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Sand Beach Monitoring at Channel Islands National Park 2007-2012

Natural Resource Report NPS/MEDN/NRR—2015/1049

ON THE COVER

Clockwise from Upper left: wrack on China Camp Beach, Old Ranch House Canyon Lagoon, elephant seals on China Camp Beach, Jacob Elliott and Stephen Whitaker conducting core samples on upper beach transect at Water Canyon, Santa Rosa Island.

Photograph by: Dan Richards

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Executive Summary

Though a smaller proportion of the island shoreline than the mainland's, sandy beaches are an important habitat of the intertidal zone of the northern Channel Islands. Often overlooked, sand beach communities offer a dynamic arena for the interaction of marine and terrestrial ecosystems. Marine organisms living within this zone are highly adapted to physical disturbance and severe temperature fluctuations. Yet, the abundant and diverse fauna of the beaches is sensitive to changes in oceanographic conditions and to perturbations such as oil spills.

Sand beach monitoring is part of the long-term ecological monitoring program at Channel Islands National Park. This report describes the monitoring and results from 2007-2012. Five to nine beaches were sampled on Santa Rosa Island annually during summer to determine abundance and population dynamics of sand crabs, amphipods (beach hoppers), olive snails, and Pismo clams. We were not able to conduct all sampling each year and no sampling was conducted in 2008. Organisms were counted in repeated transects using visual or core sample methods and select organisms were collected for size frequency measurements and released. In addition to the infauna surveys, western snowy plovers were counted in winter and breeding window surveys each year. Beach walk surveys counting shorebirds and carcasses and noting relative conditions of beaches and marine debris were conducted opportunistically.

Numbers of sand crabs tend to be highly variable from site to site and season to season. Beach hoppers and associated fauna can also be highly variable but are consistently found in greatest numbers where the most macrophyte wrack is found. Wrack was most abundant on Sandy Point and Soledad West which face into the prevailing wind and have large offshore kelp beds in the area. Pismo clams were counted in 2007, 2011, and 2012 with increased numbers seen in successive years. Shorebird counts during the summer samples are typically low. Black oystercatchers and sanderlings are usually the most common shorebird, while gulls and often ravens can be the most numerous birds present.

Three lagoons were sampled on Santa Rosa Island but only two had water present during the summer. The lagoons were hypersaline in 2009, 2010, and 2012, but brackish in 2011 when there was abundant rainfall. Between 2006 and 2012, 107 beachwalk surveys were conducted on Santa Rosa and San Miguel Island beaches. We recorded 418 carcasses, mostly pinnipeds, in those surveys. No major mortality events were seen but we did find unusual numbers of cormorants on Skunk Point in 2011 and numerous *Mola mola* (ocean sunfish) on several beaches in 2010.

Acknowledgments

The National Park Service, Channel Islands National Park (CINP) funded this program, in part using Inventory and Monitoring Prototype funding. We are grateful for the field assistance from Susie Tharratt, Anna Braswell, and Kevin Barnes in 2007, Jacob Elliott and James Anderson in 2009, and Jacob Elliott and Leita Lord in 2010, Andrew Domingos in 2011, and Kristen Mollura and Alex Laine in 2012. Additional people have helped with the snowy plover and beachwalk surveys each year including Angela Guglielmino, Lisa Drake, Brent Wilson, Bob Delong and Brent Stewart, Jen Savage and Ian Williams

List of Acronyms

Acronym	Description
CINP	Channel Islands National Park
CINMS	Channel Islands National Marine Sanctuary
OSPR	Oil Spill Prevention and Response
SCI	Santa Cruz Island
SMI	San Miguel Island
SMR	State Marine Reserve
SRI	Santa Rosa Island

Introduction

Sandy beaches are a major habitat of the intertidal zone of the northern Channel Islands. At the islands, beaches make up approximately 20% of the shoreline, opposite the southern California mainland coast which is about 80% sand. Though often overlooked, sand beach communities offer a dynamic arena for the interaction of marine and terrestrial ecosystems. Marine organisms living within this zone are highly adapted to physical disturbance and severe temperature fluctuations. Sand beaches harbor high densities of detritus, infauna, and macro-invertebrates that supply food and habitat for both marine and terrestrial organisms (Dugan et al. 2000).

Many shorebird species utilize sand beaches as roosting and foraging habitat, including the federally threatened western snowy plover. Harbor seals, northern elephant seals and California sea lions use beaches for resting and breeding habitat. Elephant seals in particular can be especially numerous on Santa Rosa Island beaches (Figure 1). This is a relatively recent phenomenon with only a relatively small number utilizing Santa Rosa Island beaches before the mid-1990's. Terrestrial mammals (mice, fox, skunk) and birds prey and scavenge on sand beach organisms. All these organisms in turn play a vital role in the functioning ecosystem we classify as sandy beaches. Introduced deer and elk were removed from the island in 2011. Deer and elk were often seen on the beaches eating kelp wrack or simply transiting the area. Deer and Elk came off the island at the end of 2011 following a five year reduction in numbers.

Channel Islands National Park (CINP) and National Marine Sanctuary (CINMS) encompass the four northern Channel Islands and Santa Barbara Island off the coast of Southern California. The park islands and surrounding waters bear the designation of an International Biosphere Reserve and State of California Areas of Special Biological Significance. The State of California maintains jurisdiction over the marine resources and manages them through the California Department of Fish and Wildlife. In 2003, a network of marine reserves was established around the Channel Islands. Only two sand beach monitoring sites (Abalone Rocks and Bechers Pier) fall inside a Marine Reserve (figure 2).

Sand beach monitoring is conducted at nine beaches on Santa Rosa Island to determine the health of the sand beach community. Invertebrates and shorebirds are counted to estimate population levels. Size frequencies are measured to determine population dynamics. We also conduct assessments of the marine debris and beached animal carcasses as measures of the perturbations and baseline conditions of the beaches. Special surveys are conducted for western snowy plovers which are listed as Threatened.

Specific sand beach monitoring objectives are: 1) to determine the long-term trends in percent cover of key beach organisms, 2) to determine population dynamics of *Emerita analoga, Tivela stultorum, and Olivella biplicata*, 3) to determine amounts of beach wrack, and 4) determine the state of coastal lagoons. Objectives are met by monitoring species abundance through core transects, and population dynamics through measuring size frequency and reproductive conditions of *E. analoga*. Temperature, salinity, and general observations characterize the lagoons. Beachwalk monitoring (Richards and Rich 2006) was conducted periodically on Santa Rosa and San Miguel Island beaches to count shorebirds and document carcasses on the beaches.

A study design for sand beach monitoring on Santa Rosa Island was completed in 1990 (Dugan et al. 1990). A draft report summarizing the inventory and design study (Dugan et al. 1993) began the data collection for the island. A reduced monitoring effort has been conducted since with sand beach monitoring performed in 1994 (Richards 1996), 1995 (Richards and Lerma 1996), 1997 (Lerma and Richards 2000), 1999 (Lerma and Richards. 2001), 2000 (Lerma and Richards 2002), and 2004 (Richards 2004). This report presents data from beach monitoring in 2007, 2009, 2010, 2011, and 2012; beachwalk surveys 2006-2012; and snowy plover counts 2005-2012.

Figure 1. Northern elephant seals, *Mirounga angustirostris,* on China Camp Beach. Hundreds of elephant seals occupy this beach from December through August during both breeding and molting cycles

Methods

Study Area

The California Channel Islands are comprised of eight islands in the Southern California Bight, five of which are within the Channel Islands National Park. The five park islands have about 323 kilometers (186 miles) of coastline, about 80% of which is rocky shore (Curdts 2011). On Santa Rosa Island, sandy beaches cover approximately 30 km of the 52 km shoreline. A wide variety of exposures and sand grain size are represented there. Sand beach monitoring is done on Santa Rosa because it provides a representation of beach types and it is the most logistically feasible of the five park islands. Beachwalk surveys were conducted on Santa Rosa Island as well as Cuyler Harbor and Simonton Cove beaches on San Miguel Island.

The park islands span the transition zone between cooler waters of the Oregonian biogeographic province and the warmer Californian waters from the south. Mean annual air temperature along the mainland in this area is 15°C. Mean rainfall is about 38 cm per year (Daily et al. 1993). There is a gradient across the island chain with San Miguel Island having the most precipitation, cloud cover, and wind. Santa Barbara Island to the southeast is the warmest and driest. The mean monthly sea temperatures range from 13°C in April at San Miguel Island to nearly 20°C at Santa Barbara Island in August and September (Engle and Richards 2001). Swell varies through the year with winter storms bringing high northwest wind and waves during the winter and spring, and distant southern hemisphere storms sending large swells to the south facing shores in summer.

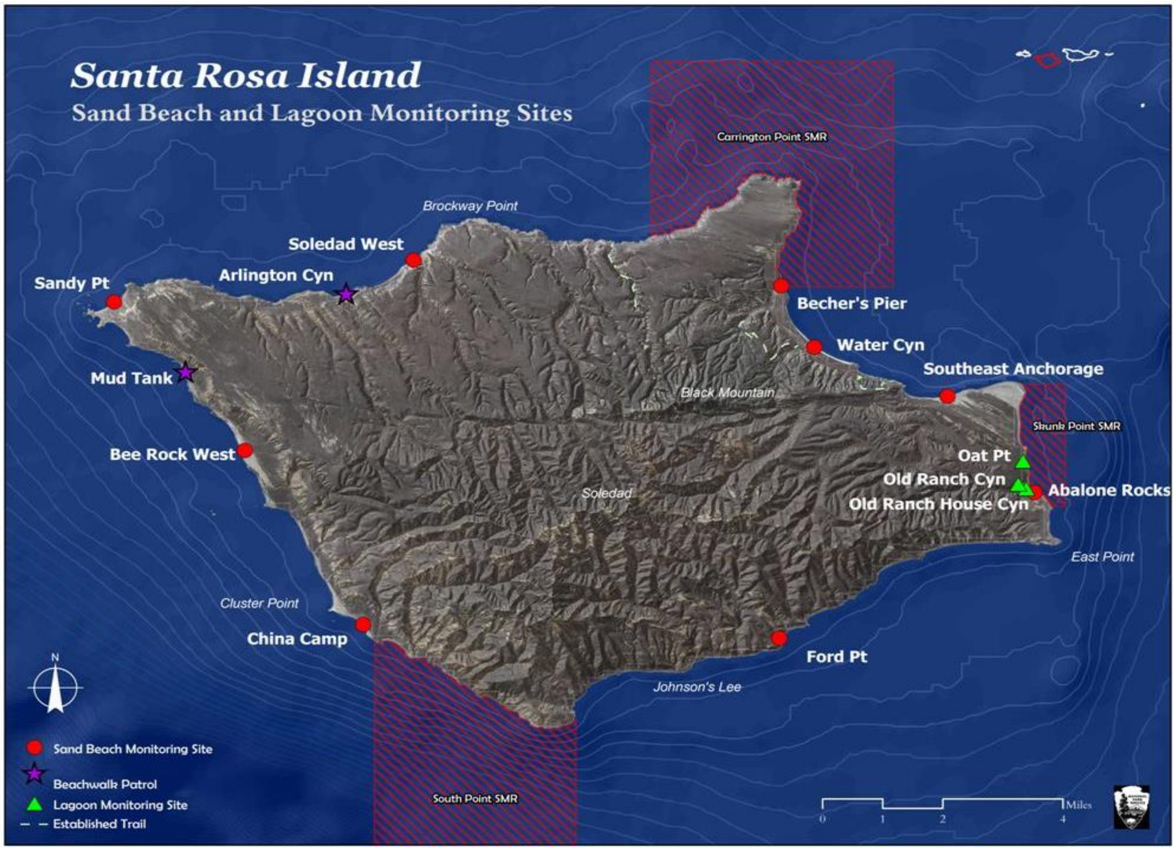

Figure 2. Beach and Lagoon monitoring locations on Santa Rosa Island. Red hatched areas are State Marine Reserves.

Table 1 Santa Rosa Island beach sampling site names and codes.

Site Name	Site Code
Bechers Pier	BB
Water Canyon	WC
Southeast Anchorage	SE
Abalone Rocks	AR
Ford Point	FP
China Camp	CC
Bee Rock West	BR
Sandy Point	SP
Soledad West	SW
Oat Point Lagoon	OP
Old Ranch Canyon Lagoon	OR
Old Ranch House Canyon Lagoon	ORH

Monitoring

Sampling was done according to standard procedures described in the beach and lagoon monitoring handbook (Dugan et al. 1990). Nine beaches and three lagoons were chosen for monitoring on Santa Rosa Island (Figure 2, Table 1), though not all sampling is performed at every beach. Logistically it takes more than one typical island tour of duty to complete all the sampling which takes a day per beach. Unfortunately we typically have been unable to devote more than one tour to the monitoring, so not all beaches were sampled each year. Beachwalk sampling (shorebird and carcass surveys) and even marine debris surveys can often be accomplished at the same time because of the reduced need for transit time.

Due to limited time only four beaches (Bechers Pier, Water Canyon, China Camp and Soledad West) were sampled in 2007 and five beaches (Water Canyon, Southeast Anchorage, Abalone Rocks, China Camp and Soledad West) were monitored in 2009. In 2010, we sampled eight beaches (Bechers Pier, Water Canyon, Southeast Anchorage, Abalone Rocks, China Camp, Bee Rock, Sandy Point and Soledad West). All nine beaches were monitored in 2011. Six beaches were sampled in 2012 (Abalone Rocks, Bechers Pier, China Camp, Sandy Point, Southeast Anchorage, and Soledad West). Monitoring was conducted between September 21-25, 2007, July 24-29, 2009, August 16-21, 2010, August 9-19, 2011, and August 14-20, 2012. The 2007 date was unusually late in the season for this protocol and we got caught in an unseasonably early rain that year.

Most of the sampling is done in vertical transects randomly located in the center of a beach. Organisms are collected to be identified and measured then returned to the beach. The sampling techniques and the organisms sampled are given in Table 2. Sampling is usually done in the center of the beach along a baseline transect for reference (Figure 3).

Upper beach core transects were done at each beach to determine the abundance of beach-hoppers (*Megalorchestia* spp.) and invertebrates typical of the upper beach community. Core samples (10 cm diameter x 10 cm depth) are taken using a clam gun (a cylindrical aluminum tube) along five vertical transects between the upper extent of beach-hopper holes and the wet sand. Samples are sieved through 1.5mm mesh. Beach-hopper amphipods, beetles, isopods, and associated species are counted to estimate the abundance of each.

The number of organisms in a meter wide strip of beach extending across the intertidal zone was calculated by multiplying the number of each species found in a transect by the inverse of the proportion of beach sampled:

organisms/m = # organisms caught in transect (core sample interval (m) x 1m)/core area (m^2).

Wash zone core transects were done with the same methods as the upper beach between the upper extent of the waves and the lowest beach swash to determine sand crab (*Emerita analoga*) abundance, size frequency and reproductive state. Olive snails (*Olivella biplicata*) and spiny mole crabs *(Blepharipoda occidentalis*) are sampled at one beach (Southeast Anchorage) in subtidal transects. Other infauna common to the wash zone include polychaete worms and isopods. Sand crabs and olive snails were washed through a series of buckets with graduated hole sizes to separate into size classes (Dugan et al. 1990).

Pismo clams (*Tivela stultorum*) are only sampled at Southeast Anchorage. Survey methods have varied slightly over the years in an attempt to develop a more standardized and repeatable approach, but generally surveys have always consisted of counting clam siphons during snorkeling surveys. Two snorkelers conducted siphon counts for 30 minutes in 2009. In 2010 -2012, two snorkelers swam perpendicular transects alternating away from shore then back to shore. Siphons were counted within a one-meter swath. In 2010 transects were 50m long. In 2011 and 2012, transects were 100m. We had very good conditions in 2011 and in addition to conducting snorkel transects we collected *Tivela stultorum* for size measurements and marking on two days. We measured all the clams collected and marked them using a hacksaw blade to make small cuts in the outer shell. Clams were marked with two parallel grooves centered near the umbo on the right valve. All clams were then returned to the nearshore and buried in proper orientation. Unfortunately we were unable to resurvey for recapture and population estimate.

Macrophyte wrack (plant and other debris stranded on the beach) was measured in three point contact transects. Transects extended from the beach back to the sand berm or wet sand and 100 points were evenly spaced along the length.

Physical measurements at each site included water temperature, beach width, and beach slope. Temperature, salinity, and water depth was measured at established stations at each lagoon (as per Dugan *et al.* 1990). Temperatures were measured with a handheld thermometer 10 cm below the surface and in the upper cm for surface temperature at the lagoons. Birds were counted on arrival at each beach and lagoon.

Beachwalk monitoring was conducted to gather baseline information about carcass accumulation on beaches as well as beach use by shorebirds and pinnipeds (Richards and Rich 2004, 2006, Rich and Richards 2005). Biologists walked the beaches, documenting findings onto a standard datasheet. Beached animals were the primary interest of the surveys; however, numbers of live animals present and notes on marine debris and human activity were also recorded. Information about each carcass included species identification (if possible), stage of decomposition, age and sex (if possible), presence of tags, evidence of scavenging, cause of death, presence of oil, and whether a photograph was taken. Photos are archived for verification of questionable identification and to create a reference/training library for monitors. Live animals encountered during surveys were identified and counted. Animals with tags were noted if present. Human activity was noted as were signs of animal foraging or plant invasion.

Figure 3. Baseline transect at Bee Rock West. Transect tape is along upper edge of wrack line.

Data Analysis

Data are maintained in Microsoft Access files in the Beach and Lagoon or Beachwalk monitoring databases at Channel Islands National Park. The purpose of this report is to present data and observations collected regarding sand beaches between 2007 and 2012. Statistical analysis of the data was not performed. Any trends presented are simple summary statistics and should be viewed as preliminary.

Table 2. Sand Beach Monitoring Core species monitored at Channel Islands National Park

	Band Transects	**Mark-recapture**	**Clamgun Transects (upper beach, washzone, subtidal)**	**Point Contact Transects**	**Size Frequency Distribution**
Pismo Clam *Tivela stoultorum*	X	X			X
Purple olive snail *Olivella biplicata*			X		X
Beachhoppers *Megalorchestia* spp.			X		
Misc. amphipods Gammaridea			X		
Isopod *Excirolana chiltoni*			X		
Isopod *Alloniscus percovexus*			X		
Common sand crab *Emerita analoga*			X		X
spiny sand crab *Blepharipoda occidentalis*			X		X
Pictured Rove Beetle *Thinopinus pictus*			X		
Misc. Rove Beetles Staphylinidae			X		
Misc. other beetles			X		
kelp flies			X		
other species			X		
Polychaete worm *Nephtys californicus*			X		
Polychaete worm *Euzonus mucronata*			X		
Macrophyte Wrack Including:				X	
red algae					
brown algae					
green algae					
Egregia menziesii					
Macrocystis pyrifera					
Phyllospadix spp.					
terrestrial plant					

Results and Discussion

Wash-zone transects

The wash zone is the wet sand area typically between the highest point of the largest waves hitting the beach and the backwash of the wave as water gets sucked out into the next wave. The zone tends to be very productive with fine particulate matter entrained by the wave action. There is great physical stress on the surface of the sand but the habitat below is probably fairly stable and well aerated. This zone is constantly migrating up and down the beach with the tidal exchange and can be quite variable depending on the strength of the waves at the time of sampling. Wave strength in turn depends on exposure of the shore and current meteorological conditions including distant storms that generate swells. Within the wash zone many of the organisms are constantly moving with the tide and so are not exposed to the extremes of high and low tides.

Most prominent in the wash zone is the sand crab, *Emerita analoga*. These crabs may grow to several centimeters in length and can be seen scurrying up or down the beach on the out-going waves. They lie buried in the sand extending only their eyes and antennae which they use to filter particles out of the water. *E. analoga* are consumed by many fish such as barred surf perch and guitarfish, and by shorebirds such as sanderlings, whimbrels, and even black oystercatchers. Male *E. analoga* are typically smaller than females and the sexes may be found in varying ratios through the year, leading to speculation that they change sex as they age, but this has not been proven (Morris *et al*. 1980).

Other crabs in the wash zone are the spiny mole crab, *Blepharipoda occidentalis*, which is bigger than *E. analoga* and typically lives in slightly deeper waters and *Lepidopa californica* which may live in more sheltered beaches and is only rarely encountered at the islands. *Excirolana* spp. and other isopods can be very numerous on beaches and may be found in the upper beach as well, though they are most commonly associated with *E. analoga*. Bloodworms, *Euzonus mucronata*, are polychaete detritivores that can be numerous in the wash zone (Kemp 1986). *Euzonus* were especially common at Soledad West and Bee Rock (Table 3). In the past they have been quite numerous at Bechers Pier (Lerma and Richards 2002, Richards 2004). However *Euzonus* numbers were quite low in 2007 and 2010 and they were not even detected there in 2011. *Nephtys californiensis* are predatory polychaetes occasionally found in the samples. *Olivella biplicata*, purple olive snails, can be quite abundant but usually occur outside of the wave zone in calmer bays.

2011 was the only year we sampled at all nine beaches. During other years we were limited by time. Sampling more than one beach a day is generally not practical because of the time necessary to travel between beaches. Note that Southeast Anchorage has a series of pocket beaches at low tide and that the “first” beach was sampled in 2009, which tends to have numerous cobble and pebble sized rocks in the sand that hampered sampling and may discourage burrowing organisms. In 2011 we sampled on the ‘third’ beach that is wider and is mostly clean sand.

The highest densities of organisms in the wash zone tend to be found on beaches that consistently receive at least moderate quantities of macrophyte wrack. Soledad West and Sandy Point face into the prevailing wind and both have extensive kelp beds offshore. China Camp, Bee Rock, and Water

Canyon are generally pretty clean beaches with only low amounts of kelp wrack. The first two, however are covered with elephant seals during the winter and presumably get high nutrient input during part of the year. Water Canyon rarely gets any wrack deposition and tends to have a large percentage of gravel and even cobble in the beach. Our sampling location at Water Canyon is right next to where the landing craft comes ashore for supplying the island. Trucks and heavy equipment drive on that segment of beach several times a year.

The overall numbers of organisms found in wash zone transects are presented in Table 3. The greatest numbers of *E. analoga* for most beaches were found in 2011. Sandy Point and Abalone Rocks had the highest density of the crabs in 2009 and 2011, though densities at all sites tended to be variable over the years showing large fluctuations and inconsistent patterns.

Excirolana numbers also varied considerably between beaches and also between years at a beach (Table 3). Bechers Pier and Soledad West typically have a high density of *Excirolana* but in 2011 we saw high densities at several sites especially Abalone Rocks and Sandy Point which had the greatest number for all sites. The highest density measured was at Soledad West in 2009, which did not correlate to particularly high amounts of wrack in the transects. There could be a lag effect from events earlier in the year that would not be recorded in the annual sampling, however. Water Canyon with its gravelly beach has a much lower density of *Excirolana* than the other beaches.

Euzonus mucronata is an interesting component of the beaches, with extremely variable densities. Soledad West consistently has high densities of *E. mucronata*. Bee Rock is another that has abundant *E. mucronata*. The beaches are quite different in exposure and kelp wrack, the latter having a southern exposure, little wrack, and large numbers of elephant seals in the winter. Both beaches have low slope and relatively fine sand though.

Emerita reproductive characteristics

The reproductive status of *Emerita analoga* was determined noting sex and egg age of each crab in different size categories. Males larger than 14mm carapace length were rare (Appendix A). Females carry their eggs under the pleopods and egg age is readily determined by the color and appearance of the egg (Figure 4). The number of ovigerous female *E. analoga* in each sample is given in Table 3. Further details on the population structure of *E. analoga* are given in Appendix A.

Table 3. Wash-zone species abundance summary 2007-2012 (mean number per meter of beach). See table 1 for site names and codes. Not all sites were sampled in all years. AR = Abalone Rocks, BB = Bechers Bay, BR = Bee Rock, CC = China Camp, FP = Ford Point, SE = Southeast Anchorage, SP = Sandy Point, SW = Soledad West, WC = Water Canyon

Year	***SiteCode***	***Total Crabs/M***	***Total Ovig/M***	***Excirolana /M***	***Olivella /M***	***Euzonus /M***	***Nephtys /M***	***Blepharipoda /M***
2009	AR	1194	0	813	0	0	0	0
2010	AR	11525	1024	599	0	0	26	0
2011	AR	18880	2429	8063	0	0	80	0
2012	AR	7627	69	21551	0	0	15	0
2007	BB	3632	206	6384	0	51	0	0
2010	BB	3670	51	3780	0	42	185	0
2011	BB	3156	20	4027	0	0	48	0
2012	BB	19709	334	3533	0	20	91	0
2010	BR	9356	844	1198	0	4472	0	0
2011	BR	16183	1180	387	0	4658	0	0
2007	CC	3373	52	533	0	0	0	0
2009	CC	7694	1057	408	0	0	0	0
2010	CC	4656	97	1071	0	0	0	0
2011	CC	6672	135	1921	0	58	0	0
2012	CC	9027	519	2156	0	0	0	0
2011	FP	11176	394	2312	0	0	0	0
2009	SE	854	78	350	23	673	41	0
2011	SE	12216	283	4252	0	0	124	0
2010	SP	14807	1485	1522	0	0	0	0
2011	SP	18035	1952	8384	0	109	0	88
2012	SP	10938	959	2732	0	14	0	34
2007	SW	594	0	5861	0	11359	456	0
2009	SW	1520	188	20289	19	7275	14	0
2010	SW	10617	482	3549	0	1101	0	0
2011	SW	8451	246	2223	0	3551	58	0
2012	SW	3272	38	174	0	1882	641	0
2007	WC	5829	684	635	0	22	0	0
2009	WC	2266	359	31	0	0	0	0
2010	WC	3937	172	794	0	53	0	0
2011	WC	3638	146	346	0	59	0	0

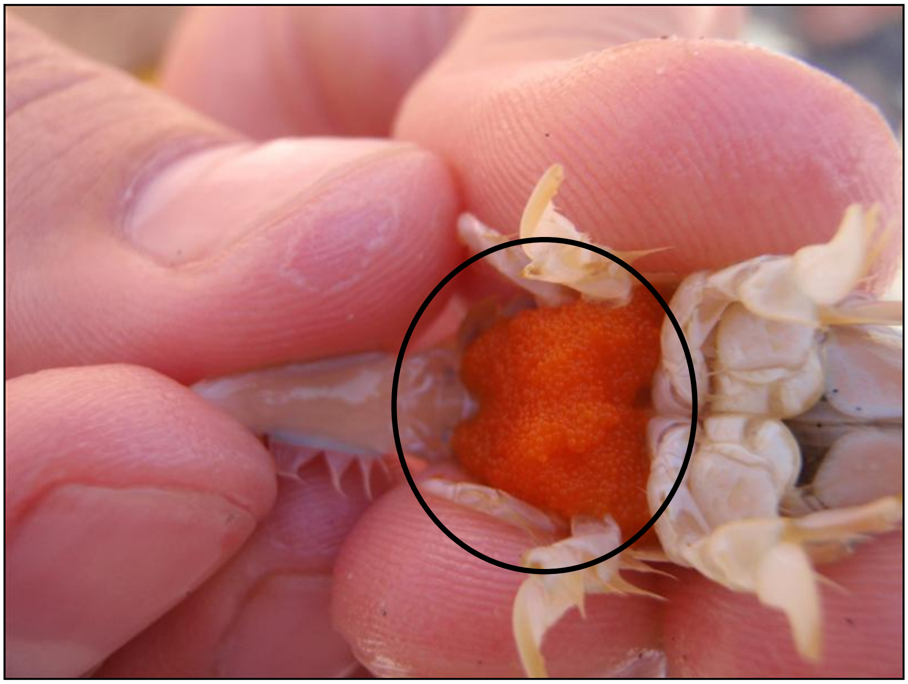

Figure 4. Emerita analoga with ‘new’ eggs. Note bright orange color indicative of ‘new’ eggs.

Olivella biplicata

Olivella biplicata can occur in very high numbers in the low intertidal and subtidal sandy protected areas. They are probably omnivorous detritivores that feed on drift kelp and dead animal tissue (Morris et al. 1980). *Olivella* were only sampled in subtidal transects at Southeast Anchorage. Because of the difficulty to perform the subtidal transects, we were not able to sample them every year.

Subtidal transects were conducted in slightly different areas in 2009 and 2011. Southeast Anchorage has a series of small beaches exposed at low tide. In 2009 sampling was conducted at the first beach and in 2011 at the third beach, though a supplemental sample for size frequency was collected at the first beach. In 2009 we found an average of 17,368 *Olivella* per meter of beach and in 2011, only 646 *Olivella* per mete (Table 4) indicating there is a lot of variability between beaches.

Olivella and polychaetes were more abundant on the first beach while *E. analoga* and isopods were more abundant on the third beach (Table 4). We suspect the difference in abundance has more to do with the beach than the sample year as the third beach is more exposed to waves and has less gravel in the substrate. The size distribution followed roughly the same pattern in both 2009 and 2011 (Figure 5 and Appendix B). The size range was slightly greater in 2009 with the larger sample.

Table 4. *Olivella biplicata* mean abundance at Southeast Anchorage as number per meter of beach.

Year	*SiteCode*	*Transect*	*Olivella*	*Emerita*	*Polychaetes*	*Isopods*
2009	SE	mean	17369	19	268	76
2011	SE	mean	646	7241	59	214

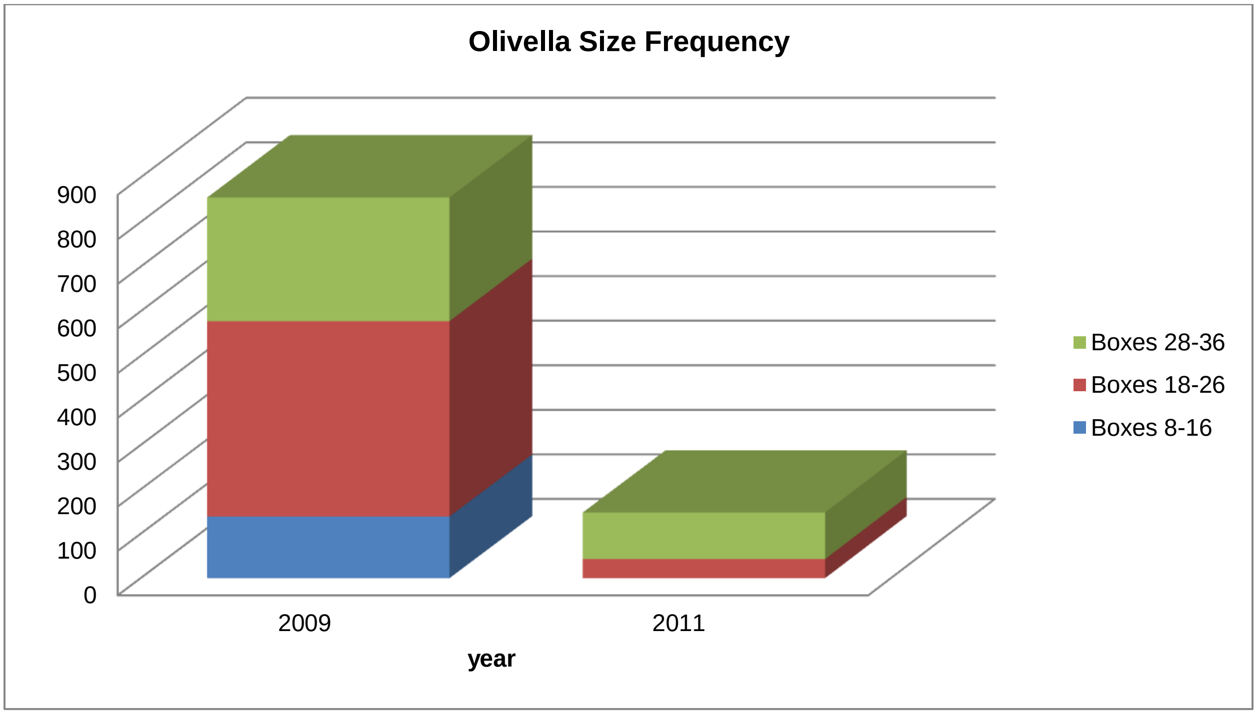

Figure 5. *Olivella biplicata* size frequency in 2009 and 2011.

Upper-beach transects

The upper beach is typically inundated by sand during the summer months on many beaches and is usually only wetted by the highest tides. Wrack may blow up on to the upper beach where it soon dries out and is buried by drifting sand if not consumed quickly. Talitrid amphipods (mostly *Megalorchestia* spp., Figure 6) are the dominant organism of the upper beach and are often present in huge numbers. Rove beetles (Staphylinidae) and kelp flies may be present in very high numbers as well, but these highly mobile invertebrates are not always well represented in the samples. *Excirolana* may be present when there are frequent wettings by waves and tides, but other isopods more closely tied to a terrestrial life such as *Alloniscus perconvexus* were more common where wrack built up in the dry sand of the upper beach (Table 5).

Beaches backed by dunes (Bee Rock, China Camp, Abalone Rocks, and Soledad West) typically have broader less sloping beaches than ones backed by cliff (Bechers Pier, Water Canyon, Ford Point, Sandy Point, and Southeast Anchorage). Vegetation grows in the dunes and there is a constant shifting as sand builds up on the back beach. Plants stabilize the dunes until storms erode the sand and cut into the dunes. Terrestrial animals such as island fox and skunk are more likely to come down through the dunes and forage on these beaches. Cliff backed beaches are often narrow, and high tides and storm waves usually wash all the way to the cliff, at least periodically, sweeping the beach clean.

Beaches with the most productive upper beach community were beaches where kelp wrack was common. Soledad West and Sandy Point, with northwest exposure, have the most consistent piles of kelp wrack and had the highest numbers of organisms, particularly amphipods and beetles (Table 5). *Excirolana* spp. did not necessarily follow this trend; however, and their abundance may be related to how much wet sand occurred in the transect. Water Canyon, besides having more rocks in the sand than other sites, appears to have waves washing over nearly the entire beach daily (Figure 7). As a result, there is almost no wrack on the beach and no invertebrates that do not tolerate total immersion at high tide.

Figure 6. Talitrid amphipod (beach hopper). These detritivores consume much of the kelp wrack deposited on beaches.

Figure 7. Water Canyon beach. High tides typically reach the cliff leaving no wrack on the beach. There is also a high content of gravel and pebbles.

Table 5. Upper-beach species abundance of most common organisms 2007-2012 (number per meter of beach). Data represent mean of five transects at each site. See table 1 for site names and codes.

Year	***SiteCode***	***Amphipods/M***	***Alloniscus/M***	***Beetles/M***	***Staphylinids/M***	***Thinopinus/M***	***Excirolana/M***	***Larvae/M***	***Other/M***
1994	AR	955	0	72	87	0	158	54	0
1995	AR	1246	0	0	18	0	1356	0	465
2004	AR	712	19	19	0	0	7691	0	72
2009	AR	559	0	195	49	16	2391	0	93
2010	AR	1666	12	9	29	33	4283	0	35
2011	AR	790	0	17	45	0	16451	14	3663
2012	AR	1971	160	0	65	33	1583	33	0
1994	BB	570	0	0	17	0	3324	0	0
1997	BB	1140	5822	0	36	15	0	0	229
1999	BB	226	0	0	0	0	4106	0	1426
2000	BB	704	0	0	14	0	2500	0	302
2004	BB	358	0	0	0	0	5019	0	10
2007	BB	1044	0	0	19	0	538	0	10
2010	BB	639	0	65	0	0	4910	127	207
2011	BB	4472	376	14	29	0	55	763	16
2012	BB	5307	967	28	77	0	1074	8	0
1994	BR	758	991	161	996	37	173	0	0
1997	BR	1694	239	87	118	0	298	0	0
1999	BR	4327	229	712	367	0	1872	0	91
2010	BR	566	2318	101	262	0	1975	19	646
2011	BR	1621	1090	86	592	12	195	86	1162

Table 5 (continued). Upper-beach species abundance of most common organisms 2007-2012 (number per meter of beach). Data represent mean of five transects at each site. See table 1 for site names and codes.

Year	*SiteCode*	*Amphipods/M*	*Alloniscus/M*	*Beetles/M*	*Staphylinids/M*	*Thinopinus/M*	*Excirolana/M*	*Larvae/M*	*Other/M*
1995	CC	130	333	22	11	0	76	0	11
1997	CC	1241	480	138	49	0	363	45	0
1999	CC	789	306	184	205	0	1109	0	23
2000	CC	1506	333	56	54	43	1697	0	210
2004	CC	1459	150	0	30	0	1944	58	0
2007	CC	1881	116	81	197	63	1054	207	0
2009	CC	366	410	61	29	0	15	104	0
2010	CC	352	145	39	57	0	18	196	20
2011	CC	902	91	171	24	49	1911	171	49
2012	CC	540	369	16	158	0	181	66	0
1994	FP	1416	61	28	21	0	0	0	0
1997	FP	508	19	10	0	0	0	0	5512
1999	FP	76	0	0	0	0	1406	0	0
2011	FP	80	18	0	0	0	10	0	6
1997	SE	0	0	22	0	0	0	0	10012
2011	SE	588	0	0	0	0	2906	11	1331
1994	SP	29991	676	154	732	39	445	0	0
1995	SP	25035	1345	52	208	0	824	343	26
1997	SP	8027	645	124	14	84	0	0	1435
1999	SP	4933	524	0	248	0	11023	0	3170
2000	SP	37335	806	404	306	0	6083	0	187
2004	SP	54047	52	487	729	393	5096	257	330
2010	SP	15683	478	100	423	37	13136	175	363
2011	SP	23263	176	175	829	50	7516	407	953
2012	SP	15155	163	144	798	53	594	9970	34

Table 5 (continued). Upper-beach species abundance of most common organisms 2007-2012 (number per meter of beach). Data represent mean of five transects at each site. See table 1 for site names and codes.

Year	***SiteCode***	***Amphipods/M***	***Alloniscus/M***	***Beetles/M***	***Staphylinids/M***	***Thinopinus/M***	***Excirolana/M***	***Larvae/M***	***Other/M***
1994	SW	14988	63	76	445	257	1501	0	0
1995	SW	16925	2220	203	1316	27	0	1980	0
1997	SW	12236	2985	303	332	104	0	0	535
1999	SW	25854	174	524	714	228	1213	0	0
2000	SW	14518	1466	153	130	0	353	59	218
2004	SW	37594	557	718	979	52	2211	0	0
2007	SW	12360	551	60	347	104	330	43	20
2009	SW	11297	750	463	987	248	2018	225	0
2010	SW	13837	7245	303	6028	233	2148	210	257
2011	SW	26030	4909	475	4173	176	280	307	1241
2012	SW	14874	4404	561	2994	174	212	196	119
1994	WC	164	0	18	0	0	1164	0	0
1999	WC	112	0	0	0	0	279	0	107
2007	WC	183	0	10	0	0	560	0	0
2009	WC	163	0	0	0	0	616	0	429
2010	WC	84	0	0	13	0	57	0	161
2011	WC	74	0	0	0	0	516	0	0

Tivela stultorum

Tivela stultorum have only been sampled at Southeast Anchorage (generally between N 33°58.809', W 120°00.696' and N 33°58.786', W 120°00.558'), and were previously sampled last in 1999. Sampling in the surf zone requires both wind and surf to be calm and at least moderately-clear (approx. 10') visibility. It is also very physically demanding to conduct the surveys.

Two snorkelers conducted a 30-minute haphazard search for clam siphons in 2009 finding a total of 23 *T. stoultorum.* In 2010, two snorkelers conducted a reconnaissance survey to locate the general location of the population. Then, starting at the east end of the cove, a 30-minute survey consisting of perpendicular transects swum alternating away from shore then back was implemented. Siphons were counted within a one-meter swath; 15 *T. stultorum* siphons were seen. Starting in the surf zone, transects were swum offshore approximately 50 m to where siphons were no longer seen, usually to a depth of about 15 to 20 ft. The next set of transects were swum inshore after moving about 10-20 m west. A total of 60 siphons were counted. The siphon counts are given in Table 6. Note that even though divers were side by side, counts were representative of separate areas.

Table 6. Number of *Tivela stultorum* siphons observed on 50m transects in 2010**.**

Divers/ transect number	***1***	***2***	***3***	***4***	***5***	***6***
1	6	5	0	4	4	6
2	2	6	4	5	9	9

Other species seen were *Cancer gracilis, Loxorhyncus crispatus,* and *Olivella biplicata*. Two half shells from *T. stultorum* (could have belonged to same animal) were found on the first beach. Only a few clams were examined. One was approximately 60 mm and another was about 160 mm, so the population included a broad range of sizes even based on a small sample. None of the shells observed were marked.

In 2011, we had very good conditions and in addition to conducting subtidal (snorkel) transects, we collected *Tivela stultorum* for size measurements and marking on two days. All clams were measured and marked with two parallel grooves on the right valve. A total of 38 clams were marked. Sizes ranged from 73mm to 151mm (Figure 8). Based on the rings evident on the shells we examined, most ages were estimated to be in the 10-12 year old range. An 82mm clam had fairly distinct bands and appeared to be 6 years old. Three clams had the sunset patterned shells. The sunset pattern is a natural color variation of note. None of the live clams or shells found had markings from previous surveys. The last time marking was done in 1999. Four *T stultorum* shells were found (three complete, one single valve) (sizes 125, 127, 142, & 146mm). We saw a total of 81 siphons in the subtidal transects (from 0-13 per 100m transect) (Table 7).

Table 7. Number of *Tivela stultorum* siphons observed on 100m transects in 2011

Divers/ transect number	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
1	3	2	0	8	12	13	13	0
2	4	4	1	1	2	11	5	2

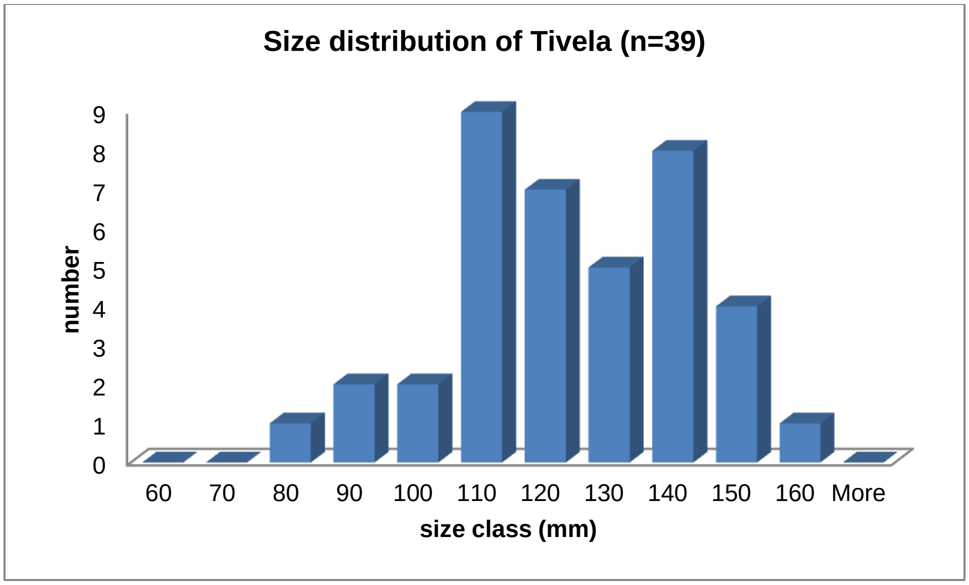

Figure 8. Size distribution of *Tivela stultorum* in 2011.

Other organisms seen during the subtidal surveys in 2011 were *Dendraster exogyris*, *Cancer gracilis*, *Heterocrypta oxidentalis*, *Loxorhyncus crispatus*, *Blepharipoda occidentalis*, *Olivella biplicata*, *Platyrhinoides triseriata*, and *Cibidichthys* sp. juveniles. *C. gracilis* seemed to be more common than we have seen before with densities approaching 1/m^2 in some areas. Most crabs were small (< 10mm carapace length).

In 2012, two divers swam 100m transects perpendicular to shore. Each diver counted 1-18 siphons per transect for a total of 132 clams (Table 8). We also counted *Cancer gracilis*, finding 0-4 crabs per transect and a total of 31 (Table 8). Note that even though divers were side by side, counts are representative of separate areas.

Table 8. Number of *Tivela stultorum* siphons and *Cancer gracilis* observed on 100m transects in 2012

Divers/ transect number	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
1 (*T. stultorum*)	2	1	2	10	15	10	11	11
2 (*T. stultorum*)	3	4	2	9	12	17	18	5
1 (*C. gracilis*)	2	4	0	2	0	3	2	4
2. (*C. gracilis)*	2	1	3	1	4	1	0	2

Macrophyte Wrack transects

The number of organisms on the upper beaches is directly correlated with vegetative matter on the beach. Amphipods and isopods break down the wrack and tend to concentrate under accumulations of debris. Beetles and other predators then hunt for amphipods. Algae and surfgrass tend to be cast on to the beaches episodically related to storm events (Figure 9). Wrack often persists for months and it typically accumulates to some degree throughout the year.

Some beaches, particularly south-facing, are used by elephant seals for at least half the year. Seals undergo a catastrophic molt on shore in spring, and the result is an accumulation of shed fur in the sand (Figure 10). At China Camp this could be significant as there is little other organic matter on that beach. Macrophyte transects only measure what is on the surface however, and the fur tends to be buried or it blows away. We have not observed organisms feeding on the fur. There are also numerous dead pups and fecal material adding to the organic matter on beaches used by seals.

Mean percentages of wrack on surveyed beaches are presented in Tables 9-13. Cover ranged from 1 to 93%. Water Canyon is usually swept clean by the high tide which reaches up to the cliff and very little material is deposited there. China Camp, Bee Rock, and Abalone rocks also had little wrack deposition. Ford Point is a narrow reflective beach that is mostly swept clean by the tides. Bechers Pier was sampled near the end of the beach where large piles of algal wrack had accumulated. Soledad West and Sandy Point both accumulate a large amount of wrack from the kelp beds offshore and consistently have high cover of wrack. At points with no wrack, the substrate type and presence of tar were recorded. Height of the wrack was also recorded. Wrack height was correlated with the amount of wrack. Annual macrophyte wrack composition over time is graphically displayed in Appendix F.

Table 9. Macrophyte wrack percent cover summary 2007. See table 1 for site names and codes.

2007	Carrion	Egregia	Macrocystis	Phyllospadix	Terrestrial	Tar	Total cover	Average height (cm)
CC	0.3	0.3	1.3	3.0	0	0.3	5.2	1.1
SW	0.3	1	33.7	26	0.3	0.3	61.6	5

Table 10. Macrophyte wrack percent cover summary 2009. See table 1 for site names and codes.

2009	Carrion	Egregia	Macrocystis	Phyllospadix	Terrestrial	Tar	Total cover	Average height (cm)
AR	0	0	0.7	2.7	0	0	3.4	1.3
CC	0	0	4.3	1.3	1	0	6.6	2
SW	0	3	16.3	10	1.7	0	31	5.3
WC	0	0	1	0	0	0	1	1.2

Table 11. Macrophyte wrack percent cover summary 2010. See table 1 for site names and codes.

2010	Carrion	Unid. algae	Brown algae	Egregia	Green algae	Macro-cystis	Phyllo-spadix	Red algae	Terrestrial	tar	Total cover	Average height (cm)
AR	0	0	0	0	1	1	11	0.3	0.3	0	13.6	2.2
BB	0	0	2	2.3	23	21.7	25.3	18.7	0.3	0	93.3	3.6
BR	0	0	0	0	0	1.3	8	1	0	0	10.3	1
CC	0	0	0	0	0	0.7	1.7	0	0	0	2.4	1
SP	1	0.3	0	2.7	0.3	33.3	18.7	3.7	0.7	0.3	61	6.7
SW	0	0	0	0.7	0	12.3	11.3	0.3	1	0	25.6	2.9
WC	0	0	0	0.3	0.3	0.7	0	1.3	0.3	0	2.9	1

Table 12. Macrophyte wrack percent cover summary 2011. See table 1 for site names and codes.

2011	Brown algae	Egregia	Green algae	Macro-cystis	Phyllo-spadix	Red algae	Terrestrial	tar	Total cover	Average height (cm)
AR	0	0	0	0.3	3.3	0	0	0	4	1
BB	0	0	3.0	0	32.3	2.7	0	0	38	1.4
BR	0	0	0	1.0	5.7	0	0	0	7	2.1
CC	0.3	0	0	4.3	1.3	0	0.7	0	7	1.6
FP	0	0	0	4.7	4.7	0	0.3	0	10	1.9
SE	0	0	0	1.7	3.7	0	0	0	5	1.3
SP	0.3	0.3	0	15.7	4.7	0.3	0.3	0	22	2.1
SW	0.7	0.7	0	18.0	22.3	0	0	0	42	2.7
WC	0	0	0.3	1.3	0.3	0	0	0	2	2.3

Table 13. Macrophyte wrack percent cover summary 2012. See table 1 for site names and codes.

2012	Carrion	Brown algae	Egregia	Green algae	Macro-cystis	Phyllo-spadix	Red algae	Terrestrial	Zostera	total	Avg. height (cm)
AR	1	0	2	2	4	61	1	1	9	81	1.82
BB	0	0	2	15	18	92	14	7	3	151	1.02
CC	0	3	0	0	10	22	2	0	1	38	1.02
SP	2	3	1	0	79	88	1	1	1	176	1.70
SW	1	1	0	0	88	125	1	2	0	218	1.46

Figure 9. Macrophyte wrack on Sandy Point, August 2011. The majority of the wrack is *Macrocystis pyrifera*. Fresh wrack piled up on the lower beach tends to be where most of the invertebrate activity is. Dried wrack is partially buried on the upper beach.

Figure 10. Patches of elephant seal fur accumulate on sand dune at China camp during the molt, 2009**.**

Shorebirds

Shorebirds, seabirds and pinnipeds observed during beach surveys are reported in Tables 14-18. The maximum number of shorebirds was usually seen at arrival to a beach but some shorebirds occasionally fly in during sampling. Often in the summer, no birds or pinnipeds are present on beaches. Shorebird counts during the summer monitoring are typically low. Additional counts were made opportunistically on major beaches throughout the year during the Beachwalk surveys. Summaries of those counts are given in Appendix E.

Seabirds such as pelicans or cormorants typically use the beaches solely for roosting. Gulls may feed on debris or carrion or simply roost on the beach. Shorebirds and terrestrial songbirds were often observed feeding on sand crabs or catching flies. Ravens were common on many of the beaches, scavenging for debris and carrion. Eagles and ospreys were most often seen flying or roosting on the cliffs behind beaches when hunting nearshore. Mallards and wading birds were often seen resting near a lagoon. Mallards sometimes nest by the lagoons. Shorebirds were commonly observed feeding on flies at the lagoons (Figure 11).

The coastal form of the western snowy plover is listed as threatened. We monitor snowy plovers during the survey windows for the Western Snowy Plover Recovery Unit 5 (usually during the middle of January and the last week of May). Because the counts are done during the same week throughout southern California, we typically rely on the assistance of the San Miguel Island ranger or fox technician to conduct the counts on San Miguel Island. Surveys on San Miguel were typically only done on Simonton Cove and Cuyler Harbor beaches because of pinniped occupation. In recent years, elephant seals have increased their use of Cuyler Harbor, making it difficult to survey there as well. Unfortunately we cannot consult the weather forecast months in advance when the dates are chosen, and all too often we often ended up with high winds or rain during the sampling period preventing counts on some beaches. Also increasing numbers of elephant seals and California sea lions are making access difficult to some beaches. On San Miguel Island we relied on National Marine Fisheries Service biologists to conduct the counts at Point Bennett because of the sensitive nature of the pinniped colony. We occasionally got reports of plover numbers at Cardwell or the southeast beaches from the San Miguel biologists, but pinnipeds generally prevented access to those beaches.

Numbers of both wintering and breeding western snowy plovers have declined since the 1990's. The lowest wintering bird count was in 2008 with only 184 birds counted (Table 19). Winter survey counts have been over 200 since 2010. Santa Rosa Island is one of the most important wintering areas for western snowy plovers on the California coast. Winter counts averaged about 300 snowy plovers in the early 1990's (Martin and Sydeman 1998). For various reasons, such as rain or high winds, we are not always able to survey every beach, but most birds have been at the Skunk Point area beaches and occasionally the south west beaches (China Camp to Bee Rocks) and every effort is made to count these beaches if possible.

Breeding snowy plovers have declined precipitously in the last decade and again the lowest count was recorded in 2008 (Table 22). The highest count in the last five years was 11 in 2011.

Comparatively, 121 adult western snowy plovers were counted on Santa Rosa Island in May 1993 (Martin and Sydeman 1998). Chicks were seen in both 2011 and 2012.

To minimize disturbance we do not monitor nests or chicks and therefore cannot say anything about productivity. Western snowy plovers are subject to several vertebrate predators including ravens, skunks, foxes, and possibly gulls (Stein 1993). The latter two are probably more opportunistic predators when they stumble upon nests (Wehtje and Baron 1993). Ravens are abundant on the island and numbers may be artificially high as a result of availability of carcasses from ranching and hunt operations on Santa Rosa Island. Deer and elk were removed from the island in December 2011. Spotted skunk numbers may have increased during the decline of island foxes. All fox on Santa Rosa Island were in captivity between 2000 and 2003. Skunk numbers were not monitored before 2008; however, they were seen more frequently during the years of fox absence and tracks appeared to be more common on the beaches during that time. The 2011 skunk population on Santa Rosa Island is estimated at over 3,000 island-wide (14.7/km^2). There may have been over 4000 skunks on the island during the absence of foxes. The Santa Rosa Island fox population is estimated to be 449 in 2011. Skunks do not occur on San Miguel Island and the fox population there numbers about 581 foxes (Coonan and Guglielmino 2012). Abiotic factors such as wind and flooding may also impact nesting success on the island. Skunk Point is the main area for breeding activity. The beach is subject to frequent overwash by high surf. High winds averaging 20 mph or more and gusting to 50 mph are common in the spring. Stein (1993) documented 22-35% nest loss due to wind.

The elephant seal population has grown significantly on Santa Rosa Island since the early 1990s when the first pups were born on the island. Most of the south side beaches are occupied by elephant seals during the pupping season in the winter months. A small number of pups have been born on some east side beaches since 2010 and solitary males have been seen on Skunk Point, though no breeding has occurred there yet. Elephant seals return to the beaches in the spring and early summer months to molt and while not as abundant or active as in the winter, their presence may still limit beach space available to western snowy plovers attempting to breed.

In order to minimize disturbance to nesting birds, the Skunk Point area was closed to visitation in the mid-1990s. Visitors do occasionally trespass to surf or hike around the point. In 2012, the park amended the rules allowing visitors access to the beach below the high tide line. The area open to access is limited to the wet sand. There is no signage or fencing indicating closed or open areas.

Figure 11. Sandpipers in upper Old Ranch House Canyon Lagoon.

Table 14. 2007 Shorebird counts. Maximum number seen at any time during sampling. (*=in general area)

Year	SiteCode	Site Name	Common Name	Count
2007	BB	Becher's Pier	Killdeer	3
2007	WC	Water Canyon	Black Oystercatcher	4
2007	WC	Water Canyon	Common Raven	1
2007	WC	Water Canyon	Herrmann's Gull	13
2007	WC	Water Canyon	Osprey*	1
2007	WC	Water Canyon	Western Gull	1
2007	SW	Soledad West	Killdeer	1

Table 15. 2009 Shorebird counts. Maximum number seen at any time during sampling. (*=in general area)

Year	SiteCode	Site Name	Common Name	Count
2009	AR	Abalone Rocks	Black Oystercatcher	1
2009	SE	Southeast Anchorage	Pigeon Guillemot*	6
2009	SE	Southeast Anchorage	Black Oystercatcher	3
2009	SE	Southeast Anchorage	Herrmann's Gull	6
2009	SW	Soledad West	Western Gull	0
2009	SW	Soledad West	Herrmann's Gull	0
2009	CC	China Camp	Western Gull	1
2009	CC	China Camp	California sea lion	1
2009	CC	China Camp	Elephant Seal	2
2009	CC	China Camp	Snowy Plover	8
2009	OR	Old Ranch	Mallard	1
2009	OR	Old Ranch	Western Sandpiper	1
2009	WC	Water Canyon	Herrmann's Gull	6
2009	WC	Water Canyon	Western Gull	2
2009	WC	Water Canyon	Common Raven	2
2009	WC	Water Canyon	Harbor Seal*	1

Table 16. 2010 Shorebird counts. Maximum number seen at any time during sampling. (*=in general area)

Year	SiteCode	Site Name	Common Name	Count
2010	BB	Becher's Pier	Least Sandpiper	1
2010	BR	Bee Rock	Snowy Plover	1
2010	BR	Bee Rock	Western Gull	4
2010	BR	Bee Rock	Western Sandpiper	1
2010	CC	China Camp	Bald Eagle*	1
2010	CC	China Camp	Black Oystercatcher	6
2010	CC	China Camp	Common Raven	3
2010	CC	China Camp	Elephant Seal	48
2010	CC	China Camp	Western Gull	4
2010	OR	Old Ranch Lagoon	Least Sandpiper	2
2010	OR	Old Ranch Lagoon	Marbled Godwit	1
2010	OR	Old Ranch Lagoon	Mallard	5
2010	OR	Old Ranch Lagoon	sandpiper	20
2010	OR	Old Ranch Lagoon	Snowy Plover	5
2010	OR	Old Ranch Lagoon	Western Gull	5
2010	OR	Old Ranch Lagoon	Western Sandpiper	6
2010	ORH	Old ranch House Lagoon	sandpiper	9
2010	ORH	Old ranch House Lagoon	Semi-palmated plover	1
2010	SE	Southeast Anchorage	Black Oystercatcher	23
2010	SE	Southeast Anchorage	Common Raven	4
2010	SE	Southeast Anchorage	Western Gull	5
2010	SP	Sandy Point	Black Oystercatcher	3
2010	SP	Sandy Point	Western Gull	3
2010	SW	Soledad West	Common Raven	1
2010	SW	Soledad West	Western Gull	2
2010	WC	Water Canyon	Brown Pelican	5
2010	WC	Water Canyon	Herrmann's Gull	20
2010	WC	Water Canyon	Western Gull	50

Table 17. 2011 Shorebird counts. Maximum number seen at any time during sampling**.**

Year	SiteCode	Site Name	Common Name	Count
2011	AR	Abalone Rocks	Common Raven	2
2011	AR	Abalone Rocks	Black Oystercatcher	4
2011	AR	Abalone Rocks	Ring-billed Gull	1
2011	AR	Abalone Rocks	Western Gull	1
2011	SP	Sandy Point	Herrmann's Gull	2
2011	SP	Sandy Point	Whimbrel	2
2011	SP	Sandy Point	Black Oystercatcher	3
2011	SP	Sandy Point	Common Raven	11
2011	SP	Sandy Point	Western Gull	2
2011	CC	China Camp	Western Gull	3
2011	FP	Ford Point	Common Raven	2
2011	SE	Southeast Anchorage	Western Gull	3
2011	SW	Soledad West	Common Raven	2
2011	SW	Soledad West	Western Gull	6
2011	BB	Becher's Pier	Song Sparrows	5
2011	BB	Becher's Pier	Common Raven	1
2011	BB	Becher's Pier	Spotted Sandpiper	1
2011	BB	Becher's Pier	Killdeer	1
2011	ORH	Old Ranch House Lagoon	Mallard duck	26
2011	ORH	Old Ranch House Lagoon	Sandpiper	10
2011	ORH	Old Ranch House Lagoon	Great Blue Heron	1
2011	ORH	Old Ranch House Lagoon	Killdeer	2
2011	ORH	Old Ranch House Lagoon	Lesser yellowlegs	2
2011	ORH	Old Ranch House Lagoon	Common raven	1

Table 18. 2012 Shorebird counts. Maximum number seen at any time during sampling.

Year	*SiteCode*	*Site Name*	*Common Name*	*Count*
2012	SP	Sandy Point	Whimbrel	4
2012	SP	Sandy Point	Common Raven	3
2012	SP	Sandy Point	Gulls (generic)	3
2012	SP	Sandy Point	Black Oystercatcher	5
2012	SW	Soledad West	Common Raven	15
2012	SW	Soledad West	Black Oystercatcher	1
2012	SW	Soledad West	Gulls (generic)	2
2012	BB	Becher's Pier	Song Sparrow	1
2012	BB	Becher's Pier	Gulls (generic)	2
2012	BB	Becher's Pier	Killdeer	1
2012	CC	China Camp	Elephant Seal	3
2012	CC	China Camp	Harbor Seal	1
2012	CC	China Camp	Bald Eagle	1
2012	ORH	Old Ranch House Lagoon	Mallard duck	4
2012	ORH	Old Ranch House Lagoon	Sandpiper	2

Table 19. Snowy Plover winter survey window counts by beach, 2005-2012.

Santa Rosa Island	***Jan 2005***	***Jan 2006***	***Jan 2007***	***Jan 2008***	***Jan 2009***	***Jan 2010***	***Feb 2011***	***Jan 2012***
Southeast Anchorage		17	6	0	0	0	0	0
Skunk Pt. (main)		120	29	73	92(140*)	205	203	63
Skunk Pt. South		0	2	2	4	0	0	139
Oat Point		0	2	0	0	0	0	0
Old Ranch		0	9	0	0	0	0	0
Abalone Rocks		0	0	0	0	0	0	0
Ford Point		0	0			nc	nc	0
Jolla Vieja		nc	0	0		nc	nc	0
Officers Beach		nc	0			nc	nc	0
China Camp		0	0	0	43	0	0	nc
Cluster Point		0	0	0	0	0	0	nc
Whetstone Canyon		0	70	0	0	0	0	nc
Noname Canyon		0	0	109	0	0	0	nc
Bee Rocks (all)		81	98	0	48	29	nc	nc
Mud Tank		0	1		7	8	nc	nc
Sandy Point		0	0		0	nc	nc	nc
Tecalote		nc	0		0	nc	nc	nc
Arlington		0	0		0	nc	nc	nc
Soledad		0	0		0	nc	nc	nc
Water Canyon		0	0			nc	0	nc
Santa Rosa total		**218**	**217**	**184**	**194**	**242**	**203**	**202**
San Miguel Island								
Cardwell Point		0			20	nc	nc	nc
Southeast Beaches		nc			nc	nc	nc	nc
Point Bennett		nc			18	nc	nc	nc
Simonton Cove	2	0			0	nc	nc	0
Cuyler Harbor	0	2				nc	nc	7

nc= not counted (some beaches could not be counted due to high winds or inaccessible roads)

*Skunk Point was recounted in Jan. 2009. The first count was reported as the official count.

Table 20. Snowy Plover breeding survey window counts by beach, 2005-2012.

Santa Rosa Island	***May 2005***	***May 2006***	***May 2007***	***May 2008***	***May 2009***	***June 2010***	***June 2011***	***May 2012***
Southeast Anchorage	0	1	0	0		0	0	0
Skunk Pt. (main)	15	2	13	0	6	2	10	2
Skunk Pt. South	20	0	0	5^		4	0	6
Oat Point	nc	4	0	0		2	1	1
Old Ranch	nc	12	0	0	3	0	0	0
Abalone Rocks	0	nc	0	0		0	0	0
Ford Point	nc	nc	nc	0	0	nc	0	0
Jolla Vieja	nc	nc	nc	nc		0	0	0
Officers Beach	0	nc	nc	nc	0	0	0	0
China Camp	0	nc	0	0	0	0	nc	0
Cluster Point	0	nc	0	0	0	0	nc	0
Whetstone Canyon	0	nc	2	0	0	0	nc	0
Noname Canyon	0	nc	0	0	0	0	nc	0
Bee Rocks (all)	2	nc	0	0	0	0	nc	0
Mud Tank	nc	nc	nc	nc	0	0	nc	0
Sandy Point	0	nc	nc	nc		nc	nc	nc
Tecalote	nc	0	0	nc	0	0	0	0
Arlington	nc	0	0	nc	0	0	0	0
Soledad	0	0	0	nc	0	0	0	0
Water Cyn	0	nc	nc	nc	0	0	nc	nc
Santa Rosa total	**37**	**19**	**15**	**5**	**9**	**8**	**11**	**9**
San Miguel Island								
Simonton Cove	0	nc	0	nc	nc	nc	0	0
Cuyler Harbor	0	nc	0	nc	nc	nc	0	nc

nc= not counted (some beaches could not be counted due to high winds or inaccessible roads)

^=8 western snowy plovers found in June 2008

Lagoon Observations

Coastal lagoons form mostly at the mouths of creeks. Often when stream flow is low, a berm will form, closing off the stream from the ocean and water will back up forming the lagoon. There may be some tidal influence if the stream mouth is open or there may be overwash during high tides when waves wash over the berm creating brackish water in the lagoon. If evaporation exceeds freshwater input, the lagoon can become hypersaline with salinity exceeding the oceans. Coastal wetlands tend to be productive habitat with highly diverse biologic communities. Coastal wetlands are also important bird habitat. The two largest wetlands on Santa Rosa Island are Old Ranch House Canyon and Old Ranch Canyon. Small wetlands also occur at the mouths of Jolla Vieja, Lobo, Green, Dry, Soledad, Arlington, and Tecalote Canyons. The Lobo and Dry Canyon lagoons may be mostly sea water. All of the wetlands tend to be variable from year to year but they may have become more stable since the cattle were removed from the island in 1996. One recommendation for the program would be expanding the lagoon monitoring to include some of these other wetlands; particularly Jolla Vieja, and Arlington Canyons.

Oat Point Lagoon does not have direct stream input, but water typically accumulates there from rain and groundwater seepage. There is also occasional overwash during storms or high tides. Oat Point often dries up during the summer and was too dry for sampling in each of the years of this report (Figure 12). In 2011, however there was a little water present which we measured at 22.5°C with salinity over 200 parts per thousand (ppt).

Temperature and salinity were measured at stations with enough water for surface and 10 cm depth readings (Appendix C). Lagoon measurements were not taken in 2007. The lowest temperatures and salinities were measured in 2011 which experienced more rain than normal. The waters were hypersaline in all samples in 2009 and 2010 and both the highest temperatures and salinities were measured in August 2010. Water temperatures ranged from 19°-30°C, and salinities from 8-46 ppt in Old Ranch Canyon. At Old Ranch House Canyon water temperature ranged from 19°-41°C and salinity from 1-72 ppt. All three lagoons experience some overwash during high tides and without enough ground water flowing into the lagoon, evaporation will create hypersaline conditions. Freshwater tends to sit on the heavier salt water and there is little mixing in these wind protected lagoons. Sometimes there were marked differences at one station between the surface conditions and 10cm depth (Appendix. C). Short distances between stations can also result in dramatic differences in salinity and temperature.

Typical vegetation around each of the lagoons was *Distichlis spicata*, *Jaumea* sp., *Salicornia* sp., and *Frankenia* sp. (Figure 13). The upper most station in Old Ranch Creek had *Typha* sp. along the shore. *Ruppia* sp. was common in the water at most stations. Brine flies, dragon flies and corixid beetles were present at most stations. Fish larvae could often be seen in the Old Ranch House Lagoon. Silversides, *Atherinops* spp., were occasionally seen and the larvae were most likely this species.

Birds commonly are found at the lagoons (Tables 14-18). The lagoons are close to each other and birds often fly back and forth from one lagoon to another. Mallard ducks have been observed with ducklings most years, but they have usually fledged by August. Four young mallards were seen in 2012.

Old Ranch Creek generally has at least a light flow of fresh water most of the year. High tides send sea water into the lagoon and if the flow is too low to keep the mouth open, hypersaline conditions may occur as it did in 2009 and 2010. Old Ranch House Canyon does not have above ground stream input but it does get ground water at the upper reaches, particularly station 3 (Figure 14).

A better picture of the dynamics of these lagoons would be achieved with quarterly sampling as called for in the monitoring handbook, but island logistics make that impractical. Temperature and salinity loggers should be considered for a more complete picture of the lagoon dynamics.

Figure 12. Oat Point Lagoon in 2011. The hypersaline water had almost all evaporated by August.

Figure 13. Old Ranch Canyon Lagoon, looking east towards mouth from station 2. *Distichlis, Frankenia* and *Salicornia* are the dominant vegetation.

Figure 14. Andrew Domingos sampling salinity at station 5 of Old Ranch House Canyon Lagoon. *Ruppia* sp. form the vegetative mats in the water.

Beachwalk surveys

Beachwalk surveys originated to provide information on where and on what bald eagles might be feeding on at the islands (Richards and Rich 2004). The surveys also include numbers and distribution of live shorebirds and pinnipeds through the year. This information can alert park management to mortality events and will serve as important baseline data in the event of an oil spill or other perturbation. From 2006 to 2012, 107 Beachwalk surveys were conducted. A total of 418 carcasses were found. Of those, 218 were pinnipeds and 159 were birds. The numbers of carcasses found on beachwalk surveys between 2006 and 2012 are presented in Appendix D. Numbers of live birds and pinnipeds found in these surveys are in Appendix E.

In 2006 we conducted 21 beach surveys on Santa Rosa and San Miguel Islands with a total of 34 beached carcasses found. In 2007 we found 102 carcasses in 20 beach surveys. A total of 15 surveys were made in 2008 finding 30 carcasses. In 2009 we found 97 carcasses in 20 surveys. In 2010 and 2011 we did 14 and 10 surveys respectively, finding 41 and 93 carcasses respectively. In 2012 there were seven surveys with only 21 carcasses found. Of the 418 dead animals found, 16 had some degree of oil present on them (Appendix D). The amount of tar was usually low and in some cases the carcass may have picked up the tar as it washed up on the beach. Animals were identified to the lowest taxonomic level possible but only broad categories are given here. We found 42 double crested cormorants at Skunk Point in 2011. No cause for the deaths of this unusually large number of cormorants was determined. In 2010 we found numerous ocean sunfish (*Mola mola*) that had lost their fins. Sea lions are known to play with young molas and have been seen tearing fins off them. In

2010 there were a fair number of northern fulmar found on San Miguel Island but not an exceptional number for this species which flies in massive flocks. A blue whale with a fetal calf found on San Miguel in 2007 was determined to be a ship strike victim. In May 2007 there was an unusual number of California sea lions found. This was probably related to an outbreak of domoic acid.

Live animals were counted during the beach walks also. Over 15,000 animals were counted. Live animals are presented in Appendix E. Counts included the wetlands along the east side of Santa Rosa Island (included in the Skunk Point count) and small lagoons at the mouths of Arlington and Tecalote Canyons. Unique sightings included a tundra swan, black-necked stilts, and a brown booby. The numbers of shorebirds and pinnipeds were especially variable depending on the time of year. Elephant seals were the most common pinniped on beaches and were most common during the winter breeding and spring molt. Snowy plovers and other shorebirds were more common in winter months, while seabirds tended to be variable using the beaches just as roosts. Eagles and Gulls tended to be attracted to dead animals and elephant seal after births.

Summary by beaches

Southeast Anchorage is a narrow reflective beach backed by cliffs. Because waves often wash over the entire beach, wrack does not accumulate on the beach and the upper beach community tends to be depauperate. On the other hand the wash-zone and subtidal organisms seem to thrive and *Emerita analoga*, *Blepharipoda occidentalis*, *Olivella biplicata*, and *Tivela stultorum* are relatively common.

Abalone Rocks can be quite broad especially when surf washes over the beach into the lagoon. Low dunes back the beach and shorebirds tend to be fairly common on this protected beach in front of Old Ranch House Canyon Beach. *Phyllospadix* wrack accumulates on the beach and low hummocks of blowing sand may form behind the wrack. Numbers of organisms on this beach tend to be variable from year to year. The east exposure tends to keep surf action minimal on this beach.

Ford Point is a steep narrow beach and summer south swell creates a lot of energy on this beach. This cliff-backed beach typically attracts a number of elephant seals in both winter and summer. High tides cover most of the beach and debris does not accumulate there. Our samples there were some of the lowest abundance and diversity found on the island.

China Camp is wide and deep and backed by low dunes and cliff. Elephant seals are abundant in the winter, taking over the entire beach. Several hundred are typically present through the spring and early summer when they typically concentrate on the ends of the beach. Macrophyte wrack is uncommon, and as a result, the upper beach fauna is very poor. Marine debris is typically low as well. The swash zone is steep and receives high energy, which combined with the coarse sand, probably contributes to the *Emerita* population being fairly low. Snowy plovers are occasionally found on the beach but tend to be a little more common to the west on Cluster Point and Whetstone Beaches.

Bee Rock Beach is wide and flat and backed by dunes. The swash zone is more of a dissipative beach with typically low energy swash zone. Moderate numbers of infaunal organisms were present in the upper beach but the diversity was high. Snowy plovers often use the wrack hummocks on the foredune. Elephant seals are abundant in the winter but less so in the spring and summer.

Sandy Point faces the northwest, and as a result, a lot of macrophyte wrack and marine debris is deposited there. The abundance of wrack feeds a large population of amphipods and other upper beach organisms. The flat beach is somewhat dissipative but sections of the beach are narrow and backed by cliff. Sand movement is dynamic throughout the year. Elephant seals are often numerous at the north and south ends of the beach, but they tend not to use the middle beaches.

Soledad West is the longest beach in our sampling and is mostly dissipative. Though it faces north, the swash zone is very wide and flat. The large quantities of kelp wrack support a large population of amphipods, isopods, and beetles. Debris tends to accumulate on the north side beaches at Soledad and Arlington Canyons and lobster traps and floats are noticeably abundant. Though the habitat seems like good snowy plover habitat, no plovers have been seen there in many years. Elephant seals have not been seen at this beach and are uncommon on the north shore in general.

Bechers Pier Beach is a shallow beach backed by cliff. Except at the north end the reflective beach accumulates very little debris and is typically scoured by the high tide surf. A new pier was built over several years (2006-2011) but did not appear to have any impact on the beach community. The beach is very dynamic in the winter when large swells pound the beach.

Water Canyon Beach is a reflective beach backed by cliffs. Gravel tends to be common in the sand matrix as well. The upper beach is typically swept clean on high tides. No wrack accumulates and the upper beach has very low numbers of organisms.

Recommendations

Many birds, fish and even terrestrial animals depend on the invertebrates found in the sand beach habitat. Changes are occurring in the beach use by pinnipeds as the populations of northern elephant seals and California sea lions expand. Global climate change is likely to have significant impacts on this habitat through changes in temperature, pH, and sea level change. Monitoring sand beach communities is important for understanding the dynamics of this rich and diverse marine habitat. This long-term data set, even with the gaps, is invaluable for establishing baseline conditions in natural resource damage assessment, but it should continue to be done and it can be much better.

A lack of committed funds and a lower priority for this sampling has led to the beach and lagoon monitoring program being something of an add-on program that rarely gets completed at all beaches. The current protocol requires a minimum of 10 days of field time just for the beach and lagoon sampling on Santa Rosa Island. With current transportation schedules, this either requires scheduling two tours on the island or making use of scheduled Island Packers trips to extend a tour extra days. Sand beach monitoring should be more formally and closely tied to the rocky intertidal monitoring. Additional support for this monitoring is needed however for both field work and data analysis and reporting. Because of the equipment needs and physical requirements of sampling, a crew of four is needed. Half the crew are typically volunteers but two trained biologists are needed for species identification and sand crab sex and egg age determination.

Pismo clams are only known from two locations at the Channel Islands. These small populations are close enough that there may be direct gamete exchange and this is something that should be studied through genetic studies. Additional Pismo clam surveys should be done to determine population size and health. At least two samples spaced a month or more apart are desirable for mark-recapture population estimates. Though annual surveys are desirable, the population is fairly stable and surveys could be done on longer cycle (preferably every 2-3 years) unless change is suspected (e.g. large storm events or El Niño). The biggest challenge for sampling clams is that clear, calm water is required for good surveys.

The ideal sand beach program would include monitoring beaches on San Miguel and Santa Cruz Islands as well. Even periodic (5-10 years) sampling on those islands may help managers relate those beaches to the dynamics on Santa Rosa allowing the use of Santa Rosa Island beaches as sentinels for the rest of the park. As a trade-off, there may be beaches that could be dropped or only sampled periodically.

To fully understand the dynamics of the lagoons, multiple samples of the physical parameters is desirable. The use of remote data loggers should be considered for the lagoon temperature and salinity monitoring. Water depth at select locations would also be desirable. Some research and design testing is needed, however to determine the best locations and methods of placement for the loggers. Flash floods can occur in the streams in winter causing loss of equipment and changes in the stream channel. Additional lagoons should also be considered for monitoring, particularly the larger wetlands at Arlington and Jolla Vieja, as those two are fairly permanent lagoons.

The biologic (species checklist) sampling of the lagoons has been rarely completed as it requires some additional sampling gear and extra time and expertise. Taxonomic expertise in beach and lagoon fauna is not common among most rocky intertidal marine biologists. Increasing the profile of this program and obtaining training from experts is needed to elevate this program to where it should be. Voucher specimens and genetic samples should be collected from at least the different islands and preferably each of the beaches.

Documenting tar abundance is something that should be considered for baseline data. Several methods are used to describe tar abundance in the Shoreline Cleanup Assessment Team standards (OSPR). The number of tar balls in a swath of beach is one standard (depending on density the swath can be 10-100m). Estimating the area covered deals with the problem of variable sized tar balls but can be somewhat subjective. There are guides to estimating the abundance available but the percent cover we generally see is quite low. Another method might be to collect and weigh the tar found in a small swath of beach. All of these abundance estimates would benefit from replication.

Beachwalk surveys should continue at least ad hoc when intertidal biologists are doing rocky intertidal and sand beach monitoring. Volunteers could be trained to conduct the surveys but they must know how to avoid disturbing pinnipeds, identify shorebirds and determine the identity of carcasses. As stated previously, these surveys are important for early detection of mortality events and collecting baseline information on strandings, marine debris and oil.

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Appendix A: *Emerita Analoga* Population Dynamics

Size frequency and reproductive stage of *E. analoga* from wash zone transects and supplemental sample. Crabs were sorted in bucket sieves. In most cases only the first ten crabs in a bucket were determined for sex. Size is the corresponding carapace length to the hole size in the sieve buckets. All sizes were sampled but tables do not include sizes above which no crabs were found in the sample.

Table A-1. Percentage of reproductive females in population at all beaches

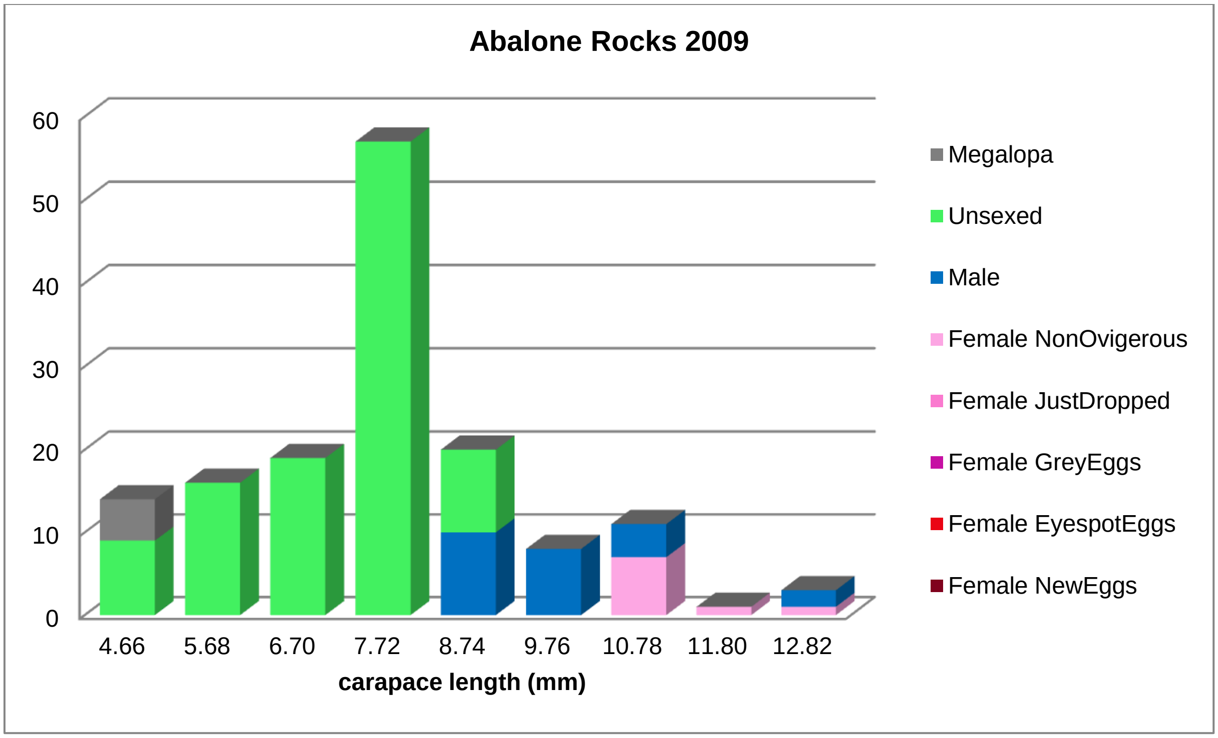
Year	Site Code	percent females ovigerous	percent females non ovigerous	percent females of total population
2007	BB	38	62	38
2007	CC	32	68	12
2007	SW	35	65	53
2007	WC	51	49	34
2009	AR	0	100	24
2009	CC	87	13	55
2009	SE	55	45	43
2009	SW	86	14	49
2009	WC	67	33	55
2010	AR	81	19	65
2010	BB	38	62	31
2010	BR	89	11	60
2010	CC	63	37	37
2010	SP	75	25	74
2010	SW	81	19	38
2010	WC	33	67	58
2011	AR	95	5	78
2011	BB	88	12	32
2011	BR	69	31	75
2011	CC	62	38	62
2011	FP	93	7	74
2011	SE	78	22	60
2011	SP	81	19	87
2011	SW	71	29	53
2011	WC	45	55	48
2012	AR	89	11	50
2012	BB	42	58	40
2012	CC	71	29	28
2012	SP	83	17	32
2012	SW	39	61	45

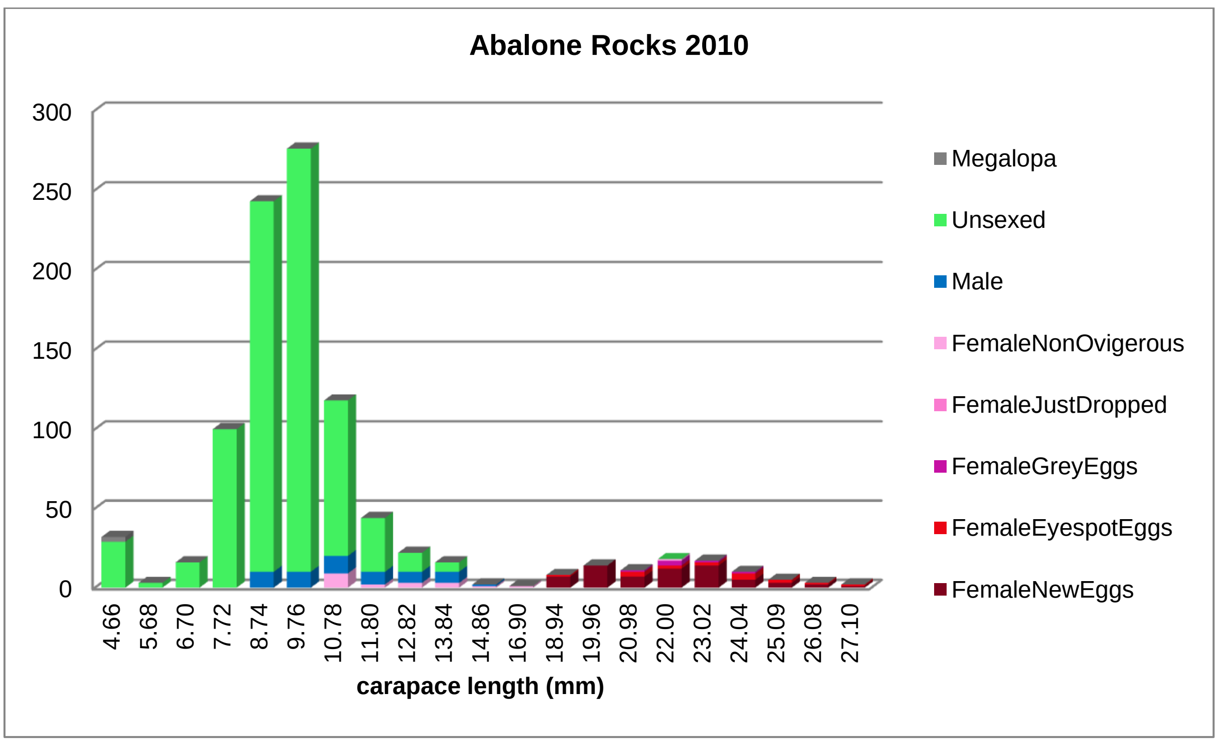
Table A-2.Reproductive status of *Emerita analoga* by size class at Abalone Rocks.

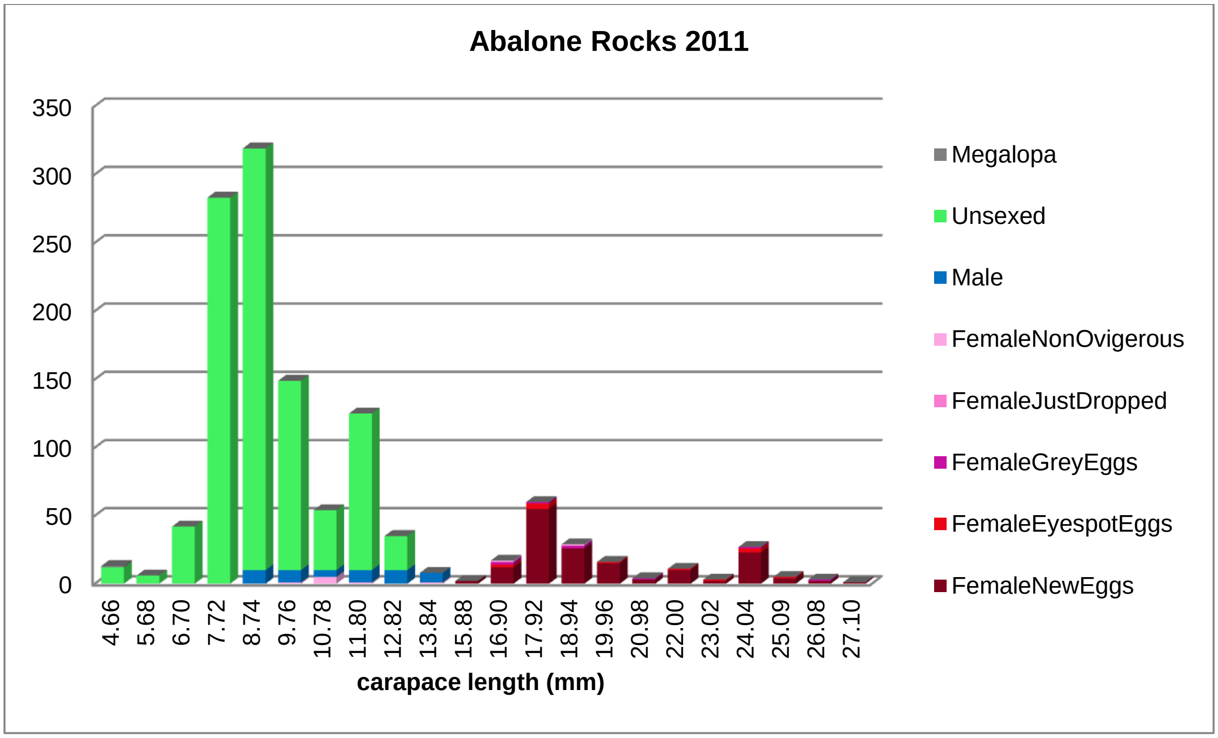
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non-Ovigerous	Male	Unsexed	Megalopa
2009	AR	4.66	0	0	0	0	0	0	9	5
2009	AR	5.68	0	0	0	0	0	0	16	0
2009	AR	6.70	0	0	0	0	0	0	19	0
2009	AR	7.72	0	0	0	0	0	0	57	0
2009	AR	8.74	0	0	0	0	0	10	10	0
2009	AR	9.76	0	0	0	0	0	8	0	0
2009	AR	10.78	0	0	0	0	7	4	0	0
2009	AR	11.80	0	0	0	0	1	0	0	0
2009	AR	12.82	0	0	0	0	1	2	0	0
2010	AR	4.66	0	0	0	0	0	0	29	3
2010	AR	5.68	0	0	0	0	0	0	3	0
2010	AR	6.70	0	0	0	0	0	0	16	0
2010	AR	7.72	0	0	0	0	0	0	100	0
2010	AR	8.74	0	0	0	0	0	10	233	0
2010	AR	9.76	0	0	0	0	0	10	266	0
2010	AR	10.78	0	0	0	0	9	11	98	0
2011	AR	4.66	0	0	0	0	0	0	12	1
2011	AR	5.68	0	0	0	0	0	0	6	0
2011	AR	6.70	0	0	0	0	0	0	42	0
2011	AR	7.72	0	0	0	0	0	0	283	0
2011	AR	8.74	0	0	0	0	0	10	309	0
2011	AR	9.76	0	0	0	0	1	9	139	0
2011	AR	10.78	0	0	0	0	5	5	44	0
2011	AR	11.80	0	0	0	0	1	9	115	0
2011	AR	12.82	0	0	0	0	0	10	25	0
2011	AR	13.84	0	0	0	0	1	7	0	0
2011	AR	15.88	2	0	0	0	0	0	0	0
2011	AR	16.90	12	2	2	0	1	0	0	0
2011	AR	17.92	55	4	1	0	0	0	0	0
2011	AR	18.94	26	0	2	0	1	0	0	0
2011	AR	19.96	15	1	0	0	0	0	0	0
2011	AR	20.98	3	0	1	0	0	0	0	0
2011	AR	22.00	10	1	0	0	0	0	0	0
2011	AR	23.02	2	1	0	0	0	0	0	0
2011	AR	24.04	23	3	1	0	0	0	0	0
2011	AR	25.09	4	1	0	0	0	0	0	0
2011	AR	26.08	2	0	1	0	0	0	0	0
2011	AR	27.10	1	0	0	0	0	0	0	0

Table A-2 (continued). Reproductive status of *Emerita analoga* by size class at Abalone Rocks.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non-Ovigerous	Male	Unsexed	Megalopa
2012	AR	6.70	0	0	0	0	0	0	22	0
2012	AR	7.72	0	0	0	0	0	0	174	0
2012	AR	8.74	0	0	0	0	0	10	171	0
2012	AR	9.76	0	0	0	0	0	10	124	0
2012	AR	10.78	0	0	0	0	2	8	23	0
2012	AR	11.80	0	0	0	0	1	9	49	0
2012	AR	12.82	0	0	0	0	1	17	0	0
2012	AR	13.84	0	0	0	0	0	1	0	0
2012	AR	14.86	3	1	0	0	0	0	0	0
2012	AR	15.88	3	1	0	1	0	0	0	0
2012	AR	16.90	7	5	1	0	0	0	0	0
2012	AR	17.92	7	0	0	1	2	0	0	0
2012	AR	18.94	1	0	0	0	0	0	0	0
2012	AR	20.98	3	0	0	0	0	0	0	0
2012	AR	22.00	7	0	1	0	0	0	0	0
2012	AR	23.02	2	0	0	0	0	0	0	0
2012	AR	24.04	2	0	0	0	0	0	0	0
2012	AR	25.09	1	0	0	0	0	0	0	0
2012	AR	27.10	3	0	0	0	0	0	0	0


Abalone Rocks 2009
60
50
40
30
20
10
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
carapace length (mm)
Megalopa
Unsexed
Male
Female NonOvigerous
Female JustDropped
Female GreyEggs
Female EyespotEggs
Female NewEggs


Abalone Rocks 2010
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
16.90
18.94
19.96
20.98
22.00
23.02
24.04
25.09
26.08
27.10
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Abalone Rocks 2011
350
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
15.88
16.90
17.92
18.94
19.96
20.98
22.00
23.02
24.04
25.09
26.08
27.10
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

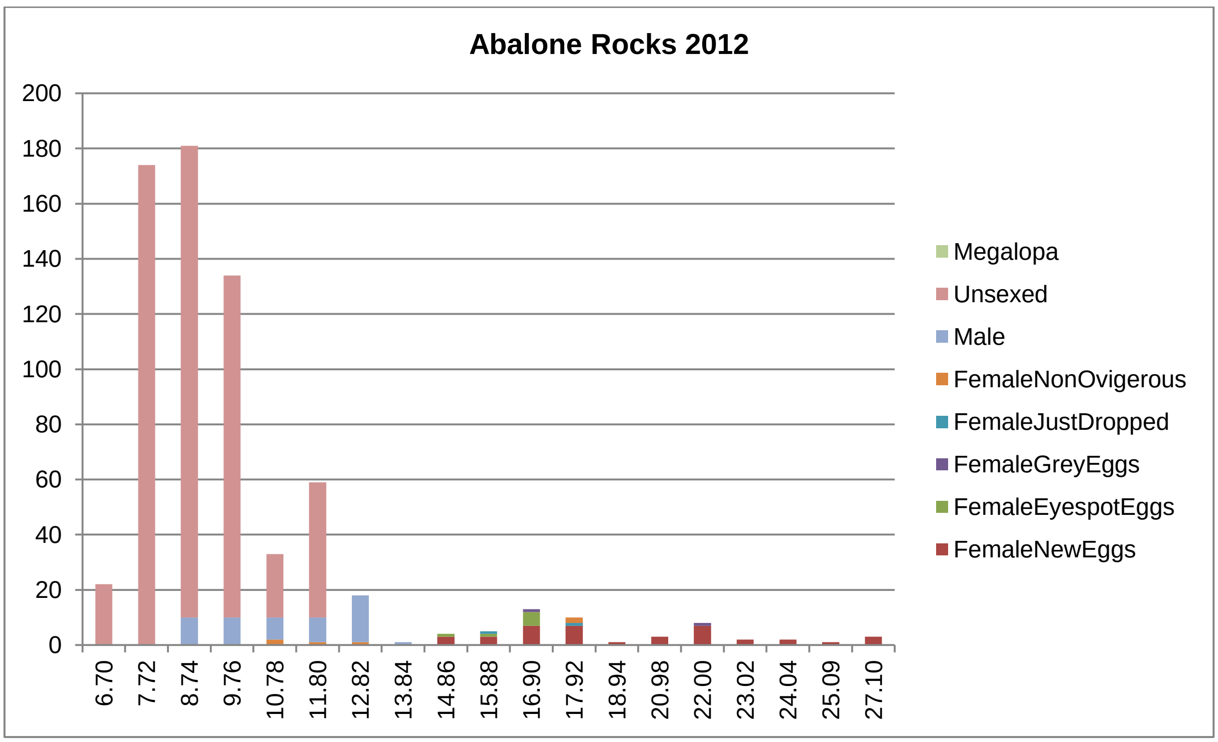
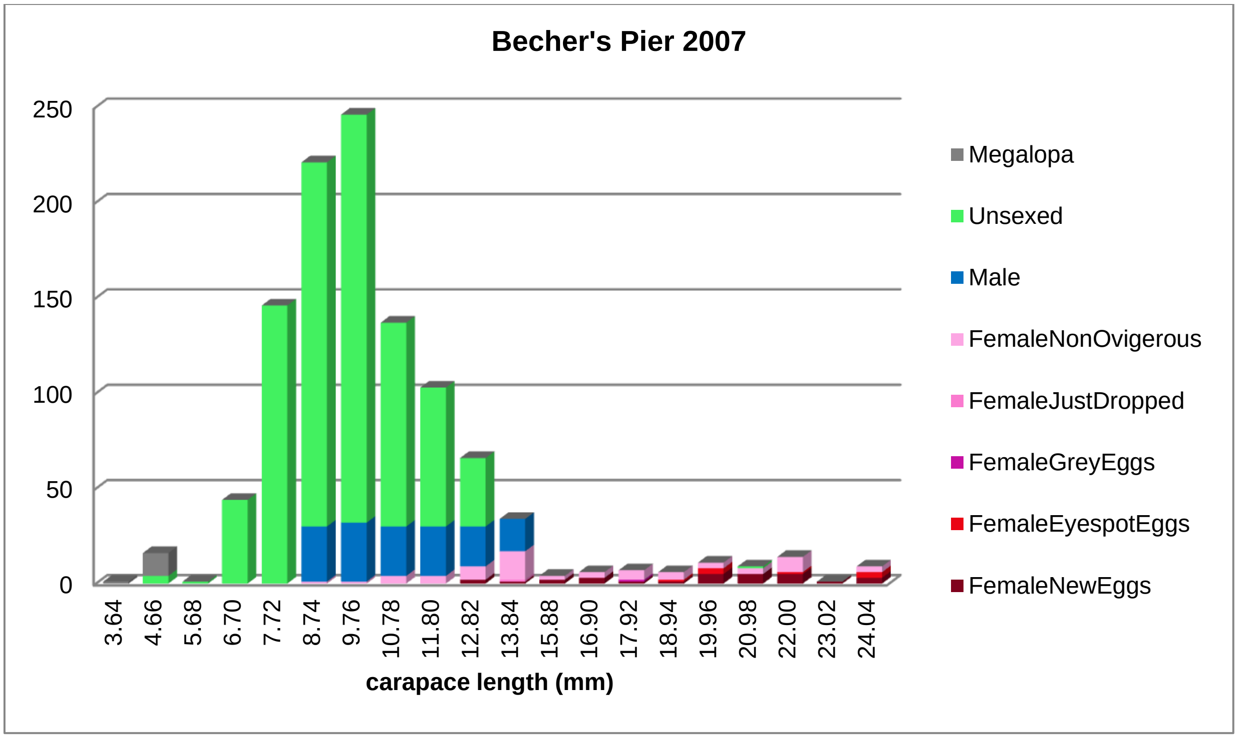

Abalone Rocks 2012
200
180
160
140
120
100
80
60
40
20
0
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
20.98
22.00
23.02
24.04
25.09
27.10
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

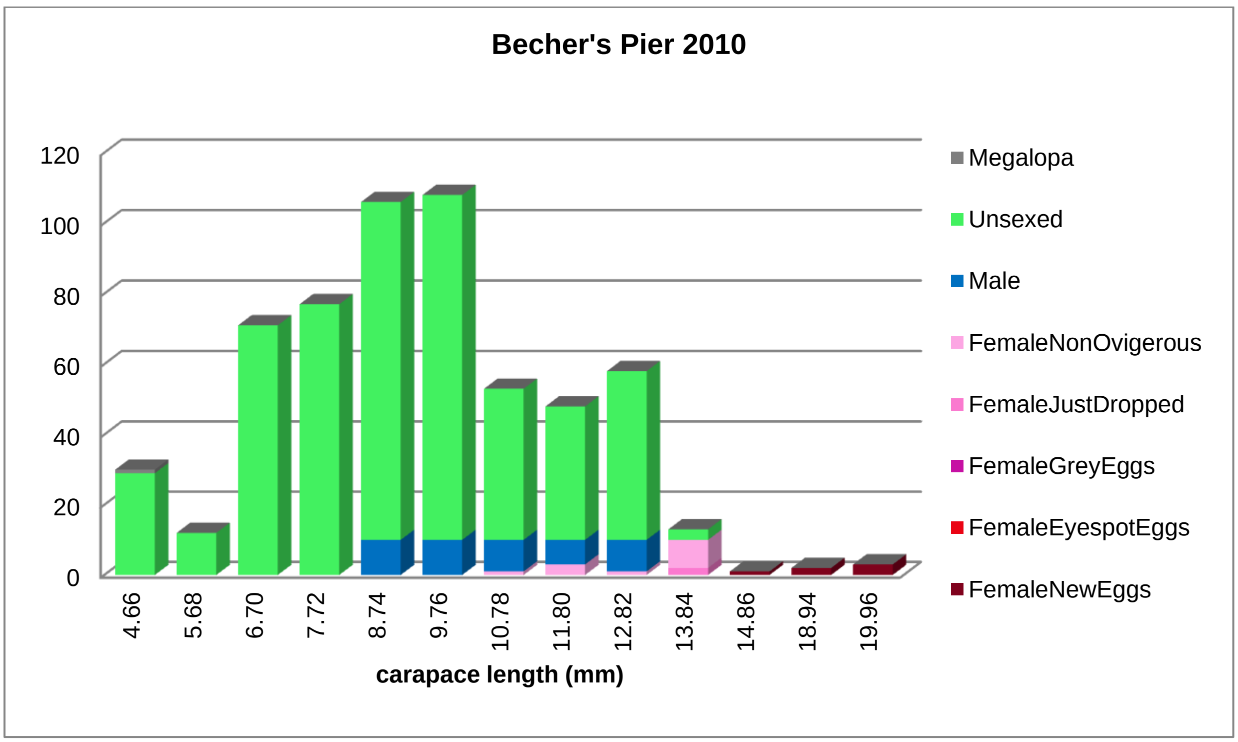
Table A-3. Reproductive status of *Emerita analoga* by size class at Bechers Pier.

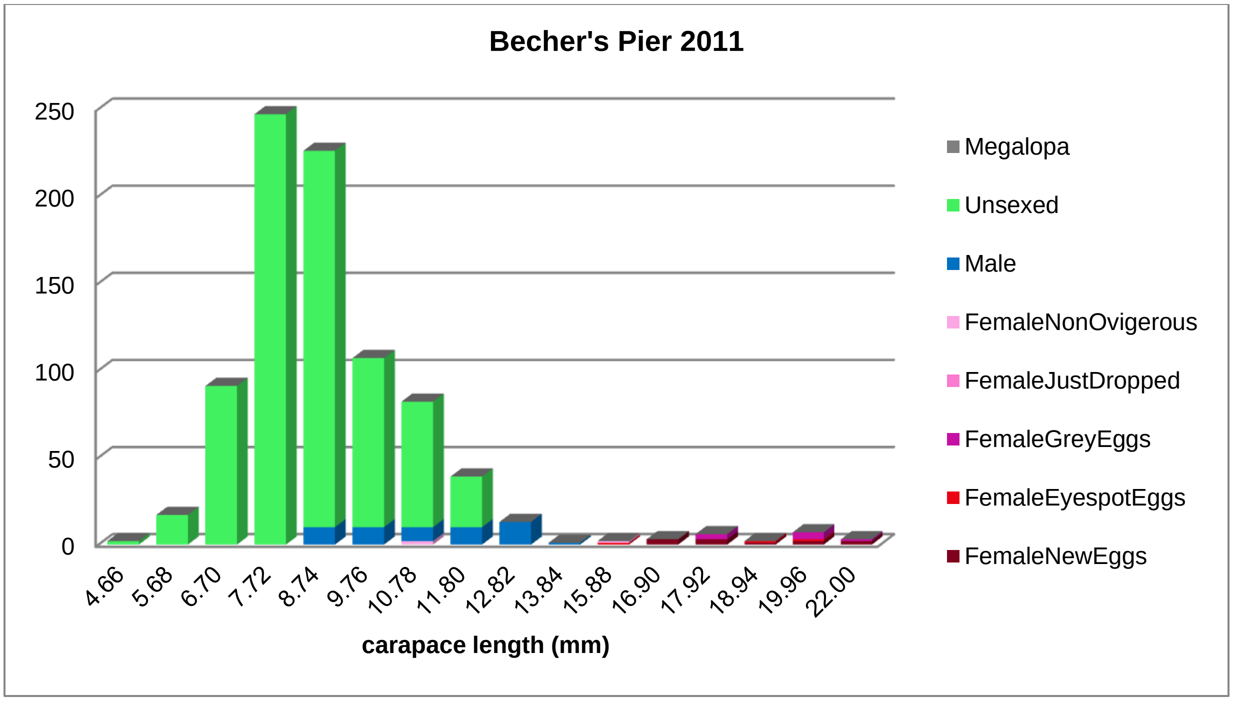
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2007	BB	3.64	0	0	0	0	0	0	0	1
2007	BB	4.66	0	0	0	0	0	0	4	12
2007	BB	5.68	0	0	0	0	0	0	1	0
2007	BB	6.70	0	0	0	0	0	0	44	0
2007	BB	7.72	0	0	0	0	0	0	146	0
2007	BB	8.74	0	0	0	0	1	29	191	0
2007	BB	9.76	0	0	0	0	1	31	214	0
2007	BB	10.78	0	0	0	0	4	26	107	0
2007	BB	11.80	0	0	0	0	4	26	73	0
2007	BB	12.82	2	0	0	0	7	21	36	0
2007	BB	13.84	1	0	0	1	15	17	0	0
2007	BB	15.88	2	0	0	0	2	0	0	0
2007	BB	16.90	3	0	0	0	3	0	0	0
2007	BB	17.92	1	0	1	0	5	0	0	0
2007	BB	18.94	1	1	0	0	4	0	0	0
2007	BB	19.96	5	3	0	0	3	0	0	0
2007	BB	20.98	5	0	0	0	3	0	1	0
2007	BB	22.00	5	1	0	0	8	0	0	0
2007	BB	23.02	1	0	0	0	0	0	0	0
2007	BB	24.04	3	3	0	0	3	0	0	0
2010	BB	4.66	0	0	0	0	0	0	29	1
2010	BB	5.68	0	0	0	0	0	0	12	0
2010	BB	6.70	0	0	0	0	0	0	71	0
2010	BB	7.72	0	0	0	0	0	0	77	0
2010	BB	8.74	0	0	0	0	0	10	96	0
2010	BB	9.76	0	0	0	0	0	10	98	0
2010	BB	10.78	0	0	0	0	1	9	43	0
2010	BB	11.80	0	0	0	0	3	7	38	0
2010	BB	12.82	0	0	0	0	1	9	48	0
2010	BB	13.84	0	0	0	2	8	0	3	0
2010	BB	14.86	1	0	0	0	0	0	0	0
2010	BB	18.94	2	0	0	0	0	0	0	0
2010	BB	19.96	3	0	0	0	0	0	0	0

Table A-3. (continued) Reproductive status of *Emerita analoga* by size class at Bechers Pier.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2011	BB	4.66	0	0	0	0	0	0	2	0
2011	BB	5.68	0	0	0	0	0	0	17	0
2011	BB	6.70	0	0	0	0	0	0	91	0
2011	BB	7.72	0	0	0	0	0	0	247	0
2011	BB	8.74	0	0	0	0	0	10	216	0
2011	BB	9.76	0	0	0	0	0	10	97	0
2011	BB	10.78	0	0	0	0	2	8	72	0
2011	BB	11.80	0	0	0	0	0	10	29	0
2011	BB	12.82	0	0	0	0	0	13	0	0
2011	BB	13.84	0	0	0	0	0	1	0	0
2011	BB	15.88	0	1	0	0	1	0	0	0
2011	BB	16.90	3	0	0	0	0	0	0	0
2011	BB	17.92	3	0	3	0	0	0	0	0
2011	BB	18.94	1	1	0	0	0	0	0	0
2011	BB	19.96	2	1	4	0	0	0	0	0
2011	BB	22.00	2	0	1	0	0	0	0	0
2012	BB	4.66	0	0	0	0	0	0	2	0
2012	BB	5.68	0	0	0	0	0	0	64	0
2012	BB	6.70	0	0	0	0	0	0	631	0
2012	BB	7.72	0	0	0	0	0	0	311	0
2012	BB	8.74	0	0	0	0	0	10	22	0
2012	BB	9.76	0	0	0	0	0	10	116	0
2012	BB	10.78	0	0	0	0	0	10	27	0
2012	BB	11.80	0	0	0	0	7	3	12	0
2012	BB	12.82	6	2	0	1	10	1	0	0
2012	BB	13.84	4	1	0	0	4	1	0	0
2012	BB	14.86	1	2	0	0	3	0	0	0
2012	BB	15.88	0	1	0	0	4	0	0	0
2012	BB	16.90	0	1	0	0	0	0	0	0
2012	BB	17.92	1	0	0	0	1	0	0	0
2012	BB	18.94	0	0	0	0	1	0	0	0
2012	BB	19.96	1	0	0	0	0	0	0	0


Becher's Pier 2007
250
200
150
100
50
0
3.64
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
15.88
16.90
17.92
18.94
19.96
20.98
22.00
23.02
24.04
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Becher's Pier 2010
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
18.94
19.96
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Becher's Pier 2011
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
15.88
16.90
17.92
18.94
19.96
22.00
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

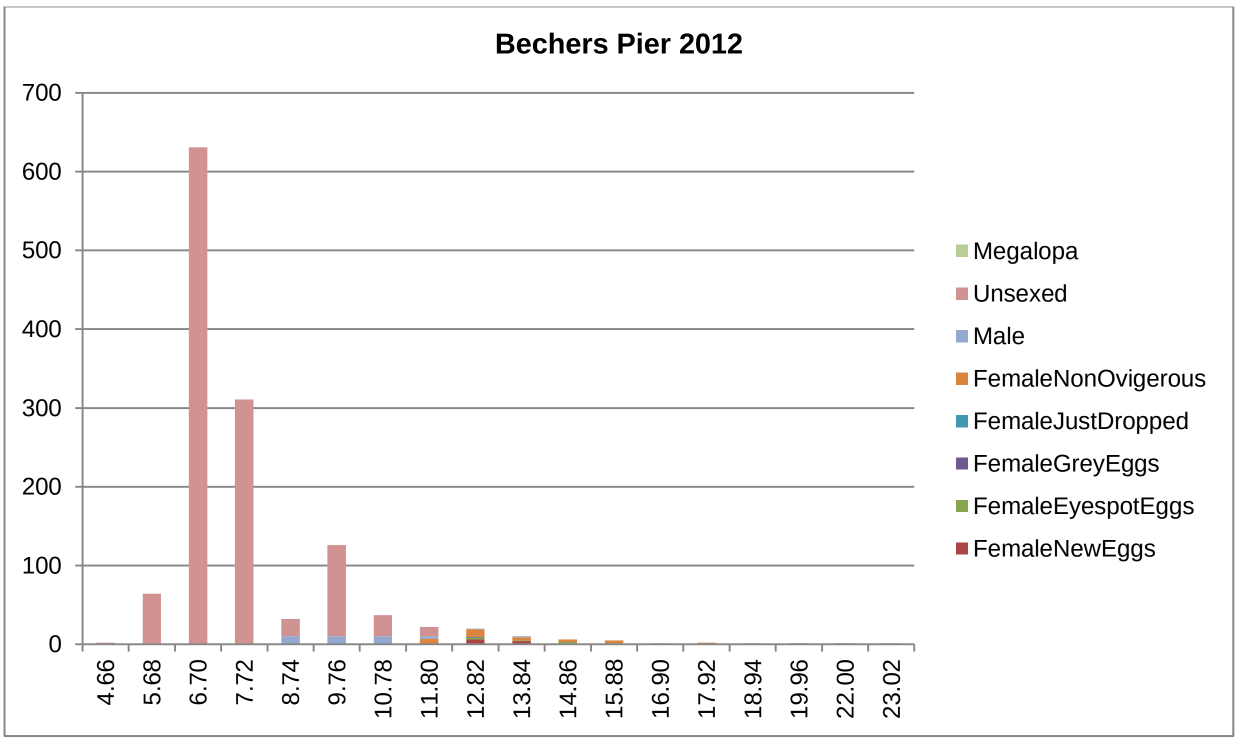
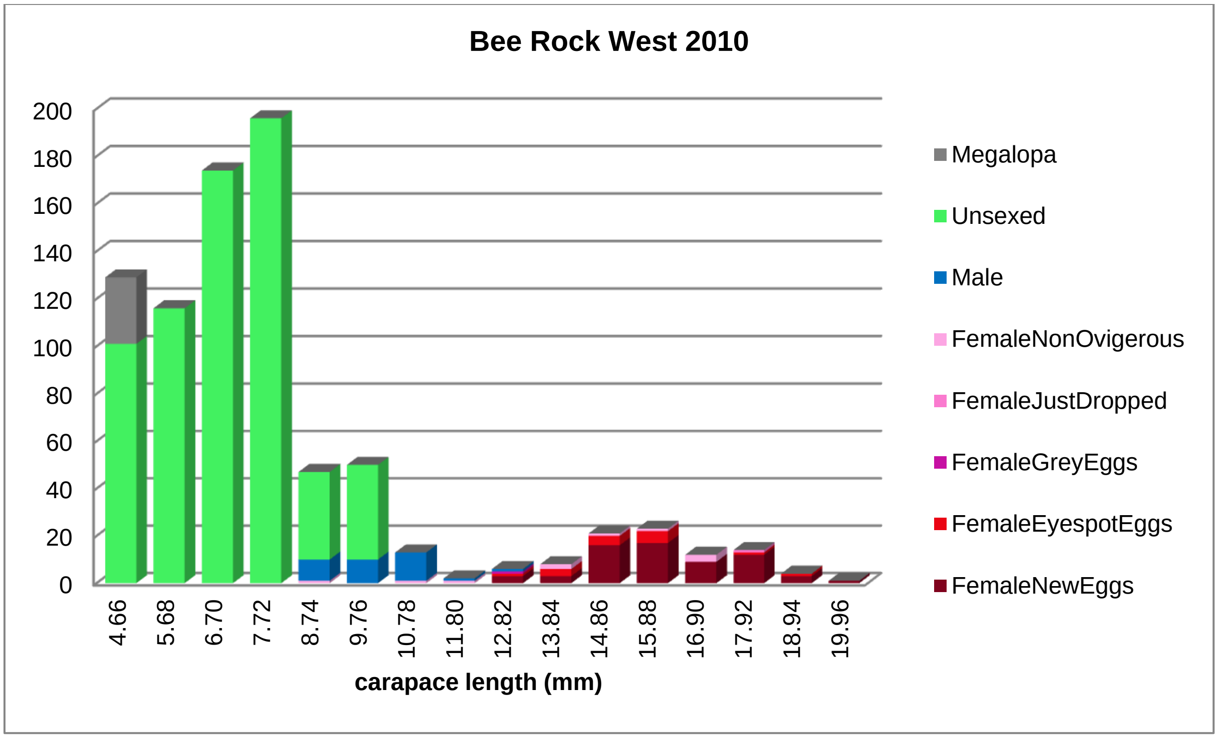

Bechers Pier 2012
700
600
500
400
300
200
100
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
22.00
23.02
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Table A-4. Reproductive status of *Emerita analoga* by size class at Bee Rock West.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2010	BR	4.66	0	0	0	0	0	0	101	28
2010	BR	5.68	0	0	0	0	0	0	116	0
2010	BR	6.70	0	0	0	0	0	0	174	0
2010	BR	7.72	0	0	0	0	0	0	196	0
2010	BR	8.74	0	0	0	0	1	9	37	0
2010	BR	9.76	0	0	0	0	0	10	40	0
2010	BR	10.78	0	0	0	0	1	12	0	0
2010	BR	11.80	0	0	0	0	1	1	0	0
2010	BR	12.82	3	1	1	0	0	1	0	0
2010	BR	13.84	3	3	0	0	2	0	0	0
2010	BR	14.86	16	4	0	0	1	0	0	0
2010	BR	15.88	17	5	0	0	1	0	0	0
2010	BR	16.90	9	0	0	0	3	0	0	0
2010	BR	17.92	12	1	0	1	0	0	0	0
2010	BR	18.94	3	1	0	0	0	0	0	0
2010	BR	19.96	1	0	0	0	0	0	0	0
2011	BR	4.66	0	0	0	0	0	0	55	2
2011	BR	5.68	0	0	0	0	0	0	267	0
2011	BR	6.70	0	0	0	0	0	0	421	0
2011	BR	7.72	0	0	0	0	0	0	23	0
2011	BR	8.74	0	0	0	0	0	10	38	0
2011	BR	9.76	0	0	0	0	0	10	62	0
2011	BR	10.78	0	0	0	0	0	10	32	0
2011	BR	11.80	0	0	0	0	1	2	0	0
2011	BR	12.82	0	1	0	0	6	1	0	0
2011	BR	13.84	6	1	0	0	9	0	0	0
2011	BR	14.86	6	1	2	0	1	0	36	0
2011	BR	15.88	8	1	4	0	11	0	0	0
2011	BR	16.90	4	3	1	0	1	0	0	0
2011	BR	17.92	8	1	0	0	0	0	0	0
2011	BR	18.94	11	1	0	0	0	0	0	0
2011	BR	19.96	6	1	1	0	2	0	0	0
2011	BR	20.98	3	0	0	0	0	0	0	0
2011	BR	22.00	1	0	0	0	1	0	0	0
2011	BR	23.02	1	0	0	0	0	0	0	0


Bee Rock West 2010
200
180
160
140
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

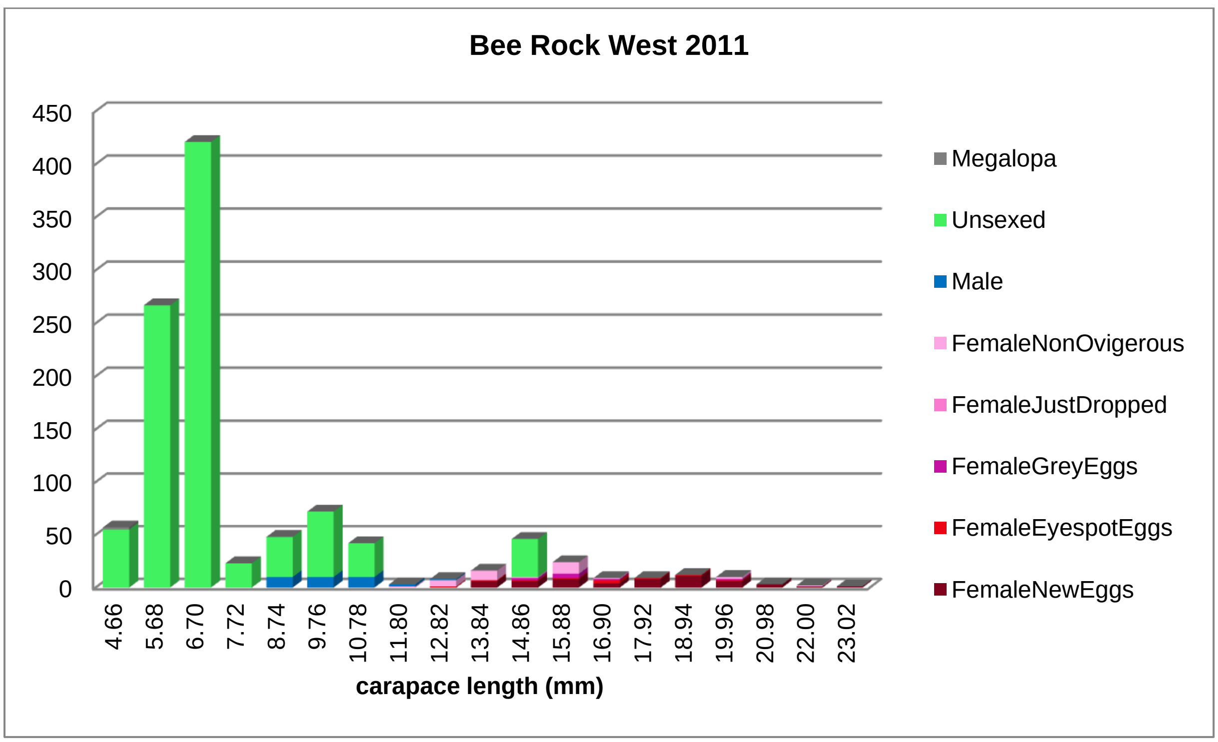

Bee Rock West 2011
450
400
350
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
20.98
22.00
23.02
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Table A-5. Reproductive status of *Emerita analoga* by size class at China Camp.

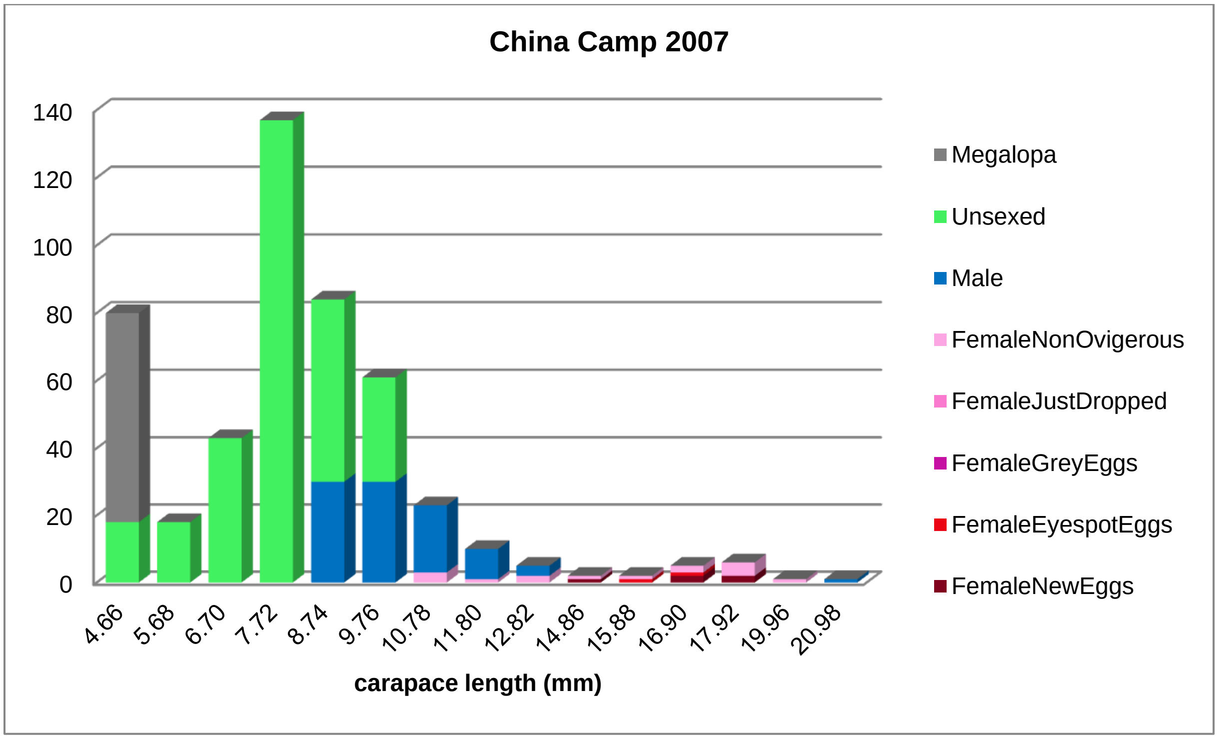
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2007	CC	4.66	0	0	0	0	0	0	18	62
2007	CC	5.68	0	0	0	0	0	0	18	0
2007	CC	6.70	0	0	0	0	0	0	43	0
2007	CC	7.72	0	0	0	0	0	0	137	0
2007	CC	8.74	0	0	0	0	0	30	54	0
2007	CC	9.76	0	0	0	0	0	30	31	0
2007	CC	10.78	0	0	0	0	3	20	0	0
2007	CC	11.80	0	0	0	0	1	9	0	0
2007	CC	12.82	0	0	0	0	2	3	0	0
2007	CC	14.86	1	0	0	0	1	0	0	0
2007	CC	15.88	0	1	0	0	1	0	0	0
2007	CC	16.90	2	1	0	0	2	0	0	0
2007	CC	17.92	2	0	0	0	4	0	0	0
2007	CC	19.96	0	0	0	0	1	0	0	0
2007	CC	20.98	0	0	0	0	0	1	0	0
2009	CC	4.66	0	0	0	0	0	0	32	0
2009	CC	5.68	0	0	0	0	0	0	69	0
2009	CC	6.70	0	0	0	0	0	0	143	0
2009	CC	7.72	0	0	0	0	0	0	142	0
2009	CC	8.74	0	0	0	0	0	10	51	0
2009	CC	9.76	0	0	0	0	5	48	0	0
2009	CC	10.78	0	0	0	0	4	17	0	0
2009	CC	11.80	0	0	0	0	0	2	0	0
2009	CC	12.82	2	0	0	0	1	1	0	0
2009	CC	13.84	18	1	1	0	0	0	0	0
2009	CC	14.86	13	5	2	1	2	0	0	0
2009	CC	15.88	10	0	3	0	0	0	0	0
2009	CC	16.90	7	4	1	0	0	0	0	0
2009	CC	17.92	2	0	0	0	0	0	0	0
2009	CC	18.94	2	0	0	0	0	0	0	0
2009	CC	19.96	6	1	1	0	0	0	0	0
2009	CC	20.98	1	0	0	0	0	0	0	0
2009	CC	22.00	0	1	0	0	0	0	0	0

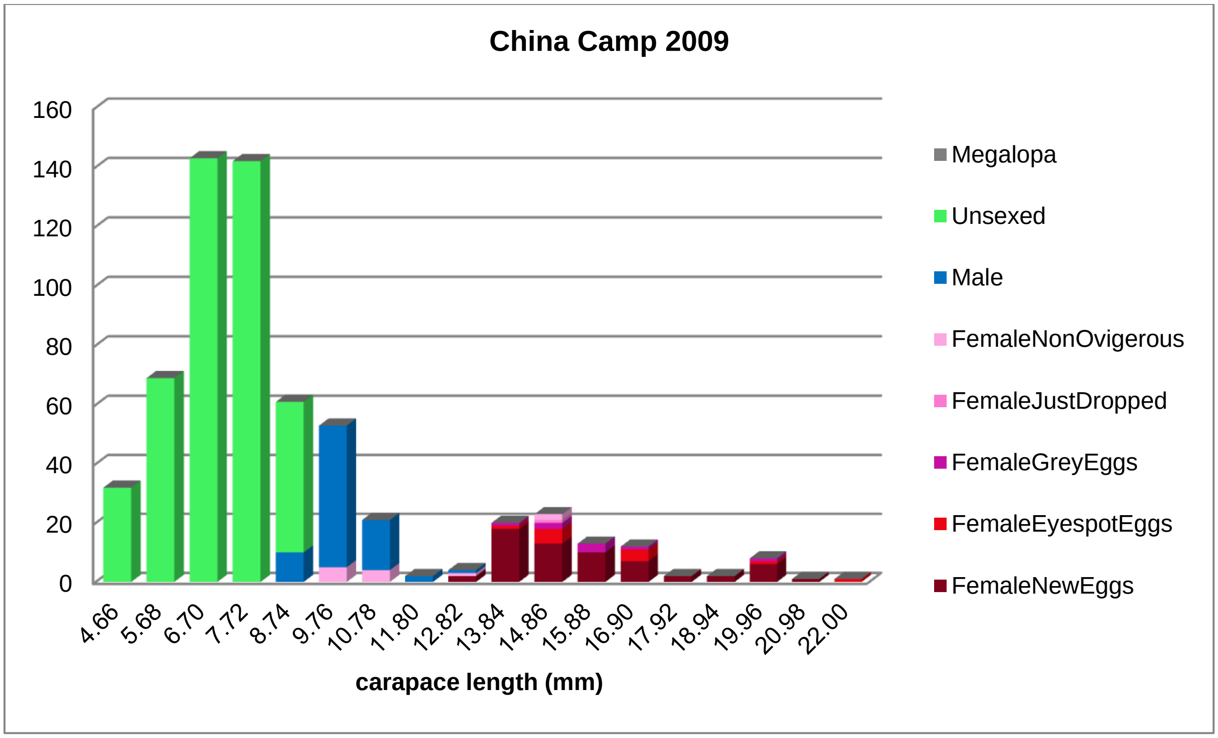
Table A-5. (continued) Reproductive status of Emerita analoga by size class at China Camp.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2010	CC	4.66	0	0	0	0	0	0	48	4
2010	CC	5.68	0	0	0	0	0	0	19	0
2010	CC	6.70	0	0	0	0	0	0	64	0
2010	CC	7.72	0	0	0	0	0	0	88	0
2010	CC	8.74	0	0	0	0	0	10	59	0
2010	CC	9.76	0	0	0	0	0	10	48	0
2010	CC	10.78	0	0	0	0	2	8	5	0
2010	CC	11.80	1	0	0	0	0	0	0	0
2010	CC	13.84	0	0	0	0	1	0	0	0
2010	CC	14.86	1	1	0	0	1	0	0	0
2010	CC	15.88	5	0	0	1	3	0	0	0
2010	CC	16.90	1	0	0	0	0	0	0	0
2010	CC	19.96	1	0	0	0	0	0	0	0
2010	CC	22.00	1	0	0	0	0	0	0	0
2011	CC	3.64	0	0	0	0	0	0	1	0
2011	CC	4.66	0	0	0	0	0	0	118	4
2011	CC	5.68	0	0	0	0	0	0	81	1
2011	CC	6.70	0	0	0	0	0	0	175	0
2011	CC	7.72	0	0	0	0	0	0	146	0
2011	CC	8.74	0	0	0	0	1	9	38	0
2011	CC	9.76	0	0	0	0	6	4	31	0
2011	CC	10.78	0	0	0	0	1	10	0	0
2011	CC	12.82	0	0	0	0	1	0	0	0
2011	CC	13.84	0	1	0	0	2	0	0	0
2011	CC	14.86	3	1	2	0	4	0	0	0
2011	CC	15.88	6	1	0	0	2	0	0	0
2011	CC	16.90	3	2	1	0	0	0	0	0
2011	CC	17.92	3	1	0	0	0	0	0	0
2011	CC	18.94	1	0	0	0	0	0	0	0
2011	CC	19.96	2	1	0	0	0	0	0	0
2012	CC	5.68	0	0	0	0	0	0	18	0
2012	CC	6.70	0	0	0	0	0	0	182	0
2012	CC	7.72	0	0	0	0	0	0	288	0
2012	CC	8.74	0	0	0	0	0	10	108	0
2012	CC	9.76	0	0	0	0	0	10	61	0
2012	CC	10.78	0	0	0	0	1	2	0	0
2012	CC	11.80	1	1	0	1	2	2	0	0

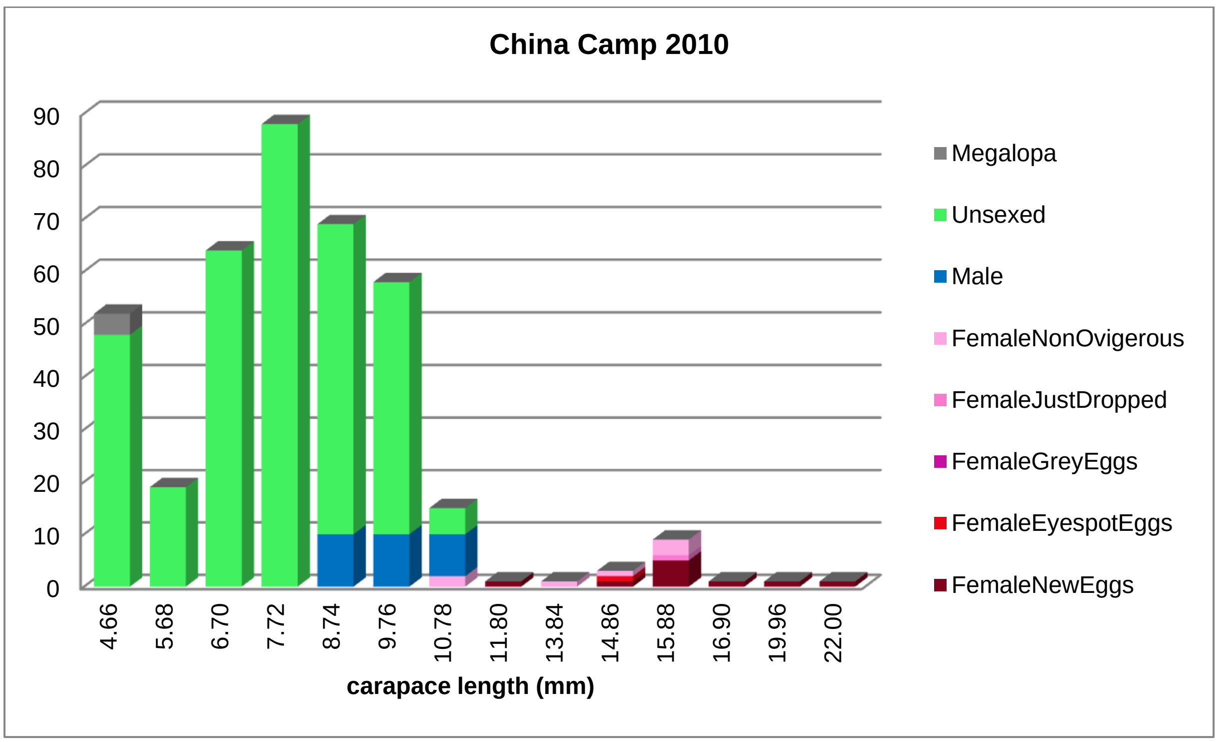
Table A-5. (continued) Reproductive status of Emerita analoga by size class at China Camp.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2012	CC	12.82	0	0	0	0	1	0	0	0
2012	CC	13.84	7	0	1	0	8	0	0	0
2012	CC	14.86	13	2	2	0	5	0	0	0
2012	CC	15.88	5	0	2	0	1	0	0	0
2012	CC	16.90	2	0	0	0	0	0	0	0
2012	CC	17.92	1	1	1	0	0	0	0	0
2012	CC	18.94	4	0	0	0	0	0	0	0

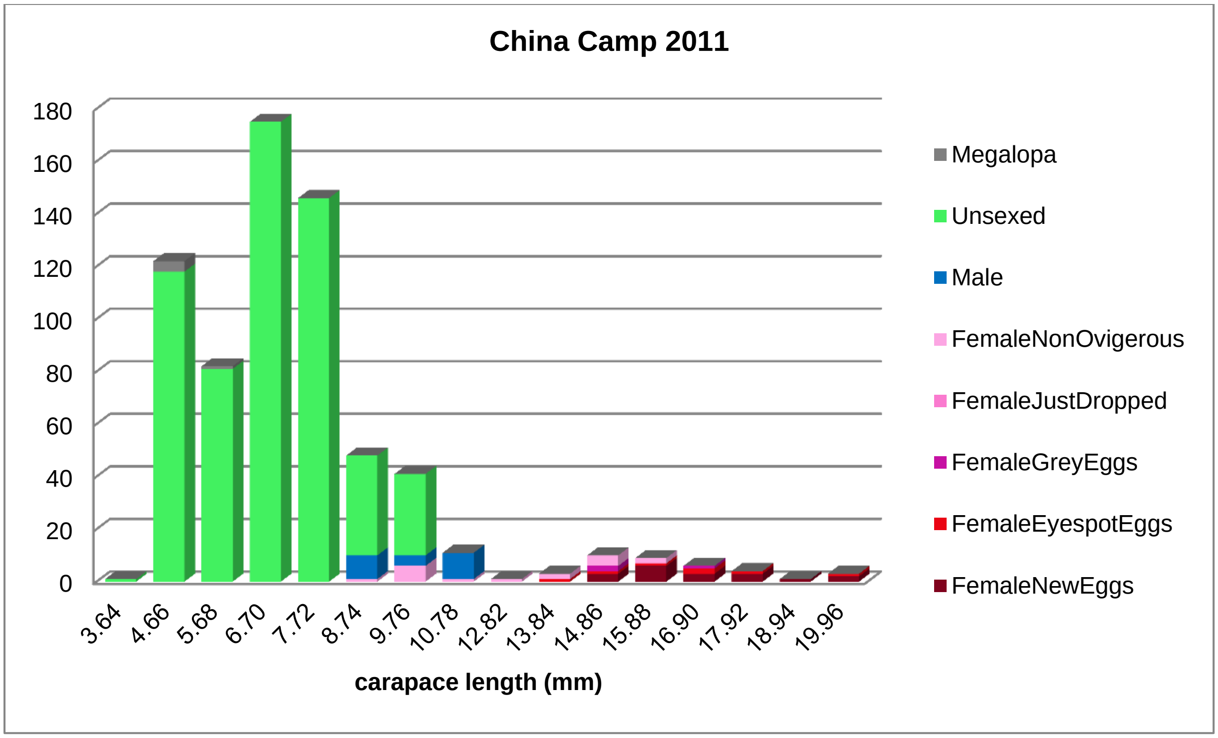




China Camp 2009
160
140
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
20.98
22.00
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs



China Camp 2010
90
80
70
60
50
40
30
20
10
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
13.84
14.86
15.88
16.90
19.96
22.00
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


China Camp 2011
180
160
140
120
100
80
60
40
20
0
3.64
4.66
5.68
6.70
7.72
8.74
9.76
10.78
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

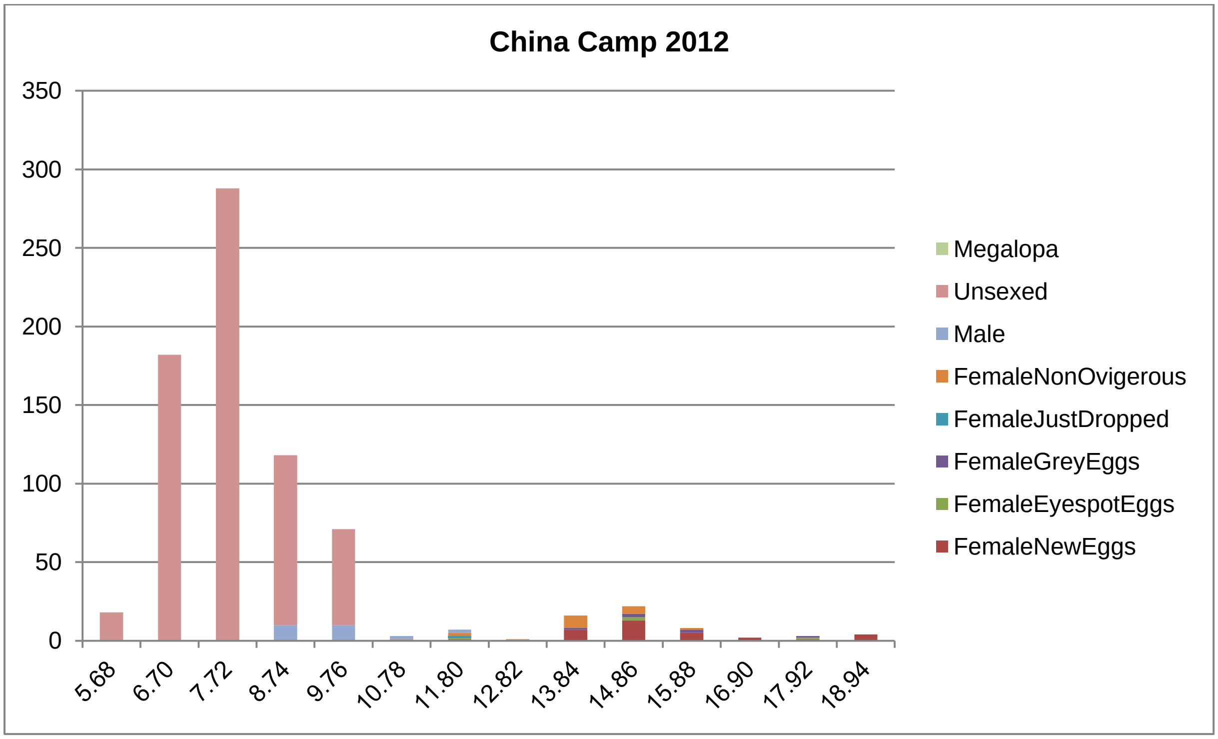

China Camp 2012
350
300
250
200
150
100
50
0
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Table A-6. Reproductive status of *Emerita analoga* by size class at Ford Point.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2011	FP	3.64	0	0	0	0	0	0	2	0
2011	FP	4.66	0	0	0	0	0	0	342	0
2011	FP	5.68	0	0	0	0	0	0	35	0
2011	FP	6.70	0	0	0	0	0	0	241	0
2011	FP	7.72	0	0	0	0	0	0	364	0
2011	FP	8.74	0	0	0	0	0	10	86	0
2011	FP	9.76	0	0	0	0	0	12	90	0
2011	FP	10.78	0	0	0	0	0	10	48	0
2011	FP	11.80	0	0	0	0	0	3	0	0
2011	FP	12.82	1	0	0	0	0	1	0	0
2011	FP	13.84	2	2	2	0	0	0	0	0
2011	FP	14.86	16	3	5	0	5	0	0	0
2011	FP	15.88	13	3	8	0	1	0	9	0
2011	FP	16.90	12	6	1	0	1	0	0	0
2011	FP	17.92	2	3	2	0	0	0	0	0
2011	FP	18.94	1	1	0	0	0	0	0	0
2011	FP	19.96	2	0	0	0	0	0	0	0
2011	FP	20.98	1	1	0	0	0	0	0	0
2011	FP	22.00	4	0	0	0	0	0	0	0
2011	FP	23.02	1	0	0	0	0	0	0	0
2011	FP	24.04	1	0	0	0	0	0	0	0

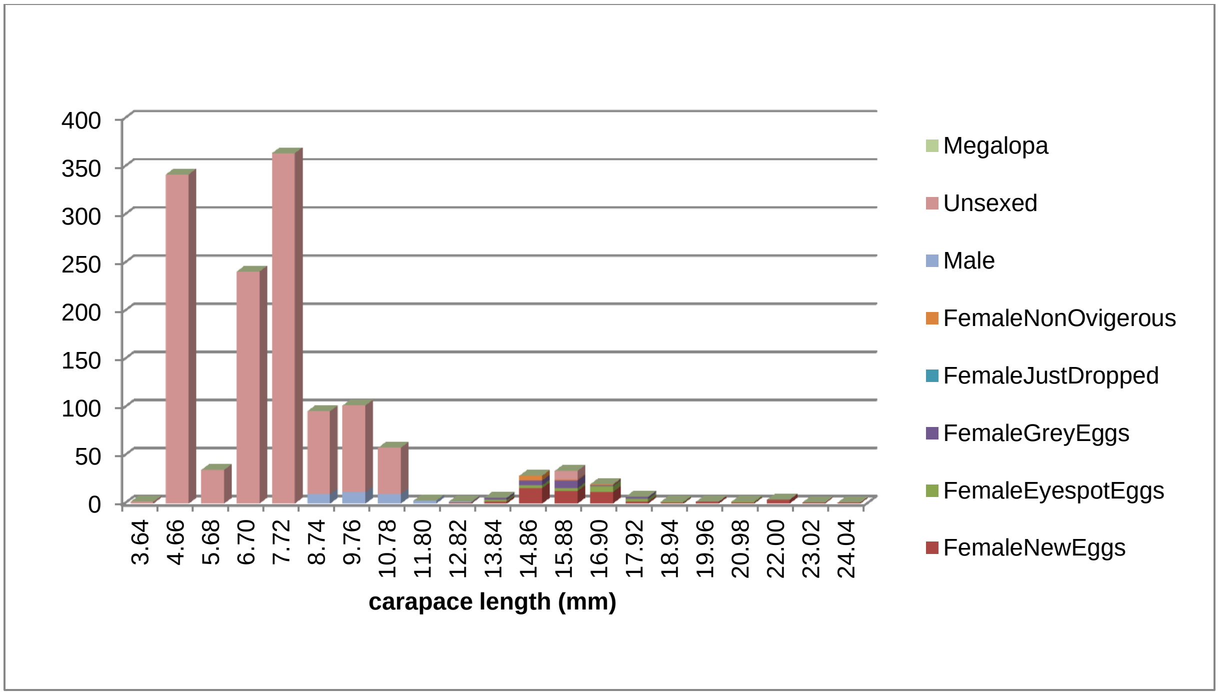
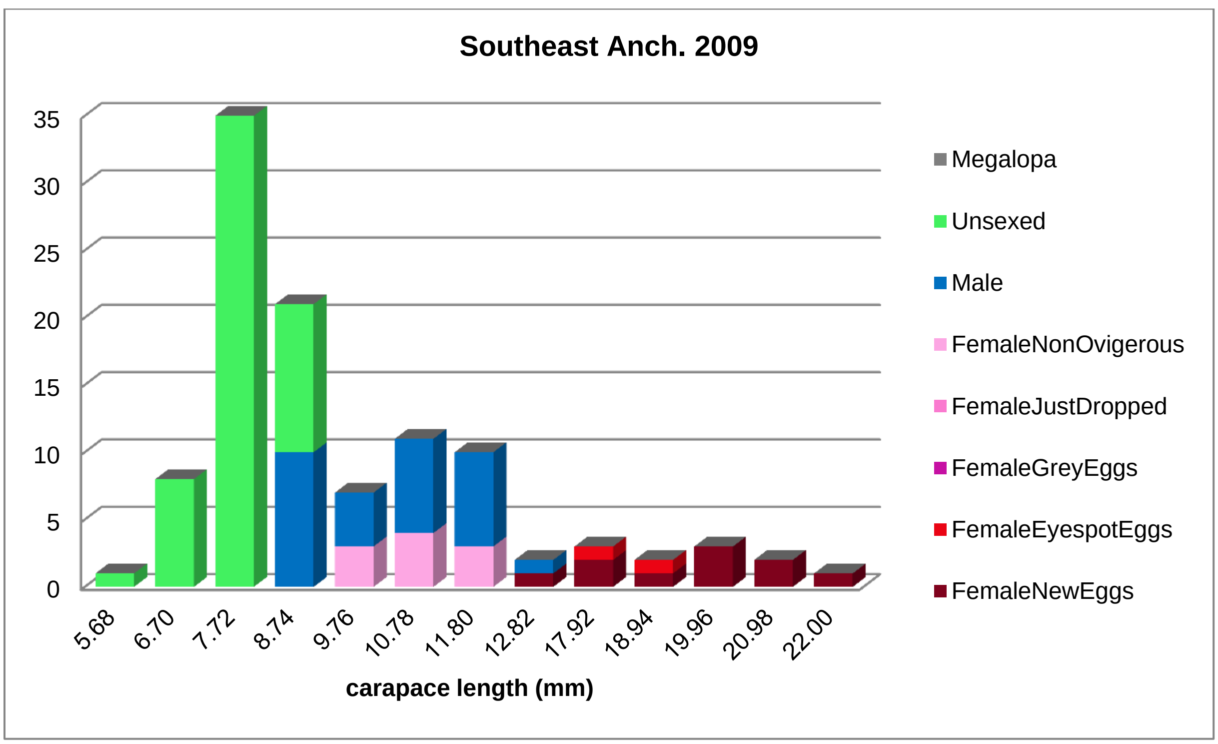


Table A-7. Reproductive status of *Emerita analoga* by size class at Southeast Anchorage.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2009	SE	5.68	0	0	0	0	0	0	1	0
2009	SE	6.70	0	0	0	0	0	0	8	0
2009	SE	7.72	0	0	0	0	0	0	35	0
2009	SE	8.74	0	0	0	0	0	10	11	0
2009	SE	9.76	0	0	0	0	3	4	0	0
2009	SE	10.78	0	0	0	0	4	7	0	0
2009	SE	11.80	0	0	0	0	3	7	0	0
2009	SE	12.82	1	0	0	0	0	1	0	0
2009	SE	17.92	2	1	0	0	0	0	0	0
2009	SE	18.94	1	1	0	0	0	0	0	0
2009	SE	19.96	3	0	0	0	0	0	0	0
2009	SE	20.98	2	0	0	0	0	0	0	0
2009	SE	22.00	1	0	0	0	0	0	0	0
2011	SE	4.66	0	0	0	0	0	0	6	3
2011	SE	5.68	0	0	0	0	0	0	2	0
2011	SE	6.70	0	0	0	0	0	0	3	0
2011	SE	7.72	0	0	0	0	0	0	37	0
2011	SE	8.74	0	0	0	0	0	10	237	0
2011	SE	9.76	0	0	0	0	0	10	331	0

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2011	SE	10.78	0	0	0	0	0	20	167	0
2011	SE	11.80	0	0	0	0	5	14	74	0
2011	SE	12.82	0	0	0	0	9	8	63	0
2011	SE	13.84	0	0	0	0	7	20	38	0
2011	SE	14.86	0	0	0	0	8	12	13	0
2011	SE	15.88	0	0	0	0	2	4	0	0
2011	SE	16.90	0	0	0	0	0	1	0	0
2011	SE	17.92	0	0	0	0	0	1	0	0
2011	SE	19.96	2	2	0	0	0	0	0	0
2011	SE	20.98	11	0	1	1	0	0	0	0
2011	SE	22.00	24	7	3	2	2	0	0	0
2011	SE	23.02	9	5	3	2	0	0	0	0
2011	SE	24.04	4	2	1	0	0	0	2	0
2011	SE	25.09	2	2	1	0	1	0	0	0
2011	SE	26.08	2	0	0	0	0	0	0	0
2011	SE	27.10	19	15	1	0	0	0	0	0



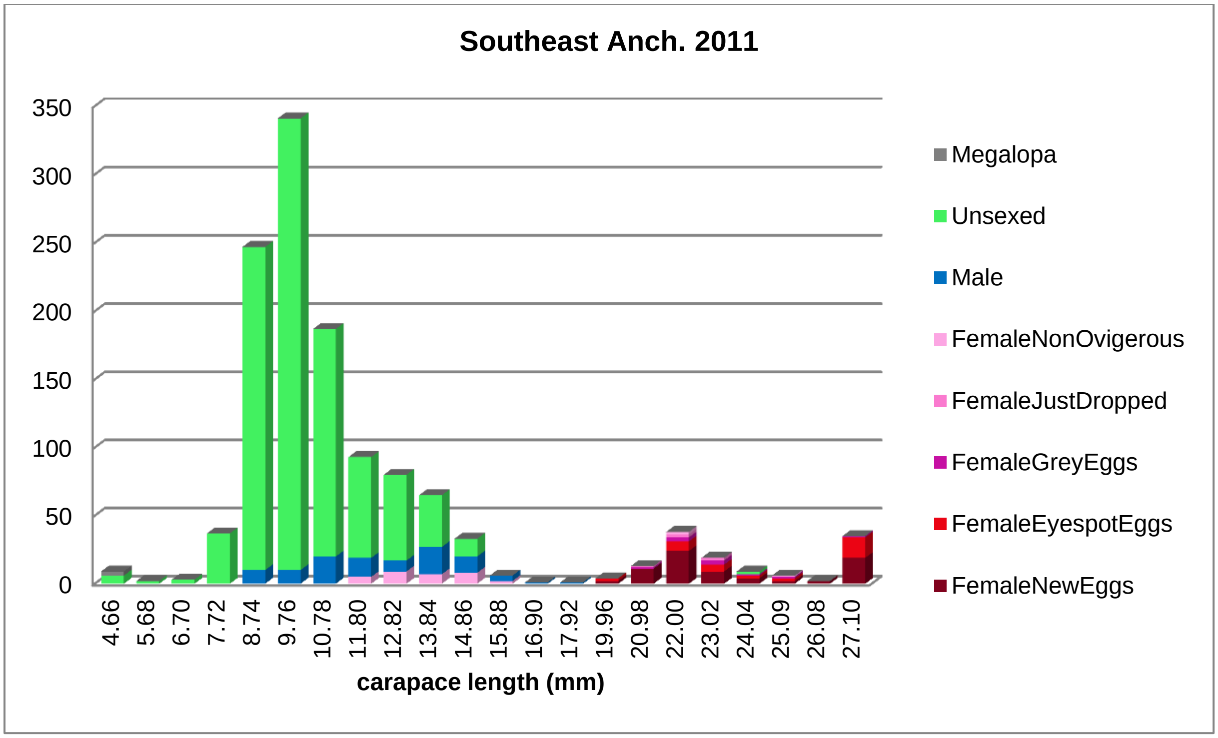
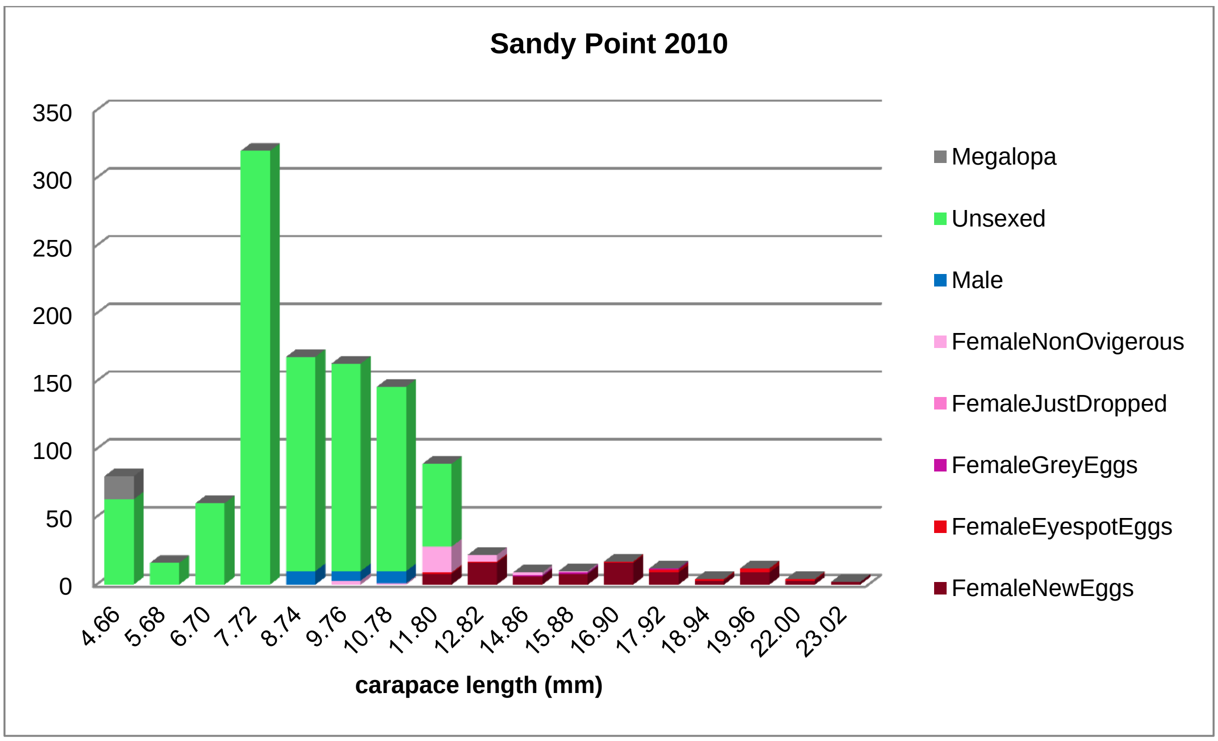
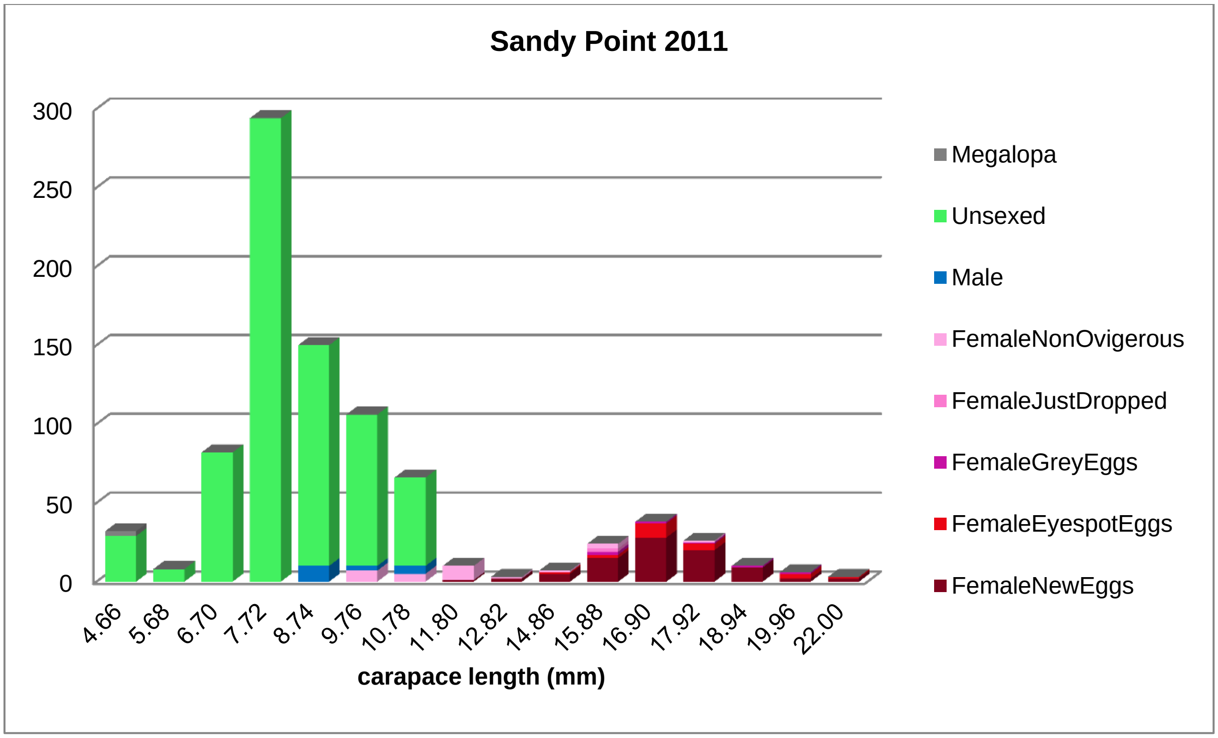

Southeast Anch. 2011
350
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
19.96
20.98
22.00
23.02
24.04
25.09
26.08
27.10
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Table A-8. Reproductive status of *Emerita analoga* by size class at Sandy Point.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2010	SP	4.66	0	0	0	0	0	0	63	17
2010	SP	5.68	0	0	0	0	0	0	16	0
2010	SP	6.70	0	0	0	0	0	0	60	0
2010	SP	7.72	0	0	0	0	0	0	320	0
2010	SP	8.74	0	0	0	0	0	10	158	0
2010	SP	9.76	0	0	0	0	3	7	153	0
2010	SP	10.78	0	0	0	0	1	9	136	0
2010	SP	11.80	8	1	0	0	19	0	61	0
2010	SP	12.82	16	1	0	0	5	0	0	0
2010	SP	14.86	6	0	1	0	2	0	0	0
2010	SP	15.88	8	0	1	0	1	0	0	0
2010	SP	16.90	16	1	0	0	0	0	0	0
2010	SP	17.92	9	2	1	0	0	0	0	0
2010	SP	18.94	3	1	0	0	0	0	0	0
2010	SP	19.96	9	3	0	0	0	0	0	0
2010	SP	22.00	3	1	0	0	0	0	0	0
2010	SP	23.02	2	0	0	0	0	0	0	0
2011	SP	4.66	0	0	0	0	0	0	29	3
2011	SP	5.68	0	0	0	0	0	0	8	0
2011	SP	6.70	0	0	0	0	0	0	82	0
2011	SP	7.72	0	0	0	0	0	0	294	0
2011	SP	8.74	0	0	0	0	0	10	140	0
2011	SP	9.76	0	0	0	0	7	3	96	0
2011	SP	10.78	0	0	0	0	5	5	56	0
2011	SP	11.80	1	0	0	0	9	0	0	0
2011	SP	12.82	2	0	0	0	1	0	0	0
2011	SP	14.86	5	1	0	0	1	0	0	0
2011	SP	15.88	15	2	2	2	3	0	0	0
2011	SP	16.90	28	9	1	0	0	0	0	0
2011	SP	17.92	20	4	1	0	1	0	0	0
2011	SP	18.94	9	0	1	0	0	0	0	0
2011	SP	19.96	2	3	1	0	0	0	0	0
2011	SP	22.00	2	1	0	0	0	0	0	0
2012	SP	4.66	0	0	0	0	0	0	6	0
2012	SP	5.68	0	0	0	0	0	0	12	0
2012	SP	6.70	0	0	0	0	0	0	33	0
2012	SP	7.72	0	0	0	0	0	0	201	0

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2012	SP	8.74	0	0	0	0	0	10	129	0
2012	SP	9.76	0	0	0	0	0	10	101	0
2012	SP	10.78	0	0	0	0	0	10	57	0
2012	SP	11.80	0	0	0	0	7	3	8	0
2012	SP	12.82	3	0	0	0	0	0	0	0
2012	SP	14.86	7	0	3	0	3	0	0	0
2012	SP	15.88	14	2	0	0	1	0	0	0
2012	SP	16.90	14	0	1	0	1	0	0	0
2012	SP	17.92	2	0	0	0	0	0	0	0
2012	SP	19.96	4	2	1	0	0	0	0	0
2012	SP	22.00	5	0	0	0	0	0	0	0




Sandy Point 2011
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
14.86
15.88
16.90
17.92
18.94
19.96
22.00
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

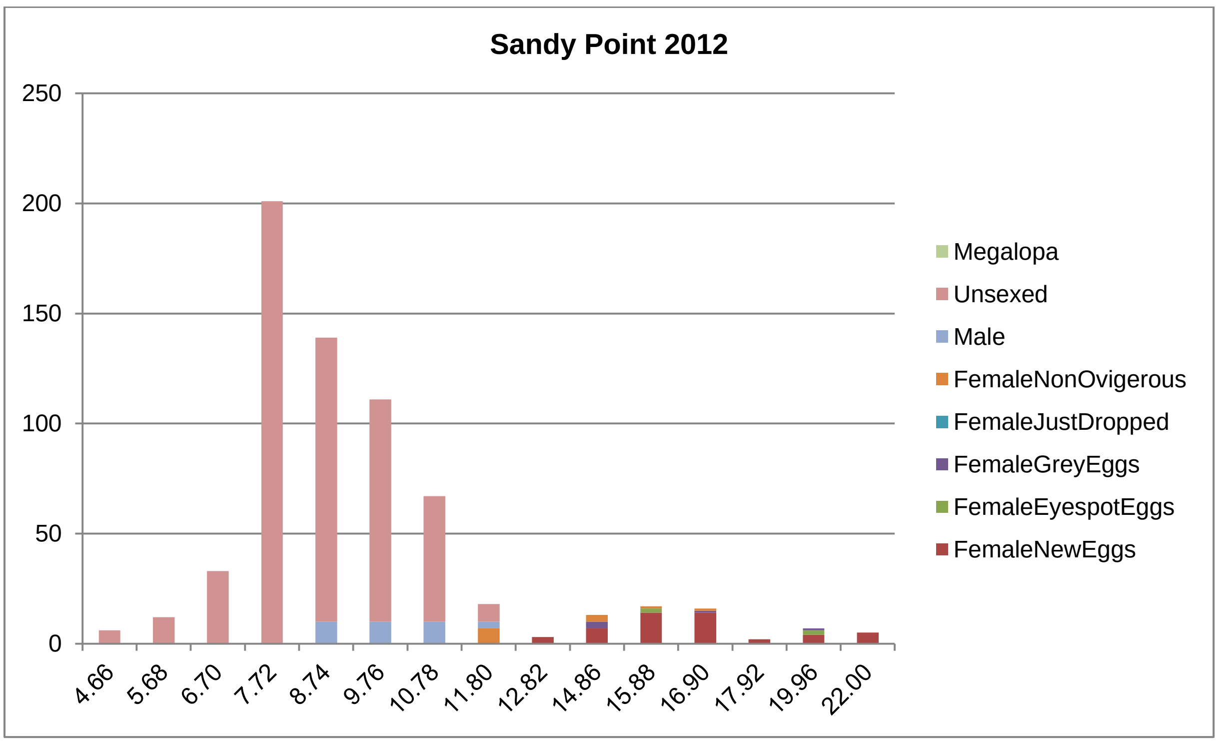

Sandy Point 2012
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
14.86
15.88
16.90
17.92
19.96
22.00
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Table A-9. Reproductive status of *Emerita analoga* by size class at Soledad West.

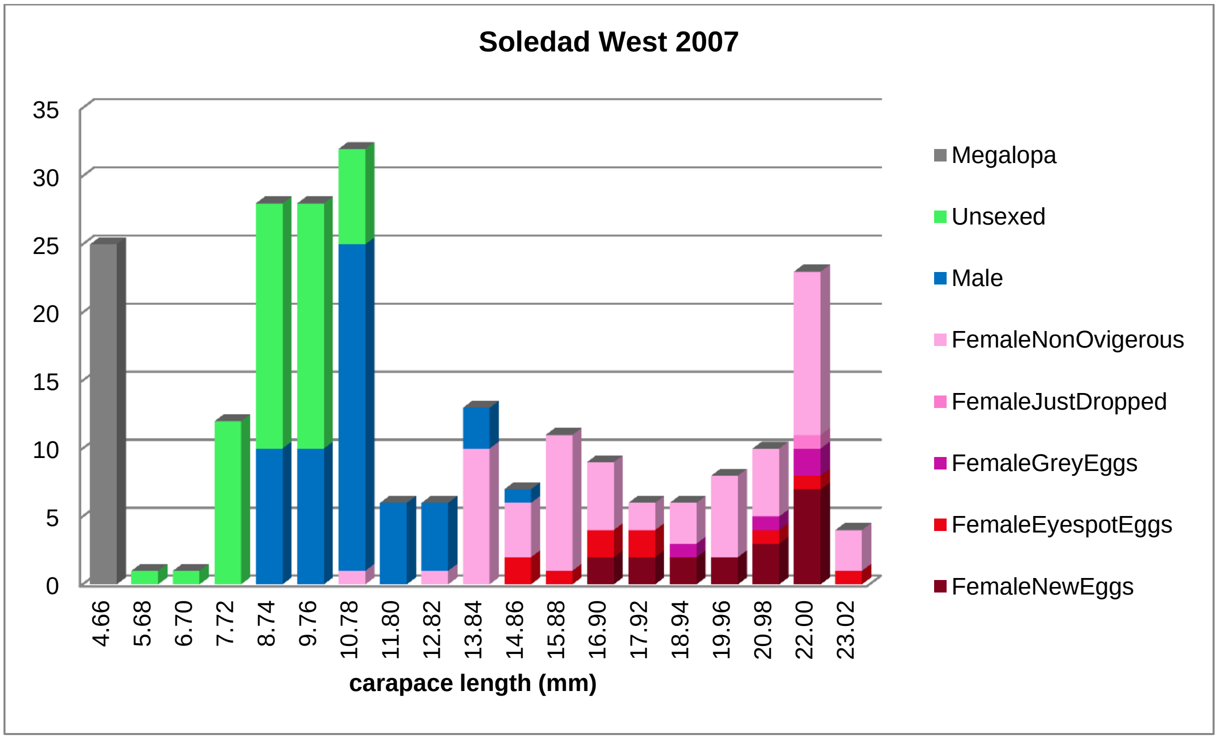
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2007	SW	4.66	0	0	0	0	0	0	0	25
2007	SW	5.68	0	0	0	0	0	0	1	0
2007	SW	6.70	0	0	0	0	0	0	1	0
2007	SW	7.72	0	0	0	0	0	0	12	0
2007	SW	8.74	0	0	0	0	0	10	18	0
2007	SW	9.76	0	0	0	0	0	10	18	0
2007	SW	10.78	0	0	0	0	1	24	7	0
2007	SW	11.80	0	0	0	0	0	6	0	0
2007	SW	12.82	0	0	0	0	1	5	0	0
2007	SW	13.84	0	0	0	0	10	3	0	0
2007	SW	14.86	0	2	0	0	4	1	0	0
2007	SW	15.88	0	1	0	0	10	0	0	0
2007	SW	16.90	2	2	0	0	5	0	0	0
2007	SW	17.92	2	2	0	0	2	0	0	0
2007	SW	18.94	2	0	1	0	3	0	0	0
2007	SW	19.96	2	0	0	0	6	0	0	0
2007	SW	20.98	3	1	1	0	5	0	0	0
2007	SW	22.00	7	1	2	1	12	0	0	0
2007	SW	23.02	0	1	0	0	3	0	0	0
2009	SW	5.68	0	0	0	0	0	0	4	0
2009	SW	6.70	0	0	0	0	0	0	24	0
2009	SW	7.72	0	0	0	0	0	0	29	0
2009	SW	8.74	0	0	0	0	0	7	0	0
2009	SW	9.76	0	0	0	0	2	11	0	0
2009	SW	10.78	0	0	0	0	0	4	0	0
2009	SW	11.80	0	0	0	0	0	1	0	0
2009	SW	14.86	1	0	0	0	1	0	0	0
2009	SW	15.88	4	0	0	0	0	0	0	0
2009	SW	16.90	4	2	0	0	0	0	0	0
2009	SW	17.92	2	1	0	0	0	0	0	0
2009	SW	18.94	5	0	0	0	0	0	0	0

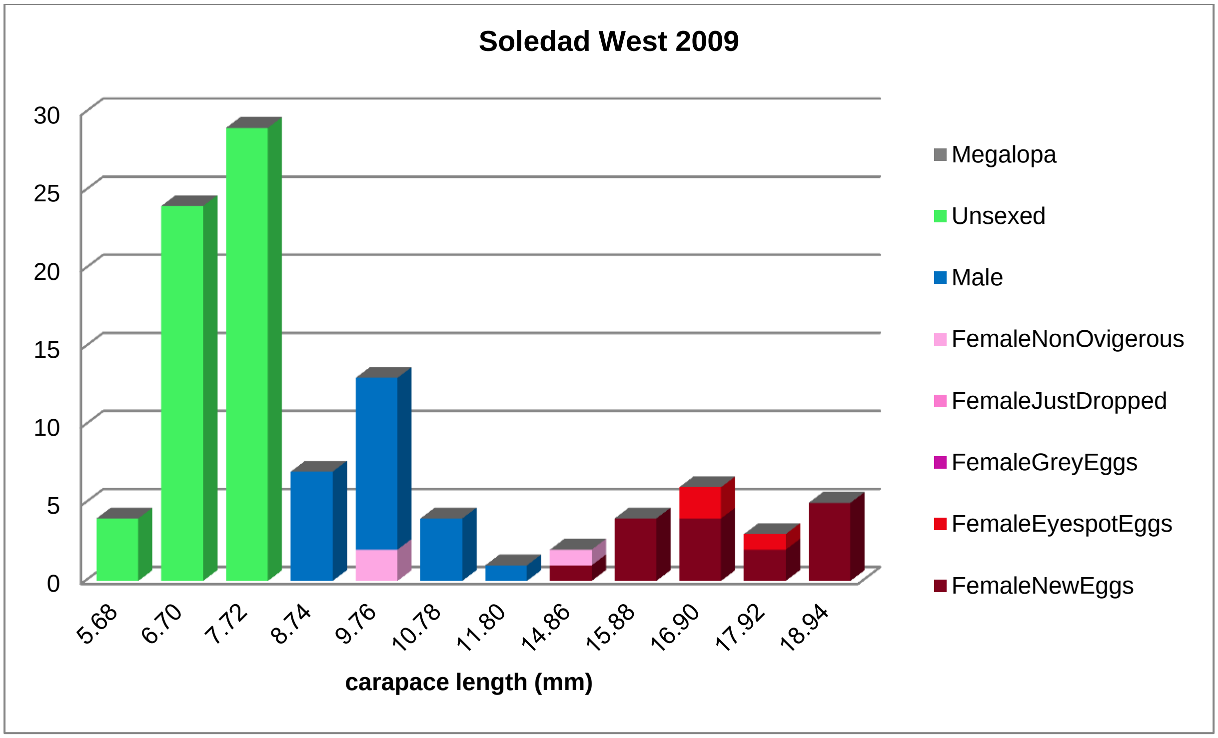
Table A-9. (continued) Reproductive status of Emerita analoga by size class at Soledad West.

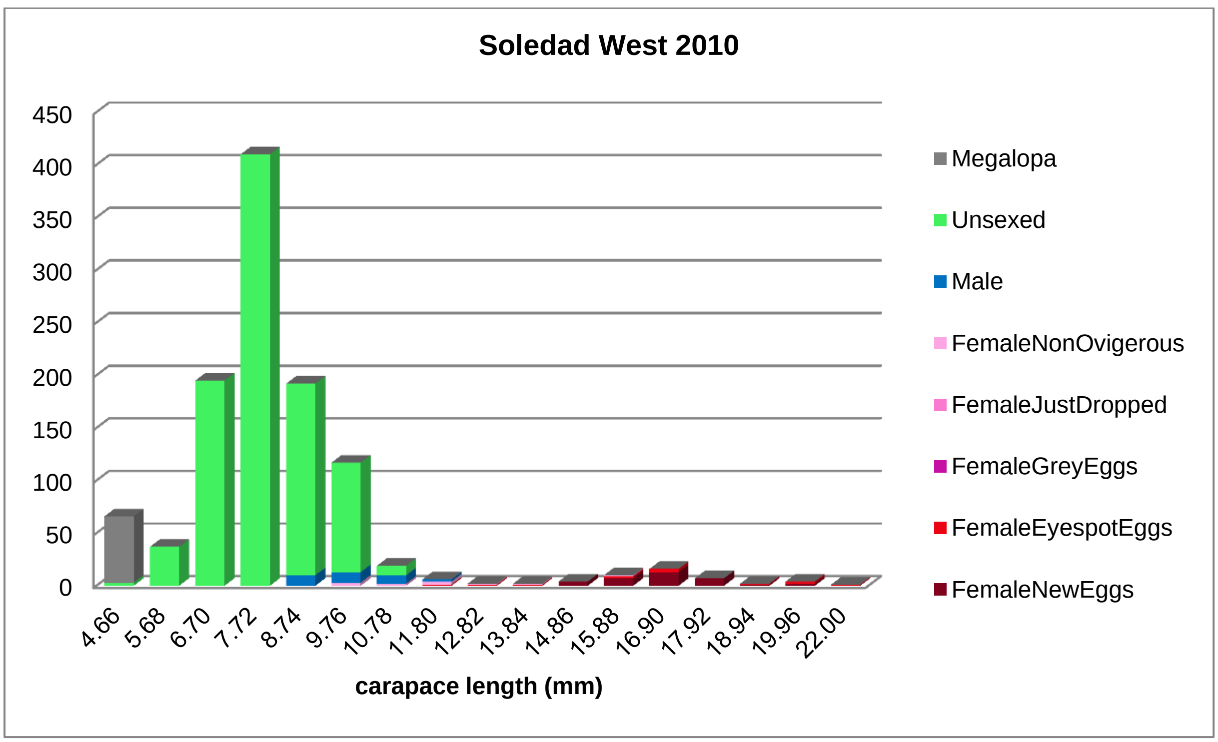
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2010	SW	4.66	0	0	0	0	0	0	3	63
2010	SW	5.68	0	0	0	0	0	0	37	0
2010	SW	6.70	0	0	0	0	0	0	195	0
2010	SW	7.72	0	0	0	0	0	0	410	0
2010	SW	8.74	0	0	0	0	0	10	182	0
2010	SW	9.76	0	0	0	0	3	10	104	0
2010	SW	10.78	0	0	0	0	2	8	9	0
2010	SW	11.80	0	1	0	0	3	2	0	0
2010	SW	12.82	0	1	0	0	1	0	0	0
2010	SW	13.84	0	1	0	0	1	0	0	0
2010	SW	14.86	4	0	0	0	0	0	0	0
2010	SW	15.88	7	2	0	0	1	0	0	0
2010	SW	16.90	13	3	0	0	0	0	0	0
2010	SW	17.92	7	0	0	0	0	0	0	0
2010	SW	18.94	1	1	0	0	0	0	0	0
2010	SW	19.96	2	2	0	0	0	0	0	0
2010	SW	22.00	0	1	0	0	0	0	0	0
2011	SW	4.66	0	0	0	0	0	0	10	0
2011	SW	5.68	0	0	0	0	0	0	11	0
2011	SW	6.70	0	0	0	0	0	0	123	0
2011	SW	7.72	0	0	0	0	0	0	325	0
2011	SW	8.74	0	0	0	0	0	10	116	0
2011	SW	9.76	0	0	0	0	0	10	75	0
2011	SW	10.78	0	0	0	0	4	6	41	0
2011	SW	11.80	0	0	0	0	2	1	0	0
2011	SW	12.82	0	0	0	0	2	0	0	0
2011	SW	13.84	2	0	1	0	0	0	0	0
2011	SW	14.86	1	2	0	0	1	0	0	0
2011	SW	15.88	5	3	0	0	0	0	0	0
2011	SW	16.90	7	1	0	0	0	0	0	0
2012	SW	4.66	0	0	0	0	0	0	12	0
2012	SW	5.68	0	0	0	0	0	0	30	0
2012	SW	6.70	0	0	0	0	0	0	104	0
2012	SW	7.72	0	0	0	0	0	0	71	0
2012	SW	8.74	0	0	0	0	0	10	13	0
2012	SW	9.76	0	0	0	0	1	4	0	0
2012	SW	11.80	0	0	0	0	3	1	0	0
2012	SW	12.82	0	0	0	0	3	0	0	0

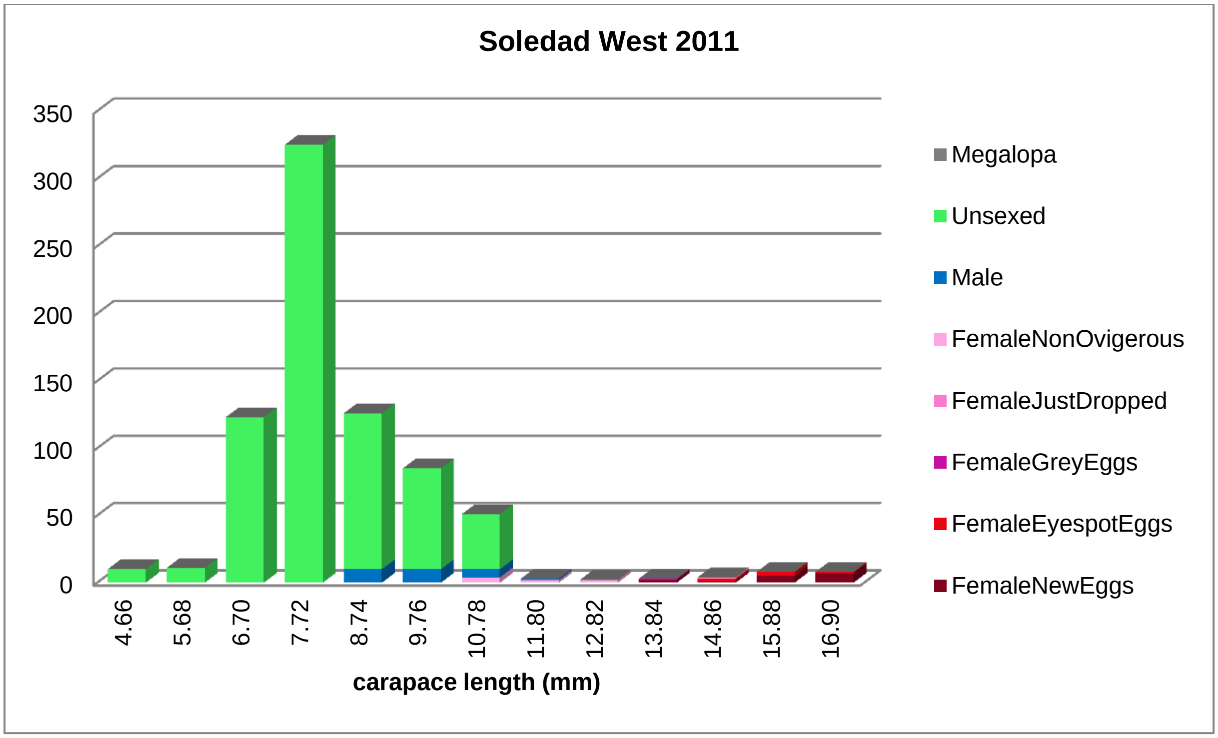
Table A-9. (continued) Reproductive status of Emerita analoga by size class at Soledad West.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2012	SW	13.84	4	0	0	0	3	0	0	0
2012	SW	14.86	0	1	0	0	1	0	0	0
2012	SW	17.92	2	0	0	0	0	0	0	0




Soledad West 2009
30
25
20
15
10
5
0
5.68
6.70
7.72
8.74
9.76
10.78
11.80
14.86
15.88
16.90
17.92
18.94
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Soledad West 2010
450
400
350
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
22.00
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Soledad West 2011
350
300
250
200
150
100
50
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

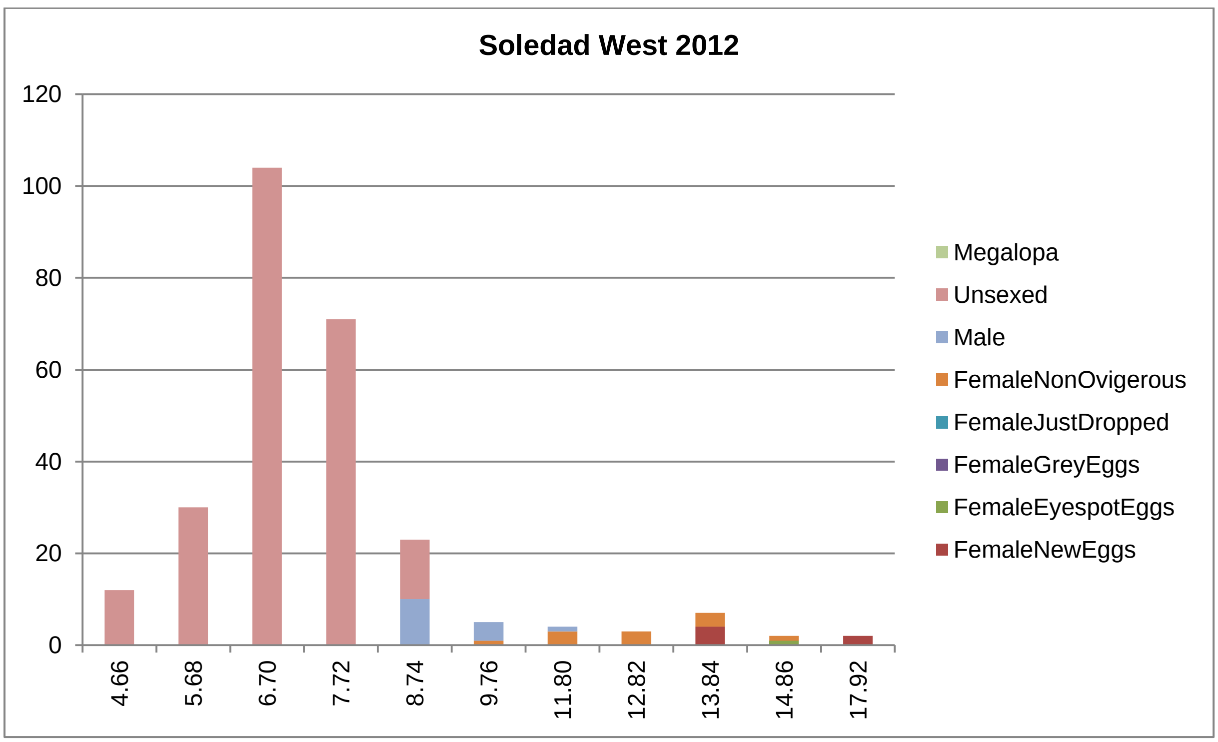
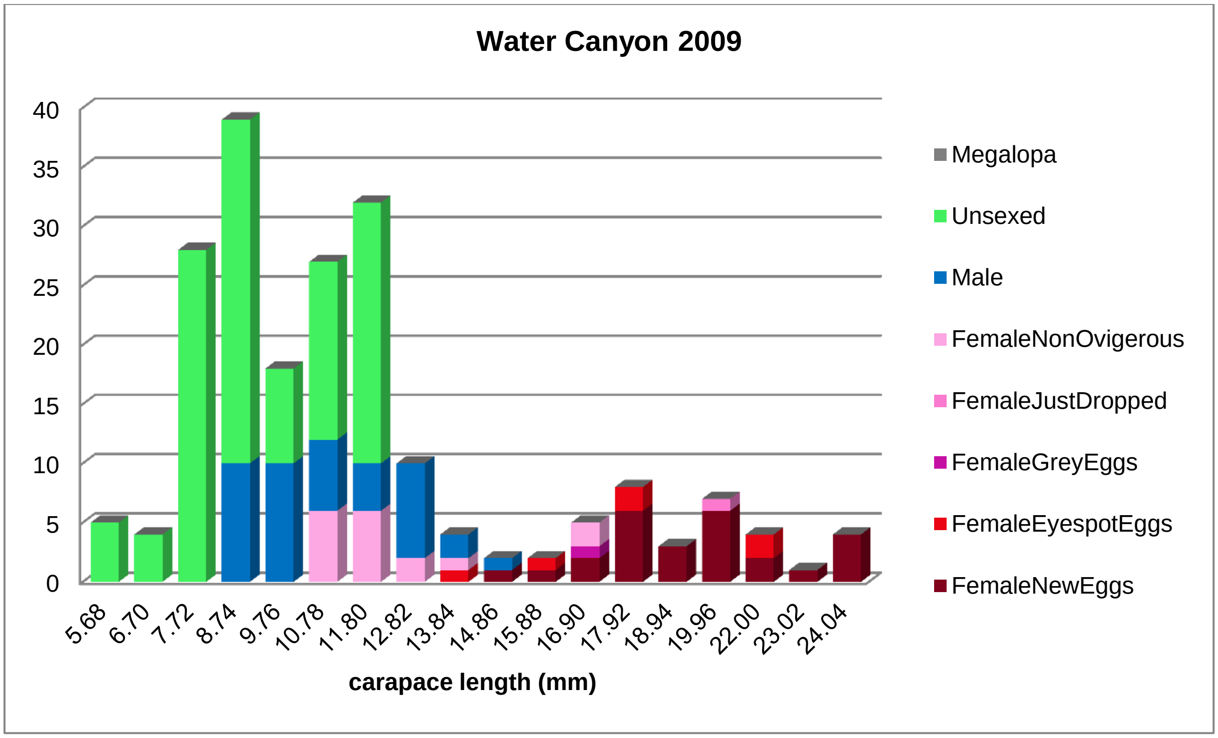

Soledad West 2012
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
11.80
12.82
13.84
14.86
17.92
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

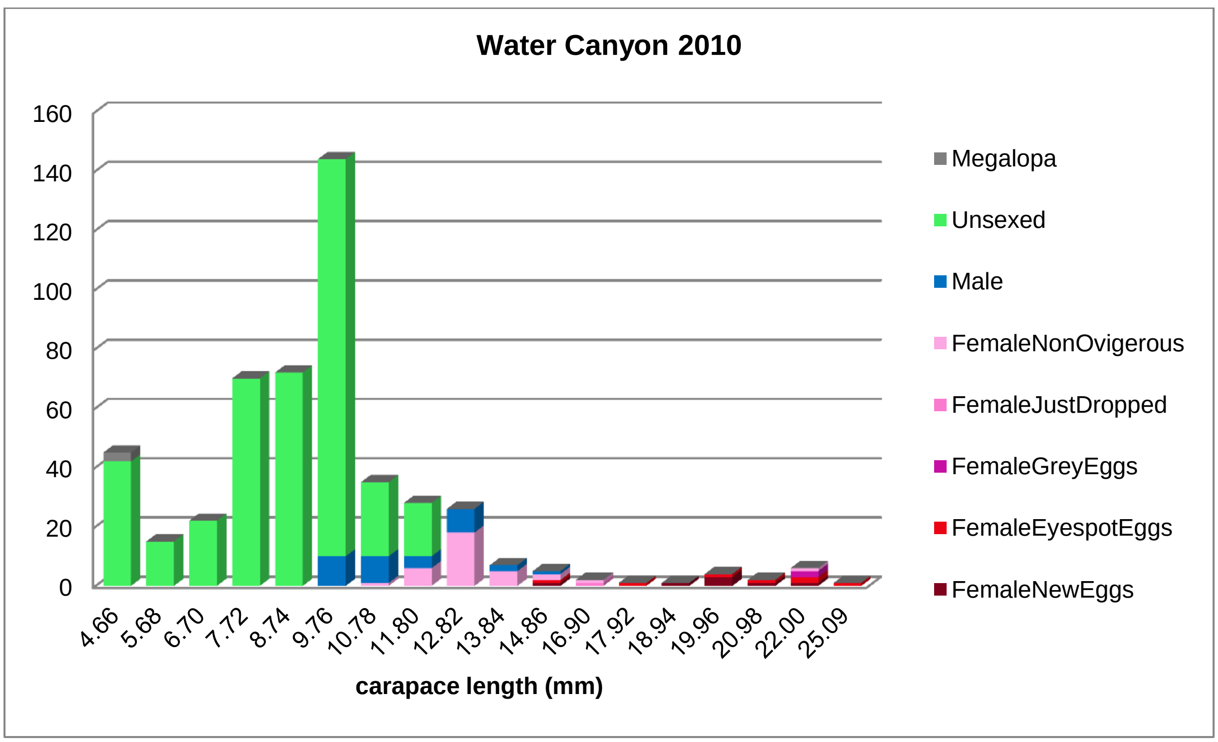
Table A-10. Reproductive status of *Emerita analoga* by size class at Water Canyon.

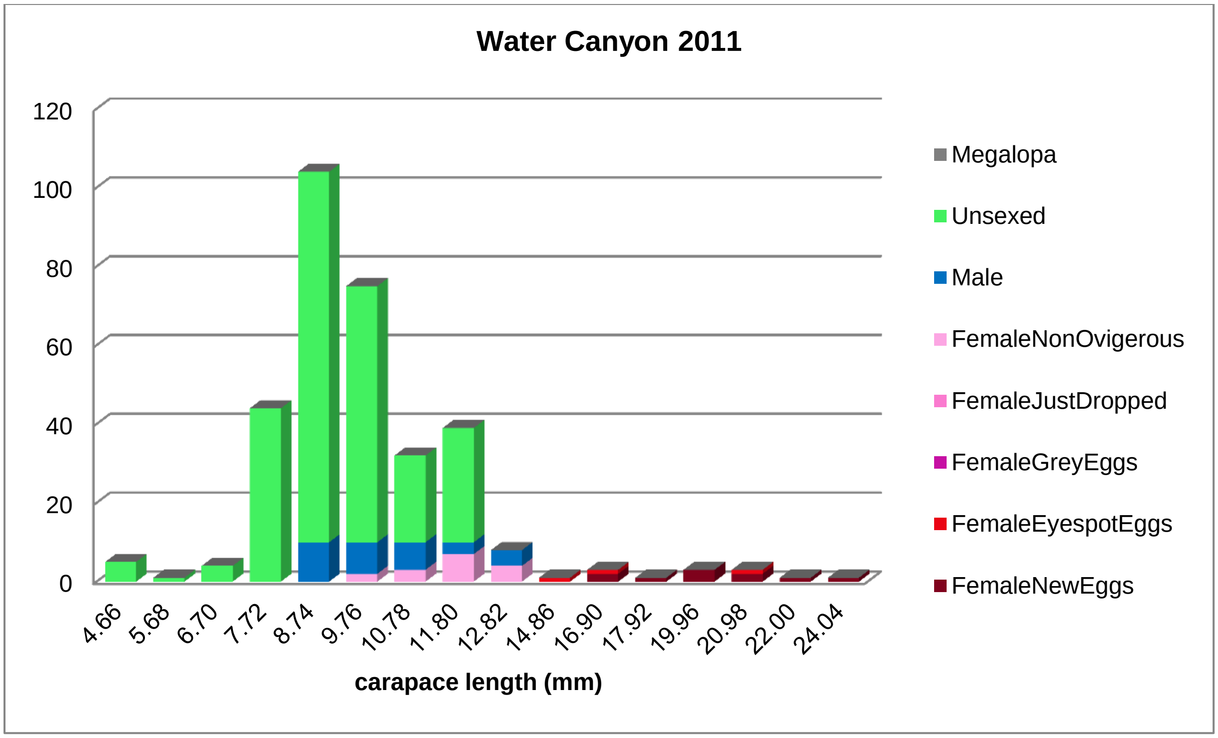
Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2007	WC	5.68	0	0	0	0	0	0	3	0
2007	WC	7.72	0	0	0	0	0	0	9	0
2007	WC	8.74	0	0	0	0	0	30	7	0
2007	WC	9.76	0	0	0	0	0	30	89	0
2007	WC	10.78	0	0	0	0	0	30	119	0
2007	WC	11.80	0	0	0	0	0	30	58	0
2007	WC	12.82	0	0	0	0	0	30	105	0
2007	WC	13.84	0	0	0	0	9	52	0	0
2007	WC	14.86	0	0	0	0	13	20	0	0
2007	WC	15.88	1	0	0	0	10	6	0	0
2007	WC	16.90	0	1	0	0	4	2	0	0
2007	WC	17.92	6	2	0	0	8	1	0	0
2007	WC	18.94	1	0	1	0	2	0	0	0
2007	WC	19.96	10	5	3	0	2	0	0	0
2007	WC	20.98	4	0	0	0	0	0	0	0
2007	WC	22.00	6	0	2	0	2	0	0	0
2007	WC	23.02	3	1	1	0	2	0	0	0
2007	WC	24.04	7	0	0	0	1	0	0	0
2007	WC	25.09	1	2	1	0	4	0	0	0
2007	WC	27.10	2	0	0	0	0	0	0	0
2009	WC	5.68	0	0	0	0	0	0	5	0
2009	WC	6.70	0	0	0	0	0	0	4	0
2009	WC	7.72	0	0	0	0	0	0	28	0
2009	WC	8.74	0	0	0	0	0	10	29	0
2009	WC	9.76	0	0	0	0	0	10	8	0
2009	WC	10.78	0	0	0	0	6	6	15	0
2009	WC	11.80	0	0	0	0	6	4	22	0
2009	WC	12.82	0	0	0	0	2	8	0	0
2009	WC	13.84	0	1	0	0	1	2	0	0
2009	WC	14.86	1	0	0	0	0	1	0	0
2009	WC	15.88	1	1	0	0	0	0	0	0
2009	WC	16.90	2	0	1	0	2	0	0	0
2009	WC	17.92	6	2	0	0	0	0	0	0
2009	WC	18.94	3	0	0	0	0	0	0	0
2009	WC	19.96	6	0	0	1	0	0	0	0
2009	WC	22.00	2	2	0	0	0	0	0	0
2009	WC	23.02	1	0	0	0	0	0	0	0
2009	WC	24.04	4	0	0	0	0	0	0	0

Table A-10. (continued) Reproductive status of *Emerita analoga* by size class at Water Canyon.

Year	Site Code	Size (mm)	Female w/ New Eggs	Female w/ Eyespot Eggs	Female w/ Grey Eggs	Female w/ Just Dropped Eggs	Female Non Ovigerous	Male	Unsexed	Megalopa
2010	WC	4.66	0	0	0	0	0	0	42	3
2010	WC	5.68	0	0	0	0	0	0	15	0
2010	WC	6.70	0	0	0	0	0	0	22	0
2010	WC	7.72	0	0	0	0	0	0	70	0
2010	WC	8.74	0	0	0	0	0	0	72	0
2010	WC	9.76	0	0	0	0	0	10	134	0
2010	WC	10.78	0	0	0	0	1	9	25	0
2010	WC	11.80	0	0	0	0	6	4	18	0
2010	WC	12.82	0	0	0	0	18	8	0	0
2010	WC	13.84	0	0	0	0	5	2	0	0
2010	WC	14.86	1	1	0	0	2	1	0	0
2010	WC	16.90	0	0	0	1	1	0	0	0
2010	WC	17.92	0	1	0	0	0	0	0	0
2010	WC	18.94	1	0	0	0	0	0	0	0
2010	WC	19.96	3	1	0	0	0	0	0	0
2010	WC	20.98	1	1	0	0	0	0	0	0
2010	WC	22.00	1	2	2	0	1	0	0	0
2010	WC	25.09	0	1	0	0	0	0	0	0
2011	WC	4.66	0	0	0	0	0	0	5	0
2011	WC	5.68	0	0	0	0	0	0	1	0
2011	WC	6.70	0	0	0	0	0	0	4	0
2011	WC	7.72	0	0	0	0	0	0	44	0
2011	WC	8.74	0	0	0	0	0	10	94	0
2011	WC	9.76	0	0	0	0	2	8	65	0
2011	WC	10.78	0	0	0	0	3	7	22	0
2011	WC	11.80	0	0	0	0	7	3	29	0
2011	WC	12.82	0	0	0	0	4	4	0	0
2011	WC	14.86	0	1	0	0	0	0	0	0
2011	WC	16.90	2	1	0	0	0	0	0	0
2011	WC	17.92	1	0	0	0	0	0	0	0
2011	WC	19.96	3	0	0	0	0	0	0	0
2011	WC	20.98	2	1	0	0	0	0	0	0
2011	WC	22.00	1	0	0	0	0	0	0	0
2011	WC	24.04	1	0	0	0	0	0	0	0


Water Canyon 2009
40
35
30
25
20
15
10
5
0
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
15.88
16.90
17.92
18.94
19.96
22.00
23.02
24.04
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Water Canyon 2010
160
140
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
13.84
14.86
16.90
17.92
18.94
19.96
20.98
22.00
25.09
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs


Water Canyon 2011
120
100
80
60
40
20
0
4.66
5.68
6.70
7.72
8.74
9.76
10.78
11.80
12.82
14.86
16.90
17.92
19.96
20.98
22.00
24.04
carapace length (mm)
Megalopa
Unsexed
Male
FemaleNonOvigerous
FemaleJustDropped
FemaleGreyEggs
FemaleEyespotEggs
FemaleNewEggs

Appendix B: *Olivella biplicata*

Table B-1. *Olivella biplicata* size distribution at Southeast Anchorage in 2009 and 2011

Year	*length (mm)*	*Count*	*Year*	*length (mm)*	*Count*
2009	4	0	2011	4	0
2009	5	0	2011	5	0
2009	6	2	2011	6	0
2009	8	4	2011	8	0
2009	9	7	2011	9	0
2009	10	42	2011	10	0
2009	12	84	2011	12	0
2009	13	62	2011	13	1
2009	14	61	2011	14	6
2009	16	61	2011	16	0
2009	17	89	2011	17	4
2009	18	166	2011	18	32
2009	20	150	2011	20	49
2009	21	93	2011	21	31
2009	22	25	2011	22	20
2009	23	8	2011	23	5
2009	25	1	2011	25	0
2009	26	0	2011	26	0
2009	28	0	2011	28	0
2009	29	0	2011	29	0
2009	30	0	2011	30	0

Table B-2. *Olivella biplicata* abundance on transects at Southeast Anchorage.

Year	*Site Code*	*Transect*	*Length*	*Cores*	*Olivella*	*Emerita*	*Polychaetes*	*Isopods*
2009	SE	1	15.0	20	138	0	1	0
2009	SE	2	15.0	20	290	0	2	0
2009	SE	3	15.0	20	52	1	3	1
2009	SE	4	15.0	20	167	0	6	0
2009	SE	5	15.0	20	262	0	2	3
2009		*mean*	*15.0*	*20.0*	*181.8*	*.2*	*2.8*	*.8*
2011	SE	1	11.6	15		88		
2011	SE	2	11.4	15	13	83		9
2011	SE	3	11.6	15	5	70	2	1
2011	SE	4	11.6	15	8	33	1	1
2011	SE	5	13.6	15	6	81		
2011		*mean*	*12.0*	*15.0*	*8.0*	*71.0*	*1.5*	*3.7*

Appendix C: Lagoon Physical Data

Table C-1. Physical data for lagoons 2009-2012. OR= Old Ranch Canyon, ORH= Old Ranch House Canyon. See handbook for station locations within each lagoon.

Year	*Site*	*Station*	*Date*	*Depth (m)*	*Temperature Surface (°C)*	*Temperature 10cm (°C)*	*Salinity Surface (ppt)*	*Salinity 10cm (ppt)*
2009	OR	1	7/28/2009	0.2	28.0	28.0	42	40
2009	OR	2	7/28/2009	0.4	26.5	26.0	41	41
2010	OR	1	8/20/2010	0				
2010	OR	2	8/20/2010	8.5	30.9	26.7	46	46
2010	OR	3	8/20/2010	87	26.5	26.1	45	42
2011	OR	1	8/10/2011	57	20.0	20.0	8	8
2011	OR	2	8/10/2011		20.0	19.5	17	21
2011	OR	3	8/10/2011	52	20.5	20.5	8	8
2011	OR	4	8/10/2011		22.5	22.5	8	8
2012	OR	1	8/15/2012		27.0	28.0	45	45
2012	OR	2	8/15/2012	0.3	26.0	26.0	43	44
2009	ORH	1	7/28/2009	0.12	27.0		46	
2009	ORH	2	7/28/2009	0.42	25.0	25.0	45	49
2009	ORH	3	7/28/2009	0.34	27.0	27.0	46	50
2009	ORH	4	7/28/2009	0.75	25.0	25.0	46	46
2009	ORH	5	7/28/2009	0.56	25.0	25.0	46	46
2010	ORH	1	8/20/2010	10	30.2	30.2	70	70
2010	ORH	2	8/20/2010	27.5	30.7	27.5	68	70
2010	ORH	3	8/20/2010	11	32.7	41.2	34	42
2010	ORH	4	8/20/2010	33.5	28.3	27.5	70	70
2010	ORH	5	8/20/2010	26.5	30.7	28.7	70	72
2011	ORH	1	8/10/2011		21.0	20.5	30	31
2011	ORH	2	8/10/2011		20.8	21.1	30	30
2011	ORH	3	8/10/2011		19.1	24.4	1	12
2011	ORH	4	8/10/2011		19.2	19.3	30	31
2011	ORH	5	8/10/2011		19.8	20.4	30	32
2012	ORH	1	8/15/2012		27.0	27.0	65	
2012	ORH	2	8/15/2012		30.0	28.0	61	63
2012	ORH	3	8/15/2012		30.0		59	59
2012	ORH	4	8/15/2012		26.0	24.0	60	60
2012	ORH	5	8/15/2012	<0.1	27.0	25.0	59	59

Appendix D: Beachwalk Survey Carcass Counts

Carcass counts from Beachwalk surveys 2006-2012. Carcasses were identified to species when possible. Pinnipeds were mostly California sea lions followed by northern elephant seals.

Table D-1. Number and types of carcasses found in Beachwalk surveys 2007-2012.

Year	Carcass type	count	Number with tar	Notes
2006	birds	9		
2006	fish	1		
2006	pinnipeds	22		
2006	deer	2		
2006	**total**	**34**		
2007	birds	28	1	
2007	fish	1		Mola
2007	pinnipeds	65	3	
2007	cetacean	4		Blue whale and calf, common dolphin,
2007	sea otter	1		
2007	mollusk	2		Sea hare
2007	deer	1		
2007	**total**	**102**		
2008	birds	11	3	
2008	fish	6		Mola
2008	pinnipeds	15	1	
2008	cetacean	2		Northern right-whale dolphin, blue whale (from 2007)
2008	mollusk	1		Sea hare
2008	**total**	**30**		
2009	birds	22	1	
2009	fish	3		Mola, rockfish, thornback ray
2009	pinnipeds	71	3	
2009	unidentified	1		
2009	**total**	**97**		
2010	birds	14		
2010	fish	6		Molas
2010	pinnipeds	14	1	
2010	cetacean	5		Risso’s dolphin, gray whale, common dolphin
2010	invertebrate	2		Jelly-fish
2010	**total**	**41**		
2011	birds	63	2	

Year	Carcass type	count	Number with tar	Notes
2011	fish	6		Molas, swellshark
2011	pinnipeds	21	1	
2011	cetacean	2		Northern right-whale dolphin, common dolphin
2011	unid	1		
2011	**total**	**93**		
2012	birds	12		
2012	fish	1		
2012	pinnipeds	8		
2012	cetacean	0		
2012	**total**	**21**		

Appendix E: Beachwalk Survey Bird and Pinniped Counts

Beachwalk live bird and pinniped counts from Santa Rosa and San Miguel Islands 2006-2012. Some categories were combined for presentation. Pinnipeds includes elephant seals, harbor seals and California sea lions; Shore birds includes black turnstone, killdeer, wandering tattler, sandpipers, sanderling, semi-palmated plover, long-billed curlew, long-billed dowitcher, dunlin, whimbrel, willet, marbled godwit; water birds includes great blue heron, great egret, brant, swan, black-necked stilt; seabirds includes cormorants, brown pelican, brown booby, and royal tern; raptors includes bald eagle, peregrine falcon, red-tailed hawk, burrowing owl, and osprey.

Table E-1. Live birds and pinnipeds from Beachwalk surveys 2006.

		pinnipeds-	black oystercatcher	black bellied plover	snowy plover	shorebirds-	common raven	ducks and coots	gulls	songbird	water birds-	seabirds-	raptor
1/11/2006	China camp												
1/12/2006	Bee rock	216			81	5				1	0	0	
1/12/2006	Sandy point	60				0					0	0	
1/13/2006	Skunk point	1		20	131	721	5	97		1	2	6	
1/15/2006	Arlington	9				0		105			0	0	
1/15/2006	Soledad	2				0					0	0	
1/16/2006	Mud tank	60				12					0	0	
1/16/2006	Water canyon					2		6			0	0	
1/24/2006	Cardwell point	500	2			0	10		100		0	0	
1/27/2006	Simonton	72	11			4	10		10	15	0	0	
1/28/2006	Cuyler harbor	175	2		2	6			60		0	0	
5/23/2006	Arlington					0		30	25		0	3	
5/23/2006	Tecalote		2			0		15			0	5	
5/24/2006	Skunk point		23		19	13	2	11	36		1	9	
11/28/2006	Skunk point		2		16	26		51			3	0	1
11/29/2006	Bee rock	9	2		46	22	3			10	0	0	
11/29/2006	China camp		2		75	21				161	4	0	
12/2/2006	Arlington					0		23			0	0	1
12/2/2006	Tecalote					0					0	0	
12/3/2006	Skunk point		10	278	76	452	1	71	50	44	1	15	
12/4/2006	Soledad				1	0					0	0	6

Table E-1 (continued). Live birds and pinnipeds from Beachwalk surveys 2007.

		pinnipeds-	black oystercatcher	black bellied plover	snowy plover	shorebirds-	common raven	ducks and coots	gulls	songbird	water birds-	seabirds-	raptor
1/10/2007	Bee Rock	54	2		98	24					0	0	
1/10/2007	China camp	153			70	7	8				0	0	1
1/10/2007	Mud tank	57			1	0					0	0	
1/12/2007	Arlington	6				0		3			0	0	
1/12/2007	Soledad	1				1		7	120		0	3	2
1/12/2007	Tecalote	1				0	60	207	100		0	0	
1/13/2007	Skunk point	81	11	401	48	301	4	20			1	0	
1/13/2007	Water canyon			1		13		9			0	0	
4/10/2007	Soledad					0	2		32		0	0	2
4/13/2007	Sandy point	163	3			30			300		0	0	
4/16/2007	Skunk point				1	13		46			9	0	
5/18/2007	Simonton		12			0			10		0	0	
5/21/2007	Cuyler harbor		3			0			50		0	0	
5/22/2007	Soledad					0			100		0	0	3
5/23/2007	Skunk point		27		13	0	1	27			5	0	
5/24/2007	Bee Rock	534	10		2	1	10		1	1	2	0	1
5/24/2007	Sandy point	100	4			0	22		6		0	0	
5/26/2007	Arlington					3	1	14			0	0	
5/26/2007	Tecalote					1	1	100			0	0	2
12/1/2007	Simonton					0			200		0	0	

Table E-1 (continued). Live birds and pinnipeds from Beachwalk surveys 2008.

		pinnipeds-	***black oystercatcher***	***black bellied plover***	***snowy plover***	***shorebirds-***	***common raven***	***ducks and coots***	***gulls***	***songbird***	***water birds-***	***seabirds-***	***raptor***
1/8/2008	Skunk point		15	164	75	375	4	14			1	2	
1/12/2008	China camp				100	0					0	0	1
5/8/2008	Simonton					2			11		0	0	
5/20/2008	Skunk point		39		6	5		19	40		1	0	
5/22/2008	Water canyon	1				0		2	8		0	0	
5/24/2008	Bee rock	154	8			0	1				0	80	
5/24/2008	China camp	500	4			0				2	0	0	
5/24/2008	Mud tank	225	23			0					0	0	
5/24/2008	Sandy point		9			0					0	0	
5/25/2008	Arlington					0		9			0	0	
5/25/2008	Skunk point		28		2	0		2			0	4	
5/25/2008	Soledad		7			0					0	0	
6/29/2008	Skunk point		23	4	8	1	5	15	36		0	130	
6/30/2008	Bee rock	31	2			0			2		0	0	
6/30/2008	China camp	100	2			1	8		4		1	150	

Table E-1 (continued). Live birds and pinnipeds from Beachwalk surveys 2009.

		pinnipeds-	black oystercatcher	black bellied plover	snowy plover	shorebirds-	common raven	ducks and coots	gulls	songbird	water birds-	seabirds-	raptor
1/7/2009	Skunk point		5	251	96	398	37	15	34		1	86	
1/8/2009	Bee rock		6		48	0	5		314		0	0	
1/8/2009	China camp	525	8		43	0	94		357	6	1	10	4
1/9/2009	Mud tank		6		7	0	4		83		1	97	1
1/9/2009	Sandy point					2	1		46		0	0	
1/10/2009	Arlington			3		4	1		35	2	0	0	
1/11/2009	Arlington	3		6		1	3		89	10	0	6	
1/12/2009	Soledad		5			6	4		14	6	0	0	5
1/12/2009	Tecalote	3				1		86	123		0	0	1
4/2/2009	Simonton	14	13			0	6		6		0	0	
4/24/2009	Bee rock	19	1			0					0	0	
4/24/2009	China camp	140	9			0	1				0	0	1
4/24/2009	Mud tank	8	3			0					0	0	
5/23/2009	Skunk point		21		9	0	1	5	293		6	93	
5/23/2009	Soledad		13			2	2		120		0	0	
5/24/2009	Bee rock	30				0					0	0	
5/24/2009	China camp	500				0	1				0	0	1
5/25/2009	Arlington					0		17			0	0	
5/25/2009	Tecalote					2	1	2	3		0	0	
7/24/2009	Skunk point		27	19		21	22	4	193	3	1	62	1

Table E-1 (continued). Live birds and pinnipeds from Beachwalk surveys 2010.

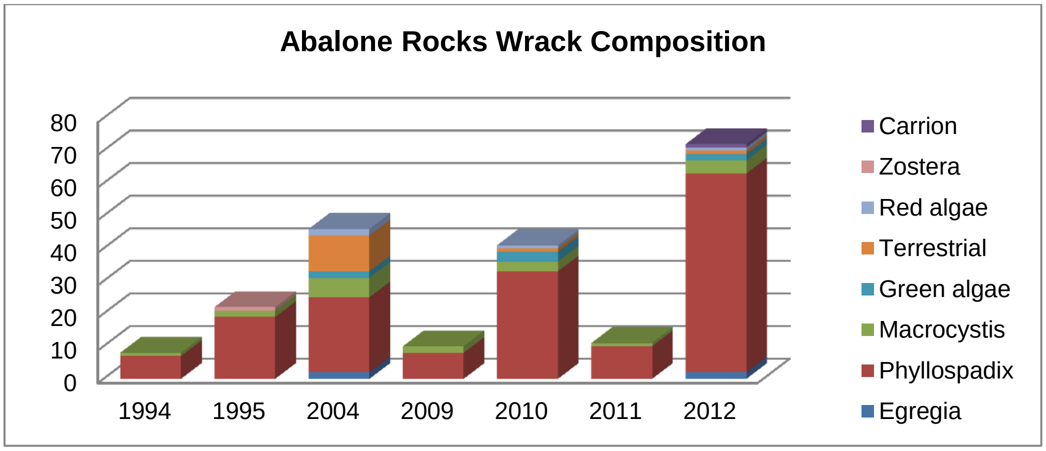
		pinnipeds-	*black oystercatcher*	*black bellied plover*	*snowy plover*	*shorebirds-*	*common raven*	*ducks and coots*	*gulls*	*songbird*	*water birds-*	*seabirds-*	*raptor*
1/15/2010	Skunk point	1	5	320	71	351	2		40		0	50	
1/16/2010	Bee rock				29	4	7				0	0	
1/16/2010	China camp	500	6			11	2		60	1	0	0	1
1/16/2010	Mud tank				8	0					0	0	
1/17/2010	Skunk point	1		100	205	200					0	0	
4/19/2010	Simonton	10	2			0					0	0	
5/31/2010	Skunk point	1	20		8	0	2	17	28		4	2	1
6/1/2010	Arlington					0		50	20		0	0	
6/1/2010	Bee rock	51	2			0					0	0	
6/1/2010	China camp	350	1			0	2		200		0	1	1
6/1/2010	Mud tank	25				0	2				0	0	1
6/1/2010	Tecalote					3	2				0	0	1
12/5/2010	Simonton		1	7		0			16		0	0	
12/7/2010	Cuyler harbor	6	1		4	0			8		0	0	

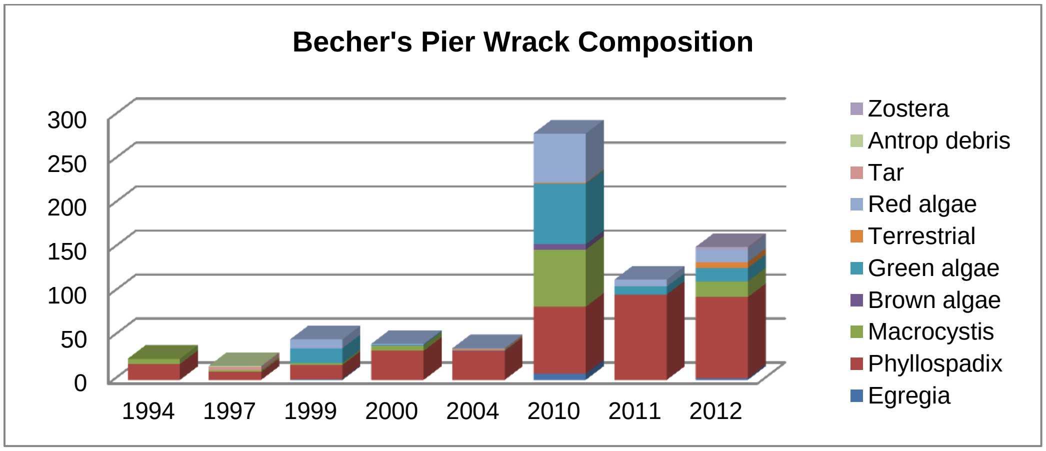
Table E-1 (continued). Live birds and pinnipeds from Beachwalk surveys 2011-2012, and summary.

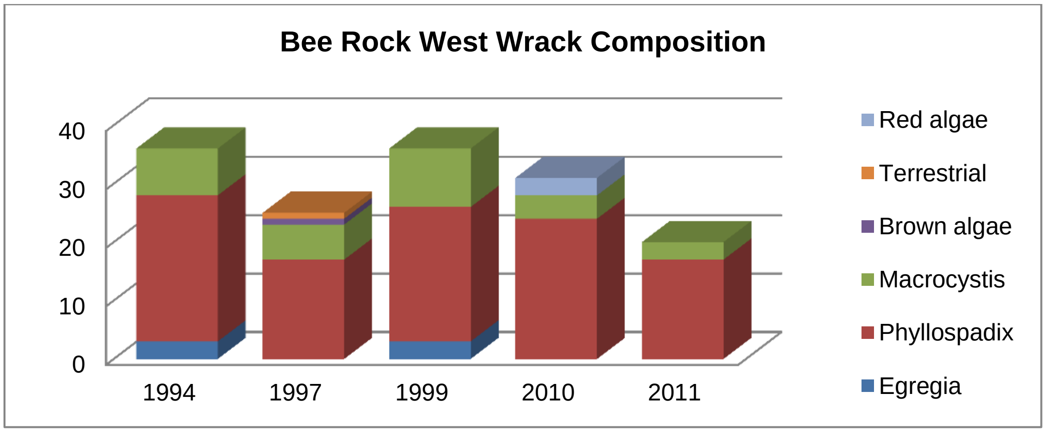
		pinnipeds-	**black oystercatcher**	**black bellied plover**	**snowy plover**	**shorebirds-**	**common raven**	**ducks and coots**	**gulls**	**songbird**	**water birds-**	**seabirds-**	**raptor**
2/7/2011	China camp					0	70		100		0	0	1
2/7/2011	Skunk point	6	19	80	203	207	7				1	0	1
6/3/2011	Arlington		3			0	1	50	50		0	1	
6/3/2011	Soledad		3			0	4		46		0	0	
6/4/2011	Skunk point		19		11	0	3	6	39		0	6	1
8/11/2011	Sandy point		3			0	6		2		0	0	
8/12/2011	China camp	100				0			5		0	0	1
8/16/2011	Skunk point		18		17	5	17		45		0	80	
8/17/2011	Soledad		1			0			4		0	0	
12/9/2011	Simonton	2	7	10		0			5		0	0	
1/15/2012	Skunk Point	1	10	44	202	64	4	34			2	80	
5/22/2012	Soledad		3				3	78	6				1
5/26/2012	Skunk Point		13	1	9	5	18	21	18		4		
5/27/2012	Bee Rock	106	3				5		9				
8/14/2012	Water Canyon								p			p	
8/16/2012	Sandy Point		5			4	3		3				
8/18/2012	Skunk Point		32	30	61	4	2		20			180	
All years	*count*	*49*	*62*	*18*	*38*	*109*	*54*	*37*	*58*	*14*	*107*	*108*	*27*
All years	*sum*	*5667*	*582*	*1739*	*1902*	*3357*	*503*	*1288*	*3735*	*263*	*52*	*1161*	*44*
All years	*mean*	*116*	*9*	*97*	*50*	*31*	*9*	*35*	*66*	*19*	*0*	*11*	*2*
All years	*median*	*51*	*6*	*25*	*24*	*0*	*4*	*17*	*36*	*5*	*0*	*0*	*1*

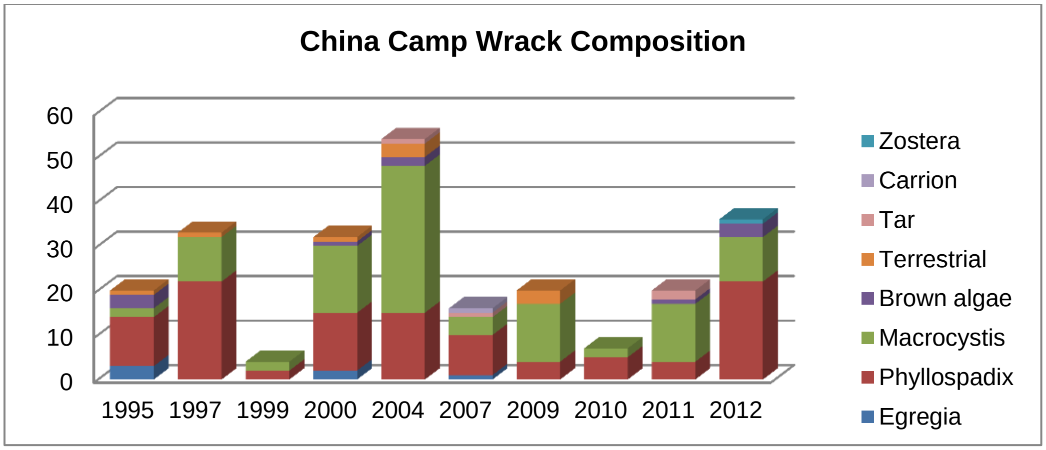
Appendix F: Macrophyte Wrack Annual Trends in Composition

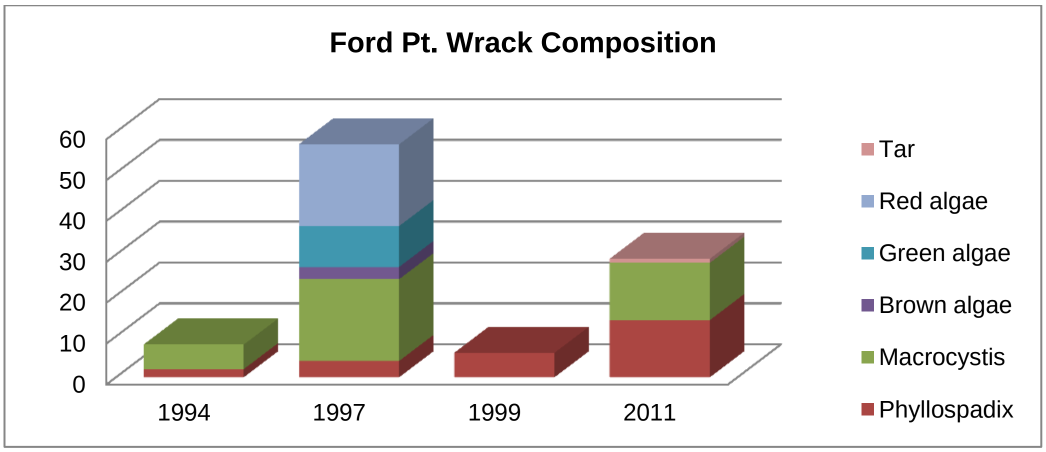
The following charts show the composition of Macrophyte wrack observed on transects from 1994-2012. The values represent the actual number of point intercepts for each category (equivalent to percent cover). The majority of wrack pile heights are only one centimeter but some categories may be higher and thus the volume would be greater. The heights are not presented here.

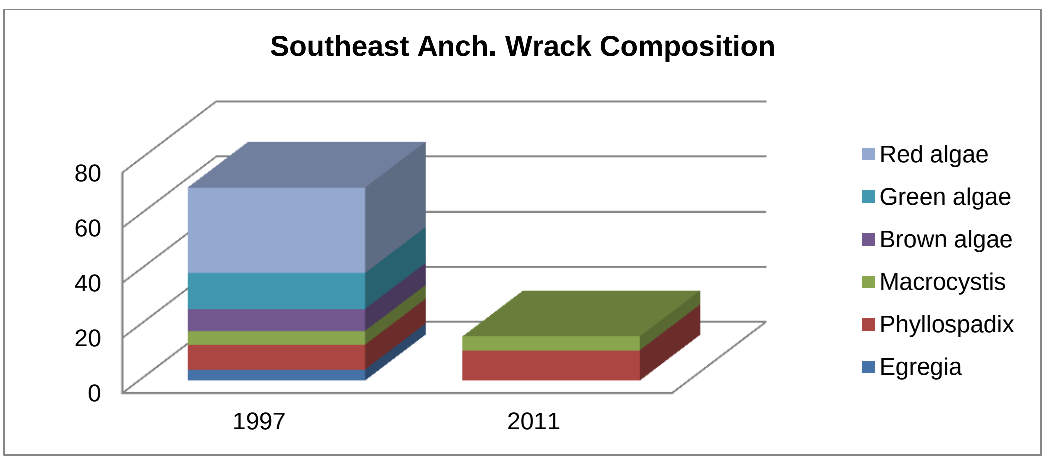


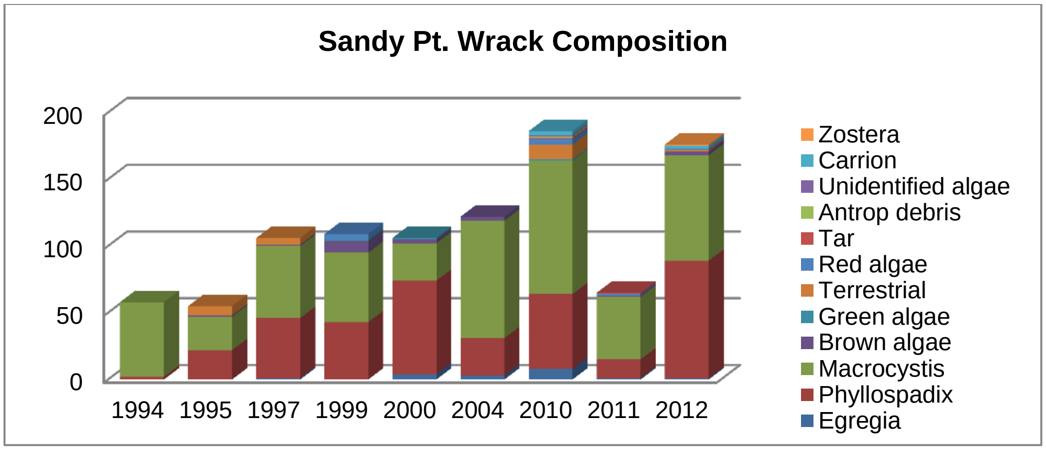


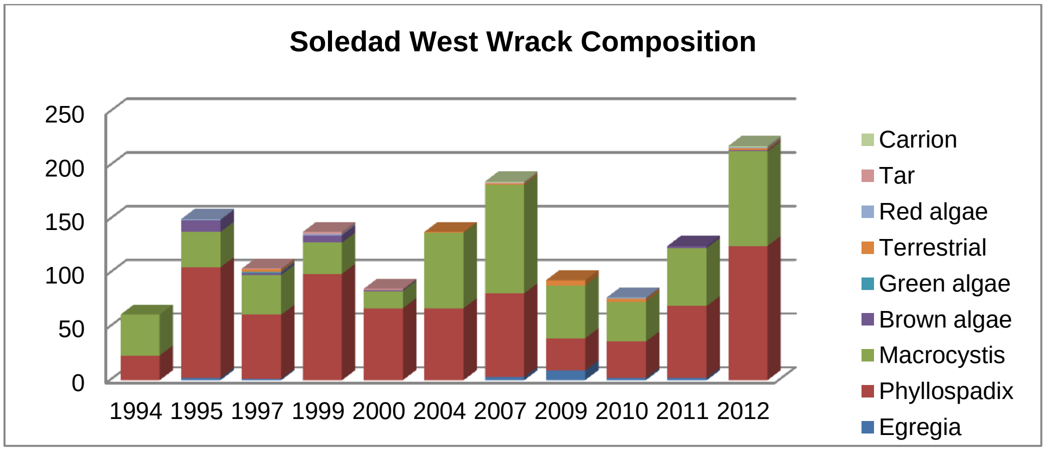


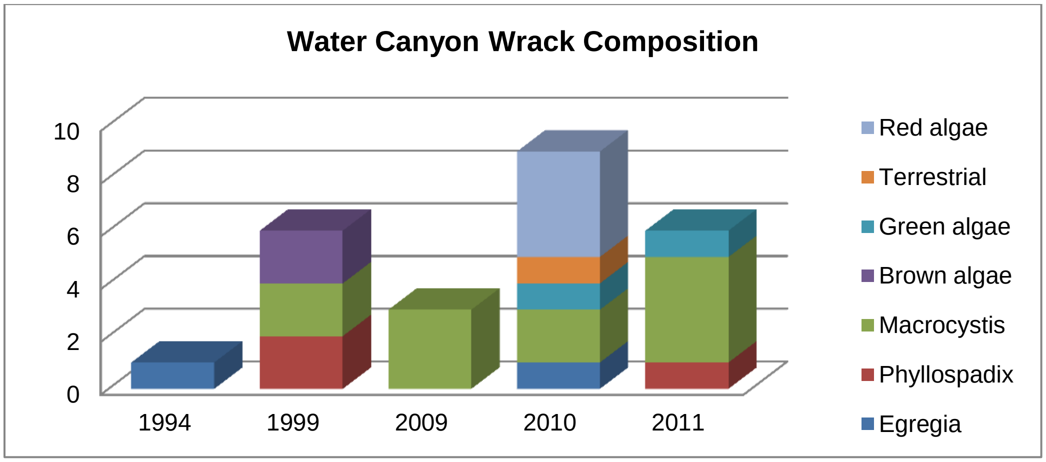

China Camp Wrack Composition
60
50
40
30
20
10
0
1995
1997
1999
2000
2004
2007
2009
2010
2011
2012
Zostera
Carrion
Tar
Terrestrial
Brown algae
Macrocystis
Phyllospadix
Egregia


Ford Pt. Wrack Composition
60
50
40
30
20
10
0
1994
1997
1999
2011
Tar
Red algae
Green algae
Brown algae
Macrocystis
Phyllospadix


Southeast Anch. Wrack Composition
80
60
40
20
0
1997
2011
Red algae
Green algae
Brown algae
Macrocystis
Phyllospadix
Egregia


Sandy Pt. Wrack Composition
200
150
100
50
0
1994 1995 1997 1999 2000 2004 2010 2011 2012
Zostera
Carrion
Unidentified algae
Antrop debris
Tar
Red algae
Terrestrial
Green algae
Brown algae
Macrocystis
Phyllospadix
Egregia


Soledad West Wrack Composition
250
200
150
100
50
0
1994 1995 1997 1999 2000 2004 2007 2009 2010 2011 2012
Carrion
Tar
Red algae
Terrestrial
Green algae
Brown algae
Macrocystis
Phyllospadix
Egregia


Water Canyon Wrack Composition
10
8
6
4
2
0
1994
1999
2009
2010
2011
Red algae
Terrestrial
Green algae
Brown algae
Macrocystis
Phyllospadix
Egregia

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