Updated 11/20/2010

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Bivalve Filter Feeders

Benthic macrofauna were sampled across deep and shallow habitats in South San Francisco Bay. Benthic biomass data was acquired from a variety of sources (Table 1) with varying sampling protocol which is listed for each data source.

Biomass was estimated for bivalves by measuring each individual and converting that length measurement to dry tissue weight based on the standard live animal method: animals are measured, dried in a 60°C oven (≥7 d), weighed (dry weight, DW), combusted at 500°C, and re-weighed (ash weight, AW) *(Crisp 1971)*. The resulting ash-free-dry weight (AFDW) of each size of bivalve was determined by difference (AFDW = DW-AW). Site and date specific regression equations based on ln-transformed shell length and AFDW data were used to estimate the dry tissue weight of the full size range of bivalves that were present. All individual bivalves were measured in the preserved samples and each size converted to AFDW. The summation of all AFDW for a sample is the biomass.

EMAP bivalve biomass had to be estimated using the most probable population structure. We matched bivalve size data for years with established bivalve age structure and weight data to years in which bivalve measurement data were not available. The match was based on the similarity in the magnitude and length of phytoplankton blooms, season, and location. The assigned median size for each species of bivalve was then used to determine the median dry tissue weight. Total biomass was based on multiplying abundance and AFDW of the median sized animal. One set of data (USGS-Kuwabara) included weight weights of bivalves and these data were converted to dry

tissue weight (wet weight x 0.055 = dry weight) based on the relationships established for preserved bivalves *(3)*.

USGS Monthly: Three replicate samples were collected at near-monthly intervals at a minimum of 7 stations from January 1991 through December 1996 using a 0.05 m^2 Van Veen grab. Samples were sieved through a 0.5mm screen, preserved in buffered formalin for a week and transferred to 70% ethyl alcohol. All bivalves were measured (maximum shell length) with an image analyzer. A length-weight relationship was developed using fresh animals at each station for each month. Biomass values are based on these measurements and the appropriate length-weight equation for the station and month.

USGS Spatial 1988-2010: Spatially intensive studies with varying number of stations (Table 1) were done at least once a year in 1988 through 1990 and 2004, two-three times a year 1993-1995 and 2006 to present. One replicate was collected at each station and the sampling protocol and measurements were as described above. Length-weight relationships were done on 1993-1995, 2004, 2006-present samples. A "universal" length-weight relationship for each species (based on a regression of data from all stations and months sampled during 1995) was used for conversion to dry weight for each individual for the 1988-1991 samples, when live animal condition analyses were not done.

REM 1987-1988: Four stations (REM San Leandro, REM Coyote Pt, South Bay Deep, Palo Alto) were sampled at bimonthly intervals using the same protocol as described for USGS sampling. Most bivalves were measured and conversion to dry weight for each individual was based on the "universal" length-weight relationship for each species. Bivalves with low abundance were not measured and the protocol described above was used for these species.

USGS-WSC Spatial: Samples were collected at 25 stations by the USGS Water Sciences Center in Sacramento. Samples were taken with a 0.05 m^2 Ponar grab and processed in the same manner as other USGS samples. Bivalves were measured and conversion to

dry weight for each individual was based on the "universal" length-weight relationship for each species.

USGS – Kuwabara: Three replicate samples were collected twice a year at one or two stations using a 10cm diameter core and the protocol mentioned above. Bivalves were weighed-wet after blotting for 10 minutes.

EMAP: This NOAA program sampled in San Francisco Bay in August of 2000 and 2001. One sample was collected at each station with a 0.04 m2 Van Veen grab. Samples were sieved through a 0.5mm screen and preserved with 10% formalin. Bivalves were not measured and are not available. Therefore we matched the location and season to population data that we had collected in 1987-1995. There were very few bivalves in these samples so the order of magnitude number used in this paper is appropriate.

Start Year	# of Sta.	Sampling Program	Sampling Dates	Frequency	Data Source
1987	2	REM	3/87-11/87	bimonthly	REM *(4)**
1988	2	REM	1/88-11/88	bimonthly	REM *(5)**
1988	27	USGS Spatial	5/88		USGS unpublished
1989	2	USGS Monthly Continuing REM	3/89-3/91	bimonthly	USGS unpublished
1989	37	USGS Spatial	9/89		USGS unpublished
1990	21	USGS Spatial	8/90		USGS unpublished
1991	7	USGS Monthly	1/91-11/91	monthly	USGS *(1)*
1992	6	USGS Monthly	1/92-11/92	monthly	USGS *(1)*
1993	10-13	USGS Monthly	1/93-12/93	monthly	USGS *(1)*
1994	13	USGS Monthly	2/94-12/95	monthly	USGS *(1)*
1993	21	USGS Spatial	3/93, 7/93, 9/93	seasonal	USGS *(1)*
1994	21-22	USGS Spatial	4/94, 7/94, 10/94	seasonal	USGS *(1)*
1995	31	USGS Spatial	2/95, 6/95, 9/95	seasonal	USGS *(1)*

1996	12	USGS	3/96, 6/96, 9/96	seasonal	USGS unpublished
1997	9	USGS	3/97	single	USGS unpublished
1998	12	USGS Monthly	3/98, 6/98, 9/98	seasonal	USGS unpublished
1998	2	USGS Kuwabara	4/98	single	USGS (4)
1999	1	USGS Kuwabara	5/99	single	USGS (4)
2000	5	EMAP	8/00	single	EMAP(6)
2001	12	EMAP	8/01	single	EMAP(7)
2003	1	USGS Kuwabara	5/03, 11/03	seasonal	USGS (5)
2004	31	USGS Spatial	10/04	single	USGS unpublished
2004	1	USGS Kuwabara	3/04, 11/04	seasonal	Kuwabara
2005	1	USGS Kuwabara	4/05	single	Kuwabara
2006	22-37	USGS Spatial	4/06, 7/06, 10/06	seasonal	USGS unpublished
2007	22+	USGS Spatial	4/07, 10/07	seasonal	USGS unpublished
2008	22+	USGS Spatial	3/08,7/08,10/08	seasonal	USGS unpublished
2009	22+	USGS Spatial	3/09,6/09, 10/09	seasonal	USGS unpublished
2010	22+	USGS Spatial	4/10, 7/10, 10/10	seasonal	USGS unpublished

Table 1: Data sources used for table. Grey sections are for periods when samples are too few (1-2 stations once or twice a year), or where samples were not available for examination and some taxonomy is in doubt (EMAP) and thus they should be used with caution. Yellow cells are samples in which bivalve biomass and community analyses are promised in current Salt Pond Study.

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