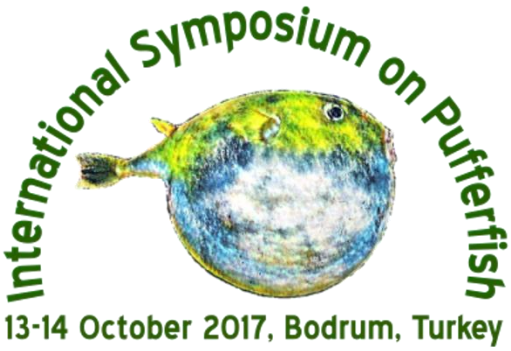


International Symposium on Pufferfish

13-14 October 2017, Bodrum, Turkey

# Symposium and Panel Summary Report

**Drafted by Ross Shotton and Symposium Chairs C. Turan and V. Ünal**

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- An international symposium and the panel as part of the symposium addressed the issues arising from the invasion and proliferation of puffer fish, especially *Lagocephalus sceleratus* in the Eastern Mediterranean including consequences of its extreme toxicity; its destructive effects on the fishing industry and, perhaps because so little is known, the consequences of this species on the wider marine ecosystem.

- The panel, chaired by Dr. C. Turan and Dr. V. Ünal, and consisting of panelists from institutions in 7 Mediterranean countries (Turkey, Greece, Croatia, Egypt, Lebanon, Israel, North Cyprus), 1 from the Far East (Japan), 1 from Finland and 1 from New Zealand. discussed how to deal with the ecological issue of pufferfish. Dr. R. Shotton was nominated as panel rapporteur.

- It was agreed that it will not be possible to eliminate this species from the Mediterranean, rather only its effects can be mitigated.

- A number of mitigation options were examined – all were problematic in one way or another.

- It was agreed that the situation with *L. sceleratus* can be described as an unfolding ecological catastrophe that may spread beyond the Mediterranean Sea.

- All agreed that none of the large number of international and national institutions with a mandate for addressing problems in the marine ecology of the Mediterranean had taken appropriate action to address the current crisis.

It was noted that it is imperative that an immediate, collaborative and regional approach to addressing the existing and growing problems (not only marine ecosystem based problems but also socio-economic problems related to the fishery related to the explosion in numbers and biomass of this invasive species is urgently needed).

***The Symposium***

This symposium addressed issues relating to the current crisis arising from the explosion in pufferfish populations in the Eastern Mediterranean and was attended by around 70 participants from Croatia, Cyprus, Greece, Egypt, Israel, Japan, Lebanon, Malta, New Zealand and Turkey. During the symposium, 30 oral presentation and 21 posters were presented (all abstracts and full text submitted manuscripts will be available online in a special supplement issue of the NESciences (http://nesciences.com/index.php?page=content) in December 2017). A panel reviewed the results of the conference.

The presentations provided information on all Tetradontidae species that inhabit the Eastern Mediterranean Sea, almost all of which are invasive having originally entered the area from the Red Sea as Lessepsian migrants through the Suez Canal. Of these species, the Silver Cheeked Toadfish, *Lagocephalus sceleratus* and yellow spotted puffer, *Torquigener flavimaculosus*, dominate this group and are by far the major source of the concerns that the conference was convened to address.

There was essentially unanimous agreement both on the nature of the threats that this extremely toxic fish poses and the current ecological situation that exists as a consequence of the rapid expansion, both areal and in terms of the biomass of the species that is present. A wide range of possible measures were discussed and it was agreed that there could be no confidence that any of these responses would resolve the problem. This summary focuses on the *Lagocephalus* problem though information on the other invasive species of pufferfish can be provided.

***The Situation***

First recorded in Turkey in 2003, by 2006 damage to fishing gear caused by *L. sceleratus* were being reported. At present this fish has extended its range through essentially all of the Mediterranean and has been reported from Algeria and Spain. *L. sceleratus* occurs in waters of a few meters depth to around 70 m, but its ecological impact will extend to far great depths through its impact on the environment. Biomass levels of *L. sceleratus* that reach 70% have been detected in some areas.

*L. sceleratus* concentrates an extremely deadly toxin – *tetradotoxin* (TTX) in its gonads, liver and intestines. There is no cure for tetradotoxin poisoning and every death are reported of people who have eaten improperly prepared fish. All countries ban the consumption of this species for self evident reasons, though despite this many people eat the fish especially in poorer countries.

***The Ecological Implications***

*L. sceleratus* has become a major member of the ichthyofauna wherever it occurs and in some regions it dominates biomass of fishes. By virtue of its powerful jaws and characteristic teeth structure of four solid incisor, it can easily crush and consume almost all species of benthos, which form part of its diet. It also predates on commercially valuable species such as octopus to the point that they no longer are present in the ecosystems in which they have characteristically been valuable

components. Apart from the effects of direct predation, by voracious predation on almost all benthic fauna, it results in a high degree of competition for food with all other benthic-feeding species.

Scientific judgment is that the ecological consequences of the explosion in *L. sceleratus* numbers should, with no risk of hyperbole, be considered an incipient ecological catastrophe that all evidence indicates will spread throughout the Mediterranean. Indeed, the continued expansion of the range of this fish will threaten the major octopus fisheries of the Nortwest African continental shelf of Morocco and possibly beyond.

***Implications for the Fishery***

*L. sceleratus* is destructive for the regional fisheries in several ways. First, it scavenges caught, but unretrieved, fish even to the point of pursuing and eating fish that have been hooked as they are being retrieved. It will scavenge fish that have been hooked through line fishing, often biting through the lines and also fish that have been caught but are still in the gill net. In doing so, it often causes significant damage to the gill nets entailing major repairs and soon requiring the gear to be discarded. When *L. sceleratus* is hooked, it is common for it to bite through the line and escape – *L. sceleratus* has been recorded with up to seven hooks in their stomach! It is difficult to overemphasize the costs to fishermen that the explosion in numbers of *L. sceleratus* has caused, through the reduction in catch, through damage to gear and through fishermen being forced to abandon traditional fishing grounds. These impacts occur in a range of Mediterranean countries.

Initial 'indicative' estimates of the direct costs to Turkish fishermen are of the order of €5 million/yr; a similar estimate would appear reasonable for Greece, so €10 million/yr is lost for just two Mediterranean countries. Of course, there will be similar costs to the fisheries sector in all of the other eastern Mediterranean countries. Such direct costs do not include losses arising from forgone catch revenues. Therefore, actual losses of fishers and the sector are much more than this rough estimated.

***Responding to the Problem***

The conference participants were in agreement that hopes for eradication of this species, by any means, are unrealistic. Rather, what must be attempted is to mitigate the consequences of the large increase in numbers of this species. How this might be done occupied much of the meeting's discussion. Among potential solutions considered were:

- Promoting the use of the toxin for pharmacological purposes – though it was noted that TTX can be synthesized more cheaply than sourcing it from natural sources
- Encouraging the consumption of the fish by processing them so as to remove the toxin-containing organs – but it was agreed that it was difficult to conceive that responsible departments would permit the sale of the food that will likely kill consumers who eat the improperly prepared product, e.g. seven deaths in Lebanon alone and many more, usually unrecorded in Egypt. In this case, a market-driven solution was envisaged.
- By using the fish as bait – but it would be in competition with other cheaply available products
- By targeted fishing, including the use of payment of a bounty for the capture of this species – though given the huge numbers of *L. sceleratus* now in the marine ecosystem it was difficult to conceive that funds would be available to ensure the success of such a program and that once funding stopped the problem would return. Another danger from targeted fishing would be mortality of commercially-valuable non-targeted bycatch species.

- By staging fishing competitions for recreational fishermen with prizes the most *L. sceleratus* that are caught – though the experience in Cyprus where this method has been undertaken is that the catch increased in every successive year that competitions were held.
- Constructing and designing fishing gears for pufferfish species to get more pufferfish catch and reduce economic losses through damage to gear.

***The Major Concerns of the Symposium Participants***

There was acute awareness among all participants about the lack of information concerning the dynamics of the relevant marine ecosystems and certainly, the lack of appropriate synthesis and evaluation of ecosystem information that is available. This concern was complemented by the awareness of the weakness, if not absence, of reliable data on the performance on the respective fisheries – inexplicably, a phenomenon of many years standing, despite its obligatory basis for effective fisheries management. One consequence of the absence of such data is the current inability to identify how the explosion of *L. sceleratus* numbers has changed the way in which the marine ecosystems function and the potential implications for marine fauna in other dependent trophic levels, from octopus through to the endangered charismatic fauna such as the Mediterranean monk seal. An initiative is urgently required to determine how to monitor ecosystem changes arising from the explosion of *L. sceleratus* and *Torquigener flavimaculosus* numbers.

While much has been done to examine and document levels of TTX in pufferfish, the consensus of the meeting was that more studies on TTX levels and factors that affect it are required. A note was also made that SDX, another toxin commonly found in pufferfish, may be a problem but not one for which attempts have been made to determine whether it is present. Analytical procedures need to be calibrated across the region if not standardized.

Participants stressed the urgent need for relevant Ministers and institutions with the mandate for fisheries and protection of the marine environment to cooperate across boundaries of management jurisdictions. The continuity of the marine environment is underscored by the spread and common, if not identical, elements of the damage being caused by *L. sceleratus*, through the ecosystem modification and competition for prey; damage to fishing gear and destruction through scavenging of hooked and gilled fish catch before it can be retrieved.

Participants noted that there was a wide range of institutions with either an explicit mandate to address issues related to the *L. sceleratus* crisis or related issues. These include agencies of the European Union (EU), the IUCN, WWF, UNEP through its regional seas programme, EastMed and environmental NGOs. Immediate efforts should be made to engage with these organizations while it was noted that delays are unavoidable in obtaining funds even though it was agreed that the issues should be addressed immediately, given that the problem existed now, and was not a possibility that may occur at some time in the future. The Working Group on Small Scale and Recreational Fisheries (WG-SSF-RF) of the GFCM is one organization with a Mediterranean-wide mandate and would appear to be the most appropriate institution to organize a regional approach to assessing the degree of the damage that is occurring to the region's fisheries, to fishermen in terms of increased costs, to forgone revenues from competition for prey and from ecosystem modification.

***Potential Mitigation of Ecological Impacts***

Funding to monitor the impact of ecological crises through the European Union can be requested through its Risk Assessment Programme, but participants noted that the issue now was not that of

risk of ecological losses – these are clearly happening and there was no element of uncertainty/risk in this regard.

The immediate challenge is to understand the ecological impacts of the explosion in pufferfish numbers, the economic and social impacts upon the fishing sector – these are widely reported and well known to those knowledgeable about the regions' fisheries. Such information is essential to quantify the changes that have occurred to usual benthic populations, e.g. octopods and crustaceans and to begin to experiment with ecological responses such as marine protected areas that are no-take zones where populations of top predators, especially sharks, which are known to eat pufferfish, may recover.

The continuing absence of reliable fisheries data in many of the countries of the region, not least several in the EU was stressed as a factor that is hampering understanding of the ecological dynamics of this invasion and change in ecosystem dynamics.

It was agreed that an urgent need exists for collaboration and provision of resources by the multitude of agencies and institutions that have a mandate for biological issues in the Mediterranean Sea and that currently, such institutions are, at this time, failing in this regard.

**Moderators:**
Cemal Turan, Iskenderun Technical University
Vahdet Ünal, Ege University

**Panelists:**
Ross Shotton, Southern Indian Ocean Deepsea Fishers Association
Shoichiro Ishizaki, Tokyo University
Argyro Zenetos, HCMR, Greece
Ramazan Çelebi, General Directorate of Fisheries and Aquaculture
Manal Nader, University of Balamand, Lebanon
Mehmet Baki Yokeş, AMBRD Laboratories
Fatih Özoğul, Çukurova University
Jakov Dulcic, Institute of Ocenography and Fisheries, Croatia

**Reporter:**
Ross Shotton, Southern Indian Ocean Deepsea Fishers Association

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