MANITOBA PUBLIC UTILITIES BOARD

IN THE MATTER OF *Order In Council 128/2013 and attached Terms of Reference Needs For and Alternatives (NFAT) Review*

AND IN THE MATTER OF *Manitoba Hydro's Filing with Respect to the Need For and Alternatives to Manitoba Hydro's Preferred Development Plan*

REBUTTAL EVIDENCE OF MANITOBA HYDRO

WITH RESPECT TO THE ORAL TESTIMONY OF:

- **ELENCHUS RESEARCH ASSOCIATES INC., ("Elenchus"); KNIGHT PIESOLD CONSULTING, ("KP"); and LA CAPRA ASSOCIATES, INC., ("LCA"), Independent Expert Consultants ("IECs") retained by the Public Utilities Board ("PUB")**

- **BILL HARPER, ECONALYSIS CONSULTING SERVICES, on behalf of Consumers Association of Canada (Manitoba) ("CAC")**

- **WHITFIELD RUSSELL, WHITFIELD RUSSELL ASSOCIATES, ("WRA"); Rick Hendriks, Camerado Energy Consulting Inc., on behalf of the Manitoba Métis Federation ("MMF")**

- **PAUL CHERNICK, RESOURCE INSIGHT, INC. on behalf of Green Action Centre ("GAC")**

May 16, 2014

Manitoba Hydro

1.0 INTRODUCTION

This Rebuttal Evidence addresses the oral testimony given on behalf of the following parties with respect to Manitoba Hydro's NFAT filing:

William Harper, Econalysis Consulting Services (ECS) on behalf of Consumers Association of Canada (Manitoba) ("CAC");

Paul Chernick, Resource Insight, Inc. on behalf of Green Action Centre ("GAC");

Whitfield Russell, Whitfield Russell Associates ("WRA");and Rick Hendriks, Camerado Energy Consulting Inc**.,** on behalf of the Manitoba Metis Federation (MMF).

Manitoba Hydro's Rebuttal Evidence also addresses the oral testimony given on behalf of the Independent Expert Consultants (IEC):

Elenchus Research Associates Inc. (Elenchus), Knight Piesold Consulting, (KP) and La Capra Associates, Inc. (LCA or La Capra).

2.0 UNCERTAINTY IN LOAD GROWTH & DSM SUGGEST NEED TO PROTECT EARLY ISD FOR KEEYASK

The evidence provided on behalf of LCA, GAC, and CAC suggests that there is no justification for new generation related to need from Manitoba load until late in the 2020's or beyond (LCA Tr. p. 5559, GAC (Chernick) Tr. p. 9647, CAC (Harper) Tr. p. 8469 – 8473). In general the assumption underlying these assertions is that with a combination of low load growth and/or continually expanding DSM there is an ability to forego new hydro for the early or mid 2020's and instead plan on natural gas generation or some other short term resource should new generation be unexpectedly required earlier. While there is no certainty that new generation is needed by the mid 2020's, there is a high likelihood that new supply will be required in the mid 2020's (i.e. by or before 2025) due to the inherent uncertainty in the underlying factors affecting the need date. It would be imprudent for Manitoba Hydro to assume that no new generation is required until late 2020s and not provide for new generation in an earlier time frame.

Two of the main factors affecting the need date for new supply are load growth and DSM achievement uncertainty. Either one of these could be higher or lower than assumed in the calculations. The fact that they have uncertainty in both directions does not cancel out the fact that such uncertainty increases risk of supply being insufficient to meet the load. This is demonstrated when calculating the Load Carry Capability of a system using the Loss Of Load Expectation (LOLE) methodology, a standard engineering methodology utilized extensively by utilities worldwide and by entities such as MISO and NERC to evaluate how much load can be met at a given reliability criteria level. Considering both the probability of load being higher and the probability of the load being lower results in the Load Carrying Capability of the system being reduced. Similarly if the probabilities of DSM overachievement and underachievement are both considered the Load Carrying Capability is reduced further.

Advancing Keeyask to 2019 and taking advantage of the interconnection development opportunity provides risk management through protecting against potential increases in load growth and/or lower levels of DSM.

Probabilities Associated with Needing New Supply in Early 2020's Based on Load Growth Uncertainty

Assuming the scenario with the 2013 Load forecast plus pipeline load minus level 2 DSM and assuming no new exports (as tabulated in Exhibit 104-3, pg 19), application of the dependable energy planning criteria indicates new supply is required in 2024. If the small deficit in 2024 were to be ignored the need date could be deferred to 2027.

The pipeline load assumed was 1344 GWh additional to the 2013 load forecast (1478 GWh once including 10% losses.)

However, load growth is uncertain. For example, over the last ten years the load forecast for the year 2023 has increased from one year to the next by up to 1292 GWH and decreased from one year to the next by up to 959 GWh.

The dependable energy demand/supply calculations utilize the base load forecast. There is the expectation that there will be a 50% probability that actual load growth will be higher or lower than forecast. Table 1 below shows the probabilities in each of the years 2020 to 2030 that the amount of dependable surplus supply would be exceeded by the load growth when considering the probability distribution curve associated with load growth economic drivers and modeling. These probabilities do not consider load uncertainty due to weather more extreme than normal; inclusion of such uncertainty would slightly increase the probabilities.

As shown in the table, there is a material probability of the domestic load growth exceeding the dependable supply in the early 2020’s. For example, given uncertainty in load growth, new supply could be required in 2023 with 41% probability or 2022 with 31% probability.

Load Growth / Supply Probabilities Considering Uncertainty in Economic Load Growth

	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31
2013 Base Load Forecast	27789	28197	28605	29013	29418	29822	30225	30625	31041	31453	31863
Pipeline Load Including Losses	1478	1478	1478	1478	1478	1478	1478	1478	1478	1478	1478
2013 Load Forecast Plus Pipeline [1]	29267	29675	30083	30491	30896	31300	31703	32103	32519	32931	33341
Economic and Model Standard Deviation	1038	1121	1202	1280	1357	1433	1507	1579	1651	1721	1791
Surplus Dependable Energy - No New Exports or Generation	1138	872	590	275	-39	661	298	-10	-369	-726	-1109
Probability Point - Load Growth Uncertainty Exceeds Surplus [2]	**86.4%**	**78.2%**	**68.8%**	**58.5%**	**48.9%**	**67.8%**	**57.8%**	**49.7%**	**41.2%**	**33.7%**	**26.8%**

[1] 2013 Load Forecast plus pipeline load minus level 2 DSM (Exhibit 104-3, p19)

[2] Not considering weather more extreme than normal or uncertainty in DSM achievement

Effect of DSM Achievement Uncertainty

These probabilities of load exceeding dependable supply also do not take into account the uncertainty in the DSM forecast. Achieved DSM will be lower or higher than targeted and forecast and thus there is additional uncertainty in the amount of surplus energy and the date when new supply will be required.

Exhibit MH #188 provides the percentage of DSM achievement compared to the target for two years 2011 and 2012 for 26 U.S. states. The average of the 26 states roughly equals the target in 2011 and exceeds the target in 2012; there are many states in which the actual DSM falls short of the target and many others in which the actual DSM exceeds the target. While Manitoba Hydro is not aware of any studies determining the probabilities of long term targets being achieved, an illustrative indication of such probabilities can be obtained from this data on 2011 and 2012 achievements for the 26 states. Applying the standard deviations calculated from the state statistics, there is a 10% probability that the incremental target one year into the future can be underachieved by 30%. While not a rigorous statistical assessment, the state statistics and the illustrative probability calculation suggest that there is a risk the Manitoba Hydro aggressive plan to quadruple its DSM program may underachieve its target. This risk of DSM underachievement increases the likelihood of the actual load exceeding the dependable energy and in new supply being required in the early and mid 2020's.

3.0 NEW SUPPLY STILL REQUIRED IN MISO UNDER POTENTIALLY LOW LOAD GROWTH

The question of the impact of a reduction in load growth on electricity prices in the MISO market was raised during the NFAT hearings by Elenchus' Mr. Todd. The essence of Mr. Todd's evidence is that conventional economic theory would suggest that, all other factors being equal, a reduction in load growth would put downward pressure on electricity prices. (Transcript page 4926, lines 19-23). Mr. Todd also notes that without modeling the effect, it is impossible to quantify the impact of assuming load growth in MISO is flat.

Manitoba Hydro acknowledges that from a strict economic theory position, Mr. Todd's statement is accurate. However, due to emerging environmental regulations MISO is facing some unique near term circumstances which mitigate the impact of load growth relative to the other factors that affect market pricing.

It should be recognized however that due to the large number of units planning on retiring in MISO, adjustment to the available supply resources in MISO will have a much larger effect on prices than load growth. The section below provides an illustrative example of this based on the 12 GW of coal retirements projected by MISO.

Coal Retirements in MISO Relative to Expected Load Growth

As noted in the NFAT filing, MISO expects 12 GW of coal to be retired in the near term (i.e. by 2020) due to a confluence of emerging EPA regulations on mercury and due to moderate natural gas prices. These retirements represent almost 20% of MISO's total coal generating fleet. The effect of three separate load growth assumptions on coal retirements is presented in the table below.

	Cumulative GW by 2020	**Net New Supply Needed due to Coal Retirements & Load Growth (GW)**
MISO Coal Retirements	12	
Cumulative Load Growth (2014-2020)*		
1%/year	7	19
0.35%/year	3	15
0%/year	0	12

**% annual load growth is based on the base resource of 120 GW year used for illustrative purposes*

The table demonstrates that even under a 1%/year load growth estimate, coal retirements would still represent about two-thirds (12 GW of 19 GW) of the supply shortfall between now and 2020. This analysis does not capture other supply side retirements of other technologies such as oil and natural gas (end of life units). Although these technology retirements (to 2020) are not expected to be significant, they will add to the supply deficit for the region.

When considering nuclear generation, most potential retirements are not expected until the 2030 timeframe when extended licences are set to expire. When nuclear retirements do occur, they have a significant impact due to the large size of the generating units.

Although load growth assumptions are an important input required to estimate the long-term electricity price for the MISO region, the impact of load growth in determining prices in relative terms is less important than expected changes to the generation fleet.

4.0 Additional Economic Analysis for Pathway 1 and Pathway 2

MMFs Mr. Hendriks in his direct evidence states “La Capra also noted in its Appendix 9B that Manitoba Hydro's fifteen (15) options also lack a set of plans to test the timing of resource additions, such as delaying Keeyask five (5) or ten (10) years; ...”[1] As discussed in NFAT Business Case Chapter 14, Pathway 1, (Gas 2023 only for domestic load, later gas generation or hydro) and Pathway 2 (Keeyask 2023 only for domestic load, later gas generation or Conawapa) contemplate the decision to build Keeyask or a Gas resource as the first option to serve Manitoba load. Manitoba Hydro’s response to LCA/MH I-336 provided an economic comparison of the Gas/Keeyask 2028 development plan (Pathway 1) which was not available at the time of the initial NFAT submission. The following provides additional economic analysis related to Pathways 1 and 2. The anlaysis includes the following incremental NPV comparisons related to the timing of Keeyask Generating Station:

1. All Gas, Gas22/K28, K22/Gas and K19/Gas compared at NFAT 2012 planning assumptions and base DSM
2. All Gas, Gas22/K28, K22/Gas and K19/Gas compared at NFAT 2012 planning assumptions (2014 Keeyask Project capital cost) and base DSM
3. Gas23/K28, K23/Gas compared at NFAT 2013 planning assumptions (2014 Keeyask Project capital cost) and base DSM

---

[1] Transcript Page 10362

Table1: Incremental NPV of Gas22/K28, K22/Gas and K19/Gas relative to All Gas at NFAT 2012 planning assumptions and base DSM

Development Plan	Incremental NPV millions of 2014 Dollars @ 5.05% Discount Rate		
	1 All Gas	Gas22/K28	K22/Gas
1 All Gas			
Lowest Capital Investment Development Plan	-	-	-
Gas22/K28	Gas22/K28 minus All Gas		
	$709	-	-
2 K22/Gas	K22/Gas minus All Gas	K22/Gas minus Gas22/K28	
	$887	$178	-
3 K19/Gas	K19/Gas minus All Gas	K19/Gas minus Gas22/K28	K19/Gas minus K22/Gas
	$1,010	$301	$123

Table 1 shows the incremental NPV of Gas22/K28, K22/Gas and K19/Gas relative to All Gas under NFAT 2012 planning assumptions and base DSM. This table shows that relative to the All Gas plan, there is a positive NPV associated with development plans that include Keeyask as a resource option. The table also shows that the incremental NPV increases as the in-service date for Keeyask Generating Station is advanced: K22/Gas has an incremental NPV that is $178 million greater than the NPV for Gas22/K28 and K19/Gas has an incremental NPV that is $123 million greater than the NPV for K22/Gas.

Table 2 Incremental NPV of Gas22/K28, K22/Gas and K19/Gas relative to All Gas at NFAT 2012 planning assumptions (2014 Keeyask capital cost) and base DSM

Development Plan	2014 Keeyask Project Capital Cost Update Incremental NPV millions of 2014 Dollars @ 5.05% Discount Rate		
	1 All Gas	Gas22/K28	2 K22/Gas
1 All Gas			
	-	-	-
Gas22/K28	Gas22/K28 minus All Gas		
	$401	-	-
2 K22/Gas	K22/Gas minus All Gas	K22/Gas minus Gas22/K28	
	$512	$111	-
K19/Gas29	K19/Gas29 minus Gas22/K28	K19/Gas29 minus Gas22/K28	K19/Gas29 minus K22/Gas
	$566	$165	$54

Table 2 shows the incremental NPV of Gas22/K28, K22/Gas and K19/Gas relative to All Gas under NFAT 2012 planning assumptions with base DSM and updated for 2014 Keeyask Project capital cost. This table shows that with the increase in the cost of the Keeyask Project, while the magnitude of the incremental NPVs has decreased, the incremental NPV is still greater for plans with earlier in-service dates for Keeyask G.S.

Table 3 Incremental NPV of Gas23/K28 and K32/Gas relative to All Gas at NFAT 2013 planning assumptions (2014 Keeyask capital cost) and base DSM

Development Plan	2014 Keeyask Project Capital Cost Update Incremental NPV millions of 2014 Dollars @ 5.40% Discount Rate	
	1 All Gas	Gas23/K28
1 All Gas	-	-
Gas23/K28	Gas23/K28 minus All Gas	
	$134	-
2 K23/Gas	K23/Gas minus All Gas	K23/Gas minus Gas23/K28
	$164	$30

Table 3 shows the incremental NPV of Gas23/K28 and K23/Gas relative to All Gas at NFAT 2013 planning assumptions with base DSM and updated 2014 Keeyask Project capital cost. Economic results for Plan K19/Gas under 2013 planning assumptions were not available. This table shows that with updated 2013 assumptions, including the increased discount rate to 5.4%, and the inclusion of the 2014 capital cost updates for the Keeyask Project there is still a positive incremental NPV associated with Keeyask Generating Station as the next new resource.

Overall the economic evaluation results provided in Tables 1, 2 and 3 demonstrate that there remains a net benefit to pursuing Keeyask Generating Station as the next resource for Manitoba load.

5.0 MEETING BETWEEN KP, VALIDATION ESTIMATING AND MANITOBA HYDRO

Subsequent to the filing of KP's April 8, 2014 report and the oral evidence provided by the KP witnesses on April 14, 2014 a meeting occurred between KP, Mr. Hollman of Validation Estimating LLC and Manitoba Hydro staff, at the request of KP. The purpose of the meeting was to permit KP to gain a better understanding of the Keeyask Risk and Contingency Analysis model recommended by Mr. Hollman. This included their obtaining a better understanding of how Manitoba Hydro addressed the inherent estimating bias in contingency planning as well as to better understand his advice about industry norms for the use of P50 and P90 for capital projects. This meeting arose as a consequence of the oral evidence and cross examination of KP and Manitoba Hydro understands that the purpose was to elicit further information for the PUB and its advisors. Attached as Appendix A to this evidence is a copy of Mr. Hollman’s report regarding the meeting and the information provided. Manitoba Hydro has also included copies of the meeting notes, together with Mr. Fichot’s email confirming that the meeting notes accurately represented the content of the meeting to demonstrate the full content of the discussions.

6.0 FINANCE

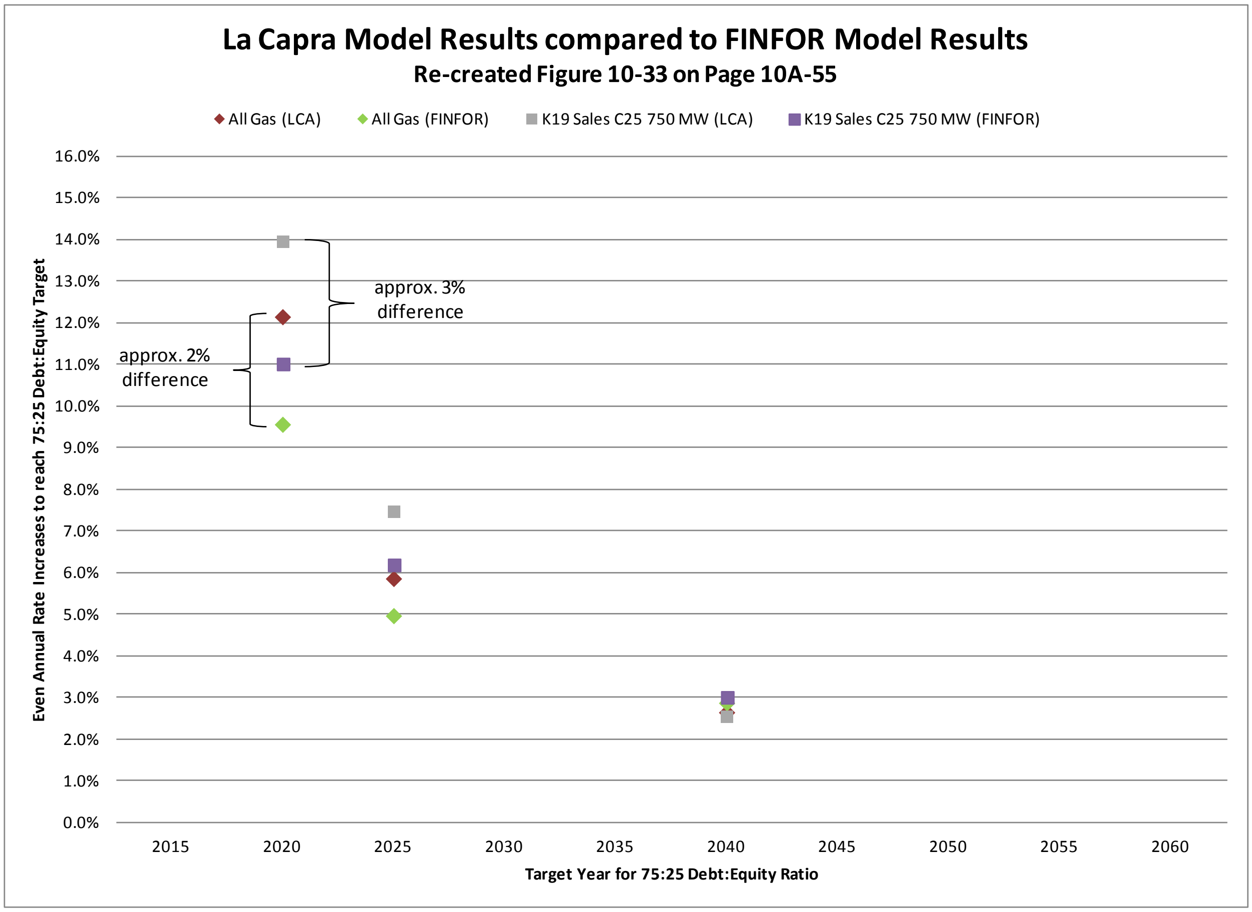
At transcript page 6352, LCA agreed to demonstrate to Manitoba Hydro how its model calculated changes between capital costs, net debt and debt equity ratio, and how these changes impacted cash, finance expense and other variables. Further, at transcript page 6354 LCA agreed to demonstrate how its model reflected changes to gross interest and cash as a result of changes to net debt impacting finance expense and interest coverage. It was determined that these matters could be addressed by way of conference call, which call took place on May 1, 2014.

In the course of the May 1 conference call, LCA confirmed that the LCA Dynamic Rates model does not project impacts to cash, net debt, finance expense, or the compounding effects of such finance expense impacts resulting from changes to rate increases, domestic revenues, load forecast, capital costs, net debt, export sales, fuel and power purchases or the target value and timing of achieving financial ratios.

LCA also agreed in the May 1 conference call that changes to assumptions would in fact change cash flows and borrowing requirements of Manitoba Hydro and further that changes to finance expense itself impacts the cash flow and borrowing requirements of Manitoba Hydro (the compounding effect of finance expense). In other words, an increase in finance expense reduces cash available to Manitoba Hydro. In a cost of service regulatory model, if that increase in finance expense is not passed directly through to the customer in the period it is incurred and is smoothed over future periods, Manitoba Hydro must increase its debt to pay for the increase finance expense. This is what Manitoba Hydro refers to as the compounding effects of finance expense.

Following the conference call, LCA provided the models used to produce the resulting in Technical Appendix 10B. LCA indicates in their report at page 10B-12 that the No New Generation Plan modeled by LCA includes an adjustment to finance expense proportionate to the change in capital expenditures relative to the All Gas Plan. In its review of the LCA model, Manitoba Hydro determined that consistent with the LCA Dynamic Rates model, the Appendix 10B model also does not project impacts to cash, net debt, finance expense, or the compounding effects of such finance expense impacts resulting from changes to rate increases, domestic revenues, reductions in additional revenue corresponding with the reduced domestic consumption associated with DSM savings, net debt, export sales, or fuel and power purchases.

LCA has invited Manitoba Hydro to provide additional modeling and replicate the LCA sensitivities and scenarios which would provide more precise information which LCA would use to update its Figures. As a result, Manitoba Hydro has partially replicated LCA's debt/equity ratio target year sensitivity and the figure below shows a difference in the rates calculated by LCA and Manitoba Hydro by approximately 3% under the Preferred Development Plan and approximately 2% under the All Gas by advancing the debt/equity target year from 2032 to 2020.It is important to note that these are annual differences over the 6 year period 2015 to 2020 and result in cumulative rate differences of 26% by 2020.



Given the constraints of the time remaining in the NFAT proceedings, Manitoba Hydro is not in a position to complete the modeling of LCA's No New Generation scenario or LCA's additional drought sensitivities.

Due to the consistent treatment of cash flow modeling in the LCA models, the same imprecision will exist in every model sensitivity or scenario produced by the LCA model. As a result, the rate metrics produced by LCA's Dynamic Rates model for the following sensitivities and cases in Technical Appendices 10A and 10B are affected by these limitations and should be used with caution:

Page 10A-19, 10% load growth sensitivity

Page 10A-53-59, Alternative Goals Analysis (including Figures 10-33, 10-34 and 10-35)

Page 10A-59-61, Alternative Goals Analysis – Interest Coverage Ratio (including Figures 10-36 and 10-37)

Page 10B-6-10, Additional Drought Analysis (including Figures 10-39, 10-40 and 10-41)

Page 10B-12-16, Rate Impacts of LCA No New Generation Case (including Figures 10-42, 10-43 and 10-44)

7.0 TRANSMISSION – Evidence of WRA

During the oral testimony of Whitfield Russell (WRA) a number of factual misunderstandings or misstatements were made. The following items are therefore offered in order to clarify the Board's understanding of Manitoba Hydro's role in the MISO market, and to address Manitoba Hydro's abilities to transaction and to obtain transmission in that market.

Mr. Russell suggested (at Tr. p. 10624) that entities owning generation in the U.S. would have an incentive to increase their sales of firm and non-firm power during the off-peak winter period, and also to engage in diversity exchanges with Manitoba Hydro. However, the assertion that U.S. utilities can sell firm winter only product is a incorrect. MISO market rules dictate that for a Load Serving Entity to count capacity toward its annual requirements, it must procure capacity for all months within a year. Therefore any sale of winter capacity would reduce summer capacity and not be in the interest of a generator.

Mr. Russell also suggested (at Tr. p. 10624) that Manitoba Hydro could easily get a line like GNTL built by submitting a Transmission Service Request. He noted that "The transmission providers (are) required to build needed upgrades when requested to do so by a transmission request and if the requesting entity is willing to pay for the studies and pay for the upgrades." It must be understood that a transmission provider (such as MISO) does not construct network upgrades but would request a transmission owner or other entity to do so as appropriate. The construction of a network upgrade as complex as regional transmission would require local and state approval and is not within the control of the transmission provider. Thus a transmission provider cannot necessarily arrange for a requested transmission upgrade to be built.

At Transcript page 10626, Mr. Russell testified that "FERC Order 1,000 requires transmission products -- projects for public purposes, such as renewable energy, to be considered in developing transmission plans; while Hydro's ability to store off- peak wind is a great enhancement to the ability of wind machines to get demand charges and firm up their ability." However, it must be noted that such a scheme would not constitute a demonstrable benefit to the region since it would be at the sole discretion of Manitoba Hydro how and when to buy or sell energy. This is different from the plan which has been put forward in which definitive agreements to sell large volumes of energy by Manitoba Hydro into the U.S. demonstrates a benefit which will definitely be realized within the U.S. A bonus to this definite U.S. benefit is the synergy benefits to Manitoba which will be possible through the additional import capability.

Mr. Russell also gave evidence (at Tr. p. 10671-2) that Manitoba Hydro would have the ability to backhaul power, and that if such a backhaul wasn't feasible its supplier could exercise its rights under the Open Access Transmission Tariff (OATT). However, "backhaul is a concept from the natural gas industry which does not exist under the OATT and the availability of firm transmission service is not determined by netting requests in opposite directions. Firm transmission reserved in one direction does not allow the transmission provider to sell additional firm transmission in the exact opposite direction because the transmission provider cannot be assured that energy will be flowing in the "one direction" when a transmission customer wishes to flow energy "in the exact opposite direction". The purchase of transmission and the right to utilize transmission does not involve the obligation to utilize the transmission in order to schedule energy transactions, which explains why transmission netting cannot be an OATT feature.

Mr. Russell also suggested that Manitoba Hydro could avoid point-to-point transmission fees by becoming a network customer (Tr. p. 10672). This overlooks the fact that because Manitoba Hydro does not have load in MISO, it is not eligible to apply for network service. Further, network service is not "free" as load taking network service pays the transmission related charges to the transmission provider.

Mr. Russell also raised, for the first time in his oral evidence the notion that FERC backstop transmission siting would benefit siting a line to export energy to Manitoba. He indicated (at Tr. p. 10674) "We have the … National Interest Electric Transmission Corridor bill, which is addressed to those very situations where … interstate transmission is frustrated". The Energy Policy Act 2005 permitted the Secretary of Energy to designate National Interest Electric Transmission Corridors which met U.S. economic benefits, supported U.S. energy independence, was in the interests of the U.S. national energy policy or would enhance U.S. national defense and homeland security[2]. A transmission line to export energy to Manitoba would not be a National Interest Electric Transmission Corridor. In fact, although enacted in 2005, to date FERC's backstop authority has not been used to route transmission for a National Interest Electric Transmission Corridor due to state opposition.

Mr. Russell also suggests that Manitoba Hydro may be able to get a portion of the required transmission capacity built by MISO as multi-value projects: (Tr. p. 10720). However, it is incorrect to state that a transmission customer could "under the multi-value program" get "transmission capacity without making large capital investments in upgrades." MISO's transmission expansion planning criteria contains specific measurable requirements for a project to qualify for inclusion as a Multi-Value Project. MISO has evaluated and determined that the transmission expansion proposed, which is primarily for the purpose of Manitoba Hydro exporting to MISO does not qualify for cost allocation under that program. MISO Transmission Expansion Planning and Multi-Value Projects do not result in large amounts of surplus transmission capacity being created, and especially not for power transfers to/from neighbour regions. Furthermore, requests for transmission service are excluded from consideration when planning is done for Multi-Value Projects.

---

[2] "The Federal Government's Role in Electric Transmission Facility Siting", A. Vann, J. DeBergh, September 8, 2011, Congressional Research Service, 7-5700, www.crs.gov, R40657

In his direct evidence (MMF Exhibit 31, slide 52), and contrary to Manitoba Hydro's previously filed rebuttal evidence, Mr. Russell suggests that Manitoba Hydro's Special Protection Systems (SPS), in dropping firm transfer to the U.S. goes well beyond the "radial customers or some local network customer". However, the SPS is not designed to automatically drop firm customers. All of Manitoba Hydro's SPSs are fully redundant and have been reviewed by NERC and the Midwest Reliability Organization in their capacity as bodies that are authorized to monitor compliance with reliability standards under Section 3(1) of the Reliability Standards Regulation. Use of the SPS has been confirmed to be a valid corrective action to ensure system performance in annual NERC transmission planning assessments.

Increasing Reliance on Imports – Transmission limitations

LCA recommended a change in Manitoba Hydro's generation planning criteria to increase its reliance on imports from 10% to 20% (Page 29, LCA direct evidence April 7, 2014). Mr. Whitfield Russell also is in favor of removing the 10 percent cap on imports (Transcript page 10650 line 2 through 10651 line 3). There are technical considerations in Manitoba that limit the ability to import large amounts of energy during certain times of the year that must be considered.

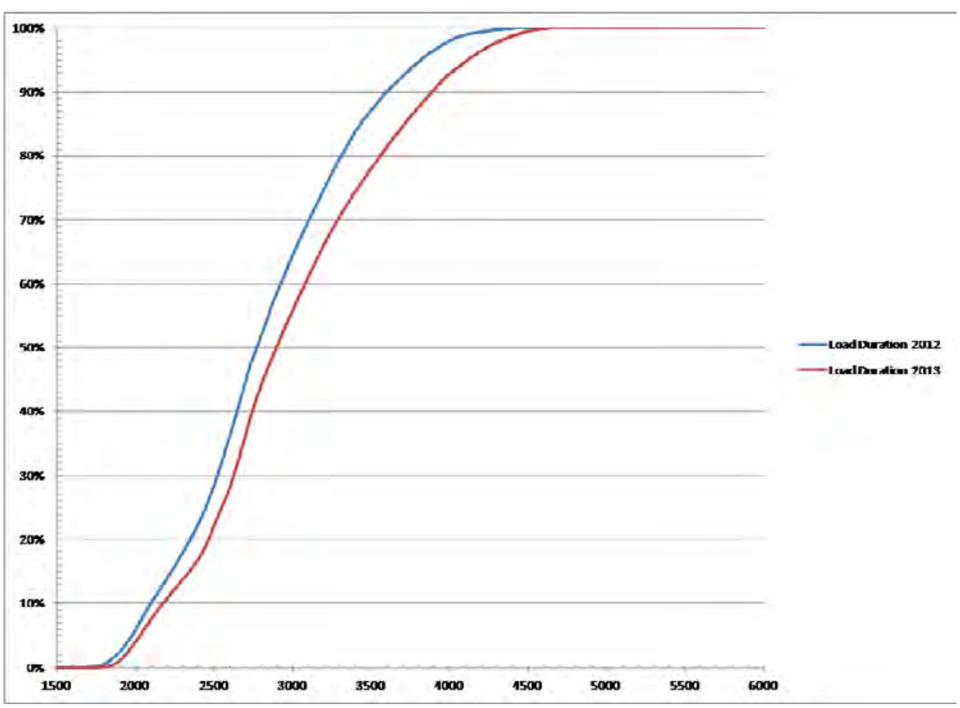
The permissible level of import is a function of Manitoba load. During periods of low load, there are restrictions on the minimum level of generation and HVDC operation to ensure secure operation[3]. A minimum of one generating unit must remain operational at each plant and the HVDC loading must not drop below 10% of the maximum rating. During an

[3] NOP-3323-01 and NOP-4432-02

emergency, the HVDC bipoles can be shut down, however, it takes a long time to restart, therefore this would not be permitted on a regular basis. The minimum permissible generation level in Manitoba is assumed to be approximately 1000 MW today and 1200 MW post Bipole III respecting secure operating guidelines.

Load duration curves for 2012 and 2013 are shown in Figure 1. The curves use 15 minute spot data from SCADA. The SCADA point MB_Load is used to quantify total Manitoba load. The absolute minimum load over the past two years was approximately 1700 MW. Assuming a minimum permissible generation level of 1000 MW in Manitoba, there would be no restrictions in the ability to import today on the existing firm 700 MW capacity Manitoba-U.S. tie lines.

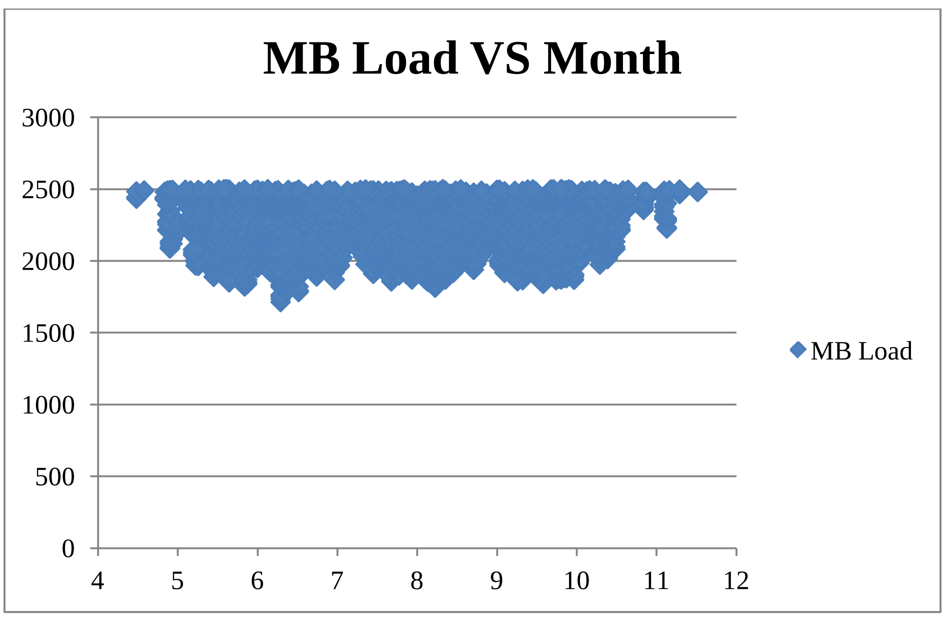
Figure 1: Load Duration Curves for 2012 and 2013



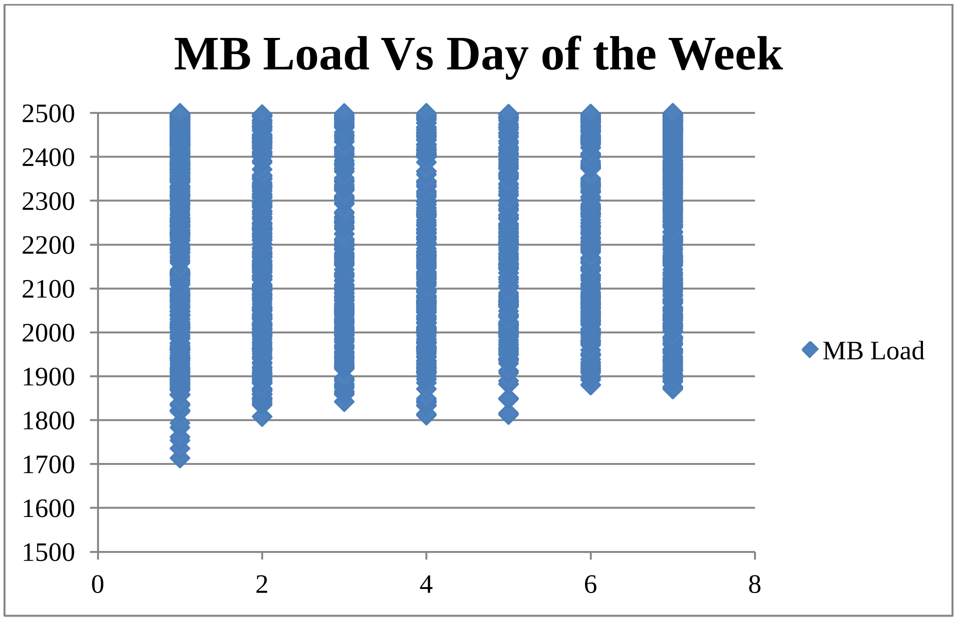
However, there will be potential restrictions in the ability to import if the capacity of the import line increases by 750 MW to 1450 MW. Assuming the minimum permissible generation level in Manitoba is 1200 MW post Bipole III in 2017, the load in Manitoba would have to be greater than 2650 MW before there are no restrictions in import capability.

Figure 2 shows in which months, the load is expected to be low (i.e. below 2500 MW). From May to November, there is a significant portion of the time when the load is low. There would be no concerns with importing during the winter months.

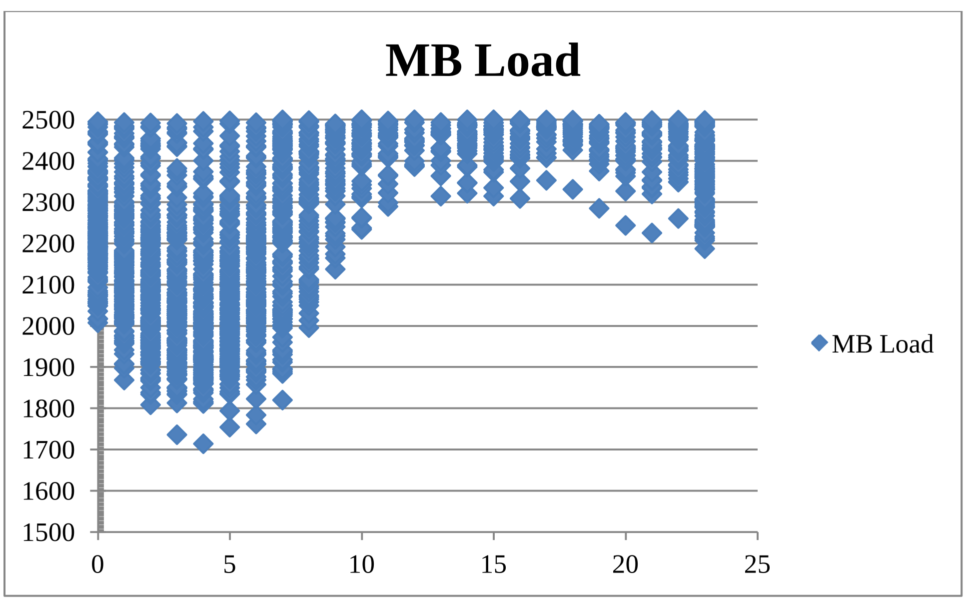
Figure 2: Manitoba low load period



Over the course of a typical week, the minimum load is fairly uniform as shown in Figure 3.



Over the course of a typical summer day, the load minimum typically occurs from about midnight to 8am.



Over year 2013, Manitoba Hydro load was below 2500 MW, 22.5% of the time. Over the period midnight to 6 am, the load is below 2500 MW, 63% of the time. From 2am to 5am, the power in the MISO market is typically at its lowest value, however, there may be minimum generation restrictions in Manitoba depending on the load at the time and magnitude of imports required.

It is difficult to predict the minimum load level into the future, especially with demand side management uncertainty. Assuming the minimum load stays fixed at being below 2500 MW for 20% of the time, is conservative.

Therefore, increased reliance on imports would need to consider operating restrictions in Manitoba. The ability to import up to the maximum firm limit of 1450 MW during off peak or minimum load conditions is limited.

8.0 LSSEP REPORT ON STURGEON

Mr. Hendrik's opined during his testimony on May 12 (Tr. p. 10435-01436), that there is a potential for Lake Sturgeon and/or caribou to experience "significant cumulative effects", which "potential" he interpreted to be "moderately likely".

With respect to the potential for cumulative (adverse) effects on Lake Sturgeon and/or caribou, the Keeyask Hydro Limited Partnership ("KHLP") has put extensive measures in place to prevent this from occurring. Moreover, more and more is being learned each month about Lake Sturgeon in particular which does not support predictions that the "potential" for significant adverse effects to this species are "moderately likely" provided the proposed mitigation measures are implemented. Manitoba Hydro's Lake Sturgeon Stewardship and Enhancement Program (LSSEP), which is described in Appendix 2.1 of the NFAT submission, recently released a Summary Report for 2008-2012 and the Annual Report for 2013 summarizing key program activities. A number of activities are directly relevant to recommendations made by the CEC in its report on Keeyask, including construction of spawning shoals downstream of Pointe du Bois on the Winnipeg River in 2009 and 2010, and subsequent monitoring since 2009, studies that have demonstrated stocking success in the upper Nelson River in 2012 and 2013, and multi-year research projects on:

- The effects of hormonal stimulation of spawning Lake Sturgeon (2011 to 2013),
- The identification, testing and prevalence of disease in Lake Sturgeon (2012 to 2015),
- Development of a high resolution genetics tool that will be used to examine relatedness among Lake Sturgeon populations (2013), and
- Development of an isotope tagging method for larvae and fingerlings (2013 to 2014).

The LSSEP reports will be posted on Manitoba Hydro's website and annual reports will be publicly available for future years as well. The LSSEP reports are provided as Appendix B to this Rebuttal Evidence.

In its Comprehensive Study Report (CSR) for Keeyask, the CEAA determined that, "…the Project is not likely to cause significant adverse environmental effects when implementation of the proposed mitigation measures, the follow-up program and adherence to conditions and requirements related to the necessary federal permits, authorizations and approvals are taken into account." (Executive Summary, CSR, p. ii). It is important to note that it is the CEAA's definition of significance that Mr. Hendriks recommended in both his report and his testimony on May 12 (p. 10470-71).

Rebuttal Evidence

John K. Hollmann PE CCP CCE DRMP

My name is John K. Hollmann. I am the owner of Validation Estimating, LLC. I have written on and conducted research on Total Cost Management and have been involved in the development of many of AACE International's Recommended Practices.

Validation Estimating's mission is to help companies improve the performance of their asset and project management systems to improve Cost Engineering, Asset Management and Project Control processes and practices. Risk Management is an increasingly critical element of these practices. I was retained by Manitoba Hydro in Nov 2013 to provide them with assistance and advice relating to project risk analysis and contingency development for the Keeyask Generating Station.

One role I had in reviewing the project risk assessments with Manitoba Hydro was to counteract any bias the project teams may have towards a tendency to have an optimistic contingency analysis (optimism bias being common for project teams).

I understand from my discussions with Mr. Bowen and Dhakal that the reports and advice I provided to Manitoba Hydro were provided to Knight Piésold ("KP") for their review as part of the NFAT hearing process. On April 24, 2014 I met by teleconference with Mr. Mike Robertson and Mr. Boris Fichot of KP, and Mr. Bishal Dhakal and Mr. Blair Purvis of Manitoba Hydro. The attached notes were kept by Mr. Dhakal. I understand they have been reviewed by Mr. Fichot at KP and he is in agreement that these notes represent the general content of the discussion and I am in general agreement with the notes as well. I am attaching the notes with my elaboration on them. My elaborations appear in red on the document provided to me.

The meeting was directed by KP and I answered their questions. In the meeting I advised KP that in my opinion using a P90 value for contingency planning for capital projects like Keeyask is unnecessarily high (contingency being an amount of money that is expected to be expended). I am of the opinion that a P50 value is reasonable and represents an amount that permits a project manager to respond to typical risks as they develop, without unreasonably delaying the project through approval processes, as delay itself adds to the risk and can increase the projects costs. I also advised that whatever is included in the contingency under the project manager's authority has an increased likelihood of being spent because control discipline is never perfect. I advised that approximately 20% of all projects are completed below the base estimate (unlike risk assessments, base estimates tend to be biased conservatively) and do not use the contingency at all, although this occurs less frequently with mega projects.

When considering the high case scenarios, I stated that one would only typically see a P90 value used for a high business case scenario. The tail of the distribution curve once P90 is exceeded is long and asymptotic. Contingency greater than P90 would start dragging out the tail of the curve, which is why it isn't generally used for quantitative analysis. In my opinion worst case scenario cannot be used for business model funding as almost no projects would get approval if the true worst case was used.

JKH

The Keeyask Risk and Contingency Analysis Report recommended a labour reserve of $210 million. The Labour risk is captured in two places, one as a specific risk and the other as a labour reserve. The labour reserve is mostly for concrete productivity and associated impacts. Manitoba Hydro itself decided to use a higher labour reserve of $304 million.

John K. Hollmann PE CCP CEP DRMP
May 14, 2014

From:	Boris Fichot
To:	Dhakal, Bishal; "hollmann@validest.com"; Mike Robertson; Purvis, Blair
Cc:	Bowen, Dave; Sam Mottram
Subject:	RE: Meeting Notes - Keeyask Risk and Contingency Estimate - Meeting with KP and John Hollmann
Date:	Tuesday, April 29, 2014 11:07:34 AM

Thank you very much for the summary and for facilitating the discussion, we have no additions.

Boris Fichot, P.Eng., P.E.
Senior Engineer
Knight Piésold Ltd.

Suite 1400 - 750 West Pender
Vancouver | British Columbia | Canada | V6C 2T8
phone: +1 604 685 0543 | fax: +1 604 685 0147
direct: +1 604 685 0543 ext 424 | mobile: +1 604 339 8892
email: bfichot@knightpiesold.com<mailto:bfichot@knightpiesold.com>
web: http://www.knightpiesold.com

From: Dhakal, Bishal [mailto:bdhakal@hydro.mb.ca]
Sent: April-29-14 6:20 AM
To: 'hollmann@validest.com'; Mike Robertson; Boris Fichot; Purvis, Blair
Cc: Bowen, Dave
Subject: Meeting Notes - Keeyask Risk and Contingency Estimate - Meeting with KP and John Hollmann

Please find the meeting notes from April 24, 2014 discussion. Please review and provide comments / edits COB May 2nd, 2014.

Date: April 24, 2014

Phone conference call

Present:

John Hollmann (Validation Estimating) – Calling from Virginia

Mike Robertson(KP), Boris Fichot (KP), - Calling from Vancouver, BC

Bishal Dhakal (MH), Blair Purvis (MH) – Winnipeg, MB

Absent:

Dave Bowen (MH)

Note taken by Bishal Dhakal

Overview: KP requested a meeting with John Hollmann, Validation Estimating, to get some clarifications on Keeyask Risk Analysis and Contingency Estimate Report prepared by John.

1. Introduction

2. General Discussion – Based on KP questions, John Hollmann provided following comments:

2.1 Contingency calculation method:

1. The Keeyask Risk Analysis and Contingency development is based on AACE recommended practices.

2. Two type of risk evaluated – systemic risk and project specific risk

3. Systemic risk are overreaching project risks which are attributable to the systems and culture of an organization. These items can be quantified by review of historical performance.

4. Specific risk:

   i. These are captured in the project risk registry.

   ii. Low, Medium and high value used for each project specific risk and probability % applied.

   iii. The project team went through the cost and schedule impact at a risk workshop. The project team didn't always come to a consensus on the potential impact.

   iv. Project team tends to be optimistic. Hollmann as a facilitator counteract the bias.

   v. Triangular distribution applied to come up with expected value.

2.2 Worst case recommendation:

1. Worst case for an individual risk is different than worst case for all project risks.

2. P90% is normally used for worst case scenario.

3. The tail of the distribution curve is long and asymptotic . Contingency >P90 would start dragging out the tail which is why it isn't generally used.

4. Disaster project tail is unknown.

5. Worst case cannot be used for business model funding. Almost no projects would get approval if worst case used.

2.3 P50 is appropriate for an organization with a portfolio of projects, is it appropriate in this case?

1. John is ok with P50 contingency regardless of project or portfolio management.

2. Most company use P50 contingency, so that PM can manage day to day risk.

3. Funding P70 will likely cause them to spend more.

4. Approximately 20% project under run and do not use any contingency at all. This figure is less for mega-projects.

3. Specific Discussion:

- Keeyask Risk and Contingency Analysis Report recommended labour reserve of $210M. This is based on mean not P50.

- Bishal Dhakal clarify that it was MH decision to use higher labour reserve amount than recommended. MH use conservative approach and decided to use discrete labour reserve $304M.

- Labour shortage risk is captured in two places. One as specific risk and other as a labour reserve.

- Labour reserve is mostly for concrete productivity and associated impact. Detail breakdown of labour reserve low, ref and high value was provide to KP.

Bishal Dhakal, P. Eng.

Project Delivery / Contract Engineer

Project Services Department

Manitoba Hydro

Ph: 1 204 360 4194

cell: 1 204 792 3014

bdhakal@hydro.mb.ca<mailto:bdhakal@hydro.mb.ca>

Lake Sturgeon Stewardship & Enhancement Program

Summary Report 2008-2012

Manitoba Hydro

LSSEP STUDIES: 2008

The program was established as a means of consolidating Manitoba Hydro's Lake Sturgeon stewardship efforts. The vision, objectives and implementation strategy were outlined in the Lake Sturgeon Stewardship & Enhancement Program document.[1]

LSSEP STUDIES: 2009

Construction and Monitoring of Pointe du Bois Spawning Shoals

A spawning shoal was constructed 25 m downstream of Unit 16 at the Pointe du Bois Generating Station, an area deemed to have suitable velocity and depth but with suboptimal substrate and flow diversity. The constructed shoal consisted of four large boulders (to create turbulence and flow diversity) immediately upstream of a boulder/cobble bed (to provide appropriate substrate for egg deposition and incubation). Egg mats were lowered on and around the spawning shoal but no egg deposition was observed in the immediate area during the spawning season. Using a DIDSON camera, fish were observed using the shoal and the area adjacent to the shoal, but no evidence of spawning activity was observed.[2]

LSSEP STUDIES: 2010

Construction and Monitoring of Pointe du Bois Spawning Shoals

Based on evidence from studies at Pointe du Bois indicating that Lake Sturgeon were keying in on areas of highest velocity in close proximity to a barrier, three additional shoals were constructed, but placed immediately downstream of the station and overlapping the unit opening and the concrete dividers between units (at units 1, 5, and 13). The shoals were monitored for spawning activity using a DIDSON camera and egg mats. Lake Sturgeon were observed on or adjacent to all three spawning shoals, and as water temperature increased, the Lake Sturgeon activity level increased. No spawning activity was observed on the shoals, but some activity was observed adjacent to the Unit 13 shoal. Egg mats deployed close to and immediately downstream of the Unit 5 shoal captured large numbers of sturgeon eggs, and mats deployed close to units 1 and 13 captured smaller numbers of eggs, suggesting that spawning occurred on or near the shoals.[3]

Churchill River Population Inventory (from Missi Falls CS to Little Churchill)

There is little knowledge on the population of Lake Sturgeon in this reach of the Churchill River. Approximately 45 km of river was surveyed in the Fidler Lake and Billard Lake areas in a year with very low flows. A single Lake Sturgeon was captured in the Billard Lake area (Catch-Per-Unit-Effort [CPUE] of 0.0005 LKST/100 m/24 h). The same individual Lake Sturgeon was recaptured in the same area three and four days later. The Lake Sturgeon population in this reach is low.[4]

Assiniboine River Population Inventory

The objective of this study was to evaluate the age distribution of this population established through stocking, to provide insight into factors affecting the successful reintroduction of Lake Sturgeon. Unfortunately due to high debris levels and high flow, the gill nets were rendered ineffective for capturing Lake Sturgeon. A Mini-Missouri trawl was deployed successfully but no fish were captured. This study will be repeated under more favourable conditions, preferably in summer or fall.[5]

Winnipeg River Population Inventory and Habitat Survey: McArthur GS to Great Falls GS

This reach of the Winnipeg River contains both lentic and lotic habitat, with large off-current bay areas. Coarse sand/pea gravel habitat is available for juveniles, suitable foraging habitat was confirmed, and the habitat immediately downstream of McArthur GS would likely provide suitable velocity and substrate for spawning. A total of 13 Lake Sturgeon were captured (9 in summer, 4 in fall), all within 3 km of McArthur GS (mean CPUE for large mesh gill nets was 0.46 LKST/100 m/24 h). The fork length of captured Lake Sturgeon ranged from 525 to 1170 mm.[6]

Winnipeg River Population Inventory and Habitat Survey: Great Falls GS to Pine Falls GS

The habitat survey identified areas with high velocity and bedrock/cobble/gravel substrate that would likely provide suitable spawning habitat including immediately below Great Falls GS, below White Mud Falls, and below Silver Falls. The habitat survey identified suitable foraging habitat, and an abundance of areas with sand substrate that would be suitable habitat for juvenile Lake Sturgeon. A total of 33 Lake Sturgeon were captured (19 in summer, 14 in fall), the majority between Great Falls and White Mud Falls. Lake Sturgeon was the dominant species captured (mean CPUE for large mesh gill nets was 0.71 LKST/100 m/24 h). The fork length of captured Lake Sturgeon ranged from 308 to 1510 mm.[6]

Development of Promotional Materials for SRSMB

Promotional materials were developed for the Saskatchewan River Sturgeon Management Board, including a short brochure that summarizes the Board's goals, initiatives, and milestones, a longer booklet that includes activities for kids, and a visual display that can be used at community meetings or events attended by the SRSMB.

LSSEP STUDIES: 2011

Monitoring of Pointe du Bois Spawning Shoals

The constructed shoals were monitored for spawning activity using a DIDSON camera and egg mats. Large numbers of sturgeon observed on and adjacent to the Unit 5 shoal and the large number (n=1863) of eggs deposited close to the shoal suggest that sturgeon spawned on the Unit 5 shoal. The shoal at Unit 1 had no observed spawning behaviour, and limited egg deposition, and the shoal at unit 13 showed congregations of Lake Sturgeon, but no spawning activity or significant egg deposition. Egg deposition observed during different hydraulic conditions over four years of observation suggests that Lake Sturgeon may be selecting for more macro-habitat features (eg. adjacent to maximum flow, turbulence) rather than specific micro-habitat features (eg. water velocity). Unit shutdowns during the spawning season influenced flow conditions and therefore likely affected where Lake Sturgeon spawned immediately downstream of the generating station.[7]

Winnipeg River Juvenile Inventory: McArthur GS to Pine Falls GS

In the reach from McArthur GS to Great Falls GS, 84 juvenile Lake Sturgeon were captured (CPUE of 5.0 LKST/100 m/24 h), with abundance strongly skewed towards the upper section. Fork lengths ranged from 155 to 777 mm. The majority of juveniles captured were age 3 (n=29) and age 6 (n=25). In the reach from Great Falls GS to Pine Falls GS, 88 juveniles and 8 adult (>800 mm) were captured (CPUE of 6.2 LKST/100 m/24 h), with abundance skewed toward the upper and middle sections. Fork lengths ranged from 243 to 910 mm (plus one large individual at 1610 mm). As in the McArthur GS to Great Falls GS reach, age 3 (n=15) and age 6 (n=20) juveniles were the most prevalent. Juvenile Lake Sturgeon in the upper sections of both reaches tended to be smaller for a given age compared to lower sections. Recruitment is occurring in these two reaches of the Winnipeg River (albeit somewhat erratically). Although year class strength between the two reaches was highly correlated, neither distribution was significantly correlated to historical May or June flow volumes.[8]

Winnipeg River Spawning Inventory: McArthur GS to Pine Falls GS

In the McArthur GS to Great Falls GS reach, 14 adult and 1 juvenile Lake Sturgeon were captured in spring (CPUE of 2.0 LKST/100 m/24 h), ranging in fork length from 713 to 1370 mm, and including one pre-spawn and nine ripe males. In the Great Falls GS to Pine Falls GS reach, 109 adult and 6 juvenile Lake Sturgeon were captured (CPUE of 6.2 LKST/100 m/24 h), with a higher CPUE at White Mud Falls (11.9) than at Great Falls GS (2.4). No Lake Sturgeon were captured at Silver Falls. Fork length of captured sturgeon ranged from 672 to 1420 mm. One ripe female and 84 ripe, three pre-spawn, and five post-spawn males were identified in the catch. Egg mats were deployed below McArthur GS, Great Falls GS, White Mud Falls, and Silver Falls. Two Lake Sturgeon eggs were deposited on an egg mat deployed on the southern edge of White Mud Falls.[9]

Winnipeg River Spawning Habitat Survey

This study took advantage of the very low water levels on the Winnipeg River in the fall to document habitat characteristics at six known or potential spawning locations, including Seven Sisters GS spillway, Whitemouth Falls, McArthur GS spillway, Great Falls GS spillway, an unnamed shelf 800 m downstream of Great Falls GS, and White Mud Falls. The data (including georeferenced photos) collected will be valuable for future studies on Lake Sturgeon spawning, including habitat criteria and the creation of spawning habitat.[10]

Winnipeg River Habitat Assessment: Seven Sisters GS to Lac du Bonnet

This habitat assessment collected bathymetry and classified substrate over 15 km of the Winnipeg River. This reach of the river has a wide range of hydraulic and physical habitat characteristics. Spawning habitat is available at the upstream portion of this reach (immediately downstream of Seven Sisters GS). The substrate in the lower sections of this reach is dominated by coarse material, and finer substrates such as sand and fine gravel are not abundant.[11]

LSSEP STUDIES 2012

Nelson River Spawning Inventory – Kettle GS to Long Spruce GS

Using large mesh gill nets to target spawning adults, seven Lake Sturgeon were captured, including four in the Kettle GS spillway area, two below the Kettle GS tailrace, and one 1.5 km downstream of the Kettle GS in offshore habitat. Sex and maturity were determined for three of the seven sturgeon. Two were classified as pre-spawn males, one of which was reclassified as ready to spawn when recaptured four days later. One sturgeon was classified as juvenile based on its size. The abundance of Lake Sturgeon in this reach of the Nelson River is relatively low, and based on the capture of only two spawning male sturgeon, the low number of Lake Sturgeon available to spawn annually may be one of the main factors limiting this population.[12]

Nelson River Population Inventory – Kettle GS to Long Spruce GS

Using ATK collected from the Fox Lake Resource User Group on this area as well as results of previous studies, bathymetry maps, and substrate maps, this study completed an inventory of Lake Sturgeon from Kettle GS to Long Spruce GS. A total of 10 sturgeon were captured. Eight sturgeon were captured in juvenile net sets in deep water habitat with sand/gravel or cobble/boulder substrate. These eight sturgeon ranged in age from four to six years, and ranged in fork length from 323 to 587 mm. Two sturgeon were caught in large mesh gill nets; one was eight years old and measured 770 mm in fork length, and the other was 11 years old and measured 855 mm in fork length (and was previously captured in June 2012). Five of the ten sturgeon captured were from the 2008 cohort, consistent with observations of a strong 2008 cohort in both Gull and Stephens lakes. Recovery of this population without supplementation through stocking appears unlikely given the size of the population and limited recruitment.[13]

Nelson River Juvenile Inventory – Sea Falls to Sugar Falls

In collaboration with the Nelson River Sturgeon Board (NRSB), this study was initiated to evaluate the survival of 20,885 fingerlings (unmarked) and 1,107 yearlings (1,014 marked with PIT tags) stocked into this reach of the Nelson River by the NRSB between 1994 and 2011. A total of 91 unique Lake Sturgeon were captured, of which 67 had PIT tags. Relative recruitment success was estimated to be more than 17 times greater for yearlings than for fingerlings based only on PIT tag recapture data. A high proportion of the non-PIT tagged fish were observed to have growth chronologies consistent with known hatchery fish (i.e. weak or absent first annuli). If these fish are assumed to have been stocked as yearlings, the relative recruitment success of yearlings is estimated at 128 times greater than for fingerlings. Stocking efforts of the NRSB has resulted in the re-establishment of a small juvenile Lake Sturgeon population in this reach of the Nelson River.[14]

Nelson River Bathymetry and Velocity Data Collection-Downstream of Kettle GS

Detailed bathymetry and velocity data were collected immediately downstream of the Kettle GS. These data will be used to develop a hydraulic model for this area. The hydraulic model will then be used to develop a Habitat Suitability Index that will help to evaluate whether existing habitat is suitable for spawning, and to identify areas that may be suitable for future spawning habitat enhancements.

Production of Lake Sturgeon Videos

Two videos were produced to promote the ongoing and collaborative sturgeon stewardship activities of the Nelson River Sturgeon Board (NRSB), Manitoba Conservation and Water Stewardship, and Manitoba Hydro, both of which are posted on YouTube and on the Manitoba Hydro website. The first video features the Board's efforts in monitoring the population in the Nelson River near the Landing River, and the ongoing spawn collection for the purposes of enhancing the population in the upper reaches of the Nelson River.[15] The second video features the role of the hatchery in hatching the eggs and rearing the Lake Sturgeon until they are released back into the Nelson River.[16]

Lake Sturgeon Stewardship & Enhancement Program Document

The Lake Sturgeon Stewardship & Enhancement Program document was updated to provide greater detail on the implementation of recovery measures through the program. The program incorporates an adaptive management approach, and the document outlines specific objectives in a number of categories for the immediate future, the near future, and the long term, all working towards protecting and enhancing Lake Sturgeon populations in Manitoba.[17]

RESEARCH PROJECTS

Research: Evaluation of the Effects of Hormonal Stimulation of Spawning Lake Sturgeon

A unique situation in Manitoba exists in that conservation stocking to enhance Lake Sturgeon populations is occurring in the same areas where the Lake Sturgeon may be subject to human consumption. Due to the difficulty in obtaining females in spawning condition (i.e. ready to release eggs), particularly in areas with depleted populations, the use of hormones to stimulate spawning is often necessary for spawn collection. This study was initiated to evaluate the levels of hormones in adult Lake Sturgeon following administration of Ovaprim™ or gonadotropin releasing hormone to determine whether the hormone levels would cause the fish to be unsafe for human consumption. This study began in 2011 and will be completed in 2013.

Research: Identification, Testing, and Prevalence of Disease in Lake Sturgeon

Over the past 20 years of sturgeon rearing at Grand Rapids Hatchery there have been occasional mortality events. Unfortunately the pathogen causing the disease has never been successfully identified. This research was initiated to classify the virus, develop a test for the presence of the virus, determine the prevalence of the virus in wild populations, and contribute to the development of tools for managing the virus in a hatchery environment. This study began in 2012 and will be completed in 2015.

5.0 REFERENCES

[1]*North/South Consultants Inc. 2008.*
Manitoba Hydro Lake Sturgeon Stewardship & Enhancement Program, Prepared for Manitoba Hydro by North/South Consultants Inc. 14 p.

[2]*Murray, L. and D.S. MacDonell. 2010.*
Pointe du Bois Modernization Project Environmental Studies Program: Lake Sturgeon spawning habitat enhancement project. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 11 p.

[3]*North/South Consultants Inc. 2011.*
Lake Sturgeon spawning habitat enhancement: Construction of spawning shoals in the Pointe du Bois tailrace, Winnipeg River, Manitoba, 2010. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro. 23 p.

[4]*North/South Consultants Inc. 2011.*
Churchill River Lake Sturgeon inventory 2010. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro. 18 p.

[5]*North/South Consultants Inc. 2011.*
Assiniboine River Lake Sturgeon inventory 2010. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro. 10 p.

[6]*Murray, L. and M.A. Gillespie. 2011.*
Lake Sturgeon inventory and habitat assessment-Winnipeg River from McArthur to Pine Falls, 2010. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc. 44 p.

[7]*Murray, L. and D.S. MacDonell. 2012.*
Construction of shoals to enhance Lake Sturgeon spawning habitat in the Winnipeg River at Pointe du Bois: 2011 Monitoring Program. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 24 p.

[8]*McDougall, C. 2011.*
Results of juvenile Lake Sturgeon inventories in the Great Falls and Pine Falls reservoirs – Fall 2011. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 46 p.

[9]*Henderson, L.M. and C.A. McDougall. 2012.*
Lake Sturgeon spawning investigations in the Great Falls and Pine Falls reservoirs – Spring 2011. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 34 p.

[10]*McDougall, C.A. and M.A. Gillespie. 2012.*
Habitat documentation at potential Winnipeg River spawning locations – Fall 2011. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 63 p.

[11]*Cooley, P.M., T.J. Sutton and E. Fishkin. 2012.*
Lake Sturgeon habitat assessment in the Winnipeg River between Seven Sisters Dam and Lac du Bonnet, 2011. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 30 p.

[12]*Lavergne, S.C. 2012.*
Lake Sturgeon Spawning Investigation in the Long Spruce Forebay, Spring 2012. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 27 p.

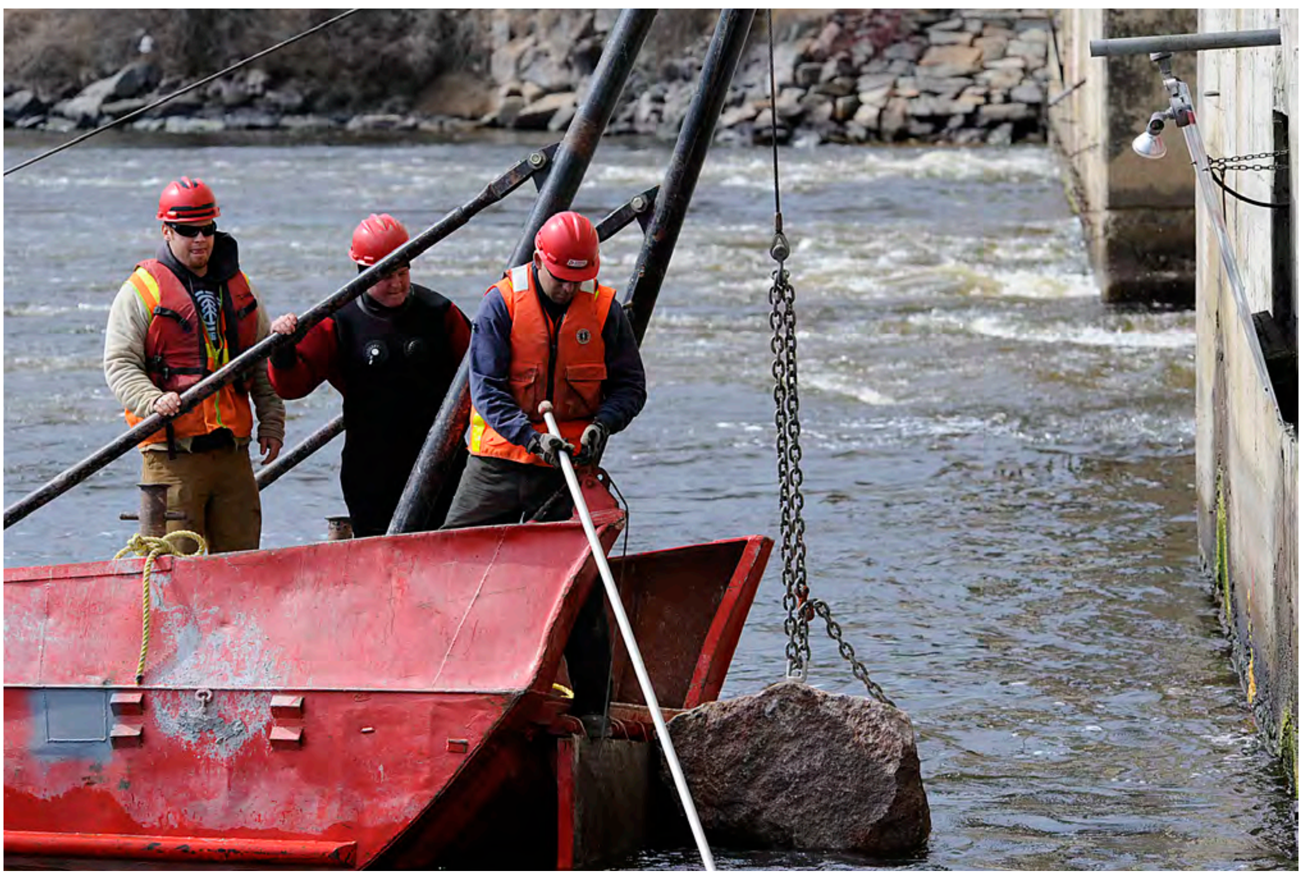
[13]*Lavergne, S.C. and C.C. Barth. 2012.*
Inventory of the Lake Sturgeon population in the Long Spruce forebay, September 2012. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 39 p.

[14]*McDougall, C.A. and D.J. Pisiak. 2012.*
Results of a Lake Sturgeon inventory conducted in the Sea Falls to Sugar Falls reach of the Nelson River – Fall 2012. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants Inc. 46 p.

[15]*Manitoba Hydro. 2012.*
Nelson River Sturgeon Management I. http://www.hydro.mb.ca/environment/projects/fish/index.shtml, Accessed March 2014.

[16]*Manitoba Hydro. 2012.*
Nelson River Sturgeon Management II. http://www.hydro.mb.ca/environment/projects/fish/index.shtml , Accessed March 2014.

[17]*Manitoba Hydro. 2012.*
Manitoba Hydro's Lake Sturgeon Stewardship and Enhancement Program.



A large boulder is placed immediately downstream of the Pointe du Bois Generating Station as part of a spawning habitat enhancemene study.

For more information please contact LakeSturgeon@hydro.mb.ca

Lake Sturgeon Stewardship & Enhancement Program

Annual Report 2013

Manitoba Hydro

The Lake Sturgeon Stewardship & Enhancement Program (LSSEP) was established in 2008 to consolidate Manitoba Hydro's Lake Sturgeon stewardship efforts. The vision of the program is "to maintain and enhance Lake Sturgeon populations in areas affected by Manitoba Hydro's operations, now and in the future." Manitoba Hydro's LSSEP is contributing to Lake Sturgeon conservation in Manitoba by increasing our knowledge of populations, advancing our understanding of local ecology, supporting stocking programs, and initiating research to improve the effectiveness of conservation efforts.

Assiniboine River – near Brandon

Following the extirpation of the natural population, Lake Sturgeon were stocked from 1996-2008, and would now be approaching sexual maturity. A population survey was initiated to determine whether natural reproduction by the stocked fish was occurring. A total of 23 juveniles (427 – 531 mm fork length) and 7 subadults/adults (820 – 1040 mm) were captured in two deeper (2.5 – 6 m) areas just downstream of the Brandon industrial sector during fall. Results indicated that the juvenile sturgeon were likely stocked in the past (i.e. not spawned in the river), and the subadults/adults captured were likely stocked as fingerlings in 1999, 2001 and 2003.[1]

Churchill River – Swallow Rapids to the confluence with the Little Beaver River

The study area included Swallow Rapids downstream for approximately 8 km and 4 km upstream of the confluence with the Little Beaver River. With input from Tataskweyak Cree Nation, habitat mapping (bathymetry and substrate) and an inventory targeting adults was completed. Only four adults were captured and the catch-per-unit-effort indicated that the adult abundance in this reach is low. However, ten juveniles were also captured suggesting that juvenile abundance may be somewhat higher.[2]

Nelson River – Landing River area

This collaborative study with the Nelson River Sturgeon Board (NRSB) confirmed that juvenile Lake Sturgeon from several age classes are moderately abundant in the Nelson River near the Landing River confluence, and present throughout much of the reach from the Sipiwesk Lake outlet downstream towards the Kelsey Generating Station. Erratic recruitment patterns are evident, but all strong year classes link back to years in which stocking was not conducted in the vicinity, substantiating previous suspicions of natural recruitment.[3]

Nelson River – Sea Falls

The NRSB has been stocking Lake Sturgeon into this reach since 1994, in response to the assumed extirpation of sturgeon in this reach of the Nelson River. Expanding on a study completed in 2012[4], a collaborative study with the NRSB was completed to estimate post-stocking survival rates. A total of 152 individual Lake Sturgeon were captured and PIT tags were detected in 122 of these fish. If the fish assumed to have been raised at the hatchery and then released at age-1 (due to weak/absent "first" annuli in fin ray) are incorporated with the fish known to have been released at age-1 (due to presence of PIT tag inserted prior to release), the post stocking survival is estimated to be 80 times greater for age 1 Lake Sturgeon than for age 0. Of the fish susceptible to capture in both the 2012 and 2013 studies, 12% of the PIT tagged fish have now been recaptured in the reach. Based on a conservative population estimate, post stocking survival/retention is estimated at 27%.[5]

Nelson River – Pipestone Lake

As a follow up to the juvenile inventory completed at Sea Falls in 2012[4], this study was a collaboration with NRSB to investigate downstream dispersal of stocked Lake Sturgeon from Sea Falls into Pipestone Lake (20 km downstream of Sea Falls). A total of 55 juvenile Lake Sturgeon were captured, of which 75% were known to have been stocked at Sea Falls based on PIT tags. The lack of inter-reach captures (i.e. same fish captured in both reaches) suggests that downstream dispersal of Lake Sturgeon stocked at Sea Falls (into the Pipestone Lake reach) has likely occurred immediately after stocking. Age-one Lake Sturgeon stocked to date are in robust condition and are growing rapidly in both the Sea Falls and Pipestone reaches.[5]

Development of Habitat Suitability Index Model downstream of Kettle Generating Station

Based on high-resolution bathymetry and velocity data collected in 2012, a hydraulic model for the area immediately downstream of the Kettle Generating Station was developed to predict flow and depths at various flow and operating scenarios. The hydraulic model was then used to develop a Habitat Suitability Index (HSI) to evaluate existing habitat that may be suitable for spawning, and identify areas that may be optimal for spawning habitat enhancements.

Pine Falls Generating Station Fisheries Assessment (not a Lake Sturgeon Stewardship & Enhancement Program study but related to future repairs at the GS)

A fisheries assessment completed immediately downstream of Pine Falls Generating Station on the Winnipeg River captured 54 Lake Sturgeon with relatively little gillnet effort. Most sturgeon were caught in spring (38) of which many were classified as males in spawning condition (22). The presence of juvenile Lake Sturgeon downstream of the generating station was also confirmed.[6]

Field crews check the juvenile Lake Sturgeon for the presence of a PIT (passive integrated transponder) tag that would uniquely identify the fish.

RESEARCH ON LAKE STURGEON SUPPORTED BY MANITOBA HYDRO

Development of a High Resolution Genetics Tool

This study has developed a new high resolution genetics tool using Single Nucleotide Polymorphisms (SNP). The study identified five genetically distinct populations, including Birthday Rapids/Gull Lake, Kelsey/Grass River, Burntwood River, Lower Nelson River (including Lower Limestone Rapids, Angling River, Weir River), and the Hayes River (including the Hayes and Gods rivers). Past mixing is evident in the Kelsey/Grass River population from both the Birthday Rapids/Gull Lake and Burntwood River populations. The study has determined that effective dispersal among the five populations is limited. The new tool will also be used to examine relatedness within populations. The results of this study will be summarized into a report.

Identification, Testing, and Prevalance of the Namao virus

Three tests were developed to detect Namao virus (NV) and other sturgeon viruses. The performance of these tests were validated and one of the tests was used to screen archived tissue and gamete samples collected from wild Lake Sturgeon broodstock and their progeny in Manitoba. A manuscript summarizing these results is currently being drafted. Studies were initiated to establish a causal relationship between NV and disease, establish whether transmission of the virus occurs between individuals, determine which tissues support virus growth and the amount of virus that can grow in different tissues, examine the influence of NV disease on the stress response of juvenile Lake Sturgeon and compare the performance of tests. Prevalence of the virus in tissue samples collected from wild populations of lake sturgeon will be assessed.

Evaluation of the Effects of Hormonal Stimulation of Spawning Lake Sturgeon

Ovaprim® and gonadotropin releasing hormone (GnRH) are used to stimulate the release of eggs in spawning female Lake Sturgeon (and sperm maturation in spawning males). This study has shown that blood and muscle levels of both testosterone and estradiol did not increase significantly in Lake Sturgeon following injection of either Ovaprim® or GnRH, confirming that subsequent human ingestion of Lake Sturgeon will not result in the consumption of excessive amounts of the injected hormones.[7] Based on its similarity to the natural GnRH found in sturgeon and the efficacy of the hormone, the study has recommended the use of GnRH for final maturation in future spawn collections. A research paper reporting sex and stress hormone concentrations, gamete quality and survival following adult release after the process of spawning induction in Lake Sturgeon has been submitted to the Journal of Applied Ichthyology.

Development of an Isotope Tagging Method

This study is evaluating the effectiveness of marking Lake Sturgeon fin rays via short term exposure to natural non-radioactive rare isotopes of ^{138}Barium and ^{86}Strontium. Lake Sturgeon were exposed as eggs (while still in spawning female), newly hatched larvae, and fall fingerlings. Sampling and analyses are ongoing but preliminary results indicate that the ^{86}Strontium isotope was more effective and reliable at leaving an identifiable mark in the fin rays than the ^{138}Barium isotope. Efforts to mark the eggs were less effective for both isotopes. Fin rays from fish that were a maximum of 4 months old have been analyzed, and fin rays have been taken from fish 21 months following immersion in the isotopes are now being prepared for analysis. Fall fingerlings were immersed in either ^{138}Barium or ^{86}Strontium labeled water for 3, 6, or 9 days in September 2013, and in March 2014 these fish will be sampled to determine if the immersion duration influences the persistence of the isotopic mark. Physiological studies are underway to investigate the uptake of strontium into juvenile Lake Sturgeon.

The length of a juvenile Lake Sturgeon is measured in a study designed to evaluate the juvenile Lake Sturgeon population.

PUBLISHED ARTICLES & THESES

Barth, C.C., W.G. Anderson, S.J. Peake, P. Nelson. 2013.
Seasonal variation in the diet of juvenile lake sturgeon, Acipenser fulvescens, in the Winnipeg River, Manitoba, Canada. Journal of Applied Ichthyology 29: 721-729.

Clouthier, S.C., E. VanWalleghem, S. Copeland, C. Klassen, G. Hobbs, O. Nielsen, E.D. Anderson. 2013.
A new species of nucleo-cytoplasmic large DNA virus (NCLDV) associated with mortalities in Manitoba lake sturgeon Acipenser fulvescens. Diseases of Aquatic Organisms 102: 195-209.

McDougall, C.A., P.J. Blanchfield, S.J. Peake, W.G. Anderson. 2013.
Movement patterns and size-class influence entrainment susceptibility of Lake Sturgeon in a small hydroelectric reservoir. Transactions of the American Fisheries Society. 142(6): 1508-1521.

McDougall, C.A., C.L. Hrenchuk, W.G. Anderson, and S.J. Peake. 2013.
The rapid upstream migration of pre-spawn Lake Sturgeon following trap-and-transport over a hydroelectric generating station. North American Journal of Fisheries Management. 33: 1236-1242.

Henderson, L.M. 2013.
Larval drift characteristics, habitat requirements and environmental determinants of year-class strength in wild age-0 Lake Sturgeon, Acipenser fulvescens, within a large impounded river. M.Sc. Thesis. University of New Brunswick, Canadian Rivers Institute, Fredericton, NB. 101 p.

A sturgeon captured in a population assessment study is weighed, measured for length, and tagged prior to release.

FUTURE DIRECTIONS AND PRIORITIES

In the near future, efforts will be directed towards the evaluation of potential locations on the Nelson River for future spawning habitat enhancement. The LSSEP will continue to address existing knowledge gaps on juvenile populations, spawning locations, survival of stocked Lake Sturgeon, habitat availability, and local ecology with the goal of identifying and then addressing the limiting factors for populations. The LSSEP will continue to support spawn camps and the rearing and release of Lake Sturgeon, continue to support ongoing and new research projects, and prepare past research for submission to peer review journals.

A Lake Sturgeon is captured in a gill net during a population assessment study in the Nelson River near the Landing River

5.0 REFERENCES

1. ***Aiken, J.K., M.D. Alperyn and C.A. McDougall. 2013.***
   Results of Assiniboine River Lake Sturgeon investigations, 2013. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc. 46 p.
2. ***Blanchard, M.A., C. Parker and R.A. Remnant. 2014.***
   Results of Lake Sturgeon investigations conducted in the Churchill River between Swallow Rapids and the confluence with the Little Beaver River, June 2013. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc.
3. ***McDougall, C.A. and D.J. Pisiak. 2012.***
   Results of a Lake Sturgeon inventory conducted in the Sea Falls to Sugar Falls reach of the Nelson River – Fall, 2012. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc. 46 p.
4. ***Groening, L.D., J.K. Aiken and C.A. McDougall. 2014.***
   Upper Nelson River juvenile Lake Sturgeon inventories, 2013: the Landing River area. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc. 49 p.
5. ***McDougall, C.A. and D.J. Pisiak. 2014.***
   Upper Nelson River juvenile Lake Sturgeon inventories, 2013: Sea Falls – Sugar Falls and the Pipestone Lake area. A Lake Sturgeon Stewardship and Enhancement Program report prepared for Manitoba Hydro by North/South Consultants, Inc. 84 p.
6. ***Lowdon, M. and L. Queen. 2013.***
   Pine Falls Generating Station Environmental Assessment Fisheries Technical Report. A report prepared for Manitoba Hydro by AAE Tech Services. 209 p.
7. ***Anderson, W.G., J. Genz and C. McDougall. 2013.***
   Using Ovaprim™ as a conservation tool for Lake Sturgeon, Acipenser fulvescens: The short and long term effects of endocrine manipulation during the reproductive cycle. Final report prepared for Manitoba Hydro. 40 p.

Manitoba Hydro

For more information please contact LakeSturgeon@hydro.mb.ca