Small-scale towing survey combined acoustical and visual observation for finless porpoise in the Yangtze River

SATOKO KIMURA[1], TOMONARI AKAMATSU[2], KEXIONG WANG[3], SONGHAI LI[3], DONG SHOUYUE[3], DING WANG[3] AND NOBUAKI ARAI[1]

[1] *Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan*
Email : sk0130@bre.soc.i.kyoto-u.ac.jp
[2] *National Research Institute of Fisheries Engineering, Fisheries Research Agency, Hasaki, Kamisu, Ibaraki 314-0408, Japan*
[3] *Institute of Hydrobiology, The Chinese Academy of Sciences, Wuhan, 430072, People's Republic of China*

ABSTRACT
The population of Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) has been decreasing rapidly in the last couple of decades. One of the large groups of this species is found near the convergent area of Poyang Lake and the Yangtze River. In this study, to monitor and assess the spatial distribution of this local population, the feasibility of towing acoustic survey method combined with visual observation using small boat was examined. During 11-16 May 2007, we conducted acoustic visual combined observations about 20 km per day in the convergent area. A time window of 100 s was employed to define simultaneous detections by both methods. Using the ratio of simultaneous detections, detection probabilities were calculated by the Petersen method as 56 % for acoustics and 24 % for visual detections, respectively. The detection probabilities of this study were higher than previous work. A survey using small boat and short cable to tow the acoustic system was effective to use to monitor local population.

KEYWORDS: finless porpoise, towing, acoustic data loggers, visual observation, detection probability

INTRODUCTION

Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) is the only freshwater population of finless porpoise living in the middle and lower reaches of the Yangtze River, China (Wei et al., 2002). The population has been decreasing rapidly in the last couple of decades and could be extinct in the next several decades if no conservation measures are taken (e.g. Zhang and Wang, 1997; Wang et al., 2000; Turvey et al., 2007).

It was confirmed by recent genetic studies that the populations were scattered over the habitat area and formed some local stocks (Zheng et al.2005). One of the large groups of this species has been found near the convergent area of Poyang Lake and the Yangtze River (Wei et al., 2002; 2003). However, human activities have been expanded greatly in this area. For their conservation, the monitoring and assessment of the spatial distribution of this group of animals are the important issues.

Yangtze finless porpoises have been observed by visual survey based on a vessel to estimate population size (Zhang et al., 1993; Wei et al., 2003;). However it is difficult to observe finless porpoises in the Yangtze River because finless porpoises are small, have no dorsal fin and no rostrum. Low visibility in the water of the Yangtze River of less than 1 m prevents visual observation of underwater animals.

Yangtze finless porpoises produce high frequency sonar signals frequently, on average 5.1 s (Akamatsu et al., 2005a) or 6.4 s (Akamatsu et al., 2007). Acoustical monitoring methods have been applied for this species these several years, such as a towing hydrophone (Akamatsu et al., 2001), tagging on animal (Akamatsu et al., 2005a) and stationary listening (Wang et al., 2005; Kimura et al., 2007 and submitted).

Akamatsu et al. (2008) validated the detection probability of the towing hydrophone system by using the simultaneous observation data by visual and acoustic methods. Detection probabilities of independent observers can be calculated by a standard statistical methodology so called Petersen method (Buckland et al., 1993).

Although Akamatsu et al. (2008) searched almost all the main stream of the Yangtze River, the data recorded around Poyang Lake mouth area was excluded in analysis because of heavy ship traffic and less maneuverability of the large survey vessel, whereas this area is one of important habitats for the porpoises (Wei et al., 2002). In this study, the feasibility of towing acoustic survey method combined with visual observation using small boat was conducted in this area. Our acoustical system was the same as Akamatsu et al. (2008).

MATERIALS AND METHODS

We investigated this area by towing two acoustic data loggers, called A-tag (ML200-AS2, Marine Micro Technology). The details of A-tag were described in Akamatsu et al. (2005b). The A-tag has two hydrophones and records ultrasonic signals from porpoises swimming within a 150m to 300m radius approximate range (Wang et al., 2005; Akamatsu et al., 2008). When underwater ultrasonic sound is received, the time, the pressure level and the time difference of received sound between the hydrophones are stored.

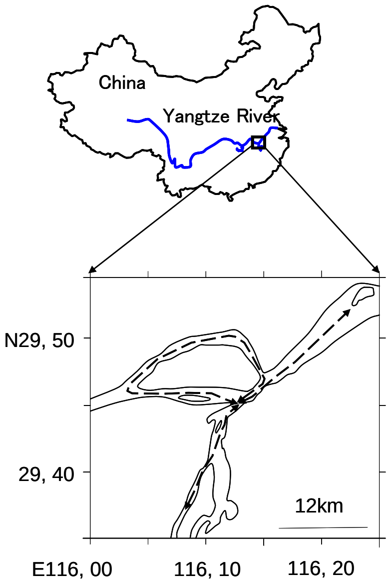

Fig. 1 Map of survey area: the convergent area of Poyang Lake and the Yangtze River. The dashed arrows indicated the survey line.

In the present study, the distal acoustic data logger was towed about 44m behind the survey boat. The other logger was placed 17m ahead of the distal one. To prevent double counting, the boat speed, 5-12 km/h was kept significantly faster than porpoise's swimming speed, 4.5 km/h (Akamatsu et al., 2002).

Using a program written on Igor Pro 5.03 (WaveMetrics, USA), data was visualised including calculated inter-pulse intervals (Fig.2). We could easily identify the track of porpoises because the inter-pulse intervals and sound pressure levels of porpoises changed smoothly (Akamatsu et al., 2005a). The time difference shown in the middle of Fig. 2 corresponded to relative angles of sound source. The positive time difference means the bow of the A-tag and the negative means the sound came from rear. Because the boat was operated faster than porpoises, the time difference of porpoises always changed from positive to negative in time series data, shown in the middle inset of Fig. 2. The number of individual porpoise was counted when porpoises were near the zero of time difference. For example in Fig. 2, one porpoise was passed abeam of A-tag at 10:27.

Visual observation was conducted simultaneously with acoustical observation. Two persons observed porpoises from the top of the decks in standing position with naked eyes. The third person recorded the data. When the observer found porpoise(s), the recorder wrote detected time, the number of animals, the direction from the transect line by clock system and the GPS data.

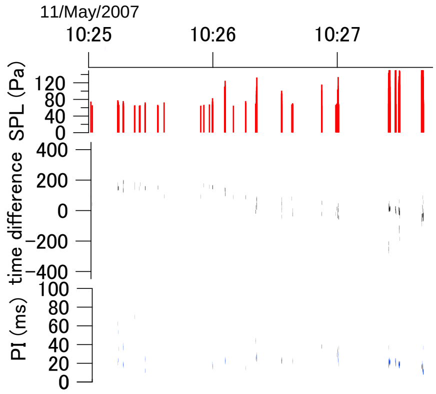

Fig. 2 An example of recorded data in A-tag.
The vertical axes show the received sound pressure level (SPL), the time difference of received sounds and inter-pulse intervals (PI). The positive and negative of the time difference means the bow and rear direction from the acoustic monitoring system.

RESULTS AND DISCUSSION

During 11-16 May 2007, we conducted acoustic visual combined observations about 20 km per day. The survey lines are show as dashed arrows in Fig. 1. Data obtained by the backward logger was used because the backward logger had less noise than the forward one. In total, 133 individuals were detected acoustically and 76 individuals were observed visually. Almost all the detections by both methods were coincident except for a single isolated individual which is easy to be missed by visual observation. The spatial distribution of the porpoise detections suggested porpoises showed preference to the junction area (2-6 individuals/km), regardless of ship traffic or any other human activities, such as populated areas. This result agrees to previous works (Wei et al., 2003).

Based on Akamatsu et al (2008), the detection probabilities of both methods were calculated. The appropriate time window was calculated as 100 s, which is the time duration of multiple counting of single animal or a group. If two separated detections occured over the time window, these detections were considered to be different animals. The calculated time window of the present study was smaller than the 120 s calculated in Akamatsu et al. (2008). In 100s, the detection probabilities of the acoustical and visual observation were estimated to be 56 and 24 %, respectively. The probabilities were also higher than those of Akamatsu et al. (2008), 46 and 19 % respectively. This was considered to be due to the length of boat and towed rope. The length of boat and towed rope of our system was 12 + 44m. On the other hand, the length of the system of Akamatsu et al. (2008) was 30 + 80 m. The shorter length of our system results in high matching detections of two methods. The survey system of Akamatsu et al. (2008) was designed to estimate total population size. However, to monitor local groups and obtain detailed information about porpoises, high detection probability enhances survey efficiency. Additionally, a small boat was expected to have fewer disturbances on animal behavior. It was concluded that our survey system was effective to use to monitor local populations.

ACKNOWLEDGMENTS

We wish to thank all members of the dolphin research team of the Institute of Hydrobiology, Chinese Academy of Sciences, the National Research Institute of Fisheries Engineering, Biosphere Informatics, Graduate School of Informatics, Kyoto University and the Hukou Fisheries Administration Bureau of Jiangxi Province. This work was supported by Grant-in-Aid for Scientific Research (B) 19405005, Research and Development Program for New Bio-industry Initiatives, Japan, National Natural Science Foundation of China (30730018, 30570233), the Chinese Academy of Science (Present Fund) and Ocean Park Conservation Foundation Hong Kong.

REFERENCES

Akamatsu, T., Wang, D., Wang, K., and Wei, Z. (2001). Comparison between visual and passive acoustic detection of finless porpoises in the Yangtze River, China, *J. Acoust. Soc. Am.* **109**, 1723–1727.

Akamatsu, T., Wang, D., Wang, K., Wei, Z., Zhao, Q., and Naito, Y. (2002). Diving behavior of freshwater finless porpoises (*Neophocaena phocaenoides*) in an oxbow of the Yangtze River, China, *ICES J. Mar. Sci.* **59**, 438–443.

Akamatsu, T., Wang, D., Wang, K., and Naito, Y. (2005a). Biosonar behavior of free-ranging porpoises, *Proc. R. Soc. Lond. B*, **272**, 797-801.

Akamatsu, T., Matsuda, A., Suzuki, D., Wang, D., Wang, K., Suzuki, M., Muramoto, H., Sugiyama, N., and Oota, K. (2005b). New stereo acoustic data logger for tagging on free-ranging dolphins and porpoises, *Mar. Technol. Soc. J.* 39, 3-9.

Akamatsu, T., Wang, D., Wang, K., Li, S., Zhao, X., Barlow, J., Stewart, B. S., and Richlen, M. (2008). Estimation of the detection probability for Yangtze finless porpoises (*Neophocaena phocaenoides asiaeorientialis*) with passive acoustic methods, *J. Acoust. Soc. Am.* 123(6), 4403-4411.

Buckland, S. T., Anderson, D. R., Burnham, K. P., and Laake, J. L. (1993). Distance Sampling: Estimating Abundance of Biological Populations, Chapman and Hall, London.

Kimura, S., Akamatsu, T., Wang, D., Wang, K., and Li, S. (2007). Monitoring Local Migration of Yangtze Finless Porpoises by Acoustic Gate. *J. Mar. Acoust. Soc. Jpn.* 34 (4): page number (in Japanese with English abstract).

Kimura, S., Akamatsu, T., Wang, K., and Li, S. Dong, S., Wang, D., Arai, N. (submitted). Comparison of stationary acoustic monitoring and visual observation for finless porpoises. *J. Acoust. Soc. Am.*

Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., Zhao, X., Reeves, R. R., Stewart, B. S., Wang, K., Wei, Z., Zhang, X., Pusser, L. T., Richlen, M., Brandon, J. R., and Wang, D. (2007). First human-caused extinction of a cetacean species?, *Biol. Lett.* **3** (5), 537-540.

Wang D., Liu R., Zhang X., Yang J., Wei Z., Zhao Q., and Wang X. (2000). Status and conservation of the Yangtze finless porpoise, *Biology and conservation of freshwater cetaceans in Asia.* **23**, 81-85. [Occas. Pap. IUCN Species Survival Comm.]

Wang, K., Wang, D., Akamatsu, T., Li, S. and Xiao, J. (2005). A passive acoustic monitoring method applied to observation and group size estimation of finless porpoises, *J. Acoust. Soc. Am.* 118(2), 1180-1185.

Wei, Z., Wang, D., Zhang, X., Zhao, Q., Wang, K., and Kuang, X. (2002). Population size, behavior, movement pattern and protection of Yangtze finless porpoise at Balijiang section of the Yangtze River, *Resour. Environ. Yangtze Basin* 11, 427–432 (in Chinese with English abstract)..

Wei Z., Zhang X., Wang K.,Zhao Q., Kuang X., Wang X., and Wang, D. (2003). Habitat use and preliminary evaluation of the habitat status of the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) in the Balijiang section of the Yangtze River, China, *Acta Zoologica Sinica* **49** (2) 163-170(in Chinese with English abstract). .

Zhang, X. and Wang, K. (1999). Population viability analysis for the Yangtze finless porpoise, *Acta Ecologica Sinica* 19, 529-533(in Chinese with English abstract).

Zhang, X., Liu, R., Zhao, Q., Zhang, G., Wei, Z., Wang, X. and Yang, J. (1993). The population of finless porpoise in the middle and lower reaches of Yangtze River, *Acta. Therio.l Sin.*, **16**, 490-496 (in Chinese with English abstract).

Zheng, J., Xia, J., He, S. and Wang, D. (2005). Population genetic structure of the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*): implications for management and conservation, *Biochem. Genet.* **43**, 307–320.