

4. BIVALVE MONITORING

BACKGROUND

The RMP has been analyzing bivalve tissue samples for trace contaminants since 1993. The RMP is continuing the long-term monitoring of the State Mussel Watch Program, which monitored sites throughout the Estuary beginning in 1976. Bivalve monitoring was conducted annually from 1993-2006. Biennial monitoring began after 2006, with sampling conducted in 2008, 2010, 2012, and 2014. Biennial bivalve monitoring is planned to continue for at least the next 10 years.

SAMPLING SITES

The bivalve sampling sites fall into three categories.

Bivalve Transplant Sites (n=7). Mussels (*Mytilus californianus*) were collected from Bodega Head, an uncontaminated “background” site of known chemistry, and transplanted to 7 targeted sites within the Bay. Three transplant sites were within the Lower South Bay-South Bay, two transplant sites were in Central Bay and two transplant sites were in San Pablo Bay. Three of the 7 transplant sites serve as back-ups in case something goes wrong with the transplants at one of the primary sites.

Resident Bivalve Sites (n=2). Resident clams (*Corbicula fluminea*) were collected from 2 sites: BG20 on the Sacramento River and BG30 on the San Joaquin River.

“Time Zero” (T-0) Bivalve Site (n=1): A subset of the mussels from Bodega Head are stored and then analyzed after the 100-day deployment period along with the transplanted samples. A new batch of mussels from Bodega Head is collected after 100 days to use a control for mussel growth during the 100-day deployment.

Station names, codes, location, and sampling dates for the 2014 monitoring effort are listed in Appendix 2 and shown in Figure 4.1.

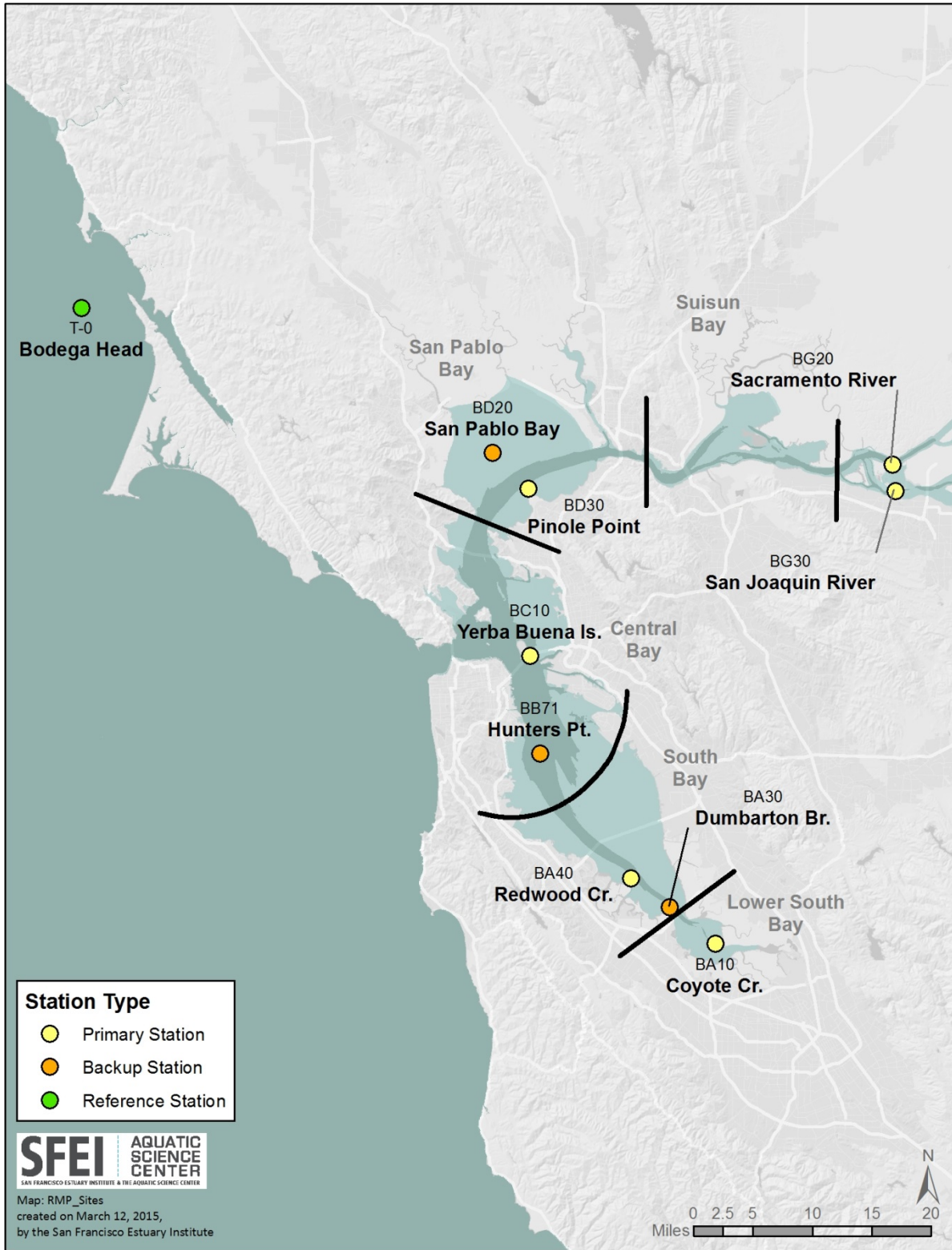


Figure 4.1 Map of 2014 Bivalve Monitoring Stations

FIELD METHODS

The RMP sampling plan for bivalve sampling is to transplant the samples during the dry season, usually in June, and retrieve the samples after approximately 100 days. In 2014, the samples were collected on May 16, transplanted on June 10-12 and retrieved on September 16-19.

Bivalve Sample Collection Methods

At each transplant site, 240 mussels were randomly allocated and placed into predator resistant cages for deployment. Mussels of approximately the same shell length were used (49-81 mm). The same number was also used for the reference (T-0) sample, which was used to provide a baseline on “pre-deployment” tissue condition before deployment.

The cages were constructed out of rigid plastic mesh and PVC pipe. The mesh overlapped around itself to keep predators from slipping through any gaps between the edges. After the cages were built, they were soaked in water for at least a day to remove potential contamination associated with the adhesives used for the construction.

At each site, a line ran from the bottom of the fixed structure out to the bivalve mooring, which consisted of a large screw (earth anchor) that was threaded into the bottom and was associated with pilings or other permanent structures. A large subsurface buoy was attached to the earth anchor by a one to two meter line. The bivalve cages were attached to the buoy line, which kept the bivalves off the bottom to prevent smothering. Since the beginning of the program, loss of a mooring has occurred on only two occasions, probably due to being ripped out by a vessel anchor. Mooring installation, bivalve deployment, and retrieval were all accomplished by SCUBA divers.

Upon retrieval, the bivalve cages were cut off the buoy line and taken to the surface. On the vessel, the number of dead organisms was recorded. Bivalves allocated for trace organic, selenium, microcystin, siloxane, and alternative flame retardants analyses were not rinsed, wrapped in two layers of aluminum foil, placed in 2-gallon zip-top bags and placed on dry ice. Bivalves allocated for growth analysis were rinsed in the field to remove overlying mud, placed in 2-gallon zip-top bags and placed on dry ice. Over the course of deployment, the bivalve cages at site Coyote Creek (BA10) were covered by three to four feet of sediment, mainly sand and shell hash, causing complete mortality. Bivalves from the backup site, Dumbarton Bridge (BA30), were analyzed in place of the planned BA10 location.

Resident clams at sites BG20 and BG30 were collected using a clam dredge approximately two feet wide by three feet long and 50 pounds in weight. The dredge was deployed from a boat and was dragged along the bottom. When brought to the surface, the clams were placed into a clean plastic container and packaged for organics analysis. At both sites, there were not enough clams encountered for all of the intended analyses. At site BG20, there was only enough sample for PCB and PBDE analyses. At site BG30, there was only enough sample for PCB, PAH, and PBDE analyses.

Based on findings by Stephenson (1992) during the RMP Pilot Program, bivalve guts were not depurated before homogenization for tissue analyses. However, sediment in bivalve guts may contribute to the total tissue concentration for trace organic contaminants.

Shipboard Measurements

CTD profiles were collected at each bivalve site during both deployment and retrieval cruises to help determine how ambient environmental factors affect the transplanted bivalves. Salinity, dissolved oxygen, temperature, and total suspended solids impact bivalve health and could affect contaminant bioaccumulation rates.

LABORATORY METHODS

SFEI contracts with a number of laboratories that provide high quality analytical services. The laboratories and analytical methods that were used to measure target analytes for the RMP Status and Trends Program are presented in Table 4.1 below. Additional target analytes for special studies or *pro bono* research by collaborators are listed below the table. SFEI maintains copies of the detailed protocols for all laboratory analyses – please contact Amy Franz (amy@sfei.org) for more details.

Table 4.1 Target Analytes: A summary table of the 2014 target analytes, field preparation codes, analytical laboratories, reporting units, and method codes

Analyte	Analytical Lab	Reporting Unit	Method #
Growth	AMS	g	AMS-CA Growth SOP
PAHs	AXYS	ng/g (ppb)	EPA 8270M
PBDEs	AXYS	ng/g (ppb)	EPA 1614M
PCBs	AXYS	ng/g (ppb)	EPA 1668AM
Selenium	BRL	ug/g (ppm)	EPA 1638M

In 2014, several requests were made by researchers outside of the RMP to collect samples to support their research during the 2014 cruise. These requests were accommodated alongside regular S&T sampling with minimal disruption to regularly planned sampling activities. Samples collected for these studies are listed below.

- Alternative flame retardants by Southern Illinois University (SIU) for a RMP Emerging Contaminants Special Study
- Microcystin analysis in bivalves by Kudela Laboratory, UC Santa Cruz for a Nutrient Management Strategy study
- Siloxanes analysis by Environment Canada

Bivalve Growth and Survival

Applied Marine Sciences (AMS) calculated the growth mean of transplanted bivalves as a measure of bivalve health measure. The growth mean is a measure of growth of the composite of bivalves at a particular site in comparison to the T-0. The growth mean was determined by taking the dry weight of each individual and subtracting the mean

dry weight of the T-0 for that species. This calculation was done for each individual bivalve. The mean of the difference of all the individuals at a particular site was then calculated to give the growth mean.

REFERENCES FOR ADDITIONAL DETAILS

2014 Bivalve Deployment Cruise Report -

http://www.sfei.org/sites/default/files/biblio_files/2014_RMP_Bivalve_Deployment_Cruise_Plan_Final.pdf

2014 Bivalve Retrieval Cruise Report –

http://www.sfei.org/sites/default/files/biblio_files/2014_RMP_Bivalve_Retrieval_Cruise_Report_Final.pdf

Quality Assurance Project Plan – http://www.sfei.org/sites/default/files/biblio_files/2014_RMP_QAPP_1.pdf