**Coastal Management**

Supporting Information for

**Monitoring Ocean Acidification within State Borders: Lessons from Washington State (USA)**

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**Text S1.**

**Quality Control of DIC and TA Data:** DIC and TA data are reviewed using three quality control levels. Level 1 encompasses deviations from the field collection methods discussed in section 2.3. When such deviations take place, they are recorded by staff in the field. If recorded deviations are judged likely to have only a minimal impact on sample quality, then resulting DIC and TA data are flagged with ‘JM,’ denoting ‘method modification.’ Such deviations have included:

1. Sample was drawn from the Niskin bottle after other samples were already collected.
2. Sample bottle contained small amount of headspace.
3. Sample bottle was not transported in cooler.
4. Sample was fixed with HgCl2 outside of the laboratory.

If recorded deviations are judged likely to have a serious impact on sample quality, then resulting DIC and TA data are flagged with ‘R,’ denoting ‘rejected.’ Such deviations have included:

1. Sample depth of collection was unknown or uncertain.
2. Sample bottle was cracked, missing rubber bands and clips, or missing Apiezon L-grease.
3. Sample was not filtered.
4. Sample was spilled.
5. Sample bottle contained excessive headspace.
6. Sample was not poisoned with HgCl2.
7. Sample was collected by hand.

Finally, if a sample is held for longer than 6 months before analysis, then resulting DIC and TA data are flagged with ‘JH,’ denoting ‘holding time exceedance.’

Level 2 encompasses measurement quality in the laboratory. As discussed in section 2.4, PMEL analyzes CRMs with known values of DIC and TA to check laboratory performance. When measured and certified CRM values differ by >0.25%, DIC or TA data from that day are rejected (following Gonski *et al.*, 2019). To date, however, no CRM analyses have yielded values that have exceeded this >0.25% threshold as shown in Table 4. PMEL analysts may also note deviations from laboratory methods or observed evidence of deviations from field collection methods. If noted deviations are judged likely to have only a minimal impact on data quality, then resulting DIC or TA data are flagged with ‘JM.’ Such deviations have included:

1. Sample had little grease on bottle stopper.
2. Sample spilled during hook up to analytical equipment.
3. Sample DIC and/or TA results appeared inconsistent with surrounding samples.
4. Sample head space appeared inconsistent with surrounding samples.

If noted deviations are judged likely to have a serious impact on data quality, then resulting DIC and/or TA data flagged with ‘R.’ Such deviations have included:

1. Sample had no grease on bottle stopper.
2. Sample had no rubber band over bottle stopper.
3. Sample DIC and/or TA results suffered from analytical equipment failure.

Finally, if equipment failure prevents sample analysis entirely, then resulting data gaps are flagged with ‘M,’ denoting ‘missing result.’

Level 3 encompasses small-scale spatiotemporal variation and the representativeness of data. Ecology collects field replicate samples at selected stations and depths. When DIC and/or TA values from field replicates differ by more than 0.5%, and there were no deviations from field or laboratory SOPs, this is a likely indication that field conditions were highly dynamic at the time of collection. DIC and TA data from such samples are flagged with a ‘1,’ denoting ‘sensor/equipment performance.’

Quality control systems for DIC and TA data should be revisited, amended, and expanded as datasets grow. For example, Ecology OA data will one day span multiple years, and it may be appropriate to begin comparing monthly values at each station to historic means to identify trends, transient extremes, or potential errors, similar to the review process for other data collected by Ecology (Bos *et al.*, 2015).

Bushnell *et al.* (2019), Dickson *et al.* (2007), Pearlman *et al.* (2019), Riebesell *et al*. (2011), and Sastri *et al.* (2019)(and the references therein) describe community-standard practices for quality control of OA datasets that can inform monitoring undertaken by regulatory agencies in other jurisdictions.

**Text S2.**

**Approach to Marine CO2 System Calculations:** Ecology uses DIC and TA data together with *in situ* temperature and salinity, hydrostatic pressure, and inorganic nutrient concentrations to constrain the marine CO2 system using the ‘Seacarb’ package (3.2.13) (Gattuso *et al*., 2020) in R (4.0.2). The ‘carb’ function is used to calculate *p*CO2, pH (on the total scale, pHT), ΩAr and ΩCa. In these calculations, inorganic carbon dissociation constants (K1 and K2) from Lueker *et al.* (2000) were used for all water samples with temperatures between 2 and 35oC and salinities between 19 and 33 while water samples with temperatures and salinities outside of these ranges used those from Waters *et al.,* (2014). It is important to note that K1 and K2 from Waters *et al.* (2014) are based on those discussed in Millero (2010) specifically for estuarine waters but recalculated for use with the free pH scale (pHF). The equilibrium constant of hydrogen fluoride (*Kf*)from Perez and Fraga (1974) was used for water samples with temperatures between 9 and 33oC and salinities between 10 and 40 while *Kf* from Dickson and Goyet (1994) was used samples with temperatures and/or salinities outside of those ranges. The borate-to-salinity ratio from Uppstrom (1974) and the dissociation constant for bisulfate from Dickson (1990) were also used in these calculations.

When DIC and TA are measured but coincident measurements of and are missing, site- and depth-specific seasonal estimates of and are used for marine CO2 system calculations. For example, was not measured on 19 February 2020 at SAR003 at 0 m, so the mean of all measurements taken at SAR003 at 0 m during January, February, and March 2020 was used as an estimate for the to constrain the remainder of the marine CO2 system for that station and depth on that day.

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**Table S1**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in Admiralty Inlet.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Admiralty Inlet** | | | | | | |
| **Month Range (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 10.07 | 1.60 | 15.91 | 7.12 | 12.32 |
| **Salinity (PSU)** | 29.23 | 3.05 | 10.42 | 19.48 | 31.32 |
| **DIC (µmol kg-1)** | 1980.63 | 170.27 | 8.60 | 1442.00 | 2106.00 |
| **TA (µmol kg-1)** | 2023.42 | 175.25 | 8.66 | 1461.90 | 2139.70 |
| **pHT** | 7.71 | 0.06 | 0.76 | 7.61 | 7.79 |
| ***p*CO2 (µatm)** | 858.50 | 154.51 | 18.00 | 550.00 | 1133.00 |
| **ΩAr** | 0.81 | 0.14 | 16.96 | 0.47 | 1.02 |
| **ΩCa** | 1.29 | 0.21 | 16.25 | 0.78 | 1.62 |
| **October-February (30 m)** | **Temperature (oC)** | 9.82 | 1.42 | 14.51 | 8.10 | 12.54 |
| **Salinity (PSU)** | 30.88 | 0.84 | 2.73 | 29.30 | 32.30 |
| **DIC (µmol kg-1)** | 2066.55 | 50.89 | 2.46 | 1981.60 | 2157.60 |
| **TA (µmol kg-1)** | 2109.18 | 42.97 | 2.04 | 2028.20 | 2181.20 |
| **pHT** | 7.69 | 0.06 | 0.77 | 7.61 | 7.78 |
| ***p*CO2 (µatm)** | 917.38 | 142.45 | 15.53 | 717.00 | 1137.00 |
| **ΩAr** | 0.83 | 0.07 | 8.97 | 0.73 | 0.93 |
| **ΩCa** | 1.31 | 0.12 | 9.07 | 1.15 | 1.48 |
| **March-September (0 m)** | **Temperature (oC)** | 11.04 | 2.17 | 19.69 | 7.80 | 14.74 |
| **Salinity (PSU)** | 30.08 | 1.33 | 4.43 | 26.39 | 31.66 |
| **DIC (µmol kg-1)** | 1971.66 | 114.68 | 5.82 | 1634.00 | 2096.50 |
| **TA (µmol kg-1)** | 2077.47 | 68.20 | 3.28 | 1885.80 | 2153.60 |
| **pHT** | 7.90 | 0.15 | 1.90 | 7.72 | 8.33 |
| ***p*CO2 (µatm)** | 581.79 | 177.38 | 30.49 | 162.00 | 885.00 |
| **ΩAr** | 1.34 | 0.47 | 34.83 | 0.86 | 2.71 |
| **ΩCa** | 2.12 | 0.75 | 35.18 | 1.37 | 4.34 |
| **March-September (30 m)** | **Temperature (oC)** | 10.28 | 1.78 | 17.29 | 8.05 | 14.44 |
| **Salinity (PSU)** | 30.84 | 0.82 | 2.67 | 29.70 | 32.17 |
| **DIC (µmol kg-1)** | 2039.72 | 51.06 | 2.50 | 1963.50 | 2132.10 |
| **TA (µmol kg-1)** | 2115.75 | 39.06 | 1.85 | 2058.90 | 2180.30 |
| **pHT** | 7.81 | 0.06 | 0.83 | 7.69 | 7.90 |
| ***p*CO2 (µatm)** | 702.86 | 123.51 | 17.57 | 541.00 | 939.00 |
| **ΩAr** | 1.07 | 0.14 | 12.83 | 0.88 | 1.28 |
| **ΩCa** | 1.70 | 0.22 | 12.79 | 1.40 | 2.03 |

**Table S2**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in Bellingham Bay.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bellingham Bay** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 8.35 | 1.74 | 20.88 | 5.84 | 10.97 |
| **Salinity (PSU)** | 28.35 | 1.64 | 5.80 | 24.30 | 29.98 |
| **DIC (µmol kg-1)** | 1951.05 | 93.48 | 4.79 | 1709.10 | 2022.50 |
| **TA (µmol kg-1)** | 1996.51 | 107.27 | 5.37 | 1718.30 | 2067.10 |
| **pHT** | 7.76 | 0.06 | 0.80 | 7.63 | 7.82 |
| ***p*CO2 (µatm)** | 751.88 | 93.50 | 12.44 | 642.00 | 921.00 |
| **ΩAr** | 0.81 | 0.15 | 19.00 | 0.50 | 1.00 |
| **ΩCa** | 1.30 | 0.24 | 18.55 | 0.82 | 1.60 |
| **March-September (0 m)** | **Temperature (oC)** | 11.60 | 2.93 | 25.24 | 7.00 | 15.85 |
| **Salinity (PSU)** | 29.00 | 1.14 | 3.92 | 26.94 | 30.26 |
| **DIC (µmol kg-1)** | 1880.93 | 99.52 | 5.29 | 1746.90 | 2018.50 |
| **TA (µmol kg-1)** | 2044.90 | 51.16 | 2.50 | 1949.60 | 2104.20 |
| **pHT** | 8.06 | 0.19 | 2.30 | 7.81 | 8.30 |
| ***p*CO2 (µatm)** | 397.83 | 188.48 | 47.38 | 184.00 | 693.00 |
| **ΩAr** | 1.89 | 0.78 | 41.13 | 1.03 | 3.19 |
| **ΩCa** | 3.00 | 1.22 | 40.80 | 1.64 | 5.04 |

**Table S3**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in Hood Canal.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hood Canal** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 10.04 | 2.84 | 28.28 | 6.68 | 13.14 |
| **Salinity (PSU)** | 25.36 | 3.39 | 13.35 | 19.66 | 28.46 |
| **DIC (µmol kg-1)** | 1818.45 | 147.66 | 8.12 | 1578.10 | 1979.60 |
| **TA (µmol kg-1)** | 1875.65 | 162.94 | 8.69 | 1598.20 | 2016.60 |
| **pHT** | 7.82 | 0.12 | 1.50 | 7.65 | 7.98 |
| ***p*CO2 (µatm)** | 655.00 | 207.78 | 31.72 | 420.00 | 990.00 |
| **ΩAr** | 0.88 | 0.25 | 28.99 | 0.51 | 1.16 |
| **ΩCa** | 1.42 | 0.40 | 28.22 | 0.85 | 1.88 |
| **October-February (30 m)** | **Temperature (oC)** | 11.05 | 0.41 | 3.67 | 10.39 | 11.46 |
| **Salinity (PSU)** | 30.39 | 0.23 | 0.75 | 29.94 | 30.62 |
| **DIC (µmol kg-1)** | 2125.69 | 18.04 | 0.85 | 2100.20 | 2146.60 |
| **TA (µmol kg-1)** | 2093.82 | 10.94 | 0.52 | 2072.00 | 2106.50 |
| **pHT** | 7.41 | 0.04 | 0.54 | 7.35 | 7.47 |
| ***p*CO2 (µatm)** | 1829.78 | 178.36 | 9.75 | 1583.00 | 2094.00 |
| **ΩAr** | 0.45 | 0.04 | 9.01 | 0.40 | 0.53 |
| **ΩCa** | 0.72 | 0.06 | 9.01 | 0.63 | 0.83 |
| **March-September (0 m)** | **Temperature (oC)** | 15.68 | 3.09 | 19.68 | 11.14 | 20.10 |
| **Salinity (PSU)** | 26.81 | 1.95 | 7.28 | 22.22 | 28.32 |
| **DIC (µmol kg-1)** | 1805.37 | 65.46 | 3.63 | 1652.70 | 1863.10 |
| **TA (µmol kg-1)** | 1921.07 | 65.12 | 3.39 | 1770.90 | 1974.00 |
| **pHT** | 7.93 | 0.09 | 1.08 | 7.85 | 8.10 |
| ***p*CO2 (µatm)** | 500.14 | 104.72 | 20.94 | 304.00 | 606.00 |
| **ΩAr** | 1.41 | 0.14 | 10.02 | 1.27 | 1.70 |
| **ΩCa** | 2.25 | 0.22 | 9.78 | 2.01 | 2.70 |
| **March-September (30 m)** | **Temperature (oC)** | 10.36 | 0.12 | 1.17 | 10.22 | 10.54 |
| **Salinity (PSU)** | 30.16 | 0.13 | 0.42 | 29.99 | 30.41 |
| **DIC (µmol kg-1)** | 2142.95 | 20.71 | 0.97 | 2118.80 | 2181.90 |
| **TA (µmol kg-1)** | 2087.01 | 7.69 | 0.37 | 2072.20 | 2096.50 |
| **pHT** | 7.34 | 0.06 | 0.79 | 7.23 | 7.41 |
| ***p*CO2 (µatm)** | 2160.50 | 309.02 | 14.30 | 1809.00 | 2764.00 |
| **ΩAr** | 0.38 | 0.05 | 12.87 | 0.29 | 0.44 |
| **ΩCa** | 0.60 | 0.08 | 12.82 | 0.46 | 0.70 |

**Table S4**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in Puget Sound Main Basin.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Puget Sound Main Basin** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 11.79 | 1.42 | 12.09 | 9.29 | 13.18 |
| **Salinity (PSU)** | 29.48 | 0.82 | 2.79 | 27.59 | 30.68 |
| **DIC (µmol kg-1)** | 2011.17 | 28.87 | 1.44 | 1926.70 | 2057.00 |
| **TA (µmol kg-1)** | 2053.76 | 36.27 | 1.77 | 1959.20 | 2113.30 |
| **pHT** | 7.68 | 0.02 | 0.24 | 7.65 | 7.71 |
| ***p*CO2 (µatm)** | 930.85 | 34.66 | 3.72 | 886.00 | 996.00 |
| **ΩAr** | 0.82 | 0.08 | 10.02 | 0.66 | 0.94 |
| **ΩCa** | 1.31 | 0.13 | 9.62 | 1.06 | 1.49 |
| **October-February (30 m)** | **Temperature (oC)** | 11.75 | 1.14 | 9.74 | 9.61 | 12.98 |
| **Salinity (PSU)** | 30.45 | 0.29 | 0.97 | 29.86 | 30.82 |
| **DIC (µmol kg-1)** | 2048.97 | 11.52 | 0.56 | 2027.50 | 2065.60 |
| **TA (µmol kg-1)** | 2094.05 | 17.96 | 0.86 | 2062.40 | 2117.00 |
| **pHT** | 7.68 | 0.02 | 0.22 | 7.64 | 7.73 |
| ***p*CO2 (µatm)** | 946.47 | 35.92 | 3.79 | 856.00 | 1031.00 |
| **ΩAr** | 0.85 | 0.07 | 8.09 | 0.74 | 0.99 |
| **ΩCa** | 1.34 | 0.10 | 7.83 | 1.17 | 1.57 |
| **March-September (0 m)** | **Temperature (oC)** | 11.78 | 2.12 | 18.04 | 8.30 | 14.97 |
| **Salinity (PSU)** | 28.90 | 1.25 | 4.34 | 24.20 | 30.48 |
| **DIC (µmol kg-1)** | 1914.71 | 83.05 | 4.34 | 1666.10 | 2025.70 |
| **TA (µmol kg-1)** | 2031.91 | 51.80 | 2.55 | 1871.80 | 2101.40 |
| **pHT** | 7.93 | 0.17 | 2.15 | 7.73 | 8.27 |
| ***p*CO2 (µatm)** | 534.11 | 205.13 | 38.41 | 195.00 | 849.00 |
| **ΩAr** | 1.44 | 0.51 | 35.81 | 0.81 | 2.50 |
| **ΩCa** | 2.29 | 0.82 | 35.90 | 1.29 | 3.97 |
| **March-September (30 m)** | **Temperature (oC)** | 10.72 | 1.91 | 17.83 | 8.16 | 13.53 |
| **Salinity (PSU)** | 29.82 | 0.36 | 1.21 | 29.29 | 30.54 |
| **DIC (µmol kg-1)** | 1985.61 | 30.09 | 1.52 | 1910.20 | 2034.30 |
| **TA (µmol kg-1)** | 2067.05 | 18.17 | 0.88 | 2040.40 | 2099.70 |
| **pHT** | 7.83 | 0.08 | 1.01 | 7.72 | 8.03 |
| ***p*CO2 (µatm)** | 654.22 | 123.34 | 18.85 | 384.00 | 853.00 |
| **ΩAr** | 1.11 | 0.21 | 18.61 | 0.80 | 1.67 |
| **ΩCa** | 1.76 | 0.33 | 18.52 | 1.27 | 2.65 |

**Table S5**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in South Puget Sound Basin.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **South Puget Sound** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 11.09 | 2.43 | 21.87 | 6.70 | 14.71 |
| **Salinity (PSU)** | 28.79 | 1.90 | 6.59 | 22.50 | 30.42 |
| **DIC (µmol kg-1)** | 1973.46 | 83.19 | 4.22 | 1696.20 | 2063.00 |
| **TA (µmol kg-1)** | 2021.35 | 92.86 | 4.59 | 1691.30 | 2096.90 |
| **pHT** | 7.71 | 0.09 | 1.19 | 7.60 | 8.02 |
| ***p*CO2 (µatm)** | 865.65 | 165.26 | 19.09 | 406.00 | 1093.00 |
| **ΩAr** | 0.86 | 0.28 | 32.54 | 0.41 | 1.81 |
| **ΩCa** | 1.37 | 0.44 | 31.86 | 0.67 | 2.85 |
| **October-February (30 m)** | **Temperature (oC)** | 11.26 | 1.88 | 16.68 | 7.90 | 13.87 |
| **Salinity (PSU)** | 29.93 | 0.48 | 1.59 | 28.76 | 30.51 |
| **DIC (µmol kg-1)** | 2025.28 | 25.43 | 1.26 | 1975.70 | 2062.90 |
| **TA (µmol kg-1)** | 2071.01 | 24.65 | 1.19 | 2016.60 | 2100.50 |
| **pHT** | 7.69 | 0.06 | 0.80 | 7.63 | 7.88 |
| ***p*CO2 (µatm)** | 914.56 | 123.68 | 13.52 | 582.00 | 1067.00 |
| **ΩAr** | 0.85 | 0.17 | 20.26 | 0.68 | 1.38 |
| **ΩCa** | 1.34 | 0.27 | 19.91 | 1.09 | 2.18 |
| **March-September (0 m)** | **Temperature (oC)** | 13.16 | 3.02 | 22.94 | 8.31 | 18.17 |
| **Salinity (PSU)** | 28.57 | 1.33 | 4.67 | 25.20 | 30.21 |
| **DIC (µmol kg-1)** | 1877.42 | 72.92 | 3.88 | 1711.80 | 2025.40 |
| **TA (µmol kg-1)** | 2015.68 | 63.00 | 3.13 | 1859.00 | 2093.30 |
| **pHT** | 7.99 | 0.13 | 1.63 | 7.72 | 8.25 |
| ***p*CO2 (µatm)** | 451.38 | 152.64 | 33.82 | 205.00 | 873.00 |
| **ΩAr** | 1.62 | 0.42 | 25.86 | 1.00 | 2.83 |
| **ΩCa** | 2.57 | 0.66 | 25.70 | 1.58 | 4.46 |
| **March-September (30 m)** | **Temperature (oC)** | 11.27 | 2.36 | 20.96 | 7.94 | 15.88 |
| **Salinity (PSU)** | 29.36 | 0.40 | 1.35 | 28.60 | 30.08 |
| **DIC (µmol kg-1)** | 1959.44 | 25.50 | 1.30 | 1900.70 | 2000.00 |
| **TA (µmol kg-1)** | 2050.34 | 20.27 | 0.99 | 2017.40 | 2096.60 |
| **pHT** | 7.86 | 0.05 | 0.66 | 7.75 | 7.97 |
| ***p*CO2 (µatm)** | 596.92 | 77.54 | 12.99 | 447.00 | 768.00 |
| **ΩAr** | 1.18 | 0.17 | 14.61 | 0.80 | 1.46 |
| **ΩCa** | 1.87 | 0.27 | 14.27 | 1.28 | 2.31 |

**Table S6**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in The Straits.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **The Straits** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 9.43 | 1.30 | 13.74 | 7.44 | 12.09 |
| **Salinity (PSU)** | 29.47 | 1.95 | 6.60 | 24.67 | 31.68 |
| **DIC (µmol kg-1)** | 1995.87 | 97.18 | 4.87 | 1763.30 | 2111.80 |
| **TA (µmol kg-1)** | 2040.75 | 97.40 | 4.77 | 1801.00 | 2148.10 |
| **pHT** | 7.73 | 0.06 | 0.72 | 7.64 | 7.84 |
| ***p*CO2 (µatm)** | 827.33 | 123.81 | 14.96 | 601.00 | 1030.00 |
| **ΩAr** | 0.82 | 0.11 | 13.19 | 0.62 | 1.04 |
| **ΩCa** | 1.31 | 0.17 | 12.92 | 1.01 | 1.65 |
| **October-February (30 m)** | **Temperature (oC)** | 9.14 | 0.91 | 9.91 | 8.04 | 10.85 |
| **Salinity (PSU)** | 30.68 | 0.82 | 2.69 | 29.42 | 32.29 |
| **DIC (µmol kg-1)** | 2063.24 | 44.38 | 2.15 | 1991.10 | 2156.30 |
| **TA (µmol kg-1)** | 2102.85 | 40.58 | 1.93 | 2047.60 | 2185.70 |
| **pHT** | 7.70 | 0.06 | 0.78 | 7.60 | 7.80 |
| ***p*CO2 (µatm)** | 910.37 | 136.53 | 15.00 | 701.00 | 1136.00 |
| **ΩAr** | 0.80 | 0.08 | 9.89 | 0.65 | 1.00 |
| **ΩCa** | 1.27 | 0.13 | 9.99 | 1.03 | 1.59 |
| **March-September (0 m)** | **Temperature (oC)** | 10.45 | 2.43 | 23.23 | 7.42 | 15.99 |
| **Salinity (PSU)** | 29.15 | 2.37 | 8.13 | 21.76 | 31.12 |
| **DIC (µmol kg-1)** | 1940.59 | 126.69 | 6.53 | 1610.80 | 2076.00 |
| **TA (µmol kg-1)** | 2044.88 | 99.31 | 4.86 | 1729.40 | 2129.60 |
| **pHT** | 7.92 | 0.13 | 1.70 | 7.71 | 8.23 |
| ***p*CO2 (µatm)** | 538.10 | 181.44 | 33.72 | 219.00 | 892.00 |
| **ΩAr** | 1.31 | 0.34 | 26.02 | 0.92 | 2.30 |
| **ΩCa** | 2.09 | 0.55 | 26.44 | 1.45 | 3.70 |
| **March-September (30 m)** | **Temperature (oC)** | 9.98 | 1.19 | 11.90 | 7.46 | 11.65 |
| **Salinity (PSU)** | 30.63 | 0.75 | 2.45 | 29.26 | 31.83 |
| **DIC (µmol kg-1)** | 2032.84 | 48.48 | 2.39 | 1912.30 | 2108.10 |
| **TA (µmol kg-1)** | 2108.16 | 34.62 | 1.64 | 2053.40 | 2166.10 |
| **pHT** | 7.81 | 0.08 | 1.07 | 7.72 | 8.04 |
| ***p*CO2 (µatm)** | 698.42 | 133.70 | 19.14 | 377.00 | 880.00 |
| **ΩAr** | 1.06 | 0.18 | 17.14 | 0.91 | 1.63 |
| **ΩCa** | 1.69 | 0.29 | 17.30 | 1.46 | 2.59 |

**Table S7**. Summary statistics of data for temperature, salinity, and marine CO2 system variables for discrete water samples collected in Whidbey Basin.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Whidbey Basin** | | | | | | |
| **Time Period (depth)** | **Variable (units)** | **Mean** | **Standard Deviation** | **Coefficient of Variation (%)** | **Minimum** | **Maximum** |
| **October-February (0 m)** | **Temperature (oC)** | 8.94 | 2.52 | 28.13 | 6.17 | 12.83 |
| **Salinity (PSU)** | 18.76 | 7.33 | 39.06 | 3.88 | 28.31 |
| **DIC (µmol kg-1)** | 1441.23 | 398.16 | 27.63 | 557.60 | 1947.00 |
| **TA (µmol kg-1)** | 1450.22 | 425.58 | 29.35 | 506.60 | 1987.30 |
| **pHT** | 7.65 | 0.17 | 2.22 | 7.18 | 7.83 |
| ***p*CO2 (µatm)** | 753.85 | 210.11 | 27.87 | 454.00 | 1226.00 |
| **ΩAr** | 0.46 | 0.27 | 58.99 | 0.02 | 1.11 |
| **ΩCa** | 0.75 | 0.42 | 56.51 | 0.03 | 1.76 |
| **October-February (30 m)** | **Temperature (oC)** | 10.63 | 1.72 | 16.13 | 6.90 | 12.44 |
| **Salinity (PSU)** | 30.10 | 0.54 | 1.78 | 28.71 | 30.58 |
| **DIC (µmol kg-1)** | 2037.06 | 41.97 | 2.06 | 1961.30 | 2083.70 |
| **TA (µmol kg-1)** | 2065.79 | 34.32 | 1.66 | 2001.00 | 2102.00 |
| **pHT** | 7.64 | 0.07 | 0.90 | 7.55 | 7.74 |
| ***p*CO2 (µatm)** | 1040.79 | 190.08 | 18.26 | 778.00 | 1311.00 |
| **ΩAr** | 0.73 | 0.07 | 9.59 | 0.64 | 0.88 |
| **ΩCa** | 1.16 | 0.11 | 9.66 | 1.01 | 1.38 |
| **March-September (0 m)** | **Temperature (oC)** | 13.00 | 3.09 | 23.74 | 7.72 | 17.91 |
| **Salinity (PSU)** | 23.37 | 3.33 | 14.25 | 16.15 | 27.69 |
| **DIC (µmol kg-1)** | 1600.76 | 168.91 | 10.55 | 1266.90 | 1863.80 |
| **TA (µmol kg-1)** | 1731.34 | 182.47 | 10.54 | 1302.90 | 1953.50 |
| **pHT** | 8.04 | 0.26 | 3.20 | 7.60 | 8.54 |
| ***p*CO2 (µatm)** | 395.82 | 223.36 | 56.43 | 85.00 | 898.00 |
| **ΩAr** | 1.54 | 0.82 | 53.15 | 0.40 | 3.19 |
| **ΩCa** | 2.49 | 1.32 | 52.88 | 0.67 | 5.22 |
| **March-September (30 m)** | **Temperature (oC)** | 10.42 | 1.98 | 19.01 | 8.55 | 16.42 |
| **Salinity (PSU)** | 29.78 | 0.36 | 1.22 | 29.14 | 30.53 |
| **DIC (µmol kg-1)** | 2023.54 | 31.48 | 1.56 | 1971.50 | 2087.70 |
| **TA (µmol kg-1)** | 2060.08 | 14.68 | 0.71 | 2040.50 | 2093.30 |
| **pHT** | 7.67 | 0.09 | 1.18 | 7.51 | 7.86 |
| ***p*CO2 (µatm)** | 961.29 | 218.33 | 22.71 | 600.00 | 1421.00 |
| **ΩAr** | 0.78 | 0.14 | 18.46 | 0.58 | 1.08 |
| **ΩCa** | 1.24 | 0.23 | 18.42 | 0.91 | 1.72 |

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**Figure S1.** Regional distributions of interpolated sea surface (a) TA, (b) DIC, (c) Salinity, and (d) pHT in State waters of Puget Sound and the Salish Sea in November 2018. Open circles indicate sampling stations from which georeferenced data were used. Please note the different color bars and scales for each panel.

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**Figure S2.** Regional distributions of interpolated sea surface (a) TA, (b) DIC, (c) Salinity, and (d) pHT in State waters of Puget Sound and the Salish Sea in May 2019. Open circles indicate sampling stations from which georeferenced data were used. Please note the different color bars and scales for each panel.