# 15.0 ECONOMIC DEVELOPMENT

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This section discusses economic activities, other than harvesting (see Chapter 14), that occur within the Hudson Bay marine ecosystem or in the coastal regions nearby. Despite its vast area, few people live along these coasts and very little development has occurred. Hydroelectric development is the activity with the greatest existing and potential impact on the marine ecosystem over the short and, perhaps, long term. To date there has been no offshore mineral development, and to our knowledge none is planned. There are, however, a number of new mining developments being established near the coasts. These developments have some potential to impact the marine environment through increased ship traffic, and possibly the release of contaminants. The impacts of transportation are low at present as communities are re-supplied during the openwater season and only the Port of Churchill is capable of docking and loading sea-going transport vessels. The main impacts of municipal developments on the marine environment are related to shoreline development, disturbances and the disposal of waste, all of which occur mainly in the immediate vicinity of the communities. The effects of ecotourism likely are low at present but may be increasing. The GRAND Canal Scheme, which proposes to dam the mouth of James Bay and reroute freshwater to the United States, is one development proposal that has raised serious concerns.

Sly (1994) reviewed the potential effects of development within the entire Hudson Bay watershed. Readers are referred to his work for an excellent broad overview. In the absence of complete data, workshops have been conducted to consider the potential impacts of: 1) the Grande Baleine hydroelectric development on the marine environment (Gilbert et al. 1996); 2) future hydroelectric development of the Nelson River system on belugas using the estuary (Lawrence et al. 1992); and 3) the potential cumulative impacts of regional development (Bunch and Reeves 1992; Sallenave 1994). Workshops have also been conducted to develop integrated approaches to ecosystem management (Fast et al. 2001), and to studies of ecosystem health (Cobb et al. 2001).

## 15.1 HYDROELECTRICITY

Hydroelectric developments have significantly altered the flow regimes of the Eastmain and La Grande rivers in Quebec, which drain into James Bay (Messier et al. 1986; Roy and Messier 1989; Hayeur 2001); the Churchill and Nelson rivers in Manitoba, which drain into southwestern Hudson Bay (Newbury et al. 1984; Rosenberg et al. 1987, 1995, 1997), and the Moose and Albany rivers in Ontario, which drain into southwestern James Bay (KGS Group et al. 1991; Stokes et al. 1999) (Table 15-1) (see also Figure 3-8). Runoff from a small portion of Grande rivière de la Baleine, which flows into southeastern Hudson Bay, has also been diverted into the La Grande system. The diversions in Quebec and Manitoba have shifted flow among rivers in the Hudson Bay watershed, changing the distribution of runoff entering the marine environment. Runoff in the La Grande River has also been augmented by the diversion of flow from the Caniapiscau River, which formerly drained via the Kokosak River into Ungava Bay, while the Nelson has been augmented by flow from headwaters of the Albany River. Large-scale impoundments have regulated flow in the Eastmain-La Grande and Churchill-Nelson systems, and altered the seasonality of their runoff into the marine environment. Runoff from the Albany River has also been diverted into the Saint Lawrence watershed via the Little Jackfish and Aguasabon rivers. The diversions of flow from the Albany have reduced its runoff into James Bay, but have not altered the seasonality of its runoff peak. Flow volume in the Moose River basin has not been altered by diversions but the seasonal runoff regime has been altered by impoundment. The longterm impacts of these water diversions on the marine environment are unknown.

Hydroelectric developments in Quebec are listed in Table 15-2 and depicted in Figure 15-1. A great deal of environmental research has been done on estuarine and marine environments related to proposed developments on Grande rivière de la Baleine, and the Nottaway and Broadback rivers, and continues for developments that have or may affect the La Grande, Eastmain and Rupert rivers.

On 18 November 1994, in response to continuing environmental concerns and a decline in the projected demand for electricity in North America, Hydro Quebec suspended plans to build the Grande Baleine hydroelectric development southeast of Hudson Bay. As proposed, this development would have involved: 1) a very large reduction in the Grande rivière de la Baleine itself and its estuary, with periodic use of the river to carry overflow;

**Table 15-1. Major drainage diversions affecting the Hudson Bay watershed (from National Atlas of Canada 5th edn 1986).**

| Source basin | Receiving basin | Mean annual flow diverted ($m^3{\cdot}s^{-1}$) | Total flow diverted (%) | Area ($km^2$) |
|---|---|---|---|---|
| **QUEBEC** | | | | |
| Opinaca River (Eastmain R.), Eastmain R. | Lac Boyd (La Grande R.) | 850 | 92 | 40274 |
| Caniapiscau River (Koksoak R.) | Riviere Laforge (La Grande R. via Grande rivière de la Baleine) | 790 | 45 | 38120 |
| Grande rivière de la Baleine | Rivière Laforge (La Grande R.) | 29 | 5 | 1710 |
| **MANITOBA** | | | | |
| Southern Indian Lake (Churchill R.) | Rat River (Burntwood R., Nelson R.) | 760 | 70 | 249239 |
| **ONTARIO** | | | | |
| Lake St. Joseph (Albany R.) | Root River (Winnipeg R., Nelson R.) | 87 | 90 | 12328 |
| Ogoki River (Albany R.) | Little Jackfish River (L. Nipigon, L. Superior, St. Lawrence R.) | 121 | 85 | 13970 |
| Long Lake (Kenogami R., Albany R.) | Aquasabon River (L. Superior, St. Lawrence R.) | 39 | 80 | 4377 |

2) an approximately 95% reduction in the flow of the Petite rivière de la Baleine; 3) an outflow from the system into Manitounuk Sound of about 700 $m^3{\cdot}s^{-1}$ averaged over the year; 4) creation of 3,395 $km^2$ of reservoirs, and 5) a shift in the summer/winter freshwater outflow, very much in the favour of the winter flow (Hydro Quebec 1991c).

On 7 February 2002, under the *Boumhounan Agreement*, Hydro Quebec cancelled plans to construct the Nottaway-Broadback-Rupert (NBR) hydroelectric project. The Agreement also served to define a new project to develop the 770 MW Eastmain-1-A dam on Eastmain 1 reservoir and to divert flow--up to 586.3 $m^3{\cdot}s^{-1}$ on average, from the Rupert River watershed into the Eastmain River watershed (Hydro Quebec 2002) (Figure 15-2). This diversion would increase the output of three existing generating stations on the Grande Riviere (Robert-Bourassa, La Grande-2-A and La Grande-1). Studies to assess the project's potential impacts on the environment are ongoing in preparation for submission of an Environmental Impact Statement to seek the necessary government approvals.

Construction of Quebec Hydro's 480 MW Eastmain-1 Hydroelectric Development began in the spring of 2002 (http://www.hydroquebec.com/eastmain1/en/batir/resume.html). This dam across the Eastmain River will create a 603 $km^2$ reservoir, with an annual drawdown of about 9 m. Its completion is scheduled for 2007.

In 1980, 80% of the flow from the Eastmain River was diverted into the La Grande River, and seasonal runoff was impounded so that it could be released to produce electricity in the winter. This has altered the seasonal freshwater plumes from the La Grande and Eastmain rivers (Peck 1976; El-Sabh and Koutitonsky 1977; Freeman et al. 1982; Ingram 1982; Messier et al. 1986, 1989; Prinsenberg 1986a; Ingram and Larouche 1987a; Roy and Messier 1989). Under these regulated conditions the natural spring freshet into James Bay does not occur at either river. The plume from the Eastmain River is much reduced and there are intrusions of saline water up to 10 km upstream, year-round (Figure 15-3; Lepage and Ingram 1986; Messier et al. 1986).

In contrast, the winter inflow of freshwater from the La Grande River into James Bay increased from 500 $m^3{\cdot}s^{-1}$ under natural conditions to over 4000 $m^3{\cdot}s^{-1}$ following the diversion during peak power production (Messier et al. 1986, 1989; Ingram and Larouche 1987). The area of the under-ice plume increased markedly as discharges increased to 1500 $m^3{\cdot}s^{-1}$, but it showed very little change with further increases in flow since there is intense mixing at the ice edge (Figure 15-4). The plume can extend 100 km northward under the landfast ice of James Bay, and further increases in midwinter flow will lead to dilution of the nearshore surface waters in southeastern Hudson Bay (Ingram and Larouche 1987). The size and shape of the summer plume remained essentially unchanged. Its offshore limit usually coincides with the coastal shelf (0-20 m depth), despite the lower monthly mean flow and higher daily flow fluctuations following diversion (Messier et al. 1986).

**Table 15-2. La Grande hydroelectric complex, 2000 (from Hayeur 2001, pg. 26).**

| | Reservoir level, max. (m) | Reservoir level, min. (m) | Area at max. level (km²) | Active storage (hm³) | Type of generating station | Number of generating units | Type of turbine | Installed capacity (MW) | Annual output (TWh) | Max. usable flow (m³/s) | Rated net head (m) | Load factor (%) | Year of commissioning |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PHASE I** | | | | | | | | | | | | | |
| *Robert-Bourassa (La Grande-2)* | 175.3 | 167.6 | 2,835 | 19,365 | U | 16 | F | 5,328 | 35.2 | 4,300 | 137.2 | 57 | 1979–1981 |
| *La Grande-3* | 256.0 | 243.8 | 2,428 | 25,200 | S | 12 | F | 2,304 | 12.3 | 3,260 | 79.2 | 62 | 1982–1984 |
| *La Grande-4* | 377.0 | 366.0 | 765 | 7,160 | S | 9 | F | 2,650 | 14.6 | 2,520 | 116.7 | 61 | 1984–1986 |
| *EOL (Opinaca)* | 215.8 | 211.8 | 1,040 | 3,395 | | | | | | | | | 1980 |
| *Caniapiscau* | 535.5 | 522.6 | 4,275 | 39,070 | | | | | | | | | 1984 |
| **Subtotal** | | | **11,343** | **94,190** | | **37** | | **10,282** | **62.1** | | | | |
| **PHASE II** | | | | | | | | | | | | | |
| *La Grande-1* | 32.0 | 30.5 | 70 | 98 | S | 12 | P | 1,368 | 7.5 | 5,950 | 27.5 | 57 | 1994–1995 |
| *La Grande-2-A* | * | * | * | * | U | 6 | F | 1,998 | 2.2 | 1,620 | 138.5 | 57 | 1991–1992 |
| *Laforge-1* | 439.0 | 431.0 | 1,288 | 6,857 | S | 6 | F | 840 | 4.5 | 1,610 | 57.3 | 60 | 1993–1994 |
| *Laforge-2* | 481.1 | 479.6 | 260 | 390 | S | 2 | K | 310 | 1.8 | 1,200 | 27.4 | 69 | 1996 |
| *Brisay* | ** | ** | ** | ** | S | 2 | K | 446 | 2.3 | 130 | 37.5 | 70 | 1993 |
| **Subtotal** | | | **1,618** | **7,345** | | **28** | | **4,962** | **18.3** | | | | |
| **TOTAL** | | | **12,961** | **101,535** | | **65** | | **15,244** | **80.4** | | | | |

Notes: * Robert-Bourassa reservoir (formerly La Grande 2) was built during Phase I.
** Caniapiscau reservoir was built during Phase I.

Type of generating station: U Underground; S Surface

Type of turbine: F Francis; P Propeller; K Kaplan

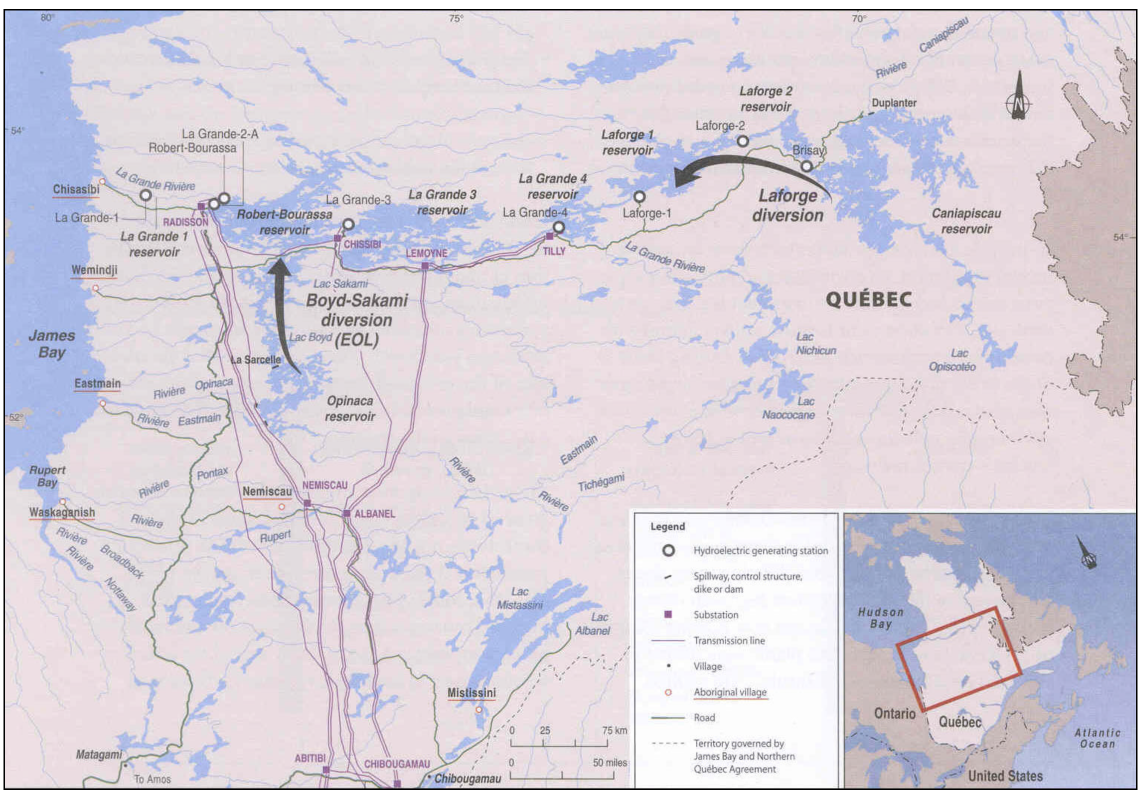


**Figure 15-1. La Grande hydroelectric complex (from Hayeur 2001, pg. 27).**

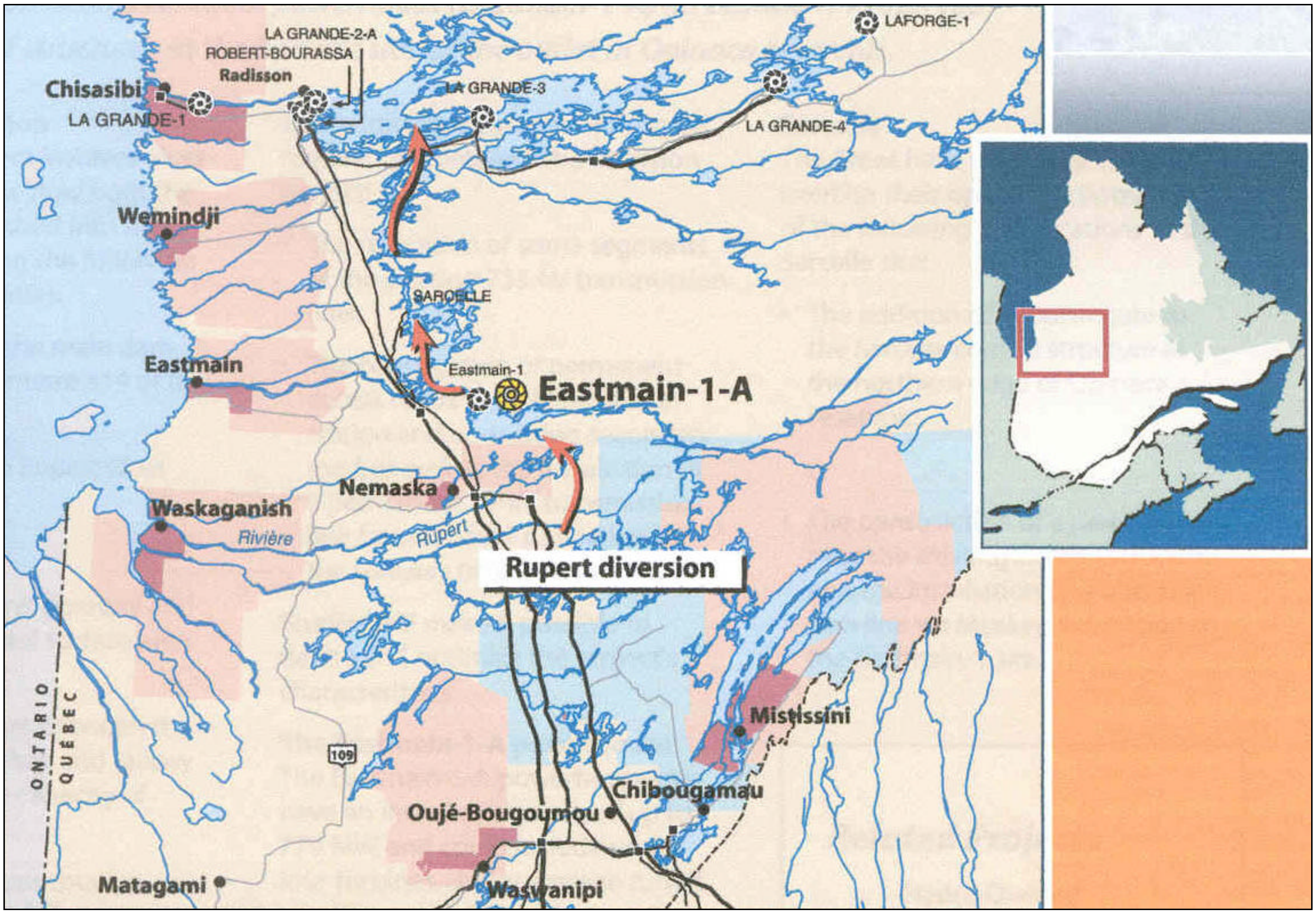


**Figure 15-2.** **Proposed diversion of water from the Rupert River watershed into the Eastmain watershed, and location of the proposed Eastmain-1-A hydroelectric generating station (from Hydro Quebec 2002).**

By decreasing the extent of the Eastmain plume, hydroelectric development has reduced the vertical stability of the affected coastal area (Ingram 1982; Ingram et al 1985; Lepage and Ingram 1986; Messier et al. 1986), while winter flow increases in the La Grande River have had the opposite effect (Freeman et al. 1982; Messier et al. 1986, 1989; Ingram and Larouche 1987a). Salinity and temperature distributions along the axes of the La Grande plume in March 1980, following diversion, are shown in Figure 15-5 and Figure 15-6. Over the first 5-10 km from the river mouth the freshwater outflow spreads out and slows (Freeman et al. 1982). There is thinning of the interface but no apparent increase in entrainment of salt water into the plume. For the next 25-30 km the upper water layer becomes progressively thinner as surface water is mixed, downward, by increasing sub-plume tidal action. A front-like feature with a strong horizontal density gradient separates this layer from the well-mixed area beyond where shoaling bathymetry increases tidal currents and vertical mixing of the water column seems to take place.

The biological effects of these plume changes on estuarine and marine biota are not particularly well understood (Drinkwater and Frank 1994). The reduction in freshwater flow to the Eastmain River estuary has lowered the estuarine water level, increased the tidal range and upstream intrusion of saltwater, and altered circulation (Ingram et al. 1985; Messier et al. 1986). Within the estuary, residual flow velocities are lower, currents have reversed, and tidal currents have increased. A mixed zone of fresh and salt water has developed in the lower 10 km of the river, and the estuary bottom, which was eroding under natural conditions, is now subject to sediment deposition. This deposition has resulted from bank erosion by larger tidal flows and from a

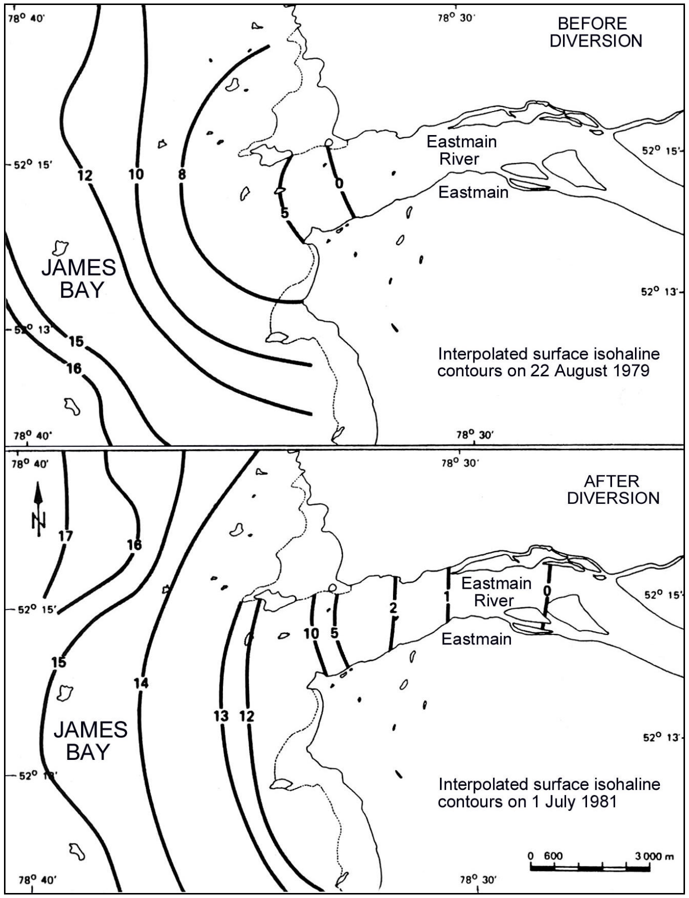


Figure 15-3. **Surface isohaline contours in the Eastmain River estuary during high tide before and after Eastmain River diversion (adapted from Messier et al. 1986).**

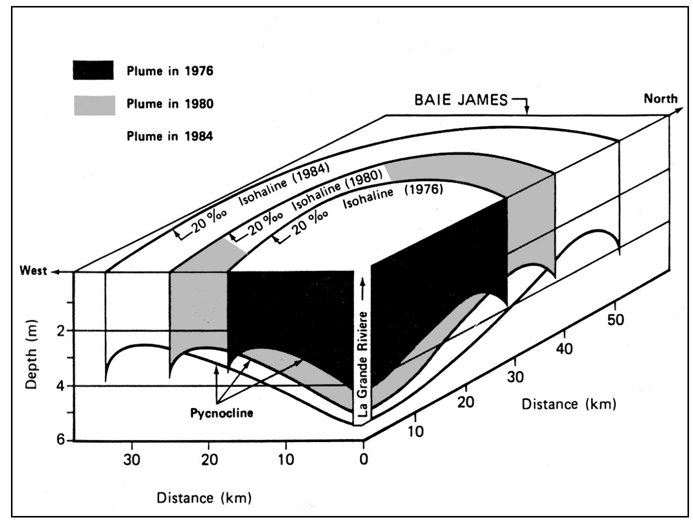


**Figure 15-4. Schematic of the evolution of the La Grande River winter plume from 1976 to 1984 (from Messier et al. 1986).**

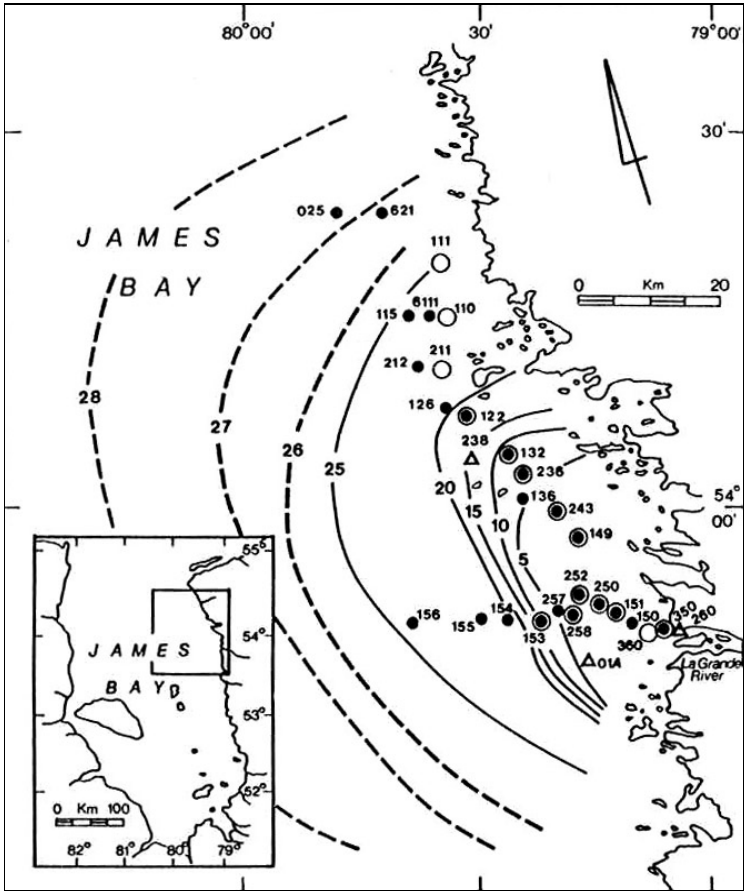


Figure 15-5. Surface salinity distribution off the La Grande River, James Bay during 15-30 March 1980. Solid dots represent conductivity-temperature-density (CTD) stations; open circles 25-hour current profile stations; and open triangles current meter stations (from Freeman et al. 1982, pg. 748).

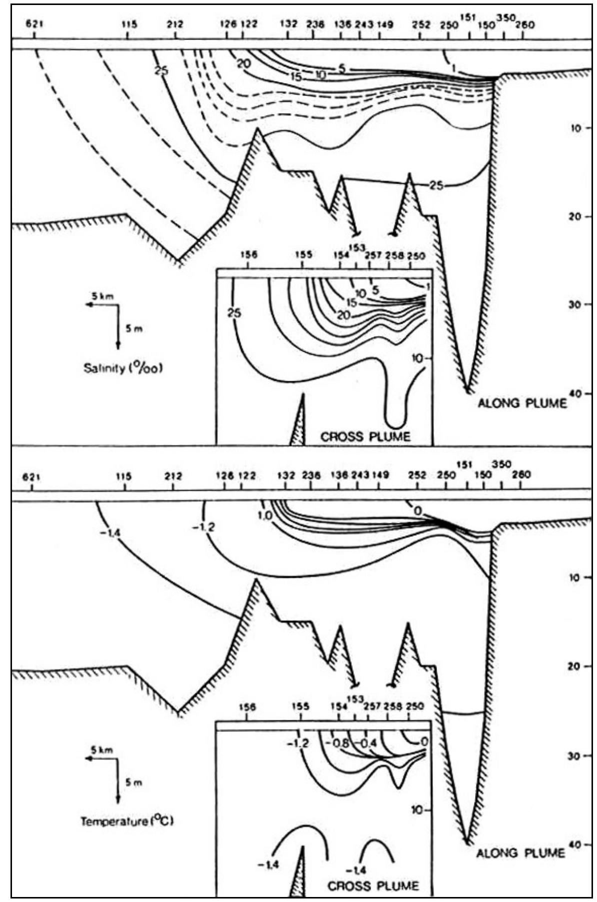


Figure 15-6. Salinity and temperature distributions along the axes of the La Grande River plume during 1-9 March 1980 (from Freeman et al. 1982, page 750). Numbers at the top of each figure refer to the sampling stations shown in Figure 15-5.

reduction in flushing by freshwater, since the sediment load carried by the river has been reduced to 3% of natural. Increased turbidity, total organic and inorganic matter, nutrients, and primary production accompanied the salinity intrusion. The source of the high nutrient concentrations is unknown, and the phytoplankton bloom was due primarily to the increased production of estuarine species (Ingram et al. 1985). There has been an upstream shift in the distribution of marine species (Ingram et al. 1985; Ochman and Dodson 1982). In contrast, the increase in flow to the La Grande River estuary has extended the influence of the freshwater plume offshore, particularly in winter (Ingram and Larouche 1987a+b). The quality of the river water remains similar, as does primary production within the river (Messier et al. 1986). Changes in fish distribution also were observed at the La Grande River estuary soon after diversion (Berkes 1982a). Post diversion monitoring has not detected significant changes in the distribution, density, or biomass of downstream eelgrass communities in response to changes in salinity (Lalumiere et al. 1994; Julien et al. 1996).

The longterm net effects of these biophysical and biochemical changes on biological productivity at all levels are unknown at either estuary. Studies in the Grande rivière de la Baleine estuary have highlighted the importance of the timing and extent of the spring freshet for the survival of larval fishes (Ponton and Fortier 1992; Ponton et al. 1993; Fortier et al. 1995, 1996) (see also Section 8.3). How changes in the Eastmain and La Grande plumes have affected prey density, and availability and thereby larval survival, is unknown but could be important. The effects of estuarine changes related to hydroelectric development on marine mammals and birds are unknown.

Mercury levels in the La Grande system rose considerably following diversion but are now declining (Schetagne and Verdon 1999; Hayeur 2001). Elevated mercury levels have been found in the flesh of marine fishes within 10-15 km of the river mouth. The expected time before mercury concentrations fall back to the condition before the start of operations is about thirty years overall. Mercury was not elevated in fish sampled at the Nelson River estuary in 1989 (Baker 1990) but there is little or no data since then, or from the Moose River estuary. Elevated levels might occur in future if waters closer to these estuaries are impounded. Dams on the lower reaches of rivers are also more likely to alter seasonal movements of anadromous fishes between freshwater spawning and overwintering habitats and estuarine feeding habitats. They might also limit upstream movements by bearded and harbour seals.

Modelling of the potential effects of hydroelectric development on oceanographic surface properties by Prinsenberg (1983) suggests that changes in the runoff cycle caused by hydroelectric development may affect the timing of the formation of a new pycnocline in the spring, and its subsequent depth and stability in Hudson Bay. Prinsenberg (1982a) also predicted that the vertical salinity gradients and currents in James Bay would increase in winter, affecting circulation of water in the bay (Figure 15-7). Modelling by Prinsenberg and Danard (1985) suggests that the surface temperature is buffered somewhat against man-made changes. They predicted that a decrease in surface temperature such as might be caused by hydroelectric development of surrounding watersheds would be gradually offset by the stabilizing effects of the colder water on the overlying air. This would act to decrease wind stress and increase the heat flux into the water. The reverse should be true in the case of an increase in water temperature. However, existing seasonal data are insufficient to test the models and facilitate predictions of the magnitude of any changes.

Ice-ocean modelling studies suggest that the bay-wide effects of the power plants are small compared with the natural variablility observed in the ice cover (Saucier and Dionne 1998). The effects of replacing the natural runoff cycle with that regulated by planned hydroelectric developments were examined using data from Prinsenberg (1980). Under this scenario, 50 $km^3$ more fresh water would enter the bay between January and April than under natural conditions. The results suggest that about 10% of this additional water may form ice, increasing ice thickness in southeastern Hudson Bay by about 10 cm; the rest would remain liquid. The thicker ice could delay breakup in southeastern Hudson Bay by 2-3 days but the additional fresh water may also enhance water column stability. The summer surface salinity would decrease by -0.1 ppt (≈psu) on average over the bay

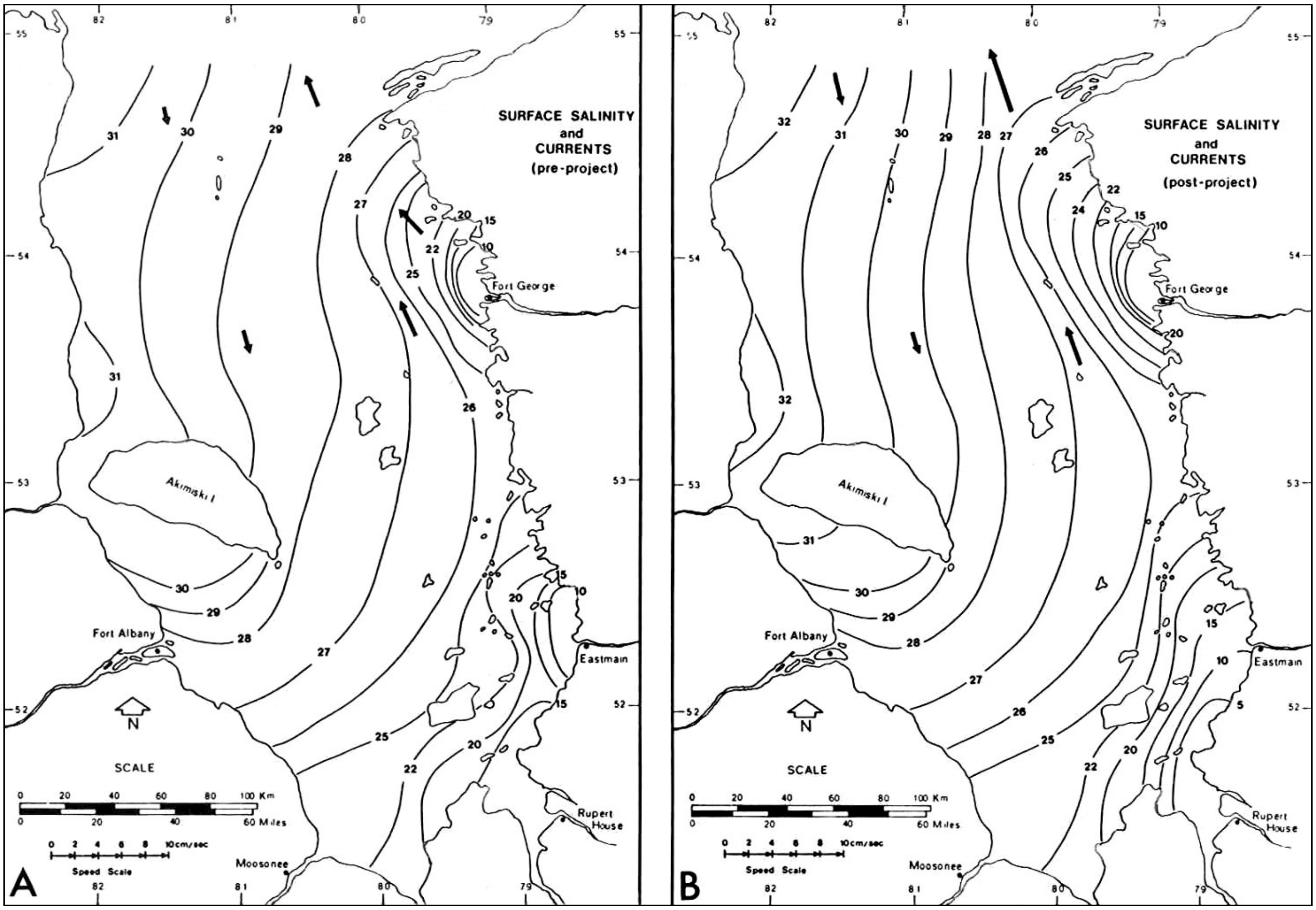


**Figure 15-7. Winter surface salinity distribution and surface current magnitude of James Bay (A) as measured pre-hydroelectric development in March 1976, and (B) as predicted by theoretical models post-development (from Prinsenberg 1982b, pg. 840).**

and by over -0.3 ppt (≈psu) in southeastern Hudson Bay. These changes could lead to higher surface temperatures during peak radiation and thereby advance freezup in southeastern Hudson Bay by about 0.8 d. These estimates do not apply to nearshore river plumes.

The environmental impacts of altering the seasonal runoff regime by impounding rivers draining into James Bay and Hudson Bay on the North Atlantic are uncertain and controversial. Mysak (1993) suggested that they might be far-reaching and that, "*cumulative hydroelectric development around Hudson Bay…could lead to a reduction in the rate of overturning in the Labrador Sea…thus weakening the global thermohaline circulation…resulting in a cooler climate in Europe and eastern North America*." LeBlond et al. (1996) argued that the hydro-related changes in runoff would be insignificant on this large scale relative to the natural variability, and undetectable. They did not address the question of whether the shift in the range of natural variability might have an effect over the longterm.

In Ontario, there are sixteen hydroelectric generating stations in the Moose River basin that affect James Bay and Hudson Bay Figure 15-3, Figure 15-8). Within the basin, there is considerable potential for the redevelopment and extensions of existing sites, and for the development of new sites on the Moose, Mattagami and Abitibi rivers (KGS Group et al. 1991). Future hydroelectric development of the Missinaibi River, another tributary of the Moose, has been effectively precluded by its designation as a provincial waterway park and nomination as a Canadian Heritage River (http://www.chrs.ca ). Ontario Power Generation Inc. has environmental approval to construct the Mattagami River Generating Station Extensions, which consist of additions of one unit to

**Table 15-3.** **Generating capacity of hydroelectric stations in the Moose River Basin (Nyboer and Pape-Salmon 2003).**

| Generating Station | Capacity (kW) | Operator | In service date |
|---|---|---|---|
| **2. Mattagami Complex:** | | | |
| **Little Long** | 133000 | Ontario Power Generation Inc. | 1963 |
| **Smoky Falls** | 52280 | Ontario Power Generation Inc | 1928 |
| **Harmon** | 140800 | Ontario Power Generation Inc | 1965 |
| **Kipling** | 141460 | Ontario Power Generation Inc | 1966 |
| **3. Kapuskasing Hydro** | 2750 | Spruce Falls Inc. | 1923 |
| **4. Carmichael Falls** | 18000 | Algonquin Power Corp. Inc. | 1995 |
| **9. Smooth Rock Falls** | 8000 | Tembec | 1917 |
| **10. Lower Sturgeon** | 5360 | Ontario Power Generation Inc. | 1923 |
| **11. Sandy Falls** | 3200 | Ontario Power Generation Inc. | 1911 |
| **12. Wawaitin** | 10630 | Ontario Power Generation Inc. | 1912 |
| **14. Otter Rapids** | 182400 | Ontario Power Generation Inc. | 1961 |
| **15. Abitibi Canyon** | 310000 | Ontario Power Generation Inc. | 1933 |
| **16. Island Falls** | 44000 | Abitibi-Consolidated Inc. | 1921 |
| **18. Long Sault Rapids** | 18000 | Algonquin Power Income Fund | 1998 |
| **19. Iroquois Falls** | 19085 | Abitibi-Consolidated Inc. | 1949 |
| **20. Twin Falls** | 24750 | Abitibi-Consolidated Inc. | 1921 |

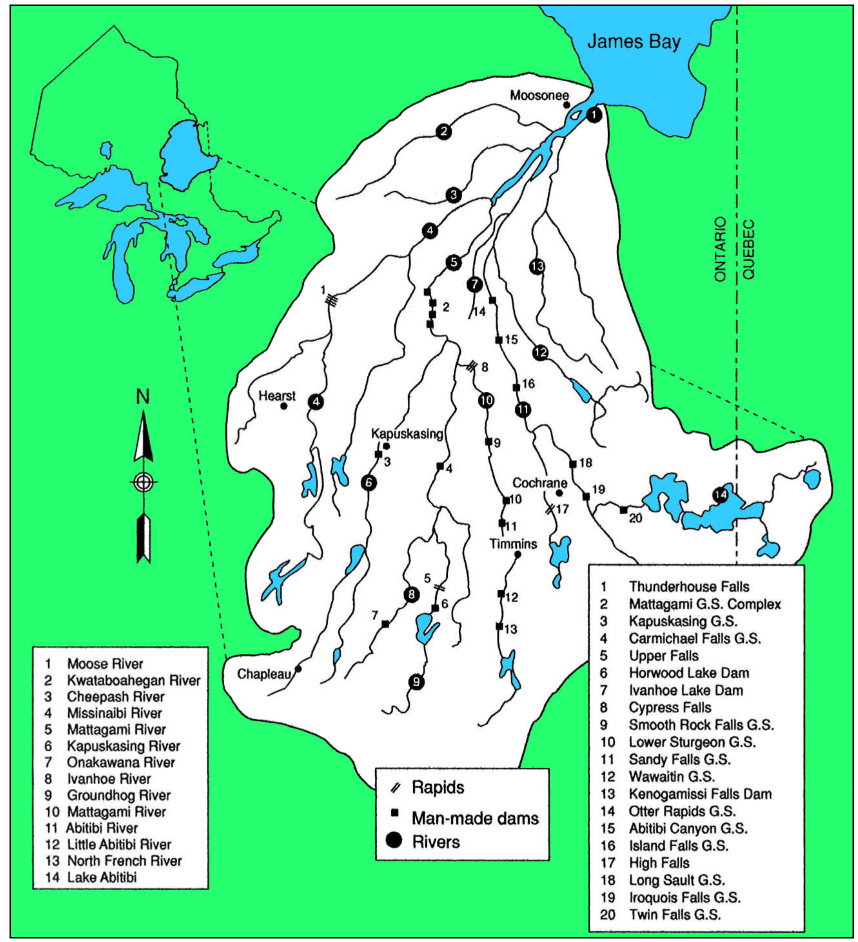


**Figure 15-8.** **Existing hydroelectric dam locations in the Moose River Basin (adapted from Stokes et al. 1999, pg. 2).**

the Little Long (62 MW), Harmon (68 MW), and Kipling (68 MW) generating stations and the construction of a new powerhouse (3 x 80 MW) adjacent to the existing Smoky Fall Generating Station (KGS Group et al. 1991). To date, project construction has not commenced despite local support (Town of Moosonee Regular Meeting Minutes August 17, 2004, Resolution 04-310).

Flow in the Moose River watershed is regulated. However, the impoundments created by the dams are small relative to those in Quebec and Manitoba, so the effect on the seasonal flow regime of runoff into James Bay should be small. Of the four stations closest to James Bay only Little Long, the uppermost, has a significant forebay (71.67 km$^2$) (KCG Group et al. 1991). The proposed extensions to the existing generating stations should have little effect on the existing hydrology and flows. No marine studies related to hydroelectric development of the Moose River basin were located.

Hydroelectric developments in Manitoba that affect Hudson Bay and James Bay are listed in Table 15-4 and depicted in Figure 15-9. In 1976, 75% of the flow of from the Churchill River was diverted into the Nelson River to produce hydroelectric power (Prinsenberg 1980; Newbury et al. 1984; see also Rosenberg et al. 1987, 1995, 1997). This has reduced runoff from the former while increasing it in the latter. Unfortunately, the estuarine impacts of this change cannot be determined, as neither estuary was studied prior to diversion. Changes in the Churchill Estuary may resemble somewhat those in the Eastmain River estuary, where flows were also reduced, while changes in the Nelson River Estuary may resemble somewhat those in the La Grande River estuary, where flows were augmented. Post-diversion studies of the Nelson River estuary have been ongoing since 1988, to obtain data prior to construction of further generating stations on the lower Nelson River, in particular the Conawapa Generating Station (e.g., Baker 1989, 1990; Baker et al. 1993, 1994; Horne 1997; Horne and Bretecher 1998; Zrum

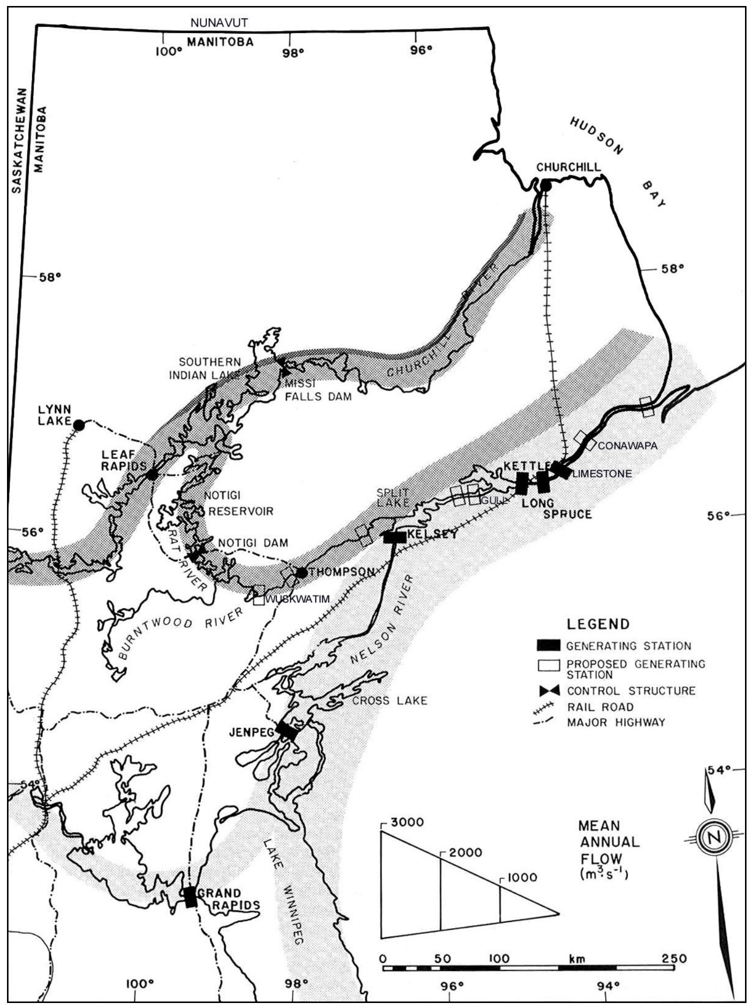


**Figure 15-9. Churchill and Nelson rivers hydroelectric development, indicating the altered flow regime of the rivers. Dark tone indicates relative magnitude of lower Churchill River discharge remaining after diversion; mid-tone indicates portion of Churchill River discharge diverted at Southern Indian lake; light tone indicates Nelson River discharge (adapted from Newbury et al. 1984, pg. 550).**

**Table 15-4. Generating capacity of hydroelectric stations on the Nelson River, Manitoba (Nyboer and Pape-Salmon 2003).**

| Generating Station | Capacity (kW) | In service date |
|---|---|---|
| **Kelsey** | 236250 | 1960 |
| **Kettle** | 1224000 | 1970 |
| **Jenpeg** | 168000 | 1977 |
| **Long Spruce** | 977500 | 1977 |
| **Limestone** | 1330000 | 1990 |

1999, 2000). The lower Churchill River and its estuary have also been studied since 1993, to assess the impacts of constructing a rock weir across the river to mitigate problems caused by low flow (e.g., Baker et al. 1994; Lawrence and Baker 1995; Peake and Remnant 2000). The weir was constructed in 1999. It has impounded the lower Churchill River to raise the water level, with the goal of improving boat access and fish habitat.

Manitoba Hydro is considering further developments on the Nelson River system. At writing, these considerations are most advanced for the 200 MW Wuskwatim Project, a "run-of-the-river" facility on the Burntwood River that would cause little flooding and rely on seasonal flow to produce power. The Manitoba Clean Environment Commission (MCEC) has conducted public environmental hearings for the project, and submitted its recommendations to the Manitoba Conservation Minister for consideration in early October 2004 (MCEC 2004). Manitoba Hydro is also considering the construction of two projects on the Nelson River, the 600 MW Gull (Keeyask) Generating Station about 30 km west of Gillam, and the 1380 MW Conawapa Generating Station on the lower Nelson River, about 28 km downstream of the Limestone Generating Station (http://www.manitobaenergy.ca). Environmental impact studies are ongoing for both projects. A Joint Federal-Provincial Environmental Impact Review was initiated for Conawapa in 1991-2. It was cancelled shortly after the draft guidelines for the EIS were submitted (see Conawapa Environmental Review Panel 1992), when Ontario decided not to enter into a long-term agreement to purchase power generated by the facility.

The Kivalliq coasts and Richmond Gulf in northern Quebec, also known as Lac Guillaume-Delisle, are the coastal areas least affected by hydroelectric developments. There are no hydroelectric developments in the Kivalliq, which is upstream of other developments that affect Hudson Bay and James Bay. The inflow to Richmond Gulf is from Clearwater Lake, which is unaffected by hydroelectric development plans, and the outlet to the sea, in the southwest, is narrow and shallow. It does not receive water from southeastern Hudson Bay, and is therefore not affected by the coastal circulation.

## 15.2 MINERALS AND HYDROCARBONS

There are no offshore mineral or hydrocarbon developments in Hudson Bay or James Bay. There has been some offshore mineral exploration and oil drilling in southwestern Hudson Bay, in the Hudson Platform, but to our knowledge no oil or gas discovery has been made, and no exploration is ongoing (Table 15-5, Figure 15-10). There are oil reserves, estimated at 190 billion barrels (Nelson 1981), in the petroliferous Ordovician shales that outcrop on Southampton Island but their extraction has not been economically attractive (see Section 3.1).

The only coastal mine, for nickel at Rankin Inlet, has been closed since the 1960s. The mine property is now owned by Comaplex Minerals Corporation, which is exploring for base metals beneath the southeast edges of the community (http://www.comaplex.com/pages/other_properties.html).

Precambrian terrains bordering the Hudson Platform may hold important mineral deposits (Johnson et al. 1986). They have the potential for discovery and development of base and precious metals, diamonds, asbestos,

**Table 15-5. Hydrocarbon wells in Hudson Bay, see Figure 15-10 for locations (from http://www.margin.gsca.nrcan.gc.ca/metamap/margin.mfw ).**

| Site | Company | Wellsite | Coordinates | Drill Ship |
|---|---|---|---|---|
| **1** | Trillium Soquip Onexco et al | Beluga O-23; depth range 1580-2210 m | 59°20'N, 88°30W | Neddrill II |
| **2** | ICG Sogepet et al | Netsiq N-01 | 60°00'N, 87°30'W | Neddrill II |
| **3** | Aquitaine et al | Walrus A-71 | 58°40'N, 87°00'W | Wodeco II |
| **4** | Aquitaine et al | Polar Bear C-11 | 58°40'N, 86°45'W | Pentagone 82 |
| **5** | Aquitaine et al | Narwhal South O-58 | 58°10'N, 84°00'W | Pentagone 82 |

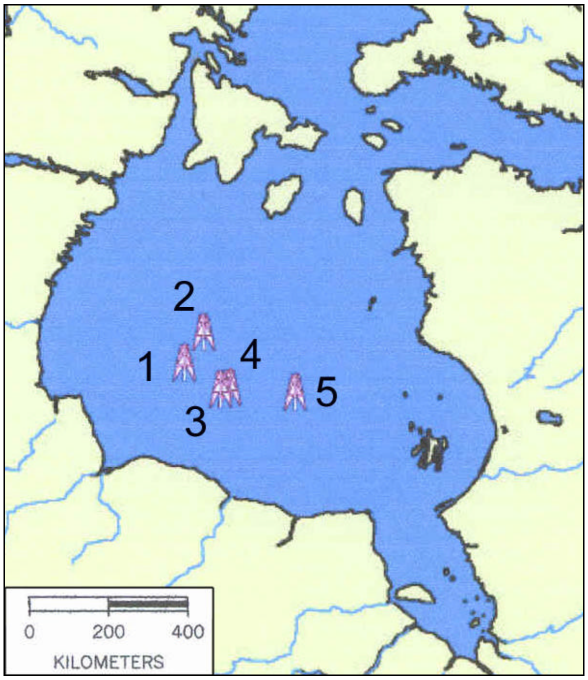


**Figure 15-10. Petroleum exploration wells, see Table 15-5 for data (from http://www.margin.gsca.nrcan.gc.ca/metamap/margin.mfw ).**

phosphate, gypsum, limestone, aggregate, and perhaps other minerals and materials (Johnson et al. 1986; NMRS 2001; Houle 2003, 2004; Moukhsil 2003; Perrault and Moorhead 2003; CIWGMI 2003; Perrault 2004).

In the Kivalliq Region of Nunavut, at least eight inland exploration projects were ongoing in 2003 (Table 15-6). Rankin Inlet, Arviat, and Baker Lake are the main staging points for these projects, which have been exploring for gold, base metals, and diamonds. Extensive surface exploration for uranium has been conducted west of Baker Lake over the past several decades, but no mine development is planned at present. In 1997, CAMECO Resources Inc. suspended its' field exploration program for uranium, citing lack of access to Inuit-owned land as one reason for its decision (Wilkin 1999). In 2002, the Canadian Nuclear Safety Commission revoked the project's Mining Facility Removal Licence at the company's request (CNSC 2002). While surface exploration activities can continue, uranium mine development cannot proceed until a new licence is issued.

Mineral exploration projects conducted in 2002 and 2003, within 150 km inland from the Quebec coast of Hudson Bay and James Bay, are summarized in Table 15-7 and Table 15-8. Those east of Hudson Bay were situated along the coast of the Hudson Bay Arc--the East Hudson Tan Project excepted. They were exploring primarily for gold and base metals (Perrault and Moorhead 2003; Perrault 2004). Projects east of James Bay were located further inland, either south of Rupert Bay or east of Eastmain and Wemindji. They were exploring primarily for diamonds associated with kimberlite deposits, and for precious and base metals (Houle 2003, 2004). While diamond-bearing kimberlite and some high-grade metal deposits have been identified, none of these projects is sufficiently advanced to provide a good estimate of the target resource.

The same is true inland from the Ontario and Manitoba coasts. In Ontario, De Beers Canada is conducting a feasibility study of diamond-bearing kimberlite deposits on its Victor Project, 90 km west of Attawapiskat, and sampling three other nearby kimberlites (http://www.debeerscanada.com/). MacDonald Mines Limited is exploring for diamonds and precious metals further inland (http://www.macdonaldmines.com/). In Manitoba, there is diamond exploration in the northern Superior Province and on the Hudson Bay Lowland (http://www.gov.mb.ca/itm/mrd/busdev/exp-dev/index.html).

Mineral deposits in the Kivalliq Region may be developed over the next decade. While they are situated inland, any development likely will require expediting services provided by the communities, improved port facilities, and servicing by shipping on Hudson Bay. Development potential along the Quebec coast of Hudson Bay, where exploration is at an earlier stage, is less certain. If development occurs along the Hudson Bay Arc, it too may rely on the coastal communities and Hudson Bay shipping for logistical support. Mining developments inland from the James Bay and southern Hudson Bay coasts may be less reliant on the coastal communities, provided that supplies, materials, and products can be transported to and from the south by road or rail.

**Table 15-6. Mineral exploration projects conducted west of Hudson Bay in the Kivalliq Region of Nunavut during 2003 (CIWGMI 2004; see also websites listed below)**

| PROJECT | LOCATION | COMMODITIES* | OPERATOR | WORK or INFERRED RESOURCE |
|---|---|---|---|---|
| **Churchill Diamond and** | extends from 15 km NW of Rankin Inlet towards Chesterfield Inlet NTS 55J, 55N, 55O | Diamonds | Shear Minerals Ltd., Stornoway Diamond Corp., BHP Billiton. | Prospecting, till sampling, aeromagnetic and ground geophysical surveys, 16 kimberlites located. http://www.shearminerals.com/ |
| **Churchill West Diamond** | NTS 55N | Diamonds | Shear Minerals Ltd., Stornoway Diamond Corp., BHP Billiton. | Prospecting, till sampling, aeromagnetic and ground geophysical surveys, 2 kimberlites located. http://www.shearminerals.com/ |
| **Ferguson Lake** | 230 km W of Rankin Inlet NTS 65I/14,15 (96°51'N, 62°52'W) | Ni, Cu, Co, Pd, Pt | Starfield Resources | 1.2 billion lbs Cu, 713 million lbs Ni, 80 million lbs Co, 2.4 million oz. Pd, 0.4 million oz. Pt. http://www.starfieldres.com/ |
| **Fox** | 100 km NW of Rankin Inlet NTS 55N/06 (93°20'N, 63°16'W) | Au, Ag | Comaplex Minerals | Prospecting, sampling, mapping; currently looking for another partner. http://www.comaplex.com/ |
| **Meadowbank (Vault Zone)** | 75 km N of Baker Lake NTS 66H/01; 56E/04 (96°00'N, 65°04W) | Au | Cumberland Resources | Estimated 3.5 million oz. Au, additional drilling, Environmental assessment process initiated. http://www.cumberlandresources.com/ |
| **Meliadine East** | 20 km NE of Rankin Inlet 56J | Au; Diamonds | Cumberland Resources; Comaplex Minerals | Till sampling, drilling; 0.3 million oz. Au. http://www.cumberlandresources.com/ |
| **Meliadine West** | 30 km N of Rankin Inlet NTS 55J/13; 55K/16; 55N/01 (92°11'N, 63°01'W) | Au | Cumberland Resources; Comaplex Minerals | 22.1 million tonnes grading 8.5 g/t Au. http://www.cumberlandresources.com/ (NMRS 2001) |
| **Qilalugaq** | near Repulse Bay | Diamonds | BHP-Billiton | Till sampling, drilling, airborne surves, mini bulk sampling of kimberlite pipes. http://www.bhpbilliton.com/ |

Au = gold, Ag = silver, Cu = copper, Co = cobalt, Ni = nickel, Pb = lead, Pd = palladium, Pt = platinum.

See also: http://www.shearminerals.com/s/Churchill.asp
http://www.bhpbilliton.com/bbContentRepository/Reports/June04EDReport.pdf
http://www.comaplex.com/pages/other_properties.html
http://www.cumberlandresources.com/
http://www.starfieldres.com/

**Table 15-7. Mineral exploration projects conducted within 150 km inland from the Quebec coast of Hudson Bay in the northern Superior Province in 2002 (Perrault and Moorhead 2003) and 2003 (Perrault 2004).**

| PROJECT | LOCATION | COMMODITIES* | OPERATOR | WORK |
|---|---|---|---|---|
| **East Hudson** | NTS 33K,L,M,N,O;<br>34B,C,F,G,H,J,K,L | Ni, Cu, Co, PGE | Falconbridge Ltd., and SOQUEM Inc. | 2002+3: geological mapping, prospecting, sampling, geochemical surveys. |
| **East Hudson Tan** | NTS 34B,C,F,G | Ni, Cu, Co, PGE | Falconbridge Ltd., and SOQUEM Inc. | 2003: prospecting, sampling, geochemical and electromagnetic surveys. |
| **Inukjuak** | NTS 34L/09 | Au, Cu, Pb, Zn | Fonds minier du Nunavik | 2002: prospecting |
| **Bates Peninsula** | NTS 34L/09 | Au, Cu, Pb, Zn | Jacob Palliser | 2002: prospecting |
| **Kuujjuarapik 1** | NTS 33N/05 | Au, Pb, Zn, | Moses Weetaltuk, Myua Niviaxie | 2003: prospecting |
| **Kuujuarapik 2** | NTS 33N/11 | Pb, Zn | Nunavik Mineral Exploartion Fund | 2003: prospecting |
| **Fivemile Inlet** | NTS 34L/09 | Au, Cu, Pb, Zn | Peter Tukai | 2002: prospecting |
| **Umiujuaq** | NTS 34L/09 | Cu, Pb, Zn | Nunavik Mineral Exploration Fund; SOQUEM Inc | 2002+2003: prospecting |
| **Sheldrake River** | NTS 34L/09 | Cu, Pb | Adamie Tooktoo | 2002: prospecting |
| **Black Whale** | NTS 23N/05 | Pb, Zn | Myva Niviaxie | 2002: prospecting |

* Au = gold, Ag = silver, Cu = copper, Co = cobalt, Ni = nickel, Pb = lead, PGE = platinum group elements, Zn = zinc,

**Table 15-8. Mineral exploration projects conducted within 150 km inland from the Quebec coast of James Bay in 2002 (Houle 2003) and 2003 (Houle 2004).**

| PROJECT | LOCATION | COMMODITIES* | OPERATOR | WORK |
|---|---|---|---|---|
| **Hernia** | NTS 32L, M | Diamonds | Dumont Nickel | 2002: drilling |
| **Nottaway Central** | NTS 32M/01,02 | Diamonds | Poplar Resources | 2002: lake bottom geochemical survey |
| **Nottaway Nord** | NTS 32L/09,10,15,16; 32M/01,02 | Diamonds | Majescor Resources | 2002+2003: lake bottom geochemical survey, magnetic surveys, drilling. |
| **Clearwater** | NTS 33B/04 | Au | Eastmain Resources | 2003: drilling and trenching |
| **EM Baie** | NTS 33B/03, 32N/07, 33F/08, 33P/03, 33F/06, 32N/02, 32N/07, 33C/03 | Ag, Au, Cu, Zn, Diamonds | SOQUEM and Inco | 2003: prospecting, drilling, electromagnetic surveys |
| **Eastmain-1** | NTS 33C/01 | Au, Cu | Les Explorations Carat | 2003: trenching and stripping |
| **Eleonore** | NTS 33C/09 | Au, Cu | Virginia Gold MInes | 2003: sampling, prospecting, trenching and stripping |
| **Wemindji** | NTS 33C/13 | Diamonds | A. Grigorita | 2003: prospecting and geochemical surveys |
| **James Bay** | NTS 33F,G | Diamonds | Dianor Resources | 2003: sampling, prospecting, geological mapping, drilling, geochemical and magnetic surveys |
| **Five Diamonds** | NTS 33F/04 | Diamonds | Antoro Resources Inc. | 2003: Geochemical and magnetic surveys. |
| **Wemindji** | NTS 33D/15 | Diamonds | Orezone Resources and Patrician Diamonds | 2002: lake bottom geochemical survey |
| **Wemindji** | 30 km E of Wemindji NTS 33D/15,16; 33E/01,02 | Diamonds | Majescore Resources | 2002: sampling, gochemical and electromagnetic surveys, drilling |
| **Sakami** | NTS 33F/02, 33F/07 | Au | Matamec Explorations | 2002+2003: prospecting, geological and induced polarization surveys, drilling, trenching and stipping |
| **Wapiscan – Riviere des peupliers** | NTS 33F/03,04 | Diamonds, Cu, Au, Ag | AntOro Resources | 2002+2003: prospecting, sampling, geochemical magnetic and electromagnetic surveys |
| **Ménarik** | NTS 33F/06 | Cu, Cr, Ni, Pd, Pt | Pro-or Mining Resources | 2002+2003: sampling, magnetic and electromagnetic surveys, metallurgical testing. |
| **Yasinski-North** | NTS 33F/05,06 | Diamonds, Au, Cu, Ni, Zn | Searchgold Resources | 2002: prospecting, geochemical surveys |
| **Blue Jay** | NTS 33F/06 | Diamonds | Paul Adomatis | 2002: prospecting, till goechemical survey |
| **Whisky Jack** | NTS 33F/06 | Diamonds | Gordon Henriksen | 2002: prospecting, till goechemical survey |
| **Radisson** | NTS 33F/06 | Diamonds, Cu, Zn, Au | Guy Galarneau | 2002: prospecting, sampling |
| **James Bay** | NTS 33D-F | Diamonds | Dianor Resources | 2002: prospecting; geological, Geochemical, magnetic and airborne geophysical surveys |
| **La Grande sud** | NTS 33F/07,09,10 | Au | Virginia Gold Mines and Cambior | 2002: electromagnetic survey, drilling |

* Au = gold, Ag = silver, Cu = copper, Co = cobalt, Ni = nickel, Pb = lead, Pd = palladium, Pt = platinum, Zn = zinc

## 15.3 TRANSPORTATION

Hudson Bay's proximity to European markets was well recognized by fur traders and whalers, but it was not until the grain-producing capabilities of the Canadian prairies became apparent that a Hudson Bay shipping route was envisaged. Following completion of the railway link with western Canada, the route became a reality in 1931, when the first freighters loaded with Canadian wheat cleared Churchill Harbour (Jones 1968). Today, annual vessel traffic within Hudson Bay includes freighters that visit the Port of Churchill to load prairie grain; ships or coastal barges that re-supply the other communities with food, dry goods, and fuel (sealift); and occasional luxury liners. Hudson Bay is a major access route to Nunavut, with the Port of Churchill and the Port of Montreal serving as the major gateways. Despite regular ship traffic to and from the region since the 1600's, few natural alterations are apparent apart from the Port of Churchill, smaller docking facilities elsewhere, and a few marine hulks. Vessel traffic is largely confined to the open water season so there is seldom a requirement for ice-breaking.

The modern shipping season is determined to a great extent by insurance rates, which increase early and late in the season (Jones 1968). The best rates are based on entry into Hudson Strait after 0001 h on 23 July and departure from Churchill by 15 October. On average the first deep-sea vessel arrives at Churchill on 27 July and the last one leaves on 11 October. Coastal vessels that winter at Churchill often start their season in early to mid-July, depending on ice conditions, and work along the coast between the shore and the pack ice (B. Pappas, Moosonee Transport Limited, Moosonee, per. comm.; L. Robb, Port of Churchill, Churchill, pers. comm.). Only vessels drawing less than 3.9 m (13 ft) can pass through Chesterfield Inlet and enter Baker Lake.

The volume of grain shipped from Churchill varies widely: 711,000 metric tones (mt) in 2000; 478,000 mt in 2001; 279,000 mt in 2002, when prairie grain production was reduced by drought; 620,000 mt in 2003; and 364,000 mt in 2004 when there was a poor, late harvest (Cash 2003a; Sanders 2004). In 2004, fourteen ships visited the port and carried a total of 400,000 mt of grain and other commodities (Sanders 2004).

Most commercial navigation in Hudson Bay and James Bay is related to the annual sealift, whereby the coastal communities are re-supplied with general cargo and fuel during the open water season. The number of sealift vessels visiting each community depends upon community requirements for the year.

In 2003, the Government of Nunavut separated the sealift contracts to supply fuel and dry goods to communities in western Hudson Bay. Northern Transportation Company Ltd. (NTCL), which had supplied these communities by barge from Churchill for much of the past three decades, did not bid on the work (Cash 2003b; Nunatsiaq News 17 January 2003). Nunavut Eastern Arctic Shipping Inc. (NEAS), an Inuit-owned company with its headquarters in Iqaluit, won the contract to ship dry goods; the Woodward Group of Labrador won the contract to ship fuel. NEAS now loads cargo at Valleyfield, Quebec to supply communities in the Canadian eastern Arctic, including those along the Quebec and Nunavut coasts of Hudson Bay (http://www.neas.ca/). Goods are transported to Hudson Bay in two ships; the M/V Umiavut, which is a multi-purpose container vessel, strengthened for heavy cargoes (LOA 113.6 m; draft 8.54 m; cargo capacity 11,840 $m^3$ or 9,587 tonnes deadweight) and the M/V Aivik a heavy lift vessel (LOA 109.9 m; draft 5.92 m; 13,388 $m^3$ or 4,860 tonnes deadweight). Both vessels had three sailings in 2003 and again in 2004, with the first vessel arriving in eastern Hudson Bay in mid-July and the last leaving western Hudson Bay in mid-October. Fuel oil, transported to Churchill by rail from the Shell refinery in Fort Saskatchewan, is delivered to the Kivalliq communities by Woodward's double-hull, ice-breaking tanker Mokami. The tanker has fully segregated ballast and is rated ice class 1A Super. (http://www.nnsl.com/ops/sea.html).

The void left in regional shipping by closure of NTCL's Churchill-based barge operation was filled by Moosonee Transportation Limited, which has provided coastal shipping services to communities in James Bay from its base in Moosonee for the past 25 years (http://www.mtlmoose.com/). In 2004, the company operated two tugs and three barges, each with a cargo capacity of 1000 tonnes. Dry goods transported to Churchill by rail were barged to Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet, Repulse Bay, Coral Harbour, Baker Lake, and Fort Severn. The first barge was scheduled to sail from Chuchill on July 19th for Arviat and the last on September 2nd for Fort Severn. The barges overwinter Moosonee or Wemindji. Cargo is also marshalled at warehouses in Moosonee, Wemindji and Chisasibi, and transported to the other communities in James Bay and southern Hudson Bay—west to Fort Severn and north to Puvirnituq, with occasional trips to other ports in Hudson Bay or Hudson Strait.

The Port of Churchill is the only deepwater port on Hudson Bay or James Bay. It is linked to southern Canada by the Hudson Bay Railway (HBRY), which is owned by OmniTRAX Inc. and services communities and resource-based industries in northern Manitoba (http://www.omnitrax.com/hbry.shtml). Major rail customers include Hudson Bay Mining & Smelting, Tolko Industries, the Canadian Wheat Board, and merchandisers of specialty crops. Wheat and barley marketed by the Canadian Wheat Board and specialty crops are exported through the Port of Churchill, which is the railway's northern terminal. Other major commodities handled by HBRY include ores and concentrates, copper and zinc metal, logs, kraft paper, lumber, petroleum products and general merchandise. Scheduled intermodal service is operated. Passenger service is provided under contract with VIA Rail Canada.

The Port offers four deep-sea berths, including one tanker berth, and can take vessels with a cargo capacity of up to 57,000 tonnes deadweight (DWT). Its facilities include a grain elevator with storage capacity of 140,000 tonnes (5 million bushels), an 82,000 sq. ft. indoor storage facility, and a petroleum terminal with storage for 50 million litres plus rail and dockside distribution systems for various petroleum products (http://www.omnitrax.com/portservice.shtml). Commodities can be delivered by rail to shipside. The Port is available for shipping and receiving ocean vessels from July until November and has three towing tugs available. Scheduling earlier or later in the season is available by using ice-class vessels or icebreakers. Recently, dredging the harbour, re-equipping the car unloading system, and repairing and strengthening the wharf have improved the Port facility and enabled the loading of panamax size vessels of 50,000 to 60,000 DWT (Omnitrax 2001a). The largest ship loaded by the end of the 2004 shipping season was the MV Invader, which loaded 56,100 tonnes of wheat bound for Egypt (Omnitrax 2001b).

Moosonee is Ontario's only marine port and the terminus of the Ontario Northland Railway, which carries passengers and freight to and from Cochrane (OMNR 1985). While it is the distribution point for supplies destined for places in James Bay and southern Hudson Bay, Moosonee is a shallow-draught port (about 2 m) (Jones 1968; R. Cool, Moosonee Transport Limited, Moosonee, pers. comm. 1992). It has limited cargo-handling capability, and deep-draught vessels cannot approach closer than about 30 km--unlike the port of Churchill. This problem is common to most communities in James Bay, so that deep-draught vessels anchor well off the settlements and transport their cargoes to jetties or beaches using powered barges.

Until recently, communities along the east coast of James Bay were supplied by barge from Moosonee and over winter roads. Chisasibi was the first James Bay community to be connected to the south by a permanent all-weather road, followed by Wemindji and Eastmain in 1995, and by Waskaganish (since 2000). These communities are now supplied largely by truck and are less reliant on cargo barged from Moosonee. On the Ontario side of James Bay, winter roads connect Moosonee to Moose Factory, Fort Albany, Kasechewan, and Attawapiskat (http://www.mndm.gov.on.ca/mndm/nordev/PDFs/winterroads0304eng.pdf). The winter road from Shamattawa, Manitoba to Fort Severn, Ontario is being extended to Peawanuck, which is connected by a winter trail to Winisk Harbour. These roads are passable by tractor train for about three months each winter (OMNR 1985).

Communities along the Hudson Bay and James Bay coasts are accessible by scheduled aircraft and receive supplies throughout the year by air, particularly perishables. Churchill and communities in the Kivalliq Region of Nunavut are serviced by a number of regional carriers, including: Calm Air, First Air, Kivalliq Air, and Skyward Aviation. Fort Severn, Ontario is serviced by Bearskin Airlines. Air Creebec serves the James Bay communites in Ontario and Quebec, and Peawanuk near the Ontario coast of Hudson Bay. Air Inuit serves the communities in Nunavik. Most, if not all, of the communities also have facilities for docking floatplanes.

Alterations to the ecosystem resulting from marine transportation include the construction of deep-water port facilities at Churchill and smaller docking or beaching facilities at the other coastal communities. The latter typically consist of gravel "push outs" at the barge landing area, with adjacent cargo martialling areas. In 1977-8, Churchill Harbour and its approach were deepened using a suction dredge and clam dipper (Macdonald and Erickson 1981). An ocean dumping permit was issued allowing the movement of up to 1,300,000 cubic yards at a rate of 4000-7000 cubic yards per day. Monitoring was carried out to ensure that cadmium levels, which were thought to be high in the sediment, did not exceed the ocean-dumping maximum of 0.6 $\mu g \cdot g^{-1}$. Cadmium levels in the sediment removed, which consisted mainly of coarse sand, were well within acceptable limits. The dredged sediments were dumped near the coast and further offshore across the peninsula from the harbour. The harbour was dredged again in 2000, using clamshell and shovelfront (closed bucket) dredges (Canadian Environmental Protection Act, 1999, Permit No. 4543-2-02882).

Vessel traffic on Chesterfield Inlet and Hudson Bay is likely to increase over time both for community re-supply as populations grow, and for shipment of product to market if mineral resources in Kivalliq and along the Hudson Bay Arc are developed. The magnitude of any increases and shipping routes are unknown--in some cases aircraft may take the place of ships. There is potential for oil spills during community re-supply, introduction of toxicants or foreign species through bilge cleaning, and disturbance to marine mammals and seabird colonies by tourists. These concerns are not new or unique to the region. Potential problems can be minimized by education and the enforcement of existing regulations, which prohibit environmental pollution, species introductions, and disturbances to wildlife. Community re-supply personnel are trained in emergency response procedures in the event of oil spills.

There have been a number of shipwrecks in the region, most of which have been destroyed by ice or dismantled for parts (Table 15-9). In 2002, mariners on Hudson Bay were still being cautioned that there was no description of coastal tracks on the east side of Hudson Bay due to inadequate chart coverage, the scarcity of soundings, and the possibility of uncharted dangers (NIMA 2002). They were were also cautioned that many of the islands in James Bay had not been accurately located, and that their charted positions could not be relied upon. There are vivid accounts of the epic journey of the survivors of the Eldorado, a Révillon Frères ship that sank off Chisasibi in 1903 (Upton 1968), and of the discovery of the Fort Churchill, a Hudson's Bay Company ship that was stranded on the Belchers in 1913 (Renouf 1921; Cameron 1948). According to Inuit oral tradition, Europeans shipwrecked on the Belchers were massacred (Saladin d'Anglure 1978).

In 1971-2, divers located two ships, tentatively identified as the Hudson Bay Company exploration frigate Albany and the New England whaler Orray Taft, in the harbours of Marble Island (Smith 1971; Smith and Barr 1971; Martin 1979). Little is known of the condition of the former, which sank in 1719; the latter remained afloat for at least a year after it was damaged and likely offers little worthwhile historical salvage (Martin 1979). It may offer interesting diving opportunities, since it is located near shore in 12 m of water.

In the 1970's, extensive studies were conducted in the Kivalliq Region to assess the feasibility of a pipeline to transport natural gas from the Arctic to southern markets. South of Boothia Peninsula, three alternative pipeline routes were considered, the "Prime" route which passed southward through the region west of Baker Lake, the "Coastal" route which crossed Chesterfield Inlet and passed southward between Kaminak Lake and the coast, and the "Quebec" route which crossed northern Hudson Bay to the Quebec mainland via Southampton, Coats, and Mansel islands (Boyd et al. 1978). Most environmental studies were conducted on the "Prime" route of the "Polar Gas Pipeline" under either the "Polar Gas Environmental Program" (e.g., Hatfield et al. 1978) or the "Arctic Islands Pipeline Program" (e.g., Lawrence et al. 1978; Allan and Hogg 1979) (Figure 15-11). The project did not proceed, in part because the pipeline in the High Arctic could not be buried deeply enough to avoid damage from iceberg scour in coastal waters.

**Table 15-9. Ships wrecked in Hudson Bay or James Bay. The Hudson's Bay Company Archives "Ships Histories" reference a wealth of unpublished archival material on many of the ships. Published reference materials are listed.**

| Ship | Description | History | References |
|---|---|---|---|
| **Albany** | Wooden sailing frigate of 100 tons. Last Ca pt. George Barlow. | Two Hudson Bay Company ships (see also Discovery) under the command of Captain James Knight were sent to Hudson Bay "discover gold and other valuable commodities". Late in the fall of 1719 they entered the harbour between Quartzite and Marble islands and the larger ship was badly damaged. The crews built a house, and some lived until the summer of 1721 with periodic help from visiting Inuit. In 1767, Hearne (1795) saw the bottoms of the hulls in 5 fathoms of water near the head of the harbour and found the house. He returned the ship's figurehead and canons to the HBC. | Hearne (1795), Neatby (1968), Smith and Barr (1971), Ross and Barr (1972). |
| **Alette** | Steam freighter (?). Last Captain Robertson. | Unable to unload her cargo at Port Nelson, she struck ice near Mansel Island in Hudson Strait and returned to Port Nelson. She was beached 4.5 miles downstream from the main camp on 16 October 1913. A hole was dynamited in her number 1 hold side to stop a smoldering coal fire and the cargo was salvaged during the winter. | Malaher (1984). |
| **Ansel Gibbs** | Wooden bark (barque). Last Captain Thomas McPherson. | New England whaler. Blown onto the rocks west of the entrance to the inner harbour of Marble Island on 18 October 1872 when her anchor line parted in a storm. She broke up quickly leaving her crew few provisions. Ten crewmen died while wintering on the island in the Orray Taft. The rest were returned to New Bedford aboard the Abie Bradford. | Martin (1979). |
| **Cam Owen** | Single-decked, two masted, carvel built, 340-ton wooden brigantine with a crew of 13. Last Master John Hawes. | Hudson Bay ship. Built at Grand River, PEI, in 1883. Wrecked on the rocks 15-20 mi. S of Cape Churchill in a heavy gale on 30-31 August 1886. The hulk was carried out to sea by ice and wind in 1896. | McTavish (1963), The Beaver: Sep. 1932, p. 32. |
| **Cearense** | Steam freighter (?) | Ran aground fifteen miles downstream from Port Nelson during a storm on 12-13 September 1913. Her cargo was salvaged the following spring but she was broken up by a storm in September 1916. | Malaher (1984) |
| **Discovery** | Wooden sloop of 40 tons. Last Commander David Vaughn. | See Albany. | See Albany. |
| **Effort** | Wooden sailing vessel chartered by the Hudson Bay Company. | Left York Factory 17 September 1858 for Montreal. Lost enroute. See below "unidentified". | |
| **Eldorado** | Motor sailing vessel, 820 tons. Last Capt. William Berry. | Chartered by Révillon Frères in August 1903 to establish posts at Fort George, Rupert House, Moose Factory, Hannah Bay, and Fort Albany. Drawing 16' of water and carrying 1450 tons of cargo she was larger than any ship the HBC had sent into James Bay. The Eldorado was wrecked on a reef and lost 9 miles out of Fort George. The 47 passengers and crew made an epic journey of 270 miles by boat through James Bay and 500 miles by canoe along the Moose and Abitibi rivers to safety. The wreck set back Révillon Frères plans in the region 3 yrs. | Upton (1968). |
| **Eskimo** | Motor vessel. | Trapped in the ice in 1955 near Moosonee by an early freeze-up. Sometimes is visible at low tide downstream from Moosonee. | Two-Bay Enterprizes Ltd., Moosonee, tour brochure. |
| **Esquimaux** | Wooden brigantine of 123 tons. Last Master William Taylor Butterwick. | Supply vessel (chartered?) operating between London and posts in James and Hudson bays. Lost on voyage from York Factory to Churchill 20-26 October 1836, in heavy ice and fog--rudder froze. Wrecked 25 mi ENE of the Cape Marsh beacon and 15 mi. WSW of of C. Tatnam, 4 mi. offshore in 3 fathoms at high water. Wreck likely destroyed by ice. | |
| **Expectation** | Wooden ketch. Last Capt. Richard Lucas. | An interloper outfitted by a syndicate, which included Charles Boone (former MP) and Thomas Phipps, to trade in James Bay and possibly to recover furs salvaged from the wreck of the Prudent Mary and hidden by her mate (Capt. Lucas). Captured in 1683 by Capt. Nehemiah Walker of the HBC, who wrecked his prize on Charlton Island while attempting to sail her to the Bottom of the Bay. The capture resulted in a long, drawn-out lawsuit against the HBC. | Rich (1958). |
| **Fort Churchill** | Wooden motor sailing ketch, 56 tons. Last Capt. Jens Ole Neilsen. | Hudson's Bay Company ship. Built at Porthleven, Cornwall and registered at Falmouth in July 1913. Arrived in York Factory late in the fall of 1913 only to be torn from her moorings in the Nelson River estuary by a severe storm. She was not located until April 1915, following Inuit reports of a vessel stranded on the Belcher Islands. Refloated and towed to Moose Factory for repairs, she served as supply vessel in Hudson Bay and later James Bay until 1939, when she was laid up at Moose Factory. Two years later she was burnt. | Renouf (1921), Cameron (1948). |

| Ship | Description | History | References |
|---|---|---|---|
| **Fort Severn** | Two-masted, carvel built, 91-ton wooden schooner with a 95 HP auxiliary diesel. Last Skipper Isaac Barbour. | Built for Révillon Frères by J.A. Weingart, Shelburne, NS in 1924. Taken over by Hudson Bay Company in 1926 and operated as supply vessel for James and Hudson bay posts until 1950. Put into ballast, towed out to Button Bay and sunk in 1952. | Moccasin Telegraph: Dec. 1952, p. 23; Spring 1944, p. 8. |
| **Fort York** | Wooden motor schooner of 94 tons. Last Commander R.H. Taylor. | Built at Porthleven, Cornwall in 1914. Serviced Hudson Bay posts in the Nelson River district from 1914-1930. She was deliberately run aground near Severn on 27-28 September 1930 during hurricane force winds to "protect life and property", and declared a total wreck. A 1951 photo showed the hulk well up on the mud flats. It was burned soon after. | Kirkland (1935, p. 66), Harding (1920). |
| **H.M.S.Hampshire** | Wooden sailing frigate with 52 guns. Last Commander John Fletcher. | Sent with Owners Love, as convoy for Hudson's Bay and Dering. Sunk by D'Iberville's Pelican near York Factory on 5 September 1697, with 290 men aboard. | Douglas and Wallace (1926). |
| **Hudson's Bay (Royal Hudson's Bay)** | Wooden sailing frigate of 150 tons with 32 guns. Last Commander Nicholas Smithsend. | Built in 1698. Engaged in a sea battle with D'Iberville's Pelican in 1697, and was forced to surrender, a helpless wreck. The hulk was beached 20 mi. east of Fort York and James Knight's men salvaged timbers from the wreck in 1715-16. | |
| **Ithaca** | Steel steam freighter. | British steamship built at Trois Rivière, Quebec in 1922. On 14 September 1960, enroute to deliver equipment to Rankin Inlet her rudder broke in a gale and she was stranded near Bird Cove about 17 km east of Churchill. | http:/www.churchillmb.net/~cccomm/pintrest.htm |
| **Lady Head** | Wooden barque, 1050 tons. Last Capt. John Graham Ford. | Purchased by HBC in 1865 from the builders, George and John Mills, of Southwick. Named after the wife of Sir E.W. Head, Governor of the HBC. Served as supply vessel for Moose Factory from 1865-75 and 1886-1903, and sailed between London and Victoria, B.C. in the intervening years. In September 1903, returning from Charlton, struck the Gasket Shoals at night in a gale and was abandoned, a total loss. | See also photos in Cotter (1934) and Upton (1968). |
| **Mary [I]** | Wooden frigate. Last Capt. James Belcher. | Ran aground on the Weston Islands, north of Charlton Island, on its homeward voyage in August 1724. Most of the furs were lost; the passengers and crew 'with much hazard came to Albany Fort in their Boates' and remained there the whole year consuming provisions. | Rich (1958); Davies and Johnson (1965). |
| **Mink** | Wooden brigantine, 92 tons. Last Capt. John Taylor. | Hudson's Bay Company ship built by James Turner in 1874. Served in James Bay from 1874-1903, delivering supplies and gathering fur returns for Moose Factory. Replaced by the Inenew in 1903, she was beached at high tide a few miles from Rupert House. | See also photos in Cotter (1934) and The Beaver Dec. 1926, p. 28. |
| **North Star** | Motor vessel. | Struck a rock pinnacle north of Grey Goose Island. | Jones (1968). |
| **Orray Taft** | Wooden bark (barque) of 134 tons. Last Captain George J. Parker. | New England whaler. Blown ashore on 13 August 1 1872 in the outer harbour at Marble Island when her anchor lines parted in a storm. Beached at the northwest end of the inner harbour. Four crewmen died while wintering on the island. The rest were returned to New Bedford aboard the Glacier, another New England whaler. Subsequent visitors stripped the hulk for lumber and firewood. In 1971, divers located a sunken ship likely the Orray Taft in 12 m of water. It's structure was covered in algae. | Smith and Barr (1971), Martin (1979). |
| **Pery (Perry)** | Wooden frigate. Last Capt. Richard Ward. | HBC ship. Ran aground and sank in the Albany River in September 1711. Some of her cargo for the James Bay posts was salvaged. | Davies and Johnson (1965). |
| **Prince Rupert I** | Wooden sailing frigate of 75 tons. Last Commander Zacchariah Gillam. | Built in 1670. Served as a supply ship. Drift ice caused her to drag anchor, drift out to sea, and sink with 9 crew and Gillam aboard on October 21, 1682. John Bidgar, newly appointed Governor of York Factory, and the remaining crew were ashore. They were taken prisoner by Radisson. | Newman (1985). |
| **Prudent Mary** | Wooden sailing vessel of about 140 tons. Last Capt. Richard Greenway. | Chartered by the HBC to carry furs from Charlton I. to England. In 1680, loaded with furs, she struck a reef on Trodely Island (Tetherley's Island), just north of Charlton Island. and was lost. Most of the furs, some isinglass,and fittings were salvaged and her Captain and crew arrived safely at Fort Albany. The partially submerged hulk was burnt in 1681. | Kenyon (1986); Rich (1958). |
| **Sorine** | Wooden barque, 6-700 tons. Last Captain Hans Andersen. | The Sorine was a Danish barque chartered by the HBC in London to deliver supplies to their posts in James Bay. She was damaged by ice in Hudson Bay while returning in ballast and run aground on the eastern tip of Charlton Island for the winter of 1910. There she stayed. | Anderson (1961); photos of the ship and hulk in Williams (1939). |
| **Stork** | Wooden barque of 479 tons. Last Captain N.E. Freakley | Built in Gothenburg in 1880, purchased by the HBC in 1904. Bound for England she was forced by ice to return to Charlton Island only to strike a submerged reef and sink near Lisbon Rock about 22 km from Charlton Island, during a blizzard. The Captain and crew abandoned ship on 11 October 1908, and arrived in Moose Factory the day before freeze-up. Part of the decking could be seen near Moose Factory in 1939. | HBC Archives: Search File A12/FT 289/1; Williams (1939); Williamson (1983). |
| **unidentified** | Wooden sailing vessel. | Belcher Islands Inuit describe a massacre of white sailors in the past, possibly the crew of the Effort, which left York Factory for Montreal on 17 September 1858, and disappeared--or perhaps some earlier ship. | Saladin d'Anglure 1978b. |


**Figure 15-11. Proposed Polar Gas Pipeline route (from National Atlas of Canada 1978).**

## 15.4 TOURISM

The effects of marine ecotourism are low at present but may be increasing. The main activity takes place at Churchill where visitors come from around the globe to see migratory birds (spring-fall), beluga whales in the estuary (summer), and polar bears (fall). At least one of the tour companies operating in the Churchill River estuary uses a boat with silenced engines and jet-drives to avoid disturbing or injuring the whales (http://www.seanorthtours.com/).

Outfitters at the other Hudson Bay communities will take visitors on local sightseeing trips to see Arctic wildlife: walrus at Coats Island and polar bears at Wager Bay are particular favourites, and diving expeditions are available at Churchill and Sanikiluaq.

Cruise ships such as the Akademik Ioffe, a refitted Russian polar research vessel (http://www.adventurecanada.com/), and international tours also visit northwest Hudson Bay in the summer (http://www.windowsonthewild.com/wow/Walrus/walrus.htm). Concern has been expressed that tourist overflights in the Cape Henrietta Maria area may stampede walrus herds into the water and cause calf mortality (C. Chenier, DNR Cochrane, ON pers. comm. 2003), and boat disturbances are a concern in the Coats Island area.

Marine tourism in the James Bay region is limited. From mid-June through mid-September, Two Bay Enterprises Ltd. operates daily cruises from Moosonee on their luxury cruise vessel the M.V. Polar Princess. The vessel travels upstream to Fossil Island and downstream to Shipsands Island and James Bay. Elsewhere in James Bay and Southeastern Hudson Bay tourists can charter smaller boats and freighter canoes.

## 15.5 MUNICIPAL ACTIVITIES

The main impacts of municipal developments on the marine environment are related to shoreline development, disturbances and waste disposal, all of which occur mostly in the immediate vicinity of the communities. The impacts of shoreline development are limited by the small regional population (see Chapter 4 (Climate), Table 4-3 for data) and by ice push and scour that largely precludes development of the intertidal zone and foreshore. There are gravel “push-outs” to facilitate barge offloading and harbour facilities at the Port of Churchill, but otherwise most of the community infrastructure is located away from the shoreline. Visual and noise disturbances related to the presence of communities and to coastal transportation, by boat in summer or snowmobile or Bombardier in winter, may affect marine mammals in particular. These impacts cannot readily be separated from those of harvesting activities. They may have played a part in the abandonment of some *uglit* (haulouts) by walruses (see Marine Mammals Section 9.8).

The development of infrastructure to deal with sewage and wastewater is an ongoing problem throughout the region. Permafrost and cold temperatures make it difficult and very expensive to develop piped collection networks and construct stable lagoons, and can cause condensation problems in secondary treatment facilities.

There is a 65% failure rate among lagoons in Nunavut that, in most cases, are not designed to handle the demands of growing populations (http://www.gov.nu.ca/finance/bp/2004/cgs.pdf). Some of the communities, such as Churchill, Rankin Inlet, and Peawanuk have piped sewage systems while others, such as Coral Harbour, still pick up sewage by truck. Where a lagoon is damaged, or lacking, bacterial and chemical contaminants may be discharged directly into the sea or flow overland to the water's edge. Fortunately, the combined effects of low temperature and high salinity kill most organisms that cause human disease in a short time. Initiatives are underway at Rankin Inlet, and elsewhere, to improve sewage treatment.

## 15.6 GRAND CANAL SCHEME

A Great Recycling and Northern Development (GRAND) Canal scheme has been proposed which would involve the construction of a dam across James Bay, so the area could serve as a reservoir from which freshwater could be diverted south into the United States (Kierans 1984, 1987, 1988). The potential effects of such a project on the oceanography of Hudson Bay, productivity of James Bay, world climate, native peoples, etc. cannot be adequately predicted (Milko 1986; Gamble 1987, 1989; Berkes 1989) and must not be underestimated. Modelling studies suggest that transforming James Bay into a massive freshwater lake would disrupt coastal currents, delaying ice melt and leading to colder, wetter coastal conditions (Rouse et al. 1992). They also suggest that the decrease in salinity would alter salt marsh vegetation in northern James Bay (Price et al. 1992). These effects are just the tip of the ecological iceberg.

## 15.7 SUMMARY

Relatively few people live along the vast coastline of Hudson Bay and James Bay and very little development has occurred. Hydroelectric development is the activity with the greatest existing and potential impact on the marine ecosystem over the short and, perhaps, long term. Mineral developments, transportation, municipal waste disposal, and tourism also have the potential to impact the marine environment. The impoundment of James Bay to provide water for the United States (GRAND Canal Scheme) is unlikely, but it would have important and far-reaching effects on the marine ecosystem. Development of a pipeline to transport natural gas south from the Arctic is also unlikely, but it too could affect the marine ecosystem.

Hydro-electric developments have altered the flow regimes of the La Grande and Eastmain rivers, which drain into James Bay, and of the Churchill and Nelson rivers, which drain into southwest Hudson Bay. The longterm impacts of these diversions on the marine environment are unknown and, in the case of the latter, impossible to assess in the absence of baseline marine data.

In 1980, 80% of the flow from the Eastmain River was diverted into the La Grande River, and seasonal runoff was impounded so that it could be released to produce electricity in the winter. Under these regulated conditions the natural spring freshet into James Bay does not occur at either river. Because of the flow diversion, the plume from the Eastmain River is much reduced and there are intrusions of saline water up to 10 km upstream, year-round. While the size and shape of the summer plume from the La Grande River are essentially unchanged by development, the area of its under-ice plume has trebled. The winter discharge of freshwater from the La Grande River into James Bay increased from 500 $m^3 \cdot s^{-1}$ under natural conditions, to over 4000 $m^3 \cdot s^{-1}$ following the diversion during peak power production. The plume can extend 100 km northward under the landfast ice of James Bay, and further increases in midwinter flow will lead to dilution of the nearshore surface waters in southeastern Hudson Bay. The biological effects of these changes are not well understood. Slightly elevated mercury levels have been found in the flesh of marine fishes within 10-15 km of the river mouth.

In 1976, 75% of the flow of from the Churchill River was diverted into the Nelson River to produce hydroelectric power. This has reduced runoff from the former while increasing it in the latter. The impacts of these changes on the estuaries cannot be assessed in the absence of pre-project data. Grande rivière de la

Baleine and the Moose, Albany, Canipiscau, and Opinaca rivers have also been affected by diversion or hydroelectric development.

The effects of hydroelectric development on the offshore surface waters are not well understood. Continued development may increase the winter surface salinity gradients and currents in James Bay. Modelling by Prinsenberg and Danard (1985) suggests that the surface temperature is buffered somewhat against man-made changes. They predicted that a decrease in surface temperature, such as might be caused by hydroelectric development of surrounding watersheds, would gradually be offset by the stabilizing effects of the colder water on the overlying air. This would act to decrease wind stress and increase the heat flux into the water. The reverse should be true in the case of an increase in water temperature. Ice-ocean modelling studies by Saucier and Dionne (1998) suggest that the bay-wide effects of the power plants are small compared with the natural variablility observed in the ice cover. The environmental impacts of altering the seasonal runoff regime on oceanographic conditions in the North Atlantic are uncertain and controversial.

Quebec Hydro plans future hydroelectric development in southern James Bay, where flow from the Rupert River would be diverted into the Eastmain River. Manitoba Hydro is considering further developments on the Nelson River system, as is Ontario Hydro on the Moose River system. With the exception of the Rupert, the flow regimes of these rivers have already been altered by development.

There are no offshore mineral or hydrocarbon developments in Hudson Bay or James Bay and the only mine on the coast, for nickel at Rankin Inlet, has been closed since the 1960's. The region has a potential for discovery and development of hydrocarbons, base and precious metals, diamonds, asbestos, phosphate, gypsum, limestone, aggregate, and perhaps other minerals and materials. There has been some offshore mineral exploration and oil drilling in southwestern Hudson Bay but to our knowledge no oil or gas discovery has been made, and no exploration is ongoing.

Mineral deposits in the Kivalliq Region that contain gold, base metals, and/or diamonds may be developed over the next decade. They may require expediting services provided by the communities, improved port facilities, and servicing by shipping on Hudson Bay. This would likely increase ship traffic on Hudson Bay, and the potential for the release of contaminants. Development potential along the Quebec coast of Hudson Bay, where exploration is at an earlier stage, is less certain. If development occurs along the Hudson Bay Arc, it too may rely on the coastal communities and Hudson Bay shipping for logistical support. Mining developments inland from the James Bay coast and from southwestern Hudson Bay would likely be less reliant on the coastal communities and transport supplies, materials and products by road or rail.

The impacts of marine transportation are low at present. Annual vessel traffic within Hudson Bay includes freighters that visit the Port of Churchill to load prairie grain and other commodities; ships or coastal barges that re-supply the other communities with food, dry goods, and fuel (sealift); and occasional luxury liners. Despite regular ship traffic to and from the region since the late 1600's, few natural alterations are apparent apart from the Port of Churchill, smaller docking facilities elsewhere, and a few marine hulks. Vessel traffic is confined largely to the open water season so there is seldom a requirement for ice-breaking, which can disrupt marine mammals and harvesting activities. Periodic dredging is required to keep the Churchill Harbour passable to large ships. In 1977-78, monitoring was carried out to ensure that cadmium levels, which were thought to be high in the sediment, did not exceed the ocean-dumping maximum of $0.6\ \mu g \cdot g^{-1}$. In the event, the levels were well within acceptable limits. There is some potential for spills of contaminants, such as oil during re-supply, and for the introduction of foreign organisms when bilges are cleaned. In James Bay, the railway to Moosonee and seasonal or all-season roads to the other communities limit the need for sealift and thereby potential impacts from shipping.

The main impacts of municipal developments on the marine environment are related to shoreline development, disturbances, and waste disposal, all of which occur mainly in the immediate vicinity of the communities. Sparse populations and ice push and scour have limited development of the intertidal zone and foreshore. Visual and noise disturbances from communities, and boat or on-ice transportation, may affect marine mammals in particular. These impacts cannot readily be separated from those of harvesting activities, but may have played a part in the abandonment of some *uglit* (haulouts) by walruses. Initiatives are under way to improve sewage and wastewater treatement facilities. Bacterial and chemical contaminants may be discharged directly into the sea or flow overland to the water's edge where lagoons are damaged or lacking. Fortunately, the combined effects of low temperature and high salinity kill most organisms that cause human disease in a short time.

The effects of marine ecotourism are low at present but may be increasing. The main activity takes place at Churchill where visitors come from around the globe to see beluga whales in the estuary (summer), and polar bears (fall) and migratory birds (spring-fall) along the coast. Outfitters at the other communities will take visitors on local sightseeing trips to see Arctic wildlife; walrus at Coats Island and polar bears at Wager Bay are particular favourites. Cruise ships also visit northwest Hudson Bay in the summer. Concern has been expressed that visitors to Coats Island and the Cape Henrietta Maria area may stampede walrus herds into the water and cause calf mortality.

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