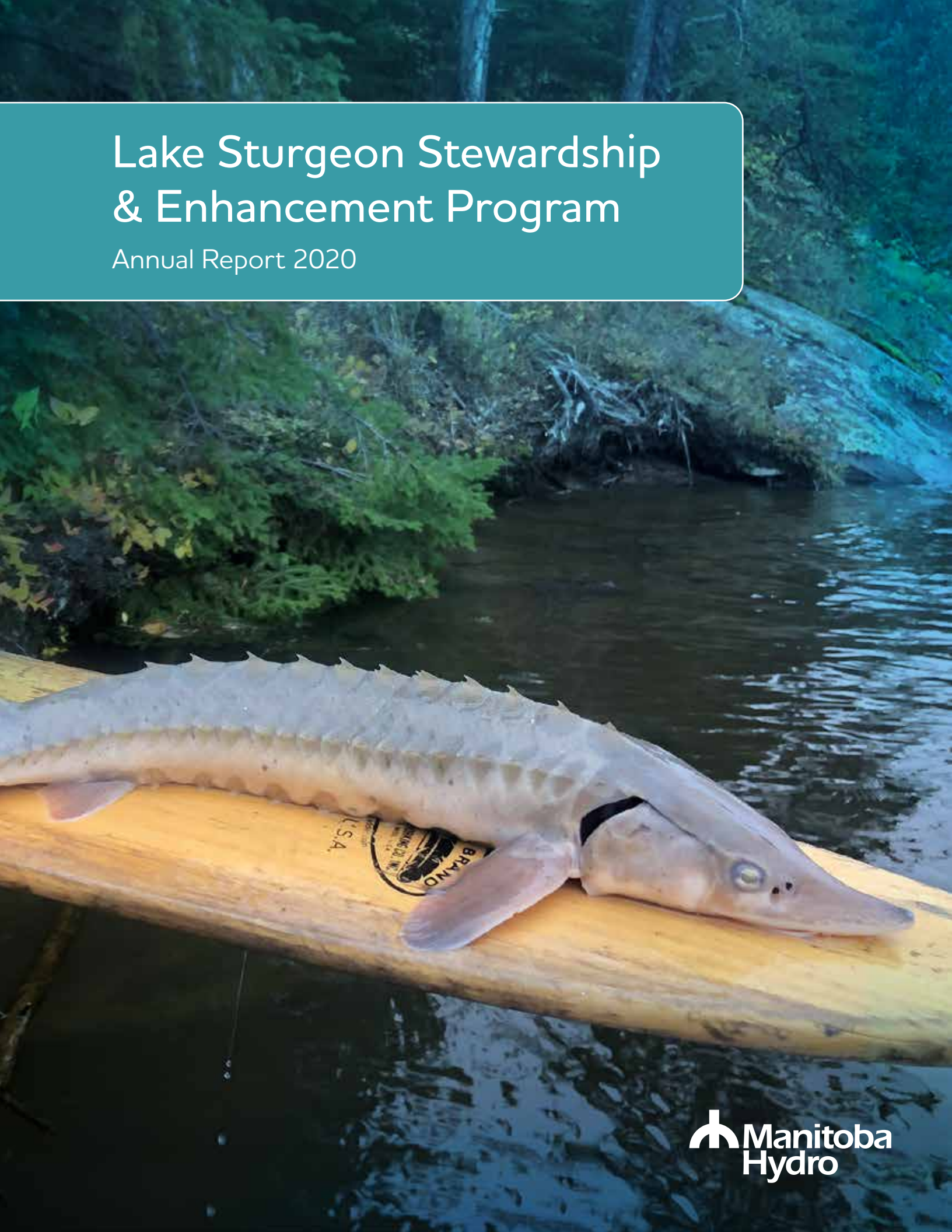
Lake Sturgeon Stewardship & Enhancement Program

Annual Report 2020



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.

LSSEP PROJECTS IN 2019/20

POPULATION INVENTORIES/ESTIMATES

Upper Churchill River Population Survey

To address a lack of data on the Lake Sturgeon population in the upper Churchill River, and in response to anecdotal reports of Lake Sturgeon captures in the area, a population survey was conducted in summer 2019. Areas upstream and downstream of Granville Lake were surveyed using adult and juvenile nets. No Lake Sturgeon were captured after over 1200 hours of gillnetting effort.

Field crews preparing to set nets in Granville Lake

Sea Falls Juvenile Inventory

Historically this reach of the upper Nelson River supported a large population of Lake Sturgeon and was targeted for commercial harvest. By the 1990s, it was believed that Lake Sturgeon were extirpated from reaches of the upper Nelson River including the Sea Falls area. In response to this, the Nelson River Sturgeon Board has stocked Lake Sturgeon since 1994. To evaluate the success of the stocking efforts, juvenile inventory studies completed in the Sea Falls area in previous years (2012–2015, 2017) were repeated in 2019. Large mesh gillnet gangs were also used to target fish >800 mm FL (subadults/adults) which are now expected to be less susceptible to juvenile gangs.

In fall 2019, 317 Lake Sturgeon were captured in juvenile gillnet gangs (Catch Per Unit Effort (CPUE) of 8.1 LKST/100m/24h), and 30 Lake Sturgeon were captured in large mesh gillnet gangs (CPUE of 1.5 LKST/100m/24h). Excluding recaptures, a total of 280 unique individuals were captured. The number of individuals captured was considerably lower than in 2015 (n = 406) and 2016 (n = 473), however; mean CPUE in 2019 was similar to 2015 and 2016 (7.6 and 8.0 LKST/100m/24h, respectively). The apparent stabilization of CPUE following a reduction in stocking numbers (to avoid over contribution by individual family groups) suggests a more sustainable long-term stocking rate for a conservation stocking program. Hatchery PIT tags were detected in 92.3% (260) of individuals captured, and all age-1 cohorts were determined to have grown well since stocking. Over half (58%) of recaptures occurred less than 1 km from the previous capture location, while 21.6% (56) of the 260 hatchery captures in the Sea Falls area had been stocked upstream in Little Playgreen Lake.

This project (completed in collaboration with the Nelson River Sturgeon Board) and continuing monitoring of this population increases our understanding of the survival, growth, dispersal and (as fish mature) eventual spawning of stocked fish, which will allow continued adaptation in the conservation stocking program.

Slave Falls Reservoir Adult Abundance

The first year of a three-year mark-recapture study designed to estimate contemporary adult abundance in the Slave Falls Reservoir on the Winnipeg River was completed in 2019. The Lake Sturgeon population in this reservoir is suspected to have been at or very near carrying capacity for the past decade. Combined with ongoing juvenile monitoring studies, this data should facilitate estimation of Lake Sturgeon biomass and help refine the understanding of Lake Sturgeon carrying capacity in the reservoir.

Large mesh gillnets were set throughout the reservoir (i.e. from the Pointe du Bois to Slave Falls generating stations) in June 2019, resulting in the capture of 382 individual Lake Sturgeon (263 of which were ≥800 mm fork length and considered to be adult size). Overall, CPUE averaged 2.61 Lake Sturgeon/100m/24h, with a mean fork length of 919 mm, weight of 6,673 g and condition factor of 0.76 K. Ages were assigned to 96 fish and ranged from 4–28 years. Year 2 of this three-year program will take place in 2020.

Winnipeg River Lakes Inventory

Due to high water levels in the fall, this program was deferred.

Lake Sturgeon captured during year one of a mark-recapture study in the Slave Falls Reservoir

ADDRESSING INFORMATION GAPS

NSERC-IRC in Lake Sturgeon Conservation Aquaculture

In 2015, Manitoba Hydro partnered with the National Science and Engineering Research Council (NSERC) and Dr. W. Gary Anderson from the University of Manitoba to establish an Industrial Research Chair (IRC) in Lake Sturgeon Conservation Aquaculture. This five year research program is focused on the influence of genetics and early rearing environment on the development of Lake Sturgeon, with the goal of refining hatchery rearing practices to improve the ability of Lake Sturgeon to survive, grow and reproduce after release for stock recovery and enhancement. The program is divided into three Research Areas, with preliminary results to date summarized below.

Research Area 1: Environment by phenotype interactions during early rearing.

This research was built on the premise that the physical and biological environment organisms are reared in will shape how they may respond to challenges later in life. Throughout the program the research found that virtually all measured biological characteristics of Lake Sturgeon were influenced by changes in early rearing environment. Temperature, substrate and pH were all shown to influence growth, metabolism, muscle development, swimming performance, the endocrine stress response and immune response. In 2019, a study of the development of metabolic rate in Lake Sturgeon resulted in the understanding that sturgeon invest all their energy toward growth and development until about 8 weeks of development at which point the fish has the capacity to store energy that may be used for further growth, improved foraging capacity or reserved for survival through the first winter of life. Diet manipulation studies demonstrated enrichment of diet with essential fatty acids improved initial growth rates and had a significant impact on development of metabolic rate, suggesting enhanced survivability of fish fed enriched diets over the first winter of life. A pilot study examined the role of temperature in immune response, with data suggesting a link between the endocrine stress response and cellular immune response in Lake Sturgeon. Collectively the research supports the contention that timing and duration of subtle changes in the environment during early rearing may have long-lasting effects on the fitness of the hatchery reared individuals. The results of this study continue to inform hatchery rearing practices at Grand Rapids Fish Hatchery (GRFH).

Research Area 2: Genotype by environment interactions and effects on phenotypic development.

Work examining the effect of temperature on growth and the ability of fish to respond to acute temperature changes has shown clear population differences between Lake Sturgeon originating from different broodstock (Winnipeg and Nelson rivers) and raised at Grand Rapids Fish Hatchery. The ability of fish to respond to temperature challenges appears to be closely related to the typical thermal history of the population source despite being raised in identical environments. Further examination has shown that cold tolerance is also different between populations. This work will assist the Grand Rapids Fish Hatchery in developing protocols for rearing fish with improved cold tolerance, and better able to acclimate to new temperatures when stocked, resulting in higher survival throughout their first winter at large.

Research Area 3: Development of tools to better determine success of stock enhancement efforts

Initial analysis and development of environmental DNA (eDNA) markers as a method to detect the presence or absence of Lake Sturgeon in the wild is promising and suggests eDNA could be used as an alternative to traditional (capture) sampling methods. Work on determination of elemental signatures and stable isotope batch marking is also ongoing. To date, it has been determined that natural elemental signatures arising from the hatchery water source allow reliable discrimination between wild and hatchery fish. Further development of this technique in combination with water chemistry data from the Coordinated Aquatic Monitoring Program (CAMP) has shown that Lake Sturgeon habitat within the Nelson River can be predicted with up to 70% accuracy from the elemental signatures in their fin rays. Furthermore, research has shown that rearing environment may influence development of hard structures, such as otoliths and fin rays in Lake Sturgeon. Changes in temperature influence the ratio of calcium carbonate crystals in the otolith, which suggests hatchery temperature regimes may impair balance and

hearing in stocked fish. In 2019, the effect of flow on otolith and fin ray development was assessed and found to have no effect on growth or fin-ray length (otolith size and composition yet to be examined).

In Spring 2020, an IRC renewal was awarded, with the following areas of research:

1. Development of palatable diet formulations toward improved growth in the first year of life
2. Using fin ray and otolith elemental signatures to understand habitat use and spawning periodicity in Lake Sturgeon
3. Further development of eDNA assays to identify signatures that can be used to determine spawning events and veracity
4. Assessment of broodstock health and understanding the natural and hatchery ploidy levels in Lake Sturgeon
5. Whole genome sequencing of Lake Sturgeon.

Lake Sturgeon fin ray sections being prepared for laser ablation analysis

Lake Sturgeon eggs incubated at the University of Manitoba

Lake Sturgeon Disease Study

Following symptoms (blisters) observed on sturgeon reared at the Grand Rapids Fish Hatchery, a collaborative research agreement was signed with Dr. Sharon Clouthier (Department of Fisheries and Oceans). The goal of this two-year research project is to describe the virus, determine the probable cause and develop a diagnostic test. To date, the virus has been successfully identified as a herpesvirus. Virus transmission and infection has been observed in cultured Lake Sturgeon gonad tissue, which represents a critical diagnostic tool for detection of this virus.

The virus has been sequenced using Next Generation Sequencing and bioinformatics analysis, and work on developing a diagnostic test is progressing. A combination of human resource changes in 2019 and the global SARS-CoV-2 pandemic in 2020 resulted in unexpected delays to activities scheduled in the second year of the project, resulting in a one-year extension during which additional activities on virus characterization, diagnostic test development and resolution of virus systematics and ecology will take place.

Investigating virus prevalence in wild Lake Sturgeon progeny reared in egg incubation units at the University of Manitoba

Lab equipment used to detect DNA from a novel Lake Sturgeon herpesvirus

Landing River Spawn Induction Trial

To assess the potential to attract spawning Lake Sturgeon to suitable habitat, effluent from pools holding spawning Lake Sturgeon was directed into the Landing River. This tributary to the Nelson River contains suitable spawning habitat historically utilized by a large spawning run. Effluent (river water used to hold fish, along with any secretions from retained Lake Sturgeon) from brood stock holding pools (used for the Nelson River Sturgeon Board's conservation stocking program) on the river bank was directed into the Landing River to qualitatively determine if the use of 'new' spawning habitat could be triggered through olfactory cues. Within an hour after females in the holding pools began releasing eggs, observers on the riverbank observed Lake Sturgeon ascending in the Landing River (multiple sightings from 15:30 on June 1 through 13:00 on June 2; observation was limited to daylight hours). None of the observed fish appeared to possess PIT tags, making it impossible to differentiate individuals, but observers recorded up to three individuals simultaneously. Two of the observed fish ascended a high velocity section of the river to hold in place in a back-eddy immediately downstream of the effluent release point. Further investigation will continue to explore the potential to attract Lake Sturgeon to newly created or restored spawning habitat.

A Lake Sturgeon observed holding position near the effluent outflow in the Landing River

Assiniboine River Angler Engagement

The Lake Sturgeon population in the Assiniboine River was determined to be extirpated prior to 2010, and stocking occurred from 1996–2013. Reports of sturgeon (large and small) being caught by anglers are increasing, leading to speculation that natural recruitment resulting from spawning of stocked fish may be taking place. Previous population inventories have not captured fish young enough to have resulted from natural recruitment. By engaging anglers through social media platforms and fishing forums, the intent of this activity was to determine if age classes younger than those stocked were present (which would trigger a field study). However, effort on this item was stopped after discussion with provincial regulators determined a more appropriate collaborative approach.

Genetics Parentage Assignment

Genotype By Sequencing (GBS) has recently been demonstrated to accurately resolve parentage and sibship in Nelson River Lake Sturgeon (Gosselin et al. 2015). Using this method (and DNA extracted from fin clips), parentage assignment based on Single Nucelotide Polymorphisms (SNPs) was used to assess the origin (hatchery/wild and relatedness between juveniles in Gull and Stephens lakes).

A stocked Lake Sturgeon, recaptured in the future Keeyask Reservoir

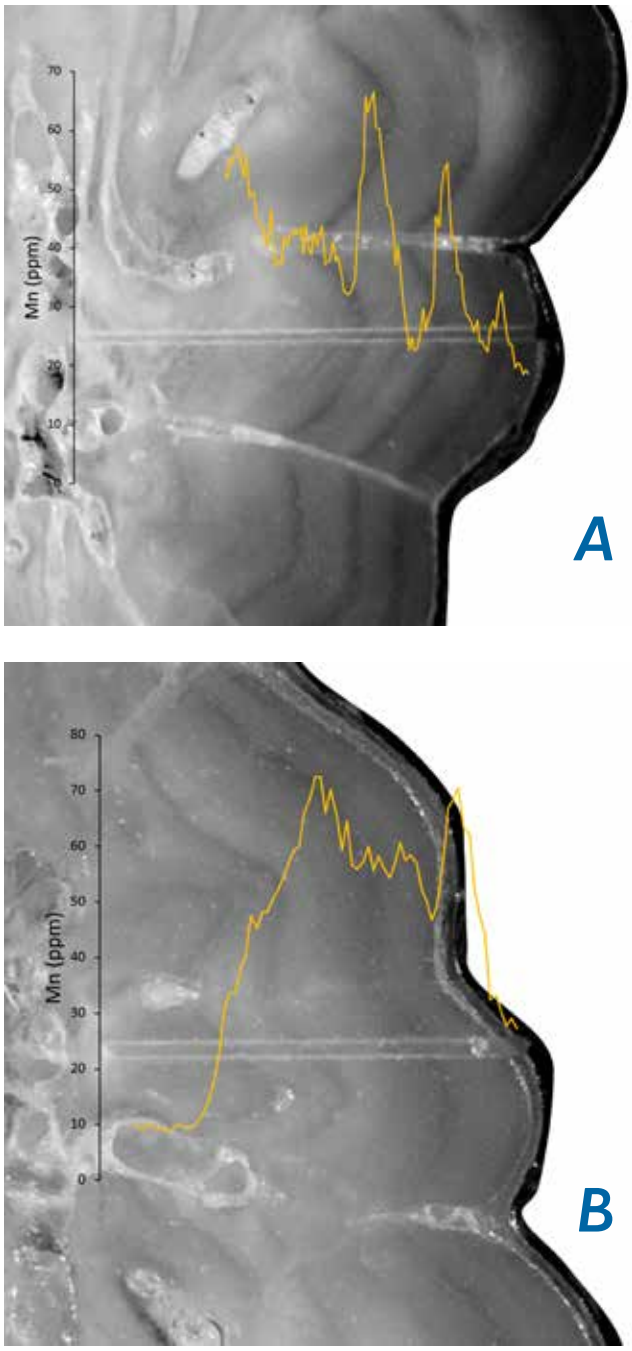
A number of juveniles captured during annual Keeyask monitoring programs were suspected to be hatchery origin (based on aging structures) but were missing hatchery PIT tags. Genetic data from known hatchery fish and brood stock was used to confirm individuals in question as stocked fish with missing or malfunctioning PIT tags.

Genotypes of wild-spawned Lake Sturgeon from the 2015 and 2016 cohorts captured in Gull and Stephens lakes were examined to determine relatedness and assess the likelihood of successful recruitment resulting from spawning in Stephens Lake (as opposed to downstream redistribution of juveniles spawned in Gull Lake). Results strongly suggested approximately 50% of the fish from both the 2015 and 2016 cohorts captured in Stephens Lake were spawned further upstream (likely Gull Lake), while the remaining 50% were unrelated to juveniles in Gull Lake, suggesting they were spawned at the base of Gull Rapids/Keeyask.

Continuing application of these newly developed high-resolution genetic tools provides additional insight into the population structure of the sturgeon population in the Keeyask area, and elsewhere.

Fin Ray Microchemistry

The incorporation of stable isotopes into the hard structures of fish differs depending on the concentration of the elements in the water at the time. Analysis of the concentration of various stable isotopes in specific annuli in Lake Sturgeon fin rays can provide an idea of habitat use, movement and location of specific fish over time. This has been demonstrated to differentiate between stocked and wild Lake Sturgeon with a high degree of accuracy, but the usefulness of this tool in other scenarios has not been fully explored. Under LSSEP, samples from multiple populations were analyzed to assess hatchery origin, as well as the utility of this tool to determine potential use of marine habitat; timing of downstream movements in the Keeyask area; and potential migration in the Churchill/Little Churchill rivers confluence area.



*Manganese concentrations along cross sections of fin-rays from two four year old Lake Sturgeon captured downstream of the Jenpeg Generating Station, allowing determination of wild origin (**A**) and hatchery origin (**B**) fish*

SUPPORT FOR STURGEON BOARDS AND CAMP

Nelson River Sturgeon Board

The Nelson River Sturgeon Board operates a Lake Sturgeon spawn camp annually at Landing River, a tributary of the upper Nelson River. LSSEP provides funding annually to support the cost of hiring Joe Hunter, a sturgeon aquaculture expert from Rainy River, Ontario, who provides advice and improves probability of the successful collection of spawn.

Saskatchewan River Sturgeon Management Board

LSSEP provides annual funding to the Saskatchewan River Sturgeon Management Board (SRSMB). In 2019, the SRSMB completed a fall juvenile sturgeon inventory in the Saskatchewan River between E.B. Campbell Hydroelectric Station and Cedar Lake. LSSEP funding was used for the Manitoba portion of the survey, which was completed over 9 days using consistent standardized methodologies targeting sturgeon less than 800 mm in length. A total of 57 Lake Sturgeon were captured, including 1 recapture. The catch was comprised of 51% juveniles and 49% sub-adults. When considered alongside the increasing catch per unit effort seen in adult inventories over the last 8 years, the results of this years study indicate an actively recruiting population in the Manitoba portion of the Saskatchewan River.

LSSEP funding also covered travel costs for board members from Opaskwayak Cree Nation to participate in SRSMB meetings as well attend and present at the North American Sturgeon and Paddlefish Society (NASPS) Annual Conference held at the Hecla Hotel and Conference Center in September 2019. In addition, Chemawawin Cree Nation and Misipawistik Cree Nation were both invited to join the SRSMB, and participated in the November committee meeting in Prince Albert, SK,

Tag and Data Support

LSSEP funds the tagging (using Passive Integrated Transponder Tags) of Lake Sturgeon captured during annual Fish Community sampling conducted through the Coordinated Aquatic Monitoring Program.

PUBLIC AWARENESS & EDUCATION INITIATIVES

LSSEP maintains a sturgeon aquarium in the Customer Contact Centre at 360 Portage Avenue. The aquarium provides an opportunity for the public to see live Lake Sturgeon and to learn about conservation aquaculture and population recovery efforts throughout Manitoba. LSSEP also continues to place an emphasis on publishing study results that advance the understanding of Lake Sturgeon biology in peer-reviewed literature. In 2019/20, four publications supported by LSSEP were either submitted or in the review process for publication in peer-reviewed journals, while an additional 11 publications resulting from the NSERC-IRC on Lake Sturgeon conservation aquaculture were accepted and published in peer-reviewed journals.

PUBLISHED ARTICLES

Bjornson, F., Earhart, M.L. and Anderson, W.G. (2020).
To feed or flee: early life history behavioural strategies of juvenile Lake Sturgeon (*Acipenser fulvescens*) during risk-sensitive foraging. *Can. J. Zool.* **98**, 541–550; https://doi.org/10.1139/cjz-2019-0181

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Effect of acclimation temperature on the thermal physiology in two geographically distinct populations of Age-0 Lake Sturgeon (*Acipenser fulvescens*). *Con. Physiol.* (accepted).

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Texture Analysis of Polycrystalline Vaterite Spherulites from Lake Sturgeon Otoliths. *Sci. Rep.* **9**, 7151; https://doi.org/10.1038/s41598-019-43434-w

Earhart, M.L., Ali, J.L., Bugg, W.S., Jeffries, K.M. and Anderson, W.G. (2020)
Endogenous cortisol production and its relationship with feeding transitions in larval Lake Sturgeon (*Acipenser fulvescens*) *Comp. Biochem. Physiol.* (accepted)

Earhart, M.L., Bugg, W.S., Wiwchar, C., Kroeker, J., Jeffries, K.M. and Anderson, W.G. (2020).
Shaken, rattled and rolled: The effects of hatchery-rearing techniques on endogenous cortisol production, stress-related gene expression, growth and survival in larval Lake Sturgeon, *Acipenser fulvescens*. *Aquacult.* **522**, 735116; https://doi.org/10.1016/j.aquaculture.2020.735116

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Identification of hatchery-reared Lake Sturgeon, *Acipenser fulvescens*, using natural elemental signatures and stable isotope marking of fin rays. *N. Am. J. Fish. Man.* **40**, 61–74; https://doi.org/10.1002/nafm.10372

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Yoon, G.R., Deslauriers, D. and Anderson W.G. (2020).
Influence of prey condition and incubation method on mortality, growth and metabolic rate during early life history in lake sturgeon, *Acipenser fulvescens*. *J. Appld. Ichthyol.* (In revision)

Yoon, G.R., Bjornson, F., Deslauriers, D. and Anderson (2020).
Comparison of Methods to Quantify the Relationship between Metabolic Rate and Body Activity in Larval Lake Sturgeon (*Acipenser fulvescens*). *J. Fish. Biol.* (in revision)

Yusishen, M.E., Yoon, G.R., Bugg, W., Jeffries, K.M., Currie, S. and Anderson, W.G. (2020).
Love thy neighbour: Social buffering following exposure to an acute thermal stressor in a gregarious fish, the lake sturgeon (*Acipenser fulvescens*). *Comp. Biochem. Physiol.* **243A**, 110686; https://doi.org/10.1016/j.cbpa.2020.110686

Yoon, G.R., Deslauriers, D. and Anderson W.G. (2019).
Influence of a dynamic rearing environment on development of metabolic phenotypes in age-0 Lake Sturgeon, *Acipenser fulvescens*. *Con. Physiol.* **7**, coz055; https://doi.org/10.1093/conphys/coz055

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Gosselin, T., P.A. Nelson, C.A. McDougall, and L. Bernatchez. (2015, December 15).
Population Genomics of Lake Sturgeon (*Acipenser fulvescens*) in the Churchill, Hayes, and Nelson Rivers. A draft report prepared for Manitoba Hydro by Université Laval and North/South Consultants Inc. Zenodo. http://doi.org/10.5281/zenodo.845491

Manitoba Hydro

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Available in accessible formats upon request.