THE IMPACT OF *LAGOCEPHALUS SCELERATUS* (GMELIN, 1789) ON SMALL-SCALE FISHERIES IN CRETE: PRELIMINARY RESULTS

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Abstract

The aim of the present study was to investigate the impacts of *Lagocephalus sceleratus* on small-scale fisheries in Crete. Based on onboard and port samplings, the by-catch of *L. sceleratus* per vessel was estimated at approximately 858 kg during the sampling period (June 2020-August 2021), with the highest by-catches recorded in trammel nets operating during spring in eastern Crete. The daily catch loss due to *L. sceleratus* predation on commercial species that had been caught by the nets or longlines was higher in spring. The longline fisheries were the most seriously affected. Gear damages to both nets and longlines were higher in spring and summer. Our results demonstrate that the establishment and subsequent population increase of *L. sceleratus* in Crete cause serious economic impacts on small-scale fisheries.

Keywords: eastern Mediterranean, silver-cheeked toadfish, catch loss, gear damages.

1. Introduction

The toxic *Lagocephalus sceleratus* (Gmelin, 1789) was first recorded in the Mediterranean Sea in 2003 (Akyol *et al.*, 2005) and it was soon characterized as a "major nuisance" for small-scale fisheries due to the damages it inflicts on fishing gears (cutting off nets and lines), baits and commercial catches (Nader *et al.*, 2012). Although the interactions between *L. sceleratus* and small-scale fisheries have been recognized as important in eastern Mediterranean countries (Galanidi *et al.*, 2018), quantitative data for the negative impacts of the species on local fisheries are scarce (Ünal & Bodur, 2017). During the last decade, the abundance of the silver-cheeked toadfish has been continuously increasing in the seas around the island of Crete (Peristeraki *et al.*, 2013). This is especially true for its eastern parts, which is considered as the starting point for the expansion of lessepsian migrants around the island (Peristeraki *et al.*, 2015; Skarvelis *et al.*, 2015). The increase in abundance of *L. sceleratus* has been accompanied by numerous complaints from Cretan fishermen regarding the damages caused to fishing gears and commercial catches. Yet, no assessment of such damages has been carried out. The present study aims at providing some first quantitative information on the impacts of *L. sceleratus* on coastal fisheries in Crete.

2. Material and Methods

The catch of *L. sceleratus* was estimated using data from 90 fishing trips of 23 vessels of the small-scale fishing fleet of Crete in which captures of the species were recorded. These trips were assigned into 5 subareas (northwest, north central, northeast, southeast and south central Crete) during the period June 2020-August 2021. The main gears sampled were static nets (trammel nets and gillnets) and bottom longlines. For each fishing trip, the catch volumes (weights) of commercial, species and *L. sceleratus* were recorded. Additional data concerning the depredation of *L. sceleratus* on commercial species (biomass loss, recorded by the scientific personnel) and the gear damages (number of holes in nets and missing hooks in longlines, reported by the fishermen), were collected from 35 out of the 90 fishing trips. The fishing days of each vessel in which *L. sceleratus* was caught, was estimated per season and fishing gear through interviews with the fishermen. For the analysis, four seasons were considered: winter (January to March), spring (April to June), summer (July to September) and autumn (October to December).

The catch of each species, as well as the weight of damaged catches per vessel and fishing day were estimated (CPUE). The mean CPUE of *L. scleratus* (LS_CPUE_{mean}) by season, fishing gear and area was estimated as follows:

$$LS_{CPUE\,mean} = \frac{1}{N_{vessels}} \sum_{i=1}^{N_{vessels}} LS_{CPUE\,i}$$

where $N_{vessels}$ *is* the number of small-scale fishing vessels sampled.

The mean fishing effort (FE_{mean}), in fishing days with *L. scleratus* catches (F.d.), by season, fishing gear and area was estimated as follows:

$$FE_{mean} = \frac{1}{N_{vessels}} \sum_{i=1}^{N_{vessels}} F.d._i$$

The total catch per vessel of *L. scleratus* (Total B_{lago}) by season and area was estimated as:

$$TotalB_{lago} = LS_{CPUE\,mean} \times FE_{mean}$$

The percentage of damaged fish (due to *L. scleratus* predation on the catches) per fishing day was estimated by gear and season, as follows:

$$\%\ Commercial\ Catch\ Loss = \sum_{i=1}^{N_{vessels}} \frac{B_{damaged}}{B_{commercial}} \times 100$$

The total catch loss of commercial species due to *L. scleratus* depredation was also estimated by species and gear. Finally, the number of gear damages (holes in nets and missing hooks in longlines) was estimated by 10 kg of catch, by gear and season:

$$Damages\ per\ 10\ kg = \frac{N\ of\ Gear\ damages}{Total\ commercial\ catch} \times 10$$

3. Results

The mean vessel catch of *L. scleratus* for the whole sampling period (June 2020-August 2021) was 858 kg corresponding to 13% of the vessel's total catch. Regarding the employed fishing gears the highest contribution on *L. scleratus* catch was provided by trammel nets (744 kg) followed by gillnets (83 kg) and longlines (31 kg). The catch was highest in spring in all areas except S and SE Crete, where the catch was highest in autumn. The seasonal and spatial distribution of estimated *L. scleratus* catches is illustrated in Figure 1.

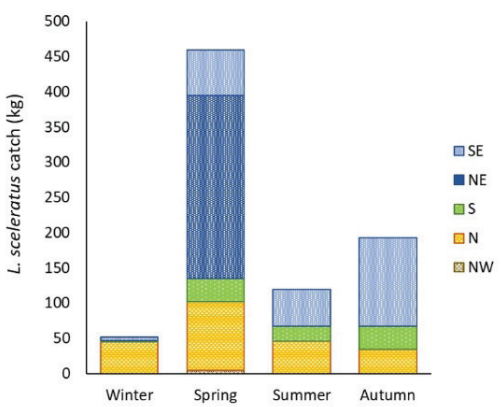

Fig. 1: Estimated catch per vessel of *L. scleratus* in Crete during June 2020-August 2021 by season and fishing area (SE: southeast Crete, NE: northeast Crete, S: south central Crete, N: north central Crete, NW: northwest Crete).

Regarding the commercial catch damaged by *L. sceleratus*, the highest loss per fishing day was recorded in longlines (13.3 %), whereas lower losses were recorded for trammel nets (2.5 %) and gillnets (1.9 %). On a seasonal base, catch loss for all gears collectively was higher in summer (11.2 %) and spring (7.2 %), compared to autumn (1.1 %) and winter (1.6 %). The highest daily catch loss was recorded for longlines during spring (17.3 %) (Fig. 2). The mean catch loss per fishing day and vessel was estimated at 0.8 ± 1.6 kg and the main species damaged included the red porgy *Pagrus pagrus* (Linnaeus, 1758) and the white seabream *Diplodus sargus* (Linnaeus, 1758) in longlines, and the common octopus *Octopus vulgaris* (Cuvier, 1797) and stripped red mullet *Mullus surmuletus* (Linnaeus, 1758) in nets (Table 1).

Fishing gear damages were higher during the summer and spring months. For every 10 kg of commercial catches landed by netters, a mean of 14 and 11 damages (holes) from *L. sceleratus* bites were calculated for summer and spring respectively. The corresponding damages to longlines (missing hooks) were 32 in spring and 5 in autumn.

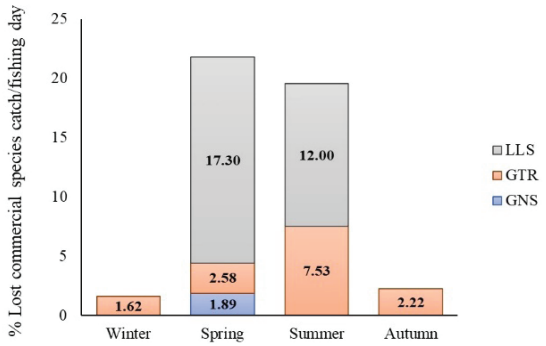

Fig. 2: Percent catch loss of commercial species due to *L. sceleratus* by fishing day, gear and season. (LLS: longlines, GTR: trammel nets, GNS: gillnets).

Table 1. Estimates of commercial species' catch loss (kg), due to *L. sceleratus* depredation, in 35 fishing trips of small-scale fisheries vessels in Crete. Blue bars indicate the percentage contribution of each species to total catch loss by fishing gear (GTR= trammel nets, GNS= gillnets, LLS= longlines).

2020-2021	GNS	GTR	LLS	Total
Boops boops			1.20	1.20
Dasyatis pastinaca		3.60		3.60
Diplodus annularis		5.20		5.20
Diplodus sargus		3.48	49.00	52.48
Diplodus vulgaris		4.65	14.00	18.65
Lithognathus mormyrus		2.60		2.60
Liza aurata		2.42		2.42
Mullus barbatus		4.50		4.50
Mullus surmuletus		17.81		17.81
Oblada melanura	0.80			0.80
Octopus vulgaris		29.00		29.00
Pagrus pagrus		3.90	63.00	66.90
Sarpa salpa		6.50		6.50
Serranus scriba			14.00	14.00
Siganus luridus		1.44		1.44
Solea solea		0.44		0.44
Sparisoma cretense			1.28	1.28
Sphyraena sphyraena		0.30		0.30
Spicara maena		0.96		0.96
Trachurus mediterraneus		3.15		3.15
Uranoscopus scaber		2.86		2.86
Total	**0.80**	**92.81**	**142.48**	**236.09**

4. Discussion/Conclusions

Results of the present study revealed, for the first time, the magnitude of damages caused by *L. sceleratus* to fishing gears and commercial catches of the coastal fisheries in Crete. The total mean by-catch of the species was approximately 858 kg in June 2020-August 2021. However, this is probably an underestimated value since many individuals that are being caught by the fishing gears eventually escape from capture through biting and cutting off the nets or lines. The high number of gear damages per 10 kg of landed catch observed during the on-board sampling corroborates to this conclusion.

Present results show that the main species damaged by *L. sceleratus* were the commercially valuable *P. pagrus* and *D. sargus* in longlines and *O. vulgaris* and *M. surmuletus* in nets. Based on damaged catches left on the gears, it was estimated that fishermen in Crete lose, on average, almost 1 kg of valuable species per fishing day, which corresponds to an average of 15-25 euro. In fact, the economic damage is probably much higher considering that a number of fish and cephalopods caught by the fishing gears might have been consumed entirely by the pufferfish with no leftovers on the gears, and these have not been included in the estimation of daily catch losses. The overall economic impacts of *L. sceleratus* on small-scale fisheries, including gear repair costs, lost fishing days, extra manhours will be assessed in a future report.

The seasonal pattern in *L. sceleratus* catches, catch losses and gear damages indicate a higher feeding activity of the species during spring and summer probably related to its increased metabolic rate during that period, caused by the sea temperature rise (Volkoff & Rønnestad, 2020). It could also be related to the spawning period of the species, which, in Crete, extends from late spring to early summer (Peristeraki *et al.*, 2010). However, the possibility of seasonal migrations of the species in the area cannot be excluded. Further investigation is required in order to discern the causes of seasonality in pufferfish-fisheries interactions as well as of the observed seasonal differences between areas, such as the high abundance of *L. sceleratus* in S and SE Crete during autumn.

5. Acknowledgements

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