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REGIONAL MONITORING
PROGRAM FOR WATER QUALITY
IN SAN FRANCISCO BAY

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2018 Bivalve Cruise Report

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Regional Monitoring Program

for Water Quality in San Francisco Bay

Cruise Report

2018 RMP Bivalve Cruise

Contract #1343

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1. Introduction

This report describes activities associated with the 2018 bivalve retrieval cruise of the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). Measurement of contaminant concentrations in transplanted bivalves accumulated during dry season deployment is designed to provide long-term data on the bioaccumulation of trace elements and trace organic compounds in tissue throughout the Estuary.

Contaminant bioaccumulation in transplanted bivalve tissues is measured by collecting bivalves from sites that are known to have low contaminant concentrations and transplanting them to mooring locations in the Estuary. *Mytilus californianus* were collected from Bodega Head on June 15, 2018, and stored in filtered seawater tanks located at the Bodega Marine Laboratory (BML) until their deployment. During this depuration period, BML Aquatic Resources Group (ARG) personnel implemented a cleaning protocol to remove fouling organisms from each mussel to minimize potential for transfer of non-resident species from Bodega coast to San Francisco Bay.

Bivalves were attached to moorings at seven sites on July 17-18, 2018. Bivalves were deployed in two or three cages at each site, with four compartments holding twenty-five bivalves in each cage.

Two additional sets of bivalves were collected as part of this sampling effort:

- Resident *Corbicula fluminea* were harvested nearby to long-term RMP water and sediment sampling locations on the Sacramento and San Joaquin River stations.
- T-1 mussels (collected at the reference location near the end of the deployment period) were collected at Bodega Head for analysis of growth.

2. Cruise Report

2.1. Objectives

With the exception of follow-up salvage operations at BC10 (discussed below), all sampling was conducted from the Romberg Tiburon Center vessels *RV Questuary* and *RV Salty Dog.* The objectives of the sampling effort were as follows:

1. Collect 30 *Mytilus californianus* (MCAL) at Bodega Head for analysis of growth (T-1).
2. Retrieve *Mytilus californianus* (MCAL) deployed at seven sites during the deployment cruise.
3. Harvest resident *Corbicula fluminea* (CFLU) from two sites, historic San Joaquin River and Sacramento River stations.
4. As available, divide surviving bivalves as follows:

   Target allocations (all sites)
   - 100 bivalves (minimum of 90) for preparation of homogenate and analysis for PAHs (AXYS), Se (BAL), algal toxins (UCSC), and preparation of an archive by SGS-AXYS (AXYS).
   - 21 bivalves for analysis of microplastics by the Rochman Lab at the University of Toronto (UofT)
   - 25-30 bivalves (no minimum) for analysis of growth by AMS.

4. Collect a CTD water column profile at nine sites (7 transplant and 2 resident sites)

2.2. Personnel

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

Table 1. Personnel for 2018 RMP Bivalve Retrieval Cruise

Name	Affiliation	Duties
Paul Salop	AMS	Cruise Manager, Field Sampling 10/24 - 10/26, 11/2
Clifton Herrmann	AMS	Field Sampling, 10/22, 10/24 - 10/26, 11/2
Winn McEnery	AMS	Field Sampling, 10/22, 10/24 - 10/26
Natasha Klasios	U of T	Field Sampling, 10/24 – 10/25
Meg Sedlak	SFEI	Field Sampling, 10/24
Ila Shimabuku	SFEI	Field Sampling, 10/25, 11/2
David Bell	SFSU	*RV Questuary* Captain, 10/22, 10/24 – 10/26
Mike Skuija	URI	Manager, salvage operations
Jerry Eldorado	Aloha Trans	Logistics, 10/24 – 10/25

Mr. Salop was responsible for oversight of sampling operations. Mr. McEnery and Mr. Herrmann were responsible for operation of acoustic release equipment and CTD profiling. Mses. Sedlak, Klasios, and Shimabuku shared responsibility for processing bivalves for laboratory analysis. Captain Skuija was responsible for vessel operations on the salvage day at site BC10, while Captain Bell was responsible for vessel operation and safety during all other operations.

2.3. Sampling Activities

Sampling activities for the 2018 RMP Water Cruise are shown in Table 2.

Table 2. Sampling Activities for 2018 RMP Bivalve Retrieval Cruise

Date	Time	Activity
October 9, 2018	1630-1700	Mr. Salop harvested T-1 mussels from Bodega Head for analysis of growth.
October 22, 2018	1100-1130	AMS personnel mobilized all sampling gear aboard vessel at Pittsburg Marina. Conducted safety briefing and departed for BG30.
	1200-1400	Collected *Corbicula fluminea* (CFLU) at site BG30, departed for BG20.
	1440-1700	Collected CFLU at site BG20, departed for Pittsburg Marina.
	1800-1830	Arrived Pittsburg Marina and demobilized vessel.
October 24, 2018	0800-0854	SFEI and AMS personnel mobilized all sampling gear aboard vessel at Pittsburg Marina. Conducted safety briefing and departed for Benicia Marina for fuel, then departed for BD30.

Date	Time	Activity
	1145-1210	Retrieved bivalves at BD30, departed for BD20
	1229-1253	Retrieved bivalves at BD20, departed for BC10
	1410-1430	Attempted retrievals at BC10, but unable to communicate with acoustic release. Departed for Paradise Cay Yacht Harbor.
	1511-1600	Arrived Paradise Cay and demobilized vessel. Aloha Transportation retrieved recovered bivalves and equipment and returned to AMS.
October 25, 2018	0900-0946	SFEI and AMS personnel mobilized all sampling gear aboard vessel at Paradise Cay. Departed for BB71.
	1052-1104	Retrieved bivalves at BB71, departed for BA10
	1227-1241	Retrieved bivalves at BA10, departed for BA30
	1315-1331	Retrieved bivalves at BA30, departed for BA40
	1400-1419	Retrieved bivalves at BA40, departed for Paradise Cay Yacht Harbor.
	1615-1715	Arrived Paradise Cay and demobilized vessel. Aloha Transportation retrieved recovered bivalves and equipment and returned to AMS.
October 26, 2018	1000-1055	AMS personnel mobilized all sampling gear aboard vessel *R/V Salty Dog* at Paradise Cay. Departed for BC10.
	1121-1239	Attempted search operations at BC10 to retrieve mooring, but unable to locate it.
	1307-1330	Arrived Paradise Cay and demobilized vessel.
November 2, 2018	0700-0715	SFEI and AMS personnel mobilized all sampling gear aboard vessel at Jack London Aquatic Center (JLAC) launch ramp. Departed for BC10.
	0801-0915	Arrived BC10. Conducted salvage operations and retrieved mooring. Departed for JLAC.
	1019-1050	Arrived JLAC and demobilized vessel. Mr. Salop returned mussels and equipment to AMS.

2.4. Sample Labeling

The sample ID labeling system used for the 2018 cruise is as follows:

RMP-18BC-XXXX-Y

Where:

RMP	=	Project
18	=	Cruise Year
BC	=	Matrix (Bivalve Cruise)
XXXX	=	Unique ID number
Y	=	Unique aliquot number (applies only to archives)

2.5. Discussion

T-0 samples were collected by hand from intertidal areas within the Bodega Marine Reserve (BMR) on June 15, 2018. All collected mussels were placed in rigid oyster bags and depurated in filtered seawater tanks operated by Bodega Marine Lab Aquatic Resource Group (ARG) prior to deployment. Under the terms of AMS' Scientific Collecting Permit (SCP), all mussels were cleaned of fouling organisms by

ARG personnel during this depuration period. AMS personnel retrieved all mussels on July 16, 2018, in preparation for deployments in San Francisco Bay, which occurred July 17th[t] and 18th.

AMS collected an additional 30 T-1 bivalves from Bodega Head during a low tide period on October 9, 2018, which were immediately frozen after collection, then returned to AMS for analysis of bivalve growth only (i.e., no chemical analysis). We anticipate analysis of growth being completed by the end of the 2018 calendar year.

2018 operations marked the first time that acoustic release devices were used to deploy and retrieve moorings in place of divers. Six of the seven units were able to be retrieved successfully using the releases. At site BC10, AMS was unable to communicate with the release unit, which was confirmation of the lack of contact that was attempted at the end of the deployment operations. In order to retrieve the mussels and equipment at this station, consistent with permitting, AMS employed a commercial diver subcontracted through Underwater Resources, Inc. (URI). The diver was able to locate the mooring and AMS staff were able to retrieve and process the mussels at this location for future analysis. AMS will follow up with the supplier of the acoustic release equipment to test / repair the two units that arrived from the manufacturer in non-working condition.

For deployed mussels and resident clams, full allotment of bivalves to support all target analyses were collected at primary mussel monitoring sites for T-0 mussels, Central Bay (BC10), South Bay (BA40), and San Pablo Bay (BD30). As in prior years, AMS deployed additional mussels at the following predetermined backup sites in case of loss or inability to use bivalves from the primary monitoring site for the region:

- Dumbarton Bridge (BA30) – backup site for both Lower South Bay (primary site BA10) and South Bay (primary site BA40) regions.
- Alameda (BB71) – backup site for Central Bay (primary site BC10) region.
- San Pablo Bay (BD20) – backup site for San Pablo Bay (primary site BD30) region.

Mussels from the backup sites are intended for analysis only if the primary sites are unable to fulfill laboratory requirements. Mussels collected from backup sites that are not used for target analyses in place of primary sites will still be shipped to AXYS for creation of archives. AXYS will dispose of excess mass.

In general, transition to acoustic release-based mooring supported higher rates of survival, likely due to presence of a buoyant item directly below the cages, which tended to place a greater distance between the sediment surface and cages.

Mussels deployed at primary deployment site for Lower South Bay (BA10) experienced relatively high levels of mortality (53%) due to sediment accumulating within the cages, which resulted in just over the target number of mussels required to support all analyses. Should decrease of mussel mass during deployment time, or increased mortality identified at lab, result in insufficient mass to support all target analyses, some prioritization of analyses may be required.

All bivalves were allocated for analyses in the field immediately after sample retrieval / collection. Following allocation, all bivalves were immediately frozen on dry ice and returned to AMS for temporary

storage in laboratory freezers. AMS then shipped all samples for chemical analysis frozen to AXYS for processing in two shipments, November 5 and 14, 2018. The mussels retrieved from BC10 and allocated for analysis of microplastics were delayed in customs and delivered November 8, 2018. Due to an error in sample handling at AMS facilities, the BD30 bivalves were compromised during the shipping process. Bivalves from the backup site at BD20 were shipped to AXYS in their place on November 14, 2018.

As is typical for river stations, abundances of live CFLU at target locations were insufficient (or potentially so) to support allocation of bivalves for all desired analyses. Sampling time for these efforts was impacted by a call for vessel assist that had to be conducted by the R/V *Questuary* during planned monitoring operations. SFEI may need to work with AXYS to prioritize allocation of tissue for analyses / archives.

The number of bivalves allocated for each analysis by site are presented in Table 3. Sample handling protocols are presented in Table 4. Locations of bioaccumulation stations and clam harvesting areas are presented in Table 5 and Appendix A. Consistent with the SCP, all mussels collected as part of this project were either shipped for laboratory analysis or disposed of following the retrieval cruise.

Table 3. Number of Bivalves Allocated for Each Analysis by Site.

Site	Species	# Recovered	PAHs	Se	Algal Toxins	Archive	Microplastics	Growth	Dead	# Discarded	Survival (%)	Comments
T-0	MCAL	NA	10	5	10	75	21	30	NA	NA	NA	
BA10	MCAL	300	10	5	10	75	21	30	159	0	47	
BA30	MCAL	300	0	0	0	0	21	0	39	261	87	
BA40	MCAL	199	10	5	10	75	21	30	13	25	93	
BB71	MCAL	199	0	0	0	0	21	0	4	195	98	
BC10	MCAL	196	10	5	10	75	21	30	9	36	95	
BD20	MCAL	196	10	5	10	75	21	30	4	192	98	
BD30	MCAL	198	0	0	0	0	21	0	3	44	98	
BG20	CFLU	NA	X	X	X	X	X	30	NA	NA	NA	Residents only
BG30	CFLU	NA	X	X	X	X	X	30	NA	NA	NA	Residents only
T-1	MCAL	30	NA	NA	NA	NA	NA	30	NA	NA	NA	For analysis of growth only

Notes:

X – Indicates sample apportioned by volume.
NA – Not applicable
NC – Not calculable
NR – Not reported

Table 4. Sample Handling for 2018 Bioaccumulation Program.

Sample	Container	Handling Requirements
AXYS Bulk Sample	1-gallon zip-top bag	Collect 100 organisms do not rinse, wrap in two layers of aluminum foil, place in zip-top bags, freeze or place on dry ice.
PAHs	N/A	Collected as split from bulk sample.
Algal Toxins	N/A	Collected as split from bulk sample. Sample material forwarded from AXYS to lab via AMS.
Selenium	N/A	Collected as split from bulk sample. Sample material forwarded from AXYS to lab via AMS.
Archive	N/A	Collected as split from bulk sample. Sample material forwarded from AXYS to lab via AMS.
Microplastics	1-gallon zip-top bag	Collect 21 organisms, place 7 bivalves in three different foil packs (double wrapped), place on dry ice.
Growth	1-gallon zip-top bag	Collect 30 organisms, place in zip-top bags, place on dry ice.

Table 5. Coordinates for RMP Bivalve Stations for 2018.

Site	Lat	Long	Comments
T-0, T-1	38.22050	-123.06550	Bodega Head State Marine Reserve
BA10	37.47013	-122.06392	Near channel marker “18”
BA30	37.51377	-122.13491	Near channel marker “14”
BA40	37.54737	-122.19524	Near channel marker “4”
BB71	37.69547	-122.33933	Near channel marker “1” 1.65 nmi. SE of Hunters Point
BC10	37.81326	-122.35902	Near western end of eastern span of Bay Bridge
BD20	38.05839	-122.43928	Near channel marker “4.” Approx 1 nmi from channel marker “1”
BD30	38.01650	-122.36778	Near channel marker “P”
BG20*	38.05570	-121.80593	Near channel marker “8” N of Sherman Island
BG30*	38.02362	-121.80048	Near channel marker “8” 0.75 nmi. E of Antioch Marina

Notes

* Approximate coordinates of dredging run starting point