

# Re-evaluation of certain aspects of the EFSA Scientific Opinion of April 2010 on risk assessment of parasites in fishery products, based on new scientific data. Part 2

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The declarations of interest of all scientific experts active in EFSA's work are available at <https://ess.efsa.europa.eu/doi/doiweb/doisearch>

## Abstract

The objective of this opinion was to determine if any wild caught fish species, originating from specific fishing grounds and consumed in the EU/EFTA could be considered free of zoonotic parasites. In this Opinion the term 'fishery products' only refers to fresh finfish. As there are multiple fish species and numerous potential parasites, *Anisakis* sp. was used as an indicator of zoonotic parasites in marine areas. This parasite species is particularly suited as it is common in marine environments, capable of infecting multiple fish species and is the subject of the majority of published studies. On the rare occasion where *Anisakis* sp. data were not available, or all tests were negative, other parasites such as *Contracaecum osculatum* (s.l.) and/or *Phocanema* spp. were considered. In freshwater systems, all zoonotic parasites were investigated. Consumption, import and landing data were used to determine the most relevant fish species and, where possible, the source fishing areas were identified. The most commonly consumed wild caught fish species in the EU/EFTA include tuna, cod, Alaskan pollock, hake, herring, sardines, mackerel, trout and saithe. Although the majority of these fish are caught in the Atlantic Ocean, the Mediterranean and the Black Sea (37) as well as several areas in the Indian Ocean, imported fish may originate from any global fishing areas, with the exception of Antarctica. Based on the data, at least one zoonotic parasite has been reported in at least one fish species in each of the FAO marine fishing areas. Thus, due to relative low fish host specificity of the zoonotic parasites, the panel concluded that all wild caught fish species may be exposed to and infected with zoonotic parasites. The same applies to freshwater fishing areas, with many areas having multiple studies reporting the presence of zoonotic parasites in the wild caught fish species.

## KEY WORDS

Anisakidae, epidemiology, finfish, fishery products, food safety, zoonotic parasites

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## SUMMARY

The objective of this opinion was to determine if any wild caught fish species, originating from specific fishing grounds, and consumed in the EU/EFTA could be considered free of zoonotic parasites. Fish, an important part of European diets, may be infected with parasites that cause disease in humans. These zoonotic parasites belong to the Nematoda, Trematoda and Cestoda taxa, and infect both farmed and wild caught fish. Relevant parasites in farmed fish are described in the previously published EFSA Scientific Opinion (Part 1) arising from the same EC Mandate. However, wild caught fish are exposed to a greater range of zoonotic parasites including species in the Acanthocephala and Myxozoa taxa, all of which are described in this opinion.

The 'EU fish market' report is a comprehensive analysis of the EU fisheries and the aquaculture industry made by the European Market Observatory for Fisheries and Aquaculture (EUMOFA). According to the report for 2023, the most consumed wild caught fish species in the EU include tuna, cod, Alaskan pollock, hake, herring, sardines, mackerel, trout and saithe. Overall, data from the EUMOFA database suggests that the most consumed species are salmon, gilthead bream, hake, cod and sardines, although this data does not distinguish between farmed and caught fish and it is likely that the majority of salmon and gilthead seabream are supplied by aquaculture.

According to Eurostat (2022) the main fish species caught by European fishing vessels in 2021 included skipjack tuna, yellowfin tuna, bigeye tuna, mackerel, cod, halibut, herring, blue whiting, hake, swordfish, blue sharks, anchovy and pilchards. The EU catch was 3.5 million tonnes by live weight and the main fishing areas were in the Atlantic and Indian Oceans as well as in the Mediterranean and the Black Sea, specifically the Atlantic northeast (FAO area 27) (70%), Atlantic northwest (FAO area 21) (1%), Atlantic southeast (FAO area 47) (1%), Atlantic southwest (FAO area 41) (4%), Atlantic eastern central (FAO area 34) (7%), Mediterranean and Black Sea (FAO area 37) (10%) and Indian ocean western (FAO areas 51, 57 & 58) (7%).

Fish is also imported and the main countries exporting finfish products into the EU, based on volumes in 2023, were Norway (EFTA country), China, Ecuador, Morocco and Iceland (EFTA country) while based on value were Norway, Morocco, China, Ecuador and United Kingdom (EU Fish Market 2023).

The FAO major fishing areas include freshwater and marine areas. The former includes African inland waters (area 01), North America inland waters (02), South America inland waters (03), Asia inland waters (04), Europe inland waters (05), Oceania inland waters (06) and Antarctica inland waters (08). The marine areas are divided as follows: Arctic ocean (18), Northwest Atlantic (21), Northeast Atlantic (27), Western Central Atlantic (31), Eastern Central Atlantic (34), Mediterranean & Black Sea (37), Southwest Atlantic (41), Southeast Atlantic (47), Atlantic Antarctic (48), Western Indian Ocean (51), Eastern Indian Ocean (57), Indian Ocean Antarctic (58), Northwest Pacific (61), Northeast Pacific (67), Western Central Pacific (71), Eastern Central Atlantic (77), Southwest Pacific (81), Southeast Pacific (87) and Pacific Antarctic (88).

*Anisakis* sp. were reported in multiple wild caught fish species in all FAO marine fishing areas except for Indian Ocean Antarctic (58). However, *Phocanema decipiens* (s.l.) and *Contracaecum osculatum* were detected in multiple fish species caught in this area. Many different zoonotic parasites including *Dibothriocephalus* spp., *Opisthorchis* spp., *Metorchis* spp., *Haplorchis* spp., *Centrocestus* spp., *Gnathostoma* spp., *Clonorchis* spp., *Metagonimus* spp., *Cryptocotyle* spp., *Cyathocotylid* spp. and *Holostephanus* spp. were found in multiple fish species from all freshwater fishing areas, except from Antarctica inland waters (8), for which data is missing, probably because there are few if any fish in Antarctica inland waters and none that are imported into the EU.

It was therefore concluded that there are no particular species of wild caught fish originating from specific marine or freshwater fishing grounds, where the fish consumed in the EU/EFTA can be considered to be free of parasites of public health importance.

## 1 | INTRODUCTION

### 1.1 | Background and Terms of Reference as provided by the requestor

In 2010 EFSA published a scientific opinion on risk assessment of parasites in fishery products.<sup>1</sup> EFSA was requested in particular to analyse three aspects:

1. Assessment of food safety concerns due to possible allergic reactions from parasites in fishery products;
2. Alternative treatments for killing viable parasites and comparison with freezing method;
3. Criteria for when fishing grounds (wild-farmed) fishery products do not present a health hazard (Atlantic salmon in particular). EFSA conclusions were taken into account for modifying part D of Annex III, Section VIII, Chapter III to Regulation (EC) No 853/2004 (Commission Regulation (EU) No 1276/2011).

In fact, part D of Annex III, Section VIII, Chapter III to Regulation (EC) No 853/2004 establishes that:

1. Food business operators placing on the market the following fishery products derived from finfish or cephalopod molluscs:
  - a. fishery products intended to be consumed raw; or
  - b. marinated, salted and any other treated fishery products, if the treatment is insufficient to kill the viable parasite; must ensure that the raw material or finished product undergo a freezing treatment in order to kill viable parasites that may be a risk to the health of the consumer.

The freezing treatment is not carried out for fishery products:

- a. that have undergone or are intended to undergo before consumption a heat treatment that kills the viable parasite. In the case of parasites other than trematodes the product is heated to a core temperature of 60°C or more for at least 1 min;
- b. that have been preserved as frozen fishery products for a sufficiently long period to kill the viable parasites;
- c. from wild catches, provided that: (i) there are epidemiological data available indicating that the fishing grounds of origin do not present a health hazard with regard to the presence of parasites; and (ii) the competent authority so authorises;
- d. derived from fish farming, cultured from embryos and have been fed exclusively on a diet that cannot contain viable parasites that present a health hazard, and one of the following requirements is complied with:
  - (i) have been exclusively reared in an environment that is free from viable parasites; or
  - (ii) the food business operator verifies through procedures, approved by the competent authority, that the fishery products do not represent a health hazard with regard to the presence of viable parasites.

Before placing on the market fishery products which have not undergone the freezing treatment or which are not intended to undergo before consumption a treatment that kills viable parasites that present a health hazard, a food business operator must ensure that the fishery products originate from a fishing ground or fish farming which complies with the specific conditions referred to in one of those points. This provision may be met by information in the commercial document or by any other information accompanying the fishery products.

The ParaFishControl is an EU H2020-funded project that aims at increasing the sustainability and competitiveness of the European aquaculture industry by improving our understanding of fish-parasite interactions and by developing innovative solutions and tools for the prevention, control and mitigation of the most harmful parasitic species affecting the main European farmed fish species. The project started in 2015 and finished in 2020 and was involving a consortium of 29 partners (public and private) from 13 countries. Research related to that project demonstrated in farmed seabass, farmed seabream, turbot, and sea caged rainbow trout that no zoonotic parasites were found, concluding that the risk related to zoonotic Anisakidae appeared as negligible. The authors suggested that there is groundwork for amending the current legislation.

Other studies demonstrated that farmed fish were found to be less infected in comparison with wild fish (2%) but not Anisakis free. Farmed fish is in general reported to be considerably less infected and therefore representing a very limited food safety risk, but guaranteeing nematode free fish remains impossible.

In addition, the EFSA 2010 Opinion concluded that “no sea fishing grounds can be considered free of *A. simplex* larvae”, and that “all wild caught seawater and freshwater fish must be considered at risk of containing viable parasites of human health hazard if these products are to be eaten raw or almost raw”. Furthermore, the BIOHAZ Panel recommended the collection of systematic data on the complete life cycle, geographical and seasonal distribution, prevalence, intensity, and anatomical location of parasites of public health importance in wild caught fishery products.

<sup>1</sup><https://efsa.onlinelibrary.wiley.com/doi/pdf/10.2903/j.efsa.2010.1543>

The European Union One Health 2020 Zoonoses report elaborated by EFSA and ECDC reports that in 2020, *Anisakis* caused two outbreaks, both reported by Spain, involving six individuals. No outbreaks were reported in 2019. The causative agent was not identified at the species level.

## TERMS OF REFERENCE

EFSA is asked to update certain aspects of its Scientific Opinion of April 2010 on risk assessment of parasites in fishery products based on any new scientific evidence that may have become available since then. In particular, EFSA is requested to review and assess:

1. The occurrence of parasites of public health importance in fishery products derived from the most relevant farmed fish species in the EU (in particular, but not limited to, Atlantic salmon, seabass, farmed seabream and turbot).
2. Diagnostic methods for the detection of parasites of public health importance in fishery products from such farmed fish species.
3. Technical developments and new scientific data available in relation to killing viable parasites of public health importance in fishery products, in particular treatments other than freezing.
4. Whether any particular species of wild caught fish originating from specific fishing grounds could be regarded as not representing a health hazard with regards to the presence of parasites of public health importance.

TORs 1–3 (Part 1) are addressed in EFSA BIOHAZ Panel (EFSA BIOHAZ Panel, 2024), while TOR 4 is addressed in this opinion (Part 2).

### 1.2 | Interpretation of the Terms of Reference

ToR 4 was translated into the following assessment question (AQ):

AQ4: Are there any particular species of wild caught fish originating from specific fishing grounds, where fish consumed in the EU/EFTA are caught, that are free of parasites of public health importance?

To answer AQ4, the following was clarified with the requestor:

- While the previous EFSA scientific opinion from 2010 (EFSA BIOHAZ Panel, 2010) is considered, this opinion focuses on information and data generated since then. Accordingly, the information/literature/data to be revised covered the period from 2010 (inclusive) to 2024.
- Allergies are not covered by the current assessment.
- The FAO<sup>2</sup> categorisation of fishing grounds is used in this opinion which includes marine, brackish and freshwater.
- Although the legal definition for 'fishery products' covers all marine water or freshwater animals (except for live bivalve molluscs, live echinoderms, live tunicates and live marine gastropods, and all mammals, reptiles and frogs) whether wild or farmed and including all edible forms, parts and products of such animals (EC 853/2004), for the purposes of this opinion only wild caught finfish species are covered. Moreover, only fresh fish were considered and frozen fish were excluded as freezing in an effective method for killing parasites.
- Only zoonotic parasites that infect finfish are considered. Parasites that do not naturally infect finfish but are found in contaminated waters (e.g. *Cryptosporidium*, *Giardia*, *Toxoplasma*, *Blastocystis*) and may be present in their gastrointestinal tract and subsequently cross-contaminating fish during processing, are excluded.

Most of the parasites considered in this opinion infect multiple fish species but exceptions exist. Thus, most fish species are considered susceptible to some extent. Therefore, it was considered that the presence of at least one parasite of public health importance, in at least one fish species, indicated that the fishing areas in which that fish was caught were not parasite-free and all fish species from that fishing area could potentially be infected with zoonotic parasites.

As the vast majority of studies to date in the marine environment have focused on *Anisakis*, this was used as an 'indicator' parasite and the focus of the literature search was to identify and review scientific papers that examined wild caught fish for this parasite. If detected, it was considered that all fish from the fishing ground where this parasite occurs, represented a hazard with regards to the presence of parasites of public health importance. If there was no record of occurrence of *Anisakis* in fish from a fishing ground or all tests were negative, other parasites, including *Contracaecum osculatum* (s.l.) and/or *Phocanema* sp. were then considered. If there were still no records of parasite detection, all of the parasites described in Section 1.3.2 were considered.

As the entire life cycles of zoonotic *Anisakis* are usually not completed in freshwater ecosystems, these parasites are not used as an indicator for the presence of zoonotic parasites in freshwater fishing areas. Instead, the literature search was extended to cover other zoonotic parasites in all fish species caught in freshwater areas (see Section 1.3.2, Table 1).

<sup>2</sup>FAO. FAO Major Fishing Areas. [Cited 1 November 2020]. <https://www.fao.org/fishery/en/area/search>.

## 1.3 | Additional information

### 1.3.1 | Update to EFSA BIOHAZ 2010 scientific opinion

In the previous BIOHAZ Panel opinion (EFSA BIOHAZ Panel, 2010) data on the prevalence of zoonotic parasites was provided for several species of wild caught fish. Given that all tested fish from various fishing grounds were found to be positive for *A. simplex*, it was concluded that no sea fishing grounds could be confirmed as parasite-free.

However, it is important to note that to the best of our knowledge there is currently only one long term (since 2006) fish-parasite surveillance programme in Europe.<sup>3</sup> This is in operation in Norway where commercially important pelagic fish species (Atlantic cod, tusk, blue whiting, herring and Atlantic mackerel) are routinely tested for *A. simplex*.

While climate change (primarily increasing surface water temperatures) is driving changes in the geographical distribution of specific parasites in marine ecosystems, changes in occurrence seem to be largely associated with changes in definitive host population abundance (Selstad Utaaker & Robertson, 2015; van Weelden et al., 2021). The impact of climate change on fish-borne parasites in freshwater systems appears to be more complex and, thus, more difficult to assess.

Some widely distributed fish-borne zoonotic parasites such as the trematode *Opisthorchis viverrini* and the cestode *Dibothriocephalus latus*, for example, are both characterised by a two intermediate host life cycle and may benefit from higher ambient water temperatures which enhances their transmission efficiency (Poulin, 2006; Wicht et al., 2009). However, long-lasting droughts and loss of wetlands, events expected to occur in many parts of the world, may result in reduced freshwater snail and fish population size and distribution. This too may lower the transmission rate of some important zoonotic trematode species (e.g. *O. viverrini*) to humans due to the reduced availability of freshwater fish as part of the daily diet in some regions of southern Asia (Marks, 2011).

There is also evidence that the increasing population of marine mammals in the Baltic Sea, due to conservation efforts protecting these animals, is positively correlated with an observed increase of anisakid infections of various fish stocks (Buchmann, 2023; Zuo et al., 2018).

### 1.3.2 | Parasites in wild caught fish

As reported in EFSA BIOHAZ Panel (2010), the zoonotic parasites of public health relevance in fishery products include species belonging to nematodes, trematodes and cestodes. Information on their life cycle and the distribution of the parasites in the fish body/muscles, was included in that scientific opinion. An update of the information currently available on the parasites infecting farmed fish tested in European waters is provided by the EFSA BIOHAZ Panel in (EFSA BIOHAZ Panel, 2024) including the nematodes Anisakidae. Other relevant species belonging to the acanthocephalan genus *Bolbosoma* (i.e. *B. capitatum* and *B. nipponicum*) and the genus *Corynosoma* (i.e. *C. villosum* and *C. validum*), as well as the relevant species of myxosporidian genus *Kudoa* (i.e. *K. septempunctata* and *K. hexapunctata*) are also described in that document. Parasites of public health to which wild fish are exposed are summarised in Table 1. Information on these parasites, if not already covered in part 1 of this opinion, is provided below.

**TABLE 1** Overview of the parasite species of public health importance found in wild caught fish.

Parasite phylum/class	Parasite family	Zoonotic parasite species
Nematoda/Chromadorea	Anisakidae	<i>Anisakis pegreffii</i>
		<i>Anisakis simplex</i> (s.s.)
		<i>Anisakis typica</i> sp. A
		<i>Anisakis typica</i> sp. B
		<i>Phocanema decipiens</i> (s.s.)
		<i>Phocanema krabbei</i>
		<i>Phocanema bulbosa</i>
		<i>Phocanema azarasi</i>
		<i>Phocanema cattani</i>
		<i>Phocanema decipiens</i> sp. E
		<i>Contracaecum osculatum</i> (s.s.)
		<i>Contracaecum osculatum</i> A
		<i>Contracaecum osculatum</i> B

<sup>3</sup><https://www.hi.no/en/hi/forskning/research-groups-1/fremmed-og-smittestoff-fres>

TABLE 1 (Continued)

Parasite phylum/class	Parasite family	Zoonotic parasite species	
Nematoda/Secernentea	Gnathostomatidae	<i>Gnathostoma spinigerum</i>	
		<i>Gnathostoma binucleatum</i>	
		<i>Gnathostoma hispidum</i>	
		<i>Gnathostoma doloresi</i>	
		<i>Gnathostoma nipponicum</i>	
Nematoda/Enoplea	Capillaridae	<i>Paracapillaria philippinensis</i>	
	Dioctophymatidae	<i>Dioctophyme renale</i> <i>Eustrongylides excisus</i>	
Platyhelminthes/Trematoda	Opisthorchiidae	<i>Opisthorchis viverrini</i>	
		<i>Opisthorchis felineus</i>	
		<i>Clonorchis sinensis</i>	
		<i>Amphimerus pseudofelineus</i>	
		<i>Metorchis conjunctus</i>	
		<i>Metorchis orientalis</i>	
		<i>Pseudamphistomum truncatum</i>	
		Heterophyidae	<i>Heterophyes heterophyes</i>
			<i>Heterophyes nocens</i>
			<i>Metagonimus yokogawai</i>
	<i>Metagonimus takahashii</i>		
	<i>Metagonimus miyatai</i>		
	<i>Centrocestus formosanus</i>		
	<i>Haplorchis taichui</i>		
	<i>Haplorchis pumilio</i>		
	<i>Haplorchis yokogawai</i>		
	<i>Pygidiopsis summa</i>		
	Clinostomidae	<i>Cryptocotyle lingua</i>	
		<i>Clinostomum complanatum</i>	
	Echinostomatidae	<i>Echinostoma hortense</i>	
<i>Echinochasmus perfoliatus</i>			
<i>Echinochasmus japonicus</i>			
<i>Echinochasmus liliputanus</i>			
<i>Echinochasmus fujianensis</i>			
Nanophyetidae	<i>Nanophyetus salmincola</i>		
Cyathocotylidae	<i>Paracoenogonimus ovatus</i>		
Platyhelminthes/Cestoda	Bothriocephalidae	<i>Dibothriocephalus latus</i>	
		<i>Dibothriocephalus dendriticus</i>	
		<i>Dibothriocephalus nihonkaiensis</i>	
		<i>Dibothriocephalus lanceolatus</i>	
		<i>Adenocephalus pacificus</i> (syn <i>Diphyllobothrium pacificum</i> )	
Rotifera/Acanthocephala	Polymorphidae	<i>Bolbosoma nipponicum</i>	
		<i>Bolbosoma capitatum</i>	
		<i>Corynosoma strumosum</i>	
		<i>Corynosoma validum</i>	
		<i>Corynosoma villosum</i>	
Cnidaria/Myxozoa	Kudoidae	<i>Kudoa hexapunctata</i>	
		<i>Kudoa septempunctata</i>	

### 1.3.2.1 | *Nematodes*

The phylum Nematoda includes the families Anisakidae, Gnathostomatidae, Capillaridae and Dioctophymatidae. *Gnathostoma* nematodes are heteroxenous parasites. The adult worms live and spawn in a tumour-like mass in the stomach of the definitive mammalian host. The eggs are released by the host's faeces into the freshwater environment, where they develop and hatch into the first-stage larvae (L1). These larvae are then ingested by the first intermediate host, a freshwater copepod, where they develop into the second-stage larvae (L2). When the infected copepods are preyed upon by the second intermediate host such as a fish or tadpole, L2 migrate into the host's muscular tissue where they develop into third-stage larvae (L3). Finally, L3 in the second intermediate, transport or paratenic host are ingested by a definitive host, where they migrate to the liver and the abdominal cavity after penetrating the gastric wall. Later they return to the gastric wall and develop into adults. The development from L3 to the adult stage usually takes 6–8 months. When L3 are eaten by paratenic hosts such as frogs, snakes, birds and mammals as well as humans, which may act as accidental host, they migrate through host tissues and remain encysted in their muscles. Human gnathostomiasis can occur through the ingestion of raw or undercooked meat of intermediate hosts, such as fish, frogs, snakes or poultry, which contains infective L3. Oral infection can also occur through drinking water, contaminated with infected copepods. Human gnathostomiasis is considered an emerging global zoonosis (Liu et al., 2020). To date, approximately 5000 cases of human gnathostomiasis have been reported worldwide, mainly from endemic areas in Japan and China, Thailand and other parts of Southeast Asia, as well as Mexico, Colombia and Peru in South America. Gnathostomiasis has also been reported, albeit less frequently, in travellers who have visited endemic areas. The most common clinical signs of the disease are migratory cutaneous swellings and eosinophilia. In severe cases, L3 also invades internal organs such as the liver, eyes, nerves, spinal cord and brain, resulting in blindness, nerve pain, paralysis, coma and even death (Nogradio et al., 2023).

*Paracapillaria philippinensis*, a pathogenic species originally isolated from human patients, is presumed to have a sylvatic life cycle, which involves birds that feed on fish, but the definitive natural host of this species remains unknown (Arumugam et al., 2024).

The most relevant genus of the Dioctophymatidae family are the *Eustrongylides*, which have a global distribution (Northern and Southern America, Europe, Asia) (Honcharov et al., 2022) and an indirect life cycle, involving a wide range of freshwater fish species and fish-eating birds. These act as definitive hosts, while oligochaetes, mainly annelids, act as first intermediate hosts, and benthic and planktivorous fish are the second intermediate hosts. In the second intermediate host the third-stage larva moults into the fourth stage (L4) and remains as L4 until ingestion by the definitive host (Moravec, 2013). L4 larvae can also be accumulated in predatory fish species, serving as paratenic hosts. Some fish species have been found infected in Europe, mainly in lakes from Italy (Castiglione et al., 2023). To date, there have been very few reports of human infection attributed to larval *Eustrongylides* and those that have occurred are from the USA and Sudan (Eberhard et al., 1989; Eberhard & Ruiz-Tiben, 2014). In the USA, cases have been characterised by abdominal pain within 24 h of eating either bait minnows or after the consumption of fresh fish used to prepare sushi and sashimi. In Sudan, the cutaneous finding of *Eustrongylides* in two patients was based on morphological identification (Eberhard & Ruiz-Tiben, 2014).

### 1.3.2.2 | *Trematodes*

There are at least 29 different fish-borne trematode species that infect humans. These belong to several genera including *Opisthorchis*, *Clonorchis*, *Metagonimus*, *Heterophyes*, *Haplorchis*, *Centrocestus* and *Cryptocotyle* (*C. lingua*) and infect an estimated 7 million people annually (Chai & Jung, 2017). These digeneans are contracted by humans ingesting raw or improperly cooked freshwater or brackish water fish (Chai & Jung, 2024). Human infections are reported globally, but the major endemic areas are in Asian countries, including Korea, China, Taiwan, Vietnam, Laos, Thailand, Malaysia, Indonesia, the Philippines and India (Chai & Jung, 2017). In the case of *Opisthorchis*, several outbreaks have been reported in Europe, especially Italy (Orlando et al., 2008).

Clinical manifestations may include abdominal pain, diarrhoea, lethargy, anorexia and weight loss (Chai & Jung, 2024). However, the severity of symptoms is variable, and it depends on the intensity of infection, immune status of the patient and previous history of infection with flukes (Chai & Jung, 2024). In addition, in immunocompromised patients the infection may have a severe clinical course, including ectopic migration of the flukes (i.e. extraintestinal heterophyiasis) in the heart and brain (Chai et al., 2000). *H. heterophyes* and *H. nocens*, for example, may cause cerebral damage, inducing epilepsy and brain cysts (Zhang, 1990).

The family Clinostomidae, genus *Clinostomum* includes digenean species with a complex life cycle. Freshwater gastropods act as first intermediate hosts, fish and amphibian species as second intermediate hosts harbouring the metacercariae, while fish-eating birds are the definitive hosts. Humans can be accidental hosts, after consumption of raw or undercooked freshwater fish (in some cases even brackish fish, such as mullet) infected with metacercariae, causing a fish-borne zoonosis responsible for a rare disease known as Halzoun syndrome. In human infections, *C. complanatum* metacercaria excysts in the stomach and then migrates and attaches to the throat causing pharyngitis or laryngitis. Ectopic migration may also occur. Tiewchaloern et al. (1999) reported a case of eye infection. Human clinostomiasis has been reported in America, Southeast Asia and Eastern Europe. The main source of infection are commercially important fish, such as European perch (*Perca fluviatilis*). Menconi, Manfrin, et al. (2020) reported a 18.75% prevalence in fish from a subalpine lake (Lake Endine) in North Italy, while a prevalence of 13.1% was reported in fish in Türkiye (Çolak, 2013). Kadlec et al. (2003)



reported a 15% prevalence in a study undertaken in the Morava River basin, Czech Republic. Soylu (2015) suggested that fish prevalence correlated with migratory routes of fish-eating birds hosting *Clinostomum complanatum*.

### 1.3.2.3 | Cestodes

Cestodes of the genus *Dibothriocephalus* (syn. *Diphyllobothrium*) include at least 13 species that infect humans. These cestodes are widely distributed in fish, mammal and bird hosts (EFSA BIOHAZ Panel, 2024) from temperate and cold-water environments. The species *D. latus* is the main species infecting humans in Europe (Kuchta et al., 2015). Human diphyllobothriosis due to *D. latus* has re-emerged in the subalpine region of Italy (Lago Maggiore and Lago di Como), Lake Geneva and from France, while it shows a decrease in other historically endemic areas, such as the Baltic countries (Kuchta et al., 2015). Raw fillets of perch (*P. fluviatilis*) are a major source of human infection. Sporadic cases of human diphyllobothriosis have also been reported in central and western European countries. As the latter countries are free of these parasites, the cases were attributed to the consumption of imported fish (Kuchta et al., 2015).

The Pacific broad tapeworm *A. pacificus* (syn. *D. pacificum*) is the causative agent of the third most common fish-borne cestodosis in humans. Although most of the nearly 1000 cases have been reported in South America (Peru, Chile and Ecuador), recently reported cases in Europe demonstrate the potential for the spread of this tapeworm globally, as a result of global trade of fresh or chilled marine fish, and travel or migration of humans. Moreover, these parasites have re-emerged in marine fish species, such as hake (Cantatore et al., 2023) that may now serve as a source of human infection when eaten raw or undercooked (Mondragón-Martínez et al., 2020).

### 1.3.2.4 | Acanthocephalans

Acanthocephalans of the genus *Corynosoma* use marine mammals (pinnipeds) as definitive hosts, in which the adult parasite attaches to the gastro-intestinal mucosa. Fish acts as paratenic hosts carrying the juvenile stage in mesenteries of the gastrointestinal tract. Human consumption of raw or semi-raw fish dishes may lead to infection and disease (Buchmann & Karami, 2024). A total of 50 species within the genus are recognised, but only few have been recovered from human patients. The first report of a human infected with a *C. strumosum* was from Alaska (Schmidt, 1971). Several other human infections were caused by *C. validum* (Takahashi et al., 2016) and/or *C. villosum* (Fujita et al., 2016) in Japan. The infections were all related to the consumption of raw marine fish.

## 1.3.3 | Consumption of wild caught finfish in the EU

Apparent consumption [AC = (catches + aquaculture production + imports) – exports, EUMOFA] of fishery and aquaculture products in the EU increased in 2021 as compared to 2020 by 10.60 million tonnes Live weight equivalent (LWE),<sup>4</sup> or by 2%, mainly linked to a growth in farmed production (European seabass) and imports (blue whiting and salmon).

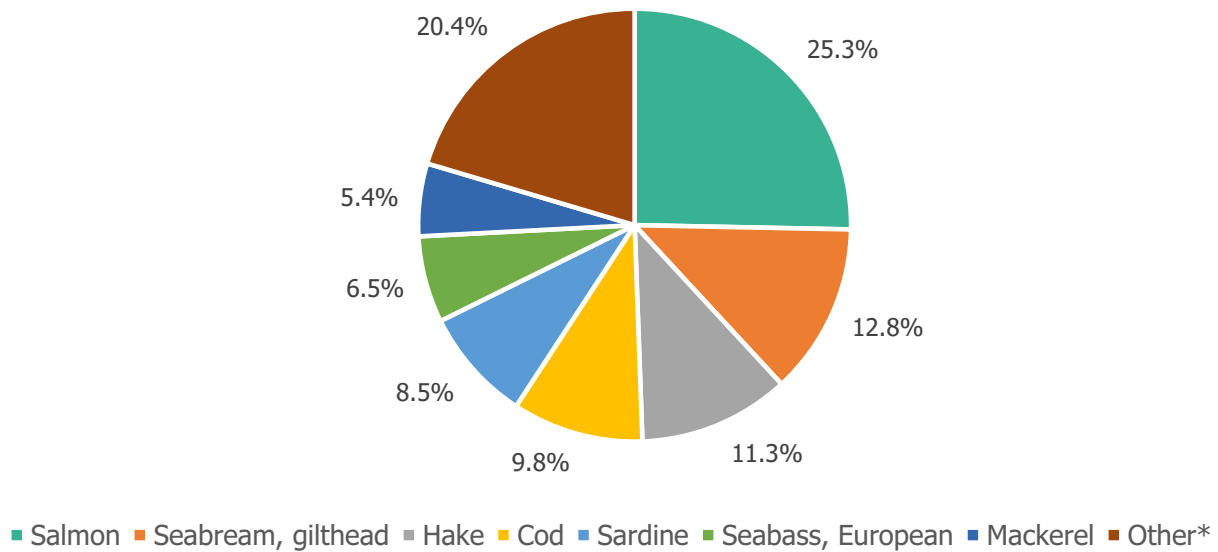
The most consumed species in the EU (LWE per capita per year) are tuna (2.86 kg), salmon (2.60 kg), cod (1.75 kg), Alaskan pollock (1.68 kg), hake (1.02 kg), herring (1.00 kg), sardines (0.54 kg), mackerel (0.53 kg), trout (0.49 kg) and saithe (0.36 kg) (EUMOFA EU Fish Market, 2023).

According to EUMOFA database (2023)<sup>5</sup> the most consumed species by households as a percentage of total volume are salmon, gilthead seabream, hake, cod and sardine. Although no distinction between wild caught and aquaculture is provided, the majority of salmon and gilthead seabream were supplied by aquaculture (Figure 1).

<sup>4</sup>Live weight equivalent (LWE) means weight calculated based on conversion factors from the weight recorded on landing, or from the net weight of the various processed products.

<sup>5</sup>European Market Observatory for Fisheries and Aquaculture Products database. Available at: <https://eumofa.eu/data>.

## Household consumption of fresh products. Main fish species in % in 2023 in reporting countries



**FIGURE 1** Household consumption of fish, in % of total volume, in 2023, for reporting countries. Graph built by EFSA based on EUMOFA database (<https://eumofa.eu/household-consumption-of-fresh-products>). \*The category 'other' includes categories 'sole, other' (3,24%); 'trout' (2,80%); 'tuna, miscellaneous' (2,75%); 'monkfish' (2,01%); 'anchovy' (1,71%); 'saithe (also known as coalfish)' (1,71%); 'swordfish' (1,57%); 'carp' (1,05%); 'herring' (0,76%); 'other freshwater fish' (0,76%); 'whiting' (0,59%); 'Allskan pollock' (0,38%); 'pangasius' (0,29%); 'scabbardfish' (0,29%); 'plaice, other' (0,19%); 'haddock' (0,16%); 'flounder, other' (0,10%); 'other salmonids' (0,02%); 'halibut, other' (0,01%); 'pike-perch' (0,01%); 'dab' (0,00%).

### 1.3.4 | Landings of finfish in the EU

The total EU catch<sup>6</sup> in 2022 was an estimated 3.4 million tonnes live weight. The fishing fleets of Spain, France, Denmark and the Netherlands accounted for a about half of the total amount of aquatic organisms caught by Member States in 2022.

About 70% of all EU catches in the seven marine areas covered by EU statistics were taken in the Atlantic, Northeast area (FAO area 27). The key species caught in this area in 2022 were herring (19% of the live weight caught in this region), sprat (14%), blue whiting (11%) and mackerel (10%).

About 10% of the total EU catch was taken in the Mediterranean and Black Sea (FAO area 37), where the main species caught were sardines (22% of the EU catch in the area) and anchovies (18%).

About 7% of the total EU catch was taken in the Atlantic, Eastern Central area (FAO area 34), where the main catches were mackerel and yellowfin tuna.

About 7% of the total EU catch was taken in the Indian Ocean, Western area (FAO areas 51, 57 & 58), where the main catch was tuna, particularly skipjack, yellowfin and bigeye tuna.

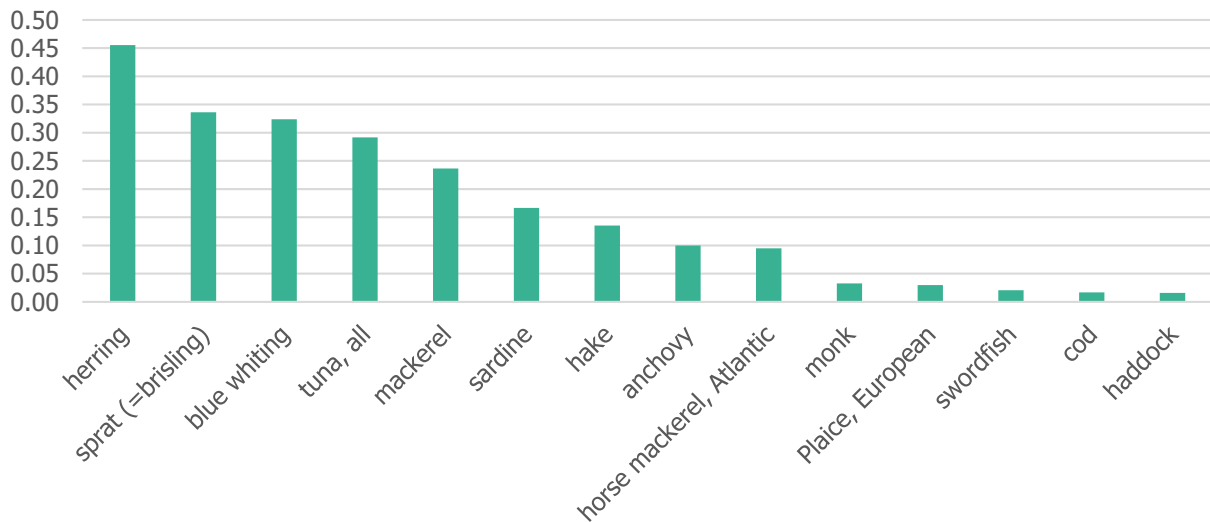
Only 6% of the total EU catch was taken in three remaining marine areas. The main species caught in these areas were the following: hake in the Atlantic, Southwest area (FAO area 41) (4%); blue sharks and skipjack tuna in the Atlantic, Southeast area (FAO area 47) (1%); and redfish, cod and halibut in the Atlantic, Northwest area (FAO area 21) (1%).

The quantity of all aquatic organisms landed in the EU in 2022 is estimated to have been about 3.2 million tonnes product weight, representing no change from the estimated 3.2 million tonnes landed in 2021 (Figure 2).

<sup>6</sup>Fish catches cover fish, molluscs, crustaceans and other aquatic animals, residues and aquatic plants that are taken for all purposes, by all types and class of vessel, gear and fishermen, operated in all the seven marine areas legally covered by EU statistical regulations.

Source: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fisheries\\_-\\_catches\\_and\\_landings#:~:text=The%20total%20EU%20catch%20in,3.4%20million%20tonnes%20live%20weight.](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Fisheries_-_catches_and_landings#:~:text=The%20total%20EU%20catch%20in,3.4%20million%20tonnes%20live%20weight.)

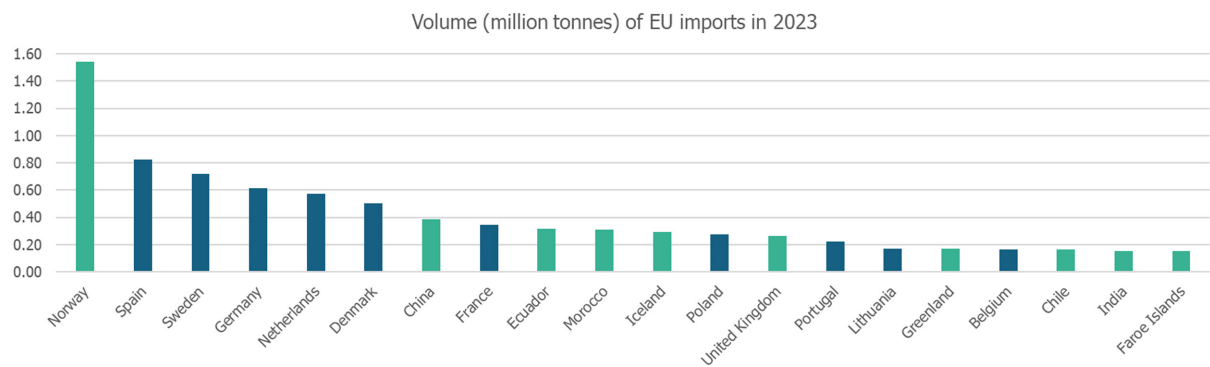
### Volume (million tonnes) of main fish species landed in the EU in 2022



**FIGURE 2** The main fish species landed in the EU by volume in 2022. The category ‘tuna, all’ includes categories ‘tuna, albacore’; ‘tuna, bigeye’; ‘tuna, bluefin’; ‘tuna, miscellaneous’; ‘tuna, skipjack’; ‘tuna, yellowfin’. Graph built by EFSA based on EUMOFA database (<https://eumofa.eu/landings>).

### 1.3.5 | Import of finfish into the EU

The volume of EU imports in 2022 is shown in Figure 3. The five top importing member states (MS) by volume were Spain, Denmark, Sweden, the Netherlands and France. The five top countries exporting finfish products into the EU were Norway, China, Ecuador, Morocco and Iceland, based on volume recorded in 2023 (EC DG-MARE, 2023). It should be noted that this data includes both farmed and caught fish.



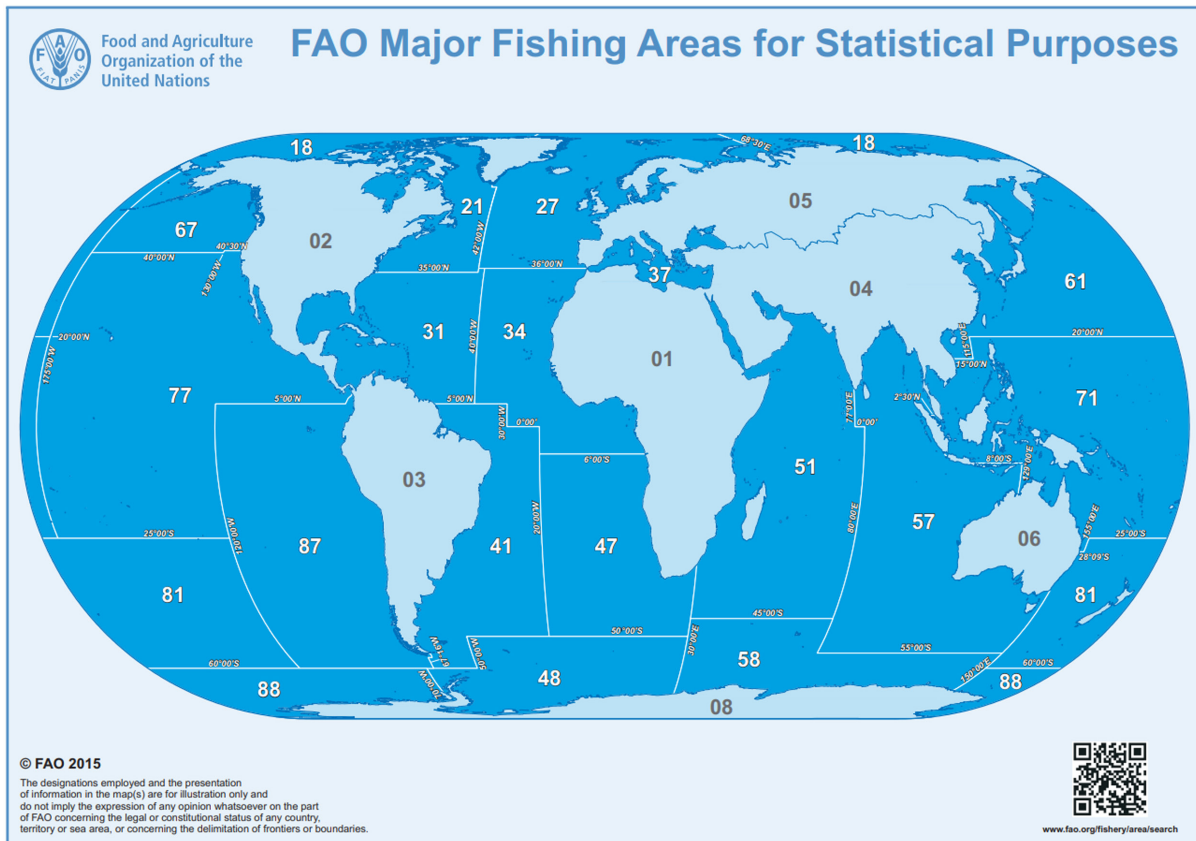
**FIGURE 3** Volume (million tonnes) of fishery products imports by countries into the EU, 2023. Graph built by EFSA based on EUMOFA database (<https://eumofa.eu/import-export>).

Intra-EU trade reached 6 million tonnes in 2023. The most imported fish species were salmon (mostly from aquaculture) from Norway (FAO sub area 27.2), cod also mainly from Norway, Alaska pollock (a large amount was imported as frozen fillets, originating from China), tuna skipjack tuna and yellowfin tuna being the most commonly imported tunas, originating mostly from Ecuador (FAO area 87) and the Seychelles (FAO area 51), respectively. The most important exporting countries were harvesting fish from geographically dispersed locations that make it difficult to define the original fishing areas.

A summary of the available information is provided in Appendix A.

### 1.3.6 | Fishing grounds that are the source of fish imported, landed and/or consumed in the EU

The FAO ‘Major Fishing Areas for Statistical Purposes’ is the world largest and complete mapping systems of the marine and freshwater areas for fishing purposes. It includes 8 inland waters (freshwater fishing areas) and 19 major marine fishing areas Figure 4.



**FIGURE 4** FAO major fishing areas.<sup>7</sup> Source: Food and Agriculture Organization of the United Nations. Reproduced with permission.

The main fishing grounds for the EU fishing fleet are located in FAO fishing areas 27 and 37 as detailed in Table 2. However, fish consumed in the EU may be caught and imported from a wide range of different fishing grounds as shown in Table 3.

**TABLE 2** Main fishing ground for EU fishing vessels.

FAO area	Description	Fleet country of origin
27	North Sea and Eastern Arctic	Mostly Denmark, the Netherlands and Germany
27	Baltic Sea	Estonia, Finland, Latvia, Poland, Denmark, Germany, Lithuania, Sweden
27	North Western Waters	Mainly France and Ireland, followed by Belgium, Denmark, Spain and the Netherlands
27	South Western Waters	Spain, France, Portugal
37	Mediterranean Sea	Cyprus, Croatia, Greece, Italy, Malta and Slovenia
37	Black Sea	Bulgaria and Romania

<sup>7</sup>FAO fishing areas: Marine areas: 18-Arctic ocean, 21-Northwest Atlantic, 27-Northeast Atlantic, 31-Western Central Atlantic, 34-Eastern Central Atlantic, 37-Mediterranean & Black Sea, 41-Southwest Atlantic, 47-Southeast Atlantic, 48-Atlantic, Antarctic, 51-Western Indian Ocean, 57-Eastern Indian Ocean, 58-Indian Ocean, Antarctic, 61-Northwest Pacific, 67-Northeast Pacific, 71-Western Central Pacific, 77-Eastern Central Atlantic, 81-Southwest Pacific, 87-Southeast Pacific, 88-Pacific Antarctic. Freshwater areas: 01-African inland waters, 02-North America inland waters, 03-South America inland waters, 04-Asia inland waters, 05 Europe inland waters, 06 Oceania inland waters, 08-Antarctica inland waters The fishing area 07 ('Former USSR area – Inland waters') referred to the area that was formerly the Union of Soviet Socialist Republics. Starting with the data for 1988, information for each new independent Republic is shown separately. The new independent Republics are: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan (statistics assigned to the fishing area 'Asia – Inland waters') and Belarus, Estonia, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine (statistics assigned to the fishing area 'Europe – Inland waters'). Source: <https://www.fao.org/fishery/en/area> (last accessed 22/10/2024).

**TABLE 3** The FAO fishing areas where the main fish species imported into the EU are caught.

<b>Fish</b>	<b>Imports to EU (million tonnes, 2023)*</b>	<b>FAO fishing area**</b>
Tuna, all	0.915	Area 21 – Atlantic, Northwest Area 27 – Atlantic, Northeast Area 31 – Atlantic, Western Central Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea Area 41 – Atlantic, Southwest Area 47 – Atlantic, Southeast Area 51 – Indian Ocean, Western Area 57 – Indian Ocean, Eastern Area 61 – Pacific, Northwest Area 67 – Pacific, Northeast Area 71 – Pacific, Western Central Area 77 – Pacific, Eastern Central Area 81 – Pacific, Southwest Area 87 – Pacific, Southeast
Cod	0.639	Area 21 – Atlantic, Northwest Area 27 – Atlantic, Northeast Area 31 – Atlantic, Western Central Area 37 – Mediterranean and Black Sea Area 41 – Atlantic, Southwest
Herring	0.521	Area 2 – America, North - Inland waters Area 21 – Atlantic, Northwest Area 27 – Atlantic, Northeast Area 31 – Atlantic, Western Central Area 5 – Europe – Inland waters
Mackerel	0.359	Area 21 – Atlantic, Northwest Area 27 – Atlantic, Northeast Area 31 – Atlantic, Western Central Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea
Hake	0.281	Area 27 – Atlantic, Northeast Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea
Saithe (=coalfish)	0.164	Area 18 – Arctic Sea Area 21 – Atlantic, Northwest Area 27 – Atlantic, Northeast Area 31 – Atlantic, Western Central
Sardine	0.162	Area 1 – Africa – Inland waters Area 27 – Atlantic, Northeast Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea Area 4 – Asia – Inland waters Area 5 – Europe – Inland waters
Seabream, gilthead	0.126	Area 27 – Atlantic, Northeast Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea Area 5 – Europe – Inland waters

(Continues)

TABLE 3 (Continued)

Fish	Imports to EU (million tonnes, 2023)*	FAO fishing area**
Seabass, European	0.0847	Area 1 – Africa – Inland waters Area 27 – Atlantic, Northeast Area 34 – Atlantic, Eastern Central Area 37 – Mediterranean and Black Sea Area 4 – Asia – Inland waters Area 5 – Europe – Inland waters

## Sources

\*<https://eumofa.eu/import-export>.\*\*The distribution of fish species per fishing area was taken from [https://fish-commercial-names.ec.europa.eu/fish-names/home\\_en](https://fish-commercial-names.ec.europa.eu/fish-names/home_en) (species distribution and habitat).

## 2 | DATA AND METHODOLOGIES

### 2.1 | Literature search

The evidence on the presence of zoonotic parasites in wild caught fish from any fishing grounds was retrieved from studies published between 2010 and 2023 (inclusive).

Under the grant agreement GP/EFSA/BIOHAW/2023/05,<sup>8</sup> the Pathogens in Food (PIF) consortium performed a systematic review on anisakids and other zoonotic parasites. PIF conducted in Distiller<sup>SR</sup> a literature screening and data extraction (in Excel format) on anisakids and then, on anisakids/ other parasites in wild caught fish, from all countries and covering studies published in Spanish, English, Portuguese and French, between January 2010 and September 2023. The search protocol for the occurrence of anisakids and other zoonotic parasites in wild caught finfish was as described by Kooh et al. (2023). These data will be incorporated in the PIF database accessible through a web application (<https://pif.esa.ipb.pt/>). Overall, data from 274 studies/papers were extracted for anisakids and from 166 papers for other parasites.

In addition, a non-systematic literature search was performed to retrieve specific missing data for fishing areas without search results. The relevance of the records was assessed by screening the title, keywords and the abstract. The review included scientific review papers, book chapters, peer-review papers and other documents known by the experts or retrieved through non-systematic searches.

### 2.2 | Uncertainty analysis

As recommended by the EFSA guidance and related principles and methods on uncertainty analysis in scientific assessments (EFSA Scientific Committee, 2018a; EFSA Scientific Committee, 2018b), an uncertainty analysis was undertaken as described in the protocol which is available in the Supporting Information section of Part 1 of this opinion (EFSA BIOHAZ Panel, 2024, Annex A). The sources of the main uncertainties related to ToR4 were identified by the experts in the WG and their impact on the uncertainty of the answers to the AQ4 were discussed. Consensus expert judgement within the WG, informed by the collected evidence and expert knowledge, was used to assess the certainty of the answer to the AQ4.

## 3 | ASSESSMENT

### 3.1 | Assessment of the presence of zoonotic parasites in caught finfish in marine fishing areas

*Anisakis* sp. were reported to be detected in many wild caught fish species in all FAO marine fishing areas except area 58 (Indian Ocean, Antarctic), for which there was no data on the occurrence of *Anisakis* sp. (Table 4). However, *P. decipiens* (s.l.) and *C. osculatum* (s.l.) were found in multiple fish species from fishing area 58 (Lukashanets et al., 2021).

<sup>8</sup>EFSA's grant agreement GP/EFSA/BIOHAW/2023/05 (Pathogens in foods database: extension with *Vibrio* and parasites) with as beneficiaries Instituto Politécnico de Bragança (IPB) as coordinator and Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Anses) as co-beneficiary.

**TABLE 4** Occurrence of zoonotic *Anisakis* species in finfish caught in FAO marine fishing areas. Full details are provided in Thébault et al., 2024

FAO marine fishing areas	Fish species	References
Area 18: Arctic Sea	<i>Boreogadus saida</i>	Køie (2009)
Area 21: Northwest Atlantic	<i>Merluccius bilinearis</i>	Fuentes, Madrid, Cuesta, et al. (2022)
	<i>Gadus morhua</i>	McClelland and Melendy (2011), Mouritsen et al. (2010), Münster et al. (2015), Severin et al. (2020)
	<i>Gadus ogac</i>	Mouritsen et al. (2010)
Area 27: Atlantic, Northeast	<i>Belone belone</i>	Rolbiecki et al. (2020)
	<i>Clupea harengus</i>	Bao et al. (2017), Levsen and Lunestad (2010), Levsen, Svanevik, et al. (2018), Mattiucci, Giuliotti, et al. (2018), Shevchuk et al. (2020), Unger et al. (2014)
	<i>Dicentrarchus labrax</i>	Bernardi et al. (2011)
	<i>Engraulis encrasicolus</i>	Dessier et al. (2016), Domingo-Hernandez et al. (2023), Rodríguez, Abollo, et al. (2018), Rodríguez, González, et al. (2018)
	<i>Gadus morhua</i>	Gay et al. (2018), Hauksson et al. (2012), Karami et al. (2022), Klapper et al. (2018), Levsen et al. (2022), Mehrdana et al. (2014), Mercken et al. (2021), Münster et al. (2015), Nadolna-Altyn et al. (2022), Nadolna and Podolska (2014), Najda et al. (2018), Sobecka et al. (2011)
	<i>Helicolenus dactylopterus</i>	Sequeira et al. (2010)
	<i>Lepidorhombus boscii</i>	Levsen, Svanevik, et al. (2018), Rodríguez, Abollo, et al. (2018) Rodríguez, González, et al. (2018)
	<i>Lophius budegassa, Lophius piscatorius</i>	Rodríguez, Abollo, et al. (2018), Rodríguez, González, et al. (2018)
	<i>Mallotus villosus</i>	Levsen et al. (2016), Rolbiecki and Izdebska (2023)
	<i>Melanogrammus aeglefinus</i>	Levsen et al. (2022), Pierce et al. (2018)
	<i>Merlangius merlangus</i>	Gay et al. (2012), Pierce et al. (2018)
	<i>Merluccius merluccius</i>	Casti et al. (2017), Ceballos-Mendiola et al. (2010), Cipriani et al. (2015), Diez et al. (2022), Fuentes, Madrid, Cuesta, et al. (2022), Pascual et al. (2018), Rodríguez, Abollo, et al. (2018), Santos et al. (2022), Tejada et al. (2014)
	<i>Micromesistius potassou</i>	Dezfuli et al. (2021), Elena Ahuir-Baraja et al. (2021), Gómez-Mateos et al. (2016), Levsen, Svanevik, et al. (2018), Llarena-Reino et al. (2012), Madrid et al. (2012), Roca-Geronès et al. (2020), Rodríguez, Abollo, et al. (2018)
	<i>Platichthys flesus</i>	Marques et al. (2010)
	<i>Pleuronectes platessa</i>	Levsen, Svanevik, et al. (2018)
	<i>Pollachius virens</i>	Levsen et al. (2022)
	<i>Reinhardtius hippoglossoides</i>	Najda et al. (2018)
	<i>Salmo salar</i>	Kent et al. (2020), Mo et al. (2021), Noguera et al. (2015)
	<i>Salmo trutta</i>	Urquhart et al. (2010)
	<i>Sardina pilchardus</i>	Caballero-Huertas et al. (2023), Dessier et al. (2016), Fuentes, Madrid, Elena, et al. (2022), Molina-Fernández et al. (2015), Rodríguez, Abollo, et al. (2018)
	<i>Scomber colias</i>	Levsen, Svanevik, et al. (2018), Rodríguez, Abollo, et al. (2018)
	<i>Scomber scombrus</i>	Levsen, Cipriani, et al. (2018), Levsen, Svanevik, et al. (2018), Llarena-Reino et al. (2012), Madrid et al. (2016), Pekmezci (2014), Rodríguez, Abollo, et al. (2018)
	<i>Sebastes mentella</i>	Klapper et al. (2016), Klapper et al. (2015), Najda et al. (2018)
	<i>Sprattus sprattus</i>	Kleinertz, Klimpel, and Palm (2012)
	<i>Trachurus picturatus</i>	Vasconcelos et al. (2017)
	<i>Trachurus trachurus</i>	Debenedetti et al. (2020), Lopes et al. (2020), Roca-Geronès et al. (2020)
	Area 31: Atlantic, Western-Central	<i>Mugil incilis</i>
Area 34: Atlantic, Eastern Central	<i>Auxis thazard</i>	Martin-Carrillo et al. (2022)
	<i>Dicologlossa cuneata</i>	Buzo-Dominguez et al. (2021)
	<i>Engraulis encrasicolus</i>	Bouzid et al. (2023)
	<i>Helicolenus dactylopterus</i>	Sequeira et al. (2010)
	<i>Katsuwonus pelamis</i>	Hermida et al. (2018)
	<i>Merluccius merluccius</i>	Martin-Carrillo et al. (2022)
	<i>Mugil cephalus</i>	Dione et al. (2014)
	<i>Sardinella maderensis</i>	Ogbon et al. (2023)
	<i>Scomber colias</i>	Martin-Carrillo et al. (2022), Abattouy et al. (2011)
	<i>Scomber scombrus</i>	Biary et al. (2021), Martin-Carrillo et al. (2022)
	<i>Trachurus picturatus</i>	Costa et al. (2012), Costa et al. (2013), Vasconcelos et al. (2017)
	<i>Trachurus trachurus</i>	Abattouy et al. (2014)
	<i>Zeus faber</i>	Pekmezci (2019)

(Continues)

TABLE 4 (Continued)

FAO marine fishing areas	Fish species	References
Area 37: Mediterranean and Black sea	<i>Alosa immaculata</i>	Shevchuk et al. (2020)
	<i>Conger conger</i>	Akmirza (2012), Graci et al. (2017)
	<i>Dicentrarchus labrax</i>	Abouzaid et al. (2018)
	<i>Diplodus annularis</i>	Chaligiannis et al. (2012)
	<i>Engraulis encrasicolus</i>	Casti et al. (2017), Cavallero et al. (2015), Chaligiannis et al. (2012), Cipriani, Sbaraglia, Palomba, et al. (2018), Costa et al. (2016), De Liberato et al. (2013), Ferrer-Maza et al. (2016), Gazzonis et al. (2017), Goffredo et al. (2019), Guardone et al. (2017), Meloni et al. (2011), Mladineo and Poljak (2013), Ozuni et al. (2021), Pulleiro-Potel et al. (2015), Roca-Geronès et al. (2020), Serracca et al. (2014)
	<i>Epinephelus aeneus</i>	Bouderbala et al. (2022)
	<i>Epinephelus marginatus</i>	Bouderbala et al. (2022), De Benedetto et al. (2021)
	<i>Lophius budegassa</i>	Pulleiro-Potel et al. (2015)
	<i>Lophius piscatorius</i>	Costa et al. (2016)
	<i>Merlangius merlangus</i>	Mladineo and Poljak (2013)
	<i>Merluccius merluccius</i>	Casti et al. (2017), Chaligiannis et al. (2012), Cipriani, Sbaraglia, Paoletti, et al. (2018), Cipriani et al. (2015), Costa et al. (2016), Ferrer-Maza et al. (2014), Fuentes, Madrid, Cuesta, et al. (2022), Goffredo et al. (2019), Graci et al. (2017), Meloni et al. (2011), Mladineo and Poljak (2013), Ozuni et al. (2021), Pekmezci et al. (2014), Sharif and Negm-Eldin (2013)
	<i>Micromesistius poutassou</i>	Chaligiannis et al. (2012), Goffredo et al. (2019), Levsen, Svanevik, et al. (2018), Madrid et al. (2012), Meloni et al. (2011), Molina-Fernández et al. (2018), Pekmezci et al. (2014), Pulleiro-Potel et al. (2015), Roca-Geronès et al. (2020)
	<i>Mullus barbatus</i>	Chaligiannis et al. (2012), Goffredo et al. (2019), Graci et al. (2017), Ozuni et al. (2021), Pekmezci et al. (2014)
	<i>Mullus surmuletus</i>	Goffredo et al. (2019), Meloni et al. (2011), Pulleiro-Potel et al. (2015)
	<i>Pagellus acarne</i>	Benamara et al. (2020), Chaligiannis et al. (2012), Pulleiro-Potel et al. (2015)
	<i>Pagellus erithrinus</i>	Chaligiannis et al. (2012), Pulleiro-Potel et al. (2015)
	<i>Sardina pilchardus</i>	Bušelić et al. (2018), Caballero-Huertas et al. (2023), Cavallero et al. (2015), Chaligiannis et al. (2012), Costa et al. (2016), Fuentes, Madrid, Elena, et al. (2022), Goffredo et al. (2019), Graci et al. (2017), Levsen, Svanevik, et al. (2018), Meloni et al. (2011), Mladineo and Poljak (2013), Pulleiro-Potel et al. (2015)
	<i>Sardinella aurita</i>	Chaligiannis et al. (2012), Ozuni et al. (2021)
	<i>Scomber colias</i>	Casti et al. (2017), Gazzonis et al. (2017), Levsen, Svanevik, et al. (2018) Abattouy et al. (2011) Abdelsalam et al. (2020) Chaligiannis et al. (2012), Goffredo et al. (2019), Mladineo and Poljak (2013), Ozuni et al. (2021), Pekmezci et al. (2014)
	<i>Scomber scombrus</i>	Chaligiannis et al. (2012), Costa et al. (2016), Goffredo et al. (2019), Graci et al. (2017), Gutiérrez-Galindo et al. (2010), Levsen, Cipriani, et al. (2018), Levsen, Svanevik, et al. (2018), Madrid et al. (2016), Meloni et al. (2011), Ozuni et al. (2021), Pekmezci et al. (2014)
	<i>Scorpaena scrofa</i>	Aydin and Pekmezci (2023)
	<i>Sphyaena sphyraena</i>	Boussellaa et al. (2018)
	<i>Sphyaena viridensis</i>	De Benedetto et al. (2021)
	<i>Spicara smaris</i>	Chaligiannis et al. (2012)
	<i>Thunnus thynnus</i>	Mladineo et al. (2011)
	<i>Trachurus mediterraneus</i>	Casti et al. (2017), Meloni et al. (2011), Pekmezci et al. (2014), Tepe and Oguz (2013)
	<i>Trachurus trachurus</i>	Abattouy et al. (2014), Chaligiannis et al. (2012), Costa et al. (2016), Debenedetti et al. (2020), Eissa et al. (2018), Graci et al. (2017), Gutiérrez-Galindo et al. (2010), Macchioni et al. (2021), Meloni et al. (2011), Menconi et al. (2022), Ozuni et al. (2021), Roca-Geronès et al. (2020), Tantanasi et al. (2012))
	<i>Trachurus picturatus</i>	Meloni et al. (2011)
	<i>Trisopterus minutus</i>	Pulleiro-Potel et al. (2015)
	<i>Trisopterus minutus capelanus</i>	Goffredo et al. (2019)
	<i>Xiphias gladius</i>	Mattiucci et al. (2014)



TABLE 4 (Continued)

FAO marine fishing areas	Fish species	References
Area 41: Atlantic, Southwest	<i>Cynoscion guatucupa</i>	Crosi Martínez et al. (2022), Fontenelle et al. (2013)
	<i>Lutjanus analis</i>	Alves et al. (2020)
	<i>Lutjanus jocu</i>	
	<i>Lutjanus synagris</i>	
	<i>Lutjanus vivanus</i>	
	<i>Lutjanus purpureus</i>	Cavalcanti et al. (2013)
	<i>Macrodon ancylodon</i>	Crosi Martínez et al. (2022)
	<i>Merluccius hubbsi</i>	Mattiucci, (2006)
	<i>Micropogonias furnieri</i>	Di Azevedo and Iñiguez (2018)
	<i>Pagrus pagrus</i>	Soares and Luque (2015)
	<i>Plagioscion squamosissimus</i>	Chagas de Souza et al. (2020), Rodrigues et al. (2015)
<i>Zenopsis conchifer</i>	Lanfranchi et al. (2016), Lanfranchi et al. (2018)	
Area 47: Atlantic, Southeast	<i>Brama brama</i>	Mackintosh et al. (2018), Mattiucci, Cipriani, et al. (2018)
	<i>Trachurus capensis</i>	
	<i>Thyrsites atun</i>	
	<i>Lophius vomerini</i>	
	<i>Merluccius capensis</i>	
	<i>Helicolenus dactylopterus</i> <i>Lepidopus caudatus</i>	
Area 48: Atlantic, Antarctic	<i>Gymnoscopelus nicholsi</i>	Klimpel, (2010)
Area 51: Indian Ocean, Western	<i>Trichiurus lepturus</i> , <i>Saurida undosquamis</i>	Cipriani et al. (2022)
	<i>Merluccius merluccius lessepsianus</i>	Abou-Rahma et al. (2016)
	<i>Scomberomorus commerson</i>	Adel et al. (2013)
Area 57: Indian Ocean, Eastern	<i>Epinephelus areolatus</i>	Kleinertz, Damriyasa, et al. (2012)
	<i>Eupleurogrammus muticus</i>	Bao et al. (2022)
	<i>Johnius belangerii</i>	Yun et al. (2022)
	<i>Lutjanus malabaricus</i>	Setyobudi (2011)
	<i>Rastrelliger</i> spp.	Setyobudi et al. (2019)
	<i>Selar crumenophthalmus</i>	Bao et al. (2022)
	<i>Trichiurus lepturus</i>	Bao et al. (2022), Setyobudi (2011)
Area 61: Pacific, Northwest	<i>Clupea pallasii</i>	Gordeev and Sokolov (2023)
	<i>Conger myriaster</i>	Chen et al. (2018)
	<i>Coryphaenoides acrolepis</i>	Kumagai and Nishino (2023)
	<i>Gadus chalcogrammus</i> <i>Gadus macrocephalus</i>	Gomes et al. (2020)
	<i>Katsuwonus pelamis</i>	Murata et al. (2021), Takano et al. (2021)
	<i>Oncorhynchus gorboscha</i>	Gordeev and Sokolov (2023)
	<i>Oncorhynchus keta</i>	Gomes et al. (2020), Gordeev and Sokolov (2023), Setyobudi et al. (2011), Setyobudi et al. (2019)
	<i>Sardinops sagax melanostictus</i>	Gomes et al. (2020)
	<i>Scomber australasicus</i>	Chen and Shih (2015), Chou et al. (2011), Gomes et al. (2020), Ohnishi et al. (2023), Sonko et al. (2020)
	<i>Scomber japonicus</i>	Bak et al. (2014), Chen et al. (2015), Gomes et al. (2020), Hidano et al. (2021), Ohnishi et al. (2023), Suzuki et al. (2010)
	<i>Scomberomorus nipponius</i>	Zhao et al. (2016)
	<i>Seriola quinqueradiata</i>	Cho et al. (2012)
	<i>Trachurus japonicus</i>	Chen et al. (2015)
	<i>Trichiurus lepturus</i>	Chen et al. (2015), Sonko et al. (2020)
Area 67: Pacific, Northeast	<i>Gadus macrocephalus</i> <i>Sebastes alutus</i>	Oguz et al. (2021)
	<i>Oncorhynchus gorboscha</i>	Karl et al. (2011)
	<i>Oncorhynchus keta</i>	
	<i>Oncorhynchus nerka</i>	

(Continues)

TABLE 4 (Continued)

FAO marine fishing areas	Fish species	References	
Area 71: Pacific, Western central	<i>Auxis thazard</i>	Anshary et al. (2014)	
	<i>Caranx</i> sp.		
	<i>Katsuwonus pelamis</i>		
	<i>Rastrelliger kanagurta</i>		
	<i>Carangoides malabaricus</i>	Hien et al. (2021)	
	<i>Lutjanus johnii</i>		
	<i>Megalaspis cordyla</i>		
	<i>Decapterus macarellus</i>		
	<i>Decapterus macrosoma</i>	See et al. (2022)	
Area 77: Pacific, Eastern central	<i>Euthynnus affinis</i>	Anshary et al. (2014), Pambudi et al. (2021)	
	<i>Liza vaigiensis</i>	Jabbar et al. (2012)	
	<i>Trichiurus lepturus</i>	Hien et al. (2021), Setyobudi et al. (2023)	
	<i>Caranx caballus</i>	Violante-González et al. (2016)	
	<i>Clupea pallasii</i>	Jacobson et al. (2012)	
	<i>Engraulis mordax</i>		
	<i>Merluccius productus</i>		
	<i>Oncorhynchus kisutch</i>		
	<i>Oncorhynchus tshawytscha</i>		
Area 81: Pacific, Southwest central	<i>Sardinops sagax</i>	Rodríguez-Santiago et al. (2020)	
	<i>Trachurus symmetricus</i>	Rodríguez-Santiago et al. (2014)	
	<i>Scorpaena guttata</i>		
	<i>Sebastes miniatus</i>		
	<i>Chrysophrys auratus</i>	Hossen et al. (2021)	
	<i>Scomber australasicus</i>	Hossen et al. (2023)	
	Area 87: Pacific, Southeast	<i>Brama australis</i>	Munoz-Caro et al. (2022), Oliva et al. (2016)
		<i>Merluccius australis</i>	Gonzalez-Poblete et al. (2022), Torres-Frenzel and Torres (2014)
		<i>Mugil cephalus</i>	Castellanos et al. (2017)
<i>Sarda chilensis</i>		Aco Alburqueque et al. (2020)	
<i>Scomber japonicus</i>			
<i>Trachurus murphyi</i>			
<i>Scomber japonicus peruanus</i>		Martinez-Rojas et al. (2021)	
<i>Trachurus symmetricus murphyi</i>			
<i>Merluccius gayi peruanus</i>			
Area 88: Pacific, Antarctic	<i>Brama japonica</i>		
	<i>Dissostichus eleginoides</i>	Brickle, (2005)	

### 3.2 | Assessment of the presence of zoonotic parasites in caught finfish in freshwater fishing areas

In freshwater fishing areas *D. latus* parasites were detected in *Pseudolithus* spp. (ray-finned fish belonging to the family Sciaenidae) in area 1 (African inland waters) (Table 5). *Dibothriocephalus* spp. were reported in Arctic char (*Salvelinus alpinus*) caught in area 2 (North America inland waters) while *Dibothriocephalus* spp., including *D. dendriticus* and *Di. latus*, were detected in a range of fish species (*Oncorhynchus mykiss*, *Salmo trutta*, *Salvelinus fontinalis*, *Percichthys trucha*, *Salmo salar*, *Odontesthes mauleanum*, *Basilichthys australis*, *Oncorhynchus kisutch*) in area 3 (South America inland waters). Multiple fish species from fishing area 4 (Asia inland waters) were infected with a range of different zoonotic parasites including *Opisthorchis* spp. *Opisthorchis felinus*, *O. viverrini*, *Metorchis* spp., *M. orientalis*, *H. taichui*, *H. pumilio*, *H. yokogawai*, *Centrocestus* spp., *C. formosanus*, *H. yokogawai*, *Gnathostoma* sp., *Clonorchis* spp., *Metagonimus* spp., *D. latus*, *D. dendriticus*, *Cryptocotyle* sp., *C. sinensis*, *M. yokogawai*, cyathocotylid trematode (Trematoda: Digenea: Cyathocotylidae) and *Holostephanus* sp. Fish in area 5 (Europe inland waters) were infected with *Dibothriocephalus* spp., *D. dendriticus*, *O. felinus*, *D. latus* and *Corynosoma* sp., while *Contracaecum bancrofti*, *Echinostoma* sp., *Clinostomum* sp. were reported in fish in area 6 (Oceania inland waters). There was no data for fishing area 8, possibly because there are few if any fish in Antarctica inland waters and none that are imported into the EU.

**TABLE 5** Occurrence of zoonotic parasites in finfish caught in freshwater fishing areas. For presentation purposes the fish species have been omitted from this table but full details are available in Kooh et al., 2024.

FAO freshwater fishing areas	Parasites	References	
Area 1: Africa – Inland waters	<i>Dibothriocephalus latus</i>	Bakare et al. (2023)	
	<i>Clinostomum</i> sp.	Tesfaye et al. (2023)	
Area 2: America, North – Inland waters	<i>Dibothriocephalus</i> spp.	Gallagher and Dick (2010)	
Area 3: America, South – Inland waters	<i>Dibothriocephalus</i> spp.	Kuchta et al. (2019), Rauque et al. (2018), Torres and Puga (2011)	
	<i>Dibothriocephalus dendriticus</i>	Rozas et al. (2012), Semenas et al. (2021), Yamasaki et al. (2023)	
	<i>Dibothriocephalus latus</i>	Semenas et al. (2021), Torres et al. (2012), Yamasaki et al. (2023)	
Area 4: Asia – Inland waters	<i>Opisthorchis</i> spp.	Labony et al. (2020), Marcus et al. (2012)	
	<i>Opisthorchis felineus</i>	Aubakirov et al. (2022), Bonina et al., 2024, Karmaliyev et al. (2023), Liberman (2019), Liberman and Voropaeva (2018)	
	<i>Opisthorchis viverrini</i>	Chai et al. (2019), Chai et al. (2020), Chai et al. (2014), Charoensuk et al. (2022), Dao et al. (2017), Eom et al. (2015), Kiatsopit et al. (2014), Laoprom et al. (2021), Manpratrum et al. (2017), Namsanor et al. (2020), Nithikathkul et al. (2014), Nithikathkul et al. (2012), Ong et al. (2016), Onsurathum et al. (2016), Phyo Myint et al. (2020), Pinlaor et al. (2013), Pitaksakulrat et al. (2017), Prakobwong et al. (2017), Pumhirunroj et al. (2020), Rim et al. (2013), Sanpool et al. (2018), Sohn et al. (2012), Sohn, Choi, Jung, Hong, Ryoo, Chang, Lee, et al. (2021), Sohn, Jung, et al. (2019)	
	<i>Metorchis</i> spp.	Bonina et al. (2024), Labony et al. (2020), Liberman (2019)	
	<i>Metorchis orientalis</i>	Qiu et al. (2017), Sohn, Na, Cho, Ju, Kim, Hwang, No, and Park (2021), Yang et al. (2019)	
	<i>Haplorchis</i> spp.	Hung et al. (2015)	
	<i>Haplorchis taichui</i>	Chai et al. (2019), Chai et al. (2020), Nithikathkul et al. (2014), Phyo Myint et al. (2020), Rim et al. (2013), Sripa et al. (2016), Wongsawad et al. (2013)	
	<i>Haplorchis pumilio</i>	Chai et al. (2019), Chai et al. (2020), Chai et al. (2014), Phyo Myint et al. (2020), Sripa et al. (2016)	
	<i>Haplorchis yokogawai</i>	Abattouy et al. (2014), Chai et al. (2019), Chai et al. (2020), Chai et al. (2014), Rim et al. (2013)	
	<i>Centrocestus</i> spp.	Chai et al. (2020)	
	<i>Centrocestus formosanus</i>	Chai et al. (2019), Chai et al. (2014), Hung et al. (2015), Rim et al. (2013), Sripa et al. (2016)	
	<i>Gnathostoma</i> sp.	Chai et al. (2020)	
	<i>Clonorchis</i> spp.	Labony et al. (2020), Marcus et al. (2012)	
	<i>Metagonimus</i> spp.	Labony et al. (2020), Sohn, Na, et al. (2019), Sohn et al. (2015)	
	<i>Dibothriocephalus latus</i>	Liberman et al. (2019)	
	<i>Dibothriocephalus dendriticus</i>	Nikulina and Polyeva (2020)	
	<i>Clonorchis sinensis</i>	Hung et al. (2015), Sohn and Na (2019), Sohn, Na, Cho, Lee, Ju, Lee, Lim, et al. (2021), Sohn, Na, Cho, Lee, Ju, Lee, Park, and Ahn (2021), Sohn et al. (2017), Wang et al. (2022), Yang et al. (2019)	
	<i>Metagonimus yokogawai</i>	Qiu et al. (2017)	
	Area 5: Europe – Inland waters	<i>Dibothriocephalus</i> spp.	Bielat et al. (2015), Kuhn et al. (2017)
		<i>Dibothriocephalus ditremum</i>	Henriksen et al. (2016)
<i>Dibothriocephalus dendriticus</i>		Borgstrøm et al. (2021), Henriksen et al. (2016), Kuhn et al. (2016)	
<i>Dibothriocephalus latus</i>		Dupouy-Camet and Yera (2015), Gustinelli et al. (2016), Menconi, Pastorino, et al. (2020), Menconi et al. (2021), Radačovská et al. (2019)	
<i>Opisthorchis felineus</i>		De Liberato et al. (2011), Drozdova et al. (2022), Simakova et al. (2022), Simakova et al. (2019), Simakova et al. (2021)	
<i>Corynosoma</i> sp.		Pilecka-Rapacz et al. (2017)	
<i>Echinostoma</i> sp. <i>Clinostomum</i> sp. <i>Eustrongylides</i> sp.		Wilson et al. (2019)	
Area 8: Antarctica – Inland waters	No data available	No data available	

## Uncertainty

There are multiple sources of uncertainty associated with the data provided above. These are summarised in [Table 6](#) including the impact they may have on the conclusions.

**TABLE 6** Sources of uncertainty and their potential impact on the conclusions.

Sources of uncertainty	Impact of the uncertainty on the conclusions
<p>It is assumed that the presence of anisakids or other zoonotic parasites in one fish species in a given marine fishing area is indicative that all fish species in that area may be infected.</p> <p>The absence of data covering the range of different zoonotic fish parasites that are found in all of the different fish species in marine fishing areas.</p>	<p>Minimum impact, because anisakids can infect all of the wild caught fish species that are consumed in the EU/EFTA. In the marine fishing areas where there were no reports of anisakids in fish (area 58), other zoonotic parasites have been detected in the fish and reported.</p> <p>It is generally accepted, based on the data published to date that there is no evidence that any fish species consumed in the EU/EFTA is free of zoonotic parasites (i.e. all fish species are susceptible to infection with at least one zoonotic parasite).</p>
<p>It is assumed that the presence of any zoonotic parasite in one fish species in a given freshwater fishing area is indicative that all fish species in that area may be infected with that or other zoonotic parasites.</p> <p>The absence of data covering the range of different zoonotic fish parasites that are found in all of the different freshwater.</p>	<p>Minimum impact, as there is data available for all freshwater fishing areas and no studies to suggest that any particular fish species cannot be infected with at least one zoonotic parasite.</p>
<p>Although there are multiple studies reported for most fishing areas there are a few where the number of studies is limited. In the marine areas for <i>Anisakis</i>, for example Area 47 (Atlantic Southwest) had only one reported study, while Areas 67 (Pacific Northeast) and 71 (Pacific western central) had 2. There are considerably less data on <i>Anisakis</i> from areas 18, 31, 48 and 88), with each reliant on one published study. A similar issue arises for the freshwater areas with all except Area 5 (Europe – Inland waters) having one to three studies.</p>	<p>Minimum impact, as when the evidence is considered in its entirety and there are multiple publications covering freshwater systems and conditions are not sufficiently different between these bodies of water to suggest that zoonotic parasites are absent from one or more.</p>

## 4 | CONCLUSIONS

AQ4: Are there any particular species of wild caught fish originating from specific fishing grounds, where fish consumed in the EU/EFTA are caught, that are free of parasites of public health importance?

It was concluded to be 99%–100% certain (almost certain) that there are no particular species of wild caught fish originating from specific marine fishing areas, where the fish consumed in the EU/EFTA are free of parasites of public health importance. Based on the data reported in the peer reviewed literature, at least one zoonotic parasite has been reported in at least one fish species in each of the FAO marine fishing areas (*Anisakis* spp. in all fishing areas, except area 58, but in which *P. decipiens* (s.l.) and *C. osculatum* (s.l.) were reported in multiple fish species). Thus, due to relative low fish host specificity of the zoonotic parasites, the panel concluded that all relevant fish species may be exposed to and infected with zoonotic parasites.

The same applies to freshwater fishing areas from which fish are consumed in the EU/EFTA, as all fishing areas, except for Antarctica, have some or multiple studies reporting the presence of a range of different zoonotic parasites in the caught fish species.

The conclusion on marine fishing areas is consistent with that of the 2010 opinion which stated that no sea fishing grounds could be considered to be free of *A. simplex* (s.l.) larva.

## 5 | RECOMMENDATIONS

It is recommended to implement routine surveillance of zoonotic parasites in wild caught fish, including niche products that are imported into the EU, using the most effective detection methods, as described in Part 1 of this Opinion.

It is also recommended that research be undertaken to address the dearth of surveillance data, especially for the most consumed wild caught fish in EU and EFTA countries, and that the effect of climate change on the zoonotic parasites' geographical distribution and risk to the consumer be assessed to evaluate the need for revised risk management practices in the future.

It is recommended that research is carried out to estimate the disease burden associated with zoonotic parasites in wild caught fish.

## GLOSSARY AND/OR ABBREVIATIONS

AC	apparent consumption
AQ	assessment question
BIOHAZ	biological hazards

DV	deliverable
ECDC	European Centre for Disease Prevention and Control
EFTA	European Food Trade Association
EUMOFA	European market observatory for fisheries and aquaculture products
EUROSTAT	Statistical office of the European Union
FAO	Food and Agriculture Organization of the United Nations
LWE	Live weight equivalent means weight calculated based on conversion factors from the weight recorded on landing, or from the net weight of the various processed products
PIF	pathogens in food
ToR	Term of Reference

## ACKNOWLEDGEMENTS

The Panel wishes to thank the following for the support provided to this scientific output: Rubén Barcia-Cruz as well as the Pathogens in Food Database consortium (EFSA grant agreement GP/EFSA/BIOHAW/2023/05).

## REQUESTOR

European Commission

## QUESTION NUMBER

EFSA-Q-2023-00172

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**How to cite this article:** EFSA BIOHAZ Panel (EFSA Panel on Biological Hazards), Allende, A., Alvarez-Ordóñez, A., Bortolaia, V., Bover-Cid, S., De Cesare, A., Dohmen, W., Guillier, L., Herman, L., Jacxsens, L., Nauta, M., Mughini-Gras, L., Ottoson, J., Peixe, L., Perez-Rodriguez, F., Skandamis, P., Suffredini, E., Buchmann, K., Levsen, A., Mattiucci, S., ... Bolton, D. (2024). Re-evaluation of certain aspects of the EFSA Scientific Opinion of April 2010 on risk assessment of parasites in fishery products, based on new scientific data. Part 2. *EFSA Journal*, *22*(11), e9090. <https://doi.org/10.2903/j.efsa.2024.9090>

## APPENDIX A

## Data on import, landings and consumption of finfish in the EU

The Tables A.1, A.2 below presents a summary of the data collated on finfish landings, imports and consumption in the EU.

**TABLE A.1** Data on import, landings and consumption of freshwater finfish species in the EU.

Freshwater fish Common names	Latin names	Landings volume (kg), 2021	Imports to EU (kg, 2023)	Per capita consumption (kg, LWE) EU, 2021	Household consumption of fresh products, EUMOFA 2021
Carp	<i>Cyprinus carpio</i>	160,800	14,377,080	–	6,342,911
Catfish	Eg.: <i>Ictalurus punctatus</i> , <i>I. furcatus</i> ; <i>Clarias</i> spp., <i>C. gariepinus</i> , <i>C. batrachus</i>	4710	70,624,813	–	–
Pike	<i>Esox lucius</i>	281,800	–	–	–
Pikeperch	<i>Sander lucioperca</i>	714,590	–	–	36,271

**TABLE A.2** Data on import, landings and consumption of marine water finfish species in the EU.

Marine fishes common names	Latin names (family/species)	Landings volume (kg), 2021	Imports to EU (kg, 2023)	Per capita consumption of wild fish (kg, LWE) EU, 2021	Household consumption of fresh products, EUMOFA 2021
Anchovy	Engraulidae	104,776,120	52,565,535	–	10,323,964
Brill	<i>Scophthalmus rhombus</i>	1,828,600	–	–	–
Cod	Gadidae	16,489,680	648,257,344	1.75	59,113,954
Dab	<i>Limanda limanda</i>	4,354,410	–	–	13,763
Eel, Cusk	<i>Genypterus blacodes</i>	1,012,340	4,825,508	–	–
Eel	Anguillidae	770,200	4,722,064	–	–
Flounder, European	<i>Platichthys flesus</i>	18,000,580	1,732,435	–	–
Grenadier	Macrouridae	1,112,270	15,869,999	–	–
Gurnard	Triglidae	10,011,030	–	–	–
Haddock	<i>Melanogrammus aeglefinus</i>	14,563,780	35,270,529	–	946,662
Hake	Merlucciidae	143,063,080	280,808,552	1.02	68,160,374
Halibut, Atlantic	<i>Hippoglossus hippoglossus</i>	299,420	3,808,625	–	–
Halibut, Greenland	<i>Reinhardtius hippoglossoides</i>	7,318,170	46,902,426	–	–
Herring	Clupeidae	492,290,670	520,769,903	1.00	4,601,847
Horse mackerel, Atlantic	<i>Trachurus trachurus</i>	76,929,490	26,109,454	–	–
John dory	<i>Zeus faber</i>	2,740,000	–	–	–
Ling	Lotidae	3,181,310	10,879,583	–	–
Mackerel	Scombridae	222,009,970	355,396,879	0.53	32,731,456
Megrim	<i>Lepidorhombus whiffiagonis</i>	15,074,920	10,825,031	–	–
Monk	Lophiidae	35,459,700	41,128,258	–	12,110,118
Mullet, Red	Mullidae	14,985,760	–	–	–
Picarel	<i>Spicara smaris</i>	1,988,110	–	–	–
Plaice, European	<i>Pleuronectes platessa</i>	37,230,580	32,294,527	–	–
Pollack	<i>Pollachius pollachius</i>	2,874,530	3,773,009	–	–
Pouting (=Bib)	<i>Trisopterus luscus</i>	5,606,340	–	–	–
Ray	Rajidae	15,533,030	5,346,570	–	–
Redfish	Berycidae, Sebastidae	11,625,700	66,081,879	–	–



TABLE A.2 (Continued)

Marine fishes common names	Latin names (family/species)	Landings volume (kg), 2021	Imports to EU (kg, 2023)	Per capita consumption of wild fish (kg, LWE) EU, 2021	Household consumption of fresh products, EUMOFA 2021
Saithe (=Coalfish)	<i>Pollachius virens</i>	12,707,860	163,051,674	0.36	10,315,553
Salmon	Salmonidae	–	–	0.15	
Sardine	<i>Sardina pilchardus</i>	170,590,560	162,945,428	0.54	51,112,532
Scabbardfish	Trichiuridae	5,028,800	–	–	1,750,880
Seabass, European	<i>Dicentrarchus labrax</i>	4,485,310	84,739,788	–	39,034,591
Seabream, Gilthead	<i>Sparus aurata</i>	3,397,350	124,167,733	–	77,233,743
Smelt	Osmeridae	5,294,750	–	–	–
Sole, common	<i>Solea solea</i>	17,122,230	13,437,914	–	–
Sprat	<i>Sprattus</i> spp.	319,583,330	60,477,577	–	–
Swordfish	<i>Xiphias gladius</i>	20,686,800	48,265,115	–	9,475,634
Toothfish	<i>Dissostichus mawsoni</i>	140,240	2,348,213	–	–
Trout	Salmonidae	–	–	0.01	
Tuna all species	Scombridae	297,007,240	912,412,724	2.84	–
Turbot	<i>Scophthalmus maximus</i>	3,729,710	10,230,750	–	–
Weever	Trachinidae	1,113,320	–	–	–
Whiting	<i>Merlangius merlangus</i>	15,737,430	8,088,909	–	3,585,404
Amberjack, Greater	<i>Seriola dumerili</i>	–	–	–	–
Wolffish, Atlantic	<i>Anarhichas lupus</i>	–	–	–	–
Barracuda	<i>Sphyræna</i>	–	–	–	–
Blue butterflyfish	<i>Stromateus fiatola</i>	–	–	–	–
Capellin	<i>Mallotus villosus</i>	–	–	–	–
Croaker	<i>Argyrosomus regius</i>	–	–	–	–
Cusk=tusk	<i>Brosme brosme</i>	–	–	–	–
Dentex, Large-eye	<i>Dentex macrophthalmus</i>	–	–	–	–
Dogfish	<i>Squalus acanthias</i>	–	–	–	–
Eel, Conger	<i>Conger conger</i>	–	–	–	–
Flounder, Arrowtooth	<i>Atheresthes stomas</i>	–	–	–	–
Greater Argentine	<i>Argentina silus</i>	–	–	–	–
Groupers	Epinephelidae	–	–	–	–
Hairtail, Largehead	<i>Trichiurus lepturus</i>	–	–	–	–
Horse mackerel, other	Carangidae	–	–	–	–
Kingklip	<i>Genypterus hubbsi</i>	–	–	–	–
Ling, Blue	<i>Molva dypterygia</i>	–	–	–	–
Ling, Common	<i>Molva molva</i>	–	–	–	–
Megrim, Four-spotted	<i>Lepidorhombus boscii</i>	–	–	–	–
Pollock, Alaska	<i>Gadus chalcogrammus</i>	–	–	–	–
Porgy, Red	<i>Pagrus pagrus</i>	–	–	–	–
Scorpionfish, black	<i>Scorpaena porcus</i>	–	–	–	–
Scorpionfish, Red	<i>Scorpaena scrofa</i>	–	–	–	–
Seabass, Argentine	<i>Acanthistius brasiliensis</i>	–	–	–	–
Seabream	<i>Pagrus pagrus</i>	–	–	–	–
Sole, Senegalese Common	<i>Solea senegalensis</i>	–	–	–	–
Weever, Greater	<i>Trachinus draco</i>	–	–	–	–
Whiting, Blue	Gadidae	–	–	–	–

Abbreviation: –, no data.