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Identification of coastal wetlands of international importance for waterbirds: a review of China Coastal Waterbird Surveys 2005–2013

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Abstract

Background: China's coastal wetlands belong to some of the most threatened ecosystems worldwide. The loss and degradation of these wetlands seriously threaten waterbirds that depend on wetlands.

Methods: The China Coastal Waterbird Census was organized by volunteer birdwatchers in China's coastal region. Waterbirds were surveyed synchronously once every month at 14 sites, as well as irregularly at a further 18 sites, between September 2005 and December 2013.

Results: A total of 75 species of waterbirds met the 1 % population level Ramsar listing criterion at least once at one site. The number of birds of the following species accounted for over 20 % of the total flyway populations at a single site: Mute Swan (*Cygnus olor*), Siberia Crane (*Grus leucogeranus*), Far Eastern Oystercatcher (*Haematopus osculans*), Bar-tailed Godwit (*Limosa lapponica*), Spotted Greenshank (*Tringa guttifer*), Great Knot (*Calidris tenuirostris*), Spoon-billed Sandpiper (*Calidris pygmeus*), Saunders's Gull (*Larus saundersi*), Relict Gull (*Larus relictus*), Great Cormorant (*Phalacrocorax carbo*), Eurasian Spoonbill (*Platalea leucorodia*), Black-faced Spoonbill (*Platalea minor*) and Dalmatian Pelican (*Pelecanus crispus*). A total of 26 sites supported at least one species of which their number met the 1 % criterion. Forty-two species met the 1 % criterion in the Yellow River Delta, Shandong; 29 at the Cangzhou coast, Hebei and 26 species at the Lianyungang coast, Jiangsu.

Conclusions: The results highlight the international importance of China's coastal wetlands for waterbirds. This study also demonstrates that participation of local birdwatchers in waterbird surveys results in data that are invaluable not only for understanding the current status of waterbirds in China's coastal regions but also for waterbird conservation and management.

Keywords: 1 % criterion, Citizen science, Coastal wetlands, Ramsar site, Waterbirds

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Background

China's coastal wetlands provide critical breeding, stopover and wintering sites for millions of waterbirds along the East Asian-Australasian Flyway. Unfortunately, coastal wetlands have been severely altered through reclamation, pollution, the spread of invasive species and overharvesting of marine organisms (MacKinnon et al. 2012; Ma et al. 2014; Hua et al. 2015). Waterbirds are not only conservation targets, but also indicators of the quality and importance of wetlands. Over the past several decades, waterbird surveys have been conducted along China's coasts. For example, between 1996 and 2005, Mark Barter and colleagues conducted surveys of migrating shorebirds in the Yellow Sea region (Barter 2002) and wintering bird surveys were conducted in Fujian (Barter et al. 2007). Waterbirds were also surveyed in nature reserves, especially focusing on threatened species such as the Red-crowned Crane (*Grus japanensis*) (Su and Zou 2012) and the Chinese Crested Tern (*Sterna bernsteini*) (Fan et al. 2011), while synchronous waterbird surveys have been conducted in some reserves continuously throughout the years. All these surveys have provided basic data for conservation and management measures.

However, the current population status of most waterbird species is still largely unclear, especially outside nature reserves where waterbird surveys have seldom been conducted. More recently, birdwatching has become increasingly popular in China; over 30 birdwatching societies have been established and the number of birdwatchers continues to increase (Ma et al. 2013). Since 2005, birdwatchers in China's coastal regions have organized and conducted synchronous waterbird surveys once every month (China Coastal Waterbird Census Group 2009, 2011). These provide basic data in order to understand the status of waterbirds in coastal regions. Our surveys complement those of wintering waterbirds reported by Cui et al. (2014).

The criteria for the identification of 'wetlands of international importance' under the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat include two that relate specifically to waterbirds: criterion 5 states that a site should regularly support 20000 or more waterbirds, while criterion 6 insists that the site should regularly support 1 % of the number of individual birds in a population of a species or subspecies of waterbirds (Ramsar Convention Secretariat 2010). Wetlands International regularly reviews waterbird populations and publishes the number of birds meeting the 1 % criterion for different populations (Wetlands International 2014). In this review, we identify sites of international importance using the Ramsar 1 % population criterion and highlight several species for which population estimates apparently require revision. This will be helpful for conservation and management measures of waterbirds and their wetland habitats.

Methods

The China Coastal Waterbird Census Group was established in 2005, training birdwatchers in bird identification and counting methods. Surveys have been conducted monthly since September 2005.

Because most of the surveyors are volunteers, surveys are conducted at weekends. To facilitate bird counts, surveys are generally conducted at high tide during periods of spring tides (China Coastal Waterbird Census Group 2009, 2011).

During surveys, surveyors walk along fixed routes and record waterbirds using binoculars and telescopes. Surveys of most sites can be finished in one day, whereas some larger sites need at least two days, e.g., along the Yalu Jiang, which covers some 60 km of coastline with multiple roost sites (Choi et al. 2015). Surveys at this site usually need at least two days to count different sections; at this site it is known that two sections for counting birds contain, essentially, discrete populations with little movement of birds between the two sections on consecutive days. Therefore, different sections at Yalu Jiang were counted on consecutive days, combining the number of birds of the two sections. This method was also used in the wider Rudong area. To ensure consistency of the survey methods, every site had a survey coordinator as the main investigator and team leader and surveys were arranged to minimize the risk of double-counting within the site on the same and consecutive days.

From September 2005 to December 2013, waterbirds were counted at 32 sites: 14 sites were surveyed each month and a further 18 sites at irregular intervals. At least one site was surveyed in each coastal province (Fig. 1). Some nature reserves were not covered in our surveys; however, there have been previous waterbird surveys in these coastal nature reserves (Barter et al. 2002).

The number of birds of each species recorded during every census were compared with the 1 % population estimates published in Waterbird Population Estimates (Wetlands International 2014).

Results and discussion

Species

A total of 75 species, including 33 shorebirds, 19 ducks and geese, 5 terns, 5 cranes, 4 gulls, 2 storks, 2 egrets, 2 spoonbills, 1 cormorant and 1 pelican, were recorded in numbers that met the 1 % criterion at least once at a single site during each census from September 2005 to December 2013 (Table 1). Among these species, the numbers of Mute Swan (*Cygnus olor*), Siberian Crane

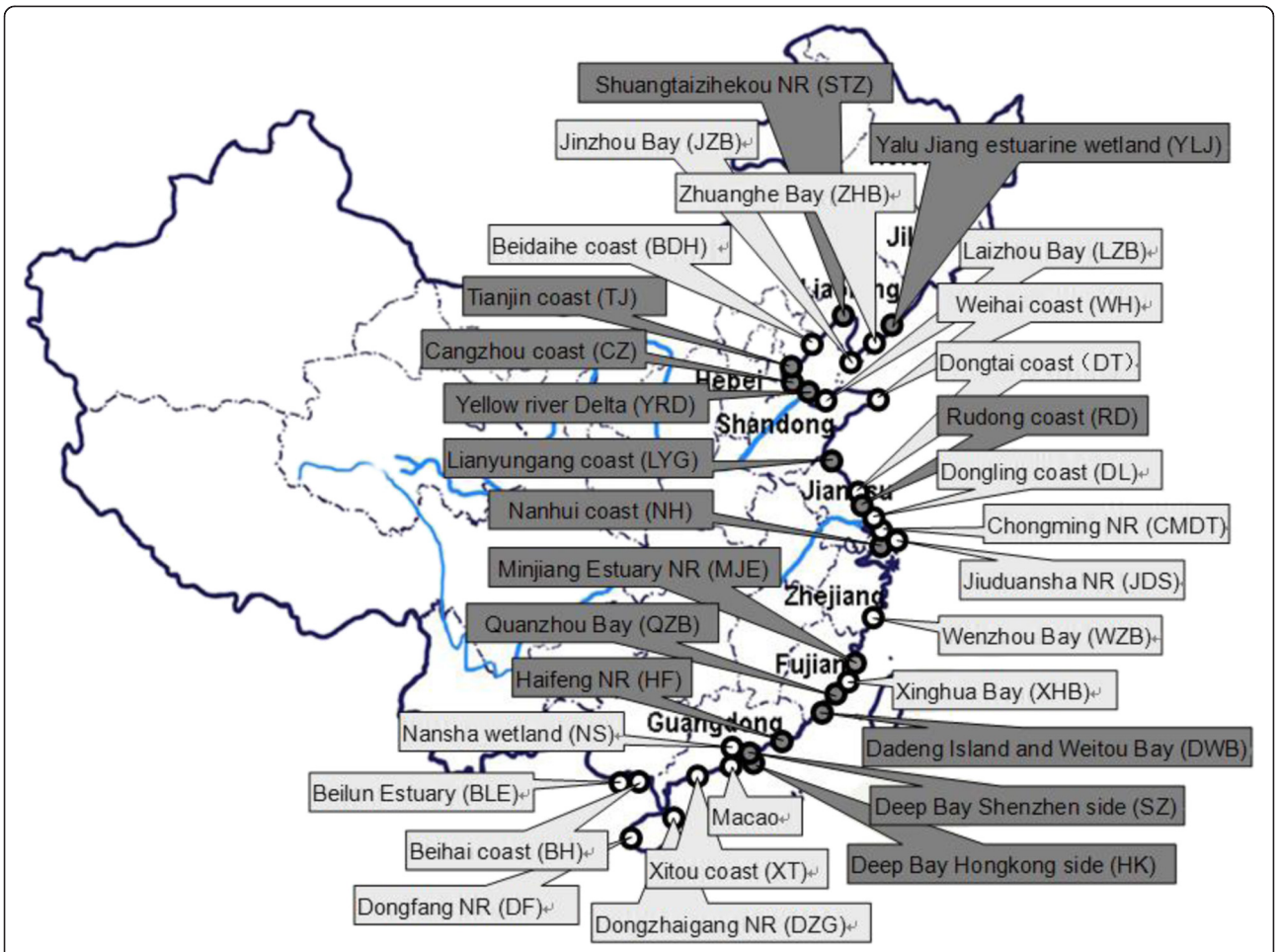

Fig. 1 Survey sites along China's coasts. The dark grey shows the regular survey sites and light grey the occasional survey sites. NR: Nature Reserve

(*Grus leucogeranus*), Far Eastern Oystercatcher (*Haematopus osculans*), Bar-tailed Godwit (*Limosa lapponica*), Spotted Greenshank (*Tringa guttifer*), Great Knot (*Calidris tenuirostris*), Spoon-billed Sandpiper (*Calidris pygmeus*), Saunders's Gull (*Larus saundersi*), Relict Gull (*Larus relictus*), Great Cormorant (*Phalacrocorax carbo*), Eurasian Spoonbill (*Platalea leucorodia*), Black-faced Spoonbill (*Platalea minor*), and Dalmatian Pelican (*Pelecanus crispus*) exceeded 20 % of the total flyway population estimate at a single site (Table 1). The numbers of Spotted Greenshank and Dalmatian Pelican exceeded the estimated numbers of the entire flyway population, suggesting an underestimate of the total population.

Some waterbird species exceeded the 1 % criterion at more than one site (Table 1). For example, the Saunders's Gull was recorded as exceeding the 1 % criterion at 12 sites, the Spotted Redshank (*Tringa erythropus*) and Kentish Plover (*Charadrius alexandrinus*) both at 11 sites and the Eurasian Curlew (*Numenius arquata*) at 10 sites.

Among the 75 waterbird species that met the 1 % criterion, shorebirds were the most abundant group. This reflects the fact that millions of shorebirds in the East Asian-Australasian Flyway depend on China's coastal wetlands for their stopover and wintering sites (Barter 2002; Bamford et al. 2008; Conklin et al. 2014). The surveys provided important data for understanding the number of shorebird populations at China's coasts, especially for those species for which data in earlier times were absent or insufficient , such as for the Spoon-billed Sandpiper and the Spotted Greenshank.

The Spoon-billed Sandpiper is a critically endangered species (IUCN 2014), endemic to the East Asian-Australasian Flyway and dependent on coastal wetlands for much of its life cycle, with an estimated population of 140–480 individuals (Wetlands International 2014). The Rudong and Dongtai mudflats in Jiangsu are the most important areas along the flyway, an important and key stopover site for refuelling and moulting on both their northward and southward migration (Tong et al. 2012).

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014)

Species	1 % criterion	Sites supporting 1 % or more of the flyway population (Maximum number, Year.Month.Date)			
		Wintering period	Northward migration	Southward migration	Summering/Breeding
Whooper Swan (*Cygnus cygnus*)	600			**YRD** (1780, 2010.11)	
Mute Swan (*Cygnus olor*)	15	**YRD** (**397**, 2013.01)			
Tundra Swan (*Cygnus columbianus*)	1000		**TJ** (960, 2011.03)	**TJ** (1118, 2009.11)	
				YRD (1040, 2007.11)	
Bean Goose (*Anser fabalis*)	1100		**CZ** (5045, 2007.03)	**YRD** (4500, 2012.11)	
			STZ (2200, 2013.03.17–18)		
			YRD (1540, 2013.03)		
Swan Goose (*Anser cygnoides*)	680	**MJE** (950, 2008.02)			
Graylag Goose (*Anser anser*)	710		**CZ** (1694, 2009.03)	**YRD** (3500, 2012.11)	
Ruddy Shelduck (*Tadorna ferruginea*)	710	**YRD** (1946, 2007.01)		**CZ** (1750, 2010.11)	
Common Shelduck (*Tadorna tadorna*)	1200		**YLJ** (7415, 2012.03.24–25)	**CZ** (7494, 2008.11)	
			STZ (3200, 2013.04.16–17)	**YLJ** (3394, 2011.10.29)	
			CZ (1521, 2011.03)		
Gadwall (*Anas strepera*)	7100			**YRD** (21500, 2011.11)	
Spot-billed Duck (*Anas poecilorhyncha*)	11,300			**YRD** (14500, 2008.08)	
Northern Shoveler (*Anas clypeata*)	5000	**SZ** (12520, 2008.01)			
		HK (7567, 2011.01)			
Falcated Duck (*Anas falcate*)	830	**LYG** (6800, 2011.02)	**CZ** (1120, 2012.04)	**YRD** (12000, 2012.11)	
		YRD (6500, 2008.01)			
		NH (1580, 2012.02.09)			
Northern Pintail (*Anas acuta*)	2400	**HK** (3615, 2010.12)			
		HF (3400, 2008.01)			
		YRD (2450, 2010.12)			
Baikal Teal (*Anas formosa*)	7100	**CMDT** (8000, 2006.02)			
Baer's Pochard (*Aythya baeri*)	5		**CZ** (15, 2012.03.09–13)	**TJ** (8, 2010.10)	
Common Pochard (*Aythya farina*)	3000			**YRD** (3500, 2010.10)	
Tufted Duck (*Aythya fuligula*)	2400	**HK** (5987, 2012.12.16)			
		SZ (4100, 2010.12)			
Smew *(Mergellus albellus*)	250	**YRD** (3100, 2007.02)	**TJ** (1600, 2011.03)	**CZ** (2924, 2010.11)	
			CZ (498, 2008.03)	**TJ** (2000, 2011.11)	
				YRD (1320, 2009.11)	

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

Common Merganser (*Mergus merganser*)	710		**TJ** (1192, 2006.03)	**YRD** (845, 2009.11)	
			YLJ (973, 2011.03)		
Siberian Crane (*Grus leucogeranus*)	30		**YRD** (42, 2011.03)	**YRD** (**700**, 2011.11)	
				STZ (500, 2013.11.17)	
White-naped Crane (*Grus vipio*)	30		**CZ** (44, 2010.03)	**YRD** (220, 2012.11)	
Common Crane (*Grus grus*)	150	**CZ** (1628, 2007.02)	**YRD** (880, 2011.03)	**YRD** (1320, 2011.11)	
		YRD (1250, 2011.12)	**CZ** (174, 2008.03)		
Hooded Crane (*Grus monacha*)	15		**YLJ** (99, 2010.03)	**YRD** (150, 2012.11)	
Red-crowned Crane (*Grus japonensis*)	4	**YRD** (123, 2011.01)	**STZ** (280, 2013.03.17–18)	**STZ** (300, 2013.11.17)	
			YRD (150, 2009.3)	**YRD** (84, 2008.11)	
			LYG (86, 2013.02)		
Black Stork (*Ciconia nigra*)	5		**YRD** (14, 2009.3)	**YRD** (8, 2009.10)	
Oriental White Stork (*Ciconia boyciana*)	30	**YRD** (65, 2011.01)	**CZ** (502, 2010.03)	**TJ** (480, 2012.11.12)	**YRD** (260, 2011.06)
			STZ (320, 2013.03.17–18)	**YRD** (150, 2010.11)	
			YRD (210, 2011.04)	**STZ** (140, 2013.11.17)	
			TJ (72, 2009.03)	**CZ** (32, 2011.11)	
Far Eastern Oystercatcher (*Haematopus ostralegus*)	70	**LYG** (**2806**, 2013.12.15)	**YLJ** (**2458**, 2013.03.17)	**STZ** (**1450**, 2012.08.26)	**YLJ** (102, 2010.06.14)
		DL (**1400**, 2013.12.10–11)	**STZ** (210, 2011.03)	**YLJ** (361, 2008.09)	
			RD (145, 2010.03.07)	**RD** (235, 2013.08.15)	
				DL (155, 2013.10.15–19)	
				CZ (111, 2011.11)	
				YRD (85, 2012.09)	
Black-winged Stilt (*Himantopus himantopus*)	1000		**TJ** (5002, 2010.04)	**YRD** (1,550, 2010.09)	**YRD** (2100, 2010.07)
			YRD (1450, 2010.05)	**CZ** (1076, 2010.09)	**CZ** (1723, 2010.08)
			CZ (1407, 2008.04)		
Pied Avocet (*Recurvirostra avosetta*)	1000	**HK** (16120, 2008.01)	**SZ** (7180, 2010.03)	**LYG** (7400, 2011.10)	
		LYG (7000, 2012.01.13)	**LYG** (3000, 2009.04)	**CZ** (4065, 2011.10)	
		SZ (2866, 2010.12)	**NS** (1572, 2013.03.19)	**YRD** (2100, 2010.09)	
			YRD (1200, 2009.04)	**TJ** (1040, 2011.11)	
Grey Plover (*Pluvialis squatarola*)	1000		**LYG** (8870, 2013.03.16)	**YLJ** (4020, 2011.08.17)	
			YLJ (6145, 2011.04.21)	**YRD** (2300, 2010.09)	
			TJ (3000, 2011.05)	**TJ** (2250, 2011.12)	
			CZ (2089, 2005.05)	**STZ** (2000, 2011.08.13–14)	

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

				RD (1741, 2012.10.14)	
				DL (1240, 2013.10.15–19)	
Little Ringed Plover (*Charadrius dubius*)	250				**YRD** (330, 2011.07)
					CZ (277, 2007.08)
Kentish Plover (*Charadrius alexandrinus*)	1000	**SZ** (4303, 2010.01)	**CZ** (4016, 2007.04)	**RD** (14760, 2010.10)	
		HK (3220, 2012.01.20)	**LYG** (2000, 2011.04)	**STZ** (10000, 2011.08.13–14)	
		QZB (1856, 2012.12.18)		**YLJ** (6500, 2010.09.12)	
				DL (5000, 2013.10.15–19)	
				LYG (2500, 2012.10.14)	
				CZ (2238, 2011.09)	
				HK (2000, 2008.11)	
				YRD (1250, 2010.08)	
				MJE (1000, 2010.11)	
Lesser Sand Plover (*Charadrius mongolus*)	390		**RD** (1000, 2010.05)	**RD** (3820, 2008.08)	
			LYG (750, 2013.05)	**RD** (3590, 2013.09.07–09)	
			XT (688, 2012.03.22)	**DL** (2000, 2013.10.15–19)	
			YLJ (520, 2010.05)	**YLJ** (1950, 2011.09.01)	
			MJE (400, 2011.05)	**LYG** (1300, 2013.09.08)	
				JDS (1044, 2006.10)	
				STZ (400, 2011.08.13–14)	
Greater Sand Plover (*Charadrius leschenaultia*)	790			**MJE** (1780, 2008.09)	
				QZB (1717, 2012.08.18–19)	
				RD (1600, 2011.08)	
				DL (1435, 2013.07.21)	
				DWB (1022, 2013.07)	
				BH (900, 2013.07.21–22)	
Asian Dowitcher (*Limnodromus semipalmatus*)	230		**LYG** (2800, 2013.5.12)	**LYG** (1899, 2012.08.07–09)	
			HK (428, 2008.04)	**TJ** (420, 2010.08)	
Black-tailed Godwit (*Limosa limosa*)	1400	**SZ** (1900, 2010.02)	**TJ** (11125, 2007.04)	**LYG** (4425, 2012.08.07–09)	
			YRD (6550, 2012.04)	**CZ** (2404, 2010.09)	
			STZ (2000, 2012.04.08–09)	**STZ** (1750, 2011.08.13–14)	
			HK (1924, 2013.04.14)		

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

Bar-tailed Godwit (*Limosa lapponica*)	1500		**YLJ** (**67826**, 2013.4.29–30)	**YLJ** (15000, 2009.08.22–23)
			LYG (4702, 2013.04.14)	**STZ** (2470, 2011.08.13–14)
			STZ (4000, 2012.04.08–09)	
			YRD (2150, 2012.04)	
			CZ (1725, 2010.05)	
Little Curlew (*Numenius minutus*)	1800		**YRD** (4300, 2007.05)	
Whimbrel (*Numenius phaeopus*)	550			**QZB** (909, 2012.08.18–19)
				CZ (865, 2007.08)
				DWB (776, 2012.08)
Eurasian Curlew (*Numenius arquata*)	1000	**CZ** (6625, 2007.01)	**CZ** (4895, 2011.03)	**CZ** (5280, 2009.11)
		TJ (2800, 2010.02)	**TJ** (3000, 2010.03)	**YLJ** (4100, 2010.09.12)
		HK (1602, 2011.01)	**YLJ** (1782, 2011.03)	**RD** (1487, 2013.10.15–19)
		QZB (1539, 2013.12.21)	**YRD** (1550, 2008.04)	**STZ** (1250, 2011.08.13–14)
		ZHB (1225, 2012.01.20)		
		LYG (1200, 2011.01)		
Far Eastern Curlew (*Numenius madagascariensis*)	320		**YLJ** (4840, 2011.04.21)	**YLJ** (5289, 2011.07.16–17)
			YRD (650, 2008.05)	**TJ** (1675, 2007.09)
			STZ (480, 2013.04.16–17)	**ZHB** (1323, 2011.09.02)
				STZ (700, 2011.08.13–14)
				CZ (603, 2007.07)
				RD (495, 2011.06)
				YRD (350, 2009.09)
Spotted Redshank (*Tringa erythropus*)	250	**HK** (1686, 2006.02)	**YRD** (1150, 2008.05)	**CZ** (2734, 2008.9)
			HK (711, 2010.04)	**YLJ** (1300, 2008.10)
			SZ (406, 2010.04)	**STZ** (1200, 2011.08.13–14)
			LYG (406, 2011.04)	**NH** (720, 2007.10)
			YLJ (380, 2011.05.05)	**TJ** (450, 2012.10.14)
			RD (300, 2012.04.22)	**YRD** (350, 2010.09)
				HF (345, 2010.07)
				LYG (250, 2011.07)
Common Redshank (*Tringa totanus*)	1000		**SZ** (5200, 2006.04)	**STZ** (1000, 2011.08.13–14)
			HK (1106, 2007.04)	

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

Common Greenshank (*Tringa nebularia*)	1000	**HK** (1027, 2011.01)	**SZ** (2528, 2010.04)	**TJ** (2064, 2011.10)	
			HK (1936, 2008.04)	**YLJ** (1626, 2013.08.24–25)	
				HK (1251, 2012.08.19)	
				STZ (1120, 2011.08.13–14)	
Spotted Greenshank (*Tringa guttifer*)	5		**HK** (46, 2007.04)	**DT** (**940**, 2013.10.15–19)	
			YLJ (40, 2013.05.10–11)	**RD** (**158**, 2013.10.15-19)	
			DWB (17, 2009.04.08)	**DL** (19, 2013.10.15–19)	
				YLJ (14, 2010.08.28)	
Terek Sandpiper (*Xenus cinereus*)	500		**QZB** (610, 2011.04)	**MJE** (980, 2012.07.22)	**LYG** (650, 2013.06.16)
				RD (880, 2013.08.15)	
				YLJ (825, 2013.07.21)	
Grey-tailed Tattler *(Heteroscelus brevipes)*	440		**QZB** (520, 2011.05)		
Ruddy Turnstone (*Arenaria interpres*)	290		**YLJ** (464, 2011.05.25)		
Great Knot (*Calidris tenuirostris*)	2900		**STZ** (**80000**, 2013.04.27)	**STZ** (12500, 2011.08.14)	
			YLJ (**74900**, 2013.04.29–30)	**DL** (5000, 2013.07.21)	
				YLJ (3220, 2011.08.19)	
				LYG (3018, 2012.08.07–09)	
Red Knot (*Calidris canutus*)	1100		**LYG** (2500, 2013.04.14)	**STZ** (4700, 2011.08.14)	
			TJ (2000, 2012.05.13)	**YRD** (1300, 2010.09)	
			CZ (1116, 2012.05.19–20)		
Sanderling (*Calidris alba*)	220	**MJE** (680, 2011.01)	**MJE** (850, 2012.04.21)	**MJE** (1900, 2008.09)	
		QZB (310, 2011.01)	**QZB** (330, 2013.04.14)	**QZB** (276, 2013.10.21)	
			LYG (232, 2010.05)		
Red-necked Stint (*Calidris ruficollis*)	3200		**NH** (7552, 2007.05)	**LYG** (6853, 2012.08.07–09)	
			LYG (3572, 2011.05)	**RD** (6710, 2008.08)	
Long-toed Stint (*Calidris subminuta*)	250			**RD** (750, 2008.08)	
				LYG (600, 2012.07.21)	
Sharp-tailed Sandpiper (*Calidris acuminate*)	1600		**LYG** (8000, 2008.05)	**STZ** (1600, 2012.08.25)	
			CZ (2549, 2012.05.19–20)		
			YLJ (1788, 2011.05.17)		
Curlew Sandpiper (*Calidris ferruginea*)	1400		**HK** (9168, 2008.04)		
			SZ (5100, 2013.04.14)		

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

			LYG (3000, 2013.05.12)		
			CZ (2481, 2012.05.19–20)		
Dunlin (*Calidris alpina*)	10,000		**YLJ** (35770, 2011.04.21)	**YLJ** (25700, 2013.09.19)	
			YRD (24500, 2012.04)		
			RD (14364, 2010.04)		
			LYG (14000, 2008.05)		
Spoon-billed Sandpiper *(Eurynorhynchus pygmeus)*	3	**MJE** (14, 2011.02)	**RD** (25, 2012.04.22)	**RD** (**103**, 2011.10.12)	
			YLJ (4, 2012.05.19–27)	**RD** (**61**, 2013.10.15–19)	
			XT (3, 2012.03.11)	**DT** (44, 2013.10.15–19)	
			DWB (3, 2006.03)	**DL** (38, 2013.10.15–19)	
Broad-billed Sandpiper (*Limicola falcinellus*)	250		**YLJ** (1869, 2010.05.26)	**RD** (500, 2011.08)	
			DWB (290, 2013.04)	**YLJ** (300, 2011.09.01)	
			LYG (250, 2013.05.12)		
Temminck's Stint (*Calidris temminckii*)	250			**TJ** (456, 2012.08.20)	
Saunders's Gull (*Larus saundersi*)	85	**XHB** (**1710**, 2007.02)	**YRD** (1450, 2009.03)	**DL** (**2555**, 2013.10.15–19)	**STZ** (**6000**, 2012.06.17)
		QZB (742, 2013.01.13)	**RD** (880, 2010.04)	**YRD** (1200, 2008.09)	**YRD** (1250, 2010.05)
		DWB (737, 2008.01.19)	**WZB** (520, 2008.03)	**YLJ** (984, 2012.09)	**RD** (1085, 2012.07.02)
		WZB (345, 2008.02)	**YLJ** (263, 2011.03)	**DWB** (669, 2009.11)	**YLJ** (930, 2013.06.22)
		CZ (256, 2012.02.17–18)		**RD** (629, 2012.09.16)	**DL** (320, 2013.07.21)
		TJ (230, 2009.02)		**TJ** (380, 2011.11)	
				LYG (226, 2009.10)	
Relict Gull (*Larus relictus*)	120	**TJ** (**4100**, 2008.02)	**TJ** (**6000**, 2010.03)	**CZ** (**3909**, 2011.09)	
		CZ (2155, 2011.02)	**CZ** (1423, 2008.03)	**STZ** (745, 2011.08.14)	
		ZHB (1730, 2012.01.20)	**YLJ** (269, 2011.03.21)	**LYG** (218, 2010.10)	
Caspian Tern (*Hydroprogne caspia*)	250	**DWB** (333, 2009.02)		**YRD** (980, 2010.10)	
				TJ (357, 2007.09)	
Chinese Crested Tern (*Sterna bernsteini*)	1		**MJE** (7, 2010.05)		
Common Tern (*Sterna hirundo*)	460			**MJE** (470, 2013.09)	**YRD** (1450, 2012.06)
					RD (1000, 2012.06)
Gull-billed Tern (*Gelochelidon nilotica*)	1000				**YRD** (1350, 2009.6)
Little Tern (*Sterna albifrons*)	1000			**TJ** (3256, 2007.09)	
Yellow-legged Gull (*Larus cachinnans*)	610	**JZB** (6,000, 2013.03.23–24)		**YLJ** (2062, 2012.10.14–15)	
		ZHB (954, 2012.01.20)			

Table 1 Waterbird species at sites that meet the Ramsar 1 % criterion (Wetlands International 2014) *(Continued)*

Mew Gull (*Larus canus*)	1000	**ZHB** (1550, 2012.01.20)			
Great Cormorant (*Phalacrocorax carbo*)	1000	**HK** (10569, 2013.01.20)	**YRD** (1450, 2011.03)	**YRD** (**21000**, 2011.11)	
		DWB (6000, 2013.01)	**STZ** (1400, 2013.04.16–17)		
		SZ (5627, 2010.02)			
		HF (3300, 2011.02)			
Chinese Egret (*Egretta eulophotes*)	35		**NH** (41, 2006.05)	**ZHB** (128, 2011.09.01)	
				YLJ (77, 2008.09.14–15)	
				LYG (31, 2012.08.07–09)	
Great Egret (*Casmerodius albus*)	1000	**HK** (1209, 2006.11)			**HF** (1172, 2007.06)
Eurasian Spoonbill (*Platalea leucorodia*)	100		**YRD** (550, 2010.04)	**YRD** (**4500**, 2011.11)	
Black-faced Spoonbill *(Platalea minor)*	15	**HK** (**482**, 2011.12)	**SZ** (57, 2013.03.17)	**XHB** (63, 2007.11)	
		DF (91, 2008.01)	**XHB** (45, 2007.03)	**ZHB** (56, 2011.09.02)	
		HF (81, 2012.01.15)		**SZ** (51, 2012.11.11)	
		SZ (37, 2013.01.20)		**MJE** (35, 2012.11.11)	
		CMDT (47, 2006.02)			
		XHB (34, 2007.02)			
		MJE (18, 2012.02)			
Dalmatian Pelican (*Pelecanus crispus*)	1	**WZB** (**66**, 2011.12)	**YRD** (**23**, 2011.03)	**DT** (**112**, 2013.11.19)	
		HF (4, 2008.12)	**LYG** (3, 2009.04)	**LYG** (**63**, 2012.11.20)	
		HK (1, 2008.02)		**YRD** (**58**, 2011.11)	
				CZ (7, 2010.10)	
Great Crested Grebe (*Podiceps cristatus*)	350	**HK** (769, 2006.12)	**CZ** (526, 2011.04)		**YRD** (350, 2010.06)

Abbreviation of the site names: Yalu Jiang estuarine wetland (YLJ), Shuangtaizihekou National Nature Reserve (STZ), Zhuanghe Bay (ZHB), Jinzhou Bay (JZB), Tianjin coast (TJ), Cangzhou coast (CZ), Yellow River Delta (YRD), Lianyungang coast (LYG), Rudong coast (RD), Dongtai coast (DT), Dongling coast (DL), Nanhui coast (NH), Chongming Dongtan National Nature Reserve (CMDT), Juduansha National Nature Reserve (JDS), Wenzhou Bay (WZB), Minjiang Estuary National Nature Reserve (MJE), Xinghua Bay (XHB), Quanzhou Bay (QZB), Dadeng Island and Weitou Bay (DWB), Haifeng Nature Reserve (HF), Xitou coast (XT), Nansha Wetland (NS), Deep Bay Hong Kong side (HK), Deep Bay Shenzhen side (SZ), Dongfang Nature Reserve (DF), Beihai coast (BH)
Numbers in bold highlight those counts which are equivalent to, or exceed, 20 % of the flyway population for that species

On 12 October 2011, 103 Spoon-billed Sandpipers were recorded at Rudong alone. In October 2012 and 2013, over 100 individual sandpipers were recorded in the Rudong area (including Dongling and Dongtai coasts), Jiangsu (Tong et al. 2013, 2014). The maximum number (143 individuals) was recorded in October 2013. Both adults and juvenile birds have been recorded in the autumn, including some adults moulting their primaries (Tong 2012). This is the only known moulting ground and it appears that most of their adult population moults here. Moreover, our surveys revealed that the Min Jiang estuary in Fujian, is a regular wintering site for the Spoon-billed Sandpiper.

The estimated total flyway population of the Spotted Greenshank was 400–600 individuals (Wetlands International 2014). However, a total of 1117 individuals was recorded at the Dongtai and Rudong (including Dongling) coasts, Jiangsu Province, between 15 and 19 October 2013 (Tong et al. 2014), of which 940 were found at the Tiaozini reclamation district, Dongtai. Moreover, a total of 112 Dalmatian Pelicans was recorded at Tiaozini reclamation district, the Dongtai coast, Jiangsu in November 2013 which exceeds the former estimated total number of 100 individuals, in East Asia (Wetlands International 2014). These results provide the basis for updating the total population of these waterbirds in the flyway.

Sites

Of the 32 sites surveyed, 26 supported at least one species that met the 1 % criterion for recognition as a site of international importance (Table 2, Fig. 2). Previously, Barter (2002) listed 10 sites along the Yellow Sea coast as being internationally important for shorebirds (two of which, Yancheng and Dong Sha, were not included in our surveys). Our surveys identified additional sites for shorebirds, as well as new sites for other waterbird taxa.

Among the 26 sites identified as being of international importance 13 are currently under some form of protection (Table 3), of which 8 are National Nature Reserves, 4 are Provincial Nature Reserves, and 1 Wetland Park. The other 13 sites currently have no legal protection. Four of the sites (Shuangtaizihekou National Nature Reserve, the Yellow River Delta National Nature Reserve, the Chongming Dongtan National Nature Reserve, as well as Mai Po and the Inner Deep Bay in the Hong Kong SAR) are currently designated by the Chinese government as Ramsar sites.

Among the sites of international importance that currently are without any form of legal protection, a number are of particular importance for conservation. For example, the mudflats in the Rudong area in Jiangsu, stretch for 120 km between Tiaozini, Dongtai in the north and Dongling in the south. This area was divided into three count sections: the Tiaozini reclamation district of Dongtai (DT), Rudong (RD) and Dongling (DL). At these three sites, a total of 19 waterbird species, including 16 shorebird species, met the 1 % criterion since 2010, including the critically endangered Spoon-billed Sandpiper and the endangered Spotted Greenshank (Table 2). As well, 112 Dalmatian Pelicans were recorded at the Tiaozini reclamation district, Dongtai.

A total of 26 waterbird species, including 20 species of shorebirds, met the 1 % criterion at the Lianyungang coast, Jiangsu, in 2010–2013 (Table 2). The Far Eastern Oystercatcher had a stable winter population at Lianyungang, with a peak number of 2806 in 2013, which is about 25 % of the total flyway population estimate and the largest known wintering congregation in China (Melville et al. 2014). In addition, 8 % of the total flyway population of the Asian Dowitcher was recorded during the southward migration in 2012 and 12 % in the northward migration in 2013. Nine per cent of the total flyway population of the Grey Plover (*Pluvialis squatarola*) was also recorded in 2013.

Xitou, Guangdong has 'only' two species that met the 1 % criterion, but this includes the 'critically endangered' Spoon-billed Sandpiper. At Quanzhou Bay, Fujian, the population of the Grey-tailed Tattler (*Heteroscelus brevipes*) met the 1 % criterion in May 2011; this is the first internationally important site for the Grey-tailed Tattler in China.

Many sites identified as being of international importance to waterbirds along the Chinese coast currently lack any formal protection and many are immediately threatened by reclamation projects (Ma et al. 2014). In particular, the Jiangsu coast is undergoing rapid development as the provincial government hopes to complete reclamation of 1800 km^2 of intertidal flats by 2020 — including much of the areas currently used by Spoon-billed sandpipers and Spotted Greenshanks, as well as many other species. Tianjin is soon to lose most of its remaining intertidal areas and the northern Bohai coast is being reclaimed for infrastructure development and aquaculture (Yang et al. 2011; Murray et al. 2014).

In view of the extent of approved and planned coastal reclamation projects and the speed with which many are being implemented, there is an urgent need to prioritise the designation of new protected areas to safeguard sites of international importance for waterbirds. Additionally, even sites that are currently reserves often suffer from a variety of management problems, including the invasion of exotic species, such as cordgrass (*Spartina*) which covers tidal flats (Gan et al. 2009), as well as boundary changes to accommodate new development projects. There is an urgent need to strengthen the management of existing reserves, as well as designating new ones.

Table 2 The 26 sites where waterbird species meeting the Ramsar 1 % population criterion have been recorded at least once during the 2005–2013 surveys

Survey sites	Waterbird species meeting the 1 % criterion	Total number of species meeting the 1 % criterion
Yalu Jiang estuarine wetland (YLJ), Liaoning	Common Shelduck, Common Merganser, Hooded Crane, Far Eastern Oystercatcher, Grey Plover, Kentish Plover, Lesser Sand Plover, Bar-tailed Godwit, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Common Greenshank, Spotted Greenshank, Terek Sandpiper, Ruddy Turnstone, Great Knot, Sharp-tailed Sandpiper, Dunlin, Spoon-billed Sandpiper, Broad-billed Sandpiper, Saunders's Gull, Relict Gull, Yellow-legged Gull, Chinese Egret	24
Shuangtaizihekou National Nature Reserve (STZ), Liaoning	Bean Goose, Common Shelduck, Siberian Crane, Red-crowned Crane, Oriental White Stork, Far Eastern Oystercatcher, Grey Plover, Kentish Plover, Lesser Sand Plover, Black-tailed Godwit, Bar-tailed Godwit, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Common Redshank, Common Greenshank, Great Knot, Red Knot, Sharp-tailed Sandpiper, Saunders's Gull, Relict Gull, Great Cormorant	22
Tianjin coast (TJ)	Tundra Swan, Baer's Pochard, Smew, Common Merganser, Oriental White Stork, Black-winged Stilt, Pied Avocet, Grey Plover, Asian Dowitcher, Black-tailed Godwit, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Common Greenshank, Red Knot, Temminck's Stint, Saunders's Gull, Relict Gull, Caspian Tern, Little Tern	20
Cangzhou coast (CZ), Hebei	Bean Goose, Graylag Goose, Ruddy Shelduck, Common Shelduck, Falcated Duck, Baer's Pochard, Smew, White-naped Crane, Common Crane, Oriental White Stork, Far Eastern Oystercatcher, Black-winged Stilt, Pied Avocet, Grey Plover, Little Ringed Plover, Kentish Plover, Black-tailed Godwit, Bar-tailed Godwit, Whimbrel, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Red Knot, Sharp-tailed Sandpiper, Curlew Sandpiper, Saunders's Gull, Relict Gull, Dalmatian Pelican, Great Crested Grebe	29
Yellow River Delta (YRD), Shandong	Whooper Swan, Mute Swan, Tundra Swan, Bean Goose, Graylag Goose, Ruddy Shelduck, Gadwall, Spot-billed Duck, Falcated Duck, Northern Pintail, Common Pochard, Smew, Common Merganser, Siberian Crane, White-naped Crane, Common Crane, Hooded Crane, Red-crowned Crane, Black Stork, Oriental White Stork, Far Eastern Oystercatcher, Black-winged Stilt, Pied Avocet, Grey Plover, Little Ringed Plover, Kentish Plover, Black-tailed Godwit, Bar-tailed Godwit, Little Curlew, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Red Knot, Dunlin, Saunders's Gull, Caspian Tern, Common Tern, Gull-billed Tern, Black-headed Gull, Great Cormorant, Eurasian Spoonbill , Dalmatian Pelican, Great Crested Grebe	42
Lianyungang coast (LYG), Jiangsu	Falcated Duck, Red-crowned Crane, Far Eastern Oystercatcher, Pied Avocet, Grey Plover, Kentish Plover, Lesser Sand Plover, Asian Dowitcher, Black-tailed Godwit, Bar-tailed Godwit, Eurasian Curlew, Spotted Redshank, Terek Sandpiper, Great Knot, Red Knot, Sanderling, Red-necked Stint, Long-toed Stint, Sharp-tailed Sandpiper, Curlew Sandpiper, Dunlin, Broad-billed Sandpiper, Saunders's Gull, Relict Gull, Chinese Egret, Dalmatian Pelican	26
Rudong coast (RD), Jiangsu	Far Eastern Oystercatcher, Grey Plover, Kentish Plover, Lesser Sand Plover, Greater Sand Plover, Eurasian Curlew, Far Eastern Curlew, Spotted Redshank, Spotted Greenshank, Terek Sandpiper, Red-necked Stint, Long-toed Stint, Dunlin, Spoon-billed Sandpiper, Broad-billed Sandpiper, Saunders's Gull, Common Tern	17
Dongtai coast (DT), Jiangsu	Spotted Greenshank, Spoon-billed Sandpiper, Dalmatian Pelican	3
Dongling coast (DL), Rudong, Jiangsu	Far Eastern Oystercatcher, Grey Plover, Kentish Plover, Lesser Sand Plover, Greater Sand Plover, Spotted Greenshank, Great Knot, Spoon-billed Sandpiper, Saunders's Gull	9
Nanhui coast (NH), Shanghai	Falcated Duck, Spotted Redshank, Red-necked Stint, Chinese Egret	4
Minjiang Estuary National Nature Reserve (MJE), Fujian	Swan Goose, Kentish Plover, Lesser Sand Plover, Greater Sand Plover, Terek Sandpiper, Sanderling, Spoon-billed Sandpiper, Chinese Crested Tern, Common Tern, Black-faced Spoonbill	10
Quanzhou Bay (QZB), Fujian	Kentish Plover, Greater Sand Plover, Whimbrel, Eurasian Curlew, Terek Sandpiper, Grey-tailed Tattler, Sanderling, Saunders's Gull	8
Dadeng Island and Weitou Bay (DWB), Fujian	Greater Sand Plover, Whimbrel, Spotted Greenshank, Spoon-billed Sandpiper, Broad-billed Sandpiper, Saunders's Gull, Caspian Tern, Great Cormorant	8
Haifeng Nature Reserve (HF), Guangdong	Northern Pintail, Spotted Redshank, Great Cormorant, Great Egret, Black-faced Spoonbill, Dalmatian Pelican	6
Deep Bay, Shenzhen side (SZ)	Northern Shoveler, Tufted Duck, Pied Avocet, Kentish Plover, Black-tailed Godwit, Spotted Redshank, Common Redshank, Common Greenshank, Curlew Sandpiper, Great Cormorant, Black-faced Spoonbill	11

Table 2 The 26 sites where waterbird species meeting the Ramsar 1 % population criterion have been recorded at least once during the 2005–2013 surveys *(Continued)*

Deep Bay, Hong Kong side (HK)	Northern Shoveler, Northern Pintail, Tufted Duck, Pied Avocet, Kentish Plover, Asian Dowitcher, Black-tailed Godwit, Eurasian Curlew, Spotted Redshank, Common Redshank, Common Greenshank, Spotted Greenshank, Curlew Sandpiper, Great Cormorant, Great Egret, Black-faced Spoonbill, Dalmatian Pelican, Great Crested Grebe	18
Zhuanghe Bay (ZHB), Liaoning	Eurasian Curlew, Far Eastern Curlew, Relict Gull, Yellow-legged Gull, Mew Gull, Chinese Egret, Black-faced Spoonbill	7
Jinzhou Bay (JZB), Liaoning	Yellow-legged Gull	1
Chongming Dongtan National Nature Reserve (CMDT), Shanghai	Baikal Teal, Black-faced Spoonbill	2
Jiuduansha Wetland National Nature Reserve (JDS), Shanghai	Lesser Sand Plover	1
Wenzhou Bay (WZB), Zhejiang	Saunders's Gull, Dalmatian Pelican	2
Xinghua Bay (XHB), Fujian	Saunders's Gull, Black-faced Spoonbill	2
Xitou coast (XT), Guangdong	Lesser Sand Plover, Spoon-billed Sandpiper	2
Nansha Wetland (NS), Guangdong	Pied Avocet	1
Dongfang Nature Reserve (DF), Hainan	Black-faced Spoonbill	1
Beihai coast (BH), Guangxi	Greater Sand Plover	1

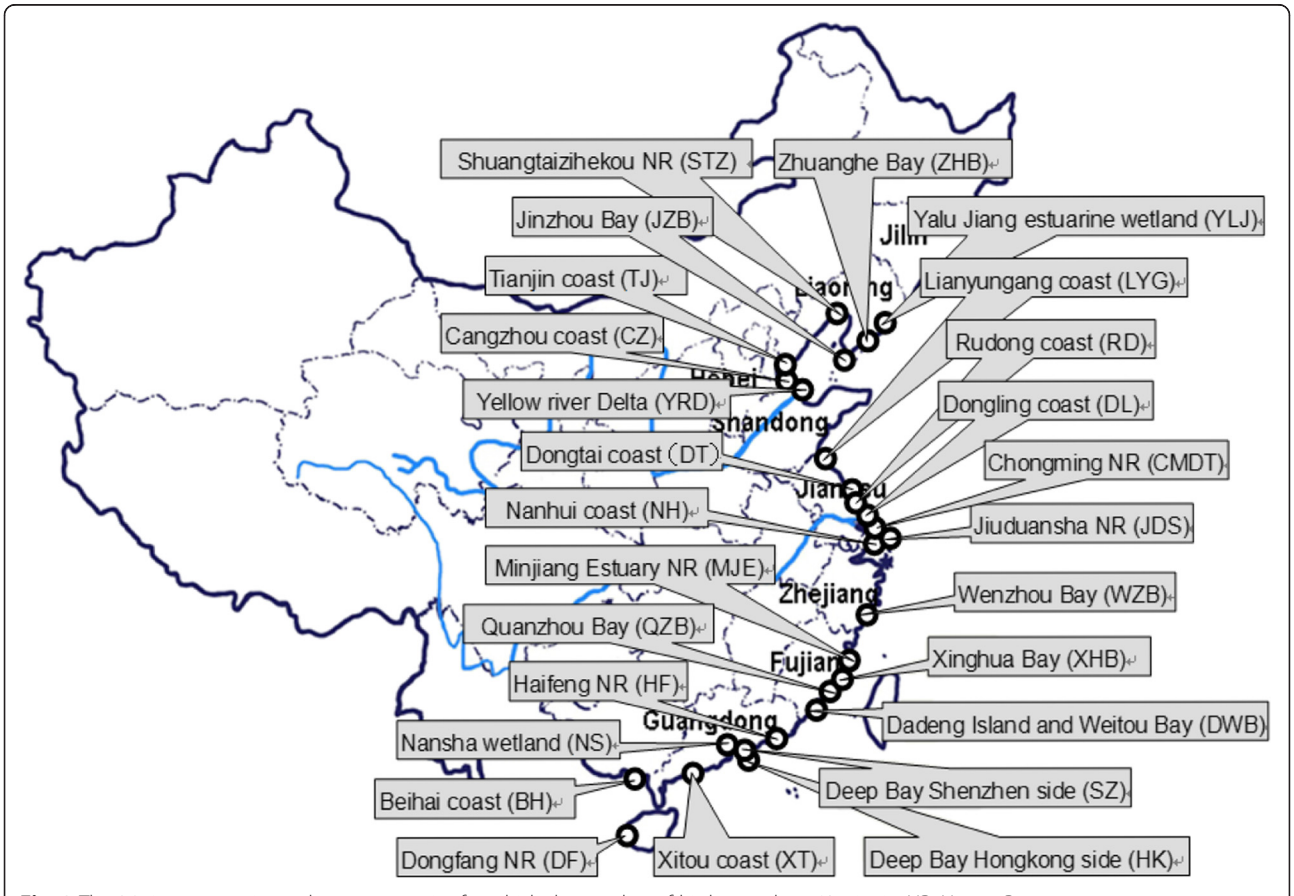

Fig. 2 The 26 sites supporting at least one species for which the number of birds met the 1 % criteria. NR: Nature Reserve

Table 3 Sites of international importance for waterbirds and their current protection status

Name of survey site	Latitude (N)	Longitude (E)	Area covered	Main habitat types	Protection status
Yalu Jiang estuarine wetland (YLJ), Liaoning	39°51′	124°11′	Yalu Jiang Estuary National Nature Reserve	Intertidal mudflat and aquaculture pond	National Nature Reserve
	39°52′	124°13′	Yalu Jiang West + Ash pond	Intertidal mudflat, ash storage pool	
	40°24′	124°48′	Yalu River in Dandong	River	
	40°01′	124°00′	Helong Reservoir	Reservoir and rice field	
Zhuanghe Bay (ZHB), Liaoning	39°40′	123°00′	Zhuanghe river mouth + Geli Island	Intertidal mudflat, aquaculture pond	
	39°36′	122°54′	Zhuanghe Port + Xiaotangfu Village	Intertidal mudflat, aquaculture pond	
Jinzhou Bay (JZB), Liaoning	39°06′	121°40′	Maoyingzi Dumping Area	Intertidal mudflat, dumping area	
Shuangtaizihekou National Nature Reserve (STZ), Liaoning	40°50′	121°30′	Shuangtaizihekou National Nature Reserve	Intertidal mudflat and pond	National Nature ReserveRamsar Site
Tianjin coast (TJ)	38°46′	117°35′	Beidagang Wetland Provincial Nature Reserve	Reservoir and pond	Provincial Nature Reserve
	38°50′	117°37′	Coast from Qingtuozi to Tangjiahekou	Intertidal mudflat	
Cangzhou coast (CZ), Hebei	38°23′	117°41′	Nandagang Wetland and Bird Provincial Nature Reserve	Reservoir	Provincial Nature Reserve
	38°31′	117°39′	Coast of Huanghua Port and Huanghua	Intertidal mudflat and pond	
	38°11′	117°44′	Haixing Wetland and Bird Provincial Nature Reserve	Reservoir, lake, intertidal mudflat	Provincial Nature Reserve
Yellow River Delta (YRD), Shandong	38°00′	118°50′	Yellow River Delta National Nature Reserve	Intertidal mudflat, reed field, pond	National Nature ReserveRamsar Site
	37°29′	118°51′	Guangbei Reservoir + coastal mudflat	Reservoir and intertidal mudflat	
	37°23′	118°49′	Swan Lake	Lake	
Lianyungang coast (LYG), Jiangsu	34°47′	119°14′	Linhong mouth	Intertidal mudflat and aquaculture pond	
	34°31′	119°38′	Liezi mouth	Intertidal mudflat and aquaculture pond	
Dongtai coast (DT), Jiangsu	32°45′	120°57′	Tiaozini Reclamation District, Jianggang, Dongtai	Intertidal mudflat, reclamation district	
Rudong coast (RD), Jiangsu	32°34′	121°02′	Xiaoyangkou, Rudong	Intertidal mudflat	
	32°30′	121°10′	Fengli Town, Rudong	Intertidal mudflat	
Dongling coast (DL), Rudong, Jiangsu	32°13′	121°27′	Dongling Kuqu Industrial Area	Intertidal mudflat, aquaculture pond	
Nanhui coast (NH), Shanghai	30°55′	121°57′	Eastern tidal flat of Nanhui	Intertidal mudflat and reed field	
Chongming Dongtan National Nature Reserve (CMDT), Shanghai	31°30′	121°58′	Chongming Dongtan Bird National Nature Reserve	Intertidal mudflat, reed field	National Nature ReserveRamsar Site
Jiuduansha Wetland National Nature Reserve (JDS), Shanghai	31°11′	122°02′	Jiuduansha Wetland National Nature Reserve	Intertidal mudflat	National Nature Reserve
Wenzhou Bay (WZB), Zhejiang	27°56′	120°52′	Wenzhou Bay	Reclamation pond, intertidal mudflat	
Minjiang Estuary National Nature Reserve (MJE), Fujian	26°00′	120°00′	Minjiang Estuary National Nature Reserve	Intertidal mudflat	National Nature Reserve
Xinghua Bay (XHB), Fujian	25°28′	119°12′	Jiangkou town, Hanjiang district, Putian	Intertidal mudflat, aquaculture pond	
Quanzhou Bay (QZB), Fujian	24°50′	118°46′	Quanzhou Bay and Jinjiang Estuary	Intertidal mudflat, pond	

Table 3 Sites of international importance for waterbirds and their current protection status *(Continued)*

Dadeng Island and Weitou Bay (DWB), Fujian	24°32′	118°32′	Dadeng Island in Xiamen and Weitou Bay in Quanzhou	Intertidal mudflat and saltworks	
Haifeng Nature Reserve (HF), Guangdong	22°52′	115°19′	Haifeng Bird Provincial Nature Reserve	Intertidal mudflat, mangrove and aquaculture pond	Provincial Nature Reserve
Deep Bay, Shenzhen side (SZ)	22°32′	114°00′	Shenzhen side of Deep Bay, including Futian National Nature Reserve	Intertidal mudflat, mangrove and aquaculture pond	National Nature Reserve
Deep Bay, Hong Kong side (HK)	22°30′	114°00′	Hong Kong side of Shenzhen Bay(Deep Bay), including Mai Po Nature Reserve	Intertidal mudflat, aquaculture pond and mangrove	National Nature Reserve Ramsar Site
Nansha Wetland (NS), Guangdong	22°36′	113°40′	Nansha Wetland Park	Ponds, mangrove	Wetland Park
Xitou coast (XT), Guangdong	21°37′	111°47′	Coast of Santouzui Village, Xitou, Yangxi county	Intertidal mudflat, mangrove and aquaculture pond	
Dongfang Nature Reserve (DF), Hainan	19°13′	108°39′	Coast of Sibi villiage, Sigeng, Dongfang City	Intertidal mudflat, mangrove	Provincial Nature Reserve
Beihai coast (BH), Guangxi	21°24′	109°11′	Coast of Yintan and Daguansha, Beihai	Intertidal mudflat, aquaculture pond and mangrove	

Conclusions

Globally, citizen science is making an increasing contribution to scientific research, especially in bird studies (Greenwood 2007; Ma et al. 2013). The China Coastal Waterbird Census is a typical case of citizen science in China: all the surveys over the past eight years were conducted by volunteer birdwatchers in their spare time. Information from the surveys is vital for understanding waterbird populations and their dynamics along China's coasts and critical for conservation strategies.

Over the past three decades, China's coastal wetlands have been subject to intensive development and the rate of wetland loss is still accelerating (Ma et al. 2014; Murray et al. 2014). The loss and degradation of coastal wetlands have become the most serious threats to waterbirds (Hua et al. 2015), which might be the major causes for the decrease in the number of waterbirds at some survey sites, e.g., the Tianjin coast (Yang et al. 2011).

Coordinated and regular waterbird surveys over the long-term, covering China's coasts, will continue to provide baseline data for understanding the effects of habitat changes on waterbirds.

Our data will contribute to the demarcation of 'ecological red lines' (Li 2014) in order to maintain biodiversity in China. It must be recognised, however, that our surveys are not comprehensive and many coastal areas remain unsurveyed, which potentially could support important waterbird populations[1].

Endnote

[1]As this paper was being finalized we discovered two further sites that support internationally important number of waterbirds, i.e., Yingkou, Liaoning (Great Knot, Far Eastern Curlew, Saunders's Gull, Relict Gull) and Qingduizi, Dalian, Liaoning (Great Knot, Far Eastern Curlew, Far Eastern Oystercatcher, Saunders's Gull).

Competing interests

The authors declare they have no competing interests.

Authors' contributions

All authors guided and participated in waterbird surveys at different sites along China's coast. All authors contributed to this work. The initial draft was prepared by QQB and all authors read and approved the final manuscript.

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