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RESEARCH PAPER

Preliminary Insights from the First Trial of Purse Traps for the Removal of Lionfish (*Pterois miles*) in the Mediterranean

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Abstract

The lionfish, *Pterois miles* is continually increasing its pressure on local fish communities, with other invasive species, along the Mediterranean coasts of Türkiye. Given the rapid invasion of *P. volitans* to the Western Atlantic, monitoring and mitigation efforts should be implemented in the Mediterranean to prevent severe damage to the ecosystem. This study was the first to use a method developed by Gittings (2017), purse trap experimental fishing gear, developed specifically for lionfish removal was tested in the Mediterranean. The opening performance of the traps was found to be 81.6%. The fishing effectiveness of the traps was assessed through a total of 22 trap deployments along Göcek and Gökova Bay between July 4 and August 31, 2022. No recruitment was observed in the trials, likely due to the limited lionfish population dispersed across completely natural reef areas, where they tend to remain in their habitat. Therefore, trials should be conducted to enrich the methodology by incorporating longer soak times to allow lionfish to become accustomed to the traps or modifications to the traps should be considered, including the integration of natural reef-like structures or alternative attractant materials or mechanisms such as sound, light, and colour.

Introduction

Pterois miles and *Pterois volitans* are two well-known Indo-Pacific lionfish species, of which *P. volitans* is recognized as one of the most harmful invasive marine fish species, causing significant damage to the environment and the economy (Albins & Hixon, 2008; Green et al., 2012; Hixon et al., 2016). Their negative impacts (mainly *P. volitans*) in the Western Atlantic and the Caribbean have positioned these invasions among the top 15 global issues in marine conservation (Sutherland et al., 2010). Despite the rarity of predator invasions in marine ecosystems, the rapid and extensive spread of lionfish has made it one of the most successful marine invasions recorded (Morris & Akins, 2009a; Green et al., 2011; Albins, 2013). Initially sighted in 1985, lionfish mainly *P. volitans* now threaten nearly all eastern coasts of the US and throughout the Carribean (Albins and Hixon, 2008; Côté et al., 2013).

The dominant species in the Mediterranean was found to be *Pterois miles* (Kleitou et al., 2021; Bernardi et al., 2024) that have notable behavioural and dietary differences from *P. volitans* that significantly influence their ecological impact as invasive species. *P. volitans* typically employs an aggressive ambush strategy, targeting smaller fish and invertebrates, allowing it to dominate shallower coral reef habitats (Morris & Akins, 2009b; Green et al., 2011). In contrast, *P. miles* show a more active approach to foraging and often engages in longer prey hunts in deeper mesophotic reefs where it exploits a different prey group (Gress et al., 2017a). In the Mediterranean, *P. miles* prefers habitats dominated by rocky reefs and, to a lesser extent, seagrass meadows mostly in coastal areas (Kleitou et al., 2021). As a result, this invasive species primarily feeds on wide variety of prey fish from various families and crustaceans found in these habitats, highlighting its opportunistic and adaptable feeding behaviour (Zannaki et al., 2019; Savva et al., 2020; Tanrıverdi et al., 2022). Furthermore, *P. volitans* is characterized by greater aggressiveness in social interactions, leading to increased territoriality and greater foraging success, whereas *P. miles* may show less aggression, favouring greater communal foraging dynamics (Morris, 2012; Lesser and Slattery, 2011). Both the Atlantic and Mediterranean Seas' lionfish invasions have important distinctions as well as some commonalities. *P. miles* in the eastern Mediterranean have a prolonged spawning season, mainly in summer, with some activity extending into autumn (Savva et al., 2020). Similarly, in other regions, *P. volitans* is observed to reproduce throughout the year, with peaks in March-April and August. The observed heterozygosity may decrease with increasing distance from the source in both cases, and natural selection may identify genes associated with invasion success. A significant distinction, though, is found in genetic diversity: Mediterranean invaders preserve diversity comparable to the source population, whereas Atlantic invaders show genetic depletion, most likely as a result of different invasion pathways (Bernardi et al., 2024).

The first record of *P. miles* in the Mediterranean was in 1991, with subsequent colonization raising concerns about ecological disaster (Kletou et al., 2016; Ulman et al., 2020). Although the spread in the Aegean Sea has been gradual comparing to the Western Atlantic, there is still a potential for a population explosion threatening native species and small-scale fisheries (SSF) (Ulman et al., 2020). Lionfish exert stress on native ecosystems, impacting biodiversity, fisheries, and human health (Morris, 2012; Anonymous, 2024). Due to the absence of natural predators, controlling lionfish populations is a priority for marine resource managers (Valdivia et al., 2014; Morris, 2012).

The proliferation of lionfish in the Mediterranean exacerbates existing stressors in an already vulnerable ecosystem, which suffers from overexploitation, pollution, and climate change (Morris & Whitfield, 2009). Given that reversing a lionfish invasion is unlikely, culling efforts are essential, particularly targeting large females with high reproductive capacity (Ulman et al., 2020). Current removal methods primarily focus on shallow reefs, where divers can operate effectively, but lionfish have been found at depths exceeding 300 meters (Gress et al., 2017b). Traditional spearfishing is limited by diving depth and associated risks, making it insufficient for managing populations in deeper areas (Andradi-Brown et al., 2017).

Research indicates that the most common removal methods include spearfishing (45%) and hand nets (37%), with less effective techniques like traps and trawls being used (Farquhar, 2017). To enhance eradication efforts, scientists are exploring new fishing methods, including low-cost gear and expensive underwater robots (ROVs) (Harris et al., 2020). Lionfish in deeper waters threaten mesophotic reef food webs, necessitating removal strategies that extend beyond shallow areas (Lesser & Slattery, 2011; Gress et al., 2017a; Harris et al., 2020, Harris et al., 2023). Innovative non-containment purse traps have shown promise for targeting deeper populations, offering advantages such as low by-catch rates and reduced ghost fishing (Harris et al., 2020; Harris et al*.*, 2023).

To prevent and/or tackle such invasions and to provide native species to thrive, their removal and a systematic approach to fisheries management is one of the primary actions to be considered (Morris, 2012). In alignment with the European Green Deal, Türkiye's Ministry of Agriculture and Forestry aims to protect fisheries and address climate change impacts through technological solutions (Anonymous, 2023). Implementing an innovative fishing gear to target the rising lionfish population could prevent further ecological damage. Therefore, this study aimed to evaluate the effectiveness of a purse trap, previously proven successful in the Atlantic, for capturing lionfish in the Mediterranean for the first time. The influence of species-specific characteristics on the initial trial results was thoroughly analyzed, and key considerations for future trials were identified. Consequently, we explored the potential of this trap as a management tool for lionfish fisheries to help control the invasive population and reduce its ecological impact.

Material and Methods

For this study, 8 purse traps were constructed replicating the technical plans and design provided by Gittings et al. (2017). Building on the original model, following the modifications of Harris et al. (2020) some additional changes were applied to achieve operational practicality. The most significant change to the model used in this study is the use of thinner diameter iron materials in the frame to make the trap lighter, and materials in some components to make it easier to unfold and retrieve the trap. This made it easier to use the traps on an SSF boat operated by just one person.

The lionfish purse trap consists of two semicircular iron frames, each 170 cm in diameter and Ø 12 mm thick, connected by a 170 cm long axle shaft that allows rotation of the jaws (Figure 1). The trap opens upon hitting the seabed and closes upon lifting, assisted by deflectors that trigger the mechanism. The iron frame is covered with a 210d/24 polyethylene net with a mesh size of 44 mm, fixed so that the mesh eyes remain open. A high impact polystyrene (HIPS) polymer fish attractor device (FAD) is mounted on the shaft and features 152 square openings positioned in a diamond shape with a mesh bar of 22 mm and a vertical polyvinyl chloride (PVC) tube to maintain its upright position on the seabed. Deploying and retrieving the trap is made easier by a strap system that ensures the jaws close when the top rope is pulled while the lure remains upright, as

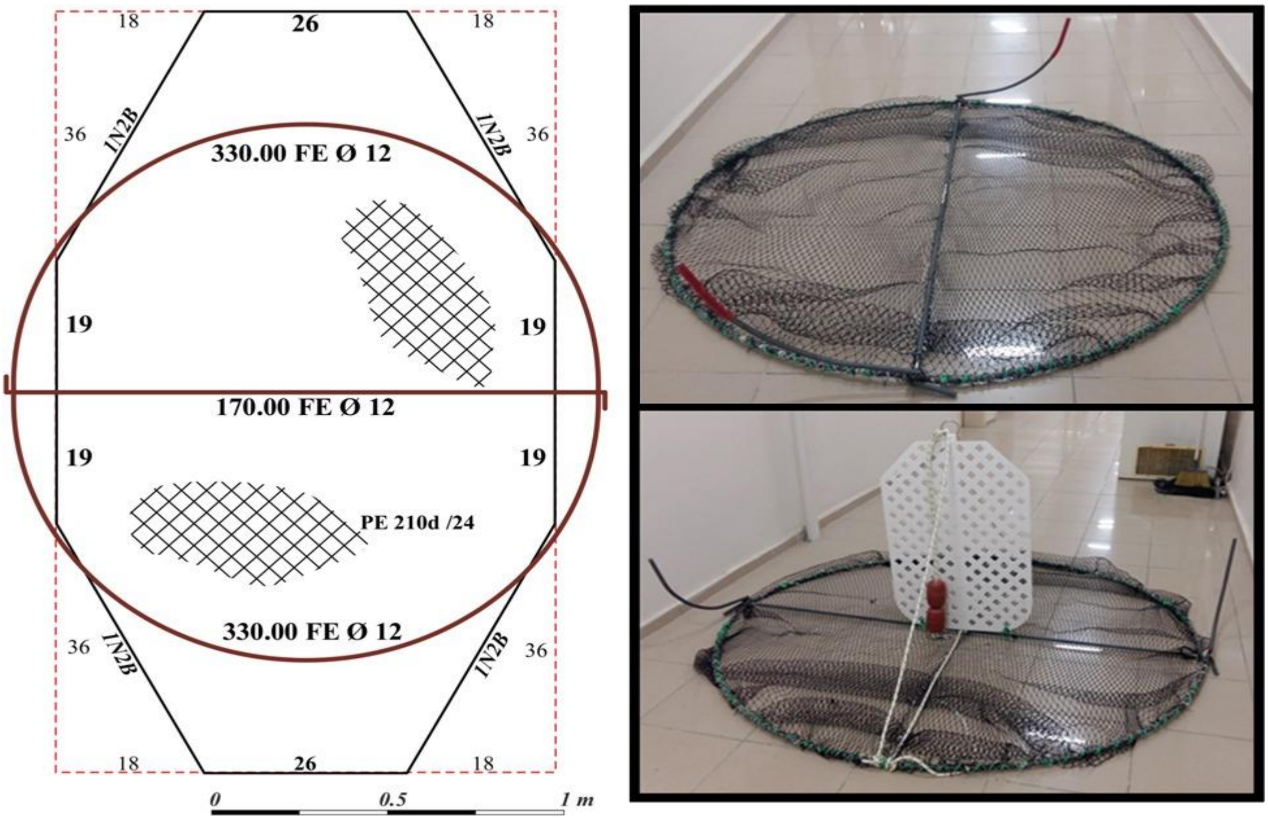

Figure 1. Scaled technical plan of the purse trap, external covering with net, fish attraction device (white plate) and harness ropes.

shown in Figure 1. To allow purse traps to capture fish, they must be fully opened on the seabed and the attractant mechanism (plastic lattice) should be positioned vertically. Therefore, the performance of the traps in various areas was evaluated and success rates were recorded. The locations for the experiments were determined considering the statements and experiences of the fishermen, the areas in which they encountered lionfish, which were initially caught as bycatch in recent years.

This study was conducted in two phases. In phase 1, eight modified non-containment purse traps were built. In phase 2, the opening performance and fishing efficiency of the purse traps were assessed between November 2021 and August 2022 in Urla, Göcek, and Gökova (Figure 2). The tests took place at depths ranging from 14 to 35 meters across seven stations with flat, sloping, sandy, muddy, and rocky seabeds. The study focused on evaluating the opening (deployment/retrieval) performance and fishing efficiency of the purse traps. The opening performance tests included all 38 deployments across Urla, Göcek, and Gökova, while the fishing efficiency tests consisted of 22 trials in Göcek and Gökova.

An experienced scuba diver was present in each operation, observing the fishing gear opening performance and conducting a visual fish count before deployment and during retrieval. Before the purse traps were set, surveys were carried out using scuba divers to count the number of points in a 100-meter radius around the reef area. In the diver survey, lionfish were counted on the reef's opposing sides and then inside the reef structure. Although the visual census method is limited due to diving times and depths, it helps optimize gear testing success by preventing equipment from being used in areas where lionfish are not present (Harmelin, 1987; Borton & Kimmel, 1991). We aimed to evaluate the efficacy of the purse traps considering the distance to the reef (m), deployment depth (m) and soak time (min). Abiotic conditions such as sea surface temperature (SST) and seafloor structures, i.e. rocky, seagrass and sandy substrates at all stations during the fishing efficiency trials were recorded.

The purse trap fishing trials, tested for the first time in the Gulf of Göcek, were conducted at two locations, Yılanlıada on July 4–5, 2022, and Zeytinada on July 5–6, 2022. In the trials conducted in Göcek Yılanlıada, 2 of the traps were positioned on the reef, while 5 of them were in a very close distance to the reef. 4 of the traps (No:1,2,3,4) were descended in shallow areas less than 20 meters, and 3 (No:5,6,7) were in deeper areas. Another trial was conducted in the Gulf of Göcek in the South of Zeytinada where the maritime traffic is less busy, and an area not restricted to fishing. Purse traps were located in between depths of 7 m and 28 m on sandy or rocky areas close to the rocky reefs.

Purse trap fishing trials in Gökova Bay took place in Kargı Cove, Nergizliburun, and the southern entrance of Löngöz Cove on August 29 and 30, 2022. On the second day, August 31, the northern entrance of Löngöz Cove and the Ballısu area were included in the trials. On the 29^{th} of August, two of the lionfish purse traps were

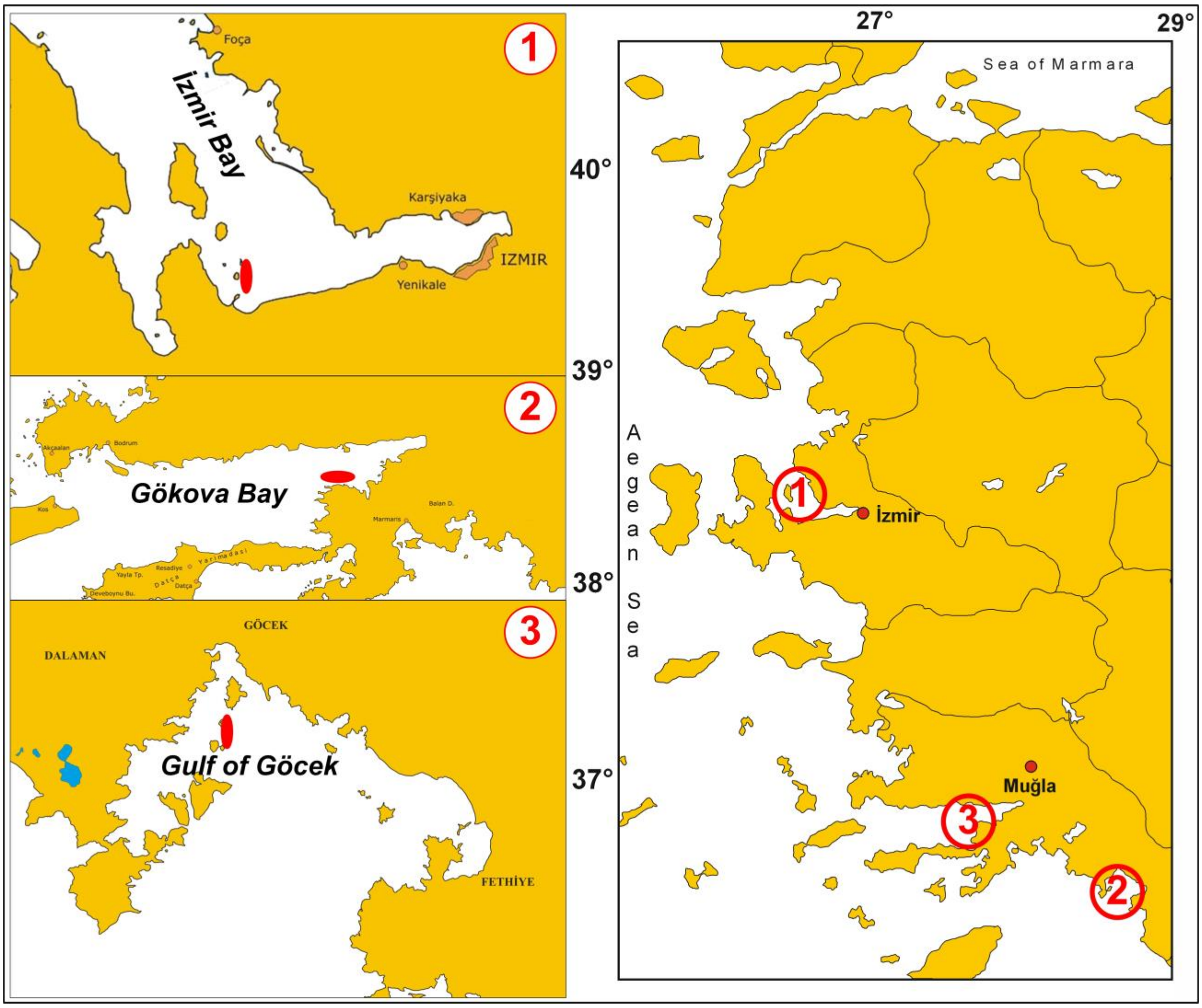

Figure 2. Areas where purse traps, opening performance and fishing efficiency tests are performed.

deployed in Kargı Cove Nergizliburun coasts and the other two in the South entrance of Löngöz cove. Purse traps were landed on rocky areas in all these areas. Since there wasn't any sandy area close to these locations, traps were located closer than 5 m to the rocky seafloor. Two of the purse traps retrieved on the 30th of August 2022 from the areas, were deployed in the North entrance of Löngöz Cove and two of them in Ballısu. The seafloor in the South entrance of Löngöz is a combination of rocky and stony, while Ballısu has rocky and seagrass (*Posidonia oceanica*) areas. Similar to previous trials, the traps landed on the seafloor closer than 5 meters to rocky areas.

Results

The purse traps were landed vertically and opened in 31 out of 38 trials, demonstrating an 81.6% success rate. As seen in Figure 3, the traps were deployed on sandy-muddy, stony-rocky and even in sloping substrates. 71.4% of low opening performance were due to currents and 28.6% were due to snagging.

Following the initial tests of the gear, recruitment trials were carried out in Gulf of Göcek and Gökova Bay within 10-30 meters of depths. The deployment and retrieval of the traps and soak times can be seen in Table 1 in detail. The average soak time per trap was 19.45 hours and varied between 15 and 24 hours.

The number of lionfish and other fish around the trap and within the footprint area of each purse trap, along with the trial characteristics, are provided in detail in Table 2. In the fishing trials conducted at Göcek Yılanlıada, 4 lionfish were observed around the area where a group of 4 traps was deployed (Figure 3). Before the retrieval, eight lionfish were counted, and 2 were observed significantly close to traps No: 2 and 4. No lionfish sighting were recorded near the other test area where three traps were located. Also, there weren't any other fish species in the footprint area of the traps. The number of lionfish during retrieval around the station at 100 m diameter were recorded and demonstrated in Table 3. In Zeytinada, before sunset, during the fish count surveys three lionfish sightings were recorded near traps no 2 and 3. After sunrise, purse traps were retrieved, one Blotched picarel (*Spicara maena*) and one Mediterranean parrotfish (*Sparisoma cretense*) were observed to gilled in the trap mesh eyes while no lionfish catch was recorded.

Figure 3. Deployment of non-containment purse traps in different ground structures.

Table 1. Details of non-containment purse traps trials in the Gulf of Göcek and Gökova Bay

	Location	No of Trap	SST*	Substrate type	Depth (m)	Distance from the reef (m)	Time of deployment	Time of retrieval	Soak time (min.)
Gulf of Göcek 4-6 July 2022	Yılanlıada	1	27°C	Rocky	15	< 2 m	13.00	07.15	1095
		2		Rocky	15	< 2 m	20.30	07.17	1067
		3		Rocky	10	On the reef	13.25	07.20	1075
		4		Rocky	15	< 1 m	20.10	07.23	1063
		5		Sandy	30	< 3 m	13.50	07.25	1055
		6		Sandy	25	< 1 m	13.55	07.28	1053
		7		Rocky	20	On the reef	14.00	07.30	1050
	Zeytinada	1	27°C	Sandy/Rocky	14	< 2 m	07.50	07.42	1432
		2		Sandy	14	On the reef	19.50	07.46	1416
		3		Sandy	28	< 2 m	19.40	08.05	1440
		4		Sandy	25	< 2 m	08.12	07.54	1422
		5		Rocky	17	< 2 m	08.15	07.58	1423
		6		Rocky	16	< 2 m	08.18	08.02	1424
		7		Rocky	19	< 2 m	08.20	07.50	1410
Gökova Bay 29-31 August 2022	Kargı Cove	1	27°C	Rocky	20	< 5 m	15.45	08.10	985
		2			25	< 5 m	16.20	07.50	930
	Löngöz (South)	3		Rocky	35	< 5 m	16.45	07.30	885
		4			22	< 5 m	17.00	07.35	875
	Löngöz (North)	1	27°C	Rocky	30	< 5 m	12.00	08.05	1205
		2			22	< 5 m	12.35	08.00	1165
	Ballısu	3		Rocky/*Posidonia oceanica*	15	< 5 m	12.55	07.25	1110
		4			17	< 5 m	13.00	07.20	1100

The number of lionfish sightings in Gökova Bay was very limited around the footprint area of the purse traps except for the trap no:3 (Table 4). During the assessments by divers prior to trap deployments on the 30th of August 2022, only one lionfish was observed around the 1st trap and 2 lionfish around the 2nd one, while no lionfish was recorded around other traps (Figure 4). Near the trap 1, White seabream (*Diplodus sargus*) and Damselfish (*Chromis chromis*) were observed, while Rabbitfish (*Siganus luridus*) and Damselfish around trap 3 were recorded. In these trials, neither lionfish nor other fish species were captured by the traps.

In the fishing trials in Löngöz and Ballısu, Trap 1 did not open since it landed horizontally due to the current, and traps 3 and 4 got stuck on the rocks on the seafloor. They ascended for 1-2 meters and lifted to allow opening and were successfully deployed. During deployment of the traps, 2 lionfish sightings were recorded around traps (Table 5). On 31st of August, no fish count survey was conducted. Therefore, we don't have information about the presence of lionfish and other fish species around the traps. It was observed that none of the traps captured any fish species.

Overall, no lionfish or other fish species were recruited in any of the traps' footprint areas.

Discussion

In order to assess a gear type that has shown high selectivity for *Pterois spp*. while minimizing bycatch of native species, we chose the Gittings purse trap for testing in the Mediterranean. The functioning principle of this trap is based on its role as an attractant mechanism for lionfish, acting as a reef habitat to collect them within the footprint area. By utilizing Lionfish's slow movement, the gear captures fish during its closure, which is triggered by the fisher. At other times, the gear does not actively fish, which prevents ghost fishing as the parts with netting are laid on the seabed, except for a small number of individual fish that may enter the net and become entangled. According to

Table 2. The trial characteristics for each purse trap, along with the number of lionfish and other fish around them.

Location	No of Trap	Substrate type	Depth (m)	Soak time (min.)	Number of lionfish around / on trap	Total number of other fish around / on trap
Yılanlıada	1	Rocky	15	1095	8 / 0	~424 / 0
	2	Rocky	15	1067	8 / 2	~424 / 0
	3	Rocky	10	1075	8 / 0	~424 / 0
	4	Rocky	15	1063	8 / 1	~424 / 0
	5	Sandy	30	1055	0 / 0	~424 / 0
	6	Sandy	25	1053	0 / 0	~424 / 0
	7	Rocky	20	1050	0 / 0	~424 / 0
Zeytinada	1	Sandy/Rocky	14	1432	Not counted	Not counted
	2	Sandy	14	1416	Not counted	Not counted
	3	Sandy	28	1440	Not counted	Not counted
	4	Sandy	25	1422	Not counted	Not counted
	5	Rocky	17	1423	Not counted	Not counted
	6	Rocky	16	1424	Not counted	Not counted
	7	Rocky	19	1410	Not counted	Not counted
Kargı Cove	1	Rocky	20	985	4 /1	~87 / 0
	2	Rocky	25	930	3 / 2	14 / 0
Löngöz (South)	3	Rocky	35	885	17 / 0	~115 / 0
	4	Rocky	22	875	1 / 0	~53 / 0
Löngöz (North)	1	Rocky	30	1205	2 / 0	~133 / 0
	2	Rocky	22	1165	2 / 0	~133 / 0
Ballısu	3	Rocky/*Posidonia*	15	1110	2 / 0	~99 / 0
	4	Rocky/*Posidonia*	17	1100	2 / 0	~99 / 0

Table 3. Fish count in the testing area of Yılanlıada, Gulf of Göcek.

Species name	Scientific name	Number
Lionfish	*Pterois miles*	8
Redsea goatfish	*Parupeneus forsskali*	17
Bogue	*Boops boops*	152
Common two banded seabream	*Diplodus vulgaris*	18
Goldblotch grouper	*Epinephelus costae*	8
White seabream	*Diplodus sargus*	5
Mediterranean parrotfish	*Sparisoma cretense*	7
Rainbow wrasse	*Coris julis*	5
Damselfish	*Chromis chromis*	200
Annular seabream	*Diplodus annularis*	3
Common octopus	*Octopus vulgaris*	1

Table 4. Fish species diversity and numbers around traps in Kargı Cove and South Langöz, Gökova Bay before the first trial deployment.

Species name	Scientific name	1. Trap	2. Trap	3. Trap	4. Trap
Lionfish	*Pterois miles*	4	3	12	1
White seabream	*Diplodus sargus*	3	2	11	
Common two banded seabream	*Diplodus vulgaris*	4			3
Saddled seabream	*Oblada melanura*	15	4	18	8
Damselfish	*Chromis chromis*	36		45	35
Goldblotch grouper	*Epinephelus costae*	5		17	4
Dusky grouper	*Epinephelus marginatus*	3 (*J)		4 (*J)	2 (*J)
Redcoat	*Sargocentron rubrum*		4		
Rabbitfish	*Siganus luridus*	17		3	
Painted comber	*Serranus scriba*			2	
Mediterranean wrasse	*Thalassoma pavo*		1	3	

**J: Juvenile*

Figure 4. The abundance of natural reefs in the trial area (30.08.2022, Gökova Bay, Türkiye).

Table 5. Fish species diversity and numbers around traps in North Langöz and Ballısu, Gökova Bay before the second trial deployment.

Species name	Scientific name	Trap no 1 and 2	Trap no 3 and 4
Lionfish	*Pterois miles*	2	2
White seabream	*Diplodus sargus*	12	4
Common two banded seabream	*Diplodus vulgaris*	37	
Rabbitfish	*Siganus luridus*		3
Damselfish	*Chromis chromis*	60	50
Goldblotch grouper	*Epinephelus costae*	15	38
Dusky grouper	*Epinephelus marginatus*		2 (*Juvenile*)
Half smooth golden pufferfish	*Lagocephalus spadiceus*	7	

earlier research, lionfish recruitment to these traps was more than ten times greater than that of native fish, suggesting that non-target species were not significantly impacted (Harris et al., 2020), a finding that our investigation also supported.

In this study, the efficiency (abundance and biomass) of the non-containment purse traps was intended to be tested considering different variables such as distance to the reef (rocky habitat), depth (m) and soak time (min). However, considering the interviews with fishermen stating that the number of lionfish decreased significantly compared to previous years, preliminary fish count surveys and the absence of lionfish landing and monitoring in deep seawaters led this study to be carried out only at equal intervals (deployment, retrieval and soak time) of the traps. In addition, since there were no suitable areas to place the traps at certain distances from the reef, the traps had to be left on or very close to the reef (<5 m).

Opening performance of the purse traps was examined in 38 trials, and the gear showed a successful deployment performance. This applied not only on flat but also on sloping sandy seafloors showing the traps suitability to be used in diverse environmental conditions. The primary reasons that prevented the traps from opening were that the currents and deflectors of the traps got stuck in rocky reef areas.

Despite their presence on neighbouring reefs, successful recruitment of lionfish was not achieved in any of the stations. In the trials conducted in Göcek, eight lionfish were observed in an area of approximately 100 m in diameter, and only three were observed in a rectangular area of 100*50 m on the second day. In the trials at Kargı Cove, the largest number of lionfish (12) was observed around the trap only once. It's doubtful that lionfish leave their natural habitat and are attracted by the traps.

In all trials, lionfish were observed to be found in dark and shadow parts of the rocks within the natural reef area along with other fish species. Although a few lionfish were counted before deployments, it is thought that the reason for the unsuccessful recruitment of lionfish in the footprint of traps was because the natural reef areas were vast enough for current lionfish population that doesn't lead them to leave their location. It may have been only possible to catch lionfish in sandy, muddy habitats when they perceive the traps as reefs (their preferred habitats). However, there wasn't any Lionfish recorded during dive surveys except for one anecdotal sighting on *Posidonia oceanica*. Therefore, purse traps haven't been tested in these habitat structures.

Trials carried out in northeast Gulf of Mexico demonstrated that the lionfish around artificial reefs were successfully attracted and recruited by the purse traps (Harris et al., 2020) whereas in another study with 3 trap designs i.e. lobster, seabass and Gittings traps in mesophotic areas the number of the lionfish captured showed a significant decrease (Harris et al., 2020, 2023). It is thought to be similar with our study in the sense of showing a positive correlation between the lionfish density and the fishing efficiency. Considering low lionfish density, deployment duration in this study was set between 15 and 24 hours. It may be another reason for the failure of the traps to recruit lionfish as Harris et al. suggested in their study in 2023 that, higher lionfish densities at neighbouring reefs, deployment times of about two days, and retrieval at dawn or dusk all improve trap fishing efficiency. Also, structures similar to natural reef areas could have been set on the purse traps to attract lionfish around the reefs as suggested by Harris et al. (2020) by applying modifications such as light, sound or different structures to increase lionfish catch. Future studies should first investigate the attraction mechanisms influencing lionfish through controlled laboratory experiments. Once identified, these mechanisms should be tested and validated in field studies under natural conditions to confirm their accuracy and practical applicability.

Another reason of no-recruitment could be the difference of behaviour patterns between *P. volitans*, which consists of 93% of the Atlantic population (Hamner et al., 2007) and *P. miles*, which are assumed to be the dominant species in the Mediterranean (Ulman et al., 2020; Bernardi et al., 2024). The attractant mechanisms used for the Gitting's purse traps might have worked better to attract *P. volitans.* Since there are significant differences between the two invasion mechanisms and species, understanding their behavioural and dietary differences is critical to developing targeted management strategies. For example, Türkiye's current national laws, which prohibit fishing with SCUBA gear, would need to be amended to allow lionfish to be legally caught using a speargun or sling. A similar approach has been successful in Belize (Ulman et al., 2020). Another study revealed that active removal of lionfish seems to help the populations remain small (Hüseyinoğlu et al., 2024) however, no effective fishing was recorded in this study to find an efficient solution for reducing lionfish in marine habitats where they spread.

While the fishermen stated that there was a decrease in the population of lionfish in areas where fishing is allowed compared to previous years, a large number of lionfish was observed during underwater monitoring carried out in July-August 2023 within the scope of projects conducted by the Mediterranean Conservation Society (MCS) in the Göcek and Gökova marine protected areas (MPA) (*Personnel com.* Z. Kızılkaya), hence, testing these purse traps noting the high selectivity of these gear for sure, in these MPAs could offer substantial benefits on measuring the fishing efficacy of the traps and tackling the increase of invasive species in MPAs.

Ethical Statement

Ethics approval and consent to participate not applicable for this study.

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Author Contribution

First Author: Conceptualization, Writing -review and editing; Investigation, Methodology; Second Author: Investigation, Methodology, Visualization and Writing -original draft; Third Author: Conceptualization, Writing -review and editing, Investigation; and Fourth Author: Investigation, Writing - review and editing.

Conflict of Interest

The authors declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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