and into surrounding waters, and with the evidence of record sizes, is evidence for a substantial level of spillover of these fish species from the marine protected area into the adjacent recreational fishery (Kenchington, 2002). The Marine Parks Malaysia thus, can provide a good supply of fishing resources for the fishing community while providing a base to support fishery stability. This is particularly significant for fish species that have been heavily exploited.

Protecting nursery grounds

By having a marine protected area the nursery ground of important commercial species can be protected. Even the Northern Prawn Fishery in Australia has recognized that

"no take" areas are an important management tool that can benefit the fishing industry by providing greater protection to critical nursery habitat than can currently be provided by the Australian Fisheries legislation.

Improving socio-economic standings of local communities.

Studies of Marine Protected Areas with "no-take" zones established in coastal and island areas that showed evidence of over fishing have demonstrated benefits of significantly improved fish catch. On the local front the anchovy fishery of Langkawi has shown improvement in catches in recent years and they attributed this to the setting up of the Pulau Payar Marine Park in Kedah.

Other strategies employed

- Establishing networking amongst managers, scientists, practitioners and local communities to share information and develop guidelines on appropriate restoration and rehabilitation practice to mitigate damage and restore damaged ecosystems;
- Taking steps to update and review existing management plans as well as the policy and legislative framework pertaining to the Marine Parks Malaysia, to be able to augment and take into consideration the necessary interventions to overcome all the threats identified.
- Review be made of restoration and rehabilitation methods and initiatives in order to evaluate cost effectiveness in recovering damaged ecosystems and the contribution towards the effectiveness of Marine Parks.

■ CONCLUSION

Preserving marine biodiversity is critically important if we are to achieve verifiably sustainable management of coastal and marine resources. The marine and coastal habitats of marine parks are subjected to threats due to multiple usage and especially man-made influence. Direct physical damage due to high development; visitor pressure especially in easily accessible shallow water coral reefs; damaged by illegal fishing activities such as by trawlers; and anchoring contribute to the degradation of the reefs. The Marine Parks Malaysia is established so that threats can be addressed but at the same time sustain the health and biodiversity of the marine resources.

The benefits of ecosystem services are often unrecognized because they are often taken for granted. Marine protected areas can help to ensure continuity and future options for those benefits by protecting the health of marine ecosystems. Well-managed marine protected areas have become major tourist attractions. Well-managed tourism can be a major source of income and pride for local communities, as well as for governments. There is now widespread experience from many countries to show that protected areas often earn significant revenue and make an important contribution to local economies.

We may be able to identify and value the current range of goods and services provided by a particular marine or coastal ecosystem but we know little of what the ocean might provide in the future in the way of new products, new resources and new opportunities to create wealth. Keeping samples of the ocean ecosystems in their natural form is a prudent investment in the future. Having a marine park with a "no-take" zone will ensure that areas are fully protected and this provide the most effective tool to avoid foreclosing on future opportunities for marine goods and services.

By having education centres on Marine Park Islands with 'no take' zones can be particularly important because they provide areas where people can experience and study marine plants and animals that are undisturbed by fishing and collecting. They can thus become points of comparison where people can observe and compare what they see with more impacted areas and appreciate the issues of sustainability.

Nevertheless, the success of the Marine Parks of Malaysia depend on the level of acceptance and compliance of policy and legislative framework and cooperation by all parties concerned.

Appendix 1

List of Islands Gazetted As Marine Park of Malaysia

State	Name of Islands	Water Area (Square miles)
Kedah	Payar	54.91
	Kaca	42.50
	Lembu	46.13
	Segantang	44.19
Terengganu	Ekor Tebu	40.60
	Kapas	21.33
	Lang Tengah	61.50
	Lima	43.90
	Nyireh	14.40
	Perthentian Besar	91.21
	Perthentian Kechil	81.07
	Pinang	48.90
	Redang	127.50
	Susu Dara	14.28
	Tenggol	24.00
Pahang	Chebeh	44.92
	Jahat	45.20
	Labas	44.78
	Sembilang	60.60
	Sepoi	44.57
	Seri Buat	77.20
	Tioman	251.15
	Tokong Bahara	45.13
	Tulai	63.03
Johor	Aur	97.45
	Besar	84.14
	Goal	45.70
	Harimau	49.00
	Hujung	52.35
	Mensirip	46.60
	Mentinggi	43.99
	Pemanggil	87.90
	Rawa	50.80
	Sibu	42.60
	Sibu Hujung	11.83
	Tengah	51.49
	Tinggi	101.80
FT Labuan	Kuraman	na
	Rusukan Kechil	na
	Rusukan Besar	na

Appendix 2

Location of the marine park centres

1. Pulau Payar – Kedah
2. Pulau Redang – Terengganu
3. Pulau Perhentian Kechil – Terengganu
4. Pulau Tioman – Pahang
5. Pulau Tingga – Johor
6. Mersing – Johor
7. Labuan -

Statistic on visitations to Marine Parks Malaysia

Year	Total
1988	1,373
1989	1,942
1990	4,312
1991	8,338
1992	15,519
1993	20,686
1994	40,524
1995	93,994
1996	109,893
1997	331,927
1998	342,834
1999	377,470
2000	465,858
2001	484,233
2002	287,031
Total	**2,585934**

ESTABLISHMENT MARINE RESERVES AND FISH SANCTUARIES IN THE PHILIPPINES

By: Pierre Easter L. Velasco, Aquaculturist 1

■ INTRODUCTION

The Philippines being an archipelago, consists of 7,107 islands, a coastline of 17,460 km, a coral reef area of 27,000 sq km and a shelf area of (Depth 200 m) of 184,600 sq km. This vast expanse of marine resource employs 806, 929 persons 374,408 of which comes from the Municipal, 357,984 from the commercial and 74,537 persons from the aquaculture sector (Philippine Fisheries Profile, 2000). However, these vast marine resources are under severe stress from the pooled impacts of human overexploitation, physical interruption, pollution, sedimentation and general neglect. The destruction and decline of coral reefs, sea grasses, mangrove and estuarine quality of the once tropical marine and coastal biodiversity center of the world is a disturbing dilemma which needs an immediate and effective solution.

To date, there are over 400 marine reserves and fish sanctuaries in the Philippines comprising a total area of 8,313.90 ha. On the other hand, only 37 areas have been well managed and protected.

Problems/issues in the Establishment of Marine Reserves and Fish Sanctuaries in the Philippines:

1. Lack of willingness, support and cooperation from the fishing communities/ stakeholders/fisherfolk
   - Improved fish-catches overtime are difficult to appreciate when benefits are long term and not easily seen.
   - Inadequate involvement of the community
   - Lack of Educational Campaign

2. Lack of Financial and Technical Capability
   - Delineation of Marine Reserves and Fish Sanctuaries
   - Surveys and Assessment

3. Traditional Rivalry or Territoriality
   - Jurisdiction of entities (i.e. academe, NGOs) over marine areas which are traditionally open-access
   - Socio-political

4. Involvement of other Government Agencies
   - DND, PNP, DILG, DENR, BFAR-RFOs

"The effectiveness of a marine reserve is closely tied to the traditional resource use patterns of the people who live within or surrounding the sites. Thus, in planning for a marine reserve, ecological knowledge of species and their habitat is no more important than a complete perspective on humans in their local environment, both in the traditional and modern senses" (CRM RL-E, BFAR-RFO-VII).

■ SITE SELECTION

Section 81 of RA 8550 otherwise known as **"The Philippine Fisheries Code of 1998"**

Social Criteria

1. Sites should be identified/recommended by the community/FARMC/LGU and validated/ assessed by the DA-BFAR Office
2. Should be accessible and manageable to the community

3. An active peoples organization

Ecological Criteria

1. Preferably the proposed site has mangrove stands, sea grass beds, or corals of no less than (20%) live coral cover and drop off slope of 22 deg

2. Away from river banks, ports, creeks, shipyard, landing area of boats of no less than two (2) kilometers

3. Should be away from fish corrals and other fixed structures

4. Presence of threatened or endangered species in the proposed site

5. Site should be diversified

6. Good water quality

7. Depth should be from zero to no more than 200 m

Economic Criteria

1. Should be outside the duly designated navigational lanes and not a landing or a docking area

2. Abutting or adjacent area should not be classified as an industrial zone

■ PROCEDURES

1. Site selection and baseline resource assessment

2. Mapping and charting of the proposed site

3. Presentation of the validation and assessment of the proposed area to the community and multi-sectoral group and consultation, feedbacknig, and dialogue thereof together with concerned agencies (DENR, DILG and DND)

4. Drafting of municipal ordinance by LGUs in consultation with the community and FARMCs and other sectors

5. Organization/strengthening of technical working group

6. Organization/strengthening of management/monitoring team group

7. Implementation, Enforcement, Monitoring and Adjustment.

■ COST ESTIMATES (10 hectares Fish Sanctuary)

1. Establishment

• Baseline Assessment	8,000.00
• Marker Buoys	37,960.00
• Billboards	6,100.00
• Post	22,800.00
TOTAL	74,860.00

2. Management and Protection

• Equipment	158,500.00

(Fiberglass boat, SCUBA Equipment, GPS, etc)

3. Structure

• Watch Tower/Guardhouse (Light materials)	27,430.00
• Mooring Buoys	5,060.00
• Sea Borne Patrol	53,500.00
TOTAL	61,303.00

4. Reef Check Training	32,500.00
TOTAL	352,150.00
Contingency (10%)	35,215.00
GRAND TOTAL	**387,365.00**

■ MANAGEMENT

Regulatory Technique

1. Passage of a municipal ordinance, FAO, Orders or any legal instrument declaring the area as Fish Sanctuary

2. Deputation of Fish Wardens

3. Regular Seaborne patrol to avoid encroachment

Non-Regulatory Technique

1. Continuing information education to the community

2. Cross visitation to areas where the implementation of the project is successful

3. Regular monitoring and assessment of the fish sanctuary

4. Organization of the Technical Working Group, management committee and monitoring team

5. Adoption of a management plan

6.Regular meeting of the management committee regarding the problems encountered in the implementation for adjustment of plan and policy.

ARTIFICIAL REEFS CONSTRUCTION PROJECT IN THAILAND

Kornwith Jankusol
Department of Fisheries, Thailand

■ ARTIFICIAL REEFS CONSTRUCTION IN THAILAND

Department of Fisheries, Ministry of Agriculture and Cooperatives take responsibility and duty to construct artificial reefs in Thailand. The government has distributed annual budget for construction cost since 1985. From the 6th national socio-economic development plan in 1987, the project of artificial reefs construction was started until now.

Before the artificial reefs construction project began, there were many artificial reefs experimental studies done by Marine Fisheries Station. Department of Fisheries. Using both natural and man made materials such as rock, wood, used tires and concrete tube to build for reef modules in various shapes. Another reef materials were designed concrete block in pyramid shapes and simple dice block. The results showed its potential to develop for fishery resource enhancement, better fishing ground for small-scale fisheries.

On the early of artificial reef construction project from 1985-1986, used tires and concrete pipes were mostly used and installed by dropping from sea surface. With the few experience of artificial reefs construction, most of the reef blocks were scattered in wide area, less fish aggregating, sunken in muddy bottom, damaged by pair trawl net boat and made troubles to gill net fishing gear of small scale fisheries. Artificial reefs construction area was within 3 kilometers from shore, where push net and trawl net were prohibited, which one objective was to be an obstacle material for those illegal fishing.

In 1987, designed concrete dice block which dimension size of one meter was used. The reef blocks were installed in smaller area of 6 square kilometers of each village site, divided into small groups at the corner and mid-length of the edge and one or two large groups at the center for better fish aggregating and reducing gill net damaged.

From 1988-1991 of the 6th national socio-economic development plan, there were two types of artificial reef construction

1. Small area artificial reef construction of 6-3 square kilometers for each village site Aimed for better fishing ground of small-scale fisheries. Reef block was concrete dice block which dimension size on one meter

2. Large area artificial reef construction of 50 square kilometers for each province site Aimed for fisheries resource enhancement and better fishing ground of fishery communities Reef block composed of concrete dice block which dimension size of 1.0 meter in large group and 1.5 and or, 2.0 meters in small group lining around

From 1992-1996 of the 7th national socio-economic development plan, two types of artificial reef construction were continued with some improvement in installation plan

1. Small area artificial reef construction

Decrease area into 0.5 square kilometers for each village site

Concrete dice block which dimension size of one meter in large group at center and 1.5 meters in small group at comer and mid length

2. Large area artificial reef construction

Concrete dice block which dimension size of 1.0 meter in large group for better fishing ground and 1.5 meters in small group lining around

From 1997-2001 of the 8th national socio-economic development plan, two types of artificial reef construction were continued with some improvement in installation plan

1. Small area artificial reef construction

Improve area into 1.0 square kilometers for each village site

Only concrete dice block which dimension size of 1.5 meter was used in 2-4 large group at center and small group at corner and mid length

2. Large area artificial reef construction

Maintained area of 50 square kilometers for each province site

Only concrete dice block which dimension size of 1.5 meter was used in large group and small group lining in cross section

From 2001-2003 of the 9th national economic development plan, two types of artificial reef construction were continued with some improvement in installation plan

1. Small area artificial reef construction

Same as before but there is a tendency to install in many groups instead of by area

2. Large area artificial reef construction

Decrease area into 30.0 square kilometers for each province site

There is more difficult in decision making of artificial reef site from difference fishing villages

■ OBJECTIVES IN ARTIFICIAL REEF CONSTRUCTION

1. To attract or aggregate fish for more efficiency fishing ground

2. To protect juvenile and young fish or be nursery ground which safety from high efficiency fishing gears such as trawl net and push net

3. To increase fishery resource production in natural

4. To be a new habitat for target fish which wanted to improve stock enhancement

■ ARTIFICIAL REEF SITE SELECTION

1. Water depth at least 5.0 meters at LLW for safety in marine transportation

2. Bottom condition of the sea is not mud and silt to avoid in sunking of concrete reef block

3. Reef site area is far away from river mount to avoid in rapid salinity changing

4. There is not much sedimentation to avoid unsuccessful succession of sessile organisms

5. Reef site area is not an obstacle for marine communication

6. Reef site area is not in area declare for marine utilities such as port area, anchor area, pilot navigation area etc.

7. Reef site area is not in area declare for navy utilities such as navy protected region, marine exercise area, country border line area etc.

■ STEP OF ARTIFICIAL REEF CONSTRUCTION

1. Site selection

2. Choosing area with the agreement of local fishermen

3. Survey of fishing status and environment conditions

4. Ask permission from Navy and Harbor Department

5. Bid process

6. Control on reef block construction and installation

7. Inform and advertise position of reef site to local fishermen and near by

8. Report to any government agencies concerned

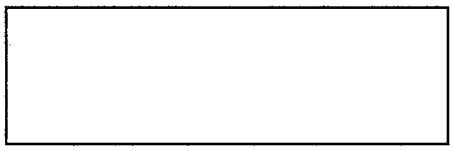
Result of Artificial Reefs Construction by DOF, from 1985-2003

Year of Budget	Small Areas			Large Areas			Total	
	Budget (Baht)	No. of Village	Area (km^2)	Budget (Baht)	No. of Province	Area (km^2)	Budget (Baht)	Area (km^2)
1985	3,000,000	5	40.81				3,000,000	40.81
1986	2,500,000	5	47.80				2,500,000	47.80
Total	5,500,000	10	88.61				5,500,000	88.61
6th National Socio-economic Development Plan								
1987	2,500,000	5	30.00				2,500,000	30.00
1988	2,000,000	4	16.00	30,000,000	2	100.00	32,000,000	116.00
1989	2,500,000	5	22.00	30,000,000	2	100.00	32,500,000	122.00
1990	5,600,000	8	24.00	30,000,000	2	100.00	35,600,000	124.00
1991	5,880,000	8	24.00	30,000,000	2	100.00	35,880,000	124.00
Total	18,480,000	30	116.00	120,000,000	8	400.00	138,480,000	516.00
7th National Socio-economic Development Plan								
1992	5,880,000	8	24.00				5,880,000	24.00
1993	7,500,000	10	2.50	30,000,000	2	100.00	37,500,000	102.50
1994	15,000,000	10	5.00	30,000,000	2	100.00	45,000,000	105.00
1995	15,000,000	10	5.00	30,000,000	2	100.00	45,000,000	105.00
1996	45,000,000	29	14.50	15,000,000	1	50.00	60,000,000	64.50
Total	88,380,000	67	51.00	105,000,000	7	350.00	193,380,000	401.00
8th National Socio-economic Development Plan								
1997	10,000,000	5	2.50	30,000,000	2	100.00	40,000,000	102.50
1998	20,000,000	10	5.00	15,000,000	1	50.00	35,000,000	55.00
Addition	30,000,000	10	10.00	20,000,000	1	50.00	50,000,000	60.00
1999	60,000,000	20	20.00	40,000,000	2	100.00	100,000,000	120.00
2000	75,000,000	25	25.00	40,000,000	2	100.00	115,000,000	125.00
Addition	12,000,000	4	4.00				12,000,000	4.00
2001	45,000,000	15	15.00	20,000,000	1	50.00	65,000,000	65.00
Total	252,000,000	89	81.50	165,000,000	9	450.00	417,000,000	531.50
9th National Socio-economic Development Plan								
2002	33,000,000	11	11.00	20,000,000	1	30.00	53,000,000	41.00
2003	48,000,000	16	16.00	40,000,000	2	60.00	88,000,000	
Total	**445,360,000**	**223**	**364.11**	**450,000,000**	**27**	**1,290.00**	**895,360,000**	**1,654.11**

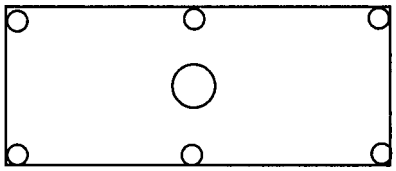
Development in Small-scale Area of ARs Construction

Reef Block installation plan

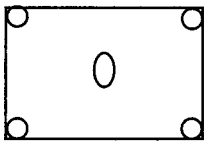
Large area (8 km^2)
Scater around area

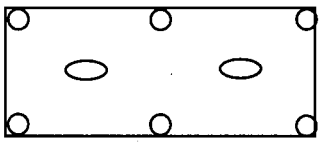


Decrease area to 3 sq.km.
Group arrangement

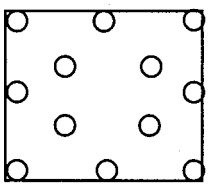


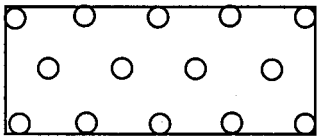
Decrease area to 0.25 & 0.5 km
1.0 m reef block in large
group at center
1.5 m at corner outside





Increase area to 1 sq.km.
only 1.5 m reef block





ARTIFICIAL REEFS IN MALAYSIA : THE MALAYSIAN EXPERIENCE IN RESOURCE REHABILITATION

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■ INTRODUCTION

Since the 18th century, artificial reefs are man-made objects intentionally placed on the sea-bed to increase the abundance of fishery resources. The bulk of documented work was carried out in the late 1900 (Ino,1974). Artificial reefs are man-made hard substrates purposely or accidentally placed on sea floors so that corals, sponges, algae, and any other reef-building organisms may colonize them. Like natural coral reefs, artificial reefs provide habitat for the same diversity of fish, invertebrates, and plants that natural reefs do.

The decline in marine fisheries resources due to the use of progressive gears resulted in habitat degradation. This decline in fisheries resources was reflected in research catch data in the coastal waters off the west coast of Peninsular Malaysia. The average catch rate decreased by 55 % from 131.1 kg/ hour in December 1970 to 58.9 kg/hour in December 1980. The average catch rate of trawlers in Peninsular Malaysia for 1986 was only 18.7 kg/hour (Department of Fisheries, 1987).

Used tyres were being deployed as artificial reefs, this programme was initiated by the Fisheries Research Institute with the first tyre reef at Pulau Telur, Kedah. Two more artificial reefs were constructed at Pulau Payar, Kedah in October, 1975 and at Pulau Aman, Penang in July, 1976.

The artificial reefs project started on a modest scale and progressed gradually utilizing existing facilities and manpower at the institute. Due to encouraging ecological development around the artificial reefs and the declined in fishery resources, the project was officially recognized as a fisheries development project. During the fifth Malaysian Plan from 1986 to 1990, the project was allocated a budget of RM 8.24 million.

Apart from the artificial reef project in Malaysia (whereby the Department of Fisheries is the executing agency), the Malaysian Fisheries Board (a semi-govtment body) also under the Ministry of Agriculture conducted a FADs development programme since 1983. For the period 1983 and the year 2001, a total of 222 FAD sites were established utilizing a budget a of RM 24 million. The FADs were constructed fromvehicle tyres, konkrit kuboid and cylindrical drain pipes. The FADs were for fishing, minimizing distance to rich fishing ground thus decreasing fuel costs and aimed at increasing the household incomes of traditional fishermen. THis paper will only discussed the experience of the Department of Fisheries Malaysia in the National Artificial Reef Programme.

■ OBJECTIVES

The objectives of the artificial reef project are :

1. To rehabilitate and conserve marine habitats that were degraded by trawling.

2. To increased the biological productivity and fishery resources through enhancement of sea-beds creating habitats for nursery and breeding of fishes and other marine organisms.

3. To acts as a nucleus for the recovery of coastal fisheries resources, thereby improving catches of artisanal fishermen.

■ ARTIFICIAL REEFS SITE SELECTION

Suitable site for artificial reef deployment was based on the following criterias :-

1. Firm seabed i.e. a sandy bottom is preferable
2. Depth range between 15 m to 25m
3. Adequate water clarity if it is intended for coral growth and for easy monitoring
4. Absence of strong currents that can result in scouring effects or artificial reefs being swept away
5. Away from traditional fishing ground
6. Away from shipping lane, guaranteed navigational safety.

■ BUILDING THE ARTIFICIAL REEFS

The materials for constructing the artificial reefs should be durable, long-lasting, cheap, easily available, handled and transported lastly it should not leach out any hazardous chemicals to the seawater.

In the initial stage, used tyres were being utilized for artificial reefs construction, tyres do not degrade seawater but if not properly tied , the tyres will litter the ocean floor and become a nuisance to gill-netters. Derelict or confiscated fishing boats were also being deployed as artificial reefs in 1984. The Fisheries Research Institute started to build artificial reefs using concrete pipes and culvert in 1986. The advantage of concrete against tyres is that they can be built bigger, stronger and in various designs.

■ TYRE REEFS DESIGN AND CONSTRUCTION

Before 1985, tyre reefs were constructed using 3 to 4 tyres tied up with polyethylene ropes, the tyres were tied into a tetrahedral shape , transported and deployed in batches of 300 to 500 tyres. The modules were tied up with other adjoining modules to limit possibility of drifting. The resulting tyre reef was irregular reaching a height of 1 meter.

Under the accelerated programme since 1984, tyres were tied into 42 tyres – pyramid, with resultant height of 1.5 m to 2 m. The floor space of a single pyramid is about 3 m^2. For every launching, 10 units of tyre pyramids were linked together by a 20 mm polyethylene rope. The tyre pyramids were randomly spaced on the seabed with occasional piling of a few pyramids reaching a height of 3 metere or more. Due to this loose arrangement, an artificial reef of 50,000 tyres can cover a seabed area of 0.7 hectares.

■ BOAT REEFS CONSTRUCTION

Before being deployed, derelict or confiscated boats were cleared of all debris and loose pieces which would otherwise result in flotsam upon sinking of boats. All water tanks and fuel tanks are opened or puncture to prevent trapped air from hindering the sinking of the boats. At preselected site, boats were anchored and then sunk by allowing water into the boats by knocking out the propeller shaft or by opening sea-cocks.

■ CONCRETE REEFS CONSTRUCTION

Malaysia's first concrete reef was built at Pulau Payar, Kedah in December 1986. The two concrete reef designs were made of concrete drainage culvert and concrete pipes. Both materials were arranged into a pyramid on a wooden platform and secure by steel cables. The resulting structure is 1.2 m in length, 2.4 m in width and 2.4 m in height. Ten units of each type of concrete reef, was individually placed on the seabed with the use of a crane.

In December 1987, another 20 units of concrete pyramids were deployed at Pulau Payar to expand the existing artificial reefs there. Modifications were made, the size of these concrete pipe units was increased to 1.8 m long and 0.9 m in diameter. The thickness of the concrete pipe was increased from 3.8 cm to 5 cm and strengthened with BRC-10

specification. The concrete pipe itself had 8 holes of 20 cm diameter and the wooden platform had 4 cross- beam instead of 3 cross-beam (previous design). The diameter of the steel cables was increased from 7 mm to 10 mm and a total of 4 such steel cables were used instead of 2 cables per pyramid in the previous design. The resulting structure is 1.8 m wide, 3.65 m in length and 3.6 m in height. Twenty artificial reef units of the same design were deployed at Muka Head, Penang in December 1987. Two concrete reefs were deployed off Kuala Ibai and Kuala Setiu, Terengganu in November 1987.

■ PVC REEFS

After the five year accelerated artificial reef programme , the project proceed at a slower phase. Other materials were being tested for suitability in artificial reef construction. PVC reefs were deployed in Pulau Lembu, Kedah in 1990. This experimental scale reef was funded under the ADB loan, subsequently a large scale PVC reef was constructed at Pulau Perhentian, Terengganu. PVC is a light, flexible material that can be easily transformed into various designs. Since it is very light, no heavy machinery such as a crane was needed for deployment of PVC reef modules. The smooth surface of the PVC pipes should be sand-papered to facilitate attachment by fouling organisms.

■ RECREATIONAL FISHING REEF

A concrete recreational reef was deployed in May 1992 at Pulau Tioman (a Marine Park) in Pahang. 720 concrete cuboids are used for this reef, each cuboid is 1.2 m. X 1.2 m. As Pulau Tioman is a tourist destination, this reef enhanced the tourism activities.

■ MALAYSIAN REEF BALL ARTIFICIAL REEF

In 1998, 1500 reef balls of different sizes were deployed at Pulau Talang-talang an island in Sarawak. Another site will be at Pulau Satang in Sarawak. Unlike other material such as used tyres and derelict vehicle bodies, the reef balls constructed from fibre-glass mould, using cement with the same pH as natural seawater contain no toxins or biologically active compounds.

■ FISHERY PRODUCTION AND ECOLOGICAL DEVELOPMENT AT ARTIFICIAL REEF SITES

Qualitative surveys were occasionally conducted by divers from the Fisheries Research Institute. Preliminary observations in some reef sites showed that the artificial reefs were rapidly colonized by fishes in the first few months after deployment and then the rate of recruitment levels off after about one year. At the Pulau Payar tyre reef in Kedah, the fish population has reached a stable state (Abdul Razak, L. and R. Mohd. Kushairi, 1989) showing the fluctuations in fish population.

Encrustation on the surface of the artificial reef be it tyres , concrete or PVC had been prolific with a variety of organisms such as micro-algae, barnacles, sponges, tunicates, anemones, hard corals, soft corals and bivalves such as oysters . The rate of encrustation appeared to be faster on the concrete reefs rather than the tyre or PVC reefs.

The major species of fish identified in the artificial reef sites are snappers, groupers, fusiliers, sweetlips, parrotfishes, rabbitfishes, jacks and damselfishes. Large shoals of snappers, Lutianus spp. numbering about 10000 – 15000 and fusiliers, Caesio spp. numbering about 10000 are not uncommon at any one time at artificial reef sites.

At the concrete reef site in Pulau Payar, Kedah large shoals of carangids were usually seen swimming in the vicinity of the concrete reef. Groupers are also a resident species, census at some reef sites indicate a population level of 1 grouper per 10 m2. The grouper population differ between artificial reef sites, certain small artificial reef may harbour as many as 30 to 40 groupers.

Many studies were carried out world-wide, Bohnsack and Sutherland (1985) reviewed artificial reef literature and found numerous, well documented observations of rapid colonization rate, high fish densities and high catch rate of artificial reef sites. High priority should be given to quantitively test predictive models and determine causes of phenomenon associated with artificial reef (Bohnsack, et. al. 1985)

■ STATUS OF THE ARTIFICIAL REEF PROGRAMME IN MALAYSIA

Until the end of 1991, utilizing the funds allocated (RM 8.24 million for the period from 1986 to 1990), fifty-two tyre reefs were established around Peninsular Malaysia, seven tyre reefs in Sabah and 6 tyre reefs in Sarawak waters. A total of 1.029 million tyres were utilized to build these reefs. In addition to the tyre reefs, there are also 9 boat reefs (7 in Peninsular Malaysia and 2 more in Sarawak) plus 4 concrete reefs in Peninsular (2 in the west coast and 2 sites in east coast). All the artificial reefs are located within the coastal inshore waters and the majority are near islands with distances ranging 200 – 500 meters from the shoreline.

■ PROBLEMS AND CONSTRAINTS AND RECOMMENDATIONS FOR FUTURE ARTIFICIAL REEF PROGRAMME

Under the accelerated programme of artificial reef development, more than 1 million tyres were collected and emplaced at all the artificial reef sites by 1990. This posed severe logistical problems in obtaining supply, storage, transportation and preparation of tyres. Accordingly the Department of Fisheries embarked into experimenting with materials other than tyres for the construction of artificial reef.

Efforts should now be directed to monitoring the reefs now considered 'matured', to quantify the benefits of the artificial reefs in terms of fisheries resource enhancement, conservation and rehabilitation of coastal ecosystems. The socio-economic impact to artisanal fisherfolks should be studied. The fisheries resources and other marine life in the immediate vicinity of the artificial reef must be protected and conserved in order to fully realize its potential in habitat rehabilitation and resource enhancement of coastal waters in Malaysia and around the world. Artificial reefs that act primarily by attraction may promote overfishing under heavy fishing pressure by increasing fish catchability.

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