Current Report

Introduction

Benthic monitoring conducted by the California Department of Water Resources (DWR) since 1975 has documented changes in the composition, density, and distribution of the macrobenthic biota inhabiting the upper San Francisco Estuary. This monitoring is performed by the Environmental Monitoring Program (EMP) as part of the Interagency Ecological Program (IEP) and is one component of the biological monitoring mandated by Water Right Decision D-1641. Since benthic species respond to changes in physical factors such as freshwater inflows, salinity, and substrate composition, benthic community data provides an indication of physical changes occurring within the Estuary. Benthic monitoring is an important component of the EMP because operation of the State Water Project can change the Estuary's flow characteristics, affecting the density and distribution of benthic biota. Benthic monitoring data is also used to detect and document the presence of new, non-native species in the Upper Estuary, such as the 1986 arrival and subsequent wide spread of the overbite clam, Potamocorbula amurensis. This article summarizes benthic community characteristics at EMP monitoring sites in 2020 and contextualizes these observations using community data from the preceeding decade.

Methods

Benthic monitoring was conducted monthly at 10 sampling sites distributed throughout the Estuary, from San Pablo Bay upstream through the Sacramento-San Joaquin Delta. Sampling in April, May, and December 2020 was not conducted due to the COVID-19 pandemic. EMP staff collected five bottom grab samples at each station using a Ponar dredge with a sampling area of 0.052 m^2. Four replicate grab samples were analyzed for benthic macrofauna and the fifth sample was analyzed for sediment composition. Benthic macrofauna samples were analyzed by Hydrozoology, a private laboratory under contract with DWR. All organisms were identified to the lowest taxon possible and enumerated. Sediment composition analysis was conducted at the

DWR Soils and Concrete Laboratory. Field collection methodology and laboratory analysis of benthic macroinvertebrates and sediment composition are described in detail in the benthic metadata found at https://emp-des.github.io/emp-reports/benthic-meta.html

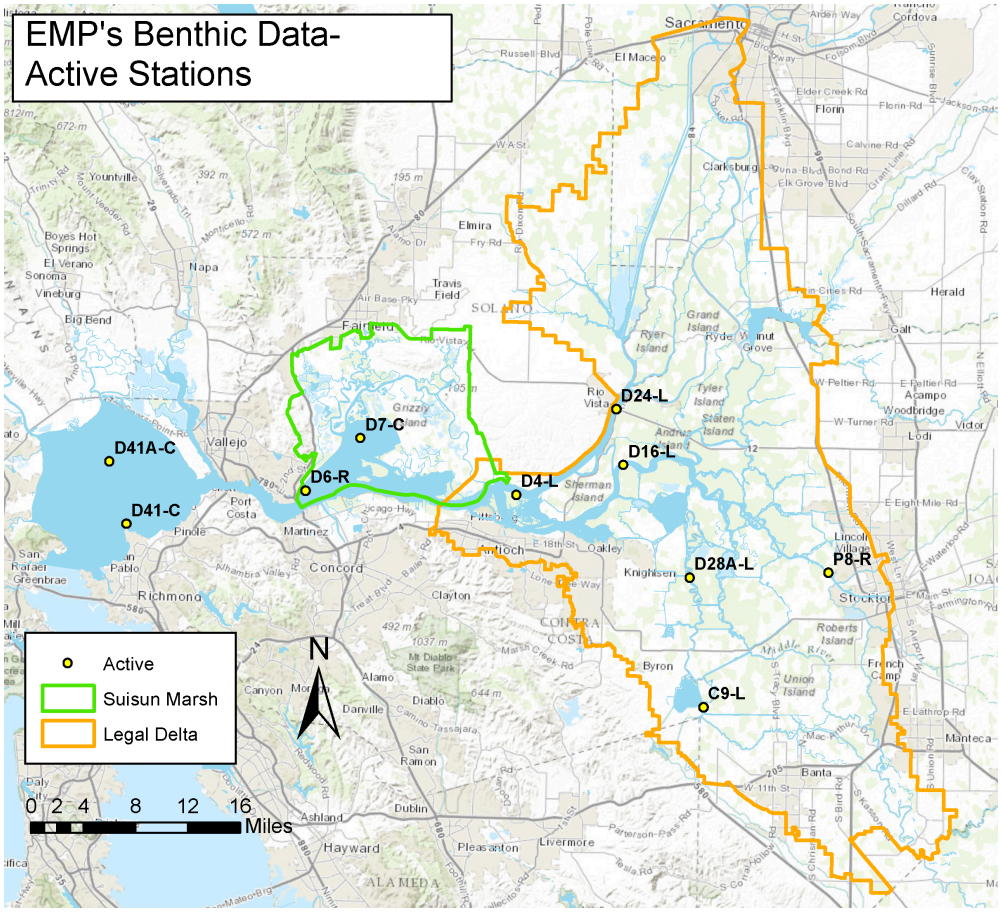

Figure 43: Map of EMP's current benthic field sites.

Prior to analysis, the units for individual organisms were transformed from count data to densities of individuals per square meter, and the average density was calculated across the four replicate grabs at each site. Species were then grouped by phyla, and time series for each station were constructed to depict seasonal patterns in benthic communities. Rare phyla (< 5% of the total organisms for the given year) were omitted from the plots. We did not report sediment compositions for 2020 because the data for most months was not yet available, due to delays from the COVID-19 pandemic.

The 2020 water year was designated as "Dry" for both the Sacramento Valley and the San Joaquin Valley according to the DWR's Water Year Hydrologic Classification Indices. Benthic communities in 2020 were expected to be like previous "Dry" and "Critically Dry" years (most recently during the 2013-2016 drought) and differ from years designated Wet or Above Normal both in species composition and in species abundances.

Results

The benthic fauna collected in 2020 comprised nine phyla: Mollusca (40% of total organisms), Arthropoda (40%), and Annelida (19%), with Phoronida, Nemotoda, Nemertea, Platyhelminthes, Chordata, and Cnidaria each representing < 1% of total organisms. Of the 180 benthic species collected in 2020, the ten most abundant species represented 83% of all individuals collected throughout the year (Table 1). These include four species of amphipod, two clams, two oligochate worms, and two polychate worms. Only one species in this group (the amphipod Americorophium spinicorne) is known to be native to this estuary; all others are non-native or are cosmopolitan species of unknown origin. Refer to Fields and Messer (1999) for descriptions of the habitat requirements, physical attributes, and feeding methods of many of these species.

Species	Organism Type	Native/ introduced status	Station(s) at which species was found*	Month(s) in which species was abundant**	Total number of individuals***
Potamocorbula amurensis	Clam	Introduced	D6, D7	All months	53,436
Ampelisca abdita	Amphipod	Introduced	D41, D41A	June-October	35,344
Corbicula fluminea	Clam	Introduced	D24, D28A, D4, P8, C9, D16	All months	13,758
Americorophium spinicorne	Amphipod	Native	D4, P8	February-July	12,257
Varichaetadrilus angustipenis	Oligochaete worm	Introduced	C9, D4, D28A, P8	All months	11,152
Sinocorophium alienense	Amphipod	Introduced	D7	January-September	8,931
Manayunkia speciosa	Polychaete worm	Introduced	D28A, P8	January-March, September-November	5,626
Gammarus daiberi	Amphipod	Introduced	D24, D4, D28A, P8	June-July, November	5,465
Limnodrilus hoffmeisteri	Oligochaete worm	Unknown; cosmopolitan	C9, P8, D4, D28A	All months	4,078
Laonome calida	Polychaete worm	Introduced	D4, C9, P8, D7, D28A	February-March, September-November	2,026

* Stations are listed in order from highest to lowest total annual abundance.

** Across all stations; abundant is defined as > 5% of total species count for the year.

*** Total number of individuals was the sum of individuals at all sites at all months in 2019.

Figure 44: List of ten most numerous benthic invertebrate species found at EMP sites in 2020.

In the site descriptions that follow, most species densities are reported as the annual densities of individuals/m^2, sometimes noting dramatic seasonal peaks. Some species, especially arthropods, display strong seasonal variability, with peak monthly densities several times higher than their annual densities. In these cases, we reported the time and magnitude of the peaks as well as the

annual densities. Please note, however, that the reported annual densities omit three months of 2020 (April, May, and December) when sampling did not occur, and comparisons to other years' annual densities or seasonal patterns should take these omissions into account. Readers who wish to see the full dataset can access it at https://emp.baydeltalive.com/.

San Pablo Bay

The most saline of our sites, D41 and D41A, are polyhaline sites in San Pablo Bay. At D41 in 2020, the most numerous species was the non-native clam Potamocorbula amurensis, whose density peaked in July to 12,587 individuals per square meter, in a pattern seen primarily in wet years. Site D41 was also notable as the only site where we saw phoronids, also known as horseshoe worms, which are only found in this higher-salinity site.

At D41A, there were high densities of the non-native amphipod Ampelisca abdita, which had a high of 9,846 individuals/m2 in December 2020, as well as Potamocorbula amurensis with an average annual density of 1,686 individuals/m2.

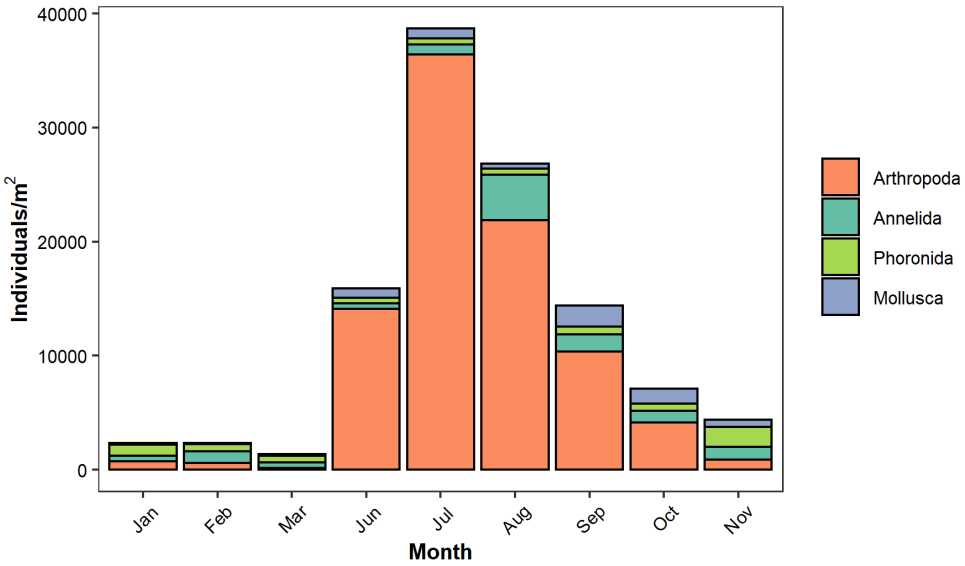

Figure 45: Density of benthic organisms, by month, collected at station D41 in 2020.

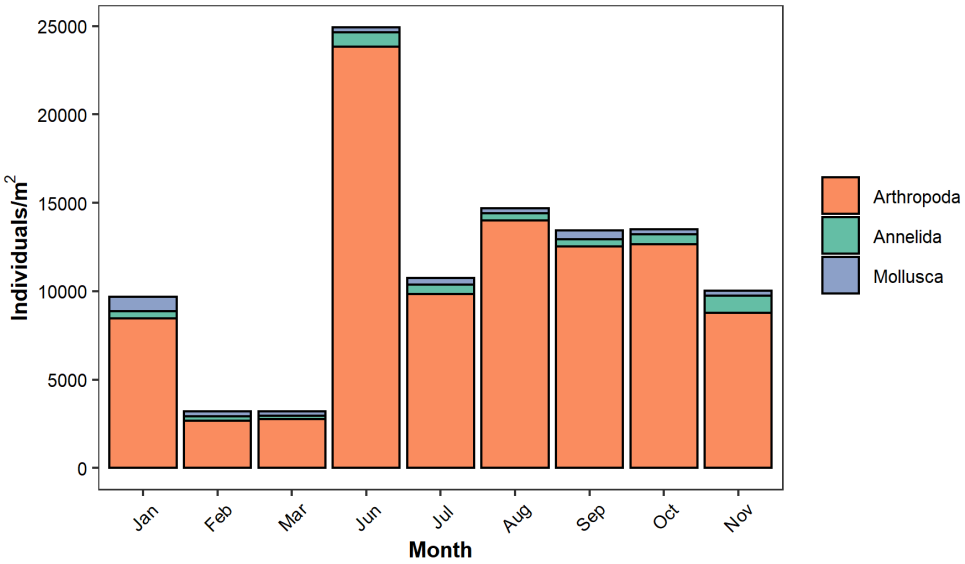

Figure 46: Density of benthic organisms, by month, collected at station D41A in 2020.

Suisun and Grizzly Bay

In Suisun Bay and Grizzly Bay in 2020, our mesohaline sites D6 and D7 both saw high numbers of the invasive clam P. amurensis, which had an average density of 9,891 individuals/m2 and comprised 97% of all organisms at D6 in 2020, similar to other recent years. At D7, P. amurensis had a September peak of 12,471 individuals/m2, and the non-native amphipod Corophium alienense had a November peak of 10,428 individuals/m2. These two species together made up 94% of all organisms at D7 in 2020.

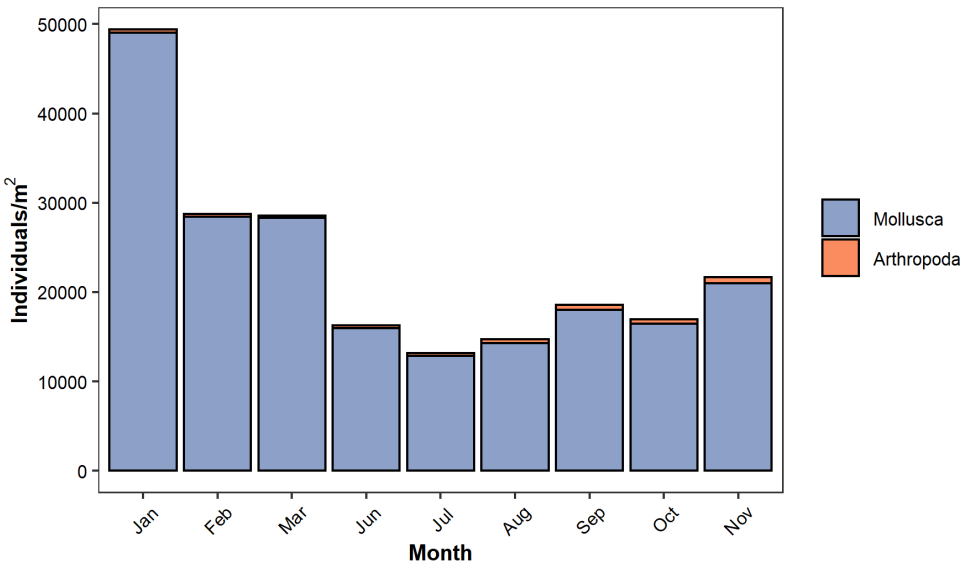

Figure 47: Density of benthic organisms, by month, collected at station D6 in 2020.

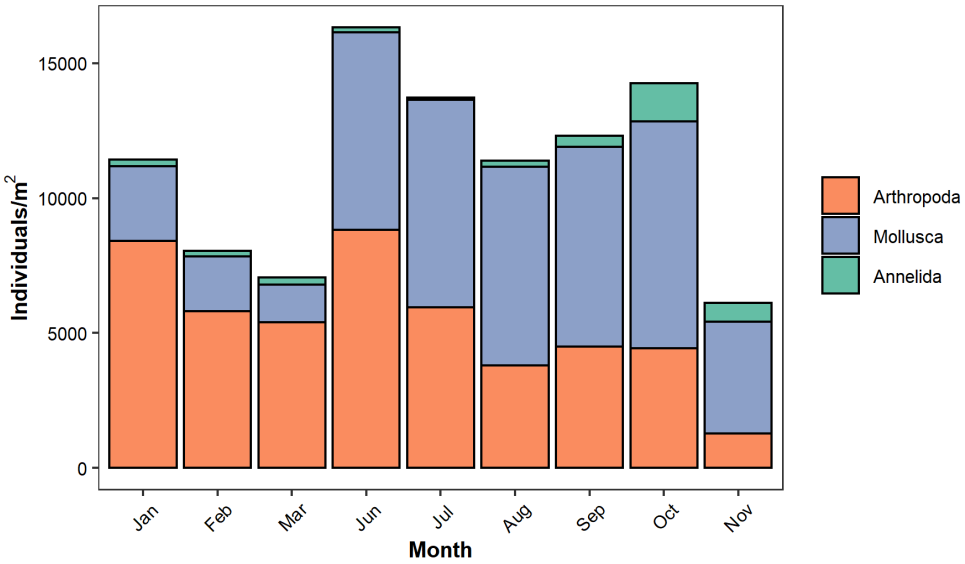

Figure 48: Density of benthic organisms, by month, collected at station D7 in 2020.

Confluence

At the confluence of the Sacramento and San Joaquin rivers, site D4's oligohaline community was comprised in 2020 largely of the amphipods Americorophium spinicorne and Gammarus daiberi, which each had high variability through the year. The oligochaete worm Varichaetadrilus angustipenis also had high density in the second half of the year.

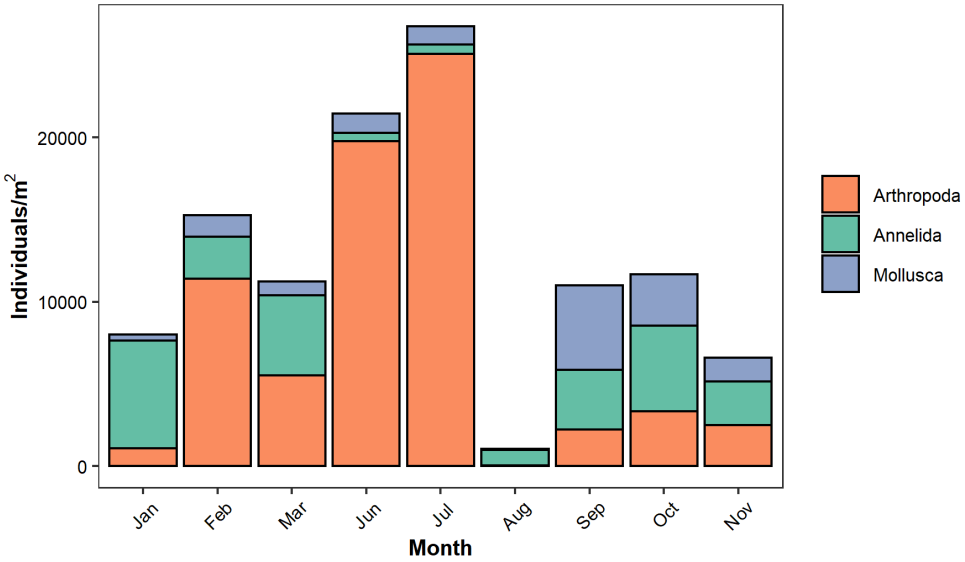

Figure 49: Density of benthic organisms, by month, collected at station D4 in 2020.

Central Delta

In the Sacramento River, freshwater site D24 was dominated by the non-native clam Corbicula fluminea, whose numbers averaged 3,016 per square meter over the course of 2020, similar to the very high densities of 2018. There was also a significant seasonal increase in densities of the amphipod Gammarus daiberi between September and December.

In the San Joaquin River, freshwater site D16 (at Twitchell Island) was dominated in 2020 by the amphipod Gammarus daiberi, which demonstrated an impressive density peak in May, as well as the clam Corbicula fluminea and the oligochaete worm V. angustipenis.

In Old River, freshwater site D28A had a diverse community in 2020. There were high densities of the ostracod crustacean Cyprideis sp. A and the sabellid worm Manayunkia speciosa at the beginning of the year and lower densities for most of the rest of 2020. There were also seasonal peaks of the oligochaete worm V. angustipenis and the amphipods G. daiberi and A. spinicorne.

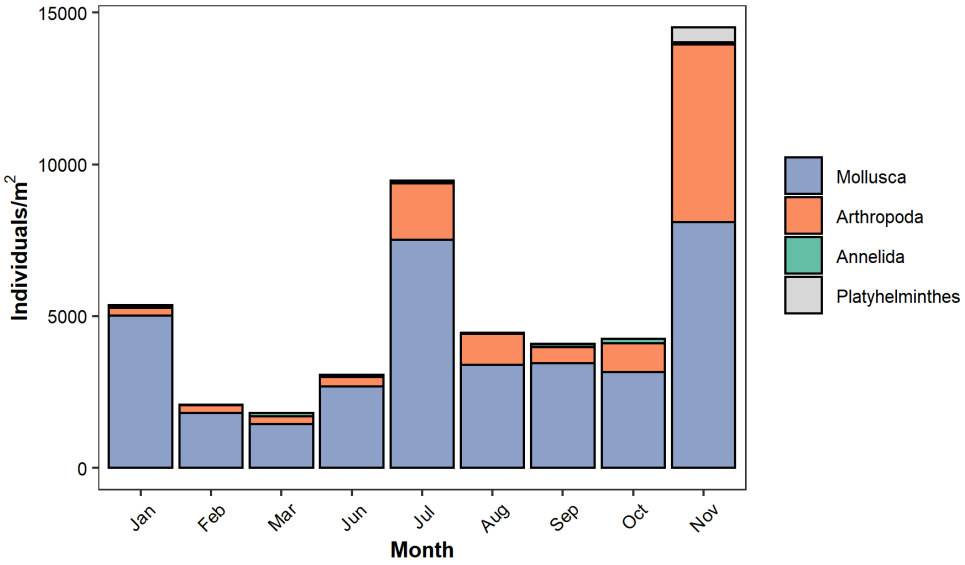

Figure 50: Density of benthic organisms, by month, collected at station D24 in 2020.

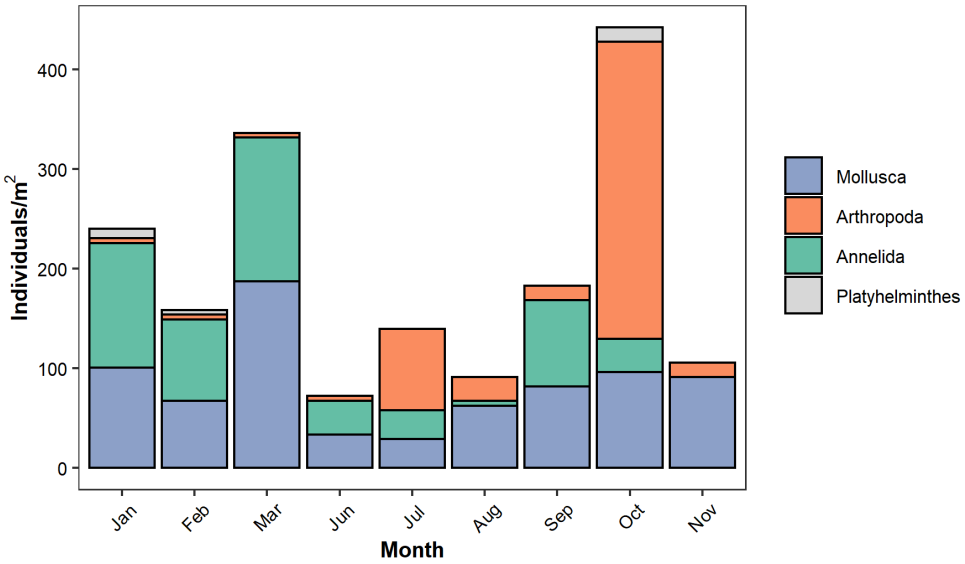

Figure 51: Density of benthic organisms, by month, collected at station D16 in 2020.

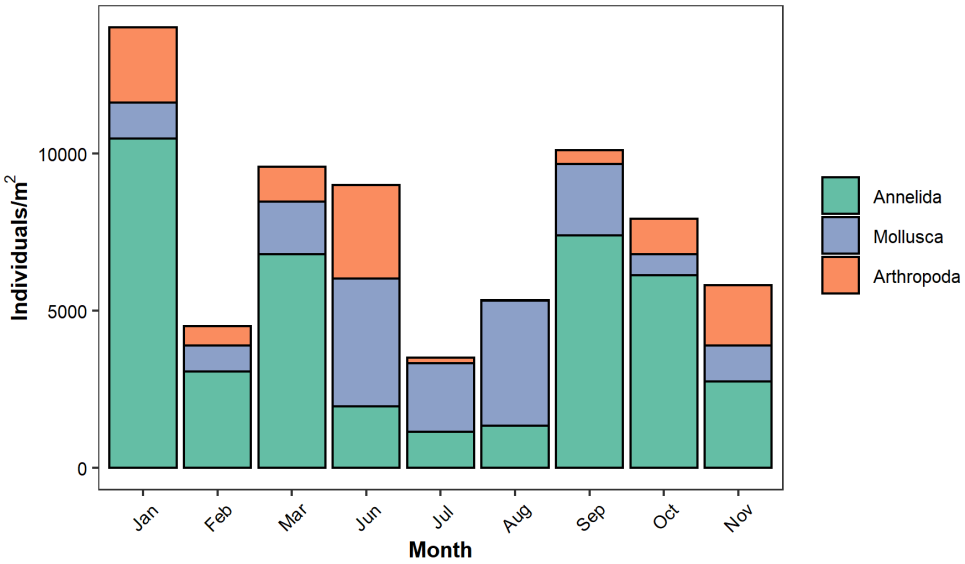

Figure 52: Density of benthic organisms, by month, collected at station D28A in 2020.

Southern Interior Delta

Further upstream in the San Joaquin River, site P8 at Buckley Cove was dominated by the sabellid worm M. speciosa which saw peaks in October and March. In addition to this species, which accounted for 59% of all organisms, site P8 saw a diverse community of freshwater oligochaetes, aquatic insects, and amphipods in addition to the non-native clam C. fluminea.

At Clifton Court Forebay, freshwater site C9 was dominated by a number of annelid species in 2020. Varichaetadrilus angustipenis, Limnodrilus hoffmeisteri,and Ilyodrilus frantzi were present at high densities throughout the year, at moderately higher levels than in 2018. The amphipod

Hyalalla sp. A experienced a dramatic peak in density in November and December. Site C9 is regularly one of our most biodiverse sites, with an additional large number of species present at low densities.

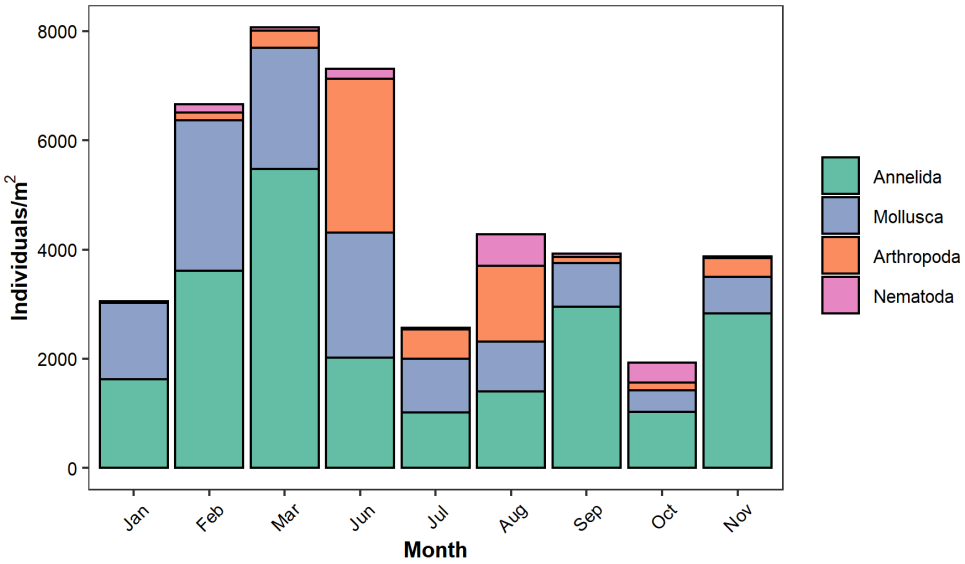

Figure 53: Density of benthic organisms, by month, collected at station P8 in 2020.

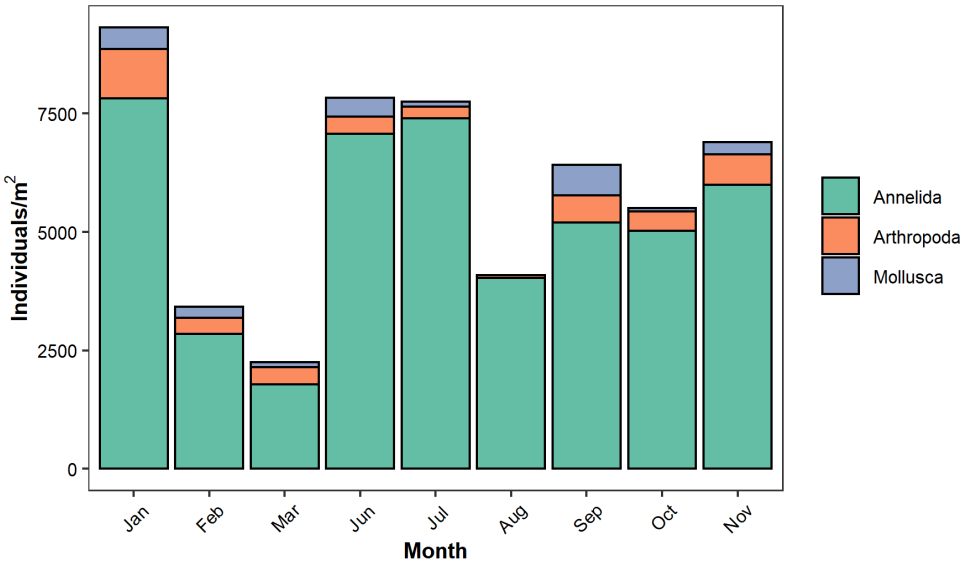

Figure 54: Density of benthic organisms, by month, collected at station C9 in 2020.

Summary

In summary, 2020 saw an overall decrease in invasive clam density from 2018 (13% for P. amurensis and 10% for C. fluminea). Other notable features of 2020 were the sharp decrease in overall density of the amphipod A. abdita in Grizzly Bay, after reaching a decadal peak in 2018, likely due to 2020's decreased salinity, as well as the 2020 increase in the annelid M. speciosa,

after its steady decrease from 2015 – 2018. Our ability to recognize these changes highlights the importance of monitoring benthic invertebrates to a high taxonomic resolution across the entire estuarine salinity gradient since the community has important interactions with various abiotic conditions as well as key parts of the estuarine food web.

Data and Archived Reports

EMP's benthos data sets are available to download here.

Archived annual reports can be found here (link currently broken).

For questions related to EMP's benthos data sets, please contact Betsy Wells at elizabeth.wells@water.ca.gov.