REPORT OF THE MULTIPARTITE COMMITTEE ON CONTAMINATED SITES OF CONCERN FOR THE ST. LAWRENCE BELUGA

TO

THE ST. LAWRENCE VISION 2000 ACTION PLAN MANAGEMENT COMMITTEE

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ABSTRACT

This report provides an overview of the work carried out by the Multipartite Committee on Contaminated Sites of Concern for the St. Lawrence Beluga under the St. Lawrence Vision 2000 action plan. The Committee was formed to identify aquatic sites in the St. Lawrence that represent a potential hazard for the beluga and the St. Lawrence ecosystem and to propose corrective measures to protect threatened resources and uses. This exercise shows that our current state of knowledge does not allow us to demonstrate that contaminated sites are a hazard for the beluga neither can it demonstrate that contaminated sites do not represent a hazard for the beluga.

Based on the review of available data on sediment quality in relatively stable deposition zones in the St. Lawrence, 38 sites highly contaminated by toxic substances of primary concern for the beluga were identified. It was possible to determine the level and extent of contamination in surface sediments at 24 sites witch were then classified according to the relative risk that the toxic substances they contain would be released from the site and contaminate the beluga food chain. For the 14 other sites, the available data was insufficient to determine the level and extent of contamination; these sites were ranked according to priority for conducting a more detailed characterization, based on uses that have been lost or that are to be recovered.

The relative importance of the 24 contaminated aquatic sites in the assessment of toxic substances of concern for the beluga was evaluated using the polychlorinated biphenyl mass balance established for the entire St. Lawrence system. This analysis suggests that in the early 1990s, the contribution of contaminated aquatic sites was much less important than that of other sources of toxic substances, such as the Great Lakes, industrial and urban discharges, and long-range airborne transport. Because toxic loads from a number of sources have been considerably reduced over the past few years, contaminated aquatic sites are,today, a relatively larger source of toxic substances. However, these sites remain a potentially minor source of contamination for the beluga.

Due to gaps in our current knowledge, it is not possible to determine the absolute risk of contaminated sites for the beluga. It is known, however, that these sites can contribute to the toxic load to which the beluga is exposed. Moreover, these sites are more or less sealed sinks of toxic substances that are targeted for virtual elimination in the St. Lawrence Beluga Recovery Plan and the Federal Toxics Policy because they are persistent and bioaccumulative.

Accordingly, the Committee is proposing a four-step plan and recommends that these steps be incorporated into the St. Lawrence Beluga Recovery Plan:

- Study sites of concern for which available information is insufficient to make an assessment;
- Ensure follow-up for each site of concern;
- Acquire knowledge, particularly on the release of toxic substances, the beluga's diet and the contamination of its prey in order to improve risk assessment;
- Establish sediment quality criteria that take into account biomagnification and toxicity of the substances for the beluga.

RÉSUMÉ

Le présent rapport réalisé dans le cadre du plan d'action Saint-Laurent Vision 2000 (SLV 2000) constitue une synthèse des travaux effectués par le Comité multipartite sur les sites contaminés pouvant affecter le béluga. Ces travaux avaient pour objectifs d'identifier les sites aquatiques susceptibles de représenter une menace pour le béluga et l'écosystème du Saint-Laurent et de proposer des actions visant à protéger les ressources et usages menacés. Il ressort de l'exercice que l'état actuel des connaissances ne nous permet pas de démontrer que les sites contaminés représentent une menace pour le béluga. D'autre part, les connaissances ne nous permettent pas davantage de démontrer que ces sites contaminés ne représentent pas de menace pour le béluga.

Les données sur la qualité des sédiments dans les zones de déposition relativement stables du Saint-Laurent ont permis d'identifier 38 sites où les sédiments contiennent des concentrations élevées de substances toxiques potentiellement préoccupant pour le béluga. Vingt-quatre de ces sites, pour lesquels les données disponibles ont permis de déterminer le niveau et l'étendue de la contamination des sédiments superficiels, ont été classifiés en fonction du risque relatif potentiel que les substances toxiques soient relarguées des sites et contaminent la chaîne alimentaire dans l'aire de répartition du béluga. Les données disponibles sur le 14 autres sites ne permettent pas de préciser le niveau et l'étendue de la contamination des sédiments ; ces sites ont donc été ordonnés en fonction de la priorité d'y réaliser une caractérisation plus détaillée en fonction des usages perdus ou à récupérer.

La contribution relative de ces sites aquatiques contaminés au bilan des substances toxiques préoccupantes pour le béluga a été évaluée à partir du bilan massique des biphényles polychlorés établi pour l'ensemble du système du Saint-Laurent. Ce bilan suggère qu'au début des années 1990, la contribution des sites contaminés était beaucoup moins importants que celle d'autres sources de substances toxiques comme les Grands Lacs, les rejets industriels et urbains et le transport atmosphérique à grande distance. Les charges toxiques en provenance de plusieurs sources ont été considérablement réduites au cours des dernières années et de ce fait, les sites aquatiques contaminés représentent, aujourd'hui, une source relativement plus importante; par contre, ceux-ci demeurent une source potentielle faible de contamination du béluga.

Les connaissances actuelles ne permettent pas de déterminer le risque absolu que représentent les sites contaminés pour le béluga. Elles indiquent cependant que ces sites

peuvent contribuer à la charge toxique à laquelle le béluga est exposé. De plus, ces sites représentent des réservoirs plus ou moins étanches de substances toxiques ciblées dans le Plan de rétablissement du béluga et visées dans la Politique sur les substances toxiques en vue de leur élimination virtuelle de l'écosystème puisqu'elles sont persistantes ou biaccumulables.

C'est pourquoi le Comité propose une série d'actions en quatre volets et recommande d'insérer ces volets dans la programmation du plan de rétablissement du béluga:

- Examiner les sites prioritaires les plus préoccupants, pour lesquels les informations disponibles ne nous permettent pas de porter un jugement;
- Assurer un suivi pour chacun des sites jugés préoccupants;
- Acquérir des connaissances, notamment sur le relargage, la diète du béluga et la contamination de ses proies, de manière à préciser le risque pour le béluga;
- Mettre en place des critères de qualité des sédiments qui tiennent compte de la bioamplification et de la toxicité des substances pour le béluga.

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1.0 COMMITTEE MANDATE

In July 1996, St. Lawrence Vision 2000 action plan (SLV 2000) partners developed an implementation plan (DFO et al. 1996) in response to the recommendations of the St. Lawrence Beluga Recovery Plan (SLBRT 1995), one of which was to identify and clean up contaminated sites that could pose a threat to the beluga. In response to this recommendation, a multipartite committee was formed in the fall of 1996 to clarify the problem of contaminated aquatic sites and identify those sites which should be targeted because of their impact on the beluga. The Committee is made up of representatives from Environment Canada (EC), the Ministère de l'Environnement et de la Faune du Québec (MEF), Fisheries and Oceans Canada (DFO) and Canadian Heritage - Parks Canada (CH).

2.0 APPROACH

The Committee's initial premise was that, since it would be difficult to establish a link between contaminated sediments and the beluga, the identification of contaminated sites to be targeted should not be based on the potential threat for the beluga alone. Accordingly, a preventive approach was taken to selecting and classifying sites in order to protect the entire ecosystem that is home to the beluga. The Committee initially limited the study area to aquatic sites in the St. Lawrence River between Cornwall and Blanc Sablon and to those in the Saguenay River. The Great Lakes, the international stretch of the St. Lawrence and the tributaries of the St. Lawrence and the Saguenay were excluded. The problem issues were then outlined on the basis of a 1989 study that identified 65 contaminated or potentially contaminated zones in the area in question (Lavalin Environnement 1989). The Committee determined that the inventory of contaminated sites was no longer up to date and that it was not possible to conduct an in-depth study of all the potential sites as to the risk for the beluga (due to time constraints, missing data, etc.). Accordingly, in February 1997, the Committee mandated Biorex Inc. to update the inventory of contaminated sites, analyse the data

available on sites outside the zones selected by Lavalin (1989) and develop an approach to briefly assess the risk of the contaminated sites for belugas. This work was carried out in close co-operation with Committee members.

A new inventory of contaminated sites was delivered in June 1997 and a series of fact sheets for each of the sites was delivered in December 1997. These two products formed the first report of the study (Gagnon and Bergeron 1997).

Despite the many gaps in current knowledge, we have used an original approach to try to classify the contaminated sites based on their relative potential impact on the beluga. However, our assessment of the importance that should be ascribed to contaminated sites in comparison to other sources of toxic substances was more speculative due to this lack of knowledge. The methodology used for the two assessments was reviewed by experts from EC, DFO and MEF in January 1998. The final version of the second report (Gagnon and Bergeron 1998), which took into account the experts' comments and suggestions, was delivered in March 1998.

In the last step before this report was drafted, the Committee and the consultant reviewed the study results and prepared a series of recommendations, which were incorporated into this report.

3.0 METHODOLOGY AND RESULTS

The work involved in identifying the contaminated sites and assessing their risk for the beluga can be divided into four distinct phases:

Phase 1. Identification and description of sites where high concentrations of toxic substances of concern for the beluga were found in sediment. Two categories of sites were identified:

Category A: Sites for which it is possible to determine the extent and level of contamination in the surface layer of sediments.

Category B: Sites for which it is impossible to determine the extent and level of contamination in surface sediments.

The distinction between these two categories is clarified in section 3.1.

Phase 2. Classification of Category A sites according to the potential risk for the beluga. Classification of Category B sites for characterization.

Phase 3. Evaluation of the contaminated sites' contribution to the overall budget of toxic

Phase 4. substances passing through the beluga's range.

3.1 Phase 1. Identification and Description of Contaminated Sites

Contaminated sites were selected on the basis of data available in June 1997 on sediment quality, sediment dynamics and sources of contaminants. The toxic substances considered in the study were those identified in the Recovery Plan as being of concern for the beluga: lead, mercury, hexachlorobenzene, organochlorine pesticides,[1] polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans.

The threshold above which sediments were considered "contaminated" is the Toxic Effect Threshold (TET) established by EC and MEF (1992). This threshold was chosen because it has been established for the majority of hazardous substances (lead, mercury, hexachlorobenzene, 14 organochlorine pesticides, 4 aroclors (PCBs), total PCBs and 7 PAHs) and because it allowed for the definition of limited areas (generally less than 0.5 km^2) where action could be taken. In general, the TET is only exceeded in limited areas where

sediment deposits are relatively stable and are contaminated by continuous sources situated immediately upstream.

Thirty-eight sites were selected for the remainder of the study based on updated data on the 65 sites selected by Lavalin (1989), on an analysis of data contained in Environment Canada's database on dredging and in the literature. The 38 contaminated sites are those where the TET was exceeded by at least one of the 29 substances in surface sediments or at a deeper level and where the information available shows that sediment deposits are sufficiently stable to allow for future action.

The raw data available for each of the 38 sites was analysed to determine the current extent and levels of contamination in surface sediments. A full assessment of these two variables was performed for 24 sites (Category A). The 14 other sites (Category B) also had levels exceeding the TET for at least one of the 29 substances under consideration. However, it was not possible to establish the level and extent of surface sediment contamination at these sites due to the lack of recent data (after 1986), the lack of data on lead, mercury, PCBs or PAHs, or because of the limited number of sampling stations.

The 24 sites in Category A (Table 1) include two large areas (Baie des Anglais and the upper Saguenay Fjord). With the exception of the *Irving Whale* site, the others have harbour facilities or canals with locks. There are two in the Gulf of St. Lawrence, two in the Baie-Comeau port area, two in the Québec City port area and 15 in the Montreal region (Figure 1).

The 14 sites in Category B (Table 2 and Figure 1) include 11 harbour areas sampled specifically in anticipation of dredging work, two littoral zones (the areas around the Îles de la Paix and the mouth of the St. Louis River) characterized in 1985 and a littoral zone

[1] The substances or groups of substances in the family of organochlorine pesticides are aldrin, chlordane, DDT (and its derivatives), dieldrin, endrin, heptachlor epoxide, heptachlor, hexachlorocyclohexanes (HCH) and Mirex.

sampled specifically (the Cap St. Ignace flats). It is possible that the contaminated sediments in the three littoral zones have moved since the characterization.

Table 1. List of contaminated sites for which the data can be used to establish the level and extent of contamination by substances of concern for the beluga in surface sediments (Category A sites).

Ref. No.	Site Name	Substance(s) exceeding TET*
A-1	Cap-aux-Meules harbour	PCBs
A-2	*Irving Whale* site	PCBs
A-3	New Carlisle barachois	Hg, Pb, PCBs, PAHs
A-4	Port of Baie-Comeau, Cargill wharves	PCBs, PAHs
A-5	Port of Baie-Comeau, Anse du Moulin	PCBs, PAHs
A-6	Baie des Anglais	PCBs, PAHs
A-7	Upper Saguenay Fjord and Ha! Ha! Bay	Hg, PAHs
A-8	Port of Québec, Saint-Charles estuary	Pb, PAHs
A-9	Port of Québec, Inner Louise Basin	Pb
A-10	Port of Montreal, Pointe aux Trembles wharf	PAHs
A-11	Port of Montreal, Marien wharf basin	Hg, PAHs
A-12	Port of Montreal, Hôtel-de-Ville park basin	Hg, PAHs
A-13	Port of Montreal, Sector 103 basins	Hg, Pb, PAHs
A-14	Port of Montreal, Racine Terminal, downstream	Pb
A-15	Port of Montreal, Vickers basin	Hg, Pb, PCBs, PAHs
A-16	Port of Montreal, Elevator No. 4 basin	Hg, Pb
A-17	Port of Montreal, Sutherland wharf basin	PAHs
A-18	Port of Montreal, Clock basin	Pb
A-19	Port of Montreal, Jacques Cartier basin	Hg, Pb
A-20	Port of Montreal, Wharf No. 1 basin	Hg, Pb
A-21	Port of Montreal, Harbour Station basin	Hg, Pb, PAHs
A-22	Port of Montreal, Bickerdike basin	Hg, Pb
A-23	Lachine Canal	Hg, Pb, PCBs, PAHs
A-24	Lesser La Prairie Basin	Pb

Source: Gagnon and Bergeron 1997

*: TET: Toxic Effect Threshold

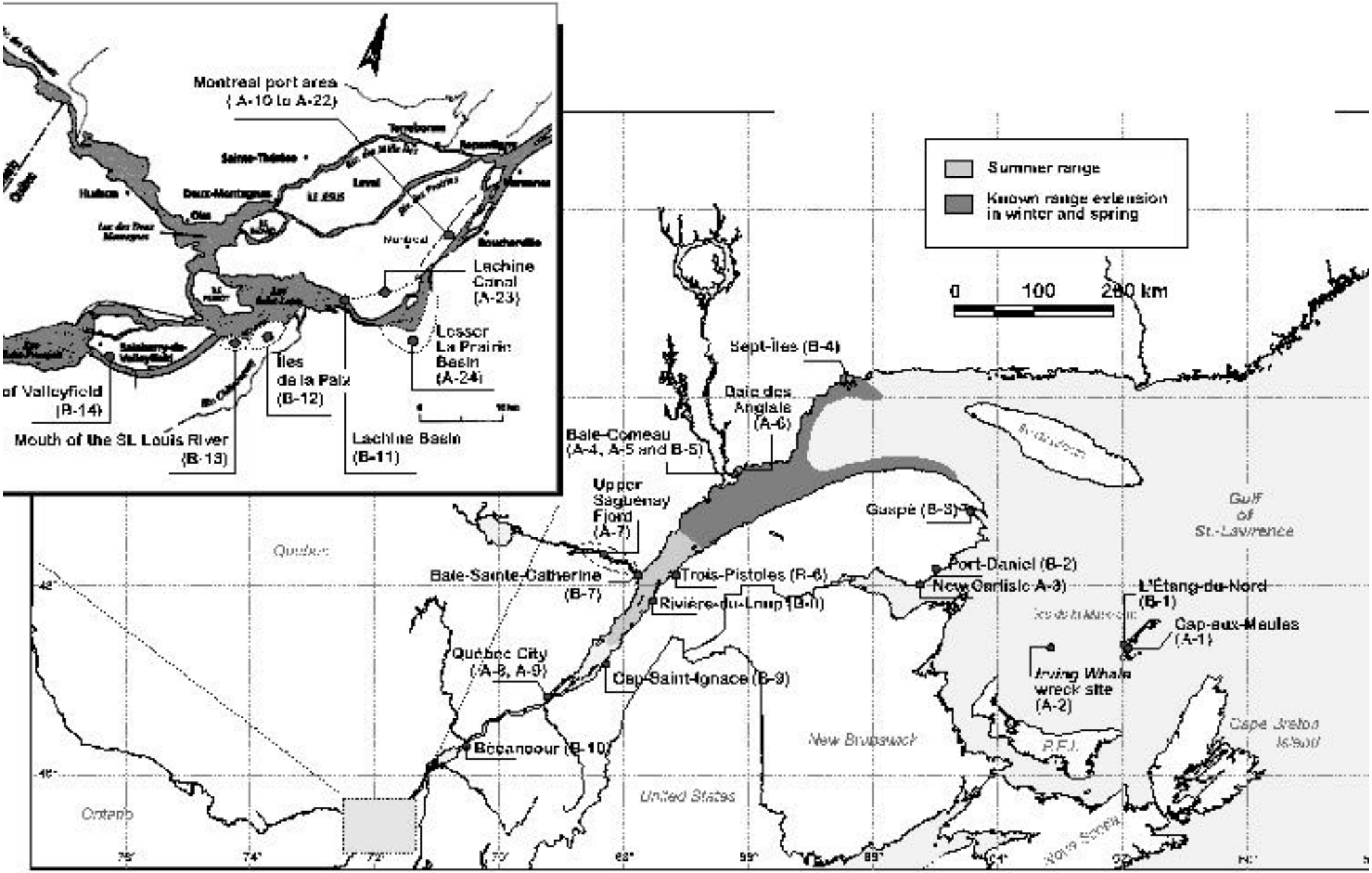

Figure 1: Location of contaminated sites in Categories A and B and the current range of the beluga. Source (range): SLBRT, 1995.

Table 2. List of contaminated sites for which the data cannot be used to establish the level and extent of contamination by substances of concern for the beluga in surface sediments (Category B sites).

Ref. No.	*Site Name*	*Substance(s) exceeding the TET* (year exceeded)*
B-1	Étang-du-Nord harbour	PAHs (1995)
B-2	Port-Daniel-Est harbour	PAHs (1996)
B-3	Port of Gaspé, Sandy Beach wharf	PAHs (1992)
B-4	Port of Sept-Îles, fishing harbour	Hg (1987)
B-5	Baie-Comeau, public port	PCBs, PAHs (1993)
B -6	Trois-Pistoles, ferry wharf	Pb (1989)
B-7	Baie Sainte-Catherine, wharf	PAHs (1991)
B-8	Port of Rivière-du-Loup	Hg (1997)
B-9	Cap-Saint-Ignace flats	Hg (1989)
B-10	Port of Bécancour	Hg (1982)
B-11	Lachine basin	Pb, Hg (1990)
B-12	Lake St. Louis, Îles de la Paix	Hg (1984-1985)
B-13	Lake St. Louis, mouth of the St. Louis River	Hg, PAHs, HCB (1984-85)
		PAHs (1988)
B-14	Port of Valleyfield	Pb (1986)

Source: Gagnon and Bergeron 1997

*: TET: Toxic Effect Threshold

The substances exceeding the TET at the 38 sites selected are lead, mercury, PCBs and PAHs. Hexachlorobenzene exceeds the TET only at the mouth of the St. Louis River while organochlorine pesticides do not exceed the threshold anywhere in the St. Lawrence, presumably because there are no major point sources for this type of substance. In the case of dioxins and furans, for which no TET has been established, there are no major local point sources in the St. Lawrence except a pulp and paper mill in Trois-Rivières and an aluminum smelter in Baie-Comeau. In the first case, there is no stable sediment deposit near the source. As for the furans found in Baie des Anglais, they appear to come from the same source as the PCBs that were discharged into the bay (effluent from an aluminum smelter) as furans can constitute impurities in commercial PCB mixtures. This site was selected for the study because the PCB level exceeded the TET.

In almost every case, the sources of the TET exceedences were either eliminated, considerably reduced or were scheduled for elimination in the early 1990s.

3.2 Phase 2. Classification of Category A Contaminated Sites Based on Their Risk for the Beluga

3.2.1 Beluga Exposure Pathways to Toxic Substances at Contaminated Sites

An initial assessment was made to determine whether belugas might be exposed to toxic substances in the 24 sites in Category A (Table 1). The beluga exposure pathways studied were:

1. Consumption of benthos at contaminated sites;
2. Consumption of fish that feed at contaminated sites;
3. Skin exposure to substances released from the sites;
4. Consumption of benthos contaminated by substances released from the sites;
5. Consumption of fish contaminated by substances released from the sites.

It is practically impossible for belugas to be contaminated through the first exposure pathway because they do not frequent any of the 24 sites, with the exception of the upper Saguenay Fjord, which is visited only occasionally by a few isolated individuals or small groups.

The second exposure pathway did not seem to be a very discriminating factor for classifying the sites. Freshwater fish cannot be part of the beluga's diet; the sedentary marine species that feed at some of the sites are not very vulnerable to predation by the beluga because the belugas do not frequent the 24 sites; and finally, anadromous fish and migratory marine fish do not spend enough time at the sites for significant bioaccumulation of toxic substances to occur. The assessment suggests that the eel (the only catadromous species in the St. Lawrence) could be the determinant for beluga contamination through the second pathway at the 24 sites. It is the only fish species that has a sedentary lifestyle in the contaminated sites and migrates within the beluga's range. Eels are likely to frequent 21 of the 24 contaminated sites before migrating to the beluga's range. The available data does not permit a comparison of how often eels frequent the sites.

It is possible for the beluga to be contaminated through exposure pathways 3, 4 and 5 at the 24 contaminated sites because the toxic substances released from the sites can be transported by water masses to the feeding grounds of the beluga or its prey, from sites several hundred kilometres both upstream and downstream from the feeding areas. Since no one knows exactly what the beluga eats and whether skin exposure might be significant, an ecosystem model combining pathways 3, 4 and 5 was developed. The model assesses the relative risk of toxic substances being released at the sites and contaminating the food chain in the beluga's range. Naturally, dilution will reduce the contribution. Because risk assessment using the model remains relative and does not allow us to judge the absolute risk of these contaminated sediments for the beluga, the classification only compares the sites among themselves.

3.2.2 Assessment Model of the Risk Associated with Release

The model developed involves six main variables: 1) site area, 2) average concentration of each toxic substance in surface sediments, 3) relative rate of release of toxics to the water column, 4) relative rate of transport of released substances to the beluga's range, 5) relative biomagnification potential of toxics in the beluga's prey, and 6) relative dangerousness of toxics for the beluga. A risk index was calculated for each contaminated site by determining the product of the six variables for each toxic substance and adding up the products obtained for all of the substances considered in the model. Since the index only takes releases into account, it is not an absolute measure of risk for the beluga; the score obtained can only be used to rank the sites among one another according to relative risk (see Gagnon and Bergeron (1998) for more details on the model).

Only 10 substances (lead, mercury, total PCBs and 7 PAHs) were considered in the model because the data available for the other substances (hexachlorobenzene, organochlorine pesticides, dioxins, furans and individual PCB congeners) was too fragmentary for comparison. The data on bioaccumulation of toxics in fish and their toxicity and carcinogenicity for mammals suggests that PCBs are determinants of risk for belugas. They are the only substances that are simultaneously abundant in sediments, highly biomagnified in fish and very toxic for mammals. Including hexachlorobenzene, organochlorine pesticides, dioxins and furans in the model would probably not have significantly changed the results. These substances are, evidently, not very abundant at the 24 sites studied and there is less biomagnification of dioxins and furans than of PCBs, while hexachlorobenzene and organochlorine pesticides are less toxic than PCBs. However, different results might have been obtained if individual PCB congeners (in particular planar PCBs) could have been considered ; some of these congeners are extremely toxic for mammals and could make up a greater proportion of PCBs at some sites.

Each of the model's variables has its own level of uncertainty, which also varies with the site and substance in question. Overall, the level of uncertainty is relatively low for area and average concentration, moderate for biomagnification potential and rate of transport, and high for rate of release and dangerousness. A sensitivity analysis was performed to assess the extent to which site ranking according to relative risk could vary. In the various scenarios studied, the relative potential for biomagnification or relative dangerousness of the substances, or the relative rates of release or transport from the sites varied by one order of magnitude.

The sensitivity analysis identified three groups of sites not subject to change, regardless of the scenario studied (Table 3): one group (Group 1) of ten sites with a relatively high risk index, a second group (Group 2) of nine sites with an intermediate risk index, and a third group (Group 3) of five sites with a relatively low risk index.

An analysis of the results also showed that the site area was one of the greatest discriminants for ranking sites according to relative risk. Some of the less contaminated sites scored relatively high risk simply because they were relatively large in area. Site ranking according to relative risk by unit area (i.e., risk index divided by area) showed that within each group of sites there were three sub-groups: sub-group a (relatively high risk per unit area), sub-group b (intermediate risk per unit area) and sub-group c (relatively low risk per unit area).

In Group 1 (Table 3), there are six port areas (sub-group 1a) that are relatively small in area and have a relatively high concentration of toxic substances and a relatively high release rate. The sediments at these sites can be disturbed more easily by natural or anthropogenic agents (dredging, ship traffic) than those at other Group 1 sites. The second sub-group (1b) consists of canals with locks (Lachine Canal and the Lesser La Prairie Basin) that have an intermediate area and a relatively low release rate. The third sub-group (1c) includes two deep-water sites characterized by a relatively large area, a relatively low concentration of

Table 3. Classification of contaminated sites in Category A[1] according to the relative risk that they represent for the beluga[2].

Group 1. Relatively High Risk		
Sub-group 1a[3]	Sub-group 1b[3]	Sub-group 1c[3]
PM[4] - Wharf 103	Lesser La Prairie Basin	Saguenay Fjord[5]
PBC - Anse du Moulin	Lachine Canal	Baie des Anglais
PM - Racine		
PM - Elevator No. 4		
PBC - Cargill		
PM - Hotel-de-Ville park		

Group 2. Intermediate Risk		
Sub-group 2a	Sub-group 2b	Sub-group 2c
PM - Pte-aux-Trembles	PM - Bickerdike	PM - Harbour Station
	PQ - Saint-Charles	
	PM - Sutherland	
	PM - Marien wharf	
	PM - Vickers	
	Irving Whale	
	PM - Clock	

Group 3. Relatively Low Risk		
Sub-group 3a	Sub-group 3b	Sub-group 3c
		PM - Wharf No. 1
		PM - Jacques Cartier
		Cap-aux-Meules
		PQ - Louise Basin
		New Carlisle

1: Sites in Category A are those where at least one of the 29 substances of concern for the beluga exceeds the TET and for which it is possible to determine the level and extent of contamination of surface sediments.

2: The relative risk was calculated using a model that takes into account the area of the site, the mean concentration of toxic substances in surface sediments, the relative rate of release of sediments, the rate of transport of sediments to the beluga's range, the relative potential for biomagnification of substances in the beluga's prey and the potential toxicity of substances for the beluga.

3: Each group of sites is subdivided into three sub-groups that correspond to the sites for which the risk per unit area is relatively high (sub-group A), intermediate (sub-group B) or relatively low (sub-group C).

4: PM: Port of Montreal; PQ: Port of Québec; PBC: Port of Baie-Comeau.

5: Based on data prior to the 1996 flood. Surface sediments in the upper Saguenay Fjord are less contaminated at this time.

toxic substances in surface sediments and a relatively low release rate. It should be noted that the Saguenay Fjord data used in the model dates from before the 1996 floods; the surface sediments at the site today are probably even less contaminated following the sedimentation of significant quantities of fairly uncontaminated sediments on the bottom of the Fjord in 1996.

In Group 2, the Pointe-aux-Trembles site (sub-group 2a) differs from the other sites in that its release index is much higher. The site is probably an unstable deposit of sediments and would not have been selected had the data available at the site-selection stage been able to show that it was an unstable deposit. The Harbour Station site (sub-group 2c) is in Group 2 only because of its large area; otherwise, it is similar to the sites in Group 3. Finally, all of the sites in Group 3 have a relatively low risk index by unit area and belong in sub-group 3c. These sites have a relatively small area, a relatively low concentration of toxic substances and a relatively low release rate.

Priorities for action should be established according to the groups in Table 3. The sub-group classification should be used to choose the means to implement action at each of the sites.

3.3 Phase 3. Classification of Category B Contaminated Sites

An analysis of Category B sites was performed in order to prioritize them for more detailed characterizations. Unlike Category A, Category B does include sites frequented by the beluga and it is possible that belugas have been contaminated at some of the sites through their benthos and the fish that feed there. The site's location should thus be a major discriminating factor for this category of sites.

Three factors were used to classify the sites: 1) the location in relation to areas frequented by the beluga, 2) the type of substance exceeding the TET in surface or deep sediments and 3)

the amplitude of the TET exceedence in surface sediments (see Gagnon and Bergeron 1998 for more details). Table 4 presents the classification results.

The area around the Baie Sainte-Catherine wharf is at the top of the list because the site is highly contaminated by PAHs and is frequented intensively by belugas. Although the mouth of the St. Louis River (in second place) is several hundred kilometres upstream from the beluga's range, it was one of the most contaminated in the St. Lawrence in the 1980s (by mercury, hexachlorobenzene and PAHs). A number of other sites are also contaminated by mercury and PAHs. Those closest to the sites frequented by the beluga (Rivière-du-Loup, Trois-Pistoles and Baie-Comeau) are ranked ahead of the other sites. The Port of Valleyfield (in last place) is contaminated only by lead, a substance that is not very biomagnified in the beluga food chain.

3.4 Phase 4. Evaluation of the Contribution of Contaminated Aquatic Sites to the Budget of Toxic Substances that are Potentially Dangerous for the Beluga

The only substances for which it is currently possible to establish a reliable mass balance for the St. Lawrence system as a whole are total PCBs and Mirex. As PCBs are determinants in assessing the risk of contaminated aquatic sites for the beluga, PCB burden was used to study the probable contribution of contaminated sites to the budget of toxic substances potentially dangerous for the beluga.

Figure 2 presents the mass balance that it was possible to establish with the data and partial budgets that were available (see Gagnon and Bergeron (1998) for details of the methodology). This approximation is representative of the situation that prevailed in the late 1980s and early 1990s. At the time, the main PCB inputs in the beluga's range were through water (and suspended solids) from the St. Lawrence River (357 kg/year), water (and suspended solids) from the Gulf of St. Lawrence (284 kg/year), migratory eels from the

Table 4. Ranking of Category B[1] contaminated sites according to the priority for carrying out a more detailed characterization.

Priority[2]	*Site*	*Location in relation to the beluga*[3]					*Substances exceeding TET and amplitude of TET exceedences (number of times the TET)*				
		A	*B*	*C*	*D*	*E*	*PCB*	*HCB*	*Hg*	*PAH*	*Pb*
1	Baie Sainte- Catherine (wharf)	X					-	-	-	28	-
2	Mouth of St. Louis River				X		-	3	35	20	-
3	Rivière-du-Loup (wharf)		X				-	-	1	-	-
3	Trois-Pistoles (wharf)		X				-	-	1	-	-
3	Baie-Comeau (federal port)			X			-	-	-	2	-
6	Iles de la Paix				X		-	-	5	-	-
7	Gaspé (port of Sandy Beach)					X	-	-	-	40	-
8	Bécancour (port)				X		-	-	3	-	-
9	Lachine Basin				X		-	-	1	-	-
9	Cap-Saint-Ignace flats				X		-	-	1	-	-
11	Sept-Îles (fishing harbour)					X	-	-	1	-	-
12	Étang-du-Nord (fishing harbour)					X	-	-	-	4	-
13	Port Daniel Est (fishing harbour)					X				1	-
14	Valleyfield (port)				X		-	-	-		3

Source: Gagnon and Bergeron 1998

1: Category B sites are those where one of 29 toxic substances of concern for the beluga exceeded the TET in surface or deep sediments but for which the level and extent of the contamination are unknown.

2: Priority was determined on the basis of a site's location compared to the sites frequented intensively by the beluga (A > B > C > D > E), the substance(s) that exceed(s) the TET in the sediments (PCB > HCB > Hg = PAH > Pb) and the amplitude of TET exceedences.

3: A: area frequented intensively; B: summer range outside areas frequented intensively; c: winter range outside summer range; D: upstream of range; E: downstream from range.

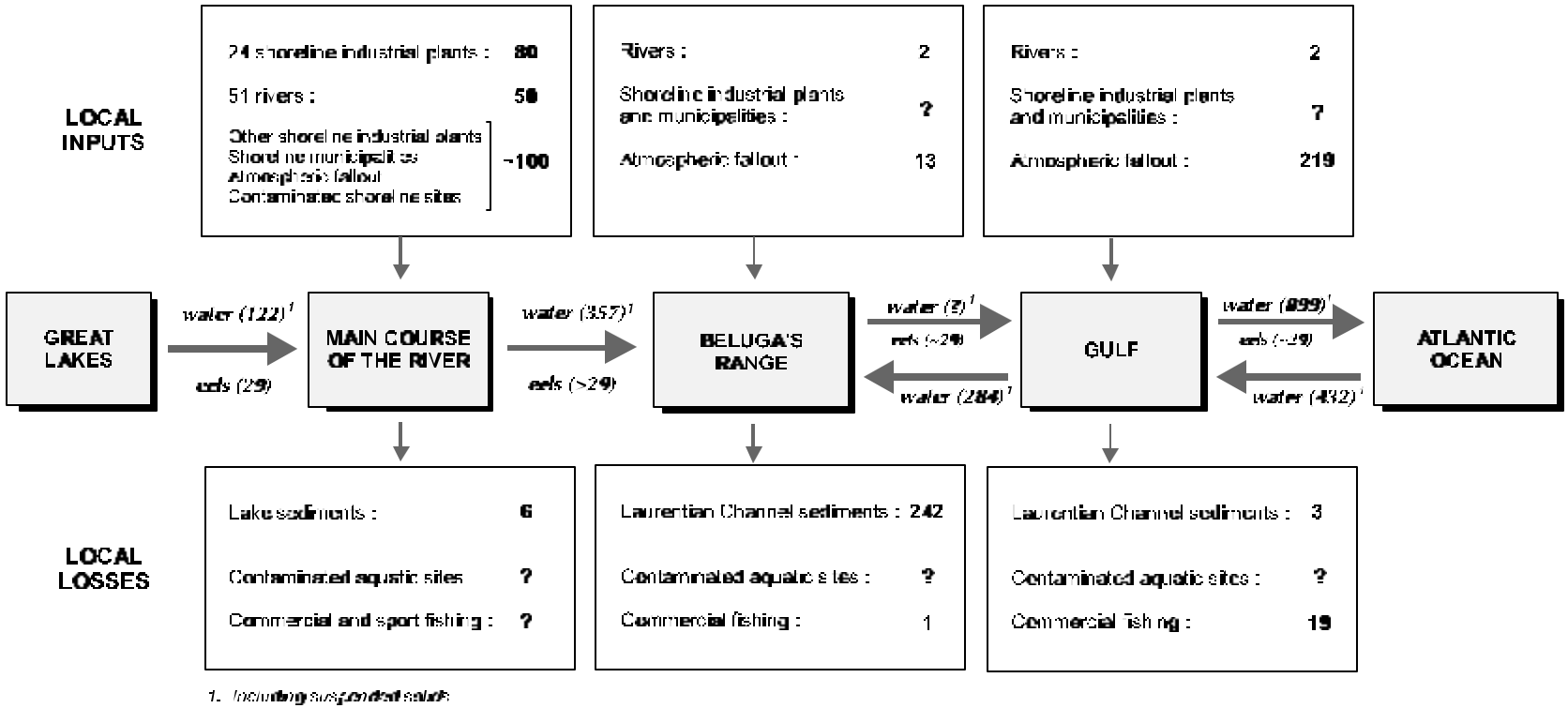

Figure 2. PCB mass balance in the St. Lawrence system in the late 1980s and early 1990s. Expressed in kilograms per year. (Source: Gagnon and Bergeron, 1998).

upper St. Lawrence (29 kg/year), direct atmospheric fallout on the beluga's range (13 kg/year) and tributaries in the beluga's range (2 kg/year).

Of the 357 kg of PCBs transported by the St. Lawrence each year, 35% came from the Great Lakes, 23% from the effluent of 24 industrial plants located along the banks of the River, 14% from the St. Lawrence's 51 main tributaries and 28% from unmeasured sources (municipalities, other industrial plants and contaminated land sites on the banks of the St. Lawrence, other tributaries and direct atmospheric fallout on the River). The PCBs transported from the Gulf to the beluga's range and by rivers flowing into the area mainly come from atmospheric fallouts. Finally, most of the PCBs transported by migratory eels come from sources in the Great Lakes, with the remainder coming from sources in the upper St. Lawrence.

Most of the PCB losses in the system resulted from exchanges of water between the Gulf and the Atlantic Ocean (net loss of 467 kg/year), from the burial of PCBs in deep layers of sediment in the upstream portion of the Laurentian Channel (Lower Estuary; 242 kg/year), from fluvial lakes (6 kg/year) and the downstream portion of the Laurentian Channel (Gulf; 3 kg/year) as well as from commercial fishing in the Estuary and in the Gulf (20 kg/year).

In this assessment, the contaminated sites are not considered sources of PCBs but rather collection basins that retain some of the toxic substances as they are being transported between actual sources of PCBs and the beluga's range. In all cases, these are point sources of PCBs located in or directly upstream from the sites. Only a small fraction of PCB inputs from distant or non-point sources pass through and stay in the contaminated sites. As long as local sources are active, the contaminated sites reduce the toxic load that is transported to the beluga's range and increase PCB residence time near the sources. Thus, these sites reduce the risk for belugas if they are not actually used by the whales and their prey for feeding, but they could increase the risk if the opposite were true.

At almost all of the contaminated sites studied, the main sources of contamination have now been eliminated or considerably reduced. The accumulated sediments at these sites are today potential sources of PCBs. Theses sites can be considered sinks, more or less sealed and fairly sheltered from natural and anthropogenic phenomena that could resuspend the PCBs. Their contribution to the overall budget remains slight.

However, it was impossible to accurately assess the importance that the 24 contaminated sites might have as sources of PCBs that pass through the beluga's range. The only site for which it was possible to conduct a brief assessment was Anse du Moulin (Baie-Comeau). This relatively unsheltered cove is exposed to intermediate tides. It is one of the most PCB-contaminated sites in the St. Lawrence and belongs to the group of sites with the highest relative risk (Table 3). Local sources of PCBs were eliminated in the 1980s. The quantity of PCBs released annually from the cove into Baie des Anglais was estimated at approximately 1.0 kg in 1994. This seems relatively low compared to the values in Figure 2 considering that only a portion of this quantity can reach the beluga's range. PCB inputs from the Great Lakes, migratory eels, industries and municipalities have decreased considerably since the early 1990s. The relative contribution of contaminated aquatic sites has consequently increased, but remains minor and appears to have more of a local impact.

If we assume that only PCBs in the first 5 cm of sediments are transferable to the marine food chain, the 24 sites in Category A appear to be sinks of resuspendable PCBs that are much less important than the upstream portion of the Laurentian Channel and are comparable to other less important sinks such as the sediments at sites frequented intensively by belugas in the Upper Estuary, water masses in the Lower Estuary and the Gulf and the biomasses of plankton and benthos in the Gulf (Table 5). However, toxic substances are buried less quickly in deep sediment at most of the contaminated sites than it would occur in deeper areas such as the Laurentian Channel because natural and anthropogenic processes that promote the mixing and release of sediments are more intense. The value of 1.2 t attributed to the contaminated sites in Table 5 might be an

Table 5. Comparison of various resuspendable PCB sinks in the St. Lawrence system in the late 1980s and early 1990s.

Sink	*Quantity of PCBs (tonnes)*
Water Masses	
• Lower Estuary	1.1
• Gulf	2.4
Sediment Deposits[1]	
• Lake St. Louis	0.9
• Lake Saint-Pierre	4.0
• Sites frequented intensively by belugas in the Middle Estuary	0.5
• Upstream portion of the Laurentian Channel (Lower Estuary > 200 m)	24.0
• Downstream portion of the Laurentian Channel (Gulf > 200 m)	6.0
• 24 contaminated aquatic sites in Category A	1.2
• 14 contaminated aquatic sites in Category B	?
Aquatic Biomasses	
• Gulf plankton	1.8
• Gulf benthos	3.6
• Gulf fish	< 0.1

Source: Gagnon and Bergeron 1998

[1]: For sediment deposits, it is assumed that only PCBs found in the first 5 cm of sediment are likely to be resuspended; the figure for contaminated aquatic sites (1.2 t) may thus underestimate the actual figure.

underestimate of its actual value. Moreover, if we were to virtually eliminate all terrestrial sources of PCBs, the importance of non-permanent sinks such as unstable sediment deposits, water masses and aquatic biomasses would decrease because the sinks are flushed naturally in a fairly short period of time. The same can be said for the importance of the sinks formed by permanent sedimentation areas in deep water (fluvial lakes, the Saguenay Fjord and the Laurentian Channel) because of the gradual covering of contaminated sediment by cleaner sediment. It is thus possible that, within a few years, contaminated sites will together form one of the main sinks of potentially dangerous substances for the beluga and if there is a significant resuspension from these sites, they will be one of the main point sources contributing to the toxic load to which the beluga is exposed.

4.0 CONCLUSION AND RECOMMENDATIONS

With what we know today, we cannot determine the impacts of contaminated aquatic sites on the beluga. We are, however, able to conclude that, regardless of their location in the St. Lawrence system, these sites may contribute to the toxic load to which the ecosystem is exposed. The brief risk assessment performed by the Committee suggests that in the early 1990s, contaminated sites accounted for only a small fraction of the overall toxic load. However, although the relative importance of contaminated aquatic sites in the overall budget increases as terrestrial sources of toxic substances are eliminated, their contribution to the ecosystem remains low. Therefore, the remediation of aquatic contaminated sites cannot be based on the risk they represent for the beluga. Despite this fact, the management of contaminated sites remains a concern and should be founded on local uses to be recovered at each site and the risk for the ecosystem.

This study improved our knowledge of the physical and chemical characteristics of the sites and enabled us to summarize the information in the form of fact sheets for each one (Gagnon and Bergeron 1997). We were able to classify the best documented sites (Category A sites) according to their potential threat to the beluga and its habitat and to identify gaps in our knowledge for some sites (Category B sites).

The Committee believes that its inability to measure the effects of contaminated sites on the beluga does not mean that there are no such effects on the ecosystem. Rather, action in this area should be based on a preventive approach aimed at protecting the St. Lawrence ecosystem and uses of the River. These contaminated sites are toxic sinks. They are not sealed and are subject to the vagaries of nature and more or less predictable human activities that could increase their contribution to the toxic load to which the ecosystem is exposed. The toxic substances[1] found in large concentrations in the sinks are on the list of the 11 persistent, bioaccumulative toxic substances that the International Joint Commission, the St. Lawrence Vision 2000 action plan and the Federal Toxics Policy are striving to virtually eliminate from the environment.

The Committee's recommendations will help better assess and possibly reduce the potential risk of contaminated aquatic sites for the beluga. The main thrust of these recommendations is to reduce the harmful effects that contaminated sediments at the selected sites could have on the entire St. Lawrence ecosystem and on local uses of the River. They repeat and complete some of the recommendations from the St. Lawrence Beluga Recovery Plan and the Implementation Plan developed by the SLV 2000 Partnership. Furthermore, several of these recommendations have already been proposed under federal, provincial and joint programs, notably the federal government's Port Divestiture Commercialization Program and two St. Lawrence Vision 2000 initiatives, the Priority Intervention Zones (ZIP) and Community Interaction Programs. The Committee's recommendations are as follows:

1. Characterize Category B contaminated sites of highest priority

The extent and level of contamination and the stability of contaminated sediment deposits should be determined first for Category B sites located in the current range of the beluga (especially those of Baie-Sainte-Catherine, Rivière-du-Loup, Trois-Pistoles and Baie-Comeau) and at the mouth of the St. Louis River, as established in table 4. The characterization should also include the identification of contaminant sources

[1] Alkyl lead, mercury, hexachlorobenzene, DDT, Mirex, dieldrin, toxaphene, PCBs, benzo(a)pyrene, dioxins and furans.

and activities that favour their release so that the sites can be classified according to local uses to be recovered and the relative risk that they represent for the ecosystem. A detailed characterization of the port at Sandy Beach (Gaspé) was carried out in the fall of 1997 under the federal government's Port Divestiture Commercialization Program but the data was not available at the time this report was written. The mouth of St. Louis River as well was characterized during the summer of 1998 and the final report will be available in 1999.

2. Ensure the follow-up of all Category A sites and widen this follow-up to those Category B sites which following a future characterization could prove to be worrisome for the beluga. If required, elaborate action plans

A portrait of active and anticipated actions for each site and a site by site evaluation of the problem should be defined in order to decide if it is necessary to develop an action plan.

If required, action plans should be established and implemented through a partnership between the owners and users of each site, using existing programs wherever possible. We believe that governments should lead by example and the projects already under way can serve as models. These plans should pursue the following objectives:

- *Update and complete information about each site as required.*

A complete description for each site should first establish a detailed status report of the situation by fully reviewing and completing (with the help field work, if necessary) the available information (see the fact sheets of Gagnon and Bergeron 1997) on:

- ◊ Uses of the site (current and anticipated);
- ◊ Historic and current sources of toxic substances;
- ◊ The stability of sediment deposits;
- ◊ The extent and level of contamination (vertical and horizontal);

- ◊ The presence of planar PCBs, dioxins and furans in the sediments;
- ◊ Natural and human phenomena that might release toxic substances towards surface sediments and the water column;
- ◊ How often the site is frequented by the beluga and its prey.

- *Identify local sources of toxic substances that are still active.*

As any action taken at contaminated sites could be ineffective if local sources of contamination are not first eliminated, it is essential to clearly identify the active sources of toxic substances.

- *Identify, describe and suggest ways to reduce the mixing of sediment and the subsequent release of contaminants.*

The site follow-up should identify and promote for each site the implementation of a series of measures aimed at reducing the risk of toxic substances being resuspended in surface sediments and the water column. The measures could take the following forms, without being limited to them:

- ◊ Zoning the site based on the risks involved;
- ◊ Education and awareness program for the public and users of the site;
- ◊ Restrictions on certain uses;
- ◊ Regulations;
- ◊ Close monitoring of dredging activities;
- ◊ Construction of infrastructures to protect the site.

- *Assess the feasibility of remediating the site.*

The volumes of sediments involved, opportunities and constraints, implementation means, the costs and sources of funding available to remediate the site by eliminating contaminated sediments or toxic substances present in sediment should be assessed according to the technology and means currently available. This exercise should be

repeated as new technologies or new means that might increase the feasibility of remediation become available.

- *Prepare remediation plans for sites when justified.*

Contaminated aquatic sites should be remediated as ecosystem risk justifies, when the aim is the recovery of local use or, in the case of the worrisome Category B sites for the beluga after characterization, when they have a significative negative impact on the beluga. Although the decontamination should follow the polluter-pays principle, the approach will stay practical and will optimize the environmental gain relative to cost. A preliminary remediation plan is required in order to solicit interest by partners.

3. Improve knowledge to more accurately assess the risk of contaminated sites for the beluga

At present, there are still major gaps in our knowledge. For this reason we are unable to assess the risk of contaminated aquatic sites for the beluga in the St. Lawrence at this point. The research activities we need to concentrate on to improve our understanding are:

- *Determining the importance of various toxic substance release methods at a contaminated site.*

A detailed study should be conducted at a contaminated site to examine the sediment dynamics and various release methods of toxic substances found in the sediments. The site chosen should be one where local sources of toxic substances have been completely eliminated, for example, contaminated sites in sub-group 1a (Table 3).

- *Taking into account individual PCB congeners in the assessment of sediment quality and the contamination level in beluga prey.*

It would be possible to make much more accurate risk assessments if we knew the concentration of individual PCB congeners (in particular highly toxic planar congeners) in sediments and prey.

- *Obtaining more accurate information on the beluga's diet and contamination of its prey*

More accurate information on the beluga's diet and contamination levels in its prey is essential to determine the relative importance of the various pathways taken by toxic substances from contaminated sites to the beluga. Other research projects in the area of ecotoxicology could be set up to learn more about the relative importance of various toxic substances for the beluga, such as the determination of bioaccumulation factors of toxic substances in beluga prey (from sediment or water) or an assessment of toxicity of these substances for marine mammals.

4. Using the new knowledge acquired, establish new sediment quality criteria that take into account biomagnification in the food chain and the toxicity of substances for the beluga (or other vertebrates).

The sediment quality criteria currently used are based on the toxicity of substances for benthos; they do not take into account the risk associated with biomagnification in the food chain and the toxicity of substances for vertebrates (fish, belugas, humans). New criteria would allow for a better definition of problem sites for the beluga.

Finally, the Committee suggests that its recommendations be included in the Beluga Recovery Plan's programming.

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