Appendix H1

Marine Station Locations

and Changes to Observed Database

Following the 2019 Bounding Scenarios Report (Ahmed et al. 2019) a few changes were made to our observed database. These changes include the addition of stations previously not included in the observational database used for comparison with SSM output and corrections of confirmed erroneous values. Stations added to our observational database are shown in Table H1-1. Data corrections were made for photosynthetically active radiation (PAR) due to a conversion error (from $\mu Em^{-2}Sec^{-1}$ to $Em^{-2}Day^{-1}$) that we identified in the original loaded dataset. Due to this error, observed PAR values reported in (Ahmed et al. 2019) are an order of magnitude smaller than they should be. These values have also been corrected in the Environmental Management Information (EIM) database. The plots in Appendices H3 and H4 show the actual PAR values observed.

Additionally, we identified problems with the observational database from the 2006 South Puget Sound Dissolved Oxygen Study used for comparison with SSM. These problems included negative Chlorophyll-a (Chl-a) values and data duplicates for various parameters from an error in the observational script. To remedy these problems, negative Chl-a values were removed, and the dataset was manually reconstructed using the original source data to get rid of duplicates. The impact of the changes listed above can be seen in Tables H1-2 and H1-3 where a comparison of goodness of fit statistics are shown before and after changes to the observed database. Further, Tables H1-2 and H1-3 contain new statistics not reported in (Ahmed et al 2019) including: Willmott Skill Score (WSS), centered RMSE (RMSEc), Relative Error (RE), and Mean Absolute Error (MAE).

$$WSS = 1 - \frac{\sum (Predicted - Obs)^2}{\sum (| Predicted - \overline{Predicted} | + | Obs - \overline{Obs} |)^2}$$

$$RMSEc = \sqrt{\frac{1}{N}\sum \left((Predicted - \overline{Predicted}) - (Obs - \overline{Obs}) \right)^2}$$

$$RE = \frac{\sum |Obs - Predicted|}{\sum Obs} \qquad\qquad MAE = \frac{\sum | Predicted - Obs |}{N}$$

Table H1-1. Stations added to data repository following (Ahmed et al. 2019)

Station	Model Years Available	Used in Bounding Scenario Report?	Used in Optimization Memorandum?
SJF000	2006,2008,2014	No	Yes
SJF001	2006,2008,2014	No	Yes
SJF002	2006,2008,2014	No	Yes
CSE002	2006,2008	2008 only	Yes, including 2006
HND001	2006	No	Yes
ELD002	2006	No	Yes
TOT002	2006,2014	2014 only	Yes, including 2006
BUD002 (also referred to as SS04)	2006,2014	No	Yes
ADM002	2006,2008,2014	2006 and 2008	Yes, including 2014
FID001	2014	No	Yes

Table D-2. Comparison of goodness of fit statistics for 2006 values published in 2019 Bounding Scenarios Report (a) vs values after data correction and inclusion of additional data (b)

| Parameter	R	WSS	RMSE	RMSEc	RE[1]	MAE	Bias	N[2]
Temperature	0.95[a] 0.95[b]	0.96[b]	0.69[a] 0.69[b]	0.58[b]	0.05[b]	0.53[b]	0.39[a] 0.38[b]	140080[a] 145919[b]
Salinity	0.84[a] 0.86[b]	0.88[b]	0.77[a] 0.74[b]	0.57[b]	0.02[b]	0.53[b]	-0.47[a] -0.47[b]	138845[a] 144850[b]
DO	0.80[a] 0.80[b]	0.85[b]	1.09[a] 1.13[b]	0.94[b]	0.14[b]	0.92[b]	-0.57[a] -0.62[b]	135115[a] 134591[b]
Chla[3]	0.52[a] 0.51[b]	0.64[b]	4.48[a] 4.48[b]	4.47[b]	0.72[b]	1.70[b]	0.19[a] 0.20[b]	112567[a] 110580[b]
Nitrate/Nitrite	0.43[a] 0.82[b]	0.90[b]	0.12[a] 0.08[b]	0.08[b]	0.16[b]	0.05[b]	-0.03[a] 0[b]	1416[a] 2356[b]
NH4	0.56[a] 0.51[b]	0.66[b]	0.02[a] 0.02[b]	0.02[b]	1.02[b]	0.01[b]	0.01[a] 0.01[b]	2082[a] 3034[b]
PAR	0.60[b]	0.69[b]	4.09[b]	4.06[b]	0.85[b]	0.76[b]	-0.51[b]	47791[b]

[1]Relative Error; [2]Sample Number

Table D-3. Comparison of goodness of fit statistics for 2014 values published in 2019 Bounding Scenarios Report (a) vs values after data correction and inclusion of additional data (b)

| Parameter	R	WSS	RMSE	RMSEc	RE[1]	MAE	Bias	N[2]
Temperature	0.95[a] 0.95[b]	0.94[b]	0.87[a] 0.78[b]	0.74[b]	0.06[b]	0.62[b]	-0.41[a] -0.23[b]	88781[a] 97687[b]
Salinity	0.75[a] 0.82[b]	0.87[b]	0.88[a] 0.84[b]	0.71[b]	0.02[b]	0.51[b]	-0.37[a] -0.44[b]	88585[a] 97487[b]
DO	0.81[a] 0.83[b]	0.89[b]	0.96[a] 0.98[b]	0.89[b]	0.11[b]	0.74[b]	-0.34[a] -0.43[b]	87284[a] 96152[b]
Chla	0.52[a] 0.52[b]	0.67[b]	3.48[a] 3.42[b]	3.42[b]	0.71[b]	1.41[b]	-0.13[a] -0.11[b]	88895[a] 87671[b]
Nitrate/Nitrite	0.84[a] 0.84[b]	0.90[b]	0.07[a] 0.07[b]	0.07[b]	0.15[b]	0.05[b]	0[a] 0[b]	1848[a] 1934[b]
NH4	0.32[a] 0.35[b]	0.56[b]	0.02[a] 0.02[b]	0.02[b]	0.58[b]	0.01[b]	0[a] 0[b]	1510[a] 1595[b]
PAR	0.61[b]	0.66[b]	6.00[b]	5.94[b]	0.78[b]	1.08[b]	-0.81[b]	82178[b]

[1]Relative Error; [2]Sample Number
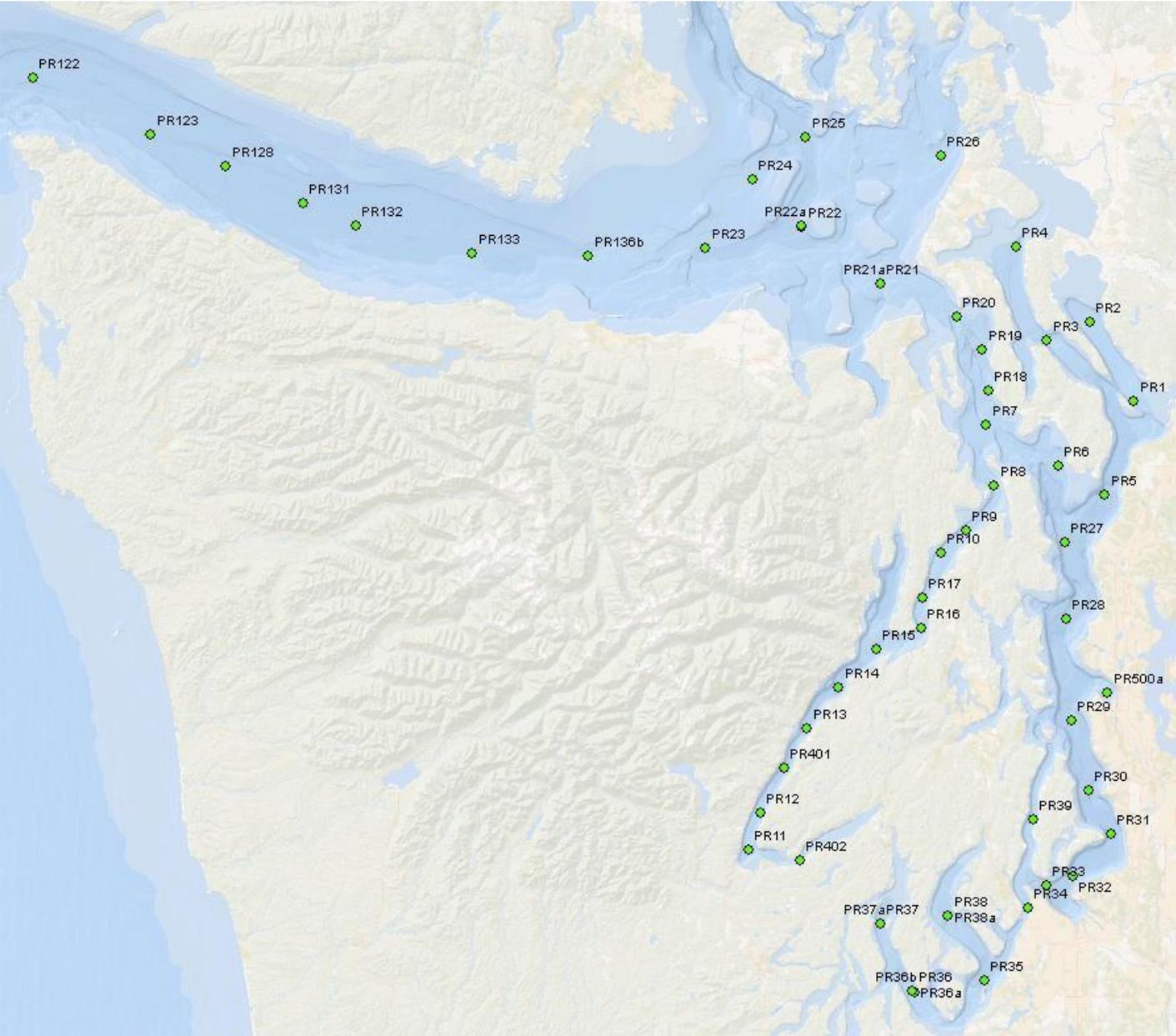
Marine Station Locations: Ecology Stations
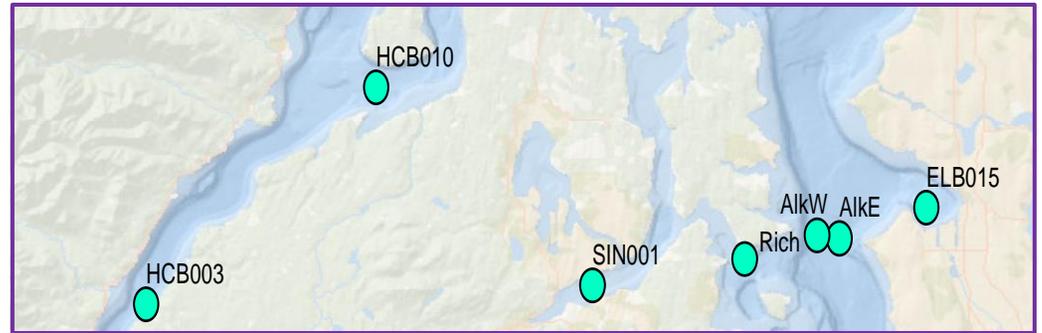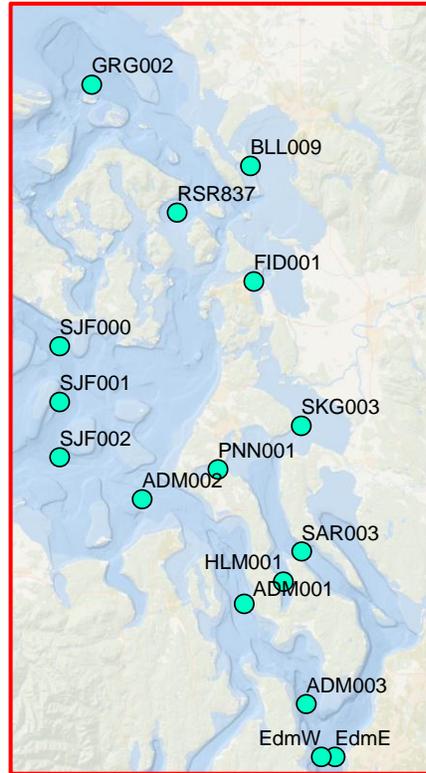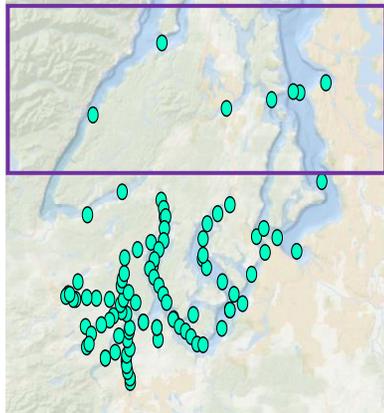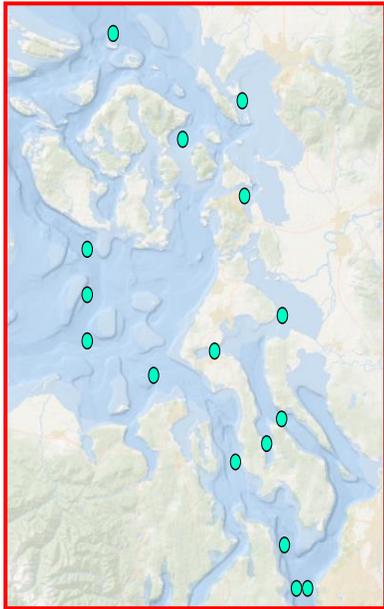
Marine Station Locations: Ecology Stations (continued)
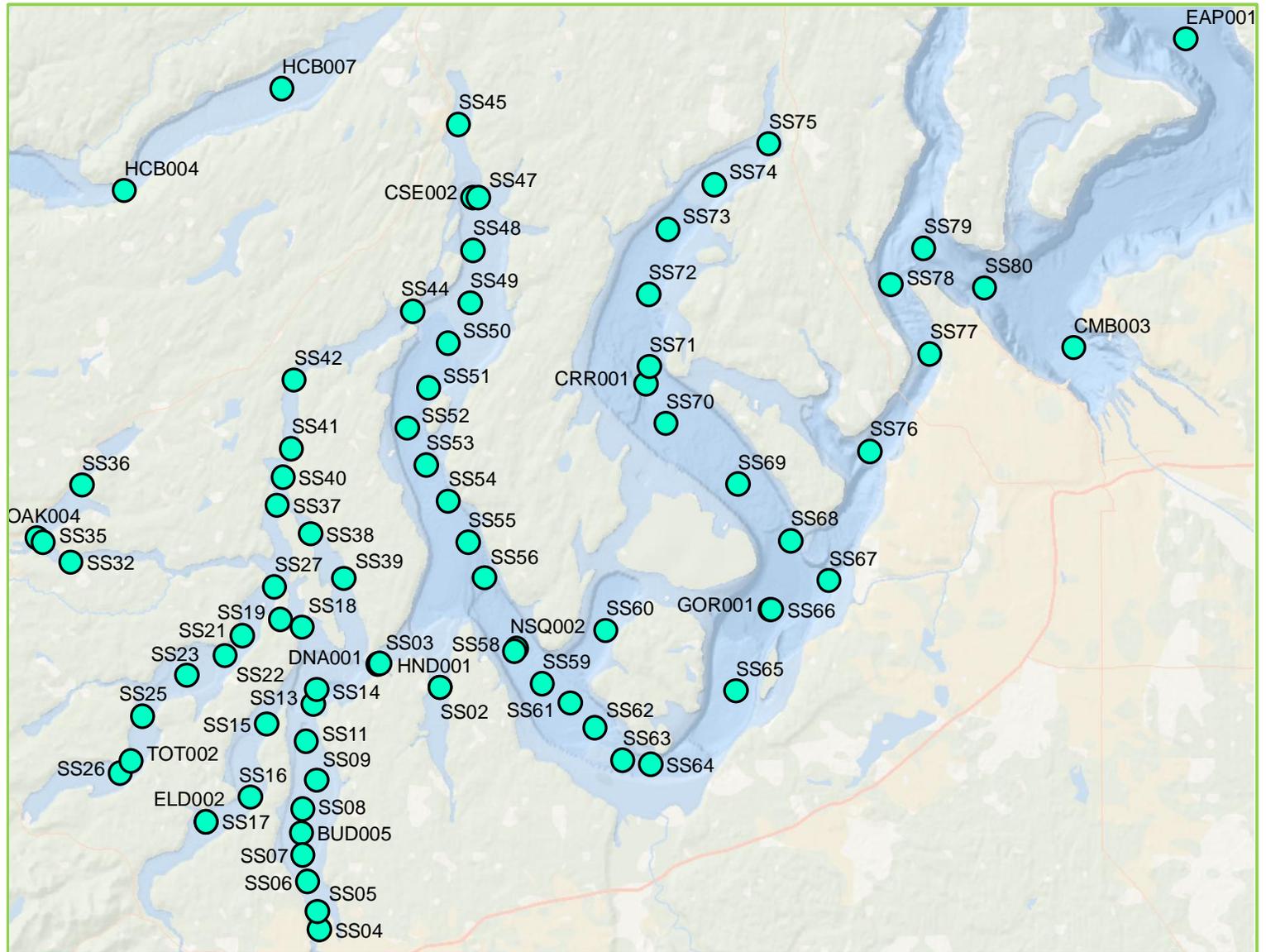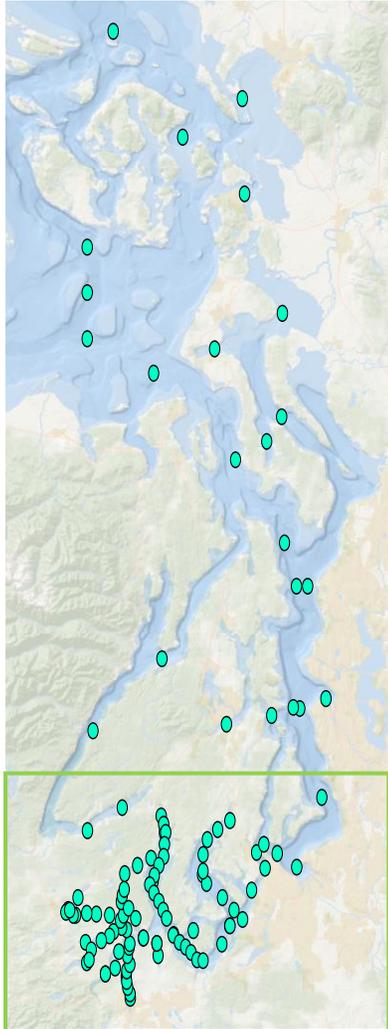
Marine Station Locations: King County
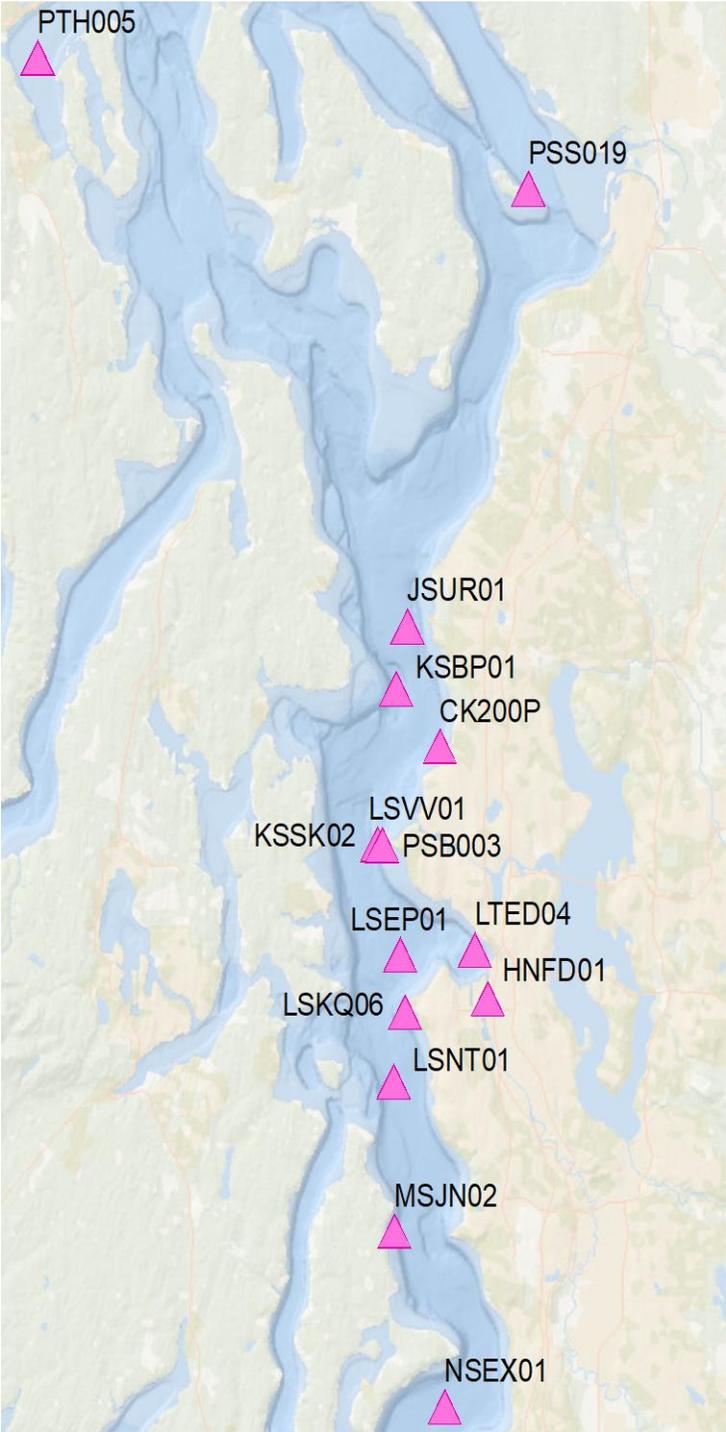
Marine Station Locations: NOAA-UW

Appendix H2
How to Read Time-Depth Plots

Below is an illustration on how to read the time-depth plots presented in this report. The purpose of the time-depth plots is to provide a simple and quick visual assessment of how model simulated values compare to all available observations for a particular parameter and monitoring station across the whole year of simulation. These are then supplemented with more detailed time-series plots at individual stations (which do not show all depths) and depth-profiles (which do not show values over time).

Legend: colors represent low to high values of a particular parameter, in this case, DO

Station ID where observations were made

HCB003, R=0.89 RMSE=1.23 Bias=-0.06 N=90

Depth (m)

7
21
38
59
83

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

DO (mg/L)

16
14
12
10
8
6
4
2
0

Date: March 31, 2006, 1:00 PM
Depth: 6.97 m
Measured value: 14.08 mg/L
Model simulated value: 9.46 mg/L

Date: August 15, 2006, 12:00 PM
Depth: 68.7 m
Measured value: 3.50 mg/L
Model simulated value: 3.78 mg/L