Toxic Contamination of Marine Resources

Background

Many chemical contaminants, including organic compounds and metals, are transported from large urban and industrial centres of North America to the Estuary and Gulf of St. Lawrence through freshwater flows and the atmosphere. The vast majority of these contaminants are mainly associated with suspended solids and are deposited in sediment in the Laurentian Channel (Figure 1), downstream from the mouth of the Saguenay Fjord. However, a portion of the contaminants transported or directly discharged into the estuary and gulf is taken up by marine biota.

Figure 1. Sampling coverage of the contaminant monitoring program in St. Lawrence marine biota

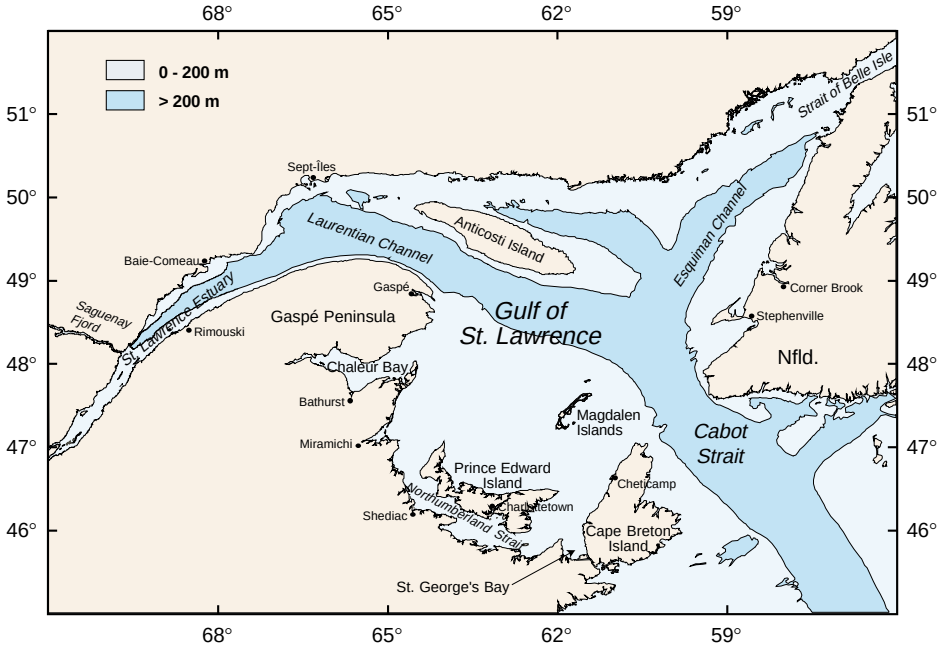


Photo: Viviane Haeberlé, Fisheries and Oceans Canada

Sampling marine organisms during a research survey in the Gulf of St. Lawrence

In the early 1990s, the Department of Fisheries and Oceans (DFO) established a contaminant monitoring program. The program aims to provide an overview of the contamination of biological resources in the estuary, fjord and northern part of the gulf, and to monitor

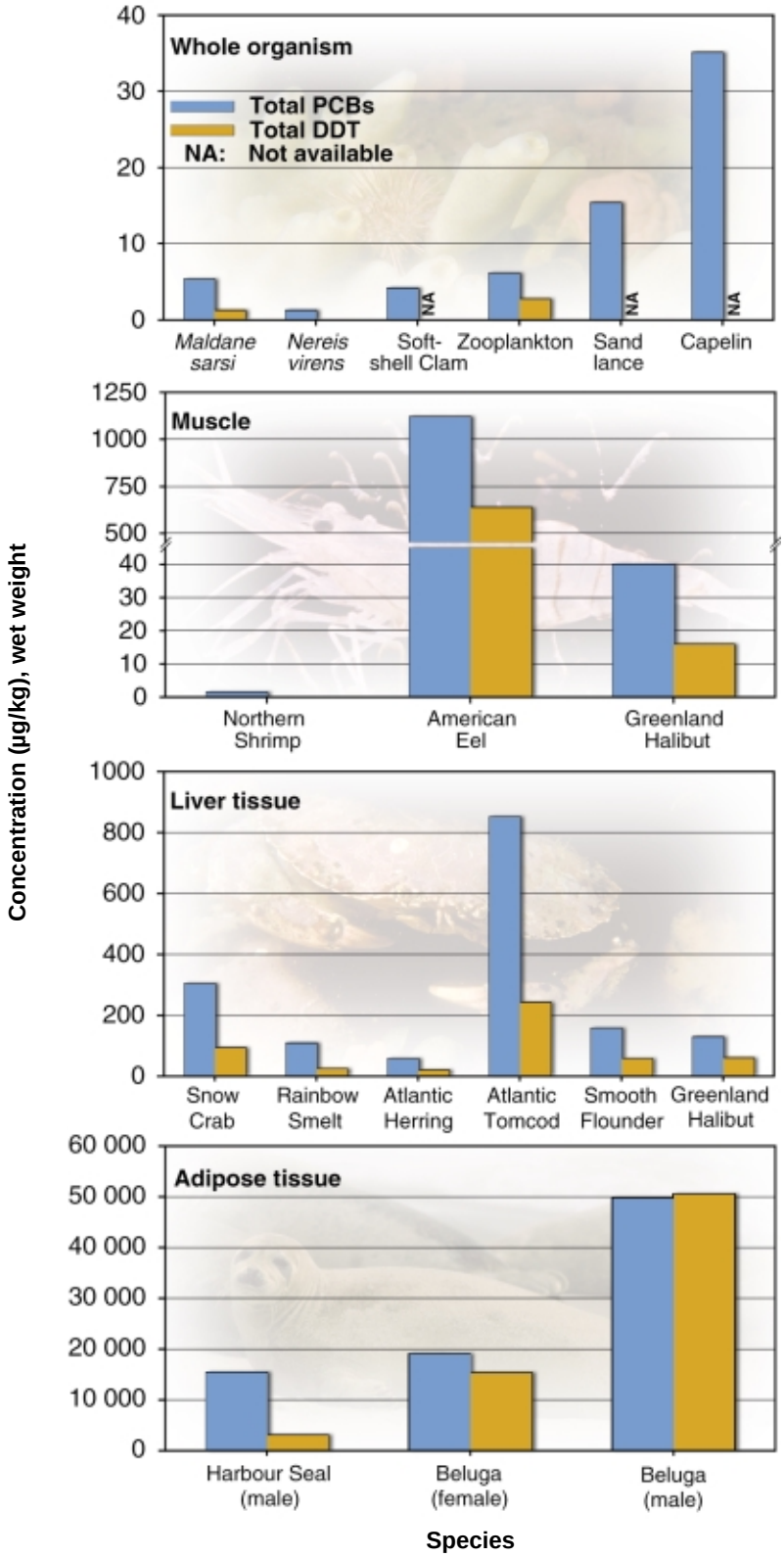
spatial and temporal variations in contamination in selected species. The program also seeks to identify new problems that may be related to emerging sources of contamination or to issues associated with contaminants not previously inventoried. Under the program, it will be possible to establish databases and biological tissue banks which, in the long term, will be useful for research activities requiring access to historical data series on contamination in the marine St. Lawrence.

Program Description

The chemical contaminants selected for monitoring are generally those whose use is controlled, restricted or prohibited. They include metals such as mercury (Hg), lead (Pb) and cadmium (Cd), as well as various persistent organic compounds, such as DDT and polychlorinated biphenyls (PCBs). Depending on the species, the contaminants are measured in the entire organism, muscle, liver, hepatopancreas or adipose tissue. The provenance of samples varies from species to species, but the sample collection is generally carried out during scientific missions at sea. In some cases, such as the beluga's, samples are provided through a monitoring program of marine mammal strandings.

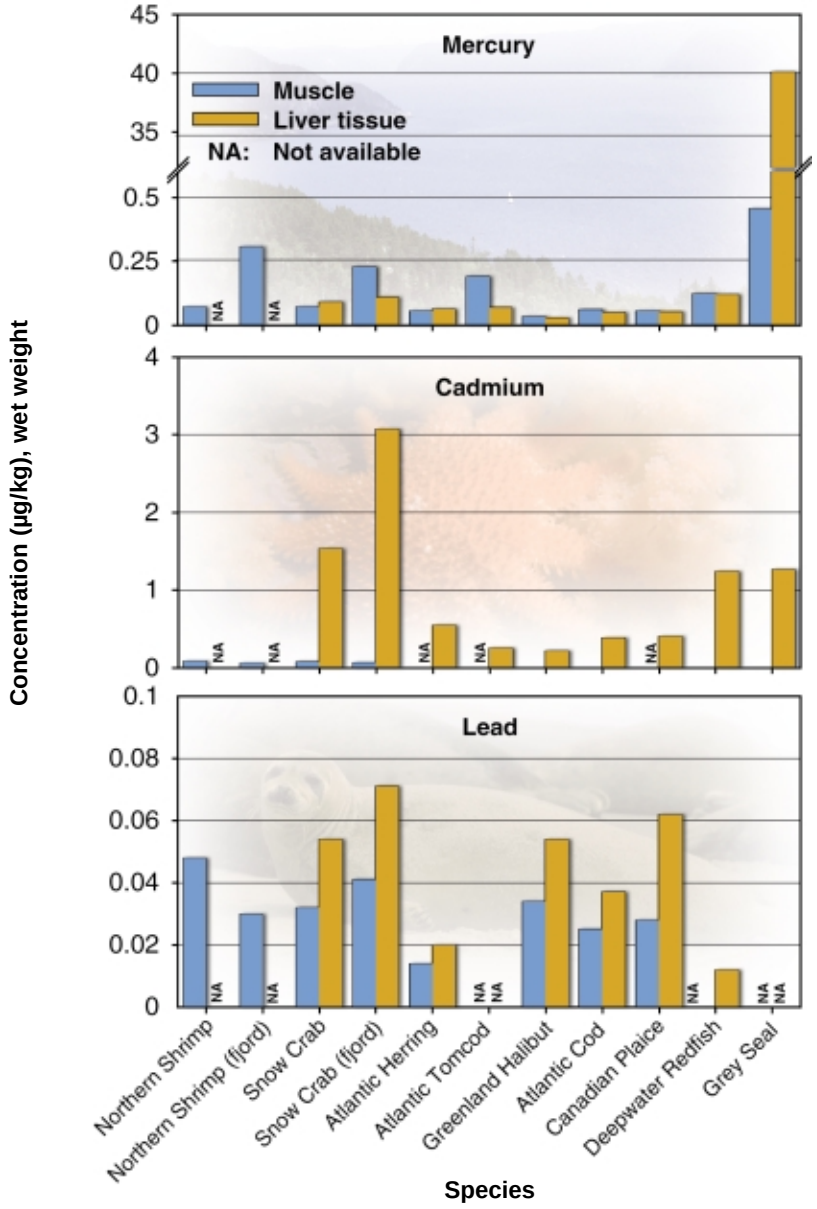
Temporal monitoring is also carried out at one- to five-year intervals for certain species of invertebrates, fish, and marine mammals, including Northern Shrimp, Snow Crab, tomcod, Greenland Halibut and beluga. Temporal monitoring sites are generally located in the Saguenay Fjord or the St. Lawrence Estuary (Figure 1). This component of the program provides the data required to monitor the evolution of contamination in certain species in specific sectors

Figure 2. PCB and DDT contamination in various species of invertebrates, fish and marine mammals in the Estuary and Gulf of St. Lawrence



Note: Total PCBs (sum of 40 measured congeners).
Total DDT (sum of 6 measured isomers and derivatives).

Figure 3. Contamination by metals (mercury, lead, cadmium) in the muscle and liver of different species of invertebrates, fish and marine mammals in the Estuary and Gulf of St. Lawrence and in the Saguenay Fjord



for which problems have been identified in the past.

Spatial monitoring is carried out for a number of species in the fjord, estuary and gulf in order to monitor geographic variations in the contamination of the biota in the St. Lawrence marine ecosystem. Northern Shrimp, Atlantic Cod, and Greenland Halibut, among others, are monitored. Spatial monitoring is also carried out within a more restricted area in order to identify the most contaminated sectors in a given region.

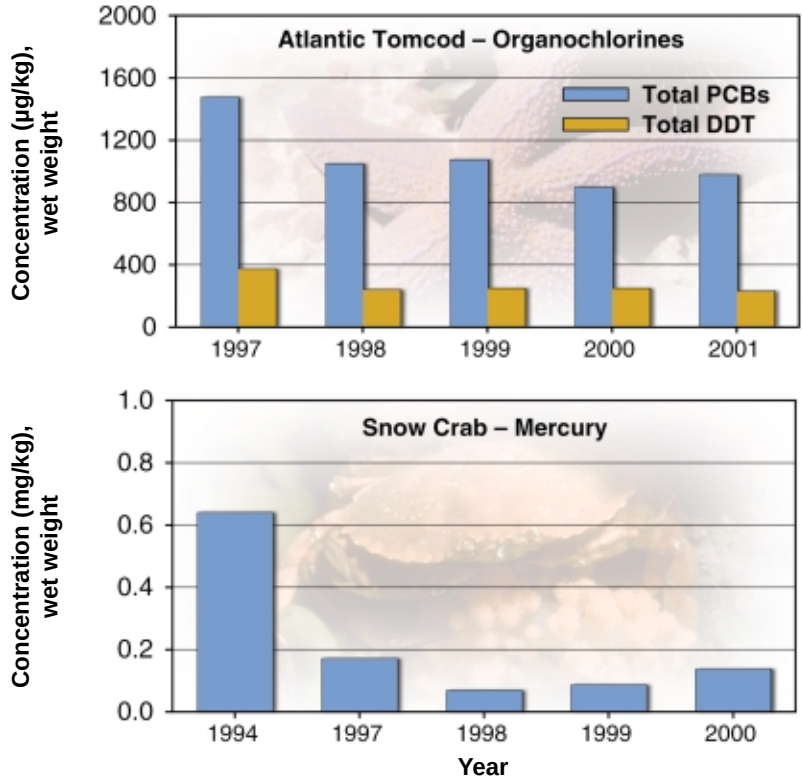
All data generated under this program are incorporated into the National Contaminants Information System (NCIS). The NCIS is a substantial source of information and ensures the long-term preservation of data. Samples collected under the program are also placed in a biological tissue bank that may be useful in retrospective studies of the contamination of marine biota by emerging chemical contaminants, among others.

Overview of the Situation

The data collected since the early 1990s generally indicate a low level of contamination of biota in the Estuary and Gulf of St. Lawrence, except for a number of species which are the focus of special attention. For all species studied, the measured concentrations of organic and inorganic contaminants are generally below acceptable limits for the commercial sale of fish products. However, contamination by organochlorine compounds, specifically DDT and PCBs, is much higher in the adipose tissues of marine mammals than in the muscle or liver of the invertebrates and fish studied. This is particularly true in the case of belugas, where concentrations in males reach 50 mg/kg (ppm) (Figure 2). Male belugas are generally more contaminated than females because of the transfer, by females, of contaminants to newborns through gestation and lactation.

PCB and DDT contamination in invertebrates and fish in the St. Lawrence marine ecosystem varies little among species, with the exception of Atlantic Tomcod and American Eel (Figure 2). The liver tissue of invertebrates and fish is generally more contaminated by organic compounds than muscle. This is due to the fact that the liver of fish generally has a higher lipid content than muscle, and that organochlorine contam-

Figure 4. Temporal variations in PCB and DDT contamination in Atlantic Tomcod from the St. Lawrence Estuary, and of mercury contamination in Snow Crab from the Saguenay Fjord in the 1990s



Note: Total PCBs (sum of 40 measured congeners).
Total DDT (sum of 6 measured isomers and derivatives).

inants tend to accumulate in tissues with high lipid content. However, PCB and DDT levels in muscle of Greenland Halibut is higher than in the other fish or invertebrates, due to their higher lipid content.

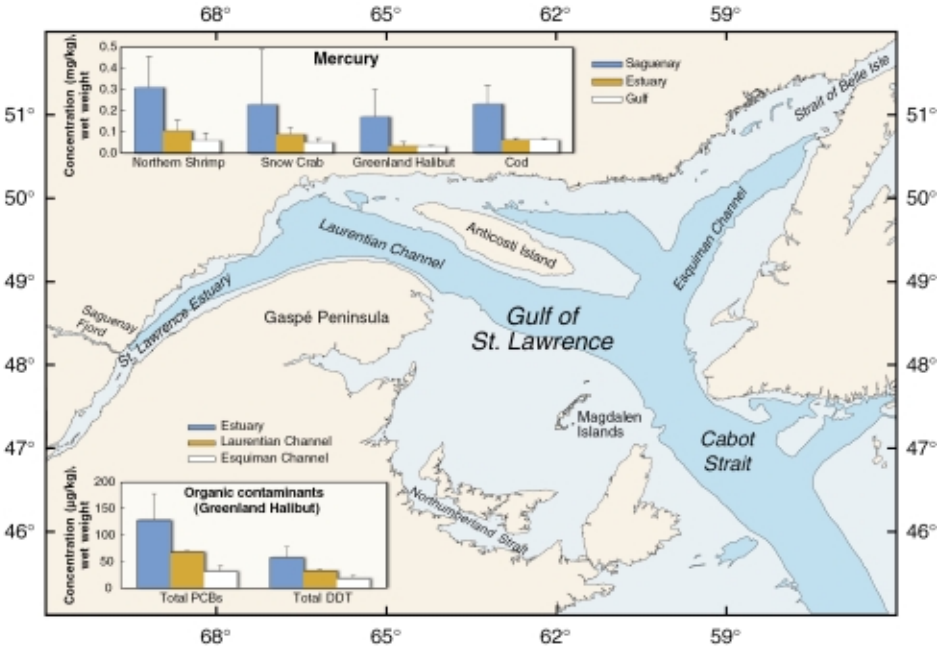
With respect to inorganic contaminants, the program results show low metal concentrations in fish products from the estuary and gulf (Figure 3). Mercury concentrations are low in all species studied, except Northern Shrimp and Snow Crab from the Saguenay Fjord, where they are close to the limit for the commercial sale of fish products (0.5 mg/kg). Lead concentrations are generally low for all crustaceans and fish from the estuary and gulf. However, cadmium is a concern due to the high concentrations (0.2 to over 3 mg/kg) found in the liver of several species of fish, Grey Seals and Snow Crab. A study is currently under way to determine the extent and origin (natural or anthropogenic) of the high cadmium concentrations.

Several trends have emerged from the monitoring of temporal variations in the contamination of certain species, suggesting an improvement in the state of health of the St. Lawrence marine ecosystem since the early 1990s. For example, the monitoring of tomcods caught in the Upper Estuary reveals that PCB and DDT concentrations in liver have decreased slightly since 1997 (Figure 4). In Snow Crab, a reduction in the mercury concentration in muscle was observed between 1994 and 1997 in the Saguenay Fjord (Figure 4). A similar downward trend was also observed for mercury in Northern Shrimp from the fjord, and for several contaminants in migratory eels from the estuary and also in belugas, for whom the trend is nonetheless not yet clear.

A number of spatial trends have also emerged from the monitoring of the contamination of biota in the St. Lawrence marine ecosystem. These trends provide a better picture of the state and origin of the contamination of resources throughout the study area. In general, the contamination of marine organisms decreases from upstream to downstream, thus reflecting variations observed in the contamination of sediments in the Laurentian Channel. This is the case for mercury, for which concentrations in some species of crustaceans and fish are higher in the estuary than in the gulf (Figure 5). This trend results from the greater contribution of contaminants transported by freshwater flows from the upstream St. Lawrence River to the estuary, relative to the gulf. The spatial variations in DDT and PCB concentrations in Greenland Halibut in the estuary and gulf (Figure 5) also illustrate this trend.

The Saguenay Fjord represents a special case in terms of contamination in the St. Lawrence marine ecosystem, particularly for mercury (Figure 5). Concentrations of this metal in muscle of Northern Shrimp, Snow Crab, Greenland Halibut and cod are higher in the fjord than in the estuary and gulf. Sediments from the fjord were heavily contaminated by mercury until the early 1970s, when mercury concentrations in Northern Shrimp exceeded 10 mg/ kg at the time,

Figure 5. Spatial variations of mercury contamination in the muscle tissue of some commercially exploited species, and of PCB and DDT contamination in Greenland Halibut, in the St. Lawrence marine ecosystem



Note: Total PCBs (sum of 40 measured congeners).
Total DDT (sum of 6 measured isomers and derivatives).

leading to the closure of the fishery. Although mercury levels in shrimp have declined considerably since then, the fjord remains closed to all commercial fishing as a preventive measure.

Other specific regions of the estuary and gulf which have had contamination problems are also being monitored, specifically Baie des Anglais, near Baie-Comeau on the north shore of the Lower Estuary, where high levels of PCBs are found in sediments.

Outlook

A considerable amount of information has been obtained since the early 1990s from the monitoring of chemical contamination of organisms in the marine St. Lawrence ecosystem. The program was recently reviewed, on the basis of this information, to identify the main marine resource contamination concerns that should be the subject of long-term monitoring. The program review also aims to define key parameters (indicators) that should be periodically measured. An exploratory component will be maintained in order to identify new resource contamination issues in the ecosystem (emerging contaminants, contaminated sites). It will enable stakeholders to be proactive in addressing contaminants in the St. Lawrence marine ecosystem.

Concurrently with these activities, the program will continue to establish a biological tissue bank to be used in retrospective analyses associated with new contamination concerns, specifically compounds not previously inventoried. Finally, DFO will continue its activities

Photo: Fisheries and Oceans Canada

KEY VARIABLES

Contamination of the St. Lawrence Beluga Whale

There is no representative universal parameter that can be used to determine the state of ecosystem contamination and inform on the state of the ecosystem. However, the study of contamination in the Beluga Whale can provide some indication of temporal variations in the contamination of the resources of the St. Lawrence marine ecosystem, especially for contaminants that are present in very small amounts in the environment.

Given their position at the top of the food chain, their long life span (up to 30 years) and the transfer of contaminants from one generation to another through gestation and lactation, belugas accumulate large quantities of contaminants and are therefore excellent integrators of contamination in the food chain. Long-term changes in concentrations of various contaminants in belugas can therefore provide reliable indications of the temporal evolution of ecosystem contamination. Belugas are one of the first species in which existing or emerging contaminants present in the environment at trace levels will be measurable.

related to the NCIS in order to secure the data obtained under the monitoring program and to ensure its availability to concerned clients and partners in the chemical contamination of organisms in the St. Lawrence marine ecosystem.

Photo: Fisheries and Oceans Canada

To Know More

GOBEIL, C., Y. CLERMONT, and G. PAQUETTE. 1997. *Concentrations en mercure, plomb et cadmium chez diverses espèces de poissons de fond, de poissons pélagiques et de crustacés de l'estuaire et du golfe du Saint-Laurent et du fjord du Saguenay*. Canadian Data Report of Fisheries and Aquatic Sciences 1011: v + 83 pp.

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State of the St. Lawrence Monitoring Program

Four government partners — Environment Canada, the ministère de l'Environnement du Québec, the Société de la faune et des parcs du Québec, and Fisheries and Oceans Canada — are pooling their expertise and efforts to provide Canadians with information on the state of the St. Lawrence and long-term trends affecting it. To this end, environmental indicators have been developed on the basis of data collected as part of each organization's ongoing environmental monitoring activities. These activities cover the main components of the environment, namely water (quality and quantity), sediments, biological resources (species diversity and condition), uses and, eventually, shorelines.

For additional copies or the complete collection of fact sheets, contact the St. Lawrence Vision 2000 Coordination Office:

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The fact sheets and additional information about the program are also available on the Web site: **www.slv2000.qc.ca** .

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