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The impact of ghost fishing on catch rate and composition in the southern Caspian Sea

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ABSTRACT

The catch rates and the catch composition of lost nets were investigated during two seasons (fall and winter) in the southern Caspian Sea. A total of 167 surveys were conducted using anchor to retrieve ghost nets, which led to recover a total of 515 monofilaments gillnet. The most abundant caught species in during both seasons was belonged to *Alosa caspia* (52.1–43.9%). At both seasons, individuals of *Huso huso*, and *Acipenser stellatus* were substantially caught below the length at first maturity. The highest mean of catch rates was discovered at 0–10 m depth (2.79 kg), while the depth of 10–20 m provided the lowest amount of catch (2.0 kg). The Spearman correlation test showed that an increase in depth is reflected in lower values of the retrieved ghost nets. Overall, this study revealed that ghost gillnets is widely distributed in the southern Caspian Sea, mainly at the shallow waters.

1. Introduction

Ghost fishing is the term given to the continued fishing by fishing gear that has been lost or abandoned in the aquatic habitat. It is largely confined to passive gears such as gillnets, trammel nets, wreck nets, and traps (Institute for European Environmental Policy, 2005). Passive fishing gear, such as gillnets, may continue to catch fish for several years after control over the gear has been lost, and thereby may cause a substantial unaccounted fishing mortality (Chopin et al., 1995; Tschernij and Larsson, 2003). Some sensitive species to anthropogenic mortality sources such as relatively low fecundity, other life-history characteristics and specially protected species include of seabirds, sea turtles, marine mammals and elasmobranchs, which can be thousands of animals in a year, are may be endangered, and threatened (Gilman et al., 2016). Species with relatively low fecundity and other life-history characteristics that make them particularly sensitive to anthropogenic mortality sources are also subject to ghost fishing mortality. These include species of seabirds, sea turtles, marine mammals and elasmobranchs, some of which are endangered, threatened or protected and it includes thousands of animals in a year (Gilman et al., 2016).

The Caspian Sea is the largest enclosed inland body of water on earth by area and volume that is bounded by Kazakhstan to the northeast, Russia to the northwest, Azerbaijan to the west, Turkmenistan to the southeast and Iran to the south. Different types of fish inhabit in the Caspian Sea, including Caspian Sea Sprats and several species of sturgeons. These fishes are being captured and exploited by various fishing methods. In the Iranian part of the Caspian Sea, there are three commercial fishing methods which include lift net, beach seine and gillnet. In lift net fishing a conical net connected to a ring with a diameter of 4 m and an underwater light is used to catch different species of Caspian Sea sprats at depths of 20 to 100 m during the year. Caspian Sea Beach seine is a huge net with length of 1100–1200 m which is used to catch costal fish at maximum depth of 50 m in fall and winter. Gillnet is widely used in the southern Caspian Sea due to the relatively low investment and easy to catch different variety of fish both in legal and illegal fishing. In addition, although they are highly selective for target species, lost passive fishing gear can continue to function, catching target, non-target, and even protected species (Erzini et al., 1997; Brown and Macfadyen, 2007). Since marine gillnets have relatively high ghost fishing potential (Gilman et al., 2016), it seems fisheries resources of the Caspian Sea are also faced the phenomenon of ghost fishing, especially due to the presence of substandard illegal fishery in this region.

Although, various studies in the all over the world assessed the negative effect of ghost nets on injury and mortality of marine organisms (Dayton et al., 1995; Revill and Dunlin, 2003; Large et al., 2009; Gilardi et al., 2010; Anderson and Alforda, 2014; Queirolo and Gaete, 2014; Stelfox et al., 2016; Egekvist et al., 2017), unfortunately, we

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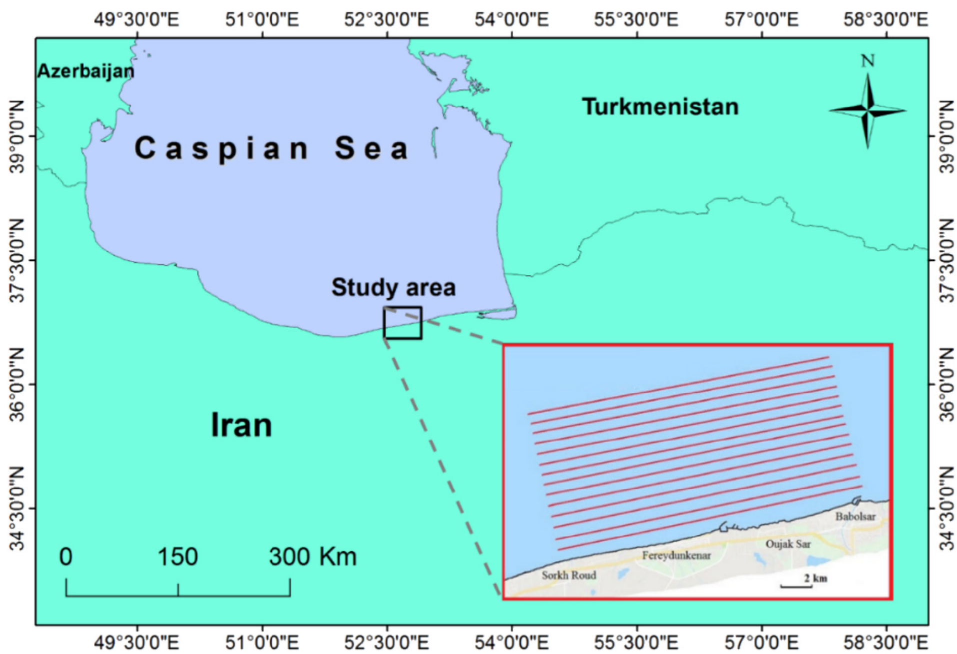

Fig. 1. Map of the survey location and anchoring area (Lines on the zoom-box) in the southern Caspian Sea.

could not find any report about negative effects of ghost fishing in the region of southern Caspian Sea. Therefore, in this study we aimed to determine catch rates and the catch composition of lost fishing nets to assess the ecological impacts of ghost fishing on marine animals during two seasons in the southern part of the Caspian Sea.

2. Material and methods

2.1. Study area

The study area was located in the southern part of the Caspian Sea along the coastal waters of Mazandaran Province (Fig. 1). The area was covered 200 km^2 from coastline to the depth of 30 m and from Babolsar (36°42′09″N 52°39′27″E), one of the most important fishing ports in the region to Fereydunkenar (36°41′11″N 52°31′21″E) and Sorkh Roud. The area is one of the most important places in fishing activity and marketing the fish. The structure of seabed is sandy from coastal parts to the depths of 10 m, but it is muddy in the deeper parts. Selection of a limited area in the southern part of the Caspian Sea has made it easier to increase the amount of anchoring.

2.2. Data collection and statistical analysis

The retrieved nets were collected by anchoring on the sea bed. For this purpose, a small motorboat with a 40 hp engine was used from November 2017 to March 2018. A total of 167 tows (77 tows in fall and 90 tows in winter) were carried out to provide an estimate of the quantity of lost, abandoned nets on the main fishing grounds in each season and depth stratum. Tows area were stratified corresponding to the depth range of the fishery activity (0–10 m, 10–20 m, and 20–30 m) in both seasons. All the sampling area and depth classes were sandy. Towing was conducted randomly inside the sampling areas of 20 km for 30 min from east to west and vice versa every day. The length of anchor rope was 2 times more than the observed depth, depending on weather and sea conditions and towed along the seabed at a speed of 1–2 knots. All the retrieved nets were removed from the sea and disposed in ports. Net characteristics and caught animals were recorded according to each retrieved lost net (Fig. 2).

All caught animals sorted by species, measured by a measuring board with accuracy of 1 cm and 1 g for their size and weight. Normally, catches are not recognizable when nets lie on the seabed for days before they are found, but in our investigation a large number of anchoring allowed us to find caught species in good conditions.

The relationship between depth and number of retrieved ghost nets and also correlation between depth and number of caught species were investigated by Spearman correlation analyses. Statistical relationships were considered significant at $\alpha = 0.05$ level.

The homogeneity of variances and normalization of data were evaluated by Levine and Kolmogorov-Smirnov tests. An analysis of variance, one-way ANOVA, was then carried out to evaluate the effect of seasons and also effect of depth stratum on catch rate values of ghost nets, and Duncan testing was conducted with a probability level of 5% to compare means. For comparing the length frequency distributions Kolmogorov–Smirnov test was used.

A *t*-test was used to compare mean length and length at maturity for fish caught in both seasons (fall and winter). Differences between season factors within each month were represented by 2-dimensional plots with non-metric multidimensional scaling ordinations (nMDS) considering season centroids (Clarke, 1993; Clarke and Warwick, 1994). Stress value is shown for nMDS plot to indicate the goodness of fit between the distances between points implied by nMDS and the matrix data input. These indicated that the lower the stress, the better the representation (stress < 0.15 is good; < 0.10 is ideal) (Clarke, 1993). SIMPER analysis (cut off 90%) was used to identify the important taxa that contributed to overall dissimilarity between seasons. All the diversity indices and statistical analyses were performed using R software (version 3.3.2, R Development Core Team, 2018).

The species richness (S), and the Shannon-Weaver diversity index (H′) (Shannon and Weaver, 1949) were determined separately. All the diversity indices were computed on the basis of the number of individuals (i.e. abundance) per species.

3. Results

A total of 515 monofilament gillnet panels were recovered, with an estimated total length of 30.9 km and average mesh size of 80 mm.

Total number of 524 fish belonging to ten species and three seabirds such as great grebe *Podiceps major* (Boddaert, 1783), great crested grebe, *Podiceps cristatus* (Linnaeus, 1758) and great cormorant, *Phalacrocorax carbo* (Linnaeus, 1758) were recorded (Table 1, Fig. 3).