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June 27, 2018

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Panel Chair, Roberts Bank Terminal 2 Project
C/O Cindy Parker, Panel Manager, Roberts Bank Terminal 2 Project
Canadian Environmental Assessment Agency
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Dear Mme. Beaudet,

From the Vancouver Fraser Port Authority re: 2017 Biofilm Dynamics Technical Data Report for the Roberts Bank Terminal 2 Project Environmental Assessment

The Vancouver Fraser Port Authority (VFPA) is pleased to submit the 2017 Biofilm Dynamics Technical Data Report (2017 Report) to the Panel.

The Roberts Bank Terminal 2 (RBT2 or Project) environmental assessment stated that the Project may affect the existing water column salinity in areas of Roberts Bank where biofilm currently exists (EIS, v3, s11.6.3.5 (PMV 2015a)). Environment and Climate Change Canada (ECCC) expressed concern that potential salinity changes may affect biofilm-associated fatty acid production at Roberts Bank (ECCC IR-02 of CEAR Document #960). To examine the relationship between abiotic factors, such as salinity, and biofilm biomass / fatty acid production in the microphytobenthic community, studies were conducted during the 2016 and 2017 western sandpiper (WESA) northward migration period at Roberts Bank.

The 2017 Report builds upon the 2016 Biofilm Dynamics Study that was submitted to the Panel in November 2017 as part of the response to IR8-04 (CEAR Document #1110).

The results of the 2017 study complement the findings of the both the 2016 study and the environmental impact statement (EIS) and adds to the overall understanding of biofilm science. The 2017 results align with the 2016 results with respect to increased mudflat exposure during the spring being the dominant driver positively affecting fatty acid abundance at Roberts Bank. Mudflat exposure is largely driven by the spring-neap tidal cycle associated with the 29.5-day lunar cycle. As the lunar cycle is a regular phenomenon that will not be affected by the Project, there is likely a dependable standing stock of fatty acids at Roberts Bank available to migrating WESA and other organisms in the spring.

In summary, the 2016 and 2017 results align with the following conclusions described in the EIS:

- Biofilm at Roberts Bank with the Project in place will not be limiting for migrating WESA;
- Ongoing salinity monitoring continues to show that under existing conditions there is large natural variation in salinity across Roberts Bank due to variable Fraser River flow and tidal mixing;
- Biofilm is abundant across the existing salinity gradient, found in both freshwater- and marine-influenced locations; and
- The Project will not affect the availability or quality of food available to migrating WESA.

Results from this work reduces uncertainty concerning adverse effects from the proposed Project and strengthens conclusions regarding the likelihood of no significant adverse effects to biofilm or western sandpipers as reported in the EIS.

A third year of biofilm sampling was conducted during western sandpiper northern migration in April and May 2018. The 2018 study will complete three years of sampling since submission of the EIS with results anticipated in Quarter 4 of 2018.

Yours sincerely,
<Original signed by>

Cliff Stewart, P.Eng., ICD.D
Vice President, Infrastructure

cc Cindy Parker, Panel Manager, Roberts Bank Terminal 2 Project
Douw Steyn, Panel Member
David Levy, Panel Member
Sean Moore, BC Environmental Assessment Office

Encl (1)
1. *2017 Biofilm Dynamics Technical Data Report for the Roberts Bank Terminal 2 Project Environmental Assessment*

Biofilm Dynamics during 2017 Northward Migration

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EXECUTIVE SUMMARY

The environmental assessment conducted on the proposed expansion of the existing container port at Roberts Bank (referred to as Roberts Bank Terminal 2 (RBT2 or Project)) stated that the expansion of the terminal may affect the existing water column salinity in areas of Roberts Bank where biofilm currently exists (EIS, v3, s11.6.3.5 (PMV 2015a)). Environment and Climate Change Canada (ECCC) expressed concern that potential salinity changes may affect biofilm-associated fatty acid production at Roberts Bank (ECCC IR-02 (CEAR Document #960)). To examine the relationship between abiotic factors, such as salinity, and biofilm biomass / fatty acid production in the microphytobenthic community, studies were conducted during the 2016 and 2017 western sandpiper (WESA) northward migration period at Roberts Bank. Results from the 2016 study have been submitted to the Panel (IR8-04 of CEAR Document #1110); this technical data report presents findings from the 2017 study program.

The western sandpiper (*Calidris mauri*, WESA) is a small migratory shorebird whose distribution is restricted to North and South America. During northward migration, the intertidal region of Roberts Bank supports approximately half of the migrating WESA population using the Fraser River estuary (FRE). Recent research has shown that WESA (among other shorebirds) at Roberts Bank, during northward migration, derive between 38% to 68% of their total daily energy requirements from biofilm, a thin (~2 mm), dense layer of predominantly organic material found on, and just below, the surface of freshwater, marine, and estuarine sediments.

Biofilm at Roberts Bank is primarily derived from microphytobenthos (e.g., diatoms) found in marine ocean waters, freshwater outflow from the Fraser River (Canoe Passage), and diatoms inhabiting the FRE. Each species of diatom is adapted to a set of environmental conditions under which they photosynthesise, grow, and produce components of biofilm such as Chlorophyll *a*, fatty acids, carbohydrates, and protein (amino acids) that provide energy and nutrients to foraging birds, marine invertebrates and fish. Certain types of fatty acids, such as saturated fatty acids (SFA, e.g., palmitic acid), monounsaturated fatty acids (MUFA, e.g., oleic acid and palmitoleic acid), and polyunsaturated fatty acids (PUFA, e.g., eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) produced by biofilm-associated diatoms are theorised to be nutritionally and/or physiologically important to long distance migrants, such as WESA. To examine the relationship between abiotic factors, biofilm parameters (fatty acid, Chlorophyll *a*, and total carbohydrate abundance), and microphytobenthos community composition the second year of a study initiated in 2016 was conducted during April/May 2017 at Roberts Bank.

Similar to previous 2016 results, fatty acids in greatest abundance were the SFAs myristic acid (14:0), and palmitic acid (16:0), the MUFAs palmitoleic acid (16:1n-7) and Oleic acid (18:1n-9), and the PUFAs EPA (20:5n-3), and DHA (22:6n-3). SFA, MUFA, and PUFA abundances were found at similar levels at freshwater-dominated and marine-influenced sites. SFA and MUFA comprised 73% and PUFA comprised 27% of total fatty acid levels. SFA and MUFA are the primary fatty acids used by WESA to fuel migration

(comprising >95% of stored fats) and are available to foraging WESA across the salinity gradient. PUFA are believed to potentially facilitate long-distance flight and are also available across the salinity gradient.

For the second year, statistically significant positive correlations among biofilm parameters (i.e., Chlorophyll *a*, fatty acids, and total carbohydrate levels) were documented during the study indicating biofilm associations are similar across the suite of productivity parameters. As Chlorophyll *a* is one of the easiest and most cost-effective biofilm parameters to assess, it is potentially a good proxy for assessing fatty acid abundances at Roberts Banks.

A consistent pattern in the levels of biofilm parameters was documented between stations, with periods of longer mudflat exposure time associated with higher biofilm parameter abundances. However, overall fatty acid levels were lower in 2017 compared to 2016 at many locations with reductions in total abundance ranging from approximately 80 to 440 mg/m^2 (9% to 40%). Larger reductions were documented in the marine/brackish Upper Intertidal area close to Brunswick Dyke and the Roberts Bank causeway compared to freshwater- dominated sites close to Canoe Passage.

Twelve of the 34 fatty acids, plus 6 summary fatty acids measures (Total Fatty Acids, Total SFA, Total MUFA, Total PUFA, Total Omega 3, and Total Omega 6 fatty acids) and Chlorophyll *a* and Total Carbohydrates were analysed using general linear modelling and Akaike Information Criterion model selection to determine factors influencing their abundance (i.e., mg biofilm parameter/m^2). Similar to 2016, the amount of time mudflats were exposed (i.e., not inundated) was positively correlated with the abundance of numerous biofilm parameters. Increases in mudflat exposure time were the primary factor driving Total Fatty Acid, SFA, and MUFA abundance. For Total MUFA (including 16:1n-7) there was little evidence of other abiotic factors influencing abundance levels. For some SFA there was some evidence that increases in 95th percentile water column temperature and 5th percentile temperature influenced fatty acid abundance. For factors affecting Total Fatty Acids, modelling indicated a weak to moderate influence from increases in 5th percentile water column temperature. In general, mudflat exposure time was the most influential factor affecting PUFA abundance in 2017; however, its influence was considered moderate with increases in water column temperature having a secondary low to moderate affect. Exceptions to this were omega 6 fatty acids (including 18:3n-6), which were strongly influenced by exposure time and 18:2n-6, which was strongly influenced by 5th percentile water temperature levels.

The 2016 and 2017 results indicate the majority of fatty acid production at Roberts Bank during the WESA northward migration period was driven by mudflat exposure, as increases in exposure time drove SFA and MUFA production, which accounted for 72%-74% of Total Fatty Acid abundance. Mudflat exposure is largely driven by the spring-neap tidal cycle associated with the 29.5-day lunar cycle. As the lunar cycle is a regular phenomenon that does not fluctuate, it is likely there is a dependable standing stock of fatty acid at Roberts Bank available to migrating WESA and other organisms in the spring.

The two years of data indicate PUFA abundance is less strongly influenced by mudflat exposure time. Results from 2016 indicated PUFA abundance was primarily influenced by increases in low salinity levels. In 2017, increase in mudflat exposure time were documented to have a moderate influence on PUFA abundance, with changes in water column salinity having a low influence on abundance. Factors influencing PUFA abundance may therefore vary annually, with the size of the annual Fraser River spring freshet and local weather conditions (e.g., amount of precipitation) playing a role. Regardless, results from two years of study have documented the biofilm community producing PUFA across the salinity gradient from freshwater-dominated sites close to the Fraser River to more marine stations close to the Roberts Bank causeway. It is therefore likely that PUFA, such as EPA and DHA, may be found under a wide range of freshet and weather conditions across Roberts Bank during WESA northward migration.

Overall fatty acid levels were lower in 2017 compared to 2016 at most locations. The reduced abundance was expressed across fatty acids (e.g., SFA, MUFA, PUFA); however, SFAs were affected more than MUFA and PUFA. In 2016, SFA proportionally comprised the greatest abundance (39% of total), with MUFA comprising approximately 36% of the total fatty abundance. In 2017, MUFA were proportionally more abundant than SFA (39% vs. 33%, respectively). PUFA were documented in similar proportions in both years. Overall, the mean fatty acid abundance across Roberts Bank was reduced by approximately 98 mg/m^2 for SFA (31%), 42 mg/m^2 for MUFA (14%), and 26 mg/m^2 for PUFA (13%). Spatially, fatty acid reductions where greater in marine/brackish locations compared to freshwater areas close to the Fraser River (i.e., Canoe Passage), which were generally comparable to 2016 abundances. The cause of these reductions is unknown, but could be a result of interannual differences in weather conditions (there was 10 times more rain in 2017 (118 mm) compared to 2016 (12 mm)) or freshet size (the 2017 freshet was smaller than 2016 during the period the study was conducted).

Similar to previous studies, diatoms of the genera *Nitzschia, Navicula,* and *Achnanthidium* were the dominant genera at all sites. Similar to 2016 results, no differences in microphytobenthic community composition among stations across the duration of the study was documented. However, a shift in the overall microphytobenthic community occurred between the periods of May 2 to May 8 and May 16 to May 23, 2017. Similar to results from 2016 (Hemmera and Advisian 2017), this change in community composition occurred after a spring tide and was primarily driven by changes in sub-dominant diatom taxa as opposed to changes in dominant taxa (i.e., *Nitzschia* spp., *Navicula* spp., and *Achnanthidium* spp.).

Key findings of this research are:

1. A large number of fatty acids (28 in 2016 and 34 in 2017) were documented in the biofilm community during the study. All fatty acids known or hypothesized to play an important role in supporting WESA migratory flight were documented across Roberts Bank from freshwater-dominated to marine-influenced intertidal sites.

2. Similar to previous 2016 results, fatty acids in greatest abundance were the SFAs myristic acid (14:0), and palmitic acid (16:0), the MUFAs palmitoleic acid (16:1n-7) and Oleic acid (18:1n-9), and the PUFAs EPA (20:5n-3), and DHA (22:6n-3). SFA, MUFA, and PUFA abundances were found at similar levels at freshwater-dominated and marine-influenced sites. SFA and MUFA comprised 73% and PUFA comprised 27% of total fatty acid levels. SFA and MUFA are the primary fatty acids used by WESA to fuel migration (comprising >95% of stored fats) and are available to foraging WESA across the salinity gradient. PUFA are believed to potentially facilitate long-distance flight and are also available across the salinity gradient.
3. Abundances of all fatty acid types (i.e., SFA, MUFA, PUFA) and all individual fatty acids analysed (n = 12) either remained constant throughout the study or increased in the latter portion of the study. No decrease in fatty acid abundance was documented over the duration of the program.
4. The biofilm parameter Chlorophyll *a*, which has been used in prior research to assess biofilm biomass, was statistically and positively correlated with the abundance of numerous fatty acids. This finding indicates the potential use of Chlorophyll *a* abundance as a proxy for assessing fatty acid abundances.
5. Similar to 2016 results, SFA and MUFA levels were documented to be primarily driven by increases in mudflat exposure time. Therefore, results suggest that SFA and MUFA abundance should be less influenced by the annual Fraser River freshet, which inputs large quantities of freshwater over the Roberts Bank mudflats, and should be annually abundant at freshwater-dominated and marine-influenced sites during WESA northward migration.
6. In 2017, the weight of evidence indicates that PUFA abundance was most strongly influenced by mudflat exposure time, which differed from 2016 results indicating water column salinity as the primary driver of PUFA abundance. Reasons for this difference are unknown, but could be a result of interannual differences in weather conditions or freshet size. Similar to 2016, this study also documented the biofilm community producing PUFA across the salinity gradient. It is therefore probable that PUFA, such as EPA and DHA, are found under a wide range of freshet conditions across Roberts Bank during WESA northward migration.
7. A large number of diatom genera (53) comprise the biofilm community during WESA northward migration. However, similar to 2016, three genera (*Nitzschia*, *Navicula*., and *Achnanthidium*) dominate the community. In both years, the dominant genera were distributed across Roberts Bank, with no difference in community composition among sampling stations documented.
8. The similarity in diatom community composition and fatty acid abundances between freshwater-dominated and marine-influenced sites may explain the previously documented high use of the Canoe Passage and Upper Intertidal areas by WESA during northward migration. As less saline sites have been documented to be physiologically less energy demanding to foraging shorebirds compared to more saline sites, it is possible that the freshwater-dominated Canoe Passage site may represents higher quality habitat compared to the Upper Intertidal area close to Brunswick Dyke. Sites at Canoe Passage also tend to be further from shore, providing unobstructed views of the surroundings, and are likely safer foraging locations from predators (i.e., falcons) than the Upper Intertidal zone located close to Brunswick Dyke and the Roberts Bank causeway.

Results from 2016 and 2017 increase the certainty in the predictions of potential effects of RBT2 on biofilm and WESA, and support the EIS conclusions that:

- Biofilm is abundant across the existing salinity gradient, being found in both freshwater- and marine-influenced locations;
- The Project is unlikely to affect the availability or quality of food available to shorebirds given biofilm's existing distribution and abundance in the LAA under highly variable freshet conditions that annually cause large variations in salinity;
- Biofilm at Roberts Bank with the Project in place will not be limiting for migrating WESA; and
- The Project will not change mudflat exposure, which is the dominant abiotic variable driving fatty acid abundance within biofilm at Roberts Bank.

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Appendix E Taxonomic Composition of Microphytobenthic Community

Glossary of Acronyms

AIC	Akaike's Information Criterion
AIC_c	Akaike's Second-Order Information Criterion
ANCOVA	Analysis of Covariance
ANOSIM	Analysis of Similarity
DHA	Docosahexaenoic Acid
EA	Environmental Assessment
ECCC	Environment and Climate Change Canada
EPA	Eicosapentaenoic Acid
EPS	Extracellular Polymeric Substances
FAME	Fatty Acids and Fatty Acid Methyl Ester
FRE	Fraser River estuary
GLM	General Linear Model
HPLC	High Performance Liquid Chromatography
MUFA	Monounsaturated Fatty Acid
nMDS	non-Parametric Multidimensional Scaling Analysis
PSU	Practical Salinity Unit
PUFA	polyunsaturated Fatty Acid
RBT2	Roberts Bank Terminal 2
RFU	Raw Fluorescence Units
SFA	Saturated Fatty Acid
SIMPER	Similarity Percentage Analysis
TOC	Total Organic Carbon
WESA	Western Sandpiper

1.0 INTRODUCTION

1.1 BACKGROUND

The western sandpiper (*Calidris mauri*, WESA) is a small migratory shorebird whose distribution is restricted to North and South America. During northward migration, the intertidal region of Roberts Bank, between the Roberts Bank causeway northwest to Canoe Passage (adjacent to Brunswick Marsh) has been shown to support approximately half of the migrating WESA population using the Fraser River estuary (FRE) during migration (Hemmera 2014). Northward migration occurs between mid-April and mid-May (Butler et al. 1987), with the peak of migration occurring between April 24 and May 3 (Drever et al. 2014). It is estimated that an average of 600,000 sandpipers (~17% of the entire population) use the area between Canoe Passage and the Roberts Bank causeway annually during northward migration (Drever et al. 2014).

Until the mid-2000s, small marine invertebrates (i.e., meio- and macrofauna such as polychaetes and bivalve molluscs) were believed to comprise WESA diet while at the FRE. In 2005, biofilm was first theorised to be consumed by WESA, with the first paper confirming biofilm in WESA diet published in 2008 (Kuwae et al. 2008). Recent research has shown that WESA at Roberts Bank derive between 38% and 68% of their total daily energy requirements from biofilm (Kuwae et al. 2008, 2012, Jardine et al. 2012).

Biofilm is a thin (~2 mm), dense layer of inorganic and organic substances (e.g., microphytobenthos[1], microbes, and organic detritus) found on the surface of shallow freshwater, marine, and estuarine sediments. Biofilm productivity is driven by photosynthetic eukaryotic organisms, primarily diatoms, which excrete extracellular polymeric substances that form a mucilaginous matrix creating a microenvironment that binds the community and promotes attachment to sediment. As the microphytobenthic community is photosynthetic, it is constrained by the depth of maximum light penetration to approximately the top 2 mm of sediments (De Brouwer and Stal 2001, Herlory et al. 2004).

The biofilm at Roberts Bank is believed to derive from diatoms found in marine ocean waters, freshwater outflow from the Fraser River (Canoe Passage), and diatoms inhabiting the FRE. Each species of diatom is adapted to a set of environmental conditions. Under optimal conditions diatoms can produce large amounts of biomass (e.g., Chlorophyll *a*, carbohydrates, and protein), while sub-optimal conditions (e.g., changes in salinity, temperature, light concentration or nutrients) that “stress” diatoms can inhibit photosynthesis, but promote fatty acid synthesis (Chu et al. 1996, Tzovenis et al. 1997, Pasquet et al. 2014, Schnurr and Allen 2015). Certain types of fatty acids, such as monounsaturated fatty acids (MUFA) (e.g., oleic acid and palmitoleic acid), polyunsaturated fatty acids (PUFA) (e.g., eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) and saturated fatty acids (SFA) produced by biofilm-associated diatoms are theorised to be nutritionally and/or physiologically important to long distance migrants, such as WESA (Guglielmo et al. 1998, Egeler and Williams 2000, Guglielmo 2010).

[1] Microphytobenthos: microscopic, photosynthetic eukaryotic algae (diatoms) and cyanobacteria that live on sediment surfaces

The Environmental Assessment (EA) conducted on the proposed expansion of the existing container port at Roberts Bank (referred to as the Roberts Bank Terminal 2 Project [RBT2]) stated that the expansion of the terminal may affect the existing water column salinity in areas of Roberts Bank where biofilm currently exists (EIS, v3, s11.6.3.5 (PMV 2015a)). Environment and Climate Change Canada (ECCC) expressed concern that potential salinity changes may affect biofilm-associated fatty acid production at Roberts Bank (Information Request ECCC IR-02 [CEAR Doc#960]). To examine the relationship between abiotic factors, such as salinity, and biofilm biomass/fatty acid production in the microphytobenthic community, studies were conducted during the 2016 and 2017 WESA northward migration period at Roberts Bank. Results from the 2016 study have been submitted to the Panel registry (Information Request IR8-04 [CEAA Doc#1110]); this technical data report presents findings from the 2017 study program.

1.2 STUDY OBJECTIVES

To further understand biofilm ecology, biofilm dynamics during northward migration were studied to:

1) Obtain data on biofilm biomass, fatty acid, and microphytobenthic community composition in areas of known WESA usage across Roberts Bank;
2) Identify and quantify the fatty acids produced by biofilm at Roberts Bank;
3) Investigate spatial and temporal differences in selected biofilm biomass parameters (Chlorophyll *a* and carbohydrate levels) and fatty acid levels at Roberts Bank during the WESA northward migration period;
4) Investigate potential relationships between biofilm biomass parameters and fatty acid levels;
5) Investigate potential correlations between fatty acid abundance and abiotic factors, including water column salinity levels;
6) Identify the microphytobenthic community composition (to diatom genera) found in biofilm at Roberts Bank during northward migration; and
7) Investigate temporal changes to the microphytobenthic community during the northward migration period.

2.0 METHODS

2.1 STUDY AREA

Biofilm sampling was conducted at the seven locations on Roberts Bank established as part of the 2016 study program (**Figure 2-1**) (Hemmera and Advisian 2017). Each sampling station incorporated a conductivity/depth/temperature logger from which water column salinity/temperature and mudflat emergence time was derived. Stations were distributed across Roberts Bank to cover a range of predicted salinity conditions (NHC 2014). Sampling stations included five of nine long-term salinity monitoring stations (i.e., stations A, C, J, I, H), and two temporary stations deployed specifically for this study (stations Y and X).

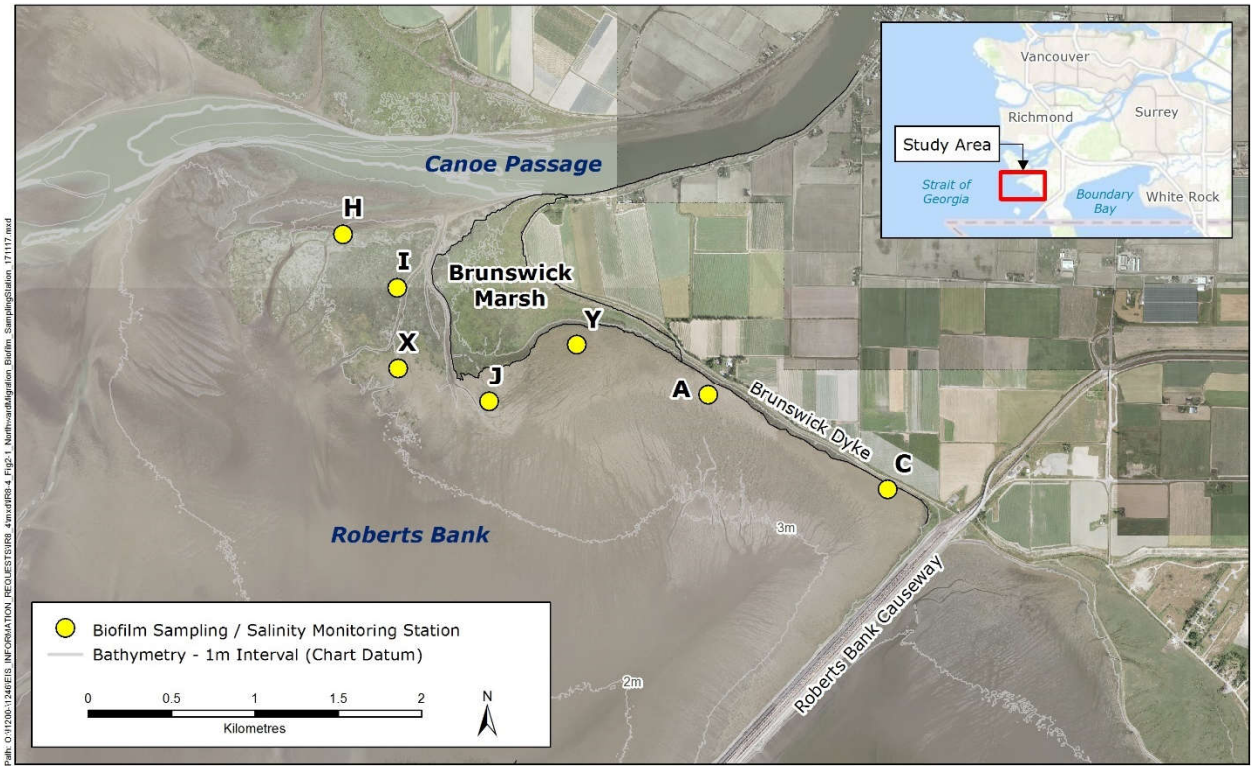


Figure 2-1 Biofilm Sampling and Abiotic Monitoring Stations within the Roberts Bank Study Area

2.2 TEMPORAL SCOPE

Biofilm sampling was conducted during five sampling events that overlapped with northward shorebird migration (**Table 2-1**). Due to logistical constraints, biofilm samples were not collected during the beginning of the 2017 WESA migratory period (approximately April 20 to 25). As biofilm productivity and microphytobenthic community composition can vary with the tidal cycle (WorleyParsons 2015*a*), surveys were also timed to occur across the Spring and Neap tidal cycle to capture predicted highs and lows of the biofilm community. Three sampling events occurred during the migratory period (April 26, May 2, and 8), while two occurred post-WESA migration (May 16 and 23).

Table 2-1 Sampling Event Dates and Tide States

Date of Sampling Event	Tide State
April 26, 2017	Spring Tide
May 2, 2017	Neap Tide
May 8, 2017	Spring Tide
May 16, 2017	Neap Tide
May 23, 2017	Spring Tide

2.3 FIELD STUDY METHODS

Biofilm sampling occurred at seven salinity monitoring stations distributed from Canoe Passage southeast to the Roberts Bank causeway (**Figure 2-1**). Coordinates were uploaded to a handheld GPS unit and used by field personnel to locate each station. Sampling was initiated approximately 60 minutes after intertidal mudflats emersion following a falling tide, providing enough time for biofilm to migrate to the surface (Herlory et al. 2004). The order monitoring stations was sampled was varied between surveys. At monitoring stations, two replicate sampling locations were randomly located and established 5-25 m from the sensor (14 locations total) (

Figure 2-2). At each location, two replicate sampling plots were positioned 2-3 m apart (7 salinity stations * 2 replicates/station * 2 plots/replicate = 28 plots total). Plots (numbered 1 to 2) were delineated using orange or yellow pin-flags and resampled during survey. At each replicate sampling plot, biofilm samples were collected using a putty knife by carefully scraping the top 2 mm of sediment from the mudflats. The depth of the scrape was controlled with the angled edge of the scraper, which was measured to be 2 mm. This was done by in-field estimation and reflects an approximate sampling depth. A 10 cm long strip of biofilm was removed with a 7.6 cm wide putty knife (76 cm^2) (**Figure 2-3**). A ruler was used to measure the 10 cm length. At each sampling plot a single chlorophyll *a*\total carbohydrate\fatty acid sample and separate (adjacent) taxonomy sample were collected (

Figure 2-2). At the second sampling plot within each replicate one chlorophyll *a* sample was collected. Successive sampling was conducted by scraping the patch of biofilm adjacent to the previous sample. The scraper was rinsed with de-ionised water between each sample. Biofilm samples were only collected on days with no precipitation and photographs were taken to document habitat (i.e., substrate and vegetation) at stations.

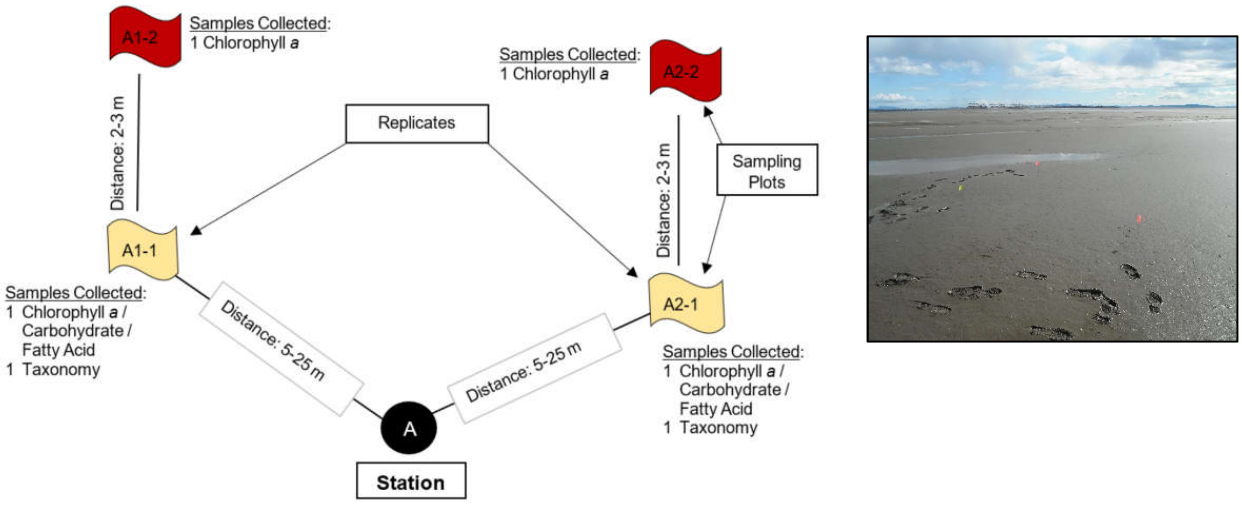


Figure 2-2 Example of the Sampling Design at each Monitoring Station, the Number and Type of Samples Collected at each Sampling Plot during Field Surveys, and Photograph of Sampling Plot at Station Y.

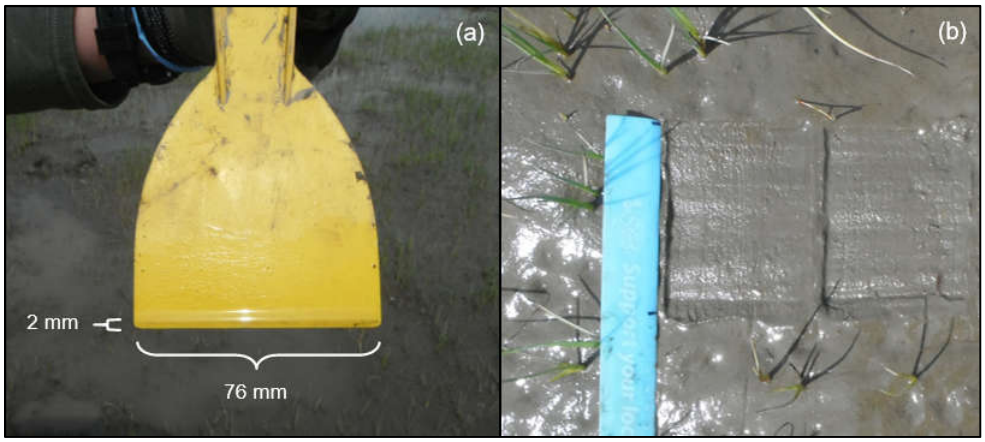


Figure 2-3 Plastic Putty Knife (with Dimensions) Used to Scrape Biofilm Samples (a) and Photograph Showing Mudflats after Biofilm was Removed, with Ruler Indicating the 10 cm Distance that was Scraped (b).

2.3.1 Biofilm Sample Collection and Storage

One hundred and thirty-three biofilm samples (119 core samples and 14 duplicates) were collected in April and May 2017 (**Table 2-2**). During all sampling events, besides April 26, 28 Chlorophyll *a* and 14 fatty acid/carbohydrate, and taxonomy samples were collected at each monitoring station. Due to logistical constraints seven samples were collected on April 26 (five from station A and two from station I). Fourteen duplicate samples were collected. All were analysed for Chlorophyll *a* and seven were analyzed for fatty acids, carbohydrates, and taxonomic composition.

Table 2-2 Number and Type of Biofilm Samples Collected for Chlorophyll a, Carbohydrate, Fatty Acid, and Taxonomic Analyses, Roberts Bank (April 26 to May 23, 2017)

Date	Chlorophyll a	Carbohydrates	Fatty Acids	Taxonomy
4/26/17	7	4	4	4
5/02/17	28	14	14	14
5/08/17	28	14	14	14
5/16/17	28	14	14	14
5/23/17	28	14	14	14
Total	119	60	60	60

Chlorophyll a, Carbohydrates, Fatty Acids

A single sample of Biofilm sediment was collected from mudflats for Chlorophyll *a*, carbohydrate and fatty acid content to be analysed, allowing for more direct comparison of biofilm parameters. Because storage and sample processing differ for samples undergoing taxonomic analyses, a separate sample was collected at each site for taxonomy (see **Section 2.5**).

2.3.2 Biofilm Sample Processing

Immediately after collection, Chlorophyll *a*/carbohydrates/fatty acid samples were placed in a 60 mL centrifuge tube, which was labelled and sealed in an individual amber bag with a second label. The samples were stored in a handheld cooler with dry ice until they could be transferred to a -80ºC freezer at the end of the day. The samples were held in the -80ºC freezer until they could be transferred to the laboratory for analysis. All samples were shipped on dry ice and remained below -30ºC during transport.

Chlorophyll *a*/carbohydrate/fatty acid samples were transported to Aquatech Enviroscience Laboratories (AEL) (Victoria, B.C.) for analyses. Samples were placed in Styrofoam coolers with dry ice and transited for less than 24 hours. Upon receiving the samples, laboratory personnel verified the temperature and confirmed the samples were accounted for in the Chain of Custody (COC). A unique laboratory ID number was issued to each sample vial. The laboratory ID number was associated with the field number provided on the centrifuge tube and inside the sealed amber bag to assure tracking of each sample.

The laboratory IDs were logged and a backup data file was created. Each wet sample was weighed, freeze-dried at -60°C, and then re-weighed to determine dry weight. Once dried, the samples were homogenised using a pestle and mortar, grinding the sample until all obvious clumps had been broken and the sample was a fine powder. Separate subsamples from the homogenised sample were used for Chlorophyll *a* (40 to 200 mg subsample), total carbohydrate (25 mg to 70 mg subsample), and fatty acid analyses (940 mg to 1550 mg). Specific methods are described in **Sections 2.4.1** and **2.4.3**.

Three separate biofilm biomass metrics were measured:

- **Chlorophyll *a*** – Chlorophyll *a* is the primary photosynthetic pigment of all oxygen-producing photosynthetic organisms and is present in all algae, cyanobacteria, and other photosynthetic organisms. It is a measure of density and primary productivity potential and used as a measure of biofilm biomass;
- **Total Carbohydrate** – the energy absorbed by Chlorophyll *a* (as well as accessory pigments such as Fucoxanthin) is transformed into glucose, which is a measure of Total Carbohydrate; and
- **Fatty Acids and Fatty Acid Methyl Esters (FAME)** – Fatty acids are the major component of lipids with fatty acid methyl esters being chemically unique types of fatty acids. Fatty acids are considered a measure of caloric and nutrient value for predators, with the fatty acids EPA (20:5n-3), DHA (22:6n-3), palmitic acid (16:0), palmitoleic acid (16:1n-7) and stearic acid (18:0) (amongst others) noted as potentially important fatty acids to long distance migrants such as WESA (Egeler and Williams 2000, Guglielmo 2010). For a list of fatty acids see **Appendix A**.

2.4 BIOFILM PARAMETERS

2.4.1 Chlorophyll *a*

The assessment of Chlorophyll *a* is a common method of estimating biofilm biomass and the potential productivity of photosynthetic organisms in the marine environment (Underwood and Smith 1998, Kuwae et al. 2008, Boyer et al. 2009, Jardine et al. 2012, Macdonald et al. 2012, MacDonald et al. 2012). For this study, the concentration of Chlorophyll *a* in each sample was measured by fluorimetry. Fluorimetry measures the fluorescence emitted by compounds when exposed to ultraviolet or other intense radiant energy. Chlorophyll *a* produces fluorescence of a characteristic colour and wavelength, allowing identification and quantification of several significant compounds in biological specimens.

Protocol

The Chlorophyll *a* content of sediment samples was determined using an extraction procedure utilising a mixture of High Performance Liquid Chromatography (HPLC) grade Acetone: Methanol at a 90:10 ratio. The measurements were performed using a Fluorescent Spectrometer from TURNER (model 7200-000, using Trilogy Module CHL-NA, Model #46, Turner Designs, Sunnyvale, CA, USA).

Prior to extraction, samples were re-lyophilised for two hours to remove any residual water, frost or ice. Chlorophyll *a* was extracted by mixing 50 to 100 mg of dry sediment in 5 mL of degassed mixture of Acetone: Methanol (90:10 by volume) in 15 mL glass tube, then vortexed. The sample tubes were flushed with N2, wrapped in aluminium foil to protect from the light, then stored in the dark at -10 to -20°C for 12 hours, before being vortexed again. The tubes were then centrifuged for five (5) minutes to achieve a better separation of the solvent extract and sediment. An aliquot of the extract (1 to 2 mL) was transferred into a clean 12 x 75 mm disposable glass test tube, where Raw Fluorescence Units (RFU) were read on the fluorimeter.

2.4.2 Total Carbohydrate

Carbohydrates are an important component of the extracellular polymeric substances (EPS) secreted by microphytobenthos found in biofilm. Carbohydrates are found in two distinct phases: liquid (colloidal) or solid (bound). Carbohydrates that are easily extracted with water from sediments are termed "colloidal carbohydrates" (Underwood et al. 1995) and include EPS and simple sugars (Taylor et al. 1999). The carbohydrates that remain in the sediment after colloidal carbohydrate extraction are termed “bound carbohydrate”. The protocol used to measure the Total Carbohydrate concentration of a sediment sample is designed for samples that have not been subjected to any extraction procedure; therefore, all carbohydrates, including intracellular, extracellular, and particle-bound material, were hydrolysed and measured. Total Carbohydrate levels were determined based on the amount of glucose.

Protocol

The analytical protocol used for Total Carbohydrate in sediments followed the methodologies described by Underwood et al. (1995) and Dubois et al. (1956). The analytical system included a Pharmacia Biotech model Ultraspec 2000 and a UV-Vis Spectrometer.

Total Carbohydrate concentrations were measured by creating a phenol-sulphuric acid assay. Two mL of distilled H2O was added to 100 mg of freeze-dried homogenised sediment in a 15 mL conical plastic tube. Then, 1 mL of 5% phenol aqueous solution and 5 mL of concentrated H_2SO_4 was added to the mixture. Once the production of gas ceased, the mixture was shaken in a vortex and put in a water bath for one hour at 30ºC. The mixture was then centrifuged at 3,000 rotations per minute (RPM) for 15 minutes. The tubes were allowed to stand for 10 minutes, then shaken and placed for 10 to 20 minutes in a water bath at 30°C. The absorbance of the supernatant was measured using a spectrometer at 485 nm.

2.4.3 Fatty Acids

Fatty acids are a form of lipid used to store energy in organisms and play an important role in the construction of biological structures, such as cell membranes. Marine microalgae including diatoms are the primary producers of certain fatty acids, with certain types of fatty acids known to be important to the health of higher vertebrate organisms (e.g., omega-3 fatty acids such as EPA and DHA) (Guglielmo 2010).

Protocol

Biofilm samples were stored at -80°C. Samples were lyophilised using a Labconco Freezone 2.5 Freeze Drier. Dry biofilm samples were then homogenised with a mortar and pestle. A portion (~0.5 g) of the homogenised biofilm was used to determine Total Organic Carbon (TOC). These results are used to determine an amount of sample needed for the FAME procedure. 10 mg of TOC was the desired amount of organic material present in the final extract designated for FAME analysis. For example, if the TOC of a sample was 10 mg/gr, then about 1,000 mg of dry homogenized sample was used for initial extractions.

Without knowing TOC results, samples can be processed "blindly" by using about 200-1000 mg of dry material. The adjustments (both, the final sample volume [50 or 500 uL] used for gas chromatography (GC) analysis and the GC injection volume [1, 2 or even 4uL]) would have to be made after preliminary GC analysis, and the samples would have to be re-analyzed at the new conditions.

As was done in 2016, fatty acids were analyzed as methyl esters using a gas chromatograph (GC; Varian CP-3800; Varian) equipped with a flame ionization detector (FID) or Ion –Trap Mass Spectrometer (ITMS) (Kainz et al. 2004). The methyl esters were prepared by trans-esterifying the lipid extract in H2SO4-CH3OH at 50C for 16 h (Kainz et al. 2002). The FAMEs were analyzed on a Supelco 2560 Capillary Column (100 m, 0.25 mm inner diameter, and 0.2 um film thickness). Helium was used as the carrier gas (1 mL/min flow rate). The following temperature ramp was used: 65ºC for 0.5 min, holding at 195ºC for 15 min after ramping at 40ºC/min, and holding at 240ºC for 10 min after ramping at 2ºC/min. Foe FID detector, Helium (make-up gas) and air (combustion) had flow rates of 30 and 300 mL/min, respectively. The sample injector was isothermal at 250ºC. FAMEs were identified by comparison of their retention times with known standards (37-component FAME mix, Supelco 47885) and corresponding mass spectra using ITMS set in Total Ion Count (TIC) mode. Quantification was performed with reference to seven-point calibration curves derived from 2.5, 50, 100, 250, 500, 1,000, and 2,000 ng/uL solutions of the FAME standard.

2.4.4 Data Treatment and Statistical Analysis

Biofilm parameters (Chlorophyll *a*, carbohydrates, and fatty acids) were expressed as an estimate of abundance per square metre (e.g., mg fatty acids/m^2) of intertidal mudflats. During field sampling, care was used to remove only the top 2 mm of sediment when collecting biofilm samples. However, slight variations in sampling depth taken over the length of the 10 cm scrape, variation in sediment grain size, and differing levels of water content within sediments led to differing amounts of sediment collected ranging from ~ 5 to 23 g (dry mass). As biofilm is restricted to the top 2 mm of sediment, the variable collection depth can act to "dilute" biofilm concentrations when more non-biofilm containing material, associated with larger sample weights, is collected in a sample (**Figure 2-4a**). Expressing biofilm abundance on a per square metre basis (**Figure 2-4b**), instead of as a concentration per unit weight of sediment, largely corrects for the dilution and variable sediment water content issues and was the rationale for expressing biofilm availability on a surface area basis. As a result, per discussions with Ryerson University, all statistical analyses of biofilm parameters were conducted on data expressed as the density or abundance of parameters per square metre (i.e., mg/m^2).

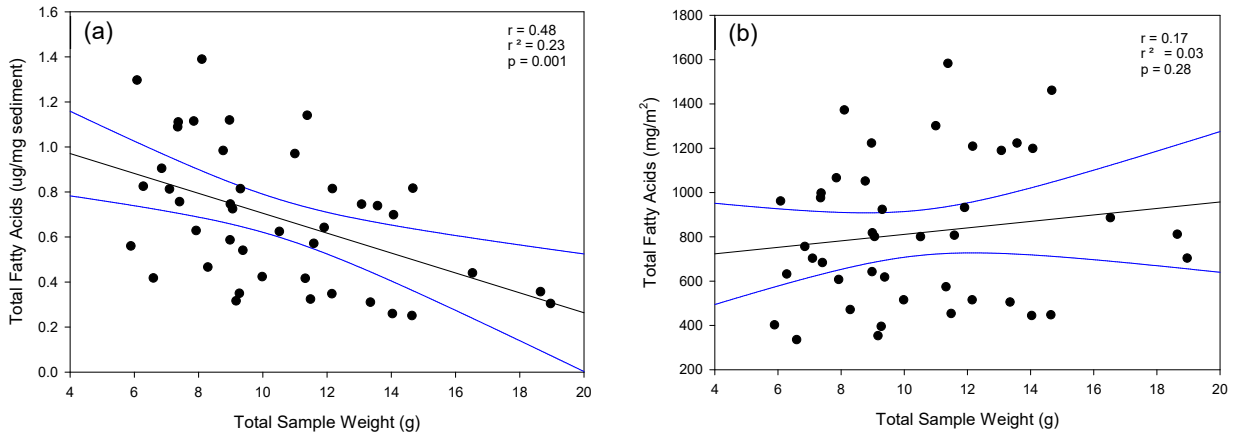


Figure 2-4 Relationship between Total Fatty Acid Levels and the Amount of Sediment Collected during Field Sampling when Expressed as (a) the Concentration of a Biofilm Parameter per Unit Mass of Sediment vs. (b) Abundance per Unit Area of Mudflats based on sampling conducted between (April 26 to May 23, 2017)

Analyses were completed using SYSTAT 13.1 (Chicago, USA). Prior to analyses, biofilm biomass indicators (Chlorophyll *a*, Total Carbohydrate) and fatty acid were tested for normality using the Shapiro-Wilk test. If parameters were found to possess non-normal distributions, attempts were made to normalise the data using accepted transformations. Transformed parameters are presented in (**Table 2-3**).

Table 2-3 Normality Test Results and Transformations of Biofilm Biomass and Fatty Acid Parameters

Biofilm Parameter	Shapiro-Wilk Statistic (p-value)		Transformation
	Untransformed Data	Transformed Data	
14:0	0.95 (0.02)	0.98 (0.43)	Square Root $(\sqrt[2]{X})$
16:0	0.93 (<0.01)	0.97 (0.17)	Square Root
16:1n-7	0.94 (<0.01)	0.96 (0.07)	1.5-Root $(\sqrt[1.5]{X})$
18:1n-9	0.92 (<0.01)	0.96 (0.08)	Square Root
18:2n-6	0.92 (<0.01)	0.99 (0.71)	Square Root
18:3n-3	0.76 (<0.01)	0.95 (0.02)	Cube Root $(\sqrt[3]{X})$
18:3n-6	0.96 (0.04)	0.97 (0.09)	Square Root
20:1	0.92 (<0.01)	0.99 (0.92)	Square Root
22:0	0.92 (<0.01)	0.97 (0.18)	Square Root
Total SFA	0.95 (0.02)	0.96 (0.07)	Square Root
Total MUFA	0.95 (0.01)	0.97 (0.09)	1.5-Root
Total Omega 6	0.95 (0.02)	0.99 (0.70)	Square Root
Chlorophyll *a*	0.96 (<0.01)	0.98 (0.14)	Square Root
Carbohydrates	0.90 (<0.01)	0.97 (0.16)	Square Root

Summary statistics were calculated for the 34 fatty acids documented in the biofilm samples during the study. Twelve of the 34 fatty acids known to be potentially important to migrating WESA, plus Chlorophyll *a*, Total Carbohydrates, and 6 summary fatty acids metrics (i.e., Total Fatty Acids, Total SFA, Total MUFA, Total PUFA, Total Omega 3, and Total Omega 6) were investigated for correlations between parameters, spatial and temporal differences during the study, and abiotic factors potentially affecting biofilm parameters.

Transformed data were used to test for statistical significance using parametric analyses (e.g., Analysis of Covariance (ANCOVA), Pearson Correlations, General Linear Models (GLM)); however, graphed relationships are presented using untransformed data when necessary to aid interpretation. Despite expressing biofilm abundance on a per square metre basis, the total amount of sediment collected in the field (total sample weight) was found to explain additional variability for some biofilm parameters and was included as a covariate in statistical analyses.

To test for relationships among measured parameters (e.g., Chlorophyll *a*, Total Carbohydrates, fatty acid levels), Pearson correlation analyses were conducted using a Bonferroni adjusted p-value to account for increased likelihood of Type I error (falsely rejecting a null hypothesis) resulting from multiple comparisons.

To test for differences in biofilm parameter abundances (e.g., Chlorophyll *a*, Total Carbohydrates, fatty acid levels) among stations and sampling dates, general linear modelling was conducted for each biofilm parameter with replicate samples nested within stations and the total dry sample weight (g) and percent soil moisture content of samples as covariates.

Results from the GLMs only indicate whether the means of the dependent variable differ significantly when considering the independent variable. To determine specific differences within each variable (i.e., differences among individual stations/dates), a Bonferroni *post-hoc* test was used. The Bonferroni p-value is adjusted to account for multiple tests, allowing for a consistent alpha (α) to control for Type I error. Temporal and spatial interactions of parameters were assessed by reviewing time series trends.

Water column salinity (expressed as practical salinity units [PSU]), water column temperature (C°), and the amount of time mudflats were exposed within a tidal cycle were recorded every five minutes using CTD-Diver dataloggers (Van Essen Instruments 2016) deployed at all stations. The percentage of time mudflats were exposed was calculated for each station for the previous 24-hour, 48-hour, 72-hour, and 96-hour periods prior to sampling to inform the conditions potentially affecting biofilm parameters. This was done by determining when the CTD-Diver dataloggers, placed at the mudflat-water interface, at each station were “dry” and not covered by water. These dry values were screened from the salinity and temperature datasets prior to calculating 5^{th}, 50^{th} (median), and 95^{th} percentile salinity and temperature estimates for the same temporal periods.

This created 28 potential variables (3 percentiles x 4 periods x 2 parameters [salinity and temperature] + 4 mudflat exposure periods) that could be used to inform variables affecting biofilm abundance.

To reduce the number of variables available for modelling and address issues of collinearity, a Pearson Correlation analyses was conducted for each abiotic parameter (e.g., 5th percentile water column temperature) to investigate the strength of correlation between temporal periods (i.e., 5th percentile water column temperature over the 24-hours vs. 48-hours vs. 72-hours vs. 96-hours prior to biofilm sampling). The correlation coefficients for each period were averaged and inspected to determine the appropriate period for inclusion in model selection procedures. All time periods within an abiotic parameter were highly correlated (**Table 2-4**). For consistency with prior research (Hemmera and Advisian 2017), the 72-hour period was included in modelling to investigate abiotic factors potentially affecting biofilm abundance at Roberts Bank.

Table 2-4 Mean Pearson Correlation Coefficients Calculated across 24-Hour, 48-Hour, 72-Hour, and 96-Hour Periods at Monitoring Stations at Roberts Bank (April 26 to May 23, 2017).

Variable	Duration of Time Prior to Biofilm Sampling			
	24-Hour	48-Hour	72-Hour	96-Hour
5th Percentile Water Column Salinity	0.97	0.99	0.99	0.99
50th Percentile Water Column Salinity	0.96	0.97	0.98	0.97
95th Percentile Water Column Salinity	0.87	0.88	0.89	0.87
5th Percentile Water Column Temperature	0.90	0.93	0.93	0.92
50th Percentile Water Column Temperature	0.92	0.96	0.94	0.95
95th Percentile Water Column Temperature	0.66	0.80	0.78	0.72
Percent Time Mudflat Exposure	0.95	0.98	0.98	0.97

To further refine the variables available during Akaike's Information Criterion (AIC) model selection, the distribution of temperature and salinity data within 5th, 50th, and 95th percentile variables were visually inspected and a Pearson's Correlation analyses between variables was conducted. In general, the 50th percentile water column temperature and salinity variables were found to be highly correlated with 5th and 95th percentile measures. During backward stepwise regression modelling, 5th and 95th percentile temperature and water column salinity variables showed the strongest and most consistent correlation with abundance measurements compared to 50th percentile values. Therefore, 5th and 95th percentile values were judged to be the most informative, and 50th percentile temperature and water column salinity variables were excluded from AIC modelling. To control for the sampling location and date that samples were collected Station and Date were included in all models as covariates. The variable Total Sample Weight was added as a covariate to each model to control for variability associated with biofilm sediment sample collection. Soil moisture content was not found to be a significant covariate in any model and was removed

from statistical modelling. Variables used to model abiotic factors potentially affecting biofilm as part of the AIC modelling are shown in **Table 2-5**.

Table 2-5 Variables used in AIC Modelling to Model Abiotic Influence on Biofilm Parameters

Variable	Definition
5th Percentile Water Column Salinity	5th percentile salinity for the 72-hour period preceding sample collection
95th Percentile Water Column Salinity	95th percentile salinity for the 72-hour period preceding sample collection
5th Percentile Water Column Temperature	5th percentile water temperature (Celsius) for the 72-hour period preceding the sampling day
95th Percentile Water Column Temperature	95th percentile water temperature (Celsius) for the 72-hour period preceding the sampling day
Percent Time Mudflat Exposure	The percentage of time the sampling station was exposed (i.e., not inundated) during the 72-hour period prior to sampling
Station	Included in all models as a covariate to control for the location samples were collected
Sampling Date	Included in all models as a covariate to control for the date samples were collected
Total Sample Weight (g)	Included in all models as a covariate to control for variability associated with biofilm sediment sample collection

Backwards stepwise regression and AIC analyses were used to assess the importance of abiotic factors on biofilm parameters. AIC, an information-theoretic approach that does not restrict variable inclusion into a model based on a variable's significance level, was used to evaluate models (Burnham and Anderson 2002). Models were evaluated using Akaike's Second-Order Information Criterion for small sample size (AIC_c). Models with $\Delta AIC_c < 2$ were considered to have substantial empirical support, $4 \leq \Delta AICc \leq 7$ had considerably less support, and models with $\Delta AICc > 10$ possessed virtually no support (Burnham and Anderson 2002). To understand the importance of each abiotic variable and its contribution to influencing biofilm parameters a balanced variable set of models were evaluated and summed Akaike model weights were calculated (Burnham and Anderson 2002, Arnold 2010). Under this approach, a set of models were constructed that included all combinations of the abiotic variables in **Table 2-6**. This created a model set of 31 models, with each variable represented in 16 of the 31 models (**Table 2-6**). The summed weights computed using this approach therefore represent a relative weighting of each variable's importance and its ability to influence biofilm parameters such as fatty acids, carbohydrates, and chlorophyll *a*.

During backward stepwise regression modelling, all candidate variables listed in **Table 2-5** plus median (50th percentile) water column salinity and temperature variables were entered into the model. At each step, the least significant variable with a p-value > 0.05 was removed from the model and previously removed variables were allowed to re-enter the model if they explained more variability than retained variables. This process continued until only statistically significant variables ($p > 0.05$) remained in the model.

Table 2-6 Complete Balanced Model Set used in AIC Analyses

Model ID	Model
1	5th Percentile Salinity
2	95th Percentile Salinity
3	5th Percentile Temperature
4	95th Percentile Temperature
5	Percent Time Mudflats Exposed
6	5th Percentile Salinity + 95th Percentile Salinity
7	5th Percentile Salinity + 5th Percentile Temperature
8	5th Percentile Salinity + 95th Percentile Temperature
9	5th Percentile Salinity + Percent Time Mudflats Exposed
10	95th Percentile Salinity + 5th Percentile Temperature
11	95th Percentile Salinity + 95th Percentile Temperature
12	95th Percentile Salinity + Percent Time Mudflats Exposed
13	5th Percentile Temperature + 95th Percentile Temperature
14	5th Percentile Temperature + Percent Time Mudflats Exposed
15	95th Percentile Temperature + Percent Time Mudflats Exposed
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed

Model ID	Model
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed

Notes: The location (i.e., Station) and date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.

2.4.5 Field Duplicates

Field duplicates were collected to assess the variability due to the data collection method and noted high spatial variability. Fourteen field duplicates were collected for Chlorophyll *a* and seven for carbohydrates/fatty acids, equalling ~ 12% of the total samples collected. The laboratory duplicate was run on a randomly assigned sample to measure the precision of the sample analysis and methodology of each analysis. Field duplicates were collected to measure the precision of sampling effectiveness (e.g., is the sample an appropriate representation of the site). The field duplicates were collected from the same sampling station, though a cleaned core and scraper were used to collect the sample. A comparison of the field duplicate to the sample was conducted to establish the percent variability in data due to sample collection protocols.

2.5 TAXONOMY

2.5.1 Sample Collection and Storage

Two samples were collected at each station during each survey event for taxonomic identification. The samples were placed in 60 mL centrifuge tubes, filled with 5% Lugol's solution in distilled water, and gently shaken to mix the sediment and the preservative solution. The tubes were labeled and placed in an individual sealable amber bag with a second label. The samples were stored in a backpack and transported to a light-proof cooler at the end of each day. The samples were held in a dark cooler at room temperatures until they were transferred to EcoAnalysts Inc. (Moscow, Idaho) for taxonomic identification to genus level.

2.5.2 Sample Processing

EcoAnalysts used the Palmer Maloney counting chamber method for counting and identifying microphytobenthos to genus level. To homogenise and evenly disperse the cells, samples were gently inverted a minimum of 30 times, then 0.1 mL of the sample was randomly collected and placed in a Palmer Maloney counting chamber using a micropipette. The counting chamber contains the sample within a defined area on a glass microscope slide.

A Leica DMIL Light Emitting Diode (LED) compound light microscope with 20X, 40X, and 63X objective magnifications were used to visually identify microphytobenthos. This microscope was integrated with a Leica DFC450 digital camera (5 megapixel resolution). The combination of microscope and camera allowed single cells greater than ~ 4-5 µM to be identified. Identification was focused on nanoplankton species. Once in the counting chamber, the samples were assessed for concentration.

Optimal efficiency and accuracy of identification/enumeration occurs at ~ 15-20 units per field of view. If the sample concentration was too high or low, the subsample was adjusted by adding or removing small volumes of sample and filtered seawater. If the volume was changed, the new volume and concentration were recorded on the datasheet.

Individual cells or natural units were identified using the latest taxonomic references (Tomas 1997, Sheath and Wehr 2003, Siver et al. 2005, John et al. 2011). The term natural units is used to distinguish between a single cell and colonial algae. Colonial algae can form aggregations of multiple cells. In this instance, the aggregation is defined as one natural unit. For each multi-cellular natural unit, the total number of cells were counted.

Microphytobenthos were identified and counted to the genus level until 300 natural units were encountered. Counts were conducted using the transect method, where taxonomists follow a straight line across the entire counting chamber, enumerating and identifying all organisms within the field of view. The identification and enumeration process takes approximately an hour to complete per sample; however, instances did occur where samples were in extremely low densities, thus making it difficult to achieve 300 natural units within a reasonable amount of time. To process these samples in an efficient manner, samples with low densities were enumerated for a maximum period of two hours. This level of effort was deemed sufficient to provide comparable taxonomic densities.

2.5.3 Data Analysis

Calculating Cell Density

To estimate microphytobenthos cell density in each sample, the length, width, and depth of each counting chamber were recorded and multiplied to calculate the volume. If applicable, the counted volume was multiplied by the dilution or concentration factor. This density was then multiplied by the total sample volume (mL) to provide a total number of cells per sample. The number of cells per sample was extrapolated to the entire 1 m^2 quadrat. The total number of cells per sample was divided by the surface area and multiplied by 10,000 cm^2/m^2.

Community Structure Indices

Measures of community structure, including total and individual taxa density were graphed to illustrate spatial and temporal patterns.

2.5.4 Community Analysis

Taxonomic density data were imported into R-statistical package (R Core Team 2017) and log+1 transformed to increase normality. The vegan and clustsig packages were used for all community analyses described herein (Whitaker and Christman 2014, Oksanen et al. 2017). The Bray-Curtis coefficients were calculated for all pairwise combinations of samples and plotted using a non-Parametric Multidimensional Scaling Analysis (nMDS). The nMDS is a dimensionless ordination plot where axes are unitless and the distance between points is relative to their similarity. Communities plotted close to each other are considered to be similar while communities plotted farther away are considered to be dissimilar. A Cluster Analysis using group average linkages was conducted to provide visual comparisons of the various levels of similarity.

Analysis of Similarity

To test for spatial and temporal difference in taxonomic composition, community similarity coefficients were assessed using the Analysis of Similarity (ANOSIM) test. The ANOSIM analysis uses the Bray-Curtis coefficients to rank the order of dissimilarity among defined groups. An R-statistic is calculated based on the difference of the mean rank similarity between and within groups as a factor of the total number of samples. The R-statistic is a scaled ratio between -1 and 1 with values close to zero indicating high similarity. A positive value means most similar samples are within a defined group; negative values means most similar samples are outside of a defined group. To test for significance of the R-statistic, random permutations are run with samples being randomly assigned to groups. The R-statistic from the random permutations is then compared against the observed R-statistics to determine if it is significantly different compared to random groupings. If the R-value is significant, it concludes that the samples within groups are more similar (to the degree of the R-value) than would be expected by random chance.

Similarity Percentage

A Similarity Percentage (SIMPER) analysis was undertaken to identify individual taxa and their influence in different temporal and spatial samples. The SIMPER analysis (Clarke 1993) uses the average Bray-Curtis coefficients among samples within each assigned group, and compares these means among groups. As the Bray-Curtis coefficient is based on the contribution of each taxon, the average dissimilarity between pairwise category comparisons can be expressed in terms of the average percent dissimilarity contributed per taxa. For each pairwise comparison, individual taxa are listed based on the average dissimilarity. The SIMPER results breakdown the community comparison and identify which taxa are dominant within a given habitat and which taxa have the greatest dissimilarity between groups.

2.6 SALINITY MONITORING

Data were recorded on abiotic intertidal water parameters at Roberts Bank throughout the duration of this study. Automated datalogging sensors (models: Schlumberger CTD-Diver and Solinst LTC Levelogger Junior) were used to collect water temperature, water pressure, and conductivity data at five-minute intervals at all stations. The raw data were entered into the Aquarius Time-Series database (Aquarius Informatics Inc. 2017) and salinity values (PSU) were calculated from the conductivity and temperature data. Water parameter sensors were deployed at the sediment-water interface at all stations to assess salinity where biofilm occurs, and at a height of 0.3 m at three stations to assess vertical mixing of fresh and saltwater (**Figure 2-5, Figure 2-6**). Data were downloaded from sensors during monthly field visits and sent to Northern Hydraulic Consultants for processing with AQUARIUS software designed to manage water quality data.

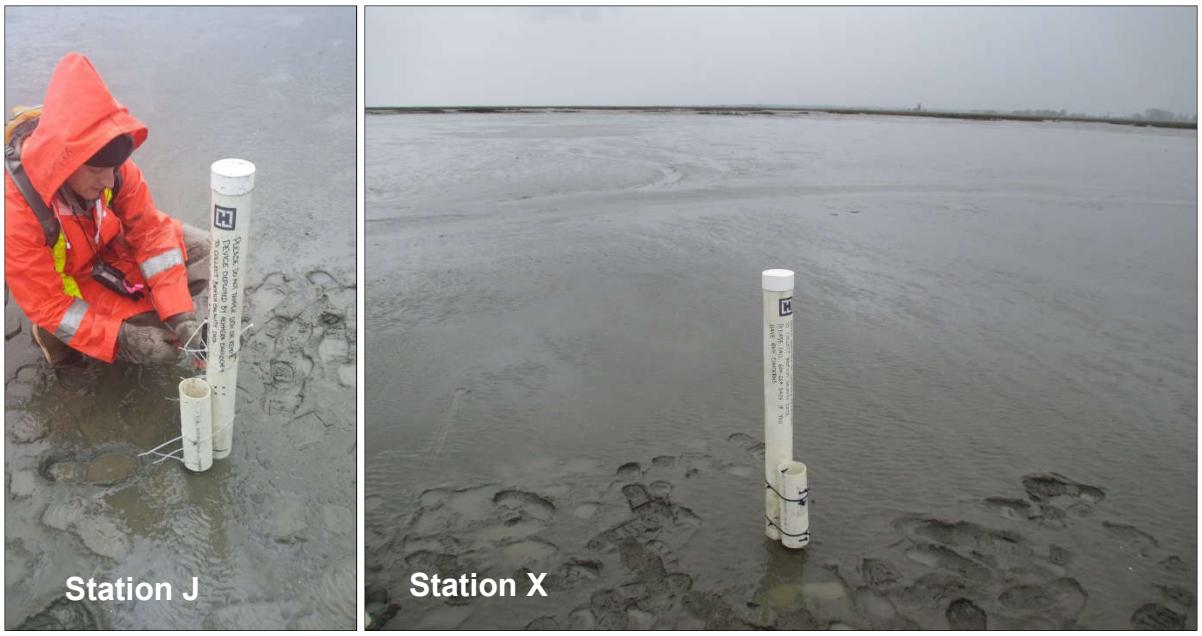


Figure 2-5 Station Housings Showing Installation of Sensor at a Height of 30 cm at Station J and Housing for Sensor at the Sediment-Water Interface at Station J and X

Figure 2-6 View of Sensor within Housing at the Sediment-Water Interface

3.0 RESULTS

3.1 BIOFILM BIOMASS AND FATTY ACID ABUNDANCE

Except in one instance (20:1 at station X on May 8), all 12 focal fatty acids analysed plus Chlorophyll *a* and carbohydrates were found at every station, on every sampling event, indicating the parameters were produced across the spatiotemporal range and across the suite of abiotic conditions experienced within the study area. Twenty-three of 34 fatty acids occurred at all stations on all sampling days and 26 of 34 occurred at all stations on all but a single sampling day (**Appendix C**). Fatty acids that did not occur, or were below the detection limit of analytical equipment, at >50% of sampling events at stations were 6:0, 8:0, and 10:0.

3.1.1 Chlorophyll *a*

Mean biofilm Chlorophyll *a* levels varied among stations and sample dates (**Table 3-1, Table 3-2**, **Figure 3-1**Error! Reference source not found.). Stations H and I located close to Canoe Passage and Station C located in the upper intertidal zone close to the Roberts Bank Causeway possessed the highest Chlorophyll *a* levels. Stations A, J, X, and Y located south and southwest of Brunswick Marsh in the middle of the study area contained the lowest Chlorophyll *a* levels. Statistically significant differences in Chlorophyll *a* abundance were documented among stations ($F_{6,83} = 14.6$, $p < 0.001$) (**Figure 3-2**). Pairwise comparisons found significant differences between stations C, I and Stations A, J, X, and Y; and Station H and Stations J, X, and Y.

Table 3-1 Biofilm Chlorophyll *a* Summary Statistics per m^2 of Intertidal Mudflats for Stations Sampled at Roberts Bank (April 26 to May 23, 2017)

Station	N	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
A	21	45	10	29	63
C	16	66	16	35	97
H	16	60	17	42	98
I	18	71	15	58	108
J	16	53	11	39	83
X	16	55	15	30	81
Y	16	51	9	35	64

Table 3-2 Biofilm Chlorophyll *a* Summary Statistics per m^2 of Intertidal Mudflats by Sampling Date at Roberts Bank (April 26 to May 23, 2017).

Sampling Date	N	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
26-Apr	7	56	27	29	108
02-May	28	52	18	29	98
08-May	28	60	17	33	105
16-May	28	56	12	35	97
23-May	28	60	13	38	83

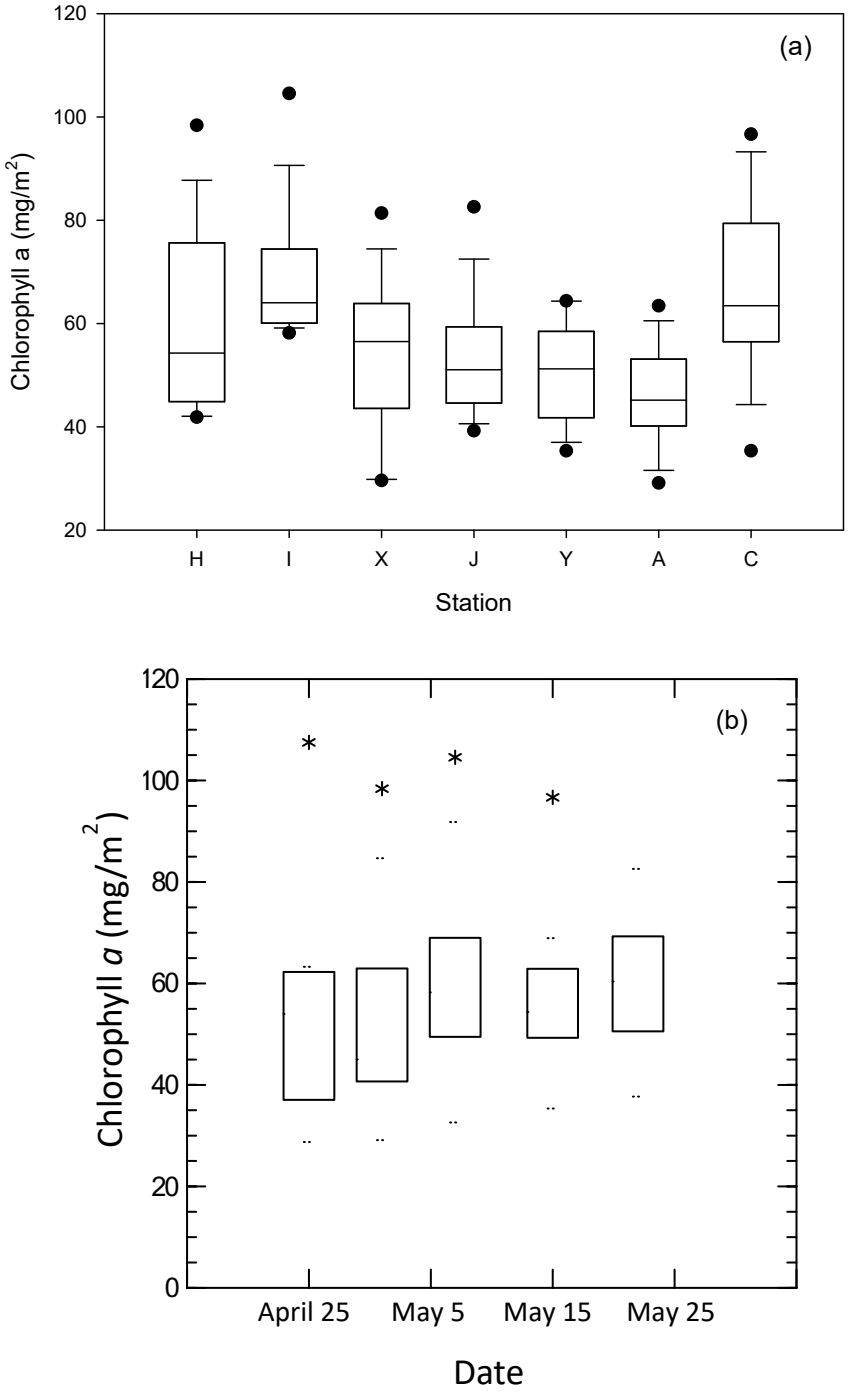
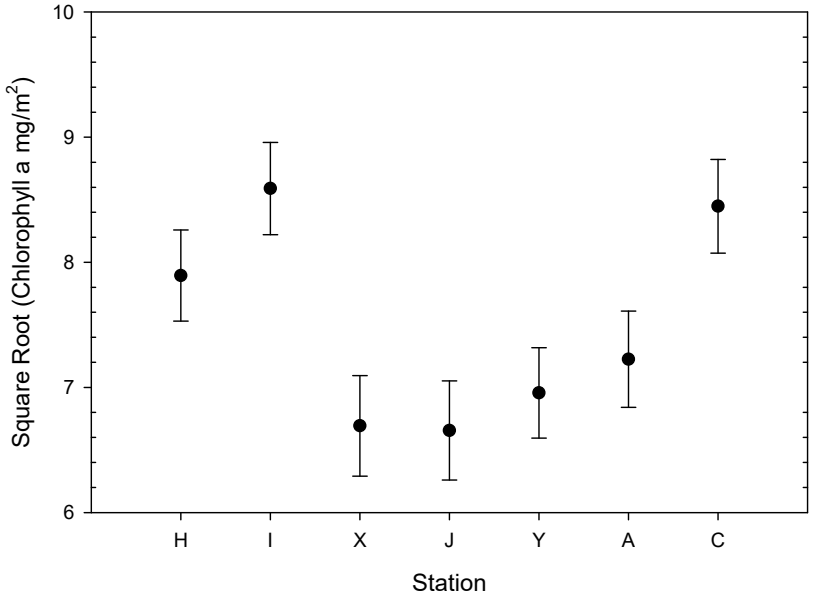


Figure 3-1 Chlorophyll a Abundance per m^2 of Intertidal Mudflats at Roberts Bank Sampling Stations (a) and Sampling Dates (b) (April 26 to May 23, 2017). Solid lines within box plots are median values. Whiskers represent 90th and 10th percentiles. Dots and whickers represent outliers.



Bonferroni Pairwise Comparison Test Results	
Station	**p-value**
H > X,J,Y	< 0.01
I, C > X,J,Y,A	< 0.001

Figure 3-2 Square Root Mean Chlorophyll *a* Abundance (Black Circles) at Roberts Bank (May 2 to May 23, 2017) Adjusted for Total Weight of Sediment Collected derived from General Linear Modeling Results. Error Bars are the 95% Confidence Interval of the Mean. Table Shows Statistically Significant Differences among Stations.

Overall Chlorophyll *a* abundance during the study varied between a mean of 52 and 60 mg/m^2 (**Table 3-2**, **Figure 3-1**Error! Reference source not found.**b**). General Linear Modelling found no difference in Chlorophyll *a* abundance among sampling dates ($F_{3,80}$ = 2.4, p = 0.07) or over the duration of the study ($F_{1,94}$ = 3.4, p = 0.07). No Difference was documented between replicate samples ($F_{7,80}$ = 0.8, p = 0.57) or sampling plots ($F_{14,80}$ = 0.8, p = 0.72) collected at stations.

3.1.2 Carbohydrates

Similar to Chlorophyll *a* (**Table 3-1** and **Figure 3-2**), the highest carbohydrate abundances documented occurred at both freshwater-dominated (stations H and I) and marine-influenced (station C) stations (**Table 3-3** and **Figure 3-3**). Station X possessed the lowest carbohydrate levels. Mean carbohydrate abundance differed approximately 78% between the highest and lowest stations.

Table 3-3 Biofilm Total Carbohydrate Summary Statistics per m^2 of Intertidal Mudflats for Stations Sampled at Roberts Bank (April 26 to May 23, 2017).

Station	n	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
A	11	7,905	4,026	2,717	15,060
C	8	9,832	3,273	4,272	15,225
H	8	8,120	3,341	3,838	12,685
I	9	10,006	3,881	5,344	15,851
J	8	7,961	6,960	3,415	24,944
X	8	5,626	2,757	2,116	10,248
Y	8	6,532	2,802	3,453	12,268

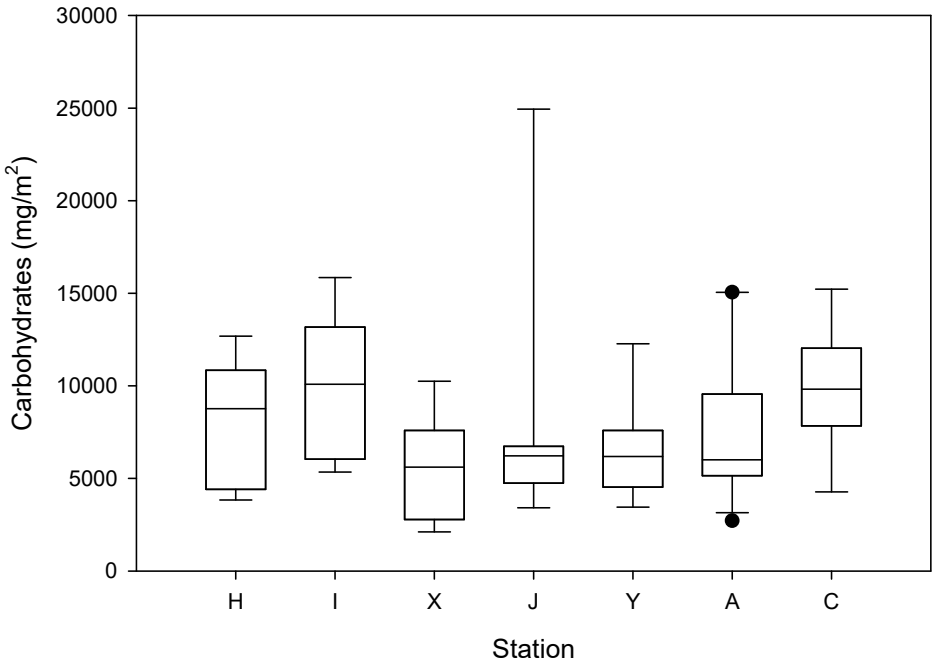


Figure 3-3 Carbohydrate Abundance per m^2 of Intertidal Mudflats at Roberts Bank Sampling Stations (April 26 to May 23, 2017). Solid lines within box plots are median values. Whiskers represent 90th and 10th percentiles.

Overall total carbohydrate abundance differed by ~66% during the course of the study, ranging from 6.2 to 10.4 g/m^2 among sampling dates (**Table 3-4**). The lowest mean carbohydrate abundance was documented on May 16, with the highest mean abundance documented 7 days later on May 23.

Table 3-4 Biofilm Total Carbohydrate Summary Statistics per m^2 of Intertidal Mudflats by Sampling Date at Roberts Bank (April 26 to May 23, 2017)

Sampling Date	n	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
26-Apr	4	9,121	5,738	2,717	15,060
02-May	14	7,891	3,964	2,234	15,059
08-May	14	7,265	3,639	2,116	15,851
16-May	14	6,251	1,821	3,838	9,550
23-May	14	10,385	5,227	5,144	24,944

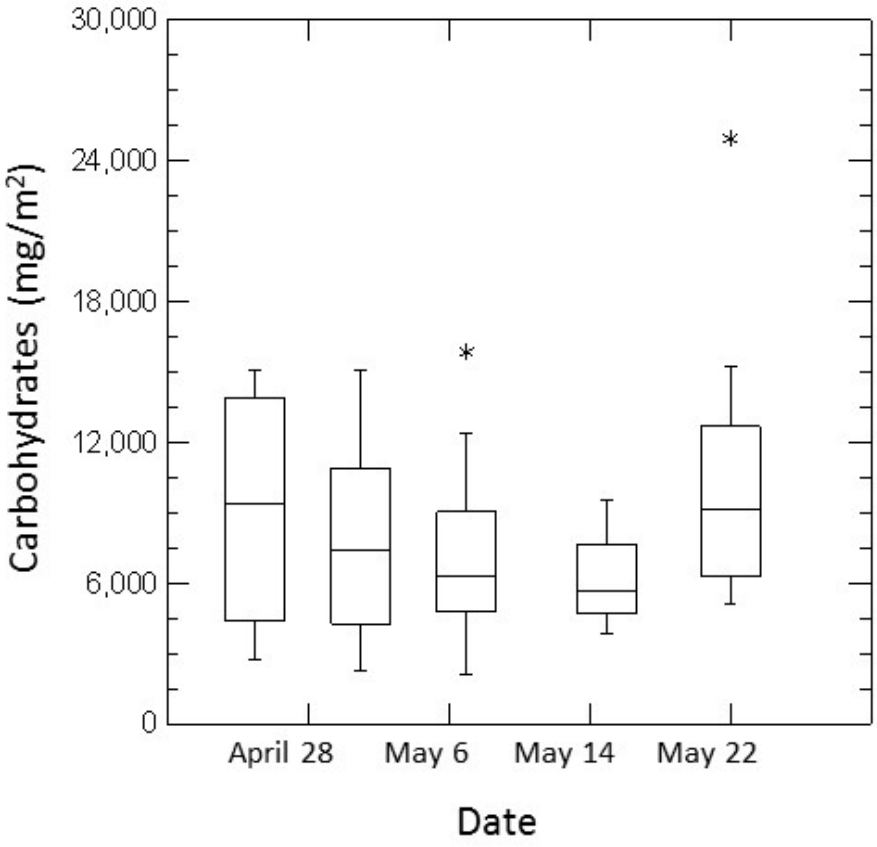
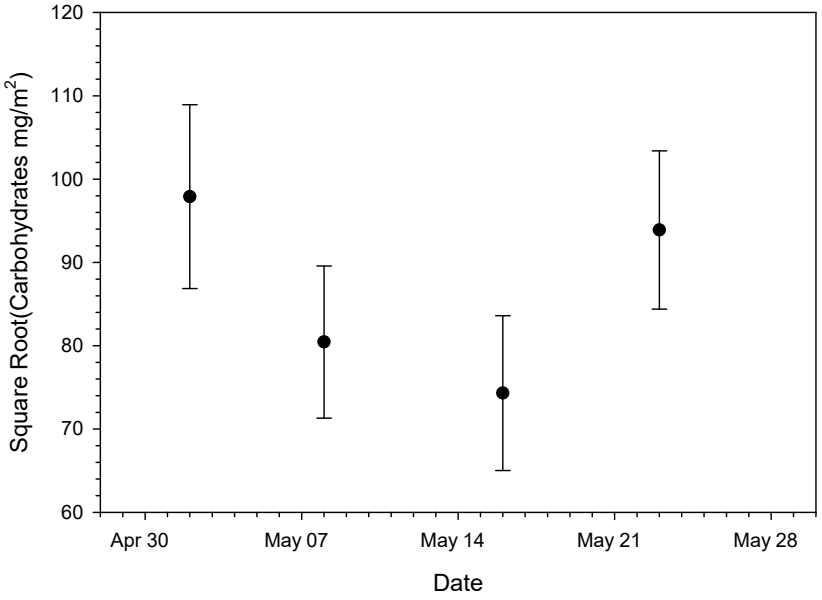


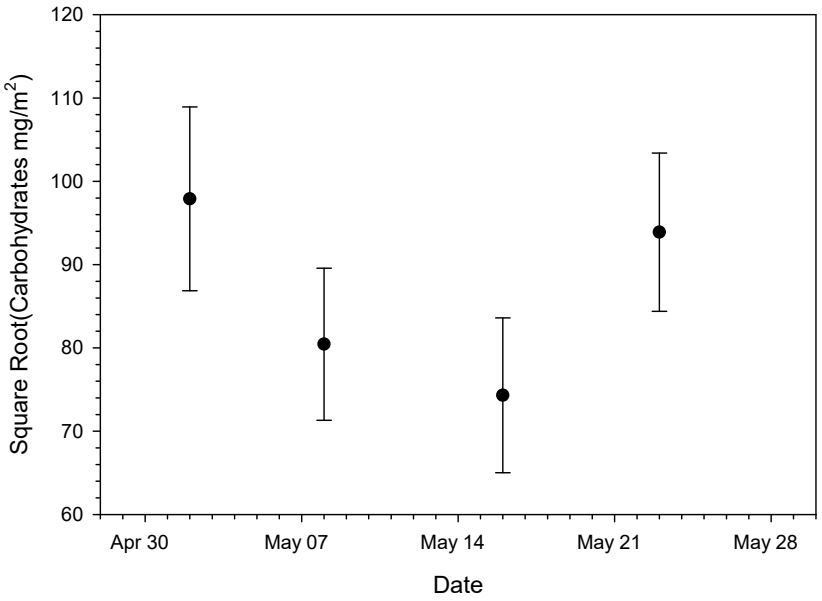
Figure 3-4 Temporal Variation of Total Carbohydrate Abundance per m^2 of Intertidal Mudflats at Roberts Bank (April 26 to May 23, 2017)

GLM results documented statistically significant differences among stations ($F_{6,38}$ = 4.9, p = 0.001) (**Figure 3-5**) and survey dates ($F_{3,38}$ = 5.6, p = 0.003) (



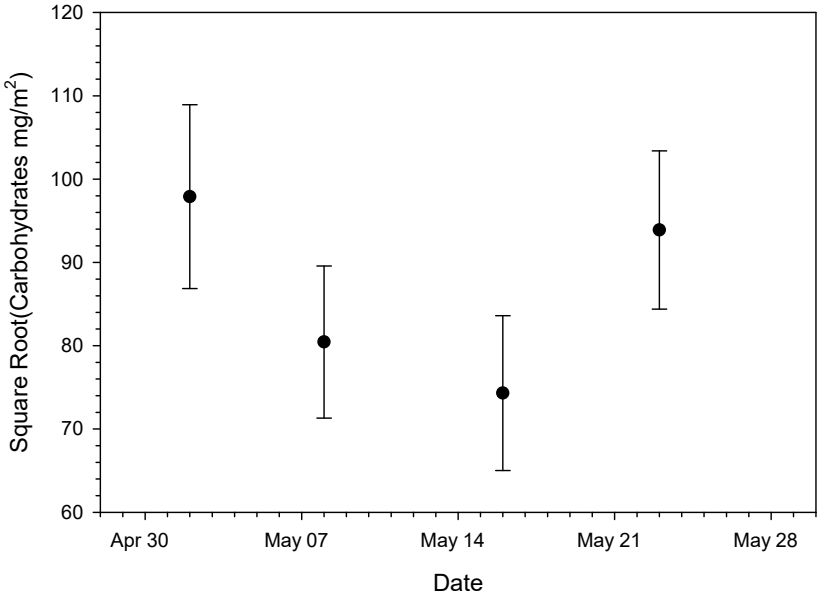
Bonferroni Pairwise Comparison Test Results	
Survey Date	**p-value**
May 2 > May 16	P = 0.02
May 23 > May 16	P = 0.02

Figure 3-6). Within the GLM, means were statistically adjusted by controlling for other factors in the model (i.e., station location, sampling date, total weight of the sample) (**Figure 3-5** and



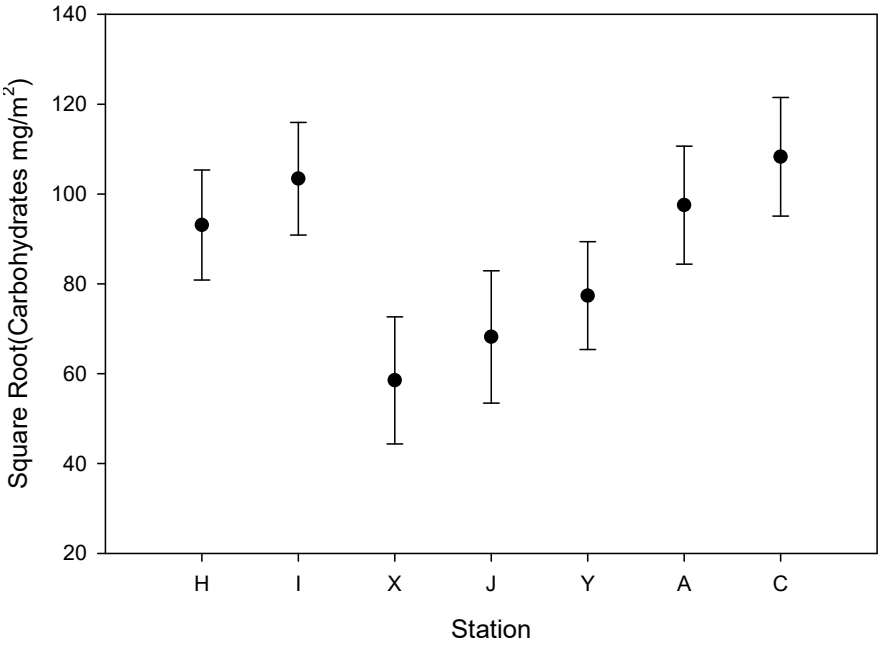
Bonferroni Pairwise Comparison Test Results	
Survey Date	**p-value**
May 2 > May 16	P = 0.02
May 23 > May 16	P = 0.02

Figure 3-6). After controlling for other factors in the model, statistically significant differences were documented between stations A, C, H, I and J, X, and Y (**Figure 3-5**) and May 2 / May 12 and May 16 (



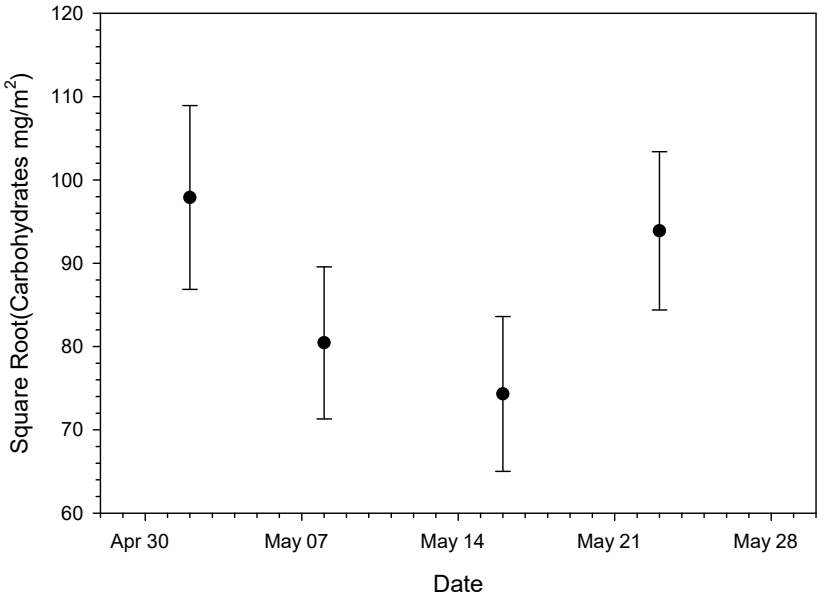
Bonferroni Pairwise Comparison Test Results	
Survey Date	**p-value**
May 2 > May 16	P = 0.02
May 23 > May 16	P = 0.02

Figure 3-6).



Bonferroni Pairwise Comparison Test Results	
Station	**p-value**
A,H > X	P < 0.02
C > X,J,Y	P < 0.02
I > X,J	P < 0.02

Figure 3-5 Mean Carbohydrate Abundance (Black Circles) at Roberts Bank (May 2 to May 23, 2017) adjusted for Sampling Date and the Total Weight of Sediment Collected derived from General Linear Modeling Results. Error Bars are the 95% Confidence Interval of the Mean. Table Shows Statistically Significant Differences among Stations.



Bonferroni Pairwise Comparison Test Results	
Survey Date	**p-value**
May 2 > May 16	P = 0.02
May 23 > May 16	P = 0.02

Figure 3-6 Temporal Variation in Mean Carbohydrate Abundance (Black Circles) at Roberts Bank (May 2 to May 23, 2017) Adjusted for the Sampling Location (Station) and Total Weight of Sediment Collected derived from General Linear Modeling Results. Error Bars are the 95% Confidence Interval of the Mean. Table Shows Statistically Significant Differences among Sampling Dates.

3.1.3 Fatty Acids

The SFAs myristic acid (14:0) and palmitic Acid (16:0), the MUFAs palmitoleic acid (16:1n-7) and oleic acid (18:1n-9), and the PUFAs EPA (20:5n-3) and DHA (22:6n-3) were the most abundant fatty acids documented, ranging from means of 27 mg/m^2 to 184 mg/m^2 (**Figure 3-7, Appendix B**). Mean abundances of all fatty acids ranged from < 1 mg/m^2 (6:0 and 8:0) to 184 mg/m^2 (16:1n-7). Twenty-eight of the 34 fatty acids analysed were documented possessing mean abundances of < 25 mg/m^2 and 23 were found at abundances < 10 mg/m^2. Fatty acids with the lowest abundances were the SFA 6:0, 8:0, 10:0, and 21:0, the MUFA 24:1n-9, and the PUFA 20:3n-3. Mean MUFA (251 mg/m^2) and SFA abundances (218 mg/m^2) were comparable and were ~23% higher than PUFA levels (181 mg/m^2) (**Appendix B**). On average, Total Fatty Acid levels were comprised of 38.6% MUFA, 33.6% SFA, and 27.8% PUFA. Mean levels of Omega 6 fatty acids (18 mg/m^2), a type of PUFA, were the lowest of all fatty acid types (**Figure 3-8**). Fatty acid summary statistics and summary statistics by stations are presented in **Appendix B** and **C**, respectively.

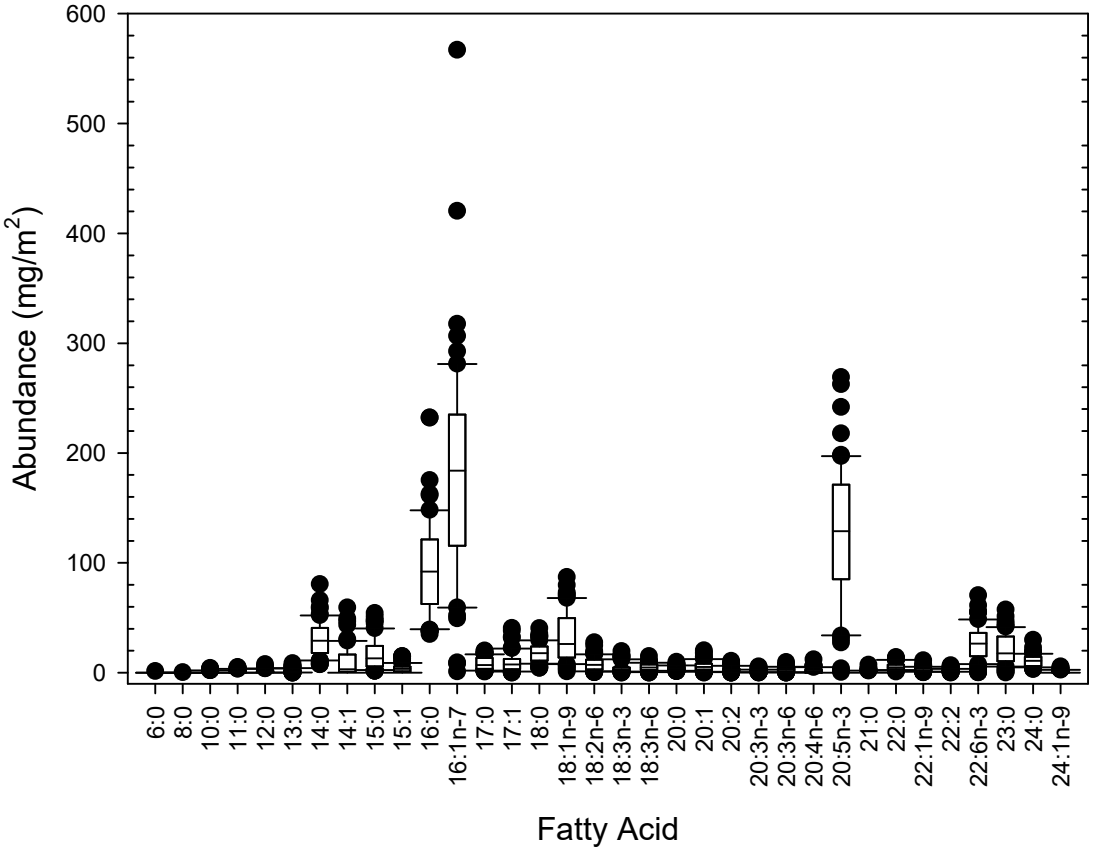


Figure 3-7 Fatty Acid Abundances per m^2 of Intertidal Mudflats at Roberts Bank (April 26 to May 23, 2017) across all Stations and Sampling Periods.

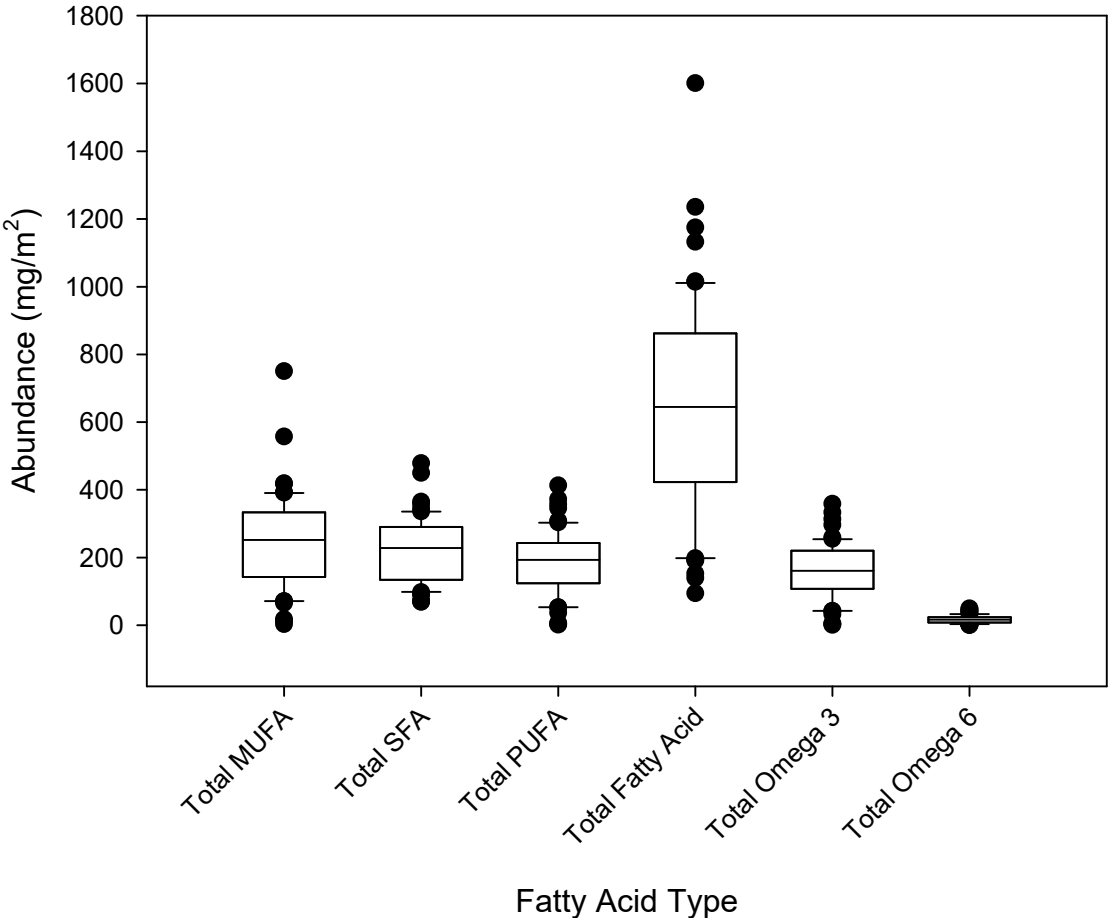


Figure 3-8 Abundance of Monounsaturated (MUFA), Saturated Fatty (SFA), Polyunsaturated (PUFA), Omega 3, and Omega 6 Acids per m^2 of Intertidal Mudflats in Biofilm at Roberts Bank (April 26 to May 23, 2017) across all Stations and Sampling Periods. Black dots indicate outliers.

3.1.3.1 Spatial and Temporal Distributions

Mean Total Fatty Acid levels varied among stations (**Figure 3-9**), but followed a similar pattern as Chlorophyll *a* (**Figure 3-1**) and Total Carbohydrates (**Figure 3-3**). Stations I (816 mg/m^2), C (793 mg/m^2), and H (764 mg/m^2) possessed the highest mean Total Fatty Acid levels, followed by station A (648 mg/m^2) and Y (634 g/m^2). Stations J (469 g/m^2) and X (413 g/m^2) possessed the lowest levels and were ~44% lower than A and C.

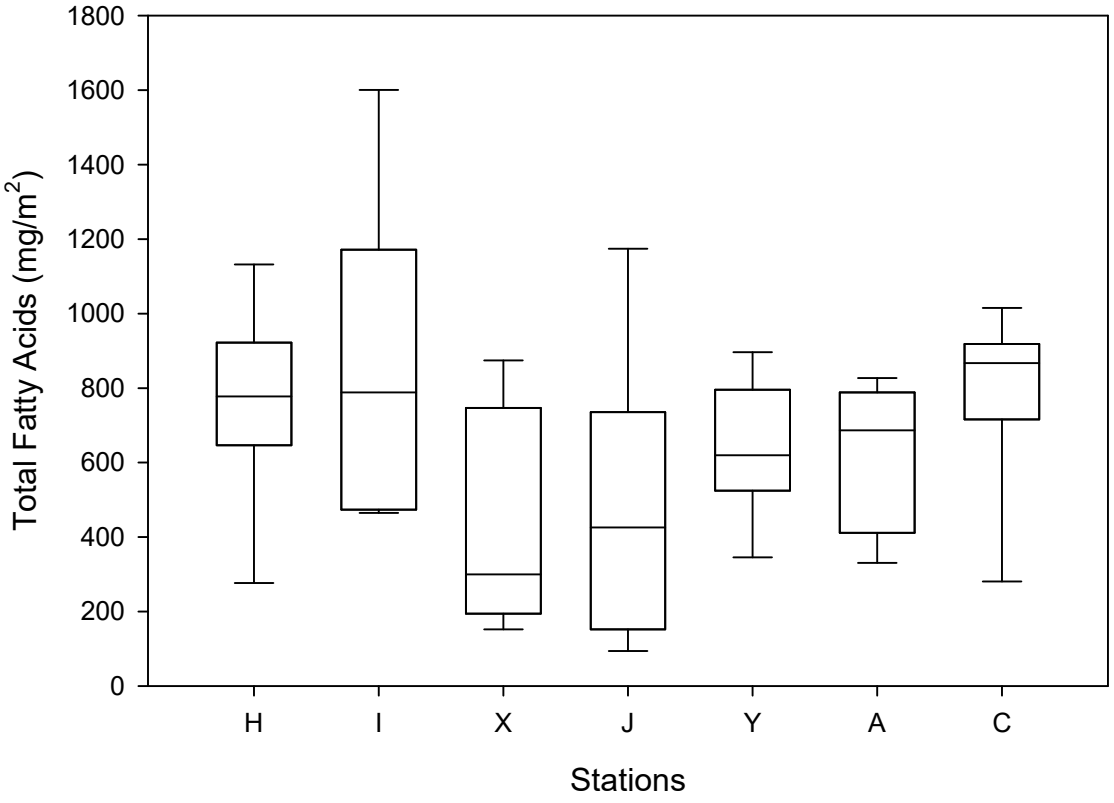


Figure 3-9 Total Fatty Acid Abundance per m^2 of Intertidal Mudflats by Sampling Station at Roberts Banks (April 26 to May 23, 2017). See Table 3-5 for Bonferroni pairwise comparison test results.

General linear modelling conducted to determine differences in biofilm Total Fatty Acid abundance among stations while controlling for Survey Date and Sample Weight found statistically significant differences ($F_{6,38}$ = 5.4, p <0.001) (**Table 3-5**). Pairwise comparisons found significant differences among stations A/C/H/I and station X, and stations C/H/I and stations J. The general patterns of fatty acid abundance at stations A/C/H/I not differing statistically, and stations A/C/H/I (or C/H/I) > stations J/X was repeated for many of the other fatty acids and types of fatty acids tested (**Table 3-5**). For example, fatty acid abundance did not differ between stations A, C, H, and I for all fatty acids tested with the exception of 18:3n-3 and 22:6n-3 where levels at station A were lower than station H or I. Also, stations C/H/I possessed statistically higher fatty acid abundance compared to stations J and X in 11 of 18 biofilm parameters (**Table 3-5**).

Table 3-5 Results from GLM Analyses Showing Differences in Fatty Acid Biofilm Parameter Abundance among Stations at Roberts Banks (May 2 to May 23, 2017) Controlling for Sampling Date and Total Sample Collection Weight

Parameter	$F_{6,38}$	p-Value	Bonferroni Pairwise Comparison Test
Total Fatty Acids	5.4	< 0.001	A,C,H,I > X ; C,H,I > J
Saturated Fatty Acids (SFA)			
Total SFA	5.5	< 0.001	A,C,H,I > J,X ; Y > X
14:0	5.7	< 0.001	A,C,H,I > J,X
16:0	3.4	0.009	H > X,J ; A,C,Y > X
18:0	5.1	0.001	A,C > J,X ; H,I > X ; C > Y
22:0	6.3	< 0.001	A,C,H,I > X ; C,H,I > J ; C,H > Y
Monounsaturated Fatty Acids (MUFA)			
Total MUFA	6.5	< 0.001	A,C,H,I,Y > J,X
16:1n-7	6.0	< 0.001	C,H,I > J,X ; A,Y > J
18:1n-9	4.9	0.001	C,H > X,J ; I > X
20:1	5.7	< 0.001	A,C,H,I,Y > X ; A,C > J
Polyunsaturated Fatty Acids (PUFA)			
Total PUFA	4.9	0.001	C,H,I > J,X
18:2n-6	1.9	0.10	-
18:3n-3	4.9	0.001	I > A,J,X,Y
18:3n-6	3.6	0.006	C > J,X
20:5n-3	4..4	0.002	C,H,I > J,X
22:6n-3	6.8	< 0.001	C,H,I > J,X ; H > A,Y
Omega 3	5.0	0.001	C,H,I > J,X
Omega 6	3.3	0.01	C > J,X

Notes: All analyses were performed on transformed variables where appropriate (see **Table 2-3**).

Mean Total Fatty Acid abundance varied between approximately 530 mg/m^2 and 880 mg/m^2 from May 2 to May 23 (**Table 3-6**). Higher fatty acid abundance was associated with spring tide events and lower abundance with neap tides (**Table 2-1**, **Table 3-6**). The lowest abundance was documented on May 2 and May 16. The highest abundance was documented on May 23.

Table 3-6 Biofilm Total Fatty Acid Summary Statistics per m^2 of Intertidal Mudflats by Sampling Date at Roberts Bank (April 26 to May 23, 2017)

Sampling Date	n	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
4/26/17	4	653	259	418	1014
5/02/17	14	527	304	191	1132
5/08/17	14	671	394	94	1601
5/16/17	14	526	251	139	897
5/23/17	14	878	123	709	1174

Statistically significant differences in abundance were documented between May 23 and May 8 or May 16 for 50% of biofilm fatty acid parameters (**Table 3-7**). Differences in fatty acid abundance among sampling dates occurred in all fatty acid types (i.e., SFA, MUFA, and PUFA). Differences in biofilm parameters documented within stations are reported in **Section 3.1.3.2**.

Table 3-7 Results from GLM Analyses Showing Differences in Fatty Acid Biofilm Parameters among Sampling Dates at Roberts Banks (May 2 to May 23, 2017) Controlling for Station and Sample Collection Weight

Parameter	$F_{3,38}$	p-Value	Bonferroni Pairwise Comparison Test
Total Fatty Acids	4.7	0.007	May 23 > May 16
Saturated Fatty Acids (SFA)			
Total SFA	8.1	< 0.001	May 23 > May 8, May 16
14:0	6.3	0.001	May 23 > May 16
16:0	5.7	0.003	May 23 > May 16
18:0	2.8	0.06	-
22:0	3.7	0.02	-
Monounsaturated Fatty Acids (MUFA)			
Total MUFA	4.9	0.006	May 23 > May 16
16:1n-7	4.6	0.008	May 23 > May 16
18:1n-9	1.1	0.38	-
20:1	5.9	0.002	May 23 > May 8, May 16
Polyunsaturated Fatty Acids (PUFA)			
Total PUFA	2.3	0.09	-
18:2n-6	2.3	0.09	-
18:3n-3	1.8	0.16	-
18:3n-6	9.6	< 0.001	May 23 > May 8, May 16
20:5n-3	1.6	0.20	-
22:6n-3	2.4	0.09	-
Omega 3	1.8	0.16	-
Omega 6	6.3	0.001	May 23 > May 16

Notes: All analyses were performed on transformed variables where appropriate (see **Table 2-3**).

3.1.3.2 Spatial-Temporal Trends

Changes in fatty acid abundance across sampling dates at individual sampling stations were documented for a number of biofilm parameters (**Figure 3-10** to **Figure 3-13**). These changes often differed between stations; however, most stations followed similar trajectories. For example, Chlorophyll a, Total Fatty Acid, Total PUFA, Total MUFA, and Total SFA followed the same overall temporal trends within stations (**Figure 3-10** and **Figure 3-11**).

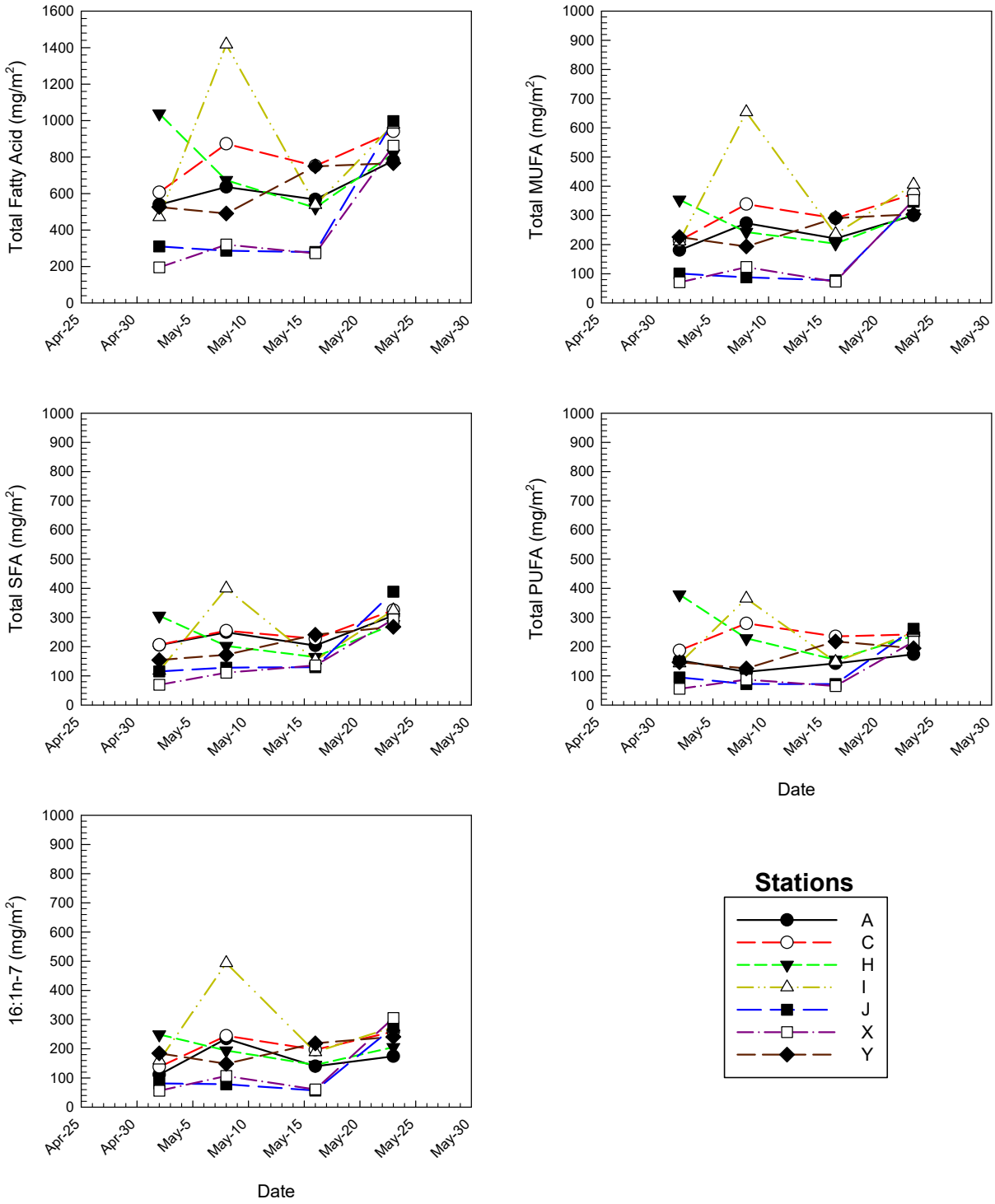


Figure 3-10 Temporal Trends in Abundance for Total Fatty Acid, MUFA, SFA, PUFA, and 16:1n-7 for Individual Stations across at Roberts Bank (May 2 to May 23, 2017). Note: differences in y-axis scale between inset figures are intentional to allow differences in levels over time to be observed.

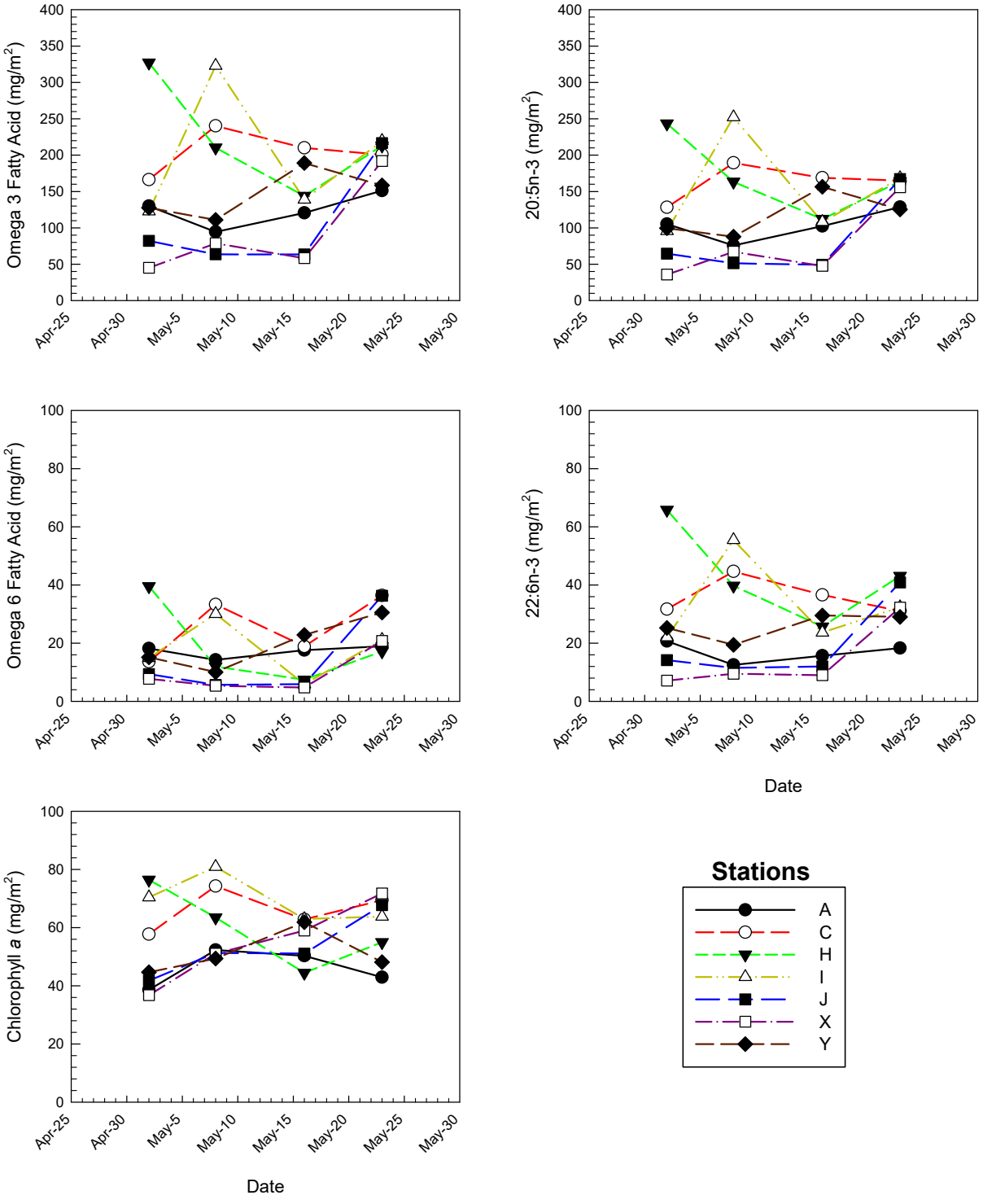


Figure 3-11 Temporal Trends in Abundance for Total Omega 3, 20:5n-3 (EPA), Omega 6, and 22:6n-3 (DHA) Fatty Acids and Chlorophyll *a* abundance for Individual Stations at Roberts Bank (May 2 to May 23, 2017). Note: differences in y-axis scale between inset figures are intentional to allow differences in levels over time to be observed.

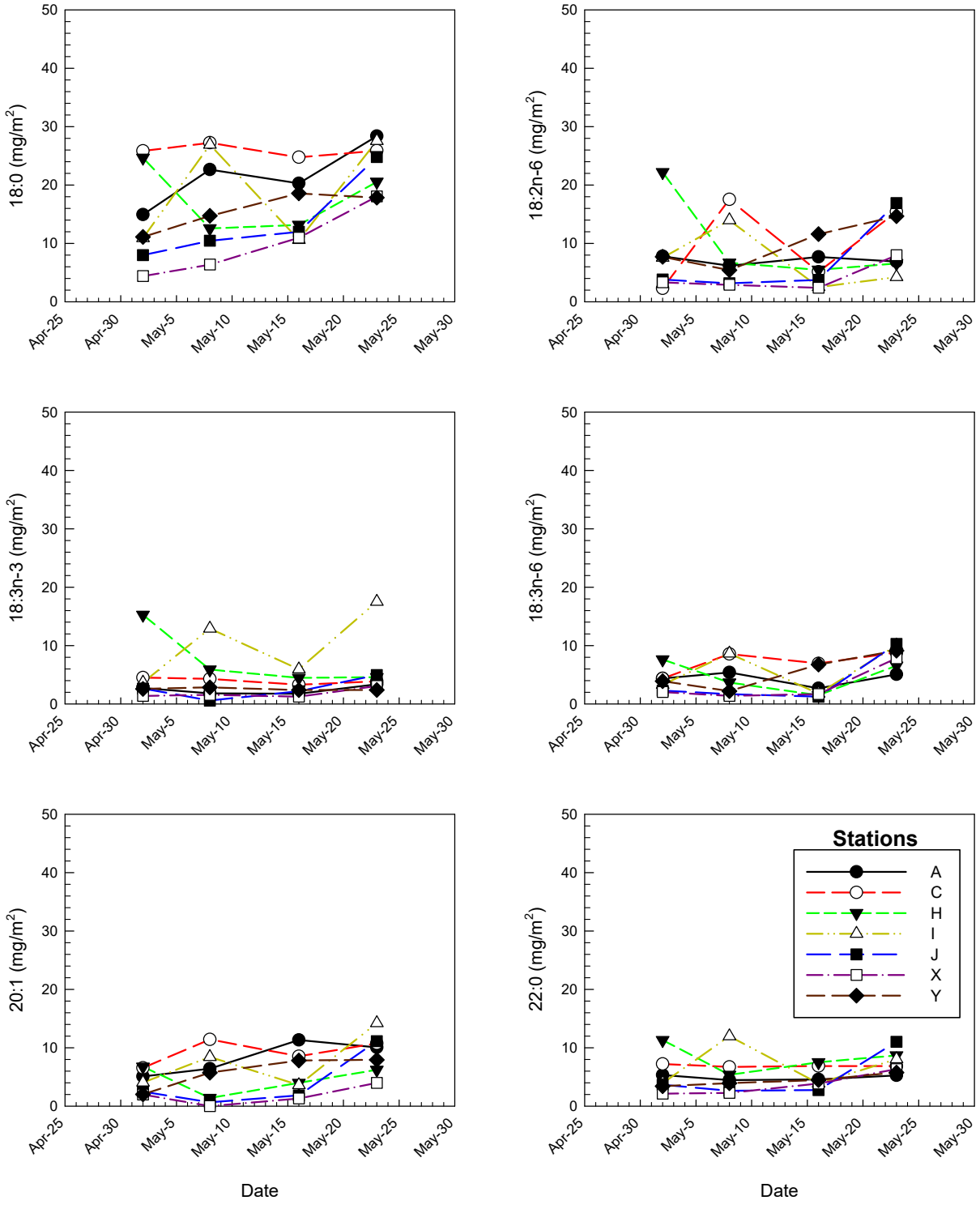


Figure 3-12 Temporal Trends in Abundance for 18:0, 18:2n-6, 18:3n-3, 18:3n-6, 20:1, and 22:0 Fatty Acids for Individual Stations at Roberts Bank (May 2 to May 23, 2017).

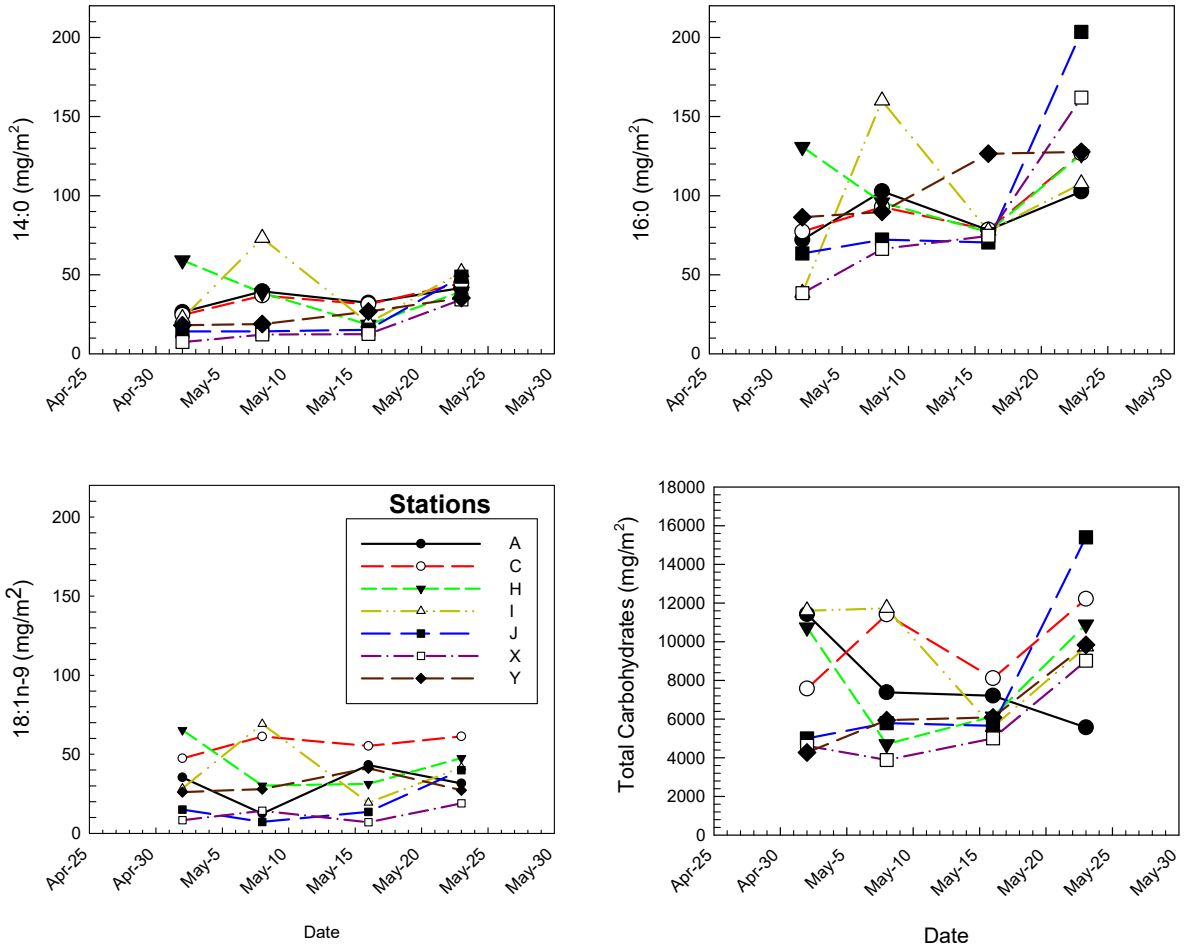


Figure 3-13 Temporal Trends in Abundance for 14:0, 16:0, 18:1n-9 Fatty Acids and Total Carbohydrates for Individual Stations at Roberts Bank (May 2 to May 23, 2017). Note: differences in y-axis scale between inset figures are intentional to allow differences in levels over time to be observed.

3.1.4 Correlations Among Biofilm Parameters

Sixty-nine percent of individual focal fatty acids and fatty acid types showed strong statistically significant positive correlations ($r > 0.70$) with each other, while 89% demonstrated moderately strong ($r > 0.6$) correlations (**Table 3-8**). Ninety-seven percent of focal fatty acid parameters were positively correlated ($p<0.05$), with no parameters demonstrating negative correlations (**Table 3-8**). Positive correlations also occurred between biofilm biomass parameters Chlorophyll *a* and Carbohydrates ($r = 0.43$, $p = 0.002$), Chlorophyll *a* and Total Fatty Acid ($r = 0.57$, $p < 0.001$), and Total Carbohydrates and Total Fatty Acid ($r = 0.55$, $p < 0.001$) (**Figure 3-14**). Chlorophyll *a* showed significant positive correlations with SFA, MUFA, and PUFA, with correlation coefficients ranged from 0.49 (SFA) to 0.57 (PUFA). Chlorophyll *a* was also positively correlated with the omega 3 fatty acids EPA ($r = 0.56$) and DHA ($r = 0.57$). Overall, Chlorophyll *a* was positively correlated with 76% of all biofilm parameters analysed ($n = 41$, listed in **Appendix B**). Correlation coefficients among fatty acid types were also highly correlated and ranged from 0.89 between MUFA and PUFA ($p<0.001$) to 0.83 between SFA and PUFA ($p<0.001$) (**Table 3-8**).

Table 3-8 Pearson Correlation Coefficients and Significance Among Biofilm Parameter Abundance

Parameter	Chlorophyll *a*	Carbohydrates	14:0	16:0	16:1n-7	18:0	18:1n-9	18:2n-6	18:3n-3	18:3n-6	20:1	20:5n-3	22:0	22:6n-3	Total SFA	Total MUFA	Total PUFA	Total Omega 3	Total Omega 6
Carbohydrates	0.43																		
14:0	**0.60**	*0.53*																	
16:0	0.45	0.37	**0.73**																
16:1n-7	**0.56**	*0.46*	**0.85**	**0.72**															
18:0	0.38	0.44	**0.81**	**0.59**	**0.62**														
18:1n-9	0.39	*0.53*	**0.73**	*0.47*	**0.67**	**0.73**													
18:2n-6	0.39	**0.61**	**0.62**	**0.55**	**0.64**	0.44	**0.67**												
18:3n-3	0.41	0.39	**0.62**	0.35	**0.61**	*0.46*	**0.63**	0.41											
18:3n-6	0.40	**0.61**	**0.80**	**0.63**	**0.81**	**0.71**	**0.73**	**0.71**	**0.56**										
20:1	0.24	**0.55**	**0.71**	0.45	**0.58**	**0.84**	**0.71**	**0.55**	*0.46*	**0.74**									
20:5n-3	**0.56**	*0.50*	**0.86**	**0.66**	**0.84**	**0.74**	**0.84**	**0.67**	**0.72**	**0.81**	**0.65**								
22:0	*0.49*	**0.60**	**0.82**	**0.67**	**0.68**	**0.80**	**0.78**	**0.58**	**0.63**	**0.70**	**0.69**	**0.86**							
22:6n-3	**0.57**	*0.50*	**0.79**	**0.57**	**0.75**	**0.65**	**0.81**	**0.65**	**0.72**	**0.75**	**0.55**	**0.95**	**0.83**						
Total SFA	*0.49*	*0.53*	**0.93**	**0.87**	**0.82**	**0.86**	**0.70**	**0.62**	*0.52*	**0.81**	**0.75**	**0.83**	**0.85**	**0.73**					
Total MUFA	*0.53*	*0.51*	**0.90**	**0.71**	**0.98**	**0.73**	**0.78**	**0.66**	**0.66**	**0.85**	**0.70**	**0.90**	**0.76**	**0.80**	**0.88**				
Total PUFA	**0.57**	**0.54**	**0.87**	**0.66**	**0.83**	**0.75**	**0.85**	**0.71**	**0.74**	**0.83**	**0.66**	**0.99**	**0.87**	**0.96**	**0.83**	**0.89**			
Total Omega 3	**0.57**	*0.51*	**0.86**	**0.65**	**0.83**	**0.73**	**0.84**	**0.66**	**0.75**	**0.80**	**0.63**	**1.00**	**0.86**	**0.97**	**0.82**	**0.89**	**1.00**		
Total Omega 6	0.40	**0.66**	**0.79**	**0.61**	**0.75**	**0.69**	**0.79**	**0.90**	**0.54**	**0.92**	**0.76**	**0.82**	**0.73**	**0.77**	**0.79**	**0.81**	**0.85**	**0.81**	
Total Fatty Acids	**0.57**	**0.55**	**0.94**	**0.79**	**0.92**	**0.81**	**0.80**	**0.68**	**0.67**	**0.85**	**0.72**	**0.94**	**0.87**	**0.85**	**0.94**	**0.97**	**0.94**	**0.93**	**0.84**

Notes: Statistical tests were conducted on the abundance of each parameters per square metre (i.e., mg/m^2).
A Bonferroni correction was used to adjust p-values to account for multiple comparison tests.
Significant p-values are represented with the following formatting: **$p < 0.001$**, *$p < 0.05$*.

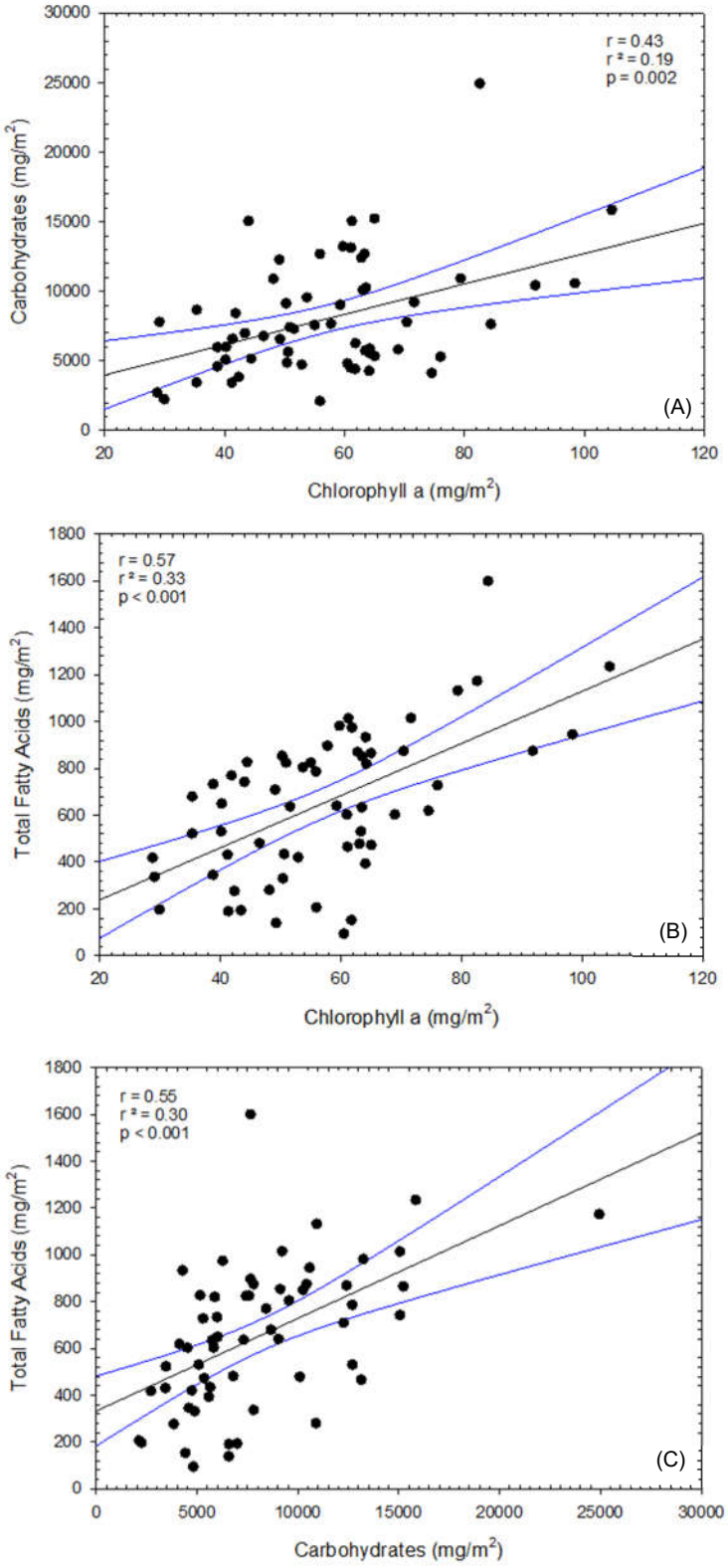


Figure 3-14 Relationships between Chlorophyll a and Carbohydrates (A), Chlorophyll *a* and Total Fatty Acids (B), and Carbohydrates and Total Fatty Acids (C). Blue lines indicate 95% confidence interval.

3.1.5 Abiotic Effects on Biofilm

Abiotic factors with the potential to affect biofilm abundance were graphed by date and station to aid in interpretation of results (**Figure 3-15**). Mudflat exposure, 5th and 95th percentile water column salinity, and 5th and 95th percentile water column temperature varied spatially and temporally over the duration of the study. All stations followed a similar pattern for the amount of time mudflats were exposed following a receding tide (**Figure 3-15A**). On May 23 mudflat exposure time was greatest and ranged from ~76-82% of the day (~18-20 hours) for Stations A, C, I, and Y to 55% (~3.6 hour) for Station H. Mudflat exposure time fluctuated with the spring-neap tidal cycle (**Table 2-1**). During the duration of the study, Stations A, C, and I tracked closely having similar exposure periods. Station Y followed a similar pattern, but possessed the longest exposure periods, typically 2-3 hours/day longer than Stations A, C, and I, and 5-6 hours longer than Stations X and J. Station H possessed the shortest exposure periods, averaging 4-7 hours less than Stations A, C, I, and Y.

Stations closest to Canoe Passage had the lowest 5th and 95th percentile salinities (**Figure 3-15B** and **C**). The 5th percentile salinities at Stations H and I over the duration of the study averaged 0.25 PSU (± 0.28 SD). Fifth percentile salinities were generally higher and more variable at Stations A and C (11.6 PSU ± 4.1 SD). Ninety-fifth percentile salinities at Stations A and C averaged 20.7 PSU (± 7.8 SD). Ninety-fifth percentile salinities at Stations H and I varied more compared to 5th percentile levels and ranged from 0.3 PSU to 13.6 PSU ($\bar{x}$ = 4.1 PSU ± 4.4 SD) over the duration of the study.

Fifth percentile water column temperatures for all five monitoring stations were less variable than exposure and salinity estimate (**Figure 3-15D**). Temperatures varied from a low of 8.0°C at station I to a high of 15.6°C at station A during the duration of the study. Mean temperatures were less variable among stations and ranged from 9.5°C at Station I to 10.9°C at Station C. The highest mean temperatures were found at stations A (10.8°C ± 3.2 SD) and C (10.9°C ± 3.1 SD), which were approximately one degree higher than the mean temperatures documented at stations H (9.8°C ± 1.0 SD) and I (9.5°C ± 1.3 SD). Variation in 95th percentile water column temperatures was greater than the 5th percentile (**Figure 3-15E**). Mean 95th percentile temperatures at stations A (21.0°C ± 4.6 SD) and C (19.9°C ± 4.5 SD) were the highest over the duration of the study and differed from each other by approximately one degree. Intermediate temperatures were documented at station J (17.1°C ± 2.0 SD), while the lowest mean temperatures were documented at stations H (14.2°C ± 3.0 SD) and I (15.3°C ± 3.2 SD). Ninety-fifth percentile water column temperatures were more variable over the duration of the study compared to 5th percentile temperatures (**Figure 3-15E**).

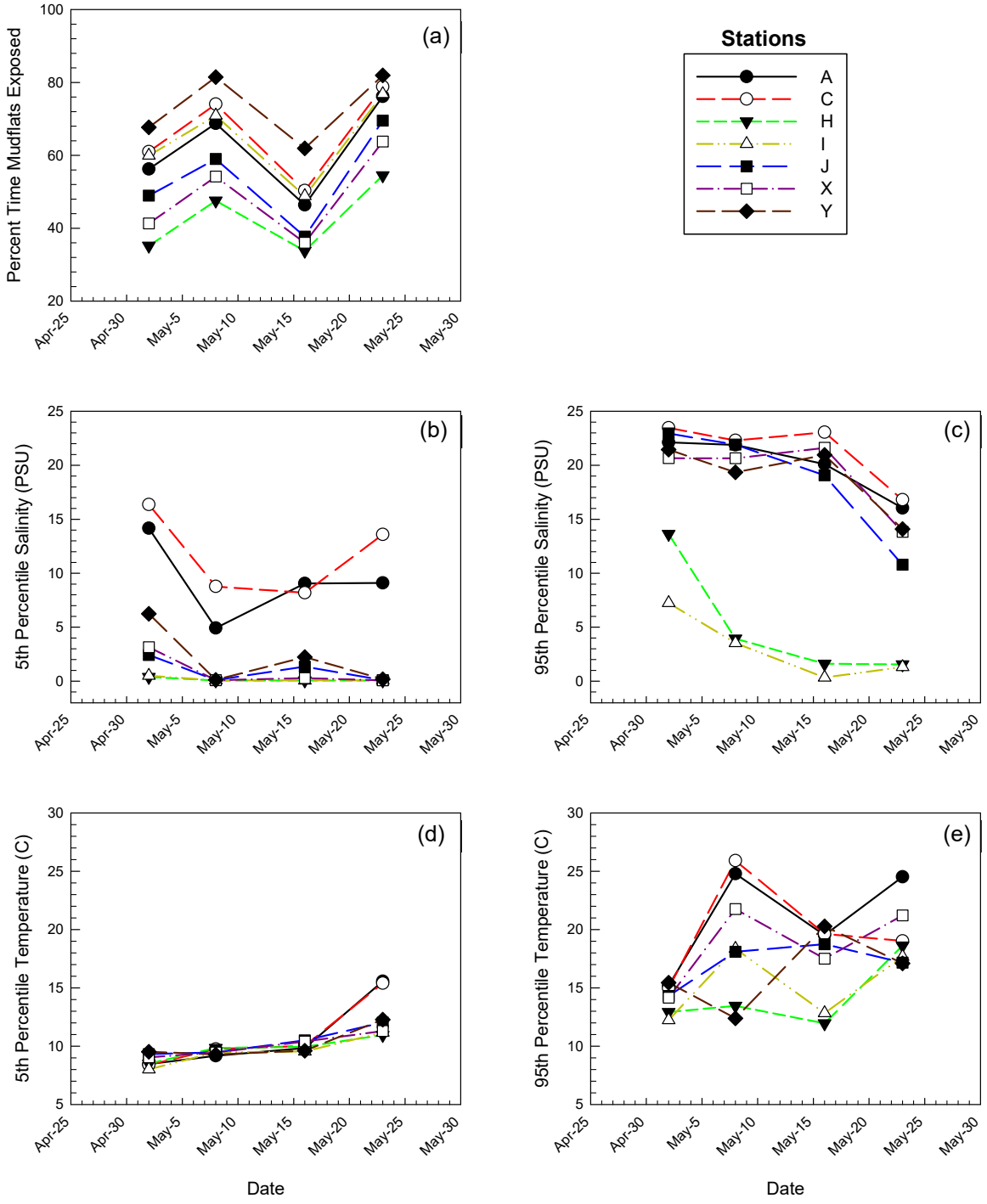


Figure 3-15 Temporal Changes in Abiotic Factors Potentially Affecting Biofilm Abundance at Monitoring Stations, Roberts Bank (May 2 to May 23, 2017). (a) = percent of time mudflats were exposed over the 72 hours prior to sampling; (b) and (c) = 5th and 95th percentile water column salinity over the 72 hours prior to sampling, respectively; (d) and (e) = 5th and 95th percentile water column temperature over the 72 hours prior to sampling, respectively.

AIC_c modelling results are presented in **Sections 3.1.5.1** to **Section 3.1.5.5** for summary biofilm parameters. Model results for individual fatty acids are summarized in **Section 3.1.5.6**. As discussed previously (**Section 0**), the amount of sediment collected for analyses (i.e., Total Sample Weight) varied among samples and was included as a covariate in modelling. The location (i.e., Station) and date (i.e., Sampling Date) samples were collected were also included in all AIC models as covariates. Therefore, Total Sample Weight, Station, and Sampling Date are not discussed or presented as factors influencing biofilm abundance, but are included in models to explain added variability associated with the sampling technique, sampling location and date.

3.1.5.1 Chlorophyll a

AIC_c results indicated models with the most support of factors influencing biofilm Chlorophyll *a* levels contained the variables: 5th percentile salinity, 95th percentile salinity, 5th percentile water temperature, and the percentage of time mudflats were exposed over the previous 72-hour period (**Table 3-9**). However, summed Akaike model weights across the entire model-set (**Appendix D**) indicate 95th percentile salinity ($\sum w_i$ = 0.98) and 5th percentile temperature ($\sum w_i$ = 0.89) were more important factors affecting biofilm abundance than 5th percentile salinity or exposure time, as their summed weights were approximately 2 to 4 times larger than the summed weights of the other factors in the analyses (**Table 3-10**).

Results from the backward stepwise regression indicated the model containing water column salinity (5th and 95th percentiles), 50th percentile water column temperature, the location (i.e., Stations) and date biofilm samples were collected, and the total dry weight of the biofilm sample collected to be the most parsimonious model, explaining the most variability of all potential models ($r = 0.79$, $P < 0.01$).

Table 3-9 Variables Influencing Chlorophyll *a* (square root transformed) Abundance in Biofilm based on Akaike's Second-Order Information Criterion (AIC_c) for the Best Models Tested. Only models with substantial empirical support (ΔAIC_c < 2.0, Burnham and Anderson 2002) are presented.

Model	Model ID	# of Parameters (K)	AIC_c	ΔAIC_c	Akaike Weight (w_i)
5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	16	8	238.34	0.00	0.21
95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	23	8	238.50	0.16	0.20
5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	27	9	239.41	1.07	0.12
95th Percentile Salinity + 5th Percentile Temperature	10	7	239.47	1.13	0.12

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**.

The variables 95th percentile salinity and 5th percentile temperature were positively associated with Chlorophyll *a* abundance in all models (**Table 3-10**). The variable 5th percentile salinity was negatively associated with Chlorophyll *a* abundance. The effects from 95th percentile temperature and mudflat exposure time varied among models.

Table 3-10 Relative Importance of Variables Potentially Influencing Chlorophyll *a* Levels in Biofilm based of Summed Akaike Weights and the Direction of Change

Variables	Sum of Weights (wi)	Direction of Change (+ / -)
95th Percentile Salinity	0.98	+
5th Percentile Temperature	0.89	+
Percent Time Mudflats Exposed	0.51	+/-
5th Percentile Salinity	0.47	-
95th Percentile Temperature	0.25	+/-

Notes: Direction of Change: + = increases in variable positively affect the biofilm parameter considered (e.g., Chlorophyll *a*, fatty acids, etc.), - = increases in variable negatively affect the biofilm parameter considered.

Chlorophyll *a* levels showed a wide range of abundance values that remained relatively consistent across the salinity spectrum (**Table 3-11**). Stations closer to Canoe Passage (e.g., Stations H and I) were generally exposed to lower 5th and 95th percentile water column salinity conditions compared to sites more distant (e.g., Stations A and C). However, samples taken under low, medium and high conditions had comparable mean Chlorophyll *a* abundances in 2017. Mean Chlorophyll *a* abundances among salinity categories (**Table 3-11**) were not statistically different ($F_{2,101} = 0.92$, $P = 0.40$).

Table 3-11 Mean Chlorophyll *a* Abundance under 5th Percentile Water Column Salinity Ranges. n = the number of biofilm samples analysed within a salinity range.

Water Column Salinity	n	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
< 5 PSU	82	59	15	30	108
5-10 PSU	20	55	18	35	97
> 10 PSU	17	52	15	29	82

3.1.5.2 Total Fatty Acid Abundance

AIC_c results indicated models with the most support to influence biofilm Total Fatty Acid levels contained the variables representing the amount of time the mudflats were exposed over the previous 72-hour period and the 5th percentile water column temperature (**Table 3-12**). However, summed Akaike model weights across the entire model-set (**Appendix D**) indicated mudflat exposure time ($\sum w_i = 0.82$) was a more important factor affecting biofilm abundance compared to temperature ($\sum w_i = 0.45$) (**Table 3-13, Figure 3-16**). Both variables were positively correlated with increased fatty acid abundance (**Figure 3-16**). The weight of evidence indicates that water column salinity (5th and 95th percentile) and 95th percentile water column temperature were significant predictors of total fatty acid levels.

Results from the backward stepwise regression indicated the model containing the percentage of time mudflats were exposed, the collection location of biofilm samples (i.e., Stations), and the total dry weight of biofilm samples to be the most parsimonious model, explaining the most variability of all potential models ($r = 0.74$, $P < 0.01$).

Table 3-12 Variables Influencing Total Fatty Acid Abundance in Biofilm based on Akaike's Second-Order Information Criterion (AICc) for the Best Models Tested. Only models with substantial empirical support (∆AICc < 2.0, Burnham and Anderson 2002) are presented.

Model	Model ID	# of Parameters (K)	AIC_c	ΔAIC_c	Akaike Weight (w_i)
Percent Time Mudflats Exposed	5	6	785.56	0.00	0.23
5th Percentile Temperature + Percent Time Mudflats Exposed	14	7	786.76	1.20	0.12
95th Percentile Salinity + Percent Time Mudflats Exposed	12	7	787.18	1.62	0.10

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**.

Table 3-13 Relative Importance of Variables Potentially Influencing Total Fatty Acid Abundance in Biofilm based of Summed Akaike Weights and the Direction of Change.

Variables	Sum of Weights (w_i)	Direction of Change (+ / -)
Percent Time Mudflats Exposed	0.82	+
5th Percentile Temperature	0.45	+
95th Percentile Salinity	0.29	+/-
95th Percentile Temperature	0.24	+
5th Percentile Salinity	0.21	+/-

Notes: Direction of Change: + = increases in variable positively affect the biofilm parameter considered (e.g., Chlorophyll *a*, fatty acids, etc.), - = increases in variable negatively affect the biofilm parameter considered.

Fatty acids were produced by biofilm sampled across the salinity gradient. Under lower salinity conditions (5th percentile PSU ≤ 5, n = 41) Total Fatty Acid levels averaged 629 mg/m^2 ± 338 SD. Under moderate 5th percentile salinities (5 < PSU ≤ 10, n = 10) fatty acid levels averaged 700 mg/m^2 ± 183 SD. Under high 5th percentile salinities levels (PSU > 10, n = 9) fatty acid levels averaged 695 mg/m^2 ± 290 SD. Mean total fatty acid abundances among salinity categories were not statistically different ($F_{2,45} = 0.33$, $P = 0.72$).

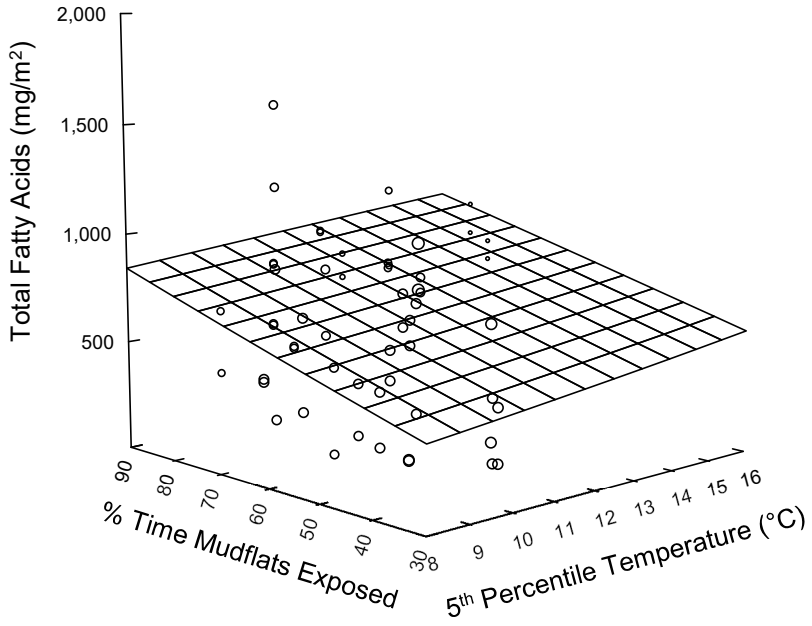


Figure 3-16 Relationship between Total Fatty Acid Abundance, the Percentage of Time Mudflats are Exposed, and the Fifth Percentile Water Column Temperature

3.1.5.3 Total PUFA

AIC_c results indicated models with the most support to influence biofilm Total PUFA levels contained the variables representing the amount of time the mudflats were exposed over the previous 72-hour period, the 95th percentile water column salinity, and the 5th percentile water column temperature (**Table 3-14**). Similar to Total Fatty Acids, summed Akaike model weights across the entire model-set (**Appendix D**) indicated

mudflats exposure time ($\sum w_i = 0.61$) to be most important variable affecting biofilm abundance (**Table 3-15**,

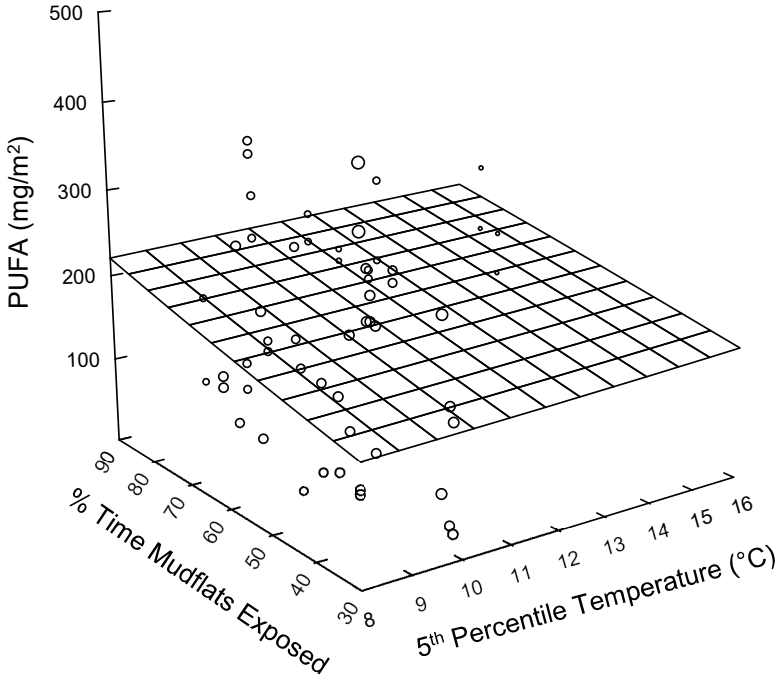


Figure 3-17). Both variables were positively correlated with increased PUFA levels. Evidence that 5th percentile water column temperature ($\sum w_i = 0.38$) or 95th percentile salinity ($\sum w_i = 0.33$) had a strong influence on PUFA abundance was weaker. AIC modelling indicated even less support that 95th percentile temperature or 5th percentile salinity had a strong influence on Total PUFA abundance.

Results from the backward stepwise regression indicated the most parsimonious model contained the location biofilm samples were collected (i.e., Station) and the total weight of biofilm sediment collected, and contained no abiotic variables ($r = 0.63$, $P < 0.01$).

Table 3-14 Variables Influencing Total Polyunsaturated Fatty Acid (PUFA) Abundance in Biofilm based on Akaike's Second-Order Information Criterion (AICc) for the Best Models Tested. Only models with substantial empirical support (∆AICc < 2.0, Burnham and Anderson 2002) are presented.

Model	Model ID	# of Parameters (K)	AIC_c	ΔAIC_c	Akaike Weight (w_i)
Percent Time Mudflats Exposed	5	6	663.66	0.00	0.19
95th Percentile Salinity + Percent Time Mudflats Exposed	12	7	664.66	1.00	0.11
5th Percentile Temperature	3	6	664.70	1.04	0.11

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**.

Table 3-15 Relative Importance of Variables Potentially Influencing Total PUFA Levels in Biofilm based of Summed Akaike Weights and the Direction of Change

Variables	Sum of Weights (w_i)	Direction of Change (+ / -)
Percent Time Mudflats Exposed	0.61	+
5th Percentile Temperature	0.38	+
95th Percentile Salinity	0.33	+/-
95th Percentile Temperature	0.29	+
5th Percentile Salinity	0.22	+/-

Notes: Direction of Change: + = increases in variable positively affect the biofilm parameter considered (e.g., Chlorophyll *a*, fatty acids, etc.), - = increases in variable negatively affect the biofilm parameter considered.

PUFA were produced by biofilm sampled across the salinity gradient. Under lower salinity conditions (5th percentile PSU ≤ 5, n = 41) PUFA abundance averaged 174 mg/m^2 ± 102 SD. Under moderate 5th percentile salinities (5 < PSU ≤ 10, n = 10) PUFA levels averaged 195 mg/m^2 ± 69 SD. Under high 5th percentile salinities levels (PSU > 10, n = 9) PUFA levels averaged 199 mg/m^2 ± 83 SD. Mean total PUFA abundances among salinity categories were not statistically different ($F_{2,45} = 0.59$, P = 0.56).

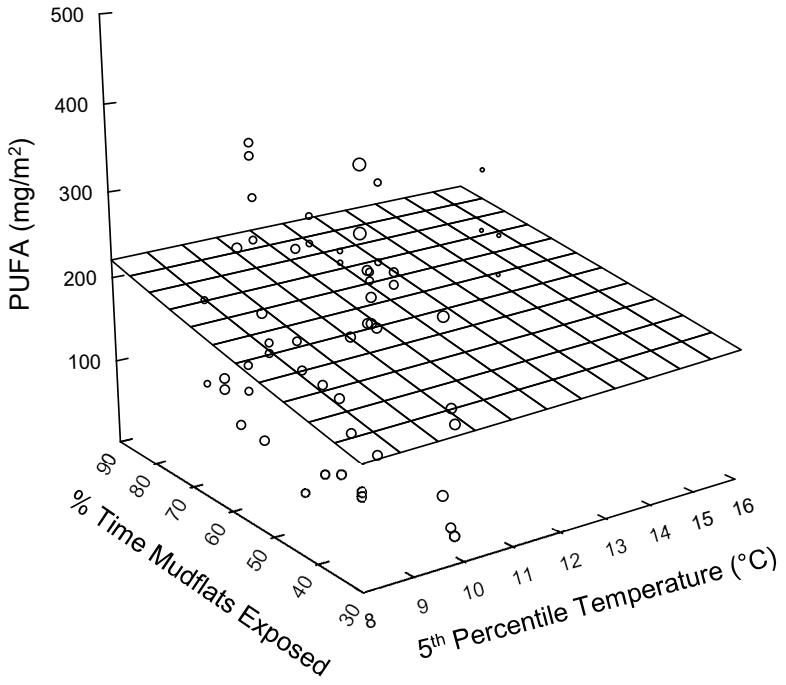


Figure 3-17 Relationship between Polyunsaturated Fatty Acid (PUFA) Levels, the Percentage of Time Mudflats are Exposed, and the Fifth Percentile Temperature

3.1.5.4 Total MUFA

AIC_c results indicated models with the most support to influence biofilm Total MUFA levels contained the variable percent of time mudflats were exposed (Model ID 5), and percent of time mudflats were exposed plus the 5th percentile water column temperature over the previous 72-hour period (Model ID 14) (**Table 3-16**). Summed Akaike model weights across the entire model-set (**Appendix D**) indicated mudflat exposure time ($\sum w_i = 0.88$) was the variable with the most influence on biofilm MUFA levels, with all other variables possessing $\sum w_i \leq 0.35$ (**Table 3-17**). In all models, mudflat exposure time and water column temperature (5th and 95th percentiles) were positively associated with increases in biofilm MUFA abundance (**Figure 3-18**). The direction of influences for water column salinity (5th and 95th percentiles) varied depending on the other variables included in the model.

Results from the backward stepwise regression indicated the model containing the percentage of time mudflats were exposed, while controlling for the location (i.e., Station) samples were collected (Model ID 5) to be the most parsimonious model, explaining the most variability of all potential models ($r = 0.77$, $P < 0.01$).

Table 3-16 Variables Influencing Total Monounsaturated Fatty Acid (MUFA) Abundance in Biofilm based on Akaike's Second-Order Information Criterion (AICc) for the Best Models Tested. Only models with substantial empirical support (ΔAICc < 2.0, Burnham and Anderson 2002) are presented.

Model	Model ID	# of Parameters (K)	AIC_c	ΔAIC_c	Akaike Weight (w_i)
Percent Time Mudflats Exposed	5	6	438.03	0.00	0.32
5th Percentile Temperature + Percent Time Mudflats Exposed	14	7	439.88	1.85	0.13

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**.

Table 3-17 Relative Importance of Variables Potentially Influencing Total MUFA Abundance in Biofilm based of Summed Akaike Weights and the Direction of Change

Variables	Sum of Weights (w_i)	Direction of Change (+ / -)
Percent Time Mudflats Exposed	0.88	+
5th Percentile Temperature	0.35	+
95th Percentile Temperature	0.28	+
95th Percentile Salinity	0.18	+/-

Notes: Direction of Change: + = increases in variable positively affect the biofilm parameter considered (e.g., Chlorophyll *a*, fatty acids, etc.), - = increases in variable negatively affect the biofilm parameter considered.

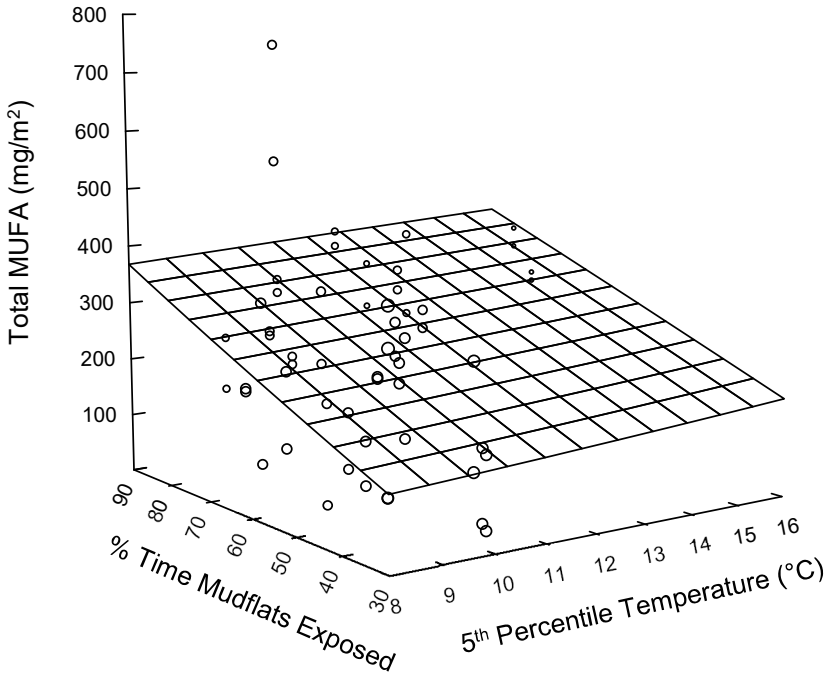


Figure 3-18 Relationship between Monounsaturated Fatty Acid (MUFA) Levels, the Percentage of Time Mudflats are Exposed, and the Fifth Percentile Temperature

MUFA were produced by biofilm sampled across the salinity gradient. Under lower salinity conditions (5th percentile PSU ≤ 5, n = 41) MUFA levels averaged 245 mg/m^2 ± 148 SD. Under moderate 5th percentile salinities (5 < PSU ≤ 10, n = 10) MUFA levels averaged 275 mg/m^2 ± 63 SD. While under high 5th percentile salinities levels (PSU > 10, n = 9) MUFA abundance was similar to that under low salinity conditions averaging 249 mg/m^2 sediment ± 117 SD. Mean total MUFA abundances among salinity categories were not statistically different ($F_{2,45}$ = 0.34, P = 0.71).

3.1.5.5 Total SFA

AIC results indicated five models had substantial support (ΔAIC_c < 2.0) to explain Total SFA abundance (**Table 3-18**). All abiotic variables, except 95th percentile water column temperature, were contained in at least one of the best supported models. The variable quantifying the percent of time mudflats were exposed over the previous 72-hour period was contained within all models with substantial support. Summed Akaike model weights across the entire model-set (**Appendix D**) indicated mudflat exposure time ($\sum w_i$ = 0.94) was the variable with the most influence on biofilm SFA levels (**Table 3-19**). The variables 95th percentile water column salinity ($\sum w_i$ = 0.51) and 5th percentile water column temperature ($\sum w_i$ = 0.39) had moderate support to influence SFA abundance, while there was less support that 5th percentile salinity ($\sum w_i$ = 0.33) and no support for 95th percentile water column temperature ($\sum w_i$ = 0.17) influencing SFA abundance. Increases in the percent of time mudflats were exposed and in 5th percentile water column temperature were positively associated with increase in SFA abundance in all models. For the remaining three abiotic variables tested, their association with SFA abundance varied depending on the other variables contained within models. However, when raw values for 95th percentile water column salinity (i.e., values that have not been adjusted for other variables in a model) are graphed against mudflat exposure time and Total SFA abundance, 95th percentile water column salinity demonstrates a negative relationship with SFA abundance (

Figure 3-19).

Results from the backward stepwise regression indicated the model containing the percentage of time mudflats were exposed, the 50th percentile water column temperature, the total weight of the biofilm sample collected to be the most parsimonious model, explaining the most variability of all potential models (r = 0.80, P < 0.04).

Table 3-18 Variables Influencing Total Saturated Fatty Acid (SFA) Levels in Biofilm based on Akaike's Second-Order Information Criterion (AICc) for the Best Models Tested. Only models with substantial empirical support ($\Delta AIC_c < 2.0$, Burnham and Anderson 2002) are presented

Model	Model ID	# of Parameters (K)	AIC_c	ΔAIC_c	Akaike Weight (w_i)
Percent Time Mudflats Exposed	5	6	267.89	0.00	0.17
95th Percentile Salinity + Percent Time Mudflats Exposed	12	7	268.38	0.49	0.14
5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	18	8	268.41	0.51	0.13
5th Percentile Temperature + Percent Time Mudflats Exposed	14	7	268.88	0.99	0.11
95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	23	8	268.96	1.06	0.10

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**.

Table 3-19 Relative Importance of Variables Potentially Influencing Total SFA Levels in Biofilm based of Summed Akaike Weights and the Direction of Change

Variables	Sum of Weights (w_i)	Direction of Change (+ / -)
Percent Time Mudflats Exposed	0.94	+
95th Percentile Salinity	0.51	+/-
5th Percentile Temperature	0.39	+
5th Percentile Salinity	0.33	+/-
95th Percentile Temperature	0.17	+/-

Notes: Direction of Change: + = increases in variable positively affect the biofilm parameter considered (e.g., Chlorophyll *a*, fatty acids, etc.), - = increases in variable negatively affect the biofilm parameter considered.

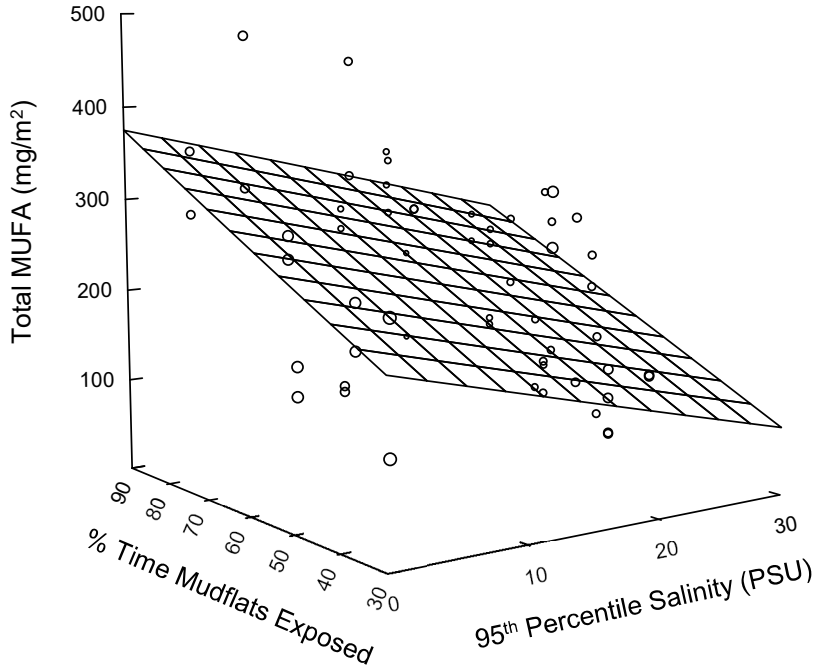


Figure 3-19 Relationship between Saturated Fatty Acid (SFA) Levels, the Percentage of Time Mudflats are Exposed, and the Ninety-fifth Percentile Water Column Salinity

SFA were produced by biofilm sampled across the salinity gradient (**Table 3-20**). Under lower salinity conditions (5^{th} percentile PSU ≤ 5, n = 41) SFA levels averaged 210 mg/m^2 ± 102 SD. Under moderate 5^{th} percentile salinities (5 < PSU ≤ 10, n = 10) SFA levels averaged 229 mg/m^2 ± 70 SD. Under high 5^{th} percentile salinities levels (PSU > 10, n = 9) SFA levels averaged 247 mg/m^2 ± 94 SD. Mean total SFA abundances among salinity categories were not statistically different ($F_{2,45}$ = 0.25, P = 0.78).

Table 3-20 Mean Total SFA Abundance under 5^{th} Percentile and 95^{th} Percentile Water Column Salinity Ranges. n = the number of biofilm samples analysed within a salinity range.

Water Column Salinity	n	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum
5^{th} Percentile Salinity					
< 5 PSU	41	210	102	68	478
5-10 PSU	10	229	70	117	336
> 10 PSU	9	247	94	109	364

3.1.5.6 Summary of Biofilm Parameters

AIC_c modelling and summed Akaike model weights indicated increases in mudflat exposure time was the primary factors positively influencing biofilm parameter abundance for many fatty acids, and had a moderate influence on most of the remaining parameters (**Table 3-21**). Increases in 5th percentile water column temperatures consistently demonstrated a weak to moderate influence on fatty acids. The one exception to this was 18:2n-6 where it demonstrated the strongest influence on abundance. The percent of time mudflats were exposed over the previous 72 hours had a strong to moderate influence on 16 and of the 18 fatty acids tested. Fifth percentile water column temperature had a moderate influence on 10 and strong influence on 2 of the 18 fatty acids tested. In all models (**Appendix D**), increases in both abiotic parameters were positively associated with increases in fatty acid abundance. Apart from two instances for 95th percentile water column temperature, water column salinity levels (5th and 95th percentiles) and 95th percentile water column temperature levels were found not to have a strong influence on any parameter and had a moderate influence over 1-3 of the 18 fatty acid parameters evaluated. Chlorophyll *a* abundance was primarily influenced by increases in 95th percentile salinity and 5th percentile water column temperature, while the primary factor driving total fatty and carbohydrate abundances was increases in the percent of time mudflats were exposed.

Total MUFA abundance, including levels of 16:1n-7, were positively influenced by increases in mudflat exposure time with little evidence that production was affected by water column salinity or temperature. In contrast, 18:1n-9 was more strongly influenced by 5th percentile water column salinity and 5th percentile water column temperature. 18:1n-9 comprised 5% of total MUFA abundance (see **Appendix B**) and had little influence on the overall factors influencing MUFA abundance.

The percentage of time mudflats were exposed had a strong positive influence on total SFA, 14:0, and 18:0 abundances; however, abundances were also moderately to strongly influenced by 95th percentile water column salinity and 5th percentile water column temperature levels. AIC modelling indicated the relationship between 95th percentile water column salinity levels on SFA abundance could be positive or negative depending on the remaining parameters in the model, possibly indicating the presence of a non-linear relationship. Increases in 5th percentile water column temperature positively influenced fatty acid levels, although the weight of evidence of the strength of the effect was generally weak (**Table 3-21**).

The weight of evidence indicates that total PUFA, omega 3, omega 6, and individual PUFA fatty acids abundances were primarily (positively) influenced by increases in mudflat exposure time and secondarily by increases in 5th percentile water column temperature. The weight of evidence for factors influencing PUFA abundance was not as strong for PUFA compared to other biofilm parameters and was general spread across multiple abiotic factors.

Table 3-21 Summary of the Relative Importance of Abiotic Factors Potentially Influencing Biofilm Parameter Abundance based on the Sum of Akaike Weights (∑wi) across the Entire Model Set (n = 31 models)

Biofilm parameter	Abiotic Factors				
	Percent Time Mudflats Exposed	5th Percentile Salinity	95th Percentile Salinity	5th Percentile Temperature	95th Percentile Temperature
Chlorophyll a	0.51	0.47	0.98	0.89	0.25
Total Carbohydrates	0.76	0.24	0.27	0.22	0.36
Fatty Acids					
Total Fatty Acid	0.82	0.21	0.29	0.45	0.24
Polyunsaturated Fatty Acids (PUFA)					
Total PUFA	0.61	0.22	0.21	0.38	0.29
18:2n-6	0.27	0.20	0.20	0.84	0.21
18:3n-3	0.42	0.48	0.24	0.32	0.22
18:3n-6	0.98	0.21	0.30	0.18	0.21
20:5n-3 (EPA)	0.52	0.22	0.29	0.40	0.35
22:6n-3 (DHA)	0.58	0.22	0.27	0.28	0.32
Omega 3 Fatty Acids	0.57	0.22	0.31	0.36	0.33
Omega 6 Fatty Acids	0.75	0.21	0.28	0.40	0.19
Monounsaturated Fatty Acids (MUFA)					
Total MUFA	0.88	0.17	0.18	0.35	0.28
16:1n-7	0.93	0.17	0.18	0.26	0.30
18:1n-9	0.29	0.37	0.28	0.40	0.24
20:1	0.58	0.23	0.28	0.25	0.27
Saturated Fatty Acids (SFA)					
Total SFA	0.94	0.33	0.51	0.39	0.17
14:0	0.97	0.18	0.74	0.35	0.19
16:0	0.64	0.24	0.20	0.66	0.17
18:0	0.86	0.22	0.73	0.24	0.20
22:0	0.62	0.30	0.25	0.34	0.26

Notes:
1. The maximum possible sum of Akaike Weights ($\sum w_i$) = 1.0. Variables with $\sum w_i$ approaching 1.0 indicates strong support for their ability to influence biofilm abundance parameters.
2. Cell coloration: Black: $\sum w_i > 0.66$; dark gray: $0.66 \geq \sum w_i \geq 0.33$; white: $\sum w_i < 0.33$.
3. For the full set of models evaluated using AIC (i.e., 31 models) see **Appendix D**

3.2 MICROPHYTOBENTHIC COMMUNITY COMPOSITION

The microphytobenthic community during the 2017 northward migration was dominated by *Achnanthidium* spp., *Navicula* spp., and *Nitzschia* spp. representing 44%, 23% and 20% of the total abundance of the diatom community, respectively (**Figure 3-20**). Fifty other genera comprised the remaining 13% of the microphytobenthic community abundance. *Achnanthidium* spp., *Navicula* spp., and *Nitzschia* spp. were

documented at all stations on all sampling dates and in 91% of biofilm samples collected (**Appendix E**). That is, in five instances, one of the two replicate samples (total # replicate samples = 56) collected at a site did not contain diatoms of the genera *Nitzschia* (3 samples), *Navicula* (1), or *Achnanthidium* (1). Four other genera occurred at >50% of sampling events at stations: *Surirella* (71%), *Aulacoseira* (61%), *Gyrosigma* (61%), and *Gomphonema* (57%). All other genera occurred at <50% of sampling events at stations, with 85% of the genera occurring at < 33% of stations when sampled.

Community composition of the dominant diatom genera was relatively similar amongst stations X, J, Y, A, and C, but differed from sites H and I. *Achnanthidium* spp. accounted for a smaller proportion of the community at Stations H and I (~12%) compared to other stations (~58%), and contained a higher proportion of *Navicula* spp. (~39%) compared to the remaining sites (~18%) (**Figure 3-20**). Total microphytobenthos abundance, along with the key taxa *Achnanthidium* spp. and *Nitzschia* spp. were observed to increase at most sites over the duration of the study (**Figure 3-21**). *Navicula* spp. abundance was more variable at stations.

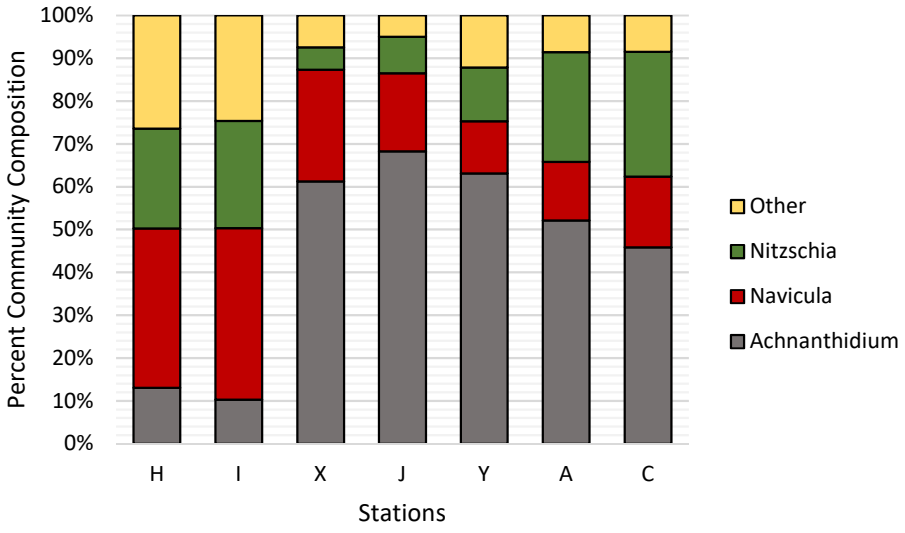


Figure 3-20 Spatial Microphytobenthos Community Composition by Station during Northward Migration at Roberts Bank (May 2 to May 23, 2017)

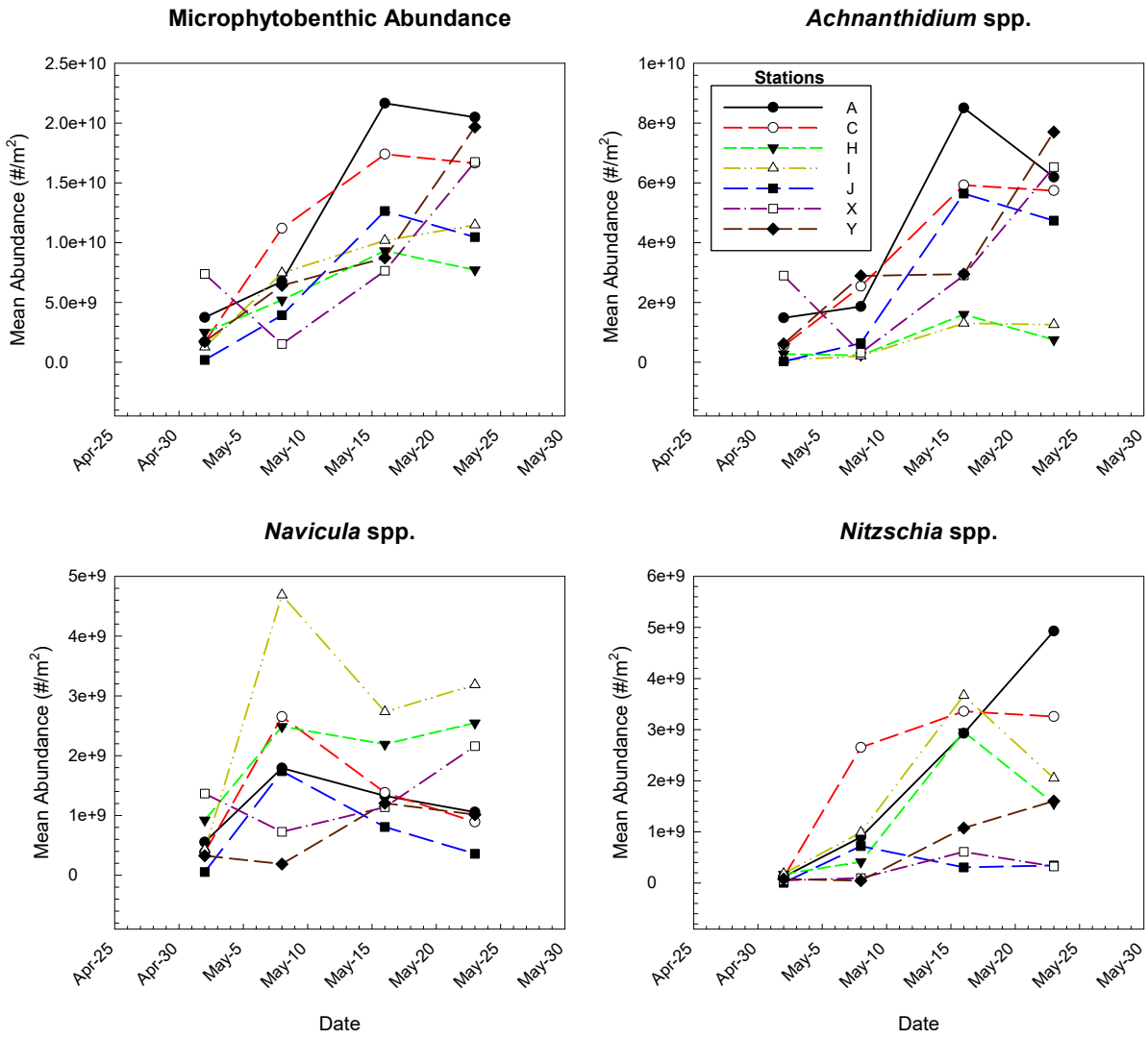


Figure 3-21 Temporal Trends in Abundance of Total Microphytobenthos, *Achnanthidium* spp., *Navicula* spp., and *Nitzschia* spp., among Stations across Roberts Bank (May 2 to May 23, 2017). Note: differences in y-axis scale between inset figures are intentional to allow differences in levels over time to be observed.

3.2.1 Community Composition Patterns

No significant difference in the microphytobenthic community among stations was documented (R = -0.04, p = 0.73); however, a significant difference was observed temporally (R = 049., p = 0.001) for all stations across Roberts Bank nested within each sampling date (**Figure 3-22** and **Figure 3-23**). The temporal difference observed in the nMDS reflect differences between the May 2 – May 8 microphytobenthic community from the May 16 – May 23 community (**Figure 3-22**). However, there is overlap between these two sample periods, with the later sample period showing increasing dissimilarity among sample sites and sample times. The associated Single Linkage Cluster Analysis is shown in **Figure 3-23** and indicates a significant changes in the microphytobenthic community across Roberts Bank from the first sampling period between May 2 and 8. Dissimilarity increases with the later sampling periods and differences are greater among sites and sampling periods of May 16 and 26.

While the results of a Similarity Profile analysis (SIMPROF) confirmed that there is significant clustering of data by sample period, pairwise analysis of similarity among sample periods show low R-squared values suggesting high variance in the community within each sampling period. A summary of temporal differences is provided in (**Table 3-22**).

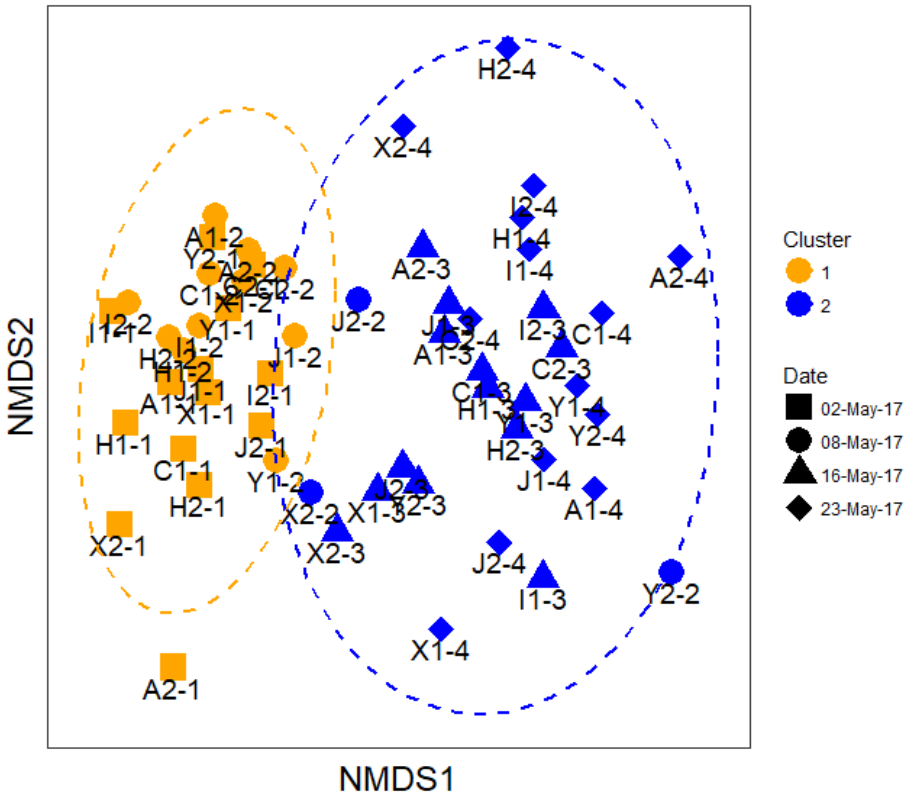


Figure 3-22 Non-Parametric Multi-Dimensional Scaling Analysis (nMDS) of Microphytobenthos Community at Roberts Bank during 2017 Northward Migration (May 2 to May 23, 2017) with 95th Confidence Ellipse

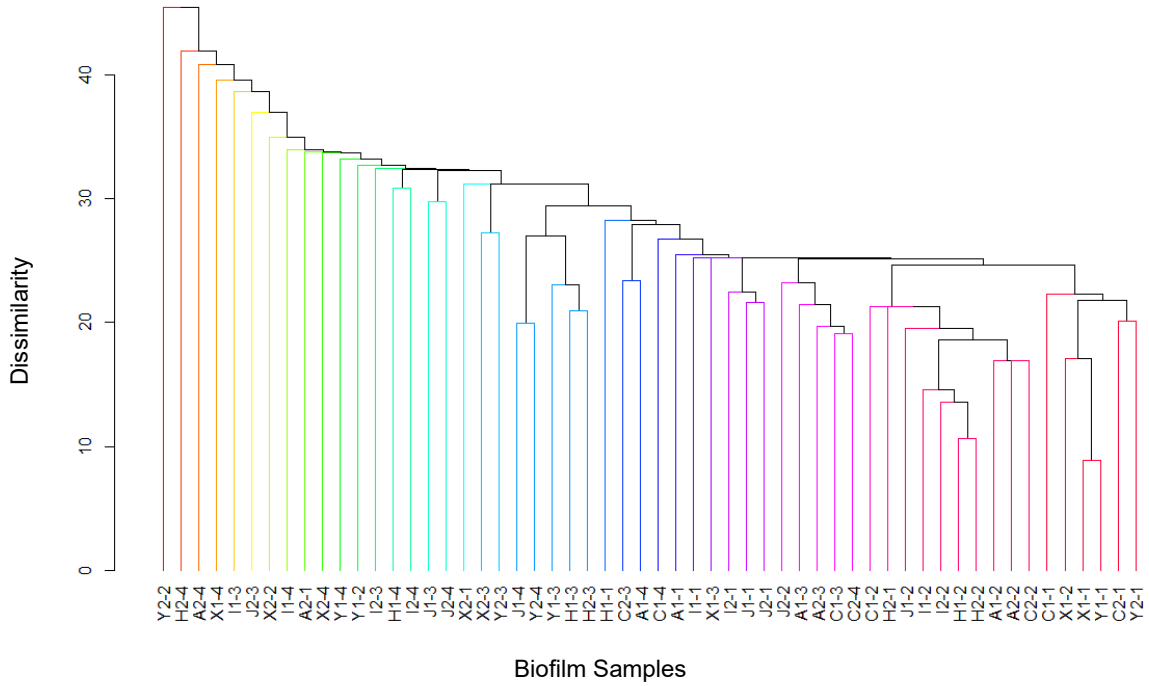


Figure 3-23 Single Linkage Cluster Analysis of Microphytobenthos Community at Roberts Bank during 2017 Northward Migration (May 2 to May 23, 2017). The key to sample codes (e.g., Y2-2) on x-axis is: (Station) (Replicate Sample Number [1,2])-(Sampling Date [1=May 2; 2=May 8; 3=May 16; 4=May 23]).

Table 3-22 Analysis of Similarities (ANOSIM) of Biofilm Sampling Dates. All values were significant ($p < 0.05$)

Dates	02-May	08-May	16-May
08-May	0.12		
16-May	0.32	0.24	
23-May	0.34	0.28	0.08

3.2.2 Temporal Community Patterns

Based on the nMDS and the cluster analyses, community data were separated into the two separate clusters:

- Cluster 1 – All Stations on May 2 - 8 data, except for Station J2 and, X2, and Y2 on May 08
- Cluster 2 – All Stations on May 16 - May 23, and Station J2, X2, and Y2 on May 8

Comparisons between Cluster 1 and Cluster 2 showed that the community differences were primarily driven by changes in sub-dominant diatom taxa as opposed to changes in dominant taxa (i.e., *Nitzschia* spp., *Navicula* spp., and *Achnanthidium* spp.) (see the "Dissimilarity" and "Contributed %" column in **Table 3-23**).

There were relatively minor increases observed in the dominant *Nitzschia* spp., *Achnanthidium* spp., and a minor decrease in *Navicula* spp. between clusters 1 and 2, which contributed minimally to the SIMPER results. Despite this, the presence of new species and/or increased abundances of minor species occurring after May 8 resulted in the overall community composition changes observed within the study area.

Table 3-23 Similarity Percentage (SIMPER) Results Between May 2–8 and May 16–23, 2017 Sampling at Roberts Bank

Species	Cluster 1 (May 2–8)	Cluster 2 (May 16–23)	Dissimilarity	Contributed	Cumulative
Tryblionella spp.	17.06	1.10	2.67	4.54	7.67
Pleurosigma spp.	15.97	-	2.41	4.40	15.10
Gyrosigma spp.	2.64	14.50	1.47	3.67	21.29
Aulacoseira spp.	11.74	2.90	1.34	3.04	26.42
Surirella spp.	9.52	8.85	1.07	2.66	30.91
Cylindrotheca spp.	9.12	1.00	1.00	2.53	35.18
Cocconeis spp.	5.51	6.29	0.89	2.26	39.00
Melosira spp.	1.25	7.78	0.86	2.20	42.72
Gomphonema spp.	3.31	7.46	0.90	2.19	46.42
Leptolyngbya spp.	-	7.38	0.77	1.89	49.60
Tabularia spp.	6.32	1.00	0.77	1.81	52.66
Cyclotella spp.	3.10	5.09	0.77	1.80	55.69
Encyonema spp.	1.98	5.70	0.75	1.75	58.65
Fragilaria spp.	5.88	0.59	0.74	1.75	61.60
Amphora spp.	3.66	4.02	0.75	1.60	64.31
Diatoma spp.	4.72	2.28	0.70	1.51	66.86
Geitlerinema spp.	5.02	-	0.60	1.42	69.26
Nitzschia spp.	17.55	20.19	0.60	1.32	71.48
Achnanthidium spp.	19.75	21.08	1.09	0.76	-
Navicula spp.	20.36	20.18	0.51	0.57	-

4.0 DISCUSSION

This study was the second year of a three year program to investigate biofilm dynamics in relation to abiotic factors influencing biofilm-associated fatty acid, chlorophyll *a*, and carbohydrate abundance (Hemmera and Advisian 2017). This program was also the second year of a program to intensively study microphytobenthic community composition during the annual spring freshet (Hemmera and Advisian 2017), and builds off previous research conducted in 2012 and 2013 (WorleyParsons 2015*b*). Results for studies conducted previously are compared to 2017 results and presented herein.

4.1 BIOFILM BIOMASS AND FATTY ACID ABUNDANCE

4.1.1 Relationship Among Biofilm Parameters

Similar to results from 2016 (Hemmera and Advisian 2017), strong statistically significant correlations between fatty acids and fatty acid types (e.g., MUFA, PUFA, SFA) were documented in 2017. In spring 2017, 69% of individual focal fatty acids and fatty acid types showed strong statistically significant positive correlations ($r > 0.70$) with each other, while 89% demonstrated moderately strong ($r > 0.60$) correlations (**Table 3-8**). Results from 2016 were similar, with the strength of the relationships between biofilm parameters being stronger the previous year (i.e., 87% of biofilm parameters demonstrating strong positive correlations). Overall, 98% of focal parameters ($n = 15$) (i.e., chlorophyll *a*, carbohydrates, and fatty acids) in 2016 and 97% of focal parameters ($n = 20$) in 2017 demonstrated positive statistically significant relationships. The strength of the relationships is evident in the consistent make-up of fatty acid profiles between stations and years. For example, in both 2016 and 2017, 70% to 84% percent of total fatty acid abundance at stations was comprised of the same 7 fatty acids (14:0, 16:0, 16:1n-7, 18:0, 18:1, 20:5n-3, and 22:6n-3) (**Figure 4-1**, **Table 4-1**). Although the proportional make of some fatty acids varied between years, possibly due to interannual variability in abiotic factors, the overall relationship between fatty acids remained consistent, with fatty acids that constituted a high proportion in one year making up a high proportion in the other year, and fatty acids in low proportion remaining low between years. This trend was observed in all fatty acids analysed and resulted in fatty acid profiles among stations within and between years remaining consistent. The consistent relationship among fatty acids in their proportional representation across stations and years also resulted in little interannual variation in overall SFA, MUFA, and PUFA profiles, which varied between 2% to 5% between 2016 and 2017 (**Table 4-1**).

These results suggest that knowledge of one biofilm parameter could facilitate the estimation of the remaining suite of parameters and the positive or negative effects documented in a single parameter are potentially indicative of effects to other biofilm parameters. Previous biofilm studies conducted at Roberts Bank used Chlorophyll *a* density (mg/m^2) as a measure of biofilm biomass and to assess how abiotic factors affect biofilm (LGL and Hemmera 2014, WorleyParsons 2014, 2015*b*). Based on results from this study, it is consistent that results from those studies can inform potential effects to biofilm-associated fatty acid and carbohydrate abundance.

Results also suggest that analysis for Chlorophyll *a* in intertidal mudflat sediments is potentially a cost effective and reliable way to measure and monitor biofilm biomass at Roberts Bank compared to the analyses of other parameters. The current method used to measure Chlorophyll *a* is through laboratory analysis of biofilm sediment samples. While accurate and one of the cheaper known methods of assessing biofilm, the procedure typically takes 30 to 60 days to obtain results and if multiple samples are taken can become costly. Newly emerging methods, such as the use of a BenthoTorch (BBE 2018) or fluorescent chlorofluorometer (Opti-Sciences 2018), may prove more cost effective as they measure and report Chlorophyll *a* abundance of biofilm-associated diatoms in the field within seconds, allowing for real-time results, trend monitoring, and the ability to sample a large area quickly and efficiently.

Table 4-1 Mean Percent Composition of Biofilm Fatty Acids across Stations in 2016 and 2017 and the Mean Difference in Proportional Composition between Years at Roberts Bank during April and May

Fatty Acid	2016		2017		Difference	
	Mean	SD	Mean	SD	Mean	SD
14:0	4%	0.7%	5%	0.5%	1%	1%
16:0	22%	2.0%	16%	4.2%	7%	5%
16:1n-7	23%	3.7%	28%	3.5%	6%	3%
18:0	4%	0.6%	3%	0.5%	1%	1%
18:1	4%	0.4%	5%	1.3%	1%	1%
20:5n-3	13%	1.8%	19%	1.7%	6%	2%
22:6n-3	6%	0.8%	4%	0.8%	2%	1%
Other	25%	3.3%	20%	3.7%	5%	3%
Total SFA	38%	2.3%	34%	4.2%	5%	5%
Total MUFA	36%	2.4%	38%	3.5%	3%	3%
Total PUFA	26%	2.8%	28%	2.6%	4%	2%

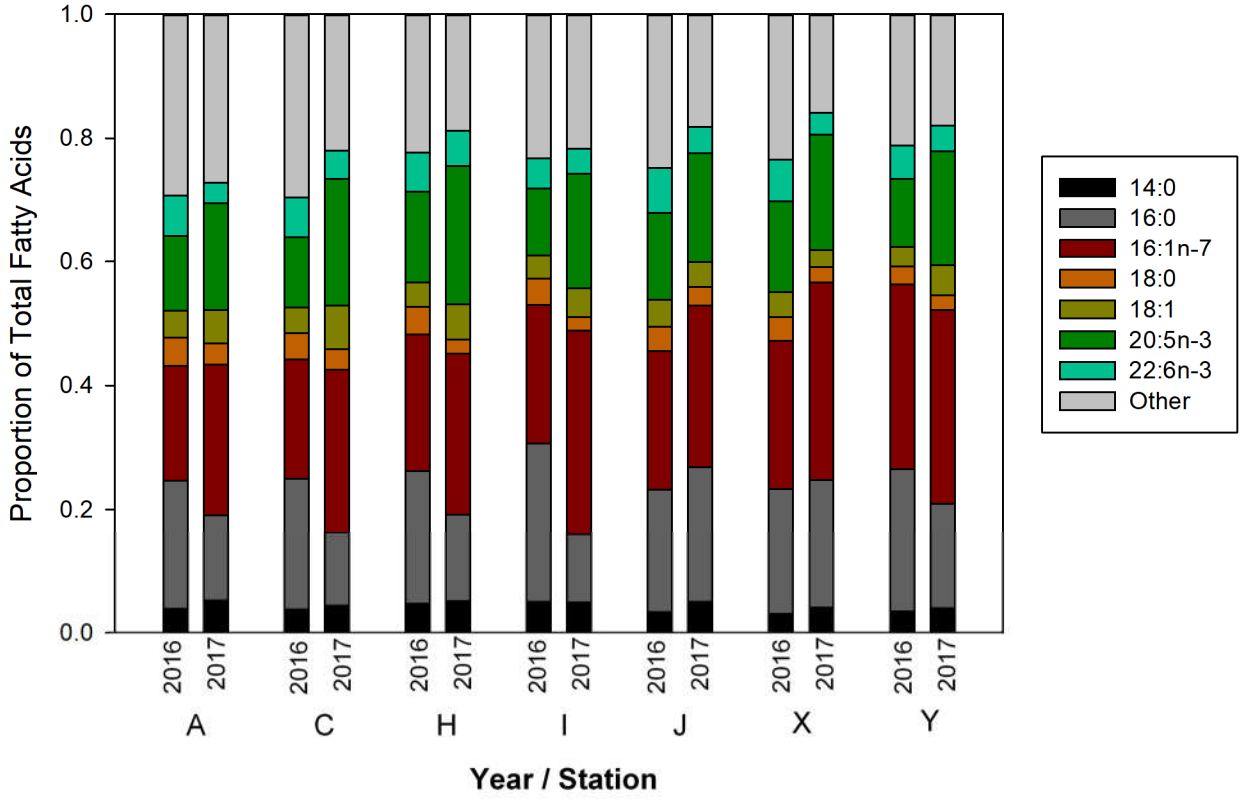


Figure 4-1 Proportional Composition of Fatty Acids at Sampling Stations in Spring 2016 and 2017 at Roberts Bank

4.1.2 Distribution and Abundance of Biofilm Parameters

A consistent pattern in the levels of biofilm parameters was documented among stations, with periods of longer mudflats exposure time associated with higher biofilm parameter abundances. Despite documented differences in parameter levels, almost all fatty acids, plus Chlorophyll *a* and Total Carbohydrates, were documented at every station on every sampling event, indicating the measured productivity parameters were produced by biofilms across the entire spatiotemporal range and across the suite of abiotic conditions experienced within the study area. Similar to 2016 (Hemmera and Advisian 2017), this included the documentation of high levels of SFA, MUFA, and PUFA under both freshwater-dominated conditions (e.g., Station H and I, 5th percentile salinity < 5 PSU) and more marine water dominated environments (e.g., Stations A and C, 5th percentile salinity > 10 PSU) (**Figure 4-2**). However, despite retention of this pattern, overall fatty acid levels were lower in 2017 compared to 2016 at many locations (**Figure 4-2, Table 4-2**). The reduced abundance was expressed across fatty acids (e.g., MUFA, SFA, PUFA); however, SFAs were affected more than MUFA and PUFA. In 2016, SFA proportionally comprised the greatest abundance (~39% of total), with MUFA comprising ~36% of the total fatty abundance. In 2017, MUFA were proportionally more abundant than SFA (39% vs. 33%, respectively). PUFA were documented in similar proportions in both years. Overall, the mean fatty acid abundance across Roberts Bank was reduced by approximately 98 mg/m^2 for SFA, 42 mg/m^2 for MUFA, and 26 mg/m^2 for PUFA.

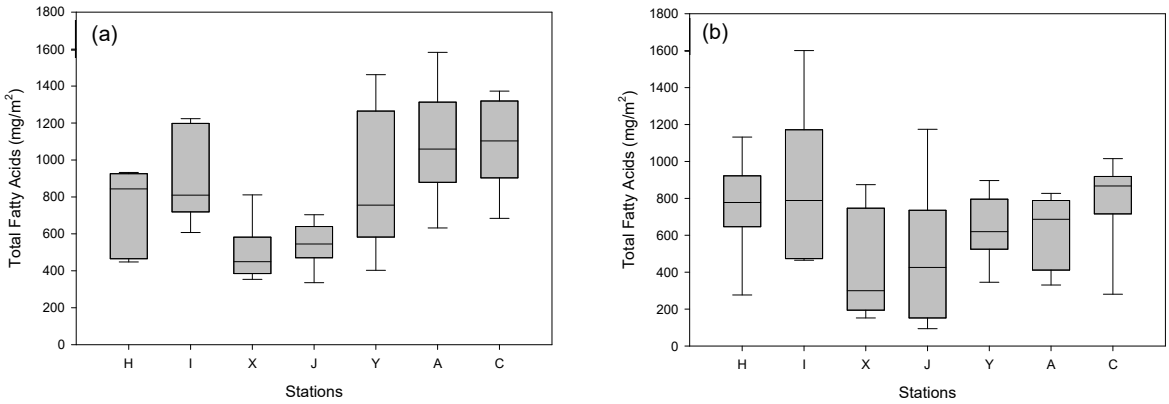


Figure 4-2 Total Fatty Acid Abundance (mg/m^2) in the 2016 (a) and 2017 (b) during the spring Fraser River freshet (April/May) at Roberts Bank

Table 4-2 Mean Fatty Acid Levels Across Stations in 2016 and 2017 and the Mean Difference Years at Roberts Bank during April and May

Biofilm Parameter	2016		2017		Difference	
	Mean (mg/m^2)	SD	Mean (mg/m^2)	SD	Mean (mg/m^2)	SD
Total Fatty Acids	818	89	648	85	-170	159
Total SFA	315	32	217	29	-98	54
Total MUFA	291	46	250	44	-42	72
Total PUFA	208	20	181	19	-26	37

Spatially, larger reductions in fatty acid abundances were documented in the more marine/brackish areas (Stations A, C, and Y) close to Brunswick Dyke and the Roberts Bank Causeway compared to stations located close to Canoe Passage, which remained largely comparable to 2016 levels. For example, total fatty acid levels at Station A in 2017 were approximately 440 mg/m^2 lower than in 2016, SFA were reduced by 175 mg/m^2, MUFA were 135 mg/m^2 lower, and PUFA were 120 mg/m^2 lower. In comparison, abundances at Station I were less affected, with total fatty acid levels reduced by 83 mg/m^2, SFA decreasing by 150 mg/m^2, and MUFA and PUFA increasing by approximately 30 and 45 mg/m^2, respectively. The greater reduction in fatty acid abundance was also larger for Stations C and Y in the Upper Intertidal area, with total fatty acid abundances reduced by approximately 300 mg/m^2 and 235 mg/m^2, respectively. Overall, total fatty acid abundance at every station, except Station H which increased by 20 mg/m^2, were between 80 and 440 mg/m^2 lower in 2017 compared to 2016. These changes resulted in Station C having the largest overall fatty acid abundance in the Upper Intertidal area (793 mg/m^2), which was comparable to fatty acid abundances documented close to Canoe Passage (Station I: 816 mg/m^2; Station H: 764 mg/m^2) in 2016 (Hemmera and Advisian 2017) and 2017 (**Appendix C**). Stations A and Y, in the Upper Intertidal area, possessed fatty acid abundances approximately 100 - 180 mg/m^2 lower (i.e., 648 mg/m^2 and 633 mg/m^2).

Approximately 90% of the energy for migratory flight in birds comes from fat deposits with the remaining 10% comprised largely of protein (Guglielmo 2010). In this study, the fatty acids in greatest abundance were the SFAs palmitic acid (16:0) and Myristic acid (14:0), the MUFAs palmitoleic acid (16:1n-7) and Oleic acid (18:1n-9), and the PUFA EPA (20:5n-3), and DHA (22:6n-3), all of which are potentially important to migrating WESA. Previous research has shown that 80 to 90% of all fatty acids stored by WESA are C_{16} and C_{18} fatty acids (i.e., the SFA palmitate [16:0] and stearate [18:0], and the MUFA palmitoleate [16:1] and oleate [18:1]) (Egeler and Williams 2000) similar to fatty acids documented in this study. During spring migration, the percentage of MUFA (e.g., 16:1 and 18:1) stored by WESA has been shown to increase, possibly because MUFA have a lower melting point and are easier to metabolize (Egeler and Williams 2000, Guglielmo 2010) than SFA (e.g., 16:0, 18:0). Despite this shift, the same four fatty acids (i.e., 16:0, 16:1, 18:0, 18:1) accounted for ~86% of fatty acids deposited in male and female WESA during northward migration (speaking to their potential importance (Egeler and Williams 2000)). Within this study and in 2016, 16:0, 16:1 (including 16:1n-7), 18:0, 18:1 fatty acids comprised 51% and 52% of the total fatty acid abundance documented, respectively (Hemmera and Advisian 2017). The importance of these fatty acids to migrating WESA is further supported by research indicating that WESA are capable of physiologically manipulating fatty acids prior to storing fats to achieve the necessary profile to fuel migratory flight (e.g., converting SFA to MUFA) (Egeler and Williams 2000, Egeler et al. 2003).

Compared to MUFA and SFA, which can originate from dietary sources and physiological manipulation, PUFA, such as EPA and DHA, and other essential fatty acids cannot be manufactured by birds and must be obtained through dietary sources alone (Egeler et al. 2003, Guglielmo 2010). Levels of PUFA in adipose tissue of migrating WESA have been documented in small quantities (~5%), with long-chained omega 3 and omega 6 fatty acids comprising less than 1% of stored fats (Egeler and Williams 2000). Therefore, PUFA, omega 3, and omega 6 fatty acids likely do not play a primary role in directly fueling migratory flight. However, it has been hypothesised that omega 3 PUFA, such as EPA, increase migratory performance by enhancing the functional capacity of membranes and thereby increase the aerobic capacity of flight muscles (Maillet and Weber 2006, 2007). This theory has not been proven, nor has it been proven that incorporation of omega 3 PUFA in adipose tissues and cell membranes improve exercise performance or are necessary for endurance flight (Guglielmo 2010).

Regardless of the essential nature of PUFA, as mentioned previously in this report and documented in 2016 (Hemmera and Advisian 2017), omega 3 and 6 PUFA (including EPA and DHA) were produced by the biofilm community across the spatiotemporal range and abiotic gradient at Roberts Bank during the spring freshet. In both 2016 and 2017, no statistical difference in total PUFA or EPA abundance between stations located within areas of higher salinity close to the Roberts Bank causeway (i.e., Stations A and C) and Station I (and H in 2017), located close to the freshwater outflow of the Fraser River, indicating the potential for similar PUFA/EPA abundance to occur across the known salinity gradient of the study area. Similarly, total PUFA abundance was documented not to differ statistically between samples collected in high 5th

percentile water column salinity locations versus low 5th percentile salinity locations in both years. Both areas (i.e., close to the Fraser River [Canoe Passage] outflow versus Roberts Bank Causeway/Brunswick Dyke) are heavily used by foraging WESA during northward migration (**Figure 4-3a**) indicating both areas likely satisfy WESA nutritional needs.

During the 2012 and 2013 WESA northward migration, sandpiper use of the less saline locations close to Canoe Passage was consistently equal to or greater than in more saline areas close to the Brunswick Dyke/Roberts Bank Causeway (Hemmera 2014). Notable in the 2012 and 2013 (**Figure 4-3)** shorebird distributions shifted usage closer to Canoe Passage into likely more freshwater conditions (**Figure 4-3a**). In 2012, the annual freshet was a large event approaching a 20-year recurrence flood resulting in elevated freshwater discharge from the Fraser River (**Figure 4-3b**). The large freshet likely decreased salinity levels across a larger area of mudflat than in typical years and may have benefited shorebirds, as the high usage of areas dominated by freshwater input likely has physiological benefits. Shorebirds feeding in saline environments must expend energy to osmoregulate salts consumed when foraging, which can be energetically expensive. Gutiérrez et al. (2011) documented a 17 and 20% increase in basal metabolic rate and daily energy consumption, respectively, in shorebirds using saltwater compared to freshwater environments indicating the environment was energetically more expensive. Additionally, the body mass of shorebirds feeding within saltwater habitats were 9-16% lower than birds using freshwater habitats. As a primary goal of WESA during northward migration is to reach the breeding grounds as quickly as possible to secure breeding territories, feeding in habitats that meet nutritional needs while minimizing physiological demands is likely a good strategy and may make freshwater-dominated areas within estuaries preferential habitats.

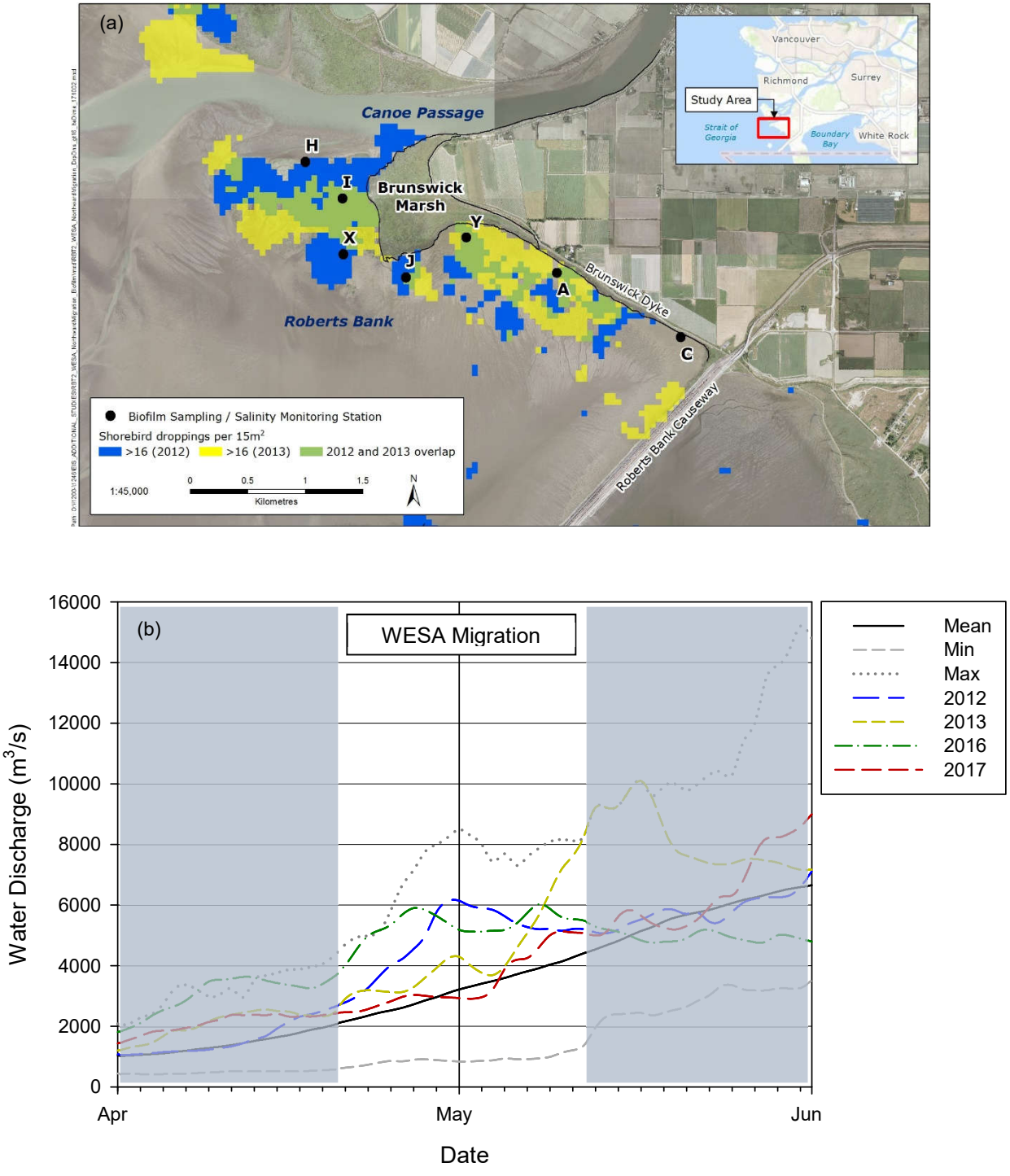


Figure 4-3 Areas of High Western Sandpiper Usage of the Study Area during Northward Migration in 2012 and 2013 Based on Sandpiper Droppings Densities less than a Canadian Dime in Size (a) and Historical (1912 to 2017) Fraser River Freshet Discharge Rates (b). Figure (a) is modified from data presented in Hemmera (2014) to present areas of greatest usage by WESA. Water data are derived from the Government of Canada (2017) Water Office for Fraser River Station at Hope, BC (08MF005).

Also, noticeable in the 2012 and 2013 western sandpiper foraging distributions is the reduced usage of the mudflats close to Station C (**Figure 4-3a)**. Based on two years of consistently high fatty acid abundances in 2016 and 2017 at this location it is likely the mudflats around Station C contained high biofilm levels in 2012 and 2013 that would be beneficial to migrating WESA. However, previous research has documented that areas close to land that provide potential cover for hunting predators (e.g., peregrine falcons [*Falco peregrinus*]) are more dangerous to shorebirds and are avoided in lieu of safer more open sites that provide good vantage to spot approaching falcons (Ydenberg et al. 2002, 2004, Pomeroy 2005, Pomeroy et al. 2006, 2008). It is therefore possible, that despite containing abundant biofilm with high fatty acid levels, the mudflats around Station C are avoided by many shorebirds in preference to more open locations. Given the high fatty acid abundance, and more open expanses of unobstructed views provided by the Canoe Passage location, in addition to it potentially being a less physiological demanding area to forage, it is possible that this freshwater-dominated location of Roberts Bank is higher quality foraging habitat to migrating WESA than the upper intertidal zone close to Brunswick Dyke and the Roberts Bank Causeway.

4.1.3 Factors Affecting Biofilm Parameters

Increases in the percentage of time the intertidal mudflats were exposed (i.e., not inundated) was the primary factor positively influencing fatty acid abundance for most fatty acids during the spring freshet in 2017 and aligns with results from 2016 (Hemmera and Advisian 2017). Similar to 2016, increases in mudflat exposure time were strongly associated with increases in total fatty acid, total MUFA (including 16:1n-7), and total SFA (including 14:0, 18:0) abundance. For total MUFA and total SFA there was little evidence that changes in water column salinity or temperature affected abundance levels. These results were supported by the regression and AIC analyses for MUFA, and by examining mean fatty acid levels under differing salinity conditions for both SFA and MUFA (**Section 3.1.5**). An exception to this were the MUFA 18:1n-9 and SFA 16:0. 16:0 was equally influenced by mudflat exposure time and increases in low (5^{th} percentile) water column temperatures, and 18:1n-9 was not strongly influenced by any factor analysed. In 2016, 16:0 was most strongly influenced by mudflat exposure time and secondarily increases in 5^{th} percentile salinity levels and 18:1n-9 was driven by increases in salinity, with exposure time, 95^{th} percentile salinity and temperature having low to moderate influence on abundance. Between 2016 and 2017, 18:1n-9 and 16:0 comprised ~ 3-5% and 15-22% of total fatty acid abundance, respectively. In both years, total fatty acid levels were primarily driven by increases in mudflat exposure time.

In general, mudflat exposure time was the most influential factor affecting PUFA abundance in 2017; however, its influence was considered moderate ($\sum w_i = 0.61$) with increases in water column temperature having a secondary affect ($\sum w_i = 0.38$). Exceptions to this were omega 6 fatty acids (including 18:3n-6), which were strongly influenced by exposure time ($\sum w_i = 0.98$) and 18:2n-6, which was strongly influenced by 5^{th} percentile water temperature levels ($\sum w_i = 0.84$).

The result that Chlorophyll *a* levels in biofilm were positively correlated with water column salinity aligns with previous research (LGL and Hemmera 2014, WorleyParsons 2014, Hemmera and Advisian 2017); however, the 2017 AIC modelling indicated Chlorophyll *a* abundance was also influenced by increases in 5th percentile water temperature ($\sum w_i$ = 0.89) and mudflat exposure time ($\sum w_i$ = 0.51).

A primary difference between 2016 and 2017 AIC modelling results were changes in the secondary factors affecting fatty acid abundances. In 2017 there was a reduced influence of water column salinity on fatty acid abundances and an increase in the number of instances water column temperature received a moderate influence rating ($0.33 \leq \sum w_i \leq 0.66$). In most cases in 2017, the summed Akaike weights for water column temperature were < 0.5 and typically were a secondary influence to other factors in the model, indicating they often had less influence than other factors in affecting abundances. This was also the case in 2016 for water column salinity levels. To simplify and summarize factors affecting fatty acid abundances, **Table 4-3** presents AIC summed Akaike weights of fatty acid types with $\sum w_i \leq 0.50$ removed for 2016 and 2017 so that only factors with moderately strong to strong influence are shown.

Table 4-3 Summary of Factors Affecting Fatty Acid Abundance during the Spring Freshet in 2016 and 2017 Based on Summed Akaike Weights across the Entire Model Set (n = 31 models)

Biofilm Parameter	Abiotic Factors (2016)		Abiotic Factors (2017)		
	Percent Time Mudflats Exposed	5th Percentile Salinity	Percent Time Mudflats Exposed	95th Percentile Salinity	5th Percentile Temperature
Chlorophyll a	0.21	0.93	0.51	0.98	0.89
Total Fatty Acid	0.88	0.41	0.82	0.29	0.45
Total PUFA	0.34	0.76	0.61	0.21	0.38
Total MUFA	0.92	0.34	0.88	0.18	0.35
Total SFA	0.92	0.32	0.94	0.51	0.39

Notes: The maximum possible sum of Akaike Weights ($\sum w_i$) = 1.0. Variables with $\sum w_i$ approaching 1.0 indicates strong support for their ability to influence biofilm abundance parameters. Weights ≥ 0.66 are highlighted in black. Weights $0.5 \leq \sum w_i \leq 0.66$ are highlighted in grey.

Collectively, the 2016 and 2017 results indicate the majority of fatty acid production at Roberts Bank during the WESA northward migration period was driven by mudflat exposure (**Table 4-3**), as increases in exposure time drove MUFA and SFA production, which accounted for 72%-74% of Total Fatty Acid abundance. This finding is substantiated by AIC results indicating mudflats exposure time as the primary driver of Total Fatty Acid production. Mudflat exposure is largely driven by the spring-neap tidal cycle associated with the 29.5-day lunar cycle. As the lunar cycle is a regular phenomenon that does not fluctuate, it is likely there is a dependable standing stock supply of fatty acid at Roberts Bank available to migrating WESA and other organisms at this time of year.

As results indicate that PUFA abundance is strongly influenced by salinity levels, it is likely that PUFA levels across Roberts Bank vary annually in association with the size and timing of the Fraser River freshet whose maximum discharge has been documented to fluctuate between 535 m^3/second and 8,500 m^3/second during WESA northward migration since 1912 (**Figure 4-3b**) (Government of Canada 2017). Fraser flows during the 2016 field season were generally larger than 2017. The differences in water discharge rates likely resulted in differing salinity regimes between years, which could have influenced PUFA production. Additionally, weather conditions in 2017 tended to be cloudier and wetter than in 2016. In 2017, 55% of the field season contained inclement weather (i.e., rain, drizzle, fog) compared to 36% of days in 2016 (Environment and Climate Change Canada 2018). This equated to ~108 mm of rainfall in 2017 compared to 12 mm in 2016. As a result, 2017 was also cloudier (i.e., 77% of days were classified as cloudy/mostly cloudy) compared to 52% of days in 2016. As biofilm is dominated by photosynthetic diatoms, differences in cloud cover, or rain falling directly on the mudflats, could have influenced PUFA production and overall abundance between years. However, as noted above, the biofilm community produced PUFA across Roberts Bank in both years from freshwater-dominated sites close to Canoe Passage to more marine stations in the upper intertidal zone close to the Roberts Bank causeway. It therefore seems possible that PUFA, such as EPA and DHA, may be found under a wide range of freshet and weather conditions across Roberts Bank during WESA northward migration.

4.2 MICROPHYTOBENTHIC COMMUNITY COMPOSITION

Fifty-three genera of diatoms were document within the study area in biofilm in 2017 (**Appendix D**) compared to 55 genera in 2016 (Hemmera and Advisian 2017). Forty-one of the same genera were documented in both years within samples. In 2016 and 2017, genera *Nitzschia, Navicula,* and *Achnanthidium* comprised ~74% and ~87% of the total abundance of the diatom community, respectively. In 2016 and 2017, and similar to previous studies (WorleyParsons 2015*b*), *Nitzschia, Navicula,* and *Achnanthidium* were distributed across the salinity gradient from Canoe Passage to the Roberts Bank causeway and were the dominant genera at all stations during WESA spring migration. Most other genera of diatoms occurred at < 50% of sampling events at stations. Based on 2013 data (WorleyParsons 2015*b*), it appears that *Nitzschia, Navicula,* and *Achnanthidium* also dominate the intertidal zones of Roberts Bank through summer, with *Nitzschia* and *Navicula* remaining dominant in winter and *Achnanthidium* decreasing in abundance. The presence of these genera in high numbers at Roberts Bank over multiple years potentially indicates they are a consistent, and an important component, of the Roberts Bank diatom community.

Similar to 2016 (Hemmera and Advisian 2017), no statistically significant difference(s) in the microphytobenthic community composition among stations was documented in 2017 (**Section 3.2.1**). However, a statistically significant temporal difference in the microphytobenthic community composition was documented between the periods of May 2 to May 8 and May 16 to May 23, 2017. Similar to results from 2016 (Hemmera and Advisian 2017), this change in community composition occurred after a spring tide and was primarily driven by changes in sub-dominant diatom taxa as opposed to changes in dominant taxa (i.e., *Nitzschia* spp., *Navicula* spp., and *Achnanthidium* spp.).

The Spring 2013 community possessed only three dominant taxa, with defined habitat preferences: *Nitzschia* spp. (predominantly marine), *Navicula* spp. (mostly marine with some freshwater species) and *Achnanthidium* spp. (freshwater) (WorleyParsons 2014, 2015*b*). This dominance allowed for general conclusions to be made regarding freshwater influence based on the presence/dominance of *Achnanthidium* spp. However, in both the 2016 and 2017 northward migration studies, *Achnanthidium* spp. was sub-dominant in freshwater-dominated sites. The reason for these differences are not known at this time, but may be related to inter-annual differences in freshet conditions and potential subsequent influences on coastal hydrology patterns.

5.0 CONCLUSIONS

This study successfully enhanced and informed the understanding of biofilm ecology, community composition, distribution, and factors affecting biofilm parameter abundance and align with previous findings. Key findings of this study include:

- A large number of fatty acids (34) were documented in the biofilm community during the study. All fatty acids (except 6:0 and 8:0) were documented across Roberts Bank from freshwater-dominated to marine-influenced intertidal sites.
- Similar to 2016 results, fatty acids in greatest abundance were the SFAs myristic acid (14:0), and palmitic acid (16:0), the MUFAs palmitoleic acid (16:1n-7) and Oleic acid (18:1n-9) and the PUFAs EPA (20:5n-3), and DHA (22:6n-3). MUFA, PUFA, and SFA abundances were found at similar levels at freshwater-dominated and marine-influenced sites. MUFA and SFA comprised 73% and PUFA comprised 27% of total fatty acid levels. MUFA and SFA are the primary fatty acids used by WESA to fuel migration (comprising >95% of stored fats) and are available to foraging WESA across the salinity gradient. PUFA are believed to potentially facilitate long-distance flight and are also available across the salinity gradient.
- A consistent pattern in the levels of biofilm parameters was documented between stations, with periods of longer mudflat exposure time associated with higher biofilm parameter abundance. However, overall fatty acid levels were lower in 2017 compared to 2016 at many locations with reductions in total abundance ranging from approximately 80 to 440 mg/m^2 (9% to 40%). Larger reductions were documented in the marine/brackish Upper Intertidal area close to Brunswick Dyke and the Roberts Bank causeway compared to freshwater-dominated sites close to Canoe Passage.
- Abundances of all fatty acid types (i.e., MUFA, PUFA, SFA) and all individual fatty acids analysed (n = 12) either remained constant throughout the study or increased in the latter portion of the study. No decrease in fatty acid abundance was documented over the duration of the program.
- The biofilm parameter Chlorophyll *a*, which has been used in prior research to assess biofilm biomass, was statistically and positively correlated with the abundance of numerous fatty acids. This finding indicates the potential use of Chlorophyll *a* abundance as a proxy for assessing fatty acid abundances.
- Similar to 2016 results (Hemmera and Advisian 2017), MUFA and SFA levels were documented to be primarily driven by increases in mudflat exposure time, with some evidence that SFA abundance was affected by changes in water column salinity levels. Therefore, results suggest that MUFA and SFA abundance should be less influenced by the annual Fraser River freshet, which inputs large quantities of freshwater over Roberts Bank mudflats and should be annually abundant at freshwater-dominated and marine-influenced sites during WESA northward migration.
- In 2017, the weight of evidence indicates that PUFA abundance was most strongly influenced by mudflat exposure time, which differed from 2016 results indicating water column salinity as the primary driver of PUFA abundance. Reasons for this difference are unknown, but could be a result of interannual differences in weather conditions (there was 10 times more rain in 2017 compared to 2016) or freshet size (the 2017 freshet was smaller than 2016).

- Similar to 2016 results, SFA, MUFA, and PUFA were documented at all stations on all sampling events and were abundant at both freshwater-dominated and marine-water dominated locations.
- A large number of diatom genera (53) make up the biofilm community during WESA northward migration. However, similar to 2016, three genera (*Nitzschia*, *Navicula*., and *Achnanthidium*) dominate the community. In both years, the dominant genera were distributed across Roberts Bank, with no difference in community composition among sampling stations documented.
- The similarity in diatom community composition and fatty acid abundance between freshwater-dominated and marine-influenced sites may explain the previously documented high use of the Canoe Passage and Upper Intertidal areas by WESA during northward migration. As less saline sites have been documented to be physiologically less energy demanding to foraging shorebirds compared to more saline sites, it is possible that the freshwater-dominated Canoe Passage site represents higher quality habitat compared to the Upper Intertidal area close to Brunswick Dyke. Sites at Canoe Passage also tend to be further from shore, providing unobstructed views of the surroundings, and are likely safer foraging locations than the Upper Intertidal zone close to Brunswick Dyke.

Results from 2016 and 2017 increase the certainty in the predictions of potential effects of RBT2 on biofilm and WESA, and support the EIS conclusions that:

- Biofilm is abundant across the existing salinity gradient, being found in both freshwater- and marine-influenced locations;
- The Project is unlikely to affect the availability or quality of food available to shorebirds given biofilm's existing distribution and abundance in the LAA under highly variable freshet conditions that annually cause large variations in salinity;
- Biofilm at Roberts Bank with the Project in place will not be limiting for migrating WESA; and
- The Project will not change mudflat exposure, which is the dominant abiotic variable driving fatty acid abundance within biofilm at Roberts Bank.

6.0 CLOSURE

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7.0 STATEMENT OF LIMITATIONS

This Work was performed in accordance with the contract for Environmental Services for the Panel Phase of the Roberts Bank Terminal 2 Project between Hemmera Envirochem Inc. (“Hemmera”) and Vancouver Fraser Port Authority (“Client”), dated January 1, 2016 (“Contract”). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by Vancouver Fraser Port Authority. In performing this Work, Hemmera have relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

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APPENDIX A

Fatty Acid Methyl Ester Key

Appendix A List of Fatty Acids

Common Name	Isomer
Caproic acid	6:0
Caprylic acid	8:0
Capric acid	10:0
Undecylic acid	11:0
Lauric acid	12:0
Tridecylic acid	13:0
Myristic acid	14:0
Myristoleic acid	14:1
Pentadecanoic acid	15:0
-	15:1
Palmitic acid (PAM)	16:0
Palmitoleic acid	16:1n-7
Margaric acid	17:0
-	17:1
Stearic acid (STA)	18:0
Oleic acid (OLA)	18:1n-9
Linoleic acid (LNA)	18:2n-6
α-Linoleic acid (ALA)	18:3n-3
γ-Linoleic acid (GLA)	18:3n-6
Arachidic acid	20:0
-	20:1
-	20:2
Eicosatrienoic acid (ETE)	20:3n-3
Dihomo-γ-linolenic acid (DGLA)	20:3n-6
Arachidonic acid (ARA)	20:4n-6
Eicosapentaenoic acid (EPA)	20:5n-3
Heneicosylic acid	21:0
Behenic acid	22:0
Erucic acid	22:1n-9
Docosadienoic acid	22:2
Docosahexaenoic acid (DHA)	22:6n-3
Tricosylic acid	23:0
Lignoceric acid	24:0
Nervonic acid	24:1n-9

APPENDIX B

Biofilm Parameter Summary Statistics

Appendix B Summary Abundance Statistics of All Biofilm Parameters Sampled at Roberts Bank (April 26 to May 23, 2017).

Biofilm Parameter	N	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum	Percent of Total Fatty Acids
6:0	60	0.0	0.2	0.0	1.4	0%
8:0	60	0.0	0.0	0.0	0.3	0%
10:0	60	0.5	1.0	0.0	4.1	0%
11:0	60	1.5	1.3	0.0	5.0	0%
12:0	60	1.4	1.5	0.0	7.7	0%
13:0	60	1.8	1.7	0.0	8.6	0%
14:0	60	30.6	16.1	7.4	80.6	5%
14:1	60	10.0	13.7	0.0	59.3	2%
15:0	60	17.1	13.9	1.7	54.2	3%
15:1	60	4.1	3.7	0.0	15.0	1%
16:0	60	96.1	44.0	35.1	232.2	15%
16:1n-7	60	183.8	97.8	1.1	566.9	28%
17:0	60	8.2	5.4	0.9	20.0	1%
17:1	60	9.6	9.0	0.0	40.6	1%
18:0	60	17.8	8.6	4.4	40.4	3%
18:1n-9	60	33.6	23.1	1.0	86.9	5%
18:2n-6	60	8.2	6.1	0.3	27.5	1%
18:3n-3	60	4.4	4.2	0.0	19.5	1%
18:3n-6	60	5.0	3.3	0.0	15.1	1%
20:0	60	4.1	1.9	1.3	9.9	1%
20:1	60	6.1	4.6	0.0	20.2	1%
20:2	60	3.0	2.1	0.0	10.7	0%
20:3n-3	60	1.4	1.1	0.0	5.7	0%
20:3n-6	60	2.9	2.0	0.0	9.5	0%
20:4n-6	60	2.0	2.2	0.0	12.0	0%
20:5n-3	60	124.9	63.9	0.5	269.1	19%
21:0	60	1.2	1.1	0.0	7.2	0%
22:0	60	5.8	3.2	0.8	14.1	1%
22:1n-9	60	2.6	2.1	0.2	11.1	0%
22:2	60	2.1	1.3	0.1	6.6	0%
22:6n-3	60	27.4	15.9	0.1	70.4	4%
23:0	60	21.7	13.6	0.0	57.3	3%
24:0	60	10.8	5.2	3.2	29.9	2%
24:1n-9	60	1.2	1.2	0.0	5.6	0%

Biofilm Parameter	N	Mean (mg/m^2)	Standard Deviation	Minimum	Maximum	Percent of Total Fatty Acids
Total Fatty Acids	60	650.7	307.9	94.1	1600.5	100%
Total SFA	60	218.5	96.2	68.5	478.3	34%
Total MUFA	60	251.0	132.2	3.0	750.5	39%
Total PUFA	60	181.2	94.2	1.5	412.8	28%
Total Omega 3	60	158.1	82.3	1.0	358.2	24%
Total Omega 6	60	18.0	11.6	0.4	49.4	3%
Chlorophyll a	119	57.0	15.8	28.7	107.5	
Carbohydrates	60	8026.1	4134.6	2115.6	24943.9	

APPENDIX C

Biofilm Parameter Summary Statistics by Station

Appendix C Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).

Station: A						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	11	0.0	0.0	0.0	0.0	0%
8:0	11	0.0	0.0	0.0	0.0	0%
10:0	11	1.0	1.4	0.0	4.1	0%
11:0	11	1.7	1.6	0.0	5.0	0%
12:0	11	1.5	1.6	0.0	5.1	0%
13:0	11	1.9	0.9	0.7	3.6	0%
14:0	11	33.6	10.7	17.9	44.7	5%
14:1	11	15.9	20.4	0.0	59.3	2%
15:0	11	31.6	11.6	11.1	54.2	5%
15:1	11	6.5	2.2	2.3	10.6	1%
16:0	11	89.7	30.2	44.7	139.1	14%
16:1n-7	11	157.9	57.7	70.2	235.3	24%
17:0	11	14.0	4.1	7.7	19.6	2%
17:1	11	13.4	6.0	2.7	22.6	2%
18:0	11	22.1	7.9	10.4	35.2	3%
18:1n-9	11	34.7	24.9	6.7	79.6	5%
18:2n-6	11	8.4	5.1	2.1	19.5	1%
18:3n-3	11	2.7	1.5	0.0	4.3	0%
18:3n-6	11	4.7	2.0	2.0	8.8	1%
20:0	11	4.4	1.7	1.8	7.7	1%
20:1	11	9.0	5.6	3.3	20.2	1%
20:2	11	2.5	1.0	1.2	4.1	0%
20:3n-3	11	1.9	1.4	0.5	5.0	0%
20:3n-6	11	3.7	1.8	0.7	6.6	1%
20:4n-6	11	2.6	1.8	0.5	5.6	0%
20:5n-3	11	113.1	48.5	50.5	196.9	17%
21:0	11	1.0	0.7	0.0	2.2	0%
22:0	11	5.7	2.9	2.0	12.7	1%
22:1n-9	11	3.5	1.6	1.1	6.4	1%
22:2	11	2.2	1.3	0.8	5.1	0%
22:6n-3	11	20.9	10.8	8.2	44.7	3%
23:0	11	23.5	10.1	9.1	36.5	4%
24:0	11	12.1	7.3	3.9	29.9	2%

Station: A						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	11	1.0	1.1	0.0	3.2	0%
Total Fatty Acids	11	648	214	331	1014	100%
Total SFA	11	244	80	117	364	38%
Total MUFA	11	242	78	119	352	37%
Total PUFA	11	163	70	73	297	25%
Total Omega 3	11	139	59	60	249	21%
Total Omega 6	11	19	9	8	40	3%
Chlorophyll a	21	45	10	29	63	
Carbohydrates	11	7905	4026	2717	15060	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: C						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	8	0.0	0.0	0.0	0.0	0%
8:0	8	0.0	0.0	0.0	0.0	0%
10:0	8	0.5	0.4	0.0	1.3	0%
11:0	8	1.5	0.2	1.1	1.9	0%
12:0	8	1.4	0.4	0.8	2.1	0%
13:0	8	1.4	0.5	1.0	2.4	0%
14:0	8	34.4	10.7	12.8	50.3	4%
14:1	8	15.3	10.4	1.2	30.6	2%
15:0	8	16.1	8.4	5.7	33.3	2%
15:1	8	4.0	1.3	1.9	5.6	1%
16:0	8	93.9	34.6	44.5	128.7	12%
16:1n-7	8	209.1	66.9	60.1	272.9	26%
17:0	8	12.9	4.5	5.5	20.0	2%
17:1	8	5.4	2.9	3.0	11.8	1%
18:0	8	25.9	9.4	11.3	40.4	3%
18:1n-9	8	56.3	23.9	7.8	86.9	7%
18:2n-6	8	10.1	7.3	1.0	18.1	1%
18:3n-3	8	4.0	1.3	2.2	6.3	1%
18:3n-6	8	7.1	2.5	2.9	10.1	1%
20:0	8	5.5	1.6	2.9	7.5	1%
20:1	8	9.3	3.3	3.7	14.0	1%
20:2	8	3.5	1.9	1.8	7.1	0%
20:3n-3	8	1.5	0.7	0.2	2.7	0%
20:3n-6	8	4.7	1.5	1.7	6.7	1%
20:4n-6	8	3.5	4.0	0.0	12.0	0%
20:5n-3	8	162.9	46.7	59.3	198.1	21%
21:0	8	1.2	0.4	0.8	1.9	0%
22:0	8	6.9	2.1	3.5	10.9	1%
22:1n-9	8	4.1	1.6	1.9	6.0	1%
22:2	8	2.3	0.6	1.5	3.1	0%
22:6n-3	8	36.0	13.6	14.6	54.8	5%
23:0	8	38.2	15.0	10.7	57.3	5%
24:0	8	13.3	4.1	5.6	18.4	2%

Station: C						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	8	1.0	0.7	0.0	2.0	0%
Total Fatty Acids	8	793	228	281	1015	100%
Total SFA	8	253	73	109	344	32%
Total MUFA	8	304	97	82	391	38%
Total PUFA	8	236	69	90	303	30%
Total Omega 3	8	204	60	78	259	26%
Total Omega 6	8	26	12	8	44	3%
Chlorophyll a	16	66	16	35	97	
Carbohydrates	8	9832	3273	4272	15225	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: H						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	8	0.0	0.0	0.0	0.0	0%
8:0	8	0.0	0.0	0.0	0.0	0%
10:0	8	0.3	0.7	0.0	2.0	0%
11:0	8	2.6	1.6	0.0	4.6	0%
12:0	8	1.8	1.3	0.0	3.8	0%
13:0	8	3.4	2.8	0.0	8.6	0%
14:0	8	39.0	16.6	10.9	59.7	5%
14:1	8	10.0	11.0	0.0	29.2	1%
15:0	8	16.8	7.0	8.5	28.7	2%
15:1	8	3.8	2.0	0.0	6.0	0%
16:0	8	107.5	30.1	50.7	142.8	14%
16:1n-7	8	198.0	50.6	95.7	269.6	26%
17:0	8	6.3	2.9	2.0	10.3	1%
17:1	8	10.7	6.0	4.0	22.3	1%
18:0	8	17.8	6.5	8.6	27.7	2%
18:1n-9	8	43.6	20.7	12.7	73.0	6%
18:2n-6	8	10.3	9.0	1.2	27.5	1%
18:3n-3	8	7.5	5.7	1.3	15.4	1%
18:3n-6	8	4.8	2.8	0.4	8.4	1%
20:0	8	5.3	1.3	2.8	7.1	1%
20:1	8	4.6	2.3	1.0	7.2	1%
20:2	8	3.7	3.6	0.0	10.7	0%
20:3n-3	8	1.6	0.9	0.6	3.5	0%
20:3n-6	8	2.0	1.4	0.0	4.2	0%
20:4n-6	8	2.0	2.8	0.0	6.6	0%
20:5n-3	8	170.8	64.2	42.5	269.1	22%
21:0	8	1.9	2.2	0.0	7.2	0%
22:0	8	8.2	3.6	2.9	13.2	1%
22:1n-9	8	3.8	3.9	0.9	11.1	1%
22:2	8	3.3	1.9	1.5	6.6	0%
22:6n-3	8	43.6	17.7	10.2	70.4	6%
23:0	8	14.8	6.5	3.7	23.6	2%
24:0	8	11.4	3.6	6.0	14.7	1%

Station: H						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	8	2.5	1.8	0.0	5.6	0%
Total Fatty Acids	8	764	250	276	1132	100%
Total SFA	8	237	73	98	333	31%
Total MUFA	8	277	80	118	386	36%
Total PUFA	8	250	102	61	413	33%
Total Omega 3	8	224	86	58	358	29%
Total Omega 6	8	19	15	2	47	2%
Chlorophyll a	16	60	17	42	98	
Carbohydrates	8	8120	3341	3838	12685	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: I						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	9	0.2	0.5	0.0	1.4	0%
8:0	9	0.0	0.1	0.0	0.3	0%
10:0	9	1.2	1.5	0.0	3.6	0%
11:0	9	1.8	1.2	0.0	3.9	0%
12:0	9	2.3	1.7	0.0	5.1	0%
13:0	9	3.1	2.0	1.1	5.7	0%
14:0	9	40.1	22.9	18.3	80.6	5%
14:1	9	13.1	19.5	0.0	49.3	2%
15:0	9	28.3	17.6	12.6	50.9	3%
15:1	9	8.7	5.3	2.6	15.0	1%
16:0	9	89.2	64.0	35.1	232.2	11%
16:1n-7	9	268.8	139.7	157.1	566.9	33%
17:0	9	9.3	5.6	3.8	16.9	1%
17:1	9	22.0	13.5	7.7	40.6	3%
18:0	9	18.1	8.8	9.1	29.1	2%
18:1n-9	9	38.3	22.6	15.3	70.2	5%
18:2n-6	9	7.4	4.5	2.0	14.0	1%
18:3n-3	9	9.7	5.8	1.7	19.5	1%
18:3n-6	9	5.7	3.7	0.6	11.1	1%
20:0	9	4.1	1.9	1.7	7.3	1%
20:1	9	7.1	4.9	3.1	17.4	1%
20:2	9	4.0	2.3	0.0	7.9	0%
20:3n-3	9	1.5	1.0	0.2	3.2	0%
20:3n-6	9	2.6	1.6	0.0	4.7	0%
20:4n-6	9	2.4	1.4	0.0	4.7	0%
20:5n-3	9	151.3	66.8	69.8	262.7	19%
21:0	9	1.0	0.6	0.0	1.7	0%
22:0	9	6.6	3.6	3.4	12.1	1%
22:1n-9	9	2.0	1.0	1.0	3.6	0%
22:2	9	2.8	1.1	1.6	4.7	0%
22:6n-3	9	33.2	14.3	13.7	55.7	4%
23:0	9	18.7	11.9	3.4	36.4	2%
24:0	9	9.8	5.2	4.8	18.5	1%

Station: I						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	9	1.2	0.9	0.0	3.0	0%
Total Fatty Acids	9	815.6	407.3	464.5	1600.5	100%
Total SFA	9	233.7	132.8	113.9	478.3	29%
Total MUFA	9	361.4	188.9	208.8	750.5	44%
Total PUFA	9	220.6	95.9	95.4	371.7	27%
Total Omega 3	9	195.7	85.0	90.1	332.9	24%
Total Omega 6	9	18.1	9.1	3.6	33.3	2%
Chlorophyll a	18	71.2	15.0	58.2	107.5	
Carbohydrates	9	10006.0	3881.3	5344.2	15851.4	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: J						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	8	0.0	0.0	0.0	0.0	0%
8:0	8	0.0	0.0	0.0	0.0	0%
10:0	8	0.0	0.0	0.0	0.0	0%
11:0	8	0.5	0.7	0.0	1.8	0%
12:0	8	1.5	2.6	0.3	7.7	0%
13:0	8	0.8	1.4	0.0	4.1	0%
14:0	8	23.2	16.5	8.1	52.4	5%
14:1	8	1.5	2.2	0.0	5.5	0%
15:0	8	6.4	7.1	1.7	19.5	1%
15:1	8	1.3	2.5	0.0	7.0	0%
16:0	8	102.5	66.9	38.1	232.0	22%
16:1n-7	8	122.4	108.4	1.1	306.5	26%
17:0	8	4.2	3.2	1.6	10.8	1%
17:1	8	3.4	4.4	0.0	13.1	1%
18:0	8	13.8	7.7	4.7	29.6	3%
18:1n-9	8	18.9	18.8	1.0	61.5	4%
18:2n-6	8	6.9	7.8	0.3	24.8	1%
18:3n-3	8	2.6	2.1	0.1	6.7	1%
18:3n-6	8	3.9	4.9	0.0	15.1	1%
20:0	8	3.6	2.7	1.3	9.9	1%
20:1	8	4.0	4.8	0.4	14.4	1%
20:2	8	2.5	2.8	0.0	9.0	1%
20:3n-3	8	1.2	1.9	0.0	5.7	0%
20:3n-6	8	2.4	3.0	0.1	9.5	1%
20:4n-6	8	1.1	1.8	0.0	5.1	0%
20:5n-3	8	83.1	67.2	0.5	188.6	18%
21:0	8	1.5	1.4	0.1	3.8	0%
22:0	8	5.0	4.1	2.4	14.1	1%
22:1n-9	8	1.4	1.4	0.3	4.6	0%
22:2	8	1.4	1.0	0.1	3.1	0%
22:6n-3	8	19.6	16.3	0.1	45.4	4%
23:0	8	16.2	14.9	0.0	42.7	3%
24:0	8	11.3	6.0	4.0	22.9	2%

Station: J						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	8	0.8	1.6	0.0	4.6	0%
Total Fatty Acids	8	469	369	94	1174	100%
Total SFA	8	190	131	73	449	41%
Total MUFA	8	154	139	3	417	33%
Total PUFA	8	125	105	1	308	27%
Total Omega 3	8	107	87	1	246	23%
Total Omega 6	8	14	16	0	49	3%
Chlorophyll a	16	53	11	39	83	
Carbohydrates	8	7961	6960	3415	24944	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: X						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	8	0.0	0.0	0.0	0.0	0%
8:0	8	0.0	0.0	0.0	0.0	0%
10:0	8	0.0	0.0	0.0	0.0	0%
11:0	8	0.6	0.8	0.0	2.0	0%
12:0	8	0.5	0.5	0.0	1.5	0%
13:0	8	0.5	0.3	0.0	0.8	0%
14:0	8	16.7	11.2	7.4	37.0	4%
14:1	8	4.0	6.1	0.0	15.9	1%
15:0	8	4.6	3.8	1.7	11.4	1%
15:1	8	0.6	1.0	0.0	2.7	0%
16:0	8	85.3	49.5	37.6	162.6	21%
16:1n-7	8	131.8	114.9	8.1	317.6	32%
17:0	8	2.4	1.3	0.9	4.5	1%
17:1	8	2.5	2.7	0.0	6.8	1%
18:0	8	10.0	5.8	4.4	18.3	2%
18:1n-9	8	12.1	6.3	3.2	19.5	3%
18:2n-6	8	4.2	3.0	0.4	10.0	1%
18:3n-3	8	1.8	1.0	0.1	3.4	0%
18:3n-6	8	3.2	3.0	0.0	8.7	1%
20:0	8	2.9	1.3	1.5	5.0	1%
20:1	8	1.8	1.6	0.0	4.4	0%
20:2	8	1.6	0.8	0.0	2.7	0%
20:3n-3	8	0.7	0.2	0.4	1.0	0%
20:3n-6	8	1.5	1.0	0.1	3.2	0%
20:4n-6	8	0.8	0.8	0.0	1.9	0%
20:5n-3	8	76.7	59.9	2.1	160.9	19%
21:0	8	0.9	0.5	0.0	1.6	0%
22:0	8	3.6	2.0	0.8	6.8	1%
22:1n-9	8	1.2	0.6	0.2	2.1	0%
22:2	8	1.1	0.5	0.1	1.8	0%
22:6n-3	8	14.4	12.6	0.2	34.5	3%
23:0	8	15.0	13.4	1.0	36.9	4%
24:0	8	9.0	5.6	3.2	17.4	2%

Station: X						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	8	0.7	0.5	0.0	1.3	0%
Total Fatty Acids	8	413	295	152	875	100%
Total SFA	8	152	91	68	293	37%
Total MUFA	8	155	131	13	369	38%
Total PUFA	8	106	81	4	222	26%
Total Omega 3	8	94	73	3	200	23%
Total Omega 6	8	10	8	1	24	2%
Chlorophyll a	16	55	15	30	81	
Carbohydrates	8	5626	2757	2116	10248	

Appendix C (cont.) **Summary Statistics of All Biofilm Parameters at Roberts Bank by Station (April 26 to May 23, 2017).**

Station: Y						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
6:0	8	0.0	0.0	0.0	0.0	0%
8:0	8	0.0	0.0	0.0	0.0	0%
10:0	8	0.1	0.1	0.0	0.4	0%
11:0	8	1.4	1.2	0.0	3.7	0%
12:0	8	0.8	1.2	0.0	3.8	0%
13:0	8	1.2	0.9	0.0	2.6	0%
14:0	8	24.8	8.6	12.0	38.1	4%
14:1	8	7.8	6.3	0.0	20.4	1%
15:0	8	9.2	4.1	4.8	16.5	1%
15:1	8	2.2	1.3	0.0	4.1	0%
16:0	8	107.6	26.0	67.8	144.0	17%
16:1n-7	8	197.8	50.5	124.3	278.4	31%
17:0	8	6.0	1.8	3.5	8.0	1%
17:1	8	7.1	2.9	2.5	11.0	1%
18:0	8	15.6	4.1	10.3	21.5	2%
18:1n-9	8	30.6	10.3	17.5	49.2	5%
18:2n-6	8	9.9	4.3	2.8	14.8	2%
18:3n-3	8	2.5	0.4	1.9	3.1	0%
18:3n-6	8	5.5	3.0	0.5	9.1	1%
20:0	8	3.2	0.8	2.1	4.6	1%
20:1	8	5.9	3.4	1.5	11.1	1%
20:2	8	3.1	1.0	1.5	4.7	0%
20:3n-3	8	0.9	0.7	0.2	2.5	0%
20:3n-6	8	3.1	2.0	0.0	6.0	0%
20:4n-6	8	1.2	1.0	0.0	2.7	0%
20:5n-3	8	117.4	40.1	54.0	196.2	19%
21:0	8	0.8	0.6	0.0	1.6	0%
22:0	8	4.4	1.6	2.2	7.0	1%
22:1n-9	8	1.6	0.6	0.9	2.9	0%
22:2	8	1.6	0.5	0.8	2.7	0%
22:6n-3	8	25.8	7.0	10.8	34.7	4%
23:0	8	24.9	10.5	10.3	41.9	4%
24:0	8	8.6	2.7	5.4	11.9	1%

Station: Y						
Biofilm Parameter	**N**	**Mean (mg/m^2)**	**Standard Deviation**	**Minimum**	**Maximum**	**Percent of Total Fatty Acids**
24:1n-9	8	0.9	1.1	0.0	2.7	0%
Total Fatty Acids	8	633	177	345	897	100%
Total SFA	8	209	60	122	279	33%
Total MUFA	8	254	67	149	352	40%
Total PUFA	8	171	55	75	269	27%
Total Omega 3	8	147	47	68	234	23%
Total Omega 6	8	20	9	3	32	3%
Chlorophyll a	16	51	9	35	64	
Carbohydrates	8	6532	2802	3453	12268	

APPENDIX D

AIC_c Model Results

Appendix D AIC_c Model Results for Chlorophyll *a* at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	251.46	13.12	0.00
2	95th Percentile Salinity	248.18	9.85	0.00
3	5th Percentile Temperature	248.63	10.29	0.00
4	95th Percentile Temperature	249.26	10.93	0.00
5	Percent Time Mudflats Exposed	251.63	13.30	0.00
6	5th Percentile Salinity + 95th Percentile Salinity	249.42	11.09	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	245.00	6.67	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	251.20	12.87	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	251.72	13.39	0.00
10	95th Percentile Salinity + 5th Percentile Temperature	239.47	1.13	0.12
11	95th Percentile Salinity + 95th Percentile Temperature	247.81	9.48	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	240.82	2.48	0.06
13	5th Percentile Temperature + 95th Percentile Temperature	246.63	8.30	0.00
14	5th Percentile Temperature + Percent Time Mudflats Exposed	250.89	12.55	0.00
15	95th Percentile Temperature + Percent Time Mudflats Exposed	250.87	12.53	0.00
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	238.34	0.00	0.21
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	250.17	11.83	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	243.23	4.90	0.02
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	246.50	8.16	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	247.52	9.18	0.00
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	252.75	14.41	0.00
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	240.54	2.21	0.07
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	238.50	0.16	0.20
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	243.38	5.04	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	249.13	10.79	0.00
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	240.83	2.49	0.06
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	239.41	1.07	0.12
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	245.84	7.51	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	248.86	10.52	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	241.02	2.68	0.06
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	242.06	3.72	0.03

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Total Carbohydrates at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	509.29	3.40	0.04
2	95th Percentile Salinity	509.73	3.84	0.04
3	5th Percentile Temperature	508.98	3.09	0.05
4	95th Percentile Temperature	509.43	3.54	0.04
5	Percent Time Mudflats Exposed	505.89	0.00	0.24
6	5th Percentile Salinity + 95th Percentile Salinity	512.54	6.65	0.01
7	5th Percentile Salinity + 5th Percentile Temperature	511.95	6.06	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	512.43	6.54	0.01
9	5th Percentile Salinity + Percent Time Mudflats Exposed	508.29	2.40	0.07
10	95th Percentile Salinity + 5th Percentile Temperature	512.24	6.35	0.01
11	95th Percentile Salinity + 95th Percentile Temperature	512.67	6.78	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	508.76	2.87	0.06
13	5th Percentile Temperature + 95th Percentile Temperature	511.67	5.78	0.01
14	5th Percentile Temperature + Percent Time Mudflats Exposed	509.10	3.21	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	507.21	1.32	0.12
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	515.35	9.46	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	515.84	9.95	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	510.67	4.78	0.02
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	515.04	9.15	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	511.39	5.51	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	510.49	4.60	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	515.02	9.13	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	512.14	6.25	0.01
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	508.18	2.29	0.08
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	510.53	4.64	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	518.55	12.66	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	513.89	8.00	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	511.35	5.46	0.02
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	513.87	7.98	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	511.71	5.82	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	514.90	9.01	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Total Fatty Acids at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	796.17	10.61	0.00
2	95th Percentile Salinity	796.25	10.69	0.00
3	5th Percentile Temperature	787.81	2.25	0.07
4	95th Percentile Temperature	793.29	7.74	0.00
5	Percent Time Mudflats Exposed	785.56	0.00	0.23
6	5th Percentile Salinity + 95th Percentile Salinity	799.39	13.83	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	791.01	5.45	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	794.76	9.20	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	788.26	2.71	0.06
10	95th Percentile Salinity + 5th Percentile Temperature	790.70	5.14	0.02
11	95th Percentile Salinity + 95th Percentile Temperature	795.82	10.26	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	787.18	1.62	0.10
13	5th Percentile Temperature + 95th Percentile Temperature	788.91	3.35	0.04
14	5th Percentile Temperature + Percent Time Mudflats Exposed	786.76	1.20	0.12
15	95th Percentile Temperature + Percent Time Mudflats Exposed	788.16	2.60	0.06
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	794.10	8.54	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	797.76	12.20	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	788.93	3.38	0.04
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	792.02	6.46	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	790.08	4.52	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	790.06	4.50	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	792.31	6.75	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	788.15	2.60	0.06
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	790.55	5.00	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	789.34	3.79	0.03
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	795.57	10.02	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	791.01	5.45	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	792.08	6.52	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	792.29	6.74	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	791.68	6.12	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	794.45	8.89	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Total Saturated Fatty Acids (SFA) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	281.28	13.38	0.00
2	95th Percentile Salinity	281.68	13.79	0.00
3	5th Percentile Temperature	271.60	3.71	0.03
4	95th Percentile Temperature	279.88	11.99	0.00
5	Percent Time Mudflats Exposed	267.89	0.00	0.17
6	5th Percentile Salinity + 95th Percentile Salinity	284.53	16.64	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	274.86	6.97	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	281.10	13.21	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	269.96	2.06	0.06
10	95th Percentile Salinity + 5th Percentile Temperature	274.18	6.29	0.01
11	95th Percentile Salinity + 95th Percentile Temperature	282.77	14.88	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	268.38	0.49	0.14
13	5th Percentile Temperature + 95th Percentile Temperature	273.80	5.91	0.01
14	5th Percentile Temperature + Percent Time Mudflats Exposed	268.88	0.99	0.11
15	95th Percentile Temperature + Percent Time Mudflats Exposed	271.10	3.20	0.04
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	277.56	9.67	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	284.37	16.48	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	268.41	0.51	0.13
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	276.90	9.01	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	271.86	3.97	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	272.74	4.85	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	276.96	9.07	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	268.96	1.06	0.10
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	271.29	3.40	0.03
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	272.18	4.29	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	280.18	12.29	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	270.57	2.68	0.05
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	271.97	4.07	0.02
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	274.97	7.08	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	272.06	4.17	0.02
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	274.27	6.37	0.01

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Myristic Acid (14:0) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	195.19	16.69	0.00
2	95th Percentile Salinity	195.23	16.73	0.00
3	5th Percentile Temperature	186.22	7.72	0.01
4	95th Percentile Temperature	190.57	12.07	0.00
5	Percent Time Mudflats Exposed	180.78	2.28	0.10
6	5th Percentile Salinity + 95th Percentile Salinity	198.40	19.91	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	188.25	9.75	0.00
8	5th Percentile Salinity + 95th Percentile Temperature	193.36	14.86	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	184.03	5.53	0.02
10	95th Percentile Salinity + 5th Percentile Temperature	187.74	9.24	0.00
11	95th Percentile Salinity + 95th Percentile Temperature	193.70	15.21	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	178.50	0.00	0.32
13	5th Percentile Temperature + 95th Percentile Temperature	185.74	7.24	0.01
14	5th Percentile Temperature + Percent Time Mudflats Exposed	182.46	3.97	0.04
15	95th Percentile Temperature + Percent Time Mudflats Exposed	182.69	4.19	0.04
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	190.44	11.95	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	196.71	18.22	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	181.21	2.71	0.08
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	189.10	10.61	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	185.63	7.14	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	185.84	7.35	0.01
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	188.64	10.14	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	179.62	1.12	0.18
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	181.91	3.41	0.06
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	184.30	5.81	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	192.19	13.70	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	183.05	4.55	0.03
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	184.70	6.21	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	187.88	9.38	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	183.20	4.70	0.03
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	186.77	8.28	0.01

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates. The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Palmitic Acid (PAM, 16:0) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	233.04	9.28	0.00
2	95th Percentile Salinity	233.48	9.72	0.00
3	5th Percentile Temperature	223.76	0.00	0.20
4	95th Percentile Temperature	233.50	9.74	0.00
5	Percent Time Mudflats Exposed	224.45	0.69	0.14
6	5th Percentile Salinity + 95th Percentile Salinity	236.08	12.32	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	226.90	3.15	0.04
8	5th Percentile Salinity + 95th Percentile Temperature	234.67	10.91	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	225.90	2.14	0.07
10	95th Percentile Salinity + 5th Percentile Temperature	226.97	3.21	0.04
11	95th Percentile Salinity + 95th Percentile Temperature	235.82	12.06	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	227.26	3.51	0.04
13	5th Percentile Temperature + 95th Percentile Temperature	226.92	3.16	0.04
14	5th Percentile Temperature + Percent Time Mudflats Exposed	224.18	0.42	0.16
15	95th Percentile Temperature + Percent Time Mudflats Exposed	227.61	3.85	0.03
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	230.22	6.47	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	237.54	13.78	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	227.79	4.03	0.03
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	230.02	6.26	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	226.94	3.18	0.04
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	229.22	5.46	0.01
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	230.31	6.56	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	226.89	3.13	0.04
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	230.10	6.34	0.01
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	227.54	3.79	0.03
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	233.57	9.82	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	229.09	5.33	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	231.31	7.56	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	230.49	6.74	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	229.92	6.16	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	232.71	8.95	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Stearic Acid (STA, 18:0) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	388.01	7.89	0.01
2	95th Percentile Salinity	386.86	6.75	0.01
3	5th Percentile Temperature	385.21	5.09	0.03
4	95th Percentile Temperature	385.63	5.51	0.02
5	Percent Time Mudflats Exposed	382.70	2.58	0.10
6	5th Percentile Salinity + 95th Percentile Salinity	390.04	9.92	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	388.29	8.17	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	388.36	8.24	0.01
9	5th Percentile Salinity + Percent Time Mudflats Exposed	385.93	5.81	0.02
10	95th Percentile Salinity + 5th Percentile Temperature	385.61	5.49	0.02
11	95th Percentile Salinity + 95th Percentile Temperature	388.44	8.32	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	380.12	0.00	0.35
13	5th Percentile Temperature + 95th Percentile Temperature	386.63	6.51	0.01
14	5th Percentile Temperature + Percent Time Mudflats Exposed	385.70	5.58	0.02
15	95th Percentile Temperature + Percent Time Mudflats Exposed	385.19	5.07	0.03
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	389.02	8.90	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	391.11	10.99	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	382.29	2.17	0.12
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	389.96	9.84	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	389.11	8.99	0.00
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	388.22	8.10	0.01
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	388.31	8.20	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	383.00	2.88	0.08
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	383.39	3.27	0.07
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	388.28	8.16	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	391.75	11.63	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	385.71	5.59	0.02
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	385.87	5.75	0.02
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	391.65	11.53	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	386.44	6.32	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	389.46	9.34	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Behenic acid (22:0) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	104.15	2.66	0.05
2	95th Percentile Salinity	105.19	3.70	0.03
3	5th Percentile Temperature	102.49	1.00	0.12
4	95th Percentile Temperature	105.13	3.64	0.03
5	Percent Time Mudflats Exposed	101.49	0.00	0.20
6	5th Percentile Salinity + 95th Percentile Salinity	107.40	5.92	0.01
7	5th Percentile Salinity + 5th Percentile Temperature	105.24	3.76	0.03
8	5th Percentile Salinity + 95th Percentile Temperature	107.38	5.90	0.01
9	5th Percentile Salinity + Percent Time Mudflats Exposed	103.18	1.69	0.09
10	95th Percentile Salinity + 5th Percentile Temperature	105.67	4.18	0.03
11	95th Percentile Salinity + 95th Percentile Temperature	108.37	6.88	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	104.28	2.80	0.05
13	5th Percentile Temperature + 95th Percentile Temperature	105.42	3.94	0.03
14	5th Percentile Temperature + Percent Time Mudflats Exposed	104.22	2.74	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	103.65	2.16	0.07
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	108.44	6.96	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	110.79	9.31	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	105.13	3.64	0.03
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	108.59	7.10	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	106.47	4.99	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	106.27	4.79	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	108.57	7.09	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	107.09	5.60	0.01
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	105.06	3.58	0.03
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	106.62	5.13	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	111.86	10.38	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	108.62	7.13	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	107.30	5.82	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	109.69	8.21	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	108.06	6.58	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	110.89	9.41	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates. The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Total Monounsaturated Fatty Acids (MUFA) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	450.28	12.25	0.00
2	95th Percentile Salinity	449.44	11.40	0.00
3	5th Percentile Temperature	442.33	4.29	0.04
4	95th Percentile Temperature	446.24	8.21	0.01
5	Percent Time Mudflats Exposed	438.03	0.00	0.32
6	5th Percentile Salinity + 95th Percentile Salinity	452.62	14.59	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	445.14	7.11	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	448.49	10.45	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	441.19	3.16	0.07
10	95th Percentile Salinity + 5th Percentile Temperature	445.57	7.53	0.01
11	95th Percentile Salinity + 95th Percentile Temperature	446.84	8.81	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	440.91	2.87	0.08
13	5th Percentile Temperature + 95th Percentile Temperature	442.48	4.45	0.03
14	5th Percentile Temperature + Percent Time Mudflats Exposed	439.88	1.85	0.13
15	95th Percentile Temperature + Percent Time Mudflats Exposed	440.19	2.16	0.11
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	448.47	10.44	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	449.69	11.66	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	443.99	5.96	0.02
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	445.85	7.82	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	443.28	5.25	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	442.84	4.81	0.03
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	445.25	7.22	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	442.77	4.74	0.03
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	443.59	5.56	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	442.00	3.97	0.04
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	448.80	10.77	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	446.31	8.28	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	446.35	8.32	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	445.34	7.31	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	445.54	7.51	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	449.03	11.00	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Palmitoleic Acid (16:1n-7) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	431.43	13.25	0.00
2	95th Percentile Salinity	430.05	11.88	0.00
3	5th Percentile Temperature	424.79	6.61	0.01
4	95th Percentile Temperature	427.11	8.93	0.00
5	Percent Time Mudflats Exposed	418.18	0.00	0.37
6	5th Percentile Salinity + 95th Percentile Salinity	432.38	14.21	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	426.54	8.37	0.01
8	5th Percentile Salinity + 95th Percentile Temperature	430.17	12.00	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	421.35	3.17	0.07
10	95th Percentile Salinity + 5th Percentile Temperature	427.69	9.52	0.00
11	95th Percentile Salinity + 95th Percentile Temperature	425.93	7.76	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	421.37	3.20	0.07
13	5th Percentile Temperature + 95th Percentile Temperature	424.36	6.18	0.02
14	5th Percentile Temperature + Percent Time Mudflats Exposed	420.70	2.53	0.10
15	95th Percentile Temperature + Percent Time Mudflats Exposed	420.08	1.90	0.14
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	429.13	10.95	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	429.34	11.16	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	424.73	6.56	0.01
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	427.64	9.47	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	423.75	5.57	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	423.43	5.26	0.03
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	425.84	7.66	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	424.01	5.84	0.02
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	423.34	5.16	0.03
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	422.62	4.44	0.04
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	429.21	11.03	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	427.31	9.14	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	426.88	8.71	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	426.19	8.01	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	426.07	7.90	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	429.81	11.64	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Oleic acid (OLA, 18:1n-9) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	232.65	0.57	0.13
2	95th Percentile Salinity	233.67	1.59	0.08
3	5th Percentile Temperature	232.08	0.00	0.17
4	95th Percentile Temperature	233.69	1.61	0.08
5	Percent Time Mudflats Exposed	233.17	1.09	0.10
6	5th Percentile Salinity + 95th Percentile Salinity	235.32	3.25	0.03
7	5th Percentile Salinity + 5th Percentile Temperature	234.64	2.56	0.05
8	5th Percentile Salinity + 95th Percentile Temperature	234.93	2.85	0.04
9	5th Percentile Salinity + Percent Time Mudflats Exposed	235.05	2.97	0.04
10	95th Percentile Salinity + 5th Percentile Temperature	234.58	2.50	0.05
11	95th Percentile Salinity + 95th Percentile Temperature	236.84	4.76	0.02
12	95th Percentile Salinity + Percent Time Mudflats Exposed	235.68	3.60	0.03
13	5th Percentile Temperature + 95th Percentile Temperature	235.29	3.21	0.03
14	5th Percentile Temperature + Percent Time Mudflats Exposed	235.32	3.25	0.03
15	95th Percentile Temperature + Percent Time Mudflats Exposed	236.41	4.33	0.02
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	236.86	4.78	0.02
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	237.99	5.91	0.01
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	236.55	4.47	0.02
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	237.53	5.45	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	237.94	5.86	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	237.92	5.84	0.01
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	237.99	5.91	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	237.82	5.74	0.01
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	238.97	6.89	0.01
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	238.69	6.61	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	240.24	8.16	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	239.67	7.60	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	240.09	8.01	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	241.07	8.99	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	241.29	9.21	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	243.42	11.34	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for 20:1 at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	136.84	2.23	0.08
2	95th Percentile Salinity	136.82	2.20	0.08
3	5th Percentile Temperature	136.73	2.11	0.08
4	95th Percentile Temperature	136.81	2.19	0.08
5	Percent Time Mudflats Exposed	134.61	0.00	0.23
6	5th Percentile Salinity + 95th Percentile Salinity	140.07	5.45	0.02
7	5th Percentile Salinity + 5th Percentile Temperature	139.98	5.37	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	140.06	5.45	0.02
9	5th Percentile Salinity + Percent Time Mudflats Exposed	137.84	3.22	0.05
10	95th Percentile Salinity + 5th Percentile Temperature	139.91	5.29	0.02
11	95th Percentile Salinity + 95th Percentile Temperature	140.01	5.40	0.02
12	95th Percentile Salinity + Percent Time Mudflats Exposed	137.06	2.45	0.07
13	5th Percentile Temperature + 95th Percentile Temperature	139.92	5.31	0.02
14	5th Percentile Temperature + Percent Time Mudflats Exposed	137.53	2.91	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	137.33	2.72	0.06
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	143.31	8.70	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	143.42	8.81	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	140.20	5.58	0.01
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	143.31	8.69	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	140.79	6.17	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	140.72	6.10	0.01
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	143.19	8.57	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	140.20	5.59	0.01
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	138.54	3.93	0.03
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	140.34	5.73	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	146.74	12.13	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	143.24	8.63	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	142.11	7.50	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	143.92	9.30	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	141.80	7.19	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	145.47	10.86	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Total Polyunsaturated Fatty Acids (PUFA) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	668.09	4.43	0.02
2	95th Percentile Salinity	668.04	4.38	0.02
3	5th Percentile Temperature	664.70	1.04	0.11
4	95th Percentile Temperature	666.01	2.35	0.06
5	Percent Time Mudflats Exposed	663.66	0.00	0.19
6	5th Percentile Salinity + 95th Percentile Salinity	671.09	7.43	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	667.95	4.29	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	668.05	4.39	0.02
9	5th Percentile Salinity + Percent Time Mudflats Exposed	666.64	2.98	0.04
10	95th Percentile Salinity + 5th Percentile Temperature	666.91	3.25	0.04
11	95th Percentile Salinity + 95th Percentile Temperature	669.26	5.61	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	664.66	1.00	0.11
13	5th Percentile Temperature + 95th Percentile Temperature	666.33	2.68	0.05
14	5th Percentile Temperature + Percent Time Mudflats Exposed	666.18	2.52	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	666.17	2.51	0.05
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	670.30	6.64	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	671.43	7.77	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	666.78	3.12	0.04
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	669.37	5.71	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	669.53	5.87	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	668.56	4.91	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	669.35	5.70	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	667.08	3.43	0.03
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	668.06	4.40	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	668.75	5.09	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	672.50	8.84	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	669.90	6.25	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	670.07	6.41	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	671.76	8.10	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	670.64	6.98	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	673.43	9.77	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Linoleic acid (LNA, 18:2n-6) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	186.89	7.37	0.01
2	95th Percentile Salinity	186.90	7.37	0.01
3	5th Percentile Temperature	179.53	0.00	0.35
4	95th Percentile Temperature	185.67	6.14	0.02
5	Percent Time Mudflats Exposed	183.00	3.47	0.06
6	5th Percentile Salinity + 95th Percentile Salinity	190.12	10.59	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	182.15	2.62	0.09
8	5th Percentile Salinity + 95th Percentile Temperature	188.77	9.25	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	186.25	6.73	0.01
10	95th Percentile Salinity + 5th Percentile Temperature	182.27	2.75	0.09
11	95th Percentile Salinity + 95th Percentile Temperature	188.69	9.16	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	185.62	6.09	0.02
13	5th Percentile Temperature + 95th Percentile Temperature	182.12	2.59	0.10
14	5th Percentile Temperature + Percent Time Mudflats Exposed	182.40	2.87	0.08
15	95th Percentile Temperature + Percent Time Mudflats Exposed	185.98	6.46	0.01
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	185.25	5.73	0.02
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	192.00	12.47	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	188.93	9.40	0.00
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	185.32	5.79	0.02
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	185.37	5.84	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	189.32	9.79	0.00
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	185.32	5.79	0.02
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	184.84	5.32	0.02
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	189.01	9.49	0.00
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	185.38	5.85	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	188.71	9.18	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	188.30	8.77	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	192.44	12.92	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	188.78	9.25	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	188.39	8.86	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	192.05	12.52	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for α-Linoleic acid (ALA, 18:3n-3) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	76.72	0.00	0.15
2	95th Percentile Salinity	78.84	2.12	0.05
3	5th Percentile Temperature	77.14	0.42	0.12
4	95th Percentile Temperature	78.83	2.12	0.05
5	Percent Time Mudflats Exposed	76.97	0.25	0.13
6	5th Percentile Salinity + 95th Percentile Salinity	79.81	3.09	0.03
7	5th Percentile Salinity + 5th Percentile Temperature	78.93	2.21	0.05
8	5th Percentile Salinity + 95th Percentile Temperature	79.38	2.66	0.04
9	5th Percentile Salinity + Percent Time Mudflats Exposed	77.65	0.93	0.09
10	95th Percentile Salinity + 5th Percentile Temperature	80.25	3.53	0.02
11	95th Percentile Salinity + 95th Percentile Temperature	82.09	5.37	0.01
12	95th Percentile Salinity + Percent Time Mudflats Exposed	79.83	3.11	0.03
13	5th Percentile Temperature + 95th Percentile Temperature	80.38	3.66	0.02
14	5th Percentile Temperature + Percent Time Mudflats Exposed	79.79	3.07	0.03
15	95th Percentile Temperature + Percent Time Mudflats Exposed	80.04	3.32	0.03
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	81.87	5.15	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	82.72	6.00	0.01
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	79.36	2.64	0.04
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	82.07	5.35	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	81.03	4.31	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	80.97	4.25	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	83.57	6.86	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	82.73	6.01	0.01
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	82.48	5.76	0.01
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	83.04	6.32	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	85.32	8.60	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	82.93	6.21	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	82.87	6.15	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	84.53	7.81	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	85.57	8.85	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	86.61	9.89	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates. The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for γ-Linoleic acid (GLA, 18:3n-6) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	149.87	12.13	0.00
2	95th Percentile Salinity	149.75	12.01	0.00
3	5th Percentile Temperature	147.51	9.78	0.00
4	95th Percentile Temperature	146.63	8.89	0.00
5	Percent Time Mudflats Exposed	137.73	0.00	0.36
6	5th Percentile Salinity + 95th Percentile Salinity	153.00	15.26	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	150.74	13.00	0.00
8	5th Percentile Salinity + 95th Percentile Temperature	148.66	10.93	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	140.73	3.00	0.08
10	95th Percentile Salinity + 5th Percentile Temperature	150.76	13.03	0.00
11	95th Percentile Salinity + 95th Percentile Temperature	148.93	11.20	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	139.37	1.63	0.16
13	5th Percentile Temperature + 95th Percentile Temperature	148.07	10.34	0.00
14	5th Percentile Temperature + Percent Time Mudflats Exposed	140.82	3.08	0.08
15	95th Percentile Temperature + Percent Time Mudflats Exposed	140.31	2.58	0.10
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	154.15	16.41	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	151.43	13.70	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	141.72	3.98	0.05
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	150.95	13.22	0.00
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	143.76	6.03	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	142.77	5.04	0.03
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	151.19	13.45	0.00
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	142.67	4.94	0.03
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	142.73	5.00	0.03
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	143.59	5.85	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	154.29	16.55	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	144.81	7.08	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	144.95	7.21	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	145.80	8.07	0.01
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	146.21	8.47	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	148.14	10.41	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Eicosapentaenoic Acid (EPA, 20:5n-3) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	624.26	3.69	0.03
2	95th Percentile Salinity	624.22	3.64	0.03
3	5th Percentile Temperature	621.15	0.58	0.12
4	95th Percentile Temperature	621.89	1.32	0.08
5	Percent Time Mudflats Exposed	620.57	0.00	0.16
6	5th Percentile Salinity + 95th Percentile Salinity	627.27	6.70	0.01
7	5th Percentile Salinity + 5th Percentile Temperature	624.41	3.83	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	623.83	3.26	0.03
9	5th Percentile Salinity + Percent Time Mudflats Exposed	623.57	3.00	0.04
10	95th Percentile Salinity + 5th Percentile Temperature	623.46	2.89	0.04
11	95th Percentile Salinity + 95th Percentile Temperature	625.14	4.57	0.02
12	95th Percentile Salinity + Percent Time Mudflats Exposed	621.92	1.35	0.08
13	5th Percentile Temperature + 95th Percentile Temperature	622.52	1.95	0.06
14	5th Percentile Temperature + Percent Time Mudflats Exposed	623.06	2.49	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	622.79	2.22	0.05
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	626.85	6.28	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	627.22	6.65	0.01
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	624.19	3.62	0.03
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	625.46	4.89	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	626.42	5.85	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	625.07	4.50	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	625.64	5.07	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	624.33	3.76	0.03
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	625.19	4.62	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	625.31	4.74	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	628.69	8.12	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	627.27	6.70	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	627.17	6.60	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	628.24	7.67	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	627.74	7.17	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	630.51	9.94	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Docosahexaenoic Acid (DHA, 22:6n-3) at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	464.11	3.45	0.04
2	95th Percentile Salinity	464.11	3.45	0.04
3	5th Percentile Temperature	462.53	1.87	0.09
4	95th Percentile Temperature	462.37	1.71	0.09
5	Percent Time Mudflats Exposed	460.66	0.00	0.22
6	5th Percentile Salinity + 95th Percentile Salinity	467.24	6.59	0.01
7	5th Percentile Salinity + 5th Percentile Temperature	465.78	5.13	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	464.70	4.04	0.03
9	5th Percentile Salinity + Percent Time Mudflats Exposed	463.72	3.07	0.05
10	95th Percentile Salinity + 5th Percentile Temperature	465.32	4.66	0.02
11	95th Percentile Salinity + 95th Percentile Temperature	465.61	4.95	0.02
12	95th Percentile Salinity + Percent Time Mudflats Exposed	462.45	1.79	0.09
13	5th Percentile Temperature + 95th Percentile Temperature	464.35	3.70	0.04
14	5th Percentile Temperature + Percent Time Mudflats Exposed	463.82	3.16	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	463.28	2.62	0.06
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	468.71	8.05	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	468.10	7.45	0.01
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	465.00	4.35	0.03
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	467.35	6.69	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	467.10	6.45	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	465.92	5.27	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	467.68	7.03	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	465.69	5.04	0.02
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	465.81	5.15	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	466.56	5.91	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	470.81	10.15	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	468.57	7.91	0.00
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	468.27	7.62	0.00
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	469.49	8.84	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	469.22	8.56	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	472.02	11.37	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Omega 3 Fatty Acids at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	651.48	3.90	0.03
2	95th Percentile Salinity	651.40	3.82	0.03
3	5th Percentile Temperature	648.65	1.07	0.11
4	95th Percentile Temperature	649.21	1.63	0.08
5	Percent Time Mudflats Exposed	647.58	0.00	0.18
6	5th Percentile Salinity + 95th Percentile Salinity	654.47	6.89	0.01
7	5th Percentile Salinity + 5th Percentile Temperature	651.90	4.32	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	651.23	3.65	0.03
9	5th Percentile Salinity + Percent Time Mudflats Exposed	650.60	3.02	0.04
10	95th Percentile Salinity + 5th Percentile Temperature	650.94	3.36	0.03
11	95th Percentile Salinity + 95th Percentile Temperature	652.46	4.88	0.02
12	95th Percentile Salinity + Percent Time Mudflats Exposed	648.73	1.16	0.10
13	5th Percentile Temperature + 95th Percentile Temperature	650.09	2.51	0.05
14	5th Percentile Temperature + Percent Time Mudflats Exposed	650.28	2.70	0.05
15	95th Percentile Temperature + Percent Time Mudflats Exposed	649.90	2.32	0.06
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	654.33	6.75	0.01
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	654.61	7.03	0.01
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	650.99	3.41	0.03
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	653.05	5.47	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	653.63	6.05	0.01
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	652.27	4.69	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	653.19	5.61	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	651.38	3.80	0.03
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	652.07	4.49	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	652.66	5.08	0.01
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	656.25	8.68	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	654.24	6.66	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	654.11	6.53	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	655.60	8.02	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	654.86	7.29	0.00
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	657.61	10.03	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

Appendix D (cont.) AIC_c Model Results for Omega 6 Fatty Acids at Roberts Bank (May 2 to May 23, 2017).

Model #	Model	AIC_c	ΔAICc	w_i
1	5th Percentile Salinity	212.83	7.12	0.01
2	95th Percentile Salinity	213.01	7.30	0.01
3	5th Percentile Temperature	207.43	1.72	0.11
4	95th Percentile Temperature	211.66	5.95	0.01
5	Percent Time Mudflats Exposed	205.71	0.00	0.26
6	5th Percentile Salinity + 95th Percentile Salinity	216.08	10.38	0.00
7	5th Percentile Salinity + 5th Percentile Temperature	210.68	4.97	0.02
8	5th Percentile Salinity + 95th Percentile Temperature	213.76	8.05	0.00
9	5th Percentile Salinity + Percent Time Mudflats Exposed	208.46	2.75	0.07
10	95th Percentile Salinity + 5th Percentile Temperature	210.29	4.58	0.03
11	95th Percentile Salinity + 95th Percentile Temperature	214.69	8.98	0.00
12	95th Percentile Salinity + Percent Time Mudflats Exposed	207.53	1.83	0.10
13	5th Percentile Temperature + 95th Percentile Temperature	209.87	4.17	0.03
14	5th Percentile Temperature + Percent Time Mudflats Exposed	207.76	2.05	0.09
15	95th Percentile Temperature + Percent Time Mudflats Exposed	208.85	3.14	0.05
16	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature	213.70	7.99	0.00
17	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature	217.08	11.37	0.00
18	5th Percentile Salinity + 95th Percentile Salinity + Percent Time Mudflats Exposed	209.46	3.75	0.04
19	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	213.11	7.41	0.01
20	5th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	211.02	5.32	0.02
21	5th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	211.34	5.64	0.02
22	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	213.17	7.46	0.01
23	95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	209.48	3.77	0.04
24	95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	210.85	5.15	0.02
25	5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	211.00	5.29	0.02
26	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature	216.55	10.85	0.00
27	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + Percent Time Mudflats Exposed	212.27	6.56	0.01
28	5th Percentile Salinity + 95th Percentile Salinity + 95th Percentile Temperature + Percent Time Mudflats Exposed	213.03	7.32	0.01
29	5th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	214.19	8.48	0.00
30	95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	212.98	7.27	0.01
31	5th Percentile Salinity + 95th Percentile Salinity + 5th Percentile Temperature + 95th Percentile Temperature + Percent Time Mudflats Exposed	216.02	10.32	0.00

Notes: Station location (i.e., Station), the date samples were collected (i.e., Sampling Date), and the Total (dry) Weight of Samples were included in all models as covariates.
The set of 31 models is balanced, containing all combinations of abiotic variables, with each abiotic variable represented in 16 models.

APPENDIX E

Taxonomic Composition of Microphytobenthic Community

Appendix E: Taxonomic Composition of Microphytobenthic Community at Roberts Bank, April 26 to May 23, 2017

	Station A					Station C				Station H				Station I					Station J				Station X				Station Y			
Genera	26-Apr	02-May	08-May	16-May	23-May	02-May	08-May	16-May	23-May	02-May	08-May	16-May	23-May	26-Apr	02-May	08-May	16-May	23-May	02-May	08-May	16-May	23-May	02-May	08-May	16-May	23-May	02-May	08-May	16-May	23-May
Achnanthidium spp.	59.71%	61.29%	37.61%	62.78%	37.59%	46.88%	29.02%	50.90%	51.79%	11.64%	4.58%	20.14%	17.75%	15.28%	5.21%	2.69%	13.51%	11.60%	19.13%	19.14%	77.80%	80.18%	63.55%	25.23%	60.00%	61.85%	54.58%	72.34%	47.71%	59.02%
Amphora spp.		0.45%				0.30%							0.83%		1.42%		0.35%	1.39%	1.35%			0.52%					0.13%			0.33%
Anabaena spp.																		1.54%												
Asterionella spp.																										1.12%				
Aulacoseira spp.			0.35%			0.32%	0.25%			0.11%	0.53%		0.85%	0.66%	1.03%	1.06%		1.94%	3.27%	1.06%	0.39%		1.45%	2.87%	1.32%		0.83%		0.64%	
Bacillaria spp.													0.28%													0.50%				
Biddulphia spp.					0.58%			0.32%																					0.60%	
Campylodiscus spp.								0.32%																						
Chantransia spp.													0.56%																	
Cladophora spp.																						0.12%								
Cocconeis spp.	0.99%		1.39%	0.32%		0.59%	1.24%		0.87%				1.11%					0.31%		0.78%	0.23%			1.72%		2.61%	1.40%			
Coscinodiscus spp.			0.93%			0.62%				0.57%			2.54%		4.61%	0.70%														
Cryptomonas spp.						0.70%									0.35%													1.05%		
Cyclotella spp.					0.58%	0.35%				1.04%				0.33%			0.26%	5.04%	1.18%		0.23%	1.57%	0.17%	0.06%	2.31%	0.77%		0.08%	0.32%	
Cylindrotheca spp.	0.68%	0.62%					0.25%			2.75%	3.63%	0.52%		0.66%	3.35%	2.04%			3.68%				0.29%	0.06%						
Cymatopleura spp.					0.29%																									
Diatoma spp.										1.21%	1.33%		0.56%	1.66%		1.20%	1.05%		2.70%		0.46%	0.52%								
Didymosphenia spp.																					0.23%			0.57%						
Diploneis spp.			0.35%		0.87%			0.96%										0.39%	0.59%		0.77%						0.13%	0.08%	6.04%	
Encyonema spp.										0.86%		1.32%	6.76%	1.33%				0.24%		0.39%				0.32%		1.02%			0.79%	1.66%
Entomoneis spp.									0.28%												0.69%	0.44%								0.63%
Epithemia spp.							0.51%			0.11%					0.22%									0.06%						
Eunotia spp.			0.17%	0.26%									0.85%																	
Fragilaria spp.	0.30%					2.11%				0.23%				0.66%	6.74%		0.79%		8.96%				0.40%				0.51%	0.04%		
Geitlerinema spp.		1.72%								8.29%	1.71%				4.26%	0.35%														
Gomphonema spp.						0.35%	0.25%		0.55%	1.15%	0.80%	2.51%	0.25%				1.32%	1.55%			0.39%	0.24%		0.13%		0.26%		1.58%	1.51%	3.04%
Gyrosigma spp.	1.05%			2.67%	6.06%			1.94%	2.76%			0.32%	3.10%		6.07%		1.01%	1.22%	3.47%	1.04%	1.85%	1.58%		0.19%				6.31%	1.85%	3.23%
Hannaea spp.																										0.26%				
Heteroleibleinia spp.																8.10%														
Hippodonta spp.																	0.70%												0.32%	
Leptolyngbya spp.					5.83%			1.60%	0.55%			1.19%	0.76%				8.36%	19.07%				0.35%								10.49%
Melosira spp.				1.53%	0.58%			1.47%	0.87%			3.12%	0.25%		0.90%		2.15%		1.77%		1.16%							7.88%		0.66%
Meridion spp.					0.87%							1.30%	0.28%									1.57%		0.06%						
Mougeotia spp.	1.92%																													
Navicula spp.	27.34%	22.81%	36.16%	9.80%	12.82%	33.05%	30.31%	11.87%	8.03%	39.23%	49.49%	27.59%	29.89%	66.45%	31.22%	61.29%	28.34%	29.39%	32.78%	51.95%	11.12%	6.06%	29.95%	57.56%	23.47%	20.46%	29.03%	4.69%	19.48%	7.75%
Nitzschia spp.	3.02%	9.95%	18.11%	21.62%	29.90%	9.71%	30.32%	28.84%	29.37%	7.30%	8.25%	37.28%	18.26%	5.65%	13.45%	12.94%	38.01%	18.92%	3.36%	21.58%	4.21%	5.81%	2.28%	7.53%	12.57%	3.07%	6.91%	2.28%	17.42%	12.28%
Oscillatoria spp.														0.33%	0.35%				0.31%											
Paralia spp.					0.57%				0.28%				0.99%															1.58%	1.51%	
Phormidium spp.																	0.31%													
Plagiotropis spp.					2.30%				0.83%				0.28%					0.78%												0.63%
Pleurosigma spp.	2.18%	0.45%	2.55%			2.94%	1.83%			23.51%	19.15%			2.66%	13.79%	4.30%			7.31%	0.27%			0.57%	2.29%			1.29%			
Pseudanabaena spp.	0.38%												0.74%	1.00%				0.24%												
Rhizosolenia spp.													11.87%				0.26%	5.23%								7.83%				
Rhoicosphenia spp.									0.32%								0.79%		1.77%							0.26%				
Rhopalodia spp.	0.38%																											0.53%		
Skeletonema spp.									0.83%																					
Surirella spp.			0.17%	0.77%	0.86%	0.30%	0.46%	1.77%	2.67%		3.69%	4.18%	0.97%		3.80%	2.38%	0.70%	0.78%	1.51%	0.53%	0.46%			0.06%				0.08%	1.81%	
Synedra spp.					0.29%												2.10%	0.39%				1.04%						1.05%		
Tabellaria spp.										0.11%		0.52%	0.28%												0.33%					0.28%
Tabularia spp.			0.55%				0.58%				1.78%					0.91%				0.46%				0.19%						
Thalassiosira spp.			0.46%				0.76%																				0.27%			
Tryblionella spp.	2.04%	2.71%	1.19%			1.77%	4.21%			1.89%	5.07%			3.32%	2.87%	2.03%			6.88%	2.80%			1.34%	1.05%			4.93%	0.44%		
Zygnema spp.															0.35%															