Pufferfish versus lionfish: comparing risks for Turkish marine economics

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Abstract

Purpose – This study aims to explore the risk level of pufferfish and lionfish by comparing them among Turkish marines. In addition, this study focuses on comparing pufferfish with lionfish to determine which one is more dangerous for marine economics in Türkiye.

Design/methodology/approach – This study employs descriptive content analysis to give some qualitative evidence for the related literature. As a sample case, Türkiye was selected in the context of being a country in the Mediterranean Basin. By reviewing recent news, reports and publications, this study firstly will conclude how invasive alien marine species affect Turkish marines. Then, pufferfish and lionfish will be compared together to determine the risk level of these species for Turkish marine economics.

Findings – As a result of descriptive findings, it is seen that captured fishery has been declined in Turkey recently due to many factors including climate change, global warming, overfishing, environmental pollution and attack of invasive alien species. Pufferfish and lionfish are seen as the most spread marine species in Turkish marines. When comparing pufferfish with lionfish, it is seen that pufferfish is more dangerous than lionfish for Turkish marine economics.

Research limitations/implications – This study provides descriptive and original findings as a result of comparison of pufferfish and lionfish due to their impact on Turkish marine economy. It is thought to give useful importation for the fight against invasive alien marine species in the Mediterranean Basin. Future studies can investigate different invasive alien marine species and their impacts on marine economics in the Mediterranean Basin.

Practical implications – Based on the Turkish cases, it is determined that there should be different policies for fight against invasive alien marine species in the Mediterranean Sea. Each marine species has different impacts on seafood market. Some of marine species can be consumed as a seafood product but some of them can't be consumed that policy makers should develop other strategies such as catching them to reduce their population in the local marines.

Social implications – The spread of invasive alien marine species is still continuing in the Mediterranean Basin. Each country has been affected by the attack of invasive alien marine species. To keep sustainable seafood market and marine economics, countries should both implement common policies and develop policies specific to threats in their own countries.

This study is derived from a paper which was presented in "2nd International Symposium on Pufferfish/Lionfish" in 2022.

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Originality/value – This study reveals key points in the rise of invasive alien marine species in Turkish marines at first. The main contribution of this study is to be a recent sample for a country which is under attack by invasive alien marine species by giving a comparison of pufferfish and lionfish.

Keywords Invasive alien marine species, Pufferfish, Lionfish, Seafood market, Mediterranean Basin, Marine economics

Paper type Research paper

Introduction

The Mediterranean Basin has been under the attack of invasive alien marine species for decades (Galil, 2014; Katsanevakis *et al.*, 2014; Mannino and Balistreri, 2021; Yildirim and Kaplan, 2022). Unfortunately, the invasion of foreign fish species in the Mediterranean continues at a rapid pace (Baggi, 2021). Cheilodipterus novemstriatus was firstly recorded in Israel in 2010 and then it was seen in in Lebanon, Turkey, Cyprus and Syria. This invasive alien species was recently seen in Greece too. Seas have changed since warming temperature and climate change and policymakers should recognize this fact to develop efficient strategies in the long term (Marine fauna, news, 2020). It has been believed that approximately one species enters the Mediterranean every 1.5 weeks. Cyprus, located in the Mediterranean, is also among the countries that are vulnerable to invasive species attacks. Therefore, within the scope of sustainable blue economy for Cyprus, necessary investments should be made for coastal and sea cleaning and protection of ecosystems in the region (Department of Fisheries and Marine Research, n.d.). The international union for conservation of nature (IUCN) stated that within the scope of the MEDMIS plan to fight against invasive marine species in marine protected areas in the Mediterranean Sea, a highly harmful invasive species of lionfish has been observed in Turkey and Cyprus. According to Dr. Carlos Jiménez (The Cyprus Institute, marine biologist), "lionfish" can have a severe negative impact on ecosystems as well as local economies. Ecologically, the nature of lionfish also imposes detrimental effects on natural marine diversity. Because they are harmful and aggressive, they can cause a decrease in herbivorous fish and an increase in algae. Since the lionfish is poisonous, it can also create dangers in terms of tourism. On the other hand, some countries outside the Mediterranean are trying to evaluate and commercialize lionfish as a food to combat this invasive alien fish species in addition to other measures (IUCN, 2016). In Table 1, temporal variability of Non-indigenous species (NIS) introductions associated with each pathway in Mediterranean is given.

Giuseppe di Carlo (director of World Wildlife Fund's (WWF's) Mediterranean marine initiative) determined that the Mediterranean was not the same sea since last decade due to its transformation into tropicalization. The climate change is today's issue when considering the impact of it on the current situation. Although the sustainability of healthy ecosystems is the biggest tool in the fight against climate change, it is seen that marine biodiversity is facing a great threat in the Mediterranean. The number of native molluscs has decreased by 90% in Israeli waters, and invasive species account for 80% of the fish caught in Turkey. Coastal communities, on the other hand, have begun to find alternative methods to combat the invasive marine species whose population is increasing. For example, catching and cooking rabbitfish, jellyfish and other alien marine species and also using some species in the cosmetic sector can all be a solution in the long term (WWF (World Wildlife Fund), 2021).

The recent studies show that the population of invasive alien marine species is increasing rapidly and there is a viral threat to blue economy in the Mediterranean Sea. It is a fact that increasing population of invasive alien species is a huge risk to seafood security and marine biodiversity in the Mediterranean Sea. The literature gives main factors such as climate change, Suez Canal, and shipping that increase the introduction of invasive alien marine species into the Mediterranean Marines (Öztürk, 2021; Yildirim and Kaplan, 2022).

Table 1.
Temporal variability of NIS introductions

Year	Release in nature	Escape from confinement	Corridor	Transport contaminant	T-S/ballast water	T-S/hull fouling	T-S/other	Sea
1970–1975	0	3	0	5	9	7	1	Western Mediterranean Sea
1976–1981	1	2	4	15	17	20	2	Western Mediterranean Sea
1982–1987	0	2	0	17	13	20	2	Western Mediterranean Sea
1988–1993	0	2	0	7	15	19	1	Western Mediterranean Sea
1994–1999	0	0	0	13	10	7	1	Western Mediterranean Sea
2000–2005	0	2	2	11	18	15	2	Western Mediterranean Sea
2006–2011	0	4	2	6	12	9	5	Western Mediterranean Sea
2012–2017	0	5	1	5	11	13	1	Western Mediterranean Sea
1970–1975	0	1	1	11	5	14	1	Central Mediterranean Sea
1976–1981	0	1	1	3	10	8	1	Central Mediterranean Sea
1982–1987	0	1	1	3	7	6	2	Central Mediterranean Sea
1988–1993	0	2	1	4	6	11	1	Central Mediterranean Sea
1994–1999	0	4	3	3	8	8	1	Central Mediterranean Sea
2000–2005	0	2	0	6	9	16	1	Central Mediterranean Sea
2006–2011	0	4	7	5	18	16	3	Central Mediterranean Sea
2012–2017	0	12	4	6	18	16	2	Central Mediterranean Sea
1970–1975	0	1	29	2	3	6	0	Eastern Mediterranean Sea
1976–1981	0	1	22	1	7	9	0	Eastern Mediterranean Sea
1982–1987	0	0	22	7	10	13	0	Eastern Mediterranean Sea
1988–1993	0	1	44	6	20	21	1	Eastern Mediterranean Sea
1994–1999	0	1	62	6	19	34	2	Eastern Mediterranean Sea
2000–2005	0	6	57	0	41	38	6	Eastern Mediterranean Sea
2006–2011	0	14	53	1	28	15	1	Eastern Mediterranean Sea
2012–2017	0	5	39	7	16	23	3	Eastern Mediterranean Sea

Source(s): European Environment Agency (EEA), (2019)

Figure 1 shows a model examining the invasion of alien marine species in the Mediterranean Sea which is developed by Yildirim and Kaplan's (2022) study.

As is seen in Table 1, climate change, global warming, connection straits, Suez Canal and shipping all increase the population and spread of invasive alien marine species in the Mediterranean Sea. Especially, climate change and global warming has transformed the Mediterranean Sea into a tropical sea. The higher population of invasive alien marine species also threatens local marine biodiversity and sustainable seafood market in the Mediterranean Basin.

Invasive alien species attack encountered by Mediterranean countries is among the important issues examined in the literature. Some of the studies are reviews and some contribute to the literature empirically. Although it is difficult to physically detect and track these alien species in invasive alien research, researchers put forward various assumptions about the effects of alien species on the seas and the fight against these species (Zenetos *et al.*, 2005; Galil, 2007; Brundu, 2015; Peyton *et al.*, 2019; Bonanno and Orlando-Bonaca, 2019; Kourantidou *et al.*, 2021). Invasive alien marine species firstly affect fishermen in the context of blue economy. Not only reducing seafood products, invasive alien marine species also damage marine tourism and biodiversity too (Sciberras and Schembri, 2007). Galil (2007) stated in his study that 500 foreign marine species are listed in the Mediterranean. How the increase in the population and diversity of these alien species will have long-term effects on local biodiversity should be among the top issues to be addressed by policymakers. Peyton *et al.* (2019) explored 225 alien marine species in Cyprus and made a risk rating in their study. It has been stated that 100 alien species examined are of very high, high or medium risk for biodiversity, and 125 species are of low-grade risk. Considering the negative impact of alien marine species on human health and the threat to biodiversity, it is an important issue to be analyzed. Zenetos *et al.* (2005) investigated invasive alien marine species in Mediterranean Sea. They analyzed 963 invasive alien marine species which were recorded until December 2005. As a result of their study, it was determined how it was hard to explore new invasive alien marine species and categorize them due to higher cost of research and lack of sufficient methods.

Invasive alien fish (species) have been expanding in the Mediterranean Sea for a long time and Turkey has been under attack by many invasive alien marine species too. This study aims to give a brief framework for examining the risk level of pufferfish and lionfish among Turkish marines.

Descriptive study design

Like as many Mediterranean countries, Turkey has been challenged with invasive alien marine species in Turkish marines. This study aims to give a brief framework for examining the risk level of pufferfish and lionfish for Turkish marines. Based on a qualitative research approach, this study will review the latest research and news about pufferfish and lionfish

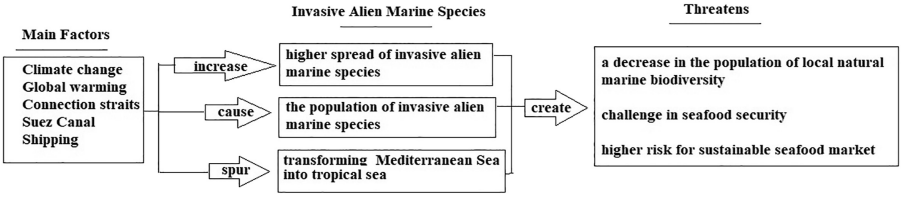


Figure 1.
A model: the invasion of alien marine species in the Mediterranean Sea

Source(s): Adapted from Yildirim and Kaplan, 2022

and give some descriptive evidence for the risk level of pufferfish and lionfish among Turkish marines. It is thought that qualitative approaches can help researchers to explore specific issues deeply to guide empirical studies in the future. Fight against lionfish and pufferfish is a general issue in Mediterranean Basin. Each study can help policymakers to find new ways of ending the population of these invasive species in marines.

Sample case: selected Turkish cases

This study collected some recent and available news and reports through different sources. When selecting cases, this study used some criteria. These criteria can be categorized as follows:

(1) Cases must be related to invasive alien species including pufferfish and lionfish.

(2) Cases must include Turkish marines.

(3) Cases must give some findings for the result of the invasion of pufferfish and lionfish into the Turkish marines.

(4) Cases should give some findings for the impact of pufferfish and lionfish on Turkish marines.

Selected recent news on invasive alien marine species in Turkish Marines can be given as follows:

(1) A type of fish that they have not encountered before in the Marmara Sea was attached to the fishing lines of amateur fishermen who sailed from Gemlik district. As a result of their investigation, the fishermen learned that the fish they caught was a pufferfish. Balloon fish, which has a very strong poison, can lead people who eat it to death. It was warned that especially amateur fishermen should be careful about the dangerous pufferfish, which can be seen in the Marmara Sea, which has a strong jaw structure and razor-sharp teeth. A balloon fish was caught on the fishing line of the fishermen, whose boat was organized for amateur fishermen in Gemlik, Marmara Sea. The fishermen who saw the poisonous blowfish for the first time in the Marmara Sea were shocked (IHA, 2021).

(2) There are around 10 alien and invasive species currently identified in the Mediterranean. This number is considerably higher than the sum of the European seas. These alien species have negatively affected the species diversity in the Mediterranean as they are the dominant species. Among these alien species, especially 10 species have been identified as those that can endanger human health. Seven of these 10 species are fish, the others are sea urchin and jellyfish. Blowfish contain very strong poisons in places such as skin and liver, most likely thanks to the bacteria they contain in their digestive systems (Bayraklı, 2021).

(3) 105 invasive alien species and 540 alien species have been detected in Turkish seas by the Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks in 2020. It has been stated that 14 of the world's 100 worst invasive alien species are found in Turkey. While the number of alien species in the Mediterranean exceeds 1,000, it has been determined that as of 2020, the number of alien species in Turkish seas has increased to 540 and the number of invasive alien species to 105. Twenty-eight alien species were seen in the Black Sea, 124 were seen in the Marmara Sea, 253 were seen in the Aegean Sea and 413 were seen in the Mediterranean. Among these invasive species, the most dangerous ones are lionfish,

pufferfish, stonefish, sea snail, migratory jellyfish and striped snake catfish (Unutmaz, 2021).

As given by Kaplan and Yildirim's (2023) study, there were important recorded news on the threats of pufferfish and lionfish in Turkish marines. The main findings of these news can be given as follows (Kaplan and Yıldırım, 2023):

(1) News based on İklim Haber (2020) and Interview with Prof. Dr. M. Gökoğlu (from Akdeniz University): It was seen that pufferfish and lionfish invaded the Mediterranean Sea and new alien marine species also keep going to the Mediterranean Sea due to the changing weather.

(2) News based on Akgüneş (2020) and Interview with Prof. Dr. Köşker (from Çukurova University): It can be said that there was no predator for Lionfish in the Mediterranean that this species was accepted to reach higher population.

(3) News based on Özacar (2020) and Interview with Assoc. Prof. Topaloglu (from Istanbul University): It was seen that the population of alien marine species was a huge danger to local biodiversity and ecosystem.

(4) News based on DHA (Demirören News Agency) (2018) and Interview with The international joint press release of the Turkish Marine Research Foundation on "Toxic Alien Species": It was seen that invasive alien marine species were dangerous for people and ecosystem.

(5) News based on Çalkaya (2020) and Interview with Ramazan Özkaya (the Chairman of the Board of Directors of the Central Union of Fisheries Cooperatives): Lionfish was so harmful to the local biodiversity and seafood market.

(6) News based on Özacar (2019) and Interview with Prof. Dr. F.S. Karakulak (from Istanbul University): It was seen that seafood market was under attack by invasive alien marine species.

(7) News based on Sarı (2021) and Interview with Prof. Dr. H. Filiz (from Mugla Sıtkı Kocman University): It was seen that invasive alien species also began to go to the Black Sea.

Descriptive findings: the risk level of pufferfish and lionfish

Descriptive findings are all based on recorded news and studies. To compare lionfish with pufferfish, this study analyzes recorded news carefully. Descriptive content analysis can help researchers to determine key factors that are related to specific issues (Yıldırım *et al.*, 2021; Öncü *et al.*, 2021; Yıldırım and Bostancı, 2021). As a result of content analysis, this study gives some useful tables and figures seen in Table 2:

As presented in Table 3, it can be said when the population of alien marine species is increasing, the population of local species in Turkish marines is decreasing. Like other threats to the biodiversity in marines, invasive alien species also influence the sustainability of marine biodiversity in the long term.

When considering literature and recorded news, it is seen that there are main differences between pufferfish and lionfish. This study categorized key issues that are examining the difference between pufferfish and lionfish as below:

(1) *First issue: Monetary incentive:* In Turkey, Pufferfish can be determined as having higher risk against seafood market. When considering some measurements for Pufferfish, it is seen that Turkish government take action to reduce the population of

Variables	Findings	Key points
Temperature of marines	Warming marine temperature welcomes new species for the Mediterranean Sea and others in Turkey	The biggest warming is seen in the Mediterranean and so higher numbers of alien species migrate to the Mediterranean
The population of invasive alien species	Recent observations said that types and numbers of alien species were all increased	There are almost higher types and numbers of alien species in the Mediterranean. Accordingly, new species (alien species) have become local species
Fishing	Fishermen complaints about invasive alien species. For example, pufferfish eat local fish and they also eat or harm fishing net	Invasive alien species such as Pufferfish and Lionfish harm fishing industry
Seafood market	Due to the decreasing numbers of caught fish and other marine species, the future of seafood market should be thought as under danger	With increasing numbers of alien species in Turkish marines, seafood market will suffer from lower quantity of seafood

Source(s): Created by authors

Table 2. Determining the risk of invasive alien species in Turkish Marines

Variables	Increase	Decrease
The local population of marine biodiversity		X
The population of alien species	X	
Types of alien species	X	
The temperature of marines	X	
Types of local fish and other seafood products		X

Source(s): Created by authors

Table 3. Changes in Turkish Marines in the last decade

Pufferfish in Turkish marines. At this point, Turkish government supports catching Pufferfish in the Mediterranean to decrease the population of Pufferfish in the Mediterranean. Fishers will be funded by Turkish government for the number of caught Pufferfish. Incentives were started to be given for the fishing of pufferfish, which is an invasive fish species. According to the legal decision published in the Official Gazette, those who catch up to 500 thousand of the Lagocephalus Sceleratus species of Pufferfish will be paid 5 Turkish Liras each, and those who catch other species will be paid 0.50 Liras up to 5 million pieces. Thanks to the fish caught, the presence of pufferfish will be reduced and the fish will be brought into the economy. The payments will be covered by the agricultural support budgets of the Ministry of Agriculture and Forestry for 2021, 2022 and 2023. Fishermen engaged in aquaculture activities will be able to catch pufferfish with a fishing vessel with a license. The support payments are public resources and lien, execution, or similar transactions cannot be carried out before the support payments transferred to the account of the fishermen (Cnntürk.com, 2021). Table 4 presents the quantity and fund for catching pufferfish.

On the other side, there is no monetary incentive for catching lionfish in Turkish marines.

(2) *Second issue: Seafood option:* Although lionfish is a dangerous species, it can be a seafood product. Especially, fight against the population of lionfish species mostly

includes using seafood option in the Mediterranean region (Ulman *et al.*, 2021). Lionfish can be used and consumed as seafood product in Turkish seafood market but pufferfish cannot be consumed or commercialized as seafood product in general. Serkan Erkan (Mediterranean Fisheries Research, Production and Training Institute Manager) stated that the consumption of lionfish will be beneficial for the fish market when suitable conditions are provided. In terms of combating the rapidly increasing population of lionfish, the absence of hunters of these fish species has made alternative ways necessary (Yıldız, 2020). Consumption of lionfish will provide economic benefits and it will be possible for people to replace seafood with an alternative species against other diminishing fish products. Assoc. Prof. İlker Aydın (Ege University, Faculty of Fisheries, Fishing Technology Department) also determined that lionfish has a commercial value in seafood market. So, fishers can benefit from catching lionfish when reducing its invasion in Turkish marines (AA, 2021).

(3) *Third issue: Position:* Both Lionfish and Pufferfish and its other sub-types were mostly introduced into the Mediterranean Sea. Recently, Lionfish was mostly observed in Aegean Sea and recent news showed that lionfish began to live in Aegean Sea (Yıldız, 2020; AA, 2021; Akgün, 2019).

(4) *Fourth issue: Danger level:* Some animals are poisonous, but their poison must reach humans in the form of ingestion, inhalation or absorption through the skin in order to harm humans. Poisonous animals tend to be more passive-aggressive and do not become aggressive. On the other hand, venom can be transmitted to humans in the form of a bite or sting. Venom consists of small and large molecules and needs a wound to enter the body. Venomous animals are active in defense (Australian Academy of Science, n.d.). Lionfish are venomous but they are not poisonous marine species. Lionfish transmit their toxins through their spines. When lionfish do not have spines, they cannot inject their venom. So as long as people avoid the spines of the lionfish, they are safe. Once the spines of these fish are carefully removed, they can be safely cooked (Lanese, 2019). The lionfish is a venomous fish that actually lives in the Atlantic Ocean, Gulf of Mexico and the Caribbean Sea. The lionfish seems so attractive marine species but it is dangerous when its spine touches you. However, it is a venomous fish, they are not aggressive to attack people frequently (Higuera, 2020). Pufferfish is a poisonous fish as having tetrodotoxin. This fish is accepted as one of the most dangerous marine species. Pufferfish has the power of murdering people when people consume or eat them carelessly (Plantz, 2021).

(5) *Fifth issue: Alternative consumption:* In Türkiye, policymakers are looking for different ways to end the invasion of pufferfish and lionfish in Turkish marines. In this context, lionfish seems to be used as seafood for households in general. On the other side, the invasion of pufferfish needs different methods to be ended. Ministry of Agriculture and Forestry, General Director of Fisheries and Aquaculture Mr. Atalay

Table 4.
The payments for Pufferfish

Types of Pufferfish	Quantity	Fund
Lagocephalus Sceleratus	Up to five hundred thousand	5 Turkish Liras
Lagocephalus Spadiceus, Lagocephalus Suezensis, Lagocephalus Lagocephalus, Lagocephalus Guentheri, Torquigener Flavimaculosus, Sphoeroides Pachygaster	Up to five million	0.50 Turkish Liras

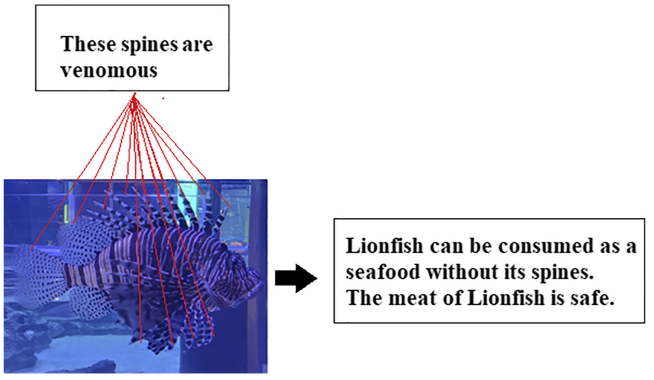
Source(s): Cnntürk.com (2021)

determined that the leather and venom of the blowfish would be used in industry in Türkiye. Because the pufferfish inflates like a balloon, its skin has a very flexible and robust structure. Therefore, it is thought to have a structure that can be used easily both in the textile and clothing industry and in other sectors. For example, a bag can be made from the leather of the pufferfish because it is easy to process and dye the leather of pufferfish. In addition, the leather of pufferfish can be used for making different jewellery, belts, ornaments, and wallets If there are companies that want to buy pufferfish in bulk from Ministry of Agriculture and Forestry, all of them will be free of charge. Ministry of Agriculture and Forestry will give pufferfish based on a specific contract. Ministry of Agriculture and Forestry will have companies sign the disposal specifications. After removing the leather of the fish and tanning it, then they will be able to use them as they wish (Adam, 2021).

Figure 2 shows lionfish situation in seafood market and Figure 3 shows pufferfish situation in seafood market. Lionfish seems to be used as a seafood product after its spines are all cleaned. On the other side, pufferfish cannot be used as a usual seafood product because it is a poisonous species.

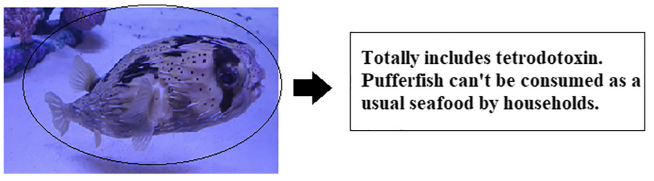
Conclusion

Mediterranean Basin has an important value in the context of marine economics. However, the invasion of alien marine species threats Mediterranean counties in recent decades. Due to many factors such as pollution, global warming, overfishing, climate change and invasion of alien species, seafood security is also in danger (Yildirim and Kaplan, 2020; Yıldırım and



Source(s): Created by authors, Lionfish was photographed by Seda Yıldırım

Figure 2.
Lionfish situation in seafood market



Source(s): Created by authors, Pufferfish was photographed by Seda Yıldırım

Figure 3.
Pufferfish situation in seafood market

Yıldırım, 2021). Invasive marine species have serious effects on the marine ecosystem. Apart from the negative effects of environmental pollution, global climate change and other human activities, the introduction of invasive marine species into the oceans and seas and their proliferation in the local marine environment is a serious threat. Unfortunately, it can be assumed that alien invasive species have the power to destroy human health, food security and diversity in the long run (Sciberras and Schembri, 2007; Galil, 2007; Brundu, 2015; Peyton *et al.*, 2019; Bonanno and Orlando-Bonaca, 2019; Mannino and Balistreri, 2021).

Pufferfish and lionfish are the two most prominent species of invasive fish species that reproduce and increase in population in the Mediterranean. At this point, this study aims to give some descriptive evidence for key factors in fight against pufferfish and lionfish by comparing them together. As seen in Table 5, there are differences between pufferfish and lionfish. Firstly, lionfish has more potential to be used in seafood market and seems less harmful to human or other marine species. But pufferfish seems to be a more dangerous species for human and other species in local marines. Pufferfish has no natural predator and there is no chance to use pufferfish in the usual seafood market in the long term.

The literature and recent news have both shown that lionfish should be used as seafood product in general. There is an option for lionfish to be cooked and consumed by households (Demirci and Demirhan, 2022; Davis, 2016; Manacıoglu and Manacıoglu, 2018; Simnitt *et al.*, 2020; Blakeway *et al.*, 2020). On the other side, pufferfish has not any option in the usual seafood market due to its poisonous nature. Reducing the population of pufferfish needs more complex ways. For example, Türkiye developed new ways to fight against pufferfish such as giving money incentive to fishermen. There are also projects on using leather of pufferfish and developing new industrial areas. Also, poison of pufferfish is thought to be used by industry in the long term. If there can be any mass market for these invasive alien marine species, their population can be reduced and controlled in marines.

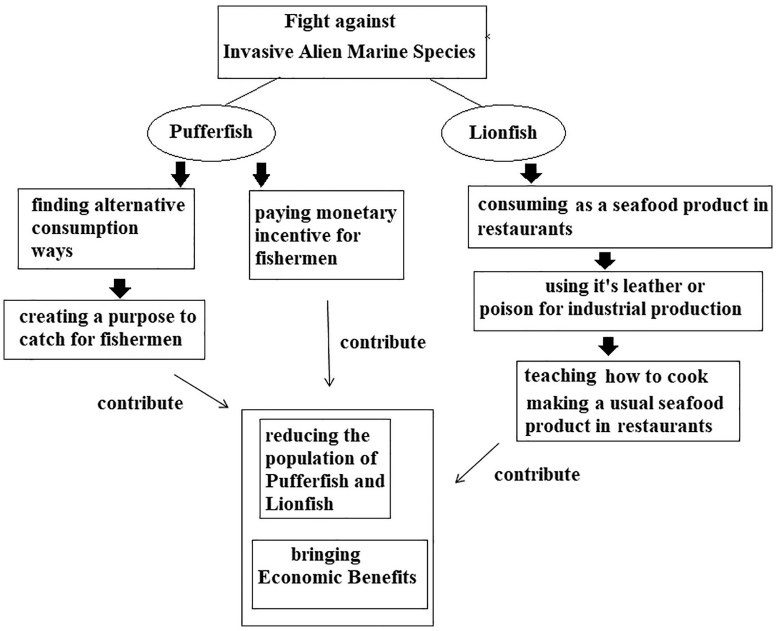
As presented in Figure 4, this study explores the ways of fight against pufferfish and lionfish as invasive alien marine species in Turkish marines. There are different ways to reduce the population of these alien species in Turkish marines. Firstly, the population of pufferfish can be reduced by usual catching methods but fishermen should be paid for it. Then, there are some alternative consumption ways for pufferfish including using its leather and poison in industry. Secondly, lionfish can be cooked and consumed as a seafood product by restaurants. Accordingly, policymakers can benefit from pufferfish and lionfish economically while their population is declining under control.

The main contribution of this study is expected to guide future studies related to fight against lionfish and pufferfish. Especially, as a country in Mediterranean Basin, Türkiye can be a good sample for similar countries in Mediterranean Basin. The invasion of alien marine species is a big threat to each county in Mediterranean Basin. Accordingly, countries should develop strategies and policies to reduce the population of these species in their marines.

Table 5.
Key elements representing Pufferfish and Lionfish among Turkish Marines

Elements	Pufferfish	Lionfish
Possibility of use as a food nutrient	Lower	Higher
Danger level	Higher	Lower
Threats for people as being an aggressive species	Higher	Lower
Its priority in sustainability policies and its place in the struggle	Higher	Lower
Degree of awareness and observation by the public	Higher	Lower
Alternative usage	Higher	Lower

Source(s): Created by authors



Source(s): Created by authors

Figure 4.
Ways to fight against pufferfish and lionfish

When considering the importance of marine economics in Mediterranean Basin, seafood security and seafood sustainability are all important issues that cannot be ignored.

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