



Australian Government

**Australian Centre for
International Agricultural Research**

Final Report

project

Abalone industry enhancement in eastern Indonesia

SADI-ACIAR research report

project number

C2007/102

date published

April 2009

prepared by

Armando C. Fermin and Vincent C. Encena II
Southeast Asian Fisheries Development Centre Aquaculture
Department, Philippines

*co-authors/
contributors/
collaborators*

Agus Suriawan, Directorate General of Aquaculture, Indonesia
Hamka, Irwan Junaidi Effendy
Woro Kusumaningtyas, University of Haluoleo, Indonesia

approved by

David Shearer

final report number

FR2009-07

ISBN

978 1 921531 86 6



Australia Indonesia Partnership
Kemitraan Australia Indonesia



published by
ACIAR
GPO Box 1571
Canberra ACT 2601
Australia

This publication is published by ACIAR ABN 34 864 955 427. Care is taken to ensure the accuracy of the information contained in this publication. However ACIAR cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests.

© Commonwealth of Australia 2009 - This work is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced by any process without prior written permission from the Commonwealth. Requests and inquiries concerning reproduction and rights should be addressed to the Commonwealth Copyright Administration, Attorney-General's Department, Robert Garran Offices, National Circuit, Barton ACT 2600 or posted at <http://www.ag.gov.au/cca>.

ACIAR's participation in the Australia–Indonesian Partnership

The Australia–Indonesia Partnership (AIP) supports Indonesia's reconstruction and development efforts, both in and beyond tsunami-affected areas. Assistance will involve long-term sustained cooperation focused on economic and social development.

As part of the AIP, the Smallholder Agribusiness Development Initiative (SADI) aims to improve incomes and productivity for farmers and agribusiness, in response to market opportunities, in four eastern provinces—East Nusa Tenggara, West Nusa Tenggara, South East Sulawesi and South Sulawesi.

ACIAR's commitment to SADI focuses on supporting market-driven adaptive research, improving the transfer of knowledge and developing the capacity of key institutional stakeholders. This commitment will overcome constraints and barriers that prevent smallholders and agribusinesses successfully engaging with the market.

Contents

1	Acknowledgments	5
2	Executive summary	6
3	Introduction.....	7
4	Current Abalone Aquaculture Industry.....	8
4.1	Facilities and resources	8
5	Status and estimated production.....	12
6	Constraints and improvements	13
7	SWOT of potential in Eastern Indonesia.....	14
8	Conclusion	15
9	Recommendations.....	16
9.1	Potential Areas for Hatchery Development and Culture.....	16
9.2	Potential Areas for MPAs, Stock Enhancement/Sea Ranching.....	16
10	Appendixes	17
10.1	Appendix 1: Report on Philippines visit by Indonesian.....	17
10.2	Appendix 2: Network of Indonesian partners.....	19

1 Acknowledgments

The authors would like to thank all those organisations and institutions willing to be involved in the scoping missions that contributed to this report. The authors also acknowledge the willingness of all their organisations, the Southeast Asian Fisheries Development Centre Aquaculture Department, the Directorate General of Aquaculture, and the University of Haluoleo, to allow them to be involved in this project.

2 Executive summary

Aquaculture plays an increasingly significant role in Indonesia's economy, employing about 2.5 million people, providing an important source of nutrition, and generating valuable foreign exchange earnings and domestic revenues. Because of its rich coastal resources and numerous inland water bodies, Indonesia has great potentials for abalone aquaculture. As a high-value species (up to US\$33/kg) and its culture becoming a lucrative aqua-business venture, abalone is considered the next most important aquaculture species in many countries today including Indonesia.

There is an existing abalone fishery in Indonesia particularly for *Haliotis asinina* and *Haliotis diversicolor diversicolor*. However, overfishing and/or unregulated harvesting brought about by a high demand and high price, abalone has been depleted as it is experienced in almost all countries where abalone fishery exists. The presence of a sub-tropical species *H. diversicolor diversicolor* (locally know as "tokubushi") in Indonesia is an important concern in terms of species diversity and the feasibility of adoption of available technologies for culture. This species has a special market as cocktail abalone especially in China, Japan, Taiwan and Hong Kong.

The availability of a reliable seed supply is a very important consideration in the commercial production of abalone. However, hatchery production at present is still insignificant to fill-in the demand by abalone growers. Government hatcheries have some basic facilities to initiate hatchery production, but facilities and equipments required for abalone seed production are still lacking. Hatchery techniques for broodstock maturation, spawning and larval rearing have to be refined. The biggest problem at present is the very low survival rate of early juveniles needed to produce the seed for stocking grow-out farms. Manpower development through hands-on training on science-based technologies should be conducted to provide hatchery personnel the knowledge on proper hatchery operations.

Sea ranching or stock enhancement program is another option where government can play a big role in helping marginalized fishermen to increase harvest. However, hatchery technology should be refined first in order to produce sufficient quantities of seeds that will support such development. Implementation of the regulations for the management marine protected areas (MPAs) or fish sanctuaries has to be strengthened to properly regulate harvesting of marine resources. Organization of community fishermen is highly recommended that will oversee and implement regulations of MPAs or fish sanctuaries.

3 Introduction

There is a world-wide interest in the aquaculture of abalone due to the high demand and high price in the export market. The contributing factors to this phenomenon are the naturally slow growth and limited production of abalone in the habitats and the heavy fishing pressure on the fishery. Although China and Taiwan which are the biggest abalone producing countries register a combined annual total production of more than 8,000 metric tons (mt), there is still a deficit of more than 7,000 mt in the year 2007 (FishTech, 2007). In Thailand and the Philippines, the aquaculture of abalone is fast becoming a lucrative aqua-business venture. It is backed-up by science-based technologies on seed production and grow-out culture developed by the Philippines-based Southeast Asian Fisheries Development Center Aquaculture Department.

In Indonesia, there is a great potential for abalone aquaculture because of its rich coastal resources and numerous inland water bodies. A growing population and declining fisheries production have caused a widening gap between supply and demand for fish. Aquaculture provides two thirds of Indonesians' animal protein requirement. But with catches from marine fisheries in decline, aquaculture could dominate the fishing industry as a major source of sustenance, jobs, and export earnings. Aquaculture plays an increasingly significant role in Indonesia's economy, employing about 2.5 million people, providing an important source of nutrition and generating valuable foreign exchange earnings and domestic revenues.

The Small-holder Agribusiness Development Initiative (SADI) was designed by the Australian Center for International Agricultural Research (ACIAR) with the purpose of developing a strong province-based agricultural R&D capacity in Indonesia which is market- and client-driven and that will effectively transfer knowledge between stakeholders. As part of the Sub-program-3 Support for Market-Driven Adaptive Research (SMAR), the Abalone Industry Enhancement Scoping Mission is designed to undertake a preliminary assessment of the current status and structure of abalone industry in Eastern Indonesia.

In view of positive results during the survey, the Mission shall review the capacity of existing abalone R&D in Eastern Indonesia, including infrastructure, hatchery technology and skilled personnel. It shall also identify strategies to increase abalone production, using hatchery produced juveniles either through re-stocking/sea ranching approaches or through cage culture.

The over-all objective of this Mission is to provide a detailed assessment including recommendation(s) to ACIAR on R&D investment opportunities which could enhance production and profitability of the abalone industry of Eastern Indonesia taking into account the program priorities and directions of ACIAR-SADI. It also aims to determine the feasibility of enhancing the current production of abalone in South East Sulawesi using hatchery-produced abalone as a result of the adoption of seed production technology for tropical abalone *Haliotis asinina* that was developed by SEAFDEC Aquaculture Department in the Philippines.

4 Current Abalone Aquaculture Industry

There is an existing abalone fishery in Indonesia particularly for *Haliotis asinina* and *Haliotis diversicolor diversicolor*. Like any other abalone producing countries, Indonesia's abalone fishery has been depleted due to heavy fishing pressures brought about by the high demand and high price of this commodity in the export market. It is a common knowledge that only middlemen and the exporters get the biggest share of the income as they dictate price on harvests of the abalone fishermen. The presence of a sub-tropical species *H. diversicolor diversicolor* in Indonesian natural waters is an important concern in terms of species diversity and the feasibility of adoption of available aquaculture technology. The availability of seaweed *Gracilaria sp* which is the preferred natural food of abalone in many areas in Indonesia can also be a big impact on the development of the abalone industry. However, the technology for the seed production and culture of abalone need to be improved in order to support such development. Availability of a reliable seed supply is a very important consideration for prospective investors on marketable-size production. Sea ranching or stock enhancement program is another option where government can play a big role in helping marginalized fishermen to increase harvest.

4.1 Facilities and resources

Under the Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries, there are three Centers operating abalone hatchery namely, the Tigaron Abalone Hatchery in Kubu, Karangasem, Bali; the Marine Aquaculture Development Center (MADC) Gerupuk Station, Central Lombok (NTB) and at the MADC Sekotong Station, West Lombok, (NTB); and the Center for Brackishwater Aquaculture Development in Takalar, Makassar. The Abalone Hatchery Facility of the University of Haluoleo Murami, Kendari is currently conducting research as well on the seed production and culture of the local abalone species.

4.1.1 Tigaron Abalone Hatchery, Kubu, Karangasem, Bali

Hatchery Facilities: The hatchery facility is quite new which started in 2006 but actual hatchery operations began in 2007. The hatchery has a number of production tanks that can sufficiently accommodate larval rearing and juvenile production activities. However, one major problem of the hatchery is the poor efficiency of seawater supply. Pumping equipments need to be upgraded to provide sufficient and good quality seawater supply. There is a need for a Phycology Laboratory for diatom culture in order to supply the needs for benthic micro-algal food of abalone postlarvae. Technical capability of production staff needs to be enhanced by hands-on training on abalone hatchery techniques.

Current Activities: The hatchery has at least 1,000 breeders (about 400 males and 600 females) of *Haliotis asinina* and *H. diversicolor*. The abalones measuring 8-10 cm in shell length, were collected from the wild. They reached sexual maturity at 4-5 cm shell length. The breeders are kept in mesh baskets inside concrete holding tanks with flowing seawater. Some of the animals are kept in floating cages in the sea. Breeders are fed mostly green algae *Ulva spp.* but some of the animals seemed not in healthy condition. Some induced spawning trials by temperature shock were done but did not succeed.

In 1997, they started the seed production activity for *H. asinina*, but only succeeded five years later in 2003. Seaweed culture was also tried using *Gracilaria gigas*. As per available information, a natural habitat for tokubushi was found in Negara, Bali, although it was claimed also that it was only introduced to Mataram.

Abalone Trading: One trader/exporter of live marine and other fishery products is actively engaged in the export of abalone *Haliotis diversicolor diversicolor*. Mr Wayan Bangsing of CV Marine Tech, Sunset Road, Kuta, Bali, and his company sell environment controlled-

aquariums that contain live corals and colorful marine fish species. He expressed interests in developing abalone aquaculture in his locality and is willing to share investments on abalone hatchery as well as marketable-size production.

Commercial Harvesting: In Negara, Bali there has been a long time fishing activity on tokobushi abalone. Mr Sharoni, has been the oldest abalone diver/collector for more than 20 years now. He has been diving and collecting “tokubushi” abalone as a means of livelihood. Based on his experience, Mr Sharoni told the group that there are three varieties of the tokubushi in the area of collection: the black, the blue, and the red, which is the more expensive among the three varieties. All three “varieties” can be found in one location but on different substrates like rocks and corals of various color. Animals may derive shell coloration from the food they eat and their habitat. There are plenty of *Ulva* present in the collection site but there are no *Gracilaria*, according to Mr Sharoni During 1987, they used to collect 100 kg of “tokubushi” in one day, but now harvest is as low as 3 kg a day.

Marketing: Harvested abalones are shipped out of Bali in the form of frozen products, with shell on. Sizes are classified as large (8-10 cm), medium (5-7 cm), and small (4 cm). The cost of abalone in 1987 was Rp1,000/kg but at present (2007) abalone would cost around Rp150,000/kg. Mr Sharoni admitted that they get more profit now than before. Abalone traders usually provide loans to the collectors, and the harvests are bought back by the traders. Sometimes the collectors could not meet the harvest equal to the cost of the loans, and so they would just quit or stop collecting abalone. When asked if he would ever stop collecting abalones now that harvests are continuously diminishing or rather shift to other species like lobster, which is now becoming more profitable due to high demand, Mr Sharoni said no. He would rather continue diving for abalone and still hoping that harvest may still improve.

4.1.2 Marine Aquaculture Development Center (MADC) Gerupuk Station, Central Lombok

Hatchery Facilities: The MADC Gerupuk Station is a 4-ha facility for marine aquaculture and seed production. The station has 20 units fiberglass tanks of 1.5 ton capacity, 12 units settlement tanks (about 3 tons capacity) and concrete tanks (about 5-6 tons capacity). The station has at least 100 pcs tokubushi abalone *Haliotis diversicolor diversicolor* and 300 pcs *H. asinina*.

Current Activities: The station was able to produced 1,000 juveniles from previous spawning trials that can add up to the current broodstock collection. They have tried natural spawning of tokobushi and have observed that a female tokubushi can spawn at least 250,000 eggs per female. Tokubushi abalone spawns at around 8:00 in the evening, and *H. asinina* was observed to spawn at around 4:00 in the morning.

They have conducted spawning trials 2x a month and reported that they obtained a hatching rate of 90% for *H. asinina* and 60% for tokobushi. They feed the broodstock and advance juveniles with *Gracilaria* which they buy at Rp 1000/kg. Hatchery operation was still not successful and still doing some refinements of the techniques. They are not using Ultraviolet light treatment and only cartridge filtration was done. The only species of diatoms used was *Nitzschia* and has been observed to give low survival rate of juveniles.

4.1.3 Marine Aquaculture Development Center (MADC), Sekotong Station, West Lombok

Hatchery trials: The Sekotong Station has conducted several trials of spontaneous spawning *H. asinina* but with little success. Their biggest problem was how to maintain good survival of settled larvae until the early juvenile stage. The only diatom species being cultured are *Nitzschia* (which may not be good for larvae at first feeding stage). *Navicula* and *Amphora* were suggested to be cultured instead to improve survival rates of the early juveniles.

Abalone broodstock were feeding on both *Ulva* and *Gracilaria*, however due to limited supply of *Gracilaria*, the animals are fed *Ulva* most of the time.

4.1.4 Provincial Fishery Office (DKP), Mataram, West Nusa Tenggara Barat (NTB)

Commercial harvesting: A report by the head of the Fishery Regional Office (DKP) included the existing harvests of abalone from the natural fishery, using compressor during high tide and by hand-picking during low tide.

Although the current major activity is on pearl oyster (*Pinctada maxima*) culture, it was reported that about 3-5 MT of abalone (5.2 tons in 2006, 3.6 tons in 2007) has been exported to Hong Kong, with a buying price of US\$5/kg. There was only 1 exporter of abalone to Hong Kong in the province. Most abalones were collected in Sapi area. The regional office has the capacity to regulate the exportation of abalone to Hong Kong by issuing certification only after some organoleptic and ash tests on abalone samples just to make sure of the quality of the product. Abalone product forms are dried and salted.

4.1.5 Abalone Fishery Resource Management

The governor of the province declared a marine protected area (MPA) or conservation area of around 1,000 hectares in Lombok to protect the existing abalone fishery. Another MPA was declared in Gilli-gilli island with an area of about 600 hectares. The community aims to develop these areas as model for stock enhancement and sea ranching activities, not only for grouper or other high-valued fish but more so for abalone. This activity is based on the local wisdom called “awik-awik” whereby the livelihood of the fishermen can be derived from conserving natural fishery resources. There is no private hatchery in the area, and so there is no abalone aquaculture activity. However there is a simple and small-scale processing of harvested abalones by drying of which dried abalone are being sold at USD17/kilo. Most of the products are sold in the domestic markets but also find its way to the export markets. Recently the fishermen are complaining about the continuously declining harvest of abalone.

4.1.6 Center for Brackishwater Aquaculture Development, Takalar, Makassar

Current Activities: Abalone is known locally as ‘Kerang mata tujuh’ which means seven eyes oyster and some people in Makassar call it “rassi-rassi”. Abalone adults were bought from a collector and transported to the station in coolboxes. Animals were held in flow-through tanks and fed seaweed *Gracilaria*. When the abalone became ripe, induced spawning was conducted following temperature shock treatment. The treated broodstock spawned successfully and produced veliger larvae. However, the number of surviving larvae was not counted. The larvae were then stocked in concrete tanks containing rows of settlement plastic plate substrates. Plates were pre-grown with diatoms mainly *Nitzschia* spp. However, no juveniles survived. New broodstock were then purchased and stocked together with old broodstock. Days later, mass mortality was observed among the stocks. It was suspected that the newly-acquired broodstock brought some disease that infected the already existing broodstock. Hatchery activities was temporarily suspended.

Issues and problems that beset the station in the operation of abalone hatchery:

- Lack of advance hatchery technology
- Poor facilities to conduct seed production trials
- Limited source of broodstock
- Lack of trained personnel to handle hatchery operation
- Lack or inadequate financial assistance

Recommendations to improve the hatchery operation are as follows:

1. Source of good quality broodstock
2. good quality seawater supply
3. transport protocol that can minimize mortality due to stress
4. natural food culture laboratory to maintain pure culture stocks of suitable benthic micro-algae
5. properly trained technical people to handle hatchery operation,
6. financial support from other institutions like universities and government agencies for continuous operation of the hatchery

The Station has on-going activities on seaweed farming, grouper pond culture, shrimp (*Penaeus vannamei*) culture. Stocks of parrot fish, *Chelinus undulatus* adults are being kept in tanks for broodstock development and future seed production activities.

4.1.7 Provincial Fishery Office (DKP), Kendari

There are existing fishermen's cooperatives in Kendari that manage several areas of natural abalone fishery. This idea was patterned after an existing activity by some community members that protect and maintain natural habitats for grouper. The area was improved by aggregating rocks that serve as shelters for abalone. Some anecdotal reports claimed that the fishermen were using trunks of papaya to serve as shelters as well as food for the abalone. Harvesting of only large abalones is being practised once or twice a year to allow natural recruitment to take place prior to succeeding harvests.

4.1.8 University of Haluoleo, Abalone Hatchery Facility, Murami, Kendari

Hatchery production research: A visit was made on the proposed relocation site for the hatchery of *H. asinina* of the University of Haluoleo. Professor Irwan Effendy the project-in-charge has successfully conducted abalone seed production activities in relation to his current research on the species. The hatchery is located in Muramu, but will eventually be relocated to another site in Tapulaga. As the visit did not proceed to the hatchery facility, pictures of the hatchery as well as the abalone broodstock, and juveniles that he produced were shown by Prof Effendy together with DGA Director General Dr Made Nurdjana who made a visit to the hatchery. Prof Effendy was recently awarded a research grant by the Ministry of Higher Education amounting to Rp300 million. His wife Andi likewise got a grant of Rp 150 million from the Science and Technology Agency for her research on abalone nutrition. The Indonesian government also awarded 75 students of the university under Prof Effendy a full scholarship to allow them specialize on abalone hatchery and culture. The scholarship includes travel to the Philippines as exchange students at University of the Philippines in the Visayas and allow then to undergo intensive research work and on-the – job training at the SEAFDEC Aquaculture Department in Iloilo, Philippines.

5 Status and estimated production

Table 1: Status of the abalone fishery, abalone product forms and estimated production

Place visited	Province	Abalone species	Status of fishery	Product form	Production
Tigarón, Karangasem	Bali	<i>H. diversicolor</i>	Open access (diver)	Live (Rp150,000/kg)	No data
		<i>H. asinine</i>	Open access (diver)	Not marketed	
Sekotong, Lombok	West Nusa Tenggara	<i>H. asinina</i>	Open access (diver) and caught during low tide	Dried* (Rp300,000/kg) Live/fresh (Rp30,00+/kg)	2006 5.21 MT 2007 3.58 MT
Gerupuk, Lombok	West Nusa Tenggara	<i>H. asinina</i> <i>H. diversicolor</i>	Open access (diver), caught during the low tide	Dried (Rp300,000/kg) Live/fresh (Rp30,00+/kg)	
Takalar, Makassar	South Sulawesi	<i>H. asinina</i>	Open access (diver) and caught during the low tide	Dried (Rp300,000/kg) Live (70-90T/kg)	No data
Kendari	Southeast Sulawesi	<i>H. asinina</i>	Open access (diver) and caught during the low tide	Dried (Rp300,000/kg) Live/fresh (Rp50,00+/kg)	No data

6 Constraints and improvements

Table 2: Abalone species, potential areas for culture, seaweed species, problems and constraints and recommendations for improvement

Place	Province	Abalone species	Potential Areas (has) for culture	Seaweeds	Constraint to Development	Recommendations for Improvement
Tigaron, Karangasem	Bali	<i>H. diversicolor</i>	11	<i>U. pertusa</i> <i>U. reticulata</i> <i>G. edulis</i> <i>G. firma</i>	Broodstock mortalities	Refinement of broodstock transport and seed production techniques Improve production of diatoms
		<i>H. asinina</i>			Low settlement rates	
Sekotong, Lombok	West Nusa Tenggara	<i>H. asinina</i>	350	<i>G. firma</i> <i>U. pertusa</i> <i>U. reticulata</i>	Low settlement rates	Refinement of hatchery techniques Improve production of diatoms
Geropok, Lombok	West Nusa Tenggara	<i>H. asinina</i> <i>H. diversicolor</i>	350	<i>G. firma</i> <i>U. pertusa</i> <i>U. reticulata</i>	Low settlement rates	Refinement of hatchery techniques Improve production of diatoms
Takalar, Makassar	South Sulawesi	<i>H. asinina</i>	20	<i>G. heteroclada</i> <i>G. tenuistipitata</i>	Broodstock mortalities	Refinement of broodstock transport, husbandry and seed production techniques
Kendari	Southeast Sulawesi	<i>H. asinina</i>	452	<i>G. heteroclada</i>	Low survival in hatchery	Refinement of seed production techniques Improve production of diatoms

7 SWOT of potential in Eastern Indonesia

Table 3: Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of Abalone Aquaculture Potential in Eastern Indonesia

Strengths	Weaknesses
Strong government support	Few skilled manpower to operate abalone hatcheries
Large areas for culture activities	Poor hatchery facilities/equipments for abalone hatchery operation
Available basic facilities for hatchery demo	Poor knowledge on advanced abalone hatchery technologies
Available natural stocks of abalone and seaweeds in the wild	Few research institutions involved in abalone industry development
Linkages between government agencies, academe and people's organizations	Regulations for MPAs are not properly implemented
Opportunities	Threats
More investors to venture in abalone aqua-business	Conflicts on use of MPAs with other marine species and stakeholders
Improve livelihood of fishermen	
Satisfy market demand for abalone products	
Job opportunities for local people	
Increase income opportunity for seaweed growers	
Eco-tourism	

8 Conclusion

The abalone culture industry in Southeast Sulawesi, Indonesia is still a developing sector of aquaculture. Hatchery production trials have been tried but with little success. There are two main species of abalone found in the different locations visited: the *Haliotis asinina* and *H. diversicolor diversicolor*. The latter which is locally known as “tokubushi” was apparently an introduced species. The abalone fishery is open access to fishers. Abalone are caught by SCUBA and compressor diving in deeper waters and by handpicking by gleaners during low tide. In some areas, abalone are just a by-catch species of some divers catching lobster, sea cucumber and octopus. Harvested abalone are sold dried or fresh/live to middlemen who export mainly to Hong Kong.

Hatchery production trials in all the hatcheries visited experienced the same problems as follows:

- low settlement rates of postlarvae
- broodstock mortalities during transport
- lack of *Gracilaria* at sufficient quantities in some areas
- lack of facilities for natural food culture
- poor and insufficient facilities for seawater supply and filtration systems
- lack of advance techniques for larval rearing and feeding.

For the abalone fishery especially in Lombok and Kendari recently, harvest of *H. asinina* has decreased considerably in terms of volume and size of animals which are mostly medium (about 4 cm) and small (less than 4 cm) in size. The same is true in Bali for *H. diversicolor*. Stock enhancement through conservation in some Marine Protected Areas is being done by small groups of fishermen in Lombok. Selective harvesting is being practiced to maintain the fishery.

Constraints to protect and manage the natural abalone fishery;

- No specific guidelines in the implementation of resources management in marine protected areas
- Most natural fishing grounds are open-access which defeats the purpose of managing the fishery
- Strengthen and empower community fishermen’s association that will manage MPAs for stock enhancement.

9 Recommendations

- Refinement of broodstock handling and maturation
- Refinement of spawning and larval rearing techniques
- Improvement in production of benthic micro-algae under laboratory and mass-scale culture systems
- Human resource development through on-site hands-on or technical training program courses for technicians and project leaders
- Establishment of provincial seed production centers and demonstration farms to further disseminate technology
- Research collaboration between government hatchery centers and the University of Haluoleo to improve research capability and develop manpower base
- Establishment of provincial abalone farmers association to manage marine protected areas (MPAs) and Fish Sanctuaries for improvement of the abalone fishery
- Development of value-adding techniques for abalone meat processing
- Development of sea ranching/stock enhancement program to maintain and manage natural abalone fishery

9.1 Potential Areas for Hatchery Development and Culture

Tigaron, Bali

Gerupuk, Lombok

Kendari, Southeast Sulawesi

Situbondo, East Java

Takalar, South Sulawesi

Ambon, Maluku

Manado, North Sulawesi

Biak island

Mamuju, West Sulawesi

Bima, Sumbawa island

9.2 Potential Areas for MPAs, Stock Enhancement/Sea Ranching

Bima, Sumbawa Island

Hari island (/ Liwutongkidi Island, Southeast Sulawesi (existing MPA)

Takabonerate Island, South Sulawesi

Bunaken Islands, North Sulawesi

10 Appendixes

10.1 Appendix 1: Report on Philippines visit by Indonesian

The Indonesian team was composed of three abalone specialists (Messrs: Hamka and Agus Suriawan, & Ms Woro Kusumaningtyas) from the Directorate General of Aquaculture, and Prof Irwan Junaidi Effendy of the University of Haluoleo. The team arrived from Jakarta to Iloilo in April 28, 2008. They paid a courtesy call on SEAFDEC Chief Dr Joebert Toledo and Technology Verification and Demonstration Division Head Dr Clarissa Marte. Then, a preliminary meeting was held to discuss the itinerary and the final report preparation. The team also visited the abalone hatchery and nursery and was able to observe the on-going seed production activities.

On April 29, a formal meeting was held between the two teams and discussed about the final report on the scoping mission prepared by the Philippine team. Comments and suggestions from both teams were considered to improve the report. In the afternoon, Mr Agus and Mr Hamka were able to participate in the hatchery activities such as broodstock selection and preparation for spawning. Ms Kusumaningtyas observed some activities in the diatom culture laboratory. She conferred with head of the Natural Food Culture Laboratory Mrs Milagros dela Pena about the techniques of diatom pure culture and mass production. The following morning of April 30, some of the selected abalone breeders spawned and the DGA guys participated in the egg collection, incubation, counting and monitoring of embryonic development. By mid-morning, a meeting was held together with Drs Toledo and Marte for the presentation of the results of the scoping mission and the final report write-up. Mr Armando Fermin, head of the Integrated Mollusc Program presented the final report on behalf of the group.

In the afternoon, the Indonesian guys stocked the surviving postlarvae in the settlement tanks and made some discussion with the Hatchery Manager Mr Nestor Bayona about some useful tips on abalone larval rearing. The group had a good impression of the abalone hatchery particularly on the early juvenile production. The group also toured the different hatcheries at the Tigbauan Main Station that included the Mudcrab hatchery, Seahorse hatchery, Marine fish hatchery and other facilities like the Fishworld museum and the SEAFDEC Library.

On May 1 (Labor Day, a holiday in the Philippines), the group visited the Igang Marine Station in Nueva Valencia, Guimaras, where abalone cages for grow-out culture are being maintained. Mr Vincent Encena led the group who discussed and explained some details on cage construction, stocking and feeding of abalone, and even the culture of seaweed using *Gracilariopsis bailinae* in floating sea cages. The group also held some discussion with a private abalone grower Mr Michael Ong who happened to be on site inspecting his cages. The group saw three different types of cages being used for abalone grow out. The cages utilized indigenous plastic materials which are being compared in terms of cost, efficiency and longevity of use. There are at present four private operators maintaining abalone grow-out cages in the Mariculture Park being managed by SEAFDEC.

In the morning of May 2, prior to the group's departure for Manila a final meeting was held between the two teams for the finalization of the report. During the meeting, a plan of action was prepared for inclusion in the report. The Indonesian team left for Manila late in the afternoon and then for Jakarta in the evening of May 2, 2008.

Fig. 8. Visit of the four Indonesian abalone specialists at the Igang Marine Station of SEAFDEC in Guimaras, Iloilo for the abalone grow-out culture facilities. Improvised cages made of local materials are used to culture *H. asinina* to marketable-size.



10.2 Appendix 2: Network of Indonesian partners

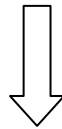
NATIONAL GOVERNMENT



Government Agencies

Ministry of Marine Affairs & Fisheries Ministry of National Education

Directorate General of Aquaculture University of Haluoleo



PROVINCIAL GOVERNMENT

DINAS, Department of Fisheries (provincial)



MUNICIPAL GOVERNMENT



NGOs (Fishermen's Ass'n,
PRIVATE SECTORS (Business Investors Fisheries Councils