Contaminated Sediments in the Walpole Delta: Comparison of 2012 and 2005 Sediment Chemistry Surveys.

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SUMMARY

Forty eight samples sediment samples were collected and analyzed from 30 discrete sampling stations located within the Walpole Delta during the period of May 27-30, 2012. The samples were analyzed for a comprehensive suite of organic contaminants (PCBs, Organochlorine Pesticides, PBDEs and PAHs) and trace elements (mercury and 18 other trace elements). None of the sampling stations collected in 2012 had chemical concentrations that exceeded Ontario Ministry of Environment Probable Effect Level (PEL) sediment quality guidelins. However, several chemicals were routinely elevated above OMOE documented Great Lakes background levels and threshold effect concentration (TEC) guidelines. Chemicals ranked by number of TEC exceedences across sampling locations were: Cd > Hg > As >B-HCH > G-BHC > total PCBs > chlordanes and chromium. Among these, Cd, As and Cr appear to have broad geochemical origins whereas Hg, HCHs and PCBs appear to have common upstream industrial sources.

Spatial patterns of contaminants within the Walpole Delta were examined using multivariate statistical approaches on the combined 2012 database to simultaneous consider all contaminants studies. A principle component analysis revealed several contaminant groups (PCBs, organochlorine pesticides, PAHs, PBDEs, mercury and copper) having similar spatial patterns of contamination within the Delta and statistically significant differences in sediment concentrations between different sampling regions within the survey. The above contaminants were found to be significantly enriched in Basset Channel, Johnston Channel and Chenel Ecarte compared to Canadian waters of Lake St. Clair. Contamination of sediments in adjacent St. Clair River main channel

stations and Chematogan Channel were intermediate in contamination and could not be distinguished from the more contaminated regions or clean areas. Goose Lake samples were not sampled at high enough replication to test against other regions sampled, but concentrations were found to be low in this area and similar in magnitude to Lake St. Clair samples.

Temporal patterns of sediment contaminant concentrations within the Walpole Delta were compared between 2005 and 2012 for sum PCBs, HCB, sum PAH, and total Hg. Paired t-tests were performed to examine for changes in global sediment contamination with time. These tests revealed that none of the above measured contaminants exhibited significant changes in sediment contamination in the Walpole Delta over the 7 year sampling interval. The spatial patterns of sum PCBs, sum PAHs and total mercury were consistent between the two survey years. Alterntatively, HCB exhibited a different spatial pattern of contamination in 2012 compared to 2005. The main difference observed in 2012 was a decrease in high contamination of HCB in several Delta channel stations, decreasing below the threshold effect concentration guideline for this compound. This implies improvement in sediment contamination for HCB, but no apparent change in sediment contamination for PCBs, PAHs or total mercury.

Overall, the data from this study suggest a common set of anothropogenic sources for organic contaminants, copper and mercury that are likely derived from upstream sediment transport. The highest sediment contamination is present in Basset Channel followed by Johnston Channel and Chenel Ecarte (which is highly variable in its sediment contamination along the channel length). Given the enriched organic carbon content of sediments associated with these locations, the higher degree of contamination found within these areas are likely due to sediment focusing and higher likelihood of deposition of organic enriched particles from upstream rather than point sources within these channels. Despite the distinct spatial scale differences noted above, priority chemical concentrations were always lower than OMOE Probable Effect Level Sediment Guidelines suggesting that the need for mitigation activities are unwarented at this time.

It is recommended that the Walpole Delta sediment chemistry survey design be re-implemented following completion of planned mitigation efforts being conducted in the St. Clair River Remedial Action Plan. This will enable testing whether such actions have impacted sediment quality within the Walpole Delta area. A relatively high frequency of TEC-guidelines for total mercury in sediments suggests that this contaminant be monitored through time to track recovery of sediments into the future.

INTRODUCTION

The delisting of the St. Clair River and the Detroit River RAPs requires an integrated approach that resolves the spatial scale of sediment contaminant issues. Questions remain such as how will mercury point source controls and sediment remediation actions in the St. Clair River affect the environmental quality in the Walpole Delta, Lake St. Clair and the Detroit River? Does the Detroit River remedial action plan depend on specific efforts being conducted in the St. Clair River? An integrated approach to linking RAPs through the Huron-Erie corridor requires that there is an assessment of the role of the Walpole Delta wetlands in regulating chemical transport of priority pollutants (mercury, OCS, HCB, DDT and PCBs). More importantly, the wetlands of the Walpole Delta support a traditional life style for the people of Walpole. Therefore, the integration of RAPs through a corridor monitoring approach is essential to protect the health and welfare of those committed to more traditional life styles. A corridor approach is not possible without a detailed understanding of the function and quality of the sediment chemistry within the Walpole Delta Area.

In 2005, a sediment chemistry survey was implemented in partnership with the Walpole Island Heritage Centre to collect sediments samples within the Walpole Delta. The survey was timed to supplement data related to a cooridor-wide assessment of sediment chemistry conducted in St. Clair River, Lake St. Clair and the Detroit River completed in 2004. During the 2005 survey, sediment samples from the upstream and downstream sections of Chenal Ecart, Johnston Channel, Chematogen Channel and Basset Channels were collected and analyzed for priority contaminants. Sediment samples were also collected from the midstream of Chenal Ecarte and Goose Lake. The above survey was repeated in 2012 again in conjunction with the Walpole Island Heritage Centre and represents the subject of this report. The objectives of the second survey was to provide an assessment of temporal changes in sediment chemistry that occurred in the Walpole Delta over the 7 year period between sampling intervals and secondly to provide a baseline of sediment contamination data prior to initiation of major upstream St. Clair River remediation activities planned for 2015-2016. Having a baseline database of chemical contamination in the Walpole Delta will enable prospective future evaluation of whether or not upstream dredging activities associated with St. Clair river causes impacts to sediment quality within the Delta.

SEDIMENT QUALITY SURVEYS

Methods

Sediment Survey Design

The first (2005 survey) sediment survey was performed during August 29-30 and encompassed the four longest channels of the delta: Chenal Ecarte, Johnston, Chematogen and Basset Channels (Figure 1). Samples from the midstream of Chenal Ecarte and Goose Lake were also collected. In addition 3 sampling sites from corridor wide Huron-Erie Corridor survey (2004) were resampled in 2005. Sampling sites (coordinates see Table 1) were selected prior to the survey implementation to insure the comparison between upstream and downstream portions of channels.

The second survey (2012) was performed during May 27-30 and consisted of sampling the same locations as sampled in the 2005 survey. In addition to the above samples, ten sediment samples (one sample/site), reflecting sample sites collected as part of the 2004 Huron-Erie Corridor sediment sampling survey were sampled. These locations were chosen such that they complimented the 2005 survey results and provided a more comprehensive spatial survey of the Walpole Delta. Finally, three additional locations (one sample/site) chosen in consultation with Walpole Island Heritage Centre were added. Two of the supplementary sites were positioned in the South Channel adjacent to Seaway Island reflecting an identified area of special concern (Williams and Anderson, Personal Communication, Oct. 2010). A third sampling station was positioned in Lake St. Clair to fill in a spatial gap from the downstream receiving waters of the delta. Sediment sample locations from the 2005 survey are provided in Figure 2.

Sediment Sample Collection and Analysis

Sediment samples were collected using a petite Ponar grab sampler. Grab samples (2 L volume) were retrieved at a given station in 3 replicates (repeated Walpole Delta stations; 1 replicate per site for the 2004 Corridor sampling stations).

In the laboratory, sediments samples were split for grain size analysis, total organic carbon (TOC) content, organic contaminant analysis and trace elements. Sediments designated for TOC, organic contaminants and metals were sieved to ensure a grain size of less than 2 mm, and then frozen until submitted for analysis.

The grain size distribution was performed using a method that involves passing the dried sediment through a series of graded sieves. Prior to the analysis, the sediment samples were dried overnight at 110°C and gently broken up with a glass pestle so as to minimize disruption of the actual grain size characteristics. The dried and weighed sediment subsamples (100-300g) were transferred to a stacked column of sieves (0.5 mm, 0.25 mm, 0.125 mm 0.063 mm) and sieved using an automatic sieve shaker (CSC Scientific, USA) for a period 3-5 minutes. Each fraction was weighed and results were recorded.

Sediment TOC content was determined using loss on ignition (LOI). The LOI procedure involved combusting pre-weighed dried sediment samples at 450^{o}C for 24h. The organic carbon was subsequently determined gravimetrically as the % of sample weight lost following combustion.

Organic contamination extraction was performed on subsamples (20 g) of wet sediment using a soxhlet apparatus and solvent system as specifid in Drouillard et al. (2006). Prior to extraction, each soxhlet was spiked with 200 ng of PCB 34 and BDE 71 for use as recovery standards. Soxhlets were refluxed with 300 mL acetone/hexane (1:1 v/v) for a 12 h period. After soxhlet extraction, the extracts were back extracted in 2L separatory funnels containing water and hexane to remove acetone over thee separate washings. The hexane extracts was subquently dried over a sodium sulphate column and concentrated to a volume of 2 mL. Clean-up of extracts was performed by activated florisil chromatography as described in Lazar et al. [18]. Florisil extracts were collected as three separate fractions (fraction 1, containing PCBs, some OC’s and PAHs was eluted with 50 mL hexane; fraction 2, containing some OC’s, PAHs and the majority of PBDEs was eluted with 50 mL; hexane/dichloromethane 85/15% v/v); fraction 3, containing heptachlor epoxide and dieldrin was eluted with 130 mL hexane/dichloromethane 50:50% v/v). Each fraction was concentratd to 2 mL and placed in a volumetric flask. Activated copper (0.2-0.5 g) was added to the flask to remove sulphur and allowed to sit overnight. If the activated copper turned black, more was added and the sample was allowed to sit for another 12 h. The cleaned-up extracts were added to 2mL GC-vials for subsequent analysis.

PCB and OC-pesticides were analyzed by separate injection of each fraction using a gas chromatograph-electron capture detector system (GC-µECD; Hewlett-Packard 5890 GC with ^{63}Ni-ECD and 7673 Autosampler equipped with a 60 m x 0.250 mm x 0.1 µm DB-5 column). PCBs and OCs were identified by retention time and quantified according to the standard response derived from a certified analytical standard (C-QME-01 - Quebec Ministry of Environment Congener Mix; AccuStandard, CT, USA) and a custom OC certified standard mixture prepared by AccuStandard, CT, USA. Working PCB standards, recovery standards and OC-pesticide standards were injected for every 8 samples/QA samples injected. Thirty three indivual or co-eluting PCB congeners: 18/17, 31/28, 33, 44, 49, 52, 70, 87, 95, 99, 101, 105/132, 110, 118, 128, 138, 149, 151/82, 153, 156/171, 158, 170, 177, 180, 183, 187, 191, 194, 195/208, 199, 205, 206, and 209 were analysed for in each sample during the 2012 survey. Sum PCBs reflect the sum of the above congeners. During the 2005 survey, 71 PCB congeners were analyzed for using an PCB standard based on Aroclor 1242:1254:1260 mixture. To facilitate comparison, the 2005 survey data were censored to contain only commonly identified peaks measured in each survey year. Method validation exercises demonstrated that samples quantified against the original Aroclor 1252:1254:1260 standard yielded similar results when quantified using the Quebec Ministry Samples when analysis was constrained to the common set of compounds. Organochlorine pesticides analyzed for included: 1,2,4,5-TCB, 1,2,3,4-TCB, QCB, HCB, a-HCH, B-HCH, g-HCH, d-HCH, OCS (octachlorostyrene), oxychlordane, trans-chlordane, cis-chlordane, trans-nonachlor, cis-nonachlor, p,p'-DDE, p,p'-DDD, p,p'-DDT, mirex, heptachlor epoxide and dieldrin.

Following injection of each fraction on GC-ECD, fractions 1 and 2 were combined, added to a new GC-vial and analyzed for PAHs by GC-MSD (Hewlett Packard 5890/5979 GC-MSD equipped with a 60 m x 0.25 mm x 0.1µm i.d. DB-5 column). The GC-MSD was operated in selective ion monitoring model and tuned weekly or the day before a given sample run. PAHs were identified by establishing appriorie rention specific ion windows to examine for the molecular ion and using a secondary major ion fragment as a qualifier ion. PAH concentrations were quantified against the standard response from a 5 point standard calibration curve (EPA 16 Priority PAHs, Supelco, PA, USA). A standard was injected for every 8 sample/QAsamples injected. The sixteen PAHs included: naphthalene (NA), acenaphthylene (AL), acenaphthene (AE), fluorine (FL), phenanthrene (PHE), anthracene (AN), fluranthene (FLT), pyrene (PY), benzo(a)antrhacene (B(a)A), chrysene/triphenlyene (CT), benzo(b)fluranthene (B(b)F), benzo(k)fluranthene (B(k)F), benzo(a)pyrene (B(a)P), indeon(12,3,c,d)pyrene (IP), dibenzo(a,h)anthracene (D(a,h)A) and benzo-(g,h,i)perylene (B(ghi)P). Sum PAHs reflects the sum of concentrations of the above compounds.

Following analysis of PAHS on GC-MSD, the samples were re-capped and later re-injected on a Waters GCT-premier time of flight high resolution mass spectrometer (GC-TOF) equipped with an HP6890 GC containing a 30 m x 0.25 mm i.d. x 0.25 µm film thickness DB-5 column and autosampler. The GC-TOF analysis was conducted under EI at 70eV. Each day of use, the instrument was tuned and mass resolution calibration performed using the Metri calibration solution. The 284.9949 ion of Metri was used as the lock mass during sample runs and calibration. PBDE's were identified by retention time and by post processing signal extraction of the three dominant ions generated for each congener. The areas were quantified against the response of a certified standard solution obtained from Wellington Laboratories, Ontario, Canada). PBDE congeners identified included 24 congeners identified by IUPAC #s as follows: 3, 7, 15, 17, 28, 47, 49, 66, 77, 85, 99, 100, 119, 126, 138, 153, 154, 183, 184, 191, 196, 206, 207, and 209.

Metals concentrations were investigated on sediment samples extracted with mixture of concentration acids according protocol described in detail by Szalinska (Szalinska et al. 2006). Metals concentrations (Al, As, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, V, and Zn) were analyzed using an Inductively Coupled Plasma Optical Emission Spectrophotometer (IRIS #701776, Thermo Jarrell Ash Corporation) and quantified against a primary standard. Total Hg was measured using an atomic absorption spectrophotometer (AAS-300, Varian) equipped with a single element hollow cathode lamp and a vapor generation accessory unit (VGA-76, Varian) for the 2005 survey. However, the above instrument was decommisoioned following 2005. During the 2012 survey, total mercury was analyzed using a DMA-80 total mercury analyzer. Prior to switching to the DMA-80, laboratory validation using certified reference samples were performed to ensure the compatability of total mercury concentrations measured using the two different instruments.

Quality assurance and quality control samples includiedc analyzing blanks and a certified reference sediment sample with each batch of samples (6 organic samples and 20 metal samples). For organics, the certified reference sediment (CRS) was the NIST 1944 (New York/New Jersey Waterway Sediment). For metals, CRS included NRC (S-Mess2 and S-Mess3). Quality assurance review for organics included assessment of recovery standard performance with 60% considered appropriate recovery for sediments. For both organics and metals, evaluation of selected analytes in CRS samples were required to be within 3 standard deviations of the certified values for each CRS analyzed to be accepted. Individual samples (organics) failing recovery expectations or sample batches failing CRS performance requirements were re-analyzed.

RESULTS

Tables 2-7 provide grain size and TOC contents, and validated analytical data for each chemical group (PCBs, Organochlorine Pesticides, PAHs, PBDEs and Trace Elements).

Exceedence of Sediment Quality Guidelines

A comparison of the number of sediment samples exceeding Ontario Ministry of Environment Sediment Quality Guidelines (OMOE SQG's) and OMOE listed Great Lakes Background levels are provided in Table 8. Great Lakes background sediment concentrations were exceeded for PCBs, HCHs chlordane, mercury, arsenic, cadmium, chromium, copper, manganese, nickle and zinc among the survey years. These same compounds tended to exceed threshold effect concentrations (TEC) at similar frequencies, albeit in many cases the listed OMOE Great Lakes background reference values exceeded or was of similar magnitude to the OMOE TEC, yielding similar exceedence frequencies in the Walpole Delta. Chemicals ranked by number of TEC exceedences across sampling locations were: Cd > Hg > As >B-HCH > G-BHC > total PCBs > chlordanes =chromium. Exceedence of TEC values for metals are relatively common in sediment samples in the Huron-Erie corridor (Szalinska et al. 2011). Mercury exceedences presents the most likely metal of concern, both for the high frequency of exceedence of TEC values observed among sampling sites and because this chemical is subject to bioaccumulation and biomagnification in fish tissues and thus presents an exposure risk to humans.

Among the organochlorine pesticides, hexachlorcyclohexanes exhibited relatively frequent exceedences that may be related to past agricultural practices in the area. These compounds are subject to bioaccumulation but do not undergo biomagnification in food webs and rarely responsible for the generation of fish consumption advisories. HCB, a former St. Clair River blob component, had concentrations exceeding OMOE TEC values in 10 samples analysed in 2005. These included all replicates from upper Johnston Channel, 2/3 replicates from downstream Johnston Channel, 2/3 replicates in midstream Chanel Ecarte, 2/3 replicates in the upper Basset Channel, and site A10 (St. Clair River Main Channel). However, no samples were found to exceed the HCB TEC value during 2012. PCBs presents a greater concern owing to the bioaccumulation and biomagnification potentials. These compounds had concentrations exceeded the TEC at only 1 location in 2012 (Middel Chenel Ecarte -MCE2). However, the high concentration observed at this site was found at an elevated value in only 1 of 3 replicates taken at that location (two other replicates had PCBs levels 10 fold lower than measured in replicate 1). This suggest that the single high PCB value was an artifact of subsampling or analytical issue.

PAHs are non-biomagnifying and present little human exposure risk via fish consumption. However, these compounds are mutagenic and present a risk to benthic invertebrate and fish populations inhabiting PAH contaminated environments. Only one location had PAH concentrations exceeding the TEC value in 2005 and one sample in 2012. In 2005, the TEC for several individual and sum PAHs was exceeded in 2/3 replicates taken from at site S27 located in the main channel of St. Clair River. However, in 2012 PAH concentrations at this site dropped back below TEC's and likely represents relocation of contaminated particles between years. In 2012, TEC for PAHs was exceeded at A005 located in the Canadian North section of Lake St. Clair. The total PAH concentrations at this location exceeded the TEC by a factor of 2 but was lower than the PEC. This site was designated for sampling in 2012 by Walpole Island Heritage Centre and there is no comparable data at this location available from earlier years.

No sampling locations in either the 2005 or 2012 sediment chemistry surveys had contaminant concentrations that exceeded the Probable Effect Concentration guideline values established by OMOE. Thus, despite relatively frequence exceedence of TEC values for several metals and organic compounds as indicated above, none of the sites had levels of contamination that would be consistent with an expected toxicity impairement to aquatic life.

Temporal patterns of selected contaminants

Based on exceedence patterns noted above and consideration of relative risks of individual pollutants (bioaccumulation and/or toxicity), the following contaminants were selected to provide a more detailed comparison of temporal patterns within the delta: sum PCBs, HCB, sum PAH, and total Hg.

Mean±SE sum PCB concentrations in sediments for all sampling sites in the Walpole delta was 10.92±2.04 ng/g dry weight in 2005 and 12.94±2.56 ng/g dry weight in 2012. Figure 3 presents site specific comparisons of sum PCB concentrations at individual sampling locations generated in each survey year. Notably, average site specific sum PCB concentrations at all locations were well below the TEC value (70 ng/g dry weight) and only 1 replicate sample (MCE2 during 2012 identified previously) exhibited a concentration above the threshold effect guideline. A total of 35% of stations analyzed showed a net decrease in sum PCB concentrations with time while 60% of sampling locations demonstrated slight increases. A paired t-test performed on average site specific sum PCB concentrations for all 20 sites where multi-year samples were collected indicated no significant differences in sum PCB concentrations with time ($p>0.1$; paired t-test). On average, between year differences in sum PCBs at individual locations were within a factor of 2.0 of one another. The largest between year differences in sum PCBs was observed for location S24 (3.94 fold increase in sum PCBs) and Goose Lake (4.85 fold increase). However, both the above sample sites had sum PCB concentrations that were well below the 2005 mean PCB concentrations measured in the Delta. This suggests that the increase in sediment concentrations observed at these locations are likely due to sediment transport phenomena as opposed to introduction of new point sources. Site specific sum PCB concentrations in 2012 were highly correlated to concentrations measured in 2005 (R=0.75; p<0.001; ANOVA) indicative of spatial structure of PCB contamination. However, channel specific patterns were not strongly evident, except for slight increases in Bassett and Johnson Channel locations and highly variable concentrations measured in Chenel Ecarte.

Mean±SE HCB concentrations at all sampling sites was 16.65±5.75 ng/g dry weight in 2005 and decreased to 6.31±1.23 ng/g dry weight in 2012. A paired t-test indicated no significant differences in HCB concentrations within the Walpole Delta over time (p>0.05; paired t-test). Figure 4 presents site specific comparisons of HCB at individual sampling locations generated in each survey year. Notably, mean concentrations of HCB were elevated at 5 locations (A10, UJC1, DJC2 and MCE2) and were at or above TEC values for this priority contaminant in 2005. However HCB concentrations at all of the above locations fell below TEC concentrations during 2012. Unlike PCBs, site specific HCB concentrations measured in 2012 were not correlated with HCB concentrations measured in 2005 (; R<0.1; p>0.1; ANOVA). This appears to be due to improvement in sediment quality at locations which were formerly contamined with HCB and stochastic variation in contaminant levels at sites where HCB concentrations were close to detection limits.

Mean±SE sum PAH concentrations at all sampling sites was 0.71±0.17 µg/g dry weight in 2005 and increased to 1.142410.55 µg/g dry weight in 2012. A paired t-test indicated no significant differences in sum PAHs within the Walpole Delta over time (p>0.47; paired t-test). Figure 5 presents site specific comparisons of sum PAHs at individual sampling locations generated in each survey year. Notably, mean concentrations of sum PAHs was elevated at 1 location (A53) in 2012 but was well below the PEC for PAHs at this location. Sum PAH concentrations at all other locations were below the TEC among the two survey years. Similar to PCBs, site specific sum PAH concentrations measured in 2012 were strongly correlated with PAH concentrations measured in 2005 (; R=0.61; $p<0.01$; ANOVA).

Mean±SE total Hg concentrations at all sampling sites was 0.43±0.55 µg/g dry weight in 2005 and decreased to 0.30±0.05 µg/g dry weight in 2012. The paired t-test indicated no significant differences in total Hg sediment concentrations in the Walpole Delta with time ($p>0.3$; paired t-test). Figure 6 presents site specific comparisons of total Hg concentrations at individual sampling locations generated in each year. As indicated previously, Hg concentrations frequently exceeded the TEC threshold at numerous locations. Elevated mercury levels in sediments were apparent in Bassette Channel, Chematogan Channel and Johnson Channel with variable contamination in Chenal Ecarte. The elevated concentrations of total mercury present within the above channels could play an important role mediating mercury bioavailability via methyl mercury production. Further research to understand the role of mercury methylation and bioavailablity to benthic invertebrates within the delta could be useful to understanding how the Walpole Delta modifys food web biomagnification of his contaminant. However, very low mercury concentrations were noted in a number of locations including Goose Lake, S25 (main channel St. Clair River) and S28 (Chenel Ecarte). Spatial patterns of mercury were evident by the significant correlation between site specific chemical concentrations measured in 2012 compared to 2005 (R = 56; $p<0.05$; ANOVA). Overall, total mercury concentrations present within the Walpole Delta are consistent with elevated levels measured in the St. Clair River and Lake St. Clair (Szalinska et al. 2011) and exceed mercury concentrations typically present on the U.S. side of the delta. There is little evience for changes in the mercury load between 2005 and 2007.

Spatial patterns of contaminants

Spatial patterns of contaminants within the Walpole Delta were evaluated focusing on the 2012 data set. Principle components analysis (PCA) was performed as a data reduction method to examine between chemical correlations and to facilitate statistical comparisons of contaminant levels between channels within individual channels of the Walpole Delta, St. Clair River main channel and North Lake St. Clair. Given that PCA requires a complete data matrix to run calculations, non-detected or missing values were replaced with the detection limit for the method. Compounds that were detected at a frequency of less than 60% across samples were excluded from the PCA in order to reduce artifacts related to replacing ND values in the data matrix. After omitting chemicals with low detection frequencies, a total of 83 parameters remained including: %TOC, grain size fractions, individual PCB congeners and sum PCBs, 10 organochlorine pesticides, individual PAHs and sum PAHs, 3 polybrominated diphenyl ether congeners and sum PBDEs, mercury, and 18 trace elements.

The first three axes of the PCA explained 77.6% of the variation in the data. Although PCA-3 explained 6.8% of the variation in the data, no chemicals showed strong loadings (correlation coefficient exceeding 0.6) to this axis and therefore it was not considered further. PCA-1 and PCA2 axes explained 51.2 and 19.6% of the variation, (combined explanatory power = 70.8% variation for these two axes). Figure 7 presents the factor loadings plot over axes 1 & 2 and Table 9 identifies individual parameters having strong loadings (R > 0.6) onto a given axes. Factor 1 was strongly positively associated with sediments having high organic carbon content (%TOC) and small grain sizes (63 µm and <63µm). Chemicals with strong positive loadings onto factor one included all PCB congeners, HCB, p,p'-DDE, p,p'-DDT, all PAH compounds, BDE 15 and BDE47, total mercury and copper. This implies stations having high scores for PCA factor 1 were enriched with the above contaminants and likely associated with anthropogenic sources. The observation of similar loadings for silt grain sizes, high TOC content and organic contaminants is not surprising owing to the high association of organic contaminants to fine grained, organic enriched sediments. However, the observation of similar loading patterns of mercury and copper onto this axis suggests that PCA 1 axis is also tracking sites having common sets of upstream chemical sources related to industrial/anthropogenic proceses.

Factor 2 was strongly negatively associated with 17 trace elements with the exception of mercury and copper which loaded onto factor 1. Thus, sampling stations showing strongly negative PCA scores on factor 2 tended to be enriched in trace elments at these sites. Given that trace elements related to factor 2 consisted of both ubiquitous and conservative non-toxic parameters (e.g. Al, Ca, Fe, K, Mg, Na) as well as priority trace metals (e.g. As, Cd, Cr, Ni, PB, Zn), it may be inferred that sources of these metals within the Walpole data are driven mainly by geochemical focusing of sediments, common patterns of erosion or other broader sources apart from those identified as likely responsible for PCA1 contaminants.

Figure 8 presents a plot of components scores across PCA axes 1 and 2. The figure also presents 90% confidence elipses surrounding samples grouped according to region: Basset Channel (BC), Chematogan Channel (CC), Chenel Ecarte (CE), Goose Lake (GL), Johnston Channel (JC), North Lake St. Clair (LSC) and Main Channel St. Clair River (SCR). Stations associated with Basset Channel had loadings furthest to the right on the x-axis, although there was considerable overlap with the other channels. LSC, Goose Lake, CC and SCR tended to show negative scores on PCA 1 indicating these areas have lower overall contamination for organic pollutants, mercury and copper relative to the above. Figure 9a presents a bar chart of PCA scores separated by region. Analysis of variance (ANOVA) conducted this data set indicated significantly higher scores ($p<0.001$; Tukey's HSD post hoc tests) at Basset Channel compared to Lake St. Clair. PCA-1 scores at Johnston Channel and Chenel Ecarte were also significantly higher ($p<0.01$; Tukey's HSD) than observed at St. Clair. Neither St. Clair River or Chematogan Channel could be distinguished from the low scores observed for LSC. Note, Goose Lake was excluded from the ANOVA because only two samples were available for this region. However, the values measured at Goose Lake were notably low and consistent with levels measured at Lake St. Clair sites.

Confidence elipses on Figure 8 demonstrated much greater overlap along the y-axis (PCA-2 scores). Figure 9b also presents the bar chart showing PCA scores for sites grouped by region. Positive, but highly variable results for PCA-2 scores were apparent for Basset Channel and Chematogan Channel while all other stations showed weak negative score values. ANOVA performed on PCA-2 scores by regions indicated no statistically significant differences by sample region (p>0.2, ANOVA). Thus region specific differences for tracel elments were not apparent in the data set.

CONCLUSIONS

Overall, no sampling stations had chemical concentrations exceeding Ontario Ministry of Environment Probable Effect Level (PEL) Sediment Quality Guidelines for priority chemicals. However, several chemicals were routinely elevated above OMOE documented Great Lakes background levels and threshold effect concentration (TEC) guidelines suggesting that continued monitoring be performed to evaluate temporal trends and baseline recovery for these contaminants. Spatial patterns of contaminants within the Walpole Delta revealed commonality in spatial patterns of PCBs, organochlorine pesticides, PAHs, PBDEs, mercury and copper. For the above contaminants, sediment contamination was higher in waters of Basset Channel, Johnston Channel and Chenel Ecarte compared to Lake St. Clair. Both Lake St. Clair and Goose Lake exhibited the lowest sediment contamination among sites tested. There were no changes in sediment concentrations with time for PCBs, PAHs, mercury or HCB. However, high values of HCB exceeding threshold effect concentration levels in 2005 were not observed in 2012 suggesting some improvement (although a non-statistical change) for this compound. Trace elements such as Cd and As which frequently exceeded threshold effect concentrations demonstrated no distinct spatial patterns by sampling region. Furthermore, given that these metals showed similar patterns as conservative and ubiquitous non-toxic elements (e.g. aluminum, sodium, calcium, potassium, magnesium, etc.) in the delta, this suggests that the origin of these metals are likely of geochemical origin rather than industrial sources as inferred for organic chemicals, mercury and copper. It is recommended that the Walpole Delta sediment chemistry survey design be repeated after planned remedial activities in the St. Clair River are completd in order to assess the impact such mitigation efforts have on sediment quality within the Walpole Delta.

REFERENCES

Drouillard, K. G., M. Tomczak, S. Reitsma, G. D. Haffner. 2006. A river-wide survey of polychlorinated biphenyls (PCBs), polycylic aromatic hydrocarbons (PAHs), and selected organochlorine pesticide residues in sediments of the Detroit River - 1999. Journal of Great Lakes Research. 32 (2): 209-226.

Lazar R., R.C. Edwards, C.D. Metcalfe, T. Metcalfe, F.A.P.C. Gobas and G.D. Haffner. 1992. A simple, novel method for quantitative analysis of coplanar (non-ortho substituted) polychlorinated biphenyls in environmental samples. Chemosphere 25:493-504.

Szalinska E, B Fryer, M Tomczak, KG Drouillard, S. Reitsma, GD Haffner. 2006. Distribution of heavy metals in sediments of the Detroit River. *J. Great Lakes Res*. 32:442-454.

Szalinska E., Haffner G.D., Drouillard K.G. 2007. Metals in the sediments of the Huron-Erie Corridor (North America): factors regulating distribution and mobilization. Lakes & Reservoirs: Research and Management, 12:217-236.

Szalinska, E, KG Drouillard, EJ Anderson, GD Haffner. 2011. Factors influencing contaminant distribution in the Huron-Erie Corridor sediments. J. Great Lakes Res. 37:132-139.

Table 1. Coordinates of Sampling Locations in 2012

Site i.d.	Region	Northing	Westing	# Samples collected	Sample Date
A001	LSC	N42.28.324	W082.37.238	Single	29-May-12
A003	LSC	N42.27.557	W082.32.899	Single	27-May-12
A004	SCR	N42.32.091	W082.38.529	Single	29-May-12
A005	LSC	N42.30.535	W082.41.238	Single	29-May-12
A006	LSC	N42.30.990	W082.41.945	Single	29-May-12
A007	JC	N42.32.892	W082.25.790	Single	28-May-12
A008	JC	N42 30.903	W82 27.536	Single	28-May-12
A009	CC	N42.33.048	W082.32.698	Single	28-May-12
A010	SCR	N42.37.218	W082.30.739	Single	28-May-12
A53	LSC	N42.27.264	W082.28.111	Single	27-May-12
AS29	CE	N42.30.854	W082.26.073	Single	27-May-12
DBC2	BC	N42.30.329	W082.35.057	Triplicate	29-May-12
DCC2	CC	N42.30.199	W082.32.005	Triplicate	28-May-12
DCE3	CE	N42.29.328	W082.26.126	Triplicate	27-May-12
DJC2	JC	N42.29.596	W082.30.676	Triplicate	28-May-12
GL1	GL	N42.30.773	W082.30.888	Single	29-May-12
GL2	GL	N42.31.617	W082.31.330	Single	29-May-12
MCE2	CE	N42.35.154	W082.26.336	Triplicate	27-May-12
S14	SCR	N42.41.518	W082.29.611	Single	30-May-12
S15	SCR	N42.39.929	W082.30.406	Single	30-May-12
S24	SCR	N42.34.194	W082.34.258	Single	29-May-12
S25	SCR	N42.32.545	W082.36.565	Single	29-May-12
S27	SCR	N42.38.249	W082.30.169	Single	27-May-12
S28	CE	N42.32.966	W082.25.221	Single	27-May-12
S57	LSC	N42.29.656	W082.40.407	Single	29-May-12
UBC1	BC	N42.32.975	W082.35.049	Triplicate	29-May-12
UCC1	CC	N42.35.791	W082.31.897	Triplicate	28-May-12
UCE2	CE	N42.38.012	W082.29.395	Four	27-May-12
UJC1	JC	N42.34.712	W082.25.790	Triplicate	28-May-12

LSC = Lake St. Clair; SCR = St. Clair River Main Channel, JC = Johnston Channel, CE = Chenel Ecarte, BC = Basset Channel, CC = Chematogan Channel, GL = Goose Lake

Table 2. Grain size and organic carbon (TOC) in 2012 Walpole Delta sediment samples.

Sample	Region	% Water	%TOC	>500µm (%)	>250µm	>125µm	>63µm	<63 µm
A004	SCR	18.80	1.14	29.04	50.85	18.91	0.91	0.39
A010	SCR	27.08	1.42	5.02	15.89	40.39	26.61	10.12
S14	SCR	28.17	1.64	11.61	8.62	41.21	31.40	6.44
S15	SCR	32.79	2.46	13.54	14.28	28.23	32.11	9.75
S24	SCR	27.91	2.20	0.52	11.58	18.79	54.32	13.06
S25	SCR	34.89	3.73	7.91	12.47	30.72	36.81	11.10
S27	SCR	36.93	4.75	8.38	11.67	18.60	44.22	16.55
UBC1-1	BC	23.59	2.69	2.97	12.01	17.09	41.59	24.08
UBC1-2	BC	23.38	3.04	0.96	9.30	16.83	45.66	25.58
UBC1-3	BC	28.98	2.25	2.82	5.85	15.06	44.37	30.11
DBC2-1	BC	41.32	5.63	1.64	10.01	12.83	43.36	30.29
DBC2-2	BC	36.40	4.35	12.54	10.10	10.42	37.41	27.71
DBC2-3	BC	40.49	3.86	4.17	12.47	14.20	46.07	21.35
UCC1-1	CC	24.78	1.81	0.48	1.63	30.55	55.87	10.20
UCC1-2	CC	26.13	2.26	0.49	3.86	26.86	55.54	12.43
UCC1-3	CC	24.42	1.12	2.12	5.45	27.02	52.68	10.65
A009	CC	39.70	4.20	24.04	13.88	27.20	22.93	10.86
DCC2-1	CC	26.62	2.18	17.26	33.27	24.67	21.07	2.69
DCC2-2	CC	30.17	1.90	8.79	23.76	24.72	37.04	4.19
DCC2-3	CC	30.48	2.02	6.00	16.99	22.00	43.44	8.96
GL1	GL	37.61	3.82	0.08	6.07	42.15	33.98	15.57
GL2	GL	22.80	1.14	0.71	9.65	77.21	10.93	0.53
UJC1-1	JC	24.39	1.92	2.67	8.93	34.24	37.34	15.40
UJC1-2	JC	23.51	1.09	1.56	8.62	39.80	34.71	13.46
UJC1-3	JC	20.61	2.56	2.62	11.03	40.84	31.03	13.65
A007	JC	23.31	2.78	0.76	9.01	34.41	42.41	11.55
A008	JC	26.73	2.02	1.79	9.49	13.69	47.48	26.45
DJC2-1	JC	40.22	4.22	1.10	11.71	21.99	51.43	12.06
DJC2-2	JC	41.30	4.13	0.48	13.41	18.16	47.32	19.40
DJC2-3	JC	41.59	4.02	12.37	11.06	13.44	37.46	23.40
UCE2-1	CE	27.18	2.60	4.55	15.86	58.70	12.21	6.78
UCE2-2	CE	28.09	2.99	2.45	12.88	60.57	14.61	8.49
UCE2-3	CE	20.01	0.47	0.93	8.55	86.29	2.51	0.30
UCE2-4	CE	21.06	2.20	0.88	11.19	64.78	15.59	7.15
AS29	CE	48.30	6.31	20.05	23.89	20.13	23.88	11.52
MCE2-1	CE	32.09	4.08	1.43	11.47	34.05	28.20	9.04
MCE2-2	CE	35.29	4.20	0.53	9.28	46.19	31.45	11.57
MCE2-3	CE	31.32	2.74	1.17	8.18	55.61	27.15	7.18
S28	CE	62.59	8.77	34.02	26.37	22.71	12.30	3.98
DCE3-1	CE	47.69	8.89	1.24	28.39	23.51	31.20	15.10
DCE3-2	CE	40.20	5.77	12.77	25.93	19.30	24.12	17.24
DCE3-3	CE	40.49	5.66	3.98	9.32	19.03	43.20	21.42
A001	LSC	21.70	0.49	2.88	28.50	60.84	6.86	0.46
A005	LSC	20.92	0.42	1.62	13.19	80.04	2.45	0.45
A006	LSC	21.44	1.23	1.11	4.63	69.01	23.61	1.04
A53	LSC	34.48	3.21	1.45	9.50	13.07	32.58	38.04
A003	LSC	16.34	0.95	1.79	9.54	82.87	5.51	0.30
S57	LSC	22.53	1.67	3.56	7.08	8.27	70.18	10.03

Table 3. PCB Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	Region	SumPCB	CB18	CB17	CB31/28	CB33	CB52	CB49
A004	SCR	0.14	0.05	ND	0.09	ND	ND	ND
A010	SCR	9.33	0.45	0.07	0.98	0.39	0.68	0.29
S14	SCR	5.77	0.22	0.02	0.49	0.37	0.52	0.33
S15	SCR	13.20	0.44	0.30	1.26	1.18	0.87	0.44
S24	SCR	9.99	0.47	0.04	1.33	0.51	0.69	0.45
S25	SCR	6.01	0.45	0.09	0.85	0.42	0.45	0.31
S27	SCR	7.12	0.39	0.02	0.92	0.35	0.48	0.28
UBC1-1	BC	29.63	1.26	0.18	4.58	1.62	2.18	1.34
UBC1-2	BC	26.98	1.18	0.27	4.43	1.51	2.09	1.29
UBC1-3	BC	43.51	1.65	0.28	5.55	1.78	2.62	1.56
DBC2-1	BC	28.08	1.21	0.10	2.06	0.60	1.33	0.71
DBC2-2	BC	13.43	0.34	0.04	2.06	0.74	0.78	0.45
DBC2-3	BC	13.74	0.56	0.12	1.59	0.69	0.65	0.47
UCC1-1	CC	11.05	0.40	0.10	1.47	0.46	0.68	0.35
UCC1-2	CC	7.89	0.31	0.05	1.40	0.23	0.56	0.39
UCC1-3	CC	6.95	0.30	0.02	1.15	0.34	0.49	0.33
A009	CC	16.96	0.71	0.23	1.73	0.71	0.34	0.46
DCC2-1	CC	1.60	0.07	0.01	0.12	0.02	0.12	0.09
DCC2-2	CC	2.60	0.09	0.04	0.22	ND	0.14	0.05
DCC2-3	CC	3.89	0.05	0.04	0.29	0.26	0.22	0.12
GL1	GL	2.91	0.16	ND	0.06	ND	0.18	0.07
GL2	GL	0.52	0.02	ND	0.07	ND	0.04	ND
UJC1-1	JC	25.74	0.93	0.15	2.66	1.09	1.52	0.99
UJC1-2	JC	19.29	0.74	0.09	2.34	0.73	1.58	0.96
UJC1-3	JC	13.17	0.58	0.06	2.13	0.62	1.26	0.70
A007	JC	10.41	0.62	0.07	1.59	0.40	1.00	0.60
A008	JC	12.24	0.57	0.02	1.77	0.62	0.75	0.41
DJC2-1	JC	23.70	0.84	0.06	2.63	1.19	1.41	0.82
DJC2-2	JC	29.58	0.61	0.08	2.36	0.88	1.29	0.96
DJC2-3	JC	19.06	0.58	0.11	2.16	0.94	0.91	0.64
UCE2-1	CE	5.53	0.37	0.03	0.53	0.23	0.55	0.36
UCE2-2	CE	11.03	0.21	0.04	0.74	0.16	0.66	0.25
UCE2-3	CE	3.05	0.12	0.02	0.38	0.10	0.31	0.20
UCE2-4	CE	8.25	0.29	0.04	1.21	0.36	0.85	0.45
AS29	CE	14.78	0.99	0.24	2.62	0.49	1.09	0.80
MCE2-1	CE	108.47	0.68	0.05	2.23	0.29	2.68	0.93
MCE2-2	CE	14.92	0.76	0.13	2.32	0.29	1.20	0.85
MCE2-3	CE	11.23	0.61	0.07	1.66	0.64	1.04	0.65
S28	CE	12.34	0.60	0.10	2.28	0.54	0.86	0.51
DCE3-1	CE	15.05	0.59	0.15	2.78	0.75	1.08	0.78
DCE3-2	CE	16.63	0.70	0.19	2.56	0.53	1.31	0.84
DCE3-3	CE	16.92	0.55	0.11	2.76	0.67	1.41	0.91
A001	LSC	0.03	ND	ND	0.03	ND	ND	ND
A005	LSC	0.14	0.06	ND	0.09	ND	ND	ND
A006	LSC	0.10	0.04	ND	0.06	ND	ND	ND
A53	LSC	6.64	0.20	ND	0.52	0.15	0.40	0.26
A003	LSC	0.04	0.01	ND	0.03	ND	ND	ND
S57	LSC	16.18	0.36	0.05	0.67	0.28	0.78	0.40

Table 3. PCB Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	CB44	CB74	CB70/76	CB95	CB101	CB99	CB87
A004	ND	ND	ND	ND	ND	ND	ND
A010	0.56	ND	0.51	0.47	0.74	0.30	0.19
S14	0.30	ND	0.37	0.32	0.47	0.15	0.26
S15	0.48	0.48	0.78	0.56	0.66	0.24	0.30
S24	0.44	ND	0.68	0.42	0.61	0.22	0.35
S25	0.18	ND	0.47	0.22	0.25	0.11	0.19
S27	0.32	ND	0.45	0.31	0.42	0.16	0.18
UBC1-1	1.76	ND	2.24	1.17	1.58	0.71	0.67
UBC1-2	1.35	ND	2.08	0.94	1.51	0.64	0.67
UBC1-3	2.07	ND	2.69	1.88	2.82	1.06	1.15
DBC2-1	0.80	ND	1.20	1.27	2.20	0.73	0.94
DBC2-2	0.57	ND	0.82	0.54	0.71	0.33	0.33
DBC2-3	0.48	ND	0.76	0.53	0.81	0.31	0.36
UCC1-1	0.40	0.45	0.58	0.45	0.70	0.25	0.31
UCC1-2	0.35	0.51	0.47	0.31	0.50	0.16	0.22
UCC1-3	0.45	ND	0.45	0.31	0.43	0.15	0.21
A009	0.41	ND	0.26	0.53	0.83	0.41	0.47
DCC2-1	0.11	ND	0.07	0.07	0.09	0.07	0.07
DCC2-2	0.06	ND	ND	0.12	0.14	0.07	0.09
DCC2-3	0.19	ND	0.01	0.18	0.21	0.13	0.16
GL1	0.08	0.08	0.13	0.15	0.21	0.09	0.08
GL2	ND	ND	0.06	0.02	0.06	ND	ND
UJC1-1	1.03	0.05	1.15	1.04	1.71	0.55	0.80
UJC1-2	1.00	0.05	0.92	0.89	1.19	0.49	0.53
UJC1-3	0.79	0.03	0.90	0.63	0.72	0.28	0.37
A007	0.65	ND	0.77	0.41	0.65	0.26	0.27
A008	0.50	ND	0.64	0.44	0.68	0.28	0.35
DJC2-1	0.87	ND	1.48	0.96	1.36	0.49	0.61
DJC2-2	0.80	ND	1.01	1.45	2.01	0.81	0.89
DJC2-3	0.60	ND	1.00	0.69	1.05	0.50	0.53
UCE2-1	0.34	ND	0.30	0.35	0.33	0.10	0.22
UCE2-2	0.34	ND	0.41	0.62	1.02	0.32	0.47
UCE2-3	0.20	0.06	0.16	0.20	0.23	0.07	0.09
UCE2-4	0.55	ND	0.47	0.40	0.51	0.19	0.23
AS29	1.10	ND	0.11	0.57	0.69	0.31	0.06
MCE2-1	1.23	ND	1.61	5.71	9.14	2.69	4.14
MCE2-2	0.84	ND	0.94	0.65	0.76	0.38	0.44
MCE2-3	0.68	ND	0.77	0.50	0.60	0.23	0.32
S28	0.65	ND	0.58	0.41	0.62	0.29	0.27
DCE3-1	0.97	0.08	0.97	0.55	0.75	0.34	0.31
DCE3-2	0.86	ND	1.16	0.59	0.78	0.35	0.40
DCE3-3	0.94	ND	1.16	0.65	0.76	0.41	0.42
A001	ND	ND	ND	ND	ND	ND	ND
A005	ND	ND	ND	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND
A53	0.29	ND	0.52	0.32	0.44	0.22	0.22
A003	ND	ND	ND	ND	ND	ND	ND
S57	0.52	ND	0.80	0.87	1.30	0.47	0.73

Table 3. PCB Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	CB110	CB82	CB151	CB149	CB118	CB153/132	CB105	CB138	CB158
A004	ND	ND	ND	ND	ND	ND	ND	ND	ND
A010	0.67	0.10	0.07	0.28	0.55	0.41	0.31	0.48	0.08
S14	0.44	ND	0.03	0.17	0.27	0.21	0.12	0.28	0.04
S15	0.73	0.22	0.09	0.29	0.61	0.62	0.35	0.56	0.06
S24	0.77	0.14	0.07	0.30	0.59	0.30	0.31	0.65	0.11
S25	0.34	0.04	0.07	0.15	0.24	0.23	0.19	0.30	ND
S27	0.62	0.08	0.06	0.22	0.42	0.37	0.22	0.40	0.08
UBC1-1	2.08	0.42	0.14	0.57	1.54	0.94	0.71	1.16	0.12
UBC1-2	1.69	0.15	0.15	0.68	1.39	0.91	0.75	1.20	0.17
UBC1-3	3.30	0.49	0.24	1.33	2.67	2.13	1.24	2.79	0.28
DBC2-1	2.25	0.20	0.24	1.17	2.10	2.09	1.06	2.52	0.31
DBC2-2	0.97	0.19	0.08	0.40	0.78	0.58	0.49	0.69	0.11
DBC2-3	0.88	0.16	0.08	0.41	0.84	0.74	0.36	0.93	0.13
UCC1-1	0.75	0.12	0.11	0.35	0.56	0.62	0.43	0.67	0.07
UCC1-2	0.49	0.16	0.05	0.19	0.32	0.27	0.16	0.28	0.03
UCC1-3	0.57	0.11	ND	0.22	0.30	0.23	0.23	0.26	0.06
A009	1.29	0.21	0.18	0.70	0.61	1.05	0.57	1.09	0.17
DCC2-1	0.14	ND	ND	0.04	0.07	0.16	0.06	0.10	ND
DCC2-2	0.20	ND	ND	0.10	0.19	0.24	0.11	0.23	0.04
DCC2-3	0.28	ND	0.04	0.16	0.28	0.29	0.18	0.33	0.06
GL1	0.23	ND	ND	0.12	0.21	0.25	0.10	0.24	0.05
GL2	0.05	ND	ND	0.04	0.04	0.06	ND	0.04	ND
UJC1-1	2.02	0.21	0.27	1.23	1.42	1.29	0.82	2.29	0.22
UJC1-2	1.53	0.11	0.12	0.67	1.07	1.04	0.47	1.11	0.17
UJC1-3	0.99	0.08	0.06	0.36	0.61	0.44	0.27	0.41	0.03
A007	0.85	0.04	0.05	0.31	0.52	0.40	0.18	0.39	0.06
A008	0.93	0.12	0.15	0.35	0.66	0.51	0.44	0.62	0.10
DJC2-1	1.72	0.16	0.15	0.80	1.28	1.32	0.81	1.47	0.21
DJC2-2	2.40	0.25	0.30	1.43	1.96	2.03	1.06	2.67	0.29
DJC2-3	1.35	0.22	0.20	0.59	1.13	0.98	0.61	1.45	0.15
UCE2-1	0.46	ND	0.08	0.20	0.27	0.28	0.15	0.29	0.02
UCE2-2	1.09	0.07	0.11	0.48	0.76	0.87	0.45	0.92	0.12
UCE2-3	0.29	ND	0.04	0.09	0.15	0.15	0.07	0.11	ND
UCE2-4	0.62	0.13	0.07	0.22	0.33	0.34	0.21	0.36	ND
AS29	0.93	0.17	0.12	0.42	0.68	0.73	0.48	0.86	0.13
MCE2-1	9.82	0.95	1.28	7.17	8.51	12.44	4.32	15.95	1.93
MCE2-2	1.09	0.18	0.11	0.38	0.68	0.69	0.42	0.71	0.10
MCE2-3	0.75	0.17	0.08	0.25	0.47	0.44	0.26	0.44	0.05
S28	0.68	0.14	0.11	0.32	0.48	0.61	0.48	0.58	0.18
DCE3-1	0.96	ND	0.13	0.40	0.72	0.66	0.44	0.64	0.07
DCE3-2	1.00	0.29	0.12	0.49	0.84	0.68	0.28	0.82	0.10
DCE3-3	1.00	0.26	0.14	0.49	0.73	0.67	0.32	0.77	0.12
A001	ND	ND	ND	ND	ND	ND	ND	ND	ND
A005	ND	ND	ND	ND	ND	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND	ND	ND
A53	0.63	0.07	0.08	0.22	0.46	0.26	0.20	0.42	0.07
A003	ND	ND	ND	ND	ND	ND	ND	ND	ND
S57	1.46	0.09	0.15	0.73	1.01	1.09	0.56	1.45	0.17

Table 3. PCB Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	CB187	CB183	CB128	CB177	CB171	CB156	CB180	CB191	CB170/190
A004	ND	ND	ND	ND	ND	ND	ND	ND	ND
A010	0.08	0.00	0.15	ND	ND	ND	0.15	ND	0.07
S14	0.03	ND	0.17	ND	ND	0.07	0.09	ND	ND
S15	0.06	0.06	0.12	ND	ND	0.06	0.17	ND	0.07
S24	0.09	0.03	0.25	ND	ND	ND	0.13	ND	ND
S25	0.04	ND	0.15	ND	ND	ND	0.04	ND	ND
S27	0.07	0.02	0.08	ND	ND	0.04	0.09	ND	0.06
UBC1-1	0.15	0.07	0.29	ND	ND	0.21	0.25	ND	0.13
UBC1-2	0.17	0.06	0.27	0.10	ND	0.17	0.30	ND	0.21
UBC1-3	0.27	0.11	0.65	0.15	0.10	0.46	0.55	ND	0.27
DBC2-1	0.22	0.12	0.45	0.13	0.08	0.38	0.45	ND	0.26
DBC2-2	0.09	0.06	0.24	0.08	ND	0.06	0.21	ND	0.10
DBC2-3	0.15	0.06	0.15	0.09	ND	0.32	0.23	ND	0.12
UCC1-1	0.09	0.04	0.07	0.05	ND	0.10	0.18	ND	0.07
UCC1-2	0.05	0.02	0.15	0.06	ND	0.10	0.11	ND	ND
UCC1-3	0.05	ND	0.11	ND	ND	ND	0.06	ND	0.08
A009	0.25	0.13	0.43	0.15	0.09	0.25	0.38	ND	0.27
DCC2-1	ND	ND	ND	ND	ND	ND	0.06	ND	ND
DCC2-2	0.05	ND	0.09	ND	ND	ND	0.11	ND	0.07
DCC2-3	0.09	ND	0.02	ND	ND	ND	0.09	ND	0.04
GL1	0.08	0.03	0.08	ND	ND	ND	0.11	ND	ND
GL2	ND	ND	ND	ND	ND	ND	0.02	ND	ND
UJC1-1	0.18	0.12	0.43	0.17	0.08	0.25	0.37	ND	0.16
UJC1-2	0.10	0.05	0.25	0.09	ND	0.14	0.17	ND	0.12
UJC1-3	0.06	0.05	0.17	0.03	ND	0.08	0.17	ND	0.08
A007	0.06	ND	0.11	ND	ND	ND	0.11	ND	0.04
A008	0.09	0.05	0.27	0.08	ND	0.18	0.13	ND	0.07
DJC2-1	0.20	0.08	0.31	0.10	0.06	0.17	0.36	ND	0.25
DJC2-2	0.24	0.16	0.47	0.20	0.17	0.23	0.49	ND	0.24
DJC2-3	0.14	0.09	0.41	0.12	0.06	0.29	0.33	ND	0.22
UCE2-1	ND	ND	ND	ND	ND	ND	0.08	ND	ND
UCE2-2	0.10	ND	0.27	0.09	ND	0.13	0.20	ND	0.11
UCE2-3	ND	ND	ND	ND	ND	ND	ND	ND	ND
UCE2-4	0.09	ND	0.16	0.06	ND	ND	0.11	ND	ND
AS29	0.13	0.10	0.25	0.11	ND	0.09	0.25	ND	0.13
MCE2-1	0.95	0.61	3.26	0.76	0.41	2.42	2.60	ND	1.99
MCE2-2	0.13	0.06	0.15	0.09	ND	0.17	0.20	ND	0.10
MCE2-3	0.09	ND	0.16	0.08	ND	ND	0.08	ND	0.08
S28	0.11	0.10	0.35	ND	ND	ND	0.20	ND	0.16
DCE3-1	0.12	0.05	0.09	0.08	ND	ND	0.27	ND	0.18
DCE3-2	0.16	0.09	0.11	0.12	ND	0.18	0.36	ND	0.16
DCE3-3	0.17	0.06	0.20	0.13	ND	0.12	0.26	ND	0.17
A001	ND	ND	ND	ND	ND	ND	ND	ND	ND
A005	ND	ND	ND	ND	ND	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND	ND	ND
A53	0.06	ND	0.19	ND	ND	ND	0.13	ND	0.07
A003	ND	ND	ND	ND	ND	ND	ND	ND	ND
S57	0.15	0.08	0.30	ND	ND	0.20	0.38	ND	0.26

Table 3. PCB Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	CB199	CB208	CB195	CB194	CB205	CB206	CB209
A004	ND	ND	ND	ND	ND	ND	ND
A010	0.08	ND	ND	ND	ND	ND	0.22
S14	ND	ND	ND	ND	ND	ND	ND
S15	ND	ND	ND	ND	ND	0.21	0.95
S24	ND	ND	ND	ND	ND	0.03	ND
S25	0.03	ND	ND	ND	ND	0.03	0.18
S27	ND	ND	ND	ND	ND	ND	ND
UBC1-1	0.08	0.05	ND	ND	ND	0.11	1.32
UBC1-2	ND	0.03	ND	ND	ND	0.07	0.55
UBC1-3	0.11	0.05	ND	0.12	ND	0.18	0.93
DBC2-1	0.03	0.06	ND	ND	ND	0.09	0.71
DBC2-2	0.08	0.02	ND	ND	ND	0.08	0.41
DBC2-3	0.07	0.04	ND	ND	ND	0.10	0.55
UCC1-1	ND	ND	ND	ND	ND	ND	0.17
UCC1-2	ND	ND	ND	ND	ND	ND	ND
UCC1-3	0.04	ND	ND	ND	ND	ND	ND
A009	0.15	0.12	ND	0.13	ND	0.58	1.05
DCC2-1	ND	ND	ND	ND	ND	0.06	ND
DCC2-2	0.06	0.05	ND	ND	ND	0.05	ND
DCC2-3	ND	ND	ND	ND	ND	ND	0.15
GL1	0.05	ND	ND	ND	ND	ND	0.09
GL2	ND	ND	ND	ND	ND	ND	ND
UJC1-1	0.05	0.04	ND	ND	ND	0.06	0.38
UJC1-2	0.10	0.04	ND	ND	ND	0.10	0.36
UJC1-3	0.05	ND	ND	ND	ND	ND	0.19
A007	ND	ND	ND	ND	ND	ND	ND
A008	0.04	ND	ND	ND	ND	0.06	0.36
DJC2-1	0.08	0.08	ND	ND	ND	0.13	1.24
DJC2-2	0.13	0.11	ND	ND	ND	0.16	1.43
DJC2-3	0.12	0.06	ND	ND	ND	0.17	0.68
UCE2-1	ND	ND	ND	ND	ND	ND	ND
UCE2-2	ND	ND	ND	ND	ND	ND	ND
UCE2-3	ND	ND	ND	ND	ND	ND	ND
UCE2-4	ND	ND	ND	ND	ND	ND	ND
AS29	0.11	ND	ND	ND	ND	ND	ND
MCE2-1	0.31	0.10	0.14	0.25	ND	0.53	0.39
MCE2-2	0.10	ND	ND	ND	ND	ND	ND
MCE2-3	0.07	ND	ND	ND	ND	ND	ND
S28	0.15	ND	ND	ND	ND	ND	ND
DCE3-1	0.14	ND	ND	ND	ND	ND	ND
DCE3-2	0.10	ND	ND	0.07	ND	ND	0.41
DCE3-3	0.09	0.04	0.07	0.05	ND	0.10	0.22
A001	ND	ND	ND	ND	ND	ND	ND
A005	ND	ND	ND	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND
A53	ND	0.03	ND	ND	ND	0.06	0.12
A003	ND	ND	ND	ND	ND	ND	ND
S57	ND	ND	ND	ND	ND	ND	0.87

Table 4. OC Pesticides (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	1245TCB	1234TCB	QCB	HCB	a-BHC	B-BHC	g-BHC	OCS
A004	0.75	ND	0.19	0.93	0.03	0.47	0.11	0.13
A010	ND	ND	1.33	6.24	ND	1.43	ND	3.05
S14	2.00	2.46	ND	2.81	ND	1.80	0.44	ND
S15	6.51	2.43	ND	18.21	ND	12.85	ND	ND
S24	1.36	ND	ND	4.83	ND	1.08	0.08	2.52
S25	1.30	0.36	0.33	0.25	0.28	0.83	0.30	0.04
S27	3.42	0.05	ND	8.14	ND	2.33	0.46	2.98
UBC1-1	3.31	ND	ND	6.56	0.10	1.77	0.28	8.77
UBC1-2	3.70	ND	ND	6.56	ND	2.63	0.27	7.13
UBC1-3	6.66	ND	ND	7.19	ND	8.08	0.77	12.55
DBC2-1	6.45	1.02	ND	18.46	0.36	ND	0.76	12.94
DBC2-2	5.37	ND	ND	14.53	ND	2.49	0.31	7.70
DBC2-3	4.54	ND	ND	14.50	0.02	3.22	0.37	4.20
UCC1-1	2.86	ND	ND	5.38	0.09	5.12	0.96	ND
UCC1-2	1.84	0.10	0.74	4.00	0.03	0.82	0.38	1.41
UCC1-3	1.87	0.08	0.74	3.80	0.03	0.28	0.08	1.23
A009	15.08	2.29	ND	3.32	ND	13.25	8.42	ND
DCC2-1	0.10	0.05	ND	0.34	0.04	0.74	0.16	ND
DCC2-2	0.79	0.67	ND	ND	ND	2.46	ND	ND
DCC2-3	6.20	0.32	ND	ND	ND	ND	ND	ND
GL1	3.82	ND	ND	ND	ND	ND	ND	ND
GL2	0.16	0.10	ND	ND	ND	ND	ND	ND
UJC1-1	1.79	0.50	ND	5.84	ND	0.40	ND	ND
UJC1-2	1.88	0.32	ND	5.34	0.03	0.35	0.07	3.87
UJC1-3	1.76	0.05	ND	4.12	ND	0.95	ND	ND
A007	0.37	0.00	ND	4.45	ND	0.31	0.04	2.44
A008	2.96	0.35	ND	8.85	ND	2.67	1.44	ND
DJC2-1	1.43	0.04	ND	8.60	ND	ND	ND	ND
DJC2-2	1.37	5.54	ND	9.20	ND	4.11	2.69	5.58
DJC2-3	3.11	1.88	ND	6.38	ND	2.66	0.66	6.18
UCE2-1	8.93	ND	ND	3.29	0.11	13.98	0.58	ND
UCE2-2	5.96	ND	ND	2.02	0.13	34.64	1.10	ND
UCE2-3	0.09	ND	ND	2.31	0.03	0.03	ND	0.92
UCE2-4	3.69	ND	ND	3.74	0.27	49.09	1.95	ND
AS29	5.58	3.31	ND	1.26	0.92	ND	1.64	ND
MCE2-1	0.26	1.12	ND	5.11	0.24	2.38	ND	ND
MCE2-2	6.06	14.06	ND	14.19	0.51	3.22	0.81	ND
MCE2-3	2.26	4.81	ND	6.74	0.72	5.50	1.75	ND
S28	1.43	66.76	ND	1.33	0.92	10.16	4.66	ND
DCE3-1	2.52	0.50	ND	3.38	0.02	2.43	0.30	ND
DCE3-2	5.63	2.02	ND	3.84	0.34	5.65	1.64	ND
DCE3-3	3.01	0.93	ND	3.80	0.02	2.04	0.49	ND
A001	0.12	ND	0.03	0.35	ND	ND	ND	0.13
A005	0.12	ND	0.05	0.33	ND	0.08	0.02	0.22
A006	0.23	ND	ND	0.34	ND	0.27	0.15	ND
A53	5.67	1.71	ND	10.97	ND	ND	ND	ND
A003	0.02	ND	0.01	0.07	ND	ND	0.01	0.03
S57	ND	ND	ND	1.46	ND	10.36	ND	ND

Table 4. OC Pesticides (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	Oxychlordane	t-chlordane	c-chlordane	t-nonachlor	p,p'-DDE	dieldrin
A004	ND	ND	ND	ND	0.02	0.02
A010	ND	0.25	ND	ND	0.27	0.18
S14	ND	ND	ND	ND	0.21	0.17
S15	ND	ND	ND	ND	ND	ND
S24	ND	0.10	0.07	ND	0.30	0.18
S25	0.38	0.27	0.31	0.31	0.35	0.44
S27	ND	0.19	0.04	0.02	0.34	0.21
UBC1-1	ND	0.47	ND	ND	0.31	0.15
UBC1-2	ND	0.48	ND	ND	0.32	0.21
UBC1-3	ND	0.82	ND	ND	0.47	0.51
DBC2-1	ND	0.58	ND	ND	0.69	0.38
DBC2-2	ND	0.20	0.07	0.03	0.40	0.21
DBC2-3	ND	0.24	ND	0.04	0.33	0.21
UCC1-1	ND	0.17	ND	ND	0.27	ND
UCC1-2	ND	0.20	0.01	ND	0.19	0.11
UCC1-3	ND	0.07	ND	ND	0.18	0.09
A009	ND	ND	ND	ND	0.77	ND
DCC2-1	ND	0.01	0.01	ND	0.26	ND
DCC2-2	ND	ND	ND	ND	0.45	ND
DCC2-3	ND	ND	ND	ND	0.84	ND
GL1	ND	ND	ND	ND	1.05	ND
GL2	ND	ND	ND	ND	0.28	ND
UJC1-1	ND	0.08	0.05	0.01	0.24	0.14
UJC1-2	ND	0.35	0.07	0.04	0.32	0.19
UJC1-3	ND	0.30	ND	ND	0.33	0.19
A007	ND	0.18	ND	ND	0.33	0.13
A008	ND	0.16	0.08	ND	0.40	0.12
DJC2-1	ND	ND	0.10	ND	0.51	0.25
DJC2-2	ND	0.16	0.11	0.06	0.54	0.30
DJC2-3	ND	0.24	0.08	ND	0.63	0.27
UCE2-1	ND	0.90	ND	ND	0.31	0.15
UCE2-2	ND	1.15	ND	ND	0.32	0.25
UCE2-3	ND	0.07	0.02	0.01	0.08	ND
UCE2-4	ND	3.40	ND	ND	0.74	ND
AS29	ND	0.33	0.20	0.14	1.15	ND
MCE2-1	ND	ND	0.32	ND	0.68	0.86
MCE2-2	ND	0.84	0.53	0.11	1.37	0.38
MCE2-3	ND	0.17	ND	ND	0.68	0.28
S28	ND	0.18	0.12	0.11	0.98	ND
DCE3-1	ND	0.54	0.21	0.13	1.29	ND
DCE3-2	ND	0.61	0.26	0.17	1.65	ND
DCE3-3	ND	0.54	0.18	0.11	1.25	ND
A001	ND	ND	ND	ND	0.03	0.02
A005	ND	ND	ND	ND	0.02	0.01
A006	ND	ND	ND	ND	0.06	ND
A53	ND	ND	0.29	ND	0.48	ND
A003	ND	ND	ND	ND	ND	ND
S57	ND	ND	ND	ND	0.30	0.17

Table 4. OC Pesticides (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	P,p'-DDD	c-nonachlor	p,p'-DDT	Mirex
A004	0.03	ND	ND	ND
A010	0.53	ND	0.12	0.05
S14	0.24	ND	ND	ND
S15	0.88	ND	ND	ND
S24	0.32	ND	0.13	0.02
S25	0.52	0.30	0.59	0.41
S27	0.83	ND	0.05	ND
UBC1-1	0.61	ND	0.19	0.07
UBC1-2	0.48	ND	0.17	0.10
UBC1-3	0.55	ND	0.10	0.10
DBC2-1	0.83	ND	0.51	0.04
DBC2-2	0.59	ND	0.20	0.04
DBC2-3	0.58	ND	0.21	ND
UCC1-1	0.47	ND	ND	ND
UCC1-2	0.27	ND	0.07	ND
UCC1-3	0.28	ND	0.06	ND
A009	1.25	ND	0.24	ND
DCC2-1	0.32	ND	ND	ND
DCC2-2	0.52	ND	ND	ND
DCC2-3	0.55	ND	ND	ND
GL1	1.55	ND	ND	ND
GL2	0.66	ND	ND	ND
UJC1-1	0.44	ND	0.34	ND
UJC1-2	0.51	ND	0.20	0.01
UJC1-3	0.50	ND	0.21	0.03
A007	0.52	ND	0.19	ND
A008	0.52	ND	0.15	ND
DJC2-1	0.65	ND	0.29	ND
DJC2-2	0.49	ND	0.62	ND
DJC2-3	ND	ND	0.36	ND
UCE2-1	0.40	0.06	0.23	ND
UCE2-2	0.34	0.09	0.37	ND
UCE2-3	0.17	ND	0.04	ND
UCE2-4	0.63	0.08	0.72	ND
AS29	0.98	ND	1.22	ND
MCE2-1	0.74	ND	ND	ND
MCE2-2	1.98	0.16	ND	0.09
MCE2-3	0.91	ND	0.32	0.02
S28	0.58	ND	1.19	ND
DCE3-1	1.11	0.05	1.65	ND
DCE3-2	1.53	0.07	0.96	ND
DCE3-3	1.16	0.06	1.09	ND
A001	0.04	ND	ND	ND
A005	0.03	ND	ND	ND
A006	0.10	ND	ND	ND
A53	0.90	ND	ND	ND
A003	ND	ND	ND	ND
S57	0.81	0.08	0.31	ND

Table 5. PAH Concentrations (µg/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	NA	AL	AE	FL	PHE	AN	FLT	PY
A004	0.001	0.000	0.000	0.001	0.005	0.001	0.002	0.003
A010	0.007	0.007	0.004	0.014	0.075	0.012	0.043	0.074
S14	0.004	0.002	0.002	0.007	0.039	0.006	0.023	0.025
S15	0.026	0.006	0.022	0.030	0.205	0.040	0.198	0.178
S24	0.010	0.005	0.004	0.012	0.078	0.015	0.066	0.071
S25	0.012	0.005	0.003	0.011	0.068	0.010	0.069	0.062
S27	0.013	0.004	0.003	0.009	0.059	0.016	0.096	0.112
UBC1-1	0.012	0.008	0.006	0.023	0.108	0.027	0.082	0.141
UBC1-2	0.009	0.009	0.005	0.020	0.096	0.023	0.076	0.127
UBC1-3	0.018	0.014	0.008	0.031	0.130	0.034	0.103	0.181
DBC2-1	0.020	0.010	0.005	0.016	0.103	0.019	0.107	0.111
DBC2-2	0.016	0.010	0.005	0.016	0.097	0.017	0.096	0.117
DBC2-3	0.025	0.014	0.006	0.019	0.115	0.021	0.105	0.126
UCC1-1	0.008	0.004	0.003	0.010	0.063	0.008	0.058	0.061
UCC1-2	0.006	0.002	0.002	0.008	0.044	0.008	0.040	0.042
UCC1-3	0.005	0.001	0.002	0.007	0.037	0.007	0.029	0.033
A009	0.016	0.008	0.003	0.014	0.085	0.014	0.100	0.145
DCC2-1	0.002	0.000	0.001	0.002	0.005	0.001	0.010	0.008
DCC2-2	0.003	0.001	0.001	0.003	0.014	0.002	0.020	0.019
DCC2-3	0.004	0.000	0.001	0.003	0.010	0.002	0.019	0.015
GL1	0.006	0.000	0.001	0.007	0.024	0.002	0.048	0.024
GL2	0.002	0.000	0.000	0.001	0.003	0.000	0.008	0.003
UJC1-1	0.026	0.006	0.009	0.025	0.143	0.030	0.105	0.139
UJC1-2	0.025	0.013	0.009	0.024	0.123	0.023	0.105	0.139
UJC1-3	0.016	0.006	0.008	0.018	0.159	0.025	0.157	0.176
A007	0.011	0.005	0.005	0.014	0.105	0.020	0.107	0.112
A008	0.014	0.008	0.005	0.016	0.103	0.017	0.107	0.130
DJC2-1	0.025	0.015	0.007	0.028	0.152	0.023	0.135	0.173
DJC2-2	0.021	0.016	0.007	0.022	0.132	0.023	0.133	0.164
DJC2-3	0.021	0.017	0.006	0.023	0.137	0.024	0.131	0.173
UCE2-1	0.012	0.003	0.003	0.006	0.041	0.005	0.025	0.030
UCE2-2	0.007	0.003	0.002	0.005	0.037	0.005	0.023	0.030
UCE2-3	0.001	0.000	0.001	0.002	0.015	0.003	0.008	0.011
UCE2-4	0.006	0.003	0.003	0.007	0.047	0.006	0.028	0.034
AS29	0.010	0.004	0.003	0.009	0.048	0.045	0.082	0.072
MCE2-1	0.025	0.005	0.005	0.013	0.070	0.016	0.050	0.063
MCE2-2	0.012	0.006	0.005	0.015	0.062	0.058	0.048	0.059
MCE2-3	0.019	0.004	0.005	0.014	0.077	0.018	0.068	0.075
S28	0.008	0.004	0.002	0.007	0.035	0.032	0.038	0.033
DCE3-1	0.006	0.005	0.002	0.007	0.044	0.005	0.061	0.067
DCE3-2	0.009	0.004	0.002	0.009	0.046	0.006	0.073	0.072
DCE3-3	0.003	0.005	0.002	0.009	0.049	0.007	0.073	0.080
A001	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.001
A005	0.085	0.049	0.029	0.039	0.605	0.120	1.110	1.120
A006	0.001	0.000	0.000	0.001	0.005	0.001	0.005	0.004
A53	0.004	0.003	0.001	0.006	0.031	0.004	0.045	0.047
A003	0.000	ND	ND	0.000	0.000	0.000	0.001	0.000
S57	0.024	0.006	0.010	0.014	0.097	0.013	0.124	0.109

Table 5. PAH Concentrations (µg/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	B(a)A	C&T	B(b)F	B(k)F	B(a)P	IP	D(a,h)A	B(g,h,i)P	sumPAH
A004	0.000	0.002	0.000	0.000	ND	ND	ND	ND	0.02
A010	0.028	0.049	0.018	0.008	0.021	0.013	0.008	0.024	0.41
S14	0.007	0.018	0.005	0.003	0.004	0.004	0.000	0.009	0.16
S15	0.100	0.112	0.084	0.035	0.097	0.079	0.014	0.086	1.31
S24	0.030	0.054	0.025	0.009	0.028	0.023	0.005	0.035	0.47
S25	0.031	0.045	0.025	0.012	0.027	0.027	0.004	0.031	0.44
S27	0.066	0.080	0.046	0.024	0.059	0.048	0.009	0.045	0.69
UBC1-1	0.055	0.085	0.032	0.012	0.046	0.028	0.010	0.040	0.71
UBC1-2	0.053	0.078	0.033	0.013	0.042	0.027	0.009	0.039	0.66
UBC1-3	0.072	0.103	0.046	0.016	0.054	0.035	0.012	0.049	0.90
DBC2-1	0.058	0.083	0.051	0.018	0.054	0.049	0.017	0.060	0.78
DBC2-2	0.059	0.081	0.057	0.019	0.061	0.050	0.012	0.064	0.78
DBC2-3	0.067	0.093	0.053	0.019	0.065	0.058	0.021	0.072	0.88
UCC1-1	0.026	0.043	0.019	0.011	0.022	0.020	0.004	0.021	0.38
UCC1-2	0.014	0.032	0.012	0.004	0.009	0.008	0.002	0.012	0.24
UCC1-3	0.010	0.029	0.009	0.004	0.007	0.006	0.001	0.009	0.19
A009	0.065	0.109	0.095	0.029	0.081	0.101	0.026	0.099	0.99
DCC2-1	0.002	0.007	0.003	0.002	0.001	0.002	0.000	0.003	0.05
DCC2-2	0.005	0.015	0.008	0.005	0.004	0.009	0.001	0.009	0.12
DCC2-3	0.005	0.014	0.007	0.005	0.003	0.006	0.001	0.007	0.10
GL1	0.008	0.020	0.006	0.011	0.001	0.014	0.001	0.009	0.18
GL2	0.001	0.003	0.001	0.002	0.000	ND	ND	ND	0.02
UJC1-1	0.083	0.109	0.052	0.017	0.064	0.050	0.021	0.069	0.95
UJC1-2	0.079	0.101	0.044	0.016	0.058	0.036	0.021	0.056	0.87
UJC1-3	0.112	0.132	0.081	0.031	0.108	0.081	0.025	0.086	1.22
A007	0.068	0.098	0.042	0.020	0.059	0.041	0.008	0.045	0.76
A008	0.075	0.097	0.060	0.018	0.071	0.051	0.015	0.057	0.85
DJC2-1	0.100	0.130	0.087	0.024	0.094	0.079	0.025	0.093	1.19
DJC2-2	0.102	0.132	0.102	0.033	0.107	0.119	0.035	0.114	1.26
DJC2-3	0.101	0.135	0.097	0.032	0.106	0.114	0.030	0.116	1.26
UCE2-1	0.010	0.023	0.009	0.005	0.003	0.004	0.001	0.011	0.19
UCE2-2	0.009	0.021	0.007	0.004	0.000	0.004	0.001	0.008	0.17
UCE2-3	0.002	0.006	0.000	0.001	0.000	ND	ND	ND	0.05
UCE2-4	0.011	0.027	0.009	0.005	0.002	0.005	0.002	0.013	0.21
AS29	0.036	0.056	0.053	0.016	0.032	0.047	0.008	0.052	0.57
MCE2-1	0.037	0.054	0.025	0.009	0.024	0.017	0.011	0.030	0.45
MCE2-2	0.028	0.045	0.022	0.005	0.022	0.015	0.006	0.027	0.43
MCE2-3	0.045	0.055	0.033	0.013	0.044	0.034	0.009	0.040	0.55
S28	0.016	0.033	0.023	0.009	0.016	0.026	0.005	0.036	0.32
DCE3-1	0.031	0.050	0.040	0.013	0.024	0.033	0.009	0.034	0.43
DCE3-2	0.038	0.060	0.052	0.015	0.037	0.054	0.011	0.047	0.54
DCE3-3	0.039	0.057	0.048	0.013	0.029	0.041	0.010	0.042	0.51
A001	ND	0.001	ND	0.000	ND	ND	ND	ND	0.01
A005	0.746	0.773	0.799	0.360	0.650	0.888	0.190	0.599	8.16
A006	0.001	0.003	0.000	0.001	ND	ND	ND	ND	0.02
A53	0.020	0.035	0.021	0.009	0.017	0.016	0.005	0.020	0.29
A003	ND	0.000	ND	ND	ND	ND	ND	ND	0.00
S57	0.052	0.080	0.056	0.026	0.039	0.043	0.008	0.052	0.75

Table 6. PBDe Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	BDE-3	BDE-7	BDE-15	BDE-17	BDE-28	BDE49	BDE-47	BDE-66	BDE-77
A004	ND	ND	ND	ND	0.02	ND	ND	ND	ND
A010	ND	ND	0.21	ND	ND	ND	ND	ND	ND
S14	0.03	ND	0.07	ND	ND	ND	0.02	ND	ND
S15	0.03	ND	0.05	ND	ND	ND	0.05	ND	ND
S24	0.20	ND	0.22	ND	ND	ND	0.10	ND	ND
S25	0.02	ND	0.07	ND	ND	ND	0.03	ND	ND
S27	0.07	ND	0.37	ND	ND	ND	0.06	ND	ND
UBC1-1	0.15	ND	0.81	ND	0.03	ND	0.04	ND	ND
UBC1-2	ND	ND	0.78	ND	0.04	ND	0.07	ND	ND
UBC1-3	0.14	ND	0.91	ND	0.04	ND	0.04	ND	ND
DBC2-1	0.10	ND	0.17	ND	0.02	ND	0.10	ND	ND
DBC2-2	0.12	ND	0.21	ND	ND	ND	0.12	ND	ND
DBC2-3	0.12	ND	0.18	ND	0.03	ND	0.04	ND	ND
UCC1-1	0.08	ND	0.25	ND	ND	ND	0.07	ND	ND
UCC1-2	0.08	ND	0.25	ND	ND	ND	ND	ND	ND
UCC1-3	0.06	ND	0.27	ND	0.03	ND	0.05	ND	ND
A009	0.30	ND	0.31	ND	ND	ND	0.06	ND	ND
DCC2-1	ND	ND	0.04	ND	ND	ND	ND	ND	0.05
DCC2-2	ND	ND	0.06	ND	ND	ND	0.05	ND	ND
DCC2-3	ND	ND	0.06	ND	ND	ND	ND	ND	ND
GL1	ND	ND	0.02	ND	ND	ND	ND	ND	ND
GL2	ND	ND	ND	ND	ND	ND	ND	ND	ND
UJC1-1	ND	ND	0.35	ND	ND	ND	0.04	ND	ND
UJC1-2	ND	ND	0.25	ND	ND	ND	0.07	ND	ND
UJC1-3	ND	ND	0.27	ND	ND	ND	0.07	ND	ND
A007	ND	ND	0.25	ND	ND	ND	0.13	ND	ND
A008	0.08	ND	0.22	ND	ND	ND	0.11	ND	ND
DJC2-1	ND	ND	0.19	ND	ND	ND	0.14	ND	0.08
DJC2-2	ND	ND	0.15	ND	ND	ND	0.11	ND	ND
DJC2-3	ND	ND	0.18	ND	0.02	ND	0.11	ND	ND
UCE2-1	0.21	ND	0.31	ND	0.03	ND	0.14	ND	ND
UCE2-2	0.16	ND	0.19	ND	ND	ND	0.09	ND	0.04
UCE2-3	0.04	ND	0.17	ND	0.07	ND	0.06	0.05	0.06
UCE2-4	0.19	ND	0.30	ND	0.04	ND	0.12	ND	ND
AS29	0.05	ND	0.05	ND	ND	ND	0.11	ND	ND
MCE2-1	0.06	ND	0.13	ND	0.01	ND	0.05	ND	ND
MCE2-2	0.14	ND	0.31	ND	0.01	0.02	0.11	ND	ND
MCE2-3	0.04	ND	0.13	ND	ND	ND	0.04	ND	ND
S28	0.13	ND	0.04	ND	ND	ND	0.16	ND	ND
DCE3-1	ND	ND	0.08	ND	ND	ND	0.19	ND	ND
DCE3-2	ND	ND	0.13	ND	0.02	0.05	0.18	ND	ND
DCE3-3	ND	ND	0.12	0.03	0.04	0.04	0.27	ND	ND
A001	0.02	ND	0.02	ND	0.03	ND	ND	ND	ND
A005	ND	ND	ND	ND	0.01	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND	ND	ND
A53	ND	ND	0.14	ND	ND	ND	0.06	ND	ND
A003	ND	ND	ND	ND	ND	ND	0.04	ND	0.14
S57	0.18	ND	0.17	ND	0.04	ND	0.15	ND	ND

Table 6. PBDe Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	BDE100	BDE119	BDE99	BDE-28	BDE85	BDE126	BDE154	BDE153	BDE138
A004	0.03	ND	ND	ND	ND	ND	ND	ND	ND
A010	0.14	ND	0.11	ND	0.15	ND	ND	ND	ND
S14	0.04	ND	0.04	ND	ND	ND	ND	ND	ND
S15	0.03	ND	0.05	ND	ND	ND	ND	ND	ND
S24	0.09	ND	ND	ND	0.10	ND	ND	ND	ND
S25	0.06	ND	0.04	ND	ND	ND	ND	ND	ND
S27	0.07	ND	ND	ND	0.11	ND	ND	ND	ND
UBC1-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
UBC1-2	0.07	ND	ND	ND	ND	ND	ND	ND	ND
UBC1-3	0.11	ND	ND	ND	ND	ND	ND	ND	ND
DBC2-1	ND	ND	0.07	ND	ND	ND	ND	ND	ND
DBC2-2	0.09	ND	0.19	ND	ND	ND	ND	ND	ND
DBC2-3	0.04	ND	0.13	ND	ND	ND	ND	ND	ND
UCC1-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
UCC1-2	0.13	ND	0.14	ND	ND	ND	ND	ND	ND
UCC1-3	0.05	ND	ND	ND	ND	ND	ND	ND	ND
A009	0.43	0.31	ND	ND	ND	ND	ND	ND	ND
DCC2-1	ND	ND	ND	ND	3.72	ND	ND	ND	ND
DCC2-2	0.07	ND	0.04	ND	ND	ND	ND	ND	ND
DCC2-3	0.06	ND	ND	ND	ND	ND	ND	ND	ND
GL1	0.02	ND	ND	0.04	ND	ND	ND	ND	ND
GL2	ND	ND	ND	ND	ND	ND	ND	ND	ND
UJC1-1	0.07	ND	ND	ND	ND	ND	ND	ND	ND
UJC1-2	ND	ND	ND	ND	ND	ND	ND	ND	ND
UJC1-3	ND	ND	ND	ND	ND	ND	ND	ND	ND
A007	ND	ND	0.17	ND	ND	ND	ND	ND	ND
A008	ND	ND	ND	ND	0.33	ND	0.14	ND	ND
DJC2-1	0.14	ND	0.29	ND	3.85	ND	ND	ND	ND
DJC2-2	0.09	ND	0.17	ND	0.48	ND	ND	ND	ND
DJC2-3	0.21	ND	0.10	ND	ND	ND	ND	ND	ND
UCE2-1	0.11	0.06	ND	ND	ND	ND	ND	ND	ND
UCE2-2	0.11	ND	0.15	ND	0.06	ND	ND	ND	ND
UCE2-3	ND	ND	ND	ND	0.26	ND	ND	ND	ND
UCE2-4	0.05	ND	0.09	ND	ND	ND	ND	ND	ND
AS29	0.06	ND	0.08	ND	ND	ND	ND	ND	ND
MCE2-1	0.06	0.04	0.06	ND	ND	ND	ND	ND	ND
MCE2-2	0.07	0.06	0.12	ND	ND	ND	ND	ND	ND
MCE2-3	0.07	0.05	0.06	ND	ND	ND	ND	ND	ND
S28	0.24	ND	0.13	ND	ND	ND	ND	ND	ND
DCE3-1	0.12	ND	0.19	ND	0.29	ND	ND	ND	ND
DCE3-2	0.06	ND	0.23	ND	0.32	ND	ND	ND	ND
DCE3-3	0.09	ND	0.11	ND	0.39	0.14	0.17	ND	ND
A001	ND	ND	ND	ND	ND	ND	ND	ND	ND
A005	ND	ND	ND	ND	0.48	ND	ND	ND	ND
A006	ND	ND	ND	ND	ND	ND	ND	ND	ND
A53	0.04	ND	ND	ND	0.20	ND	ND	ND	ND
A003	0.07	ND	ND	ND	6.48	ND	ND	ND	ND
S57	0.05	ND	0.12	ND	ND	ND	ND	ND	ND

Table 6. PBDe Concentrations (ng/g dry wt.) in 2012 Walpole Delta sediment samples.

Site	BDE184	BDE183	BDE191	BDE197	BDE196	BDE207	BDE206	BE209	SumBDE
A004	ND	ND	ND	ND	ND	ND	ND	ND	0.06
A010	ND	ND	ND	ND	ND	ND	ND	ND	0.62
S14	ND	ND	ND	ND	ND	ND	ND	ND	0.20
S15	ND	ND	ND	ND	ND	ND	ND	ND	0.21
S24	ND	ND	ND	ND	ND	ND	ND	ND	0.71
S25	ND	ND	ND	ND	ND	ND	ND	ND	0.23
S27	ND	ND	ND	ND	ND	ND	ND	ND	0.69
UBC1-1	ND	ND	ND	ND	ND	ND	ND	ND	1.03
UBC1-2	ND	ND	ND	ND	ND	ND	ND	ND	0.95
UBC1-3	ND	ND	ND	ND	ND	ND	ND	ND	1.23
DBC2-1	ND	ND	ND	ND	ND	ND	ND	ND	0.46
DBC2-2	ND	ND	ND	ND	ND	ND	ND	ND	0.73
DBC2-3	ND	ND	ND	ND	ND	ND	ND	ND	0.54
UCC1-1	ND	ND	ND	ND	ND	ND	ND	ND	0.40
UCC1-2	ND	ND	ND	ND	ND	ND	ND	ND	0.60
UCC1-3	ND	ND	ND	ND	ND	ND	ND	ND	0.46
A009	ND	ND	ND	ND	ND	ND	ND	ND	1.41
DCC2-1	ND	ND	ND	ND	ND	ND	ND	ND	3.81
DCC2-2	ND	ND	ND	ND	ND	ND	ND	ND	0.22
DCC2-3	ND	ND	ND	ND	ND	ND	ND	5.13	5.25
GL1	ND	ND	ND	ND	ND	ND	ND	ND	0.08
GL2	ND	ND	ND	ND	ND	ND	ND	ND	ND
UJC1-1	ND	ND	ND	ND	ND	ND	ND	ND	0.47
UJC1-2	ND	ND	ND	ND	ND	ND	ND	ND	0.32
UJC1-3	ND	ND	ND	ND	ND	ND	ND	ND	0.34
A007	ND	ND	ND	ND	ND	ND	ND	ND	0.55
A008	ND	ND	ND	ND	ND	ND	ND	ND	0.88
DJC2-1	ND	ND	ND	ND	ND	ND	ND	ND	4.68
DJC2-2	ND	ND	ND	ND	ND	ND	ND	ND	1.00
DJC2-3	ND	ND	ND	ND	ND	ND	ND	ND	0.61
UCE2-1	ND	ND	ND	ND	ND	ND	ND	ND	ND
UCE2-2	ND	ND	ND	ND	ND	ND	ND	ND	0.78
UCE2-3	ND	ND	ND	ND	ND	ND	ND	9.10	9.81
UCE2-4	ND	ND	ND	ND	ND	ND	ND	ND	0.80
AS29	ND	ND	ND	ND	ND	ND	ND	ND	0.35
MCE2-1	ND	ND	ND	ND	ND	ND	ND	ND	0.42
MCE2-2	ND	ND	ND	ND	ND	ND	ND	ND	0.84
MCE2-3	ND	ND	ND	ND	ND	ND	ND	ND	0.40
S28	ND	ND	ND	ND	ND	ND	ND	ND	0.70
DCE3-1	ND	ND	ND	ND	ND	ND	ND	ND	0.86
DCE3-2	ND	ND	ND	ND	ND	ND	ND	ND	0.98
DCE3-3	ND	ND	ND	ND	ND	ND	ND	ND	1.41
A001	ND	ND	ND	ND	ND	ND	ND	ND	0.07
A005	ND	ND	ND	ND	ND	ND	ND	ND	0.50
A006	ND	ND	ND	ND	ND	ND	ND	ND	ND
A53	ND	ND	ND	ND	ND	ND	ND	ND	0.44
A003	ND	ND	ND	ND	ND	ND	ND	ND	6.74
S57	ND	ND	ND	ND	ND	ND	ND	ND	0.71

Table 7. Trace Element Concentrations (ug/g dry wt.) in 2012 Walpole Delta sediments.

Site	Total Hg	Al	As	Bi	Ca	Cd	Co
A004	RDL	1267.72	11.90	4.64	22656.13	1.74	2.01
A010	0.46	1622.78	11.17	5.86	16299.92	1.92	1.97
S14	0.14	1680.24	11.55	6.47	21058.92	2.05	2.12
S15	0.18	2656.15	3.06	10.13	20275.72	1.44	3.10
S24	0.19	2788.35	2.39	9.35	24469.07	1.27	2.98
S25	0.14	3042.67	2.49	9.42	20492.95	1.26	2.93
S27	0.21	3660.17	2.71	12.55	24687.85	1.49	3.57
UBC1-1	0.79	2397.67	13.21	8.70	22601.87	2.67	3.15
UBC1-2	0.84	3645.84	17.32	12.47	25716.37	3.36	4.09
UBC1-3	0.81	2375.17	13.39	8.68	21990.08	2.59	3.20
DBC2-1	0.50	3781.44	2.52	11.67	24725.36	1.66	3.70
DBC2-2	0.30						
DBC2-3	0.34	3347.83	2.23	10.35	22330.55	1.48	3.35
UCC1-1	0.30	1628.97	10.47	6.07	19959.71	1.85	2.37
UCC1-2	0.22	1274.23	10.68	4.86	18787.92	1.64	1.95
UCC1-3	0.20	1706.21	11.33	6.86	20686.32	1.78	2.25
A009	0.60	3035.61	10.50	8.89	8911.88	2.09	2.99
DCC2-1	0.05	1994.41	10.19	7.00	7555.94	1.71	2.24
DCC2-2	0.11	1855.34	8.41	6.00	6306.86	1.57	2.20
DCC2-3	0.09						
GL1	0.10	1592.31	8.50	5.55	14341.55	1.42	1.60
GL2	RDL	823.11	7.33	4.93	5028.63	0.80	0.87
UJC1-1	0.33	2174.45	2.94	6.08	24491.43	1.45	3.22
UJC1-2	0.52	2088.71	13.48	7.52	26052.92	2.71	2.96
UJC1-3	0.38	2046.54	13.68	7.87	24631.11	2.83	2.62
A007	0.23	2420.02	12.68	8.73	23404.93	2.18	2.36
A008	0.41	2514.74	13.34	8.10	24300.29	2.37	2.76
DJC2-1	0.27	3455.86	2.07	7.37	20117.17	1.46	3.26
DJC2-2	0.45	3288.80	2.57	8.93	20871.73	1.49	3.27
DJC2-3	0.46	3220.50	2.71	9.84	21095.72	1.48	3.29
UCE2-1	0.28	2613.88	2.00	7.66	21720.68	1.20	2.61
UCE2-2	0.15	909.55	8.36	4.26	10804.13	1.15	1.41
UCE2-3	0.32	2107.77	12.35	6.09	19257.46	2.50	2.65
UCE2-4	0.10	2505.39	14.01	7.90	21354.25	2.43	2.62
AS29	0.21	7004.58	2.07	13.19	16309.17	1.98	4.35
MCE2-1	0.27	3077.48	14.24	9.84	23655.99	2.95	2.88
MCE2-2	0.28	3554.71	16.35	11.56	23439.38	3.19	3.02
MCE2-3	0.53	3088.04	14.65	9.65	23924.42	2.64	2.78
S28	0.09	6518.62	1.67	14.57	9871.21	1.50	3.07
DCE3-1	0.16	7556.14	1.98	13.46	18562.40	2.18	4.31
DCE3-2	0.17	6978.20	2.24	13.49	19615.90	2.21	4.60
DCE3-3	0.26	5787.37	2.18	13.53	19999.92	1.98	4.44
A001	0.13	935.73	10.20	4.32	8078.89	1.45	1.99
A005	0.04	942.13	8.98	4.22	11719.66	1.41	1.38
A006	0.03	1097.25	9.52	4.79	10914.91	1.64	1.63
A53	0.23	3084.77	12.51	9.53	27516.67	2.20	2.52
A003	RDL	943.48	7.51	4.63	3095.86	1.40	1.74
S57	0.58	2019.61	12.32	7.12	19001.23	2.24	2.58

Table 7. Trace Element Concentrations (ug/g dry wt.) in 2012 Walpole Delta sediments.

Site	Cr	Cu	Fe	K	Mg	Mn	Na	Ni
A004	15.40	0.59	3728.42	178.79	39553.49	98.41	117.37	3.54
A010	17.69	3.59	4089.43	359.68	51228.78	88.31	134.86	4.39
S14	18.36	2.79	4192.61	409.56	53156.94	106.22	121.92	4.35
S15	24.78	6.71	5849.73	756.01	51537.39	123.50	128.66	7.71
S24	23.95	6.54	4964.79	668.52	72274.11	142.16	166.12	7.14
S25	24.12	6.40	5228.76	760.67	60046.40	155.20	161.59	7.41
S27	27.39	9.17	6276.36	1024.90	66595.86	157.55	175.18	9.12
UBC1-1	24.23	6.35	5244.26	567.77	78564.59	127.51	159.66	6.69
UBC1-2	30.67	11.00	7318.14	944.12	75822.80	177.21	196.29	10.16
UBC1-3	23.21	6.19	5248.34	586.93	75528.27	122.31	153.81	6.53
DBC2-1	30.63	10.10	7071.46	1025.03	73862.07	166.85	219.04	9.83
DBC2-2								
DBC2-3	26.96	8.91	6107.71	897.85	69035.72	151.16	178.64	8.60
UCC1-1	16.20	3.44	3443.43	362.46	50252.94	100.96	148.84	4.61
UCC1-2	14.22	3.54	2978.61	262.95	42886.99	90.25	148.81	4.01
UCC1-3	16.16	2.89	3392.66	405.88	49167.48	99.02	162.81	4.48
A009	20.23	11.10	4401.10	776.62	38378.28	69.17	127.00	7.77
DCC2-1	14.34	2.31	3217.23	440.08	25386.16	53.67	137.06	4.71
DCC2-2	15.38	1.53	3012.84	370.93	22973.32	45.90	114.74	4.85
DCC2-3								
GL1	13.36	1.91	2824.95	367.37	41761.59	74.21	159.43	3.31
GL2	6.03	DL	1675.32	135.29	12869.14	40.85	129.18	1.55
UJC1-1	25.60	4.94	5931.62	451.48	59131.84	162.66	140.66	6.77
UJC1-2	22.25	6.44	5178.18	478.98	60344.57	141.77	170.35	6.44
UJC1-3	24.65	3.29	5524.64	500.87	56091.39	138.31	162.55	5.27
A007	20.01	4.89	4467.03	609.92	60239.81	135.70	177.11	5.51
A008	22.25	7.59	4809.12	615.62	77899.70	127.87	179.31	6.54
DJC2-1	26.88	9.12	5718.20	829.01	58975.34	153.06	139.30	8.78
DJC2-2	27.14	10.43	5769.10	818.88	62248.62	149.13	127.26	8.80
DJC2-3	26.55	10.35	5815.92	807.49	58278.01	141.47	151.85	8.85
UCE2-1	23.15	4.55	5264.12	660.81	51968.18	139.39	116.68	6.65
UCE2-2	9.75	0.84	2328.16	163.09	23111.44	66.42	136.81	2.69
UCE2-3	22.19	4.13	5253.53	497.73	44105.40	122.50	144.15	6.30
UCE2-4	21.71	5.12	5018.72	627.71	48691.81	131.21	181.73	6.54
AS29	38.89	11.20	9012.24	1763.05	35934.01	192.06	158.08	12.90
MCE2-1	25.70	3.41	5373.50	736.83	47353.97	132.35	179.78	6.44
MCE2-2	26.59	6.73	5723.34	877.12	47812.75	133.22	199.60	7.66
MCE2-3	24.04	5.76	5506.56	788.46	52882.64	138.67	193.00	6.96
S28	31.28	7.30	6957.68	1848.34	25139.60	131.10	175.65	10.22
DCE3-1	42.34	12.22	8931.28	1993.92	42099.56	188.75	276.11	13.58
DCE3-2	42.57	13.67	9432.72	1784.78	48899.88	197.82	212.64	13.95
DCE3-3	38.11	13.27	8482.57	1407.64	50339.29	183.29	211.06	12.94
A001	11.86	DL	3008.64	122.10	23930.99	75.21	110.69	2.47
A005	11.91	DL	2836.20	172.48	26073.78	61.38	95.52	2.40
A006	14.10	DL	3227.40	203.80	35249.44	71.51	112.30	2.69
A53	21.03	5.13	4647.34	798.63	74946.52	113.71	150.70	6.15
A003	11.17	DL	3050.52	125.54	5861.95	49.65	99.95	2.19
S57	20.66	3.47	4446.68	460.21	68452.04	115.82	142.79	5.06

Table 7. Trace Element Concentrations (ug/g dry wt.) in 2012 Walpole Delta sediments.

Site	Pb	Sb	V	Zn
A004	2.41	134.94	7.00	9.55
A010	3.87	311.32	10.10	17.60
S14	2.84	336.23	10.88	17.44
S15	4.36	723.59	14.66	26.75
S24	3.63	603.08	11.98	30.58
S25	3.78	562.52	11.71	24.66
S27	4.53	850.59	14.77	34.38
UBC1-1	5.63	441.64	11.17	30.52
UBC1-2	7.03	634.82	14.28	35.27
UBC1-3	6.88	420.00	10.92	30.64
DBC2-1	5.99	611.97	14.91	33.46
DBC2-2				
DBC2-3	4.70	548.08	13.18	31.50
UCC1-1	3.37	466.59	7.64	19.78
UCC1-2	3.36	385.44	6.19	17.31
UCC1-3	3.02	477.39	8.18	19.66
A009	7.71	881.17	10.82	26.30
DCC2-1	2.74	460.36	7.37	17.81
DCC2-2	2.52	452.03	6.96	14.20
DCC2-3				
GL1	4.86	777.19	6.29	16.69
GL2	2.40	173.50	4.04	7.55
UJC1-1	4.46	428.94	11.90	26.20
UJC1-2	5.34	426.37	10.90	26.02
UJC1-3	4.65	320.10	13.34	22.60
A007	2.92	345.89	10.71	20.61
A008	4.20	459.33	11.41	26.09
DJC2-1	4.49	487.37	12.13	30.63
DJC2-2	5.43	519.73	12.66	31.35
DJC2-3	5.64	585.65	12.19	30.83
UCE2-1	4.28	392.83	11.68	22.93
UCE2-2	3.73	80.69	5.30	8.80
UCE2-3	4.76	353.26	10.44	28.70
UCE2-4	4.30	393.15	10.26	21.59
AS29	5.20	331.03	19.56	40.42
MCE2-1	3.99	381.82	13.73	21.85
MCE2-2	4.74	453.52	13.52	30.14
MCE2-3	3.67	453.87	13.11	24.98
S28	2.75	264.07	18.42	30.04
DCE3-1	4.81	420.83	21.49	39.80
DCE3-2	5.40	410.93	20.85	42.47
DCE3-3	5.93	444.03	18.29	38.13
A001	2.15	72.51	5.44	13.83
A005	2.14	89.01	6.87	8.99
A006	1.74	76.86	9.01	14.39
A53	2.84	624.26	11.78	25.79
A003	1.56	54.29	7.50	6.86
S57	3.65	250.60	10.64	26.77

Table 8. Number of samples having chemical concentrations in sediments that exceed Great Lakes backround concentrations (OMOE), OMOE Threshold Effect Concentration (TEC) and OMOE Probable Effect Concentration (PEC) values in the Walpole Delta.

Chemical	NA	2012 #Sites >Background (Great Lakes)	2004/05 # Sites >TEC	2012 # Sites >TEC	2004/05 #Sites >PEC	2012 #Sites >PEC
Total PCBs	NA	8	0	1	0	0
HCB	NA	NA	10	0	0	0
a-BHC	NA	0	NA	0	NA	0
B-BHC	NA	27	NA	11	NA	0
G-BHC	NA	9	NA	2	NA	0
Chlordane	NA	5	NA	0	NA	0
p,p’-DDE	NA	0	NA	0	NA	0
Dieldrin	NA	0	NA	0	NA	0
p,p’-DDD	NA	0	NA	0	NA	0
p,p’-DDT	NA	0	NA	0	NA	0
mirex	NA	0	NA	0	NA	0
FL	NA	NA	1	0	0	0
PHE	NA	NA	1	1	0	0
AN	NA	NA	2	0	0	0
FLT	NA	NA	1	1	0	0
PY	NA	NA	2	1	0	0
B(a)A	NA	NA	1	1	0	0
C&T	NA	NA	2	1	0	0
B(k)F	NA	NA	0	1	0	0
B(a)P	NA	NA	0	1	0	0
IP	NA	NA	0	1	0	0
D(ah)A	NA	NA	2	1	0	0
B(ghi)P	NA	NA	1	1	0	0
Sum PAHS	NA	NA	1	1	0	0
Mercury	38	38	34	29	0	0
As	1	30	0	29	0	0
Cd	0	45	11	30	0	0
Cr	1	5	2	46	0	0
Cu	5	0	18	13	0	0
Fe	0	0	3	0	0	0
Mn	2	0	1	0	0	0
Ni	1	0	9	0	0	0
Pb	0	0	0	0	0	0
Zn	5	0	0	0	0	0

Table 9. Chemicals having strong loadings (R>0.6) onto principle component axes 1&2 as derived using the 2012 data set.

Factor 1 (51.2% of variation)	Factor 2 (19.6% of variation)	Non-Loaded Chemicals No Axis Affiliation
%TOC, 63µm fraction, <63µm fraction Sum PCBs, CB18, CB17, CB31/28, CB33, CB52, CB49, CB44, CB70/76, CB95/66, CB101, CB99, CB87, CB110, CB82, CB151, CB149, CB118, CB153/132, CB105, CB138, CB158, CB187, CB183, CB128, CB180, CB170/190, HCB, p,p'-DDE, p,p'-DDT, sum PAHs, Na, Al, AE, FL< PHE, AN, FLT, PY, B(a)A, C&T, B(b)F, B(k)F, B(a)P, IP, D(ah)A, B(ghi)P, BDE15, BDE47, total Hg, Cu	Al, As, Bi, Ca, Cd, Co, Cr, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, V, Zn	1,2,4,5-TCB, 1,2,3,4-TCB, b-BHC, g-BHC, trans-chlordane, dieldrin, p,p'-DDD, BDE-100, sum PBDEs,

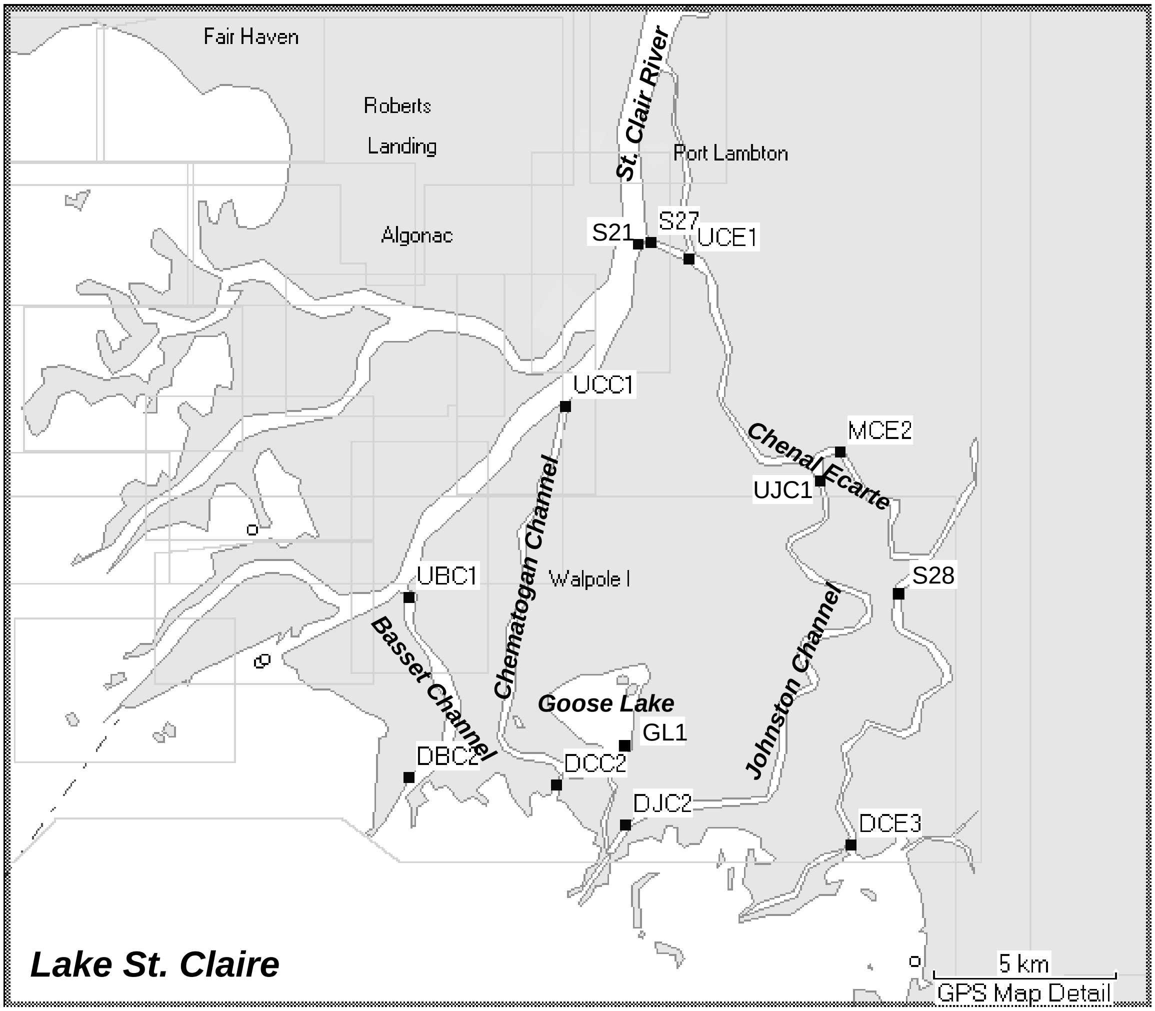

Figure 1. Localization of sampling sites for the Walpole Delta in the 2005 survey.

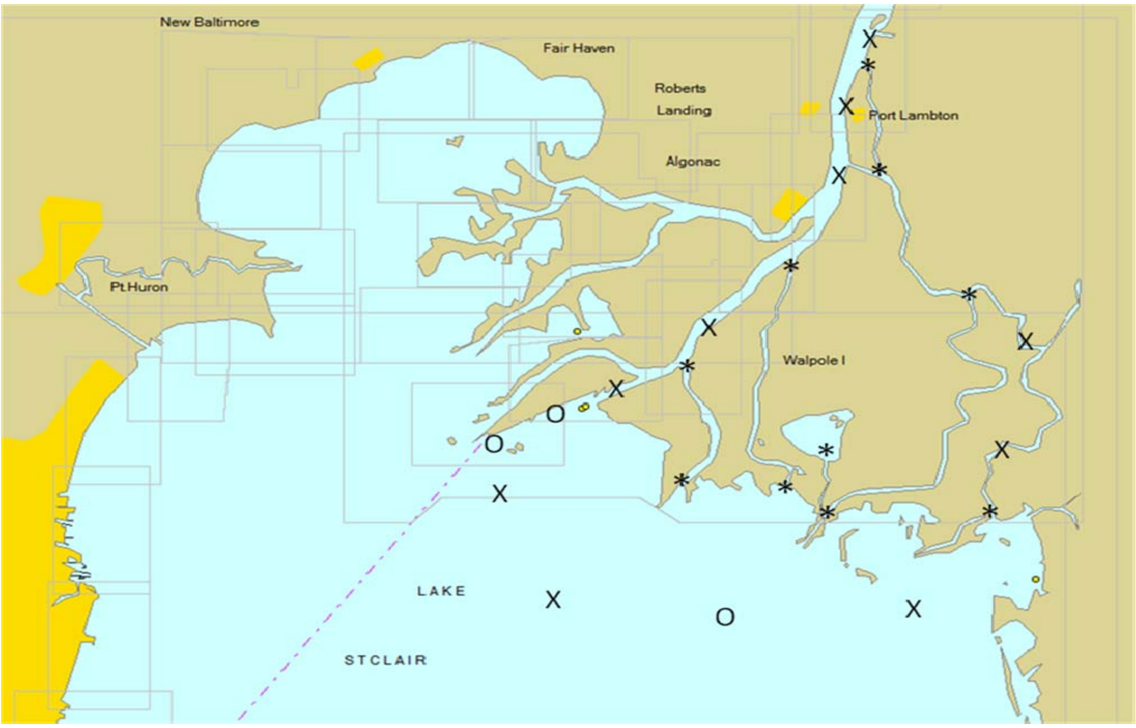

Figure 2. Localization of sampling sites for the Walpole Delta in the 2012 survey. Symbols designed by (*) refer to survey stations repeatedly sampled (2005 Walpole Delta Survey Station) . Stations designated by (X) refer to survey stations used in the 2004 Huron-Erie Corridor sediment survey. Stations designated by (O) refer to supplemental stations added to address special concerns and spatial gaps in the overall sampling design

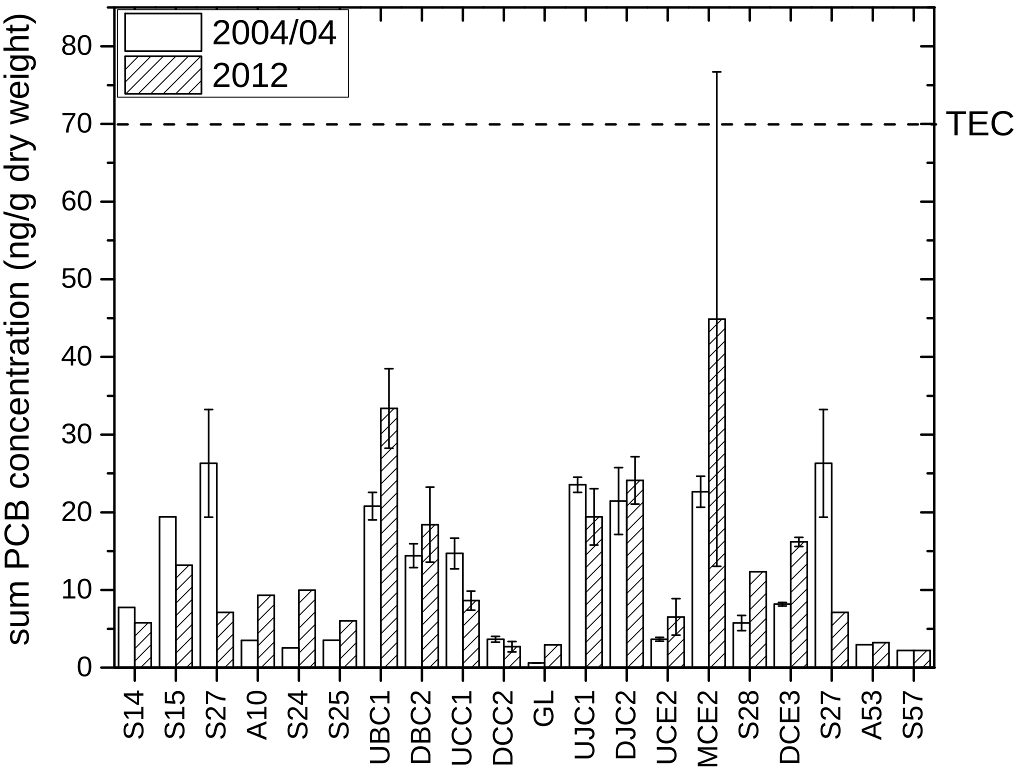

Figure 3. PCB Concentrations in Walpole Island Sediments during 2005/04 compared to 2012 at individual sampling locations. Bars represent the mean concentration at a site, error bars represent standard error for sites where triplicate samples were taken.

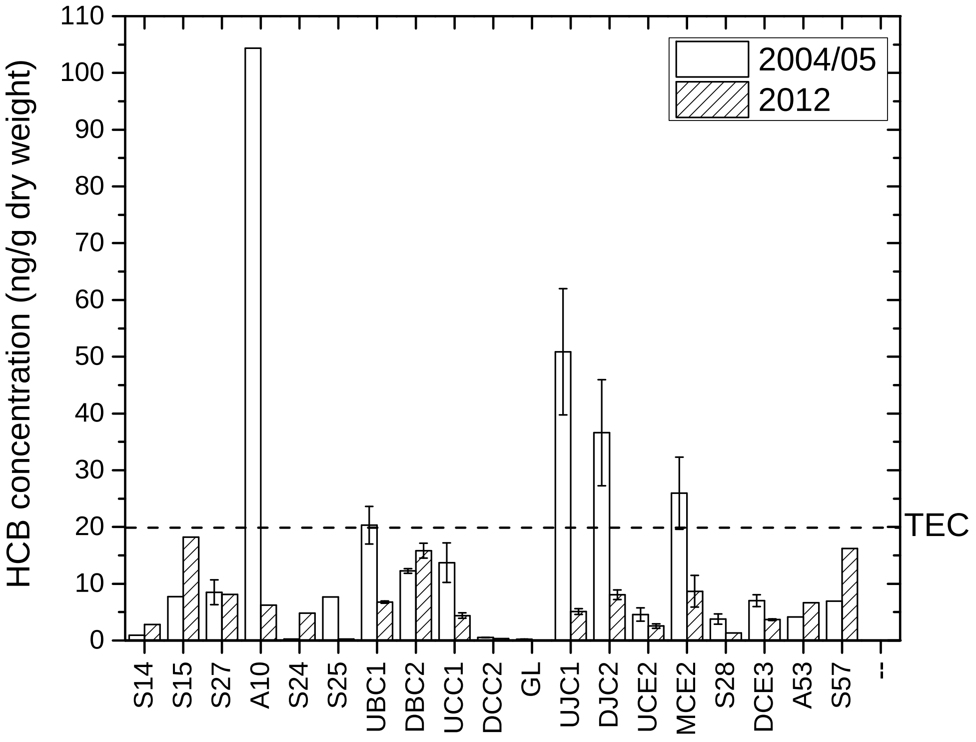

Figure 4. HCB Concentrations in Walpole Island Sediments during 2005/04 compared to 2012 at individual sampling locations. Bars represent the mean concentration at a site, error bars represent standard error for sites where triplicate samples were taken.

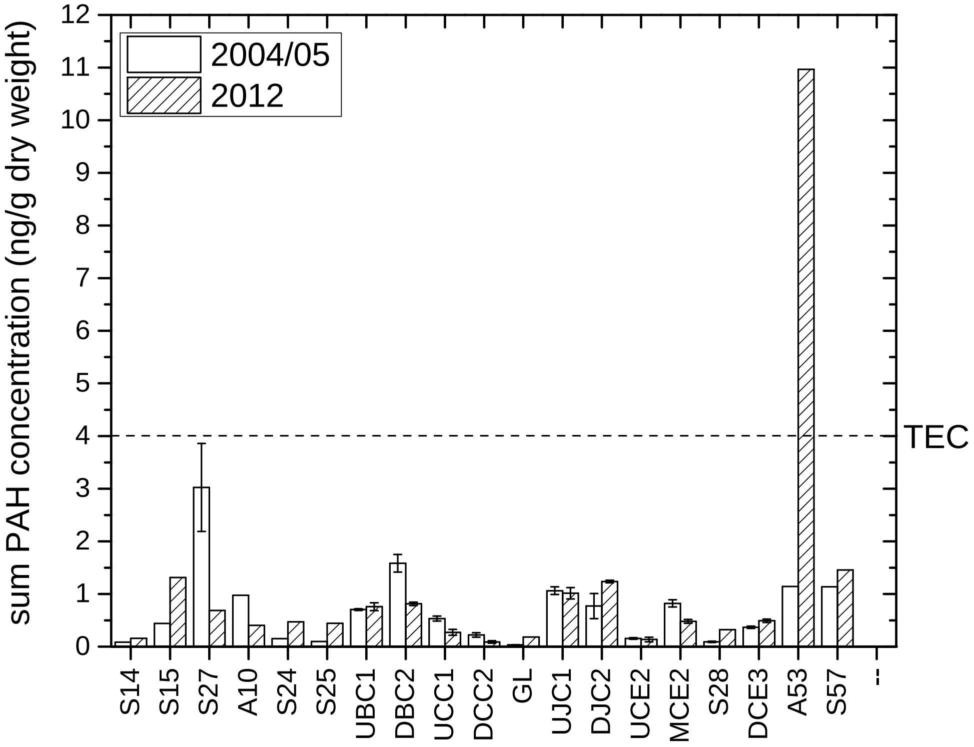

Figure 5. sum PAH Concentrations in Walpole Island Sediments during 2005/04 compared to 2012 at individual sampling locations. Bars represent the mean concentration at a site, error bars represent standard error for sites where triplicate samples were taken.

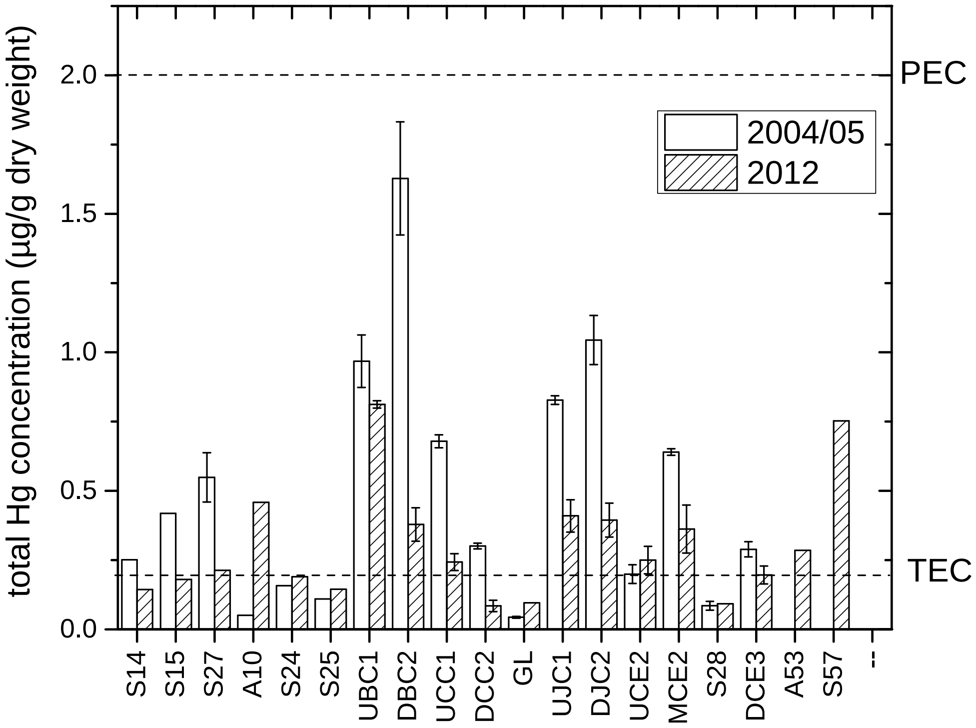

Figure 6. Total mercury concentrations in Walpole Island sediments during 2005/04 compared to 2012 at individual sampling locations. Bars represent the mean concentration at a site, error bars represent standard error for sites where triplicate samples were taken. OMOE sediment quality guidelines (TEC and PEC) shown by dashed horizontal lines.

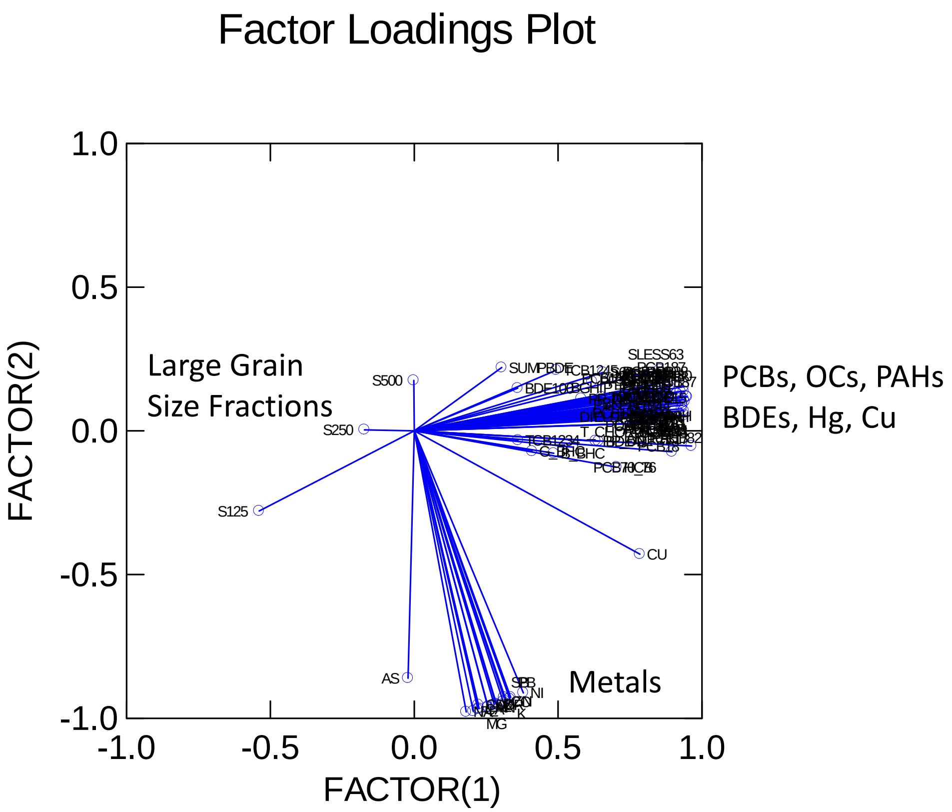

Figure 7. Factor loadings plot from principle components analysis of sediment chemistry parameters collected from the Walpole Delta during 2012.

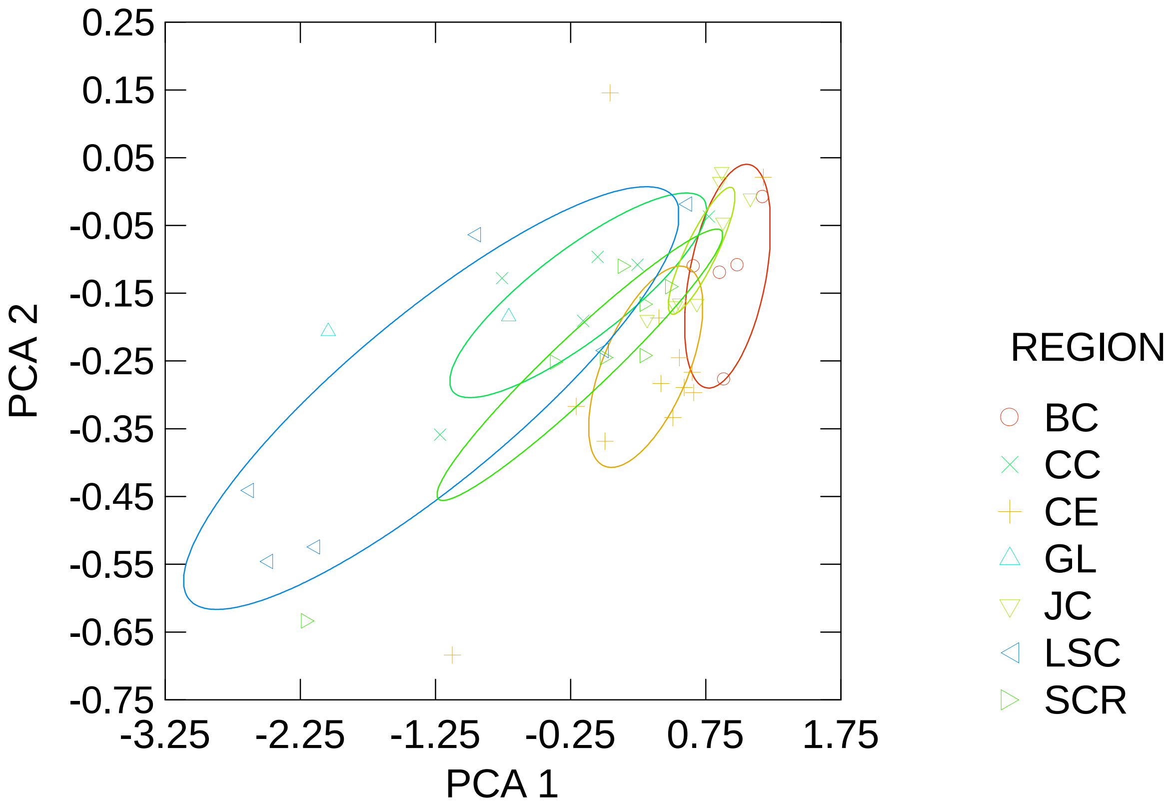

Figure 8. Principle Components Scores and 90% confidene ellipses for samples grouped by region in Walpole Delta sediments based on the 2012 data set.

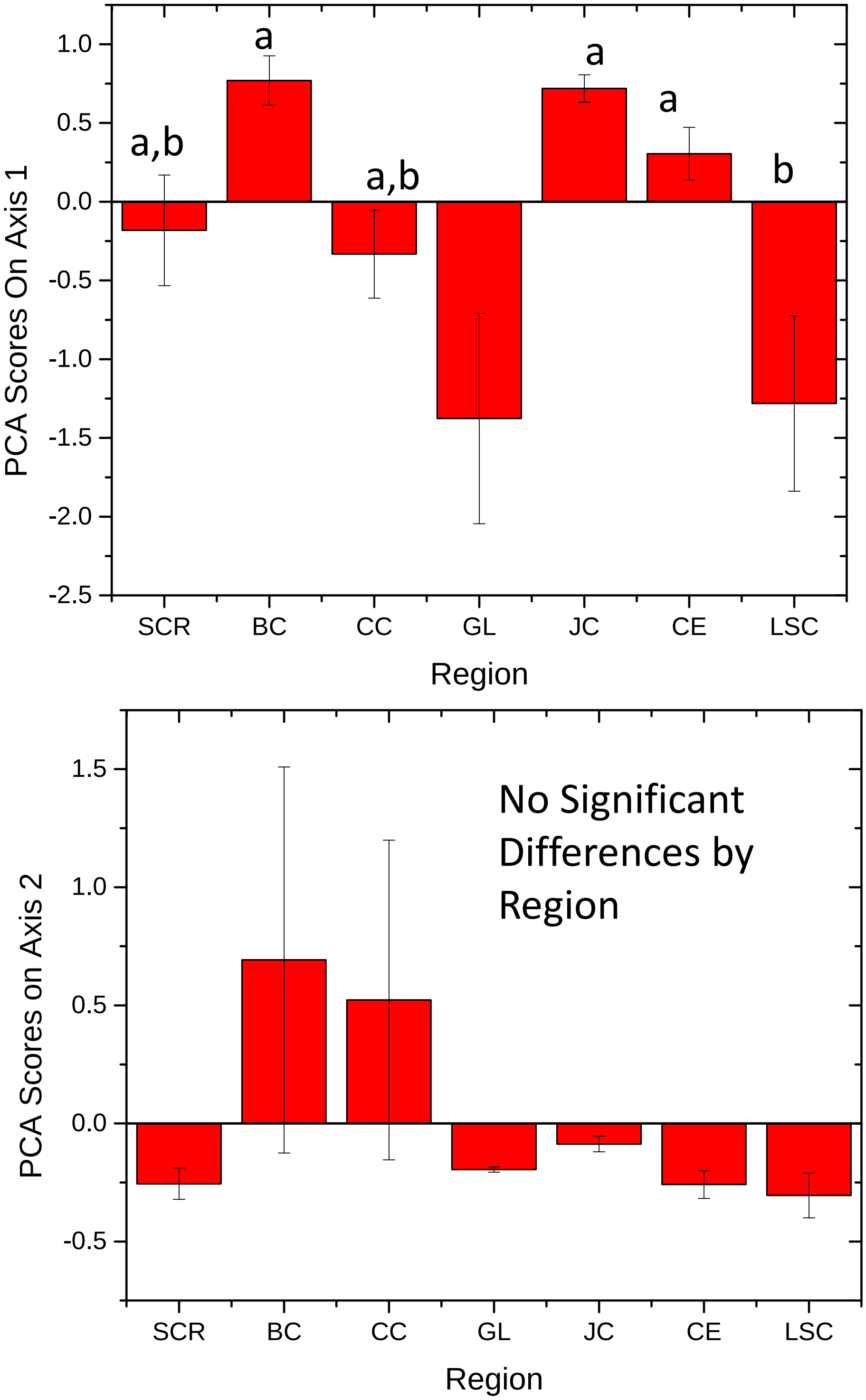

Figure 9. Regional differences in PCA scores for PCA axis 1 (top) and 2 (bottom). Bars with different letters are significantly different than one another ($p<0.05$; Tukeys HSD).