0THE PROBLEM IS THE LACK OF SILICA

Silica Shelled Diatom Phytoplankton

The Foundation of the Aquatic Food Web

Atlantic Cod

Atlantic Salmon

"Diatoms are at the bottom of the food chain and suck up nearly a quarter of the atmosphere's carbon dioxide . . . Size matters for the creatures that eat them and also for carbon sequestration, as large diatoms are more likely to sink when they die . . . If smaller size diatoms dominate, then carbon sequestration becomes less efficient, and there may be more carbon dioxide in the atmosphere, which would exacerbate global warming. " (Litchman et. Al. 2000).

Stephen M. Kasprzak
October 15, 2018

This Report is being written as a supplement to the editorial "*Reject CMP Power Line Because Hydro-Quebec Facilities Damage Ecosystem,"* which was published in the Portland Press Herald on October 9, 2018 (see Attachment 1). It also documents how Hydro-Quebec has significantly contributed to the lack of silica in northwest Atlantic and Gulf of Maine.

ABSTRACT

There is a commonly held belief that climate change is the driving force behind the decline in the population of cod, salmon, capelin and other fisheries in the Gulf of Maine and northwest Atlantic, as well as warming their waters.

There is another factor, namely, the lack of silica!

This Report documents how the lack of silica is the driving force in the decline of the fisheries and not overfishing. The following two quotes are consistent with my claim that the fisheries are being starved:

Research scientist with the Department of Fisheries and Oceans (DFO) Dr. Mariano Koen-Alonso says the sudden and sharp decline in cod stock is something being seen across the ecosystem.

"We've seen very important reductions in biomass of many species across the board," said Koen-Alonso. "We have to look at the big picture here, there are several factors and species involved."

"With reductions in the biomass of the cod's food sources such as shrimp and capelin, Koen-Alonso says the cause of the cod's decline appears to be more bottom-up than top-down. Bottom-up meaning that a lack of food and poor conditions are the driving force in the shrinking biomass, rather than predators or overfishing which are chief factors in a top-down cause of depletion.

Koen-Alonso says the signs show the capelin's declining numbers can also be traced to the food chain." (Northern Pen May 10, 2018).

and

"Atlantic ocean plant life, the phytoplankton, has been observed to be in tremendous decline. International science teams have measured more than 26% lost in the last 30 years. How bad is 26%? Remember when we destroy just 1 in 10 of any form of life we say that we have decimated that life. It's bad. Very bad. And the starvation and disappearance of Atlantic Cod stand as testimony to the collapse of the Atlantic Ocean pastures. Ocean pasture grass is plankton." (Russ 2014).

The building and management of Quebec Hydropower's reservoir hydroelectric facilities have reduced river discharge during spring freshet into Eastern Hudson Bay and Labrador Sea by forty to fifty percent and increased winter discharge by 300 percent.

"Eighty percent of the annual input of dissolved silicate to the ocean is transported via our rivers and streams." (Paul Treguer et. al. 1995). In our northern latitudes, the majority of this annual budget is delivered by the roaring waters of the spring freshet.

Less dissolved silicon, during spring months, is starving the silicon diatom phytoplankton blooms, which are the essential basis of marine food web.

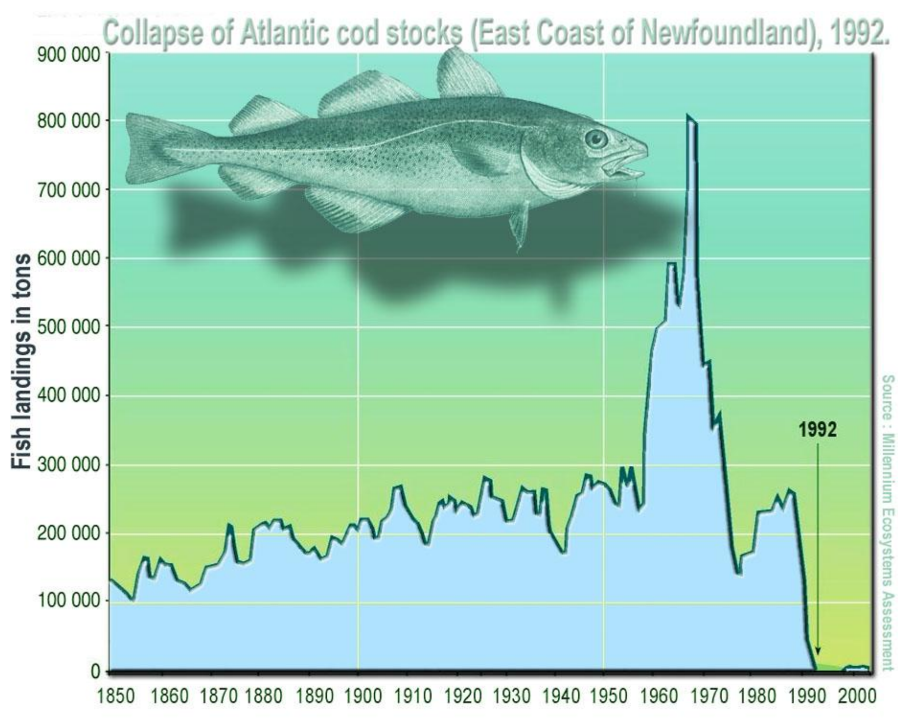
The advocates of hydroelectricity claim it is a power source that is clean and renewable because it uses the earth's annual water cycle to generate electricity.

They fail to mention that hydroelectric reservoir facilities have changed the seasonal pattern of annual natural water cycle by significantly reducing the spring run-off and summer outflows and using the captured waters to double and triple the winter outflows, due to high winter demand for electricity.

This is just the opposite to a typical unregulated river, which experiences low flows in winter when water is stored in the seasonal snowpack, then high flows during the snowmelt-driven freshet in spring and early summer.

STARVATION OF ATLANTIC NORTHWEST COD FISHERY

There have been two collapses of the Atlantic northwest cod fishery in the past fifty years, and they are illustrated in the graph below. Both collapses have been analyzed as one and the cause blamed on overfishing and global warming.



There is no doubt that overfishing caused the spike in cod landings during the 1960's and the subsequent decline in the 1970's.

However, the second and more lasting decline occurred in the 1989-1991 period. The major factor of this decline has been the lack of silica caused by the capture of the spring freshet in the reservoirs of hydroelectric facilities owned by Quebec Hydropower. These facilities have significantly reduced the transport of dissolved silica and other nutrients needed for healthy spring and summer diatom phytoplankton blooms in the northwest Atlantic and Gulf of Maine.

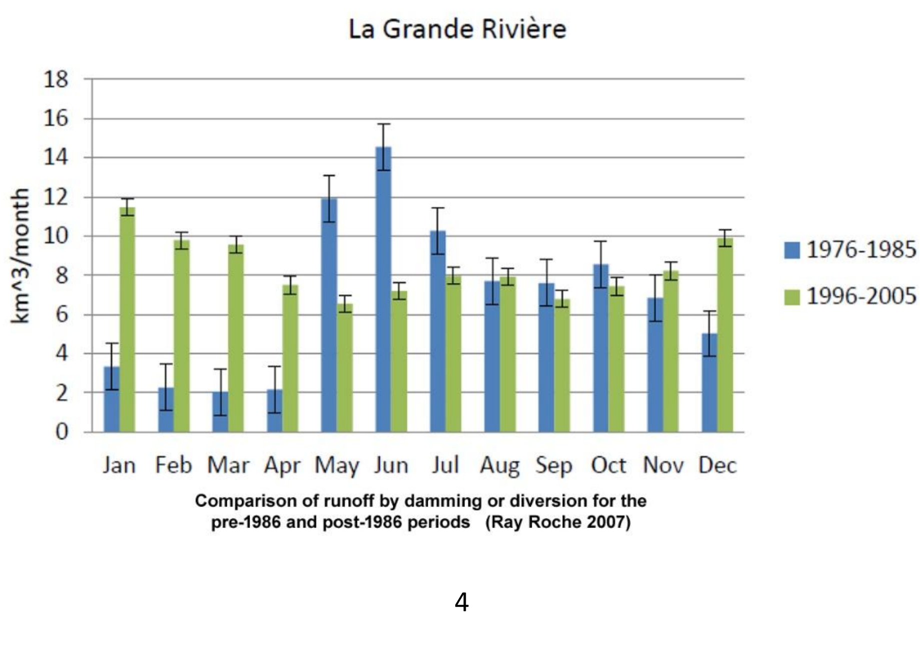
"The growth rate of diatoms (silica-shelled phytoplankton) are determined by the supply of silicate." (Venugopalan Ittekkot et. al. 2000).

"Diatom phytoplankton populations are the usual food for zooplankton and filter feeding fishes and contribute in a direct way to the large fishable populations in coastal zones." (C.B. Officer et. al. 1980).

***"The lack of silica can change aquatic ecosystems from those dominated by diatoms to non-diatom based aquatic ecosystems usually dominated by flagellates."*(**E. Struyf 2009).

QUEBEC HYDROPOWER HAS REDUCED SPRING FRESHET RIVER FLOWS BY 40 TO 50 PERCENT

A good example is the three LaGrande reservoir hydroelectric facilities, which have an annual capacity of 7,302 megawatt (MW). Two of the reservoir facilities went online in 1986 and the third in the early 1990's. The graph below illustrates how the dams have been used to capture the waters of the spring freshet which are then used to increase winter outflows by more than 300%.



Comparison of runoff by damming or diversion for the pre-1986 and post-1986 periods (Ray Roche 2007)

The following points should help put into perspective the scale of this facility:

1. Maine's annual hydroelectric generating capacity is 723 MW, compared to 7382 at LaGrande
2. The June outflow (1976-1985) of 14.5 cubic kilometers (KM^3)/month has been reduced to 7.0 KM^3./month (1996-2005). This reduction of 7.5 KM^3/month equals 102,129 cubic feet ($ft.^3$)/sec
3. The historic median flow in June on the Penobscot River at W. Enfield in Maine is 10,000 ft^3/sec
4. This June reduction in outflows from the LaGrande River into Hudson Bay would be analogous to eliminating 10 Penobscot Rivers flowing into the Gulf of Maine in June
5. The May reduction in outflows of 5.5KM^3/month would be analogous to eliminating 7 Penobscot Rivers flowing into the Gulf during May

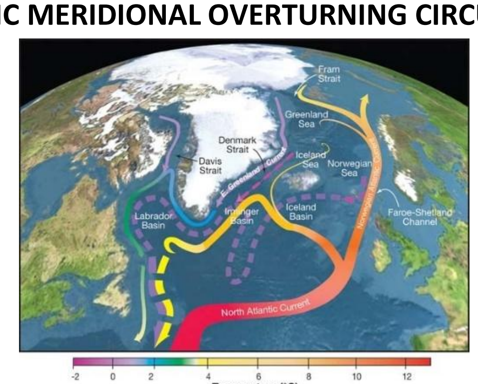
QUEBEC HYDROPOWER IS USING THE CAPTURED WATERS OF THE SPRING FRESHET TO INCREASE WINTER RIVER DISCHARGE THREE-FOLD

In a recent Canadian study of trends in river discharge from 1964-2013, the authors found: ***"that there has been a three-fold increase in river discharge during winter, when electric demand peaks, into the estuaries of Labrador Sea and Eastern Hudson Bay for the 2006-2013 period compared to 1964-1971 and a forty percent reduction in discharge during the summer."*** (*Recent Trends and Variability in River Discharges Across Northern Canada* Dery et. al. 2016).

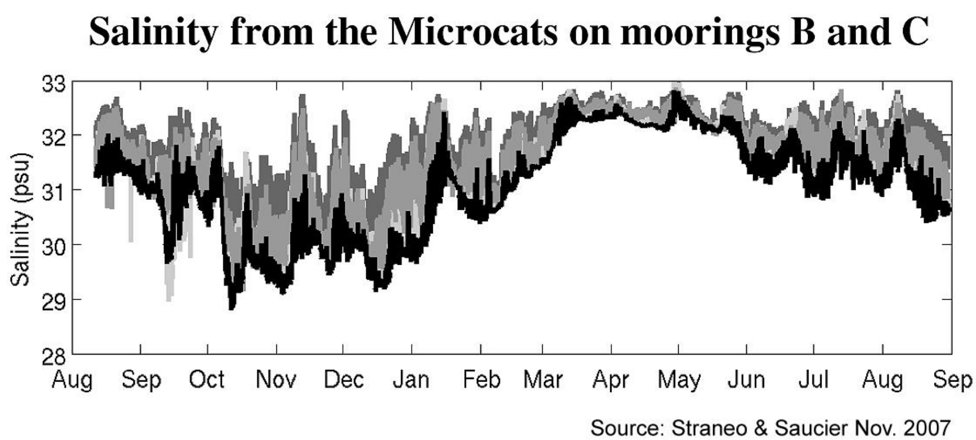
The earlier LaGrande Riverine Graph shows January-April outflows have been increased four-fold on average. Before reservoir hydroelectric facilities were built in Quebec and Newfoundland/Labrador (NL), the brooks, streams and rivers in these watersheds freely and naturally transported 80% of the annual budget of dissolved silica and other nutrients to the ocean.

The riverine spring freshet historically transported the majority of the annual load of silica and other nutrients into the Hudson Bay and eventually the Labrador Sea and Current via the Hudson Strait and then into the Gulf of Maine via the Labrador Current. These captured waters of the spring freshet are now being saved and historic summer generation reduced by forty percent in order to increase winter generation by threefold or more.

ATLANTIC MERIDIONAL OVERTURNING CIRCULATION



THE OUTFLOWS FROM THESE RESERVOIR DAMS ARE SO LARGE THAT SALINITY LEVELS IN HUDSON STRAIT ARE IMPACTED, AS SHOWN IN THE FOLLOWING GRAPH FROM A 2007 STUDY, <u>THE OUTFLOW FROM HUDSON STRAIT AND ITS CONTRIBUTION TO THE LABRADOR CURRENT</u>, BY STRANEO AND SAUCIER.



This graph shows the waters with the highest salinity flow past the moorings in the Hudson Strait during the mid-March through June period. Historically (pre-1970) this time period would have had the lowest salinity waters because of the high flows of the natural spring freshet flowing into Hudson Bay and then into Hudson Strait. This finding is another piece of evidence that these dams are starving the silica diatom phytoplankton of silica and other nutrients during the spring and summer.

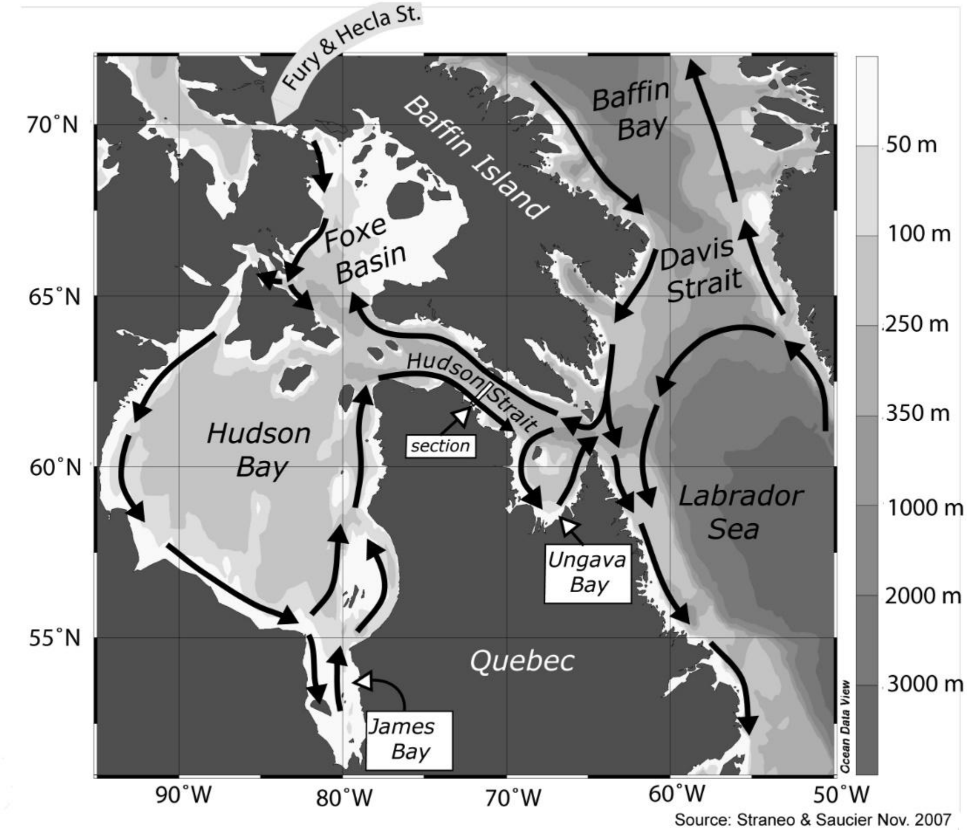
The threefold increase in winter discharge from the dams results in waters with the lowest salinity from mid-October through mid-January.

Straneo and Saucier wrote the following in their 2007 Report:

"Our results suggest that approximately 15% of the volume and 50% of the fresh water carried by the Labrador Current is due to Hudson Strait outflow. This is a striking new result, which suggests that we need to rethink the source waters for the Labrador Current and, in general, the fresh water pathways into the sub polar North Atlantic. They indicate that the role of Hudson Strait had been previously overlooked due to the absence of direct measurements from the Strait."

The surface area of water in Maine is only 4,537 square miles, compared to Quebec with 68,312 square miles and NL with 12,100 square miles. It is obvious that the Gulf of Maine is very dependent on the dissolved silica and nutrients transported by the rivers of these provinces during the spring freshet to fuel the Gulf's diatom phytoplankton blooms.

Hudson Bay System: bathymetry and schematic circulation



These blooms are the essential basis of the marine food web and their decline in both size and quantity are starving all the fisheries.

QUEBEC HYDROPOWER HAS SIGNIFICANTLY REDUCED SILICA AND NUTRIENT-ENRICHMENT ATTRIBUTED TO LAND BASED RUNOFF AND COASTAL UPWELLING IN HUDSON BAY AND LABRADOR SEA

"Most fisheries production world-wide is associated with three nutrient-enrichment processes: coastal upwelling, tidal mixing and land-based runoff, including major river outflow" (Caddy and Bakun, 1994).

"Many documented reductions in fisheries production have been attributed to river regulation, modifying natural variation in freshwater flow. Protecting natural flow regimes is likely to be an effective management strategy to maintain the production of estuarine and coastal fisheries" (Gillson, 2011).

Land based runoff has been significantly reduced as Quebec Hydropower manages it reservoir dams to capture the spring freshet and reduced summer outflows. Compounding this reduction in annual input of silica and other nutrients from land based runoff is the fact that nutrient enrichment from coastal upwelling is so limited in Hudson Bay.

The following was written in Bay Sys 2016 Mooring Program Cruise Report by Claire Hornby: *"The high riverine freshwater input in James Bay is causing a strong thermohaline stratification at the entrance to Hudson Bay,"*

and

"In Hudson Bay, a massive freshwater input by river runoff causes a strong stratification restricting upward nutrient flux into the surface layer and limiting phytoplankton production particularly in summer."

This is a double whammy negatively impacting the abundance of silica shelled diatom phytoplankton.

ABUNDANCE OF DIATOM PHYTIOPLANKTON HAS DECLINED

The results of a 2010 Study by Daniel Boyce using a 100-year data set concluded that the abundance of diatom phytoplankton had declined by 40% since 1950, and in a recent NASA study in "Global Biogeochemical Cycles," the authors have concluded the global diatom populations have declined by 1% per year from 1998 to 2012.

"Atlantic ocean plant life, the phytoplankton, has been observed to be in tremendous decline. International science teams have measured more than a 26% loss in the last 30 years. How bad is 26%? Remember when we destroy just 1 in 10 of any form of life we say that we have decimated that life. It's bad. Very bad. And the starvation and disappearance of Atlantic Cod stand as testimony to the collapse of the Atlantic Ocean pastures. Ocean pasture grass is plankton." (Russ 2014).

I offer the following analogy to help understand these spring blooms of the silicon diatom phytoplankton pastures and their dependence on the timely deliverance of this essential nutrient.

In the winter our lawns and fields are brown and barren. Spring heralds in more sunlight and the ground warms up. After the first rains deliver much needed nutrients to the lawns and fields, they seem to green up almost overnight. The farm animals begin grazing on the fresh and luscious grass, and the grasses begin transferring through photosynthesis carbon dioxide out of the atmosphere.

Out on the ocean, silica diatom phytoplankton are the pastures of the aquatic food web and one of earth's atmospheric thermostats for carbon levels. During late fall and through the winter these phytoplankton pastures are barren.

Spring heralds in more sunlight, and the oceans warm up. As the snow melts and rain falls on the landscape, the spring freshet begins to flow through our brooks and streams turning the rivers into a tumultuous roar.

These roaring waters are scrubbing silica, which is the second most common element, from the earth's crust.

Quebec Hydropower manages its reservoir hydroelectric generating facilities to capture the spring freshet. Spring discharges are now only 40% to 50% of historic (before reservoir damming) flows and silica diatoms are being starved of silica and other nutrients at this critical time of the growing season.

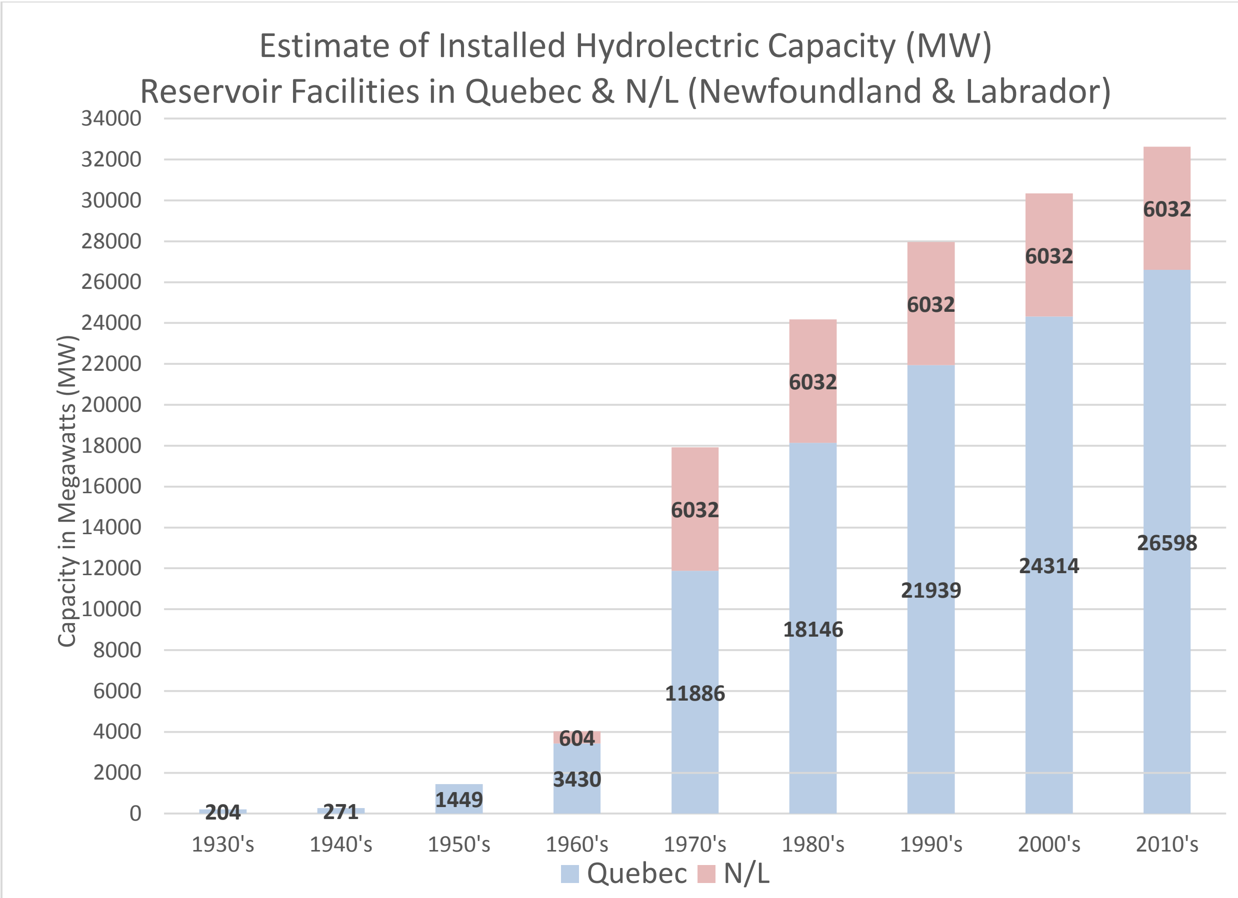
Starving the diatoms of silica means Quebec Hydropower's actions are starving the fisheries and maybe contributing to the increasing levels of carbon in our atmosphere.

Historically (thousands of years) if there was too much carbon in the atmosphere, then the atmosphere and oceans would warm up. This was followed by more evaporation and increased rainfall and snow, which resulted in roaring rivers transporting more silica to the oceans. This increased the size and abundance of silica diatom phytoplankton blooms, which provided more food for the fisheries and increased transference of carbon dioxide to the oceans. This, in turn, cooled off the atmosphere and oceans.

THE PROLIFERATION OF RESERVOIR HYDROELECTRIC FACILITIES OVER THE LAST FIFTY YEARS HAS PRODUCED A LACK OF SILICA WHICH HAS NEGATIVELY IMPACTED THE ABUNDANCE OF DIATOM PHYTOPLANKTON AND STARVED THE FISHERIES AND MAY BE CONTRIBUTING TO CLIMATE CHANGE

Quebec Hydropower not only built huge reservoir hydroelectric facilities throughout Quebec, but also built the 5,428 (MW) Churchill Falls Generating Station in Newfoundland and Labrador (NL).

The graph below illustrates how the annual capacity in MW's from Quebec Hydropower's reservoir hydroelectric facilities increased by 450 percent from 4,034 MW in the 1960's to 17,918 in the 1970's. and by another 200% in the 2010's to 32,630 MW.



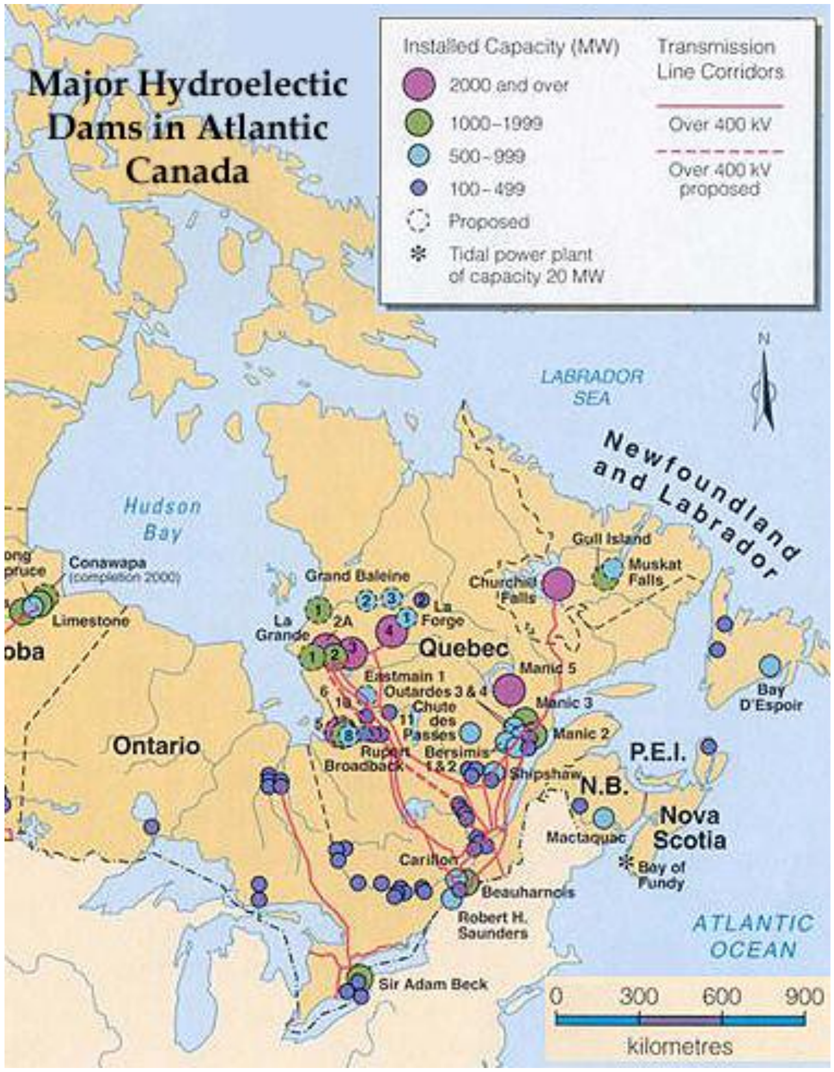
Earlier I used an analogy to show how the reduction in May and June outflows from the LaGrande facilities is equivalent to eliminating 7 Penobscot Rivers flowing into the Gulf of Maine during May and 10 Penobscots flowing into the Gulf in June.

The LaGrande facilities have 3 reservoir facilities and one Run of the River, and their total annual capacity is 8,738 MW.

The graph above shows a total annual capacity for reservoir facilities of 32,630 MW.

It would not be unreasonable to estimate that the reduced May and June outflows from these facilities would be the equivalent of eliminating 26 (7 Penobscots x 32,630 MW ÷ by 8,738 MW) Penobscot Rivers flowing into Gulf during May and 37 in June.

These estimates are conservative as I did not include, in the above graph, facilities in Manitoba and Ontario.



THE CUMULATIVE EFFECT OF FIFTY-PLUS YEARS OF REDUCED ANNUAL INPUT OF DISSOLVED SILICATE FROM ALL THESE DAMS IS DESTROYING BOTH THE FISHERIES AND ECOSYSTEM OF GULF OF MAINE

The following quotes from a scientific report, *Hydrological Alterations and Marine Biogeochemistry: A Silicate Issue?*, by Ittekkat et. al. (2000) describes some of the processes that are responsible for the decline we are seeing in the ecosystem and fisheries of Gulf of Maine and Northwest Atlantic.

"Freshwater and sediment inputs from rivers play a major role in sustaining estuarine and coastal ecosystems. Nutrients from rivers promote biological productivity in estuaries and coastal waters . . . and help to maintain ecosystems along the periphery of land masses."

"Most studies addressing the causes of eutrophication have concentrated on the elements nitrogen and phosphorus, mainly because both these nutrients are discharge by human activities. Silicate, however, also plays a crucial role in algal growth and species composition."

"The source, transport and sink characteristics of silicate, as they relate to change in the hydrology of rivers, are distinct from those of nitrogen and phosphorus. Large-scale hydrological alterations on land, such as river damming and river diversion, could cause reductions of silicate inputs to the sea (Humbug et al 1997). By contrast, although all nutrients (nitrogen, phosphorus and silicon) get trapped in reservoirs behind dams, nitrate and phosphate discharged from human activities downstream of the dam more than make up for what is trapped in reservoirs, for silicate, there is no such compensation. The resulting alteration in the nutrient mix reaching the sea could also exacerbate the effect of eutrophication—that is, silicate limitation in perturbed water bodies can set in much more rapidly than under pristine conditions, leading to changes in the composition of phytoplankton in coastal waters."

QUEBEC HYDROPOWER'S RESERVOIR FACILITIES AND OPERATIONS ARE INCONSISTENT WITH MAINE'S NATURAL RESOURCES PROTECTION ACT

The proliferation of large reservoir hydroelectric dams by Quebec Hydropower over the last 50 years never would have been allowed in Maine because the construction and management of these dams would have violated Section 401 of the Clean Waters Act and Maine's Natural Resources Protection Act.

To put this in perspective, Quebec Hydropower has 66 hydropower generating sites, and 38 are Run of River with a total capacity of 11,100 megawatts (MW), and 28 are reservoirs with a total capacity of 26,800 MW.

Maine's annual hydropower generating capacity is only 723 MW.

Quebec Hydropower's reservoir facilities have basically eliminated the spring freshet on these rivers by capturing and storing the spring run-off.

This would be an act of pollution on Maine's rivers under the Clean Waters Act, because the storage of these free-flowing cold waters has reduced by 40% to 50% the historic and natural delivery of the annual budget of dissolved silicate to the Gulf of Maine via the waters flowing through the Hudson Strait and the Labrador current.

In 2006, the Maine Department of Environmental Protection (MeDEP) and S. D. Warren argued before the U. S. Supreme Court over whether S. D. Warren was polluting the Presumpscot River and violating Section 401 of the Clean Water Act (CWA), because it was using too low a minimum flow during hot summer months.

MeDEP argued that dissolved oxygen levels were too low in the river downstream of the Eel Weir Dam and a higher flow was needed to provide more dissolved oxygen for aquatic life.

The Supreme Court agreed with MeDEP in a 9 to 0 decision, and Justice Souter wrote "***The decision interprets term "discharge" according to its "ordinary and natural meaning"*** and rejects efforts by S. D. Warren to have the Court read into CWA Section 401 any requirement that the regulated activity result in the ***"addition of a pollutant."***

In other words, holding back clean water laden with dissolved oxygen was polluting downstream water, which did not have enough dissolved oxygen to support the river's fisheries and aquatic life.

Furthermore, the construction of these reservoirs have not only flooded and eliminated the functions and values of hundreds of thousands of acres of wetlands, but have also captured the cold and free-flowing water of thousands of miles of brooks, streams and rivers in these reservoirs, along with the dissolved silica, which was being transported in the spring freshet by these once naturally free-flowing water bodies.

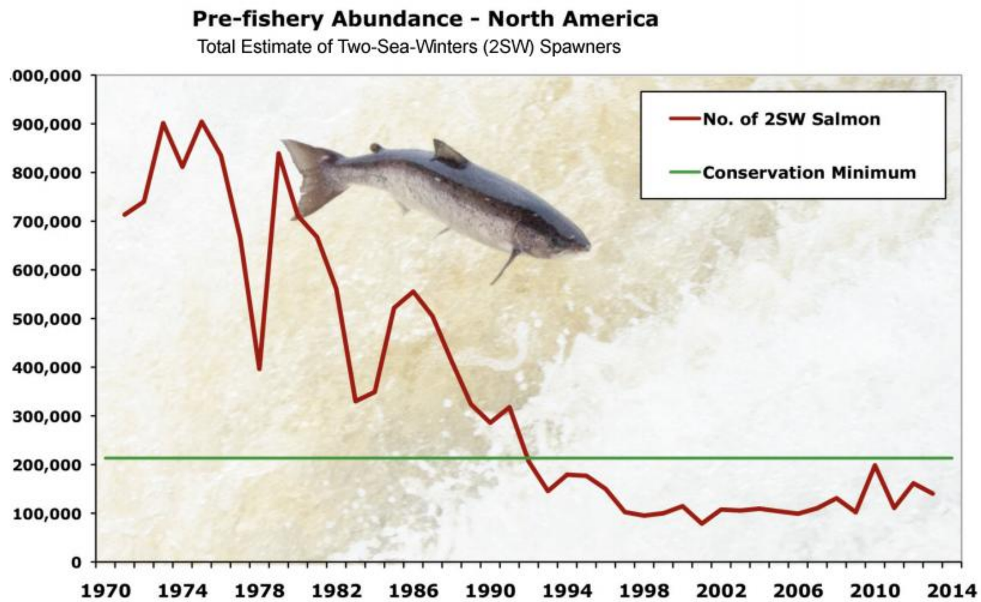
Quebec Hydropower's reduction of spring and summer outflows is polluting Hudson Bay, Labrador Sea and the Gulf of Maine by depriving the silica encased diatom phytoplankton population of its much needed dissolved silica during its growing season.

Diatoms are algae cells enclosed with cell walls made of silica, and their growth rate and size are determined by the availability of dissolved silica and the temperature of the water. In March, with more daylight hours, the diatom population increases its rate of photosynthesis enabling it to start dividing and multiplying into a healthy diatom bloom and the more silica, the bigger the diatoms and bloom.

These reservoirs prevent the cold natural waters of the spring freshet from reaching the coastal estuaries, and these retained waters are then exposed to "aging" as the water temperature quickly rises and changes in its biochemistry occur before being discharged from the dam.

The Gulf of Maine is one of the most important oxygen producing ocean "rain forests" in the world, and its diatom rich ecosystem is responsible for superior fisheries, ameliorating ocean acidification and regulating climate change. The cumulative effect and the proliferation of reservoir hydropower in its ecosystem are destroying it.

QUEBEC HYDROPOWER RESERVOIR FACILITIES ARE NOT ONLY STARVING THE SILICA DIATOM PHYTOPLANKTON POPULATION, BUT ALSO THE ATLANTIC SALMON FISHERY (SEE GRAPH BELOW)



Pre-fishery Abundance (PFA) graph for North American 2SW salmon showing the total number needed to meet the total Minimum Conservation Limit in North American rivers in green (corrected for 11 months of natural mortality). The PFA numbers are those 11 months before they return to their home rivers in North America.

Source: Atlantic Salmon Federation 2015

IT IS NO LONGER A QUESTION OF MAY!

There were early warning signals that the proliferation of these reservoir hydroelectric facilities may have a negative impact on the food chain in the northwest Atlantic and Gulf of Maine.

Sutcliffe et. El. (1983) hypothesized that reducing the spring freshet by hydroelectric regulation in the Hudson Bay area may affect northern cod populations along the Labrador coast.

The following was written in a 1998 Canadian study:

a. ***"Hydroelectric development on major rivers is seasonally altering the physical structure of the water column in coastal waters,"*** **and** ***"the implications of these hydro developments on the marine environment are not fully understood."*** **(Harding 1992)**
b. ***"Hydroelectric development has markedly reduced this spring run-off, and this may be enough to delay the phytoplankton bloom and thereby shorten an already brief growing season for larvae fishes and benthic invertebrates." (*****Morin et al. 1980)**

THE GULF OF MAINE AND CHINA SEA ARE WARMING AT AN ALARMING RATE, AND NOW THERE IS ANOTHER AREA

The countries who are the biggest producers of hydroelectricity are warming their nearby oceans**.** The Gulf of Maine and South China Sea are two areas in the global ocean, which are warming the fastest, and they are located next to the two largest producers of hydroelectricity in the world. Number one is China, and number two is Canada. Quebec Hydropower is Canada's largest producer, and it's warmer than natural discharge waters flow via the Labrador Current into the Gulf of Maine.

The third area is Barents Sea, and scientists say *"changes are so sudden and vast that in effect, it will soon be another limb of the Atlantic, rather than a characteristically icy Arctic Sea."* The Barents Sea is being impacted by Norway and Russia, which are the 5th and 6th largest producers of hydroelectricity in the world.

The water impounded by these large reservoirs is heated by the sun, and the discharged water from the impoundment is much warmer than the natural free flowing water upstream of the reservoirs. The temperature of the Gulf of Maine's waters is responding to the cumulative impact of more and more reservoir hydropower generation sites being built in the past fifty years. Since 1969, Quebec Hydro has built 22 reservoir hydropower dams, which is almost one every other year.

Since 1986, the area of the under ice plume from the LaGrande River has trebled and can extend 100 KM (62 miles) under the land fast ice of James Bay in the Hudson Bay (Roche 2017). Plumes of this magnitude, with warmer than natural flowing waters, could be contributing to thinner and weaker ice in the impacted area.

MORE CARBON IN THE AIR

The reduction in both the size and abundance of diatom phytoplankton blooms have contributed to the increased carbon in the air by significantly reducing the natural transference of carbon dioxide from the atmosphere to the ocean.

Mighty Diatom

(silica shelled phytoplankton)

The mighty diatoms are the microscopic plants that dominate all other ocean species in converting carbon dioxide to carbon and releasing oxygen.

"Diatoms are at the bottom of the food chain and suck up nearly a quarter of the atmosphere's carbon dioxide . . . Size matters for the creatures that eat them and also for carbon sequestration, as large diatoms are more likely to sink when they die . . . If smaller sized diatoms dominate, then carbon sequestration becomes less efficient and there may be more carbon dioxide in the atmosphere, which would exacerbate global warming" (Litchman et. al.2000).

Here in Maine, we criticize those that irresponsibly bring destruction to the world's oxygen producing forests, and yet we are fully complicit in policies that diminish the freshwater delivery of the critical necessary nutrients like silica to our own "ocean rain forests."

The proliferation of reservoir hydroelectric facilities on Quebec's major rivers has greatly altered the seasonal timing of silica-laden freshwater quantities delivered to Hudson Bay, Labrador Sea and eventually the Gulf of Maine. The diatom plankton ecosystems have not evolved to be starved of nutrients in the spring and summer and then fed nutrients under lower light and temperature conditions in late fall and winter. As a result, diatom population is adversely affected, and the rest of the food chain is starving and the percent of carbon dioxide in the atmosphere is increasing.

Quebec Hydropower's management is contrary to the good science found in the conclusion of a 2004 scientific report Lost to the Tide: the Importance of Freshwater Flow to Estuaries, by University of Rhode Island oceanographer Scott Nixon, et. al;

1. ***" Realization that fresh water serves an important ecological function in estuaries means that all engineering interventions in the flow of water to the coast should be looked at very carefully to see if diversions are really necessary and to see if releases from storage can be programmed to parallel the natural pattern as closely as possible."***
2. ***"It is important to understand that the freshwater that reaches the coast plays an important role in sustaining the productivity of estuarine ecosystems, which are also very important to people. Maintaining the flow of fresh water to the coast should be a consideration in fresh water management decisions."***

Mr. Jonathan Gilson wrote the following in a 2011 Report, in which, he referenced 217 Reports to support his conclusions:

"Episodic flood and drought events have pronounced impacts on fisheries production due to rapid change in physicochemical conditions modifying species richness and diversity. Many documented reductions in fisheries production have been attributed to river regulation modifying natural variation in freshwater flow. Protecting natural flow regimes is likely to be an effective management strategy to maintain the production of estuarine and coastal fisheries."

CONCLUSION

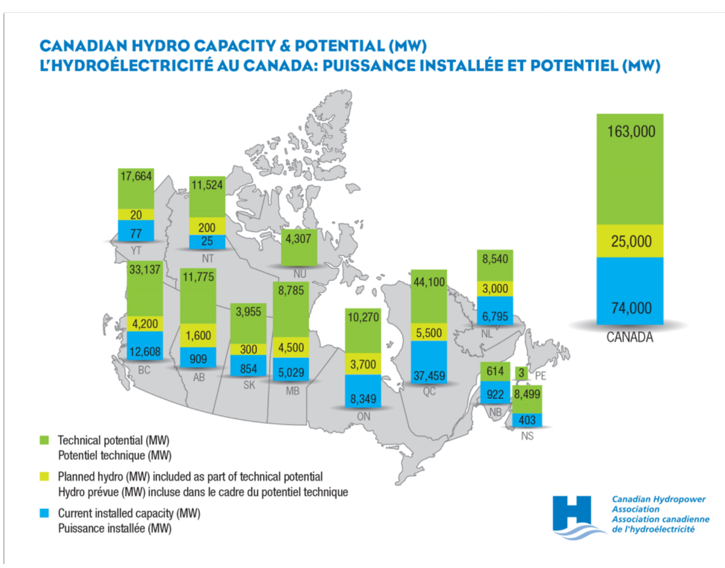
Let's put some of the above observations in layman's terms. It would be declared an extreme drought by meteorologists if total spring and summer precipitation was forty percent below normal. If it happened for fifty continuous years on land in the northern latitudes, the people would have starved to death. In the ocean waters of Newfoundland, Labrador and Maine, the fisheries are being starved to death.

For the past fifty years, a three-fold increase in river discharge of these warmer than normal reservoir waters (mid-thirty degree Fahrenheit) during the three months of winter represents a deluge of biblical proportion to the frozen seas. There are thousands of reservoir hydroelectric facilities throughout the northern latitudes operating in a similar manner.

The cumulative impact is predictable! Since the start of regular satellite observations in 1979, there has been an overall decline in Arctic sea ice in the past forty years. However, total sea ice in the Antarctic has increased by one percent per decade. Is this deluge of warmer than natural discharged waters a key factor in the decline of Arctic sea ice?

This Report has documented how the building and management by Quebec Hydropower of its reservoir hydroelectric facilities has captured the spring freshet and reduced the historic transport of dissolved silica. These actions are the driving force in the starvation of the fisheries and may be contributing to increase carbon levels in the atmosphere. Canada has ambitious plans to build many more reservoir facilities, which will only exacerbate the problem and may prove to be the tipping point.

MAP OF EXISTING AND FUTURE FACILITIES



Reject CMP Power Line Because Hydro-Quebec Facilities Damage Ecosystem

I am publicly writing to ask Maine's Department of Environmental Protection (MeDEP) to deny a permit for the 145-mile transmission corridor proposed by Avangrid-CMP to carry hydroelectricity generated by Quebec Hydropower from Canada to Massachusetts because Quebec Hydropower reservoir hydroelectric facilities are starving the fisheries in the Gulf of Maine and warming its waters.

In a recent 2016 Canadian study of trends in river discharge from 1964-2013, the authors found: that there has been a three-fold increase in river discharge during winter , when electric demand peaks, into the estuaries of Labrador Sea and Eastern Hudson Bay for the 2006-2013 period compared to 1964-1971 and a forty percent reduction in discharge during the summer. (*Recent Trends and Variability in River Discharges Across Northern Canada* Dery et. Al. 2016).

Let's put these findings in layman's terms. It would be declared an extreme drought by meteorologists if total spring and summer precipitation was forty percent below normal. If it happened for fifty continuous years on land in the northern latitudes, the people would have starved to death. In the ocean waters of Newfoundland, Labrador and Maine, the fisheries are being starved to death.

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The proliferation of large reservoir hydroelectric dams by Quebec Hydropower over the last 50 years never would have been allowed in Maine for the following reasons:

1. The construction and management of these dams would have violated Section 401 of the Clean Waters Act and Maine's Natural Resources Protection Act.
2. These dams are starving the fisheries of Hudson Bay, Labrador Sea and the Gulf of Maine, by reducing the transport of the annual budget of dissolved silicate during spring freshet to silicon diatom phytoplankton, which is the essential basis of the marine food web.

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3. The reduction in diatom phytoplankton blooms have increased carbon in the air by significantly reducing the natural transference of carbon dioxide from the atmosphere to the ocean.
4. These reservoir dams are warming the waters of the Hudson Bay, Labrador Sea and the Gulf of Maine by capturing the spring freshet behind these dams and holding these waters to maximize hydropower generation during peak demand in the winter months.

If a permit is issued, it should be conditioned on Quebec Hydropower changing the management of their reservoir facilities to a Run of River mode, which uses the natural flow of the river. This would help restore large silicon diatom phytoplankton blooms to feed the fisheries and increase carbon dioxide transference from the atmosphere to the ocean. It should also help reduce the warming of the waters of Hudson Bay, Labrador Sea and the Gulf of Maine.

> *"Half of the Gulf of Maine's ecosystem lies in Canada, where much of the water feeding the Gulf and affecting its temperature comes from*," was written by Colin Woodward in 10/15/15 Maine Sunday Telegram article.
>
> Quebec Hydropower's reservoir facilities have eliminated the spring freshet on these rivers by capturing and storing run-off.

The proliferation of reservoir hydroelectric facilities on Quebec's major rivers has greatly altered the seasonal timing of silica-laden freshwater quantities delivered to Hudson Bay, Labrador Sea and eventually the Gulf of Maine. This would be an act of pollution on Maine's rivers under the Clean Waters Act.

The diatom plankton ecosystems have not evolved to be starved of nutrients in the spring and summer and then fed nutrients under lower light and temperature conditions in late fall and winter. As a result, diatom population is adversely affected, and the rest of the food chain is starving and the percent of carbon dioxide in the atmosphere is increasing.

It is time to recognize that there may be a key regional factor starving the fisheries and warming Hudson Bay, Labrador Sea and the Gulf of Maine. If the fisheries are starving in all these waters, then the obvious place to look is the food chain.

Stephen M. Kasprzak

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