Annual Report of Activities
of the
Partnership for Interdisciplinary Studies of Coastal Oceans
within the
Monterey Bay National Marine Sanctuary

Submitted to:

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August 20, 2008

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Permitted Activities (as of September 22, 2005, Amendment 3 to Permit MBNMS-2005-018)

Disturbance of the seabed within the Monterey Bay National Marine Sanctuary (MBNMS) for the installation, maintenance, and recovery of scientific instrumentation and equipment as related to PISCO research projects.

Permit Duration

All activities between May 4, 2007 and December 31, 2009 are permitted under permit amendment MBNMS-2005-018-A4. Activities from June 28, 1999 to May 4, 2007 were covered under permit MBNMS-14-1999 and MBNMS-2005-018 and its Amendments: A1 through A3.

Summary of Project Activities

Information in this report is for calendar year 2007, or in some cases, for the one-year period April 5, 2007 through April 5, 2008. Detailed information on activity in prior years can be found in annual reports for 2006 and earlier.

Physical Oceanography Monitoring

Summary of activity prior to 2007:

Since 1999, PISCO has installed and operated moorings in nearshore waters of the MBNMS to obtain data on ocean temperatures and currents (Figure 1, Tables 1 and 2). An initial set of five temperature moorings were deployed in 1999 along the 20 meter isobath at the north end of Monterey Bay (Sand Hill Bluff and Terrace Point), at the south end of the bay (Hopkins Marine Station and Stillwater Cove), and at Point Sur along the Big Sur coast. The first four of these moorings also included bottom-mounted acoustic doppler current profiler (ADCP) current meters. In 2001 a sixth temperature mooring was added at Soquel Point inside the northern portion of Monterey Bay, and two more Big Sur temperature moorings were added in 2002 at San Simeon and White Rock. All of the moorings were serviced on roughly a 3-month interval to retrieve and redeploy temperature loggers and current meters and to monitor mooring condition. Temperature and current data from these moorings were used with biological data from PISCO's subtidal and intertidal study sites to characterize the effects of physical processes (e.g., upwelling and current variations, including inter-annual variability due to climatic phenomena such as El Niño/La Niña) on nearshore ecosystem structure and processes.

In 2005, in addition to continuing temperature and current monitoring using the existing mooring network, 11 new temperature moorings were installed for the MBNMS at sites from Pigeon Point and Año Nuevo in the northern end of the sanctuary to Point Sierra Nevada in the south (Figure 1, Table 1). These moorings were designed and installed similarly to the existing PISCO moorings, and were located to fill gaps in the existing network and to extend temperature measurements into deeper waters off of Terrace Point. These moorings were serviced by PISCO using the same procedures established previously for PISCO moorings. In 2006 normal servicing was continued at the eight PISCO moorings and the eleven MBNMS/PISCO moorings.

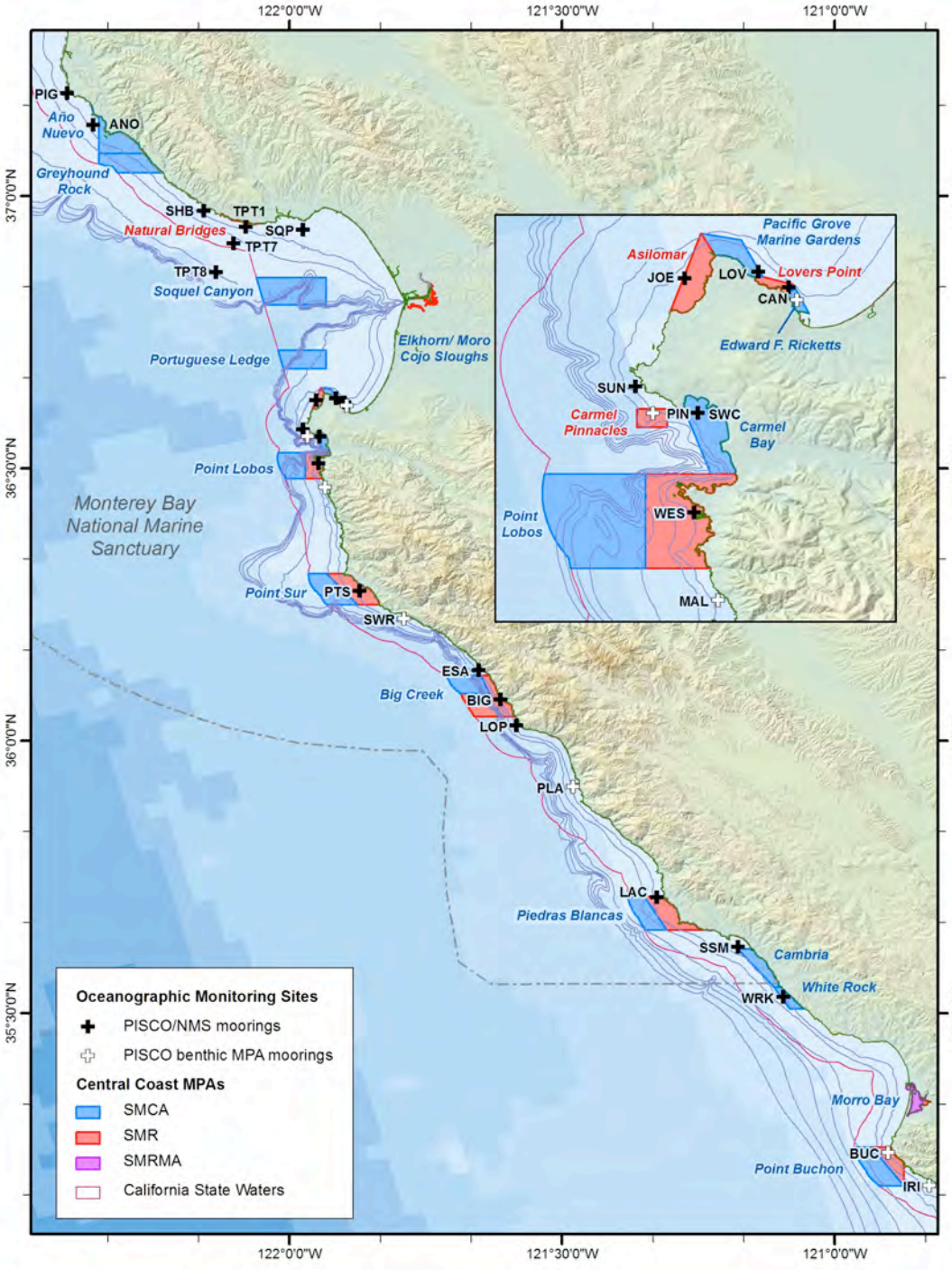

Figure 1. PISCO physical oceanography moorings operated in and adjacent to the MBNMS in 2007. Marine Protected Areas (MPAs) also are shown for reference.

Table 1. Long-term mooring deployments in and adjacent to the MBNMS, 1999 - 2007.

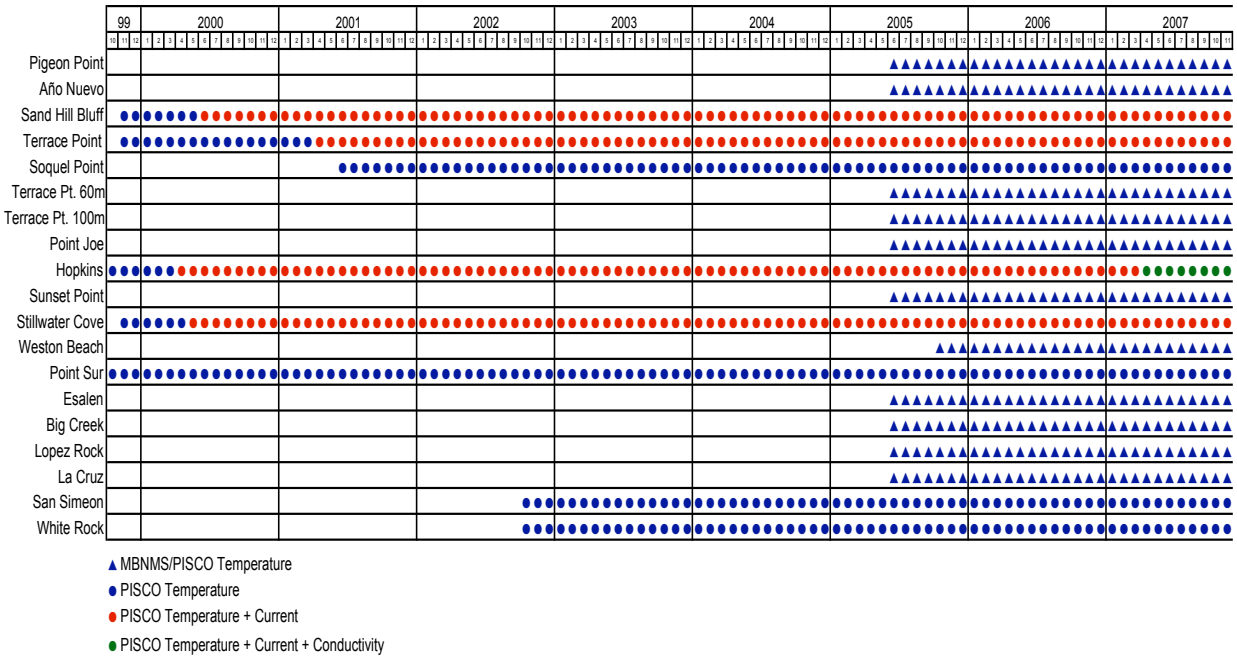

Table 2. Summary data for long-term physical oceanography moorings in and adjacent to the MBNMS, 2007. D = depth, TL = Temperature Logger, ADCP = Acoustic Doppler Current Profiler, CT = Conductivity and Temperature logger.

Site	Code	D (m)	Latitude	Longitude	Instruments
Pigeon Point	PIG	21	37° 11.34' N	122° 24.49'W	7 TL
Año Nuevo	ANO	21	37° 7.836'N 122°	21.617'W	7 TL
Sand Hill Bluff	SHB	21	38° 56.315'N	121° 58.51'W	7 TL, ADCP
Terrace Point	TPT1	18	37° 56.650'N	122° 4.781'W	7 TL, ADCP
Terrace Point	TPT7	60	37° 54.814'N	122° 6.303'W	11 TL
Terrace Point	TPT8	100	36° 51.626'N	122° 8.089'W	13 TL
Soquel Point	SQP	21	37° 56.315'N	121° 58.51'W	7 TL
Hopkins	HMS	20	36° 37.286'N	121° 53.976'W	7 TL, ADCP,CT
Point Joe	JOE	23	36° 37.554'N	121° 57.073'W	7 TL
Sunset Point	SUN	26	36° 34.321'N	121° 58.544'W	7 TL
Stillwater Cove	SWC	22	37° 33.537'N	121° 56.681'W	7 TL, ADCP
Weston Beach	WES	30	37° 30.564'N	121° 56.799'W	9 TL
Point Sur	PTS	21	37° 16.557'N	121° 52.313'W	7 TL
Esalen	ESA	25	36° 7.819'N	121° 39.179'W	7 TL
Big Creek	BIG	26	36° 4.595'N	121° 36.812'W	7 TL
Lopez Rock	LOP	26	36° 1.709'N	121° 35.004'W	7 TL
La Cruz	LAC	23	35° 42.807'N	121° 19.595'W	7 TL
San Simeon	SSM	22	35° 37.338'N	121° 10.638'W	7 TL
White Rock	WRK	24	36° 31.816'N	121° 5.668'W	7 TL

2007 activity:

In 2007 no new long-term moorings were installed, and with the exception of adding a Seabird SBE37 conductivity/temperature recorder to the Hopkins mooring, activity associated with the mooring network was limited to normal servicing and maintenance.

2007 PISCO-wide Coupled Biophysical Processes Study

Summary of activity prior to 2007:

This was a one-year project initiated in 2007. Therefore, there is no activity prior to 2007.

2007 activity:

From 5/16/07 to 9/19/07, a study was conducted off the northern end of Monterey Bay to assess the coupling between physical oceanographic processes and fish and invertebrate recruitment to nearshore subtidal and intertidal communities. This study involved the deployment of 16 temporary moorings and associated instruments (Figure 2, Table 3), as well as an AWAC wave and current meter that was deployed at 15 m depth on the Terrace Point line from 6/28/07 to 7/30/07. All of the moorings were configured, deployed and retrieved using procedures similar to those used for the existing long-term moorings. Bottom-mounted ADCPs, wave gauges, and the AWAC were mounted on weighted frames and lowered to the bottom.

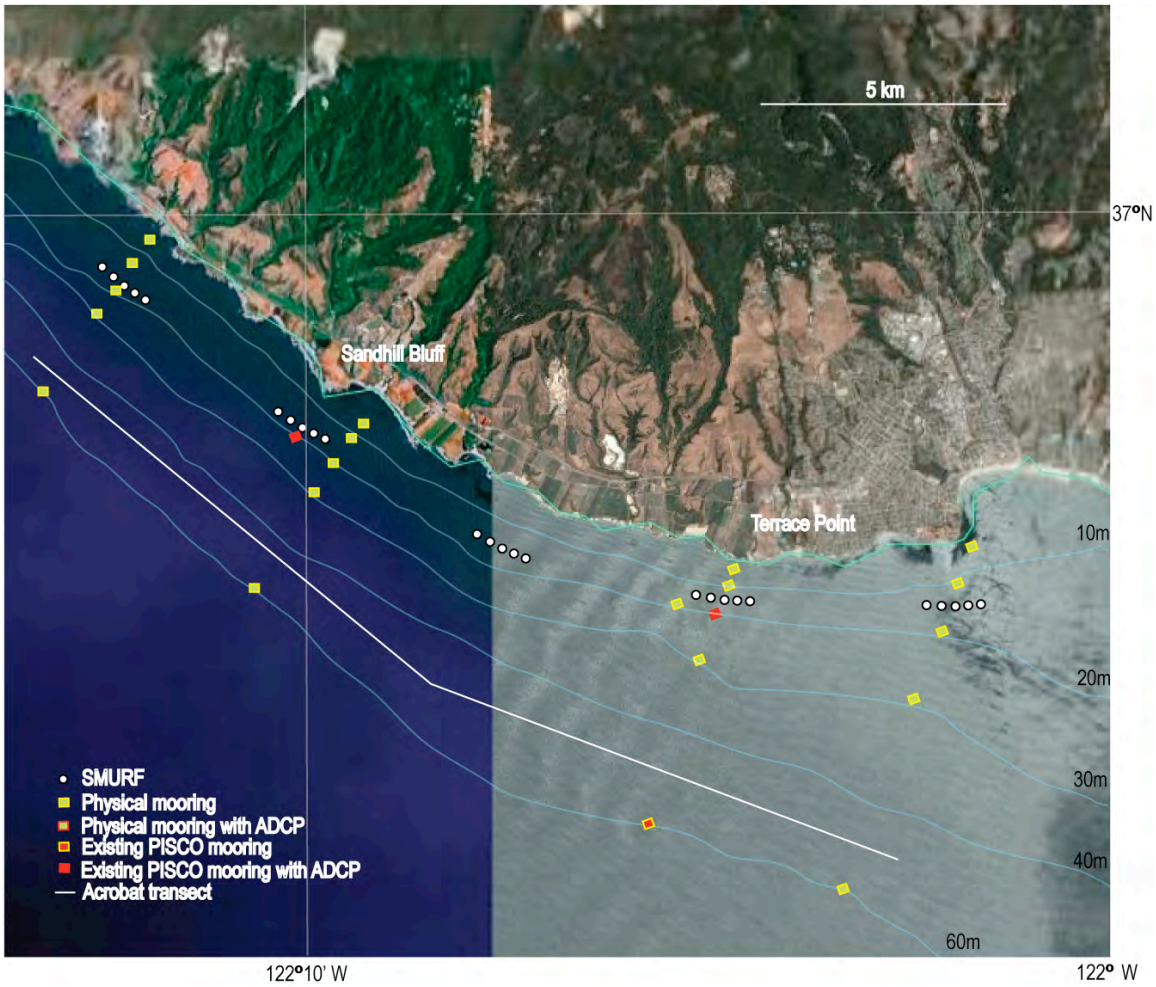

Figure 2. Map of study site and deployment array near Terrace Point and Sandhill Bluff in in northern Monterey Bay.

Table 3. Moorings and equipment deployed for coupled biophysical process study.

Mooring ID	Depth (m)	Lat, ºN	Lon., ºW	Anchor/Mount
Lighthouse Point				
LHP010	10	36.944	122.028	Mooring anchor
LHP020	20	36.936	122.031	6 Mooring Anchors and ADCP Mount (5 for SMURFs placed ~50m apart alongshore)
LHP030	30	36.926	122.034	Mooring anchor
LHP060	50	36.894	122.047	Mooring anchor
Terrace Point				
TPT010	10	36.945	122.078	Mooring anchor
TPT020 *existing*	20	36.944	122.080	6 Mooring Anchors and ADCP Mount (5 for SMURFs placed ~50m apart alongshore)
TPT020X	20	36.944	122.080	Mooring anchor
TPT030	30	36.933	122.084	Mooring anchor
TPT060	50	36.913	122.096	Mooring anchor
Sandhill Bluff				
SHB010	10	36.974	122.157	Mooring anchor
SHB020 *existing*	20	36.973	122.158	6 Mooring Anchors and ADCP Mount (5 for SMURFs placed ~50m apart alongshore)
SHB020X	20	36.973	122.158	Mooring anchor
SHB030	30	36.963	122.158	Mooring anchor
SHB060	50	36.949	122.180	Mooring anchor
North Sandhill				
NSB004	4	36.996	122.188	Mooring anchor
NSB010	10	36.992	122.192	Mooring anchor
NSB020	20	36.988	122.196	6 Mooring Anchors (5 for SMURFs placed ~50m apart alongshore)
NSB030	30	36.982	122.202	Mooring anchor

MPA Benthic Temperature Monitoring

Summary of activity prior to 2007:

This is a new project associated with our monitoring of kelp forest ecosystems for the MLPA marine protected area (MPA) monitoring program. Therefore, there is no activity prior to 2007.

2007 activity:

In October of 2007 seven new benthic moorings were deployed in roughly 20m of water in newly-designated State Marine Protected Areas (MPAs) and in nearby reference sites (Figure 1, Table 4). Moorings were deployed where existing PISCO moorings were unavailable or unsuitable for providing bottom-water temperature data. The new moorings consisted of poured concrete anchors (~30 lb) with 2 meters of polypropylene line and a small float. Two replicate Onset tidbit temperature loggers were attached to the line one meter above the bottom and programmed to record temperature every 15 minutes. Loggers will be recovered and new loggers deployed annually.

Table 4. MPA Benthic Temperature Mooring Locations.

Location	Code	Lat (ºN)	Lon (ºW)
Cannery	CAN	36.61	121.90
Pinnacles	PIN	36.56	121.97
Malpaso	MAL	36.47	121.93
South Wreck	SWR	36.22	121.79
Plasket	PLA	35.92	121.48
Pt Buchon	BUC	35.24	121.90
Little Irish	IRI	35.18	121.83

Kelp Forest and MPA Monitoring

Summary of activity prior to 2007:

Since the inception of PISCO in 1999, we have monitored kelp forest ecosystems at a growing number of sites throughout the MBNMS. Kelp forest ecosystem monitoring includes depth stratified quantitative surveys of the density of select fishes, macroinvertebrates and macroalgae and estimates of percent cover of select invertebrates and macroalgae. Surveys are conducted once each year at each site. Detailed descriptions of the sampling design, protocols and history are available at the PISCO kelp forest monitoring web site:
http://www.piscoweb.org/research/community/subtidal.
No permanent markers or instruments have been deployed in conjunction with these surveys with the exception of thermistors for monitoring benthic water temperature described in the previous section.

2007 activity:

In 2007, PISCO-UCSC was selected to monitor kelp forest communities inside and outside of the marine protected areas (MPAs) established this year by the California Marine Life Protection Act (MLPA). The sampling design and protocols used in these surveys are almost identical with the previously established PISCO design and protocols. One exception is the addition of size-frequency estimates for species of sea urchins and abalone. All of the existing PISCO survey sites were incorporated into the new MLPA monitoring program. The new MPA and reference sites added to our surveys are not yet posted on the web site, and are therefore listed below and identified on the following map of the Central Coast Study Region.

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Table 5. PISCO subtidal survey cells sampled in the MBNMS in 2007.

SITE	Longitude_WGS84	Latitude_WGS84	SURVEY 2007
SANDHILL_UC	-122.1521087	36.9743055	Fish, Benthic
SANDHILL_DC	-122.1494286	36.9729305	Fish, Benthic
THREE_MILE_CEN	-122.1200668	36.9577570	Benthic
SPROUTS_CEN	-122.0731594	36.9469424	Benthic
TERRACE_UC	-122.0662811	36.9449077	Fish, Benthic
TERRACE_DC	-122.0642891	36.9448714	Fish, Benthic
STOCKTON_CEN	-122.0500098	36.9462276	Benthic
SABER_JETS_CEN	-122.0340353	36.9480181	Benthic
CYPRESS_PT_DC	-121.9824678	36.5796455	Fish, Benthic
CYPRESS_PT_UC	-121.9803309	36.5857737	Fish, Benthic
CHINA_ROCK_CEN	-121.9724191	36.5984362	Fish, Benthic
BIRD_ROCK_CEN	-121.9720658	36.5936325	Fish, Benthic
PT_JOE_CEN	-121.9714654	36.6050941	Fish, Benthic
LONE_TREE_CEN	-121.9706883	36.5664179	Fish, Benthic
PINNACLES_OUT	-121.9677367	36.5579363	Fish, Benthic
PINNACLES_IN	-121.9661127	36.5594759	Fish, Benthic
PESCADERO_UC	-121.9597613	36.5611205	Fish, Benthic
PESCADERO_DC	-121.9551908	36.5594115	Fish, Benthic
SPANISH_BAY_DC	-121.9546055	36.6166620	Fish, Benthic
SPANISH_BAY_UC	-121.9538365	36.6188088	Fish, Benthic
BLUEFISH_DC	-121.9487775	36.5251430	Fish, Benthic
WESTON_UC	-121.9487649	36.5126127	Fish, Benthic
STILLWATER_UC	-121.9473202	36.5601161	Fish, Benthic
ASILOMAR_DC	-121.9466773	36.6322452	Fish, Benthic
WESTON_DC	-121.9457864	36.5103468	Fish, Benthic
ASILOMAR_UC	-121.9455894	36.6365120	Fish, Benthic
STILLWATER_DC	-121.9440143	36.5597289	Fish, Benthic
BLUEFISH_UC	-121.9435417	36.5222251	Fish, Benthic
BUTTERFLY_UC	-121.9362971	36.5396554	Fish, Benthic
BUTTERFLY_DC	-121.9356697	36.5374389	Fish, Benthic
MALPASO_CEN	-121.9339835	36.4657472	Fish, Benthic
MONASTERY_DC	-121.9333219	36.5254154	Fish, Benthic
MONASTERY_UC	-121.9305068	36.5252671	Fish, Benthic
SOBERANES_CEN	-121.9291444	36.4453426	Fish, Benthic
PINOS_CEN	-121.9287343	36.6404538	Fish, Benthic
OTTER_PT_DC	-121.9211615	36.6364837	Fish, Benthic
OTTER_PT_UC	-121.9189292	36.6346329	Fish, Benthic
SIREN_CEN	-121.9185902	36.6307335	Fish, Benthic
PALO_COLORADO_CEN	-121.9114309	36.3977172	Fish, Benthic
LOVERS_DC	-121.9107348	36.6257745	Fish, Benthic
LOVERS_UC	-121.9090818	36.6242203	Fish, Benthic
BIXBY_CEN	-121.9074994	36.3684681	Fish, Benthic
HOPKINS_DC	-121.9041960	36.6235861	Fish, Benthic
HOPKINS_UC	-121.9007885	36.6216490	Fish, Benthic
MACABEE_DC	-121.8968352	36.6181844	Fish, Benthic
CANNERY_DC	-121.8960366	36.6149533	Fish, Benthic
MACABEE_UC	-121.8956954	36.6171481	Fish, Benthic

SITE	Longitude_WGS84	Latitude_WGS84	SURVEY 2007
CANNERY_UC	-121.8945742	36.6126385	Fish, Benthic
FALSE_SUR_CEN	-121.8868219	36.2775558	Fish, Benthic
ANDREW_MOLERA_UC	-121.8759883	36.2776852	Fish, Benthic
ANDREW_MOLERA_DC	-121.8730375	36.2760886	Fish, Benthic
COOPER_CEN	-121.8566084	36.2631456	Fish, Benthic
SOUTH_WRECK_UC	-121.7905448	36.2252947	Fish, Benthic
SOUTH_WRECK_DC	-121.7874083	36.2238636	Fish, Benthic
FULLERS_CEN	-121.7521649	36.2081061	Fish, Benthic
TORRE_CANYON_CEN	-121.7077983	36.1842176	Fish, Benthic
ESALEN_UC	-121.6530459	36.1281131	Fish, Benthic
ESALEN_DC	-121.6479869	36.1244095	Fish, Benthic
DOLAN_UC	-121.6335611	36.1092023	Fish, Benthic
DOLAN_DC	-121.6283739	36.1001754	Fish, Benthic
BIG_CREEK_UC	-121.6080395	36.0691516	Fish, Benthic
BIG_CREEK_DC	-121.6051153	36.0690791	Fish, Benthic
LOPEZ_UC	-121.5816756	36.0290104	Fish, Benthic
LOPEZ_DC	-121.5812329	36.0222411	Fish, Benthic
MILL_CREEK_UC	-121.4934892	35.9759288	Fish, Benthic
MILL_CREEK_DC	-121.4911620	35.9720981	Fish, Benthic
PLASKETT_DC	-121.4800787	35.9129127	Fish, Benthic
PLASKETT_UC	-121.4787328	35.9158708	Fish, Benthic
LA_CRUZ_UC	-121.3253889	35.7130091	Fish, Benthic
LA_CRUZ_DC	-121.3240760	35.7104256	Fish, Benthic
NORTH_SAN_SIMEON_CEN	-121.2116136	35.6350420	Fish, Benthic
SAN_SIMEON_UC	-121.1949397	35.6305674	Fish, Benthic
SAN_SIMEON_DC	-121.1902480	35.6316670	Benthic
SAN_SIMEON_BAY_CEN	-121.1646993	35.6240499	Fish, Benthic
PICO_CREEK_UC	-121.1556904	35.6125180	Fish, Benthic
PICO_CREEK_DC	-121.1506953	35.6053224	Fish, Benthic
CAMBRIA_UC	-121.1271452	35.5704948	Fish, Benthic
CAMBRIA_DC	-121.1243185	35.5678931	Fish, Benthic

Fish Movement Study

Summary of activity prior to 2007:

In 2003, PISCO graduate student Jan Freiwald began a fish movement study at three sites near Lovers Point, Monterey. At each site three acoustic tracking buoy moorings, one acoustic reference tag, and one moored data logger were used to investigate the movement patterns of three species of kelp forest fishes in relation to their physical and biological habitat. Monitoring was performed by deploying acoustic tracking buoy (VRAP buoys by Vemco Ltd) at each of the three sites, with the buoys moved between moorings on a monthly schedule. The buoys consist of a sealed container enclosing the monitoring equipment, with a below-surface hydrophone and above-surface antenna for radio communication. Foam surrounding the central instrument package provides buoyancy and protection from boat strikes. Between buoy deployments, moorings without a tracking buoy were outfitted with a subsurface float to facilitate relocation and to keep the mooring line off the bottom. Monitoring at these sites continued into 2005. In 2005 the initial phase of the fish movement project was concluded and research was focused on one of the three species (kelp greenling). Four new study sites were established for an

experimental study on the movement of this species in relations to population density. All of the equipment used for the 2003-2004 study was removed and reused at the new study sites, except for the mooring anchors which were left in place for possible future use. Eight VR2 acoustic data loggers also were installed around the sites using sand anchor moorings. In 2006 the experimental field work at the four sites established in 2005 was continued. Experimental density manipulations were conducted at all four sites and VRAP buoys were continuously rotated among sites throughout the year on a weekly schedule. VR2 loggers were maintained at the same sites as in 2005, with loggers recovered and replaced by divers every two to three months.

2007 activity:

The study of kelp greenling movement, initiated in 2005, was completed in 2007. The moorings and hardware from this and earlier studies were recovered and removed from the ocean unless they were lost (Table 6 and 18). Several of the secondary acoustic data loggers (VR2s) were also removed and two were lost in 2007 (Tables 7 and 18). The mooring of one receiver was recovered. Of the second mooring only the sand anchor was recovered. 5m of line, 1.5 meters of 3/8 inch galvanized chain, 2 shackles and hard plastic subsurface float were lost.
In 2007 the acoustic study sites were moved once again to study the movement two species, kelp greenling and kelp rockfish, across the boundary of two newly established marine protected areas (MPA) at Lover's Point, Monterey. Two mooring arrays were installed to establish a study site spanning the boundary between the Lovers Point State Marine Reserve and the Pacific Grove Marine Gardens State Marine Conservation Area. The mooring were constructed and installed in the same way as in previous years. These new sites required the installment of four new moorings (Table 8). The movement study started in 2007 is scheduled to continue through 2008 and at the end of this study all hardware will be removed from the sites.

Table 6. 2005-2006 VRAP acoustic tracking buoy moorings that were recovered or lost in 2007.

Site	DEPTH (m)	LAT			LONG		Removed
		degrees	minutes		degrees	minutes	
Octopus reef A	14	36	37.751		121	54.961	removed
Octopus reef B	12	36	37.755		121	55.032	Mooring blocks lost in sediment
Octopus reef C	15	36	37.794		121	54.993	removed
Sand Dab A	13	36	37.708		121	54.941	removed
Sand Dab B	10	36	37.711		121	54.989	removed
Sand Dab C	13	36	37.744		121	54.963	removed
Thornback A	14	36	37.701		121	54.856	removed
Thornback B	13	36	37.714		121	54.928	removed
Thornback C	16	36	37.76		121	54.876	removed
Spider reef A	12	36	37.583		121	54.781	Mooring blocks lost in sediment
Spider reef B	12	36	37.651		121	54.814	removed
Spider reef C	15	36	37.645		121	54.727	Mooring blocks lost in sediment

Mooring block that were lost in the sediment had sunken into the sandy bottom too far to be safely recovered. Divers were not able to attach chains for save recovery or could not find the mooring blocks because they had sunk into the sediment.

Table 7. VR2 data logger locations still in use or removed in 2007.

Location	Latitude			Longitude			
Boulder_field	36	37.599	N	121	54.734	W	In use
Lovers_inshore	36	37.622	N	121	54.792	W	In use
Pacific_grove_inshore	36	37.673	N	121	54.974	W	removed
Lovers_center	36	37.691	N	121	54.734	W	removed
Pacific_grove_center	36	37.759	N	121	54.938	W	removed
Toward_pinos	36	37.963	N	121	55.088	W	removed

Table 8. New a VRAP acoustic tracking buoy mooring sites established at Lovers Point, Monterey in 2007.

Site	DEPTH (m)	LAT			LONG		Installed
		degrees	minutes		degrees	minutes	
MPA site A	9	36	37.601		121	54.833	7/23/2007
MPA site B	12	36	37.599		121	54.798	7/20/2007
MPA site C_out	12	36	37.626		121	54.809	7/20/2007
MPA site C_in	13	36	37.575		121	54.816	8/8/2007

Kelp Forest Detritus Study

Summary of activity prior to 2007:

PISCO graduate student Jared Figurski has been studying the ecological role of detritus in kelp forests since 2004. Originally, experiments addressed the role of macrophyte detritus on the seafloor as a nursery habitat for young of the year (YOY) rockfish and surfperch. Artificial corrals (used to imitate detritus habitat) were deployed in August 2004 on a sand flat adjacent to Lovers Point (36° 37.42'N/121° 55.05'W). Half of the corrals were retrieved in September 2004, and the rest in November 2004. Additional details on these experiments can be found in the 2004 annual report. In 2005 and 2006, the detritus study focused on monitoring the abundance of drift algae in 6 kelp forests, evaluating impacts of kelp harvesting on drift algae production, and on identifying the community of invertebrates that utilize drift algae as habitat. None of the 2005 detritus research impacted the seabed. 2006 research focused on the community of invertebrates utilizing drift algae as habitat and included one experiment that affected the seabed within the Hopkins State Marine reserve (36° 37.30' N/121° 54.03' W). The experiment was designed to test which organisms utilize drift algae on the seafloor, and specifically how communities change as a function of the residence time of drift algae. Equipment deployed for the experiment included 15 earth anchors, 450 meters of ¼ inch nylon line, 120 zipties, 10 1-ounce weights, and 188 ft^2 of 1-inch plastic deer fencing. A temporary 10 x 30 meter grid was constructed over flat, sandy habitat (16 meters depth) by stringing line between the anchors to permit the attachment of small mesh bags made of deer fencing and filled with drift algae. Initial deployment was in July 2006; all materials were retrieved from the seafloor at the conclusion of the experiment in early December 2006.

2007 activity:

In 2007, Jared Figurski surveyed kelp forest invertebrate communities occurring in drift algae and further tested experimentally how those communities vary as a function of swell exposure and depth. Surveys were completed by collecting up to 1 kg of drift algae per sample. A total of 144 samples were collected from the eastern side of the Monterey peninsula between June and September. This activity did not modify the seabed. To understand how the dynamics of drift algae in reef habitats influence detritivore communities, Jared ran an experiment using half-cinderblocks to simulate standardized reef crevices. All blocks had 1/8" plastic bottoms attached by 4 cable ties. Some blocks were topped with wire mesh to hold drift algae inside. The blocks were distributed across three locations on the east side of the Monterey peninsula and across three depth zones (6, 9, 13 meters). A temporary mooring designed to measure relative swell exposure was deployed at each of the 12 locations. Moorings were used to anchor small acceleration loggers and were constructed from 10kg steel I-beams, plastic coke bottle floats, and ¼" parachute cord. All of the materials used in the experiment were retrieved in September 2007. There were no incidental losses. The equipment and mooring locations are summarized in Table 9 and 10.

Table 9. Summary of equipment deployed in the drift algae of 2007.

Material	**Quantity**	**Deployed**	**Retrieved**
Cinderblock (8"x8"x8")	115	8/22/07	9/25/07
2" Wire Mesh (12" x 12")	32	8/22/07	9/25/07
8" Cable Ties	460	8/22/07	9/25/07
10 kg I-Beams	12	8/22/07	9/25/07
Parachute Cord	12 m	8/22/07	9/25/07
Coke Bottles	12	8/22/07	9/25/07

Table 10. Locations of cinderblocks and moorings used for the 2007 drift algae study.

Site	**Depth (m)**	**Latitude**	**Longitude**
McAbee Reef	6	N36°37.0293'	W121°53.8923'
McAbee Reef	9	N36°37.0213'	W121°53.8289'
McAbee Reef	13	N36°37.0382'	W121°53.7836'
Lover's Point	6	N36°37.4432'	W121°54.7673'
Lover's Point	9	N36°37.5015'	W121°54.7461'
Lover's Point	13	N36°37.5305'	W121°54.6572'
Chase Reef	6	N36°37.9897'	W121°55.2000'
Chase Reef	9	N36°38.0168'	W121°55.1769'
Chase Reef	13	N36°38.0327'	W121°55.1475'
Point Pinos	6	N36°38.2293'	W121°55.6464'
Point Pinos	9	N36°38.2798'	W121°55.5980'
Point Pinos	13	N36°38.3586'	W121°55.5369'

Standard Monitoring Unit for the Recruitment of Fishes (SMURF) Study

Summary of activity prior to 2007:

Since June of 1999, PISCO researchers have been using SMURFs (Standardized Monitoring Unit for Recruitment of Fishes) to assess fish recruitment in kelp forest ecosystems in the sanctuary. A SMURF deployment at a given site typically consists of a set of five moorings equally spaced along a line, generally along isobath at depths of 20m, although a few have been deployed at depths of up to 25-29m. SMURFs are deployed only for part of the year (typically May – October) during the expected recruitment period. Moorings are removed during the winter for refurbishment and to prevent damage and equipment loss during winter storms. Deployed SMURFs typically have been maintained and sampled by divers daily to weekly. Maintenance includes checking the condition of each SMURF, removing any fouling, and replacing broken units with fresh ones to minimize the chance of loss in heavy swell. Moorings consist of a main bottom weight, a mooring line with a subsurface float, and a surface float and SMURF unit attached to the subsurface float by a slack line to allow for depth fluctuations due to tides and swell. Details of SMURF deployment locations and configurations from 1999-2004 can be found in the 2004 annual report. In 2005 and 2006, SMURFs were deployed at previously utilized sites at Hopkins, Stillwater and Terrace Point, and an additional SMURF site was established at Sand Hill Bluff (Table 11). At each of these sites an array of five moorings was deployed in May and sampled weekly until the moorings were removed in October each year.

Table 11. Locations of SMURF mooring installations from May to October annually since 2005.

Site	Latitude	Longitude
Terrace Point	36°56.715'N	122°03.87'W
Sand Hill Bluff	36°58.483'N	122°09.339'W
Hopkins	36°37.540'N	121°54.550'W
Stillwater	36°33.565'N	121°56.558'W

2007 activity:

SMURF deployments in 2007 were identical to those in 2005 and 2006.

Intertidal Studies

Summary of activity prior to 2007:

In the fall of 1995, prior to the start of PISCO, two intertidal sites (Point Sierra Nevada and Piedras Blancas) were established with funding from the Minerals Management Service. In the summer of 1999, PISCO began setting up additional intertidal sites between Pigeon Point and Mill Creek. In July 2004, the MBNMS funded seven new abalone monitoring sites to fill in gaps between existing abalone monitoring sites. To date, PISCO has established 27 intertidal study sites within MBNMS that continue to be monitored on various time intervals (Table 12).

Table 12. Locations of intertidal study sites *(* indicates MLPA sites).*

Site	Latitude	Longitude
Pebble Beach	37°13' N	122°24'W
Pigeon Point	37°11' N	122°24'W
Waddell Creek	37°7' N	122°18'W
Franklin Point	37°8' N	122°21'W
Scott Creek	37°2' N	122°14'W
Davenport*	37°1' N	122°12'W
Sand Hill Bluff	36°58' N	122°9'W
Wilder Ranch*	36°57' N	122°6'W
Terrace Point	36°57' N	122°4'W
Natural Bridges*	36°56' N	122°3'W
Hopkins	36°37' N	121°54'W
Point Pinos*	36°38' N	121°56'W
China Rocks*	36°36' N	121°57'W
Stillwater Cove	36°34' N	121°56'W
Carmel Point	36°32' N	121°56'W
Point Lobos	36°30' N	121°56'W
Mal Paso	36°28'N	121°55'W
Garrapata*	36°28'N	121°56'W
Soberanes Point	36°27' N	121°55'W
Andrew Molera	36°18' N	121°53'W
Partington	36°10' N	121°41'W
Mill Creek	35°59' N	121°29'W
Pacific Valley	35°56' N	121°28'W
Pt. Sierra Nevada	35°73' N	121°31'W
Piedras Blancas	35°66' N	121°28'W
San Simeon Pt *	35°38' N	121°11'W
Vista del Mar	35°36' N	121°8'W

2007 activity:

Activity in 2007 consisted of continued monitoring of sites established in prior years. Monitoring is performed at different intervals for different parameters: barnacle recruitment plates and Tuffies are exchanged every month, while temperature loggers are swapped out every two to four months. Mussel growth experiments are installed once yearly and monitored throughout the year. Intertidal fluorometers and photo-synthetically-active radiation (PAR) sensors are installed each summer and are left out for approximately five months (Table 13). Permanent long term monitoring sites are surveyed three times per year (Table 14). While some experiments, such as the mussel growth experiment, do not require permanent hardware installation, the majority of experiments require permanent bolts to allow consistent monitoring at each site. Hardware from completed experiments has been removed.

Seven additional sites were established within the MBNMS as part of the Marine Life Protection Act (MLPA) Initiative. New sites are indicated with asterisks in Table 12.

Table 13. Equipment details for each intertidal site by experiment.

Experiment	Sites	Installation Date	Equipment (per site)
Temperature	Pebble Beach	December 2006	• 1 Stowaway Tidbit or Onset Hobo Pendant temperature logger • 1 steel mesh cage • 4 plastic wall anchors • 4 stainless steel lag screws • 2 plastic zipties
	Pigeon Point	June 2000	
	Pigeon Point South	December 2003	
	Waddell Creek	June 2003	
	Franklin Point	Dec 2006	
	Scott Creek	May 2001	
	Davenport	October 2007	
	Sand Hill Bluff	December 1999	
	Wilder	October 2007	
	Terrace Point	December 1999	
	Hopkins	December 1999	
	Point Pinos	November 2007	
	China Rocks	November 2007	
	Stillwater Cove	December 1999	
	Carmel Point	December 2006	
	Point Lobos	March 2004	
	Garrapata	November 2007	
	Soberanes	June 2003	
	Andrew Molera	April 2000	
	Partington Cove	December 2006	
	Mill Creek	April 2004	
	Pacific Valley	December 2006	
	Pt. Sierra Nevada	July 2005	
	Piedras Blancas	October 2005	
	San Simeon Pt33	September 2007	
	Vista del Mar	November 2006	
Intertidal Fluorometers & PAR Sensors	Pigeon Point	May 2003- September 2003, May 2004 – September 2004, May 2005 – September 2005, June 2006 – September 2006	Fluorometer (1 per site, installed May - September) • Fluorometer in PVC housing, 3 stainless steel mesh straps • 12 plastic wall anchors • 12 stainless steel lag screws • 12 ½" stainless steel washers PAR Sensors (2 per site, installed May – September) • PAR sensor in PVC housing • 2 stainless steel mesh straps • 4 plastic wall anchors • 4 stainless steel lag screws • 4 ½" stainless steel washers
	Terrace Point	July 2002 – October 2002, May 2003 – September 2003, May 2004 – September 2004, May 2005 – September 2005, June 2006 – September 2006	
	Hopkins	July 2002 – October 2002	

Experiment	Sites	Installation Date	Equipment (per site)
Recruitment – Mussel and Barnacle	Pigeon Point	June 2003 (tuffies) April 2005 (plates)	Tuffies (swapped out every month) • 5 SOS plastic mesh scrubbers • 5 plastic wall anchors • 5 stainless steel lag screws • 1" stainless steel washers Barnacle plates (swapped out every month) • 5 10cm x 10cm PVC plates • 5 plastic wall anchors • 5 stainless steel lag screws
	Sand Hill Bluff	November 1999	
	Terrace Point	November 1999	
	Hopkins	November 1999	
	Stillwater Cove	April 2000	
	Andrew Molera	October 1999	
	Point Sierra Nevada	December 2003	
Recruitment – Algae	Point Sierra Nevada	December 2003	• 5 10 cm x 10 cm PVC plates covered with carpet – for *Silvetia* collecting • 5 10 cm x 10 cm plaster barnacle molds – for *Endocladia* collecting • 10 plastic wall anchors • 10 stainless steel lag screws
Mussel Growth	Pigeon Point	May 2001	• 40 plastic wall anchors • 40 stainless steel lag screws • 40 PVC washers • Vexar plastic mesh Note: All hardware is removed after one to two months
	Scott Creek	May 2001	
	Terrace Point	May 2001	
	Hopkins	May 2002	
	Andrew Molera	May 2001	
Predation 1	Waddell Creek	April 2001 – May 2004	• 6 stainless mesh fences (3 sided, perimeter = 50 x 50 cm, 3" tall) • 24 stainless steel hex bolts • 90 stainless steel lag screws • 75 PVC washers • 90 plastic wall anchors • 12 Tuffies (swapped out every month)
	Scott Creek	April 2001 – May 2004	
	Terrace Point	May 2001 – May 2004	
	Soberanes	May 2001 – May 2004	
Predation 2	Waddell Creek	May 2005 – February 2007	• 16 stainless mesh fences (20 x 20 cm, 3" tall) • 128 stainless steel lag screws • 128 plastic wall anchors • 96 PVC washers
	Scott Creek	May 2005 – February 2007	
Recovery	Point Sierra Nevada	July 2003	• 99 stainless steel lag screws • 99 plastic wall anchors • 44 plastic labels and zipties • 33 3/8" stainless steel hex bolts
Succession	Terrace Point	May 2002	• 48 stainless steel lag screws • 48 plastic wall anchors • 24 plastic zipties
	Hopkins	May 2002	

Table 14. Equipment details for each activity under the intertidal community structure surveys.

Long Term Monitoring Activity	Sites	Installation Date	Equipment (per site)
Photo Plots	Scott Creek	October 1999	• 45-90 stainless steel bolts
	Davenport	October 2007	
	Sand Hill Bluff	October 1999	
	Wilder	October 2007	
	Terrace Point	October 1999	
	Natural Bridges	October 2007	
	Hopkins	November 1999	
	Point Pinos	November 2007	
	China Rocks	November 2007	
	Stillwater Cove	April 2000	
	Point Lobos	November 1999	
	Garrapata	November 2007	
	Andrew Molera	November 1999	
	Mill Creek	October 1999	
	Pt Sierra Nevada	October 1995	
	Piedras Blancas	September 2007	
	San Simeon Point	September 2007	
	Vista del Mar	September 2007	
Barnacle Recruitment	Scott Creek	July 1999	• 5 10 cm x 10 cm PVC plates (swapped out 3 times per year) • 5 plastic wall anchors • 5 stainless steel lag screws
	Sand Hill Bluff	July 1999	
	Terrace Point	July 1999	
	Hopkins	July 1999	
	Stillwater Cove	April 2000	
	Point Lobos	August 1999	
	Andrew Molera	August 1999	
	Mill Creek	August 1999	
	Pt Sierra Nevada	October 1995	
Sea Stars	Scott Creek	December 1999	• 6-12 stainless steel bolts
	Davenport	October 2007	
	Wilder	October 2007	
	Terrace Point	October 1999	
	Natural Bridges	March 2008	
	Hopkins	November 2001	
	Point Pinos	November 2007	
	China Rocks	November 2007	
	Stillwater Cove	April 2000	
	Garrapata	November 2007	
	Andrew Molera	November 2001	
	Mill Creek	October 1999	
	Pt Sierra Nevada	October 1995	
	Piedras Blancas	September 2007	
	Vista del Mar	September 2007	
Abalone	Pebble Beach	July 2004	• 6-12 stainless steel bolts
	Pigeon Point	April 2002	
	Franklin Pt	July 2004	
	Scott Creek	May 2006	
	Hopkins	March 2005	
	Point Pinos	November 2007	
	China Rocks	November 2007	
	Stillwater Cove	April 2002	
	Carmel Pt	July 2004	
	Point Lobos	May 2000	
	Mal Paso	June 2000	

Long Term Monitoring Activity	Sites	Installation Date	Equipment (per site)
	Garrapata	November 2007	
	Soberanes Pt	July 2004	
	Andrew Molera	December 1999	
	Partington Cove	July 2004	
	Mill Creek	October 1999	
	Pacific Valley	July 2004	
	Pt Sierra Nevada	October 1995	
	Piedras Blancas	October 1997	
	Vista del Mar	July 2004	
Surfgrass	Scott Creek	October 1999	• 6 stainless steel bolts
	Davenport	October 2007	
	Sand Hill Bluff	November 1999	
	Hopkins	November 1999	
	Stillwater Cove	April 2000	
	Andrew Molera	December 1999	
	Mill Creek	October 1999	
	Pt Sierra Nevada	October 1995	
	Vista del Mar	September 2007	
Lottia	Sand Hill Bluff	November 1999	• 5 stainless steel bolts
	Wilder	October 2007	
	Terrace Point	November 1999	
	Natural Bridges	March 2008	
	Hopkins	November 1999	
	Point Pinos	November 2007	
	China Rocks	November 2007	
	Stillwater Cove	April 2000	
	Point Lobos	August 1999	
	Garrapata	November 2007	
	Mill Creek	October 1999	
	San Simeon Point	September 2007	
Postelsia	Scott Creek	December 1999	• 2-10 steel bolts
	Sand Hill Bluff	December 1999	
	Mal Paso	June 2000 (2 bolts)	
	Point Sierra Nevada	November 2004 (2 bolts)	
	Piedras Blancas	April 2008	

Intertidal Coastal Biodiversity Surveys

Summary of activities prior to 2007:

Prior to 2007, a total of 15 intertidal sites were established and surveyed in the Monterey Bay National Marine Sanctuary as part of the PISCO Coastal Biodiversity Surveys (Table 15). Information collected included mobile invertebrate quadrant counts, point contact identification, sea star band counts, and tidal height topographic measurements. Twelve of these sites have been re-sampled since they were originally established.

Table 15. Coastal biodiversity sites.

Site Name	Latitude	Longitude	Dates Sampled	Bolts* Installed
Fitzgerald	37° 31.300' N	122° 31.000' W	Nov 2002 Nov 2006	4
Pigeon Pt	37° 11.109' N	122° 23.813' W	Nov 2002 Oct 2006	5
Año Nuevo	37° 06.744' N	122° 19.776' W	Jun 2002	4
Scott Creek	37° 02.769' N	122° 14.244' W	Jan 2000 Jan 2003 Dec 2006	4
Sandhill Bluff	36° 58.830' N	122° 09.306' W	May 2004	6
Terrace Point	36° 56.917' N	122° 03.874' W	Jan 2000 Jan 2003 Jan 2006	4
Hopkins	36° 37.268' N	121° 54.422' W	Feb 2000 Jan 2003 Dec 2006	4
Stillwater Cove	36° 33.663' N	121° 56.410' W	Feb 2001 Apr 2005	5
Point Lobos	36° 30.38' N	121° 56.27' W	Feb 2001 Mar 2005	8
Andrew Molera	36° 16.836' N	121° 51.790' W	Feb 2001 Mar 2003 Feb 2004	4
Partington Cove	36° 10.430' N	121° 41.796' W	Nov 2003 Apr 2004	4
Lucia	36° 00.863' N	121° 32.430' W	Apr 2004	0
Mill Creek	35° 58.783' N	121° 29.430' W	Feb 2001 Nov 2003 Apr 2004	6
Point Sierra Nevada	35° 43.726' N	121° 19.110' W	Apr 2001 Apr 2003	7
Cambria	35° 32.417' N	121° 05.570' W	Jun 2001 Jul 2005	5

**Bolts are 3/8"in diameter, stainless steel hex or carriage top secured with marine epoxy and protrude 1" above rock surface.*

2007 activity:

No existing sites were re-sampled in 2007. However, 10 additional sites were established within the MBNMS as part of the Marine Life Protection Act (MLPA) Initiative (Table16).

Table 16. MLPA site locations within MBNMS.

Site Name	Latitude (dd.ddd)	Longitude (dd.ddd)	Dates Sampled	Bolts* Installed
Davenport	37.0223	122.2153667	October, 2007	4
Wilder Ranch	36.956083	122.10405	October, 2007	4
Natural Bridges	36.949033	122.061133	October, 2007	4
Point Pinos	36.63796	121.93758	November, 2007	4
China Rocks	36.60567	121.95975	November, 2007	4
Garrapata	36.4689	121.93434	November, 2007	4
Piedras Blancas	35.66568	121.28653	December, 2007	4
San Simeon Point	35.634767	121.195633	September, 2007	4
Vista del Mar	35.60434	121.14227	December, 2007	4
Diablo	35.22665	120.87367	December, 2007	4

Carmel Acoustic Tagging Project

Summary of activities prior to 2007:

In 2005, a new collaborative PISCO/Moss Landing Marine Laboratories (MLML) project was initiated to track fish movements in and around Carmel Bay. The objectives of the study are to:

1. Determine the movements of fishes on relatively long (> 1 yr) time scales.
2. Determine whether movements are associated with time of day, season, photoperiod, water temperature, or tide.
3. Compare rates and patterns of movement among size classes and sex.
4. Determine if site fidelity differs over high and low relief habitats.
5. Determine the depth distribution of tagged fishes throughout the year.
6. Compare movement patterns among species.

The principal investigators on the project are Dr. Mark Carr (PISCO/UCSC) and Dr. Richard Starr (MLML). The project uses an array of 30 Vemco (Inc.) model VR-2 acoustic receivers/loggers on subsurface moorings (Figure 3, Table 17) to monitor the movements of acoustically tagged fish. Moorings are located in 10 to 40 m of water and consist of 60 lb cement blocks with approximately 4 m of galvanized chain attached to the receiver/logger and a float that maintains the chain in a nominally vertical configuration. Although the moorings do not have surface markers, equipment can be located and retrieved on SCUBA using GPS coordinates. Initial deployment of 22 moorings was performed in September 2005, with an additional 8 moorings deployed in September 2006 (Table 17). The project is expected to continue for five years; all components of the moorings, including the weights, will be recovered upon completion of the project.

As of March 2007, 100 fish had been surgically implanted with acoustic tags. Tagged species include: black rockfish (*Sebastes melanops*), blue rockfish (*S. mystinus*), grass rockfish (*S. rastrelliger*), cabezon (*S. marmoratus*), and lingcod (*Ophiodon elongatus*). All investigators involved with the project have obtained necessary scientific collecting permits from the Department of Fish and Game, and the project is approved by the Institutional Animal Care Use Committee (IACUC) at San Jose State University.

2007 activity:

In 2007, ten additional juvenile black rockfish were tagged during the months of June and July. This additional work was approved by the Institutional Animal Care Use Committee (IACUC) at San Jose State University and San Francisco State University. In September and October of 2007, new moorings as described above (cement block, galvanized chain, galvanized shackles, line, subsurface float) were replaced for all receiver locations, and old moorings were removed. New moorings were redeployed in the approximately the same location. Coordinates of mooring locations are shown in Figure 3 and Table 17.

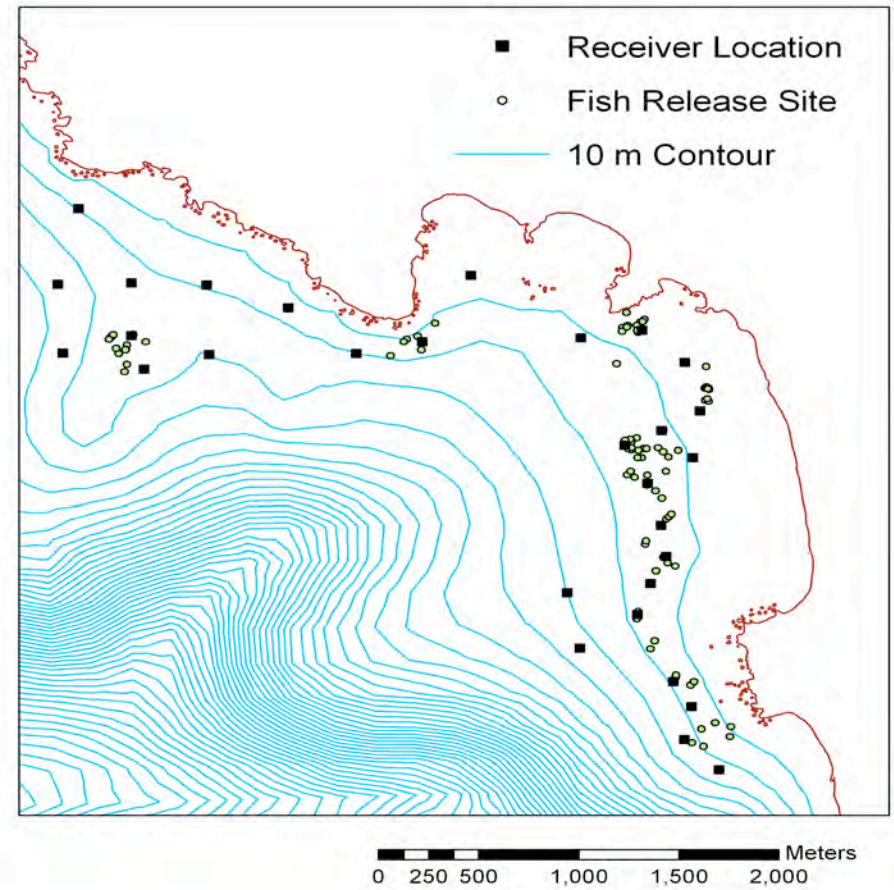

Figure 3. Receiver locations in and around Carmel Bay. Locations where tagged fish were released also are shown.

Table 17. Subsurface acoustic receiver mooring locations.

Location	Latitude	Longitude	Deployed
1	36.5668° N	121.9702° W	9/2006
2	36.5628° N	121.9714° W	9/2006
3	36.5591° N	121.9711° W	9/2006
4	36.5628° N	121.9672° W	9/2006
5	36.5600° N	121.9673° W	9/2006
6	36.5582° N	121.9666° W	9/2006
7	36.5627° N	121.9631° W	9/2006
8	36.5590° N	121.9630° W	9/2006
9	36.5614° N	121.9585° W	9/2005
10 (9/05-9/06)	36.5593° N	121.9530° W	9/2005
10 (> 9/06)	36.5590° N	121.9548° W	9/2006
11	36.5595° N	121.9511° W	9/2005
12	36.5630° N	121.9483° W	9/2005
13	36.5597° N	121.9422° W	9/2005
14	36.5600° N	121.9388° W	9/2005
15	36.5583° N	121.9364° W	9/2005
16	36.5557° N	121.9356° W	9/2005
17	36.5547° N	121.9378° W	9/2005
18	36.5539° N	121.9399° W	9/2005
19	36.5532° N	121.9361° W	9/2005

Location	Latitude	Longitude	Deployed
20	36.5519° N	121.9386° W	9/2005
21	36.5497° N	121.9379° W	9/2005
22	36.5480° N	121.9376° W	9/2005
23	36.5466° N	121.9385° W	9/2005
24	36.5449° N	121.9393° W	9/2005
25	36.5461° N	121.9432° W	9/2005
26	36.5432° N	121.9425° W	9/2005
27	36.5413° N	121.9373° W	9/2005
28	36.5400° N	121.9363° W	9/2005
29	36.5382° N	121.9368° W	9/2005
30	36.5366° N	121.9348° W	9/2005

Installation and Removal Techniques Used

Physical Oceanography Moorings

All of the PISCO thermistor-string moorings deployed to date have been anchored in sandy substrate using steel or steel-and-concrete anchors. Anchor weights are lowered slowly to the bottom from a surface vessel, and the mooring line then is measured and installed by divers. Steel train wheels weighing between 300 and 600 pounds were used to anchor the original 20-meter moorings, but since 2002 specially constructed steel-and-concrete anchors have been used (typically 500-600 lbs). For the original 20-meter moorings, the mooring line was attached to the wheels by galvanized shackles and supported by a Norfloat inflatable buoy. Two 18-inch modules (made of PVC and galvanized all-thread) were placed in line along the length of the mooring line. The Norfloat was placed two meters below mean low water in accordance with US Coast Guard Regulations. A line running from the Norfloat to the surface was used to attach a 12-inch lobster float as a stringer. For the two moorings installed in 2002 and the 11 MBNMS moorings installed in 2005, shackles, chain, and all-thread were eliminated, and special chafe-resistant materials were used to protect the main line at its attachment to the mooring weight. The type of subsurface inflatable buoys also was changed to a pass-through design, and larger and heavier surface stringers with counterweights and long-line flags were added to reduce loss of stringers due to boat damage. Moorings are recovered by lifting the mooring weights off the bottom using the main mooring line.

ADCPs are located approximately 15 meters from associated temperature moorings. ADCP mounts used at the Sand Hill Bluff, Hopkins, and Stillwater sites are made from 4-inch diameter stainless pipe approximately 7 feet long. For installation, the pipe was attached to a seawater pump and hose and 'jetted' directly in to the sand substrate by a diver until approximately 2 to 3 feet protruded vertically from the bottom. A lift bag was attached to the mount during installation to keep the pipe vertical and to prevent the pipe from sinking too rapidly. The ADCP then was bolted to a bracket on the vertical portion of the pipe, and a ground line added to connect the ADCP mount to the base of the thermistor mooring. At the Terrace Point site, the ADCP is mounted over hard substrate. At this site, a pyramidal PVC frame was constructed and lowered to the bottom under diver supervision, where it was placed on a level portion of mixed mudstone and sand and weighted with approximately 480 pounds of lead ingots bolted to the frame. The mount then was tethered to the thermistor mooring with a ground line. The ADCP moorings will be recovered by repeating the jetting procedure for the pipe mounts and by removing the ballast weights and lifting the mooring frame into a surface vessel at the Terrace Point site.

2007 PISCO-wide Coupled Biophysical Processes Study Moorings and Bottom-Mounted Instruments

Thermistor-string moorings were deployed using procedures similar to those described above for PISCO's physical oceanography moorings. Bottom-mounted ADCPs, wave gauges, and the AWAC were mounted on weighted frames and lowered to the bottom. SMURF moorings were deployed using procedures identical to those used for the long-term SMURF moorings (see below under "SMURF Moorings"). All moorings and bottom-mounted instruments were retrieved at the end of the study period by hauling from a surface vessel.

MPA Benthic Temperature Loggers

MPA benthic temperature moorings were constructed from poured concrete anchors (~30 lb) with 2 meters of polypropylene line and a small float. Moorings were deployed by divers using lift bags to position the mooring weight. Moorings will be recovered using similar techniques.

Kelp Forest and MPA Monitoring

No equipment or markers are installed in association with this monitoring program.

Fish Movement Moorings

Acoustic tracking buoy moorings are anchored using two 120 to 150-pound blocks of a concrete-steel mix. The blocks are lowered to a sandy area of the seafloor from a small boat and a steel sand anchor is set into the substrate next to them. The blocks are connected to the sand anchor with 1.5 meter of galvanized chain. A second chain (5 meters of 1/2-inch galvanized) leads from the bottom chain to a line that reaches to approximately five meters below the surface. The chain and line (1/2-inch synthetic, braided) are attached through two galvanized shackles and one galvanized thimble. The acoustic monitoring buoy is connected to the line by a chain (5 meters of 1/2-inch galvanized) attached through a galvanized shackle and thimble. Once the moorings are installed the only maintenance is the movement of buoys among sites. To move the buoys divers detach the buoy chain about 5 m below the surface and swim the buoy to the new mooring location. A subsurface float is installed on moorings without a buoy to keep the mooring line off the seafloor.

Data loggers (VR2 type, Vemco Ltd.) in and surrounding the study sites are attached to smaller moorings that use a single sand anchor, 1.5 m of chain (3/8 inch galvanized) and about 5 meters of line, which is kept vertical by a subsurface foam float. The chain and line are connected by two galvanized shackles. The data logger is a small self-contained unit with a hydrophone and is attached to the line by cable ties. Additionally, a thin steel cable attaches the sand anchor to the VR2 unit using small stainless steel shackles. VR2 data loggers are recovered and replaced by divers every 2 to 3 month.

Kelp Forest Detritus Corrals

Detritus corrals installed in 2006 were constructed from 15 earth anchors, 450 meters of ¼ inch nylon line, 120 zipties, 10 1-ounce weights, and 188 ft^2 of 1-inch plastic deer fencing.
A temporary 10 x 30 meter grid was constructed over flat, sandy habitat by stringing line between the anchors to permit the attachment of small mesh bags made of deer fencing and filled with drift algae. All installation and removal was performed by divers using SCUBA and manual methods.

SMURF Moorings

SMURF moorings used in 2007 are configured as a set of five light-duty moorings constructed of 3/8-inch polypropylene crab-pot line attached to 4- to 5-foot, 1½- to 2-inch PVC spar buoys

with flags. Moorings are on sandy substrate, with each of the five moorings anchored with a small (50-100 lb) steel-and-concrete weight to facilitate ease of deployment and retrieval from a small boat. A subsurface styrofoam float at 10 meters depth maintains each line in a nominally vertical configuration, with a SMURF attached to the surface extension of the line (1.5 meter below the surface) with stainless steel long-line snaps. A weighted ground-line connects the five SMURF anchors at each site. For deployment, individual moorings are lowered sequentially by hand from a small boat using a GPS to locate and align the positions of each mooring. Retrieval is the reverse of deployment.

Intertidal Monitoring and Survey Equipment

Temperature

Temperature loggers are installed in stainless steel cages with two plastic zipties. For each cage four holes are drilled and the cages are attached with four wall anchors and four lag screws each. There is one temperature logger per site.

Recruitment

Barnacle plates are installed with one wall anchor and one lag screw each. Next to each barnacle plate a 10x10cm plot is marked with z-spar marine epoxy and scoured clean for *in situ* barnacle recruitment measurements. Tuffies are installed with one wall anchor, one lag screw, and one stainless steel washer each. There are five barnacle plates, five barnacle clearings, and five Tuffies per site.

Recruitment – algae

Algal recruitment plates are installed with a wall anchor and one 1/4" stainless steel lag screw each. There are 10 algae collectors at Point Sierra Nevada.

Mussel Growth

The mussel growth plots are attached to the rock surface using wall anchors, lag screws, Vexar plastic mesh, and PVC washers making sure there are no gaps through which the mussels might wash away. After a month the Vexar is loosened in a dome fashion around the mussels. A month later the Vexar, PVC washers, lag screws, and wall anchors are removed.

Predation 1

Two types of plots were created for this experiment. Each control plot consisted of two hex bolts. Each fenced plot had four to six support rods for the cages and two hex bolts to mark the lower-limit of the plot. At the end of the experiment, all hardware was removed.

Predation 2

Six types of treatments were used in this experiment: 1) control, 2) cleared control, 3) cage control, 4) *Pisaster* exclusion, 5) *Nucella* exclusion, 6) *Pisaster* + *Nucella* exclusion. Treatments 1 and 2 consisted of four wall anchors and four lag screws each. Treatments 3 – 6 consisted of six wall anchors, six lag screws, six PVC washers, and a 20 x 20 cm section of 3 inch tall stainless mesh caging each. There were four replicates containing all six treatments at each site. At the end of the experiment, all hardware was removed.

Recovery

Recovery plots were established at Point Sierra Nevada by marking 11 plots in the *Chthamalus*, *Silvetia*, *Mytilus* and *Endocladia* zones (44 plots total). Plots in the *Mytilus* zone were each

marked with three 3/8 inch stainless steel hex bolts and plots in the remaining 3 zones were each marked with three wall anchors and three 1/4" stainless steel lag screws.

Succession
Four controls and four clearings were established in the high and mid intertidal zones at each site. The eight high zone plots measure 10 x 15 cm and consist of three wall anchors and three lag screws each. The eight mid zone plots measure 20 x 30 cm and consist of three wall anchors, three lag screws, and three plastic zipties each. The plastic zipties are attached to the mid zone screws to make locating the plots easier.

Photo plots
For the photo plot installation, five 1/2 x 3/4 meter plots primarily covered by the target organism are found for each species. These plots are placed away from sand scour and not on boulders. Each plot is marked with three hex bolts in the lower left and the two upper corners. The bolts in the upper left hand corner are notched to indicate the plot number.

Barnacle Recruitment
Barnacle recruitment plates are placed near a barnacle photo-plot. The plate is attached to rock with a plastic wall anchor and lag screw. Next to the plate a 10x10cm plot is marked with z-spar and scoured clean for *in situ* recruitment measurements.

Sea stars and Abalone
The *Pisaster* and abalone plots are large polygonal areas. Each plot is marked with two to six bolts.

Lottia
The *Lottia* plots are either large rectangles or a one-meter radius circle. Each plot is marked with one to four bolts.

Surfgrass
Surfgrass plots are 10-meter long transects. Each plot is marked with two bolts.

Postelsia
Postelsia plots are either 5-20 meter long transects or a series of transects forming a grid. Each transect is marked with two bolts.

Intertidal Coastal Biodiversity Surveys

Coastal Biodiversity Survey sites are marked with bolts in each corner. Sites that consist of one section generally are marked with four bolts (total), and sites that consist of two sections are marked with eight bolts (total).

Carmel Acoustic Tagging Project Moorings

Acoustic moorings initially are lowered from a small boat to the seabed. If required, repositioning is performed by divers using lift bags. Moorings are recovered by hand from a small boat with diver assistance as necessary.

Equipment Maintenance, Loss, or Replacement

Equipment maintenance and replacement did not involve any disturbance to the seabed in 2007 except for the routine retrieval and redeployment of moorings at sites where divers are unable to perform regular maintenance (Pigeon Point and Año Nuevo, due to shark hazard, and Terrace Point 60m and 100m moorings due to depth). The deployment of temporary moorings and bottom-mounted instruments for the biophysical coupling study and the deployment of new benthic temperature moorings for MPA monitoring had minimal impacts: seabed impacts due to retrieval and redeployment of thermistor-string moorings were similar to those described previously under "Installation and Removal Techniques Employed". Impacts of temporary moorings used for the biophysical coupling study were negligible as all were deployed on sandy substrates, and impacts of installing MPA benthic temperature moorings were minimal due to their small size and diver placement.

All of the equipment deployed by PISCO is regularly inspected and maintained. It is the intent of PISCO to retrieve all equipment deployed in the MBNMS, but equipment occasionally is lost due to unusual events such as boat strikes, vandalism, animal impacts, and severe weather. Items lost and not retrieved in 2007 are listed in Table 18.

Table 18. Items lost from all studies described above in the MBNMS in 2007.

Qty	Item	Description
12	Photoplot bolts	3/8" Stainless steel hex bolt
27	Barnacle Plate	10 x 10 cm PVC plate
8	Tuffies	SOS plastic mesh scrubber
1	Temperature logger	Hobo Temp Logger
1	Temperature logger cage	Stainless steel mesh cage
39	Lag Screws	1/4" stainless steel lag screw
4	PVC washer	small PVC washer
1	Water collection bottle	250 ml Nalgene brown bottle
1	SMURF	4' tube of plastic snow fencing (black)
0	Spar buoys	PVC tube with caps and eyebolt
0	Longline flags	Orange plastic flag ~ 10"
8	VR2	Acoustic data logger
0	Galvanized Shackle	1/2 in shackles
119	Zipties	Plastic zipties 6" – 8"
10	Wire ties	Romex cable, ~10" section
9	Mooring spar buoy	Canister buoy (yellow)
8	Temperature logger	Onset Tidbit
5	Temperature logger	Onset XTI and pressure case
5	Rigid link	~10' section foam-filled firehose
5	Subsurface float	14" Norfloat
470m	Mooring line	¾" EZ-Splice Polytron
4	Mooring weight	Concrete or steel, ~500-700 lb, buried
24.3m	Surface buoy chain	1" stainless steel chain
8	Logger attach clip	Ganion clip
1	Vexar	Circle of plastic mesh ~25" in diameter
4	Safety Walk	A plastic 10"x10" square of rough, sticky material

In general, subtidal equipment is lost more regularly and is more difficult to retrieve than intertidal equipment due to the nature of the environment. All feasible attempts are made to retrieve any lost items. The PISCO project has caused no archaeological disturbances nor has it contributed any unauthorized discharges into the Sanctuary at any time.