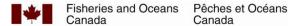# Water temperature and dissolved oxygen monitoring in Areas of Concern in the St. Clair-Detroit River System

Sarah M. Larocque, Rex W.K. Tang, and Susan E. Doka

2020

Canadian Technical Report of Fisheries and Aquatic Sciences 3380

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Canadian Technical Report of Fisheries and Aquatic Sciences

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Sarah M. Larocque, Rex W.K. Tang, and Susan E. Doka

Fisheries and Oceans Canada
Ontario and Prairie Region
Great Lakes Laboratory for Fisheries and Aquatic Sciences
867 Lakeshore Road
Burlington, Ontario
L7S 1A1

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ABSTRACT

Larocque, S.M., Tang, R.W.K., and Doka, S.E. 2020. Water temperature and dissolved oxygen monitoring in Areas of Concern in the St. Clair-Detroit River System. Can. Tech. Rep. Fish. Aquat. Sci. 3380: xiv + 120 p.

The objective of this study was to extend the spatial coverage of water temperature and dissolved oxygen (DO) monitoring in the St. Clair-Detroit River System (SCDRS), with a focus on shallow, protected embayments and/or connecting tributaries. This report describes approximately seven years of seasonal data collected in the St. Clair River and Detroit River Areas of Concern (AOCs), and describes trends within the river over time between reaches of the river and exposed and sheltered sites. In both AOCs, water temperature fluctuated seasonally, with temperatures rising from April to early July, peaking in mid-July to August and declining from September to December. Mann-Kendall tests on both the St. Clair River and Detroit River summer temperatures showed no significant trend of increasing or decreasing temperature over the years at sites that had sufficient data for trend analysis. For both AOCs, water temperatures appeared relatively similar between upstream to downstream sites within a given year. Both AOCs showed seasonal trends in which DO increased from September to February/March and decreased from April to August. Generally, DO levels were within set exceedance levels throughout the sampling periods in both AOCs to support a healthy fish community. Overall, the SCDRS showed relatively consistent seasonal trends in both water temperature and DO throughout the AOCs. However, to assess long-term changes, continual monitoring should be considered. Summarizing and describing this data will assist in accurately quantifying fish habitat health and determine if delisting targets are being met in the SCDRS AOCs.

RÉSUMÉ

L'objectif de cette étude était d'élargir la couverture spatiale de la surveillance de la température de l'eau et de l'oxygène dissous dans le Réseau des rivières St. Clair et Détroit, en mettant l'accent sur les échancrures protégées en eaux peu profondes et les affluents qui s'y jettent. Le présent rapport décrit environ sept années de données saisonnières recueillies dans les secteurs préoccupants de la rivière Sainte-Claire et de la rivière Détroit, en plus de décrire les tendances dans les tronçons des rivières et les sites exposés et abrités au fil du temps. Dans les deux secteurs préoccupants, la température de l'eau fluctue selon les saisons; les températures montent du mois d'avril au début juillet, atteignent un sommet de la mi-juillet au mois d'août, puis diminuent de septembre à décembre. Aux sites où la quantité de données permettait l'analyse des tendances, les tests de Mann-Kendall visant les températures estivales de la rivière Sainte-Claire et de la rivière Détroit n'ont montré aucune tendance à la hausse ou à la baisse au fil des années. Pour les deux secteurs préoccupants, les températures de l'eau semblaient assez similaires aux sites en amont et en aval au cours d'une année donnée. Les deux secteurs préoccupants ont démontré des tendances saisonnières selon lesquelles l'oxygène dissous augmentait de septembre à février/mars, et diminuait d'avril à août. En général, pour toutes les périodes d'échantillonnages dans les deux secteurs préoccupants, les niveaux d'oxygène dissous ne dépassaient pas les niveaux établis pour appuyer la santé des communautés de poissons. Dans l'ensemble, le Réseau des rivières St. Clair et Détroit a démontré des tendances saisonnières assez constantes en ce qui concerne la température de l'eau et l'oxygène dissous dans les secteurs préoccupants. Toutefois, pour évaluer les changements à long terme, une surveillance continue devrait être envisagée. Un résumé et une description de ces données aideront à quantifier avec exactitude la santé de l'habitat du poisson et à déterminer si les cibles pour la radiation de la liste sont atteintes dans les secteurs préoccupants du Réseau des rivières St. Clair et Détroit.

1.0 INTRODUCTION

1.1 AREAS OF CONCERN

In 1987, under the Great Lakes Water Quality Agreement, 43 areas in the Laurentian Great Lakes were designated as environmentally degraded hot spots, or Areas of Concern (AOC) (Great Lakes Water Quality Agreement 2012). The AOCs listed were considered degraded environments as a result of contamination and water quality degradation due to anthropogenic activities such that the chemical, physical, or biological integrity of the ecosystem had become impaired in one or more criteria of beneficial uses. In the St. Clair-Detroit River System (SCDRS) there are two designated AOCs: the St. Clair River and the Detroit River.

The St. Clair River is a 64 km connecting river channel between Lake Huron and Lake St. Clair. Ongoing intensive urban and industrial development has resulted in shoreline hardening (e.g., riprap shorelines) and alterations that affect fish habitat, shoreline processes, and water quality. In 1985, the St. Clair River was designated as an AOC (Environment Canada and Ontario Ministry of the Environment 2010a).

The Detroit River is a connecting channel between Lake St. Clair and Lake Erie. Its watershed—more than 2000 km^2 in size—contains two large metropolises: Detroit, Michigan and its suburbs (with a population over three million) and Windsor, Ontario and its suburbs (with a population of 280,000). The river is approximately 51 km long, with a width that varies from 0.6 km at the Ambassador Bridge to over 6 km where it drains into Lake Erie. The depth ranges from 16 m in the upper stretches to 0.9 m in parts of the lower river, with a flow rate of approximately 453 billion litres per day (Green et al. 2010). In 1986, the Detroit River was designated as an AOC (Environment Canada and Ontario Ministry of the Environment 2010b).

Up to 14 Beneficial Use Impairments can be identified within an AOC, and are monitored and assessed with the aim of restoring the AOC (Environment Canada and Ontario Ministry of the Environment 2010a, 2010b). Beneficial Use Impairment #3 and #14 address the degradation of fish and wildlife populations and the loss of fish and wildlife habitat, respectively, which identifies a list of fish habitat impairments due to the loss of coastal wetland habitat, shoreline hardening, loss of fish spawning habitat and contaminants in sediments that are particularly toxic to young fish (Environment Canada and Ontario Ministry of the Environment 2010a, 2010b). As part of assessing healthy fish habitat, some of the main factors affecting fish habitat are water temperature and dissolved oxygen (DO) levels.

1.2 WATER TEMPERATURE AND DISSOLVED OXYGEN

Water temperature plays an important role in fish life-history processes with regards to metabolic processes functioning within an optimum thermal range. Although optimum temperature ranges vary between species, fish can generally be classified into a thermal guild based on their predominant thermal associations (i.e., coldwater, coolwater, or warmwater species). Fish survival and growth are impacted by their thermal tolerances, particularly when a thermal maximum or minimum for their guild is exceeded. Since temperature can directly impact fish life-history processes and survival, temperature is an important variable to include in fish habitat assessments.

Similarly, DO is a vital factor affecting fishes in all aquatic ecosystems. Fishes require adequate levels of DO to survive and carry out life-history processes. Depleted levels of DO, or hypoxia, can result in mass fish kills, physiological stress, habitat loss, changes in fish communities, and altered life-history processes (Davis 1975, United States Environmental Protection Agency 1986). Given the range of potential effects that low DO can have on fishes, DO is a crucial variable to include in fish habitat and population assessments.

Although there are no DO targets for the St. Clair River and Detroit River AOCs, comparisons were made to DO targets for the Cootes Paradise, Hamilton Harbour AOC. In Cootes Paradise, the target states: "DO should be ≥5 mg/L for 80% of the number of times sampled during any given month of the growing season (May–September)" (Tang et al. 2018 *submitted to Remedial Action Plan (RAP)*). However, DO values should not be <3 mg/L in more than 5% of the samples during any given month of the growing season. Thus 95% of the time, in a given month, DO should be ≥3 mg/L.

By characterizing the thermal and DO structure of the AOCs, we can more accurately quantify fish habitat health and determine whether delisting targets are being met. Binationally, various agencies have collected water temperature data—typically in the mid-channel of the SCDRS—that can be used for thermodynamic modelling. However, earlier life stages of fish tend to be associated with shallow, protected embayments or tributaries, where the temperature may be more variable when compared to the open, exposed areas in the SCDRS.

1.3 OBJECTIVES

The objective of this study was to extend the spatial coverage of temperature and DO monitoring in the SCDRS, with a focus on shallow, protected embayments and/or connecting tributaries, to allow for more comprehensive fish habitat assessments in the St. Clair River and Detroit River AOCs. This report describes approximately seven years of seasonal data (2007–2018) collected in the SCDRS AOCs, and explores potential

trends within the river, between reaches of the river, and for exposed and sheltered sites over time.

2.0 METHODS

2.1 LOGGER DEPLOYMENT

Fisheries and Oceans Canada's Great Lakes Laboratory for Fisheries and Aquatic Sciences has been monitoring temperatures in the Detroit River since 2007 and in the St. Clair River since 2011. During 2014 to 2016, DO was monitored, primarily during the ice-off seasons (Figure 2 and 4).

HOBO™ loggers were used to monitor temperature (Tidbits: TBI32-05+37; HOBO U22) and DO (HOBO U26) at given depths and locations. Prior to deployment, the DO loggers were calibrated with a new sensor cap, using a 2-point calibration method in 100% and 0% saturated water. The temperature and DO loggers also underwent a performance check to ensure logger accuracy (Appendix 3). All loggers were programmed to record temperature or DO at 30 minute intervals (48 samples per day), from the date of deployment until retrieval.

The materials and methods used for logger deployment varied over time (Figure 1). Prior to 2015, loggers were deployed using an anchor with a rope and surface float attached. The loggers were then hung from a secondary subsurface float that was suspended 30 cm above the anchor. However, some loggers setups were lost from ice scouring or tampered with. In 2015, the deployment setup was changed. Instead of a surface float, a 3/16-inch stainless steel cable was used to attach the anchor (with logger and subsurface float) to an immovable object on shore (e.g., a tree or post). Loggers were generally deployed between April to May, and logger exchanges for winter monitoring typically occurred from October to November, depending on the site, for continuous monitoring

2.1.1 Detroit River

Loggers were deployed in 2007 and from 2011 to 2016. Deployment effort varied over the monitored years by location, where strong currents and overwinter ice breakup and ice scouring may affect data quality.

Loggers were deployed at 10 sites along the Detroit River, beginning upstream at the confluence with Lake St. Clair (Peche Island), then proceeding downstream to near the confluence with Lake Erie (Amherstburg) (Figure 2). Due to heavy currents and ice scouring, some loggers drifted slightly from their original deployment location. Of the 10 deployment sites, six sites had loggers in multiple locations at that respective site (Figures 2 and 3). The upstream-of-Canard site had three subsites (Upper, Lower and

Confluence), , and the University of Windsor site had two subsites. Both Upstream of Canard and University of Windsor sites did not have consistent logger deployments throughout our monitoring period.

The four other sites in the Detroit River with multiple loggers (Peche Island, LaSalle Drain, Protected Backwater Bay, and Amherstburg) had two subsites—one, an "inner" more protected area, and the other, an "outer" more exposed location; loggers were deployed consistently at these locations, from 2013 to 2016. In the summer of 2014, additional loggers were deployed at each of these four sites (and subsites), where a surface logger ("surface") was set in tandem with the typical near-bottom ("bottom") logger. Protected Backwater Bay (2014–2015) was the only site in the Detroit River with a DO logger deployed.

Table 1 summarizes details for all the loggers deployed in the Detroit River, and includes deployment/retrieval dates and any known technical issues pertaining to the deployments. Figure 3 summarizes all effort with temperature loggers and the quality of data retrieved over time for the Detroit River. All processed data (as per 2.2 Data Analyses) were plotted for each year and site, and can be found in Appendix 1.

2.1.2 St. Clair River

Loggers were deployed from 2011–2018. Data retrieval was relatively consistent, with the exception of the Chenal Ecarte site, where loggers regularly went missing over the deployment periods, likely due to tampering by the public.

Thirteen sites were sampled throughout the St. Clair River, beginning upstream at the confluence with Lake Huron (Point Edward), continuing downstream and into the St. Clair delta and Lake St. Clair (Mitchell's Bay) (Figure 4). Although some logger locations may have shifted slightly over time, the most accurate site locations are shown in Figure 4. Of the 13 sites, three sites (Chenel Ecarte, Swan Lake, and Mitchell's Bay) had loggers in multiple locations (Figures 4 and 5). These sites had two subsites (one inner, more protected and one outer, more exposed), with loggers deployed consistently from either 2013 or 2014 to 2016. Also, in the summer of 2014, additional loggers were deployed at each of these three sites (and subsites) as well as at Point Edward, where surface loggers were set in tandem with the typical near-bottom loggers. Overall, temperature was collected successfully from 12 of the 13 sites (Figure 5).

In 2014 and 2015, nine sites were sampled with DO loggers (primarily in the St. Clair delta). Table 2 summarizes details for all the loggers deployed in the St. Clair River, and includes deployment/retrieval dates and any associated issues. Figure 5 summarizes all the effort with temperature loggers and the quality of data retrieved over time. All processed data (as per 2.2 Data Analyses) were plotted for each year and site, and can be found in Appendix 2.

2.2 DATA ANALYSES

Upon logger retrieval, data were processed following the standard operating procedure for quality assurance and quality control (QAQC) for the Fish Habitat Lab with the Great Lakes Laboratory for Fisheries and Aquatic Science at Fisheries and Oceans Canada. Where appropriate for the DO loggers, QAQC also included a biofouling correction, which can compensate for errors in recorded DO caused by the accumulation of biological material during deployment. Also, DO profiles for each logger were evaluated to determine whether the sensor had become submerged in the substrate (a common occurrence in nearshore areas with soft substrates) which may artificially decrease DO measurements (i.e., a buried logger).

For both AOCs, within each year, temporal trends in temperature and DO data from all loggers were summarized with monthly boxplots that illustrate the distribution of the data with the box showing the median bounded by the first and third quartiles. Temperature data were also summarized by seasonal means ±1 standard deviation (SD), maximum and minimum temperature during the season, and the number of full days data were recorded during the season (since the duration of logger deployment varied between sites). Seasons were split into three-month intervals; spring (March to May); summer (June to August); fall (September to November); winter (December to February). For the sites with the longest duration of data, annual trends were summarized over time. Sites with sufficient years of data were analyzed for trends in summer water temperatures, using a Mann-Kendall test (see below). Lastly, the percent of DO readings that fell below 5 mg/L (lower than saturation) and 3 mg/L (considered to be anoxic) each month were determined at each site. These percentages were then compared to the Hamilton Harbour AOC target for DO.

2.2.1 Mann-Kendall trend analysis

A Mann-Kendall analysis was conducted to assess short-term water temperature trends. Mann-Kendall analysis is a non-parametric analysis for detecting annual monotonic trends for series of environmental or climate data (Mann 1945) (package: Kendall, R version 3.5.0). The Mann-Kendall test is not sensitive to missing values and is therefore suitable for analyzing sites without consistent periodic data. We performed Mann-Kendall tests on a per-site, per-year basis, and only data from the summer months (June to August) were considered for the analysis. Summer data was the most consistent over the entire sampling period. Sites with less than four years of summer monitoring were also excluded from the analysis to avoid overfitting or underfitting the model. Mann-Kendall tests were performed on the annual mean water temperature values for all sites when it meets the aforementioned data sorting requirements. When a significant trend was detected, a Sen's slope estimate method was applied to assess the magnitude of the trend (Sen 1968). Significant trend detection levels were set at $\alpha < 0.05$.

3.0 RESULTS

3.1 DETROIT RIVER

3.1.1 Temperature

In 2007, three sites spanning the upper, middle, and lower sections of the Detroit River (Peche Island, outer; Fighting Island; Amherstburg, inner) were monitored from July to September (Figures 2 and 6). Mean water temperatures were between 22 to 24 °C at all sites during the monitored summer months (Table 3). Maximum temperatures reached 28 °C at Amherstburg (inner subsite). Fall temperatures were not well represented with only September data; however, all sites showed similar temperatures (Figure 6; Table 3).

In 2011, three sites (Turkey Creek, LaSalle Drain, and Upstream of Canard) were monitored from May to November. However, all 3 sites were relatively close to each other in the middle-lower section of the Detroit River (Figures 2 and 7). From May to July, the Turkey Creek and upstream-of-Canard sites had warmer water temperatures than the LaSalle drain site; this is likely due to the tributary streams warming up sooner than the mainstream of the Detroit River. Seasonally, LaSalle Drain showed cooler spring (May) mean temperatures (15 °C) than the other sites (18–19 °C). Summer and fall mean temperatures were more similar between sites with mean temperatures ranging from 23.6 to 25.3 °C and 14.5 to 15.2 °C, respectively (Table 4). Maximum water temperature (32.4 °C) occurred at the upstream-of-Canard site in 2011 (Table 4).

In 2013, temperature monitoring expanded, where three sites with inner and outer subsites (Peche Island, LaSalle Drain, and Amherstburg) were monitored from June to November. The Protected-Backwater-Bay site was monitored from November 2013 to the beginning of 2014 (Figure 8). The four sites spanned the entire river (Figure 2). The three sites with inner and outer subsites showed similar seasonal changes for temperature, with maximum temperatures occurring in July (Peche Island-inner, at 29.7 °C). A high degree of variability in temperatures was seen in October and is indicative of fall turnover and seasonal water cooling (Figure 8; Table 5). The inner and outer subsites were similar within each site combination (Table 5). The temperature logger at the protected-backwater-bay site was deployed mid-November; therefore the logger only captured temperatures between mid-November to December, and the data are not comparable to the November data from the other sites.

In 2014, four sites with inner and outer subsites (Peche Island, LaSalle Drain, Protected Backwater Bay, and Amherstburg) were monitored consistently between May and September. Both of the Peche Island subsites were monitored for the remainder of the year, and the protected-backwater-bay inner subsite was monitored for the entire year (Figure 9). The four sites spanned the entire Detroit River (Figure 2).

To determine possible variation in the water column, temperatures were monitored in tandem at the surface and near-bottom (the standard location of the temperature loggers) at each of the four sites. Only Peche Island and LaSalle Drain had usable data from both the surface and bottom loggers at their respective inner and outer subsites (Figure 10). Due to logger failures, data were only collected from the Protected Backwater Bay bottom logger and the Amherstburg surface logger. All four main sites showed similar seasonal trends, with temperatures rising in May and June, peaking between 20 and 25 °C in July and August (Figure 9).

Maximum water temperatures reached 28.8 °C at the LaSalle Drain inner surface subsite in the summer (Table 6). September 2014 showed greater variability when temperatures started to decrease (Figure 9). Protected Backwater Bay (outer; deployed for the same duration as other loggers) showed slightly higher mean temperatures (by approximately 1–2 °C) than the other sites throughout spring, summer, and fall (Figure 9; Table 6). Inner and outer subsites were relatively similar within each site when deployed simultaneously (Figure 9; Table 6). Surface and bottom subsites at both Peche Island and LaSalle Drain were relatively similar monthly and seasonally, although inner surface subsites were slightly warmer, and outer bottom subsites were slightly cooler (Figure 10; Table 6). This is expected since the surface subsites were likely more responsive to the summer air temperatures than the bottom subsites.

Similar to 2014, the same four sites were monitored in 2015 at both the inner and outer subsites, spanning the entire Detroit River. Consistent coverage occurred from May to October at all sites and subsites. Peche Island and Protected Backwater Bay had year-round coverage for the inner and outer subsites, while LaSalle Drain and Amherstburg continued coverage beyond October to the new year at the inner subsite. Similar to 2014, all four sites showed similar seasonal trends with temperatures rising in May and June, and peaking between 20 and 25 °C in July and August (Figure 11). Maximum water temperatures reached 27.6 °C at Protected Backwater Bay (inner) in the summer (Table 7). Water temperature in September stayed warm (median of 20–24 °C), and median temperatures dropped to approximately 12 °C in October (Figure 11). By December, mean water temperatures had dropped to 5 °C (Table 7). Protected Backwater Bay (when monitored for the same duration as the other sites) had consistently higher mean temperatures than the other sites (Figure 11; Table 7), similar to 2014 (Figure 10). As in previous years, mean water temperatures at the inner and outer subsites were similar and fell within 1 °C of each other, within a site (Figure 11; Table 7).

In 2016, four subsites spanning the entire river (Peche Island outer, LaSalle Drain inner, Protected Backwater Bay outer, and Amherstburg inner) were monitored consistently throughout the year. Multiple subsites were not monitored. Similar to 2014 and 2015, Protected Backwater Bay had higher water temperatures than the other sites (Figure 12; Table 8). Protected Backwater Bay was less exposed to the Detroit River flows

compared with the other sites, so temperatures remained warmer there than at the other sites. The three other sites had similar seasonal mean temperatures that fell within 1 °C of each other (Table 8). Overall, mean spring, summer, fall, and winter temperatures at the four sites were between 7.5 to 9.4 °C, 23.2 to 24.6 °C, 15.2 to 17.0 °C, and 1.0 to 3.1 °C, respectively (Table 8). All four sites showed similar seasonal trends, with temperatures rising from April through June, and peaking in July and August at around 25 °C (Figure 12). Maximum water temperatures reached 28.6 °C at Protected Backwater Bay (outer) in the summer (Table 8). September stayed warm, and cooling started in October through December (Figure 12).

In 2017, those four subsites, spanning the entire river (Peche Island outer, LaSalle drain inner, Protected Backwater Bay outer, and Amherstburg inner) were monitored from January to September. Multiple subsites were not monitored. As in other years, Protected Backwater Bay had higher water temperatures than the other sites (Figure 13; Table 9). Temperatures measured at the other three sites appeared similar, with seasonal means falling within 1 °C (Table 9). Overall, mean spring, summer, fall, and winter temperatures at the four subsites were between 7.6 to 9.6 °C, 21.9 to 23.3 °C, 19.3 to 20.8 °C, and 0.8 to 3.0 °C, respectively (Table 9). All four sites showed similar seasonal trends; temperatures rose from April through June, peaking between 20 and 25 °C in July and August, and started cooling in September (Figure 12). Maximum water temperatures reached 27.4 °C at Protected Backwater Bay outer in the summer (Table 9).

Peche Island outer temperature trends were similar over the years (Figure 14), with temperatures rising from April to June, peaking in July and August, and declining from September to December (Figure 14). When comparing years within seasons that had similar sampling effort, 2016 had the highest mean summer temperatures and warmest fall, but there was no consistent pattern (e.g., increased temperatures or variability) over the years (Table 10).

Among all sampled sites in the Detroit River, only four sites met the criteria for Mann-Kendall analysis where more than four years of summer monitoring data were available (Table 11). Years assessed for these sites ranged from 2007 to 2017, with some annual data gaps where data were deemed either unusable due to logger failure or a site was not monitored for the given year (Table 11). Mann-Kendall scores (S) showed that temperatures at Peche Island (outer), Amherstburg (inner), and LaSalle drain (inner) showed a very slight decreasing trend, while Protected Backwater Bay (outer) showed a slight positive trend; however, the results were not significant for all four sites within the monitoring period (P >0.05). Therefore, mean temperature in the summer across different years from all sites in this dataset showed no serial correlation over time and were identically distributed. The summarized mean annual temperature data is considered a small sample size in Mann-Kendall analysis, and therefore it is not reflective of long-term temperature changes in Detroit River.

3.1.2. Dissolved oxygen

Dissolved oxygen was monitored at Protected Backwater Bay (inner subsite) during the summer months of 2014 and 2015. In both years, there was a trend of decreasing DO from May to September (Figure 15). When monitored in October, DO increased, presumably with the fall turnover. In July of 2014, there was a decline in DO which led to DO falling below the 5 mg/L and 3 mg/L thresholds for 41% and 15% of the number of times sampled, respectively. DO fell in July 2014 more than in any other month (Table 12). This decline may partially be due to the growth of a bryozoan on the logger; although the data directly affected by the bryozoan was removed, there may have been residual effects on the logger. Otherwise, September had a few more occurrences of DO falling below the 5 mg/L and 3 mg/L thresholds in both 2014 and 2015 (Table 12). September of 2015 had DO fall below the 5 mg/L and 3 mg/L thresholds by 26% and 10% of the number of times sampled, respectively. This trend did not continue into October. Therefore, we saw DO at the Protected Backwater Bay inner subsite fall below the Cootes Paradise, Hamilton Harbor AOC DO targets in July 2014 and September 2014 and 2015 (Table 12).

3.2. ST. CLAIR RIVER

3.2.1. Temperature

In 2011, three sites (Point Edward, Cathcart Park, Marshy Creek) were monitored from April to December, and one site (Off Channel) was monitored from July to November; these sites spanned the St. Clair River (Figures 4 and 16). All four sites showed similar seasonal trends with water temperatures rising from April through July, peaking between 22 and 26 °C in August, and starting to cool from September to December (Figure 16). Maximum water temperatures reached 29.4 °C at Cathcart Park in the summer (Table 13). Mean temperatures at Cathcart Park were slightly warmer in both the spring and fall compared to all the other sites, while Marshy Creek was cooler in the spring (Table 13).

In 2012, three sites spanning the entire St. Clair River (Point Edward, Baby Creek, Marshy Creek) were monitored from June to August (Figures 4 and 17). Water temperatures peaked in July and August between 22 and 26 °C (Figure 17). Maximum water temperatures reached 28.4 °C at Point Edward in the summer (Table 14). Mean water temperatures at Point Edward were slightly warmer in the summer compared to all the other sites (Table 14).

In 2013, five sites, one with two subsites (Point Edward, Baby Creek, Cathcart Park, Marshy Creek, and Mitchell's Bay inner and outer subsites) were monitored consistently from June to October. Point Edward and the two Mitchell's Bay subsites were monitored into November (Figure 18). These five sites spanned the entire St. Clair River and the northeast part of Lake St. Clair (Figure 4). All five sites showed similar seasonal trends

with water temperatures rising in June, peaking in July and August between 20 and 25 °C, and starting to cool from September to October (Figure 18). Maximum water temperatures reached 29.1 °C at Mitchell's Bay (inner subsite) in the summer (Table 15). Mean temperatures at Cathcart Park were slightly warmer in both the summer and fall compared to all the other sites, while Baby Creek and Marshy Creek were cooler in the summer (Table 15). Mitchell's Bay was also slightly warmer in the summer due to warmer temperatures in June, however inner and outer subsites appeared similar (Figure 18; Table 15).

In 2014, seven sites, two with subsites (Point Edward, Baby Creek, Cathcart Park, Marshy Creek, McDonald Park, and both Swan Lake and Mitchell's Bay with inner and outer subsites) were monitored generally from May to December, although some sites were not monitored for that entire time (Figure 19). The sites spanned the St. Clair River, into the St. Clair delta (Swan Lake) and the northeast part of Lake St. Clair (Mitchell's Bay; Figure 4). To determine if there was much variation in temperature between surface and near-bottom (the standard location of temperature loggers), further subsites of surface and bottom were monitored at Swan Lake (inner and outer), Mitchell's Bay (inner and outer), and Point Edward (Figure 20).

All seven sites showed similar seasonal trends with water temperatures rising in May and June, peaking in July and August between 18 and 25 °C, and starting to cool from September to November with increased variability in temperatures (Figure 19). Maximum water temperatures reached 28.7 °C at Mitchell's Bay (outer surface subsite) in the summer (Table 16). Mean temperatures at Cathcart Park and Mitchell's Bay (outer) were slightly warmer (by 1 °C) in the spring compared with all the other sites, while Baby Creek and Marshy Creek were cooler in the summer (Table 16). Temperatures at the inner and outer subsites for Mitchell's Bay were relatively similar. However, the Swan Lake outer subsite was warmer than the inner subsite (Figure 19; Table 16). Surface and bottom subsites at all three sites were relatively similar monthly and seasonally, although surface subsites were slightly warmer than bottom subsites for both inner and outer subsites (Figure 20; Table 16).

In 2015, 11 sites, two with subsites (Point Edward, Baby Creek, Cathcart Park, marshy Creek, McDonald Park, Swan Lake [inner and outer subsites], Goose Bay, Johnston's Bay, St. Anne's Bay, Volkswagon Bay, Mitchell's Bay [inner and outer subsites]) were monitored mostly from January to October. Some of these sites were not monitored for that entire time, and Cathcart Park and McDonald Park were monitored through to the end of the year (Figure 21). These sites spanned the St. Clair River and continued into the St. Clair delta (five sites) and the northeast part of Lake St. Clair (Mitchell's Bay; Figure 4).

All 11 sites showed similar seasonal trends with water temperatures rising from April to June, peaking in July to September between 20 and 25 °C, and starting to cool from

September to October (Figure 21). Maximum water temperatures reached 28.7 °C at Volkswagon Bay in the fall, due to a warmer September (Table 17). Mean temperatures at Cathcart Park were slightly warmer (by 1–2 °C) in the spring and summer compared with all the other sites in the St. Clair River (Table 17). In the St. Clair delta, all sites were relatively similar and appeared to be warmer than the river sites, but the St. Clair delta sites were not monitored for the same duration as the St. Clair River sites. Mean water temperatures during the spring, summer, and winter at Swan Lake (inner subsite) and Mitchell's Bay (outer subsite) were warmer than the other subsites by at least 1 to 5 °C (Figure 21; Table 17).

In 2016, seven sites, one with subsites (Point Edward, Baby Creek, Cathcart Park, Marshy Creek, McDonald Park, Goose Bay, Mitchell's Bay [inner and outer subsites]) were monitored generally from April to December; Cathcart Park and McDonald Park were the only sites monitored for that entire time (Figure 22). The sites spanned the entire St. Clair River and continued into the St. Clair delta (Goose Bay) and the northeast part of Lake St. Clair (Mitchell's Bay; Figure 4).

All seven sites showed similar seasonal trends, with water temperatures rising from April to July, peaking in August between 22 and 26 °C, and starting to cool from September to December (Figure 22). Maximum water temperatures reached 28.6 °C at Mitchell's Bay (outer subsite) in the summer (Table 18). When comparing sites monitored for similar durations, mean temperatures at Cathcart Park were slightly warmer by almost 1 °C in the summer and fall compared to all the other sites in the St. Clair River (Table 18). In the St. Clair delta, mean water temperatures in Goose Bay appeared warmer than in the river, however loggers were not deployed for the same duration. As in previous years, mean water temperatures during the spring and summer at Mitchell's Bay (outer subsite) were slightly warmer than the inner subsite (Figure 22; Table 18).

In 2017, six sites (Point Edward, Baby Creek, Cathcart park, Marshy Creek, McDonald Park, Mitchell's Bay inner subsite) were monitored from January to September; McDonald Park was monitored into November (Figure 23). The sites spanned the St. Clair River, and the northeast part of Lake St. Clair (Mitchell's Bay; Figure 4).

All six sites showed similar seasonal trends with water temperatures rising from April to June, peaking in July and August between 20 and 25 °C, and starting to cool in September (Figure 23). Maximum water temperatures reached 27.3 °C at Mitchell's Bay (inner) in the fall, likely due to extreme September ambient temperatures (Table 19). When comparing sites monitored for similar durations, mean seasonal water temperatures at Cathcart Park were slightly warmer in all four seasons compared with all other sites, while Marshy Creek and McDonald Park were notably cooler in the spring (Table 19).

Point Edward, Cathcart Park, and Marshy Creek had some of the longest records of temperature, covering 6 continuous years (2011–2017), and together these three sites span the St. Clair River (Figure 24). Of the data available, temperature trends at all three sites were quite similar over the years, with water temperatures rising from April to July, peaking in August, and starting to decline from September to December (Figure 24). When comparing years within seasons that had similar sampling effort, 2012 had the highest mean summer temperatures. However, there appears to be no consistent pattern (e.g., increased temperatures or variability) over the years, particularly when comparing all the sites together (Tables 20–22).

Among all sampled sites in the St. Clair River, six sites met the criteria for Mann-Kendall analysis (Table 23), with more than 4 years of summer monitoring data were available (Table 23). Data for all sites were assessed from 2011 to 2017 with some gaps where data was deemed either unusable due to logger failure or a site was not monitored for the given year (Table 23).

For all sites, annual summer temperature analyzed in St. Clair River showed a slight decreasing Mann-Kendall score, with the exception of Mitchell's Bay (outer) (Table 23). Monotonic trends were also not significant (P >0.05) for all sites except for Mitchell's Bay (outer). Although Mitchell's Bay (outer) met the requirements for Mann-Kendall analysis, due to the small number of years being monitored in this site, Mann-Kendall test was unable to resolve the ranks and therefore no trend could be analyzed. Mean annual summer temperature across all St. Clair River sites showed no serial correlation over time and were identically distributed.

3.2.2. Dissolved oxygen

In 2014, DO was monitored at two sites in the St. Clair River AOC: one in each the St. Clair River and Lake St. Clair from May to September. Both Point Edward and Mitchell's Bay (inner) showed a decline in DO over the summer months, although none exceeded target levels of falling below 5 mg/L and 3 mg/L, 20% and 5% of the time, respectively (Figure 25; Table 24). The logger at a third site (Swan Lake in the St. Clair delta) appears to have been buried or had extremely low DO during all months that it was deployed, and the data retrieved were not included for analyses.

In 2015, eight sites (Point Edward, Cathcart Park, McDonald Park, Goose Bay, Johnston's Bay, St. Anne's Bay, Volkswagon Bay, Mitchell's Bay inner subsite) were monitored for DO, primarily over the summer from either May or July to October, with Cathcart Park and McDonald Park being monitored from October to December (Figure 26). Generally, the St. Clair River, St. Anne's Bay, and Lake St. Clair sites had similar trends with decreasing DO from May until August, and then DO started to increase (Figure 26). DO at the remainder of the sites in the St. Clair delta appeared to decrease slowly over the summer months. Only Goose Bay occasionally exceeded the Cootes

Paradise, Hamilton Harbor AOC targets of falling below 5 mg/L (July) and 3 mg/L (August) by 20% and 5% (respectively) of the number of times sampled. (Figure 26; Table 25). Generally, DO was at high levels to support a healthy fish community at all sites for the duration of deployment in 2015.

In 2016, Cathcart Park and McDonald Park were monitored for DO from January to October (Figure 27). Both sites showed similar trends with DO rising until February or March, declining until August, and then starting to rise again (Figure 27). McDonald Park had higher DO than Cathcart Park for all months. From June to October, Cathcart Park had DO fall below 5 mg/L, and during August exceeded target levels of low DO for both 5 mg/L and 3 mg/L (Figure 27; Table 26). Generally, DO concentration was at a sufficient level to support a healthy fish community at both sites for the duration of deployment in 2016.

In 2017, Cathcart Park and McDonald Park were monitored for DO from May to November (Figure 28). Both sites showed similar trends with DO declining until August, and then starting to rise again (Figure 28). McDonald Park had higher DO than Cathcart Park for all months and showed very similar trends and levels compared to 2016. From May to October, Cathcart Park DO fell below 5 mg/L and 3 mg/L, and exceeded the Hamilton Harbor AOC target levels of low monthly DO (Table 27). During August, DO at Cathcart Park was below 3 mg/L for 99.8% of the time (Table 27). The DO levels at Cathcart Park were a lot lower compared to 2016. It is possible the logger there was close to the anoxic layer near the bottom during deployment since the McDonald Park values appeared comparable between the two years.

4.0 DISCUSSION

This report describes the approximately seven years of seasonal temperature and DO data collected in both the Detroit River and St. Clair River AOCs, spanning the SCDRS. We have summarized trends between reaches of the corridor, between exposed and sheltered sites (or connecting tributaries), and within the corridor over time. In both AOCs, water temperature fluctuated seasonally, with temperatures rising from April to July, peaking in July and August, and declining from September to December. In both AOCs, due to the lack of complete yearly coverage, no clear patterns emerged, aside from expected seasonal changes of warming and cooling.

For both rivers, the St. Clair delta, and Lake St. Clair, temperatures were not different from each other within a given year. However, a few sites had temperatures higher than the mean for each area.

In the Detroit River, upstream of Canard and Turkey Creek (2011) showed elevated temperatures in the summer months compared to LaSalle Drain. These two sites are

situated in connecting tributaries and may warm up more than the sites near the main flow of the river, like the LaSalle Drain site. Protected Backwater Bay, a more frequently sampled site, had consistently elevated temperatures year-round over multiple years relative to other sites that were more exposed to the main flow of the Detroit River. Protected Backwater Bay is more sheltered than any other site on the Detroit River (Figure 2) and slower exchange/mixing of water increased water temperatures relative to other sites, year-round.

In the St. Clair River, Cathcart Park appeared to have consistently warmer temperatures in the spring and summer (and occasionally fall) relative to other sites. This site is in a tributary and may be more protected and less exposed than other sites that are closer to the main flow of the St. Clair River. However, most of the sites along the river are relatively protected in a tributary or located away from the main flow (e.g., Point Edward is in a marina), with the exception of McDonald Park. Water from the tributary at Cathcart Park likely warms up more than other tributaries in the area.

Some sites had associated subsites with more protected inner and more exposed outer locations. In 2014, the inner and outer subsites were further divided with surface and bottom subsites. Presumably, the more sheltered inner and surface subsites would have had a greater variability in temperatures, or had more extreme temperatures (warmer in the summer months, colder in the winter months) than the outer or bottom subsites—similar to some of the more protected sites throughout the rivers. In the Detroit River, inner and outer subsites were similar. Surface and bottom subsites were relatively similar within the inner and outer subsites, and overall the inner surface subsites showed slightly warmer temperatures than the outer bottom subsites. These subsites within the Detroit River may not be as distinct as initially thought, particularly if the sites experienced a large degree of water mixing from the main flow of the river.

Conversely, the St. Clair delta and Lake St. Clair inner and outer subsites showed some differences. The Swan Lake inner subsite was consistently slightly warmer than the outer subsite, while Mitchell's Bay had the opposite effect in spring and summer. Both Swan Lake and Mitchell's Bay have lower flows than the St. Clair River and Detroit River, and would experience less mixing. The St. Clair River Swan Lake inner site was more protected from river flows than the outer site, while for Mitchell's Bay, the outer site would have lower flows since it is further away from the river confluence or may be more protected from wetland vegetation than the inner site (Figure 4), resulting in increased temperatures.

In the St. Clair River, surface subsites were slightly warmer than bottom subsites. The increased surface temperatures relative to bottom temperatures were likely related to the more sheltered sites in either the St. Clair delta or Lake St. Clair, or were more isolated away from the river (e.g., Point Edward is in a marina) compared with the sites in the Detroit River. The differences between the subsites within the two rivers are likely

associated with the extent of exposure to river flows, hence sites at St. Clair River that are less exposed are more likely to show differences between its subsites, in contrast to the Detroit River, where subsites are mostly exposed to flowing water.

Mann-Kendall tests on both the St. Clair River and Detroit River summer temperatures showed no significant increases or decreases at sites with sufficient data for trend analysis. This is expected as year to year summer temperatures for both the St. Clair River and Detroit River showed small monthly variations (Figures 6–28). Thus more long-term data is required to determine possible long-term changes in water temperature.

DO also showed seasonal trends that were consistent within the corridor. Throughout the monitoring period, DO increased from September to February/March and decreased from April to August.

DO in the Detroit River AOC was only monitored for two summers (2014 and 2015) at Protected Backwater Bay. Here, mean water temperature was highest among monitored sites during the 2 years of monitoring, suggesting the potential for low DO. However, DO only fell below and exceeded low DO targets (Hamilton Harbor AOC targets; <3 mg/L) in July 2014 and September 2015 (Table 12) (one instance may have been associated with bryozoan growth). Generally, DO in Protected Backwater Bay was sufficient to support a healthy fish community throughout the entire monitoring period. Since this site was the warmest site, it indicates that DO levels are likely high throughout the Detroit River, likely due to constant water mixing effects.

DO was sampled more frequently in the St. Clair River AOC, and was monitored from 2014 to 2017 at various sites in the St. Clair River, the St. Clair delta, and in Lake St. Clair. At Cathcart Park in 2017, DO levels were extremely low in the summer months, with >90% of values below the 3 mg/L threshold in July and August 2017. The reason for the change is unknown at this time, but it is unlikely that the logger was buried since we saw continual variation of DO concentrations throughout the summer months. The decrease seen may be due to a sudden change in water quality in the delta of Cathcart Park. Otherwise, DO levels were high in other monitored sites throughout the year in both rivers to support a healthy fish community.

DO was lower in the St. Clair delta sites relative to the other sites in 2015 and may be a factor of natural wetland function relative to rivers and Mitchell's Bay. Relative to the river sites, highly productive wetlands can result in the development of sediments with a considerable amount of organic material undergoing decay. The breakdown of organic material consumes oxygen and may result in a localized decline in DO levels. If decomposition rates are high, oxygen may be consumed from the depth stratum where the logger was situated (i.e., 30 cm off the bottom). Floating vegetation (e.g., pond or water lilies) can also limit photosynthesis and promote the decay of submerged aquatic

vegetation and phytoplankton, further reducing DO levels (as has been observed in *Eichhornia crassipes* [Rai and Munshi 1979], and *Trapa natans*, [Caraco and Cole 2002; Midwood and Doka 2017]). Similarly, at Cathcart Park in 2017, the lower DO values in the summer months may be attributed to high decomposition rates and oxygen consumption near the bottom.

Both the Detroit River and St. Clair River have been monitored in shallow, protected embayments or tributaries for water temperature and DO using loggers to characterize the thermal structure of the rivers with more detail than mid-channel buoy temperature data alone. Future work should compare the mid-channel buoy temperatures to these protected sites. Time-series analyses may reveal statistical trends between sites or years, as opposed to merely describing the trends seen or the short-term Mann-Kendall analyses of annual summer water temperatures. Overall, the SCDRS showed seasonal trends in both water temperature and DO that were relatively consistent throughout the AOCs. Mann-Kendall analysis was unable to detect any short-term monotonic temperature trends in the data. Therefore to assess the long-term changes, continual monitoring should be considered. Summarizing and describing these data will assist in accurately assessing fish habitat health and determining if delisting targets are being met in the AOCs.

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Table 1. Summary of long-term temperature and dissolved oxygen (DO) monitoring deployments in the Detroit River. From upstream to downstream sites within the Detroit River, site and subsite, logger type (temperature or dissolved oxygen), year, instrument depth, deployment and retrieval dates, and any issues with the data are noted.

Site	Subsite	Logger Type	Year	Depth (m)	Deploy Date	Retrieval Date	Notes
Peche Island	Outer	Temperature	2007	1.5	2007-07-03	2007-08-15	
	Outer			1.5	2007-08-15	2007-09-20	Assumed GPS; switched out mid-summer; other logger zapped with efisher
	Inner		2013	1.15	2013-06-03	2013-11-19	
	Outer			1.5	2013-06-03	2013-11-19	
	Inner			1	2013-11-14	2014-05-14	Missing - estimated retrieval date
	Outer			1	2013-11-14	2014-05-14	Missing - estimated retrieval date
	Inner		2014	1.15	2014-05-14	2014-09-25	
	Inner - Surface			1.15	2014-05-14	2014-09-25	
	Outer			1.3	2014-05-14	2014-09-25	
	Outer - Surface			1.3	2014-05-14	2014-09-25	
	Inner			-	2014-09-25	2015-05-13	
	Outer			-	2014-09-25	2015-05-13	
	Inner		2015	1.3	2015-05-13	2015-10-29	
	Outer			2	2015-05-13	2015-10-29	
	Outer			1.2	2015-10-29	2016-04-12	
	Outer		2016	1.7	2016-04-13	2016-10-25	
	Outer		2017	-	2016-10-26	2017-09-11	
	Outer		2018	-	2017-09-11	-	Currently logging
University of Windsor	McKee Park 1	Temperature	2011	-	2011-05-18	2011-11-18	Can't download (corrupt)
	McKee Park 1		2013	-	2013-06-04	2013-11-14	Logger initialized, no record of deployment/retrieval - Estimated dates
	McKee Park 2			-	2013-06-04	2013-11-14	Logger initialized, no record of deployment/retrieval - Estimated dates
Turkey Creek	-	Temperature	2011	-	2011-05-18	2011-11-18	
LaSalle Drain	Inner	Temperature	2011	-	2011-05-18	2011-11-18	
	Inner		2013	1.25	2013-06-04	2013-11-13	
	Outer			1.17	2013-06-04	2013-11-13	Records had the wrong temp logger #
	Inner			0.8	2013-11-13	2014-05-16	Missing - estimated retrieval date
	Outer			0.9	2013-11-13	2014-05-16	Missing - estimated retrieval date
	Inner		2014	1.2	2014-05-16	2014-09-24	
	Inner - Surface			1.2	2014-05-16	2014-09-24	
	Outer			1.2	2014-05-16	2014-09-25	

Site	Subsite	Logger Type	Year	Depth (m)	Deploy Date	Retrieval Date	Notes
LaSalle Drain (con't)	Outer - Surface			1.2	2014-05-16	2014-09-25	
	Inner			1	2014-09-24	2015-05-13	Missing - estimated retrieval date
	Outer			1	2014-09-24	2015-05-13	Missing - estimated retrieval date
	Inner		2015	1.1	2015-05-13	2015-10-30	
	Outer			1.3	2015-05-13	2015-10-30	
	Inner			1.2	2015-10-30	2016-04-13	
	Inner		2016	1.5	2016-04-14	2016-10-25	
	Inner		2017	-	2016-10-26	2017-09-11	
	Inner		2018	-	2017-09-11	-	Currently logging
Hotte Marine	-	Temperature	2011	-	2011-05-18	2011-11-18	Can't download (corrupt)
Off Channel	-	Temperature	2011	1.25	2011-07-06	2011-11-18	Missing - estimated retrieval date
Fighting Island	-	Temperature	2007	1.4	2007-07-04	2007-09-18	
Upstream of Canard	Upper	Temperature	2011	-	2011-05-18	2011-11-18	
	Lower			1.17	2011-07-06	2011-11-23	Can't download (corrupt)
	Lower		2012	-	2012-05-24	2012-10-07	Assumed GPS; assumed dates based on data; data appears buried – not valid
	Confluence		2013	1.25	2013-06-04	2013-11-13	No record of retrieval - potentially still at location
	Lower			1.14	2013-06-04	2013-11-13	No record of retrieval - potentially still at location
Protected Backwater Bay	Outer	Temperature	2011	1.3	2011-07-06	2011-11-18	Missing; wrong coordinates or site name - estimated retrieval date
	Inner			1.35	2011-07-06	2014-05-05	Missing and found May 5, 2014; not initialized correctly
	Inner		2013	1	2013-06-04	2013-11-14	Missing - estimated retrieval date
	Outer			1.4	2013-06-04	2013-11-14	Missing - estimated retrieval date
	Inner			1	2013-11-14	2014-05-15	
	Outer			1.5	2013-11-14	2014-05-15	Messed up; supposed to be bottom; found at surface; froze overwinter
	Inner		2014	1.3	2014-05-15	2014-07-14	Removed early - redundant w/ DO logger; covered in bryozoan - removed bad data
	Inner - Surface			1.3	2014-05-15	2014-09-25	Missing - estimated retrieval date
	Outer			1.2	2014-05-15	2014-09-25	
	Outer - Surface			1.2	2014-05-15	2014-09-25	Missing - estimated retrieval date
	Inner			0.7	2014-09-25	2015-05-14	

Site	Subsite	Logger Type	Year	Depth (m)	Deploy Date	Retrieval Date	Notes
Protected Backwater Bay (con't)	Outer			2.1	2014-09-25	2015-05-14	Missing - estimated retrieval date
	Inner		2015	1.6	2015-05-13	2015-10-30	
	Outer			1.6	2015-05-13	2015-10-30	
	Outer			1.5	2015-10-30	2016-04-13	
	Inner		2016	1.75	2016-04-14	2016-10-25	
	Inner		2017	-	2016-10-26	2017-09-11	
	Inner		2018	-	2017-09-11	-	Currently logging
	Inner	Dissolved Oxygen	2014	1.3	2014-05-15	2014-09-25	Covered in bryozoan for a period before cleaning - removed portion of data
	Inner		2015	1.6	2015-05-13	2015-10-30	
Amherstburg	Inner	Temperature	2007	1.2	2007-07-05	2007-09-17	
	Inner		2013	1.44	2013-06-04	2013-11-14	
	Outer			1.33	2013-06-04	2013-11-14	
	Inner		2014	1.2	2014-05-15	2014-09-25	Missing - estimated retrieval date
	Inner - Surface			1.2	2014-05-15	2014-09-25	
	Outer			1.2	2014-05-15	2014-09-25	Missing - estimated retrieval date
	Outer - Surface			1.2	2014-05-15	2014-09-25	
	Inner			0.5	2014-09-25	2015-05-14	Missing - estimated retrieval date
	Outer			0.6	2014-09-25	2015-05-14	Missing - estimated retrieval date
	Inner		2015	1.3	2015-05-14	2015-10-30	
	Outer			1.7	2015-05-14	2015-10-30	
	Inner			1.4	2015-10-30	2016-04-13	
	Inner		2016	1.5	2016-04-14	2016-10-25	
	Inner		2017	-	2016-10-26	2017-09-11	
	Inner		2018	-	2017-09-11	-	Currently logging

Table 2. Summary of long-term temperature, water level, and dissolved oxygen (DO) monitoring deployments in the St. Clair River. From upstream to downstream sites within the St. Clair River, site, subsite, logger type (temperature, water level or DO), year, instrument depth, deployment and retrieval dates, and any issues with the data are noted.

Site	Subsite	Logger Type	Year	Depth (m)	Deployment Date	Retrieval Date	Notes
Point Edward	-	Temperature	2011	-	2011-04-29	2011-12-22	
	-		2012	-	2012-06-05	2012-08-13	Retrieved on Nov 9, 2012; memory filled by Aug 13, 2012 - logged every 5 min - not 30 min
	-		2013	-	2013-06-04	2013-11-28	Assumed GPS
	-		2014	-	2014-05-15	2014-09-17	Estimated deploy date; pulled out of water from July 22- Aug 19 - deleted associated data
	Surface			-	2014-05-15	2014-09-17	Estimated deploy date; pulled out of water from July 22- Aug 19 - deleted associated data
	-			-	2014-09-23	2015-05-12	
	-		2015	2.3	2015-05-12	2015-10-28	
	-		2016	1.5	2016-04-13	2016-10-26	
	-			2.0	2016-10-27	2017-05-01	
	-		2017	-	2017-05-03	2017-09-12	
	-			-	2017-09-13	-	Currently logging
	-	DO	2014	-	2014-05-15	2014-09-17	Surface?; Estimated deploy date from logger
	-		2015	2.3	2015-05-12	2015-10-28	
Baby Creek	-	Temperature	2012	-	2012-06-05	2012-08-13	Retrieved on Nov 9, 2012; memory filled by Aug 13, 2012 - logged every 5 min - not 30 min
	-		2013		2013-05-30	2013-10-30	Assumed GPS
	-		2014		2014-05-15	2014-09-17	Estimated deploy date; pulled out of water from July 22- Aug 19 - deleted associated data
	-				2014-09-23	2015-05-12	
	-		2015	0.50	2015-05-12	2015-10-28	
	-		2016	1.5	2016-04-13	2016-10-26	
	-			-	2016-10-27	2017-05-01	
	-		2017	-	2017-05-03	2017-09-12	

Site	Subsite	Logger Type	Year	Depth (m)	Deployment Date	Retrieval Date	Notes
	-			1.5	2017-09-13	-	Currently logging
Cathcart Park	-	Temperature	2011	-	2011-04-29	2011-12-12	
	-		2012	-	2012-06-05	2012-11-09	Missing
	-		2013	-	2013-05-30	2013-10-30	Assumed GPS
	-		2014	-	2014-05-15	2014-09-17	Estimated deploy date; pulled out of water from July 22- Aug 19 - deleted associated data
	-			-	2014-09-23	2015-05-12	
	-		2015	0.75	2015-05-12	2015-10-28	
	-			1.0	2015-10-28	2016-04-12	
	-		2016	1.5	2016-04-13	2016-10-26	
	-			1.0	2016-10-27	2017-05-01	
	-		2017	-	2017-05-03	2017-09-12	
	-			1.5	2017-09-13	-	Currently logging
	-	DO	2015	1.0	2015-10-28	2016-04-12	
	-		2016	1.0	2016-04-13	2016-10-26	
	-		2017	-	2017-05-04	2017-11-03	
Off Channel	-	Temperature	2011	0.90	2011-07-05	2011-11-23	
Marshy Creek	-	Temperature	2011	-	2011-04-29	2011-12-22	
	-		2012	-	2012-06-05	2012-08-13	Retrieved on Nov 9, 2012; memory filled by Aug 13, 2012 - logged every 5 min - not 30 min
	-		2013	-	2013-05-30	2013-10-30	Assumed GPS
	-		2014	-	2014-05-15	2014-09-17	Estimated deploy date from logger
	-			-	2014-09-23	2015-05-12	
	-		2015	0.70	2015-05-12	2015-10-28	
	-		2016	1.2	2016-04-13	2016-10-26	
	-			-	2016-10-27	2017-05-01	
	-		2017	-	2017-05-03	2017-09-12	
Marshy Creek	-			1.5	2017-09-13	-	Currently logging
McDonald Park	-	Temperature	2014	-	2014-09-23	2015-05-12	
	-		2015	0.70	2015-05-12	2015-10-28	
	-			1.2	2015-10-28	2016-04-12	
	-		2016	1.1	2016-04-13	2016-10-26	
	-			1.0	2016-10-27	2017-05-01	
	-		2017	-	2017-05-04	2017-11-03	

Site	Subsite	Logger Type	Year	Depth (m)	Deployment Date	Retrieval Date	Notes
McDonald Park (con't)	-	DO	2015	1.2	2015-10-28	2016-04-12	
	-		2016	1.05	2016-04-13	2016-10-26	
	-			-	2016-10-27	2017-05-01	Logger malfunction
	-		2017	-	2017-05-04	2017-11-03	
Chenal Ecarte	1	Temperature	2013	1.4	2013-06-03	2013-11-20	Missing
	2			1.3	2013-06-03	2013-11-20	Missing
	1			-	2013-11-20	2014-05-14	Missing
	2			-	2013-11-20	2014-05-14	Missing
	1		2014	-	2014-05-14	2014-09-23	Missing
	1 - Surface			-	2014-05-14	2014-09-23	Missing
	2			-	2014-05-14	2014-09-23	Missing
	2 - Surface			-	2014-05-14	2014-09-23	Missing
Swan Lake	Inner - Surface	Temperature	2014	-	2014-08-21	2014-10-02	Estimated deploy/retrieve date from logger
	Outer			-	2014-08-21	2014-10-02	Estimated deploy/retrieve date from logger
	Outer - Surface			-	2014-08-21	2014-10-02	Estimated deploy/retrieve date from logger
	Inner			-	2014-10-02	2015-10-29	Estimated deploy date from logger
	Outer			-	2014-10-02	2015-10-29	Estimated deploy date from logger
	Inner	Level	2014	-	2014-08-21	2014-10-02	
	Outer			-	2014-08-21	2014-10-02	
	Inner	DO	2014	-	2014-08-21	2014-10-02	Estimated deploy/retrieve date from logger; logger suspected to be buried
Goose Bay	-	Temperature	2015	0.98	2015-07-30	2015-09-19	
	-		2016	-	2016-08-07	2016-12-08	
	-	DO	2015	0.98	2015-07-30	2015-09-19	
	-		2016	-	2016-08-07	2016-12-08	Buried – no data
Johnston's Bay	-	Temperature	2015	0.94	2015-07-30	2015-09-23	
	-	DO	2015	0.94	2015-07-30	2015-09-23	
St. Anne's Bay	-	Temperature	2015	1.2	2015-07-30	2015-10-22	
	-	DO	2015	1.2	2015-07-30	2015-10-22	
Volkswagen Bay	-	Temperature	2015	1.2	2015-07-30	2015-09-25	
	-	DO	2015	1.2	2015-07-30	2015-09-25	

Site	Subsite	Logger Type	Year	Depth (m)	Deployment Date	Retrieval Date	Notes
Mitchell's Bay	Inner	Temperature	2013	1.3	2013-06-03	2013-11-20	
	Outer			1.5	2013-06-03	2013-11-20	
	Inner		2014	-	2014-05-13	2014-07-15	Removed early; redundant with DO logger
	Inner - Surface			-	2014-05-13	2014-09-24	
	Outer			-	2014-05-13	2014-09-24	
	Outer - Surface			-	2014-05-13	2014-09-24	
	Inner			-	2014-09-24	2015-05-13	
	Outer			-	2014-09-24	2015-05-13	
	Inner		2015	1.3	2015-05-13	2015-10-27	Loggers tangled on anchor; tampered?
	Outer			1.6	2015-05-13	2015-10-27	
	Outer			1.4	2015-10-27	2016-04-12	Missing
	Inner		2016	1.4	2016-04-12	2016-10-25	
	Outer			1.8	2016-04-12	2016-10-25	
	Inner		2017	-	2016-10-26	2017-09-13	
	Outer			-	2016-10-26	2017-09-13	
	Inner			1.5	2017-09-13	-	Currently logging
	Inner	DO	2014	-	2014-05-13	2014-09-24	
	Inner		2015	1.3	2015-05-13	2015-10-27	Loggers tangled on anchor; tampered?

Table 3. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the Detroit River in 2007.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Summer	Peche Island - Outer	23.23	1.41	26.47	19.50	58
	Fighting Island	22.91	1.29	25.51	20.12	58
	Amherstburg - Inner	23.75	1.58	28.01	20.43	57
Fall	Peche Island - Outer	21.28	2.17	24.68	16.77	19
	Fighting Island	21.58	1.78	23.61	17.69	17
	Amherstburg - Inner	22.14	2.24	25.69	16.72	16

Table 4. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the Detroit River in 2011.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Turkey Creek	18.19	3.04	25.65	12.87	13
	LaSalle Drain - Inner	15.05	1.31	19.65	11.78	13
	Upstream Canard	19.03	3.35	26.70	12.78	13
Summer	Turkey Creek	24.33	2.36	31.23	16.70	92
	LaSalle Drain - Inner	23.60	3.11	31.26	15.37	92
	Upstream Canard	25.36	2.55	32.38	19.44	92
Fall	Turkey Creek	15.17	4.70	29.34	4.53	78
	LaSalle Drain - Inner	15.08	4.95	30.24	4.87	78
	Upstream Canard	14.51	5.33	29.46	-0.12	78

Table 5. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the Detroit River in 2013.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Summer	Peche Island - Inner	22.80	2.75	29.67	15.34	89
	Peche Island - Outer	21.97	2.49	27.85	15.58	89
	LaSalle Drain - Inner	22.14	2.41	27.73	16.34	88
	LaSalle Drain - Outer	22.25	2.40	28.39	16.30	88
	Amherstburg - Inner	22.25	2.39	27.68	16.39	88
	Amherstburg - Outer	22.22	2.38	27.43	16.39	88
Fall	Peche Island - Inner	15.45	6.00	26.72	2.77	79
	Peche Island - Outer	15.32	5.65	24.99	3.83	79
	LaSalle Drain - Inner	16.18	5.20	24.75	2.74	73
	LaSalle Drain - Outer	16.19	5.24	25.19	2.64	73
	Protected Backwater Bay - Inner	5.57	2.30	11.47	1.62	16
	Amherstburg - Inner	16.06	5.30	25.14	4.66	74
	Amherstburg - Outer	16.05	5.29	24.94	4.58	74
Winter	Protected Backwater Bay - Inner	3.18	1.30	6.43	0.22	31

Table 6. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the Detroit River in 2014.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Peche Island - Inner - Surface	15.85	2.71	22.06	10.03	17
	Peche Island - Inner	14.92	2.29	20.46	9.95	17
	Peche Island - Outer - Surface	14.28	2.19	19.44	10.76	17
	Peche Island - Outer	14.23	2.17	19.41	10.76	17
	LaSalle Drain - Inner - Surface	15.47	2.24	20.27	11.69	15
	LaSalle Drain - Inner	15.12	2.07	19.37	11.66	15
	LaSalle Drain - Outer - Surface	15.17	2.10	19.87	11.64	15
	LaSalle Drain - Outer	14.97	1.98	18.91	11.66	15
	Protected Backwater Bay - Inner	8.89	5.62	21.58	1.59	91
	Protected Backwater Bay - Outer	17.07	2.10	20.75	13.50	16
	Amherstburg - Inner - Surface	14.89	2.00	19.18	11.71	16
	Amherstburg - Outer - Surface	15.15	2.05	19.60	11.69	16
Summer	Peche Island - Inner - Surface	22.39	1.85	27.28	16.20	92
	Peche Island - Inner	22.02	1.87	26.30	15.99	92
	Peche Island - Outer - Surface	21.77	1.68	25.67	16.39	92
	Peche Island - Outer	21.69	1.66	25.57	16.37	92
	LaSalle Drain - Inner - Surface	22.40	2.01	28.77	17.03	92
	LaSalle Drain - Inner	21.64	1.49	24.65	17.03	92
	LaSalle Drain - Outer - Surface	21.92	1.71	27.09	17.03	92
	LaSalle Drain - Outer	21.65	1.53	24.73	17.06	92
	Protected Backwater Bay - Inner	22.82	1.34	26.40	18.94	72
	Protected Backwater Bay - Outer	23.10	1.32	26.16	19.22	92
	Amherstburg - Inner - Surface	21.85	1.60	25.89	17.34	92
	Amherstburg - Outer - Surface	22.01	1.60	26.01	17.39	92
Fall	Peche Island - Inner - Surface	20.43	2.63	27.04	15.61	24
	Peche Island - Inner	12.56	6.89	26.87	0.00	90
	Peche Island - Outer - Surface	20.50	2.42	25.48	16.25	24
	Peche Island - Outer	12.84	6.76	25.43	0.30	90
	LaSalle Drain - Inner - Surface	20.99	2.82	28.35	16.06	24
	LaSalle Drain - Inner	20.35	2.59	25.02	16.11	23
	LaSalle Drain - Outer - Surface	20.68	2.61	26.57	16.39	24
	LaSalle Drain - Outer	20.42	2.55	25.36	15.82	24
	Protected Backwater Bay - Inner	14.51	6.36	26.34	0.19	90
	Protected Backwater Bay - Outer	21.72	2.36	26.09	18.25	24
	Amherstburg - Inner - Surface	20.66	2.52	25.84	16.51	24
	Amherstburg - Outer - Surface	20.69	2.58	26.04	16.44	24
Winter	Peche Island - Inner	2.21	0.85	4.32	-0.12	31
	Peche Island - Outer	2.23	0.72	3.54	0.22	31
	Protected Backwater Bay - Inner	2.85	1.16	7.52	1.21	90

Table 7. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the Detroit River in 2015.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Peche Island - Inner	6.89	5.88	18.96	0.02	91
	Peche Island - Outer	6.27	5.49	17.08	-0.03	91
	LaSalle Drain - Inner	15.05	1.75	19.32	10.66	18
	LaSalle Drain - Outer	14.70	1.63	19.63	10.71	18
	Protected Backwater Bay - Inner	9.11	5.81	21.46	1.10	91
	Protected Backwater Bay - Outer	17.69	1.78	21.39	14.51	17
	Amherstburg - Inner	15.04	1.53	18.53	11.69	17
	Amherstburg - Outer	14.82	1.43	17.65	11.73	17
Summer	Peche Island - Inner	21.31	2.48	26.55	13.71	92
	Peche Island - Outer	21.20	2.41	25.96	14.46	92
	LaSalle Drain - Inner	21.26	2.16	26.16	14.27	92
	LaSalle Drain - Outer	21.22	2.21	25.57	14.34	92
	Protected Backwater Bay - Inner	22.52	2.32	27.55	14.60	92
	Protected Backwater Bay - Outer	22.71	2.30	27.51	15.20	92
	Amherstburg - Inner	21.56	2.39	26.62	14.15	92
	Amherstburg - Outer	21.41	2.36	26.04	14.19	92
Fall	Peche Island - Inner	17.68	4.30	25.99	9.83	58
	Peche Island - Outer	14.77	5.49	25.87	5.39	90
	LaSalle Drain - Inner	14.43	5.43	24.70	3.67	90
	LaSalle Drain - Outer	17.51	4.24	24.80	10.47	59
	Protected Backwater Bay - Inner	19.23	3.90	26.43	12.75	59
	Protected Backwater Bay - Outer	16.03	5.64	26.52	5.62	90
	Amherstburg - Inner	14.77	5.72	26.09	4.77	90
	Amherstburg - Outer	17.79	4.33	25.04	10.79	59
Winter	Peche Island - Inner	0.14	0.11	0.99	0.02	59
	Peche Island - Outer	2.00	2.65	7.95	0.02	90
	LaSalle Drain - Inner	5.14	1.04	7.80	2.85	31
	Protected Backwater Bay - Inner	1.89	0.48	4.79	0.02	59
	Protected Backwater Bay - Outer	6.18	0.94	8.32	4.25	31
	Amherstburg - Inner	5.15	1.00	7.52	3.35	31

Table 8. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the Detroit River in 2016.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Peche Island - Outer	7.52	4.43	18.13	0.08	91
	LaSalle Drain - Inner	8.23	4.47	18.22	0.08	91
	Protected Backwater Bay - Outer	9.39	4.81	22.54	1.72	91
	Amherstburg - Inner	8.30	4.51	18.32	0.16	91
Summer	Peche Island - Outer	23.20	2.61	27.90	16.80	92
	LaSalle Drain - Inner	23.27	2.47	27.60	16.63	92
	Protected Backwater Bay - Outer	24.58	2.34	28.64	18.41	92
	Amherstburg - Inner	23.44	2.51	27.68	17.01	92
Fall	Peche Island - Outer	15.36	5.92	24.92	3.25	91
	LaSalle Drain - Inner	15.24	5.95	24.61	3.35	90
	Protected Backwater Bay - Outer	16.96	5.86	26.77	6.18	90
	Amherstburg - Inner	15.46	6.04	25.33	4.77	90
Winter	Peche Island - Outer	1.10	1.74	7.02	-0.06	91
	LaSalle Drain - Inner	1.10	1.43	6.23	-0.09	91
	Protected Backwater Bay - Outer	3.08	1.35	7.75	0.25	91
	Amherstburg - Inner	0.99	1.48	6.13	-0.09	91

Table 9. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the Detroit River in 2017.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Peche Island - Outer	7.63	4.89	16.39	-0.03	92
	LaSalle Drain - Inner	8.26	5.10	18.99	-0.09	92
	Protected Backwater Bay - Outer	9.56	4.90	18.89	0.85	92
	Amherstburg - Inner	8.24	5.03	17.23	-0.09	92
Summer	Peche Island - Outer	21.94	2.25	25.94	15.10	92
	LaSalle Drain - Inner	22.07	2.11	25.84	15.63	92
	Protected Backwater Bay - Outer	23.31	1.96	27.43	17.42	92
	Amherstburg - Inner	22.12	2.15	26.13	15.65	92
Fall	Peche Island - Outer	19.47	0.80	21.13	17.84	11
	LaSalle Drain - Inner	19.32	0.81	21.01	17.82	11
	Protected Backwater Bay - Outer	20.81	0.75	22.23	19.25	11
	Amherstburg - Inner	19.47	0.84	21.34	17.82	11
Winter	Peche Island - Outer	0.77	0.88	3.80	-0.09	59
	LaSalle Drain - Inner	0.91	1.00	5.18	-0.06	59
	Protected Backwater Bay - Outer	2.98	1.12	6.61	0.63	59
	Amherstburg - Inner	0.82	1.07	4.51	-0.03	59

Table 10. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled over time at Peche Island – Outer subsite, Detroit River.

Season	Year	Mean	SD	Max	Min	# Days Sampled
Spring	2014	14.23	2.17	19.41	10.76	17
	2015	6.27	5.49	17.08	-0.03	91
	2016	7.52	4.43	18.13	0.08	91
	2017	7.63	4.89	16.39	-0.03	92
Summer	2007	23.23	1.41	26.47	19.50	58
	2013	21.97	2.49	27.85	15.58	89
	2014	21.69	1.66	25.57	16.37	92
	2015	21.20	2.41	25.96	14.46	92
	2016	23.20	2.61	27.90	16.80	92
	2017	21.94	2.25	25.94	15.10	92
Fall	2007	21.28	2.17	24.68	16.77	19
	2013	15.32	5.65	24.99	3.83	79
	2014	12.84	6.76	25.43	0.30	90
	2015	14.77	5.49	25.87	5.39	90
	2016	15.36	5.92	24.92	3.25	91
	2017	19.47	0.80	21.13	17.84	11
Winter	2014	2.23	0.72	3.54	0.22	31
	2015	2.00	2.65	7.95	0.02	90
	2016	1.10	1.74	7.02	-0.06	91
	2017	0.77	0.88	3.80	-0.09	59

Table 11. Results from Mann-Kendal trend analysis on Detroit River temperature data for the summer (June to September). Only sites with four or more years were analyzed and no significant trends were found (P >0.05).

Site	*n* Years	*P*-value	Score	Slope	Variance Score	Tau	Years Included
Peche Island - Outer	6	0.45	-5.00	15.00	28.33	-0.33	2007 2013 2014 2015 2016 2017
Amherstburg - Inner	5	0.46	-4.00	10.00	16.67	-0.40	2007 2013 2015 2016 2017
LaSalle Drain - Inner	6	0.45	-5.00	15.00	28.33	-0.33	2011 2013 2014 2015 2016 2017
Protected Backwater Bay - Outer	4	0.73	2.00	6.00	8.67	0.33	2014 2015 2016 2017

Table 12. Monthly occurrence (%) of dissolved oxygen (mg/L) falling below the 5 mg/L and 3 mg/L thresholds at Protected Backwater Bay, Detroit River in 2014 and 2015.

Year	Month	Measurement Frequency	% below 5 mg/L	% below 3 mg/L
2014	May	768	0.00	0.00
	Jun	1085	0.00	0.00
	Jul	831	40.80	14.60
	Aug	1488	4.20	1.40
	Sep	1152	11.50	1.70
2015	May	864	0.0	0.00
	Jun	1440	0.10	0.00
	Jul	1488	0.40	0.00
	Aug	1488	2.00	0.00
	Sep	1440	26.80	10.10
	Oct	1392	0.10	0.00

Table 13. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the St. Clair River in 2011.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Point Edward	10.87	1.85	16.89	6.69	32
	Cathcart Park	12.82	1.93	18.53	7.92	32
	Marshy Creek	9.58	1.79	13.04	5.10	32
Summer	Point Edward	21.13	3.50	25.89	11.95	92
	Cathcart Park	22.03	3.75	29.44	13.28	92
	Off Channel	22.66	1.53	25.21	18.01	57
	Marshy Creek	20.10	4.02	25.84	11.13	92
Fall	Point Edward	14.18	5.05	25.26	5.90	91
	Cathcart Park	15.39	5.29	27.19	3.56	91
	Off Channel	14.89	4.24	24.27	7.72	83
	Marshy Creek	14.26	4.68	24.99	4.82	91
Winter	Point Edward	4.51	0.91	6.08	2.77	21
	Cathcart Park	3.49	1.66	7.19	0.05	11
	Marshy Creek	5.63	0.67	7.02	3.83	21

Table 14. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the St. Clair River in 2012.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Summer	Point Edward	23.26	2.03	26.70	17.06	68
	Baby Creek	21.70	2.74	28.39	14.94	68
	Marshy Creek	21.55	2.78	26.55	14.77	68

Table 15. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites along the St. Clair River and Lake St. Clair in 2013.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Baby Creek	18.20	1.03	20.39	15.70	1
	Cathcart Park	19.15	1.51	22.54	15.87	1
	Marshy Creek	13.54	0.71	14.79	12.56	1
Summer	Point Edward	21.20	2.86	26.52	13.31	88
	Baby Creek	20.00	2.67	26.92	11.90	92
	Cathcart Park	22.07	2.65	28.64	14.48	92
	Marshy Creek	19.81	3.27	25.96	11.37	92
	Mitchell's Bay - Inner	21.84	2.91	29.12	13.93	89
	Mitchell's Bay - Outer	21.70	2.77	28.72	14.07	89
Fall	Point Edward	14.61	5.98	23.86	2.07	88
	Baby Creek	17.06	3.50	23.11	8.12	59
	Cathcart Park	19.70	3.24	26.21	10.08	59
	Marshy Creek	17.78	3.29	23.62	9.71	59
	Mitchell's Bay - Inner	14.84	5.75	25.31	0.69	80
	Mitchell's Bay - Outer	14.74	5.67	24.61	0.83	80

Table 16. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the St. Clair River, St. Clair delta, and Lake St. Clair in 2014.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Point Edward - Surface	12.58	1.76	17.11	9.73	16
	Point Edward	11.99	1.54	16.28	8.77	16
	Baby Creek	13.72	2.08	19.72	9.04	16
	Cathcart Park	14.86	1.84	19.18	11.05	16
	Marshy Creek	10.60	1.68	14.75	7.95	16
	Mitchell's Bay - Inner Surface	14.95	2.53	23.02	11.47	17
	Mitchell's Bay - Inner	14.00	1.54	20.58	11.38	18
	Mitchell's Bay - Outer Surface	16.59	3.14	23.81	12.27	17
	Mitchell's Bay - Outer	16.04	2.90	23.57	12.17	17
Summer	Point Edward - Surface	20.10	2.31	24.29	14.15	92
	Point Edward	19.75	2.37	23.56	13.38	92
	Baby Creek	18.87	2.27	22.75	12.49	92
	Cathcart Park	20.23	2.38	25.45	14.79	63
	Marshy Creek	18.59	2.55	22.82	12.41	92
	Swan Lake - Inner Surface	23.06	1.49	27.43	19.58	10
	Swan Lake - Inner	20.60	0.68	21.54	19.20	10
	Swan Lake - Outer Surface	21.68	0.42	23.30	20.98	10
	Swan Lake - Outer	21.65	0.35	22.51	21.03	10
	Mitchell's Bay - Inner Surface	20.28	2.29	27.51	14.48	92
	Mitchell's Bay - Inner	19.79	2.14	27.18	14.36	92
	Mitchell's Bay - Outer Surface	21.77	2.41	28.69	14.29	92
	Mitchell's Bay - Outer	21.17	2.31	28.59	14.00	92
Fall	Point Edward - Surface	21.21	1.85	24.46	17.49	16
	Point Edward	14.12	6.43	23.98	1.26	84
	Baby Creek	12.47	5.42	22.82	0.91	84
	Cathcart Park	13.74	6.07	25.11	0.74	84
	Marshy Creek	12.88	5.21	22.59	3.43	84
	McDonald Park	11.40	4.24	18.68	4.27	68
	Swan Lake - Inner Surface	18.44	3.49	27.31	12.46	31
	Swan Lake - Inner	10.66	5.48	21.08	-0.17	90
	Swan Lake - Outer Surface	18.94	2.09	24.15	16.23	31
	Swan Lake - Outer	13.10	5.45	22.42	2.82	90
	Mitchell's Bay - Inner Surface	19.66	2.40	24.87	16.23	23
	Mitchell's Bay - Inner	12.91	5.70	23.42	-0.12	90
	Mitchell's Bay - Outer Surface	19.87	2.77	25.91	15.37	23
	Mitchell's Bay - Outer	12.47	6.31	25.55	-0.09	90
Winter	Point Edward	2.48	0.70	4.40	0.85	31
	Baby Creek	3.52	0.86	6.08	0.63	31
	Cathcart Park	5.22	1.19	7.70	0.77	31
	Marshy Creek	3.66	0.70	5.90	1.21	31
	McDonald Park	3.74	0.66	5.82	1.72	31
	Swan Lake - Inner	3.27	0.97	5.69	0.99	31
	Swan Lake - Outer	3.51	0.61	5.26	1.56	31
	Mitchell's Bay - Inner	3.32	0.79	5.05	-0.09	31
	Mitchell's Bay - Outer	2.77	0.98	5.15	0.00	31

Table 17. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the St. Clair River, St. Clair delta, and Lake St. Clair in 2015.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Point Edward	5.57	4.49	15.99	0.02	91
	Baby Creek	5.81	4.50	16.44	0.02	91
	Cathcart Park	8.04	5.07	17.87	0.02	91
	Marshy Creek	4.62	4.09	13.16	0.02	91
	McDonald Park	4.50	4.01	12.97	0.02	91
	Swan Lake - Inner	10.98	6.86	26.55	1.32	92
	Swan Lake - Outer	5.63	4.40	14.19	-0.03	92
	Mitchell's Bay - Inner	6.57	6.22	22.63	-5.92	91
	Mitchell's Bay - Outer	7.44	6.56	23.91	0.02	90
Summer	Point Edward	19.33	3.38	24.92	10.79	92
	Baby Creek	18.82	2.65	23.98	11.35	92
	Cathcart Park	20.44	2.58	25.38	11.66	92
	Marshy Creek	18.39	3.11	23.21	10.08	92
	McDonald Park	18.35	3.09	23.06	10.35	92
	Swan Lake - Inner	22.75	3.69	34.68	11.42	92
	Swan Lake - Outer	19.41	2.58	23.62	12.49	92
	Goose Bay	23.66	2.25	28.46	17.98	32
	Johnston's Bay	23.24	1.96	27.14	18.01	32
	St. Anne's Bay	22.97	1.74	27.24	18.18	32
	Volkswagon Bay	24.22	2.28	28.67	18.39	32
	Mitchell's Bay - Inner	19.91	2.47	25.23	11.78	92
	Mitchell's Bay - Outer	20.98	2.68	26.55	11.30	92
Fall	Point Edward	17.77	3.87	23.95	11.25	57
	Baby Creek	17.25	3.55	23.09	10.69	57
	Cathcart Park	15.43	5.02	25.31	7.14	90
	Marshy Creek	17.30	3.51	23.21	11.52	57
	McDonald Park	14.75	4.54	22.85	7.04	90
	Swan Lake - Inner	15.69	4.69	24.99	6.03	58
	Swan Lake - Outer	17.46	3.56	23.16	11.93	58
	Goose Bay	23.48	2.94	28.54	17.06	19
	Johnston's Bay	22.17	2.51	27.01	16.73	22
	St. Anne's Bay	18.11	4.59	27.16	7.77	51
	Volkswagon Bay	23.08	3.11	28.72	16.73	24
	Mitchell's Bay - Inner	17.75	3.61	24.07	11.20	56
	Mitchell's Bay - Outer	17.53	3.97	25.26	9.51	56
Winter	Point Edward	0.13	0.12	0.85	0.00	59
	Baby Creek	0.18	0.27	1.70	0.00	59
	Cathcart Park	3.71	3.15	10.74	-0.03	90
	Marshy Creek	0.15	0.34	1.86	0.02	59
	McDonald Park	2.39	3.13	8.27	0.00	90
	Swan Lake - Inner	2.64	0.80	4.53	1.59	59
	Swan Lake - Outer	0.13	0.31	1.56	-0.03	59
	Mitchell's Bay - Inner	-1.62	2.35	1.56	-9.13	59
	Mitchell's Bay - Outer	0.31	0.23	1.40	0.00	59

Table 18. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the St. Clair River, St. Clair delta, and Lake St. Clair in 2016.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Point Edward	9.25	2.08	14.77	4.53	48
	Baby Creek	9.52	2.24	16.30	4.45	48
	Cathcart Park	8.70	3.79	16.58	0.08	91
	Marshy Creek	8.48	2.32	13.11	3.22	48
	McDonald Park	5.68	3.48	13.02	0.02	91
	Mitchell's Bay - Inner	11.34	4.58	24.22	4.38	49
	Mitchell's Bay - Outer	12.17	4.58	25.28	4.40	49
Summer	Point Edward	21.19	3.09	25.77	11.66	92
	Baby Creek	20.64	3.03	25.67	13.04	92
	Cathcart Park	21.86	2.94	27.41	13.40	92
	Marshy Creek	20.43	3.14	25.60	12.07	92
	McDonald Park	20.37	3.11	25.09	12.03	92
	Goose Bay	25.44	1.02	28.06	23.48	25
	Mitchell's Bay - Inner	21.68	2.82	27.01	14.07	92
	Mitchell's Bay - Outer	23.02	2.89	28.62	15.03	92
Fall	Point Edward	15.08	5.46	24.15	5.33	90
	Baby Creek	14.44	5.26	23.95	2.85	90
	Cathcart Park	15.77	5.27	25.53	5.87	90
	Marshy Creek	14.86	4.89	23.93	7.27	90
	McDonald Park	14.91	4.85	23.47	7.65	90
	Goose Bay	15.10	5.92	25.24	4.02	91
	Mitchell's Bay - Inner	14.90	5.25	24.27	1.78	91
	Mitchell's Bay - Outer	18.50	3.90	24.58	1.78	55
Winter	Point Edward	2.64	2.29	7.34	0.38	31
	Baby Creek	3.08	1.97	8.10	0.19	31
	Cathcart Park	2.64	2.22	9.19	-0.03	91
	Marshy Creek	4.47	1.99	8.12	1.32	31
	McDonald Park	2.59	2.17	8.15	0.02	91
	Goose Bay	4.51	1.43	8.02	1.26	8
	Mitchell's Bay - Inner	3.12	2.08	7.80	-0.09	31

Table 19. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled at different sites (and subsites) along the St. Clair River and Lake St. Clair in 2017.

Season	Site	Mean	SD	Max	Min	# Days Sampled
Spring	Point Edward	7.03	3.94	15.49	0.58	91
	Baby Creek	7.31	4.20	16.37	0.00	91
	Cathcart Park	9.04	4.58	19.67	-0.03	91
	Marshy Creek	5.67	3.95	14.17	-0.03	91
	McDonald Park	5.48	3.93	13.62	-0.03	90
	Mitchell's Bay - Inner	8.10	4.85	21.37	-0.09	92
Summer	Point Edward	20.36	2.49	23.88	13.83	92
	Baby Creek	19.72	2.66	23.71	12.51	92
	Cathcart Park	20.97	2.48	24.92	13.88	92
	Marshy Creek	19.57	2.78	23.40	12.32	92
	McDonald Park	19.44	2.75	22.82	12.48	92
	Mitchell's Bay - Inner	20.88	2.16	24.68	14.55	92
Fall	Point Edward	19.53	0.60	20.65	18.41	12
	Baby Creek	19.02	0.64	20.46	17.56	12
	Cathcart Park	20.26	0.81	22.13	18.44	12
	Marshy Creek	19.29	0.66	20.53	17.99	12
	McDonald Park	17.60	2.75	20.88	11.32	64
	Mitchell's Bay - Inner	19.68	1.33	27.26	18.11	13
Winter	Point Edward	1.22	0.89	4.35	0.14	59
	Baby Creek	1.53	1.57	9.78	0.00	59
	Cathcart Park	2.01	2.04	10.15	-0.06	59
	Marshy Creek	1.27	1.03	4.06	-0.03	59
	McDonald Park	1.23	0.97	3.80	-0.03	59
	Mitchell's Bay - Inner	1.30	1.44	6.97	-0.14	59

Table 20. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled over years at Point Edward, St. Clair River.

Season	Year	Mean	SD	Max	Min	# Days Sampled
Spring	2011	10.87	1.85	16.89	6.69	32
	2014	11.99	1.54	16.28	8.77	16
	2015	5.57	4.49	15.99	0.02	91
	2016	9.25	2.08	14.77	4.53	48
	2017	7.03	3.94	15.49	0.58	91
Summer	2011	21.13	3.50	25.89	11.95	92
	2012	23.26	2.03	26.70	17.06	68
	2013	21.20	2.86	26.52	13.31	88
	2014	19.75	2.37	23.56	13.38	92
	2015	19.33	3.38	24.92	10.79	92
	2016	21.19	3.09	25.77	11.66	92
	2017	20.36	2.49	23.88	13.83	92
Fall	2011	14.18	5.05	25.26	5.90	91
	2013	14.61	5.98	23.86	2.07	88
	2014	14.12	6.43	23.98	1.26	84
	2015	17.77	3.87	23.95	11.25	57
	2016	15.08	5.46	24.15	5.33	90
	2017	19.53	0.60	20.65	18.41	12
Winter	2011	4.51	0.91	6.08	2.77	21
	2014	2.48	0.70	4.40	0.85	31
	2015	0.13	0.12	0.85	0.00	59
	2016	2.64	2.29	7.34	0.38	31
	2017	1.22	0.89	4.35	0.14	59

Table 21. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled over years at Cathcart Park, St. Clair River.

Season	Year	Mean	SD	Max	Min	# Days Sampled
Spring	2011	12.82	1.93	18.53	7.92	32
	2013	19.15	1.51	22.54	15.87	1
	2014	14.86	1.84	19.18	11.05	16
	2015	8.04	5.07	17.87	0.02	91
	2016	8.70	3.79	16.58	0.08	91
	2017	9.04	4.58	19.67	-0.03	91
Summer	2011	22.03	3.75	29.44	13.28	92
	2013	22.07	2.65	28.64	14.48	92
	2014	20.23	2.38	25.45	14.79	63
	2015	20.44	2.58	25.38	11.66	92
	2016	21.86	2.94	27.41	13.40	92
	2017	20.97	2.48	24.92	13.88	92
Fall	2011	15.39	5.29	27.19	3.56	91
	2013	19.70	3.24	26.21	10.08	59
	2014	13.74	6.07	25.11	0.74	84
	2015	15.43	5.02	25.31	7.14	90
	2016	15.77	5.27	25.53	5.87	90
	2017	20.26	0.81	22.13	18.44	12
Winter	2011	3.49	1.66	7.19	0.05	11
	2014	5.22	1.19	7.70	0.77	31
	2015	3.71	3.15	10.74	-0.03	90
	2016	2.64	2.22	9.19	-0.03	91
	2017	2.01	2.04	10.15	-0.06	59

Table 22. Mean (± standard deviation [SD]), maximum and minimum seasonal water temperature (°C) and number of days sampled over years at Marshy Creek, St. Clair River.

Season	Year	Mean	SD	Max	Min	# Days Sampled
Spring	2011	9.58	1.79	13.04	5.10	32
	2013	13.54	0.71	14.79	12.56	1
	2014	10.60	1.68	14.75	7.95	16
	2015	4.62	4.09	13.16	0.02	91
	2016	8.48	2.32	13.11	3.22	48
	2017	5.67	3.95	14.17	-0.03	91
Summer	2011	20.10	4.02	25.84	11.13	92
	2012	21.55	2.78	26.55	14.77	68
	2013	19.81	3.27	25.96	11.37	92
	2014	18.59	2.55	22.82	12.41	92
	2015	18.39	3.11	23.21	10.08	92
	2016	20.43	3.14	25.60	12.07	92
	2017	19.57	2.78	23.40	12.32	92
Fall	2011	14.26	4.68	24.99	4.82	91
	2013	17.78	3.29	23.62	9.71	59
	2014	12.88	5.21	22.59	3.43	84
	2015	17.30	3.51	23.21	11.52	57
	2016	14.86	4.89	23.93	7.27	90
	2017	19.29	0.66	20.53	17.99	12
Winter	2011	5.63	0.67	7.02	3.83	21
	2014	3.66	0.70	5.90	1.21	31
	2015	0.15	0.34	1.86	0.02	59
	2016	4.47	1.99	8.12	1.32	31
	2017	1.27	1.03	4.06	-0.03	59

Table 23. Results from Mann-Kendal trend analysis on St. Clair River temperature data for the summer (June to September). Only sites with four or more years were analyzed and no significant trends were found (P > 0.05).

Site	*n* Years	*P*-value	Score	Slope	Variance Score	Tau	Years
Cathcart Park	6	0.71	-3.00	15.00	28.33	-0.20	2011 2013 2014 2015 2016 2017
Marshy Creek	7	0.37	-7.00	21.00	44.33	-0.33	2011 2012 2013 2014 2015 2016 2017
Point Edward	7	0.37	-7.00	21.00	44.33	-0.33	2011 2012 2013 2014 2015 2016 2017
Baby Creek	6	0.45	-5.00	15.00	28.33	-0.33	2012 2013 2014 2015 2016 2017
Mitchell's Bay - Inner	4	0.73	-2.00	6.00	8.67	-0.33	2013 2015 2016 2017
Mitchell's Bay - Outer	4	1.00	0.00	6.00	8.67	0.00	2013 2014 2015 2016

Table 24. Monthly occurrence (%) of dissolved oxygen (mg/L) falling below the 5 mg/L and 3 mg/L thresholds at sites in the St. Clair River and Lake St. Clair in 2014.

Site	Month	Measurement Frequency	% below 5 mg/L	% below 3 mg/L
Point Edward	May–Sep	5952	0.00	0.00
Mitchell's Bay - Inner	May	864	0.00	0.00
	Jun	1440	0.00	0.00
	Jul	1488	2.70	0.50
	Aug	1488	15.10	0.30
	Sep	1104	10.00	0.40

Table 25. Monthly occurrence (%) of dissolved oxygen (mg/L) falling below the 5 mg/L and 3 mg/L thresholds at sites in the St. Clair River, St. Clair delta, and Lake St. Clair in 2015. Bolded values exceeded target DO levels.

Site	Month	Measurement Frequency	% below 5 mg/L	% below 3 mg/L
Point Edward	May	912	0.00	0.00
	Jun	1440	0.30	0.20
	Jul	1488	0.10	0.00
	Aug	1488	0.00	0.00
	Sep	1440	0.20	0.00
	Oct	1296	0.00	0.00
Cathcart Park	Oct–Dec	3072	0.00	0.00
McDonald Park	Oct–Dec	3072	0.00	0.00
Goose Bay	Jul	48	25.00	0.00
	Aug	1488	14.10	6.90
	Sep	912	110	4.10
Johnston's Bay	Jul	48	6.30	0.00
	Aug	1488	0.40	0.00
	Sep	1056	0.00	0.00
St. Anne's Bay	Jul	48	0.00	0.00
	Aug	1488	10.10	0.10
	Sep	1440	10.90	0.70
	Oct	1008	0.00	0.00
Volkswagon Bay	Jul–Sep	2688	0.00	0.00
Mitchell's Bay - Inner	May	864	0.00	0.00
	Jun	1440	1.50	0.00
	Jul	1488	0.60	0.00
	Aug–Oct	3696	0.00	0.00

Table 26. Monthly occurrence (%) of dissolved oxygen (mg/L) falling below the 5 mg/L and 3 mg/L thresholds at sites in the St. Clair River in 2016. Bolded values exceeded target DO levels.

Site	Month	Measurement Frequency	% below 5 mg/L	% below 3 mg/L
Cathcart Park	Jan–May	6560	0.00	0.00
	Jun	1440	6.40	0.00
	Jul	1488	5.20	0.50
	Aug	1488	22.20	10.80
	Sep	1440	0.60	0.00
	Oct	1200	2.30	0.20
McDonald Park	Jan–Oct	14304	0.00	0.00

Table 27. Monthly occurrence (%) of dissolved oxygen (mg/L) falling below the 5 mg/L and 3 mg/L thresholds at sites in the St. Clair River in 2017. Bolded values exceeded target DO levels.

Site	Month	Measurement Frequency	% below 5 mg/L	% below 3 mg/L
Cathcart Park	May	1344	26.20	11.00
	Jun	1440	92.80	71.80
	Jul	1488	100.00	99.80
	Aug	1488	99.10	96.00
	Sep	1440	98.50	72.00
	Oct	1488	61.50	37.00
	Nov	144	0.00	0.00
McDonald Park	May–Nov	8832	0.00	0.00
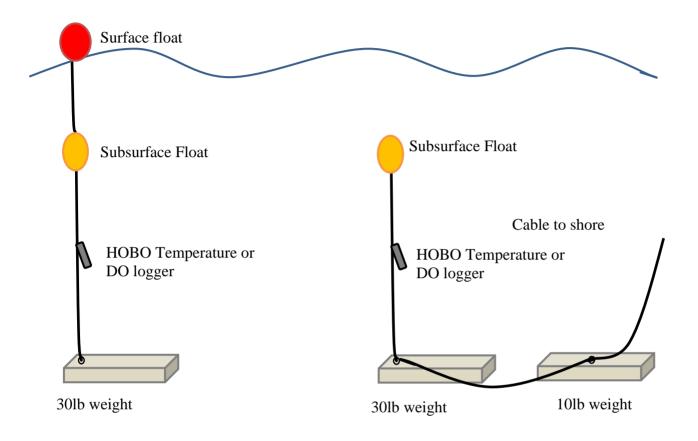
Figure 1. Temperature and dissolved oxygen (DO) logger deployment setups in the Huron Erie Corridor.
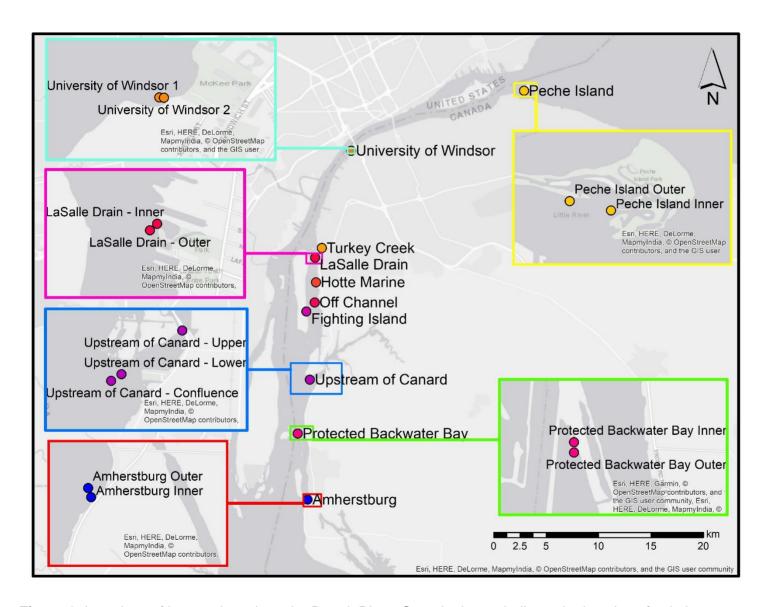
Figure 2. Locations of logger sites along the Detroit River, Canada. Insets indicate the location of subsites.

Figure 3. Summary of long-term temperature deployments and quality of data retrieved in the Detroit River from 2007–2018. Overall, the sites are listed from upstream (Peche Island) to downstream (Amherstburg). Sites and subsites are delineated by dashed lines. The quality of data during the duration of the logger deployment is indicated by colour.
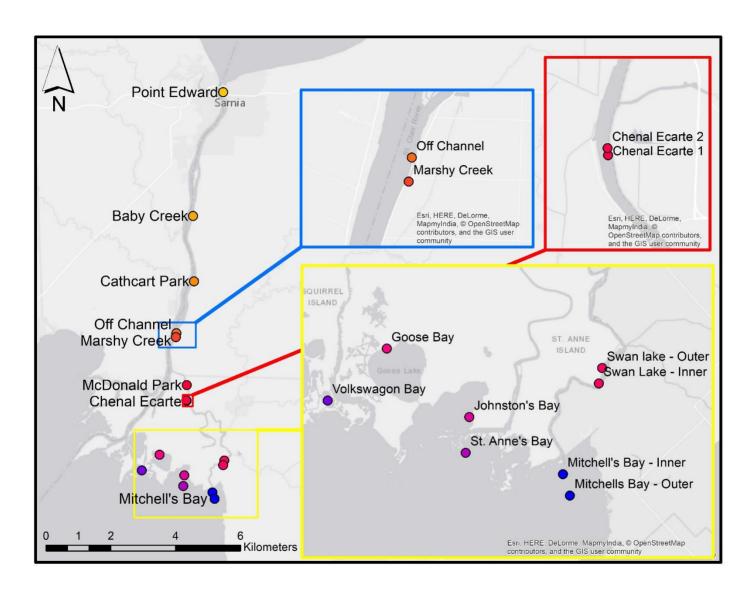
Figure 4. Locations of logger sites along the St. Clair River, Canada.

Figure 5. Summary of long-term temperature-logger deployments and quality of data retrieved in the St. Clair River from 2011–2018. Overall, sites are listed from upstream to downstream: from Point Edward down to McDonald Park in the St. Clair River; Swan Lake to Volkswagon Bay in the St. Clair delta; and then into Lake St. Clair (Mitchell's Bay). Sites and subsites are represented by dashed lines.
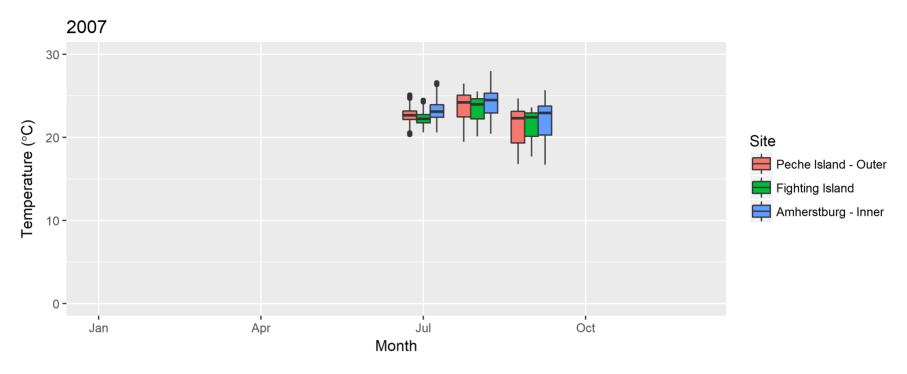
Figure 6. Monthly boxplots of water temperature (°C) at different sites along the Detroit River in 2007. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles.
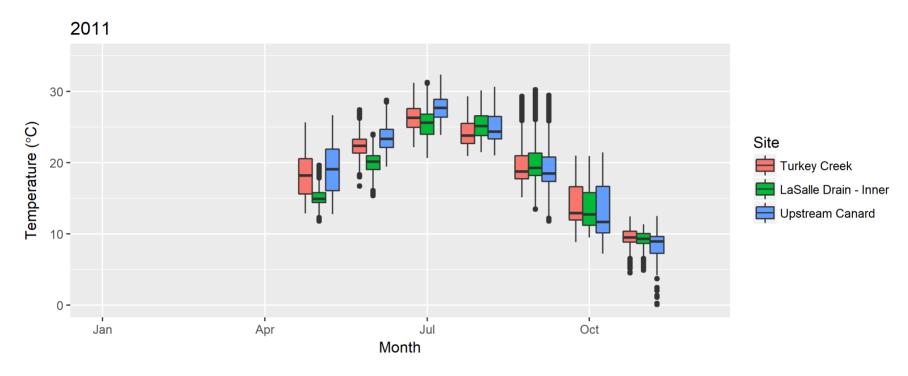
Figure 7. Monthly boxplots of water temperature (°C) at different sites along the Detroit River in 2011. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
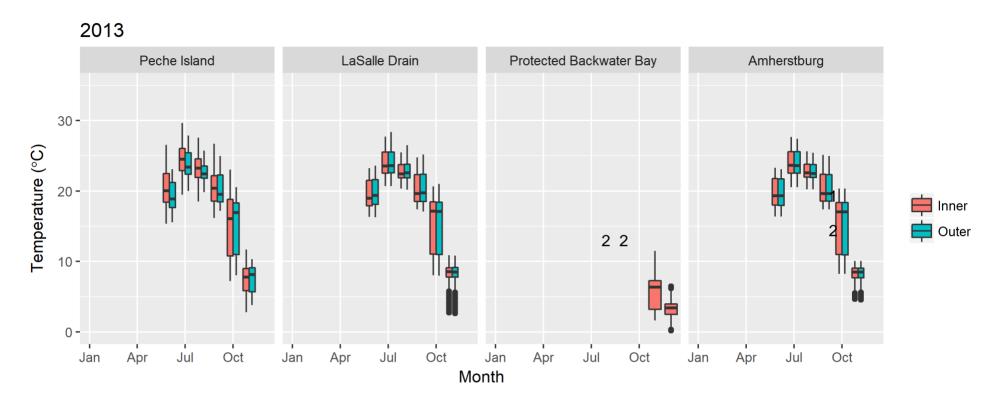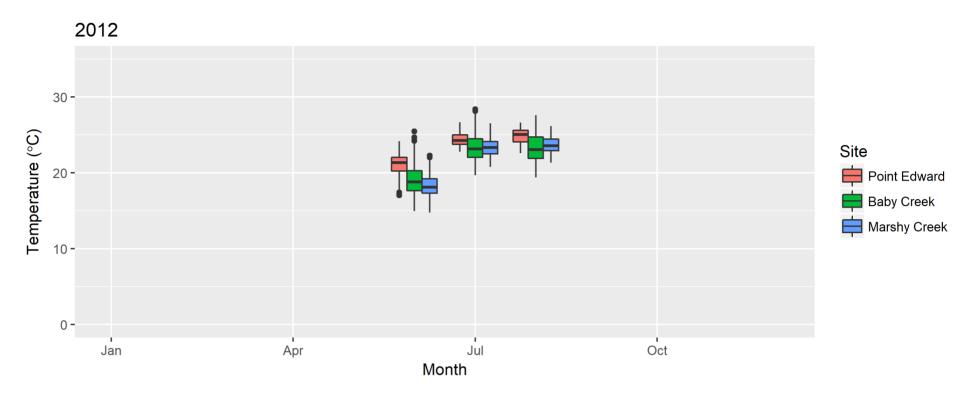
Figure 8. Monthly boxplots of water temperature (°C) at different sites (panels) and inner and outer subsites within those sites along the Detroit River in 2013. Boxplots illustrate data distribution, with the box 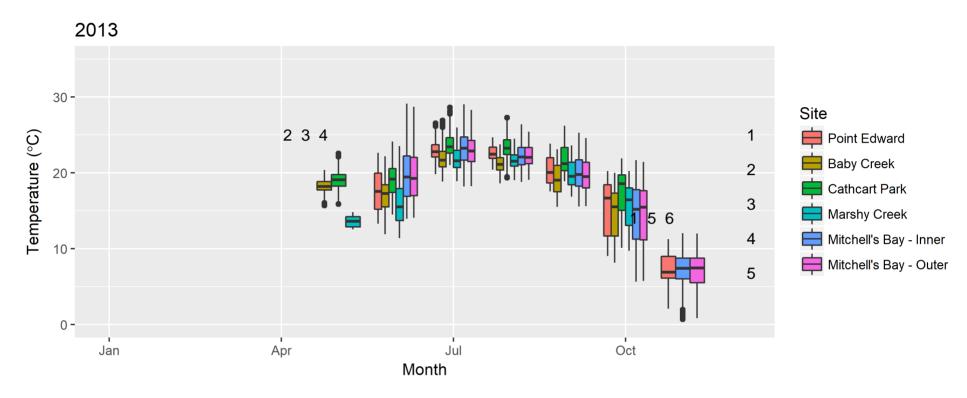showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
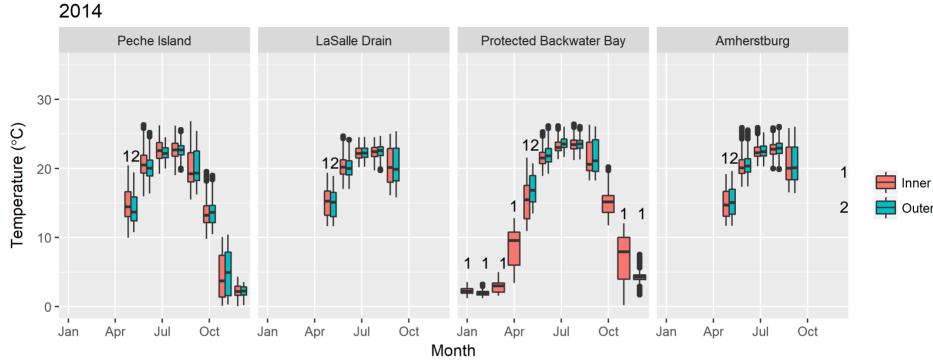
Figure 9. Monthly boxplots of water temperature (°C) at different sites (panels) and inner and outer subsites within those sites along the Detroit River in 2014. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Inner and outer sites are identified by their legend index number.
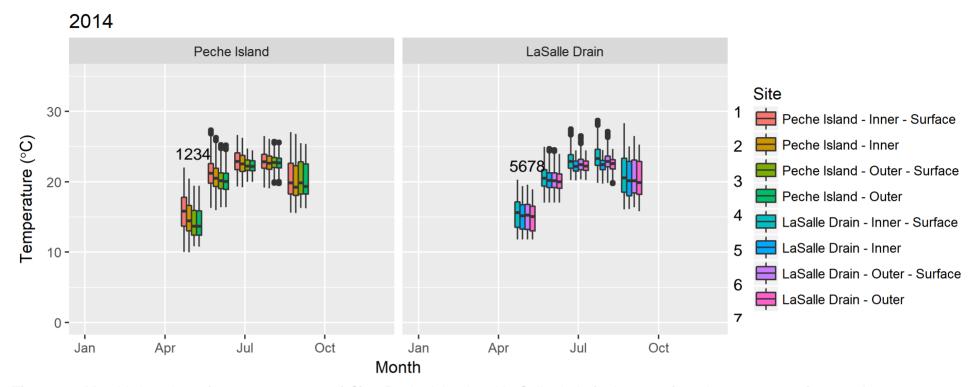
Figure 10. Monthly boxplots of water temperature (°C) at Peche Island and LaSalle drain for inner surface, inner, outer surface, and outer subsites along the Detroit River in 2014. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
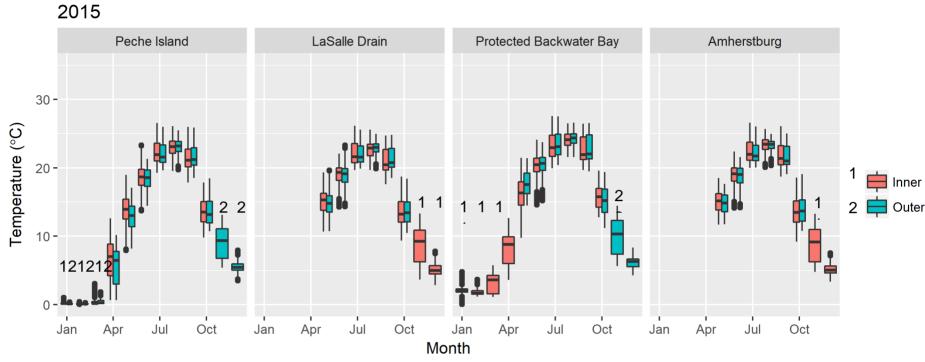
Figure 11. Monthly boxplots of water temperature (°C) at four sites (Peche Island, LaSalle Drain, Protected Backwater Bay, Amherstburg) with inner and outer subsites along the Detroit River, in 2015. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
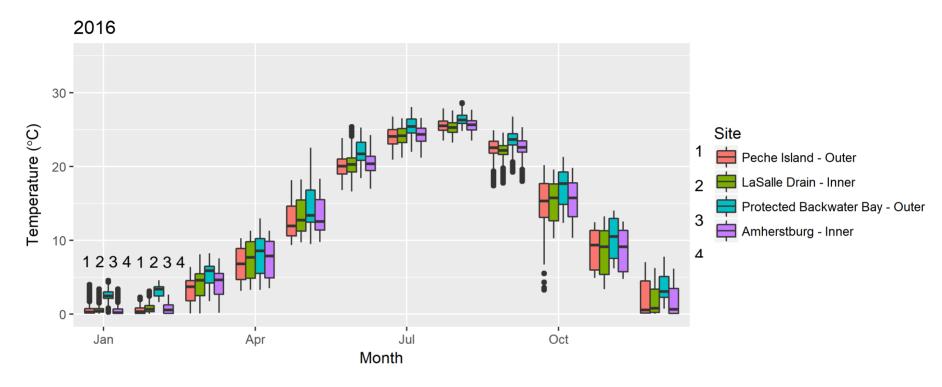
Figure 12. Monthly boxplots of water temperature (°C) at four subsites (from left to right: Peche Island, outer; LaSalle drain, inner; Protected Backwater Bay, outer; and Amherstburg, inner) along the Detroit River in 2016. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
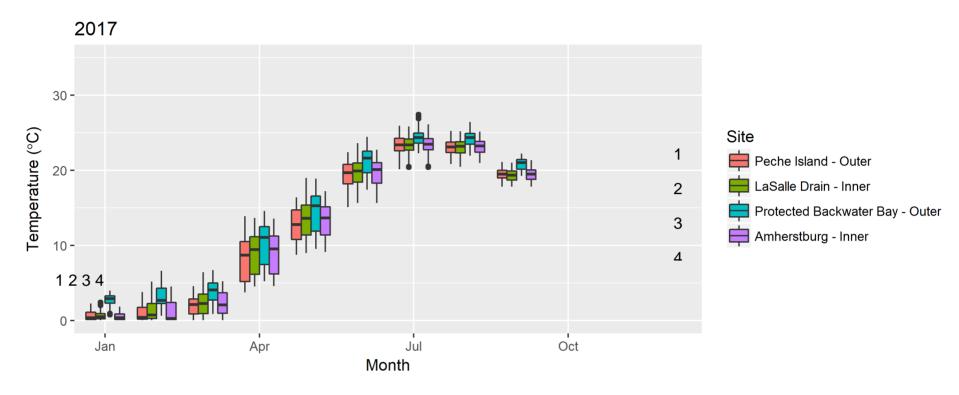
Figure 13. Monthly boxplots of water temperature (°C) at four subsites (from left to right: Peche Island, outer; LaSalle drain, inner; Protected Backwater Bay, outer; and Amherstburg, inner) along the Detroit River in 2017. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
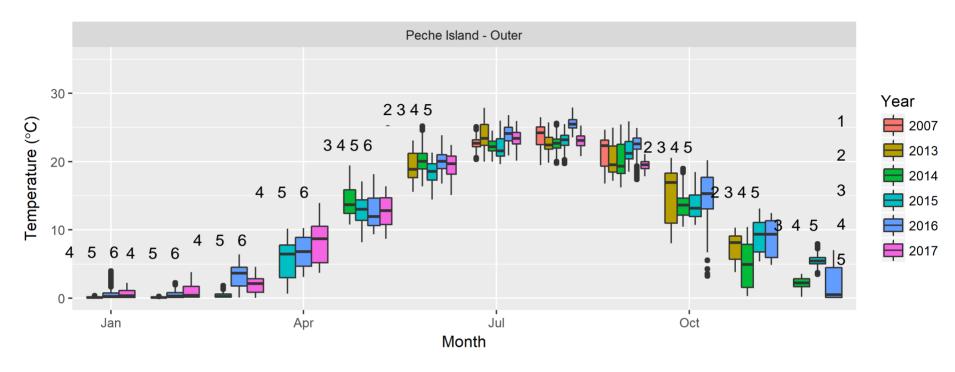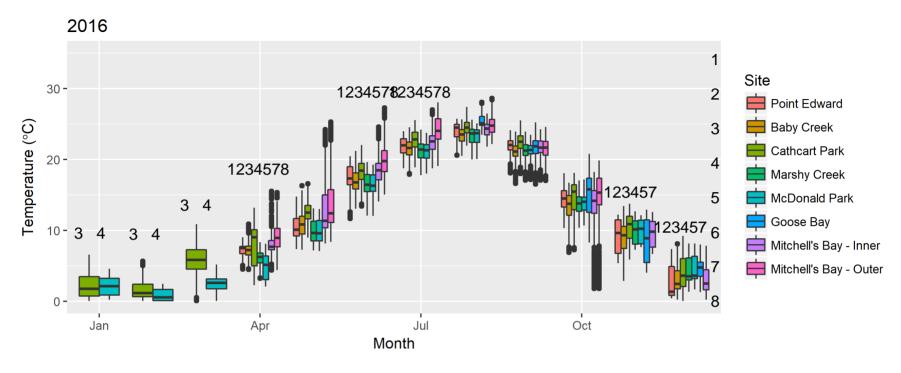
Figure 14. Monthly boxplots of water temperature (°C) over time at the Peche Island outer subsite, Detroit River. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
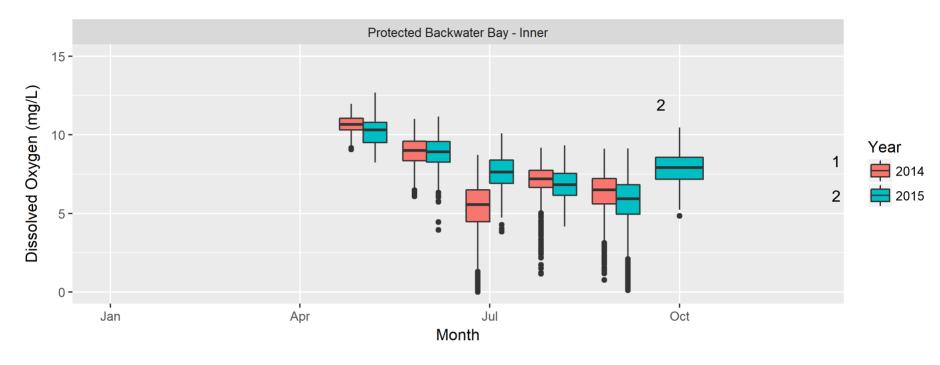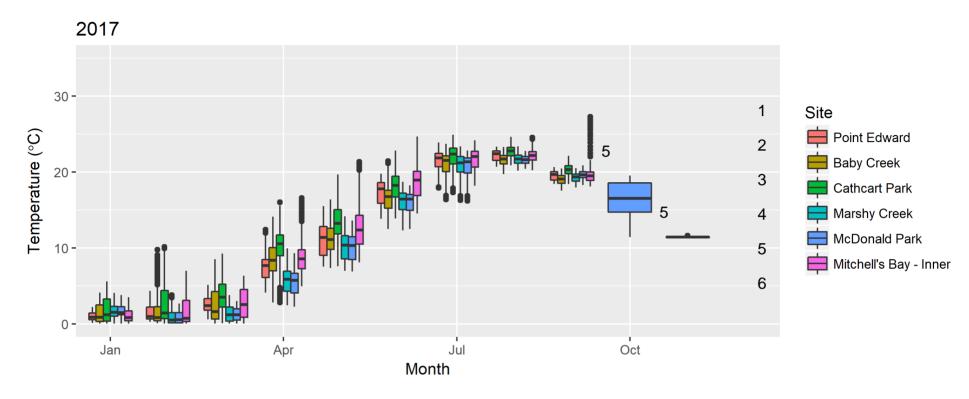
Figure 15. Monthly boxplots of dissolved oxygen (mg/L) at the Protected Backwater Bay inner subsite, Detroit River, in 2014 and 2015. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
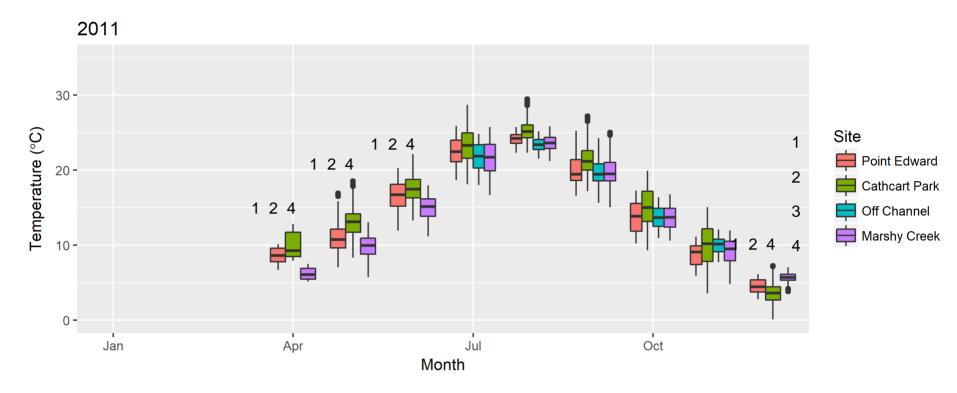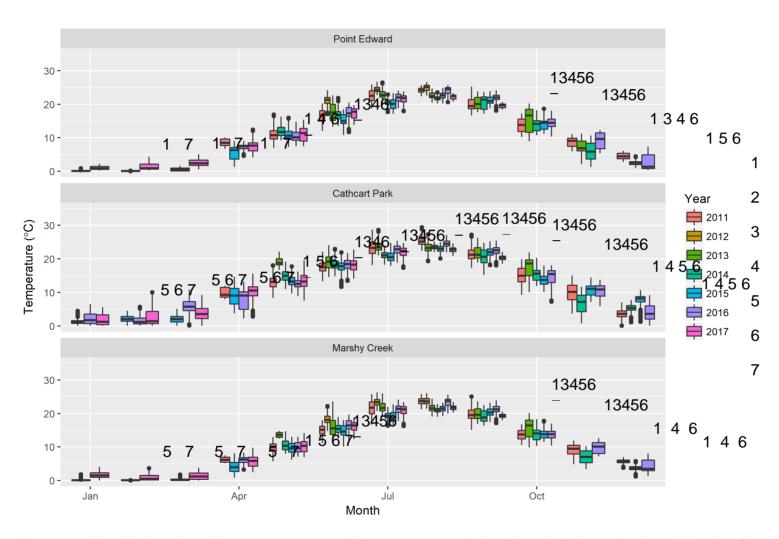
Figure 16. Monthly boxplots of water temperature (°C) at different sites along the St. Clair River in 2011. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.

Figure 17. Monthly boxplots of water temperature (°C) at different sites (from left to right each month: Point Edward, Baby Creek, and Marshy Creek) along the St. Clair River in 2012. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles.

Figure 18. Monthly boxplots of water temperature (°C) at different sites along the St. Clair River and in Lake St. Clair in 2013. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
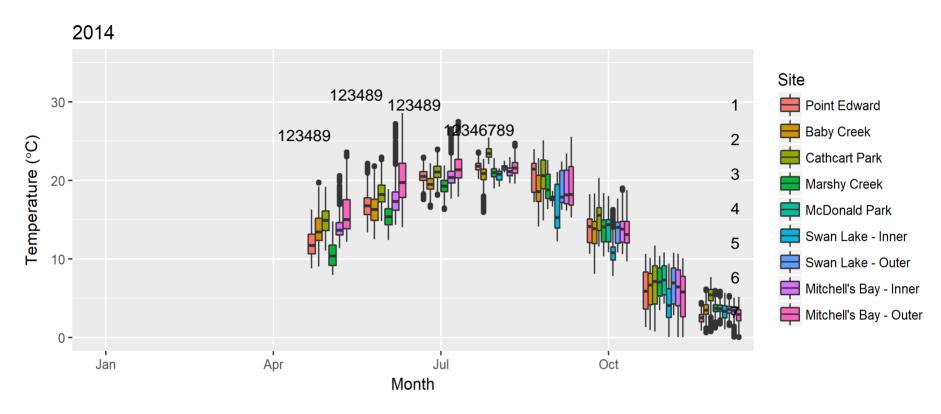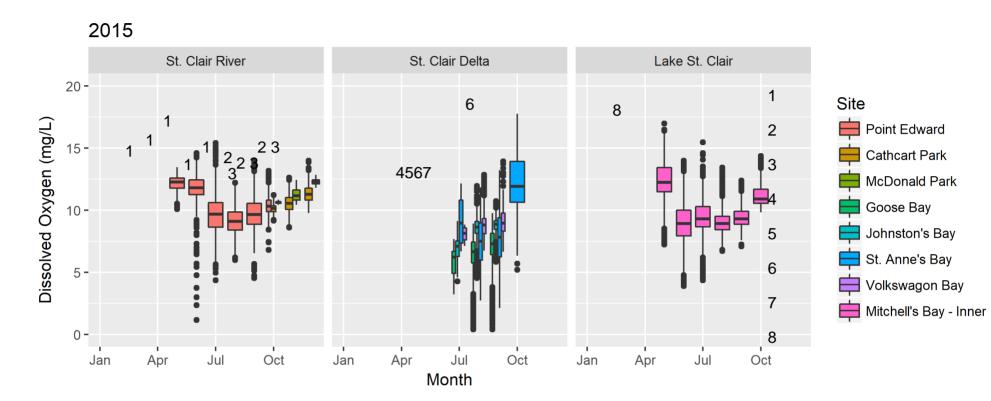
Figure 19. Monthly boxplots of water temperature (°C) at different sites along the St. Clair River, St. Clair delta and in Lake St. Clair in 2014. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
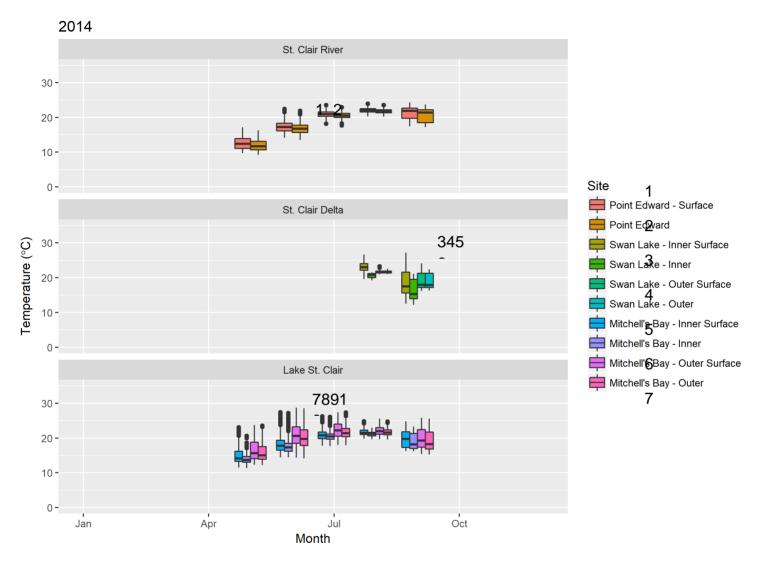
Figure 20. Monthly boxplots of water temperature (°C) at three sites with inner and outer, and/or surface and bottom (no labels) subsites along the St. Clair River, St. Clair delta, and Lake St. Clair in 2014. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
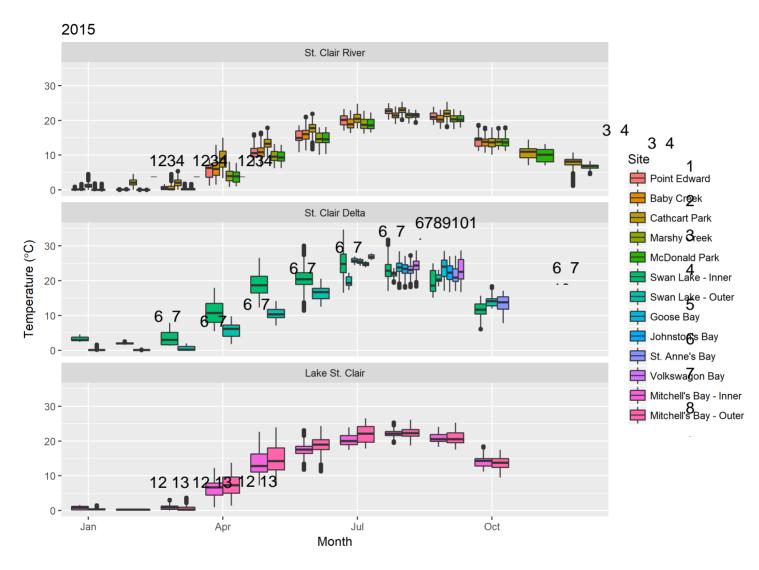
Figure 21. Monthly boxplots of water temperature (°C) at different sites within the St. Clair River, St. Clair delta, and Lake St. Clair (see panels) in 2015. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
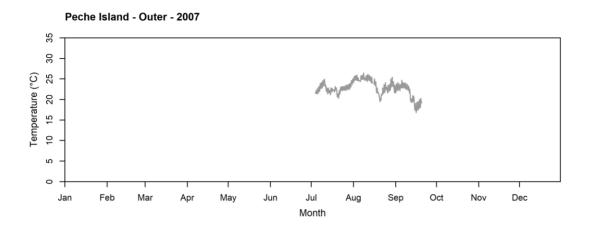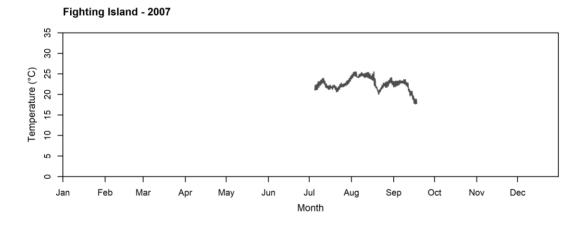
Figure 22. Monthly boxplots of water temperature (°C) at different sites along the St. Clair River, St. Clair delta and Lake St. Clair in 2016. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.

Figure 23. Monthly boxplots of water temperature (°C) at different sites along the St. Clair River and in Lake St. Clair, in 2017. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.

Figure 24. Monthly boxplots of water temperature (°C) over years at Point Edward, Cathcart Park, and Marshy Creek, in the St. Clair River. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
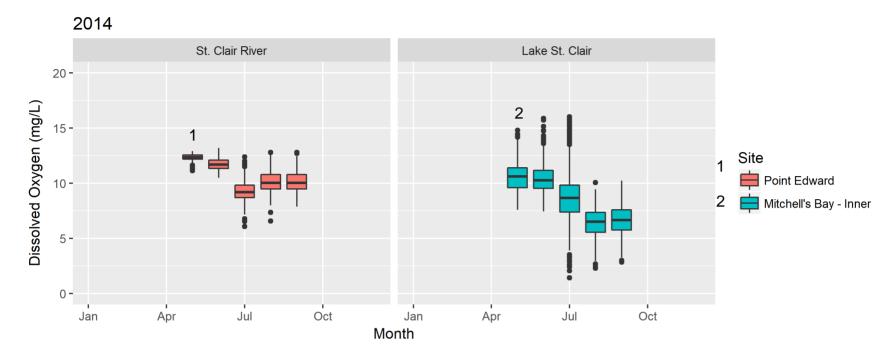
Figure 25. Monthly boxplots of dissolved oxygen (mg/L) at Point Edward and Mitchell's Bay inner subsite, in the St. Clair River, and Lake St. Clair in 2014. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.

Figure 26. Monthly boxplots of dissolved oxygen (mg/L) at different sites along the St. Clair River, St. Clair delta, and Lake St. Clair in 2015. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
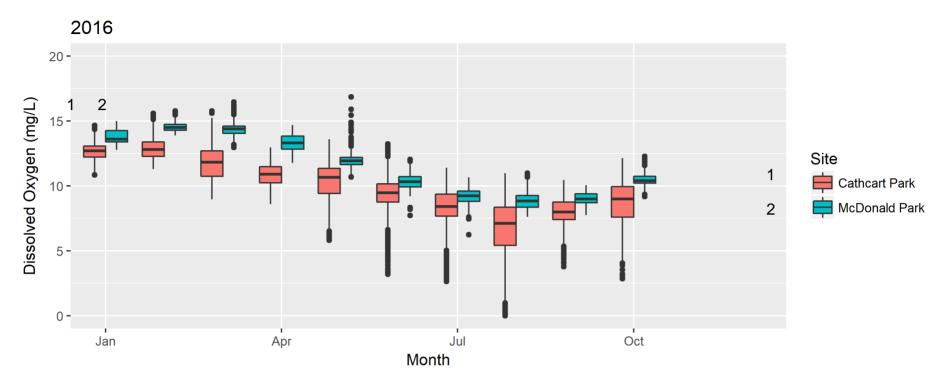
Figure 27. Monthly boxplots of dissolved oxygen (mg/L) at different sites along the St. Clair River in 2016. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.
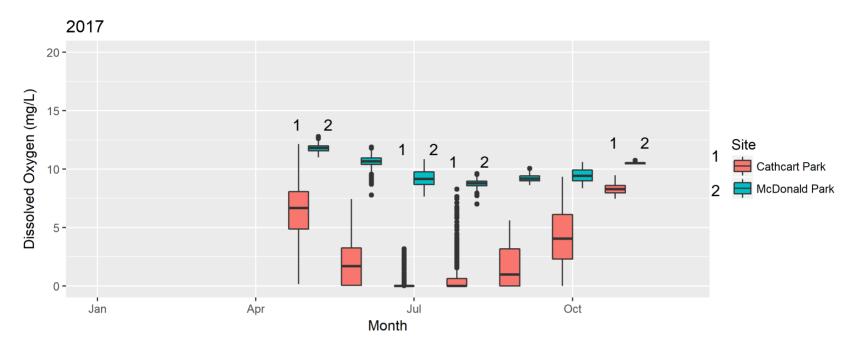
Figure 28. Monthly boxplots of dissolved oxygen (mg/L) at different sites along the St. Clair River in 2017. Boxplots illustrate data distribution, with the box showing the median bounded by the first and third quartiles. Individual sites are identified by their legend index number.

APPENDIX 1 — Detroit River Processed Temperature Data

Peche Island - Outer - 2007

Fighting Island - 2007

Amherstburg - Inner - 2007
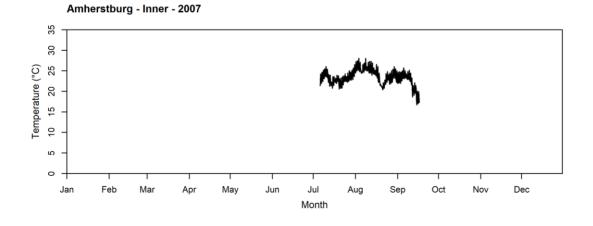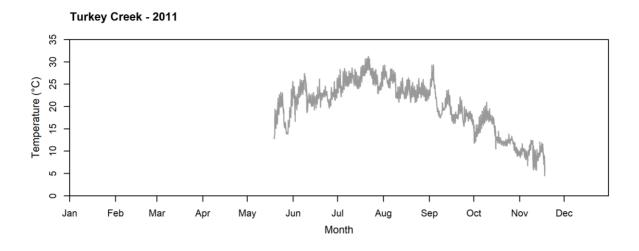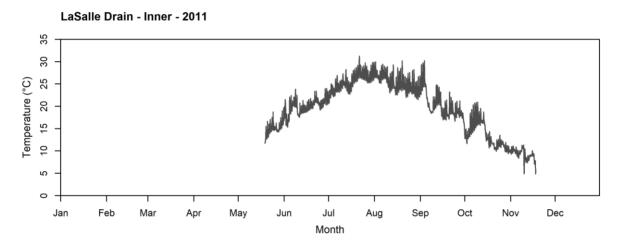
Figure A1.1. Year 2007 Detroit River processed temperature data for Peche Island (outer subsite), Fighting Island, and Amherstburg (inner subsite).
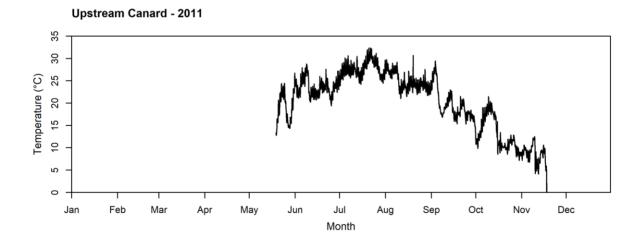
Figure A1.2. Year 2011 Detroit River processed temperature data for Turkey Creek, LaSalle Drain (inner site), and Upstream Canard.

Figure A1.3. Year 2011 Detroit River processed temperature data for Upstream Canard.
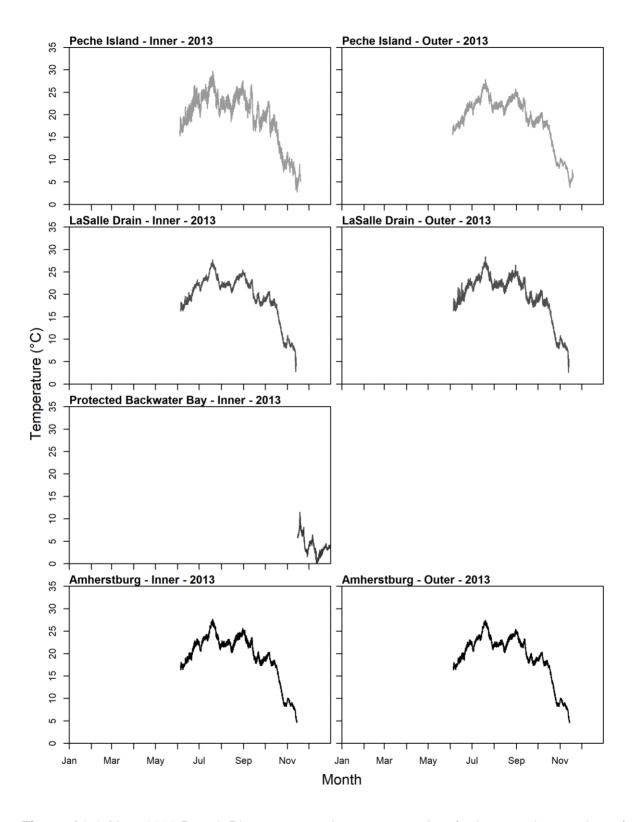
Figure A1.4. Year 2013 Detroit River processed temperature data for inner and outer sites of Peche Island, LaSalle Drain, Protected Backwater Bay (inner only), and Amherstburg.
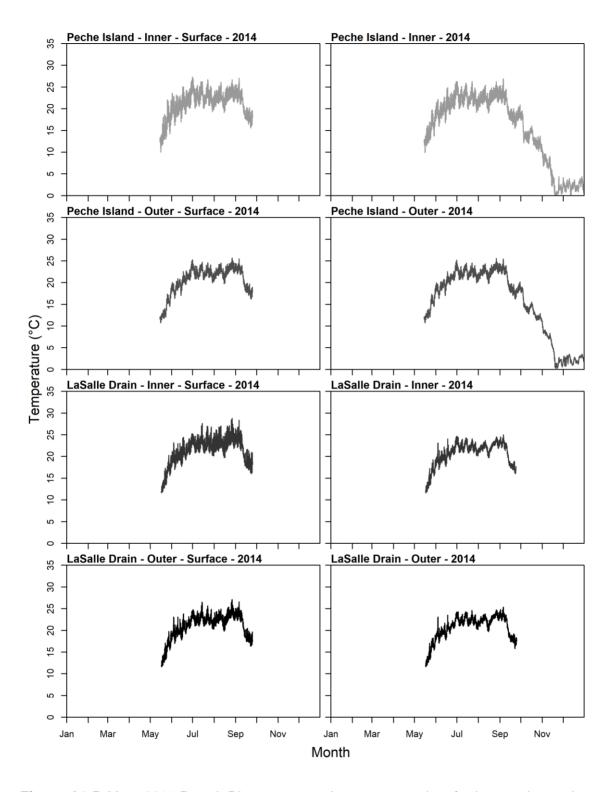
Figure A1.5. Year 2014 Detroit River processed temperature data for loggers located near the surface and bottom for the inner and outer sites of Peche Island and LaSalle Drain.
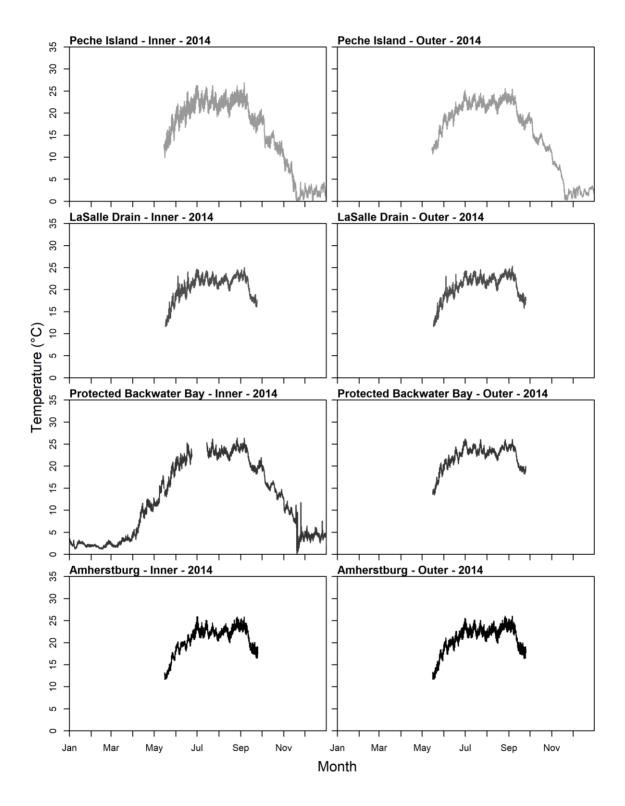
Figure A1.6. Year 2014 Detroit River processed temperature data for inner and outer sites of Peche Island, LaSalle Drain, Protected Backwater Bay, and Amherstburg.
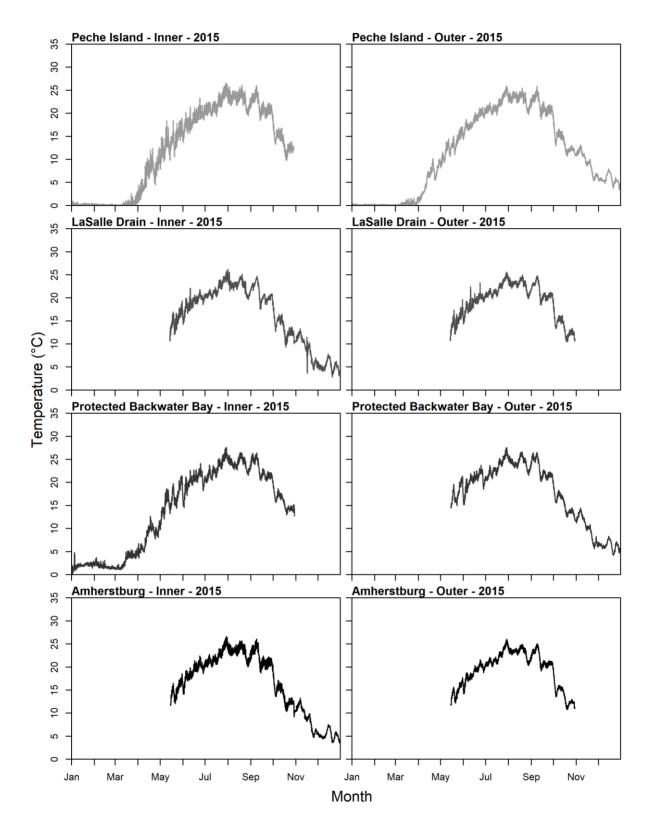
Figure A1.7. Year 2015 Detroit River processed temperature data for inner and outer sites of Peche Island, LaSalle Drain, Protected Backwater Bay, and Amherstburg.
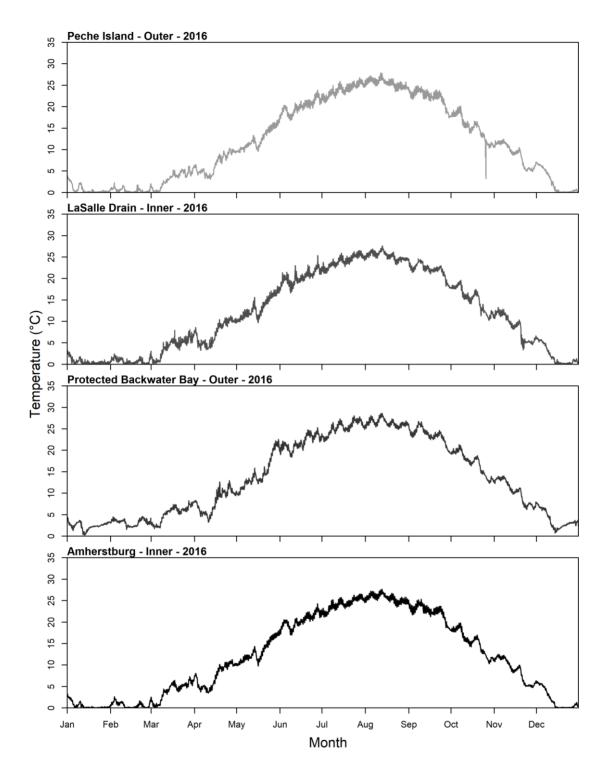
Figure A1.8. Year 2016 Detroit River processed temperature data for Peche Island (outer site), LaSalle Drain (inner site), Protected Backwater Bay (outer site), and Amherstburg (inner site).
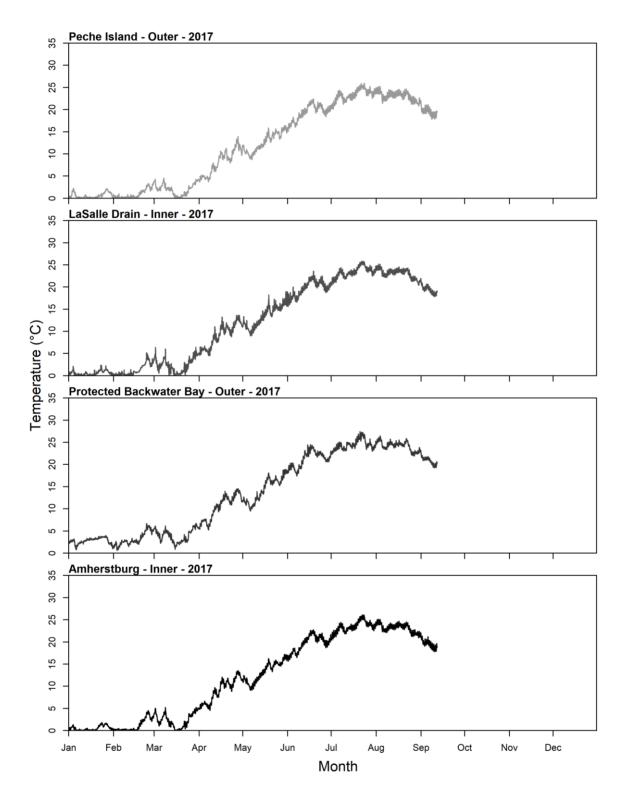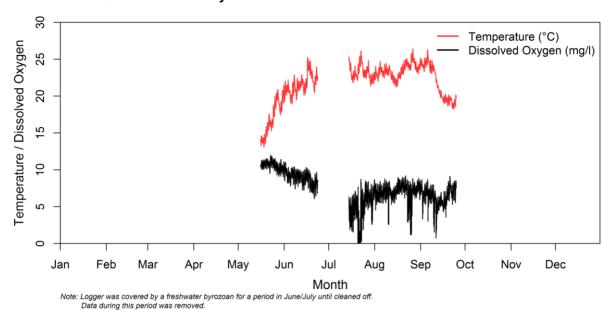
Figure A1.9. Year 2017 Detroit River processed temperature data for Peche Island (outer site), LaSalle Drain (inner site), Protected Backwater Bay (outer site), and Amherstburg (inner site).

Protected Backwater Bay - Inner - 2014

Note: Logger was covered by a freshwater byrozoan for a period in June/July until cleaned off. Data during this period was removed.

Figure A1.10. Year 2014 Detroit River processed dissolved oxygen and temperature data for Protected Backwater Bay (inner site).
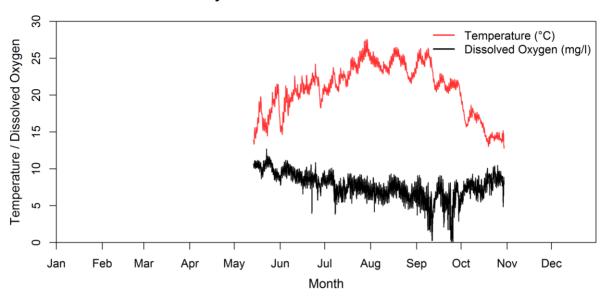
Figure A1.11. Year 2015 Detroit River processed dissolved oxygen and temperature data for Protected Backwater Bay (inner site).
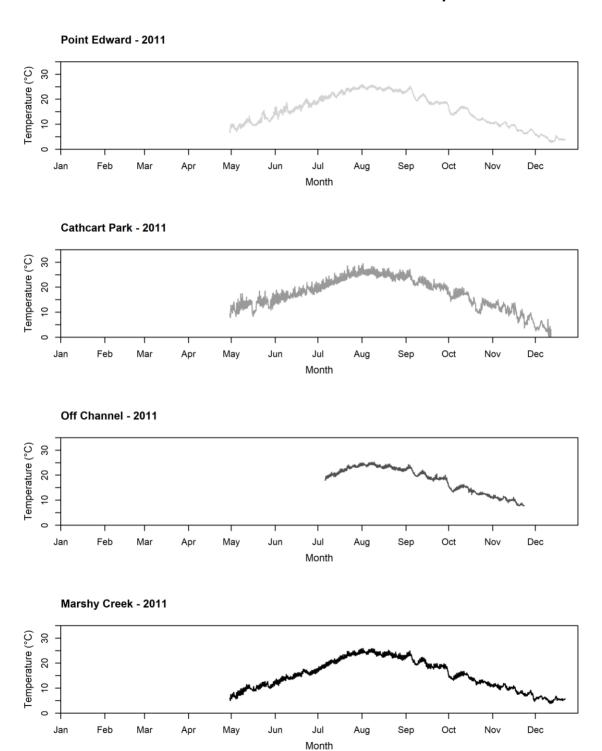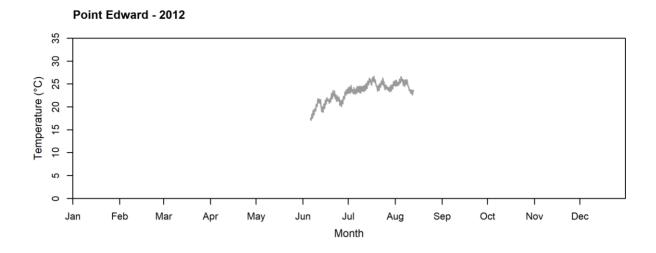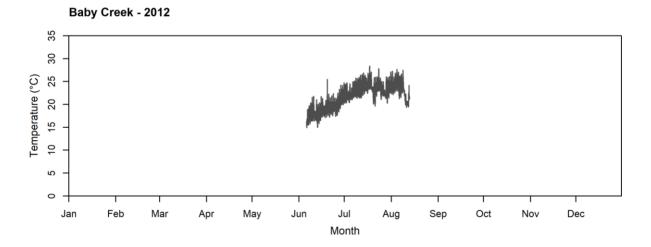
APPENDIX 2 — St. Clair River Processed Temperature Data

Point Edward - 2011

Cathcart Park - 2011

Off Channel - 2011

Marshy Creek - 2011

Figure A2.1. Year 2011 St. Clair River processed temperature data for Point Edward, Cathcart Park, Off Channel, and Marshy Creek.**.**
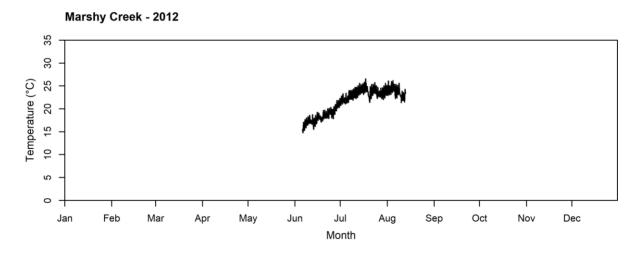
Figure A2.2. Year 2012 St. Clair River processed temperature data for Point Edward, Baby Creek, and Marshy Creek.
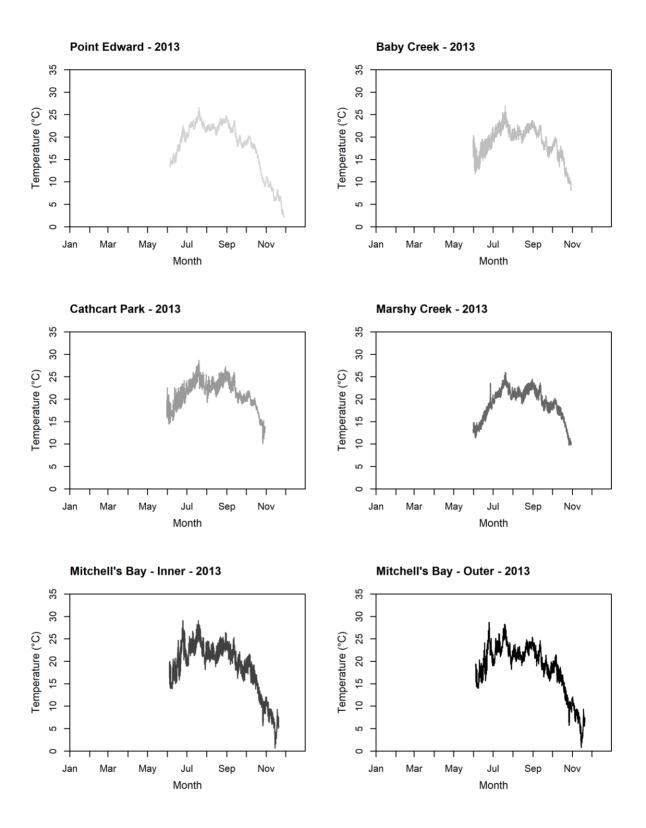
Figure A2.3. Year 2013 St. Clair River processed temperature data for Point Edward, Baby Creek, Cathcart Park, Marshy Creek, and Mitchell's Bay (inner and outer sites – Lake St. Clair).
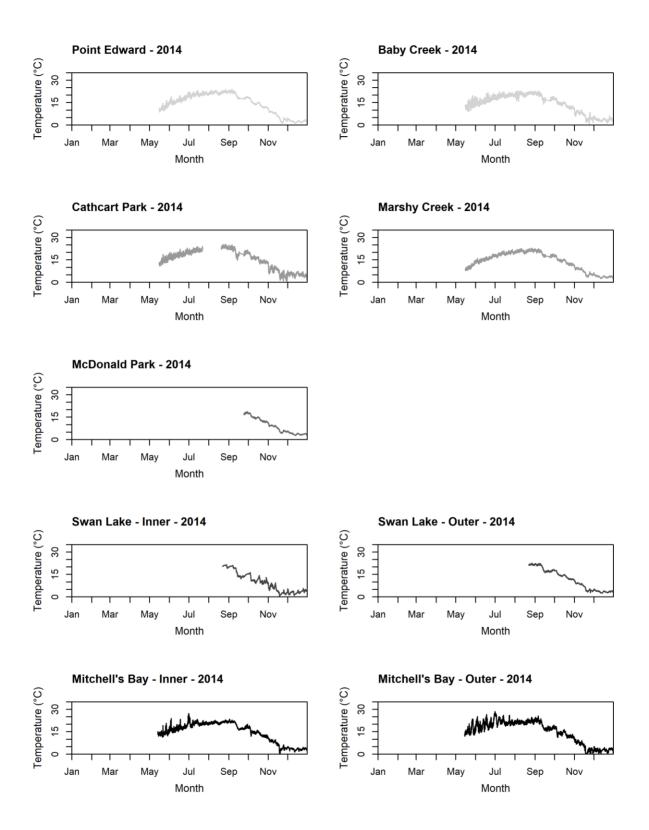
Figure A2.4. Year 2014 St. Clair River processed temperature data for Point Edward, Baby Creek, Cathcart Park, Marshy Creek, McDonald Park, and inner and outer sites for Swan Lake (St. Clair delta) and Mitchell's Bay (Lake St. Clair).
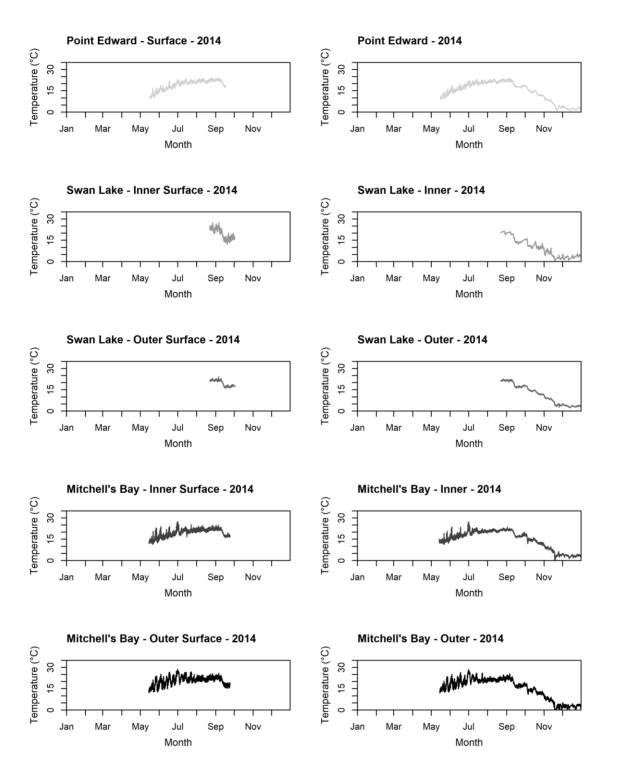
Figure A2.5. Year 2014 St. Clair River processed temperature data for loggers located near the surface and bottom of Point Edward, and inner and outer sites for Swan Lake (St. Clair delta) and Mitchell's Bay (Lake St. Clair).
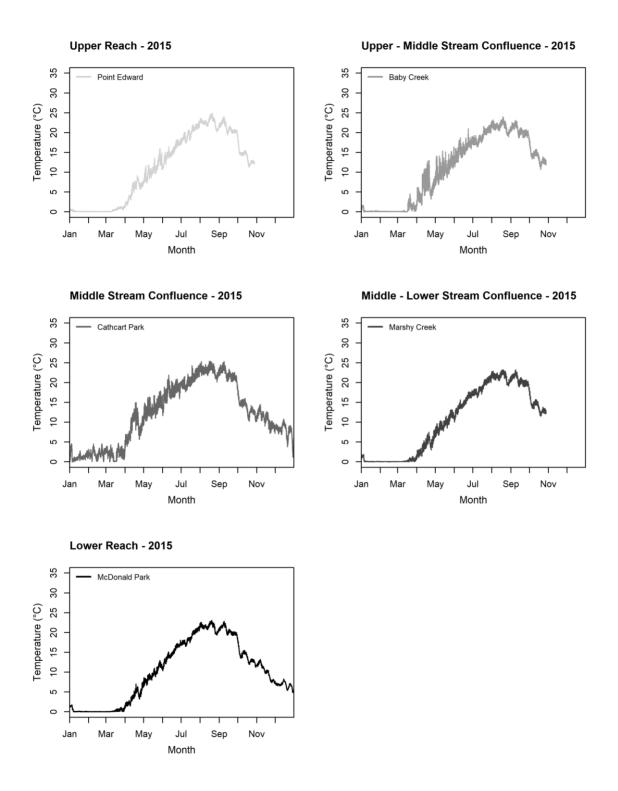
Figure A2.6. Year 2015 St. Clair River processed temperature data for Point Edward, Baby Creek, Cathcart Park, Marshy Creek, and McDonald Park.
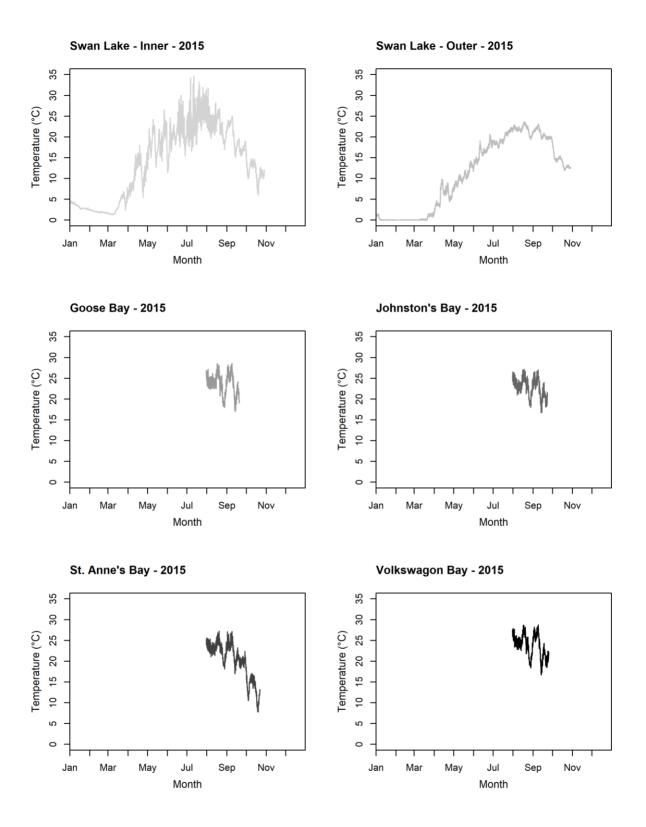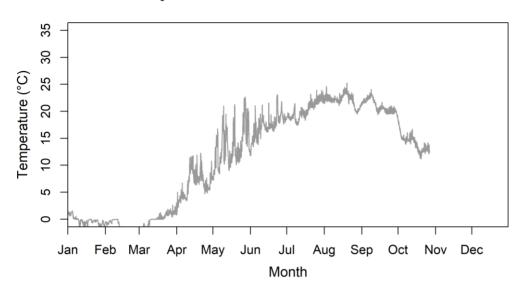
Figure A2.7. Year 2015 St. Clair delta processed temperature data for Swan Lake (inner and outer sites), Goose Bay, Johnston's Bay, St. Anne's Bay and Volkswagon Bay.

Mitchell's Bay - Inner - 2015

Mitchell's Bay - Outer - 2015
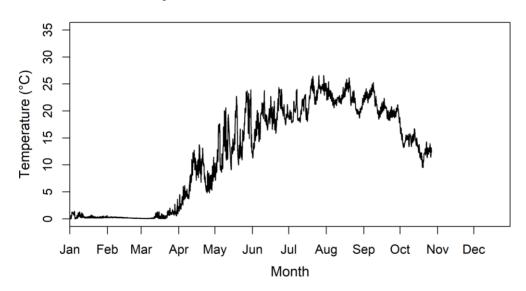
Figure A2.8. Year 2015 Lake St. Clair processed temperature data for inner and outer sites of Mitchell's Bay.

Figure A2.9. Year 2016 St. Clair River processed temperature data for Point Edward, Baby Creek, Cathcart Park, Marshy Creek, and McDonald Park.
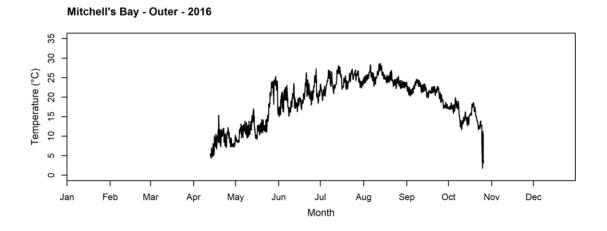
Figure A2.10. Year 2016 St. Clair delta processed temperature data for Goose Bay and Lake St. Clair processed temperature data for Mitchell's Bay (inner and outer sites).
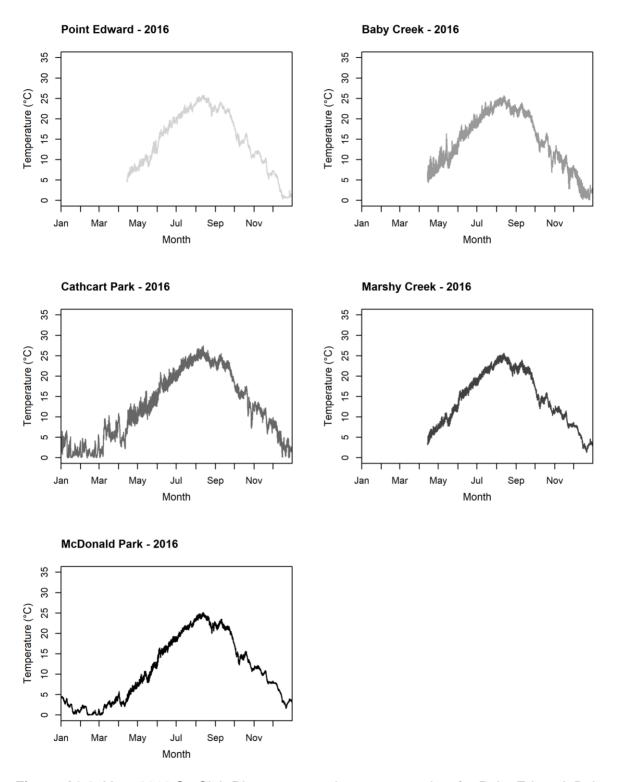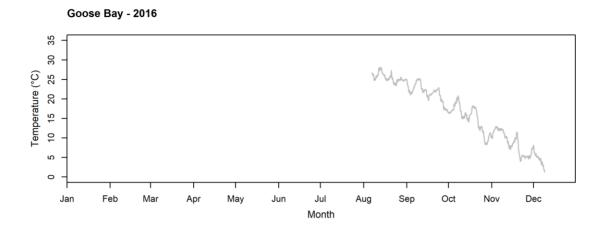
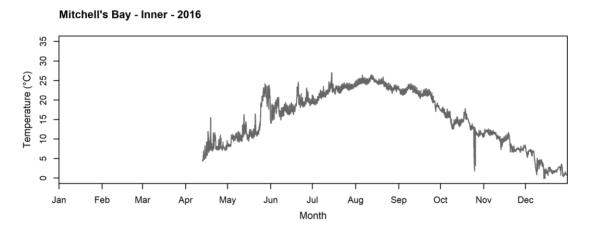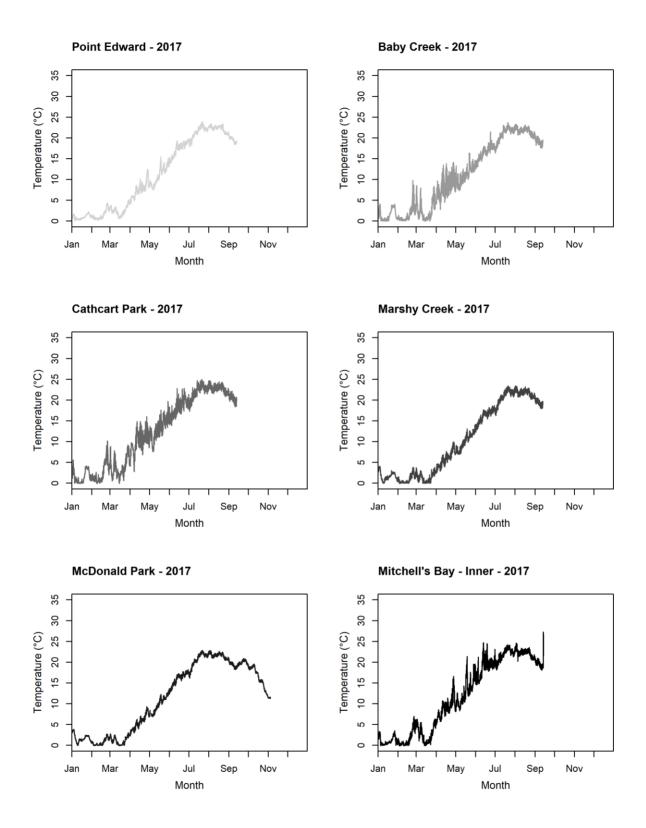**Figure A2.11.** Year 2017 St. Clair River processed temperature data for Point Edward, Baby Creek, Cathcart Park, Marshy Creek, McDonald Park, and Mitchell's Bay (inner site – Lake St. Clair).

Figure A2.12. Year 2014 St. Clair River processed dissolved oxygen and temperature data for Point Edward.
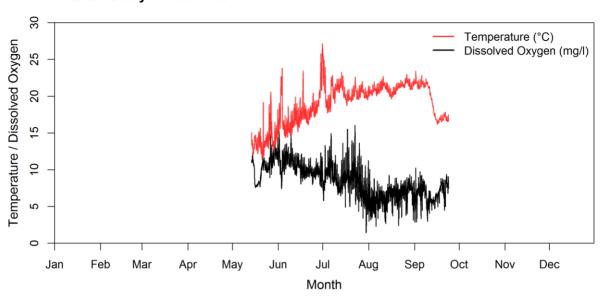
Figure A2.13. Year 2014 Lake St. Clair processed dissolved oxygen and temperature data for Mitchell's Bay (inner site).

Figure A2.14. Year 2015 St. Clair River processed dissolved oxygen and temperature data for Point Edward.

Figure A2.15. Year 2015 St. Clair delta processed dissolved oxygen and temperature data for Johnston's Bay.
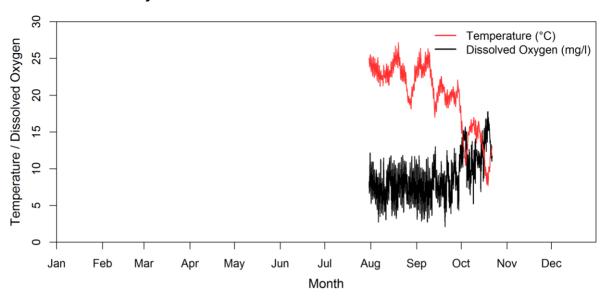
Figure A2.16. Year 2015 St. Clair delta processed dissolved oxygen and temperature data for St. Anne's Bay.

Figure A2.17. Year 2015 St. Clair delta processed dissolved oxygen and temperature data for Volkswagon Bay.
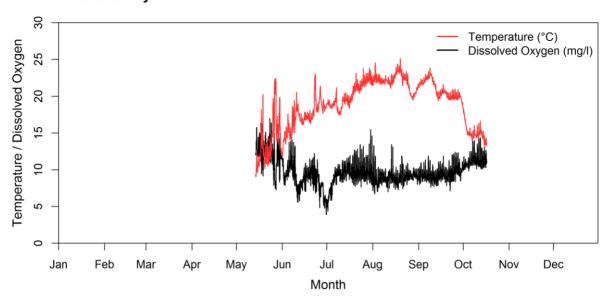
Figure A2.18. Year 2015 Lake St. Clair processed dissolved oxygen and temperature data for Mitchell's Bay (inner site).

Figure A2.19. Year 2016 St. Clair River processed dissolved oxygen and temperature data for McDonald Park.

Figure A2.20. Year 2016 St. Clair River processed dissolved oxygen and temperature data for Cathcart Park.

Figure A2.21. Year 2017 St. Clair River processed dissolved oxygen and temperature data for McDonald Park.

Figure A2.22. Year 2017 St. Clair River processed dissolved oxygen and temperature data for Cathcart Park.

APPENDIX 3 — Protocol for Calibration, Performance Check, and Biofouling Correction of Dissolved Oxygen Loggers

This protocol was developed at the Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Version 2.0, June 14, 2016. It should be used for the Onset HOBO U26 Dissolved Oxygen Logger.

Sensor Cap Installation:

Important: Install the cap only when ready to use since it expires **seven months** after initialization. It is extremely important that sensor cap expiration dates are tracked in the database. **Loggers must be retrieved within 6 months of cap initialization; if caps expire while loggers are deployed in the field, the logger is unable to read or record any further data and the biofouling protocol cannot be completed post-deployment.** The biofouling protocol should be performed as soon as DO loggers are returned to the lab to ensure that caps do not expire.

Avoid allowing moisture, including atmospheric humidity, inside the cap. Keep the cap in its sealed canister until you are ready to install it. Once installed, the sensor cap will expire seven months after it is initialized, which occurs automatically if the logger is currently logging. If it is not logging, you can initialize it the next time you launch the logger, check the status, or use the Lab Calibration tool in HOBOware. You must initialize the cap before calibrating and launching.

- Follow instructions provided by the HOBO DO logger (if new DO logger)/Sensor Replacement Kit (if replacing sensor cap) to install the new sensor cap. Instructions are provided separately.
- In the logger database, record the sensor cap lot code and cap expiration date for each DO logger getting a new sensor cap. This may be important if certain sensor cap lots malfunction – e.g., cannot be calibrated – and need to be returned to Hoskins.

Calibration (check before deployment[1]):

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[1] Repeat this step each time a new sensor cap is installed and/or each time new offset values are recorded. Necessary every 6 months as a minimum, due to sensor cap expiration.

- It is recommended to do the calibration in the lab using the HOBOware lab calibration tool, as opposed to the field calibration readings.
- Follow the calibration instructions with the lab calibration tool provided by the HOBO DO logger.
    - Always go through with the calibration and do not use previous settings
    - Conduct both the 100% and 0% calibration points.
    - Record the date the cap was initialized, date calibration was performed, barometric pressure, time, readings/gains for both the 100% and 0% saturation tests, the overall gain and offset adjustments (when calibration is completed), and any additional notes.
    - The 100% calibration point environment can be createdby attaching a HOBO logger boot with a wet sponge inside 15 mins prior to calibration so air can saturate in the boot.
    - If no boots and sponges are not available, you can also create a 100% saturated environment by submersing the logger into a pre-bubbled bucket of tap water.
    - The 0% calibration point can be conducted using either:
        - dissolved oxygen standard – Sodium Sulfate solution – relatively shorter time
        - yeast solution – warm water and yeast mix - requires a longer resident time
            - With the yeast solution, the DO logger sometimes needs to be gently swished around to remove any oxygen trapped within the guard so that it reads 0 mg/L. Ensure that it reads 0, occasionally it may read 0.01 to -0.2 but aim for it to read 0 or below 0
    - Typically spending 15 minutes at the 100% and 0% saturation is not required if the readings are accurate, getting data from logger should stay relatively the same at least 3 times continuously (±0.01mg/L)

Two-Point Dissolved Oxygen Performance Check Prior to Deployment:

- **Launch** the loggers with a logging interval of 15 minutes and delay launch so that they all start at the same time. When launching check to ensure the battery life is above 1/3, any loggers with less than 1/3 should be set aside and sent back to Hoskin. Launch a clean "reference" logger (either a new unused or previously checked logger) using the same logging settings to compare results.
- 100% oxygen saturation step: Prepare a 25 L bucket with cool tap water sufficient to cover loggers; place a bubbler in bucket for 30 minutes prior to the performance check to allow the bucket to become saturated with oxygen

and run for the duration of the performance check. Suspend loggers vertically in mid-column in the bucket. For example, use zip ties to hang loggers from a metal frame which fits over top of the bucket. Allow loggers to remain in 100% solution for at least a couple hours, or up to 24 hrs depending on one's schedule. The maximum number of loggers per bucket should not exceed 12. This ensures loggers are evenly spaced and allows sufficient flow of water.

- o Prepare a second bucket with warm water, yeast and sugar following the yeast solution method indicated above. Briefly, place sufficient active dry yeast and sugar in a bucket of warm water and allow yeast to rise for approximately 30 minutes to ensure 0% dissolved oxygen. Generally, 4 L of water with 16 tbsp of sugar and yeast should be enough to submerge the loggers above the sensor cap. The top of the bucket should be covered with saran wrap to prevent oxygen saturation during the preparation and active logging. Allow loggers to record in oxygen depleted environment for 1-2 hrs depending on time allowed.
- o Rinse off and offload loggers and graph results; compare results to "reference" logger.

Downloading and Graphing Data:

- Download data and turn all loggers **OFF** using the Hobo Software. **NOTE**: You can set the preferences in HOBO for batch download to speed up the process. Each "batch" is considered all the loggers used in the same bucket. Do not mix results of loggers used in different buckets.
- Save the Excel and .hobo files in a designated Performance Check folder for each logger type. For ease of location, performance checks are separated by year, season, and date (e.g., File path: I:\ WaterTemp_DO_database\Calibration Biofoul Performance Tests\DO Logger Performance Check\2015\Spring 2015\May 12th 2015).
- Follow the format used for previous years.
    - o Create a new folder for the current year, if necessary, and current season, and current date and save each batch of loggers in a separate folder (e.g., "bucket 1" folder).
    - o Name the files after the logger name
- For each batch separately, copy all data into a single Excel Spreadsheet and graph it. (DO on the Y axis and date & time on the X axis). If the graph does not appear to plot properly, change the date/time to only show the time (h:mm); alternatively, format the X-axis to "text" instead of date, and set the interval value to 12 (this should not be necessary if the other method works).
- Performance check: Do all devices display the same curve compared to the reference logger? (i.e. do the curves overlap?; minor variation is OK)

- If loggers display the same curves:
  - In the inventory database, indicate which loggers have passed the performance check and are good for use. Basically, make a traceable record.
- If loggers do not display the same curves:
  - The amount that a logger can deviate from the curves of the other loggers is subjective. If off by more than the accuracy specifications of the logger (or a reasonable amount for the study at hand—e.g., 0.5 mg/L or more), then it is inaccurate.
  - If the device cannot be calibrated and the error observed is consistent, note the correction factor and the device serial number for further correction after field deployment. Put this note in the Logger Inventory
  - If the pattern displayed by the device is erratic, send it back to Hoskin for repair/ replacement (http://www.hoskin.ca/contact-us).

Dissolved Oxygen loggers Biofouling Protocol:

- DO loggers should be collected within 6 months of sensor cap initialization to avoid cap expiry prior to biofouling protocol completion.
- Optional: Once loggers have been retrieved, take photos documenting the extent of biofouling including a whole logger body shot with the serial number displayed, a close up of the logger biofouling guard in place and a close up of the sensor cap with the biofouling guard removed.
- Retrieved loggers should not be cleaned prior to biofouling check protocol and staff must ensure that sensor caps have not expired (6 months).
- It is important to run the biofouling check (see below), even if loggers underwent field maintenance, just to ensure loggers are not biofouled at the end of the deployment period.
- If loggers had field maintenance it is important to check the loggers values against the recorded DO values to ensure that biofouling did not occur between maintenance checks. If values are in consistent between maintenance checks, conduct the biofouling correction for that period. Ideally, the maintenance will reduce the likelihood of biofouling occurring and no corrections will be necessary.

Biofouling Check:

- Fill a 25 L bucket with water (sufficient for all the loggers) and use a bubbler to saturate oxygen in water for approximately 30 minutes and for the remainder of the biofouling check.
- Offload the loggers (should have been done previously—see launching, deploying, retrieving and downloading protocol) and redeploy sampling at **1 minute interval** and delay launch so that they all start at the same time. Also redeploy a new or

unfouled logger as a "reference"—similar to the performance check - using the same logging settings to compare results. If a new or unfouled logger is not available, use the EXO 1/hydrolab to log during the entire procedure and record battery power, DO and Temperature. Suspend loggers (and EXO 1/hydrolab, if applicable) vertically in mid-column in the bucket. For example, use zip ties to hang loggers from a metal frame which fits over top of the bucket. Allow loggers to actively record for approx. 1 hr. This is considered the "pre-clean" stage.

- Note the times that logging started.
- Remove each fouled logger one at a time and clean the loggers housing; wipe the green oxygen sensor cap clean with a soft cloth, install a cleaned biofouling guard and place the logger back into bucket. Record the time loggers were removed from bucket and time that logger was replaced in bucket (i.e., the time when the first logger was removed and the time the last logger was replaced in the bucket).
- Allow cleaned loggers to log for an additional 1 hour. This is considered the "post-clean" stage. Record time that loggers were removed from the bucket.
- Download data and turn all loggers **OFF** using the Hobo Software. **NOTE**: You can set the preferences in HOBO for batch download to speed up the process. Each "batch" is considered all the loggers used in the same bucket. Do not mix results of loggers used in different buckets.
- Save the Excel and .hobo files in a designated Biofouling Correction folder for each logger type. For ease of locating data, biofouling corrections are separated by year, season, and date (e.g., File path: I:\ WaterTemp_DO_database\Calibration Biofoul Performance Tests\DO Logger—Biofoul Test\2015\Fall\Nov 12).
- Follow the format used for previous years.
  - ○ Create a new folder for the current year, if necessary, and current season, and current date and save each batch of loggers in a separate folder (e.g., "bucket 1" folder). Probably unlikely to be running multiple batches of DO loggers.
  - ○ Name the files after the logger name
- For each batch separately, copy all data into a single Excel Spreadsheet and graph it. (DO on the Y axis and date & time on the X axis). If the graph does not appear to plot properly, change the date/time to only show the time (h:mm); alternatively, format the X-axis to "text" instead of date, and set the interval value to 12 (this should not be necessary if the other method works).
- Biofouling check: Do all devices display the same curve compared to the reference logger? (i.e. do the curves overlap?; minor variation is OK)
  - **a)** If loggers display the same curves as the reference logger, within an acceptable margin of error, during both the pre-clean and post-clean periods (usually within 0.5 mg/L):

- o Loggers are not biofouled. In the inventory database, indicate which loggers have passed the biofouling check. The field data only needs basic QAQC and is good for analyses.
  b) If loggers do not display the same curves as the reference logger, within an acceptable margin of error, during both the pre-clean and post-clean periods:
  - o There is possibly an issue with the calibration. Use field data with caution.
  - o If the pattern displayed by the device is erratic, send it back to Hoskin for repair/ replacement (http://www.hoskin.ca/contact-us).
  - o **NOTE:** This is highly unlikely to happen if proper calibration occurred prior to deployment.
  c) If loggers do not display the same curve as the reference logger ONLY during the pre-clean period, but has a similar curve during the post-clean period:
  - o Loggers are biofouled. In the inventory database, indicate which loggers have failed the biofouling check. The field data needs to proceed with the biofouling correction factor calculation to account for biofouling and finish the QAQC process.

Biofouling Correction Factor Calculation

At the moment, the biofouling correcting factor calculation is determined in excel. However, this could be either coded in R (for slightly more automation) or depending on trial runs, the HOBOware can correct for this in the Dissolved Oxygen Assistant using deployment and retrieval DO readings from another logger/hydrolab/YSI meter (note the protocol calls for recording DO upon deployment/retrievals). Even if HOBOware or R is used, it is important to determine if all the data can be reliably used for later analyses. This is particularly important if DO values go to zero and remain at zero upon retrieval as this could be false or true zero values and since it is unknown, it likely is to be deleted (under the assumption the logger was buried). More details are found below about this issue. NOTE: If using excel, the auto-fill feature (double click on the lower right hand side of a cell) is essential for doing the correction quickly, efficiently, and correctly.

An excel file accompanies the following biofouling correction steps to help visualize and see the formulas used to calculate the correction.

- Step 0: Determine whether biofouling is prevalent from the biofouling protocol conducted in the lab.
  - o From the data collected from the loggers during the biofouling protocol, a quick graph of all the loggers during the pre-clean and post-clean

period will give an idea if a biofouling correction should be made to the raw data. If so, continue onwards.

- Step 1: Load raw data (that has had pre/post deployment sections removed)
  - o Important to copy the full date twice, once to keep original data, second time to convert to day only—using 'text to column' function in excel.
  - o Rename data sheet with logger ID and site name.
  - o Also keep the logger ID and site name at the top of the first column for reference.

- Step 2: Determine difference between daily max and min DO values
  - o Create a pivot table with date as 'row' and max and min DO as values.
  - o Copy data from pivot table into new columns
  - o New column, for each day, calculate the max-min values (difference between daily max and min)

- Step 3: Visualize the data
  - o Look at raw data—select all date time, DO, and temp values and create a line graph to look at overall trends.
  - o ***** Important with biofouling ***** if over time, DO values went to zero and remained at zero until the logger was retrieved, and biofouling (based on the biofouling protocol above) occurred, then there is no way to determine if the water was truly anoxic or if the logger was badly biofouled it can record zero dissolved oxygen values when in reality it was another value. If this occurs, then the zero data may need to be removed as it is not reliably known what water conditions were at the time. If the logger reads zero yet later increased to higher values, then it can be assumed that it is working properly, and the zero period can be considered a true indication of hypoxic/anoxic conditions.

- Step 4: Determine the time period of biofouling
  - o Graph max-min values over date with a line graph.
  - o There will always be variation in the max-min values over time – e.g., daily weather can impact how much DO is utilized/released. However, when biofouling occurs, there is a dampening of the signal and the max-min values will decrease over time.
  - o From the example, it is to note that biofouling is harder to detect during overwinter conditions versus summer conditions. When correcting for biofouling, it is important to take into consideration the season and

seasonal effects (e.g., ice over, stratification, mixing events) over the sampling period. For instance, there may be low fluctuations in max-min in the dead of winter when plant growth is at a minimum.
- o Approximate when biofouling likely started. If it is unclear, one can choose an earlier date, as the correction factor will be miniscule at the start of the biofouling period. Always have a rationale for determining this period, especially when the graph is not clear whether biofouling occurred.

- Step 5: Determine the maximum and minimum correction factor from the biofouling protocol conducted in the lab.
  - o Copy data from the lab biofouling check results.
  - o Determine the maximum correction factor or the maximum difference between clean and biofouled readings for each logger. First, calculate the mean DO readings from the pre and post clean periods of the biofouling protocol.
  - o Apply the following formula to get the Maximum correction factor using the following equation:

Correction Factor$_{max}$ =1- $\left(\frac{Mean\ preclean\ DO\ readings}{mean\ postclean\ DO\ readings} \right)$

- o This gives an idea of the amount of correction needed, and whether correction is needed. If the value is trivial (e.g., <5%), one can decide if a biofouling correction is needed or not—this would have been done before, visually.
- o The max correction factor is the maximum amount of biofouling that occurred over the sampling period, however, since biofouling accumulates over time, a minimum correction factor which will be incrementally applied over time will be required.
- o Minimum correction factor is based on the biofouling period determined in step 4.

Correction Factor$_{min}$ =1- $\left(\frac{Correction\ Factor_{max}}{Days\ of\ biofouling} \right)$

Step 6: Determine daily biofouling correction
- o Copy the dates of the biofouling period (only) to a new column.
- o The first day will have a correction factor of the minimum correction factor.
- o Any subsequent days will have a cumulative incremental higher correction factor. E.g., correction factor for day 1 = 0.02, day 2 = 0.04, day 3 = 0.06. It does not double by day, but the minimum correction

factor keeps adding on from the day before. A cumulative formula can be applied:

Formula= (correction factor of the day before +
(the absolute minimum correction factor from day 1)

 (e.g., =BD8+BD6).

Copy this formula for the entire biofouling period (each day).

- o The last day of deployment should have the same correction factor as the maximum correction factor. If not, troubleshoot your formulas.

- Step 7 - Apply the daily correction factor incrementally by day to correct raw data during the biofouling period

   - o Copy the raw date (date only, not date time) and raw DO values to a new column.
   - o Remove any negative DO values; renumber as 0.

Formula = IF(raw DO>0, raw DO,0)

e.g., =IF(BG6>0,BG6,0). Double check to see if this worked correctly.

   - o Associate each raw value with the proper correction factor using

Formula = IF (ISERROR (INDEX (BD$6:BD$48, MATCH (BF6,BB$6:BB$48,0))), 0, INDEX (BD$6:BD$48, MATCH(BF6, BB$6:BB$48,0))).

This is a special formula that selects from the range of dates on the daily biofouling period (BB$6:BB$48), whether it matches the raw date (BF6), if so, it inserts the associated biofouling correction factor (BD$6:BD$48), if it doesn't (e.g., a time before biofouling started) than it has a correction factor of zero. Double check to see if this worked correctly.

   - o Lastly, correct the DO values. Based on the potential for nil values to come back (e.g., #DIV0), we use the formula:

Formula = IF(ISERROR(no negatives DO*(1+daily correction factor)),

0,no negatives DO*(1+daily correction factor))

[e.g., =IF(ISERROR(BH6*(1+BI6)),0,BH6*(1+BI6))]

- Step 8: Create the polished QAQC data to be copied to a .csv file in the QAQC folder

    o In new columns, copy the date time raw data, the new corrected DO data, and the raw temp data.
    o Copy the columns and save as a .csv file in the QAQC folder.

To help understand the process

It is important to note that the correction factor is a proportional value, therefore it is unit-less and cannot be added directly to a raw DO value (mg/l). It is not a matter of 'adding' mg/L to the raw DO and is more so a correction rate. For example, if the difference between the biofouled and clean readings is 0.2, then you can only correct for 0.2 times the raw DO values. Using a proportional correction is a conservative way to correct for the data, as it can be difficult to interpret what the true value was at the time of logging. Thus, frequent field maintenance (cleaning the sensor cap) remains the most effective way to reduce logger biofouling and have the most accurate DO readings.

Issues and Subjectivity in data interpretation

Are zero values truly zero?

The interpretation of biofouled corrected values are subjective and the rationale used should be recorded. This is especially important when interpreting DO values near zero when the correction factor is smaller than with higher DO values (e.g. 10 mg/L) – as it is a proportional correction factor and not added directly to a raw DO value (e.g., one cannot simply add a 2 mg/L difference to 0 mg/L, and a correction factor would be null when multiplied against zero). It is unknown whether biofoul corrected DO values are truly zero or incorrectly reading as zero from heavy biofouling. When the DO values appear to be biologically sound (e.g., Summer anoxic period, Winter ice cover anoxic period, only a minor biofoul correction, not buried in mud), then it is likely to be kept in the data. It is also important to note all changes applied to the dataset, in cases where backtracking is needed. For example make a note if any data was removed as a result of heavy biofouling and being unable to reliably know what DO values should be.