Addendum to Pre-Construction Monitoring of the Windsor Salt Marsh: Fish Sampling, 2019

Prepared for:

Nova Scotia Department of Transportation and Infrastructure Renewal

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CBWES Inc. March 2019

Report No. 28

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Purpose of Study

It is well known that the construction of causeways and tide gates across tidal estuaries can cause significant, often negative, impacts to the physical and biological conditions of the system. Salt marshes and mudflat complexes often experience the most dramatic and observable effects caused by the change in the movement of water and sediment. In advance of upgrades to the causeway and aboiteau as part of the Highway 101 Twinning Project, baseline monitoring was completed in 2017 (Graham et al., 2018), and post-construction monitoring will be undertaken during and following construction in order to detect and quantify environmental impact predictions of the EA report (https://novascotia.ca/nse/ea/highway-101-twinning-three-mile-plains-to-falmouth.asp), inform the Ramsar Administrative Authority of any changes to the ecological character of this globally-significant wetland (https://rsis.ramsar.org/ris/379), and to support efforts to adequately offset any unavoidable negative impacts to the salt marsh and associated habitats (i.e., tidal channels, creeks and mudflat). The original monitoring program included habitat mapping, morphological change detection, elevation surveys, vegetation surveys, and tidal channel network analysis (Graham et al., 2018) and was intended to establish the physical and biological conditions of the salt marsh prior to construction.

At the request of the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR), fish sampling within the marsh was conducted in 2019 to complement a larger, longer-term, study by Mik'maw Conservation Group examining fish populations within the Avon, Cogmagun and Halfway Rivers. The purpose of the additional, within the marsh, fish sampling program was to provide an indication of the presence and diversity of fish within the salt marsh itself, in advance of upgrades to the causeway and aboiteau as part of the Highway 101 Twinning Project. The water quality information presented was obtained as part of a separate hydrological study that was conducted by Saint Mary's University.

Methodology

Tidal wetlands support a wide range and abundance of organisms that swim, collectively referred to as nekton, which include fish and many types of invertebrates. Fish and macrocrustaceans are an important ecological link between the primary producers of the marsh (plants) and near shore fisheries (Neckles and Dionne 2000). Their position in the upper levels of the coastal food webs and their dependence on a wide range of food and habitat resources serve to integrate ecosystem elements, processes and productivity (Kwak and Zedler 1997).

Fish surveys were conducted on spring tides on 31 July, 29 August and 27 September 2019 in order to ensure over marsh flood conditions. On each occasion six minnow traps and a fyke net were deployed within the two main tidal channels of the marsh; causeway channel and aboiteau channel (Figure 1). The associated drainage basins for each channel were ~ 179,050 m² (majority of nets) and 170,000 m² (minnow traps August and September) respectively. However, during the spring high tides when hydraulic divides are not controlled by topography, nekton may move freely between drainage basins. This means that although the drainage basin(s) associated with individual tidal channels are known, a net/trap set within a given channel may capture fish that

entered the marsh from different part of the system during the flood tide. Likewise, fish that enter the marsh via the channel and basin in which a net/trap was deployed, may leave the marsh via a different drainage basin.

Sampling within the main tidal channel was conducted using a set of six minnow traps, baited with a combination of bread and dog food. The traps were anchored to the marsh surface and set within the thalweg of the channel (middle; deepest part). The fyke net was deployed based on the methodology for sampling tidal wetlands originally described in Dionne et al. (1999). On each sampling date, the fyke net was set in the same location within a first order channel flowing from the vegetated marsh surface into the main aboiteau channel (Figure 2). The net was set with the catch chamber within the thalweg of the channel and the wings extended up the slope and over the mudflat surface at approximately 45^0 angles and anchored within the vegetated edge of the marsh platform. All traps were left to fish over the high tide and retrieved when the water dropped to a level that would allow access to the net/traps while ensuring sufficient water to sustain captured fish (approximately three hours).

Fish sampling was limited to these locations and times due the hydrological conditions at the site, access and safety issues. Fish sampling within the interior of the marsh was not feasible given that the marsh completely drains of water within approximately three hours of high tide and the inability to access the central marsh by foot except at low tide, which would mean that any fish captured would not survive. Similarly, the ability to access the central marsh by boat is limited to a very short duration on only the highest of spring tides, which presents significant safety risk and limited return.

All captured fish were held in buckets, identified to species using identification guides (Audubon Society 1993; Graff and Middleton 2002; Scott and Scott 1988), counted (to a maximum of 300 per species), and measured for length (15 individuals per species).

Water Quality data was collected in the Avon River aboiteau channel between the Elderkin marsh and the Newport Bar over four spring tides between 30 September and 1 October 2019. An RBR XR-420 data logger [1] deployed within the main Avon River channel collected data for temperature, salinity, and turbidity (Figure 1). Ruskin software[2] was used for deployment, data download and post-processing.

[1] https://rbr-global.com/products
[2] https://rbr-global.com/products/software

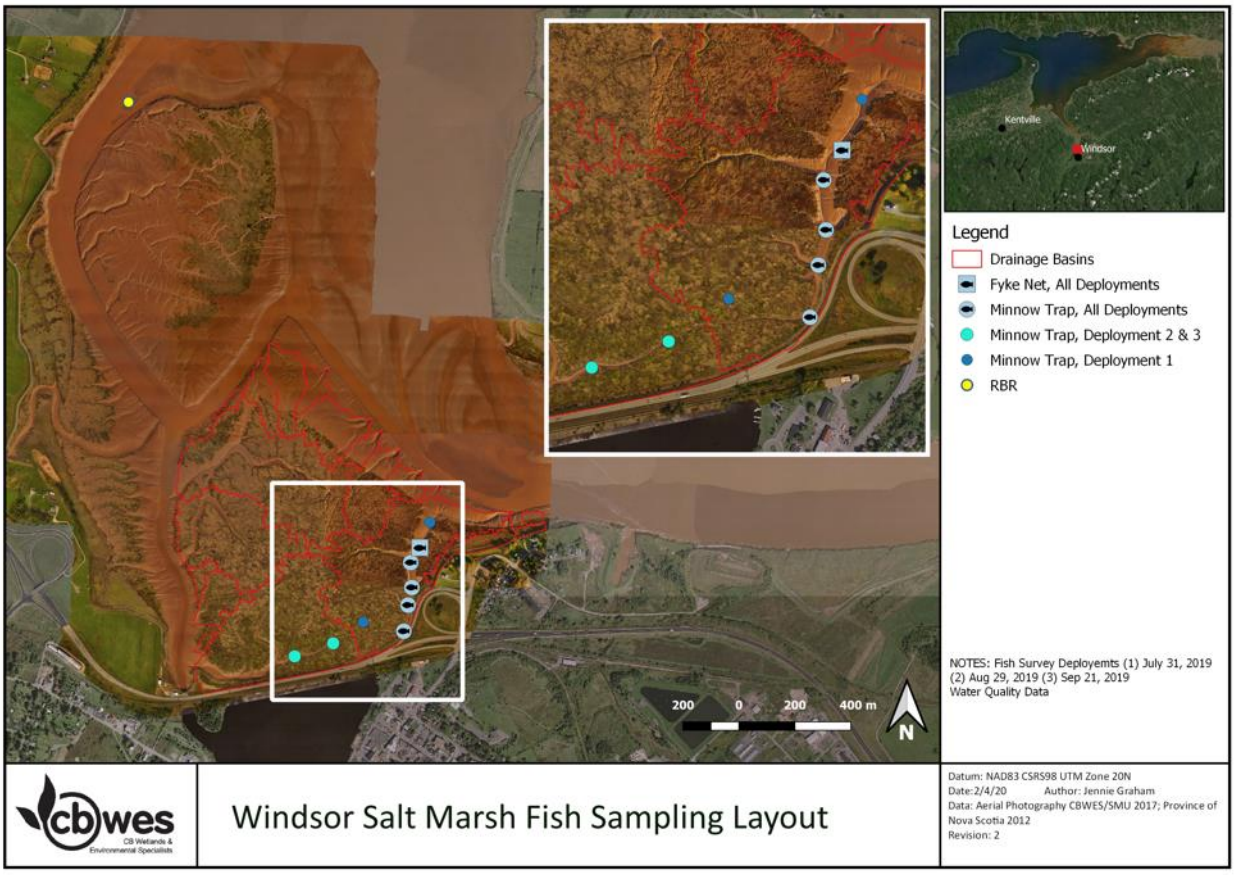

Figure 1: Sampling location for minnow traps, fyke net and RBR (water quality).

Figure 2 Fyke net deployed within secondary drainage channel on a falling tide on 27 September 2019.

Results

Nekton Survey

Total Catch and average measured lengths are shown in Table 1 and

Table 2. The largest portion of the total catch was composed of Sand Shrimp (*Crangon sp.*, 38%), followed by American eel (*Anguilla rostrate*, 29%), Tomcod (*Microgadus tomcod*), and Atlantic Silversides (*Menidia menidia*). The largest catch occurred in the fall deployment (September, 62%, Figure 3) which is consistent with results of other fish surveys by CBWES (CBWES Inc., 2019). When catch by effort was calculated the rankings of catch remain primarily the same, except for Tomcod which were all caught in a single sampling event (fyke net; September) which results in a higher catch/effort when empty traps are excluded. The American eel is listed as "Threatened" by The Committee on the Status of Endangered Wildlife in Canada (COSEWIC), however populations in Nova Scotia are designated as secure by the Atlantic Canada Conservation Data Centre. Eel is known to be a migratory species found in freshwater, estuaries and salt marshes (Dionne et al. 1999, Bemis and Kynard 1997). Mummichogs (*Fundulus heteroclitus*), are a resident species in NS salt marshes, and are typically the most abundant fish species caught by CBWES in salt marshes elsewhere in the province (CBWES Inc, 2019). They were found in low numbers at the Windsor Marsh, presumably because of the morphology of the marsh – specifically a lack of habitat conditions to support resident mummichogs throughout the tidal cycle (i.e., pannes and tidal channels that do not completely drain at low tide).

When all species are considered, the fyke net fished more efficiently than the minnow traps (43.7 individuals/effort vs. 11 individuals/effort when empty traps were excluded); this is due largely to the deployment method. Minnow traps are normally deployed in pannes; however, the Windsor salt marsh does not have panne habitat, hence deployment in the main channels. Other sites in the Bay of Fundy have shown similar patterns, where minnow traps in channels do not fish well compared to those in pannes. This is most likely related to the depth, velocities and sediment concentrations in the Windsor salt marsh channels.

Water Quality

Turbidity, salinity, and temperature results for four consecutive high tides, September 29 to October 1st, within the main Avon River Aboiteau Channel (perimeter of the marsh) are shown in Table 3 and Figure 4. Maximum recorded water temperature was 18.3 degrees, which was warmer than the air during low tide period when instruments were exposed. Salinity ranged from 0.1 to 27.7 ppt, peaking with the high tide. Turbidity levels peaked at 1706 NTU during the ebb tide on 1 October 2019, but generally turbidity was seen to increase during the rising and falling tides, but decreased during the slack tide when velocities decrease and processes such as flocculation lead to deposition of sediment and hence the decrease in turbidity.

Table 1: Total Catch at Windsor salt marsh. Catch/Effort calculated as catch divided by the number of traps/nets deployed, including and excluding empty nets.

Species	Catch by Net		Total Catch	Total Catch (%)	Catch/ Effort (Excluding empty nets)	Catch/ Effort (Including empty nets)
	Fyke	*Minnow Trap*				
Sand Shrimp	25	42	67	38%	16.8	3.2
American eel	48	2	50	29%	10.0	2.4
Tomcod	24		24	14%	24.0	1.1
Atlantic Silverside	19		19	11%	6.3	0.9
Rainbow Smelt	6		6	3%	6.0	0.3
Gaspereaux	4		4	2%	1.3	0.2
Mummichog	4		4	2%	4.0	0.2
Flounder sp.	1		1	1%	1.0	0.0
Total Catch	131	44	175	100%	25	8.3
Total Catch (%)	75%	25%				
Catch/ Effort (Exc. empty nets)	43.7	11				
Catch/ Effort (Inc. empty nets)	43.7	2.4				

Table 2: Average lengths of fish catch at Windsor salt marsh.

Species	Average Length (mm)
Gaspereaux	59
Atlantic Silverside	71
American eel	336
Flounder sp.	90
Sand Shrimp	40
Mummichog	49
Rainbow Smelt	51
Tomcod	151

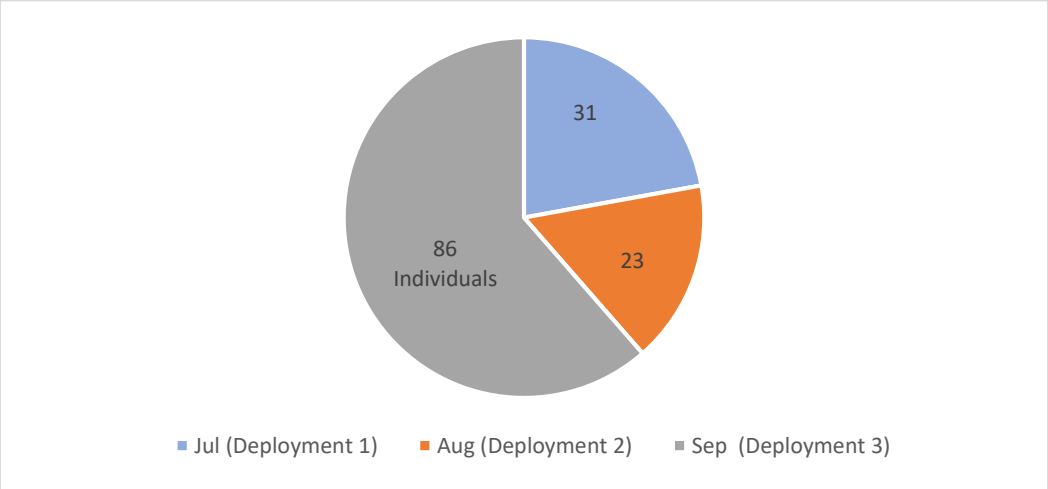

Figure 3: Total catch by month (deployment).

Table 3: Water Quality Statistics within the Avon River for September 29 to October 1, 2019.

	Temp (° C)	Turbidity (NTU)	Salinity (ppt)
Maximum	18.3	1706	27.7
Mean	15.8	444	24.7
Median	15.7	406	26.4
Standard Dev.	0.9	249	4.8
Minimum	9.6	0	0.1

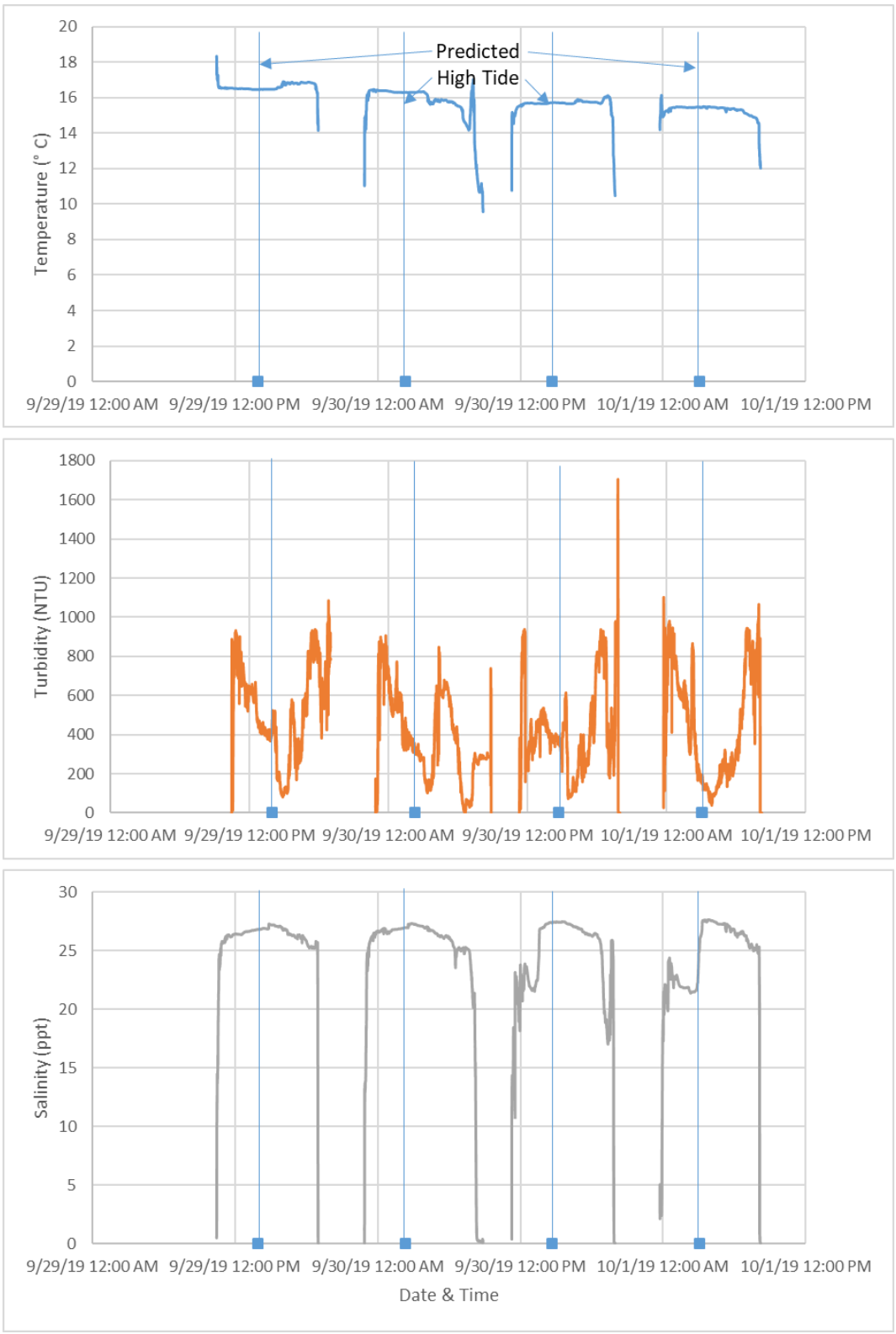

Figure 4: Temperature (top), turbidity (middle) and salinity (bottom) over four consecutive spring tides, September 29 to October 1, 2019 (logger exposed at low tide).

Summary

Fish survey results, within the Windsor salt marsh, reflect the habitat, particularly the hydrological, conditions. The numbers for typical salt marsh resident species such as mummichogs, were low compared to surveys by CBWES on other salt marshes in the province. Transient (species known to travel into and out of coastal marshes with the tide) and migratory species, including American eel, Tomcod, and Gaspereaux made up a majority of the catch. American eel, the second most caught species, was present on all three sampling events. Sand shrimp, a resident species in muddy marsh systems, were the most encountered species.

References

Audubon Society. 1993. The Audubon Society Field Guide to North American Fishes, Whales & Dolphins. Random House of Canada Ltd., Toronto, ON.

Bemis, W.E., Kynard, B. 1997. Sturgeon Rivers: An Introduction to Acipenseriform Biogeography and Life History. *Envir. Bio. Of Fishes* 48:167-183.

CBWES, Inc. 2019. Literature Review of Tidal Wetlands & Analysis of Fish Monitoring Data. Report Prepared for Department of Fisheries and Oceans & Department of Transportation and Infrastructure Renewal, November 2019, Halifax NS.

Dionne, M., Short, F.T., Burdick, D.M. 1999. Fish Utilization of Restored, Created and Reference Salt-Marsh Habitat in the Gulf of Maine. *American Fisheries Society Symposium* 22:384-404.

Graff, L. and J. Middleton. 2002. Wetlands and Fish: Catch the Link. National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service. Maryland.

Graham, J., Bowron, T.M., van Proosdij, D., Baker, G., Ellis, K. (2018) Avon River Aboiteau and Causeway Upgrades: Pre-Construction Monitoring of the Avon River Estuary. Report prepared Department of Transportation and Infrastructure Renewal, Halifax NS.

Kwak, T. and J.B. Zedler. 1997. Food Web Analysis of Southern California Coastal Wetlands Using Multiple Stable Isotopes. Oecologia. 110: 262-277.

Neckles, H. and M. Dionne. (eds.) 2000. Regional Standards to Identify and Evaluate Tidal Wetland Restoration in the Gulf of Maine. A GPAC Workshop. Wells National Estuarine Research Reserve, Wells, ME.

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat.