

Management in Practice

Public feedback on early warning initiatives undertaken for hazardous non-indigenous species: the case of *Lagocephalus sceleratus* from Italian and Maltese waters

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Abstract

The expansion of invasive non-indigenous species in the Mediterranean is generating an increasing concern about biodiversity protection and human health, with European countries being solicited to apply early warning measures in such circumstances. The recent expansion of the hazardous fish *Lagocephalus sceleratus* in the Straits of Sicily, the subsequent actions adopted to manage the risk and the feedback received from the public are herein presented, as an example of the interaction between experts and the public in promoting scientific citizenship through an ad hoc action. A rapid increase in media reports related to *L. sceleratus* had been registered after the launch of the early warning campaign as part of a scientific and health risk communication strategy, and seven new records of this species have emerged shortly after. This study represents a useful contribution to the further bridging of the science-policy gap.

Key words: science policy, health communication, scientific citizenship, science communication, risk communication, interaction experts / publics

Introduction

Biological invasions by non-indigenous species are considered as one of the main threats to biodiversity worldwide, affecting native species, habitats and ecosystems, socio-economic activities and human health, to such an extent that they are addressed in several International Conventions, Directives and Regulations (Genovesi et al. 2013). The European Union, through the Marine Strategy Framework Directive (MSFD) 2008/56/CE, considers alien species as one of the eleven descriptors of Good Environmental Status (GES) of European marine waters (Descriptor 2), whilst UNEP/MAP includes them among the Ecological Objectives of the Mediterranean Strategy EcAp (Ecosystem Approach). Paying particular attention to species hazardous to human health is a best practice strongly endorsed by the Convention on Biological Diversity (CBD) at the 12th meeting

of the Conference of the Parties (CoP) held in Pyeongchang (Republic of Korea) in October 2014, by EU Regulation n. 1143/2014 on the prevention and management of the introduction and spread of invasive alien species (IAS), by the International Union for Conservation of Nature (IUCN), and also by the IMO (International Maritime Organization) through its International Convention on Ballast Water Management. Despite a wealth of international agreements tackling invasive species, managing this complex environmental issue is dogged by a profound “theory-action” gap, whereby scientific knowledge is often poorly translated into action in the form of effective management strategies (Darling 2015 and literature contained therein).

In order to protect marine ecosystems and human health, the scientific community is currently engaged in the in-depth study of the biology of alien species and their invasion pathways. These studies can be

supplemented by developing an early warning communication strategy (EWCS) pursuant to promulgating the rapid detection, identification and risk assessment of introduced or undesired species, followed by the rapid alerting of the Authorities with intervention capabilities. The development of such an EWCS, which is an essential stage in the Early Detection and Rapid Response (EDRR) process, is also a crucial milestone to be reached if any integrated early warning system for alien species is to be effective. The realization of such a system has been proposed by the Italian working group for Descriptor 2 within the MSFD, in compliance with Article 10 of the Directive.

The need for the development of an EWCS is even more pressing due to the recent introduction of different marine toxic, venomous and poisonous alien species, which caused detrimental effects to human health, and even fatal intoxications in the most serious of cases (Bentur et al. 2008; Gweta et al. 2008; Tichadou et al. 2010). The most notorious examples of such negative effects caused by allochthonous species in the Mediterranean are those triggered by toxic microalgae (e.g. *Ostreopsis ovata* Fukuyo, 1981), stinging venomous organisms (e.g. the Atlantic siphonophore *Physalia physalis* (Linnaeus, 1758) as well as siganid and scorpaeniform fishes) and poisonous fishes (e.g. tetraodontid species) (De Donno et al. 2014; Kosker et al. 2016; Prieto et al. 2015; Tichadou et al. 2010 and literature therein). Within the latter group, the most well-known representative is the silver-cheeked toadfish *Lagocephalus sceleratus* (Gmelin, 1789) whose consumption by humans caused several cases of intoxication and even death, due to poisoning from tetrodotoxin (TTX) (see Kheifets et al. 2012 and literature therein; Nader et al. 2012). Based on the criteria used by the IUCN/GISP and endorsed by the SEBI2010 Working Group 5, the silver-cheeked toadfish is considered as one of the “worst” invaders of the Mediterranean Sea, exhibiting a well-documented impact and/or possessing the potential to cause serious negative impacts on biological diversity and socio-economy (Streftaris and Zenetos 2006). This species exhibited a remarkable westward expansion within the Basin ever since its first record at Golkova Bay (Turkey) in 2004 (Filiz and Er 2004). Its rapid and consistent colonisation of the Levantine Basin constituted a considerable threat to public health and to the fishery sector by damaging gear and preying on fish caught in nets and lines, as well as reducing local stocks of cephalopods through predation (Nader et al. 2012). In 2010, *L. sceleratus* reached the Straits of Sicily (Jribi and Bradai 2012), rapidly spreading along the Tunisian coast (Ben

Souissi et al. 2014). Such an exceptional and worrying spread of this hazardous species encouraged the Institute for Environmental Protection and Research (ISPRA) in 2012 to promote a first informative campaign for the southern Sicilian fishers operating within the Straits of Sicily, in order to alert fishermen about the possible implications of the capture of silver-cheeked toadfish individuals.

Given the recent geographical expansion of other Lessepsian species (i.e. *Fistularia commersonii* Rüppell, 1838, *Hemiramphus far* (Forsskål, 1775), *Siganus luridus* (Rüppell, 1829)) through the Sicily Straits (Azzurro et al. 2014a), the appearance of *L. sceleratus* in Italy and Malta was somehow expected. The “anticipated” arrival of the species triggered the implementation of some early warning measures, aimed to mitigate the hazard posed by this hazardous species for human health.

The aim of this manuscript is to present the measures that have been undertaken in Italy and in Malta to communicate the risk associated with the occurrence of *L. sceleratus*, and to document the public feedback these adaptive measures elicited.

Methods

Details of the awareness campaigns to manage the risk associated with the occurrence of *L. sceleratus* conducted by the competent governmental Institutions—ISPRA in Italy and the Department of Fisheries in Malta—were collated.

We also employed the engines “Google web” and “Google news” to run searches by year in order to assess the complete repository of online pages and publications related to *Lagocephalus sceleratus*.

Actions in Italy

The arrival of *Lagocephalus sceleratus* along the Tunisian coast in 2010 was first publicised by local papers online (e.g. babnet.net). As also highlighted by Ben Souissi et al. (2014), a series of anecdotal reports of the species, in the form of videos, articles and facebook posts, circulated online in 2011 and these are considered as additional evidence of the spread of this fish through the Sicily Straits.

Following these anecdotal reports—and in agreement with the paragraph 17.6a of the UNEP/CBD/COP 12 (2014) which encourages the use of social media as potential communication tools “to raise awareness of the risks associated with the introduction of invasive and potentially invasive alien species...”, ISPRA launched an informative campaign about the species, targeting the southern Sicilian fisheries. A fact sheet on *L. sceleratus*, containing

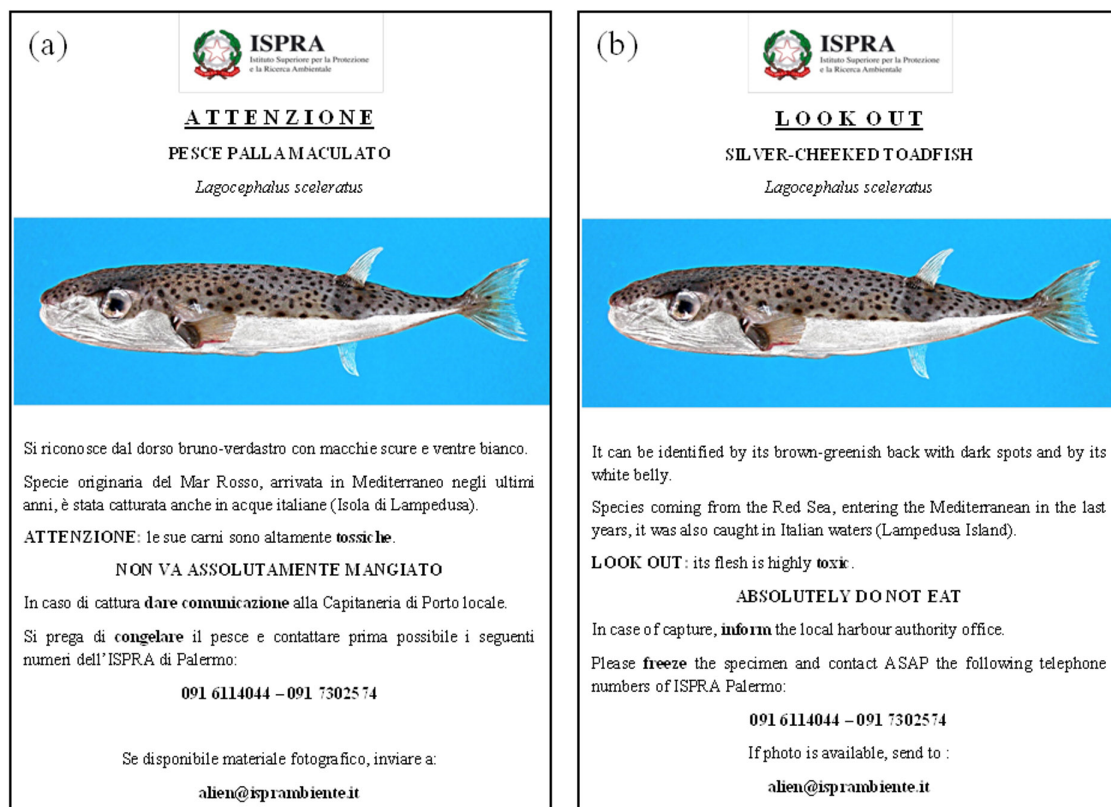


Figure 1. Ad hoc fact sheet alert for *Lagocephalus sceleratus*. (a) Italian version (b) English translation.

a photo of the species, distinctive characters, and contact data (phone numbers) through which to alert ISPRA scientists in case of capture, was distributed within three important fishing harbours of southern Sicily (i.e. Porto Palo di Menfi, Sciacca, Selinunte) in March 2012, as well as in local newspapers and television portals. This first campaign elicited only one report of the species, from a fisherman based in Sciacca, who declared to have caught one specimen in summer 2013 by longline and to have discarded it back into the sea (without taking photographs and therefore without any documentation of such an alleged capture), out of fear that this fish individual could have been hazardous to handle. The first documented record of *L. sceleratus* from Italian waters was made on the 7th October 2013 at Lampedusa Island (Azzurro et al. 2014b), which lies about 70 nautical miles from the nearest Tunisian outpost of Mahdia. One single specimen was caught by a local sport fisherman by line fishing and it was delivered to the staff of the Marine Protected Area of the Pelagian Islands, after alerting ISPRA researchers. Based on this documented capture, ISPRA researchers alerted local fishermen, informally through personal

contacts, about the potential entry of *L. sceleratus* in Sicilian waters and, on the 7th November 2013, ISPRA launched an official informative and educational campaign on the species. In order to avoid the species' infiltration within local fishing markets and its consumption by the public, a fact sheet (Figure 1) documenting the hazard that the species posed for human health was disseminated through email to local fishery associations as well as in a printed format which was delivered by hand to fishermen. A bulletin, reporting the catch of the abovementioned specimen, accompanied with the abovementioned fact sheet, was sent to the competent Authorities, both at the national (e.g. Ministry for Agricultural and Forestry Policies, Ministry of the Environment, Ministry for Health) and local (e.g. Sicilian Office for Territory and Environment, Sicilian Office for Health, Sicilian Office for Fishery) scale, who in turn further disseminated the alert to competent bodies (such as harbour offices, fish markets, national fishery associations) and to the media.

In 2013 and 2014, news related to this alert were published within different sectoral media portals (e.g. those focusing on human health, fishery, tourism,

Table 1. List of *Lagocephalus sceleratus* records collected before (*) and after the alert and official bulletin launched by ISPRA in 2013.

Date of record	Site	Coordinates	N° of specimens	Bottom depth	Method of capture	Habitat	Communicator / Gatherer	Reference
(*) 7 Oct 13	Lampedusa Island (Straits of Sicily)	35°29'49"N, 12°35'24"E	1	20 m	Line fishing	Sandy/seagrass bottom	Fisherman to MPA Pelagie Islands (first record in Italian waters)	Azzurro et al. 2014b
Nov 13	Lampedusa Island (Straits of Sicily)	35°30'N, 12°37'E	1	20 m	Line fishing	Sandy bottom	Fisherman to ISPRA Researchers	Azzurro et al. 2014b
22 Nov 13	Bari, (Adriatic Sea)		1		Trawl		Journalist to media	Published online
16 Dec 13	Scoglitti, (Straits of Sicily)	36°52'N, 14°22'E	1	~ 40 m	Trammel net	Sandy bottom	Fisherman to Harbour Office to ISPRA Researchers	unpublished
27 Dec 13	Lampedusa Island, (Straits of Sicily)	35°31'N, 12°39'E	2	~ 70 m	Line fishing	Rocky bottom	Fisherman to ISPRA Researchers	unpublished
27 Dec 13	Lampedusa Island, (Straits of Sicily)	35°31'N, 12°39'E	Shoal of about 80 specimens		Observed in water	Rocky bottom	Fisherman to ISPRA Researchers	unpublished
16 Jan 14	Avola, (Ionian Sea)	36°55'09.7"N, 15°10'42.4"E	1	15–20 m	Trammel net	Sandy bottom	Fisherman to local Researchers	Kapiris et al. 2014
4 Dec 14	Lampedusa Island (Straits of Sicily)	35°29'N, 12°36'E	1		Line fishing		Fisherman to ISPRA Researchers	unpublished

alimentary products, etc). The rapid surge of media reports related to *L. sceleratus* was apparent from the number of Italian news and web pages that rapidly increased after 2013 and peaked in 2014 (Figure 2). This peak was also apparent from the entire body of information available on the subject matter from the web, which abruptly increased after 2007, when *L. sceleratus* was firstly recorded in Greece (Corsini et al. 2006).

This broad dissemination of the risks associated with the occurrence of *L. sceleratus* led to the provision of a series of additional species records from Italian waters (see Table 1). In two out of seven cases, the caught specimens were photographed and preserved by the fishermen in question, as recommended in the alert fact sheet; one further record referred to an observation made directly in the water and not involving a capture; in two other cases, the caught specimens were thrown back into sea; one specimen photographed at a fish market was impossible to collect while another specimen, already skinned and eviscerated, was intercepted in time, avoiding its consumption.

Actions in Malta

The first documented capture of *L. sceleratus* from Maltese waters, dating back to the summer of 2014, attracted considerable media attention in the archipelago, with all TV and printed portals giving prominence to the event. The awareness-generation

approach adopted within the Maltese Islands differs considerably from that adopted in Italy, with the Department of Fisheries launching a more informal campaign with Maltese fishermen about the threat to public health posed by the same species. This approach is normally considered to be effective within the Maltese Islands by virtue of the small and close-knit typology of the fishers' communities on the islands, which numbers slightly more than 1,000 members. Amateur and sports fishermen were targeted through regular postings within ad hoc social media interest groups, such as "Spinning in Malta", "Sports Fishing News in Malta" and "Sustainable Fishing in Malta". Once the first documented capture of the species was publicised on Maltese media portals, a number of fishermen came forward claiming they had previously caught, on numerous occasions, the same species, as early as nine years ago in one particular case. Upon closer inspection of the photos provided by at least some of the same fishermen, however, it transpired that the specimens they were referring to actually belonged to *Sphoeroides pachygaster* (Müller and Troschel, 1848), the blunthead puffer, which has a circum-global distribution within tropical and temperate seas and which has been known from the Mediterranean since 1979 (Oliver 1981). This mis-identification could possibly confuse fishermen and fish consumers and underscores the need to promote a greater collaboration between fisheries scientists and fishermen networks. Yet again, there was no centralised response

taken in Malta in such a circumstance. In fact, no formal statement was issued by the Department of Fisheries in Malta to highlight such misidentifications, with individual marine biologists taking upon themselves the responsibility of approaching interested fishermen and journalists on a one-to-one basis.

Discussion

The on-going arrival of non-indigenous species in the Mediterranean Sea is a phenomenon of increasing concern and is mainly due to the introduction of species through the Suez Canal (Nunes et al. 2014). Some of these species may develop abundant populations and spread over large distances with serious consequences for the environment, the economy and, in some cases, even human health (Streftaris and Zenetos 2006; Katsanevakis et al. 2016). When these hazardous species are recorded, according to international recommendations (Regulation (EU) No 1143/2014; UNEP/CBD/COP 12 2014), the competent authorities should be prepared to identify the species at an early stage, to evaluate the associated risks and to activate appropriate management responses. This call has been made in numerous parts of the world subjected to the introduction of hazardous marine species, such as through the early warning weather-based system for the occurrence of Ciguatera Fish Poisoning (CFP) in the Pacific Ocean (e.g. Gingold et al. 2014).

In the last decade, the silver-cheeked toadfish has progressively expanded over different Mediterranean countries. Consequently, a number of governmental initiatives have been launched to rapidly disseminate information about the risks posed by this toxic invader.

This is, for instance, the case of Egypt, Turkey, Lebanon (Nader et al. 2012), Cyprus, Greece, (Pancucci-Papadopoulou et al. 2012), Tunisia (Ben Souissi et al. 2014) and Spain, with the latter country being the most recent to document the occurrence of *L. sceleratus* in its waters (Katsanevakis et al. 2014). Raising awareness about the risks associated with the consumption of hazardous species is one of the key actions aimed at mitigating the impacts of unwanted invaders (Nader et al. 2012) and to safeguard human health.

From the experience gained through the implementation of warning campaigns in Italy on the public health dangers of ingesting *Lagocephalus sceleratus* flesh, a number of points for further consideration, mainly dealing with the contents and approach of such a campaign and with the avenues of communication used, emerged. The alert message launched at a local scale (southern Sicily only) during the first campaign, immediately after the arrival of

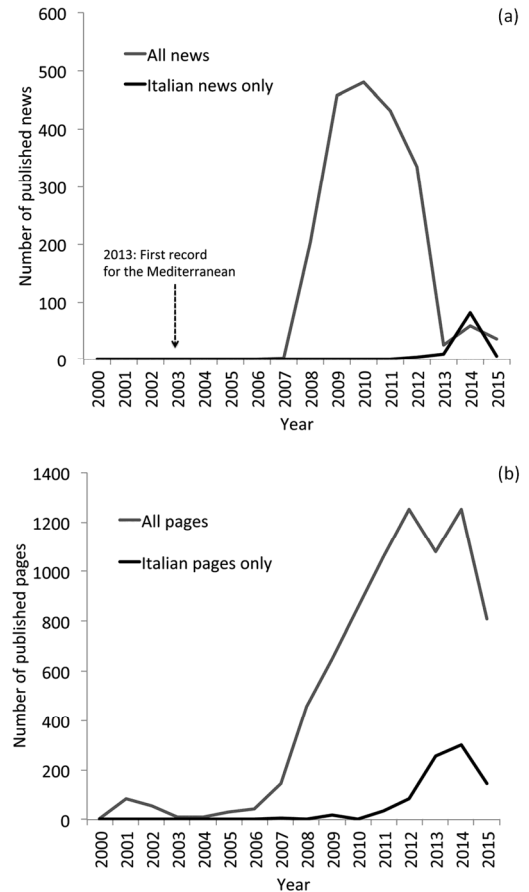


Figure 2. Number of published references per year retrieved under the key search word “*Lagocephalus sceleratus*” during the January 2000–June 2015 period. (a) number of published news items retrieved from the search engine “Google news”; (b) number of published news pages retrieved from the search engine “Google news”.

this species in Tunisian waters, received considerable attention by the local media portals, which contributed to its spread online and boasting, to date, more than 1,300 views. This isolated online news foray, however, had a very limited impact in terms of species reports, resulting in only one unverified record of the species from Sciacca. The same alert message was limited in its factual content, reporting the general toxicity of the species’ flesh without specifying that the danger resides solely in the ingestion of the flesh. This lack of specific detail induced the fisherman from Sciacca to discard immediately the entire fished specimen, out of fear of handling it and any subsequent health consequences. In the second campaign, launched at the national level after the first record of the arrival of the species in Sicilian waters (Lampedusa, October 2013), the alert message was revised so as to include

the recommendation that the fish should never be consumed. The bulletin disseminated by local entities responsible for the environment, public health and fishing, similarly received a lot of interest by the media, as testified by the high number of published news (peaking at 82 in the year 2014, Figure 2a) and web pages (peaking at 303 in the year 2014, Figure 2b) which spawned soon after its dissemination. This broad media campaign stimulated a spontaneous flow of information on *L. sceleratus*, increasing the communication among fishermen, citizens and professional researchers. This reasonably enhanced the probability of being informed about further captures of *L. sceleratus* along the Italian coasts, providing researchers with a new monitoring tool, whilst concurrently contributing towards avoiding species' consumption by fishermen and its penetration into the fish markets along with other local fare.

The publication in an English-language Maltese newspaper (Times of Malta) on the 18th of May 2015 of the first record of *L. sceleratus* from Maltese waters occurred only after the same record had been published within a peer-reviewed journal (Deidun et al. 2015), resulting in an interval of 10 months since the same individual was first caught in Malta in August 2014. This first media report in turn generated a flurry of subsequent media reports about the same species with different media portals, including TV news bulletins and online news pages. Interestingly enough, in one particular case, the front page of a newspaper reported a claim by a Maltese amateur fisherman that the same species had been caught a full nine years before. Photos supplied by the same fisherman and accompanying such an article, however, revealed that the species in question was not *L. sceleratus* but rather *Sphoeroides pachygaster*. This further highlights the need for scientists to better communicate their findings to stakeholders in the field, notably fishermen, and to media portals, in order to ensure that only evidence-based messages and recommendations reach the general public.

Conclusions

This first awareness campaign launched by ISPRA, resulted to be particularly effective in the period immediately following the awareness activities (up to three months after). The absence of records received by the public after this period may be related to a drop of the public alert. Therefore, we stress the urgency of reinforcing the communication strategy both at institutional and media level. Training activities should be also promoted involving fishermen associations and other categories operating in marine activities in order to make them aware of the problems

associated with the invasion of alien species. Finally, developing tools for the rapid submission of records, such as apps for mobile, may strengthen and speed up surveillance activities carried out by fishermen.

The differing responses of both Italy and Malta to the occurrence of *L. sceleratus* in their waters constitutes a first step towards the development of an appropriate early warning communication system aimed at mitigating the risks posed by this hazardous species. We revealed how these early warning activities have the potential to trigger appropriate feedbacks from the targeted community, whose contribution is essential to monitor the occurrence of these newcomers, especially during the first phases of their invasion. The further spread of *L. sceleratus* to other parts of the Mediterranean has prompted a similar adoption of such strategies by other national and regional authorities, such as the ones in Catalunya (Spain), after the first record of the species in these waters (Katsanevakis et al. 2014). The early warning communication strategies promoted within this study build further upon existing methods of participatory action research, such as citizen science, whose importance in detecting new marine arrivals is acknowledged within EU Regulation 1143/2014 (Regulation on Invasive Alien Species) and which has been applied with success in the field in unearthing such new arrivals (Azzurro et al. 2013; Crall et al. 2010; Delaney et al. 2008; Dickinson et al. 2010; Hourston et al. 2015). Considering the continuous expansion of the distribution range of *L. sceleratus* to other western Mediterranean regions and the danger that this species may entail for human health, it is strongly recommended that similar early warning initiatives are adopted by all Mediterranean countries in view of the transboundary nature of the issue, ideally under the aegis of the Barcelona Convention.

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