Chapter 9

Exclusive Economic Zones and the Management of Fisheries in the South China Sea

Ma. Carmen A. Ablan and Len R. Garces
WorldFish Center, Jalan Batu Maung Batu Maung Bayan Lepas Penang, Malaysia 11960
(*m.ablan@cgiar.org and l.garces@cgiar.org*)

1. INTRODUCTION

The 1982 United Nations Convention on the Law of the Sea (LOSC), with the provisions for defining an Exclusive Economic Zone (EEZ), is the international agreement that has had the greatest influence on the structure of fisheries policies in national and international arenas. It had the profound effect of increasing the contribution of fisheries to the national gross domestic product or GDP. It brought about a redistribution of benefits from fishing from distant water fishing fleets to the coastal states. Investments flowed in to the fisheries sector. Countries that had fisheries resources but limited capacity to exploit them established joint ventures with states that owned fishing fleets (ADB, 1997). The end result was a substantial increase in the contribution of fisheries to the national GDP especially in developing countries and the overall shift in total capture fisheries production from the developed to the developing world (Delgado et al., 2003).

The LOSC and the EEZ are strongly associated with ownership and the implication that fisheries will be better managed within some property rights regime. These concepts were modified by coastal states to apply to fisheries management policies at the scale of local governments and even communities. Shortly after the Third United Nation's Conference on the Law of the Sea ended in 1982, community-based initiatives to define fishing rights and effectively manage fisheries proliferated. There was a stronger effort to move national policy toward devolution of fisheries management to local government units and encourage co-management and stakeholder participation in the management of coastal resources. There were several efforts to develop Integrated Coastal Zone Management (ICZM) Plans and establish Community Based Coastal Resource Management (CBCRM) strategies in the Philippines first, and later in Indonesia, Thailand, Malaysia and Vietnam.

In this paper, we present case studies where there is a poor institutional fit between the EEZs of coastal states and the natural structure of fisheries resources. This has led to the formulation of inadequate fisheries policies, difficulties in monitoring and controlling the overexploitation of fish stocks, and a massive degradation of fish habi-

S.A. Ebbin et al. (eds.), A Sea Change:
The Exclusive Economic Zone and Governance Institutions for Living Marine Resources, 136–149.

tats vital to the survival and sustainability of stocks. In the first two decades of the LOSC, states have focused on implementing Articles 55-56 and 61-62, which detailed their jurisdiction and right to exploit resources optimally. In this next decade of implementing the LOSC, states will need to consider the provisions for transboundary cooperation detailed in Articles 63 to 67 of Part V of the LOSC. We highlight the importance of knowledge of institutional interplay in fisheries management at the local, sub-national, national and regional scales, and how this relates to the structure of fish stocks and national jurisdiction. We also suggest some research priorities and institutional adjustments required to increase the chances of devising a successful fisheries policy, embody a broader regional perspective of the needs and aspirations of fisheries, as well as national goals. The case studies presented are derived from the experiences of coastal states that border the South China Sea.

2. GEOGRAPHICAL CONTEXT

The South China Sea and its extensions, the Gulf of Thailand and the Gulf of Tonkin, cover an area of 3.8×10^6 km^2. Over 270 million people, or about 5% of the total world population, live in the coastal sub-regions of the South China Sea. The South China Sea extends northwards from the equator to about 22^{o}N and is bounded by the coastline of Taiwan and China to the north, Thailand, Vietnam and Cambodia to the west, Malaysia, Singapore, Indonesia and Brunei Darussalam to the south and the Philippines to the east. These countries are among the most densely populated in the world and, until recently, their economies have been the fastest growing worldwide (Talaue-McManus, 1999). Table 9.1 provides some basic information pertaining to these countries.

The South China Sea embraces a wide variety of habitats such as mangroves, sea grasses, soft bottom shelves and coral reefs. It has the highest species diversity in the world. The natural diversity of flora and fauna probably accounts for the high natural rates of production in the area (Morton and Blackmore, 2001). However, over 120 rivers that carry with them nutrients and pollutants from the land drain into this sea.

In 1995, close to 10% of the world's total landed catch from capture fisheries was estimated to have come from the South China Sea. In 1996, the total fisheries production was 10.4 million metric tons valued at US$6.1 million (SEAFDEC, 1999). Five of the eight top shrimp producers in the world border the South China Sea – Indonesia is first, Vietnam is second, China is fourth, Thailand is sixth, and the Philippines is eighth. The countries of the region produce 23% of the world catch of tuna, including three-quarters of the world's production of canned tuna (Talaue-McManus, 1999).

The oceanic conditions in the South China Sea are dominated by alternating monsoons. The Northwest monsoon from November to March brings with it strong dry winds that create an anti-clockwise circulation pattern in the major basin. In May to September, the Southeast monsoon season is characterised by rain-bearing winds that create clockwise currents, flowing from the south in the Java Sea northward towards Taiwan. During the period of the Southeast monsoon, low-pressure cells frequently build up and eventually manifest as typhoons moving through the Philippines toward Taiwan and Japan to the north or westward towards Vietnam and the southern provinces

of China (Morton and Blackmore, 2001). The changing wind and surface current patterns are one of the dominant factors that influence the distribution and abundance of flora and fauna in the sea and the patterns of exploitation of its fisheries (Talaue-McManus, 1999).

Table 9.1. Selected statistics on countries at the border of the South China Sea

Country	Population	Per Capita GDP	Land Area	Exclusive Economic Zone	Continental Shelf Area (0-200 m depth)	
	(x 10^3)	(US$,2002)	(x $10^3 km^2$)	(x $10^3 km^2$)	(x10^3 km^2)	As % of EEZ
Brunei Darussalam	358	18,600	5.8	38.6	9	22
Cambodia	13,124	1,600	181.0	55.6	15	27
China	1,286,975	4,700	9596.9	n.a.	n.a.	n.a.
Indonesia	234,893	3,100	1919.4	5,408.6	2777	51
Malaysia	23,092	8,800	329.8	475.6	374	79
Philippines	84,620	4,600	300.0	1786	178	10
Taiwan	22,603	18,000	35.9	n.a.	n.a.	n.a
Thailand	64,265	7,000	514.0	257.6	86	33
Vietnam	81,624	2,300	329.5	722.1	328	45

Sources: CIA FactBook (www.cia.gov/cia/publications/factbook/); Nationmaster.com (www.nationmaster.com); Silvestre and Pauly (1997)

This short description of the South China Sea would not be complete without mention of the Spratly and Paracel islands found in the main basin of the sea. These island groups are rich fishing grounds and are also believed to contain oil and gas deposits. The Spratly Islands consist of more than 100 small islands and reefs. They are claimed in their entirety by China, Taiwan and Vietnam, whereas portions are claimed by Malaysia, Brunei and the Philippines (CIA FactBook, 2003). The Paracel Islands to the north of the Spratly Islands are claimed by Taiwan and Vietnam. A suggestion to declare this group of islands as an international marine park was made because of their possible strategic value as a source of fish recruits to coastal states on the boarder of the South China Sea based on ecological considerations such as the duration of pelagic larvae, surface circulation patterns, seasonality in abundance of adults and larvae, and reproductive strategies, among others (McManus, 1994; McManus and Menez, 1998). The proposal was later followed up by a list of ecological considerations on the boundaries that further of the South China Sea (McManus and Menez, 1998). The idea for the international marine park has been on the agenda of international discussions but has not yet elicited any action.

3. SUMMARY OF FISHERIES MANAGEMENT ISSUES AND THE IMPLICATIONS OF THE EEZ

Many problems plague the management of fisheries in the South China Sea – see Silvestre et al., 2003 for an in-depth discussion of the coastal fisheries management

issues most relevant to developing countries within the region. Five of the most pervasive problems that are inadequately addressed or aggravated by the implementation of EEZs in the South China Sea are discussed below.

3.1 Overexploitation and Overcapacity of Coastal Fisheries

The establishment of EEZs since the mid-1970s has contributed to overexploitation of fisheries in developing countries. Fisheries have become part of national development agendas, and a major contributor to national GDP. Governments have encouraged development of national fishing capacity and the use of advanced fishing technology to promote development. Governments have provided subsidies to fisheries for social, economic and cultural reasons. They have also encouraged fishing offshore and fishing agreements with other countries, which in several cases has created excess capacity. All these factors have increased, and continue to increase, fishing effort on fish stocks.

As a result, employment in the fisheries sector increased dramatically. It tripled globally from 1970-1990, a growth rate higher than either the population growth rate or employment in the agriculture sector (Garcia and Willman, 1999). After building overcapacity, the fishing sector has had difficulty restricting access and containing expansion due to social, economic, political and cultural pressures.

Overfishing in coral reefs is widespread among countries in Southeast Asia (McManus, 1997). Maximum sustainable yield (MSY) has already been exceeded for demersal (Silvestre et al., 2003), pelagic (Dalzelle and Ganaden, 1987; Trinidad et al., 1993) and reef fisheries (McManus, 1992) in the Philippines. Similar cases occur elsewhere in the region, such as in Vietnam (Long, 2003) and eastern Malaysia (Abu Talib et al., 2003) where growing populations have turned to fishing for livelihoods. In some areas, the current level of effort is 150-300% greater than the required for MSY (Silvestre et al, 1987) and fish biomass is down to 5-30% of levels prior to the expansion of fishing (Silvestre et al., 2003).

Aside from being unsustainable, overfishing in the region has implications for species diversity and the abundance of both pelagic (Pauly et al., 1998) and reef fisheries (McManus et al., 1997). In heavily exploited areas, the large, high-value predatory species have become uncommon and there is a tendency to fish for lower-valued species (Pauly et al., 1998). By 2000, the abundance of fish from the higher trophic levels in the South China Sea had declined to less than half the levels found in 1960 and high concentrations of fish occurring within protected areas around the South China Sea had disappeared by 2000 with the exception of the waters off Brunei where fisheries are relatively unexploited (Christensen et al., 2003). Losses of biodiversity were also evident in local-scale extinctions of reef-associated species, such as the sea urchin (*Tripneustes gratilla)* (Talaue-McManus and Kesner, 1995) and the giant clams (Menez et al., 1997).

3.2 Fisheries Policy Implemented at Inappropriate Scales

The implementation of the EEZ may result in conflicts and inconsistencies in fisheries policy. This is especially true in the case of overlapping jurisdictions and shared resources. National governments will have different perspectives on the value of fisher-

ies and different approaches to the development of their coastal resources. Inevitably there will be differences in national fisheries policies. There is also a wide variability in the biophysical, social, cultural and economic dimensions of multi-gear and multi-species fisheries within each coastal state further creating inconsistencies in the policies.

Consider as an example the definition of fishing zones for small-scale and commercial fishing vessels. Small-scale fishers in all countries complain that commercial trawlers compete with them for their catch. These larger boats also cause damage to the fishing gear of the small-scale fleet. To avoid confrontations, separate fishing zones for small-scale and commercial fishing have been defined by several central governments to be implemented nationwide. These definitions vary considerably in the region, (Table 9.2) rendering them ineffective if the fisheries resources are shared among two or more coastal states. Difficulty in implementation also arises when fishing grounds are at the boundary of two or more countries.

National policies in large countries such as China, Indonesia and the Philippines can potentially result in inefficiencies because a single policy is implemented nationwide when the biophysical conditions or socio-economic dependence on the fishery may vary greatly among places. Take the same example of defining fishing zones for small-scale and commercial vessels. In the Philippines, the boundary of 15 km from shore used to separate these sectors is based on the general change in the composition of fish communities with distance from the shore. Recent studies, however, indicate that depth rather than distance from the shore has a greater influence on the species composition on the eastern side of the country (Campos, 2003).

China has been implementing no-fishing seasons for two months in summer, starting in 1998, to reduce pressure on the fisheries of Bohai, Huanghai and East China Sea (Morton, 2003). The decision to implement a similar fishing ban for the summer in the South China Sea is a more complicated management strategy. It will require additional social, economic and institutional support because of the larger number and capacity of fishing vessels in this area, the existence of a regulation that already bans year-round trawling on spawning sites within the Chinese territorial waters in the South China Sea and the possibility of competition with fishers from other countries (Morton, 2000).

3.3 Monitoring, Surveillance and Control of Illegal Fishing

The EEZ comprises the area that a state is responsible for monitoring and managing. It was believed that the ability to delineate state jurisdiction would yield better management of fisheries in comparison to the previous open access arrangements. Most countries on the margins of the South China Sea, however, have very limited resources to effectively monitor and control the area bounded by their EEZs, particularly from illegal, unreported and unregulated (IUU) fishing.

Table 9.2. Fisheries management zones in some coastal states of the South China Sea based on existing legislation

Country	Fishing Zone I	Fishing Zone II	Fishing Zone III	Fishing Zone IV
Brunei – Darussalam	Shore to 3 nm.	3 to 20 nm	20 to 45 nm	45 nm to EEZ limit
	Small-scale/ artisanal	Industrial: trawlers <350 HP[1] engine and purse seiners <20 m LOA[2]	Industrial: trawlers with 350-550 HP engine and purse seiners with 20-30 m over-all length	Industrial: purse seiners >30 m LOA
Cambodia	Shore to 20m depth	20 m to EEZ limit		
	Coastal small-scale with/without engine (5 HP to 50 HP engine)	Commercial: >50 HP		
Indonesia	Shore to 3 nm	3 to 7 nm	7 to 12 nm	>12 nm
	Small-scale: vessels <5 GT[3]/10 HP engine	Small-scale: vessels <25 GT/50 HP engine	Industrial: vessels <100 GT/200HP engine	Industrial: vessels >100GT/200HP engine
Malaysia	5 nm	5 nm to 12 nm	12 nm to 30 nm	30 nm to EEZ
	Traditional: artisanal, owner-operated vessels	Commercial: owner-operated trawlers and purse seines of <40 GT	Commercial: trawlers and purse seines of >40 GT, wholly owned and operated by Malaysian fishers	Commercial: deep sea fishing vessels >70 GT
Myanmar	Northern area: shore to 5 nm,	Outer limit of Zone I to EEZ		
	Southern area; shore to 10 nm	Industrial: vessels >30 feet or engine >12 HP		
	Coastal: vessels < 30 feet or engine <12 HP			
Philippines	Shore to 15 km	15km to EEZ limit		
	Municipal: vessels <3 GT or fishing not requiring the use of fishing vessels	Commercial: Small-scale - passive or active gear and vessels 3.1 GT to 20 GT		
		Medium-scale – active gear and vessels 20.1GT to 150 GT		
		Large-scale –active gear and vessels of > 150 GT		
Thailand	Shore to 12 nm	12 nm to EEZ limit		
	Small-scale: vessels <5 GT operating	Large-scale: vessels >5 GT		

[1] HP – horse power
[2] LOA – over-all length
[3] GT – gross tonnage

Country	Fishing Zone I	Fishing Zone II	Fishing Zone III	Fishing Zone IV
Vietnam	Northern and Southern areas: shore line to 30 m depth in, Central area: shore to 50 m depth Small-scale:, vessels with no engine or <40 HP engine	Limit of Zone I to EEZ limit Large-scale: engine >40 HP		

Source: Silvestre et al., 2003

The incidence of IUU fishing is as pervasive, if not more pervasive, in this part of the world than in others (Morton, 2003). It is difficult to estimate the extent of IUU fishing, and only a minority of the IUU fishing activities is checked. The state boundaries are difficult to patrol when they include undeveloped areas or islands of considerable distance from the mainland and city centres. It is not uncommon to have trespassing vessels make a U-turn and continue their illegal fishing activities after being chased off by national coast guards.

Surveillance, monitoring and control of fishing activities become even more complicated for distant and disputed fishing grounds at the centre of the South China Sea basin. Unfortunately, these areas are also reported to have a high biological productivity and diversity. The excess fishing effort and ensuing habitat destruction of the Spratly and Paracel Islands are a function of both the number of fishers that consider these areas part of their national boundaries, and the struggle of the coastal states to implement effective management of fishing activities.

The Dong Sha Atoll in the Paracel Islands provides an example. Morton (2002) reports that 2014 of the 7976 boats fishing around the 600 km^2 Dong Sha Atoll were unidentified. The difficulty to monitor and control fishing effort and destructive fishing practices has severely devastated the coral reef areas.

IUU fishing is no longer exclusive to trawlers and offshore fishing vessels. The more agile small-scale fishing boats have joined the ranks of IUU fishers with the availability of high-powered motorized crafts and active fishing gear. These fishers often employ destructive fishing methods such as the use of dynamite or cyanide to catch fish. Dynamite fishing is non-selective. It wipes out fish, regardless of species or size, and destroys the reef area within a few meters of the blast. Cyanide fishing is associated with the harvest of colourful fish for aquariums or for the live fish trade. Cyanide released from squirt bottles stuns the fish and kills the corals in which they take refuge (Halim, 2002).

Clearly, states by themselves with their limited monitoring, control and surveillance capabilities are unable to control IUU fishing particularly in distant and disputed areas. There is a need for international cooperation and pooling of resources to prevent further destruction, and to ensure sustainable harvesting.

3.4 Competition Over Straddling Stocks, Migratory Species, and Other Species with Complicated Life Cycles

The implementation of the EEZ may have intensified fishing pressure on fisheries, especially for stocks that occur both within the EEZs and on the remaining high seas. Highly migratory species and straddling stocks of tuna are most affected. The new entrants from coastal state fishing fleets do not necessarily displace distant water fishing vessels in the high seas, but actually add to the fishing effort. Aside from these commercial vessels, highly migratory fish stocks are also harvested by small-scale, near-shore, hook and line fishers, further aggravating the pressure on the resource.

Tunas and tuna-like fish are among the most valued and traded species group caught by commercial vessels in the South China Sea. Taiwan, Indonesia, Philippines and Thailand are among the top 20 tuna producing countries globally (Talaue-McManus, 1999). National policies to manage these species tend to encourage rather than control fishing effort, and have resulted in plans to increase the number of fishing vessels that operate in the high seas (Silvestre et al., 2003).

The management of straddling stocks and migratory species is focused on the control of the fishing activities of commercial vessels. Policy makers seem to ignore the fact that some of these straddling stocks and migratory species are actually caught by small-scale hook and line fishers, and that the numbers of these fishers are growing. Small-scale fishers are also now more capable of travelling to distant and disputed fishing grounds with their high-powered motorized boats. Their contribution to fishing effort for straddling stocks and migratory species has not been assessed thoroughly.

Species that have complex lifecycles may also be managed ineffectively because of the poor institutional fit between natural fish boundaries and EEZs. Species such as the groupers, croakers and hinds, as well as the commercial invertebrates are closely associated with benthic habitats and are more sedentary as adults, but at some point during their early lifecycle many of these habitat-associated species are in the water column for substantial periods (Brothers and Thresher, 1985). Also, many of them grow into juveniles after settling in nursery habitats such as mangroves and sea grasses before they migrate into new areas.

For some species, the adults remain sedentary for most of their lifetime. Intermittently, however, they will travel long distances to aggregate and spawn. They release their eggs and sperm into the water column and the larvae may be dispersed passively thousands of kilometres from their origin (Roberts, 2000) or retained (Cowen et al., 2000) through active swimming and local current patterns. This reproductive strategy increases the vulnerability of populations to fishing pressure and increases the possibility of local extinctions when the aggregation is heavily fished. Sustainability of the stocks is dependent on both the survival of a substantial percentage of the adult spawning aggregation and the larvae, as well as the availability of habitats for all stages of their lifecycle.

3.5 Degradation of the Environment, Connectivity and the Spatially Explicit Nature of Fisheries Management

The area and scale at which the biological and ecological processes that maintain fish stocks take place may be transboundary in nature, crossing the lines drawn by a country's EEZ.

An area that is highly dependent on another area for stock recruitment has to be managed differently from one that is primarily self-recruiting (Tuck and Possingham, 2000). When resources are interdependent or common between two states, several different local or national fishing fleets harvest from the same pool. Thus, management regimes in one area may be ineffective because of competing uses of the resource elsewhere. Such connectivity also has implications for the vulnerability of sink areas[4] when these areas that supply recruits experience massive damage either from anthropogenic or natural causes (Ablan et al., 2002). There are very few fisheries (Silvestre et al., 2003), and fisheries habitats (Burke et al., 2000), that are well managed, pristine, or only moderately threatened in the South China Sea. Where they remain, these areas should receive priority consideration, especially if they are important for more than one country.

Within a single large country, national policies based on experiences from one fishing area may be inappropriate for other areas some distance away. Discrepancies between natural resource boundaries and administrative boundaries demand an approach where management interventions and assessment activities are considered at nested scales.

It is of interest to note that the follow-up guidelines such as the UN Fish Stocks Agreement, the FAO Code of Conduct and other international agreements place greater emphasis on managing the harvest of fish and protecting the adult phase, and less on protecting the physical structures that provide essential habitats for other life stages of the fish to ensure long-term sustainability of these stocks.

For some fish species, survival before they finally recruit into a harvestable population, is dependent on the availability of suitable habitats and water quality. With the implementation of the EEZ, the protection of habitats and the rehabilitation of degraded areas has become the responsibility of coastal states.

Coastal development, land conversion, pollution, sedimentation and destructive fishing practices threaten most coastal habitats. The incentives and plans for development are determined at both the local and national scale. Enforcement and monitoring are commonly the responsibility of local governments or communities. It is, however, very difficult to establish the extent of the effects of habitat degradation. There is reason to believe that the consequences are not restricted to national EEZs, as in cases where a specific coral reef is the site for a spawning aggregation of fish, or where nutrients from large-scale aquaculture are transported to the waters of adjacent coastal states.

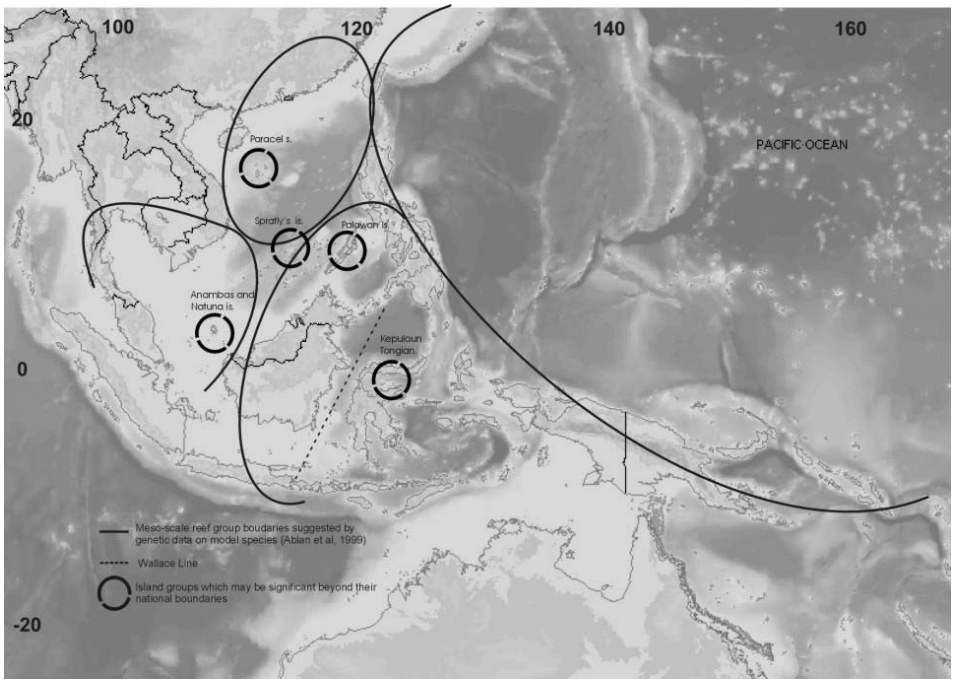
Oil spills are another issue to contend with. Cargo ships and oil tankers regularly ply the route across the South China Sea. Accidents can happen as these ships cross the

[4] Sink areas refer to the environment where juveniles eventually settle and mature and recruit into the fisheries.

shallow reefs and shoals in the centre of the basin[5]. Over 100,000 oil tankers and container and cargo vessels transit the Straits of Malacca and Singapore each year. These tankers carry over three million barrels of crude oil through the straits each day (Tookey, 1997). The South China Sea has also been reported to be an illegal dumping ground for ship sludge[6] (The Straits Times, 1995).

4. MESO-SCALE TRANSBOUNDARY UNITS FOR MANAGING FISHERIES IN THE SOUTH CHINA SEA

An initial effort by the WorldFish Center to define transboundary fisheries management units in the South China Sea identified four major sub-regions. The structure is based on evidence from genetic profiles of habitat-associated fish in five countries: Malaysia, the Philippines, Indonesia, Vietnam, and Taiwan (Map 9.1). Double gyres are formed within the South China Sea basin during the northeast monsoon (Morton and Blackmore, 2001).



Map 9.1. Suggested meso-scale transboundary units for managing habitat associated fisheries in Southeast Asia and reefs which may be significant beyond national boundaries (Source: Ablan et al., 2002)

[5] An example would be the oil-spill that occurred on 21 October 1994 when the tanker Thanassis A ran aground 700 km off the coast of Hong Kong spilling 10.9 million gallons of oil (Source: www.scu.edu.au/schools/edu/student_pages/1999/tryfell/OIL%20WEB/Largest%20Spills/Table%202.htm).
[6] Sludge refers to the waste left over after the holds of ships and oil tankers are cleaned.

This pattern coincides with the structure determined by genetic data suggesting that the pattern is persistent over ecological timeframes. These results are preliminary and work is on-going to further test the temporal and spatial stability of these patterns. Models and methods are being developed at the WorldFish Center in collaboration with fisheries agencies and research partners in the region to estimate the connectivity among fish populations and habitats using numerous data sets ranging from molecular markers and environment-sensitive shape analyses, to local and traditional knowledge of fish migrations.

'Resource Maps', like the one presented in Map 9.1, will become increasingly available and used in developing both regional and sub-national fisheries management strategies, which attempt to meet regional, rather than just national or local, needs and aspirations. Map 9.1 shows that, aside from Thailand, every coastal state in the region is represented in two or three sub-regions, and each sub-region is within the jurisdiction of at least two coastal states. A cluster of distant reef areas, which may be crucial to the maintenance of some fish populations, exists in the centre of the semi-enclosed basin. These reefs may play a valuable role in the lifecycle of fish populations or in providing recruits to more polluted areas closer to the mainland. These reefs are likely to be significant beyond their national boundaries, especially if they remain pristine and healthy. The Spratly Islands are located at the intersection of three sub-regions.

These types of maps allow managers and decision-makers to establish the appropriate scales for the implementation and formulation of policies relevant to fisheries based on biologically and ecologically defined management units. Managers can identify areas of critical ecological importance, including areas that may extend beyond national boundaries, and prioritise them for conservation and protection.

When layers of other spatially explicit information are added to this map, (e.g. information on marine protected areas, surface circulation patterns, incidence of oil spills, locations of spawning aggregations or nursery habitats, pollution plumes, vulnerability to erosion, coastal development, exploitation patterns, etc.), the resulting map can help improve the 'fit' of management institutions and bio-physical systems and facilitate effective regional resource management strategies that integrate fisheries with other activities within the EEZ. These maps can be used to identify enforcement 'hot spots', allowing a network of monitoring, control and surveillance teams from different states to act more effectively under the constraints of limited capabilities to enforce regulations. They may also assist in setting national fisheries research priorities.

Efforts to implement transboundary management institutions for fisheries may prove to be less effective if the issues and sites where cooperation is needed are not specific. Without knowledge of these meso-scale units for management in the South China Sea, it is very difficult to identify which states should cooperate, and the specific sites where cooperation is required.

Incentives for states to cooperate to manage fisheries jointly will also need to ensure that some objectives on their national agendas are achieved. To raise the profile of fisheries concerns in multi-lateral discussions, we must be able to articulate how development and management of fisheries could be rationalised *vis à vis* the requirements and interests of other sectors. This is more practical for bilateral or trilateral discussions on specific geographical areas. Finally, we will also need to find 'champions' who can effectively structure the political and institutional mechanisms to

accomplish what needs to be done, with due consideration of the best available scientific information recommended by Article 61(2) of Part V of the LOSC.

5. CONCLUSION

The current implementation of the LOSC and the EEZ by the coastal states in the South China Sea has focused primarily on fisheries management within national boundaries and less on transboundary cooperation. The efforts to restore and manage fisheries, however, will require strategies at nested scales (i.e. local, sub-national, sub-regional and regional) because (1) fish stocks and the ecological/biological processes that support them are transboundary in nature; (2) habitats that are crucial in the lifecycle of some fish species, or essential to the recovery of decimated fisheries, may exist beyond national boundaries; and (3) no single country has the capacity (human and financial resources) to monitor, control and survey their entire EEZ, particularly if they include distant and disputed islands.

The LOSC acknowledges the occurrence of shared resources and has made provisions for joint cooperation. For example, Article 61 highlights the need to adopt measures for interdependent and associated species, to foster scientific cooperation and data exchange, and the use of the best available scientific evidence to ensure proper conservation and management measures. Articles 63 to 67 emphasise cooperation for the conservation, exploration and exploitation, protection, and preservation of shared stocks. Several sections highlight the role of dialogue through national channels or international (i.e. sub-regional, regional or global) organisations to facilitate cooperation or to settle disputes. The duty to cooperate with respect to straddling and highly migratory fish stocks (Articles 63(2) and 64) has been given further substance by the 1995 UN Fish Stocks Agreement.

Intense and sustained effort and political will is required to address the challenges posed by the poor institutional fit between the boundaries defined by the EEZ and the natural distribution and migratory patterns of the fish. This can be achieved if provisions for joint cooperation in the LOSC are given due consideration, including the identification or establishment of an appropriate regional organisation to oversee the necessary arrangements.

Acknowledgements

This contribution is made possible through the support of national institutions in Thailand, Vietnam, Indonesia, Malaysia, the Phillipines and Taiwan and with funding from the John D Catherine T MacArthur Foundation, the International Coral Reef Action Network (ICRAN), the Asian Development Bank through ADB RETA 5766 and the partner countries of the WorldFish Center.

References

Ablan, M.C.A., J.W. McManus, J. Bell, C.A. Chen, K.T. Shao, A.S. Cabanban, V.S. Tuan, and I.W. Arthana, 2002, Meso-scale trans-boundary units for the management for coral reef areas in the South China Sea and adjacent areas, *NAGA the WorldFish Center Quarterly* **25**: 4-9.

Abu Talib, A., M.I. Mahyam, I. Mohd. Saupi and Y. Sharum, in press, Status of demersal fishing resources of Malaysia, in: Assessment and management of tropical fisheries in Asia, G. Silvestre, L.R. Garces, C. Luna, M. Ahmed, R.A.V. Santos, L. Lachica-Aliño, V. Christensen and D. Pauly, eds., ICLARM Conf. Proc.

ADB, 1997, The Bank's Policy on Fisheries, Asian Development Bank, Manila.

Campos, W.L., 2003, Analysis of demersal fish assemblages in selected Philippine fishing grounds, in: Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries, G. Silvestre, L. Garces, I. Stobutzki, C. Luna, M. Ahmed, R.A.Valmonte-Santos, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly, eds., World Fish Center Conference Proceedings, 67, Penang, pp. 227-248.

Christensen, V., L.R. Garces, G.T. Silvestre and D. Pauly, 2003, Fisheries impact on the South China Sea Large Marine Ecosystem: a preliminary analysis using spatially explicit methodology, in: Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries, G. Silvestre, L. Garces, I. Stobutzki, C. Luna, M. Ahmed, R.A.Valmonte-Santos, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly, eds., World Fish Center Conference Proceedings, 67, Penang, pp. 51-62

CIA FactBook. 2003. See also http://cat.middlebury.edu/southchinasea/

Cowen, R.K., M. Kamazima, M. Lwiza, S. Sponaugle, C. B. Paris, D. B. Olson, 2000, Connectivity of Marine Populations: Open or Closed?, *Science*, **287**: 857-859,

Dalzell, P. and R. Ganaden, 1987, The overfishing of small pelagic fish stocks in the Philippines, *RAPA Rep*., **10**: 249-256.

Delgado, C.L., N. Wada, M.W. Rosegrant, S. Meijer and M. Ahmed, 2003, *Fish to 2020: Supply and Demand in Changing Global Markets*, International Food Policy Research Institute, Washington.

Garcia, S.M. and R. Willman, 1999, Responsible Marine Capture Fisheries: Main Global Issues and Solutions, Mimeo, FAO, Rome.

Halim, A., 2002, Adoption of cyanide fishing practice in Indonesia, *Ocean and Coastal Management*, **45**: 313-323.

Long, N., 2003, A preliminary analysis on the socioeconomic situation of coastal communities in Vietnam, in: Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries, G. Silvestre, L. Garces, I. Stobutzki, C. Luna, M. Ahmed, R.A.Valmonte-Santos, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly, eds., World Fish Center Conference Proceedings 67, Penang, pp. 657-688

Longhurst, A.R. and D. Pauly, 1987, *Ecology of tropical oceans*, Academic Press, San Diego.

McManus, J.W., 1992, How much harvest should there be?, in: Resource ecology of the Bolinao coral reef system, J.W.McManus, C. Nañola and K. Reyes, eds., *ICLARM Stud. Rev*., **22**: 52-56.

McManus, J.W., 1994, The Spratly Islands: a marine park? *Ambio*, **23**(3): 181-186.

McManus, J.W., 1997, Tropical marine fisheries and the future of coral reefs: a brief review with emphasis on Southeast Asia, *Coral Reefs*, **16** Suppl: S121-S127.

McManus,J.W. and L.B. Menez, 1998, The proposed international Spratly Island marine park: ecological considerations, in: Proceedings of the 8th International Coral Reef Symposium 2., H. Lessions, ed., Smithsonian Tropical Research Institute, Panama, pp 1943-1948.

Meñez, L.A.B., M.A.R. Juinio-Meñez and C.L. Villanoy, 1997, Spatial distribution of *Tridacna maxima* in selected Philippine reefs, *Philipp. Sci.* **34**: 47-54.

Morton, B., 2003, Fishing for diplomacy in China's Sea, *Marine Pollution Bulletin*, **46**: 795-796.

Morton, B., 2002, Dong-Sha Atoll, South China Sea: Ground Zero, *Marine Pollution Bulletin*, **44**: 835-837.

Morton, B. and G. Blackmore, 2001, South China Sea, *Marine Ecology Progress Series*, **42**: 1236-1263.

Morton, B., 2000, Fishing in the South China Sea, *Marine Pollution Bulletin* **40**: 287-288.

Nationmaster.com. 2003. (www.nationmaster.com)

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese, F. Torres Jr., 1998, Fishing down marine food webs, *Science*, **279**: 860-863.

Roberts, C.M., 2000, Connectivity and management of Caribbean coral reefs, *Science*, **278**: 1454-1457.

Silvestre, G., F. Federison, J. Muñoz and D. Pauly, 1987, Overexploitation of the demersal resources of Manila Bay and adjacent seas, in: IPFC. Proceedings of the Symposium on the Exploitation and Management of Marine Fishery Resources in Southeast Asia, 16-26 February 1987, Darwin, Indo-Pacific Fisheries Commission, RAPA 1987/10, pp. 269-287.

Silvestre, G.T. L.R. Garces, I. Stobutski, M. Ahmed, R.A. Valmonte-Santos, C.Z. Luna and W. Zhou, 2003, South and Southeast Asia coastal fisheries: their status, directions for improved management. Conference synopsis and recommendations, in: Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries, G. Silvestre, L. Garces, I. Stobutzki, C. Luna, M. Ahmed, R.A.Valmonte-Santos, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly, eds., World Fish Center Conference Proceedings, 67, Penang, pp. 1-40.

Southeast Asian Fisheries Development Center, 1999, Fishery Statistical Bulletin for the South China Sea Area, Bangkok.

Talaue-McManus, L., 1999, Trans-boundary Diagnostic Analysis for the South China Sea (Draft version 4, February 1999), UNEP.

Talaue-McManus, L. and K. Kesner, 1995, Evaluation of Philippine municipal sea urchin and implications of its collapse, in: Philippine coastal resources under stress. Selected papers from the Fourth Annual Common Property Conference, Manila, Philippines, M.A. Juinio-Meñez and G.F. Newkirk, eds., Marine Science Institute University of the Philippines, Quezon City, pp. 229-239

The Straits Times, 1995, Ships now dumping sludge in the South China Sea May 13, 1995.); www.recyclingpoint.com.sg/Articles/1995May13ShipnowDumping.htm

Trinidad, A.C., Pomeroy, R.S., Corpuz, P.V. and M. Aguero, 1993, Bioeconomics of the Philippine small pelagics fishery, *ICLARM Technical Report*, **38**.

Tookey, D.L., 1997, Shipborne pollution and the ASEAN co-operation plan on transboundary pollution, in: *Oil and gas law taxation review*, ESC Publisher, Oxford, pp.18-23

Tuck, G.N. and H.P. Possingham, 2000, Marine protected areas for spatially structured exploited stocks, *Marine Ecology Progress Series*, **192**: 89-101.