BIODIVERSITY

TOWARD AN ACCOUNT OF THE BIODIVERSITY IN CHINESE SHELF WATERS: THE ROLES OF SEALIFEBASE AND FISHBASE[1], [2]

Bonnie Huang,
William Cheung,
Vicky W.Y. Lam,
Maria Lourdes D. Palomares
The Sea Around Us *Project, Fisheries Centre, University of British Columbia,*
2202 Main Mall, Vancouver, British Columbia, Canada, V6T 1Z4; Email: m.palomares@fisheries.ubc.ca

Patricia M.E. Sorongon
SeaLifeBase Project, Aquatic Biodiversity Informatics Office
Khush Hall, IRRI, Los Baños, Laguna, Philippines; Email: p.sorongon@cgiar.org

Daniel Pauly
The Sea Around Us Project, *Fisheries Centre, University of British Columbia,*
2202 Main Mall, Vancouver, British Columbia, Canada, V6T 1Z4; Email: d.pauly@fisheries.ubc.ca

ABSTRACT

Global online databases exist, in the form of FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org) which can be used to make a huge amount of marine biodiversity information available for all maritime countries of the world. This applies also to China. For that country, however, most of data sources used are non-Chinese, which may lead to the impression that these databases were designed with non-Chinese sources in mind. This is not the case, and to correct this impression, this account presents an overview of the marine biodiversity of China based predominantly on Chinese sources.

It is then planned to use the documents cited here as our sources to complement the present coverage of Chinese waters by FishBase and SeaLifeBase, following standardization of the sources' nomenclature. This will not only lead to a nearly complete coverage of the marine biodiversity for China and some neighbouring countries, but also highlight the role of FishBase and SeaLifeBase and of global species databases in general in building bridges between cultures and languages, in particular among marine biologists, and people who love the oceans and the species living therein.

INTRODUCTION

Assembling a comprehensive list of the biodiversity occurring along the coast of a major country such as China requires a huge amount of work, ranging from identifying and locating compilations of species accounts and validating the species names and identifications they contain, to creating databases that organize this information and make it accessible to a wide range of users. Global online databases exist, in the form of FishBase (www.fishbase.org) and SeaLifeBase (www.sealifebase.org), which can be used to

[1] Cite as: Huang, B., Cheung, W., Lam, V.W.Y., Palomares, M.L.D., Sorongon, P.M.E., Pauly, D. 2010. Toward an account of the biodiversity in Chinese shelf waters: the roles of SeaLifeBase and FishBase. *In*: Palomares, M.L.D., Pauly, D. (eds.), *Marine Biodiversity of Southeast Asian and Adjacent Seas*. Fisheries Centre Research Reports 18(3), p. 2-14. Fisheries Centre, University of British Columbia [ISSN 1198-6727].
[2] Presented at the FishBase Mini-Symposium, Innovation Building, YSFRI, Qingdao, China, September 1, 2008.

make marine biodiversity information available for all maritime countries of the world, and which already contain a huge amount of data, including on China. However, most of data sources used for that country are non-Chinese, which may lead to the impression that these databases were designed with non-Chinese sources in mind. This is not the case, and to correct this impression, we have assembled an overview of the marine biodiversity of China based mainly on Chinese sources.

The living marine resources of China and the state of marine biodiversity have been reviewed by Huang (2000) and Zhou *et al.* (2005). In this contribution, we briefly review the status of that biodiversity in terms of functional groups, i.e., groups of species with similar functions within the marine ecosystem.

The ecosystem structure we used follows roughly that of a food web model of the Southern China Sea (Figure 1c), the most biodiverse part of the Chinese coast, constructed and documented by Cheung (2007) and consisting of 31 functional groups, of which 10 are fishes (Figure 2). For each of the non-fish functional groups, we present, so far available the number of species; the habitat requirements and other key biological information; IUCN Status of component species; treaties and/or protection measures relevant to these species; sources of additional information on these species.

Our list is incomplete, and biased towards fishes, bivalves and crustaceans, which are commercially important and thus well studied. However, this list may serve as an example of what we believe is the minimum database each country should create and maintain to document its marine biodiversity (see also Palomares and Pauly, 2004; Pan *et al.*, 2008).

BRIEF REVIEW OF THE CHINESE COASTAL (INCLUDING SHELF) ECOSYSTEMS

The marine ecosystems of China are extensive, with latitudinal range extending from around 4° to 41° N and include the continental shelf, slope and the abyssal plains of the Northwest and West Pacific. These ecosystems consist of three marginal seas: the Yellow Sea (Figure 1a), the East China Sea (Figure 1b) and the South China Sea (Figure 1c), each of which a Large Marine Ecosystem (LME; Sherman *et al.*, 2003) with well-defined physical features, fauna, and patterns of human exploitation (see also www.seaaroundus.org). Major rivers discharging into these systems include the Yalu River in the North, and the Yangtze, Qiantang and Min Rivers to the South, the Yangtze River estuary representing the transition from the Yellow to the East China Sea (Jin *et al.*, 2003).

The Yellow Sea and East China Sea ecosystems are semi-enclosed temperate (32°-42°N) and sub-tropical (23°-33°N) seas, respectively. The relatively small and shallow Yellow Sea has an area of 380,000 km² and average depth at 44 m. Northwest of Yellow Sea is an inner sea, the Bohai Sea, covering an area of 80,000 km² (Tang *et al.*, 2000). The East China Sea has an area of 770,000 km², with average and maximum water depth of 370 m and 2,719 m, respectively. Plankton diversity is high in both the Yellow Sea and the East China Sea, with

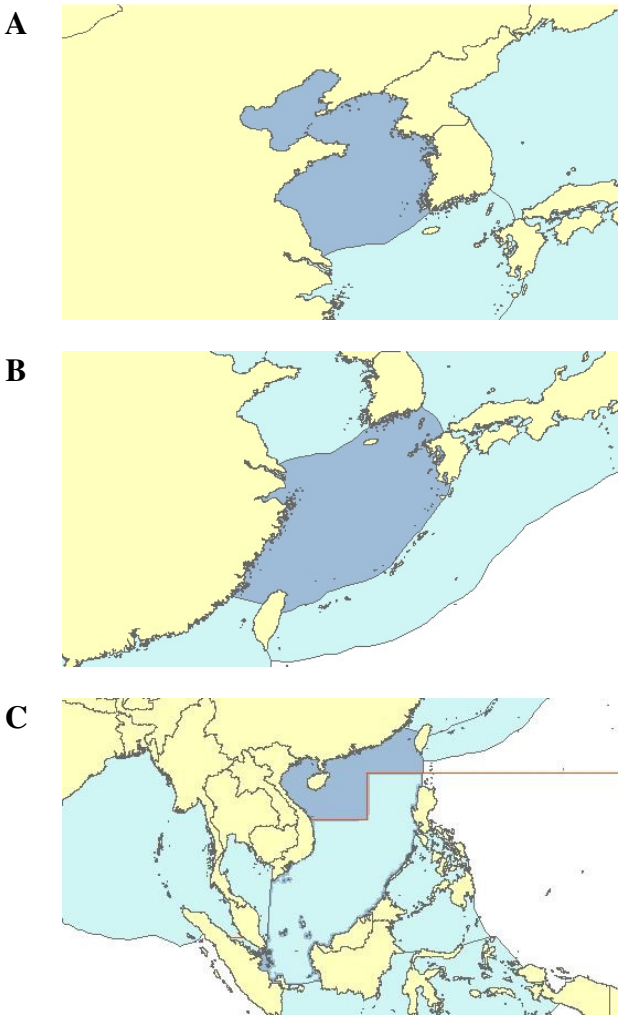

Figure 1. The three Chinese Large Marine Ecosystems in the Northwest Pacific (dark blue): (A) Yellow Sea, with the Bohai Sea in the northeast; (B) East China Sea and (C) South China Sea (in part). This paper focuses on the northern part of the South China Sea, roughly corresponding to the area north of the straight (or red) line in (c), and representing the southern boundary of FAO area 61, i.e., the Northwest Pacific.

over 400 recorded phyto- and zooplankton species. Patterns of fisheries exploitation and the status of fisheries resources parallel those in the South China Sea, i.e., many resource species have strongly declined, and are threatened by overfishing, pollution and coastal development, which we described in detail in the following paragraphs.

The South China Sea is a tropical system that includes diverse habitats ranging from mangrove forests, seagrass beds, estuaries and coastal and offshore coral reefs (Morton and Blackmore, 2001). It lies within the Tropic of Cancer, and has an area of approximately 3.5 x 10^6 km^2 (Caihua *et al.*, 2008), of which 30% of the region is deep sea, with average depth at 1,400 m. It is heavily influenced by monsoonal climate with Southwest Monsoon in summer and Northeast Monsoon in winter. The complexity of the surface current patterns greatly influences the structure and distribution of marine species. For example, the Kuroshio Current brings warm and high salinity water to the northern margin of the South China Sea such as the area around Taiwan and Hong Kong, there allowing for a mixture of tropic and subtropical biological communities (Morton and Blackmore, 2001). Major rivers discharging into the South China Sea includes the Pearl and Mekong Rivers. The South China Sea exhibits a diverse fauna and flora, with over 2,300 species of fishes (Caihua *et al.*, 2008), 58 species of cephalopods and many other invertebrates (Jia *et al.*, 2004). Fishery resources are exploited mainly by trawlers (demersal, pelagic and shrimp), gillnets, hook and line, purse seine and other fishing gears such as traps.

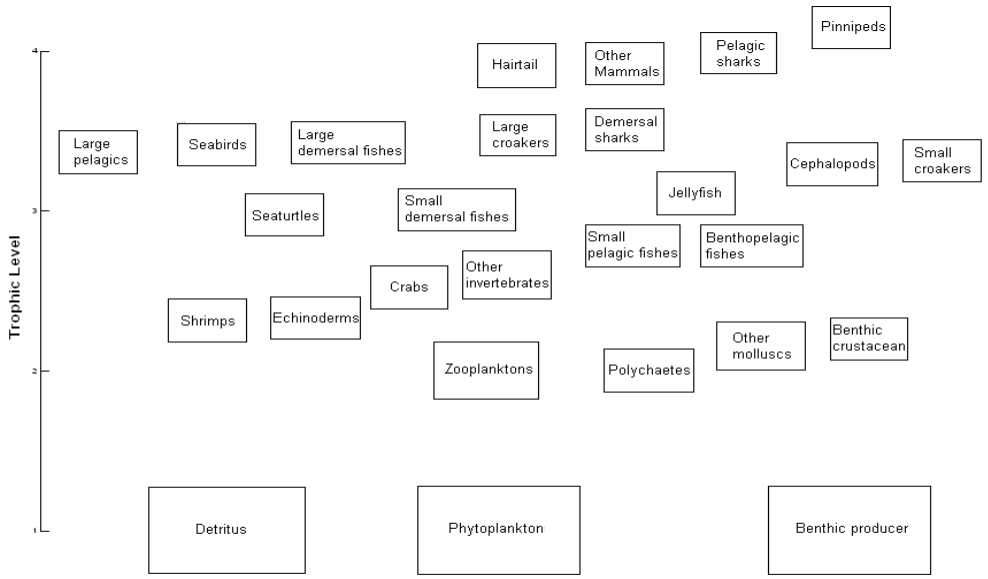

Figure 2. A modified version of the food web model of the South China Sea based on which we summarized marine biodiversity in the 3 Chinese marine ecosystems (Cheung, 2007). The figure shows the trophic level of each functional group only, while the linkages between groups are not displayed. The model consists of 27 functional groups, including 2 mammal groups, 1 reptile group, 1 bird group, 10 fish groups, 10 invertebrates groups, 2 primary producer groups and 1 group representing detritus.

The fisheries of the South China Sea have suffered dramatic depletion over the past five decades (Cheung and Pitcher, 2008). After the founding of the People's Republic of China (PRC) in 1949, there was a rapid growth of the marine capture fisheries. This growth slowed down towards the 1970s, but increased again after the end of 1978, with a large increase in the number of fishing boats and improvement in fishing technology (Pang and Pauly, 2001). The dramatic expansion of fishing fleets resulted in over-exploitation of near-shore, and later, offshore fisheries resources (Shindo, 1973; Cheung and Sadovy, 2004) – a change that is similar to most other fisheries globally (Pauly *et al.*, 2002). A range of species with high

vulnerability to exploitation were extirpated locally or regionally by fishing (Sadovy and Cornish, 2000; Sadovy and Cheung, 2003; Cheung and Sadovy, 2004). For instance, the large yellow croaker (*Larimichthys crocea*), now at an all-time low, was once one of the most important fishery resource species in the East and South China Sea (Liu and Sadovy, 2008).

In addition, critical habitats for marine species such as coral reefs and seagrass beds have been damaged or degraded as a result of the use of destructive fishing methods and coastal development (Hutchings and Wu, 1987; Morton and Blackmore, 2001). Overall, over-exploitation in the South China Sea raises serious fishery management and biodiversity conservation concerns, and this also applies to the Yellow and East China Seas.

PROTECTION OF MARINE BIODIVERSITY IN CHINA

International Legislation

China ratified and joined a number of international treaties and conventions to protect its marine biodiversity and environment. They include (Wang *et al.*, 2000; Chen and Uitto, 2003):

1) Conventions for conserving biodiversity:
   a) Convention on Biological Diversity (1992);
   b) RAMSAR Convention;
   c) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
   d) Migratory Bird Convention; and,
   e) National Biodiversity Action Plan (1994).
2) Conventions for controlling marine pollution from various sources:
   a) International Convention for the Prevention of Pollution from Ships (1973);
   b) Convention on the Prevention of Marine Pollution of Wastes and Other Matter (1985); and,
   c) UN Convention on Law of the Sea (1996).

After participating in successive UN environmental summits since 1972, China created the China Ocean Agenda 21 based on the model of the global Agenda 21 formulated at the 1992 Earth summit in Rio de Janeiro. The China Ocean Agenda 21 proposed a sustainable development strategy for China's marine waters, emphasizing the involvement of all levels of government for coordinating the development and protection of marine resources (Chen and Uitto, 2003).

China also cooperated with many international organizations such as WWF, IUCN and the World Bank, etc., on conserving marine biodiversity. The Biodiversity Working Group (BWG) of the China Council for International Cooperation on Environment and Development (CCICED), a high level non-governmental advisory body established in 1992 for enhancing international cooperation on environment and development, has a particular focus on biodiversity.

Domestic Legislation

The State Council of China started to draft legislation for specific environmental issues since 1973 (Chen and Uitto, 2003), and earlier legislations included the 1994 Provisional Regulations on the Prevention of Pollution of Coastal Waters (Palmer, 1998). Several studies (e.g., Palmer, 1998; Li *et al.*, 1999; Wang *et al.*, 2000; Chen and Uitto, 2003) provide a comprehensive overview of the development and implementation of environmental and biodiversity conservation legislation in China. The major laws, measures and regulations in China for conserving marine biodiversity were extracted from these reviews. The laws and regulations for conserving marine and coastal biodiversity and environment include:

1) Laws
   a) Marine Environmental Protection Law (1982, revised in 1999);
   b) Water Pollution Prevention and Control Law (1984, revised in 1996);
   c) Fishery Law (1986);
   d) Wildlife Protection Law (1988);
   e) Environmental Protection Law (1988);
   f) Water and Soil Conservation Law (1991);
   g) Prevention and Control of Water Pollution Law (1996).

2) Administrative Regulations
   a) Regulations about Aquatic Resources Conservation (1979);
   b) State Council's General Order of Strictly Protecting Rare Wild Animals (1983);
   c) Regulations of the PRC on the Control over Prevention of Pollution by Vessels in Sea Waters (1983);
   d) Administrative Regulations about Prevention of Pollution and Damage of Marine Environment by Seashore Construction Projects (1983);
   e) Regulations on the Control over Dumping Wastes into Sea Waters (1985);
   f) Provisional Regulations on Environment Control for Economic Zones Open to Foreigners (1986);
   g) Regulations for the Implementation of the Fishery Law (1987);
   h) Regulations on Protection and Administration of Wild Medicinal Material Resources (1987);
   i) Regulations on the Implementation of the Law on the Prevention and Control of Water Pollution (1989);
   j) Administrative Regulations on the Prevention and Control of the Pollution and Damage Caused to the Marine Environment by Coastal Construction Projects (1990);
   k) Regulations for the Protection of Aquatic Wild Animals (1993).

Central Government Institutions

There are two main institutions in the central government of China that are in charge of marine environment protection: the State Commission on Environmental and Natural Resources Protection and the State Council Committee for Environmental Protection. These institutions are responsible for general environmental policy maters such as drafting legislation, regulations and guidelines on the environmental welfare issues. They also supervise and coordinate other provincial environmental agencies and activities in protecting the environment (Chen and Uitto, 2003). Five other central institutions are also working complementary to each other for protecting the marine environment under the 1999 Marine Environmental Protection Law. Their responsibilities are listed in Table 1.

Table 1. Responsibilities of some central institutions on protecting marine environment (adapted from Chen and Uitto, 2003; **www.novexcn.com**, 2008).

Institutions	Responsibilities
State Environmental Protection Administration (SEPA)	Coordinating, supervising and providing guidelines for the country's marine environment protection. Conducting scientific research. Prevention of marine pollution caused by land-based sources and coastal construction projects.
State Oceanic Administration (SOA)	Monitoring and managing the marine environment, organizing marine environment surveys, and conducting scientific research. Prevention and control of pollution from offshore construction projects and marine dumping.
State Harbor Superintendence Administration (SHSA)	Managing and monitoring pollution from non-fishing and non-military vessels.
State Fishery Administration (SFA)	Managing and supervising pollution from fishing vessels, and protecting ecosystems in fishing areas.
Environmental Protection Department of the Peoples' Liberation Army	Monitoring pollution by naval vessels

Problems

Although China has participated in international treaties, developed comprehensive environmental policies, laws and regulations for protecting its marine resources, the marine environments and biodiversity in China continue their downward spiral (Palmer, 1998). Liu and Diamond (2005) suggested that these policies, laws and regulations listed above, which seem to be adequate, actually do not do the job, because their enforcement is usually ineffective to non-existent. In fact, at least at the local level, economic development has a far higher priority than biodiversity and environmental conservation.

SOURCES FOR REVIEWING THE MARINE BIODIVERSITY OF CHINA

In the following, we describe the data sources we tapped to assemble the biodiversity lists presented further below.

The list of marine species of China by Huang (2000) was used as starting point, while Zhou *et al.* (2005) supplied a great amount of additional information on marine biodiversity in China. Li (1990) and Wang (1999) contributed to the species diversity of seabirds and marine mammals. Dai and Yang (1991), Zheng *et al.* (1999), Wang *et al.* (2000) and Hong (2002) provided a considerable part of the marine invertebrate list. The list of marine mammals was improved with additional information from Zhu *et al.* (2002). Birdlife International (2008; see www.birdlife.net) supplied information and data on seabirds as well. Information on fish groups was obtained from Jiao and Chen (1997), Li and Luo (2004), Ma *et al.* (2006) and Caihua *et al.* (2008).

The list of threatened species was obtained from the Internet version of IUCN (2007; see www.redlist.org); the list of internationally protected species was obtained from CITES (2007).

Our presentation of Chinese marine biodiversity is organized by ecosystem functional groups. We adopted the functional group structure of an ecosystem model of the South China Sea (Cheung, 2007), slightly modified, based on the ecosystem model of Tang *et al.* (2000), to make it applicable to the three Large Marine Ecosystems in China (Figure 2).

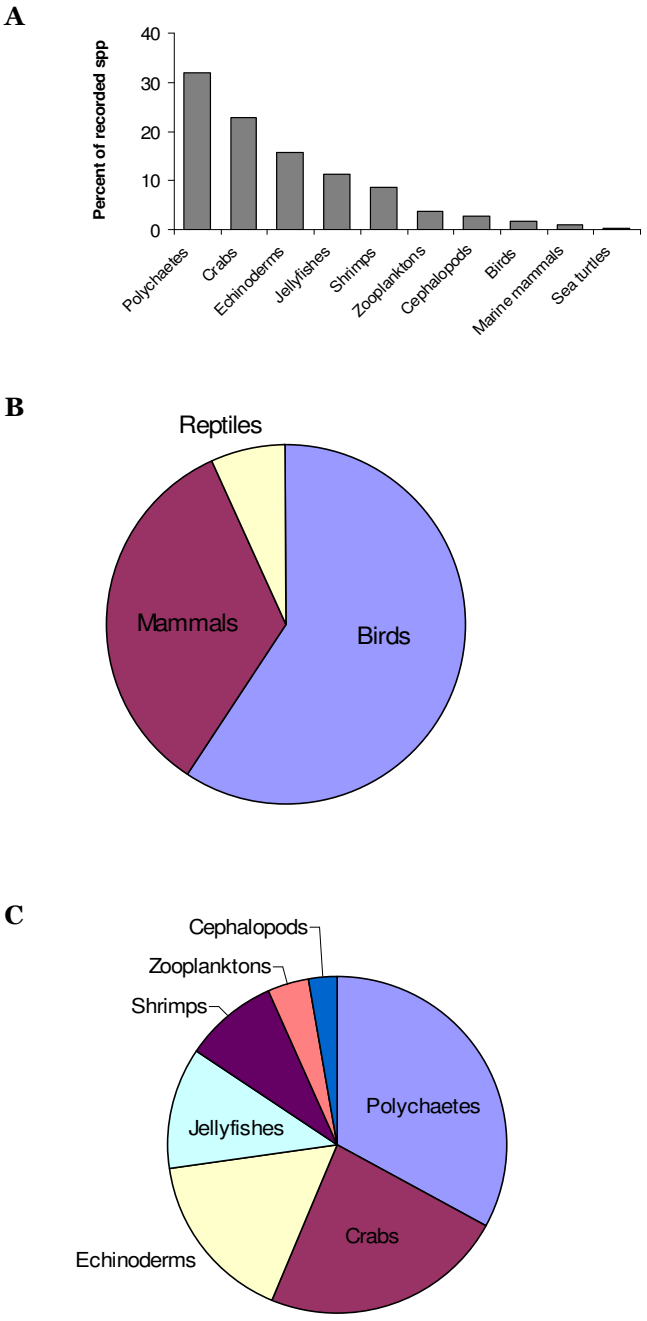

Figure 3. Composition of species richness by major functional groups in Chinese marine ecosystems: (A) percentage of species number of all recorded non-fish species, (B) percentage of species of higher marine vertebrates, and (C) percentage of species of marine invertebrates.

RESULTS

Group-specific results

The following describe in some detail results obtained for each of the groups for which information is available (see Figure 3). Note that viruses, microflagellates, bacteria, macroalgae and phytoplankton species are not discussed.

Birds

A total of 62 species of seabirds, including 13 endangered species, were recorded by Li (1990). He lists 35 coastal birds and also provides detailed morphological, distributional and behavioral information for the following species: Short-tailed albatross (*Phoebastria albatrus*), Streaked shearwater (*Calonectris leucomelas*), Swinhoe's storm-petrel (*Oceanodroma monorhis*), Red-billed tropicbird (*Phaethon aethereus*), Spot-billed pelican (*Pelecanus philippensis*), Red-footed booby (*Sula sula*), Pelagic cormorant

(*Phalacrocorax pelagicus*), Christmas Island frigatebird (*Fregata andrewsi*), Pomarine jaeger (*Stercorarius pomarinus*), Black-tailed gull (*Larus crassirostris*), Indian skimmer (*Rynchops albicollis*) and Ancient murrelet (*Synthliboramphus antiquus*). Fifteen endangered bird species are listed in the Birdlife International species database for the Chinese mainland, including three seabirds: Black-footed albatross (*Phoebastria nigripes*), Chinese crested tern (*Sterna bernsteini*) and Christmas frigatebird (*Fregata andrewsi*).

Li (1990) and Birdlife International also list three commercially important guano producing species: White pelican (*Pelecanus onocrotalus*), Great cormorant (*Phalacrocorax carbo*) and Red-footed booby (*Sula sula*). Christmas frigatebird (*Fregata andrewsi*) is the only species included in the IUCN Red List species of seabirds in China. Only 16 of those listed in the Birdlife database are listed by CITES (2007).

Marine mammals

Wang (1999) reports 36 species of cetaceans (eight baleen whales and 28 toothed whales, dolphins and porpoises) occurring in Chinese waters, with detailed information on morphology, distribution, migration, biology, and ecology. A new species of cetaceans, *Sousa huangi*, found in South China Sea, 21°31'N, 109°10'E, was recorded for the first time by Wang (1999). Zhu *et al.* (2002) reports 35 species of cetaceans (eight baleen whales and 27 toothed whales, dolphins and porpoises) as well as five pinnipeds and one sirenian (*Dugong dugong*). The number of cetaceans in Chinese waters represents a considerable 41% of the total number of species worldwide. Of these, only one is endemic, Baiji (*Lipotes vexillifer*), found in freshwater, particularly in the middle and lower reaches of the Yangtze River (Wang, 1999), but which is now considered functionally extinct (Guo, 2006; Reeves and Gales, 2006). Two otter species, Eurasian river otter (*Lutra lutra*) and Smooth-coated otter (*Lutrogale perspicillata*) also appear to be occurring in China (see www.sealifebase.org).

The use of stranded cetaceans can be traced back to thousands of years ago (Wang, 1999). Zhu *et al.* (2000) concluded that the human-induced threat to the cetaceans and other marine mammals in Chinese waters has been reduced by the late 1970s ban on whaling. However, a number of species are currently threatened by human activities such as fisheries, where marine mammals occur as by-catch, coastal development and aquatic pollution. Moreover, despite of the protection of marine mammals through national and international programmes, many of the once heavily exploited species are still vulnerable and rare. Also, as a result of the development and expansion of commercial fisheries, fish populations also consumed by marine mammals have declined tremendously in terms of their size and quality, while pollution and habitat destruction also contribute to population declines (Zhu *et al.*, 2000).

Sea turtles

Of the seven species of sea turtles known worldwide, five occur in Chinese waters: Green sea turtle (*Chelonia mydas*), Loggerhead turtle (*Caretta caretta*), Olive ridley turtle (*Lepidochelys olivacea*), Hawksbill turtle (*Eretmochelys imbricate*) and Leatherback turtle (*Dermochelys coriacea*) (Cheng, 1998). Of these five species, only Green sea turtles, Loggerhead and Hawksbill turtles nest along the east coast of China, with most individuals found in the South China Sea, especially around the Xisha and Nansha Islands. From 16,800 to 46,300 sea turtles are thought to occur in China, of which Green sea turtle is thought to contribute about 87% (Zhou *et al.*, 2005).

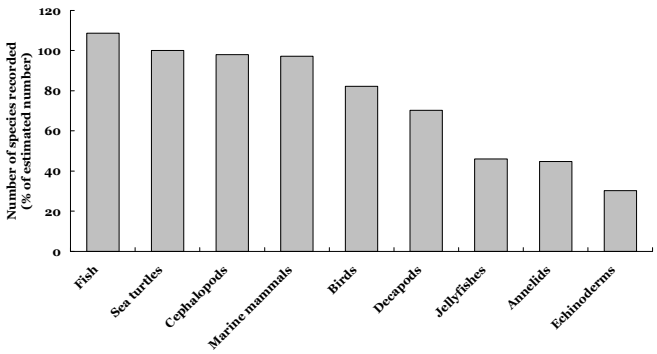

Figure 4. Current coverage of global species databases as %of reported estimates of Chinese marine biodiversity recorded in this study. FishBase accounted for 3,421 fish species, i.e., more than the 3,048 species reported by Jiao and Chen (1977), which explains the above 100% record in this figure. SeaLifeBase accounted for 4,831 species across the non-fish groups and is almost complete for marine mammals, sea turtles and cephalopods (see Discussion).

All five species are listed as endangered species in the 2007 IUCN Red List, with the Hawksbill and the Leatherback turtle being critically endangered. However, none of them are listed in the CITES database. According to

Cheng (1998), at least 30,000 sea turtles were slaughtered between 1959 and 1989 in the South China Sea. Although nominally protected by Chinese regulation and international programmes, sea turtles in China are under critical threat from habitat destruction and illegal hunting.

Fishes

The diversity of fish in Chinese waters is high and shows a clear latitudinal gradient. Overall, 3,048 species of marine fish, belonging to 288 families, have been recorded in China (Jiao and Chen, 1997). This represents over 20% of fish species in the world. Species richness is lowest in the Bohai and Yellow Sea, with 327 species (Jiao and Chen, 1997). The East China Sea has a total of 760 fish species belonging to 173 families (Li and Luo, 2004). Fish diversity is highest in the South China Sea, with 2,321 species belonging to 236 families (Ma *et al.*, 2006; Caihua *et al.*, 2008). However, this figure includes fish that are recorded from areas of the South China Sea far away from Chinese territories, including offshore reefs. Shelf diversity in the northern part of the South China Sea (as defined in Figure 1) is currently 1,066 species. The present coverage of FishBase relative to these numbers is discussed further below (see also Figure 4).

Cephalopods

Zheng *et al.* (1999) reported 95 species of cephalopods occurring in Chinese waters, representing 18% of the total number of cephalopod species worldwide. Of these, 78 species, over 21 families and 6 classes, occur in the South China Sea. The most abundant species are in the Family Sepiidae and Octopodidae, which are all included in SeaLifeBase (see www.sealifebase.org). None of the cephalopod species are listed in the IUCN or in the CITES Appendices I-III.

Cephalopods are abundant in the South China Sea where 89 species have been reported (Guo and Chen, 2000). In the South China Sea, 78 species of cephalopods have been reported (Zheng *et al.*, 1999) with 21 species, including Japanese flying squid (*Todarodes pacificus*), Mitre squid (*Uroteuthis chinensis*), Swordtip squid (*Uroteuthis edulis*), Whiparm octopus (*Octopus variabilis*) and Common octopus *(Octopus vulgaris*), that are commercially important or potentially important species (Cheng and Zhu, 1997; Guo and Chen, 2000; Zheng *et al.*, 2003). From the 1950s to the 1970s, Spineless cuttlefish (*Sepiella inermis*) was one of the four main fisheries in China; the Golden cuttlefish (*Sepia esculenta*) was first exploited in the Yellow Sea prior to the 1970s; later became a primary target of fisheries in the East China Sea in 1990s (Zheng *et al.*, 2003).

Shrimps

There are more than 300 species of shrimps (free swimming and benthic decapods) reported by Wang *et al.* (2000) in Chinese waters, including 135 species in the South China Sea (Zhang, 2002). The common commercially important shrimps include Fleshy prawn (*Fenneropenaeus chinensis*), Southern rough shrimp (*Trachysalambria curvirostris*), Japanese sand shrimp (*Crangon affinis*), Kishi velvet shrimp (*Metapenaeopsis dalei*) and Chinese ditch prawn (*Palaemon gravieri*) (Cheng and Zhu, 1997).

Crabs

Dai and Yang (1991) report over 800 species of marine crabs occurring in Chinese waters, including a list of 604 species with description of morphological characteristics, ecology and geographical distributions.

In the East China Sea, 324 species, over 22 families, have been found. Fifty species belong to the Family Majidae, and 37 species belong to the Leucosiidae (Yu *et al.*, 2003). Despite this diversity, only about 20 species are considered edible. Among these, 8-9 are commercially important species, such as Horse crab (*Portunus trituberculatus*), Three-spot swimming crab (*Portunus sanguinolentus*), Sand crab (*Ovalipes punctatus*), Crucifix crab (*Charybdis feriatus*) and Japanese swimming crab (*Charybdis japonica*) (Yu *et al.*, 2004). Usually found at depths 20-120 m, Horse crabs have been overexploited since 1980s; Sand crabs, meanwhile, have become the most abundant species with the highest exploitation potential (Yu *et al.*, 2004).

Jellyfishes

About 400 species of jellyfishes are know from Chinese waters, about 40% of the total number of species worldwide (Hong, 2002): 250 species of Hydromedusa, 100 species of Siphonophora, 50 species of Scyphomedusae and 10 species of ctenophores. The South China Sea alone has 270 species of jellyfish, of which 160 are Hydromedusa. Five edible jellyfish species have been reported from China, i.e., *Rhopilema esculentum*, *Rhopilema hispidum*, *Stomolophus meleagris* (Cannonball jelly), *Lobonema smithi* and *Lobonemoides gracilis* (Hong, 2002). Some species, such as *Rhopilema esculentum* have been used as traditional Chinese medicine since the Ming dynasty (1368-1644 AD), for the treatment of asthma, the flu and other ailments (Hong, 2002).

Recently, jellyfish blooms in the East China Sea, mainly caused by large jellyfishes such as *Stomolophus meleagris* and *Aequorea* sp., have resulted in negative impacts on populations of fishes and commercial invertebrates. Because these jellyfishes, as part of their zooplankton diet, consume fish eggs and shrimp and fish larvae, the populations of commercial fishes and shrimps exposed to such blooms have declined (Cheng *et al*., 2005).

Echinoderms

According to Zhou *et al.* (2005), 553 species of echinoderms have been reported from Chinese waters. Echinoderms are most diverse in the South China, which harbors 76% of the species reported from Chinese waters. Over 100 species of sea urchins are reported in China, of which only 10 are deemed edible. Catches of sea urchins are composed mainly of *Anthocidaris crassispina*, *Hemicentrotus pulcherrimus* and *Strongylocentrotus nudus*. In 1989, *Strongylocentrotus intermedius* was introduced to China from Japan, and has since become a major commercial species. *Glyptocidaris crenularis* has recently become an important farmed species (Liu, 2000). More than 100 species of sea cucumbers are reported from China, of which 20 are edible, and 10 commercially important, such as *Apostichopus japonicus* (Liao, 2001). Sea stars, or starfishes, widely distributed worldwide, especially in the Northern Pacific Ocean, and are found at depths ranging from 0 to 6,000 m (Wang *et al*., 1999). More than 1,000 species of sea stars are known worldwide, of which over 100 occur in Chinese waters. The most common sea stars in the Bohai and Yellow Seas are *Luidia quinaria*, *Asterias rolleston* and *Solaster dawsoni* (Zhou *et al*., 2005). Other common echinoderms include *Amphioplus japonicus* and *Amphioplus lucidus* (Sun and Liu, 1991).

Polychaetes

Zhou *et al.* (2005) report 1,123 species of marine annelids in China, including more than 900 species of polychaetes (see also Figure 3); of these 404 were reported from the western Taiwan Strait, 213 from the Bohai and the Yellow Seas region (Wu, 1993; Bi and Sun 1998). Common species include *Sthenolepis japonica*, *Ophiodromus angustifrons*, *Nephtys oligobranchia*, *Lumbrineris latreilli* and *Sternaspis scutata* (Sun and Liu, 1991). Xu (2008) also lists 20 species of pelagic polychaetes from the East China Sea, the most abundant being *Pelagobia longicirrata*, *Tomopteris elegans* and *Sagitella kowalevskii*.

Benthic invertebrates

Sun and Liu (1991) and Hu *et al.* (2000) reported 338 benthic species, including 71 species of crustaceans, 75 species of mollusks, 115 species of polychaetes, 23 species of echinoderms, 9 species of coelenterates and 7 species of others benthic organisms from the Bohai and Yellow Seas The dominant species include *Scapharca suberenata*, *Bullacta exarata*, Horse crab (*Portunus trituberculatus*), *Palaemon gravieri, Ophiopholis mirabilis* and *Acila mirabilis*.

Zheng *et al.* (2003) reported 855 of benthic species occurring in the East China Sea, i.e., 268 species of polychaetes, 283 of mollusks, 171 of crustaceans, 68 of echinoderms and 65 of other groups. Jia *et al.* (2004) reported on 851 benthic species from the South China Sea, mostly benthic fish, but also including 154 species of crustaceans and 42 species of cephalopods. More than 230 species of crustaceans are known from the South China Sea, about half of them benthic (Zhang, 2002).

About 150 species of benthic crustaceans appear in commercial fisheries catches in the East China Sea, but they do not contribute more than about 3% of the catch in weight. Shrimps, especially *Parapenaeus fissuroides*, are dominant (Jia *et al*., 2004). Other commercially important crustaceans include *Tellina*

emarginata, *Atrina pectinata*, *Cultellus scalprum*, *Macoma candida*, *Solenocera koelbeli* and *Metapenaeopsis lata* (Zheng *et al*., 2003).

Zooplankton

Meng *et al*. (1993) listed 133 species of zooplankton in the Bohai and Yellow Seas, including 36 species of hydromedusae and 69 species of copepods. *Aidanosagitta crasssa* and *Labidocera euchaeta* are the two species that tend to dominate the zooplankton for the whole year. Other dominant species include *Acartia pacifica*, *Calanus sinicus* and *Euphausia pacifica*. Xu (2004) reported 316 species of zooplankton from the East China Sea, belonging to more than seven phyla. The dominant group was the crustaceans, consisting of 208 species; among these, the copepods were dominant (36.7%) with regard to the total number of species, followed by the Hyperiidea (11.1%).

In the Taiwan Strait, 1,329 species of zooplankton were reported by Li *et al*. (2001), with two dominant groups, copepods and jellyfishes, consisting of 298 and 232 species, respectively. The dominant species included *Temora turbinata*, *Canthocalanus pauper*, *Pseudophausia sinica*, Akiami paste shrimp (*Acetes japonicus*), *Euphausia diomedeae*, *Flaccisagitta enflata* and *Calanoides carinatus*, which occurred below 200 m. Li *et al*. (2004) reported 709 zooplankton species from the South China Sea, in over eight phyla. The crustaceans, the dominant group, consisted of 470 species. The dominant species included *Temora discaudata*, *Undinula vulgaris*, *Canthocalanus pauper*, *Centropages furcatus*, *Eucalanus subcrassus*, *Euchaeta concinna*, *Flaccisagitta enflata* and *Lucifer intermedius*.

DISCUSSION

China is one of the mega-centers of biodiversity (Hicks, 2008) with probably over 20,000 marine species. We, however, located sources for only about 15,000 of them. It is clear, however, that Chinese marine biodiversity increases from North to South, with species being reported in the hundreds from the Yellow Sea and Bohai Seas, while over 4,000 metazoans species are reported from the East China Sea and nearly 6,000 from the South China Sea (Huang 2000; Zhou *et al*. 2005).

Another clear result is that unwary Internet users would be misled by many of the biodiversity databases available online. To illustrate this, we performed a search for 'China' through the IUCN (www.iucn.org) species search. This resulted in a list of 218 marine species, 32 of which were marine mammals, 56 fish (sharks) and 5 marine turtles. A similar search for species listed in the UNEP-WCMC database for 'China' yielded 364 amphibians, 1,232 birds, 515 fishes, 659 invertebrates, 650 mammals, 431 reptiles and 131 other species. Also, since habitats were not provided, we examined the list for distinctions by habitat. This yielded 22 species (17 reptiles, four corals and one bird species) listed in CITES Appendices I-III, ratified July 1st 2008, and which are protected by the Chinese government.

It is thus obvious that FishBase and SeaLifeBase, which, jointly, are meant to cover all marine metazoans of the world, including those of China, have a big task ahead. The most difficult, but necessary, task is the identification of valid (*versus* synonymous) scientific names, which will help establish the actual number of valid species per functional group.

Preliminary comparisons of the results of this study with what is currently available in FishBase (Figure 4) resulted to a total count of 3,421 fish species, which is more than the number of species reported by Jiao and Chen (1997). FishBase accounts 50.1% of this total to the South China Sea, 25.1% to the East China Sea, 34.2% to the Yellow Sea and 8.0% to the Sea of Japan. Ray-finned fishes are dominant in all of these large marine ecosystems followed by sharks and rays. This shows that FishBase already has a very good coverage of the marine fishes of China and can be used as a reliable online biodiversity resource for China. SeaLifeBase, has almost 50% coverage of the marine non-fish metazoans occurring in China (including Taiwan; see Figure 4), with data for 4,831 species. Of these, 62% are assigned to the South China Sea, 26% to the East China Sea and 5.5% in the Yellow Sea. This is heavily biased towards i) mollusks, which makes up 40.2% of the species distribution; ii) crustaceans, 29.2%; and iii) annelids, 10.4%. If we accept the estimate of 20,000 species for Chinese marine areas, these two global databases together already account for more than 41% of China's marine biodiversity.

We intend to use the documents cited here to complement the present coverage of Chinese waters by FishBase and SeaLifeBase, following standardization of their nomenclature. This will not only lead to a

nearly complete coverage of biodiversity for China and some neighboring countries, but also highlight the role of FishBase and SeaLifeBase in building bridges between cultures and languages, in particular among marine biologists, and people who love the oceans and the species living therein.

ACKNOWLEDGEMENTS

This is a contribution of the *Sea Around Us* project, a joint scientific activity of the University of British Columbia and the Pew Environment Group. We also acknowledge the generous support of the Oak Foundation, Geneva, for SeaLifeBase.

REFERENCES

Bi, H., Sun, D., 1998. The ecological characteristics of polychaetes in Jiaozhou Bay. *Acta Ecologica Sinica* 18(1), 63-70. [In Chinese with English abstract].

Birdlife International, 2008. Birdlife's online world bird database: the site for bird conservation. Version 1.0 Cambridge, UK: Birdlife International. Available: http://www.birdlife.net (accessed on August 18, 2008).

Caihua, M.A., Kui, Y., Meizhao, Z., Fengqi, L., Dagang, C., 2008. A preliminary study on the diversity of fish species and marine fish faunas of the South China Sea. *Oceanic and Coastal Sea Research* 7(2), 210-214.

Chen, Q., 1997. Current status and prospects of marine biodiversity in China. *Chinese Biodiversity* 5(2), 142-146. [In Chinese with English abstract].

Chen, S., Uitto, J.I., 2003. Governing marine and coastal environment in China: building local government capacity through international cooperation. *China Environment Series* 6, 67-80.

Chen, S., Zhu, M., Ma, Y., 1999. The research and international plans on global large marine ecosystems. *Journal of Oceanography of Huanghai and Bohai Seas* 17(4), 103-109. [In Chinese with English abstract].

Cheng, J., Zhu, J., 1997. A study on the diet characteristics and the trophic levels of primary commercial invertebrates in the Yellow Sea. *Acta Oceanologica* 19(6), 102-108. [In Chinese with English abstract].

Cheng, J., Ding, F., Li, S., Yan, L., Lin, J., Li, J., Liu, Y., 2005. A study on the quantity and distribution of macro-jellyfish and its relationship to seawater temperature and salinity in the East China Sea Region. *Acta Ecologica Sinica* 25(3), 440-445. [In Chinese with English abstract].

Cheng, Y., 1998. The problems of sea turtle conservation in China. *Sichuan Journal of Zoology* 17(2), 74-75. [In Chinese with English abstract].

Cheung, W.W.L., 2007. Vulnerability of Marine Fishes to Fishing: from Global Overview to the Northern South China Sea. The University of British Columbia, Vancouver, Canada. 354 p.

Cheung, W.W.L., Pitcher, T., 2008. Evaluating the status of exploited taxa in the northern South China Sea using intrinsic vulnerability and spatially explicit catch-per-unit-effort data. *Fisheries Research* 92, 28-40.

Cheung, W.W.L., Sadovy, Y., 2004 Retrospective evaluation of data-limited fisheries: a case from Hong Kong. *Reviews in Fish Biology and Fisheries* 14, 181-206.

CITES, 2007. www.unep-wcmc.org/index.html?http://www.unep-wcmc.org/CITES/redirect.htm~main.

Dai, A., Yang, S., 1991. Crabs of the China Seas. China Ocean Press, Beijing; Springer Verlag, Berlin. 682 p.

Guo, J., 2006. River dolphins down for the count, and perhaps out. *Science* 314: 1860.

Guo, J., Chen, P., 2000. A study on exploitation of Cephalopoda stock in the South China Sea. *Tropic Oceanology* 19(4), 51-58 [In Chinese with English abstract].

Hicks, C., 2008. Countdown 2010 in China: communicating the importance of biodiversity. *Living Forests* (14), 29-36.

Hong, H., 2002. [Medusa and jellyfishes]. *Bulletin of Biology* 37(2), 13-16. [In Chinese]

Hu, H., Huang, B., Tang, J., Ren, S., Shao, X., 2000. Studies on benthic ecology in coastal waters of Bohai and Yellow Seas. *Donghai Marine Science* 18(4), 39-46. [In Chinese with English abstract]

Huang, Z., 2000. The biodiversity and sustainable utilization of Chinese marine biological resources. In: *Proceedings of the Symposium on Biodiversity*. Museum of Natural Science, Taipei, Taiwan p. 179-189.

Hutchings, P.A., Wu, B.L., 1987 Coral reefs of Hainan Island, South China Sea. *Marine Pollution Bulletin* 18(1), 25-26.

Jia, X., Li, Z., Li, C., Qiu, Y., Gan, J., 2004. [*The Ecosystem and Fisheries Resources in the Commercial Zone and the Continental Shelf of the South China Sea*]. Science Press, Beijing. 647 p. [In Chinese].

Jiao, Y., Chen, D., 1997. [Study of the marine fish diversity in China]. *Shan-tong Fisheries* 14(2), 18-20.

Jin, X., Xu, B., Tang, Q., 2003. Fish assemblage structure in the East China Sea and southern Yellow Sea during autumn and spring. *Journal of Fish Biology* 62(5), 1194-1205.

Li, C., Jia, X., Cai, W., 2004. Diversity of marine zooplankton in the north of South China Sea. *Journal of Fishery Sciences of China* 11(2), 139-146. [In Chinese with English abstract].

Li, G., Lu, J., 2004. [Status and analysis of fish diversity in the continental shelf of East China Sea] In: *Proceedings of the Fifth National Symposium on the Conservation and Sustainable Use of Biodiversity in China* [Climate Press], Beijing, p. 56-57 [In Chinese].

Li, W., Tang, Y., Huang, L., 1999. Comparison and research on the fishery laws and regulations of China and Japan. *Transactions of Oceanology and Limnology* 4, 69-76. [In Chinese with English abstract]

Li, X., 1990. [Seabirds in China]. *Bulletin of Biology* 4, 8-11. [In Chinese].

Liao, Y., 2001. [Sea cucumbers in China]. *Bulletin of Biology* 35(9), 1-5. [In Chinese].

Liu, H., 2001. Review on the world sea urchin fishery. *Marine Sciences* 25(3), 38-41. [In Chinese with English abstract].

Liu, J., Diamond, J., 2005. China's environment in a globalizing world. *Nature* 435, 1179-1186.

Liu, M., Sadovy, Y., 2008. Profile of a fishery collapse: why mariculture failed to save the large yellow croaker. *Fish and Fisheries* 9(3), 219-242.

Luo, H., 2003. [How many marine species are there in China's waters?]. Available at http://www.bjkp.gov.cn/bjkpzc/kjqy/hykx/7183.shtml. (accessed on August 18, 2008). [in Chinese].

Ma, C., You, K., Li, F., Zhang, M., 2006. A study on the relationship of the fish biodiversity and the faunal distribution in the South China Sea. *Periodical of Ocean University of China* 36(4), 665-670.

Meng, F., Qiu, J., Wu, B., 1993. Zooplankton of the Yellow Sea large marine ecosystem. *Journal of Oceanography of Huanghai and Bohai Seas* 11(3), 30-37. [In Chinese with English abstract].

Morton, B., Blackmore, G., 2001 South China Sea. *Marine Pollution Bulletin* 42(12), 1236-1263.

Nie, Z., Li, X., 2006. Study on the regeneration of sea cucumber. *Marine Sciences* 30(5), 78-82. [In Chinese with English abstract].

Novexcn, 2008. The marine environmental protection law of the People's Republic of China. Available at http://www.novexcn.com/marine_environemental_prot.html (accessed on August 13, 2008).

Palmer, M., 1998. Environmental regulation in the People's Republic of China: the face of domestic law. *China Quarterly* 156, 788-808.

Palomares, M.L.D., Pauly, D., 2004. Biodiversity of the Namibian Exclusive Economic Zone: a brief review with emphasis on online databases. *In:* Sumaila, U.R., Boyer, D., Skogen, M.D., Steinshamm, S.I. (eds.) *Namibia's fisheries: ecological, economic and social aspects*. Eburon Academic Publishers, Amsterdam, p. 53-74.

Pan, M., Bailly, N., Conejar, J., Coronado, C., Dar, C., Froese, R., Garilao, C.V., Guerzon, L.I., Laxamana, E., Paglinawan, L., Pauly, D., Sorongon, P.M., Tabaranza, G.K., Palomares, M.L.D. 2008. Philippine marine biodiversity thru SeaLifeBase: current progress and gaps. UPV Journal of Natural Sciences 13 Supplement, 123-192.

Pang, L., Pauly, D., 2001. Chinese marine capture fisheries from 1950 to the late 1990s: the hopes, the plans and the data. *In:* Watson, R., Pang, L., Pauly, D. (eds.), *The Marine Fisheries of China: Development and Reported Catches*. Fisheries Centre Research Report 9(2), p. 1-27.

Pauly, D. Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R., Zeller, D., 2002. Towards sustainability in world fisheries. *Nature* 418, 689-695.

Reeves, R.R., Gales, N.J., 2006. Realities of baiji conservation. Conservation Biology 20(3): 626-628.

Sadovy, Y., Cheung, W.L., 2003 Near extinction of a highly fecund fish: the one that nearly got away. *Fish and Fisheries* 4, 86-99.

Sadovy, Y.J., Cornish, A.S., 2000 Reef Fishes of Hong Kong. Hong Kong University Press, Hong Kong.

Sherman, K., Ajayi, T., Anang, E., Cury, P., Diaz-de-Leon, A.J., Fréon, P., Hardman-Mountford, N.J., Ibe, C.A., Koranteng, K.A., McGlade, J., Nauen, C.E.C., Pauly, D., Scheren, P.A.G.M., Skjodal, H.R., Tang, Q., Zabi, S.G., 2003. Suitability of the Large Marine Ecosystem concept. *Fisheries Research* 64, 197-204.

Shindo, S., 1973 General review of the trawl fishery and the demersal fish stocks of the South China Sea. FAO Fish. Tech. Pap. 120. Rome, 49 p.

Sun, D., Liu, Y.. 1991. Species composition and quantitative distributions of biomass and density of the macrobenthic infauna in the Bohai Sea. *Journal of Oceanography of Huanghai and Bohai Seas* 9(1), 42-50. [In Chinese with English abstract].

Tang, Tong Ling, Tang Qisheng, Pauly, D., 2000. A preliminary approach on mass-balance Ecopath model of the Bohai Sea. *Chinese Journal of Applied Ecology* 11(3), 435-440.

Wang, A., Wang, W., Hu, J., Liu, B., Sun, R., 2000. Study on marine organism diversity in China. *Journal of Hebei University* 20(2), 204-208. [In Chinese with English abstract]

Wang, C., Gu, Q., Zhou, P., 1999. Starfish *Asterias amurensis* - a potential seafood resource. *Journal of Fishery Science of China* 6(4), 67-71. [In Chinese with English abstract].

Wang, D., Wang, Z., Tian, H., Shao, X., Wei, L., 2006. Study on sea urchin and its utilization. *Chinese Journal of Marine Drugs* 25(4), 52-54. [In Chinese with English abstract].

Wang, P., 1999. Chinese Cetaceans. Ocean Enterprises Ltd, Hong Kong. 325 p.

Wang, S., Wang, X., Xie, Y.at2000. Developing and implementing national biodiversity strategy and action plan: lesson from China. Available: http://bpsp-neca.brim.ac.cn/calendars/workshop-1/9.html (accessed on August 13, 2008).

Wu, Q., 1993. Polychaete ecology in soft-bottom in western Taiwan Strait. *Journal of Oceanography in Taiwan Strait* 12(4), 324-334. [In Chinese with English abstract].

Xu, Z., 2004. Relationship between red tide occurrence and zooplankton communities structure in the coastal sea of East China. *China Environmental Science* 24(3), 257-260. [In Chinese with English abstract].

Xu, Z., 2008. Environmental adaptation of pelagic Polychaeta in the East China Sea. *Chinese Journal of Applicable Environmental Biology* 14(1), 53-58. [In Chinese with English abstract].

Yu, C., Song, H., Yao, G., 2003. Geographical distribution and faunal analysis of crab resources in the East China Sea. *Journal of Zhejiang Ocean University (Natural Science)* 22(2), 108-113. [In Chinese with English abstract].

Yu, C., Song, H., Yao, G., 2004. Assessment of the crab stock biomass in the continental shelf Waters of the East China Sea. *Journal of Fisheries of China* 28(1), 41-46. [In Chinese with English abstract].

Zhang, L., 2002. Study on the characteristics and its exploitation strategy of South China Sea resources. *Journal of Zhanjiang Ocean University* 22(2), 13-17. [In Chinese with English abstract].

Zheng, Y., Chen, X., Cheng, J., Wang, Y., Shen, X., Chen, W., Li, C., 2003. [Resources and the environment in the continental shelf of the East China Sea]. Scientific and Technical Publishers, Shanghai. 835 p. [In Chinese].

Zheng, Y., Lin, J., Yan, L., Zhou, J., Shen, J., 1999. Cephalopod resources and rational utilization in East China Sea. *Journal of Fishery Sciences of China* 6(2), 52-56. [In Chinese with English abstract].

Zhou, J., Zou, X., Ji, Y., 2005. Review on the study of marine medicinal starfish. *Chinese Journal of Current Practical Medicine* 4(2), 34-38. [In Chinese with English abstract].

Zhou, L., Yang, S., Chen, B., 2005. Studies on marine biodiversity in China. *Science and Technology Review* 23(2), 12-16. [In Chinese with English abstract].

Zhu, Q., Jiang, B., Tang, T., 2000. Species, distribution and protection of marine mammals in the Chinese coastal Waters. *Marine Sciences* 24(9), 35-39. [In Chinese with English abstract].