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MiniReview

Fishing Status and Management Proposal in Bandon Bay, Suratthani Province, Thailand

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Abstract

Bandon bay is one of the importance and high-pressure fishing grounds of southern Thailand in the Gulf of Thailand. The present fishing grounds are under threat due to three main issues. Firstly, the fishing area has been minimized because some parts of the fishing grounds are now used for clam-culture. Secondly, fishery resources *per se* are in a vulnerable state because the catch is largely composed of unsalable and immature fish, resulting in a noticeable decrease in the fisherman's income. Lastly, the growth in the price of gasoline (i.e. marginal cost) index was higher than the growth of catch price index. Thus, the short- and a long- term plans for the fishery management of Bandon bay are urgently required. This article presents the current threats in detail and develops management plans for the purpose of a sustainable fishing industry in Bandon bay, in terms of socio-economics, environmental and fishery resources as well as policies aspects.

Keywords: Fisheries, catch compositions, costs and prices, management, Bandon bay

Introduction

Fishing is one of the main occupations of Thai people and has a long tradition, with fish considered a cheap animal protein source for Thai people. At present, the aquatic resources have become depleted because the fishermen have exploited larger amounts of aquatic resources than in the past to support demand from both domestic and international markets. The catches are normally sold fresh but are also used as raw materials for the food industrial sector such as frozen- and canned- fish. The fishermen are usually highly dependent on fishing resources (i.e. very few supplies from aquacultures). Thus, if there is any uncertainty or decrease in the abundance of fishing resources, the fishermen are the first group that will be impacted, especially in terms of their incomes. As their income decreases, the fishermen try to catch more fish, both in terms of weight and numbers, by developing fishing equipment such as decreasing the mesh size of the fishing net and using new technologies to easier to locate the fish schools [1]. Moreover, the development and varieties of fishing equipment result in them collecting various aquatic faunas of different sizes, i.e. non-selectivity [2]. It was found that, due to the poor selectively of fishing equipment, immature aquatic faunas have a greater chance to being caught than the past [3]. This causes a reduction in the size of the fish stocks, i.e. stock depletion.

As a result of stock depletion of aquatic faunas in both marine and costal fisheries, aquaculture has been intensively introduced to maintain the supplies to support demands from fishery and fishery-related industries. Moreover, the Thai government also supports the fishermen to fish overseas in neighbouring countries' territories [4]. Both represent solutions to the problem of demand, however, they have less impact for artisanal fishers who still face the

problems caused by stock depletion since they catch mostly immature fish in their coastal areas, which sell for low prices compared to the products from aquaculture and overseas catches. Moreover, fishing costs particularly the gasoline, the major operation cost, is getting higher year by year. Therefore, the artisanal coastal fisheries are an important issue in fishing and as such are of concern to Thailand.

Thailand has 2,614 km of coastline with the west and east coast borders connected to the Andaman Sea and the Gulf of Thailand, respectively. Twenty-three out of 76 provinces in the country border the sea and about 70 % of the population lives within a few kilometres of the sea [5]. Bandon bay (**Figure 1**), located between Thachana and Donsak districts, including Phangan and Samui islands, of Suratthani province, is the largest estuarine and mangrove inlet on the east coast of the country, with a coastline of 156 km. It is one of the most important and high pressure fishing areas, where a huge area of intertidal mudflats, extending 1 - 2 km offshore, encompassing the delta of the Tapi river and at least nine other smaller rivers [6]. It can be said that all the coastal and marine fisheries in Suratthani are located in the Bandon bay area. Most people living close to the coast indicate that fishing is their main occupation. There are a variety of fishing equipment operating in this area, such as squid light luring cast nets, clam dredges, push nets, trawl nets, traps, gillnets and handlines etc. [3]. In terms of the aquatic ecosystem, Bandon bay is important as a natural spawning, nursery and feeding ground for many shellfishes such as oysters, blood cockles, green mussels, short-necked clams, mud crabs and shrimps [7] and other fish [8,9]. This area also serves as an excellent area for shellfish mariculture.

However, many lessons in fishery resources management can be learnt from Bandon bay, particularly over-exploitation of resources as well as degradation of the estuarine ecosystem, due to anthropogenic pressures, with severe socio-economic consequences [3]. Moreover, the fishing ground in this area has been minimized because many parts are now occupied by clam culture sites. Thus, this article presents an analysis of the present fisheries situation in Bandon bay and indicates guidelines for sustainable fishery management strategies for short- and long-term management plans.

Fishing Status

About 70 % of people, who live around the coastal area of Bandon bay, are involved in either fisheries or aquaculture industries [10]. The total number of fishing boats in Suratthani province (i.e. fishing in Bandon bay) is 3,632 but only 697 have registered fishing licenses. They consist of 362 boats, less than 14 m in length, 210 and 125 boats ranging between 14 - 18 m and 19 - 25 m in length, respectively (**Table 1**). The non- registered boats operate push net-, beam trawl-, and clam seeds dredges-fisheries [11]. Other common fishing equipment operated in the area is shown in **Table 2**. Most of the non- registered boats are among the main causes of conflicts with fisheries in the area because they devastate other fishing equipment, for example when push nets and trawls were operated, they generally destroy the stationary nets, which are set in their area such as gill nets and traps [12]. Another emerging conflict is related to the area's use, which in some parts of the bay has changed to clam culture (**Figure 2**) thus overlapping with the fishing grounds. However, this conflict does not occur in some places because the clam farmers used to be fishermen before [3].

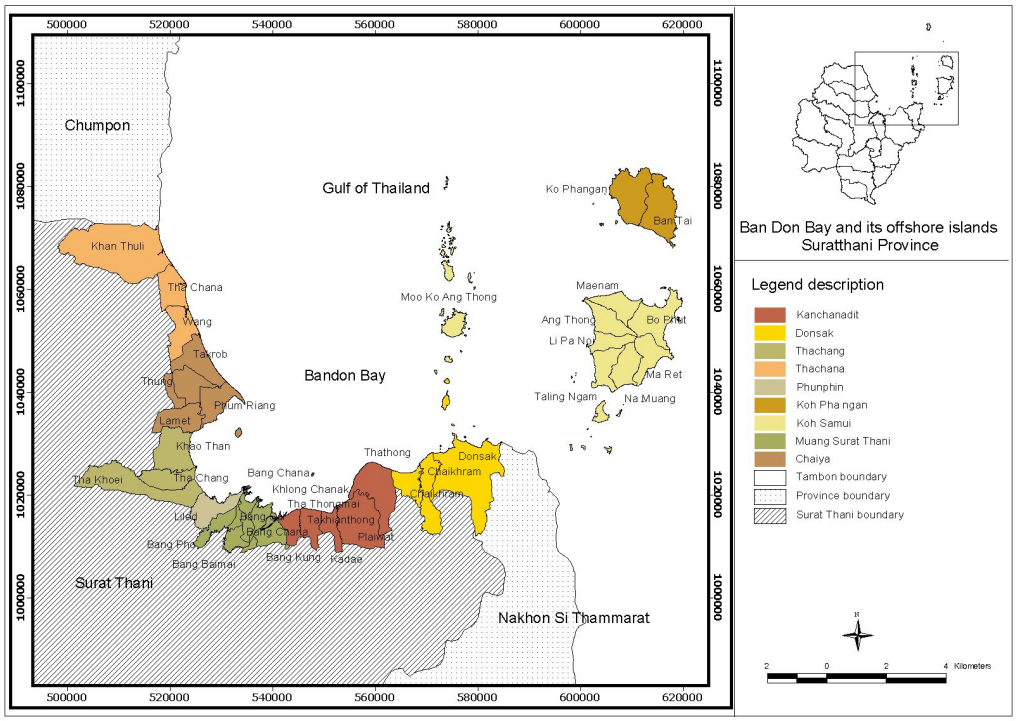

Figure 1 Bandon bay and its surrounding districts, Suratthani province.

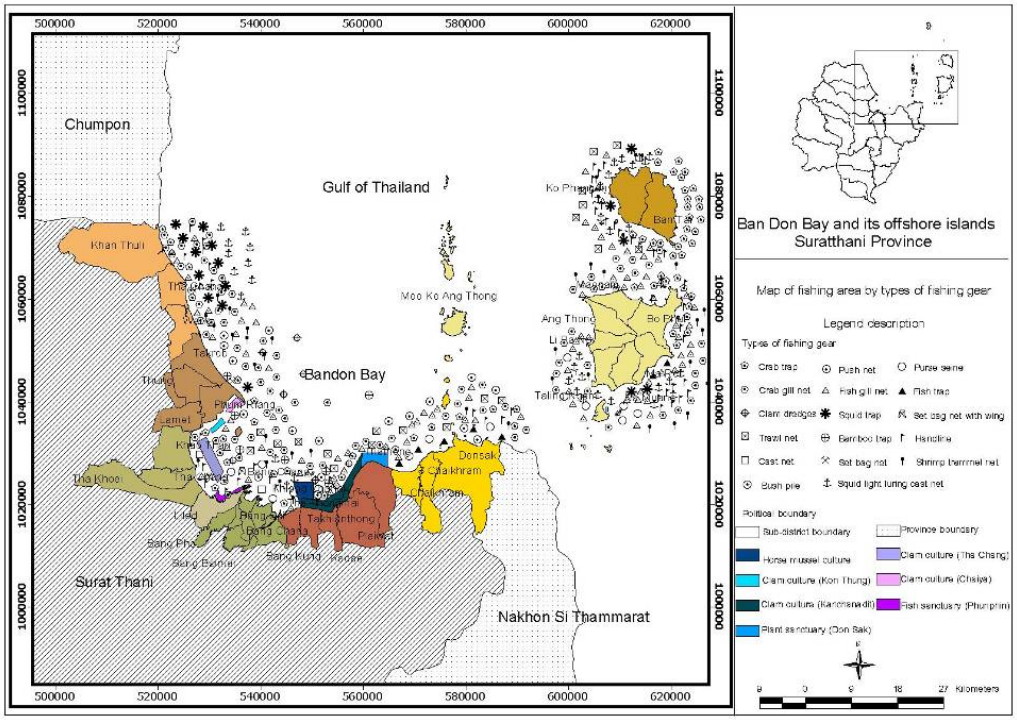

Figure 2 Map of fishing grounds in the Bandon bay, Suratthani province [3].

Table 1 Number of fishing boats registered by size and total gross tonnage in 2006 [11].

Types of fishing method	< 14 m		14 - 18 m		19 - 25 m		Total	
	No	Gross Ton	No	Gross Ton	No	Gross Ton	No	Gross Ton
Otter board trawl	58	479	44	943	26	1,136	128	2,565
Pair trawl net	2	38	32	780	8	300	42	1,118
Beam trawl net	7	15	1	6	0	0	8	21
Purse seine	0	0	0	0	9	551	9	551
Anchovy purse seine	0	0	1	50	9	642	10	693
Spanish mackerel gill nets	1	15	3	114	4	199	8	327
Crab gill net	113	544	31	556	21	757	165	1,857
Shrimp trammel net	20	110	3	32	1	29	24	171
Other types of gill net	0	0	0	0	3	299	3	299
Squid falling nets	48	481	49	959	18	716	115	2,155
Other lift nets	37	272	4	56	1	32	42	360
Push net	76	367	42	486	25	646	143	1,499
Total	362	2,320	210	3,988	125	5,308	697	11,615

Status of Fishing Resources

By operating the push net boats less than 14 m in length, which is the most common fishing boat in the area (**Table 2**), the average catch, during the 1980s, was about 109 kg/boat/day consisting of economic fish (55 kg/ boat/day or 51 %) and trash fish (53 kg/boat/day or 49 %). This shows that the proportions of economic- and trash-fishes were almost equal. Refining the composition of the economic catches during this period, it was found that nearly half of them (47.2 %) were invertebrates such as shrimps, cuttlefishes, octopuses, crabs and mantis shrimp. The trash fish portion can be divided into 2 groups, i.e. genuine trash fish (26.1 %) and immature economic species (27.7 %). The latter groups were mostly the juveniles of both pelagic fishes (e.g. anchovy, trevallies, hardtail scads, indo-pacific mackerel, wolf-herrings, pomfret, sardinellas, barracuda and mullet) and demersal fishes (e.g. crocker, sand whiting, crescent perch, lizard fish, hair tails, eel, flatfish, flathead fish and red snapper) [13].

A survey in the 2005 fishing season (i.e. February to November) [14], by the same fishing method, revealed that catches ranged between 9 and 714 kg/ boat/day with an average of 179.9 kg/ boat/day. The percentage of economic- and trash-fish species were 32 and 68 %, respectively. In terms of fishing operation, the fishing effort per day ranged between 7 and 12 h/day, but mostly 12 h/day, with an average 11.26 h/day. Although the Catch per Unit Effort (CPUE) in 2005 was higher than in the 1980s, about 65.5 %, this is really an illusion. This is because the catch composition in the 1980s comprised about 50 % trash fish compared to about 70 % in 2005.

Table 3 presents the analysis from annual survey by staff from The Chumphon Marine Fisheries Research and Development Centre at Bandon bay during 2001 - 2005 [15]. Contributions in each component varied year by year but the trash fish was always dominant, except in 2002, when cuttlefishes and squids were highly exploited. Another aspect of concern was that the proportions of demersal fish, shrimps and prawns as well as crabs were continuously decreased. Except for crabs, the CPUE of immature fish was higher than the mature ones in every component (**Figure 3**).

Table 2 Numbers of fishing gears used by districts in the Suratthani province in 2006 [11].

Fishing gears	1	2	3	4	5	6	7	8	9	Total
Pair trawl net									66	66
Trawl net	192	74					4		16	286
Push net	102	115			1	141	68		150	577
Crab gill net	67	104	37	19	203	2	38	51	223	744
Fish gill net	33	48	41	51	27		10	29	171	410
Spanish mackerel gill nets									1	1
Shrimp trammel net	23	103	215	5	2			29	15	392
Squid trap		4		18	1			4		27
Crab trap	9	50	2	2	48	1	24	66	217	419
Fish trap		2		5						7
Shrimp trap	2						1		7	10
Squid light luring cast net	1	14	5	66			1	55	44	186
Beach seine					1					1
Anchovy purse seine		10					4		1	15
Mullet gill net	4	16	2				4	1	16	43
Shark net									2	2
Cockle dredges	37					1				38
Short necked clam dredges							3		35	38
Horse mussel collection	3						1			4
Longline	4	5	1	18			5	1	20	54
Handline(shrimp)	3	2	17				6		3	31
Handline(fish)		2	21	67		3			1	94
Cast net	3					1	18	1	88	111
Traditional crab trap (Raeo)							1			1
Fishery product transportation								1		1
Bush pile									2	2
Total	527	550	341	251	309	149	188	238	1,079	3,632

Notes: 1 = Kanchanadit, 2= Donsak, 3 = Koh Samui, 4 = Koh Phangan, 5 = Chaiya, 6 = Thachang, 7 = Phunphin, 8 = Thachana and 9 = Muang

Table 3 Percentage of catch composition in the Bandon bay by type of aquatic fauna (2001 - 2005) [3].

% of catch composition	Period				
Total catch (tonnes)	**2001**	**2002**	**2004**	**2004**	**2005**
Pelagic fish	4.46	5.84	4.63	11.11	12.22
Demersal fish	7.37	14.64	4.98	4.80	2.64
Squids/Cuttlefish	10.84	37.58	9.61	21.11	35.11
Shrimp/prawn	0.49	2.59	1.68	1.69	0.35
Crab	1.20	9.46	1.89	0.61	0.50
Shell/clam	0.00	0.00	0.66	0.01	0.00
Trash fish	74.46	28.15	72.67	59.45	47.78
Others	1.19	1.75	3.88	1.22	1.41

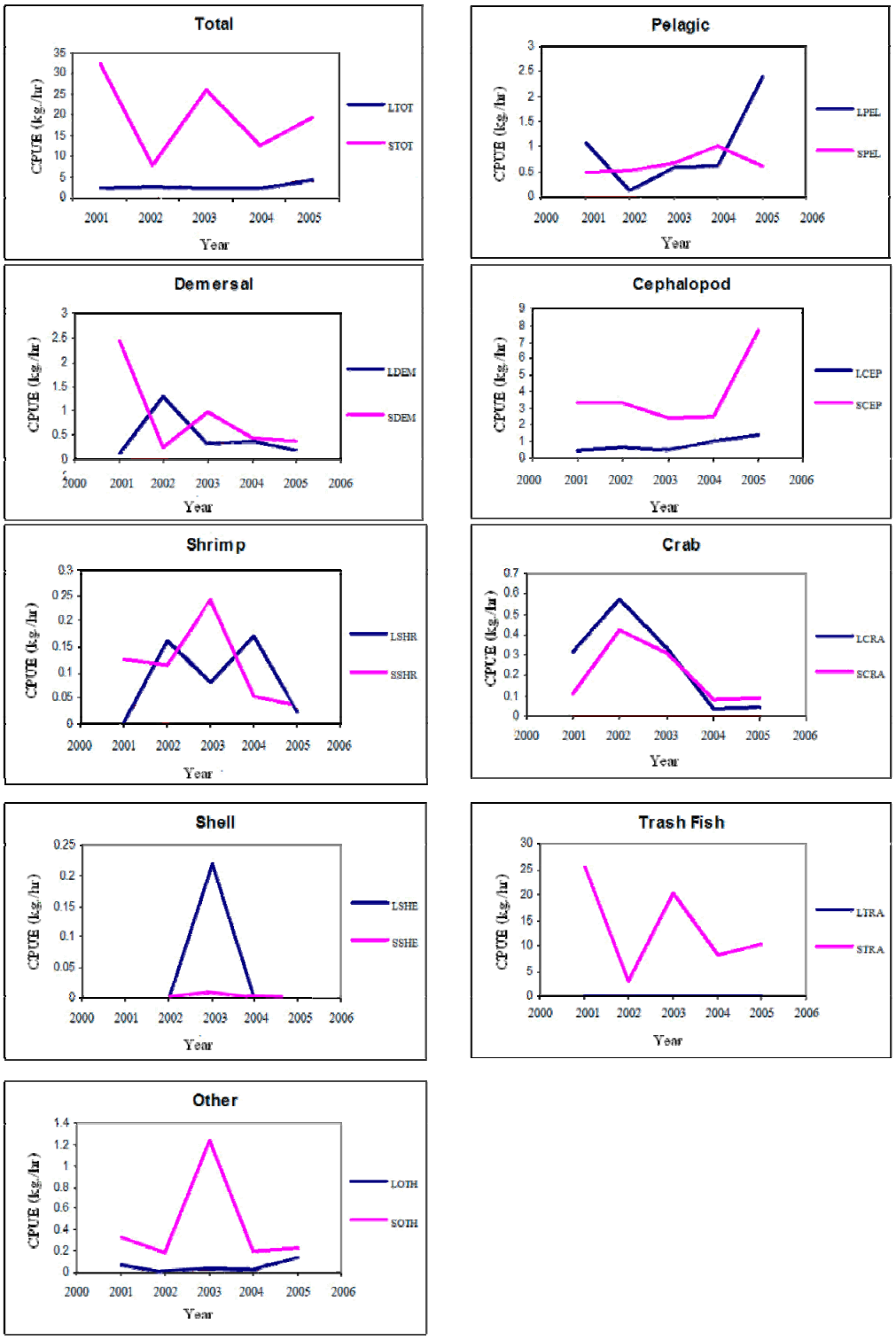

Figure 3 Catch per Unit Effort (CPUE) (kg/hr) by using Otter board trawl net.
Note: First Alphabet (L = Large size, S = Small size, C = From code-end).

Cost and Fish Price

Cost

The marginal cost for fishing is from gasoline, which ranges between 30 and 70 % depending on whether stationery- or active-fishing is in operation [16,17]. Therefore, variations in gasoline price always affect the cost for and benefit to the fishermen. Results on the cost and benefit of Thai marine fisheries in 2003 (gasoline price was 14.59 Baht per litre) showed that most of the fishing boats, regardless of size and modes of fishing, hardly made a profit. Therefore, the trend in increasing gasoline price at present is a cause of the loss of profit to most fishing industries.

The retail price of gasoline, both benzyl 91 and diesel, has increased continuously since 1997 with a sharp increase starting in 2004 (**Figure 4**) [18]. The gasoline break-even price was on average 12.61 Baht per litre but varied according to the size of the boat and modes of operation (**Table 4**) [19]. Therefore, the increase in gasoline price has a significant impact on fishermen, as confirmed by the annual strategic planning of the Department of Fisheries [20,21] to put out the mitigation measures such as providing cheap gasoline or even compensating the fishermen in case of a remarkable increase in the gasoline price.

Table 4 The gasoline break-even price by type of boats [19].

Type of boats	Gasoline break even price (Baht/Litre)
By boat sizes	
- Small size (< 14 m)	11.44
- Medium and large size (> 14 m)	13.06
- Average	12.61
By gears	
- otter board trawl	11.91
- pair trawl	13.36
- push net	11.33
- purse seine	12.40

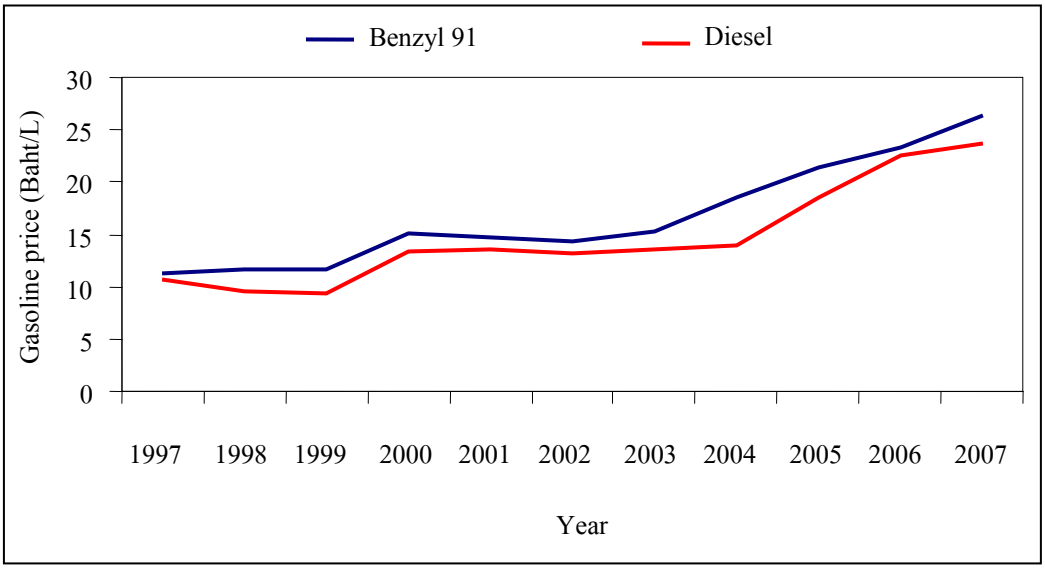

Figure 4 Changes in the price of gasoline (Benzyl 91 and Diesel) 1997 - 2007 [18].
Note: *These prices were adjusted with a baseline using the consumer price index from the Bank of Thailand 2002*.

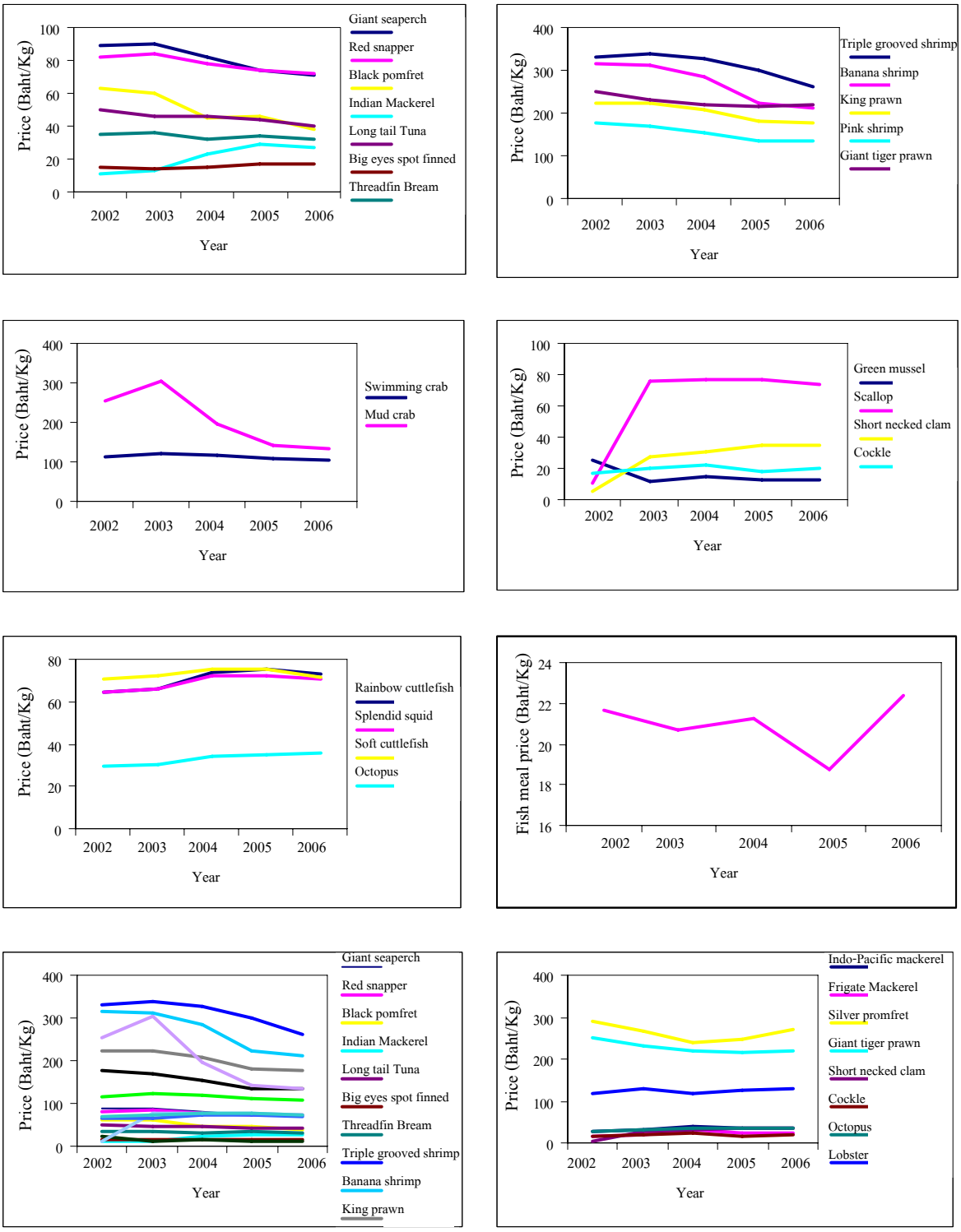

Figure 5 Fish price by species groups (2002 - 2006) [22].

Fish Price

The price of the catch is an important variable that can indicate the benefit available to fishermen. The data provided by the Fish Market Office (2002 - 2006) [22], adjusted with a baseline using the fish price index in 2002, reveals that the fish prices of almost all groups decreased noticeably, due to most of the catch being trash fish and immature aquatic fauna. However, the prices of some fish groups increased slightly, e.g. indo-pacific mackerel, frigate mackerel, silver promfet, giant tiger prawn, short necked clam, cockle, octopus, and lobster (**Figure 5**). This was because these fish and shellfish are important either in the fish processing industries (e.g. mackerels) or the export industry (e.g. giant tiger prawn) [23].

Only the price of fish meal, made by trash fish, has increased since 2005. This is because of the expansion of the animal farms in the country. The significant increase in the price of fish meal is one of the reasons that the fishermen exploited more trash fish, which inevitably impact the immature economically viable fish. This situation would lead to growth in the catching of many pre-adults and over-fishing in the near future. It was found, in general, that growth in the gasoline price index was higher than the growth in the fish price index, from 2002 onwards (i.e. the rate of gasoline price increase sharply). The trend in the gasoline price appears to be increasing when compared to the fish price index which is increasing more slowly (**Figure 6**).

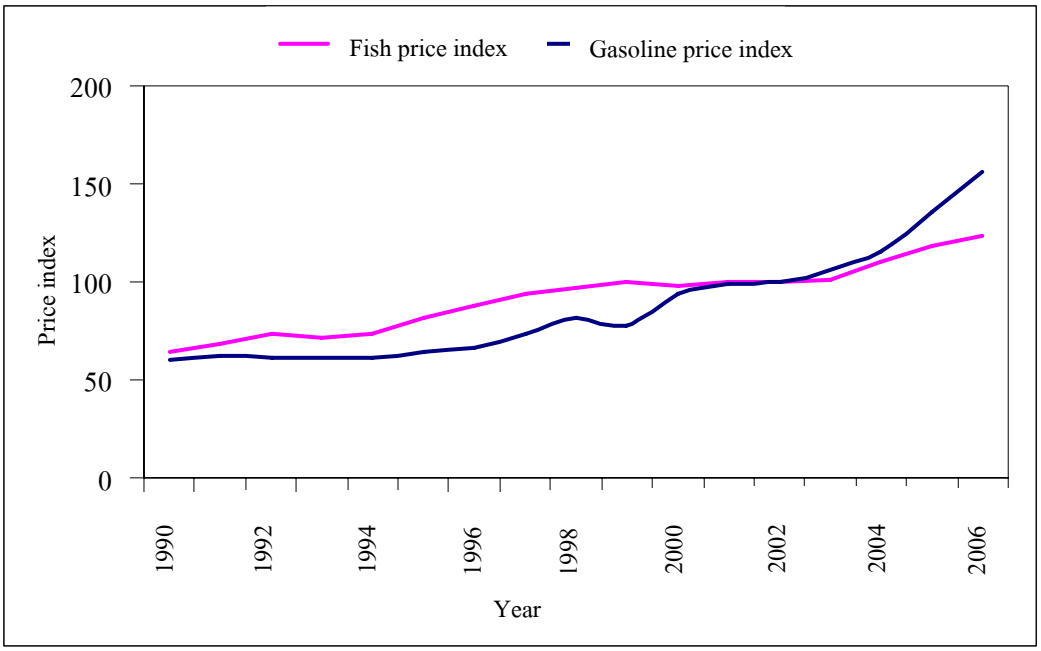

Figure 6 Comparison of growth in the catch price index and gasoline price index [3].

Fishermen's Perspective on Fishing Ground Management

Zoning, one of important concepts in fishing management, is designed to meet a variety of environmental and socioeconomic goals, including the protection of commercial and non-commercial marine species, the generation of tourism revenue, the conservation of critical habitats and ecosystem processes, and the creation of educational and research opportunities [24]. Many areas have, however, failed to achieve their management objectives [25]. A global assessment showed, for instance, that only 10 % of the world's zoning were reaching their goals in the mid-1990s [25]. Low success rates have often been attributed to inadequate consultation and involvement of local

communities during the planning and decision making processes [25-30]. With many user-groups relying on marine ecosystems for their livelihoods and sustenance, stakeholders' needs often come into direct conflict with each other and with the conservation of marine habitats, biodiversity, and ecological processes [31]. Thailand has encountered many of the park management issues as other countries worldwide, including poor compliance to local regulations and mounting conflicts among user groups [32].

Generally, the preference of fishermen in Bandon bay was that they would like a clear boundary between the fishing and prohibited zones. The current prohibited zone is 3,000 m from the shoreline, in which small scale fishing boats cannot go to fish. Thus, the fishermen have an idea to define a new prohibited zone based on the specific characteristics of each coastal area. For example, slope of the coast can be used to identify the prohibited zone. Moreover, the fishermen prefer to have additional occupations, to release aquatic fauna into natural water bodies and to develop a fishery group. At present, they lack financial support to initiate such a group [3]. The aquatic fauna caught are currently small. This situation will not be good for the future status of the fishing resources as the small fish have no chance to spawn.

Recommended Plans

Short-term Planning

1. Local participation involvement to release more aquatic fauna seeds into the Bandon bay to strengthen the relationship between the government and local fishermen.
2. Provide support for additional occupations for fishermen during the monsoon season and in the closed season. The fishermen recommended their additional occupations should be relevant to the fishing activities that they are familiar with. They believe that they should use raw materials that are available in the area to reduce input costs and the market should be prepared to sell their products.
3. Provide basic knowledge to the fishermen about fish processing to add value to their fishing resources.
4. Develop agreement and friendship, and reduce the spatial conflicts between the fishermen and the clam culture owners.

Long-term Planning

Socio-economic Aspect

1. Develop an accurate and up to date database of the fishing census including information of fishermen and aquaculture farmers in Bandon bay.
2. Develop a central market for the distribution of the catch and fishing products and promote the market to increase the marketing opportunity for the fishermen in the Bandon bay.
3. Promote and support the development of fishing cooperatives in each sub-district so that the fishermen will be able to negotiate the catch price and buy cheaper fishing equipment as well as support the fishermen to save the money through the fishing cooperatives.
4. Promote eco-tourism to motivate people to increase their awareness about conservation, increasing the income of the local fishermen.
5. Develop the mechanism for monitoring and controlling the discharged water from different sources, e.g. factories and shrimp farms, to reduce water pollution in Bandon bay. This should be done with the participation of inter government sectors and local communities.
6. Campaign to raise awareness of environment and fish conservation in Bandon bay and support the fishing conservation group in each district (the fishermen would like to have groups but they lack understanding about the process and a lack of funds makes this difficult).
7. Campaign for the treatment of discharged water from households and the reduction of solid waste from households into the canal to reduce pollution in the Bandon bay.

Environmental and Fishery Resource Aspects

1. Change the types of fishing equipment that are considered destructive, e.g. push net, trawl net, traditional net (Uan Rang in Thai), and traps or other activities by training the fishermen to make other types of fishing equipment or to do culture activities, e.g. cockle farming and cage culture. The destructive equipment usually catches small fish, which will have no chance to spawn.
2. Support a study on the life history of aquatic fauna, evolution of aquatic fauna, and structure of the aquatic fauna community that will help in understanding the food chain and ecosystem in Bandon bay. The data can be used for Ecological Based Fisheries Management.

3. Develop a database of environmental and fishing resources, which can be used and extended by other studies and will be useful for administration and management of the environment and fishing resource in Bandon bay.

4. Rehabilitate the aquatic fauna that have the potential to increase, such as swimming crab, Sesarmid crab, and cockle.

5. Promote the extension of mangrove plantations, in particular for vulnerable areas to increase the nursery grounds for aquatic juveniles.

6. Evaluate the economic loss from use of small aquatic fauna and disseminate the information to the fishermen to increase their awareness of the problem.

7. Promote the use of appropriate mesh size so that the small fish will have chance to spawn.

8. Study the possibility of setting up an artificial reef in Bandon bay to increase the number of habitats for the aquatic fauna.

Policy Aspect

1. Cleary define the clam culture zone, fishing zone, and conservation zone to reduce conflicts between the fishermen and clam culture farmers. The conservation zone should be defined by considering the opinions of the fishermen to ensure that the policy developed will be practical to implement and there are no protests.

2. Review the measures that ban fishing activities within 3,000 m from the shoreline by considering the possibility of operating the fishing activities and characteristics of the coast in each area. This should be done to ensure that the policy developed will be accepted by the local community and in the long-term the government can reduce the cost for monitoring and enforcement.

3. Ban fishing activities using destructive fishing equipment, e.g. push net, trawl net, traditional net (Uan Rang in Thai), and traps in the conservation zone that is accepted by the community to reduce the destruction of small aquatic fauna.

Conclusions

Depletion in the fish stock of Bandon bay has taken place and the status of fishermen is at risk both by the overexploitation and increasing marginal cost (i.e. gasoline). The short- and long-terms plans recommended in this article should be taken into pragmatic action as soon as possible. Cooperation concerning the plans between all stakeholders is among the major aspects needed for sustainable resource management.

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References

[1] A Sawusdee. Population dynamics of the Spotted Scat *Scatophagus argus* (Linnaeus, 1766) in Pak Panang Bay, Nakhon Si Thammarat, Thailand. *Walailak J. Sci. & Tech.* 2010; **7**, 23-31.

[2] A Sawusdee, T Jutagate, TT Chaidee, S Thongkhoa and P Chotipuntu. Fish in Pak Panang Bay and river in relation to the anti-salt dam operation, Part 2: Tropic model. *Kasetsart J. Nat. Sci.* 2009; **43**, 107-19.

[3] A Sawusdee. Bandon Bay and its offshore islands management planning project: Analysis and diagnosis of the coastal production systems (Fisheries sector). Coastal habitats and resources management project (CHARM), 2007, p. 1-119.

[4] The Thai overseas fisheries association. Thai oversea article, Available at: http://www.tofa.or.th/index.php?mo=3&art=442009, accessed September 2010.

[5] Office of the nation environment board. Ministry of science, Technology and environment Bangkok, Thailand. The integrated management plan for Bandon Bay and Phangnga Bay. *ICLARM Tech. Rep*. 1992; **30**, 1-161.

[6] A Ngampongsai and J Nabhitabhata. Occurrences of endanger and rare wide animals in upper south area, Bandon Bay, peninsular Thailand. *Tigerpaper (FAO)*. 1987; **14**, 25-6.

[7] A Jarernpornnipat, O Pedersen, KR Jensen, S Boromthanarat, S Vongvisessomjai, P Choncheanchob and AT Williams. Sustainable management of shellfish resources in Bandon Bay, Gulf of Thailand. *J. Coastal Conser*. 2003; **9**, 135-46.

[8] RF Myers. Micronesian reef fishes. 2nd ed. Coral Graphics, Barrigada, Guamm, 1991, p. 1-298.

[9] NT Nguyen and VQ Nguyen. Biodiversity and living resources of the coral reef fishes in Vietnam marine waters. *Science and Technology Publishing House*. 2006, Available at: http://fishbase.org/References/FBRefSummary.php?id=58534, accessed September 2010.

[10] Y Musik, P Wilaipun, V Dulyapurk, S Aungsumalin and M Kaewnern. Major plan for fishery development and fishery production management in Surathani province project. Fisheries Faculty, Kasetsart University, 2006, p. 1-309.

[11] Suratthani fisheries provincial office. Collection of fishing gears census in Suratthani province. Suratthani Fisheries Provincial Office, 2006, p. 1-10.

[12] Suratthani fisheries provincial office. Conflict solved meeting reports, Available at: http://www.fisheries.go.th/fpo-suratthani/index.php?option=com_content&view=article&id=56:2553&catid=28:2553&Itemid=57, accessed September 2010.

[13] T Chanprasoetphon. Aquatic resource status by push net boat. Bulletin No. 5/1988. Resources and fisheries status assessment group. Marine fisheries division. Department of Fisheries, 1988, p. 1-46.

[14] Suratthani fisheries provincial office. Catch composition survey by push net in Tha Chang district, Suratthani province. Suratthani fisheries provincial office, 2005.

[15] Chumphon marine fisheries research and development centre for middle gulf of Thailand. Aquatic fauna survey in Ban Don Bay. Chumphon marine fisheries research and development centre for middle gulf of Thailand, 2001 - 2005; (excel file).

[16] P Bunchuwong. Impacts of changes in gasoline price on marine fishery business fishery economic section office of fishery development and transfer. Department of Fisheries, Bangkok, 2003, p. 1-97.

[17] A Sawusdee. 2005, Burrowing goby (*Trypauchen vagina* Bloch & Schneider, 1801) fishery management in Pak Panang Bay, Nakhon Si Thammarat province. Master Thesis, Kasetsart University, Bangkok.

[18] PTT public company limited. Price of gasoline (benzyl 91 and diesel) during 1997 - 2007, Available at: http://www2.bot.or.th/statistics/BOTWEBSTAT.aspx?reportID=409&language=ENG, accessed September 2010.

[19] Department of fisheries. Study on cost and benefit of fishers in marine fisheries business. Department of Fisheries, 2003, p. 1-35.

[20] Department of fisheries. The fuel supporting project for coastal fishermen, Available at: http://www.fisheries.go.th/marine/ChaoLe/Fuel/fuel_index.htm, accessed September 2010.

[21] Ministry of Agriculture and Cooperative. The fuel supporting project for coastal fishermen, Available at: http://www.krabiunited.com/index.php?app=extra_news&fnc=detail&newsid=1315, accessed September 2010.

[22] Fish market office. Fish prices during 2002 – 2006, Available at: http://www.fishmarket.co.th/stat/product_fmo_d.php?address_id=1, accessed September 2010.

[23] BioThai foundation. The critical of Thai fishery industries. Biothai publication, Available at: http://www.biothai.net/news/2964, accessed September 2010.

[24] RV Salm, J Clark and E Siirila. Marine and coastal protected areas: A guide for planners and managers. Washington: IUCN, 2000, p. 1-115.

[25] G Kelleher, C Bleakley and S Wells. A global representative system of marine protected areas. Washington: The World Bank, 1995, p. 1-92.

[26] AT White. Marine reserves: How effective as management strategies for Philippine, Indonesian, and Malaysian coral reef environments? *Ocean Manage.* 1986; **10**, 137-59.

[27] D Laffoley. Techniques for managing marine protected areas: Zoning. Marine protected areas: Principles and techniques for management, 1995, p. 103-18.

[28] S Wells and T White. Involving the community. Marine protected areas: Principles and techniques for management, 1995, p. 61-84.
[29] J Alder. Have tropical marine protected areas worked? An initial analysis of their success. *Coast. Manage.* 1996; **24**, 97-114.
[30] AT White, CA Courtney and A Salamanca. Experience with marine protected area planning and management in the Philippines. *Coast. Manage.* 2002; **30**, 1-26.
[31] JA Dixon, L Fallon Scura and T van't Hof. Meeting ecological and economic goals: Marine parks in the Caribbean. *Ambio* 1993; **22**, 117-25.
[32] S Chettamart and D Emphandhu. Environmental Protection and Rural Development in Thailand: Challenges and Opportunities, White lotus press, 2002, p. 113-6.