

The price of this fish remained stable in 2000. Cultured fish of 0.5–0.8 kg could be sold at about HK\$ 95–100/catty.

At least one hatchery in Taiwan and two hatcheries in Bali, Indonesia, produced high-finned grouper (*Cromileptes altivelis*) fry. Taiwan culture fishermen are not interested in this species because it grows very slowly and cannot be reared in ponds there.

The asking price was very high at the beginning of the season at HK\$ 55 per 6-cm-long fish. No culture fishermen wanted to take the risk. The price dropped to HK\$ 8/fish for fish 2–3 cm long but there were still no buyers from Hong Kong or PRC.

We believe at least 20,000–30,000 high-finned grouper fry were hatched and grew bigger than 3 cm but we do not know their fate, as no buyers were available.

Hatcheries in Taiwan are currently able to hatch more than 40 species of marine fish for mariculture with *Epinephelus coioides*, *Trachinotus blochii*, *Lutjanus argentimaculatus*, *L. stellatus* and *Acanthopagrus latus* being the species raised in greatest numbers. Giant grouper (*E. lanceolatus*) joined this list in 2000.



Seed supply for grouper cage culture in Khanh Hoa, Vietnam

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Grouper culture has developed in recent years in Khanh Hoa in response to high market value, the availability of unused shrimp ponds because of disease, and a cage culture tradition related to the fattening of lobsters. Grouper culture is dependent on wild seed.

A broad-based study was undertaken between January and July 1998, which examined technical, environmental, and socio-economic issues related to wild grouper seed supply in Khanh Hoa in order to assess the prospects for the sustainable development of grouper culture in the province as well as elsewhere in Vietnam. Field work for the study was carried out from December 1997 to April 1998 in four districts of Khanh Hoa Province (Van Ninh, Ninh Hoa, Nha Trang, and Cam Ranh) which are the main areas for grouper seed supply and grouper culture in Central Vietnam.

The study used existing information, supplemented with an interview survey of fishermen, and a physical/ecological survey of catching grounds. Parameters related to grouper seed supply, such as physical and ecological characteristics of catching areas, technical attributes of seed fisheries, and market and socio-economic aspects of seed supply, were recorded and investigated using a framework adapted from the “Handbook for

rapid appraisal of fisheries management systems” (version 1) (Pido et al. 1996).

The method of determining the coverage of seaweed, seagrass and coral samples were collected and identified based on the FAO key. The ecological data was analysed using cluster analysis, as developed in the ADE 4 package (University of Lyons). The methodology and results have been described in detail elsewhere (Tuan 1998).

Field work for the study was funded under the DFID Renewable Natural Resources Knowledge Strategy: Improved management of small-scale tropical cage culture systems in Asia.

Ecological attributes of catching areas

Four *catching areas* were identified: Van Phong, Nha Phu, Nha Trang and Cam Ranh, corresponding broadly to the four coastal districts of Van Ninh, Ninh Hoa, Nha Trang and Cam Ranh, respectively. These areas were all characterised by the presence of seagrass “forest” or seaweed beds. Two seagrass species were common to all areas: *Thalassia hemprichii* and *Enhalus acoroides*. Within each area were several catching sites where the bulk of fishing for seed took place, amounting to a total of 16 catching sites. Cluster analysis revealed

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three broad types of catching site, corresponding closely to the conventional classifications of coral reef, lagoon and estuary.

Species and habitat preference

In total, seven species of seed grouper were caught regularly at the various sites. Using the key provided by Heemstra and Randall (1993), the species were identified as in Table 1.

Seed production from the catching sites was related to ecological variables, and the nature of the relationship varied between species. Production of most species increased with increasing sea grass cover. *E. akaara*, on the other hand, was collected at sites with a specific level (31–50%) of seagrass cover. Seagrass cover was the most important variable explaining variation in abundance of seed of most grouper species. For example, it explained 94 per cent of the variation in seed production of *E. coioides* and *E. merra*, but less in other species. In the six “black grouper” species, seed production declined with increasing depth and increasing salinity. Production was negatively related to coral cover in all species except for *E. coioides* (no relationship) and *E. akaara* (positive relation). Production of *E. akaara* and *E. merra* was positively associated with seaweed cover, while this relationship was negative for other species.

Status and management of grouper seed habitat

Recently, many seagrass beds, especially in the Nha Phu lagoon, have been heavily damaged by motorised push-nets and trawling nets. There were about 200 motorised boats fishing in the lagoon using these gears, despite a prohibition on their use.

Coral reefs have become overexploited recently. Approximately 30 explosions were heard a day in

the Van Phong Bay in 1996, especially around coral reefs. In addition, dead coral, the main raw material for Hon Khoi Cement Plant, is exploited in the south-west of the bay. Cement production has increased from 5000 tonnes/year to 10,000 tonnes/year in recent years (Long et al. 1996). Coral reefs may also have suffered some damage from tourism, especially in the Nha Trang Bay.

Seaweed in the Khanh Hoa Sea, especially *Sargassum* spp. “forests” has almost disappeared in recent years. This may be related to the overexploitation of one species of sea urchin for export, allowing an increase in the population of another. The latter may have overgrazed the *Sargassum* seaweed. However, the ecology of these systems is poorly understood.

Much mangrove has been destroyed for constructing shrimp farms around Nha Phu lagoon. From 1994 to 1997 approximately 500 ha of mangrove was destroyed out of a total area of 810 ha recorded in the years of 1981 to 1983 (Cho 1996).

Fishing for seed

A total of 649 households (6.5% and 0.6% of fishing households and rural households in the province, respectively) collect approximately 200,000 seed each year, mainly “black grouper”: *Epinephelus akaara*, *E. bleekeri*, *E. coioides*, *E. malabaricus*, *E. merra* and *E. sexfasciatus*.

Among the fishing gears, seine net, scoop net and push net were mainly used for collecting small fish of 1–3 cm. Seine nets provided the highest yield (catch per unit effort) in terms of number of pieces per trip. For larger seed, encircling nets, used together with artificial reefs, were the most important in terms of quantity and quality of catch. The seasonality of use of different gears reflects the growth of the seed and their move to deeper water as the season progresses.

Table 1. Grouper seed species collected in Khanh Hoa Province

Scientific name	FAO English name	Local name
<i>Epinephelus akaara</i>	Hong Kong grouper	Ca mu cham do, Ca mu tieu do
<i>Epinephelus bleekeri</i>	Duskytail grouper	Ca mu soi, Ca mu tieu den
<i>Epinephelus coioides</i>	Orange-spotted grouper	Ca mu song
<i>Epinephelus malabaricus</i>	Malabar grouper	Ca mu me
<i>Epinephelus merra</i>	Honeycomb grouper	Ca mu cham to ong
<i>Epinephelus sexfasciatus</i>	Sixbar grouper	Ca mu sau soc

Status of the fishery

The fishermen had to spend more time to catch the same amount of seed compared with previous years. Seed production appears to be in decline, as is the capture trend for grouper in the province, and the demersal marine finfish.

The reasons for the decline of fishing production of commercial demersal marine finfish in general, and grouper in particular, probably include over-exploitation, especially of broodstock; using harmful fishing gears such as motorised push-nets, trawling nets, dynamite, and sodium cyanide; and nursery habitat destruction.

Market attributes

The fishing production of grouper seed in the province has remained at about 200,000 pieces per year in recent years. The four species *E. malabaricus*, *E. coioides*, *E. sexfasciatus* and *E. bleekeri* were the main cultured species. Six species had the common name “black grouper”, and commanded similar price. The pricing system varied according to time and location. The price ranges by fish size in 1998 are shown in Table 2.

The primary buyers were nursing farmers, grow-out farmers and middlemen. The middlemen were the main buyers, and their price was up to double the fishermen’s price. In some cases, especially between February and March, the middlemen price could peak as high as VND 13,000–14,000/piece.

The price has shown an increasing trend year to year, probably related to the increase in total culture area and limited production. Most seed were purchased for grow-out locally, either directly by farmers, or through middlemen. Other seed was sold by middlemen to exporters who in turn sold mainly to Taiwan and Hong Kong. The latter were usually more than 100 g in size, and were mainly “red grouper” *Cephalopholis miniata* (Phan 1997). Small quantities of seed were sold to Ho Chi Minh City.

In the past, the fishing production of Khanh Hoa met the demand for grouper seed. There was almost no pressure on the seed supply except for

the period just after Tet Holidays (Chinese New Year’s days). Recently, the local grow-out farmers had to import grouper seed from neighbouring provinces such as Phu Yen and Ninh Thuan. The percentage of the imported grouper seed was 15% for the 1998 crop.

The estimated provincial government’s target marine finfish production for 2010 (820 ha of ponds and 800 cages) corresponds to a requirement for about 8.3 million seed to produce 4200 t of fish. This compares with current production of grouper seed of 200,000 and a production of 140 t. Clearly, current levels of seed production are totally inadequate to meet the targets.

Socio-economic benefits

The average income of collector households from seed collection was VND 720,000 per year (ca 11% of total household income), and return on labour varied between VND 10,906 and 37,135 per person per day.

The seed collecting households were divided into three classes according to their annual income. The proportion of collector households in the three classes was broadly similar to that for the wider community, although there were marginally fewer in the highest class. This suggests that seed collection has relatively little impact on household wealth, and vice-versa.

In recent years, the number of collectors has decreased as some have moved to offshore fishing activities, which were funded by the central government.

The fishermen prefer the new job where they can receive a higher return on labour than that in the collecting seed,

Table 2. Price ranges by fish size

Type of fish	Typical price range per piece (in VND)	
	Fishermen to primary buyers	Middlemen to farmers companies
0.5–5 cm (av. 1–3 cm)	500–1000	1000–3000
5–10 cm (av. 5–8 cm)	2000–3000	3000–5000
10–20 cm (av. 10–15 cm)		
• <100 g	4000–5000	6000–7500
• 100–500 g (VND/kg)	40,000–50,000	60,000–70,000

Discussion and conclusions

Poverty, lack of access to alternative livelihoods, and lack of environmental awareness has resulted in overexploitation of nearshore resources, and continuing poverty in coastal areas of Khanh Hoa Province. Alternative non-fishing jobs such as aquaculture could help the fisherfolk in lower income classes to escape from this “poverty trap”.

Small-scale, mainly family-run cage culture of grouper in Khanh Hoa Province is now a significant activity, providing a relatively high return to labour compared with existing alternative activities (Trai and Hambrey 1998). Internationally there is strong and continuing demand for high quality marine finfish. However, culture of grouper in Khanh Hoa depends on a supply of seed from the wild.

The seed are caught in lagoon, estuarine and coral reef habitat, and are commonly associated with seagrass, considered as “indicative” by local fishermen. A significant proportion (almost 40%) of the seed came from one catching area, Nha Phu lagoon, a well-known nursing ground for many marine organisms. All inshore areas are under intense pressure.

The supply of wild grouper seed to the cage culture industry appears to be unsustainable in the short-term and inadequate in the longer term. There are several reasons for this:

- catch per unit effort of seed appears to be in decline;
- catch and catch per unit effort of adult stocks also appears to be in decline;
- nursery and adult habitat (seagrass, mangrove, coral) has been, and continues to be, severely damaged from habitat conversion, destructive fishing practices, coral extraction and possibly local pollution;
- government targets for cage culture are high (an estimated trebling of cages by 2010);
- stocking densities have shown an upward trend, and this is likely to continue; and
- the cost of seed is already high, and is likely to increase, threatening the competitiveness of the grow-out sector.

It is clear that even to maintain the current wild seed supply will require substantial improvements in stock and habitat management. This should not be difficult in theory — seed production is highly concentrated in a few key areas. Broad frameworks for coastal area management plans and programmes have been developed in the past, but there is an immediate need to take these forward in

practice at a local level. Improved grouper seed habitat management might offer an important starting point for these initiatives.

For the future, hatchery production will be the only way to provide sufficient seed to allow the industry to expand. The high and increasing price of seed should make hatchery production economically viable, despite its technical difficulty.

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