LE FLEUVE

NEWSLETTER
ST. LAWRENCE VISION 2000
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IN TUNE

BETWEEN THE SEA AND FRESH WATER

Most likely because the inhabited portion of the St. Lawrence basically corresponds to the fluvial section of the St. Lawrence River, the actions taken to safeguard the Lower Estuary and the Gulf of St. Lawrence are less well-known to the general public. The ecosystems found here are literally sandwiched in-between the sea and fresh water.

This issue is almost entirely devoted to the researchers who are striving to update our understanding of the marine environment of the St. Lawrence River. For the most part employed by the Maurice-Lamontagne Institute, these researchers are blazing new trails in fields where either data were practically nonexistent just a few years ago or are completely out of date.

This newsletter is to small a format to give an account on all the research projects under way. Instead, we have decided to present an in-depth article on how the monitoring of the Gulf and the Estuary makes use of an entire range of technologies and branches of scientific expertise and why this aspect is so promising for the years ahead. Another article, on marine sediment, a veritable witness to bygone eras, illustrates how this material is a boon to research. You might also read up on the restoration of coastal habitats in Chaleurs Bay, the flocking of the fin whale to the Upper Estuary and the new *Atlas of Tidal Currents of St. Lawrence*.

Developing Plan III

A Watershed Issue

The Development Committee and task forces worked intensively throughout the fall toward a future Plan III. The objective set by experts and managers was to have priorities and actions stipulated for each of the targetted Components that are to be included in a third five-year plan on the River. Let us remind you of the six issues that have captured the attention of the Committee: Health, Agriculture, Urban Works, Industrial Concerns, Community Involvement and Biodiversity. In September, a seventh component was added to this list: Monitoring the Ecosystem.

An eighth task force was also set up to examine all the aspects related to navigation on the River. Previously incorporated in the group discussions held on biodiversity, this issue begs several questions, i.e., dredging management, accidental spills of various products, and the erosion of banks, to name but a few. The input of seasoned experts and experienced managers are needed to deal with these questions. Indeed, the new task force includes representatives from government departments and independent organizations all concerned by this topic, as well as representatives of the Advisory Committee of SLV 2000 and Stratégies Saint-Laurent. The group formally kicked off its activities last November 14th.

Negotiations under way

At the time of going to press, the two Co-chairs of the Development Committee had all the information on hand to etch out an action plan to be implemented over the next five years beginning April 1, 1998. In light of all the information provided by the umpteen individuals and experts who have been consulted in recent months, the Co-chairs have all the necessary tools to table their Action Plan on schedule before the appropriate decision-making bodies. Over the coming weeks, several proposals will be submitted and discussed. In fact, there is no doubt the two Co-chairs will be able to return to the Development Committee with a concrete proposal—complete with operating budgets—by the beginning of 1998.

SUMMARY

Finally, since Mr. Ronaldo Raviolatti, SLV 2000 coordinator and provincial secretary, will be stepping down at the end of 1997, Mr. François Duchesneau, from the Québec ministère de l'Environnement et de la Faune, will be filling his shoes. For some time now, Mr. Duchesneau has been involved in the development process of the future Plan III, with a view to becoming better acquainted with the challenges before us as well as the many stakeholders involved in safeguarding the St. Lawrence River.

LETTERS to the Editor

Readers of *Le Fleuve* are invited to send us their comments, opinions or questions concerning the articles we publish.

This is a reminder that you may reach us at the following address:

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AN ADDRESS TO REMEMBER

St. Lawrence Vision 2000 has had its Internet site for several months already:
http://www.slv2000.qc.ec.gc.ca
Come visit us!

A Closer Look at the Gulf of St. Lawrence Estuary

The ocean is not inexhaustible. The collapse of Eastern Canada's cod stocks and the headlines in recent years concerning the problems faced by fishermen on both the Atlantic and Pacific coasts have played a powerful role in raising public awareness of the need for better knowledge of the marine environment so that marine resources can be managed in a sustainable way.

The project to monitor the state of the marine environment in the Gulf of St. Lawrence estuary brings together a number of researchers from the Maurice- Lamontagne Institute, and is designed precisely to improve knowledge of the marine ecosystem structure and dynamics in order to understand variations in resource levels. Action in this sense was also prompted by concerns about climate changes and their effects on the marine environment. The monitoring project comprises four components: (1) acquisition and analysis of physical data; (2) acquisition and use of remote sensing data; (3) acquisition of data on water levels and the Gaspé current in the Gulf; and (4) the development of a computerized management system for oceanographic data.

Acquisition and analysis of physical data on the Gulf

Until 1991, very little was known about interannual variability in the physical properties of the Gulf, with the exception of data gathered in previous years on the 200—300 m deep water layer. Since 1994, research has focussed mainly on the cold intermediate layer (CIL), since it is in direct contact with the sea floor on the Magdalen Islands plateau and affects local populations of groundfish (cod and perch) and Snow crab, two of the main resources in Eastern Canada's fisheries.

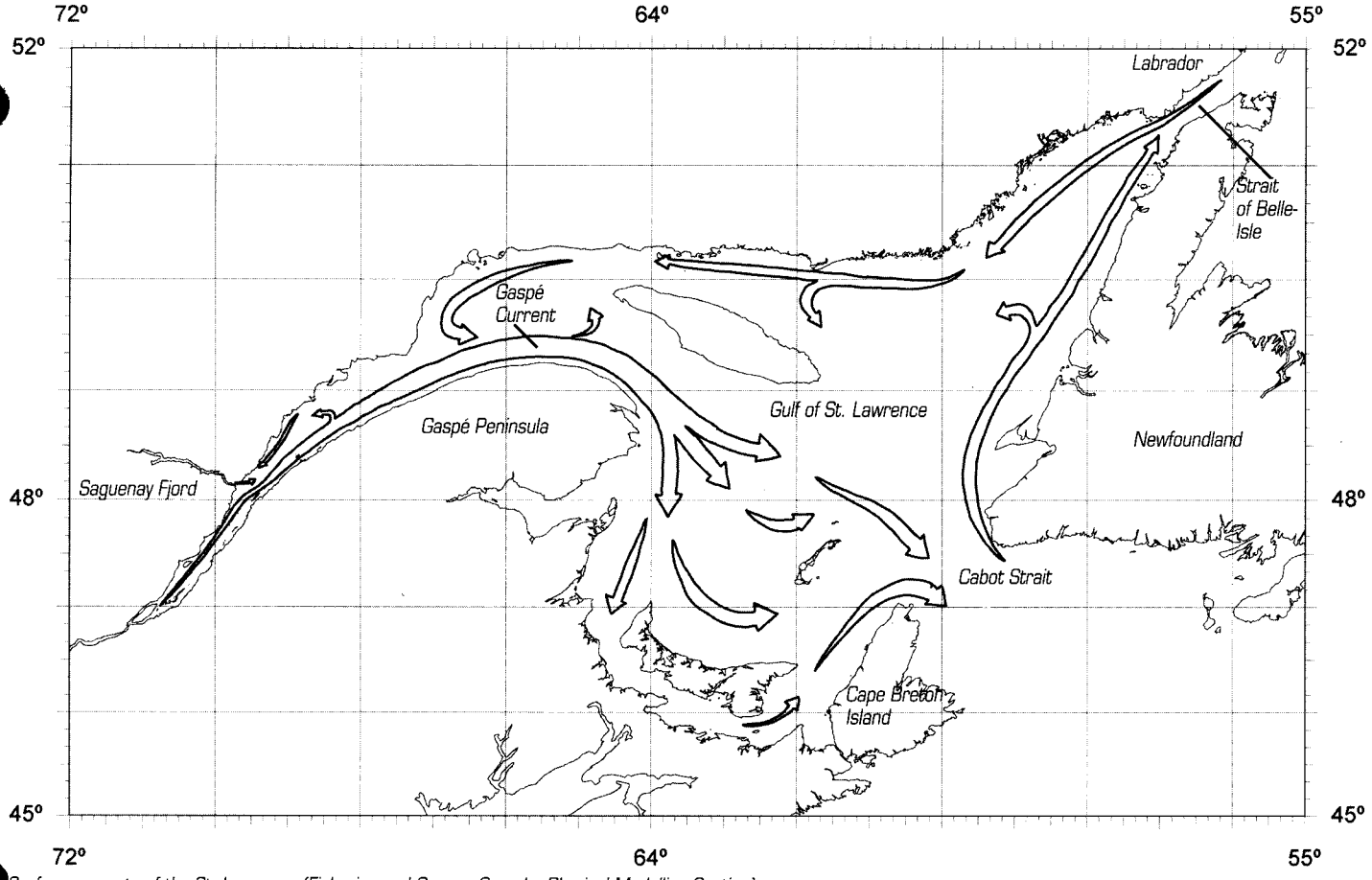
"The data gathered during summer groundfish stock evaluation missions between 1985 and 1995 suggest that the CIL was colder than usual during that period," says Denis Gilbert, physical oceanography researcher at the Maurice Lamontagne Institute. "We now know, too, that the CIL's minimum core temperature is subject to interdecadal variations of approximately 1°C. By comparing this climatic indicator with other data, we can obtain valuable information concerning the impact of water temperatures on the variability of fish resources."

Several different measuring devices (current metres, thermistor chains and tide gauges) were also installed at different points in the Gulf in 1996, and especially in the Cabot Strait. "The data obtained from these devices on currents, temperatures and water levels will enable us to quantify flows between the Gulf of St. Lawrence and the Atlantic Ocean through the Cabot Strait, and will also provide a more accurate picture of the mechanisms governing winter CIL formation," says Denis Gilbert.

The effectiveness of remote sensing

The physical and biological properties of the St. Lawrence gulf and estuary are characterized by a high level of variability due to seasonal changes, interaction of marine forces, freshwater flow and winds. As a result of this complex and ever-changing situation, ship-based current observation techniques are unable to provide the type of information that would enable researchers to understand the spatial and temporal variability of the ecosystem as a whole.

Satellites, from their ideal position more than 800 km above the Earth's surface, can observe broad expanses of ocean in a very short period of time (a few minutes). Moreover, the intervals at which they pass over the ocean (varying from a few hours to a few days) means that they can obtain frequent views of physical and biological processes as they occur. It was with this in mind that, in 1994, the Remote Sensing Laboratory installed an image receiving station on the roof of the Maurice Lamontagne Institute. The station is able to capture images several times every day from the NOAA (National Oceanic and Atmospheric Administration, U.S.A.) meteorological satellites. The images are con-



Surface currents of the St. Lawrence (Fisheries and Oceans Canada, Physical Modelling Section).

verted into ocean surface temperature fields, allowing researchers to observe the spatial distribution of different dynamic phenomena (marine currents, eddies, upwellings of cold water, etc.) occurring in the St. Lawrence.

The MLI receiving station can also capture images from the new *Orbview 2* satellite which specializes in observing the colour of the ocean. After processing, the images reveal the spatial structure of chlorophyll, which can be linked to the concentration of marine phytoplankton (the first link in the marine food chain). Coupled with information drawn from the ocean temperature images, the *Orbview 2* images enable researchers to study the links between the biological and physical processes occurring in the St. Lawrence.

"When conditions are suitable, the receiving station can capture eight ocean surface temperature images and two chlorophyll images," comments physicist Pierre Larouche, head of the coastal processes section at the MLI. The main obstacle to the use of this technique is the cloud cover, which prevents observation of the ocean surface. However, this problem can be countered by regular acquisition of images to produce weekly averages for the variables under observation. As the images are accumulated over time, they can be used to study seasonal processes and, in the longer term, climate changes that may affect the ecosystem. Remote sensing therefore opens a new window that will allow researchers to gain a better understanding of the complex St. Lawrence ecosystem.

The gateway to the Atlantic

Water from the Atlantic Ocean flows into the Gulf of St. Lawrence through two inlets: the Strait of Belle Isle, separating Labrador and Newfoundland, and the Cabot Strait, between Newfoundland and Cape Breton Island (Nova Scotia). The Strait of Belle Isle lets the cold water from Labrador flow inward, annually accounting for one-forth of the Gulf's frigid water. In studies of Gulf cod stocks, researchers decided to give priority to the monitoring of water flows between the Gulf and the Atlantic Ocean, because the water temperature factor seemed to be particularly important for the survival and growth of certain fish stocks in the Gulf.

Because it is so narrow—approximately 25 km—the Strait of Belle Isle is ideally suited to the use of tide gauges located at different points to measure water levels. "Since the water tends to accumulate to the north rather than to the south when it flows through the Strait into the Gulf, it is possible to obtain an accurate measure of the quantities of water involved by differentiating between the levels on the Newfoundland coast (to the south) and the Labrador coast (to the north)," explains physicist Denis Lefaivre, scientific researcher and head of the physical modelling section at the Maurice Lamontagne Institute. "The difference is in fact due to the Earth's rotation. Conversely, the level is higher to the south when the water leaves the Gulf."

Water entering the Gulf via the Cabot Strait can also be measured using current metres and tide gauges, but the Strait's breadth (104 km) means that the amount of water coming in from the Atlantic cannot be measured by comparing the levels on the two coasts. Finally, researchers have also measured the Gaspé current, the most important in the Gulf, along the north of the Gaspé

Pierre Larouche

Current meter mooring from the Martha L. Black *in the Gaspé Current of Tourelle (Gaspé Peninsula).*

peninsula. "The Gaspé current is the major source of fresh water in the Gulf of St. Lawrence. We will learn a great deal about water circulation within the Gulf as a whole by studying this current, as it is the combined result of the wind action and freshwater discharges from the rivers," emphasizes Denis Lefaivre.

Better management of oceanographic data

For the last fifteen years, data gathered at great expense by researchers have been entered and stored in a number of different ways. Information concerning methodology, apparatus and laboratory analysis methods is collated very differently from one project to the next. Data are also stored in several different places, and since 1991 hard copies have not been kept in many instances ... Therein lies the problem.

The MLI's Oceanographic Data Management System is designed to centralize, organize and standardize data so as to prevent the loss of information that is often irreplaceable, especially for the study of long-term changes in the situation, and on which considerable sums of money have already been spent. "It's rather like detective work," says physicist and oceanographer Bernard Pelchat, head of the MLI's data management section. "It is easier for the physical data, which is naturally less complex than biological data, for example. In the latter case, we need much more metadata—in other words, additional information for interpretation. This kind of data is often incomplete or difficult to find, which complicates interpretation and comparison work."

To be able to use oceanographic data effectively and efficiently, a data cataloguing and archiving system with adequate functions is needed. The first step is to convert existing data into standardized, documented computer formats before entering them in the system. The use of standard tools compatible with these formats must also be encouraged during acquisition of new data by scientists working on current research projects.

Some data have been stored using operating systems that are now obsolete, or on the point of becoming obsolete. These data must now be entered or stored in more up-to-date formats—otherwise, they may be lost forever.

Another important factor is the physical safety of the data. Back-up copies, stored outside the MLI in disaster-proof premises, are needed. At the same time, the scientists who gather and organize the data must be given a period of exclusivity, during which they can use the data for the purposes of their research projects.

Clearly, then, the computer component constitutes a significant element of the puzzle. It has therefore been necessary to buy powerful computer hardware and software, not to mention the time and experience invested by the human resources to bring the project to a successful conclusion. "The archiving and cataloguing system will be ready in March 1998—in other words, for the end of SLV 2000," says Bernard Pelchat. "Obviously, not all the data will have been entered by then, but the system will be functional and operational."

Significant steps have therefore been taken to ensure that existing and future oceanographic data can be kept in the best possible way. In the longer term, this should reduce storage costs and facilitate access to the prodigious amount of information available on the St. Lawrence marine ecosystem.

See *Oceanographic Conditions in the Gulf of St. Lawrence in 1996 (Conditions océanographiques dans le golfe du Saint-Laurent en 1996).* To obtain a copy, please contact the Regional Stock Assessment Bureau, Fisheries and Oceans Canada, Maurice Lamontagne Institute, P.O. Box 1000, Mont-Joli, Québec, G5H 3Z4.

The Summer Quarters of the Fin Whale

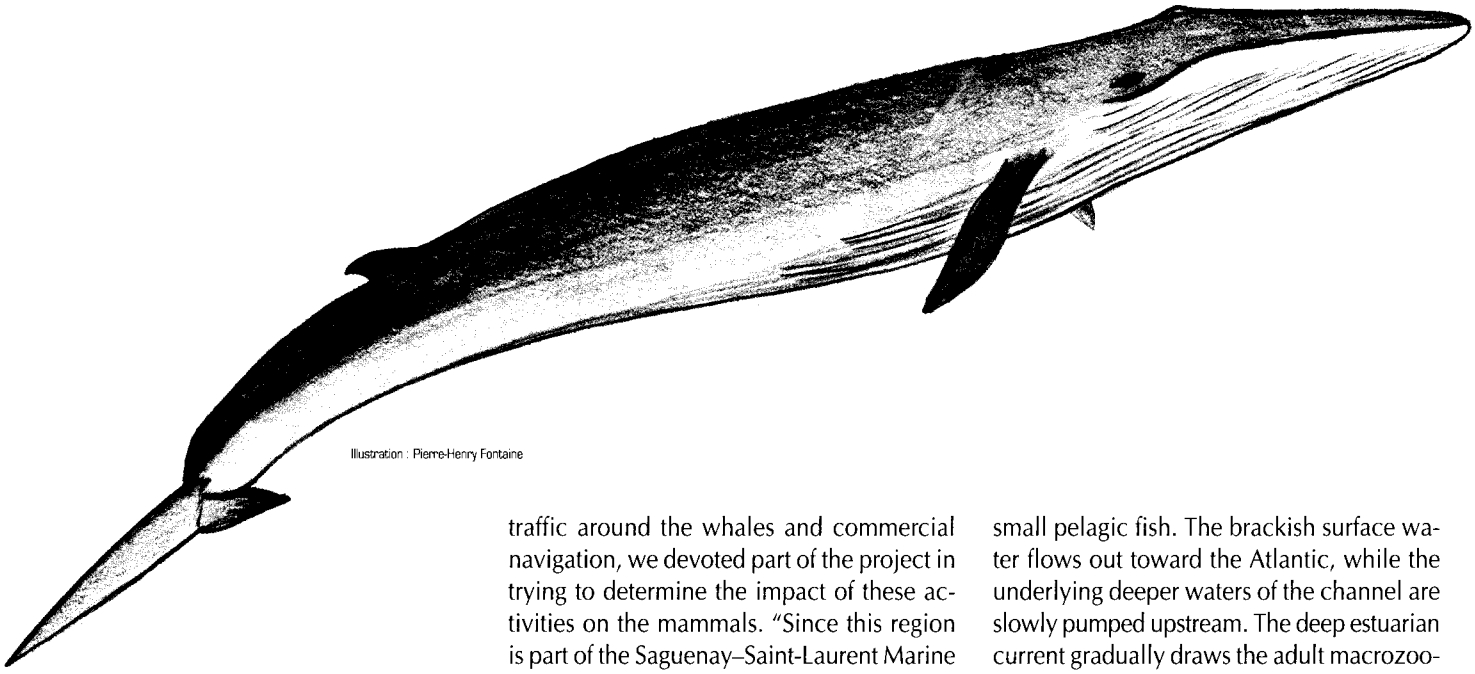


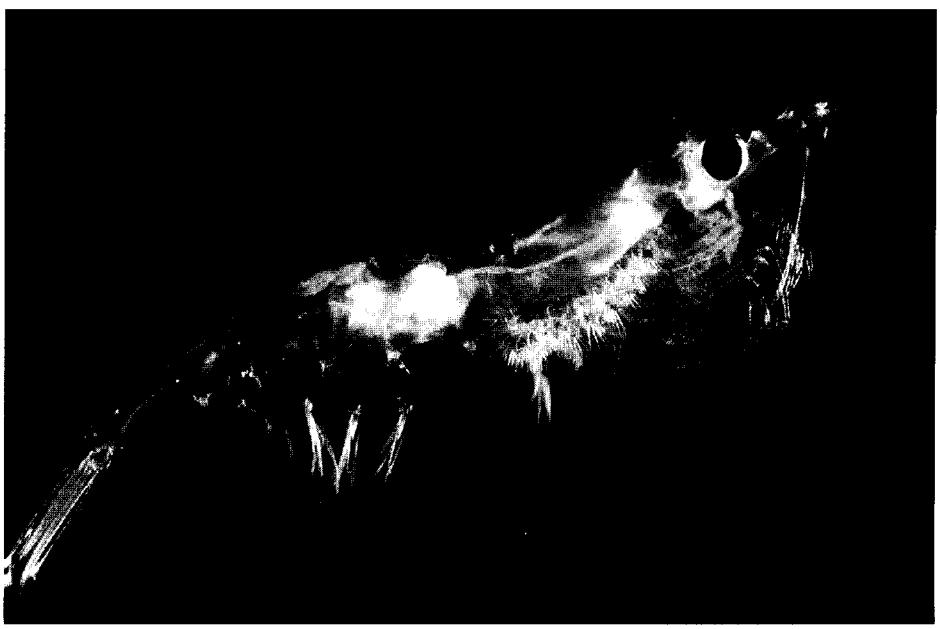
Illustration : Pierre-Henry Fontaine

For several years now, whales have become the undisputed stars of the marine estuary of the St. Lawrence. The summertime flocking to this sector of several species of this sea mammal—fin whales, blue whales, mike whales and humpback whales—has been a boon to a newfound industry whose economic spinoffs are far from negligeable. Yet their presence in this location in summer does not date back to yesterday. The particularly favourable conditions making for rich feeding grounds have been beckoning whales for centuries to this area—off the north shore towns of Tadoussac, Les Escoumins and Grandes-Bergeonnes—a popular feeding ground which boosts the whales' energy reserves.

We became interested in the feeding and behavioural ecology of the fin whale at the head of the Laurentian channel and wanted to find out the exact reasons why these sea mammals flocked to a specific area, and the factors that influence the food resource", explains Yvan Simard, a researcher at the fish and marine mammal division at the Maurice-Lamontagne Institute. "Knowing that the head of the channel is an intensive feeding ground during the summer, we wanted to study how the whales and their prey managed to divide up the territory. Also motivated by concerns of increasing boat traffic around the whales and commercial navigation, we devoted part of the project in trying to determine the impact of these activities on the mammals. "Since this region is part of the Saguenay–Saint-Laurent Marine Park, it is all the more important to gather data that will allow for the sustainable development of resources found there.

Where does the whales' food come from?

The abundance of food sought by the whales far upstream the Laurentian channel is due to the specific topography of that location in the river and the hydrodynamics of the St. Lawrence Estuary. In fact, the bi-level circulation of water in the estuary explains why this sector is a storehouse of zooplankton and small pelagic fish. The brackish surface water flows out toward the Atlantic, while the underlying deeper waters of the channel are slowly pumped upstream. The deep estuarian current gradually draws the adult macrozooplankton crustaceans that are dominant in the Gulf of St. Lawrence toward the head of the Laurentian channel, where they are caught in a topographical dead-end. The journey is a long one: it takes more than one year for the tiny crustaceans to reach Les Escoumins—varieties such as euphausiacea (krill), *Thysanoessa rachi*, *Meganyctiphanes norvegica* and copepoda of the *Calanus* genus—which make up part of the high-energy diet of whales. Small pelagic fish (e.g., capelin, sand eel, herring) are another source of food for the whales, who also feed on



Fisheries and Oceans Canada, J. F. Carpentier

zooplankton. They therefore act both as predators and prey in this sector.

The distribution of whales and their food

The St. Lawrence Estuary is a turbulent zone where several complex oceanographic events occur. The factors influence the variability of the resource and the feeding strategies of whales. "We have observed the movements of whales during the summers of 1995 and 1996 and noticed rapid changes in the concentrations of krill and pelagic schools of fish," adds Yvan Simard. "Thanks to hydroacoustic observations and the marking of whales, we have gathered data on the locations, depths and rate of rorqual dives: the krill concentrations attract fin whales and blue whales; minke whales are more numerous nearby the schools of pelagic fish. "Whales use several feeding techniques and take advantage of fluctuations in temperature and water flow to trap the fish and organisms.

The impact of ecotourism

In the last decade, the growth of the whale watching industry in the estuary has been quite phenomenal. Whereas in 1988, only fifteen or so boats offered excursions in the Tadoussac area, now close to fifty vessels take a quarter of a million of people each summer to catch a glimpse of this popular sea mammal. How do the whales react to all this boat travel in a relatively small zone?

Under the direction of Robert Michaud, a researcher with the *Groupe de recherche sur le milieu marin* (GREMM), an observation program aimed at assessing the impact of these excursions on the fin whales was set up in 1994 and continued for a few summers. "First of all, we wanted to check to see whether the animals reacted to nearby boat traffic," explains Robert Michaud, " and then find out if there were costs we could associate with the impact of ecotourism in the area. For example, has the noise and boating led the mammals to modify their behaviour, perhaps to feed less?"

We fixed tracking devices to the backs of approximately 25 whales in order to be able to follow and record their rates of ventilation, as well as the depths and frequency of their dives. The attachment system included, between the suction cup and the tracking device, a magnesium joint which was slowly corroded by the salt water. When the joint gave out, the air under the suction cup was released, and the tracking device came off the animal. Next, we simply had to pick up the floating device on the water's surface. By analysing the fluctuations in ventilation rates, we were able to deduce that the whales altered their rate when there were more than five boats in their vicinity. The animals therefore reacted in a specific way to the increase of traffic around them.

Does ecotourism has a negative impact on whales? We attempted to answer this question by looking at the proportion of time the whales spent in a variety of activities, in accordance with the number of boats around them. By comparing their behaviour models during periods when they were followed by one or two boats with periods when many more boats moved around them, we hoped to discover whether their activities were influenced by the proximity and number of vessels. "We are still analysing the data gathered during hundreds of hours of observation in the 1994, 1995 and 1996 seasons to answer such questions, explains Robert Michaud. "We expect to have the findings by March 1998."

The findings will be discussed in April 1998 at a workshop that will bring together the ecotourism industry and managers alike around issues related to this regional industry which has millions of dollars of spinoffs. Besides the possible disturbance to whales, other concerns are now surfacing. The quality of the experience of visitors, their safety and that of the whales, the way in which to take advantage of the whales' flocking to a marine park dedicated to the conservation of marine resources are all aspects to be examined seriously if we want to harmoniously pursue the development of ecotourism in the region. There is no doubt that the findings of the studies on the fin whale will be very useful in managing an industry that greatly attributes the ecological "awakening" of visitors to the beauty of the marine ecosystem of the St. Lawrence Estuary.

Vital Sources of Information on Environmental Contamination

The levels of concentration of most chemical contaminants in the sediments of the Lower Estuary of the St. Lawrence are approximately ten times less than those of Lake Ontario. However, the quantity of certain toxic products accumulated in the estuary's sediments is huge. In fact, the environmental conditions of the estuary have turned it into a dumping and accumulation site of contaminants. There are reportedly 16,000 tonnes of lead, 170 tonnes of mercury and close to 20 tonnes of organochlorine pollutants.

Fisheries and Oceans Canada, M.C. Mongeon

Sediment samplimg aboard the Fogo Isle.

Researchers at the Maurice-Lamontagne Institute have launched research projects with a view to better delimiting the study of contaminated sediments in the marine environment. What is the importance of the sediment vector in the transfer of toxic chemical products in the food chain? One of these projects, spearheaded by chemist Michel Lebeuf, a researcher in the field of organic contaminants with the Habitat Management and Environmental Sciences Division, looks at the quality of sediments with the perspective of toxic chemical products being transmitted to benthic organisms and groundfish. Working in the same division, Kenneth Lee, has pursued an objective of developing quick and inexpensive methods in order to monitor the impact of high sea waste disposal operations on the benthic environment by measuring certain microbial activities in the sediment.

Using sediment to predict the contamination of organisms

It is a well-known fact that sediments is a sort of well where the toxic compounds having been discharged into the environment accumulate. That is why researchers are interested in sediment, for in a certain way it represents the memory of the contamination of a body of water. Its property analysis poses no problem provided we are able to identify the contaminants present and assess their amount. Certain models that allow us to predict the degree of accumulation of toxic chemical products in the various trophic levels in the food chain have been proposed by researchers, but can these be applicable to the context of the Saguenay Fjord and the St. Lawrence Estuary?

"Some of the models are highly complex," points out Michel Lebeuf. "This of course makes for versatile models of prediction, but they are difficult to use and require a great deal of basic information. However, by identifying and targetting only the most sensitive parameters in the transfer of contaminants in the sectors under study, the modelling approach is greatly simplified."

Fisheries and Oceans Canada, C. Corbeil

Sediment core.

Fisheries and Oceans Canada, C. Corbeil

A chemist slices a sediment core in a non-reactive atmosphere.

The BSAF Factor (Biota Sediment Accumulation Factor)

A simple model was therefore applied to the benthic organisms (sea worms of the polychaete annilid type and the Snow crab) as well as groundfish (Atlantic halibut, American plaice and Atlantic cod). By pooling the knowledge of contaminant distribution in sediments in relation to the total contents of organic matter contained in the sediments, and knowing the concentration of the contaminant in the organism under study in relation to the total contents of lipids, we can define a constant called BSAF, or the Biota Sediment Accumulation Factor. Armed with the knowledge of the BSAF factor of a toxic product, we could—in theory—predict its concentration in organisms such as benthic worms, relying only on the data concerning the sediment.

"The findings we obtained are quite interesting," notes Michel Lebeuf. "For benthic worms, we have shown that the model is relatively accurate. The hydrophobic feature of the contaminants plays an essential role in the transferability of the toxic products of the sediments to the benthic organisms. When the contaminant is not very soluble or else is highly soluble, the transfer rate is low; however, if it is moderately soluble, its rate of accumulation will be higher in the benthic organisms."

The Snow crab, in physical contact with the sediment, and feeding on benthic organisms, has higher levels of accumulation. It is the bioamplification principle at work: the contaminants accumulated in prey are transferred to the predators who feed on them. The higher complexity of the groundfish gives them means to eliminate some of the toxic compounds through metabolization.

Michel Lebeuf's team naturally focussed on the study of persistent organic contaminants such as PCBs, organochlorine pesticides, dioxins and furans, for these are the contaminants which are found to be incorporated in the food chain, and which can therefore be transmitted to human beings. The project continues to inform managers on the spatial distribution of contaminants in the St. Lawrence and the Saguenay, as well as on the process that directs the transfer of contaminants towards the biological resources of the environment.

New biological assays to monitor the impact of contaminants

Although the chemical analysis of sediment informs us on the nature and extent of its contamination, it provides only few answers on its biological consequences. The interest for biological assays on a microscale—microbiotests can expose a single-cell organism or a small multi-cell organism to a sediment sample in such a way as to measure a specific effect—has risen considerably in recent years for the valid reason that the biological and chemical procedures which occur in marine sediments do so through the microorganisms present. If the contaminants have a negative impact on the activity of the microbial community, one can deduce that the effects will have a repercussion on the aquatic ecosystem in the whole.

However, existing microbiotests use specific bacterial index species that are often foreign to the study environment. In the opinion of Kenneth Lee, the use of natural bacterial communities for the monitoring of changes in a marine environment would be more representative of the indigenous biota, and therefore more appropriate for the evaluation of the toxic effect of contaminants.

Another important point for researchers is enzyme activity. Its importance is now acknowledged, for the toxicity of most contaminants is attributable to enzymatic inhibition. "There again," adds Kenneth Lee, "it has not been shown that the activity of an enzyme measured in the laboratory is related to its activity in a living system, in natural conditions. To monitor the impact of contaminants in a benthic environment, we proposed a biochemical measurement of the change in the activity of enzymes secreted by the bacterial community in the samples of sediments taken from the area under study."

One of the sites used for sampling sediments is the high-sea waste disposal site of île aux Hérons, located 15 km from Dalhousie (New Brunswick) in Chaleurs Bay. The site has been closed since 1978 due to high contamination levels. Tests run by Kenneth Lee's team on local sediments have allowed for a status report on the extent of the site's rehabilitation.

Other tests were carried out in 1995 on sediments in another waste disposal site in the ocean, that of Pointe-Noire, located close to Saint John (also in New Brunswick). Once again, the tests proved useful in the decision-making process concerning the regulation of the dumping of solid and liquid waste into the open sea. The low cost of this type of waste disposal has made this a popular option, which is obviously not without consequence for the marine environment. The studies carried out by Kenneth Lee and his team provide managers with practical and efficient solutions with a view to monitoring the immediate and long-term effects of waste disposal in a benthic environment.

Biodiversity and Habitats

Restoration of the Bonaventure Cove

Barachois: n., *Atlantic Canada.* A tidal pond partly obstructed by a bar (ITP Canadian Dictionary); A cove or mal bay: A tidal pond almost completely cut off from the sea by a bar (Canadian Permanent Committee on Geographical Names (CPCGN). From the French *barre-à-cheoir* or *barre-echouée* (meaning a place where boats rest). Modern usage tends to favour the term *cove.*

As indicated, the use of this term is specific to the Atlantic provinces. Coves have been recognized as being extremely productive habitats of coastal regions. Highly frequented by wildfowl and shorebirds, they are also juvenile rearing areas and resting grounds for many fish species that come to seek shelter and food. There are two major types of coves: the estuary type, where fresh water from a river mixes in with the salt water of the ocean that seeps in through narrows and the lagoon type, where the body of water is fed only by sea water.

Historically, coves have often acted as natural havens for small fishing vessels; cod was left to dry on the strips of land separating the water in the coves from the sea. However, as villages and industries not related to fishing sprang up along the coastline, such as sawmills, these areas unfortunately received more domestic or industrial waste as well as the wastewater dumped from surrounding towns. In addition, the construction of roads, railways, wharfs and other types of landfill for several uses hindered these natural havens.

Among the fifteen or so coves located between Forillon and the end of Chaleurs Bay, the Bonaventure cove has been undergoing restoration since 1995. Covering an

area of 1.8 km^2, this estuary-type cove is one of the biggest one in the Chaleurs Bay and was, until recently at least, one of the most disturbed of the region.

"The Bonaventure Cove is a rather large basin used for human activity throughout the years," indicates Marie-France Dalcourt, head of marine interventions at the Habitat Management and Environment Sciences Division of the Department of Fisheries and Oceans. "Due to the initiative of a local organization to clean it up and the interest the cove represents from a wildlife point of view, the cove restoration project appeared to be quite feasible and having an important impact on habitat. Furthermore, it naturally fell under one of the objectives of St-Lawrence Vision 2000."

Re-establishing water flow and salinity of the cove

The construction of a municipal road and a lead-in jetty (Route 132) in the early 1970s closed off a major portion in the northwestern portion of the cove. As a result, this northwestern basin sustained a drop in the water flow and salinity, since the water from the Chaleurs Bay only entered through a canal that reaches the Bonaventure River. Following a hydrodynamic study of the site, it was determined that a culvert 8 metres wide under Route 132 could be built to restore 95% of the natural breadth between high sea and low sea and the supply of salt water, indispensable for maintaining the viability of marine species (benthic plants and invertebrates) of the ecosystem.

In 1994, once the make-up of the physical environment, an inventory of the biological components, and the restoration plan were complete, it was possible to commence the restoration work *per se* in the fall of 1995. Four partners were involved in carrying out the work: the *Association pour la revalorisation du barachois de Bonaventure (ARBB)*, Fisheries and Oceans Canada, the ministère des Transports du Québec and the Municipality of Bonaventure.

The first stage

The excavation and relocating of the municipal road that linked up the strip of land to Route 132 and the construction of an 8-metre culvert under Route 132 were carried out in the fall of 1995 and the winter of 1996. Once this initial work had been completed, a physical property analysis was conducted on the coves after the reopening of the northwestern basin in order to compare the new conditions created through the development to the former hydrodynamic system that existed earlier.

Index map sheet of the Bonaventure cove (illustrated by the firm Biorex).

"Through the second study, we were able to see that the objectives of the coves' salinity had not been adequately reached by the first stage of work," explains Marie-France Dalcourt. "We observed an increase in the average salinity in the northwestern basin, but it was not enough to change the estuarian character of the lagoon into an ecosystem with more of a marine character, closer to the natural conditions of this cove sector." To do so, the solution seemed to be closing the canal that supplied fresh water from the Bonaventure River to the northwestern basin. This seemed to be the most reasonable solution.

A second stage necessary

The closing of the canal meant the installation of a breakwater dam at the junction of the river and the canal. However, the work necessary in the second stage first of all required an environmental assessment by the federal and provincial governments and approval by them before being conducted. This process is under way and, if everything goes off without a hitch, the closing should be

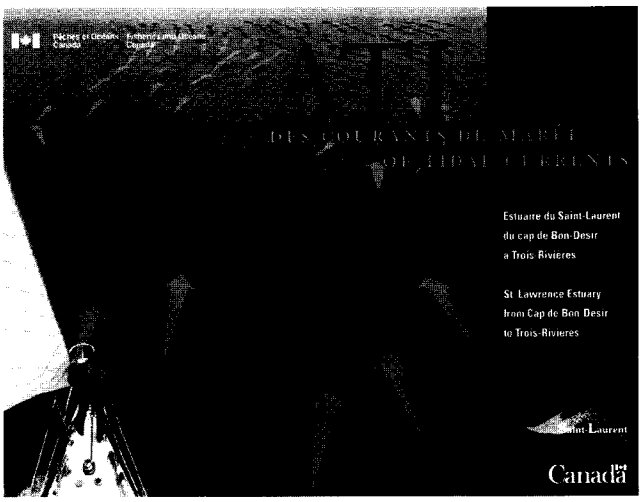
authorized and completed by the end of the winter of 1998 at the same time that the SLV 2000 will come to a close.

Among the results expected by the restoration process, it is hoped to see the turtle grass flats reintroduced into the northwestern basin. Such habitats, which attract a great deal of fish and birds, can already be seen in other sectors of the cove area, which could allow for a quicker colonization of the sector. In addition, during migration, large flocks of Canada geese come to feed in the vicinity of the Bonaventure Marina, where such grass is abundant.

On a socioeconomic level, the restoration of the cove is part of the recreation and tourism development scheme of the region. The Bonaventure Biopark, a large-scale recreational development project slated to open in 1998, will include the cove in its interpretation program of fauna and flora of the Gaspé coast. A regional park is also being planned by the Municipality of Bonaventure.

The Atlas of Tidal Currents of the Upper Estuary of the St. Lawrence River

As the River Flows



The St. Lawrence is not the long, quiet river it appears. With strong, ofttimes highly variable currents, it is known to test the will and know-how of pleasure crafts operators and navigators alike. Frequent changes in direction—which may occur up to four times a day—do not make sailing easy and may spell danger for the less-experienced captains. Upriver from Trois-Pistoles, currents regularly reach four knots and can be as high as eight knots, or the equivalent of 15 km/h.

The Atlas of Tidal Currents—Estuary of the St. Lawrence, from Cap de Bon-Désir to Trois-Rivières is a follow-up to a book published in 1939 by the Canadian Hydrographic Service. It is easy to surmise that knowledge on the river has been considerably updated in the last 58 years. The new Atlas, produced using a summary of very complete data, traces a very accurate portrait of the tidal currents in the upper estuary of the St. Lawrence River.

"We limited ourselves to the river section between Cap du Bon-Désir, located on the north shore opposite Trois-Pistoles, and Trois-Rivières because it is in that sector that the currents are the strongest and the most predictable," explains François Saucier, scientific researcher for The Ocean sciences Division at Fisheries and Oceans Canada. "In the Gulf and Lower Estuary, the tidal currents—weaker due to the greater depths—are also frequently dominated by currents due to winds and variations in the water's density. This creates situations where the currents are unpredictable and make it impossible to achieve an atlas of currents for that portion of the St. Lawrence."

Modelling was used to be able to reproduce the hydrodynamics of the river. Just like we see air masses move across Quebec on weather maps, hydrodynamic models show the flow of water based on information concerning the bottom's topography, the average flow of rivers, levels of water, different densities of water levels, temperature, salinity, and so on. "After that step, we validated the models through observations *in situ*," adds François Saucier. "In the summers of 1994 and 1995, currents of the surface water were measured using drifting buoys equipped with a GPS (Global Positioning System) receptor. These measures were compared with the drift predictions we had obtained through the modeling process." In calm weather, after corrections for the rise and fall of tides, the average mistake for current speed is ± 0.5 knot.

On the practical side

Those in charge of the *Atlas* wanted to make a book that was at once accurate and easy to consult for navigators. The portion of the river between Trois-Pistoles and Trois-Rivières was therefore divided into 9 sectors. Since tides have an average length of 12 hours and 25 minutes, there are twelve maps showing the typical cycle of a semi-diurnal tide at one-hour intervals for each sector. Only the

summer season, from June to September, was examined. Different-coloured and sized arrows illustrate the speed of current and drift associated with each current. A boater can therefore find out where an object in the current will float to in a 20-minute interval. Of course, the *Atlas* must be used in conjunction with the *Canadian Tide and Current Tables, Volume 3*, which indicates the times and tides of the River.

The information is presented in a bilingual, soft-cover book, measuring 8 × 10 inches and including 108 pages. "To make map-reading easier, we eliminated a certain number of points to emphasize locations which are the most popular for boats and where the currents are the strongest," adds François Saucier. "We wanted to make the *Atlas* an easy reference to consult, even if it renders it slightly less accurate."

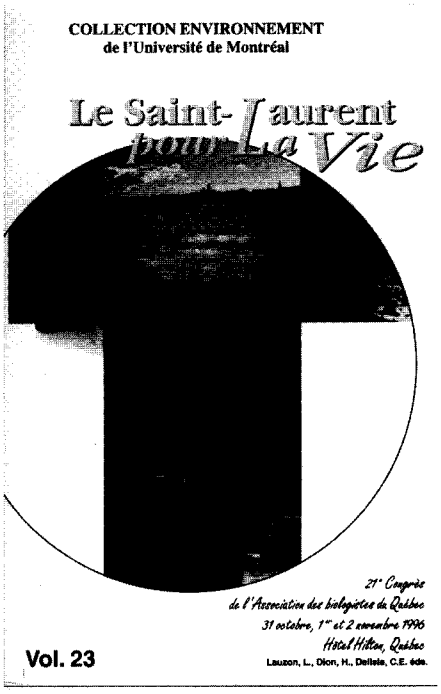
The *Atlas* team apparently made the right decision, for sales certainly got off to a good start. More than one thousand copies had already been sold by the end of September of this year. It seems that pleasure craft owners appreciate the increase in nautical safety they can have through the *Atlas*, particularly in the turbulent areas of the St. Lawrence such as the mouth of the Saguenay off the shores of Tadoussac. The *Atlas* is also a vital source of information for those involved in safety operations on the River.

Fuelled by the success achieved with the *Atlas*, researchers at the Ocean Productivity Division of the Canadian Hydrographic Service have initiated other projects, including a work on the physical aspects of the St. Lawrence, several scientific articles and a Web site, which will be even more accurate than the *Atlas*; it will provide visitors with data in real time on the river's hydrodynamics on a day-to-day basis. It has also produced, in collaboration with Parks Canada, a mini-atlas for the Saguenay.

The *Atlas* may be obtained through the authorized depositories of the Canadian Hydrographic Service, or directly through the Marine Map Distribution Bureau, Fisheries and Oceans Canada, 1675, Russel Road, P.O. Box 8080, Ottawa (Ontario) K1G 3H6. Tel: (613) 998-4931; Fax: (613) 998-1217. Internet Site: http://www.chshq.dfo.ca. Cost: $35, plus taxes.

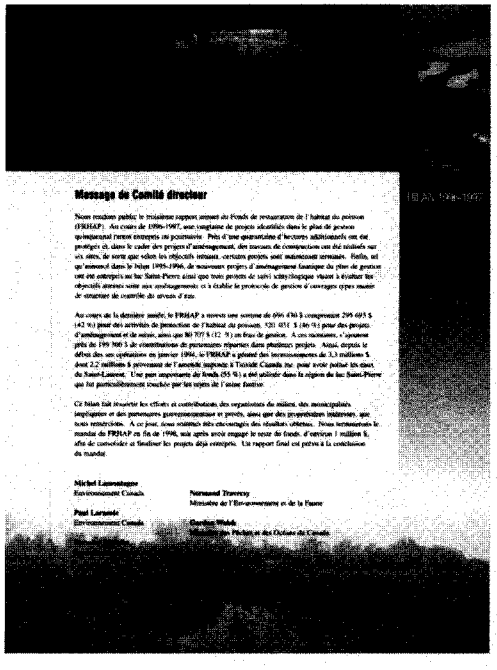
RECENT PUBLICATIONS

The proceedings of the Symposium *Le Saint-Laurent pour la vie (The St. Lawrence—for Life)*, held in Quebec City on October 30, and November 1 and 2, 1997, at the 21st Convention of the *Association des biologistes du Québec*, have just been published as part of the *Environment* collection of the Université de Montréal. For information, call (541) 340-5918 or (514) 343-6820.



The regional assessment on Côte-Nord-Anticosti, accompanied by three technical reports (all French-language:) *Synthèse des connaissances sur les aspects physiques et chimiques de l'eau et des sédiments du secteur d'étude Côte-Nord-Anticosti, Synthèse des connaissances sur les aspects des communautés biologiques du secteur d'étude Côte-Nord-Anticosti, Synthèse des connaissances sur les aspects socio-économiques du secteur d'étude Côte-Nord-Anticosti.*

These documents are available at the St. Lawrence Centre of Environment Canada; simply call (514) 283-7000.


Message du Comité directeur

1996-1997 Annual Report entitled "Fonds de restauration de l'habitat du poisson (FHRAP)". This report may be obtained by calling (418) 646-6863.

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AGENDA

DU KAYAK AU CARGO, UN FLEUVE POUR TOUS

Intended for all navigators of the St. Lawrence, including pleasure craft to larger sea-faring vessels, are dropping anchor at the hotel *Delta* in Trois-Rivières April 24 and 25, 1998.

In the *International Year of Oceans*, let us discover together all the angles and pleasures of travelling the St. Lawrence in complete safety and in harmony with the environment.

An information and discussion meeting organized by
Les Amis de la Vallée du Saint-Laurent

For information, please call (418) 796-2422.

LE FLEUVE

NEWSLETTER
St. Laurence Vision 2000

Le Fleuve is published by all the St. Lawrence Vision 2000 partners. It is distributed free of charge to individuals, companies and organizations concerned by the protection, conservation and restoration of the St. Lawrence River. To subscribe, you may contact Nancy Lainé at Environment Canada, 1141, route de l'Église, 6th floor, P.O. Box 10,100, Sainte-Foy, Quebec G1V 4H5. Tel.: (418) 648-3444.

Management and Coordination:
Communications Component
St. Lawrence Vision 2000

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