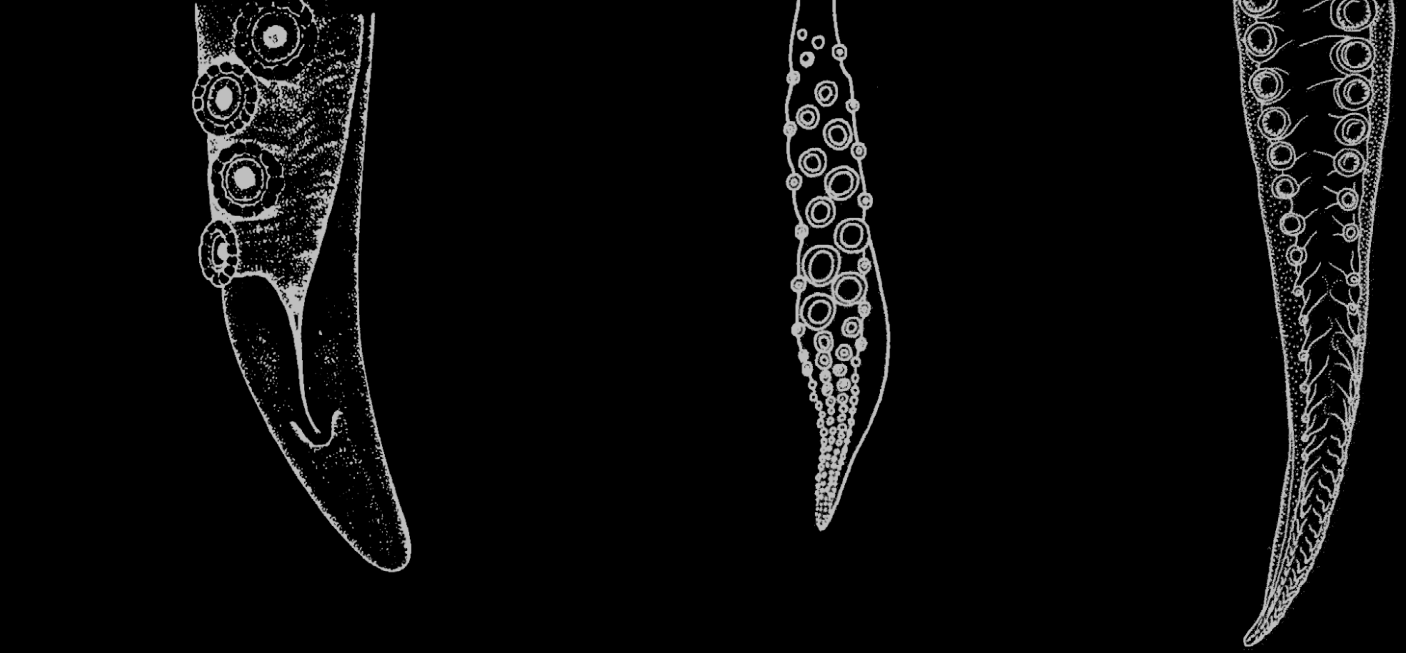
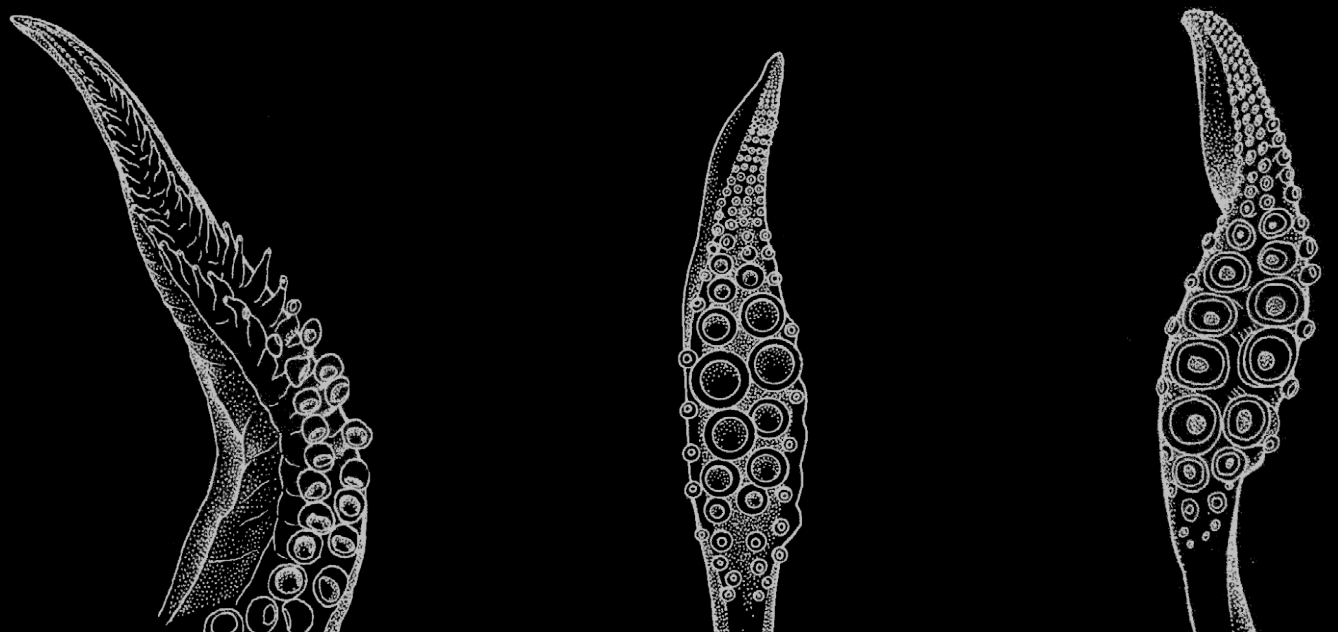


Cephs & Chefs

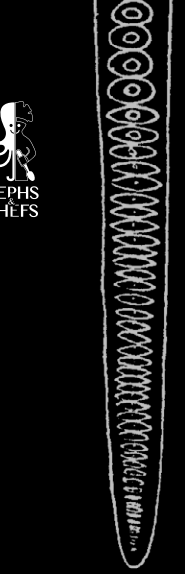
A POLICY BRIEF

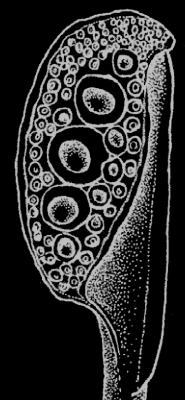


Interreg Atlantic Area
European Regional Development Fund

EUROPEAN UNION

CEPHS & CHEFS

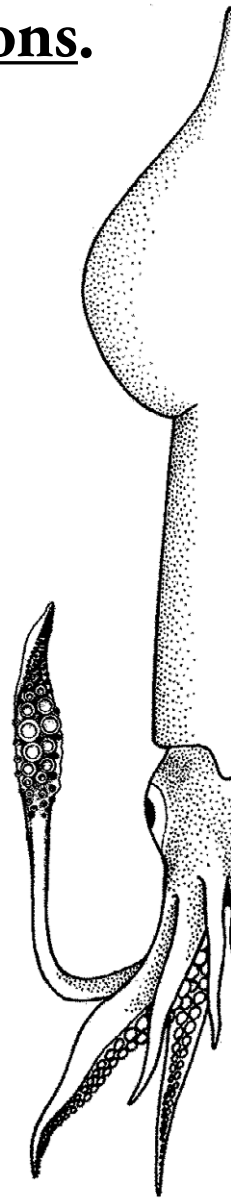




In this policy brief we examine 10 important current issues affecting cephalopods and we propose possible solutions.

Nowadays "sustainable fishing" is a familiar concept. It has evolved in recent years to move beyond "Maximum Sustainable Yield", encompassing the environmental impacts of fishing, the social and economic dimensions of fishing, and to follow seafood through the value chain, from sea to plate (i.e. to incorporate traceability). However, there is no "one size fits all" solution to achieve sustainable fishing, because not all fish and shellfish are the same and because emerging seafood resources present novel challenges that require novel solutions. Octopus, squid, and cuttlefish are marine molluscs generally designated as cephalopods. In Europe, the most important cephalopod species are the common octopus (*Octopus vulgaris*) in the south, and the common cuttlefish (*Sepia officinalis*) in the north. Several species of squid, and two other octopuses are also landed. In recent years, global cephalopod landings have typically reached around 4 million tonnes annually but in Europe they have long been considered as minor resource species. Historically, their catches in commercial fisheries were sufficiently unimportant for cephalopods to be excluded from the European catch quota system. Although octopus, and to some extent squid and cuttlefish, have long been important fishery resources in southern Europe, they were mainly taken by small-scale fisheries in inshore waters and thus fell under national jurisdiction and not under the Common Fisheries Policy. However, cephalopod stocks in Europe are now under increasing pressure from both small-scale and large-scale fisheries. In southern Europe, it is economically essential to coastal communities that these resources are not overfished. In contrast, increasing interest in cephalopod products in northern Europe offers new opportunities, it also creates new risks to sustainability.

Overall, this document aims at providing a concise summary of scientific information that can help managers and policy-makers make informed decisions about the sustainability of cephalopod fisheries.



01

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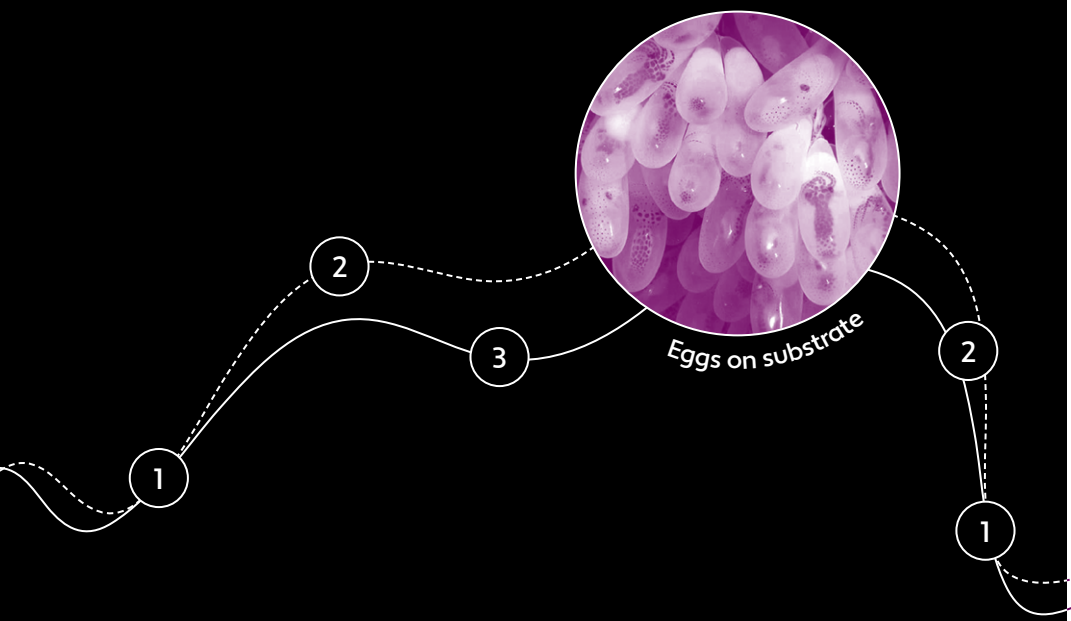

NATURAL HIGHS AND LOWS IN ABUNDANCE

One of the biggest challenges to sustainable cephalopod fisheries is the high natural variability in the abundance of these resources, reflecting their sensitivity to environmental change and their short life cycle (often only 1 year). This leads to large year-to-year differences in abundance, with years of plenty followed by very poor years. Examples include the "black gold rush" in the English Channel in 2017, when cuttlefish were unusually abundant, at least locally, and also the very low amount of *Octopus vulgaris* landed on the Spanish Atlantic coast in 2020.

Fishery forecasting tools are needed to provide advance notice of changes in cephalopod abundance. This is feasible given adequate monitoring, appropriate stock assessment and a good ecological understanding of how environmental change impacts the stocks and expertise in statistical and mathematical modelling. An adaptable and diverse value chain is needed to cope with unavoidable lean years.

Management of fishing effort would avoid overfishing, which is contributing to exacerbate the natural fluctuations in cephalopod abundance.

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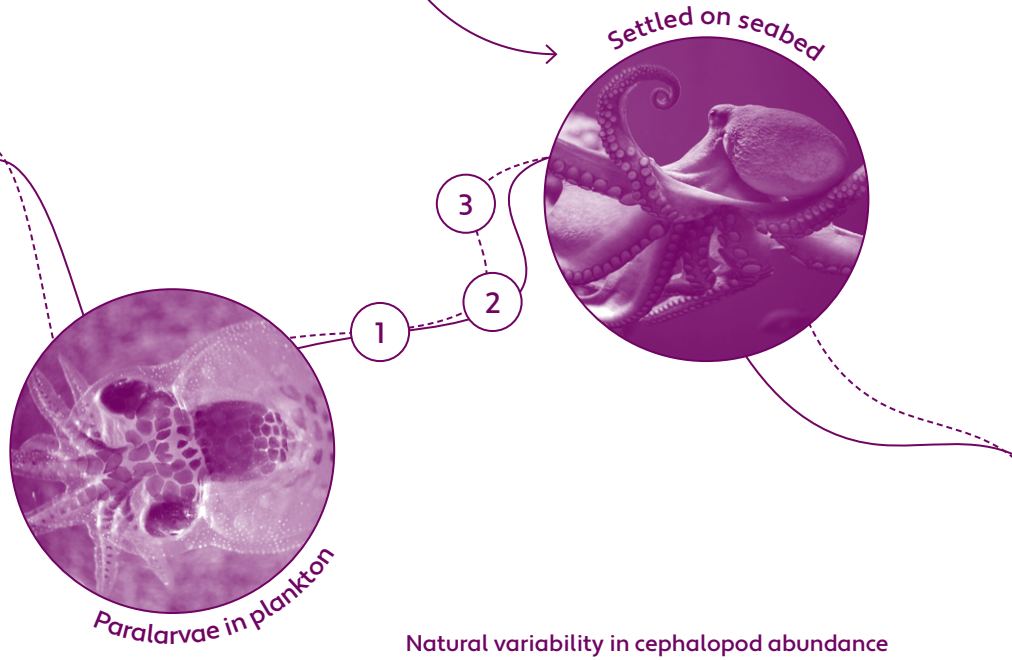


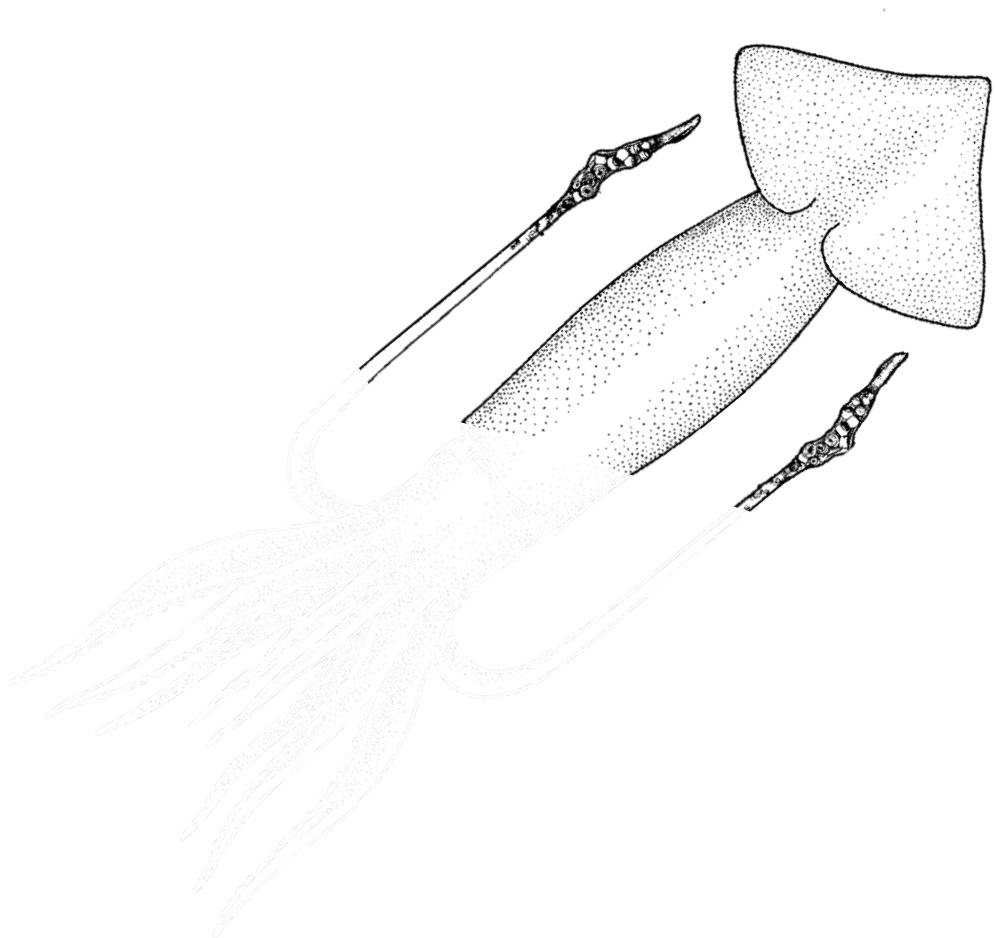
Natural variability in cephalopod abundance is conditioned by:

① internal regulation processes
② external environmental factors, including temperature, food availability, and predation (the latter two mostly on paralarvae)
③ fishing

02

click to jump 06

No unregulated fishing. Regulation of the amount and distribution of fishing effort informed by better monitoring of cephalopod abundance and spatial distribution. Also, the introduction of routine stock assessment and fishery forecasting would help minimize this problem. Protection of spawning areas would also help minimize the risk of stock collapse. A regional seas agreement, incorporating international waters as well as national exclusive economic zones (EEZs) and involving all interested fishing nations could help solve this issue.



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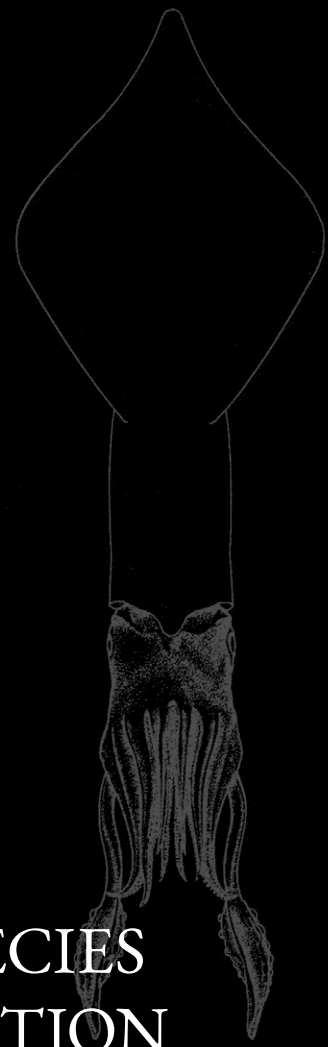
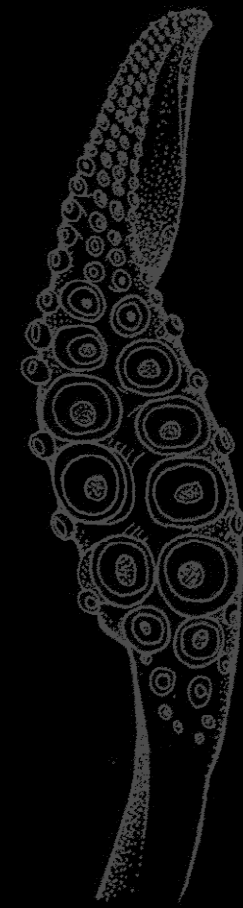


Loligo vulgaris



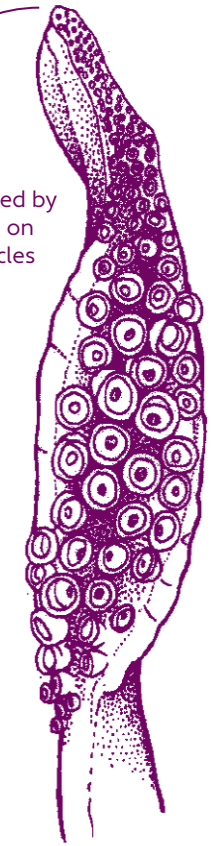
LACK OF SPECIES IDENTIFICATION

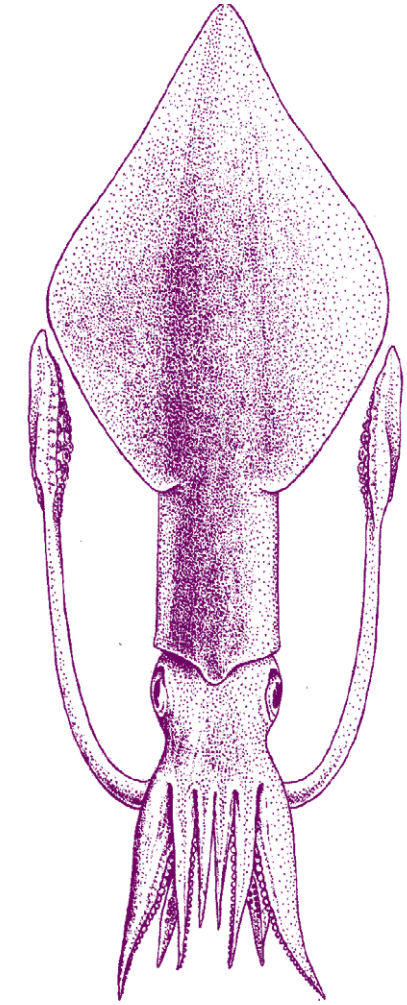
Cephalopod species are not always easy to identify, especially if damaged. Due to this lack of species identification, the already limited monitoring data are unsuitable to assess stock status (this is true for fishery landings data and also, at least until quite recently, catch data from trawling surveys). While some countries carry out limited market sampling to determine the proportion of different species in catches, such results cannot be extrapolated to other areas and time of year, as these proportions are likely to vary in space and time.

click to jump 04

Loligo forbesii

distinguished by the suckers on their tentacles





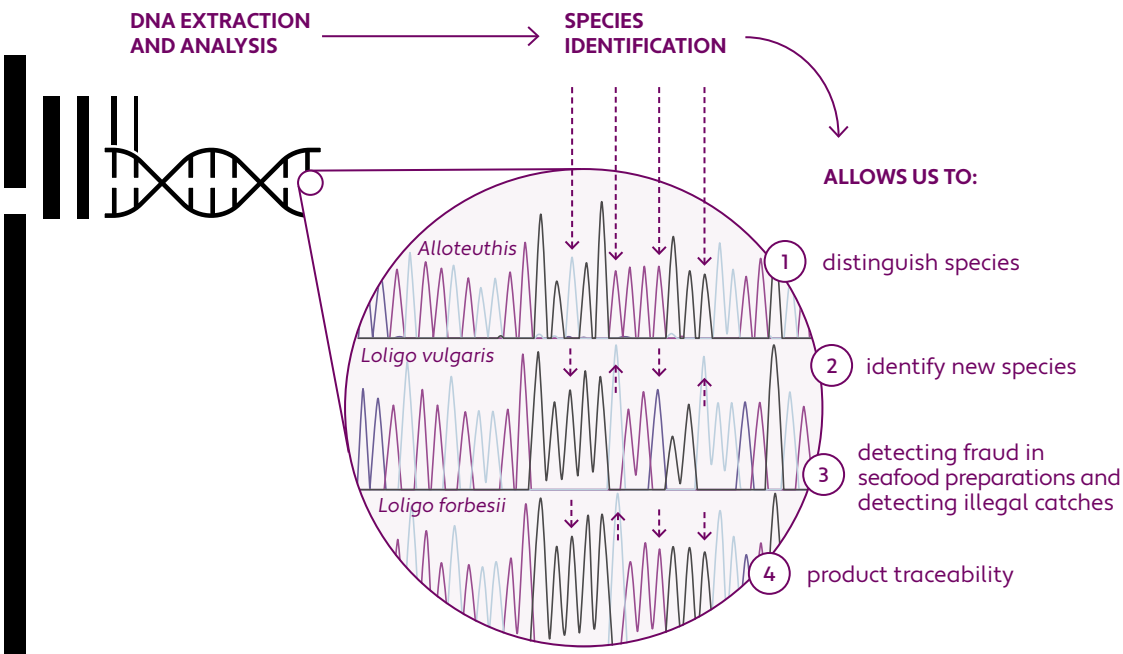
The Working Group on Cephalopod Fisheries and Life History from International Council for the Exploration of the Sea (ICES, WGCEPH) and the Centre for Environment, Fisheries and Aquaculture Science (UK Cefas) (among other organisations) have recently produced new and updated field guides for cephalopod identification (e.g. Laptikhovsky & Ouréns, 2017). Genetic barcoding can provide a rapid indication of identity. These methodologies are only useful however if coupled with sufficient regular sampling of catches to determine the proportions of the different species caught throughout Europe.

04

INADEQUATE STOCK IDENTIFICATION, MONITORING, AND ASSESSMENT

Although good fishery management requires a solid knowledge base, a combination of lack of interest and unusual biology has restricted the development and introduction of regular routine stock assessment. Currently, stocks are either not formally defined or their definition is based on arbitrary geographical boundaries. Routine fishery monitoring lacks the intensity needed for short-lived species and the use of fishery data for assessment is seriously undermined by inadequate species identification in catches. Moreover, relatively few standard stock assessment methods are suitable for cephalopods due to their short life cycles and highly variable growth rates (the latter meaning that length is not a reliable indicator of age).

Routine use of genetic barcoding and better training in identification, coupled with holistic (multi-method) studies of population spatial structure and ongoing monitoring of stock distributions could ensure adequate species identification and facilitate stock definition.



For squid, and to some extent cuttlefish and octopus, existing fishery surveys using trawls collect data on catches, which can help reveal changes in abundance as well as shifts in distribution and phenology, for example related to environmental variation and climate change. Routine monitoring of commercial fishery catches, including sampling of biological data, on a (preferably) weekly or (at least) monthly basis during the period leading up to and including the main fishing season, would permit in-season real-time assessment of stock status. Depletion methods of stock assessment have been successfully applied in the southwest Atlantic and in the Spanish (Asturias) octopus fishery.

01 click to jump

05

ABSENCE OF SUITABLE MANAGEMENT MEASURES

Traps

In European waters, catching cephalopods in large-scale fisheries is essentially unregulated. Because they are often not the target species, catching cephalopods is controlled only indirectly, e.g. via restrictions on the types of fishing gear that can be deployed and the catch quotas issued for non-cephalopod species. When large-scale fisheries in Europe target cephalopods there are no catch limits. In fact, fishing regulations may even be relaxed when fishers target cephalopods: e.g. trawl fishers who declare that they are targeting squid are allowed to use a smaller-sized mesh on their nets. In small-scale fisheries targeting cephalopods, especially in southern Europe, regulatory restrictions on fishing activity are numerous but few regulations are targeted at maintaining the status of cephalopod stocks - and these regulations are not always followed. As a specific example, the number of octopus pots in the sea in Portuguese coastal waters is thought to vastly exceed the permitted number.

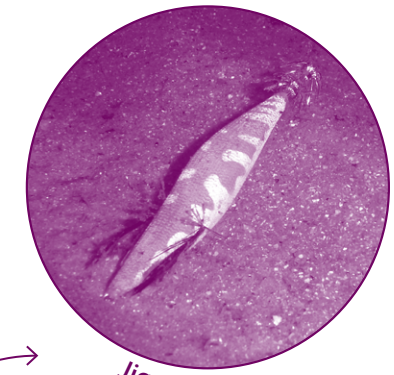
Additional issues applying to cephalopod catches in most fisheries include:

- the lack of monitoring and assessment, which if carried out could facilitate informed management actions
- the logistic difficulties of protecting "minor" species in mixed fisheries
- biological knowledge gaps, notably about locations of spawning areas
- uncertainty about the suitability of existing minimum landing size limits: in octopus, small animals caught in pots and returned to the sea will likely survive but trawl-caught cephalopods are usually damaged and might not survive release.

Pots

click to jump 06

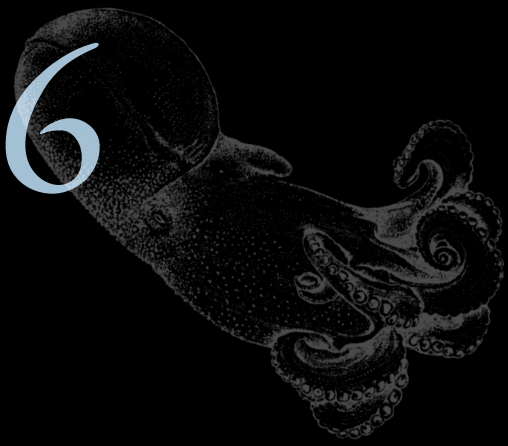
Evidently, adequate monitoring and assessment would be useful and would permit sensible decisions about effort or catch limits in directed cephalopod fisheries. For cuttlefish and loliginid squid, protecting the spawning grounds during the spawning season would help ensure recruitment to the next generation.



Jigs

More selective gears, which cause less damage to individual cephalopods and the habitat, could also offer multiple benefits including lower bycatch of finfish, better survival of released animals, and increased value of catches.

06



ENVIRONMENTAL IMPACT OF CEPHALOPOD FISHING

Fishing for cephalopods has several adverse environmental impacts. Bottom trawling for squid, like all use of bottom trawls, causes damage to the seabed habitat. Bycatch of fish in directed trawling for squid appears to be quite low; however, whiting has been caught in large amounts by trawlers fishing for squid in the UK. Traps (including those set for cuttlefish) and bottom set nets cause egg mortality in squid and cuttlefish due to their habit of attaching their egg masses to fixed objects on or near the seabed. In one study in the Mediterranean, traps deployed by just 15 fishers destroyed around 3 million cuttlefish eggs. In addition, contact with fishing nets damages the skin of cephalopods caught in them, reducing their chances of survival, if released alive and their value, if landed.

05 click to jump

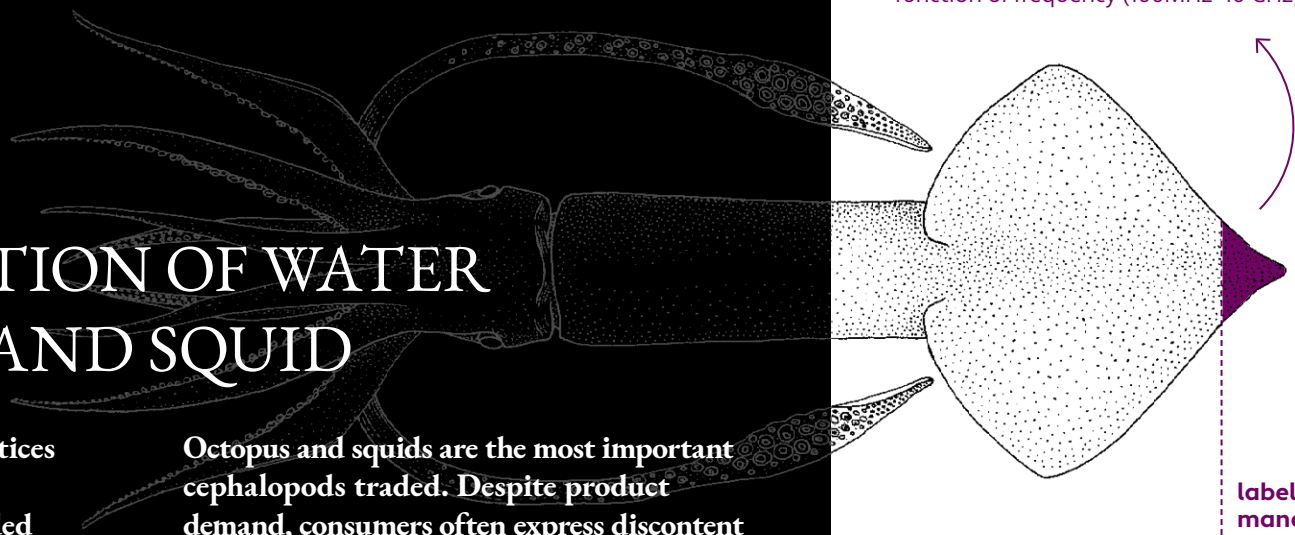
In principle, trawling for squid could be replaced by jigging, which is more selective and less damaging to the squid caught. Although commercial jigging vessels elsewhere in the world mainly target ommastrephid squid, jigging might also be used for loliginid squid. Certainly, hand jigs are commonly used to catch loliginid squid in small-scale and recreational fisheries in southern Europe. Providing artificial substrates for egg-laying, inside or in the vicinity of fishing gear, to which squid and cuttlefish can attach their eggs, may significantly reduce egg mortality due to eggs laid on the gear.

In a study in the Mediterranean, placing removable ropes inside cuttlefish traps, to which the cuttlefish attached some of their eggs, permitted recovery of around

24% **of eggs laid in/ on the traps.**

07

FRAUD: ADDITION OF WATER TO OCTOPUS AND SQUID



Seafood is often the target of practices that may affect product integrity, especially in species with high added value. One example of these practices is the abusive and non-reported water addition to compensate for moisture losses or to add weight. In the European Union, the labelling rules that enacted the mandatory Quantitative Ingredients Declaration enable consumers to get comprehensive information about the content and composition of food products for an informed choice while purchasing foodstuffs. In the case of seafood, the amount of added water must be included in the label of fishery products and prepared fishery products, sold either sectioned or whole. Therefore, consumers do not expect to find an amount of water in the purchased fishery product significantly higher than that stated in the label.

Octopus and squids are the most important cephalopods traded. Despite product demand, consumers often express discontent with the purchased product, in particular regarding the excessive reduction of weight/volume after cooking: it is common to end up with cooked octopus/squid reduced to less than half the purchased weight. Media and scientific reports concerning food fraud, and in particular seafood counterfeiting, have increased in recent years and diverse incidents to defraud the general public, restaurants, retailers, and other seafood businesses have been reported. Studies show that most cephalopod processors present in the Portuguese market, and possibly supplying other EU markets, have misleading practices that defraud the expectation of consumers, who are forced to buy octopus with high water content and see the product lose more weight while cooking.

The RFQ-Scan® system offers a means to detect added water. This system is based on the measurement of the product's dielectric properties in the microwave band as a function of frequency (100MHz–10 GHz).

labelling is mandatory if added water is more than

5%

of the weight of the finished product

A legal framework that regulates the practices aimed at the incorporation of water in cephalopods should be enforced together with the definition of a set of physicochemical reference parameters in the final product to control its quality and protect consumers.

08

HEALTH AND SAFETY RISKS RELATED TO CONSUMPTION

According to the European Union's Rapid Alert System for Food and Feed (RASFF Portal), risk notifications for cephalopod products include heavy metals, pathogens and parasites. Most notifications resulting in serious actions relate to visual inspections rather than laboratory analyses. There are also notifications due to fraudulent health certificates, illegal importation or unknown quantity of products.
Although most cephalopods caught in European waters are considered safe to eat, those caught in polluted sites present a risk and even low contamination levels can be hazardous to frequent consumers. Contaminants like heavy metals tend to be found in highest concentrations in the digestive gland (the cephalopod equivalent of the liver). This is also the part of the animal which accumulates most paralytic shellfish toxins. Contamination by bacterial pathogens can occur at various points throughout the supply chain. Parasites are problematic when edible parts are slightly cooked or consumed raw.
In addition, changes in climatic and/or environmental conditions facilitate migration into European waters of non-native cephalopod species for which we have no information on contaminant concentrations or parasite burdens.

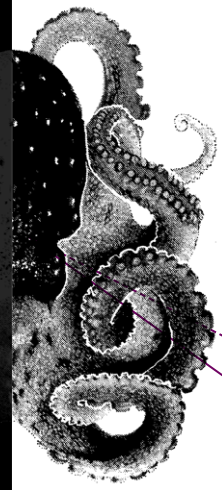
- **HEAVY METAL CONTAMINANTS** absorbed from the aquatic environment (e.g. cadmium, mercury)
- **BACTERIAL PATHOGENS** related to cold chain breach or cross-contamination (primarily *Salmonella enterica* and *Listeria monocytogenes*)
- **PARASITES** (primarily nematode species such as *Anisakis* spp.)

The generally small risk to consumers from heavy metals (e.g. cadmium) and other contaminants in cephalopod products can be further reduced by not eating the digestive gland or other viscera (i.e. the animals should be gutted prior to consumption). The number of nematodes present in cephalopods tends to be lower than in many marine fish but the risk of ingesting nematodes can be minimised by visual inspection prior to cooking, and adequate cooking should eliminate any risk of infection or allergic reaction to nematode proteins.
Ideally any health risks associated with seafood products should be monitored – and prevented – in the country of origin as a condition of access to EU markets, and the scope of EU risk assessment programs should be expanded to include a broader range of contaminants, pathogens and parasites among a wider range of cephalopod species. Finally, since new species migrating into European waters may not be listed in the food safety regulations, species lists should be regularly updated.

Seafood should always be purchased from a reputable source.

09

MARKET SHOCKS

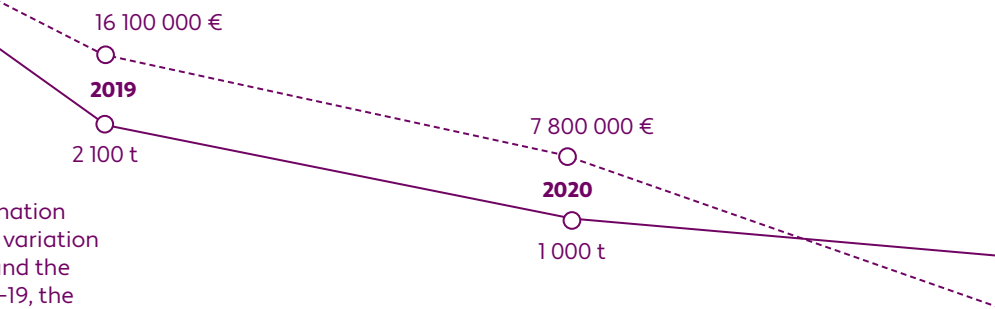


Currently, cephalopods account for around 2.5% of global combined fish and shellfish production, having increased in relative terms by 416% since 1961 to reach almost 4 million tonnes in 2013. East Asia and South America, led by China and Peru, respectively, have increased production the most, while Japan has seen the greatest decrease, halving production of cephalopods over the last 50 years (FAO, 2020). However, cephalopod fisheries are naturally volatile due to sensitivity to environmental conditions exacerbated by overfishing, especially in situations where catching cephalopods is unregulated, as is the case for most large-scale commercial fishing for cephalopods in Europe.

In addition to their negative impacts across many sectors of economic activity in Europe, both Brexit and the COVID-19 pandemic have negatively affected cephalopod trading. Southern European countries, Spain in particular, import fresh squid from the UK and Falkland Islands/Malvinas via well-established supply chains. Like many seafood imports from the UK, squid imports have been hit by severe delays since 31 December 2020 due to the new regulations imposed by Brexit. The cephalopod industry has also been significantly affected by the COVID-19 pandemic. Despite its designation as an essential service, there was a reduction in landings and fishing activity.

click to jump 02

In relation to the unpredictable variation of cephalopod abundance, forecasting may reduce unpredictability, but it will not affect the variability. Producers and the value chain need to diversify to cope with lean years. Avoiding overfishing and improving fisheries management (e.g. to set limits on catches or fishing effort in cephalopods fisheries and to achieve higher level of compliance) may also help reduce variability.



Due to the combination of environmental variation in Galician bays and the Impacts of COVID-19, the volume of landings of *Octopus vulgaris* in Galicia (Spain) suffered a 52% Reduction in 2020, and the value of landings also decreased by 51%.

From the market point of view, improving official trade statistics by increasing the level of disaggregation of species (facilitated by better identification of species) would help to identify changes in the balance of cephalopod supply/demand. Linked to cephalopod supply/demand is the issue of species/product traceability. The complexity of the trade flows, along with variations in (or lack of) labelling systems and official lists of seafood trade names in different countries, can make it difficult to accurately identify the origin of the raw material used in cephalopod products. Using DNA tests can help solve the traceability issue, especially in processed preparations where potentially identifiable anatomical features have been removed and mixed species are included, or in products that are made using more than one method. Health and safety concerns are also linked to connectivity and traceability of seafood products through the global trade network. All of the above demonstrates the importance of identifying the catch area on product labelling.

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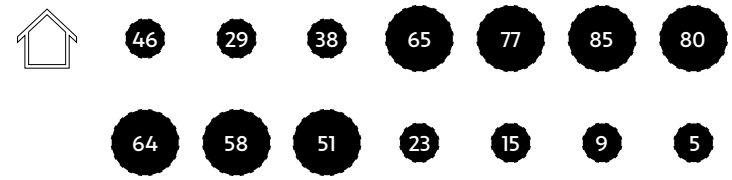

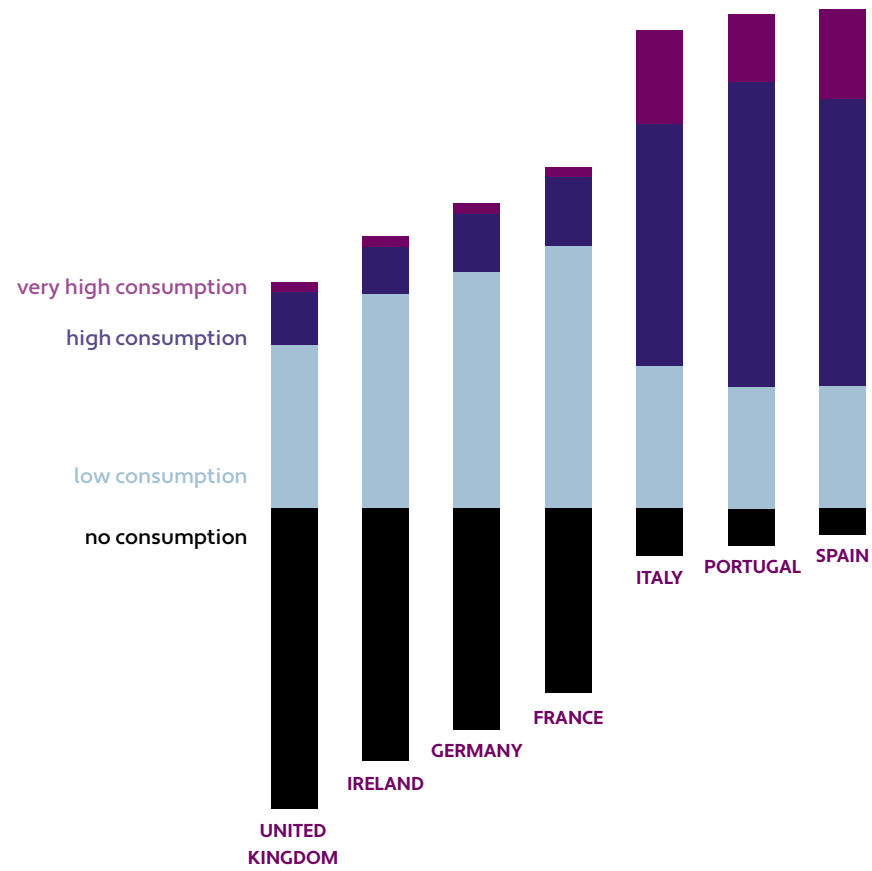

Frequency of consumption (%) of cephalopods in European countries.
While northern Europeans eat cephalopods more frequently abroad, in restaurants, southern Europeans eat them more frequently at home.

In northern European countries, campaigns directed at consumers and the education of chefs can be carried out to increase knowledge about cephalopods and how to cook them, and thus encourage their consumption. In southern European countries (namely Portugal and Spain), the development of new products, such as smoked octopus and cuttlefish, frozen cephalopods, and ready-to-eat cephalopod meals can be carried out to increase the value of cephalopods.
The establishment and promotion of events directed at consumption of cephalopods (e.g. food festivals) can also promote the species and inform the public about the socioeconomic importance of these fisheries.

08
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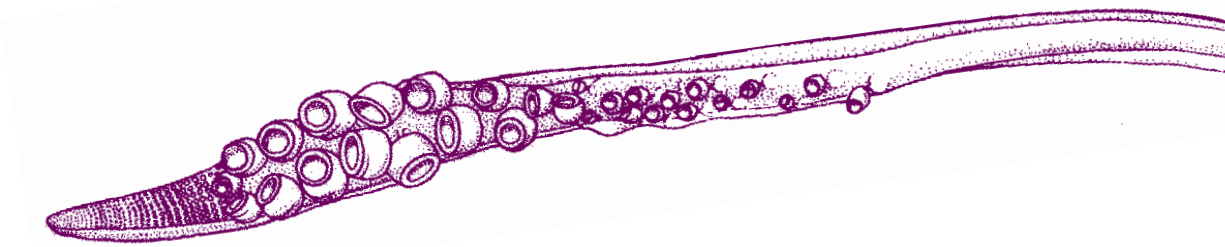

FURTHER READING

01. ABUNDANCE VARIATION / 02. STOCK COLLAPSE:
Doubleday et al. 2016, Global proliferation of cephalopods, https://doi.org/10.1016/j.cub.2016.04.002; ICES. 2020. Working Group on Cephalopod Fisheries and Life History (WGCEPH; outputs from 2019 meeting), http://doi.org/10.17895/ices.pub.6032.

03. SPECIES IDENTIFICATION:
Laptikhovsky and Ouréns 2017, Identification guide for shelf cephalopods in the UK waters (North Sea, the English Channel, Celtic and Irish Seas). Ver. 2, http://www.nmbaqcs.org/media/1717/cephalopod-guide-150917.pdf

04. STOCK ID, MONITORING, ASSESSMENT / 05. MANAGEMENT:
Arkhipkin et al. In Press, Stock assessment and management of cephalopods: advances and challenges for short-lived fishery resources, https://doi.org/10.1093/icesjms/fsaa038 ; Moustahfid et al. In Press, Ecological-fishery forecasting of squid stock dynamics under climate variability and change: Review, Challenges and Recommendations, https://doi.org/10.1080/23308249.2020.1864720 ; Pita et al. 2021, Fisheries for common octopus in Europe: socioeconomic importance and management, https://doi.org/10.1016/j.fishres.2020.105820 ; Sobrino et al. 2020, Abundance prediction and influence of environmental parameters in the abundance of Octopus (Octopus vulgaris Cuvier, 1797) in the Gulf of Cadiz, https://doi.org/10.1016/j.fishres.2019.105382

06. ENVIRONMENTAL IMPACT:
Melli et al. 2014, From trap to nursery. Mitigating the impact of an artisanal fishery on cuttlefish offspring, https://doi.org/10.1371/journal.pone.0090542

07. ILLEGAL PRACTICES:
Mendes et al. 2017, Water uptake and cooking losses in Octopus vulgaris during industrial and domestic processing, https://doi.org/10.1016/j.lwt.2016.11.087

08. HEALTH AND SAFETY:
Alves et al. 2018, Oral bioaccessibility of toxic and essential elements in raw and cooked commercial seafood species available in European markets, https://doi.org/10.1016/j.foodchem.2017.11.045 ; Ariano et al. 2019, Metal concentration in muscle and digestive gland of common octopus (Octopus vulgaris) from two coastal site in southern Tyrrhenian Sea (Italy), https://doi.org/10.3390/molecules24132401 ; D'Amico et al. 2018, Seafood products notifications in the EU Rapid Alert System for Food and Feed (RASFF) database: Data analysis during the period 2011–2015, https://doi.org/10.1016/j.foodcont.2018.06.018

09. MARKET SHOCKS / 10. MARKET OPPORTUNITIES:
FAO. 2021, The impact of COVID-19 on fisheries and aquaculture food systems, possible responses, https://doi.org/10.4060/cb2537en ; Love et al. 2020, Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system, https://doi.org/10.31235/osf.io/x8aew

GENERAL REFERENCES:
Jereb et al. 2015, Cephalopod biology and fisheries in Europe: II. Species Accounts, https://www.ices.dk/sites/pub/Publication%20Reports/Cooperative%20Research%20Report%20(CRR)/CRR325.pdf ; Lischenko et al. 2021, A review of recent studies on the life history and ecology of European cephalopods with emphasis on species with the greatest commercial fishery and culture potential, https://doi.org/10.1016/j.fishres.2020.105847

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Illustrations FAO Species Catalogue (Vol. 3), Cephalopods of The World: An Annotated and Illustrated Catalogue of Species of Interest to Fisheries

Photography Sam Levin, NOAA Photo Library, Morten Brekkevold (pág. 3), Isado, Saspotato (pág. 7), Nikita Tikhomirov (pág. 10)

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