Introduced Aquatic Species in California Open Coastal Waters

Final Report

December 2006

California Department of Fish and Game

San Jose State University Foundation/
Moss Landing Marine Laboratories

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This report should be cited as:
Maloney, E., Fairey, R., Lyman, A., Reynolds, K., Sigala, M. 2006. Introduced Aquatic Species in California Open Coastal Waters. Final Report. California Department of Fish and Game. Office of Spill Prevention and Response. Sacramento, CA., 93 pp.

ACKNOWLEDGEMENTS
This study was completed thanks to the efforts of the following individuals:

California Department of Fish and Game: Project Management and Reporting
Marian Ashe, Michael Sowby, Peter Ode, Steve Foss

San Jose State University Foundation- Moss Landing Marine Laboratories
Marine Pollution Studies Laboratory: Project oversight, field sampling, literature review and data analysis
Russell Fairey, Erin Maloney, Ashleigh Lyman, Mark Pranger, Marco Sigala, Kyle Reynolds, Phil Hoos, Maya George, Whelan Gilkerson, Mark Gleason, Jason Felton, Vince Christian, Jon Walsh.

Marine Benthic Ecology Laboratory: Project oversight, training, sample transfer, sorting and gross taxonomy, data entry
Alta Anzalone, Melissa Apodaca, Daniele Ardizzone, Ethan Barnes, Lewis Barnett, Luie Camilli, Aaron Carlisle, Stepheni Ceperley, Jesse Christiansen, Paul Chua, Eric Cronk, Jenny Erbes, Daphne Gehringer, Cori Gibble, Rob Haas, Kamille Hammerstrom, Andy Hansen, Scott Hansen, Brian Hoover, Brent Hughes, Berkeley Kauffman, Diana Kohtio, Lyndsey Lefebvre, Paula Lin, Jim Oakden, John Oliver, Alexis Osgood, Chelsea Phillips, Alex Ponik, Catalina Reyes, Heather Robinson, Jayna Schaaf, Greg Schroeder, Peter Slattery, Rachael Spencer, Andrew Thurber, Brad Travers, Tonatiuh Trejo, Sam Trimmer, Jared von Schell, Tom Wadsworth, Jon Walsh, Megan Wehrenberg.

The following individuals contributed extensively to species identification and introduction status determinations (additional information listed in Appendix B): Shane Anderson, Kelvin Barwick, Shannon Carpenter, Rachel Collin, Jack Engle, Daphne Fautin, Matt Forrest, Jeff Goddard, Leslie Harris, Gordon Hendler, Gretchen Lambert, Welton Lee, Megan Lilly, John Ljubenkov, Valerie Macdonald, Laurie McConnico, Kathy Ann Miller, Steve Murray, Jaya Nolt, John Pearse, Tony Phillips, Richard Rowe, John Ryland, Greg Schroeder, Peter Slattery, Paul Valentich-Scott.

We would also like to thank Pete Raimondi, Dave Lohse, Jack Engle, Steve Murray, Steve Lee and Kathy Ann Miller for advice on sampling protocols and site selection.

We would like to thank Bonnie Becker, Jarrett Byrnes, Beth Christian, Matt Dubois, Steve Foss, Kamille Hammerstrom, David Kushner, Steve Lonhart, Karl Menard, Melissa Miner, Joe Newman, Matt Paulson, Vikki Pearse, John Tarpley, Jay Tunstin and Chris Wiese for help during field sampling, often volunteering.

The following people and institutions provided vessel transportation and support to survey sites: Curt Buyser, Mark Crossland, Bob Farrell, Dennis McKiver, Jerry Mendes (CDFG); Jamie Grover (UCSC); Shane Anderson (UCSB); Skyli McAfee and Henry Fastenau (UCD); Henri Chomeau on his boat the Blue Jacket (Tatman Foundation); John Lindsay (PG&E).

Thanks to the following institutions for access to field sites: Bodega Marine Reserve (UCD), Point Reyes National Seashore (NPS), Fitzgerald marine Reserve (CDFG), Ano Nuevo State Reserve, Montana de Oro State Park, Vandenberg Airforce Base, Carpinteria State Park, Diablo Canyon (PG&E), Paradise Cove (private), Cabrillo Marine Reserve (Cabrillo Marine Aquarium), Dana Point Marine life Reserve (Ocean Institute), Cabrillo National Monument (NPS).

Thanks to the following photographers for sharing species photographs: George Brooks and the California Academy of Sciences, Andrew Cohen, Leslie Harris, John H. Hollemank, Kathy Ann Miller and Greg Schroeder.

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INTRODUCTION

The Marine Invasive Species Act of 2003 as specified in Chapter 491, Statutes of 2003 stipulates that the California Department of Fish and Game (DFG) will conduct several studies, including a supplemental survey to augment the baseline data of Non-indigenous Aquatic Species (NAS) that was developed under the Ballast Water Management Act of 1999. The supplemental survey is to focus on the intertidal and subtidal habitats of the open coast. The DFG's Office of Spill Prevention and Response (OSPR) was assigned the task of conducting the NAS investigations. The OSPR has identified potential areas along the outer California coast to conduct field and laboratory studies for the presence of NAS. These areas include prominent headlands that are proximate to shipping lanes, as well as other locations where ballast water exchange could likely result in NAS invasions. The work described below is in part a continuing effort begun in the fall of 2000 in the harbors and bays of northern, central and southern California. Literature and data reviews were complimented by field and laboratory studies jointly conducted by DFG/OSPR and San Jose State University Foundation's, Moss Landing Marine Laboratories (MLML). Additional universities and specialized laboratories provided taxonomic expertise in identification of marine species.

As noted by Grozholz, studies on species invasions have increased in marine systems over the last decade (Grozholz, 2002). The vast majority of known marine introductions in California have occurred in bays and harbors, probably because several of the major introduction vectors have historically concentrated in bays and harbors (ballast exchange, aquaculture, and ship hull fouling). It remains unknown whether the open coastal environment is more resistant to invasions and/or less exposed to them. As studies of marine species invasions continue, it is apparent that knowledge of the natural histories of both native and non-native species is vital to understanding and predicting sustainable invasions (Carlton, 1996). The survey presented here should aid our knowledge of the extent of invasions and subsequent ecological adaptations, as well as prevalent trends in recruitment and succession caused by bioinvasions. To help address the legislative question of whether or not ballast water exchange initiatives have been successful in slowing the rate of species invasions, this survey will be repeated in 2007, three years after the initial survey, and the same sites will be sampled using the same protocol.

This study aimed at collecting baseline information on the presence, distribution, and abundance of NAS on California's open coast. Taxonomic experts for each phylum were relied upon heavily for comments and direction in determining the status of species as introduced, cryptogenic, or native. Taxonomist's comments were supplemented with literature reviews to address questionable or problematic species determinations. This process led to several updates to the introduction statuses reported by MLML (CDFG, 2002), and these updates are described in text and tables below. Additionally, the process highlighted the need for basic taxonomic and ecological research before many determinations can be finalized.

The sampling design was adapted from the design used in previous DFG/MLML NAS surveys conducted in California bays and harbors (CDFG, 2002), and focused on whole community structure rather than singling out any one "invasive" species or habitat. Multiple habitats were surveyed at each of 22 open coastal sites (Figure 1). Site selection and general descriptions are detailed below.

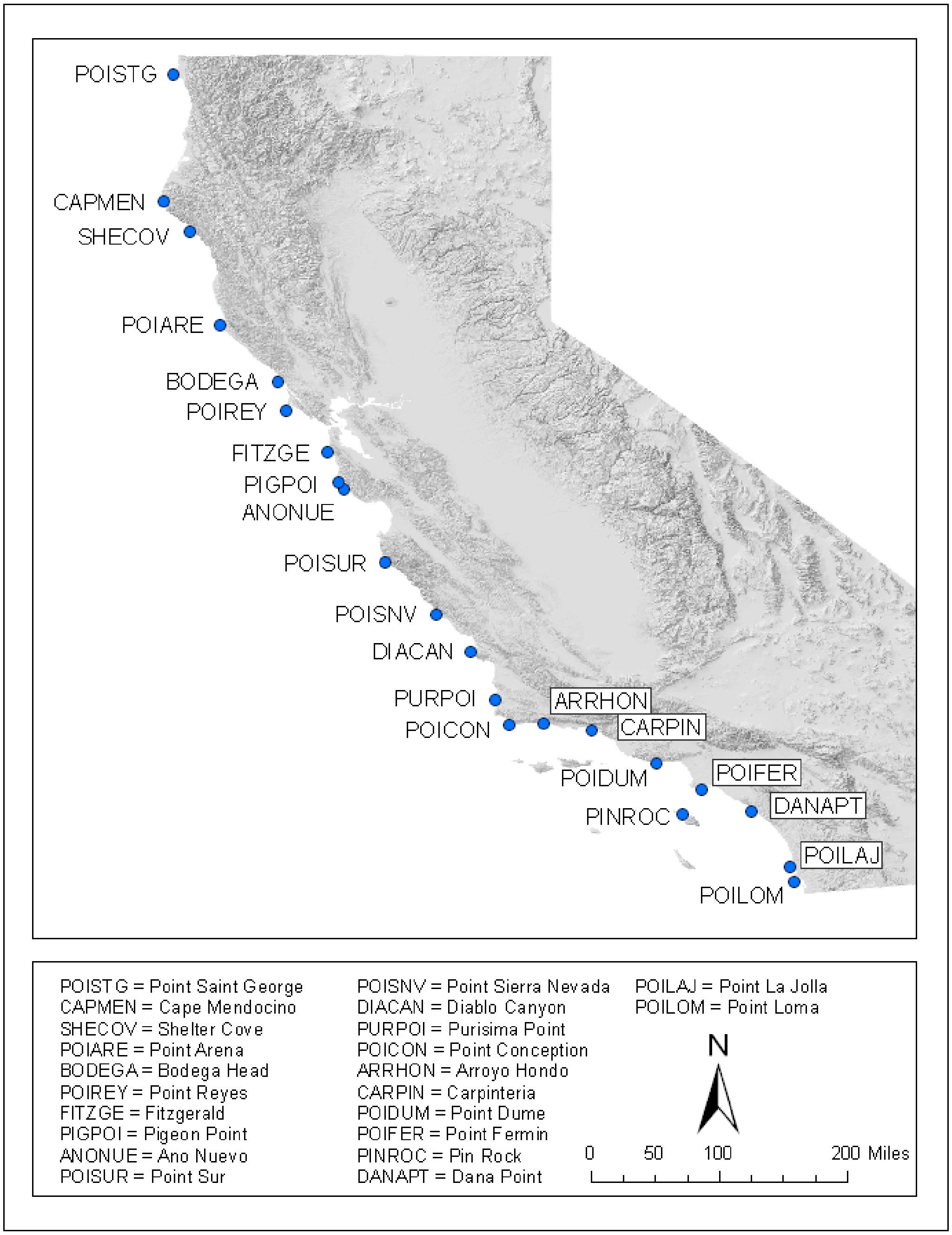


Figure 1. Outer coast sites sampled during the 2004 surveys.

Outer Coast Survey Sites

Site Selection
The OSPR originally developed a list of 22 geographic areas spanning California's outer coast, targeting prominent headlands in proximity to shipping lanes and potential entrainment areas that may have increased larval settlement. MLML further refined these areas to 22 specific sampling sites to 1) find accessible intertidal and subtidal habitats near the areas identified by OSPR, and 2) whenever possible, overlap locations with historic or current species datasets that could be used to monitor change in species composition over time.

Point Saint George
This site was chosen as the northern-most prominent headland to sample for the current survey. Point Saint George lies approximately 15 miles south of the Oregon-California border. The point itself is composed mostly of rugged, rocky reef, whereas the nearby coastline is composed of mainly large boulder fields with some rocky outcrops and few small sandy patches. The subtidal terrain is equally as rugged as the intertidal coastline. As one of the few accessible rocky intertidal reefs along the extreme northern California coastline, this site is also a current study site for other intertidal ecological research and monitoring (PISCO. Retrieved on October 23, 2006, from http://www.piscoweb.org; SWAT. Retrieved on October 23, 2006, from http://cbsurveys.ucsc.edu/). Intertidal sampling for the 2004 survey occurred on the downcoast-facing side of the rocky point that jets out from the coastline and is exposed only at low tide. Subtidal sampling occurred on the south side of Point Saint George, not far offshore from the intertidal site (Figure 2).

Cape Mendocino
Sampling occurred approximately five miles south of Cape Mendocino, in an area thought to be a larval entrainment area (Ebert and Russell, 1988). The survey site lies approximately 30 miles south of Humboldt Bay, between the mouth of the Bear River to the north and the Mattole River to the south. This site is very remote as well as subject to winter storms and strong surf. There is a large, easily accessible intertidal rocky reef where other ecological experimental and monitoring historically and currently occur (PISCO. Retrieved on October 23, 2006, from http://www.piscoweb.org; SWAT. Retrieved on October 23, 2006, from http://cbsurveys.ucsc.edu/). Subtidal sampling took place directly offshore from the intertidal reef sampled (Figure 2).

Shelter Cove
Shelter Cove was chosen as one of the major geographical points along the northern California coastline (Point Delgada). Although remote and difficult to get to by boat or car, this area is a small hub for fishing boat traffic. The specific sampling locations were all adjacent to the bulk of boating activities in the area, which included a small boat launch, permanent moorings, and transient anchorages. Intertidal sampling took place at the reef just north of the Shelter Cove boat launch area and extended upcoast and around the point a few hundred meters. The intertidal sandy sampling occurred on the beach that extended downcoast from the boat launch area. Subtidal rocky sampling occurred on a rocky reef off of Point Delgada and the subtidal sandy sampling occurred offshore from the launch ramp (Figure 2). This area's rocky intertidal reefs have also been studied and are currently monitored by marine ecological researchers and

monitoring groups (PISCO. Retrieved on October 23, 2006, from http://www.piscoweb.org; SWAT. Retrieved on October 23, 2006, from http://cbsurveys.ucsc.edu/).

Point Arena

This site was selected because it is one of the most prominent headlands along the Mendocino/Sonoma coastline. Point Arena itself consists of steep cliffs and rugged rocky coastline and was deemed inaccessible by MLML field crew. Moss Landing Marine Laboratory staff sampled approximately 1.5 miles to the south of Point Arena at an accessible rocky reef (Figure 2) which has previously been a site for ecological studies conducted by various researchers (PISCO. Retrieved on October 23, 2006, from http://www.piscoweb.org; SWAT. Retrieved on October 23, 2006, from http://cbsurveys.ucsc.edu/). The land inshore from the rocky reef was recently donated to the Bureau of Land Management (BLM) by the Stornetta Ranch, and just months before this survey's sampling event became open to public access. There were no sandy beaches with fine enough sand in the immediate vicinity of the rocky reef, so all sandy samples were taken approximately seven miles north of Point Arena, at Manchester State Beach.

Bodega

This site was chosen by CDFG as a prominent headland in this area of the coastline. MLML chose to sample approximately one mile North of Bodega Harbor, at Bodega Marine Lab, within the Bodega Marine Reserve. Researchers from Bodega Marina Lab and other ecological research and monitoring groups constantly study this shoreline (PISCO. Retrieved on October 23, 2006, from http://www.piscoweb.org; SWAT. Retrieved on October 23, 2006, from http://cbsurveys.ucsc.edu/), which could provide historical species datasets for comparison. The rugged but accessible rocky reef adjacent to a sandy cove also made this an ideal sampling site (Figure 2).

Point Reyes

CDFG originally selected Point Reyes as a sample location because of its prominence as a headland in the area. However, the headland itself consists of steep cliffs and is virtually inaccessible for intertidal sampling. After researching possibilities in the area, and based on the recommendation of Point Reyes National Seashore park researchers, MLML chose the rocky intertidal reef at Bolinas Point as the alternate intertidal sampling site. Bolinas Point is another fairly prominent point on the southern portion of Point Reyes National Seashore, and still within national park protection. In addition, it is difficult to find a subtidal sampling site considered safe for SCUBA divers, as this area is known to have an abundance of White Sharks. Bodega Marine Lab scientific collectors experienced in sampling this area directed MLML to a subtidal site at the north end of Drakes bay near Chimney Rock. This was accepted as the only site in the area safe enough for sampling via SCUBA, and even then the sampling event was timed to occur after the vast majority of sharks were thought to have left the area. Although technically inside Drakes Bay, the bay is very large, open and exposed like the outer coast (Figure 2).

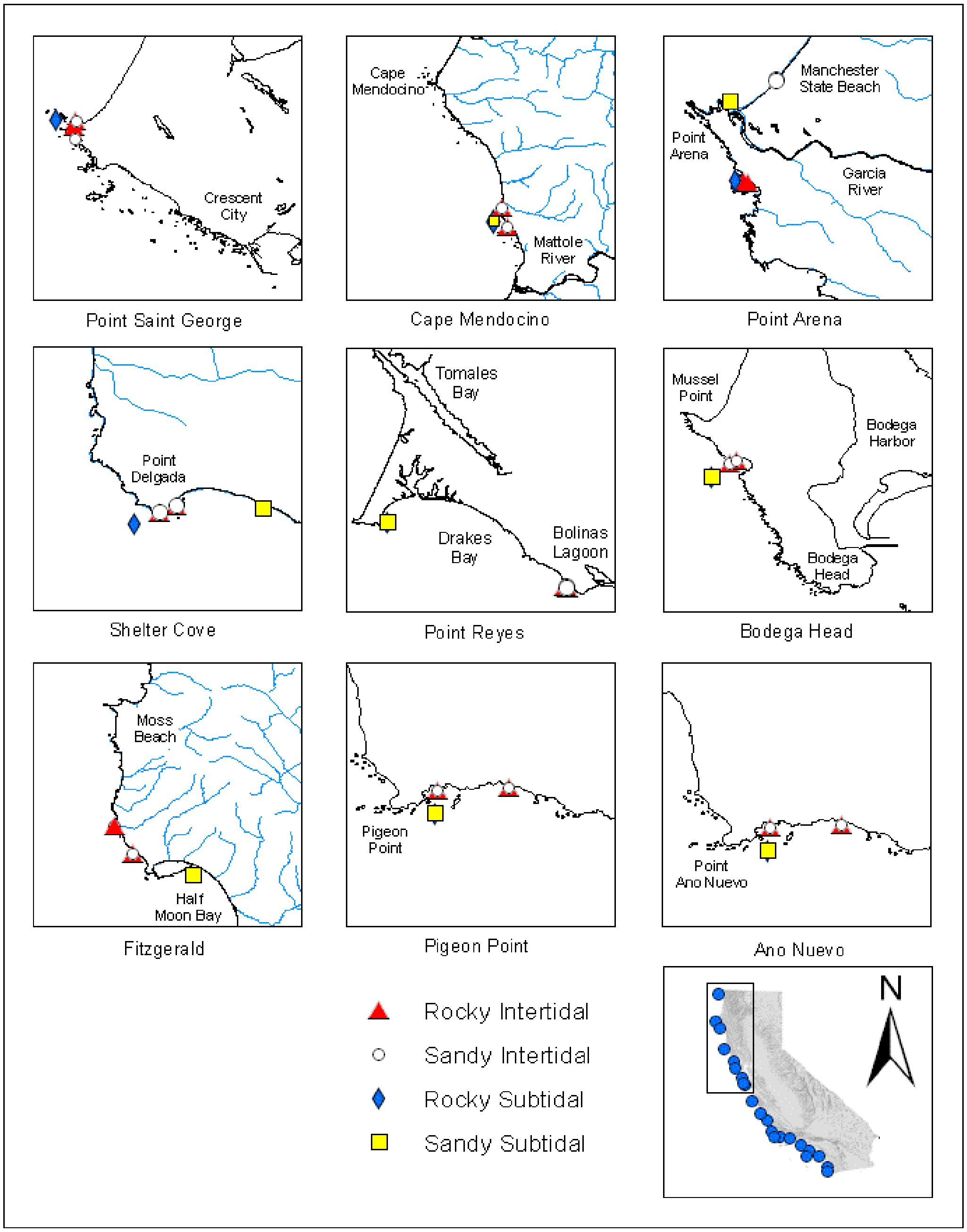


Figure 2. Northern California sites sampled during the 2004 surveys.

Fitzgerald
Fitzgerald State Park was selected as a sampling site due to its large, accessible rocky intertidal reef with an adjacent sandy beach (Figure 2), and since other rocky reef research occurs at the site there may be historical species datasets available for comparison (SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/). Fitzgerald State Park is less than five miles north of the world-famous big wave surf spot, Maverick's reef, and is within protected state park boundaries. This intertidal area is regularly visited by locals and tourists, and the trampling disturbance may make it more susceptible to species introductions than other nearby areas. An additional local disturbance comes from harbor seals who regularly haul out in certain areas of the rocky intertidal reef sampled. This area is known to have a high abundance of white sharks, so subtidal sampling at this site was conducted without SCUBA divers through retrieval of kelp holdfasts.

Pigeon Point
This sampling site was selected because it is a prominent headland in the area, and it has been studied by other marine ecological researchers (PISCO. Retrieved October 23, 2006, from http://www.piscoweb.org). Intertidal sampling occurred south of the point, along a sandy beach and adjacent rocky outcrops that are somewhat protected by the point. Subtidal sampling occurred just offshore from the intertidal sampling, and did not include SCUBA diving as this area is known to be frequented by white sharks.

Ano Nuevo
Point Ano Nuevo was selected as a sampling site for several reasons. It is a prominent headland in the region, historical datasets reported introduced species found in the rocky intertidal up to 30 years ago, and it is a site researched by other groups both historically and currently (J. Pearse, personal communication, July 14, 2004). There is a rocky intertidal reef, an adjacent low-lying boulder field, and adjacent beaches, all somewhat protected by Ano Nuevo Island just offshore (Figure 2). Elephant seals haul out at this site, creating a disturbance that may increase this site's susceptibility to introductions. White sharks attracted to the elephant seals are abundant in this area so subtidal samples were not collected using SCUBA divers. The rocky reef surveyed is also currently a site of other intertidal ecological monitoring research (SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/).

Point Sur
CDFG selected Point Sur as a prominent headline along the Big Sur coastline in southern Monterey County. The point itself is a rugged, steep headland, so sampling occurred approximately 0.5 miles to the south, in between Point Sur and Andrew Molera State Park (Figure 3). Accessible intertidal rocky reef is adjacent to a long sandy beach, and just offshore lays a large rocky reef and kelp forest. Since this area is directly in the lee of Point Sur, it may be an area of larval entrainment. This intertidal and subtidal rocky reef area is also being studied and monitored by PISCO (Retrieved on October 23, 2006, from http://www.piscoweb.org).

Point Sierra Nevada
Point Sierra Nevada lies just south of the Big Sur coastline, in between Ragged Point to the north and Point Piedras Blancas to the south. Point Sierra Nevada is an historical rocky intertidal study/monitoring site for other research groups, including monitoring funded by the Minerals Management Service (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/;

PISCO. Retrieved October 23, 2006, from http://www.piscoweb.org); SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/). Since no sandy beaches are adjacent to the intertidal rocky reef sampled, sandy samples were collected at the next accessible beach south on Highway 1. This area is approximately 5 miles north of a recovering Elephant Seal rookery at Piedras Blancas and thus is presumably white shark habitat, so using SCUBA divers was deemed unsafe at this site. All subtidal samples were collected from a boat by retrieving kelp holdfasts and using a sediment grab at the nearest possible location to Point Sierra Nevada (Figure 3).

Diablo Cove

Considered a potential recruitment area for introduced species due to the warm water output from the nuclear power plant, Diablo Cove was selected as a sampling site for the current survey. Species assemblages at Diablo Cove are known to be unusual for that area as a result of the warm water. Although Diablo Cove has been highly studied and species lists date back decades, MLML does not know of any other surveys conducted at this site that focused on introduced species detection. This site is situated between Point Buchon to the north and San Luis Obispo Bay to the south (Figure 3).

Purisima Point

Purisima Point lies approximately 10 miles north of Point Arguello, and is this survey's southernmost sampling site within the cold waters of the California Current north of Point Conception. At Purisima Point, an accessible, flat, intertidal reef jets out to sea and is exposed only at low tide, while a subtidal reef and kelp bed lie just offshore in the lee of the point (Figure 3). The rocky intertidal habitat on the point is a long-term monitoring site, and researchers report observations of large amounts of kelp and debris washing up to shore, leading us to suspect that it is an area of larval retention (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/; P. Raimondi, personal communication, May 27, 2004). Researchers have also observed higher species richness in attached marine algae at this site than any other nearby rocky intertidal sampling site (P. Raimondi, personal communication, May 27, 2004). There is an intertidal beach on the north side of the point, but the sand is typically very coarse there and not suitable for collecting infaunal samples for this survey. However, suitable beaches can be found slightly downcoast of the rocky reef.

Point Conception

Point Conception is both a major headland within the region and known as a biogeographic boundary along the California coastline and the northern or southern range limit for many marine species. Cojo Anchorage lies just to the south of the point and is an accessible dive site with kelp forests (Figure 3). Rocky intertidal benches line parts of the coastline around Point Conception, but are not easily accessible by land or by boat, making the coastline well protected from human trampling. Both the intertidal and subtidal rocky reef habitats have been studied and monitored historically at this site (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/; M. Readdie, personal communication, October 23, 2006).

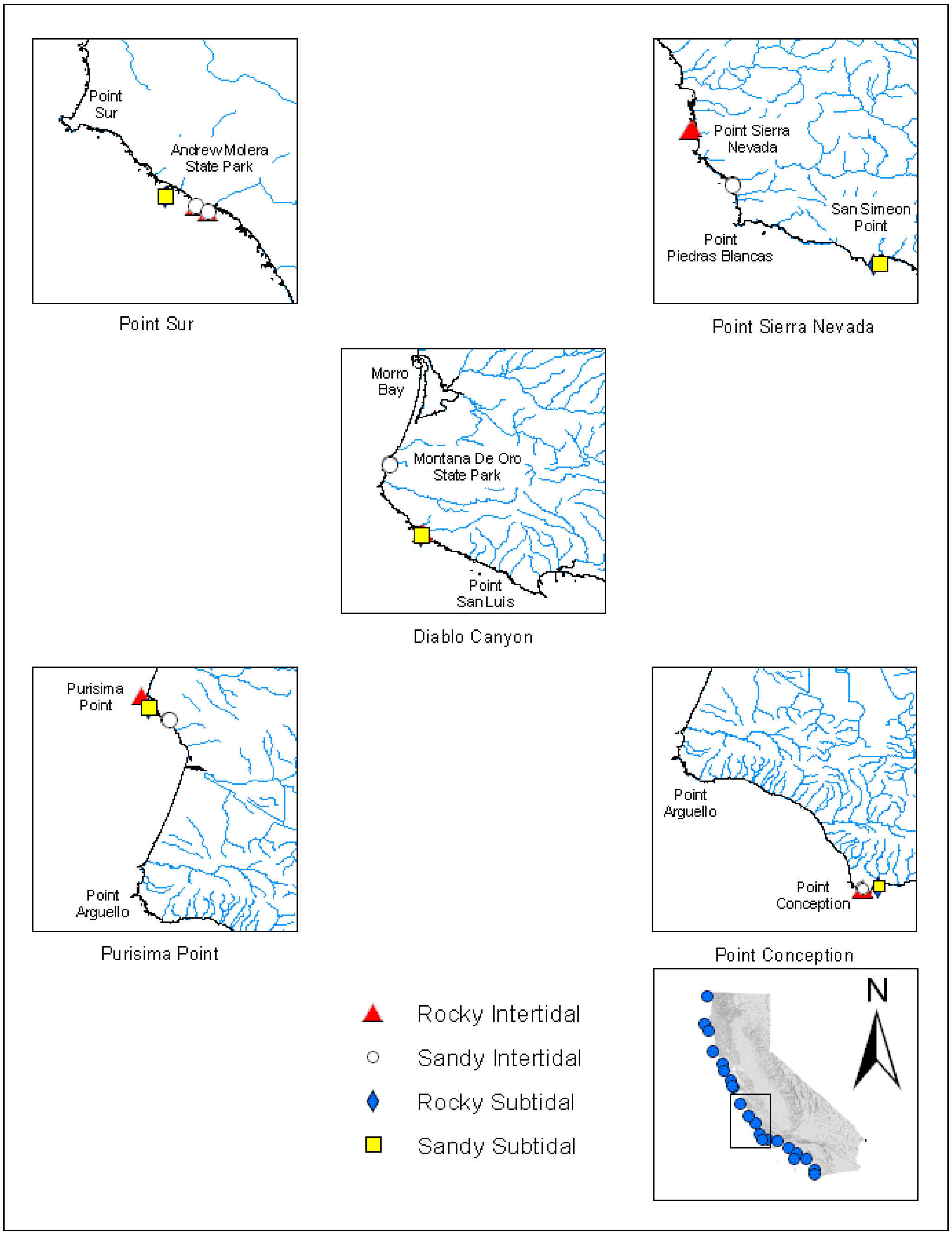


Figure 3. Central California sites surveyed during the 2004 surveys.

Arroyo Hondo
This fairly remote site is between Gaviota and Goleta, towards the northern end of the Santa Barbara Channel (Figure 4). The majority of the surrounding coastline is dominated by sandy beaches and low-lying rocky reefs. Arroyo Hondo's rocky intertidal reef was recommended as the most extensive rocky intertidal reef in the area, is a site of long-term monitoring and ecological experiments, and was also a known and studied location of the introduced marine algae *Sargassum muticum* (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/; SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/). The reef also extends offshore to kelp forest habitat and is an accessible dive site.

Carpinteria
South of the city of Santa Barbara, Carpinteria State Beach lies in the lee of Sand Point, and near a small estero. One of the only rocky intertidal reefs along this area of coastline is in the middle of Carpinteria State Beach, and there is a subtidal reef and kelp forest habitat offshore (Figure 4). Both the rocky intertidal and subtidal reefs sampled for this project are also study locations for biological monitoring and ecological experiments (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/; SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/; C. Nelson, personal communication, October 23, 2006).

Point Dume
Point Dume is a major headland on the north end of Santa Monica Bay. The point is very exposed, with large boulders and rocky outcrops, so the area just downcoast of the point and stretching along the beach to Paradise Cove was selected as the site for the current survey (Figure 4). Rocky intertidal habitat included cobble and boulder fields as well as a small but prominent intertidal rocky reef. This intertidal rocky reef is a study site for various long-term monitoring studies and ecological experiments (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/; SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/). This area is a popular beach and experiences high human traffic. Both sandy and rocky reef habitat are found offshore in this area.

Point Fermin
Located just upcoast of San Pedro Bay, and adjacent to the major shipping centers of Los Angeles and Long Beach Harbors (Figure 4), this sampling site was selected as a prime candidate for marine species introductions spreading out from the harbors. Samplers also observed the container ships sitting offshore waiting for their turn to enter the harbor and offload their cargo. In addition, this rocky intertidal site has historically been studied by various groups both for long-term biological monitoring as well as ecological experimentation (SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/; PISCO. Retrieved October 23, 2006, from http://www.piscoweb.org). Although part of a Marine Life Refuge, this site is centered in an area of high human population and is subject to human visitors and trampling disturbances.

Dana Point
Dana Point was recommended as a sampling site because all target habitats are present, and historical and current ecological and monitoring datasets exist for this area (SWAT. Retrieved October 23, 2006, from http://cbsurveys.ucsc.edu/). The sampling site is also just downcoast from Dana Point itself, which is quite prominent for this area and currents may create an eddy or

retention area on its south side (Figure 4). Dana Point Harbor is also less than one mile away from the sampling site, potentially making this site a likely candidate for introduced species either spreading from within the harbor or in the water column from all of the small boat traffic in the vicinity. Dana Point is also within a Marine Life Refuge.

Pin Rock, Catalina Island

Pin Rock was selected as an outer coast sampling location on Catalina Island for several reasons. First, all of the target habitats are found at or near Pin Rock, which is uncommon along the shoreline of Catalina Island. This is one of the few sites on the south-west facing side of the island with a rocky bench rather than sheer cliffs. The survey site also extends along the shore to the mouth of one of the few small boat harbors on the island, Catalina Harbor (Figure 4). This proximity to the harbor could increase the vulnerability of the outer coast habitats to introductions, because non-native marine species had previously been reported from within Catalina Harbor (K. Miller, personal communication, October 23, 2006). The survey site at Pin Rock is also on the "back side," or what is considered to be in the lee of the island, protected from north swells.

Point La Jolla

After careful reconnaissance and consideration, the Point La Jolla area was selected as a sampling site for this survey primarily because all of the target habitats are available and fairly close together. Intertidal sampling actually occurred south of Point La Jolla, near Bird Rock, while subtidal sampling occurred closer to the point (Figure 4). During reconnaissance, samplers discovered that this site harbored a significant band of *Mytilus californianus* in the rocky intertidal, which is currently uncommon this far south, and is also one of the habitats targeted in this survey at other sites.

Point Loma

Point Loma was selected as the southernmost survey site along the California coastline. The sampling site is within the jurisdiction of Cabrillo National Monument, which maintains rocky intertidal zones that are protected from daily human visitor traffic and disturbance as well as zones that are not protected. Samples collected at this site are from areas of varying human disturbances, but still within a fairly condensed overall area. Point Loma is also in close proximity to two bays with known introductions, as it is adjacent to the mouth of San Diego Bay, and approximately 6 miles south of Mission Bay (Figure 4).

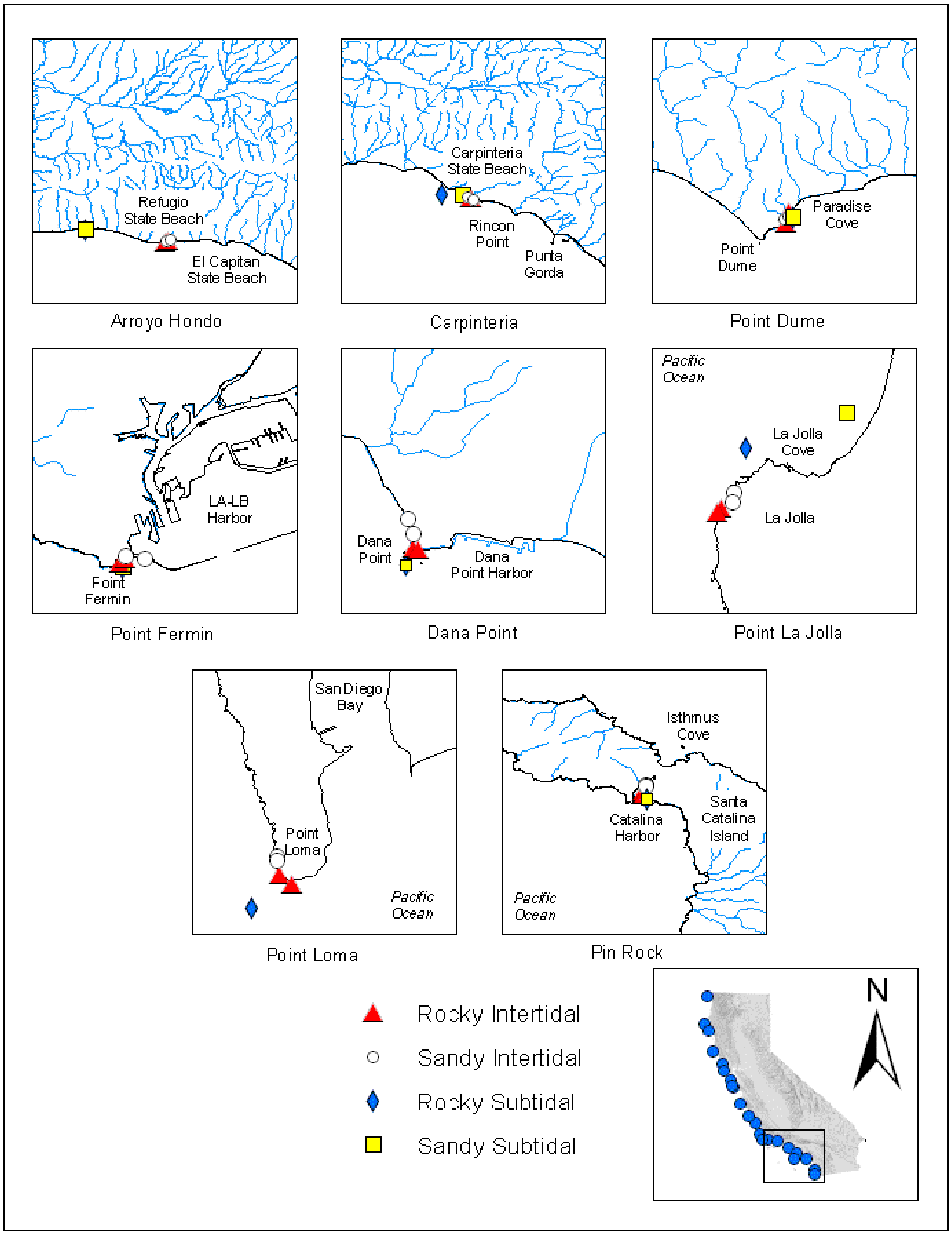


Figure 4. Southern California sites sampled during the 2004 surveys.

METHODS

Summary of Introduction Status Determinations

As experts on the respective taxa, taxonomists are familiar with the most updated and informative sources, current literature, and occasionally even unpublished records of specimen collections. For this reason, taxonomists identifying samples for the current survey were asked to provide an assessment on the introduction status for species they identified. Status determinations made by taxonomists were used to establish a master outer coast taxa list for the current survey. The baseline status determinations in this master taxa list were then compared against introduction statuses reported in other datasets, including CDFG (2002) and DFG's California Aquatic Non-native Organism Database (CANOD). When status discrepancies were found, further literature reviews were conducted by MLML to refine information regarding the species' native range, current known distribution and reported introductions. These further literature reviews targeted multiple sources of information including peer reviewed scientific publications, web sites, agency literature, field surveys and personal communications. Final species status determinations were made to the best of our knowledge based on all available sources, and after both careful consideration and consultation with taxonomists. Sources used in making status determinations were documented, and the master taxa list was used to identify introduced and cryptogenic species collected from the field surveys of this study.

Using a synonym list provided by the U.S. Environmental Protection Agency's Pacific Coast Estuarine Information Systems (PCEIS) database (Lee and Reusser, in progress), MLML eliminated known, outdated taxa name synonyms from the master species list generated by the current survey.

Summary of Sampling Design

Field Protocol Design

While the basic sampling regime used in the DFG/MLML 2002 NAS survey was retained (CDFG, 2002), protocol details were adjusted for the current survey by MLML to accommodate for the more natural substrates found at outer coast habitats. Depending on sampling location and the collection method, sampling can potentially underestimate the true populations if not all habitat types are represented, as seen in studies of ships' ballast (Carlton and Geller, 1993). It must be acknowledged that all possible subtidal and intertidal habitats and communities were not sampled in this broad statewide survey, but every attempt was made to be as representative as possible within the logistical and budgetary constraints of the project.

At each of the 22 outer coast sites (Figure 1), 4 main habitat types were targeted: rocky intertidal, rocky subtidal (kelp forests if possible), sandy intertidal and sandy subtidal. The overriding principle was to collect samples from as many different habitats as possible, and within each of those habitats to target the most diverse appearing areas, rather than randomly selecting locations for sample collections. Sampling included the use of qualitative and quantitative sampling protocols to survey representative communities for the presence of NAS. Methods employed included the use of sediment cores and grabs, quadrat clearings and qualitative taxonomic surveys. Samples were then preserved and transported to the appropriate laboratories and taxonomists for identification and enumeration. Taxonomists familiar with local marine flora and fauna participated in qualitative visual searches for introduced species at the majority of intertidal habitats and at subtidal habitats whenever available. Taxonomists also provided information about historical or ongoing ecological or monitoring research conducted at or near survey sites.

Outer coast subtidal sampling focused on average depths less than 30 feet, and rocky subtidal sampling in particular focused on kelp forest habitat whenever possible to target high diversity communities. Due to habitat differences that could influence larval recruitment and subsequent colonization, the sampling strategy encompassed multiple depths, intertidal zones, substrates and light exposure conditions.

Summary of Field Sampling Methods

Sampling Vessel
Whenever possible, collections were made using a 19 ft Boston Whaler (*Ms. B1*) with a Johnson 100 hp commercial outboard engine and 15 hp spare outboard engine. *Ms. B1* was outfitted with a 5.5 hp Honda motor that powers a hydraulic winch, used for the sediment grabs at sites where diving was not possible or prudent. Since many sampling locations were remote and required larger seagoing vessels or local knowledge for safety purposes, several research vessels from other institutions were used, including CDFG, University of California Santa Cruz, University of California Santa Barbara, University of California Davis, Moss Landing Marine Labs, University of Southern California, PG &E, as well as private vessel use donated by Henri Chomeau of the Tatman Foundation. All sampling events were recorded as latitude and longitude (decimal minutes, NAD83 or WGS 84 datum) using a Garmin GPS Map76S Global Positioning System. All station information pertinent to the sampling effort was recorded in a field logbook.

Epifaunal Sample Collection

<u>Quantitative quadrat clearings</u>

At each of the 22 outer coast sites, epifaunal samples were collected quantitatively from rocky intertidal and subtidal substrate, by scraping clear and collecting the biological contents from quadrats of known areas (0.05 m^2). As opposed to the 2 quadrats used at each site in the 2002 DFG/MLML survey, the current survey used 4 quadrats (totaling the same area as in 2002), in order to target more variety in the outer coast rocky reef habitats. In order to increase the chances of detecting a non-native species, field samplers selectively placed quadrats in areas that appeared to have the most diversity or were likely to harbor non-native species, including but not limited to overhangs, big cracks in the rock, mussel beds and turf communities. Decisions made on quadrat placement were primarily based on background research on the natural history of known non-native algae and invertebrates on the outer coast. Digital photographs were taken of both the plot and its surrounding community before the plot was cleared. Samplers carefully and completely collected everything found within quadrat clearings of 0.05m^2 each.

At rocky intertidal habitat, 4 quadrats were cleared for a total area of 0.2m^2. Whenever possible, the 4 intertidal quadrat clearings were distributed in the intertidal as follows: 1) one clearing from the mid-zone mussel bed; 2) one clearing from the mid zone, non-mussel bed, in what appeared to be the most diverse habitat, (note: in Southern California, sites with turf habitat covering much of the intertidal area were often encountered. At many of these sites this mid zone quadrat was placed in mid to high zone turf habitat); 3) one clearing from the low zone, oriented horizontally, in the most seemingly diverse habitat; 4) one clearing from the low zone on a vertical surface or under an overhanging rock.

Subtidal surveys were conducted via SCUBA at all sites unless white shark presence prohibited diving (see Summary of Field Surveys in Results and Discussion for details by site). In rocky subtidal habitat, the total area of $0.2m^2$ was modified into 3 quadrats ($0.05m^2$ each), and one kelp holdfast when kelp was present. All subtidal sample collections were taken from a target depth of 30 feet or less if possible. At least one subtidal quadrat clearing was taken from a vertical surface or overhang, while the other two clearings were taken from the most seemingly diverse habitat types observed at each site. MLML staff determined the placement of the quadrats, and two other divers followed to collect the quadrat contents. *Macrocystis pyrifera* and *Nereocystis leutkeana* plants with a holdfast diameter of at least 20cm were targeted for the holdfast collection whether found dead or alive. Holdfasts collected which were 60-100cm in diameter were cut into smaller, more manageable pieces before being put into containers. For larger holdfasts (~100cm), a representative subsample was taken. At sites where shark presence prohibited diving, attempts were made to collect four holdfasts of either *M. pyrifera* or *N. leutkeana* from a boat by tying off to the kelp stipes at the surface and pulling on them. Quadrat clearings could not be collected without SCUBA divers, so the contents of the holdfasts were the only rocky subtidal samples collected from non-dive sites.

Quadrat and holdfast samples collected underwater were placed in mesh bags (0.5mm mesh), which were closed tight and transferred to the surface. On the boat, the entire contents within the mesh bags for each sample were carefully sieved through a 0.5mm screen and then transferred into separate containers and labeled. Intertidal collections were placed first in a ziplock bag and then transferred to separate containers and labeled. All quantitative clearing samples were fixed in 10% formalin in the field and later preserved in 80% ethanol.

<u>Visual Searches</u>

To the extent that they were available, taxonomists and/or natural historians familiar with the local flora and fauna conducted qualitative visual searches for introduced species at each site, collecting algae and invertebrates that they either recognized as non-native species or did not recognize at all. The goal was to have at least one invertebrate expert and one phycologist conduct visual surveys at each intertidal site, and to dive at subtidal sites if possible. Due to budgetary and logistical constraints related to SCUBA diving, taxonomists were not actively sought out for all subtidal surveys. Full-time MLML staff assisted taxonomists, or conducted the visual searches when local taxonomists were unavailable. At intertidal habitats, taxonomists and/or MLML staff spent one low tide (approximately 3 hours) conducting the survey. At subtidal habitats, MLML staff (and sometimes taxonomists) conducted the swimming visual searches for approximately 30 minutes (or the duration of one SCUBA dive) and focused on depths of 30 feet or less. Since the priority of this project was to detect any NAS, as opposed to making a comparison between sites, there was no attempt to standardize search time, expertise, or search effort between sites. However, the total time searched and personnel involved were recorded for each site. During swimming surveys, unidentified species and small rocks or large algal blades that could potentially house a variety of species such as bryozoans were collected.

Specimens collected during the visual searches were sorted into rough groups and fixed in a manner that best preserved identification characteristics, as recommended by taxonomists for each phylum. A 10% formalin fixative was used with all specimens, with the exception of bryozoans, hydroids and echinoderms which were fixed in 70% isopropanol, and poriferans, *Crepidula* and *Mytilus* which were fixed directly in 85-95% ethanol. *Diadumene spp*. were divided and fixed in both formalin and ethanol when enough specimens were present. Ascidians were also relaxed in a mixture of freshwater and magnesium chloride, until unresponsive to touch, before being fixed in the formalin. Algal collections were pressed on herbarium paper, and some were also preserved in 5-10% formalin or in silica gel for potential future genetic analysis. Pre-preservation photographs were taken of many organisms to record live color and appearances.

Infaunal Sample Collection

In order to target as many habitats as possible at each site, five quantitative benthic infaunal cores were collected for community analyses from the low intertidal (targeting -1.0 ft tide height, below the sand crab zone), 5 cores were collected from the high intertidal (targeting substrate underneath beach wrack and sampling through beach wrack whenever possible), and 5 cores were collected in subtidal sand from approximately 30 foot depths. Cores were taken using large (15 cm diameter) coffee cans and lowering them to a maximum depth of 10 cm where possible, making sure to capture the surface layer. The multiple core samples collected resulted in a total surface area of $0.1m^2$ collected from each of the three zones. Subtidal infaunal samples were collected by SCUBA divers whenever possible, and at sites where no dives were conducted, subtidal cores were collected using a Young-modified Van Veen sediment grab ($0.05m^2$ per grab for a total area of $0.25m^2$ per subtidal site). The five cores in each zone were spread out over approximately 10-20 meters. Contents from high zone core samples were sieved through a 1.0 mm mesh screen, and the contents from low zone and subtidal core samples were sieved through a 0.5 mm screen. Residues (e.g., organisms and remaining sediments) were rinsed into unique, pre-labeled storage containers, fixed in 10% formalin, and preserved in 80% ethanol.

Grain Size Sample Collection

At each of the 22 outer coast sites, three representative grain size samples were collected within the general area of the infaunal core sample collections (one from the intertidal high zone, one from the intertidal low zone, and one from the subtidal sandy area). For each grain size collection, a tube was lowered approximately 5-10 cm into the sand, and the entire sample placed in a bag and kept cool. Samples were then transferred to MLML's Benthic Laboratory for analysis.

Field Abundance Measurements of NAS Algae
Since marine algal species were not identified in the quadrat clearing samples, extra efforts were made to assess abundance of an introduced algal species found in rocky intertidal habitats at many of the survey sites, *Sargassum muticum* (Heterokontophyta). *S. muticum* generally grows in patches, and is often limited to tidepools. Whenever *S. muticum* was common within a sampling site (as per CDFG (2002): "a common species would be relatively easy to find, and often would occur in significant numbers"), MLML field samplers conducted a timed count of individual *S. muticum* plants over a known area of rocky intertidal reef. At each site, two samplers roamed and counted *S. muticum* plants for 15-20 minutes each, making sure to not count the same plant twice. The duration of the count depended on how widespread *S. muticum* was at a site, and count time was set to allow samplers to cover the entire area or the majority of the area where *S. muticum* was found. Latitude and longitude coordinates were recorded to mark the boundary of the area counted, and not all plants within the boundary were necessarily counted. Timed counts may be repeated during future surveys to crudely detect any changes in the density or expansion of *S. muticum* plants from within the boundary over time.

Documentation of Sample Sites
Latitude and longitude coordinates were documented for the upcoast and downcoast borders of the rocky intertidal area searched, upcoast and downcoast borders of sandy intertidal beaches sampled, and from the boat at subtidal sampling events. A crude map was drawn for each site and notes were taken on anything unique about the area searched, the geology of the intertidal bench, and the specific reason for choosing the sample area. Digital overview photos were also taken of the site.

Summary of Laboratory Processing Methods for Quantitative Samples
Preserved quadrat, holdfast and infaunal quantitative field samples were sent to MLML's Benthic Laboratory for processing and sorting as described below and were then sent to taxonomists for identification. Quantitative field samples were fixed in 10% buffered formalin in the field. Formaldehyde penetrates tissue at about 5 mm per day and, after a few days, acidity can begin breaking down small calcareous structures. Because almost all organisms were very small, complete penetration through all tissue was easily completed in 3-4 days and samples were transferred from formalin to a preserving solution of 70% isopropyl or 80 % ethyl alcohol. All quantitative samples were stained with rose Bengal, a vital stain that colors animal tissue red. The red color allows animals, particularly small ones, to be more easily recognized and separated from detritus and sediment during sorting. Staining was necessary because of the very large size of samples, great quantity of detritus, and great disparity in animal sizes.

Subsampling
Subsampling of each of the quantitative samples was accomplished by placing the entire sample contents into a large, flat photographic tray marked into 4 equal-sized quadrats for subsampling, a procedure modified from Harrington and Born (Lazorchak et al., 1999). The sample was gently agitated until equally distributed across the tray. Most of the alcohol was then drawn off the sample by suctioning with a turkey baster from the center of the tray until the sample was immobile within the tray. Animals that were drawn up with the alcohol were caught on a screen guard and returned to the center to the tray. When subsampling occurred, a flat plastic blade was used to draw the sample in from the sides of a randomly selected quadrat until the sample was

concentrated into the corner of the selected quadrat, away from the other three quadrats. This isolated portion of the entire sample was the one-quarter quantitative subsample. Depending on the size of the sample, contents were subsampled to 1/2, 1/4, 1/8, and occasionally 1/16, 1/32, and 1/64. The volume of the subsampled portion ranged from 500ml to 1L. The fractional sample was then sorted by standard sorting procedure described below. The portion of the original sample that was not subsampled (i.e. fully sorted as described below) was redistributed in the tray and inspected with a magnifying glass or magnifying lamp. Any taxa that were not represented in the sorted fraction were removed for a qualitative subsample (called a "scan" sample) of the remaining sample. The remaining unsorted fractions were archived. A subsampling log was maintained, and entries were made for each sample, including those which were not subsampled. Some samples were not subsampled if the volume was small enough that the entire sample could be sorted.

At the beginning of the project subsampling was also accomplished by density fractionating the sample. The entire sample was transferred to a large plastic tub which was then filled with enough water to cover the sample plus another one quarter to one third of the sample volume. The tub was then swirled – contents were agitated in a smooth circular motion, causing less dense animals to be suspended in the supernatant, while heavier animals and sediment fell to the bottom and comprised the granular portion. Each fraction, supernatant and granular, was then subsampled as above. Because of the added difficulty in record-keeping, this manner of subsampling did not save time as hoped, and was discontinued early in the project.

Sorting

High-resolution dissecting microscopes (Wild, Nikon and Olympus) with high intensity (fiber optic) light sources were used to sort the sample materials. Samples were sorted into 1 dm or 2 dm shell vials with airtight plastic stoppers or Wheaton snap-cap vials, also with airtight lids. Some samples needed to be retained in quart or gallon plastic or glass jars. Labels were prepared with underwater paper (which is not affected by water or preservatives) and pencil (which does not break down, fade, or run as some ink does). The embossing affect of pencil is further assurance of permanence. Each label contained the unique sample identifier (IDORG), collection date, station code, sample type (sandy or rocky, intertidal or subtidal) and replicate. All samples were always maintained within secondary containers. This was a mandated human safety procedure, due to alcohol flammability, and also ensured greater protection for the samples in case of a spill.

Animals were sorted in water or alcohol with fine forceps from residue into appropriate size container, mostly 1 dm glass shell vials. They were separated into phylogenetic groups: Amphipoda, Arachnida, Arthropoda, Cirripedia, Bryozoa, Cnidaria, Crustacea, Echinodermata, Gastropoda, Hydrozoa, Insecta, Isopoda, Kamptozoa, Mollusca, Mytilus, Nemertea, Oligochaeta, Ophiuroidea, Platyhelminthes, Pollicipes, Polychaeta, Porifera, Pycnogonida, Sipuncula, Urochordata, and Other. Some duplication of taxa (Amphipoda and Crustacea, for example) allowed the sorters to place large numbers of a particular taxon into a separate container, to assist the taxonomists with sample handling. A label was placed into each vial and the animals stored in fresh alcohol. Exceptionally large or entangling organisms were separated into a large container. Each vial or jar was assigned a code called a subIDORG, which included the IDORG and a four character qualifier that designated whether the sample was quantitative or scan, the method of subsampling, and what the phylogenetic group was. If there were two containers for a particular taxon, the subIDORG was followed by a decimal and a number. For example, subIDORG 0050QX06.1 represents a sample from IDORG 0050, which is quantitative (Q), subsampled without density fractionating (X), contains crustaceans (06), and is one of multiple containers for that IDORG (.1). The subIDORG was written on the back of the pre-printed sample label in pencil, and if there was space, the phylogenetic group was also written.

Infaunal samples were processed similarly to epifaunal samples with the major exception that the whole sample was processed in most cases. The samples were swirled as above. The supernatant fraction was sorted and then the residue was sorted. Most sorted samples fit within 1 dm or 2 dm vials.

Laboratory QA/QC

Laboratory quality assurance/quality control (QA/QC) procedures have been described in Stephenson et al. (1994). The more important ones are summarized here along with applications specific to this project. The prime quality assurance rests with competent personnel. All workers on this project are associated with academic institutions, experienced laboratory and microscope workers, and familiar with sample management and care. In addition, all were trained on the job to refine their skills specifically to this project. A senior biologist was present and supervised sorting technicians.

Chain of custody was maintained in the sorting lab where samples were delivered and logged into the master ledger where each individual sample was recorded. Sample labels in the jars were verified and checked against the master ledger. Each sorter logged out the replicate to be sorted and recorded it in the master ledger with their initials and date opposite the sample replicate. Many samples were very large and often required several days to complete sorting of a given sample. When completed, samples were logged back into the master ledger and the number and taxa of each vial or jar was recorded. Weekly the senior sorter conducted a sample inventory to ensure that each sample was accounted for. The senior sorter maintained a database of sorted samples and an entry was made for each subIDORG which was used to generate a Chain of Custody (COC) to transfer sorted samples back to the personnel responsible for sending samples to taxonomists. As each batch of samples was transferred, two people checked the subIDORG of each vial or container against the COC. At the same time the COC was generated, the subsampling data were entered into a separate spreadsheet. Every time a batch of samples was transferred, electronic copies of the COC and subsampling data were sent to the database managers.

Following is a summary of our laboratory QA/QC principles:

1. Adherence to Chain of Custody procedure with written documentation to sample condition, location, and status.
2. Instructions to sorters on project objectives, sample handling, sorting procedures, and taxonomic procedures.
3. Check points of sample fidelity to schedule of progress.
4. Instrument maintenance.
5. Proper supply availability.
6. Competent and experienced laboratory personnel.

7. Efficiency checks and verification of sample progress. Includes checks on sorting technique, efficiency, accuracy, productivity, taxonomic determination, and compliance with established protocols such as labeling, sample storage, supply use and equipment functioning.

The most vulnerable point in the sample processing was during sorting, when the sample was open and exposed. Samples were processed over safeguard trays, large photographic trays that could contain spills so contents of jars, dishes, and other containers subject to spilling were always protected by an underlying tray. Transfer of organisms to vials always took place over the trays. No spills occurred. All samples were stored in glass or plastic containers, grouped by station or taxon and placed within secondary containment vessels of plastic.

Summary of Specimen Identification

Specialized taxonomists received both qualitative (preserved according to taxonomic group in the field and sent directly to taxonomists) and quantitative (fixed in formalin in the field and sorted as per the above protocols) field samples for identification. Taxonomists were selected according to qualifications, experience and specialty. Appendix B lists taxonomists involved with identifying specimens for this study.

In a standardized Excel file provided by MLML, taxonomists were requested to provide a list of species identified from each sample, to count non-native species in the quadrat clearing, holdfast and infaunal samples, to maintain a list of all species reported for this survey, and to create vouchers of introduced, cryptogenic, and provisional species identified in the current survey. Instructions sent to taxonomists can be viewed in Appendix C. On the list of species they identify, taxonomists were asked to fill in details pertinent to each particular species, including but not limited to higher taxonomic classifications, taxonomic authority/date, primary identification source, and up-to-date assessments and information about each species' introduction status with regards to the boundaries of California (as per the terminology outlined below). Taxonomists were urged to identify specimens to the lowest taxonomic level possible in order to make status determinations; however, emphasis was placed on careful identification and taxonomists were encouraged to seek the help of other experts whenever necessary.

Summary of Grain Size Analysis

Particle size analyses were carried out with a Beckman-Coulter LS 13 320 laser particle size analyzer. For the relatively coarse, silt to sand size beach samples, the analyses were done with an attached dry module and conventional (Fraunhofer), laser beam diffraction (from 0.4 µm to 2 mm). For very fine sediments, particle size analyses were done with an aqueous module equipped with a pump and a built-in ultrasound unit. This module analyzes very small (~1 g) amounts of sediments and the measured size distributions range from 0.04 µm to 2 mm. Measurements of such a wide particle size range are possible because the particle sizer equipped with the aqueous module combines conventional laser beam diffraction with polarized intensity differential scatter (PIDS), which measures particles based on the Mie theory of light scattering (Beckman Coulter, Inc., 2003).

Particle size data include the mean size and mode for both bulk and non-organic carbon fractions and 30 s sonication. Further statistical data include (SD) standard deviation and three percentiles

(10%, 50%, and 90%). Percent fines were summarized and reported as the sum of clay, fine silt and coarse silt fractions (0-64 μm grain sizes).

Summary of Sample Tracking Methods
A Chain of Custody (COC) form accompanied each batch of samples during transportation from MLML to any taxonomist or external source, as well as upon return to MLML. Upon receipt of a batch of samples, the recipient was required to check that the contents of the package matched the sample list on the COC, then sign one COC copy and send it back to MLML. A COC was also required when samples were returned to MLML, at which point MLML was responsible for double checking the contents against the list.

Summary of Data QA/QC Methods
Extensive measures were taken to assure the quality and accuracy of reported data in this survey. All data was scrutinized and made to undergo rigorous quality control checks, both manual and computer-based, before any analyses were performed.

Field Data
Datasheets from the field were hand-entered into an Access database form designed specifically with a similar layout as the field datasheets for easier transfer of data. To further reduce the risk of data entry error, whenever possible, data entry fields were designed as drop-down boxes to force the person entering the data to select from a set of choices rather than type them in each time, eliminating the possibility of typing errors. This included, but was not limited to, choices for location details, sample method and profile, sampling equipment used, GPS model and datum used, station name and project ID code. Further quality control measures included manual visual checks of the entered datasheet data. MS Access queries were designed to check for missing or inaccurate data. Latitudes and longitudes of all reported coordinates were also checked by being plotted onto a GIS program to allow for visual inspection.

Taxonomist Data
Samples were mailed to taxonomists along with a data CD which included, among other files, a blank formatted datasheet and species list in Excel for taxonomists to fill out as they identified the samples. When sample identifications were completed, taxonomists emailed their completed datasheets back to MLML to be uploaded into the MS Access database. Before being uploaded, however, datasheets were manually checked and then re-checked by two different personnel for missing, inaccurate, or unclear data. Once questions were communicated to the appropriate taxonomist and resolved, the datasheet could begin the uploading process which involved a series of queries designed to identify missing or duplicate data.

MLML Database
Once taxonomist data was uploaded into the MLML database, additional queries were run prior to data analysis to ensure that no errors were introduced during or after the uploading process. Again, these queries were designed to identify missing, inaccurate or duplicate data. Spreadsheets of missing data were generated from these queries and sent to the appropriate taxonomist to be completed (e.g. missing counts for non-native species, missing introduction status assessments, missing authority and dates). As a final measure of quality control, after all missing data was returned to MLML and uploaded into the database, taxonomists were sent a

master copy of their species list with all additions and changes included and asked to look over their respective lists for errors.

Summary of Voucher and Archiving Methods

Voucher Collection
Representative examples of introduced, cryptogenic, and provisional species from all sample types have been vouchered by taxonomists during the identification process and will be stored in a collection at MLML. In addition, respective taxonomists were required to submit informal descriptions of unpublished provisional species reported in this survey to be stored in conjunction with the voucher collection. These voucher specimens will be made available to interested taxonomists for purposes of species verification or appropriate related research.

Archiving
All samples collected in the current survey have been archived until further notice at MLML, with the exception of native species identified from the qualitative visual searches and some taxa of interest that have been sent to natural history museums or herbariums. In addition, unsorted sample portions are archived within the MLML storage facilities and available for processing if it is determined that more data are required. The storage location of all samples is recorded in MLML's database so that they may be relocated in the future.

Summary of Sampling for EMAP-offshore
As an opportunistic effort to gather species information from outer coast habitats not sampled in the DFG/MLML surveys, archived infaunal samples from the 2003 EMAP survey were sorted, and species were identified. Species lists generated from the EMAP survey samples were reviewed by MLML for the presence of NAS. This effort was conducted to develop an initial baseline for NAS data from the 30m-120m depth range in offshore waters along the California coast.

The overall objective of the coastal portion of the Environmental Monitoring and Assessment Program (EMAP) Western Pilot is to create an integrated comprehensive coastal monitoring program along the West Coast (including Alaska and Hawaii) to assess estuarine condition. This is a joint project in the State of California by key monitoring agencies involved in the development of California's Coastal Monitoring Strategy. These agencies are the US Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), the State Water Resources Control Board (State Board), the Southern California Coastal Water Research Project (SCCWRP), the San Francisco Estuary Institute (SFEI), and San Jose State University Foundation (SJSUF). The Western EMAP Pilot studies are designed to address two major questions: 1) what is the condition of ecological resources in the Western States? and 2) what stressors are associated with degradation of ecological resources?

Sampling locations along the California coast for the 2003 offshore component focused on waters from 30m to 120m in depth. The base design for offshore California included forty nine randomly allocated locations throughout the northern and central reaches of the coastline (Figure 5). These sample locations were selected from a GIS data layer by the EMAP design team. All forty nine locations were sampled for water column, sediment, and benthic community structure.

Sampling was conducted in cooperation with NOAA, aboard their vessel, the RV MacArthur, with a science crew from Moss Landing Marine Laboratories.

Sediments were collected using a 0.1 m^2 Van Veen grab, with multiple sediment grabs taken to provide sufficient sediment for physical, chemical and benthic community analyses. Sediments for benthic community analyses were washed through a 0.5-mm mesh sieve, placed in a container, and fixed in 10% buffered formalin solution. Sieved samples were subsequently secondarily sieved through a 1mm sieve, and screen residues rinsed with water to remove formalin and stored in 70% ethanol until sorted. The sample fraction passing through the 1mm sieve, and that fraction retained on a 0.5mm sieve were collected and analyzed separately. The EMAP program was only interested in infaunal counts from the 1mm fraction while the current CDFG survey augmented the infaunal analysis by providing the taxonomic identifications for the 0.5mm fraction. Species lists from both fractions were reviewed by MLML for NAS.

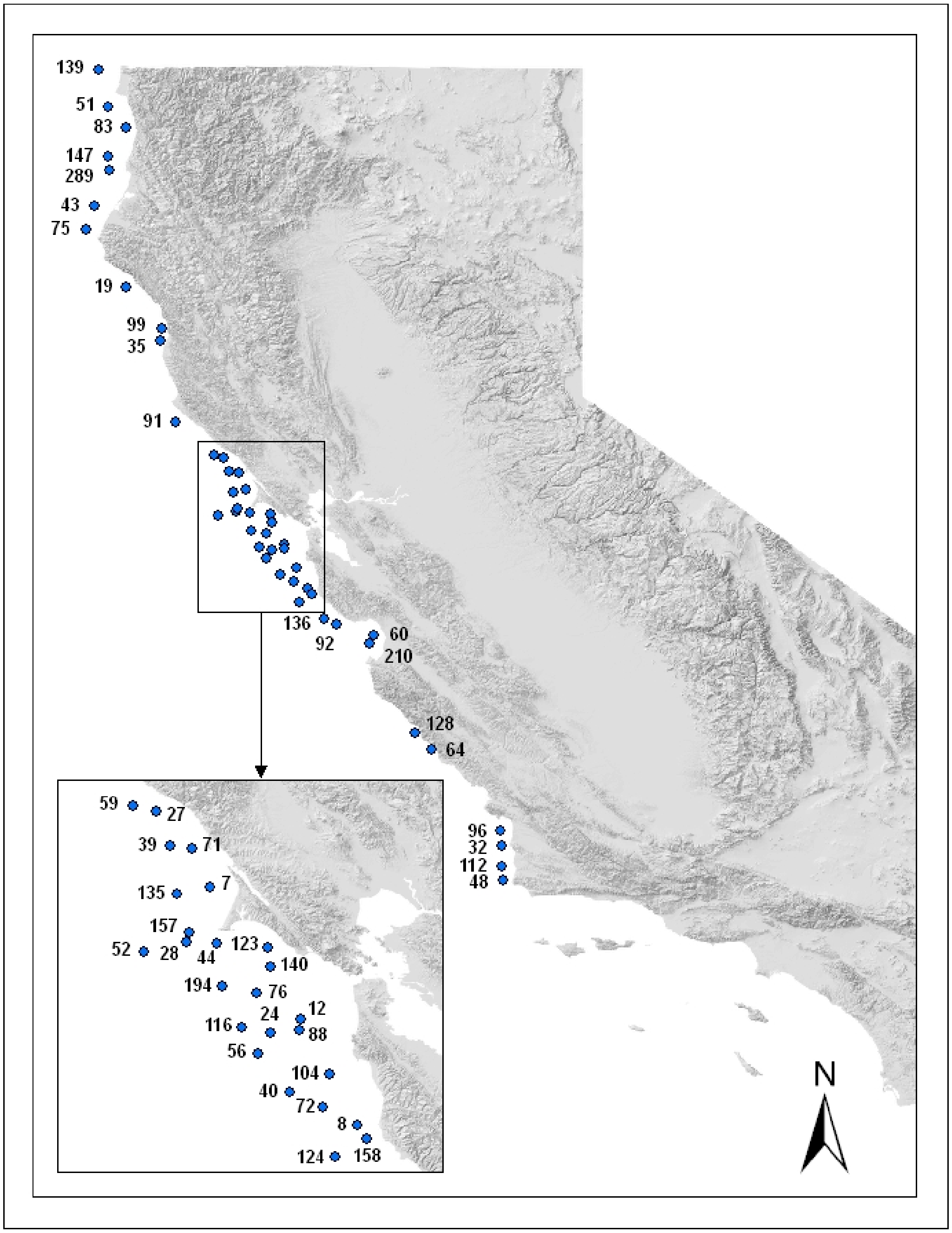


Figure 5. EMAP-offshore stations sampled in 2003.

RESULTS AND DISCUSSION

Terminology

Standardization of terms used in this study is crucial because many descriptors were encountered that describe species' biogeography as being either native, including pre-historical invasions (Carlton, 1996), introduced, invasive, or cryptogenic (Cohen and Carlton, 1995). Because most literature does not use a standard definition in describing the analogous terms "introduced", "exotic", and "non-indigenous" species, some assumptions must be made. This report used the definition of Boudouresque and Verlaque (2002), as they categorize an introduced species with these four succinct points:

> "1) It colonizes a new area where it was not previously.
> 2) The extension of range is linked, directly or indirectly, to human activity.
> 3) There is a geographic discontinuity between native area and new area (remote dispersal).
> 4) Finally, new generations of the non-native species are born in situ without human assistance, thus constituting self-sustaining populations: the species is established."

In addition, the classification of "introduced" species used in this study will refer to both innocuous and invasive introductions without specificity to either. In order to address the stipulations of the legislation, and for the purposes of this report, any species that is not native to California waters and whose native range is outside of the California borders is considered an introduced species. This includes species whose native range is elsewhere along the northeast Pacific coastline, not including California. These criteria result in a non-intuitive definition of "introduction" based on geopolitical boundaries rather than biological range or habitats, but this is necessary to meet the legislative intent of the Marine Invasive Species Act of 2003 in collecting baseline information on the presence, distribution and abundance of NAS in California waters.

A cryptogenic species is defined as "a species that is not demonstrably native or introduced" (Carlton, 1996). Cryptogenic is used as a catchall category for species with insufficiently documented life histories or native ranges to allow characterization as either native or introduced. In addition, when status discrepancies are found in the literature, that species is labeled here as cryptogenic until the discrepancy is resolved. As has been suggested by Carlton (1996), cryptogenic species are quite common, but have been underestimated to such an extent as to misshape our understanding of the true effects that invasions have on the eco-system.

The habitats sampled in the current survey comprise a large area along the California coastline from which native species have not been thoroughly described. Therefore, determining whether a species is native or introduced can be especially difficult with species collected from outer coast habitats. Unless compelling evidence was present that a species is either native or introduced to California, it was designated as cryptogenic. For instance, species were classified as cryptogenic if records of collections from outside of California were found in the literature and native ranges were unclear. Many of the species listed as cryptogenic may be native to the California coastline but have gone previously undescribed. Occasionally, evidence suggests that a cryptogenic species is either more likely to be native or more likely to be introduced, even though not enough solid evidence is present to make the full determination of introduced or native. These cryptogenic species have been flagged in the MS Access database as “Likely Native” or “Likely Introduced” accordingly.

After careful consideration, the above terms “introduced”, “cryptogenic” or “native” were assigned to each species identified in the current survey, based on recommendations from taxonomists and all available documentation. The native designation is surprisingly troublesome to use because species that have been historically reported as native in southern California may not have been historically native in northern California, and vice versa. In the current survey, native California species were identified in areas where they have not been previously reported (e.g., southern California species were found at Point Saint George in northern California). There is no way to convincingly state whether the new identification is a result of this survey sampling previously unsampled habitats, whether it is a natural range extension, or whether it is from an anthropogenic introduction. Considering the physical impediments to major natural range expansions in California, it is likely that many of these new identifications are a result of recent intrastate vessel activity, but proof is lacking. MLML previously listed these species as “Native X” (CDFG, 2002), but the current survey does not use that term. Rather, these species are reported here as native, and to note this disparity, they have been flagged within the database as new records to a location or depth range to note that they are native to California, but that they are being identified in this survey in areas where not previously reported. The body of this report focuses only on introduced and cryptogenic species, and does not focus on true native species within their historic range. These assigned terms of introduced and cryptogenic should not be considered as static, but instead should be modified as research continues and taxonomy, native ranges and vectors of introduction are better resolved.

Specimens that could not be identified beyond the family, class, order, or genus level (e.g. - *Ophiopholis sp*) could not be confidently classified as introduced, cryptogenic or native and were assigned an “unresolved” status. Specimens given temporary provisional names were also classified as “unresolved” unless world-wide literature has been thoroughly researched to assure that no species with the same description has a native range that does not include California. Specimens classified as unresolved will require additional taxonomic resolution before their true status can be confidently assigned. It is however important to include these specimens in our reporting because they may include new species or represent significant range extensions.

An additional term used to describe some biota in the literature is “invasive”. An invasive species includes any introduced species that has caused a disruption to the ecosystem resulting in damage either environmentally or economically. Literature that uses the word “invasive” as a descriptor may refer to species with detrimental economic impacts on native populations, while others use the term to simply indicate weedy species that may or may not impact native communities. Our review found that the use of the term was so subjective in the literature that consistent application of the term was impossible. To avoid the mixing of poorly clarified uses of the subsequently ambiguous term “invasive”, it was not used in this report.

Summary of Introduction Status Determinations

Taxonomists identifying specimens collected in the current survey reported several species with an introduction status that did not match the status reported for those species in the 2002

DFG/MLML NAS survey results (CDFG, 2002). Literature reviews and further communications with taxonomists regarding the status of those species led to 44 species introduction status revisions made in the current survey from what was reported in 2002 (Table 1). Of the revisions, 15 were updated from introduced to cryptogenic, 4 from introduced to native, and none were updated to introduced from another classification. The remaining updates were between cryptogenic, native, nativeX and unresolved classifications as depicted in Table 1.

It should be noted that the species list generated from the current survey of the outer coast differed greatly from the species list generated in the DFG/MLML 2002 survey of bays and harbors in California, and several species identified in the current survey were not found listed with introduction statuses by other sources. Therefore, for species not found previously listed with an introduction status, the determinations made by taxonomists in the current survey are not verified or checked against other sources. Introduction statuses reported here reflect the most current and updated information to our knowledge.

Table 1. Species names and introduction status updates from DFG/MLML 2002 report.

Species Name	Status in 2002 Report	Updated Status	Status Determination Sources
Achelia echinata	Introduced	Cryptogenic	Cadien 1997
Bowerbankia gracilis	Introduced	Cryptogenic	USGS-NAS
Brania brevipharyngea	Cryptogenic	Native	L. Harris, personal communication, May 5, 2006; Green and Bakus, 1993
Bugula neritina	Introduced	Cryptogenic	Cohen and Carlton, 1995; Robertson, 1905
Caprella californica	Cryptogenic	Cryptogenic, Likely Native	Laubitz, 1970
Caprella natalensis	Introduced	Cryptogenic	Laubitz, 1970
Caprella penantis	Introduced	Cryptogenic	Carlton, 1979
Celleporella hyalina	NativeX	Native	Soule, Soule, and Chaney, 1995
Chaetozone bansei	Cryptogenic	Cryptogenic, Likely Native	Blake, 1996; L. Harris, personal communication, January 26, 2006
Crepidula onyx	Introduced	Native	R. Collin, personal communication, May 3, 2006; Collin, 2003
Diplosoma listerianum	Introduced	Cryptogenic	G. Lambert, personal communication, May 1, 2006
Dipolydora caulleryi	Introduced	Cryptogenic	L. Harris, personal communication, January 26, 2006
Dodecaceria concharum	NativeX	Cryptogenic	L. Harris, personal communication, January 26, 2006
Ericthonius brasiliensis	Introduced	Cryptogenic	Bousfield, 1973; Barnard, 1979
Euchone limnicola	Cryptogenic	Native	CDFG, 2002
Eurystomella bilabiata	Cryptogenic	Native	G. Schroeder, personal communication, April 27, 2006; Canu and Bassler, 1929
Eusiroides monoculoides	Cryptogenic	Native	Barnard, 1969
Halichondria panicea	Introduced	Cryptogenic	W. Lee, personal communication, October 31, 2006
Haliotis rufescens	Introduced	Native	Morris et al., 1980

Species Name	Status in 2002 Report	Updated Status	Status Determination Sources
Heteropodarke heteromorpha	Introduced	Cryptogenic	L. Harris, personal communication, May 5, 2006
Hiatella arctica	NativeX	Native	Coan et al., 2000
Ianiropsis tridens	Native	Cryptogenic	Schultz, 1969; CDFG, 2002
Ischyrocerus anguipes	Introduced	Cryptogenic	Barnard, 1969; Barnard, 1954
Ischyrocerus pelagops	Cryptogenic	Cryptogenic, Likely Native	Barnard, 1962
Jassa slatteryi	NativeX	Cryptogenic	Conlan, 1995
Jassa staudei	Cryptogenic	Native	Conlan, 1990; P. Slattery, personal communication, May 25, 2006
Leucothoe alata	Introduced	Cryptogenic	Barnard, 1962; Cohen and Carlton, 1995
Macoma balthica	Introduced	Native	Coan and Scott, 2000/SCAMIT, 2001; P.V. Scott, personal communication, May 13, 2006
Mediomastus californiensis	Native	Cryptogenic	L. Harris, personal communication, January 26, 2006; Hilbig, 2000
Microjassa litotes	Cryptogenic	Cryptogenic, Likely Native	Barnard and Karaman, 1991; Barnard, 1962; Conlan, 1995
Myxicola infundibulum	Introduced	Cryptogenic	L. Harris, personal communication, January 26, 2006
Ophiactis simplex	Native	Cryptogenic	Morris et al., 1980; Christensen, 2004; G. Hendler, personal communication, October 23, 2006
Paracerceis sculpta	NativeX	Native	CANOD Database
Paranthura elegans	Introduced	Native	Schultz, 1969
Pista brevibranchiata	Cryptogenic	Native	Hilbig, 2000; L. Harris, personal communication, January 26, 2006
Podocerus cristatus	Introduced	Cryptogenic	Barnard, 1962; Lamb and Hanby, 2005
Polydora websteri	Introduced	Cryptogenic	L. Harris, personal communication, January 26, 2006
Prionospio lighti	NativeX	Native	L. Harris, personal communication, January 26, 2006; Blake, 1996; Blake and Arnofsky, 1999
Sabellaria gracilis	NativeX	Native	Hartman, 1969; CDFG, 2002
Spiophanes bombyx group	Cryptogenic	Unresolved	NA
Syllis gracilis group	Cryptogenic	Unresolved	NA
Thormora johnstoni	Cryptogenic	Native	L. Harris, personal communication, January 26, 2006
Tubulanus cingulatus	NativeX	Native	Coe, 1905
Tubulanus polymorphus	NativeX	Native	Morris et al., 1980

Summary of Field Surveys
A total of 166 epifaunal samples (rocky substrate scrapings) and 321 infaunal samples (sandy cores) were collected along California's outer coast from 22 sites. In addition, a total of 208 qualitative samples were collected during the visual scans at the 22 outer coast sites. Sixty three sediment samples were also collected for grain size analysis. Station position and sampling information for each location are given in Appendix A.

Point Saint George
Intertidal -The downcoast-facing side of Point Saint George was the location for rocky intertidal sampling. The rugged, rocky reef jetting out to sea and the adjacent intertidal boulder field offered extensive rocky intertidal habitat exposed during low tide. Along with MLML staff, John Pearse conducted the visual search for introduced invertebrates while Laurie McConnico conducted the visual search for introduced algae at this site. The intertidal reef was searched thoroughly for introduced species, but none were identified in the field. An introduced alga, *Sargassum muticum*, was collected in drift at this site, but since it is capable of drifting in the currents with kelp wrack for long distances, it is impossible to know whether a population is established anywhere nearby. Some of the more common native rocky intertidal taxa in the community included *Mytilus* in patches, *Alaria, Hedophyllum, Egregia* and *Dilsea* in the low zone, and *Fucus, Mastocarpus, Cryptosiphonia woodii* in the mid zone. *Microcladia coulteri* was abundant at this site, as was *Porphyra*. *Egregia* holdfasts seemed particularly hardy. Overall, relatively low red algal diversity was observed in the low zone. The site appeared to be very exposed to disturbances from large surf and sand movement.

Samplers walked downcoast of the rocky reef approximately 0.5 miles in search of a sandy beach to sample and found only very few sandy pockets. Three cores from a low zone intertidal sandy pocket were collected, but no high zone sand was found south of the main reef sampled. The remaining intertidal sandy cores were collected from the north side of Point Saint George where sand had accumulated. All of the sand collected was relatively coarse.

Subtidal - The subtidal rocky sampling occurred on the south side of the point, tucked in between several pinnacles. The subtidal rocky bottom was equally as rugged as what was found in the intertidal, with very large boulders and crevices. No kelp was found in the area for the kelp holdfast collection, so a fourth quadrat clearing was collected instead. No algae were present and the rocky subtidal community consisted mostly of encrusting sponges, tunicates, hydroids and some very large *Balanus nubilus*. Visibility was extremely poor, and the surge was very strong, making it difficult to collect quadrat clearings. Due to the conditions, divers were unable conduct as wide a visual search as normal. On the second and third dives at this site, which began approximately 30 minutes after completing the first dive, the water suddenly turned completely black and divers were forced to abort the dives for safety reasons.

The sandy core sampling equipment which had been left underwater on the first dive was not relocated on the second or third dives at this site, so no subtidal sandy cores were collected. Although a comprehensive search was not conducted at the site, divers noted that no sandy habitat was observed in the area, and future sampling of subtidal sandy habitat may require moving north or south to sample offshore of a sandy beach.

Cape Mendocino
Intertidal – There were adjacent, extensive areas to sample both the rocky and sandy intertidal. Jeff Goddard conducted the visual search for invertebrates and MLML staff searched for introduced algae at this site. The large rocky intertidal reef, which included many deep channels and several tidepools, was searched thoroughly. The rocky intertidal community included but was not limited to *Fucus*, *Endocladia* and mussels in patches in the mid zone, as well as *Laminaria*, *Egregia*, surfgrass, and *Mazzaella spp*., and various other species of red algae in the low zone. *Postelsia* was also present in wave-exposed areas at the site. The *Egregia* individuals were very large, often with stipes approximately 30 feet long and 30-40 stipes per plant. No introduced species were identified in the field.

Sandy intertidal sampling took place at the beach adjacent and to the north end of the rocky bench, with the core samples spread out along approximately 200m of beach. The low zone beach was medium sloped with rocks interspersed and medium to fine grain sands, whereas the high zone had a steeper slope and coarse sand to fine gravel. The five core reps were collected in areas with a variety of grain sizes.

Subtidal- The subtidal dive site was located just offshore from the intertidal reef and consisted of a few large, underwater rock formations (approximately 15 feet tall) surrounded by sand. Even on a calm day the surge was very strong, but the rocky reef seemed very rich and diverse. The reef had a small amount of smaller red algae and Laminarians, but mostly appeared to be very rich and diverse with invertebrates. A current began to pick up and strengthen towards the end of our dives, indicating that this area is exposed to strong currents. No introduced species were identified in the field. There was no kelp to sample at that dive site, so kelp holdfasts were collected from a kelp bed to the north, at Devil's Gate Rock, between the subtidal site and Cape Mendocino.

The subtidal cores were collected from the sand surrounding the main rocky reef. The sand had large ripples and no "sinks," also indicating exposure to strong surge.

Shelter Cove
Intertidal – The rocky intertidal site search and quantitative collections occurred along the extensive rocky reef that wraps around Point Delgada (Figure 6). The reef has large topographic relief, with tall outcrops, tidepools, deep channels, and low-lying areas with large cobbles/small boulders to turn over. The low zone is very slick to walk along as it has thick algal coverage. Mussels (*Mytilus*) were present in patches on the higher outcrops. *Pelvetiopsis* and *Endocladia* were common in the mid zone on this area of the rocky reef. Jeff Goddard searched for invertebrates and MLML staff searched for algae at this site. No introduced species were identified in the field.

The sandy intertidal samples were collected downcoast from the rocky reef, where boats launch below the town of Shelter Cove. The beach is in a cove protected from northwest swell but exposed to west and southwest swells, as well as to extensive foot and vehicle traffic. The entire beach was shallow–sloped, from the low tide water line to the base of the cliffs, and composed of fine black sand. The low zone had rock interspersed with sand, whereas the high zone had algae wrack scattered across the beach up to the base of the cliffs and no distinct wrack line. Some insects but very few hoppers were seen. Samples were collected along approximately 100m of beach.

Subtidal – The rocky subtidal dive site was located just offshore of the intertidal rocky reef sampled and seemed fairly extensive and exposed to surge from all directions. No *Nereocystis leutkeana* (giant kelp) was seen from the surface, nor holdfasts found underwater, so a fourth quadrat clearing was collected in place of a kelp holdfast. The subtidal rocky reef community consisted of almost no algae save small reds on flat surfaces and a few tattered *Laminaria* stipes. Seastars and sponges were common on the reef.

No sand was found in the area of the subtidal rocky reef, so subtidal sandy samples were taken in the cove, offshore from the intertidal sandy sampling location. The sand there had small ripples, no tubes and fine grain size.

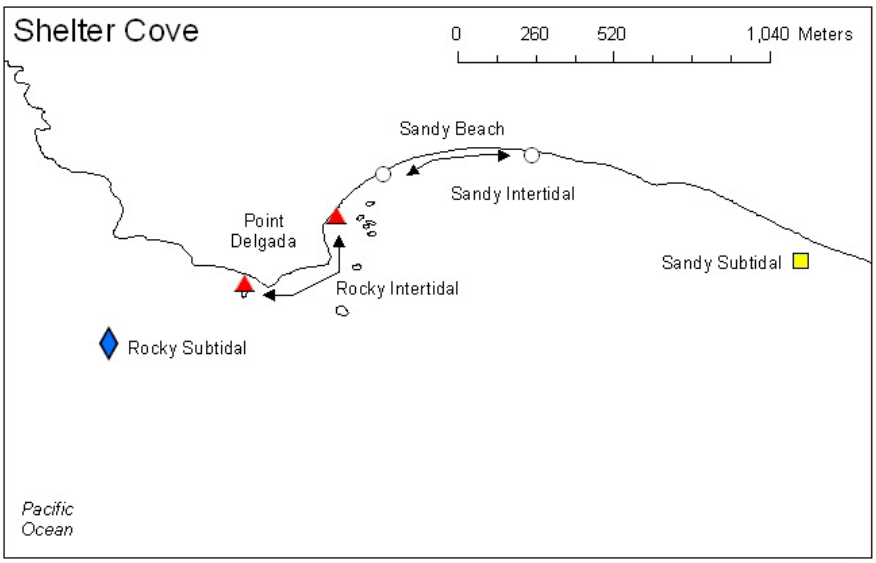


Figure 6. Map of survey layout showing the four habitats sampled at Shelter Cove.

Point Arena

Intertidal – The rocky intertidal sample location was tucked back in a cove and partially protected by an island called Sea Lion Rocks approximately 150m offshore. *Nereocystis* was growing directly offshore and close to the intertidal rocky bench, and *Postelsia* lined the outer edges of the intertidal bench. The area of the intertidal bench searched during this survey was thick with algae. Some of the native algal taxa observed included *Egregia, Laminaria, Corallina, Silvetia, Mazzaella spp., Mastocarpus, Endocladia, Halosaccion, Gelidium, Gastroclonium*, and *Odonthalia*. There were burrows along the rocky bench but no urchins in them. Parts of the bench were covered with a thin layer of sand. Since only very small patches of mussels were found on the main part of the rocky reef, one quadrat clearing was collected on the adjacent upcoast reef which had a large enough patch of mussels. Vertical surfaces on this rocky bench had few sponges and tunicates. John Pearse and Laurie McConnico conducted the visual search for introduced invertebrates and algae, respectively, and no introduced species were positively identified in the field.

Sandy core samples were collected on the north side of Point Arena at Manchester State Beach, near the mouth of the Garcia River. The beach was several miles long and had a gentle slope to the water. The sand was fine-grained and a medium amount of dead, thinning algae wrack was present in the high zone.

Subtidal - The rocky subtidal dive site was located just offshore of the rocky intertidal bench, near Sea Lion Rocks. Samples were collected from a rocky reef, adjacent to a field of large boulders. *Nereocystis* was present but not abundant in the immediate area. *Laminaria*, *Pterogophora*, encrusting and articulated coralline algae and smaller bladed red algae were all present. Sponges were present but not diverse, and no bryozoans were collected. Several different tunicates were found and collected. Red abalone were abundant and large at the dive site. The diving conditions were exceptional for that area of the coastline, with good visibility and low surge. No introduced species were identified in the field.

No sand was found at the rocky subtidal dive site, so sandy samples were collected offshore from the intertidal sandy samples, at Manchester State Beach near the Garcia River mouth. The dive site was near a rocky reef with a kelp forest and sand channels interspersed. The sediment collected from these sand channels had medium-sized ripples.

Bodega
Intertidal – The rocky intertidal sampling location was right out from Bodega Marine Lab, starting adjacent to Horseshoe Cove and wrapping upcoast along the extensive rocky reef. Jeff Goddard conducted the visual survey for invertebrates and MLML staff surveyed for algae at this site. The rocky intertidal community included a band of surfgrass, some *Egregia* and various species of red algae in the low zone, prominent mussel patches covered with *Porphyra* in the mid zone, *Pelvetiopsis, Cladophora,* and *Endocladia* patches in the high zone. The rocky reef is exposed to the surf, which is known to be energetic and large at times along this area of the coastline. No known introduced species were identified in the field.

Sandy intertidal cores were collected at the beach along Horseshoe Cove. This beach may be somewhat protected by the large rocky reefs and cliffs on the north and south side of the cove, but depending on swell direction is still fairly exposed to waves. The beach had a steep slope and large-grain sand. Harbor seals were abundant nearby, but seemed unconcerned with the presence of human samplers. The only noticeable human disturbance along the beach was run-off from the Bodega Marine Lab pump house. The high zone of the beach had a well-defined wrack line with abundant hopper holes, flies and other insects.
Subtidal – Subtidal sampling occurred offshore from the intertidal sampling reef, in approximately 35 ft. of water. The bottom consisted of patchy reefs surrounded by sandy patches. No giant kelp was found, so a fourth rocky quadrat clearing was collected in place of a kelp holdfast. The only algae found were small, red bladed species. Several sponges and tunicates were collected, including the cryptogenic tunicate *Diplosoma listerianum*, which was found epibiotic on a crab and identified in the field. The diving conditions were exceptional for this area, with low surge and good visibility.

Subtidal sandy cores were collected from the sand patches in between the rocky outcrops. The sand had large ripples and large grain size, indicating that the area is exposed to large swell and disturbance.

Point Reyes

Intertidal – Rocky intertidal sampling occurred between Duxbury Reef and Bolinas Point. The rocky reef consisted of a flat bench and small boulders extending out far to the low tide water line. Zonation patterns in the algal species are clearly visible along the slightly elevated patches of rock along the bench. The rocky intertidal community included several low-zone red algal species and a band of *Mytilus californianus* near the low tide water line; *Mazzaella spp, Mastocarpus, Halosaccion,* and *Odonthalia* were abundant in the mid, flat zone. There was not much of a high zone along this reef. Samplers also searched Duxbury reef, mainly looking for *Sargassum muticum* which had been previously reported there. This reef jets out to sea, pointing south, and is exposed only at low tide. Jeff Goddard searched for invertebrates and MLML staff searched for algae during the visual survey at this site, and no introduced species were identified in the field at this location.

Sandy intertidal samplers walked north of the rocky reef and sampled a small beach/lagoon just south of Bolinas Point. The beach had a low-medium slope, large grain size, and no sand ripples, appearing to be somewhat protected by the adjacent rocky reef. High zone cores were taken in a beach wrack line, though not many hoppers were observed.

Subtidal - Bodega Marine Lab collectors experienced in diving in this area collected the subtidal rocky and sandy samples near the old lifeboat station pier, just inshore from Chimney Rock. This area is an Elephant Seal haul out location. The seals have only recently vacated this beach for the summer, and some were still seen on a nearby beach. Rocky subtidal samples were collected from the patchy rocky reef or boulders, in 6-12 feet of water, with one of the three quadrat clearing samples being collected from an old pier piling. Diving conditions were poor, with wind chop at the surface and low underwater visibility. The limited habitat available in a safe sampling location and the poor sampling conditions may have compromised the samples collected from this location. Sandy subtidal cores were collected adjacent to the patches of rocky reef by the pier at a depth of 12 feet. No known introduced species were identified in the field.

Fitzgerald

Intertidal – The intertidal rocky reef consisted of an extensive bench and an adjacent field of small boulders that were easily flipped. Rocky quadrat clearings were collected from the bench, but both the bench and the boulder field were searched for introduced species. A freshwater stream flowed into the sea on the north side of the sample site. The low zone had high algal cover, and seemed to have high diversity of red algal species. Mussel bands hosted large mussels forming a deep mussel bed with many porcelain crabs (*Pachycheles* sp). Several field taxonomists were present for the visual survey at this site, including John Pearse, Matt Forrest and Peter Slattery to search for invertebrates and Laurie McConnico to search for algae. No introduced species were identified in the field at this intertidal site.

Intertidal sandy cores were collected from the beach south of the rocky reef. The beach had a medium-low slope; coarse grain sand with small pebbles was found in the low zone, and medium grain sand and beach wrack were found in the high zone. The beach was backed by a crumbly cliff and fronted by a mudstone reef.

Subtidal – MLML attempted to sample rocky and sandy subtidal habitats offshore from Fitzgerald State Park via boat. Field crew searched offshore from Pillar Point to Montara Point scanning the surface for kelp to collect as holdfast samples, but did not find any.

The crew was also unable to locate the desired subtidal sandy habitat due to medium-sized swell, the proximity of dangerous reefs, and breaking waves on the reefs. Even on a calm day it is questionable whether it would be possible to find sandy subtidal habitat for sediment grabs right offshore from Fitzgerald. As an alternate site, subtidal sandy cores were collected using the Van Veen grab south of Pillar Point, outside the breakwater at Half Moon Bay and offshore from El Granada Beach.

Pigeon Point
Intertidal – The rocky intertidal reef is composed of patchy, tall rock outcrops surrounded by low-lying reef that is often found covered by sand to varying degrees. John Pearse, Peter Slattery and Matt Forrest conducted the visual invertebrate search while Laurie McConnico searched for introduced algal species. All of the rocky quadrat clearings were collected amongst these outcrops. Very few mussels were at this site, and they were found in small patches rather than a continuous mussel band. Algal cover is high in the low zone and includes various species of red algae, *Egregia* and surfgrass. Other algae found at the site included *Endocladia, Mastocarpus, Silvetia, Porphyra, Odonthalia*, and coralline algae. Just south of the rock outcrops stood a low-lying reef and boulder field that was searched well during this survey. No known introduced species were identified in the field.

High zone intertidal sandy cores were collected from a large beach upcoast from the rocky intertidal survey and downcoast from the lighthouse. A wrack line was present and cores were taken from under decayed kelp. Low zone sandy cores were collected from a pocket beach nearby. Both beaches had a shallow slope and fine-grained sand.

Subtidal – Since this area is known to be visited frequently by White Sharks, samples were not collected using SCUBA divers. Via boat, MLML field crew searched the coastline from north of Pigeon Point to Ano Nuevo for giant kelp to collect, but found none. There are no rocky subtidal results for this sampling location.

Subtidal sandy samples were collected offshore of the intertidal sandy beach, using a modified Van Veen sediment grab from the boat, at a depth of approximately 23 feet.

Ano Nuevo
Intertidal - The rocky intertidal survey occurred along both the reef and the lower-lying boulder field which is mostly exposed during low tide. The reef consisted of mostly low zone with few outcrops tall enough for mussels and the associated community. There was no high, barnacle zone at this location. The reef had high algal cover, which included but was not limited to *Mastocarpus, Porphyra, Cystoseira, Egregia* and surfgrass. The boulder field community included *Mastocarpus, Egregia, Porphyra*, and some large *Dodecaceria* colonies. The entire intertidal area is at an Elephant Seal haul out site, which presumably adds disturbance and

nutrients to the local environment. John Pearse, Matt Forrest and Peter Slattery were present to search for introduced invertebrates and Laurie McConnico searched for introduced algae at this site. No known introduced species were identified in the field.

Intertidal sandy cores were collected from the adjacent beach downcoast from the rocky reef area. The low zone that was sampled had direct wave exposure to heavy surf. The beach also had a low profile (slope). The high intertidal beach sampled was broad, moderately steep, backed by a cliff, and fronted by mudstone. There were two hopper zones, and fresh beach wrack found with flies and hoppers.

Subtidal – Subtidal sampling at this location was conducted from a boat without using SCUBA divers due to well known occurrence of white sharks in the area. *Macrocystis* was located offshore and slightly downcoast from the intertidal rocky reef. Several attempts were made to collect kelp holdfasts by gathering as many stipes as possible, wrapping line around them, and pulling, but all of the stipes broke off before the holdfast came loose from the substrate. We attempted to pull up 5 plants on the first visit to this location. On a return visit, thicker line was used to attempt to collect 7 plants, but still no holdfasts came loose. The only rocky subtidal samples collected from this site came from smaller rocks that were incidentally collected during subtidal sandy grabs from the boat and these samples are not considered quantitative.

Subtidal sandy samples were collected from the boat using a modified Van Veen grab, offshore from the intertidal sandy beaches sampled. The substrate proved to be mostly rocky reef with patches of sand. Out of seventeen attempted grabs, four were successful. After several hours on site the wind and fog started to increase, so the fifth sandy core and the grain size sample were not collected at this location.

Point Sur
Intertidal – Sampling occurred along the rocky intertidal reef and beach just upcoast from Andrew Molera State Park. The sampling site seemed to be pristine and rich in both invertebrate and algal species. John Pearse, Matt Forrest and Peter Slattery conducted the search for intertidal invertebrate species while Laurie McConnico conducted the algae search for introduced species at this site. Mussels were abundant in beds in the mid zone, along with *Silvetia, Mastocarpus* and *Endocladia*. The high zone boasted barnacles, *Endocladia* and *Pelvetiopsis*, and the low zone was thick with several species of red algae, *Egregia* and surfgrass. The rocky bench there has quite a lot of relief, and several pools and channels. Several sponges and tunicates were collected from the vertical edges of the surge channels. No known introduced species were identified in the field.

Sandy intertidal cores were collected upcoast from the rocky reef. The low zone intertidal samples were taken from a single beach that was somewhat protected and had enough sand to appear biologically viable. High intertidal samples were collected farther upcoast where there was more protection from waves and more beach wrack. A few drainage areas crossed the beach from the fields and stock ponds inland, and samples were taken next to these anthropogenic disturbance areas as well as from open beach areas.

Subtidal – Subtidal sampling occurred within the kelp forest just offshore of the sandy intertidal beach sampled, in between Point Sur and Andrew Molera State Park, in approximately 30 feet of water. The kelp bed consisted mostly of *Nereocystis*, with an occasional, large *Macrocystis* individual. The understory community where the rocky quadrat clearings were collected included *Pterogophora*, various species of red algae with epibiotic bryozoans, tube worms, high cover of sponges and tunicates, and many other invertebrates. No known introduced species were identified in the field. The *Macrocystis* holdfast collected was so large that only 1/8 of the holdfast was kept and equaled the sample size of a typical whole holdfast.

Subtidal sandy samples were collected from a large sand flat near the kelp forest. The sand had small ripples and fine grain sand and did not appear to have been recently exposed to strong surge or surf. Samplers observed many hermit crabs on the sand.

Point Sierra Nevada
Intertidal – Rocky intertidal habitat at this site consists of an extensive rocky bench exposed to large surf, and little, cobbly pocket beaches. All of the rocky quadrat clearing samples were collected on the main rocky reef, while the visual survey covered a much larger area. Mussel beds were found in the exposed areas of the bench; the adjacent low rocky intertidal zone included surfgrass, various red algal species, *Egregia, Laminaria*, tunicates, sponges, and *Anthopleura* anemones; mid zone species included but were not limited to *Endocladia* and *Pelvetiopsis.* Upcoast from the rocky bench the survey continued over a lower-lying, less exposed more bouldery area that was covered with three different species of *Anthopleura* anemones. John Pearse conducted the visual search for introduced invertebrates and MLML staff searched for introduced algae at this intertidal site, and no introduced species were identified in the field.

Sandy intertidal cores were collected downcoast of the rocky reef, at an exposed beach with offshore rocks. High zone cores were collected in the beach wrack. A thick layer of larger cobble was found underneath the sand in both the high and low zones, and no hoppers or other holes were observed in the sand.

Subtidal – Subtidal samples were all collected from CDFG vessels due to nearby elephant seal rookery and white shark presence. Both *Nereocystis* and *Macrocystis* plants were found near Point Sierra Nevada, but they were not in thick kelp beds, and they seemed to be very hardy plants. Several attempts were made to tie off to the kelp plants of both species and pull up their holdfasts, but none were successfully collected there. Inside the more protected area at San Simeon Bay the kelp plants were not as hardy and the field crew successfully collected four holdfasts.

No sand was found at Point Sierra Nevada, so the sandy subtidal samples were also collected from the large sandy flat at San Simeon using a modified Van Veen grab from the boat.

Diablo Cove
Intertidal – Rocky intertidal reefs in two different coves were surveyed at this site. Two quadrat scrapings were collected from North Diablo Cove, where warmer water is expelled from the cooling system of the power plant, while two quadrat scrapings were collected from the next cove to the north (Fields Cove), which had noticeably cooler water. Visual surveys were conducted in both coves. Although so close in proximity, the rocky intertidal community differed substantially between the coves. An introduced algal species, *Sargassum muticum*, was

common in Diablo Cove and not found in Fields Cove. *Mytilus galloprovincialis/trossulus* was rare at this site, as was *Mytilus californianus*. John Pearse conducted the intertidal visual survey for introduced invertebrates at this site, and MLML staff conducted the algal survey.

Only cobble beaches were found at the Diablo Cove sampling site, so sandy intertidal core samples were collected approximately 10 miles north at Schooner's Cove in Montana de Oro state park. Although finer grained than at Diablo, the sand sampled at Montana de Oro was still fairly coarse, and little biology was observed in the core samples. Little beach wrack was present.

Subtidal – Divers surveyed the warm North Diablo Cove at approximately 20' depth. *Macrocystis pyrifera* was present but not growing in thick beds, while erect coralline algae was abundant at the dive site. Diving conditions were exceptional compared to other outer coast sites, and divers were able to swim along a 250' transect line through the middle of the cove to search for introduced species. Special attention was given to looking for *Undaria pinnatifida* and *Sargassum muticum* during the dive survey but no introduced species were identified in the subtidal survey.

No sand was observed at the North Diablo Cove dive, so subtidal sandy cores were collected from a sandy area near the entrance to the intake cove, which experiences a large amount of water flow.

Purisima Point

Intertidal – All of the rocky intertidal quadrat clearings were collected from the long, flat reef which jets out to sea at Purisima Point. Large boulders and reef outcrops provided a variety of small intertidal communities to sample. *Mytilus californianus* was present but in patches on the rock outcrops. Other common native species observed on boulders or outcrops included *Silvetia compressa*, *Gelidium spp*., and *Endocladia muricata*. Purple urchins were very common in low zone areas and pools. Jeff Goddard conducted the survey for introduced invertebrates, and MLML staff conducted the survey for algae at this site. No introduced species were identified in the field during this survey.

No sandy beaches were present at this site at the time of sampling, so sandy intertidal core samples were collected on a separate sampling event from the nearest sandy beach to the south of the point, which still had fairly coarse sand. No wrack line was present, but some hopper holes were observed. Two cores were collected from near very slow-flowing freshwater drainages along the beach.

Subtidal – Several small kelp beds were present along the subtidal reef on the south side of Purisima Point, and samples were collected from one of the kelp beds closest to the point. Poor visibility and large swell/strong underwater surge experienced during the subtidal survey dives made the survey difficult. No introduced species were identified in the field. Native species including *Pterogophora* and other small red algal species were noted from within the kelp bed area. The substrate did not have much relief.

Sand was observed at the rocky reef but only in small, shallow patches and was not sufficient for sandy cores collection. Divers searched for sand farther south and collected sandy core samples from a sandy area offshore of a large beach nearly a mile to the south of the rocky reef sampled.

Point Conception

Intertidal – MLML staff sampled intertidal habitats approximately 1 mile south of Point Conception at Government Point. No taxonomists were available, so MLML staff conducted the rocky intertidal visual survey at this site. In order to access the intertidal location, samplers paddled to shore on surfboards with the sampling gear and thus needed to find a beach that was safe to paddle into and that was adjacent to an accessible rocky intertidal bench. The intertidal rocky bench that was sampled is within meters of one of MARINe's long-term intertidal biological monitoring sites (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/). *Mytilus californianus* were found in a distinct band across the intertidal bench. Other native taxa observed common during the survey included *Phragmatopoma*, surfgrass, erect coralline algae, and *Egregia*. Tar, presumably from natural offshore seeps, was abundant on the rocky reef and in the water. No introduced species were identified in the field at this site.

Subtidal – The subtidal survey was conducted within a kelp forest on the south side of Point Conception at Cojo Bay for safety and accessibility purposes. The entire reef had a thin layer of sand cover, and underneath was shale bedrock. Diving conditions were exceptional so an extensive underwater survey was conducted. Shane Anderson, who is experienced as University of California Santa Barbara's marine collector, also conducted an underwater transect from the kelp bed to shore and back searching for introduced species during this survey. No introduced species were identified in the field.

Sandy cores were also collected at Cojo Bay from very fine sediment with small ripples and algae drift present.

Arroyo Hondo

Intertidal – Due to winter storms and intense rains, samplers were unable to get across the creek to get to the rocky intertidal reef at Arroyo Hondo and sampled the rocky reef nearby at the upcoast end of Refugio State Beach. The water along the coastline and in the tidepools was muddy, chocolate brown and difficult to see into, making the visual surveys challenging and possibly compromising the visual survey results. In addition, an unusual amount of freshwater and debris was flowing into the ocean at Refugio beach. Hogback formations on the rocky intertidal reef found at Refugio are representative of that section of coastline. Mussels (*Mytilus californianus*) and *Endocladia muricata* were found in patches at the tops of hogbacks or boulders. Surfgrass was also present in the low zone. Jeff Goddard conducted the visual survey for invertebrates and MLML staff surveyed for introduced algal species. No introduced species were identified in the field at this site.

Sandy cores were collected along Refugio State Beach amongst the brown water and debris.

Subtidal – The subtidal survey was conducted several months prior to the intertidal survey of this site described above. Weather conditions were much more favorable and did not prevent samplers from diving at the targeted site, offshore of the long-term MMS rocky intertidal monitoring site at Arroyo Hondo (MARINe. Retrieved October 23, 2006, from http://www.marine.gov/). Exceptional visibility and low surge allowed for an extensive diving survey. Samples were collected from within a kelp forest formed over a rocky reef made of hogbacks. Shane Anderson, UCSB's marine collector, conducted an additional swimming transect survey to shore and back searching for introduced species. The algae *Sargassum muticum* was the only introduced species identified in the field at this site.

Sandy subtidal cores were collected from a sandy area adjacent to the kelp forest reef. Sand appeared undisturbed with small ripples, some reddish coloration on top, and worm tubes.

Carpinteria
Intertidal – Rocky intertidal samples were collected along the main reef at Carpinteria state beach. The water along the coastline and in the tidepools was muddy, chocolate brown and difficult to see into, making sampling challenging and possibly compromising the visual survey results. In addition, an unusual amount of freshwater, tar and debris was in the ocean and on the beach near this intertidal site. The reef was fairly flat inshore and built up to taller outcrops which were covered with mussels offshore. Invertebrate diversity seemed high at this site. Jeff Goddard conducted the invertebrate survey and MLML staff conducted the algal survey, and no introduced species were identified in the field.

Sandy cores were collected from the sandy beach upcoast from the rocky reef and downcoast from the mouth of the creek. The grain size of the sand decreased downcoast along the beach between the creek and the reef. Little biology was observed in the samples.

Subtidal – Rocky subtidal samples were collected from kelp forests offshore from Carpinteria State Beach, and near UCSB permanent transects (C. Nelson, personal communication, October 23, 2006). Aside from *Macrocystis pyrifera* and *Laminaria* species, very little algae was observed at this site, but a thick diatom film covered most of the reef. The reef had little topographical relief and the sediment seemed somewhat anoxic. Diving conditions were exceptional during the visual survey, and no introduced species were identified in the field.

Sandy cores were collected south of the kelp forest sampling site, in fine grain sand with very small ripples.

Point Dume
Intertidal – Rocky intertidal samples were collected from outcrops near a small rocky reef situated almost perpendicular to the beach near Paradise Cove. Although small, the reef was home to many taxa including but not limited to *Mytilus californianus*, *Phragmatopoma, Anthopleura*, *Egregia*, and mid-zone algal turf assemblages. Jeff Goddard surveyed for invertebrates and Steve Murray surveyed for introduced algae at this site. The visual survey extended upcoast to the more bouldery rocky intertidal habitat found right at Point Dume. *Sargassum muticum* was the only introduced species identified in the field at this site.

Due to recent winter storms, much of the sand that is normally found at the beach was absent during this sampling event. Intertidal sandy cores were collected from small beaches between the rocks. High zone cores were collected in the wrack line at the top of the beach and base of cliffs.

Subtidal – Point Dume was one of the last subtidal sites sampled in the current survey because winter storms created poor visibility for several months in early 2005. Once able to sample the site, divers experienced exceptional conditions, with fair visibility and calm seas. The rocky subtidal survey was conducted in a kelp forest directly offshore of the intertidal rocky reef sampled. Divers noted an abundance of invertebrates at this site, including a native orange tunicate species growing on several species of algae present. The algae *Sargassum muticum* was the only introduced species identified in the field during the dive surveys.

Subtidal sandy cores were collected in a sandy area adjacent to the kelp forest sampled. Sand sampled had small ripples and was very fine-grained.

Point Fermin
Intertidal – Rocky intertidal samples were collected at the reef on the upcoast side of the San Pedro Bay's breakwater wall (Figure 7). Jack Engle conducted the visual survey for invertebrates and Kathy Ann Miller conducted the algal visual survey for introduced species. *Mytilus galloprovincialis/trossulus* was collected from within and nearby the larger *Mytilus californianus* patches. Three species of introduced algae were identified in the field: *Caulacanthus ustulatus*, *Lomentaria hakodatensis* and *Sargassum muticum*. The low zone was composed mostly of large boulders and did not have much turf habitat, so quadrat clearing samples were collected from mid zone turf. Large container ships were observed sitting offshore, waiting to enter the harbor to offload cargo.

Sandy cores were collected from Cabrillo beach, the intertidal beach adjacent to the breakwater for the harbor.

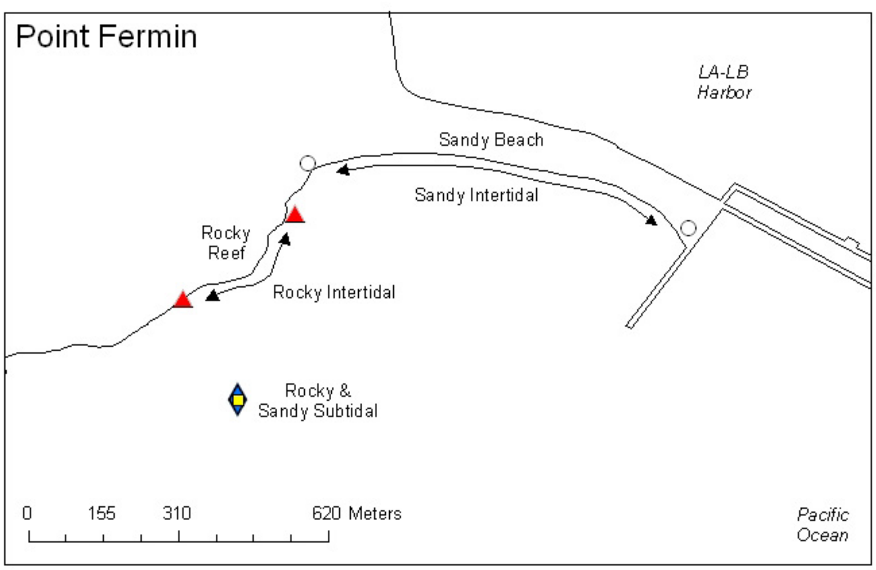


Figure 7. Map of survey layout showing the four habitats sampled at Point Fermin.

Subtidal – Rocky subtidal samples were collected from within a kelp forest just offshore of the intertidal rocky reef sampled. The reef was fairly flat with little topographical relief, so it was difficult to find a good variety of communities from which to collect quadrat clearing samples. Adjacent to the kelp forest was a large urchin barren. *Macrocystis pyrifera* individuals in the kelp forest seemed smaller and less robust than usual. After a fairly extensive underwater swimming survey, no introduced species were identified in the field.

Subtidal sandy cores were collected offshore of Cabrillo beach, which is where intertidal sandy cores were collected, and in close proximity to the harbor. Sand had small ripples and appeared to have little exposure to waves.

Dana Point
Intertidal – Rocky intertidal samples were collected from both the reef jetting out from Dana Point and from the bouldery area extending downcoast from the point. Jeff Goddard conducted the invertebrate survey and Steve Murray surveyed for introduced algae at this site. Invertebrate diversity seemed low at this site, and was dominated by *Tetraclita*, *Phragmatopoma* and *Serpulorbis* on the ledges. Turf composed of *Corallina* species mixed with other red algae was abundant. *Strongylocentrotus purpuratus* (purple urchins) occupied small intertidal urchin barrens. Sponges and tunicates were difficult to find at this site. *Sargassum muticum* and *Caulacanthus ustulatus* were the two introduced algal species identified at this site, while no introduced invertebrates were identified in the field. Both *S. muticum* and *C. ustulatus* were common to abundant, and a timed count was conducted for *S. muticum* to semi-quantify its abundance.

Sandy core samples were collected from a beach north of Dana Point approximately ¼ mile. Sediment was fine-grained and bamboo and kelp were observed at the wrack line in the high zone.

Subtidal – Subtidal samples were collected from within a kelp forest offshore and slightly downcoast from Dana Point. There was not much contiguous rocky reef present, but rather *Macrocystis pyrifera* and other species were growing mostly attached to large rocks or boulders, rarely more than one holdfast per boulder. *Phragmatopoma* also covered much of the boulders and/or was in colonies so thick they looked like boulders. Although sand was in between the boulders, it was not very deep, and rocky reef was discovered about 5 cm underneath the sand.

Sandy cores were taken in between the boulders in shallow sand patches. Small ripples were present in the sand and cores were collected through the crests of the ripples to get extra depth. Core samples from this site were approximately 5-7 cm deep.

Pin Rock, Catalina Island
Intertidal – Rocky intertidal samples were collected from the rocky reef and bouldery area at the entrance to Catalina Harbor. Evidence of recent winter storms remained as some boulders appeared to be freshly flipped and a nearby small landslide was fresh and sediment was still running off into the ocean. Kathy Ann Miller and Jack Engle conducted the algal and invertebrate field surveys. The introduced algal species *Sargassum muticum* was found growing nearby but in a slightly different habitat than two native *Sargassum* species. *Watersipora* was also collected in the field and brought to the lab for further identification as it had not been seen

at any other outer coast sites in the current survey. Not much bedrock was present at this site, and very few mussels were present. No other introduced species were identified in the field.

Sandy cores were collected from the intertidal beach that wraps from the rocky reef at the entrance to the inside of Catalina harbor, on the protected side of Ballast Point, where numerous small boats were moored. Ideally cores would not be collected from within the harbor but no other intertidal sand was found anywhere in proximity. Rocks were present at the high wrack line so high zone cores were collected at the highest sand available.

Subtidal – Underwater visibility was poor directly offshore from the intertidal reef sampled due to sediment runoff from the landslide, so subtidal samples were collected from within a kelp forest offshore and downcoast approximately 200m from the intertidal site. The bottom sloped down from the island quickly and samples were collected deeper than usual at this site, in 30-50' of water. Kathy Ann Miller and Jack Engle accompanied the subtidal survey and conducted the swimming visual search for invertebrates and algae at this site. A brown film of sediment or algae covered most of what was growing on the rocks at this site. Taxonomists collected bryozoans and other questionable invertebrates for later identifications, and also noted the presence of large and small green abalone at this site. No introduced species were identified in the field during the subtidal survey.

Sandy cores were collected from subtidal sand offshore and deeper than the rocky reef sampled, in 50' of water. Sand was covering cobble and was not very deep in some spots. The sediment appeared fairly undisturbed with small ripples in the sand and drift kelp settled.

Point La Jolla
Intertidal – Rocky intertidal samples were collected from a reef south of Point La Jolla and Seal Rock. Jack Engle and Steve Murray conducted visual surveys of invertebrates and algae for this intertidal survey. The reef is fairly flat with deep surge channels and bordered by sandy beaches upcoast and downcoast. Few boulders or rocks were found at this site. With large waves offshore and known surf spots nearby, this site appeared to be exposed to large waves during winter storms. This is the southernmost site in the current survey with a substantial mussel bed. A turf comprised of coralline and other algae grew on the vertical surface in the low zone of the reef. Two species of introduced algae, *Lomentaria hakodatensis* and *Caulacanthus ustulatus*, were identified growing amongst the turf species at this site. *Sargassum muticum* was also found on one end of the reef growing in two main surge channels but not considered abundant at this site. No introduced invertebrate species were identified in the field at this site.

Sandy intertidal cores were collected from a beach on the upcoast side of the rocky reef sampled. The low intertidal zone of the beach had high energy wave motion, coarse grained sand and no visible organisms. The high zone of the beach ended in cliffs and had very little drift material at the wrack line.

Subtidal – Rocky subtidal samples were collected from a kelp forest on the north side of Point La Jolla. The reef had substantial topographical relief as it was made of large boulders and some smaller sandy patches. Sponges covered large portions of the rocky reef and were also found in mats in the sand. Red-orange tunicates grew on much of the red algae. Hydroids were observed on the kelp and stinging in the water column. No introduced species were identified in the field during the subtidal survey.

Sand at the rocky reef was not sufficient so sandy core samples were collected farther upcoast, offshore from La Jolla Shores Beach, south of the Scripps Pier. Sand was fine-grained with medium sized ripples and no noticeable tubes. The beach inshore was popular for swimming and surfing.

Point Loma
Intertidal – Sampling occurred within the intertidal area of Cabrillo National Monument, which is broken down into three zones, each with different levels of protection from human visitors and trampling. Zone 1 is fully open to the public, while zones 2 and 3 are progressively more protected. The rocky intertidal survey was conducted mostly within zone 3 of Cabrillo National Monument, targeting both turfy mid-low zone and boulder mid-low zone habitat. While the visual search concentrated in zone 3, zone 1 was surveyed as well but not as thoroughly. Jack Engle, Steve Murray, and Kathy Ann Miller were all present to conduct the visual survey for introduced invertebrates and algae at this site. *Mytilus californianus* was rare at this site, and found only in very small patches, so one mussel bed quadrat clearing was collected from the reef around Point Loma and towards San Diego bay. Three introduced species were identified in the field at this site, and all were algae. *Sargassum muticum* was abundant in patches and was predominantly in zone 1. *Caulacanthus ustulatus* was found growing on a variety of substrates and in several habitats and was common. *Lomentaria hakodatensis* was initially difficult to notice growing in turf samples, but was found with patchy distribution in the turfy areas. *Mytilus galloprovincialis/trossulus* was identified within the mussels that were present. While invertebrate diversity appeared high, no introduced invertebrates were identified in the field.

Sandy intertidal cores were collected from sand pockets among the rocks. The beach was heavily disturbed by foot traffic. Very little wrack was present, and cores targeted small burrow holes in the sand.

Subtidal – Subtidal samples were collected south of Point Loma in a fairly small kelp bed. The reef was large and flat. Many kelp holdfasts were present but with stipes that had been torn off in the winter storms. Quadrat clearings were all on horizontal surfaces as no overhangs or large cracks were found in the flat reef. No introduced species were identified in the subtidal survey at this site.

Judging by the extensive kelp forests surrounding the survey site and by the cliffs onshore, subtidal sandy habitat was thought to be unavailable at this site. One survey dive was conducted, but no sand was found and sandy cores were not collected from this site.

Summary of Taxonomic Identifications

From the samples collected during the current field surveys, a total of 1265 species were identified, of which 26 were classified as introduced, 127 were classified as cryptogenic and 1112 were classified as native to California. In addition, samples collected during the field surveys produced 615 different taxa which were not identified to species level and were classified as unresolved for this report. The compiled database (MS Access), available through Moss Landing Marine Laboratories, gives detailed information for all samples, sampling information and all species identified, including native species.

Table 2 lists the 22 field survey sites and the number and percentage of taxa identified within each classification at each site. Introduced species across the state ranged from a low of 1 species (at 5 different sites) to a high of 8 species at Point Fermin, and represented 0.3% to 2.2% of the total taxa collected from each site along the coastline. Cryptogenic species ranged from 9 to 44 species collected, representing 5.1% to 10.6% of total taxa at each site, while native species ranged from 99 to 250 species collected, representing 47.5% to 65% of total taxa collected at each site.

Table 2. Number and percentage of total taxa identified for each classification for each site.

Station Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**175**	1 (0.6%)	15 (8.6%)	99 (56.6%)	60 (34.3%)
Cape Mendocino	**365**	4 (1.1%)	27 (7.4%)	215 (58.9%)	119 (32.6%)
Shelter Cove	**326**	1 (0.3%)	21 (6.4%)	195 (59.8%)	109 (33.4%)
Point Arena	**276**	3 (1.1%)	23 (8.3%)	159 (57.6%)	91 (33.0%)
Bodega	**318**	1 (0.3%)	19 (6.0%)	199 (62.6%)	99 (31.1%)
Point Reyes	**364**	3 (0.8%)	31 (8.5%)	207 (56.9%)	123 (33.8%)
Fitzgerald	**248**	1 (0.8%)	23 (9.3%)	118 (47.5%)	106 (42.7%)
Pigeon Point	**178**	4 (2.2%)	9 (5.1%)	102 (57.3%)	63 (35.4%)
Ano Nuevo	**224**	1 (0.4%)	13 (5.8%)	123 (54.9%)	87 (38.8%)
Point Sur	**365**	3 (0.8%)	32 (8.8%)	219 (60.0%)	111 (30.4%)
Point Sierra Nevada	**309**	5 (1.6%)	22 (7.1%)	184 (59.5%)	98 (31.7%)
Diablo Canyon	**291**	5 (1.7%)	22 (7.6%)	163 (56.0%)	101 (34.7%)
Purisima Point	**343**	2 (0.6%)	25 (7.3%)	222 (64.7%)	94 (27.4%)
Point Conception	**329**	2 (0.6%)	32 (9.7%)	214 (65.0%)	81 (24.6%)
Arroyo Hondo	**281**	2 (0.7%)	29 (10.3%)	164 (58.4%)	86 (30.6%)
Carpinteria	**310**	2 (0.6%)	33 (10.6%)	175 (56.5%)	100 (32.3%)
Point Dume	**359**	3 (0.8%)	31 (8.6%)	213 (59.3%)	112 (31.2%)
Point Fermin	**369**	8 (2.2%)	35 (9.5%)	228 (61.8%)	98 (26.6%)
Dana Point	**345**	3 (0.9%)	30 (8.7%)	208 (60.3%)	104 (30.1%)
Pin Rock	**446**	6 (1.3%)	44 (9.9%)	250 (56.1%)	146 (32.7%)
Point La Jolla	**368**	5 (1.4%)	38 (10.3%)	211 (57.3%)	114 (31.0%)
Point Loma	**296**	6 (2.0%)	31 (10.5%)	163 (55.1%)	96 (32.4%)

On a state-wide level, an average of 3.3 introduced species were found per site, representing an average of 1% of the total taxa collected from each site. There is no obvious difference in the number of introduced species and percentage of total taxa represented by them between northern and southern California (Figure 8). An average of 2.7 introduced species were identified, representing 1.0% of the total taxa identified per site at the 13 sites north of Point Conception. At the survey sites south of Point Conception an average of 4.1 introduced species were identified, which represented an average of 1.2% of the total taxa per site. At all sites, more than 81% of taxa collected and resolved to species-level identifications were native.

Additionally, there is little overlap between introduced species observed from outer coast survey sites and nearby major ports in southern California. For instance, Point Fermin and Pin Rock (Catalina Island), two of the outer coast survey sites with the highest number of introduced species, are in close proximity to a major shipping port, Los Angeles/Long Beach harbor. Interestingly, the species found at Point Fermin are all different than the species found at Pin Rock with only one exception, the seaweed *Sargassum muticum*. Furthermore, none of the 8 introduced species found at Point Fermin in the current survey are recorded from Los Angeles/Long Beach harbor to our knowledge, and only 2 of the 6 introduced species found at Pin Rock in the current survey are known from Los Angeles/Long Beach harbor. As another example, Point Loma is another outer coast survey site with one of the highest number of introduced species identified. This site is in close proximity to San Diego bay, another major shipping port which experiences a large amount and variety of vessel traffic. Only half of the introduced species (3 of 6) identified from the outer coast survey site at Point Loma are known from inside San Diego bay. This disparity between introduced species present within harbors and at nearby outer coast sites runs contrary to what one might intuitively expect and further confuses patterns of colonization. It remains unknown what factors are influencing the distribution patterns of outer coast introductions.

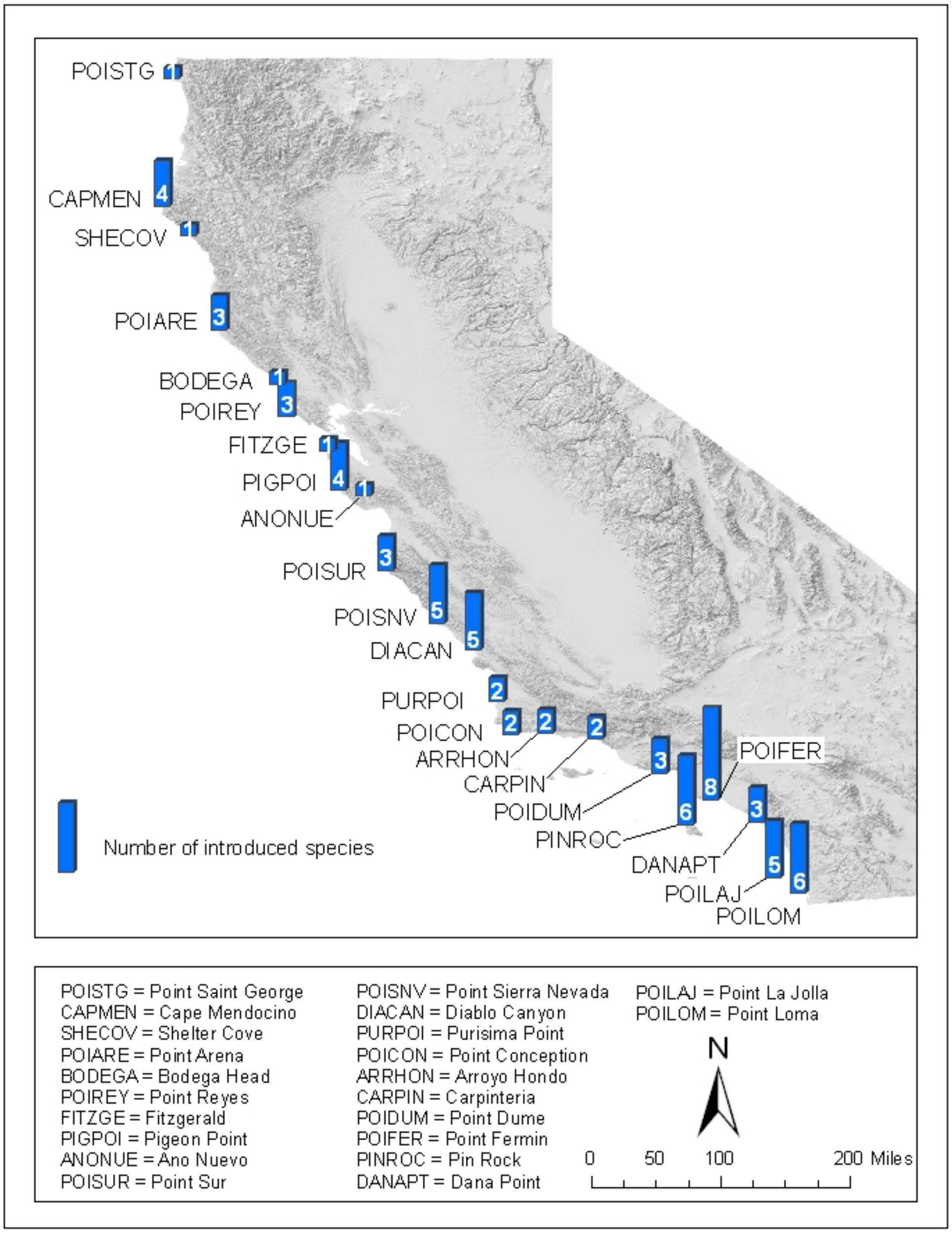


Figure 8. Number of introduced species identified from each of the 22 survey sites.

Although four very distinct habitats were sampled in the current survey, the percentage of taxa collected and classified as introduced was very similar between the habitats. While the percentages were similar, the numbers of introduced species identified from each habitat type varied remarkably (Table 3). Among the four main habitat types sampled, the highest number of introduced species were found in the rocky intertidal, at 16 species. Rocky subtidal habitat had the second highest number of introduced species, at 12, while sandy intertidal and subtidal habitats had 7 introduced species each. Over 50% of the taxa collected in each habitat type were classified as native. The next greatest percentage of identifications were classified as unresolved. Appendix D depicts the number and percentages of taxa identified in each classification for the four habitat types sampled at each site.

Table 3. Number of species and percentage of total taxa within each classification for each habitat type sampled.

Habitat Type	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Rocky Intertidal	**1090**	16 (1%)	59 (5%)	667 (61%)	348 (32%)
Sandy Intertidal	**333**	7 (2%)	25 (8%)	171 (51%)	130 (39%)
Rocky Subtidal	**1016**	12 (1%)	67 (7%)	602 (59%)	335 (33%)
Sandy Subtidal	**581**	7 (1%)	61 (11%)	297 (51%)	216 (37%)

The higher number of introduced species found in rocky intertidal habitat may be due, in part, to a greater sampling effort afforded in that habitat. Taxonomists accompanied the intertidal survey at most sites, spending an average of 3 hours per site conducting a visual search of the rocky intertidal. Sampling time and expertise in the rocky subtidal was limited because samplers were on SCUBA, and taxonomists or natural historians were present for only 4 of the rocky subtidal surveys conducted. In addition, sandy habitat surveys were not supplemented with an on-site, qualitative visual search. When introduced species which were only identified during the visual search of rocky habitats are excluded from the totals above, rocky intertidal still had 12 introduced species, rocky subtidal had 10 introduced species and sandy habitats still had 7 introduced species each. In this case, the numbers of introduced species found in rocky habitat are still higher than what was found in sandy habitat.

Another potential reason for the lower number of introduced species found in sandy habitat is that the sandy habitat at the outer coast survey sites may not provide the appropriate habitat for many infaunal organisms. The grain size analysis results indicate that despite sampling the lee side of most of the major headlands targeted, all sediments sampled are coarse grain size dominated by sand. Percent fines ranged from 0% to 8.4% among the survey sites, and averaged 0.7% over all grain size samples collected from the outer coast. Appendix E gives results from the grain size analysis in percent fines for each habitat type at each survey site.

Table 4 details the number and percentage of species within each classification for the major phyla identified in the current survey. Of the 26 introduced species identified in the current survey, 4 were annelids, 7 were arthropods, 2 were cnidarians, 9 were ectoprocts, 1 was a mollusc, and 3 were marine algae.

Table 4. Number of species and percentage of total taxa of each classification for each phylum.

Phylum	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Annelida	**525**	4 (1%)	73 (14%)	198 (38%)	250 (48%)
Arthropoda	**419**	7 (2%)	28 (7%)	285 (68%)	99 (24%)
Chlorophyta	**10**			9 (90%)	1 (10%)
Chordata	**46**		1 (2%)	37 (80%)	8 (17%)
Cnidaria	**103**	2 (2%)	3 (3%)	48 (47%)	50 (49%)
Echinodermata	**48**		3 (6%)	31 (65%)	14 (29%)
Ectoprocta	**82**	9 (11%)	2 (2%)	51 (62%)	20 (24%)
Heterokontophyta	**28**	1 (4%)		24 (86%)	3 (11%)
Mollusca	**366**	1 (0%)		263 (72%)	102 (28%)
Nemertea	**41**		6 (15%)	19 (46%)	16 (39%)
Phoronida	**1**				1 (100%)
Platyhelminthes	**29**		1 (3%)	16 (55%)	12 (41%)
Porifera	**90**		7 (8%)	53 (59%)	30 (33%)
Rhodophyta	**84**	2 (2%)		78 (93%)	4 (5%)
Sipuncula	**6**		3 (50%)		3 (50%)

Unresolved taxa numbered from 1 to 250 unique taxa collected within each phylum, and accounted for 5% to 100% of the total taxa collected within each phylum in the current survey. Specimens were classified as 'unresolved' as a result of insufficient taxonomic resolution at the species level, which may have been due to a variety of reasons including damaged or juvenile specimens, undescribed species, and problems in the taxonomic literature for those taxa. An average of 32% of the total taxa collected at each site were classified as unresolved; this large percentage of unresolved specimens points to the difficulty facing scientists when evaluating introductions throughout the world and the need for continued basic research on resolving taxonomy of marine species.

In order to determine the strongest factors causing the high numbers of unresolved taxa in this type of survey, DFG/MLML asked taxonomists to record the reason for each identification not resolved to species level. Taxonomists were asked to start recording that information after over one quarter of the identifications had already been made, when DFG/MLML realized unresolved taxa numbers could be similar to what was seen in the 2000-2001 DFG/MLML survey of bays and harbors. Of 3871 unresolved identifications for the current survey, 2172 (56%) had recorded explanations for this designation. Of those, approximately 50% were due to juvenile or non-reproductive specimens, approximately 21% were due to damaged specimens (presumably damaged during the collection process), approximately 10% were due to undescribed or unrecognized species, approximately 8% were due to other reasons which were not specified by the taxonomists (Table 5). Approximately 11% of the unresolved identifications were due to a combination of one or more of the above categories.

Table 5. Number and percentage of total recorded unresolved identifications for each unresolved taxa category.

Unresolved Taxa Category	Unresolved Identifications
Juvenile or Non-reproductive Specimen	1095 (50%)
Damaged Specimen	461 (21%)
Undescribed or Unrecognized Species	210 (10%)
Other	172 (8%)
Combination of two or more of the above categories	234 (11%)

Table 6 depicts the number and percentage of unresolved identifications made within each phylum in the current survey. The majority of unresolved identifications came from annelids, with juvenile, non-reproductive, and damaged specimens as the leading causes preventing species-level identification. Since species-level identifications are critical for determining the introduction status of specimens collected, DFG/MLML is currently reviewing these results in detail to determine whether aspects of the sampling regime should be revised in order to reduce the number of unresolved identifications in future surveys.

Table 6. Number and percentage of total unresolved identifications for each phylum and unresolved taxa category.

Phylum	Total Number of Unresolved Identifications	Juvenile or Not Reproductive	Damaged Specimen	Unrecognized or Undescribed Species	Other (reason not specified by Taxonomist)	Combination of two or more of the above categories
Annelida	1245 (57%)	492 (40%)	337 (27%)	131 (11%)	148 (12%)	137 (11%)
Arthropoda	82 (4%)	24 (29%)	6 (7%)	2 (2%)	1 (1%)	49 (60%)
Chordata	21 (1%)	14 (67%)	5 (24%)		1 (5%)	1 (5%)
Cnidaria	133 (6%)	80 (60%)	16 (12%)	18 (14%)	4 (3%)	15 (11%)
Echinodermata	75 (3%)	60 (80%)	6 (8%)			9 (12%)
Ectoprocta	85 (4%)	57 (67%)	28 (33%)			
Heterokontophyta	1 (<1%)	1 (100%)				
Mollusca	230 (11%)	200 (87%)	17 (7%)	13 (6%)		
Nemertea	176 (8%)	128 (73%)	27 (15%)		1 (1%)	20 (11%)
Phoronida	5 (<1%)			5 (100%)		
Platyhelminthes	70 (3%)	37 (53%)	5 (7%)	28 (40%)		
Porifera	46 (2%)		14 (30%)	13 (28%)	16 (35%)	3 (7%)
Sipuncula	2 (<1%)	2 (100%)				

Results from the current outer coast field survey can be roughly compared to results from the DFG/MLML field survey conducted in 2000-2001 for introduced species in California bays and harbors because of the similar field protocols used in both surveys (CDFG, 2002), and some striking differences can be noted. Introduced species accounted for a higher percentage of the total species identified in the field surveys of bays and harbors (10%) than in the outer coast

(2%) (Table 7). Also, less than a quarter (6 of 26) of the introduced species identified on the outer coast in the current survey were also identified during the 2000-2001 DFG/MLML field survey of California's bays and harbors. In addition, native species accounted for a lower percentage of the total species identified in bays and harbors (78%) than on the outer coast (88%).

Some similarities also exist between the results from the current outer coast survey and the 2000-2001 field survey of bays and harbors. For instance, cryptogenic species represented 10% of the total species identified from the outer coast and 11% of the total species identified from bays and harbors.

Table 7. Number and percentage of total species identified for each classification in two field surveys.

Survey	Total Species	Introduced	Cryptogenic	Native	NativeX
California Bays and Harbors (DFG/MLML 2002)	**818**	82 (10%)	87 (11%)	642 (78%)	7 (1%)
California Outer Coast (DFG/MLML Current)	**1265**	26 (2%)	127 (10%)	1112 (88%)	na

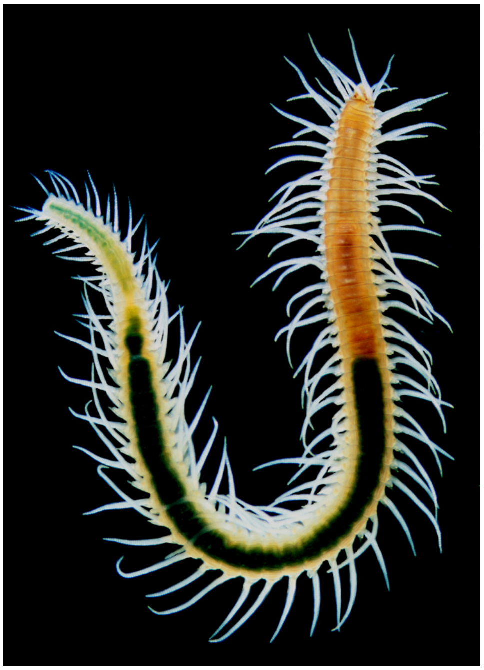
It should also be noted that the above comparisons are made strictly between the current field survey and the 2000-2001 field survey conducted by MLML/CDFG. Additional literature research and field surveys conducted by other research teams working with DFG/OSPR as a part of the 2000-2001 study resulted in a much larger list of introduced marine species known from California, and these results are included in CDFG's CANOD database (CDFG, 2002). See the "Summary of MS Access Database" section below for more details and website information for CANOD.

Table 8 shows the sites where each of the 26 introduced species were identified in the current survey. The survey sites are ordered from north (left) to south (right). Presence/absence data is listed for colonial organisms and for identifications made from qualitative visual searches of the site, where individual organisms were not counted. Numbers of individual organisms are shown for identifications made from quantitative samples which were counted. The counts shown are not always based on equal collection areas for all stations. Appendix F lists the cryptogenic species collected in the current survey, along with assessments about whether some of those species are most likely native or introduced, and the number of survey sites where each species was observed. Of the 127 cryptogenic species listed, 37 have been considered to be "likely native" while 7 have been considered "likely introduced".

Table 8. Number of individuals and presence/absence data for introduced species observed at each site in the current survey.

Species Name	Phylum	Total Sites Observed	Maximum Number of Individuals Observed	Pt. Saint George	Cape Mendocino	Shelter Cove	Point Arena	Bodega	Point Reyes	Fitzgerald	Pigeon Point	Ano Nuevo	Point Sur	Pt. Sierra Nevada	Diablo Canyon	Purisima Point	Point Conception	Arroyo Hondo	Carpinteria	Point Dume	Point Fermin	Dana Point	Pin Rock	Point La Jolla	Point Loma
Alcyonidium polyoum	Ectoprocta	**1**	**NA**						P																
Bowerbankia gracilis	Ectoprocta	**1**	**NA**												P										
Caulacanthus ustulatus	Rhodophyta	**4**	**NA**																		P	P		P	P
Conopeum commensale	Ectoprocta	**1**	**NA**											P											
Dipolydora barbilla	Annelida	**1**	**2**																				2		
Dynamena disticha	Cnidaria	**2**	**NA**				P								P										
Eobrolgus spinosus	Arthropoda	**4**	**48**				16		2			48	1												
Gibberosus myersi	Arthropoda	**9**	**22**								3		1	6	5		1		4	P	10	22			
Grandidierella japonica	Arthropoda	**1**	**2**																				2		
Harmothoe praeclara	Annelida	**2**	**144**			8								144											
Heteropora alaskensis	Ectoprocta	**1**	**NA**		P																				
Ianiropsis serricaudis	Arthropoda	**2**	**28**				28									8									
Lomentaria hakodatensis	Rhodophyta	**3**	**NA**																		P			P	P
Obelia dichotoma	Cnidaria	**1**	**NA**											P											
Pleurocope floridensis	Arthropoda	**1**	**124**																					124	
Pontogeneia rostrata	Arthropoda	**4**	**33**					4					16				33				P				
Pseudopolydora paucibranchiata	Annelida	**3**	**33**						15														33		8
Rhamphostomella gigantea	Ectoprocta	**1**	**NA**																		P				
Rhynchozoon bispinosum	Ectoprocta	**9**	**NA**		P						P			P	P				P	P	P			P	P
Sargassum muticum	Heterokontophyta	**8**	**NA**												P			P		P	P	P	P	P	P
Sinelobus stanfordi	Arthropoda	**1**	**96**	96																					
Tricellaria erecta	Ectoprocta	**4**	**NA**		P						P					P		P							
Tricellaria gracilis	Ectoprocta	**3**	**NA**								P												P		P
Urosalpinx cinerea	Mollusca	**2**	**20**		20					8															
Vermiliopsis infundibulum	Annelida	**1**	**12**																		12				
Watersipora sp A Schroeder	Ectoprocta	**1**	**NA**																				P		

Summary of Annelid Taxonomy (Segmented Worms)



Typosyllis sp 19. Photo used with permission by Leslie Harris

Four introduced and 73 cryptogenic species of annelids were identified in the current survey. Although annelids were collected at each survey site, introduced species were identified at only 6 sites, and represented 0% to 1% of the total annelid taxa at each site (Table 9). . *Dipolydora barbilla,* an introduced polychaete, was identified from subtidal sandy habitat at Pin Rock. This species has previously been reported from southern California waters, both on the mainland and some channel islands (SCCWRP. Retrieved 10/23/2006, from http://www.sccwrp.org:8000/query.php). The introduced polychaete *Pseudopolydora paucibranchiata* was also previously known from California waters (Carlton, 1979) and identified at three sites spanning from northern to southern California in the current survey: Point Reyes, Pin Rock and Point Loma. *P. paucibranchiata* was also collected from three different habitat types in the current survey, including rocky intertidal, sandy intertidal and sandy subtidal. *Harmothoe praeclara,* an introduced polychaete originally described from Australia, was found in subtidal rocky habitat at two sites north of Point Conception, Shelter Cove and Point Sierra Nevada. A fourth introduced polychaete species, *Vermiliopsis infundibulum,* was found only at Point Fermin in intertidal rocky habitat. To our knowledge, the later two introduced polychaetes have not previously been reported from California waters.

Cryptogenic annelid species ranged from a low of 3 at Point Saint George to a high of 27 at Pin Rock, representing 5% to 20% of the total annelid taxa identified at each site. Unresolved taxa represented 39% to 53% of the total annelid identifications at each site, while native annelid taxa represented 31% to 49% of the total identifications at each site. The relatively high proportion of unresolved annelid taxa is in part due to the high number of provisional species names assigned to specimens which have little known about them, such as *Typosyllis* sp 19 pictured above. Unless world-wide literature has been reviewed to assure the provisional species is not described elsewhere, each provisional is designated as unresolved for this study. Following the above guidelines, of the 92 provisional polychaete species identified in the current survey, 11 are designated as cryptogenic, 1 as native, and 80 as unresolved.

Table 9. Number of species and percentage of total Annelid taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**43**		3 (7%)	18 (42%)	22 (51%)
Cape Mendocino	**101**		9 (9%)	39 (39%)	53 (52%)
Shelter Cove	**83**	1 (1%)	8 (10%)	31 (37%)	43 (52%)
Point Arena	**113**		8 (7%)	53 (47%)	52 (46%)
Bodega	**100**		5 (5%)	42 (42%)	53 (53%)
Point Reyes	**118**	1 (1%)	19 (16%)	49 (42%)	49 (42%)
Fitzgerald	**97**		15 (15%)	39 (40%)	43 (44%)
Pigeon Point	**55**		6 (11%)	24 (44%)	25 (45%)
Ano Nuevo	**76**		10 (13%)	33 (43%)	33 (43%)
Point Sur	**128**		15 (12%)	57 (45%)	56 (44%)
Point Sierra Nevada	**109**	1 (1%)	11 (10%)	53 (49%)	44 (40%)
Diablo Canyon	**95**		14 (15%)	34 (36%)	47 (49%)
Purisima Point	**86**		10 (12%)	36 (42%)	40 (47%)
Point Conception	**92**		14 (15%)	42 (46%)	36 (39%)
Arroyo Hondo	**85**		14 (16%)	35 (41%)	36 (42%)
Carpinteria	**116**		17 (15%)	40 (34%)	59 (51%)
Point Dume	**120**		15 (13%)	48 (40%)	57 (48%)
Point Fermin	**108**	1 (1%)	22 (20%)	34 (31%)	51 (47%)
Dana Point	**98**		12 (12%)	44 (45%)	42 (43%)
Pin Rock	**148**	2 (1%)	27 (18%)	53 (36%)	66 (45%)
Point La Jolla	**113**		16 (14%)	49 (43%)	48 (42%)
Point Loma	**85**	1 (1%)	12 (14%)	29 (34%)	43 (51%)

Summary of Arthropod Taxonomy

Grandidierella japonica, photo with permission by George Brooks © Cal Academy of Sciences

Seven introduced and 28 cryptogenic species of arthropods were identified in the current survey (Table 10). Introduced species were found at 17 of the survey sites, representing 0% to 3% of total arthropod taxa from each site, while cryptogenic species were found at all 22 sites and represented 3% to 15% of total arthropod taxa from each site. The majority of arthropod taxa were native species, ranging from 51% to 77% of the total arthropod taxa at each site. Unresolved taxa represented 9% to 38% of total arthropod taxa per site. All of the introduced arthropods identified in the current survey have previously been reported from California.

Table 10. Number of species and percentage of total Arthropod taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**60**	1 (2%)	9 (15%)	39 (65%)	11 (18%)
Cape Mendocino	**91**		14 (15%)	60 (66%)	17 (19%)
Shelter Cove	**94**		8 (9%)	59 (63%)	27 (29%)
Point Arena	**85**	2 (2%)	12 (14%)	58 (68%)	13 (15%)
Bodega	**77**	1 (1%)	8 (10%)	57 (74%)	11 (14%)
Point Reyes	**97**	1 (1%)	9 (9%)	62 (64%)	25 (26%)
Fitzgerald	**63**		7 (11%)	32 (51%)	24 (38%)
Pigeon Point	**48**	1 (2%)	3 (6%)	28 (58%)	16 (33%)
Ano Nuevo	**59**	1 (2%)	2 (3%)	39 (66%)	17 (29%)
Point Sur	**108**	3 (3%)	14 (13%)	78 (72%)	13 (12%)
Point Sierra Nevada	**92**	1 (1%)	8 (9%)	68 (74%)	15 (16%)
Diablo Canyon	**70**	1 (1%)	5 (7%)	52 (74%)	12 (17%)
Purisima Point	**78**	1 (1%)	11 (14%)	58 (74%)	8 (10%)
Point Conception	**104**	2 (2%)	13 (13%)	78 (75%)	11 (11%)
Arroyo Hondo	**74**		9 (12%)	49 (66%)	16 (22%)
Carpinteria	**87**	1 (1%)	11 (13%)	67 (77%)	8 (9%)
Point Dume	**89**	1 (1%)	10 (11%)	66 (74%)	12 (13%)
Point Fermin	**82**	2 (2%)	11 (13%)	57 (70%)	12 (15%)
Dana Point	**100**	1 (1%)	12 (12%)	67 (67%)	20 (20%)
Pin Rock	**94**	1 (1%)	10 (11%)	63 (67%)	20 (21%)
Point La Jolla	**97**	1 (1%)	14 (14%)	68 (70%)	14 (14%)
Point Loma	**78**		12 (15%)	56 (72%)	10 (13%)

Four of the introduced arthropod species identified from the current survey were amphipods. *Eobrolgus spinosus* was found in rocky and sandy intertidal habitat in northern California at Point Arena, Point Reyes, Ano Nuevo and Point Sur. Figure 9 demonstrates that the geographic distribution of *E. spinosus* in the current survey was restricted to central California survey sites, a pattern that was rare amongst the other introduced species identified. Another introduced amphipod species, *Gibberosus myersi,* was collected from multiple habitats at 9 survey sites spanning both southern and central California (Figure 10).

The other 2 introduced amphipod species identified in the current survey were *Grandidierella japonica* (pictured above) and *Pontogeneia rostrata*. The tube-dwelling amphipod *G. japonica* was identified from one site in the current survey, Pin Rock. Native to Japan, this species has been established in southern California bays since the 1980's and has also been reported from the more northern San Francisco and Tomales Bays as early as 1966 and 1969, respectively (Cohen and Carlton, 1995), but no records were found from outer coast collections previous to this survey. In the current survey this species was only collected from Pin Rock's sandy intertidal samples, which were taken from a more bay-like location due to the lack of sandy beaches in the vicinity of Pin Rock. An introduced amphipod previously reported from the Japan Sea, Okhotsk Sea, Bering Sea (Barnard, 1962), Baja California (Barnard, 1964), and California's Channel Islands (SCCWRP. Retrieved October 23, 2006, from http://www.sccwrp.org:8000/query.php), *P. rostrata,* was identified in the current survey from five sites spanning both northern and southern California.

Two introduced isopod species were identified from samples collected in the current survey. *Ianiropsis serricaudis* was collected from rocky intertidal habitat at Point Arena and Purisima Point, while *Pleurocope floridensis* was identified from rocky intertidal habitat at Point La Jolla. To our knowledge, neither of these two isopods have previously been reported from outer coast habitat in California.

An introduced tanaid species, *Sinelobus stanfordi,* was identified in the current survey from Point Saint George in rocky intertidal habitat. The broad distribution in range and habitat of *S. stanfordi* identifications along the Pacific Coast indicate that there may be some remaining difficulties with the taxonomy of this genus, and that this tanaid species may actually be a different species and part of a broader species complex. However, the entire genus is considered introduced to California (Cohen and Carlton, 1995).

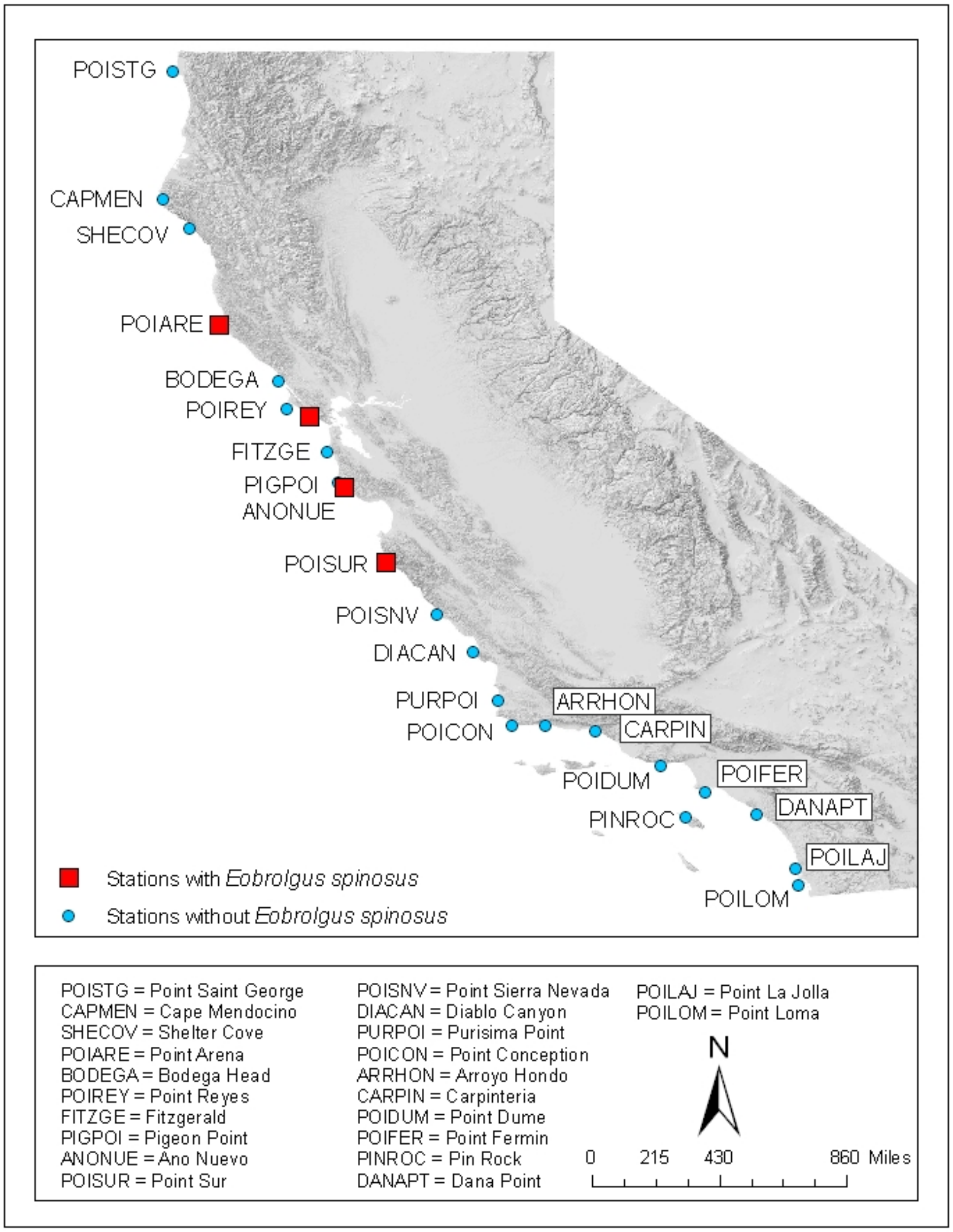


Figure 9. Geographical distribution of *Eobrolgus spinosus* among the 22 sites surveyed.

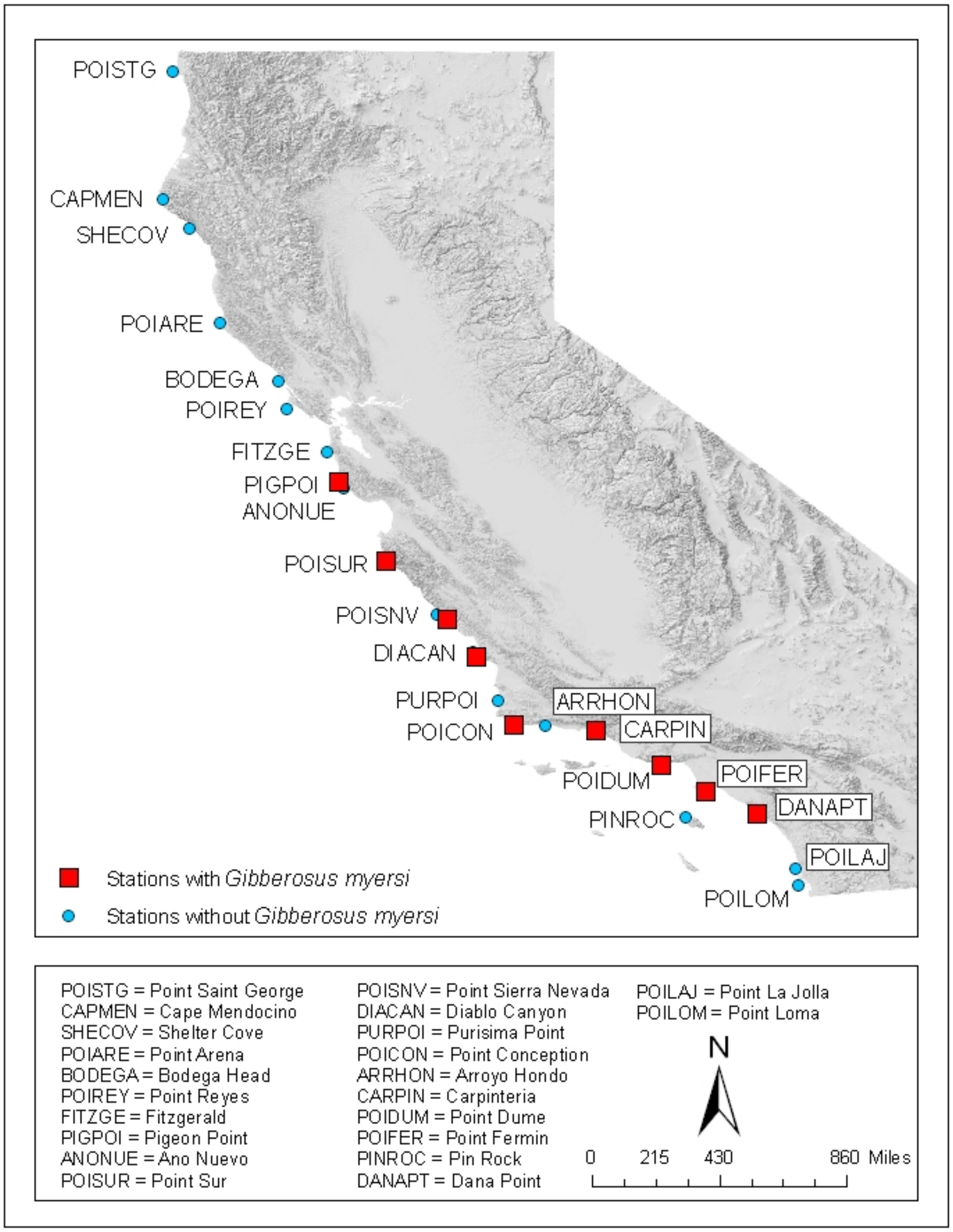


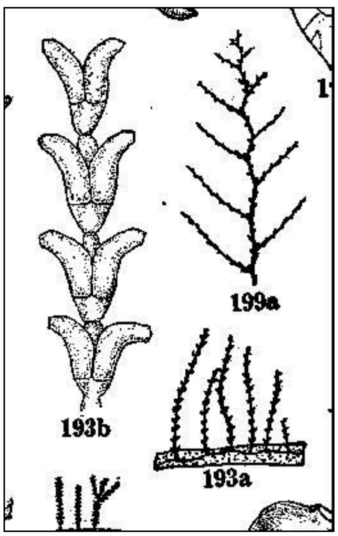
Figure 10. Geographical distribution of *Gibberosus myersi* among the 22 sites surveyed.

Summary of Chordata Taxonomy (Tunicates)
No introduced tunicate species were identified in the current survey. One cryptogenic species, *Diplosoma listerianum*, was identified from rocky intertidal habitat at Shelter Cove and subtidal rocky habitat at Bodega and Point Sur, representing 0% to 7% of total chordate taxa among the survey sites (Table 11). *D. listerianum* belongs to the family Didemnidae, and grows on algae forming transparent colonies (Marine Life Encyclopedia. Retrieved October 25, 2006, from http://www.habitas.org.uk/marinelife/species.asp?item=ZD970). This species was listed by CDFG (2002) as introduced and has been updated to cryptogenic in this report due to its ubiquitous distribution around the world and the lack of solid evidence that it is either native or introduced (G. Lambert, personal communication, May 2, 2006). The majority of chordate taxa identified were native, representing 67% to 100% of total chordate taxa per site, whereas the proportion of unresolved taxa was relatively low compared to other phyla in this survey, ranging from 0% to 33% of total chordate taxa per site.

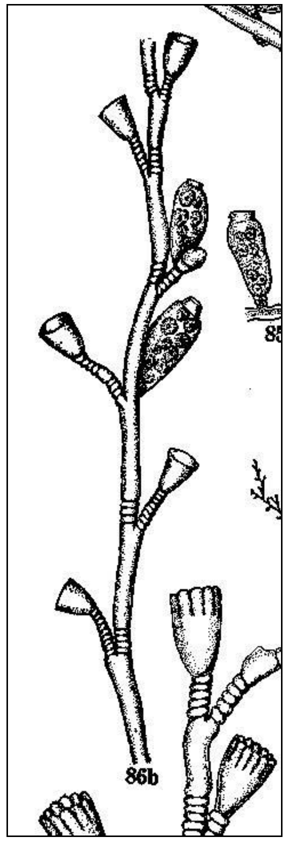
Table 11. Number of species and percentage of total Chordata taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**4**			3 (75%)	1 (25%)
Cape Mendocino	**15**			12 (80%)	3 (20%)
Shelter Cove	**15**		1 (7%)	14 (93%)	
Point Arena	**4**			4 (100%)	
Bodega	**20**		1 (5%)	15 (75%)	4 (20%)
Point Reyes	**2**			2 (100%)	
Fitzgerald	**1**			1 (100%)	
Ano Nuevo	**7**			7 (100%)	
Pigeon Point	**7**			7 (100%)	
Point Sur	**17**		1 (6%)	13 (76%)	3 (18%)
Diablo Canyon	**6**			4 (67%)	2 (33%)
Point Sierra Nevada	**4**			4 (100%)	
Purisima Point	**15**			15 (100%)	
Arroyo Hondo	**5**			4 (80%)	1 (20%)
Carpinteria	**11**			10 (91%)	1 (9%)
Point Conception	**6**			6 (100%)	
Point Dume	**11**			10 (91%)	1 (9%)
Point Fermin	**5**			4 (80%)	1 (20%)
Pin Rock	**2**			2 (100%)	
Dana Point	**10**			9 (90%)	1 (10%)
Point La Jolla	**15**			13 (87%)	2 (13%)
Point Loma	**7**			5 (71%)	2 (29%)

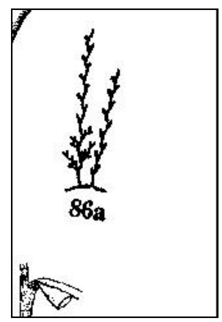
Summary of Cnidarian Taxonomy



Dynamena disticha (Fraser, 1937)



Obelia dichotoma (Fraser, 1937)



Obelia dichotoma (Fraser, 1937)

Two introduced and 3 cryptogenic cnidarian species were identified in the current survey. Introduced species represented 0% to 20% and cryptogenic species represented 0 to 10% of total cnidarian taxa collected at each site (Table 12). *Dynamena disticha* (pictured above), an introduced hydrozoan, was identified in subtidal sandy habitat at Point Arena and in subtidal rocky habitat at Diablo Canyon in the current survey. This species has been reported from multiple worldwide locations including the Bermudas, the Indian Ocean, western and eastern Pacific, Brazil and the western Atlantic (Kelmo & Vargas, 2002), and has been reported previously from California. Another introduced hydrozoan, *Obelia dichotoma* (pictured above), was identified in rocky intertidal habitat at Point Sierra Nevada in the current survey. Described from Europe, this species was collected in San Francisco Bay as early as 1894 (Carlton and Cohen, 1995). The 3 cryptogenic cnidarians collected in the current survey are *Syncoryne mirabilis, Plumularia setacea* and *Plumularia alicia*. Cryptogenic cnidarians were only collected from southern California sites. The proportion of native cnidarians collected in the current survey was low respective to the other phyla, representing 0% to 67% of total cnidarian taxa. Meanwhile, unresolved taxa represented the majority of cnidarians collected, at 33% to 100% of cnidarians at each site.

Table 12. Number of species and percentage of total Cnidarian taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**11**			3 (27%)	8 (73%)
Cape Mendocino	**21**			12 (57%)	9 (43%)
Shelter Cove	**9**			6 (67%)	3 (33%)
Point Arena	**5**	1 (20%)			4 (80%)
Bodega	**15**			7 (47%)	8 (53%)
Point Reyes	**20**			5 (25%)	15 (75%)
Fitzgerald	**7**				7 (100%)
Pigeon Point	**5**				5 (100%)
Ano Nuevo	**5**			1 (20%)	4 (80%)
Point Sur	**7**				7 (100%)
Point Sierra Nevada	**8**	1 (13%)			7 (88%)
Diablo Canyon	**11**	1 (9%)	1 (9%)	3 (27%)	6 (55%)
Purisima Point	**20**			11 (55%)	9 (45%)
Point Conception	**15**			7 (47%)	8 (53%)
Arroyo Hondo	**20**			9 (45%)	11 (55%)
Carpinteria	**14**			6 (43%)	8 (57%)
Point Dume	**17**			8 (47%)	9 (53%)
Point Fermin	**3**				3 (100%)
Dana Point	**9**			2 (22%)	7 (78%)
Pin Rock	**21**			7 (33%)	14 (67%)
Point La Jolla	**20**		1 (5%)	8 (40%)	11 (55%)
Point Loma	**11**		1 (9%)	1 (9%)	9 (82%)

Summary of Echinoderm Taxonomy

Zero introduced and 3 cryptogenic echinoderm species were identified in the current survey. Cryptogenic species were found at 12 of the survey sites, and represented 0% to 25% of total echinoderm taxa at each site (Table 13). Native species represented 0% to 83%, while unresolved species represented 8% to 100% of the total echinoderm taxa at each site. Collections with unresolved identifications were relatively high for this phyla, probably because overall numbers of echinoderms collected were relatively low and specimens were often juveniles or damaged, making species-level identification impossible.

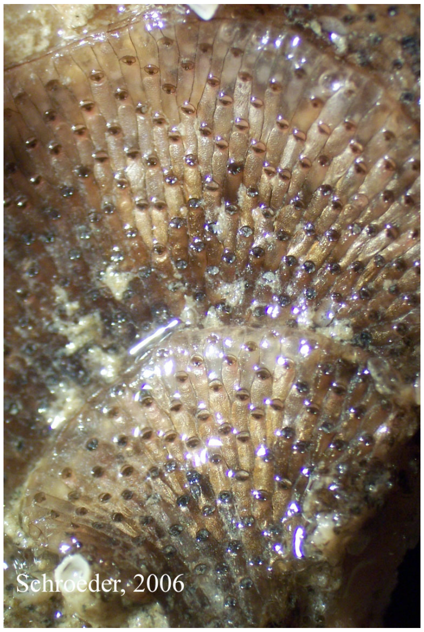
All 3 cryptogenic species of echinoderms were ophiuroids, or brittle stars. *Amphipholis squamata* was collected at seven of the survey sites, spanning northern and southern California. This species is distributed nearly worldwide (Morris et al., 1980) and the native range is unknown. *Ophiactis simplex* was identified in the current survey at 8 southern California sites in both intertidal and subtidal rocky habitat. This species is currently considered cryptogenic, but was previously reported as native by CDFG (2002). *O. simplex* was first reported from San Diego in 1908, and therefore is likely native to California. However, it is thought to occur in

Texas and may be identical to another *Ophiactis* species described from Florida, leaving open to question the taxonomy and range of the species (G. Hendler, personal communication, October 23, 2006). The third cryptogenic ophiuroid, *Ophiopholis kennerlyi*, was identified from rocky subtidal habitat at two northern California sites in the current survey.

Table 13. Number of species and percentage of total Echinoderm taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**4**			1 (25%)	3 (75%)
Cape Mendocino	**14**		1 (7%)	8 (57%)	5 (36%)
Shelter Cove	**12**			8 (67%)	4 (33%)
Point Arena	**7**		1 (14%)	2 (29%)	4 (57%)
Bodega	**11**		1 (9%)	6 (55%)	4 (36%)
Point Reyes	**5**			4 (80%)	1 (20%)
Fitzgerald	**6**				6 (100%)
Ano Nuevo	**3**			1 (33%)	2 (67%)
Point Sur	**10**			5 (50%)	5 (50%)
Point Sierra Nevada	**7**			4 (57%)	3 (43%)
Diablo Canyon	**8**		1 (13%)	4 (50%)	3 (38%)
Purisima Point	**14**			11 (79%)	3 (21%)
Point Conception	**7**			4 (57%)	3 (43%)
Arroyo Hondo	**8**		1 (13%)	5 (63%)	2 (25%)
Carpinteria	**8**		2 (25%)	3 (38%)	3 (38%)
Point Dume	**12**		1 (8%)	10 (83%)	1 (8%)
Point Fermin	**5**		1 (20%)	1 (20%)	3 (60%)
Dana Point	**16**		2 (13%)	9 (56%)	5 (31%)
Pin Rock	**10**		2 (20%)	3 (30%)	5 (50%)
Point La Jolla	**8**		2 (25%)	3 (38%)	3 (38%)
Point Loma	**11**		2 (18%)	4 (36%)	5 (45%)

Summary of Ectoproct Taxonomy (Bryozoans)



Watersipora sp A Schroeder, photo used with permission by Greg Schroeder

Ectoprocts were collected from all sites surveyed, and the majority of taxa were native to California. Nine introduced species (0% to 18% of total ectoproct taxa per site) and 2 cryptogenic species (0% to 13% of total ectoproct taxa per site) of ectoporocts were identified from the current survey (Table 14). Native species represented 55% to 100% of total ectoproct taxa at a site, while unresolved taxa ranged from a low of 0% to a high of 30% of the total ectoproct taxa at each site.

Alcyonidium polyoum was identified from a holdfast collection at Point Reyes. This introduced species has previously been reported from nearby locations including San Francisco Bay and Tomales Bay (Cohen and Carlton, 1995), but to our knowledge has not previously been reported from California's outer coast. *Bowerbankia gracilis* is an introduced ectoproct identified in the current survey from rocky subtidal habitat at Diablo Canyon. The known distribution of this introduced species in the northeast Pacific includes bays ranging from British Columbia to Baja California, Mexico (Cohen and Carlton, 1995), but to our knowledge, *B. gracilis* has not previously been reported from outer coast habitats in California. Another introduced species, *Conopeum commensale* was identified from a holdfast collection at Point Sierra Nevada, and it is considered a probable synonym with *Conopeum tenuissimum* of Filice, 1959 and of Aldrich, 1961, which has been reported as introduced in San Francisco bay (Cohen and Carlton, 1995).

Table 14. Number of species and percentage of total Ectoproct taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**8**		1 (13%)	6 (75%)	1 (13%)
Cape Mendocino	**23**	3 (13%)	1 (4%)	15 (65%)	4 (17%)
Shelter Cove	**14**			12 (86%)	2 (14%)
Point Arena	**6**			6 (100%)	
Bodega	**5**			5 (100%)	
Point Reyes	**9**	1 (11%)		6 (67%)	2 (22%)
Fitzgerald	**12**			10 (83%)	2 (17%)
Pigeon Point	**23**	3 (13%)		14 (61%)	6 (26%)
Ano Nuevo	**10**			7 (70%)	3 (30%)
Point Sur	**16**			12 (75%)	4 (25%)
Point Sierra Nevada	**11**	2 (18%)	1 (9%)	6 (55%)	2 (18%)
Diablo Canyon	**14**	2 (14%)		8 (57%)	4 (29%)
Purisima Point	**16**	1 (6%)	1 (6%)	10 (63%)	4 (25%)
Point Conception	**24**			20 (83%)	4 (17%)
Arroyo Hondo	**9**	1 (11%)	1 (11%)	6 (67%)	1 (11%)
Carpinteria	**15**	1 (7%)	1 (7%)	10 (67%)	3 (20%)
Point Dume	**17**	1 (6%)	1 (6%)	11 (65%)	4 (24%)
Point Fermin	**24**	2 (8%)		21 (88%)	1 (4%)
Dana Point	**13**			13 (100%)	
Pin Rock	**24**	2 (8%)	1 (4%)	15 (63%)	6 (25%)
Point La Jolla	**18**	1 (6%)	1 (6%)	14 (78%)	2 (11%)
Point Loma	**15**	2 (13%)	1 (7%)	9 (60%)	3 (20%)

Heteropora alaskensis was identified in the current survey from the rocky intertidal at Cape Mendocino. This introduced species is typically found at very low tide in Alaska, British Columbia and Oregon (Osburn, 1953), and to our knowledge has not previously been reported from California. The introduced ectoproct *Rhamphostomella gigantea*, previously reported by Osburn (1952) from 140 and 80 feet in Alaska, was identified in the current survey from 20-25 foot depths at the subtidal rocky reef at Point Fermin. The introduced ectoproct *Rhynchozoon bispinosum* was found at 9 of the current survey sites, spanning the coastline from Cape Mendocino in the north to the southernmost survey site, Point Loma (Figure 11). *R. bispinosum* was also collected from all 4 habitat types sampled in the current survey. Osburn (1952) reports this species from Alaska, western Europe, and the British Isles.

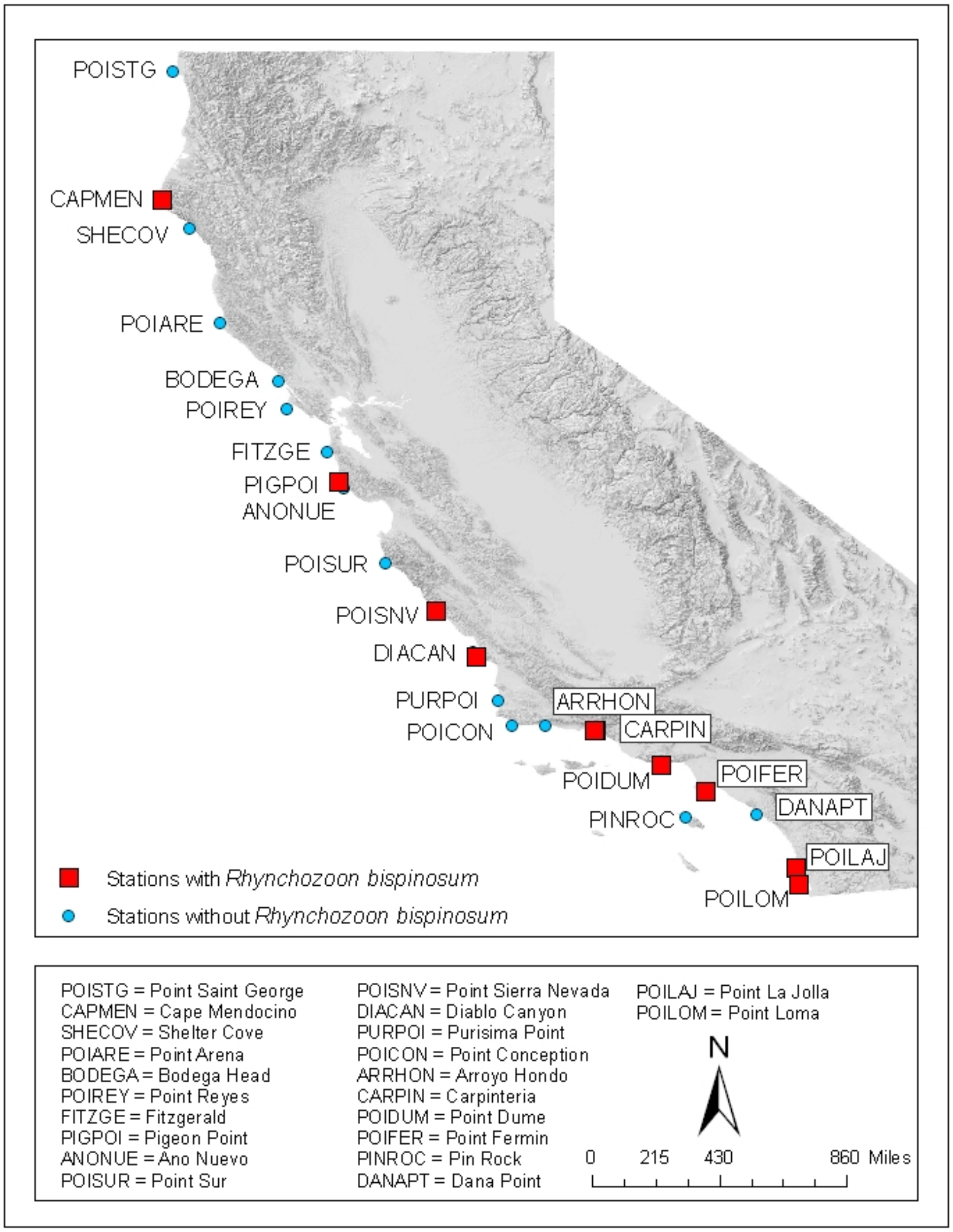


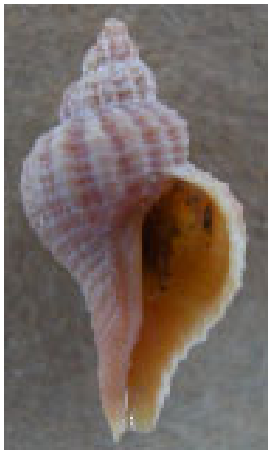
Figure 11. Geographical distribution of *Rhynchozoon bispinosum* among the 22 sites surveyed.

Two introduced ectoprocts, *Tricellaria erecta* and *Tricellaria gracilis*, were each found intertidally and subtidally at 3 survey sites spanning northern and southern California. It appears that the native range for these two species is Alaska (Osburn, 1950), and *T. gracilis* has not previously been reported from California waters to our knowledge.

In addition, a provisional ectoproct species, called *Watersipora sp* A Schroeder for the current study (photographed above), was identified at one outer coast location, in the rocky intertidal at Pin Rock on Catalina Island. Multiple species of *Watersipora* are known to be widespread in California waters, but distinguishing among the different species based on morphological characters is currently difficult (Soule and Soule, 1976; Seo, 1999). *W. sp* A Schroeder is most likely one of the known *Watersipora* species already introduced to California, and because this entire genus is considered introduced to California, the current survey lists *W. sp* A Schroeder as introduced. Jonathan Geller, Gregory Schroeder and Daphne Gerhinger (MLML), under supplemental funding from DFG/OSPR, are currently conducting genetic analyses of *Watersipora* colonies collected from bays and harbors spanning the state of California in order to try to resolve this taxonomic confusion and establish baseline information about the distribution of the different *Watersipora* species in California. While *Watersipora* species tend to be aggressive invaders in bays and harbors, this species was not observed to be widespread at the outer coast collection site. The scarcity could have been due to the timing of the sampling event, as the site was visited in between rain storms in February and *Watersipora* has been observed to die back in the winter in some locations. It remains unknown whether this is an established population or a newly settled colony not yet established at this outer coast location.

The cryptogenic species *Bugula neritina* was collected only south of Point Conception, in intertidal and subtidal habitats during this survey, but has previously been reported in numerous bays and harbors in both southern and northern California (Guide to Exotic Species of SF Bay. Retrieved October 23, 2006, from http://www.exoticsguide.org/species_pages/b_neritina.html). Both Cohen and Carlton (1995) and CDFG (2002) reported this species as introduced to California. However, it remains unclear whether there is a morphologically similar but native species also present in California. Therefore, this study reports the status as cryptogenic and acknowledges that it is likely introduced. A second cryptogenic species considered likely to be introduced to California, *Flustrellidra corniculata*, was identified from rocky intertidal habitat at four survey sites north of Point Conception (Point Saint George, Cape Mendocino, Point Sierra Nevada and Purisima Point).

Summary of Mollusc Taxonomy (Soft Bodied Invertebrates)



Urosalpinx cinerea, photo used with permission by Andrew N. Cohen

Molluscs were collected from all sites sampled in the current survey. One introduced (0% to 2% of total mollusc taxa per site) and no cryptogenic species were identified in the samples (Table 15). The majority of taxa identified were native species, representing 56% to 81% of total mollusc taxa among the survey sites. Unresolved taxa ranged from 19% to 44% of the total mollusc taxa among the sites.

The introduced mollusc *Urosalpinx cinerea* (pictured above) is native to the NW Atlantic coast and was identified in rocky intertidal samples from Cape Mendocino and Fitzgerald in the current survey. This small snail, commonly known as the "oyster drill", is a major predator on oysters and a pest on commercial shellfish aquaculture. This species is established in intertidal and shallow subtidal habitat in several bays and estuaries along the California coastline, but to our knowledge has not previously been reported from the outer coast (Guide to Exotic Species of SF Bay. Retrieved October 23, 2006, from http://www.exoticsguide.org/species_pages/b_neritina.html).

Both the native *Mytilus trossulus* and the introduced *Mytilus galloprovincialis* have previously been collected in outer coast rocky intertidal habitat in California (Braby and Somero, 2006). These 2 species along with a third, *Mytilus edulis*, form a complex that can be morphologically indistinguishable at the species level. In addition, Braby and Somero (2006) confirmed a zone along the California coastline between Monterey and Cape Mendocino where *M. trossulus* and *M. galloprovinicialis* hybrids are found. In the current survey, *Mytilus* specimens morphologically identified to be part of this complex, but not identified down to species level, were collected from fourteen outer coast survey sites, spanning from northern to southern California. Since the complex includes both a native and an introduced species, this complex was given the introduction status 'unresolved' for this study. Even though the current study lacks genetic confirmation that *M. galloprovincialis* was collected, data from these previous studies suggest that some if not all of the current survey's sites harbor this introduced species. *M. galloprovincialis* is listed by the World Conservation Union as one of the world's 100 worst invaders (1000 of the World's Worst Invasive Alien Species. Retrieved October 23, 2006, from http://www.issg.org/booklet.pdf).

Table 15. Number of species and percentage of total Mollusc taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**25**			17 (68%)	8 (32%)
Cape Mendocino	**69**	1 (1%0		50 (72%)	18 (26%)
Shelter Cove	**69**			48 (70%)	21 (30%)
Point Arena	**37**			29 (78%)	8 (22%)
Bodega	**48**			39 (81%)	9 (19%)
Point Reyes	**83**			63 (76%)	20 (24%)
Fitzgerald	**41**	1 (2%)		24 (59%)	16 (39%)
Pigeon Point	**22**			13 (59%)	9 (41%)
Ano Nuevo	**36**			20 (56%)	16 (44%)
Point Sur	**49**			33 (67%)	16 (33%)
Point Sierra Nevada	**52**			37 (71%)	15 (29%)
Diablo Canyon	**54**			42 (78%)	12 (22%)
Purisima Point	**70**			55 (79%)	15 (21%)
Point Conception	**47**			36 (77%)	11 (23%)
Arroyo Hondo	**47**			38 (81%)	9 (19%)
Carpinteria	**36**			27 (75%)	9 (25%)
Point Dume	**50**			40 (80%)	10 (20%)
Point Fermin	**58**			43 (74%)	15 (26%)
Dana Point	**60**			46 (77%)	14 (23%)
Pin Rock	**55**			36 (65%)	19 (35%)
Point La Jolla	**48**			39 (81%)	9 (19%)
Point Loma	**51**			41 (80%)	10 (20%)

Summary of Nemertean Taxonomy (Ribbon Worms)

Zero introduced and 6 cryptogenic species of Nemerteans were identified in the current survey. Cryptogenic species were identified from 13 survey sites, representing from 0% to 27% of the total nemertean taxa from each site (Table 16). The majority of nemertean taxa from most sites were unresolved, ranging from 30% to 86% of total nemertean tax at each site. The proportion of native nemertean species in the samples was relatively low, ranging from 0% to 70% of total nemertean taxa identified from each survey site. No native nemerteans were identified from Point Arena.

Two of the 6 cryptogenic nemertean species were identified from survey sites spanning northern and southern California. A nemertean commonly found on California's shoreline, *Amphiporus imparispinosus* was collected from rocky intertidal habitat at 4 sites. *Zygonemertes virescens* was collected from 6 survey sites in rocky intertidal and subtidal samples. *Z. virescens* is known to occur growing on algae, bryozoans, rocks and other objects in the low intertidal and below, and is listed as cryptogenic due to its ubiquitous distribution along both east and west coasts of the US and unknown native range (Smithsonian Tropical Research Institute. Retrieved October 23, 2006, from http://striweb.si.edu/bocas_database/details.php?id=3077). Both of the above cryptogenic nemerteans have previously been reported from California. All but 1 (*Nipponemertes pacifica*, collected from Dana Point in the current survey) of the remaining 4 cryptogenic nemerteans have previously been reported from California.

Table 16. Number of species and percentage of total Nemertean taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**3**			1 (33%)	2 (67%)
Cape Mendocino	**6**			1 (17%)	5 (83%)
Shelter Cove	**8**		1 (13%)	3 (38%)	4 (50%)
Point Arena	**7**		1 (14%)		6 (86%)
Bodega	**9**			3 (33%)	6 (67%)
Point Reyes	**12**		2 (17%)	5 (42%)	5 (42%)
Fitzgerald	**4**			2 (50%)	2 (50%)
Pigeon Point	**2**			1 (50%)	1 (50%)
Ano Nuevo	**13**			4 (31%)	9 (69%)
Point Sur	**6**			2 (33%)	4 (67%)
Point Sierra Nevada	**15**		1 (7%)	5 (33%)	9 (60%)
Diablo Canyon	**11**			4 (36%)	7 (64%)
Purisima Point	**13**		1 (8%)	3 (23%)	9 (69%)
Point Conception	**15**		4 (27%)	5 (33%)	6 (40%)
Arroyo Hondo	**12**		1 (8%)	4 (33%)	7 (58%)
Carpinteria	**8**		1 (13%)	1 (13%)	6 (75%)
Point Dume	**15**		3 (20%)	5 (33%)	7 (47%)
Point Fermin	**10**			7 (70%)	3 (30%)
Dana Point	**8**		1 (13%)	2 (25%)	5 (63%)
Pin Rock	**11**		1 (9%)	4 (36%)	6 (55%)
Point La Jolla	**14**		1 (7%)	3 (21%)	10 (71%)
Point Loma	**9**		1 (11%)	3 (33%)	5 (56%)

Summary of Phoronid Taxonomy (Horseshoe worms, or worm-like invertebrates)
Only one taxon was identified from the phylum Phoronida in the current survey, the unresolved genus *Phoronis sp*. This genus was found in sandy subtidal habitat at Fitzgerald, Point Sierra Nevada and Point La Jolla, representing 100% of phoronid taxa at those sites (Table 17).

Table 17. Number of species and percentage of total Phoronid taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Fitzgerald	**1**				1 (100%)
Point Sierra Nevada	**1**				1 (100%)
Point La Jolla	**1**				1 (100%)

Summary of Platyhelminthes Taxonomy (Flatworms)

Eurylepta aurantiaca, photo used with permission by John J. Holleman

The overall number of platyhelminthes taxa collected in the current survey was low relative to other phyla, at 29 taxa. Of those, no introduced and 1 cryptogenic species were identified. *Eurylepta aurantiaca* (pictured above), a cryptogenic species known from the Caribbean, was found at Shelter Cove during the visual search of the rocky intertidal, representing 50% of the total platyhelminthes taxa identified at that site. This species has previously been reported from California (Morris et al., 1980). Sixteen native species represented 0% to 71% of total platyhelminthes taxa collected from each site, and 12 unresolved taxa represented 29% to 100% of totally platyhelminthes taxa from each site (Table 18).

Table 18. Number of species and percentage of total Platyhelminthes taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**4**			1 (25%)	3 (75%)
Cape Mendocino	**1**				1 (100%)
Shelter Cove	**2**		1 (50%)		1 (50%)
Point Arena	**3**				3 (100%)
Bodega	**2**				2 (100%)
Point Reyes	**4**			1 (25%)	3 (75%)
Fitzgerald	**2**				2 (100%)
Ano Nuevo	**2**				2 (100%)
Point Sur	**2**				2 (100%)
Point Sierra Nevada	**3**			2 (67%)	1 (33%)
Diablo Canyon	**6**			1 (17%)	5 (83%)
Purisima Point	**9**			5 (56%)	4 (44%)
Point Conception	**5**			3 (60%)	2 (40%)
Arroyo Hondo	**7**			5 (71%)	2 (29%)
Carpinteria	**2**				2 (100%)
Point Dume	**8**			4 (50%)	4 (50%)
Point Fermin	**7**			4 (57%)	3 (43%)
Dana Point	**9**			5 (56%)	4 (44%)
Pin Rock	**3**			1 (33%)	2 (67%)
Point La Jolla	**8**			3 (38%)	5 (63%)
Point Loma	**5**			2 (40%)	3 (60%)

Summary of Porifera Taxonomy (Sponges)

Sixty species of sponges were identified in the current outer coast survey, and none were classified as introduced to California. Seven cryptogenic species were identified, representing 0% to 25% of the total porifera taxa at each site (Table 19). Native species represented 47% to 100%, while unresolved taxa represented 0% to 50% of total porifera taxa at each site. Thirty different unresolved porifera taxa were identified in the current survey.

Two of the cryptogenic sponges were found only at Point La Jolla in rocky subtidal habitat, *Dragmacidon sp.* of Lee and *Tedania (Trachytedania) gurjanovae.* The first of those is either a new species yet to be fully described or a variety of *Dragmacidon mexicanum* from Baja, and was known to California prior to the current survey (W. Lee, personal communication, October 2, 2006). Considered rare in California, *T. gurjanovae* was described from the Arctic (by Koltun in 1958) and has been known for some time from British Columbia and California (W. Lee, personal communication, October 2, 2006).

Two of the cryptogenic sponges identified in the current survey are considered likely to be introduced to California, *Dysidea fragilis* and *Guancho blanca*. *D. fragilis* was collected from the rocky intertidal at Dana Point, was known to California's outer coast previous to the current survey, and is often referred to as 'cosmopolitan'. *G. blanca* was identified from rocky subtidal habitat at Pin Rock, Catalina Island in the current survey, and was also previously reported from the outer coast of California. Three additional cryptogenic sponge species, *Halichondria panacea, Lissodendoryx (Lissodendoryx) sp.1* of Lee and *Suberites ficus* were also identified from collections made during the current survey.

Table 19. Number of species and percentage of total Porifera taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**4**		1 (25%)	2 (50%)	1 (25%)
Cape Mendocino	**19**		1 (5%)	14 (74%)	4 (21%)
Shelter Cove	**17**		1 (6%)	12 (71%)	4 (24%)
Point Arena	**5**			4 (80%)	1 (20%)
Bodega	**20**		3 (15%)	16 (80%)	1 (5%)
Point Reyes	**10**		1 (10%)	6 (60%)	3 (30%)
Fitzgerald	**4**			2 (50%)	2 (50%)
Pigeon Point	**7**			6 (86%)	1 (14%)
Ano Nuevo	**2**			1 (50%)	1 (50%)
Point Sur	**12**		1 (8%)	10 (83%)	1 (8%)
Point Sierra Nevada	**3**			2 (67%)	1 (33%)
Diablo Canyon	**9**			7 (78%)	2 (22%)
Purisima Point	**17**		1 (6%)	14 (82%)	2 (12%)
Point Conception	**8**			8 (100%)	
Arroyo Hondo	**6**		1 (17%)	5 (83%)	
Carpinteria	**7**			6 (86%)	1 (14%)
Point Dume	**13**			8 (62%)	5 (38%)
Point Fermin	**8**			6 (75%)	2 (25%)
Dana Point	**15**		2 (13%)	8 (53%)	5 (33%)
Pin Rock	**6**		1 (17%)	4 (67%)	1 (17%)
Point La Jolla	**19**		2 (11%)	9 (47%)	8 (42%)
Point Loma	**18**		1 (6%)	11 (61%)	6 (33%)

Summary of Sipunculid Taxonomy (Peanut Worms)

Three sipunculid taxa were resolved to species level identifications from the samples collected in the current survey; all are listed as cryptogenic and represented 50% to 100% of total sipunculid taxa per survey site (Table 20). *Apionsoma misakianum* was collected from sandy subtidal habitat at Pin Rock in the current survey. The Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) reports that this cryptogenic worm is commonly found in the southern California bight but is also reported from other areas of the Pacific, Atlantic and Caribbean (SCAMIT, 2000). The cryptogenic species *Phascolosoma agassizii* was identified at 20 sites spanning the entire California coastline, and in several habitats in the current survey. These are not new reports for California, as this species has been reported as common on both sides of the north Pacific Ocean as well as from the Indian Ocean (Cutler and Cutler, 1990). *P. agassizii* is known to survive to 110 fathoms as well as in a range of intertidal zone habitats, including under or in crevices of rocks and in fine sand and mud at the bottoms of tide pools

(Fisher, 1952). *Thysanocardia nigra*, a third cryptogenic sipunculid, was collected from rocky subtidal habitat at Arroyo Hondo. Known from Japan and China (Stephens and Edmonds, 1972), this species has also been reported at several southern California locations (SCCWRP. Retrieved October 24, 2006, from http://www.sccwrp.org:8000/query.php). Unresolved taxa represented 33% to 50% of total sipunculid taxa per site.

Table 20. Number of species and percentage of total Sipunculid taxa for each classification.

Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	**1**		1 (100%)		
Cape Mendocino	**1**		1 (100%)		
Shelter Cove	**1**		1 (100%)		
Point Arena	**1**		1 (100%)		
Bodega	**1**		1 (100%)		
Fitzgerald	**1**		1 (100%)		
Ano Nuevo	**1**		1 (100%)		
Point Sur	**1**		1 (100%)		
Point Sierra Nevada	**1**		1 (100%)		
Diablo Canyon	**2**		1 (50%)		1 (50%)
Purisima Point	**1**		1 (100%)		
Point Conception	**1**		1 (100%)		
Arroyo Hondo	**3**		2 (67%)		1 (33%)
Carpinteria	**1**		1 (100%)		
Point Dume	**1**		1 (100%)		
Point Fermin	**1**		1 (100%)		
Dana Point	**1**		1 (100%)		
Pin Rock	**3**		2 (67%)		1 (33%)
Point La Jolla	**2**		1 (50%)		1 (50%)
Point Loma	**1**		1 (100%)		

Summary of Algal Taxonomy (Seaweeds)
The list of algae identified from the current survey of the outer coast surveys is quite typical for the California coastline, and all of the species identified have previously been found in California. Three species of introduced algae were identified during this survey: *Sargassum muticum, Caulacanthus ustulatus* and *Lomentaria hakodatensis*. No cryptogenic species were identified, and the vast majority of algae collected in the current survey was native (Table 21). Unlike invertebrates collected in the current survey, algal species were not identified from the quadrat clearing samples, and seaweed identifications come only from the qualitative visual searches of each site. Because not all known native species observed during the qualitative visual searches were listed, native species are underrepresented in the dataset, and percentages have been left out of Table 21.

Sargassum muticum, photo used with permission by Kathy Ann Miller

The introduced species *Sargassum muticum* (phylum: Heterokontophyta and pictured above) was collected at 8 sites in the current survey. While found in the rocky intertidal at 7 of the 8 sites, it was found in the rocky subtidal at only 2 sites, Arroyo Hondo and Point Dume. The observed abundance of this species varied among survey sites, and interestingly, native *Sargassum* species were observed only at 2 survey sites, Pin Rock and Dana Point rocky intertidal. The first reported collection of *S. muticum* in California was in 1963 from Crescent City, and this species has subsequently been collected from many locations in California, both bays and outer coast (Guide to the Exotic Species of San Francisco Bay. Retrieved October 24, 2006, from http://www.exoticsguide.org/species_pages/s_muticum.html). The same authors report that this species is also found in some areas in Washington and Oregon. As shown in Figure 12, of the 22 sites surveyed for the current study, *S. muticum* was collected from only southern and central California survey sites and was absent from northern California survey sites. In the current survey, *S. muticum* was observed at Point Saint George as a piece of drift algae cast up on shore, but none was found attached to the substrate. To our knowledge, no established *S. muticum* populations are known on the outer coast of California north of Monterey.

Table 21. Number of species and percentage of total seaweed taxa for each classification.

Phylum	Site Name	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Chlorophyta	Bodega	**1**			1	
Chlorophyta	Pigeon Point	**1**			1	
Chlorophyta	Ano Nuevo	**2**			2	
Chlorophyta	Point Dume	**3**			2	1
Chlorophyta	Point Fermin	**2**			2	
Chlorophyta	Dana Point	**2**			1	1
Chlorophyta	Pin Rock	**6**			6	
Chlorophyta	Point La Jolla	**1**			1	
Chlorophyta	Point Loma	**1**			1	
Heterokontophyta	Point Saint George	**1**			1	
Heterokontophyta	Point Arena	**1**			1	
Heterokontophyta	Bodega	**1**			1	
Heterokontophyta	Pigeon Point	**2**			2	
Heterokontophyta	Ano Nuevo	**2**			2	
Heterokontophyta	Point Sur	**1**			1	
Heterokontophyta	Point Sierra Nevada	**1**			1	
Heterokontophyta	Diablo Canyon	**2**	1		1	
Heterokontophyta	Purisima Point	**1**			1	
Heterokontophyta	Point Conception	**1**			1	
Heterokontophyta	Arroyo Hondo	**2**	1		1	
Heterokontophyta	Carpinteria	**1**			1	
Heterokontophyta	Point Dume	**2**	1			1
Heterokontophyta	Point Fermin	**11**	1		9	1
Heterokontophyta	Dana Point	**3**	1		2	
Heterokontophyta	Pin Rock	**23**	1		20	2
Heterokontophyta	Point La Jolla	**2**	1		1	
Heterokontophyta	Point Loma	**2**	1		1	
Rhodophyta	Point Saint George	**7**			7	
Rhodophyta	Cape Mendocino	**4**			4	
Rhodophyta	Shelter Cove	**2**			2	
Rhodophyta	Point Arena	**2**			2	
Rhodophyta	Bodega	**7**			7	
Rhodophyta	Point Reyes	**4**			4	
Rhodophyta	Fitzgerald	**8**			8	
Rhodophyta	Pigeon Point	**6**			6	
Rhodophyta	Ano Nuevo	**6**			6	
Rhodophyta	Point Sur	**8**			8	
Rhodophyta	Point Sierra Nevada	**2**			2	
Rhodophyta	Diablo Canyon	**3**			3	
Rhodophyta	Purisima Point	**3**			3	
Rhodophyta	Point Conception	**4**			4	
Rhodophyta	Arroyo Hondo	**3**			3	
Rhodophyta	Carpinteria	**4**			4	
Rhodophyta	Point Dume	**1**			1	
Rhodophyta	Point Fermin	**45**	2		40	3
Rhodophyta	Dana Point	**1**	1			
Rhodophyta	Pin Rock	**40**			36	4
Rhodophyta	Point La Jolla	**2**	2			
Rhodophyta	Point Loma	**2**	2			

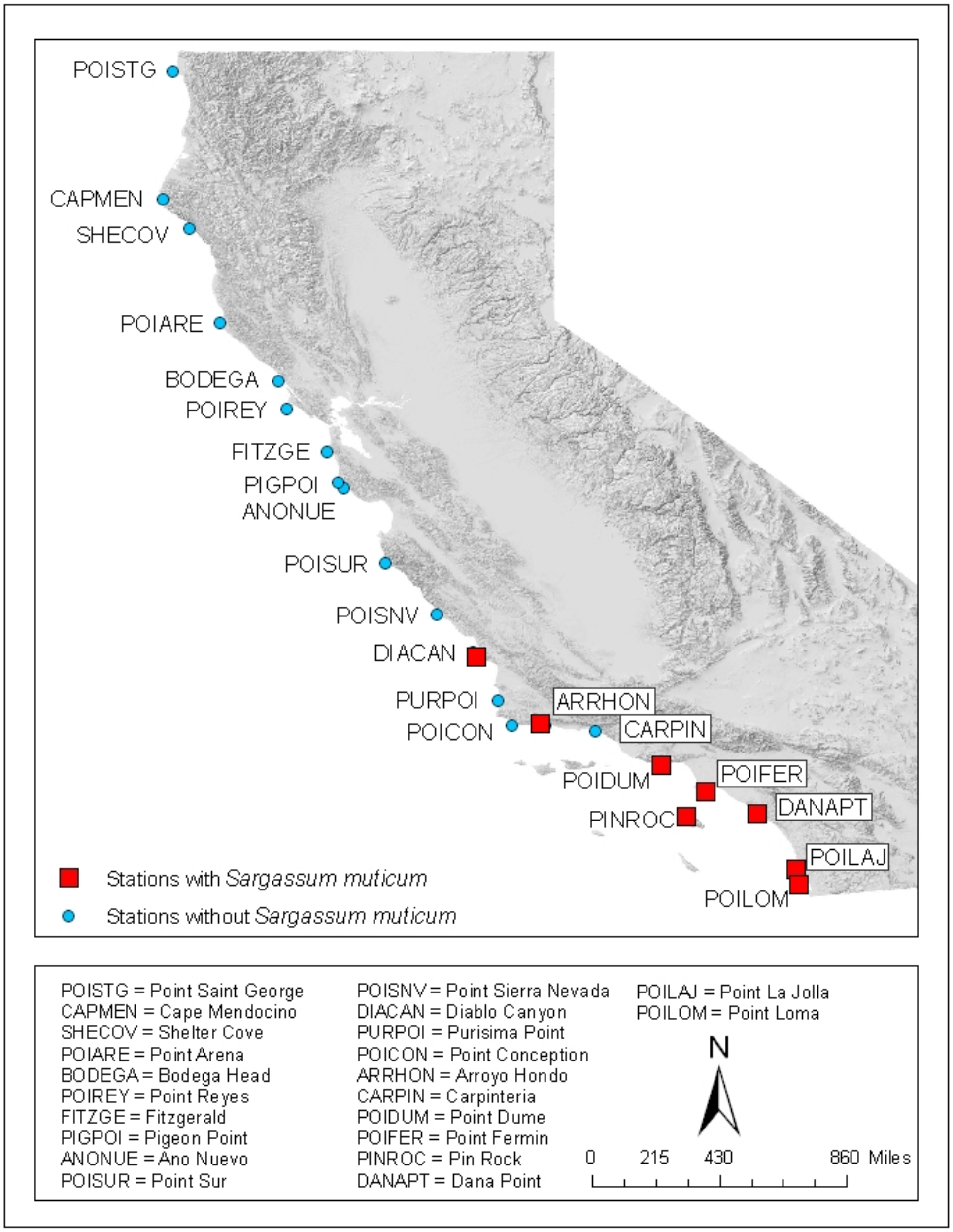


Figure 12. Geographical distribution of *Sargassum muticum* among the 22 sites surveyed.

Caulacanthus ustulatus (phylum: Rhodophyta) was collected from 4 southernmost sites in the current survey, and was only observed in rocky intertidal habitat. This species has also been observed along the California coastline from several rocky intertidal sites that were not included in this survey (Whiteside and Murray, unpublished results). *C. ustulatus* is found at numerous locations world-wide, but was not reported from California until recently (Miller, 2004). *Lomentaria hakodatensis* (phylum: Rhodophyta) was collected from rocky intertidal habitat at three southern California sites, Point Fermin, Point La Jolla and Point Loma in the current survey, and was usually found growing as part of a turf community with other algal species. Native to Japan, *L. hakodatensis* was reported from Mexico in 1925 and from British Columbia in the 1950's (CDFG, 2002), and previous to this survey was also known from the coasts of Washington, Oregon and California (Miller, 2004). While identified from southern California in the current survey, to our knowledge this species has not been reported from the northern California coastline. All of the sites where *L. hakodatensis* was collected overlap with sites and habitats where *C. ustulatus* was collected, and most collections were from turfy intertidal habitats.

An additional introduced species, *Undaria pinnatifida*, was discovered in an outer coast subtidal kelp forest habitat at Catalina Island in 2001 (Silva et al., 2002), and although that location was not a survey site for this project, MLML staff observed and collected individuals of *U. pinnatifida* from that population during a Catalina Island sampling event. While *U. pinnatifida* has been introduced to several southern and central California bays, this is currently the only known population of *U. pinnatifida* growing interspersed throughout an open coast kelp forest on the California coastline.

Summary of potential introduction vectors

Based on literature reviews, vector information is shown for 13 of the 26 outer coast introduced species identified in the current survey (Table 22), all of which have been found in California estuaries, bays, and harbors and may have dispersed into adjacent outer coast habitats. No information was located regarding the possible introduction vectors for the remaining 15 non-indigenous species identified in the current survey.

Only 3 probable vectors were implicated in the introduction of open coast aquatic species: oyster aquaculture, ballast water, and ship fouling. Eight of the outer coast introduced species are considered polyvectic, that is, were potentially introduced by more than one mechanism, so these species were placed in more than one vector category. This literature survey suggests that shipping may play a significant role in dispersal of new species into California outer coastal areas.

It is difficult to determine the general mechanisms of transport of new species into California, and furthermore the relative contribution of the ballast water and hull fouling vectors is extremely difficult, if not impossible to distinguish (Fofonoff et al., 2003). This is, however, a critical issue that deserves more attention than has been afforded in the past. More thorough reviews of the literature as well as tracing invasion history using molecular techniques are promising areas of research that may better elucidate mechanisms of introductions.

Table 22. Summary of potential vectors of introduction for a subset of the introduced species identified in the current survey.

Introduced Species	Ballast Water	Oyster Shipments	Ship Fouling	Documentation
Alcyonidium polyoum	X	X (Atlantic)	X	Cohen and Carlton, 1995
Bowerbankia gracilis	X	X (Atlantic)	X	Cohen and Carlton, 1995
Caulacanthus ustulatus			X	S. Murray, personal communication, November 1, 2006
Conopeum commensale	X	X (Atlantic)	X	Cohen and Carlton, 1995
Grandidierella japonica	X	X (Japanese)	X	Cohen and Carlton, 1995
Ianiropsis serricaudis	X		X	Cohen and Carlton, 1995; Carlton, 1979
Lomentaria hakodatensis			X	S. Murray, personal communication, November 1, 2006
Obelia dichotoma	X	X (Atlantic and Japanese)	X	Cohen and Carlton, 1995
Pseudopolydora paucibranchiata	X	X (Atlantic and Japanese)	X	Cohen and Carlton, 1995
Sargassum muticum		X (Japanese)		CDFG, 2002; Cohen and Carlton, 1995
Sinelobus stanfordi	X		X	Cohen and Carlton, 1995
Urosalpinx cinerea		X (Atlantic)		Cohen and Carlton, 1995
Watersipora sp A Schroeder			X	Cohen and Carlton, 1995
Totals for Vectors:	**8**	**8**	**11**	

Summary of EMAP-offshore data

Four of the species identified from infaunal samples collected in deeper waters (30-120 m) offshore of California were classified as introduced: *Anobothrus gracilis*, *Laonice cirrata*, *Melinna oculata* and *Trochochaeta multisetosa*. All of the introduced species were polychaetes (phylum: Annelida), and represented 1% of the total annelid taxa identified from these samples. In addition, none of the introduced species identified in these offshore samples were identified from the coastal samples collected in the current outer coast survey.

Forty three cryptogenic species were identified from the offshore samples: 37 annelids, 5 arthropods and 1 mollusc. A large number of the taxa identified from the offshore samples have not been assigned an introduction classification and are shown in Table 23 as "unknown classification". The data presented here may serve as a baseline species list and further efforts will be made to determine and refine the introduction statuses as an ongoing effort.

Table 23. Number of species and percentage of total taxa of each classification for each phylum collected in the EMAP-offshore samples.

Phylum	Total Taxa	Introduced	Cryptogenic	Native	Unresolved	Unknown Classification
Annelida	**320**	4 (1%)	37 (12%)	44 (14%)	102 (32%)	133 (42%)
Arthropoda	**160**		5 (3%)	48 (30%)	29 (18%)	78 (49%)
Cercozoa	**1**				1 (100%)	
Chordata	**1**				1 (100%)	
Cnidaria	**14**				14 (100%)	
Echinodermata	**13**				4 (31%)	9 (69%)
Echiura	**2**				1 (50%)	1 (50%)
Foraminifera	**1**				1 (100%)	
Hemichordata	**2**				2 (100%)	
Mollusca	**97**		1 (1%)	16 (16%)	36 (37%)	44 (45%)
Nematoda	**1**				1 (100%)	
Nemertea	**1**				1 (100%)	
Phoronida	**1**				1 (100%)	
Platyhelminthes	**1**				1 (100%)	
Sipuncula	**1**				1 (100%)	

Summary of MS Access Database

The data for this survey are assembled in a Microsoft (MS) Access 2000 relational database that includes both field and analytical data. This database is available through the Department of Fish and Game's Office of Spill Prevention and Response. A copy of the database resides at Moss Landing Marine Laboratory's Marine Pollution Studies Lab.

In addition, to manage introduced species data from this survey as well as other sources, OSPR created a database that contains the name and location of every known non-native (or suspected non-native) species on the California coast. Called CANOD (California Aquatic Non-native

Organism Database), the database is available to the public on the OSPR Web Site at http://www.dfg.ca.gov/ospr/; link to Invasive Species.

CANOD serves as a baseline for addressing the following questions: 1. Which NAS have arrived in California via Ballast Water? 2. Is the rate of new introductions increasing or not? 3. Have ballast water regulations been successful in limiting introductions of new organisms? (a long-term question) 4. To what extent have humans redistributed plants and animals within California?

To answer these questions, the database includes information about the pathway of introduction (e.g. ballast water, intentional introduction), date of introduction, locations observed, and native region of each species. CANOD will be updated with relevant results from the current literature and field surveys, and will also be refined in the future as more surveys for non-native aquatic species are completed.

SUMMARY

Of the 1265 species identified from the collections of the current survey, 26 species were classified as introduced, 127 as cryptogenic and 1112 as native. Six hundred fifteen additional unique taxa were not identified to species level and were given a classification of unresolved. Each of the 22 outer coast sites surveyed had at least one introduced species present, and up to 8 introduced species were found at one site. Introduced species represented 0.3% to 2.2% of the total taxa collected from each site along the coastline, while cryptogenic species represented 5.1% to 10.6% of the total taxa at each site. In contrast, native and unresolved species represented the majority of taxa from each site, at 47.5 to 65% and 24.6% to 42.7%, respectively. The highest number of taxa not identified to species level and therefore classified as unresolved were annelids, with juvenile and/or non-reproductive specimens being the leading reason for not being able to identify those to species.

On average, only slightly higher numbers and percentages of introduced species were identified from sites in southern California. The two phyla with the most introduced species were ectoprocts (9 species), and then arthropods (7 species). Some of the major phyla with no introduced species identified in the current survey included the Porifera (sponges), Chordata (Tunicates) and Echinodermata. Of the 4 different habitat types sampled, rocky intertidal had the highest number of introduced species (16), followed by rocky subtidal (12), then sandy intertidal and subtidal, each with 7 introduced species.

Of the 26 introduced species identified along the outer coast, 6 were not previously known from California to our knowledge: *Harmothoe praeclara, Vermiliopsis infundibulum, Heteropora alaskensis, Rhamphostomella gigantean, Rhynchozoon bispinosum* and *Tricellaria gracilis.* At least 6 additional introduced species identified in the current survey, which were reported from California previously, had only been reported from bays or estuarine habitats and were not known to be present on the outer coast to our knowledge.

Compared to the DFG/MLML field survey conducted in California's bays and harbors in 2000-2001 with similar sampling protocols, far fewer introduced species but more cryptogenic and native species were found on the outer coast. Introduced species comprised a lower percentage of the total species identifications on the outer coast as well. Far more species (all classifications combined) were identified on the outer coast (1265 species) as compared to the bays and harbors survey (818 species). Only 6 of the 26 outer coast introduced species were also identified in the field survey of California's bays and harbors.

In addition, the species list compiled from the EMAP-offshore surveys produced 4 different introduced species from deeper habitat offshore of California's coastline, and ongoing efforts will provide more information about the many species from that dataset that have not yet been assigned an introduction classification by MLML or CDFG.

Further literature research would help refine the baseline dataset generated by the current outer coast survey for introduced species. Species lists generated by other researchers conducting experimental and monitoring studies in the outer coast habitats should be perused for the presence of introduced or cryptogenic species along the coastline. Taxonomic uncertainties should also be addressed by researchers and taxonomists whenever possible in order to help reduce the number of unresolved and cryptogenic identifications, helping to determine whether those taxa are native or introduced to California.

Finally, it should be stated that while the results from the current survey serve as a baseline of information about the species from the targeted habitat types at the targeted sites, there are undoubtedly species that were missed in the survey. Some species may have been in microscopic or otherwise undetectable life stages during the time of sampling, whereas other species could be established in areas that were not surveyed. Repeated sampling and further investigations into other existing datasets will add to the understanding of introduced species on California's outer coast.

REFERENCES

Barnard, J.L. 1954. *Marine Amphipoda of Oregon.* Oregon State College. Corvallis, Oregon.

Barnard, J.L. 1962. Benthic marine amphipoda of southern California: Families Tironidae to Gammaridae. Pacific Naturalist 3(2):73-116.

Barnard, J.L. 1964. Marine Amphipoda of Bahia de San Quintin, Baja California. Pacific Naturalist 4(3):114-115.

Barnard, J.L. 1969. The families and genera of marine Gammaridean Amphipoda. Bulletin of the United States National Museum 271:1-535.

Barnard, J.L. 1979. Littoral gammaridean Amphipoda from the Gulf of California and the Galapagos Islands. Smithsonian Contributions to Zoology 71:1-149.

Barnard, J.L. and G.S. Karaman. 1991. The Families and Genera of Marine Gammaridean Amphipoda (Except Marine Gammaroids), Supplement 13 Part 1. Globe Press. Melbourne. 412 pp.

Beckman Coulter, Inc. 2003. *LS 13 320 Particle Size Analyzer Manual PN 7222061AI*. Miami (Beckman).

Blake, J.A. 1996. Chapter 1. Family Orbiniidae. *In* Taxonomic Atlas of the Santa Maria Basin and Western Santa Barbara Channel Volume 6. Annelida Part 3. Polychaeta: Orbiniidae to Cossuridae. J.A. Blake and B. Hilbig (Eds.). Santa Barbara Museum of Natural History. Santa Barbara, California.

Blake, J.A. and P.L. Arnofsky. 1999. Reproduction and larval development of the spioniform Polychaeta with application to systematics and phylogeny. Hydrobiologia 402:57-106.

Boudouresque, C.F. and M. Verlaque. 2002. Biological pollution in the Mediterranean Sea: invasive versus introduced macrophytes. Marine Pollution Bulletin 44(1):32-38.

Bousfield, E.L. 1973. *Shallow-water gammaridean Amphipoda of New England.* Comstock Publishing Associates. Ithaca, New York.

Braby, C.E. and G.N. Somero. 2006. Ecological gradients and relative abundance of native (Mytilus trossulus) and invasive (Mytilus galloprovincialis) blue mussels in the California hybrid zone. Marine Biology 148:1240-1262.

Cadien, D. 1997. The Pycnogonida and The Crustacea – Part 1 (Decapoda and Mysidacea). *In* Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel. J.A. Blake and B. Hilbig (Eds.). Santa Barbara Museum of Natural History. Santa Barbara, California.

California Department of Fish and Game (CDFG). 2002. A Survey of Non-Indigenous Species in the Coastal and Estuarine Waters of California. California Department of Fish and Game. Sacramento, California. 116 pp.

Carlton, J.T. 1979a. History, biogeography, and ecology of the introduced marine and estuarine invertebrates of the Pacific Coast of North America. Ph.D. Thesis, University of California, Davis, California. 904 pp.

Carlton, J.T. 1979b. Introduced invertebrates of San Francisco Bay. *In* San Francisco Bay: The Urbanized Estuary. T.J. Conomos (Ed.). pp 427-444. Pacific Div./Amer. Assoc. Adv. Sci., San Francisco, California.

Carlton, J.T. 1996. Biological invasions and cryptogenic species. Ecology 77(6):1653-1655.

Carlton, J.T. and J.B. Geller. 1993. Ecological roulette: the global transport of nonindigenous marine organisms. Science 261:78-82.

Canu, F. and R.S. Bassler. 1929. Bryozoa of the Philippine region. Bulletin of the United States National Museum 100:1-685.

Christensen, A.B. 2004. A new distribution record and notes on the biology of the brittle star *Ophiactis simplex* (Echinodermata: Ophiuroidea) in Texas. Texas Journal of Science 56:175-179.

Coan, E.V., P.V. Scott, and F.R. Bernard. 2000. *Bivalve Seashells of North America.* Santa Barbara Museum of Natural History. Santa Barbara, California.

Coan, E.V., P.V. Scott, and F.R. Bernard. 2000. *Bivalve seashells of western North America: marine bivalve mollusks from Arctic Alaska to Baja California.* Santa Barbara Museum of Natural History. Santa Barbara, California.

Coe, W.R. 1905. *Nemerteans of the west and northwest coasts of America.* Museum of Comparative Zoology at Harvard College. Cambridge, Massachussets.

Cohen, A.N. and J.T. Carlton. 1995. Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta. A Report for the United States Fish and Wildlife Service, Washington D.C. and The National Sea Grant College Program, Connecticut Sea Grant.

Collin, R. 2003. Worldwide patterns in mode of development in calyptraeid gastropods. Marine Ecology Progress Series 247:103-122.

Conlan, K.E. 1990. Revision of the crustacean amphipod genus Jassa Leach (Corophioidea: ischyroceridae). Canadian Journal of Zoology 68(10):2031-2075.

Conlan, K.E. 1995. The Crustacea - Part 3. *In* Taxonomic Atlas of the Santa Barbara Channel. J.A. Blake and B. Hilbig (Eds.). Santa Barbara Museum of Natural History. Santa Barbara, California.

Cutler, N.J. and E.B. Cutler. 1990. A Revision of the SubGenus Phascolosoma (Sipuncula: Phascolosoma). Proceedings the Biological Society of Washington 103(3):691-730.

Ebert, T.A. and M.P. Russell. 1988. Latitudinal Variation in Size Structure of the West Coast Purple Sea Urchin: A Correlation with Headlands. Limnology and Oceanography 33(2):285-294.

Fisher, W.K. 1952. The sipunculid worms of California and Baja California. Proceedings of the United States National Museum 102:371-450.

Fofonoff, P.W., G.M. Ruiz, B. Steves, and J.T. Carlton. 2003. In ships or on ships? Mechanisms of transfer and invasion for non-native species to the coasts of North America. *In* Invasive species: vectors and management strategies. G.M. Ruiz and J.T. Carlton (Eds.). Island Press. Washington, DC.

Fraser, C. McLean. 1937. Hydroids of the Pacific Coast of Canada and the United States. University of Toronto Press, Toronto. 207 pp., 44 pls.

Green, K. and G. Bakus. 1993. The Porifera – Volume 2. *In* Taxonomic Atlas of the Santa Barbara Channel. Santa Barbara Museum of Natural History. Santa Barbara, California.

Grosholz, E. 2002. Ecological and evolutionary consequences of coastal invasions. Trends in Ecology & Evolution 17(1):22-27.

Harrington, J. and M. Born. 1999. Bioassessment for citizen monitors. A new era for water quality. Sustainable Land Stewardship International Institute. Sacramento, California.

Hartman, O. 1969. *Atlas of the Sedentariate Polychaetous Annelids from California.* Allan Hancock Foundation. Los Angeles, California.

Hewitt, C.L. and R.B. Martin. 1996. Port Surveys for Introduced Marine Species- Background Considerations and Sampling Protocols. Center for Research on Introduced Marine Pests, Technical Report Number 4.

Hilbig, B. 2000. The Annelida – Part 4. *In:* Taxonomic Atlas of the Santa Barbara Channel. J.A. Blake and B. Hilbig (Eds.). Santa Barbara Museum of Natural History. Santa Barbara, California.

Kelmo, F. and R. Vargas. 2002. Anthoathecatae and Leptothecatae hydroids from Costa Rica (Cnidaria: Hydrozoa). Revista de Biologia Tropical 50(2):599-627

Lamb, A. and B.P. Hanby. 2005. *Marine Life of the Pacific Northwest: A Photographic Encyclopedia of Invertebrates, Seaweeds and Selected Fishes*. Harbour Publishing. Madeira Park, British Columbia.

Laubitz, D.R. 1970. Studies on the Caprellidae (Crustacea, Amphipoda) of the American North Pacific. Publications in Biological Oceanography. Ottawa National Museum of Natural Sciences 1:1-89.

Lazorchak, J., D. Klemm, D. Averill, and D. Peck. 1999. Environmental monitoring and assessment program – surface waters. Field operations and methods for measuring the ecological condition of non-wadeable streams in Oregon. U.S. Environmental Protection Agency. Corvallis, Oregon.

Lee II, H. and D.A. Reusser. In Progress. Pacific Coast Ecosystem Information System (PCEIS) with contributions from K. Welch, R. Fairey, and L. Hillman. U.S. Environmental Protection Agency. Newport, Oregon.

Miller, K.A. 2004. California's Non-Native Seaweeds. Fremontia 32(1):10-15.

Morris, R.H., D.P. Abbott, and E.C. Haderlie. 1980. *Intertidal Invertebrates of California*. Stanford University Press. Palo Alto, California.

Osburn, R.C. 1950. *Bryozoa of the Pacific Coast of America*, Part 1 Cheilostomata-Anasca. Allan Hancock Pacific Expeditions. Vol. 14. Universitiy of Southern California Press. Los Angeles, California.

Osburn, R.C. 1952. *Bryozoa of the Pacific Coast of America*, Part 2 Cheilostomata-Ascophora. Allan Hancock Pacific Expeditions. Vol. 14. Universitiy of Southern California Press. Los Angeles, California.

Osburn, R.C. 1953. *Bryozoa of the Pacific Coast of America*, Part 3 Cyclostomata, Ctenostomata, Entoprocta, and Addenda. Allan Hancock Pacific Expeditions. Vol. 14. Universitiy of Southern California Press. Los Angeles, California.

Robertson, A. 1905. Non-encrusting chilostomatous Bryozoa of the west coast of North America. University of California Publications in Zoology 2(5):235-322.

Schultz, G.A. 1969. *The marine isopod crustaceans.* W.C. Brown Company. Dubuque, Iowa.

Seo, J.E. 1999. Taxonomic Review of Korean *Watersipora* (Bryozoa, Gymnolaemata, Cheilostomata). The Korean Journal of Systematic Zoology 15(2):221-229.

Silva, P.C., R.A. Woodfield, A.N. Cohen, L.H. Harris, and J.H.R. Goddard. 2002. First report of the Asian kelp *Undaria pinnatifida* in the northeastern Pacific Ocean. Biological Invasions 4:333-338.

Soule, D.F., J.D. Soule, and H.W. Chaney. 1995. The Bryozoa – Volume 13. *In* Taxonomic atlas of the benthic fauna of the Santa Maria Basin and Western Santa Barbara Channel. J.A. Blake, H.W. Chaney, P.H. Scott and A.L. Lissner (Eds.). Santa Barbara Museum of Natural History. Santa Barbara, California.

Soule, D.F. and J.D. Soule. 1976. Species groups in Watersiporidae. *In* Bryozoa 1974, Proceedings of the third Conferences, International Bryozoology Association. S. Pouyet (Ed.). Documents des Laboratories de Geologie de la Faculte des Sciences de Lyon, h.s. 3(2):299-309.

Southern California Association of Marine Invertebrate Taxonomists (SCAMIT). 2000. SCAMIT Newsletter, February 14, 2000. SCAMIT. San Pedro, California.

Southern California Association of Marine Invertebrate Taxonomists (SCAMIT). 2001. A Taxonomic Listing of soft-bottom macro- and megainvertebrates from infaunal and epibenthic monitoring programs in the Southern California Bight. Edition 4. SCAMIT. San Pedro, California.

Stephens, A.C. and S.J. Edmonds. 1972. *The Phyla Sipuncula and Echiura*. British Museum of Natural History. London.

WEB REFERNCES

ANS Task Force Reports and Publications. http://www.anstaskforce.gov/sfinvade.htm

Coastal Biodiversity Survey (SWAT). http://cbsurveys.ucsc.edu

Invasive Species Specialist Group (ISSG). World's Worst Invasive Alien Species. http://www.issg.org/booklet.pdf

Multi-Agency Rocky Intertidal Network (MARINe). http://www.marine.gov/

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). http://www.piscoweb.org

San Francisco Estuary Institute (SFEI). Guide to the Exotic Species of San Francisco Bay. http://www.exoticsguide.org/species_list.html

Smithsonian Tropical Research Institute. Bocas del Toro Species Database. http://striweb.si.edu/bocas_database/

Southern California Coastal Watershed Research Project (SCCWRP). SCCWRP Data Mapper. http://www.sccwrp.org:8000/query.php

United States Geological Survey. Non-Indigenous Aquatic Species Database. http://nas.er.usgs.gov/

APPENDICES

Appendix A – Outer Coast Sampling Site Locations

Latitude and longitude coordinates are given for the upcoast boundary of the area sampled for intertidal habitats, and for the central location of the survey of subtidal habitats.

Site Name	Station Code	Habitat Type	Sample Date	Latitude DD	Longitude DD
Point Saint George	103POISTG	Rocky Intertidal	30/Aug/2004	41.78581	-124.25454
Point Saint George	103POISTG	Sandy Intertidal	30/Aug/2004	41.7802	-124.25497
Point Saint George	103POISTG	Rocky Subtidal	27/Sep/2004	41.78638	-124.26101
Cape Mendocino	112CAPMEN	Rocky Intertidal	02/Aug/2004	40.35013	-124.36314
Cape Mendocino	112CAPMEN	Sandy Intertidal	02/Aug/2004	40.35013	-124.36314
Cape Mendocino	112CAPMEN	Rocky Subtidal	28/Sep/2004	40.34079	-124.36852
Cape Mendocino	112CAPMEN	Sandy Subtidal	28/Sep/2004	40.34079	-124.36852
Shelter Cove	112SHECOV	Rocky Intertidal	03/Aug/2004	40.02135	-124.0694
Shelter Cove	112SHECOV	Sandy Intertidal	03/Aug/2004	40.02135	-124.0694
Shelter Cove	112SHECOV	Rocky Subtidal	03/Aug/2004	40.01952	-124.07349
Shelter Cove	112SHECOV	Sandy Subtidal	03/Aug/2004	40.02201	-124.00279
Point Arena	113POIARE	Rocky Intertidal	31/Aug/2004	38.93787	-123.72964
Point Arena	113POIARE	Sandy Intertidal	31/Aug/2004	38.96255	-123.72189
Point Arena	113POIARE	Rocky Subtidal	01/Sep/2004	38.93824	-123.73178
Point Arena	113POIARE	Sandy Subtidal	01/Sep/2004	38.95725	-123.73288
Bodega	115BODEGA	Rocky Intertidal	17/Aug/2004	38.31638	-123.07204
Bodega	115BODEGA	Sandy Intertidal	17/Aug/2004	38.31638	-123.07204
Bodega	115BODEGA	Rocky Subtidal	18/Aug/2004	38.539167	-123.198889
Bodega	115BODEGA	Sandy Subtidal	18/Aug/2004	38.539167	-123.198889
Point Reyes	201POIREY	Rocky Intertidal	16/Aug/2004	37.90306	-122.72585
Point Reyes	201POIREY	Sandy Intertidal	16/Aug/2004	37.90276	-122.72488
Point Reyes	201POIREY	Rocky Subtidal	14/Apr/2005	37.99431	-122.7318
Point Reyes	201POIREY	Sandy Subtidal	14/Apr/2005	37.99431	-122.7318
Fitzgerald	202FITZGE	Rocky Intertidal	18/Jul/2004	37.52309	-122.51788
Fitzgerald	202FITZGE	Sandy Intertidal	18/Jul/2004	37.52309	-122.51788
Fitzgerald	202FITZGE	Sandy Subtidal	09/Sep/2004	37.49457	-122.47228
Ano Nuevo	304ANONUE	Rocky Intertidal	19/Jul/2004	37.11199	-122.32938
Ano Nuevo	304ANONUE	Sandy Intertidal	19/Jul/2004	37.11199	-122.32938
Ano Nuevo	304ANONUE	Rocky Subtidal	06/Oct/2004	37.111	-122.32016
Ano Nuevo	304ANONUE	Sandy Subtidal	06/Oct/2004	37.111	-122.32016
Pigeon Point	304PIGPOI	Rocky Intertidal	17/Jul/2004	37.18273	-122.39123
Pigeon Point	304PIGPOI	Sandy Intertidal	17/Jul/2004	37.18273	-122.39123
Pigeon Point	304PIGPOI	Rocky Subtidal	17/Mar/2005	37.18093	-122.39149
Pigeon Point	304PIGPOI	Sandy Subtidal	17/Mar/2005	37.18093	-122.39149
Point Sur	308POISUR	Rocky Intertidal	20/Jul/2004	36.28136	-121.86365
Point Sur	308POISUR	Sandy Intertidal	20/Jul/2004	36.28136	-121.86365
Point Sur	308POISUR	Rocky Subtidal	22/Oct/2004	36.28404	-121.87252
Point Sur	308POISUR	Sandy Subtidal	22/Oct/2004	36.28404	-121.87252

Site Name	Station Code	Habitat Type	Sample Date	Latitude DD	Longitude DD
Diablo Canyon	310DIACAN	Sandy Intertidal	12/Nov/2004	35.21091	-120.86076
Diablo Canyon	310DIACAN	Sandy Intertidal	05/Mar/2005	35.27496	-120.88853
Diablo Canyon	310DIACAN	Rocky Subtidal	12/Nov/2004	35.21091	-120.86076
Diablo Canyon	310DIACAN	Sandy Subtidal	12/Nov/2004	35.21254	-120.86014
Point Sierra Nevada	310POISNV	Rocky Intertidal	11/Nov/2004	35.73027	-121.3168
Point Sierra Nevada	310POISNV	Sandy Intertidal	11/Nov/2004	35.69126	-121.29
Purisima Point	313PURPOI	Sandy Intertidal	23/Feb/2005	34.7341	-120.61714
Purisima Point	313PURPOI	Rocky Subtidal	24/Nov/2004	34.74488	-120.63445
Purisima Point	313PURPOI	Sandy Subtidal	24/Nov/2004	34.74488	-120.63445
Arroyo Hondo	315ARRHON	Rocky Intertidal	09/Jan/2005	34.46027	-120.07526
Arroyo Hondo	315ARRHON	Sandy Intertidal	09/Jan/2005	34.46188	-120.07346
Arroyo Hondo	315ARRHON	Rocky Subtidal	14/Oct/2004	34.47185	-120.14626
Arroyo Hondo	315ARRHON	Sandy Subtidal	14/Oct/2004	34.47185	-120.14626
Carpinteria	315CARPIN	Rocky Intertidal	10/Jan/2005	34.38742	-119.51677
Carpinteria	315CARPIN	Sandy Intertidal	10/Jan/2005	34.38955	-119.51958
Carpinteria	315CARPIN	Rocky Subtidal	16/Sep/2004	34.30109	-119.54301
Carpinteria	315CARPIN	Sandy Subtidal	16/Sep/2004	34.39064	-119.52431
Point Conception	315POICON	Rocky Intertidal	15/Oct/2004	34.44563	-120.45901
Point Conception	315POICON	Sandy Intertidal	15/Oct/2004	34.44784	-120.46075
Point Conception	315POICON	Rocky Subtidal	14/Oct/2004	34.44745	-120.44451
Point Conception	315POICON	Sandy Subtidal	14/Oct/2004	34.4492	-120.44199
Point Dume	404POIDUM	Rocky Intertidal	22/Jan/2005	34.0087	-118.7938
Point Dume	404POIDUM	Sandy Intertidal	22/Jan/2005	34.01037	-118.79426
Point Dume	404POIDUM	Rocky Subtidal	05/Apr/2005	34.01156	-118.79028
Point Dume	404POIDUM	Sandy Subtidal	05/Apr/2005	34.01156	-118.79028
Point Fermin	404POIFER	Rocky Intertidal	08/Feb/2005	33.70628	-118.2873
Point Fermin	404POIFER	Sandy Intertidal	08/Feb/2005	33.7088	-118.28497
Point Fermin	404POIFER	Rocky Subtidal	15/Sep/2004	33.70439	-118.28629
Point Fermin	404POIFER	Sandy Subtidal	15/Sep/2004	33.70439	-118.28629
Pin Rock	406PINROC	Rocky Intertidal	09/Feb/2005	33.42747	-118.50713
Pin Rock	406PINROC	Sandy Intertidal	09/Feb/2005	33.43129	-118.50546
Pin Rock	406PINROC	Rocky Subtidal	10/Feb/2005	33.42382	-118.50497
Pin Rock	406PINROC	Sandy Subtidal	10/Feb/2005	33.42382	-118.50497
Dana Point	901DANAPT	Rocky Intertidal	23/Jan/2005	33.46017	-117.71501
Dana Point	901DANAPT	Sandy Intertidal	23/Jan/2005	33.46618	-117.71616
Dana Point	901DANAPT	Rocky Subtidal	14/Sep/2004	33.45671	-117.71648
Dana Point	901DANAPT	Sandy Subtidal	14/Sep/2004	33.45671	-117.71648
Point La Jolla	906POILAJ	Rocky Intertidal	25/Jan/2005	32.84365	-117.28096
Point La Jolla	906POILAJ	Sandy Intertidal	25/Jan/2005	32.84599	-117.27895
Point La Jolla	906POILAJ	Rocky Subtidal	06/Apr/2005	32.85321	-117.27689
Point La Jolla	906POILAJ	Sandy Subtidal	06/Apr/2005	32.85321	-117.27689
Point Loma	908POILOM	Rocky Intertidal	24/Jan/2005	32.66602	-117.24442
Point Loma	908POILOM	Sandy Intertidal	24/Jan/2005	32.66889	-117.2449
Point Loma	908POILOM	Rocky Subtidal	06/Apr/2005	32.66071	-117.24874
Point Loma	908POILOM	Sandy Subtidal	06/Apr/2005	32.66071	-117.24874

Appendix B – Name, affiliation, and specialty of taxonomists making specimen collections and/or identifications in the current survey.

Taxonomist Name	Specialty	Affiliation
Shane Anderson	Field Taxonomist	University of California-Santa Barbara
Kelvin Barwick	Mollusca - identification of collected specimens	City of San Diego, Environmental Monitoring & Technical Services Laboratory, SCAMIT
Shannon Carpenter	Mollusca - identification of collected specimens	Santa Barbara Museum of Natural History
Rachel Collin	Crepidula - identification of collected specimens	Smithsonian Tropical Research Institute
Jack Engle	Field Taxonomist	University of California-Santa Barbara, MARINe
Daphne Fautin	Diadumene - identification of collected specimens	University of Kansas
Matt Forrest	Bryozoa - identification of collected specimens	SCRIPPS Institute of Oceanography
Jeff Goddard	Nudibranchs - identification of collected specimens	University of California-Santa Barbara
Leslie Harris	Polychaeta - identification of collected specimens	Natural History Museum of Los Angeles County, SCAMIT
Gordon Hendler	Ophiuroidea - identification of collected specimens	Natural History Museum of Los Angeles County, SCAMIT
Gretchen Lambert	Urochordata - identification of collected specimens	University of Washington- Friday Harbor Labs, SCAMIT
Welton Lee	Porifera - identification of collected specimens	California Academy of Sciences
Megan Lilly	Nemertea - identification of collected specimens	City of San Diego, SCAMIT
John Ljubenkov	Cnidaria - identification of collected specimens	Dancing Coyote Ranch, SCAMIT
Valerie Macdonald	Oligochaeta - identification of collected specimens	Biologica Environmental Services, SCAMIT
Laurie McConnico	Field Taxonomist	Moss Landing Marine Labs
Kathy Ann Miller	Marine Algae - identification of collected specimens and visual surveys at some field sites	University of California-Berkeley
Steve Murray	Field Taxonomist	California State University-Fullerton, MARINe
Jaya Nolt	Mollusca - identification of collected specimens	Santa Barbara Museum of Natural History
John Pearse	Field Taxonomist	Long Marine Laboratory, University of California-Santa Cruz
Tony Phillips	Nemertea & Platyhelminthes - identification of collected specimens	City of Los Angeles, Environmental Monitoring Division, SCAMIT

Taxonomist Name	Specialty	Affiliation
Rick Rowe	Polychaeta - identification of collected specimens	City of San Diego, Polychaete Identification Consulting Services, SCAMIT
John Ryland	Alcyonidium - identification of collected specimens	Swansea University, Wales
Greg Schroeder	Bryozoa - identification of collected specimens	Moss Landing Marine Labs
Peter Slattery	Crustacea, Other - identification of collected specimens	Moss Landing Marine Labs, SCAMIT
Paul Valentich-Scott	Mollusca - identification of collected specimens	Santa Barbara Museum of Natural History, SCAMIT

Appendix C – Instructions sent to taxonomists identifying specimens from the collections.

Introduced Species Surveys (ISS)
Season 1: Outer Coast
Protocols for Taxonomic Identifications of Samples

Dear Taxonomists,

The goal of this project is to compile a list of species and locations found of Non-native Aquatic Species (algae and invertebrates) found along California's outer coast, bays and harbors. This first sampling season (there will be a total of four sampling seasons) we focused on 22 sites along California's outer coast. At each of these 22 coastal sites, we conducted field surveys and collected samples from four habitat types: Rocky Intertidal, Sandy Intertidal, Rocky Subtidal (~30' deep in or near kelp forests) and Sandy Subtidal (~30' deep). We have quantitative samples collected from a known area as well as qualitative samples collected during a walking or swimming search of the site. All samples collected in the field have been preserved, sorted into taxa, and are being sent to specialized taxonomists for identification. If possible, we will also measure the abundance of the NAS identified.

In general, we ask each taxonomist to provide a list of species identified from each sample, to count non-native species in the quantitative samples and separate them into vials by species, and to provide up to date information about each species' classification status (i.e. native, cryptogenic, introduced or unresolved). We provide a standardized Excel file with multiple tabs, one for entering species identification data for each sample, and another, called the 'Species Table,' where each taxonomist will maintain a taxa list and fill in information about each species they identify. Please read the "ReadmeInfo" tab on the excel file provided for more detailed instructions on using the datasheet. We may also send you photos taken of specimens before they were fixed.

In addition, under the terms of our contract we must archive all quantitative samples and create a voucher collection for non-native species found over the duration of this four-year project. We ask that each taxonomist pull aside and voucher examples of non-native species found in the samples (including introduced, cryptogenic species and unresolved taxa). Please see our "Voucher Collection Protocols" for more details. If you are interested in retaining all or parts of samples please contact us. Once the voucher collection requirements are fulfilled, some samples may be dispersed as long as we can track them down in the future.

Please keep in mind that in order to determine whether specimens are native or not we strive to have these samples accurately identified to the lowest taxonomic level possible. We also urge you to recognize when specimens don't quite fit the description for species known from the region, rather than forcing an identification that may not be accurate. We encourage and support reaching out to other taxonomists, even internationally, whenever necessary to help finalize or confirm an identification, so please let us know if we can be of assistance in that respect.

Below is a more detailed list of what we need from you for each type of sample you may receive. Please identify each sample as either qualitative or quantitative by referring to the "Sample Type Code" column on the Chain of Custody (COC) spreadsheet provided. Please use the datasheet provided for entering all data, and feel free to contact us with any questions.

Qualitative Samples (visual site search collections). We need:
-A list of all species identified per sample, with corresponding species info on your master taxa list
-No count is necessary for qualitative samples
-At least 2 voucher specimens returned to us for each non-native species (see detailed voucher protocol below)
-You may keep or discard all native species and non-natives not vouchered from these samples as we will not archive qualitative samples at MLML

Quantitative Samples (Clearing/Grab/Holdfast collection from hard substrate or sandy cores). We need:
-A list of all species identified per sample, with corresponding species information on your master taxa list
-A count for all introduced and cryptogenic species. If you count a subsample of what was sent to you, please indicate the % of the sample that you counted in the column provided on the datasheet.
-At least 2 voucher specimens returned to us for each non-native species listed (see detailed voucher protocol below)
-Return all quantitative samples to MLML to be archived. Natives and non-natives that were not vouchered can be re-combined in the original sample jars and then returned to MLML. Please make sure that voucher jars are labeled with the subIDORG and final taxonomic identification.

ISS Voucher Collection

With your help, we will create a voucher collection for non-native species found on California's Outer Coast during this survey. The collection will include introduced and cryptogenic species, as well as examples of any new or provisional species identified during this study. If you are listing provisional names for specimens you identify, (such as *Onchidella* sp. A Maloney), please provide both a vouchered specimen and a short description of the specimen. This collection will not include species identified and known with certainty to be native. The main purposes of this voucher collection are to provide evidence of what was identified in this survey, and to provide examples of introduced species for our own use and education. At least two vouchers are needed for each species; one set will be stored and used at MLML, while the other set may go to a museum. Taxonomists will provide the appropriate voucher specimens separated out into vials, and MLML staff will properly label and organize the voucher collection.

For each introduced, cryptogenic, provisional or new species, we need:

-<u>At least two</u> specimens vouchered, placed in separate vials or jars, labeled with subIDORG number and final taxonomic identification. (Labeling specimens by subIDORG allows us to link it to the appropriate sample information)

-If significant morphological variations are observed among samples, additional specimens should also be vouchered to show these variations.

<u>Sample Tracking</u>

A Chain of Custody (COC) form will accompany each 'batch' of samples you receive from us. When you receive a package, please check that the contents of the package match what's listed on the COC, sign and date one COC copy and mail it back to MPSL.

After identifications are completed for each sampling season, taxonomists will return to MPSL 1) all quantitative samples (for our archive collection), and 2) all vouchered specimens for that season. Taxonomists may arrange to keep or donate some of these samples, but only after first providing vouchers for the MPSL collection. Please contact MPSL staff to get approval before retaining any samples for personal use or for depositing to a museum; we will need a list of samples (by subIDORG) as well as contact information that will allow us to relocate the sample in the future if necessary.

When you are ready to return samples to us (for voucher or archive collection), please complete a Return COC, using the template provided for you on the CD. You can contact our staff to discuss logistics for shipping the samples.

<u>Mis-sorts</u>

When mis-sorts (specimens not within your specialty)are encountered, please send them back to MPSL as soon as possible so that we may get them out to the appropriate taxonomist in a timely manner. This will help keep the process of identifying samples and entering data on track. Send missorts early and often!

<u>Data Tracking</u>

****The deadline for returning identification data for Season 1 -Outer Coast is October 1, 2005**

As mentioned above, we have a standardized Excel file for all taxonomists to use when entering species identification and count data. The file has multiple tabs, some with explanations and instructions, and others for data entry. Please familiarize yourself with this file (either included on a CD in your package of samples or emailed to you) and let us know if you have any questions. Your cooperation with using the datasheet provided is an essential component of our datamanagement and is appreciated.

Appendix D – Number of species and percentage of total taxa for each station and habitat type sampled.

Site Name	Habitat Type	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Point Saint George	Rocky Intertidal	**97**	1 (1%)	9 (9%)	57 (59%)	30 (31%)
Point Saint George	Sandy Intertidal	**26**		3 (12%)	12 (46%)	11 (42%)
Point Saint George	Rocky Subtidal	**92**		6 (7%)	55 (60%)	31 (34%)
Cape Mendocino	Rocky Intertidal	**177**	2 (1%)	10 (6%)	111 (63%)	54 (31%)
Cape Mendocino	Sandy Intertidal	**11**			8 (73%)	3 (27%)
Cape Mendocino	Rocky Subtidal	**180**	2 (1%)	16 (9%)	105 (58%)	57 (32%)
Cape Mendocino	Sandy Subtidal	**61**	2 (3%)	7 (11%)	27 (44%)	25 (41%)
Shelter Cove	Rocky Intertidal	**176**		9 (5%)	115 (65%)	52 (30%)
Shelter Cove	Sandy Intertidal	**21**			14 (67%)	7 (33%)
Shelter Cove	Rocky Subtidal	**156**	1 (1%)	10 (6%)	84 (54%)	61 (39%)
Shelter Cove	Sandy Subtidal	**49**		6 (12%)	26 (53%)	17 (35%)
Point Arena	Rocky Intertidal	**156**	2 (1%)	14 (9%)	89 (57%)	51 (33%)
Point Arena	Sandy Intertidal	**32**		1 (3%)	15 (47%)	16 (50%)
Point Arena	Rocky Subtidal	**118**		16 (14%)	67 (57%)	35 (30%)
Point Arena	Sandy Subtidal	**37**	1 (3%)	4 (11%)	19 (51%)	13 (35%)
Bodega	Rocky Intertidal	**136**		9 (7%)	87 (64%)	40 (29%)
Bodega	Sandy Intertidal	**35**	1 (3%)	1 (3%)	16 (46%)	17 (49%)
Bodega	Rocky Subtidal	**174**		8 (5%)	119 (68%)	47 (27%)
Bodega	Sandy Subtidal	**41**		4 (10%)	11 (27%)	26 (63%)
Point Reyes	Rocky Intertidal	**152**		7 (5%)	103 (68%)	42 (28%)
Point Reyes	Sandy Intertidal	**44**	1 (2%)	4 (9%)	16 (36%)	23 (52%)
Point Reyes	Rocky Subtidal	**124**	1 (1%)	10 (8%)	67 (54%)	46 (37%)
Point Reyes	Sandy Subtidal	**107**	1 (1%)	17 (16%)	49 (46%)	40 (37%)
Fitzgerald	Rocky Intertidal	**165**	1 (1%)	12 (7%)	80 (48%)	72 (44%)
Fitzgerald	Sandy Intertidal	**34**		5 (15%)	14 (41%)	15 (44%)
Fitzgerald	Sandy Subtidal	**72**		8 (11%)	35 (49%)	29 (40%)
Pigeon Point	Rocky Intertidal	**123**	2 (2%)	5 (4%)	68 (55%)	48 (39%)
Pigeon Point	Sandy Intertidal	**55**	1 (2%)	2 (4%)	37 (67%)	15 (27%)
Pigeon Point	Sandy Subtidal	**24**	1 (4%)	2 (8%)	14 (58%)	7 (29%)
Ano Nuevo	Rocky Intertidal	**153**	1 (1%)	7 (5%)	84 (55%)	61 (40%)
Ano Nuevo	Sandy Intertidal	**17**			11 (65%)	6 (35%)
Ano Nuevo	Rocky Subtidal	**4**			4 (100%)	
Ano Nuevo	Sandy Subtidal	**69**		6 (9%)	38 (55%)	25 (36%)
Point Sur	Rocky Intertidal	**153**		14 (9%)	90 (59%)	49 (32%)
Point Sur	Sandy Intertidal	**30**	1 (3%)		20 (67%)	9 (30%)
Point Sur	Rocky Subtidal	**187**	1 (1%)	18 (10%)	115 (61%)	53 (28%)
Point Sur	Sandy Subtidal	**79**	1 (1%)	8 (10%)	49 (62%)	21 (27%)
Pt Sierra Nevada	Rocky Intertidal	**100**	2 (2%)	6 (6%)	61 (61%)	31 (31%)
Pt Sierra Nevada	Sandy Intertidal	**23**		2 (9%)	8 (35%)	13 (57%)
Pt Sierra Nevada	Rocky Subtidal	**177**	2 (1%)	13 (7%)	107 (60%)	55 (31%)
Pt Sierra Nevada	Sandy Subtidal	**77**	1 (1%)	6 (8%)	48 (62%)	22 (29%)

Site Name	Habitat Type	Total Taxa	Introduced	Cryptogenic	Native	Unresolved
Diablo Canyon	Rocky Intertidal	**121**	1 (1%)	12 (10%)	71 (59%)	37 (31%)
Diablo Canyon	Sandy Intertidal	**18**		1 (6%)	8 (44%)	9 (50%)
Diablo Canyon	Rocky Subtidal	**141**	3 (2%)	8 (6%)	89 (63%)	41 (29%)
Diablo Canyon	Sandy Subtidal	**97**	1 (1%)	9 (9%)	44 (45%)	43 (44%)
Purisima Point	Rocky Intertidal	**258**	2 (1%)	20 (8%)	167 (65%)	69 (27%)
Purisima Point	Sandy Intertidal	**11**			5 (45%)	6 (55%)
Purisima Point	Rocky Subtidal	**109**		6 (6%)	75 (69%)	28 (26%)
Purisima Point	Sandy Subtidal	**28**		3 (11%)	17 (61%)	8 (29%)
Point Conception	Rocky Intertidal	**117**		10 (9%)	69 (59%)	38 (32%)
Point Conception	Sandy Intertidal	**34**		2 (6%)	24 (71%)	8 (24%)
Point Conception	Rocky Subtidal	**187**	1 (1%)	18 (10%)	126 (67%)	42 (22%)
Point Conception	Sandy Subtidal	**86**	2 (2%)	11 (13%)	51 (59%)	22 (26%)
Arroyo Hondo	Rocky Intertidal	**112**	1 (1%)	10 (9%)	68 (61%)	33 (29%)
Arroyo Hondo	Sandy Intertidal	**20**	1 (5%)		13 (65%)	6 (30%)
Arroyo Hondo	Rocky Subtidal	**157**	1 (1%)	18 (11%)	92 (59%)	46 (29%)
Arroyo Hondo	Sandy Subtidal	**42**		4 (10%)	25 (60%)	13 (31%)
Carpinteria	Rocky Intertidal	**136**	1 (1%)	16 (12%)	68 (50%)	51 (38%)
Carpinteria	Sandy Intertidal	**17**		1 (6%)	9 (53%)	7 (41%)
Carpinteria	Rocky Subtidal	**159**	1 (1%)	16 (10%)	97 (61%)	45 (28%)
Carpinteria	Sandy Subtidal	**61**	1 (2%)	8 (13%)	35 (57%)	17 (28%)
Point Dume	Rocky Intertidal	**192**	2 (1%)	14 (7%)	115 (60%)	61 (32%)
Point Dume	Sandy Intertidal	**33**	2 (6%)	4 (12%)	16 (48%)	11 (33%)
Point Dume	Rocky Subtidal	**195**	2 (1%)	21 (11%)	114 (58%)	58 (30%)
Point Dume	Sandy Subtidal	**38**		3 (8%)	23 (61%)	12 (32%)
Point Fermin	Rocky Intertidal	**195**	4 (2%)	17 (9%)	127 (65%)	47 (24%)
Point Fermin	Sandy Intertidal	**23**	1 (4%)	2 (9%)	17 (74%)	3 (13%)
Point Fermin	Rocky Subtidal	**156**	3 (2%)	14 (9%)	93 (60%)	46 (29%)
Point Fermin	Sandy Subtidal	**79**	1 (1%)	9 (11%)	43 (54%)	26 (33%)
Dana Point	Rocky Intertidal	**140**	2 (1%)	11 (8%)	78 (56%)	49 (35%)
Dana Point	Sandy Intertidal	**14**		1 (7%)	10 (71%)	3 (21%)
Dana Point	Rocky Subtidal	**205**	1 (0%)	18 (9%)	138 (67%)	48 (23%)
Dana Point	Sandy Subtidal	**45**	1 (2%)	3 (7%)	23 (51%)	18 (40%)
Pin Rock	Rocky Intertidal	**194**	2 (1%)	17 (9%)	123 (63%)	52 (27%)
Pin Rock	Sandy Intertidal	**101**	2 (2%)	11 (11%)	49 (49%)	39 (39%)
Pin Rock	Rocky Subtidal	**135**	1 (1%)	12 (9%)	79 (59%)	43 (32%)
Pin Rock	Sandy Subtidal	**137**	1 (1%)	23 (17%)	65 (47%)	48 (35%)
Point La Jolla	Rocky Intertidal	**153**	4 (3%)	15 (10%)	77 (50%)	57 (37%)
Point La Jolla	Sandy Intertidal	**19**			8 (42%)	11 (58%)
Point La Jolla	Rocky Subtidal	**242**	1 (0%)	26 (11%)	147 (61%)	68 (28%)
Point La Jolla	Sandy Subtidal	**44**		5 (11%)	24 (55%)	15 (34%)
Point Loma	Rocky Intertidal	**128**	6 (5%)	15 (12%)	68 (53%)	39 (30%)
Point Loma	Sandy Intertidal	**22**	1 (5%)		14 (64%)	7 (32%)
Point Loma	Rocky Subtidal	**200**	1 (1%)	21 (11%)	119 (60%)	59 (30%)

Appendix E – Grain size analysis results given in percent fines for each habitat type at each survey site.

Site Name	Habitat Type	Collection Depth	% Fines
Point Saint George	Sandy Intertidal	High	0.073
Point Saint George	Sandy Intertidal	Low	0.001
Cape Mendocino	Sandy Subtidal	43ft	0.04
Cape Mendocino	Sandy Intertidal	High	0.033
Cape Mendocino	Sandy Intertidal	Low	0
Shelter Cove	Sandy Intertidal	High	0
Shelter Cove	Sandy Intertidal	Low	1.045
Point Arena	Sandy Subtidal	18ft	0.337
Point Arena	Sandy Intertidal	High	0
Point Arena	Sandy Intertidal	Low	0
Bodega	Sandy Subtidal	37ft	0
Bodega	Sandy Intertidal	High	0
Bodega	Sandy Intertidal	Low	0.141
Point Reyes	Sandy Subtidal	12ft	3.614
Point Reyes	Sandy Intertidal	High	0
Point Reyes	Sandy Intertidal	Low	0.239
Fitzgerald	Sandy Subtidal	27.5ft	8.448
Fitzgerald	Sandy Intertidal	High	0
Fitzgerald	Sandy Intertidal	Low	0
Pigeon Point	Sandy Subtidal	23ft	0.291
Pigeon Point	Sandy Intertidal	High	0.123
Pigeon Point	Sandy Intertidal	Low	0.413
Ano Nuevo	Sandy Intertidal	High	0
Ano Nuevo	Sandy Intertidal	Low	0.001
Point Sur	Sandy Subtidal	29ft	2.108
Point Sur	Sandy Intertidal	High	0
Point Sur	Sandy Intertidal	Low	0.389
Point Sierra Nevada	Sandy Subtidal	25ft	5.625
Point Sierra Nevada	Sandy Intertidal	High	No data
Point Sierra Nevada	Sandy Intertidal	Low	0
Diablo Canyon	Sandy Subtidal	35ft	0.176
Diablo Canyon	Sandy Intertidal	High	0
Diablo Canyon	Sandy Intertidal	Low	0.12
Purisima Point	Sandy Subtidal	24ft	0.6
Purisima Point	Sandy Intertidal	High	0
Purisima Point	Sandy Intertidal	Low	0
Point Conception	Sandy Subtidal	32ft	1.697
Point Conception	Sandy Intertidal	High	0
Point Conception	Sandy Intertidal	Low	0.557
Arroyo Hondo	Sandy Subtidal	21ft	0.8
Arroyo Hondo	Sandy Intertidal	High	0
Arroyo Hondo	Sandy Intertidal	Low	0.542
Carpinteria	Sandy Subtidal	20ft	0.525
Carpinteria	Sandy Intertidal	High	0.337
Carpinteria	Sandy Intertidal	Low	0.585
Point Dume	Sandy Subtidal	14ft	0.802
Point Dume	Sandy Intertidal	High	0
Point Dume	Sandy Intertidal	Low	0.557

Site Name	Habitat Type	Collection Depth	% Fines
Point Fermin	Sandy Subtidal	21ft	4.652
Point Fermin	Sandy Intertidal	High	0
Point Fermin	Sandy Intertidal	Low	0.574
Dana Point	Sandy Subtidal	39ft	0.154
Dana Point	Sandy Intertidal	High	0
Dana Point	Sandy Intertidal	Low	0
Pin Rock	Sandy Subtidal	50ft	2.719
Pin Rock	Sandy Intertidal	High	1.574
Pin Rock	Sandy Intertidal	Low	0.794
Point La Jolla	Sandy Subtidal	24ft	1.362
Point La Jolla	Sandy Intertidal	High	0
Point La Jolla	Sandy Intertidal	Low	0
Point Loma	Sandy Intertidal	High	0
Point Loma	Sandy Intertidal	Low	0

Appendix F – Cryptogenic species identified in the current survey.

Species Name	Phylum	Likely Introduced or Likely Native	Total Sites Observed
Achelia echinata	Arthropoda		12
Ammothea hilgendorfi	Arthropoda		1
Ammothella menziesi	Arthropoda		1
Amphipholis squamata	Echinodermata		7
Amphiporus imparispinosus	Nemertea	Likely Native	4
Ampithoe lacertosa	Arthropoda		5
Aphelochaeta monilaris	Annelida		3
Apionsoma misakianum	Sipuncula		1
Apoprionospio pygmaea	Annelida		14
Argissa hamatipes	Arthropoda		3
Aricidea (Acmira) catherinae	Annelida		5
Aricidea (Acmira) lopezi	Annelida		1
Aricidea (Acmira) rubra	Annelida		1
Boccardia basilaria	Annelida	Likely Native	1
Boccardia proboscidea	Annelida	Likely Native	5
Boccardia tricuspa	Annelida		7
Boccardiella hamata	Annelida	Likely Introduced	7
Branchiosyllis exilis	Annelida	Likely Introduced	1
Brania mediodentata	Annelida		1
Bugula neritina	Ectoprocta	Likely Introduced	6
Caprella californica	Arthropoda	Likely Native	3
Caprella equilibra	Arthropoda		9
Caprella natalensis	Arthropoda	Likely Native	2
Caprella penantis	Arthropoda		10
Carazziella sp. A SCAMIT	Annelida	Likely Native	1
Carinomella lactea	Nemertea	Likely Native	2
Caulleriella alata	Annelida	Likely Native	1
Caulleriella hamata	Annelida	Likely Native	1
Chaetozone bansei	Annelida	Likely Native	5
Chone sp. SD1	Annelida	Likely Native	2
Cumella vulgaris	Arthropoda		11
Diplosoma listerianum	Chordata		3
Dipolydora caulleryi	Annelida		1
Dipolydora socialis	Annelida		13
Dispio uncinata	Annelida		6
Dodecaceria concharum	Annelida		2
Dodecaceria fewkesi	Annelida	Likely Native	3
Dragmacidon sp. of Lee	Porifera		1
Dysidea fragilis	Porifera	Likely Introduced	1
Eobrolgus chumashi	Arthropoda		9
Ericthonius brasiliensis	Arthropoda		17
Eunice antennata	Annelida	Likely Native	2
Eurylepta aurantiaca	Platyhelminthes		1
Exogone lourei	Annelida	Likely Native	21
Flustrellidra corniculata	Ectoprocta	Likely Introduced	4
Glycera americana	Annelida	Likely Native	2
Glycera capitata	Annelida		4
Glycera macrobranchia	Annelida	Likely Native	9

Species Name	Phylum	Likely Introduced or Likely Native	Total Sites Observed
Glycera oxycephala	Annelida		3
Goniada littorea	Annelida	Likely Native	4
Goniada maculata	Annelida		1
Grandifoxus grandis	Arthropoda		2
Guancho blanca	Porifera	Likely Introduced	1
Halichondria panicea	Porifera		7
Hemipodia simplex	Annelida		8
Heteropodarke heteromorpha	Annelida		8
Ianiropsis tridens	Arthropoda		16
Ischyrocerus anguipes	Arthropoda		1
Ischyrocerus pelagops	Arthropoda	Likely Native	1
Jassa borowskyae	Arthropoda	Likely Native	2
Jassa carltoni	Arthropoda		4
Jassa morinoi	Arthropoda	Likely Native	7
Jassa slatteryi	Arthropoda		11
Laticorophium baconi	Arthropoda		12
Leptochelia dubia	Arthropoda		21
Leucothoe alata	Arthropoda		6
Lineus ruber	Nemertea		1
Lissodendoryx (Lissodendoryx) sp.1 of Lee	Porifera		1
Lumbrineris japonica	Annelida	Likely Native	4
Lumbrineris latreilli	Annelida	Likely Native	2
Mediomastus ambiseta	Annelida		1
Mediomastus californiensis	Annelida		6
Megalomma	Annelida	Likely Native	4
Metatiron tropakis	Arthropoda		3
Microjassa litotes	Arthropoda	Likely Native	15
Monticellina siblina	Annelida		1
Mooreonuphis nebulosa	Annelida	Likely Native	1
Myxicola infundibulum	Annelida		1
Neanthes arenaceodentata	Annelida		2
Nebalia hessleri	Arthropoda		3
Nephtys ferruginea	Annelida	Likely Native	3
Nephtys parva	Annelida		1
Nephtys simoni	Annelida		1
Nereis grubei	Annelida		5
Nereis mediator	Annelida		17
Nipponemertes bimaculata	Nemertea	Likely Native	1
Nipponemertes pacifica	Nemertea	Likely Native	1
Notomastus tenuis	Annelida		6
Novafabricia sp. A Harris	Annelida	Likely Native	1
Ophiactis simplex	Echinodermata	Likely Native	8
Ophiopholis kennerlyi	Echinodermata		2
Paradoneis lyra	Annelida		2
Pectinaria granulata	Annelida		1
Pettiboneia sanmatiensis	Annelida		4
Phascolosoma agassizii	Sipuncula		20
Phyllodoce longipes	Annelida		5
Pilargis sp. A Harris	Annelida	Likely Native	1
Platynereis bicanaliculata	Annelida		22
Plumularia alicia	Cnidaria		1
Plumularia setacea	Cnidaria		1

Species Name	Phylum	Likely Introduced or Likely Native	Total Sites Observed
Podocerus cristatus	Arthropoda		11
Poecilochaetus johnsoni	Annelida		1
Polydora cornuta	Annelida		1
Polydora heterochaeta	Annelida		1
Polydora websteri	Annelida		8
Prionospio cirrifera	Annelida	Likely Native	1
Prionospio dubia	Annelida		1
Prionospio heterobranchia	Annelida	Likely Introduced	4
Proceraea okadai	Annelida		7
Protolaeospira eximia	Annelida		5
Pterocirrus sp. A Harris	Annelida	Likely Native	2
Scolelepis (Parascolelepis) sp. B Harris	Annelida		2
Scolelepis tridentata	Annelida		1
Scoloplos (Scoloplos) squamatus	Annelida		1
Sphaerodoropsis biserialis	Annelida	Likely Native	1
Spio filicornis	Annelida	Likely Native	1
Streblosoma sp. F Harris	Annelida	Likely Native	5
Suberites ficus	Porifera		4
Syncoryne mirabilis	Cnidaria	Likely Native	1
Tedania (Trachytedania) gurjanovae	Porifera		1
Thysanocardia nigra	Sipuncula		1
Trypanosyllis sp. C Harris	Annelida		1
Typosyllis sp. VR4	Annelida		1
Typosyllis sp. VR5	Annelida		1
Typosyllis sp. VR6	Annelida		3
Zeuxo normani	Arthropoda		14
Zygonemertes virescens	Nemertea		10