

An overview of cetacean strandings, bycatches and rescues along the western coast of the Taiwan Strait, China: 2010–2015

ZHAO Liyuan^{1†}, ZHU Qian^{2†}, MIAO Xing¹, XU Min², WU Fuxing¹, DAI Yufei¹, TAO Cuihua¹, MOU Jianfeng¹, WANG Xianyan^{1*}

¹Laboratory of Marine Biology and Ecology, Third Institute of Oceanography, State Oceanic Administration, Xiamen 361005, China

²Ocean College, Shandong University (Weihai), Weihai 264209, China

Received 20 January 2017; accepted 2 May 2017

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Abstract

The analysis of cetacean strandings can provide fundamental information about species diversity and composition in a particular region. The present study collected and analyzed cetacean strandings, bycatches and rescues along the western coast of the Taiwan Strait, China, from 2010 to 2015. In total, 48 records, including 37 strandings, 8 bycatches and 3 rescues, involving 13 known species were collected. Among them, Indo-Pacific humpback dolphins (*Sousa chinensis*) and finless porpoises (*Neophocaena phocaenoides*) were the most common species, consisting of 31.3% and 25%, respectively. Notably, 10 out of the 48 (20.8%) records were collected from the Pingtan Island and included 3 species of Mysticeti and 4 species of Odontoceti. Finally, we compared the cetacean species composition between the western and eastern coasts of the Taiwan Strait; 31 cetacean species occurred in the Taiwan Strait, indicating a relatively high cetacean diversity in this region. Systematic field surveys are urgently needed to explore the cetacean species composition, population stock and the related habitat status in the Taiwan Strait, which may improve conservation management in the future.

Key words: cetacean, stranding, bycatch, rescue, species diversity, Taiwan Strait

Citation: Zhao Liyuan, Zhu Qian, Miao Xing, Xu Min, Wu Fuxing, Dai Yufei, Tao Cuihua, Mou Jianfeng, Wang Xianyan. 2017. An overview of cetacean strandings, bycatches and rescues along the western coast of the Taiwan Strait, China: 2010–2015. Acta Oceanologica Sinica, 36(12): 31–36, doi: 10.1007/s13131-017-1100-5

1 Introduction

Preservation of top predators is important for the conservation of biodiversity within an ecosystem, and monitoring strategies are increasingly needed in the context of biological conservation (Mace and Baillie, 2007; Sergio et al., 2006, 2008). However, as the top predators of the ocean, cetaceans are difficult to monitor. They are distributed over large areas and spend the majority of their lives underwater; some pelagic species live far from shores, and usually migrate long distances between feeding and breeding grounds, which increases the difficulties of monitoring programs (Drouot et al., 2004; Huang, 1989). These difficulties also make the collection of at-sea data expensive. Therefore, the collection of cetacean stranding data across wide spatial and temporal ranges is valuable, and it can provide fundamental information on species composition and populations of cetaceans without requiring any expensive field work at sea (Borsa, 2006; MacLeod et al., 2004; Peltier et al., 2012; Pyenson, 2010). Stranded cetacean data also provide an invaluable source of information on the morphology, diet, and life history of some special species, such as beaked whales (Dalebout et al., 2002).

Long-term systematically recorded information on the time

and location of stranding events can give clues to cetacean spatial distribution and seasonal movements (Peltier et al., 2012), and provides similar rank-order relative abundances as live surveys (Pyenson, 2010), albeit caution is still needed in the interpretation of such information. Many countries have established cetacean stranding collection networks or national databases. The United Kingdom established the first cetacean stranding network, with published reports annually since 1913 (Sheldrick, 1976). The French stranding network provides one of the largest dataset on cetaceans in Europe since 1970 (Peltier et al., 2012). In addition, in the United States, a stranding network emerged in 1972 and has become more uniform and consistent since 1991 (Pyenson, 2010). Stranding networks are becoming common in other coastal countries, such as New Zealand (Brabyn and Frew, 1994). They usually make the information available through annual publications or in other reports. However, the recording effort in China has lagged. Thus far, there is no standard reporting scheme or network, which reduces potential knowledge and information of many cetacean species and prohibits a better understanding of cetacean threats and efficient conservation management.

Foundation item: The National Natural Science Foundation for Young Scholars of China under contract No. 41506164; the foundation of the State Oceanic Administration of China under contract No. 201105011; the Natural Science Foundation for Young Scholars of Fujian Province under contract No. 2017J05062; China-ASEAN maritime cooperation fund under contract No. HX150702; the foundation of the Ministry of Agriculture of the People's Republic of China under contract No.1070413701307; the Ocean Park Conservation Foundation, Hong Kong (OPCFHK) under contract No. MM03_1617.

*Corresponding author, E-mail: wangxianyan@tio.org.cn

†These authors contributed equally to this work.

Special habitat features such as hydrographic fronts and abrupt topographies, which are characterized by strong sea surface temperature gradients, enhance local productivity and aggregate high species richness and abundance of cetaceans (Whitehead et al., 2010; Worm et al., 2005). Oceanographic processes such as upwellings are key factors that determine patterns of cetacean distribution (Baumgartner et al., 2001; Di Tullio et al., 2016; Gill et al., 2015). The Taiwan Strait (22°00′–27°10′N, 117°10′–125°00′E) is the largest channel in China and is located in the northwest of the Pacific Ocean between the East China Sea and the South China Sea. It is characterized by different dominant hydrographic dynamics, such as the Kuroshio branch, and the Min-Zhe coastal current (Wu, 1982, 1991). There are many upwelling regions in the Taiwan Strait, which brings water with high nutrient concentrations to the surface and creates five major fishing grounds of a total area covering 213 237 km² (Dai, 2005; Fu, 1984). Therefore, the diversity of the cetaceans as the top predators may also be high in this area. However, very limited information is available regarding cetacean distribution in the Taiwan Strait, except for some sporadic reports (Li, 1997; Wang, 2012; Wang et al., 2006a, 2007), which prevents a better understanding of the status of cetaceans and the related threats and conservation.

In the present study, cetacean strandings, bycatches and rescues along the western coast of the Taiwan Strait were collected from 2010 to 2015. The objectives of the present paper are (1) to provide an initial analysis of the cetacean species composition along the western coast of the Taiwan Strait, and compare with the eastern coast of the Taiwan Strait to find out the species composition in the Taiwan Strait; (2) to promote the establishment of a standard reporting network for cetacean strandings, bycatches and injuries in this region and even in the whole country.

2 Methods

Strandings in the present study refer to the beaching or washing ashore alive or dead aquatic mammals, as well as dead animals found floating in the water. Rescues refer to injured but live animals that were found floating in the water that we helped return to the ocean. Bycatches are dead animals killed by fishing activities that were reported directly by fishermen. From January 2010 to December 2015, cetacean stranding, bycatch and rescue records were collected from six cities (Ningde, Fuzhou, Putian, Quanzhou, Xiamen, and Zhangzhou) along the western coast of the Taiwan Strait, China. Most of the records were from local fishery administrations, natural reserves, or local fishermen and

we directly participated in most of these cases. We have made detailed descriptions and measurements for every sample if we were present at the scene. We recorded the number, species, sighting date, location, body condition (alive, dead, state of injury or decay) and the sex of carcasses. If the sample was kept fresh, we made a detailed measurement of the length, weight and flipper length, etc. Some records from internet news that were supported by detailed descriptions, photos and voucher specimens, or confirmed by a marine mammal identification expert were considered reliable and also included in the subsequent data analysis. Sighting location of each event was plotted on a digitized chart to determine the distribution pattern. To explore the cetacean species composition in the entire Taiwan Strait, we also compared our collected records to previous cetacean reports, as well as records along the eastern coast of the Taiwan Strait from an available stranding website of Taiwan: http://taibif.tw/whale/whale_browser.php, which recorded systematical information on the time and location of stranding events (from 1994 to 2005).

3 Results

3.1 Species composition

From January 2010 to December 2015, a total of 48 records, including 37 strandings, 8 bycatches and 3 rescues were collected (Table 1), with an average of 8 cases each year. All the events involved a single animal. Those 48 records were classified to 13 species in 6 families of cetaceans covering both Mysticeti and Odontoceti. Three species of Mysticeti were gray whale (*Eschrichtius robustus*) (Fig. 1a), Omura's whale (*Balaenoptera omurai*) (Fig. 1b), and common minke whale (*Balaenoptera acutorostrata*) (Fig. 1c); 10 species of Odontoceti were pygmy sperm whale (*Kogia breviceps*), Blainville's beaked whale (*Mesoplodon densirostris*) (Fig. 1d), short-finned pilot whale (*Globicephala macrorhynchus*) (Fig. 1e), false killer whale (*Pseudorca crassidens*), Indo-Pacific humpback dolphin (*Sousa chinensis*) (Fig. 1f), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Risso's dolphin (*Grampus griseus*), pantropical spotted dolphin (*Stenella attenuata*), short-beaked common dolphin (*Delphinus delphis*) and finless porpoise (*Neophocaena phocaenoides*) (Figs 1g and h) (Table 1). The species of Indo-Pacific humpback dolphin ($n=15$, 31.3%) and the finless porpoise ($n=12$, 25%) each made up a large proportion, followed by the Indo-Pacific bottlenose dolphin ($n=5$, 10.4%). Other stranding species each had no more than 5 records.

Table 1. Stranding, bycatch and rescue records of cetaceans along the western coast of the Taiwan Strait (2010–2015)

Cetacea	Family	Species	Total	Stranding	Bycatch	Rescue	
Mysticeti	Balaenopteridae	Omura's whale	1	1			
		common minke whale	2	1	1		
	Eschrichtiidae	gray whale	1		1		
Odontoceti	Kogiidae	pygmy sperm whale	2	2			
	Ziphiidae	Blainville's beaked whale	4	4			
		short-finned Pilot whale	2	2			
	Delphinidae	false killer whale	1				1
		Indo-Pacific humpback dolphin	15	14	1		
		Indo-Pacific bottlenose dolphin	5	1	3	1	
		Risso's dolphin	1	1			
		pantropical spotted dolphin	1		1		
		short-beaked common dolphin	1	1			
		finless porpoise	12	10	1	1	
total		48	37	8	3		



Fig. 1. Photos of some stranded species. a. Gray whale stranded in the Pingtan Island in 2011, b. Omura's whale stranded in the Pingtan Island in 2011, c. common minke whale stranded in the Pingtan Island in 2015, d. Blainville's beaked whale stranded in the Pingtan Island in 2015, e. short-finned pilot whale stranded in Putian in 2014, f. Indo-Pacific humpback dolphin stranded in Xiamen in 2015, g. finless porpoise (*N. p. phocaenoides*) stranded in Quanzhou in 2015, and h. finless porpoise (*N. p. sunameri*) stranded in the Pingtan Island in 2015.

3.2 Spatial distribution

The highest number of records occurred in Xiamen City ($n=17$), followed by Fuzhou ($n=12$), Quanzhou ($n=10$), Zhangzhou ($n=5$), Putian ($n=3$) and Ningde ($n=1$) (Fig. 2). Though Xia-

men had the highest number, but species were limited to the Indo-Pacific humpback dolphin ($n=12$), finless porpoise ($n=3$), Indo-Pacific bottlenose dolphin ($n=1$), and false killer whale ($n=1$). The diversity of species composition was the highest in

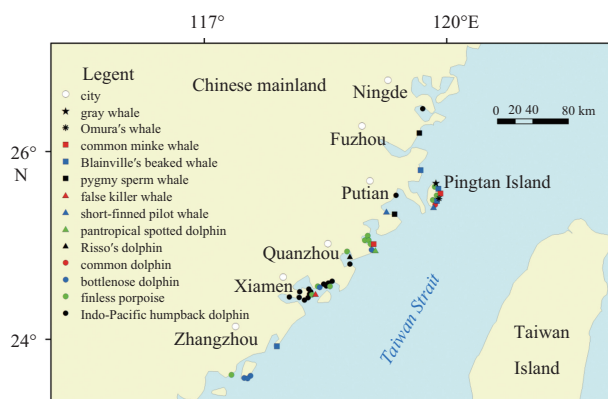


Fig. 2. Distribution patterns of cetacean strandings, bycatches, rescues along the western coast of the Taiwan Strait, China during 2010–2015.

Fuzhou City, with 8 confirmed species involved. It was also the only city with records of many large baleen whales, such as Omura's whale, gray whale and common minke whale; furthermore, we still found unknown craniums of baleen whale species. In Fuzhou, there were also records of 5 Odontoceti species, i.e., pygmy sperm whale, Blainville's beaked whale, short-finned pi-

lot whale, finless porpoise and short-beaked common dolphin. Quanzhou City had records of 6 confirmed species, 50% of which were finless porpoises, while the others were the common minke whale, Indo-Pacific humpback dolphin, Indo-Pacific bottlenose dolphin, Risso's dolphin and pantropical spotted dolphin. Indo-Pacific humpback dolphins, finless porpoises and Indo-Pacific bottlenose dolphins are common species usually found in Xiamen, Quanzhou and Zhangzhou (Fig. 2).

3.3 Species composition between the western and eastern coasts of the Taiwan Strait

In the present study, 13 cetacean species in 6 families covering both Mysticeti and Odontoceti were collected in the western waters of the Taiwan Strait. When compiled with the previous records by Li (1997) and Wang (2012), there are 23 total known species, including 7 Mysticeti species and 16 Odontoceti species, along the western coast of the Taiwan Strait. According to the Taiwan stranding network and Wang (2012), 29 species have been collected along the eastern coast of the Taiwan Strait. Altogether, there are 31 cetacean species that occur in the Taiwan Strait, with 7 Mysticeti species and 24 Odontoceti species (Table 2).

4 Discussion

The occurrence of beached or stranded specimens can offer fundamental information of the species diversity in a particular

Table 2. Cetacean species composition occurred along the western and eastern coasts of the Taiwan Strait

Cetacea	No.	Species	Western coast	Reference	Eastern coast	Reference
Mysticeti	1	sei whale	+	Ref22, Ref25	+	Ref22
	2	Omura's whale	+	this study, Ref22	+	Internet
	3	common minke whale	+	this study, Ref22, Ref25	+	Ref22
	4	Bryde's Whale	+	Ref22	+	Internet
	5	pygmy bryde's whale	+	Ref22, Ref25	+	Internet, Ref22
	6	gray whale	+	this study, Ref25	-	
	7	humpback whale	+	Ref25	+	Ref22
Odontoceti	8	sperm whale	+	Ref22, Ref25	+	Ref22
	9	pygmy sperm whale	+	this study, Ref22	+	Internet, Ref22
	10	dwarf sperm whale	+	Ref22	+	Internet, Ref22
	11	Blainville's beaked whale	+	this study, Ref22	+	Internet, Ref22
	12	ginkgo-toothed beaked whale	-		+	Internet, Ref22
	13	Cuvier's beaked whale	-		+	Internet, Ref22
	14	killer whale	-		+	Ref22
	15	false killer whale	+	this study, Ref22, Ref25	+	Internet, Ref22
	16	pygmy killer whale	+	Ref22	+	Internet, Ref22
	17	short-finned pilot whale	+	this study	+	Internet, Ref22
	18	melon-headed whale	-		+	Internet, Ref22
	19	Risso's Dolphin	+	this study, Ref22, Ref25	+	Internet, Ref22
	20	long-beaked common dolphin	+	Ref25	+	Internet, Ref22
	21	short-beaked common dolphin	+	this study, Ref22	+	Internet, Ref22
	22	Fraser's dolphin	-		+	Internet, Ref22
	23	rough-toothed dolphin	-		+	Internet, Ref22
	24	Spinner dolphin	-		+	Internet, Ref22
	25	pantropical spotted dolphin	+	this study, Ref22	+	Internet, Ref22
	26	striped dolphin	-		+	Internet, Ref22
	27	Pacific white-sided dolphin	+	Ref25	-	
	28	Indo-Pacific humpback dolphin	+	this study, Ref22, Ref25	+	Internet, Ref22
	29	Indo-Pacific bottlenose dolphin	+	this study, Ref22, Ref25	+	Internet, Ref22
	30	South bottlenose dolphin	+	this study, Ref22, Ref25	+	Internet, Ref22
	31	finless porpoise	+	this study, Ref22, Ref25	+	Internet, Ref22

Note: + means indeed collected and confirmed and - no record of sample collected. Some data is from internet: http://taibif.tw/whale/whale_browser.php.

region. Thus far, 37 cetacean species have been reported along Chinese coastlines (Wang, 2012). Li (1997) recorded 16 cetacean species along the western coast of the Taiwan Strait, 3 new records were recently added: Blainville's beaked whale in 2006 (Wang et al., 2006b), pygmy sperm whale in 2007 (Wang et al., 2007), and Omura's whale in 2008 and 2009 (Wang, 2012). In the present study, the short-finned pilot whale is the first reported in this region. This species is widespread and abundant throughout the world's warm-temperate and tropical waters. There are many detailed reports about this species in Japanese waters. However, the Chinese mainland has few reports. The first exact report in 1990 (Xisha Islands) revealed the short-finned pilot whale also lived in Chinese waters (Wang, 2012). Recently, it has been found several times in eastern waters of the Taiwan Strait (Wang, 2012). The two short-finned pilot whales in the present study are the first report in Fujian Province. Thus stranding data is valuable to supplement existing knowledge on distribution of marine mammals, especially for uncommon species.

In the present study, Indo-Pacific humpback dolphins and finless porpoises occupied a large proportion of observations, and the number of records of the two species added together is more than half of the total records. As estuarine and coastal cetacean species, they usually show geographic proximity to areas with intensive human activities, thus, they are more likely to be exposed to severe anthropogenic threats, such as coastal fishing activities, shipping traffic, and marine construction. A small population of Indo-Pacific humpback dolphins (60–79 individuals) are known to occur in the Xiamen Bay (Wang et al., 2015a), and there were some sporadic sightings in Quanzhou and Ningde waters (Wu et al., 2014). The stranding data of Indo-Pacific humpback dolphins in the present paper, including most humpback dolphin records from the Xiamen Bay and very few records from Quanzhou, Ningde and Putian, is in accordance with the distribution pattern from the previous field survey. There are three sub-species of finless porpoises in Chinese waters: *Neophocaena phocaenoides phocaenoides*, *N. p. asiaeorientalis*, and *N. p. sunameri*. *N. p. asiaeorientalis* are found only in the Changjiang River (Yangtze River), *N. p. phocaenoides* are mainly distributed in the South China Sea, and *N. p. sunameri* usually occur in the Bohai Sea and the Yellow Sea (Wang, 2012). It is interesting that both subspecies *N. p. sunameri* and *N. p. phocaenoides* have been found in the Taiwan Strait (Figs 1g and h), indicating that the Taiwan Strait may be the transition area of the two subspecies.

It is interesting that the water around the Pingtan Island of Fuzhou City has the highest cetacean biodiversity. Ten (20.8%) of the 48 records occurred around the Pingtan Island, including 3

species of Mysticeti, i.e., gray whale, Omura's whale and common minke whale, and 4 species of Odontoceti, i.e., Blainville's beaked whale, short-finned Pilot whale, finless porpoise and short-beaked common dolphin. Gray whales are exceptionally rare off China in recent years (Weller et al., 2013). This specimen was the first gray whale record from Chinese waters in the 21st century. Wang et al. (2015b) suggested the possibility of a past (and perhaps current) gray whale wintering area was in or near the Taiwan Strait for the western North Pacific population. Omura's whale was recently recognized as a new baleen whale species and was considered as one of the most mysterious species among them (Wada et al., 2003). Wang et al. (2006b) described the first Omura's whale record from Chinese coastal waters. In the following decade, rare specimens of this species were reported. For Omura's whale in China, all carcasses were mainly distributed along the southeast coast of China, including Zhejiang, Fujian, Guangdong Provinces and Taiwan Island. Except for two records in the South China Sea, all others appeared in the East China Sea, particularly concentrated in the Taiwan Strait (Xu et al., 2017). Common minke whales are widespread and distribute nearshore in Chinese waters. Though the north of the Yellow Sea is thought to be the main feeding area, the southeast record of common minke whale in China is in the Guangxi Province (Wang, 2012). In China, most Blainville's beaked whales were recorded in the Taiwan Province; and there have been more and more findings in Fujian Province in recent years (Wang, 2012). The short-finned pilot whale was found in the western waters of Taiwan Strait for the first time. Finless porpoises, both subspecies *N. p. sunameri* and *N. p. phocaenoides*, are common species in the Taiwan Strait. Because the short-beaked common dolphin is a pelagic species, there were few records of this species.

Due to the high diversity and quantity of stranding and bycatch cetaceans around the Pingtan Island of Fuzhou City, we tried to analyze the causes based on their damages (Table 3). The Pingtan Island is located in the northwest of the Taiwan Strait. The Minjiang River has a great impact on this region. The fresh water brings considerable amounts of organic matter and inorganic salts, which delivers high concentrations of nutrients to this region. Otherwise, there are thousands of reefs here, which are very suitable for different marine species to inhabit (Dai et al., 2002). Therefore, there is much fishing activity here. However, fishery bycatch is a common threat to cetaceans, and fishing gear entanglement is the greatest direct source of human-caused mortality, such as in No. 2 common minke whale, No. 3 gray whale and No. 8 finless porpoise (Table 3). Furthermore, there are other potential threats, such as underwater explosions, re-

Table 3. Basic information of stranding or bycatch records of cetaceans around the Pingtan Island (2010–2015)

No.	Species	Date	Sex	Body length/cm	Damages	Stranding or bycatch
1	Omura's whale	2011-11-27	male	715	smelly, without obvious scars	stranding
2	common minke whale	2015-01-13	female	470	fresh	bycatch
3	gray whale	2011-11-07	female	1310	fresh	bycatch
4	Blainville's beaked whale	2014-08-22	NA	NA	skin peeling off, without obvious scars	stranding
5	Blainville's beaked whale	2015-09-07	male	406	fresh, without obvious scars	stranding
6	short-finned pilot whale	2014-08-12	female	305	many scars, suspecting bitten by other animals	stranding
7	finless porpoise (<i>N. p. sunameri</i>)	2015-02-12	NA	NA	relatively fresh, only photos from fisherman	stranding
8	finless porpoise (<i>N. p. sunameri</i>)	2015-03-03	male	104	with scars by fishing net	bycatch
9	finless porpoise (<i>N. p. phocaenoides</i>)	2015-10-19	female	136	fresh, without obvious scars	stranding
10	short-beaked common dolphin	2015-08-24	NA	NA	without tail, only photos from fisherman	stranding

Note: NA means we do not obtain the information.

clamation projects and busy shipping traffic (which also intensified during the construction of the Pingtan Free Trade Zone), which might contribute to some extent to so many stranding events.

To date, there are 37 marine cetacean species reported in Chinese waters (Wang, 2012), and 31 species have been recorded in the Taiwan Strait. Though the real provenience of some pelagic species is unknown, all the species have been recorded many times in this area. It covers 83.8% of the total cetacean species in Chinese waters, indicating really high cetacean species diversity in this region. However, the cetacean field survey in this region is very limited, except for some research on Indo-Pacific humpback dolphins in the Xiamen Bay and the western coastal waters of Taiwan. There is almost a research gap for cetacean species in offshore waters. We suggest research institutions across the Taiwan Strait cooperate to start the field surveys of cetacean species composition and habitat status, which will help develop proper conservation and management.

Acknowledgements

The authors are grateful to Tong Shenhan from the Xiamen Institute of Aquatic and Terrestrial Product for their generous help and collection of samples.

References

- Baumgartner M F, Mullin K D, May L N, et al. 2001. Cetacean habitats in the northern Gulf of Mexico. *Fishery Bulletin*, 99(2): 219–239
- Borsa P. 2006. Marine mammal strandings in the New Caledonia region, Southwest Pacific. *Comptes Rendus Biologies*, 329(4): 277–288
- Brabyn M, Frew R V C. 1994. New Zealand herd stranding sites do not relate to geomagnetic topography. *Marine Mammal Science*, 10(2): 195–207
- Dai Tianyuan. 2005. Sustainable yield of fishery resources in the Taiwan Straits and its adjacent waters. *Marine Fisheries Research* (in Chinese), 26(3): 1–8
- Dai Quanshui, Ye Quantu, Lu Zhenbin. 2002. The resources protection and ecology of neoton in the waters of Pingtan Island, Fujian Province. *Journal of Fujian Fisheries* (in Chinese), (2): 52–60
- Dalebout M L, Mead J G, Baker C S, et al. 2002. A new species of beaked whale *Mesoplodon perrini* sp. n. (Cetacea: Ziphiidae) discovered through phylogenetic analyses of mitochondrial DNA sequences. *Marine Mammal Science*, 18(3): 577–608
- Di Tullio J C, Gandra T B R, Zerbini A N, et al. 2016. Diversity and distribution patterns of cetaceans in the subtropical southwestern Atlantic outer continental shelf and slope. *PLoS One*, 11(5): e0155841
- Drouot V, Gannier A, Goold J C. 2004. Diving and feeding behaviour of sperm whales (*Physeter macrocephalus*) in the northwestern Mediterranean Sea. *Aquatic Mammals*, 30(3): 419–426
- Fu Zilang. 1984. Upwellings in Taiwan Strait. *Marine Sciences* (in Chinese), 8(2): 52–54
- Gill P C, Pirzl R, Morrice M G, et al. 2015. Cetacean diversity of the continental shelf and slope off southern Australia. *The Journal of Wildlife Management*, 79(4): 672–681
- Huang Rongxiang. 1989. Upwelling in middle and north Taiwan Strait. *Transactions of Oceanology and Limnology* (in Chinese), (4): 8–12
- Li Shuqing. 1997. Studies on sea mammals and its distribution from Fujian coastal waters. *Journal of Oceanography in Taiwan Strait* (in Chinese), 16(4): 479–485
- Mace G, Baillie J E M. 2007. The 2010 biodiversity indicators: challenges for science and policy. *Conservation Biology*, 21(6): 1406–1413
- MacLeod C D, Pierce G J, Santos M B. 2004. Geographic and temporal variations in strandings of beaked whales (Ziphiidae) on the coasts of the UK and the Republic of Ireland 1800–2002. *Journal of Cetacean Research and Management*, 6(1): 79–86
- Peltier H, Dabin W, Daniel P, et al. 2012. The significance of stranding data as indicators of cetacean populations at sea: modelling the drift of cetacean carcasses. *Ecological Indicators*, 18: 278–290
- Pyenson N D. 2010. Carcasses on the coastline: measuring the ecological fidelity of the cetacean stranding record in the eastern North Pacific Ocean. *Paleobiology*, 36(3): 453–480
- Sergio F, Caro T, Brown D, et al. 2008. Top predators as conservation tools: ecological rationale, assumptions, and efficacy. *Annual Review of Ecology, Evolution, and Systematics*, 39(1): 1–19
- Sergio F, Newton I, Marchesi L, et al. 2006. Ecologically justified charisma: preservation of top predators delivers biodiversity conservation. *Journal of Applied Ecology*, 43(6): 1049–1055
- Sheldrick M C. 1976. Trends in the strandings of Cetacea on the British coasts 1913–72. *Mammal Review*, 6(1): 15–23
- Wada S, Oishi M, Yamada T K. 2003. A newly discovered species of living baleen whale. *Nature*, 426(6964): 278–281
- Wang Peilie. 2012. Chinese Cetaceans (in Chinese). Beijing: Chemical Industry Press, 1–382
- Wang Peilie, Tong Shenhan, Yuan Hongmei. 2006a. Stranding of Blainville's beaked whale (*Mesoplodon densirostris*) along the coast of Hui'an, Fujian Province, China. *Fisheries Science* (in Chinese), 25(10): 524–527
- Wang Huogen, Fan Zhongyong, Shen Hong, et al. 2006b. Description of a new record species of whales from Chinese coastal waters. *Fisheries Science* (in Chinese), 25(2): 85–87
- Wang Peilie, Tong Shenhan, Yuan Hongmei. 2007. Stranding of pygmy sperm whale in Zhangpu, Fujian Province. *Fisheries Science* (in Chinese), 26(12): 671–674
- Wang Xianyan, Wu Fuxing, Turvey S T, et al. 2015a. Social organization and distribution patterns inform conservation management of a threatened Indo-Pacific humpback dolphin population. *Journal of Mammalogy*, 96(5): 964–971
- Wang Xianyan, Xu Min, Wu Fuxing, et al. 2015b. Insights from a gray whale (*Eschrichtius robustus*) bycaught in the Taiwan Strait off China in 2011. *Aquatic Mammals*, 41(3): 327–332
- Weller D W, Burdin A M, Brownell Jr R L. 2013. A gray area: on the matter of gray whales in the western North Pacific. *Journal of the American Cetacean Society*, 42: 29–33
- Whitehead H, O'Brien K, Worm B. 2010. Diversity of deep-water cetaceans and primary productivity. *Marine Ecology Progress Series*, 408: 1–5
- Worm B, Sandow M, Oschlies A, et al. 2005. Global patterns of predator diversity in the open oceans. *Science*, 309(5739): 1365–1369
- Wu Boyu. 1982. Some problems on circulation study in Taiwan Strait. *Taiwan Strait* (in Chinese), 1(1): 1–7
- Wu Boyu. 1991. Kuroshio and circulations in China seas. *Journal of Oceanography in Taiwan Strait* (in Chinese), 10(1): 25–32
- Wu Fuxing, Wang Xianyan, Ding Xiaohui, et al. 2014. Distribution pattern of Indo-Pacific humpback dolphins (*Sousa chinensis*) along coastal waters of Fujian Province, China. *Aquatic Mammals*, 40(4): 341–349
- Xu Min, Wang Xianyan, Miao Xing, et al. 2017. A stranding record of Omura's whale (*Balaenoptera omurai* Wada, Oishi and Yamada, 2003) in the Taiwan Strait, China. *Aquatic Mammals*, 43(3): 289–298