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Distribution and Abundance of the East Asian Finless Porpoise in the Coastal Waters of Shandong Peninsula, Yellow Sea, China

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Abstract: The baseline data pertaining to the population of the East Asian finless porpoise (*Neophocaena asiaeorientalis sunameri*) in Chinese waters are significantly deficient. Boat-based visual line transect surveys were conducted from 2018 to 2020 to evaluate the distribution and abundance of the East Asian finless porpoise in the coastal waters (depth < 30 m) of the Yellow Sea, with a specific focus on the Shandong Peninsula. A total of 50 transects covering 2705 km were conducted, encompassing an area of 23,604 km^2 between 119°30′ E–123°15′ E and 35°25′ N–38° N. Throughout the surveys, a total of 117 East Asian finless porpoise groups were detected, with over 90% of these groups occurring within 15 km of the coast or adjacent islands. The estimated abundance of the East Asian finless porpoise in the study area was determined to be 3978 individuals (*CV* = 22.39%, 95%*CI* = 2561–6177), reflecting a low density of 0.169 individuals/km^2 (*CV* = 22.39%, 95%*CI* = 0.109–0.262) within the coastal waters of the Yellow Sea in the Shandong Peninsula. The findings highlight the need for conservation measures to address the threats faced by this species, including bycatch, habitat degradation, and pollution. The establishment of marine protected areas and the implementation of bycatch mitigation measures are crucial for the long-term survival of the East Asian finless porpoise population in the study area. By providing valuable data on the distribution and abundance of the East Asian finless porpoise, this study contributes to our understanding of the population dynamics and conservation status of this threatened species in the Yellow Sea of the Shandong Peninsula.

Keywords: East Asian finless porpoise; abundance; Yellow Sea; conservation; density

Key Contribution: This study provides the first estimation of the abundance and density of the East Asian finless porpoise in the coastal waters of the Yellow Sea in the Shandong Peninsula, China.

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1. Introduction

Abundance and distribution data are fundamental in the fields of ecology and conservation biology [1]. These data provide valuable insights into the spatial patterns of species occurrence and help to identify areas of high conservation significance [2,3]. By identifying critical habitats, conservation efforts can be targeted towards these areas, ensuring the preservation of essential resources and promoting the long-term viability of populations [4]. Furthermore, abundance and distribution data are essential for assessing population trends and monitoring changes over time. These data serve as a basis for evaluating the effectiveness of conservation measures and adjusting management strategies as needed. By regularly updating abundance and distribution information, researchers and conservation practitioners can make informed decisions and prioritize conservation actions accordingly [5,6].

The East Asian finless porpoise (*Neophocaena asiaeorientalis sunameri*), a small toothed whale with an inshore distribution, is a subspecies of the narrow-ridged finless porpoise

(*N. asiaeorientalis*). It is found in the Taiwan Strait and East China Sea, and extends northward to the Bohai/Yellow Sea in China, as well as the coastal regions of Korea and Japan [7–9]. In recent years, the population of the East Asian finless porpoise has significantly been altered by human impacts, particularly fisheries by-catch [10]. Previous studies have reported significant population declines, such as nearly 70% from 1976–1978 to 1999–2000 in the Seto Inland Sea of Japan [11,12] and approximately 70% in the Korean portion of the Yellow Sea from the early 2000s to 2011 [13]. Due to its rapid population rate of decline, the East Asian finless porpoise was reclassified as "Endangered (EN)" on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.

Despite the recognized threats to its survival, information on the distribution and abundance of East Asian finless porpoises, which are small and cryptic and therefore difficult to survey, is limited to a few regions [11–14]. In Japanese waters, five subpopulations have been distinguished based on skull morphology and mtDNA variability [14]. Aerial sighting surveys conducted by Shirakihara (2007) estimated abundances ranging from 289 to 7572 individuals in the Ariake Sound/Tachibana Bay, Omura Bay, and Inland Sea [12]. Their abundance in Ise/Mikawa Bay and Ise/Mikawa Bay was reported separately as 3743 and 3387 individuals [15,16]. In Korean waters, the line transect method was used to estimate abundance, reporting densities of 0.122 individuals/km^2 in western Korean waters (Yellow Sea) offshore and 0.151 individuals/km^2 in the inshore areas [13]. However, there are no available abundance estimates reported for the East Asian finless porpoise in Chinese marine waters [17].

Therefore, boat-based surveys of East Asian finless porpoises were conducted in the coastal waters of the Shandong Peninsula (Yellow Sea), China, from 2018 to 2020, covering an area of 23,603.51 km^2. This study aims to: (1) estimate the abundance and density of the East Asian finless porpoise; (2) identify the spatial distribution of the East Asian finless porpoise within the survey area; and (3) provide further ecological insight into population conservation and management over a wider spatial range. It was expected to aid researchers, conservationists, and policymakers in developing effective conservation and management plans for the East Asian finless porpoise.

2. Materials and Methods

2.1. Study Area

The Shandong Peninsula, boasting a total coastline of 3345 km, is situated on the western shore of the Pacific Ocean. This geographical region borders the Bohai Sea and Yellow Sea and faces the Korean Peninsula and Japanese Archipelago across a vast expanse of sea (Figure 1a). Characterized by more than 200 bays and 10 estuaries of seagoing rivers, the area's aquatic landscape exhibits remarkable diversity. The prevailing main coastal current exhibits a persistent eastward flow along the southern coast of the Bohai Sea and a southward flow along the western coast of the Yellow Sea. Serving as a confluence point for multiple water systems, the region has encompassed numerous crucial fishing grounds, including the Yan(tai)-Wei(hai) and Wei(hai)-Qing(dao) fishing grounds [18]. These waters have been identified as a pivotal habitat for the East Asian finless porpoise. In this study, we conducted three sighting surveys within the 30 m isobath between 119°30′ E–123°15′ E and 35°25′ N–38°0′ N (depth < 30 m) of the Yellow Sea of the Shandong Peninsula (Figure 1b).

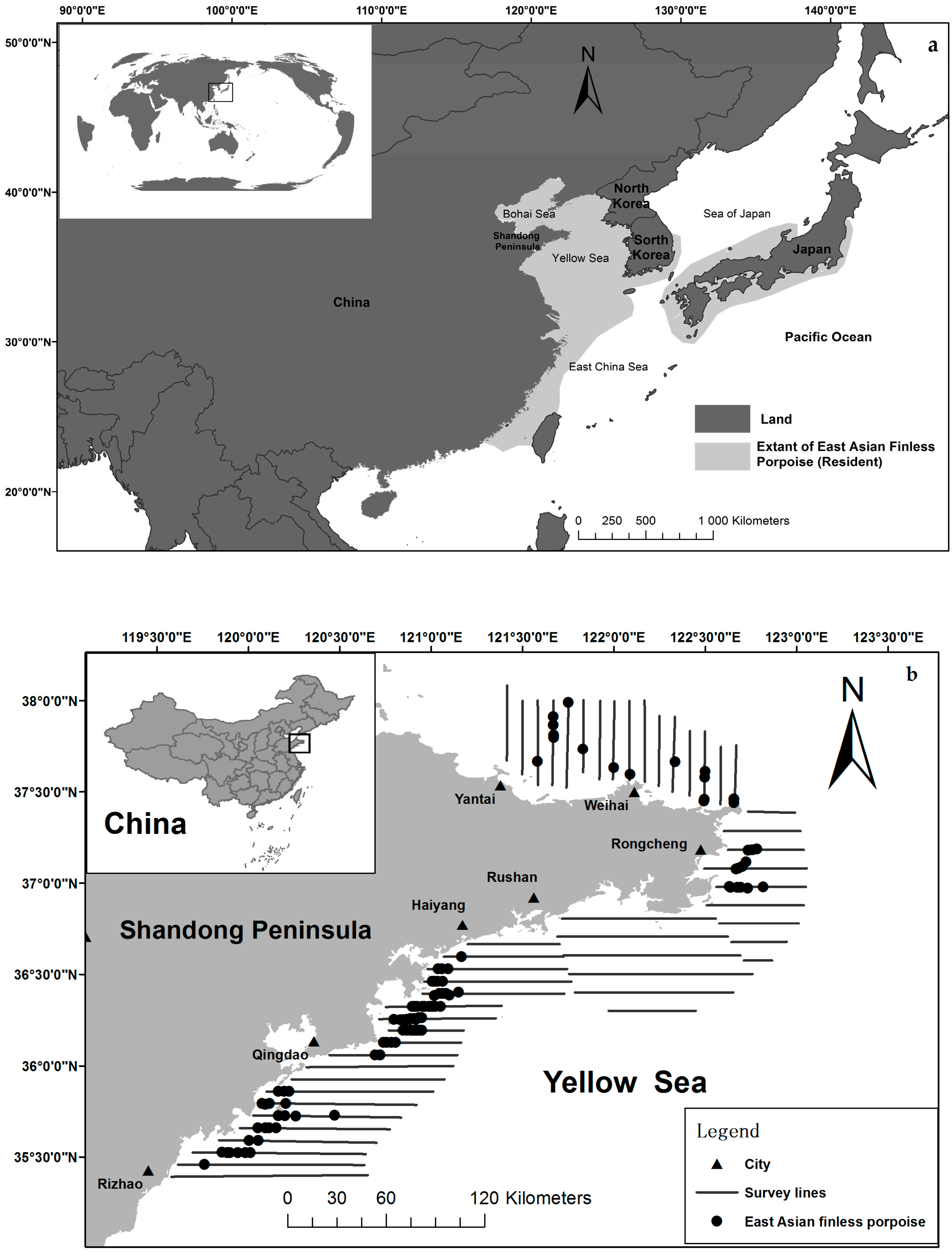

Figure 1. (**a**) The distribution map of East Asian finless porpoise; (**b**) survey designs and locations of East Asian finless porpoise group sightings in the study area.

2.2. Line Transect Surveys

Line transect surveys were conducted over 41 days, and due to the interruptions caused by unfavorable weather conditions, they were divided into three disjunct periods (Figure 1b): 24 May–3 June 2018 (Weihai city–Qingdao city, study area 1), 3–11 June 2019 (Qingdao city–Rizhao city, study area 2), and 14–30 June 2020 (Yantai city–Weihai city, study area 3). The line transect method was employed to estimate the abundance of the

East Asian finless porpoise and will not be discussed in detail here [19]. Survey transects were set parallel to the density gradient of the porpoise population, as the density tends to decline from the inshore to offshore areas [19,20]. The survey transects in this study were established intervals of approximately 11 km, moving in a south-north direction from Yantai city to Weihai city and an east-west direction from Weihai city to Rizhao city (Figure 1b).

To maximize the probability of detecting the East Asian finless porpoise, surveys were scheduled only during calm sea conditions with a Beaufort scale rating of less than 3. This ensured better detectability of the porpoises, as poor sea conditions with whitecaps would have hindered sightings. Two types of boats were used for the surveys: the research vessel Zhongyuke 102 (398G/T, 634 kilowatts) of the Ministry of Agriculture and Rural Affairs of China for the study area 1 and 2, and a fishing boat with a 235 kilowatts diesel engine for the study area 3. The speed of the two types of boats were maintained at 12–15 km/h. Sea conditions were updated as needed, and if conditions deteriorated, the survey was terminated until conditions improved. All surveys occurred during daylight.

The observation platform is located at the top of the captain's cabin, approximately 5 m above sea level. The research team consists of four members, and they rotate positions on the observation platform. The three designated positions are the left observer, data recorder, and right observer, and they switch roles every 30 min. During the observation, the left and right observers are responsible for monitoring the fan-shaped water area on their respective sides, ranging from 0° (aligned with the heading direction) to 90°. Meanwhile, the center observer, who also served as the data recorder, scanned the entire area. Using 7 × 50 mm Fujinon binoculars, three observers (left, center, and right) searched for porpoises. When finless porpoises were sighted, various data, including the species, time, sea state, location, sighting angle, distance, detection mode, and population size, were recorded. An angle board was used to measure sighting angles. The position of the boat, recorded automatically every minute, and the location of each sighting were logged using a handheld Garmin GPSmap60cs global positioning system (GPS). Glare, which could affect detectability [21], was not taken into account in the abundance estimation due to difficulties in evaluation. Polarized sunglasses were used to reduce glare.

2.3. Abundance Estimation

Sighting distances and angles were used to calculate perpendicular distances using simple trigonometry [22]. The software program Distance version 7.2 (The University of St Andrews, St Andrews, England) [23] was then employed to estimate the density and abundance of the East Asian finless porpoise. To improve the fit of the detection function and remove outliers, 5% of observations from the farthest distance were excluded. The detection probability was estimated using the Conventional Distance Sampling (CDS) model [22]. Three types of CDS models (uniform, half-normal, and hazard-rate) with three adjustment terms (cosine, simple polynomial, and Hermite polynomial) were tested, and the best model was selected based on Akaike's information criterion [24]. The effective strip half-width (ESW) was obtained from the most suitable model. To ensure consistency in width estimation, the same observers and sighting methods were used in the three surveys conducted from 2018 to 2020.

The abundance of the East Asian finless porpoise was estimated using the calculation Equation [22]:

$$N = \frac{nE(s)A}{2Lg(0)\mu} \tag{1}$$

$$D = N/A \tag{2}$$

where N is the abundance estimate, D is the density estimate, n is the number of groups sighted within the survey area, A is the survey area in square kilometers, $E(s)$ is the expected group size, μ is the effective strip half-width (ESW), $g(0)$ is the detection probability on the trackline, and L is the total length of the transect lines.

In this survey, it was assumed that all animals on the trackline were observed ($g(0) = 1$). The coefficient of variation (CV) and the 95% confidence interval (CI) were calculated using the following Equation [11,12]:

$$CV = \sqrt{\frac{v(n)}{n^2} + \frac{v[E(s)]}{[E(s)]^2} + \frac{v[g(0)]}{[g(0)]^2}} \quad (3)$$

$$95\%CI = exp\left\{1.96\sqrt{ln\left[1 + \frac{v(N)}{N^2}\right]}\right\} \quad (4)$$

3. Results

3.1. Sightings (Groups) and Distribution

Table 1 provides details of the three surveys conducted between 2018 and 2020, along with the sightings of the East Asian finless porpoise. A total of 117 sightings were recorded over a transect length of 2705 km, resulting in an encounter rate of 0.043 groups/km. Group size was determined based on the number of animals seen within 300 m of the boat, which was considered the reliable visibility range for finless porpoises. Only two bottlenose dolphins were detected, and no other species of marine mammal were observed.

Table 1. Summary of the survey and East Asian finless porpoise sightings.

Survey Area (km^2)	Number of Transects	Length Surveyed (km)	Number of Groups Detected	Encounter Rate (Groups/km)
23,604	50	2705	117	0.043

The spatial distribution of porpoise sightings in the study area was uneven, as depicted in Figure 1. More than 90% of the East Asian finless porpoise groups were found near the coast within 15 km from the shore or islands, as shown in Figure 2. Qingdao Laoshan Bay exhibited the highest encounter rate (Figure 3) compared to other areas along the southern coast of the Shandong Peninsula.

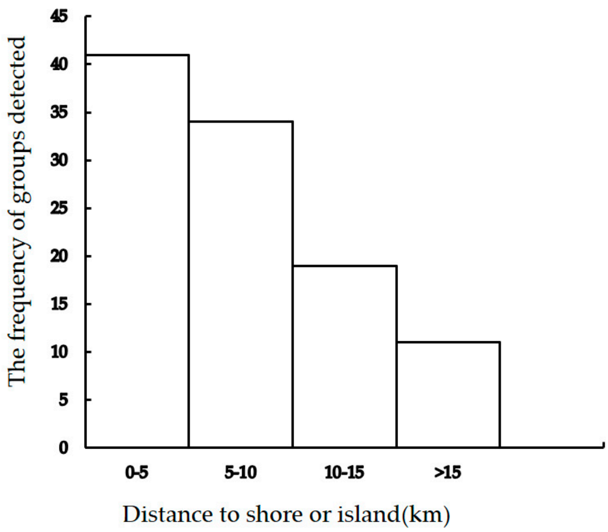

Figure 2. The distance to shore or island of East Asian finless porpoises relative to frequency of groups detected in the study area.

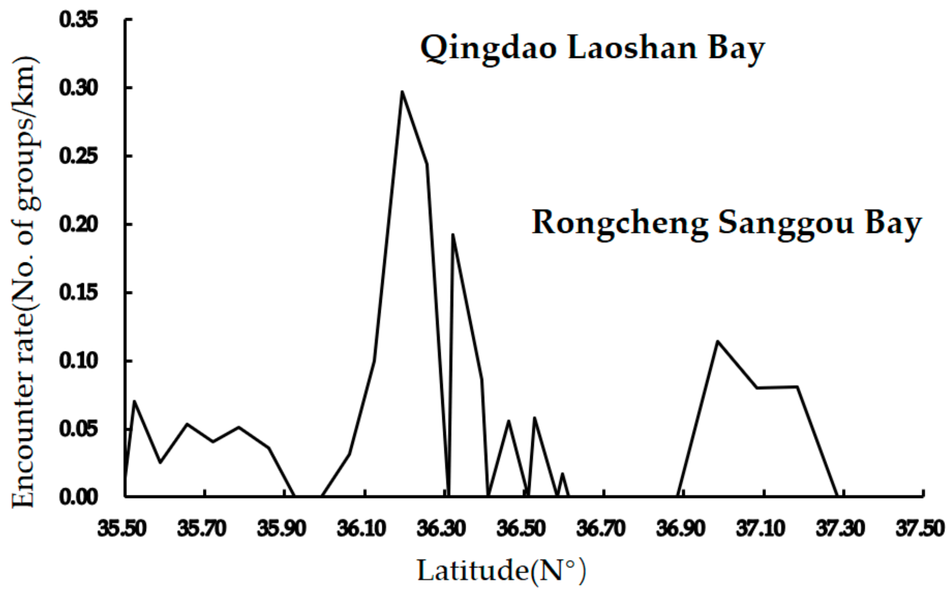

Figure 3. Latitudinal changes in encounter rates of East Asian finless porpoises on the southern coast of the Shandong Peninsula.

3.2. Estimation of the Model and Effective Strip Width (ESW)

The frequency distributions of the perpendicular distance did not show significant differences between the two observers (Kolmogorov–Smirnov Test, $p > 0.05$). Additionally, there was no observer difference in the number of individuals detected (t-test, $p > 0.05$). Hence, it was concluded that both observers conducted the surveys in a consistent manner, and the sighting data were pooled. The frequency distributions of the perpendicular distance are illustrated in Figure 4, depicting a typical distance sampling frequency distribution with the highest observation frequency near the survey line, gradually decreasing with distance.

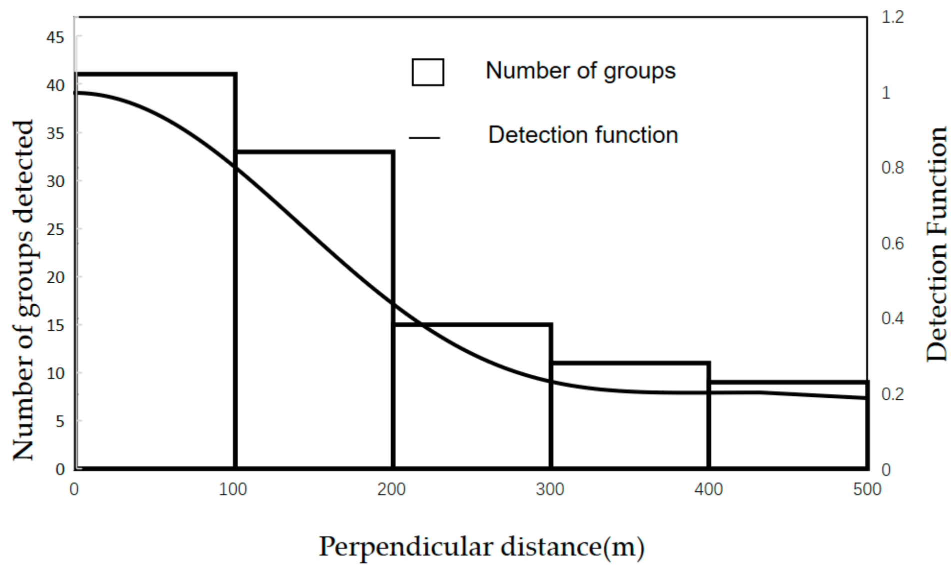

Figure 4. Frequency distribution and histogram of the perpendicular distance and fitted detection function for the best Akaike's information criterion (AIC) selected model of the survey.

The AIC values of the uniform model, half-normal model, and hazard-rate model are shown in Table 2. Among the combinations of CDS models, the uniform model exhibited the lowest estimated value (1313.6) and was selected as the best detection function model. The estimated ESW value for the survey using the uniform model was 215.47 m (CV = 9.9%).

Table 2. Parameter estimates of each model used to fit the perpendicular distance data for East Asian finless porpoise groups.

Model	ESW (m)	AIC	Chi-p	*p*	F(0)
Uniform	215.47	1313.6	0.680	0.498	0.005
Half-normal	216.47	1315.4	0.645	0.500	0.005
Hazard-rate	198.73	1315.3	0.535	0.459	0.005

ESW = effective strip width, AIC = Akaike information criterion, Chi-p = probability for chi-square goodness of fit test, *p* = probability of observing an object in defined area, F(0) = Value of probability density function at zero.

To improve the estimation model and eliminate outliers, 5–10% of the data from the farthest distance of observation were excluded. After removing 5% of these data, 111 sightings remained, resulting in an encounter rate of 0.041 groups/km (*CV* = 19.69%) (Table 3).

Table 3. Estimate of East Asian finless porpoise density and abundance along the coastal waters of Yellow Sea of Shandong Peninsula.

Parameter	Estimate	CV (%)	95%CI	
			Lower	Upper
Groups (5% truncated)	111			
Encounter rate (groups/km)	0.041	19.69	0.028	0.061
Mean Cluster size	1.743	3.69	1.620	1.876
Expected cluster size	1.770	3.96	1.636	1.914
D (individuals/km^2)	0.169	22.39	0.109	0.262
N (individuals)	3978	22.39	2561	6177

D = estimate of density of animals, *N* = estimate of number of animals in specified area, *CV* = co-efficient variance, CI = confidence interval.

3.3. Abundance Estimate

Table 3 displays the expected cluster size, density, abundance, and coefficients of variation (*CV*) estimated for the study area. The abundance of East Asian finless porpoise in the coastal waters of the Yellow Sea in the Shandong Peninsula was estimated to be 3978 individuals (*CV* = 22.39%, 95%*CI* = 2561–6177). The density was calculated as 0.169 individuals/km^2 (*CV* = 22.39%, 95%*CI* = 0.109–0.262). The expected cluster size was 1.77 (*CV* = 3.96%, 95%*CI* = 1.636–1.914).

4. Discussion

4.1. Abundance and Density Estimates

The East Asian finless porpoise is a small cetacean species that lacks a dorsal fin, making them more challenging to survey and study compared to other marine mammals with prominent dorsal fins. As a result of their inconspicuous appearance and elusive behavior, obtaining accurate baseline information about their population and ecology becomes even more difficult. This study provides the first estimation of the absolute abundance and density of this threatened porpoise in the Yellow Sea of China. It is estimated that the number of porpoises is 3978 (95%*CI* = 2561–6177) individuals, which were discovered in the study area based on the assumption that $g(0) = 1$ (Table 3). The assumption that $g(0) = 1$, implying that all animals are detected directly on the trackline, is a critical premise of line transect sampling [22]. However, in practice, we could hardly detect groups that were under the surface, and we may even have missed some of the surfacing groups on the trackline; thus, $g(0) < 1$ [25,26]. Consequently, the estimates presented here could be considered conservative. The double-platform methodology can accurately determine $g(0)$ [27]. This methodology would require an increase in the number of observers and a larger vessel, which may restrict the observers' proximity to shore. It is important to note that the above estimate represents a minimum value. Since the surveys were conducted at different times in the study area, this may introduce additional variance when pooling abundance estimates due to the potential movements of individuals in adjacent areas, compared to a synoptic survey [28]. Despite the need to correct and account for the underestimation of abundance, the current estimate holds significance for porpoise conservation efforts.

The estimated density was 0.169 individuals/km^2 in the study area (Table 3). It was lower than the density of 0.221 individuals/km^2 reported for the Sendai Bay-Tokyo Bay population in 2012, which represented the lowest levels among the five populations in Japanese waters [29]. However, it was slightly higher than the density of 0.151 individuals/km^2 reported for the West Coast of Korea in 2011 (0.122 individuals/km^2 for offshore areas) [13]. It should be noted that these estimates used the same assumption of $g(0) = 1$. East Asian finless porpoises prefer shallow depths (<50 m) [30], so the density in inshore areas tends to be higher than offshore areas [31]. Considering that the depth of our survey area was <30 m, the density in the coastal waters (<50 m) of the Yellow Sea in the Shandong Peninsula may be lower than the estimated value (0.169 individuals/km^2).

4.2. Distribution

The findings of this study demonstrate a significant level of spatial heterogeneity in the distribution of the East Asian finless porpoise. Such heterogeneity is evident in both regional variations (Figure 1b) and distances from the shore or islands (Figure 2). It was found that Qingdao Laoshan Bay and Rongcheng Sanggou Bay exhibited higher encounter rates (Figure 3) compared to other regions, and a greater number of porpoises were observed within 15 km from the shore or islands than were observed beyond 15 km, indicating that the waters in the bays and close to the coastline or islands may provide coastal habitats for East Asian finless porpoises.

The underlying reasons for this observed spatial heterogeneity may be attributed to the porpoises' habitat preferences, although this study solely focused on estimating density and abundance, without directly assessing habitat use. The distribution of cetaceans is often influenced by oceanographic features, such as tidal races and eddies, which promote the aggregation of prey species. These features elevate nutrient levels, stimulating primary production and creating localized aggregations of schooling fish, leading to concentrated patches of prey for marine predators [32]. East Asian finless porpoises likely remain in close proximity to these food resources to satisfy their energetic requirements for maintenance, growth, and reproduction; therefore, their distribution is likely to reflect foraging opportunities. Both Laoshan Bay and Sanggou Bay are important spawning grounds and habitats for several fishery resources [33], which likely contributes to the higher encounter rates of East Asian finless porpoises. Similar patterns have been observed for other dolphin species, such as the Yangtze finless porpoise and bottlenose dolphins [34–36]. It is important to explain the relationship between East Asian finless porpoise density and environmental factors in future studies. The absence of porpoise sightings in certain areas, particularly from Haiyang city to Rushan city waters (36.6° N–36.9° N), suggests the possibility of habitat fragmentation (Figure 3). To confirm distributional gaps, repeated intensive sighting surveys should be conducted in the future [37].

4.3. Conservation Implications

The population decline rate in the Yellow Sea of China cannot be estimated accurately due to limited previous work on the abundance of East Asian finless porpoises for comparison. Population estimates from adjacent waters (Korea and Japan) may apply to our study area. Significant declines of approximately 70% in the population have been observed in regions such as the Seto Inland Sea of Japan and the Korean portion of the Yellow Sea [11,13]. The density decreased by approximately 70% over 22 years in Japan and would decrease by approximately 90% over 50 years [38].

As a coastal species, East Asian finless porpoises are vulnerable to various anthropogenic influences, including pollution, bycatch, ship strikes, and habitat loss and degradation [17,39]. Among these impacts, bycatch in net fisheries is considered the most serious threat in many habitats [40,41]. Declines in population size have been detected in the west coast of Korea and the Seto Inland Sea, Ariake Sound, and Tachibana Bay in Japan, with bycatch being a major factor responsible for these declines. In Korean inshore waters alone, a total of 2017 finless porpoises were estimated to have been caught in nets in 2012. Similar issues affect Japanese waters, with approximately 5% to 10% of the population in Ariake Sound estimated to be caught annually as bycatch in gillnet fisheries [42]. Reducing the threat of bycatch is of high priority for the conservation of finless porpoises, and the use of acoustic equipment, such as pingers, has been demonstrated to be effective [43,44] and should be promoted for widespread use. It is also important to establish rescue organizations to aid injured finless porpoises affected by bycatch and stranding events [45].

In addition to bycatch, other anthropogenic impacts should also be addressed. Identifying the main factors that pose a serious threat to the species' conservation is challenging, as these threats may have a stronger effect when combined. Long-term strategies are necessary for population and habitat conservation in response to human activities that negatively affect their status. The establishment of marine protected areas (MPAs) is a common approach to address anthropogenic impacts on coastal finless porpoises and is considered an important tool for biodiversity conservation by international frameworks [46–48]. Many natural and ex-situ reserves have been established for the Yangtze finless porpoise, another subspecies of the narrow-ridged finless porpoise, in the middle and lower reaches of the Yangtze River [49]. Similar conservation efforts should be undertaken for the East Asian finless porpoise in coastal waters.

4.4. Research Recommendations

Boat-based line transect visual surveys, although valuable for studying East Asian finless porpoises, are subject to limitations when compared to alternative survey methodologies. These limitations encompass potential observer bias, susceptibility to weather and sea state conditions, and the incomplete detection of subsurface individuals. Future research endeavors should embrace an integrative approach that synergistically incorporates diverse methodologies. This integrative approach entails the concurrent utilization of acoustics, unmanned aerial vehicles (UAVs), and environmental DNA (eDNA) analysis. By amalgamating these techniques, a comprehensive assessment of the East Asian finless porpoise population can be attained, encompassing precise abundance estimation and the elucidation of intricate spatio-temporal variations in their habitat utilization patterns. Given the considerable gravity of fisheries-related mortality as the principal immediate threat to these porpoises, it is imperative to conduct robust evaluations of its impact. Furthermore, it is of utmost importance to expand survey efforts to encompass the Yellow Sea and Bohai Sea, as the paucity of abundance estimates for finless porpoises in these Chinese marine waters necessitates a more holistic understanding of their distribution and conservation status.

5. Conclusions

This study provides the first estimation of the abundance and density of the East Asian finless porpoise in the coastal waters of the Yellow Sea in the Shandong Peninsula, China. The population was estimated to be 3978 individuals, with a density of 0.169 individuals/km^2. The distribution of the species was primarily restricted to areas near the coast within 15 km from the shore or islands. The findings highlight the need for conservation measures to address the threats faced by this species, including bycatch, habitat degradation, and pollution. The establishment of marine protected areas and the implementation of bycatch mitigation measures are crucial for the long-term survival of the East Asian finless porpoise population in the study area.

Author Contributions: Conceptualization, Y.L. and J.W.; conceived, designed, and conducted the field surveys, and wrote the manuscript, Y.L.; collected the data as observers, Z.C. and R.C.; original data analysis and revised the manuscript, T.Z. and M.N.; project administration, J.W. All authors have read and agreed to the published version of the manuscript.

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References

1. Pillay, R.; Miller, D.A.; Raghunath, R.; Joshi, A.A.; Mishra, C.; Johnsingh, A.J.T.; Madhusudan, M.D. Using Interview Surveys and Multispecies Occupancy Models to Inform Vertebrate Conservation. *Conserv. Biol.* **2022**, *36*, e13832. [CrossRef]
2. Dagosta, F.C.P.; Silveira, R.M.; Soares, A.L.O.; Barbosa, M. Existing protected areas provide a poor safety-net for threatened Amazonian fish species. *Aquat. Conserv. Mar. Freshw. Ecosyst.* **2021**, *31*, 1167–1189. [CrossRef]
3. Baker, D.J.; Hinsley, A.K.; Stephens, P.J.; Sutherland, W.J. Conserving the abundance of nonthreatened species. *Conserv. Biol.* **2019**, *33*, 319–328. [CrossRef]
4. Bonizzoni, S.; Ceraulo, A.; La Manna, G.; Mazzola, S. Modelling dolphin distribution within an Important Marine Mammal Area in Greece to support spatial management planning. *Aquat. Conserv. Mar. Freshw. Ecosyst.* **2019**, *29*, 1665–1680. [CrossRef]
5. Stem, C.; Cumming, G.S.; Clark, D.A.; Gurney, G.C. Monitoring and evaluation in conservation: A review of trends and approaches. *Conserv. Biol.* **2005**, *19*, 295–309. [CrossRef]
6. Moore, M.J.; Landers, S.H.; Eberhart, L.L.; Smith, C.R. REVIEW Assessing North Atlantic right whale health: Threats, and development of tools critical for conservation of the species. *Dis. Aquat. Org.* **2021**, *143*, 205–226. [CrossRef]
7. Wang, D. Population status, threats and conservation of the Yangtze finless porpoise. *Chin. Sci. Bull.* **2009**, *54*, 3473–3484. [CrossRef]
8. Cheng, Z.; Li, Y.; Pine, M.K.; Zuo, T.; Niu, M.; Wang, J. Association between porpoise presence and fish choruses: Implications for feeding strategies and ecosystem-based conservation of the East Asian finless porpoise. *Integr. Zool.* **2023**, *18*, 169–182. [CrossRef]
9. Jefferson, T.A.; Wang, J.Y. Revision of the taxonomy of finless porpoises (genus *Neophocaena*): The existence of two species. *J. Mar. Anim. Ecol.* **2011**, *4*, 3–16.
10. Patel, T.S. A Range-Wide Assessment of *Neophocaena:* Threats and Priorities for Research and Conservation. Master's Thesis, San Francisco State University, San Francisco, CA, USA, 2022.
11. Kasuya, T. Abundance decline in the finless porpoise population in the Inland Sea of Japan. *Raffles Bull. Zool.* **2002**, *50*, 57–65.
12. Shirakihara, K.; Shirakihara, M.; Yamamoto, Y. Distribution and abundance of finless porpoise in the Inland Sea of Japan. *Mar. Biol.* **2007**, *150*, 1025–1032. [CrossRef]
13. Park, K.J.; Sohn, H.M.; An, Y.R.; Kim, H.W.; An, D.H. A new abundance estimate for the finless porpoise *Neophocaena asiaeorientalis* on the west coast of Korea: An indication of population decline. *Aquat. Sci.* **2015**, *77*, 411–416. [CrossRef]
14. Yoshida, H.; Yoshioka, M.; Shirakihara, M.; Chow, S.-K. Population structure of finless porpoises (*Neophocaena phocaenoides*) in coastal waters of Japan based on mitochondrial DNA sequences. *J. Mammal.* **2001**, *82*, 123–130. [CrossRef]
15. Suzuki, M.; Taru, H.; Takai, N.; Okutsu, K.; Ito, H.; Ishii, T. The haplotypes of four finless porpoises stranded on the coast of Sagami Bay and Tokyo Bay during 2011–2013. *Mamm. Study* **2015**, *40*, 127–132. [CrossRef]
16. Amano, M.; Iwata, T.; Sakamoto, K.Q.; Kasuya, T.; Ohizumi, H.; Amano, T. Abundance estimate of finless porpoise *Neophocaena phocaenoides* in eastern Hiroshima Bay, Japan. *Ecol. Res.* **2007**, *22*, 141–151.
17. The IUCN Red List of Threatened Species. 2017. Available online: https://www.iucnredlist.org/species/41754/50381766 (accessed on 10 June 2023).
18. Zhang, Z.; Qiao, F.; Guo, J.; Yu, F. Seasonal variation of coastal water movement in the southern Bohai Sea and water exchange between the Bohai Sea and the Yellow Sea. *Adv. Mar. Sci.* **2010**, *28*, 142–148.
19. Buckland, S.; Anderson, D.; Burnham, K.; Laake, J. *Distance Sampling: Estimating Abundance of Biological Populations*; Chapman and Hall: London, UK, 1993; pp. 200–446.
20. Kasuya, T.; Kureha, K. The population of finless porpoise in the Inland Sea of Japan. *Sci. Rep. Whales Res. Inst.* **1979**, *31*, 1–44.

21. Dawson, S.; Slooten, E.; DuFresne, S.; Wade, P.; Clement, D. Small-boat surveys for coastal dolphins: Line-transect surveys of Hector's dolphins (*Cephalorhynchus hectori*). *Fish. Bull.* **2004**, *102*, 441–451.
22. Buckland, S.T.; Anderson, D.R.; Burnham, K.P.; Laake, J.L.; Borchers, D.L.; Thomas, L. *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*; Oxford University Press: Oxford, UK, 2001; pp. 100–432.
23. Thomas, L.; Buckland, S.T.; Rexstad, E.A.; Laake, J.L.; Strindberg, S.; Hedley, S.L.; Bishop, J.R.; Marques, T.A.; Burnham, K.P. Distance software: Design and analysis of distance sampling surveys for estimating population size. *J. Appl. Ecol.* **2010**, *47*, 5–14. [CrossRef]
24. Albahli, S.; Yar, G.N.A.H. Defect Prediction Using Akaike and Bayesian Information Criterion. *Comput. Syst. Sci. Eng.* **2022**, *41*, 1117–1127. [CrossRef]
25. Shucksmith, R.; Jones, N.H.; Stoyle, G.W.; Davies, A.; Dicks, E.F. Abundance and distribution of the harbour porpoise (*Phocoena phocoena*) on the north coast of Anglesey, Wales, UK. *J. Mar. Biol. Assoc. United Kingd.* **2009**, *89*, 1051–1058. [CrossRef]
26. Huang, J.; Mei, Z.; Chen, M.; Han, Y.; Zhang, X.Q.; Moore, J.E.; Zhao, X.J.; Hao, Y.J.; Wang, K.X.; Wang, D. Population survey showing hope for population recovery of the critically endangered Yangtze finless porpoise. *Biol. Conserv.* **2020**, *241*, 108315. [CrossRef]
27. Barlow, J.; Cameron, G.A. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gill net fishery. *Mar. Mammal Sci.* **2003**, *19*, 265–283. [CrossRef]
28. Skaug, H.J.; Øien, N.; Schweder, T.; Bøthun, G. Abundance of minke whales (*Balaenoptera acutorostrata*) in the Northeast Atlantic: Variability in time and space. *Can. J. Fish. Aquat. Sci.* **2004**, *61*, 870–886. [CrossRef]
29. Shirakihara, K.; Nakahara, F.; Shinohara, M.; Shirakihara, M.; Hiramatsu, K.; Irie, T. Abundance decline in the narrow-ridged finless porpoise population off the Pacific coast of eastern Japan. *Popul. Ecol.* **2019**, *61*, 325–332. [CrossRef]
30. Shirakihara, M.; Takemura, A.; Shirakihara, K. Age, growth, and reproduction of the finless porpoise, *Neophocaena phocaenoides*, in the coastal waters of western Kyushu, Japan. *Mar. Mammal Sci.* **1993**, *9*, 392–406. [CrossRef]
31. Park, K.-J.; Kim, Z.-G.; Zhang, C.-I. Abundance estimation of the finless porpoise, *Neophocaena phocaenoides*, using models of the detection function in a line transect. *Korean J. Fish. Aquat. Sci.* **2007**, *40*, 201–209.
32. Cade, D.E.; Friedlaender, A.S.; Calambokidis, J.; Goldbogen, J.A. Predator-scale spatial analysis of intra-patch prey distribution reveals the energetic drivers of rorqual whale super-group formation. *Funct. Ecol.* **2021**, *35*, 894–908. [CrossRef]
33. Wang, X.; Liu, L.; Zhao, L.; Xu, H.; Zhang, X. Assessment of dissolved heavy metals in the Laoshan Bay, China. *Mar. Pollut. Bull.* **2019**, *149*, 110608. [CrossRef]
34. Kimura, S.; Akamatsu, T.; Li, S.; Dong, L.; Wang, K.; Wang, D.; Arai, N. Seasonal changes in the local distribution of Yangtze finless porpoises related to fish presence. *Mar. Mammal Sci.* **2012**, *28*, 308–324.
35. Zhang, X.; Yu, D.; Wang, H.; Wan, A.; Chen, M.; Tao, F.; Song, Z. Effects of fish community on occurrences of Yangtze finless porpoise in confluence of the Yangtze and Wanhe Rivers. *Environ. Sci. Pollut. Res.* **2015**, *22*, 9524–9533. [CrossRef]
36. Bennington, S.; Rayment, W.; Dawson, S. Putting prey into the picture: Improvements to species distribution models for bottlenose dolphins in Doubtful Sound, New Zealand. *Mar. Ecol. Prog. Ser.* **2020**, *653*, 191–204. [CrossRef]
37. Hooker, S.K.; Cañadas, A.; Hyrenbach, K.D.; Corrigan, C.; Polovina, J.J.; Reeves, R.R. Making protected area networks effective for marine top predators. *Endanger. Species Res.* **2011**, *13*, 203–218. [CrossRef]
38. Hashimoto, M.; Shirakihara, K.; Shirakihara, M.; Hiramatsu, K. Estimating the rate of increase for the finless porpoise with special attention to predictions for the Inland Sea population in Japan. *Popul. Ecol.* **2013**, *55*, 441–449. [CrossRef]
39. Hashimoto, M.; Shirakihara, K.; Shirakihara, M. Effects of bycatch on the population viability of the narrow-ridged finless porpoises in Ariake Sound and Tachibana Bay, Japan. *Endanger. Species Res.* **2015**, *27*, 87–94. [CrossRef]
40. Reeves, R.R.; Wang, J.Y.; Leatherwood, S. The finless porpoise, *Neophocaena phocaenoides* (G. Cuvier, 1829): A summary of current knowledge and recommendations for conservation action. *Asian Mar. Biol.* **1997**, *14*, 111–143.
41. Read, A.J.; Drinker, P.; Northridge, S. Bycatch of marine mammals in US and global fisheries. *Conserv. Biol.* **2006**, *20*, 163–169. [CrossRef]
42. Shirakihara, M.; Shirakihara, K. Finless porpoise bycatch in Ariake sound and Tachibana Bay, Japan. *Endanger. Species Res.* **2013**, *21*, 255–262. [CrossRef]
43. Werner, T.; Kraus, S.; Read, A.; Zollett, E. Fishing techniques to reduce the bycatch of threatened marine animals. *Mar. Technol. Soc. J.* **2006**, *40*, 50–68. [CrossRef]
44. Prajith, K.; Das, P.D.; Edwin, L. Dolphin Wall Net (DWN)—An innovative management measure devised by ring seine fishermen of Kerala-India to reducing or eliminating marine mammal–fishery interactions. *Ocean Coast. Manag.* **2014**, *102*, 1–6. [CrossRef]
45. Wang, Y.; Li, W.; Van Waerebeek, K. Strandings, bycatches and injuries of aquatic mammals in China, 2000–2006, as reviewed from official documents: A compelling argument for a nationwide strandings programme. *Mar. Pol.* **2015**, *51*, 242–250. [CrossRef]
46. Gubbay, S. Marine Protected Areas—Past, Present and Future. In *Marine Protected Areas*; Gubbay, S., Ed.; Springer: Berlin/Heidelberg, Germany, 1995; pp. 1–14.
47. Hyrenbach, K.D.; Forney, K.A.; Dayton, P.K. Marine protected areas and ocean basin management. *Aquat. Conserv. Mar. Freshw. Ecosyst.* **2000**, *10*, 437–458. [CrossRef]

48. Hooker, S.K.; Gerber, L.R. Marine reserves as a tool for ecosystem-based management: The potential importance of *megafauna*. *Bioscience* **2004**, *54*, 27–39. [CrossRef]
49. Li, Y.T.; Wang, D. Estimation of the carrying capacity of Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) in Tian-E-Zhou Oxbow based on linear food network model. *Appl. Ecol. Environ. Res.* **2020**, *18*, 6981–6994. [CrossRef]