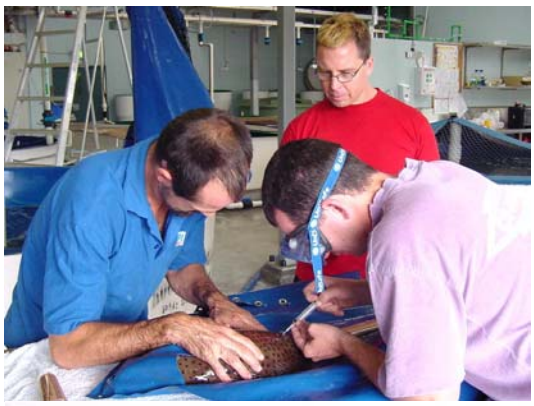
Report on the formalization of an Asia-Pacific marine finfish aquaculture network

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1 Executive summary

The Asia-Pacific Grouper Network was initiated in 1998 at a meeting of grouper aquaculture researchers in Bangkok, Thailand, to promote effective regional cooperation among Asia-Pacific economies involved in grouper aquaculture research and development. Since 1998, a range of government and non-government institutes and agencies with complementary skills and expertise have worked together and achieved considerable progress in grouper aquaculture research and development. The networking activities have also gradually expanded to cover tropical marine fish aquaculture and other aquaculture species of importance.

The network has held several meetings (www.enaca.org/grouper) to promote research cooperation and implement research activities. In the recommendations from participants at the APEC/NACA workshop in Medan in 2000[1], NACA was requested to formalize the participation of institutes within the network. This report provides details of the formalization process and was presented in draft form to the 13th NACA Governing Council for consideration. The process, supported by the APEC Fisheries Working Group and NACA, was undertaken through survey and consultations by questionnaire, that was widely circulated throughout the Asia-Pacific region.

The survey showed a wide range of grouper and other marine finfish species that are currently under research in institutes of the Asia-Pacific region. The research is mostly focused on production technology and appears to give less attention to non-technical issues, such as environment, marketing, food supply, certification, socio-economics and livelihoods. Efforts are being taken under the network to support further research on these issues. The survey shows a strong support for participation in a grouper network, and indeed expansion of networking activities to other species. The following gives the main recommendations arising from the survey that were presented for review by the NACA Governing Council.

This report has been prepared based on the recommendations of the NACA member governments to formalize the network within NACA as a regional network to support research and development in marine fish culture in the Asia-Pacific region. The main recommendations as adopted by the NACA Governing Council are provided below.

Structure of the network

Recommendation 1: The Governing Council approves the concept of absorbing the grouper network into the NACA network under an Asia-Pacific marine fish research and development programme and giving the NACA Secretariat a continuing mandate to coordinate the grouper network in close collaboration with an informal steering group comprising Queensland DPI, SEAFDEC AQD and the APEC Fisheries Working Group.

Recommendation 2: That the network comprise the following:

[1] Regional Workshop in Sustainable Seafarming and Grouper Aquaculture. Organised by the Asia-Pacific Economic Cooperation (APEC) in cooperation with the Government of Indonesia, the Network of Aquaculture Centres in Asia-Pacific (NACA) and the Bay of Bengal Programme (BOBP-FAO), 17th-20th April 2000. Medan, Indonesia. APEC Fisheries Working Group (FWG) project FWG 01/99 "Collaborative APEC Grouper Research and Development Network".

a) A small and informal steering committee that would be responsible for overseeing the activities of the marine fish network. The steering committee would involve the NACA Secretariat, and individuals from selected collaborating centers and collaborating agencies.
b) A number of collaborating centers would be selected based on present and planned research and development activities. The objective should be to engage a range of institutes or agencies involved in marine fish research and development within the Asia-Pacific region.
c) An inclusive and broader network of people, institutes and agencies involved in research and development of marine fish, that would be engaged largely through electronic means (eNACA), workshops, training and other activities.

Recommendation 3: That existing grouper network information mechanisms, including the web site and newsletters be maintained and further developed.

Recommendation 4: That small networks be established by NACA on other major commodities as required (eg seacucumbers, mudcrabs, tropical rock lobsters, tunas).

Process of formalization

Recommendation 5: That an official letter and Term of References (TOR) be sent to selected institutes to seek confirmation of their participation in the formalization of the grouper network (marine finfish network) and develop a joint program of work. The TOR will be circulated to APEC grouper project overseers and active participating institutes for comments and improvement.

Recommendation 6: That a Steering Committee be formalized under NACA for coordination of the network activities and identify participating centers. A workshop will be held in mid to late 2002, to formally mark the launching of the marine fish network.

Recommendation 7: That the following should be the responsibilities of participating institutes in the formalized grouper (marine finfish) network.

a) Responsibility for leading research on designated research activities related to marine fish culture development.
b) Provision of regular research and related activities update from the institute on a regular (quarterly) basis.
c) Provision of support to the activities of the marine fish network within the institutes designated area of strength and capability.
d) Participating in project development and seeking funding for network activities
e) Provide and send publications to the network, either in hard copy and/or electronic version.

Funding

Recommendation 8: That funding for the grouper network be principally through ongoing funding sources, including national funded research and development

projects. The core NACA secretariat funds will also be used to support selected coordinating functions. The sustainability of the network will heavily rest on the commitment of collaborating centers and participating institutes to commit their internal funding resources to support their participation in the network.

Recommendation 9: That the Steering Committee and collaborating centres seek additional funds for workshops, project activities and information dissemination.

Recommendation 10: That occasional workshops be promoted to bring people together to exchange experiences and develop more specific contacts and joint projects on issues of mutual interest.

Recommendation 11: That the networking concept is approved by the Governing Council, and the Steering Committee, in consultation with selected participating centres will further work towards development of funding mechanisms to support research and development in sustainable marine fish culture in the Asia-Pacific region.

2 Background

The Asia-Pacific Grouper Network was initiated in 1998 at a meeting of grouper aquaculture researchers in Bangkok, Thailand, to promote effective regional cooperation among Asia-Pacific economies involved in grouper aquaculture research and development. In response to concerns that there was considerable overlap of research effort in grouper aquaculture in the Asia-Pacific region, the meeting recommended that a Coordinated grouper research network in the Asia-Pacific Region should be established. This could be facilitated by:

a) Establishment of a research program comprising institutional and collaborative projects and facilitated by NACA in cooperation with other institutes.
b) Agreements by institutions to participate in a regional coordinated research program on grouper aquaculture technology development.
c) Additional training opportunities, for example through staff exchanges and short-term attachments at participating institutions.

Since the network was established in 1998, a range of government and non-government institutes and agencies with complementary skills and expertise have worked together and achieved considerable progress in promoting and undertaking grouper aquaculture research. Due to the success of the network its activities are also gradually expanding to cover tropical marine fish aquaculture and other aquaculture species of importance in coral reef areas. This broader approach recognizes that a range of different culture systems and species will eventually emerge that support the economic, social and environmental objectives of the network.

The network has held several meetings (see http://www.enaca.org/grouper/) to promote research cooperation and implement research activities. In the recommendations from participants at the APEC/NACA workshop in Medan in 2000[2], NACA was requested to formalize the participation of institutes within the network. The expected outcomes at the end of the formalization process were:

a) Structured research and development network working on grouper and marine fish aquaculture within the Asia-Pacific region.
b) Identification of expertise and responsibilities within the network.
c) Formal agreement among institutions/people on network participation, including a set of criteria on contribution and active involvement in the network activities.
d) Published list of research institutes in the region that are participants in the network, including detailed information on each of the members, facilities, expertise, interests, and other related information.

[2] Regional Workshop in Sustainable Seafarming and Grouper Aquaculture. Organised by the Asia-Pacific Economic Cooperation (APEC) in cooperation with the Government of Indonesia, the Network of Aquaculture Centres in Asia-Pacific (NACA) and the Bay of Bengal Programme (BOBP-FAO), 17th-20th April 2000. Medan, Indonesia. APEC Fisheries Working Group (FWG) project FWG 01/99 "Collaborative APEC Grouper Research and Development Network".

The process of formalization of the network was supported by the APEC Fisheries Working Group project "FWG 01/2001 – Collaborative Grouper Research & Development Network" and NACA. It involved collation of information on institutes and agencies involved in grouper aquaculture research and development in the Asia-Pacific region, mainly through a questionnaire. This information was supplemented through personal consultations and review of the materials from the two APEC/NACA grouper workshops (Hat Yai and Medan) and ACIAR project materials. The questionnaire that circulated is attached in the Annex (Section 8.1).

This report represents the outcome of this process and that was presented to the NACA Governing Council meeting in Langkawi in February 2002 for review and adoption.

3 Structure of the regional research program

The overall research program for the Asia-Pacific Grouper Network is:

1 Production technology
  1.1 Broodstock
  1.2 Larviculture
  1.3 Nursery
  1.4 Grow-out
  1.5 Post-harvest
2 Environment
3 Marketing
4 Food supply, certification
5 Socio-economics, livelihoods
6 Fish health

A number of project initiatives have been taken to address these key areas. These include the ACIAR Project FIS/97/73 'Improved Hatchery and Grow-out Technology for Grouper Aquaculture in the Asia-Pacific Region'; APEC FWG 02/2000 "Development of a Regional Research Programme on Grouper Virus Transmission and Vaccine Development"; APEC FWG 01/2000 "Development of a Health and Husbandry Manual for Grouper Farming"; and APEC FWG 01/99 "Regional Survey of Fry/Fingerling Supply and Current Practices for Grouper Mariculture: Evaluating Current Status and Long-term Prospects for Grouper Mariculture in Southeast Asia". Three staff exchanges have also been organized to promote exchange of expertise, and a study on the role of aquaculture in alleviating destructive fishing practices is ongoing.

4 Institutional survey findings

4.1 Institutional address and contact persons

The questionnaire was sent to 45 institutes, plus all NACA Governing Council members and all APEC Fisheries Working Group members in June 2001, and made available in the grouper electronic newsletter and on the web site (http://www.enaca.org/grouper/).

A total of 19 institutes provided detailed responses. Among them, 18 were from the Asia-Pacific (17 APEC members and one NACA member in South Asia), and one from South America (Colombia). This report will only analyze the information based on the 17 APEC institutes and 1 NACA member country as outlined below (the code for subsequent analysis is also given):

Institute	Code
Northern Fisheries Centre, Cairns – Australia	AU1
Darwin Aquaculture Centre - Australia	AU2
CSIRO Marine Laboratory, Cleveland - Australia	AU3
Department of Fisheries – Brunei Darussalam	BN1
Agriculture, Fisheries and Conservation Department – Hong Kong, China	HK1
Center for Brackishwater Aquaculture Development (CBAD), Jepara - Indonesia	ID1
National Seafarming Development (NSDC), Lampung - Indonesia	ID2
Research Institute for Coastal Fisheries, Maros - Indonesia	ID3
Laboratory of Marine Biotechnology, Sam Ratulangi University, Manado - Indonesia	ID4
Gondol Research Institute for Mariculture, Bali - Indonesia	ID5
Marine Research Institute, Chenju National University – Korea	KR1
Fisheries Research Institute (FRI), Penang – Malaysia	MY1
Marine Finfish Production & Research Centre (MAFPREC), Terengganu – Malaysia	MY2
National Marine Prawn Fry Production & research Centre (NAPFRE), Pulau Sayak - Malaysia	MY3
Brackishwater Aquaculture Research Centre (BARC), Johor – Malaysia	MY4
Sabah Fish Hatchery Center, Kota Kinabalu - Malaysia	MY5
Krabi Coastal Aquaculture Development Station, Krabi - Thailand	TH1
Marine Fisheries Department – Pakistan	PA1
CEINER – Oceanario Islas del Rosario, Colombia – South America	SA1

Contact details and preliminary institutional profiles are provided in Section 8.2.

Institutes involved in the ACIAR project, such as SEAFDEC AQD, that is actively involved in network activities, had expressed an interest to continue, but had not completed the formalization questionnaire at the time of writing this report.

4.2 Institute facilities and human resources

The survey provides details of facilities and human resources in institutes involved with grouper aquaculture. It appears that institutes in Australia, Malaysia and Korea are very well equipped with good facilities and human resources. In Indonesia, some institutes seem to have good facilities and with sufficient staff for research activities. The detailed institutional profiles are provided in the Annex (Section 8.3).

4.3 Production technology

There is a wide range of grouper and other marine finfish species that are currently under research in responding institutes. The table below provides a summary of the species and research activities in different institutes on different aspects of culture.

Species	Broodstock	Larviculture	Nursery	Grow-out	Post-harvest
Chelienus undulatus	ID1; ID2; MY5;				
Cromileptes altivelis	AU1; AU2; ID1; ID5; MY5;	AU1; AU2; ID1; ID2; ID4; ID5; MY5;	AU1; ID1; ID2; ID5; MY5;	AU1; AU3; HK1; ID1; ID2; ID3; ID5; MY5;	MY5;
*Epinephelus akaara (*Hong Kong grouper*)*	KR1;				
Epinephelus bleekeri				MYs;	
Epinephelus coioides	BN1; ID5; TH1;	AU1; BN1; HK1; ID5; TH1;	AU1; BN1; MYs; TH1;	AU1; BN1; MYs; TH1;	BN1;
Epinephelus fuscoguttatus	AU1; ID1; ID2; ID5; MYs; MY5;	AU1; ID1; ID2; ID5; MY5;	AU1; ID1; ID2; ID5; MY5;	AU1; ID1; ID2; ID5; MY5;	MY5;
Epinephelus malabaricus	BN1; ID1; ID2;	BN1;	BN1; MYs;	BN1; MYs;	BN1;
Epinephelus suillus	ID1;				
Epinephelus tauvina	BN1;	BN1;	BN1;	BN1;	BN1;
Epinephelus polyphekadion	ID5;	ID5;			
Epinephelus sp.		ID4;	HK1;	HK1;	
Lates calcarifer	AU2; HK1; ID1; MYs; MY5; TH1;	AU2; MYs; MY5; TH1;	AU2; MYs; MY5; TH1;	AU2; AU3; MYs; MY5; TH1;	AU2; MY5;
Lutjanus argentimaculatus	MYs;	ID2;	TH1;		
Lutjanus johnii	AU2;	AU2;	AU2;		
Lutjanus sp.	HK1; MY5;	HK1;	HK1;	HK1;	
*Pagrus major (*red seabream*)*	KR1;	KR1;	KR1;		
Chanos chanos				ID3;	
Trachinotus blochii (*Pompano*)	MYs;	MYs;	MYs;	MYs;	
Sciaenops ocellatus	MYs;	MYs;	MYs;	MYs;	
*Diagramma pictum (*painted sweetlip*)*	MYs;				
Convict grouper	KR1;				
Olive flounder	KR1;	KR1;	KR1;		
Parrot fish	KR1;	KR1;	KR1;		
Jewfish grouper	SA1;		SA1;		

The table below provides a further list of grouper and other marine finfish species that are targeted for future research activities in the responding institutes. These two tables clearly demonstrate what broad research is being undertaken or planned in the region.

Species	Broodstock	Larviculture	Nursery	Grow-out	Post-harvest
Cheleinus undulatus	ID1; ID2; ID5;	ID5; MY5;	MY5;	MY5;	MY5;
Cromileptes altivelis	ID1; MYs;	ID2; MYs;	AU2; ID2; MYs;	AU2; ID2; MYs;	AU2;
Epinephelus bruneus	KP1;	KP1;			
Epinephelus coioides	AU1; BN1; HK1; MYs;	• BN1; HK1; MYs;	BN1; ID5;	BN1; ID5;	BN1;
Epinephelus fuscoguttatus	ID1;	ID2; MYs;	ID2; MYs;	AU3; ID2; MYs;	
Epinephelus lanceolatus	MYs; TH1;			TH1;	
Epinephelus malabaricus	BN1; ID1; ID2; MYs;	BN1; MYs;	BN1;	BN1;	BN1;
Epinephelus suillus	ID1;				
Epinephelus tauvina	BN1;	BN1;	BN1;	BN1;	BN1;
Epinephelus polyphekadion			ID5;	ID5;	
Epinephelus sp.	PA1;	PA1;	PA1;	PA1;	PA1;
Lates calcarifer	ID1; PA1;	ID2; PA1;	ID2; PA1;	ID2; PA1;	PA1;
Lutjanus argentimaculatus	ID2;				
Lutjanus johnii				AU2;	AU2;
Lutjanus sp.	ID5;	ID5;	ID5;	AU3; ID5;	
Plectropomus spp.	AU1; ID5; MYs; MY5; TH1;	AU1; ID5; MYs; MY5;	AU1; MYs; MY5; TH1;	AU1; MYs; MY5;	MY5;
*Diagramma pictum (*painted sweetlip*)*	MYs;				
Ornamental Fish	KP1;	KP1; TH1;			
Seabreams	PA1;	PA1;	PA1;	PA1;	PA1;
Jewfish grouper	SA1;	SA1;	SA1;	SA1;	

4.4 Current research activities on culture technology

The questionnaire provides detailed information on existing project activities. The following summarizes ongoing research under the following culture technology topics: broodstock; larviculture; nursery; grow-out; and post-harvest. These areas correspond to the main research areas on culture technology under the programme. Summaries are provided here, and much of the detail is given in the Annex (Section 8.3).

4.4.1 Broodstock

In Australia, some institutes are working on broodstock management and domestication on *C. altivelis* and *E. fuscoguttatus.* Environmental manipulation on reproductive and spawning on *E. fuscoguttatus* is also being tried in one institute. The institute in Brunei Darussalam is currently working on broodstock maintenance and conditioning for species such as *E. coioides, E. malabaricus*, and *E. tauvina*. Studies on gonad maturation and spawning season of *E. fuscoguttatus, E. malabaricus* and *Cheilinus undulatus* are being carried out in Indonesia. Broodstock management and egg quality improvement for *C. altivelis*, *E. fuscoguttatus*, *E. polyphekadion*, *C. undulates* and red snapper are also conducted in Indonesia. The Korean institute is

conducting research on induction of sex maturation on *E. akaara*, and induced spawning of various species of grouper and marine finfish. The research institutes in Malaysia are working on broodstock maintenance of *L. calcarifer*, *L. argentimaculatus, S. ocellatus, E. fuscoguttatus, C. altivelis, T. blochii* and *D. pictum*. They are also working on natural spawning of *L. argentimaculatus* and *S. ocellatus* and induction spawning on *E. fuscoguttatus, T. blochii* and *D. pictum*. Genetic improvement work on *Lates calcarifer* is also being researched. In Thailand, broodstock nutrition for egg quality improvement on *E. coioides* is being carried out.

4.4.2 Larviculture

There is a considerable amount of research work on larviculture ongoing throughout the region. In Australia, research institutes are working on larval rearing techniques for *C. altivelis, E. fuscoguttatus, L. johnii,* and *L. calcarifer*. One of the institutes is looking at commercialization of the hatchery technique of *L. johnii* and *L. calcarifer*. Live food production of rotifers and copepod techniques are also commonly conducted within institutes. Hong Kong is conducting larviculture in an indoor intensive environment. Institutes in Indonesia are establishing larviculture techniques for *C. altivelis, E. fuscoguttatus, E. polyphekadion, E. coioides* and *Lutjanus* spp. Some of the institutes are working on natural food aspects on larviculture. In Korea, culture environment and live food organism are some of the ongoing research activities in the institute. Malaysian institutes are working on mass culture of live food organisms, and semi-intensive and intensive fry production techniques for *E. fuscoguttatus* and *L. argentimaculatus*. The Institute in Thailand is conducting research for *E. coioides* and trying to factors that can improve survival rate in hatchery.

4.4.3 Nursery

An Australian institute is working on commercial nursery operation of *L. calcarifer* and *L. johnii* aiming at improving survival and growth rates. In Indonesia, some of the nursery activities are carried out in hapa systems, and studies on multivitamins and live food are currently done on *E. fuscoguttatus* and *C. altivelis*. Nursery in floating cages for these two species are also being carried out. The Korean institute is running studies on environment and nutritional aspects on larviculture. Malaysian institutes are conducting research on semi-intensive and intensive nursing techniques for *E. coioides* and *E. malabaricus*. In Thailand, the institute is looking into trash fish replacement with artificial pellet diet for *E. coioides*.

4.4.4 Grow-out

The grow-out activities are not common in most Australian research institutes as currently fingerlings supply are lacking. Some work has been done on feed development based on *L. calcarifer*. Brunei Darussalam is conducting some floating cage culture. Hong Kong is focusing on grow-out nutrition and feed formulation for marine finfish species. Indonesian institutes are conducting studies on multivitamin enrichment feed and local ingredients for fishmeal replacement. *C. altivelis* and *E. fuscoguttatus* grow-out in sea cages are being carried out in some institutes. In Malaysia, open sea cage culture and sea pens culture for grow-out activities of marine finfish species are on trial at government and commercial farms. Experiments on floating cages and earthen ponds grow-out for grouper species are common in some research institutes. Old shrimp ponds are being used for grouper grow-out experiments in Thailand.

4.4.5 Post-harvest

Most institutes reported that they do not conduct any post-harvest research activities, except Malaysia that is working on a sanitary and phytosanitary (SPS) program for seafood products. One of the Australian institutes is cooperating with the industry on this aspect.

4.5 Future or planned research on culture technology

This section of the report describes future research project activities planned at the responding institutes. It is divided into 5 areas under the following topics: broodstock; larviculture; nursery; grow-out; and post-harvest.

4.5.1 Broodstock

The research institutes in Australia are interested in molecular techniques on sex change and reproduction and environmental manipulation in *C. altivelis*. Broodstock genetic improvement on *L. calcarifer* is also an area for further research. Brunei Darussalam is still working toward breeding techniques, both natural and induced for marine finfish species. In Hong Kong, the government agency is aiming at research activities on broodstock conditioning and induced and/or natural spawning in sea cages. Some of the research institutes in Indonesia are planning to develop technology on broodstock maturation and domestication of coral reef fish species, such as coral trout, *Cheilinus undulatus, E. malabaricus* and *Lutjanus* spp. In Korea, the research institute is interested in broodstock management and induction of sex maturation. In Malaysia, a National Mariculture Broodstock Centre is planned for future development of high priority mariculture species. Thailand intends to go into virus free broodstock selection activities.

4.5.2 Larviculture

Research institutes in Australia are planning to develop and investigating into ozone treatment of marine fish eggs for nodavirus control. They are also interested on further development and refining the larval rearing techniques for *C. altivelis* and *E. fuscoguttatus*. Assessment of nutritional value of live food and select breeding of SS-strain rotifers are some of the planned future activities. In Indonesia, larviculture techniques for *E. fuscoguttatus* and *C. altivelis* will be refined and live food production will be developed further to support larviculture, a research institute will work on larval rearing for coral trout and napoleon wrasse. Korea is interested in developing and industrialization of the culture of live food organisms. In Malaysia, the development trend will be moving toward intensive and super-intensive larviculture of marine finfish species. A research institute in East Malaysia will conduct collaborative research and development on artificial propagation of napoleon wrasse and grouper species with local universities. The research institute in Thailand will conduct trials on grouper larviculture in earthen ponds. Pakistan is planning to develop and culture some marine finfish such as seabass, groupers and seabreams.

4.5.3 Nursery

In Australia, the development of nursery and management techniques to minimize cannibalism in grouper species will be the future research activities. The government in Brunei Darussalam will be moving toward study on stocking of yolkfish directly into nursery ponds. Artificial diet formulation and development will be the future research activities for some institutes in Indonesia. An institute in Indonesia will also conduct research on nursery of *E. polyphekadion* and napoleon wrasse. In Malaysia, the intensive and super-intensive fry production of marine finfish species in closed system will be the development aspects.

4.5.4 Grow-out

The institutes in Australia will be working in collaboration with the industry to develop grow-out techniques for grouper and snapper species. Brunei Darussalam is interested in intensive culture in ponds and cages. Most institutes in Indonesia will be working toward developing artificial diets for grow-out of marine finfish species, which includes bioprocessing of local feed ingredient for fishmeal replacement. Research effort will also focus on pond grow-out of some grouper species and net cage grow-out of *E. polyphekadion* and *E. coioides* in one Indonesia research institute. Malaysia will be looking at further improvement of the current grow-out techniques.

4.5.5 Post-harvest

The institute in Brunei Darussalam is interested to work on transportation techniques of live grouper for market while the institutes in Malaysia would like to look at documentation on procedures and conditions for the importation of live grouper.

4.6 Current research on non-production/husbandry issues

This section requested responses on questions regarding research on: environment; marketing; food safety and certification; socio-economics and livelihoods.

4.6.1 Environment

There are several research activities carried out by the institutes with regards to environmental issues. Institutes in Australia are working on recirculation technology and effluent treatment systems for nutrient removal. Monitoring and environmental impact studies have been carried out in Australia, Hong Kong, Indonesia and Malaysia. Brunei Darussalam is working on zonation for aquaculture. In Korea, recovery of reef fish resources activities is being conducted. The research institute in Thailand is working on environmentally sustainable artificial feed for grouper culture.

4.6.2 Marketing

None of the institutes responded indicating any form of marketing activities for grouper aquaculture (apart from that reported under post-harvest above).

4.6.3 Food Safety and Certification

An institute in Australia is currently conducting some quality control system for production of disease free marine finfish fingerlings. Brunei Darussalam is using

HACCP program for monitoring seafood safety. Malaysia has developed an aquaculture farms certification scheme.

4.6.4 Socio-economics and livelihoods

This section requested that particular attention be given to activities designed to promote aquaculture as an alternative to destructive fishing in coral reef areas. One of the Australian institutes is providing technical support to The Nature Conservancy at Komodo, Indonesia, for a project on alternative livelihood programs for fishermen who were involved in destructive reef fish fisheries in that area. In Malaysia, the research institute provides on-the-job training for farmers and providing technical assistance to the farmers when needed, the government is also provide aid to farmers in the form of seed supply and farm materials to encourage and promote aquaculture. However, there appears to be relatively limited research on this aspect undertaken in the institutes responding to this survey.

4.7 Future research on non-production/husbandry issues

4.7.1 Environment

Australia plans to work on refining and further development on recirculation technology and effluent treatments systems for land-based aquaculture activities. In Brunei Darussalam, the government is looking at rehabilitation of cage culture areas in the country. Malaysia will carry out more environmental impact studies of aquaculture sites nation wide. In Indonesia, monitoring the impact of cage culture in the sea environment, and water quality monitoring activities including fluctuation in heavy metals in Hurun Bay area are being planned for future studies.

4.7.2 Marketing

None of the respondent institutes reported any future plan on grouper marketing.

4.7.3 Food Safety and Certification

There is no indication that any of the institutes that responded to the survey have any future research plans for food safety and certification. However, NACA is aware that the TNC in Komodo Park, Indonesia is looking at developing standards for for aquaculture of marine finfish, particularly for grouper and coral reef fish species. APEC has also recently funded a project on this activity in cooperation with the International Marinelife Alliance (IMA), TNC and the Marine Aquarium Council (MAC).

4.7.4 Socio-economics, Livelihoods

Further assistance is being provided to TNC Komodo Mariculture Project by Australian institutes. Brunei Darussalam will be looking at grouper fingerling fisheries for fishermen in the country. In Malaysia, joint collaborative work of research institutes to combat destructive fishing practices (DFA) including blast fishing and cyanide are planned.

4.8 Current extension and training activities

This section requested information on activities designed to transfer technologies to farmers/fishers and the private sector.

All the responding institutes in Australia provide some forms of extension or training courses, for example finfish hatchery technology specialized in *Lates calcarifer*, and also some fieldwork attachments for students. In Brunei Darussalam, the government provides training to new aquaculture farm operators. Hong Kong organized regular technical seminars and farm visits for promoting sustainable marine fish farming. The Korean institute provides technical transfer through seminars and networking. In Indonesia, with government support, institutes have conducted several training courses for fish farmers, and also provide job training for students, and also small workshops on mariculture. The Gondol Research Institute for Mariculture (GRIM)_ has been particularly active in training and extension. Training courses on grouper hatchery and milkfish hatchery can also conducted by research institutes in Indonesia. Institutes in Malaysia run short-term and long-term training course, technical workshops and seminars on marine finfish fry production, and these institutes also provide skilled staff attachment to private hatcheries. In 2002, the Thailand research institute conducted a grouper rearing training course for Fisheries Biologists.

4.9 Future and planned extension and training

Only two institutes provided plans for further extension and training activities. One Australian institute is currently developing economic models that can be used for project evaluation, and can possibly be used for extension purposes. The Gondol Research Institute for Mariculture (GRIM) in Indonesia plans to conduct seminars on mariculture development.

4.10 Current fish health research activities

There is a considerable amount of marine fish health research ongoing in the region. Australian institutes are currently working on nodavirus project on seabass and also developing PCR test kit for VNN. Health management program on broodstock and grow-out techniques are ongoing activities. Vaccine development against *Vibrio* spp., is also included. Brunei Darussalam is carrying out a monitoring program for water quality and bacterial load in the aquaculture area. In Hong Kong, the government agency provides regular farm visits and veterinary services to the fish farmers. Most institutes in Indonesia are working on the bacterial diseases on marine finfish, some institutes are also working on detection and control of VNN diseases and iridovirus in grouper grow-out activities. The institute in Korea is developing a supplement diet to enrich immunity in marine fish. Broodstock health management and viral detection, and fish vaccination are being carried out in Malaysian institutes. Thailand is working on selection of disease free broodstock for groupers.

More detailed information on research activities on grouper health is provided in the report of the APEC FWG 02/2000 project “Development of a Regional Research Program on Grouper Virus Transmission and Vaccine Development”.

4.11 Future and planned fish health research

Australia institute is planning for further work on nodavirus in finfish. Brunei Darussalam is planning to establish a central laboratory for fish pathology. In Indonesia, the research institutes are interested in conducting study on viral nervous necrosis in wild grouper and vaccination research, and some institutes report planning to conduct more studies on control of diseases in grouper larvae, grow-out and broodstock. Further development on broodstock health management and viral detection are planned for Malaysian institutes, and fish vaccination is also being considered. An institute in Malaysia is building a fish quarantine and fish health management center for supporting fish health activities.

4.12 Information on research and development of other coral reef species

In addition to marine finfish research and development, some coral reef and commercially important species are also being researched in some of the responding institutes. For example, tropical rock lobster, mud crab and shrimp are some of the ongoing research activities in Australia. Brunei Darussalam and Malaysia is involved in some abalone research activities. Research on pearl oyster and seahorse breeding and farming are found in Indonesia. Malaysia is also conducting sea cucumber and giant clam seed production activities, and also working on various mollusk species such as *Perna viridis*, *Crassostrea* spp. and abalone. In Thailand the research institute is trying to rear seahorses, sea urchin and sea anemones.

4.13 What do you want from a grouper and marine fish network?

The questionnaire requested comments on what institutes would like and offer to a grouper and marine fish aquaculture network. There was most widespread support for information and staff exchanges activities in the network.

There is an indication that the staff exchange program funded by APEC is highly recommended. The information dissemination mechanisms currently used such as Grouper Electronic Newsletter, Websites, Aquaculture Asia Magazine, and other forms of publication are supported for further extension and development. Although all the institutes support information exchange, it is clear from experiences within the NACA Secretariat that more active contributions from network members is required.

In addition, development of training courses, support to collaborative project development and seeking of funding sources were also identified.

4.14 Funding

The questionnaire requested information and ideas on funding mechanisms to support regional cooperation in grouper and marine fish aquaculture.

Some institutes are recommending that APEC and ACIAR funding should widen to other institutes. In Indonesia, human resources development was considered as a priority need that requires funding. Some institutes suggested establishing joint ventures and co-funding arrangements with the private sector.

Some institutes emphasized the importance of network support in developing collaborative research proposals on topics of common interest.

4.15 How can the private sector be more involved?

The responses to this question indicate that most research institutes are keen to work closer with the private sector. A few suggestions were made to involve private sector to commercialize the research outcomes. The details of the responses are listed in the table below. However, there has so far been less emphasis on commercial viability within research activities. Further consultation with the private sector and their input on research projects development for the network is a crucial point that needs to be addressed. This way, the network might be able to attract private sector participation to fund or co-fund some of the network research activities and increase the impact and commercial relevance of the work undertaken.

5 Summary of research activities

5.1.1 Status of research program

The status of research as indicated by this questionnaire survey show that a considerable amount of technical research is ongoing that is within the framework of the grouper research and development network.

The survey again, and as indicated by participants during the Medan workshop, shows that the other (non-technical areas of) research – environment, markets, socio-economics and livelihood issues – are not so well covered by the responding institutes. These topics, of considerable importance in the overall development of a sustainable grouper and marine fish aquaculture in the Asia-Pacific region, clearly need to be addressed. In particular, the links with institutes and projects involved with coral reef management and development, have yet to be firmly established. Learning from the experience in other coastal aquaculture developments, such as shrimp, environmental sustainability and social issues will have to be addressed clearly within the research program.

At the same time, there are also new areas of research emerging, for example, rock lobster farming, and tuna farming in Indonesia and Australia, and these offer interesting opportunities for cost effective regional collaborative research and development activities. Again, the networking requires being flexible to adapt to changing circumstances and priorities.

Opportunities also exist for broadening partnerships, including coral reef management and conservation initiatives, coastal livelihood projects and other regional or global programmes, such as the APEC Fisheries and Marine Resources Working Group activities, STREAM[3], UNEP South China Seas programme and the "Reversing Habitat Degradation and Increasing Productivity in the Coastal Zone" being proposed by CGIAR/ICLARM. Such collaborative partnerships also need to be explored, as do closer links with the private sector.

[3] Support to Regional Aquatic Resources Management (STREAM). A regional initiative of NACA, DFID, FAO, AUSAID and VSO – see www.streaminitiative.org

5.1.2 Identification of expertise and responsibilities within the network

The survey so far has indicated that considerable technical expertise exists within the institutes involved in grouper and marine fish research within the Asia-Pacific region. There are clearly also institutes interested in being involved in the network that are not represented here but ideally should be more involved in the networks activities.

The formal responsibilities within the network have yet to be identified. Following approval of the NACA Governing Council to absorb the grouper network under the intergovernmental organization, follow up activities are being undertaken to clearly identify individual institutional responsibilities within the network.

5.1.3 Benefits to participating centers

The commitment of institutions to participate in the network will bring significant benefits. Subject to further discussion, a title along the lines of "NACA Collaborating Centre" might be provided as might priority for assistance with developing training courses, participation in projects and support to identification of funding sources, for example.

6 Structure and mechanisms for grouper network operation

6.1.1 Structure

The grouper network has worked in line with NACA policy, with:

(a) a number of centers undertaking specific research activities within the network; and
(b) informal information exchange system (involving the electronic newsletter (that is received by 250 people/institutes at present, workshops).

The activities have been coordinated by the NACA Secretariat, in close collaboration with an informal steering group comprising some of the institutes cooperating in the ACIAR grouper project (Queensland DPI, SEAFDEC AQD) and the APEC Fisheries Working Group. This type of coordination can continue, provided the Governing Council providing the Secretariat with a continuing mandate.

The future network be formally absorbed within the NACA intergovernmental organization and be organized along similar lines. This would be in line with the NACA policy for participation of "collaborating centers" within the network and for more "people oriented" networking. Furthermore, the emphasis on using electronic means of communications, the web site and email newsletters, is in line with eNACA information approach, and will be strengthened.

The network would comprise the following:

a) A small and informal steering committee that would be responsible for overseeing the activities of the marine fish network. The steering committee would involve the NACA Secretariat, and individuals from selected collaborating centers and collaborating agencies.

b) A number of collaborating centers, that would be selected based on present research and development activities. The objective would be to engage a range of institutes or agencies involved in marine fish research and development within the Asia-Pacific region

c) An inclusive and broader network of people, institutes and agencies involved in research and development of marine fish, that would be engaged largely through electronic means (eNACA), workshops, training activities *etc*.

6.1.2 Information dissemination mechanisms

The questionnaire responses and consultations were supportive of a continuation of existing grouper information mechanisms. These include the following:

6.1.2.1 Website

The Asia-Pacific Grouper Network (APGN) website is now available at http://www.enaca.org/grouper. This includes sections such as: Background; E-Newsletter; Projects Section; Meetings & Workshops; Publications & Articles; Institute Profiles; Database; and Linkages. Further work is being undertaken to expand the scope of the website with a discussion forum and updated library/reference database. The web site also provides access to a dedicated ACIAR Grouper project (http://www.enaca.org/aciar) that provides a listing of ACIAR grouper project reports and allows researchers to access all relevant project material in one location.

6.1.2.2 Grouper Electronic Newsletter

Since the establishment of the Grouper Electronic Newsletter in 1999, the number of subscribers has continued to expand. The newsletter serves as means of exchange of research results from NACA, APEC and ACIAR projects, and from researchers active throughout the grouper network. To date the subscribers on the mailing list number about 250 people. Subscribers are from Asia and the Pacific, and the Americas, and Europe. There have been 15 issues of the newsletter so far by the end of 2001. All newsletters are available on the new website at http://www.enaca.org/grouper/E-Newsletter. The subject matter for the newsletter has also recently been broadened to cover other marine fish species.

6.1.2.3 Aquaculture Asia Magazine and other publications

The information made available has also been published in several reports and magazines that include a marine fish section in the Aquaculture Asia Magazine and other reports. A full list of available reports can be found at http://www.enaca.org/grouper.

6.1.2.4 Workshops

The network has supported several workshops and meetings, including the APEC/NACA Cooperative Grouper Aquaculture Workshop, 7-9 April 1999, Hat Yai, Thailand and Regional Workshop on Sustainable Seafarming and Grouper Aquaculture, 17-20 April 2000, Medan, Indonesia. These workshops have involved participants from government, non-government organizations and the private sector, from various economies with APEC and NACA members.

6.1.2.5 Training Courses

Arrangements are being made to expand training activities, through a Grouper Hatchery Training Course with the Gondol Research Institute for Mariculture, Bali, Indonesia, that will be held in May 2002. Other training courses will be organized in future, based around the expertise of the centers within the network.

6.1.2.6 Grouper Exchange Program

The network has supported staff exchanges and APEC Secretariat finally approved three exchanges during the period from 2001-2002. Staff exchanges leading to further expansion of project activities have been supported through ACIAR. Further such technical exchanges between institutes and agencies will continue to be promoted and supported.

Some of the future issues that need to addressed and have been identified in the questionnaire responses:

1. Expansion to non-grouper finfish species.
2. Support to development of funding sources and cooperative project preparation
3. Expansion of the grouper newsletter (perhaps each newsletter to be based around special research and development themes)
4. Closer links with coastal development and private sector activities in marine fish culture.
5. Further training activities

Regarding other "non-finfish" species, it is recognized that there are good opportunities and needs for more effective networking of institutes and people involved in other commodities. It is suggested that small groups be established on other major commodities as required (eg seacucumbers, mudcrabs, tropical rock lobsters, tunas etc).

A key issue now will be to lock in on-going responsibility for participation and coordinating the network. There is a need to be able to maintain the website and hold a workshop every so often so that the linkages are maintained. Around these can be built specific research linkages, projects and funding applications as the need arises.

7 Process of formalization

This report has been presented to the 13th NACA Governing Council Meeting for review. The Governing Council meeting has approved the concept of absorbing the grouper network into the NACA network under an Asia-Pacific marine fish research and development programme.

Following approval from the NACA Governing Council, an official letter and Term of References (TOR) are being discussed with selected institutes to seek confirmation of their participation in the formalization of the grouper network (marine finfish network) and develop a joint program of work. The TOR will be circulated to APEC grouper project overseers and active participating institutes for comments and improvement.

A Steering Committee would be formalized under NACA for coordination of the network activities and identify participating centers. It is proposed that a workshop be held in mid to late 2002, to formally mark the launching of the marine fish network.

7.1.1 Draft Terms of Reference for collaborating centers

The following are a list of responsibilities suggested for participating institutes in the formalized grouper (marine finfish) network.

- Responsibility for leading research on designated research activities related to marine fish culture development.
- Provision of regular research and related activities update from the institute on a regular (quarterly) basis.
- Provision of support to the activities of the marine fish network within the institutes designated area of strength and capability.
- Participating in project development and seeking funding for network activities
- Provide and send publications to the network, either in hard copy and/or electronic version

7.1.2 Funding mechanisms

The grouper network funding will be principally through ongoing funding sources, including national funded research and development projects. The core NACA secretariat funds will also be used to support selected coordinating functions. The sustainability of the network will heavily rest on the commitment of collaborating centers and participating institutes to commit their internal funding resources to support their participation in the network.

In addition, the Steering Committee and collaborating centres will seek additional funds for workshops, project activities and information dissemination. This would include the possibility of donor funds, joint government funds, NGOs and private funding mechanisms for future research and development activities. The networking would provide opportunities for cooperative research funding involving centers working on key issues and for close linkage with others working on coastal development, and should be attractive to government, donor and private sector funding.

Occasional workshops will be promoted to bring people together to exchange experiences and develop more specific contacts and joint projects on issues of mutual interest.

The Steering Committee, in consultation with selected participating centers, will further work towards development of funding mechanisms to support research and development in sustainable marine fish culture in the Asia-Pacific region.

8 Annexes

8.1 Questionnaire

Asia-Pacific Grouper Network

Questionnaire for Research Institutes and Other Agencies involved in Grouper and Marine Fish Aquaculture Research and Development

Institute name:					
Address:					
Contact Person:					
E-mail:					
Phone:		***Fax:***			
Please indicate whether your institute is interested in formally participating in the regional grouper research network				*Yes* ڤ	*No* ڤ

Background

The Asia-Pacific Grouper Network was initiated in 1998 to promote effective regional cooperation among Asia-Pacific economies involved in grouper aquaculture research and development. The network has been supported by the APEC Fisheries Working Group (FWG), the Australian Centre for International Agricultural Research (ACIAR) and the Network of Aquaculture Centres in Asia-Pacific (NACA).

The reasoning behind the development of a cooperative approach was to facilitate progress in research through cooperation. Previously, research on grouper aquaculture experienced limited success in breeding and larval rearing because research groups were isolated and not communicating well. The reason to strengthen cooperation on groupers was the very real concern to provide a source of aquaculture fish as an alternative to the capture of wild species and to protect endangered coral reefs and reef fish from the pressures of illegal and destructive fishing practices.

Since 1998, a range of government and non-government institutes and agencies with complementary skills and expertise have worked together informally and considerable progress has been made in grouper aquaculture research. The networking activities are also gradually expanding to cover tropical marine fish aquaculture other aquaculture species of importance in coral reef areas.

Following the request of participants at a workshop in Medan in 2000, NACA has been requested to formalize the participation of institutes activities of the network. The process is expected to complete in the period from April to August 2001 and the results will be presented at the NACA Governing Council in January 2002. The expected outcomes at the end of the formalization process are:

e) Structured research and development network working on grouper and marine fish aquaculture within the Asia-Pacific region.

f) Identification of expertise and responsibilities within the network.
g) Formal agreement among institutions/people on network participation, including a set of criteria on contribution and active involvement in the network activities.
h) Published list of research institutes in the region that are participants in the network, including detailed information on each of the members, facilities, expertise, interests, etc.

The first step in the formalization of the network is to prepare an update of the research and development activities of institutions and agencies involved in grouper and marine fish aquaculture research and development activities in the Asia-Pacific region. We would also appreciate if you would include your work on other coral reef species.

In this regard, we would appreciate if you would take the time to complete the questionnaire below and return to the NACA Secretariat by the 31st July 2001, either in hard copy, or by e-mail.

Institute
(*address, phone, fax, e-mail, web address*)

Contact person
(*name, address, phone, fax, e-mail*)

Institute details
Please provide brief information about your institute in term of facilities, human resources, etc.

Please provide outline of your projects/activities under the following program structure. Please include details of any collaborative aspects of these activities (e.g. other participating / collaborative laboratories or agencies).

1. Production Technology

	Species (groupers and other marine fish)	
Research Areas	**Current**	**Future / potential**
Broodstock		
Larviculture		
Nursery		
Grow-out		
Post-harvest		

1.1. Broodstock

- *Describe existing project activities*
- *Describe any future activities that are planned*

1.2. Larviculture

- *Describe existing project activities*
- *Describe any future activities that are planned*

1.3. Nursery

- *Describe existing project activities*
- *Describe any future activities that are planned*

1.4. Grow-out

- *Describe existing project activities*
- *Describe any future activities that are planned*

1.5. Post-harvest

- *Describe existing project activities*
- *Describe any future activities that are planned*

2. Environment

(*includes, but is not limited to, assessment of environmental impacts, alleviation of environmental impacts, assessment of impacts of wild-caught fingerlings on fisheries, etc*.)

- *Describe existing project activities*
- *Describe any future activities that are planned*

3. Marketing

- Describe existing project activities
- *Describe any future activities that are planned*

4. Food Safety and Certification

- *Describe existing project activities*
- *Describe any future activities that are planned*

5. *Socio-economics, Livelihoods*

(*particularly activities designed to promote aquaculture as an alternative to destructive fishing in coral reef areas*)

- *Describe existing project activities*
- *Describe any future activities that are planned*

6. *Extension and Training*

(*activities designed to transfer technologies to farmers/fishers and the private sector*)

- *Describe existing project activities*
- Describe any future activities that are planned
- *Training that can be offered to other network participants*
  (*including technical training in research and development methodology, etc.*)

7. *Fish Health*

- *Describe existing project activities*
- *Describe any future activities that are planned*

Please give information on research and development other activities involving aquaculture of other coral reef species (molluscs, seahorses etc).

What do you want from a grouper and marine fish network?
Please give brief comments on what you and your institute would like from, and would offer to, a grouper and marine fish aquaculture network.

Funding
Please give your ideas on funding mechanisms to support regional cooperation in grouper and marine fish aquaculture.

How do you think the private sector can be more involved?

Thank you for your time in completing this questionnaire. Please return the completed questionnaire to:

Mr. Sih Yang Sim
Asia-Pacific Grouper Network
c/o NACA
PO Box 1040
Kasetsart Post Office
Bangkok 10903
Thailand
Tel: 66-2-561-1728 to 1729 (Ext 120)
Fax: 66-2-561-1727
E-mail: grouper@enaca.org or sim@enaca.org

8.2 Institutional profiles

Details of the institutes and contact persons are listed in the table below.

Institute and Contact Person	Telecommunication Details
Australia	
Code: AU1 Dr Mike Rimmer Department of Primary Industries Agency for Food and Fibre Sciences – Fisheries and Aquaculture Northern Fisheries Centre, Cairns PO Box 5396, Cairns Queensland 4870 Australia	Tel: +61-7-4035 0109 Fax: +61-7-4035 1401 E-mail: Mike.Rimmer@dpi.qld.gov.au Website:
Code: AU2 Mr Jerome Bosmans Department of Primary Industry & Fisheries Darwin Aquaculture Centre GPO Box 990 Darwin, NT 0801 Australia	Tel: +61-8-8924 4266 Fax: +61-8-8924 4277 E-mail: bosmansj@ozemail.com.au Website:
Code: AU3 Dr Kevin Williams CSIRO Marine Research CSIRO Marine Laboratory PO Box 120, Cleveland, Queensland 4163 Australia	Tel: +61-7-3826 7284 Fax: +61-7-3826 7222 E-mail: Kevin.Williams@marine.csiro.au Website:
Brunei Darussalam	
Code: BN1 Ms Hajah Laila Haji Abd Hamid Department of Fisheries 3rd Floor, Ministry of Primary Resources Building Jln. Menteri Besar, BSB BB3910 Brunei Darussalam	Tel: +673-2-770 109; 770 736 Fax: +673-2-771 105 E-mail: laila_hamid@fisheries.gov.bn fishserasa@brunet.bn fisheriesplan@brunet.bn bruneifisheries@brunet.bn Website: http://www.fisheries.gov.bn
Hong Kong SAR	
Code: HK1 Dr Jim Chu Agriculture, Fisheries and Conservation Department The Government of Hong Kong SAR Cheung Sha Wan Government Offices 303 Cheung Sha Wan Road Kowloon Hong Kong, China	Tel: +852-2873 8332 Fax: +852-2814 0018 E-mail: jim_cw_chu@afcd.gov.hk Website: http://www.afcd.gov.hk
Indonesia	
Code: ID1 Dr Endhay Kusnendar Center for Brackishwater Aquaculture Development (CBAD) PO Box 1, Pemandian Kartini Jepara, Central Java, Indonesia	Tel: +62-291-591 125 Fax: +62-291-591 724 E-mail: badc@indo.net.id Website:

Code: ID2 Mr Sudjiharno Head of NSDC National Seafarming Development Center (NSDC) Balai Budidaya Laut, PO Box 74, Teluk Betung Bandar Lampung 35401 Indonesia	Tel: +62-721-471 380 Fax: +62-721-471 379 E-mail: asts@indo.net.id Website:
Code: ID3 Dr Taufik Ahmad Research Institute for Coastal Fisheries Jl. Makmur Dg. Sitakka No. 129 Maros, South Sulawesi Indonesia	Tel: +62-411-371 544 Fax: +62-411-371 545 E-mail: rsyah@indosat.net.id Website:
Code: ID4 Dr Inneke F. M. Rumengan Sam Ratulangi University Laboratory of Marine Biotechnology Faculty of fisheries and Marine Science Kampus Unsrat-Bahu, Manado 95115 Indonesia	Tel: +62-431-868 027; 856 864 Fax: +62-431-856 864 E-mail: inneke_rumengan@yahoo.com Daniel@manado.wasantara.net.id Website:
Code: ID5 Dr Adi Hanafi Gondol Research Institute for Mariculture PO Box 140 Singaraja, Bali 81101 Indonesia	Tel: +62-362 92278 Fax: +62-362 92272 E-mail: gondol@singaraja.wasantara.net.id Website:
Korea	
Code: KR1 Dr Young-Don Lee Marine Research Institute Chenju National University 3288 Hamdeok-ri, Jocheon-eup, Buk-gun, Jeju-do 695-810 Korea	Tel: +82-64-782 8922 Fax: +82-64-783 6066 E-mail: leemri@cheju.cheju.au.kr Website: http://mri.cheju.ac.kr
Malaysia	
Code: MY1 Mr Ismail Awang Kechik or Mr V. Palanisamy Director of Research Fisheries Research Institute, Malaysia Batu Maung, Pulau Pinang 11960 Malaysia	Tel: +6-04-626 3925/6 Fax: +6-04-626 2210 E-mail: ismawa01@dof.moa.my fripen@tm.net.my Website: http://agrolink.moa.my/dof/fri/
Code: MY2 Mr Hussin Mat Ali or Miss Nik Haiha Nik Yusoff Head of Centre Marine Finfish Production & Research Centre (MAFPREC) Tanjung Demong, Besut 22200, Terengganu Malaysia	Tel: +6-09-695 6778 Fax: +6-09-695 8626 E-mail: pppil@hotmail.com Website:
Code: MY3 Mr Yaakob Ahmad or Mr Ali Awang Head of Centre National Marine Prawn fry Production & Research Centre (NAPFRE) Pulau Sayak, Kota Kuala Muda 08500, Kedah Malaysia	Tel: +6-04-437 4021 Fax: +6-04-437 4470 E-mail: pppbuk@po.jaring.my Website:

Code: MY4 Mr K. Subramaniam Head of Centre Brackishwater Aquaculture Research Centre (BARC) Gelang Patah 81550, Johor Malaysia	Tel: +6-07-510 1202 Fax: +6-07-510 3015 E-mail: pptap@po.jaring.my Website:
Code: MY5 Mr Rooney Biusing Sabah Fish Hatchery Center Department of Fisheries Menara Khidmat, Kota Kinabalu Sabah 88628 Malaysia	Tel: +6-088-235 966 Fax: +6-088-240 511 E-mail: pnp2.ikan@sabah.gov.my Website: http://fishdept.sabah.gov.my
Thailand	
Code: TH1 Mr Paiboon Bunlipatanon Krabi Coastal Aquaculture Development Station 141 Moo 6, Saithai Muang District, Krabi 81000 Thailand	Tel: +66-75-695 149 to 151 Fax: +66-75-695 150 E-mail: Website:
Pakistan	
Code: PA1 Director General Marine Fisheries Department Ministry of Food, Agriculture & Livestock Government of Pakistan West Wharf, Fish Harbour, Karachi Pakistan	Tel: +92-21-231 2923 Fax: +92-21-231 6539 E-mail: Website:
South America	
Code: SA1 Mr Carlos A. Bohorquez CEINER – Oceanario Islas del Rosario PO Box 7877, Cartagena, Colombia South America	Tel: Fax: +57-56-673 4045 E-mail: ceiner@ctgred.net.co oceanario@ctgred.net.co Website:

8.3 Details of questionnaire responses

8.3.1 Institutional details

Facilities	Human Resources
Institute: Northern Fisheries Centre, Cairns, Australia	
Broodstock facility: • 6 × 60 m^3 • 7 × 30 m^3 • 6 with photothermal control Larviculture facility: • Replicated experimental system with 300-litre larval rearing tanks • Replicated experimental system with 30-litre larval rearing tanks • 900 and 5000 litre rearing tanks Live prey facility: • Stock cultures of a range of tropical microalgae • Algal culture laboratory capable of producing axenic cultures • Small-scale algal production unit (up to 5 m^3 tanks) • Rotifer (*Brachionus rotundiformis*) production facility • Copepod (*Acartia, Bestiolina*) production facilities Nursery facility: • 12 × 2 m3 tanks • Grading, transport facilities • Coded wire tagging system for stock enhancement studies Pond facility: • 1 × 0.3 ha broodstock pond • 4 × 0.3 larval rearing ponds (Oonoonba Veterinary Laboratory, Townsville) Laboratory: • pH meters, spectrophotometers, salinity meters, DO meters, etc • range of compound and stereo microscopes, including digital and 35-mm cameras • wax and resin histology processing facility • -80°C freezer, conventional refrigeration and freezer facilities • refrigerated centrifuge • spectrophotometric and fluorescent 96-well plate reader	• Marine finfish: 15 staff • Tropical rock lobster: 4 staff • Environmental impacts of prawn aquaculture: 3 staff • Related activities (licensing, administration, etc): 3 staff
Institute: Darwin Aquaculture Centre, Darwin, Australia	
Broodstock facility: • 1 x 45,000 litre • 1 x 70,000 litre (temperature control) • 6 x 20,000 litre (one temperature control) • 1 x 100,000 litre (temperature control) Hatching facility: • 8 x 1,000 litre Larval rearing facility: • 8 x 7,000 litre	• 14 staff

• 2 x 40,000 litre • 2 x 20,000 litre Nursery facility (intensive system): • 8 x 1,500 litre • 8 x 10,000 litre	
Institute: CSIRO Marine Research, Australia	
Laboratories in Cleveland, Hobart and Perth Research in all aspects of: • Marine environment and fisheries • Oceanography • Environment and aquaculture • Biotechnology Research collaborates widely with other research agencies in Australia and throughout the Asia-Pacific region	Total scientific staff approximately 300
Institute: Department of Fisheries, Brunei Darussalam	
Details not provided Government department	Details not provided
Institute: Agriculture, Fisheries and Conservation Department, Hong Kong, China	
Government Agency No further details provided	Details not provided
Institute: Center for Brackishwater Aquaculture Development (CBAD), Indonesia	
Total area: 60 ha land consist of 10 divisions, i.e. Shrimp hatchery, Marine finfish hatchery, Growout facilities; Fish Health Division, Fish Nutrition Division, Biotech Division, Soil and Water Analysis Division, and Live Food Division Facilities include: • Ponds • Tanks • Laboratory equipments	• 1 PhD • 11 Master • 50 Bachelors • 136 other staff
Institute: National Seafarming Development Center (NSDC), Indonesia	
Details not provided • Technical Executive unit under Directorate General of Aquaculture, Department of Marine and Fisheries in Lampung. • The main task of NSDC is to implement applied technique on breeding and seafarming system of marine commodities and keep sustainable fish resources and the environment.	Details not provided
Institute: Research Institute for Coastal Fisheries (RICF), Indonesia	
Two main installations: • Shrimp ponds • Floating net cages	Researchers are divided into the following groups/division: • Nutrition • Pathology • Bioecology • Aquaculture engineering • Genetics
Institute: Faculty of Fisheries and Marine Science, Sam Ratulangi University, Indonesia	
Department of Aquatic Researches Management • Laboratory hidrobioecology and fisheries biometrics • Laboratory fisheries business and economics • Laboratory aquaculture • Laboratory marine sciences Department of Processing Technology and Product Quality	Teaching Staff • Professor – 5 • PhD – 20 • Master – 82 • Sarjana – 71

Control • Laboratory processing technology and product quality control • Laboratory fishing technology • Integrated laboratory for coastal resources management	
Institute: Gondol Research Institute for Mariculture, Indonesia	
• Laboratory for biology, water quality, nutrition, diseases, genetic and biotechnology • Hatchery systems for shrimp, fish and crab • Concrete tanks for broodstock, larval rearing and live food mass production area • Brackishwater pond of 21 hectares • Floating Net cages in sea	• Researchers: 35, with 3 PhD and 9 Master • Supporting staff: 90
Institute: Marine Research Institute, Korea	
Total area: 14,895 m^2 • Main building: 2,470 m^2 • Other facilities: 1,498 m^2 with a fish culture room and a pump room 33 m^2.	• 2 full time researchers • 59 affiliation researchers • 4 invited researchers • 2 official staffs • 6 engineers
Institute: Fisheries Research Institute (FRI), Malaysia	
Laboratories and Research Facilities: • National Fish Health Centre • Aquaculture (technologies) Section • Aquatic Ecology Section • Fishery Resources Section • Fishery Products & Biotechnology Section	• Research Officer – 35 • Administrative Staff – 23 • Supporting Staff – 85
Institute: Marine Finfish Production & Research Centre (MAFPREC), Malaysia	

• Hatchery Phase I – 900 m^3 (in/out door tanks)
• Hatchery Phase II – 820 m^3 (in/out door tanks)
• Hatchery Phase III – 1,300 m^3 (indoor tanks)
• Semi-concrete pond (sandy bottom) – 4 @ 200-300 m^3
• Marine cages (for broodstock) – 6 @ 6x3x3m
• Brackishwater cages (for broodstock) – 14 @ 6x3x3m
• Dry laboratories for:
  o Nutrition
  o Pure algae culture
  o Fish diseases
  o Water quality
  o Biotechnology
• Wet laboratories for:
  o Bioassay experiments
• Training facilities with accommodation (available end of 2001)
	• Research Officer – 7
	• Administrative Staff – 10
	• Supporting Staff – 25

Institute: National Marine Prawn Fry Production & Research Centre (NAPFRE), Malaysia	
• Prawn/fish hatchery – indoor, open system • Mollucs hatchery – indoor, open system • Marine fish hatchery – indoor, recirculating system • Brackishwater nursery/grow-out pond • Training facilities with accommodation	Research Officer – 14 Administrative Staff – 14 Supporting Staff – 29
Institute: Brackishwater Aquaculture Research Centre (BARC), Malaysia	
• Brackishwater pond complex phase-I, without lining • Brackishwater pond complex phase-II, with different lining materials • Concrete tanks • Raceways • Laboratories for: o Fish nutrition	Research Officer – 5 Administrative Staff – 11 Supporting Staff – 16

○ Fish diseases ○ Biotechnology	
Institute: Sabah Fish Hatchery Center, Malaysia	
Facilities: • 2 fisheries research centers including marine hatchery center and 15 aquaculture development projects (freshwater, brackishwater cage culture, mollusk culture, shrimp culture and seaweed culture)	Workforce: • 650 persons including 50-odd graduates at PhD, masters, bachelor and diploma levels
Institute: Krabi Coastal Aquaculture Development Station, Thailand	
Total area of 93 rais, consist of earthen ponds of 2 and 4 rais in size, hatchery facilities, water and soil instruments	• 3 Fisheries Biologists • 4 assistants • 50 temporary workers
Institute: Marine Fisheries Department, Pakistan	
Department Facilities for: • Biology • Hydrology • Micro-biology • Fishing technology research Hatchery facilities for: • Fish and shrimp seed production	Details not provided
Institute: CEINER Oceanario Islas del Rosario, South America	
• Dry lab area: 24 m^2. • Broodstock sea pen 218m^2 • Grow-out cages – 8m^2 (currently rebuilding) Library computer room Outboard motor boats	Only few personnel

8.3.2 Ongoing production technology research

8.3.2.1 Broodstock

Australia	
AU1:	• Develop broodstock management and captive breeding techniques for *C. altivelis* and *E. fuscoguttatus* • Investigate the influences of environmental (photothermal) control on reproductive condition and spawning in *E. fuscoguttatus*
AU2:	• Domestication of the *C. altivelis* and investigation of the reproduction • Year round spawning of *Lates calcarifer*
Brunei Darussalam	
BN1:	• Broodstock maintenance and conditioning at floating cages
Indonesia	
ID2:	• Applied study on gonad maturation and spawning season of tiger grouper • Applied study on breeding of malabar grouper • Study on gonad spawning of napoleon wrasse with environment and hormonal manipulation
ID5:	• Broodstock management for improvement of egg quality for *C. altivelis, E. fuscoguttatus, E. polyphekadion*, Napoleon fish and red snapper
Korea	
KR1:	• Induction of sex maturation – control of photoperiod and water temperature • Induction of spawning – LHRH injection • Production of fertilized eggs (species such as convict grouper, hongkong grouper, olive flounder, red seabream, and parrot fish)
Malaysia	
MYs:	• The use of HUFA and free tyrosine for improvement of eggs and hatching quality of seabass

	• Broodstock maintenance and natural spawning of *L argentimaculatus* and *S. ocellatus* in tank • Broodstock maintenance and induction spawning of *E. fuscoguttatus*, *T. blochii* and *D. pictum* in tank • Genetic improvement of seabass broodstock through selective breeding
MY5	• Broodstock comprising of mainly groupers (estuarine & coral reef), snappers & seabass are kept in 2 cage culture stations based in Kota Kinabalu & Sandakan
Thailand	
TH1:	• Study on broodstock nutrition for larvae quality improvement
South America	
SA1:	• Development and maintenance of jewfish broodstock

8.3.2.2 Larviculture

Australia	
AU1:	• Development of larval rearing techniques for *C. altivelis* and *E. fuscoguttatus* • Assessment of the nutritional value of live prey organisms, with particular respect to fatty acid composition and vitamin composition • Assessment of larval preference for available live prey species • Development of production techniques for new live prey species, particularly copepods • Selective breeding of SS-strain rotifers (Brachionus rotundiformis) • Nutritional requirements of grouper larvae, particularly fatty acid requirements • Development of the digestive tract of grouper larvae • Ontogeny of digestive enzymes in grouper larvae
AU2:	• Commercialization of golden snapper • Develop larviculture for *C. altivelis* • Improve method for copepod production • Operating a commercial *L. calcarifer* hatchery and nursery • Disease monitoring of *L. calcarifer*, *L. johnii* and *C. altivelis*
AU3:	• Collaboration with QDPI and laboratories in Indonesia and Philippines in ACIAR Grouper Project
Brunei Darussalam	
BN1:	• Suspended awaiting completion of hatchery
Hong Kong, China	
HK1:	• Larviculture in indoor intensive environment
Indonesia	
ID1:	• Larvae production using natural food (*Chlorella*, Rotifera, *Artemia* and Copepoda), and the survival rate still very low (less than 1%)
ID2:	• Applied study on survival rate of tiger grouper larvae rear in different colour of rearing media • Applied study on larvae rearing in outdoor system • Applied study on larvae rearing of mouse grouper • Applied study on mangrove snapper (*Lutjanus* spp.) at different light intensity period
ID4:	• Determining the age of a rotifer population where physical growth of the initial members is static • Stimulating resting eggs production and hatching which will be used to continue selection based on small resting eggs
ID5:	• Establish larval rearing technology for grouper (C. altivelis, E. fuscoguttatus, E. polyphekadion and E. coioides)
Korea	
KR1:	• Experiment on the optimal rearing conditions (rearing water temperature, rearing density, photoperiod, pH, and DO) • Development of live food organisms (photosynthetic bacteria, oyster larvae, and small size rotifer)
Malaysia	
MYs:	• Mass culture of alternative live food as substitution to Artemia • Semi-intensive and intensive fry production techniques of *E. fuscoguttatus* and *L.*

	argentimaculatus in tanks and ponds
MY5	• Fish larvae are cultured in HDPE water tanks (7-40 ton capacity) and concrete ponds at the Sabah Fish Hatchery Center
Thailand	
TH1:	• Find the factors to improve survival rate and decrease cost
Pakistan	
PK1:	• Hatchery has been established for shrimp and fish seed production

8.3.2.3 Nursery

Australia	
AU1:	• None at present due to lack of juveniles for experimental work
AU2:	• Operation of a commercial *L. calcarifer* nursery in aiming to improve survival and growth of *L. calcarifer* and *L. johnii*
Indonesia	
ID1:	• Nursery of grouper seed in hapas in brackishwater pond using chopped trash fish and small crustacean (*Acetes* and *Mesopodopsis*)
ID2:	• Applied study on juvenile of tiger grouper fed with fresh fish add with different composition of multivitamins • Applied study on fingerling stage of mouse grouper fed with fresh fish enriched with multivitamin • Study on different additional multivitamins in diet on growth and survival rate of fingerling stage of tiger grouper and seabass in floating cages • Applied study on nursing stage of mouse grouper fed with fresh fish add different kind of multivitamins • Applied study on fed formulation for juvenile and fingerling stage of tiger grouper
ID5:	• Nursery for *C. altivelis* and *E. fuscoguttatus*
Korea	
KR1:	• Research on the growth effect based on rearing water temperature, density, and food and nutrition
Malaysia	
MYs:	• Semi-intensive and intensive nursing techniques for *E. coioides* and *E. malabaricus* in tanks and ponds
MY5:	• Fish larvae are nursed in 7-ton HDPE tanks and concrete ponds at the Sabah Fish Hatchery Center
Thailand	
TH1:	• Trash fish replacement with pellet diet

8.3.2.4 Grow-out

Australia	
AU1:	• None currently undertaken due to lack of seed stock
AU2:	• None at the center but collaborate with the industry (cage and pond farming)
AU3:	• Primary focus is feed development – determination of nutritive value of feed as alternatives to fishmeal and the specification of requirements for nutrients of critical importance to feed cost on fish productivity
Brunei Darussalam	
BN1:	• Floating cage culture
Hong Kong, China	
HK1:	• Grow-out nutrition and feed formulation for marine finfish species
Indonesia	
ID1:	• Raising grouper in brackishwater pond, using trash fish and live food (small crustacean)
ID2:	• Applied study on growth of mouse grouper and tiger grouper in floating net cage fed fresh fish enriched with different multivitamins
ID3:	• Inventory of local feed ingredient locally available in South Sulawesi • Nutritional requirement and fishmeal replacement
ID5:	• *C. altivelis* and *E. fuscoguttatus* in the sea net cages
Malaysia	

MYs:	• Culture of seabass, snappers, groupers and other marine finfish in open sea cages • Culture of seabass, snappers, groupers and other marine finfish in big pens
MY5:	• Grouper fries are cultured using floating cages at the nearby Cage Culture Station at Trayong & earthen ponds at the Menggatal Aquaculture Development Center
Thailand	
TH1:	• Culture grouper in old shrimp ponds

8.3.2.5 Post-harvest

Australia	
AU2:	• None at the center but collaborate with the industry
Malaysia	
MYs:	• SPS program for seafood products

8.3.3 Future or planned research on culture technology

8.3.3.1 Broodstock

Australia	
AU1:	• Application of molecular techniques to control of sex change and reproduction in *C. altivelis*
AU2:	• Genetic improvement of *L. calcarifer* broodstock • Environmental manipulation of *C. altivelis*
Brunei Darussalam	
BN1:	• Breeding both natural and induced
Hong Kong, China	
HK1:	• Broodstock conditioning and induced/natural spawning in sea cages
Indonesia	
ID1:	• Improving the quality of eggs and larvae using nutrition (artificial feed)
ID2:	• Applied technology on gonad maturation of malabar grouper and estuary snapper broodstock • Applied technology on domestication of napoleon wrasse
ID5:	• Broodstock management for coral trout
Korea	
KR1:	• Management of broodstock and induction of sex maturation
Malaysia	
MYs:	• The setting up of a National Mariculture Broodstock Centre for high priority mariculture species including finfish, crustacean, mollusk, etc
MY5:	• Plans are in the pipeline to establish a cage culture station in Semporna (mainly for stocking of high value coral reef finfish
Thailand	
TH1:	• Selection of virus (VNN) free broodstock
South America	
SA1:	• Biology reproductive of jewfish grouper

8.3.3.2 Larviculture

Australia	
AU1:	• Development of larval rearing techniques for *C. altivelis* and *E. fuscoguttatus* • Assessment of the nutritional value of live prey organisms, with particular respect to fatty acid composition and vitamin composition • Assessment of larval preference for available live prey species • Development of production techniques for new live prey species, particularly copepods • Selective breeding of SS-strain rotifers (*Brachionus rotundiformis*) • Nutritional requirements of grouper larvae, particularly fatty acid requirements • Development of the digestive tract of grouper larvae • Ontogeny of digestive enzymes in grouper larvae
AU2:	• Investigation of ozone treatment of marine fish eggs for nodavirus control

Brunei Darussalam	
BN1:	• Verification and refinements of available technology
Indonesia	
ID1:	• Improve the quality of natural food • Using multispecies phyto- & zooplankton • Using artificial feed • To increase survival rate and quality of the larvae
ID2:	• Applied technology on eggs and seed production of tiger grouper, mouse grouper and seabass • Applied technology on mass production of live food to support seed production
ID4:	• Analysis of the effect on growth rate and fecundity from any reduction in rotifer size • Change of rotifer size during the enrichment process • Use of UV radiation to induce mutation in rotifer resting eggs • Investigation of other selection pressures to select for recessive traits
ID5:	• Larval rearing for coral trout and Napoleon fish
Korea	
KR1:	• Development and industrialize of live food organisms
Malaysia	
MYs:	• Intensive and super-intensive larviculture of seabass, snappers and groupers in closed system hatchery (with water recirculating)
MY5:	• Plans are in the pipeline to upgrade existing facilities. Collaborative R & D on the artificial propagation of groupers & napoleon wrasse with local universities (Universiti Malaysia Sarawak – UNIMAS & Universiti Malaysia Sabah – UMS)
Thailand	
TH1:	• Try to rear larvae in earthen ponds
Pakistan	
PK1:	• It is planned to culture some marine fish such as seabass, groupers, seabreams, etc.

8.3.3.3 Nursery

Australia	
AU1:	• Development of nursery techniques, management techniques to minimize cannibalism in *E. fuscoguttatus*
AU2:	• Develop nursery method for *C. altivelis*
Brunei Darussalam	
BN1:	• Direct stocking of yolkfish to nursery ponds
Indonesia	
ID1:	• Nursing the grouper in concrete ponds and earthen ponds using artificial feed of our formulation
ID2:	• Applied technology on juvenile and fingerlings of seabass and grouper (mouse & tiger grouper) • Applied technology on diet formulation for juvenile and fingerling of marine fish
ID5:	• Nursery for *E. polyphekadion* and Napoleon fish
Malaysia	
MYs:	• Intensive and super-intensive fry production of seabass, snappers and grouper in closed system
MY5:	• Plans are in the pipeline to upgrade existing facilities. Collaborative R & D on the nursery of groupers & napoleon wrasse fries with local universities (Universiti Malaysia Sarawak – UNIMAS & Universiti Malaysia Sabah – UMS)
South America	
SA1:	• Different trials with different food (microencapsulates)

8.3.3.4 Grow-out

Australia	
AU1:	• Future grow-out work to be undertaken in collaboration with commercial farms in Queensland
AU2:	• Collaborative work with the industry on *L. johnii* and *C. altivelis*

Brunei Darussalam	
BN1:	• Intensive culture in ponds and cages
Indonesia	
ID1:	• Raising the grouper using artificial feed of own formulation
ID2:	• To implement an applied technology on marketable size seabass and grouper (mouse and tiger grouper) in floating net cages to farmers
ID3:	• Nutritional requirement • Bioprocessing of several local feed ingredient to improve their quality
ID5:	• Grow-out in the pond for some species of groupers • Grow-out in the net cages for *E. polyphekadion* and *E. coioides*
Malaysia	
MYs:	• Improve productivity of the current culture systems
MY5:	• Plans are in the pipeline to upgrade existing facilities. Collaborative R & D on the grow-out of groupers & napoleon wrasse fries with local universities (Universiti Malaysia Sarawak – UNIMAS & Universiti Malaysia Sabah – UMS)

8.3.3.5 Post-harvest

Australia	
AU2:	• None at the centre but will work collaborative with the industry
Brunei Darussalam	
BN1:	• Transportation of live grouper for market
Malaysia	
MYs:	• Documentation on Procedures and Conditions for the Importation of Live Grouper

8.3.4 Ongoing research on non-production/technology issues

8.3.4.1 Environment

Australia	
AU1:	• Development of recirculation technology for shrimp farms (also applicable to fish farms or mixed applications) • Development of effluent treatment systems using constructed mangrove wetlands for nutrient removal
AU2:	• Environmental impact of commercial sea cage farming and ongoing monitoring of discharge from landbase aquaculture facility
Brunei Darussalam	
BN1:	• Zonation of areas for aquaculture
Hong Kong, China	
HK1:	• Water quality and phytoplankton monitoring at fish culture zones
Indonesia	
ID2:	• Monitoring on water quality at Hurun Bay (location of net cages) of NSDC • Monitoring on water quality in NSDC Hatchery
Korea	
KR1:	• Broodstock and seed production of reef fish and recovery of reef fish resources by fish liberated because of rapidly decrease of the fish resources due to strong fisheries in coastal water area
Malaysia	
MYs:	• Environmental impact studies of pens culture at Setiu Lagoon, Terengganu
Thailand	
TH1:	• More environmental sustainable feed for grouper culture

8.3.4.2 Marketing

None provided (apart from that reported under post-harvest).

8.3.4.3 Food Safety and Certification

Australia	
AU2:	• Developing a quality control system for production of disease free marine finfish fingerlings
Brunei Darussalam	
BN1:	• Monitoring of aquaculture area inline with HACCP program of the Department
Malaysia	
MYs:	• Preparation of the documents for Aquaculture Farms Certification Scheme in Malaysia

8.3.4.4 Socio-economics and livelihoods

Australia	
AU1:	• Providing technical support for The Nature Conservancy Komodo Mariculture Project to provide alternative livelihoods for fishers in Komodo National Park through the development of grouper aquaculture in the Labuan Bajo/Komodo region
AU3:	• Production responses to developed feed will be used in economic models developed by QDPI to determine most acceptable feed and feeding systems
Korea	
KR1:	• Technical development on the diversification of culture species suitable to the local characteristic • Technical development for the higher productivity of fish culture
Malaysia	
MY5:	• DOF Sabah is presently giving out aid in the form of seeds & other farm materials to encourage/promote aquaculture. • Farmers are given adequate on-the-job training prior to the release of subsidies. • Technical assistance is also given to these farmers.

8.3.5 Future research on non-production/technology issues

8.3.5.1 Environment

Australia	
AU1:	• Development of recirculation technology for shrimp farms (also applicable to fish farms or mixed applications) • Development of effluent treatment systems using constructed mangrove wetlands for nutrient removal
Brunei Darussalam	
BN1:	• Rehabilitation of cage culture areas
Indonesia	
ID1:	• Manipulation of water quality to increase survival rate of larvae
ID2:	• Monitoring on water quality at outside of Hurun Bay (private shrimp pond and floating netcages) • Observation on fluctuation of heavy metals at Hurun Bay
ID5:	• Monitoring the impact of cage culture in the sea environment
Malaysia	
MYs:	• Environmental impact studies of more water bodies used for aquaculture

8.3.5.2 Marketing

None of the responded institutes have any future plan on grouper marketing.

8.3.5.3 Food Safety and Certification

No responses.

8.3.5.4 Socio-economics, Livelihoods

Australia	
AU1:	• Providing technical support for The Nature Conservancy Komodo Mariculture Project to provide alternative livelihoods for fishers in Komodo National Park through the development of grouper aquaculture in the Labuan Bajo/Komodo region
Brunei Darussalam	
BN1:	• Collection of grouper fingerlings in estuaries
Malaysia	
MY5:	• Joint collaborative work with UMS, UNIMAS & WWF to combat destructive fishing practices (DFA) including blast fishing and usage of cyanide • One of the identified strategies is to offer coastal communities involved in DFA other alternative income generating activities including aquaculture.
South America	
SA1:	• Introduce in local artisanal fisherman aquaculture of the jewfish grouper both in sea pen and floating cages as way to reduce overfish and dynamite fishing, specially into the Corales del Rosario y San Bernardo Coral Reef National Park

8.3.6 Current extension and training activities

This section requested information on activities designed to transfer technologies to farmers/fishers and the private sector.

Australia	
AU1:	• Training in finfish hatchery technology (currently concentrating on seabass/barramundi) in the areas of: o Broodstock maintenance and spawning o Larval rearing o Live feed production
AU2:	• Weekly work experience students doing certificate/degree • Monthly extension contract with aquaculture industry or as required
AU3:	• Actively participate in domestic and international industry and scientific forum to report funding of research
Brunei Darussalam	
BN1:	• Training of new aquaculture farm operators
Hong Kong, China	
HK1:	• Technical seminars and farm visits for promotion on the use of pellet feeds and adoption of good husbandry practice
Indonesia	
ID2:	• Conducted and organized several training for fish farmers funding by government annual budget and other institutions. The aim of this activity is to transfer technology to farmers. • Conducted a job training for students and others who want to develop marine farming
ID5:	• Small workshop on mariculture
Korea	
KR1:	• Technique transfer through the seminar and networking and so on
Malaysia	
MYs:	• Short-term training on marine finfish fry production • Incubation program (long term training in hatchery) for commercial marine finfish hatchery operation • Skilled staff attachment at private hatcheries for specific purpose
MY5:	• Technical training workshops, seminars & ICT media are used to transfer technologies to the target group.
Thailand	
TH1:	• In 2002, grouper rearing training course for Thai Fisheries Biologists

8.3.6.1 Training that can be offered to other network participants

Australia	
AU1:	• Training in finfish hatchery technology (currently concentrating on seabass/barramundi) in the areas of: o Broodstock maintenance and spawning o Larval rearing o Live feed production
AU2:	• Staff exchange o Copepod culture – *Acartia* spp o Tropical marine finfish larvae rearing – *L. johnii, L. calcarifer* o Commercial *L. calcarifer* hatchery and nursery
AU3:	• Can host short or long-term placements (eg. Post-graduate studies) at CSIRO providing persons are self-funded
Indonesia	
ID5:	• Grouper hatchery • Milkfish hatchery • Diseases control for fish and shrimp
Malaysia	
MY5:	• Facilities are available for training purposes
Thailand	
TH1:	• Training can be provided, but it should be in small group (3-5 people)
South America	
SA1:	• Development and maintenance of grouper (jewfish) broodstock in sea pens

8.3.6.2 Future and planned extension and training

Australia	
AU1:	• Development of economic models for grouper hatchery, nursery and grow-out
Indonesia	
ID5:	• Seminar on mariculture development
South America	
SA1:	• Training for artisanal fisherman courses

8.3.7 Current fish health research activities

Australia	
AU1:	• QDPI's Oonoonba Veterinary Laboratory has a project on nodavirus (VNN) in seabass
AU2:	• PCR/VNN – develop a PCR test kit relevant to the NT • Peritonitis – develop a vaccine against *vibrio* spp., endemic to the NT • Develop health management program for *C. altivelis* broodstock • Improve health management of intensively cultured of *L. calcarifer*
Brunei Darussalam	
BN1:	• Monitoring of aquaculture farms in terms of water quality and bacterial load
Hong Kong, China	
HK1:	• Regular farm visits and veterinary services for fish farmers
Indonesia	
ID1:	• Study on bacterial disease (*vibriosis*) on *C. altivelis* fry • Study on ECP and its toxicity to fry
ID2:	• Isolation and identification of bacteria fish pathogen • Examination on resistance of bacteria to the effect of antimicroba compounds, especially antibiotics • Histopathology examination on the effect of antioxidant application (Vit. E and Silenium) on marine fish culture
ID5:	• Detection and control of VNN diseases in grouper, iridovirus in grouper grow-out activity and control the parasites
Korea	
KR1:	• Development of the functional supplement diet for enriched immunity

Malaysia	
Mys:	• Detecting of latest viral disease of broodstock • High health broodstock management practices • Overall fish diseases diagnostic and prevention • Fish vaccination
MY5:	• Farm inspections and sampling are carried out in selected farms throughout the state
Thailand	
TH1:	• Select of disease free broodstock

8.3.8 Future fish health research activities

Australia	
AU1:	• Continued work on nodavirus (VNN) in finfish
Brunei Darussalam	
BN1:	• Establishment of central laboratory that could analyze fish pathology parameters
Indonesia	
ID1:	• Study on the vaccination against *V. alginolyticus* by some methods of rovtes and vaccine preparation • Study on viral nervous necrosis (VNN) distribution among wild grouper in Indoensia
ID2	• Examination on vaccines and vaccines application on marine fish culture
ID5:	• Develop technique to control diseases in grouper larvae, grow-out and broodstock
Malaysia	
MYs:	• Detecting of latest viral disease of broodstock • High health broodstock management practices • Overall fish diseases diagnostic and prevention • Fish vaccination
MY5:	• The DOF Sabah fish quarantine & fish health management center is 80% completed for this purpose
South America	
SA1	• Possible agreement with the university of Llanos, Veterinary Department

8.3.9 Information on research and development of other coral reef species

Australia	
AU1:	• Tropical rock lobster aquaculture o Development of larval rearing technology for tropical rock lobster o Development of grow-out techniques for tropical rock lobster
AU2:	• Mud crab research project
AU3:	• Active research on all aspects of shrimp production and on emerging industries such as rock lobster
Brunei Darussalam	
BN1:	• Research and development on breeding and culture abalone (*H. assinina*)
Indonesia	
ID2:	• NSDC conducted an applied study on molluscs such as pearl oyster breeding and farming, beside that NSDC also conducted an applied study on seahorse breeding and juvenile rearing
Malaysia	
MYs:	• Abalone seed production • Sea cucumber seed production • Giant clam seed production and transplanting
MY5:	• Working on various mollusk species such as *Perna viridis, Crassostrea* spp., *Tridacna* spp., and abalone
Thailand	
TH1:	• Try to rear seahorses, sea urchin and sea anemones
South America	
SA1:	• Development and maintenance of the jewfish broodstock, also looking for complete funds to the research in reproductive biology and induced reproduction of the jewfish grouper.

	• In the past, working with seahorse, neon gobi, Nassau grouper and snook. But actually no research is doing because the laboratory is re-building to get a double in size.

8.3.10 Future network activities

Australia	
AU1:	• Exchange of information on grouper aquaculture, production technology • Opportunities for staff training at other research institutions • Opportunities for collaborative research with other institutions working with grouper aquaculture
AU2:	• Exchange of information • Staff exchange • Annual report and progress on R&D
AU3:	• Awareness of development in grouper aquaculture in region • Opportunity for collaborative research and exchange of information • Access to technical information on all aspects of grouper culture and production
Brunei Darussalam	
BN1:	• Sharing of information on recent technology on grouper breeding and seed production • Training and attachment of experts to assist in breeding and seed production • Exchange of expertise (or the same as above attachment of experts)
Hong Kong, China	
HK1:	• Information exchange and networking
Indonesia	
ID1:	• Quick and comprehensive information of grouper and marine culture
ID2:	• The institute really wish to take part on grouper and marine fish network whatever event dealing with this network, such as we would like to attending seminar, workshop or exchange staff and also joint research or scholarship if it is possible
ID3:	• Provide special issues such as nutrition edition, health edition etc.
ID5:	• Grouper and marine finfish network is very useful for my institute to exchange information with each others, so we can do our research more specific on certain areas to complete the technology
Malaysia	
MYs:	• Expert and information exchange programs including network on grouper diseases and prevention activities • Bilateral for external training/workshop/exchange program • Accessibility to research facilities and equipments of other participating institute
Thailand	
TH1:	• Exchange of knowledge on grouper aquaculture
South America	
SA1:	• We like to receive all the information produced by the group, receiving some training, interchange or internship into the network and take the advantage of the discussion group on the internet to resolve and discuss topic requiring urgent advice • We offer to the network all the information we can produce, also all the opinion and ideas about how to deal with this entire topic. Also if there is possible to receiving research people from other countries just for a short time or longer visit

8.3.11 Funding

Australia	
AU2:	• APEC funded exchange (information and/or staff) • Expansion of ACIAR project to includes Darwin Aquaculture Centre
AU3:	• Host institutes could provide some seed funding if cost was not too great and shared widely by all/most participating agencies
Brunei Darussalam	
BN1:	• Solicit donations/contribution from member institutions
Indonesia	
ID1:	• First priority of funding should be given to improve human resources development, especially for technical staff, such as training and study abroad to get Master and

	Doctoral degree • Next priority, the fund should be for facilities required
ID2:	• The ideas on funding mechanisms to support regional cooperation in grouper and marine fish aquaculture are distributing the fund through fisheries cooperation, mainly on groupers aquaculture development. But government technical staff must supervise the funding distribution.
ID3:	• The funding should be transferred directly to the operational institution
ID5:	• Get budget from private sectors and establish organization (JV)
Malaysia	
MYs:	• Internal funds o Development funds from the Department of Fisheries for additional research infrastructures and facilities o IRPA (national research fund from Ministry of Science, Technology & Environment) funds for "top down" and "bottom up" research projects at local institution • External funds o Funds from APEC and other regional and international funding agencies for research projects specified by relevant funding agencies and attending regional seminars/workshops
South America	
SA1:	• In Colombia, the marine aquaculture is just on shrimp. There are only few relatively big companies. These companies together as an association were jointed with government (Agriculture Minister) and funding the research center on aquaculture. That center is looking for funds into the country (Governmental agencies) and outside from European Industry, and other International Agencies funding apply research. • Some industries would do some donations to the initiatives from non-profit organizations. Generally is easy to ask the industry for donations to cover cost of equipment and materials, also the industry offer some advise or labor from their staff.

8.3.12 How can the private sector be more involved?

Australia	
AU1:	• Collaborative work with the private sector to scale-up, commercialize research outcomes
AU2:	• Industry & Government o More trust – direct implication to their production/project planning o More involvement in annual meeting o More feed back when their money is utilized o Staff exchange industry/research o Better marketing of research benefits o Use their facility and knowledge/experiences
AU3:	• Sponsorship of industry forums – Roche might be a good company to target • Nice to think that the feed manufacturers (who will benefit most from advances in nutritional research) would also contribute towards some of the costs to maintain the grouper network
Brunei Darussalam	
BN1:	• Conducting verification trials in their farms
Indonesia	
ID1:	• Training to improve their knowledge and skill • Technological dissemination, such as grouper grow-out in brackishwater pond and larvae production
ID2:	• To compose/establish a local network grouper association and conducting regular meeting
ID3:	• Providing applicable technology
ID5:	• Provide private sector more information that we have and what will we do with the given budget from them
Malaysia	
MYs:	• Attending local training programs at MAFPREC, NAPFRE, etc.

	• Attending overseas training at participating institutions • Attending seminars/workshops at local and regional level • Attachment of local and/or foreign experts at private hatcheries/farms • R & D collaboration (government and private)
MY5:	• Joint venture with interested private companies with sharing of final returns • Guarantee given by DOF Sabah to buy unsold fish fries which are given out as subsidies to small-scale fish farmers • DOF Sabah to identify suitable land for coastal aquaculture or ADA (aquaculture development area). ADAs will be gazetted and leases out to interested investors