# Fishers' experience and perceptions of marine mammals in the South China Sea: insights for improving community-based conservation

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**ABSTRACT**

1. Successful conservation of marine mammals is often dependent upon support from local fishing communities, and valuable conservation insights can be obtained through understanding fishers' attitudes and awareness of marine mammals.
2. A new local ecological knowledge dataset was obtained through large-scale questionnaire-based interviews with 510 artisanal fishers from 16 coastal fishing communities around Hainan, China. Almost all respondents (92.7%) reported regular encounters with marine mammals. Many respondents reported negative interactions with marine mammals, including by-catch (25.5%), consumption (36.1%), and sale of meat (9.2%), and respondent perceptions of marine mammals were often negative.
3. Generalized linear models (GLMs) indicated that respondent experience of marine mammal encounters and by-catch events was mainly predicted by indices of fishing effort and experience rather than by geographic or socio-economic factors. Respondent experience of eating or selling marine mammal meat was predicted by geographic location and by some livelihood and socio-economic factors. Respondent perceptions of marine mammals were instead predicted by fishing experience and education level.
4. Classification and regression trees (CARTs) showed that the most important factors determining respondent experience and perceptions were number of fishing years and educational level, respectively. Both GLMs and CARTs

indicated the complex effects of geographic, livelihood and socio-economic factors on respondent experience and perceptions of marine mammals.

5. Regional community-based conservation of marine mammals could be promoted through improved regulatory management and environmental education, sustainable ecological exploitation and economic development, and positive partnerships and collaboration between fishing communities, enforcement agencies and researchers.

**Keywords**: Marine fisheries, fishing communities, artisanal fishers, local ecological knowledge, interview survey, marine mammal conservation

## 1. INTRODUCTION

Resource conflicts between marine fisheries and marine mammals have raised considerable concerns worldwide among regulatory agencies and the scientific community (Trites, Christensen, & Pauly, 1997; Yodzis, 2001). Conservation actions for marine mammals therefore need to focus on mitigating this human-wildlife conflict (Peterson, Birckhead, Leong, Peterson, & Peterson, 2010). Successful conservation is often dependent upon support from local communities (Berkes, 2007), which is strongly influenced by local people's attitudes and awareness (Bennett & Dearden, 2014; Mintzer et al., 2015). In particular, artisanal fishers are likely to encounter and interact with marine mammals frequently in their fishing areas, and may develop negative perceptions and attitudes towards these species due to space and resource competition (Zappes, de Sá Alves, da Silva, et al., 2013). Local fishers

are therefore widely recognized as the most important demographic group with which to engage when designing strategies for marine mammal conservation (Butler, Middlemas, Graham, & Harris, 2011; Gonzalvo, Giovos, & Moutopoulos, 2015; Zappes et al., 2016), and obtaining conservation-valuable insights from fishing communities is an important action for marine mammal conservation (Dickman, 2010), especially in regions where baseline data are limited but conservation need is urgent.

Local ecological knowledge (LEK) represents the experiential knowledge of specific demographic groups derived from their familiar environments and wildlife (Davis & Wagner, 2003). LEK has the potential to provide extensive biological and ecological information on aquatic resources or conservation-valuable objectives (Manzan & Lopes, 2015, 2016), together with relevant socio-economic and cultural information on interactions between resource users and local environments (Bashir, Khan, Behera, & Gautam, 2010; Leeney & Poncelet, 2015). However, LEK also includes potential bias, uncertainty or error that can hinder straightforward interpretation, meaning that careful data collection and analysis methods are required (Davis & Wagner, 2003). In recent decades, LEK has been increasingly recognized as part of the conservation management toolkit (Brook & McLachlan, 2008; Paudel Levesque, Saavedra, Pita, & Pal, 2016), and community-based interviews are frequently used to gather large-scale LEK datasets across wide geographic areas (Zappes, da Silva, Pontalti, Danielski, & Di Beneditto, 2013).

Intensive fishing activities around the world are often associated with negative fishery interactions with marine mammals, such as entanglement injuries, incidental by-catch or even intentional killing (e.g. López, Pierce, Santos, Gracia, & Guerra, 2003; Machado et al., 2016; Zappes, da Silva, Pontalti et al., 2013). The South China Sea (SCS) is known to contain over 30 cetacean species across an area of approximately 3.5 million $km^2$ (Jefferson, Webber, & Pitman, 2015; Wang, 2012), but also supports a huge amount of subsistence and commercial fishing activity (FAO, 2016). Hainan, China's southernmost province, is home to many communities that practise fishery activities in the SCS. Official data showed that there are 340 fishing communities situated along the coast of Hainan, with 155,228 registered marine fishers and 1.28 million tons of marine fishing harvest reported in 2017 (China Fishery Statistics Yearbook, 2018). Local fishers generally made a professional living by harvesting aquatic resources in marine environments that are also used by marine mammals (Liu, Lin, Turvey, & Li, 2017). However, there has so far been minimal research into interactions between marine fisheries and marine mammals in the SCS. Furthermore, little is known regarding to attitudes and awareness of local communities about marine mammal conservation in this region. These information gaps present substantial difficulties for effective conservation management of marine mammals in the SCS, indicating the urgent need for a more robust knowledge base.

The community-based interview approach was used to conduct a large-scale LEK survey in fishing communities around Hainan Island in the northern SCS. These LEK data reveal local fishers' experience and perceptions of marine mammals, as well

as the effects of variation in geography, livelihood and socio-economic variables on local knowledge. This study aims to: (1) emphasize that effective community-based conservation of marine mammals in the SCS should be promoted on Hainan, and (2) provide new insights into suitable approaches for mitigation of conflicts between fishing communities and marine mammals in this region.

## 2. Methods

### 2.1 Study area and LEK survey

A large-scale LEK survey was conducted to carry out questionnaire-based interviews with local fishers around Hainan Island between 30 November and 21 December 2013. Sixteen coastal survey sites (Figure 1), either traditional villages or huge fishing ports with sizeable fishing communities, were selected as representatives. They were situated 20–100 km apart, and distributed around the entire coast of Hainan. The questionnaire was based on interview techniques and methods described by Chambers (1992), and modified for conservation research in Chinese fishing communities following Turvey, Barrett, Hao, et al. (2010), Turvey, Barrett, Hart, et al. (2010), Turvey, Risley, Barrett, Hao, and Ding (2012), and Turvey et al. (2013). Respondent sample size and saturation followed Mason (2010). Interviews were conducted by three experienced marine mammal researchers and 42 trained university students. Respondents were selected only if they had lived on Hainan for most of their lives, and practised marine fishing activities around Hainan as their main source of family income. Although age, gender and ethnicity were not used as selection criteria,

interview data were not obtained from anyone below the lawful adult age of 16. Only one member of each fishing family/boat was interviewed to ensure data independence. Further details of survey methods are given in Liu et al. (2017). Research was approved by the Institute of Deep-Sea Science and Engineering, Chinese Academy of Sciences.

### 2.2 Questionnaire-based interview process

At the beginning of all interviews, respondents were informed about the survey's aims, that participation in the survey was voluntary and anonymous, and that their responses would be kept confidential and only used for scientific research. To check their suitability for further questioning, they were then asked if they were local fishers who generally make a professional living by harvesting marine resources. If they matched these selection criteria, they were then asked a standard series of 42 questions (multiple choice and open-ended) about: (1) socio-economic and livelihood characteristics, (2) fishery interactions with marine mammals, (3) local fishery characteristics, and (4) experience and perceptions of marine mammals (see Text S1 for details). They were also shown photographs of 36 marine mammal species (35 cetacean species and dugong *Dugong dugon*; Jefferson et al., 2015; Wang, 2012) that are known to occur in the SCS to confirm species identification (see Liu et al., 2017 and Table S1 for details). Basic socio-economic and non-sensitive questions were asked first to build rapport and increase the likelihood of honest answers. Interviews

were usually conducted on the beach near a fishing community or on-board boats in fishing ports, and took 20−30 min to complete.

### 2.3 Data analysis

Descriptive statistics were generated about demographic and socio-economic patterns in the respondent dataset. Patterns of variation were investigated in respondent experience (sighting, by-catch, eating meat, selling meat) and perceptions (ecological importance, conservation requirements) of marine mammals (binary: 1 for yes, 0 for no) (Table 1). Respondent perceptions of marine mammals were explored through two aspects i.e. ecological importance (Q34: Do you think marine mammals play important roles in marine environment?) and conservation requirements (Q35: Do you think marine mammals should be protected?) respectively (see Text S1 for details). Mann-Whitney U tests were used to investigate differences in proportions of respondent experience or perceptions between different interview localities (survey sites; nominal variable), to assess whether respondent LEK about marine mammals varied with geographic location. Univariate generalized linear models (GLMs) with binomial error structure and logit link function (Pont et al., 2015; Turvey et al., 2017) were used to further investigate whether variation in respondent experience or perceptions were affected by geographic location, livelihood factors (number of fishing years, boat length, number of fishing days per year; scale variables), or socio-economic factors (educational level, fishing income; ordinal variables) (see Table 1 for details). Classification and regression trees (CARTs) were also built to test

which predictor variable was the most important factor in determining each of the response variables. Analyses were conducted in R 3.4.0 (R Development Core Team, 2016), with CARTs built using the 'rpart' package (De'ath & Fabricius, 2000; Jog, Sule, Bopardikar, Patankar, & Sutaria, 2018). Age, gender and ethnicity were not used as further potential predictors, because most respondents were middle-aged males of Han ethnicity (China Fishery Statistics Yearbook, 2018).

## 3. RESULTS

### 3.1 Fishers' profile

In total, 510 respondents were interviewed (498 men, 97.6%; 12 women, 2.4%), with an average of 32 ± 12 respondents (mean ± SD; range: 12−63) in each survey site (Table S2), although not all respondents provided answers to all questions. Respondents belonged to three ethnic groups (Han, 98.6%; Li, 1.2%; Zhuang, 0.2%), their age ranged from 16 to 79 (42.1 ± 12.7, mean ± SD), and number of fishing years varied from 1 to 66 (23.9 ± 12.2 years, mean ± SD). Boat length varied from 3 to 60 m (17.4 ± 9.2 m, mean ± SD). Respondents reported that they spent a mean of 177 ± 57 days (mean ± SD) on fishing activities per year. Most respondents were either uneducated (5.1%, 26 of 510) or educated only to elementary school (33.1%, 169 of 510) or middle school level (46.9%, 239 of 510), and only 11.4% (58 of 510) and 0.4% (2 out of 510) were educated to high school and college level, respectively. Reported income from fishing was generally low (<6000 RMB/month[1]). Frequencies of

[1] Equivalent to 920 US$/month (exchange rate in November 2013 is about 6.5 : 1)

reported respondent livelihood and socio-economic variables are shown in Figure S1.

### 3.2 Fishers' experience and perceptions of marine mammals

Overall, most respondents (92.7%, 473 of 510) reported regular encounters with marine mammals, 25.5% (130 of 510) reported marine mammal by-catch events, 36.1% (184 of 510) had eaten marine mammal meat, and 9.2% (47 of 510) had sold marine mammal meat (Figure 2a-b). Positive perceptions about the ecological importance and the need to conserve marine mammals were reported by 54.3% and 73.7% (277 and 376 of 510), respectively.

### 3.3 Geographic variation

There was no geographic variation between survey sites in reported patterns of marine mammal sightings and by-catch events (Table 2 and Figure 3a-b), but geographic variation was present in reported patterns of eating and selling marine mammal meat. The proportion of respondents from southern and western Hainan was significantly higher than from eastern and northern Hainan for both eating (Mann-Whitney U test: $Z = -3.27$, $p < 0.001$) and selling marine mammal meat (Mann-Whitney U test: $Z = -2.15$, $p < 0.001$) (Table 2 and Figure 3c-d). There was no geographic variation in respondent perceptions about marine mammals (Table 2 and Fig 3e-f).

### 3.4 Livelihood and socio-economic factors

GLMs showed that the likelihood of respondents reporting sightings, by-catch events, eating meat and selling meat were all positively correlated with increasing number of fishing years ($p_{sighting} = 0.025$, $p_{by\text{-}catch} = 0.001$, $p_{eating} < 0.001$, $p_{selling} = 0.003$; Figure 4a), while the likelihood of respondents reporting positive perceptions was negatively correlated with this predictor variable ($p_{ecological\ importance} = 0.037$, $p_{conservation\ requirements} < 0.001$; Figure 4a). Likelihood of respondents reporting sightings and by-catch events was positively correlated with boat length ($p_{sighting} = 0.009$, $p_{by\text{-}catch} < 0.001$; Figure 4b). Likelihood of respondents reporting sightings was also positively correlated with number of fishing days per year ($p = 0.029$; Figure 4c). Likelihood of respondents reporting both eating and selling meat was negatively correlated with increasing education level ($p_{eating} = 0.031$, $p_{selling} = 0.006$; Figure 4d), and likelihood of positive respondent perceptions was positively correlated with this predictor variable ($p_{ecological\ importance} = 0.021$, $p_{conservation\ requirements} = 0.008$; Figure 4d). Likelihood of respondents reporting eating meat was negatively correlated with fishing income ($p_{eating} = 0.045$; Figure 4e). CARTs indicated that the most important predictor influencing respondent experience was number of fishing years, followed by boat length or educational level, and then number of fishing days per year or survey site (Figure 5a-d). The most important predictor influencing respondent perceptions was educational level, followed by number of fishing years (Figure 5e-f).

## 4. DISCUSSION

### 4.1 Negative experience and perceptions

This is the first study to examine patterns and determinants of local fishers' experience and perceptions of marine mammals in the SCS, a globally important region for marine mammal diversity and conservation. The intensive marine fisheries in the SCS support a large number of professional fishers who engage primarily in coastal or artisanal fishery activities (Liu et al., 2017), and the great majority of whom (92.7%) have seen/encountered marine mammals during their fishing career (Fig. 3a). This study reveals that a substantial proportion of respondents from fishing communities around Hainan reported negative interactions with marine mammals such as by-catch, eating meat and selling meat (Figure 2a-b and 3b-d), and respondents' perceptions of marine mammals were also fairly negative (Figure 3e-f). These findings are very similar to previous studies of other regional coastal fisheries, including those in the Mediterranean, Scotland, Brazil, West Africa and India (e.g. Cosentino & Fisher, 2016; Jog et al., 2018; Leeney, Dia, & Dia, 2015; Snape et al., 2018; Zappes et al., 2016). In these above regions, marine mammals are often blamed by artisanal fishers for reducing fishery harvest (Goetz, Read, Santos, Pita, & Pierce, 2013; Gonzalvo et al., 2015), and may be killed deliberately in retaliation or accidentally in by-catch events (Bearzi, Bonizzoni, & Gonzalvo, 2011; Butler et al., 2011).

### 4.2 Consumption of marine mammal meat

The findings of this study indicate that a relatively substantial number of Hainanese fishers practice negative behaviours toward marine mammals, including

the eating and selling of marine mammal meat, which appear to represent traditional cultural practices known from this island (Liu et al., 2017; Wang, 2012). To protect marine mammals, China's 1988 Wild Animal Protection Law lists all marine mammal species in China as Grade I or II National Key Protected Animals. Despite this act, harmful behaviours towards marine mammals, including both accidental by-catch and deliberate killing and consumption, have continued to occur frequently in Chinese fishing communities in recent decades, as demonstrated both by this study (Figure 2a-b) and by previous studies (Liu et al., 2017; Porter & Lai, 2017; Robards & Reeves, 2011). Similar harmful behaviours targeting protected marine mammal species are also known to occur in other geographic regions (e.g. Alves, Zappes, & Andriolo, 2012; Leeney et al., 2015; Loch, Marmontel, & Simoes-Lopes, 2009; Mintzer, Diniz, & Frazer, 2018; Robards & Reeves, 2011), with negative fishery interactions being the main threats for some threatened populations (Turvey et al., 2013; Zappes, da Silva, Pontalti, et al., 2013).

### 4.3 Geographic variation in fishers' experience

Previous studies have found that fishers' interactions with marine mammals can vary locally based on differences in specific fishing environments, such as estuaries, bays or lagoons (Manzan & Lopes, 2016; Revuelta et al., 2018), and thus variation in geographic location across a surveyed system might affect respondent experience and perceptions of marine mammals between local communities (e.g. Gonzalvo et al., 2015; Zappes, de Sá Alves, da Silva, et al., 2013). Geographic variation in reported

selling and eating of marine mammal meat was detected between interview localities around Hainan, although not in respect of respondent sightings, experience of by-catch events, or perceptions about marine mammals (Table 2 and Figure 3a-f). GLM and CARTs analyses also indicated the complex effects of geographic as well as livelihood and socio-economic factors on respondent experience and perceptions of marine mammals (Table 2, Figure 4 and 5). The geographic variation detected in consumption of marine mammal meat might be ascribed to ethnoecological difference in cultural and traditional practices between different fishing communities across Hainan (D'Lima, Marsh, Hamann, Sinha, & Arthur, 2014; Leeney & Poncelet, 2015; Paudel et al., 2016; Turvey et al., 2014), an island with considerable ethnic, environmental, and socio-cultural diversity (Liu et al., 2017). Such geographic variation might also reflect variation in local occurrence and abundance patterns of marine mammals around Hainan (Liu, Lin, Zhang, Xue, & Li, 2018; Manzan & Lopes 2015), particularly small odontocetes such as Indo-Pacific finless porpoise (*Neophocaena phocaenoides*) and pantropical spotted dolphin (*Stenella attenuata*), which are known prey or by-catch items in Hainanese fishing communities (consumed as "sea pig"/"*haizhu*" or "black fish"/"*heiyu*, *dayu*") (Fig. 2a-b; Liu et al., 2017).

### 4.4 Complex effects of livelihood and socio-economic factors

GLM results indicated that respondents who spent more time fishing (number of fishing years, number of fishing days per year) and/or were able to fish further from

the coast (boat length) would have more experience of marine mammals, which was consistent with some previous studies in other regions (Jog et al., 2018; Manzan & Lopes, 2015). However, some of these livelihood factors also negatively affected respondent perceptions about marine mammal ecological importance or conservation requirements, possibly due to the increased likelihood of experiencing resource conflict with marine mammals with increasing amounts of time spent fishing (D'Lima et al., 2014; Zappes, de Sá Alves, da Silva, et al., 2013). Both fishing income and education level affected respondent experience and perceptions (Table 2), with education level and fishing income both having a negative relationship with likelihood of respondents reporting eating and/or selling of marine mammal meat (Figure 4d-e), and education level having a positive relationship with likelihood of positive respondent perceptions (Figure 4d). CARTs indicated that the primary determinants affecting respondent experience and perceptions were number of fishing years and educational level, respectively (Figure 5a-f). Overall, these important livelihood and socio-economic factors should be taken into account in order to develop effective community-based conservation strategies for marine mammals (Table 2 and Figure 4a-e), both in the study area and also other similar economically underdeveloped regions where conflicts exist between local communities and marine mammals (Bennett & Dearden, 2014; Dickman, 2010; Holtzman, 2017; Zappes et al., 2014, 2016).

### 4.5 Conservation management suggestions

Decisions about actions to improve marine mammal conservation based on livelihood and socio-economic data will inevitably be complex, but the findings of this study suggest ways in which community-based conservation of marine mammals could be promoted on Hainan. First, harmful behaviours such as consumption of marine mammal meat, which were documented at relatively high levels in local fishing communities (Figure 2a-b), require strict management and increased enforcement (Liu et al., 2017), especially in southern and western Hainan (Figure 3c-d). Second, environmental and regulatory education should be improved to raise awareness and enthusiasm in local communities about marine mammal conservation, and to reduce support and demand for selling and eating of marine mammal meat (Figure 4d; Alves et al., 2012; Manzan & Lopes, 2015; Pont et al., 2015). Third, because reported income from fishing was generally low among respondents (Figure S1), and low fishing income was associated with an increased likelihood of having sold marine mammal meat (Figure 4e), it is suggested that more sustainable sources of income could be assessed as a potential replacement for fishing activities in low-income communities (Bashir et al., 2010; Bearzi et al., 2011). Finally, establishing positive partnerships between fishing communities, enforcement agencies and researchers is also urgently needed to encourage collaboration in marine mammal conservation (Cvitanovic et al., 2016). These initiatives can help encourage fishing communities around Hainan to become more cognizant of local biodiversity and practise more sustainable environment usage without compromising marine mammal conservation.

## AUTHOR CONTRIBUTIONS

M. Liu (liuming@idsse.ac.cn) and M. Lin (mingli@idsse.ac.cn) contributed equally to this work. S. Li (lish@idsse.ac.cn) and M. Lin conceived the ideas. S. Li, M. Lin, and S.T. Turvey (samuel.turvey@ioz.ac.uk) designed the methodology. S. Li and M. Lin directed and conducted the field surveys. M. Liu carried out the data analysis and led the draft writing. All authors contributed to writing the manuscript.

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## SUPPLEMENTARY INFORMATION

**Table S1** Details of 36 marine mammal species potentially occurring in the South China Sea

**Table S2** Summary of interview data collected from Hainan

**Figure S1** Frequencies of reported respondent livelihood and socio-economic variables: (a) number of fishing years, (b) boat length, (c) number of fishing days per

year, (d) educational level, and (e) fishing income

**Text S1** Questionnaire used in interview survey (English language version)

**Table 1** Respondent geographic, livelihood and socio-economic variables, and experience and perceptions of marine mammals on Hainan, divided into predictor and response variables for analysis

| | Categories | Variables | Types | Answer categories |
|---|---|---|---|---|
| Predictor | Geographic | Survey site | Nominal | ML, YG, LT, BS, HW, XY, DL, XH, XB, QL, QG, TM, WC, LA, XC, SY [a)] |
| | Livelihood | Number of fishing years | Scale | |
| | | Boat length | Scale | |
| | | Number of fishing days per year | Scale | |
| | Socio-economic | Educational level | Ordinal | Uneducated, elementary school, middle school, high school, college |
| | | Fishing income | Ordinal | <2000, 2000−4000, 4000-6000, 6000−8000, >8000 (unit, RMB Yuan/month) |
| Response | Experience | Sighting | Logical | Yes, No |
| | | By-catch | Logical | Yes, No |
| | | Eating meat | Logical | Yes, No |
| | | Selling meat | Logical | Yes, No |
| | Perceptions | Ecological importance | Logical | Yes, No/Do not sure |
| | | Conservation requirements | Logical | Yes, No/Do not sure |

[a)] Survey site abbreviation (shown in Figure 1): ML, Meilian; YG, Yinggehai; LT, Lingtou; BS, Basuo; HW, Haiwei; XY, Xinying; DL, Diaolou; XH, Xinhai; XB, Xinbu; QL, Qinglan; QG, Qingge; TM, Taimen; WC, Wuchang; LA, Li'an; XC, Xincun; SY, Sanya

**Table 2** Final univariate generalized linear models (GLMs) investigating predictors of respondent experience and perceptions of marine mammals around the coast of Hainan

| | | *Estimate* | *SE* | *z-value* | *p-value* |
|---|---|---|---|---|---|
| Experience | 1. Sighting | | | | |
| | Intercept | -1.289 | 1.098 | -1.174 | 0.240 |
| | Survey site | 0.000 | 0.003 | 0.107 | 0.915 |
| | Number of fishing years | 0.036 | 0.016 | 2.236 | 0.025* |
| | Boat length | 0.068 | 0.026 | 2.602 | 0.009* |
| | Number of fishing days per year | 0.819 | 0.375 | 2.184 | 0.029* |
| | Educational level | 0.285 | 0.238 | 1.199 | 0.231 |
| | Fishing income | 0.031 | 0.041 | 0.759 | 0.448 |
| | 2. By-catch | | | | |
| | Intercept | -2.354 | 0.677 | -3.475 | <0.001* |
| | Survey site | 0.001 | 0.002 | 0.630 | 0.529 |
| | Number of fishing years | 0.029 | 0.009 | 3.214 | 0.001* |
| | Boat length | 0.038 | 0.012 | 3.326 | <0.001* |
| | Number of fishing days per year | -0.321 | 0.224 | -1.434 | 0.152 |
| | Educational level | 0.149 | 0.128 | 1.164 | 0.244 |
| | Fishing income | -0.011 | 0.024 | -0.462 | 0.644 |
| | 3. Eating meat | | | | |
| | Intercept | -2.061 | 0.630 | -3.273 | 0.001* |
| | Survey site | 0.000 | 0.002 | 0.164 | 0.007* |
| | Number of fishing years | 0.056 | 0.009 | 6.214 | <0.001* |
| | Boat length | 0.010 | 0.011 | 0.896 | 0.370 |
| | Number of fishing days per year | -0.058 | 0.208 | -0.280 | 0.780 |
| | Educational level | 0.107 | 0.119 | 0.894 | 0.031* |
| | Fishing income | -0.014 | 0.022 | -0.624 | 0.533 |
| | 4. Selling meat | | | | |
| | Intercept | -2.771 | 1.016 | -2.728 | 0.006* |
| | Survey site | -0.006 | 0.003 | -1.980 | 0.048* |
| | Number of fishing years | 0.039 | 0.013 | 2.933 | 0.003* |
| | Boat length | -0.016 | 0.018 | -0.905 | 0.366 |
| | Number of fishing days per year | -0.045 | 0.346 | -0.131 | 0.896 |
| | Educational level | 0.132 | 0.190 | 0.697 | 0.006* |
| | Fishing income | 0.072 | 0.036 | 2.009 | 0.045* |
| Perceptions | 1. Ecological importance | | | | |
| | Intercept | 0.525 | 0.575 | 0.912 | 0.026* |
| | Survey site | 0.000 | 0.002 | -0.201 | 0.840 |
| | Number of fishing years | -0.017 | 0.008 | -2.091 | 0.037* |
| | Boat length | -0.008 | 0.010 | -0.811 | 0.418 |

| | *Estimate* | *SE* | *z-value* | *p-value* |
|---|---|---|---|---|
| Number of fishing days per year | 0.178 | 0.194 | 0.918 | 0.359 |
| Educational level | -0.097 | 0.111 | -0.876 | 0.021* |
| Fishing income | 0.017 | 0.020 | 0.829 | 0.407 |
| 2. Conservation requirements | | | | |
| Intercept | 0.919 | 0.674 | 1.364 | 0.173 |
| Survey site | 0.005 | 0.002 | 2.701 | 0.057 |
| Number of fishing years | -0.039 | 0.009 | -4.169 | <0.001* |
| Boat length | -0.018 | 0.012 | -1.557 | 0.120 |
| Number of fishing days per year | 0.282 | 0.227 | 1.243 | 0.214 |
| Educational level | -0.138 | 0.130 | -1.067 | 0.008* |
| Fishing income | 0.040 | 0.025 | 1.626 | 0.104 |

Asterisks * represent statistically significant relationship ($p < 0.05$).

## FIGURE LEGENDS

**Figure 1** Map of Hainan Island and South China Sea, showing locations of 16 survey sites

**Figure 2** Examples of marine mammal consumption in local fishing communities on Hainan: (a) Indo-Pacific finless porpoise (*Neophocaena phocaenoides*); (b) Pantropical spotted dolphin (*Stenella attenuata*)

**Figure 3** Proportion of respondents who reported marine mammal (a) sighting, (b) by-catch, (c) eating meat, and (d) selling meat, and proportion of positive respondent perceptions on (e) ecological importance and (f) conservation requirements of marine mammals in 16 survey sites

**Figure 4** Proportions of reported respondent experience and perceptions of marine mammals in different categories of (a) number of fishing years, (b) boat length, (c) number of fishing days per year, (d) education level (U, uneducated; E, elementary school; M, middle school; H&C, high school and college), and (e) fishing income. Only statistically significant relationships listed in Table 2 are shown

**Figure 5** Classification and regression trees (CARTs) for predictors affecting respondent experience of (a) sighting, (b) by-catch, (c) eating meat, and (d) selling

meat of marine mammals, and respondent perceptions of (e) ecological importance and (f) conservation requirements of marine mammals