RMP
REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY

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2020-2021 North Bay Selenium Study

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Cruise Report

2020-21 RMP North Bay Selenium Study

Contract No. 1484

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Submitted to:

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1. Introduction

This report details activities associated with the Regional Monitoring Program North Bay Selenium Study in 2020 and 2021. The study was designed to monitor two sites for selenium (Se) in water and clam tissue six times annually between June and February. Due to the COVID pandemic, however, four sample collection events were completed. This report outlines the sampling activities, personnel, and site locations monitored for the project.

2. Cruise Report

2.1. Objectives

The objectives of this sampling effort were to conduct the following at each site:

1. Collect a vertical CTD water profile measurement for conductivity, salinity, temperature, optical back scatter (OBS), and dissolved oxygen (DO).
2. Collect whole water samples for filtration and subsequent laboratory analysis of particulate selenium by Brooks Applied Labs (BAL).
3. Collect filtered water samples for analysis of dissolved Se by BAL.
4. Collect whole water samples for analysis of Chl-a, SSC, and TOC by CalTest.
5. Collect a minimum of 100, 8 – 20 mm, clams (*Potamocorbula amurensis*) for analysis of selenium by BAL.

2.2. Personnel

The personnel and work assignments for this cruise are shown in Table 1.

Table 1. Personnel for 2020-21 North Bay Selenium Study Monitoring Events

Name	Affiliation	Dates
Clifton Herrmann	AMS	7/1/20, 8/11/20, 1/29/21, 2/23/21
Ellen Goldenberg	AMS	7/1/20, 8/11/20, 1/29/21, 2/23/21
Jeff Haran	Dixon Marine	7/1/20, 8/11/20
Nathan Mason	Dixon Marine	7/1/20, 8/11/20
Dirk Rosen	MARE	1/29/21, 2/23/21
Pat Conroy	MARE	1/29/21
Luis Martinez	MARE	2/23/21

2.3. Methods

Sampling was conducted at two long-term monitoring locations established by USGS: site 4.1 near Honker Bay and site 8.1 in Carquinez Strait. Sampling events on 7/1/20 and 8/11/20 were conducted from Dixon Marine Services Inc.'s *R/V Walter Marie*, and events on 1/29/21 and 2/23/21 were conducted from Marine Applied

Research and Exploration (MARE)'s *R/V Tom Cat*. Upon arrival at target locations, AMS personnel implemented the following procedures:

1. Deployed a SBE19 CTD to log water column Salinity, Temperature, Depth, Dissolved Oxygen and Turbidity.
2. Collected whole water samples to support analytical chemistry using a stainless-steel grab sampling pole to fill clean 4 L amber glass bottles.
3. Collected near-bottom water in volume using a Niskin water sampler to support clam depuration at AMS facility.

Water samples for laboratory analysis were stored on bagged ice. This is a modified methodology designed to reduce COVID-19 exposure risk for field staff. SFEI staff previously generated the particulate fraction Se sample using an on-board filtering apparatus. The modified methodology alternatively has SFEI staff receive 4 L glass bottles upon AMS' return to dock, which are sub-sampled on site for immediate shipment of non-filtered samples. Particulate sample filtration was then conducted back at the SFEI office prior to shipment. Water collected for depuration was stored on wet ice for transport to AMS facilities.

Clams were collected with a stainless-steel dredge (Figure 1). The device was slowly dragged along the bottom until the dredge met refusal, or a sufficient time or distance had been achieved that warranted inspection. AMS personnel then returned the dredge to the vessel deck and deposited collected material into clean coolers for inspection and collection of clams. Sampling occasionally required multiple repetitions to achieve the target biomass for analysis of selenium in tissues (minimum of 100 clams). At locations with high densities, this target was achieved with a single deployment. Once a sufficient number of target species were collected, AMS personnel transferred the clams to a large HDPE plastic jar filled with near-bottom site water and placed on ice for transport to AMS facilities.

After completion of field sampling, SFEI personnel retained water samples for delivery to laboratory couriers and AMS retained clams and volume site-water for depuration at AMS facilities.

Figure 1. Stainless steel clam dredge

AMS staff prepared water for the depuration process by filtering near-bottom site water collected in equal parts from the two stations through a new, trace metal-clean filter. The resulting composite filtrate was placed into a large cooler and maintained at 10º C with a recirculating water chiller. Aquarium air stones were used to aerate the depuration tank. AMS staff sorted clams from each site into size bins based on maximum anterior–posterior shell length and placed them into individual mesh (vinyl-coated fiberglass screening) bags. Standardized size classes for the 2020-2021 sampling year include: 8–11 mm, 12—15 mm, and 16–20 mm. The mesh bags were then placed into the tank and clams were left to depurate for a minimum of 48 hours (Figure 2). When depuration was complete, the clams were placed in plastic bags and immediately transferred to laboratory freezers. Upon completion of sampling for the year, frozen clams were batch-shipped overnight on dry ice to BAL.

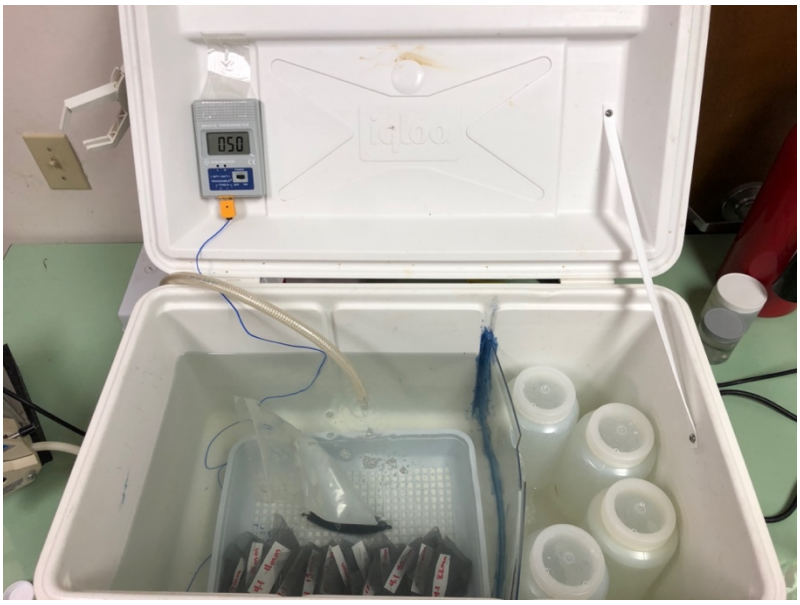

Figure 2. *P. amurensis* clams in filtered site water for depuration at AMS facility.

2.4. Sampling Sites

RMP North Bay Selenium Study 2020 – 2021 sampling dates and locations are listed in Table 2. Complications due to the COVID-19 pandemic resulted in successful completion of 4 out of 6 sampling events for this period. Sample containers and sample handling procedures are summarized in Table 3. Weather conditions encountered at time of sampling are shown in Table 4. The detailed timing and order of sampling events are outlined in Appendix A. Scanned copies of all field datasheets are provided in Appendix B.

Table 2. North Bay Se Monitoring. Site Coordinates and Water Depth at Initiation of Sampling. Sample depths are not corrected for tidal action.

Date	Site Code	Target		Actual		Depth (ft)	No. Dredging Runs
		Lat	Long	Lat	Long		
7/1/20	USGS 4.1	38.05712	-121.94485	38.05707	-121.94481	11	2
	USGS 8.1	38.03167	-122.14027	38.05570	-122.17997	50	1
8/11/20	USGS 4.1	38.05712	-121.94485	38.05694	-121.94500	20	2
	USGS 8.1	38.03167	-122.14027	38.03167	-122.14028	58	1
1/29/21	USGS 4.1	38.05712	-121.94485	38.05763	-121.94533	20	1
	USGS 8.1	38.03167	-122.14027	38.03195	-122.13860	55	4
2/23/21	USGS 4.1	38.05712	-121.94485	38.05297	-121.93896	16	2
	USGS 8.1	38.03167	-122.14027	38.03138	-122.14056	58	3

Table 3. Containers and Sample Handling for North Bay Se Study (T=total, P=particulate, D=dissolved).

Parameter	T/P/D	Lab	Container	Handling Requirements
Water for depuration	T	AMS	10 L LDPE plastic container	Store on ice
Se – Dissolved*	D	BAL	1 L HDPE plastic bottle (1 per site)	Store on ice
Se – Particulate*	P	BAL	1 L HDPE plastic bottle (1 per site)	Filter upon receipt, store polycarbonate filter in 15mL centrifuge tube on wet ice
Chl-a*	T	Caltest	1 L plastic amber bottle (9 total: 3 per site, plus 3 at USGS4.1 for QA duplicate)	Store on ice
SSC*	T	Caltest	500 mL clear plastic bottles (2 per site)	Store on ice
TOC*	P	Caltest	40 mL amber VOAs (triplicate) (3 per site)	Store on ice
Se in Clams	P	AMS	1 L plastic bottle (~100 clams per site)	Store on ice in near-bottom site water until moved into depuration tank, freeze upon removal

*Containers and handling refer to sample condition as delivered to respective laboratories. Initial sample collection utilized a stainless-steel grab sampling pole to fill clean 4 L amber glass bottles, which were stored on ice and delivered to SFEI staff for final preparation.

Table 4. Weather During RMP North Bay Selenium Study.

Site	Date	Sea State	Wind Speed (kts)	Cloud Cover (% Overcast)
USGS 4.1	7/1/2020	Choppy	10 - 15	0
USGS 8.1	7/1/2020	Calm (rippled)	5 – 10	0
USGS 4.1	8/11/2020	Choppy	5 – 10	0
USGS 8.1	8/11/2020	Calm (rippled)	5 – 10	0
USGS 4.1	1/29/2021	Calm (glassy)	5 – 10	10
USGS 8.1	1/29/2021	Calm (rippled)	5 – 10	10
USGS 4.1	2/23/2021	Choppy	10 - 15	25
USGS 8.1	2/23/2021	Choppy	15 – 20	10

3. Discussion

All sampling objectives were achieved for 4 out of the 6 sampling events for the 2020 – 2021 season. Both the June and December 2020 sampling events were cancelled as a result of safety concerns and logistical issues related to the COVID-19 pandemic.

CTD casts were collected with a SeaBird SBE 19, processed by AMS staff using the Seasoft V2 SBE Data Processing Software and formatted using R Statistical Computing version 4.0.2. Review of these data indicated a high degree of quality, with 0% of observations bearing a flag.

Locations with sufficient densities of *P. amurensis* were identified in the 2019 – 2020 sampling year (Figure 3). Similar densities were observed at these locations in July and August 2020. In January 2021, field staff noted a reduction in target species at USGS site 8.1. Multiple dredge runs were required to obtain the minimum number of clams. Future sampling events will identify a new dredge location at USGS site 8.1 as close to the water sampling target as practicable.

AMS prepared three aliquots of collected clams for each station and sampling event (Table 5). After the clams were depurated and sorted, they were immediately frozen. Clams that did not fall within the specified size classes were discarded.

Figure 3. Project sites and nearby secondary locations, previously identified to have sufficient clam densities. In 2021, AMS staff noted that the density of clams at USGS site 8.1 appeared to have declined since 2020.

Table 5. Clam Aliquots Prepared for Laboratory Analysis

		Station 4.1			Station 8.1		
Date	**Bin**	**Sample ID**	**Size range (mm)**	**Count**	**Sample ID**	**Size range (mm)**	**Count**
7/1/20	1	STN41_2020-0701_8-11	8-11	100	STN81_2020-0701_9-11	9-11	51
	2	STN41_2020-0701_12-15	12-15	22	STN81_2020-0701_12-14	12-14	62
	3	STN41_2020-0701_16-19	16-19	13	STN81_2020-0701_15-17	15-17	20
8/11/20	1	STN41_2020-0811_8-11	8-11	115	STN81_2020-0811_8-11	8-11	86
	2	STN41_2020-0811_12-15	12-15	81	STN81_2020-0811_12-15	12-15	138
	3	STN41_2020-0811_16-20	16-20	12	STN81_2020-0811_16-20	16-20	15
1/29/21	1	STN41_2021_0129_8-11	8-11	67	STN81_2021_0129_8-11	8-11	43
	2	STN41_2021_0129_12-15	12-15	58	STN81_2021_0129_12-15	12-15	65
	3	STN41_2021_0129_16-20	16-20	27	STN81_2021_0129_16-20	16-20	10
2/23/21	1	STN41_2021_0223_8-11	8-11	70	STN81_2021_0223_8-11	8-11	271
	2	STN41_2021_0223_12-15	12-15	124	STN81_2021_0223_12-15	12-15	82
	3	STN41_2021_0223_16-20	16-20	24	STN81_2021_0223_16-20	16-20	6

Appendix A: Timing and order of sampling events

Date	Time	Events
7/1/20	0830 - 0930	Arrive at Antioch Marina, Mobilize R/V, Depart for USGS 8.1
	0930 - 1130	Transit to USGS 8.1
	1130 - 1245	Sample USGS 8.1, 1 dredge run
	1245 - 1350	Transit to USGS 4.1
	1350 - 1445	Sample USGS 4.1, 2 dredge runs
	1445 - 1545	Transit to Antioch Marina
	1545 - 1605	Demobilize R/V
8/11/20	0845 - 0915	Arrive at Pittsburg Marina, Mobilize R/V, Depart for USGS 4.1
	0915 - 0945	Transit to USGS 4.1
	0945 - 1100	Sample USGS 4.1, 2 dredge runs
	1100 - 1230	Transit to USGS 8.1
	1230 - 1340	Sample USGS 8.1, 1 dredge run
	1340 - 1540	Transit to Pittsburg Marina
	1540 - 1600	Demobilize R/V
1/29/21	0830 - 0915	Arrive at Benicia Marina, Mobilize R/V, Depart for USGS 4.1
	0915 - 0950	Transit to USGS 4.1
	0950 - 1045	Sample USGS 4.1, 1 dredge run
	1045 - 1125	Transit to USGS 8.1
	1125 - 1315	Sample USGS 8.1, 4 dredge runs
	1315 - 1330	Transit to Benicia Marina
	1330 - 1400	Demobilize R/V
2/23/21	0900 - 0930	Arrive at Benicia Marina, Mobilize R/V, Depart for USGS 4.1
	0930 - 1000	Transit to USGS 4.1
	1000 - 1135	Sample USGS 4.1, 2 dredge runs
	1135 - 1215	Transit to USGS 8.1
	1215 - 1420	Sample USGS 8.1, 3 dredge runs
	1420 - 1430	Transit to Benicia Marina
	1430 - 1450	Demobilize R/V

Appendix B: Field Datasheets from 2020 – 2021 sampling.

RMP Selenium Clam Collection Data Sheet

Vessel: Walter	Personnel: CH, EG, Jeff & Nathan (Dixon)		Date: ~~7~~ 7/1/20
Time departed dock: 0930	Time arrived at dock:		

Site Code: USGS 4.1	**Site Name:** Suisun Bay		Depth: 11
Time On Station: 1350	Time Off Station: 1447		
Sea State: 1-2ft Chop	Wind: 10-15 Kts	% Overcast: 0	Current:
Site Target: 38.0571167°, -121.944850°		Clam Target: 38.0614°, -121.9537°	

Cast	Time	Lat	Long	Notes
CTD	1433	38.05~~4~~7069	-122.944815	
Niskin 1	1352	38.06298	-121.95845	
Niskin 2				
Niskin 3				
Clam Start	1355			a lot of macrophytes
Clam Stop	~~1402~~			few clams in shell hash
Clam Start	1410	38.06119	-121.95543	slightly deeper ~17ft
Clam Stop	1417	38.06039	-121.95240	clams!
Clam Start				
Clam Stop				

Additional Comments:

Site Code: USGS 8.1	**Site Name:** Carquinez Strait		Depth: 50 ft
Time On Station: 1130	Time Off Station: 1244		
Sea State: Calm	Wind: 5-10 kts	% Overcast: 0	Current:
Site Target: 38.031667°, -122.140267°		Clam Target: 38.0516°, -122.1726°	

Cast	Time	Lat	Long	Notes
CTD	1135			
Niskin 1	1215	38.055696	122.179966	
Niskin 2			~~122~~	
Niskin 3				
Clam Start	12:22	38.055751 26	122.17963764	
Clam Stop	12:27	38.0548286	122.17566113	consolidated mud, high clam density
Clam Start	~~1235~~			
Clam Stop				
Clam Start				
Clam Stop				

Additional Comments:

RMP Selenium Clam Collection Data Sheet

Vessel: Walter	Personnel: EG, CH, Jeff & Nathan	Date: 8/11/20
Time departed dock: 0915	Time arrived at dock: 1600	

Site Code: USGS 4.1	**Site Name:** Suisun Bay		Depth: 6m
Time On Station: 0945	Time Off Station: 1100		
Sea State:	Wind:	% Overcast: 0	Current:
Site Target: 38.0571167°, -121.944850°		Clam Target: 38.0614°, -121.9537°	

Cast	Time	Lat	Long	Notes
CTD	0949	38.05694	-121.945	
~~Niskin 1~~	0952	38.05694	-121.945	
~~Niskin 2~~	0955	" "	" "	
Niskin 3				
Clam Start	1024	38.05944	-121.95111	
Clam Stop	1037	38.06111	-121.95444	Redeploy
Clam Start				
Clam Stop	1058	38.06278	-121.95639	Clams!
Clam Start				
Clam Stop				

Additional Comments:

Site Code: USGS 8.1	**Site Name:** Carquinez Strait		Depth: 16.75m
Time On Station: 1230	Time Off Station: 1340		
Sea State:	Wind:	% Overcast:	Current:
Site Target: 38.031667°, -122.140267°		Clam Target: 38.0516°, -122.1726°	

Cast	Time	Lat	Long	Notes
CTD	1231	38.03167	-122.14028	
~~Niskin 1~~	1236	" "	" "	
~~Niskin 2~~	1240	" "	-122.14056	
Niskin 3				
Clam Start	1310	38.05583	-122.18	
Clam Stop	1320	38.0561	-122.17694	Clams!
Clam Start				
Clam Stop				
Clam Start				
Clam Stop				

Additional Comments:

RMP Selenium Clam Collection Data Sheet

Vessel: RV TomCat	Personnel: Dirk, EG, CH, Pat (cancel)	Date: 1/29/21
Time departed dock: 0915	Time arrived at dock: 1340	

Site Code: USGS 4.1	**Site Name:** Suisun Bay		Depth:
Time On Station: 0950	Time Off Station: 1045		
Sea State:	Wind:	% Overcast:	Current:
Site Target: 38.0571167°, -121.944850°		Clam Target: 38.0614°, -121.9537°	

Cast	Time	Lat	Long	Notes
CTD	1001	38.05763	-121.94533	1 min acclimation
Niskin 1				
Niskin 2	1016	38.05756	-121.94431	
Niskin 3				
Clam Start	1033	38.06213	-121.95389	
Clam Stop	1048	38.06179	-121.95366	
Clam Start				
Clam Stop				
Clam Start				
Clam Stop				

Additional Comments:

Site Code: USGS 8.1	**Site Name:** Carquinez Strait		Depth:
Time On Station: 11:25	Time Off Station: 1300		
Sea State:	Wind:	% Overcast:	Current:
Site Target: 38.031667°, -122.140267°		Clam Target: 38.0516°, -122.1726°	

Cast	Time	Lat	Long -122.13860	Notes
CTD	1130	38.03195		
Niskin 1				
Niskin 2	1131	38.03194	-122.13902	
Niskin 3				
Clam Start	~~1135~~ 1200	38.05131	-122.17214	
Clam Stop				Stop/Start NR
Clam Start				
Clam Stop	1252	38.04737	-122.17037	
Clam Start				
Clam Stop				

Additional Comments: ~~3~~ 4 dredge deployments @ 8.1. Cross ref prefficious loc.

RMP Selenium Clam Collection Data Sheet

Vessel: TomCat	Personnel: EG, CH, Luis, Dirk	Date: 2/23/21
Time departed dock: 0930	Time arrived at dock: 1510	

Site Code: USGS 4.1	**Site Name:** Suisun Bay		Depth:
Time On Station: 1000	Time Off Station: 1135		
Sea State: 1-2ft chop	Wind: 5-10Kts	% Overcast: 5	Current:
Site Target: 38.0571167°, -121.944850°		Clam Target: 38.0614°, -121.9537°	

Cast	Time	Lat	Long	Notes
CTD	1015	38.05297	-121.93896	all water (CTD, Grab, Niskin)
Niskin 1				
Niskin 2				
Niskin 3				
Clam Start	1050	38.05187	-121.95490	
Clam Stop				
Clam Start	1116	38.05192	-121.94712	
Clam Stop				
Clam Start				
Clam Stop				

Additional Comments:

Site Code: USGS 8.1	**Site Name:** Carquinez Strait		Depth:
Time On Station: 1215	Time Off Station:		
Sea State: 1-2ft chop	Wind: 5-10Kts	% Overcast: 0	Current:
Site Target: 38.031667°, -122.140267°		Clam Target: 38.0516°, -122.1726°	

Cast	Time	Lat	Long	Notes
CTD	1227	38.03138	-122.14056	all water
~~Niskin 1~~				
~~Niskin 2~~				
~~Niskin 3~~				
Clam Start	1254	38.05139	-122.17306	
Clam Stop	1314	NR	NR	
Clam Start	1322	38.04917	-122.17028	
Clam Stop	1336	38.05560	-122.17569	
Clam Start	1356	38.05361	-122.17611	
Clam Stop	1415	NR	NR	

Additional Comments: Re-check Clam coords, possible change to location of dense potamocorbula