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Comparison of bycatch in three types of traps for catching *Macrobrachium nipponense* (De Haan, 1849) in Anzali Lagoon

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ABSTRACT

Most of the studies about bycatch are in industrial fishing. Consequently, the information about bycatch in the small-scale fishery is limited. Small-scale fisheries are promoted as a sustainable alternative to large-scale industrial fisheries. However, studying their effectiveness concerning bycatch and their effect on aquatic species is essential. In this study, we compared bycatch in three types of traps (Cylindrical pot, Operahouse trap, and Hokkaido pot) to catch *Macrobrachium nipponense* in the Anzali lagoon during 2015. The results showed a significant difference in bycatch rate and CPUE bycatch for all three fishing gear (P< 0.05). Operahouse trap had the highest mean CPUE for bycatch per trip (20.11). The highest discard rate of biomass and number of organisms was on the Operahouse trap, but comper to the total catch, it was the lowest one, which means the bycatch rate in the Operahouse trap was low (0.35). The results indicated *Neogobius caspius, Blicca bjoerkna,* and *Cyprinus carpio* had more papulations in the Cylindrical pot, Operahouse trap, and Hokkaido pot, respectively. In conclusion, the Operahouse trap, compare to the Cylindrical pot and Hokkaido pot, had a better efficiency, but it needs to improve this trap to reduce total bycatch.

INTRODUCTION

The Anzali Lagoon is located on the southern coast of the Caspian Sea in the Guilan province. Although the water for the Anzali lagoon is polluted, this place is an important place for breeding fish. The lagoon's water is between freshwater and brackish ecosystems, making a special ecotone (**Aminisarteshnizi, 2021a**). Most of the fish in the Anzali lagoon are commercial fish. Some of these fish are considered in Conservation Dependent IUCN categories; therefore, bycatch is a challenge for the fisheries in the Anzali lagoon (**Aminisarteshnizi, 2021b**). The Oriental river prawn (*M. nipponense*) is an exotic species for the Anzali lagoon. Recently, *M. nipponense* has been one of the targets for fishing, but bycatch is one of the challenges for catching them.

Bycatch has been an issue for many fisheries worldwide, including the Anzali lagoon. Almost all fisheries produce unwanted catches by the fishery. The fishery varies by the ecological and economic implications resulting from a non-targeted catch (**Favaroa et al., 2010**). The environmental impacts of bycatch negatively affect all aquatic species, some of which may be protected. For the economic impact of bycatch, we can point to the increasing expenses of modifying fishing gear and spending more time on fishing (**Page et al., 2013**). Most of the studies about the implications of bycatch have come from large-scale fishing.

In comparison, studies about the implications of bycatch in small-scale fishing gears are sparse. Definition of Small-scale fisheries is the length of vessels is under 15 m, manual or semi-mechanized fishing gear, low rate of catch per vessel, and the ownership is local (**Chuenpagdee et al., 2006**). Small-scale fisheries provide more than half of total fisheries production globally, and the number of employees is more than 99% worldwide (**Berkes et al., 2001**). In the competition between small-scale fisheries and large-scale fisheries, the small-scale fisheries suffer because of the lack of resources and infrastructure to monitor and manage exploited populations. Nevertheless, some characteristics of small-scale fisheries (such as low technology for extraction and limited fishing area) make it the best way to utilize coastal marine resources (**Pauly, 2006**).

In this study, we quantify and compare the potential impacts of three fishing gear types (Cylindrical pot, Operahouse trap, and Hokkaido pot) in terms of their bycatch. The prawn fisheries of Anzali lagoon use only trap. Therefore, the study's objectives were 1: to evaluate bycatch in three different traps, 2: to determine the bycatch efficiencies (in terms of CPUE), and 3: to compare the bycatch rates regarding weight and number in the Anzali lagoon.

MATERIALS AND METHODS

Study area

In this study, three localities were used, namely Site 1 (GPS coordinates: 37° 47' 026.42" N and 49° 34' 307.12" E) and Site 2 (GPS coordinates: 37° 41' 2998.45" N and 49° 41' 6902.1" E) Site 3 (GPS coordinates: 37° 44' 2998.45" N and 49° 44' 6902.1" E) (Figure 1).

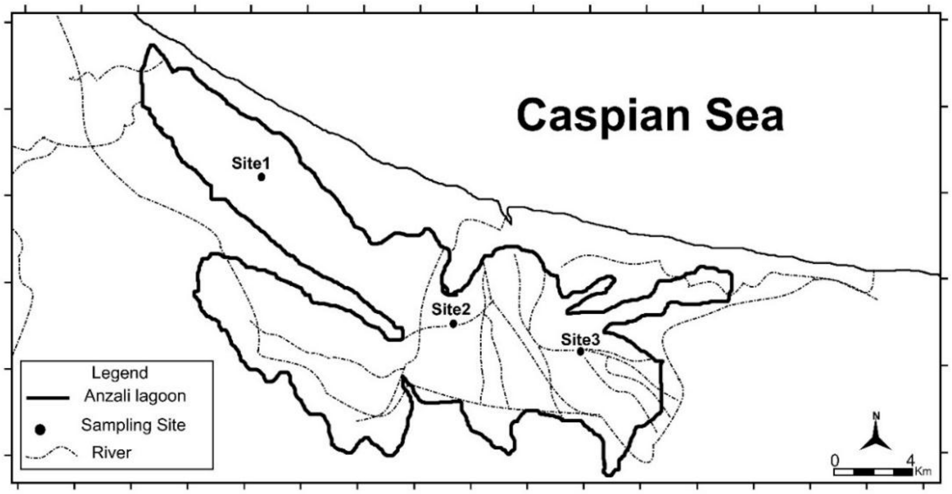

Figure 1. Sampling area for *M. nipponense* in Anzali Lagoon, Iran.

Specimens sampling

Twenty-seven (27) traps were randomly selected for the three sites in the Anzali lagoon. All the traps were used simultaneously to sample prawns in this study. The traps were checked every 24 hours, and the samples were collected at night for Twenty (20) nights per month for six (6) months (April 2015 to September 2015). All traps were set baited by bread.

Bycatch quantification

For the definition of bycatch, we used the National Marine Fisheries Service, which includes all organisms that are caught in fishing gear, but they are not the purpose of fisheries. We recorded the species, length, and weight on each fishing trip, then estimated their biomass. Total bycatch biomass (g) of the fish by each gear type on observed trips is reported in Table 1.

Catch per unit effort

Collected samples were removed, placed in iceboxes, and transferred to the laboratory for further analyses. Total weight was measured on a digital scale with 0.1 g accuracy. CPUE for bycatch was computed by using the following equation (**White, 1987**):

CPUE = Total catch / Unit Effort

Unit Effort = Traps × Long-lasting trap in the water (24 h), Total catch = Total weight of the catch

All information about the fishing trip, the number of traps, and some characteristics of the Cylindrical pot, Opera house trap, and Hokkaido pot are reported in Table 2. Bycatch rates were calculated based on the number of fishing gear and fishing trips.

Table 1. Total bycatch biomass (g) of the fish by each gear type on observed trips

Species name	Common name	Cylindrical pot	Operahouse trap	Hokkaido pot
Pseudorasbora parva	Stone Moroko	525	4260	718
Scardinius erythrophthalmus	Common Rudd	592	22890	2660
Carassius gibelio	Prusian Carp	70	2240	276
Neogobius caspius	Caspian goby	3882	7755	1282
Cyprinus carpio	Eurasian carp	95	30650	20172
Blicca bjoerkna	silver bream	164	40890	25269
Esox lucius	Northern pike	0	7755	1282
Hemiculter leucisculus	Sharpbelly	525	7110	761
Alburnus alburnus	Common bleak	0	0	30
Gambusia punctata	Gambusia	0	30	30
Alburnus chalcoides	Danube bleak	0	70	90
Total		5853	123650	52570

Table 2. Characteristics of three traps that were used for catching prawns

Traps	Dimensions L × W × H (cm)	Entrance	Trap volume	Total fishing trip	Number of traps
Cylindrical	64 × 30 × 30	2 entrances with a 30cm ramp	45216 cm^3	120	9
Operahouse	74 × 55 × 64	2 entrance with 32cm ramp	300000 cm^3	120	9
Hokkaido	50 × 40 × 35	1 entrance with 20cm ramp	53301.5cm^3	120	9

Statistical methods

Total bycatch is indicated in terms of the number or weight, and unit effort is the mean of one collection from the trap in 24 hours. The variance (ANOVA) analysis determined differences in bycatch among gear types were determined using the variance (ANOVA) analysis, and CPUE differences for each gear type were determined using Duncan's multiple range test.

RESULTS

The results showed a significant difference in bycatch rate and CPUE bycatch for all three fishing gear ($P < 0.05$). Operahouse trap had the highest mean CPUE for bycatch per trip (20.11). But for the bycatch rate was the lowest one (0.35). The bycatch rate showed no difference in Cylindrical and Hokkaido pot ($P > 0.05$). The result indicates the total CPUE for the target had a significant difference among all traps ($P < 0.05$). The highest CPUE was in the Operahouse trap (56.77), and the lowest was in the Cylindrical pot (3.52) (Figure 2).

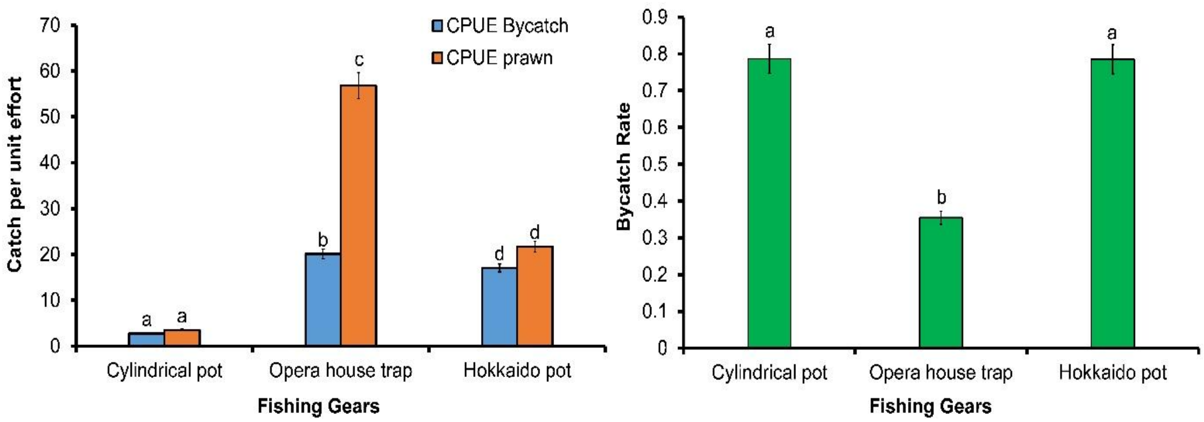

Figure 2. Catch per unit effort and bycatch rate in three different fishing gear.

The mean discard rate of each fishing gear as a percentage of total bycatch showed Operahouse trap had the highest discard rate of biomass and number of organisms compere to the other fishing gear ($P < 0.05$). On the other hand, the mean discard rate of biomass in the Operahouse trap as a percentage of total catch had the lowest rate for the biomass. The results showed that the bycatch fishes in the Operahouse trap were higher than the other fishing gear. This result confirmed that the bycatch rate in the Operahouse trap was lower than the other fishing gear (Figure 3).

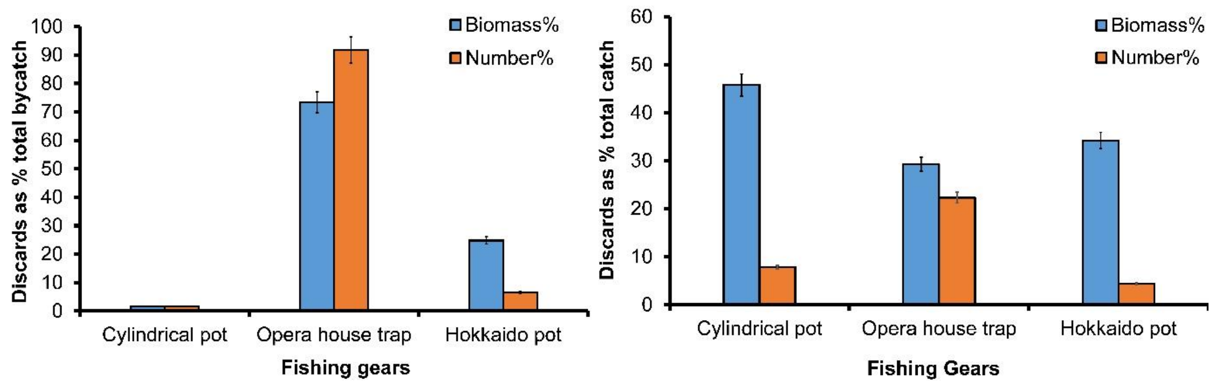

Figure 3. Mean discard rate of each fishing gear as a percentage of total bycatch and total catch, in terms of biomass and number.

The variation of bycatch among Cylindrical pot, Operahouse trap, and Hokkaido pot was the same, but their biomass was different (Figure 3). At the Cylindrical pot, biomass for *N. caspius* was more than the other fishes. On the other hand, *B. bjoerkna* was the highest biomass on the Operahouse trap, and for Hokkaido pot, *C. carpio* had the most biomass among the other fishes (Figure 4).

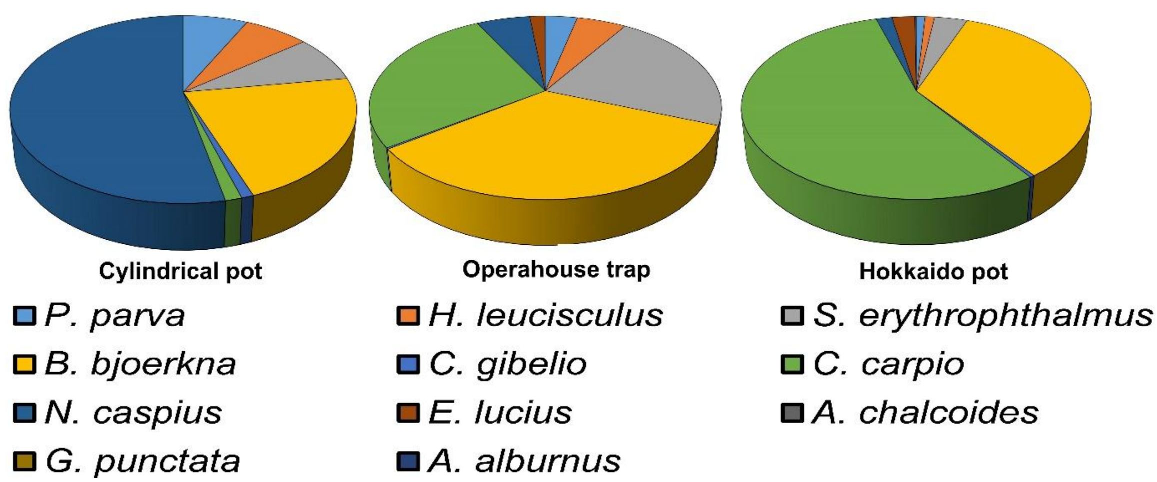

Figure 4. Bycatch composition by species for each fishing gear quantified by biomass.

DISCUSSION

Small-scale fisheries are promoted as a sustainable alternative to large-scale industrial fisheries. However, studying their effectiveness concerning bycatch and their effect on aquatics species is essential. Traps and pots are fishing gear that they categorize in small-scale fisheries. The advantage of these fishing gears is that they can catch alive. Therefore, all bycatch can be released. However, we do not know what will happen to them after release, so it is better to refuse bycatch instead of catch non-target and then release them. For this purpose, we need information about bycatch and bycatch rate in fishing gear. Unfortunately, information about bycatch in traps and pots is limited. In this study, the results indicated Operahouse trap had the highest bycatch compere to the other fishing gear. On the other hand, **Aminisarteshnizi (2021c)** reported that capture efficiencies and catch rates on the Operahouse trap were higher than the other traps. Therefore, it means the efficiency of the Operahouse trap was better.

Bycatch rate is one of the important factors in the number of non-target catches compared to the total catch. Bycatch rate is the mean bycatch per unit effort divided by the mean catch of target species per unit effort **(Moore et al., 2021)**. This rate can discover the efficiency of fishing gear. The results showed bycatch rate in the Operahouse trap was the lowest one compere to Cylindrical and Hokkaido pot. It means the reason for the high bycatch in the Operahouse trap was the high total catch. **Shester and Micheli (2011)** reported that when the population of target species goes up, bycatch rates will go down. Because the chance of catching target species goes up and then total CPUE goes up, therefore bycatch rate comes down. The result showed bycatch based on biomass, and the number in the Operahouse trap was high, but compere to total catch was low. It showed the efficiency in the Operahouse trap was better than the other traps, but it is necessary to improve this trap to reduce total bycatch.

Dietary habits may also influence catch rates of bycatch in taps and pots. **Aminisarteshnizi (2021d)** reported suitable bait for the traps has an important role in catching target species. For example, *E. lucius* is always looking for small prawns or fish. Therefore, when the number of prawns increases in the traps, these fish want to hunt the prawn then they are trapped. It is the cause of observation them in the Operahouse trap and Hokkaido pot. Because of the entrance of traps in this study, the flexible body and size of the fish are important. In the Cylindrical pot, most fishes and even prawns could escape because of the shape and size of the entrance (**Aminisarteshnizi, 2021c**). Therefore, species abundance is not always directly related to bycatch composition in traps and pots. Collectively, ecological traits and physical characteristics of traps probably play the most significant role in what fish species are retained as bycatch in pots (**Page et al., 2013**). Some species, such as *Silurus glanis*, have been commonly observed in gillnet sampling in the Anzali lagoon (**Moradinasab, 2012**) but were not found in trap and pot in this study. These fish have ecological traits that differ from many common species captured as bycatch in this study.

CONCLUSION

In conclusion, the proportion of non-target catch by total catch was low in the Operahouse trap. However, the presence of some important fish in prawn traps and the observed rate of these fish raise concerns about the magnitude of bycatch that may occur in the catching prawn. It is important to note that our research survey and the commercial fishery differed in spatial extent, the timing of fishing, trap mesh size and bait types. Nevertheless, because some of these fish are considered in Conservation Dependent IUCN categories, every effort should be made to reduce bycatch, regardless of gear type. Therefore, bycatch reduction technology that excludes these fishes while maintaining prawn catch rates would be desirable. In addition, to have better management, especially for fishes on the red list, the fishing mortality should be quantified in these traps.

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