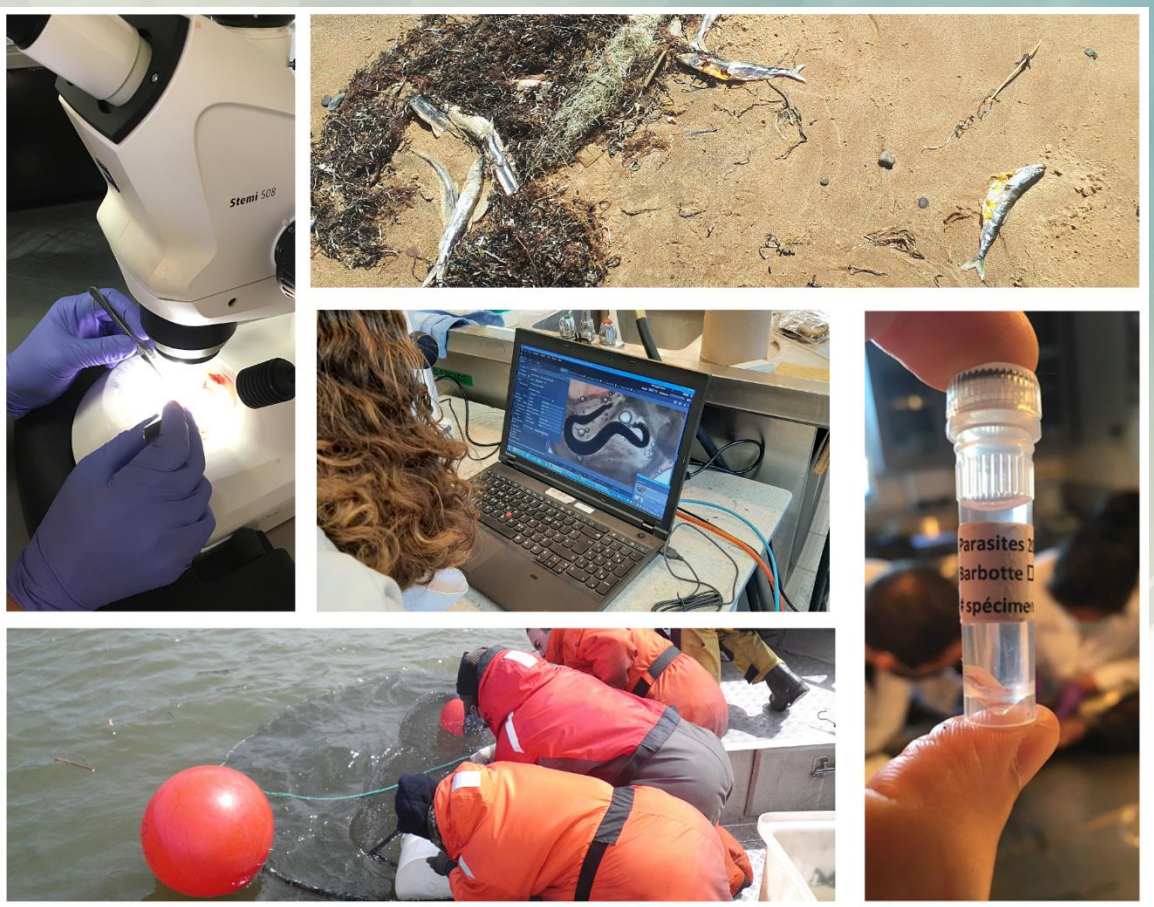
MINISTÈRE DE L'ENVIRONNEMENT,
DE LA LUTTE CONTRE
LES CHANGEMENTS CLIMATIQUES,
DE LA FAUNE ET DES PARCS

Wild Fish Health survey in Québec in 2020-2021

Review of Unusual Fish kills Reports and Knowledge Acquisition Projects



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Mandates of the Direction de l'expertise sur la faune aquatique

The *Direction de l'expertise sur la faune aquatique* (DEFA) at the Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) is tasked with a number of mandates relating to the health of aquatic wildlife. They include the following:

- Coordinate the detection, monitoring and control of aquatic wildlife diseases likely to have harmful consequences for indigenous aquatic species.
- Carry out risk analyses, appropriate intervention strategies and research projects on diseases and parasites affecting aquatic wildlife.
- Design communication products to inform the MELCCFP's client base about fish diseases and parasites, and present the information in an easily-understandable way.
- Address the concerns of the MELCCFP's client base with respect to fish health and safe fish consumption (client services).
- Prepare guidelines to structure the MELCCFP's management of unusual mortality events affecting wild fish, and use its expertise and knowledge of intervention protocols to support regional wildlife management offices when they receive reports of such events.[1]
- In cooperation with the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), prepare a collaborative framework to address unusual fish kills, which sets out the roles and responsibilities of each department.
- Oversee the enforcement of the *Regulation respecting aquaculture and the sale of fish* (chapter C-61.1, r. 7 - s. 26) (RASF) when requests to import fish to Québec are submitted to the MELCCFP, by analyzing the risk of introducing pathogenic organisms and diseases.
- Ensure that regulatory provisions are implemented with a view to preventing the introduction and spread of fish diseases in Québec's territory.
- Cooperate with the Canadian Food Inspection Agency (CFIA) for the surveillance of reportable diseases in Canada pursuant to the *Health of Animals Act* (S.C. 1990, ch. 21 (s. 2 para. 2).
- Maintain a partnership with the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ) on issues relating to animal health in aquacultural environments.

[1] The DEFA sends reports of dead fish received by the MELCCFP's client service department to the regional wildlife management offices concerned. The DEFA also ensures fluidity of communications when incidents are reported to the Wildlife and Parks Sector by members of the general public or by the media.

- Maintain a close relationship with other organizations involved in the management of aquatic wildlife diseases, including the Centre québécois sur la santé des animaux sauvages (CQSAS) and the Canadian Animal Health Surveillance System (CAHSS).

Wild fish kills

Like most living creatures, fish can be sick, injured or infested with parasites. The occasional presence of deformities, lesions or parasites among wild fish is therefore not, of itself, unusual. Issues such as these can be seen in every type of environment, from large cities to remote areas, because they are not necessarily related to water or habitat quality. For example, the presence of parasites in a wild fish population depends on the presence, in the ecosystem, of a set of living organisms that allows those parasites to develop from eggs to adult status (e.g. crustaceans, birds, predators, etc.). Mortality is also observed every year among wild populations. Although mortality, diseases and parasites are integral parts of ecosystems, some specific situations can be of more concern for wild populations.

The MELCCFP becomes involved when diseased fish or unusual fish kills are observed in natural environments in Québec. Its role is to assess the scope of the situation and, if possible, identify the cause of the mortality. In most cases, it is a question of natural causes deriving from the lifestyle of the fish or sudden environmental changes.

An in-depth investigation of reported cases may be needed when mortality cannot be explained, a new pathogen is suspected, a large number of fish are affected or the affected species are vulnerable (e.g. species at risk, species of interest for sport fishing or to the media, etc.). In these cases, MELCCFP biologists or technicians are sent to the site to verify and complete the information received in the report. Where necessary and where conditions permit (e.g. if dying or recently deceased fish are available), fish are harvested and sent to the CQSAS for analysis. These steps take place in accordance with established DEFA protocols (see the document entitled *Directives lors d'un signalement de mortalité anormale*).[2]

If a fish displays lesions or physical deformities, it is impossible to give a diagnosis without examining it. On the other hand, descriptions of observed clinical signs and analyses of photographs can provide diagnostic guidance and allow hypotheses to be formed.

The most frequent environment-related causes of fish kills include suffocation due to low dissolved oxygen content (hypoxia), stress due to overly warm water, exposure to toxins due to proliferations of harmful algae, and contaminant spillages. It is therefore important to gather information on the physico-chemical parameters of the environment, the weather conditions in the days preceding the mortality event, and sudden changes in the use of the adjacent land or the upper watershed (e.g. spreading of farm waste). It should be noted that water currents can cause dead fish to accumulate at some distance from the mortality site, which can hinder efforts to identify the source and nature of any causal agents.

Most fish kills events arising from fish health are the result of diseases caused by micro-organisms found naturally in bodies of water. Fish health generally returns to normal without intervention, in the space of

[2] Brisson-Bonenfant, C. and M. Pimentel. (2022). Problème de santé et mortalité anormale chez les poissons sauvages - Directives lors d'un signalement. Ministère des Forêts, de la Faune et des Parcs. 20 pages and 13 appendices.

a few days. Fortunately, most diseases and parasites found in wild fish are not dangerous to humans. However, some infections linked to parasites in the *Anisakidae* (roundworm) family and the *Diphyllobothrium* (segmented flatworm) genus can affect humans and cause digestive problems (e.g. gastrointestinal pain, nausea, vomiting, dizziness, etc.). Treatment is available to remove infections. The DEFA is required to inform the public about preventive measures to avoid contamination by the organisms in question.

In Canada, some diseases with significant repercussions for aquatic animal health or the Canadian economy are monitored and managed by the CFIA. These diseases are known as reportable diseases.[3] If the mortality was caused by a reportable disease, the CIFA, in collaboration with the MELCCFP, must launch an investigation and decide how to manage the disease (e.g. analysis, quarantine, eradication or isolation). The MAPAQ will also be involved if an outbreak of such a disease occurs in a fish farming environment.

The DEFA also responds to reports of parasites or physical deformities made by members of the general public to the Client Service department. Normally, these reports concern parasites found in the flesh or organs of wild fish captured by recreational anglers.

Compilation of reports

Unusual fish kill event involving wild fish

The DEFA is tasked with compiling unusual fish kills events reported to the MELCCFP. In 2020, 16 such events were declared (see Appendix 1). They occurred in seven administrative regions of Québec: Bas-Saint-Laurent, Capitale-Nationale, Mauricie, Estrie, Lanaudière, Montérégie and Centre-du-Québec (Figure 1),[4] in lakes (13) or rivers (3).

In 2021, 26 events were reported (Appendix 1). They occurred in nine administrative regions of Québec: Saguenay–Lac-Saint-Jean, Capitale-Nationale, Estrie, Outaouais, Chaudière-Appalaches, Lanaudière, Laurentides, Montérégie and Centre-du-Québec (Figure 1),[4] in lakes (14), streams (2), rivers (8) and the St. Lawrence River (2).

Most of the deaths were due to one-time environmental causes (e.g. high water temperature, lack of oxygen, cyanobacteria blooms, etc.). A potential toxic spillage was suspected in two events reported in 2020 and 2021, but could not be confirmed. In some cases, MELCCFP employees visited the site to complete the information in the report. Although fish were sampled for subsequent analysis by the CQSAS in most of these cases, the cause of mortality could not be identified because the fish were in an

[3] Anyone who owns or works with aquatic animals and knows of or suspects a reportable disease is required to notify the CFIA (in accordance with the *Health of Animals Act* [S.C. 1990, ch. 21]) and the MAPAQ.
[4] The maps were designed using information received by the DEFA and the regional wildlife management offices. There may be other events that have not been reported.

advanced state of decomposition. Some events were also reported in the media, possibly because of the large number of fish involved (Appendix 2).

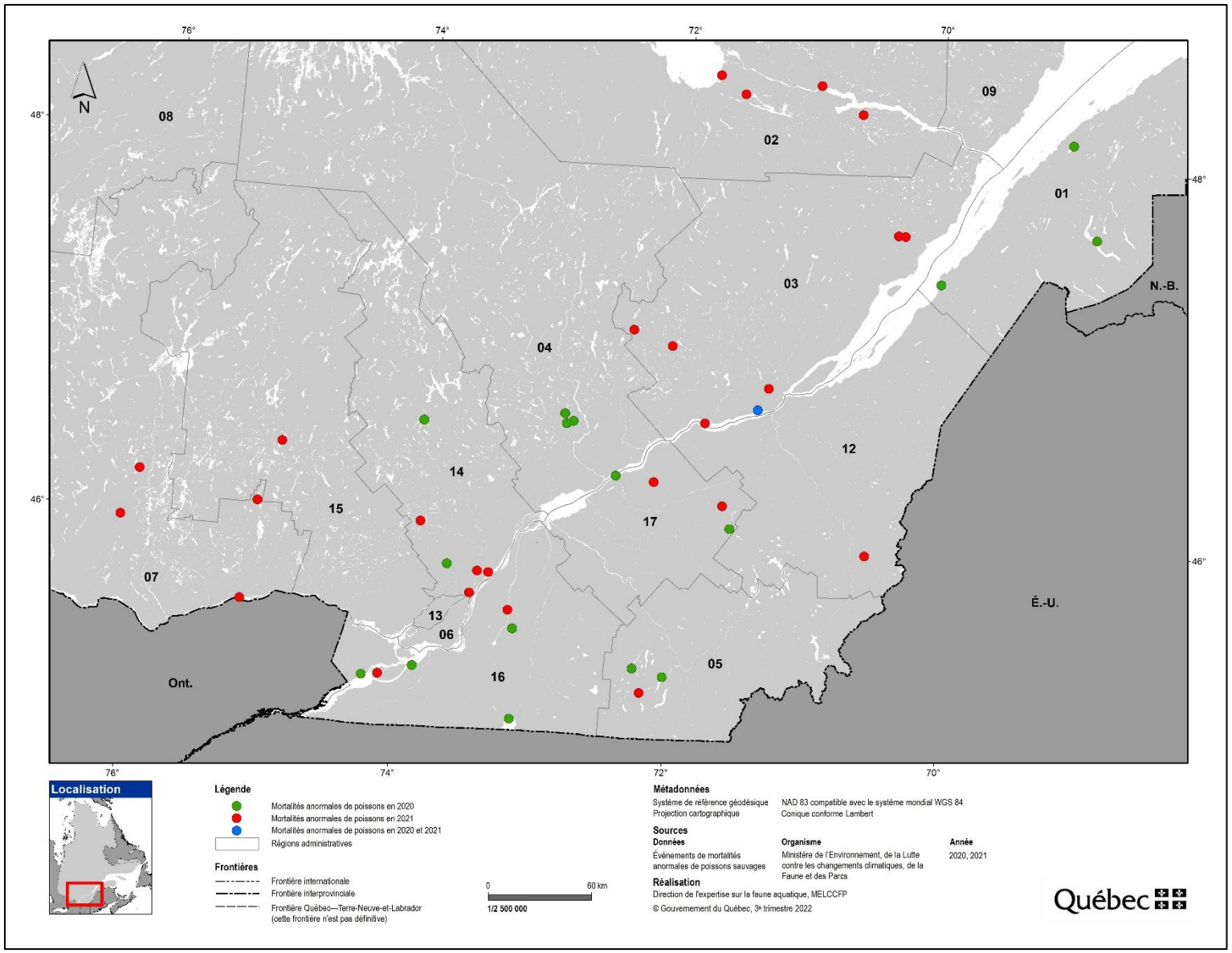

Figure 1. Distribution of unusual fish kills events reported to the Ministère des Forêts, de la Faune et des Parcs in 2020 and 2021.

Reports of parasites, physical deformities or diseases

The DEFA, via the MELCCFP's Client Service department, received 10 (in 2020) and 18 (in 2021) reports of parasites or physical deformities in fish caught by members of the general public. The main concern of the people making the reports was whether or not the fish could be consumed. In every case, information on the precautions to take in order to consume wild fish safely were sent to the people concerned (see the box below). If the problem cannot be diagnosed from the report alone, photographs (where available) can often be used to form a hypotheses as to the diagnosis. The presence of parasites from the nematode, trematode or copepod groups is often suspected.

Although most fish diseases are not dangerous to humans, and although it is rare for parasites to be transmitted from fish to humans, the following precautions will avoid any possibility of an adverse reaction after consuming wild fish:

- Do not consume a fish that appears to be diseased, or is dying, or was dead when found.
- When fishing, gut the fish quickly after death and keep it cool to limit migration of parasites from the organs to the flesh.
- Do not consume fish that are infested extensively with parasites or that have major deformities or multiple minor deformities.
- When preparing fish for cooking, manually remove all parasites and all visible deformities. Parasites are often found in the internal organs, but some may have made their way into the skin or flesh. Since they are always well-hidden, it is impossible to guarantee that there are no parasites at all in a fish.
- Cook the flesh fully (to an internal temperature of 63^{o} C for at least 15 seconds). Cooking destroys organisms that may cause adverse reactions in humans. The flesh should flake easily with a fork, and there should be no remaining translucent areas.
- It is not advisable to consume raw or partially cooked wild fish (e.g. in sushi). If you nevertheless wish to consume your fish in this state, please note that it must be deep-frozen at a constant temperature of 20 °C for at least seven days to destroy the parasites. This is not always achievable with a domestic freezer.
- Smoking of the fish is advisable only if the internal temperature of the fish reaches 63 °C for at least 15 seconds.
- Preparations involving salt or marinades are insufficient to destroy parasites.

Knowledge acquisition

The MELCCFP has been involved in a number of research projects over the years to acquire knowledge of diseases and parasites affecting wildlife, including fish, that are either already established in Québec or may be introduced (Ministère des Forêts, de la Faune et des Parcs, 2016 ; Lelièvre et al., 2010 ; Lelièvre et al., 2011). Among other things, this knowledge will be used to address the concerns of users and to manage both the animal species involved and the related socio-economic activities.

Many parasites need aquatic organisms to complete their life cycles, generating numerous interactions with fish. In addition, the aquatic environment plays an inherent role in the survival of numerous parasite infectious stages, as well as facilitating direct or indirect contacts with potential hosts (e.g. by ingestion). As a result, the freshwater ecosystem contains a broad range of parasites. By identifying their presence in specific fish species, we gain a better understanding of local parasite diversity and interactions between hosts. The DEFA coordinates and leads a number of research projects (Figure 2) aimed at understanding the role of parasites and other pathogens (e.g. bacteria, viruses, etc.) in the ecosystem and their impacts on fish populations. Many of these projects are carried out in conjunction with the regional wildlife management offices.

The main current projects in 2020 and 2021 are:

- Surveillance of the parasite *Anguillicola crassus* in the American eel (*Anguilla rostrata*) and development of a copepoda-based diagnostic method.
- Identification of parasites in the brown bullhead (*Ictalurus nebulosus*) and cormorant (*Phalacrocorax auritus*) in the Lac Saint-Pierre archipelago.
- Identification of parasites in the walleye (*Sander vitreus*), sauger (*S. canadensis*) and Atlantic tomcod (*Microgadus tomcod)* in the St. Lawrence River.
- Characterization of parasite diversity in tench (*Tinca tinca*) populations in Québec.

Figure 2. Projets sur les parasites de poissons réalisés par le MELCCFP.

Main research projects in 2020 and 2021

Parasites in the American eel: *Anguillicola crassus*

Anguillicola (synonym *Anguillicoloides*) *crassus* is a nematode parasite of Asian origin that infects the air bladders of eels belonging to the the *Anguillidae* family (Figure 3). It has the attributes of an excellent colonizer, including a high fertility level, low intermediary host specificity and the ability to use a broad range of fish as paratenic (optional) hosts. Research has shown that the parasite's spread may have played a role in the decline of American eel populations (Laetsch et al., 2012). Because of this significant democratic decline, a number of conservation measures have been introduced for the species, including repopulation of quality habitats from which it has disappeared or is present in small numbers. The transfer of eels from sufficiently populated sources is the best way of achieving repopulation. However, *A. crassus* complicates measures such as these, since it is important to avoid propagating the parasite. The MELCCFP carries out annual monitoring of the parasite to understand its distribution in Québec and to identify the best habitats from which to obtain unaffected eels.

At the present time, the only method that can be used to diagnose the presence of *A. crassus* in a habitat involves sacrificing eels and dissecting their air bladders. The development of a non-lethal method is therefore important. Given that the parasite transits via different organisms before infecting eels, it is suggested that a method should be developed to identify the parasite in its intermediate hosts. In 2021, the MELCCFP removed copepodas from bodies of water known to contain *A. crassus* in order to develop a molecular test to identify the parasite's DNA. The project is being carried out in collaboration with the laboratory run by D^{r} Louis Bernatchez (Université Laval).

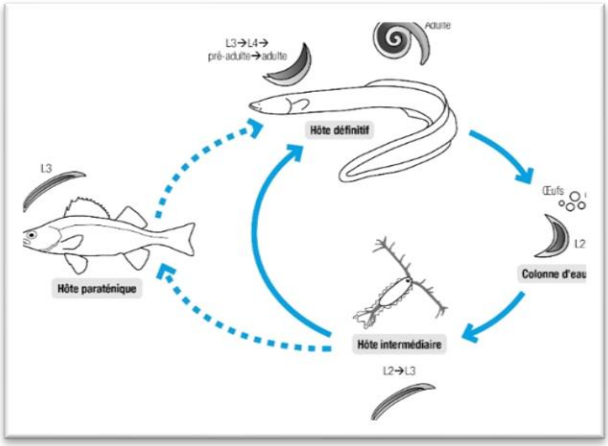

Figure 3. Life cycle of the parasite *Anguillicola crassus*. Adult parasites, which are found in the air bladders of eels, expel eggs into the water. These eggs hatch into free-swimming coral larvae which, when consumed by zooplankton, transform into a stage that can infect eels that feed on the zooplankton.

Parasites in the St. Lawrence River brown bullhead population

In recent years, a significant increase in the number of bullheads with white nodules at the base of their tails and in their muscles has been observed in the Lac Saint-Pierre commercial fishery (Nicolet sector). The increase appears to be in the region of 70 %. Three brown bullheads were sent to the CQSAS in 2018. Based on specimen necropsies, these nodules may be encystments of the trematoid *Clinostomum marginatum* (a condition commonly known as “yellow grub”). A pilot project was undertaken in 2020, jointly with the Mauricie–Centre-du-Québec regional wildlife management office, to confirm the identification of the parasite and learn more about the situation. Twenty bullhead fillets and twenty double-crested cormorant carcasses (the parasite’s suspected final host) were examined (Figure 4). The MELCCFP then carried out a genetic identification of the parasites harvested. The results of these analyses were not conclusive, however, probably because of the molecular test that was used. The condition of the samples may also explain the failure to obtain a result, since it was not possible to extract quality DNA from several of them. In 2021, 30 new fish were harvested to see whether the problem had persisted and, if so, to identify the parasites concerned using a new approach.

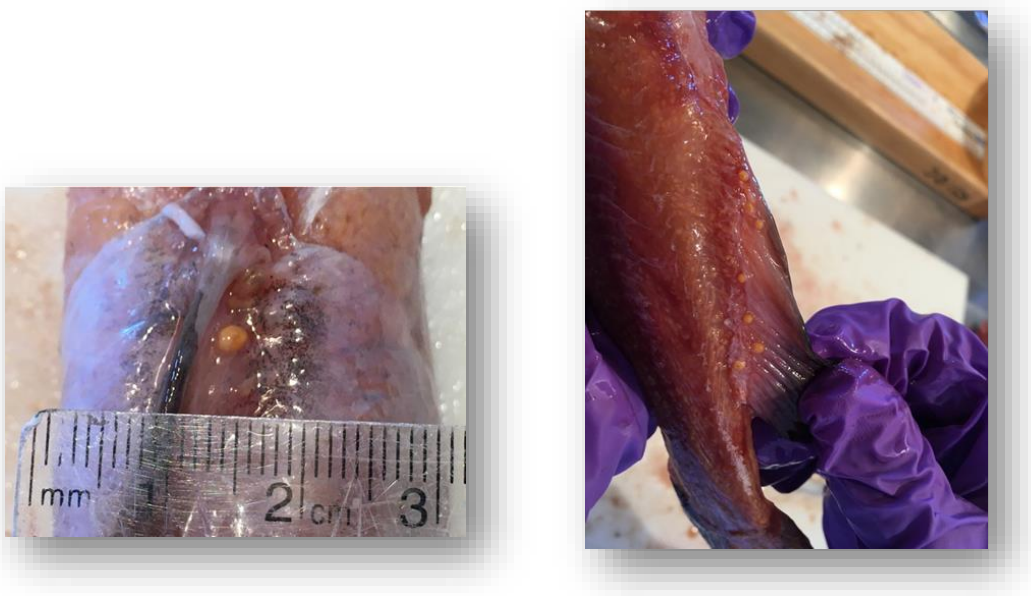

Figure 4. Photographs showing parasites in the flesh of brown bullhead fish caught in the St. Lawrence River

Parasites in the St. Lawrence River walleye, sauger and tomcod populations

In recent years, fishing enthusiasts have informed the MELCCFP that they have seen parasites in the flesh of walleye caught in the St. Lawrence River, mainly in Lac Saint-Pierre. Sampling was carried out in the summer of 2014, in the Lac Saint-Pierre archipelago, to learn more about this issue. The purpose of the sampling was to identify the prevalence of parasitic worms in walleye and sauger in this sector, and then to identify the parasites observed. It was found that 69% of the sampled saugers had at least one parasite in their flesh (fillets). Some of the parasites were identified morphologically and genetically by the laboratory run by D^{r} David Marcogliese (Environment and Climate Change Canada). They were nematodes known as *Pseudoterranova decipiens*. To develop, they need different intermediate hosts and a final host from the phocid (seal) family. It is for this reason that they are generally found on saltwater fish. To our knowledge, this is the first time *P. decipiens* has been found in Canada in a non-anadromous species harvested from a freshwater environment. The presence of this parasite in fish populations in Lac Saint-Pierre is also surprising, since the body of water is located at some distance upstream from the salinity front.

To investigate further, additional samples were harvested in 2019 and 2020. The purpose of the study was to compare the prevalence and abundance of parasitic nematodes in the flesh of two freshwater species (walleye and sauger) and one saltwater species (Atlantic tomcod) from different locations in the St. Lawrence River. The aims were as follows: (1) to calculate the prevalence of fish with nematodes in their flesh; (2) to assess the probability of being invested by nematodes; (3) to compare the abundance of nematodes in the flesh of fish from three sectors of the St. Lawrence River and (4) to confirm the natural occurrence of *P. decipiens* using genetic tools. The early results showed that *P. decipiens* was present in the flesh of three sampled fish. This result raises some new hypotheses concerning the potentially key role of the Atlantic tomcod, a saltwater species that reproduces in freshwater, in spreading *P. decipiens* from seals to walleye and sauger in the St. Lawrence River. The complete results from the study will be available in 2022.

Figure 5. Photograph of a nematode removed from a sauger

Parasites in Québec's tench population

The tench is a fish that originated in Europe and was introduced to Québec in the 1990s. In its original range, the tench may host a variety of parasite species, but only four have been observed in the tench in Québec (Marcogliese et al., 2009). This is consistent with a general trend observed in introduced species, which tend to host fewer parasites than their counterparts in their original range and indigenous species. (Torchin et al., 2003). The exotic cestode *Valipora campylancristrota* was found in two tench in Rivière Richelieu in 2000 (Marcogliese et al., 2009). This parasite, never before identified in Québec, may have been introduced at the same time as the tench. Its current prevalence among tench or other indigenous fish species is unknown.

The tench population in the St. Lawrence River is currently undergoing significant expansion and could become a vector for parasite spread. The project's aims are 1) to assess the parasite load of the tench population to address requests for its development, 2) to compare differences in the tench parasite load over time (between 2000 and 2021) and in space (between the colonization front and the sectors in which it is established), 3) to compare the parasite load of tench with that of other (indigenous and exotic) fish species in Rivière Richelieu, and 4) to identify new exotic parasites. A second round of samples will be taken in 2022. The study's findings should be available in 2023.

Communication methods

The DEFA has prepared a variety of products to convey information on fish diseases and parasites and the associated risks to MELCCFP client groups. For example, the departmental website presents detailed information sheets on fish diseases found in or near Québec. In addition, the DEFA posts regularly on the Ministère's Facebook page. In 2020 and 2021, seven posts were made on fish parasites, safe consumption of wild fish, and certain fish-specific diseases (e.g. black spot disease and dermal sarcoma of walleye). These posts always generate a lot of interest! The capsule on black spot disease, produced in 2020, was shared more than 3,000 times. A poster summarizing the precautions to be taken when consuming wild fish was also produced. Lastly, a paper on the myths and realities of aquatic parasites was published in the journal *In Vivo* produced by the Association des biologistes du Québec (Pimentel, 2020) (Figure 6).

Figure 6. Examples of communication products created and circulated in 2020 and 2021 by the MELCCFP.

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Appendix 1. Summary of reports of unusual fish kills

	Regional wildlife management office (DGFa)	Date	Location	Species affected/number and condition of fish	Possible cause
2020	Bas-Saint-Laurent	14 May	Rivière-Ouelle	Capelin (100-200)	Normal capelin mortality along the shore
		22 May	Lac Saint-Mathieu	Rainbow smelt	Suspected environmental origin (reduction of oxygen dissolved in the water)
		08 July	Lac Témiscouata	A lot of dead fish	Unknown
	Capitale-Nationale–Chaudière-Appalaches	25 June	Lac Saint-Augustin	Several specimens from several species	Lack of oxygen
	Mauricie-Centre du Québec	27 June	Lac des Piles	Largemouth bass (3)	Heatwave the previous week and significant temperature variation
		29 June	Lac William	Yellow perch, brown bullhead (30 fish in all)	Possibly temperature-related
		24 July	Lac à la Pêche in Shawinigan	Dead fish (3)	Probably a toxic spillage
		13 August	Rivière Bécancour	Diseased and dead fish (10+)	Overinfection of pathogens, possibly temperature-related
		8 November	Lac à la Perchaude	Numerous dead fish (rudd)	Cyanobacteria bloom
	Estrie-Montréal-Montérégie-Laval	20 June	Lac Champlain — Baie Missisquoi	Different species (several thousand fish)	Environmental changes (high temperature, hypoxia) that may have been a direct cause of mortality, or may have fostered the development of fatal bacterial infections
		6 July	Lac Stukely	Brown trout (living fish exhibiting unusual behaviour or dead fish)	Fungal growth (saprolegnia)
		6 July	Lac Saint-François	Numerous dead fish: minnows (Saint-Zotique) and largemouth bass (Beauharnois)	Unknown
		4 August	Petit lac Magog	Dead lake trout (5)	Lack of an ideal habitat, plus heat and low water flow, probably caused the deaths
		10 August	Lac Hertel	Numerous dead fish	Probably natural mortality, hyperthermia or anoxia
	Lanaudière et des Laurentides	6 July	Lac du Trèfle	Yellow perch (70+)	Unknown
		18 September	Rivière L'Achigan	Numerous deadfish of every species and every size	Unknown

	Regional wildlife management office (DGFa)	Date	Location	Species affected/number and condition of fish	Possible cause
2021	Saguenay–Lac-Saint-Jean	13 June	Rivière Valin (Saint-Fulgence)	Large number of dead fish (rainbow smelt)	Unknown
		8 July	Lac Otis	Dead rainbow smelt	Post-spawning mortality
		14 August	Petite rivière Bédard	Fish of several species (1,000)	Cause of death undetermined, very unlikely to be infectious in nature
		Unknown	Rivière Ticouape	Smelt (10+)	Unknown
		Unknown	Ruisseau des Boivin	Brown bullhead (50)	Unknown
	Capitale-Nationale–Chaudière-Appalaches	4 May	Rivière Duberger	Some dead fish	Unknown
		7 July	Cap-Santé in Portneuf	Sturgeon carcasses	Unknown
		24 August	Lacs Versicolore and Lac Canton	Numerous brook trout	High water temperature and hypoxia
		10 November	Lac à France	Numerous specimens of numerous species	Unknown
		Unknown	Lac Saint-Augustin	Numerous specimens of numerous species	Unknown
		Unknown	Lac Nairne	Brook trout mortalities	Unknown
		Unknown	Lac Sainte-Marie	Brook trout mortalities	Unknown
	Mauricie–Centre-du-Québec	26 May	Lac Rose	Brown bullhead (220)	Probably thermal shock
		13 July	Lac Camille	Fish kill	Sudden periods of high temperature in spring
	Estrie-Montérégie-Montréal-Laval	2 June	Rivière Saint-Charles (Salaberry-de-Valleyfield)	Numerous dead fish	Unknown
		18 June	Rivière Richelieu	Several dozen fish	Probably lack of oxygen
	Outaouais	12 April	Rivière des Outaouais-baie Noire	Numerous species (common carp, northern pike, perch, brown bullhead, yellow bullhead, panfish, largemouth bass, common sucker) (100+)	Combination of environmental factors Water quality
		11 June	Lac Grant	Numerous fish (including dozens of panfish)	Unknown
		22 July	Lac Lyons	Dead fish (including perch and panfish) (500+)	Unknown

Regional wildlife management office (DGFa)	Date	Location	Species affected/number and condition of fish	Possible cause
Lanaudière and Laurentides	30 April	Marais du ruisseau de Feu	Dead fish of different species (including some chub) (1,750)	Winter mortality Oxygen shortage
	22 May	Lac Nominingue	Thousands of rainbow smelt	Mortality often observed after the spawning period because the accumulation of fish is conducive to the spread of diseases (bacteria, viruses) that are naturally present in the population. In addition, a heat episode in the preceding days may also have made the fish more vulnerable to disease.
	12 June	Quai Saint-Sulpice	Sturgeon and brown bullhead (15)	Heat and low water levels
	29 July	Lac Robert à Chertsey	1 common sunfish, 1 perch and hundreds of frogs	Hypothesis of a toxic spillage into the lake
	27 September	Rivière Saint-Esprit	Thousands of dead fish (American chub, chub, panfish, perch and spottail shiner	Unknown

Appendix 2. Media review: Fish kills events involving wild fish

*Media Review, 2020			
Newspaper	**Title**	**Date**	
La Voix de l'Est	Des centaines de poissons morts sur les rives de la baie Missisquoi	18 June 2020	https://www.lavoixdelest.ca/actualites/des-centaines-de-poissons-morts-sur-les-rives-de-la-baie-missisquoi-a48f46dbae49864a5473d46e52005018
Versants		15 June 2020	https://www.versants.com/des-poissons-morts-sur-les-rives-du-richelieu/
L'Avenir et des Rivières	Des centaines de poissons morts à Philipsburg et Venise-en-Québec	16 June 2020	https://www.laveniretdesrivieres.com/2020/06/16/des-centaines-de-poissons-morts-a-philipsburg-et-venise-en-quebec/
TVA nouvelles	Des centaines de poissons morts dans un lac à Saint-Augustin-de-Desmaures	21 June 2020	https://www.tvanouvelles.ca/2020/06/21/des-centaines-de-poissons-morts-dans-un-lac-a-saint-augustin-de-desmaures
Métro l'appel	Facture partagée pour les poissons morts au lac Saint-Augustin	10 July 2020	https://www.quebechebdo.com/local/journal-lappel/215096/facture-partagee-pour-les-poissons-morts-au-lac-saint-augustin/
Le Journal de Montréal	Des centaines de poissons meurent dans un déversement	27 September 2020	https://www.journaldemontreal.com/2020/09/27/des-centaines-de-poissons-meurent-dans-un-deversement

*Media Review, 2021			
Newspaper	**Title**	**Date**	
Le Droit	Plaisance : des dizaines de poissons morts échoués dans la Baie-Noire	12 April 2021	https://www.ledroit.com/actualites/petite-nation/plaisance-des-dizaines-de-poissons-morts-echoues-dans-la-baie-noire-8c8fcd0ed472a93fd95a8f9190cc7501
TVA nouvelles	Mystérieuse présence de tortues et de poissons morts sur les berges de deux rivières	20 June 2021	https ://www.tvanouvelles.ca/2021/06/20/mysterieuse-presence-de-tortues-et-de-poissons-morts-sur-les-berges-de-deux-rivieres
Le Journal de Chambly	Le « festival » du poisson mort…	25 June 2021	https://www.journaldechambly.com/carpes-asiatiques-mortes/
Les Versants	Des poissons morts sur les rives du Richelieu	7 July 2021	https ://www.versants.com/des-poissons-morts-sur-les-rives-du-richelieu/
Néomedia Vaudreuil-Soulanges	Les poissons meurent par dizaines dans la rivière Rigaud en Ontario	9 September 2021	https://www.neomedia.com/vaudreuil-soulanges/actualites/environnement/436659/les-poissons-meurent-par-dizaines-dans-la-riviere-rigaud-en-ontario

*Non-exhaustive list

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