

The Yangtze River dolphin or baiji (Lipotes vexillifer): population status and conservation issues in the Yangtze River, China

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ABSTRACT

1. Baiji were sighted 17 times during three recent simultaneous multi-vessel surveys in the Yangtze River, China (November 4–10, 1997; December 4–9, 1998; October 31–November 5, 1999). There were 11 sightings in 1997 (consisting of 17 animals), five in 1998 (seven animals), and two in 1999 (four animals). It was concluded that 13 individuals could be considered as a minimum number of the baiji currently in the Yangtze River.

2. An annual rate of population decrease was roughly estimated as 10%. From the body sizes observed, the proportions of old, adult and immature individuals were approximately estimated at 57, 26, and 17% respectively.

3. Baiji showed a significant attraction to confluences and sand bars with large eddies. The present distribution range of the baiji is less than 1400 km in length in the Yangtze main river. Distances between the two nearest groups of baiji appear to be increasing.

4. Two typical sightings are described, in which surfacing and movements of baiji were recorded. Baiji were often found swimming together with finless porpoise. In the surveys they occurred in the same group in 63% of occurrences. Interactions between baiji and finless porpoise are described and discussed.

5. Human activities are the main threats to the baiji. Illegal electrical fishing accounted for 40% of known mortalities during the 1990s. Engineering explosions for maintaining navigation channels have become another main cause of baiji deaths. The last hope of saving the species may be to translocate the remaining baiji into a semi-captive reserve, known as the 'Baiji Semi-natural Reserve'.

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KEY WORDS: Yangtze River dolphin; baiji; conservation

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INTRODUCTION

The baiji or Yangtze River dolphin (*Lipotes vexillifer*, Miller), which inhabits only the middle and lower reaches of the Yangtze River in China, is the world's most endangered cetacean species (Reeves and Leatherwood, 1994; Reeves *et al.*, 2000). In a similar way to other river cetaceans (Smith *et al.*, 1994) the baiji faces human impacts, such as overfishing of prey species, accidental killing as a result of gillnet by-catch, ensnarement in rolling hook fishing gear, electrocution from electrical fishing methods, collisions with motorized vessels, habitat loss and disturbance resulting from the construction of water development projects, and water pollution (Chen and Hua, 1989; Chen *et al.*, 1992; 1993).

Except for the baiji, there is another small cetacean that shares the Yangtze River—the finless porpoise (*Neophocaena phocaenoides*, Pilleri and Gühr). The finless porpoise is a small-toothed cetacean species, and is distributed in a narrow band along the coast of tropical and temperate Asia. It also occurs in the middle and lower reaches of the Yangtze River, Dongting Lake and Poyang Lake of China. All other known populations of the species occur principally in marine and estuarine waters. The population in the Yangtze River is a unique freshwater sub-species known as the Yangtze finless porpoise (*N. p. asiaeorientalis*). This suffers from many of the same impacts that affect the baiji in the Yangtze River and populations have been continuously decreasing in recent years (Zhang *et al.*, 1993; Wang *et al.*, 1996, 1998). The porpoise was listed in the 2000 IUCN Red List of Threatened Animals as 'Endangered (EN C2b)'.

Because of the small population size of the baiji, opportunities to observe them in the wild are very rare. In the past, several methods have been used to survey baiji and estimate their absolute or relative abundance (Table 1, Figure 1). However, there have been problems with the surveys. The baiji's scattered distribution and low density make them difficult to find and count. In addition, funds to carry out expensive boat-based surveys have been difficult to secure.

To meet these challenges, both single- and multi-vessel surveys have been carried out (Zhou *et al.*, 1977; Chen *et al.*, 1980; Zhou *et al.*, 1980; Zhou, 1982; Zhou *et al.*, 1982; Lin *et al.*, 1985; Chen *et al.*, 1987; Chen

Table 1. Survey results between 1979 and 1996

Code in Figure 1	Year	Survey area	Survey method	No. of boats	No. of km surveyed	No. of surveys sighted	No. of baiji groups	No. of baiji estimated	Authors
1	1979	Wuhan-Chenglingji	S	1	230	1	19		Chen <i>et al.</i> , 1980
2	1979	Nanjing-Taiyangzhou	S	1	170	2	10		Zhou <i>et al.</i> , 1980
3	1979–1981	Nanjing-Guichi	S	1	250	6	3–6 groups	400	Zhou <i>et al.</i> , 1982
4	1978–1985	Yichang-Nantong	S	1	1600	9	> 20 groups	156	Lin <i>et al.</i> , 1985
5	1985–1986	Yichang-Jiangyin	M	1 + 4–6 ^a	1510	2	42 groups	300	Chen and Hua, 1986, 1989
6	1979–1986	Fujiangsha-Hukou	S	1	630	18	78–79	100 ^b	Zhou and Li, 1989
7	1987–1990	Yichang-Shanghai	M + B	1 + 4–6 ^a	1669	12	108	200	Chen <i>et al.</i> , 1993
8	1989–1991	Hukou-Zhenjiang	P	8 boats	500	5	29	120	Zhou <i>et al.</i> , 1993a, b
9	1991–1996	Xinchang-Wuhan	M	1 + 4–6 ^a	413	10	42	< 100	Wang <i>et al.</i> , 1998

^aOne main vessel plus four to six small boats.

^bLower reaches only.

S denotes single boat survey. M denotes Multi-vessel survey. B indicates observation from the river bank. P denotes that opportunistic photo-identification of individual animals was possible.

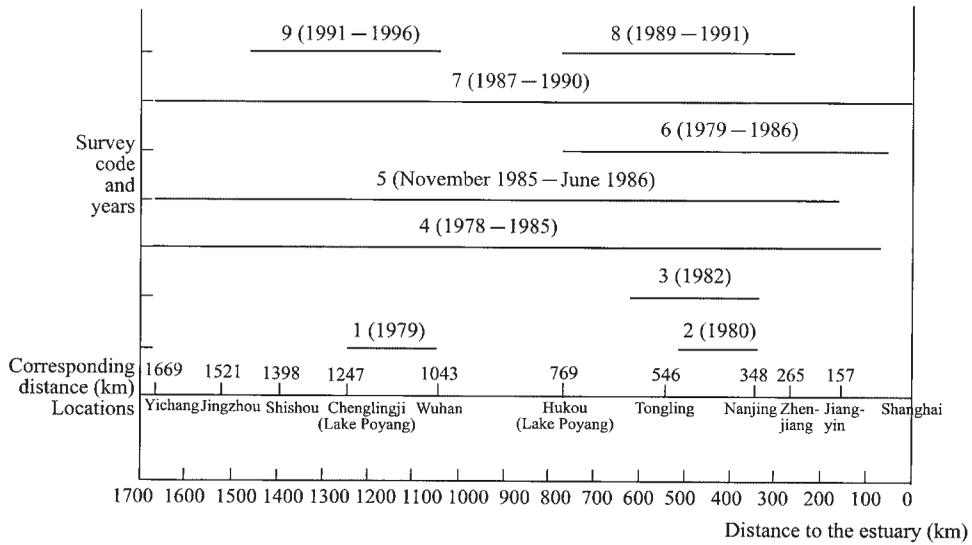


Figure 1. Survey history of baiji between 1979 and 1996 (for survey codes refer to Table 1).

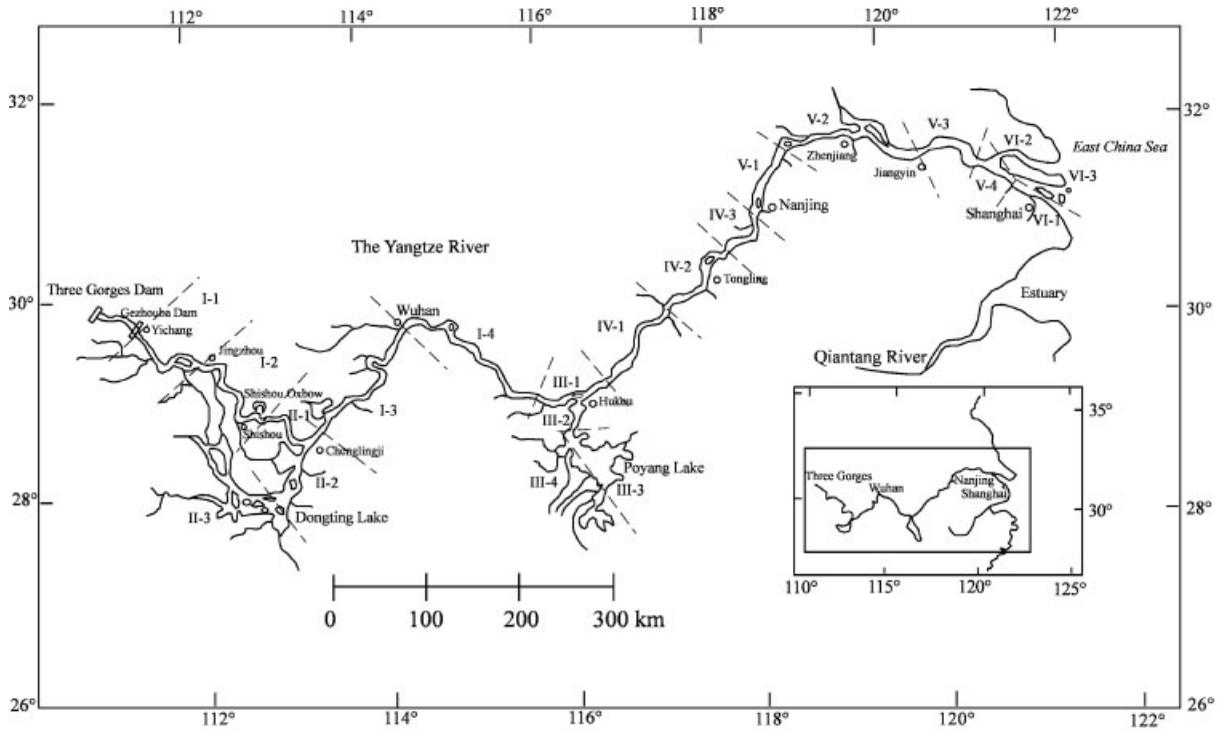


Figure 2. Map of the middle and lower reaches of the Yangtze River, and the Qiantang River, showing survey areas and the estuary area (also refer to Table 2).

and Hua, 1989; Zhou and Li., 1989; Chen *et al.*, 1993; Zhang, 1993; Zhou *et al.*, 1993a). Using a mark-recapture model, photo-identification approaches have been tested (Hua *et al.*, 1990; Zhou *et al.*, 1993b; Hua *et al.*, 1994). Results of surveys of isolated sections of the river are shown in Table 1 and Figure 1. Because of the difficulty in studying the baiji and the different methods used, it is not surprising that estimated numbers vary considerably. However, the evidence suggests that numbers are declining (Table 1). A recent estimation of the baiji's population size was fewer than 100 individuals, according to extrapolations from single and multi-vessel, relative abundance surveys, calculated from sightings per day or per kilometre (Zhang *et al.*, 1993; Liu *et al.*, 1996; Wang *et al.*, 1996, 1998; Liu *et al.*, 1997a; Xiao and Zhang, 2000).

In this study new sighting data on the baiji population is presented from three simultaneous multi-vessel surveys in the Yangtze River from November 1997 to November 1999. The surveys were designed to maximize precision and minimize bias by providing maximum simultaneous observer coverage. The implications of the survey results for survival of the species and conservation 'rescue' measures are also discussed.

METHODS

Definition of study area and observer training

Based on previous knowledge of baiji distribution, the study area was defined as the main river of the middle and lower reaches of the Yangtze River, and its estuary. The main river and the estuary were divided into 16 sections (Figure 2). Lengths of these sections varied from 50 to 200 km. A total length of 1687 km

Table 2. Study areas and sections of the three surveys (also refer to Figure 2)

Area code in Figure 2	Study areas/sections	Section length in the river (km)	Distance from the mouth of the river at Shanghai (km)	Surveying year		
				1997	1998	1999
I	<i>Hubei</i>					
I-1	Yichang-Jingzhou	148	1669–1521	✓		
I-2	Jingzhou-Tashiyi	152	1521–1369	✓	✓	✓
I-3	Luoshan-Wuhan	201	1244–1043	✓	✓	✓
I-4	Wuhan-Wuxue	206	1043–837	✓		
II	<i>Hunan</i>					
II-1	Tashiyi-Luoshan	125	1369–1244	✓	✓	✓
III	<i>Jiangxi</i>					
III-1	Wuxue-Madang	122	837–715	✓	✓	✓
IV	<i>Anhui</i>					
IV-1	Madang-Zongyang	120	715–595	✓		
IV-2	Zongyang-Digang	106	595–489	✓	✓	✓
IV-3	Digang-Ma'anshan	94	489–395	✓		
V	<i>Jiangsu</i>					
V-1	Ma'anshan-Siyuangou	99	395–296	✓	✓	✓
V-2	Siyuangou-Jiangyin	140	296–156	✓	✓	✓
V-3	Jiangyin-Langshan	67	156–89	✓		
V-4	Langshan-Liuhekou	67	89–22	✓		
VI	<i>Shanghai</i>					
VI-1	South Branch of Congming Island	50	22–28 ^a	✓	✓	✓
VI-2	North Branch of Congming Island	50	22–28 ^a	✓		
VI-3	Beigang Branch of Congming Island	50	22–28 ^a	✓		

^aThese surveys went beyond the 0 km point and extended up to 28 km into the oceanic waters.

was surveyed in the main river. Two lakes, the Poyang Lake and Dongting Lake, which are the two largest lakes in China and still linked to the main river, were also surveyed during 1997–1999 (Figure 2, Table 2).

To standardize the survey methods, training courses were held for all the observers before the start of the first survey. About 300 people were involved in the surveys; most were not researchers but well-educated fishery management officers. Three-day training courses were arranged and only trainees who passed a final examination could serve as observers. There was at least one experienced observer in each survey vessel.

Survey procedures

There were two survey vessels for each section. Each river section was scanned at least twice during each survey (Figure 3). Binoculars ($\times 7$ to $\times 10$ power) and the naked eye were used in searching for baiji from research vessels with platform heights that varied from 2 to 4 m. Usually, each research vessel carried three observers. The speed of the two vessels was kept at $8\text{--}12\text{ km h}^{-1}$. The two vessels could cover a stripe width of 1200 m. Data forms modified from Smith and Reeves (2000) were used on all survey vessels.

When a group of dolphins (not only baiji, but also the Yangtze finless porpoise) was first sighted, the vessel slowed down as the dolphins were approached. The captain reported sightings to another vessel sailing in parallel by using marine-band (VHF) hand-held radios or mobile phones. After the sighting was

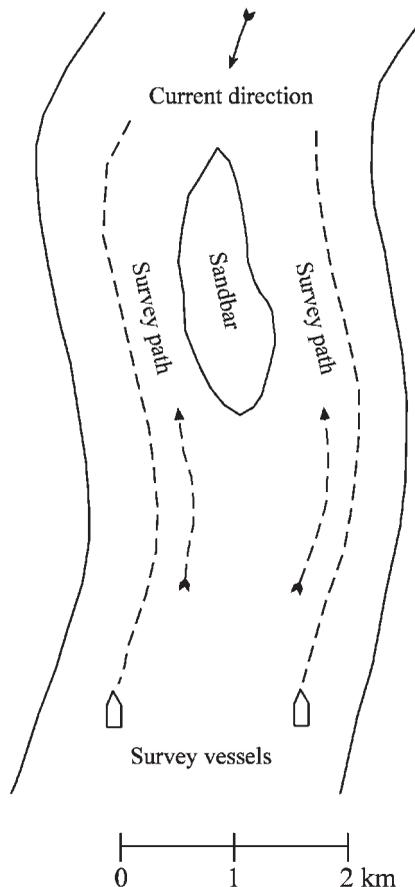


Figure 3. Survey track in the river.

Table 3. Environment codes used in this study

Code	Environment type	Code	Environment type
1	Confluence—river	10	Water channel of sand bar
2	Confluence—stream	11	City/town/port
3	Confluence—lake	12	Factory with discharge into the river
4	Sand bank	13	Fishing area—rolling hooks
5	Sand bar	14	Fishing area—nets
6	Soil bank	15	Fishing area—boxing nets
7	Rock bank	16	Dredging area
8	≤90° turn	17	Construction (dam, sluice gate, etc.)
9	<180° turn		

made, one observer tracked the baiji by naked eye or sometimes by binoculars, while a second recorded information on the data forms. Where possible, a third observer photographed the dolphins. Time and location (local place name), direction of travel, direction and distance from the vessel, and distance to the nearest bank were recorded as well as any human activities in the vicinity and the habitat in which the animals were sighted (Table 3). At the same time, the vessel followed behind the cetaceans and maintained a similar speed to the dolphin group. Once a group was close enough for all surfacings to be easily observed, the minimum, maximum, and best estimate of total number of animals present was recorded. Where possible the numbers of 'large', 'medium', and 'small' individuals was recorded. The large animals had a body length more than 2.5 m, small ones about 1–1.5 m, and medium-sized animals around 2 m. Calves were defined by their small body size (about half the length of an accompanying adult) and the positioning of the lower jaw close to an adult's flipper.

The timing of the surveys was determined by the water level in the Yangtze River. The river's flood season usually ends when the water level is consistently lower than 6.2 m at Chenglingji Station in the mouth of the Dongting Lake. The first survey was conducted on 4–10 November 1997 using 34 vessels. During the second survey (4–9 December 1998) 14 vessels were used, and 16 vessels were used during the last survey (31 October–5 November 1999). The number of survey sections was reduced during the last two surveys because of funding shortages (Table 2, Figure 4).

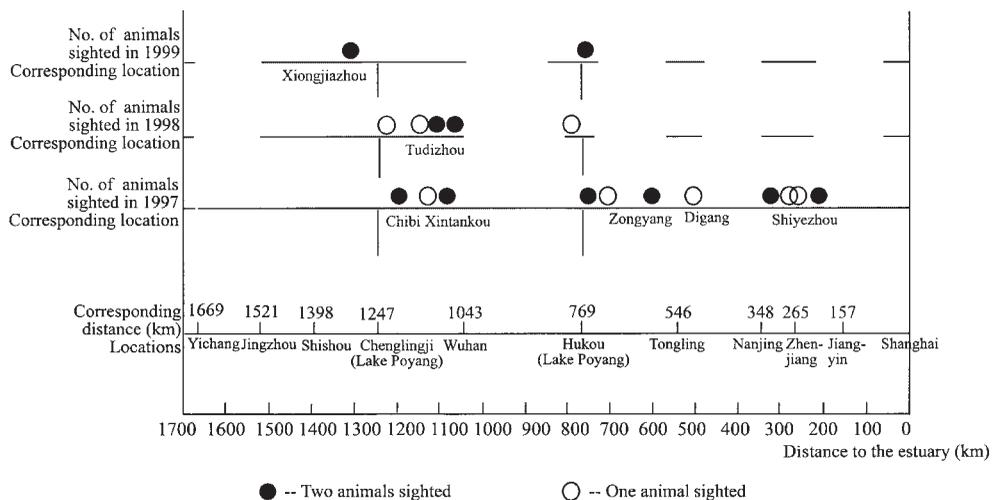


Figure 4. Time and location of baiji sighted in the three surveys (also refer to Table 4).

Table 4. Sightings of baiji in the three surveys, with group size estimates. L denotes a large animal, M is medium-sized, S is small. f.p. denotes finless porpoises that were also present.

Sighting/ Survey year	Date and times	Location, distance to the estuary	Behaviour	Size class			Estimates of group size			Human activities/habitat type (refer to Table 3)
				L	M	S	Best	High	Low	
1/97	11/09, 1440	Chibi, 1206 km	Up and down river with three f. p.		2		2	2	2	-/1, 3, 7, 11
2/97	11/09, 0905	Tudizhou, 1136 km	Grouping with 20 f. p.	1						-/5
3/97	11/08, 0725	Xiangxintan, 1120 km	Up river, feeding with 30 f. p.	1		1	2	3	2	Transportation vessel/ 3
4/97	11/05, 0857	Balijiangkou, 769 km	Down river, with 4 f. p.		1		2	3	2	-/1, 4, 5, 6
5/97	11/05, 1035	Balijiangkou, 769 km	Up river, with f. p.		2				2	-/1, 4, 5, 6
6/97	11/06, 1530	Zongyang, 603 km		1		1	3	3	3	Transportation vessel/ 1
7/97	11/07, 1430	Digang, 491 km		1						-/1, 7
8/97	11/05, 1056	Xixiashan, 321 km	Grouping, feeding with f. p.		2					-/6, 17
9/97	11/05, 0945	Jiaoshan, 265 km	Down river, with 5 f. p.	1			4	4	4	Transportation vessel/ 10
10/97	11/05, 1030	Jiaoshan, 258 km		1		1				-/5
11/97	11/08, 1320	Jiaoshan, 258 km		1						-10
Subtotal					17 counts		13	15	13	
12/98	12/04, 1050	Leigutai, 1273 km		1			1	1	1	-/5
13/98	12/06, 1320	Shangbeizhou, 1135 km	Down with 4 f. p.	2						
14/98	12/08, 1508	Yaohu, 1140 km	Up river, with f. p.	1			2	2	2	Transportation and fishing vessels
15/98	12/09, 0923	Tudizhou, 1136 km	Up river, with f. p.	2						
16/98	12/07,	Jiujiang, 810 km	Grouping, with f. p.	1			1	1	1	
Subtotal					7 counts		4	4	4	
17/99	11/02, 1102	Xiongzhou, 1308 km	Grouping, with f. p.	2			2	2	2	-/5, 6, 7
18/99	11/03, 0954	Balijiangkou, 769 km		1		1	2	2	2	Transportation vessel/ 1, 4, 5, 6
Subtotal					4 counts		4	4	4	
Total					28 counts		21	23	21	

L denotes a large-sized animal, M is medium-sized, S is small, and f. p. denotes finless porpoises that were also present.

Data processing

An estimate of absolute abundance was not calculated, as the number of sightings was too small. The data were treated as relative abundance estimates of number of sightings per vessel day (SPVD). Population trends were compared among SPVDs from different surveys. Data from other surveys conducted in the 1990s were also used for documenting behaviour and causes of mortality.

RESULTS

Sightings across study areas

Baiji groups were encountered 17 times during the three surveys: 11 in 1997 (consisting of 17 animals), five (seven animals) in 1998, and two (four animals) in 1999. From the sightings, an estimate of total sighted number in the survey was 21–23 individuals, in which 13–15 individuals were sighted in 1997, four in 1998, and another four in 1999 (Table 4).

Population trends and composition

Although the sample size was too small for detecting statistically significant trends in abundance, the values of SPVDs (Figure 5) suggest that the population appears to be decreasing (at roughly 10% per annum). At this rate, the baiji will soon become extinct unless drastic conservation measures are taken (Zhang *et al.*, 1994).

From the above estimate of group size, and their body sizes, the proportion of large, medium, and small individuals of the whole population could be roughly counted. The proportion was 57% for large ones (13), 26% for medium-sized ones (6), and 17% for small ones (4). Male baiji mature at 4 years old with a body length of 172 cm while females mature at 6 years old with a body length of 205 cm (Chen *et al.*, 1985). Suppose the large individuals correspond to post-adult or old animals, medium-sized individuals correspond to adult ones, and small individuals correspond to immature animals, the population structure tends to be aging compared with that in 1985 (Lin *et al.*, 1985). The proportion for post-adult and old animals increased from 29 to 57%, that for mature animals changed from 41 to 26%, and that for immature ones decreased from 31 to 17%. On the other hand, newborn baiji were sighted on these surveys. A neonate was observed with an accompanying adult at Zhangjiazhou, 769 km from the river mouth on November 3, 1999, close to the entrance of Poyang Lake.

Habitat preferences

Twenty-three habitat types were recorded during 16 sightings in the 1997 survey (sometimes one sighting composed more than one habitat type), including river confluences (30%); sand bars (17%); lake

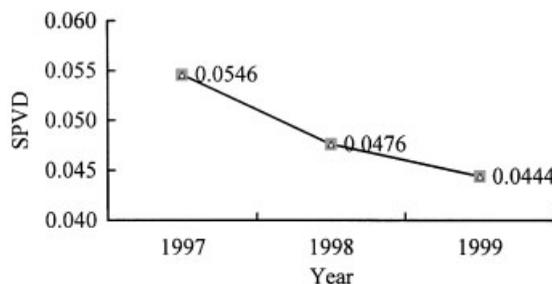


Figure 5. Comparison of sightings per vessel day (SPVDs) among the three surveys.

confluences, soil banks, rock banks, and water channels within sand bars (9% each); and others (17%). The results suggested that baiji was significantly attracted to confluences and sand bars with large eddies. These areas may provide benefits to the baiji, and appeared to strongly influence their distribution (Hua *et al.*, 1989). A higher fish density was also found in those areas since more fishing boats were usually encountered during the surveys. On the other hand, many of these preferred habitats were unpopulated by baiji along the middle and lower reaches of the Yangtze River.

Distribution and movements

No sightings were recorded in the section between Yichang and Jingzhou (1689–1521 km from the river mouth), between Jiangyin and the estuary (156–0 km from the river mouth), and around the estuary area during the three surveys. No sightings were recorded either in the Poyang Lake or in the Dongting Lake. This suggests that the baiji are distributed only in the main stream of the Yangtze River and that at present there are no baiji in the section upstream of Jingzhou and in the section below Jiangyin. This means that the present range of baiji is less than 1400 km in length, similar to that reported by Chen *et al.* (1997).

Baiji may stay in one area as long as 20 days. One large baiji was seen in the north channel of the Balijiangkou area on 27 October 1994 (Figure 6). There was a small prominence in the front of its dorsal fin, which made it easy to re-identify later. The baiji swam up and down in a 2–3 km segment throughout the day. The same animal was seen again in the same area on November 17 for 20 min, and it was sighted again the following day. It is possible that the baiji had remained in the same area for this 20-day period. Zhou *et al.* (1993a, b) also recorded that a baiji remained within a 10 km segment for as long as about a month.

Baiji may also make long-range movements. Hua *et al.* (1994) recorded a single individual moving more than 300 km from March 1989 to January 1992, implying that the baiji's distribution range may be dynamic. Anecdotal information from fishermen in the river during the surveys indicated that baiji move upstream when water rises in the spring and downstream when water recedes in winter.

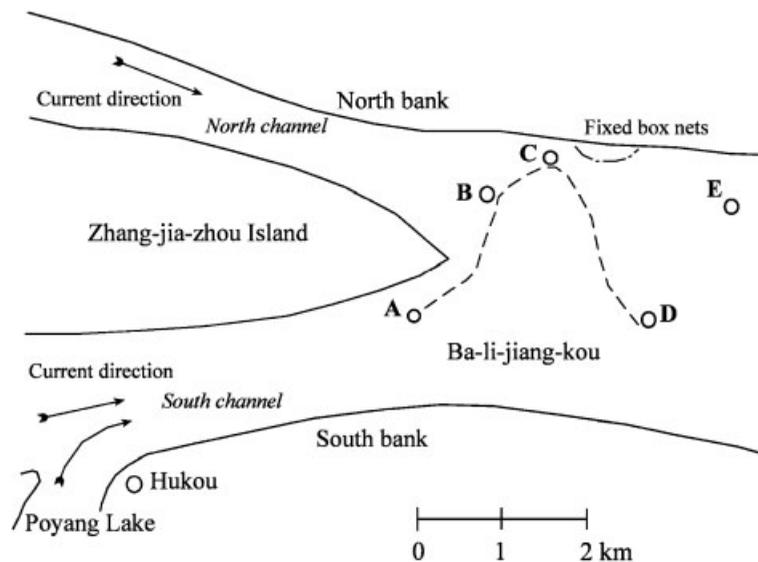


Figure 6. Sketch map of Ba-li-jiang-kou area, showing the moving path of a baiji sighted on November 5, 1997.

Distances between dolphin groups varied from 67 to 351 km (mean = 159 km) in 1997, 135 to 346 km (mean = 241 km) in 1998, and 537 km in 1999 (Table 5). The distance between groups or individuals appears to be increasing, making it more difficult for the dolphins to encounter each other for mating or for other interactions.

Descriptions of two typical sightings

As there are so few baiji surviving, and opportunities to see them in the wild are so rare, description of the sightings made during the surveys is considered valuable and two typical sightings are described below.

One individual (sighted for the first time) and two individuals (sighted for the second time, on the same day), were recorded in Balijiangkou of Jiangxi Province, 769 km from the river mouth, on 5 November 1997. The first baiji, a medium-sized animal, was seen by Vessel no. 32 at 08:57 near the end of Zhangjiazhou Island, a 15 km long island in the main river near the mouth of Poyang Lake (Figure 6). At this location, the island divides the river into two channels (north and south). The south channel is the main channel used by shipping, and it is also connected to the mouth of Poyang Lake. The two channels join together at the end of the island, where it is called Balijiangkou. The baiji was seen at point A downstream at 08:57, where it was about 100 m from the island (Figure 6). Soon, the baiji crossed the river towards the north, and arrived at point B in the north channel. The baiji kept downstream and swam to within about 50 m of the north bank at point C. There were three sets of fixed box nets in the shallow water near point C, where three finless porpoises were seen. When the baiji met the finless porpoises, they stayed together for 4 min, swimming together. The baiji subsequently headed downstream to the main river, and was last sighted at point D at 09:19. Seventy-six minutes later, two medium-sized baiji were sighted upstream by Vessel no. 33, associating with finless porpoises at point E, about 1.5 km from point C and 200 m from the north bank. The two baiji changed direction going downstream to the main river and departed soon when vessels nos. 32 and 33 tried to approach to them. It appeared that one of the two 'newcomers' was the animal which had been sighted 76 min previously. For these encounters, the minimum and best estimate of group size was two, and the maximum estimate of group size was three (Table 4).

Two large animals were sighted in Xiongjiazhou (Hubei Province) 1308 km from the river mouth, at 11:02 on 2 November 1999. About 30 counts of surfacing were recorded for the two baiji during an 8 min period of observation. It was the only record for baiji surfacing rates during the three surveys. The surfacing rates were about 1.88 min^{-1} , which were a little higher than the value of 1.75 min^{-1} , observed by Würsig *et al.* (2000), and that of Qi-Qi (a captive male baiji in Wuhan, China): 1.77 min^{-1} (Yang *et al.*,

Table 5. Distances between two nearest groups in the three surveys

Location	Distance from the mouth of the river at Shanghai (km)	Year sighted	Distance between two groups or individuals (km)	Average distance (km)
Chibi	1206	1997	86	
Xiangxintan	1120	1997	351	
Zhangjiazhou	769	1997	166	
Zongyang	603	1997	112	159
Digang	491	1997	170	
Xixiashan	321	1997	67	
Dingyizhou	254	1997		
Leigutai	1271	1998	135	241
Tudzhou	1136	1998	346	
Jiujiang	790	1998		
Xiongjiazhou	1306	1999	537	537
Zhnagjiazhou	769	1999		

1997). These two baiji completely mixed with a large group of about 30 Yangtze finless porpoises; in fact, they were first seen after researchers had started to record the numbers and surfacing rates of the porpoise group.

Interactions with Yangtze finless porpoises

It was often observed in the current surveys that baiji swam together with the Yangtze finless porpoises. In 1997, the proportion of encounters in which baiji and the Yangtze finless porpoise were found together was as high as 63% of the total sightings. On 8 November 1997, two baiji were observed with about 30 Yangtze finless porpoises in Xiangxintan. The two baiji stayed beside each other swimming upstream with the porpoises during a 15 min period of observation. A similar situation was observed during the 1999 survey, at Xiongjiashou, Hubei Province; on 2 November 1999, two baiji were found with a group of about 30 porpoises.

Two or three Yangtze finless porpoises pursued a baiji against the current in Balijiangkou (Figure 6) on 27 October 1994. At first, the porpoises surfaced following on the fluke of the baiji; sometimes, the baiji and the two porpoises surfaced at the same time side by side. Occasionally, a porpoise's body crossed above the baiji's. It appeared as though the porpoise was trying to push down or submerge the baiji, even though the baiji was strong enough to resist.

DISCUSSION

Population trends

The results from the simultaneous multi-vessel surveys are believed to be more reliable than those from previous single-vessel surveys or one team multi-vessel surveys. However, it is still considered that the sighting rates in the surveys were lower than expected due to the great width of the river, variation in observers' searching ability, influence of weather on sighting conditions, the relatively short duration of the surveys, and the cryptic behavior of baiji. Therefore, 13 individuals, the number sighted in 1997, can only be considered as a minimum number of the baiji currently in the Yangtze River.

Threats and conservation recommendations

Twelve baiji deaths were recorded in the 1990s (Table 6), although complete details were not available for all of these. Of the five where the sex of the animal was known, four were females. Illegal fishing using

Table 6. Records of accidental deaths of baiji from 1990–1999

Date	Location	Sex	Body Length (cm) or Weight (kg)	Causes of death	Percentage
Spring 1990	Hubei	?	?	Poison	20
Spring 1990	Hubei	?	?	Poison	
1991/10/??	Wangjiang	?	150 kg	Electricity	40
1992/09/25	Zongyang	M	38 kg	Electricity	
1994/04/??	Ma'anshan	?	200 kg	?	
1995/02/??	Shishou	F	?	Explosion	20
1995/02	Huangshi	?	?	Explosion	
1995/11/??	Taiyangzhou	?	?	?	
1996/06/23	Shishou	F	229 cm	Tangled in nets	10
1996/?	Jiangyin	?	?	Electricity	
1997/01/08	Shishou	F	245 cm/182.5 kg	Electricity	
1998/03/01	Congming	F	226 cm	Stranded	10

electricity has accounted for 40% of known mortalities and has become the main threat to baiji survival, even though rolling hook and other fishing gear accounted for a higher proportion of known deaths in the early 1980s (Chen and Hua, 1989; Zhou and Li, 1989; Zhang, 1993). Engineering explosions for maintaining navigation channels have become another main cause of baiji deaths, while poisoning caused by accidental overturn of vessels transporting pesticide also threatens the Yangtze environment.

A new problem that threatens the baiji is population fragmentation, as the distances between used habitats and groups are increasing. The recent surveys have shown that the distances between the two nearest groups is increasing (Table 5). It should be noted, however, that the data in Table 5 should be treated with caution due to variability in sighting effort. This suspected trend may decrease breeding opportunities, which could lead to low reproduction and inbreeding. Small isolated populations may also be more susceptible to the risks of human impacts and environmental catastrophes (Taylor and Gerrodette, 1993; Zhang *et al.*, 1994).

With the deterioration in the ecological conditions of the Yangtze River because of expanding human activities, and the likelihood that this trend may last for many more years, there may be little hope for the long-term survival of baiji in the river (Reeves *et al.*, 2000). A last resort for the species may be to move the remaining individuals out from the main river into an area where they can enjoy a natural environment with full protection. For this purpose, a so-called 'Baiji Semi-natural Reserve' was established in 1992 in Tian-E-Zhou Oxbow located in Shishou City, Hubei Province (Zhang *et al.*, 1995). This oxbow is 21 km long and 1–2 km wide, and used to be part of the distribution range of the baiji before 1972. It was naturally separated by current force in 1972, but it is still connected to the main river at high water for about 5 months each year. Fish are relatively abundant and there are fewer human activities in the oxbow. Unfortunately, however, a female baiji translocated to this reserve died as the result of accidental entanglement in a barrier net during summer 1996 (Liu *et al.*, 1997a, b). Since then conditions in the reserve have been much improved. A kind of 'hard' barrier—a soil dam with water gates (instead of a net)—has been built at both ends of the reserve. It is proposed that about 600 fishermen who used to make a living by fishing in the reserve should change to culturing fish in ponds outside of the reserve. There are no baiji in the reserve at present, but there are about 20 translocated finless porpoises living there. The porpoises not only survive but also reproduce naturally in the reserve (Wang *et al.*, 2000).

In order to monitor the Yangtze River dolphin population, simultaneous multi-vessel surveys should be conducted once every 3 years. Surveys of relative abundance should be carried out once a year. Line transect surveys by experienced observers should be used to obtain absolute abundance estimates and monitor changes in the baiji population in the Yangtze River in the future. There are still some baiji in the Yangtze River, and their habitat and population should be monitored carefully.

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