Ecological Life Sciences
ISSN: 1308 7258
Article ID: 5A0187

Status : Research Article
Received: 03.09.2022
Accepted: 06.01.2023

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DOI	http://dx.doi.org/10.12739/NWSA.2023.18.1.5A0187	
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MAPPING ABUNDANCE AND DISTRIBUTION OF INDO-PACIFIC STRIPED EEL CATFISH *Plotosus lineatus* IN THE NORTHEASTERN MEDITERRANEAN SEA

ABSTRACT

The underwater visual census is the most widely used approach for assessing the density and biomass of fishes. Iskenderun and Mersin Bays are the most important pathway of alien species in the northeastern Mediterranean, Turkey. In this study, Indo-Pacific striped eel catfish *Plotosus lineatus* was monitored in twelve different regions at the Iskenderun and Mersin Bays in the northeastern Mediterranean, by underwater visual census method. The total transect area monitored was 2.0 ha. *P. lineatus* was usually observed under rocky and dark habitats with aggregations. Mean density comprising 8-20m depth was 106n/ha^{-1}, indicating that *P. lineatus* has significant population increases after the first occurrence in Turkish coasts. The establishment and invasiveness of *P. lineatus* in Turkish marine waters were also confirmed with this study. If management action is not taken, it is estimated that the species will spread to all Turkish Mediterranean coasts in a few years.

Keywords: *Plotosus lineatus*, Mapping, Northeastern Mediterranean, Underwater Visual Census, Abundance and Distribution

1. INTRODUCTION

The opening of the Suez Canal coupled with climate change has increased the number of alien species in the Mediterranean [1 and 2]. Records of alien species have been increased considerably in recent decades in Turkish marine waters [3 and 4]. It is important to know the current status of these alien species such as their abundance, biomass, richness to undertake any management consideration for controlling their extension [5]. The underwater visual census (UVC) method is widely used approach for assessing the regional abundance of fishes [6 and 7]. UVC has been developed for use in tropical coral reef fish studies [8]. Nowadays, the application of UVC is widespread in temperate waters, such as the Mediterranean Sea. It has been successfully applied in marine protected areas (MPAs), as well as in other important marine habitats, such as rocky reefs, submarine caves, and seagrass meadows [9, 10 and 11]. Indo-Pacific striped eel catfish *Plotosus lineatus* (Thunberg, 1787) was first reported in the Mediterranean Sea by Golani [12] and then it was recorded in Egypt [13], Syria [14] and Turkey [15], also its westernmost extension range in the Mediterranean Sea at Tunisian coast [16]. *P. lineatus* is inhabiting of 20-50m deep range and rocks and coral reefs [17]. The dorsal and pectoral fin spines and dermal tissues contain toxins that

How to Cite:
Turan, C. and Doğdu, S.A., (2023). Mapping Abundance and Distribution of Indo-Pacific Striped Eel Catfish *Plotosus lineatus* in The Northeastern Mediterranean Sea. Ecological Life Sciences, 18(1):1-7, DOI: 10.12739/NWSA.2023.18.1.5A0187.

are a potential threat for swimmers, fishermen, divers, and the public [18 and 19].

2. RESEARCH SIGNIFICANCE

After the first record of *P. lineatus* on the coast of Turkey [15], they were recorded six years later on the Mersin coast of Turkey [4]. In this study, we investigated the monitoring and distribution of *P. lineatus* by UVC method in the Iskenderun and Mersin Bays. This study aims to show the population increases of *P. lineatus* after the first occurrence on the Mediterranean coast of Turkey in 2016.

Highlights:

- The striped eel catfish *Plotosus lineatus* seems to the increased extension to the westward of the Mediterranean because of the current abundance in the Iskenderun Bay as well as it is the most abundant and dominant Indo-Pacific alien fish along the eastern Mediterranean Sea.
- Results show that, *P. lineatus* population increases within years of its first appearance in the northeastern Mediterranean Sea.
- The invasiveness of *P. lineatus* in Turkish marine waters was confirmed in this study. If management action is not taken, it is estimated that the species will spread to all Turkish Mediterranean coasts in a few years.

3. EXPERIMENTAL METHOD-PROCESS

P. lineatus species was monitored by scuba diving in twelve different locations in the Iskenderun and Mersin Bays. All location coordinates were given in Table 1. The UVC method was used to quantify the density and distribution of *P. lineatus* in the areas. Belt transect method was applied that can reveal species zonation patterns along the line by showing where particular species occur on the line and also how much of it is present at any point along the line [20, 21 and 22]. The length and width of the transect were 150m and 5m, respectively. One depth range from deep to shallow as deep 10-20m was monitored for two divers. 3 replicate transects at the size of 5mx100m were screened for each region, covering an area of 1500m^2 for two divers. *P. lineatus* species were recorded in numbers. The observer adjusts his swimming rate slightly (10-15 min/transect), and transects with high fish densities were sampled slower than those with low densities. For a striped eel catfish, the estimate of the mean density (D) on transect is expressed as:

$$D = \frac{\sum_{i=1} n_i}{a}$$

Where n is the number of striped eel catfish seen, and a=census area [21].

4. FINDINGS AND DISCUSSIONS

Dives took place in 12 different locations. The occurrence of *P. lineatus* populations was detected with high density in all diving locations (Figure 1).

Figure 1. *P. lineatus* aggregation was observed in the diving area (Photograph: C.Turan)

The number of individuals in the population was over 10 and, also *P. lineatus* was usually observed under rocks and dark habitats with aggregations. The total transect area monitored on Iskenderun and Mersin coasts were 2.0 ha. The mean density comprising 10-20m depth range was 106n/ha^{-1} (Table 1; Figure 2).

Table 1. Coordinates of the diving locations and observed density of *P. lineatus*

Coordinates	Density (n/ha^{-1})
36°49'32.7"N-36°10'06.1"E	120
36°45'42.0"N-36°11'48.3"E	101
36°39'23.2"N-36°12'42.3"E	93
36°32'08.1"N-36°02'29.3"E	50
36°25'01.1"N-35°52'51.6"E	132
36°21'25.6"N-35°48'57.5"E	155
36°17'31.6"N-35°46'53.5"E	162
36°14'17.9"N-35°49'45.1"E	72
36°07'47.2"N-35°54'45.7"E	53
35°59'22.5"N-35°57'30.7"E	160
36°27'25.2"N 34°08'31.4"E	80
36°16'00.2"N 33°49'32.7"E	95

Besides the enlargement of the Suez Canal, the spreading of lessepsian fish species in the Mediterranean Sea is associated with several factors such as increasing temperature, and cyclonic Mediterranean shore currents [14]. Overfishing also threatens the biodiversity in the Mediterranean Sea and facilitates the spreading of lessepsian fish species in the Mediterranean Sea [3 and 23]. There are other additional factors such as the destruction of habitats and the introduction of harmful pollutants. Many species of successful Lessepsian fishes have established large populations with considerable effects on the local biota such as pufferfish, lionfish, and goatfish [24, 25, 26 and 27]. *P. lineatus* threatens the biodiversity of economically important native species such as *Mullus barbatus* and *Mullus surmuletus* [28 and 29]. The ecological impact of *P. lineatus* in their invaded habitats has not been effectively studied, but their potential impacts can be competition with native species for food and habitat, deleterious effects on native predators and the potential to

change the structure of native communities in the invaded areas [30]. The striped eel catfish form in high-density populations and move together. *P. lineatus* is well-known for being highly venomous which cause painful injuries and it was included in the list of top 100 worst invasive species in the Mediterranean Sea [24]. A high number of *P. lineatus* injuries have been reported in many countries [18, 27, 31, 32, 33 and 34]. The injuries from striped eel catfish could be deadly, but no deaths due to *P. lineatus* venom have been recorded so far [18 and 35].

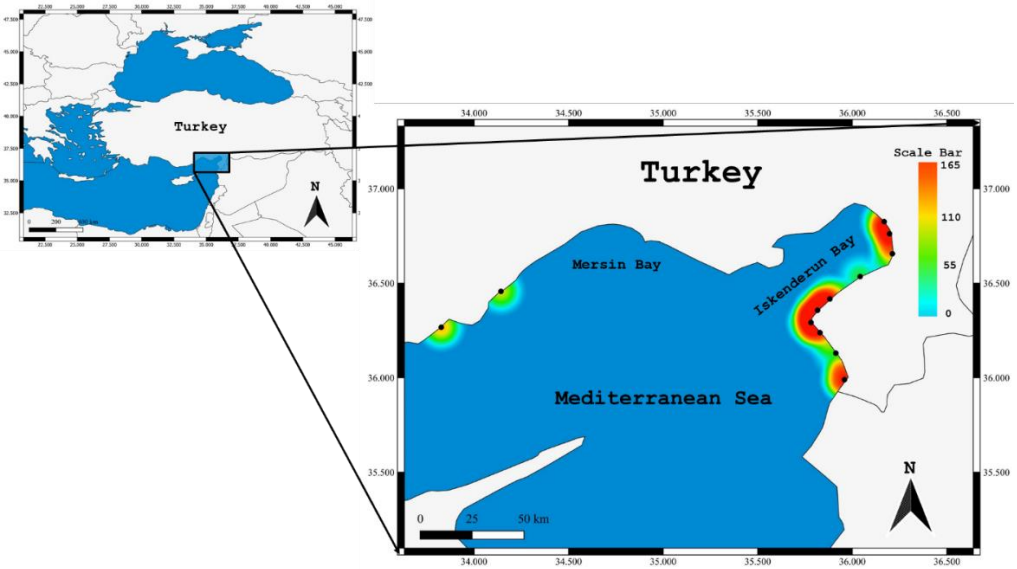

Figure 2. The density mapping of *P. lineatus* populations in the diving locations

5. CONCLUSION AND RECOMMENDATIONS

The striped eel catfish *P. lineatus* seem to increase its extension to the westward of the Mediterranean because of the current abundance in the Iskenderun Bay as well as it is the most abundant and dominant Indo-Pacific alien fishes along the eastern Mediterranean Sea. It has shown impressive population increases within years of its first appearance in the Mediterranean Sea [29]. This study shows that *P. lineatus* has impressive population increases after the first occurrence on the Mediterranean coast of Turkey in 2016. The establishment and invasiveness of *P. lineatus* in Turkish marine waters were also confirmed with this study. If management action is not taken, it is estimated that the species will spread to all Turkish Mediterranean coasts in a few years.

ACKNOWLEDGEMENT

Thanks to the UNDP MarIAS Project (Addressing Invasive Alien Species Threats at Key Marine Biodiversity Areas Project) and Natural and Sciences Society (www.dogavebilim.com) for support.

NOTICE

Part of this study was presented at 15th International Congress on the Zoogeography and Ecology of Greece and Adjacent Regions, 12-15 October 2022, Mytilini, Greece.

CONFLICT OF INTEREST

The authors have no conflicts of interest to be disclosed.

FINANCIAL DISCLOSURE

The authors declare that this study has received no financial support.

DECLARATION OF ETHICAL STANDARDS

The authors of this article declare that the materials and methods used in this study do not require an ethical committee.

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