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# Habitat preference of the Yangtze finless porpoise in a minimally disturbed environment

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ABSTRACT

Analyses of animal species distribution in a neutral or minimally-interrupted habitat provide a baseline that is essential for assessment of population status, identification of key habitat, and conservation planning for habitat protection and restoration. In this study, we surveyed the occurrence of the Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) and corresponding habitat characteristics, including bathymetry, benthic slope and fish resources, in the newly established He-wang-miao reserve. Based on sightings from field surveys, the extent of occurrence of the finless porpoise was 9.532 $km^2$. General linear model analysis indicated the distribution of the finless porpoise was influenced by water depth and fish density. Habitat preference analysis illustrated a proxy to identify key habitat for the finless porpoise: moderate water depth (between 7 m and 12 m), flat benthic slope (lower than 2°) and moderately-high fish density (0.6 ind/$m^3$ and 1.2 ind/$m^3$). We proposed that this proxy has great potential for conservation planning to identify habitat conservation priorities in the Yangtze River and to guide management actions such as *ex situ* reserve selection and habitat restoration.



## 1. Introduction

Distribution pattern of animals, including the extent of occurrence and core-habitat selection, relates to the complex and dynamic functions of habitat selectivity, accessibility of preys, social interactions, predator-prey interactions and inter-habitat mobility (Wilson et al., 1997; Heithaus, 2001; Davis et al., 2002; Torres et al., 2008; Garaffo et al., 2011; Braulik et al., 2012; Wang et al., 2015a, 2015b, 2016), which discloses ecological niche of animals in their living environment (Guo and Liu, 2010; Baird et al., 2013; Merow et al., 2013). Analysis on the animal distribution and habitat characteristics provides a valid approach to identify key features that define core habitats of animals (Skov et al., 2008; Garaffo et al., 2010, 2011). In conservation, these kinds of studies provide insights into population status, key habitat identification and action planning of habitat protection, management and restoration (International Union for Conservation of Nature IUCN, 2001; Wilson et al., 2004; Cañadas et al., 2005; Garaffo et al., 2011; Choudhary et al., 2012; Harihar and Pandav, 2012; Zhao et al., 2013; Wang et al., 2015a, 2015b, 2016). Distribution patterns disclosed from field surveys are often regarded as baselines of the habitat preference and selection. The habitat preference and selection analyses substantially depend on the sighting records of animals in field surveys (as in Baird et al., 2013), which are generally assumed at neutral status. The patterns of animal distribution and habitat preference, however, frequently fluctuate with biotic and abiotic status of the habitat environment (Rayment et al., 2010; Fury and Harrison, 2011; Cox et al., 2016; Wang et al., 2016), especially the anthropogenic activities. In areas where anthropogenic activities are frequent and intense, the change in distribution patterns and habitat preference can be substantial (Buckstaff et al., 2013; Huang et al., 2013; Huang and Karczmarski, 2015) and can reshape the population social structure and habitat preference (Wang et al., 2015a, 2015b). However, studies in the habitats where anthropogenic activities are frequent and intense may identify a misleading 'baseline' which actually represents a shifted status rather than a baseline representing the original habitat status. Conservation decisions based on a shifted 'baseline' can jeopardize the effectiveness and efficiency of conservation management. Analysis of animal distribution in a neutrally or minimally interrupted

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habitat can provide a natural state baseline that is essential for identifying key habitat characteristics and planning habitat protection and restoration measures.

The Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*), which is an endemic odontoceti in Yangtze River, China, is now critically endangered (Mei et al., 2012, 2014a, 2014b; Wang et al., 2013; Huang et al., 2016). Current conservation managements include enactment of a number of *in situ* and *ex situ* reserves, four months fishing ban and a captive breeding population (Mei, 2013; Huang et al., 2016). Since 2015 *ex situ* conservation measures such as establishing *ex situ* reserves receives more attention; and many local governments are seeking to establish their own *ex situ* 'reserve'. There has been a long-standing debate over whether *ex situ* conservation measures are sufficient to preserve the critically endangered Yangtze finless porpoise (Huang et al., 2016). The latest modeling analysis of population dynamics demonstrated the necessity to implement and strengthen *ex situ* measures to preserve a number of viable porpoise populations for future reintroduction (Huang et al., 2016). However, the question of selecting adequate sites for *ex situ* reserves remains insufficiently answered, since knowledge of the baseline of habitat preference with little or no human disturbance for the porpoise are generally lacking.

The pervasive anthropogenic activities in the nature habitats of the finless porpoise, including the Yangtze River and the adjacent Dongting Lake and Poyang Lake, present a major challenge to acquire the baseline of habitat preference (Wang, 2009; Mei, 2013; Wang et al., 2013; Mei et al., 2014a, 2014b). It becomes extremely difficult and impracticable to find a site in natural habitats with little or no human disturbance. In contrast, the *ex situ* reserves provide a suitable environment where anthropogenic activities are minimal or controlled. Inside the reserve vessel traffic, fishing and behaviors likely polluting water quality are not allowed. Anthropogenic activities such as livestock breeding, farming and tree planting, on the other hand, shall be hold at least 200 m away from the reserve. Within a confined habitat, the extent of occurrence and distribution pattern can be used to extrapolate fundamental habitat requirements for the Yangtze finless porpoise in the wild.

A new *ex situ* reserve was enacted at He-wang-miao oxbow in 2015. This oxbow connects with the main stem of Yangtze River while earlier study indicates a water environment that is suitable for the Yangtze finless porpoise (Mei et al., 2014a, 2014b). We conducted a survey of the occurrence of the Yangtze finless porpoise and measure the habitat characteristics including bathymetry, benthic slop and fish resources in the *ex situ* He-wang-miao reserve, aiming to approach the baseline of habitat preference. We analyzed the correlations between porpoise occurrence and the three habitat characteristics. Based on above analysis, we discussed the habitat preference of the Yangtze finless porpoise, and the proxy to select adequate sites to enact *ex situ* reserves. These results shed a light to action planning of key-habitat protection and habitat restoration for the porpoise in the wild.

## 2. Methods

### 2.1. Study site

The He-wang-miao oxbow (112.983°N, 29.708°E), which is 33 km in length and 46.7 $km^2$ in coverage, located in Hubei Province, China (Fig. 1), is currently an *ex situ* reserve of the Yangtze finless porpoise established in March 2015. A small channel at downstream connects the oxbow to the mainstream of the Yangtze River. A total of eight finless porpoises were translocated into this reserve in March 2015 (two females and two males) and December 2015(two females and two males) respectively.

Two nylon-net blockades were set up at upstream and downstream of the oxbow (Fig. 1) and enclosed the core region, where human activities are completely prohibited. Inside the nets the water area is 14.3 $km^2$. The outside bank length is 14.06 km and the inside is 11.29 km. The net mesh is 7 cm, a suite of bamboo sticks were vertically set 10 m in front of each net to prevent the porpoise to approach the nets. Then the porpoise cannot pass through the nets but the water exchange and fish migration between the oxbow and the mainstream of the Yangtze River are not restricted.

### 2.2. Field surveys

Field surveys included porpoise surveys for exploring the distribution pattern of the Yangtze finless porpoise and hydroacoustic surveys for measure the densities of fish resources in the oxbow. The porpoise surveys were conducted at navigable weather condition once a day between April 2015 and May 2016. Each survey adopted a round trip of ~25 km in the core region which took almost 3 h and started from the reserve administration station at random time, either morning or afternoon. The survey vessel was an eight-meter-long wooden fishing boat with a six horsepower diesel engine and cruised at a constant ground speed (~8 km/h). Two trained observers searched the porpoises on both side of the bow with unaided eye. Survey routes were recorded by a portable GPS receiver (Garmin GPSmap 621sc). When the porpoises were sighted, vessel engine was stop for 15 min, and information including the GPS location, water depth, group size and behavior of the porpoise was recorded.

Hydroacoustic survey was conducted in 17th September 2015 by a calibrated Simrad EY60 portable echo-sounder (Horten, Norway) and a circular split-beam 120 kHz transducer (7° of nominal angle) to record the water depth and fish density data over the He-wang-miao reserve. A zigzagging route design was used in this survey. The water depth data were further used to construct bathymetry DEM (digital elevation model) through Triangulated Irregular Networks (TIN) and interpolation processes. Based on the bathymetry DEM, we extracted the information of benthic slope. Then, a GIS database of the He-wang-miao reserve, including bathymetry DEM, benthic slope and fish densities, was built by ArcGIS10.3 (ESRI).

### 2.3. Distribution pattern and habitat preference analyses

The minimum convex polygon (MCP) and kernel density estimate (KDE) techniques were used to identify the extent of occurrence (MCP and 95% KDE) and core habitat (50% KDE) of the finless porpoise (IUCN, 2001; Wang et al., 2015a, 2015b, 2016). We assumed all sighting data were mutually independent in KDE analysis (Worton 1989). This analysis was processed by the Home Range Tools in ArcGIS 10.3 (http://flash.lakeheadu.ca/~arodgers/hre/). Areas outlining MCP, 50% KDE and 95% KDE were calculated by ArcGIS 10.3.

The encounter points of the porpoise were used as sample points, and the same number of random points was then generated in ArcGIS 10.3 as controls. The information of habitat characteristic of each point was extracted, including bathymetry, benthic slope and fish densities. We used a general linear model to test the relation between porpoise distribution probabilities (measured by KDE) and habitat characteristics. We conducted a correlation analysis to examine associations between each factor and the porpoise presence (i.e. the encounter points), and to measure the preference range for each characteristic that was significantly correlated with the porpoise presence. Both general linear model analysis and habitat preference analysis were conducted in SPSS 19.0.