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Risk Management

At the onset of the La Grande hydroelectric project, the mercury issue related to reservoirs was virtually unknown. The Native Cree Indians were informed as soon as monitoring revealed significant increases of mercury levels in fish.

Hydro-Québec's Corporate Research Program on Mercury

Hydro-Québec established a Mercury Research and Management Program to address the issue of increasing mercury levels in fish caused by hydroelectric development. The following activities were included in this program:

- monitoring of mercury levels in fish of modified environments of the La Grande complex;
- development of models predicting mercury levels in fish;
- assessment of risks to piscivorous fauna;
- the study of the sources and fate of mercury in natural environments and hydroelectric reservoirs of Northern Québec;
- research on mitigation measures;
- assessment of the health risks and benefits associated with the consumption of fish.

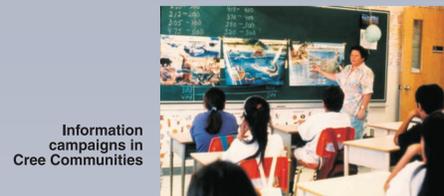
A number of these studies were carried out in collaboration with Canadian universities and Government organizations such as the Canadian Wildlife Service and the National Science and Engineering Research Council of Canada (which supported part of the funding of the HYDRO-QUEBEC-NSERC-UQAM Environmental Chair).

The James Bay Mercury Agreement

In addition to its Corporate research program on mercury, Hydro-Québec was part of the James Bay Mercury Agreement signed between the Government of Québec, the Cree of Québec and Hydro-Québec. The overall objective of this Agreement was to reduce the health risks and provide for remedial measures allowing the Cree to carry on their traditional hunting and fishing activities and maintain their way of life. This 10 year Agreement (1987-1996), with a total budget of 18 M\$ (of which 12 M\$ was paid by Hydro-Québec), dealt with Health, Socio-cultural and Environmental aspects of the mercury issue.

- A critical review of potential mitigation measures aimed at reducing the increases of mercury levels in fish of young reservoirs failed to reveal any realistic solution. Activities were oriented towards remedial measures aimed at reducing health risks by providing low mercury bush food:
- subsidies for family and community fishing in natural lakes;
 - subsidies for coastal fisheries of anadromous species;
 - wildlife enhancement schemes;
 - schemes to increase harvesting of migratory waterfowl, etc.

Information tools, such as booklets, maps and videos, were developed and information campaigns were carried out in the Cree communities to explain the mercury issue and the health risks and benefits related to fish consumption. Fish consumption advisories were also distributed to Cree sport and subsistence fishers, according to exposure criteria of the Cree Regional Board of Health and Social Services of James Bay.



Information campaigns in Cree Communities



Information tool produced in French, English and Cree, in the form of a table mat



Fish consumption advisories

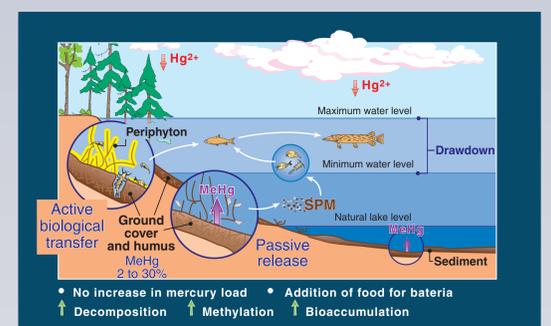
Results of the Risk Management Program

Hydro-Québec's Corporate Research Program permitted a comprehensive understanding of the biogeochemical processes involved in the production of methylmercury in reservoirs and its transfer to fish. A **Monograph** on the sources and fate of mercury in natural environments and hydroelectric reservoirs of Northern Québec was published (Lucoffe *et al.*, 1999). It is presented in the form of 14 peer reviewed papers addressing the issue of mercury in natural lakes, terrestrial environments, hydroelectric reservoirs and fish eating wildlife, with an overall synthesis.

The compensation type **mitigation measures** selected and financed under the James Bay Mercury Agreement, encouraged traditional hunting and fishing activities. Replacement fisheries aimed at non-piscivorous species were the most favoured by the Cree communities. These fisheries were monitored to prevent any risk of overharvesting. The implementation of the mitigation measures program has contributed to a reduction in the Cree's exposure to mercury and helped maintain traditional hunting and fishing activities (Chevalier *et al.*, 1997).



Mercury Monograph



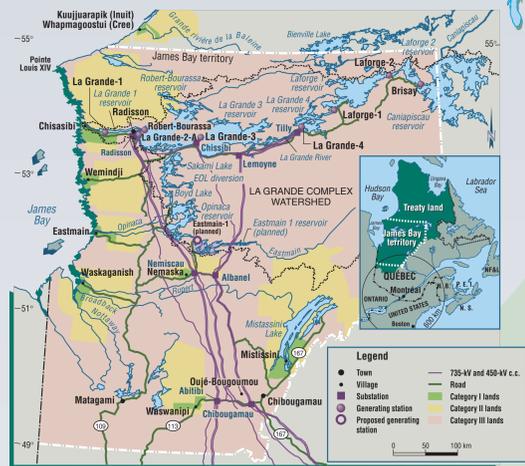
Processes involved in the temporary increase of methylmercury production and transfer in reservoirs

Abstract

The development of hydroelectric reservoirs causes temporary increases of mercury levels in fish. A management program has been implemented to reduce health risks related to mercury exposure which includes: the signing of the James Bay Mercury Agreement; the study of the source and fate of mercury in Northern Québec; the monitoring of mercury levels in fish and of the Cree exposure to mercury; public information campaigns and fish consumption advisories.

Outline of the Project

The James Bay territory, located in Northern Québec, Canada, lies between the 48th and 55th North parallels and covers 350 000 km². The La Grande hydroelectric complex comprises eight generating stations and required the impounding of eight reservoirs with a total surface area of 12 953 km².



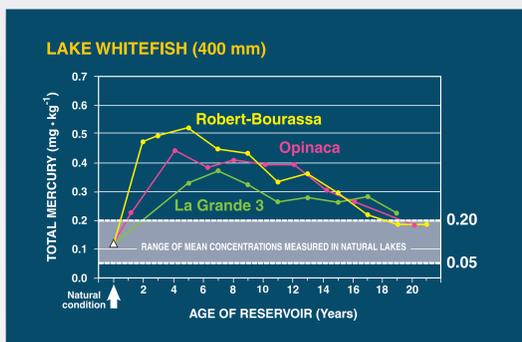
The La Grande hydroelectric project

Features of the Project Area

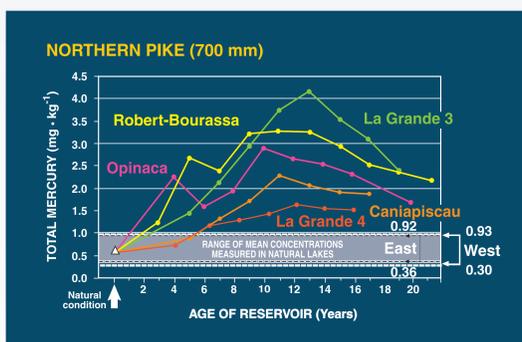
The whole territory, which is part of the Canadian Shield, is divided into a coastal plain, with scattered peat bogs and clay deposits, and a hilly plateau covered by a large number of lakes. The annual average temperature is around -4°C. The region is home to some 12 000 Cree Indians, belonging to 9 communities.

Major Impacts

After reservoir impoundment, mercury concentrations increased temporarily in all fish species. Peak concentrations reached levels 3 to 7 times those measured in surrounding natural lakes. Concentrations in the non-piscivorous species, such as lake whitefish (*Coregonus clupeaformis*), have returned to levels typical of natural lakes 10 to 19 years after impoundment. In the piscivorous northern pike (*Esox lucius*), the rate of decline strongly suggests that natural concentrations are reached between 20 to 30 years after impoundment. These increases in fish mercury levels considerably reduce the recommended rate of fish consumption in order to respect the level of mercury exposure considered safe by public health authorities.



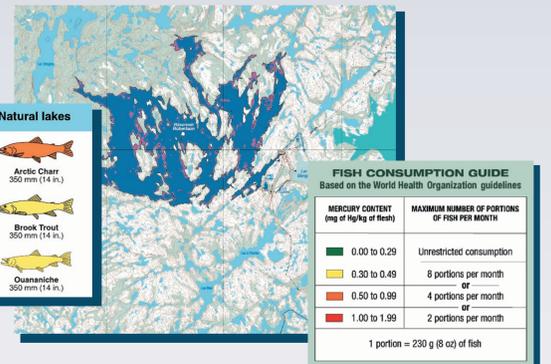
Temporary increases of mercury levels in a non piscivorous fish of the La Grande complex



Temporary increases of mercury levels in a piscivorous fish of the La Grande complex

Fish consumption advisories in the form of maps distributed to sport fishers

For each new project, **fish consumption advisories** for non-sport fishers were also prepared in collaboration with Québec Public Health agencies according to Canadian and provincial exposure criteria.



Eeyou Namess Corporation

The James Bay Mercury Agreement was recently renewed with an additional budget of 27 M\$ (Mercury Agreement 2001). A non-profit organization, the Eeyou Namess Corporation, was established to implement the activities of the Agreement which consists of Monitoring and Research Programs as well as Fishery Restoration and Development Programs. The affairs of the Corporation are managed by a Board of Directors comprised of 4 persons appointed by the Cree Regional Authority and 3 persons appointed by Hydro-Québec.

The **risk management program** demonstrated that the mercury issue can be adequately managed through appropriate monitoring, compensation measures, and information and communication campaigns informing fishers on the health risks and benefits of fish consumption.

Reasons for Success

The management of the mercury issue at the La Grande complex was a true success because Hydro-Québec took immediate action, informed rapidly all those concerned and sought collaboration and partnerships to properly address the issue.

References

Chevalier, G., Dumont, C., Langlois, C., Penn, A., 1997. Mercury in northern Québec: role of the mercury agreement and status of research and monitoring. *Water, Air and Soil Pollution*, vol. 97 (1977), p 53-61.

Lucoffe, M., Schetagne, R., Thérien, N., Langlois, C., Tremblay, A., 1999. Mercury in the Biogeochemical Cycle: Natural Environments and Hydroelectric Reservoirs of Northern Québec. Berlin: Springer. 334 p.