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Supplementary Material

This document contains 8 figures and 6 tables that support:

Seasonally and Spatially Variable Organic Matter Contributions from Watershed, Marine Macrophyte, and Pelagic Sources to the Northeast Pacific Coastal Ocean Margin

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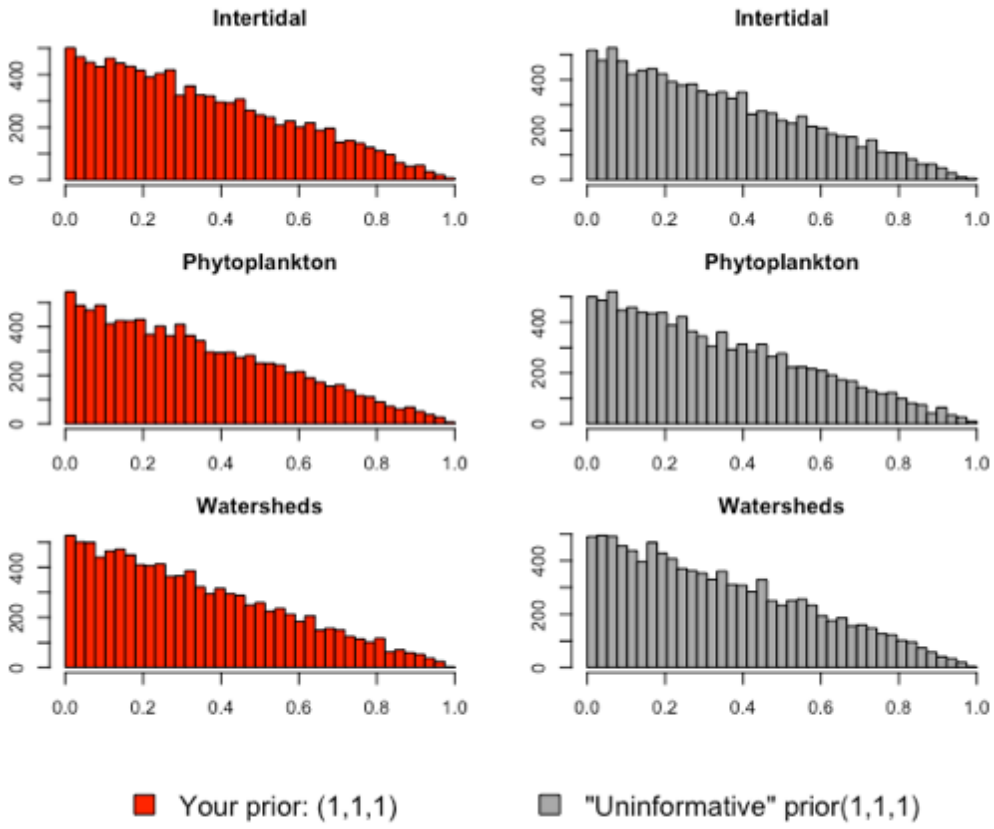
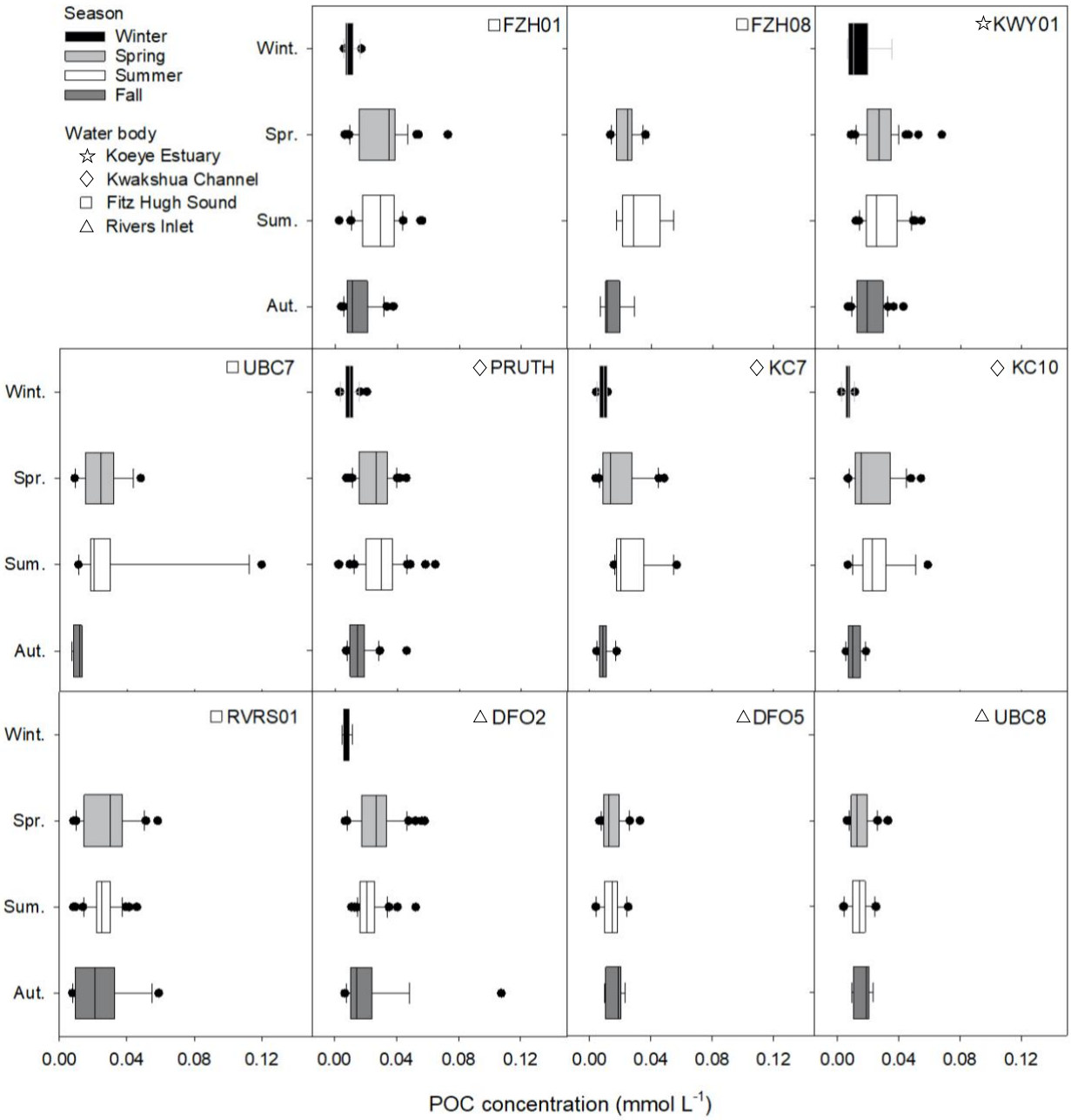
1 Supplementary Figures and Tables

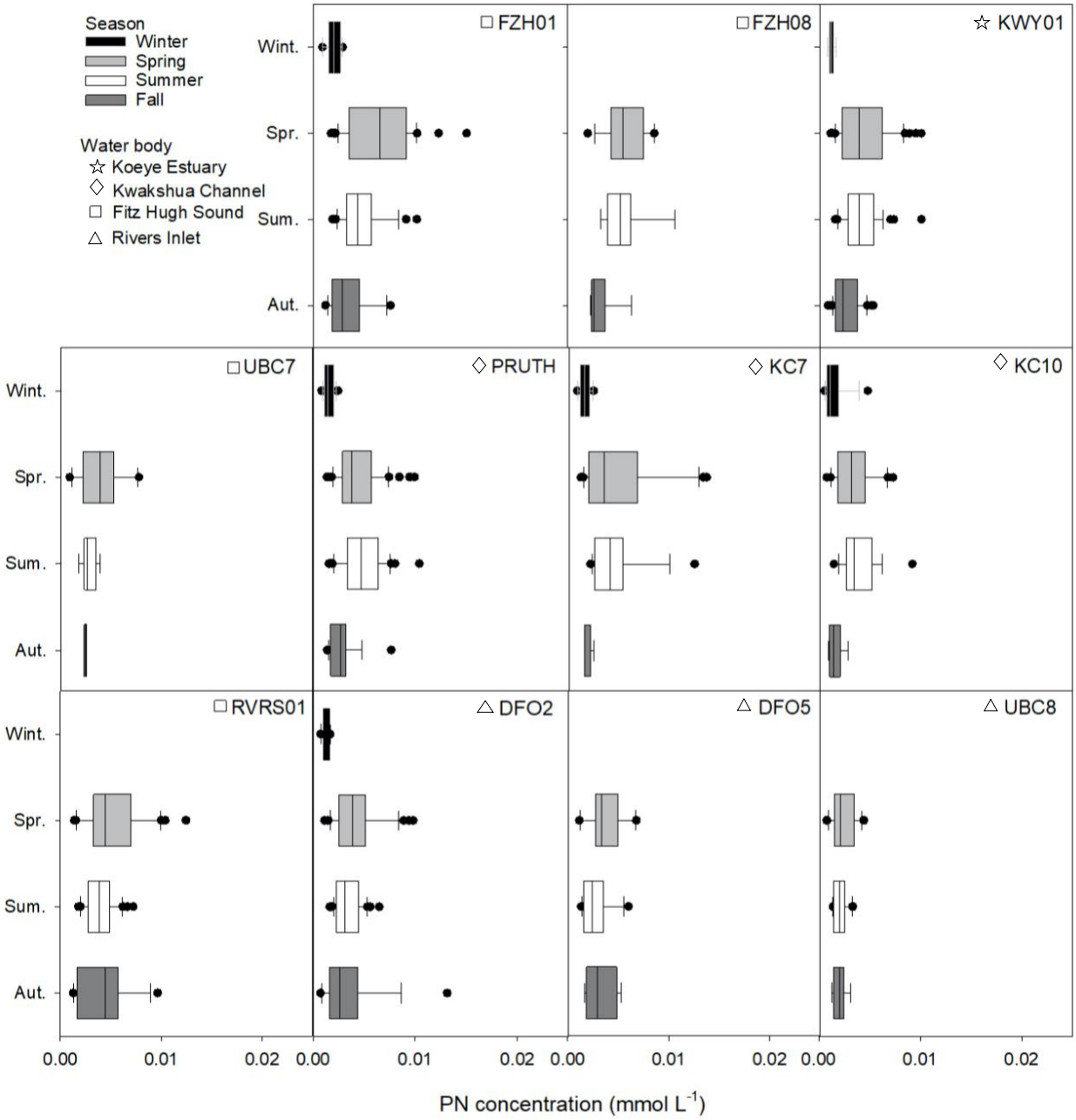
1.1 Supplementary Figures



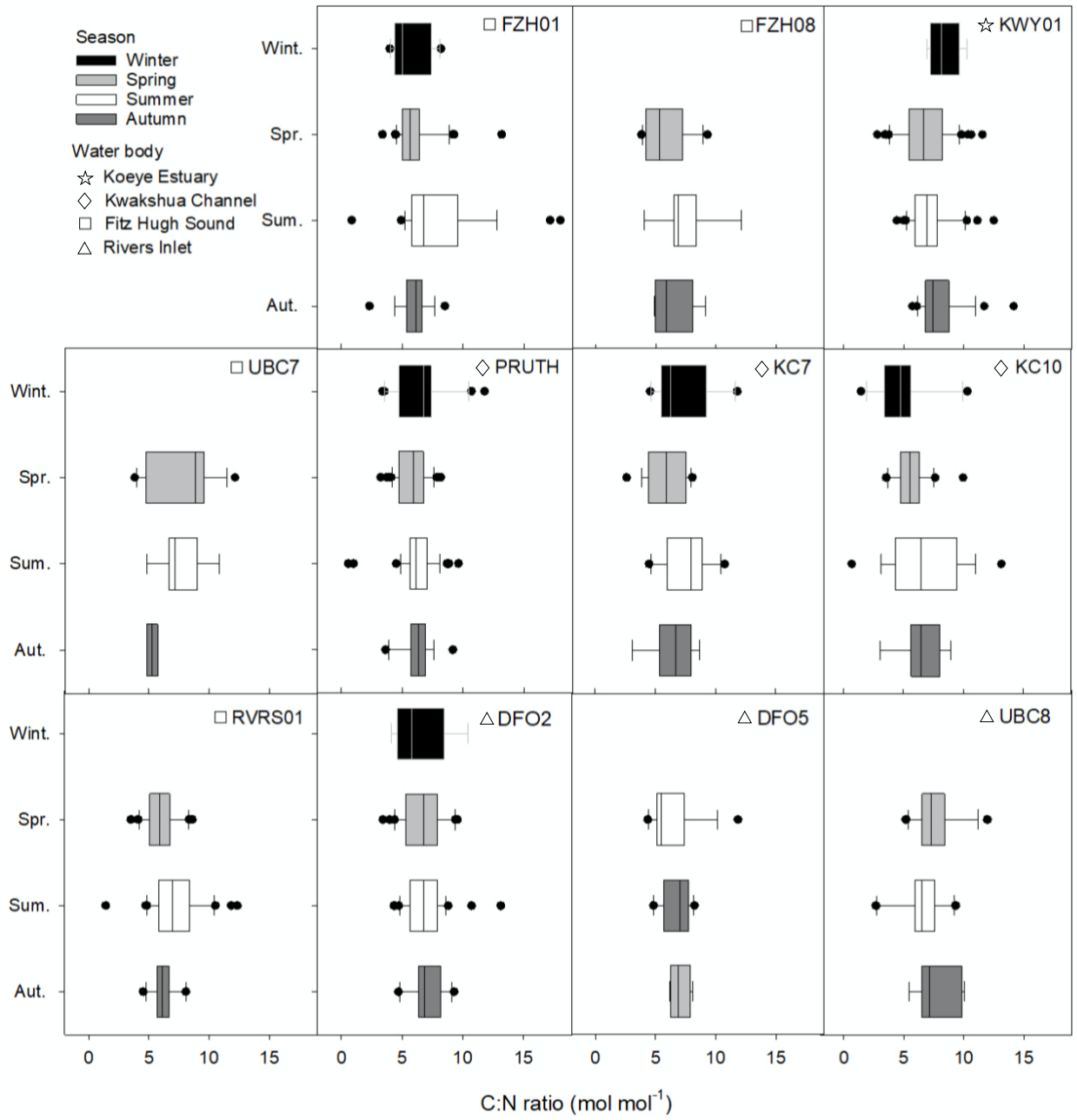
Supplementary Figure 1. Uninformative prior used in Bayesian mixing model specification.



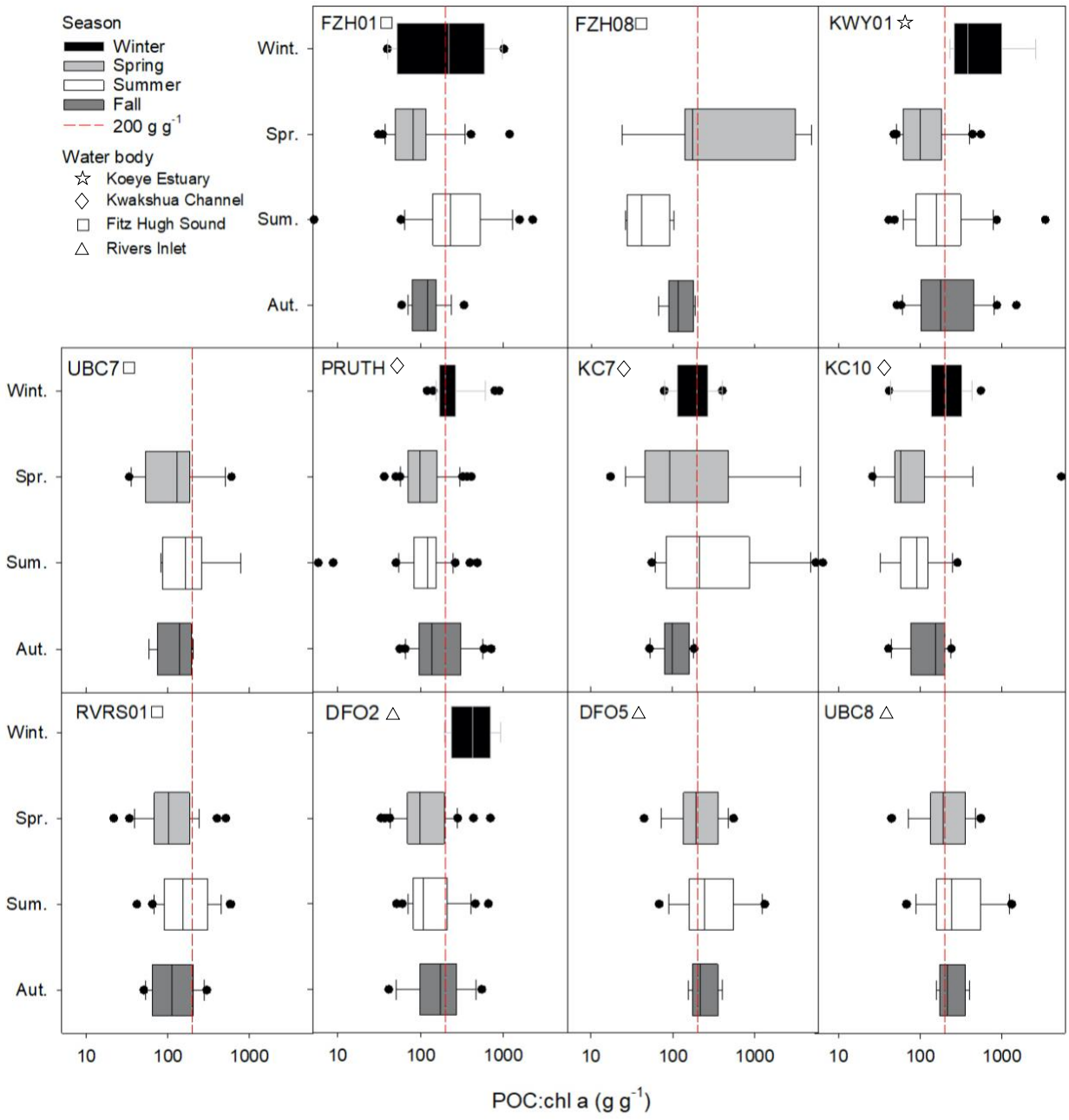
Supplementary Figure 2. Seasonal particulate organic carbon (POC) concentrations in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



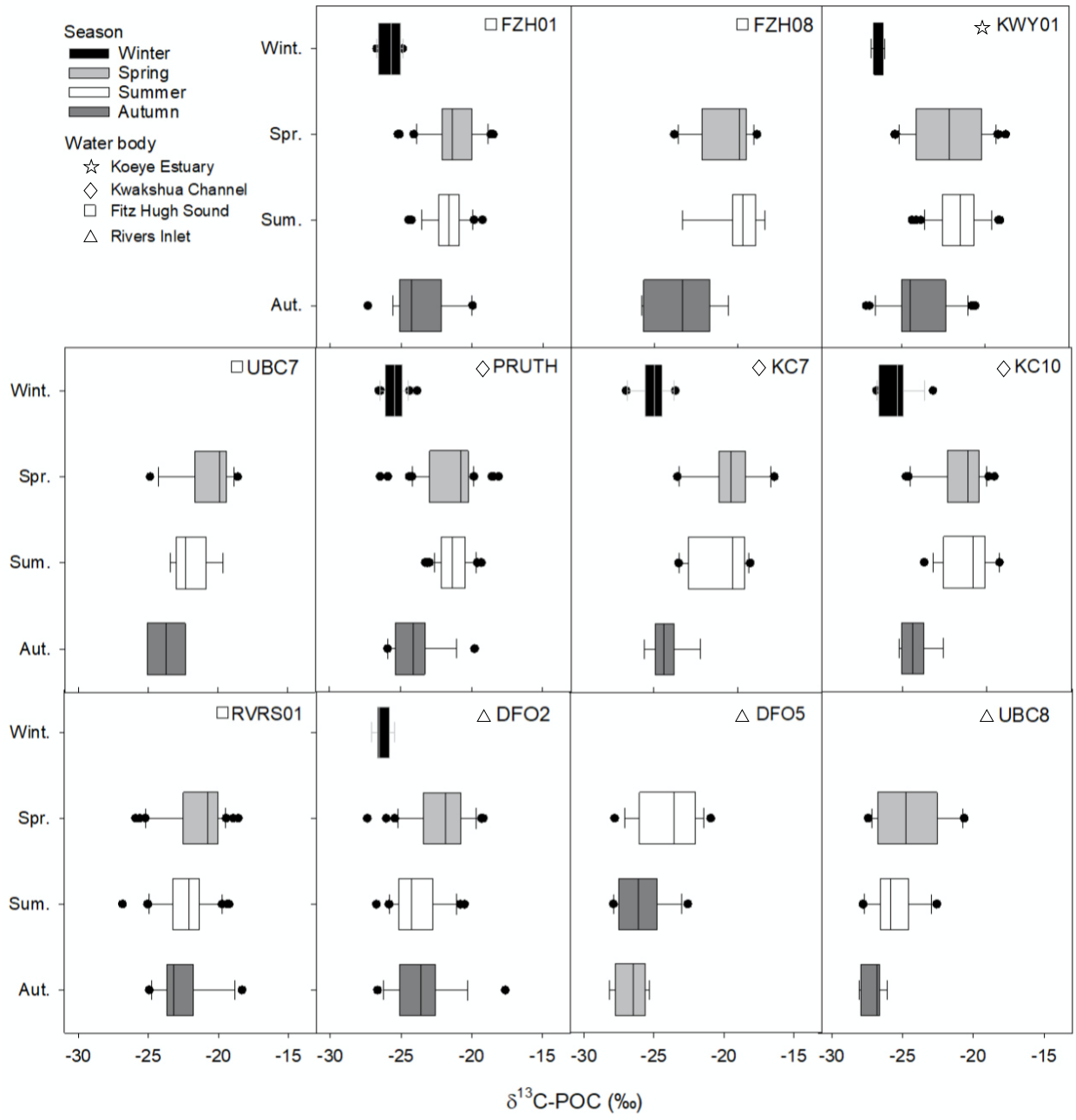
Supplementary Figure 3. Seasonal particulate nitrogen (PN) concentrations in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



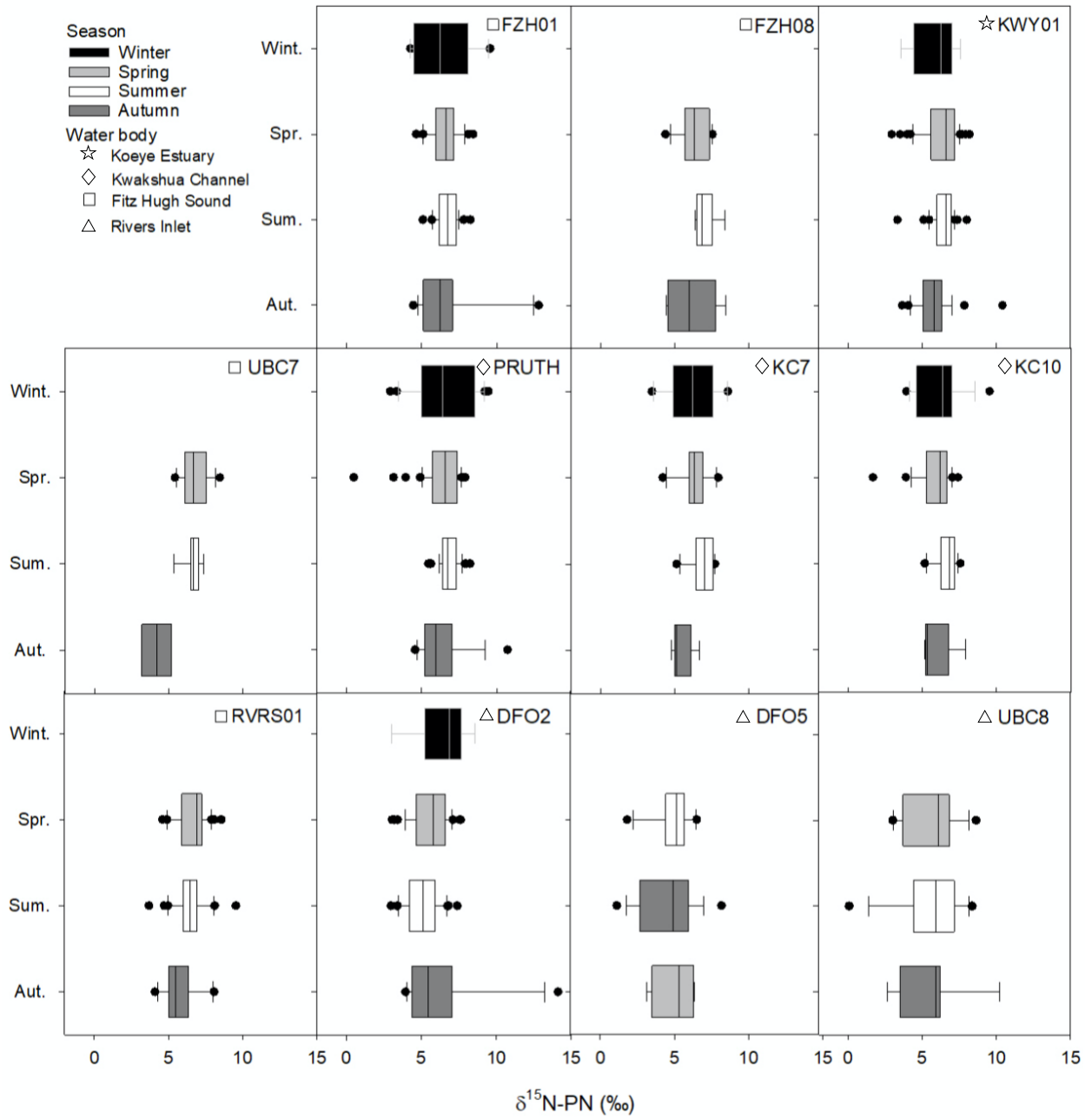
Supplementary Figure 4. Molar ratio of particulate organic carbon to particulate organic nitrogen (C:N) in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



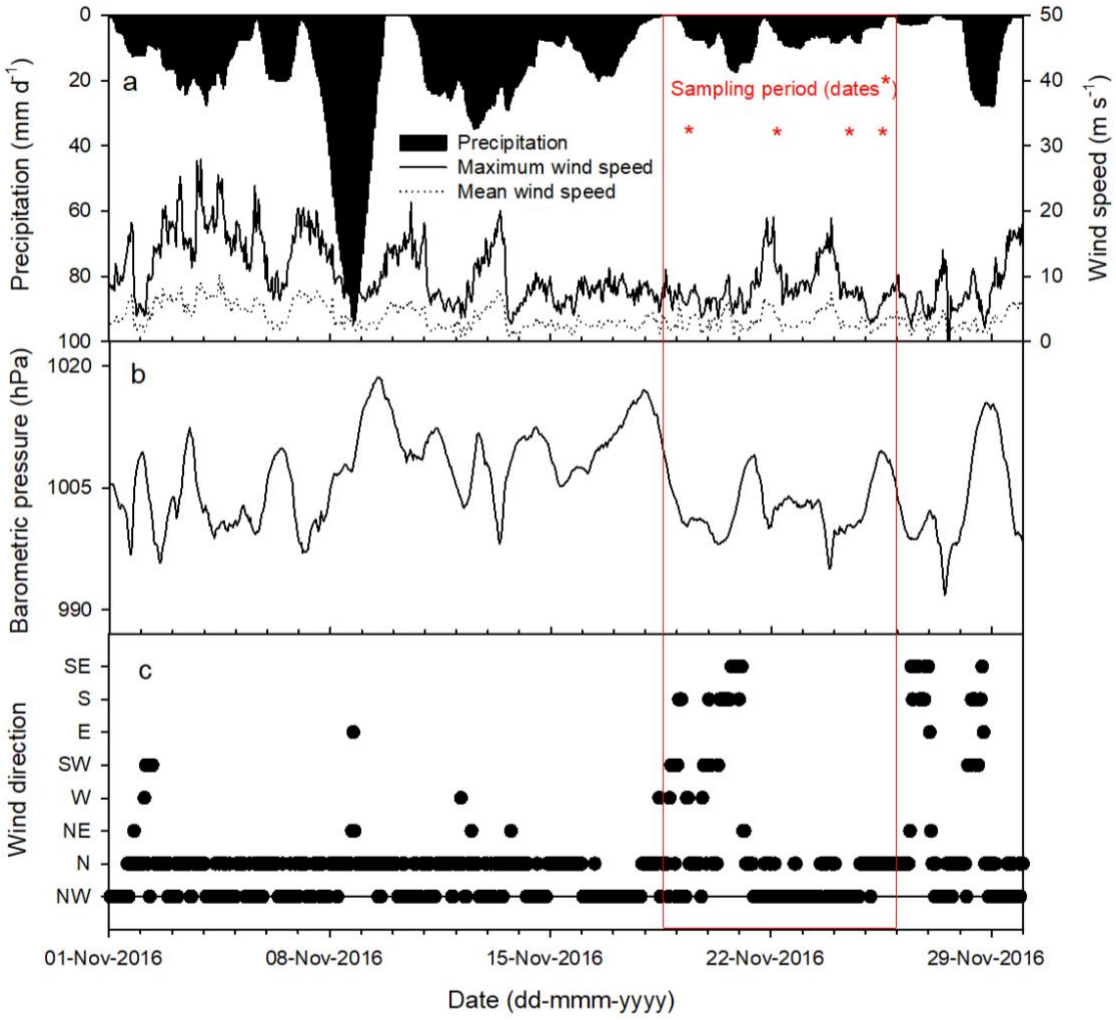
Supplementary Figure 5. Seasonal mass ratios particulate organic carbon (POC) to chlorophyll *a* in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



Supplementary Figure 6. Stable isotope signatures of the particulate organic carbon (δ^{13}C-POC) in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



Supplementary Figure 7. Stable isotope signature of the particulate organic nitrogen (δ^{15}N-PN) in coastal surface (0-10 m) waters across 11 stations along the Central Coast of British Columbia. Seasons are defined by the calendar year, where winter is December to February, spring is March to May, summer is July to August, and autumn is September to November. The water body where each station is located is demarcated by a symbol. Station coordinates are provided in Supplementary Table 1.



Supplementary Figure 8. Hourly meteorological observations recorded at Mt. Buxton, Calvert Island (Haughton et al., 2020) for November 2016, including precipitation (a), maximum and mean wind speed (a), barometric pressure calculated at sea level (b), and mean hourly wind direction. The period during which sampling occurred in November 2016 is delineated by a red box, with specific sampling dates indicated by asterisks (*).

1.2 Supplementary Tables

Supplementary Table 1. Characteristics of the river and stream sampling stations contributing to the watershed end-member.[†]

River/stream name	Station ID	Watershed area (km^2)	% glacier coverage	Max. elevation (m.a.s.l.)	Mean annual discharge[*]	Mean annual temperature (°C)	Mean annual precipitation (mm)	Snow (%)
Koeye River	KR01	171	0	1304	n/a	7.0	3753	9.95
Stream 626 [‡]	WS626	3.2	0	164	6.07×10^6 m^3	8.4	3187	3.93
Stream 1015 [‡]	WS1015	3.3	0	436	5.44×10^6 m^3	8.3	3445	4.45
Stream 844 [‡]	WS844	5.7	0	493	11.83×10^6 m^3	8.1	3664	4.97
Stream 703 [‡]	WS703	12.8	0	1014	39.36×10^6 m^3	7.7	3762	6.83
Wannock River	WR01	3947	15	3106	9.92 km^3	3.1	3569	44.83

[†] Properties derived from the Freshwater Atlas watershed boundaries (GeoBC, 2009), TRIM-based digital elevation model (DEM), the Randolph Glacier Inventory (RGI Consortium, 2017), and ClimateNA 1981-2010 climate normals (Wang et al., 2016).
[‡] Watershed areas for the Calvert and Hecate Island streams determined with a LiDAR derived DEM (Giesbrecht et al., 2021).
[*] Discharge data for the Calvert and Hecate Island streams are derived from Korver et al. (2020).

Supplementary Table 2. Key characteristics for the marine sampling stations, with stations ordered from north to south.

Station ID	Latitude (°N)	Longitude (°W)	Depth (m)	Salinity (salinity units)*	Temperature (°C)*	Water body	Record dates (dd-mm-yyyy)
KWY01	51.7477	127.8801	12	27.36 ± 4.11	10.35 ± 2.36	Koeye Estuary	14-03-2015 to 22-04-2018
FZH08	51.7579	127.9443	385	27.15 ± 3.45	11.21 ± 2.30	Fitz Hugh Sound	14-03-2015 to 02-11-2015
PRUTH	51.6554	128.0913	70	28.81 ± 2.30	10.37 ± 2.41	Kwakshua Channel	21-01-2015 to 11-09-2018
KC7	51.6535	128.0464	168	28.71 ± 1.56	11.21 ± 2.30	Kwakshua Channel	25-02-2015 to 27-02-2016
KC10	51.6505	127.9516	345	28.99 ± 1.60	10.16 ± 2.22	Kwakshua Channel	21-01-2015 to 19-08-2018
FZH01	51.6394	127.8958	290	28.03 ± 2.15	10.73 ± 2.53	Fitz Hugh Sound	25-02-2015 to 18-08-2018
UBC7	51.5003	127.8182	163	27.22 ± 2.18	11.50 ± 2.48	Fitz Hugh Sound	16-03-2015 to 01-11-2015
RVRS01	51.4414	127.8044	120	27.02 ± 3.74	11.22 ± 2.19	Fitz Hugh Sound	16-03-2015 to 21-08-2018
DFO2	51.5208	127.5583	333	21.67 ± 7.61	10.87 ± 2.96	Rivers Inlet	16-03-2015 to 21-08-2018
DFO5	51.6773	127.3122	198	17.02 ± 11.97	10.47 ± 2.25	Rivers Inlet	07-04-2015 to 22-08-2018
UBC8	51.6737	127.2668	30	15.56 ± 12.78	10.27 ± 2.17	Rivers Inlet	07-04-2015 to 25-07-2018
QCS01[†]	51.7050	128.2384	125	30.49 ± 0.88	10.97 ± 2.25	Queen Charlotte Sound	15-03-2015 to 13-09-2018

* Mean ± SD salinity and temperature calculated from CTD measurements corresponding to the depth (0, 1, 5, 10 m) of bottle samples collected.
[†] QCS01 is located in Queen Charlotte Sound, off the west coast of Calvert Island, and was used to represent the more open-ocean-influenced waters of the "outer coast".

Supplementary Table 3. Characterisation of the end-member dataset by season.

End-member	Station ID	Winter (Dec, Jan, Feb)	Spring (Mar, Apr, May)	Summer (June, July, Aug)	Autumn (Sept, Oct, Nov)	Total no.
Marine phytoplankton	QCS01	2 (5%)	15 (39%)	9 (24%)	12 (32%)	38 (100%)
Watershed	All	21 (20%)	20 (19%)	36 (34%)	29 (27%)	106 (100%)
	Koeye River	0	0	2	3	5
	Stream 626	6	6	7	6	25
	Stream 1015	6	5	9	6	26
	Stream 844	5	4	9	6	24
	Steam 703	4	5	6	5	20
	Wannock River	0	0	3	3	6
Macrophyte	11 sites	2 (1%)	22 (19%)	104 (34%)	40 (27%)	169 (100%)

Supplementary Table 4. Mean ± SD of stable isotope signatures for the three particulate organic matter sources (coloured) used in the mixing model. Breakdowns by watershed type and macrophyte genus are shown for the watershed and marine macrophyte end-members, respectively.

Source	δ^{13}C-POC (‰)	δ^{15}N-PN (‰)	C:N (mol mol^{-1})	n
Watershed | Calvert streams (rain-dominated)	-27.238 ± 0.513	3.022 ± 1.156	12.963 ± 7.940	95
Watershed | Koeye (rain-dominated)	-28.464 ± 0.843	2.569 ± 0.732	12.942 ± 1.824	5
Watershed | Wannock (glacierized)	-28.084 ± 0.639	0.982 ± 2.871	8.220 ± 2.394	6
Watersheds	-27.344 ± 0.619	2.885 ± 1.356	12.694 ± 7.619	106
Marine phytoplankton	-22.282 ± 1.797	6.091 ± 1.304	5.574 ± 1.664	38
Macrophyte | *Fucus* (rockweed)	-15.749 ± 2.485	7.094 ± 0.914	56.174 ± 17.712	35
Macrophyte | *Ulva* (sea lettuce)	-15.637 ± 4.579	7.605 ± 0.601	26.505 ± 13.381	30
Macrophyte | *Zostera* (eelgrass)	-9.691 ± 2.099	6.702 ± 1.123	20.269 ± 6.096	104
Marine macrophyte	-12.001 ± 4.020	6.943 ± 1.060	28.812 ± 17.869	169

Supplementary Table 5. Characterisation of the mixture dataset by station and season.

Station ID	Winter (Dec, Jan, Feb)	Spring (Mar, Apr, May)	Summer (June, July, Aug)	Autumn (Sept, Oct, Nov)	Total no. (% of total)
KWY01	5	43	34	29	111 (15%)
FZH08	0	13	8	6	27 (4%)
PRUTH	22	45	39	19	125 (17%)
KC7	10	19	15	7	51 (7%)
KC10	14	23	18	8	63 (9%)
FZH01	10	36	29	18	93 (13%)
UBC7	0	13	8	2	23 (3%)
RVRS01	0	30	30	11	71 (10%)
DFO2	9	39	35	15	98 (13%)
DFO5	0	14	15	4	33 (5%)
UBC8	0	13	13	7	33 (5%)
All samples	**70 (10%)**	**288 (40%)**	**244 (33%)**	**126 (17%)**	**728 (100%)**

Supplementary Table 6. Median [95% Bayesian credible interval] source contributions by season across 11 inner coast marine stations.

Station	Season	Watersheds	Phytoplankton	Macrophyte
KWY01	Winter	0.696 [0.613, 0.766]	0.300 [0.230, 0.383]	0.003 [0.001, 0.012]
	Spring	0.115 [0.080, 0.157]	0.788 [0.738, 0.832]	0.097 [0.071, 0.124]
	Summer	0.184 [0.140, 0.233]	0.681 [0.623, 0.732]	0.135 [0.105, 0.168]
	Autumn	0.354 [0.299, 0.409]	0.613 [0.558, 0.666]	0.033 [0.016, 0.055]
FZH08	Winter	-	-	-
	Spring	0.046 [0.014, 0.090]	0.850 [0.785, 0.899]	0.104 [0.068, 0.152]
	Summer	0.078 [0.026, 0.139]	0.770 [0.685, 0.839]	0.151 [0.105, 0.211]
	Autumn	0.169 [0.059, 0.280]	0.787 [0.677, 0.892]	0.043 [0.019, 0.074]
PRUTH	Winter	0.534 [0.439, 0.612]	0.463 [0.384, 0.557]	0.003 [0.001, 0.010]
	Spring	0.063 [0.040, 0.094]	0.875 [0.838, 0.908]	0.061 [0.040, 0.084]
	Summer	0.108 [0.074, 0.149]	0.802 [0.755, 0.843]	0.090 [0.063, 0.117]
	Autumn	0.217 [0.159, 0.278]	0.759 [0.697, 0.816]	0.023 [0.010, 0.040]
KC7	Winter	0.535 [0.428, 0.625]	0.459 [0.370, 0.566]	0.005 [0.001, 0.017]
	Spring	0.062 [0.035, 0.099]	0.843 [0.795, 0.884]	0.094 [0.064, 0.129]
	Summer	0.104 [0.064, 0.155]	0.759 [0.697, 0.813]	0.137 [0.100, 0.180]
	Autumn	0.217 [0.146, 0.296]	0.746 [0.665, 0.818]	0.037 [0.017, 0.063]
KC10	Winter	0.562 [0.445, 0.653]	0.433 [0.343, 0.552]	0.004 [0.001, 0.017]
	Spring	0.069 [0.039, 0.108]	0.841 [0.793, 0.883]	0.090 [0.063, 0.122]
	Summer	0.114 [0.070, 0.168]	0.755 [0.694, 0.810]	0.130 [0.096, 0.168]
	Autumn	0.235 [0.157, 0.318]	0.730 [0.649, 0.806]	0.035 [0.016, 0.058]
FZH01	Winter	0.546 [0.363, 0.666]	0.448 [0.326, 0.632]	0.006 [0.001, 0.018]
	Spring	0.064 [0.030, 0.106]	0.824 [0.776, 0.867]	0.111 [0.086, 0.141]
	Summer	0.105 [0.051, 0.164]	0.734 [0.673, 0.792]	0.161 [0.132, 0.192]
	Autumn	0.225 [0.121, 0.312]	0.731 [0.642, 0.832]	0.044 [0.022, 0.069]
UBC7	Winter	-	-	-
	Spring	0.087 [0.032, 0.151]	0.782 [0.703, 0.849]	0.131 [0.095, 0.175]
	Summer	0.140 [0.054, 0.231]	0.677 [0.576, 0.770]	0.183 [0.137, 0.237]
	Autumn	0.292 [0.125, 0.430]	0.659 [0.523, 0.822]	0.049 [0.023, 0.082]
RVRS01	Winter	-	-	-
	Spring	0.061 [0.031, 0.100]	0.862 [0.820, 0.900]	0.076 [0.053, 0.100]
	Summer	0.103 [0.055, 0.159]	0.783 [0.730, 0.836]	0.112 [0.085, 0.141]
	Autumn	0.212 [0.129, 0.291]	0.756 [0.681, 0.838]	0.030 [0.014, 0.049]
DFO2	Winter	0.776 [0.703, 0.832]	0.222 [0.166, 0.296]	0.001 [0, 0.005]
	Spring	0.171 [0.120, 0.224]	0.776 [0.724, 0.827]	0.054 [0.034, 0.077]
	Summer	0.268 [0.207, 0.327]	0.658 [0.598, 0.718]	0.073 [0.049, 0.099]
	Autumn	0.458 [0.395, 0.512]	0.526 [0.473, 0.586]	0.016 [0.006, 0.029]
DFO5	Winter	-	-	-
	Spring	0.344 [0.274, 0.416]	0.649 [0.575, 0.719]	0.006 [0.001, 0.019]
	Summer	0.491 [0.407, 0.575]	0.500 [0.415, 0.582]	0.008 [0.002, 0.023]
	Autumn	0.677 [0.587, 0.751]	0.322 [0.249, 0.411]	0.001 [0, 0.005]
UBC8	Winter	-	-	-
	Spring	0.395 [0.323, 0.466]	0.595 [0.522, 0.667]	0.009 [0.002, 0.027]
	Summer	0.545 [0.461, 0.624]	0.442 [0.362, 0.527]	0.011 [0.003, 0.031]
	Autumn	0.723 [0.640, 0.791]	0.275 [0.207, 0.358]	0.002 [0, 0.006]

References

RGI Consortium (2017). "Randolph Glacier Inventory - A Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Global Land Ice Measurements from Space". Version 6.0 (Colorado, USA).

GeoBC (2009). "Freshwater Atlas". (Victoria, BC: Integrated Land Management Bureau, Ministry of Agriculture and Lands). https://www2.gov.bc.ca/gov/content/data/geographic-data-services/topographic-data/freshwater

Giesbrecht, I.J.W., Floyd, W.C., Tank, S.E., Lertzman, K.P., Hunt, B.P.V., Korver, M.C., Oliver, A.A., Brunsting, R., Sanborn, P., Gonzalez Arriola, S.G., Frazer, G.W., St. Pierre, K.A., Hateley, S., Mcphail, J., Owen, C., Butler, S., Fedje, B., Myers, E., Quayle, L., Haughton, E., Desmarais, I., White, R., Levy-Booth, D.J., Kellogg, C.T.E., Jackson, J.M., Mohn, W.W., Hallam, S.J., and Del Bel Belluz, J. (2021). The Kwakshua Watersheds Observatory, central coast of British Columbia, Canada. *Hydrol. Processes* 35**,** e14198. doi: 10.1002/hyp.14198

Haughton, E., Floyd, W.C., Brunsting, R., and Hateley, S. (2020). "Precipitation 2013 through 2019 on the Central Coast and Quadra Island, British Columbia, Canada. " Version 1.0. Hakai Institute (Heriot Bay, BC, Canada). doi: 10.21966/xnh1-tp28

Korver, M.C., Floyd, W.C., and Brunsting, R. (2020). "Observed stream flow from seven small coastal watersheds in British Columbia, Canada, Sept. 2013 - Sept. 2019. " Version 5.0. Hakai Institute (Heriot Bay, BC, Canada). doi: 10.21966/fh63-w427

Wang, T., Hamann, A., Spittlehouse, D., and Carroll, C. (2016). Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America. *PLoS One* 11**,** e0156720. doi: 10.1371/journal.pone.0156720