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The Yangtze finless porpoise: On an accelerating path to extinction?

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ABSTRACT

For the conservation of endangered animals to be effective, information on population distribution and abundance requires regular updating from census efforts. The Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) has recently been reclassified as critically endangered (CR) due to a rapid decline in abundance. Baseline measures currently used for identifying extinction risk and implementing conservation actions may lag behind the actual demographic trend of a population and, thus, should be updated frequently. In this study, we report the results of a line transect survey of porpoises conducted in the middle and lower reaches of the Yangtze River in 2012. Five hundred and five porpoises (95% CI = 348 to −662, CV = 15.86%) remain in the main stem of the Yangtze River, mostly concentrated between Ezhou and Zhenjiang. Our results reveal that the decline in the Yangtze finless porpoise population is more rapid than previously estimated. The porpoise distribution has become more restricted and fragmented with two new gaps in their distribution. We show that the extinction risk for the Yangtze finless porpoise population has increased substantially and, hence, the expected time to extinction has moved closer. Current conservation methods are insufficient and ineffective, and need to be revised. More active conservation actions, such as enforcing year-long fishing bans in the *in situ* reserves and building more *ex situ* reserves, should be implemented urgently.

1. Introduction

The distribution pattern and abundance of a population are baseline measures that are essential for the effective conservation of endangered species (IUCN, 2001; Zhao et al., 2008, 2013). These measures require constant updating for a declining species. Predictive modelling for the population viability of freshwater cetaceans under ongoing habitat deterioration indicates an accelerating rate of decline prior to their extinction (Huang et al., 2012). In a declining population, population baselines can change rapidly. Assessment of extinction risk (or population viability) is likely to be biased for the declining population, and is usually underestimated (Panigada et al., 2011; Mei et al., 2012) if such assessments are based primarily on past population baselines. Conservation actions based on outdated baselines are likely to be ineffective (Zhao et al., 2013).

The Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*), a subspecies of the narrow-ridged finless porpoise (Committee on Taxonomy, 2011), is endemic to the middle and lower reaches of the Yangtze River and its two adjoining lakes (Poyang Lake and Donting Lake), China (Gao and Zhou, 1993). It is the only freshwater cetacean remaining in the Yangtze River following the presumed extinction of the baiji (*Lipotes vexillifer*) in 2006 (Turvey et al., 2007). A series of studies has revealed a continuous decline of the Yangtze finless porpoise since the early 1980s (Zhang et al., 1993; Yang et al., 1998; Wang et al., 1998, 2000; Zhou et al., 1998; Xiao and Zhang, 2000, 2002; Yang et al., 2000; Yu et al., 2001; Wei et al., 2002; Zhao et al., 2008), from more than 2500 porpoises in 1991 (Zhang et al., 1993) to 1225 porpoises within the main stem of the Yangtze River between Yichang and Shanghai (Zhao et al., 2008). The total population abundance of the Yangtze finless porpoise was estimated to be approximately 1800 individuals, based on surveys conducted in the Yangtze River in

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2006 and in the two lakes prior to 2006 (approximately 1225 porpoises in the Yangtze River, approximately 400 porpoises in Poyang Lake, and 100–150 porpoises in Dongting Lake: Zhao et al., 2008). Recent demographic trends highlight the accelerating decline of Yangtze finless porpoise (Mei et al., 2012) and indicate a high probability of extinction (86%) within the next 100 years (Mei et al., 2012). However, this estimate is likely to be optimistic if the rate of porpoise decline is accelerating (Mei et al., 2012).

Several conservation measures for the protection of porpoises have been implemented since the 1990s, including the creation of *in situ* and *ex situ* reserves and the enforcement of a three-month fishing ban (Wang, 2009). However, the effectiveness of these measures appears to be limited because the porpoise abundance is continuing to decrease (Turvey et al., 2013; Zhao et al., 2013). Zhao et al. (2013) have suggested that one of the reasons that the *in situ* reserves have failed to secure the viability of the porpoise population is because the locations of these reserves do not encompass the geographic distribution of the Yangtze finless porpoise. This is likely to be a consequence of current management strategies that were designed using outdated baseline data that no longer reflects the current conditions. Here, we report the results from the second Yangtze Freshwater Dolphin Expedition (YFDE) conducted between November and December, 2012 (YFDE2012), and use these updated census data to more accurately describe the current distribution of the Yangtze finless porpoise and estimate the rate of population decline.

2. Material and methods

2.1. Study region and survey design

This census of Yangtze finless porpoises was conducted in the middle and lower reaches of the Yangtze River (approximately 1700 km in length) between Yichang and Shanghai (Fig. 1), spanning the entire historic distribution range of the porpoise in the main stem of the river during the low-water-level season (from 11th November to 24th December, 2012). This period corresponded to the season when YFDE2006 census was conducted (Zhao et al., 2008) to allow direct comparison of sighting conditions and results between the two censuses. The survey area of the Yangtze River between Yichang and Shanghai, was divided into upper (Yichang–Ezhou), middle (Ezhou–Huayang), and lower (Huayang–Shanghai) sections (Fig. 1) based on an initial inspection of porpoise density and the local administrative districts according to Zhao et al. (2008). Two research vessels (V1 and V2), each 27 m long with a 4 m-high viewing platform, were operated independently and in parallel to survey the two riverbanks. Each boat travelled at a constant ground speed of approximately 15 km/h and both vessels travelled along the main river channel and navigable side channels during the round-trip survey from Yichang to Shanghai.

Passing mode and closing mode were used throughout the survey (Butterworth and Borchers, 1988; Buckland, 2001; Dawson et al., 2008). The sightings of Yangtze finless porpoises were located and identified by previously trained and highly experienced on-board observers (some of whom had participated in the YFDE2006 census). A three-day training course and a one-week pilot survey were undertaken before the beginning of the census. A primary observer (PO) team for each vessel comprised six POs and included three observer positions (left, centre and right). POs searched for porpoises using 7 × 50 mm Fujinon binoculars, rotating among the three positions every 30 min and then resting for 90 min. A conditionally independent observer (CIO: Barlow, 1995) was deployed on one of the vessels to estimate the proportion of porpoises missed by the PO team. Two POs were exchanged between the vessels on each day of the census for evaluation of the observation bias by the CIO. Distances from the boat to the animals were estimated by the naked eye. Distance calibration tests were conducted once each week to improve the ability of observers to estimate distances and to calibrate and correct the distance estimates of each observer.

2.2. Density and abundance estimate

The abundance of Yangtze finless porpoises in each section of the river (N_i) was estimated as:

$$Ni = A_i \times D_i \tag{1}$$

where A_i is the area of section i and D_i is the density of Yangtze finless porpoises within section i, calculated as:

$$D_i = \frac{n_i \times \hat{f}(0) \times \bar{s}}{2L \times \hat{g}(0)} \quad (\text{Buckland, 2001; Thomas et al., 2006}) \tag{2}$$

where n_i is the number of sightings observed in section i, $\bar{s}$ is the mean group size, L is the length of section i, $\hat{f}(0)$ is the sighting probability density on the trackline in section i, and $\hat{g}(0)$ is the detection probability on the trackline. We used the methods of Zhao et al. (2008) to analyse the density and abundance of porpoises. Estimates of $\hat{f}(0)$ were obtained by a complex model that assumed uniform distribution of the animals within strata (see below). Multiple-covariate distance sampling (MCDS) was also used to further improve modelling of the detection function through the inclusion of covariates (i.e. vessel identity, survey direction and mode; Marques, 2001; Marques and Buckland, 2003; Zhao et al., 2008). The model with the smallest AIC value identified via stepwise fitting was selected.

Zhao et al. (2008) used the strip transect model and two line transect models, the simple model and complex model, to estimate population abundance. Although these three models estimated similar abundance (1111, 1000 and 1225 respectively), the complex model may provide the most accurate estimate of the abundance of Yangtze finless porpoises because more sightings were used in the analyses (Zhao et al., 2008). Accordingly, we selected the complex model, dividing the river into a mid-channel stratum (>500 m from the bank opposite the boat) and a near-bank stratum along the trackline. The near-bank stratum was further divided into three different substrata based on the distance from the trackline to the nearest riverbank: 300–500 m substrata, 150–299 m substrata, and <150 m substrata (treated as a strip transect where density was calculated directly using the observed number of porpoises divided by the area between the trackline and the riverbank).

Thus, D_i can be calculated as:

$$D_i = \frac{1}{2 \times L_i} \sum_{j=1}^{n_i} \frac{f(0, c_j) \times s_j}{g_j(0)} \quad (\text{Buckland, 2001}) \tag{3}$$

where n_i is the number of sightings observed in stratum i, s_j is the number of porpoises in each sighting group, L_i is the length of on-effort tracklines in stratum i, $f(0, c_j)$ is the sighting probability density on the trackline in each stratum with associated covariates c_j, and $g_j(0)$ is the trackline detection probability of sighting j. The $g(0)$ and the variance of $g(0)$ was calculated by the CIO method (cf. Barlow, 1995):

$$g(0) = 1 - \frac{n_{2w} f_2(0)}{n_{1w} f_1(0)} \quad (\text{Barlow, 1995}) \tag{4}$$

where n_{1w} is the overall number of groups sighted by the POs within the truncation distance, n_{2w} is the overall number of groups sighted by the independent observers within the truncation distance, $f_1(0)$ is the sighting probability density on the trackline sighted by POs, and $f_2(0)$ is the sighting probability density on