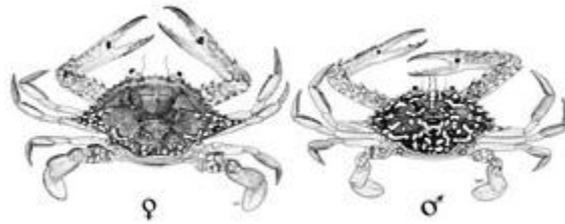




+333
10051 5th Street N., Suite 105
St. Petersburg, Florida 33702-2211
Tel: (727) 536-9070
Fax: (727) 536-0207
Email: MRAG.Americas@mrغامericas.com

President: Andrew A. Rosenberg, Ph.D.

Pre-Assessment of the Thailand Blue Swimming Crab (*Portunus pelagicus*) Fishery



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Richard Banks, Lead Assessor, Poseidon
Richard@consult-poseidon.com
Robert J. Trumble, Vice President, MRAG
bob.trumble@mrغامericas.com

Client details

Stephanie Bradley
Senior Program Officer
World Wildlife Fund
171 Forest Avenue
Palo Alto, CA 94301

office +1 650.323.3504
mobile +1 202.299.6204
stephanie.bradley@wwfus.org

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ACRONYMS

AFLP	Amplified fragment length polymorphism
BMSY	Equilibrium total biomass at Maximum Sustainable Yield
CB	Certification Body
CCRF	Code of Conduct for Responsible Fisheries (FAO)
CPUE	Catch Per Unit Effort
CHARM	Coastal Habitats and Resources Management Projects
CMDEC	Chumphon Marine Fisheries Research and Development Centre
DOF	Department of Fisheries
DOFM	Department of Fisheries Malaysia
DMCR	Department of Marine and Coastal Resources
EMCED	Eastern Marine Fisheries Research and Development Centre
EAFM	Ecosystem Approach to Fisheries Management
EEZ	Exclusive Economic Zone
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
FSARG	Fisheries Statistics Analysis and Research Group
FAO	Food and Agricultural Organization
GoT	Gulf of Thailand
HACCP	Hazard Analysis and Critical Control Points
HS	Harvest Strategy
IUU	Illegal , Unreported, Unregulated
MCS	Monitoring, Control and Surveillance
MRFDB	Marine Fisheries Research and Development Bureau
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MoU	Memorandum of Understanding
M&E	Monitoring and Evaluation
NPOA	National Plan of Action
PAFM	Precautionary Approach to Fisheries Management
PI	Performance Indicator
PSA	Productivity Susceptibility Analysis
RBF	Risk Based Framework
RFMO	Regional Fisheries Management Organizations
SG	Scoring Guidepost
SICA	Scale Intensity Consequence Analysis
TCPG	Thai Crab Product Group
TFFA	Thai Frozen Food Association
TAC	Total Allowable Catch
UNCLOS	UN Convention on the Law of the Sea
UNFSA	UN Fish Stocks Agreement
VMS	Vessel Monitoring System

1. Executive summary

The Marine Stewardship Council (MSC) pre-assessment of the Thailand (*Portunus pelagicus*) blue swimming crab trap and bottom gillnet fishery was undertaken by Richard Banks (Lead Assessor, MRAG Americas) and Bob Trumble (Vice President, MRAG Americas). Richard Banks is an assessor with work experience in South East Asia, the Pacific and Australia. Bob Trumble is the Vice President of MRAG Americas and coordinator for this project.

The pre-assessment was conducted in the period from 7 October to 20 October inclusive and involved site visits to Bangkok, Trat, Rayong, Surat Thani, Nakhon Si Thammarat, Chumphon, Phang Nga and Trang. Key stakeholders consulted in the assessment process included the Department of Fisheries (DoF), Department of Marine and Coastal Resources (DMCR), the Thai Crab Product Group, scientists, vessel owners, fishermen and NGOs.

The main strengths identified during the assessment include:

- Stock assessments are undertaken in most offshore fisheries and one coastal fishery. The stock status for the offshore fishery appears to be in a reasonable condition;
- Information systems are in place, but there is limited information on fleet structure, especially in coastal fisheries;
- Research activities would appear to be in place, but it is unclear how comprehensive this may be across the range of the fishery;
- There are reasonably strong engagement processes that deal with endangered, threatened, and protected (ETP) species interactions and promotion of environmental awareness;
- Governance structures are in the process of development with a new fisheries Act in draft. The national fisheries strategy confirms application of the precautionary principle and ecosystem approach to fisheries management, but these have yet to be adopted in practice; and
- Roles and responsibilities are clearly identified. These include fisheries (Department of Fisheries) and ecosystem managers (Department of Marine and Coastal Resources), researchers (Marine Fisheries Research and Development Bureau) and key stakeholders (Thai Crab Product Group), village tambon groups and fishing vessel owners.

The main weaknesses include:

- Stock status is likely to be over exploited for the fishery as a whole, but heavily over exploited in coastal areas;
- Limit and target reference points have not been set nor incorporated into management;
- There are no fishery specific harvest strategies, nor rules in place;
- There are some localised management measures in place, including crab banks and voluntary no take zones, including the preservation of crab habitat (sea grass beds). These are by no means widespread throughout the coastal communities, but evidence suggests that initiatives such as these are being encouraged;
- There is limited information on fleet structure;
- There is limited data on retained and bait fish species affected or applied by the two fishing methods – traps and bottom set gill nets; and
- There is no fishery specific management plan in place nor supporting management systems that would ensure appropriate management actions would be implemented.

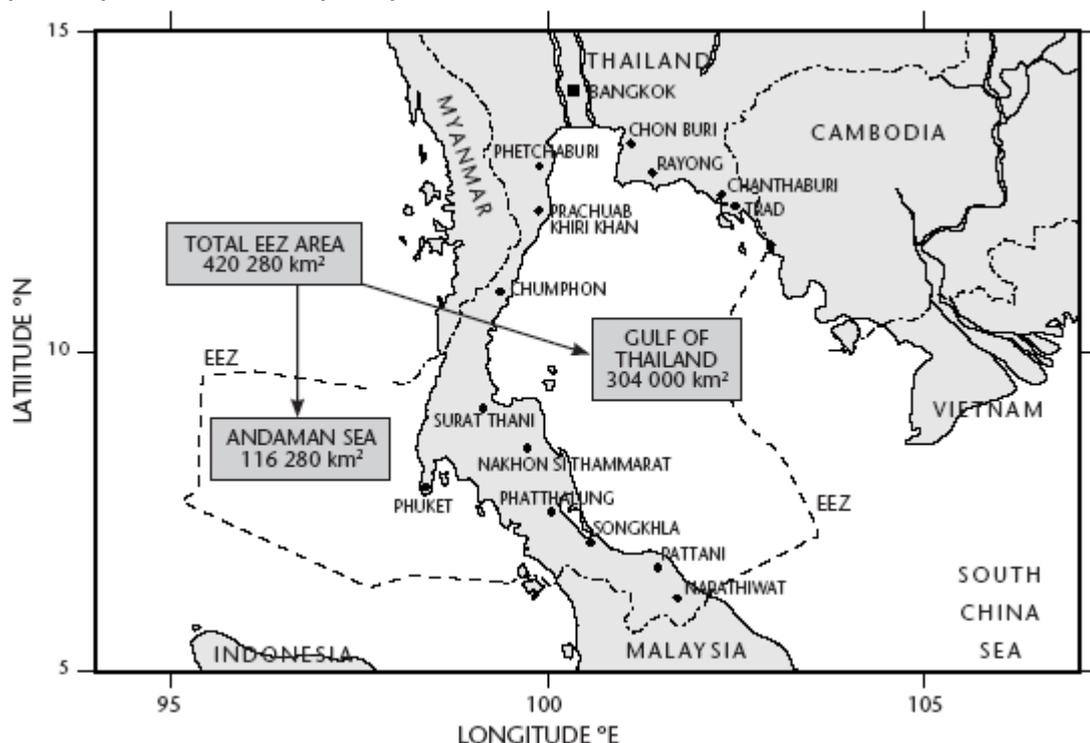
In its current state, the fishery would fall below the MSC standard for all three principles. It is expected that the results from this pre-assessment will support the development of a Fisheries Improvement Project (FIP) process, which would seek to improve the environmental performance of the fishery to a level consistent with the MSC standard.

2. Introduction

2.1 Aims/scope of pre-assessment

This report represents a pre-assessment of the Thai blue swimming crab fishery, and covers the fishing activities in the Gulf of Thailand and Andaman Sea (Map 1). Fishing activities comprise both bottom gillnet and trap, used across a range of boat sizes ranging from small coastal to the larger commercial fleets. The major commercial fishing centres are Prachuab-Kirikhan, Surat Thani, Chumphon and Nakohn Si Thammarat, whilst coastal activities take place from almost all the Gulf of Thailand provinces, as well as Phang Nga, Trang, Satun and Ranong on the Andaman Sea (Map 1).

Map 1: Map of Thailand and principal coastal locations



It should be noted that a pre-assessment of a fishery does not attempt to duplicate a full assessment against the MSC standard. A full assessment involves an expert assessment team and public consultation stages, which are not included in a pre-assessment. A pre-assessment provides a provisional assessment of a fishery against the MSC standard based on information provided by the client.

2.2 Constraints to the pre-assessment of the fishery

The pre-assessment uses literature provided by the client, WWF Thailand, and observations interpreted from interviews with 47 stakeholders. It also draws from the assessor's own knowledge of the Thailand fishery sector and its fishery administrative system.

2.3 Unit(s) of certification

There are potentially 4 Units of Certification (UoCs). This could extend to additional units if distinct genetic differences were to be identified in the Gulf of Thailand stock.

Unit of Certification

The fishery assessed for MSC certification is defined as:

Thailand blue swimming crab (*Portunus pelagicus*) fishery

Sub groups:

Gulf of Thailand bottom gillnet fishery

Andaman Sea bottom gillnet fishery

Gulf of Thailand trap fishery

Andaman Sea trap fishery

Geographical Area: The Gulf of Thailand is defined as between 6° to 13.5° North latitude and 99° to 104.5° East longitude within the Western Pacific (FAO zone 71).

The Andaman Sea is defined as between 6° to 10° North latitude and 95° to 100° East longitude within the Eastern Indian Ocean (FAO zone of 57).

Methods of Capture: bottom set gillnet and trap

Stock: *Portunus pelagicus*. Two distinct stocks in the Andaman Sea and the Gulf of Thailand with potentially other genetic distinctions within the Gulf of Thailand.

Management System: The fisheries are managed by zonal delimitation but without restricted entry licensing and effective technical limits (closed seasons, minimum landing sizes, etc.).

Client Group: WWF US in association with WWF Thailand.

3. Description of the fishery

3.1 Scope of the fishery in relation to the MSC programme

The blue swimming crab fishery is identified as a wild stock, which has a very limited management system in place. Natural productivity and genetic biodiversity of the population and any impacts on long-term sustainability are the main focus areas of this assessment. There have been attempts to enhance the fishery by use of crab banks¹ to preserve and disperse eggs post-capture. However, as yet, evidence of any positive impact on recruitment from this method is anecdotal. If evidence exists to show that crab banks are effective, then this would have to be assessed under the MSC enhanced fishery requirements process.

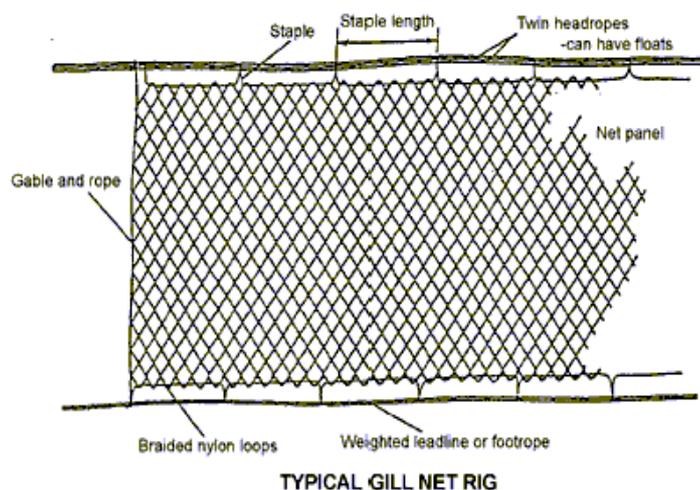
¹ A crab bank is a system where gravid females are placed in onshore storage to release eggs. Once released, the eggs are dispensed into the sea and the females are taken for processing.

3.2 Overview of the fishery

Blue swimming crab is a major export species from Thailand, accounting for approximately 5,000 (Thongchai²) of processed product and between 12,000³-15,000⁴ tonnes landed weight. The export market is valued at US\$ 60-80 million (Thailand Crab Product Group, pers com, October, 2011).

The major fishing gears that Thai fishermen use for catching blue swimming crab are bottom gillnet (Figure 1) and collapsible crab trap.

Figure 1: Bottom Gillnet rig



The gillnets may vary in length based on the size of the vessel, but the gillnet may comprise several tiers of around 180 m per tier and 1-2m in depth. Maximum lengths range from 400-2,000 metres for coastal fishers, but can be up to 5 km for offshore commercial vessels. Coastal fishers may deploy up to 8 nets at any one time for a soakage period of up to 24 hours, whilst commercial fishers deploy one net over the course of around 40

hours, the period for setting and retrieving. The mesh size of the net is usually around 6.4 cm (2.5in) for inshore netters and 8 cm for offshore commercial vessels. Bottom set gillnets have been deployed since the early 1980s (Thongchai⁵).

The crab trap is mostly a collapsible trap⁶ (Picture 1). It is constructed from aluminium wire with dimensions 30 x 60 x 20 cm and a green nylon net with a the mesh size of 1.4 cm. There are no escape gaps in the trap but there is a minimum size limit for trap floors (5.5 cm). The traps are attached to a main rope. These can be up to 1 km in length. Some coastal fishers may deploy individual traps (Thongchai⁷). Each trap has an interval of 20 m. In each trip the fishers may deploy between 80-200 traps in coastal waters, but up 3,000 traps for longboats and to 5,000 traps for larger commercial vessels. Coastal fishers use bait, taken from fish caught in baitfish gillnets, whilst commercial vessels purchase Indian mackerel or occasionally mussels. Indian mackerel is purchased from a purse seine fishery in Rayong⁸ (Nanthanee, pers com, September, 2011).

² Thongchai, N., and Kungwan, J., (Undated), Sustainable Management Measures for Blue Swimming Crab (*Portunus pelagicus*) Fishery: A case study in Sikao District, Trang Province, Thailand.

² Trawlers and push nets account for 20% in the Gulf of Thailand and around 30% in the Andaman Sea.

³ Assumes a 30% yield from exported processed product.

⁴ Assumes between 15-30% yield.

⁵ Thongchai *Ibid.*

⁶ Cylindrical traps suspended from floats, and non collapsible traps are also used, but very much in a minority.

⁷ Thongchai *Ibid.*

⁸ Baitfish fisheries also form part of the overall assessment, and there is no information on the sustainability of the various baitfish sources

Coastal traps are set at depths from 2-5 m, usually 3 km from the shore, whilst offshore vessels lay traps in deeper water (30-50m) 5-7 km from the shore. These types of traps have been set since the early 2000s, replacing older iron traps. Individual traps may last up to 8 months (Piangchan, S., pers com, September, 2011).

Picture 1: Collapsible trap



Other methods that may catch *P. pelagicus* as a bycatch include otter trawl, pair trawl, shrimp trammel net and push net (Table 1). Inshore fisheries (within 3 km) are reserved entirely for coastal fishers. Commercial vessels may only catch crab outside 3 km but run the risk of interactions with other fishing methods, most notably trawlers. These trawlers also catch blue swimming crab as a bycatch⁹ and are known to fish inside the inshore zones, causing much conflict. Specific areas may also be reserved for non-commercial fisheries (Athiyut, pers com, October, 2011).

Table 1: Distribution of crab catches by fishing method

Gulf of Thailand			Andaman Sea	
Fishing method	Tonnes	% total catch	Tonnes	% total catch
Gillnet	9,539	59%	5,720	74%
Trap	3,353	21%	717	9%
Otter trawl	1,694	11%	1,162	15%
Pair trawl	580	4%	134	2%
Push net	573	4%	-	
Shrimp trammel net	317	2%	-	

Source: DoF Fisheries Statistics, 2008; Note: includes other swimming crab species.

Reported annual catches (DoF, 2008¹⁰) of swimming crab are around 24,000 to 30,000 tonnes in the period 2004 to 2008 (DoF, 2009); however, these may include some other species. Current landings of swimming crabs are estimated to be around 23,000 tonnes, with the commercial crab fleet catching around 30% of the total volume (7,000 tonnes). Catches (DoF, 2009) by bottom gillnet are reported at 70% of the total, whilst catches by trap are reported at 16% of the total. Anecdotal evidence from crab processors suggest that the balance between the two fisheries is more evenly

⁹ Trawlers and push nets account for 20% in the Gulf of Thailand, and around 30% in the Andaman Sea.

¹⁰ DoF catches are broadly consistent with trade data. Product yields average at 30%, but range from 15% to 50% dependent on size and sex. Large male crabs recording the higher yields.

spread (Athiyut, Si Chon; Thawatchai, Viya, pers com, October, 2011), with the principal export companies stating 60-70% dependency on the commercial fleet (TCPG, pers com, October, 2011).

There is a high genetic diversity of *P. pelagicus* in Thai waters found between the Andaman Sea and the Gulf Thailand (Sirawut *et al*, 2007)¹¹. Some distinctions are also found in the populations from Chanthaburi and Prachuap Khiri Khan (Northern Gulf of Thailand Stock), and Surat Thani (Sirawut *et al*, 2007). However, whilst processors confirm differences between the Andaman Sea and Gulf of Thailand (Athiyut, *Ibid*), reflected by harder shells and lower yields in the former, they question the GoT distinctions. It is also noteworthy that Kangas (2000)¹², draws attention to localised longshore drifts in larvae, which must ensure mixing between itinerant stocks. However, based on tagging experiments in Australia, the adults are known to remain within a limited geographical range, linked to specific river systems, providing for some potential differences in genetic distinction over large ranges. The localised nature of *P.pelagicus* movements is also highlighted in Sezmis¹³, 2004 and Bryars¹⁴ *et al*, 1999.

Some other distinguishing features (Thongchai¹⁵) are:

- Crab gillnet catch is mainly composed of medium and large sized crab whereas offshore traps catch mainly large crab and most inshore traps catch mainly small crab;
- The fishing grounds in deeper water are more prosperous than those in shallow water because of a higher abundance of medium and large-sized crab;
- The catch per trip and size composition varies from season to season. The catch in the rainy season is higher than the dry season, and in the rainy season the fishers catch more large crab than in the dry season.

The information on the total number of fishers actively targeting blue swimming crab has not been made available to the assessors and requires clarification. The major difficulty lies in the fact that not all coastal fishers are registered (Chaiyan, DoF, Trat, pers com, October, 2011). However, the number of commercial gillnet vessels (Picture 2) is believed to be 845 (Table 2), though this may also be questionable. There are also a large number of offshore commercial trap vessels (Pictures 3 & 4), but these are not reported in the DoF statistics (Athiyut, *Ibid*).

¹¹ Sirawut, K., Kannika, K, Bavornlak, K., Piamsak, M., (2007), Genetic Heterogeneity of the Blue Swimming Crab (*Portunus pelagicus*) in Thailand Determined by AFLP Analysis Biochem Genet (2007) 45:725–736

¹² Kangas MI (2000) Synopsis of the biology and exploitation of the blue swimmer crab, *P. pelagicus* Linnaeus, in Western Australia. Fish Res Rep Fish West Aus 121:1–22

¹³ Sezmis E (2004) The population genetic structure of *Pors. pelagicus* in Australian waters. Ph.D. thesis, Murdoch University, Australia

¹⁴ Bryars SR, Adams M (1999) An allozyme study of the blue swimming crab, *P.pelagicus* (Crustacean: Portunidae), in Australia: stock delineation in southern Australia and evidence for a cryptic species in northern waters. Mar Freshw Res 50:15-26

¹⁵ Thongchai, *Ibid*

Table 2: Licensed crab gill netters, Thailand

District	<14metres	14-18 m	19-26 m	>25 m	Total
Gulf of Thailand					
Trat	29	5	1		35
Chonburi	15	1			16
Chachoengsao	1				1
Phetchaburi	9	11			28
Prachuap Khiri Khan	95				95
Chumphon	7	2			14
Surat Thani	14	17	7		38
Nakhon Si Thammarat	40	40	12		98
Songkla	277	2			279
Andaman Sea					
Ranong		2	3		5
Phangnga	39				39
Trang	194				194
Satun	3	3			3
	684	83	23	0	845

Source: Department of Fisheries (2008), Thai fishing vessel statistics.

Picture 2: Example of coastal net vessel



Picture 3: An example of a large commercial crab trap vessel



Picture 4: An example of > 14 m offshore long boat



The numbers of coastal fishers may be many thousands, and crab gillnets and traps account for the largest percentage of catch amongst the coastal fleet (Lymer *et al*, 2008). In Trat province alone, there were an estimated 2,100 coastal fishers, or approximately 700 boats (Jarupa, DoF). Known locations for GoT blue swimming crab coastal fisheries are Prachuap Khiri Khan, Phetchaburi, Chonburi, Rayong, Chanthaburi, Trat, Chumphon, Nakhon Si Thammarat, Surat Thani, Songkhla, Pattani, and Narathiwat; whilst blue swimming crab fishing in the Andaman Sea takes place in Ranong, Phang Nga, Phuket, Krabi, Trang and Satun. Including seasonal fishers, the number of coastal fishers is likely to be in the region of 25,000 to 30,000 vessels (Funge-Smith, pers com, 2011). The accuracy of active fisher numbers is largely dependent on information transmitted from the

Provincial DoF to DoF Fisheries Statistics Analysis and Research Group (FSARG). In some cases, information flows may be limited (Funge-Smith, pers com, October, 2011).

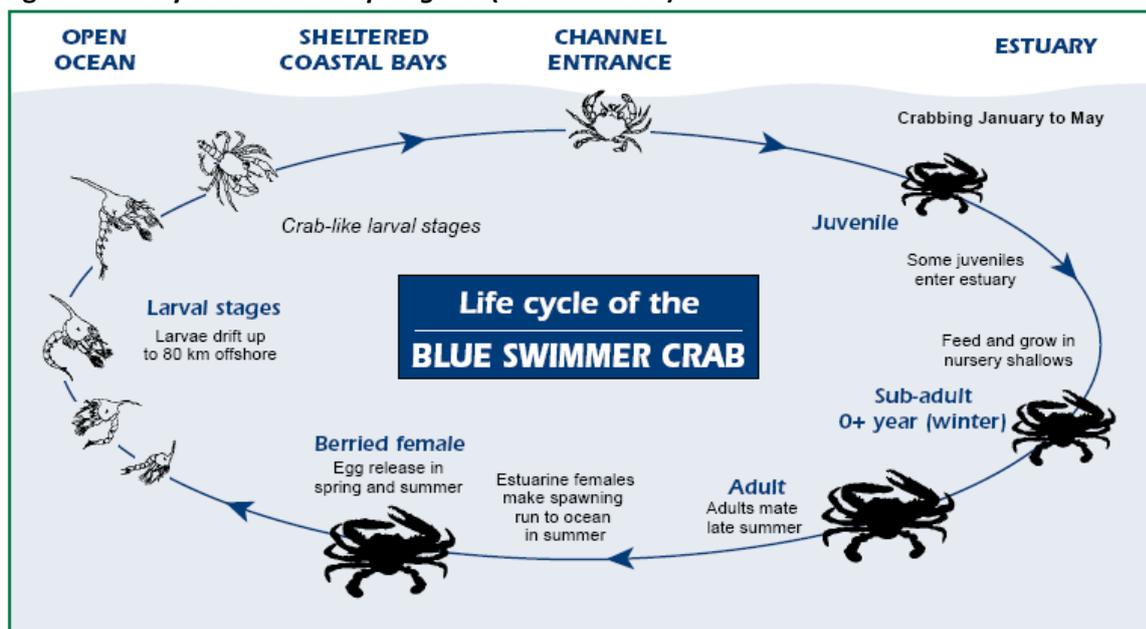
3.3 Principle One: Target species background

Outline of the fishery resources including life histories as appropriate

The blue swimming crab, *P. pelagicus* (Linnaeus 1758), is a large, edible species inhabiting coastal areas throughout the Indo-West Pacific region, from east Africa to Japan and northern New Zealand (Kailola *et al.* 1993¹⁶). Within Thailand, *P. pelagicus* is distributed along the coast in both the Andaman Sea (west) and the Gulf of Thailand (east) (Naiyanetr, 1998)¹⁷. The male blue swimming crabs are bright blue in colour with white spots and with characteristically long chelipeds, while the females have a duller green/brown, with a more rounded carapace. The carapace can be up to 20 cm wide. Blue swimmer crabs live in a wide range of inshore and continental shelf areas, including sandy, muddy or algal and seagrass habitats, from the intertidal zone to at least 50 m depth (Williams, 1982¹⁸).

The life cycle of *P. pelagicus* is composed of five larval stages, which last for 15–45 days total, and the crab phase (Kangas 2000¹⁹) (Figure 2).

Figure 2. Life cycle of *Portunuspelagicus* (from: N. 2006).



Spawning takes place all year in tropical waters (Potter *et al.* 1983²⁰). Adults generally spawn either in the entrance channels of estuaries or in adjacent coastal waters. Movement of *P. pelagicus* in and

¹⁶ Kailola PJ, Williams MJ, Stewart PC, Reichelt RE, McNee A, Grieve C (1993) Australian Fisheries Resources. Bureau of Resource Sciences, Department of Primary Industries and Energy, and the Fisheries Research and Development Corporation, Canberra, Australia,

¹⁷ Naiyanetr P (1998) Checklist of the Crustacean Fauna in Thailand (Decapoda and Stomatopoda). Office of environmental policy and planning biodiversity series 5, 161 pp

¹⁸ Williams, M.J. (1982). Natural food and feeding in the commercial sand crab *P. pelagicus* Linnaeus, 1766 (Crustacea: Decapoda: Portunidae) in Moreton Bay, Queensland. *Journal of Experimental Marine Biology and Ecology*, **59**: 165-176.

¹⁹ Kangas MI (2000) *Ibid*

²⁰ Potter, I.C., Chrystal, P.J. and Loneragan, N.R. (1983) The biology of the blue manna crab *P. pelagicus* in an Australian estuary. *Marine Biology*, **78**: 75-85.

out of estuaries into the open ocean occurs in response to lower salinities. Lower levels of salinity may cause females to leave inshore estuarine areas and move offshore to spawn (Kangas, 2000)²¹.

The released larvae spend up to six weeks in coastal waters being mixed and distributed by the prevailing currents. During the larval phase, the crabs may drift by up to 80 km out to sea before returning to settle in shallow inshore waters (Williams, 1982²²). Immature blue swimming crabs occupy near-shore areas, especially around seagrass meadows and river mouths, whereas mature crabs inhabit more far-shore areas²³. Small crabs prefer seagrass and near-shore areas as nursery grounds, and may use the shade of seagrass shoots as shelter areas (Kenyon *et al.*, 1999²⁴). In addition, low salinity (20-30 psu) is an important environmental factor, which may increase the survival rate of the larval stage of crabs (Tanasomwang *et al.*, 2005²⁵). High mortality is observed in larval *P. pelagicus*. Ingles and Braum (1989²⁶) estimated 98% mortality from hatching to the megalopal stage for *P. pelagicus* in the Philippines.

Ovigerous females are mostly found during October to December (from the end of the wet season), (Tanasomwang *et al.*, 2005), but may also be found further offshore in the rainy season (August and September). The main fishing season is from May to September (Surasak; Athiyut). Outside this period, commercial boats will continue to fish for crab and some coastal vessels will also fish October to April for shrimp (Tat, pers com, October, 2011)).

Female crabs spawn up to two million eggs per batch, larger crabs producing more eggs than smaller crabs. The eggs and larvae of blue swimmer crabs are planktonic. The eggs hatch after about 15 days at 24°C. The life span of blue swimming crabs may be around three years (Williams²⁷).

Blue swimmer crabs mature at about one year of age (Smith 1982). In India, males may undergo a pubertal moult at a carapace width (CW) ranging between 8.5 and 9 cm, and females at 8-9 cm CW (Sukumaran *et al.*, 1996²⁸). The first moult size in Thailand is 9.74 cm for females and 6.50 cm for males²⁹.

Table 3 below provides a summary of the data on catch size and sex by location.

²¹ Kangas *Ibid.*

in Western Australia

²² Williams, M.J. (1982). *Ibid.*

²³ Thongchai *Ibid.*

²⁴ Kenyon, R. A., Haywood, M. D. E., Heales, D. S., Loneragan, N. R., Pendrey, R. C. and Vance, D. J. 1999. Abundance of fish and crustacean postlarvae on portable artificial seagrass units: Daily sampling provides quantitative estimates of the settlement of new recruits. *Journal of Experimental Marine Biology and Ecology*. 232, 197-216.

²⁵ Tanasomwang, V. and Chutpoom, P. 2005. Effects of water salinities on the hatching rates of eggs from berried aprons of blue swimming crab (*Portunus pelagicus* Linnaeus, 1758). *Thai Fisheries Gazette*. 58, 53-60.

²⁶ Ingles, J.A. and Braum, E. (1989). Reproduction and larval ecology of the blue swimming crab, *P. pelagicus*, in Ragay Gulf, Philippines. *Internationale Revue der gesamten Hydrobiologie*, 74: 471-490.

²⁷ Williams, *ibid*

²⁸ Sukumaran, K.K. and Neelakantan, B. (1996a). Relative growth and sexual maturity in the marine crabs, *P. sanguinolentus* (Herbst) and *P. pelagicus* (Linnaeus) along the south-west coast of India. *Indian Journal of Fisheries*, 43: 215-223.

²⁹ Phattareeya S, Thitiporn S, Seiichi Etoh and Virgilia Sulit (Undated). The Role of Crab Bank System in Securing Fisheries Livelihood and Resources Conservation and Management

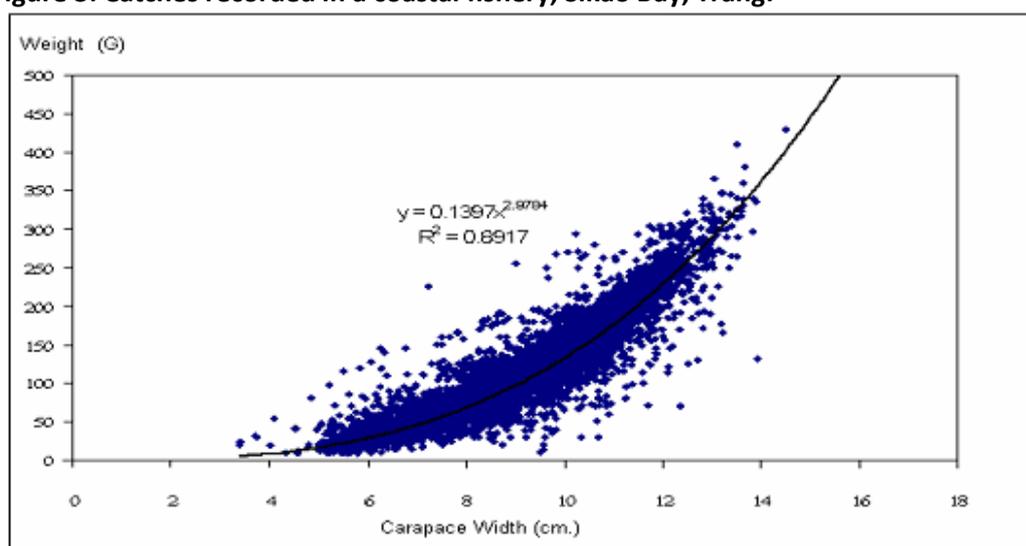
Table 3: Crab size characteristics by area, location and gear in Thai waters.

Author	Location	Activity area	Method	Size (cm)
Sansanee <i>et al</i> ³⁰	Donsak	Offshore	Trap	12,44 (m), fem 12.85 (f)
Apirak <i>et al</i>	Sikao Bay, Trang Province	Coastal	Trap	2.5 to 15
Jindalikit <i>et al</i>	Upper Gulf of Thailand	Offshore	Trap	
Kornwit, <i>et al</i> ³¹	Inner Gulf of Thailand	Coastal	Gill net	9-11
Kornwit			Trap	8.1-10.5
Waraporn <i>et al</i> ³²				
Charlarmchat <i>et al</i> , ³³	All Thai waters	Offshore	Commercial trawl	11-13.5
Montri <i>et al</i> ³⁴	Ranong (Kapoe and Suksamran fishing grounds)	Coastal and offshore		9.9-14.1

Source: MFRDB/Rajamangkala University, Trang

Two specific case studies illustrate the range of catches from an inshore fishery (trap and gillnet in Trang Province) (Figure 3) and an offshore fishery (trap and gillnet in Upper Gulf of Thailand) (Figure 4).

Figure 3: Catches recorded in a coastal fishery, Sikao Bay, Trang.



Source: Apirak, 2011

³⁰ Sansanee, S., and Jinda, P., (2006), Crab Trap Fisheries in the Middle Gulf Of Thailand, MFRDB Technical Paper 15/2006

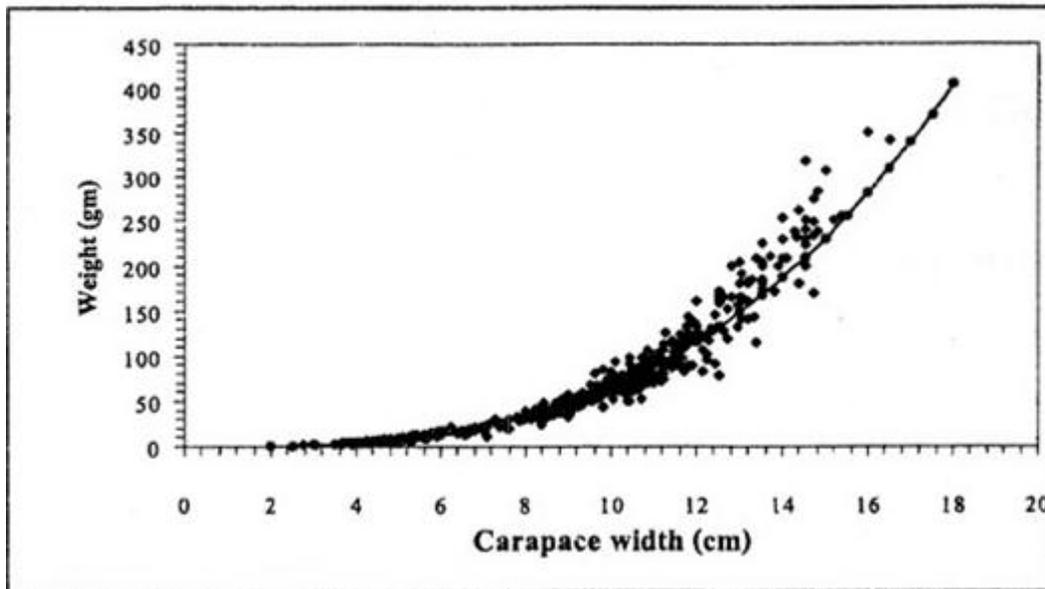
³¹ Kornwit, J., and Saowanee, S., (2009), Crab bottom gill net and collapsible trap fisheries in the inner Gulf of Thailand, MFRDB Technical paper 3/2009.

³² Waraporn, D., and Hassapong S., (2006), Blue swimming crab in the Southern Gulf of Thailand, MFRDB Technical Paper 19/2006.

³³ Charlarmchat, A., Kumpon, L., Trerayut, S., Tidarat, K., and Jintana, J., Saowamol, P., (2010), Catch rate and size composition of blue swimming crab from trawl and push net fisheries in Thai waters, MFRDB Technical Report, 8/2010

³⁴ Montri, S., and Wudtichai, W., (2006), Crab gill net fishery in Ranong Province, MFRDBV Technical Paper 27/2006

Figure 4: Catches taken in the offshore fishery of the upper Gulf of Thailand.



Source: Jindalikit, 2008

Figure 3 shows that considerably more than half the catch in coastal waters is likely to be of a small size, and potentially pre-gravid stages. Some caution should be applied to this data because it only represents a small proportion of Thai catch. Nevertheless, Konwit, 2009 confirmed that only 29% and 17% of females, from the gillnet and trap fisheries respectively, were above the age of first maturity in coastal fisheries within the Gulf of Thailand. Figure 4 shows a fairly typical distribution of catch, by size (cm), taken in offshore waters.

The average percentage of berried females taken in the Southern Thailand fishery was 21% in gillnets and 29% in traps³⁵.

An important feature of a sustainable crab stock is to allow survival for at least at 50% of the females at maturity. Table 4 below provides examples of carapace size at 50% maturity.

Table 4: Carapace width at 50% maturity (CW_{50}) for *P. pelagicus*.

Source	CW_{50} males	CW_{50} females	Comments
Josileen J and Menon N G (2007)	100 mm	100 mm	South West India
Potter, I.C. & S. de Lestang (2000)	84 mm	97 mm	Australian temperate waters
Ingles, J.A & E. Braum (1989)	96.4 mm	106.0 mm	Philippines

³⁵ Waraporn, D *et al*

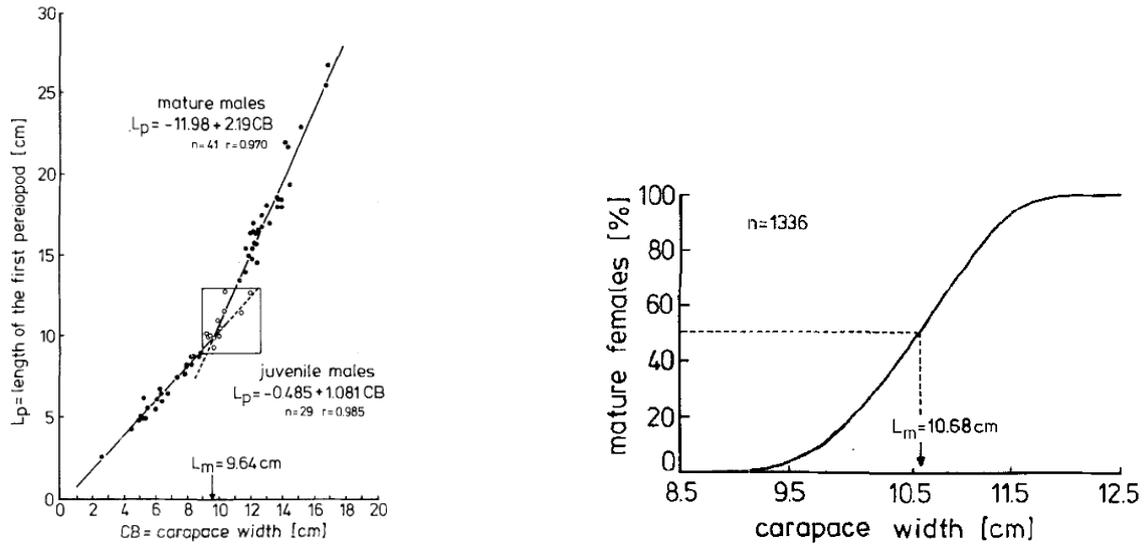


Figure 5: Size at maturity

Left: CW_{50} determination in male *P. pelagicus*. Right: cumulative frequency of mature females (in %) per size classes. L_m represents CW_{50} (from Ingles & Braum 1989).

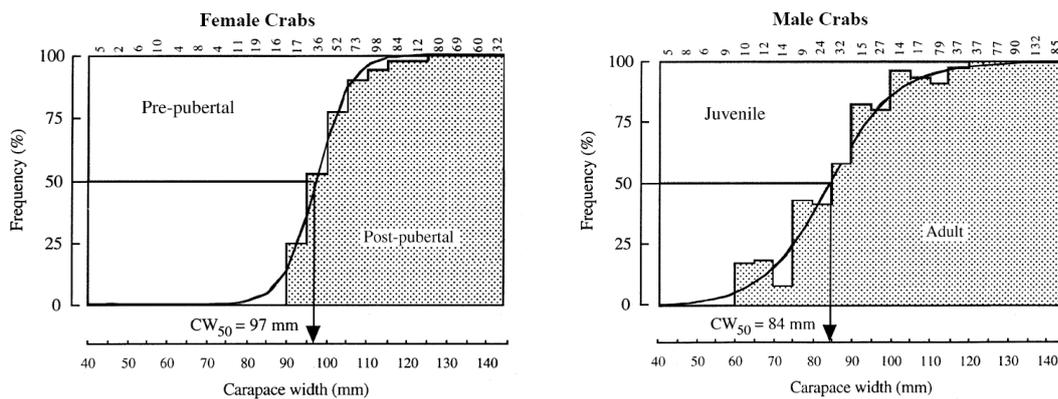


Figure 6. Pubertal molt at first maturity

Left: Percentage of those females in each sequential 5 mm carapace width interval that had not undergone a pubertal moult and would thus not have mated, and for those which had undergone a pubertal moult and were therefore of mature size. The logistic curve was fitted to the percentage of crabs that had undergone a pubertal moult in order to determine the CW_{50} at first maturity. Right: For males, the logistic curve was fitted to the carapace widths of those crabs which, from the relationships between the lengths of the propodus of the largest chela and the carapace widths, were capable of mating and were thus adults of mature size. Arrows denote CW_{50} for size at maturity of female and male crabs (from Potter & de Lestang 2000).

Specific fishery-related assessments have been undertaken on size and sex of the catch (Apirak, 2011; Jindalikit, 2008) as well as a stock assessment (Apirak, 2011; Jindalikit, 2008).

Outline of status of stocks as indicated by stock assessments, including a description of the assessment methods, standards, stock indicators, and biological limits

Stock assessments have been used as tools in the Thai fishery from as early as 1984 (Amara, *et al*)³⁶.

The methodologies applied to analyse stock status have included:

- Cohort analysis (Jones, 1984)
- Growth parameter: Bhattacharya (Sparre and Venema, 1998)
- Curvature growth parameter, K and Asymptotic length, L_{∞} (Gulland and Holt, 1959)
- Total mortality coefficient, Z (Sparre and Venema, 1998)
- mortality rate: Pauly's empirical formula (Sparre and Venema, 1998)
- Fishing mortality, F (Sparre and Venema, 1998)
- Data Analysis model: FiSAT II (Version 1.2.0) (FAO – ICLAMRM Stock Assessment Tools)

There are three more recent papers applying the same methodology as listed above, examining the state of fisheries in the Upper Gulf of Thailand (Jindalikit *et al*, 2008³⁷) covering offshore and coastal fisheries from Samut prakran up to Chonburi; Eastern Gulf of Thailand (Thiwarat *et al*, Unpublished³⁸) from Rayong, Chantaburi and Trat province; and for a coastal fishery (Apirak, 2011) from Sikao Bay, Trang. This would appear to be the extent of work undertaken to date.

The broad conclusion from these and other publications, along with evidence of declining CPUE and average crab sizes in almost every location, is that the Thai fishery is exploited by a range of 10% (Jindalikit, 2008) to 50% (Apirak, 2011). Average CPUE of blue swimming crab caught in commercial crab traps and small scale crab traps, along with Apirak's research (2011) suggest that the level of fishing in Silkao Bay, Trang needs to be reduced to half its current levels.

Most interviews with fishers, owners and processors reported declining catches, sometimes up to 50% (Surasak, Trat, pers com., October, 2011) except where specific management initiatives may have occurred, such as spatial closures (Tat, Sapanhin, pers com., October, 2011) and releasing berried hens (Piangchan, pers com., October, 2011).

Reported size and catch distributions indicate high numbers of pre-gravid crabs caught in inshore fisheries (Susasak, Klong Yai-Trat; Twawatchai, Viya, pers com., October 2011), and Figure 6 illustrates that a very large number of pre-mature crabs are taken in the fishery. Sirawut *et al*. (2007)³⁹ reports that the occurrence of an increasingly large proportion of small sizes of *P. pelagicus* suggests overexploitation of this species.

The stock assessment process applied by Apirak (2011) and Jindalikit (2008) is seemingly robust, but only specific to Trang and the Upper Gulf of Thailand, respectively. The researchers apply Jones' length-based cohort analysis (length and frequency mortality coefficients) to calculate biomass and

³⁶ Amara Cheunpan and Achara Vibhasiri (2002), Stock assessment and management proposal of blue swimming crab (*Portunus pelagicus*) fisheries in the upper Gulf of Thailand

³⁷ Jintana Jindalikit, Chakaphan Pinpathasilp, Kanitha Sereerak and Suwarak Wongtho (2008), Biological and stock assessment of blue swimming crab in the upper gulf of Thailand

³⁸ Thiwarat Sinanun (2011, unpublished paper), Stock Assessment of Blue Swimming Crab (*Portunus pelagicus* (Linnaeus, 1758)) in the Eastern Gulf of Thailand

³⁹ Sirawut, K., *et al* (2007)

maximum sustainable yield (MSY). The results such as yield, the value of recruits to the blue swimming crab stock, growth parameters and mortality coefficient (including the value in each carapace width interval) are also used to analyze the MSY.

Based on the knowledge of existing stock assessment work, it is likely that the research systems are quite strong, but to date, are limited to a few locations. However, there is some evidence that the various MFRDB research stations are now cooperating under the auspices of Dr Jindalikit (MFRDB, Upper Gulf Marine Fisheries Research and Development Center (Samut Prakan, December, 2011)). A list of scientists collaborating on stock assessment work is provided in Section 4.8.

MRAG applied the Scale Intensity Consequence Analysis (SICA) to provide an indicator for stock status. Using the subcomponent 'age, size and sex' of the SICA, > 60% of the total range of the stock that overlaps with all fishing activity affecting the stock (resulting in a spatial score of 6), fishing occurs daily (resulting in a temporal score of 6), and there is easily detectable localized evidence of activity or widespread and frequent evidence of activity (resulting in an intensity score of 6). Taken together, these scores fail to meet the MSC Consequence Category 3 (60 Scoring Guidepost) since existing evidence suggests that long-term recruitment dynamics are most likely to be adversely affected.

However, the species productivity would demonstrate some robustness because of its high levels of fecundity. These characteristics are potentially a reason why the stock may not have collapsed. Nevertheless, the susceptibility scores would most likely reflect high levels of fishing intensity.

Table 5: target species summary of biological characteristics for blue swimming crab

<i>Characteristics</i>	<i>Definition</i>		
Average age at maturity	< 1 year	<5 years	Low (1)
Average maximum age	2.5 years	< 10 years	Low (1)
Fecundity	1,600,000 eggs per batch.	>20,000 eggs	Low (1)
Average maximum size	180.0 mm	< 100 cm	Low (1)
Average size at maturity (common)	90 mm	40 cm	Low (1)
Reproductive strategy	Egg layers and tidal dispersion	Broadcast spawner	Low (1)
Trophic level (from diet composition unless otherwise stated)	2.62	>3.25	Medium (2)
Resilience	Highly fecund		
Vulnerability	Vulnerable during premature stage		

Source: Various authors above

History of fisheries management

The crab fisheries (commercial and coastal) are open access, and most coastal and offshore fisheries have witnessed an expansion in effort, both in respect to boat numbers and gear.

Zonal access restrictions apply within 3 km (i.e., excluding access for commercial boats⁴⁰) and exclusion of trawlers and push nets. Thai legislation also prohibits fishing for crab during the spawning season (October to December)⁴¹, though there is no evidence of this being applied or respected. Another law prohibits the use of trawl or push net from 400 metres of any licensed static gear (DoF, July, 1972, cited in Sampam, 2008).

There are no restrictions on the length of bottom set gillnets that can be used in the blue swimming crab fishery. Bottom set gillnets vary in length from 350-1,500m depending on boat size and fishing area. There are also no specific mesh size requirements in the fishery. Mesh size varies from 75-120mm (DoF website).

There are no restrictions on the number of crab traps per boat. There is, however, a minimum mesh size restriction to the trap floor (3.8 cm)⁴². There are no specified escape gaps in traps, but some work was undertaken to evaluate the effectiveness of crab traps (Anukorn⁴³). Chumphon Marine Fisheries Research and Development Centre (CMDEC) has also promoted the use of 6.4 cm in mesh size in crab traps. These have been applied in some coastal villages (Pakklong Pathew District, pers com., September, 2011).

There are no restrictions on the taking of gravid females. The Government is presently supporting a programme of setting up voluntary crab banks (Phattareey⁴⁴).

Some processing plants reported only taking crabs of 10 crabs/kg. Higher price premiums were also offered for larger sizes, although this was in part of a reflection of higher yields (>30%-50%) in the larger crab sizes⁴⁵.

Box 1: Case study of crab bank and voluntary trap mesh size increase.

CMDEC supported the establishment of a crab bank system in 2002 for the Crab Bank Group Pakklong Fishers Group or PFG. The Group established their own rules and regulations that include some conditions for membership, including that fishers should have at least 300 crab traps per member per boat, should be a member of the fishers group, should bring at least one gravid crab per day or 30 gravid crabs per month, and the bottom of their crab traps should have a mesh size of 2.5 inches while the mesh size of the top and sides should be 1.25 inches. In an effort to further conserve the crab resources, the Chumphon Provincial Fisheries Office in August 2003, provided the fishers in its area with 100 traps (with enlarged mesh size of 2.5 in.) per person in exchange for their old traps (with mesh size of 1.25 in.). The CMDEC, which has promoted the use of 2.5 in. mesh size crab traps, monitored the performance of the enlarged mesh size of the traps. The initial results showed an increasing trend in carapace size and volume of catch. When the mesh size used was 1.25

⁴⁰ Commercial boats using inboard power boats of more than 10 gross tonnes. Generally, they comprise vessels in excess of 10-12m, but each Province appears to set its own base definition.

⁴¹ DoF (2004), Book of Fisheries Law

⁴² Thongchai, *Ibid*

Songrak@hotmail.com

⁴³ Anukorn B, Chaichan M, Songsri M (Undated), Suitable escape gaps of selective collapsible crab trap and appropriate ait for blue swimming crab trap Fishery

⁴⁴ Phattareeya, *Ibid*

⁴⁵ Crab pickers are keen to accept only larger sized crab because of larger yields, e.g. 4.5kg/day, as opposed to smaller crabs, 2.5 kg/day. Larger sized crabs result in average incomes per picker of 450 TH Baht/day, as opposed to 300 TH Baht/day. Thus pickers often refuse to accept small crab (TCPG, October, 2011).

in, the average size of female caught was smaller. Following the mesh size increase, the average carapace size for male and female increased from 8.60cm and 8.97cm to 10.39 and 10.62cm, respectively (2002-2006).

Source: Phattareeya (2009)⁴⁶

Some fishers have set up voluntary no take zones (zero to 1 km from the shore) or prohibit fishing on sea grass beds (Surasak; Trat; Jakree, Laung Suan, pers com., October, 2011). The level of control applied to these is broadly strong, but not always (Warin, Poom Riang, pers com., October, 2011). Otherwise, there are various Marine Protected Areas (MPAs) that exclude access to all fishers. These management measures are issued by way of Notifications.

Information systems and data collection

Two DoF organizations have the responsibility of collecting, processing, analysing, and reporting fish landings data in Thailand, namely the Fisheries Statistics Analysis and Research Group (FSARG)⁴⁷ and Marine Fisheries Research and Development Bureau (MRFDB). FSARG collects data throughout the country for national fisheries statistics, but these have been restricted to the commercial fleet and the main commercial ports. A one-off study was prepared for FAO⁴⁸, which provided some estimates of catch of blue swimming crab, and determined a methodology for collecting data at village level. There are some expectations that this will be repeated within 5 years (Funge-Smith, pers com., October, 2011).

MRFDB only collects data from large to middle-scale fisheries in Thai Waters for research purposes. In such cases, data on crab is extracted only from the trawl catches (Praulia, DoF, pers com., 2011). Some data on catches and vessel numbers are also provided by DoF Provincial offices to FSARG, which provide input into the Annual Statistical Report (Chaiyan, Do, pers com, October, 2011). Commercial vessels are required to complete logbooks, but this system does not appear to be operational for the crab fleet. There was no evidence of information being extracted from vessel owners, middlemen or from processing factories.

Marine fisheries statistics are based on a sample survey multiplied upwards based on the number of licensed vessels of each fishing category in each port (Lymer, 2008). The data are extracted from landing declarations and counted against the province where the fishing gear is registered no matter where the vessel actually lands its catch. FSARG has been conducting surveys of this type at 37 selected landing places along Thai coasts since 1974. These data are re-interpreted following extrapolation of information gleaned from vessel logbooks. No bycatch or ETP species interactions are recorded in the logbooks. FSARG has been collecting logbook data since 1964. FSARG produces four publications each year, namely: 1) Fisheries Statistics of Thailand, 2) Marine Fisheries Statistics Base on the Sample Survey, 3) The Landing Place Survey and 4) Thai Fishing Vessels Statistics and Fishing Community Production Survey. Those publications are distributed to all DoF organizations.

MRFDB also collect data, including species caught (including crabs), weight, number and size frequency, and effort (days fished, fishing trip length and hours fished). All data collected by MRFDB are inputted, processed, analysed, reported and published as MRFDB technical papers (Praulai, pers come, October, 2011). MRFDB also undertake long-term monitoring on fish larvae, phytoplankton, zooplankton and environmental parameters using research survey vessels.

⁴⁶ Phattareeya *et al*

⁴⁷ The assessor was unable to meet the fishery statisticians. Two relevant experts are Naruepon Sukumasavin (naruepos@gmail.com) and Marina Waiyasilp (marina.1954@hotmail.com)

⁴⁸ Lymer *et al*, 2008

3.4 Principle Two: Ecosystem background

The retained, bycatch and endangered, threatened or protected (ETP) species including their status and relevant management history

For the purpose of this assessment, retained species are divided into bottom set gillnet and trap. Data on gillnet catches are available in the DOF Annual Statistical Report (Table 6). Species interactions were checked amongst the coastal fishers, and were identified as being representative. There has been no reported discards/bycatch.

Table 6: Quantities of retained species caught in crab gillnet and trap

Bottom set gillnet				
Gulf of Thailand			Andaman Sea	
Species	Tonnes	% total catch	Tonnes	% total catch
Blue swimming crab	9,539	83.6%	5,720	95%
Tiger Shrimp (<i>monodon</i>)	251	2.2%		0%
White banana shrimp (<i>Indicus</i>)	61	0.5%		0%
Mantis shrimp	188	1.6%		0%
Mangrove crab	308	2.7%		0%
Blue spot crab	652	5.7%		0%
Squid	11	0.1%	3	0%
Shark	77	0.7%		0%
Ray	42	0.4%	64	1%
Sea catfish	12	0.1%		0%
Croaker	4	0.0%		0%
Catfish eel	2	0.0%		0%
Other food fish	249	2.2%	242	4%
Mackerels	11	0.1%	11	0%

Trap				
Gulf of Thailand			Andaman Sea	
Species	Tonnes	% total catch	Tonnes	% total catch
Blue swimming crab	3,353		717	50%
Three spot crab		25-50% dependent on season	215	15%
Mud crab	496		400	28%
Other crab (includes musk crab and ?)	21		102	7%

Source: DoF, 2009

The retained species catch for gillnet included a number of fish species, but predominantly included 'unidentified' sharks and ray. There is limited research specific to the indicators of 'other fish species' or the type of sharks or ray. Mala *et al*, 2005⁴⁹ cites top level predators as being significantly low in number, suggesting potentially high risks to these species from fishing. Other bycatch species of significance caught in gillnet include banana shrimp (*P.indicus*), mantis shrimp (*Odontodactylus scyllarus*) in coastal locations, and tiger shrimp (*P. monodon*) in offshore waters.

⁴⁹ Mala, S., Ratanawalee, P., Christensen, V., (2005), Trophic levels of multi-species in the Gulf of Thailand, Project no. 003711, ECOST

The retained catch data available for crab traps (DoF, 2008) did not specify the catch composition by crab species. However, the assessor carried out visual inspections, and clarified these with vessel owners. Bycatch species identified included three spot crab (*Portunis sanguinolentus*), musk crab (*Charybdis cruciata*), mud crab (*Scylla serrata*) and rock swimming crab (*Charybds cruciata*). The level of bycatch of other species was extremely low. The variation in retained species in the Gulf of Thailand (GoT) was seasonal, with higher numbers of musk crab taken from January to March (around 50% of the total). Musk crab also tended to dominate in the offshore fishery, whereas three spot crab and mud crab were usually found closer to shore. In other parts of the year, catches of other crab species would be less than 15%. Retained species catches in the Andaman Sea showed a much higher dependency on three spot crab (accounting for 30% of the total catch), reflecting catches in shallower waters. All other species of crab were sold into the domestic markets in both the GoT and Andaman Sea (DoF, 2008).

Table 7 assesses species productivity information.

Table 7: Biological characteristics

Species	Common name	Average age at maturity	Average maximum age	Fecundity	Average maximum size	Average size at maturity (common)	Reproductive strategy	Trophic level (from diet composition unless otherwise stated)
<i>Penaeus monodon</i>	Tiger Shrimp	6 months	1-2 years	500,000- 750,000 eggs/spawning (FAO- species fact sheet- for aquaculture)	336mm body length (females) 130g body weight (females) (FAO- species fact sheet)	>35g body weight for males >70g bodyweight for females (FAO- species fact sheet- for aquaculture)	offshore egg layers (FAO- species fact sheet- for aquaculture)	2.35 (ECOST)
<i>Penaeus Indicus</i>	White Indian shrimp	6 months	1-2 years	68,000 to 1,254,200 eggs (produced at 140-200mm body length) (FAO- species fact sheet- for aquaculture)	184mm (male) 228mm (female) max carapace length 56mm (FAO- species fact sheet)	170mm (FAO- species fact sheet)	offshore egg layers (FAO- species fact sheet- for aquaculture)	2.35 (ECOST)
Stomatopoda (<i>Odontoda ctylus scyllarus</i>)	Mantis shrimp	12 months	> 30 years	from 19,300 eggs for 8 cm BL to 92,100 eggs for 14 cm BL	18 cm	8 cm	Coastal, borrowing	2.35 (ECOST)
Mangrove crab	<i>Scylla serrata</i>	12-18 months	3-5 years	over 3,000,000 eggs ⁵⁰	max c.w. 250-280mm max weight 2-3 kg	90-100mm carapace width (c.w.) 0.5-1kg ⁵¹	Coastal waters	2.62 (ECOST)

⁵⁰ <ftp://ftp.fao.org/docrep/fao/011/i0254e/i0254e13.pdf>

⁵¹ http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/375892/Giant-Mud-Crab.pdf

Species	Common name	Average age at maturity	Average maximum age	Fecundity	Average maximum size	Average size at maturity (common)	Reproductive strategy	Trophic level (from diet composition unless otherwise stated)
<i>Portunis sanguinolentus</i>	Three spot crab	1-2 years	3 years	650,000-1,760,000 eggs/spawning -increases with c.w. (Kumar <i>et al.</i> 2000)	83-74cm c.w. (carapace width) – males (FAO- species fact sheet)	144mm c.w. (64mm carapace length) (FAO- species fact sheet)	Female carries fertilised eggs. multiple spawning per season possible. Males inhabit deeper water – 40 m, juveniles and females in coastal shallow waters . 10 m	2.62 (ECOST)
<i>Charybdis cruciate</i>	Musk crab	1-2 years	3 years	As above	As above	As above	Coastal waters for juvenile and gravid females. Males found in deeper water	2.62 (ECOST)

Source: www.fishbase.org, <http://www.fao.org/fishery/species>, and West Australian Fisheries Department

Specific constraints, e.g., details of any undesirable bycatch species, their conservation status and measures taken to reduce this as appropriate

All catches are retained. As such, there are no bycatch species. However, commercial vessels buy frozen Indo Pacific mackerel (*Rastrelliger brachysoma*) from Rayong (GoT). Coastal fishers catch small pelagic species in the bait nets (Somporn, Ban Pra, pers com, October, 2011). However, there may be other species, which have not been identified.

ETP interactions

DMCR has supported the creation of community conservation groups in many of the coastal fishing villages (Nipawan; Chalati, DMCR, pers com, October, 2011). These include DMCR workshops on ETP awareness and establishment of reporting systems. In response, the fishers become the custodians of local seagrass beds.

There are two species of turtle in the GoT (Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricate*)); and four species in the Andaman Sea (Green, Hawksbill, Olive Ridleys (*Lepidochelys olivacea*), and the leatherback turtle (*Dermochelys coriacea*)⁵²). The decline in turtle populations within the Gulf of Thailand and Andaman Sea has to a large extent been due to interaction with trawlers (Supot⁵³), and up until the 1980s, from direct targeting by fishers. DMCR also report some crab gillnet interactions, but the scale of these relative to population size is uncertain because live releases are not reported (Pramot, DMCR, pers com., September, 2011).

Awareness of declining sea turtle populations in Thailand has raised serious attempts to conserve sea turtles (Mickim *et al*⁵⁴). Sea turtle conservation projects were first started at the Phuket Marine Biological Centre in the Andaman Sea as early as 1971 and at Man-Nai Island in the Gulf of Thailand. Government Organizations including DMCR, the Thai Navy and some NGO groups have taken on very high profile involvement in sea turtle protection and conservation. The conservation activities are carried out in several nesting locations. In addition, the Thai government has established laws and regulations to protect sea turtles and has promoted education and campaign programs that are distributed to the public (Pramot, DMCR, *Ibid*).

Data on turtle interactions are reported through conservation groups and include a comprehensive data set collected by DMCR Research Institutes, including date, ID number, location, sex, species, size, and dead/alive/injured. Gear interactions are subsequently identified from regular call out responses. Reporting levels are very comprehensive (Pramot, DMCR, *Ibid*) from East coast coastal villages. Turtles that are released alive are probably only recorded some of the time (Tat, Sapanhin conservation group). There are no gillnet fisheries close to the two main rookeries in the GoT. Turtle rookeries are found in Kra (near Sogklar) and Koh Talu (Rayong) in the GoT for green and hawksbill, respectively. Similar levels of interactions were identified in the Andaman Sea. Interviews with some fishing communities confirmed some interactions with sea turtles that occur without reporting (releasing turtles that are alive and keeping dead turtles for the shell) (Armed, Kuraburi, pers com., October, 2011).

⁵² Loggerhead turtles are reported to be extinct in the Andaman Sea (Supot, C.)

⁵³ Supot, C (Undated), Status of marine turtles in Thailand

⁵⁴ Mickmin, C (1999)

Dugongs are also reported to be active in the same areas as crab fishers, but confined to the seagrass beds, which are largely protected (Kajana, 2006⁵⁵). However, interactions between crab gillnet fishers and these species are very limited. Kanjana, 1999⁵⁶, reports only one interaction between dugongs and crab gillnet gear from 1979 to 1999. Most interactions with fishing were attributed to other gillnet, stake trap and trawl fisheries.

There are no publications citing crab gillnet interactions with cetaceans. Somchai *et al*, 1999⁵⁷ reported some fishing net entanglements with Irrawady dolphins (*Orcaella brevirostris*). The type of gear was not specified.

DMCR now provides a status report on ETPs⁵⁸. These are coordinated through the Andaman Sea Research Centre (DMCR, 2011 (to be published⁵⁹)).

The Wildlife Reservation and Protection Act B.E. 1992 lists a number of protected species. However, aside from listing species, there are no specific acceptable limits defined that might set benchmarks for an acceptable level of interaction. Measures are in place through Notifications prohibiting interactions with ETP species (CHARM, 2005⁶⁰), but DMCR relies heavily on its system of voluntary reporting and community awareness workshops as a means of mitigating interactions. Assessor observations suggest that these are very effective, but rely on active DMCR and NGO participation (Pramot, DMCR, pers com, October, 2011).

The aquatic ecosystem, it's status and any particularly sensitive areas, habitats or ecosystem features influencing or affected by the fishery

Sea grass beds provide nursery grounds for blue swimming crabs. All sea grass beds are mapped by DMCR (DMCR, 2011). These are protected by law under the Enhancement and Conservation of the National Environmental Quality Act B.E. 1992, which provides for the protection of wetlands amongst other things. Seagrass beds are also supported by specific National Action Plans (Kanjana, 2006). The community conservation groups also participate in sea grass protection, in some cases facilitated by NGOs. Fishing in these areas is rare (Suthep, DMCR, Rayong; Nantthawadee, DMCR, Chumphon, pers coms., September, 2011). However, Pramot (DMCR, pers com., September, 2011) stated that trap fisheries in the Phang Nga area were fairly indiscriminate, recording higher catches of juvenile crabs. The degradations of seagrass beds are mainly caused by human impacts such as sedimentation from coastal construction, and illegal trawling activities⁶¹.

Most fishing on the east coast was reported to be across soft sand/mud. In some parts of the Andaman Sea, fishing was observed as being on mixed ground, rock and sand (Fisherman, Phang Nga, pers com., October, 2011) with obvious sign of interactions with benthic assemblages (Picture 5), such as corals, giant mussels, skate and sponges. In other areas, such as Ban Nam Rab, Trang (Somporn, pers com., October, 2011), fishing was on sand, with limited sign of benthic assemblages caught in the net.

⁵⁵ Kanjana, A., and Sombat, P., (2006), Dugong (Dugong dugon) and seagrass in Thailand: present status and future challenges, Phuket Marine Biological Center, Department of Marine and Coastal Resources

⁵⁶ Kanjana, A., (1999), Dolphin, dugong and whales, Phuket Marine Biological Centre, Research Institute of Oceanography

⁵⁷ Somchai, M., and Suraphol S,(1999), Office of Environmental Policy and Science, Research Institute of Oceanography

⁵⁸ Indications were that this has been a new initiative.

⁵⁹ DMCR (2011) Status Report on Endangered Marine Species, DMCR, Chumphon Research.

⁶⁰ CHARM (2005), Thai Fishery Laws, Coastal Habitats and Resource Management Project.

⁶¹ Kanjana (2006) *et al*

Picture 2: Benthic assemblages, Phang Nga



DMCR has also established a network of moorings on all coral reefs, in order to reduce coral reef damage (Nantthawadee, 2011).

Details of any critical environments or sources of concern and actions required to address them

The main environmental influences to crab productivity are changes to salinity, which responds to high levels of river run off during the monsoon period, and variation in water temperature (Tanasomwang⁶²). These generally affect the migratory patterns and spawning triggers for crabs. However, the extent of these impacts on stock status is not quantified.

Diet is largely dependent upon local availability of prey species. The main foods for intertidal stages are small hermit crabs and gastropods, while subtidal *P. pelagicus* feed mainly on bivalves and ophiuroids (Williams 1982). Williams (1982) found that diet composition changed little with size of crab although within broad taxonomic groups, prey species change with size of crab. However, Edgar (1990) found size-related changes in the diets of crabs. These changes were influenced by the different habitats of small and larger crabs. Seagrasses and algae may be eaten occasionally. In some localities, fish and squid discarded from trawlers may be important sources of food (Wassenberg and Hill 1987, 1990a⁶³).

Edgar (1990)⁶⁴ reports that the major items in the diet of *P. pelagicus* in seagrass beds comprise slow-moving invertebrates, in particular molluscs (31.6% of the volume of foregut contents) and polychaetes (16.1% of volume). However, the crabs also consumed lesser quantities of seagrass (10.2% of volume). Small (<50 mm carapace length) crabs predominantly forage on shallow sand flats, whereas larger individuals occur most abundantly amongst seagrass and un-vegetated habitats further offshore. Although *P. pelagicus* generally forages in the habitat in which they rest during the day, they readily move to other habitats where larger prey is abundant.

⁶²Tanasomwang, *Ibid*

⁶³ Wassenberg, T.J. and Hill, B.J. (1990a). Partitioning of material discarded from prawn trawlers in Moreton Bay. *Australian Journal of Marine and Freshwater Research*, **41**: 27-36.

⁶⁴ Edgar, G.J. (1990). Predator-prey interactions in seagrass beds. II. Distribution and diet of the blue manna crab *P. pelagicus* Linnaeus at Cliff Head, Western Australia. *Journal of Experimental Marine Biology and Ecology*, **139**: 23-32

Crabs cease feeding prior to and during moulting. Immediately after moulting, the gastric mill is filled with calcareous fragments. As the crab shell hardens, feeding on organic material commences, being greatest during the early intermoult period and reduced in later intermoult. During the breeding season, females feed very little and do not moult, while males stop feeding only at premoult and postmoult periods of 1-2 days and feed actively during an intermoult period of several months.

P. pelagicus rely on chemical and/or tactile cues rather than sight to locate their prey and food, and so the crabs' efficiency at locating prey is not affected by the structure that seagrass provides, for example (Haywooda *et al.* 2003⁶⁵).

Predators of the blue swimming crab comprise rays and shark (Kangas, 2000).

Mala *et al*⁶⁶ applied Ecopath with Ecosim, versions 5.1 and 6, to construct energy flow and mixed trophic impact of fishery resources in the Gulf of Thailand. The data used were from the research vessels surveys, previous studies and literature. Forty functional ecological fish groups were categorized in the present analysis which assessed the trophic levels, energy flow and interactions among them. The simulation results show the mass balance of the multi-species in the Gulf of Thailand. The trophic levels of fish groups were ranging from 1 - 4.8. Shark was the top predator, followed by large piscivores, coastal tuna, Scomberomorus and Saurida. Food chains and food webs of all species groups and some certain species have been shown. The mixed trophic impact analyses indicated that demersal fish, pelagic fish and invertebrates interacted with each other as well as the multi-gear and multi-fleet fisheries which are characteristic of tropical fisheries of the Gulf. Each group would have impact to another group in the ecosystem. Since the demersal fisheries are overexploited, the fisheries turned to invertebrates, resulting in an imbalance in the ecosystem.

Sharks and rays are the main predators for crab. Reduced abundance of sharks and rays, along with lower levels of predation on juveniles are likely to allow for a reduced mortality amongst crab populations. Mala advocates a strategy of promoting the re-seeding of crab eggs.

3.5 Principle Three: Management system background

Area of operation of the fishery and under which jurisdiction it falls

Overall Governance

Thailand is a constitutional monarchy with three levels of government: National Government, Provincial Government, and Local Government. There are 19 coastal provinces with responsibility for fisheries inside 6nm. Provincial Governors and District Officers are appointed by the National Government and act as their representatives. Provinces are divided into a number of districts, headed by district officers falling under the responsibility of the Provincial Governor (Banks *et al.*, 2010⁶⁷).

The main laws governing fisheries are:

- The Fisheries Act B.E. 1947 (revised in 1953 and 1985) ("the Act")
- The Act Governing the Right to Fish in Thai Waters B.E. 1939 ("the Thai Waters Act")

⁶⁵ Haywooda, M.D.E., F.J. Mansona, N.R. Loneragana & P.J. Toscas (2003). Investigation of artefacts from chronographic tethering experiments - interactions between tethers and predators. *Journal of Experimental Marine Biology and Ecology* 290: 271– 292.\

⁶⁶ Mala, S., Ratanawalee, P., Christensen, V., (2005), Trophic levels of multi-species in the Gulf of Thailand, Project no. 003711, ECOST

⁶⁷ Banks, R. and Souter, D, Capacity strengthening in RPOA countries, country profile_ Thailand, MRAG/Poseidon, DAFF

- The Thai Vessel Act B.E. 1938

The Act provides the overarching framework for fisheries management and sets out arrangements on types of fishing ground (sanctuary, leasable area, reserved area and open area), licensing, penalties and offences. The Act was revised in 1985 to strengthen the severity of penalties and to make domestic vessels responsible for any damage or expense created where they have violated the laws of a foreign state. Under the Act, the Minister is empowered to make notifications on fishery specific conservation and management arrangements. These are implemented through *Notifications of the Ministry of Agriculture*. The Act also allows for the Provincial Governor to make management arrangements for fisheries within their province, with the agreement of the Minister. The Act has also been used in the past to apply local co-management arrangements.

The Act has recently been the subject of an extensive 8 year review, with a revised Act having been submitted for 2 years, awaiting Parliamentary approval. Revisions to the old Act are aimed at modernising the fisheries legislation, most explicitly in the context of updating legislation to incorporate references to international conventions, Port State Measures, and the precautionary and participatory approaches to fisheries management (Smith, T, pers com June 2010). However, the revised Act has encountered delays in passing through the legislature and is now unlikely to reach Parliamentary approval in 2011. The Act does not include any reference specific to the Ecosystem Approach to Fisheries Management.

The Thai Waters Act establishes Thailand's territorial waters and exclusive economic zone (EEZ). The Thai Vessel Act requires the owners of a fishing vessel with an engine or a vessel that is 6 gross tonnes or larger, to register fishing rights with the Harbour Department. Only Thai nationals or companies are eligible to register fishing rights.

A number of environment-related pieces of legislation also influence fisheries management including the Wildlife Reservation and Protection Act B.E. 1992, which lists a number of protected species, and the Enhancement and Conservation of the National Environmental Quality Act B.E. 1992, which provides for the protection of wetlands, mangroves, coral reefs, and sea grass beds.

The principal institution responsible for fisheries management is the Department of Fisheries (DoF). DoF's⁶⁸ main tasks include:

- Implementation of relevant Acts;
- Research and development on fisheries and aquaculture;
- Survey of waters inside and outside the Thai EEZ to support increased productivity and management;
- Application of legal measures to manage capture fisheries;
- Research and development in relation to post-harvest food safety and quality issues;
- Management of international fisheries affairs;
- Development of fishery information systems; and
- Other operational matters as required.

A number of other national agencies also play a role in fisheries-related issues including the Department of Marine and Coastal Resources (DMCR), the Ministry of Natural Resources and Environment, the Navy's Civil Affairs Department, and the National Social and Economic Development Board.

⁶⁸ DoF (2008). *The Master Plan Marine Fisheries Management of Thailand*. Department of Fisheries, Ministry of Agriculture and Cooperatives. November 2008

Traditionally, the management of coastal fisheries in Thailand has been centralized. DOF is the sole agency with the mandate for the management of coastal fisheries and all management measures have been established by DOF without consulting fishers or other stakeholders. The central management authorities delegate only very limited management functions and responsibilities to the local level. Thus, DOF has difficulty in obtaining positive results in coastal fishery resources conservation and management, and the fishers do not accept or have negative attitudes regarding fisheries measures established by DOF (Panjarat, 2005⁶⁹). However, in recent years, increasing responsibility for monitoring, control and enforcement have been delegated to the local authority (Sub-district authority or Ao Bo To) consistent with the policy of decentralization in the National Constitution B.E. 2540. Under these arrangements, marine fishers are required to seek permission from Ao Bo To on the use of various fishing gears, as well as submit gears for examination⁷⁰.

General Management Arrangements

At the national level, Thailand's fisheries management is led by DoF. The organisation needs to improve its overall capacity to implement effective fisheries management. No fishery specific management plans have been developed for the main fisheries, and few of the measures outlined in the FAO Code of Conduct for Responsible Fisheries (CCRF) in relation to management planning have been implemented – for example, the limit of the specific development of target and limit reference points appropriate to the stock and appropriate harvest control rules. The crab fisheries remain open access, and previous attempts to introduce limited licensing systems have failed⁷¹. There is evidence of overfishing and overcapacity, yet fisheries management policies continue to be influenced by production-driven objectives, and few measures have been taken to effectively reduce fishing capacity.

Some fisheries, most particularly the trawl fisheries, are subject to licence moratoriums. The main management measures available include closed areas, closed seasons and minimum legal landing sizes.

Overall strategies

Thailand's national and international fisheries policy objectives for marine capture fisheries are set out in a Master Plan for Marine Fisheries ("the Master Plan"), approved by cabinet and commencing from 2010. The Master Plan takes into account a number of overarching economic and development plans of the Thai Government including National Economic and Social Development Plans (1-9) of 1963-2006 and the 10th National Economic and Social Development Plan (2007-2011). The Vision, mission, objectives and strategies to achieve the objectives are set out in Box 2.

⁶⁹ S. Panjarat, Sumontha, M., Loychuen, K., Pantakit, V. and Singtongyam, W. 2005. Fishermen's Attitude on Management of Blue Swimming Crab Resources in The Andaman Sea.. Technical Paper no. 14/2007. Marine Fisheries Research and Development Bureau, Department of Fisheries, Ministry of Agriculture and Cooperatives. 33-33 pp.S. Panjarat, 2005. Fishermen's Attitude on Management of Blue Swimming Crab Resources in the Andaman Sea. op cit

⁷⁰ DoF (2006), *Ibid*

⁷¹ FAO (2005). *Report of the National Seminar on the Reduction and Management of Commercial Fishing Capacity in Thailand*. Cha-Am, Thailand, 11-14 May 2004. Food and Agriculture Organization of the United Nations Rome, 2005

Box 2: Main features of the Master Plan: Marine Fisheries Management of Thailand.

Vision: “Sustainable fisheries development based on the sufficiency economy that places the people at the centre”

Mission

- 1) To manage all activities pertaining to resource use, rehabilitation, maintenance and protection of the marine environment to ensure its high productivity under the current socio-economic reality and the state of the marine resources and ecosystem;
- 2) To carry out the human resource development, institutional strengthening, and activities leading to the generation of bodies of knowledge pertaining to marine fisheries and environment management;
- 3) To promote the application of the FAO Code of Conduct for Responsible Fisheries, and to promote the networking of such an observance at all levels.

Objectives

- 1) To manage the responsible and sustainable marine fisheries;
- 2) To facilitate the rapid recovery of the depleted fish stocks and to safeguard marine ecosystem from any destructive practices;
- 3) To support the fishery institutional strengthening and co- management, including the networking at all levels to enable their active participation in marine fisheries management;
- 4) To promote the capacity building of fishing enterprises at all levels to enable their effective operations under the changing fisheries situation around the globe, and the increasingly stringent governance;
- 5) To enhance fishermen’s quality of life;
- 6) To ensure the seafood safety and the confidence of consumers of fish and fish products.

To accomplish the tasks and results as outlined in the objective and the targets within the scope provided by the vision and the mission, this Master Plan formulates five strategies to address matters in marine fisheries management.

These are:

Strategy 1: Efficiency enhancement of marine fisheries management system and co-management

- Review and upgrade fisheries law to ensure effective enforcement
- Demarcate the boundaries of fishing grounds
- Promote fisheries co-management, leading to rights based fishers
- Management fishing capacity in recognition of stock depletions issues

Strategy 2: Structural strengthening and efficiency improvement of fisheries bodies

- Establish fisheries management structure with a focus on stakeholder national and regional fishery management committees.
- Strengthen the capacities of fishery organizations
- Support to local government agencies to support strengthening of community organization activities in fisheries management
- Establish a marine fisheries database
- Develop and enhance local body knowledge in fisheries management

Strategy 3: Development and promotion of responsible and sustainable fisheries

- Develop and promote fishing gears to improve selectivity
- Regulate practices that are destructive to fish stocks and their habitats
- Promote the utility of fish catch to its fullest potential
- Develop methods that make use of potential resources not currently utilize

Strategy 4: Ecosystem and Fishing Ground Rehabilitation to Safeguard Biodiversity and Marine Environmental Quality

- Introduce temporal and permanent closed areas supported by participatory support by community organizations
- Promote the ecosystem approach to fisheries management
- Promote sea ranching

Strategy 5: Promotion and development of distant water fisheries

- Establish a distant water fishing data base
- Restructure the distant water operations
- Improve the institutional structure of distant water fisheries

Source: DoF (2008). *The Master Plan Marine Fisheries Management of Thailand*. Department of Fisheries, Ministry of Agriculture and Cooperatives. November 2008.

In addition to the actions outlined in the Master Plan, the 2006 Fishery Policy Directions of Thailand Statement notes that rights-based fisheries management is being actively promoted by government and will replace open access arrangements over time. Likewise, the statement notes that a specific fishing capacity reduction program for the Gulf of Thailand is being developed and is hoped to be implemented 'in the coming years'⁷².

Positive and negative incentives

Thailand has a policy of supporting the adoption of rights based fisheries management systems, but as yet, has not applied these to any fishery. The country does promote the use of custodial rights through community tambon groups, relying on fishers groups to act as custodians for fishery conservation orientated activities. Such a practice does not exist for the offshore fleet (Banks, *et al.*, 2011).

Thailand openly advocates adoption of green fuels, which are duty free. This policy is applied in order to prevent fishermen from using lower grade, with high sulphur dioxide emissions. Two programmes exist. These are the Purple and Green Fuel Programmes, respectively. The former supports reduced levels of sulphur dioxide. These subsidies have been in operation since 2001⁷³. The general view is that these subsidies are neither positive nor negative, and fishers generally prefer to use non subsidised lower grade fuels (Smith, pers com., May 2010).

Particulars of the recognised groups with interests in the fishery

The main industry groupings comprise the Thai Crab Product Group with membership comprising six companies, including the principal export groups Phillips Seafood, Handy and Pak Food.

There are no specific groups of fishers. These are defined as offshore, where a number of boats are owned by single owners, who sell direct to the factories; and coastal, comprising village groups, which on occasion are formed into wider networks (e.g., up to 19 villages). These groups sell their product through middlemen, but some may have their own dedicated crab picking facilities.

As referred to earlier, the principal management authorities are DoF and DMCR. Each of these organisations has its own regional research capacity linked to the regions of Rayong, Chumphon, Samut Prakan, Songkla, and Andaman (Phuket).

Details of consultations leading to the formulation of the management plan

A formal consultation procedure is defined under Article 57 of the revised Fishery Act, 1985. The Act defines the role of a Fishery Conservation Committee. The process allows for local decisions to be formulated and passed to the Committee for consideration (Praulai, pers com., October, 2011). The Committee has powers to then recommend to Government, the adoption of regional specific Notifications. A series of measures have been introduced, but not specifically for the crab sector. Evidence from interviews suggests limited interaction with the crab fishery sector. However, based

⁷² DoF (2006) *Ibid*,

⁷³ Sampam, P., (2008) Sustainable fisheries in the Andaman Sea coast of Thailand, The Nippon Foundation, Oceans and Law of the Sea

on the field visit assessments, DMCR supports the establishment of community conservation groups. These have facilitated development of local/network coastal management strategies, formulated with the support of DMCR and occasionally DoF local offices.

Arrangements for on-going consultations with interest groups

The new Act introduces participatory and consultative processes for stakeholders in fisheries management through two mechanisms: firstly through the establishment of a national fisheries policy committee, and secondly through the establishment of the local fisheries committees. When the new fisheries law is issued, it is expected to be a more effective instrument for fisheries resources management (Smith, T, pers com., October, 2011).

Apart from the DMCR community groups, there are only occasional consultations between DoF and interest groups. However, DoF supports crab larvae release programs and the establishment of up to 85 crab banks. Once established, these banks could lead to improved community relations and joint actions (Surasak, Tat, Warin, Jakree, Boankruem, pers comms., October, 2011).

Details of non-fishery users or activities, which could affect the fishery, and arrangements for liaison and coordination

There are some donors and NGOs (local and international) that have been actively supporting crab conservation activities, such as crab banks, in various communities. Examples include WWF, IUCN, Wetland International, Sustainable Development Foundation (SDF), Save Andaman Network (SAN), Government Saving Bank, and Pran Talay company.

Details of the decision-making process or processes, including the recognised participants

See consultation process above.

Objectives for the fishery (referring to any or all of the following if relevant)

Thailand has a fisheries management plan but not one specifically for the crab sector. Any such plan would have to determine objectives specific to the two seas, Gulf of Thailand and Andaman Sea. It may be that assessment of other sub-units could be explored, linked to the regional research centres. Any such plan would require evidence of stock independence.

Particulars of arrangements and responsibilities for monitoring, control and surveillance and enforcement

Thailand (Banks *et al.* 2010⁷⁴), has a range of agencies involved in the monitoring, control and surveillance (MCS) of fisheries. These include:

- DoF (Marine Fishery and Management and Compliance Sections) – at sea patrols, boarding and inspection, licensing, logbooks, etc;
- Marine Police – all illegal activities including breaches of fisheries law;
- Marine Department – vessel registration and safety checks, port inspections;
- Navy – at sea surveillance, boarding and inspection;
- Immigration – policing of crew nationality requirements; and
- DMCR – marine protected areas, protected species.

DoF currently has fisheries inspectors throughout the provincial and coastal centres. MCS priorities

⁷⁴ All MCS issues detailed below are extracted from *Banks et al. 2010*.

are determined largely at the local level. Each of the six regional centres has its own compliance plan based on the time and resources available, seasonal circumstances, relevant local closures and the like. Thailand has a National Plan of Action (NPOA) with respect to illegal, unregulated and unreported (IUU) fishing, which was implemented on 1st January 2010.

DoF currently has approximately 400 fisheries inspectors throughout six coastal centres. The annual budget is 43.3 million baht (US\$1.4m) for inspection, and 4 million baht (US\$128k) to fund tambon level pilot MCS groups. An additional 32 million baht (US\$1.03m) is available to monitor supply chain catch certificates. Funding is provided by the central government. The central government allocates funding annually to monitor supply chain catch certificates.

Responsibility for maritime surveillance is split between DoF, Marine Police and the Navy. DoF has a fleet of 56 vessels - 21 X >60ft boats; 8 X 30ft boats; 30 X 18-28ft boats – to patrol both the Gulf of Thailand and the Andaman Sea; however, deployment is often limited by fuel costs. Moreover, most of the vessels are over 10 years old and a significant proportion of the budget is absorbed in maintenance costs. Many vessels are not operational and requests to repair or replace vessels have often been rejected. Most DoF vessels are also limited in range to 20-30 miles. The Marine Police is also operationally divided into regional centres, each covering about 3 coastal provinces. Each centre operates a fleet of four to five 60ft patrol vessels, which support the enforcement of all maritime laws. Maritime Police also operates a fleet of larger patrol vessels (3 X 180ft boats; 3 X 110ft boats), which are coordinated from Marine Police headquarters. Marine Police patrols tend to operate on intelligence and ad hoc information, and it is not known how much patrol time is dedicated to fisheries compliance.

Some coordination between the agencies involved in fisheries MCS occurs (i.e., Navy, DoF, Marine Police, Customs, DMCR) and is led by the Navy. This has included discussions on specific issues – for example, a recent workshop on IUU fishing – as well as annual meetings to review effectiveness; however, it is not known how effective this process has been.

Electronic systems to support MCS are in the development stage. Vessel monitoring systems (VMS) have been installed on 100 vessels to date, but these do not include commercial crab vessels. No electronic system exists to collect, store, process and exchange information. Consequently, MCS information is not yet routinely cross-referenced, other than by occasional checks at landing sites.

Current port inspection measures are not very effective. DoF does not have authority under the fisheries legislation to inspect landings at port. Some inspections are carried out by the Department of Marine Transport; however, these are largely focused on vessel registration and safety. To address these concerns in the short-term, DoF has approached the major processors to agree on compliance MOUs to prohibit the sale of IUU fish. In the longer term, changes are proposed in the current revision of the Act to provide powers for port state compliance.

The current sanction regime is also not as effective as it could be. Fines average 5,000-10,000 baht (US\$160-320) with the maximum penalty of one year in prison for repeat offences. There is a general view that historically fines were too low, though this is being addressed in the current review of the Act. The most common breaches are the use of prohibited gear, violations of closed areas and unlicensed fishing activity. A major impediment to effectiveness in the sanction regime has been political lobbying at the local level to avoid prosecution.

National level training capacity on MCS issues needs improving. No relevant courses are available through domestic technical institutions and most officers receive training only from within the agency. Some external providers have undertaken workshops on MCS related issues (e.g., FAO/APFIC/SEAFDEC on port state measures).

Community MCS groups have been set up in a number of coastal villages, with the support of DoF, to protect their fishing zones from commercial trawlers, and to monitor compliance by their own communities to ensure protection of sea grass beds and other no take zones. Participation in these activities has been seen to have been effective. In many cases, trawler/coastal fisher conflicts are mitigated through exchanges between the various groups. Such systems appear to exist in many coastal communities, and have been seen to have been effective. The initiative for the Tambon MCS pilot projects came from fishers and follows the successful EU-funded Coastal Habitats and Resources Management Project (CHARM).

Date of next review and audit of the management plan

There are mechanisms for reviewing the fisheries management decision making systems within Thailand both at DoF and DMCR levels. For example, the Master Plan does contain provision for monitoring and evaluation (M&E). This has not been enacted as part of a management planning process. Similarly, DMCR publishes an annual report every year (DMCR 2011⁷⁵).

Description of the measures agreed upon for the regulation of fishing in order to meet the objectives within a specified period

Measures to support development of the fishery to meet with the objectives are to be addressed through further stakeholder consultation processes. These are likely to relate to—

P 1 Stock status

- Clarification of the Units of Certification (UoC) and defining management units linked to specific stocks;
- Strengthening of the stock assessment process to cover all coastal and offshore stocks;
- Formulating limit and target reference points;
- **Developing harvest strategies for coastal communities, offshore fleets, covering the gears used;**
- **Adopting and implementing specific rules and management measures suitable, and acceptable to fishing operators, which will support a rebuilding strategy; and**
- **Improving information systems for coastal boats, strengthening the log book compliance, and developing an information network linked to the Thai Crab Product Group (TCPG) members.**

P 2 ecosystem impacts

- Collecting more detailed information on retained species in each fishery and undertaking a risk assessment for each species, when identified;
- **Developing management mitigation measures for these species where they are defined as medium to high risk;**
- Collecting information on bait species used and undertaking a risk assessment for each species, once identified;
- Develop bait fish management plans, if required;
- Strengthening the reporting system on ETP interactions, to include live release, especially turtles, but also interactions with other ETP species;
- Strengthen the system of community conservation groups;
- If ETP interactions are deemed to have a negative impact specific species, implement additional management mitigation measures

⁷⁵ Department of Marine and Coastal Resources, 2011 Annual report

- Collect information on benthic fauna interactions and assess the potential risks to these assemblages;
- Determine management measures that will reduce benthic interactions; and
- Specifically address the ecosystem impacts that the fishery may have, and determine if appropriate, actions that can support the recovery of these ecosystems.

P 3 Governance and species specific management

- The Government of Thailand to pass the fishery act, and if at all possible, integrate the EAFM into the Act, if not to include EAFM into a crab fishery specific management plan;
- Strengthen the consultation and decision making process through establishing fishery specific management councils;
- Ensure that conservation, as opposed to growth objectives, are implemented in conformity with the national fishery strategy;
- Develop fishery specific management plans for the Gulf of Thailand and Andaman Sea that conform to MSC principles 1 and 2;
- Strengthen the system of compliance by promoting the spread of community MCS groups and strengthening the application of sanctions to support all management measures, including on offshore crab vessels, and other fisheries with some interactions of crab – trammel net, trawl and push net;
- Design a DoF and DMCR Research Plan that seeks to improve data collection and modelling of the crab stocks and fishery dependent ecosystems; and
- As part of the Management Plan, introduce a system of performance reviews on all elements of the management process, and make provision within this, for external review.

4. Evaluation Procedure

4.1 Assessment methodologies used

The report has used **MSC Certification Requirements, Version 1.0, August 15 2011**, (http://www.msc.org/documents/scheme-documents/msc-scheme-requirements/copy_of_msc-certification-requirement/view), and has followed the **MSC Annual Pre-Assessment reporting template V1** (<http://www.msc.org/documents/scheme-documents/forms-and-templates/msc-annual-pre-assessment-reporting-template-v1/view>).

4.2 Summary of site visits and meetings held during pre-assessment

This audit is based upon the following information sources:

Table 8: List of persons met

Date	Name	Organisation	e-mail
9/10/11	Jesse Marsh Stephanie Bradley Saisunee Chaksuin Thananya Inthasak Jaruwan Janphen	Senior programme officers, WWF WWF, Project officers Thailand	Stephanie.Bradley@wwfus.org Jesse.Marsh@wwfus.org saisunee@yahoo.com Janphen@wwf.panda.org
10/10/11	Ms.Phansiri Winichagoon	WWF Thailand Country Director	pwinichoon@wwfgreatermekong.org
	Praulai Nootmorn	DoF	nootmorn@yahoo.com
	Dr.Kangwan Jantarachote	Fishery Research Center, Kasetsart University	Kungwan.j@ku.ac.th
	Smith Thummachua	DoF	smiththummachua@gmail.com 0867001725
	Ms.Natsinee Indharaprasert Mr.Surasak Indharaprasert : Surachai Ruenjit	Village chief of Mai-Rood sub- district, Laem Klad-Mai Rood, Klong Yai-Trad Assistant	
	Mr.Tat Jitsataporn Mr Saner Jansen	Head of Sapanhin conservation group, Laem Klad sub-district Village conservation officer	
11/10/11	Chaiyan Kansomneth Ms.Jarupa Siri	Provincial Chief, DoF. Senior Fishery officer, Trat	
12/10/11	Ms.Chalatip Chanchompoo; Mr Suthep Jualaorg	Marine Biologists, DMCR Research Centre, Rayong	
13/10/11	Athiyut	Si Chon, crab processor	don@ddseafoods.com
	Piangchan Sakkasem	Owner of commercial vessel, Chokanana	
	Nanthanee Cheiklin	Owner of fishing vessels, Pae Niti	
	Phanurat Amronphinyokiat,	Commercial Manager, Viya Crab Product Co.,Ltd.	pamornphinyokiat@phillipsfoods.com
	Surasith Laroa Thawatchai Phunchuay	Viya, crab processors	Lsurasit@viyacrabproducts.co.th Jaeoo11@hotmail.com
	Warin Loichom Manusyimyong	Poom Rieng, coastal village.	
14/10/11	Mr. Jakree Janthon; Head of Village	Crab site visit Laung Suan	

	Mr.Jang Fungfueng Pratuang Matyod	Chairman of Blue crab conservation group Commercial fisherman	
		Crab site visit, Pra Tew, Chumphon	
	Dr.Nipawan Budsarawit Nantthawadee Bantiwiwatkul Pramot Chimlad	Director of DMCR Chumphon Center Head of seagrass and Head of Marine Endanger species of DMCR -Chumphon Center	086 961 1791 Bnipavan@yahoo.com kuwnnubee@hotmail.com Sinsamud_p@hotmail.com
15/10/11	Mr.Songpol Tippayawong,	Crab site visit at Ban Soi Surao, Kuraburi Fishery staff, Phang Nga office	086 689 4784
17/10/11	Mr Somporn Boonnuan	Head of alternative livelihoods group, Ban Nam Rab, Trang	
	Asst.Prof. Apirak Songrak ; Mr Boankruem Pondachanan	Lecturer, Rajamonkala University of Technology (Si Kao) Head of DoF Kantang District	Apirak.s@rmutsv.ac.th
18/10/11	Simon Funge-Smith	FAO APFIC, Regional Fishery Officer	Simon.FungeSmith@fao.org
19/10/11	Micheal Hallager Jiroj Sintavanuruk Jadrin Jay Ivancic Mick Dallura Craig Perry Saowanee Khamfang	Phillips/Thai Crab Product Group PakFood/TCPG Handy/TCPG Phillips Phillips TFFA	mhallagher@phillipsfoods.com jiroj@pakfood.co.th jay@handyinternational.com Mdallura@ phillipsfoods.com Cperry@phillipsfoods.com saowanee@thai-frozen.or.th
24/10/11	Jason Cottier	Chicken of the Sea	jcottier@cosff.com

4.3 Stakeholders to be consulted during a full assessment

Table 9: Stakeholder list

Stakeholder	Organisation	Email address
Government departments		
Department of Fishery		
Mr.Wimol Chantharothat	DG, DoF	wimol@moac.go.th
Dr Prulai Nootmorn	Director, MRFDB, DoF	nootmorn@yahoo.com
Mrs.Tiwarat Seel A-nun	EMDEC Rayong	tpsinanun@yahoo.com
Ms.Jintana Jindalikit	Senior Fishery Biologist UMDEC, Samutprakran	
Thitiphorn Suppanirun	MMDEC, Chumphon	
Mr.Wirat Sanitmajjaro	LMDEC. Songkla	wiratanas@gmail.com
Mr. Wutthichai Wangkahart	Director, Andaman Research Centre	wungkahart@yahoo.com 076 391138
Marina Waiyasilp	FSARG, Bangkok	marina.1954@hotmail.com
Mr.Chaiyan Karnsomnet Mrs.Jaruaa Siri	Trat Provincial Fishery Biologist, Trat	jarupa_siri@yahoo.com 089 676 3981
Mr.Sitisak Noonchuay	Fishery Biologist, Chumporn	Sit59@hotmail.com 089 725 7553
Mr.Montree Sumontha	Fishery Biologist, Ranong	087 024 1486
Mr.Likhit Boonsit	Fishery Biologist, PrachuabKirikhan	Boonsit_2505@yahoo.com 081 010 5885
Ms.Aruneee Manakla	Senior Fishery officer, Trang	
Mr.Boonkren Porndej-Anun	Head of KanTang Fishery, Trang	086 985 3463
Department of Marine and Coastal Resources		
Dr.Kongkiet Kittiwantawong	DMCR, Phuket Marine Biological Center.	
Dr.Nipawan Budsarawit	Director of Chumporn Research Center	bnipawan@yahoo.com 086 961 1791
Ms.Nanthawadee Bantiwiwatkul	Head of Marine Ecosystem	kuwnnubee@hotmail.com 081 707 3776
Mr.Pramot Chimhad	Head of Endangered Species	Sissamud_p@hotmail.com 087 453 7596
Mr.Pramot Chimhad	Head of Endangered Species	Sissamud_p@hotmail.com 087 453 7596

Ms.Chalatip Chanchompoo	Marine Biologists, DMCR Research Centre, Rayong	junchompoo@yahoo.com 089 455 7736
Mr.Suthep Jualaor	Marine Biologists, DMCR Research Centre, Rayong	Saisawat_aor@hotmail.com 081 151 6919
Crab exporters		
Mr.Micheal Hallager	Phillips/Thai Crab Product Group	mhallagher@phillipsfoods.com
Mr.Jiroj Sintavanuruk	PakFood/TCPG	jiroj@pakfood.co.th
Mr.Jadrin Jay Ivancic	Handy/TCPG	jay@handyinternational.com
Mr.Jason Cottier		icottier@cosff.com
Mr.Athiyut Hanne-montri		don@ddseafoods.com
Mr.Thawatchai Phunchuay	Viya Crab Products co.,Ltd	Jae0011@viyacrabproducts.co.th
Mr.Mick Dallura	Si Chon, crab processor Chicken of the Sea	
Mr.Norman Chwang	Shrimp Mart Thai, Hai Yai	089 870 0221
Ms.Thanitha Jangprai	Executive Director, Thai Frozen Foods Association	thanitha@thai-frozen.or.th 081 812 1637
Commercial boat owners		
Mrs.Piangchan Sakkasem	Commercial boat owner, Chokanun pier, Surat Thani	081 569 1228
Mrs.Nanthanee Chei klin	Commercial boat owner, Nithi pier, Surat Thani	
Mr.Pratuang Makyod	Commercial boat, Chumporn (supplier to Ladda pier, Samut Sakhon, 081 857 2620 and to Viya Crab)	084 705 0442
Fishers		
Mr.Jang Fungfunag	Fishermen, Head of Conservation group, Pratiew, Chumporn	081 556 3515
Warin Loichom	Poom Rieng, coastal village.	
Mr.Somporn Boonuan;	Head of Fishery Conservation Group, Kan Tang	

Mr. Jakree Janthon	Head of Village, Lang Suan , Chumporn	083 632 9589
Mr.Tat Jitsataporn	Head of Sapanhin conservation group, Laem Klad sub-district, Trat	086 836 1409
Mr.Boonnote Poomanee	Head of village, Laem Hin, Laem Klad, Trat	080 568 5079
Mr.Surasak Intharaprasert	Head of Fishery Conservation group, Mairood, Trat	kamnantoy@yahoo.com 081 733 7990
Mr.Natsinee Intharaprasert	Head of sub-district, Mairood, Trat	Natsini23@hotmail.com 089 544 0909
Universities		
Dr.Kangwan Jantarachote	Fishery Research Center, Kasetsart University	Kungwan.j@ku.ac.th
Asst.Prof. Apirak Songrak ;	Lecturer, Rajamongkala University of Technology	Apirak.s@rmutsv.ac.th
Pracheep Choopunth	Rajamangala University of Technology Srivijaya, Songkla	southern@rmutsv.ac.th
NGOs		
Ms. Phansiri Winichagoon	WWF Thailand Country Director	pwinichagoon@wwfgreatermekong.org
Ms.Saisunee Chaksuin	WWF, Project Manager	saisuneec@wwf.panda.org

Source: WWF, Thailand

4.4 Harmonisation with any overlapping MSC certified fisheries

There are presently two other fisheries where blue swimming crab assessments have taken place. These are Jakarta Bay, east along the Java coast of Indonesia (conducted by MRAG Americas) and Kien Giang, Vietnam (conducted by Intertek Moody Marine). Both fisheries are in the process of developing Fisheries Improvement Projects. Since no fisheries have been certified to date, the issue of harmonisation is not relevant.

5. Traceability (issues relevant to chain of custody certification)

5.1 Eligibility of fishery products to enter further chains of custody

Crab are landed into either coastal villages or a number of medium and large scale fishing centres. Blue swimming crab are separated from other species. In the case of commercial vessel landings, the catches are boiled on site and either picked in on-site Hazard Analysis and Critical Control Points (HACCP) approved sites, or transported to processing plants where the product is picked and then packed. The fishery certification would include product until offloaded from the vessel. The Chain of

Custody process commences from delivery of the product to a receiver onshore. Products may be destined to any one of the seven processing plants:

- Phillips, Donsak, Surat Thani
- Pakfood, Mahachai and Nakon Si Thammarlart
- Viya/Handy, Surat Thani
- Si Chon, Surat Thani
- Royal Sea, Songkhla
- Grand Bay, Trang
- New Meir, Trang

Opportunities for mixing product may occur at the processing plant where some quantities, especially supplies into Trat, are sourced from Cambodia (Cottier, pers com, November, 2011). Product is packed into own brand and brand specific cans. Most product sold to the US is packed as own brand. This risk would require a robust procedure to maintain traceability of the product.

These companies source between 60-70% from the commercial fishery sector, and of their total supplies, 80% is said to come from the GoT (Thai Crab Product Group, October, 2011), and primarily from the Chumphon area. Other sales are destined primarily for the Thai domestic and tourist markets. The volumes destined for export are estimated to account for more than 95% of supplies. Most product is sold as canned. Some product is exported as pasteurised crab to Europe.

Whilst other swimming crabs may be landed, these are separated on landing and sold into the domestic market.

6. Preliminary evaluation of the fishery

6.1 Applicability of the default assessment tree

6.1.1 Expectations regarding use of the Risk-Based Framework (RBF)

It is not clear as to whether the data deficiencies in the target stock are considerable or not. These issues require further exploration. Retained and bait fish species are likely to be data deficient, requiring use of the RBF.

6.2 Summary of likely Performance Indicator (PI) scoring levels

Key to Likely scoring level

Information suggests fishery is not likely to reach SG60 and therefore would not pass the MSC standard	<60
Information suggests fishery will reach SG60 but may need a condition for this PI	60-79
Information suggests fishery is likely to exceed SG80 resulting in an unconditional pass for this PI	≥80

Table 10: Summary of pre-assessment scoring (Trap fishery)

Principle	Component	PI number	Performance Indicator	Likely scoring level
1	Outcome	1.1.1	Stock status	<60
		1.1.2	Reference points	60-79
		1.1.3	Stock rebuilding	<60
	Management	1.2.1	Harvest Strategy	<60
		1.2.2	Harvest control rules and tools	<60
		1.2.3	Information and monitoring	60-79
		1.2.4	Assessment of stock status	<60
2	Retained species	2.1.1	Outcome	<60
		2.1.2	Management	<60
		2.1.3	Information	60-79
	Bycatch species	2.2.1	Outcome	<60
		2.2.2	Management	<60
		2.2.3	Information	<60
	ETP species	2.3.1	Outcome	Borderline between pass and no pass
		2.3.2	Management	Borderline between pass and no pass
		2.3.3	Information	60-79
	Habitats	2.4.1	Outcome	60-79
		2.4.2	Management	60-79
		2.4.3	Information	60-79
	Ecosystem	2.5.1	Outcome	<60
		2.5.2	Management	<60
		2.5.3	Information	<60
3	Governance and Policy	3.1.1	Legal and customary framework	<60
		3.1.2	Consultation, roles and responsibilities	60-79
		3.1.3	Long term objectives	<60
		3.1.4	Incentives for sustainable fishing	60-79
	Fishery specific management system	3.2.1	Fishery specific objectives	<60
		3.2.2	Decision making processes	<60
		3.2.3	Compliance and enforcement	<60
		3.2.4	Research plan	60-79
		3.2.5	Management performance evaluation	<60

Table 11: Summary of pre-assessment scoring (Bottom Gillnet fishery)

Principle	Component	PI number	Performance Indicator	Likely scoring level
1	Outcome	1.1.1	Stock status	<60
		1.1.2	Reference points	60-79
		1.1.3	Stock rebuilding	<60
	Management	1.2.1	Harvest Strategy	<60
		1.2.2	Harvest control rules and tools	<60
		1.2.3	Information and monitoring	60-79
		1.2.4	Assessment of stock status	<60
2	Retained species	2.1.1	Outcome	<60
		2.1.2	Management	<60
		2.1.3	Information	<60
	Bycatch species	2.2.1	Outcome	Default 100
		2.2.2	Management	Default 100
		2.2.3	Information	Default 100
	ETP species	2.3.1	Outcome	Borderline between pass and no pass
		2.3.2	Management	60-79
		2.3.3	Information	60-79
	Habitats	2.4.1	Outcome	More information needed
		2.4.2	Management	More information needed
		2.4.3	Information	60-79
	Ecosystem	2.5.1	Outcome	<60
		2.5.2	Management	<60
		2.5.3	Information	<60
3	Governance and Policy	3.1.1	Legal and customary framework	<60
		3.1.2	Consultation, roles and responsibilities	60-79
		3.1.3	Long term objectives	<60
		3.1.4	Incentives for sustainable fishing	60-79
	Fishery specific management system	3.2.1	Fishery specific objectives	<60
		3.2.2	Decision making processes	<60
		3.2.3	Compliance and enforcement	<60
		3.2.4	Research plan	60-79
		3.2.5	Management performance evaluation	<60

6.3 Recommendation

The pre-assessment predicts that the fishery may receive scores for individual performance indicators of less than 60, which means that the fishery does not meet the MSC standard and would not achieve MSC certification, and scores greater than or equal to 60 but less than 80, which require conditions. As a fishery cannot pass an MSC certification with a score of <60, and cannot pass if the average score for a Principle falls below 80, we recommend that the client consider entering a Fishery Improvement Project (FIP) to begin a structured process of raising scores of performance indicators.

We emphasize that the MSC requires fisheries that achieve certification to address the conditions such that the scores of those PIs with conditions reach at least SG80 by the time of the re-assessment (5 years). In many cases, fulfilling the conditions may require resources beyond the reach of the client. We encourage the client to consider how to address the underlying causes that lead to failing scores and conditions, especially if the conditions require actions by or cooperation with federal and regional bodies. The MSC specifies that if a client action plan to achieve the conditions does not have a high likelihood of success, the fishery cannot pass. Moving to full assessment should take into account working relations with the management authorities and any measures that require resources of the management authorities. This fishery will need good working relations with the federal and regional management and research agencies, and you should advise them of your interest before announcing any full assessment in order for the fishery assessment process to go smoothly.

6.4 Moving to Full Assessment

At the time that a client decides to move into full assessment and signs a contract with a certifying body (CB), the client (through the CB) must make an announcement through the MSC web site of the decision to move forward. The MSC further requires that the CB that prepares the pre-assessment must send the pre-assessment to the MSC at the time of the announcement.

The client must be prepared to liaise with management agencies, environmental groups, post-harvest sectors, and relevant commercial and non-commercial fishing groups to ensure their understanding of the MSC process and the implications (including costs and benefits) of certification. It is imperative that the client recognize that any conditions identified in a full assessment will require an action plan designed to bring scores for any performance indicators scoring between 60 and 79 up to the 80 level within the 5-year certification period.

The client must provide a detailed action plan as to how the conditions will be addressed, by whom, the specified time period, how the action(s) is expected to improve the performance of the fishery, and how the outcome will be assessed in audits by the certification body. If the client must rely on external entities, for example management agencies, the action plan must contain consultation with those entities. If the conditions are likely to require investment of time or money by these entities, changes to management arrangements or regulations, or re-arrangement of research priorities by these entities, the consultation must satisfy the CB that the conditions are both achievable by the certification client and realistic in the time frame specified. If the fishery were to move to full assessment, it should take into account working relations with the management authorities. The Thai blue swimming crab fishery will need good working relations with DoF and DMCR, and you should advise them of your interest and elicit support during the assessment process. Where the client and the certification body are unable to agree on the terms of conditions that will achieve the required increase in the score(s) in question, certification shall not be awarded.

The client must also consider the location of the site visit to the fishery for meetings with fishery participants, management agencies, and other stakeholders. In the case of the Thai blue swimming crab fishery, the primary focus is likely to be on the Central Gulf of Thailand, which is the primary source of product for crab exporters. However, excluding other supply sources (such as the Andaman Sea) may result in substantial problems for receiving MSC Chain of Custody.

At the time of the decision to enter full assessment, the client should be prepared to consult with the selected CB to determine the timing and content of the public announcement and the location of the site visit.

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Annex 1. Provisional evaluation of the fishery against the Performance Indicators

Table A1

Definition of scoring ranges for PI outcome estimates	Shading to be used
Information suggests fishery is not likely to meet the SG60 scoring issues.	No Pass (<60)
Information suggests fishery will reach SG60 but may not meet all of the scoring issues at SG80. A condition may therefore be needed.	Pass with Condition (60-79)
Information suggests fishery is likely to exceed SG80 resulting in an unconditional pass for this PI. Fishery may meet one or more scoring issues at SG100 level.	Pass (≥ 80)
Where the PI is not relevant to the fishery or UoC under evaluation	Default 100

Pre-assessment evaluation tables

Principle 1

Component	Outcome		
PI 1.1.1- Stock status	The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing		
Scoring issues	SG60	SG80	SG100
a. Stock status	It is likely that the stock is above the point where recruitment would be impaired.	It is highly likely that the stock is above the point where recruitment would be impaired.	There is a high degree of certainty that the stock is above the point where recruitment would be impaired.
b. Stock status in relation to target reference point		The stock is at or fluctuating around its target reference point.	There is a high degree of certainty that the stock has been fluctuating around its target reference point, or has been above its target reference point, over recent years .
Justification/Rationale			
<p>Genetic distinctions have been identified for the Gulf of Thailand and Andaman Sea, showing two different stocks (Sirawut, K <i>et al</i>, 2007). Some genetic distinctions also exist between specific sites in both the Gulf of Thailand and Andaman Sea, but could potentially be considered the same stock because of related genetic traits (Sirawut, <i>Ibid</i>).</p> <p>Evidence of overfishing (Jindalikit (2008), Apirak (2011) and Sinanun (2011) and reports of declining CPUE and increasing reduction in the average size of crab are common features, but there are some possibilities of localised recovery following community initiatives (Tat, pers com, Oct, 2011.). However, these appear to be very rare, if occurring at all. The offshore fisheries appear to exhibit some robustness, as larger crabs are targeted (Jindalikit, <i>et al</i>, 2008). However, the connect in outward migrations of the juvenile crab to deeper water, and re-migration of females back to shallower water, would suggest that stock is being overfished, and in some cases (Aprirak, 2011), heavily overfished, in the coastal area, and the species is particularly susceptible during its juvenile growth stages. The identified outputs suggest that stock assessment processes need to extend throughout the range of the fisheries (all regions and methods, which would include trap, bottom gillnet and trawl). It is acknowledged that such work is underway, but more details are required on the network of this research.</p>			
RBF Required? (✓/✗/)	X	Likely Scoring Level (pass/pass with condition/fail)	NO PASS

Component	Outcome		
PI 1.1.2 Reference points	Limit and target reference points are appropriate for the stock		
Scoring issues	SG60	SG80	SG100

a. Appropriateness of reference points	Generic limit and target reference points are based on justifiable and reasonable practice appropriate for the species category.	Reference points are appropriate for the stock and can be estimated.	
b. Level of limit reference point		The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity.	The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity following consideration of relevant precautionary issues.
c. Level of target reference point		The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome.	The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome, or a higher level , and takes into account relevant precautionary issues such as the ecological role of the stock with a high degree of certainty.
d. Low trophic level species target reference point		For key low trophic level species, the target reference point takes into account the ecological role of the stock.	
Justification/Rationale			
Some stock assessments have been undertaken (Jindalikit (2008), Apirak (2011) and Sinanun (2011). These indicate that the stock is not maintained at a level consistent with B_{MSY} .			
No limit or target references points are used, but stock assessment work suggests that these can be extrapolated.			
The species is not low trophic as it does not primarily fish on plankton nor is it on the TAB D_036 list of species.			
RBF Required? (✓/✗/)	X	Likely Scoring Level (pass/pass with condition/fail)	PASS with conditions

Component	Outcome		
PI 1.1.3 Stock Rebuilding	Where the stock is depleted, there is evidence of stock rebuilding within a specified timeframe.		
Scoring issues	SG60	SG80	SG100
a. Rebuilding strategy design	Where stocks are depleted rebuilding strategies, which have a reasonable expectation of success are in place.	Where stocks are depleted rebuilding strategies are in place.	Where stocks are depleted, strategies are demonstrated to be rebuilding stocks continuously and there is strong evidence that rebuilding will be complete within the specified timeframe.

b. Rebuilding timeframes	A rebuilding timeframe is specified for the depleted stock that is the shorter of 30 years or 3 times its generation time . For cases where 3 generations is less than 5 years, the rebuilding timeframe is up to 5 years.	A rebuilding timeframe is specified for the depleted stock that is the shorter of 20 years or 2 times its generation time . For cases where 2 generations is less than 5 years, the rebuilding timeframe is up to 5 years.	The shortest practicable rebuilding timeframe is specified which does not exceed one generation time for the depleted stock.
c. Rebuilding evaluation	Monitoring is in place to determine whether the rebuilding strategies are effective in rebuilding the stock within the specified timeframe.	There is evidence that the rebuilding strategies are rebuilding stocks, or it is highly likely based on simulation modelling or previous performance that they will be able to rebuild the stock within the specified timeframe .	
Justification/Rationale			
Crab banks form part of the strategy. However, these are intermittent, crab mortality is high (98%), and evidence is not sufficiently reasonable to show that they are successful. However, local knowledge suggests that there may be some partial recovery (Phattareeya <i>et al</i> , Sept, 2011). Clearer evidence would be required to illustrate that crab banks and other localised supporting measures (closed areas, trawler prohibitions and increases in mesh size) are effective. Similarly, such rebuilding actions would have to be wide-spread.			
No timeframes have been set and no system of monitoring is place, but there are some initiatives in the Andaman Sea and a number of case studies in GoT.			
RBF Required? (✓/✗/)	X	Likely Scoring Level (pass/pass with condition/fail)	NO PASS

Component	Harvest strategy (management)		
PI 1.2.1 Harvest strategy	There is a robust and precautionary harvest strategy in place		
Scoring issues	SG60	SG80	SG100
a. Harvest strategy design	The harvest strategy is expected to achieve stock management objectives reflected in the target and limit reference points.	The harvest strategy is responsive to the state of the stock and the elements of the harvest strategy work together towards achieving management objectives reflected in the target and limit reference points.	The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points.

b. Harvest strategy evaluation	The harvest strategy is likely to work based on prior experience or plausible argument.	The harvest strategy may not have been fully tested but evidence exists that it is achieving its objectives.	The performance of the harvest strategy has been fully evaluated and evidence exists to show that it is achieving its objectives including being clearly able to maintain stocks at target levels.
c. Harvest strategy monitoring	Monitoring is in place that is expected to determine whether the harvest strategy is working.		
d. Harvest strategy review			The harvest strategy is periodically reviewed and improved as necessary.
Justification/Rationale			
<p>There is a single harvest strategy (a closed season to protect spawning crabs) but it has not been implemented (DoF (various), September, 2011).</p> <p>There may be some additional localised initiatives such as no take zones (Tat, pers com, Oct, 2011), mesh size limits (Phattareeya <i>et al</i>, Sept, 2011), and some positive processing buying practices (e.g., selecting 10 crabs per kg and higher premiums for higher yielding crabs) (Viya, pers com, Oct, 2011).</p> <p>Measures are needed to formally link a harvest strategy to the limit references points set.</p>			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Harvest strategy		
PI 1.2.2 Harvest control rules and tools	There are well-defined and effective harvest control rules in place		
Scoring issues	SG60	SG80	SG100
a. Harvest control rules design and application	Generally understood harvest control rules are in place that are consistent with the harvest strategy and which act to reduce the exploitation rate as limit reference points are approached.	Well-defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached.	Well-defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached.
b. Harvest control rules account for uncertainty		The selection of the harvest control rules takes into account the main uncertainties.	The design of the harvest control rules take into account a wide range of uncertainties.

c. Harvest control rules evaluation	There is some evidence that tools used to implement harvest control rules are appropriate and effective in controlling exploitation.	Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules.	Evidence clearly shows that the tools in use are effective in achieving the exploitation levels required under the harvest control rules.
Justification/Rationale			
Some issues needing to be addressed as potential in the harvest control rules and tools are the: the need for some limited entry licensing or rights based approach at local and offshore level, a minimum landing size, small mesh sizes (especially in crab traps), trap escape gaps, restrictions on the length of gill net, limits on trap numbers, taking of berried females, and spatial (except some sea grass areas) and temporal closed areas (that are enforced or respected). A combination of some or all of these measures would have to be implemented and demonstrated as effective prior to proceeding to MSC Certification.			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Harvest strategy		
PI 1.2.3 Information / monitoring	Relevant information is collected to support the harvest strategy		
Scoring issues	SG60	SG80	SG100
a. Range of information	Some relevant information related to stock structure, stock productivity and fleet composition is available to support the harvest strategy.	Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy.	A comprehensive range of information (on stock structure, stock productivity, fleet composition, stock abundance, fishery removals and other information such as environmental information), including some that may not be directly relevant to the current harvest strategy, is available.
b. Monitoring	Stock abundance and fishery removals are monitored and at least one indicator is available and monitored with sufficient frequency to support the harvest control rule.	Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule , and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule.	All information required by the harvest control rule is monitored with high frequency and a high degree of certainty, and there is a good understanding of the inherent uncertainties in the information [data] and the robustness of assessment and management to this uncertainty.
c. Comprehensiveness of information		There is good information on all other fishery removals from the stock.	

Justification/Rationale	
<p>Size, age and sex parameters appear to be documented for the offshore and some coastal fisheries (MRFDB), across a range of gears (Table 4). It also appears from the publications that the level of analysis by each MFRDB institute is quite extensive, if not regular.</p> <p>A major weakness appears to be the inadequacy of coastal fleet data and the impact that this element of the fleet has on stock status. Only a limited amount of size, sex and age data is collected at the coastal level.</p> <p>DoF District and Provinces have undertaken some coastal surveys on fleet composition and are presently supporting the registration of all fishing vessels. A 5 year community based survey is believed to be proposed (Funge Smith, Oct, 2011). Based on available evidence, information is not sufficient and must incorporate coastal parameters.</p> <p>Log book data collection would appear to be unreliable (Apirak, Sept, 2011), though some information is available on other fleet removals (e.g., from shrimp trammel nets, push nets and trawl).</p>	
Likely Scoring Level (pass/pass with condition/fail)	PASS with conditions

Component	Harvest Strategy		
PI 1.2.4 Assessment of stock status	There is an adequate assessment of the stock status.		
Scoring issues	SG60	SG80	SG100
a. Appropriateness of assessment to stock under consideration		The assessment is appropriate for the stock and for the harvest control rule.	The assessment takes into account the major features relevant to the biology of the species and the nature of the fishery.
b. Assessment approach	The assessment estimates stock status relative to reference points.		
c. Uncertainty in the assessment	The assessment identifies major sources of uncertainty.	The assessment takes uncertainty into account.	The assessment takes into account uncertainty and is evaluating stock status relative to reference points in a probabilistic way.
d. Evaluation of assessment			The assessment has been tested and shown to be robust. Alternative hypotheses and assessment approaches have been rigorously explored.
e. Peer review of assessment		The assessment of stock status is subject to peer review.	The assessment has been internally and externally peer reviewed.

Justification/Rationale	
<p>There is some evidence that MFRDC have implemented stock assessment processes in the sub offices and that there is now a degree of coordination (Jindalikit pers com, 2011). This may not apply to all areas, but early indications are encouraging to the extent that MFRDB is now building up a composit information on stock status. There is one known case study (Apirak <i>et al</i>, 2011), where stock assessment is taking place at the coastal level. Growth (age, sex, weight and length) form the components to the assessments. These assessments are based on Jones' length-based cohort analysis (length and frequency mortality coefficients) to calculate biomass and MSY.</p>	
Likely Scoring Level (pass/pass with condition/fail)	NO PASS

Principle 2

Component	Retained Species		
PI 2.1.1 Outcome Status	The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.		
Scoring issues	SG60	SG80	SG100
a. Retained species stock status	Main retained species are likely to be within biologically based limits. If not, go to scoring issue c below.	Main retained species are highly likely to be within biologically based limits. If not, go to scoring issue c below.	There is a high degree of certainty that retained species are within biologically based limits and fluctuating around their target reference points.
b. Target reference points			Target reference points are defined for retained species.
c. Recovery and rebuilding	If main retained species are outside the limits there are measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding of the depleted species.	If main retained species are outside the limits there is a partial strategy of demonstrably effective management measures in place such that the fishery does not hinder recovery and rebuilding.	
d. Measures if poorly understood	If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.		
Justification/Rationale			
<p>Trap: The main bycatch species are other crab (DoF, 2009). These are likely to exhibit similar risks to blue swimming crab (i.e., medium to high risk) (Assessors preliminary RBF assessment on blue swimming crab).</p> <p>There are no measures in place that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits</p> <p>Gillnet: Not all species interactions are known, but the main species at risk are likely to include top predators, sharks and rays. It is noted that these top level predators are already highly vulnerable. There are no measures in place that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits.</p> <p>SICA and PSA assessments will have to be undertaken as part of the main assessment. Further information will be required on teleosts and elasmobranchs caught in gillnet gear.</p>			
TRAP			

RBF required? (✓/✗)	✓	Likely Scoring Level (pass/pass with condition/fail)	NO PASS
GILLNET			
RBF required? (✓/✗)	✓	Likely Scoring Level (pass/pass with condition/fail)	NO PASS

Component	Retained Species		
PI 2.1.2 Management strategy	There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species.		
Scoring issues	SG60	SG80	SG100
a. Management strategy in place	There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding.	There is a partial strategy in place, if necessary, that is expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding.	There is a strategy in place for managing retained species.
b. Management strategy evaluation	The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).	There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or species involved.	Testing supports high confidence that the strategy will work, based on information directly about the fishery and/or species involved.
c. Management strategy implementation		There is some evidence that the partial strategy is being implemented successfully .	There is clear evidence that the strategy is being implemented successfully .
d. Management strategy evidence of success			There is some evidence that the strategy is achieving its overall objective .
Justification/Rationale			
<p>Trap: There are no measures in place that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits.</p> <p>Gillnet: There are no measures in place that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits.</p>			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS
GILLNET			

Component	Retained Species		
PI 2.1.3 Information/Mo nitoring	Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species.		
Scoring issues	SG60	SG80	SG100
a. Information quality	Qualitative information is available on the amount of main retained species taken by the fishery. (Trap)	Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery. (Trap)	Accurate and verifiable information is available on the catch of all retained species and the consequences for the status of affected populations.
b. Information adequacy for assessment of stocks	Information is adequate to qualitatively assess outcome status with respect to biologically based limits. (Trap)	Information is sufficient to estimate outcome status with respect to biologically based limits.	Information is sufficient to quantitatively estimate outcome status with a high degree of certainty.
c. Information adequacy for management strategy	Information is adequate to support measures to manage main retained species. (Trap)	Information is adequate to support a partial strategy to manage main retained species. (Trap)	Information is adequate to support a comprehensive strategy to manage retained species, and evaluate with a high degree of certainty whether the strategy is achieving its objective.
d. Monitoring		Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy)	Monitoring of retained species is conducted in sufficient detail to assess ongoing mortalities to all retained species.
Justification/Rationale			
<p>Trap: DoF does not have quantitative information on trap species interactions (i.e., interactions with other crab species including three spot crab (<i>Portunis sanguinolentus</i>), musk crab (<i>Charybdis cruciata</i>), mud crab (<i>Scylla serrata</i>) and one other unidentified species).</p> <p>Gillnet: The DoF Fisheries Statistics report (2008) has some information on gillnet retained species interactions. However, specific species information on 'other fish', shark and ray (without naming species) is not provided in sufficient detail. Other species, such as mantis shrimp, may also be caught in gillnets. This information will also have to be collected.</p>			
TRAP			
NOTE: When RBF is used to score PI 2.1.1, scoring issue b. (text in brackets above) should not be scored.	Likely Scoring Level (pass/pass with condition/fail)		PASS with conditions
GILLNET			

	Likely Scoring Level (pass/pass with condition/fail)	NO PASS
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Component	Bycatch Species		
PI 2.2.1 Outcome Status	The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.		
Scoring issues	SG60	SG80	SG100
a. Bycatch species stock status	Main bycatch species are likely to be within biologically based limits. If not, go to scoring issue b below	Main bycatch species are highly likely to be within biologically based limits If not, go to scoring issue b below	There is a high degree of certainty that bycatch species are within biologically based limits.
b. Recovery and rebuilding	If main bycatch species are outside biologically based limits there are mitigation measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding.	If main bycatch species are outside biologically based limits there is a partial strategy of demonstrably effective mitigation measures in place such that the fishery does not hinder recovery and rebuilding.	
c. Measures if poorly understood	If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the bycatch species to be outside biologically based limits or hindering recovery.		
Justification/Rationale			
<p>Trap: There are no known non commercial species caught as bycatch in the blue swimming crab trap fishery. Fishing vessel owners and small scale fishers stated that Indian mackerels and small pelagic species are used as baitfish. These species would have to be assessed, applying RBF, based on the impact on these fisheries by the target method (purse seine on Indian mackerel and encircling net on coastal pelagic species).</p> <p>Gillnet: All species caught are retained, as such this fishery would score the default 100 (Athiyut, pers com, 2011).</p>			
TRAP			
RBF required? (✓/×)	✓	Likely Scoring Level (pass/pass with condition/fail)	NO PASS
GILLNET			

RBF required? (✓/✗)	✗	Likely Scoring Level (pass/pass with condition/fail)	PASS BY DEFAULT
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Component	Bycatch Species		
PI 2.2.2 Management Strategy	There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations.		
Scoring issues	SG60	SG80	SG100
a. Management strategy in place	There are measures in place, if necessary, which are expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery.	There is a partial strategy in place, if necessary, that is expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery.	There is a strategy in place for managing and minimising bycatch.
b. Management strategy evaluation	The measures are considered likely to work, based on plausible argument (e.g. general experience, theory or comparison with similar fisheries/species).	There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or the species involved.	Testing supports high confidence that the strategy will work, based on information directly about the fishery and/or species involved.
c. Management strategy implementation		There is some evidence that the partial strategy is being implemented successfully .	There is clear evidence that the strategy is being implemented successfully .
d. Management strategy evidence of success			There is some evidence that the strategy is achieving its objective .
Justification/Rationale			
<p>Trap: There is no baitfish management strategy.</p> <p>Gillnet: All species caught are retained, as such this fishery would score the default 100.</p>			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS
GILLNET			
			DEFAULT 100

Component	Bycatch Species		
PI 2.2.3 Information/monitoring	Information on the nature and amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch.		
Scoring issues	SG60	SG80	SG100
a. Information quality	Qualitative information is available on the amount of main bycatch species affected by the fishery.	Qualitative information and some quantitative information are available on the amount of main bycatch species affected by the fishery.	Accurate and verifiable information is available on the amount of all bycatch and the consequences for the status of affected populations.
b. Information adequacy for assessment of stocks	Information is adequate to broadly understand outcome status with respect to biologically based limits.	Information is sufficient to estimate outcome status with respect to biologically based limits.	Information is sufficient to quantitatively estimate outcome status with respect to biologically based limits with a high degree of certainty .
c. Information adequacy for management strategy	Information is adequate to support measures to manage bycatch.	Information is adequate to support a partial strategy to manage main bycatch species.	Information is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective .
d. Monitoring		Sufficient data continue to be collected to detect any increase in risk to main bycatch species (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).	Monitoring of bycatch data is conducted in sufficient detail to assess ongoing mortalities to all bycatch species.
Justification/Rationale			
<p>Trap: Insufficient data is known on bait fisheries, and the range of individual species. SICA and PSA assessments will have to be undertaken as part of the main assessment. Further information will be required on bait fish used and the methods of capture applied. This will form part of the FIP.</p> <p>Gillnet: All species caught are retained, as such this fishery would score the default 100.</p>			
TRAP			
NOTE: When RBF is used to score PI 2.2.1, scoring issue b. (text in brackets above) need not be scored.	Likely Scoring Level (pass/pass with condition/fail)	NO PASS	
GILLNET			
	Likely Scoring Level (pass/pass with condition/fail)	DEFAULT 100	

Component	ETP Species		
PI 2.3.1 Outcome Status	The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.		
Scoring issues	SG60	SG80	SG100
a. Fishery effects within limits	Known effects of the fishery are likely to be within limits of national and international requirements for protection of ETP species.	The effects of the fishery are known and are highly likely to be within limits of national and international requirements for protection of ETP species.	There is a high degree of certainty that the effects of the fishery are within limits of national and international requirements for protection of ETP species.
b. Direct effects	Known direct effects are unlikely to create unacceptable impacts to ETP species.	Direct effects are highly unlikely to create unacceptable impacts to ETP species.	There is a high degree of confidence that there are no significant detrimental direct effects of the fishery on ETP species.
c. Indirect effects		Indirect effects have been considered and are thought to be unlikely to create unacceptable impacts.	There is a high degree of confidence that there are no significant detrimental indirect effects of the fishery on ETP species.
Justification/Rationale			
<p>Protected Species are specified in the Wildlife Reservation and Protection Act B.E. 1992. Notifications also prohibit the catch of dolphins, turtles and whale sharks.</p> <p>Gillnet: There are some turtle bycatch interactions with crab gill nets but it is unclear whether these contribute to unacceptable impacts on the species status, or whether catches are occasional or not. The likelihood is that these are low, but this requires further verification. However, it is more likely that other gears may well have a highly significant impact on the populations. There is some quantitative assessment of interactions between gillnets and turtles at the village level, where DMCR sponsored conservation groups have been created, and are seen to report turtle interactions regularly (DMCR, 2011). A fishery will not fail if there are turtle actions. The Strategy, which there is has to demonstrate that it is working.</p> <p>Trap and Gillnet: There may also be some interactions between long boat engines and dugongs. Anecdotal information suggested other limited interactions if at all with dugongs, especially as most fishing occurred outside dugong habitat (sea grass).</p> <p>It is not clearly known whether direct effects are unlikely to create unacceptable impacts.</p>			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			Border line between FAIL and PASS with a condition
GILLNET			
			Border line between FAIL and Pass with a condition

Component	ETP Species		
PI 2.3.2 Management strategy	<p>The fishery has in place precautionary management strategies designed to:</p> <ul style="list-style-type: none"> - meet national and international requirements; - ensure the fishery does not pose a risk of serious or irreversible harm to ETP species; - ensure the fishery does not hinder recovery of ETP species; and - minimise mortality of ETP species. 		
Scoring issues	SG60	SG80	SG100
a. Management strategy in place	<p>There are measures in place that minimise mortality of ETP species, and are expected to be highly likely to achieve national and international requirements for the protection of ETP species.</p>	<p>There is a strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, which is designed to be highly likely to achieve national and international requirements for the protection of ETP species.</p>	<p>There is a comprehensive strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, which is designed to achieve above national and international requirements for the protection of ETP species.</p>
b. Management strategy evaluation	<p>The measures are considered likely to work, based on plausible argument (e.g. general experience, theory or comparison with similar fisheries/species).</p>	<p>There is an objective basis for confidence that the strategy will work, based on information directly about the fishery and/or the species involved.</p>	<p>The strategy is mainly based on information directly about the fishery and/or species involved, and a quantitative analysis supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully.</p>
c. Management strategy implementation		<p>There is evidence that the strategy is being implemented successfully.</p>	<p>There is clear evidence that the strategy is being implemented successfully.</p>
d. Management strategy evidence of success			<p>There is evidence that the strategy is achieving its objective.</p>
Justification/Rationale			
<p>There are some measures in place through DMCR sponsored conservation groups that highlight awareness of ETP interactions. These include workshops, information brochures, and reporting requirements. These may mitigate against high levels of interactions where known migrations occur. Reporting systems of interactions are in place. However, it is not clear whether these are sufficient and measures are considered likely, but there is plausible argument to suggest that measures are effective. DMCR reporting would be needed to test the effectiveness of this strategy, which may be recognised as a significant achievement.</p>			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			Border line between FAIL and PASS with a condition
GILLNET			
			PASS with a Condition

Component	ETP Species		
PI 2.3.3 Information/monitoring	Relevant information is collected to support the management of fishery impacts on ETP species, including: - information for the development of the management strategy; - information to assess the effectiveness of the management strategy; and - information to determine the outcome status of ETP species.		
Scoring issues	SG60	SG80	SG100
a. Information quality	Information is sufficient to qualitatively estimate the fishery related mortality of ETP species.	Sufficient information is available to allow fishery related mortality and the impact of fishing to be quantitatively estimated for ETP species.	Information is sufficient to quantitatively estimate outcome status of ETP species with a high degree of certainty.
b. Information adequacy for assessment of impacts	Information is adequate to broadly understand the impact of the fishery on ETP species.	Information is sufficient to determine whether the fishery may be a threat to protection and recovery of the ETP species.	Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.
c. Information adequacy for management strategy	Information is adequate to support measures to manage the impacts on ETP species	Information is sufficient to measure trends and support a full strategy to manage impacts on ETP species	Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives.
Justification/Rationale			
There is insufficient information on live releases, but this may be available through DMCR conservation groups as some reporting is known to occur. There is no data on the interaction between long boat engines and ETPs. Information is adequate to broadly understand the impact of the fishery on ETP species, and to support measures to manage the impacts on ETP species.			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			PASS with Conditions
GILLNET			
			PASS with Conditions

Component	Habitats		
PI 2.4.1 Outcome Status	The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.		
Scoring issues	SG60	SG80	SG100
a. Habitat status	The fishery is unlikely to reduce habitat structure	The fishery is highly unlikely to reduce habitat structure	There is evidence that the fishery is highly unlikely to

Component	Habitats		
PI 2.4.1 Outcome Status	The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.		
	and function to a point where there would be serious or irreversible harm.	and function to a point where there would be serious or irreversible harm.	reduce habitat structure and function to a point where there would be serious or irreversible harm.
Justification/Rationale			
<p>The response is dependent on relative habitat structures. Sandy bottoms may be more resilient. However, some fishing grounds, such as Phang Nga, were mixed rock and sand, with considerable benthic diversity and gillnet damage to fauna. Most fishing occurred off seagrass beds, but with some exceptions. More information is required to be able to assess benthic impacts.</p> <p>Traps are unlikely to cause notable impact and highly unlikely to reduce habitat structure.</p>			
RBF required? (✓/✗)		Likely Scoring Level (pass/pass with condition/fail)	Traps: Will most likely pass for traps
			Gillnet: Potentially a pass, but greater knowledge required on some benthic interactions by gillnet (e.g Phang Nha (Picture 5))

Component	Habitats		
PI 2.4.2 Management strategy	There is a strategy in place that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to habitat types.		
Scoring issues	SG60	SG80	SG100
a. Management strategy in place	There are measures in place, if necessary, that are expected to achieve the Habitat Outcome 80 level of performance.	There is a partial strategy in place, if necessary, that is expected to achieve the Habitat Outcome 80 level of performance or above.	There is a strategy in place for managing the impact of the fishery on habitat types.
b. Management strategy evaluation	The measures are considered likely to work, based on plausible argument (e.g. general experience, theory or comparison with similar fisheries/habitats).	There is some objective basis for confidence that the partial strategy will work, based on information directly about the fishery and/or habitats involved.	Testing supports high confidence that the strategy will work, based on information directly about the fishery and/or habitats involved.
c. Management strategy implementation		There is some evidence that the partial strategy is being implemented successfully.	There is clear evidence that the strategy is being implemented successfully.

d. Management strategy evidence of success			There is some evidence that the strategy is achieving its objective.
Justification/Rationale			
There is a strategy in place to protect seagrass habitats through zoning; and coral reefs through mooring systems (DMCR, Sept. 2011). It is not clear how wide spread damage to other assemblages may be. The strategy is likely to be effective for trap fisheries.			
Likely Scoring Level (pass/pass with condition/fail)			Potentially a pass, but greater knowledge required on some benthic interactions by gillnet. Will pass for traps.

Component	Habitats		
PI 2.4.3 Information / monitoring	Information is adequate to determine the risk posed to habitat types by the fishery and the effectiveness of the strategy to manage impacts on habitat types.		
Scoring issues	SG60	SG80	SG100
a. Information quality	There is a basic understanding of the types and distribution of main habitats in the area of the fishery.	The nature, distribution and vulnerability of all main habitat types in the fishery area are known at a level of detail relevant to the scale and intensity of the fishery.	The distribution of habitat types is known over their range, with particular attention to the occurrence of vulnerable habitat types.
b. Information adequacy for assessment of impacts	Information is adequate to broadly understand the nature of the main impacts of gear use on the main habitats, including spatial overlap of habitat with fishing gear	Sufficient data are available to allow the nature of the impacts of the fishery on habitat types to be identified and there is reliable information on the spatial extent of interaction, and the timing and location of use of the fishing gear.	The physical impacts of the gear on the habitat types have been quantified fully.
c. Monitoring		Sufficient data continue to be collected to detect any increase in risk to habitat (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	Changes in habitat distributions over time are measured.
Justification/Rationale			
Information is known on habitat types and species interactions. The nature, distribution and vulnerability of all main habitat types in the fishery area is not known.			
Likely Scoring Level (pass/pass with condition/fail)			PASS with a Condition

Component	Ecosystem		
PI 2.5.1 Outcome Status	The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.		
Scoring issues	SG60	SG80	SG100
a. Ecosystem status	The fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	There is evidence that the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.
Justification/Rationale			
<p>Trap: The catch of large numbers of pre-adult crab is likely to impact the ecosystem structure by causing greater truncated size composition, reducing the rate of recovery for all crab species caught by trap. These issues would largely have to be dealt with under harvest strategy. The impacts are likely to be minimal in offshore areas where juveniles are not caught. Removing, as opposed to returning female crabs may also be a consideration.</p> <p>Gillnet: The fishery is likely to cause a detrimental impact on the target stocks and their predators, especially sharks and rays. However, the fishery is as likely to be affected by changes in exogenous environmental parameters, especially salinity. But, the trophic inter-dependencies on the target and allied crab stocks are less likely to be affected. It could be argued that lower levels of predation may benefit stock status as a whole.</p> <p>A critical issue would be to assess the relative damage caused to top predators from the gillnet fishery as opposed to other methods. Thai statistics show that the catches of shark and ray account for 3% and 2% of the total catch by the Thai fleets operating in both the Gulf of Thailand and the Andaman Sea, respectively (DoF, 2008). Evidence would have to show that trophic cascades in these retained species have not occurred, but given their relative low fecundities, greater attention might be required to mitigating impacts in areas of high interaction. How this may be achieved in a gillnet fishery would be unclear.</p> <p>The fisheries are less likely to change the evenness in species spread and dominance, given the combination in catches of predator and prey.</p> <p>All these issues would require careful consideration in a specific ecosystem orientated study.</p>			
Trap:			
RBF required? (✓/✗)	✓	Likely Scoring Level (pass/pass with condition/fail)	NO PASS
Gillnet:			
	✓	Likely Scoring Level (pass/pass with condition/fail)	NO PASS

Component	Ecosystem		
PI 2.5.2 Management strategy	There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.		
Scoring issues	SG60	SG80	SG100
a. Management strategy in place	There are measures in place, if necessary.	There is a partial strategy in place, if necessary,	There is a strategy that consists of a plan , in place.
b. Management strategy design	The measures take into account the potential impacts of the fishery on key elements of the ecosystem.	The partial strategy takes into account available information and is expected to restrain impacts of the fishery on the ecosystem so as to achieve the Ecosystem Outcome 80 level of performance.	The strategy , which consists of a plan , contains measures to address all main impacts of the fishery on the ecosystem, and at least some of these measures are in place. The plan and measures are based on well-understood functional relationships between the fishery and the Components and elements of the ecosystem. This plan provides for development of a full strategy that restrains impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm.
c. Management strategy evaluation	The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/ ecosystems).	The partial strategy is considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/ ecosystems).	The measures are considered likely to work based on prior experience , plausible argument or information directly from the fishery/ecosystems involved.
d. Management strategy implementation		There is some evidence that the measures comprising the partial strategy are being implemented successfully .	There is evidence that the measures are being implemented successfully .
Justification/Rationale			
<p>Trap: The catching of juvenile target and retained crab species in coastal waters is likely to have detrimental impacts on the ecosystem. The management response to this will be consistent with the actions in PI 2.1.2 and PI 2.2.2.</p> <p>Gillnet: There are no measures in place, but actions would depend on assessment of the risks to the ecosystem.</p>			
TRAP			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS
GILLNET			

Component	Ecosystem		
PI 2.5.3 Information / monitoring	There is adequate knowledge of the impacts of the fishery on the ecosystem.		
Scoring issues	SG60	SG80	SG100
a. Information quality	Information is adequate to identify the key elements of the ecosystem (e.g. trophic structure and function, community composition, productivity pattern and biodiversity).	Information is adequate to broadly understand the key elements of the ecosystem.	
b. Investigation of fishery impacts	Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but have not been investigated in detail.	Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, and some have been investigated in detail.	Main interactions between the fishery and these ecosystem elements can be inferred from existing information, and have been investigated in detail.
c. Understanding of component functions		The main functions of the Components (i.e. target, Bycatch, Retained and ETP species and Habitats) in the ecosystem are known	The impacts of the fishery on target, Bycatch, Retained and ETP species and Habitats are identified and the main functions of these Components in the ecosystem are understood.
d. Information relevance		Sufficient information is available on the impacts of the fishery on these Components to allow some of the main consequences for the ecosystem to be inferred.	Sufficient information is available on the impacts of the fishery on the Components and elements to allow the main consequences for the ecosystem to be inferred.
e. Monitoring		Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	Information is sufficient to support the development of strategies to manage ecosystem impacts.
Justification/Rationale			
Some general work has been undertaken on the trophic structure in the GoT (Male <i>et al.</i> , 2005). Similarly, there appears to be some knowledge of the species and habitat interactions. This information needs to be able to specifically assess the issues of trophic impact (and the likelihood of cascades) from the crab fishery, which would include depletion of top predators (sharks and rays), truncated sizes (target and retained species), gross changes to species diversity, and changes to genetic diversity.			

Principle 3

Component	Governance and Policy		
PI 3.1.1 Legal and/or customary framework	<p>The management system exists within an appropriate and effective legal and/or customary framework which ensures that it:</p> <ul style="list-style-type: none"> - Is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2; - Observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; and - Incorporates an appropriate dispute resolution framework. 		
Scoring issues	SG60	SG80	SG100
a. Consistency with laws or standards	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2.		
b. Resolution of disputes	The management system incorporates or is subject by law to a mechanism for the resolution of legal disputes arising within the system.	The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes which is considered to be effective in dealing with most issues and that is appropriate to the context of the fishery.	The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes that is appropriate to the context of the fishery and has been tested and proven to be effective .
c. Approach to disputes	Although the management authority or fishery may be subject to continuing court challenges, it is not indicating a disrespect or defiance of the law by repeatedly violating the same law or regulation necessary for the sustainability for the fishery.	The management system or fishery is attempting to comply in a timely fashion with binding judicial decisions arising from any legal challenges.	The management system or fishery acts proactively to avoid legal disputes or rapidly implements binding judicial decisions arising from legal challenges.
d. Respect for rights	The management system has a mechanism to generally respect the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner	The management system has a mechanism to observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1	The management system has a mechanism to formally commit to the legal rights created explicitly or established by custom on people dependent on fishing for food and livelihood in a manner consistent with the

	consistent with the objectives of MSC Principles 1 and 2.	and 2.	objectives of MSC Principles 1 and 2.
e. Monitoring		Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	Information is sufficient to support the development of strategies to manage ecosystem impacts.
Justification/Rationale			
<p>There is no management system in place across the whole of the study area that focuses on blue swimming crab or its associated retained species. A Fisheries Act is in place, and its replacement is in process. The new Act does contain reference to the UN Convention on the Law of the Sea (UNCLOS), UN Fish Stocks Agreement (UNFSA), PAFM and Port State Measures, but not EAFM (Banks et al., 2010). This PI will only be deemed acceptable once the new Act is in place. Historic delays in the Act reaching Parliamentary approval suggest that it could be a long time before the Act is approved. Existing Notifications are not a substitute for the Act.</p> <p>There is management hierarchy in place with DoF responsible for overall policy and implementation of management actions. Management measures may be introduced as Notifications. Many of the measures appear to be ad hoc and not linked to a harvest control strategy.</p>			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Governance and Policy		
PI 3.1.2 Consultation, roles and responsibilities	<p>The management system has effective consultation processes that are open to interested and affected parties.</p> <p>The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties.</p>		
Scoring issues	SG60	SG80	SG100
a. Roles and responsibilities	<p>Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are generally understood.</p>	<p>Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for key areas of responsibility and interaction.</p>	<p>Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for all areas of responsibility and interaction.</p>
b. Consultation processes	<p>The management system includes consultation processes that obtain relevant information from the main affected parties, including local knowledge, to inform the management system.</p>	<p>The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information obtained.</p>	<p>The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information and explains how it is used or not used.</p>

c. Participation		The consultation process provides opportunity for all interested and affected parties to be involved.	The consultation process provides opportunity and encouragement for all interested and affected parties to be involved, and facilitates their effective engagement.
Justification/Rationale			
<p>Organisations, roles and responsibilities are clearly defined across fishery and ecosystem management and research bodies.</p> <p>Thailand has a consultative and democratic approach to fisheries with consultative bodies and their membership inscribed in law both at the national level and, where ordinances exist, at the provincial level. However, there were clear inadequacies in the application of this process, as major stakeholders, fishers and processors cited only a small number of cases with DoF. Interaction with DMCR at the coastal level through exchanges and workshops was significantly greater, demonstrating opportunity for interaction with interested parties and consideration of information obtained. DoF's cited constraint to dialogue and interaction was lack of funding.</p> <p>There is no fishery specific Management Advisory Committee for Blue swimming crab, nor a process for feeding through current assessment information.</p>			
Likely Scoring Level (pass/pass with condition/fail)			PASS with conditions

Component	Governance and Policy		
PI 3.1.3 Long term objectives	The management policy has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria, and incorporates the precautionary approach.		
Scoring issues	SG60	SG80	SG100
a. Objectives	Long term objectives to guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are implicit within management policy.	Clear long term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within management policy.	Clear long term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within and required by management policy
Justification/Rationale			
Long term objectives are contained as part of the National Fisheries Masterplan (DoF, 2008). This plan is of good quality and makes reference to EAFM; however, is not implicit or explicit in the application of the management policy.			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Governance and Policy		
PI 3.1.4 Incentives for sustainable fishing	The management system provides economic and social incentives for sustainable fishing and does not operate with subsidies that contribute to unsustainable fishing.		
Scoring issues	SG60	SG80	SG100
a. Incentives	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and seeks to ensure that perverse incentives do not arise.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and explicitly considers incentives in a regular review of management policy or procedures to ensure that they do not contribute to unsustainable fishing practices.
Justification/Rationale			
<p>There is unlikely to be strong evidence of negative fisheries incentives (subsidies) that would encourage overfishing.</p> <p>Strengthening roles , rights and responsibilities of the various fishing groups engenders a sense of ownership. Tambon groups may therefore be interpreted as a positive incentive. Any means to establish property rights in offshore fisheries could do likewise.</p> <p>Stimulating the participatory approach to fisheries management through crab banks and surrounding support measures, if effective, and research may also engender further positive incentives.</p>			
Likely Scoring Level (pass/pass with condition/fail)			PASS with conditions

Component	Fishery- specific management system		
PI 3.2.1 Fishery- specific objectives	The fishery has clear, specific objectives designed to achieve the outcomes expressed by MSC's Principles 1 and 2.		
Scoring issues	SG60	SG80	SG100
a. Objectives	Objectives , which are broadly consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are implicit within the fishery's management system.	Short and long term objectives , which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.	Well defined and measurable short and long term objectives , which are demonstrably consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.
Justification/Rationale			
There is no blue swimming crab management plan in place. Therefore, fishery-specific objectives, nor the means to achieve these, have not been defined.			

Likely Scoring Level (pass/pass with condition/fail)	NO PASS
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Component	Fishery- specific management system		
PI 3.2.2 Decision-making processes	The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives.		
Scoring issues	SG60	SG80	SG100
a. Decision-making processes	There are some decision-making processes in place that result in measures and strategies to achieve the fishery-specific objectives.	There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives.	
b. Responsiveness of decision-making processes	Decision-making processes respond to serious issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take <u>some</u> account of the wider implications of decisions.	Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions.	Decision-making processes respond to all issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions.
c. Use of precautionary approach		Decision-making processes use the precautionary approach and are based on best available information.	
d. Transparency of decision-making		Explanations are provided for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.	Formal reporting to all interested stakeholders describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.
Justification/Rationale			
<p>There are formal decision making processes applied by DoF. However, in the case of the blue swimming crab trap and gillnet fisheries, they are clearly not responding to relevant research.</p> <p>The precautionary approach to fisheries management is not being applied.</p> <p>There are no explanations of decisions taken, or for that matter why management decisions are not made for the crab fleets.</p>			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Fishery- specific management system		
PI 3.2.3 Compliance and enforcement	Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with.		
Scoring issues	SG60	SG80	SG100
a. MCS implementation	Monitoring, control and surveillance mechanisms exist, are implemented in the fishery under assessment and there is a reasonable expectation that they are effective.	A monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated an ability to enforce relevant management measures, strategies and/or rules.	A comprehensive monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated a consistent ability to enforce relevant management measures, strategies and/or rules.
b. Sanctions	Sanctions to deal with non-compliance exist and there is some evidence that they are applied.	Sanctions to deal with non-compliance exist, are consistently applied and thought to provide effective deterrence.	Sanctions to deal with non-compliance exist, are consistently applied and demonstrably provide effective deterrence.
c. Compliance	Fishers are generally thought to comply with the management system for the fishery under assessment, including, when required, providing information of importance to the effective management of the fishery.	Some evidence exists to demonstrate fishers comply with the management system under assessment, including, when required, providing information of importance to the effective management of the fishery.	There is a high degree of confidence that fishers comply with the management system under assessment, including, providing information of importance to the effective management of the fishery.
d. Systematic non-compliance		There is no evidence of systematic non-compliance.	
Justification/Rationale			
<p>There are no apparent monitoring, control and surveillance (MSC) management measures in place. Local MCS groups appear to be functioning, but are not seemingly widespread. As and when they do, there does appear to be sufficient peer review pressure applied where voluntary measures have been introduced, but without the range of required measures applied, it is difficult to test how effective the system might become with additional harvest control tools in place.</p> <p>There does appear to be widespread non-compliance of the trawl sector, fishing inside the 3 km zone. There do appear to be some levels of engagement between crab fishers and trawlers to mitigate against these incursions.</p> <p>The DoF perception of the effectiveness of the current sanction regime is also weak to moderate. Fines average 5,000-10,000 baht (US\$160-320) with the maximum penalty of one year in prison for repeat offences. There is a general view that historically fines were too low, though this is being addressed in the current review of the Act. The most common breaches are the use of prohibited gear, violations of closed areas and unlicensed fishing activity. A major impediment to effectiveness in the sanction regime has been political lobbying at the local level to avoid prosecution.</p>			
Likely Scoring Level (pass/pass with condition/fail)			NO PASS

Component	Fishery- specific management system		
PI 3.2.4 Research plan	The fishery has a research plan that addresses the information needs of management.		
Scoring issues	SG60	SG80	SG100
a. Research plan	Research is undertaken, as required, to achieve the objectives consistent with MSC's Principles 1 and 2.	A research plan provides the management system with a strategic approach to research and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2.	A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2.
b. Research results	Research results are available to interested parties.	Research results are disseminated to all interested parties in a timely fashion.	Research plan and results are disseminated to all interested parties in a timely fashion and are widely and publicly available .
Justification/Rationale			
Some research reports are available in the DoF and Research Centre libraries. It is not clear from the information provided how comprehensive the research is.			
A Research Plan is in the process of development (Praluai, pers com., May 2010). No details have been made available.			
Likely Scoring Level (pass/pass with condition/fail)			PASS with conditions

Component	Fishery- specific management system		
PI 3.2.5 Monitoring and management performance evaluation	There is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives. There is effective and timely review of the fishery-specific management system.		
Scoring issues	SG60	SG80	SG100
a. Evaluation coverage	The fishery has in place mechanisms to evaluate some parts of the management system.	The fishery has in place mechanisms to evaluate key parts of the management system.	The fishery has in place mechanisms to evaluate all parts of the management system.
b. Internal and/or external review	The fishery-specific management system is subject to occasional internal review.	The fishery-specific management system is subject to regular internal and occasional external review.	The fishery-specific management system is subject to regular internal and external review.
Justification/Rationale			
There is no current mechanism for peer review of the management decision making system within Thailand, however, the Master Plan does contain provision for M&E.			

Component	Fishery- specific management system	
PI 3.2.5 Monitoring and management performance evaluation	<p>There is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives.</p> <p>There is effective and timely review of the fishery-specific management system.</p>	
Likely Scoring Level (pass/pass with condition/fail)		NO PASS