# Introduced Aquatic Species in California Bays and Harbors - 2006

# Final Report

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Moss Landing Marine Laboratories
Marine Pollution Studies Laboratory

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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 (CDFG) will conduct appropriate studies necessary to develop a baseline of non-indigenous species (NIS) occurring in the marine and estuarine waters of the state, and then to monitor those areas for any new introductions. The CDFG's Office of Spill Prevention and Response (OSPR) provided the lead role for the NIS investigations. The OSPR has identified the areas within California's ports and harbors to conduct field and laboratory studies on the presence of NIS. These areas include a variety of man made and natural habitat types such as floating structures, pilings, bulkheads and muddy soft bottom. The focus of this study was bay, port and marina locations where introductions from ballast water are most likely to have occurred.

The work described below is part of the monitoring effort required under the statute. The NIS baseline for bays, ports and harbors was established through surveys conducted in 2000/2002 (Foss et al., 2007). That baseline was expanded to include sites along the outer coast with the survey of 2004. In the present survey, sites in the harbors and bays of northern, central and southern California were revisited. These areas include: the ports of San Diego, Los Angeles/Long Beach, Hueneme, Stockton, Sacramento, San Francisco Bay and adjacent waters, Humboldt Bay, Tomales Bay and numerous small harbors encompassing the entire California coast (Figure 1). Literature and data reviews were complimented by field and laboratory studies jointly conducted by CDFG/OSPR and San Jose State University Foundation's Moss Landing Marine Laboratories (MLML). Additionally, San Francisco State University's Romberg Tiburon Station (SFSU/RTC) conducted plankton field sampling in San Francisco Bay. Additional universities and specialized laboratories provided taxonomic expertise in identification of marine species.

As noted by Grosholz, studies on species invasions have increased in marine systems over the last decade (Grosholz, 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. 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.

This study aimed at collecting information on the presence, distribution, and abundance of NIS in California bays and harbors. 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 in many cases to address questionable or problematic species determinations. This process led to several updates to the introduction statuses previously reported by MLML/CDFG (Foss et al., 2007; Maloney et al., 2006; CDFG, In

Prep.), 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 MLML/CDFG NIS 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. Site selection and general descriptions are detailed below.

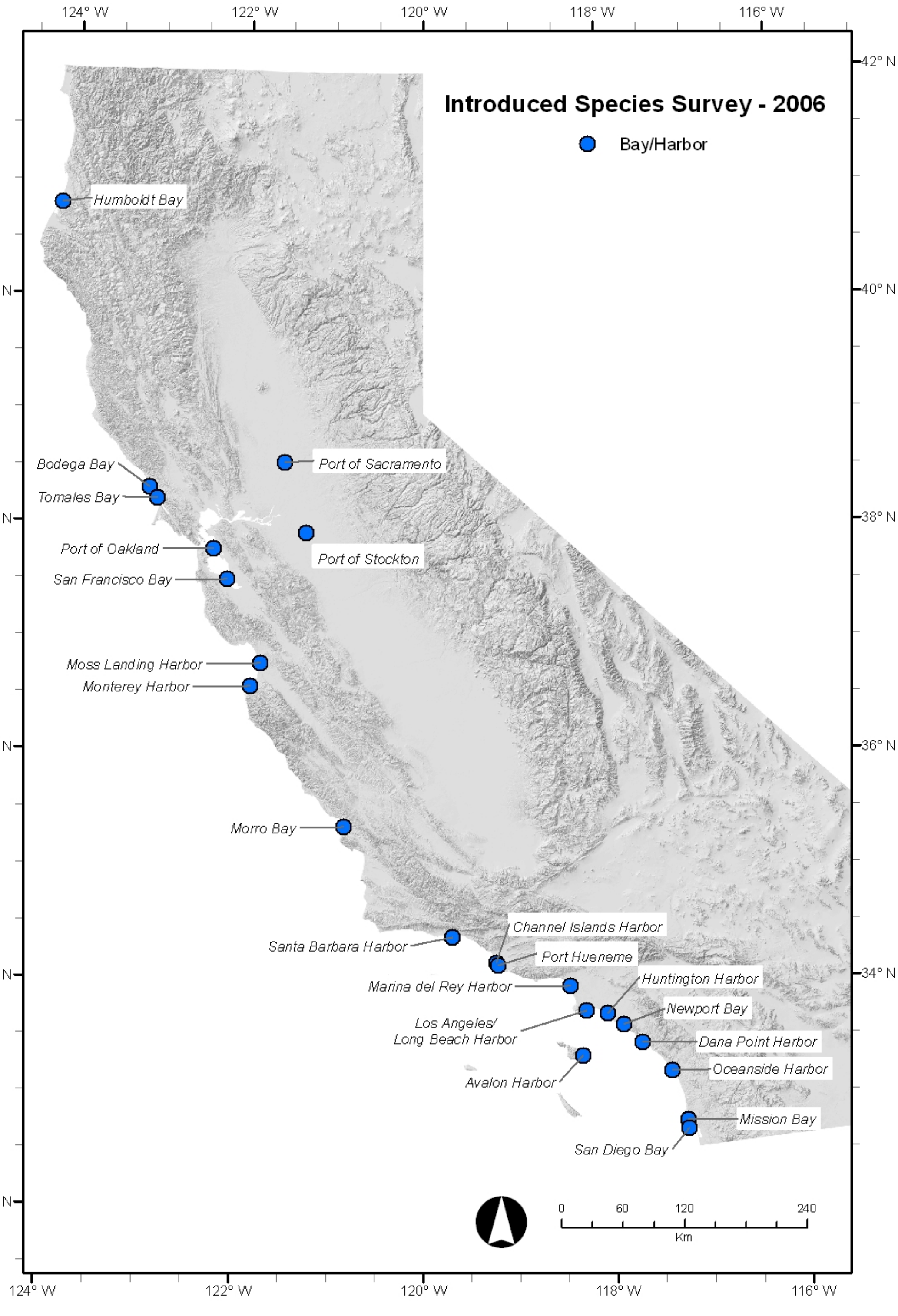



**Figure 1. California bays and harbors surveyed in the current study.**

## *METHODS*

### Summary of Introduction Status Determinations

As experts on their respective taxa, taxonomists are familiar with the most updated and relevant 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 taxa list for the current survey. The master taxa list was compared to and then combined with the taxa list stored in MLML/CDFG's California Aquatic Non-native Organism Database (CANOD), which is available to the public through the CDFG website (CDFG, 2008). See references section for current full web address.

When introduction status discrepancies were found between what taxonomists reported for the current survey and what was listed in CANOD or from other sources, 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.

It should be noted that this survey did not attempt to determine the population status of the introduced species identified from the survey sites. Rather, this survey reports the presence of these species at the survey sites at the time of the survey. Since most survey sites were visited just once during the course of this survey, and often times the introduced species were identified well after the sampling had taken place, further efforts would be necessary to make a reliable determination of the status of these populations as established or not.

### Summary of Survey Site Selection

Epifaunal and infaunal habitats were surveyed in 20 bays and harbors, and water column samples were collected for zooplankton taxa in 6 of the 20 bays and harbors for the current survey. Most survey sites were specifically selected to overlap the sites surveyed by MLML/CDFG in 2000-2001 so that the datasets may be used to monitor changes in the species detected at these sites over time (CDFG, 2002). Additional criteria used during site selection for epifaunal and infaunal sampling included 1) obtain good geographic distribution over sample regions, 2) target as many areas affected by anthropogenic activities occurring in the sample region as possible, 3) locate and sample sites harboring a variety of hard substrates with fouling communities. Infaunal habitats were sampled at approximately half of the sites where epifaunal habitats were sampled in each bay or harbor. Epifaunal and infaunal habitats were recently surveyed in San Diego Bay as a part of MLML/USFWS study conducted in 2005 (Maloney et al., 2007), and also in San Francisco Bay and the Port of Oakland as a part of MLML/CDFG study conducted in 2005 (CDFG, In Prep.), so only the zooplankton community was sampled in these harbors as a part of the current survey.  Sampling of the water column for zooplankton occurred in six of the harbors, including Humboldt Bay, Port Hueneme, Los Angeles/Long Beach harbors, San Francisco Bay, Port of Oakland and San Diego Bay.  Figures 2 through 8 detail sampling site locations and habitats surveyed at each site.

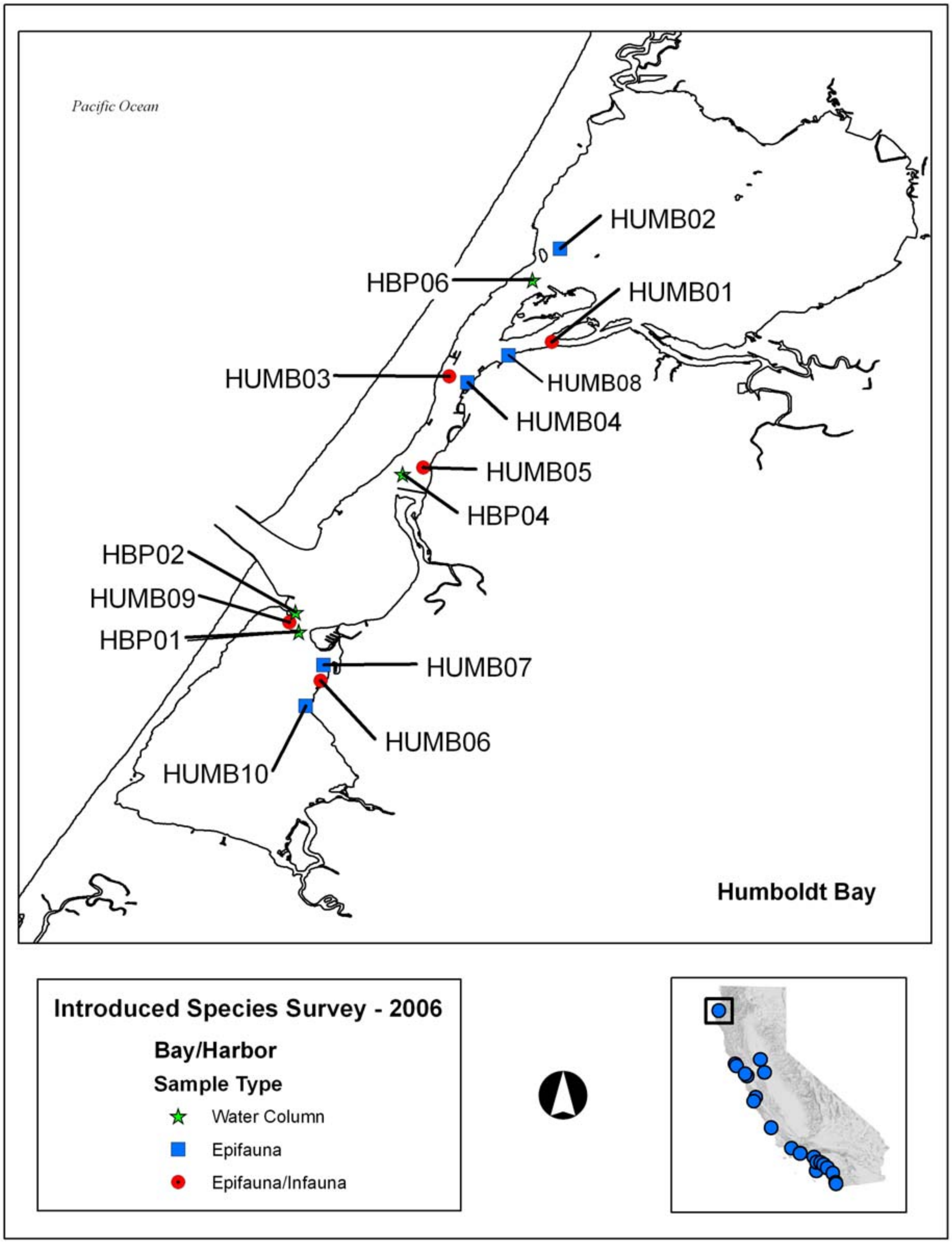



**Figure 2. Sites sampled and sample types collected from Humboldt Bay.**

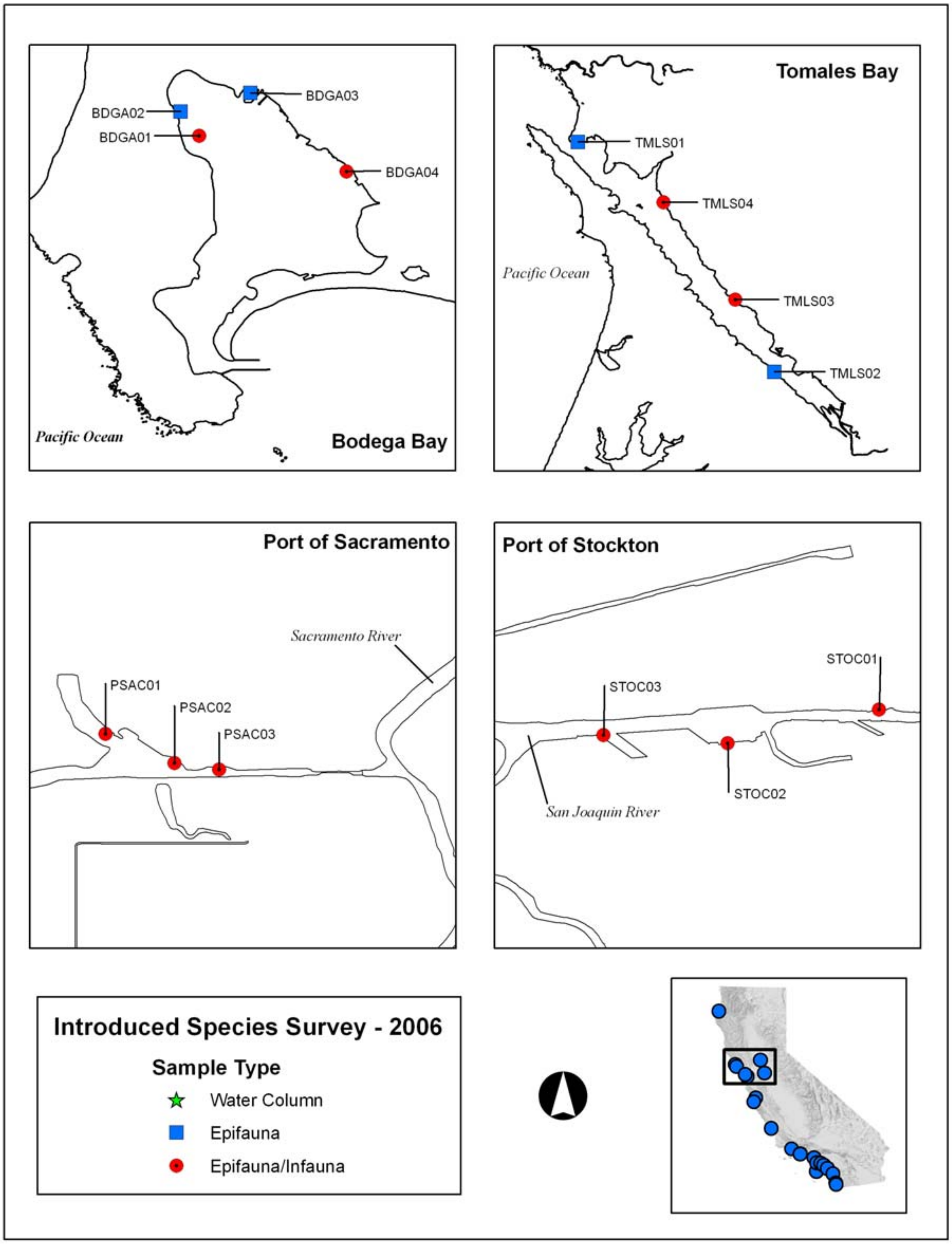



**Figure 3. Sites sampled and sample types collected from northern California bays and harbors.**

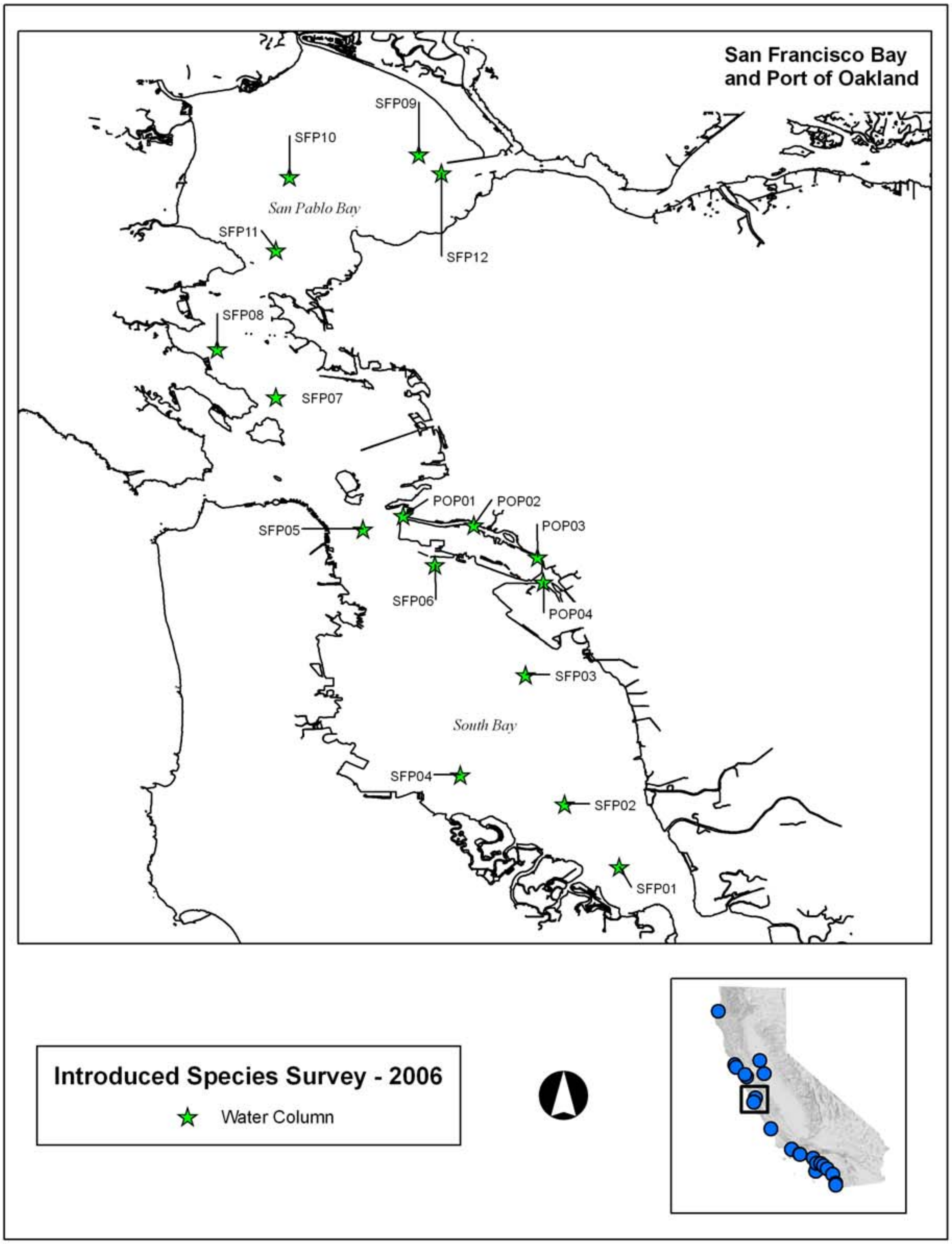



**Figure 4. Sites where the water column was sampled for zooplankton in San Francisco Bay and the Port of Oakland.**

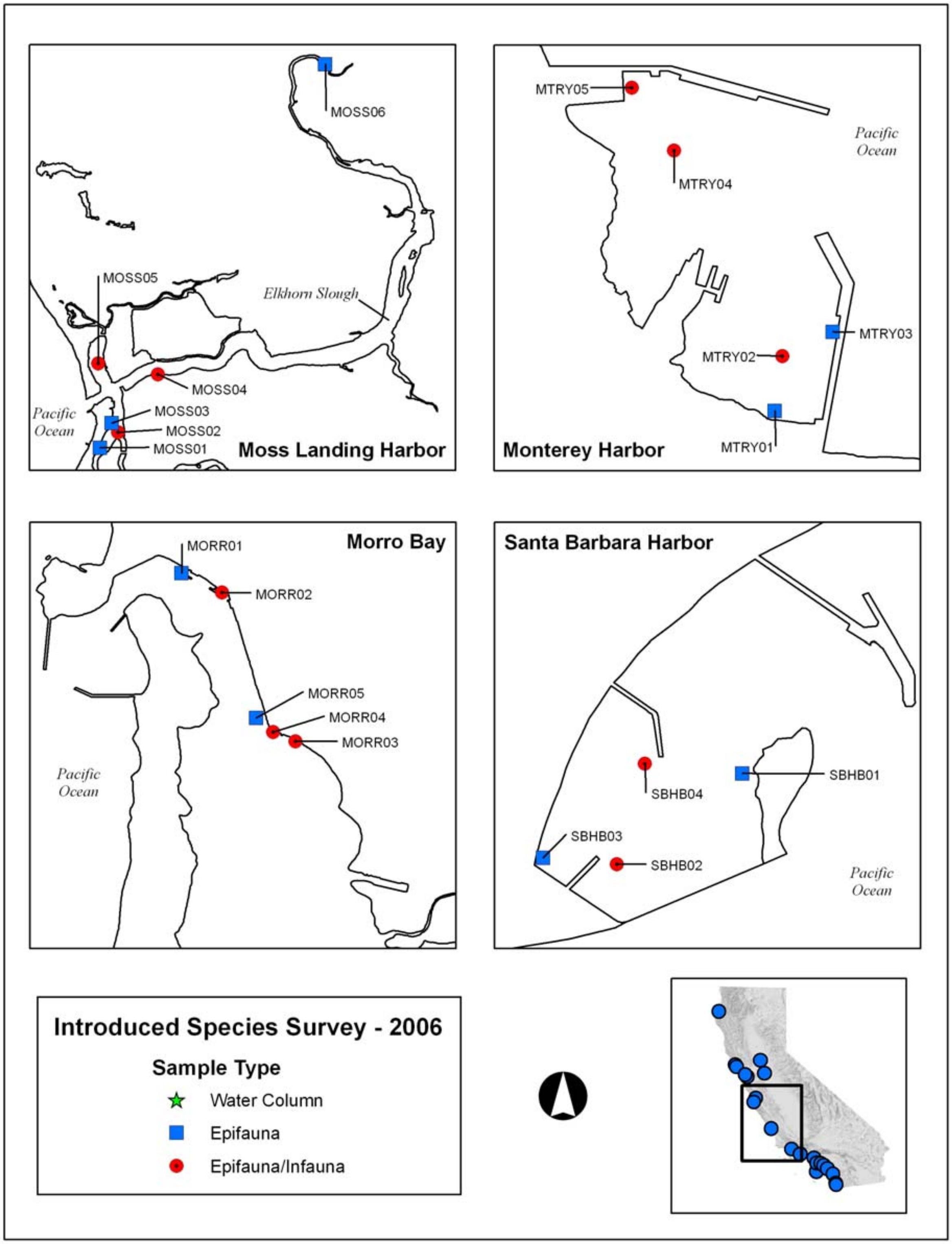



**Figure 5. Sites sampled and sample types collected from central California bays and harbors.**

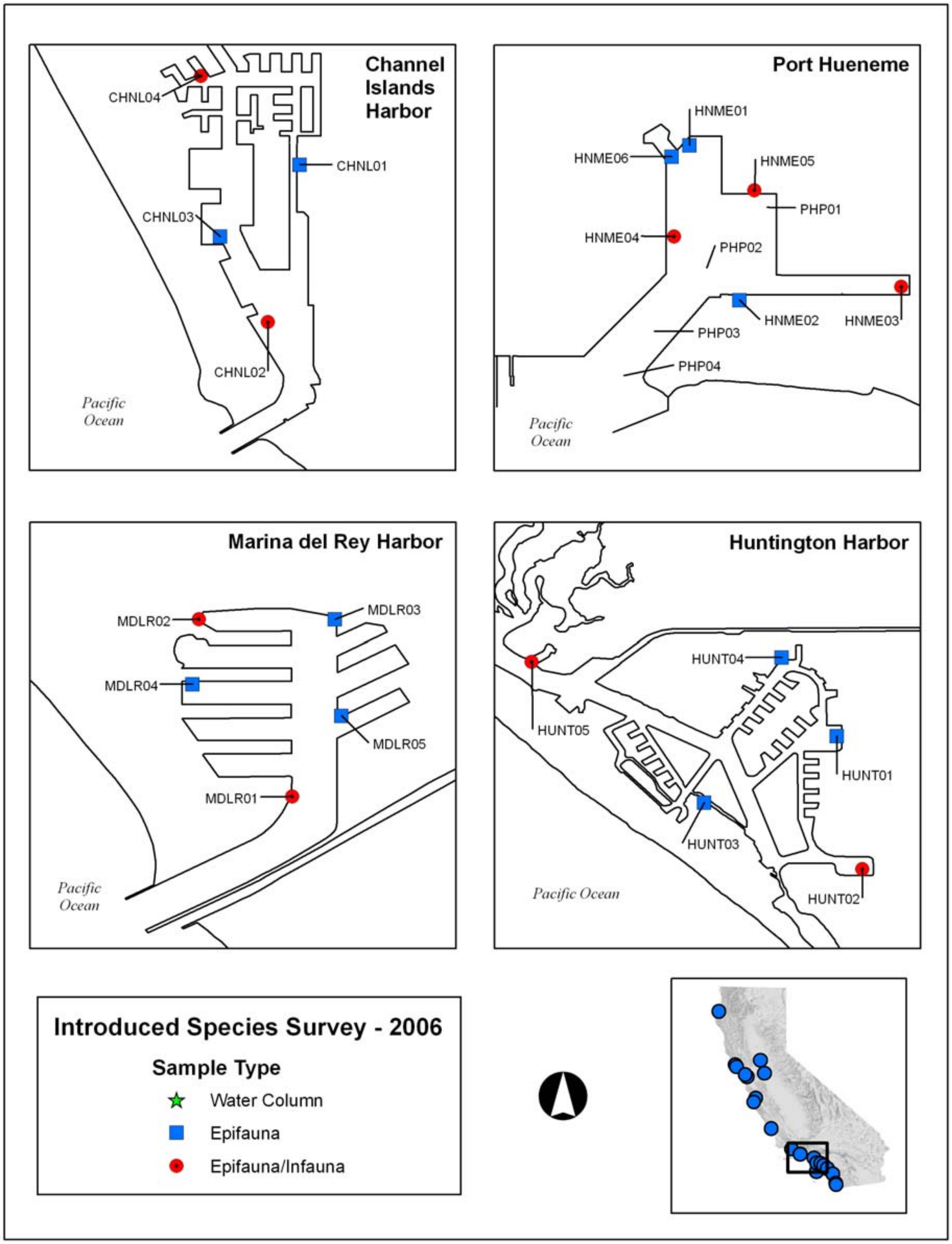



**Figure 6. Sites sampled and sample types collected from southern California bays and harbors.**

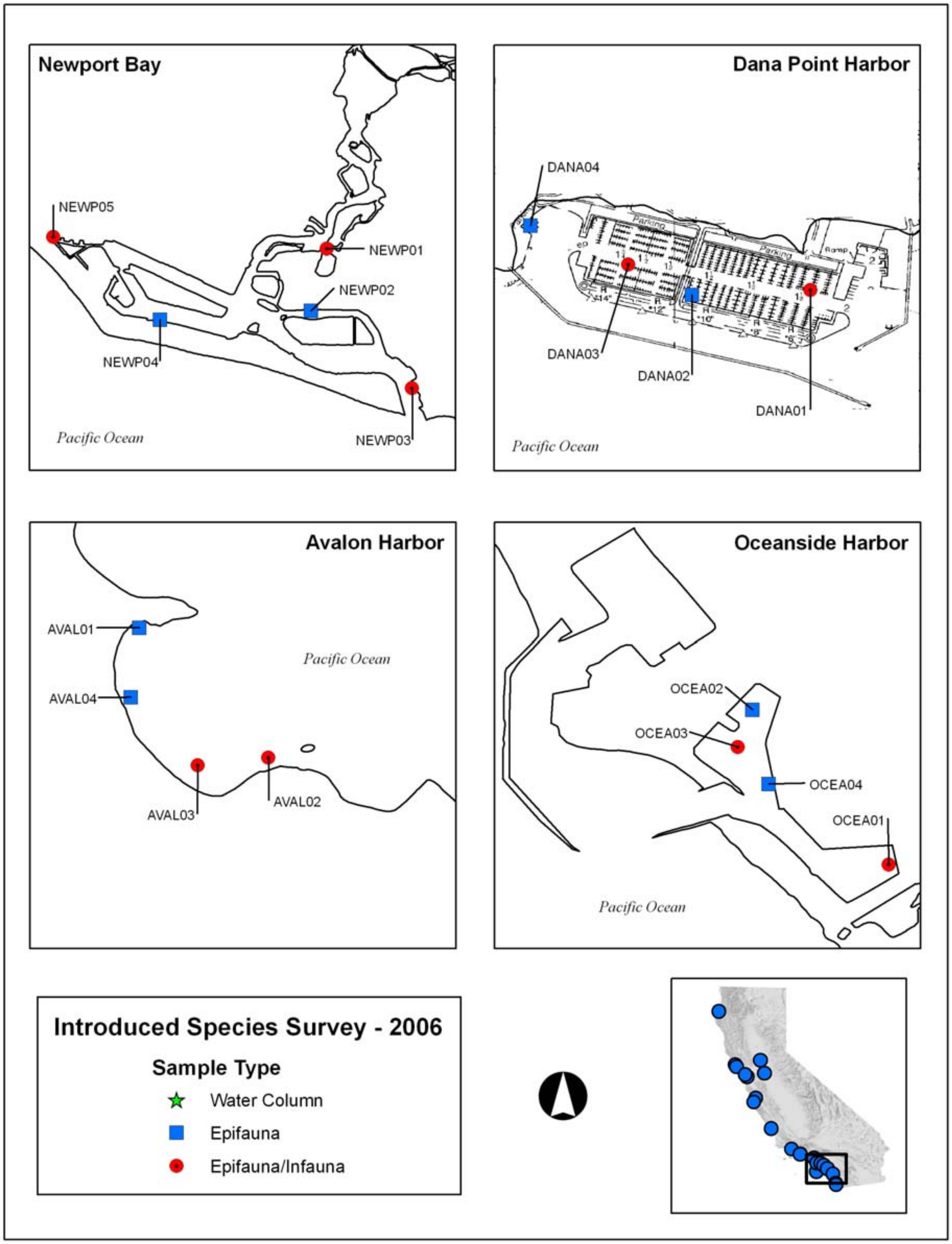



**Figure 7. Sites sampled and sample types collected from additional southern California bays and harbors.**

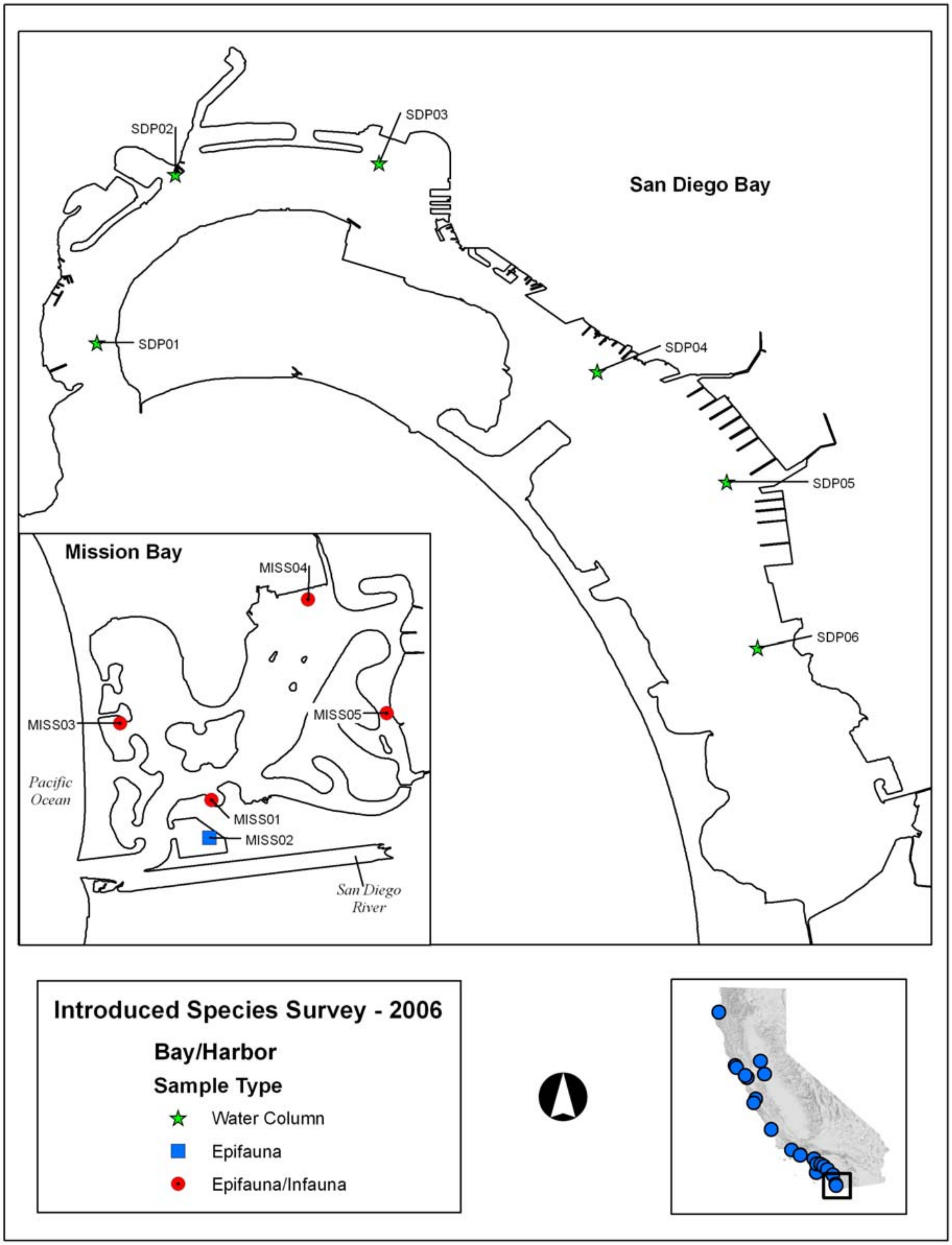



**Figure 8. Sites sampled and sample types collected from San Diego Bay and Mission Bay**

## Summary of Sampling Design

### Field Protocol Design

The basic sampling design was adopted from the MLML/CDFG 2000-2001 NIS survey of California's bays and harbors (CDFG, 2002). Depending on sampling location and the collection method, sampling can potentially underestimate 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 habitats and communities were not sampled in this broad survey, but every attempt was made to be as representative as possible within the logistical and budgetary constraints of the project.

In California's bays and harbors, two main habitat types were targeted: subtidal fouling (also called epifaunal in this report), and subtidal infaunal communities. 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 NIS. Methods employed included the use of sediment cores and grabs, quadrat clearings, qualitative taxonomic surveys and plankton tows. Samples were preserved and transported to the appropriate laboratories and taxonomists for identification and enumeration. Taxonomists also occasionally provided information about historical or ongoing ecological or monitoring research conducted at or near survey sites.

While all subtidal sampling focused on average depths less than 30 feet, epifaunal subtidal sampling, in particular, often focused on substrates at or near the surface. Due to habitat differences that could influence larval recruitment and subsequent colonization, the sampling strategy encompassed multiple depths, substrates, orientations and light exposure conditions.

## Summary of Field Sampling Methods

### Sampling Vessel

Collections were made using a 19 ft Boston Whaler (*Ms. B2*) with a Mariner 135 hp commercial outboard engine and 15 hp spare outboard engine. *Ms. B2* was outfitted with a 5.5 hp Honda motor used in conjunction with 20 meters of line, for the sediment grabs. All sampling event locations were recorded as latitude and longitude (decimal minutes, NAD 83 datum) using a Garmin GPS Map76S Global Positioning System. All station information pertinent to the sampling effort was recorded in a field logbook.

### Documentation of Sample Sites

Latitude and longitude coordinates were documented for each survey site within the harbors. If epifaunal, infaunal, and plankton collections were not all taken from the same approximate location, additional coordinates were documented for specific collection locations. Notes were taken on anything unique about the area searched, and digital overview photos were also taken of each site.

## Epifaunal Sample Collection

### Quantitative quadrat clearings

At each of the survey sites, epifaunal samples were collected quantitatively from subtidal substrates via divers using SCUBA. Divers scraped clear and collected the biological contents from quadrats of known areas. All quadrat clearing collections were taken from a target bottom depth of 30 feet or less, and most were taken from waters less than 15 feet deep. Four quadrats (0.05 $m^2$ each) were attempted for the epifaunal collections at each site in order to target a larger variety of physical conditions and biological communities.

In order to increase the chances of detecting a non-native species in the harbors, 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 wooden, metal and styrofoam dock sides and undersides, wooden and concrete pilings, floating logs or buoys and hulls of vessels. A variety of substrates were targeted from each survey site. Vertical and horizontal orientations of substrates were noted. Samplers carefully and completely collected everything found within each of the quadrat clearings.

Quadrat samples collected underwater were placed in mesh bags (0.5mm mesh), which were closed tight, secured with cable ties 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. Of the four quadrat clearings collected, two each were combined into one sample, making up two samples for each site. All quantitative clearing samples were fixed in 10% formalin in the field and later preserved in 80% ethanol.

### Visual Searches

At each survey site within a harbor, MLML staff divers familiar with many of the introduced species present conducted swimming visual searches via SCUBA for approximately 20 minutes. The visual searches focused on all fouling communities found at each site from depths of approximately 15 feet or less. Since the priority of this project was to detect any NIS as opposed to making a comparison between sites, search time, expertise and search effort was only roughly standardized between sites. However, the total time searched and personnel involved were recorded for each site. During swimming surveys, all unidentified species observed were collected as well as introduced species for verification by taxonomists.

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, cnidarians 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 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 all poriferans and several other organisms to record live color and appearances.

## Infaunal Sample Collection

At approximately half of the sites sampled for epifauna in each marine harbor, one benthic infaunal sample was collected for community analyses with a Young-modified Van Veen sediment grab (0.05m² area). Because infaunal invertebrates are less abundant in freshwater habitat, one grab was taken from every station sampled in the Delta in order to obtain a more representative sample of the community. The contents of each grab were sieved through a 0.5 mm screen; residues (e.g., organisms and remaining sediments) were rinsed into unique, pre-labeled storage containers and fixed with a 10% formalin solution. After at least 24 hours in formalin, samples were transferred and preserved in 80% ethanol.

## Grain Size Sample Collection – Bays and Harbors

At each of the harbor grab sites, sediment samples were collected for grain size analysis using a 0.05m² Young-modified Van Veen grab. The grab was rinsed with seawater between sites. The top 5 cm was subsampled and placed in a clean, labeled ziplock bag for grain size analysis. Grain size samples were also collected from the two Delta freshwater harbors.

## Water Colum Sample Collection

Water column samples were collected for zooplankton taxa in 7 bays and harbors including Humboldt Bay, San Francisco Bay, the Port of Oakland, Port Hueneme, Los Angeles Harbor, Long Beach Harbor and San Diego Bay. Each harbor was sampled for zooplankton a total of 3 times between March 2006 and September 2007 (with the exception of San Francisco Bay, which was sampled for zooplankton 4 times within that time period). Field sampling was conducted by OSPR and MLML staff at all bays and harbors except San Francisco, where sampling was conducted by SFSU/RTC staff.

At each station, latitude, longitude, time in, time out and station depth were recorded, and a net tow conducted to collect zooplankton. At each station a vertical tow through the entire water column was performed using a 50cm diameter, 153 µm net mounted on a half meter ring with a G.O. Environmental flow meter (Model #B17155) fitted with a low-speed rotor.  The net was slowly dropped to 1 meter off the bottom and then slowly returned to the surface.  Net depth was calculated by using meter markers along the line to determine the depth by the amount of line deployed.  After each tow the net was rinsed to obtain all individuals and the contents of the cod end were transferred to a one liter container and preserved with 5% buffered formalin solution.

Sampling in San Francisco Bay was conducted quarterly by SFSU/RTC on the *RV Questuary* at twelve predetermined stations.  Six stations were located in the channel and six stations matching stations were located on the shoal.  At each station, latitude, longitude and station depth data was collected.  Secchi depth was also recorded using a secchi disk.  A CTD cast was performed with a Seabird SBE19 CTD, and a net tow was done to collect zooplankton.  The 150 µm zooplankton net was mounted on a half meter ring, with a General Oceanics Inc. flow meter fitted with a low-speed rotor.  At the six channel stations a 3 minute oblique tow was performed.  The net was slowly dropped to 1 meter off the bottom, allowed to tow for two minutes at depth and then slowly returned to the surface.  Net depth was calculated by taking the wire angle with an inclinometer (Rieker Instrument, Model# 2055) and using it to determine depth by the amount of line deployed.  At the six shoal stations the zooplankton net was towed for 3 minutes at the surface.  At all stations the net was rinsed to obtain all individuals and the contents of the cod end were transferred to a 250ml container and preserved with 5% formalin buffered with 1%–2% sodium borate.

**Summary of Laboratory Processing Methods for Quantitative Samples**

Bays and harbors quantitative (i.e. quadrat clearing) field samples were sent to MLML's Benthic Laboratory, for processing and sorting and were then sent to taxonomists for identification.  Field samples from the two freshwater harbors (Port of Sacramento and Port of Stockton) were sent directly to the Aquatic Bioassessment Laboratory for processing, sorting and identification.  All water column samples were sent directly to SFSU/RTC for processing, sorting and identification.  Epifaunal and infaunal samples were fixed in 10% buffered formalin in the field, and water column samples were fixed in a 5% buffered formalin solution.  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.

**MLML Benthic Laboratory Protocols**

## Subsampling

Laboratory sorting 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 of the tray. 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 one half, one quarter, one eighth, and occasionally one sixteenth, one thirty-second, and one sixty-fourth. The sample was then sorted by standard sorting procedure. The unsorted faction 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 residues were archived. A subsampling log was maintained, and entries were made for each sample, including those which were not subsampled.

## Sorting

High-resolution dissecting microscopes (Wild, Nikon and Olympus) with high intensity (fiber optic) light sources were used to sort the sieved 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 (infauna or fouling/epifauna, 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 containers, mostly 1 dm glass shell vials. They were separated into phylogenetic group: Arthropoda, Bryozoa, Cirripedia, Cnidaria, Crustacea, Echinodermata, Gastropoda, Hydrozoa, Insecta, Isopoda, Kamptozoa, Mollusca, Mytilus, Nemertea, Oligochaeta, Ophiuroidea, Platyhelminthes, 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 subIDORG, which included the sample 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 3100QX06.1 represents a sample from IDORG 3100, 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.

## Aquatic Bioassessment Laboratory Protocols

### Subsampling for Epifaunal Samples

Each jar sent to the lab was assigned a subIDORG in the field, which included the sample IDORG and a three character qualifier. If there were two containers for a particular subIDORG, the subIDORG was followed by a decimal and a number. For example, subIDORG 3375Z88.1 represents a sample from IDORG 3375, which is a Delta freshwater sample (Z), not associated with any particular taxa (88) 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.

Laboratory processing was completed using the USGS Qualitative Visual Sort Method for Processing Benthic Macroinvertebrate Samples (Grotheer and Siebenmann, 2005). The goal of the qualitative visual sort processing method is to produce a comprehensive list of benthic macroinvertebrate (BMI) taxa present in a sample. Samples were visually sorted for up to 2 hours. To increase sorting effectiveness, samples were first size-fractionated to separate coarse and fine detritus. The sample was placed in a 4.75 mm mesh sieve over a washbasin. If the sample volume was excessive, smaller amounts were washed incrementally in the sieve. The sample was then gently agitated in the sieve to allow fine sample detritus to pass through and placed on a sample tray. A second sieve of equal or slightly smaller mesh size was placed in a second washbasin and the sample detritus from the first washbasin that passed through the 4.75 mm sieve was washed through the second sieve. These steps were repeated, if necessary, until the entire sample was size-fractioned. A properly size-fractionated sample consisted of two portions: fine detritus (detritus passing through the 4.75 mm sieve) and coarse detritus (detritus retained by the 4.75 mm sieve). Fine and coarse sample detritus were evenly distributed into separate trays and filled with enough water to cover the entire sample. The coarse sample detritus was examined for at least 0.25 hours and the remaining time (up to 1.75 hours) was dedicated to examine the fine sample detritus. Each sample received was washed and re-preserved in its original container in 70% ethanol or processed within 2 weeks of receipt. Each container was labeled with the sample identification code, the first initial and last name of the individual who processed the sample, and the date the sample processing was completed.

**Sorting Protocols for Epifaunal Samples**

All unidentified benthic macroinvertebrates found were placed in their own vial according to taxonomic grouping and appropriately labeled with the correct sample identification information. All identified benthic macroinvertebrates found were placed in their own vials, labeled with the species determination, taxonomist name, date and sample identification code. Any Chironomids identified to the family level were placed into vials designated to be mounted or retained and were later identified.

A rack of vials was prepared, filled with 70% ethanol and corresponding to the following taxonomic groupings as needed: Gastropoda, Bivalvia, Oligochaeta, Hirudinea, Acari, Decapoda, Amphipoda/Isopoda, Ephemeroptera, Odonata, Plecoptera, Heteroptera, Megaloptera, Trichoptera, Lepidoptera, Coleoptera, Diptera (excluding Chironomidae), Chironomidae, Other or Miscellaneous. Each sample tray was visually sorted, re-distributed then quickly re-scanned to remove any additional specimens found. Each specimen sorted was put into vials according to their taxonomic grouping. Special attention was given to sorting specimens from groups that were difficult to identify to the genus or species level visually. Empty mollusk shells were sorted only if other similar looking shells did not contain soft body parts. Immature or damaged specimens were sorted only if they were likely to represent new taxa. The objective of this type of sorting was to find as many distinct taxa as practical within the two hour time limit. Taxa were reported only as “present.” Individual abundances of each taxon were not determined. Vertebrates, arthropod exuvia, branchiobdellids, eggs, microcrustaceans and terrestrial specimens were not sorted.

**Subsampling Protocols Infaunal Samples**

Laboratory sorting was accomplished by placing the entire sample contents into a 0.5 mm sieve over a large catch tray. The sample was lightly showered with water and gently shaken back and forth in the sieve to dislodge any small sediment from the sample. Rocks, sticks, leaves or any other assorted large items were thoroughly inspected, rinsed and removed. The sample was then placed into the sample tray by firmly tapping the overturned sieve into the tray and thoroughly rinsing. Two jars were used in this process: one for the remnants of the sample and one for the original sample left after processing. The sample was spread out evenly in the sample tray and no thicker than one-half inch in any one grid. The total number of grids was recorded and then a grid was randomly selected to work on using either a random number generator or a twenty sided dice. Within the chosen grid, a one-quarter size subsample was taken. If this size subsample did not yield enough macroinvertebrates (90+ for 600 count samples, 70+ for 500 count samples, 50+ for 300 count samples), the subsample size was increased to one-half a grid-size in the next random grid. If the subsample size yielded too many macroinvertebrates, the subsample size was decreased to one-eighth a grid-size in the next random grid. However, no subsample size was lower than one-eighth a grid-size and emphasis was placed on process material from at least three grids if possible.

**<u>Sorting Protocols for Infaunal Samples</u>**

A subsample of the original was placed in a Petri dish and sprayed with ethanol until just covered. The Petri dish was gently shaken to evenly distribute the subsample within the dish and placed on the dissecting scope stage with a view at a minimum magnification of 1.0. The subsample was thoroughly scanned for macroinvertebrates which were removed and placed into sorting vials according to taxonomic order. After scanning the subsample once, the dish was gently swirled again, scanned a second time and the remaining contents poured into the "remnant" jar.

Total number of macroinvertebrates found was recorded and this process was repeated until a fixed count was reached (300, 500 or 600). If the fixed count was reached before a scan was finished, all remaining macroinvertebrates were placed into a new "extras" vial. Total number of grids process and total processing time was also recorded. The remaining sample was returned to the "original" jar making sure the sample was covered with at least one inch of ethanol. Labels were placed into both jars containing the project name, the taxonomic ID, number of individuals, time the sample took to process and the sampler's initials. The jars were also distinguished by the word "remnant" or "original." Each vial that was removed was given a corresponding "QC" label. The corresponding taxonomic information for each vial was recorded on a sorting worksheet, including the fixed count and total count, processing time and the date. Vials were bundled together and placed next to the "remnant" jar to be QC'd.

**San Francisco State University Laboratory Protocols for Zooplankton Identification**

Subsampling, sorting and identification of zooplankton taxa protocols for the water column samples are available through SFSU/TRC.

**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 over 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 (the exceptions being the Delta freshwater and plankton samples that were directly transferred to their associated taxonomists for processing and sorting). 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**
Sorted bays and harbors quantitative samples were sent to a variety of specialized taxonomists. A variety of specialized taxonomists also received qualitative samples from the harbors (preserved according to taxonomic group in the field and sent directly to taxonomists). Taxonomists were selected according to qualifications, experience and specialty. Appendix A 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 clearings 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 B. 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 – Bays and Harbors**
Sediment samples collected for grain size analysis from the bays and harbors were transferred to Ken Davis at Applied Marine Sciences, Inc. for analysis. The grain size samples were analyzed according to Plumb, 1981. Sediment samples were wet sieved through a No. 230 (0.0625 mm) U.S. Standard Sieve. The fine fraction (silt and clay) were collected in a 1-Liter graduated cylinder. Soil retained on the No. 230 sieve was washed with distilled water into labeled, pre-weighed beakers and oven-dried for 24 hours at 105$^{o}$C. After drying, the soil was sieved using a No. 10 (2.00 mm) sieve to determine the percent gravel, and a No. 230 (0.0625 mm) sieve to determine percent sand. Sediment passing the No. 230 sieve was added to the fine fraction in the graduated cylinder. The fine fraction was stirred and aliquots secured to determine the percent silt (0.0625 mm to 0.0039 mm) and clay (<0.005 mm) using hydrometers as described in ASTM D-422.

Quality control consisted of a duplicate analysis with each batch of 20 or fewer samples. The resulting relative percent difference should be less than 35% for each fraction. Sieves and hydrometers utilized for this project were conformed to ASTM Specification E 11 (sieves) and ASTM Specification E 100 (hydrometers). Certificates of Calibration for sieves and hydrometers are retained on file for a period of three years after the project deadline.

**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.

**Data Handling**
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. Once taxonomist data was uploaded into the CANOD 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).

## 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 will be archived by 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 will be stored at MLML storage facilities. The storage location of all samples is recorded in the CANOD database so that they may be relocated in the future.

## *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."

The only exception to the above is that the type of sampling conducted for this survey does not provide enough information to determine whether these species have established populations at the locations sampled, as explained above. Therefore, we report collections of species considered introduced and do not attempt to evaluate whether the population is self-sustaining. 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 known to be 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 may 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 NIS 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.

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, and may be referred to in this report, 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. Native California species were identified in areas where they have not been previously reported. For example, the seaweed *Halymenia schizymenioides*, previously listed only from north of Santa Barbara, was identified from Channel Islands Harbor. It remains undetermined 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 introduction status of 'unresolved'. Likewise, most specimens from the current survey which have been given temporary provisional names were assigned an introduction status of unresolved. Specimens given the introduction status of unresolved will require additional taxonomic resolution before their true status can be confidently assigned. Specimens that were identified to the level of species complex in this survey were assigned introduction statuses according to the present understanding of the entire species complex. Due to the design of the CANOD database, and the long term goals for CANOD, it is not possible to record different introduction statuses (such as native and introduced) by location for the same species. Thus, a new introduction status term, "unresolved complex," was used during the current survey in order to flag some of the situations where indistinguishable members of the species complex would be considered native if collected from some locations or habitats in California (e.g. the outer coast) and introduced from other locations or habitats in California (e.g.. bays and harbors). This report gives further explanations for several of the taxa given the introduction status of unresolved complex to reflect current understanding for each of these. 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 is generally thought of as 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**

One on-going effort of this project is to update introduction status determinations for species as new information becomes available for species that have been identified during the previous surveys and listed in the CANOD database. Taxonomists identifying specimens collected reported several species with an introduction status that did not match the status last reported by MLML/CDFG. Literature reviews and further communications with taxonomists and other authorities on invasive species led to several species introduction status revisions from what was previously reported with the MLML/CDFG NIS survey results. In addition, outside reviews of the California NIS listed in the CANOD database led to several species name changes and/or introduction status revisions. Appendix C lists the changes that have been made to introduction statuses as they were reported most recently by MLML/CDFG (CDFG, In Prep.), and Table 1 shows an example of what can be found in appendix C. Some species and statuses listed may not have been specifically referred to in previous reports, but they may have either previously been categorized in reports or previously been listed in the CANOD database according to their old introduction status, so those changes are included here. Of the revisions, a total of 6 statuses were revised to introduced: 4 from cryptogenic to introduced, 1 from unresolved to introduced, and 1 from unknown to introduced. A total of 33 of the revisions resulted in a status change from introduced to another status: 17 were updated from introduced to cryptogenic, 8 from introduced to native, 6 from introduced to unresolved complex, and 2 from introduced to unresolved. Other categories with high rates of change included 40 status revisions from native to cryptogenic and 24 from cryptogenic to unresolved.

Also of the status revisions, 76 were to species from the phylum Annelida, 22 were from phylum Arthropoda, 7 were from phylum Ectoprocta, 3 were from phylum Cnidaria, 2 were from phylum Mollusca and 1 each were from the phyla Chordata, Rhodophyta and Chlorophyta.

It should be noted that for species not found previously listed with an introduction status, the determinations made by taxonomists are not always verified or checked against other sources. Introduction statuses reported here reflect the most current and updated information to our knowledge.

**Table 1. Examples of introduction status revisions fully listed in Appendix C.**

| Species Name | Phylum | Previous Introduction Status | Updated Introduction Status | Status Determination Sources |
|---|---|---|---|---|
| *Acanthomysis californica* | Arthropoda | Native | Cryptogenic, Likely Native | D. Cadien personal notes |
| *Aglaothamnion cordatum* | Rhodophyta | Introduced | Cryptogenic | K. A. Miller pers. comm., Feb. 2008; Abbott and Hollenberg, 1976 |
| **Alcyonidium polyoum* (Identifications changed to genus *Alcyonidium*) | Ectoprocta | Introduced | Unresolved | J. Ryland pers. comm., Jan. 2008 |
| *Amaeana occidentalis* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |

## Summary of Field Surveys

A total of 202 epifaunal samples (hard substrate scrapings) were collected from the bays and harbors. In addition, a total of 97 qualitative samples were collected during the swimming visual scans. Fifty six infaunal and grain size samples were also collected from the bays and harbors. All of the epifaunal, qualitative and infaunal samples collected were sent to taxonomists for identifications of the specimens. Of the 56 grain size samples collected, a subset from each harbor was selected for analysis, and a total of 29 grain size samples were analyzed. One hundred twenty water column samples were collected for zooplankton specimens from the 6 bays and harbors. Station position and sampling information for each location are given in Appendix D.

## Summary of Taxonomic Identifications

From the samples collected during the current field surveys, a total of 775 species were identified, of which 82 were classified as introduced, 126 were classified as cryptogenic and 567 were classified as native to California. The samples collected during the field surveys also produced 396 different taxa which were not identified to species level and were classified as unresolved for this report. In addition, a total of 6 taxa identified to the species complex level were classified with an introduction status of unresolved complex, and may or may not be introduced to California's bays and harbors as explained above. Species classified as introduced are listed in each of the phyla sections to follow. 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 all of the bays and harbors surveyed, and the number and percentage of taxa identified within each introduction status classification. It is important to note that different combinations of habitats were sampled at the different harbors, as indicated by the asterisks in the table, so direct comparisons between bays based on this table should be made cautiously. Table 2 also includes results from a survey of San Diego Bay conducted in 2005 by CDFG/USFWS (Maloney et al., 2007). For the 2005 survey of San Diego Bay, epifaunal and infaunal habitats were sampled using the same sampling protocol used in the current survey, but 20 sites were sampled within San Diego Bay, which is considerably more sampling effort afforded the harbors sampled for the current survey.

**Table 2. Number of taxa identified from samples for each classification in each harbor where infaunal, epifaunal and water column samples were collected.**

| Waterbody | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|
| *Humboldt Bay | 370 | 23 (6.2%) | 48 (13.0%) | 173 (46.8%) | 3 (0.8%) | 123 (33.2%) |
| Bodega Bay | 177 | 18 (10.2%) | 38 (21.5%) | 59 (33.3%) | 2 (1.1%) | 60 (33.9%) |
| Tomales Bay | 148 | 23 (15.5%) | 24 (16.2%) | 62 (41.9%) | 1 (0.7%) | 38 (25.7%) |
| **San Francisco Bay | 47 | 9 (19.1%) | 4 (8.5%) | 27 (57.4%) | 1 (2.1%) | 6 (12.8%) |
| **Port of Oakland | 36 | 8 (22.2%) | 3 (8.3%) | 18 (50.0%) | 1 (2.8%) | 6 (17.7%) |
| Moss Landing Harbor | 157 | 20 (12.7%) | 25 (15.9%) | 66 (42.0%) | 2 (1.3%) | 44 (28.0%) |
| Monterey Harbor | 260 | 14 (5.4%) | 35 (13.5%) | 118 (45.4%) | 2 (0.8%) | 91 (35.0%) |
| Morro Bay | 241 | 17 (7.1%) | 33 (13.7%) | 108 (44.8%) | 3 (1.2%) | 80 (33.2%) |
| Santa Barbara Harbor | 220 | 21 (9.5%) | 38 (17.3%) | 77 (35.0%) | 2 (0.9%) | 82 (37.3%) |
| Channel Islands Harbor | 210 | 24 (11.4%) | 34 (16.2%) | 75 (35.7%) | 2 (1.0%) | 75 (35.7%) |
| *Port Hueneme | 355 | 24 (6.8%) | 47 (13.2%) | 166 (46.8%) | 3 (0.8%) | 115 (32.4%) |
| Marina del Rey Harbor | 160 | 24 (15.0%) | 36 (22.5%) | 50 (31.3%) | 1 (0.6%) | 49 (30.6%) |
| *Los Angeles Harbor | 354 | 34 (9.6%) | 57 (16.1%) | 158 (44.6%) | 1 (0.3%) | 104 (29.4%) |
| *Long Beach Harbor | 301 | 31 (10.3%) | 42 (14.0%) | 137 (45.5%) | 1 (0.3%) | 90 (29.9%) |
| Huntington Harbor | 162 | 24 (14.8%) | 22 (13.6%) | 65 (40.1%) | 1 (0.6%) | 50 (30.9%) |
| Newport Bay | 199 | 31 (15.6%) | 35 (17.6%) | 69 (34.7%) | 1 (0.5%) | 63 (31.7%) |
| Dana Point Harbor | 153 | 22 (14.4%) | 23 (15.0%) | 52 (34.0%) | 2 (1.3%) | 54 (35.3%) |
| Avalon Harbor | 190 | 17 (8.9%) | 24 (12.6%) | 87 (45.8%) | 1 (0.5%) | 61 (32.1%) |
| Oceanside Harbor | 143 | 20 (14.0%) | 19 (13.3%) | 53 (37.1%) | 1 (0.7%) | 50 (35.0%) |
| Mission Bay | 218 | 31 (14.2%) | 29 (13.3%) | 85 (39.0%) | 1 (0.5%) | 72 (33.0%) |
| ***San Diego Bay | 486 | 44 (9.0%) | 56 (11.5%) | 204 (42.0%) | 0 | 182 (37.4%) |
| Port of Sacramento | 50 | 3 (6.0%) | 4 (8.0%) | 9 (18.0%) | 1 (2.0%) | 33 (66.0%) |
| Port of Stockton | 33 | 2 (6.1%) | 3 (9.1%) | 3 (9.1%) | 1 (3.0%) | 24 (72.7%) |

* includes sites where the water column was sampled for zooplankton
** only includes sites where the water column sampled for zooplankton
***includes water column results from current survey as well as epifaunal and infaunal results from 2005 MLML/USFWS survey of San Diego Bay

In the marine bays and harbors where infaunal and epifaunal habitats were sampled (and for some harbors, water column for zooplankton as well), introduced species ranged from a low of 14 species (at 2 different harbors) to a high of 44 species at San Diego Bay, and represented 5.4% to 15.6% of the total taxa collected from each harbor. Also in the marine harbors, cryptogenic species ranged from 19 species collected in Oceanside harbor to 57 species collected in Los Angeles Harbor, representing 12.6% to 22.5% of total taxa at each site. Native species in marine harbors ranged from 50 to 204 species collected, representing 31.3% to 57.4% of total taxa collected from each harbor, while up to 3 taxa were classified as unresolved complex from each marine harbor, representing 0.3% to 1.3% of the total taxa in each harbor.

Fewer species overall were identified in the freshwater ports surveyed, and a larger portion of species collected in freshwater ports were unresolved taxa as compared to marine harbors. If unresolved identifications are not considered, at least 9% of the total taxa from each marine harbor surveyed were classified as introduced, whereas at least 25% were classified as introduced in each freshwater port. Two introduced species were identified at Sacramento, and 3 introduced species were identified at Stockton. Introduced species represented approximately 6% of the total taxa (including the unresolved taxa) collected from each of those freshwater ports. Three cryptogenic species were identified at Stockton, representing 9.1% of the total taxa collected, while 4 cryptogenic species were identified at Sacramento, which represented 8% of the total taxa collected. At Sacramento, 9 native species were identified, which represented 18% of the total taxa collected at that site. Three native species were identified from Stockton, representing 9.1% of the total taxa collected there. One unresolved complex taxa was identified from each of the two freshwater ports, representing 2% to 3% of the total taxa.

In two ports, San Francisco Bay and the Port of Oakland, the only habitat sampled was the water column for zooplankton. Since the taxa list differs substantially from the taxa collected in epifaunal and infaunal habitats surveyed, zooplankton identification results from all harbors where the water column sampling occurred are further detailed separately below.

Figure 9 shows all of the bays and harbors surveyed, and the number of introduced species identified from each. Like in table 2, note that different combinations of habitats were sampled at the different harbors, as indicated by the asterisks on the figure. Figure 9 also includes results from the CDFG/USFWS San Diego Bay survey of epifaunal and infaunal habitat conducted in 2002 (Maloney et al., 2007). The number of introduced species collected from marine harbors along the state showed some patterns. Freshwater ports had far fewer introduced species than did the marine bays and harbors. Also, all of the bays and harbors with the highest number of introduced species were in southern California. The highest number of introduced species identified from northern and central California bays and harbors was 24 species, whereas five different harbors in southern California had over 30 introduced species.

Species assemblage correlations between sites may exist but were not analyzed for this report.

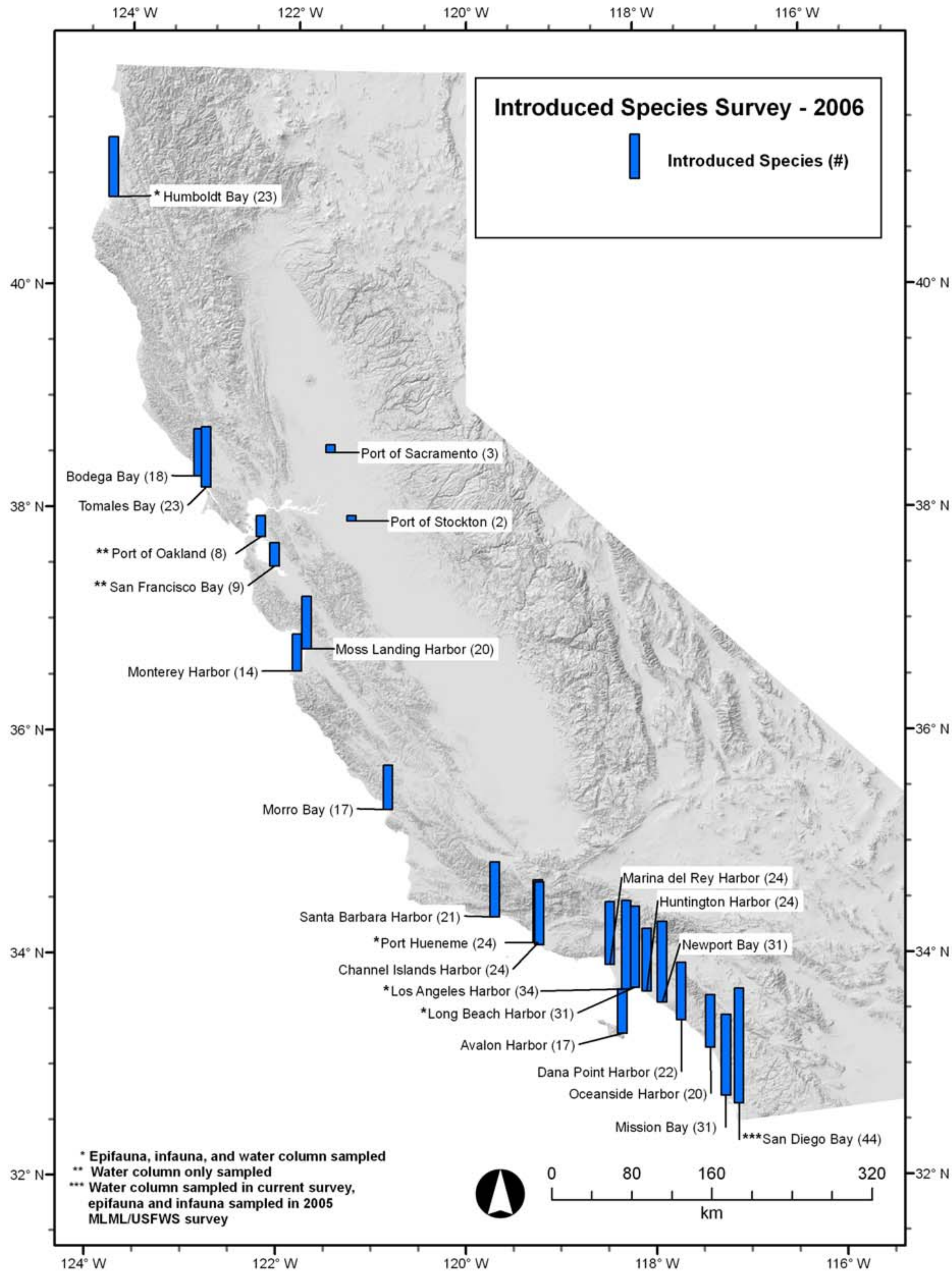



**Figure 9. Number of introduced species identified from each of bays and harbors surveyed.**

Epifaunal samples collected during the current survey yielded nearly twice as many total unique taxa than did the infaunal samples (Table 3). Likewise, the number of introduced species identified from epifaunal samples (66 species) was more than twice the number identified from infaunal samples (31 species). Although the number of introduced species identified from epifaunal samples was over twice the number of introduced species identified from infaunal samples, the percent of total taxa represented by introduced species was relatively similar for the two habitats. The percentages of introduced and native zooplankton taxa were higher than the percentages from epifaunal and epifaunal habitats for those classifications. In contrast, the percentages of cryptogenic and unresolved zooplankton taxa were lower than what was seen in the epifaunal and infaunal habitats.

**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 Complex | Unresolved |
|---|---|---|---|---|---|---|
| Epifaunal | 884 | 66 (7.5%) | 91 (10.3%) | 393 (44.5%) | 4 (0.5%) | 330 (37.3%) |
| Infaunal | 456 | 31 (6.8%) | 66 (14.5%) | 216 (47.4%) | 2 (0.4%) | 141 (30.9%) |
| Water Column | 78 | 11 (14.1%) | 4 (5.1%) | 50 (64.1%) | 1 (1.3%) | 12 (15.4%) |

From the identifications made, 43 introduced species were unique to epifaunal habitat, and 8 introduced species were unique to infaunal habitat. Also, greater numbers of native, cryptogenic and unresolved taxa were identified from epifaunal samples as compared to the infaunal samples. Water column samples produced the fewest total unique taxa of the three habitats sampled. More introduced species were found in epifaunal samples compared to both infaunal and water column samples at each individual harbor sampled as well (Appendix E).

The higher number of introduced species found in epifaunal habitat may be due, in part, to a greater sampling effort in that habitat. A greater total area was sampled in epifaunal habitat than in infaunal habitat ($0.2m^2$ vs. $0.\ 05m^2$, respectively per sampling location, with some sampling locations excluding infaunal sampling all together). Additionally, an on-site, qualitative visual search conducted via SCUBA accompanied surveys in epifaunal habitat but not in infaunal habitat. Four introduced invertebrate and 4 algae species were identified from the visual searches in epifaunal habitat which were not detected in the quantitative samples collected from the same sites and habitats. Additionally, more samples were collected from infaunal habitat than from the water column habitat. More investigation into possible habitat type preferences for introduced species may help explain the trends observed**.**

Appendix F depicts results from the grain size analysis in percent fines for each survey site. There was no discernable correlation between grain size and the number of introduced species found per site.

Table 4 details the number and percentage of species within each classification for the major phyla identified in epifaunal and infaunal habitats. From the epifaunal and infaunal samples, introduced species were found from 20 different phyla. The phylum with the highest number of introduced species (25 species) was Arthropoda. However, introduced species represented the highest percentage of total taxa within the phylum Malignophyta (100% were introduced, but only one taxa was collected from that phylum total), followed by the phylum Chordata (40%). Of the introduced species identified in the infaunal and epifaunal samples from current survey, 25 were arthropods, 18 were chordates, 9 were annelids, 9 were molluscs, and 6 were ectoprocts. There were less than 5 each of cnidarians, entoprocts, magnoliophytes, porifera, and marine algae. Results are further detailed by phylum in the following sections.

**Table 4. Number of species and percentage of total taxa of each classification for each phylum, combining epifaunal and infaunal samples.**

| Phylum | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|
| Annelida | 352 | 9 (2.6%) | 61 (17.3%) | 114 (32.4%) | 2 (0.6%) | 166 (47.2%) |
| Arthropoda | 327 | 25 (7.6%) | 34 (10.4%) | 172 (52.6%) | 1 (0.3%) | 95 (29.1%) |
| Bacillariophyta | 1 | | | | | 1 (100.0%) |
| Brachiopoda | 1 | | | | | 1 (100.0%) |
| Chlorophyta | 8 | | 1 (12.5%) | 6 (75.0%) | | 1 (12.5%) |
| Chordata | 45 | 18 (40.0%) | 1 (2.2%) | 12 (26.7%) | | 14 (31.1%) |
| Cnidaria | 52 | 1 (1.9%) | 4 (7.7%) | 16 (30.8%) | 1 (1.9%) | 30 (57.7%) |
| Echinodermata | 17 | | 2 (11.8%) | 6 (35.3%) | | 9 (52.9%) |
| Ectoprocta | 35 | 6 (17.1%) | 3 (8.6%) | 20 (57.1%) | 1 (2.9%) | 5 (14.3%) |
| Entoprocta | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Magnoliophyta | 1 | 1 (100.0%) | | | | |
| Mollusca | 147 | 9 (6.1%) | 1 (0.7%) | 105 (71.4%) | | 32 (21.8%) |
| Nemata | 1 | | | | | 1 (100.0%) |
| Nemertea | 35 | | 8 (22.9%) | 15 (42.9%) | | 12 (34.3%) |
| Heterokontophyta | 11 | 2 (18.2%) | | 8 (72.7%) | | 1 (9.1%) |
| Phoronida | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Platyhelminthes | 19 | | 2 (10.5%) | 10 (52.6%) | | 7 (36.8%) |
| Porifera | 26 | 1 (3.8%) | 2 (7.7%) | 13 (50.0%) | | 10 (38.5%) |
| Rhodophyta | 22 | 1 (4.5%) | 2 (9.1%) | 17 (77.3%) | | 2 (9.1%) |
| Sipuncula | 2 | | 2 (100.0%) | | | |

Unresolved taxa numbered from zero to 166 unique taxa collected within each phylum, and accounted for 0% to 100% of the total taxa collected within each phylum. 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 37% of the total taxa collected within each phylum were classified as unresolved; this large percent 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, MLML asked taxonomists to record the reason for each identification that is not resolved to species level. Table 5 lists the possible reasons for unresolved identifications and the number of specimens counted that were not identified to species level for each reason. This table combines results from all habitat types sampled. The total number of specimens counted that were not resolved to species level identifications was 281,636. In comparison, over 3 million specimens were identified to the species level. It should be noted that taxonomists were not required to count specimens classified as native to California, nor were specimens counted when identified from the qualitative search collections, so the above counts do not reflect exact numbers of specimens collected in the survey. However, the numbers and percentages shown in table 5 are still useful both for comparing the different reasons for unresolved identifications and for comparing the number of unresolved specimens versus specimens identified to species level.

Of the unresolved identifications for the current survey, approximately 53% were due to juvenile or non-reproductive specimens, approximately 6% were due to damaged specimens (presumably damaged during the collection process), approximately 15% were both juvenile and damaged, approximately 21% were due to undescribed or unrecognized species, approximately 5% were due to other reasons which were not specified by the taxonomists. Approximately 0.2% 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 |
|---|---|
| Juvenile or Non-reproductive | 148,984 (53%) |
| Damaged Specimen | 17,726 (6%) |
| Juvenile and Damaged Specimen | 42,034 (15%) |
| Undescribed | 58,226 (21%) |
| Other | 14,090 (5%) |
| Combination of two or more of the above categories | 576 (0.2%) |

In addition, 3152 specimens classified as unresolved complex were counted (represented by 6 unique taxa). Of those specimens, 3072 were classified as such because some or all of the species from that complex remain undescribed, while 80 specimens were classified as such for other reasons. Other reasons for classifying taxa as unresolved complex are described above in the terminology section above.

Table 6 depicts the number and percentage of unresolved identifications shown above by phylum. The majority of unresolved identifications came from annelids (60%) and arthropods (36%), which together comprised 96% of the recorded unresolved identifications from the current survey. The leading reason(s) for the unresolved identifications differed between these two phyla. For annelids, three reasons played fairly significant roles: juvenile/non-reproductive specimens, undescribed species, and specimens that were both too juvenile and too damaged for proper identifications. In contrast, the leading reason for the unresolved arthropod identifications was specimens that were juvenile or non-reproductive. CDFG/OSPR and MLML shared results similar to these from previous surveys with taxonomists, and asked for input as to whether these numbers of unresolved taxa seemed too high, and asked for ideas on how these numbers may be lowered in future surveys. The general consensus among the taxonomists was that these numbers are to be expected in any survey of this nature, and that the survey is being conducted during the best season for most phyla as far as reducing the number of juveniles (summer/fall). However, these data may still be useful when considering alternative sampling seasons or procedures.

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

| Phylum | Total Number of Unresolved Identifications | Juvenile/Non-reproductive | Damaged | Undescribed | Other | Juvenile/Damaged | Combination of Two or More Categories |
|---|---|---|---|---|---|---|---|
| Annelida | 170,097 | 39,577 (23.3%) | 16,122 (9.5%) | 60,434 (35.5%) | 13,978 (8.2%) | 39,986 (23.5%) | |
| Arthropoda | 102,590 | 101,066 (98.5%) | 748 (0.7%) | 696 (0.7%) | 80 (0.1%) | | |
| Bacillariophyta | 0 | | | | | | |
| Brachiopoda | 0 | | | | | | |
| Chlorophyta | 0 | | | | | | |
| Chordata | 4596 | 3012 (65.5%) | 376 (8.2%) | 88 (1.9%) | | 544 (11.8%) | 576 (12.5%) |
| Cnidaria | 32 | 16 (50.0%) | | 16 (50.0%) | | | |
| Echinodermata | 2378 | 938 (39.4%) | 96 (4.0%) | | | 1344 (56.5%) | |
| Ectoprocta | 16 | | | 16 (100.0%) | | | |
| Mollusca | 1546 | 1162 (75.2%) | 176 (11.4%) | | 48 (3.1%) | 160 (10.3%) | |
| Nemata | 64 | | | | 64 (100.0%) | | |
| Nemertea | 2401 | 2225 (92.7%) | 176 (7.3%) | | | | |
| Heterokontophyta | 0 | | | | | | |
| Phoronida | 0 | | | | | | |

| | | | | |
|---|---|---|---|---|
| Platyhelminthes | 1068 | 988 (92.5%) | 32 (3.0%) | 48 (4.5%) |
| Porifera | 0 | | | |
| Rhodophyta | 0 | | | |

Appendix G shows which harbor(s) each of the introduced species were identified in, including results from all habitats sampled. Note that for the Port of Oakland, San Francisco Bay and San Diego Bay, only water column sampling for zooplankton specimens was conducted. 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 area subsampled among sites has not been standardized, so counts of individuals should be used cautiously in a relative sense rather than an accurate, quantitative sense. If more accurate density estimates are needed, additional data analysis should be performed.

Appendix H lists the cryptogenic species collected, along with assessments of whether some of those species are most likely native or introduced, and the number of bays and harbors where each species was observed. Of the 126 cryptogenic species listed, 8 have been considered to be “likely introduced” while 27 have been considered “likely native”.

The report sections below that give detailed results by phyla identified include data from only epifaunal and infaunal habitats sampled. Zooplankton identification results from the third habitat sampled, the water column, are summarized in a separate section after the phyla sections.

**Summary of Annelid Taxonomy (Segmented Worms)**


*Nicolea sp A* Harris, photo used with permission by Leslie Harris

Nine introduced species of annelids were identified from the epifaunal and infaunal samples collected for the current survey of bays and harbors, and introduced annelid species were found at 15 out of the 20 bays and harbors where infaunal and epifaunal habitats were surveyed. Introduced annelids collected in epifaunal habitat ranged from zero to 4 species per bay or harbor, representing 0% to 20% of the total annelid taxa from epifaunal samples per bay or harbor (Table 7). Introduced annelids collected in infaunal habitat per bay or harbor ranged from zero to 2 species, representing 0% to 14.3% of the total annelid taxa from infaunal samples per bay or harbor (Table 8). Eight of the nine introduced annelid species identified are polychaetes: *Branchiosyllis exilis, Ficopomatus enigmaticus, Hydroides elegans, Manayunkia speciosa, Myrianida pachycera, Nicolea sp A* Harris (pictured above)*, Streblospio benedicti complex*, and *Typosyllis nipponica*. The ninth introduced annelid is an oligochaete, *Branchiura sowerbyi*.

Sixty one annelid species were identified and classified as cryptogenic. Cryptogenic annelids per bay or harbor ranged from 0 to 16 species in epifaunal habitat, representing 0% to 42.9% of total infaunal annelid taxa per bay or harbor. One hundred fourteen native annelid species were identified from epifaunal and infaunal samples. Native species represented 0% to 39.4% of the annelid taxa identified from each bay or harbor for epifaunal samples and 13.3% to 52.9% in infaunal samples.

A large proportion of the annelid taxa (116 taxa out of 352 total unique taxa) collected were not identified to the species level and were classified as unresolved. Unresolved taxa represented 20% to 66.7% of the total annelid taxa collected in epifaunal habitat per pay, and 12.5% to 66.7% in infaunal habitat per bay or harbor. Two annelid taxa collected were classified as unresolved complex. These include *Nais communis/variabilis* complex and *Harmothoe imbricata* complex. *N. communis/varibilis* complex was only collected from the epifaunal communities at the freshwater ports sampled, Port of Sacramento and Port of Stockton, whereas *H. imbricata* complex was found at several marine bays and harbors in both epifaunal and infaunal habitats. A large number of identifications with provisional species names contribute to high percentage of "unresolved" annelids, which is consistent with findings from other similar surveys.

**Table 7. Number of species and percentage of total annelid taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 68 | | 9 (13.2%) | 17 (25.0%) | 1 (1.5%) | 41 (60.3%) |
| Port of Sacramento | Epifauna | 5 | | 2 (40.0%) | 1 (20.0%) | 1 (20.0%) | 1 (20.0%) |
| Bodega Bay | Epifauna | 57 | | 10 (17.5%) | 10 (17.5%) | 1 (1.8%) | 36 (63.2%) |
| Tomales Bay | Epifauna | 26 | | 6 (23.1%) | 8 (30.8%) | | 12 (46.2%) |
| Port of Stockton | Epifauna | 5 | 1 (20.0%) | 1 (20.0%) | | 1 (20.0%) | 2 (40.0%) |
| Moss Landing Harbor | Epifauna | 38 | 2 (5.3%) | 8 (21.1%) | 11 (28.9%) | | 17 (44.7%) |
| Monterey Harbor | Epifauna | 66 | | 9 (13.6%) | 26 (39.4%) | 1 (1.5%) | 30 (45.5%) |
| Morro Bay | Epifauna | 64 | | 7 (10.9%) | 16 (25.0%) | 1 (1.6%) | 40 (62.5%) |
| Santa Barbara Harbor | Epifauna | 63 | 2 (3.2%) | 8 (12.7%) | 10 (15.9%) | 1 (1.6%) | 42 (66.7%) |
| Channel Islands Harbor | Epifauna | 53 | 1 (1.9%) | 7 (13.2%) | 12 (22.6%) | 1 (1.9%) | 32 (60.4%) |
| Port Hueneme | Epifauna | 73 | 1 (1.4%) | 10 (13.7%) | 15 (20.5%) | 1 (1.4%) | 46 (63.0%) |
| Marina del Rey Harbor | Epifauna | 60 | 3 (5.0%) | 16 (26.7%) | 11 (18.3%) | 1 (1.7%) | 29 (48.3%) |
| Los Angeles Harbor | Epifauna | 78 | 3 (3.8%) | 14 (17.9%) | 24 (30.8%) | 1 (1.3%) | 36 (46.2%) |
| Long Beach Harbor | Epifauna | 84 | 3 (3.6%) | 13 (15.5%) | 23 (27.4%) | 1 (1.2%) | 44 (52.4%) |
| Huntington Harbor | Epifauna | 40 | 3 (7.5%) | 7 (17.5%) | 8 (20.0%) | 1 (2.5%) | 21 (52.5%) |
| Newport Bay | Epifauna | 59 | 4 (6.8%) | 11 (18.6%) | 12 (20.3%) | 1 (1.7%) | 31 (52.5%) |
| Dana Point Harbor | Epifauna | 49 | 2 (4.1%) | 6 (12.2%) | 12 (24.5%) | 1 (2.0%) | 28 (57.1%) |
| Avalon Harbor | Epifauna | 29 | 2 (6.9%) | 3 (10.3%) | 7 (24.1%) | | 17 (58.6%) |
| Oceanside Harbor | Epifauna | 58 | 2 (3.4%) | 8 (13.8%) | 15 (25.9%) | 1 (1.7%) | 32 (55.2%) |

**Table 8. Number of species and percentage of total annelid taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 39 | 1 (2.6%) | 12 (30.8%) | 13 (33.3%) | 1 (2.6%) | 12 (30.8%) |
| Port of Sacramento | Infauna | 8 | 1 (12.5%) | 3 (37.5%) | 3 (37.5%) | | 1 (12.5%) |
| Bodega Bay | Infauna | 23 | | 9 (39.1%) | 8 (34.8%) | 1 (4.3%) | 5 (21.7%) |
| Tomales Bay | Infauna | 19 | | 7 (36.8%) | 5 (26.3%) | | 7 (36.8%) |
| Port of Stockton | Infauna | 7 | 1 (14.3%) | 3 (42.9%) | 1 (14.3%) | | 2 (28.6%) |
| Moss Landing Harbor | Infauna | 17 | 1 (5.9%) | 2 (11.8%) | 9 (52.9%) | | 5 (29.4%) |
| Monterey Harbor | Infauna | 56 | | 8 (14.3%) | 14 (25.0%) | | 34 (60.7%) |
| Morro Bay | Infauna | 19 | | 5 (26.3%) | 10 (52.6%) | | 4 (21.1%) |
| Santa Barbara Harbor | Infauna | 34 | 1 (2.9%) | 11 (32.4%) | 9 (26.5%) | 1 (2.9%) | 12 (35.3%) |
| Channel Islands Harbor | Infauna | 33 | 1 (3.0%) | 10 (30.3%) | 6 (18.2%) | 1 (3.0%) | 15 (45.5%) |
| Port Hueneme | Infauna | 49 | 1 (2.0%) | 9 (18.4%) | 21 (42.9%) | | 18 (36.7%) |
| Marina del Rey Harbor | Infauna | 17 | 1 (5.9%) | 6 (35.3%) | 3 (17.6%) | | 7 (41.2%) |
| Los Angeles Harbor | Infauna | 72 | 2 (2.8%) | 21 (29.2%) | 25 (34.7%) | | 24 (33.3%) |
| Long Beach Harbor | Infauna | 26 | | 5 (19.2%) | 10 (38.5%) | 1 (3.8%) | 10 (38.5%) |
| Huntington Harbor | Infauna | 20 | 1 (5.0%) | 6 (30.0%) | 3 (15.0%) | | 10 (50.0%) |
| Newport Bay | Infauna | 29 | | 10 (34.5%) | 6 (20.7%) | 1 (3.4%) | 12 (41.4%) |

| | | | | | |
|---|---|---|---|---|---|
| Dana Point Harbor | Infauna | 15 | 5 (33.3%) | 2 (13.3%) | 8 (53.3%) |
| Avalon Harbor | Infauna | 35 | 10 (28.6%) | 7 (20.0%) | 18 (51.4%) |
| Oceanside Harbor | Infauna | 3 | | 1 (33.3%) | 2 (66.7%) |
| Mission Bay | Infauna | 15 | 4 (26.7%) | 4 (26.7%) | 7 (46.7%) |

**Summary of Arthropod Taxonomy**


*Grandidierella japonica*, photo used with permission by Leslie Harris

Arthropods represent the phylum with the highest number of introduced species in the current survey. Twenty five introduced species (including *Grandidierella japonica*, pictured above) and 34 cryptogenic species of arthropods were identified from the epifaunal and infaunal habitats sampled. The introduced arthropod species identified are:

| | | |
|---|---|---|
| *Amphibalanus amphitrite* | *Grandidierella japonica* | *Nippoleucon hinumensis* |
| *Ampithoe valida* | *Incisocalliope derzhavini* | *Paracorophium lucasi* |
| *Anopsilana jonesi* | *Limnoria quadripunctata* | *Paradexamine churinga* |
| *Aoroides secundus* | *Limnoria tripunctata* | *Paradexamine sp. SD1 SCAMIT* |
| *Balanus eburneus* | *Melita nitida* | *Sphaeroma quoianum* |
| *Caprella mutica* | *Melita rylovae* | *Stenothoe valida* |
| *Caprella scaura* | *Microdeutopus gryllotalpa* | *Synidotea laticauda* |
| *Corophium heteroceratum* | *Monocorophium acherusicum* | |
| *Eusarsiella zostericola* | *Monocorophium insidiosum* | |

Both introduced and cryptogenic species of arthropods were identified from all marine bays and harbors surveyed and neither of the two freshwater ports sampled for the current survey (Tables 9 and 10). For marine bays and harbors surveyed, introduced species represented 3.8% to 19.5% of arthropods from epifaunal samples, and 0% to 40% of arthropods from infaunal samples. Cryptogenic arthropods represented 15.7% to 39.3% of arthropods in epifaunal and 0% to 40% in infaunal samples collected from marine bays and harbors.

The majority of arthropod taxa in marine bays and harbors were native species, while in the freshwater ports, few native arthropods were found and the majority of arthropods were unresolved taxa. Native arthropods in epifaunal habitat in marine bays and harbors ranged from ranged from 44.1% to 64.7% of the arthropod taxa per harbor, and from 33.3% to 66.7% in infaunal habitat. Ninety five taxa of arthropods collected from all epifaunal and infaunal habitats were not identified to species level and were classified as unresolved. These unresolved taxa represented 0% to 100% of the arthropods collected in both habitats from each bay or harbor.

**Table 9. Number of species and percentage of total arthropod taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 95 | 7 (7.4%) | 16 (16.8%) | 50 (52.6%) | | 22 (23.2%) |
| Port of Sacramento | Epifauna | 20 | | | 2 (10.0%) | | 18 (90.0%) |
| Bodega Bay | Epifauna | 36 | 3 (8.3%) | 12 (33.3%) | 16 (44.4%) | | 5 (13.9%) |
| Tomales Bay | Epifauna | 41 | 8 (19.5%) | 9 (22.0%) | 19 (46.3%) | | 5 (12.2%) |
| Port of Stockton | Epifauna | 13 | | | 1 (7.7%) | | 12 (92.3%) |
| Moss Landing Harbor | Epifauna | 48 | 6 (12.5%) | 11 (22.9%) | 21 (43.8%) | | 10 (20.8%) |
| Monterey Harbor | Epifauna | 57 | 4 (7.0%) | 11 (19.3%) | 35 (61.4%) | | 7 (12.3%) |
| Morro Bay | Epifauna | 78 | 6 (7.7%) | 15 (19.2%) | 42 (53.8%) | | 15 (19.2%) |
| Santa Barbara Harbor | Epifauna | 50 | 3 (6.0%) | 14 (28.0%) | 22 (44.0%) | | 11 (22.0%) |
| Channel Islands Harbor | Epifauna | 43 | 6 (14.0%) | 11 (25.6%) | 19 (44.2%) | | 7 (16.3%) |
| Port Hueneme | Epifauna | 78 | 3 (3.8%) | 15 (19.2%) | 42 (53.8%) | | 18 (23.1%) |
| Marina del Rey Harbor | Epifauna | 28 | 2 (7.1%) | 11 (39.3%) | 14 (50.0%) | | 1 (3.6%) |
| Los Angeles Harbor | Epifauna | 67 | 7 (10.4%) | 15 (22.4%) | 35 (52.2%) | | 10 (14.9%) |
| Long Beach Harbor | Epifauna | 66 | 8 (12.1%) | 13 (19.7%) | 34 (51.5%) | | 11 (16.7%) |
| Huntington Harbor | Epifauna | 34 | 3 (8.8%) | 7 (20.6%) | 22 (64.7%) | | 2 (5.9%) |
| Newport Bay | Epifauna | 41 | 5 (12.2%) | 11 (26.8%) | 19 (46.3%) | | 6 (14.6%) |
| Dana Point Harbor | Epifauna | 34 | 5 (14.7%) | 8 (23.5%) | 15 (44.1%) | | 6 (17.6%) |
| Avalon Harbor | Epifauna | 51 | 6 (11.8%) | 8 (15.7%) | 29 (56.9%) | | 8 (15.7%) |
| Oceanside Harbor | Epifauna | 22 | 2 (9.1%) | 5 (22.7%) | 11 (50.0%) | | 4 (18.2%) |
| Mission Bay | Epifauna | 57 | 7 (12.3%) | 12 (21.1%) | 26 (45.6%) | | 12 (21.1%) |

**Table 10. Number of species and percentage of total arthropod taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 15 | 4 (26.7%) | 4 (26.7%) | 5 (33.3%) | | 2 (13.3%) |
| Port of Sacramento | Infauna | 13 | | | 1 (7.7%) | | 12 (92.3%) |
| Bodega Bay | Infauna | 15 | 3 (20.0%) | 4 (26.7%) | 6 (40.0%) | | 2 (13.3%) |
| Tomales Bay | Infauna | 8 | 3 (37.5%) | 1 (12.5%) | 3 (37.5%) | | 1 (12.5%) |
| Port of Stockton | Infauna | 5 | | | | | 5 (100.0%) |
| Moss Landing Harbor | Infauna | 17 | 2 (11.8%) | 5 (29.4%) | 9 (52.9%) | | 1 (5.9%) |
| Monterey Harbor | Infauna | 27 | 2 (7.4%) | 4 (14.8%) | 17 (63.0%) | | 4 (14.8%) |
| Morro Bay | Infauna | 29 | 4 (13.8%) | 5 (17.2%) | 15 (51.7%) | | 5 (17.2%) |
| Santa Barbara Harbor | Infauna | 15 | 1 (6.7%) | 3 (20.0%) | 10 (66.7%) | | 1 (6.7%) |
| Channel Islands Harbor | Infauna | 20 | 3 (15.0%) | 6 (30.0%) | 10 (50.0%) | | 1 (5.0%) |
| Port Hueneme | Infauna | 14 | 1 (7.1%) | 5 (35.7%) | 7 (50.0%) | | 1 (7.1%) |
| Marina del Rey Harbor | Infauna | 11 | 1 (9.1%) | 3 (27.3%) | 7 (63.6%) | | |
| Los Angeles Harbor | Infauna | 16 | 1 (6.3%) | 3 (18.8%) | 8 (50.0%) | | 4 (25.0%) |
| Long Beach Harbor | Infauna | 5 | | 2 (40.0%) | 3 (60.0%) | | |
| Huntington Harbor | Infauna | 4 | | 1 (25.0%) | 2 (50.0%) | | 1 (25.0%) |
| Newport Bay | Infauna | 20 | 3 (15.0%) | 4 (20.0%) | 11 (55.0%) | | 2 (10.0%) |
| Dana Point Harbor | Infauna | 5 | 2 (40.0%) | 1 (20.0%) | 2 (40.0%) | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Avalon Harbor | Infauna | 16 | | 2 (12.5%) | 13 (81.3%) | 1 (6.3%) |
| Oceanside Harbor | Infauna | 1 | | | 1 (100.0%) | |
| Mission Bay | Infauna | 10 | 1 (10.0%) | 1 (10.0%) | 8 (80.0%) | |

One arthropod species complex was identified from the infaunal samples at Avalon Harbor, and was classified as an unresolved complex for the current report: *Gibberosus myersi* complex. *G. myersi* (identified to species level) was previously reported by MLML/CDFG as introduced to California's outer coast (Maloney et al., 2006) but is included in this report as a status update (Appendix C). The change of *G. myersi* to *G. myersi* complex was based on the idea that *G. myersi* belongs to a species complex, and that the while clade(s) found in bays and harbors may be an introduced species, the clade found among native species including *Phyllospadix, Silvetia and Anthopleura* on the open coast is native (J. Carlton, personal communication, February 10, 2008). Until further taxonomic resolution is achieved for this species complex in California, *G. myersi* complex has been classified under the unresolved complex category.

Figure 10 shows the contrasting distribution of two introduced arthropod species among the bays and harbors sampled. *Caprella mutica* was identified from many of the bays and harbors sampled, including the northernmost and southernmost bays and harbors, whereas *Caprella sacura* was identified only from southern California bays and harbors. Interestingly, even though *C. mutica* had such wide distribution among the bays and harbors, it was not identified from 3 of the 6 bays and harbors where *C. sacura* was identified. Figure 11 shows the widespread distribution of another introduced arthropod, *Grandidierella japonica*, which was also identified from both the northernmost and southernmost bays and harbors sampled.

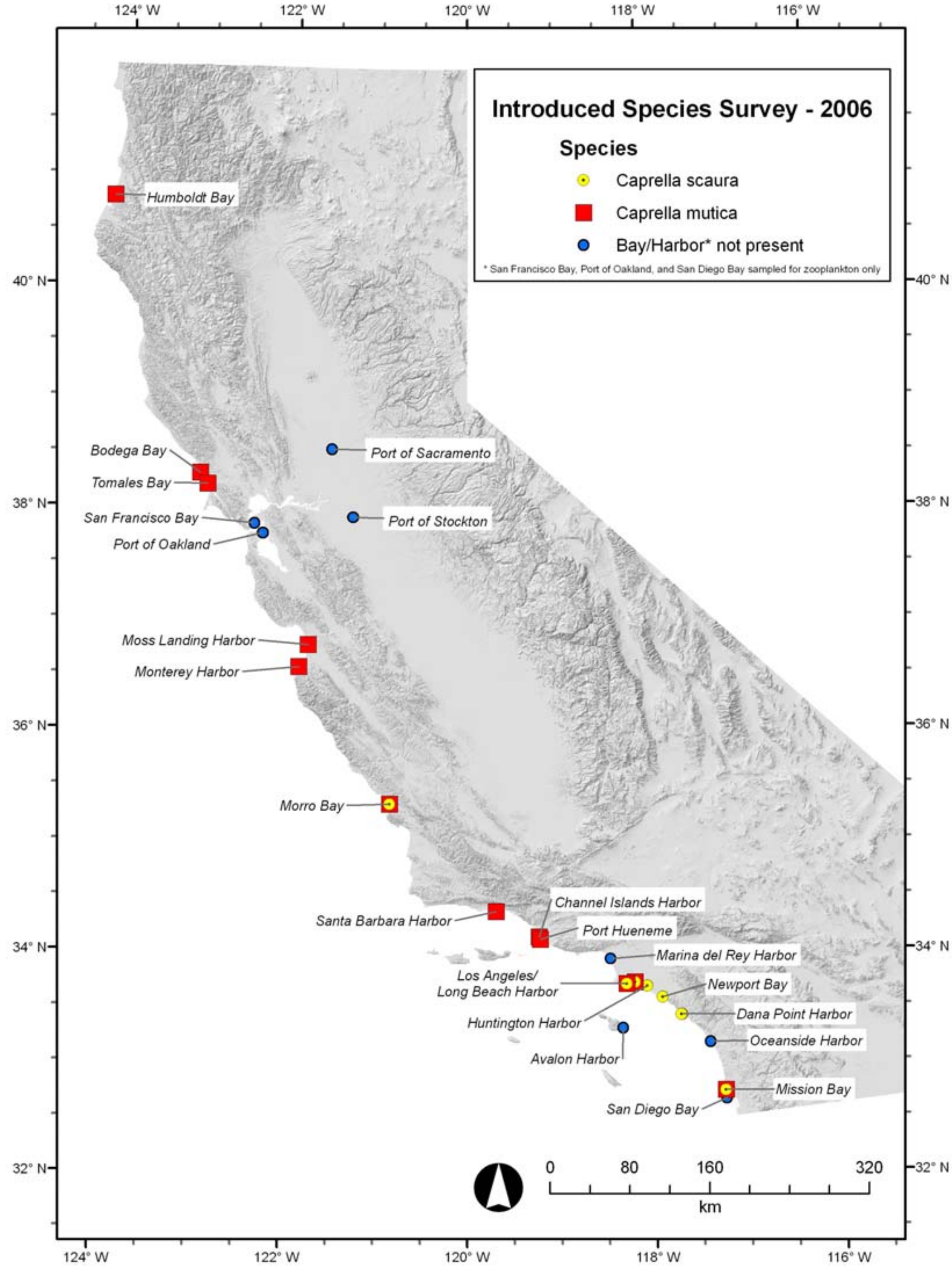



**Figure 10. Geographical distribution of *Caprella mutica* and *Caprella sacura* among the bays and harbors sampled for epifauna and infauna.**

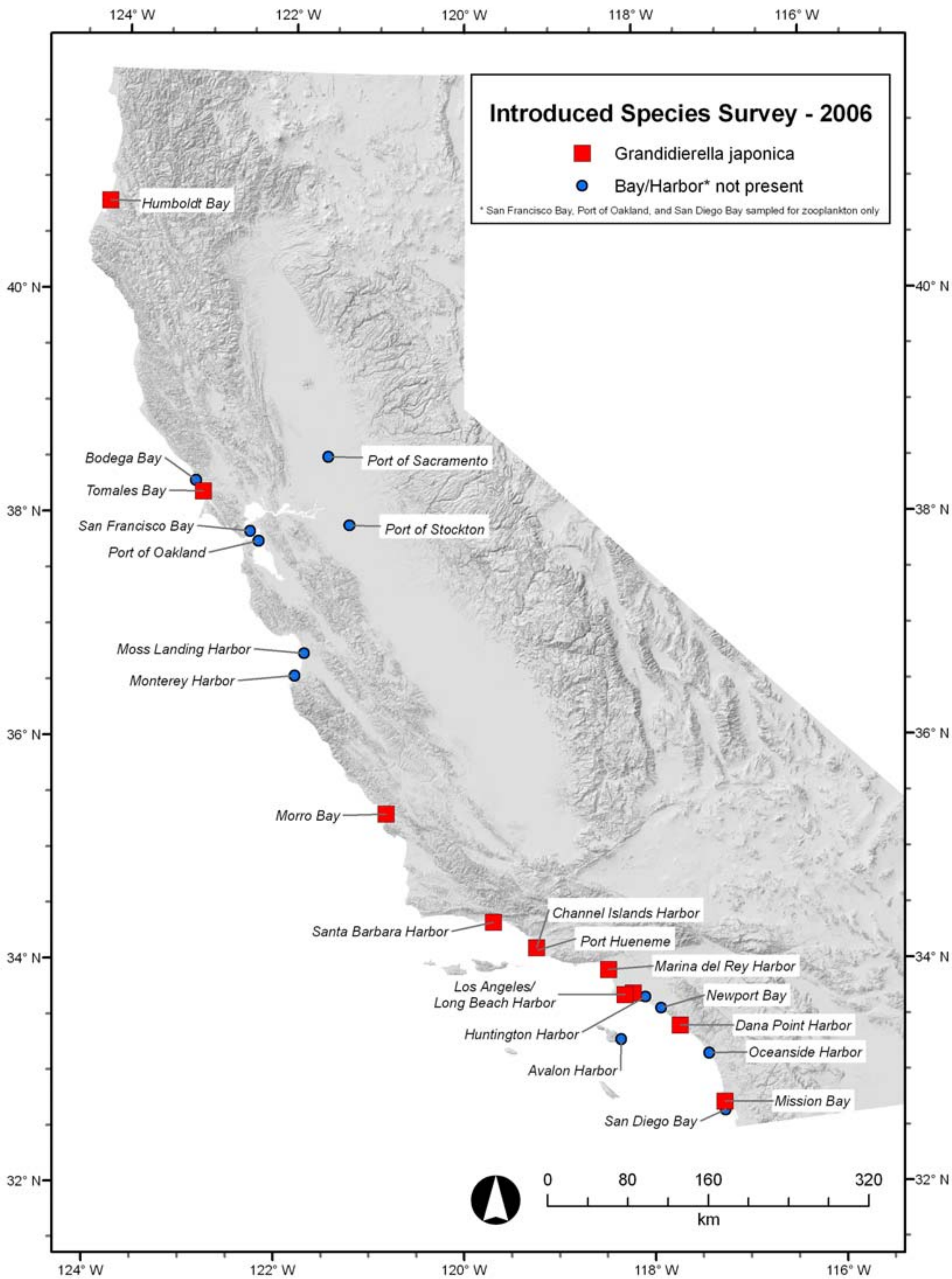



**Figure 11. Geographical distribution of *Grandidierella japonica* among the bays and harbors sampled for epifauna and infauna.**

**Summary of Chordata Taxonomy (Tunicates)**

*Ciona savignyi*, photo used with permission by Gretchen Lambert

Eighteen introduced species of chordates were identified from the epifaunal and infaunal samples collected for the current survey of bays and harbors, including *Ciona savignyi* pictured above. All introduced chordates collected were ascidians (tunicates). Introduced ascidian species were found at 18 out of the 20 bays and harbors where infaunal and epifaunal habitats were surveyed. Introduced ascidians collected in epifaunal habitat per bay or harbor ranged from 2 to 13 species, representing 0% to 73.3% of the total chordate taxa from epifaunal samples per bay or harbor (Table 11). Introduced ascidians collected in infaunal habitat per bay or harbor ranged from zero to 3 species, representing 0% to 100% of the total chordate taxa from infaunal samples per bay or harbor (Table 12). As seen in table 12, few chordates were collected from infaunal habitat, but most of those that were have been classified as introduced. Introduced chordate species identified from the current survey include:

| | | |
|---|---|---|
| *Ascidia zara* | *Ciona intestinalis* | *Molgula manhattensis* |
| *Botrylloides perspicuum* | *Ciona savignyi* | *Polyandrocarpa zorritensis* |
| *Botrylloides sp. A Lambert* | *Didemnum sp. A Lambert* | *Styela canopus* |
| *Botrylloides violaceus* | *Diplosoma listerianum* | *Styela clava* |
| *Botryllus schlosseri* | *Microcosmus squamiger* | *Styela plicata* |
| *Botryllus sp. A Lambert* | *Molgula ficus* | *Symplegma reptans* |

Only one chordate species was classified as cryptogenic, *Aplidium sp. A* Lambert. This cryptogenic ascidian was identified in epifaunal habitat at 7 bays and harbors, representing 0% to 7.5% of the total chordate taxa per bay or harbor in epifaunal. It was not identified from infaunal habitat at any of the bays and harbors surveyed. Native chordate species collected from epifaunal habitat ranged from 0 to 7 species, representing 0% to 40% of the total chordate taxa per bay or harbor, whereas only one native species of chordates was identified from infaunal habitat at one harbor. Unresolved chordate taxa represented 9.1% to 66.7% of the total chordate taxa per harbor for epifaunal, and 0% to 100% of the total chordate taxa per harbor for infaunal habitat sampled.

**Table 11. Number of species and percentage of total chordate taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 16 | 7 (43.8%) | | 4 (25.0%) | | 5 (31.3%) |
| Bodega Bay | Epifauna | 14 | 6 (42.9%) | 1 (7.1%) | 3 (21.4%) | | 4 (28.6%) |
| Tomales Bay | Epifauna | 11 | 6 (54.5%) | | 4 (36.4%) | | 1 (9.1%) |
| Moss Landing Harbor | Epifauna | 11 | 6 (54.5%) | | 2 (18.2%) | | 3 (27.3%) |
| Monterey Harbor | Epifauna | 9 | 4 (44.4%) | | 3 (33.3%) | | 2 (22.2%) |
| Morro Bay | Epifauna | 10 | 2 (20.0%) | | 4 (40.0%) | | 4 (40.0%) |
| Santa Barbara Harbor | Epifauna | 17 | 9 (52.9%) | | 2 (11.8%) | | 6 (35.3%) |
| Channel Islands Harbor | Epifauna | 22 | 11 (50.0%) | 1 (4.5%) | 5 (22.7%) | | 5 (22.7%) |
| Port Hueneme | Epifauna | 22 | 9 (40.9%) | | 7 (31.8%) | | 6 (27.3%) |
| Marina del Rey Harbor | Epifauna | 15 | 11 (73.3%) | 1 (6.7%) | | | 3 (20.0%) |
| Los Angeles Harbor | Epifauna | 27 | 13 (48.1%) | | 5 (18.5%) | | 9 (33.3%) |
| Long Beach Harbor | Epifauna | 25 | 11 (44.0%) | | 4 (16.0%) | | 10 (40.0%) |
| Huntington Harbor | Epifauna | 21 | 12 (57.1%) | 1 (4.8%) | 2 (9.5%) | | 6 (28.6%) |
| Newport Bay | Epifauna | 19 | 12 (63.2%) | 1 (5.3%) | 2 (10.5%) | | 4 (21.1%) |
| Dana Point Harbor | Epifauna | 16 | 10 (62.5%) | | 1 (6.3%) | | 5 (31.3%) |
| Avalon Harbor | Epifauna | 6 | 2 (33.3%) | | | | 4 (66.7%) |
| Oceanside Harbor | Epifauna | 16 | 9 (56.3%) | 1 (6.3%) | 1 (6.3%) | | 5 (31.3%) |
| Mission Bay | Epifauna | 20 | 12 (60.0%) | 1 (5.0%) | 1 (5.0%) | | 6 (30.0%) |

**Table 12. Number of species and percentage of total chordate taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 1 | | | | | 1 (100.0%) |
| Moss Landing Harbor | Infauna | 1 | 1 (100.0%) | | | | |
| Channel Islands Harbor | Infauna | 1 | 1 (100.0%) | | | | |
| Los Angeles Harbor | Infauna | 3 | 3 (100.0%) | | | | |
| Oceanside Harbor | Infauna | 1 | | | 1 (100.0%) | | |
| Mission Bay | Infauna | 1 | 1 (100.0%) | | | | |

## Summary of Cnidarian Taxonomy

One introduced cnidarian species, *Thuiaria thuiaroides*, was identified. *T. thuiaroides* was identified only from Humboldt Bay, where it represented 8.3% of the total epifaunal taxa (Table 13). Four cryptogenic cnidarian species were identified in the epifaunal habitat (*Metridium exilis, Metridium senile, Obelia longissima* and *Obelia nr. Dichotoma*), and zero cryptogenic cnidarians were identified from infaunal habitat (Table 14). Cryptogenic cnidarian species represented from 0% to 50% of the total cnidarian taxa per bay or harbor for epifauna. The majority of cnidarians collected were classified as unresolved taxa, which represented from 40% to 100% of the total cnidarian taxa collected in epifaunal habitat, and 0% to 100% in infaunal habitat per bay or harbor. Native species accounted for 0% to 60% and 0% to 100% of total cnidarian taxa in epifaunal and infauna habitats per bay or harbor respectively.

One cnidarian species complex was identified, *Obelia dichotoma* complex. *Obelia dichotoma* (identified to species level) was previously reported by MLML/CDFG as introduced to California's outer coast (Maloney et al., 2006) but is included in this report as a status update (Appendix C). The change of *Obelia dichotoma* to *O. dichotoma* complex was based on the idea that *O. dichotoma* probably belongs to a global species complex that would require genetic comparison among populations to establish biogeographic and historical status (J. Carlton, personal communication, October 22, 2007). It is possible that specimens collected from the outer coast and/or bays and harbors of California are other members of this species complex that may or may not be native, so until further resolution is achieved, these have been classified under the unresolved complex category.

**Table 13. Number of species and percentage of total cnidarian taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 12 | 1 (8.3%) | 2 (16.7%) | 2 (16.7%) | 1 (8.3%) | 6 (50.0%) |
| Port of Sacramento | Epifauna | 1 | | | | | 1 (100.0%) |
| Bodega Bay | Epifauna | 4 | | 2 (50.0%) | | | 2 (50.0%) |
| Tomales Bay | Epifauna | 5 | | 1 (20.0%) | 1 (20.0%) | | 3 (60.0%) |
| Moss Landing Harbor | Epifauna | 4 | | | | 1 (25.0%) | 3 (75.0%) |
| Monterey Harbor | Epifauna | 8 | | 2 (25.0%) | 2 (25.0%) | | 4 (50.0%) |
| Morro Bay | Epifauna | 13 | | 2 (15.4%) | 3 (23.1%) | 1 (7.7%) | 7 (53.8%) |
| Santa Barbara Harbor | Epifauna | 6 | | | 2 (33.3%) | | 4 (66.7%) |
| Channel Islands Harbor | Epifauna | 6 | | | 2 (33.3%) | | 4 (66.7%) |
| Port Hueneme | Epifauna | 10 | | | 4 (40.0%) | 1 (10.0%) | 5 (50.0%) |
| Marina del Rey Harbor | Epifauna | 5 | | | 1 (20.0%) | | 4 (80.0%) |
| Los Angeles Harbor | Epifauna | 3 | | | | | 3 (100.0%) |
| Long Beach Harbor | Epifauna | 7 | | 1 (14.3%) | 1 (14.3%) | | 5 (71.4%) |
| Huntington Harbor | Epifauna | 4 | | | | | 4 (100.0%) |
| Newport Bay | Epifauna | 6 | | | 2 (33.3%) | | 4 (66.7%) |
| Dana Point Harbor | Epifauna | 1 | | | | | 1 (100.0%) |
| Avalon Harbor | Epifauna | 10 | | | 3 (30.0%) | | 7 (70.0%) |
| Oceanside Harbor | Epifauna | 5 | | | 3 (60.0%) | | 2 (40.0%) |
| Mission Bay | Epifauna | 4 | | | | | 4 (100.0%) |

**Table 14. Number of species and percentage of total cnidarian taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 3 | | | 2 (66.7%) | | 1 (33.3%) |
| Port Hueneme | Infauna | 1 | | | 1 (100.0%) | | |
| Los Angeles Harbor | Infauna | 2 | | | | | 2 (100.0%) |
| Huntington Harbor | Infauna | 1 | | | | | 1 (100.0%) |
| Newport Bay | Infauna | 1 | | | | | 1 (100.0%) |
| Dana Point Harbor | Infauna | 1 | | | 1 (100.0%) | | |
| Avalon Harbor | Infauna | 1 | | | | | 1 (100.0%) |
| Mission Bay | Infauna | 3 | | | 2 (66.7%) | | 1 (33.3%) |

## Summary of Echinoderm Taxonomy

Few echinoderm taxa were identified. No introduced species, and two cryptogenic echinoderm species, *Ophiactis simplex* and *Amphipholis squamata* (both ophiuroids, or brittle stars), were identified. Cryptogenic species were collected in epifaunal habitat at 14 harbors, representing 0% to 100% of the total echinoderm taxa collected per harbor for epifauna (Table 15). Cryptogenic species were collected in infaunal habitat at 5 harbors, and represented from 0% to 100% of echinoderm taxa identified from each harbor for infauna (Table 16).

**Table 15. Number of species and percentage of total echinoderm taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 4 | | 1 (25.0%) | 1 (25.0%) | | 2 (50.0%) |
| Monterey Harbor | Epifauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Morro Bay | Epifauna | 3 | | 1 (33.3%) | 1 (33.3%) | | 1 (33.3%) |
| Santa Barbara Harbor | Epifauna | 3 | | 1 (33.3%) | 1 (33.3%) | | 1 (33.3%) |
| Channel Islands Harbor | Epifauna | 5 | | 2 (40.0%) | 2 (40.0%) | | 1 (20.0%) |
| Port Hueneme | Epifauna | 4 | | 2 (50.0%) | | | 2 (50.0%) |
| Marina del Rey Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Los Angeles Harbor | Epifauna | 6 | | 2 (33.3%) | 1 (16.7%) | | 3 (50.0%) |
| Long Beach Harbor | Epifauna | 7 | | 2 (28.6%) | 2 (28.6%) | | 3 (42.9%) |
| Huntington Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Newport Bay | Epifauna | 2 | | 1 (50.0%) | 1 (50.0%) | | |
| Dana Point Harbor | Epifauna | 2 | | 2 (100.0%) | | | |
| Avalon Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Oceanside Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Mission Bay | Epifauna | 2 | | 2 (100.0%) | | | |

**Table 16. Number of species and percentage of total echinoderm taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 1 | | 1 (100.0%) | | | |
| Moss Landing Harbor | Infauna | 1 | | 1 (100.0%) | | | |
| Morro Bay | Infauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Channel Islands Harbor | Infauna | 3 | | 1 (33.3%) | | | 2 (66.7%) |
| Los Angeles Harbor | Infauna | 3 | | 1 (33.3%) | 1 (33.3%) | | 1 (33.3%) |
| Dana Point Harbor | Infauna | 1 | | | 1 (100.0%) | | |
| Avalon Harbor | Infauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Mission Bay | Infauna | 2 | | 1 (50.0%) | | | 1 (50.0%) |

Five native species and 9 unresolved taxa of echinoderms were also identified. Both native and unresolved taxa represented from 0% to 50% of the total echinoderm taxa per bay or harbor for epifaunal habitat. Native species represented 0% to 100% of total echinoderm taxa per bay or harbor for infaunal habitat as well, whereas unresolved taxa represented 0% to 66.7% of total echinoderm taxa per bay or harbor for infaunal habitat.

## Summary of Ectoproct Taxonomy (Bryozoans)

*Amathia convoluta*, photo used with permission by Greg Schroeder

Introduced species of ectoprocts were collected from epifaunal habitat at all 18 marine bays and harbors surveyed, and from infaunal habitat at 16 of the 18 marine bays and harbors surveyed (Tables 17 and 18). No ectoprocts were collected from the freshwater ports sampled, Port of Sacramento and Port of Stockton. A total of six introduced species of ectoprocts were identified from infaunal and epifaunal habitats, including *Amathia convoluta* (pictured above)*, Cryptosula pallasiana, Schizoporella unicornis, Watersipora arcuata, Watersipora subtorquata/ n. sp.* Mackie and *Zoobotryon verticillatum*. In epifaunal habitat, introduced ectoproct species ranged from 1 to 4 per marine harbor, representing 7.7% to 36.4% of the total epifaunal ectoproct taxa in those harbors. In infaunal habitat, introduced ectoprocts ranged from 0 to 3 species per marine harbor, representing 0% to 100% of the total infaunal ectoproct taxa in those harbors.

**Table 17. Number of species and percentage of total ectoproct taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 13 | 1 (7.7%) | 1 (7.7%) | 7 (53.8%) | 1 (7.7%) | 3 (23.1%) |
| Bodega Bay | Epifauna | 10 | 3 (30.0%) | 1 (10.0%) | 4 (40.0%) | 1 (10.0%) | 1 (10.0%) |
| Tomales Bay | Epifauna | 10 | 3 (30.0%) | 1 (10.0%) | 4 (40.0%) | | 1 (10.0%) |
| Moss Landing Harbor | Epifauna | 7 | 2 (28.6%) | 1 (14.3%) | 2 (28.6%) | 1 (14.3%) | 1 (14.3%) |
| Monterey Harbor | Epifauna | 10 | 2 (20.0%) | 1 (10.0%) | 5 (50.0%) | 1 (10.0%) | 1 (10.0%) |
| Morro Bay | Epifauna | 8 | 3 (37.5%) | 2 (25.0%) | 1 (12.5%) | 1 (12.5%) | 1 (12.5%) |
| Santa Barbara Harbor | Epifauna | 12 | 3 (25.0%) | 1 (8.3%) | 6 (50.0%) | 1 (8.3%) | 1 (8.3%) |
| Channel Islands Harbor | Epifauna | 11 | 3 (27.3%) | 1 (9.1%) | 4 (36.4%) | 1 (9.1%) | 2 (18.2%) |
| Port Hueneme | Epifauna | 15 | 3 (20.0%) | 3 (20.0%) | 6 (40.0%) | 1 (6.7%) | 2 (13.3%) |
| Marina del Rey Harbor | Epifauna | 11 | 4 (36.4%) | 1 (9.1%) | 5 (45.5%) | | 1 (9.1%) |
| Los Angeles Harbor | Epifauna | 19 | 3 (15.8%) | 3 (15.8%) | 10 (52.6%) | | 3 (15.8%) |
| Long Beach Harbor | Epifauna | 11 | 2 (18.2%) | 2 (18.2%) | 6 (54.5%) | | 1 (9.1%) |
| Huntington Harbor | Epifauna | 12 | 4 (33.3%) | 2 (16.7%) | 5 (41.7%) | | 1 (8.3%) |
| Newport Bay | Epifauna | 15 | 4 (26.7%) | 2 (13.3%) | 7 (46.7%) | | 2 (13.3%) |
| Dana Point Harbor | Epifauna | 11 | 3 (27.3%) | 1 (9.1%) | 5 (45.5%) | 1 (9.1%) | 1 (9.1%) |
| Avalon Harbor | Epifauna | 10 | 3 (30.0%) | 1 (10.0%) | 6 (60.0%) | | |
| Oceanside Harbor | Epifauna | 11 | 4 (36.4%) | 1 (9.1%) | 5 (45.5%) | | 1 (9.1%) |
| Mission Bay | Epifauna | 13 | 4 (30.8%) | 2 (15.4%) | 6 (46.2%) | 1 (10.0%) | 1 (7.7%) |

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). Based on recent genetic research on California *Watersipora* collections (Geller et al., 2008), the provisional previously reported by MLML/CDFG as *Watersipora sp* A Schroeder has been updated in the CANOD database to *Watersipora subtorquata/ n. sp.* Mackie. *W. subtorquata/ n. sp.* Mackie, as recorded in the CANOD database, lumps two morphologically indistinguishable species that are known to co-occur in California. Both *W. subtorquata* and the newly identified species are considered introduced to California. *Watersipora* species tend to be aggressive invaders in bays and harbors, a trend that was also observed in the current survey. *W. subtorquata/ n. sp.* Mackie was among the most widespread introduced species found, and was collected from epifaunal habitat at 17 of 18, and from infaunal habitat at 16 of 18 marine harbors where epifaunal and infaunal habitats were surveyed. *Watersipora arcuata* was identified from epifaunal habitat at 10 of 18, and from infaunal habitat at 4 of 18 harbors where epifaunal and infaunal habitats were surveyed.

**Table 18. Number of species and percentage of total ectoproct taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 3 | 1 (33.3%) | 1 (33.3%) | 1 (33.3%) | | |
| Bodega Bay | Infauna | 1 | 1 (100.0%) | | | | |
| Tomales Bay | Infauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Moss Landing Harbor | Infauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Monterey Harbor | Infauna | 5 | 3 (60.0%) | | 2 (40.0%) | | |
| Morro Bay | Infauna | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Santa Barbara Harbor | Infauna | 5 | 2 (40.0%) | 1 (20.0%) | 2 (40.0%) | | |
| Channel Islands Harbor | Infauna | 2 | 2 (100.0%) | | | | |
| Port Hueneme | Infauna | 5 | 1 (20.0%) | | 3 (60.0%) | | 1 (20.0%) |
| Marina del Rey Harbor | Infauna | 5 | 3 (60.0%) | | 2 (40.0%) | | |
| Los Angeles Harbor | Infauna | 4 | 1 (25.0%) | | 3 (75.0%) | | |
| Long Beach Harbor | Infauna | 5 | 2 (40.0%) | | 3 (60.0%) | | |
| Huntington Harbor | Infauna | 3 | 2 (66.7%) | 1 (33.3%) | | | |
| Newport Bay | Infauna | 2 | 2 (100.0%) | | | | |
| Dana Point Harbor | Infauna | 2 | | | 2 (100.0%) | | |
| Avalon Harbor | Infauna | 5 | | | 4 (80.0%) | | 1 (20.0%) |
| Oceanside Harbor | Infauna | 3 | 2 (66.7%) | | 1 (33.3%) | | |
| Mission Bay | Infauna | 5 | 2 (40.0%) | | 2 (40.0%) | | 1 (20.0%) |

Three cryptogenic ectoprocts were identified from the infaunal and epifaunal collections: *Amathia distans, Bugula neritina* and *Membranipora membranacea*. Cryptogenic species represented 7.7% to 25% of the total epifaunal ectoprocts at marine bays and harbors, and represented 0% to 33.3% of the total infaunal ectoprocts at marine bays and harbors surveyed. Native species represented 12.5% to 60% of total epifaunal ectoprocts at marine bays and harbors, and represented 0% to 100% of total infaunal ectoprocts at marine bays and harbors surveyed.

One ectoproct identified was at the species complex level and classified as unresolved complex, *Bowerbankia gracilis* complex. *Bowerbankia gracilis* (at the species level) was previously reported by MLML/CDFG as introduced to California's outer coast (Maloney et al., 2006), but was determined to belong to a species complex, and introduction statuses of species within this complex are not resolvable at this time (J. Carlton, personal communication, October 20, 2007). Therefore, the identification was updated to *Bowerbankia gracilis* complex, and the introduction status updated to unresolved complex. *B. gracilis* complex was identified from epifaunal habitat at 10 harbors.

Introduction statuses have been updated in the current report for six other ectoproct species, all of which were reported as introduced to the open coast by MLML/CDFG (Maloney et al., 2006). One of these status revisions was the result of an incorrect identification. *Alcyonidium polyoum* was identified from samples collected during the MLML/CDFG outer coast survey conducted in 2004, but further investigation and personal communication with John Ryland revealed that several unnamed species of *Alcyonidium* are present in California, for which the introduction status also remains unresolved (J. Ryland, personal communication, January 4, 2008). Therefore, the 2004 outer coast identifications of *A. polyoum* were updated to the genus level, *Alcyonidium*, and classified with an introduction status of unresolved. The other 5 ectoproct status revisions reported here were determined to be new reports of native species rather than introductions to California (J. Carlton, personal communication, October 20, 2007). Those 5 species include: *Heteropora alaskensis, Rhamphostomella gigantea, Rhynchozoon bispinosum, Tricellaria erecta* and *Tricellaria gracilis*.

## Summary of Entoproct Taxonomy (Goblet worms, or Kamptozoans)

Three entoproct taxa were identified. Of those, one was classified as introduced: *Barentsia benedeni,* a colonial kamptozoan that grows as twisted stalks growing out of an intertwined stolon. This species was identified from epifaunal samples at 9 marine harbors, representing 33.3% to 100% of the total epifaunal entoproct taxa at those harbors (Table 19). *B. benedeni* was identified from infaunal samples at only 1 harbor, Humboldt Bay, and represented 100% of the total infaunal entoproct taxa identified there (Table 20). Two native entoproct species, both of which were from the same genus, *Barentsia,* were identified from 7 harbors.

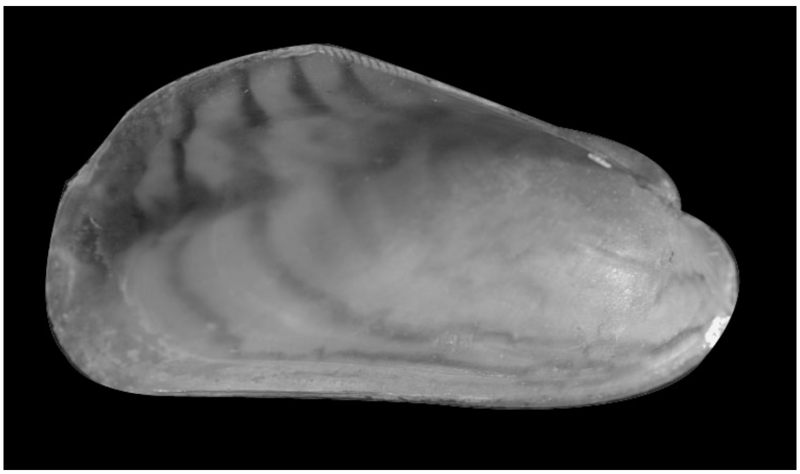
**Table 19. Number of species and percentage of total entoproct taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Bodega Bay | Epifauna | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Tomales Bay | Epifauna | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Moss Landing Harbor | Epifauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Monterey Harbor | Epifauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Morro Bay | Epifauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Port Hueneme | Epifauna | 3 | 1 (33.3%) | | 2 (66.7%) | | |
| Los Angeles Harbor | Epifauna | 1 | 1 (100.0%) | | | | |
| Avalon Harbor | Epifauna | 1 | 1 (100.0%) | | | | |

**Table 20. Number of species and percentage of total entoproct taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 1 | 1 (100.0%) | | | | |
| Moss Landing Harbor | Infauna | 1 | | | 1 (100.0%) | | |

## Summary of Mollusc Taxonomy (Soft Bodied Invertebrates)



*Musculista senhousia*, photo used with permission from the Santa Barbara Museum of Natural History

Nine introduced molluscs were identified from California bays and harbors, including seven introduced bivalve species and two introduced gastropods. The introduced mollusc taxa identified are: *Corbicula, Crassostrea gigas, Crassostrea virginica, Crepidula fornicate, Musculista senhousia* (pictured above*), Mytilus galloprovincialis, Philine auriformis, Theora lubrica* and *Venerupis philippinarum*. Introduced molluscs were found in epifaunal habitat at 17 bays and harbors, ranged from 0 to 3 species in any given bay or harbor, and represented from 0% to 33.3% of the total epifaunal mollusc taxa per bay or harbor (Table 21). Introduced molluscs were found in infaunal habitat at 7 bays and harbors, ranged from 0 to 2 species per bay or harbor, and represented 0% to 100% of the total infaunal mollusc taxa per bay or harbor (Table 22).

One cryptogenic mollusc, the gastropod *Dendronotus frondosus*, was identified, and was only found in epifaunal habitat at Bodega Bay. This species represented 10% of the total epifaunal mollusc taxa at Bodega Bay. Molluscs were dominated by native species in both epifaunal and infaunal habitat at most bays and harbors surveyed. Native species represented 33.3% to 90.3% of the total epifaunal mollusc taxa for each bay or harbor, and 0% to 100% of the total infaunal mollusc taxa for each bay or harbor surveyed. No mollusc taxa were classified as unresolved complex, but some were classified as unresolved. Unresolved taxa represented

0% to 66.7% of the total epifaunal mollusc taxa for each bay or harbor, and 0% to 66.7% of the total infaunal mollusc taxa per bay or harbor surveyed.

**Table 21. Number of species and percentage of total mollusc taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 34 | 1 (2.9%) | | 24 (70.6%) | | 9 (26.5%) |
| Port of Sacramento | Epifauna | 4 | | | 2 (50.0%) | | 2 (50.0%) |
| Bodega Bay | Epifauna | 10 | 1 (10.0%) | 1 (10.0%) | 6 (60.0%) | | 2 (20.0%) |
| Tomales Bay | Epifauna | 9 | 3 (33.3%) | | 4 (44.4%) | | 2 (22.2%) |
| Port of Stockton | Epifauna | 3 | | | 1 (33.3%) | | 2 (66.7%) |
| Moss Landing Harbor | Epifauna | 8 | 1 (12.5%) | | 6 (75.0%) | | 1 (12.5%) |
| Monterey Harbor | Epifauna | 16 | 1 (6.3%) | | 10 (62.5%) | | 5 (31.3%) |
| Morro Bay | Epifauna | 14 | 2 (14.3%) | | 10 (71.4%) | | 2 (14.3%) |
| Santa Barbara Harbor | Epifauna | 13 | 1 (7.7%) | | 9 (69.2%) | | 3 (23.1%) |
| Channel Islands Harbor | Epifauna | 11 | 1 (9.1%) | | 10 (90.9%) | | |
| Port Hueneme | Epifauna | 25 | 1 (4.0%) | | 19 (76.0%) | | 5 (20.0%) |
| Marina del Rey Harbor | Epifauna | 9 | 2 (22.2%) | | 6 (66.7%) | | 1 (11.1%) |
| Los Angeles Harbor | Epifauna | 16 | 2 (12.5%) | | 13 (81.3%) | | 1 (6.3%) |
| Long Beach Harbor | Epifauna | 28 | 2 (7.1%) | | 24 (85.7%) | | 2 (7.1%) |
| Huntington Harbor | Epifauna | 15 | | | 14 (93.3%) | | 1 (6.7%) |
| Newport Bay | Epifauna | 11 | 2 (18.2%) | | 8 (72.7%) | | 1 (9.1%) |
| Dana Point Harbor | Epifauna | 11 | 1 (9.1%) | | 7 (63.6%) | | 3 (27.3%) |
| Avalon Harbor | Epifauna | 11 | 2 (18.2%) | | 7 (63.6%) | | 2 (18.2%) |
| Oceanside Harbor | Epifauna | 10 | 1 (10.0%) | | 9 (90.0%) | | |
| Mission Bay | Epifauna | 21 | 2 (9.5%) | | 17 (81.0%) | | 2 (9.5%) |

**Table 22. Number of species and percentage of total mollusc taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 11 | | | 8 (72.7%) | | 3 (27.3%) |
| Port of Sacramento | Infauna | 1 | 1 (100.0%) | | (0.0%) | | |
| Bodega Bay | Infauna | 5 | | | 4 (80.0%) | | 1 (20.0%) |
| Tomales Bay | Infauna | 2 | 1 (50.0%) | | 1 (50.0%) | | |
| Moss Landing Harbor | Infauna | 11 | | | 8 (72.7%) | | 3 (27.3%) |
| Monterey Harbor | Infauna | 16 | | | 12 (75.0%) | | 4 (25.0%) |
| Morro Bay | Infauna | 7 | | | 4 (57.1%) | | 3 (42.9%) |
| Santa Barbara Harbor | Infauna | 7 | | | 6 (85.7%) | | 1 (14.3%) |
| Channel Islands Harbor | Infauna | 9 | | | 4 (44.4%) | | 5 (55.6%) |
| Port Hueneme | Infauna | 13 | 2 (15.4%) | | 8 (61.5%) | | 3 (23.1%) |
| Marina del Rey Harbor | Infauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Los Angeles Harbor | Infauna | 12 | 1 (8.3%) | | 10 (83.3%) | | 1 (8.3%) |
| Long Beach Harbor | Infauna | 4 | 1 (25.0%) | | 3 (75.0%) | | |
| Huntington Harbor | Infauna | 3 | | | 1 (33.3%) | | 2 (66.7%) |
| Newport Bay | Infauna | 5 | 2 (40.0%) | | 2 (40.0%) | | 1 (20.0%) |
| Dana Point Harbor | Infauna | 2 | | | 2 (100.0%) | | |
| Avalon Harbor | Infauna | 7 | | | 6 (85.7%) | | 1 (14.3%) |
| Oceanside Harbor | Infauna | 1 | | | 1 (100.0%) | | |
| Mission Bay | Infauna | 6 | 2 (33.3%) | | 3 (50.0%) | | 1 (16.7%) |

**Summary of Nemertean (Ribbon Worm) Taxonomy**

No introduced nemertean species were identified in the epifaunal and infaunal habitats during the current survey, but 8 cryptogenic species were identified from these habitats, including *Amphiporus cruentatus, Amphiporus imparispinosus, Carinomella lacteal, Cerebratulus marginatus, Lineus rubber, Micrura alaskensis, Tetrastemma candidum* and *Zygonemertes virescens*. Of those cryptogenic species, *A. imparispinosus* and *C. lacteal* were listed as likely native to California. Seven of these cryptogenic species were collected from epifaunal habitat, and cryptogenic species represented 0% to 50% of the total epifaunal nemertean taxa per bay or harbor (Table 23). Five of these cryptogenic species were found in infaunal habitat, and cryptogenic species represented 0% to 50% of the total infaunal nemertean taxa per bay or harbor as well (Table 24). Native species ranged from 0 to 5 species per bay or harbor in epifaunal habitat, and represented 0% to 55.6% of the total epifaunal nemertean taxa per bay or harbor. Native species ranged from 0 to 4 per bay or harbor in the infaunal habitat, representing 0% to 100% of the total infaunal nemertean taxa per bay or harbor. No nemertean taxa were classified as unresolved complex. Unresolved nemertean taxa were present at all bays and harbors sampled. Unresolved nemerteans represented 33.3% to 100% of total epifaunal nemertean taxa per bay or harbor, and 0% to 100% of total infaunal nemertean taxa per bay or harbor.

**Table 23. Number of species and percentage of total nemertean taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 11 | | 2 (18.2%) | 4 (36.4%) | | 5 (45.5%) |
| Port of Sacramento | Epifauna | 1 | | | | | 1 (100.0%) |
| Bodega Bay | Epifauna | 3 | | 1 (33.3%) | | | 2 (66.7%) |
| Tomales Bay | Epifauna | 9 | | 1 (11.1%) | 5 (55.6%) | | 3 (33.3%) |
| Port of Stockton | Epifauna | 1 | | | | | 1 (100.0%) |
| Moss Landing Harbor | Epifauna | 7 | | | 3 (42.9%) | | 4 (57.1%) |
| Monterey Harbor | Epifauna | 9 | | 1 (11.1%) | 2 (22.2%) | | 6 (66.7%) |
| Morro Bay | Epifauna | 5 | | 1 (20.0%) | 2 (40.0%) | | 2 (40.0%) |
| Santa Barbara Harbor | Epifauna | 4 | | 1 (25.0%) | 1 (25.0%) | | 2 (50.0%) |
| Channel Islands Harbor | Epifauna | 5 | | 1 (20.0%) | 1 (20.0%) | | 3 (60.0%) |
| Port Hueneme | Epifauna | 10 | | 3 (30.0%) | 2 (20.0%) | | 5 (50.0%) |
| Marina del Rey Harbor | Epifauna | 5 | | 1 (20.0%) | | | 4 (80.0%) |
| Los Angeles Harbor | Epifauna | 5 | | 2 (40.0%) | | | 3 (60.0%) |
| Long Beach Harbor | Epifauna | 4 | | 1 (25.0%) | 2 (50.0%) | | 1 (25.0%) |
| Huntington Harbor | Epifauna | 2 | | | | | 2 (100.0%) |
| Newport Bay | Epifauna | 4 | | 2 (50.0%) | | | 2 (50.0%) |
| Dana Point Harbor | Epifauna | 4 | | 2 (50.0%) | | | 2 (50.0%) |
| Avalon Harbor | Epifauna | 1 | | | | | 1 (100.0%) |
| Oceanside Harbor | Epifauna | 5 | | 2 (40.0%) | | | 3 (60.0%) |
| Mission Bay | Epifauna | 4 | | 2 (50.0%) | | | 2 (50.0%) |

**Table 24. Number of species and percentage of total nemertean taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Infauna | 6 | | 3 (50.0%) | | | 3 (50.0%) |
| Tomales Bay | Infauna | 1 | | | | | 1 (100.0%) |
| Moss Landing Harbor | Infauna | 3 | | | 1 (33.3%) | | 2 (66.7%) |
| Monterey Harbor | Infauna | 6 | | 1 (16.7%) | 2 (33.3%) | | 3 (50.0%) |
| Channel Islands Harbor | Infauna | 5 | | 1 (20.0%) | 2 (40.0%) | | 2 (40.0%) |
| Port Hueneme | Infauna | 5 | | 1 (20.0%) | | | 4 (80.0%) |
| Los Angeles Harbor | Infauna | 7 | | 2 (28.6%) | 4 (57.1%) | | 1 (14.3%) |
| Long Beach Harbor | Infauna | 3 | | | 2 (66.7%) | | 1 (33.3%) |
| Newport Bay | Infauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Dana Point Harbor | Infauna | 1 | | | | | 1 (100.0%) |
| Avalon Harbor | Infauna | 6 | | 1 (16.7%) | 3 (50.0%) | | 2 (33.3%) |
| Oceanside Harbor | Infauna | 3 | | 1 (33.3%) | 1 (33.3%) | | 1 (33.3%) |
| Mission Bay | Infauna | 2 | | | 2 (100.0%) | | |

## Summary of Platyhelminthes (Flatworm) Taxonomy

A total of nineteen different taxa from the phylum Platyhelminthes were identified from bays and harbors. Of those, none were classified as introduced, 2 were classified as cryptogenic, 10 were classified as native and 7 were unresolved taxa. The two cryptogenic flatworms identified were *Acerotisa californica* and *Eurylepta aurantiaca*. Cryptogenic flatworms were identified from 10 bays and harbors, and were only found in epifaunal habitat. They represented from 0% to 100% of the total epifaunal flatworm taxa in each bay or harbor (Table 25). Platyhelminthes taxa were only collected from 2 bays and harbors in the infaunal samples, one native species and one unresolved taxa (Table 26).

**Table 25. Number of species and percentage of total platyhelminthes taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 4 | | 1 (25.0%) | 1 (25.0%) | | 2 (50.0%) |
| Port of Sacramento | Epifauna | 1 | | | | | 1 (100.0%) |
| Bodega Bay | Epifauna | 1 | | 1 (100.0%) | | | |
| Tomales Bay | Epifauna | 1 | | | | | 1 (100.0%) |
| Port of Stockton | Epifauna | 1 | | | | | 1 (100.0%) |
| Moss Landing Harbor | Epifauna | 2 | | 1 (50.0%) | 1 (50.0%) | | |
| Monterey Harbor | Epifauna | 5 | | 1 (20.0%) | 2 (40.0%) | | 2 (40.0%) |
| Channel Islands Harbor | Epifauna | 1 | | | 1 (100.0%) | | |
| Port Hueneme | Epifauna | 6 | | 2 (33.3%) | 3 (50.0%) | | 1 (16.7%) |
| Marina del Rey Harbor | Epifauna | 2 | | | 1 (50.0%) | | 1 (50.0%) |
| Los Angeles Harbor | Epifauna | 7 | | 1 (14.3%) | 4 (57.1%) | | 2 (28.6%) |
| Long Beach Harbor | Epifauna | 6 | | 2 (33.3%) | 3 (50.0%) | | 1 (16.7%) |
| Huntington Harbor | Epifauna | 5 | | 1 (20.0%) | 3 (60.0%) | | 1 (20.0%) |
| Newport Bay | Epifauna | 1 | | | | | 1 (100.0%) |
| Dana Point Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Avalon Harbor | Epifauna | 1 | | | 1 (100.0%) | | |
| Oceanside Harbor | Epifauna | 3 | | 1 (33.3%) | 1 (33.3%) | | 1 (33.3%) |
| Mission Bay | Epifauna | 3 | | | 3 (100.0%) | | |

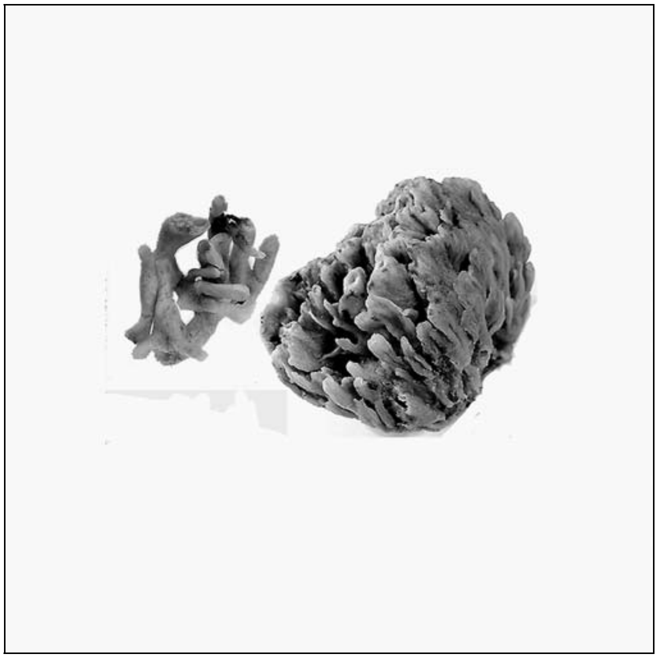
**Table 26. Number of species and percentage of total platyhelminthes taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Tomales Bay | Infauna | 1 | | | 1 (100.0%) | | |
| Huntington Harbor | Infauna | 1 | | | | | 1 (100.0%) |

## Summary of Brachiopoda (Lophophore), Nemata (Unsegmented Worm), and Phoronid (Horseshoe Worm) Taxonomy

No introduced or cryptogenic Brachiopod, Nemata, or Phoronid species were identified from the bays and harbors, and relatively few total species were identified from any of those 3 phyla. Any of these taxa that were identified to species level were classified as native.

**Summary of Porifera Taxonomy (Sponges)**



*Halichondria bowerbanki*, photo used with permission from Welton Lee

One introduced sponge species was identified from the epifaunal survey, *Halichondria bowerbanki* (pictured above), and no sponges were identified from infaunal samples. *H. bowerbanki* was identified from 15 marine harbors surveyed, and represented 0% to 100% of the total sponge taxa identified per bay or harbor (Table 27). In addition, two sponge species identified were classified as cryptogenic: *Clathrina clathrus* and *Halichondria panacea*. *C. clathrus* was only identified from Marina del Rey, where it represented 20% of the total sponge taxa collected, while *H. panacea* was only identified from Tomales Bay, where it represented 14.3% of the total sponge taxa collected.

Twelve native sponge species were identified, and 50% or more of the sponge species identified were native for several bays and harbors. Native sponge species represented 0% to 80% of the total sponge taxa identified per bay or harbor, while unresolved sponge taxa represented 0% to 50% of the total sponge taxa identified per bay or harbor. No sponges were identified from the two freshwater ports surveyed (Port of Sacramento and Port of Stockton).

**Table 27. Number of species and percentage of total porifera taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 8 | 1 (12.5%) | | 6 (75.0%) | | 1 (12.5%) |
| Bodega Bay | Epifauna | 3 | 1 (33.3%) | | 1 (33.3%) | | 1 (33.3%) |
| Tomales Bay | Epifauna | 7 | 1 (14.3%) | 1 (14.3%) | 4 (57.1%) | | 1 (14.3%) |
| Moss Landing Harbor | Epifauna | 1 | 1 (100.0%) | | | | |
| Morro Bay | Epifauna | 4 | 1 (25.0%) | | 2 (50.0%) | | 1 (25.0%) |
| Santa Barbara Harbor | Epifauna | 6 | 1 (16.7%) | | 4 (66.7%) | | 1 (16.7%) |
| Channel Islands Harbor | Epifauna | 8 | 1 (12.5%) | | 3 (37.5%) | | 4 (50.0%) |
| Port Hueneme | Epifauna | 5 | 1 (20.0%) | | 4 (80.0%) | | |
| Marina del Rey Harbor | Epifauna | 5 | 1 (20.0%) | 1 (20.0%) | 3 (60.0%) | | |
| Los Angeles Harbor | Epifauna | 5 | 1 (20.0%) | | 2 (40.0%) | | 2 (40.0%) |
| Long Beach Harbor | Epifauna | 4 | 1 (25.0%) | | 3 (75.0%) | | |
| Huntington Harbor | Epifauna | 7 | 1 (14.3%) | | 4 (57.1%) | | 2 (28.6%) |
| Newport Bay | Epifauna | 4 | 1 (25.0%) | | 3 (75.0%) | | |
| Dana Point Harbor | Epifauna | 5 | | | 3 (60.0%) | | 2 (40.0%) |
| Avalon Harbor | Epifauna | 4 | | | 2 (50.0%) | | 2 (50.0%) |
| Oceanside Harbor | Epifauna | 4 | 1 (25.0%) | | 2 (50.0%) | | 1 (25.0%) |
| Mission Bay | Epifauna | 6 | 1 (16.7%) | | 4 (66.7%) | | 1 (16.7%) |

Figure 12 shows the distribution of the one introduced sponge species identified among the bays and harbors sampled for epifauna and infauna, *Halichondria bowerbanki*. *H. bowerbanki* was present in infaunal habitat from the northernmost to the southernmost bays and harbors sampled, and was not identified from only 3 marine harbors sampled for epifauna.

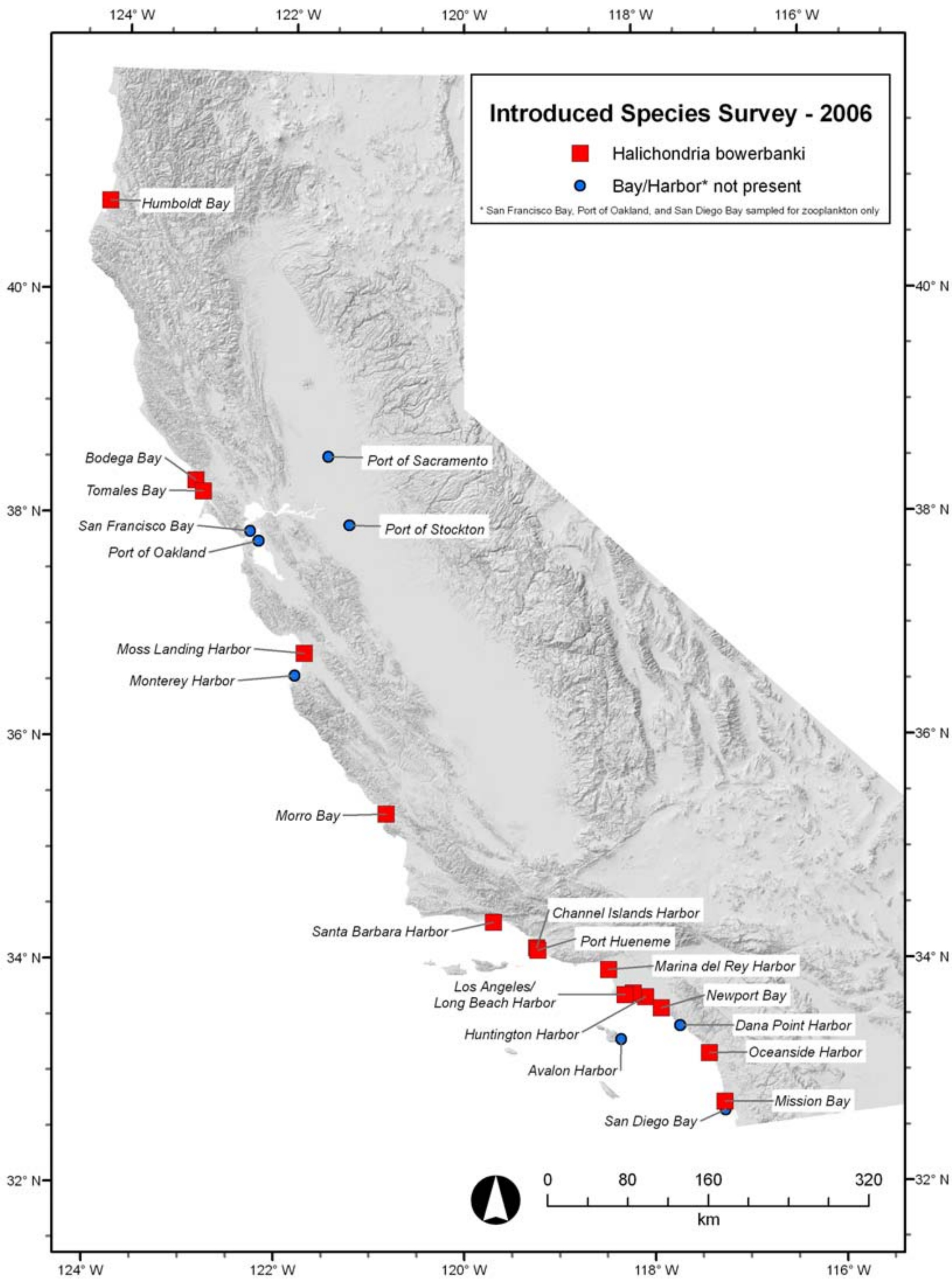



**Figure 12. Geographical distribution of *Halichondria bowerbanki* among the bays and harbors sampled for epifauna and infauna.**

## Summary of Sipuncula Taxonomy (Peanut Worms)

Two species from the phylum sipuncula were identified from the current survey, and both were classified as cryptogenic. In epifaunal habitat, *Phascolosoma agassizi* was identified from 10 bays and harbors (Table 28). *P. agassizi* was also identified in infaunal habitat at 3 bays and harbors, while *Thysanocardia nigra* was identified only from infaunal habitat at Santa Barbara harbor (Table 29).

**Table 28. Number of species and percentage of total sipuncula taxa for each classification identified from epifaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifauna | 1 | | 1 (100.0%) | | | |
| Bodega Bay | Epifauna | 1 | | 1 (100.0%) | | | |
| Moss Landing Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Monterey Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Santa Barbara Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Channel Islands Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Port Hueneme | Epifauna | 1 | | 1 (100.0%) | | | |
| Los Angeles Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Long Beach Harbor | Epifauna | 1 | | 1 (100.0%) | | | |
| Mission Bay | Epifauna | 1 | | 1 (100.0%) | | | |

**Table 29. Number of species and percentage of total sipuncula taxa for each classification identified from infaunal samples.**

| Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Monterey Harbor | Infauna | 1 | | 1 (100.0%) | | | |
| Santa Barbara Harbor | Infauna | 1 | | 1 (100.0%) | | | |
| Channel Islands Harbor | Infauna | 1 | | 1 (100.0%) | | | |
| Port Hueneme | Infauna | 1 | | 1 (100.0%) | | | |

**Summary of Marine Algal and Aquatic Plant Taxonomy (Seaweeds)**

*Lomentaria hakodatensis*, photo used with permission from Kathy Ann Miller

Three species of introduced marine algae were identified from the bays and harbors sampled: *Sargassum muticum, Undaria pinnatifida* (both from phylum Heterokontophyta), and *Lomentaria hakodatensis* (pictured above, phylum Rhodophyta). *S. muticum* was identified from Avalon Harbor, Oceanside Harbor, and Port Hueneme (Table 30). *U. pinnatifida* was identified from Monterey Harbor, Santa Barbara Harbor, Channel Islands Harbor, Port Hueneme and Los Angeles Harbor. *L. hakodatensis* was identified from Bodega Bay, Moss Landing Harbor, and Long Beach Harbor. Three cryptogenic species were also identified. *Aglaothamnion cordatum* (Rhodophyta) was found at Huntington Harbor*, Grateloupia californica* (Rhodophyta) was found at 7 marine harbors, and *Bryopsis hypnoides* (Chlorophyta) was found at Morro Bay.

Unlike invertebrates collected, 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 marine algal species observed during the qualitative visual searches were collected and listed, native algal species are underrepresented in the dataset, and occurrence percentages have been left out of Table 30.

In addition, one introduced aquatic plant species was collected from the freshwater Port of Sacramento, *Myriophyllum spicatum*, which is commonly known as the Eurasian water-milfoil. This species is one of the most troublesome of freshwater invasives, as it can halt boat traffic and fill lakes from shore to shore (Aquatic, Wetland and Invasive Plants Database, 2001).

**Table 30. Number of marine algal taxa identified from visual searches for each classification.**

| Phylum | Waterbody | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|---|
| Chlorophyta | Humboldt Bay | Epifauna | 3 | | | 2 | | 1 |
| Chlorophyta | Bodega Bay | Epifauna | 1 | | | 1 | | |
| Chlorophyta | Tomales Bay | Epifauna | 2 | | | 2 | | |
| Chlorophyta | Morro Bay | Epifauna | 3 | | 1 | 2 | | |
| Chlorophyta | Long Beach Harbor | Epifauna | 1 | | | 1 | | |
| Chlorophyta | Avalon Harbor | Epifauna | 1 | | | 1 | | |
| Heterokontophyta | Monterey Harbor | Epifauna | 2 | 1 | | | | 1 |
| Heterokontophyta | Santa Barbara Harbor | Epifauna | 1 | 1 | | | | |
| Heterokontophyta | Channel Islands Harbor | Epifauna | 1 | 1 | | | | |
| Heterokontophyta | Port Hueneme | Epifauna | 3 | 2 | | 1 | | |
| Heterokontophyta | Marina del Rey Harbor | Epifauna | 1 | | | 1 | | |
| Heterokontophyta | Los Angeles Harbor | Epifauna | 1 | 1 | | | | |
| Heterokontophyta | Long Beach Harbor | Epifauna | 1 | | | 1 | | |
| Heterokontophyta | Huntington Harbor | Epifauna | 1 | | | 1 | | |
| Heterokontophyta | Newport Bay | Epifauna | 2 | | | 2 | | |
| Heterokontophyta | Dana Point Harbor | Epifauna | 2 | | | 2 | | |
| Heterokontophyta | Avalon Harbor | Epifauna | 3 | 1 | | 2 | | |
| Heterokontophyta | Oceanside Harbor | Epifauna | 3 | 1 | | 2 | | |
| Heterokontophyta | Mission Bay | Epifauna | 1 | | | 1 | | |
| Rhodophyta | Humboldt Bay | Epifauna | 6 | | 1 | 4 | | 1 |
| Rhodophyta | Bodega Bay | Epifauna | 3 | 1 | | 2 | | |
| Rhodophyta | Tomales Bay | Epifauna | 2 | | | 1 | | 1 |
| Rhodophyta | Moss Landing Harbor | Epifauna | 4 | 1 | 1 | 2 | | |
| Rhodophyta | Monterey Harbor | Epifauna | 2 | | 1 | 1 | | |
| Rhodophyta | Morro Bay | Epifauna | 5 | | 1 | 4 | | |
| Rhodophyta | Santa Barbara Harbor | Epifauna | 1 | | 1 | | | |
| Rhodophyta | Channel Islands Harbor | Epifauna | 2 | | 1 | 1 | | |
| Rhodophyta | Los Angeles Harbor | Epifauna | 4 | | 1 | 2 | | 1 |
| Rhodophyta | Long Beach Harbor | Epifauna | 3 | 1 | | | | 2 |
| Rhodophyta | Huntington Harbor | Epifauna | 4 | | 1 | 1 | | 2 |
| Rhodophyta | Newport Bay | Epifauna | 3 | | | 2 | | 1 |
| Rhodophyta | Dana Point Harbor | Epifauna | 1 | | | | | 1 |
| Rhodophyta | Avalon Harbor | Epifauna | 1 | | | 1 | | |
| Rhodophyta | Mission Bay | Epifauna | 1 | | | | | 1 |

Figure 13 shows the distribution of the introduced alga *Undaria pinnatifida* among the bays and harbors sampled. The first California observation of *U. pinnatifida* was in March, 2000 in Los Angeles Harbor (Silva et al., 2002), and this species has subsequently been reported from several other southern California bays and harbors. None of the identifications reported here are first records, but rather a snapshot of where *U. pinnatifida* was observed during the current survey. Note that the northernmost location *U. pinnatifida* was identified from is Monterey Bay.

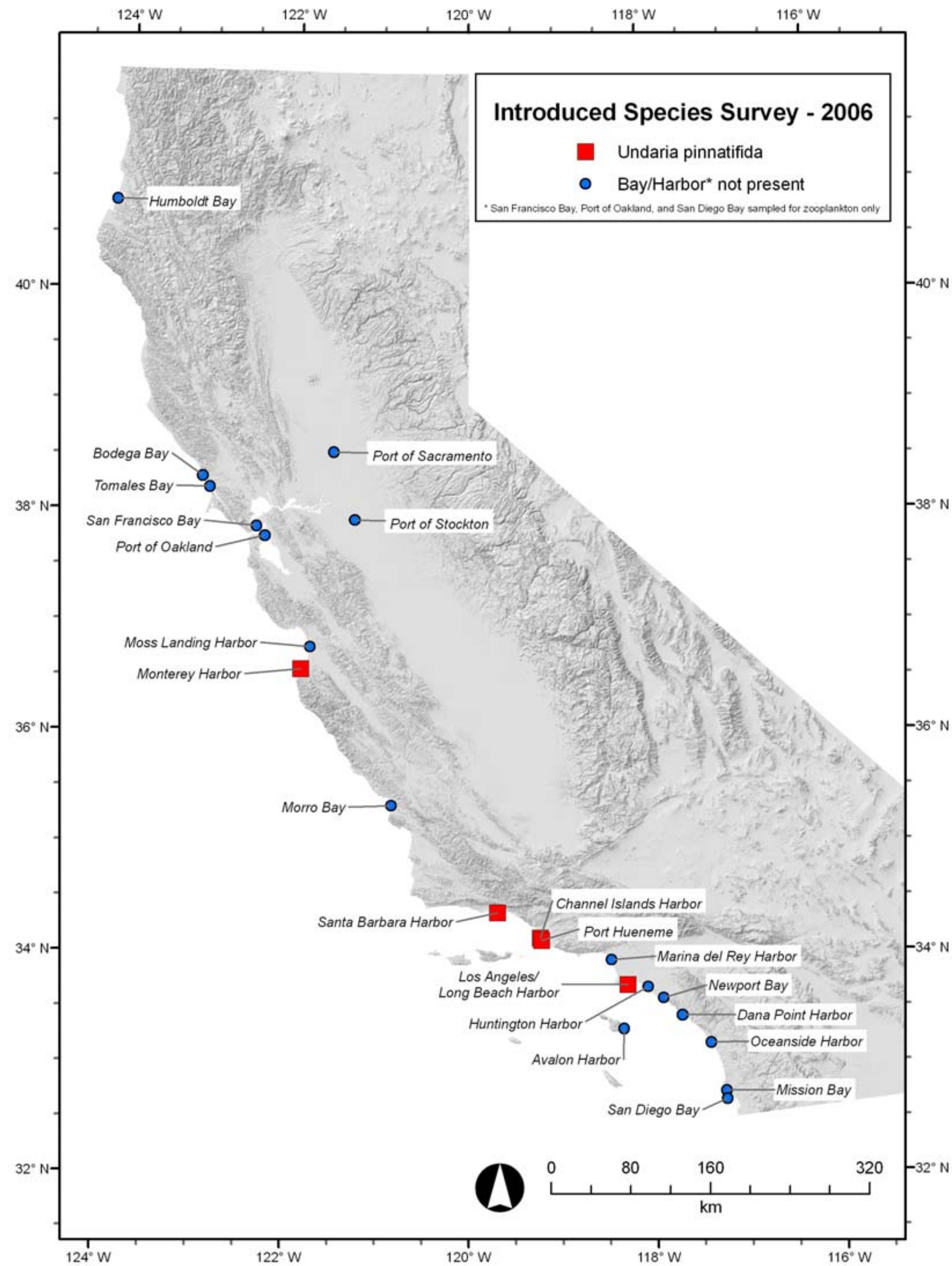



**Figure 13. Geographical distribution of *Undaria pinnatifida* among the bays and harbors sampled.**

**Summary of Zooplankton Taxonomy from Water Column Samples**

Table 32 lists the 7 bays and harbors where water column surveys were conducted, and the total number and percentage of zooplankton taxa identified within each introduction status classification. Results show all sample events combined for each sample location, which for San Francisco Bay includes 4 sample dates, and includes 3 sample dates for all other bays and harbors. Introduced zooplankton species ranged from a low of 1 in Port Hueneme and Humboldt Bay to a high of 9 species in San Francisco Bay, and represented 2.6% to 22.2% of the total zooplankton taxa collected from each harbor. Cryptogenic species ranged from a low of 2 species to a high of 4 species, and represented 5.4% to 8.6% of the total zooplankton taxa collected from each harbor. The number of native zooplankton species collected from the water column was higher than any other introduction classification in each harbor sampled. Native species ranged from 18 to 28 species per harbor, and represented 50% to 74.3% of the total zooplankton taxa collected from each harbor. Unresolved taxa were collected from each harbor sampled, while taxa classified as unresolved complex were collected from only two harbors sampled.

**Table 31. Number of taxa identified from samples for each classification in each harbor where water column samples were collected.**

| Waterbody | Total Taxa | Introduced | Cryptogenic | Native | Unresolved complex | Unresolved |
|---|---|---|---|---|---|---|
| Humboldt Bay | 35 | 1 (2.9%) | 2 (5.7%) | 26 (74.3%) | | 6 (17.1%) |
| San Francisco Bay | 47 | 9 (19.1%) | 4 (8.5%) | 27 (57.4%) | 1 (2.1%) | 6 (12.8%) |
| Port of Oakland | 36 | 8 (22.2%) | 3 (8.3%) | 18 (50.0%) | 1 (2.8%) | 6 (16.7%) |
| Port Hueneme | 38 | 1 (2.6%) | 3 (7.9%) | 28 (73.7%) | | 6 (15.8%) |
| Los Angeles Harbor | 37 | 2 (5.4%) | 2 (5.4%) | 24 (64.9%) | | 9 (24.3%) |
| Long Beach Harbor | 29 | 2 (6.9%) | 2 (6.9%) | 19 (65.5%) | | 6 (20.7%) |
| San Diego Bay | 35 | 2 (5.7%) | 3 (8.6%) | 22 (62.9%) | | 8 (22.9%) |

San Francisco Bay and the Port of Oakland stand out as having the highest numbers of introduced zooplankton species among all of the bays and harbors where water column sampling for zooplankton taxa took place. San Francisco Bay water column sampling protocols differed from those used at all of the other bays and harbors. One primary difference was that the plankton net was towed for 3 minutes during each sampling event at each site in San Francisco Bay, whereas, at all other bays and harbors (including the Port of Oakland sites), the plankton net was slowly lowered straight to the bottom and straight back up. In addition, each San Francisco Bay site was sampled 4 times over approximately one year, whereas sites in all other bays and harbors (including the Port of Oakland) were only sampled 3 times each. There were also more sampling sites in San Francisco Bay than in other bays and harbors surveyed. Therefore, the total volume of water sampled was greater in San Francisco Bay, which may contribute to the relatively higher number of introduced species (and total taxa) identified there. However, relatively high numbers of introduced species and total taxa were also identified from the Port of Oakland, which was sampled the same as all bays and harbors except San Francisco, and directly shares water circulating from San Francisco Bay. The similarity in the results from Port of Oakland and San Francisco Bay could argue that the higher numbers of introduced species identified from San Francisco Bay were not just driven by the greater sampling effort in San Francisco Bay. The percentages of total taxa represented by introduced, cryptogenic and native species was also similar between San Francisco Bay and Port of Oakland, and relatively different than all other bays and harbors sampled.

Table 33 details the number and percentage of zooplankton species within each classification for the 7 phyla identified in the water column surveys. The majority of zooplankton taxa identified were arthropods (87%), and all of the introduced species identified from the water column surveys were arthropods. Of 67 unique arthropod taxa identified, 11 species were classified as introduced: *Eurytemora affinis* complex*, Hyperacanthomysis longirostris, Limnoithona tetraspina, Monocorophium acherusicum, Monocorophium insidiosum, Nippoleucon hinumensis, Oithona davisae, Pseudodiaptomus forbesi, Pseudodiaptomus marinus, Sinocalanus doerrii* and *Tortanus dextrilobatus*. Introduced species represented 16.4% of the total arthropod zooplankton taxa collected.

**Table 32. Number of species and percentage of total taxa of each classification for each phylum identified from water column samples.**

| Phylum | Total Taxa | Introduced | Cryptogenic | Native | Unresolved complex |
|---|---|---|---|---|---|
| Annelida | 1 | | | | |
| Arthropoda | 67 | 11 (16.4%) | 4 (6.0%) | 46 (68.7%) | 1 (1.5%) |
| Chaetognatha | 2 | | | 2 (100.0%) | |
| Chordata | 2 | | | 1 (50.0%) | |
| Cnidaria | 2 | | | 1 (50.0%) | |
| Ectoprocta | 1 | | | | |
| Mollusca | 2 | | | | |
| Phoronida | 1 | | | | |

Of the introduced arthropods collected, *H. longirostris*, *M. acherusicum* and *S. doerrii* were collected only from San Francisco Bay; *M. insidiousm, N. hinumensis* and *T. dextrilobatus* were identified from both Port of Oakland and San Francisco Bay; *L. tetraspina* and *P. forbesi* were only collected from the Port of Oakland; *E. affinis* complex was identified from sites within Humboldt Bay, Port of Oakland, and San Francisco Bay; *O. davisae* was identified from 6 of the 7 bays and harbors surveyed, including all but Humboldt Bay; and *P. marinus* was collected from 5 harbors including San Francisco Bay, Port of Oakland, Los Angeles Harbor, Long Beach Harbor and San Diego Bay.

The four cryptogenic zooplankton species identified were also all arthropods, and included the species *Cumella vulgaris, Hemicyclops japonicus, Hemicyclops subadhaerens* and *Oithona* *similis*. All of these cryptogenic zooplankton species were collected from several harbors, with the exception of *Hemicyclops subadhaerens* which was only collected from San Francisco Bay. Cryptogenic species represented 4.6%, while native species represented 68.7% and unresolved complex species represented 1.5% of the total arthropod zooplankton taxa.

Zooplankton identification data from the water column surveys will be further analyzed for the seasonal component, but when looking at the basic observable trends, one interesting seasonal variation is apparent: the number of both total taxa and introduced species identified from each bay or harbor was lowest from the summer sampling event for all bays and harbors except San Francisco Bay and the Port of Oakland (Table 34). In San Francisco Bay and the Port of Oakland, the summer sampling event turned up the highest number of introduced species and overall zooplankton taxa. The total volume of water sampled during the summer sampling event was slightly less in the summer for all bays and harbors, including San Francisco Bay, except for the Port of Oakland, where the volume sampled was not recorded for the summer sampling event. The sampling effort for San Francisco Bay was the most standardized across all seasons. It remains unclear whether the lower numbers of taxa identified from most bays and harbors is driven by the difference in sampling protocols and/or effort, or by some seasonal variation in the zooplankton species present in those bays and harbors. It also remains unclear whether the zooplankton species identified from San Francisco Bay and Oakland have a unique seasonal component that differs from the zooplankton species in the other bays and harbors, or if higher numbers of total taxa (and potentially introduced species) would have been observed in other bays and harbors with additional sampling effort. More in depth data analysis, as well as research into the natural history of the zooplankton species identified, would help clarify the picture that these results depict.

When San Francisco Bay and Port of Oakland species lists are combined, all 11 introduced zooplankton species identified from California bays and harbors are present. In addition, several different distribution patterns occurred for the different species. Two of those species, *P. marinus*, and *O. davisae* (Figure 14), were identified from all sites, and *T. dextrilobatus* was identified from all but one site sampled in San Francisco Bay and Port of Oakland. *M. acherusicum* was identified only from the northern section of San Francisco Bay, while all but one of the sites where *N. hinumensis* was identified were in the southern section of San Francisco Bay. *P. forbesi* was only identified from sites within the Port of Oakland. Two species were found from only one site in the San Francisco Bay and Port of Oakland area; *L. tetraspina* was found at only one Port of Oakland site, and *S. doerrii* was only found at the farthest northeast site sampled in San Francisco Bay.

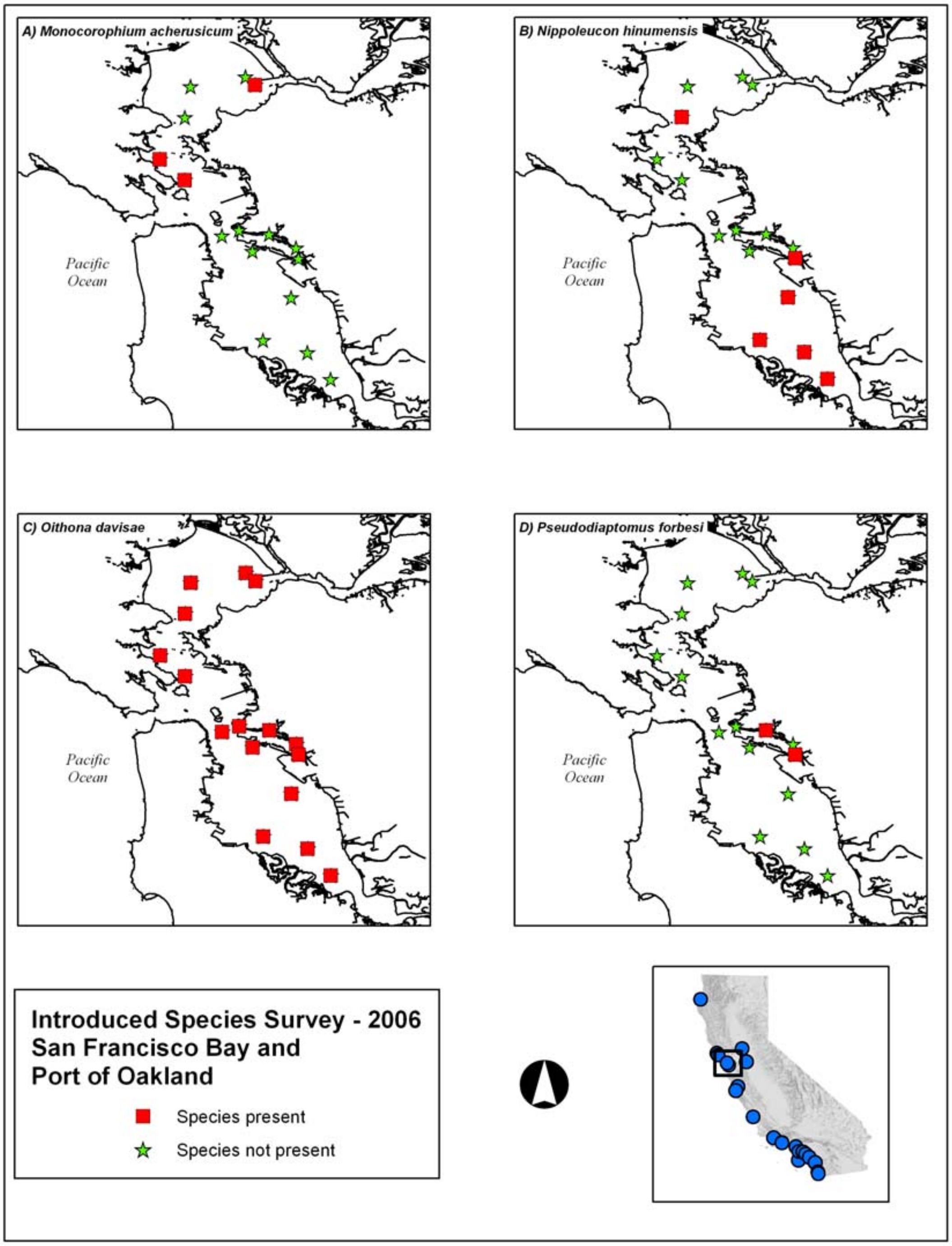



**Figure 14. Species distribution maps for four introduced zooplankton species identified from San Francisco Bay and/or Port of Oakland.**

**Table 33. Seasonal variation in total taxa and each classification for zooplankton identified from each bay or harbor surveyed.**

| Waterbody | Sample Date | Season | Total Volume of Water Sampled (cubic meters) | Total Taxa | Introduced | Cryptogenic | Native | Unresolved complex | Unresolved |
|---|---|---|---|---|---|---|---|---|---|
| Humboldt Bay | March 30, 2006 | Spring | Not recorded | 24 | 1 | 1 | 17 | | 5 |
| Humboldt Bay | August 8, 2006 | Summer | 15.37 | 20 | | 2 | 13 | | 5 |
| Humboldt Bay | February 21, 2007 | Winter | 31.04 | 22 | 1 | 1 | 16 | | 4 |
| San Francisco Bay | November 2, 2006 | Fall/winter | 813.52 | 24 | 5 | 4 | 11 | | 4 |
| San Francisco Bay | February 16, 2007 | Winter | 686.81 | 31 | 6 | 2 | 18 | | 5 |
| San Francisco Bay | June 28, 2007 | Summer | 456.61 | 32 | 6 | 2 | 18 | 1 | 5 |
| San Francisco Bay | September 28, 2007 | Fall | 531.16 | 18 | 4 | 1 | 8 | 1 | 4 |
| Port of Oakland | March 27, 2006 | Spring | 11.93 | 19 | 3 | 1 | 10 | 1 | 4 |
| Port of Oakland | June 12, 2006 | Summer | Not recorded | 23 | 6 | 3 | 8 | 1 | 5 |
| Port of Oakland | March 9, 2007 | Spring | 18.85 | 16 | 3 | 1 | 8 | 1 | 3 |
| Port Hueneme | March 16, 2006 | Spring | 17.89 | 27 | | 2 | 20 | | 5 |
| Port Hueneme | July 25, 2006 | Summer | 15.74 | 22 | | 1 | 15 | | 6 |
| Port Hueneme | November 22, 2006 | Fall/winter | 37.75 | 25 | 1 | 3 | 16 | | 5 |
| Los Angeles Harbor | March 15, 2006 | Spring | 21.85 | 26 | | 2 | 17 | | 7 |
| Los Angeles Harbor | August 22, 2006 | Summer | 11.04 | 21 | | 2 | 13 | | 6 |
| Los Angeles Harbor | November 21, 2006 | Fall/winter | 30.52 | 28 | 2 | 2 | 17 | | 7 |
| Long Beach Harbor | March 15, 2006 | Spring | 18.60 | 26 | 1 | 2 | 17 | | 6 |
| Long Beach Harbor | August 23, 2006 | Summer | 12.24 | 16 | | 1 | 10 | | 5 |
| Long Beach Harbor | November 21, 2006 | Fall/winter | 45.29 | 23 | 1 | 2 | 15 | | 5 |
| San Diego Bay | March 14, 2006 | Spring | 20.02 | 27 | 2 | 2 | 17 | | 6 |
| San Diego Bay | June 15, 2006 | Summer | 16.56 | 24 | 2 | 1 | 15 | | 6 |
| San Diego Bay | November 20, 2006 | Fall/winter | 50.93 | 30 | 2 | 3 | 19 | | 6 |

## *SUMMARY*

### Summary of MS Access Database

To manage introduced species data from this survey as well as other sources, OSPR created a Microsoft (MS) Access 2000 relational database that includes field and analytical data as well as 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 Department of Fish and Game's Office of Spill Prevention and Response (OSPR) web site at http://www.dfg.ca.gov/ospr/; link to Invasive Species. A copy of the database resides at Moss Landing Marine Laboratory's Marine Pollution Studies Lab.

CANOD serves as a baseline for addressing the following questions: 1. Which NIS 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 is 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 Surveys

Seven hundred seventy five species were identified, of which 82 were classified as introduced, 126 as cryptogenic and 567 as native to California. In addition, 396 different taxa were not resolved to the species level, and have been classified as unresolved, while 6 taxa were identified to the species complex level and classified as unresolved complex. Several of the unresolved taxa are identified to the genus level and are listed with an unofficial, temporary provisional species name.

At least 17 introduced species were identified from each of the marine harbors where epifaunal and infaunal habitats were surveyed, while the highest number of introduced species found at any one harbor surveyed was 34 (Los Angeles Harbor). Introduced species represented from 5.4% to 22.2% of the total taxa collected from each marine harbor surveyed for epifauna and infauna, and cryptogenic species represented 12.6% to 22.5% of the total taxa identified from of those bays and harbors. The number of native species identified in the marine harbors was relatively high compared to the number of introduced species, at 50 to 173 native species per bay or harbor, representing 31.3% to 46.8% of the total taxa collected per bay or harbor. In most marine harbors, the percentage of unresolved taxa was most often less than the percentage of native species.

The two freshwater ports surveyed showed quite different results from the marine harbors, with lower numbers of introduced species and higher percentages of unresolved taxa.  Two introduced species were identified from the port of Stockton, and 3 were identified from the port of Sacramento, and introduced species represented 8.0% and 9.1% of the total taxa collected in these ports.  Numbers of cryptogenic, native and unresolved complex taxa were also relatively low.  Unresolved taxa represented 66.0% and 72.7% of the total taxa in these two ports.

One to 2 introduced zooplankton species were identified from the water column surveys in 5 of 7 bays and harbors surveyed.  The two places surveyed with higher numbers of introduced zooplankton species were San Francisco Bay (12 sites sampled per season) and the Port of Oakland (4 sites sampled per season), which turned up 9 and 8 introduced zooplankton species respectively.  Introduced species represented from 19.1% to 22.2% of the total taxa in San Francisco Bay and Port of Oakland, while representing from 2.6% to 6.9% of the total taxa in the other 5 harbors sampled.  Cryptogenic zooplankton species represented from 5.4% to 8.6% of the total taxa in each bay or harbor, native zooplankton species represented from 50% to 74.3% of the total taxa in each bay or harbor, and unresolved species represented 12.8% to 24.3% of the total zooplankton taxa in each bay or harbor.  It remains unknown whether the higher number of introduced species identified in San Francisco Bay was due to increased sampling effort;  Port of Oakland also had a relatively high number of introduced zooplankton species but had less sampling effort than San Francisco Bay, and similar sampling effort to the other bays and harbors.  Seasonally, the summer sampling event produced the fewest introduced zooplankton species for most bays and harbors, whereas the summer sampling event produced the highest number of introduced zooplankton species for San Francisco Bay and the Port of Oakland.

No strong trends were observed between the bays and harbors, although southern California had a higher average number of introduced species than northern and central California bays and harbors.  The 2 phyla with the highest number of introduced species from the epifaunal and infaunal samples were arthropoda (25 introduced species) and chordata (18 introduced species).  The only phylum in which introduced species were identified from the water column surveys was arthropoda, which had 11 introduced zooplankton species.

Epifaunal, or fouling, habitat produced the highest number of overall species (884), followed by infaunal (456) and water column habitat (78).  Likewise, more introduced and cryptogenic species were identified from epifaunal habitat (66 introduced, 91 cryptogenic) as compared to the other two habitats sampled, followed by infaunal (31 introduced, 66 cryptogenic) and water column habitats (11 introduced, 4 cryptogenic).

Juvenile or non-reproductive specimens caused the majority (53%) of identifications not resolved to species level.  Twenty one percent of the unresolved identifications were a result of undescribed species having been collected.  The 2 phyla of arthropods and annelids comprised the majority of the unresolved identifications.

Further literature research would help refine the dataset generated by the current survey. Species lists generated by other researchers conducting experimental and monitoring studies in these locations and habitats should be perused for the presence of introduced or cryptogenic species.  Taxonomic uncertainties could also be addressed by researchers and taxonomists 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 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 would add to the understanding of introduced species in these marine and freshwater regions of California.

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## *APPENDICES*

### *Appendix A – Name, specialty and affiliation of taxonomists identifying specimens in the current survey.*

| Taxonomist Name | Specialty | Affiliation |
|---|---|---|
| Kelvin Barwick | Mollusca - identification of collected specimens | City and County of San Francisco, SFPUC, Natural Resources and Lands Division, SCAMIT |
| Christopher Brown | Porifera – identification of collected specimens | Independent Consultant |
| Don Cadien | Arthropoda – identification of collected specimens | Los Angeles County Sanitation Districts Marine Biology Laboratory, SCAMIT |
| Shannon Carpenter | Mollusca - identification of collected specimens | Santa Barbara Museum of Natural History |
| Keun-Hyung Choi | Plankton – identification of collected specimens | San Francisco State University - Romberg Tiburon Center |
| Ken Davis | Grain Size Analysis | Applied Marine Sciences, Inc. |
| Daniel Geiger | Mollusca - identification of collected specimens | Santa Barbara Museum of Natural History |
| Nick Haring | Echinodermata - identification of collected specimens | City of San Diego, Environmental Monitoring & Technical Services Laboratory, SCAMIT |
| 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 |
| Wim Kimmerer | Plankton – identification of collected specimens | San Francisco State University - Romberg Tiburon Center |
| Gretchen Lambert | Tunicata, Ascidiacea - identification of collected specimens | University of Washington-Friday Harbor Labs, SCAMIT |
| Welton Lee | Porifera - identification of collected specimens | California Academy of Sciences |

| | | |
|---|---|---|
| John Ljubenkov | Cnidaria - identification of collected specimens | Dancing Coyote Ranch, SCAMIT |
| Valerie Macdonald | Oligochaeta - identification of collected specimens | Biologica Environmental Services, SCAMIT |
| Kathy Ann Miller | Marine Algae - identification of collected specimens and visual surveys at some field sites | University of California-Berkeley |
| Jaya Nolt | Mollusca - identification of collected specimens | Santa Barbara Museum of Natural History |
| Dorothy Norris | Polychaeta - identification of collected specimens | City and County of San Francisco, SFPUC, Natural Resources and Lands Division, SCAMIT |
| **Taxonomist Name** | **Specialty** | **Affiliation** |
| Tony Phillips | Nemertea & Platyhelminthes - identification of collected specimens | City of Los Angeles, Environmental Monitoring Division, SCAMIT |
| Daniel Pickard | Identification of collected freshwater specimens | California Department of Fish and Game, Aquatic Bioassessment Laboratory, CSU Chico |
| Veronica Rodriguez | Polychaeta - identification of collected specimens | City of San Diego, Environmental Monitoring & Technical Services Laboratory, EcoMar Consulting Services, SCAMIT |
| Rick Rowe | Polychaeta - identification of collected specimens | Polychaete Identification Consulting Services, SCAMIT |
| 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 |
| Jared von Schell | Crustacea - identification of collected specimens | Moss Landing Marine Labs |

**Appendix B – Instructions sent to taxonomists identifying specimens from the field collections.**

## Introduced Species Surveys (ISS)
## Protocols for Taxonomic Identifications of Samples

Dear Taxonomists,

The goal of this project is to compile a list and measure the abundance of Non-Native Aquatic Species (algae and invertebrates) found in Bays and Harbors in California. We have quantitative samples collected from a known area as well as qualitative samples collected during a swimming search of the site. All samples collected in the bays and harbors have been preserved, sorted into taxa, and are being sent to specialized taxonomists for identification. All samples collected from the two sites sampled in the Delta have been preserved, but were not sorted, and are being sent directly to specialized taxonomists for identification.

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' introduction 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 project. We ask that each taxonomist set aside and voucher examples of non-native species found in both quantitative and qualitative samples (including introduced, cryptogenic species and unresolved taxa). Please see the "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 amongst museums, etc as long as they can be tracked 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 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, with corresponding entries on your master taxa list
-Only vouchers need to be returned for the qualitative portion
-At least 2 voucher specimens returned to us for each non-native species (see detailed voucher protocol below)
- No count is necessary for qualitative samples
-You may keep or discard all native species and non-natives not vouchered from these samples as we will not archive qualitative samples

**Quantitative Samples** (Clearing/Grab/Holdfast collection from hard substrate or sandy cores). We need:

-A list of all species identified, with corresponding entries 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 the remaining native and non-native species combined in the original sample jar for archival of quantitative samples (let us know if you need additional jars/vials). Make sure the jar is labeled with the subIDORG.

**ISS Voucher Collection**

With your help, we will create a voucher collection for native and non-native species found in the four year duration of this survey. The main purpose of this voucher collection is to provide evidence of what was identified in this survey, and to keep examples to re-examine in the future. Vouchers will be kept at Moss Landing Marine Labs, and may also be used for our own education and field identification skills. 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 Smith), please provide both a vouchered specimen and a short description of the specimen. One exception is that we do not need vouchers of unresolved taxa that were so distinguished because samples were juveniles, too damaged to identify, or too poorly preserved. This collection will not include species identified and known with certainty to be native. At least two vouchers are needed for each species; these two sets will be stored and used by MLML and CDFG. 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:***

-At least two 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.

**Sample Tracking**

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 MLML.

After identifications are completed for each sampling season, taxonomists will return to MLML all quantitative samples (for the archive collection). The voucher collection is on-going through each season of sampling, so that set will be returned at the end of the project. Taxonomists may arrange to keep or donate some of these samples, but only after first providing vouchers for the MLM collection. Please contact MLML 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. You can contact our staff to discuss logistics for shipping the samples.

**Missorts**

When missorts (specimens not within your specialty) are encountered in the samples, please send them back to MLML 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!

**Data Tracking**

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 greatly simplifies uploading data into the database, reducing errors and improving data management on our end and is much appreciated.

## Appendix C – Revisions to introduction statuses most recently reported by MLML/CDFG.

| Previous Introduction Status | Updated Introduction Status | Number of Revisions |
|---|---|---|
| Introduced | Cryptogenic | 17 |
| Introduced | Native | 8 |
| Introduced | Unresolved | 2 |
| Introduced | Unresolved Complex | 6 |
| Cryptogenic | Introduced | 4 |
| Cryptogenic | Cryptogenic, Likely Native | 1 |
| Cryptogenic | Native | 2 |
| Cryptogenic | Unresolved | 24 |
| Cryptogenic | Unresolved Complex | 5 |
| Native | Cryptogenic | 40 |
| Native | Unresolved | 1 |
| Unresolved | Introduced | 1 |
| Unresolved | Unresolved, Likely Introduced | 1 |
| Unresolved | Cryptogenic | 1 |
| Status Unknown | Introduced | 1 |
| | **Total** | 114 |

| Species Name | Phylum | Previous Introduction Status | Updated Introduction Status | Status Determination Sources |
|---|---|---|---|---|
| *Acanthomysis californica* | Arthropoda | Native | Cryptogenic, Likely Native | D. Cadien personal notes |
| *Aglaothamnion cordatum* | Rhodophyta | Introduced | Cryptogenic | K. A. Miller pers. comm., Feb. 2008; Abbott and Hollenberg, 1976 |
| **Alcyonidium polyoum* (Identifications changed to genus *Alcyonidium*) | Ectoprocta | Introduced | Unresolved | J. Ryland pers. comm., Jan. 2008 |
| *Amaeana occidentalis* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Amathimysis trigibba* | Arthropoda | Native | Cryptogenic, Likely Introduced | D. Cadien personal notes |
| *Amphicteis scaphobranchiata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Ancistrosyllis groenlandica* (Name updated to *Ancistrosyllis cf. groenlandica*) | Annelida | Introduced | Cryptogenic | L. Harris pers. comm., Feb. 2008 |
| **Anobothrus gracilis* (Identifications changed to genus *Anobothrus*) | Annelida | Introduced | Unresolved | L. Harris pers. comm., Nov. 2007; MPSL |
| **Anonyx cf. lilljeborgi* (Identifications changed to genus *Anonyx*) | Arthropoda | Cryptogenic | Unresolved | MPSL |
| **Amphilochus neapolitanus* (Name updated to *Apolochus barnardi*) | Arthropoda | Cryptogenic | Native | Hoover and Bousfield, 2001 |
| **Arcteobia cf. anticostiensis* (Identifications changed to genus *Arcteobia*) | Annelida | Cryptogenic | Unresolved | MPSL |
| *Aulodrilus japonicus* | Annelida | Introduced | Cryptogenic | P. Fofonoff pers. comm., Feb. 2008; Kathman and Brinkhurst, |

| | | | | |
|---|---|---|---|---|
| | | | | 1998; |
| *Axiothella rubrocincta* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Species Name** | **Phylum** | **Previous Introduction Status** | **Updated Introduction Status** | **Status Determination Sources** |
| **Bowerbankia gracilis* (Identification changed to *Bowerbankia gracilis* complex) | Ectoprocta | Cryptogenic | Unresolved Complex | J. Carlton pers. comm., Oct. 2007 |
| ***Branchiomaldane simplex* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007; MPSL |
| *Bryopsis hypnoides* | Chlorophyta | Native | Cryptogenic | K. A. Miller pers. comm., Feb. 2008; Silva, 1979 |
| *Capitella* | Annelida | Cryptogenic | Unresolved | MPSL |
| *Caprella laeviuscula* | Arthropoda | Native | Cryptogenic | D. Cadien pers. comm., Nov. 2007; Laubitz, 1970 |
| *Carazziella sp. A* SCAMIT | Annelida | Cryptogenic | Unresolved, Likely Native | L. Harris pers. comm., Jan. 2008 |
| ***Caulleriella alata* | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Feb. 2008 |
| ***Caulleriella hamata* | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Feb. 2008 |
| *Chone ecaudata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Chone sp. SD1* (Name updated to *Chone eiffelturris*) | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Jan. 2008; Tovar-Hernandez, 2007 |
| *Chone minuta* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Chone mollis* (Identification changed to *Chone mollis* complex) | Annelida | Native | Unresolved, Likely Native | L. Harris pers. comm., Jan. 2008; Tovar-Hernandez, 2007 |
| ***Chrysopetalum occidentale* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007; Perkins, 1985 |
| *Colomastix pusilla* | Arthropoda | Native | Cryptogenic, Likely Native | Cadien pers. comm., Nov. 2007 |
| *Corbicula* | Mollusca | Unresolved | Introduced | Hanna, 1966 |
| *Cossura candida* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Jan. 2008 |
| *Coullana canadensis* | Arthropoda | Introduced | Cryptogenic | P. Fofonoff personal notes; Stysma et al, 2004 |
| *Chone minuta* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Crangonyx floridanus* (Identification changed to *Crangonyx floridanus* complex) | Arthropoda | Cryptogenic | Unresolved Complex | P. Fofonoff pers. comm., Feb. 2008 |
| *Diplosoma listerianum* | Chordata | Cryptogenic | Introduced | G. Lambert pers. comm., Jan. 2007; J. Carlton pers. comm., Jan. 2007 |
| ***Dipolydora barbilla* | Annelida | Introduced | Cryptogenic | L. Harris pers. comm., Nov. 2007; MPSL |
| *Dipolydora bidentata* | Annelida | Introduced | Cryptogenic | L. Harris and P. Fofonoff pers. comm., Feb. 2008; Light and Smith, 2007 |
| *Dipolydora quadrilobata* | Annelida | Introduced | Cryptogenic | L. Harris and P. Fofonoff pers. comm., Feb. 2008; Light and Smith, 2007 |
| *Dorvillea (Schistomeringos) annulata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Dynamena disticha* (Identification changed to *Dynamena disticha* complex) | Cnidaria | Introduced | Unresolved Complex | J. Carlton pers. comm., Oct. 2007; Light and Smith, 2007 |
| *Eteone aestuarina* | Annelida | Introduced | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Euchone analis* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Eudorella pacifica* | Arthropoda | Native | Cryptogenic, Likely Native | Cohen et al., 2005 |
| **Eurytemora affinis* complex (Identification changed to *Eurytemora affinis* complex) | Arthropoda | Cryptogenic | Introduced | P. Fofonoff personal notes; Lee, 2000 |
| *Gammarus daiberi* | Arthropoda | Status Unknown | Introduced | Cohen, 1996 |
| **Gibberosus myersi* (Identification changed to *Gibberosus myersi* complex) | Arthropoda | Introduced | Unresolved Complex | J. Carlton pers. comm., Feb. 2008 |

| Species Name | Phylum | Previous Introduction Status | Updated Introduction Status | Status Determination Sources |
|---|---|---|---|---|
| **Glycera capitata* (Identification changed to *Glycera capitata* complex) | Annelida | Cryptogenic | Unresolved Complex | L. Harris pers. comm., Nov. 2007 |
| *Glycinde picta* | Annelida | Native | Cryptogenic, Likely Native | L. Harris pers. comm., Nov. 2007; Boggemann, 2005 |
| *Harmothoe hirsuta* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Harmothoe praeclara* | Annelida | Introduced | Cryptogenic | J. Carlton pers. comm., Oct. 2007; L. Harris pers. comm.. Nov. 2007 |
| **Heteromastus filiformis* complex (Identification changed to *Heteromastus filiformis* complex) | Annelida | Introduced | Unresolved Complex | J. Carlton pers. comm., Feb. 2008 |
| *Heterophoxus* | Arthropoda | Cryptogenic | Unresolved, Likely Native | D. Cadien pers. comm., Nov. 2007; Jarrett and Bousfield, 1994b |
| *Heteropora alaskensis* | Ectoprocta | Introduced | Native | J. Carlton pers. comm., Nov. 2007 |
| *Hourstonius vilordes* | Arthropoda | Cryptogenic | Native | Barnard, 1962; Light and Smith, 2007 |
| **Hyalella azteca* (Identification changed to *Hyalella azteca* complex) | Arthropoda | Cryptogenic | Unresolved Complex | Pennak 1989; Gonzalez and Watling, 2002 |
| *Hydroides elegans* | Annelida | Cryptogenic | Introduced | P. Fofonoff pers. comm., Feb. 2008; Carlton, 1979a; Cohen et al., 2002 |
| *Lanassa venusta venusta* | Annelida | Introduced | Unresolved Complex | L. Harris and P. Fofonoff pers. comms., Feb. 2008 |
| *Laonome sp. SF1* Norris | Annelida | Unresolved | Cryptogenic, Likely Introduced | L. Harris pers. comm., Nov. 2007; K. Fitzhugh pers. comm. with Harris |
| **Hydrobiidae sp. KB1* (Name updated to *Littoridinops monroensis*) | Mollusca | Cryptogenic | Introduced | Hershler er al., 2007 |
| *Lumbrineris cruzensis* | Annelida | Native | Cryptogenic | L. Harris pers. comm.., Nov. 2007 |
| *Lumbrineris inflata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Namanereis pontica* (Name updated to *Lycastopsis pontica*) | Annelida | Introduced | Cryptogenic | P. Fofonoff pers. comm., Feb. 2008 |
| ***Marphysa sp. C* Harris | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Megalomma* | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Munna chromatocephala* | Arthropoda | Native | Cryptogenic, Likely Native | D. Cadien personal notes |
| *Muricea* | Cnidaria | Cryptogenic, Likely Native | Unresolved | J. Ljubenkov pers. comm., Feb. 2008 |
| **Nais communis/ variabilis* (Identification changed to *Nais communis/ variabilis* complex) | Annelida | Cryptogenic | Unresolved Complex | S. Fend pers. comm., Dec. 2007; Kathman and Brinkhurst, 1998; Brinkhurst and Gelder, 2001 |
| ***Neoamphitrite robusta* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Neoamphitrite sp. A* Harris | Annelida | Unresolved | Unresolved, Likely Introduced | L. Harris personal notes |
| *Neodexiospira pseudocorrugata* | Annelida | Introduced | Cryptogenic | L. Harris pers. comm., Nov. 2007; P. Fofonoff pers. comm., Jan. 2008 |
| *Nicomache personata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Novafabricia sp. A* Harris | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007; K. Fitzhugh pers. comm. with Harris |
| **Obelia dichotoma* complex (Identification changed to *Obelia dichotoma* complex) | Cnidaria | Introduced | Unresolved Complex | J. Carlton pers. comm., Oct. 2007 |
| *Oithona similis* | Arthropoda | Introduced | Cryptogenic | P. Fofonoff pers. comm., Feb. 2008; Ward and Hirst, 2007 |
| *Ophiodromus pugettensis* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Paranthura elegans* | Arthropoda | Introduced | Native | Schultz, 1969; Cadien and Brusca, 1993; Light and Smith, 2007 |

| Species Name | Phylum | Previous Introduction Status | Updated Introduction Status | Status Determination Sources |
|---|---|---|---|---|
| *Pholoidae genus A* Harris *sp. B* Harris | Annelida | Cryptogenic | Unresolved, Likely Native | L. Harris pers. comm., Nov. 2007 |
| *Pilargis sp. A* Harris | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Pista brevibranchiata* | Annelida | Native | Cryptogenic | Hilbig, 2000 |
| *Podocerus brasiliensis* | Arthropoda | Native | Cryptogenic, Likely Native | D. Cadien personal notes; Barnard, 1979; Light and Smith, 2007 |
| *Podocerus fulanus* | Arthropoda | Cryptogenic | Cryptogenic, Likely Native | D. Cadien personal notes |
| *Pontogeneia rostrata* | Arthropoda | Introduced | Cryptogenic | D. Cadien personal notes; J. Carlton pers. comm., Feb. 2008 |
| **Autolytus cornutus* (Name updated to *Proceraea cornuta*) | Annelida | Introduced | Cryptogenic | Nygren, 2004 |
| *Protocirrineris sp. B* SCAMIT | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Pseudopolydora paucibranchiata* | Annelida | Introduced | Cryptogenic | L. Harris pers. comm., Nov. 2007; (V. Radashevsky pers. comm. with Harris); Light and Smith, 2007 |
| *Pterocirrus sp. A* Harris | Annelida | Cryptogenic | Unresolved, Likely Native | L. Harris pers. comm., Nov. 2007 |
| *Questa caudicirra* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007; Beesley 2000 |
| *Rhamphostomella gigantea* | Ectoprocta | Introduced | Native | J. Carlton pers. comm., Oct. 2007 |
| *Rhynchozoon bispinosum* | Ectoprocta | Introduced | Native | J. Carlton pers. comm., Oct. 2007 |
| **Sabellaria spinulosa* (Name updated to *Sabellaria gracilis*) | Annelida | Introduced | Native | Hartman, 1969; Boyd et al., 2002 |
| *Salmacina tribranchiata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Jan. 2008 |
| *Schistocomus hiltoni* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Scolelepis squamata* (Identification changed to *Scolelepis (Scolelepis) squamata* complex) | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| **Scoletoma tetraura* (ID changed to *Scoletoma tetraura* compelx) | Annelida | Cryptogenic | Unresolved | L. Harris personal notes |
| *Scoletoma zonata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Sinelobus stanfordi* (Identification changed to *Sinelobus stanfordi* complex) | Arthropoda | Introduced | Unresolved Complex | J. Carlton pers. comm., Oct. 2007 |
| *Sphaerosyllis californiensis* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Sphaerosyllis sp. RR2* | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Sphaerosyllis sp. SF1* Harris | Annelida | Cryptogenic | Unresolved, Likey Introduced | L. Harris personal notes |
| *Spionidae sp. RR1* | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Spiophanes duplex* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Sthenelais verruculosa* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| **Streblosoma sp. F* Harris (Name updated to *Streblosoma sp. SD1* Rowe) | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Syllides reishi* | Annelida | Native | Cryptogenic, Likely Native | L. Harris pers. comm., Jan. 2008 |
| *Tharyx parvus* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Thormora johnstoni* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007 |
| *Tricellaria erecta* | Ectoprocta | Introduced | Native | J. Carlton pers. comm., Oct. 2007 |
| *Tricellaria gracilis* | Ectoprocta | Introduced | Native | J. Carlton pers. comm., Oct. 2007 |
| *Trochochaeta multisetosa* | Annelida | Introduced | Cryptogenic, Likely Native | L. Harris pers. comm., Feb. 2008 |
| *Typosyllis adamanteus* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007; Licher, 1999 |
| *Typosyllis elongata* | Annelida | Native | Cryptogenic | L. Harris pers. comm., Nov. 2007; Licher, 1999 |
| *Typosyllis heterochaeta* | Annelida | Native | Cryptogenic | Licher, 1999 |

| Species Name | Phylum | Previous Introduction Status | Updated Introduction Status | Status Determination Sources |
|---|---|---|---|---|
| *Typosyllis sp. 19* Harris | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| **Typosyllis sp. VR6* (Name updated to *Typosyllis sp. 24* Harris) | Annelida | Cryptogenic | Unresolved | L. Harris pers. comm., Nov. 2007 |
| *Typosyllis typica* | Annelida | Introduced | Native | L. Harris and P. Fofonoff pers. comms., Feb. 2008 |
| *Vermiliopsis infundibulum* | Annelida | Introduced | Cryptogenic | J. Carlton pers. comm., Oct. 2007; L. Harris pers. comm., Nov. 2007; Bastida-Zavala, 2000 |

*** Status change was the result of a species name change or change of identification**

**** Status changed "pending specimen reexamination"**

## Appendix D - Sampling Site Locations.

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| Humboldt Bay | 110HUMB01 | Epifauna | 08/Aug/2006 | 40.8070 | -124.1666 | NAD83 |
| Humboldt Bay | 110HUMB01 | Infauna | 08/Aug/2006 | 40.8070 | -124.1666 | NAD83 |
| Humboldt Bay | 110HUMB02 | Epifauna | 08/Aug/2006 | 40.8285 | -124.1648 | NAD83 |
| Humboldt Bay | 110HUMB03 | Epifauna | 08/Aug/2006 | 40.7991 | -124.1903 | NAD83 |
| Humboldt Bay | 110HUMB03 | Infauna | 08/Aug/2006 | 40.7991 | -124.1903 | NAD83 |
| Humboldt Bay | 110HUMB04 | Epifauna | 08/Aug/2006 | 40.7977 | -124.1860 | NAD83 |
| Humboldt Bay | 110HUMB05 | Epifauna | 08/Aug/2006 | 40.7781 | -124.1962 | NAD83 |
| Humboldt Bay | 110HUMB05 | Infauna | 08/Aug/2006 | 40.7781 | -124.1962 | NAD83 |
| Humboldt Bay | 110HUMB06 | Epifauna | 09/Aug/2006 | 40.7291 | -124.2198 | NAD83 |
| Humboldt Bay | 110HUMB06 | Infauna | 09/Aug/2006 | 40.7291 | -124.2198 | NAD83 |
| Humboldt Bay | 110HUMB07 | Epifauna | 09/Aug/2006 | 40.7327 | -124.2192 | NAD83 |
| Humboldt Bay | 110HUMB08 | Epifauna | 09/Aug/2006 | 40.8040 | -124.1766 | NAD83 |
| Humboldt Bay | 110HUMB09 | Epifauna | 09/Aug/2006 | 40.7426 | -124.2269 | NAD83 |
| Humboldt Bay | 110HUMB09 | Infauna | 09/Aug/2006 | 40.7426 | -124.2269 | NAD83 |
| Humboldt Bay | 110HUMB10 | Epifauna | 09/Aug/2006 | 40.7233 | -124.2232 | NAD83 |
| Humboldt Bay | HBP01 | Water Column | 30/Mar/2006 | 40.7406 | -124.2246 | WGS84 |
| Humboldt Bay | HBP01 | Water Column | 09/Aug/2006 | 40.7404 | -124.2248 | NAD83 |
| Humboldt Bay | HBP01 | Water Column | 21/Feb/2007 | 40.7640 | -124.2183 | WGS84 |
| Humboldt Bay | HBP02 | Water Column | 30/Mar/2006 | 40.7447 | -124.2251 | WGS84 |
| Humboldt Bay | HBP02 | Water Column | 09/Aug/2006 | 40.7449 | -124.2256 | NAD83 |
| Humboldt Bay | HBP02 | Water Column | 21/Feb/2007 | 40.7688 | -124.2130 | WGS84 |
| Humboldt Bay | HBP04 | Water Column | 30/Mar/2006 | 40.7772 | -124.2015 | WGS84 |
| Humboldt Bay | HBP04 | Water Column | 08/Aug/2006 | 40.7766 | -124.2010 | NAD83 |
| Humboldt Bay | HBP04 | Water Column | 21/Feb/2007 | 40.7769 | -124.2030 | WGS84 |
| Humboldt Bay | HBP06 | Water Column | 30/Mar/2006 | 40.8213 | -124.1711 | WGS84 |
| Humboldt Bay | HBP06 | Water Column | 08/Aug/2006 | 40.8213 | -124.1711 | NAD83 |
| Humboldt Bay | HBP06 | Water Column | 21/Feb/2007 | 40.8213 | -124.1704 | WGS84 |
| Port of Sacramento | 510PSAC01 | Epifauna | 26/Sep/2006 | 38.5660 | -121.5551 | NAD83 |
| Port of Sacramento | 510PSAC01 | Infauna | 26/Sep/2006 | 38.5660 | -121.5551 | NAD83 |
| Port of Sacramento | 510PSAC02 | Epifauna | 26/Sep/2006 | 38.5624 | -121.5467 | NAD83 |
| Port of Sacramento | 510PSAC02 | Infauna | 26/Sep/2006 | 38.5624 | -121.5467 | NAD83 |
| Port of Sacramento | 510PSAC03 | Epifauna | 26/Sep/2006 | 38.5616 | -121.5412 | NAD83 |
| Port of Sacramento | 510PSAC03 | Infauna | 26/Sep/2006 | 38.5616 | -121.5412 | NAD83 |
| Bodega Bay | 115BDGA01 | Epifauna | 11/Aug/2006 | 38.3295 | -123.0565 | NAD83 |
| Bodega Bay | 115BDGA01 | Infauna | 11/Aug/2006 | 38.3295 | -123.0565 | NAD83 |
| Bodega Bay | 115BDGA02 | Epifauna | 11/Aug/2006 | 38.3321 | -123.0585 | NAD83 |
| Bodega Bay | 115BDGA03 | Epifauna | 11/Aug/2006 | 38.3340 | -123.0511 | NAD83 |
| Bodega Bay | 115BDGA04 | Epifauna | 11/Aug/2006 | 38.3257 | -123.0410 | NAD83 |
| Bodega Bay | 115BDGA04 | Infauna | 11/Aug/2006 | 38.3257 | -123.0410 | NAD83 |
| Tomales Bay | 201TMLS01 | Epifauna | 10/Aug/2006 | 38.2314 | -122.9680 | NAD83 |
| Tomales Bay | 201TMLS02 | Epifauna | 10/Aug/2006 | 38.1078 | -122.8623 | NAD83 |
| Tomales Bay | 201TMLS03 | Epifauna | 10/Aug/2006 | 38.1466 | -122.8832 | NAD83 |
| Tomales Bay | 201TMLS03 | Infauna | 10/Aug/2006 | 38.1466 | -122.8832 | NAD83 |
| Tomales Bay | 201TMLS04 | Epifauna | 10/Aug/2006 | 38.1991 | -122.9220 | NAD83 |
| Tomales Bay | 201TMLS04 | Infauna | 10/Aug/2006 | 38.1991 | -122.9220 | NAD83 |
| San Francisco Bay | SFP01 | Water Column | 02/Nov/2006 | 37.5360 | -122.1670 | WGS84 |
| San Francisco Bay | SFP01 | Water Column | 16/Feb/2007 | 37.5360 | -122.1670 | WGS84 |
| San Francisco Bay | SFP01 | Water Column | 28/Jun/2007 | 37.5360 | -122.1670 | WGS84 |
| San Francisco Bay | SFP01 | Water Column | 28/Sep/2007 | 37.5360 | -122.1670 | WGS84 |
| San Francisco Bay | SFP02 | Water Column | 02/Nov/2006 | 37.5830 | -122.2080 | WGS84 |
| San Francisco Bay | SFP02 | Water Column | 16/Feb/2007 | 37.5830 | -122.2080 | WGS84 |

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| San Francisco Bay | SFP02 | Water Column | 28/Jun/2007 | 37.5830 | -122.2080 | WGS84 |
| San Francisco Bay | SFP02 | Water Column | 28/Sep/2007 | 37.5830 | -122.2080 | WGS84 |
| San Francisco Bay | SFP03 | Water Column | 02/Nov/2006 | 37.6800 | -122.2370 | WGS84 |
| San Francisco Bay | SFP03 | Water Column | 16/Feb/2007 | 37.6800 | -122.2370 | WGS84 |
| San Francisco Bay | SFP03 | Water Column | 28/Jun/2007 | 37.6800 | -122.2370 | WGS84 |
| San Francisco Bay | SFP03 | Water Column | 28/Sep/2007 | 37.6800 | -122.2370 | WGS84 |
| San Francisco Bay | SFP04 | Water Column | 02/Nov/2006 | 37.6050 | -122.2860 | WGS84 |
| San Francisco Bay | SFP04 | Water Column | 16/Feb/2007 | 37.6050 | -122.2860 | WGS84 |
| San Francisco Bay | SFP04 | Water Column | 28/Jun/2007 | 37.6050 | -122.2860 | WGS84 |
| San Francisco Bay | SFP04 | Water Column | 28/Sep/2007 | 37.6050 | -122.2860 | WGS84 |
| San Francisco Bay | SFP05 | Water Column | 02/Nov/2006 | 37.7890 | -122.3590 | WGS84 |
| San Francisco Bay | SFP05 | Water Column | 16/Feb/2007 | 37.7890 | -122.3590 | WGS84 |
| San Francisco Bay | SFP05 | Water Column | 28/Jun/2007 | 37.7890 | -122.3590 | WGS84 |
| San Francisco Bay | SFP05 | Water Column | 28/Sep/2007 | 37.7890 | -122.3590 | WGS84 |
| San Francisco Bay | SFP06 | Water Column | 02/Nov/2006 | 37.7620 | -122.3050 | WGS84 |
| San Francisco Bay | SFP06 | Water Column | 16/Feb/2007 | 37.7620 | -122.3050 | WGS84 |
| San Francisco Bay | SFP06 | Water Column | 28/Jun/2007 | 37.7620 | -122.3050 | WGS84 |
| San Francisco Bay | SFP06 | Water Column | 28/Sep/2007 | 37.7620 | -122.3050 | WGS84 |
| San Francisco Bay | SFP07 | Water Column | 02/Nov/2006 | 37.8880 | -122.4240 | WGS84 |
| San Francisco Bay | SFP07 | Water Column | 16/Feb/2007 | 37.8880 | -122.4240 | WGS84 |
| San Francisco Bay | SFP07 | Water Column | 28/Jun/2007 | 37.8880 | -122.4240 | WGS84 |
| San Francisco Bay | SFP07 | Water Column | 28/Sep/2007 | 37.8880 | -122.4240 | WGS84 |
| San Francisco Bay | SFP08 | Water Column | 02/Nov/2006 | 37.9240 | -122.4680 | WGS84 |
| San Francisco Bay | SFP08 | Water Column | 16/Feb/2007 | 37.9240 | -122.4680 | WGS84 |
| San Francisco Bay | SFP08 | Water Column | 28/Jun/2007 | 37.9240 | -122.4680 | WGS84 |
| San Francisco Bay | SFP08 | Water Column | 28/Sep/2007 | 37.9240 | -122.4680 | WGS84 |
| San Francisco Bay | SFP09 | Water Column | 02/Nov/2006 | 38.0700 | -122.3170 | WGS84 |
| San Francisco Bay | SFP09 | Water Column | 16/Feb/2007 | 38.0700 | -122.3170 | WGS84 |
| San Francisco Bay | SFP09 | Water Column | 28/Jun/2007 | 38.0700 | -122.3170 | WGS84 |
| San Francisco Bay | SFP09 | Water Column | 28/Sep/2007 | 38.0700 | -122.3170 | WGS84 |
| San Francisco Bay | SFP10 | Water Column | 02/Nov/2006 | 38.0530 | -122.4140 | WGS84 |
| San Francisco Bay | SFP10 | Water Column | 16/Feb/2007 | 38.0530 | -122.4140 | WGS84 |
| San Francisco Bay | SFP10 | Water Column | 28/Jun/2007 | 38.0530 | -122.4140 | WGS84 |
| San Francisco Bay | SFP10 | Water Column | 28/Sep/2007 | 38.0530 | -122.4140 | WGS84 |
| San Francisco Bay | SFP11 | Water Column | 02/Nov/2006 | 37.9980 | -122.4240 | WGS84 |
| San Francisco Bay | SFP11 | Water Column | 16/Feb/2007 | 37.9980 | -122.4240 | WGS84 |
| San Francisco Bay | SFP11 | Water Column | 28/Jun/2007 | 37.9980 | -122.4240 | WGS84 |
| San Francisco Bay | SFP11 | Water Column | 28/Sep/2007 | 37.9980 | -122.4240 | WGS84 |
| San Francisco Bay | SFP12 | Water Column | 02/Nov/2006 | 38.0560 | -122.3000 | WGS84 |
| San Francisco Bay | SFP12 | Water Column | 16/Feb/2007 | 38.0560 | -122.3000 | WGS84 |
| San Francisco Bay | SFP12 | Water Column | 28/Jun/2007 | 38.0560 | -122.3000 | WGS84 |
| San Francisco Bay | SFP12 | Water Column | 28/Sep/2007 | 38.0560 | -122.3000 | WGS84 |
| Port of Stockton | 544STOC01 | Epifauna | 27/Sep/2006 | 37.9538 | -121.3045 | NAD83 |
| Port of Stockton | 544STOC01 | Infauna | 27/Sep/2006 | 37.9538 | -121.6045 | NAD83 |
| Port of Stockton | 544STOC02 | Epifauna | 27/Sep/2006 | 37.9509 | -121.3175 | NAD83 |
| Port of Stockton | 544STOC02 | Infauna | 27/Sep/2006 | 37.9509 | -121.3175 | NAD83 |
| Port of Stockton | 544STOC03 | Epifauna | 27/Sep/2006 | 37.9516 | -121.3282 | NAD83 |
| Port of Stockton | 544STOC03 | Infauna | 27/Sep/2006 | 37.9516 | -121.3282 | NAD83 |
| Port of Oakland | POP01 | Water Column | 27/Mar/2006 | 37.7991 | -122.3286 | WGS84 |
| Port of Oakland | POP01 | Water Column | 12/Jun/2006 | 37.7991 | -122.3286 | WGS84 |
| Port of Oakland | POP01 | Water Column | 09/Mar/2007 | 37.7991 | -122.3286 | WGS84 |
| Port of Oakland | POP02 | Water Column | 27/Mar/2006 | 37.7920 | -122.2758 | WGS84 |
| Port of Oakland | POP02 | Water Column | 12/Jun/2006 | 37.7920 | -122.2758 | WGS84 |
| Port of Oakland | POP02 | Water Column | 09/Mar/2007 | 37.7920 | -122.2758 | WGS84 |

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| Port of Oakland | POP03 | Water Column | 27/Mar/2006 | 37.7680 | -122.2282 | WGS84 |
| Port of Oakland | POP03 | Water Column | 12/Jun/2006 | 37.7680 | -122.2282 | WGS84 |
| Port of Oakland | POP03 | Water Column | 09/Mar/2007 | 37.7680 | -122.2282 | WGS84 |
| Port of Oakland | POP04 | Water Column | 27/Mar/2006 | 37.7491 | -122.2237 | WGS84 |
| Port of Oakland | POP04 | Water Column | 12/Jun/2006 | 37.7491 | -122.2237 | WGS84 |
| Port of Oakland | POP04 | Water Column | 09/Mar/2007 | 37.7491 | -122.2237 | WGS84 |
| Moss Landing Harbor | 306MOSS04 | Epifauna | 01/Nov/2006 | 36.8112 | -121.7793 | NAD83 |
| Moss Landing Harbor | 306MOSS04 | Infauna | 01/Nov/2006 | 36.8112 | -121.7793 | NAD83 |
| Moss Landing Harbor | 306MOSS05 | Epifauna | 01/Nov/2006 | 36.8128 | -121.7880 | NAD83 |
| Moss Landing Harbor | 306MOSS05 | Infauna | 01/Nov/2006 | 36.8128 | -121.7880 | NAD83 |
| Moss Landing Harbor | 306MOSS06 | Epifauna | 02/Feb/2007 | 36.8562 | -121.7550 | NAD83 |
| Moss Landing Harbor | 309MOSS01 | Epifauna | 01/Nov/2006 | 36.8005 | -121.7877 | NAD83 |
| Moss Landing Harbor | 309MOSS02 | Epifauna | 01/Nov/2006 | 36.8027 | -121.7851 | NAD83 |
| Moss Landing Harbor | 309MOSS02 | Infauna | 01/Nov/2006 | 36.8027 | -121.7851 | NAD83 |
| Moss Landing Harbor | 309MOSS03 | Epifauna | 01/Nov/2006 | 36.8041 | -121.7860 | NAD83 |
| Monterey Harbor | 309MTRY01 | Epifauna | 02/Nov/2006 | 36.6023 | -121.8907 | NAD83 |
| Monterey Harbor | 309MTRY02 | Epifauna | 02/Nov/2006 | 36.6034 | -121.8905 | NAD83 |
| Monterey Harbor | 309MTRY02 | Infauna | 02/Nov/2006 | 36.6034 | -121.8905 | NAD83 |
| Monterey Harbor | 309MTRY03 | Epifauna | 02/Nov/2006 | 36.6039 | -121.8895 | NAD83 |
| Monterey Harbor | 309MTRY04 | Epifauna | 02/Nov/2006 | 36.6077 | -121.8928 | NAD83 |
| Monterey Harbor | 309MTRY04 | Infauna | 02/Nov/2006 | 36.6077 | -121.8928 | NAD83 |
| Monterey Harbor | 309MTRY05 | Epifauna | 02/Nov/2006 | 36.6090 | -121.8936 | NAD83 |
| Monterey Harbor | 309MTRY05 | Infauna | 02/Nov/2006 | 36.6090 | -121.8936 | NAD83 |
| Morro Bay | 310MORR01 | Epifauna | 28/Jul/2006 | 35.3707 | -120.8585 | NAD83 |
| Morro Bay | 310MORR02 | Epifauna | 28/Jul/2006 | 35.3691 | -120.8552 | NAD83 |
| Morro Bay | 310MORR02 | Infauna | 28/Jul/2006 | 35.3691 | -120.8552 | NAD83 |
| Morro Bay | 310MORR03 | Epifauna | 28/Jul/2006 | 35.3570 | -120.8492 | NAD83 |
| Morro Bay | 310MORR03 | Infauna | 28/Jul/2006 | 35.3570 | -120.8492 | NAD83 |
| Morro Bay | 310MORR04 | Epifauna | 28/Jul/2006 | 35.3577 | -120.8510 | NAD83 |
| Morro Bay | 310MORR04 | Infauna | 28/Jul/2006 | 35.3577 | -120.8510 | NAD83 |
| Morro Bay | 310MORR05 | Epifauna | 28/Jul/2006 | 35.3589 | -120.8524 | NAD83 |
| Santa Barbara Harbor | 315SBHB01 | Epifauna | 27/Jul/2006 | 34.4067 | -119.6889 | NAD83 |
| Santa Barbara Harbor | 315SBHB02 | Epifauna | 27/Jul/2006 | 34.4045 | -119.6919 | NAD83 |
| Santa Barbara Harbor | 315SBHB02 | Infauna | 27/Jul/2006 | 34.4045 | -119.5919 | NAD83 |
| Santa Barbara Harbor | 315SBHB03 | Epifauna | 27/Jul/2006 | 34.4047 | -119.6937 | NAD83 |
| Santa Barbara Harbor | 315SBHB04 | Epifauna | 27/Jul/2006 | 34.4069 | -119.6913 | NAD83 |
| Santa Barbara Harbor | 315SBHB04 | Infauna | 27/Jul/2006 | 34.4069 | -119.6913 | NAD83 |
| Channel Islands Harbor | 410CHNL01 | Epifauna | 25/Jul/2006 | 34.1741 | -119.2235 | NAD83 |
| Channel Islands Harbor | 410CHNL02 | Epifauna | 25/Jul/2006 | 34.1641 | -119.2255 | NAD83 |
| Channel Islands Harbor | 410CHNL02 | Infauna | 25/Jul/2006 | 34.1641 | -119.2255 | NAD83 |
| Channel Islands Harbor | 410CHNL03 | Epifauna | 25/Jul/2006 | 34.1696 | -119.2285 | NAD83 |
| Channel Islands Harbor | 410CHNL04 | Epifauna | 25/Jul/2006 | 34.1798 | -119.2297 | NAD83 |
| Channel Islands Harbor | 410CHNL04 | Infauna | 25/Jul/2006 | 34.1798 | -119.2297 | NAD83 |
| Port Hueneme | 410HNME01 | Epifauna | 26/Jul/2006 | 34.1532 | -119.2095 | NAD83 |
| Port Hueneme | 410HNME02 | Epifauna | 26/Jul/2006 | 34.1478 | -119.2077 | NAD83 |
| Port Hueneme | 410HNME03 | Epifauna | 26/Jul/2006 | 34.1482 | -119.2020 | NAD83 |
| Port Hueneme | 410HNME03 | Infauna | 26/Jul/2006 | 34.1482 | -119.2020 | NAD83 |
| Port Hueneme | 410HNME04 | Epifauna | 26/Jul/2006 | 34.1500 | -119.2100 | NAD83 |
| Port Hueneme | 410HNME04 | Infauna | 26/Jul/2006 | 34.1500 | -119.2100 | NAD83 |
| Port Hueneme | 410HNME05 | Epifauna | 26/Jul/2006 | 34.1516 | -119.2072 | NAD83 |
| Port Hueneme | 410HNME05 | Infauna | 26/Jul/2006 | 34.1516 | -119.2072 | NAD83 |
| Port Hueneme | 410HNME06 | Epifauna | 26/Jul/2006 | 34.1528 | 119.2101 | NAD83 |
| Port Hueneme | PHP01 | Water Column | 16/Mar/2006 | 34.1512 | -119.2066 | WGS84 |
| Port Hueneme | PHP01 | Water Column | 25/Jul/2006 | 34.1510 | -119.2067 | NAD83 |

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| Port Hueneme | PHP01 | Water Column | 22/Nov/2006 | 34.1512 | -119.2066 | WGS84 |
| Port Hueneme | PHP02 | Water Column | 16/Mar/2006 | 34.1490 | -119.2088 | WGS84 |
| Port Hueneme | PHP02 | Water Column | 25/Jul/2006 | 34.1489 | -119.2089 | NAD83 |
| Port Hueneme | PHP02 | Water Column | 22/Nov/2006 | 34.1490 | -119.2088 | WGS84 |
| Port Hueneme | PHP03 | Water Column | 16/Mar/2006 | 34.1469 | -119.2105 | WGS84 |
| Port Hueneme | PHP03 | Water Column | 25/Jul/2006 | 34.1467 | -119.2107 | NAD83 |
| Port Hueneme | PHP03 | Water Column | 22/Nov/2006 | 34.1469 | -119.2105 | WGS84 |
| Port Hueneme | PHP04 | Water Column | 16/Mar/2006 | 34.1453 | -119.2118 | WGS84 |
| Port Hueneme | PHP04 | Water Column | 25/Jul/2006 | 34.1451 | -119.2118 | NAD83 |
| Port Hueneme | PHP04 | Water Column | 22/Nov/2006 | 34.1453 | -119.2118 | WGS84 |
| Marina del Rey Harbor | 404MDLR01 | Epifauna | 25/Aug/2006 | 33.9702 | -118.4496 | NAD83 |
| Marina del Rey Harbor | 404MDLR01 | Infauna | 25/Aug/2006 | 33.9702 | -118.4496 | NAD83 |
| Marina del Rey Harbor | 404MDLR02 | Epifauna | 25/Aug/2006 | 33.9830 | -118.4564 | NAD83 |
| Marina del Rey Harbor | 404MDLR02 | Infauna | 25/Aug/2006 | 33.9830 | -118.4564 | NAD83 |
| Marina del Rey Harbor | 404MDLR03 | Epifauna | 25/Aug/2006 | 33.9830 | -118.4465 | NAD83 |
| Marina del Rey Harbor | 404MDLR04 | Epifauna | 25/Aug/2006 | 33.9783 | -118.4569 | NAD83 |
| Marina del Rey Harbor | 404MDLR05 | Epifauna | 25/Aug/2006 | 33.9761 | -118.4461 | NAD83 |
| Los Angeles Harbor | 411LALB01 | Epifauna | 21/Aug/2006 | 33.7446 | -118.2762 | NAD83 |
| Los Angeles Harbor | 411LALB02 | Epifauna | 21/Aug/2006 | 33.7410 | -118.2746 | NAD83 |
| Los Angeles Harbor | 411LALB02 | Infauna | 21/Aug/2006 | 33.7410 | -118.2746 | NAD83 |
| Los Angeles Harbor | 411LALB03 | Epifauna | 21/Aug/2006 | 33.7348 | -118.2479 | NAD83 |
| Los Angeles Harbor | 411LALB03 | Infauna | 21/Aug/2006 | 33.7348 | -118.2479 | NAD83 |
| Los Angeles Harbor | 411LALB04 | Epifauna | 21/Aug/2006 | 33.7165 | -118.2801 | NAD83 |
| Los Angeles Harbor | 411LALB06 | Epifauna | 22/Aug/2006 | 33.7233 | -118.2685 | NAD83 |
| Los Angeles Harbor | 411LALB06 | Infauna | 22/Aug/2006 | 33.7233 | -118.2685 | NAD83 |
| Los Angeles Harbor | 411LALB07 | Epifauna | 22/Aug/2006 | 33.7271 | -118.2339 | NAD83 |
| Los Angeles Harbor | 411LALB07 | Infauna | 22/Aug/2006 | 33.7271 | -118.2339 | NAD83 |
| Los Angeles Harbor | 411LALB08 | Epifauna | 22/Aug/2006 | 33.7667 | -118.2774 | NAD83 |
| Los Angeles Harbor | 411LALB09 | Epifauna | 22/Aug/2006 | 33.7655 | -118.2528 | NAD83 |
| Los Angeles Harbor | 411LALB10 | Epifauna | 22/Aug/2006 | 33.7645 | -118.2428 | NAD83 |
| Los Angeles Harbor | 411LALB10 | Infauna | 22/Aug/2006 | 33.7645 | -118.2428 | NAD83 |
| Los Angeles Harbor | LAP01 | Water Column | 15/Mar/2006 | 33.7322 | -118.2294 | WGS84 |
| Los Angeles Harbor | LAP01 | Water Column | 22/Aug/2006 | 33.7323 | -118.2294 | NAD83 |
| Los Angeles Harbor | LAP01 | Water Column | 21/Nov/2006 | 33.7322 | -118.2294 | WGS84 |
| Los Angeles Harbor | LAP02 | Water Column | 15/Mar/2006 | 33.7636 | -118.2501 | WGS84 |
| Los Angeles Harbor | LAP02 | Water Column | 22/Aug/2006 | 33.7636 | -118.2502 | NAD83 |
| Los Angeles Harbor | LAP02 | Water Column | 21/Nov/2006 | 33.7636 | -118.2501 | WGS84 |
| Los Angeles Harbor | LAP06 | Water Column | 15/Mar/2006 | 33.7146 | -118.2726 | WGS84 |
| Los Angeles Harbor | LAP06 | Water Column | 22/Aug/2006 | 33.7147 | -118.2727 | NAD83 |
| Los Angeles Harbor | LAP06 | Water Column | 21/Nov/2006 | 33.7146 | -118.2726 | WGS84 |
| Long Beach Harbor | 411LALB05 | Epifauna | 22/Aug/2006 | 33.7440 | -118.2358 | NAD83 |
| Long Beach Harbor | 411LALB11 | Epifauna | 23/Aug/2006 | 33.7483 | -118.1973 | NAD83 |
| Long Beach Harbor | 411LALB11 | Infauna | 23/Aug/2006 | 33.7483 | -118.1973 | NAD83 |
| Long Beach Harbor | 411LALB12 | Epifauna | 23/Aug/2006 | 33.7594 | -118.1866 | NAD83 |
| Long Beach Harbor | 411LALB12 | Infauna | 23/Aug/2006 | 33.7594 | -118.1866 | NAD83 |
| Long Beach Harbor | 411LALB13 | Epifauna | 23/Aug/2006 | 33.7628 | -118.2144 | NAD83 |
| Long Beach Harbor | 411LALB14 | Epifauna | 23/Aug/2006 | 33.7708 | -118.2113 | NAD83 |
| Long Beach Harbor | 411LALB16 | Epifauna | 23/Aug/2006 | 33.7697 | -118.2284 | NAD83 |
| Long Beach Harbor | LAP03 | Water Column | 15/Mar/2006 | 33.7694 | -118.2260 | WGS84 |
| Long Beach Harbor | LAP03 | Water Column | 23/Aug/2006 | 33.7694 | -118.2259 | NAD83 |
| Long Beach Harbor | LAP03 | Water Column | 21/Nov/2006 | 33.7694 | -118.2260 | WGS84 |
| Long Beach Harbor | LAP04 | Water Column | 15/Mar/2006 | 33.7472 | -118.2309 | WGS84 |
| Long Beach Harbor | LAP04 | Water Column | 22/Aug/2006 | 33.7473 | -118.2309 | NAD83 |
| Long Beach Harbor | LAP04 | Water Column | 21/Nov/2006 | 33.7472 | -118.7424 | WGS84 |

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| Long Beach Harbor | LAP05 | Water Column | 15/Mar/2006 | 33.7424 | -118.2015 | WGS84 |
| Long Beach Harbor | LAP05 | Water Column | 23/Aug/2006 | 33.7423 | -118.2016 | NAD83 |
| Long Beach Harbor | LAP05 | Water Column | 21/Nov/2006 | 33.7424 | -118.2015 | WGS84 |
| Huntington Harbor | 801HUNT01 | Epifauna | 24/Aug/2006 | 33.7224 | -118.0561 | NAD83 |
| Huntington Harbor | 801HUNT02 | Epifauna | 24/Aug/2006 | 33.7126 | -118.0542 | NAD83 |
| Huntington Harbor | 801HUNT02 | Infauna | 24/Aug/2006 | 33.7126 | -118.0542 | NAD83 |
| Huntington Harbor | 801HUNT03 | Epifauna | 24/Aug/2006 | 33.7175 | -118.0659 | NAD83 |
| Huntington Harbor | 801HUNT04 | Epifauna | 24/Aug/2006 | 33.7283 | -118.0602 | NAD83 |
| Huntington Harbor | 801HUNT05 | Epifauna | 24/Aug/2006 | 33.7279 | -118.0786 | NAD83 |
| Huntington Harbor | 801HUNT05 | Infauna | 24/Aug/2006 | 33.7279 | -118.0786 | NAD83 |
| Newport Bay | 801NEWP01 | Epifauna | 14/Sep/2006 | 33.6194 | -117.8933 | NAD83 |
| Newport Bay | 801NEWP01 | Infauna | 14/Sep/2006 | 33.6194 | -117.8933 | NAD83 |
| Newport Bay | 801NEWP02 | Epifauna | 14/Sep/2006 | 33.6097 | -117.8957 | NAD83 |
| Newport Bay | 801NEWP03 | Epifauna | 14/Sep/2006 | 33.5974 | -117.8798 | NAD83 |
| Newport Bay | 801NEWP03 | Infauna | 14/Sep/2006 | 33.5974 | -117.8798 | NAD83 |
| Newport Bay | 801NEWP04 | Epifauna | 14/Sep/2006 | 33.6082 | -117.9195 | NAD83 |
| Newport Bay | 801NEWP05 | Epifauna | 14/Sep/2006 | 33.6213 | -117.9364 | NAD83 |
| Newport Bay | 801NEWP05 | Infauna | 14/Sep/2006 | 33.6213 | -117.9364 | NAD83 |
| Dana Point Harbor | 901DANA01 | Epifauna | 15/Sep/2006 | 33.4594 | -117.6941 | NAD83 |
| Dana Point Harbor | 901DANA01 | Infauna | 15/Sep/2006 | 33.4594 | -117.6941 | NAD83 |
| Dana Point Harbor | 901DANA02 | Epifauna | 15/Sep/2006 | 33.4591 | -117.6992 | NAD83 |
| Dana Point Harbor | 901DANA03 | Epifauna | 15/Sep/2006 | 33.4605 | -117.7020 | NAD83 |
| Dana Point Harbor | 901DANA03 | Infauna | 15/Sep/2006 | 33.4605 | -117.7020 | NAD83 |
| Dana Point Harbor | 901DANA04 | Epifauna | 15/Sep/2006 | 33.4622 | -117.7063 | NAD83 |
| Avalon Harbor | 406AVAL01 | Epifauna | 10/Oct/2006 | 33.3483 | -118.3265 | NAD83 |
| Avalon Harbor | 406AVAL02 | Epifauna | 10/Oct/2006 | 33.3442 | -118.3225 | NAD83 |
| Avalon Harbor | 406AVAL02 | Infauna | 10/Oct/2006 | 33.3442 | -118.3225 | NAD83 |
| Avalon Harbor | 406AVAL03 | Epifauna | 10/Oct/2006 | 33.3440 | -118.3247 | NAD83 |
| Avalon Harbor | 406AVAL03 | Infauna | 10/Oct/2006 | 33.3440 | -118.3247 | NAD83 |
| Avalon Harbor | 406AVAL04 | Epifauna | 10/Oct/2006 | 33.3461 | -118.3268 | NAD83 |
| Oceanside Harbor | 902OCEA01 | Epifauna | 13/Sep/2006 | 33.2057 | -117.3897 | NAD83 |
| Oceanside Harbor | 902OCEA01 | Infauna | 13/Sep/2006 | 33.2057 | -117.3897 | NAD83 |
| Oceanside Harbor | 902OCEA02 | Epifauna | 13/Sep/2006 | 33.2122 | -117.3954 | NAD83 |
| Oceanside Harbor | 902OCEA03 | Epifauna | 13/Sep/2006 | 33.2106 | -117.3960 | NAD83 |
| Oceanside Harbor | 902OCEA03 | Infauna | 13/Sep/2006 | 33.2106 | -117.3960 | NAD83 |
| Oceanside Harbor | 902OCEA04 | Epifauna | 13/Sep/2006 | 33.2091 | -117.3947 | NAD83 |
| Mission Bay | 906MISS01 | Epifauna | 12/Sep/2006 | 32.7671 | -117.2362 | NAD83 |
| Mission Bay | 906MISS01 | Infauna | 12/Sep/2006 | 32.7671 | -117.2362 | NAD83 |
| Mission Bay | 906MISS02 | Epifauna | 12/Sep/2006 | 32.7621 | -117.2365 | NAD83 |
| Mission Bay | 906MISS03 | Epifauna | 12/Sep/2006 | 32.7774 | -117.2484 | NAD83 |
| Mission Bay | 906MISS03 | Infauna | 12/Sep/2006 | 32.7774 | -117.2484 | NAD83 |
| Mission Bay | 906MISS04 | Epifauna | 12/Sep/2006 | 32.7939 | -117.2232 | NAD83 |
| Mission Bay | 906MISS04 | Infauna | 12/Sep/2006 | 32.7939 | -117.2232 | NAD83 |
| Mission Bay | 906MISS05 | Epifauna | 12/Sep/2006 | 32.7788 | -117.2127 | NAD83 |
| Mission Bay | 906MISS05 | Infauna | 12/Sep/2006 | 32.7788 | -117.2127 | NAD83 |
| San Diego Bay | SDP01 | Water Column | 14/Mar/2006 | 32.6932 | -117.2306 | WGS84 |
| San Diego Bay | SDP01 | Water Column | 15/Jun/2006 | 32.6932 | -117.2306 | WGS84 |
| San Diego Bay | SDP01 | Water Column | 20/Nov/2006 | 32.6932 | -117.2306 | WGS84 |
| San Diego Bay | SDP02 | Water Column | 14/Mar/2006 | 32.7204 | -117.2180 | WGS84 |
| San Diego Bay | SDP02 | Water Column | 15/Jun/2006 | 32.7204 | -117.2180 | WGS84 |
| San Diego Bay | SDP02 | Water Column | 20/Nov/2006 | 32.7204 | -117.2180 | WGS84 |
| San Diego Bay | SDP03 | Water Column | 14/Mar/2006 | 32.7223 | -117.1849 | WGS84 |

| Waterbody | Station Code | Habitat Type | Sample Date | Latitude DD | Longitude DD | Datum |
|---|---|---|---|---|---|---|
| San Diego Bay | SDP03 | Water Column | 15/Jun/2006 | 32.7223 | -117.1849 | WGS84 |
| San Diego Bay | SDP03 | Water Column | 20/Nov/2006 | 32.7223 | -117.1849 | WGS84 |
| San Diego Bay | SDP04 | Water Column | 14/Mar/2006 | 32.6885 | -117.1495 | WGS84 |
| San Diego Bay | SDP04 | Water Column | 15/Jun/2006 | 32.6885 | -117.1495 | WGS84 |
| San Diego Bay | SDP04 | Water Column | 20/Nov/2006 | 32.6885 | -117.1495 | WGS84 |
| San Diego Bay | SDP05 | Water Column | 14/Mar/2006 | 32.6706 | -117.1285 | WGS84 |
| San Diego Bay | SDP05 | Water Column | 15/Jun/2006 | 32.6706 | -117.1285 | WGS84 |
| San Diego Bay | SDP05 | Water Column | 20/Nov/2006 | 32.6706 | -117.1285 | WGS84 |
| San Diego Bay | SDP06 | Water Column | 14/Mar/2006 | 32.6437 | -117.1236 | WGS84 |
| San Diego Bay | SDP06 | Water Column | 15/Jun/2006 | 32.6437 | -117.1236 | WGS84 |
| San Diego Bay | SDP06 | Water Column | 20/Nov/2006 | 32.6437 | -117.1236 | WGS84 |

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

| Water Body | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Humboldt Bay | Epifaunal | 281 | 19 (6.8%) | 34 (12.1%) | 125 (44.5%) | 3 (1.1%) | 100 (35.6%) |
| Humboldt Bay | Infaunal | 80 | 7 (8.8%) | 21 (26.3%) | 29 (36.3%) | 1 (1.3%) | 22 (27.5%) |
| Humboldt Bay | Water Column | 35 | 1 (2.9%) | 2 (5.7%) | 26 (74.3%) | | 6 (17.1%) |
| Port of Sacramento | Epifaunal | 33 | 1 (3.0%) | 2 (6.1%) | 5 (15.2%) | 1 (3.0%) | 24 (72.7%) |
| Port of Sacramento | Infaunal | 22 | 2 (9.1%) | 3 (13.6%) | 4 (18.2%) | | 13 (59.1%) |
| Bodega Bay | Epifaunal | 146 | 16 (11.0%) | 30 (20.5%) | 45 (30.8%) | 2 (1.4%) | 53 (36.3%) |
| Bodega Bay | Infaunal | 44 | 4 (9.1%) | 13 (29.5%) | 18 (40.9%) | 1 (2.3%) | 8 (18.2%) |
| Tomales Bay | Epifaunal | 126 | 22 (17.5%) | 19 (15.1%) | 54 (42.9%) | 1 (0.8%) | 30 (23.8%) |
| Tomales Bay | Infaunal | 33 | 5 (15.2%) | 8 (24.2%) | 11 (33.3%) | | 9 (27.3%) |
| San Francisco Bay | Water Column | 47 | 9 (19.1%) | 4 (8.5%) | 27 (57.4%) | 1 (2.1%) | 6 (12.8%) |
| Port of Stockton | Epifaunal | 24 | 1 (4.2%) | 1 (4.2%) | 2 (8.3%) | 1 (4.2%) | 19 (79.2%) |
| Port of Stockton | Infaunal | 12 | 1 (8.3%) | 3 (25.0%) | 1 (8.3%) | | 7 (58.3%) |
| Port of Oakland | Water Column | 36 | 8 (22.2%) | 3 (8.3%) | 18 (50.0%) | 1 (2.8%) | 6 (16.7%) |
| Moss Landing Harbor | Epifaunal | 133 | 20 (15.0%) | 23 (17.3%) | 49 (36.8%) | 2 (1.5%) | 39 (29.3%) |
| Moss Landing Harbor | Infaunal | 53 | 5 (9.4%) | 8 (15.1%) | 29 (54.7%) | | 11 (20.8%) |
| Monterey Harbor | Epifaunal | 189 | 13 (6.9%) | 27 (14.3%) | 88 (46.6%) | 2 (1.1%) | 59 (31.2%) |
| Monterey Harbor | Infaunal | 111 | 5 (4.5%) | 14 (12.6%) | 47 (42.3%) | | 45 (40.5%) |
| Morro Bay | Epifaunal | 210 | 15 (7.1%) | 30 (14.3%) | 88 (41.9%) | 3 (1.4%) | 74 (35.2%) |
| Morro Bay | Infaunal | 60 | 5 (8.3%) | 10 (16.7%) | 32 (53.3%) | | 13 (21.7%) |
| Santa Barbara Harbor | Epifaunal | 177 | 20 (11.3%) | 27 (15.3%) | 57 (32.2%) | 2 (1.1%) | 71 (40.1%) |
| Santa Barbara Harbor | Infaunal | 62 | 4 (6.5%) | 16 (25.8%) | 27 (43.5%) | 1 (1.6%) | 14 (22.6%) |
| Channel Islands Harbor | Epifaunal | 169 | 24 (14.2%) | 25 (14.8%) | 60 (35.5%) | 2 (1.2%) | 58 (34.3%) |
| Channel Islands Harbor | Infaunal | 74 | 7 (9.5%) | 19 (25.7%) | 22 (29.7%) | 1 (1.4%) | 25 (33.8%) |
| Port Hueneme | Epifaunal | 255 | 21 (8.2%) | 36 (14.1%) | 105 (41.2%) | 3 (1.2%) | 90 (35.3%) |
| Port Hueneme | Infaunal | 88 | 5 (5.7%) | 16 (18.2%) | 40 (45.5%) | | 27 (30.7%) |
| Port Hueneme | Water Column | 38 | 1 (2.6%) | 3 (7.9%) | 28 (73.7%) | | 6 (15.8%) |
| Marina del Rey Harbor | Epifaunal | 142 | 23 (16.2%) | 32 (22.5%) | 42 (29.6%) | 1 (0.7%) | 44 (31.0%) |
| Marina del Rey Harbor | Infaunal | 35 | 5 (14.3%) | 9 (25.7%) | 13 (37.1%) | | 8 (22.9%) |
| Los Angeles Harbor | Epifaunal | 241 | 31 (12.9%) | 39 (16.2%) | 96 (39.8%) | 1 (0.4%) | 74 (30.7%) |
| Los Angeles Harbor | Infaunal | 119 | 8 (6.7%) | 27 (22.7%) | 51 (42.9%) | | 33 (27.7%) |
| Los Angeles Harbor | Water Column | 37 | 2 (5.4%) | 2 (5.4%) | 24 (64.9%) | | 9 (24.3%) |
| Long Beach Harbor | Epifaunal | 248 | 28 (11.3%) | 35 (14.1%) | 104 (41.9%) | 1 (0.4%) | 80 (32.3%) |
| Long Beach Harbor | Infaunal | 43 | 3 (7.0%) | 7 (16.3%) | 21 (48.8%) | 1 (2.3%) | 11 (25.6%) |
| Long Beach Harbor | Water Column | 29 | 2 (6.9%) | 2 (6.9%) | 19 (65.5%) | | 6 (20.7%) |
| Huntington Harbor | Epifaunal | 146 | 23 (15.8%) | 20 (13.7%) | 60 (41.1%) | 1 (0.7%) | 42 (28.8%) |
| Huntington Harbor | Infaunal | 32 | 3 (9.4%) | 8 (25.0%) | 6 (18.8%) | | 15 (46.9%) |
| Newport Bay | Epifaunal | 167 | 28 (16.8%) | 28 (16.8%) | 58 (34.7%) | 1 (0.6%) | 52 (31.1%) |
| Newport Bay | Infaunal | 59 | 7 (11.9%) | 14 (23.7%) | 20 (33.9%) | 1 (1.7%) | 17 (28.8%) |
| Dana Point Harbor | Epifaunal | 137 | 21 (15.3%) | 20 (14.6%) | 45 (32.8%) | 2 (1.5%) | 49 (35.8%) |
| Dana Point Harbor | Infaunal | 27 | 2 (7.4%) | 6 (22.2%) | 10 (37.0%) | | 9 (33.3%) |
| Avalon Harbor | Epifaunal | 130 | 17 (13.1%) | 13 (10.0%) | 59 (45.4%) | | 41 (31.5%) |
| Avalon Harbor | Infaunal | 72 | | 13 (18.1%) | 34 (47.2%) | 1 (1.4%) | 24 (33.3%) |

| Water Body | Habitat Type | Total Taxa | Introduced | Cryptogenic | Native | Unresolved Complex | Unresolved |
|---|---|---|---|---|---|---|---|
| Oceanside Harbor | Epifaunal | 138 | 20 (14.5%) | 19 (13.8%) | 49 (35.5%) | 1 (0.7%) | 49 (35.5%) |
| Oceanside Harbor | Infaunal | 12 | 2 (16.7%) | 1 (8.3%) | 6 (50.0%) | | 3 (25.0%) |
| Mission Bay | Epifaunal | 193 | 29 (15.0%) | 27 (14.0%) | 72 (37.3%) | 1 (0.5%) | 64 (33.2%) |
| Mission Bay | Infaunal | 44 | 6 (13.6%) | 6 (13.6%) | 21 (47.7%) | | 11 (25.0%) |
| San Diego Bay | Water Column | 35 | 2 (5.7%) | 3 (8.6%) | 22 (62.9%) | | 8 (22.9%) |

## Appendix F – Grain size analysis results given in percent fines for each site sampled.

| Waterbody | Station Code | Collection Depth (m) | % Fines |
|---|---|---|---|
| Humboldt Bay | 110HUMB01 | 5.3 | 87.18 |
| Humboldt Bay | 110HUMB05 | 9.8 | 20.86 |
| Humboldt Bay | 110HUMB06 | 10.3 | 28.27 |
| Port of Sacramento | 510PSAC02 | 9.9 | 37.75 |
| Bodega Bay | 115BDGA04 | 4.1 | 97.35 |
| Tomales Bay | 201TMLS03 | 3.1 | 49.25 |
| Port of Stockton | 544STOC02 | 11.4 | 90.71 |
| Moss Landing Harbor | 306MOSS04 | 2.3 | 30.86 |
| Moss Landing Harbor | 309MOSS02 | 3.7 | 99.47 |
| Monterey Harbor | 309MTRY02 | 4.3 | 23.65 |
| Morro Bay | 310MORR02 | 3.5 | 17.03 |
| Morro Bay | 310MORR04 | 4 | 3.59 |
| Santa Barbara Harbor | 315SBHB04 | 5.4 | 41.79 |
| Channel Islands Harbor | 410CHNL02 | 4.6 | 83.83 |
| Port Hueneme | 410HNME04 | 11 | 65.71 |
| Marina del Rey Harbor | 404MDLR02 | 4.4 | 85.57 |
| Los Angeles Harbor | 411LALB02 | 14.9 | 75.74 |
| Los Angeles Harbor | 411LALB07 | 11.6 | 43.03 |
| Los Angeles Harbor | 411LALB10 | 11.2 | 69.71 |
| Long Beach Harbor | 411LALB12 | 9.8 | 93.89 |
| Huntington Harbor | 801HUNT02 | 4.4 | 99.22 |
| Newport Bay | 801NEWP01 | 3 | 99.21 |
| Newport Bay | 801NEWP05 | 3.7 | 69.86 |
| Dana Point Harbor | 901DANA03 | 2.5 | 48.4 |
| Avalon Harbor | 406AVAL03 | 4.5 | 9.79 |
| Oceanside Harbor | 902OCEA01 | 12 | 96.43 |
| Mission Bay | 906MISS01 | 4.2 | 80.86 |
| Mission Bay | 906MISS03 | 4.5 | 69.21 |
| Mission Bay | 906MISS04 | 6.9 | 96.42 |

**Appendix G – Number of individuals and presence/absence data for introduced species observed at each bay.**

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amathia convoluta* | Epifauna | Ectoprocta | **1** | | | | | | | | | | P | | |
| *Amphibalanus amphitrite* | Epifauna | Arthropoda | **2** | | | | | | | | | | | | 96 |
| *Ampithoe valida* | Epifauna | Arthropoda | **6** | 496 | | | 224 | | | | | | | | |
| *Anopsilana jonesi* | Epifauna | Arthropoda | **2** | | | | | | | | | | | | |
| *Aoroides secundus* | Epifauna | Arthropoda | **6** | | | | | | | | | 896 | 112 | | 16 |
| *Ascidia zara* | Epifauna | Chordata | **10** | | | | | | | | | | | 64 | 48 |
| *Ascidia zara* | Infauna | Chordata | **1** | | | | | | | | | | | | |
| *Balanus eburneus* | Epifauna | Arthropoda | **4** | | | | | | | | | | | | |
| *Balanus eburneus* | Infauna | Arthropoda | **1** | | | | | | | | | | | | |
| *Barentsia benedeni* | Epifauna | Entoprocta | **9** | P | | P | P | | | | P | P | P | | |
| *Barentsia benedeni* | Infauna | Entoprocta | **1** | P | | | | | | | | | | | |
| *Botrylloides perspicuum* | Epifauna | Chordata | **4** | | | | | | | | | | | | |
| *Botrylloides sp. A Lambert* | Epifauna | Chordata | **2** | P | | | | | | | | | | P | |
| *Botrylloides violaceus* | Epifauna | Chordata | **15** | 128 | | 464 | 96 | | | | 64 | P | 48 | 32 | P |
| *Botryllus schlosseri* | Epifauna | Chordata | **17** | 32 | | 64 | 16 | | | | 16 | 48 | | 104 | 160 |
| *Botryllus sp. A Lambert* | Epifauna | Chordata | **4** | 64 | | P | | | | | 32 | | | | |
| *Branchiosyllis exilis* | Epifauna | Annelida | **3** | | | | | | | | | | | | 48 |
| *Branchiura sowerbyi* | Infauna | Annelida | **2** | | P | | | | P | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amathia convoluta* | Epifauna | Ectoprocta | **1** | | | | | | | | | | | |
| *Amphibalanus amphitrite* | Epifauna | Arthropoda | **2** | 16 | | | | | | | | | | |
| *Ampithoe valida* | Epifauna | Arthropoda | **6** | | | 16 | | 16 | | 64 | 368 | | | |
| *Anopsilana jonesi* | Epifauna | Arthropoda | **2** | | | | 64 | 64 | | | | | | |
| *Aoroides secundus* | Epifauna | Arthropoda | **6** | | | | 144 | | | | | 32 | 144 | |
| *Ascidia zara* | Epifauna | Chordata | **10** | | 72 | P | 144 | 112 | 112 | 16 | 32 | | 32 | |
| *Ascidia zara* | Infauna | Chordata | **1** | | | | | | | | | | 16 | |
| *Balanus eburneus* | Epifauna | Arthropoda | **4** | | | | | | 112 | 240 | 64 | | 608 | |
| *Balanus eburneus* | Infauna | Arthropoda | **1** | | | | | | | 176 | | | | |
| *Barentsia benedeni* | Epifauna | Entoprocta | **9** | P | | P | P | | | | | | | |
| *Barentsia benedeni* | Infauna | Entoprocta | **1** | | | | | | | | | | | |
| *Botrylloides perspicuum* | Epifauna | Chordata | **4** | | | | 32 | | 16 | | | P | P | |
| *Botrylloides sp. A Lambert* | Epifauna | Chordata | **2** | | | | | | | | | | | |
| *Botrylloides violaceus* | Epifauna | Chordata | **15** | | 40 | 40 | 192 | 48 | P | P | | | P | |
| *Botryllus schlosseri* | Epifauna | Chordata | **17** | P | 80 | 48 | 16 | 32 | 448 | 80 | 112 | 128 | 144 | |
| *Botryllus sp. A Lambert* | Epifauna | Chordata | **4** | | | 16 | | | | | | | | |
| *Branchiosyllis exilis* | Epifauna | Annelida | **3** | 64 | | | | | | | | | 1792 | |
| *Branchiura sowerbyi* | Infauna | Annelida | **2** | | | | | | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Caprella mutica* | Epifauna | Arthropoda | **12** | 11728 | | 7024 | 1344 | | | | 18128 | 2784 | 25800 | 1056 | |
| *Caprella mutica* | Infauna | Arthropoda | **2** | | | | | | | | 432 | 129 | | | |
| *Caprella scaura* | Epifauna | Arthropoda | **6** | | | | | | | | | | 336 | | |
| *Caprella scaura* | Infauna | Arthropoda | **2** | | | | | | | | | | | | |
| *Ciona intestinalis* | Epifauna | Chordata | **13** | | | 16 | 16 | | | | | | | 1088 | 256 |
| *Ciona savignyi* | Epifauna | Chordata | **12** | | | | | | | | | 16 | | 16 | 16 |
| *Corbicula* | Infauna | Mollusca | **1** | | 45 | | | | | | | | | | |
| *Corophium heteroceratum* | Infauna | Arthropoda | **1** | | | 208 | | | | | | | | | |
| *Crassostrea gigas* | Epifauna | Mollusca | **1** | | | | | | | | | | | | |
| *Crassostrea virginica* | Epifauna | Mollusca | **1** | | | | 32 | | | | | | | | |
| *Crepidula fornicata* | Epifauna | Mollusca | **2** | | | | | | | | | | | | |
| *Cryptosula pallasiana* | Epifauna | Ectoprocta | **16** | | | P | P | | | | P | P | P | P | P |
| *Cryptosula pallasiana* | Infauna | Ectoprocta | **7** | | | | | | | | | P | | | P |
| *Didemnum sp. A Lambert* | Epifauna | Chordata | **6** | 64 | | 496 | 128 | | | | 64 | | 24 | | |
| *Didemnum sp. A Lambert* | Infauna | Chordata | **1** | | | | | | | | 16 | | | | |
| *Diplosoma listerianum* | Epifauna | Chordata | **15** | 16 | | | 16 | | | | 96 | 16 | | 8 | 80 |
| *Diplosoma listerianum* | Infauna | Chordata | **1** | | | | | | | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Caprella mutica* | Epifauna | Arthropoda | **12** | | 1296 | 216 | 5280 | 48 | | | | | 64 | |
| *Caprella mutica* | Infauna | Arthropoda | **2** | | | | | | | | | | | |
| *Caprella scaura* | Epifauna | Arthropoda | **6** | | | | 53776 | 6624 | 176 | | 48 | | 16 | |
| *Caprella scaura* | Infauna | Arthropoda | **2** | | | | 16 | | | 16 | | | | |
| *Ciona intestinalis* | Epifauna | Chordata | **13** | | 72 | 140 | 672 | 1392 | 1072 | 240 | 64 | 48 | 352 | |
| *Ciona savignyi* | Epifauna | Chordata | **12** | | P | 4 | 320 | 544 | 48 | P | 32 | 128 | 192 | |
| *Corbicula* | Infauna | Mollusca | **1** | | | | | | | | | | | |
| *Corophium heteroceratum* | Infauna | Arthropoda | **1** | | | | | | | | | | | |
| *Crassostrea gigas* | Epifauna | Mollusca | **1** | 1 | | | | | | | | | | |
| *Crassostrea virginica* | Epifauna | Mollusca | **1** | | | | | | | | | | | |
| *Crepidula fornicata* | Epifauna | Mollusca | **2** | | | | 16 | 16 | | | | | | |
| *Cryptosula pallasiana* | Epifauna | Ectoprocta | **16** | P | P | P | P | P | P | P | | P | P | |
| *Cryptosula pallasiana* | Infauna | Ectoprocta | **7** | | P | | | P | P | P | | | P | |
| *Didemnum sp. A Lambert* | Epifauna | Chordata | **6** | | | 116 | | | | | | | | |
| *Didemnum sp. A Lambert* | Infauna | Chordata | **1** | | | | | | | | | | | |
| *Diplosoma listerianum* | Epifauna | Chordata | **15** | 16 | 32 | 48 | 80 | 144 | 208 | P | 16 | 16 | | |
| *Diplosoma listerianum* | Infauna | Chordata | **1** | | 16 | | | | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Eurytemora affinis complex* | Water Column | Arthropoda | **3** | P | | | | P | | P | | | | | |
| *Eusarsiella zostericola* | Infauna | Arthropoda | **1** | 16 | | | | | | | | | | | |
| *Ficopomatus enigmaticus* | Epifauna | Annelida | **1** | | | | | | | | 270 | | | | |
| *Grandidierella japonica* | Epifauna | Arthropoda | **4** | 64 | | | | | | | | | | | |
| *Grandidierella japonica* | Infauna | Arthropoda | **8** | 16 | | | 32 | | | | | | 176 | 352 | 16 |
| *Halichondria bowerbanki* | Epifauna | Porifera | **15** | P | | P | P | | | | P | | P | P | P |
| *Hydroides elegans* | Epifauna | Annelida | **8** | | | | | | | | | | | 144 | 10304 |
| *Hydroides elegans* | Infauna | Annelida | **1** | | | | | | | | | | | | 16 |
| *Hyperacanthomysis longirostris* | Water Column | Arthropoda | **1** | | | | | 1310 | | | | | | | |
| *Incisocalliope derzhavini* | Epifauna | Arthropoda | **2** | 80 | | | | | | | | 80 | | | |
| *Limnoithona tetraspina* | Water Column | Arthropoda | **1** | | | | | | | P | | | | | |
| *Limnoria quadripunctata* | Epifauna | Arthropoda | **3** | | | | 16 | | | | 96 | | | | |
| *Limnoria tripunctata* | Epifauna | Arthropoda | **2** | | | | | | | | | | | | |
| *Lomentaria hakodatensis* | Epifauna | Rhodophyta | **3** | | | P | | | | | P | | | | |
| *Manayunkia speciosa* | Epifauna | Annelida | **1** | | | | | | P | | | | | | |
| *Melita nitida* | Epifauna | Arthropoda | **2** | | | | 800 | | | | 192 | | | | |
| *Melita rylovae* | Epifauna | Arthropoda | **1** | | | | | | | | | | | | |
| *Microcosmus squamiger* | Epifauna | Chordata | **9** | | | | | | | | | | | | 32 |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Eurytemora affinis complex* | Water Column | Arthropoda | **3** | | | | | | | | | | | |
| *Eusarsiella zostericola* | Infauna | Arthropoda | **1** | | | | | | | | | | | |
| *Ficopomatus enigmaticus* | Epifauna | Annelida | **1** | | | | | | | | | | | |
| *Grandidierella japonica* | Epifauna | Arthropoda | **4** | | 16 | | 48 | 448 | | | | | | |
| *Grandidierella japonica* | Infauna | Arthropoda | **8** | | 32 | | | | | | 2 | | 64 | |
| *Halichondria bowerbanki* | Epifauna | Porifera | **15** | | P | P | P | P | P | P | | P | P | |
| *Hydroides elegans* | Epifauna | Annelida | **8** | | | | 32 | 272 | | 16 | 6368 | 10112 | 768 | |
| *Hydroides elegans* | Infauna | Annelida | **1** | | | | | | | | | | | |
| *Hyperacanthomysis longirostris* | Water Column | Arthropoda | **1** | | | | | | | | | | | |
| *Incisocalliope derzhavini* | Epifauna | Arthropoda | **2** | | | | | | | | | | | |
| *Limnoithona tetraspina* | Water Column | Arthropoda | **1** | | | | | | | | | | | |
| *Limnoria quadripunctata* | Epifauna | Arthropoda | **3** | 48 | | | | | | | | | | |
| *Limnoria tripunctata* | Epifauna | Arthropoda | **2** | 16 | 128 | | | | | | | | | |
| *Lomentaria hakodatensis* | Epifauna | Rhodophyta | **3** | | | | | P | | | | | | |
| *Manayunkia speciosa* | Epifauna | Annelida | **1** | | | | | | | | | | | |
| *Melita nitida* | Epifauna | Arthropoda | **2** | | | | | | | | | | | |
| *Melita rylovae* | Epifauna | Arthropoda | **1** | | | | 176 | | | | | | | |
| *Microcosmus squamiger* | Epifauna | Chordata | **9** | | 32 | | 32 | 32 | 160 | 16 | 96 | 16 | 112 | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Microdeutopus gryllotalpa* | Infauna | Arthropoda | **1** | | | | | | | | | | 96 | | |
| *Molgula ficus* | Epifauna | Chordata | **8** | | | | | | | | | | | | 16 |
| *Molgula manhattensis* | Epifauna | Chordata | **6** | 32 | | | 64 | | | | | | | | |
| *Molgula manhattensis* | Infauna | Chordata | **1** | | | | | | | | | | | | |
| *Monocorophium acherusicum* | Epifauna | Arthropoda | **14** | 47232 | | 2048 | 3504 | | | | 6656 | | 33912 | 168 | |
| *Monocorophium acherusicum* | Infauna | Arthropoda | **5** | | | | 64 | | | | 1728 | | 400 | | |
| *Monocorophium acherusicum* | Water Column | Arthropoda | **1** | | | | | P | | | | | | | |
| *Monocorophium insidiosum* | Epifauna | Arthropoda | **11** | 12240 | | 5296 | 752 | | | | 90288 | 32 | 18000 | 16 | |
| *Monocorophium insidiosum* | Infauna | Arthropoda | **8** | 48 | | 16 | 80 | | | | | 16 | 864 | | |
| *Monocorophium insidiosum* | Water Column | Arthropoda | **2** | | | | | P | | P | | | | | |
| *Musculista senhousia* | Epifauna | Mollusca | **5** | | | | 17 | | | | | | 16 | | 16 |
| *Musculista senhousia* | Infauna | Mollusca | **3** | | | | 16 | | | | | | | | |
| *Myrianida pachycera* | Epifauna | Annelida | **3** | | | | | | | | | | | | |
| *Myriophyllum spicatum* | Epifauna | Magnoliophyta | **1** | | P | | | | | | | | | | |
| *Mytilus galloprovincialis* | Epifauna | Mollusca | **16** | 336 | | 160 | 208 | | | | 16 | 32 | 16 | 512 | 336 |
| *Nicolea sp. A Harris* | Epifauna | Annelida | **7** | | | | | | | | | | | | |
| *Nicolea sp. A Harris* | Infauna | Annelida | **1** | | | | | | | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Microdeutopus gryllotalpa* | Infauna | Arthropoda | **1** | | | | | | | | | | | |
| *Molgula ficus* | Epifauna | Chordata | **8** | | 616 | | 64 | 16 | 80 | 928 | 96 | | 176 | |
| *Molgula manhattensis* | Epifauna | Chordata | **6** | | 8 | | 336 | 256 | | P | | | | |
| *Molgula manhattensis* | Infauna | Chordata | **1** | | | | 16 | | | | | | | |
| *Monocorophium acherusicum* | Epifauna | Arthropoda | **14** | | 216 | 2612 | 368 | 512 | | 1168 | 192 | 208 | 688 | |
| *Monocorophium acherusicum* | Infauna | Arthropoda | **5** | | 64 | 16 | | | | | | | | |
| *Monocorophium acherusicum* | Water Column | Arthropoda | **1** | | | | | | | | | | | |
| *Monocorophium insidiosum* | Epifauna | Arthropoda | **11** | 16 | 1192 | | | 48 | | | 352 | | | |
| *Monocorophium insidiosum* | Infauna | Arthropoda | **8** | | 352 | | | | | 80 | 2 | | | |
| *Monocorophium insidiosum* | Water Column | Arthropoda | **2** | | | | | | | | | | | |
| *Musculista senhousia* | Epifauna | Mollusca | **5** | | | | | | | 308 | | | 192 | |
| *Musculista senhousia* | Infauna | Mollusca | **3** | | | | | | | 192 | | | 48 | |
| *Myrianida pachycera* | Epifauna | Annelida | **3** | 48 | | | | | 48 | 176 | | | | |
| *Myriophyllum spicatum* | Epifauna | Magnoliophyta | **1** | | | | | | | | | | | |
| *Mytilus galloprovincialis* | Epifauna | Mollusca | **16** | | 648 | 1032 | 2048 | 736 | | 304 | 16 | 544 | 272 | |
| *Nicolea sp. A Harris* | Epifauna | Annelida | **7** | | | | 2608 | 1472 | 176 | P | 160 | 112 | 160 | |
| *Nicolea sp. A Harris* | Infauna | Annelida | **1** | | | | 32 | | | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Nippoleucon hinumensis* | Epifauna | Arthropoda | **1** | | | | 24 | | | | | | | | |
| *Nippoleucon hinumensis* | Infauna | Arthropoda | **1** | | | 144 | | | | | | | | | |
| *Nippoleucon hinumensis* | Water Column | Arthropoda | **2** | | | | | 690 | | 4 | | | | | |
| *Oithona davisae* | Water Column | Arthropoda | **6** | | | | | 936879 | | 796 | | | | | |
| *Paracorophium lucasi* | Infauna | Arthropoda | **1** | 928 | | | | | | | | | | | |
| *Paradexamine churinga* | Epifauna | Arthropoda | **3** | | | | | | | | | | | | |
| *Paradexamine sp. SD1 SCAMIT* | Epifauna | Arthropoda | **6** | | | | | | | | | | | | |
| *Philine auriformis* | Infauna | Mollusca | **1** | | | | | | | | | | | | |
| *Polyandrocarpa zorritensis* | Epifauna | Chordata | **7** | | | | | | | | | | | | 96 |
| *Pseudodiaptomus forbesi* | Water Column | Arthropoda | **1** | | | | | | | 4 | | | | | |
| *Pseudodiaptomus marinus* | Water Column | Arthropoda | **5** | | | | | 665989 | | 183 | | | | | |
| *Sargassum muticum* | Epifauna | Phaeophyta | **3** | | | | | | | | | | | | |
| *Schizoporella unicornis* | Epifauna | Ectoprocta | **2** | | | P | P | | | | | | | | |
| *Sinocalanus doerrii* | Water Column | Arthropoda | **1** | | | | | 60 | | | | | | | |
| *Sphaeroma quoianum* | Epifauna | Arthropoda | **1** | | | | | | | | 1472 | | | | |
| *Stenothoe valida* | Epifauna | Arthropoda | **2** | 32 | | | | | | | | | 416 | | |
| *Streblospio benedicti complex* | Epifauna | Annelida | **1** | | | | | | | | 16 | | | | |
| *Streblospio benedicti complex* | Infauna | Annelida | **3** | 16 | | | | | | | 832 | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Nippoleucon hinumensis* | Epifauna | Arthropoda | **1** | | | | | | | | | | | |
| *Nippoleucon hinumensis* | Infauna | Arthropoda | **1** | | | | | | | | | | | |
| *Nippoleucon hinumensis* | Water Column | Arthropoda | **2** | | | | | | | | | | | |
| *Oithona davisae* | Water Column | Arthropoda | **6** | | | 313 | 576 | 69 | | | | | | 143106 |
| *Paracorophium lucasi* | Infauna | Arthropoda | **1** | | | | | | | | | | | |
| *Paradexamine churinga* | Epifauna | Arthropoda | **3** | 80 | | | | | | 144 | | | 16 | |
| *Paradexamine sp. SD1 SCAMIT* | Epifauna | Arthropoda | **6** | 144 | 104 | | | 192 | 128 | 640 | | | 80 | |
| *Philine auriformis* | Infauna | Mollusca | **1** | | | 16 | | | | | | | | |
| *Polyandrocarpa zorritensis* | Epifauna | Chordata | **7** | | | | P | | 32 | 16 | 64 | 80 | 48 | |
| *Pseudodiaptomus forbesi* | Water Column | Arthropoda | **1** | | | | | | | | | | | |
| *Pseudodiaptomus marinus* | Water Column | Arthropoda | **5** | | | | 16 | 16 | | | | | | 85175 |
| *Sargassum muticum* | Epifauna | Phaeophyta | **3** | P | | P | | | | | | P | | |
| *Schizoporella unicornis* | Epifauna | Ectoprocta | **2** | | | | | | | | | | | |
| *Sinocalanus doerrii* | Water Column | Arthropoda | **1** | | | | | | | | | | | |
| *Sphaeroma quoianum* | Epifauna | Arthropoda | **1** | | | | | | | | | | | |
| *Stenothoe valida* | Epifauna | Arthropoda | **2** | | | | | | | | | | | |
| *Streblospio benedicti complex* | Epifauna | Annelida | **1** | | | | | | | | | | | |
| *Streblospio benedicti complex* | Infauna | Annelida | **3** | | | | | | 76 | | | | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Styela canopus* | Epifauna | Chordata | **1** | | | | | | | | | | | | |
| *Styela clava* | Epifauna | Chordata | **12** | | | P | | | | | 16 | | | 16 | P |
| *Styela clava* | Infauna | Chordata | **1** | | | | | | | | | | | | |
| *Styela plicata* | Epifauna | Chordata | **10** | | | | | | | | | | | 16 | 48 |
| *Styela plicata* | Infauna | Chordata | **1** | | | | | | | | | | | | |
| *Symplegma reptans* | Epifauna | Chordata | **1** | | | | | | | | | | | | |
| *Synidotea laticauda* | Epifauna | Arthropoda | **1** | | | | 8 | | | | | | | | |
| *Theora lubrica* | Infauna | Mollusca | **4** | | | | | | | | | | | | |
| *Thuiaria thuiaroides* | Epifauna | Cnidaria | **1** | P | | | | | | | | | | | |
| *Tortanus dextrilobatus* | Water Column | Arthropoda | **2** | | | | | 21327 | | 7 | | | | | |
| *Typosyllis nipponica* | Epifauna | Annelida | **8** | | | | | | | | | | | 256 | 96 |
| *Typosyllis nipponica* | Infauna | Annelida | **4** | | | | | | | | | | | 16 | |
| *Undaria pinnatifida* | Epifauna | Phaeophyta | **5** | | | | | | | | | P | | P | |
| *Venerupis philippinarum* | Epifauna | Mollusca | **1** | | | | | | | | | | | | |
| *Venerupis philippinarum* | Infauna | Mollusca | **1** | | | | | | | | | | | | |
| *Watersipora arcuata* | Epifauna | Ectoprocta | **10** | | | | | | | | | | | P | P |
| *Watersipora arcuata* | Infauna | Ectoprocta | **4** | | | | | | | | | P | | P | P |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Styela canopus* | Epifauna | Chordata | **1** | | | | | | | | | 16 | | |
| *Styela clava* | Epifauna | Chordata | **12** | | 32 | 24 | 304 | 64 | 144 | 176 | 32 | | 32 | |
| *Styela clava* | Infauna | Chordata | **1** | | | | 48 | | | | | | | |
| *Styela plicata* | Epifauna | Chordata | **10** | | 16 | | 304 | 112 | 144 | 304 | 448 | 48 | 16 | |
| *Styela plicata* | Infauna | Chordata | **1** | | | | 16 | | | | | | | |
| *Symplegma reptans* | Epifauna | Chordata | **1** | | | | | | | | | | 16 | |
| *Synidotea laticauda* | Epifauna | Arthropoda | **1** | | | | | | | | | | | |
| *Theora lubrica* | Infauna | Mollusca | **4** | | | 16 | 176 | 16 | | | | | 16 | |
| *Thuiaria thuiaroides* | Epifauna | Cnidaria | **1** | | | | | | | | | | | |
| *Tortanus dextrilobatus* | Water Column | Arthropoda | **2** | | | | | | | | | | | |
| *Typosyllis nipponica* | Epifauna | Annelida | **8** | | 128 | 472 | 48 | 48 | 352 | 48 | | | | |
| *Typosyllis nipponica* | Infauna | Annelida | **4** | | 128 | 16 | 16 | | | | | | | |
| *Undaria pinnatifida* | Epifauna | Phaeophyta | **5** | | P | P | P | | | | | | | |
| *Venerupis philippinarum* | Epifauna | Mollusca | **1** | 64 | | | | | | | | | | |
| *Venerupis philippinarum* | Infauna | Mollusca | **1** | | | | | | | 64 | | | | |
| *Watersipora arcuata* | Epifauna | Ectoprocta | **10** | P | | P | P | | P | P | P | P | P | |
| *Watersipora arcuata* | Infauna | Ectoprocta | **4** | | | | | | | | | P | | |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Humboldt Bay | Port of Sacramento | Bodega Bay | Tomales Bay | San Francisco Bay | Port of Stockton | Port of Oakland | Moss Landing Harbor | Monterey Harbor | Morro Bay | Santa Barbara Harbor | Marina del Rey Harbor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Watersipora subtorquata/ n. sp. Mackie* | Epifauna | Ectoprocta | **18** | P | | P | P | | | | P | P | P | P | P |
| *Watersipora subtorquata/ n. sp. Mackie* | Infauna | Ectoprocta | **16** | P | | P | P | | | | P | P | P | P | P |
| *Zoobotryon verticillatum* | Epifauna | Ectoprocta | **7** | | | | | | | | | | | | P |

| Species Name | Habitat Type | Phylum | Total Harbors Observed | Avalon Harbor | Channel Islands Harbor | Port Hueneme | Los Angeles Harbor | Long Beach Harbor | Huntington Harbor | Newport Bay | Dana Point Harbor | Oceanside Harbor | Mission Bay | San Diego Bay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Watersipora subtorquata/ n. sp. Mackie* | Epifauna | Ectoprocta | **18** | P | P | P | P | P | P | P | P | P | P | |
| *Watersipora subtorquata/ n. sp. Mackie* | Infauna | Ectoprocta | **16** | | P | P | P | P | P | P | | P | P | |
| *Zoobotryon verticillatum* | Epifauna | Ectoprocta | **7** | | P | | | | P | P | P | P | P | |

Appendix H – Cryptogenic species identified in the current survey.

| Species Name | Phylum | Likely Introduced or Likely Native | Total Waterbodies Observed |
|---|---|---|---|
| *Acanthomysis californica* | Arthropoda | Native | 1 |
| *Acerotisa californica* | Platyhelminthes | | 8 |
| *Aglaothamnion cordatum* | Rhodophyta | | 1 |
| *Amaeana occidentalis* | Annelida | | 4 |
| *Amathia distans* | Ectoprocta | | 6 |
| *Amathimysis trigibba* | Arthropoda | Introduced | 5 |
| *Ammothea hilgendorfi* | Arthropoda | | 8 |
| *Ampharete acutifrons* | Annelida | | 1 |
| *Amphicteis scaphobranchiata* | Annelida | | 1 |
| *Amphiduros pacificus* | Annelida | | 1 |
| *Amphipholis squamata* | Echinodermata | | 8 |
| *Amphiporus cruentatus* | Nemertea | | 1 |
| *Amphiporus imparispinosus* | Nemertea | Native | 1 |
| *Ampithoe lacertosa* | Arthropoda | | 10 |
| *Aphelochaeta monilaris* | Annelida | | 2 |
| *Aplidium sp. A Lambert* | Chordata | | 7 |
| *Apoprionospio pygmaea* | Annelida | | 3 |
| *Aulodrilus pigueti* | Annelida | | 2 |
| *Axiothella rubrocincta* | Annelida | | 1 |
| *Boccardia proboscidea* | Annelida | Native | 1 |
| *Boccardiella hamata* | Annelida | Introduced | 2 |
| *Bryopsis hypnoides* | Chlorophyta | | 1 |
| *Bugula neritina* | Ectoprocta | Introduced | 18 |
| *Caprella californica* | Arthropoda | Native | 15 |
| *Caprella equilibra* | Arthropoda | | 6 |
| *Caprella laeviuscula* | Arthropoda | | 2 |
| *Caprella natalensis* | Arthropoda | Native | 2 |
| *Carinomella lactea* | Nemertea | Native | 4 |
| *Ceratonereis singularis* | Annelida | | 1 |
| *Cerebratulus marginatus* | Nemertea | | 2 |
| *Chone minuta* | Annelida | | 15 |
| *Chone paramollis* | Annelida | | 3 |
| *Chrysopetalum occidentale* | Annelida | | 8 |
| *Clathrina clathrus* | Porifera | | 1 |
| *Colomastix pusilla* | Arthropoda | Native | 2 |
| *Cossura candida* | Annelida | | 3 |
| *Ctenodrilus serratus* | Annelida | Introduced | 1 |
| *Cumella vulgaris* | Arthropoda | Native | 9 |
| *Dendronotus frondosus* | Mollusca | | 1 |
| *Dero digitata* | Annelida | | 2 |
| *Dipolydora giardi* | Annelida | | 2 |
| *Dipolydora socialis* | Annelida | | 2 |
| *Dodecaceria concharum* | Annelida | | 13 |
| *Dodecaceria fewkesi* | Annelida | Native | 2 |
| *Ericthonius brasiliensis* | Arthropoda | | 17 |
| *Euchone limnicola* | Annelida | | 8 |
| *Eudorella pacifica* | Arthropoda | Native | 2 |
| *Eurylepta aurantiaca* | Platyhelminthes | | 4 |
| *Eusiroides sp. A Cadien* | Arthropoda | Native | 3 |

| Species Name | Phylum | Likely Introduced or Likely Native | Total Waterbodies Observed |
|---|---|---|---|
| *Exogone lourei* | Annelida | Native | 18 |
| *Gammarus lacustris* | Arthropoda | Introduced | 2 |
| *Glycera americana* | Annelida | Native | 10 |
| *Glycinde picta* | Annelida | Native | 6 |
| *Grateloupia californica* | Rhodophyta | | 7 |
| *Halichondria panicea* | Porifera | | 1 |
| *Harmothoe hirsuta* | Annelida | | 1 |
| *Harmothoe imbricata* | Annelida | | 5 |
| *Hemicyclops japonicus* | Arthropoda | | 7 |
| *Hemicyclops subadhaerens* | Arthropoda | | 1 |
| *Hemiproto sp. A SCAMIT* | Arthropoda | Native | 1 |
| *Ianiropsis tridens* | Arthropoda | | 10 |
| *Incisocalliope newportensis* | Arthropoda | Native | 5 |
| *Ischyrocerus pelagops* | Arthropoda | Native | 1 |
| *Jassa slatteryi* | Arthropoda | | 12 |
| *Lanice sp. A Harris* | Annelida | Native | 1 |
| *Laticorophium baconi* | Arthropoda | | 15 |
| *Leptochelia dubia* | Arthropoda | | 18 |
| *Leucothoe alata* | Arthropoda | | 12 |
| *Levinsenia gracilis* | Annelida | | 4 |
| *Limnodrilus hoffmeisteri* | Annelida | | 2 |
| *Lineus ruber* | Nemertea | | 2 |
| *Mediomastus californiensis* | Annelida | | 3 |
| *Melinna oculata* | Annelida | | 1 |
| *Melita sp. A Cadien* | Arthropoda | Native | 1 |
| *Membranipora membranacea* | Ectoprocta | | 3 |
| *Metridium exilis* | Cnidaria | | 1 |
| *Metridium senile* | Cnidaria | | 4 |
| *Microjassa litotes* | Arthropoda | Native | 5 |
| *Micrura alaskensis* | Nemertea | | 6 |
| *Monticellina siblina* | Annelida | | 1 |
| *Munna chromatocephala* | Arthropoda | Native | 1 |
| *Neanthes acuminata complex* | Annelida | | 9 |
| *Nebalia hessleri* | Arthropoda | | 1 |
| *Nebalia pugettensis complex* | Arthropoda | Native | 2 |
| *Neoamphitrite robusta* | Annelida | | 2 |
| *Neodexiospira pseudocorrugata* | Annelida | | 1 |
| *Nephtys ferruginea* | Annelida | Native | 1 |
| *Nereis mediator* | Annelida | | 1 |
| *Obelia longissima* | Cnidaria | | 4 |
| *Obelia nr. dichotoma* | Cnidaria | | 1 |
| *Oithona similis* | Arthropoda | | 7 |
| *Ophiactis simplex* | Echinodermata | Native | 13 |
| *Ophiodromus pugettensis* | Annelida | | 8 |
| *Phascolosoma agassizii* | Sipuncula | | 10 |
| *Phyllodoce longipes* | Annelida | | 1 |
| *Pileolaria marginata* | Annelida | | 1 |
| *Piromis sp. 2 Harris* | Annelida | | 1 |
| *Pista brevibranchiata* | Annelida | | 7 |
| *Pista wui* | Annelida | | 2 |
| *Platynereis bicanaliculata* | Annelida | | 11 |

| Species Name | Phylum | Likely Introduced or Likely Native | Total Waterbodies Observed |
|---|---|---|---|
| *Podocerus brasiliensis* | Arthropoda | Native | 11 |
| *Podocerus cristatus* | Arthropoda | | 11 |
| *Podocerus fulanus* | Arthropoda | Native | 3 |
| *Polydora cornuta* | Annelida | Introduced | 5 |
| *Polydora limicola* | Annelida | | 9 |
| *Polydora websteri* | Annelida | | 8 |
| *Pontogeneia rostrata* | Arthropoda | | 4 |
| *Prionospio heterobranchia* | Annelida | Introduced | 9 |
| *Pristina leidyi* | Annelida | | 1 |
| *Proceraea okadai* | Annelida | | 1 |
| *Pseudopolydora paucibranchiata* | Annelida | | 13 |
| *Pseudotanais makrothrix* | Arthropoda | Native | 1 |
| *Questa caudicirra* | Annelida | | 1 |
| *Sigambra tentaculata* | Annelida | | 1 |
| *Sphaerosyllis californiensis* | Annelida | | 9 |
| *Spiophanes duplex* | Annelida | | 9 |
| *Terebellides californica* | Annelida | | 1 |
| *Tetrastemma candidum* | Nemertea | | 1 |
| *Thormora johnstoni* | Annelida | | 2 |
| *Thysanocardia nigra* | Sipuncula | | 1 |
| *Trochochaeta franciscanum* | Annelida | | 1 |
| *Typosyllis armillaris* | Annelida | | 6 |
| *Typosyllis elongata* | Annelida | | 11 |
| *Zeuxo maledivensis* | Arthropoda | Introduced | 2 |
| *Zeuxo normani* | Arthropoda | | 18 |
| *Zygonemertes virescens* | Nemertea | | 14 |