*Sipiwesk Lake Shoreline on the Nelson River –*
*high turbidity, poor shoreline habitat - September 2013*

# COMMENTS ON SOME ISSUES OF CONCERN TO PIMICIKAMAK REGARDING THE KEEYASK GENERATION PROJECT ENVIRONMENTAL IMPACT STATEMENT

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Annette Luttermann PhD
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COMMENTS ON SOME ISSUES OF CONCERN TO PIMICIKAMAK
REGARDING THE KEEYASK GENERATION PROJECT EIS

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# 1. Introduction

## 1.1 Professional Background

Pimicikamak Okimawin requested that I assist them with their assessment of the proposed Keeyask Generating Station and related infrastructure.

The expertise I bring to this task is based on academic, professional and personal experience with hydroelectric development over a period of approximately twenty-five years. I began to work with Pimicikamak on northern Manitoba hydroelectric development about two years ago.

My academic background includes a BA in cultural anthropology from McGill University, in the context of which I also studied arctic and boreal ecology, and the sociocultural and biophysical impacts of hydroelectric development in the James Bay region of northern Québec. I completed a Masters of Environmental Studies at Dalhousie University with a thesis on co-management issues related to the George River barren ground caribou herd based on its range. For my doctoral work I conducted a study in collaboration with the Innu Nation in Labrador on the historical effects of river regulation on riparian habitats of the Mishta Shipu (Churchill River of Labrador) and the importance of a basin-wide scope for cumulative effects assessment.

I am currently working also with the Treaty 8 Tribal Association on the environmental review of another proposed hydroelectric project on the Peace River in British Columbia.

I live in Golden, BC at the confluence of the Kicking Horse and Columbia Rivers. There are 14 dams built on the main stem of the Columbia and many more on the tributaries. I am familiar with efforts to recover white sturgeon and other aquatic species in this river.

I base my perspectives and opinions upon:

- Review of the Keeyask EIS
- Discussions with Pimicikamak citizens
- Review of literature on the Nelson River region and other regions of Canada and the circumboreal north
- My own research in other boreal regions of Canada on the effects of hydroelectric development on riparian vegetation communities
- Field visits to parts of the upper Nelson River
- Review of literature pertinent to questions such as restoration and enhancement of riparian wetlands, sturgeon recovery efforts to date in other regions, and cumulative effects assessment concepts and methodology

## 1.2 Pimicikamak Concerns with the Keeyask EIS

In the course of consultation with Pimicikamak citizens to date, the primary environmental questions that have been asked about Keeyask are:

1. What will be left of this river after all of this development?
2. This river is so degraded now. The water quality, fish, birds, plants on the shorelines, insects, frogs, and many other animals have declined. Will Keeyask make this worse?
3. How effective will the proposed mitigation measures be, especially for fish such as sturgeon, and for river shoreline habitats?
4. Will there be any direct or indirect effects of the proposed project on the operation of the Nelson River hydroelectric system as a whole?
5. If we want to work towards increased "harmony and balance" in our environment, should we not be working harder to mitigate the effects of the existing hydroelectric development rather than building more infrastructure?
6. In what ways will this project contribute to "sustainable development"?
7. Don't we have any other choices for this river besides more hydroelectric development?

These are legitimate questions to ask in the context of an environmental assessment of a proposed new development. Pimicikamak citizens have shared many of their perspectives on these questions based on their prior and ongoing experience with existing hydroelectric development on the Nelson and Churchill rivers. The focus is always on whole river systems, and the whole of Pimicikamak traditional territory. The rivers are the center of the cultural landscape.

Since the upper reaches of the Churchill now flow into the Nelson, and the flow into the main stem downstream is controlled to service the Nelson River generating stations, these rivers can be considered as an integrated basin in hydrological terms.

Some of the questions and concerns raised by Pimicikamak relate to the importance of an understanding of the historical and current ecological context. What is the scale of current effects of hydroelectric development on this river? This river system in its entirety has already been seriously affected and little attention appears to be paid to the question of how much is too much development?

In this discussion I will focus on a small subset of the elements of the Keeyask environmental assessment that have been raised as concerns by Pimicikamak. These topics include:

(a) The level of confidence in the Keeyask EIS conclusions related to the significance of the cumulative degradation of riparian habitats in the Nelson River.

(b) The level of confidence in the potential success of proposed mitigation measures for aquatic habitat conversion and lake sturgeon (*Acipenser fulvescens*) in particular.

(c) The rationale for a broader geographical and temporal scope of cumulative effects assessment within the regulatory requirements for a project specific environmental assessment.

(d) Whether major hydroelectric development meets the objectives of "sustainable development" in the context of concerns about climate change on a global and regional scale.

# 2. Direct and Cumulative Effects on Nelson River Riparian Habitats

## 2.1 Limited Spatial and Temporal Scope of Assessment

The assessment of wetlands as valued ecosystem components in the Keeyask EIS includes valuable information that adds to our understanding of wetlands in the Keeyask region of the Nelson River watershed. There is some good general description and consideration of concepts such as ecological functional complexity and diversity, resilience and uncertainty.

However, the fact that the Keeyask project EIS focuses primarily on one portion of the Nelson River system presents a number of weaknesses from the perspective of developing an understanding of the potential landscape level ecological effects of the proposed Keeyask project added to the existing hydroelectric developments in this river system. Pimicikamak has asked what is left of the river now, and what will be left in the future?

Riparian wetlands typically form approximately 1% of any region, however they are generally found to represent some of the most productive habitats within the broader landscape. The riparian habitats of the main stems of large rivers are typically more species rich in plants than smaller rivers in the same region (Nilsson et al. 2005).

The Nelson River wetlands are already degraded and are accorded little value now. The EIS states that "*All of the natural Nelson River shoreline wetlands in the Regional Study Area were either lost to flooding, or have been altered by modified water and ice regimes*." (Terrestrial Environment Section 2: Habitat and Ecosystems 2.8 Wetland Function p. 2-166). The analysis of historical air photo imagery in the lower Kelsey reservoir, Gull Lake, Kettle reservoir and Long Spruce reservoir concluded that well vegetated shorelines on the main stem constituted a relatively small percentage of the riparian zone, before hydro development. (Environmental Studies Program Report 11-05). Even if this was the case, these areas likely hosted some of the more species rich riverine marshes and swamps historically in the region. They were also important areas used by Aboriginal Peoples along a major travel route.

The Nelson River shoreline habitats that would have existed prior to initial hydroelectric development are effectively written off in this assessment. What does exist there today are described as "non-native wetland types" as a result of the severe effects of existing river regulation (Terrestrial Environment Section 2: Habitat and Ecosystems 2.8 Wetland Function p. 2-185).

It is acknowledged in the EIS that the Nelson River is not a naturally functioning system, and that the Nelson River riparian wetlands have been modified beyond recognition. This cannot be considered to be a pristine area. Nevertheless, the reaches that would be flooded by the proposed Keeyask project are still influenced by riverine hydrological processes. Tributaries entering the Nelson River along this reach still maintain natural seasonal run-off patterns. These may temper to some extent the regulated flow patterns in the main stem.

A discussion in the EIS of the overall approach to assessing loss of wetland function states:

> "*In regions that are in relatively pristine condition, it is anticipated that some degree of area loss can be absorbed without adversely affecting ecosystem functions*" (Terrestrial Environment Section 2: Habitat and Ecosystems 2.8 Wetland Function p. 2-158).

It goes on to assert that:

> "*Focusing on particularly important wetlands for evaluation and mitigation is an appropriate approach for this Project Assessment since the Project is located in a region with extensive wetlands that are in relatively pristine condition, except along the Nelson River*"; and, "*The regional ecosystem is the appropriate ecosystem level to assess the effects of development on wetland function in a naturally functioning ecosystem*". (Terrestrial Environment Section 2: Habitat and Ecosystems 2.8 Wetland Function p. 2-160).

The EIS also states that:

> "*In most cases, a development will affect a very small proportion of a regional wetland area, so the focus is on a screening technique that identifies wetlands that are particularly important for the regional level ecosystem*". (Terrestrial Environment Section 2: Habitat and Ecosystems 2.8 Wetland Function p. 2-161).

Important ecological questions include:

1. What remains of the former riparian wetland habitats in the main stem of the river and tributaries directly affected by regulation?
2. What is the condition of these areas at the present time and what are the implications for biodiversity and functioning of the riparian corridors of these large rivers?
3. Given the known extent of existing degradation of habitats associated with the main stem of a major river, what is an appropriate level of effort to assess the significance of further alteration of wetlands in this river system?

The regulation of the whole river has a significant influence on relatively unique main stem riparian habitats including tributary mouths. In my opinion, it would be reasonable to consider a broader regional assessment area as more appropriate context for an evaluation of how pristine the current Keeyask region is within the Nelson River. This could then lead us to consider the extent to which further mitigation may be possible along this river.

### 2.1.1 Cumulative Effects – Concepts of Spatial and Temporal Overlap

Effects on the characteristics of river shorelines are one of the most apparent and direct consequences of river regulation. The natural seasonal flow patterns of water and sediment transport are the main drivers that form and maintain the complex morphology and habitats typical of large rivers. When these fundamental processes are altered, the characteristics of shoreline habitats are dramatically changed. The ongoing effects of existing developments and the incremental change caused by successive hydroelectric developments, are much discussed by Pimicikamak citizens.

The CEAA Guidelines refer to spatial and temporal “overlap” as a way to determine boundaries for cumulative effects assessment. This is meant to help us to study and begin to understand the incremental and possibly synergistic effects of multiple developments on the environment.

There are differences of opinion as to what may constitute meaningful geographical and temporal boundaries. It is acknowledged in the EIS that the project effects do not need to overlap completely with the VEC in order for the boundary of the VEC to be used as a study boundary. The range of a population of a species could be used as a study boundary for cumulative effects. The range of metapopulations could also be important to address long-term effects of fragmentation. Incremental loss of good quality habitat over a large, previously connected area of the landscape, coupled with direct barriers for dispersal, could result in important cumulative effects.

A naturally functioning riparian corridor of a large river should be considered to be one logical and meaningful “VEC” for a landscape level understanding of what may be required to maintain regional biodiversity over the long term. This is especially so for river systems regulated by dams and impoundments.

How does the proposed Keeyask Project overlap with this important landscape feature, and what is its current state?

The approach taken in the Keeyask EIS uses in part the measure of likely “discernable or detectable effects” to define the study areas. Many direct effects are not expected to be detectable outside the hydrological zone of influence. However it is not possible to map or understand fragmentation of a corridor in this way. And as such, this approach cannot and does not capture an understanding of the effects of fragmentation of the northern river systems on which Pimicikamak depends.

To illustrate this concept in simplified way, the highway that connects my town to others is often closed due to landslides, avalanches, washouts and accidents. These are mountain passes with not many ways around. During those periods, nothing moves through. Some people will drive an extra six to ten hours to go a different way to the south or north. If this fragmentation was long-term, it would significantly affect the dispersal of people and all sorts of other things they carry throughout the region. Studying the traffic and local human population along another part of the highway may not explain the condition of the highway as a whole and effects of events on other stretches on that local area.

Of course dams and reservoirs are permeable in various ways to some species. Additionally, a river corridor is not the only travel route for all species, however it is likely an important one for many. Factors including the characteristics of the species, the patterns of water control and how these affect habitat, and the specific design of the infrastructure influence the extent to which the river corridor is fragmented.

### 2.1.2 Appropriate Spatial Scope for Understanding Effects on Northern River System Fragmentation of Riparian Habitats

Choosing a VEC with a landscape-level ecological function to study cumulative effects would also correspond more closely to the Cree world view. The Keeyask project overlaps in space and time with the ongoing effects of multiple dams and impoundments on the Nelson River riparian corridor. The existing hydro project is not in the past, but rather most of the major effects are ongoing, so there is clear temporal overlap with the river corridor as a whole. In terms of spatial overlap, the range of migratory bird species, historical range of aquatic species, dispersal corridors for many species of plant propagules are all overlapping in part with Keeyask.

Even limiting a cumulative effects assessment to the Nelson River portion of the watershed could be considered to be an overly restrictive geographical scope given the very real influence of the upstream reaches of Lake Winnipeg and the entire basin on sediment and nutrient transport, and dispersal of species, among other ecological processes. However, where should we draw the line in the interest of a focused and reasonable approach to environmental assessment of a project?

Ecologists have investigated the role of riparian corridors in maintaining regional biodiversity and have described them as "a key landscape feature with substantial regulatory controls on environmental vitality" (Naiman 1992). One paper sums up the importance of broad spatial management scales (watersheds) for river ecosystems with the following statement:

> *Natural riparian corridors are the most diverse, and complex biophysical habitats on the terrestrial portion of the earth. They possess an unusually diverse array of species and environmental processes. This "ecological" diversity is related to variable flood regimes, geomorphic channel processes, altitudinal climate shifts, and upland influences on the fluvial corridor. This dynamic environment results in a variety of life history strategies, and a diversity of biogeochemical cycles and rates, as organisms adapt to disturbance regimes over broad spatial-temporal scales. These facts suggest that effective riparian management could ameliorate many ecological issues related to land use and environmental quality. We contend that riparian corridors should play an essential role in water and landscape planning, in the restoration of aquatic systems, and in catalyzing institutional and societal cooperation for these efforts. (Naiman, Decamps and Pollock 1993: 209)*

Many species of terrestrial and aquatic plants and animals disperse over the short and long-term up and down river corridors with connected riparian habitats (Nilsson and Svedmark 2002). This habitat connectivity is likely an important function of riparian habitats along large rivers.

For example, the distribution maps in the Keeyask EIS (Terrestrial Environment Section 5 Amphibians and Reptiles Appendix 5B p.5B-1) suggest that the Nelson River may have been a corridor along which frogs dispersed north of Lake Winnipeg. Pimicikamak elders have stated that frogs were formerly abundant in the Nelson River riparian areas, and are now scarce. The reasons for this decline likely include the fungus

The management plan for the western boreal and prairie populations of the northern leopard frog (*Lithobates pipiens*) states that natural and anthropogenic factors are suspected to have been responsible for dramatic declines in abundance and area of occupancy in the mid-1970s and 1980s (Environment Canada 2013). Depending upon the specific area in question, the causes of these declines are thought to include drainage and filling of water bodies, conversion of upland habitat, urbanization, livestock operations, alteration of water regimes, introduction or increase incidence of disease and parasites, the increased frequency in drought periods, environmental contaminants, fish stocking, mortality from road traffic, and commercial harvesting and collecting. In most places the declines are probably a cumulative effect of some of these factors.

Like other amphibians, as individuals Northern leopard frogs do not disperse long distances. They require appropriate habitats during different parts of their life cycle: shallow marshes for breeding, moist uplands for summer foraging, and permanent water bodies for wintering (Environment Canada 2013). In order for populations to grow, disperse, repopulate areas that have experienced disease and persist over time, these quality habits must exist in relatively close proximity.

The management plan states:

> *In Manitoba, the Northern Leopard Frog, Western Boreal/Prairie Populations, was historically widespread both west and south of Lake Winnipeg, reaching as far north as Southern Indian Lake. It was particularly abundant in marshes along the southern shores of southern lakes such as Lake Winnipeg and Lake Manitoba. The Manitoba range of the species contracted significantly following extensive die-offs in 1975 and 1976. Local populations appear to have increased considerably in the last thirty years. However, there is little information to confirm the degree of recovery in size of the local populations and their area of occupancy.* (Environment Canada 2013:4).

Many Pimicikamak citizens have observed that frogs in general in the Nelson River reaches they are familiar with are very scarce since hydroelectric development began. To what extent has river regulation influenced these populations in combination with other factors? To what extent does the degradation of riverine riparian marshes and barriers on the rivers affect the ability for this species to rebound in this region? Could the habitat conditions be mitigated if the water control system was operated differently? The answers to these questions are not well understood at all.

Along the Stephens reservoir, adjacent to the proposed Keeyask reservoir, very few frogs were observed in surveys conducted for the EIS. Is this result related to the quality of riparian habitat in that reservoir? It is impossible to know from the EIS report, as the level of survey effort was very weak in the Stephens reservoir. If there is a further decline in amphibians in the Nelson River corridor as a whole, or the broader region, it would not be known whether any of this is related to hydroelectric development, or if it is related to habitat conditions in the local or regional area. If populations do decline in one part of the river due to a stochastic event such as a large wildfire, a large river corridor with good quality riparian habitat could allow natural dispersal and repopulation of that area. This wetland function then acts as a support for regional biodiversity and the resilience of metapopulations of species.

Increasing the temporal and spatial scope of cumulative effects assessment obviously requires more effort. However, it would not be expected that the same level of detail be investigated for every question. Even for the Keeyask EIS regional study area, terrestrial invertebrates were not studied, but rather general information on habitat associations in boreal environments was used.

The scale of assessment and mitigation effort should be equal to the scale of effects of the hydroelectric system as a whole.

## 2.2 Interpretation of the Significance of Residual Effects of Wetland Habitat Alteration and Fragmentation

The EIS summary of residual effects recognises the significance of habitat alteration and fragmentation for wetlands within the study area boundaries and the importance of maintaining natural flow patterns for wetlands. It proposes mitigation measures for those wetlands that are not already directly affected by impoundment and downstream flow changes. The proposed mitigation measures could potentially lessen the effects on the off-system wetlands within the study area, however it is recognised that the residual effects will likely still be significant. (Summary of Potential Residual Effects of the Project p: 38-14)

Given this understanding, the significance of the cumulative negative influence of hydroelectric infrastructure and operations on riparian wetlands in all on-system reaches of the river where hydrological patterns are completely disrupted should be assessed in a comprehensive way.

The very high level of significance of additional impoundment on this river system for aquatic and riparian habitats, must be appreciated by regulators.

In addition, in the interpretation of residual effects, the extent to which the project may preclude opportunities for mitigation of the effects of river regulation on riparian wetland habitats in future, by impounding this reach of the river must be better appreciated.

For example, to what extent have the opportunities for designing ecological flows into the operations of the hydroelectric system throughout the Nelson and Churchill Rivers been investigated for the benefit of aquatic and terrestrial ecosystems that are already degraded? Downstream reaches that are not impounded would have the greatest potential to benefit from changes in flow regimes to balance flood control and power generation with ecosystem health. The Keeyask EIS gives no indication that such objectives have been considered.

Some of the operational constraints that are already in place for various parts of the hydroelectric system may serve to mitigate some effects of regulation. It would be helpful to articulate where this may be the case, and investigate where the opportunities might be.

# 3. Mitigation for Effects on Sturgeon and Cumulative Effects

Lake sturgeon (*Acipenser fulvescens*) are a unique and precious component of the biodiversity and cultural heritage of the Nelson River. According to the IUCN, 85% of sturgeon species around the globe are at risk of extinction. The global harvest of wild sturgeon has decreased by 97% since 1975. In all cases, the decline of sturgeon species is attributed to excessive commercial harvest and habitat loss and degradation.

Habitat enhancement and a long-term stocking program are proposed as mitigation measures for the predicted adverse effects of impoundment of Gull Lake to Birthday Rapids and further fragmentation of the river on lake sturgeon and other fish species. Residual effects are predicted to be not significant after mitigation.

In fact, the environmental assessment suggests that a residual effect of the Project will be that habitat enhancement and stocking will increase the number of sturgeon in the reach of the Nelson River between the Kelsey Generating Station and the Kettle Generating Station. It concludes that: "*During the operation period, no long-term adverse effects to lake sturgeon numbers in the area directly affected by the Project are expected due to mitigation measures that provide habitat for all life history stages both above and below the generating station, and an extensive stocking program.*"

This assessment of no residual effects with a high level of confidence appears to be overly optimistic for several reasons.

The first is that although fish habitat enhancement measures look promising, and a good deal of thought has gone into them, they must still be considered to be experimental for this particular environment. There is no guarantee of success.

There are also limited detailed data on habitat conditions for sturgeon in other reaches of the Nelson River where sturgeon are also severely depleted. The extent to which former critical habitats such as spawning sites have been lost is not well documented, nor is the importance of changes in turbidity or water quality and flow patterns at sites that are not impounded. The quality of foraging habitat (food sources) is not well studied. The degree to which longer migrations (ie: well beyond the area of immediate impact of Keeyask) may have played a role in the past in maintaining the fitness of populations in various parts of the river is not known. Nor is it well understood the extent to which the ability for large, reproductively mature adults to migrate up and down stream helped to periodically replenish depleted populations in the past. These are all issues that can contribute to the resilience of self-sustaining populations in a large river system.

Therefore the prediction of no significant residual effects with a high level of certainty, due to habitat loss, is not considered to be precautionary and is considered to be far too uncertain.

In terms of the stocking program, it is likely that stocking will be capable of increasing sturgeon numbers in even isolated reaches with no safe fish passage. The methods for raising fish in hatcheries are improving. However, whether stocking will result in self-sustaining Nelson River populations over the long-term given the many variables associated with degraded habitat conditions is not known. There are some indications of progress towards this goal in other river systems and some very preliminary observations in the upper Nelson River. The results are still in early stages.

Certainly the numbers of sturgeon that may be found in this reach of the river at any one time, regardless of their age or reproductive capacity would be expected to increase if an area is stocked regularly with several thousand hatchery raised fingerlings or age 1 individuals. The question many Pimicikamak ask is how many of these fish will survive over the longer-term given degraded habitat conditions? This is a legitimate question.

The Recovery Potential Assessment for the Nelson River Lake sturgeon populations discusses what are considered to be appropriate mitigation measures by DFO (DFO 2010:12). It is concluded that conservation stocking must not be considered a substitute for other measures to address habitat degradation. The suggested mitigation measures for habitat degradation or loss from dams and impoundments are as follows:

- *Adjust water management operating conditions of dams and impoundments and other barriers for those currently in place and those planned in the future to optimize the survival and recovery of Lake sturgeon, especially during spawning and incubation periods.*
- *Rehabilitate habitat in key areas to mitigate habitat degradation or loss of important habitat (i.e. spawning sites) and improve age-0 and juvenile survival.*
- *Ensure design of new dams and modernization of existing dams does not jeopardize the survival and recovery of Lake Sturgeon (e.g. consider the need for fish passage).*
- *Protect spawning and rearing habitat.* (DFO 2010:12)

Some elements of these recommendations are proposed for the Keeyask project. However the extent to which they ensure that predicted loss of spawning and rearing habitat and further fragmentation of the river corridor will be fully mitigated is uncertain.

## 3.1 Level of Confidence in the Success of Fish Habitat Enhancement at Keeyask

The fish habitat compensation measures proposed for Keeyask state that the following habitat enhancement works will be constructed:

> *A spawning structure below/adjacent to the tailrace area with provision for modification of additional areas (~5.0 ha). This habitat would offset the loss of spawning habitat in Gull Rapids for Lake Sturgeon and other spring spawning species such as Walleye.*
>
> *The design of this structure is based on successful spawning structures constructed elsewhere (e.g. Quebec) and the results of experimental shoals constructed at the Pointe du Bois GS on the Winnipeg River. Use of designs tested in other systems increases the certainty that the spawning structure will be successful.*
>
> *Young-of-the-year sturgeon rearing habitat (~20-40 ha), if monitoring indicates that suitable habitat for this life stage is not formed within the reservoir in the first years of impoundment. This habitat would also be suitable for juvenile and sub-adult sturgeon. This measure is based on the current understanding of YOY habitat, which is rapidly evolving, and should be considered experimental, as similar work has not been conducted elsewhere.* [emphasis added] (TAC Public Rd 3 DFO-0001 P. 6-7 of 17)

There has been some success with artificial spawning structures in other rivers, but none have been tried in the Nelson River. The idea to create young-of-the-year habitat is a good one to pursue, however it is experimental. There is insufficient evidence to conclude that it will off-set the negative effects of additional habitat alteration and destruction.

### 3.1.1 Pointe du Bois Spawning Shoal Creation

Manitoba Hydro refers to the success of artificial spawning shoals at the Pointe du Bois power station, and that lessons learned there have been applied to the proposed habitat enhancement for species that spawn in rapids below the Keeyask tailrace.

The Pointe du Bois Generating station was first put into operation in 1911. All 16 units were commissioned by 1926. This is currently the oldest power plant still in operation on the Winnipeg River. There is a resident lake sturgeon population in the reaches below the structure. This demonstrates that sturgeon can survive and spawn near a powerhouse.

Artificial spawning shoals were constructed below the dam in various areas of the spillway area to test whether resident sturgeon would use them successfully. Some success has been reported with this experiment. Sturgeon spawning has been reported below tailrace and in the spillway area on constructed shoals.

However, are conditions there sufficiently similar to Keeyask to provide a reasonable level of confidence that it will work similarly at Keeyask? My opinion is that they are not.

Water velocities below the tailrace of the Pointe du Bois Generating station range from < 0.5 -1.5 $m^3$/s. under all flows. The maximum capacity outflow of the generating station is 712 $m^3$/s. The flow past the station and spillway combined averages 880 $m^3$/s, and has ranged between 51 $m^3$/s -2617 $m^3$/s over the period of record under extreme drought and extreme flood conditions.

It is predicted that the flows below the Keeyask tailrace would provide velocities within a suitable range for spawning of sturgeon and other species, in a portion of the outflow area under all flow conditions predicted on the basis of historical flows. However the area below the tailrace with velocities within this range would change under various flow conditions and would not be nearly as consistent as the Pointe du Bois station.

The Keeyask GS will be operated as a peaking station, whereas the Pointe du Bois GS is a run of river station and does not store water for peaking operations.

Under high flow conditions, the Keeyask station would operate with base load (maximum capacity 4000 m3/s), and not peaking, so that tailrace outflow would remain constant during a 24 hour period, but at mostly higher velocities than those suitable for spawning - >1.5 $m^3$/s. During lower flow conditions plant outflow could vary between ~1600 - 4000 $m^3$/s under the 50$^{th}$ percentile predictions, and between ~550 and 2800 $m^3$/s in a 24 hour period. (Physical Environment Surface Water and Ice Regimes p.4-73).

The Keeyask Fish Habitat Compensation Plan has considered these factors and has proposed a number of innovative design and seasonal operation plans to attempt to create suitable spawning conditions along the north shore below the tailrace (Section 4.6 pp.41-43). For example, during the spawning season, the two generators along the north shore will not be operated on peaking mode regardless of the total flow conditions. This would provide more consistent daily flows that are important for spawning and incubation. These plans are building upon the knowledge gained from experimental shoals in other systems, and are cognisant of the major physical and operational differences between these systems and Keeyask that may affect artificial spawning shoal success. Nonetheless, what happens with Keeyask will be experimental and must be regarded this way. If the Keeyask project proceeds, much more will be learned from monitoring whether these plans are successful, and experimenting with alterations in design. It is incorrect to attribute a high level of certainty to this program, as Manitoba Hydro has done.

### 3.1.2 Great Lakes Sturgeon Recovery - Habitat Enhancement and Stocking

Hartig et al. (2010) reported on experimental artificial spawning shoal construction in the Detroit River to attract spawning fish. They utilised and achieved the habitat criteria as described by LaHaye et al. (1992) for sturgeon. Significant success was reported for many species of fish. The results for lake sturgeon are promising, however appear to be much slower.

A review of lake sturgeon recovery efforts in the Great Lakes basin suggests that results are in the preliminary stages. A report on water quality in the Great Lakes states: "While recent spawning success in the Detroit River and other traditional spawning habitats is encouraging, recovery cannot be assumed." (IJC 2012:157)

It appears overly optimistic to conclude at this point that the effects of the Keeyask project will not be significant for the severely depleted wild populations of lake sturgeon in the Nelson River, based on habitat enhancement results to date elsewhere.

## 3.2 Sturgeon Stocking Program for Keeyask Mitigation

Given the status of remnant populations in many reaches of the Nelson River, a stocking program to attempt to recover sturgeon populations is likely a necessary and prudent conservation initiative. I do not dispute that a stocking strategy is a suitable mitigation measure to address some of the adverse effects of the proposed Keeyask project.

The goal of the sturgeon recovery program as described in the Keeyask EIS and supplementation documentation makes it clear that stocking is not intended to be continued indefinitely. A 25 year period is proposed along with monitoring to determine whether hatchery raised fish are reproducing in the wild.

The question I have is the extent to which we can conclude that stocking will necessarily result in self-sustaining populations in these reaches in the long-term, and whether this along with artificial habitat enhancement will fully compensate for the additional loss of what is still functioning habitat. Too much is not yet known and a high degree of uncertainty about this still exists. It would be incorrect to attribute a high level of certainty to this, as Manitoba Hydro does in the EIS.

### 3.2.1 Sturgeon Recovery in the Upper Nelson River

Pimicikamak citizens have expressed concerns about the long-term effectiveness of sturgeon stocking programs in the upper reaches of the Nelson River. It is recognised that there is increasing local expertise in sturgeon culture, both with spawn collection and rearing at the hatchery. However the ability of sturgeon populations throughout the Nelson River system to recover and become self-sustaining given the multiple dams and impoundments is uncertain.

To date, the results of the stocking programs described for the *upper* Nelson River suggest that these initiatives are at a very early stage and have yet to demonstrate that stocking will re-establish self-sustaining populations. Some juveniles have been caught by fishers in the Sea Falls area. Continued artificial hatching and rearing may be necessary to avoid further decline in lake sturgeon numbers. Additional work must be done to more clearly establish the extent to which habitat is a limiting factor in the recovery of lake sturgeon in the upper Nelson.

A minimum of 15 to 20 years is required to begin to develop a comprehensive assessment that is capable of providing adequate evidence of success of stocking in any particular water body. The upper Nelson stocking program has been carried out since 1995, however successful rearing has not been accomplish each year. It is still too early to assess whether it will succeed in creating self-sustaining sturgeon populations there.

Some description of the challenges with sturgeon stocking is provided in the Keeyask EIS. Additional information for the upper Nelson River program was provided following information requests through the review process. Mr. Don Macdonald (Regional Manager, Northern Region, Fisheries Branch, Manitoba *Conservation and Water Stewardship)* provided an account of the problematic issues faced specifically with the upper Nelson River stocking program that may be relevant to the program being proposed for the lower Nelson River. Mr. Macdonald has been the provincial representative on the Nelson River Sturgeon Board since its inception and has led the sturgeon stocking program conducted by the Board. Mr. Macdonald and the technical team conducting the trial spawn collection at the Burntwood River for the Keeyask Project have worked closely together for the past several years to address issues relevant to the stocking programs on both the upper and lower Nelson River.

With reference to the specific issues faced by the Board Mr. Macdonald stated that challenges include:

> *1. Lack of collection of spawn from females: With the depletion of the Landing River spawning run in the early 1990s, the only location on the Nelson River where sturgeon could be observed spawning was gone and the Board had to develop methods of collecting spawn from fish that were not actively spawning at the time they were captured. This greatly increased the complexity of spawn collection, and increased vulnerability to things like changes in the weather. When the Board first started working on the river, the sex ratio of the population was strongly skewed in favour of males. This was likely an artifact of the commercial fishery which targeted larger fish. The lack of females in the population limited opportunities to capture spawning females. This is becoming less of an issue in recent years. The introduction of the use of hormones to induce spawning in 2011 has also been a major factor in addressing the limited brood stock.*
>
> *2. Die-off of sturgeon in the hatchery: Lake Sturgeon culture is a developing field. Over almost two decades of experimenting with sturgeon culture techniques, there have been several years*

*where rearing was not successful. In some cases it appears that the problems arose from failure to convert to the feed provided, in others the cause remained unknown. Recently more has become known about sturgeon diseases that can cause mortality in a hatchery environment.*

*3. Death of female sturgeon used to collect spawn: This occurred in 2012. All sturgeon injected with a hormone that triggered spawning were removed from the river for 30 days to ensure that all traces of injected hormones were gone before fish were available to be caught and consumed by subsistence fishers. In this case the stress of transporting a large fish resulted in the death of that fish. This issue was addressed in 2013 following research which showed that changing to a different hormone would eliminate the need to hold fish.*

*Sturgeon stocking since 1994 has focused on the reach between Norway House and Cross Lake, where the natural population was considered largely extirpated. A survey conducted by Manitoba Hydro and the Nelson River Sturgeon Board near Sea Falls in this reach in 2012 captured nearly 100 young sturgeon (McDougall and Pisiak 2012)."*

There is still some spawning occurring in the upper Nelson River but recruitment is very low. Recruitment means the number of fish hatched in the wild and living to reach a certain size or reproductive stage. A question is whether habitat is a limiting factor or are there simply too few individuals left to repopulate? Habitat factors are not well understood but suspected to be important. The survival of young of the year is in question.

The efforts on the sturgeon stocking program in the upper Nelson are important and appear to be making progress. However, many challenges and questions remain. Little work has been done on addressing habitat loss and degradation in the upper Nelson. It is thought that habitat could not be a limiting factor to population growth because some fish are surviving and there is some indication that growth rates do not reflect food shortage. However, there is an argument to be made for more analysis of habitat conditions, and opportunities for enhancement in these regulated reaches.

### 3.2.2 Success of Sturgeon Stocking Programs in Other Regulated River Systems

The Keeyask EIS cites success in other regulated rivers with sturgeon recovery programs as an indication that the mitigation measures proposed in response to the predicted adverse effects of the Keeyask project on sturgeon have sufficient promise that they will reduce the residual effects to a non-significant level.

A review of sturgeon stocking programs concluded that:

*Stocking as a conservation strategy may be an essential tool required to rehabilitate selected lake sturgeon populations. A stocking strategy has the potential to have negative impacts on wild populations and should only be applied where a strong biological rationale exists and where other strategies have been deemed unsuitable for achieving management objectives (Smith 2009).*

A review of reported success in other jurisdictions does not necessarily offer a sufficient level of confidence at this point in time, to justify a conclusion that additional habitat destruction and degradation in the Nelson River will be fully mitigated by habitat enhancement and stocking and that therefore no significant effects can be assessed. The work being done on sturgeon recovery and management including stocking programs in Wisconsin through the Department of Natural Resources is viewed as a model of one of the most progressive programs and is cited as a region where success in stocking programs has been achieved.

The Winnebago lake system has one of the largest self-sustaining wild populations of lake sturgeon in the world. The watershed is also home to native shovelnose sturgeon (*Scaphirhynchus platorynchus*).

Lake Winnebago is controlled by two dams constructed in 1850 and 1930. The lake levels are regulated for flood control, to reduce ice damage to private property, to release water for hydropower and pollution dilution downstream, and to extend the high water season for boating.

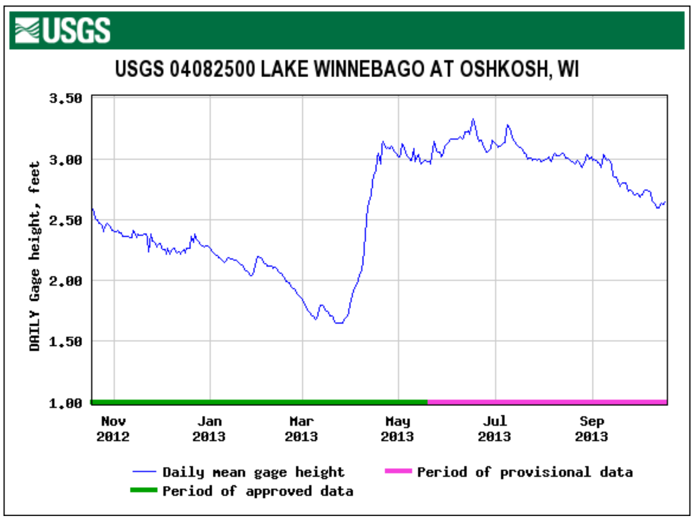


*Figure 1 Daily water levels at Lake Winnebago 2013*

A hydrograph from a station on Lake Winnebago shows the seasonal water levels over the past year.

We can compare this hydrograph with the water levels in portions of the main stem of the Nelson River system to consider one parameter of the habitat conditions that may affect the life history stages of species such as sturgeon.

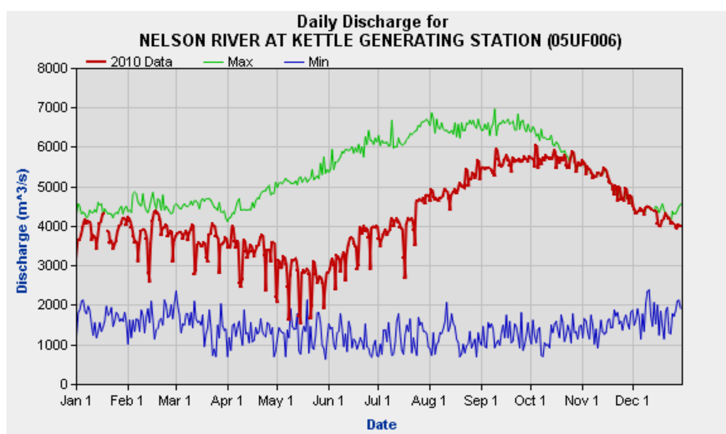


*Figure 2 Peaking operation at Kettle Generating Station results in daily fluctuating flows and reservoir levels (not shown here). Data from 2010 Water Survey of Canada*

In contrast to Lake Winnebago operations, the peaking operations at the Kettle Generating station produce constant fluctuations in the Stephens reservoir and downstream in the Long Spruce reservoir.

It is proposed that the Keeyask reservoir would be operated within a 1 m range (with a daily and weekly peaking pattern). This operation would contrast with systems such as Winnebago Lake where a more natural hydrograph is apparent despite the regulation by dams. The extent to which this difference may influence the ability to establish self-sustaining populations of lake sturgeon in the future with additional loss of spawning and rearing habitat is uncertain.

Changes in levels of turbidity and dissolved oxygen that will be expected in different parts of the Keeyask reservoir, may also affect the quality of sturgeon rearing and foraging habitat. It is possible that future reservoir conditions may also be influenced by changes in water quality in the Nelson River as whole. In Lake Winnipeg eutrophication (excess nutrients leading algae blooms and oxygen depletion among other effects) is increasing. The extent to which this may be having downstream effects on water quality in the Nelson River has not been assessed to my knowledge.

## 3.3 Columbia River White Sturgeon Recovery

Harvest of white sturgeon for subsistence or commercial purposes in the Columbia River including subsistence for Aboriginal Peoples, has been completely closed since 1994. Overfishing in the late 1800's and early 1900's is acknowledged as a significant cause of sturgeon population decline. However later habitat conversion through dam construction is thought to be the primary cause of recruitment failure.

A recovery plan was released in 2013 for white sturgeon in the upper Columbia River. The plan states:

> "*The construction of dams and creation of reservoirs on the Upper Columbia River has resulted in unquestionable and substantive physical changes to the former natural riverine ecosystem. These changes have a numerous effects that could potentially negatively impact White Sturgeon recruitment. As such, dam construction, reservoir formation, and flow regulation are considered as primary causes of recruitment failure.*" (Hildebrand and Parsley, 2013:50).

The assessment in the recovery plan states:

> *"Remaining population segments are primarily restricted to reaches with <u>significant riverine habitat</u> and subpopulations in marginal habitat areas have been lost or consist solely of a few remnant individuals"* (Hildebrand and Parsley, 2013:49).

Stocking programs are ongoing and artificial fertilization of lakes on the river system are part of efforts to increase habitat productivity. Trap and truck efforts have been attempted.

One issue that has been mentioned by people working in the field is that there are not enough resources for the programs despite the Columbia River Fish Habitat Compensation Program.

Regarding the success of recovery efforts to date, the document states:

> *The short-term objectives identified in the original plan focussed on an assessment of population status and actions to prevent further reductions in White Sturgeon distribution, numbers, and genetic diversity. Many of these objectives have been met through intensive studies and the success of the conservation hatchery program. The original medium-term objectives were to determine survival limitations (bottlenecks) for remaining supportable populations and establish feasible response measures. <u>Due to the difficulty in identifying reasons for recruitment failure, many of these objectives have not been met. The original long-term objectives to re-establish natural population age structure, achieve target abundance levels, and restore beneficial uses through self-sustaining recruitment, have not been achieved</u>* (Hildebrand and Parsley, 2013:iii). [emphasis added]

The success of hatchery programs in rearing disease free young sturgeon for release in the wild is certainly important. However these programs are generally considered to be the last resort in conservation measures, to be used as interim population support, and not as a long-term replacement for natural recruitment. Protection of all remaining suitable habitats, and potential improvement of degraded habitats through means such as habitat, flow, and/or water quality restoration remain the focus of long-term recovery efforts.

The recovery plan concludes that: "…*it is still unclear what specific and feasible actions will be effective at stimulating natural recovery*. *Currently, recovery planning is hampered by a lack of understanding of key factors limiting natural recruitment*." (Hildebrand and Parsley, 2013:iv)

Despite extensive effort in this regulated river to date, recovery is still not ensured.

## 3.4 Conclusions Regarding Mitigation Measures for Sturgeon

Manitoba Hydro expresses a high level of confidence when presenting overall conclusions regarding its prediction that lake sturgeon populations in the lower Nelson River will be healthier as a result of the Keeyask project than they are now due to planned habitat enhancement and increased stocking programs. However, the technical supporting documents indicate a high level of uncertainty in several areas. In addition, following requests for more detailed information on habitat effects by DFO and others including Pimicikamak, areas of uncertainty have been more clearly acknowledged by Manitoba Hydro.

Despite the admirable work that has gone into the proposed mitigation measures, there is still nothing close to a guarantee of success. The measures remain experimental. One hopes that if the project goes ahead they will be successful. The decision must be made whether to risk additional habitat loss for sturgeon given the endangered status of this species in the river at the present time and given the seminal importance of this species to the way of life and culture and Pimicikamak and other Cree peoples.

Pimicikamak citizens have expressed a high level of concern about the minimal habitat mitigation measures being implemented in other parts of the Nelson River for sturgeon.

The recently released Manitoba Lake Sturgeon Management Strategy (2012) recognises the importance of habitat that will provide for all life history stages in order to maintain self-sustaining populations. For several management units where suitable habitat continues to exist, the Strategy recommends that future development does not affect habitat. However, for the lower Nelson River protection of existing habitat is not the focus. The Strategy clearly supports the proposed additional hydroelectric developments.

Pimicikamak seeks the full implementation of the NFA including additional and much better mitigation efforts for already degraded habitats throughout the Nelson River system. This should begin with more research into habitat conditions in the upper Nelson.

There is a concern that the resilience of self-sustaining wild populations of this species over time will be further compromised with additional development. With each new project, the opportunities for mitigation in the existing environment may become more limited, for ecological and practical reasons.

For example, there may be reduced availability of financial resources and expertise to apply to mitigation in other parts of the system, if so much is allocated to the Keeyask project. It is possible that if the project is economically successful, there could be more expertise and resources in the future for mitigation in other parts of the Nelson River. However, it will be many years before this could be realised. In the meantime, Pimicikamak remains deeply concerned that not nearly enough is being done to implement the NFA mitigation measures, or to engage in adequate measures for lake sturgeon. It might be too late to ensure the viability of this species if we have to wait several years to assess the success (or lack thereof) of the Keeyask mitigation measures for sturgeon.

Another concern is that ecological resilience could be further weakened if stocking programs do not achieve their goals and instead introduce disease or reduce genetic fitness; if fragmentation of the river system has greater effects than are currently understood; if water quality is further reduced due to the cumulative effects of agricultural practices in the upper watershed, climate change, impoundments and non-native species such as carp which may thrive better in northern reservoir environments than native species.

In sum, there is a great deal of uncertainty about what Keeyask will do to lake sturgeon populations in the Nelson River system, and whether proposed mitigation measures will be successful or not.

# 4. Cumulative effects of additional dams and impoundments, climate change, and implications for meeting the objectives of sustainable development

## 4.1 Hydroelectric development versus climate change

Goal 1 of the eight Federal sustainable development goals as discussed in the Keeyask EIS with regards to Climate Change is to: *Reduce greenhouse gas emission levels to mitigate the severity and unavoidable impacts of climate change* (Chapter 6, Section 9.2.2)

The Keeyask EIS concludes that the project will contribute to substantial reductions in greenhouse gas emissions (GHG) by displacing fossil fuel electricity generation. Hydroelectric generating stations do produce significantly less GHG emissions per unit of energy produced than fossil fuel powered generation. However, as is discussed in the Keeyask EIS the project will contribute to the combustion of fossil fuels during planning, construction, and operations.

Only if there is direct displacement of fossil fuel combustion elsewhere will the Project have a net positive benefit on GHG emissions. It is not known conclusively whether Keeyask will have this effect or whether it will simply facilitate more electricity consumption and provide a disincentive for more effort into energy conservation.

If we consider the immediate and long-term effects of hydroelectric development on river systems and compare these effects to those feared from climate change, the irony is not lost on people living in that watershed that hydroelectric development is evaluated as a positive alternative to reduce the effects of climate change.

What are some of the feared consequences of climate change?

- Extreme weather events such as drought. Many areas of the Nelson River and Churchill Rivers are permanently or periodically dewatered due to hydroelectric operations.
- Increased precipitation and severe weather events causing flooding. Hydroelectric development causes immediate and long-term flooding and permanent loss of the natural riverine landscape to which native species are adapted.
- Habitat change. From the perspective of species conservation, habitat change is one of the most important effects of climate change. Dams and impoundments cause direct habitat change over areas that are large in the context of the main river corridor.
- Melting of permafrost. This is also an effect of flooding and infrastructure development.
- Invasion of non-native species with indirect additional, cascading effects on habitats is another potential effect of climate change. Invasive species have likely been facilitated by hydroelectric development (detail below).

The common carp (*Cyprinus carpio*) is an introduced species that began to be observed in southern Manitoba in the Red River in the late 1930s (Badiou and Goldsborough 2006). Between 1950 and 1970 this species' range expanded into Lake Winnipeg, Lake Manitoba, and Lake Winnipegosis. Carp were first reported in Split Lake in 1963, but were in very poor condition. Since then and especially in the past decade carp have become more established in the lower Nelson as far down as the Limestone rapids.

Badiou and Goldsborough (2006) have hypothesized that hydroelectric development has facilitated the spread of carp by flooding reservoirs, creating shallow water marsh-like habitats such as that within Stephens reservoir, that are suitable for carp spawning. The variable water levels of the reservoir may be tolerated better by carp than by native fish species.

The non-native carp are a concern in southern marshes due to their ability to significantly increase turbidity while spawning and foraging. This can potentially create a negative feedback effect reducing the productivity of aquatic macrophytes and other associated species. So an increase in lentic shallow water habitats in the Nelson River may not result in healthy habitats for native species. Whether carp can have a wide-spread negative effect on the Nelson River is not known. However, it is possible that they could contribute to cumulative degradation of shoreline wetlands and increased turbidity in some near shore waters. What is suggested by Badiou and Goldsborough (2006) is not a simple cause and effect relationship, but a complex ecological relationship that may take many decades to begin to understand.

Interestingly, as mentioned previously, the Nelson River riparian habitats themselves are already described in the Keeyask EIS as "not-native" due to the direct and ongoing effects of river regulation. This is not meant to refer to non-native species, but rather to the shoreline habitats themselves that now have characteristics so different than the pre-development shorelines that they cannot be described using a standard wetland classification methods.

The effects of climate change are global, but regionally the effects manifest differently. This is especially significant for those people who are living in their cultural and spiritual homeland. River regulation projects that contribute to extreme landscape change on a basin-wide scale, can be seen as akin to, or more severe than climate change. Reducing GHGs is important, but it is not and should not be the only goal in trying to achieve sustainable development. Choices that lower GHGs *and* avoid further environmental and cultural harm, should be seriously considered.

## 4.2 Reservoir Operations and Sustainable Development

The northern Manitoba hydroelectric system is already operating under several constraints including: variable annual and seasonal water flows into the system; Water Power Act licence conditions that attempt to provide flood and drought control in Lake Winnipeg, and attempt to regulate operations at each station including through consideration of the protection of existing infrastructure in communities throughout the river system; and new commitments to maintain water level ranges in reaches such as Split Lake.

Water level constraints within licences are primarily maximum and minimum levels in reservoirs, or flows below control structures, and restrictions on rates of change permitted. There do not appear to be many stipulations for water control that relate to seasonal ecosystem needs. In most cases these may be simply too inconsistent with power generation goals.

Within these constraints, reservoirs are primarily operated to maximize energy revenue. The reservoir optimization scheme currently employed is not designed specifically to seek flow regimes that maximize ecosystem health.

Given the many known ecological effects of dams and impoundments, it would seem that in order to meet the objectives of sustainable development, system planning would attempt to find a balance that would meet society's needs for water and power while better protecting the long-term health of the river ecosystem as a whole (Richter and Thomas 2007, Jager and Smith 2008).

Operation of the reservoirs and not just their size has an important influence on aquatic and shoreline habitats. The patterns of water level changes directly affect what can live on the shorelines. For example, optimization studies that include environmental goals throughout the river system would include investigation of the potential for adjusting reservoir levels to provide periodic spring flooding, or explore seasonal flow patterns in downstream affected reaches to consider flows that may improve shoreline vegetation structure, or aquatic ecosystem health.

There is a proposal for fish habitat compensation for the Keeyask project that would see some coordination of releases from two of the units at the station to provide more consistent flows in part of the tailrace area during the spawning and incubation period. This is hoped to create more suitable velocities for artificial spawning shoals proposed for that area. This idea is innovative and worth pursuing if the project is built. However, it is a small part of a new project that will inevitably contribute to further habitat degradation overall in the river system.

## 4.3 Hydropower Sustainability Assessment Protocol

The Hydropower Sustainability Assessment Protocol established by the International Hydropower Association, clearly explains the range of effects to consider when assessing new hydroelectric projects and managing existing infrastructure (International Hydropower Association 2011). For example, the section on passage of aquatic species states in part:

*"… freshwater fish move within river systems such as up tributary streams to spawn. Depending on their location, dams can present barriers to these species for migration in both upstream and downstream directions. As well as creating direct physical barriers, flow and water quality characteristics of the natural river regime may act as migratory cues. Whilst hydroelectric schemes can block passage of native or commercial fish, they can also facilitate passage of pest species into uninfested waterways through water transfers around the system."*

According to this, as only one example of ecological considerations, the Keeyask project assessment does not appear to meet the sustainability standards. It is clear from this description that issues related to movement of species, water flow and water quality, are better understood on a river system-wide scale. The incremental effects of multiple dams and impoundments on aquatic environment can be better understood if the context of inquiry is not limited to the reaches of the river immediately affected by a new project. Even if data are limited, the scope of the assessment should endeavour to include the wider watershed.

An additional large scale hydroelectric development on the Nelson River should be seen to represent a compromise from the perspective of ecological health, if the energy and this specific type of economic development is necessary, as opposed to a model of sustainable development as suggested in the Keeyask EIS.

## 4.4 Purpose and Limitations of Cumulative Effects Assessment

Issues of cumulative effects assessments are controversial all across Canada. Recent and ongoing assessments of large hydroelectric projects from Labrador to British Columbia are being criticised for failing to adequately consider the incremental degradation of large river systems converted into stepped series of dams and impoundments.

People who live along a large river, as well as many landscape ecologists consider a river system or a watershed to be an interconnected landscape entity and typically ask: What proportion of a river system is acceptable to dedicate to hydroelectric production? The Nelson River has a dam and control structure at its inlet at Lake Winnipeg and is therefore affected by an altered, unnatural flow regime along its entire length.

Another important question that should be asked in a cumulative effects assessment is: Will the Keeyask project increase the economic incentive to manage the river primarily for hydroelectric production? Will it further restrict the opportunities to manage flows for ecological and cultural values?

If a more balanced approach was taken to river development (balance between ecosystem health and energy generation), the question of whether additional generating capacity could actually offer some opportunities for ecological flow management given the additional surplus energy could be investigated. In other words, the intent is to sell the entire energy surplus to the United States for export revenue. This makes good business sense. However, to meet the needs of ecosystems for seasonal water flows and supply energy demand, some flexibility in the system to spill or hold back water strategically could be a good thing.

This option will be constrained by the economics of the projects, but the costs of this hydroelectricity should reflect more clearly the ecological costs of its generation.

## 4.5 Science and the "Cree World View"

I am curious about the purported discrepancy between science and the "Cree world view" as described in the EIS and by many speakers at the Hearings. Vicky Cole explained earlier in these proceedings that after four years of discussion it was decided that these approaches to the EA would have to take "separate but parallel paths". I do not believe that this should be entirely necessary.

There are many problems with trying to contrast "science" with the "Cree world view".

First, science itself is not a world view; rather it is a methodology. Its practice and results can influence world views. As a methodology, science is designed to try to reduce the bias inherent in our respective personal experience and ways of seeing things, as we gather information and test theories to attempt to better understand the world around us. Science is not an all-encompassing way of seeing the world. I suspect that few practitioners of the biophysical sciences would agree that scientific methodology and what we can learn through its pursuit defines their entire personal world view.

In addition, virtually no scientist is able to comprehend the full range of scientific knowledge that has been generated through the various disciplines. Likewise, many Pimicikamak and other Aboriginal people I have come to know are interested in science while holding a strong traditional world view – many believe that science can inform traditional worldviews. Differences of opinion can occur from variable experience, observation, scientific methodology, and beliefs. They can also occur because of differences in values, whether we are asking all the questions that are important to us, and whether we feel that something is being imposed upon us without our consent.

The discrepancy or conflict that may be more relevant to this environmental assessment is perhaps among aspects of the world view of Cree cultures, as compared to the corporate economic world view, or the economic growth imperative of current industrial society, or indeed the influence of personal vested interest. We all have it. These are surely value systems that are exerting as great an influence on this environmental assessment process as biophysical science and/or traditional Cree values. And yet, this conflict is not directly addressed in the EIS and instead attention is diverted to the so-called conflict or tension between science and “Cree” world views.

Third, the conflict between economic growth imperative and a traditional world view of seeking to protect the land in as natural a state as possible, leads to a number of points of conflict in an environmental assessment. Cree values were certainly not given equal weight in the regulatory assessment of what constitutes a significant effect. If an effect is considered to be significant, then it requires mitigation. Pimicikamak asserts that further mitigation is required for the many already significant cumulative effects of multiple dams and impoundments on the river basin as a whole in order to avoid further compromising the health, integrity and long-term resilience of the environment with more dams.

The Keeyask environmental assessment is complex. However, it is not nearly as complex as the myriad ways in which this project will actually affect the ecological and cultural environment and add to the existing adverse effects of hydroelectric development on northern Manitoba river systems.

The disciplines of the ecological sciences such as landscape ecology, and conservation biology attempt to ask some of the broader questions that are of interest to the Peoples who know northern Manitoba as their homeland and are concerned with caring for the natural world the way it was before industrial development. They may offer some additional common ground for people to work together to understand the implications of building another dam on this river.

Any assessment must be simplified partly in accordance with our collective knowledge and understanding, and partly in response to the limits placed on time and financial resources available to apply to these exercises. The use of the concept of VECs in an environmental assessment is due in part to these constraints, and to recognition of the fact that ecosystems are highly complex. Focusing on components as indicators is certainly a more manageable way to assess them.

The EIS states that it is concerned with identifying pathways of effects. VEC’s could be natural features such as un-fragmented rivers as “corridors” within the landscape. A VEC could be an “ecological process” such as the natural hydrological regime as a key driver (and an indicator) of biodiversity in a river landscape. It is recognised in the EIS that water regime is a primary driver of shoreline ecosystems. We can ask: to what extent have these been altered by past, present and future developments? This approach would bring some of the elements of science and the “Cree world view” closer together.

# 5. Conclusions

In conclusion, some of my concerns with the Keeyask EIS are that:

1. The geographical and temporal scope of cumulative effects assessment is too limited to be meaningful for several ecological questions. It is possible to identify areas of focus for a broader assessment while using the river corridor as an ecological and cultural landscape feature and the natural hydrological regime as one indicator. This approach would better meet the spirit and intent of cumulative effects assessment of a river regulation project within the regulatory requirements. It would also better address some of the questions raised by Pimicikamak

citizens and other Aboriginal Peoples with regards to cumulative change throughout the major northern Manitoba waterways.

2. The assessment of no significant effects on Lake Sturgeon based on proposed mitigation measures must be viewed as speculative. This is not to say that there is not promise in the proposals, or that they should not be implemented if the Project is approved. It is simply that the known risks of further habitat loss for this endangered species are more certain and therefore represent a high risk. The mitigation measures face several challenges and may not succeed as planned.

3. The effects of large-scale hydroelectric development are more similar in nature, but more immediate and severe on the riverine ecological and cultural landscape than the regional effects of climate change. The effects are much more strongly born by the people living along the river, and the benefits are not equally shared. This must be taken into consideration when assessing the environmental effects of a new hydroelectric project, compared to alternatives, in the context of climate change and sustainable development objectives.

Several of my questions and concerns relate to our comparatively weak appreciation of the effects of each additional new development within the broader scale of the river as a connected system. The concerns are with our scope of understanding, both geographically and with regards to the uncertainty related to the long-term effects of these major projects on river ecosystems.

I would feel more comfortable with this project specific EIS if in its final conclusions it:

1. More clearly acknowledged there are many known adverse environmental and sociocultural effects directly associated with an expanding hydroelectric system in northern Manitoba;
2. Acknowledged and expressed the extensive geographical and temporal scope of these adverse effects and the interdependence of the various components of the system;
3. Acknowledged that from an environmental perspective large-scale hydroelectric development cannot continue to be described and marketed as simply “clean and cheap” power, but rather represents many significant compromises in exchange for economic activity, centralised energy production, and reduced GHG production relative only to fossil fuel generation, but not necessarily relative to other forms of smaller scale, decentralised production or energy conservation and efficiency.
4. Acknowledged that the costs are not born equally by different geographical and cultural groups.

The province should initiate an independent comprehensive regional cumulative effects assessment that begins with a thorough review and interpretation of existing knowledge and data, and develops research questions in close collaboration with affected Aboriginal Peoples.

When the province has a better understanding of the ongoing accumulating impacts from the existing hydro development, it should then begin to allocate resources to further remediate and mitigate the existing adverse ecological and social effects throughout the affected watersheds, including through fuller implementation of the NFA.

It is understood that this is much easier said than done. I will not speculate on what could be accomplished, as such work would require considerably more information than has been compiled to date along with substantial analysis. However the scale of the effort should be in keeping with the scale of the adverse effects felt by Pimicikamak and other aboriginal peoples and the scale of the benefits that are reaped by the rest of society. Why should we all expect to have access to abundant electricity without accounting for the true costs?

We must work and make decisions within constraints, however we must always be cognisant of the limitations of our knowledge, and of the responsibility we have for present and future environmental conditions. Hence the need for the precautionary principle when knowledge is imperfect as it is with the Keeyask EIS.

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