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International Joint Commission – International Watershed Initiative Project

Red River Telemetry Study

2018/19 Final Report

by

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Summary

The "Red River Telemetry Study" is funded by the International Joint Commission (IJC) to investigate inter-boundary movements of Bigmouth Buffalo (*Ictiobus cyprinellus*) and Channel Catfish (*Ictalurus punctatus*) in the Red River. The funding provided in 2016 by the IJC to Fisheries and Oceans Canada (DFO) was used purchase acoustic telemetry equipment. The equipment was deployed in the 2017 field season in the US portion of the Red River from the international border to Fargo, North Dakota. Eighteen receivers were installed in the Red River and twenty Bigmouth Buffalo and forty Channel Catfish were tagged by the US partners Dr. Mark Pegg from University of Nebraska - Lincoln and his lab, Jamison Wendel from the Minnesota Department of Natural Resources, and Todd Caspers from the North Dakota Game and Fish Department.

The funding received from IJC to DFO in 2017 and 2018 partially supported a DFO staff member responsible for data management and analysis of the telemetry data. A database was developed that encompasses all data collected in the frame of the larger "Lake Winnipeg Basin Fish Movement Project" that comprises the "Red River Telemetry Study". The database contains information on all tagged fish as well as all fish detections recorded since 2016. In addition R scripts have been developed to facilitate the data analysis, in particular we developed code to display the fish movement spatially on maps, to investigate spatial-temporal migration patterns, home ranges, spawning site fidelity as well as to summarize individual fish movement patterns using Gant charts. Currently, we are working on methodologies to assess fish mortality from the detections of the receiver network.

Study results were presented at various national and international symposia and conferences. This is the final report for the first three years of the study, however, the IJC will continue to support "Red River Telemetry Study" for another three years.

Date: 18 March 2019

1 Lake Winnipeg Basin Fish Movement Project

1.1 Background

Fisheries and Oceans Canada in collaboration with several partner organizations, including Manitoba Sustainable Development, Lake Winnipeg Foundation, University of Nebraska – Lincoln, University of Manitoba, Lakehead University, Minnesota Department of Natural Resources, and North Dakota Game and Fish Department, is conducting a large-scale, long-term telemetry project in the Lake Winnipeg basin.

The aim of the project is to answer several state, provincial, and federal stakeholder questions by collecting information and gaining knowledge on fish movement. For example, for the:

(1) **International Red River Board (IRRB) part of the International Joint Commission (IJC)**: to make recommendations for water apportionment in the Red River by answering questions on Instream Flow Needs for fish movement and habitat.

(2) **Department of Natural Resources Minnesota, North Dakota Game and Fish Department, and Manitoba Sustainable Development**:

(a) To improve fishery management objectives and provide key information on transboundary fish movements and habitat use. In addition, habitat maps developed in the frame of this project are providing valuable input information for the provincial Zebra Mussel (*Dreissena polymorpha*) assessment.

(b) To obtain information on river connectivity in the Red River and the use of tributaries; much effort has been made to restore connectivity to many tributaries but some fish barriers still remain. This research provides critical information regarding the use of tributaries by these large river fish species.

(c) To improve restoration efforts of Lake Sturgeon (*Acipenser fulvescens*) in the Red River basin. Until now, the agencies were relying on anecdotal information, such as angler reports, to obtain basic distribution and movement information. This research advances our knowledge of Lake Sturgeon in the Red River basin and guides restoration efforts.

(3) **US Army Corps of Engineers**: to provide baseline data prior to the construction of the Fargo Floodway.

(4) **Fisheries and Oceans Canada's Species-at-Risk (SAR) program**: to protect and preserve species at risk. In particular, findings on fish movement and habitat use contribute to the recovery strategy of Mapleleaf mussel (*Quadrula quadrula*) by studying its host, the Channel Catfish and to the management plan for Bigmouth Buffalo. This research will

also help to inform SAR managers when a listing decision needs to be made for Lake Sturgeon.

(5) **Fisheries and Oceans Canada's Aquatic Invasive Species (AIS) program**: to manage impacts of invasive species such as Zebra Mussel and Common Carp (*Cyprinus carpio*) on the aquatic ecosystem.

(a) The project provided a unique short window of opportunity, to sample baseline habitat before the full establishment of Zebra Mussel in Lake Winnipeg.

(b) Common Carp is thought to disturb the ability of one of Canada's largest wetlands, the Netley-Libau Marsh, situated on the outflow of the Red River into Lake Winnipeg, to remove nutrients from the watershed. In Delta Marsh, located in the southern end of Lake Manitoba, Common Carp destroy submerged vegetation and, with it, critical marsh habitat. Outcomes of this study are to establish the habitat use of Common Carp in the Netley-Libau Marsh and help determine potential impacts on the ability of this valuable marsh habitat to buffer nutrient inputs in Lake Winnipeg.

(6) **Fisheries and Oceans Canada's Fisheries Protection program (FPP)**: to gain valuable insight on:

(a) Fish passage requirements in the Lake Winnipeg basin.

(b) The efficiency of existing fish passage structures (e.g., fishway at St. Andrews Lock and Dam on the Red River at Lockport, Manitoba).

1.2 Red River Telemetry Study

Through the International Red River Board, the Aquatic Ecosystem Committee submitted a project proposal to the International Watershed Initiative (IWI) for funding from IJC to extend the Lake Winnipeg Basin Fish Movement Project into the United States (US) by installing receivers every 30 river km (rkm) upstream of the international border until Fargo, North Dakota and tag fish in the US portion of the Red River.

The collected information on habitat use and fish movement are valuable input information for Instream Flow Needs predictions of the Hydrological Committee of the International Red River Board and provide detailed information on fish movement, spawning sites and timing, and overwintering areas. Additionally, we increase our understanding of the population structure and movement of fish in the Red River between the US and Canada.

2 Achievements of the 2018/19 field season

2.1 Receiver deployment

Overall 247 Vemco VR2W receivers (Figure 1) were deployed in the Lake Winnipeg basin in 2018 (Figure 2). The acoustic receivers were installed in the Red River up to the US border, the Assiniboine River upstream to the Portage Diversion Dam, and the Winnipeg River upstream to the Pine Falls Generating Station (Table 1). In the rivers, distances between receivers varied between 5 and 30 river rkm depending on river reach. In the lake, the receivers were installed on a grid design varying between 5 km in the southern part of the south basin and 7 km for the rest of the south basin and narrows, and 14 km in the southern part of the north basin. Currently, a total of 860 rkm in Red, Assiniboine, and Winnipeg rivers and an area of ~9,000 km^2 in Lake Winnipeg are monitored by receivers.

Figure 1: Acoustic receiver setup.

Table 1: Numbers of receivers deployed at different locations throughout the Lake Winnipeg basin in 2016, 2017, and 2018, respectively.

Location	2016	2017-2018
Assiniboine River	6	4
Cooks Creek	1	1
Dauphin River	0	1
Devils Creek	1	1
La Salle River	1	1
Lake Winnipeg	69	130
Manigotagan River	1	1
Red River	30	32
Red River - USA	3	18
Rivière Aux Rats	0	1
Roseau River	0	1
Saskatchewan River	0	1
Seine River	1	1

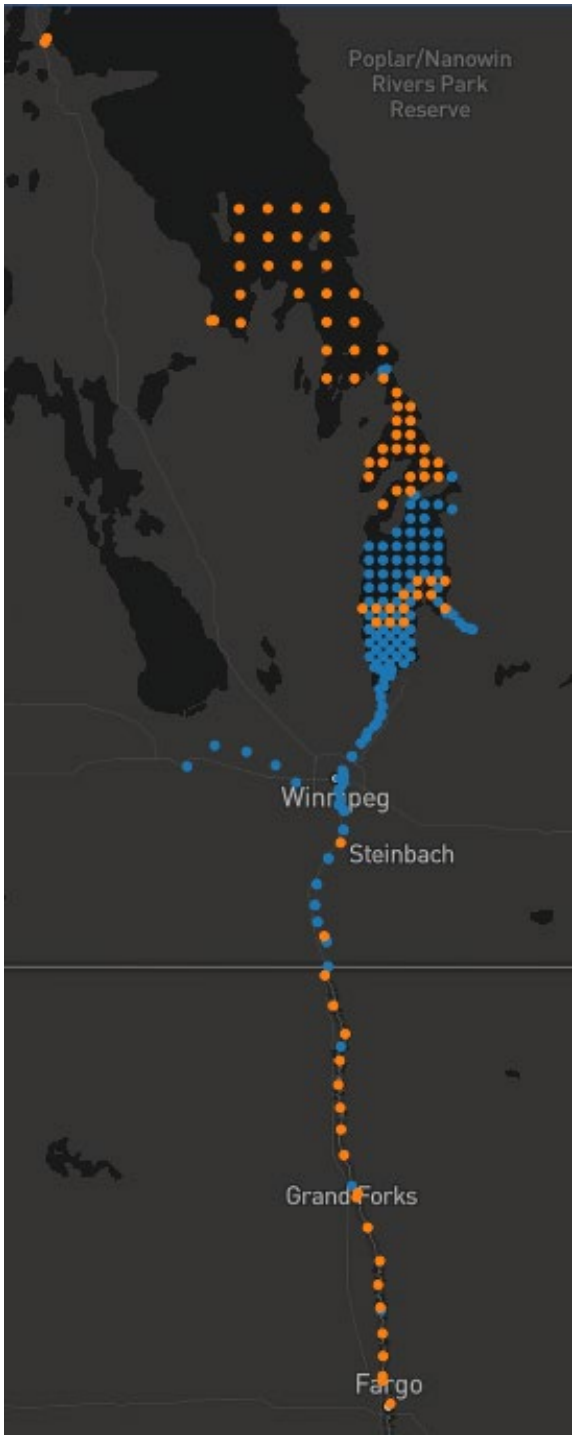

Figure 2: Receiver locations in the Lake Winnipeg basin. Receivers installed in 2016 are indicated in orange and in 2017 in blue.

2.2 Fish tagging

For the acoustic telemetry study, fish were caught using different methodologies:
Bigmouth Buffalo, Common Carp, Freshwater Drum, and Walleye (*Sander vitreus*) were captured by boat electrofishing. Channel Catfish and Burbot were angled. Lake Sturgeon were caught using multi-panel multifilament gill nets with large mesh size.

Upon capture, fish were placed in holding tanks filled with ambient water. Captured fish were measured and weighed immediately and undersized individuals (>2% tag:body weight ratio; >1.2 kg) released. Vemco V16-4H acoustic transmitters (16 mm diameter, 6½ years battery life) or V13 (13 mm diameter, 2.3 years battery life), depending on individual fish body mass, were implanted in the body cavity of the fish (Figure 3).

Figure 3: Vemco V16-4H acoustic transmitter used in telemetry study.

A small fin clip was taken for genetic testing of all fish before they were released to be used in a population genetics study.

In 2016, a total of 244 fish were tagged (Table 2), of these 40 were Bigmouth Buffalo (20 in the La Salle River and 20 in the Seine River), 121 Channel Catfish (67 in the Lower Red River, 24 in the Upper Red River, 30 in the Winnipeg River), 40 Common Carp (20 in the Netley Marsh and 20 in the Libau Marsh), 43 Lake Sturgeon (42 in the Winnipeg River and 1 in the Red River).

In 2017, an additional 40 Bigmouth Buffalo (40 in the Lower Red River and 40 in the US portion of the Red River), 40 Channel Catfish (tagged in the US portion of the Red River), 2 Lake Sturgeon (Lower Red River), and 204 Walleye in Lake Winnipeg were tagged. Further, two Lake Sturgeon joined the study site from an ongoing telemetry study of hatchery reared and released Lake Sturgeon in the upstream portion of the Assiniboine River.

In 2018, 80 Freshwater Drum (40 in the Lower Red River and 40 in the Dauphin River) and 153 Walleye (30 in the Lower Red River, 41 at Sandy Bar in Lake Winnipeg, 41 in the Dauphin River, 41 at Matheson in Lake Winnipeg. Finally, in 2019, 15 Burbot were tagged in the Winnipeg River.

Table 2: Number of tagged fish per species and location in 2016-2019, respectively.

Species	Year	Site	Number	Total
Bigmouth Buffalo	2016	La Salle River	20	**80**
	2016	Seine River	20	
	2017	Red River	20	
	2017	Red River - USA	20	
Channel Catfish	2016	Red River	91	**161**
	2016	Winnipeg River	30	
	2017	Red River - USA	40	
Common Carp	2016	Libau Marsh	20	**40**
	2016	Netley Marsh	20	
Lake Sturgeon	2016,2017	Red River	1, 2	**44**
	2016	Winnipeg River	41	
Walleye	2017,2018	Red River	110, 30	**357**
	2017, 2018	Sandy Bar	60, 41	
	2017, 2018	Dauphin River	18, 41	
	2017, 2018	Matheson	10, 41	
	2017	Winnipeg River	6	
Freshwater Drum	2018	Red River	40	**81**
	2018	Dauphin River	40	
Burbot	2019	Winnipeg River	15	**15**

2.3 Reference tags

To determine probability of detecting a fish, seven references tags are deployed in Lake Winnipeg and four reference tags are deployed in the Red River. The reference tag line in Lake Winnipeg has a spacing of 300 m and extends to 2.1 km.

2.4 Receiver download

Data is downloaded annually and the receivers are refurbished with new batteries at the same time.

2.5 Data analysis

We developed R-code for creating a SQLite database for the establishment of a relational database of all telemetry data acquired in the frame of the Lake Winnipeg Basin Fish Movement Project. Furthermore, we developed code to display the fish movement spatially on maps, to investigate spatial-temporal migration patterns, home ranges, spawning site fidelity as well as to summarize the individual fish movement patterns using Gant charts. Currently, we are working on methodologies to assess fish mortality given the fish detections on the receiver network.

3 Results

3.1 Fish movement and distribution per species

3.1.1 Bigmouth Buffalo

Bigmouth Buffalo in the Red River moved extensively. The maximum movement for a single fish was 621.9 km in a year and the minimum movement 4.2 km. The average movement observed in 2016 for Bigmouth Buffalo was 176.2 km, 131.5 km in 2017, and 150.9 km in 2018 (Figure 4). Fish were predominately moving between receivers in the open water season between April to October (Figure 5).

3.1.2 Channel Catfish

In comparison to Bigmouth Buffalo, Channel Catfish moved less in the river (Figure 4). The maximum movement for a single fish was 277.0 km and the minimum movement 4.9 km. In all years, Channel Catfish had significantly smaller home ranges than Bigmouth Buffalo (2016: mean 32.7 km *vs* 177.5 km, $p < 0.001$; 2017: mean 91.0 km *vs* 132.6 km, $p = 0.03$; 2018: mean 60.0 km *vs* 150.9 km, $p < 0.01$, Figure 4).

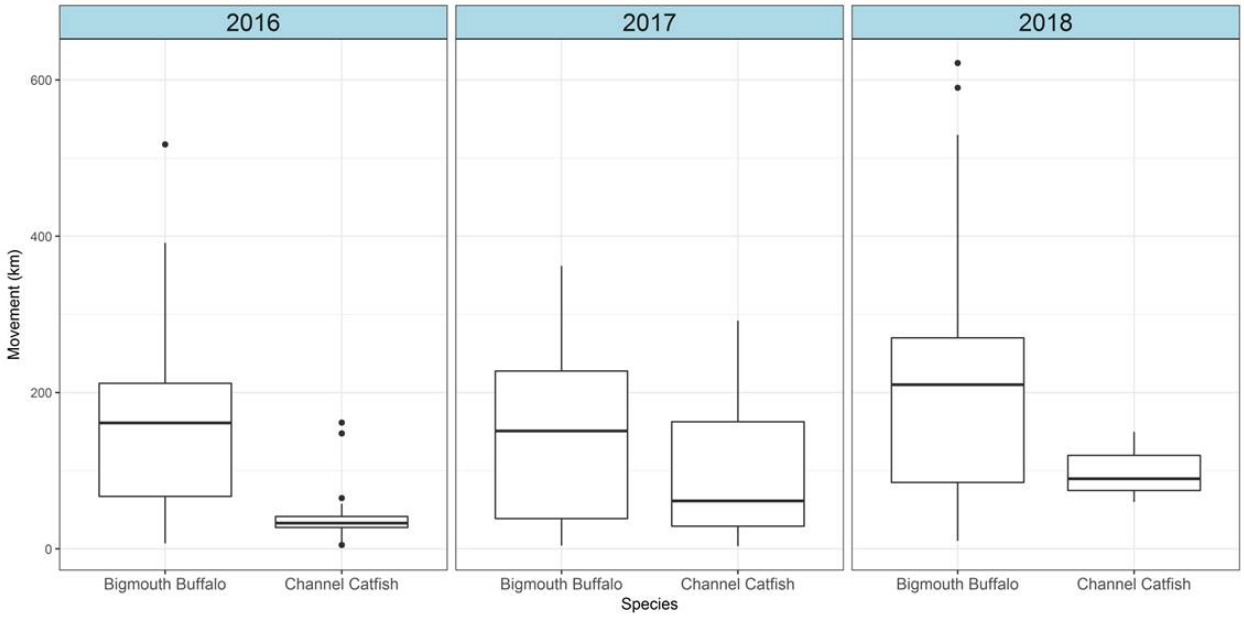

Figure 4: Box-Whisker plots on the interspecific river movement (in km) comparing movements of Bigmouth Buffalo and Channel Catfish in river habitat between years, respectively.

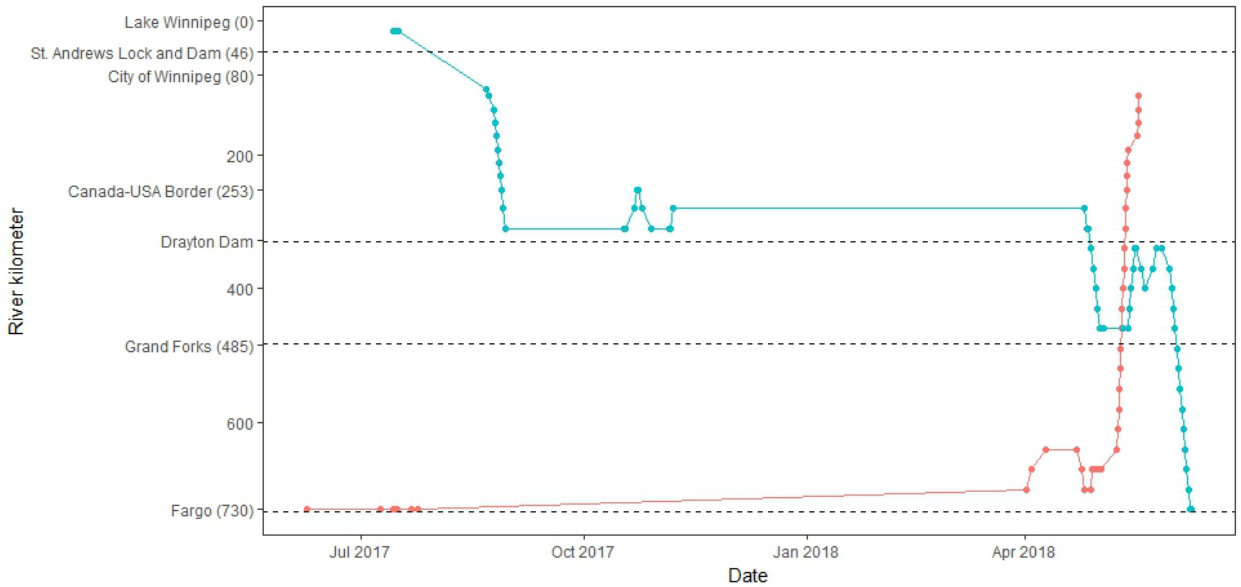

Figure 5: Examples of seasonal variations in fish movement patterns for Bigmouth Buffalo in the river habitat.

3.2 Habitat fragmentation

In 2016, nine of the tagged Bigmouth Buffalo moved upstream over the Drayton Dam, while no Channel Catfish was detected moving upstream over the weir (Table 3). In the following year, a total of twelve Bigmouth Buffalo and 17 Channel Catfish were observed to pass upstream over the Drayton Dam. In 2018, Bigmouth Buffalo completed 13 upstream movements and no Channel Catfish was observed. Downstream passage over the Drayton Dam has been observed in 2017 (n = 4 Bigmouth Buffalo and n = 2 Channel Catfish) and 2018 (n = 13 Bigmouth Buffalo). Interestingly, both up and downstream movements over the weir at the Drayton Dam for both species appear to occur during peak flows or descending hydrographs.

Fewer fish passages were observed at the St. Andrews Lock and Dam; three Bigmouth Buffalo passed upstream over the dam in 2017 and one in 2018. Upstream passage for Channel Catfish was not observed. One single downstream passage of Bigmouth Buffalo was detected in 2016 over the dam, four in 2017 and one in 2018 whereas five Channel Catfish passed downstream in 2016 and three in 2017. Similar to the movement patterns observed in Drayton, up- and downstream passage at the St. Andrew Lock and Dam appears also to be associated with peak and descending hydrographs in the open water season.

The Portage Diversion Dam is impassable for upstream fish migration. Tag detections from the receiver closest to the Portage Diversion Dam suggest that the dam blocked the upstream movement of three Bigmouth Buffalo in 2016 (n = 2) and 2017 (n = 1). The individuals remained below the diversion structure up to four months in the summer before returning into the Red River.

The Pine Falls Hydroelectric Station does not provide upstream passage. Tag detections revealed that Channel Catfish tagged in the Lower Winnipeg River moved upstream towards the Pine Falls Hydroelectric Station in each study year. In 2016, 2017, and 2018, 27, six, and one, respectively, of the 30 tagged Channel Catfish that were tagged in the Lower Winnipeg River moved up to the Pine Falls Hydroelectric Station where further upstream movement was impeded by the dam.

Table 3: Number per fish species and year of up- and downstream passage over the St. Andrews Lock and Dam, Drayton Dam, and Riverside Dam and number of fish present downstream (Downstream Presence) of the Portage Diversion Dam and the Pine Falls Hydroelectric Station that are impassable for upstream migrating fish.

Barrier	Passage/Presence	Bigmouth Buffalo			Channel Catfish		
		2016	2017	2018	2016	2017	2018
St. Andrews Locks and Dam	Upstream passage	0	3	1	0	0	0
	Downstream passage	1	4	1	5	3	0
Drayton Dam	Upstream passage	9	12	13	0	17	0
	Downstream passage	0	4	13	0	2	0
Riverside Dam	Upstream passage	1	0	3	0	0	0
	Downstream passage	0	0	4	0	1	0
Portage Diversion	Downstream presence	2	1	0	0	0	0
Pine Falls Station	Downstream presence	0	0	0	27	6	1

4 Plan for the 2019/20 field season

4.1 Fish tagging

In 2019 field season, we foresee tagging an additional 20 Common Carp in the Netley-Libau Marsh. Fish will be caught by boat electrofishing and tagged with a V16 acoustic transmitter.

4.2 Receiver download

The acoustic receivers have a battery life of 15 months. We will start the receiver downloads mid to late May 2019, weather permitting. The Red River is likely to flood in spring 2019, which may delay river downloads. The receivers will be refurbished with new batteries at the same time.

4.3 Data management, data quality assurance, and data analysis

For 2019/20, the Red River Telemetry Study will receive $25K for a biologist salary needed to coordinate fish tagging, receiver deployments and downloads, and the data management, quality assurance of the data, and data analysis.

4.4 Habitat mapping

A bathymetry and substrate project funded by Environment and Climate Change Canada (ECCC)'s Lake Winnipeg Basin Program, began in 2017 in the south basin of Lake Winnipeg using a BioSonics MX Aquatic Habitat Echosounder. The collected data comprises bathymetry, and substrate composition along a predetermined transect plan (~7 km grid) and at 3 and 6 m contour lines. The BioSonics MX automatically geo-references the data collected. Substrate classes (rock, sand, mud, etc.) are identified. Habitat maps are created in Bionic Visual Habitat software and the substrate types identified by the software are ground-truthed using Ponar grabs.

Annex I - Project partners

Fisheries and Oceans Canada
Doug Watkinson, Colin Charles, Doug Leroux, Colin Kovachik, Tyana Rudolfsen, Paul Blanchfield, Eva Enders

Manitoba Sustainable Development
Geoff Klein, Derek Kroeker, Jeff Long, Kevin Casper, Darcy Pisiak

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Todd Caspers

University of Manitoba
Jason Treberg, Kenneth Jeffries, Darren Gillis, Saman Muthukumarana, Jenn Jeffry, Inesh Prabuddha, Lilian Wiens, Matt Thorstensen

Annex II – Theses, Publications, and Presentations to date

Thesis:

Hansen, H (2019) Implications of Channel Catfish Movement in An Internationally Managed System. M.S. thesis, University of Nebraska-Lincoln. http://digitalcommons.unl.edu/natresdiss/279/

Publications:

Kraus, R, C Holbrook, C Vandergoot, T Stewart, M Faust, DA Watkinson, C Charles, M Pegg, EC Enders, and C Krueger (2018) Evaluation of acoustic telemetry grids for determining aquatic animal movement and survival. *Methods in Ecology and Evolution* 9 (6): 1489-1502. https://doi.org/10.1111/2041-210X.12996

Enders, EC., C Charles, AL Caskenette, TA Rudolfsen, and DA Watkinson (accepted) Distribution patterns of the early invasion of zebra mussels (*Dreissena polymorpha*) in the south basin of Lake Winnipeg. *BioInvasions Records*.

Enders, EC, C Charles, DA Watkinson, C Kovachik, DR Leroux, H Hansen, and MA Pegg (submitted) Identifying requirements for fish passage at dams and weirs using a large-scale acoustic receiver network. *Sustainability*.

Presentations:

Charles, C, DA Watkinson, and EC Enders (2018) Quantifying system performance in a large acoustic telemetry array in Lake Winnipeg and its applications for future research. *Annual Meeting of the Great Lakes Acoustic Telemetry Observation System (GLATOS)*, Ann Arbor, MI, USA.

Enders, EC, DA Watkinson, C Charles, and MA Pegg, (2018) Identifying requirements for fish passage at dams and weirs using a large-scale hydroacoustic receiver network. *International Symposium of Ecohydraulics*, Tokyo, Japan.

Enders, EC, DA Watkinson, C Charles, MA Pegg, J Wendel, and T Caspers (2018) Red River Telemetry Study – An Aperçu. *Annual Meeting of the International Red River Board Commission*, Winnipeg, MB, Canada.

Gaudry, MJ, KM Jeffries, EC Enders, DA Watkinson, C Charles, C Kovachik, DR Leroux, DM Gillis, and JR Treberg (2018) Development of a relative telomere length assay for Walleye (*Sander vitreus*) Blood: Comparison across a Large Lake Ecosystem(poster) *Annual Meeting of the Canadian Society of Zoologists*, St. John's, NL, Canada.

Jeffrey, JD, MJ Gaudry, EC Enders, KM Jeffries, and JR Treberg (2019) Assessing the physiological status of Walleye (*Sander vitreus*) across two contexts in Manitoba. *Canadian Conference for Fisheries Research*, London, ON, Canada.

Jeffries, KM, EC Enders, DA Watkinson, C Charles, C Kovachik, DR Leroux, MJ Gaudry, DM Gillis, and JR Treberg (2018) Integrating molecular indices with ecosystem-wide movement in Walleye in large lake ecosystems (poster). *Annual Meeting of the Canadian Society of Zoologists*, St. John's, NL, Canada.

Jeffries, KM, MJ Thorstensen, JD Jeffrey, DA Watkinson, EC Enders, and JR Treberg (2019) Integrating molecular and metabolic indices with Walleye movement patterns in Lake Winnipeg, *Canadian Conference for Fisheries Research*, London, ON, Canada.

Munaweera, I, S Muthukumarana, DM Gillis, DA Watkinson, and C Charles (2019) Assessing Lake Winnipeg Basin walleye fish movement patterns (poster) *Canadian Conference for Fisheries Research*, London, ON, Canada.

Rudolfsen, T, DA Watkinson, C Charles C Kovachik, and EC Enders (2019) Substrate mapping of Lake Winnipeg. *Great Plains Fishery Workers Association Meeting*. Lethbridge, AB, Canada.

Turner, N, M Rennie, EC Enders, DA Watkinson, G Klein, and C Charles (2019) Walleye (*Sander viterus*) movement ecology in Lake Winnipeg, Canada: past and present (poster) *Canadian Conference for Fisheries Research*, London, ON, Canada.

Watkinson, DA, C Charles, C Kovachik, DR Leroux, MA Pegg, H Hansen, G Klein, KM Jefferies, JR Treberg, DM Gillis, P Blanchfield, J Wendel, M Stainton, M Rennie, and EC Enders (2018) Lake Winnipeg Fish Movement Project. *Annual Meeting of the Great Lakes Acoustic Telemetry Observation System (GLATOS)*, Ann Arbor, MI, USA.

Watkinson, DA, C Charles, C Kovachik, DR Leroux, MA Pegg, H Hansen, G Klein, KM Jefferies, JR Treberg, DM Gillis, P Blanchfield, J Wendel, M Stainton, M Rennie, and EC Enders (2018) Lake Winnipeg Fish Movement Project. *Lake Winnipeg Research Consortium Science Workshop*, Winnipeg, MB, Canada.

Wiens, LM; JD Jeffrey, EC Enders, KM Jeffries, and JR Treberg (2019) Metabolic profiling of Walleye (*Sander vitreus*) blood from the Lake Winnipeg basin suggests regional differences in nutritional status (poster) *Canadian Conference for Fisheries Research*, London, ON, Canada.

News stories:

Researchers wire up Grand Forks catfish by Brad Dokken in the Grand Forks Herald on May 26, 2017 https://www.grandforksherald.com/sports/outdoors/4273737-researchers-wire-grand-forks-catfish

Fish tags help inform managers of spawning sites and fish passage in Red River by Kevin Bunch in Watter Matters on August 21, 2018 https://www.ijc.org/en/fish-tags-help-inform-managers-spawning-sites-and-fish-passage-red-river

Lake Winnipeg, Red River, and the Freshwater Institute by Lawrence Guenther on Blue Fish Radio on October 5, 2018 https://player.fm/series/the-blue-fish-radio-show/winnipeg-lake-red-river-and-the-freshwater-institute

Tagging and telemetry research begins to shed light on Red River catfish travels by Brad Dokken in the Grand Forks Herald on March 3, 2019 https://www.grandforksherald.com/sports/outdoors/4578668-tagging-and-telemetry-research-begins-shed-light-red-river-catfish-travels

Annex III – Lessons learned

A project can teach many valuable lessons about the applied process and tasks and the team. These insights can then be used to make changes to process and task if needed or to set best practice for future projects, increase efficiencies, work better as a research team, improve communication, and tasks if deemed required. Here, we highlight lessons learned from the Red River Telemetry Study.

Lessons Learned Report:

In general, this binational, multi-agency and multi-disciplinary project was conducted without any major pitfalls. The annual planning meetings and the meeting minutes helped laying out expectations and involvements of all collaborators. The Red River Telemetry Study's success can be in particular contributed to Dr. Mark Pegg's lab leading all required field work in the US portion of the Red River.

Procurement of the telemetry equipment was facilitated by the IJC providing funding in Canadian currency and a standing offer between the equipment provider and DFO.

The working relation between IJC and DFO in the development of the MOU and the working reports was very good and we are thankful that IJC accepted DFO's MOU template. We also appreciated that IJC featured our project in the IJC's newsletter.

Fortunately, anticipated risks such as (1) loss hydroacoustic receivers and recorded data in the field that would have led to missing information in the fish movement patterns was minimal and (2) fish not moving between river sections was not the case, instead we observed impressable large scale movements from Bigmouth Buffalo and Channel Catfish in unimpeded river sections.

Relying on a single vessel to tend all the receivers installed in Lake Winnipeg was problematic when weather and mechanical delays restricted the number of days available to boat on Lake Winnipeg. As a results nine receivers in the north basin were not downloaded. In 2019, we will have access to a second boat and crews will work through weekends, weather permitting, to ensure the download of all data.

In future, we will plan to work closer with IRRB's Hydrological Committee to feed our biological findings on fish movement and habitat use in their Instream Flow Needs Study for the Red River.