Appendix E1. Parameters and Rates

For this work, we reviewed two Salish Sea Model (SSM) runs with different baseline parametrizations: Khangaonkar et al. (2018), optimized for dissolved oxygen (DO), and Bianucci et al. (2018), optimized for carbonate system parameters. The bounding scenarios were conducted with parameterization employed in Khangaonkar et al. (2018).

We explored different parameters with the goal of optimizing the performance for both DO and carbonate system parameters. During our exploration in parametrization, we systematically tested the model performance upon varying parameters to determine model sensitivity. We also researched the observational literature to assess whether a firm basis exists for varying those parameters. The resulting parameter set achieved a more balanced performance between DO and pH, but it did not improve global model performance for DO. Both the kinetic parameters of Khangaonkar et al. (2018) used in bounding scenarios (Exist1) as well as alternative set of kinetic parameters arrived at (Exist2) are included as Appendix E2. Figure E1 shows a planview map of minimum DO predictions for model runs with rates and constants of Khangaonkar et al. (2018) and with the alternative set of kinetic parameters.

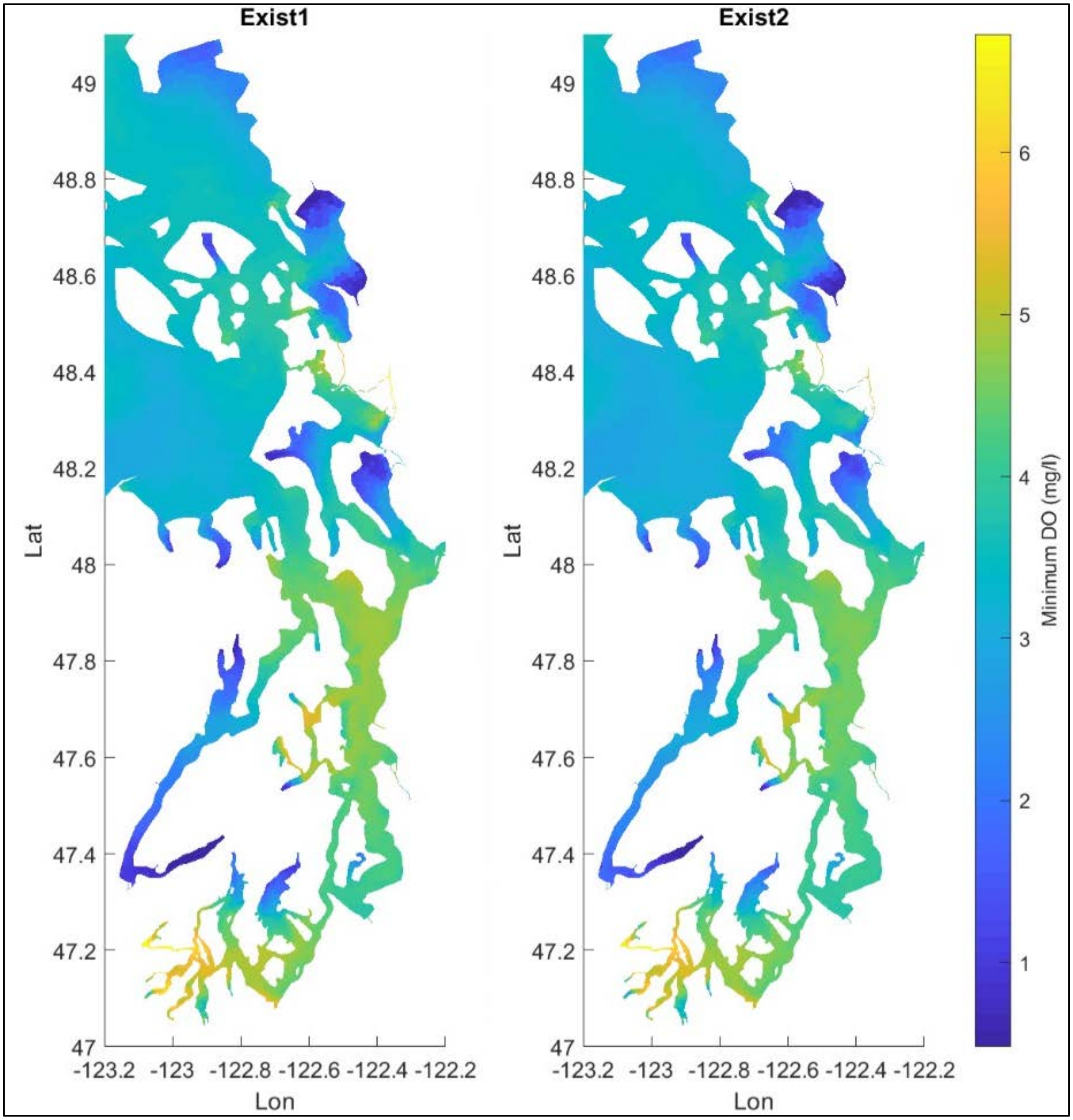

Figure E1. Minimum DO predictions for 2008 with two different set of parameters: Exist1 and Exist2.

Explorations in global parametrization

To enhance our understanding of using alternative and reasonable parametrization, we followed two approaches:

1. Researched the observational literature to hone in on specific parameters that were deemed to be potentially important in defining the system.
2. Reviewed ICM parameterization used in another analogous modeling system in Chesapeake Bay (Cerco et al., 2010).

Below is a listing of the parameters that we explored and the basis for any adjustments made to the values used in the alternative parametrization that was developed. Table E1 shows results of sensitivity runs conducted to assess changes to aeration coefficients, settling rates, half-saturation concentration of ammonium ion required for nitrification, slope of irradiance versus production, and half-saturation rate for nitrogen uptake. The remainder of this section contains information and discussion about each parameter set considered. Since the overall statistics (R, RMSE, and bias) did not improve using the alternative parametrization, we used the Khangaonkar et al. (2018) global parametrization to conduct all model runs reported in this volume.

Table E1. Sensitivity in DO predictions to changes in rate parameters.

Run	year	Parameter set	A_{rear}	C_{rear}	WSLAB/ WSREF	KHNNT	ALPHA1/ ALPHA2	KHN1	R	RMSE	Bias
Run1	2008	Exist2*	0.1	1.5	10	0.5	12/12	0.06	0.71	2.12	-1.8
Run2	2008	Exist2	0.251	1.5	10	0.5	12/12	0.06	0.84	1.49	-1.23
Run3	2008	Exist2	0.251	2	10	0.5	12/12	0.06	0.84	1.23	-0.85
Run4	2008	Exist2	0.251	2	5	0.5	12/12	0.06	0.84	1.17	-0.78
Run5	2008	Exist2	0.251	2	5	1	12/12	0.06	0.84	1.13	-0.73
Run6	2008	Exist2	0.251	2	5	1	8/10	0.06	0.83	1.11	-0.67
Run7	2008	Exist2	0.251	2	5	1	8/10	0.02	0.83	1.13	-0.72
Baseline	2008	Exist1*	0.251	2	5	0.5	12/12	0.06	0.85	0.98	-0.53

*Exist2 uses the alternative rates and constants, whereas Exist1 uses the rates and constants of Khangaonkar et al. (2018).

1. Aeration coefficients

The model is sensitive to the empirical constants in the equation that are used to compute K_r, the reaeration coefficient:

$$K_r = A_{rear} \times R_v \times W_{ms}^{Crear}$$

Where:

A_{rear}= empirical constant

C_{rear} = empirical constant

R_v= ratio of kinematic viscosity of pure water at 20 °C to kinematic viscosity of water at specified temperature and salinity

W_{ms}= wind speed measured at 10m above surface water in meters per second.

We tested A_{rear} values of 0.1 (to evaluate the effects of wind sheltering as suggested in the ICM manual) and 0.251 (per Wanninkhof, 2014). The latter improved RMSE and bias as shown in Table E1 (compare Run 1 and Run2). We also tested C_{rear} at values of 1.5 and 2 with Exist2 for 2008, and obtained improved RMSE and bias with the latter (compare Run2 and Run3 in Table E1).

2. Settling rates

Settling rates for labile (WSLAB) and refractory (WSREF) particulates can make a significant difference in model performance, but very limited observational data are available to evaluate this parameter. Cerco et al. (2010) used values of 1 m/day for settling rates of both labile and refractory particulate matter; whereas, Bianucci et al. (2018) used 10 m/day for both, and Khangaonkar et al. (2018) used 5 m/day. Tests with these values demonstrated the degree of sensitivity. A value of 5 m/day showed improvement in RMSE and bias compared to a value of 10 m/d (compare Run3 with Run4 in Table E1).

3. Nitrification

Tests demonstrated that the model is slightly sensitive to KHNNT, the half-saturation concentration of ammonium ion required for nitrification. Increasing the half saturation constant for nitrification from 0.5 to 1 reduced the RMSE and bias of DO predictions as shown in Table E1 (compare Run4 and Run5).

4. Algal kinetics: Light Limitation

The influence of light on phytoplankton production is represented by the following equation:

$$P^B = P^B m \frac{I}{\sqrt{I^2 + Ik^2}}$$

in which:
P^B = photosynthetic rate (g C g-1 Chl d-1)
$P^B m$ = maximum photosynthetic rate (g C g-1 Chl d-1)
I = irradiance (E m-2 d-1)
Parameter Ik is defined as the irradiance at which the initial slope (α) of production vs. irradiance relationship intersects the value of $P^B m$:

$$Ik = \frac{P^B m}{\alpha}$$

Thus, the parameter α has an impact in the total productivity and the timing of the blooms. The larger α (ALPHA), earlier blooms in the spring and later blooms in the fall are possible. Cerco et al. (2010) used values of 8 and 10 g C g^{-1} Chl /(E m^{-2}) for algal group 1 and 2, respectively, whereas Khangaonkar et.al. (2018) used a value of 12 for both. We tested both sets. For 2008, the larger number resulted in a small earlier bloom, in March, and a small later bloom in the fall. Overall global RMSE and bias for predicting DO improved slightly with lower value set (compare Run5 and Run6 in Table E1).

5. Algal kinetics: Half-saturation rate for Nitrogen uptake (KHn)

The half-saturation rate for nitrogen uptake features in two algorithms that determine algal growth kinetics: modulating overall growth via a limitation parameter and algal ammonium ion preference.

Phytoplankton growth (G) limitation is simulated by the following equation:

$$G = \frac{P^B m}{CChl} \cdot f(T) \cdot \text{minimum}\left(\frac{Na}{KHn + Na}, \frac{Pa}{KHp + Pa}, \frac{I}{\sqrt{I^2 + Ik^2}}\right) \quad \textbf{(10)}$$

in which:
Na = areal nitrogen concentration (g N m^{-2})
KHn = half-saturation concentration for nitrogen uptake (g N m^{-3})
Pa = areal dissolved phosphate concentration (g P m^{-2})
KHp = half-saturation concentration for phosphorus uptake (g P m^{-3})

Ammonium ion preference is simulated by the following equation:

$$PN = NH_4 \bullet \frac{NO_{23}}{(KHn + NH_4) \bullet (KHn + NO_{23})} + NH_4 \bullet \frac{KHn}{(NH_4 + NO_{23}) \bullet (KHn + NO_{23})}$$

in which

PN = algal preference for ammonium uptake ($0 \leq Pn \leq 1$)
KHn = half saturation concentration for algal nitrogen uptake (g N m^{-3})

SSM values for KHn for algal group 1 and 2 (ALG1 and ALG2) are fixed spatially. KHn is meant to represent the composite values for all phytoplankton represented within each algal group.

Puget Sound phytoplankton data (Phifer, 1933; Hannach and Swanson, 2016) reveal that taxonomic categories vary temporally. *Chaetocerus* constitutes, at times, the largest annual bio-volume generator in the central Puget Sound region (Phifer, 1933; Hannach and Swanson, 2016). It is a genus that is widespread worldwide, able to live in a large variety of habitats with temperature ranges from -1.1 - 23.5 °C (Encyclopedia of Life, 2018).

Reported KHn values for *Chaetocerus* vary widely. Eppley (1969) reported values at a reference temperature of 18 °C of up to about 0.01 mg N/L for a *Chaetocerus* strain originating in the Costa Rica Dome. Eppley et al. (1969) also reported KHn values for two other phytoplankton genera found occasionally in the Puget Sound: *Skeletonema* (up to 0.01 mg N/L) and *Gonyaulax* (up to 0.18 mg N/L), also at 18 °C. On the other hand, an online library tool (Robson et al., 2018) containing a downloadable library of rates and constants reports values of 0.04 and 0.06 mg N/L for the two strains of *Chaetocerus* found in the library, both at a reference temperature of 20 °C.

The KHn values in SSM are intended to be a composite of both modeled algal groups, which generally represent diatoms and dinoflagellates. EPA's compilation of published values (EPA, 1985) for Khn for diatoms range from 0.003 to 0.923 mg N/L, and for dinoflagellates range from 0.005 to 0.589 mg N/L. The values we are currently using in the model are 0.06 mg N/L for both ALG1 and ALG2.

We used the Robson et al. (2018) parameter library to further compare our current values of KHn for ALG1 and ALG2. We downloaded the data from the library, and sorted the species by class into marine diatoms and dinoflagellates. The library facilitates the estimation of rates at different temperatures by applying an Arrhenius response curve to the compiled reference values. We obtained the following table (Table E2) for the mean, 5th and 95th percentiles, estimated at both 10 °C, and 20 °C. It should be noted that the optimum temperature for diatoms and dinoflagellates used in the model is 12 °C and 18 °C, respectively.

Table E2. Half saturation rates for Diatoms and Dinoflagellates for nitrogen

Class or Phylum (mg N/L)	Mean		5th percentile		95th percentile	
Temperature	10 °C	20 °C	10 °C	20 °C	10 °C	20 °C
Diatoms	0.02	0.05	0.002	0.003	0.06	0.13
Dinoflagellates	0.03	0.06	0.008	0.02	0.11	0.12

In conclusion, the KHn values in use in SSM fall within the reported literature range, including specifically for the genus *Chaetocerus*. For diatoms, 0.06 mg N/L (KHn1) represents the upper limit of a composite of species at 10 °C, and about half of the corresponding estimated value at 20 °C. For dinoflagellates, 0.06 mg N/L (KHn2) represents the mean at 20 °C, and about twice the mean at 10 °C. Given the large variation in the literature for KHn, these values seem reasonable. Nonetheless, we conducted a sensitivity run with a KHn value for 0.02 mg N/L for diatoms to understand how that change modulates DO and primary productivity. The tests, as shown in Table E1 (compare Run6 and Run7) showed that with KHn of 0.06 the RMSE and bias for DO predictions was slightly better. Figure E2 shows the minimum DO for year 2008 with KHN1 of 0.06 and KHN1 of 0.02.

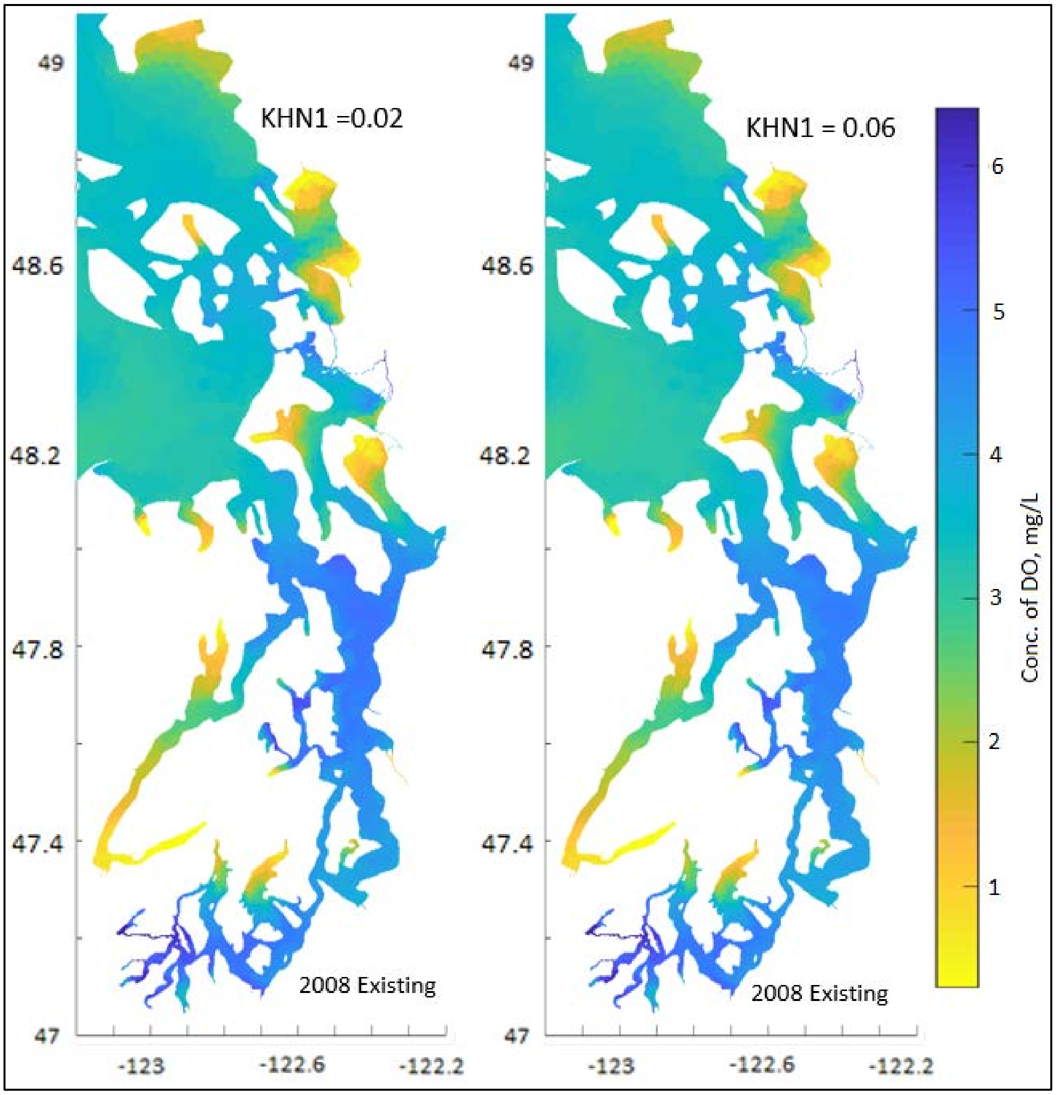

Figure E2. Predicted minimum DO with KHN1 = 0.02 (left) and KHN1 = 0.06 (right) for 2008 existing conditions

6. Fractionation of particulate organic matter due to predation

SSM has simple relationships for algal predation by zooplankton and does not specifically include zooplankton growth kinetics. The fate of phytoplankton consumed by predation is partitioned into the various organic carbon fractionations. Estimates for these fractions were found in Engel and Macko (1993). It is estimated that 45% of the ingested phytoplankton is metabolized into zooplankton growth and 3-4% of ingested phytoplankton results in fecal pellets. Effectively, this fraction becomes part of the particulate organic carbon (POC) pool. Another 50% of the phytoplankton carbon is either used in respiration or excreted as dissolved organic carbon (DOC). The resulting fractions are shown in Table E7 under the symbols FDOP (fraction released as CO_2 during predation), FCLDP (fraction released as labile DOC), FCRDF (fraction released as refractory DOC), FCLP (fraction released as labile POC) and FCRP (fraction released as refractory POC). The existing model run distributes the algal carbon fraction consumed by zooplankton predation as 70% particulate carbon (FCLP = 0.5, FCRP = 0.2), 30% dissolved organic carbon (FCLDP = 0.1 and FCRDP = 0.2) with no fraction directly assigned to zooplankton respiration (i.e. FDOP = 0). However, a sensitivity test was done assigning a specific fraction to zooplankton respiration to assess whether the model's pH performance might be improved. Respiration carbon was set at 20% (FDOP = 0.2), and dissolved carbon fraction was kept at 30% (FCLDP = 0.1 and FCRDP = 0.2) adding up to 50% of algal carbon consumed per Engel et al. (1993). The remaining 50% was assigned to particulate organic carbon and distributed as 40% labile (FCLP = 0.4) and 10% refractory (FCRP = 0.1). A sensitivity test was done with these fractions as shown in Table E3.

This alternate fractionation scheme slightly improved RMSE and bias for pH likely through production of CO2 from zooplankton respiration (FDOP = 0.2)and slightly deteriorated RMSE and bias for DO likely from reduced particulate carbon (70% in existing run versus 50% in alternate fractionation scheme) as shown in Table E3.

Table E3. Sensitivity in DO and pH predictions to fractionation of particulate organic matter

Model run	Year	FDOP	FCLDP	FCRDP	FCLP	FCRP	DO			pH		
							R	RMSE	bias	R	RMSE	bias
SSM2_1	2014	0	0.1	0.2	0.5	0.2	0.79	1.26	-0.29	0.59	0.28	0.14
SSM2_2	2014	0.2	0.1	0.2	0.4	0.1	0.78	1.29	-0.32	0.59	0.27	0.12

7. Mineralization

Heterotrophic bacteria are a crucial component of the ecosystem due to the role they play in breaking down organic carbon via respiration and nutrient cycling. Heterotrophic microbial respiration is modeled as the dissolution of organic carbon via first order kinetics, and is one of the key processes that the SSM simulates; however, heterotrophic respiration rate measurements at a Sound-wide scale have not been conducted to date. Domain specific data on the spatial variability of heterotrophic respiration rates may help to improve model performance. The SSM has the capability of using spatially distinct minimum heterotrophic respiration rate constants, but without the necessary data, it is currently run with a constant, minimum domain wide heterotrophic rate. The minimum heterotrophic respiration rate (KLDC) currently used is 0.025 per day which is in the lower range (0.025 – 0.05) of values used in Chesapeake Bay model (Cerco et al., 2010). A sensitivity test using the higher value of 0.05 is shown in Table C8.

The equation used in the SSM (Cerco et al. 1995) for the change in the concentration of organic carbon substrate (DOC) is shown below:

$$\frac{\delta}{\delta t} DOC = FCD \bullet R \bullet B + FCDP \bullet PR + Klpoc \bullet LPOC$$
$$+ Krpoc \bullet RPOC - \frac{DO}{KHodoc + DO} \bullet Kdoc \bullet DOC - DENIT \bullet DOC$$

In which:

DOC = dissolved organic carbon (g m^{-3})

LPOC = labile particulate organic carbon (g m^{-3})

RPOC = refractory particulate organic carbon (g m^{-3})

FCD = fraction of algal respiration released as DOC ($0<FCD<1$)

FCDP = fraction of predation on algae released as DOC ($0<FCDP<1$)

Klpoc = dissolution rate of LPOC (d^{-1})

Krpoc = dissolution rate of RPOC (d^{-1})

Kdoc = dissolution rate of DOC (d^{-1})

R = Algal respiration (d^{-1})

B = Algal biomass (g C m^{-3})

PR = rate of predation on algal groups (d^{-1})

DENIT =denitrification rate of dissolved organic carbon (d^{-1})

DO = dissolved oxygen (mg/l)

KHodoc = half-saturation DO concentration for oxic respiration (mg/l)

The organic carbon dissolution rate tied to the heterotrophic respiration rate is modeled with both labile and refractory terms (KDOC and KRDC). It is represented as a first order rate constant that is applied to the availability of organic carbon substrate, and modulated by temperature and DO concentrations at each model cell. The equation for KDOC used in SSM (from Cerco, et al. 1995), contains two terms, as shown below:

$$KDOC = KLDC + KDCALG*ALGCAR$$

Where:

KDOC = the labile respiration rate in units of 1/days

KLDC = the minimum respiration rate in units of 1/days (can be either KLDC or KRDC) where L indicates labile, R refractory; D indicates dissolved.

KDCALG = constant that relates DOC respiration to algal biomass ($m^3\ g^{-1}\ C\ d^{-1}$)

ALGCAR= Algal biomass for each algal group simulated ($g\ C\ m^{-3}$)

As discussed above, the first term in the equation above (KLDC), and the analogous term (KRDC) are global minimum constants currently used uniformly throughout the domain. The second term is based on the established correlation between heterotrophic activity and algal biomass, as algae produce labile carbon which can fuel heterotrophic activity.

An exponential function is used to adjust KDOC and KRDC to changing temperatures in each grid cell layer over time. In addition, a Monod- type ratio is applied using a constant for the half-saturation concentration of DO required for oxic respiration KHodoc and the DO concentration in each cell.

A related term which generates DOC is the dissolution rate for labile particulate organic carbon (KLPC), and the currently used value for it is 0.01 which is lower than the value (0.12) used in Chesapeake Bay model (Cerco et al., 2010). So a sensitivity test with KLPC= 0.1 was done for different values of KLDC and vice versa as shown in Table E4.

The rates for particulate organic carbon dissolution as well as the overall dissolved organic carbon dissolution rate have an impact on DIC, pCO2 and pH. Sensitivity tests conducted showed that the changes made to the above rates worsened the RMSE and bias for DO predictions (see Table E4).

Table E4. Sensitivity in DO predictions to KDOC and KLPOC

Model run	Parameter set	Year	KLDC	KLPC	R	RMSE	Bias
S1*	Exist1	2008	0.025	0.01	0.85	0.98	-0.53
S2	Exist1	2008	0.05	0.01	0.84	1.07	-0.65
S3	Exist1	2008	0.025	0.1	0.84	1.01	-0.54
S4	Exist1	2008	0.05	0.1	0.83	1.13	-0.7

*S1 is the baseline run with rates and constants of Khangaonkar et al. (2018)

8. Algal settling rates

Settling rates for diatoms and flagellates are highly variable. EPA (1985) reports a range of 0.02 to 17.1 meters/day (m/d) for diatoms, and 0.05 to 8 meters per day for flagellates. In SSM, WS1 is the settling rate for diatom and WS2 is the settling rate for dinoflagellates. Khangaonkar et al. (2018) used a value of 0.4 m/d and 0.2 m/d for WS1 and WS2, respectively. However, Bianucci et al. (2018) used a somewhat higher values of 0.6 m/d and 0.3m/d for WS1 and WS2, respectively.

Comparing the rates used by Khangaonkar et al. (2018) and Bianucci et al. (2018) results in significantly altered particulate organic carbon time series in the bottom layer, as shown in the example below (Figure E3) which corresponds with a node in Bellingham Bay. In case 1, peak particulate organic carbon (POC) concentrations approach 1.5 mg/L, whereas in case 2, POC values peak at about half of that, around 0.7 mg/L. This large difference in POC concentrations at the bottom layer did not make a significant difference in predicted DO concentrations, pH or dissolved inorganic carbon (DIC) values (Table E5).

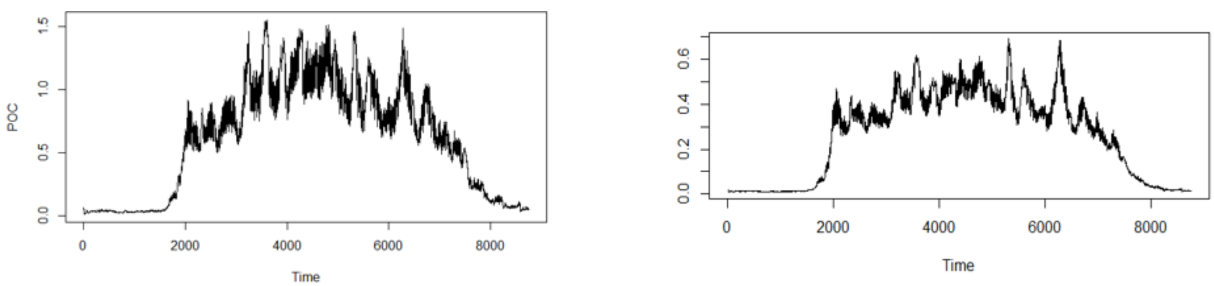

Figure E3. Example of comparison of bottom layer time series for model runs utilizing different algal settling rates. ***Left*, Case 1**: WS1= 0.4 m/d, WS2= 0.2 m/d. ***Right*, Case 2**: WS1= 0.6 m/d, WS2= 0.3 m/d.

Table E5. Sensitivity to settling rates of algae

Model run	Year	WS1	WS2	DO			pH			DIC		
				R	RMSE	bias	R	RMSE	bias	R	RMSE	bias
SSM2_1	2014	0.4	0.2	0.79	1.26	-0.29	0.59	0.28	0.14	0.68	88.57	-13
SSM2_3	2014	0.6	0.3	0.79	1.26	-0.29	0.58	0.27	0.14	0.68	88.16	-10.82

Exploration of a source-specific parameter

No available data exists for fractionation of labile and refractory organic carbon entering estuarine waters. Current efforts are underway to measure these factions at river mouths. Labile carbon is generally defined for the purposes of this modeling work as organic compounds that are completely decomposed in the estuary within roughly sixty days (Cerco and Cole, 1995). Refractory carbon are organic compounds that are decomposed in longer than sixty days. We decided to examine the spatial DO response to changes in this parameter.

Figure E4 is a plot of the difference in minimum DO between two scenarios (Scenario 1 – 2) with exactly the same carbon input loading magnitude from rivers and point sources, but different fractions of labile and refractory carbon, where Scenario 1= 90% Labile, 10 % refractory OC, Scenario 2= 50%/50%. Throughout large portion of Puget Sound, the difference in the labile fraction results in DO depletion of up to about 0.06 mg/L, or about 30% of the total anthropogenic cumulative allowance. The 50/50 split resulted in a slightly better RMSE and bias (RMSE = 1.45 and bias = -1.19) compared with a 90/10 split (RMSE = 1.49 and bias = -1.23) using the Exist2 parameters (Appendix E2) while simulating year 2008. However, the 90/10 split is reasonable given that in excess of 90% of BOD is expected to be consumed within 60 days even with a very low BOD decay rate constant of 0.05 per day (estimated as per BOD kinetic equations in Metcalf and Eddy, 1991). When data from river mouths becomes available, we will use it to update the riverine labile and refractory fractions used in the model.

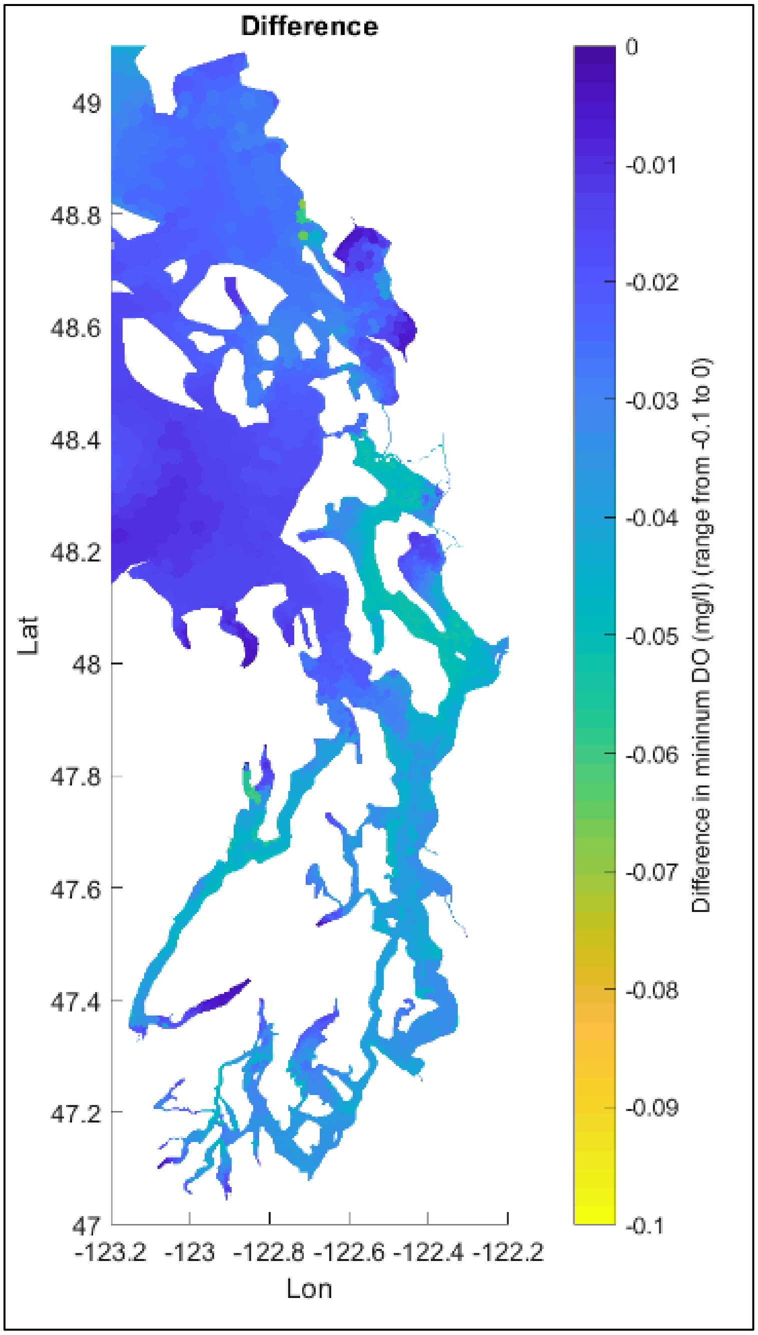

Figure E4. Difference in minimum DO between two SSM model runs (using Exist2 parameters) one with 90/10 and the other with 50/50 split between labile and refractory organic carbon fractions for year 2008.

References

Bianucci L., W. Long, T. Khangaonkar, G. Pelletier, A. Ahmed, T. Mohamedali, M. Roberts, and C. Figueroa-Kaminsky. 2018. Sensitivity of the regional ocean acidification and the carbonate system in Puget Sound to ocean and freshwater inputs. *Elementa Science of the Anthropocene* 6(1): 22.

Cerco, C., and T. Cole. 1995. User's Guide to the CE-QUAL-ICM Three-Dimensional Eutrophication Model, Release Version 1.0. Technical Report EL-95-15.

Cerco, C., K. Sung-Chan, and M. Noel. 2010. The 2010 Chesapeake Bay Eutrophication Model, A Report to the US Environmental Protection Agency Chesapeake Bay Program and to the US Army Engineer Baltimore District, US Army Engineer Research and Development Center, Vicksburg, MS.

Engel, M., and S. Macko. (editors). 1993. *Organic Geochemistry: Principles and Applications*. Plenum Press, New York, p. 156.

EPA (United States Environmental Protections Agency). 1985. Rates, constants and kinetic formulations in surface water quality modeling, second edition. EPA /600/3-85/040.

Eppley, R., J. Rogers, and J. McCarthy. 1969. Half-saturation constants for uptake of nitrate and ammonium by marine phytoplankton. *Limnology and Oceanography* 14: 912–920. https://doi.org/10.4319/lo.1969.14.6.0912.

Hannach, G., and Swanson. 2016. King County Marine Phytoplankton: 2016 Highlights. King County Environmental Laboratory, Water and Land Resources Division.

Metcalf and Eddy, Inc. 1991. Wastewater Engineering: Treatment, Disposal and Reuse, third edition. Edited by G. Tchobanoglous and F. Burton. McGraw-Hill Publishing Company, New York.

Phifer, L. 1933. Seasonal Distribution and Occurrence of Planktonic Diatoms at Friday Harbor, Washington. University of Washington Publications in Oceanography, Volume 1, No. 2. University of Washington Press, Seattle.

Testa, J., D. Brady, D. DiTori, W. Boynton, J. Cornwell, and W. Kemp. 2013. Sediment flux modeling: Simulating nitrogen, phosphorus and silica cycles. *Estuarine, Coastal and Shelf Science* 131: 245–263.

Encyclopedia of Life, accessed 6/13/2018, http://eol.org/pages/12010/details.

Robson, B.J., Arhonditsis, G.B., Baird, M.E., Brebion, J., Edwards, K.F., Geoffroy, L., Hebert, Marie-Pier, van Dongen-Vogels, V., Jones, E.M., Kruk, C, Mongin, M., Shimoda, Y., Skerratt, J.H., Trevathan-Tackett, S.M., Wild-Allen, K., Kong, X. and Steven, A. 2018. Towards evidence-based parameter priors for aquatic ecosystem modelling. *Environmental Modelling & Software* 100: 74–81.

Wanninkhof, R. 2014. Relationship between wind speed and gas exchange over the ocean revisited. *Limnology and Oceanography Methods* 12(6): 351–362.

Appendix E2. Parameters and Rates for Sensitivity Analyses

Parameter	Symbol	Khangaonkar et al. 2018 Exist1	Alternative Exist2	Unit	Literature Range	Definition
Algae	ALPHMN1	12	8	$g\ C\ g^{-1}\ Chl$ / $(E\ m^{-2})^{-1}$		Photosynthesis vs. Irradiance slope for algal group 1
Algae	ALPHMN2	12	10	$g\ C\ g^{-1}\ Chl$ / $(E\ m^{-2})^{-1}$		Photosynthesis vs. Irradiance slope for algal group 2
Algae	ANC1	0.175	0.175	g N g-1 C		nitrogen-to-carbon ratio for algal group 1
Algae	ANC2	0.175	0.175	g N g-1 C		nitrogen-to-carbon ratio for algal group 2
Algae	BM1	0.1	0.1	d^{-1}	0.01 – 0.1	basal metabolic rate of algal group 1
Aeration	A_{rear}	0.251	0.251			empirical constant in reaeration equation
Aeration	C_{rear}	2	2			reaeration coefficient as a function of wind speed
Algae	BM2	0.1	0.1	d^{-1}	0.01 – 0.1	basal metabolic rate of algal group 2
Algae	BPR1	1	1	d^{-1}	0.05 – 1.0	base predation rate of algal group 1
Algae	BPR2	0.5	0.5	d^{-1}	0.05 – 1.0	base predation rate of algal group 2
Algae	CCHL1	37	37	$g\ C\ g^{-1}\ Chl$	30 – 143	carbon-to-chlorophyll ratio for algal group 1
Algae	CCHL2	50	50	$g\ C\ g^{-1}\ Chl$	30 – 143	carbon-to-chlorophyll ratio for algal group 2
Algae	G1	calculated	calculated	d^{-1}		growth rate of algal group 1
Algae	G2	calculated	calculated	d^{-1}		growth rate of algal group 2
Algae	FCLP	0.5	0.4	0 < FCDP < 1		Fraction of algal carbon recycled to the labile particulate pool via predation
Algae	FCRP	0.2	0.1	0 < FCRP < 1		Fraction of algal carbon recycled to the refractory particulate pool via predation
Algae	FDOP	0	0.2	0 < FDOP < 1		Fraction of algal C consumed in direct respiration by predators

Parameter	Symbol	Khangaonkar et al. 2018 Exist1	Alternative Exist2	Unit	Literature Range	Definition
Algae	FCLDP	0.1	0.1	0 < FCDP < 1		Fraction of algal carbon recycled to the Labile dissolved organic pool via predation
Algae	FCRDP	0.2	0.2	0 < FCDP < 1		Fraction of algal carbon recycled to the Refractory dissolved organic pool via predation
Algae	Khn	0.06 (Alg1) 0.06 (Alg2)	0.06 (Alg1) 0.06 (Alg2)			Half saturation for nitrogen uptake
Algae	PM1	350	350	g C g^{-1} Chl d^{-1}	200 – 350	maximum photosynthetic rate of algal group 1
Algae	PM2	350	350	g C g^{-1} Chl d^{-1}	200 – 350	maximum photosynthetic rate of algal group 2
Algae	TMP1	12	12	°C	up to 35	optimal temperature for growth of algal group 1
Algae	TMP2	18	18	°C	up to 35	optimal temperature for growth of algal group 2
Mineralization	AANOX	0.5	0.5		0-1	ratio of denitrification to oxic carbon respiration rate
Mineralization	ANDC	0.933	0.933	g N g^{-1} C	0.933	mass nitrate-nitrogen reduced per mass diss. organic carbon
Mineralization	AOCR	2.67	2.67	g O_2 g^{-1}C		oxygen-to-carbon mass ratio in production and respiration
Mineralization	AONT	4.33	4.33	g O_2 g^{-1} N		oxygen consumed per mass ammonium nitrified
Mineralization	DENIT	calculated	calculated	d^{-1}		denitrification rate
Mineralization	KHNDN	0.1	0.1	g N m^{-3}		half-saturation conc. of nitrate required for denitrification
Mineralization	KHNNT	0.5	1	g N m^{-3}		half-saturation conc. of NH4 required for nitrification
Mineralization	KHODOC	0.5	0.5	g O_2 m^{-3}		half-saturation conc. of DO required for oxic respiration
Mineralization	KHONT	3	3	g O_2 m^{-3}		half-saturation conc. of DO required for nitrification

Parameter	Symbol	Khangaonkar et al. 2018 Exist1	Alternative Exist2	Unit	Literature Range	Definition
Mineralization	KLDC	0.025	0.025	d^{-1}		dissolved organic carbon dissolution rate
Mineralization	KLPC	0.01	0.03	d^{-1}		particulate organic carbon dissolution rate
Mineralization	KTNT1	0.0045	0.0045	$°C^{-2}$		effect of sub-optimal temperature on nitrification
Mineralization	KTNT2	0.0045	0.0045	$°C^{-2}$		effect of super-optimal temperature on nitrification
Mineralization	NT_m	0.4	0.4	$g\ N\ m^{-3}\ d^{-1}$	0.01 – 0.7	maximum nitrification rate
Mineralization	TMNT	30	30	°C	25 – 35	optimal temperature for nitrification
Settling	WSSNET	0.2	0.2	$m\ d^{-1}$		net settling velocity of inorganic solids to sediments
Settling	WS1	0.4	0.6	$m\ d^{-1}$	0 – 30	settling velocity of algal group 1
Settling	WS2	0.2	0.3	$m\ d^{-1}$	0 – 30	settling velocity of algal group 2
Settling	WSLAB	5	5	$m\ d^{-1}$		labile particulate organic solids settling rate
Settling	WSREF	5	5	$m\ d^{-1}$		refractory particulate organic matter settling rate
Sediments	G1	0.5	0.65	fraction		In sediment module, the most rapidly reactive organic material, 20 day half-life. [a]
Sediments	G2	0.3	0.25	fraction		In sediment module, organic material with slower reactivity, and approximately 1-year half-life. [a]
Sediments	G3	0.2	0.1	fraction		In sediment module, the non-reactive organic material. [a]

[a] Testa et al. (2013).