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Uncovering unmet demand and key insights for the invasive blue crab (*Callinectes sapidus*) market before and after the Italian outbreak: Implications for policymakers and industry stakeholders

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Abstract

In the summer of 2023, the Atlantic blue crab, *Callinectes sapidus*, experienced an unprecedented outbreak in the Northern Adriatic Sea, significantly impacting Italy's shellfish farming industry and generating widespread media attention. Given that commercially harvesting this edible species is recognized as one of the main strategies to manage its invasion, we conducted an extensive online survey to explore key aspects of *C. sapidus* market. The survey included questions on public awareness, market availability, consumer's acceptance, market prices and willingness to pay. We gathered responses from 2466 participants across Italy, between November 2022 and October 2023. To explore possible changes in public perceptions, we compared data from periods before and after the

media upsurge. Our findings underscore a rapid rise in public interest fueled by media coverage, coupled with a high favorable reception from Italian consumers, who positively assessed the blue crab's qualities. A notable mismatch between consumer interest and the current availability of *C. sapidus* in national markets was highlighted, suggesting the importance to address this major gap in the distribution chain of blue crab across all the Italian regions. By tapping into a highly impactful and readily available yet currently underutilized resource, significant economic potential can be unlocked. This approach should be considered while developing long-term adaptation strategies, ensuring sustainable harvesting practices and carefully assessing any potential challenge.

Introduction

The Atlantic blue crab, *Callinectes sapidus*, native to the western Atlantic Ocean, and introduced into Mediterranean waters in the mid-1900s, dramatically exploded in the Northern Adriatic, during the summer 2023, posing significant challenges to the local ecosystem and fisheries sector, particularly those operating in coastal lagoons and Po river delta. This sudden and unprecedented outbreak, not yet documented in scientific literature, garnered attention due to its severe impact on one of the most economically important farmed bivalves in Europe, which is the Manila clam *Ruditapes philippinarum* [36], a commercially important alien species, deliberately introduced into the Northern Adriatic in 1983 for economic purposes [12]. The Coldiretti (organization of agricultural entrepreneurs at national and European level) described the crabs' presence as a "natural calamity" which threatened the survival of 3000 family firms in the Po delta, and called for government support. According to Fedagri Pesca-Confcoop (fishers Confederation of Italian Cooperatives), the crabs have already caused economic damage estimated at around €100 millions in Italy. Further data on blue crab abundances and damage to production are currently scarce and so far, scattered in technical reports (e.g.

https://veneto.coldiretti.it/wp-content/uploads/2024/03/Dgr_165_24_AllegatoA_524424.pdf

↗

). The socio-economic implications of the blue crab outbreak, coupled with its potential as a novel food source, attracted widespread media attention across various platforms, making it one of the most widely reported stories in Italy's press, periodicals, television, and social networks. This phenomenon was reflected in online search results, where the Italian keyword 'granchio blu' returned over 4.16 million results in Google searches as of June 4th, 2024.

As a response to this invasion, political measures were taken by the Italian government in favor of consortia, aquaculture and fishing companies that provide capture and disposal of

blue crab. These mainly consisted in a first allocation of 2.9 million euros (Ministerial Decree No. 587931 on October 23, 2023) and then a further allocation of 10 million euros (Ministerial Decree No. 628456 on November 13, 2023) aimed at reimbursement of expenses incurred for 'clams sowing, repopulation and the purchase of fixed and mobile structures installed for the protection of farms. To the best of our knowledge, no incentives were offered to promote the consumption of the blue crab, even if *C. sapidus* was officially included in the list of commercial species [Integrazione al decreto 22 settembre 2017, concernente: Denominazioni in lingua italiana delle specie ittiche di interesse commerciale, specie *Callinectes sapidus*, Granchio Blu. 24A00348 (GU Serie Generale n.21 del 26-01-2024)]. *C. sapidus*, is a highly valued species in the Western Atlantic being the most widely harvested and consumed crab in the US. The Chesapeake Bay is particularly important, with a large and intense fishery that accounts for over one-third of all US commercial blue crab landings [38], [40]. The same name of this species comes from the Latin word *sapidus*, which means "savory" or "tasty" and, not surprisingly, *C. sapidus* can be considered as one of the emblematic cases of 'edible invasions' [35]. This invasive species has gradually expanded its distribution in the Mediterranean Sea and neighboring areas [33]. In recent decades, it has become ubiquitous all over the Mediterranean, and although population outbreaks have been sparsely documented, they have occurred in several countries, including Albania [39], [7], Algeria [28], Egypt [37], Greece [27], [29], Montenegro [44], Morocco [56], Spain, [15], [22] and Turkey [43], [8]. Noteworthy, before the Northern Adriatic outbreak, occurrences of *C. sapidus* were often reported in Italy and an intense fishery existed in the Lagoon of Lesina (Apulia, southern Adriatic coasts), where this species was already appreciated as a popular seafood item [14], [16], [2], [58].

Globally, invasion rates are showing no signs of saturation [50], with increasing threats to ecosystem services [53] and massive implications for the global economy. The IPBES Global Assessment Report on Biodiversity and Ecosystem Services, recently estimated the global annual costs of IAS to exceed US\$423 billion [26]. According to this report, the vast majority of these economical losses is related to the impacts that these species have on nature's contributions to people or on good quality of life, while only 8% of these costs is devoted to the management of invasive alien species (IAS).

A recurring strategy to control invasive populations and compensate for related economic losses is harvesting these species for human consumption [1], [25], [49]. GFCM (General Fisheries Commission for the Mediterranean) listed the creation of adaptation strategies to cope with the potential effects of invasive species on fisheries as target outputs of the mid-term strategy (2017–2020) [20]. Specifically, GFCM recommended (recomm. GFCM/42/2018/7) and finally established a regional research program on the invasive blue

crabs *C. sapidus* and *Portunus segnis*, in order to ‘properly evaluate their population status and maintain sustainable fisheries’. This program, which involves 13 Mediterranean Countries (Algeria, Croatia, Cyprus, Egypt, France, Greece, Italy, Montenegro, Morocco, Slovenia, Spain, Tunisia, Türkiye), clearly recognizes that: ‘*Stakeholders now agree that this is the only way to both control their expansion and create new market opportunities for the fishers, where previously the crabs only had negative effects on the sector*’ (<https://www.fao.org/gfcm/researchprogramme-bluecrabs/en/> ↗). Indeed, invasive bluecrabs support important fisheries along several Mediterranean countries [35] and an increasing number of studies have highlighted the high nutritional qualities of their meat (e.g [30]). Furthermore, some national enterprises have spontaneously begun to commercialize Italian blue crabs both domestically and internationally (e.g. <https://www.blueat.eu> ↗).

This study sought to develop a socio-economic understanding of the blue crab invasion in Italy and explore consumer perceptions toward the blue crab as a food product, their awareness and willingness to pay. Additionally, we analyzed potential shifts in relevant indicators following its media prominence. Recognizing the pivotal role of public opinion in shaping decision-making frameworks and supporting management strategies for marine invaders [57], our anticipation was to gather valuable insights for the effective management of this invasive species in Italy.

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Section snippets

Questionnaire administration

Data was collected through an online questionnaire, built using Google Forms tool (<https://forms.gle/o5STU6ynX2o2ztP86> ↗) and disseminated through various social media platforms, and especially on a great variety of Facebook groups to engage the maximum number of citizens all over Italy. Considering that some of these groups were related to fishing subjects, we added a specific question (Q27) to assess the percentage of people involved in fishing-related activities.

Participation in the survey was ...

Description of the sample according to the period before and after the media surge

A total of 2466 individuals participated in the online survey conducted between November 2022 and October 2023, covering a span of 49 weeks (Fig. 1). According to the analysis of *Google Trend* searches, a significant breakpoint was identified on August 7, 2023. This date is here employed to distinguish between the periods before and after the media surge related to the blue crab in Italy, herein referred to as 'pre-boom' and 'post-boom'. The pre-boom period extends from November 12, 2022, to...

Discussion

Engaging Italian consumers in investigating aspects of the *C. sapidus* market was expected to be particularly informative, given the recent and notable outbreak of this invasive species in the north-western Adriatic. While the survey, mainly operated online through social networks, is not immune to possible biases [3], this methodology allowed to engage a high number of Italian consumers to report their perceptions and information related to the blue crab. To our knowledge, such investigations...

Ethical statement

Data collection was confidential, as interviewers did not record any sensitive personal information about respondents. At the beginning of the interview, respondents were informed about the purposes of the study and gave informed consensus to use the provided information for scientific purposes. The authors declare that there is no conflict of interests in this work....

CRedit authorship contribution statement

Gian Marco Luna: Supervision, Funding acquisition. **Rocco De marco:** Software, Methodology, Data curation. **Marina Chiappi:** Methodology, Data curation. **Sara Bonanomi:** Data curation. **Andrea Bonifazi:** Investigation. **Francesco Tiralongo:** Investigation, Data curation. **Stefano Guicciardi:** Methodology, Formal analysis. **Matilde Cella:** Methodology, Formal analysis, Data curation. **Ernesto Azzurro:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Data curation,...

Credit authorship contribution statement

EA, PS, RM: Conceptualization of the study and development of the sampling methodology; EA, PS, AB, FT, MCh, MCE: Survey dissemination; MCh, SB Data curation; SG, MCE, MCh Statistical analyses; SG, SB, EA Results; EA writing, with contributions of all coauthors...

Declaration of Competing Interest

Here we declare that our work has not been published previously and that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder....

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