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Long-term Monitoring Protocol for Rocky Intertidal Communities of Golden Gate National Recreation Area and Point Reyes National Seashore, California

Version 1.0

Natural Resource Report NPS/SFAN/NRR—2011/348

ON THE COVER
Dave Press counting invertebrates at Slide Ranch, Golden Gate National Recreation Area.
Photograph by: Marcus Koenen

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Protocol Narrative

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Executive Summary

This protocol is designed to monitor trends in population dynamics of target algae and invertebrate species inhabiting the rocky intertidal zone within the San Francisco Bay Area Network (SFAN) including Golden Gate National Recreation Area (GOGA) and Point Reyes National Seashore (PORE). Rocky intertidal monitoring occurs at two sites at PORE (Santa Maria Creek and Bolinas Point) and three sites at GOGA (Alcatraz, Point Bonita, and Slide Ranch).

Monitoring of the rocky intertidal zone of GOGA and PORE date back to the 1990s. Plots were established to evaluate effects of human disturbance (e.g., Point Bonita) and changes associated with pollution (e.g., oil spills) in the area. In 2006, the National Parks in the San Francisco Bay Area joined the Multi-Agency Rocky Intertidal Network (MARINe). The monitoring network is comprised of various government agencies, universities, and private organizations. This network surveys over 110 sites from southern California to northern Washington, with the SFAN intertidal monitoring sites filling in a geographic gap in northern California.

As a result of joining MARINe, existing sampling plots within sites were modified to meet standard practices (http://www.marine.gov/). In the revised design, the same number of fixed plots is established in each zone using a random, stratified experimental design appropriate to the highly patchy habitat. Plots and line transects are all "fixed," or measured in the same location every season. The benefit of this sampling design is that it limits some of the natural variability in the system that can obscure important trends in the data. However, the tradeoff is that it is not possible to extrapolate trends to the whole area without additional corroborative information such as high resolution area-wide photos.

This protocol guides all aspects of implementing rocky intertidal monitoring including the sampling design, field methods, data management, reporting, analytical methods, annual budget, and personnel. The contents of this document were largely taken from a monitoring protocol developed for the Klamath Network of the National Park Service Inventory and Monitoring Program by Ammann and Raimondi (2008) of the Department of Ecology & Evolutionary Biology, Center for Ocean Health/Long Marine Laboratory, University of California, Santa Cruz. The rocky intertidal habitats at the Klamath Network are similar to those in SFAN. Although field methods were largely taken verbatim from the original protocol, site descriptions, program staffing, and budget sections were modified to describe conditions in SFAN. Data management, data analyses, and data reporting were updated to address new methods.

Two designated Lead Project Field Biologists (LPFBs or 'Project Leads'), one at PORE and one at GOGA, are responsible for coordinating sampling logistics, packing and maintaining gear, and field sampling. Trained Biological Researchers (TBRs) are responsible for assisting the LPFBs with preparations for field work, monitoring, and help with volunteer supervision. A crew of at least four researchers will conduct the monitoring. The SFAN Data Manager will act as one of the TBRs. The SFAN Data Manager will also enter data and produce reports in coordination with the LPFBs.

The monitoring involves annual summer sampling of permanent photoquadrats, ochre star (*Pisaster ochraceus*) plots, and surfgrass (*Phyllospadix spp.*) transects. Sampling sites are visited during low tides in summer (June/July) at four sites and visited during low tide in fall (October/November) at Alcatraz to avoid disturbing nesting seabird colonies.

Data are entered into the MARINe database. Annual progress reports will provide a quick look at the Intertidal Monitoring Program's progress at meeting sampling and deliverable goals. Biennial reports will be produced to summarize results. Summary statistics include abundance for the key species found in the photoplots (e.g., barnacles [*Chthamulus, Balanus*, etc.], mussels [*Mytilis* spp.], and rockweed species [e.g., *Pelvetiopsis limitata*]) and line transects (e.g., surfgrass [*Phyllospadix* spp.]). Mean percent cover values will be presented for each site.

Every six years, SFAN will develop statistically rigorous trend reports. Trend reports will describe annual community changes, as well as explore broader spatial and temporal scales. Basic trends of percent cover, averaged by zone, will be plotted for all key species for photoplots (e.g., barnacles [*Chthamulus, Balanus*, etc.], mussels [*Mytilis* spp.], rockweed species [e.g., *Silvetia compressa*], and line transects for surfgrass [*Phyllospadix* spp.]. Plot data may be averaged into a single trend for the whole park or sites may be considered separately. For each taxon, long-term trends will be investigated using regression analysis as described in SOP 14.

Particular attention will be paid to changes >50% in the abundance of target taxa. Such changes will trigger management action which could include a range of options including targeted research, enhanced law enforcement, area closures or new public outreach campaigns.

Acknowledgements

Much of this protocol was excerpted from the rocky intertidal monitoring protocol written by Ammann and Raimondi (2008) of the Department of Ecology & Evolutionary Biology, Center for Ocean Health/Long Marine Laboratory, University of California, Santa Cruz. Appropriate sections were modified to apply to the sampling needs of SFAN. We thank the Klamath Network Inventory and Monitoring Program, especially Daniel Sarr, for funding the original protocol development. We thank the three anonymous reviewers for their comments on both the original protocol and this version.

1 - Background and Objectives

1.1 Overview

The coastline of northern California is home to a diverse array of nearshore habitats that contain a wide variety of species. Geographic location, habitat diversity, and complex oceanographic patterns contribute to the rich diversity of marine life in this area. The coastlines of Point Reyes National Seashore (PORE) and Golden Gate National Recreation Area (GOGA) in the San Francisco Bay Area Network (SFAN) of the Inventory and Monitoring Program (I&M) are composed of extensive sandy beaches and rocky intertidal areas dominated by boulders and rocky bench areas (Kinyon et al. 2009). The rocky intertidal zone comprises a narrow patchy band along the coast. The upper limits include areas only reached by extreme high tides and more regularly by splash or spray (+7 ft, mean sea level) (Ricketts et al. 1985). The lower limits include areas that are mostly submerged and only exposed by extreme low tides (-1.5 ft, mean sea level) (Ricketts et al. 1985). Areas below this tide height are considered subtidal.

The importance of establishing a long-term regional monitoring program of marine resources has been acknowledged by many organizations. Recognizing the value of long-term monitoring (NPS 1995) the National Park Service (NPS), within its nationwide I&M Program, developed the intertidal monitoring program for Channel Islands National Park (CHIS) in the 1980s (Richards and Davis 1988) and for Cabrillo National Monument (CABR) (Engle and Davis 1996, Becker 2006) in the early 1990s. The Klamath Network and the North Coast and Cascades Network have also included intertidal habitats in their vital signs monitoring programs (Ammann and Raimondi 2008, Fradkin and Boetsch 2009).

The pioneering work of the I&M Program advanced the practice of intertidal monitoring in California. In 1997 over 20 coast-wide academic and government organizations such as the University of California, Santa Barbara (UCSB), NPS and the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) formed the Multi-Agency Rocky Intertidal Network (MARINe). With support from the Minerals Management Service (renamed Bureau of Ocean Energy Management, Regulation and Enforcement [BOEMRE] in 2010), MARINe addressed the need to standardize and synthesize ecological data in order to provide the most robust and cost-effective regional dataset for the assessment of intertidal health and trends along California's rocky shores. Through the standardization of data collecting methods, MARINe now jointly coordinates and shares data from partnered organizations through an integrated database and unified sampling protocol (Engle et al. 1994, Engle 2005). SFAN has adopted MARINe protocols and regularly submits data to MARINe (SOP 13) but no formal contract or cooperative agreement is currently in place with MARINe, BOEMRE or PISCO.

MARINe has added partners and expanded its sampling network into northern California, Oregon and Washington. Participating national parks are CABR, CHIS, GOGA, PORE, Redwood National and State Parks (REDW), Olympic National Park (OLYM), San Juan Island National Historical Park (SAJH) and Lewis and Clark National Historical Park (LEWI). Adoption of MARINe protocols which were pioneered at CHIS represents a progression of careful evaluation and implementation which has been ongoing for the last 30 years. These eight national parks can now leverage their efforts by sharing common protocols and data. This

coordination of intertidal monitoring allows comparisons of population dynamics to be made between sites along the entire west coast of the United States. SFAN sites are critical links in this coast-wide intertidal monitoring network.

1.2 Rationale for Selecting this Resource to Monitor

The rocky shores of the west coast of North America are among the most diverse marine regions in the world (Morris et al. 1980). They offer a great opportunity for learning and recreation, as they are the most accessible marine areas for human use. Few studies have focused on the intertidal communities of northern California. Fortunately, studies suggest that some intertidal areas in central and northern California regions are still relatively undisturbed compared with southern California (Roy et al. 2003). Deterioration of these relatively pristine intertidal habitats can happen rapidly, making the establishment of a baseline assessment and continued monitoring program of these resources critical. Furthermore, rocky intertidal habitat is a somewhat scarce resource in SFAN. Compared to the total area of a park, long and narrow shorelines are very small. Monitoring will allow us to identify trends inconsistent with the baseline conditions and natural variation. A monitoring program is necessary to assess the continued status of the rocky shores and address current and future impacts.

The national parks are responsible for establishing a baseline assessment of their coastal marine resources and then monitoring those resources that are deemed most important (Richards 2000). SFAN identified rocky intertidal communities as one of two critical marine vital signs relevant to management (Adams et al. 2006). Monitoring rocky intertidal habitats provides a means for early detection of invasive species within the sites surveyed, especially in collaboration with the coast-wide MARINe program. While non-native species are not currently a serious problem in the marine intertidal of SFAN parks, the habitats could be susceptible to future invasions.

Population monitoring within the rocky intertidal provides baseline information essential for detection, assessment, and study of the short- and long-term effects of natural disturbances such as severe storms, cliff erosion, and tsunamis, as well as anthropogenic disturbances such as visitor use impacts and oil spills. Monitoring also provides fundamental ecological knowledge of system dynamics. For instance, the abundance and distribution of major algal species (*Pelvetiopsis, Endocladia, Fucus*) and invertebrates, such as barnacles (*Chthamalus, Balanus*) and mussels (*Mytilus*), in SFAN are likely to change in response to both natural and human-caused events. These structural changes are likely to affect the abundances of motile species, such as sea stars (*Pisaster, Leptasterias*), crabs (*Pagurus, Pachygrapsis*) and snails (*Nucella, Tegula*).

1.3 Linking Monitoring with Management

Intertidal monitoring provides data on changes in the abundance, size, percent cover, and distribution of target taxa. Park managers will use these data to advise future management decisions on issues such as coastal access or over-harvesting. Interpretive staff can incorporate results from intertidal monitoring into interpretive tools and outreach programs. The MARINe protocol has been used in other parts of California to document disturbance events associated with the El Niño Southern Oscillation (Miner et al. 2005), population declines resulting from disease and over-harvesting (Raimondi et al. 2002), and invasions by non-native species (Miller et al. 2007). These examples demonstrate that this is an effective protocol for monitoring intertidal communities. Using the MARINe protocols also allows broad scale geographic

comparisons to be made. Data from SFAN sites are directly comparable with data collected from over 110 sites from southern California to northern Washington.

Monitoring intertidal communities is critical for making informed management decisions. Tracking changes in these communities allows determination of “normal” limits of variation, as well as long-term patterns. Long-term abalone data from the CHIS monitoring program were critical in assessing the status of black abalone leading to the eventual listing of this species as endangered. Understanding these patterns is necessary for detecting anthropogenic changes resulting from climate change or disturbances such as oil spills. As was learned from the Exxon Valdez oil spill in 1989, accurate baseline information about intertidal communities is paramount for determining appropriate clean-up and restoration procedures (Paine et al. 1996, Peterson et al. 2003, Sharman et al. 2004). Rocky intertidal data from PORE and GOGA have been used to assess injury and recovery of rocky intertidal communities from the 2007 Cosco Busan oil spill.

Rocky intertidal data will help assess biotic responses associated with global climate change. Rocky intertidal organisms are assumed to live very close to their thermal tolerance limits (Wethey 1983, Bertness et al. 1999). For this reason, many studies have suggested that climate change may have strong effects on the distributional patterns of intertidal organisms (Fields et al. 1993, Barry et al. 1995, Sagarin et al. 1999, Smith et al. 2006). Reports produced from this study will address the corresponding climate variability during the study period. Using available oceanographic models, it may be possible to determine if species range shifts can be explained by climate data. Once species ranges are established for a region (e.g., northern California), it may be possible to forecast effects of decadal and seasonal scale climate change on the geographic distribution of ecosystem foundation species and to test the forecasted hypothesis with long-term monitoring data.

It is also necessary for the baseline data to be appropriate to the scale of the anthropogenic disturbance event. Having site-specific monitoring data is important, however, managers must also know what resources exist throughout the region and the natural spatial and temporal variation (Schoch and Dethier 1996). The site-specific monitoring data need to be put into context of a larger spatial scale and related to other similar locations. Joining the MARINe network provides the larger context, to help interpret natural variability at a site level.

While arguably one of the greatest benefits of long-term monitoring is documenting community response to known natural or human induced phenomena, additional value comes from having researchers consistently present in the field so that we may opportunistically capture events that would otherwise be missed (Miner et al. 2005). An additional benefit of long-term monitoring work is that researchers become familiar with the composition and abundance of species at a site and are thus more likely to notice if a new species invades or if particular species increase or decrease in abundance.

Marine monitoring, like the canary in the mine, can be used to signal abnormal conditions. If the monitoring results show large negative or positive changes in plant or animal density or cover, it should trigger park management and resource personnel to investigate the causes of the changes (whether natural or human caused). For example, if they are negative and human related, those activities should be restricted or modified (e.g., tidepooling, harvesting mussels or limpets, and

shore fishing). Management practices may include restricting access to sensitive areas or by creating in-park regulations. Where the parks do not have the authority, cooperation with state (e.g., California Department of Fish and Game) or federal agencies may be necessary. The parks may also promulgate new federal regulations or modify existing laws.

Another result of the intertidal monitoring is uncovering patterns that may lead to additional research. For example, many researchers utilize the Santa Maria Creek and Bolinas Point intertidal sites for their own research because baseline monitoring data exist at these locations.

Prudent stewardship obliges the coastal parks to monitor their marine resources. Without monitoring that provides data on the status of these resources, properly informed management decisions cannot be made. Such is the case in the decision process to set aside Marine Protected Areas (MPAs) in California. Monitoring data are necessary to assess the relative ecological value of various intertidal areas. These assessments can then be cited to advocate for MPA placement in the locations with the greatest conservation value.

In addition to advising the siting of new MPAs, the data from the SFAN intertidal monitoring program can be used to help evaluate the effectiveness of newly designated MPAs. New state MPAs have recently (May 2010) been designated in PORE under California State law (Marine Life Protection Act). The Point Reyes State Marine Reserve is in close proximity to the PORE Santa Maria Creek intertidal site while the Duxbury Reef State Marine Conservation Area includes PORE's Bolinas Point intertidal site. With the implementation of these new state MPAs comes an obligation to assess their effectiveness utilizing sites inside and outside of the MPAs. Data collected by the SFAN monitoring program can be used in the study of the new MPAs. SFAN could also benefit from new cooperative research programs in PORE and GOGA to study the new state MPAs.

Although coastal national parks often do not have jurisdiction below the mean high tide line and are limited in their management practices that influence the low tide areas, PORE and GOGA do have some management jurisdiction below mean high tide line. At GOGA, well over half of the submerged coastal lands are state lands leased by the NPS and extend 1,000 ft offshore from the ordinary high water mark. The lease agreement has implicit monitoring requirements. The NPS has agreed to manage the leased tide and submerged lands "to protect and conserve the environment and any cultural and historical resources that may be present" and "to preserve the subject lands in their natural state and protect them from development and uses which would destroy their scenic beauty and natural character" (California 1989). Some of the submerged lands that were formerly owned by the Coast Guard or Army that have transferred to the park are owned in title. At PORE all of the submerged lands extending ¼ mile offshore are under the jurisdiction of the park.

When incorporated on a regional scale, monitoring studies can also be utilized to plan more effective management strategies (Miner et al. 2005). In the event that degradation occurs as a result of natural or anthropogenic drivers, monitoring data will enable managers to assess the impacts and determine biological responses (Raimondi et al. 1999). However, these assessments will be limited if monitoring is restricted to the rocky intertidal areas within SFAN. This highlights the value of linking park-based monitoring with regional scale efforts.

1.4 History of Rocky Intertidal Monitoring in SFAN

Broad-brush rocky intertidal assessments have been done at both PORE and GOGA. Most recently, a Coastal Biophysical Inventory (patterned after methods developed at Glacier Bay National Park) has mapped shoreline segments based on physical properties and collected broad intertidal community data (Kinyon et al. 2009). Rocky intertidal biological assessments have been completed at PORE by Chan (1971) and Applied Marine Sciences (2002).

A long-term monitoring program was established in 1996 at three sites in PORE (Santa Maria Creek, Bolinas Point, and Elephant Rock) that continued until 2005 (Applied Marine Sciences 2002). The data for the Applied Marine Science and NPS monitoring are available in a Microsoft Access database. Furthermore, the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) established long-term Coastal Biodiversity Survey sites at Santa Maria Creek (surveyed 2002, 2005) and Bolinas Point (surveyed 2002, 2005, and 2008). These data are highly detailed assessments of a large area (~100 m x 50 m) as opposed to most intertidal programs that assess small plots (http://cbsurveys.ucsc.edu).

At GOGA, a rocky intertidal monitoring program was established initially in 1989 at Alcatraz Island and Slide Ranch with assistance from Dan Richards, CHIS. For sites established in 1989, the field sampling protocol was based on a rocky intertidal monitoring program created and implemented by CHIS (Richards and Davis 1988). Permanently established photoquadrat plots (50 x 75 cm) were placed in mid- and high-intertidal sites and targeted typical assemblages of the area (e.g., *Fucus*, *Endocladia*, or *Mastocarpus*). Data for Slide Ranch were summarized by Cosentino and Chess (1997). A new site was added in 1998 at Point Bonita and sampling was based on field point counts (Cosentino 1998). PISCO established a long-term Coastal Biodiversity Survey site at Alcatraz in 2005.

In 2006 both GOGA and PORE established pilot plots with researchers from the MARINe program to track changes in the algal and invertebrate communities found in the rocky intertidal habitats and to describe the patterns of variability of the abundant and ecologically important species (Cox and McGary 2006).

1.5 Measurable Objectives

1.5.1 Monitoring Objectives

- Monitor the temporal dynamics of target invertebrate and algal species (listed in Appendix A) and surfgrasses across accessible, representative, and historically sampled rocky intertidal sites at PORE and GOGA to help assess level of impacts and changes outside normal limits of variation due to oil spills, non-point source pollution, or other anthropogenic stressors that may come from within and outside the parks.
- Determine status, trends, and effect sizes (as applies) through time for morphology, color ratios, and other key parameters describing population status (e.g., size, structure) of the selected intertidal organisms.

- Integrate with and contribute to a monitoring network spanning a broad geographic region, in order to evaluate trends at multiple scales, from the park to region-wide, taking advantage of greater sample sizes at broader scales.
- Detect and document invasions of non-native species, changes in species ranges, disease spread, and rates and scales of processes affecting the structure and function of rocky intertidal populations and communities to better understand normal limits of variation.

1.5.2 Measurement and Analysis Objectives

- Provide a fine-scale photographic record of sessile invertebrates and algae (and potentially oil and other non-point source pollutants) using fixed plots (photoplots) as a reference.
- Provide an annual, high-resolution photographic record of general site conditions to document broad-scale biological and physical conditions at each site.
- Determine percent cover of organisms within select fixed plots in the field as time and tide levels allow. These are the same fixed plots (interchangeably called photoplots or photoquadrats) that are photographed in the field.
- Use field sampling to determine relative densities and sizes of motile invertebrates, such as snails, chitons, limpets, and crabs, that may indicate ecosystem health.
- Determine changes in surfgrass abundance by measuring cover along fixed point-intercept transects.
- Track changes in the density of a keystone predator, the ochre sea star (*Pisaster ochraceus).*
- Identify trends inconsistent with the established baseline conditions, whether they are park-specific or broader in occurrence and whether there are potential management actions to mitigate them.
- Prepare summary reports every two years and peer reviewed trend analysis reports every six years. Reports will display major (>50%) changes in the abundance of target taxa between sampling intervals as a highlight for potential management actions.

1.5.3 Scope of Management Options

If major (>50%) changes in abundance of target taxa are detected, it is the responsibility of the Lead Project Field Biologists (LPFBs) and the Trained Biological Researchers (TBRs) to inform park managers about these large changes. Once informed, park management may act on any or all of the following options.

- Initiate targeted research to identify causal factors.
- Enforce existing regulations.
- Propose new regulations.
- Institute area closures.
- Utilize monitoring results to engage legislators and the public in support of resource conservation initiatives (e.g., support for legislation to mitigate effects of climate change).
- Wait for additional information from future monitoring efforts before implementing an action.

2 - Sampling Design

2.1 Rationale for Selecting this Sampling Design over Others

Sampling of the two rocky intertidal sites in PORE and three in GOGA follows the protocols described in Engle (2005), which are modeled after methods used by the CHIS intertidal monitoring program (Richards and Davis 1988) and the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) (Ambrose et al. 1995). The protocols focus on sampling fixed plots of target species or assemblages (Appendix A). A fixed plot sampling design provides data about changes within the plot over time and reduces the variability in those data, unrelated to temporal trends (Murray et al. 2006). Implementing this sampling design provides a collaboration opportunity with MARINe, an established network and well tested monitoring program. The MARINe network, encompassing sites from San Diego to northern California, Oregon, Washington, and the Channel Islands, is the longest running, large scale intertidal monitoring program on the west coast of North America.

There is a long-standing debate in the literature about fixed versus random sampling. Murray et al. (2006) lists numerous pros and cons of both methods. Sampling with fixed plots reduces confounding spatial variation, whereas random sampling reduces confounding temporal variability. Both methods have strong statistical models and approaches. The argument comes down to the questions of feasibility and budget constraints. The more cost effective, fixed-replicate selection is efficient for tracking temporal change in specific assemblages. If budget were not a constraint, random sampling would be the preferred means to generalize over the greatest spatial context. However, the spatial variance encountered during intertidal monitoring is so large that random sampling is not feasible with the funding available. Unfortunately, masses of random replicates would be needed to monitor temporal change. In order to balance the realistic constraints of budget with the optimal amount of temporal change, multi-site fixed plot sampling has been shown to be the best solution.

A consequence of the fixed plot design is limitations on the amount of spatial inference that can be made. In order to increase the level of inference to surrounding areas and sites, larger scale sampling is used. For example, overview photographs are taken of entire zones within each site to put fixed plots into a broader site context. In addition, Coastal Biodiversity Surveys (CBS) are conducted to complement the long-term monitoring program. A full description of the program can be found on the CBS website (http://cbsurveys.ucsc.edu). CBS quantifies species' distribution and abundance across an entire rocky bench (UC Santa Cruz 2006). These surveys have been conducted at three of the five monitoring sites described in this protocol (Santa Maria Creek and Bolinas Point at PORE, Alcatraz at GOGA). Much of the broader scale data collected is intended to be ancillary data that will not be analyzed until the need arises. For instance, in the event of an oil spill, this information will be available to put the monitoring data in a larger spatial context.

Repeated sampling with a fixed plot design is used by many other large scale monitoring programs. The Long-Term Ecological Research group (LTER), established by the National Science Foundation (NSF), uses fixed sampling as a model for their network's research. Forest Inventory and Analysis (FIA) surveys have provided forest inventories for 13 states since 1933 and uses repeated samples of panels (or fixed plots). Statisticians have shown that analysis of

data from the long-term repeated surveys lead to a better statistical inference than one-time inventories (Reams and Van Deusen 1999).

Past efforts directed at monitoring intertidal patterns have been compromised because of variation in sampling design, sampling effort, and sampler expertise. The protocols for the MARINe Community Dynamics Surveys use identical sampling in terms of design, effort, and expertise at all sites (Minchinton and Raimondi 2001). This consistency provides the ability to track changes at an ecosystem level. The collective monitoring effort by MARINe addresses questions related to biogeography, effects of human use, management of coastal resources, and conservation along the temperate west coast of North America. The data resulting from this work allow us to evaluate temporal and spatial community dynamics in both the short- and long-term. This information is essential for assessing impacts due to natural or human induced disturbance (see Raimondi et al. 1999 for examples of both), as well as understanding biological community response to important physical phenomena, such as inter-decadal changes in sea surface temperature (McGowan et al. 1998).

Data collected will provide both local insights into marine resources and regional comparisons. The benefits of this collaboration include the following (from Engle 2005):

- Increases reliability, efficiency, and cost-effectiveness of programs.
- Increases cooperation and communication among agencies and organizations.
- Enhances long-term support to ensure continuity of sampling.
- Provides opportunity for identification and rectification of data gaps.
- Allows more timely access to standardized data by all users.
- Integrates information for efficient analysis, synthesis, and reporting.
- Permits evaluation of large-scale spatial and temporal patterns.
- Facilitates periodic review of ability of monitoring to achieve goals.
- Expedites linkages to other relevant programs.
- Enhances public outreach and interpretation programs.
- Assists in designing and critiquing restoration programs for impacted resources.
- Aids in framing research questions regarding cause and effect relationships.
- Increases public awareness of knowledge-based environmental management.
- Provides a cadre of trained biologists capable of rapid response to impacts.

2.2 Site Selection

2.2.1 Criteria for Site Selection

The sites for rocky intertidal monitoring at SFAN were selected with the assistance of resource management staff at the park, historical research, based on accessibility, budget limitations, and the following criteria (adapted from Engle 2005):

- Areas previously surveyed or monitored that provide historical data.
- Unsurveyed areas representing major data gaps.
- Areas of concern with regard to human impacts, including potential oil spills.
- Areas with relatively pristine habitats.
- Areas with species assemblages and ecological conditions representative of rocky intertidal habitats of the northern California coastline.
- Areas that provide habitat for sensitive or rare intertidal species.
- Areas with optimum conditions for long-term monitoring.

Optimum conditions for monitoring include reasonable and safe site access, adequate bedrock surfaces for establishing permanent plots, sufficient abundance of key species, and minimal disturbance to other sensitive resources (e.g., seabird colonies, marine mammal rookeries).

The SFAN marine areas host a diverse array of habitats, including sandy beaches, cobble beaches, boulder fields, rocky benches, cliffs, and estuaries. This proposal focuses on rocky intertidal areas within the park. The amount and distribution of rocky intertidal habitat within SFAN has been quantified by a coastal biophysical inventory project through a cooperative agreement with UCSC and the NPS-Cooperative Ecosystem Studies Unit (CESU) (Kinyon et al. 2009). This assessment of the habitat and vegetation types of the SFAN coastline is intended to enhance the physical data available for this coastline. The one-time habitat study will help to place the proposed long-term monitoring program in a larger spatial context within SFAN.

Rocky bedrock benches and boulder fields are the only habitat type proposed for the intertidal sampling. These sites provide the greatest species diversity and best opportunity to track the established vital signs along the SFAN coastline. Establishing rocky intertidal sites also allows for comparisons to be made with similar study sites along the Pacific west coast. Inclusion of sandy beach sampling in the SFAN intertidal monitoring protocol was deemed a lower priority when “vital signs” and budget considerations were assessed. The site and seasonal variation in sandy sites was so high in both biological and physical parameters that obtaining statistically meaningful data would require extensive sampling. This habitat is also relatively species poor compared to rocky habitats. Cobble beaches are also not included in the monitored sites because most of the organisms live under the cobble and feasible methods for monitoring them have not been developed.

In the event of an oil spill along the Pacific coast, there are established emergency protocols that include a range of coastal habitats (sandy beach, rocky bench, and boulder fields) (Ambrose and Diaz 2008a,b). The same researchers that conduct the MARINe style intertidal monitoring program are trained in these emergency protocols. The emergency protocols are designed to enhance the ability of the existing monitoring program to assess oil spill damage. This cooperative pre- and post-spill sampling has been used to assess effects of the 1997 southern California Torch Oil Spill (Raimondi et al. 1999) and for the San Francisco Bay Cosco Busan spill which occurred in 2007. Establishing the intertidal long-term monitoring program for SFAN will provide the comparative data necessary to assess a potential oil spill in this region.

2.2.2 Procedures for Selecting Site Locations

A site consists of a rocky intertidal bench at least 30 m wide that is representative of the surrounding area. Plots within each site have been established in particular assemblages of target species (SOP 3). Sites were selected primarily as a function of existing monitoring sites that had been established in suitable habitat by previous monitoring programs. Analysis has demonstrated that the monitored sites can be used to extrapolate information to surrounding rocky intertidal areas and that there is good agreement between monitored sites and other surrounding sites (Minchinton and Raimondi 2001). CHIS's kelp forest and intertidal monitoring programs established fixed monitoring sites using a similar stratified random approach because the primary purpose of the program was to measure change over time, not to make population estimates for the entire park (Davis 2005). Fixed ecological monitoring sites are established so that changes in parameters reflect changes over time and are not confounded by within-site variation.

2.2.3 Number and Location of Sites

Taking into account the above mentioned site selection criteria and the range of the intertidal areas within SFAN, five rocky intertidal sites were selected for monitoring at GOGA and PORE. The selected sites are Alcatraz, Santa Maria Creek, Bolinas Point, Slide Ranch, and Point Bonita (Figure 1). Brief site descriptions are as follows (also see SOP 18 which includes detailed navigational directions to the intertidal sites):

Santa Maria Creek (38°00'37"N, 122°50'45"W) is located along the shores of Drake's Bay approximately ¼ mile southeast of the mouth of Santa Maria Creek. Point Reyes Peninsula offers this site some protection from the predominantly northwesterly winds and seas. The site is on a sedimentary rock platform which has numerous crevices and gullies.

Bolinas Point (37°54'13"N, 122°43'40"W) is approximately ten miles southeast of Santa Maria Creek and northwest of the town of Bolinas. The survey plots are located on the outermost intertidal bench and consist primarily of sedimentary rock outcrops with folded layers oriented in a NW-SE direction.

Alcatraz Island (37°49'30"N, 122°25'19"W) is in San Francisco Bay approximately three miles east of the Golden Gate Bridge. The site consists of a rock outcrop (approximately 3-4 m wide) at the base of a 10 m cliff on the SW end of the island. Plots are located along the bench and transects remain submerged until peak low tide.

Slide Ranch (37°52'27"N, 122°36'3"W) is at the base of a steeply sloped cliff that opens onto a large cobble beach. Large boulders are scattered throughout the intertidal zone and into the deep water. Transects and plots are scattered along the cobble beach. The site receives high wave action but there are many semi-protected holes, caves, and ledges among the large serpentine and greywacke boulders in the area.

Point Bonita (37°49'9"N, 122°31'46"W) is located at the base of a moderately sloped cliff that opens onto a large cobble beach. A few large boulders are scattered throughout the intertidal zone and into the deep water. The transects are located along the northern edge of the cobble beach with the northernmost transect ending at the base of a horizontal cliff face. The plots are

scattered throughout the cobble beach. The southernmost plot is located adjacent to the remnant rails of the former lifeboat station.

Joseph Kinyon, Pacific Coast Science & Learning Center, January 7, 2010, Aerial Imagery http://www.sfbayquakes.org 2006

Figure 1. Locations of the five SFAN rocky intertidal survey sites.

2.3 Sampling Frequency and Replication

The rocky intertidal sites are sampled annually using fixed plots and transects in target community assemblages and overview photographs to place the fixed plots in a broader spatial context. Fixed plots allow the dynamics of rocky intertidal species to be monitored with reasonable sampling effort. Targeting key species or assemblages allows the sampling effort to focus on ecologically important components of the assemblage and provides greater power to detect changes over space or time. Replication comes from individual quadrats, plots, or transects at a given site and sample period.

Using the MARINe protocols (Engle 2005), site overview assessments (SOP 5), permanent photoplots (SOP 3), and sea star plots (SOP 9) were set up at Bolinas Point, Santa Maria Creek, Slide Ranch, and Point Bonita in 2006. Three surfgrass (*Phyllospadix*) transects were also established at Bolinas Point and Slide Ranch in 2006, but Alcatraz, Santa Maria Creek and Point Bonita had minimal surfgrass coverage so no transects were established there (SOP 10). The photoplots record changes in the cover of certain populations, including mussels (*Mytilus californianu*s), barnacles (*Chthamalus dalli and Balanus glandula*), and three species of algae (nailbrush seaweed [*Endocladia muricata*], rockweed [*Pelvetiopsis limitata*], and dwarf rockweed [*Fucus gardneri*]). Slide Ranch and Point Bonita sites also have barnacle plots but none were established at Bolinas Point and Santa Maria Creek due to lack of barnacles. These species were chosen for monitoring because they are conspicuous, bed-forming, abundant, and ecologically important. Each target species type is monitored in five replicate plots at each site.

For the ochre sea star (*Pisaster ochraceus)*, three irregular plots were established at Bolinas Point, three transects each at Slide Ranch and Point Bonita, one transect at Santa Maria Creek, and two transects at Alcatraz. Recording size and color information for ochre sea stars gives an indication of population structure at the various sites and enables us to determine which sites receive the highest levels of recruitment and contain the largest individuals.

Table 1. Photoplot type and number of replicates at each site. NP= No plots.

	Park	**Mussels**	**Barnacles**		**Rockweeds/Sessile algae**		
Site		*Mytilus spp.*	*Chthamalus, Balanus*	*Pelvetiopsis limitata*	*Mastocarpus*	*Endocladia muricata*	*Fucus gardneri*
Bolinas Point	PORE	5 plots	NP	NP	5 plots*	5 plots*	5 plots
Santa Maria Creek	PORE	5 plots	NP	5 plots	NP	NP	NP
Alcatraz	GOGA	NP	5 plots	NP	5 plots	NP	5 plots
Slide Ranch	GOGA	5 plots	5 plots	5 plots	NP	5 plots	NP
Point Bonita	GOGA	5 plots	5 plots	NP	NP	5 plots	NP

*Same plots

2.4 Timing of Field Sampling

The sampling at each site is timed to correspond to the seasonal low tide series. A spring/summer sampling event occurs at four of the sites between June and July each year. Alcatraz Island is sampled in the fall (October/November) after the seabird nesting season. Tidal schedules dictate the precise timing of sampling which occurs during morning tides. Ocean conditions must be monitored closely prior to sampling.

Most of the plots can be sampled at a -0.5 ft or lower tide, but most transects and mussel plots require tides that are -1.0 ft or lower. Sampling dates will be scheduled on the lowest possible tides of the season with at least a -1.0 tide. Sampling will start two to three hours before the low tide (earlier for lower tides) to perform work as the tide is going out. When choosing dates, field personnel check sunrise or sunset times to estimate the actual amount of daylight work time. For Alcatraz Island, sample dates and times need to be coordinated with current boat schedules. Sampling can begin or end in the dark but is most efficiently performed during daylight hours.

2.5 Level of Change that can be Detected for Amount/Type of Sampling

Long-term monitoring of MARINe sites allows for assessment of change within intertidal communities on many levels. The fixed plot sampling of targeted assemblages has high power to detect changes in the abundance of common intertidal species (Minchinton and Raimondi 2005). Researchers using these sampling methods have documented naturally occurring seasonal variation, as well as longer-term fluctuations in the abundance of species (Miner et al. 2005). This record of species dynamics within sites has enabled scientists to assess damage and document recovery following human induced impact and natural disturbance. The existing MARINe monitoring program has produced what is, in terms of its spatial and temporal extent, one of the most comprehensive sets of data ever collected for species living in rocky intertidal communities.

A study from southern California examined the level of change that can be effectively detected by the temporal and spatial design of the current intertidal monitoring program. The purpose of this analysis was to determine whether modifications to the spatial and temporal aspects of the sampling design are necessary, so that future impacts may be reliably detected (Minchinton and Raimondi 2005). The ability of the monitoring program to estimate the effects of impacts is demonstrated using power analyses with a Before-After design. Statistical analyses of the data revealed that the current sampling design and monitoring protocols have a great ability to show the natural limits of variation and to detect trends in the abundance of target species. This analysis suggested that this methodology is able to detect a 50% change in abundance with 80% power, a level that has been proposed as a reasonable goal for monitoring studies (Fairweather 1991). The study concluded that no changes should be made to the current monitoring program, but additional sites and target species should be added as resources permit. Additionally, Applied Marine Sciences (2002) concluded, from an analysis of 1996-1997 data collected at PORE, that monitoring should focus on fixed plots (and eliminate random plots) if the monitoring objective was detection of temporal trends.

The intertidal habitat is characterized by bands or zones of assemblages that have a high percent cover of a given species. The target species for each site are chosen based on the predominant bands at the site. The protocols outline establishing plots with high (>70%) percent cover of a target species (SOP 3). Consequently, the initial monitored change commonly shows a dip in percent cover however, this variation can be modeled out over time. This method of plot selection has been shown to have the best likelihood of picking up natural variation over time. The effectiveness of this sampling methodology has been shown in the Torch Oil Spill assessment. Intertidal data collected during this spill in southern California was compared to nearby MARINe monitored sites to assess the possibility of biological effects resulting from the

spill (Raimondi et al. 1999). Using models to tease out temporal trends and determine natural variation provided control sites for the oil spill assessment. Methods included a BACIP (Before-After Control-Impact Procedure) test to examine if post-spill data from potentially affected sites differed from “expected” values. The “expected” values were based on pre-spill monitoring data from control sites located outside of the impact zone.

The purpose of summarizing these spatial and temporal trends was to examine changes in the structure and dynamics of the target species. Given the relatively long temporal series of data over a relatively large number of sites, it is possible to identify both short (e.g., seasonal) and long-term (e.g., El Niño events) changes in abundance over both local (e.g., sites separated by miles) and regional (e.g., sites separated by the biogeographic break at Point Conception) spatial scales. Because of the relatively large number of target species, it is possible to identify whether changes are species-specific or common across taxa. Investigating such spatial and temporal patterns of species abundance can help identify dramatic changes outside normal limits of variation and lead to considerable insights about the factors which might be responsible for such fluctuations (e.g., changes due to human impacts such as oil spills).

3 - Field Methods

3.1 Field Season Preparations and Equipment Setup

Scheduling and logistical preparation should be arranged three to six months prior to the sampling season (SOP 1). Field gear will be maintained and ready for use prior to sampling events. The GOGA or PORE headquarters will be notified prior to any sampling event to ensure that any special circumstances are taken into account (e.g., bird nesting or marine mammal presence). Batteries for drill, flashlights, and cameras should be charged prior to the first day of sampling.

A field notebook will be maintained that includes site maps, site overview photos, interplot measurements, GPS measurements, tidal heights, text descriptions, and multiple photographs for each plot (SOP 3). This guide will help field team members with site and plot orientation and should be consulted often to avoid changes in plot orientation through time. It should be kept up to date with changes and additions. It will be the responsibility of the Lead Project Field Biologist to maintain the field notebook.

3.2 Sequence of Events during Field Season

Sampling of all sites will occur during the same low tide series, taking one to two days per site. At the beginning of each sampling period, all the plots should be found and marked with PVC quadrats (rectangles measured to the same size as the plot), oriented appropriately on each photoplot. Care should be taken not to disturb the plots or transects while finding and marking them, including disturbing vegetation. All fixed plots are marked with permanent markers. Photoplots are marked on three corners with bolts. All bolts are stainless steel hex bolts, anchored by a mound of marine epoxy (Z-Spar A-788 Splash Zone Compound, available at marine supply stores). Occasionally, plot markers may be buried beneath mussels or thick vegetation. A metal detector may be used to locate hidden bolts. Any broken or missing bolts should be repaired during each sampling period (SOP 3).

Once PVC quadrats are laid out at all of the permanent plots, the photographer should take pictures of the plots while another sampler draws a series of field notes for each plot. As soon as a plot has been photographed and drawn, researchers may begin the motile invertebrate sampling within each plot. Sea star plots and surfgrass transects may not be accessible until close to low tide therefore, they should be sampled as close to low tide as possible.

3.3 Details of Taking Measurements with Field Forms

A detailed explanation of sampling methods and field datasheets is given in SOPs 4–10. Sampling protocols and the latest version of these datasheets can also be found on the MARINe web site (www.marine.gov). The following is a brief overview of field methods and should not be relied upon for sampling purposes. Permanent photoplots (50 x 75 cm) are established and marked by three permanent bolts in target assemblages, such as barnacles, mussels, turfweed, and rockweed. Target assemblages are listed in Appendix A.

Estimates of percent cover of the major taxa within these photoplots is assessed using photographic analysis (GOGA) or field scoring (PORE). Plots are photographed at all sites but

the PORE photographs are maintained for photo documentation purposes and not analyzed because field scoring is employed at Bolinas Point and Santa Maria Creek. A digital camera (minimum 5.0 mega pixel resolution and 3x optical zoom) is used on a 50 x 75 cm PVC photo framer, to ensure equal scale among plots. Photoplots are scored for percent cover of sessile species using a rectangular 10 x 10 grid of 100 evenly spaced points (Figure 2). This grid is overlaid on the digital photos and switched on and off to determine what taxon is below each point. Different layers of algae are not scored separately, so the total percent cover is constrained to 100%.

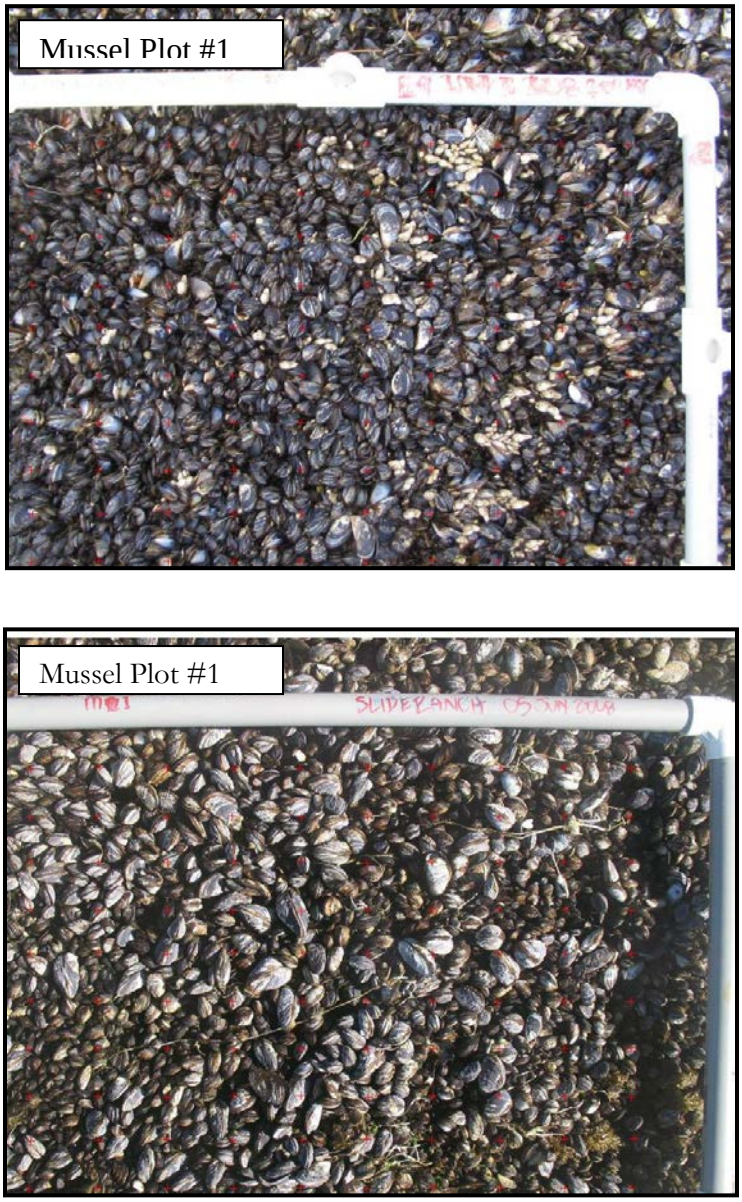

Figure 2. Examples of photoplots taken from sites within GOGA in 2007 (top) and Slide Ranch in 2008 (bottom). Photos are of plots from different sampling periods with an overlaid 100-point grid (red points).

In addition to percent cover measurements, small motile invertebrates are counted within each permanent photo plot area (SOP 8). With the exception of burrowing organisms and amphipods, all motile invertebrates are counted in the field within the 50 x 75 cm PVC quadrat. The quadrat is aligned with three plot marker bolts to ensure accurate replication. Species targeted in these plots include snails: turban snail (*Tegula funebralis*), unicorn snail (*Acanthina* spp.), dog whelks (*Nucella emarginata* and *Nucella canaliculata*), rock snail (*Ocenebra circumtexta)*, and periwinkle (*Littorina* spp.), chitons: gould's baby chiton (*Lepidochitona dentiens*), rough chiton (*Nuttalina* spp.), and mossy chiton (*Mopalia* spp.), and marine crabs: striped shore crab (*Pachygrapsus crassipes*), hermit crabs (*Pagurus* spp.), and various limpets. Depending upon the targeted species, counts may be done of the entire quadrat or in a subset of the quadrat.

Permanent plots (Bolinas Point) or transects (Alcatraz, Slide Ranch, Point Bonita and Santa Maria Creek) are also established for the large, motile ochre sea stars (*Pisaster ochraceus)* (SOP 9). The ochre sea star sampling protocol includes measuring and recording color information within the designated plots. These protocols are employed at sites from southern California to northern Washington for monitoring sea stars. Despite a large body of ecological and developmental biology information on ochre sea stars, few studies have rigorously examined color patterns or their causes across its geographic range. A recent analysis of ochre sea star data collected by the MARINe and PISCO programs show that the frequency of orange sea stars is approximately 20% with little variation across a broad latitudinal band (Raimondi et al. 2007).

Permanent, 10 m line transects are used to estimate the cover of surfgrass (*Phyllospadix scouleri/torreyi*) and associated species (SOP 10). The transects are designed to sample a larger area by field scoring what occurs under 100 points spaced at 10-cm intervals along a 10-m tape stretched out between marker bolts. These point-intercept transects are established at Slide Ranch in GOGA and Bolinas Point in PORE. These sites were the only ones found to have suitable cover of surfgrass for sampling.

A series of photographic panoramas are taken at set locations throughout the site. These overview photographs, along with field notes, are used to describe general conditions at the site and to document the distribution and abundance of organisms not found within the photoplots. Information about the physical conditions (e.g., water temperature), presence of marine mammals, birds, and humans, and species conditions are recorded in the field log. Field log information and site reconnaissance characterization are recorded on the two-page field log data form. General site information is collected during each sampling trip with a standardized datasheet of categories. Completing the datasheet includes categorizing target species abundance, appearance, and recruitment, as well as recording general physical and biological conditions at the site. These observations, along with the habitat overview photographs, provide valuable perspective on site dynamics that aid interpretation of data from the fixed plots and transects. The complete protocol for the field log and site reconnaissance is in SOP 4.

3.4 Post-collecting Processing

Taxa which cannot be identified in the field will be returned to the office in labeled plastic bags which will be kept refrigerated until identification can be determined using taxonomic literature. If identifications cannot be determined by NPS staff, local experts will be consulted. Algae will be identified by staff of the Jepson Herbarium at the University of California, Berkeley and

invertebrates will be taken to the Department of Invertebrate Zoology and Geology at the California Academy of Sciences in San Francisco. Specimens which are new to science or otherwise notable will be accessioned into the collections of these two museums.

3.5 End-of-season Procedures

At the end of each sampling day, photos are downloaded to the computer. The photoplots and overview photos should be promptly labeled to avoid confusion. File names should follow MARINe conventions outlined in SOP 12. Photographs are organized and analyzed by a specialist (SOP 7). Data collected on field forms will be entered into the MARINe database or the Motile Invertebrate spreadsheet (SOP 13). At the end of the sampling season, sampling equipment will be cleaned and repaired and expendable supplies will be replenished as described in SOP 1.

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4 - Data Handling, Analysis, and Reporting

Metadata Procedures

Metadata procedures for SFAN are outlined in SOP 16. The purpose of metadata is to archive the data, along with providing sampling specifics such as how, when, and who collected the data presented.

Cataloging the data collected from the Rocky Intertidal Monitoring Program will be a joint effort between the LPFBs and the SFAN Data Manager.

4.1 Overview of Database Design

Data collected using core MARINe protocols will be entered into a Microsoft Access database which is named "The MARINe Database". This database was designed by the Southern California Coastal Water Research Project (SCCWRP) to house data collected by many cooperating groups and it therefore is not strictly adherent to the NPS Natural Resources Database Template although it does conform to standard best practices for relational databases. A detailed user's guide for the MARINe Database is available online (Miner et al. 2007) with an overview in SOP 13. The data relationships and data dictionary are presented in Appendix B. Protocols accommodated by the database include: field log (SOP 4), photoplot (SOPs 5, 6 and 7), sea star (SOP 9), and surfgrass (SOP 10). An advantage of using the MARINe database is that it contains data from sites along the entire West Coast (including other NPS sites) allowing SFAN intertidal data to be placed in a broad spatial context.

Data collected using the motile invertebrate protocol (SOP 8) cannot be entered into the MARINe Access database. A Microsoft Excel catalog is used to enter these data (SOP 13). The MARINe Excel catalog is maintained by Rani Gaddam of the PISCO group at the University of California, Santa Cruz.

4.2 Data Entry, Verification, and Editing

At the end of each field day, the LPFB and Data Manager will review the datasheets to look for omissions, errors, and illegible marks. Data from field forms will then be entered into a local copy of the MARINe database by the SFAN Data Manager. After a series of quality control checks, the newly collected data will be uploaded into the main database via the MARINe Egnyte file server (SOP13). Uploading should occur after all data from each site have been entered for an entire season. Datasheets, maps, photographs, and computer files are managed as described for each survey method in the individual SOPs. Data entry, error checking and correction, and other data management procedures for the MARINe database are described in SOP 13.

4.3 Annual Progress Report

A short (approximately two pages) progress report will be prepared each year. The report will be prepared in memo format and addressed to the SFAN Technical Steering Committee. It will summarize accomplishments and problems encountered by the SFAN Rocky Intertidal Monitoring Program during the most recent field season, and will also summarize the status of data collection and submittal of data to MARINe. Notable changes in the health or the

distribution and abundance of intertidal flora and fauna will be noted in the report but no formal data analysis will be required for this report.

4.4 Routine Data Summaries and Statistical Analysis to Detect Change

Data summaries may help to synthesize noteworthy events and interpret data in that context as well as summarize data for later trend analysis. To examine variation in the abundance of target species in space and time, summary statistics (mean and standard error of the mean) for all sites and sample periods are calculated and graphically displayed (SOP 14). These results will be presented in biennial reports. Analyses of covariance (ANCOVA) procedures are used to assess temporal patterns of abundance for each of the target species at each site (Miner et al. 2005).

All data collected by MARINe, including SFAN data, are available to the public (http://data.piscoweb.org/DataCatalogAccess/DataCatalogAccess.html), except for sensitive species data which is withheld to avoid targeted exploitation. In addition, SFAN data can also be obtained from the SFAN Data Manager. Monitoring data have been used in a variety of analyses and scientific publications by the broader scientific community. See the MARINe publication list (http://www.marine.gov/Findings/Publications.html) for an extensive catalog of scientific literature using intertidal monitoring data collected by MARINe.

4.5 Recommended Reporting Schedule

The network will produce summary reports every two years and trend reports every six years. Both reports are the responsibility of the SFAN Data Manager and the LPFBs. The summary reports will be delivered to SFAN for internal review by February 15th every other year.

4.6 Recommended Report Format

Biennial reports and six-year reports summarizing the data collected within SFAN parks will be presented in the NPS Natural Resource Technical Report format. Details for report writing are in SOP 14.

In general, the report will follow the outline below:

- Title Page, with Technical Report number
- Abstract
- Table of Contents
- List of Figures
- List of Tables
- Introduction
- Results
- Discussion
- Acknowledgements
- Literature Cited
- Appendices

4.7 Recommended Methods for Long-term Trend Analysis

After six years of data have been collected, a comprehensive report will examine long-term trends. This time span will allow for adequate data collection for a comprehensive report. Focused analysis of the data to detect change, report trends, and report statistical significance will be presented in the trend analysis report. The reports may be in conjunction with other west coast sites to encompass a broader scale and be able to make comparisons with sites outside of SFAN. These reports will be similar to the recent report released covering 10 years of data from southern and central California intertidal monitoring (Miner et al. 2005).

4.8 Other Information Reporting Mechanisms

Biennial and trend reports are of great importance to park managers and are critical for informing adaptive management decisions. Given their data rich content, they are not generally easy to comprehend for non-technical audiences. O'Herron (2009) developed a science communication strategy for SFAN that helped identify a variety of methods to effectively communicate results to other internal audiences including educators, park interpreters, park planners, and other park service staff. At a minimum, the LPFBs should work with science communication staff to develop Resource Briefs and web updates every 1–2 years. In addition, project highlights should be submitted to monthly natural resource updates and end of year program reports. See O'Herron (2009) for product descriptions and examples.

4.9 Data Archival Procedures

All data will be archived in the established MARINe database with backups of data and digital photos on the SFAN computer server. Archived versions of the database will be stored by the SFAN Data Manager, who is responsible for making sure they are stored in their proper location, properly backed up, and correctly named. All data and information will follow guidelines provided in the SFAN Data Management Plan.

5 - Personnel Requirements and Training

5.1 Roles and Responsibilities

Two designated Lead Project Field Biologists (LPFBs) at PORE and GOGA are responsible for coordinating sampling logistics, packing and maintaining gear, and field sampling. Trained biological researchers are responsible for assisting the LPFBs with preparations for field work, monitoring, and help with volunteer supervision. A crew of at least four researchers will conduct the monitoring.

The Network Data Manager is a field team member with training equivalent to a biological researcher. The Data Manager is also responsible for assisting data collection, data entry, data verification, validation, copying datasheets, organizing, and filing datasheets. The Data Manager will be responsible for data archiving, data security, data dissemination, and metadata procedures. The Data Manager is also responsible for working with LPFBs to disseminate information with summary reports and six-year trend reports, posting information in the national I&M databases including NRInfo, updating web sites with the latest reports, organizing and storing the information on the network server, adding reports and images to their corresponding databases, distributing reports to park staff and interested scientists, and creating Resource Briefs.

5.2 Qualifications

In order to collect long-term standardized data that can be compared along an extensive spatial scale, the level of expertise among samplers is critical. LPFBs are expected to be taxonomic experts in marine algae and invertebrates to ensure the reliability of data. The field crew must be physically fit and able to carry backpacks across uneven terrain, including on steep ascents and descents, in various weather conditions. Photo analysis will be conducted by trained biological researchers.

5.3 Training Procedures

SOP 2 outlines training procedures for new workers and continuous updates for all researchers. Training begins with a general academic background in marine sciences that is enhanced through supervised field experience. All groups involved in the MARINe intertidal sampling network collaborate on training procedures and gather on an annual basis to review protocols and taxonomic issues. These meetings allow the various groups to review taxonomic changes and maintain a consistent sampling regimen.

6 - Operational Requirements

6.1 Annual Workload and Field Schedule

The LPFBs at GOGA and PORE will coordinate and lead sampling events. Sampling will occur annually at each site during a low tide series. The single summer sampling event will occur between June and July. The Santa Maria Creek site requires one day of sampling and Bolinas Point requires two days, employing a field team of four to six researchers. GOGA sites each require one to two days of sampling depending on the tide window. Sampling on Alcatraz will be delayed until the fall, after the seabird nesting season ends.

Each sampling trip involves two days of pre- and post-trip planning and packing. Photo analysis requires one day per site per sampling event at GOGA (SOP 7). PORE sites are scored entirely in the field (SOP 6). Data entry requires approximately two days per park per sampling event. Data analysis and report writing will require several weeks every two years and will be a collaborative effort with the MARINe program biologists when feasible.

Table 2. Annual field schedule for rocky intertidal monitoring at Alcatraz, GOGA, and PORE.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alcatraz sampling											X	
GOGA sampling						X						
PORE sampling						X						
Data Entry							X					X
Annual Report												X

6.2 Facility and Equipment Needs

Facilities at the Pacific Coast Science Learning Center at PORE and Resource Management at GOGA will be used for storing gear, processing samples, and performing photographic analysis. Specialized equipment, such as the PVC photo framer, are built and maintained by each park (SOP 5). Refer to Table SOP 1.1 for a field equipment list.

6.3 Startup Costs and Budget Considerations

Sampling sites and the MARINe project database have also already been established. The maintenance of the database is a shared cost among a network of monitoring groups. These factors eliminate startup costs and greatly reduce the cost of data management. The annual budget for maintaining sampling at the five sites amounts to $25,900. This averages approximately $5,180 per site.

Funding for this protocol comes from contributions made by the SFAN Inventory and Monitoring Program, GOGA, and PORE. The Pacific Coast Science and Learning Center (PCSLC) Director contributes by serving as the LPFB for PORE. Table 3 shows a general breakdown of the budget for annual sampling for SFAN:

Table 3. Annual budget for the SFAN rocky intertidal monitoring program.

Category	Item	Annual Expenses
Project Income		
	SFAN I&M Program	$17,500
	Pacific Coast Science and Learning Center	$4,200
	GOGA Contribution	$4,200
Total Income		$25,900
Project Expense		
Personnel	LPFB GOGA GS-12 Step 10 (1 pp)	$4,200
	LPFB PCSLC GS-12 Step 10 (1 pp)	$4,200
	Data Manager GS-11 Step 9 (4 pp)	$13,400
	Experienced Researcher GS-11 Step 10 (1 pp)	$3,400
Equipment	Repair/replacement	$500
Supplies	Miscellaneous	$200
Total Expense		$25,900*
Balance		0

*additional field assistance contributed by staff from GOGA, PORE, and the SFAN I&M Program make up less than 1 pp and is not included in the budget.

Table 4. Percent of effort breakdown for intertidal team members.

Team Member	Data Collection	Data Management	Data Analysis and Reporting
LPFB GOGA	60	10	30
LPFB PCSLC	60	10	30
Data Manager	10	60	30
Experienced Researcher	60	20	20

6.4 Permitting and Compliance

LPFBs are responsible for maintaining NPS scientific research permits. They are also required to comply with the requirements of the Marine Mammal Protection Act. If any marine mammal is disturbed during intertidal sampling the incident must be reported to the National Marine Fisheries Service (NMFS). The parks have an Incidental Harassment Permit (IHP) which requires annual reporting to NMFS. Disturbance characterization should include the following information: date, time, species which was disturbed, number of animals disturbed, behavior of disturbed animals, scientific activity which caused the disturbance, and whether or not animals returned to the disturbed area. Point Bonita is the most likely intertidal site for marine mammal disturbances because harbor seals haul out there. Disturbance information should be emailed to Sarah_Allen@nps.gov (Ocean coordinator, Pacific West Region) who is the principal investigator under the IHP.

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Appendix A. Species Monitored: Target, Core, and Optional Species Defined

The definitions of monitored species are taken from the MARINe handbook (Engle 2005).

Target Species

"Target" species (also called key or indicator species) are species or species groups specifically chosen for long-term monitoring. Target species are a subset of the "Core" species group which is monitored by every MARINe participant (see below). Target species dominate particular zones or biotic assemblages in rocky intertidal habitats. The criteria for selecting target species include the following:

- Species that are ecologically important in structuring intertidal communities.
- Species that are competitive dominants or major predators.
- Species that are abundant, conspicuous, or large.
- Species whose presence provides numerous microhabitats for other organisms.
- Species that are slow growing and long lived.
- Species that have interesting distributions along California coasts.
- Species found throughout California shores.
- Species characteristic of discrete intertidal heights.
- Species that are rare, unique, or found only in a particular intertidal habitat.
- Species approaching their biogeographic limits in California.
- Species that have been well studied, with extensive literature available.
- Species of special human interest.
- Species vulnerable and/or sensitive to human impacts, especially from oil spills.
- Species with special legal status.
- Introduced or invasive species.
- Species harvested by sport or commercial activities.
- Practical species for long-term monitoring.
- Readily identifiable species.
- Sessile or sedentary species of reasonable size.
- Non-cryptic species.
- Species located high enough in the intertidal to permit sufficient time to sample.

Currently, there are **18 designated target species monitored by MARINe (**underlined species are currently monitored at GOGA and PORE): *Egregia menziezii*, *Fucus gardneri*, *Hedophyllum*

sessile, *Hesperophycus californicus*, *Pelvetiopsis limitata*, *Silvetia compressa*, *Endocladia muricata*, *Neorhodomela larix*, *Phyllospadix scouleri/torreyi*, *Anthopleura elegantissima/sola*, *Mytilus californianus*, *Lottia gigantea*, *Haliotis cracherodii*, *Chthamalus dalli/fissus/Balanus glandula*, *Semibalanus cariosus*, *Tetraclita rubescens*, *Pollicipes polymerus*, and *Pisaster ochraceus* (Table A.1).

Designated target species have the highest priority for monitoring and are monitored at as many sites as possible. If the species is present in sufficient numbers and it is logistically possible, plots or transects are established to monitor it. Anywhere from 1 to 11 target assemblages are monitored at a given site. More information on target species (e.g., photos and how to identify) can be found on the MARINe public web site.

Core Species

"Core" species are those **species, species groups, or substrates that are scored using one or more survey methods by everyone in MARINe**. Core species must be reasonably and consistently identifiable using the designated scoring protocol (e.g., from lab scored photos of fixed plots possibly supplemented by plot sketches/notes). They also must be important enough to warrant scoring for abundance trends. Some of these species only occur at northern sites, or conversely, southern sites. However, to ensure that we notice if they expand their range, we must score everywhere. Table A.2 provides the official list of core species. All target species (shown in bold on the table) are core species. It is important that **scorers in all monitoring groups be able to identify and record all core species. Datasheets must include all core species**, though core species that are absent or rarely occur at a site can be deemphasized. Entries for all core species will be required for data submission to the MARINe database. Definitions for core higher taxa and substrates are provided below.

Optional Species

"Optional" species are **non-core species or species groups that one or more monitoring groups choose to score at their sites, however, for various reasons, these species are not appropriate or feasible for all groups to score**. Since optional species will not be scored by everyone, regional comparisons of trends for these species will be limited or not possible.

Each monitoring group desiring to score optional species shall provide a list of these species to the MARINe Data Manager, Melissa Miner (mwilson@biology.ucsc.edu), **along with mechanisms to translate optional species data to core species categories.** For example, if choosing to monitor *Codium fragile*, you would submit the optional species data, which would be stored in the database as *Codium fragile*, but for standard regional comparisons of core species, it would be lumped by the database to the next higher core species group "other green algae." **Choosing optional species requires a commitment to monitor the species consistently for a long period of time.** There is little value in scoring a species on an occasional basis (e.g., only when a particular person is available in the field to identify that species).

Table A.1. MARINe List of target species, standardized names and species codes.

		Official Target Species for MARINe			
Plot Name	**Plot Type**	**Scientific Name**	**Common Name**	**6-Letter Code**	**3-LetterBrief**
Plants					
Egregia	Transect	*Egregia menziesii*	Boa Kelp	EGRMEN	EGR
Fucus	Photoplot	*Fucus gardneri*	Northern Rockweed	FUCGAR	FUC
Hedophyllum	Transect	*Hedophyllum sessile*	Sea Cabbage	HEDSES	HED
Hesperophycus	Photoplot	*Hesperophycus californicus*	Olive Rockweed	HESCAL	HES
Pelvetiopsis	Photoplot	*Pelvetiopsis limitata*	Dwarf Rockweed	PELLIM	PEL
Silvetia	Photoplot	*Silvetia compressa*	Golden Rockweed	SILCOM	SIL
Endocladia	Photoplot	*Endocladia muricata*	Turfweed	ENDMUR	END
Neorhodomela	Photoplot	*Neorhodomela larix*	Black Pine	NEOLAR	NEO
Phyllospadix	Transect	*Phyllospadix scouleri/torreyi*	Surfgrass	PHYOVR	PHY
Invertebrates					
Anthopleura	Photoplot	*Anthopleura elegantissima/sola*	Green Anemone	ANTELE	ANT
Mytilus	Photoplot	*Mytilus californianus*	California Mussel	MYTCAL	MYT
Lottia	Size/Count	*Lottia gigantea*	Owl Limpet	LOTGIG	LOT
Haliotis	Size/Count	*Haliotis cracherodii*	Black Abalone	HALCRA	HAL
Chthamalus/Balanus	Photoplot	*Chthamalus dalli/fissus/Balanus glandula*	White Barnacle	CHTBAL	CHT
Semibalanus	Photoplot	*Semibalanus cariosus*	Thatched Barnacle	SEMCAR	SEM
Tetraclita	Photoplot	*Tetraclita rubescens*	Pink Barnacle	TETRUB	TET
Pollicipes	Photoplot	*Pollicipes polymerus*	Goose Barnacle	POLPOL	POL
Pisaster	Size/Count	*Pisaster ochraceus*	Ochre Seastar	PISOCH	PIS
		Other Species "Targeted" by Some Monitoring Groups			
Plot Name		**Scientific Name**	**Common Name**	**6-Letter Code**	**3-LetterBrief**
Plants					
Mastocarpus	Photoplot	*Mastocarpus papillatus*	Turkish Washcloth	MASPAP	MAS
Mazzaella	Photoplot	*Mazzaella spp (=Iridaea spp)*	Iridescent Weed	MAZSPP	MAZ
Postelsia*	Size/Count	*Postelsia palmaeformis*	Northern Sea Palm	POSPAL	POS
Red Algae	Photoplot Transect	(includes plots targeting *Gelidium* & Red Algal & transects targeting Turf)	Red Algae	REDALG	RED
Invertebrates					
Balanus	Photoplot	*Balanus glandula*	Northern Barnacle	BALGLA	BAL
Other					
Tar	Photoplot		Tar	TAR	TAR
Recovery	Photoplot		Recovery	RECOV	REC
*note these data are not yet in database, and will likely be added to tblSpeciesCountSize (# of plants counted in 2 m swaths or in grids)					

“ note2 “Recovery” plots are designated enabled assessment of damage and document recovery following human induced impact and natural disturbance.

Table A.2. MARINe core species, higher taxonomic groups to which they belong and substrates on which they are found.

(Target species are shown in bold.)	Photoplots	Transects	Size & Counts	Field Log Recon	Motile Inverts
GREEN ALGAE					
Cladophora columbiana	X			X	
Ulva/Enteromorpha	X			X	
Other Green Algae (any greens not listed above)*	X	X			
BROWN ALGAE					
Egregia menziesii (Boa Kelp)	X	X		X	
Eisenia arborea	X	X		X	
Enderachne/Petalonia	X			X	
Fucus gardneri (= *F. distichus*)(Northern Rockweed)	X			X	
Halidrys dioica/Cystoseira spp	X	X		X	
Hedophyllum sessile (Sea Cabbage)	X	X		X	
Hesperophycus californicus (= *H. harveyanus*)(Olive Rockweed)	X			X	
Pelvetiopsis limitata (Dwarf Rockweed)	X			X	
Postelsia palmaeformis (Northern Sea Palm)			X	X	
Sargassum muticum	X	X		X	
Scytosiphon spp	X			X	
Silvetia compressa (= *Pelvetia fastigiata*)(Golden Rockweed)	X			X	
Other Brown Algae (any browns not listed above)*	X	X			
RED ALGAE					
Chondracanthus canaliculatus (= Gigartina canaliculata)	X			X	
Endocladia muricata (Turfweed)	X			X	
Mastocarpus papillatus (blade)(Turkish Washcloth)	X			X	
Mazzaella affinis (= Rhodoglossum affine)	X			X	
Mazzaella spp.(= *Iridaea* spp.)(Iridescent Weed)	X			X	
Neorhodomela larix) (Black Pine)	X			X	
Porphyra sp	X			X	
Articulated Corallines (Erect Corallines)	X	X			
Crustose Corallines (Encrusting Corallines)	X	X			
Other Red Algae (any reds not listed above)*	X	X			
ALGAE/PLANTS					
Phyllospadix scouleri/torreyi (Surfgrass)	X	X		X	
Non-Coralline Crusts (reds and browns)	X	X			
Other Plant/Algae*	X	X			
ANEMONES					
Anthopleura elegantissima/sola (Green Anemone)	X	X		X	
POLYCHAETE WORMS					
Phragmatopoma californica	X	X		X	
MOLLUSKS					
Acanthina spp					X
Fissurella volcano					X
Haliotis cracherodii (Black Abalone)			X	X	
Katharina tunicata			X		
Lepidochitona hartwegii					X
Littorina spp				X	X
Lottia gigantea (Owl Limpet)	X		X	X	X

MARINe Core Species (cont.)

(Target species are shown in bold.)

	Photoplots	Transects	Size & Counts	Field Log Recon	Motile Inverts
MOLLUSKS (cont.)					
Mopalia spp					X
Mytilus californianus **(California Mussel)**	X	X		X	
Nucella emarginata					X
Nucella canaliculata					X
Nuttallina spp					X
Ocenebra circumtexta					X
Tegula brunnea					X
Tegula funebralis					X
Tegula gallina					X
Tegula spp				X	
Limpets	X				
Large Limpets > 15mm (excluding *L. gigantea*)					X
Medium Limpets 5-15mm					X
Small Limpets < 5mm					X
Chitons	X				
BARNACLES					
Balanus glandula (Northern Barnacle)	X**				
Chthamalus dalli/fissus & Balanus glandula (White Barnacle)	X			X	
Pollicipes polymerus (Goose Barnacle)	X			X	
Semibalanus cariosus (Thatched Barnacle)	X			X	
Tetraclita rubescens (Pink Barnacle)	X			X	
Barnacles		X			
Other Barnacles (any barnacles not listed above)*	X				
ECHINODERMS					
Pisaster ochraceus (Ochre Star)	X	X	X	X	
Henricia spp			X		
Strongylocentrotus purpuratus				X	
CRUSTACEANS					
Ligia occidentalis				X	
Pachygrapsis crassipes					X
Pagurus spp					X
INVERTEBRATES					
Other Invertebrates (Other Animals) (any inverts not listed above)*	X	X			
SUBSTRATES					
Rock (Bare Rock)	X	X			
Sand	X	X			
Tar	X	X		X	
UNDETERMINED					
Other Substrate (e.g., dead mussel shells or barnacle tests)	X	X			
Unidentified (cannot tell if plant, invert or substrate)	X	X			

* The specific definitions of these categories are different for photoplots compared to transects.

** Core species for MARINe North only.

Articulated (Erect) Corallines: erect, jointed, calcified, red algae of the Family Corallinaceae, with flexible, articulate fronds arising from crustose bases.

Barnacles: adults or juveniles of any barnacle (Phylum Arthropoda, Class Crustacea, Subclass Cirripedia) species.

Chitons: adults or juveniles of any chiton (Phylum Mollusca, Class Polyplacophora) species.

Crustose (Encrusting) Corallines: thin, flattened, calcified, crust-like red algae of the Family Corallinaceae, having no erect, articulated fronds. Bleached crustose corallines (white) are scored as well because they may be alive.

Limpets: adults or juveniles of any limpet (Phylum Mollusca, Class Gastropoda, Family Acmaeidae) species, including *Lottia gigantea*.

Non-Coralline Crusts: any thin, flattened, crust-like red or brown algae that are not calcified species of the Family Corallinaceae.

Other Invertebrates (Other Animals): any invertebrates not listed or not identifiable in other more specific categories on the score sheet.

Other Barnacles: any barnacles not listed or not identifiable in other more specific categories on the score sheet.

Other Brown Algae: any brown algae not listed or not identifiable in other more specific categories on the score sheet (score “non-coralline crusts” separately).

Other Green Algae: any green algae not listed or not identifiable in other more specific categories on the score sheet.

Other Plant (Other Algae): any plants (algae) not listed or not identifiable in other more specific categories on the score sheet.

Other Red Algae: any red algae not listed or not identifiable in other more specific categories on the score sheet (score “non-coralline crusts” separately).

Rock (Bare Rock): bare, unconsolidated substrates larger than sand/gravel (including cobble, rocks, and boulders) and all consolidated substrates (e.g., bedrock) that contain no obvious living organisms or tar (epoxy corner markers and inconspicuous blue-green algal films are scored as “rock”).

Sand: granular, particulate (fine sand to gravel) substrate. In photoplots, score “sand” unless you can positively identify what lies under the sand in the photo. In transects, score “sand” whenever sand cover is 2 cm or greater.

Tar: fresh or weathered oil or tar coating on the substrate.

Unidentified: cannot tell if plant, invertebrate, or substrate.

Literature Cited

Engle, J. M. 2005. Unified monitoring protocols for the Multi-Agency Rocky Intertidal Network (update). Outer Continental Shelf Study Mineral Management Service 05-01.

Appendix B. Database Relationships and Data Dictionary for MARINe Database

Data Dictionary for MARINe Database

Table Design-Lookup Lists

TABLE_NAME luList01_SurveyingGroups

Field Name	Type	Required	Description
GroupCity	Text	Y	The group city.
GroupCode	Text	Y	A code used to identify each group.
GroupName	Text	Y	The group name.
GroupState	Text	Y	The group State. Default = CA
GroupStreetAddress	Text	Y	The street address of the group.
GroupZipCode	Text	Y	The group zip code
MonitoringGroup	Yes/No	Y	Is this a monitoring group? If yes, this group conducts seasonal surveys.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME luList02_Personnel

Field Name	Type	Required	Description
GroupCode	Text	Y	A code used to identify each agency.
Remarks	Text	N	Remarks
PersonnelMiddleInitial	Text	N	Middle Initial
PersonnelLastName	Text	Y	Last Name
PersonnelInitials	Text	Y	Initials
PersonnelID	Text	Y	Unique Personnel Identifier. A combination of Group code and a four digit sequential number. example: SCCWRP0001
LastDate	Date/Time	N	The last date this person participated. If a date is present then this person will not appear on personnel lists for new records.
FirstDate	Date/Time	Y	The first date this person participated.
ContactPhoneNumber	Text	N	The contact's phone number.
ContactInternalMailCode	Text	N	The internal mail code if available
ContactFaxNumber	Text	N	The contact's fax number
ContactEMail	Memo	N	The contacts EMail.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PersonnelFirstName	Text	Y	First Name.

TABLE_NAME luList03_MARINECommonSeason

Field Name	Type	Required	Description
Year	Number	Y	The four digit calendar for this season.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
MCSSeason	Number	Y	A consecutive number used to order the surveying groups seasons. Used this field to sort the surveying seasons in calendar order.
SeasonCode	Text	Y	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year.
SeasonName	Text	Y	The common name of the season
SeasonSeq	Number	Y	The Season sequence within each year. 1=Spring, 2=Summer, 3=Fall, 4=Winter. Used with the year field as an alternate method to sort seasons in calendar order.

TABLE_NAME luList04_Methods

Field Name	Type	Required	Description
MethodCode	Text	Y	A code for the method
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	A description of the method

TABLE_NAME luList05_QualifierCodes

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	The description of the qualifier.
Qualifier	Text	Y	Used to modify the associated numeric field.
SeqNumber	Number	Y	Sequence Number. Use to control the sequence items appear in lists.

TABLE_NAME luList07_Units

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Unit	Text	Y	The unit of measure used.
UnitDescription	Text	Y	The description of the unit.

TABLE_NAME luList08_Roles

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
RoleDescription	Text	N	Description of the role.
RoleID	Number	Y	Unique Identifier for each person involved in the project
RoleName	Text	Y	The name of the role.

TABLE_NAME luList10_SurveyTypes

Field Name	Type	Required	Description
DataSource	Text	Y	The source of the data.
LoadDate	Date/Time	Y	The data the data was loaded.
SurveyTypeID	Number	Y	The ID of the type of survey.
SurveyTypeName	Text	Y	The name of the survey type.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME luList13_OchreSeastars

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
LottiaSize	Number	Y	The size of the lottia.

TABLE_NAME luList14_Counties

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
CountyCode	Text	Y	A unique Code for each county
CountyName	Text	Y	The county name

TABLE_NAME luList16_FieldLogValues

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	Description
Sequence	Number	Y	used to sequence the drop down boxes
Value	Text	Y	Values from the field log sheet.

TABLE_NAME luList17_FieldAbundance

Field Name	Type	Required	Description
AbundanceCode	Text	Y	The abundance code from field data sheet conditions
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	Description
Sequence	Number	Y	Used to control the display sequence

TABLE_NAME luList18_FieldConditions

Field Name	Type	Required	Description
Sequence	Number	Y	Used to control the order of items in a list.
Description	Text	Y	Description
ConditionsCode	Text	Y	A code indicating the species condition.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

Sequence	Number	Y	Used to control the order of items in a list.

TABLE_NAME luList20_RecruitmentCode

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Description	Text	Y	The meaning of the code.
RecruitmentCode	Text	Y	A code for the recruitment state
Sequence	Number	Y	Used to control sequence

TABLE_NAME luList21_FieldEventBirds

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
BirdName	Text	Y	The common name of the bird.
Sequence	Number	Y	Used to sequence display of names in drop down lists.

TABLE_NAME luList22_FieldEventMam

Field Name	Type	Required	Description
Sequence	Number	Y	Used to sequence display of names in drop down lists
MammalName	Text	Y	The common name of the mammal.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent

Species System

TABLE_NAME organismConcept

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	Y	This is a foreign key to the reference in which the name was used, thereby defining a concept.
ORGANISMCONCEPT_ID	Number	Y	Database assigned value to each unique record in the commConcept table.
ORGANISMLevel	Text	N	The classLevel attribute specifies a level in the taxonomic hierarchy that a class belongs.
ORGANISMNAME_ID	Number	Y	This is the foreign key into the plant name list, the entry in which when combined with a reference constituted a concept.
ORGANISMParent	Number	N	The organismParent is a recursive key to the concept of the parent level in the classification
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismCorrelation

Field Name	Type	Required	Description
ORGANISMSTATUS_ID	Number	Y	This is the foreign key into the organismStatus table "pointing" to a concept no longer viewed as standard by the party. Reference "pointing" to a concept no longer viewed as standard by the party. Reference organismStatus.ORGANISMSTATUS_ID
PhotoPlotsCoreSpecies	Yes/No	Y	Is this a core photoplot species?
SixLetterCode	Text	Y	A six-letter code for analysis output.
SpeciesCoreFlag	Yes/No	Y	Is this species a core MARINE species?
TargetSpecies	Yes/No	Y	Is this a target species?
TransectsCoreSpecies	Yes/No	Y	Is this a transect species?
correlationStop	Date/Time	N	This is the stop date for recognition by a party of a correlation between two concepts.
TargetSpecies	Text	Y	Is this a target species?
ORGANISMCONCEPT_ID	Number	N	This is the foreign key into the organismtConcept table "pointing" to a concept recognized by the party as a "standard" concept.
organismConvergence	Text	N	This is the descriptive attribute that is used to relate the congruence between two concepts.
correlationStart	Date/Time	Y	This is the start date for recognition by a party of a correlation between two concepts.
CircularPlotCoreSpecies	Yes/No	Y	Is this a circular plot species?
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
AbaloneSeastarsCore	Yes/No	Y	Is this a Abalone/Seastar species?
ORGANISMCORRELATIO N_ID	Number	Y	Database assigned value to each unique record in the organismCorrelation table.

TABLE_NAME organismLineation

Field Name	Type	Required	Description
ORGANISMSTATUS1_ID	Number	Y	This is the foreign key into the organismStatus table "pointing" to a child concept. Reference organismStatus.ORGANISMSTATUS_ID
ORGANISMSTATUS2_ID	Number	Y	This is the foreign key into theorganismStatus table "pointing" to parent concept. Reference organismStatus.ORGANISMSTATUS_ID
ORGANISMLINEAGE_ID	Number	Y	Database assigned value to each unique record in the organismLineage table
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismName

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	N	Foreign key into the organismReference table to identify the original source of the name (usually the type description). Reference organismReference.ORGANISMREFERENCE_ID
dateEntered	Date/Time	N	Field stores the date that the name was entered into the database.
organismName	Text	N	The organism name.
ORGANISMNAME_ID	Number	Y	Database assigned value to each unique record in the organismName table.
organismNameWithAuthor	Text	N	The organism name with any with author notation embedded.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME organismParty

Field Name	Type	Required	Description
ORGANISMPARTY_ID	Number	Y	Database generated identifier assigned to each unique party
salutation	Text	N	Salutation preceding one's given name.
owner	Number	N	recursive foreign key to the Party who owns this party record and who has exclusive rights to update the information
originizationName	Text	N	Name of an organization.
middleName	Text	N	One's middle name or initial, if any.
givenName	Text	N	One's first name.
currentName	Number	N	Recursive foreign key to current name of this party. Reference organismParty.ORGANISMPARTY_ID
Reference organismParty.ORGANISMPARTY_ID			
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
surName	Text	N	Name shared in common to identify the members of
a family, as distinguished from each member's given			
contactInstructions	Text	N	Instructions for contacting a party.

TABLE_NAME organismReference

Field Name	Type	Required	Description
ORGANISMREFERENCE_ID	Number	Y	Database assigned value to each unique record in the organismReference table
title	Text	N	Name by which the cited reference is known.
tableCited	Text	N	name/number of published table containing plant name
seriesName	Text	N	Name of a series.
pubDate	Date/Time	N	Date the citation was published
page	Text	N	Page of the book or serial where the article appears.
otherCitationDetails	Text	N	Other information identifying the issue of the series.
issueIdentification	Text	N	Information identifying the issue of the series.
ISSN	Text	N	International Standard Serial Number.
ISBN	Text	N	International Standard Book NUmber
edition	Text	N	Version of the cited resource.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
organismDescription	Memo	N	Description of the organism. Used where the organismReference table record serves as a self reference for purposes of establishing a taxon concept(taxon assertion). Primary used for nonstandard taxa used by field ecologists, such as "Hariry grass #3".

authors	Text	N	Names of the authors as they appear within the entity being cited.

TABLE_NAME organismStatus

Field Name	Type	Required	Description
organismConceptStatus	Text	N	Status of the concept by the party (accepted, not accepted, undetermined).
stopDate	Date/Time	N	This is the date which the status assignment by the party ended.
startDate	Date/Time	N	This is the date which the status assignment by the party started.
ORGANISMSTATUS_ID	Number	Y	Database assigned value to each unique record in the organismStatus table.
ORGANISMREFERENCE_ID	Number	N	Link to a reference where the status was reported. Reference organismReference.ORGANISMREFERENCE_ID
organismReference.ORGANISMREFERENCE_ID			
ORGANISMPARTY_ID	Number	N	Foreign key that identifies the party that madn the status assignment. Reference organismParty.ORGANISMPARTY_ID
ORGANISMCONCEPT_ID	Number	N	Foreign key to identify the concept to which a party assigns a status.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
organismPartyComments	Text	N	Comments by party providing rationale for status assignment.

TABLE_NAME organismUsage

Field Name	Type	Required	Description
ORGANISMNameStatus	Text	Y	This field shows the status of the application on the name to the concept by the party
usageStart	Date/Time	Y	This is the date on which the party applied the name to the concept.
usageStop	Date/Time	N	This is the date on which the party ceased to apply the name to the concept.
ORGANISMPARTY_ID	Number	N	Foreign key that identifies the party that uses the concept with the name
ORGANISMCONCEPT_ID	Number	Y	This is the foreign key into the organismConcept table. Reference
classSystem	Text	N	This is the name of the classification sustem wherin the name is applied (e.g., EnglishCommon of Scietific).
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
ORGANISMUSAGE_ID	Number	Y	Database assigned value to each unique record in the organismUsage table.
ORGANISMNAME_ID	Number	Y	This is the foreign key into the organismName table. Reference plantName.ORGANISMNAME_ID

Information Tables

TABLE_NAME tblCountSizePlotInfo

Field Name	Type	Required	Description
CountSizePlotTargetSpecies	Text	Y	The species the plot was set up to measure.
GroupCode	Text	Y	A code for the group responsible for the measurement. The code must come from
CountSizePlotMethod	Text	N	The method used.
CountSizePlotLoadDate	Date/Time	Y	The date the data was loaded or changed.
CountSizePlotID	Text	Y	The ID of the Plot
CountSizePlotEffectiveEndDate	Date/Time	N	The last date this plot configuration was effective.
CountSizePlotDataSource	Text	Y	The source of the data. This will be the submissionID on all new data.
CountSizePlotComments	Text	N	Additional remarks
CountSizePlotAreaUnits	Text	N	The unit of measurement for the Plot area. Default is "CM" centimeters. From luList7_Units.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
CountSizePlotArea	Number	N	The area of the Plot.
CountSizePlotDateEstablished	Date/Time	N	The date this plot configuration became effective.
SiteID	Text	Y	The siteID of site where the measurement was taken.

TABLE_NAME tblDataTransmission

Field Name	Type	Required	Description
DateStamp	Date/Time	Y	Date and Time the file was made.
SendFilename	Text	Y	Name of the file that had the data tables in it.

TABLE_NAME tblEventBirds

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SiteID	Text	Y	The siteID
LoadDate	Date/Time	N	The date the date was loaded or changed
GroupCode	Text	Y	The surveying group
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
Bird Count	Number	Y	The number of birds encountered.
SurveyDate	Date/Time	Y	The date of the survey.
BirdName	Text	Y	The Bird name from the luList21_FieldEventBirds

TABLE_NAME tblEventMammals

Field Name	Type	Required	Description
MammalCount	Number	Y	The number of Mammals encountered.
SiteID	Text	Y	The site ID
SurveyDate	Date/Time	Y	The date of the survey.
MammalSpeciesCode	Text	Y	The Species code from the lulist22_FieldEventMammals
GroupCode	Text	Y	The surveying group code
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
LoadDate	Date/Time	N	The date the data was loaded or changed

TABLE_NAME tblEventParticipants

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The date the data was loaded or changed
SurveyDate	Date/Time	Y	The date of the survey
ParticipantPersonnelID	Text	Y	The personnelID of the participant. From luList2_Personnel
GroupCode	Text	Y	The surveying Group.
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SiteID	Text	Y	The Siteid

TABLE_NAME tblFieldLogEvents

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
HumansReef	Number	N	The number of people on the reef
OilTar	Text	N	The level of oil or tar. From luList16_FieldLogValues
OtherNotes	Memo	N	The trip report
LoadDate	Date/Time	N	The date the data was loaded
HumansSand	Number	N	The number of people at the beach.
HumansNotes	Text	N	Notes about the humans on the beach.
GroupCode	Text	Y	The surveying group from luList01_SurveyingGroup
Driftwood	Text	N	The level of driftwood. From luList16_FieldLogValues
DeadAnimals	Text	N	The level of dead animals. From luList16_FieldLogValues
BirdMammalNotes	Memo	N	Bird/Mammal Notes
PlotNotes	Memo	N	Event metadata
DataSource	Text	N	The source of the data. This will be the submissionID on all new data. Initial data load
TideLevelTime	Date/Time	N	The time the tide level was measured
PlantWrack	Text	N	The level of plant wrack. From luList16_FieldLogValues
Wind	Text	N	Wind speed (ND=No Data; 0=None; L=Low; M=Med.; H=High; or Actual Value)
Trash	Text	N	The level of trash. From luList16_FieldLogValues
TideLevelFeet	Number	N	The tide level in feet

SurveyStartTime	Date/Time	N	The time of day the survey started.
SurveyEndTime	Date/Time	N	The time the survey ended.
SurveyDate	Date/Time	Y	The date of the survey.
Surge	Text	N	A description of the surge. From luList16_FieldLogValues
SiteID	Text	Y	The ID of the site surveyed.
ShellDebris	Text	N	The level shell debris. From luList16_FieldLogValues
RecentRain	Text	N	Level of recent rain. From luList16_FieldLogValues
WaterTemperature	Text	N	Description of water tempature or actual value. Actual value in Degrees °C
SedimentLevel	Text	N	luList16_FieldLogValues
PhysicalConditionNotes	Memo	N	Notes on physical conditions
Rain	Text	N	Rain at the site during surveying
Recorder	Text	Y	The personnelID of the recorder
RockMovement	Text	N	The level of rock movement. From luList16_FieldLogValues
SampleSeason	Number	Y	The Survey Season
SamplingSeasonCode	Text	Y	A code for the survey season. The first are the season and the last two numbers are the year. Example FA01 = Fall 2001
Scour	Text	N	The level of scour. From lu

TABLE_NAME tblOptionalPhotoSpecies

Field Name	Type	Required	Description
GroupCode	Text	Y	The code of the group needing the additional (optional) species
SpeciesLong	Text	Y	The full name of the species.
Seqnum	Number	Y	This controls the order of display on the frmPhotoPlotDataEntry for optional species
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Species	Text	Y	This is the species loaded into the label for each results on frmPhotoPlotDataEntry for optional

TABLE_NAME tblOptionalTransectSpecie

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
GroupCode	Text	Y	The code of the group needing the additional (optional) species
Seqnum	Number	Y	This controls the order of display on the frmPhotoPlotDataEntry for optional species
Species	Text	Y	This is the species loaded into the label for each results on frmPhotoPlotDataEntry for optional
SpeciesLong	Text	Y	The full species name.

TABLE_NAME tblParameters

Field Name	Type	Required	Description
Value	Text	N	The parameter value.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Code	Text	N	The parameter code
Description	Text	N	Description

TABLE_NAME tblPhotoPlotInfo

Field Name	Type	Required	Description
EffectiveEndDate	Date/Time	N	The last date this plot configuration was effective.
TargetSpecies	Yes/No	Y	The target species the plot was set up to measure.
SiteID	Text	Y	The siteID of site where the measurement was taken.
QuadNumber	Text	Y	The replicate quadrat number.
PhotoPlotAreaUnits	Text	N	The unit of measurement for the Plot area. Default is "CM" centimeters. From luList7_Units
TargetSpecies	Text	Y	The target species the plot was set up to measure.
PhotoPlotArea	Number	N	The area of the Plot.
GroupCode	Text	Y	A code for the group responsible for the measurement. The code must come from
DateEstablished	Date/Time	N	The date this configuration or the plot was established.
DataSource	Text	Y	The source of the data.
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
LoadDate	Date/Time	Y	The date the data was loaded or changed.

TABLE_NAME tblPersonnelRoles

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PersonnelID	Text	Y	A unique identifier for each person. From luList2_Personnel
RoleID	Number	Y	The role ID from luList8_Roles

TABLE_NAME tblPhotoPlots

Field Name	Type	Required	Description
SampleSeason	Number	Y	Consecutive sampling number.
whoscored	Text	N	The person who scored the pictures.
TargetSpecies	Text	N	Target species that plot has been set up to monitor
TargetSpecies	Yes/No	N	Target species that plot has been set up to monitor
SurveyDate	Date/Time	N	The date the survey was taken.
Species	Text	N	Species being counted.
SiteID	Text	Y	Name of the site sampled .
ScoringMethod	Text	N	Field or Lab
SamplingSeasonCode	Text	Y	Sampling season, SP=Spring F=Fall plus the last 2 digits of the year
Qualifier	Text	N	Flag for count
QuadNumber	Text	Y	Replicate quadrat number, starting from 1 for each target species. Size: 50 cm x 75 cm
PctCover	Number	N	Percent of cover.
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
LoadDate	Date/Time	N	The date the data was loaded
GroupCode	Text	Y	Group doing the count
DataSource	Text	N	The data submission ID that supplied this data. Initial data is coded "IDL" Initial Data Load
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SampleSeason	Number	Y	Consecutive sampling number.

TABLE_NAME tblPhotoSpecies

Field Name	Type	Required	Description
Species	Text	Y	The Six Letter Code from the Species System
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
SpeciesLong	Text	Y	The full name from the Species System
Seqnum	Number	Y	This field controls the display order on the Photo Plot Data Entry

TABLE_NAME tblReconnaissance

Field Name	Type	Required	Description
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
Condition	Text	Y	Description of the condition. From luList18_FieldConditions
GroupCode	Text	Y	The surveying group from luList 01 SurveyingGroups
SurveyingGroups			
Notes	Text	N	Additional Remarks
Recruitment	Text	Y	The level of recruitment from luList 20_RecruitmentCodes
SiteID	Text	Y	The site id from tblSites
SpeciesName	Text	Y	The species name from the species system
SurveyDate	Date/Time	Y	The date the survey was taken expressed as dd/mmm/yyyy
Abundance	Text	Y	Description of the abundance found.

TABLE_NAME tblRecruteSpecies

Field Name	Type	Required	Description
Species	Text	Y	Species name.
MidZone	Yes/No	Y	Is this found in the mid zone.
TargetSpecies	Yes/No	Y	Is this a target species
HighZone	Yes/No	Y	Is this found in the high zone.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
DisplaySequence	Number	N	Used to control display sequence
TargetSpecies	Text	Y	Is this a target species

LowZone	Yes/No	Y	Is this found in the low zone.

TABLE_NAME tblSites

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The date the data was loaded or changed
SiteName	Text	Y	The name of the site location. Example Crystal Cove
SiteLongitude	Number	N	The longitude of the site in decimal degrees to 5 decimal places (NAD 83) expressed as an negative number
SiteLatitude	Number	N	The latitude of the site in decimal degrees to 5 decimal places (NAD 83)
PIID	Text	N	The personnel ID of the Principal Investigator who originally established the site. Must be in the luList2_Personnel and have a role of Principal Investigator.
IslandCode	Text	Y	A code for Island or Mainland. From luList9_Islands
FundingAgency	Text	Y	The agency funding the establishment of surveys at the site
Datum	Text	N	The datum used to establish the site.
DateEstablished	Date/Time	N	The date the site was established.
DataSource	Text	Y	The source of the data. This will be the submissionID on all new data. Initial data load
CountyCode	Text	Y	The county in which the site is located. From luList14_Counties
Comments	Text	N	Comments
EstablishingGroupCode	Text	Y	The code of the surveying group responsible for the establishment of site. Must be in luList1_SurveyingGroups
SiteID	Text	Y	The Unique ID assigned to each Site

TABLE_NAME tblSpeciesCountSize

Field Name	Type	Required	Description
Timed SearchEnd Time	Date/Time	N	The time the timed search ended.
SiteID	Text	Y	The site ID
TimedSearchStartTime	Date/Time	N	The time the timed search started.
SizeUnit	Text	N	The unit of measure for the size
SizeQualifier	Text	N	A description of the size from luList5_Qualifiers
SpeciesCount	Number	Y	The species count
SpeciesSize	Number	N	The size of the species found
SurveyDate	Date/Time	Y	The date the survey was taken.
TargetSpecies	Text	Y	From the luList6_Species
SamplingSeasonCode	Text	Y	An alpha code for the sample season
TargetSpecies	Yes/No	Y	From the luList6_Species
CountSizeTime	Date/Time	N	The time the survey was taken. Not used on all surveys.
SampleSeason	Number	Y	The Surveying Season
Species	Text	Y	The species encountered
Comments	Text	N	Comments
DataSource	Text	N	The source of the data
GroupCode	Text	Y	The surveying group
LoadDate	Date/Time	N	The data the data was loaded
MethodCode	Text	Y	The method used.
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
PlotID	Text	Y	The plot number
SampleSeason	Number	Y	The Surveying Season
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

TABLE_NAME tblSurveyDataCollectors

Field Name	Type	Required	Description
LoadDate	Date/Time	N	The data the data was loaded.
SiteID	Text	Y	The siteid of the site surveyed.
TargetSpecies	Text	Y	The target species.
TargetSpecies	Yes/No	Y	The target species.
SurveySeasonCode	Text	Y	The season code for this season. From luList03_MarineCommonSeason
SurveyDate	Date/Time	Y	The date the survey was taken.
SampleSeason	Number	Y	The MCS Season number.
SampleSeason	Number	Y	The MCS Season number.
PersonnelID	Text	Y	The personnel ID of the person doing the data collection.
GroupCode	Text	Y	The Surveying Group
DataSource	Text	N	The source of the data.
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
RoleID	Number	Y	The role ID for the type of activity the data collector preformed

TABLE_NAME tblTransectInfo

Field Name	Type	Required	Description
GroupCode	Text	Y	A code for the group responsible for the measurement.
TargetSpecies	Text	N	The target species the transects was set up for.
TargetSpecies	Yes/No	N	The target species the transects was set up for.
SiteID	Text	Y	The siteID of site where the measurement was taken.
TransectNumber	Text	Y	The replicate transect number.
LoadDate	Date/Time	Y	The date the data was loaded
DateEstablished	Date/Time	N	The date this transect configuration was established.
DataSource	Text	Y	The source of the data. This will be the submissionID on all new data. Initial data load
Comments	Text	N	Additional remarks
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
MethodCode	Text	N	The method used for the transect.
EffectiveEndDate	Date/Time	N	The last date this configuration was effective

TABLE_NAME tblTransects

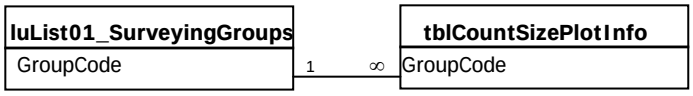
Field Name	Type	Required	Description
SampleSeason	Number	N	Consecutive sampling number
TransectNumber	Text	Y	Replicate transect number, starting from 1. Length: 10 m
TargetSpecies	Text	Y	The initial species the transect was created.
SurveyDate	Date/Time	N	The date the survey was taken.
Species	Text	Y	The species counted FK to the luList6_SpeciesList
SiteID	Text	Y	Name of the site sampled (see Appendix A for full site names and counties). site names and counties).
SampleSeason	Number	N	Consecutive sampling number
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.
PctEncountered	Number	N	Percent Encountered. Used to be called SpeciesCount
OriginalSpecies	Text	N	The species as originally recorded on the data sheets. Used for historical reference.
MethodCode	Text	N	The method used for the transect.
LoadDate	Date/Time	Y	The data the data was loaded
GroupCode	Text	Y	The Group Conducting the count.
DataSource	Text	Y	The submission id of the data
Comments	Text	N	Supporting Remarks.
Qualifier	Text	N	A qualifier code for the counts FK to luList5_QualifierCodes
SamplingSeasonCode	Text	Y	Survey season descriptive code.

TABLE_NAME tblTransectSpecies

Field Name	Type	Required	Description
SpeciesLong	Text	N	The full name from the Species System
Species	Text	N	The Six Letter Code from the Species System
Seqnum	Number	N	This field controls the display order on the Transect Data Entry
ActivityDate	Date/Time	N	Data transmission date, no date means data not sent.

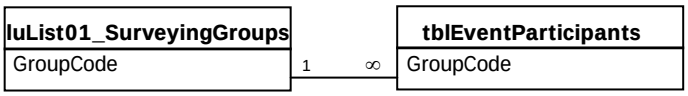
Relationships for the MARINe Database

luList01_SurveyingGroupstblCountSizePlotInfo



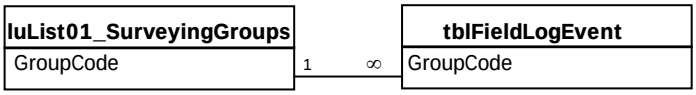
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblEventParticipants



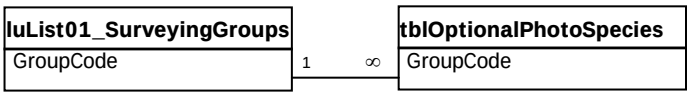
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblFieldLogEvent



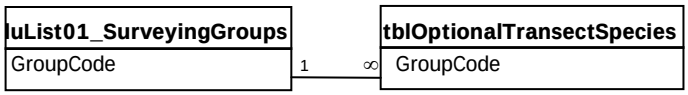
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblOptionalPhotoSpecies



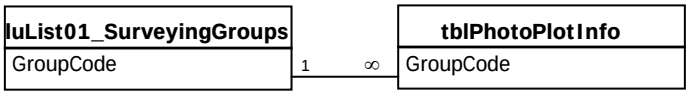
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblOptionalTransectSpecies



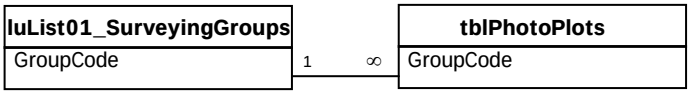
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblPhotoPlotInfo



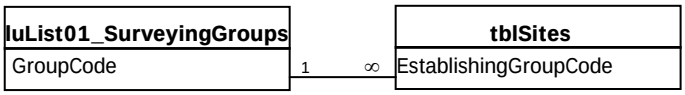
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblPhotoPlots



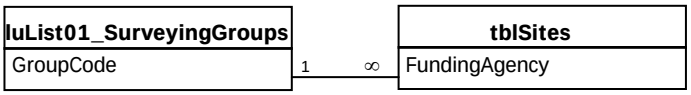
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSites



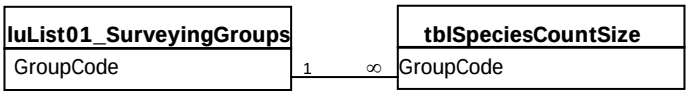
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSites



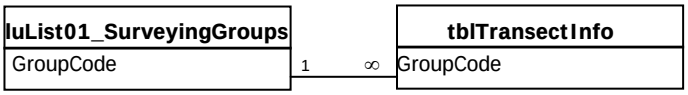
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblSpeciesCountSize



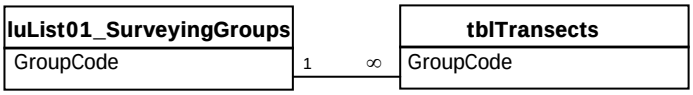
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblTransectInfo



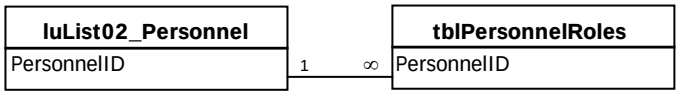
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList01_SurveyingGroupstblTransects



Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList02_PersonneltblPersonnelRoles

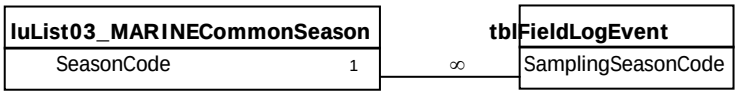


Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblFieldLogEvent

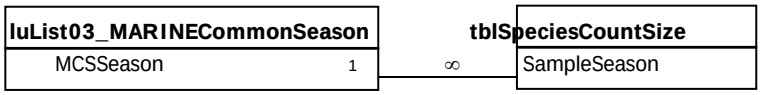
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblFieldLogEvent



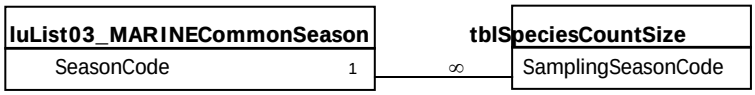
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblSpeciesCountSize



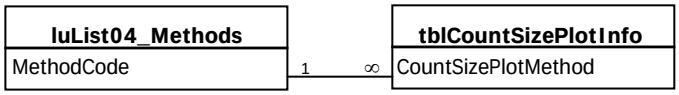
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList03_MARINECommonSeasontblSpeciesCountSize



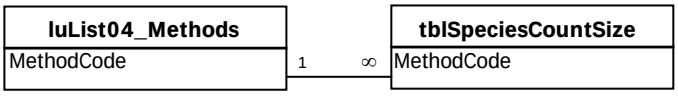
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList04_MethodstblCountSizePlotInfo



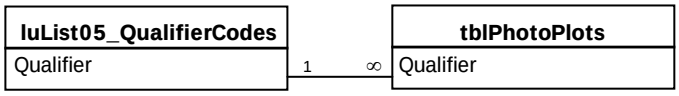
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList04_MethodstblSpeciesCountSize



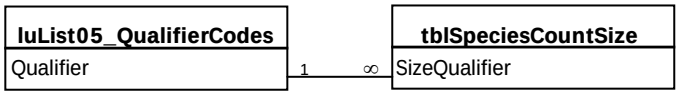
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblPhotoPlots



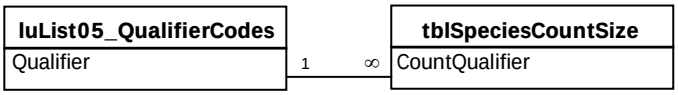
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblSpeciesCountSize



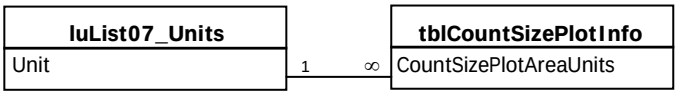
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList05_QualifierCodestblSpeciesCountSize



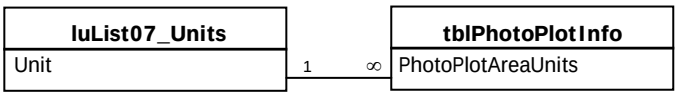
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList07_UnitstblCountSizePlotInfo



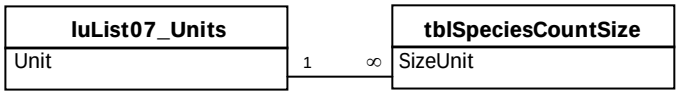
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList07_UnitstblPhotoPlotInfo



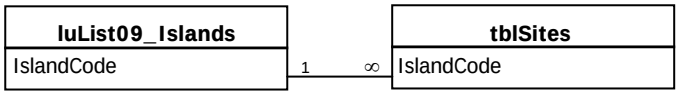
Attributes: Enforced
RelationshipType: One-To-Many

luList07_UnitstblSpeciesCountSize



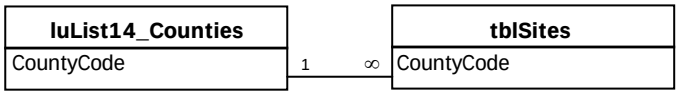
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList09_IslandstblSites



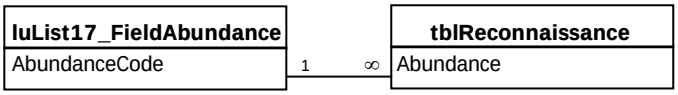
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList14_CountiestblSites



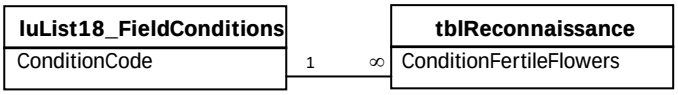
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList17_FieldAbundancetblReconnaissance



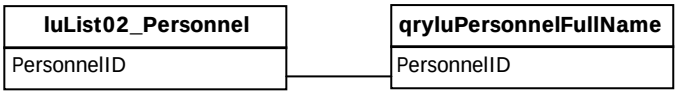
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList18_FieldConditionstblReconnaissance



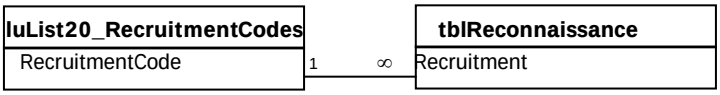
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList02_PersonnelqryluPersonnelFullName



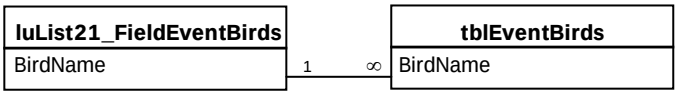
Attributes: Not Enforced
RelationshipType: One-To-Many

luList20_RecruitmentCodestblReconnaissance



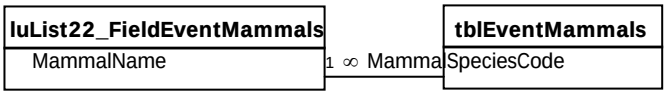
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList21_FieldEventBirdstblEventBirds



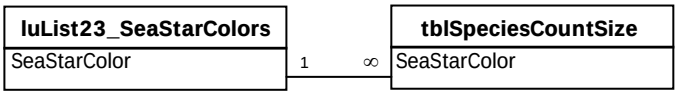
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList22_FieldEventMammalstblEventMammals



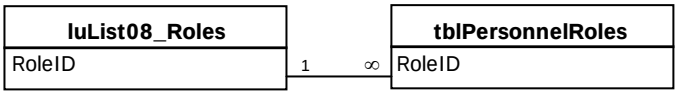
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList23_SeaStarColorstblSpeciesCountSize



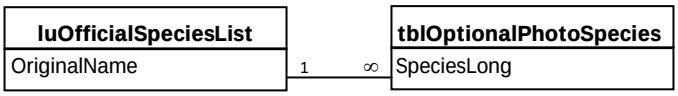
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luList08_RolestblPersonnelRoles



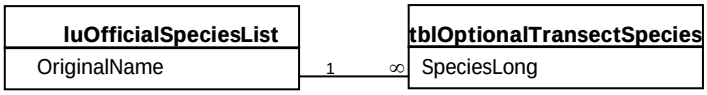
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblOptionalPhotoSpecies



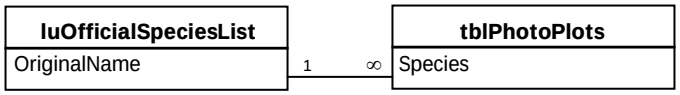
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblOptionalTransectSpecies



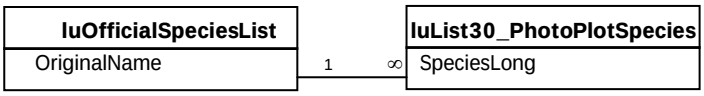
Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListtblPhotoPlots



Attributes: Enforced, Cascade Updates
RelationshipType: One-To-Many

luOfficialSpeciesListluList30_PhotoPlotSpecies



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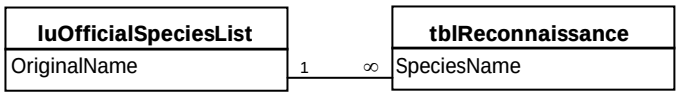

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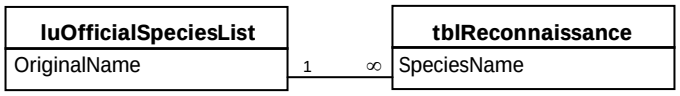

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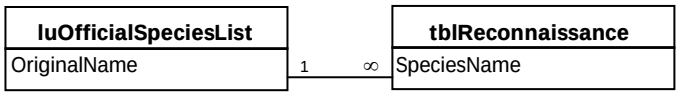

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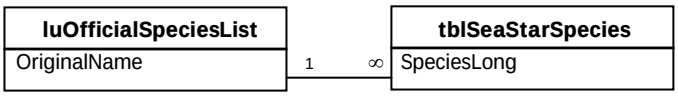

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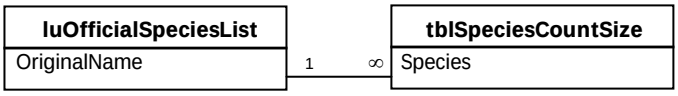

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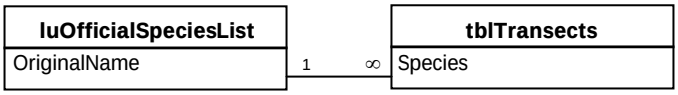

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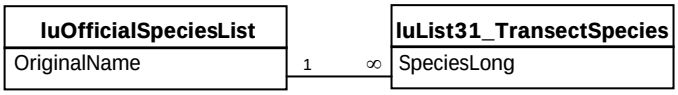

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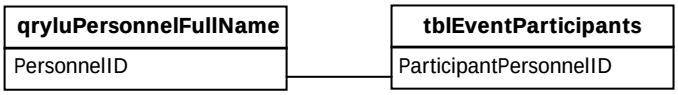

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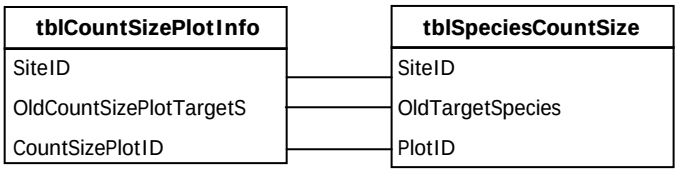

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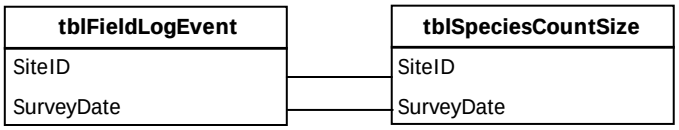

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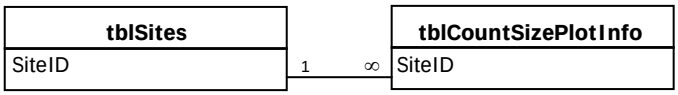

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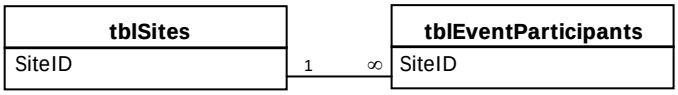

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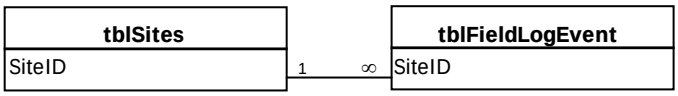

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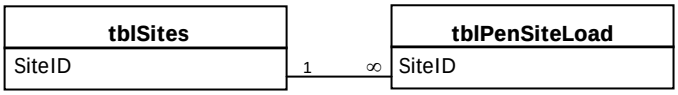

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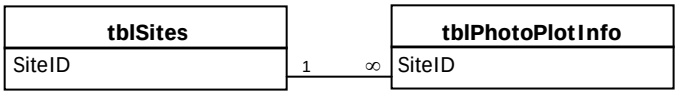

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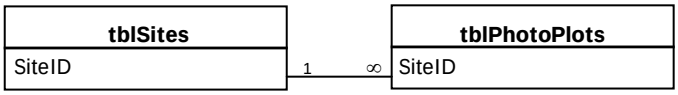

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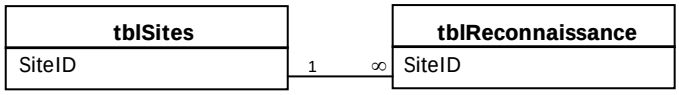

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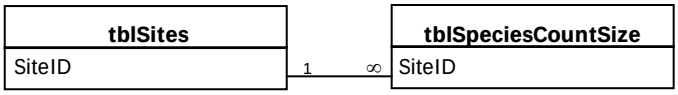

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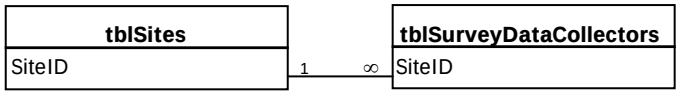

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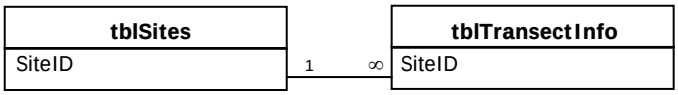

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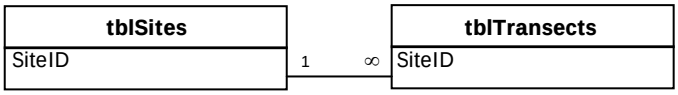

Attributes: Enforced, Cascade Updates

RelationshipType: One-To-Many

Appendix C. Explanation of Column Headings in the Motile Invertebrates Excel Workbook

Spreadsheet/column heading	Description
survey_teams	The survey_teams sheet lists each person, survey type, and target species surveyed for a given site/date. Entry into this sheet is optional, and some groups may not choose to retain this information
GroupCode	The unique code for the monitoring group conducting survey
SiteID	The unique letter code that indicates where the survey was performed
NorthSouthOrder	Used to order the sites geographically along the coast
SampleSeason	Consecutive sampling number created to allow sequencing of the seasons
SamplingSeasonCode	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year
Sample Year	sample year indicated by sampling season code - may differ from actual year (rare - i.e. FA06 surveys conducted in January, 2007).
SeasonSeq	The Season sequence within each year: SP(1), SU(2), FA(3) and WN(4)
Survey Year	The year the survey was conducted
Survey Month	The month the survey was conducted (1-12)
Survey Day	The day the survey was conducted (1-31)
SurveyTypeID	The numeric code for the type of survey being conducted
TargetSpecies	The species that this plot was created to monitor
Full Name	The full name of individual conducting the survey
RoleName	The specific role of the individual conducting the survey
motile_counts	**The motile_counts spreadsheet contains total motile counts for the entire plot**
GroupCode	The unique code for the monitoring group conducting survey
SiteID	The unique letter code that indicates where the survey was performed
NorthSouthOrder	Used to order the sites geographically along the coast
SampleSeason	Consecutive sampling number created to allow sequencing of the seasons
SamplingSeasonCode	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year
Sample Year	sample year indicated by sampling season code - may differ from actual year (rare - i.e. FA06 surveys conducted in January, 2007).
SeasonSeq	The Season sequence within each year: SP(1), SU(2), FA(3) and WN(4)
Survey Year	The year the survey was conducted
Survey Month	The month the survey was conducted (1-12)
Survey Day	The day the survey was conducted (1-31)
TargetSpecies	The species that this plot was created to monitor
PlotID	Replicate plot number, starting from 1
LEPHAR	lepidochitona hartwegii
LEPSPP	lepidochitona spp
NUTSPP	nuttallina spp
MOPSPP	mopalia spp
LEPDEN	lepidochitona dentiens
FISVOL	fissurella volcano
PACCRA	pachygrapsus crassipes
PAGSPP	pagurus spp
PAGSAM	pagurus samuelis

Spreadsheet/column heading	Description
PAGHIR	pagurus hirsutiusculus
PAGGRA	pagurus granosimanus
PAGBER	pagurus beringanus
OCECIR	ocenebra circumtexta
OCESPP	ocenebra spp
LIMPLG	limpets over 15 mm in size on any substrate/organism
NUCEMA	nucella emarginata
NUCCAN	nucella canaliculata
ACASPP	acanthinucella spp
TEGFUN	tegula funebralis
TEGAUR	tegula aureotincta
TEGBRUN	tegula brunnea
TEGEIS	tegula eiseni
TEGGAL	tegula gallina
LOTGIG	lottia gigantean
LSMROC	limpets under 5 mm in size on rock
LSMMUS	limpets under 5 mm in size on mussels
LMDROC	limpets 5-15 mm in size on rock
LMDMUS	limpets 5-15 mm in size on mussels
LITSPP	littorina spp
ALISPP	alia spp
AMPVER	amphissa versicolor
APLCAL	aplysia californica
BITESC	bittium eschrichtii
CALSPP	calliostoma spp
CERNUT	ceratostoma nuttalli
CHITON	Chitons
CONCAL	conus californicus
CRESPP	crepidula spp
EPITIN	epitonium tinctum
FLATWO	Flatworm
HALCRA	haliotis cracherodii
HEMNUD	hemigrapsus nudus
HEMPAC	pachygrapsus crassipes and hemigrapsus nudus recruits
HERMIT	hermit crabs
HOMSPP	homalopoma spp
JUVBRIT	juvenile unidentified brittlestar
KELKEL	kelletia kelletii
LEPIDO	lepidozona spp
LEPTAS	leptasterias spp
MACLIV	macron lividus
NORNOR	norrisia norrisi
NUCLAM	nucella lamellosa
NUCSPP	nucella spp
OCEPOU	ocenebra poulsoni
ONCBOR	onchidella borealis

Spreadsheet/column heading	Description
OPASPP	opalia spp.
PACSPP	pachycheles spp
PETSPP	petrolisthes spp
PISOCH	pisaster ochraceus
PUGSPP	pugettia spp
STRPUR	strongylocentrotus purpuratus
CountQualifier	additional information used to modify the count data for this plot - pertains to the whole plot, and is not species specific
MethodCode	the code for the survey method used to count the plot
Comments	Notes
limpet_litt	**The limpet_litt sheet calculates subsampled small limpets and littorines for the entire plot - totals are then copied (values only) into the motile_counts sheet**
SiteID	The unique letter code that indicates where the survey was performed
NorthSouthOrder	Used to order the sites geographically along the coast
SampleSeason	Consecutive sampling number created to allow sequencing of the seasons
SamplingSeasonCode	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year
SeasonSeq	The Season sequence within each year: SP(1), SU(2), FA(3) and WN(4)
TargetSpecies	The species that this plot was created to monitor
PlotID	Replicate plot number, starting from 1
1_LSMROC	number of limpets under 5 mm counted in 1st 20 x 20 cm subsampling quadrat
2_LSMROC	number of limpets under 5 mm counted in 2nd 20 x 20 cm subsampling quadrat
3_LSMROC	number of limpets under 5 mm counted in 3rd 20 x 20 cm subsampling quadrat
1_LSMMUS	number of limpets under 5 mm counted on mussels in 1st 20 x 20 cm subsampling quadrat
2_LSMMUS	number of limpets under 5 mm counted on mussels in 2ndt 20 x 20 cm subsampling quadrat
3_LSMMUS	number of limpets under 5 mm counted on mussels in 3rd 20 x 20 cm subsampling quadrat
1_LMDROC	number of limpets 5-15 mm counted in 1st 20 x 20 cm subsampling quadrat
2_LMDROC	number of limpets 5-15 mm counted in 2nd 20 x 20 cm subsampling quadrat
3_LMDROC	number of limpets 5-15 mm counted in 3rd 20 x 20 cm subsampling quadrat
1_LMDMUS	number of limpets 5-15 mm counted on mussels in 1st 20 x 20 cm subsampling quadrat
2_LMDMUS	number of limpets 5-15 mm counted on mussels in 2nd 20 x 20 cm subsampling quadrat
3_LMDMUS	number of limpets 5-15 mm counted on mussels in 3rd 20 x 20 cm subsampling quadrat
1_LITSPP	number of littorines counted in 1st 10 x 10 cm subsampling area (or other appropriate area)
2_LITSPP	number of littorines counted in 2nd 10 x 10 cm subsampling area (or other appropriate area)
3_LITSPP	number of littorines counted in 3rd 10 x 10cm subsampling area (or other appropriate area)
tot_LSMROC	formula used to calculate total number of limpets under 5 mm (not on mussels) in entire 50 cm x 75 cm quadrat
tot_LSMMUS	formula used to calculate total number of limpets under 5 mm on mussels in entire 50 cm x 75 cm quadrat
tot_LMDROC	formula used to calculate total number of limpets 5-15 mm (not on mussels) in entire 50 cm x 75 cm quadrat

Spreadsheet/column heading	Description
tot_LMDMUS	formula used to calculate total number of limpets 5-15 mm on mussels in entire 50 cm x 75 cm quadrat
tot_LITSPP	formula used to calculate total number of littorines in entire 50 cm x 75 cm quadrat
motile_sizes	**The motile_sizes sheet is where sizes for all species being measured according to the motile quadrat protocols is recorded.**
GroupCode	The unique code for the monitoring group conducting survey
SiteID	The unique letter code that indicates where the survey was performed
NorthSouthOrder	Used to order the sites geographically along the coast
SampleSeason	Consecutive sampling number created to allow sequencing of the seasons
SamplingSeasonCode	A four-character code to identify the Sampling season. The first two characters indicate the season and the last 2 characters indicate the year
Sample Year	sample year indicated by sampling season code - may differ from actual year (rare - i.e. FA06 surveys conducted in January, 2007).
SeasonSeq	The Season sequence within each year: SP(1), SU(2), FA(3) and WN(4)
Survey Year	The year the survey was conducted
Survey Month	The month the survey was conducted (1-12)
Survey Day	The day the survey was conducted (1-31)
TargetSpecies	The species that this plot was created to monitor
PlotID	Replicate plot number, starting from 1
SixLetterCode	The species code of the specific species being measured
SpeciesSize	The size of the species being counted, to the nearest millimeter
SizeQualifier	additional information used to modify the size measurement
MethodCode	the code for the survey method used to count the plot
Comments	Notes

SOP 1. Pre-season Preparations

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) covers general information for planning and scheduling sampling trips to intertidal field sites at the San Francisco Area Network (SFAN) parks. Pre-trip planning includes transportation to sites as well as organizing sampling and personal gear. Annual sampling of the five rocky intertidal sites requires a great deal of advance planning and coordination among sampling team members.

General Overall Scheduling Considerations

Field sampling at the SFAN sites requires about 5-7 days of field work to complete regular monitoring protocols. Sampling is annual, completed each spring/summer. Planning and teams for each park may be independent.

Consideration of factors, including time of and the number of days in a low tide series, weather conditions, vehicle availability and travel distance, number of monitoring sites, number of plots, and anticipated need for and availability of sampling assistance, will likely influence the order and dates of visitation during a sample season. As expected, specific knowledge of sites and familiarity with sampling nuances is helpful for this type of field work planning.

Sampling requires a reasonably good tide series (3-4 days) of negative tides (-0.0 mean lower low water or lower) for access and time for the completion of all protocols. Generally, one site per day can be sampled, owing to the distance between sites and to time and transportation constraints. With advance preparation and adequately experienced personnel, each monitoring site can be completely sampled in one visit. Although some sites might be workable with a +0.5 ft tide, generally these higher tide levels will not afford enough time to complete all sampling, especially when swell is present.

To predict the tide series, use software programs (e.g., Nautical Software, tides and currents for windows) or web-based applications (e.g., NOAA's Tides and Currents: http://tidesandcurrents.noaa.gov/tides06/). Features vary by application but will allow you to view predicted tidal levels for the nearest station (San Francisco or Point Reyes Headland) by month or by selected criteria (e.g., all low tides less than -0.1 and during certain hours) and will assist with your planning for near-future sampling trips. Sampling is limited to daylight tides for safety and common-sense reasons.

General Schedule Considerations

It will be the duty of the Lead Project Field Biologist (LPFB) to make logistical arrangements prior to each sampling trip. The vagaries of biological field work will be in play. Consequently unforeseen circumstances can not be addressed by this protocol. A sampling trip will be subject to cancellation or modification if severe weather or other unanticipated circumstances arise.

Organizing Field Work Supplies and Equipment: A Checklist

All necessary equipment and supplies must be organized in advance of sampling site visits. Supplies used for SFAN sampling trips are maintained and stored at the Pacific Coast Science and Learning Center at PORE and Resource Management at Fort Cronkite for GOGA. Organizing equipment will be the responsibility of the LPFB.

In general, remote monitoring poses additional planning effort. It is prudent to bring extra gear, such as a back-up camera, extra sampling grids, and batteries, because the unexpected happens and resources are very limited in the area. While it may be possible to purchase some things at the local hardware store in Point Reyes Station or San Francisco (e.g., batteries), for the most part sampling crews need to be "self-contained."

Field team members should be reminded to bring sufficient food and water. Changeable weather necessitates dressing in layers. Intertidal sampling footwear (boots or waders) will be provided by the LPFB.

Safety considerations should be discussed by all field staff prior to heading to sampling sites Everyone needs to know where safety equipment including first aid kits, park radios or cell phones are located. Extreme caution should always be exercised, particularly at sites with high swell or in rough sea-state conditions. Expect changing weather and sea state conditions. The weather forecast should be checked by the LPFB prior to departure of the field team. For details, see SOP 17.

Compile Checklist

1. An equipment list should be compiled, with equipment organized and made ready for the field several days in advance of the sampling event. Table SOP 1.1 is a SAMPLE checklist for field equipment necessary for adequate sampling of rocky intertidal monitoring sites.

2. Remember to make **scheduled maintenance and periodic operational checks** to equipment between periods of use or disuse.

3. Reserve an adequate number of vehicles on proposed sampling dates and backup dates. Two sport utility vehicles or pickup trucks are generally necessary to transport field teams and sampling equipment. Vehicles will be obtained from the Resource Management motor pools at PORE and GOGA.

4. Before departing for the site, make sure **all field gear is in good working order** far enough in advance to repair or replace damaged or missing items. Inventory and purchase any consumable supplies needed, such as batteries, flash memory cards, etc. Recharge batteries for cameras, strobes, drills, radios, and other electrical items. Print enough datasheets to cover all the monitoring sites, plus some additional sheets. Datasheets printed on "rite in the rain" or another type of waterproof paper are recommended. Pen does not work when wet, so pencils are required. It is critical that you have all necessary site maps, site descriptions, GPS, and other equipment for all sites prior to departure. Prudent planners read previous trip notes to decide if special equipment or sampling will be required.

5. In addition to field equipment, each member of the monitoring group will need to bring his/her personal gear. A personal gear list is provided in Table SOP 1.2.

End-of-Season Procedures

The LPFB at each park will be responsible for inventorying, cleaning, repairing and storing field equipment at the end of the field season. Equipment exposed to sea water such as quadrats and meter tapes must be washed in fresh water. Cameras should be cleaned with compressed air and a brush to remove sand and grit. PORE and GOGA maintain separate sets of field equipment. Facilities at the Pacific Coast Science Learning Center at PORE and Resource Management (Fort Cronkhite Building 1061) at GOGA will be used for storing gear.

Table SOP 1.1. Sample field equipment checklist for rocky intertidal sampling.

Item	Item
All	**Community Structure Sampling**
Clipboards with rubber bands	**Sea Stars**
Pencils	Meter tapes (many)
Waterproof datasheets	Rulers
Site Map	Yellow forestry crayon
Compass	Flashlights
Knee rests	
Reference books	**Barnacles**
"Community Structure Field Notebook" with site photos	Nut driver
Foul weather gear/boots	Labeled replacement plates
	Barnacle rack
	Steel brush
Installation/Repair	
Cordless Drill + 2 spare batteries	**Surfgrass**
$^{3}/_{8}$ in bits and $^{5}/_{8}$ in bit (at least 2)	Meter tapes
Hammer	
Z-spar 2 part epoxy	**Mobile Invertebrate Counts**
Water bottle	Quadrats
Notched stainless steel bolts (various sizes)	Calipers
Unnotched stainless steel bolts	
Small containers	**Overview Photos**
	Quadrats
Photographs	Digital Camera
Digital camera (5.0+ mega pixel)	
2-3 quadrats	
Dry erase marker	
Camera manual	
Strobe manual	
Screw driver	

Table SOP 1.2. Sample personal gear list.

- Daypack
- Tidepool sampling gear, including shoes that can get wet and that have good traction!
- Towel(s) (a small towel to dry your feet before changing back to boots is a good idea)
- Sturdy hiking shoes or boots
- US Coast Guard approved Personal flotation device (Alcatraz Island)
- Rubber boots and or hip waders used during sampling
- Warm, layerable clothes (including gloves)
- Warm hat
- Sun hat or ball cap
- Flashlight
- Sunglasses
- Water bottle/canteen and snacks
- Sunscreen
- Foul weather gear (check the forecast!)
- Any personal prescribed medications

SOP 2. Training Field Workers

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes expectations for and the training of field workers and volunteers participating in the Rocky Intertidal Monitoring Program at SFAN.

Expectations for Field Researchers and Workers

Training of the field sampling team is the responsibility of the Lead Project Field Biologist (LPFB). Rocky intertidal monitoring at SFAN requires a crew of at least four experienced researchers. Assistance from at least two others who may be less experienced or volunteer workers will be helpful. Experienced researchers have undergone extensive field training, have taxonomic expertise in identifying rocky intertidal organisms, and have participated in numerous field sampling trips. They are the primary data collectors for meeting the program's objectives.

To ensure reliable collection of field data, site-specific training is necessary and expected of workers, particularly those classified as "less experienced." Less experienced workers include volunteers and field assistants with little prior background in sampling methods or field identification of organisms and recent hires who have not participated in prior SFAN monitoring programs. Less experienced individuals will be required to participate in several sampling trips and to learn SFAN protocols prior to collecting data themselves. This protocol uses the terms "sampler" and "worker" interchangeably to refer to any member of the field sampling team.

Although new or less experienced workers may not collect data themselves, many important supporting tasks can be assigned. New or inexperienced workers can be taught (with minimal instruction) on how to record data for an experienced researcher, while gaining experience in field sampling methods. The LPFB may increase the responsibilities of new workers when he or she deems them competent and proficient and an appropriate training period has passed. The training period is not set and can vary considerably depending upon the individual. Once a new worker has demonstrated his or her ability to perform sampling with a high degree of accuracy and precision, then he or she can begin independently collecting data. However, this worker's initial sampling efforts should be double-checked by experienced researchers and periodic rechecking of data collection is appropriate for all sampling team members.

Effective field monitoring requires pre-planning and good communication among all participants. Because all sampling (SOPs 4–10) is somewhat restricted by the tidal cycle and some tasks are further restricted to specific low tidal heights, the order with which the tasks are completed will require flexibility and communication among workers. It may be required that one task be set aside to complete another.

A "Field Plan" which outlines who is going to complete which monitoring task and in what order will be discussed prior to each sampling effort. Sampling duties can be divided among the field team members into the following tasks:

1. Site/Gear set-up (2-3 experienced researchers familiar with site).
2. Overview photos (1 experienced photographer).
3. Seastar plots (1-2 experienced researcher(s) with 1 data recorder).
4. Mobile invertebrates (2-4 experienced researchers with 1 data recorder each).
5. Surfgrass transects (1 experienced researchers with 1 data recorder).

6. Photographing plots (1 experienced researcher).
7. Plot sketches (1 experienced researcher).
8. Plot repairs (1 worker familiar with this task and comfortable using the hammer drill).
9. Field log (completed at the end of the day with participation of all workers).

Training New Workers

Most training occurs in the field. However, familiarization with protocols, datasheets, and species identification using guidebooks and web-based information (Appendix SOP 2A) can and should occur prior to field trips. Inexperienced or volunteer workers should be additionally instructed as to any necessary supplemental procedures in order to increase overall sampling effectiveness and efficiency.

Pre-field training instruction will:

1. Provide an overview of sampling procedures.
2. Provide copies of datasheets and instructions on how to complete the datasheets.
3. Identify target, core, or optional species with resources to find pictures and species descriptions (Appendix SOP 2A,).
4. Outline necessary gear and protocols for safety and minimizing hazards.
5. Familiarize participants with sites and maps and locating photoplots and reference bolts.
6. Review safety considerations and job hazard analysis (SOP 17).

Additional training including specialized taxonomic training or mock data collection exercises are encouraged.

Ongoing Training

The intertidal monitoring protocols are subject to modification. Additionally, species ranges may change, creating the necessity to alter existing species lists. Therefore, all groups involved with intertidal monitoring should maintain contact and regularly meet to discuss changes and taxonomic questions. There are currently annual taxonomic meetings of members of the MARINe monitoring group. See http://www.marine.gov/ for current meeting schedules and other updates. At least two people involved in the intertidal monitoring for SFAN should plan to attend this annual meeting.

Appendix SOP 2A. Field Guides and Resources for Identifying Intertidal Algae and Invertebrate Species

Abbott, I. A., and G. J. Hollenberg. 1976. Marine algae of California. Stanford University Press Stanford, California.

Guiry, M. D., and G. M. Guiry. 2010. AlgaeBase. National University of Ireland, Galway. Online. (http://www.algaebase.org). Accessed 24 February 2010.

Kozloff, E. N. 1993. Seashore life of the Northern Pacific Coast. University of Washington Press, Seattle.

Kozloff, E. N. 1996. Marine invertebrate of the Pacific Northwest. University of Washington Press, Seattle.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. 1980. Intertidal invertebrates of California.Stanford University Press, Stanford.

Murray, S., and E. Yee. 2004. Intertidal species. World-wide electronic publication. California State University, Fullerton. Online. (http://www.marine.gov or http://cbsurveys.ucsc.edu/findings/specieslists.html). Accessed 11 March 2010.

Ricketts, E. G., J. Calvin, J. Hedgepeth, and D. W. Phillips. 1985. Between Pacific tides, 5th edition. Revised by J. Hedgepeth. Stanford University Press, Palo Alto, California.

SOP 3. Establishing and Maintaining Plots

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) provides information regarding establishing new intertidal monitoring plots or transects and maintaining plots. The Rocky Intertidal Monitoring Program at SFAN parks is designed using a fixed-plot approach, meaning that repeated measurements are taken from the same locations through time. Fixed plots are permanent areas of rocky intertidal habitat defined by epoxy or bolt markers. Fixed plots may be variable in size and shape, including rectangular, irregular, or one-dimensional transect lines. Specific plot types are discussed in separate SOPs for individual sampling methods.

General Survey Considerations for Establishing New Photoplots

Permanent plots or transects are generally established during initial site set-up but may be added to expand the surveys at an existing site. Each plot chosen for monitoring should have a high percentage (70% or more) of the target species and needs to be relatively flat, though not necessarily horizontal. Photos will be best if the entire plot falls into a narrow field of focus with no heavy shadows from rock cracks or boulders. Reflections on pools may obscure what is below. The frame should be able to rest on the plot. Five plots that are representative of each zone are established. A stratified random approach can be used by identifying all the possible plot candidates within a target zone, numbering them, and randomly selecting the five to be established. Using numerous quadrat frames (50 x 75 cm) laid out as guides helps to locate overall layout.

Procedure for Establishing New Plots

1. Locate plot position following general considerations above.
2. An area of about 5-cm x 5-cm is cleared to bare rock below each quadrat corner using scrapers and wire brushes as needed.
3. A hammer drill is used to drill $^{5}/_{8}$-inch holes, approximately two inches deep, in the rock substrate below the three corners of the quadrat.
4. Plots are marked with stainless steel bolts in three corners: the upper left, upper right, and lower left corners. For plots that may be overgrown by mussels, it is recommended that longer stainless steel (SS) hex bolts (3/8” in diameter and 4–6” long) be used in at least two corners to mark the plot. The upper left bolt is marked with one to five notches in the head to identify the plot number for each zone (1 = plot 1, 5 = plot 5). A dollop of marine epoxy (combined to activate in field using a little seawater) is pressed into the drilled rock at each corner to secure the bolt. Clean rock is important for good adhesion of the epoxy.
5. The upper left corner of the plot is numbered. The standard convention for choosing the upper left has been when viewing the plot with one’s back to the ocean. Some plots cannot be photographed from that orientation, however, and then the upper left corner should be chosen according to how the photo will be taken. Refer to SOP 5 for more details about taking plot photographs.
6. For new plots, pre-establish what the plot numbers will be. Remember unique numbers from all other plots at the location must be used. Number changes need to be avoided for data consistency.

7. Careful mapping is necessary to be able to distinguish plots *between* adjacent zones, as each zone has bolts marked 1 through 5. See number 4 below for more detail.

Procedure for Maintaining Plots

1. Finding corners overgrown by organisms is occasionally a problem, especially in the mussel zone. Clean the corners with a scraper or wire brush on each visit to clear the growth (so that corners can be located more readily next visit).
2. If necessary where bolts are overgrown by mussels, install longer SS hex bolts (3/8 inch in diameter and 4-6 inches long) in at least two corners to mark the plot.
3. Metal detectors can be used to find hidden bolts (i.e., when covered by more than 6 cm of growth, like mussels).
4. Map and photograph new plots and place documents in the program data binder. Detailed descriptions, maps, and area photographs (with quadrat frames left in place as visual reference) are important. Differential GPS units are used to create relatively accurate and precise maps of individual plot locations and site features. However, even with the best precision, finding individual plots with a GPS is not yet practical. Therefore, descriptive mapping of topographic features such as pools, ridges, and cracks in the rock are still more valuable in finding the individual plots. Interplot measurements (distances and compass bearings) between plots are important in relocating lost plots (Appendix SOP 3A). Overview photos of the site, from different angles and with the individual plots identified, can also be very useful.

Appendix SOP 3A. Interplot Measurement Datasheet

Interplot Measurements

site:_____ date:_____

From	To	Distance	Bearing	From	To	Distance	Bearing

SOP 4. Completing Field Logs and Assessing Site-wide Species Conditions

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

The Rocky Intertidal Monitoring Program at the San Francisco Area Network (SFAN) parks is designed to identify and follow trends in population dynamics of selected indicator organisms within the rocky intertidal zone. The program is conducted annually, with visits during spring/summer to two fixed monitoring sites at GOGA and two sites at PORE as well as a winter visit to Alcatraz. Field logs are required at each site even if visited off-season (e.g., plot maintenance or research-oriented visits). Field logs are the basic means of recording what becomes the metadata for each site visit (i.e., who, what, where, when). They are also the means for recording any observations about an area, species, or event and will become the basis for future trip reports. This SOP details the mechanics of completing accurate field logs and assessing site-wide conditions for all monitoring efforts. An explanation of field form and data codes is presented in Appendix SOP 4A. The Field Log and Site-wide Species Condition Datasheet is provided in Appendix SOP 4B.

General Considerations

General site notes are an integral part of monitoring work; researchers working at sites from San Diego to the Oregon/Washington border have an identical list of core species for which relative abundance (including absence) and condition (e.g., reproductive, bleached) is recorded. This standard species list allows monitoring groups to consistently make general observations about species that are not targeted in specific plots. Field observations are important in light of recent evidence suggesting that species ranges may be shifting due to climate change (Barry et al. 1995.) and also that introductions of non-native species into the marine environment are rapidly increasing (Carlton and Geller 1993).

During each site visit, it is important to complete a field log (i.e., who, what, where, when) as well as to observe and record general physical and biological conditions at the site. The Lead Project Field Biologist is responsible for filling out the field log, but input from all members of the field crew is important. Physical and weather-related conditions are collected initially upon reaching the site, as are counts of birds, marine mammals, and humans. Other impressions and observations are collected throughout the monitoring event by all field crew members. The field log will provide a narrative of the sampling effort and may aid in the interpretation of data from fixed plots, area photos, and transects.

Additional site-wide categorization of target and other core species abundance, appearance, and recruitment is collected whenever time permits. Site-wide data (back page of the Field Log datasheet) are collected to provide categorical estimates of site-specific abundance, condition, and recruitment level of certain target/core/optional species and are usually scored upon completing other monitoring protocols.

The goal of a well written field log is to provide an accurate and succinct record of general observations at the monitoring site, weather conditions, participants, changes to or deviations from the protocols, and unique or unusual occurrences. Equipment required includes: MARINe Field Log datasheet (includes “Rocky Intertidal Monitoring Site-wide Species Conditions” on the reverse side), clipboard, and submersible thermometer.

A field notebook should also be maintained that includes site maps, interplot measurements, GPS measurements, tidal heights, text descriptions, and multiple photographs for each plot. The field notebook for each site will be consulted prior to sampling and will be brought on sampling trips. This guide should help workers with site and plot orientation and should be consulted often to avoid changes in plot orientation through time. It should be kept up to date with changes and additions. It will be the responsibility of the Lead Project Field Biologist to maintain the field notebook.

Procedures

Procedure for Completing Field Log

1. Use the front page of the Field Log datasheet to record daily notes, observations, and site conditions. Field Log / Site-wide Species Conditions datasheet should be printed on Xerox Never-Tear Paper for inclement weather conditions or on multipurpose 20 lb-weight Xerox paper if conditions are expected to remain dry. Field logs can be filled in with pencil. Clearly cross out errors or extraneous marks, do not erase. Be as complete as possible and write in complete sentences.
2. Site, Date, Time, Low Tide, and Participants should all be filled in upon arrival to site.
3. Weather and sea-state conditions, estimates of substratum changes, and debris and pollutant accumulations are noted (Appendix SOP 4A). Should conditions change in the course of sampling (e.g., fog descends or swell increases), document those changes (especially if it affects the quality of the monitoring sampling) in "Notes on Physical Conditions." Remember the main reason for noting weather conditions is how it relates to sampling effort and how it may affect the organisms (e.g., shorebirds) seen.
4. Birds and mammals will require a certain level of species familiarity and careful observation periodically during sampling. Generally, maximum numbers of bird and mammal species are observed when you first approach the site, so begin counts as you approach.
5. Document human activity observed while at the monitoring location (other than the monitoring party).
6. Note plot marker losses and repairs made.
7. Record other notes as needed.
8. Complete the "Survey Checklist" at the bottom of the page after completion of the day's sampling.

Procedure for Assessing Site-wide Conditions

1. Use the reverse side of the Field Log datasheet to record daily notes, observations, and site conditions. Field Log / Site-wide Species Conditions should be printed on Xerox Never-Tear Paper (or "rite in the rain" paper) for inclement weather conditions or on multipurpose 20 lb-weight Xerox paper if conditions are expected to remain dry. Clearly cross out errors or extraneous marks, do not erase. Be as complete as possible and write in complete sentences.
2. Give highest priority to scoring target species, particularly those monitored at the site. Core species should be scored when possible, or indicate "no data (ND)."
3. When scoring, consider the site-wide condition of the species within its annotated zone(s) of occurrence.
4. These assessments will go into the MARINe database, along with other notes from the Field Log, so use the standard categories provided in each column and **base decisions on the abundance or condition of that organism site-wide within the range of its habitat**.

5. Other species can be added if desired however, they will not be entered into the MARINe database unless they have been designated as an optional species. It is not practical to score for non-discrete algae and most small invertebrates where determination would be too time-consuming.

Procedure for Datasheet Management

1. At the end of the field day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.
2. File the "Field Log" datasheet with all other datasheets from the monitoring event in the appropriate data binder.
3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager at the Network office. , The hardcopy copies of the datasheets will be stored in a file cabinet.
4. The data will be entered into the MARINe database at the end of the season (SOP 13).

Literature Cited

Barry, J. P., C. H. Baxter, R. D. Sagarin and S. E. Gilman. 1995. Climate-related, long-term faunal change in a California rocky intertidal community. Science **267**:672-675.

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

Appendix SOP 4A. Explanation of Field Form and Data Codes for (MARINE Rocky Intertidal Field Log/Site-wide Conditions Datasheet)

Field Form: Front Side
"MARINE Rocky Intertidal Field Log"

Site: Designate clearly with Site Code.

Date: Clearly record in standard American date format (month/day/year).

Time: Expressed as military time (24-hr clock) (e.g., 0800 to 1630) and should reflect **time onsite (**i.e., excludes hiking/travel time).

Low tide: State negative datum (in feet) at time (hr) based on predicted tide chart.

Participants: List all participants, your name given first as recorder. Use full last names.

Weather and Sea Conditions, Substratum Changes, Debris and Pollutants, and Notes on Physical Conditions: There are six generalized categories for describing physical and weather-related observations:

ND = No Data
0 = None
L = Low
M = Medium
H = High
[Value] = Actual value (e.g., 13 ^{o}C) as measured water temperature

Spaces are provided to record values or categorical levels (**0, L, M, H**). Record accumulations of tar, plant wrack (e.g., driftwood, natural organics), or debris (e.g., plastics). Note if tar is fresh or weathered. Explanatory notes or comments can be recorded in the "Notes on Physical Conditions" section. Describe the environmental working conditions, especially if these affect the quality of the monitoring sampling.

Birds and Mammals: Record the maximum number of shorebirds and marine mammals seen at any one time during the sampling. This will often be when you arrive on site, so approach slowly while observing through binoculars and counting. Identify to species when possible. Transcribe the number directly to the datasheet in the appropriate grid box to ensure accuracy. Also note any observed seabird or marine mammal stranding or any circumstances out of the typical in "Bird/Mammal Notes."

Humans: Record the maximum number of humans observed during sampling, including behaviors as appropriate. Allocate human visitors to one of two categories: "Reef" or "Sand," differentiating whether they are sunbathers on nearby beaches or rocky intertidal/snorkeler explorers at the reef site. Kayakers and recreational boaters should be separately described.

Plot Marker Loss/Repair Notes: Note any problems with lost markers or difficult to find plots and record any repairs completed or newly installed bolts or plots/transects. Identify problems that need to be

fixed on the next visit. It is good practice to check past field logs prior to visiting a site for notes on needed repairs.

Other Notes: Useful things to note include: general appearance of algae and encrusting animals, damaged patches of reef, signs of disease, changes observed since the last visit, absence of animals or algae that might occur at the site, whether anything was done different from the standard methods, and problems encountered with equipment or locating plots.

Survey Checklist: Use the checklist to note completion of the different protocols with a check. It is helpful to indicate the number of plots completed and/or observer initials.

Field Form: Reverse Side
"Rocky Intertidal Monitoring Site-wide Species Conditions"

Reading right to left, there are five columns of importance in completing this datasheet:

Species (Column 1) **–** Genus and specific name are given and **bold** identifies the organism as a target species. All effort should be made to evaluate target species site-wide and other species as time permits. Next to the species name is a one letter code (**H, M, L**), representing approximate tidal elevation this species is likely found, it is in reference to the zero datum, or mean lower low water (MLLW) level.

H = High Intertidal
M = Middle Intertidal
L = Low Intertidal

Abundance (Column 2) **–** There are seven categorical values for abundance.

ND = no data
0 = absent
R = rare
U = uncommon
P = present
C = common
A = abundant

Condition (Column 3) **–** This is a subjective evaluation of the overall appearance of the majority of individuals within its habitat/zone.

ND = No data
OK = healthy, not damaged
<u>Unhealthy or Damaged condition</u>:
UL = low level of damage/unhealthiness
UM = medium level of damage/unhealthiness
UH = high level of damage/unhealthiness

Recruitment (Column 4) **–** This is a subjective estimate of the level of new propagules or individuals "recruited" to the population.

0 = absent
ND = no data

L = low level of recruitment
M = medium level of recruitment
H = high level of recruitment

Notes (Column 5) – Space is provided for notes as needed.

MARINE Rocky Intertidal Field Log Definitions

Codes

No Data (----): Draw a horizontal line through any blank area to indicate that this category was not evaluated or does not apply.
None (0): None were found within the defined site boundaries.
Low (L): Relatively few or low levels were found within the defined site boundaries.
Med (M): Medium numbers or moderate levels were found within the defined site boundaries.
High (H): High numbers or high levels were found within the defined site boundaries.
Weather and Sea Conditions (emphasis on those affecting quality of sampling)
Swell/Surge: L/M/H relative levels of water movement over seaward portion of site.
Wind: L = ≤10 knots M = 11-20 knots H => 20 knots
Rain: L/M/H relative amounts of precipitation at the site during the survey.
Recent Rain: Evidence or knowledge of L/M/H amounts of rain at the site within the past few days.
Water Temp: Actual seawater temperature (°C) or L = ≤14°C (57°F), M = 15-18°C, H = >18°C (64°F).
Substratum Changes
Sediment Level: L/M/H relative levels of unconsolidated sand/gravel/cobble along reef/sediment interfaces.
Scour: L/M/H relative extent of scoured reef surfaces within the defined site boundaries.
Rock Movement: L/M/H relative extent of overturned boulders or bedrock breakouts.
Debris and Pollutants
Plant Wrack: L/M/H levels of unattached algae or other drift plants within the site.
Driftwood: L/M/H levels of sticks, branches, and logs within the site.
Shells: L/M/H levels of dead shells, especially mussel shells.
Dead Animals: L/M/H levels of dead invertebrates, fish, birds, or mammals.
Trash: L/M/H levels of human debris including cans, bottles, plastics, and metal items.
Oil/Tar: L/M/H relative extent of fresh or weathered oil/tar within the site.

Birds and Mammals

Core categories are listed and must be scored. Record maximum number seen at any one time during the sampling, preferably upon arrival at site. Other more specific categories or species may be added but must define linkage to core taxa. Only score species within the defined site, either onshore or within 50 m of shore. Note relevant behaviors.

Humans
Record maximum number of people seen at any one time during the sampling. Especially check at low tide. Separate counts for people on rock and on sand. Note relevant behaviors. Note also if people are present upcoast or downcoast of the site.

Plot Marker Loss/Repair, Other Notes, and Survey Checklist

These are optional categories. Information may or may not be added to the database as text entries.

Site-wide Species Conditions (especially Abundance, Appearance, and Recruitment)

Give highest priority to scoring target species. Core species should be scored or indicate no data. Other species can be scored if desired. Consider the site-wide condition of the species within its optimum zone(s).

Abundance: Relative numbers of individuals or cover of species, in five levels: **0**=Absent, **R**=Rare, **U**=Uncommon, **P**=Present, **C**=Common, **A**=Abundant with "Present" representing the middle level. Consider only the optimum zone(s) for each species throughout the site.

Appearance: Checkmark indicates typical "healthy" non-reproductive appearance. If appearance is not typical, pair noted appearance codes with level codes (FL, FM, FH, BL, BM, BH, DL, DM, DH). Score L/M/H relative levels of reproductive appearance (F) (plants showing evidence of fertility), bleaching (B) (plants only: e.g., appearing pale or translucent or red algae appearing greenish), or damage (D)(plants and animals: e.g., abraded, torn, broken, withered, diseased, injured, or dead individuals).

Recruitment: For appropriate species when evident, score L/M/H relative levels of recruit abundances (settlers that have become obvious since the previous sampling). This category is not practical for turf or other non-discrete algae and some invertebrates where determination would be too time-consuming.

Appendix SOP 4B. MARINE Rocky Intertidal Field Log Datasheet (Front and Back)

MARINE Rocky Intertidal Field Log

(Fill in all blanks.: **----**=No Data; **0**=None: **L**=Low; **M**=Med; **H**=High; or Actual Value)

Site:_____ Date:_____ Time:_____ to _____ Low Tide:_____(ft) at _____(hr)
Participants
(Recorder1st):_____
Weather and Sea Conditions (affecting quality of sampling)(use codes listed above)
Swell/Surge:_____ Wind:_____ Rain:_____ Recent Rain:_____ Water Temp (°C):_____
Substratum Changes (sediment=sand, gravel, cobble) (magnitude at site)
Sediment Level:_____ Scour:_____ Rock Movement:_____
Debris and Pollutants (magnitude at site):
Plant Wrack:_____ Driftwood:_____ Shells:_____ Dead Animals:_____ Trash:_____ Oil/Tar:_____
Notes on Physical Conditions:_____
_____
_____

Birds and Mammals (maximum # seen at any one time during the sampling)(see bird/mammal list for other species)

Pelican	Great Egret			CA Sea Lion
Cormorant	Snowy Egret			Harbor Seal
Gull	Lg Shorebird			Elephant Seal
Tern	Sm Shorebird			Sea Otter
Oystercatcher	Other Birds			Dog
Blue Heron				

Bird/Mammal Notes:_____
_____

Humans (maximum # seen at any one time during the sampling; note behavior) Reef:_____ Sand:_____
_____

Plot Marker Loss/Repair Notes:_____
_____
_____

Other Notes:_____
_____

Survey Checklist

Photoplots:___ Plot Sketches___ Field Scoring___ **Point-Transects**:___ Photos___
Owl Limpets:___ Photos___ **Abalone**:___ Time-Search___ **Seastars**:___ Time-Search___
Mobile Inverts:___ **Birds**:___ **Mammals**:___ **Humans**:___
Site Overview: Photos___ Video___ Field Log:___ **Plot Marker Repairs**:___

Rocky Intertidal Monitoring Site-wide Species Conditions

Species	Abundance	Appearance		Recruitment	Notes
Target Species shown in bold. **Optimum Intertidal Zone** (may occur in 1, 2 or 3 zones) **H**=High **M**=Mid **L**=Low	----=No Data **0**=Absent **R**=Rare **U**=Uncommon **P**=Present **C**=Common **A**=Abundant	----=No Data √=Typical (healthy) **F**=Fertile/Flowers **B**=Bleached **D**=Damaged	**L**=Low level **M**=Med level **H**=High level	----=No Data **0**=Absent **L**=Low level **M**=Med level **H**=High level	
Cladophora columbiana ***ML***					
Ulva/Enteromorpha ***HML***					
Egregia menziezii L					
Eisenia arborea ***L***					
Endarachne/Petalonia ***HM***					
Fucus gardneri ***HM***					
Halidrys dioica/Cystoseira spp. ***L***					
Hesperophycus californicus H					
Pelvetiopsis limitata H					
Sargassum muticum ***L***					
Scytosiphon spp. ***HM***					
Silvetia compressa **M**					
Endocladia muricata **HM**					
Chondracanthus canaliculatus ***M***					
Mastocarpus papillatus ***HM***					
Mazzaella affinis ***M***					
Mazzaella spp.(= Iridaea spp.) ***ML***					
Porphyra sp. ***HM***					
Phyllospadix scouleri/torreyi L					
Anthopleura elegantissima/sola ML					
Phragmatopoma californica ***ML***					
Mytilus californianus ML					
Littorina spp ***H***					
Lottia gigantea HM					
Haliotis cracherodii **L**					
Tegula spp. ***L***					
Chthamalus spp/B. glandula HM					
Tetraclita rubescens M					
Pollicipes polymerus HM					
Ligia occidentalis ***H***					
Pisaster ochraceus L					
Strongylocentrotus purpuratus ***L***					
Tar					

SOP 5. Photographing Plots and Taking Area Photos

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) gives instructions for conducting the first portion of rocky intertidal site monitoring, taking digital photographs of the fixed plots and area (overview) photos while in the field. The second part in the monitoring, "Scoring the Photoplots," occurs subsequent to the completion of this protocol either in the field (SOP 6) or office (SOP 7). General camera use and quadrapod procedures are also discussed in this SOP.

General Survey Considerations using Digital Cameras

Digital cameras provide immediate feedback on image quality and simplify data management issues such as image organization, storage, and analysis.

Before departing for the field sites, all digital camera and sampling equipment (camera, memory cards, quadrapod, etc.) are checked for good working order and are properly packed. Ensure that all rechargeable batteries are fully charged, memory cards are operational and empty (i.e., erased), and extra consumables like spare alkaline batteries and/or back-up memory card(s) are packed (SOP 1). For quality control purposes, check the camera settings (date, time, etc.). This information gets automatically stored with the jpeg and incorrect information may cause confusion in the future.

Photoplots Photos

The monitoring objective for taking photoplot photographs is to provide a fine-scale photographic record using *fixed plots (photoplots)* as reference. These provide a visual record of the species composition and abundance for each plot, can be office scored for percent cover when field scoring is not performed, and secures a digital image record to allow for comparisons of plot change over time.

Procedure for Taking Digital Photographs of Photoplots (in Field):

1. Assemble quadrapod frame (Figure SOP 5.1).
2. Locate photoplots. It may be advantageous to first locate and mark all the plots with pin flags (i.e., survey flags) or flagging tape if personnel are unfamiliar with the site. Use area photos, site maps, and/or distance and bearing measurements as needed to find troublesome plots (SOP 3).
3. Locate plot boundaries by identifying all plot corners. It is important that when searching for plot corners that you not disturb the way in which organisms lay in the plot. Photos should show algae or invertebrates in their original position. This is especially important in the rockweed (*Pelvetiopsis limitata*) zones. Moving rockweed will not only bias cover estimates, but organisms under canopy can suffer if shade and humidity microclimes are disturbed. Loose drift algae or other debris not attached to the substrate should be carefully removed from the plot.
4. *Verify* proper plot orientation using previous knowledge and/or site maps. Quadrat orientation just a few degrees off can provide false record of fixed plots. Remember that the four corners are subject to a lot of fouling! Do not assume positioning if marker is not visible. Locate and remove fouling or use reference photos to help locate and orient plots, especially when overgrowth is heavy or if plot corners have been dislodged/lost.

5. Place the quadrapod frame with the mounted camera over the plot, lining up the frame corners with the bolt markers, keeping the notched bolt in the upper left corner.
6. The quadrapod should set the camera in a flat view over the plot, reducing risks of parallax or depth of field distortions.
7. Site Code and Date are recorded in each photo on an erasable square slate, attached to the quadrapod frame, at the start of that day's sampling.
8. The plot type is also recorded on the erasable slate. Adjust the label at the base of the photoframer to reflect each plot label and number (e.g., M-1 for mussel plot #1). This label will appear in the top left of each photo as a fixed permanent record of plot number (in case photo is misnamed).
9. Check settings and, while camera is in picture taking mode, view LCD screen. Check that all frame corners are just visible at the photo's edge.
10. Hold the quadrapod steady and press camera's shutter trigger.
11. Record sequence of photos and relevant information, such as camera settings or encountered problems, on the "Rocky Intertidal Photodata Log" datasheet (Appendix SOP 5A). This information is useful for later photo labeling and metadata procedures. Dominant species present can be recorded in the comment line for verification when scoring slides. Camera or strobe problems, misplaced or moved label slate, or anything else that might affect the photo should be noted in the Comment column.
12. Before moving on to the next plot, clean all the plot's corners (i.e., markers) of growth and note if epoxy needs to be repaired or replaced. This is noted in the Comment column of the Photodata Log datasheet.
13. Locate next plot and repeat procedures #2-12 above, until all photoplots at the site have been photographed. Double-check records to *verify* that all plots have been recorded.
14. Disassemble quadrapod and store camera (protect from heat and sun) and housing until you are ready to proceed with shooting area photos (procedure detailed below).

Note: Digital file labeling and image storage is treated in SOP 12.

Area (Overview) Photos

The monitoring objective of taking area photographs is to provide a habitat-level photographic record of the monitoring site using *photopoints* and *panoramics.* These provide a visual record of the overall site appearance and can record the relationship of fixed plots to the surrounding area, allowing for future comparisons of site change.

Photopoints consist of a few photographs from a specific vantage point. These are indicated on site maps. A standard vantage point is best for each point, though this varies with site and plot type. *Panoramics* include a panorama series of photos taken from specific reference points. Panoramas can be stitched together for broad views and even 360° views of the site.

In addition, digital records are also taken of anything "out of the ordinary," such as rock breakage or reef damage, poor organism health (bleached plants, dead barnacles, etc.), intrusion

of sand (beach level, scour, or smothering effects), noticeable recruitment events, interesting aggregations of species, unidentified taxa, presence and extent of oil/tar, evidence of pollution, or human or feral animal impacts.

Procedures for Taking Digital Overview/Area Photos:

1. Locate reference bolts and/or areas of interest for that site, which provide the necessary overview of the different habitats as described under "Photopoints" in the Site Description. Having printed copies of previously shot overview photos is helpful. Reference numbers (e.g., R1, R2) for the bolts may be written into the epoxy at the base of the bolt.
2. Using markers or bolts as reference, take necessary photos. Generally, the automatic setting on the camera will serve the purpose. Best results are obtained with a steady camera. Avoid shooting sky or sea as it will throw off the exposure and reduce the utility of the photograph.
3. Each Site Description may have a slightly varied Photopoint list, dependant upon the area's biological assemblages.
4. For panoramic photos, include sequential, overlapping habitat photos (i.e., "pans") taken (approximately 5-10 m way from reference point) while rotating the view area in a circular fashion (either clockwise or counterclockwise) from a fixed point marked with a reference bolt or epoxy. Prior to taking panoramic photos, markers should be present to identify the photoplots (e.g., flagging or PVC frames). Select the panorama mode on the camera. This mode helps line up images and maintains even lighting for all photos. Keep the camera level (try not to point camera down at a sharp angle) to avoid distortion or the "fan" effect on the horizon when stitching photos together. A steady hand or monopod may be used to keep the camera level and minimize hand movement during picture taking. Overlap approximately $^{1}/_{3}$ of the image in each frame. Using a convention of panning left to right (or clockwise) and starting viewing to the north will aid labeling and give more consistent results.
5. Panoramic photos should be inclusive of the full array of intertidal assemblage.
6. Record notes on the Photodata Log datasheet. Indicate number of pans and rotation (clockwise) accordingly. Indicate area photopoints. The notes should include camera file name and significant features seen in particular photos (e.g., person standing next to Endocladia #5).
7. In the office, various freeware software such as Hugin or commercial software such as Photoshop may be used to stitch panoramic photos together.

Note: Digital file labeling and image storage will be the same as for photoplots and is addressed in SOP 12.

Figure SOP 5.1. PVC photo framer for photographing permanent 50 x 75 cm plots. A camera and strobe (not shown here) are mounted to the top brackets to ensure accurate replicate size

Appendix SOP 5A. PhotoLog Datasheet

Overview Photo Log

Site:_____ **Photographer:_____**

Date:_____

Overview #	# of photos taken	Notes (mistakes, etc.)

SOP 6. Estimating Percent Cover in Field Using Point-Intercept Method

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes the procedures for *field scoring* photoplots using a Fixed-Point Contact (FPC) method. This method estimates percentage cover of targeted organisms by scoring (tallying) 100 point-intercepts in a fixed plot (photoplot). Plots scored using the field scoring method are referred to as "photoplots" even though scoring is not done using photographs. All photoplots are scored at PORE using the methods described in this SOP. Alternatively, plots may be scored in the lab or office using graphical software (see SOP 7) the same scoring rules shall be applied.

General Monitoring Considerations

The monitoring objective is to determine percent cover of organisms within fixed plots. These are the same fixed plots (interchangeably called photoplots or photoquadrats) that are photographed in the field (SOP 5). At PORE fixed plots are overlaid with a string-divided 50 x 75 cm quadrat and systematically field scored, identifying each organism that intercepts directly below 100 fixed points.

For precision and accuracy, scoring rules must be applied and consistently followed to achieve a meaningful estimate of percent cover (see below). Remember that consistency and positive species identifications are crucial.

Scoring plots in the field requires that individuals be familiar with all species monitored. This includes target, core, and optional species (Appendix A, SOP 2). Some genera, especially algae, will look entirely different in different environmental conditions (e.g., heat stress) and in different seasons (e.g., reproductive versus non-reproductive). An alga that has dried may appear to have a different color and/or texture than a fully hydrated one. In the field, some species are difficult to distinguish or easily confused with others; photo plates in field guides do not always help to differentiate. First-hand, local species knowledge is important! When in doubt, ask and/or collect a specimen. Taxa which cannot be identified in the field will be returned to the office in labeled plastic bags which will be kept refrigerated until identification can be determined using taxonomic literature. If identifications cannot be determined by NPS staff, local experts will be consulted. Algae will be identified by staff of the Jepson Herbarium at the University of California, Berkeley and invertebrates will be taken to the Department of Invertebrate Zoology and Geology at the California Academy of Sciences in San Francisco. Specimens which are new to science or otherwise notable will be accessioned into the collections of these two museums.

Over time, program objectives may result in alterations of some rules or the addition of some species for monitoring. Changes in scoring rules and species monitored will be documented with revised protocols (SOP 15).

Equipment

The following equipment is needed to score photoquadrats in the field: polyvinyl chloride **(**PVC) scoring quadrat (divided in grid-like fashion), tally meter/s, photoplot scoring datasheet, and kneepads or gardening foam pads.

The field scoring frame is a rectangle, made of $^{3}/_{4}$ inch PVC pipe with partially-glued L-joints (one end only), finished to an inside dimension of 50 x 75 cm. Ten strings are permanently affixed (knotted) and stretched at regular intervals between the short-side (50 cm) dimension.

This allows the frame to be disassembled for travel by rolling up the two 50 cm lengths with strings affixed and securing them to the removable longer lengths. The longer sides (75 cm) have glued L-joints and are also notched to hold a steel rod (width of notch/rod = $^{1}/_{32}$ inch) across the frame. Ten points are then created where the rod perpendicularly intersects the strings for each of the 10 notches on the frame, thus creating 100 point-intercepts (hence grid-like). These intercepts are scored sequentially at their point of intersection as the rod is moved along notched positions. Organisms lying directly beneath intercepts are identified and enumerated. Numbers are tallied by species on Photoplot Scoring datasheets (Appendix SOP 6A). Kneepads or gardening pads are useful for protection (especially on mussel beds) when kneeling for close examination of the plot.

Procedure for Field Scoring Photoplots

1. Locate fixed plot boundary (same as photoplot) and the proper orientation carefully within the target species zone using previous site knowledge or appropriate site map (SOP 3).
2. Place the 50 x 75 cm frame (field-scoring frame, divided) on the plot in its proper orientation.
3. Using a multi-bank tally counter, with appropriate species designated to each tally, count species occurring directly below the point-intercept along the gridlines.
4. Follow the "**Scoring Rules**" as outlined below, without exception!
5. Keep careful checks on scoring method, making sure that tallies are applied to appropriate taxa. Not all species encountered will be stored on the bank tally. Therefore, a systematic tally system will need to be employed. Species presence and abundance will vary from plot to plot, so some adjustments will be necessary. Additional species may need to be tallied on the datasheet, for instance. Ask more experienced workers about their methods, if necessary. Be sure to communicate effectively if using a data recorder.
6. It is best to work *methodically* (e.g., left to right, up to down) in whatever way works but in the same way for each plot.
7. Double check that the column representing the plot on the data sheet is appropriately labeled with the correct plot number and that the values entered into the column add up to 100. Erase extraneous marks and make sure the numbers are legible.
8. Move to the next plot and repeat the procedure.

Rules for Scoring

Multi-layering of species will not be accounted for here (only topmost layer is scored). **A total percent cover in each plot will always be 100% total for all combined species (including rock and tar).** Notes can and should be made about epiphyte cover in the field. Plot sketches are helpful.

All organisms are identified to the lowest taxonomic level possible. Use of a bank tally (3, or 8 counters in one) helps increase speed when counting multiple species. Having another person act as data recorder also improves efficiency. It is most helpful when the recorder is familiar with the species names and datasheet layout for ease of recording. Review the datasheet and species with him/her prior to field recording.

Organisms should be identified to the specific level when possible, though these may be "rolled up" into higher taxonomic classification for practical or comparative purposes on the datasheet (e.g., for analysis consistent with past data when level of identification was more general).

Conceptually, the points overlying the plot (in the field or the photo) should be imagined to be infinitely small (i.e., hits only one organism or substrate). Try to avoid changing perspective or errors associated with parallax.

1. **Always score the topmost (visible) layer that is attached to the substrate (i.e., not an obvious epibiont) unless the topmost layer is a "weedy" species obviously overlaying a non-weedy species.** This rule applies regardless of the target or core species involved. The rule was formulated to work consistently for scoring from photos in the lab (SOP 7). Examples of epibionts include algae (e.g., coralline or non-coralline crusts, articulated corallines), red seaweed (*Endocladia spp.*), or invertebrates (e.g., barnacles, limpets) on live mussel shells or thatched barnacle (*Tetraclita rubescens*) tests. Examples of "weedy" species include various alga genera such as sea lettuce (*Ulva spp.*) and *Enteromorpha*, *Endarachne*, *Porphyra*, and *Scytosiphon*. The topmost rule eliminates much of the uncertainty of trying to determine what lies below the upper layer and does not bias for or against target species. This method will underestimate target species cover whenever the target species is covered by another species (e.g., rockweeds (*Pelvetiopsis limitata*)) or any plant whose attachment lies outside the plot. Such situations should be noted and considered when evaluating data trends. Though desirable, scoring cover of understory target species is too complex and time-consuming to fall within the scope of this core monitoring protocol. Fortunately, layering is not a major issue for most target species, except in plots where rockweeds occur.

2. **If tar is on rock or a dead organism (e.g., barnacle), the point would be scored as tar.** When tar is coating a live organism, the underlying organism is scored. However, a separate tally count of oiled organisms is added to the datasheet for potential Natural Resource Damage Assessment use. This tally is not included in the MARINe database.

3. **Score sedentary motile invertebrates occurring under a photopoint as one of the following core categories: giant owl limpet (*Lottia gigantea*), limpet, chiton, ochre sea star *(Pisaster ochraceus*), or other invertebrate.** Since black abalone and purple urchins are rarely encountered (if at all) in photoplots, they have not been designated as core species for this protocol. If encountered, they would be scored as "other invertebrate." If an un-removed active motile invertebrate occurs under a photopoint, score what is likely underneath it if possible otherwise, score the point as "unidentified" (do not score the active motile invertebrate as "other invertebrate"). For example, the herbivorous sea hare (*Aplysia californica)*, or the predatory dog whelks (*Nucella spp.*), should be counted as an active motile invertebrate, not scored as cover (e.g., sedentary other invertebrate).

4. **Score bleached crustose corallines (appearing white) as "crustose corallines," not "rock."** Bleached crustose corallines may still be alive (and may regenerate), so assume they are live and score as such.

5. **Score obviously dead barnacle tests, dead mollusk shells, etc. as "dead species" (e.g., dead acorn barnacle), unless they are covered by something (crustose algae, sponge), in which case they should be scored as the covering organism.** The rationale behind this is that dead shells and empty tests are substrates and not organisms at this point.

6. **Epoxy corner markers and bolts should be scored as "rock."**
7. **When sand is present under a point in the photo, if you can positively identify what is under the sand, score the underlying core species or "rock;" otherwise, score as "sand."** This means that "sand" will be scored whenever sand thickness is greater than just a thin layer with patches of rock or some core species showing through.
8. **Thin (i.e., not obvious) layers of cyanobacteria (blue-green algae) get scored as "bare rock." A noticeable *thick* mat of cyanobacteria would be scored as a "non-coralline crust."** Note that some rock types have mineral deposits that appear similar to non-coralline crusts in the photos. Look carefully; these should be scored as "bare rock" and NOT as "non-coralline crusts."
9. **An unknown species will be scored in one of these two categories: "*Other Algae*" or "*Other Invertebrate.*"**

Further Guidelines

1. If acorn barnacles (*Chthamalus spp.*) occur as an epibiont on thatched barnacles (*Tetraclita*), score the point as "Tetraclita."
2. If one species of rockweed overlays another species of rockweed, simply score the top layer as is, without moving either species. If a rockweed is obviously overlaying a mussel, score the rockweed because it is the top layer, is not an epibiont, and is not a "weedy" species.
3. **If plant species are attached outside the plot but draping over target or core species in the plot, score the overlying species (if it is not a "weedy" species) without regard to place of attachment.** For example, in the rare case where feather boa kelp (*Egregia menziesii)* drapes across a mussel plot, leave it in place and score it as the top layer species (but note on the Sketch Datasheet what it is covering). Ideally, one would like to follow the target or core species, despite over-draping, but in practice it would be too complex for field workers to record and would likely lead to inconsistencies.

   Take notes in the field about the dominant species present (e.g., when mussels are under algae or what lies under a layer of "weedy species"). Also note where tar occurs, as some non-coralline crusts may be confused with tar in photos if scored later. If it is impossible to tell what lies below the "weedy species" or the weedy species is over rock, then simply record the point as the topmost layer (i.e., the weedy species).

   Do not bias towards the target or core species haphazardly, but do keep in mind that the primary goal of targeting, for example, the mussel zone plots, is to track changes in mussel (*Mytilis spp.*) cover over time and not the annual changes in sea lettuce (*Ulva*) cover. Keep the target organism in mind when scoring rules fail.

   Data are recorded on datasheet "Photoplot Scoring," regardless if scored in the field or the lab.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are filled in completely and the percent cover scores for each plot sum to 100. Add any other notes as appropriate.

2. File the “Photoplot Scoring” datasheet with all other datasheets from the monitoring event in the appropriate data binder.
3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager at the Network office. , The hardcopy copies of the datasheets will be stored in a file cabinet.
4. The data will be entered into the MARINe database at the end of the season (SOP 13).

Appendix SOP 6A. Photoplot Scoring Datasheet

MARINE Photoplot Slide Scoring Datasheet

Site:_____ Sampling Season:_____ Date Sampled:_____

Assemblage:_____ Recorder:_____ Date

Taxa	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Cladophora					
Ulva/Entero.					
Pelvetia					
Pelvetiopsis					
non coralline crust					
Endocladia					
Mastocarpus					
Porphyra					
Mytilus					
Balanus					
Chthamalus					
dead Balanus					
dead Chtham					
Pollicipes					
Tetraclita					
Semibalanus					
dead Semibal					
limpet					
rock					
tar					

SOP 7. Scoring Photoplots in Office (Using Graphical Software)

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes the procedures for "*office scoring*" photoplots using the Fixed-Point Contact (FPC) method by aid of computer software. A graphics package (such as Adobe Photoshop) is used to overlay a grid of 100 regularly spaced, fixed points onto a digital plot record. An estimate of percent cover for the selected targeted organisms is obtained by scoring (i.e., identifying) what organism underlies (intercepts) each of the 100 points. Office scoring is performed for all sites sampled in GOGA.

General Monitoring Considerations

Office scoring applies a computer-generated, 100 point grid over the digital record of the photoplot using suitable graphics software. This procedure requires extensive training and experience and for consistency is performed by a trained specialist.

The monitoring objective is to determine percent cover of organisms within fixed plots (interchangeably referred to as photoplots or photoquadrats). Plots are regularly documented (photographed) each monitoring season using a digital camera mounted on a quadrapod (SOP 5). Then plots are subject to a grid overlay to effectively estimate overall percent cover.

Scoring plots in the office (or lab) requires individuals be familiar with all species monitored. This includes target, core, and optional species (Appendix A). Organisms may appear quite different in photographs compared to in their natural setting. Some species are easily confused with others in digital and/or film images, often appearing the same even with good photographic technique (e.g., proper exposure and depth of field).

For precision and accuracy, scoring rules must be applied and consistently followed to achieve a meaningful estimate of percent cover (see below). Remember that consistency and positive species identifications are critical.

While office scoring of photoplots may pose unique challenges, it has proven to be practical for saving time in the field and for consistency of data. Field scoring requires an experienced Biological Researcher or two and time in the field may be much more of a commodity than office time. Logistical constraints, including weather conditions and availability of daylight, may all reduce time spent in the field. For example, in high surf conditions, while it may be possible to shoot photos between wave sets, it may not be safe to spend time field scoring plots. Having a very experienced researcher score all of the photoplots maintains consistency in taxonomic identification and sampling methodology.

Note that changes in scoring rules and/or species monitored will be documented with new protocols or revisions (SOP 15).

Equipment

The following equipment is needed to score photoplots in the office:

- downloaded digitized photo records of plots
- a suitable computer workstation with installed software (Photoshop Elements, Photoshop, ArcGIS), field notes and/or sketches

- a blank tally
- a Photoplot Scoring datasheet
- a pencil.

Procedure for Office-Scoring Digitized Photo Records using Photoshop

1. Open Photoshop 6 or a newer version.
2. Under "File," open "2x3 grid w/ 100 pts" (a file template made for this purpose).
3. Overlay the 100 point grid using cursor in select mode + to highlight (include the yellow outline that contains the 100 points).
4. Copy grid (Edit → Copy).
5. Open photo to be scored in Photoshop.
6. Paste grid onto photo.
7. To fit grid to the photo, go to Edit → free transform.
8. Move grid so that all points are within the plot but that the grid is at its maximum coverage. General rule of thumb is that the yellow border falls in the midline of the white PVC frame. (You can rotate grid if you click on the line at the corners.)
9. Hit Enter to apply the grid. Then you can apply/remove it by clicking on/off the layer window (grid is layer at this point).
10. Score the photo using the scoring rules. Zoom in and out of the quadrants (4) using the navigator window. Generally score at full view of one quadrant, with the ability to zoom in to points as necessary.
11. If points are too dark to score, select the point and go to Image →Adjust → Levels and move the middle arrow to adjust the level. You can save the adjusted level or not; sometimes this does not lend any help.
12. Using a multi-bank tally counter, with appropriate species designated to each tally, count species occurring directly below the 100 points.
13. Follow the rules for scoring, as outlined below, without exception!
14. Keep careful checks on scoring method, making sure that tallies are applied to appropriate taxa. Not all species encountered will be stored on the bank tally. Therefore, a systematic tally system of your choosing will need to be used.
15. It is best to work *methodically* (e.g., left to right, up to down) in whatever way works but in the same way for each plot.
16. Transcribe data from bank tally to datasheet as you complete each plot. Be sure not to reset tally BEFORE data are transcribed to datasheet, otherwise you will have to rescore the 100 points!
17. Double check that the datasheet column is correctly labeled with the appropriate plot number and that the column adds up to 100. Erase extraneous marks and make sure all numbers are legible.

18. Once finished scoring, go to Layer → Merge visible (there should now only be one layer in the layer window).
19. Select File →Save As → jpeg (e.g., smch_myt1_401_sp05g.jpeg). In the file name, "g" indicates "grid," with a "g" placed at the end of the file name to differentiate the scored grid slide from the original. Procedures for naming photoplot files are described in SOP12).
20. Save a copy of the original photoplot record and a grid-overlaid record to the computer.
21. Move to the next photoplot record and repeat procedure.

Rules for Scoring

Check to see if any plot sketches (Sketch datasheet) or field notes were taken in the field that may assist in interpreting the photograph. In some cases, the Field Log or Photo Log will have notes about the dominant species present, obscure or undifferentiated species, where tar occurs (as some non-coralline crusts may be confused with tar in photos if scored later), etc.

Multi-layering of species will not be accounted for here. **A total percent cover in each plot will always be 100% total for all combined species**.

All organisms are identified to the lowest level possible. Organisms should be identified to the specific level when possible, though these may be "rolled up" into higher taxonomic classification for practical or comparative purposes on the datasheet (e.g., for analysis consistence with past data when level of identification was more general).

Conceptually, the grid points overlying the plot image (in the photo) should be imagined to be infinitely small (i.e., hits only one organism or substrate). You may toggle grid layer On/Off to better see what lies directly underneath. It also works well to increase the grade-scale for "Transparency" of the grid layer to lighten but not remove the grid points.

1. **Always score the topmost (visible) layer that is attached to the substrate (i.e., not an obvious epibiont) unless the topmost layer is a "weedy" species obviously overlaying a non-weedy species.** This rule applies regardless of the target or core species involved. The rule was formulated to work consistently for scoring from photos in the lab and in the field (covered in SOP 6) supplemented when possible with rough plot sketches and brief notes. "Obvious" means that the layering can be discerned from the photograph or is clear from the brief field sketch/notes (e.g., a plot noted in the field to have 100% cover of mussels topped with weedy algae). Examples of epibionts include algae (e.g., coralline or non-coralline crusts, articulated corallines), red seaweed (*Endocladia spp.*), or invertebrates (e.g., barnacles or limpets) on live mussel shells or thatched barnacle (*Tetraclita rubescens*) tests. Examples of "weedy" species include various alga genera such as sea lettuce (*Ulva spp.)* and *Enteromorpha*, *Endarachne*, *Porphyra*, and *Scytosiphon*. The topmost rule eliminates much of the uncertainty of trying to determine what lies below the upper layer, does not bias for or against target species, and generally keeps the photograph as the primary source of archival data (rather than some difficult to reconstruct combination of photo, plot sketch, and/or field scoring). This method will underestimate target species cover whenever the target species is covered by another

species (e.g., by rockweeds (*Pelvetiopsis limitata*)) or any plant whose attachment lies outside the plot. Such situations should be noted and considered when evaluating data trends. Though desirable, scoring cover of understory target species is too complex and time-consuming to fall within the scope of this core monitoring protocol. Fortunately, layering is not a major issue for most target species, except in plots where rockweeds occur.

2. **If tar is on rock or a dead organism (e.g., barnacle), the point would be scored as tar.** When tar is coating a live organism, the underlying organism is scored. However, a separate tally count of oiled organisms is added to the datasheet for potential Natural Resource Damage Assessment use. This tally is not included in the MARINe database.

3. **Score sedentary motile invertebrates occurring under a photopoint as one of the following core categories: giant owl limpet (*Lottia gigantea*), limpet, chiton, ochre sea star *(Pisaster ochraceus*), or other invertebrate.** Since black abalone and purple urchins are rarely encountered (if at all) in photoplots, they have not been designated as core species for this protocol. If encountered, they would be scored as "other invertebrate." If an un-removed active motile invertebrate occurs under a photopoint, score what is likely underneath it, if possible; otherwise, score the point as "unidentified" (do not score the active motile invertebrate as "other invertebrate"). For example, the herbivorous sea hare (*Aplysia californica)* or the predatory dog whelks (*Nucella spp.*) should be counted as an active motile invertebrate, not scored as cover (e.g., sedentary other invertebrate).

4. **Score bleached crustose corallines (appearing white) as "crustose corallines,, not "rock."** Bleached crustose corallines may still be alive (and may regenerate), so assume they are live and score as such.

5. **Score obviously dead barnacle tests, dead mollusk shells, etc. as "dead species," unless they are covered by something (e.g., crustose algae, sponge), in which case they should be scored as the covering organism.** The rationale behind this is that dead shells and empty tests are substrates and not organisms at this point.

6. **Epoxy corner markers and bolts should be scored as "rock."**

7. **When sand is present under a point in the photo, if you can positively identify what is under the sand, then score the underlying core species or "rock;" otherwise score "sand."** This means that "sand" will be scored whenever sand thickness is greater than just a thin layer with patches of rock or some core species showing through.

8. **Thin (i.e., not obvious) layers of cyanobacteria (blue-green algae) get scored as "bare rock." A noticeable *thick* mat of cyanobacteria would be scored as a "non-coralline crust."** Note that some rock types have mineral deposits that appear similar to non-coralline crusts in the photos. Look carefully; these should be scored as "bare rock" and NOT "non-coralline crusts."

9. **An unknown species will be scored in one of these two categories: "*Other Algae*" or "*Other Invertebrate.*"**

Further Scoring Guidelines

1. If acorn barnacles (*Chthamalus spp.*) occur as epibionts on thatched barnacles (*Tetraclita*), score the point as "Tetraclita."

2. If one species of rockweed overlays another species of rockweed, simply score the top layer as is. If a rockweed is obviously overlaying a mussel, score the rockweed because it is the top layer, is not an epibiont, and is not a "weedy" species.

3. **If plant species are attached outside the plot but draping over target or core species in the plot, score the overlying species (if it is not a "weedy" species) without regard to place of attachment.** For example, in the rare case where feather boa kelp (*Egregia menziesii)* drapes across a mussel plot, leave it in place and score it as the top layer species (but note on the Sketch datasheet what it is covering). Ideally one would like to follow the target or core species despite over-draping, but in practice it would be too complex for field workers to record and would likely lead to inconsistencies.

   Do not bias towards the target or core species haphazardly, but do keep in mind that the primary goal of targeting, for example, the mussel zone plots, is to track changes in mussel (*Mytilis spp.*) cover over time and not the annual changes in sea lettuce (*Ulva*) cover. Keep the target organism in mind when scoring rules fail.

   Data are recorded on datasheet "Photoplot Scoring" (Appendix SOP 7A). Be sure to indicate where scored as office (O).

Procedure for Datasheet Management

1. Upon completion of office scoring, check that the datasheet is legible, all headers are completely filled in and the percent cover scores for each plot sum to 100. Make added notes as appropriate.

2. File the "Photoplot Scoring" datasheet with all other datasheets from the monitoring event in the appropriate data binder.

3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager at the Network office. , The hardcopy copies of the datasheets will be stored in a file cabinet.

4. The data will be entered into the MARINe database at the end of the season (SOP 13).

Appendix SOP 7A. Photoplot Scoring Datasheet for Office Scoring Photoplots.

Site:_____ Sampling Season:_____Date Sampled:_____

Assemblage:_____ Recorder:_____Date Scored:_____

Core Taxa*	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Cladophora columbiana CL					
Ulva/Enteromorpha UE					
Other Green Algae OG					
Egregia menziezii EM					
Fucus gardneri FG					
Hesperophycus californicus HE					
Pelvetiopsis limitata PL					
Scytosiphon spp SC					
Silvetia compressa SI					
Hedophyllum					
Other Brown Algae OB					
Endocladia muricata EN					
Chond. canaliculatus CO *canaliculatus (= Gigartina canaliculata)*					
Mastocarpus papillatus MP					
Mazzaella affinis MZ					
Mazzaella spp MS					
Porphyra sp PS					
Articulated corallines AC					
Crustose corallines CC					
Neorhodomela					
Gelidium					
unidentified					
Other Red Algae OR					
Phyllospadix scouleri/torreyi PY					
Non-coralline crusts NC					
A. elegantissima/sola AE					
Phragmatopoma californica PH					
Mytilus californianus MY					
Lottia gigantea LG					
Limpets LI					
Chitons CI					
Chthamalus spp/Bal glandula CB					
Tetraclita rubescens TR					
Pollicipes polymerus PO					
Semibalanus					
Other Barnacles BA					
Pisaster ochraceus PI					
Other Invertebrates OI					
Rock R					
Sand S					
Unidentified					

SOP 8. Motile Invertebrate Counts

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes the procedures for conducting motile invertebrate counts using established monitoring protocols and for recording data to the "Motile Invertebrates for Northern MARINe Sites" datasheet (Appendix SOP 8A). Target species or species groups (core and optional) are monitored regularly at SFAN sites. Motile counts are collected during all sampling events.

General Survey Considerations

The target motile invertebrates are small, mostly herbivorous or scavenger predators. They likely respond differently than benthic organisms monitored in photoplots (which are mostly autotrophs or filter feeders) to changes in climate, severe weather, pollution (especially oil spills), alien species invasion, disease, or disruption of the ecosystem by resource extraction. For example, changes in abundance due to predation in the intertidal zone by alien rats on crabs and snails are tracked by this type of monitoring.

This protocol measures relative abundance (rather than absolute) since cryptic or small sized individuals in complex-structured plots are likely overlooked in counting (e.g., the periwinkle (*Littorina spp.*) and small limpets are especially difficult to see on certain rock types). Density variability (e.g., aggregating behavior) suggests that relative numbers are more important in determining population abundance and system functioning than absolute numbers. The monitoring objective is to determine relative densities of snails, chitons, limpets, and crabs for annual comparisons. Invertebrate densities may serve as an indicator of overall or specific ecosystem health.

Species Monitored

The following motile invertebrates are targeted for monitoring at SFAN

Core species (are always enumerated in MARINe program)

Acanthina spp.
Ocenebra circumtexta
Tegula funebralis
Tegula brunnea
Tegula gallina
Nucella emarginata
Nucella canaliculata
Lottia gigantea
Fissurella volcano
Mopalia spp.
Nuttalina spp.
Lepidochitona spp.
Pachygrapsus crassipes
Pagurus spp.
Littorina spp.
Limpets (all spp. excluding *Lottia gigantea*)

Optional species (enumeration optional under MARINe)

Amphissa versicolor
Epitonium tinctum
Ceratostoma nuttalli
Haliotis cracherodii
Haliotis fulgens
Pagurus samuelis
Pagurus hirsutiusculus
Pagurus granosimanus
Pisaster ochraceus
Pisaster giganteus
Patiria miniata
Leptasterias hexactis
S. purpuratus
S. franciscanus
Mexacanthina lugubris
Stenoplax spp.
Tonicella lineata
Lepidozona spp.

Procedures

Established fixed photoplots previously sampled for percent cover (SOP 5) are re-sampled for this protocol. No additional plots are monitored. Field equipment necessary to count motile invertebrates includes: 50 x 75 cm quadrat frame (same as used for photoplots, but without dividing strings), a 10 x 10 cm wire frame (for sub-sampling), a 20 x 20 cm wire frame (for sub-sampling), kneepads, calipers, long forceps (helpful in picking up snails from crevices), and "Motile Invertebrates for Northern MARINe Sites" datasheet**.**

Completing this sampling procedure is fairly labor intensive. This method has been tested and compared to complete counts. It was decided that overall numbers (and size class structure in the case of limpets) was adequate for general monitoring for periwinkles and limpets.

Procedure for Conducting Motile Invertebrate Counts

1. Locate photoplots using the appropriate site map (SOP 3).
2. Place a 50 x 75 cm frame over the photoplot.
3. Systematically search the entire plot, counting all individuals of species listed on the datasheet. Some species will require sub-sampling (see Procedures below). While searching through the plot, algae may have to be moved aside, especially in rockweed plots. For this reason, ***it is best to shoot photos and field score plots <u>before</u> counting motile invertebrates*****.** It often works best to conduct multiple searches, concentrating search images by counting only one or two species at a time. Target invertebrates can be removed from plots and placed in a container for counting and/or measuring but should be returned to the specific plot when sampling is completed. Plastic forceps have proved useful for extracting whelks from crevices and from amongst mussels.
4. Use tally marks on the datasheet to keep track of number of each taxon. Having someone record the data for the observer helps with efficiency and minimizes recording errors.
5. Organisms are all identified to species level when possible, except periwinkles (*Littorina* spp) and limpets. For enumeration purposes, all limpets except the owl limpet (*Lottia gigantea*) are lumped together as either small (<5 mm), medium sized (5-15 mm), or large (>15 mm), due to the excessive time and skill involved with identification to species level. Do not forget in the count data that this size class information is collected for limpets.

Procedures for Sub-sampling Motile Invertebrates in Plots

1. Three replicate sub-samples comprise a "sub-sample." Limpets are placed into three size categories (small: <5 mm, medium: 5-15 mm, and large: >15 mm). Small and medium limpets (all species except owl limpets (*Lottia gigantea*)) are sub-sampled when numerically abundant, using a 20 x 20 cm wire frame in the <u>upper left</u>, <u>center</u>, and <u>lower right</u> corners of the photoplot. Search carefully, as tiny limpets may at first appear as little more than dark specks on the rock. (Note: large limpets are recorded separately at the top section of the datasheet.)
2. Periwinkles *(Littorina* spp) are sub-sampled in 10 x 10 cm frames within the upper right corner of each 20 x 20 cm frame (resulting in three sub-samples).

Procedure for Collecting Length Data

1. Length frequencies of certain snail genera *(Nucella, Acanthina, Tegula,* and *Ocenebra*) are collected by measuring the first 10 individuals encountered in each plot.
2. Record the sizes, to the nearest millimeter, in each column and write the total number in the narrow box on the left of each column. Circling the total number on the datasheet helps identify it from tallies and sizes.

Procedures for Quality Assurance

1. While still at the site, each datasheet is checked for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Be sure that total numbers are distinct from tally marks or partial counts (it is good practice to circle totals and always circle or underline 11 to distinguish from two tally marks).
2. Any variation to the normal protocol should be noted on the daily log and briefly on the datasheet itself. Transcribe any notes made on slates or other datasheets so that all information pertinent to this protocol is kept together.
3. Make sure sub-sampling methods are clear. Clearly note any unidentified or questionable species, and if possible, collect a specimen for proper identification. Taxa which cannot be identified in the field will be returned to the office in labeled plastic bags which will be kept refrigerated until identification can be determined using taxonomic literature. If identifications cannot be determined by NPS staff, local experts will be consulted. Algae will be identified by staff of the Jepson Herbarium at the University of California, Berkeley and invertebrates will be taken to the Department of Invertebrate Zoology and Geology at the California Academy of Sciences in San Francisco. Specimens which are new to science or otherwise notable will be accessioned into the collections of these two museums.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.
2. File the “Motile Invertebrates” datasheet with other datasheets from the specific monitoring event in the appropriate data binder.
3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager at the Network office. The hardcopy copies of the datasheets will be stored in a file cabinet.
4. Data will be entered into the MARINe Excel workbook (SOP 13). The MARINe Access database does not currently accept motile invertebrate data.

Appendix SOP 8A. Mobile Invertebrates for Northern MARINe Sites

Plot Type:_____ Site:_____

Counter:_____ Date:_____

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Species counted in whole plot (can be sub-sampled if abundant)* For hermits, I.D. 1st 10 & multiply % by total.					
Lepidochitona hartwegii					
Nuttalina spp.					
Mopalia spp.					
Lepidochitona dentiens					
Pachygrapsus crassipes					
Pagurus samuelis					
Pagurus hirsutiusculus					
Pagurus granosimanus					
Ocenebra circumtexta					
Large limpets (>15mm) (excluding L. gigantea)					

Species counted and measured (1st 10 encountered only) in whole plot (can be sub-sampled if abundant)*										
	#	sizes	#	sizes	#	sizes	#	sizes	#	sizes
Nucella emarginata										
Nucella canaliculata										
Acanthina spp.										
Tegula funebralis										
Lottia gigantea										

Species sub-sampled in 3 20 x 20 cm quadrats placed in UL, middle & LR of plot** Count limpets on rock (R) and mussels (M) separately.										
	R	M	R	M	R	M	R	M	R	M
limpet <5 mm										
limpet 5-15 mm										
Sample in 10 cm x10 cm section of 20x20 cm quadrat**										
Littorina spp.										

Optional Species (count if present)
Tegula brunnea
Tegula gallina
Amphissa versicolor
Epitonium tinctum
Ceratostoma nuttalli
Haliotis cracherodii
Haliotis fulgens
Pisaster ochraceus
Pisaster giganteus
Patiria miniata
Leptasterias hexactis
S. purpuratus
S. franciscanus
Mexacanthina lugubris
Stenoplax spp.
Tonicella lineata
Lepidochitona spp.
Lepidozona spp.
Fissurella volcano

UCSC 05/11/06

SOP 9. Sea Star Monitoring

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes the procedures for conducting sea star monitoring using established monitoring protocols. Sea star monitoring will be conducted during the regular monitoring visit. The ochre sea star (*Pisaster ochraceus*) is the target species for size frequency measurements. All other sea star species will be noted if they are found. These species include *Patiria miniata*, *Pisaster giganteus*, and *Pycnopodia helianthoides*. Rarer species of sea stars such as *Leptastarias hexactis* and *Dermasterias imbricata* are also noted when seen. This SOP summarizes procedures for: 1) conducting irregular plot surveys at Bolinas Point, and transects at Santa Maria Creek and the GOGA sites, and 2) completing "*Pisaster* Size Frequency Datasheet" (Appendix SOP 9A).

General Survey Considerations

Sea stars are important predators in the rocky intertidal community. Populations can be highly variable and mobile. Standard procedures involve intensive searching in irregular plots, checking in cracks and crevices, and carefully counting individual sea stars. Sea stars have been susceptible to a wasting disease in Southern California during warm water years. This is usually identified by missing arms with frayed, rotten tissue or just a general look of soft, rotten flesh. Any observations of diseased sea stars should be noted on the field log.

Protocols are adapted from the MARINe Handbook in order to create irregular plots and band transects comparable over a large geographic range (Engle 2005). The plots and transects are not intended to quantify densities at an overall site, but are meant to provide discrete sampling sites where abundance and size distribution of sea stars can be monitored over time. The plots and transects are placed in areas of high sea star density to obtain as many counts and measurements for size frequency as possible**.**

Irregular plots are marked by four or more "corner" bolts, one of which is notched with the plot number. The plots are placed in areas of high sea star density to obtain as many counts and measurements for size frequency as possible**.**

To survey a plot, at sufficiently low tide, a meter tape is laid out around the irregular plot perimeter and the entire area encompassed by the boundary tape is carefully searched. All sea stars within the plot are recorded while only ochre sea stars (*Pisaster ochraceus*) are measured. Ochre sea stars (*Pisaster ochraceus*) are recorded if any part of the animal is inside the plot. Each sea star is temporarily marked with yellow forestry chalk to avoid duplicate counts.

Transects are marked by two "end" bolts, one of which is notched with the transect number. To survey a transect, at sufficiently low tide, a meter tape is stretched between the two bolts. Sea stars within 1 meter of each side of the transect line are counted and measured.

Plot and Transect Selection

Irregular plots or band transects were established at SFAN sites in locations where both 1) ochre sea stars (*Pisaster ochraceus*) were consistently found in relatively high numbers and 2) the plots or transects could be re-visited during each survey . The choice of plot or transect was indicated by characteristics of the site which must provide stable substrate and a relatively high density of *Pisaster*.

Because sea stars are typically found in exposed locations with high mussel growth, locating transect/plot markers may be difficult. The use of detailed maps, interplot measurements, and overview photos is necessary for locating transects/plots. Sea star aggregations often move across the reef so that fixed transects/plots may detect more variability than is actually present.

Procedures

Procedure for Fixed Irregular Plot Search for Sea Stars (Bolinas Point Only)

1. Locate irregular plots. Stretch a meter tape around the permanent bolts to outline the perimeter of the plot.
2. The defined plot is surveyed for the presence of sea stars. Flashlights are used to search the undersides of rocks
3. Ochre sea stars are measured with a ruler from the center of the disc to the tip of the longest ray to the nearest 5 mm for animals <10 mm and the nearest 10 mm for larger sea stars. Often sizes have to be estimated because sea stars are wedged in tight spots with rays curved. A flashlight is used to see in cracks and overhangs. Sea stars are never "straightened" or removed from the rock.
4. The color category (Purple/Other or Orange) is recorded for ochre sea stars.
5. Other species of sea stars are enumerated only.
6. Once recorded, sea stars are temporarily marked with a forestry crayon to avoid double counting.
7. Size measurement and species are recorded directly to the "*Pisaster* Size Frequency Sheet." Usually one or two people search for stars and one person records measurements.
8. While still at the site, each datasheet is checked for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Any variation to normal protocol should be noted briefly on the datasheet itself <u>and</u> on the daily log. Transcribe any notes made on slates or other datasheets so that all information is kept together.

Procedure for Transect Search for Sea Stars (Santa Maria Creek and GOGA sites)

Use the same as procedure for Fixed Irregular Plots (above) except that data is collected within 1 meter on either side of the transect. Stretch a transect line (between the two bolts) with a meter tape and use a 2 meter long pole to count sea stars within 1 – meter of the tape. The zero of the meter tape is located at the seaward end of the transect.

For GOGA transects, the seastar counts are further itemized according to their location along the transect. The counts are tallied in 1 m bins. Table SOP 9.1 shows the nominal transect lengths which can vary by as much as one meter depending on field conditions.

Table SOP 9.1. Transect number and transect length for GOGA and PORE sampling sites.

Site	Transect (no.)	Transect Length (m)
Santa Maria Creek	1	7.2
	2	4.9
	3	4.6
Alcatraz	1	8.5
	2	14.2
Slide Ranch	SS1	15
	SS2	15
	SS3	15
Point Bonita	T1	20
	T2	15
	T3	19

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.
2. File the "*Pisaster* Size Frequency Sheet" with all other datasheets from the monitoring event in the appropriate data binder.
3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager who will store them in a file cabinet at the network office.
4. The data will be entered into the MARINe database at the end of the season (SOP 13).

Literature Cited

Engle, J. M. 2005. Unified monitoring protocols for the Multi-Agency Rocky Intertidal Network (update). Outer Continental Shelf Study Mineral Management Service 05-01.

Appendix SOP 9A. *Pisaster* Size Frequency Sheet

Site:_____ Recorder:_____

Date:_____ Sampler:_____

Pisaster

Size	Plot 1		Plot 2		Plot 3	
Radius (mm)	Purple/ Other	Orange	Purple/ Other	Orange	Purple/ Other	Orange
5						
10						
20						
30						
40						
50						
60						
70						
80						
90						
100						
110						
120						
130						
140						
150						
160						
170						
180						
190						
200						

Other Seastars (total # only, no sizes)

Species	Plot 1	Plot 2	Plot 3

SOP 10. Surfgrass Monitoring

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes the procedures for conducting surfgrass transect monitoring using established monitoring protocols. Surfgrasses (*Phyllospadix scouleri* and *Phyllospadix torreyi*) are the target species. Monitoring is conducted along three transects during intertidal surveys at Bolinas Point in PORE and Slide Ranch in GOGA. This SOP summarizes procedures for conducting surfgrass transect monitoring and for recording data to the "Surfgrass Point Intercept Transect" datasheet (Appendix SOP 10A).

General Survey Considerations

Surfgrasses are considered sensitive species because of their vulnerability to disturbance, particularly oil spills, and their importance for providing habitat for many species of fishes and invertebrates. Two species of surfgrass (*Phyllospadix scouleri* and P. *torreyi)* occur in our area. These may be intermixed with species coralline algae, feather boa kelp (*Egregia menziesii*), and a number of red algae. Surfgrass often becomes abraded or bleached and will seasonally die back. Surfgrass may be torn out by heavy surf or other disturbance to the intertidal, or may be replaced by other colonizing species. The monitoring objective is to determine changes in surfgrass zone by observing cover along fixed point-intercept transects. Thickness of surfgrass is also measured at 10 points along each transect to determine changes in the density of surfgrass.

Plot Selection

Transects are 10 m long and were established in the surfgrass zone where one or both species of surfgrass were the dominant cover. Ideally the start and end of each transect (and even the middle point) have a high spot where a bolt can be placed and easily found again. Areas of high wave impact should be avoided, as should deep tidepools.

A list of established permanent surfgrass transects in SFAN is given in Table SOP 10.1.

Table SOP 10.1. Monitoring sites with permanent surfgrass transects, dates established, and the number of replicates.

Site Name	Date Established	Number of Transects
Slide Ranch	2007	3
Bolinas Point	2007	3

Procedures

In order to establish or monitor transects, you will need a meter tape, a compass (for laying the tape, especially if both end bolts are not found), and a Surfgrass Point-Intercept Transect Datasheet.

Procedure for Establishing a (New) Surfgrass Transect

1. Two or three 10 m transects should be established in relatively dense surfgrass assemblages.
2. Drill reference bolt holes and epoxy stainless steel bolts (6 inch or larger) into the rock, preferably at high spots at each end of the 10 m transect.

3. One bolt from each transect (usually closest to shore) is notched with its number, 1, 2, or 3, to identify the transect number and starting point. An additional bolt may be permanently affixed in the center of the transect line to aid in location. However, do not notch this one.
4. Carefully measure distance and bearing of the transect ends to the other adjacent plot markers and describe the orientation and placement of each transect. Note the bearing of each transect bolt in reference to its other end. Record and document.

Procedure for Conducting Existing Surfgrass Transect Monitoring

Note: Sampling is best performed at the lowest point in the day's tidal cycle.

1. Locate transect line bolts. Clean and repair, as needed.

2. Lay the meter tape out taunt between the bolts. Be careful not to disturb the position of plants (canopy) along transect. Verify compass bearing to site map.

3. Each transect is scored (see "Rules" below) for species occurrence under distinct 100 point-intercepts uniformly distributed at 10 cm intervals (10 cm, 20 cm, 30 cm, and so on, until 1000 cm) along the meter tape.

4. The accepted standard method to record a species intercept has been to record the number of occurrences, or hits, by each species (essentially an estimate of percent cover), regardless of order found. Though recording each point in order would essentially map distributions each time, it has been found to be much slower.
5. Observers must be able to identify the various cover species on a transect. Refer to the Surfgrass Point-Intercept Transect datasheet (Appendix SOP 10A) for taxa recorded.

6. If possible, calling out the species at each point-intercept to a data recorder improves efficiency and reduces potential for recording error. A tally is kept next to the appropriate taxa for each point-intercept.

7. Perform quality control on data recorded while still on site. Make sure 100 points were read. Check datasheet for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Any variation to the normal protocol should be noted on the daily log as well as stated briefly on the datasheet. Transcribe any notes made on slates or other datasheets so that all information pertinent to this protocol is kept together.

Rules for Scoring

Note: Scoring for surfgrass is similar to scoring Photoplots. This procedure documents surfgrass even when it is covered by another species. Total transect cover will be **greater** than 100% when understory (e.g., feather boa kelp (*Egregia menziesii)* is lying across surfgrass (*Phyllospadix spp.*) on the point) surfgrass is scored. Since any amount >100% cover represents understory surfgrass only, compatibility with previous "top layer only" scoring is maintained. Scoring other

understory species, though possible in the field, would be tedious and impractical given personnel and time constraints, especially when transects are periodically awash.

1. Each of the 100 points along the transect meter tape is located and scored as one of 22 categories (Appendix SOP 10A) of core species, higher taxa, or substrates.
2. Only the topmost (visible) layer that is attached to the substrate (e.g., not an obvious epibiont such as the alga *Enteromorpha* or *Smithora*) is scored, except that surfgrass is also scored separately when it is covered by another non-epibiont species (see below).
3. *Phyllospadix spp.* is scored in either of two categories*: **"***Phyllospadix* Overstory," or "*Phyllospadix* Understory."
4. Additional (optional) taxa can be used but must be rolled up into higher taxa for data entry. Optional species, once stated, should be scored consistently (all transects) for the monitoring event.
5. Abundance (none, low, medium, high) of the epiphytic alga *Smithora* and *Melobesia*, and overall condition of surfgrasses (e.g., bleached and abraded appearance, brown, presence of flowers), are categorized for the overall transect area.
6. Surfgrass thickness is scored in the center of each meter along the transect (10 points total). Thickness is measured by pinching the clump of surfgrass in the center of each meter and using calipers to measure the thickness of the clump. Calipers should be closed gently around the clump, but not squeezed so much that they flatten the clump.
7. Record any other pertinent notes or unique findings.

Procedure for Datasheet Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.
2. File the original "Surfgrass Point-Intercept Transect Datasheet" with all other datasheets from the monitoring event in the appropriate data binder.
3. At the end of the field season, copies of the datasheets will be delivered to the SFAN Data Manager at the Network office. The hardcopy copies of the datasheets will be stored in a file cabinet.
4. The data will be entered into the MARINe database at the end of the season (SOP 13),

Appendix SOP 10A. Surfgrass Point-Intercept Transect Datasheet

Site:_____Date:__Time:_____Sampler:_____

Recorder:_____

Directions: Record 100 point-intercepts (every 10 cm) along 10m transect lines.

Category	Species	Transect 1	Transect 2	Transect 3
Phyllospadix	overstory			
	understory			
Egregia menziezii				
Eisenia arborea				
Halidrys/Cystoseira				
Sargassum muticum				
Neorhodomela larix				
Mazzaella spp.				
Crustose	coralline			
	non-coralline			
Articulated corallines				
"Turf"	filamentous red			
	C. canaliculatus			
	Gastroclonium			
	Gelidium			
Other algae	red			
	brown			
	green			
Anthopleura elegantissima/sola				
Phragmatopoma californica				
Mytilus californianus				
Barnacles				
Pisaster ochraceus				
Other inverts				
Rock				
Sand				
Other				
Total:				
Approx. % cover of *P. torreyi*				
Approx. % cover of *P. scouleri*				

Grass Thickness	1	2	3	4	5	6	7	8	9	10
1										
2										

SOP 11. Temperature Loggers

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) summarizes the procedures for deploying and maintaining temperature loggers in the Rocky Intertidal Monitoring Program at SFAN.

General Considerations

Intertidal Temperature Loggers

Intertidal temperature loggers are deployed at each of the SFAN sites**.** These small units ("Tidbits " from Onset Corporation, see Figure SOP 11.1) record automated ambient temperatures (sea or air depending on tide height) at pre-set time intervals (usually every 15 minutes). Temperature loggers are housed in capped PVC tubes or wire mesh cages and bracketed to the rock in the mid-mussel zone or just below the mussel zone. The units are changed out (or downloaded to an "Optic Shuttle") during each monitoring survey. After data are downloaded, the unit can be reset to use again. Battery life for the approximately $120 Tidbits is about five years; once batteries fail, units are discarded. Start use dates should be noted and units (Tidbit) or batteries (Pendant) replaced after end of specified battery life span to prevent loss of data. Data managers can process the temperature records to separate submerged periods from times when the units are exposed to air.

First, the data logger is connected to a personal computer. Then the turn-key software (Box Car Pro) is used to select logging parameters (sampling intervals, start time, etc.) and initiate the logger. A delayed start can be programmed for the date of sampling. The logger is then disconnected and deployed in the desired location. The logger records each measurement and stores it in memory along with the time and date. The logger is then reconnected to the personal computer and the software is used again to readout the data and to display the measurements as a graph, showing the profile over time (Figure SOP 11.2). The tabular data can be viewed or exported to a spreadsheet for further manipulation.

Procedures for Deploying a New Temperature Logger

1. Select a site near the lower edge of a mussel bed that has enough surface area to mount the temperature logger housing. The site should not be in an area of potential foot traffic or be obvious to people walking by. The temperature logger should not be covered by overhanging canopy.
2. Determine housing placement and mark areas where screws will fasten housing to rock. Drill necessary holes in rock to secure housing with a rotary hammer drill and 3/8 inch drill bit.
3. Secure temperature logger in housing with zip ties.
4. Use a handheld speed wrench to secure the screws in the pre-drilled holes and tighten down the temperature logger housing. Plastic PVC washers may help to secure the screws.
5. Draw a detailed map and take overview pictures of the temperature logger location to make finding it on subsequent trips easy.

Procedures for Downloading and Re-deploying a Temperature Logger

1. During each sampling trip, locate the temperature logger housing.

2. Remove the zip ties securing the current temperature logger to the housing and take out the temperature logger.
3. Examine the temperature logger for any obvious signs of damage and remove excessive growth (e.g., algae and invertebrates).
4. Either swap out the temperature logger for a new programmed logger or download the temperature logger with an "optic shuttle."
5. Record the serial number of the logger on the field log datasheet.
6. Replace the new or downloaded temperature logger in housing and secure with zip ties. Double check that housing is still secure.
7. Offload data from data logger or optic shuttle onto a computer using the data shuttle, as soon as possible after sampling trip.
8. The software program BoxCar Pro is used to download temperature logger data (Figure SOP 11.1, 11.2).

Procedure for Datasheet Management

1. Data will be downloaded by the SFAN Data Manager following the procedures specified in this SOP.

2. Each temperature logger serial number and date of data download will be entered into a log which will be kept in a filing cabinet in the SFAN office. Files of temperature data from each site will be is stored on the SFAN file server at \\Inpgogamahe1\Divisions \NetworkI&M\IndividualVitalSigns\RockyIntertidal\Data\Temperature_Loggers.

Figure SOP 11.1. Photos of Onset brand temperature logger (top) and wire mesh temperature logger housing deployed at intertidal site (bottom).

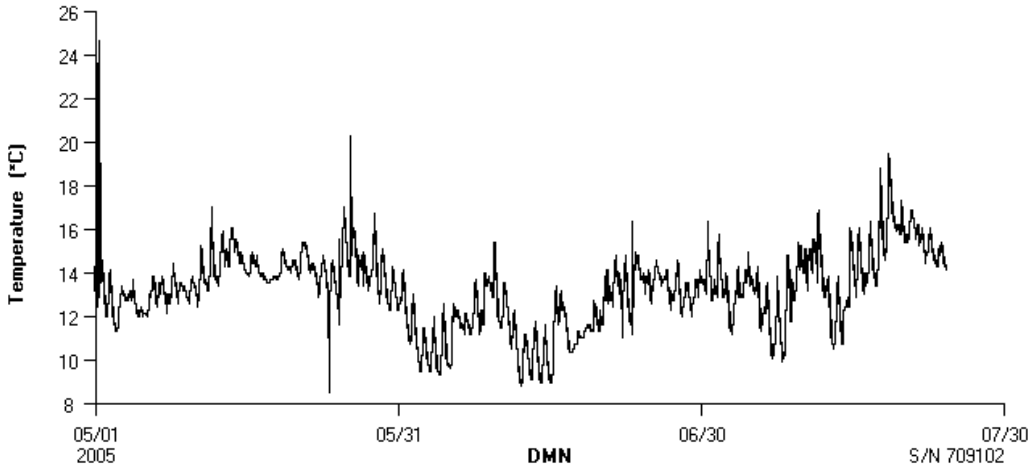

Figure SOP 11.2. Example readout of temperature graph recorded from Onset temperature logger using Program Boxcar Pro.

SOP 12. Downloading Digital Photos and Photo Image Management

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
			-		

This Standard Operating Procedure (SOP) provides specific procedures for the downloading of digital images following photograph documentation of photoplots in the field (SOP 5). The SOP provides details on how to download images, how to properly name images, and how to back up and/or archive photo records.

General Considerations for Digital Records

Digital records are the preferred image media. Digital imagery refers to electronic images obtained using digital cameras. This section covers the download and naming of digital camera files, procedures should apply to most digital cameras and computers operating in the Microsoft XP operating system and having a Universal Serial Bus (USB) port connection. Consult specific equipment operating manuals and/or software user manuals as needed.

When taking images, you should adhere to the following guidelines.

1. SFAN requires all images to be submitted as TIFF or Joint Photographic Experts Group (JPEG) format.
2. All images should be stored at as high a resolution as possible. At no time should images be taken with less than four megapixels of spatial resolution unless this goes beyond the operational limits of the equipment.
3. Although some cameras can imprint date and time onto an image, this is not recommended. Date and time are embedded in JPEG headers by most cameras. In addition, imprinting an image can reduce the image quality and overall value.

Procedure for Downloading Images to PC Computer

Field cameras change frequently. To download images, consult directions that came with the camera being used.

Procedure for Naming Digitized Photoplot Images

The naming standards described here are adapted from Jack Engle's Photo Label Standards (updated 4/01/05) and are for photoplot file names only. Digital image file names have been standardized and are meant to conform to MARINe naming convention.

The rationale for the photoplot file name standard includes the following:

1. Photo file name must be easy to understand and implement and compatible with typical database style.
2. Photo file names should not use spaces or special characters. The underscore is OK as a separator.
3. For simplicity and reducing possibility of errors, photo file names should include only lowercase letters.
4. Even though a photo database can organize files based on keywords, etc., it is best if file names are descriptive and display in a logical order. However, not all information needs to be included in the file name (directories can be used to separate some broad categories) and the file name should not be lengthy (<20 characters preferred).

There are six main types of information that have been incorporated into MARINe photoplot file names. This hierarchy (in order from general to specific) is as follows:

1. Site: We will use standardized codes (lowercase) to conform with the database (Table SOP 12.1).
2. Target Species: We will use the first three letters (lowercase) of the target species plot names in the database (Table SOP 12.2). Using fewer than three letters could lead to ambiguities, while more letters unnecessarily lengthens the file name.
3. Plot Number: Plot identifiers should conform to consecutive #'s starting with "1" if possible (e.g., 1, 2, 3, 4, 5 ...).
4. Date (Season/Year): Most of the core MARINe sampling takes place semi-annually (fall/winter and spring), though some northern sites are sampled annually (summer). Due to the nature of our sampling schedules (including limited number of adequate low tide periods, site access limitations, and weather delays), we have defined three sampling seasons (no winter), each four months long, as follows: fall = October-January; spring = February-May; and summer = June-September. This does not quite match the calendar year; thus, a sample in January 2005 would be listed as a Fall 2004 sample. Sites sampled in the winter months (i.e., December-January) are often referred to as fall/winter sampling periods but are entered as fall. Seasons will be abbreviated as lowercase two-letter codes (fall = fa, spring = sp, summer = su) and years will be abbreviated as the final two digits (e.g., 1997 = 97, 2004 = 04). Using these codes means the file names as listed in alphanumeric order will group all fall photos, followed by all spring photos, and then all summer photos. Also, years in the new century (2000s) will sort out before the 1900s. This partial breakdown of chronological order was not considered significant enough to change to lengthier and less intuitive file names since the eventual implementation of a photo database will allow all kinds of sorts, including chronological.
5. Photo Replicate: For each photoplot sampling, there will be at least two photos to store: 1) the photo used for scoring and 2) that same photo overlain with the grid of 100 dots). In addition, there may be one to two (or more) other photos, often representing different exposures (e.g., one more overexposed and one more underexposed). (Note: we should not label and organize photos that we are unlikely to use, such as duplicate exposures or poor quality extra photos.) To differentiate the various photos for a given plot, we will add a single lowercase letter after the year in the file name as follows:
    - "a" = scored photo (no dot grid).
    - "b," "c," "d," "e," or "f" = additional photos taken (e.g., different exposures).

Table SOP 12.1. Site Codes used in naming digital images for the SFAN monitoring locations.

Site Code	Regular Monitoring Location
ALC	Alcatraz
BOL	Bolinas Point
SMC	Santa Maria Creek
SLR	Slide Ranch
PTB	Point Bonita

Table SOP 12.2. Three letter codes for "Target Species" in Photoplot File Naming.

Target Species	Code	Target Species	Code
Chthamalus/Balanus	cht	Mytilus	myt
Endocladia	end	Fucus	fuc
Mastocarpus	mas	Pelvetiopsis	pel
Phyllospadix (surfgrass)	phy		

Based on the above criteria, the **MARINe photoplot digital photo name standard** shall be: **"site" "_" "target species" "plot #" "_" "season" "year" "replicate"**

Photoplot File Name Examples:

alc_maz2_fa04b.jpg = Alcatraz, Mazzaella Plot #2, fall 2004, Replicate "b" (different exposure)

slr_myt5_su05a.jpg = Slide Ranch, Mussel Plot #5, summer 2005, Replicate "a" (scored photo)

Procedure for Naming Other Digitized Images

For naming special photos, including reference overview and panoramic photos or other photos of interest, a systematic file naming convention will be followed.

1. **Panoramic (Pan) Photos** are a series of pictures that document the site. It is VERY important that these be taken in approximately the same way/place every year. To name a pan, one should know from where the series was taken. Pan photos are usually part of a sequential pan of the reef and will be taken from reference points. Label the reference point as you would a plot number (e.g., r1). When possible, the first of the series should be taken facing north and then rotating clockwise. The standard should look like this:
   "site" "_" pan "_" "point where taken" "_" "numerical order in the series (e.g., 2of4)" "_" "season year"
   Example: fkc_pan_r1_7of10_fa97
2. **Overview Photos** show general topography or detail of the site but are not in a series of photos (like pans). These show areas of interest that are taken year after year. For naming, follow similar procedures as photoplot naming with the following exceptions: instead of target species, use "area" and instead of plot #, use a descriptive word or number. The descriptive word is something that will differentiate the photo from other area photos (e.g., mussel_bed). The standard should look like this:
   "site" "_" area "_" "descriptive word/number" "_" "season year" "replicate"
3. **Species Photos:** These pictures are close-ups of a marine organism. They are typically used for species identification or documenting a sighting of an organism. The standard should look like this:
   "site" "_" species name (latin preferred, or common)" "_" "season year" "replicate"
   Example: srfr_s_purpuratus_fa06_b
4. **People Photos:** These are photos of people monitoring or in the field that do not fit into the area category. The standard should look like this:
   "site" "_" people "_" "descriptive word/number (if needed)" "_" "season year" "replicate"

General Considerations for Submitting and Archiving Digital Records

Digital camera photos should be copied regularly to CD or DVD for archiving purposes. In addition, all images should be cataloged and metadata added using image management software according to the information management plan for the park.

The Project Manager should review the pictures and metadata, remove any photographs of poor quality, and submit the photographs and metadata to the SFAN Data Manager.

Metadata

Key information for each photograph is contained in the file name as described above. Additional notes can be placed in an individual file's summary information tab which can be accessed by right clicking on the file and then left clicking PROPERTIES

File Structure and Folder Name

Photos being managed will be stored in the Rocky Intertidal images folder (\\INPGOGAMAHE1\Individual Vital Signs\Rocky Intertidal\Images). Folders are named by location and date (Figure SOP 12.1).

Figure SOP 12.1. The Rocky Intertidal image file structure.

Network Photo Database

In addition to archiving photos following the conventions presented above, the Data Manager is also responsible for copying photos of publication quality to the Network's photograph database (\\INPGOGAMAHE1\Photographs\SFAN_Photo_Database), which is used to store and distribute photographs to Network staff.

Photograph Folder

The "Photographs" folder will contain all photographs managed by the Network. Photographs will be divided into "Category" folders that resided in the "Photographs" folder. Each category folder is used to separate the photographs into logical groups (Figure SOP 12.2).

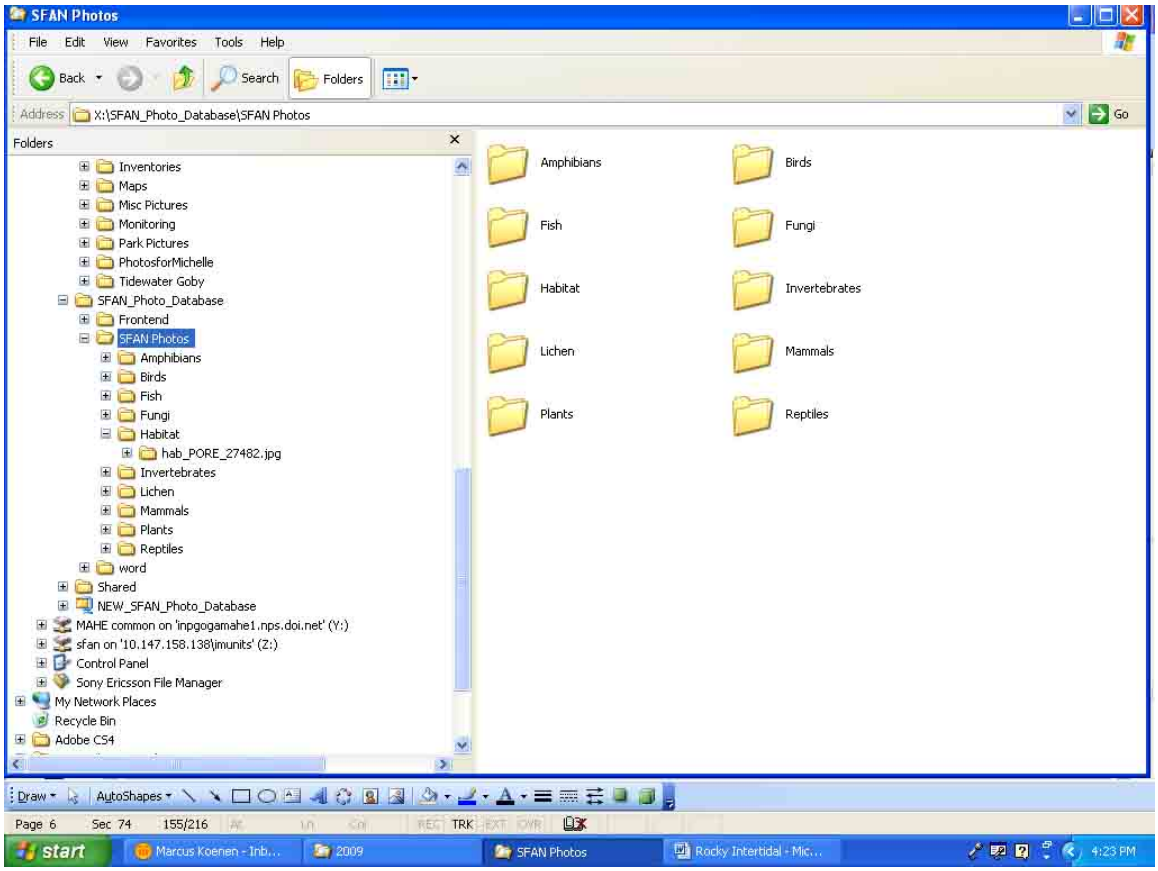

Figure SOP 12.2. The SFAN Photograph folder with various category folders.

Category Folder

It is the responsibility of the individual downloading or saving an image to place photos into broad categories (e.g. amphibian, fish, habitat). Rocky intertidal photos should be stored in the habitat folder. Metadata including date, location, photographer, and key words. While the database is fairly self explanatory, complete directions for the photo database are located here: \\INPGOGAMAHE1\SFAN_Photo_Database\word.

SOP 13. Data Entry and Management including Uploading to MARINe Database

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

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Tables

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Table SOP 13.1. Summary of submission and release dates for the MARINe database, by survey season. ..... SOP 13.13

This Standard Operating Procedure (SOP) provides an overview of data management procedures, including entering biological data into the Multi-Agency Rocky Intertidal Network (MARINe) database and data certification. This SOP also includes instructions on how and when to upload data to the MARINe database. Submitting newly collected data to the MARINe program requires the use of the MARINe Access database and the MARINe Excel workbook. The Access database is used for entering site-wide, photoplot, seastar and surfgrass data. The Excel workbook is used for entering motile invertebrate data. Following submittal to the MARINe program, the data contained in the Access and Excel files are combined in the final master online MARINe database.

The MARINe Access database was developed by Bruce Bealer and Larry Cooper at Southern California Coastal Water Research Project (SCCWRP) (Bealer and Cooper 2003, see also Miner et al. 2007). The database is now maintained by the PISCO group at the University of California, Santa Cruz. PISCO acquires and distributes data using the MARINe Egnyte file server (https://marine.egnyte.com). The file server is password protected, to obtain a login for the file server a request should be sent to Melissa Miner (mwilson@biology.ucsc.edu). The file server is also used to distribute new versions of the MARINe database, the MARINe motile invertebrate Excel catalog and the Marine Database User Guide. Instructions for using the MARINe motile invertebrate Excel catalog are contained in sheet1 and sheet2 of the catalog.

MARINe Database Overview

The MARINe Data Management System (MDMS) provides a uniform data acquisition, data analysis, and information storage and retrieval system. Members of MARINe, including SFAN, survey intertidal sites during the daylight low tides.

Basic Structure

Each site is a geographical location defined by its longitude and latitude. Within each site, collected data are categorized by one of three method types: photoplots, transects, or count and size. Within each method, plots or transects are grouped by target species. There can be one or more plots associated with a target species. It is this combination of site, plot type, target species, and individual plot ID which provides the uniqueness of each species recorded.

The site-specific data are combined with seasonal environmental sampling event data to provide a unique survey result record. The environmental event data must be entered prior to entering biological data.

Using the Database

It is the responsibility of the SFAN Data Manager to enter all data into the MARINe database. Each season, a new version of the database will be downloaded from the MARINe file server (internal web site and stored on the Data Manager's main computer. A backup will be stored on the University of California at Santa Cruz's computer network in a restricted folder. Copies of the database should not exist on multiple computers. It is highly recommended to directly work in the MARINe database only when doing seasonal maintenance or adding survey results. All analysis and investigation should be through links into the Access database. The simple activity of adding a new table could cause automated functions in the MARINe database to fail. Refer to

the complete MARINe database user's manual (Miner et al. 2007) before attempting to enter or manipulate data.

The following are general guidelines to keep in mind:

1. Data entry should occur as soon after data collection as possible, so that field crews keep current with data entry tasks and catch any errors or problems as close to the time of data collection as possible.
2. The working database will first be copied onto one workstation hard drive. All entry for a given field season will occur on this copy, usually by the SFAN Data Manager.
3. Each data entry form is patterned after the layout of the field form and has built-in quality assurance components such as drop down lists and validation rules to test for missing data or illogical combinations.
4. As data are being entered, the person entering the data should visually review each data form to make sure that the data on screen match the field forms. This should be done for each record, prior to moving to the next form for data entry.
5. Backing up the entered data should occur frequently with caution made to name the backed up database something that will not be confused with the working database copy.
6. When an entire season of data has been entered and checked for errors, the data are submitted to the main MARINe database.

Starting a New Season

Data for a season must be added in a specific sequence because most information depends upon supporting data having been previously entered. The basic sequence for entering data for a new season is to enter maintenance data, then event data, and finally results data. The items below indicate which activities to perform and their sequence.

Main Menu

The Main Menu (Figure SOP 13.1) is the first screen presented after the application is launched. This menu provides access to all the database functions.

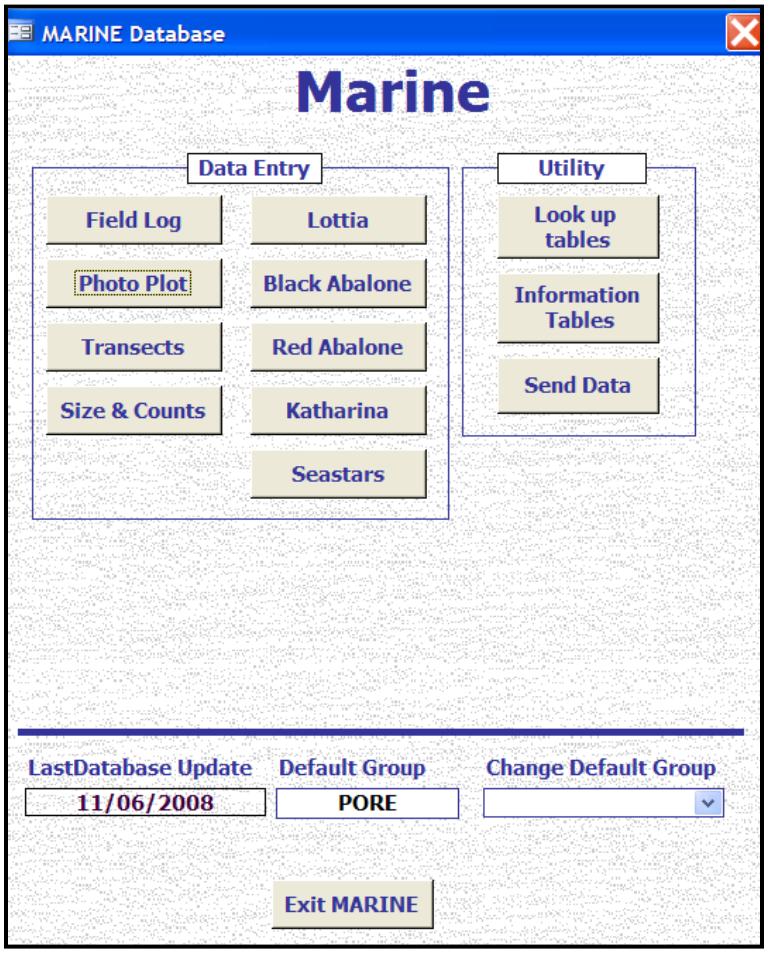

Figure SOP 13.1. MARINe database main menu.

Data Entry Sequence

Tables must be loaded in a specific sequence because data in one table are dependent on data in a related table. Tables should be loaded in the following order (Miner et al. 2007 contains detailed instructions):

1. Maintenance data: Enter any changes or additions to maintenance tables first. Maintenance data are recorded in lookup tables. Lookup table names start with luListXX_LookupName. The season and personnel tables are examples of maintenance tables. *Add new seasons and personnel before entering any results data*.
2. Information tables: These tables contain data specific to MARINe that is not the result of seasonal surveying activity; therefore, they will rarely need to be updated. The site table is an example of an information table.
3. Results table: These tables record the actual results data of a field site survey. The field log event table is an example of a results table. It must be populated before the other results tables.

Survey Data Entry

These results tables record the survey data of the intertidal field monitoring. The following is a list of the results tables with a brief description of each. Refer to the MARINe User's Manual (Miner et al. 2007) for complete data entry instruction. Steps are described in the order they should be performed.

Field Log Event Data Entry Form: The Field Log Event Data Entry form is actually two forms: the Field Log form (Figure SOP 13.2) and Site-wide Species Conditions form (Figure SOP 13.3). For field methods, refer to SOP 4. When you complete the Field Log form, click the "Continue" button and the Site-wide Conditions form will open. Both pages of the form must be completed at the same time. These forms must be loaded before the other results tables. The survey dates entered here appear in drop down boxes on the other forms.

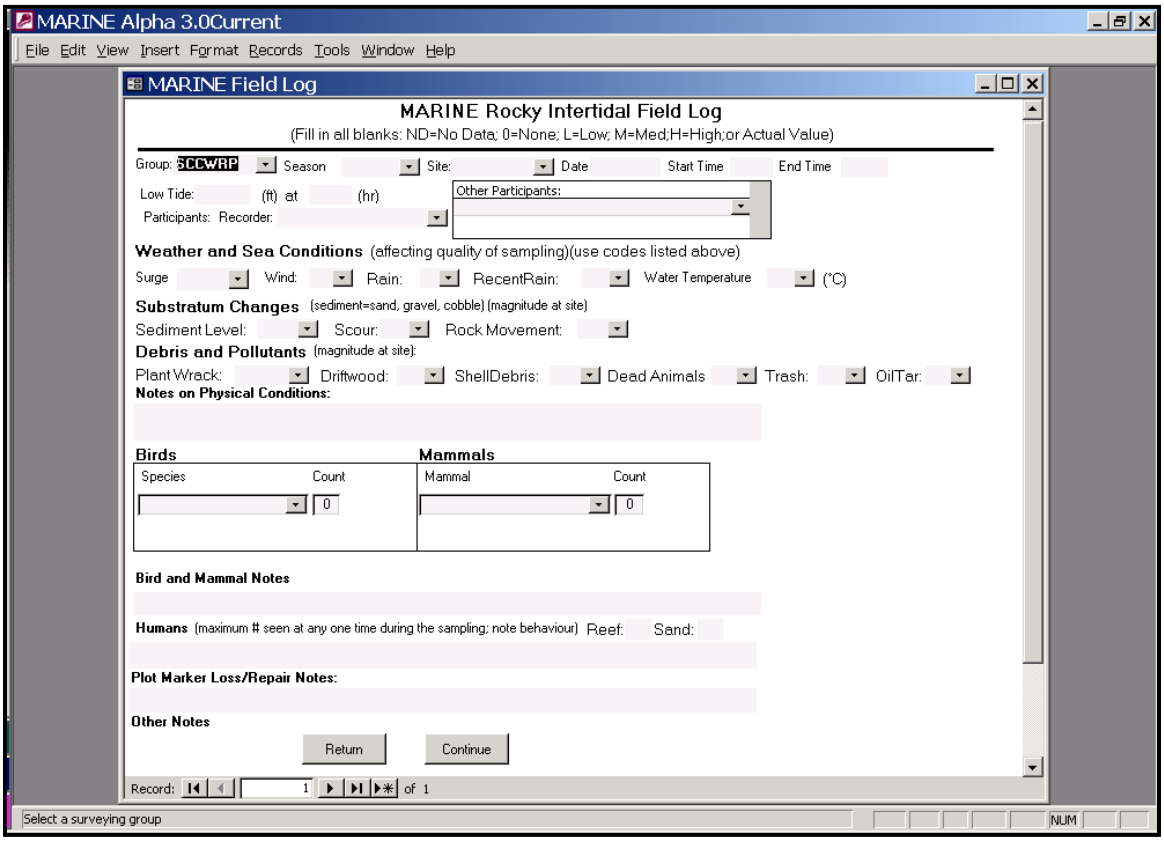

Figure SOP 13.2. MARINe Rocky Intertidal Field Log form.

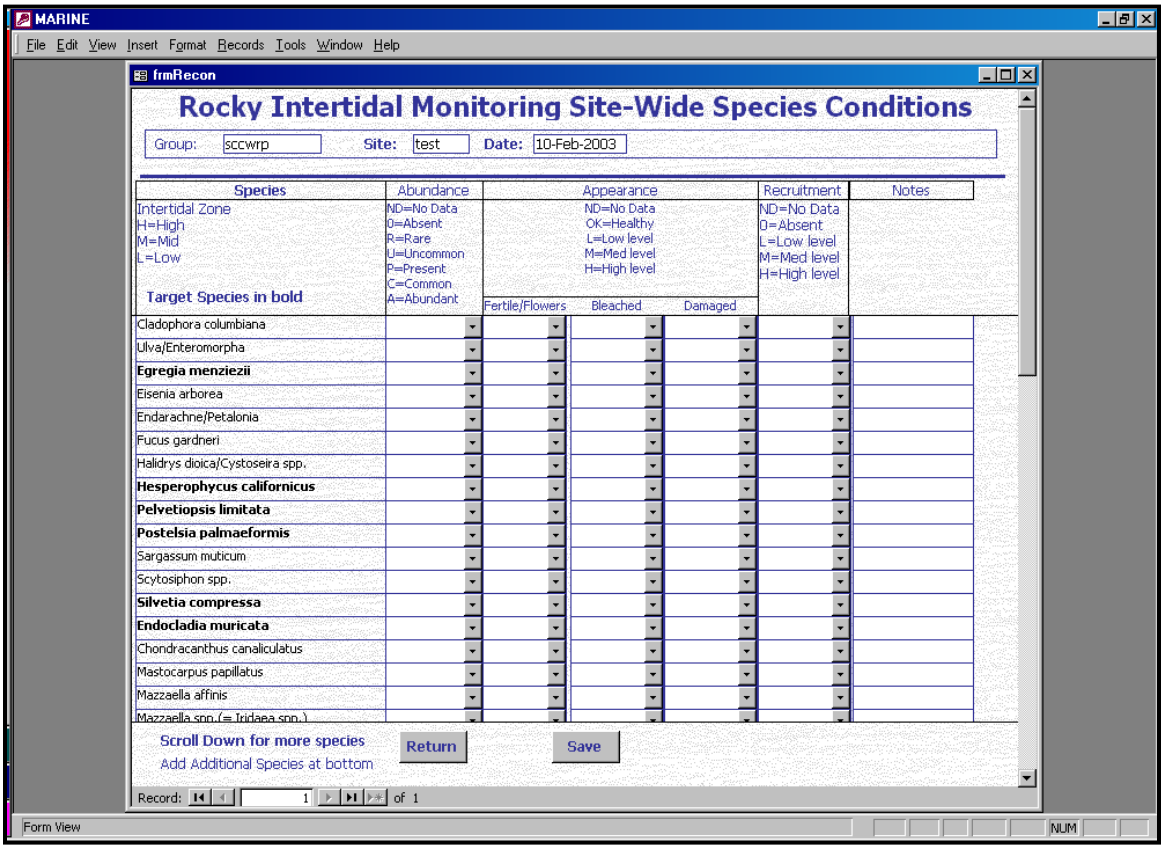

Figure SOP 13.3. MARINe Rocky Intertidal Site-wide Species Conditions form.

Photoplot Data Entry Form: This screen (Figure SOP 13.4) is for entering summarized photoplot data (SOPs 5–7) (i.e., data that have been converted to percent cover for selected target species plots). The photoplot data entry form is designed to enter results one plot at a time.

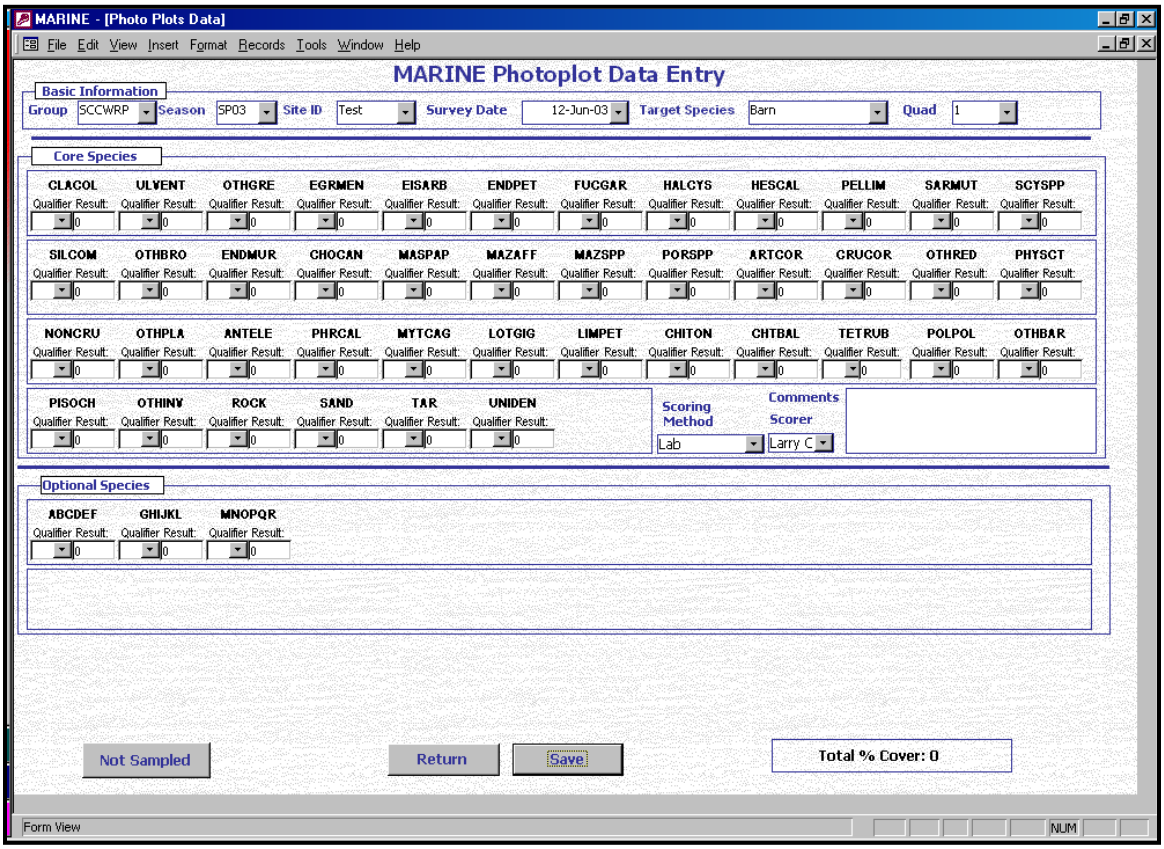

Figure SOP 13.4. Photoplot data entry form.

Transects Data Entry Form: This screen (Figure SOP 13.5) is for entering summarized transect data (SOP 10). That is, data that have been converted to percent encountered for selected target species transects, namely surfgrasses (*Phyllospadix scouleri/torreyi*).

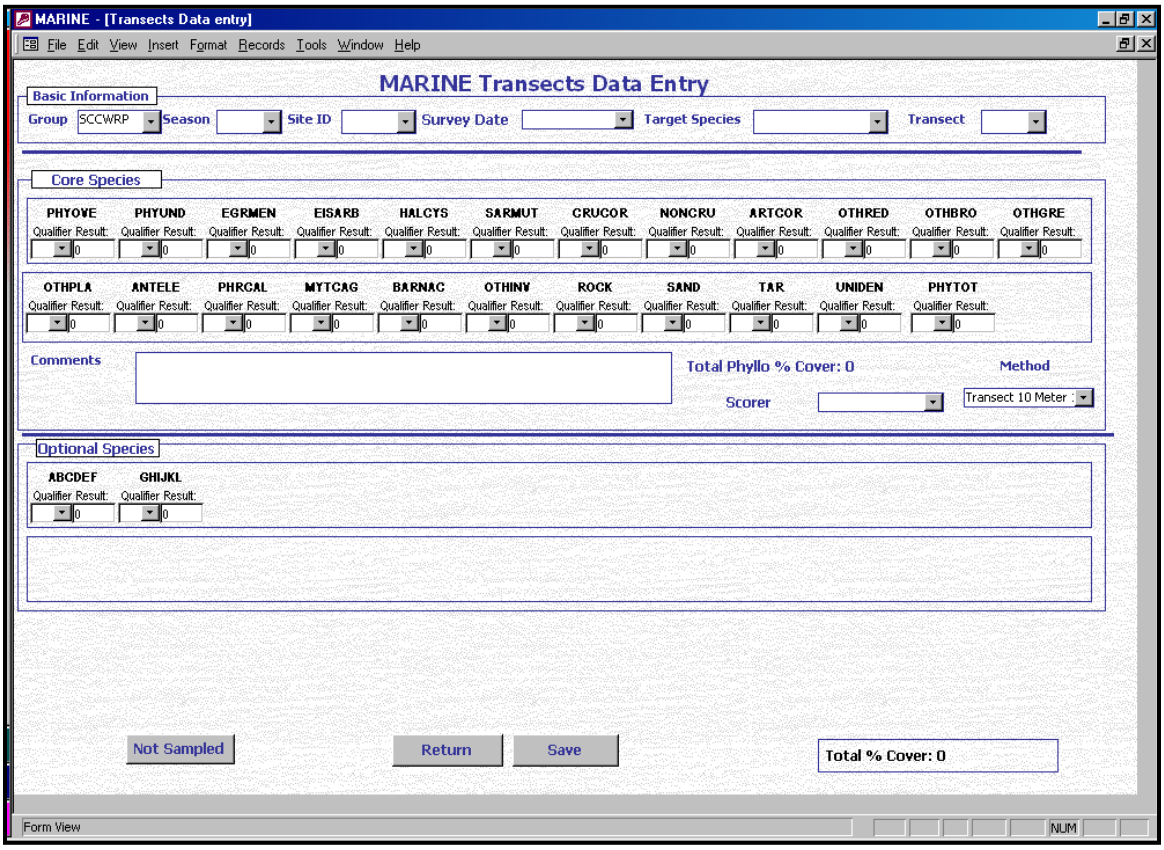

Figure SOP 13.5. Transects data entry form.

Sea Stars Data Entry Form: This form (Figure SOP 13.6) is for entering summarized size and count information that has been totaled for each size class of ochre sea star (*Pisaster ochraceus*) (SOP 9).

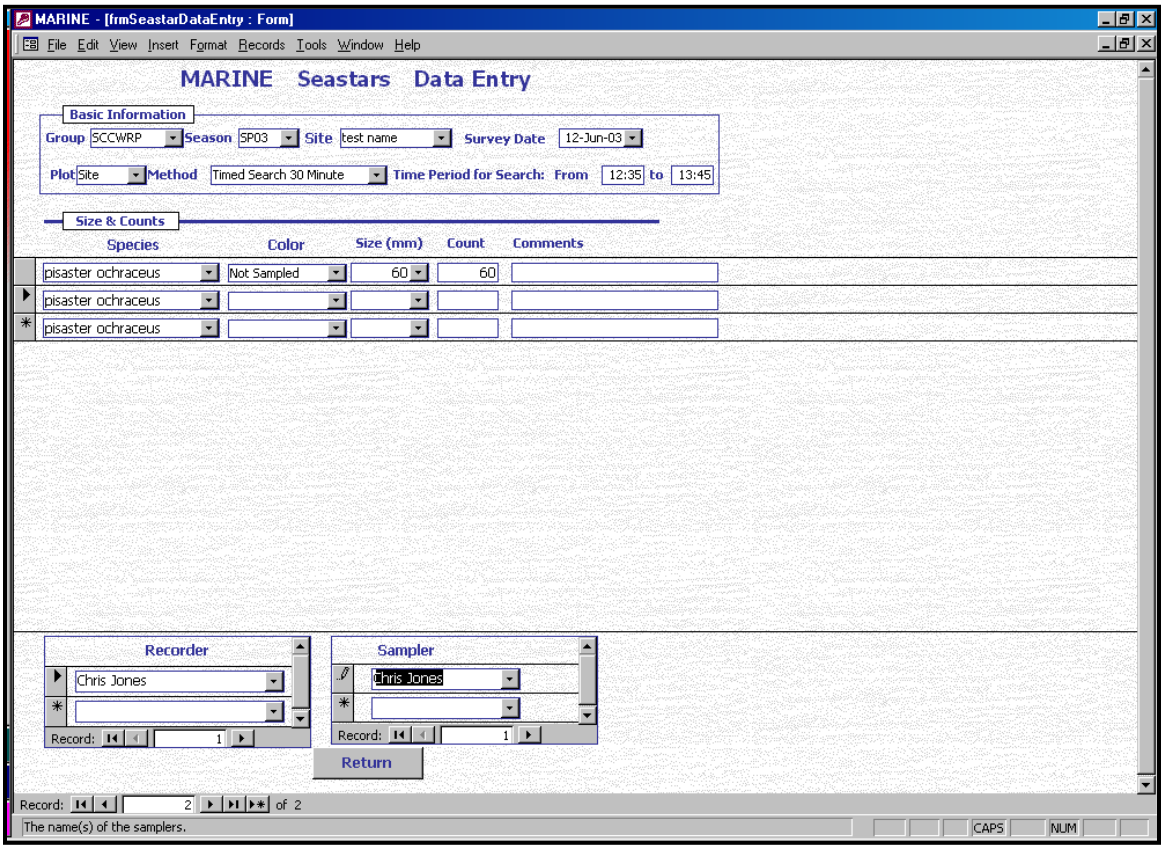

Figure SOP 13.6. Sea stars data entry form.

Motile Invertebrate Data Entry Spreadsheets: Four separate MS Excel spreadsheets which are contained in a single Excel workbook are used for entering motile invertebrate data (Figures SOP13.7–10).

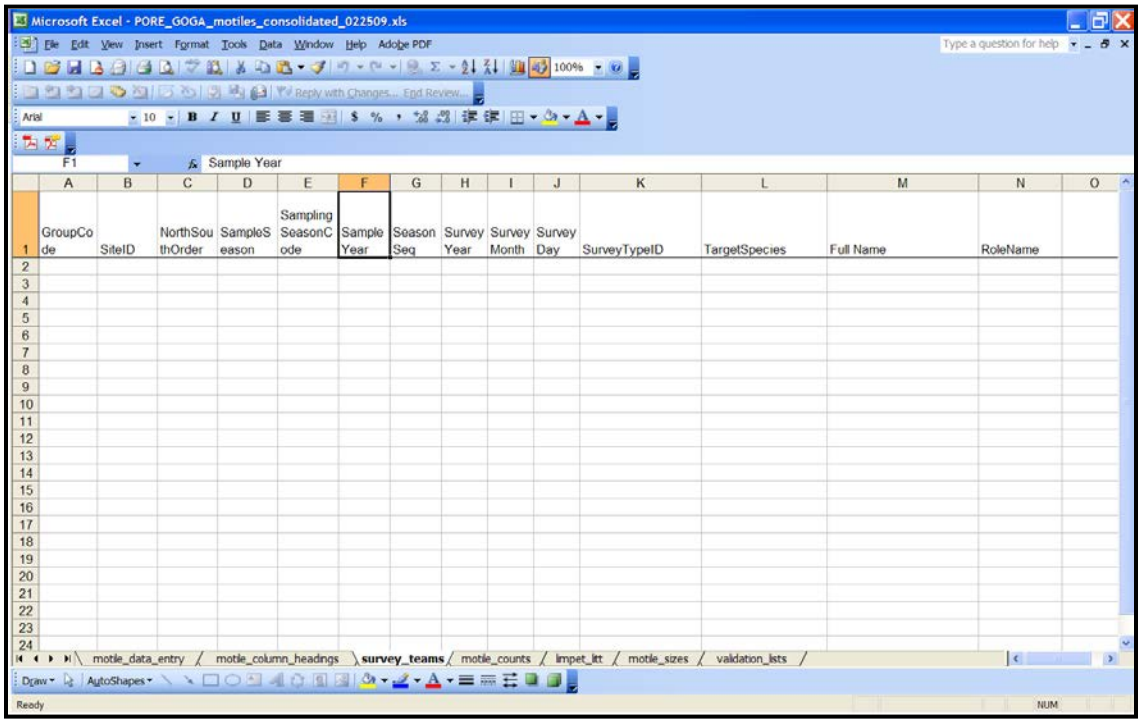

Figure SOP 13.7. Survey teams sheet.

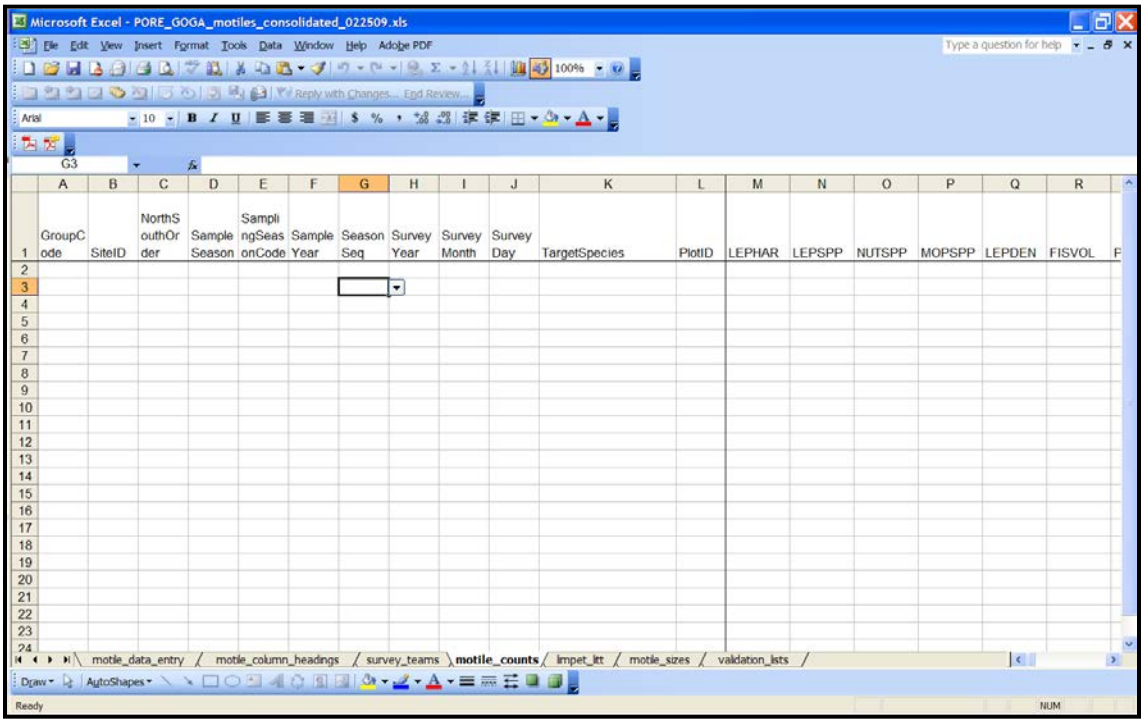

Figure SOP 13.8. Motile counts sheet. Note that the actual spreadsheet contains more fields than are shown in this figure. A complete list of fields is .provided in Appendix C.

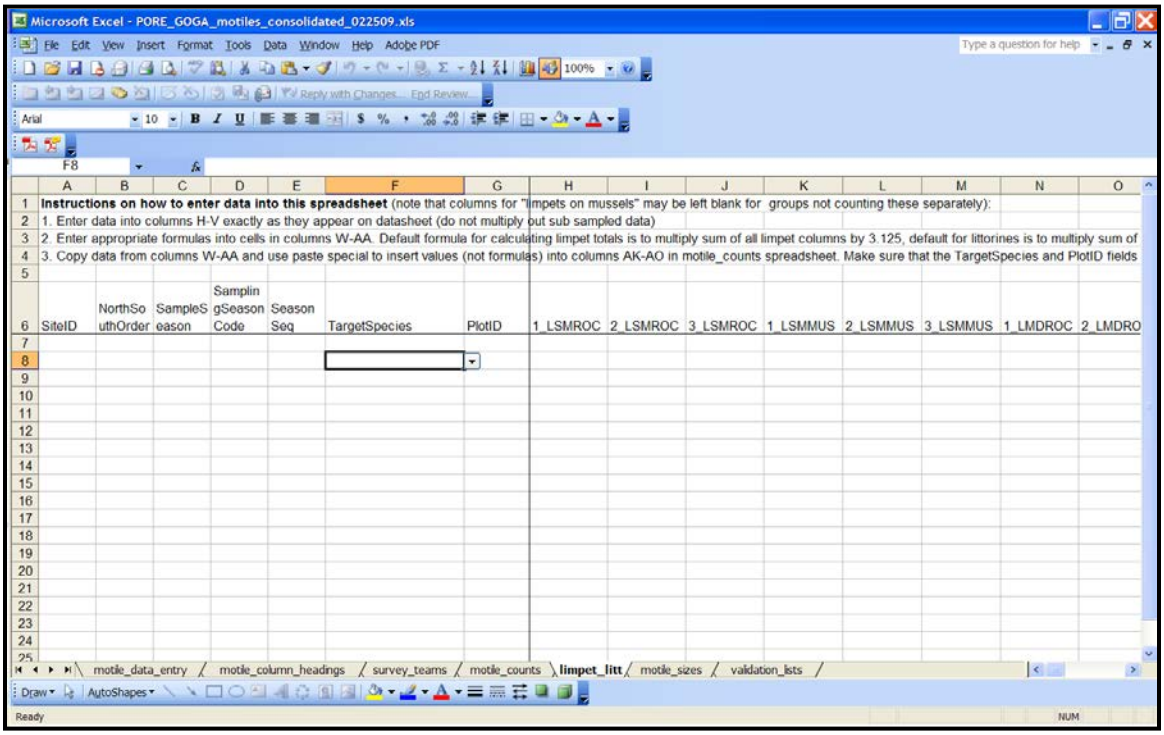

Figure SOP 13.9. Limpet and Littorina count spreadsheet. Note that the actual spreadsheet contains more fields than are shown in this figure. A complete list of fields is .provided in Appendix C.

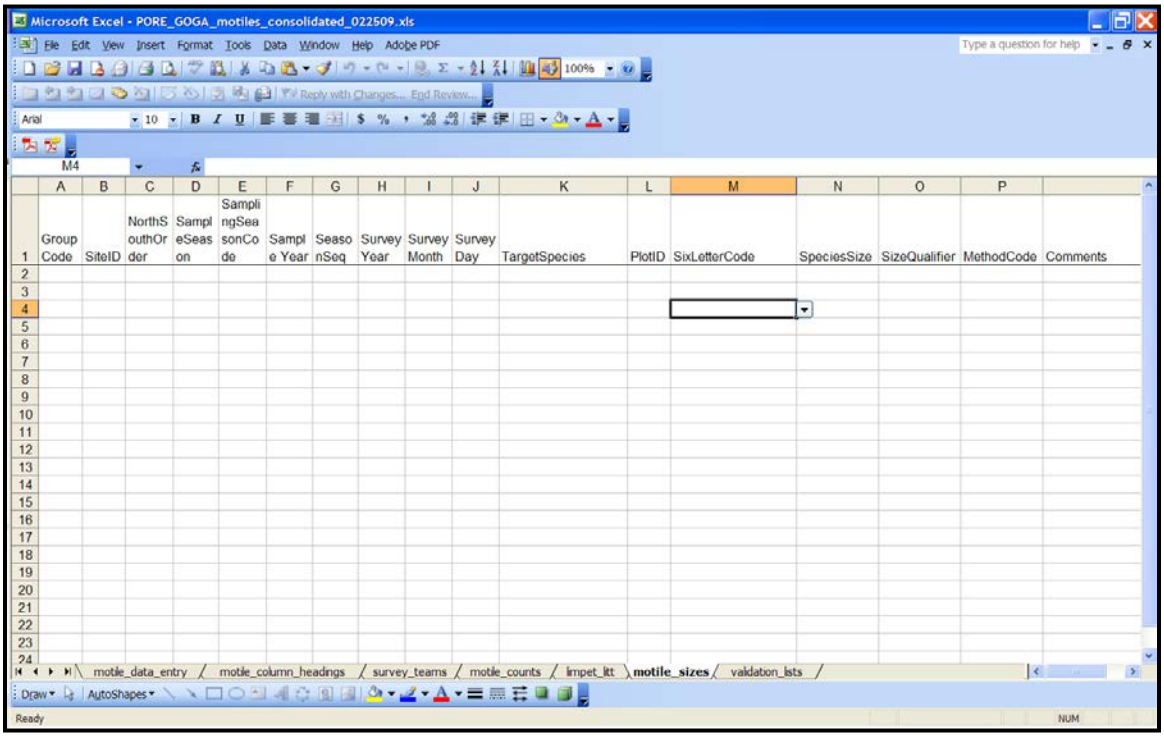

Figure SOP 13.10. Motile invertebrate sizes.

Submitting Data

Submitting the MARINe database to PISCO

The main MARINe database is maintained by the PISCO group at the University of California, Santa Cruz (UCSC). After each field season's data are entered into a copy of the database and thoroughly checked for any obvious mistakes, this copy is sent to PISCO to be included in the updated version of the main database. The Data Manager will be responsible for all database tasks, including entering, checking, and submitting data. Only data which have not previously been sent to UCSC can be edited in the MARINe database. If corrections to data previously submitted to the MARINe master database are desired, a list of corrections must be provided to Melissa Miner (mwilson@biology.ucsc.edu) and she will make the corrections.

The Send Data button on the main menu of the MARINe database will invoke a process which will select data that have not been sent to UCSC and create an Access database to house it. The resultant transfer Access database should then be uploaded to the MARINe Egnyte file server https://marine.egnyte.com.

Database Update Schedule

Fall survey data (typically October-January) should be submitted to the main MARINe database no later than **March 1** of the following year. Summer survey data (typically May-August) should be submitted no later than **October 1** of the current year. This allows roughly three months for scoring photoplots and completing the data entry templates. Updated versions of the database will be released twice a year: by **April 1** and **August 1**. Table SOP 13.1 summarizes this schedule.

Table SOP 13.1. Summary of submission and release dates for the MARINe database, by survey season.

Survey Season	Data Submission Deadline	Database Update Released
Fall	March 1	April 1 or August 1
Summer	October 1	April 1 or August 1

Sending the Motile Invertebrate spreadsheet to UCSC

The completed MARINe motile invertebrate Excel catalog should be submitted to Rani Gaddam at UCSC (gaddam@biology.ucsc.edu).

Completing Data Certification

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all deliverables except reports. The Data Manager is primarily responsible for completing the SFAN Data Certification form (Attachment SOP 13A), which tracks the submission of project products for the Network. The Certification form should be submitted, along with all project products, prior to the start of a new field season. A new Certification form should be submitted each time a product is submitted. If multiple products are submitted at the same time, only one Certification form is needed for those products. Digital copies of completed product certification forms are stored in the

Intertidal_Document folder, a subfolder the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal).

The Data Certification form ensures that:

1. The data are complete for the period of time indicated on the form.
2. The data have undergone the quality assurance checks indicated in the vital sign monitoring protocol.
3. Metadata for all datasets has been provided.
4. Project timelines are being followed and all products from the field season have been submitted.

Data Certification Form

A description of each field on the certification form is included below.

1. Certification date: The date the form was submitted to SFAN.
2. Certified by: The name of the person certifying the products.
    a. Title: Position of the person certifying the products.
    b. Affiliation: Agency / Organization / University.
3. Project code: Each project will be given a code by SFAN.
    a. Project title: Each project will be given an official title by SFAN.
4. Ranges of dates for certified data: Include the month and year of the data collected for the products you are submitting.
5. Description of the data being certified: Give a brief description of each product that is being submitted.
6. Parks and details: List any parks that are represented by the products being submitted. Provide any details that might be necessary to understand the relationship between the products being submitted and the park represented.
7. Certification product and name: Put a checkmark next to each type of product you are submitting. Indicate the name of the file(s) next to the product. If the product is an image, indicate the name of the folder used to store the images.
8. Sensitive information: Indicate if the product can be released to the public. This does not mean SFAN will release the product, but this information is necessary in case we have to, or chose to, release the product (e.g., FOIA request).
9. Data processing and quality assurance procedures: Describe what QA/QC steps were involved to ensure the accuracy and quality of the data. You only need to describe processes outlined in the protocol that were NOT followed, or processes that were not outlined in the protocol but were used for these products.
10. Who reviewed the product: Describe who reviewed the product for content, sensitivity, and quality. At a minimum, the Data Manager should be included in this step.

11. Results of the QA: Describe what steps were involved to resolve any issues that came up during the quality assurance reviews.

Literature Cited

Bealer, B., and L. Cooper. 2003. MARINe database user guide. Version 3.1. SouthernCalifornia Coastal Water Research Project, Westminster, California.

Miner, M., B. Bealer, and L. Cooper. 2007. Revised MARINe Database User Guide. U.S. Minerals Management Service Report. U.S. Department of the Interior, Minerals Management Service, Online (http://www.marine.gov/Findings/Reports/MinerEtAl2007MARINeDatabaseManualV30_OCT07.pdf). Accessed 15 December 2010.

Appendix 13A. SFAN Certification Form

1) Certification date:_____

2) Certified by: _____
Title: _____
Affiliation: _____

3) Project code: _____
Project title: _____

4) Range of dates for certified data: _____

5) Description of data being certified: _____
6) List the parks covered in the certified data set, and provide any park-specific details about this certification.

Park	Details

7) This certification refers to data in accompanying files. Check all that apply, and indicate file names (folder name for images) to the right:

_____ Hardcopy Datasheet(s):_____
_____ PDF Datasheet(s): _____
_____ Database(s): _____
_____ Spreadsheet(s):_____
_____ Spatial data theme(s): _____
_____ GPS file(s): _____
_____ Geodatabase file(s): _____
_____ Photograph(s): _____
_____ Data Logger(s) files: _____
_____ Other (specify): _____
Certified data are already in the master version of a park, SFAN or NPS database. Please indicate the database system(s): _____

8) Is there any sensitive information in the certified data which may put resources at greater risk if released to the public (e.g., spotted owl nest sites, cave locations, rare plant locations)?
_____ No _____ Yes Details:
_____

9) Was all data processing and quality assurance measures outlined in the protocol followed? Yes / No
If No, Explain_____
_____

10) Who reviewed the products? _____

11) Results and summary of quality assurance reviews, including details on steps taken to rectify problems encountered during data processing and quality reviews.

SOP 14. Data Analysis and Report Writing

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

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Figure SOP 14.2. Example of a plot illustrating size frequency distributions of Ochre sea stars (*Pisaster ochraceus*) at three sites within (REDW)..... SOP 14.7

Figure SOP 14.3. Sample figure illustrating size frequency distributions of black turban snails (*Tegula funebralis*) and striped dogwinkles (*Nucella emarginata*) at three sites within REDW during 2006 and 2007 ..... SOP 14.8

Figure SOP 14.4. Example trend graphs from nine years of MARINe data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Shell Beach, San Louis Obisbo Co..... SOP14.12

Figure SOP 14.5. Example graph from two years of percent cover data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Damnation Creek, REDW .....SOP 14.12

Tables

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Table SOP 14.1. Photoplot summary of the mean percent cover by zone at Scorpion Rock, Santa Cruz Island, Spring 2004 (five plots/zone)……..SOP 14.10

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Table SOP 14.3. Motile invertebrate counts for Scorpion Rock, Santa Cruz Island, Spring 2004, categorized by zones (Banacle and Endocladia) and plots within zones…….SOP 14.11

This Standard Operating Procedure (SOP) gives important guidelines for completing reports for the Rocky Intertidal Monitoring Program at SFAN. This SOP discusses annual progress reports, biennial reports and trend reports and includes procedures on when, where and to whom the reports should be electronically submitted.

General Considerations for Writing Reports

Annual progress reports and biennial summary reports are the responsibility of the Data Manager who works closely with the LPFBs. The reports' main purpose is to summarize recently collected data. Analysis of data will be presented in trend reports which will be prepared every six years. Trend reports will also be the responsibility of the Data Manager with input and review from the LPFBs. Trend reports are subject to a thorough peer review process that includes park staff.

Annual progress reports will be prepared in memo format addressed to the SFAN Technical Steering Committee. Biennial reports and trend analysis reports will use the Natural Resource Technical Report template. This template and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Procedures for Biennial Reporting

1. The biennial report will be published every other year as a Natural Resource Technical Report (NRTR). These reports will be issued frequently enough to alert resource managers to conditions which may threaten park resources.
2. Collate document together, with appendices (use of templates posted on the NRPM web site is highly recommended), and submit draft manuscript and the NRPM Manuscript Submittal Form and Checklist via email to PWR Peer Review Manager.
3. The NPS Peer Review Manager determines whether or not additional peer review is necessary based on the manuscript content and the quality of the initial reviews, and if deemed appropriate, arranges for and oversees additional peer review. The PWR Peer Review Manager determines whether or not a management review is necessary, and if so, selects an appropriate reviewer who can verify consistency with NPS policy, clear and appropriate relation to NPS policy, and appropriate treatment to sensitive issues.
4. Once the Peer Review Manager is satisfied that reviewer comments have been adequately incorporated and the report meets the minimum standards for the series, the report is approved for publication in the NRTR series and the Data Manager obtains a report number as well as an NPS Technical Information Center (TIC) identification number following the guidance on the NRPM web site.
5. Once the report numbers are added, the SFAN Data Manager will be responsible for archiving and distributing the document following processes outlined in SOP 16. Biennial reports will be sent to the Resource Chiefs of each park, uploaded to NRInfo, and posted on the SFAN Internet and Intranet web sites. A record for the report will be created in NRInfo.

Procedures for Trend Reporting

1. Complete a trend report every six years (or more frequently when events warrant), The trend report, will be published as a technical report in the Natural Resources Technical Report (NRTR) series. The use of templates posted on the NRPM web site is highly recommended.
2. Trend reports should be coordinated and timed with MARINe 3-year reports.
3. The Data Manager is responsible for ensuring standard NPS font and graphic guidelines are followed and for checking report accuracy and completeness.
4. The report should be directed at a general audience level and use graphic presentation of the data where possible. Since the data have been summarized in the biennial report, trend reports will concentrate on temporal changes.
5. Naming conventions for trend reports should follow a similar format to the biennial report described above.
6. After an initial review by internal staff and incorporation of revisions/comments, the trend report will be submitted for review to the PORE Science Advisor, SFAN Program Manager, SFAN Data Manager, and any additional experts that could provide critical input.
7. Once reviews are complete, follow steps 3-7 under the biennial reporting section of this document.

Components of Biennial and Trend Reports

The general outline of the biennial and trend reports should include:

1. A brief Narrative section describing the project along with the goals and objectives as well as any logistic problems that were encountered and providing suggestions for preventing or coping with similar problems in the future.
2. A Methods section detailing data collection procedures and analytical techniques; this may change little from year to year but should still be included as part of each report. The section should highlight any changes from previous methods.
3. A Results section that describes the content of the summary tables and figures (see data analysis in next section).
4. A Discussion section that highlights and interprets any notable findings, such as detections of unexpected or invasive species, unexpectedly large changes in species abundance patterns (>50% change), or factors such as unusual oceanic conditions that might have affected results.
5. An Acknowledgements section thanking individuals and organizations who contributed to the field season or the report.

Data Summaries and Analysis

Biennial data summary reports will provide basic summary statistics used to examine variations in abundance and cover for the key species found in the photoplots (e.g., barnacles [*Chthamulus*, *Balanus*, etc.], mussels [*Mytilis* spp.], and rockweed species [e.g., *Pelvetiopsis limitata*]) and line

transects (e.g., surfgrass [*Phyllospadix* spp.]). Mean percent cover values will be presented for each site. A sample photoplot summary figure from Redwood National and State Parks is presented in Figure SOP 14.1. Biennial data summary reports will also provide figures illustrating changes in size modes of target invertebrates. Such figures allow recruitment and mortality events to be tracked over time. Examples of size frequency plots are provided in Figures SOP 14.2 and SOP 14.3.

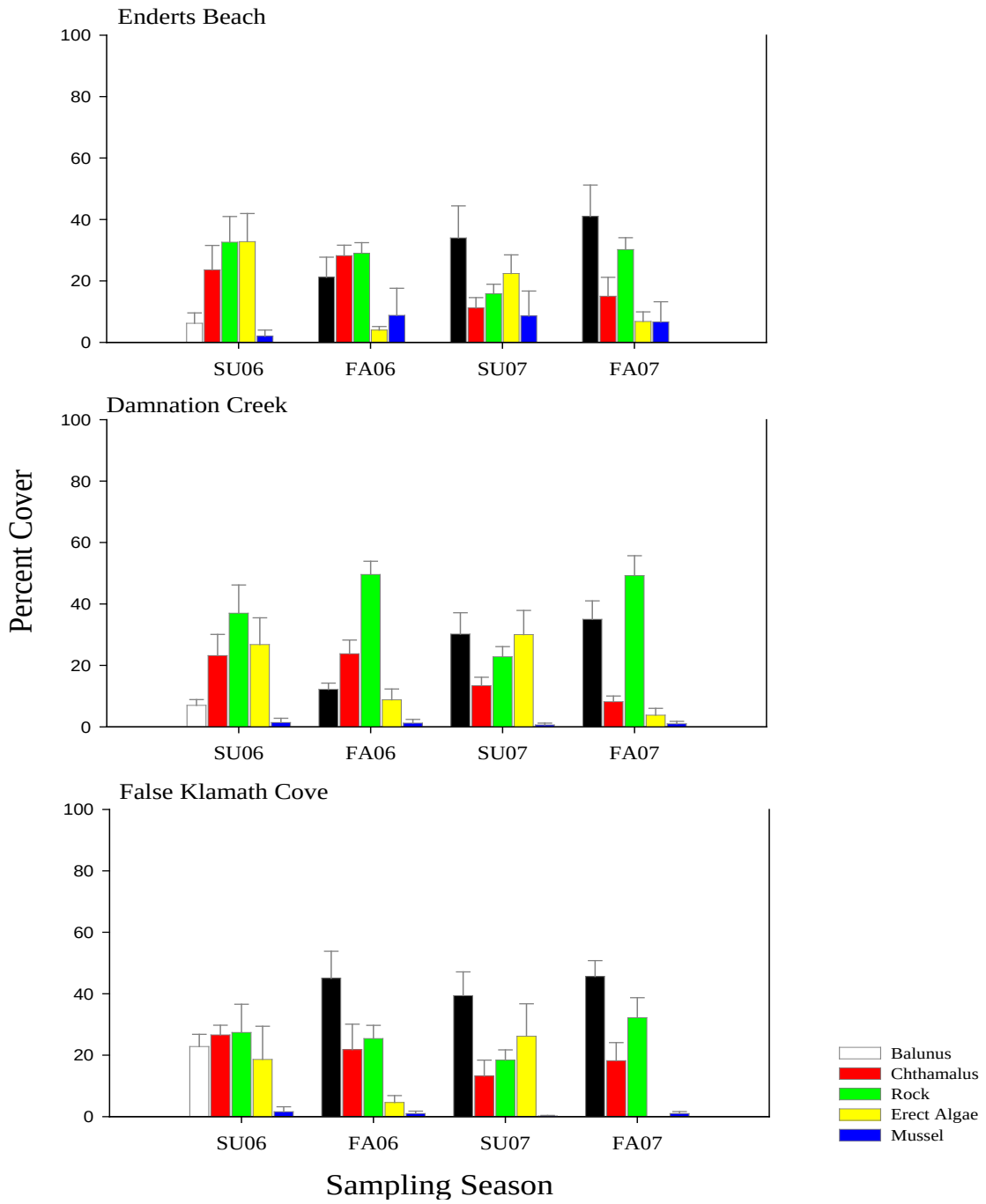


Figure SOP 14.1. Example of photoplot summary figure showing mean percent cover (± 1SE) of species in barnacle (*Balanus/Chthamalus*) photoplots at Redwood National and State Parks (REDW). Figure from Ammann et. al. 2009.

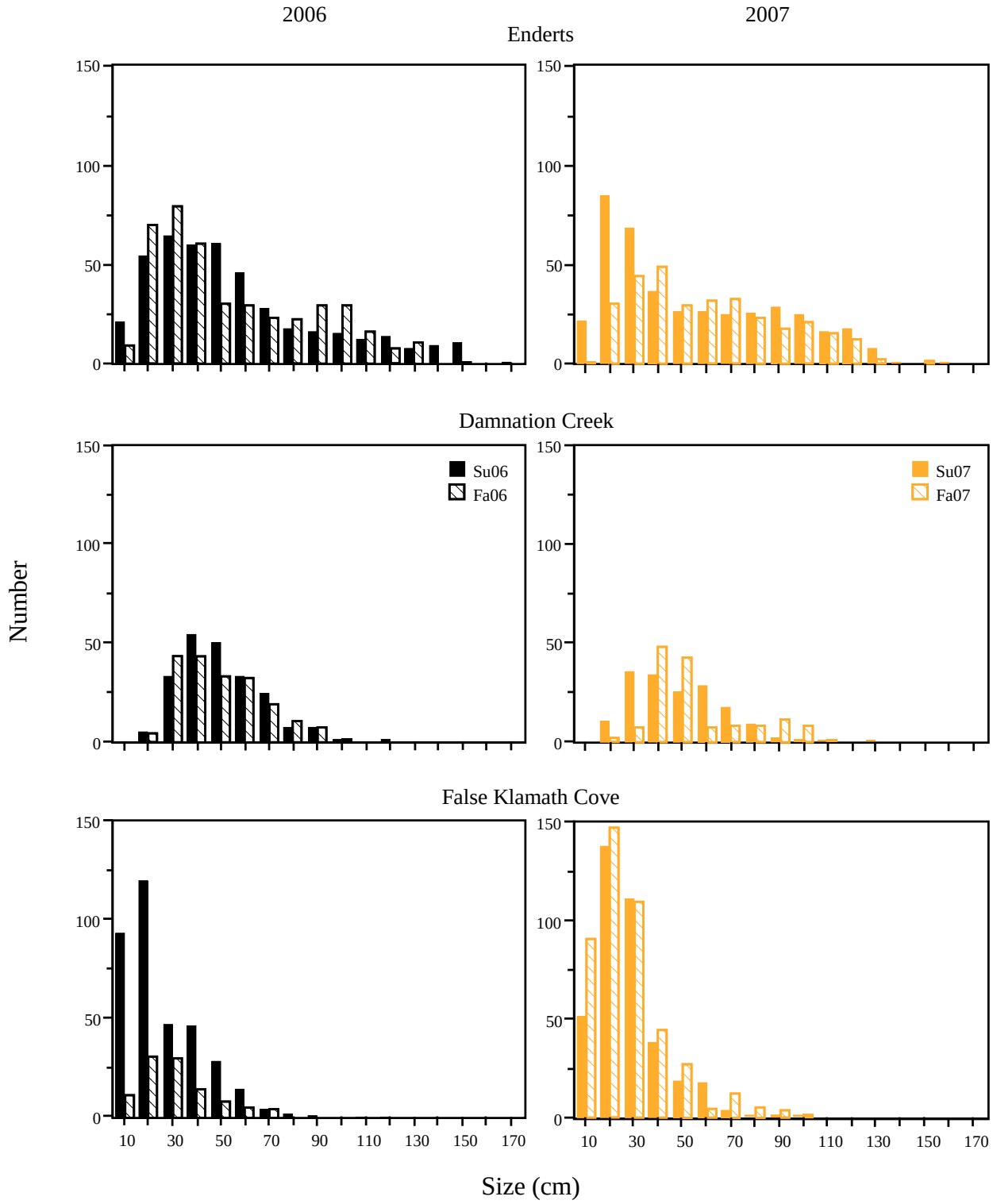
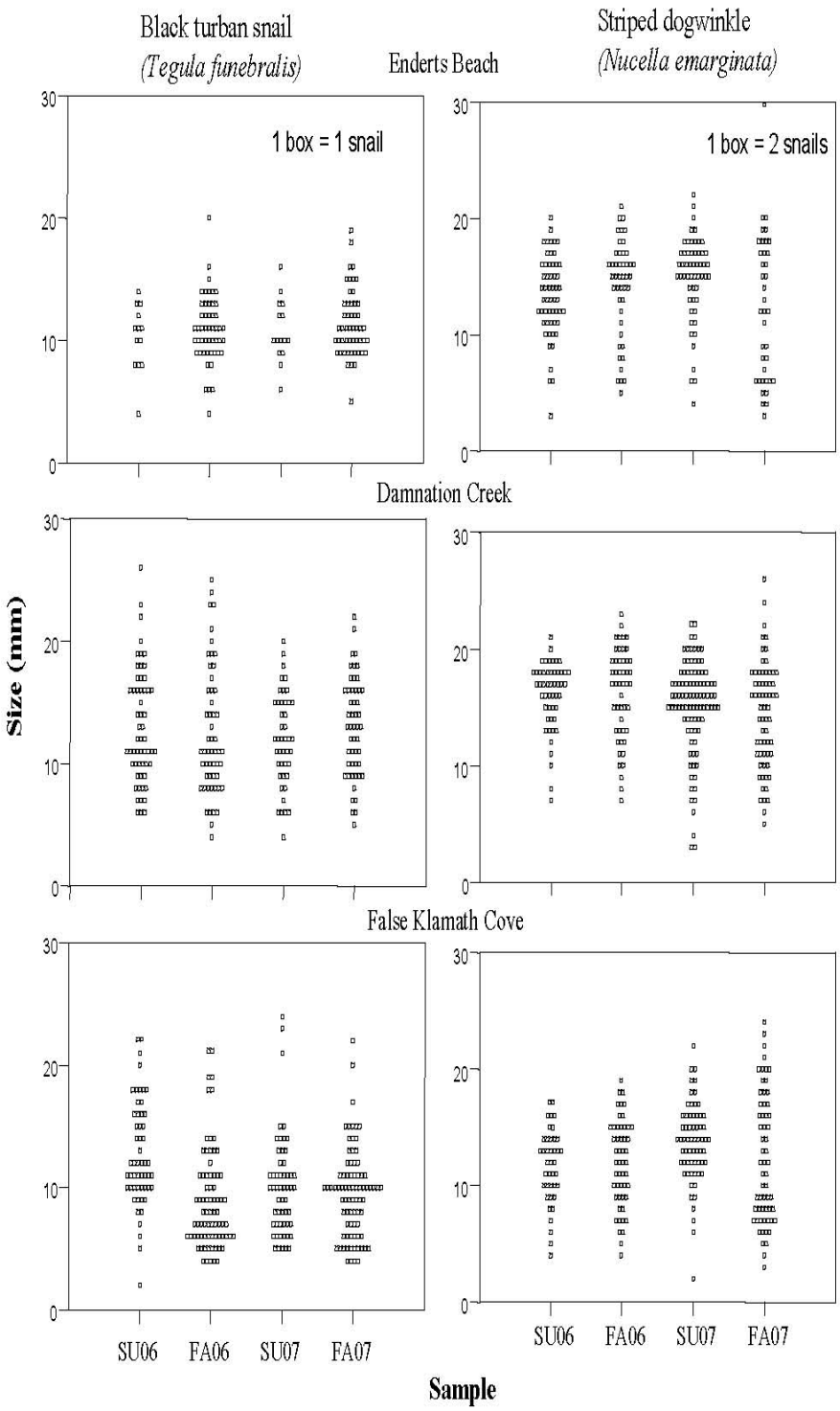


Figure SOP 14.2. Example of a plot illustrating size frequency distributions of Ochre sea stars (*Pisaster ochraceus*) at three sites within the Redwood National and State Parks (REDW). Figure from Ammann et. al. 2009.

Figure SOP 14.3. Sample figure illustrating size frequency distributions of black turban snails (*Tegula funebralis*) and



striped dogwinkles (*Nucella emarginata*) at three sites within REDW during 2006 and 2007. The width of each bar represents the abundance of each size class. Figure from Ammann et. al. 2009.

Statistical trend analyses will be conducted every six years. Comparisons of the community dynamics among the SFAN sites are used to track changes and are also integrated within the broader sampling efforts of MARINe. This collaboration provides more power to evaluate local changes in the context of a broader system, which is able to consider large-scale changes in the environment such as geographic variation in climate.

Analysis for the SFAN status and trend reports will follow a similar assessment to the trend reports completed for Cabrillo National Monument's rocky intertidal program (Becker 2006). Details of these analyses can be found in the Cabrillo National Monument Trend Report and are paraphrased as follows. The same number of fixed plots is established in each zone using a random, stratified experimental design appropriate to the highly patchy habitat (Miller and Ambrose 2000). Basic trends of percent cover, averaged by zone, are graphed for all key species for photoplots (e.g., barnacles (*Chthamulus*, *Balunus*, etc.), mussels (*Mytilis spp.*), rockweed species (e.g., *Silvetia compressa*), and line transects for surfgrass (*Phyllospadix spp.*). In order to minimize variability, photoplot target types are not pooled when analyzed. For example, the percent cover of mussels was considered only in mussel plots. Line transect target types are pooled, since there are only two transects of each target type in each zone. Photoplots and line transects are all "fixed," or measured in the same location every season.

The benefit of this sampling design is that it limits some of the natural variability in the system that can obscure important trends in the data. However, the tradeoff is that it is not possible to extrapolate trends in the plots to the whole area without using additional information about the area (Miller and Ambrose 2000, Murray et al. 2006). In addition, data from the same place at different times are not statistically independent and therefore the types of statistical analyses appropriate for this study are limited (Murray et al. 2006). In order to determine if there are differences between plots in zones, or between the trends in the plots in zones (a "Zone x Time" interaction effect), we will use two methods. First a repeated-measures ANOVA will be conducted on all of the trends. The analysis is conducted, with year as the within-subject variable (dependents), zones as the between-subject variable (factors) and cover as the response variable (independents). Percent cover data need to be transformed to normality prior to analyses. If a zone/time interaction is found, the zone and time analyses become meaningless (Underwood 2002). For the second method we will also treat all the data as binomial and run as a generalized linear model with grouped effect in each habitat type and an autoregressive effect since we are sampling the same plots each year.

If there is no significant ($p<0.05$) zone effect or zone/time interaction for a given species, all plots from all zones are averaged into a single trend for all sites. If there is a significant difference in the time effect among the zones, the trends for each zone are considered separately. Trends are examined using a regression analysis. For each taxon, the goodness of fit (r^2) will be investigated with linear (GLM) and non-linear (GAM) models. The regression descriptive statistics (slopes and intercepts) are also reported.

Summary Table and Trend Graph Examples

Below are examples of photoplot summary (Table SOP 14.1) and a summary of motile invert counts and size frequency (Tables SOP 14.2–3). Example trend graphs of acorn barnacles from the MARINe program (Figure SOP 14.4) and KLMN (Figure SOP 14.5) are also included.

Table SOP 14.1. Photoplot summary of the mean percent cover by zone at Scorpion Rock, Santa Cruz Island, Spring 2004 (five plots/zone). (Channel Islands National Park rocky intertidal monitoring data excerpt).

Zone	Bare Rock	Barnacle	Tetra-clita	Endo-cladia	Hespero-phycus	Silvetia	Mussels	Turf-weed	Leaf Barnacle	Misc Algae	Misc Animal	Other
Barnacle	36.4	17.2	0.0	25.8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.4
Endocladia	28.4	4.0	0.4	53.8	0.0	0.2	1.4	0.0	1.4	10.0	0.2	0.2
Mussels	24.2	10.4	16.4	2.6	0.0	0.0	29.4	1.0	0.2	12.8	1.8	1.2
Tetraclita	55.4	3.6	11.4	3.8	0.0	0.0	13.4	0.0	3.0	7.2	1.6	0.6
Hespero-phycus	40.4	0.4	0.0	23.8	20.8	11.0	0.8	0.0	0.2	2.6	0.0	0.0

Table SOP 14.2. Motile invertebrate size frequency measurements (mm). (Channel Islands National Park rocky intertidal monitoring data excerpt).

	Nucella emarginata	***Acanthina spp.***	***Tegula funebralis***	***Ceratostoma nuttali***	***Ocenebra circumtexta***	***Lottia gigantea***
Count	8	19	4	1	84	8
Average size	17	16	17	29	12	41
Minimum size	11	7	15	29	4	12
Maximum size	22	22	19	29	36	63

Table SOP 14.3. Motile invertebrate counts for Scorpion Rock, Santa Cruz Island, Spring 2004, categorized by zones (Banacle and Endocladia) and plots within zones. (Channel Islands National Park rocky intertidal monitoring data excerpt).

	Barnacle					**Endocladia**				
Species	**801**	**802**	**803**	**804**	**805**	**806**	**807**	**808**	**809**	**810**
Lepidochitona spp.							2	1		
Nuttalina spp.								1		
Fissurella volcano										
Pachygrapsis					4			3	2	
Pagurus spp.										
large limpets(>15mm)										
S. purpuratus									1	
Amphissa versicolor										
Nucella emarginata	1						3			
Acanthina spp.			1		3			1	2	
Tegula funebralis						1				
Ceratostoma nuttali										
Ocenebra circumtexta			1			2	2	3	5	8
Lottia gigantea										
Pisaster ochraceus										
Littorina spp.	325	2,563	413	1,363	938	253	197	253	344	1,225
subsample1	3	94	18	48	18	41	24	56	75	37
subsample2	9	77	11	31	24	16	20	22	14	42
subsample3	14	34	4	30	33	24	19	3	21	19

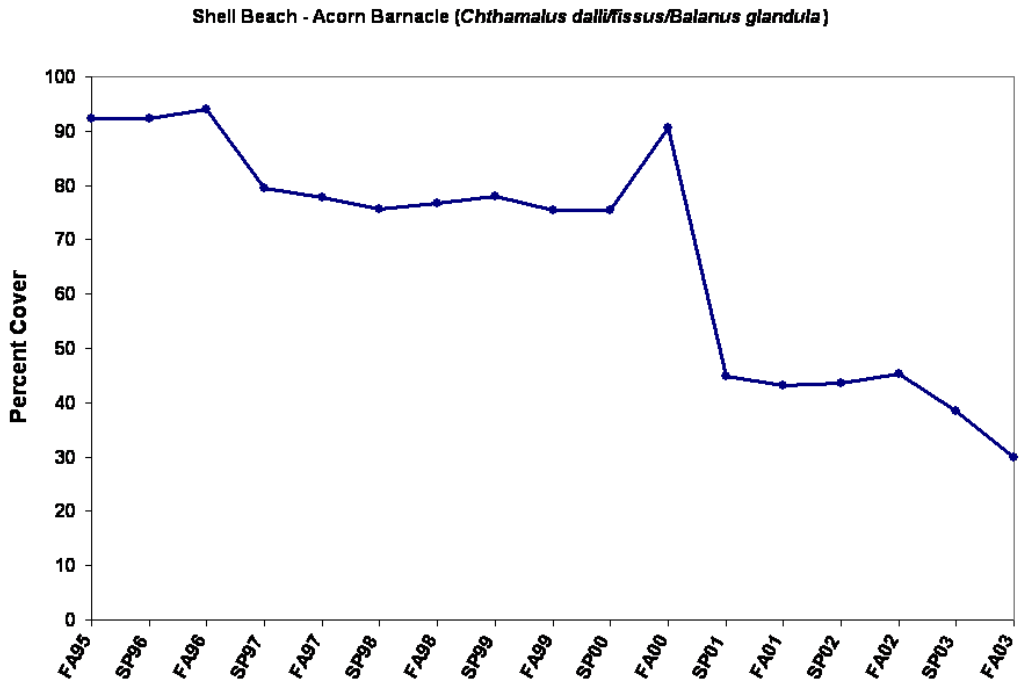


Figure SOP 14.4. Example trend graphs from nine years of MARINe data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Shell Beach in San Louis Obisbo County (from http://www.marine.gov/).

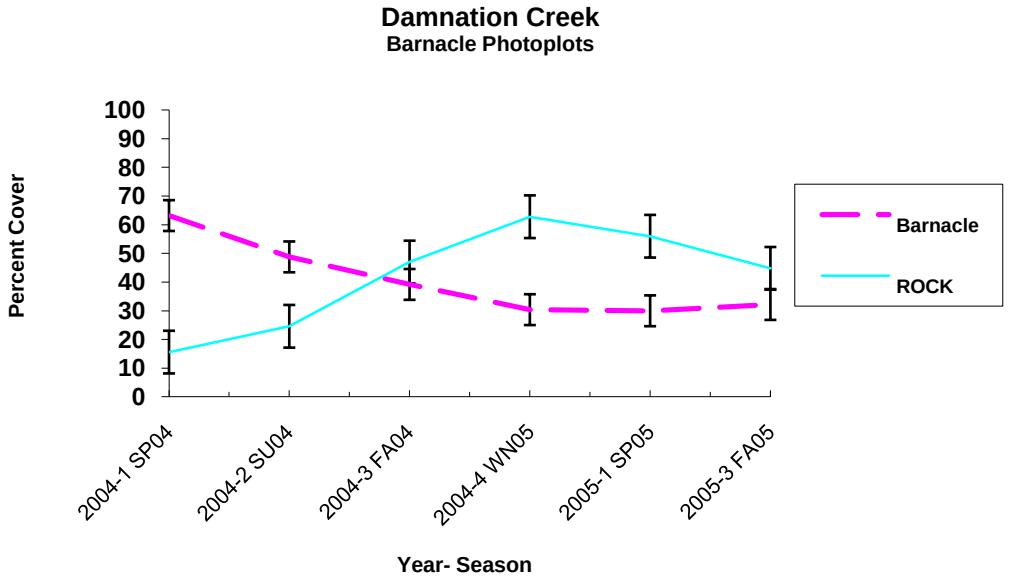


Figure SOP 14.5. Example graph from two years of percent cover data for Acorn Barnacles Chthamalus dalli/fissus/Balanus glandula at Damnation Creek, REDW.

Literature Cited

Ammann, K. N., P. T. Raimondi, and D. Lohse. 2009. Monitoring of rocky intertidal communities of Redwood National and State Parks, California: 2006–2007 annual report. Natural Resource Report NPS/PWR/KLMN/NRTR—2009/274. National Park Service, Fort Collins, Colorado.

Becker, B. J. 2006. Status and trends of ecological health and human use of the Cabrillo National Monument rocky intertidal zone (1990–2005). Natural Resource Technical Report NPS/PWR/CABR/NRTR—2006/03. National Park Service, Seattle, WA.

Miller, A. W., and R. F. Ambrose. 2000. Sampling patchy distributions: Comparison of sampling designs in rocky intertidal habitats. Marine Ecology-Progress Series **196**:1–14.

Murray, S. N., R. F. Ambrose, and M. N. Dethier. 2006. Monitoring rocky shores. University of California Press. Berkeley, California.

Underwood, A. J. 2002. Research techniques in animal ecology: Controversies and consequences, edited by L. Boitani and T.K. Fuller. Journal of Experimental Marine Biology and Ecology, **268**:115–116.

SOP 15. Revising the Protocol

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) explains how to make changes to the San Francisco Area Network's (SFAN) Rocky Intertidal Monitoring Protocol, the narrative, and the accompanying SOPs, and how to properly track these changes. Any persons making changes to the protocol should first read this SOP to ensure that proper reviews are conducted and documentation standards are followed.

General Considerations

This Rocky Intertidal Monitoring Protocol, the narrative, and accompanying SOPs have been implemented using best-fit methodologies and protocols for the collection and analysis of long-term marine rocky intertidal resource data. However, standard protocol, regardless of how appropriate its method, will require editing as new and/or different information becomes available.

Any persons asked to edit the Protocol Narrative, or any of supporting SOPs, will need to follow this outlined procedure carefully in order to eliminate confusion as to which methods were employed when data were collected and analyzed. It is equally important to articulate any new or changed procedures as clearly and concisely as possible for credible interpretation of data acquired after the implementation of the change.

Procedure for Revising Protocol

1. The Rocky Intertidal Monitoring Protocol Narrative and accompanying SOPs designed to provide adequate documentation to ensure that differences between observers and observation years do not create bias in data collection. However, changes and revisions will inevitably be necessary based on new information; these changes will be documented as soon as they are deemed necessary and appropriate reviews conducted.
   All edits will be reviewed technical accuracy and overall clarity. Minor changes or additions to existing methods will be reviewed by relevant network and park staff. However, if a substantial change in methods is anticipated then an outside review is required. Subject matter experts familiar with wetland and riparian habitat monitoring and data analysis will evaluate the proposed changes.
2. Edits and protocol revisions will be documented in the Revision History Log that accompanies the Protocol Narrative and each SOP. Only changes in the Protocol Narrative or specific SOP that has been edited will be logged. Minor changes, such as an alteration of species lists, will be recorded as decimal increases in version number (*e.g.*, Version 1.1 to 1.2). Major changes, such as an alteration in objectives or update after five-year analysis, will be recorded as integer increases in version number (*e.g.*, Version 1.2 to 2.0). "Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number" (Peitz et al. 2002). Changes to conform to the most recent formatting required by NPS "Instructions to Authors" (NPS 2006) are generally completed as part of protocol revision and not noted separately as changes.
3. Notify the Network Lead Data Manager or Project Manager of any changes to the Protocol Narrative or SOP so that the new version number can be in the project database per any changes to the Protocol Narrative and SOPs.

4. Post new versions on the internet and notify all individuals known to have a previous version of the Protocol Narrative or SOP.
5. When any significant changes in the data collection protocols occur, such as changes in sample collection techniques or equipment, a change in database, or changes in staff, there should be an overlap of methods and personnel (Oakley et al. 2003). This requires using both the old and new techniques on a given survey as well as having both the outgoing and new staff survey concurrently.

Protocol Review

Appendix SOP 15A will contains the PWR Protocol Review Checklist, comments provided by peer reviewers and author responses.

Review Approval and Distribution

Key personnel involved with the development, implementation, and review of this monitoring protocol will be on the electronic mailing list for receipt of this document and subsequent major revisions. The current version is listed in Table SOP 15.1. Key personnel include:

- Dale Roberts, Data Manager, San Francisco Bay Area Network
- Dave Press, Data Manager, San Francisco Bay Area Network
- Darren Fong, Aquatic Ecologist, Golden Gate National Recreation Area
- Daphne Hatch, Chief of Natural Resource Management, Golden Gate National Recreation Area
- Natalie Gates, Chief of Natural Resource Management, Point Reyes National Seashore
- Ben Becker, Director of the Pacific Coast Science and Learning Center, Point Reyes National Seashore
- Marcus Koenen, Inventory and Monitoring Program Manager, San Francisco Bay Area Network
- Dr. Peter Raimondi, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz.
- Sarah Allen, Ocean coordinator, Pacific West Region.

Table SOP15.1. Current Rocky Intertidal Monitoring Protocol documents.

Document Name	Current Version	Version Date	Author
Long-term Monitoring Protocol for Rocky Intertidal Communities of Golden Gate National Recreation Area and Point Reyes National Seashore, California	1.0	January 2011	Ammann et al.
SOP 1: Pre-season Preparations	1.0	January 2011	Ammann et al.
SOP 2: Training Field Workers	1.0	January 2011	Ammann et al.
SOP 3: Establishing and Maintaining Plots	1.0	January 2011	Ammann et al.
SOP 4: Completing Field Logs and Assessing Site-wide Species Conditions	1.0	January 2011	Ammann et al.
SOP 5: Photographing Plots and Taking Area Photos	1.0	January 2011	Ammann et al.
SOP 6: Estimating Percent Cover in Field Using Point-Intercept Method	1.0	January 2011	Ammann et al.
SOP 7: Scoring Photoplots in Office (Using Graphical Software)	1.0	January 2011	Ammann et al.
SOP 8: Motile Invertebrate Counts	1.0	January 2011	Ammann et al.
SOP 9: Sea Star Monitoring	1.0	January 2011	Ammann et al.
SOP 10: Surfgrass Monitoring	1.0	January 2011	Ammann et al.
SOP 11: Temperature Loggers	1.0	January 2011	Ammann et al.
SOP 12: Downloading Digital Photos and Photo Image Management	1.0	January 2011	Ammann et al.
SOP 13: Data Entry and Management including Uploading to MARINe Database	1.0	January 2011	Ammann et al.
SOP 14: Data Analysis and Report Writing	1.0	January 2011	Ammann et al.
SOP 15: Revising the Protocol	1.0	January 2011	Ammann et al.
SOP 16: Project Deliverables	1.0	January 2011	Ammann et al.
SOP 17: Safety Procedures	1.0	January 2011	Ammann et al.
SOP 18: Study Site Descriptions	1.0	January 2011	Ammann et al.

Literature Cited

Oakley, K. L., L. P. Thomas, and S. G. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 31:1000–1003.

National Park Service. 2006. Instructions to Authors—Natural Resource Report and Natural Resource Technical Report: Version 2.4. Natural Resource Report NPS/NRPC/NRTR—2006/001. National Park Service, Fort Collins, Colorado. Online. (https://science1.nature.nps.gov/naturebib/biodiversity/2007-6-5/Instructions_to_Authors.pdf). Accessed 2 March 2010.

Peitz, D. G., S. G. Fancy, L. P. Thomas, and B. Witcher. 2002. Bird monitoring protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Prairie Cluster prototype monitoring program.

SOP 16. Project Deliverables

Version 1.0

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This Standard Operating Procedure (SOP) summarizes expectations for project deliverables in the Rocky Intertidal Monitoring Program at SFAN. This document provides details on the process of submitting completed datasets, reports and other project deliverables. Appendix SOP 16A provides a synopsis of who is responsible and the destination and target submission dates for specific deliverables.

Data Deliverables

The Data Manager at SFAN is responsible for working with the LPFBs to deliver the following by December of every year:

- Working MARINe database in MS Access format containing data from previous season (SOP 13).
- Data certification report: A brief questionnaire that describes the certified data product(s) being submitted. The data certification report is in SOP 13.
- Digital overview and scored photoplot photographs and photograph metadata for the previous season(s). Digital photograph products are described in SOPs 5 and 12.
- Field data forms from the previous season(s). Data forms from all intertidal sampling methods are found in SOPs 4–10.
- Updated data dictionary. If changes occur to the structure of the MARINe database, an updated data dictionary will be submitted.

Annual Progress Report

The Data Manager will prepare an annual progress report which will be a short (approximately two pages) status report in memo format addressed to the SFAN Technical Steering Committee. The report will summarize accomplishments and problems encountered by the SFAN Rocky Intertidal Monitoring Program during the most recent field season. The progress reports will also summarize the status of data collection and submittal of data to MARINe. Notable changes in the health or the distribution and abundance of intertidal flora and fauna will be noted in the progress report but no formal data analysis will be required.

Biennial and Trend Reports

It is the responsibility of the Data Manager to work with the LPFBs to develop the biennial and trend reports in the proper format using current literature and appropriate data analysis tools. Biennial reports should be submitted to SFAN for review no later than February 15th of every other year. The trend reports will be completed every six years (or when additional analyses are warranted). Once reviewed, the LPFBs should send the report to the Inventory and Monitoring (I&M) key official, by February every other year, for submission as a NPS technical report. Once approved, the report should be sent to the GOGA and PORE representatives as a PDF. In addition, the PDF and all documents (e.g., .doc, .xls, .snp) incorporated into the PDF should be sent to the SFAN Data Manager in their original format no later than March every other year (SOP 14).

Other Publications

The LPFBs, Data Analyst, members of the MARINe group or individuals of the public may publish scientific literature that includes data from the SFAN intertidal monitoring program. Individuals or groups should seek permission from the LPFBs prior to using any data from the SFAN intertidal monitoring program. Publications that include GOGA and PORE intertidal data will be made available to SFAN for local park collections. Copies will also be made available through the NPS Natural Resource Information Portal (NRInfo).

Storage and Posting of Project Deliverables

The posting and storage of all project deliverables will be coordinated by the Data Manager. Once the data has been stored and posted, the Project Lead will be notified that the year's data have been uploaded and successfully processed. The Data Manager will store, post, and use the products created as part of the intertidal monitoring effort in the following arrangement:

Biennial Reports

- Posted: The biennial report will be posted to the SFAN Internet and Intranet web sites. Electronic copies will be sent to the Resource Chiefs at each park in the Network and to any NPS staff associated with the project. A record will be created in NRInfo for each report and the reference code will be added to the properties of the document. The report will be submitted to the NPS Natural Resource Technical Report series.
- Timelines: Biennial reports are posted to all the above locations and delivered to the Resource Chiefs within two weeks of finalizing the document. A new record in NRInfo will be created within one month of completing the reports.
- Stored: The biennial report will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal). Backups will follow processes listed in the SFAN Network Data Management Plan (Press 2005).
- Use: SFAN will use these reports to update the SFAN I&M Program Annual Report.

Trend Reports

- Posted: Trend reports will be posted to the SFAN Internet and Intranet web sites. Electronic copies will be sent to the Resource Chiefs at each park in the Network and to any NPS staff associated with the project. A record will be created in NRInfo for each trend report and the reference code will be added to the properties of the document. The report will be submitted to the NPS Natural Resource Technical Report series.
- Timelines: Trend reports will be posted to all the above locations and delivered to the Resource Chiefs within two weeks of receiving the document. A new record in NRInfo will be created within one month of receiving the reports.
- Stored: The trend report will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal). Backups will follow process listed in the SFAN Data Management Plan (Press 2005).

- Use: Trend reports will be used to detect and evaluate natural and anthropogenic changes in intertidal communities and interpret findings for resource managers.

Database

Posted: After being screened for sensitive information, a copy of the current database will be made available by contacting the SFAN Data Manager.

Timelines: After a holding period of two years, the Data Manager will upload the certified data to the NPS Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems.

Stored: The database will be stored in the Intertidal_Data folder, a subfolder of the Intertidal project folder located on the SFAN network drive. Backups will follow process listed in the SFAN Data Management Plan (Press 2005). Copies of the MARINe database and motile invertebrate spreadsheet will be submitted annually to MARINe on the schedule described in table SOP 13.1.

Use: Species listed as observed in the database will be compared to species on the PORE or GOGA species list located in the National I&M database, NPSpecies. If a species is in the MARINe database and not on the species list, the Project Manager and park lead will be contacted to determine if the new species should be added to the species list.

Metadata Interview Form

Posted: A parsed XML metadata record for the MARINe database will be posted on the NPS Data Store. The Metadata Interview Form will be used to update the metadata on the NPS Data Store.

Timelines: If needed, metadata will be updated and posted to the NPS Data Store whenever a new data set is posted to the Data Store.

Stored: The Metadata Interview Form will be stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal). Backups will follow process listed in the SFAN Data Management Plan (Press 2005).

Use: This form, along with the Data Dictionary, will be used to develop and update the metadata for the MARINe database. This form will also be used to determine if any sensitive data is contained in the database.

Photographs

Posted: Photographs are currently not posted for public use. Photos, however, are maintained on the network drive (\\INPGOGAMAHE1\Individual Vital Signs\RockyIntertidal\Images).

Timelines: All photographs will be inserted into the proper folders within one month of taking them.

Stored: Photographs will be stored in the Intertidal_Image folder, a subfolder of the Intertidal project folder located on the SFAN network drive. Photographs

appropriate for publications will be copied to the SFAN Photo Database at the end of each field season.

Use: Pictures will be used in a variety of methods including reports, presentations, web sites, trainings, etc.

Photograph Metadata

Posted: Photograph metadata are currently not posted for public use.

Timelines: Photographs and related metadata will be moved to the network drive (\\INPGOGAMAHE1\Individual Vital Signs\RockyIntertidal\Images) within one month of receiving the electronic images.

Stored: Metadata for each photograph is contained in the file name as described in SOP 12 above. Additional notes can be placed in an individual file's summary information tab which can be accessed by right clicking on the file and then left clicking PROPERTIES. Backups follow processes listed in the SFAN Data Management Plan (Press 2005).

Use: Photograph metadata is used to describe date, time, location, and other information about each picture in detail so photos can be used by current and future staff.

Product Certification Form

Posted: Product certification forms are not posted for public use.

Timelines: Product certification forms will be moved to the proper folder immediately upon delivery.

Stored: Product certification forms are stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal). Backups follow processes listed in the SFAN Data Management Plan (Press 2005).

Use: These forms are used to track when a product was distributed to SFAN.

Field Data Forms

Posted: Field forms are not posted for public use.

Timelines: Field forms will be converted to a PDF document and the electronic files will be stored in the project folder within two weeks of delivery. Field forms will be returned to the Project Lead within one month of receiving the forms.

Stored: Hardcopy field forms will be converted to a PDF and stored in the Intertidal_Document folder, a subfolder of the Intertidal project folder located on the SFAN network drive (\\INPGOGAMAHE1\Individual_Vital_Signs\ RockyIntertidal) Backups follow processes listed in the SFAN Network Data Management Plan (Press 2005). Hardcopy forms will be photocopied and stored in the proper locked file cabinet. Originals will be returned to the LPFBs.

Use: Field forms will be used to compare to the electronic data as issues arise. In addition, electronic versions of the forms will be available for archive and use by future park staff.

Literature Cited

Press, D.T. 2005. Data management plan for the San Francisco Area Network Inventory and Monitoring Program. USDI National Park Service. San Francisco, California. Online. (http://science.nature.nps.gov/im/units/sfan/MonitoringReports.cfm). Accessed 5 March 2010.

Appendix SOP 16A. Schedule for Project Deliverables

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Digital photographs and metadata	Data Manager	December 15 of the same year	SFAN Digital Library[1]
Certified working database	Data Manager	December 15 of the same year	SFAN Digital Library[1], and NRInfo[2]
Data certification report	Data Manager	December 15 of the same year	SFAN Digital Library [1]
Metadata interview form	Data Manager	December 15 of the same year	SFAN Digital Library[1]
Annual progress report	Data Manager	December 15 of the same year	SFAN Digital Library
Full metadata (parsed XML)	Data Manager	December 15 of the same year	NRInfo[2], SFAN Digital Library[1]
Biennial report	Data Manager and LPFBs	Every 2 years by February 15th of the following year.	NRInfo[2], SFAN Digital Library[1], SFAN Internet and Intranet web pages, printout to local park collections, Natural Resource Technical Report Series
Resource Briefing	LPFBs	Every 2 years	SFAN Internet
Field data forms	Data Manager	December 15	scanned PDF files in SFAN Digital Library[1], physical copies moved to park collections
Six year trend report	Data Manager and LPFBs	Every 6 years by February 15th of the following year	NRInfo[2], SFAN Digital Library[1], SFAN Internet and Intranet web pages, printout to local park collections, Natural Resource Technical Report Series
Other publications	LPFBs, Data Manager	as completed	NRInfo[2], SFAN Digital Library[1], SFAN Internet and Intranet web pages, printout to local park collections
Other records	LPFBs	review for retention every January	retain according to NPS Director's Order #19[3]

[1]The SFAN Digital Library is a hierarchical digital filing system stored on the SFAN file servers. Network users have read-only access to these files, except where information sensitivity may preclude general access.
[2]NRInfo is a repository of NPS natural resource data, metadata and references (http://nrinfo.nps.gov).
[3]NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://www.nps.gov/refdesk/DOrders/DOrder19.html

SOP 17. Safety Procedures

Version 1.00

Revision History Log

Previous Version #	Revision Date	Author	Changes Made	Reasons for Change	New Version #
				.	1

Purpose

This SOP provides guidelines for field safety procedures for the Rocky Intertidal Monitoring Protocol implemented at GOGA and PORE.

Scope and Applicability

This SOP includes discussion on the following safety related topics:

- Field trip preparations and emergency contacts
- Transportation
- Environmental Conditions
- Animals
- Plants
- Checklist of Safety Equipment

Also see SFAN Field Safety SOP maintained on the GOGA Marin Headlands server (Inpgogamahe\Divisions\Network I&M\Shared\Standard Operating Procedures\SFAN Field SOPs\Standard Operating Procedures) for information on:

- Emergency Procedures
- Vehicle Safety
- Air Quality Guidelines
- Slippery Substrates

Intertidal investigations may be dangerous, due to the high wave energy at many sites. In addition to the dangers posed by waves, intertidal sites are often in remote locations with restricted access. The dangers of intertidal investigations are compounded by having to work within the tight time constraints imposed by the tides. It is essential that all field personnel working in the intertidal are familiar with the appropriate safety precautions and that they are properly equipped and trained to work in this demanding environment.

When planning fieldwork, the initial consideration is that the work can be conducted during daylight low tides. Ideally, work should be conducted during significant minus tides, although each site is different and some sites may require lower tides than others. Prior to going on-site NOAA weather radio should be monitored to determine average wave height. Once on site, investigators should take a few minutes to observe the wave action and determine that it is safe to sample prior to beginning sampling activities. If possible, investigators should face the ocean and frequently scan incoming waves to ensure that egress from the site is not blocked by rising seas. If conditions are marginal, one person should serve as an observer to warn others of approaching large waves.

A safety meeting should be held each day, prior to entering the field. The plans for the day should be discussed, and any potential safety hazard should be analyzed and actions taken to minimize any hazards.

Procedures and General Requirements

Site visit notification

Prior to conducting site visits, field staff should review the Site Visit Checklist (Table SOP 17.1). For individual safety, it is critical to inform park staff about the field itinerary. Park staff may need to contact you while you are in the field and may need to provide assistance in case of emergency. Informing park staff can also provide interpretive opportunities to park visitors. In addition, other staff including seasonal employees or volunteers may want to accompany field surveys whenever possible.

Table SOP 17.1. Site visit checklist.

Check	Required Action
	Inform supervisor regarding your field activities including: - sampling locations (with map) - mode of transportation - names of field team members - expected sampling times - vehicle information (make/model)
	Your cell phone or radio is fully charged.
	Check weather and be aware of potential changes (eg. storms, floods, etc.
	All field team members have reviewed SOP Field Safety and know how to contact emergency personnel or park staff if needed

Environmental Precautions

Harbor seals or other marine mammals may occur close to or in Rocky Intertidal Monitoring Sites. The area adjacent to the Point Bonita sampling site is also a known harbor seal haul-out. The seals are most likely to haul out during low tide which is the same time period required to effectively monitor the intertidal zone. Care must be taken not to flush animals from the haul out by wandering around the study site. If seals are in the study area, the sampling must be postponed until it can be entered without disturbing animals.

Safety Precautions

Individuals should not be left alone in the intertidal. All field staff should obtain First Aid and CPR training before working in the field. Wilderness First Aid or higher is recommended because some sampling sites are remote and it may take more than one hour to get assistance.

Weather and Field Attire

Summer conditions are often hot (between 75 - 90°F). Because of the possibility of encountering poison oak and general uneven terrain found off-trail, field personnel should wear long pants and high-topped hiking boots when hiking to field sites. Leg gaiters are also recommended to reduce the exposure to poison oak and the risk of tick bites during surveys. If rubber boots are worn, they should fit well to reduce risk of slipping. Additionally, the choice of footwear is an important water safety consideration during sampling. A good combination for both rocky and muddy sites is neoprene waders (i.e., wet-suit material) with either attached boots or worn in

combination with snug fitting knee-high boots. If the attached boot style is preferred, be sure that the boots fit snugly. This style of wader will float a person who has fallen into the water, rather than dragging them to the bottom like the old vinyl or rubber on canvas style waders will do.

Field Hazards

Water Safety

Regardless of the habitat, personnel working in intertidal environments should be proficient swimmers. This not only means that individuals will be able to help themselves in the case of a dunking, but it also means that all personnel will be able to help a person who falls into the water. Untrained personnel should not attempt water rescues. At Alcatraz Island, strong current conditions require all field personnel within 3 meters of the water to be wearing personal flotation devices.

Exposure

Hypothermia is the most commonly encountered health hazard for intertidal investigators. It is recommended that all field personnel pack a change of clothes, and at minimum a waterproof parka, regardless of the weather at the beginning of the day.

Falling Rocks

The bluffs surrounding the rocky sites are constantly eroding and are highly unstable. Investigators should remain alert for falling rocks.

Insects

Biting or stinging invertebrates (wasps, spiders, ticks, mosquitoes) may be encountered. The bites or stings from these animals can be painful, but usually not fatal. If bitten or stung and painful swelling or an allergic reaction occurs, seek medical attention immediately. Check your clothing and exposed skin frequently when in the field for ticks and upon returning from the field, do a more thorough body search for ticks. Ticks are common and may transmit Lyme's disease. Ticks embedded in the skin should be carefully removed immediately. They can be tested for the presence of Lyme's disease and the bite should be monitored for symptoms. West Nile Virus is also present and is transmitted by mosquitoes. Only a few species of mosquitoes carry the virus and fewer are infected. Another issue to be aware of is Hantavirus which is spread through rodent feces and normally a concern indoors, or garages, or other areas where equipment may be stored.

Poisonous/Toxic Plants

Poison oak is found throughout the study area. Before doing any fieldwork personnel should become familiar with the dangers associated with exposure to this native plant. If exposure occurs wash thoroughly with soap and rinse with plenty of water upon returning from the field and then apply Tecnu® ointment (provided at headquarters). If a strong reaction occurs, seek medical attention and alert your supervisor as soon as possible.

Hazardous Wildlife

Mountain lions occur in the study are but are rare. Rattlesnakes may also occur but rarely near coastal areas where sampling will occur. Harbor seals and sea-lions occur in the study area but do not generally pose a risk to field staff.

Inclement Weather

Sampling along the shoreline is always challenging because of the uneven terrain. The area is especially dangerous during storm events especially those that result in large waves. Boomer waves are infrequent but may occur in the sampling area. Weather including wave conditions should be checked prior to field work to ensure that sampling area is safe.

Contaminated Water

Waterborne pathogens include typhoid, tetanus, hepatitis, polio, and rabies. Excess quantities of E. coli can cause gastrointestinal problems but are usually less severe than the previously mentioned pathogens. Never drink water straight from a creek. Water in intertidal zone may be contaminated with pathogens or harmful chemicals. Use extra precautions when working with water that is known to be contaminated. Some precautions include not eating or drinking while sampling and not putting objects such as pencils in your mouth. In particular, keep hands away from nose, ears and mouth (this also helps reduce spreading of poison oak). Wash hands thoroughly before eating. If no soap and water are available, use of an antibacterial hand cleanser is highly recommended.

Transportation

Most of us drive a vehicle regularly and may not always think about the hazards associated with it. It is very important to inspect the vehicle before leaving. Ensure that safety equipment is in the vehicle. During driving to and from sampling areas it is particularly important to consider issues such as nighttime driving and fatigue, storms, road flooding, driving in (initially) unfamiliar areas and remote areas where large animals may be crossing the road.

Environmental Hazards and General Emergency Information

Individual parks have occupant emergency plans which cover safety procedures for medical emergencies, earthquakes, floods, fires, bomb threats. Be familiar with the procedures and emergency contact numbers of your duty station park as well as other parks you may visit during field sampling activities. Overall, be aware of your environment, use common sense, do not exceed your limits (for example, operation of equipment; lifting heavy objects and equipment; physical tolerance to exertion, heat, and cold), and trust your instincts.

Mandatory Safety Equipment

Each field crew is required to carry the following equipment:

- park radio and a cell phone.
- first-aid kit.
- each vehicle must have a flashlight, safety triangles, spare tire and tools.

Recommended Personal Gear

Each field team member is strongly encouraged to carry the following equipment:

- water bottles
- snacks

- hat
- pocket knife
- long-sleeved shirt and light-colored, long pants
- sunscreen
- insect repellent
- leather work gloves (if needed)
- solid footwear
- rubber boots or waders
- compass and map
- backpack
- rain poncho
- special medications if necessary (eg Benadryl, EpiStick)

Job Hazard Analysis (JHA) for Rocky Intertidal Monitoring Activities

Table SOP 17.2 is a Job Hazard Analysis (JHA) developed to analyze the duties, tasks, and potential hazards associated with the program, and addresses the hazards through safe work behaviors and procedures.

Table SOP 17.2. Job hazard analysis (

Work activities	Hazards	Controls and Safe Behaviors
Office Work- Computer use for email and data entry	Muscle and eye strain, repetitive stress injury	Proper posture and use of ergonomic furniture
		Take breaks every hour
Travel to Field Locations in Vehicle	Driving hazards such as accident	Use defensive driving techniques
		Expect oncoming traffic on one-lane roads in park
		Be alert for foggy conditions
		Watch for deer and other wildlife, and adjust speeds to safely operate around areas of high use
`		Obey traffic laws and wear seatbelt at all times
		Do not drive when fatigued, be familiar with route or prepare for unknown route
		Do not talk on radio or cell phone while driving
		Do not put hot drinks on your lap
		Be familiar with the vehicle and its operation

Table SOP 17.2. Job hazard analysis (continued).

Work activities	Hazards	Controls and Safe Behaviors
		Check gauges, tires, wipers, fluids and replace when necessary
		Check vehicle has spare tires, jumper cable and jack with all parts.
Hiking to work areas on trails, routes or off trail navigation	Getting lost or confused as a group	Have map, compass, GPS and other navigational aids and know how to use them.
	Losing a crew member	Travel together when off-trail
		Make sure both members of the team are aware of location, and can find route out if they are separated.
		When trail hiking, plan stops at trail junctions to regroup.
		Arrange meeting places and times -- all crewmembers must wear a watch.
		Have a travel plan for each day and make sure it is understood by all crewmembers
		Stay in communication via radio or stay in sight
		Cell phone and/or radio and spare batteries
		If lost or disorientated, stay calm, assess location by consulting map and landmarks, and proceed to nearest road or trail.
		Do not panic -- Have a mental plan for what to do if lost
		If injured, stay put and radio dispatch.
	Loose footing	When traveling in areas with steep or unstable terrain, stagger your positions so that you are not immediately below someone, yell "rock" if you dislodge one.
	Exposure to cold, wet conditions	Wear proper equipment- and bring extra layers.
		Recognize the signs of hypothermia in yourself and others
		Carry and eat high-calorie foods, stay well-hydrated
	Exposure to heat and sun	Have hat, sunscreen and sunglasses
	Overexertion and dehydration	Recognize the signs of dehydration
		Take frequent rest stops (15 min per every 2 hours) and stay hydrated

Table SOP 17.2. Job hazard analysis (continued).

Work activities	Hazards	Controls and Safe Behaviors
	Injuries due to hiking (aches, sprains and blisters)	Pay attention to footing- plan ahead for the route to avoid steep, unstable terrain
		Use appropriate footwear, boots and socks.
		Prevent blisters and have blister treatments (moleskin, tape etc) accessible.
	Injuries due to falling (lacerations, broken bones, head injuries)	Pay particular attention to traveling on steep slopes, unstable terrain, through dense vegetation, and in foggy conditions. Practice fall- arrest techniques (roll on to stomach, dig elbow, feet and knees in).
		Have first aid kit, stabilize injured person, treat for shock and know how to initiate rescue via radio
	Injuries due to carrying a heavy pack	Reduce pack weights when possible
		Pay attention to how you put your pack on (avoid twisting motions- get help or place pack on surface or against tree)
		Make sure your pack is properly fitted and balanced
Sampling during storm events.	Rain storm	Individuals should never be left alone. Be mindful of increased risk factors (slippery surfaces).
	Lightning storms	In the event of a lightning storm, turn your radio off, if near a vehicle, get entirely inside. If in the out of doors try to do the following: separate the group, get off ridge tops and away from trees, get as low as possible and if possible lie on non-conductive material.
	Wind storms	If it is windy enough to blow small twigs and branches out of the trees, try to get out of the woods or find an area away from hazard trees
	Large waves	Pay heed to the adage “Never turn your back to the sea”, always keep an eye on conditions and don’t take risks on shore edges. Use common sense- if the waves look unsafe, don’t take the risk. Where possible, if a team member needs to collect data (count seastars, for example) with their back to the ocean, appoint another team member to watch waves.
	Swept out to see/caught in rip current.	Swim back to shore. If caught in a rip current, swim parallel to shore until out of the current. Then swim back to shore. See hypothermia below.

Table SOP 17.2. Job hazard analysis (continued).

Work activities	Hazards	Controls and Safe Behaviors
Hiking to/around work areas-stream and river crossings, ponds	Exposure, sprains, broken bones,	Avoid swift or deep water crossings by using foot or automobile bridges.
		Be careful on slippery logs and watch footing on either side of stream crossing.
	Falling into water, drowning	When sampling with waders always wear a life jacket.
		If carried by rip currents allow the current to carry you offshore until the strength of the current dissipates. Then swim parallel to shore until out of the rip and then swim back to shore. ..
	Hypothermia	Recognize early symptoms for hypothermia and treat as necessary (e.g. change into warm/dry clothing). Notify dispatch and evacuate sampling site if symptoms worsen.
Working in the outdoors	Exposure to allergy-causing plants and insects	Alert crew members to possible problems with allergens. Be alert for toxic plants and alert to common bee and wasp nesting habitat and activity-especially the person in front.
		Carry Benadryl, epi-pen or other antihistamine
	Hazardous marine life	Most hazards come from sticks by sea urchin spines or fish spines, or from crab pinches. Use caution with picking up organisms or reaching into pools. Don't reach where you can't see.
	Exposure to toxic plants	Avoid poison oak and stinging nettle when possible. Wear long-sleeved shirts, long pants, and hiking boots. Wash skin exposed to poison oak with Tecnu or other appropriate cleaner and change clothes if necessary at end of day/survey.
		Do not eat any fungus or plant unless you are 100% sure it is edible.
	Exposure to ticks	Wear proper attire (long-sleeved shirts and long pants) and do frequent tick checks. If bitten by black legged tick, properly remove tick and monitor general health condition.
	Exposure to giardia, E. coli and other pathogens	Do not drink any water unless it has been filtered, boiled or treated in some fashion
		Do not create more contaminated areas-urinate away from streams and water, dig a cathole for solid waste and bury toilet paper.
		Wash hands when possible and carry hand cleaner

Table SOP 17.2. Job hazard analysis (continued).

Work activities	Hazards	Controls and Safe Behaviors
	Improper nutrition due to inappropriate food choices	Bring a variety of healthy, nutritious food that will give you good energy during travel and work. Do not rely on sugar snacks.
	Loss of food to ravens, raccoons, small animals	Prevent animals from getting into your food by not leaving you backpack open or accessible to animals.
	Cougar attack	If approached by cougar make yourself large and noisy, wave arms, yell, grab a stick. Back away from cougars but do not turn and run, ever. If attacked, fight back.
	Strange or aggressive human interactions	Terminate contact with the individual and leave the area, contact dispatch or emergency numbers (911)

SOP 18. Study Site Descriptions

Version 1.00

Revision History Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
					1.0

Figures

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Figure SOP 18.5. Site map and access of Alcatraz, Golden Gate National Recreation Area. ..... SOP 18.17

Figure SOP 18.6. Sketch of sample sites on Alcatraz, Golden Gate National Recreation Area. ..... SOP 18.18

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Table SOP 18.7. Slide Ranch interplot measurements ……..……SOP 18.29

This Standard Operating Procedure (SOP) provides detailed site descriptions and a history of occupation for the program's rocky intertidal monitoring sites.

General

The monitoring site descriptions include maps of the monitoring sites to show the location of photoplots, transects, photo points, and any key topographic features to aid the field staff in finding past sampling locations. The site descriptions contain some general physical information (such as geology and habitat type) that can assist others in interpreting monitoring data. Site descriptions are reviewed annually and updated as needed and become a history of the station. As a site description is updated the superseded description is archived, thus the station description becomes a living document detailing the history of the station.

Site Descriptions

Santa Maria Creek, Marin County, California, Point Reyes National Seashore
Location: The monitoring site S of Limantour Beach. Midpoint geographic coordinates: 38°00'37"N, 122°50'45"W (Figures SOP 18.1–2).

Directions: In Point Reyes National Seashore, turn off Limantour Road toward the Clem Miller Education Center. Passing through the locked gate, take Coast Trail to Coast Camp. From the area near the horse-hitching bars, take the trail southwest along the east bank of the creek to Santa Maria Beach. Proceed southeast along the beach approximately 1/4 mile to another creek. The sampling site is the most southeastern platform of the rock outcrop just southeast of the creek.

Establishment: Monitoring at this site was begun in 1996 by Applied Marine Sciences (2002). The MARINe monitoring plots were established in 2006.

Plot/Transect Information: The site contains 10 plots and three seastar transects (Fig. SOP 18.2).

History: A monitoring program was established in 1996 at three sites in PORE (Santa Maria Creek, Bolinas Point, and Elephant Rock; Applied Marine Sciences 2002). From 1998 to 2005, monitoring site was sampled twice yearly during the summer and winter. Sample procedures include point contact (0.3x0.5 m) of quadrats and area searches for seastars. General site photographs and quadrat photos were also taken. Motile invertebrate surveys were also conducted within the same quadrats using a smaller frame (0.25x 0.25 m). Because of time and personnel constraints, motile invertebrate surveys were conducted less frequently. From 2006 to present, the monitoring site is sampled once a year during the early summer at three targeted assemblages using photoquadrats, seastar belt transects, motile invertebrates, and site photographs.

Benchmarks: None used.

Geology/Landform: Granitic rocky bench with some interspersed sand.

Cooperation: The monitoring site is maintained by PORE. Current point-of-contact- Dale Roberts, SFAN Data Manager, 415-663-1408.

Land Ownership: U.S. government (PORE)

USGS Quadrangle: Inverness (7.5 minute)

Period of Record: October 22, 1998 to present.

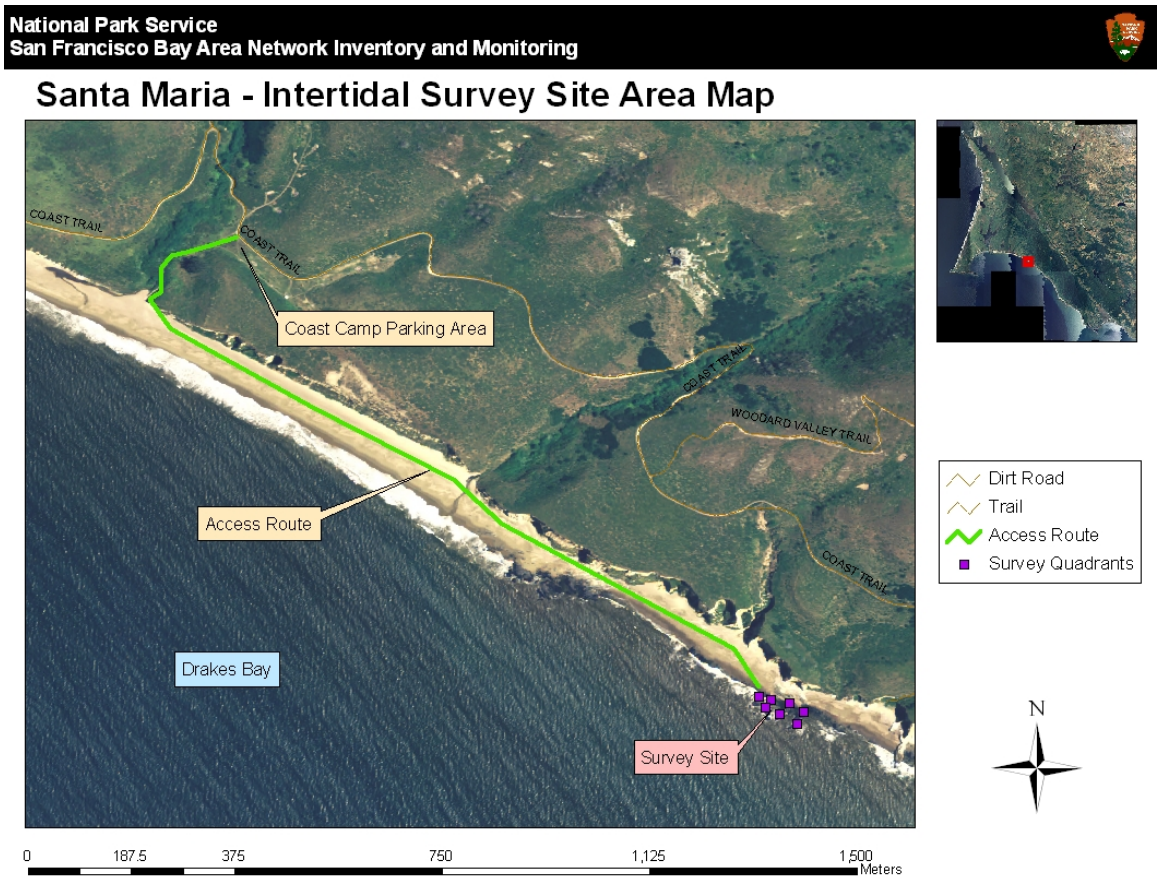


Figure SOP 18.1. Site map and access of Santa Maria Creek, Point Reyes National Seashore.

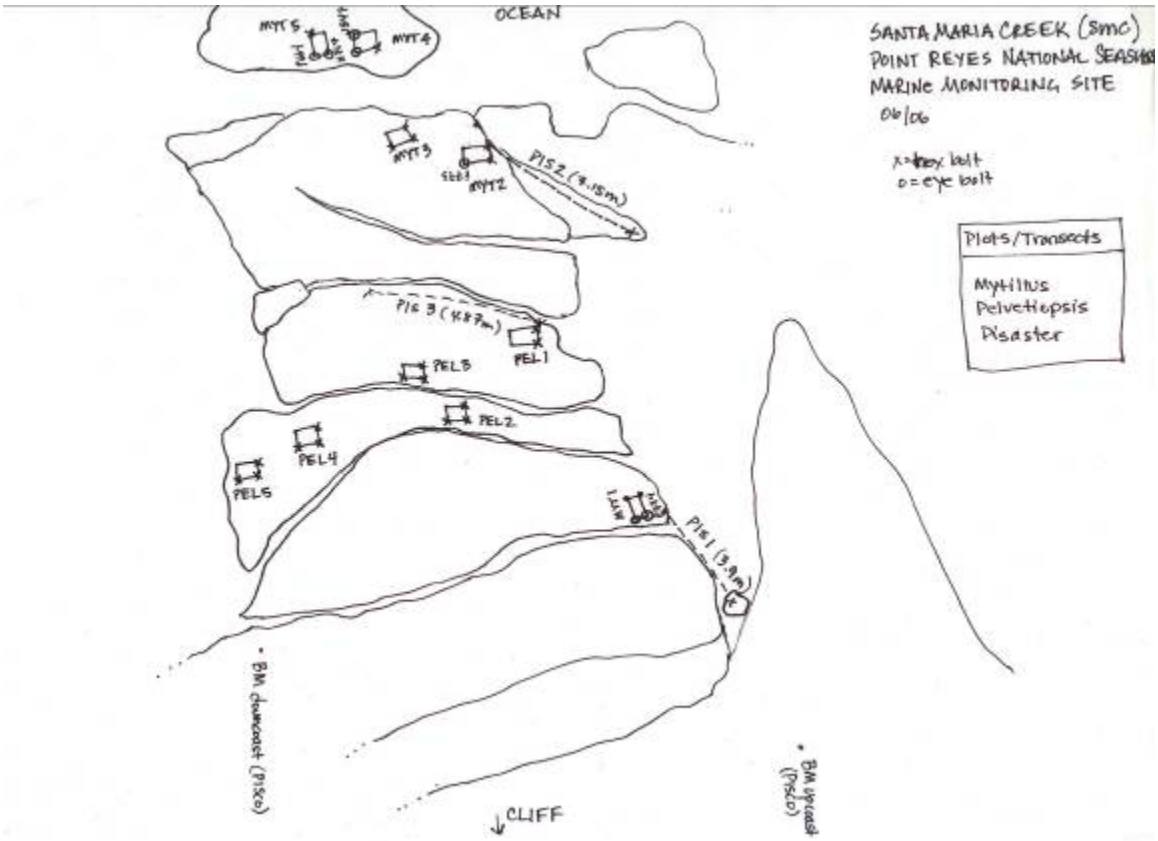


Figure SOP 18.2. Sketch of sample sites at Santa Maria Creek, Point Reyes National Seashore.

Table SOP 18.1. Santa Maria Creek monitoring locations (UTM coordinates, NAD83 datum, zone 10) ND = no data.

Quadrat/ Feature	Established	X coord.	Y coord.
PIS1	2006	513242	4207172
PIS2	2006	513243	4207166
PIS3	2006	513248	4207169
MYT1	2006	513244	4207179
MYT2	2006	513249	4207164
MYT3	2006	513255	4207165
MYT4	2006	513252	4207159
MYT5	2006	513253	4207157
PEL1	2006	513248	4207175
PEL2	2006	513253	4207177
PEL3	2006	513253	4207174
PEL4	2006	513264	4207175
PEL5	2006	513267	4207178

Bolinas Point, Marin County, California, Golden Gate National Recreation Area

Location: The monitoring site at Bolinas Point is located approximately just W of the town of Bolinas Midpoint geographic coordinates: 37°54’13”N , 122°43’40”W (Figures 18.3–4).

Directions: Access is through locked gates at the Commonweal and MCI facilities off Mesa Road in Bolinas. Take the road through the gates to its end at the bluffs overlooking the beach and walk down to the beach *via* the path that angles northward down the bluff. The site is on the outermost intertidal bench offshore and slightly south of a cleft in the bluff through which seasonal freshwater runoff drains to the beach, approximately 3/8 mile south of where the path down the bluff emerges on the beach.

Establishment: The first surveys at this location were conducted by NOAA in 1995 (Consentino and Chess 1997). The MARINe monitoring plots were established in 2006.

Plot/Transect Information: The site contains 20 plots. There are three seastar plots and three surfgrass transects (Figure SOP 18.4).

History: Quadrats and transects were originally established in 1995 (Consentino and Chess 1997). A long-term monitoring program was established in 1996 at three sites in PORE (Santa Maria Creek, Bolinas Point, and Elephant Rock) that continued until 2005 (Applied Marine Sciences 2002). Furthermore, the Partnership for the Study of Coastal Oceans (PISCO) established monitoring plots at Santa Maria Creek and Bolinas Point that were surveyed in 2003 and 2006. These data are highly detailed assessments of a large area (~100m x 50m) as opposed to most intertidal programs that assess small plots (www.piscoweb.org).

Benchmarks: None Used.

Geology/Landform: The Bolinas monitoring site contains a mixture of bedrock bench intermixed with small boulder fields generated by the eroding headlands. The adjacent upslope geology consists of Cretaceous-Jurassic-Fransican complex (greywacke and greenstone) and is reflected in the nature of the boulders themselves.

Cooperation: The monitoring site is maintained by PORE. Current point-of-contact- Dale Roberts, SFAN Data Manager, 415-663-1408.

Land Ownership: U.S. government (PORE)

USGS Quadrangle: Bolinas (7.5 minute)

Period of Record: 1995 to present.

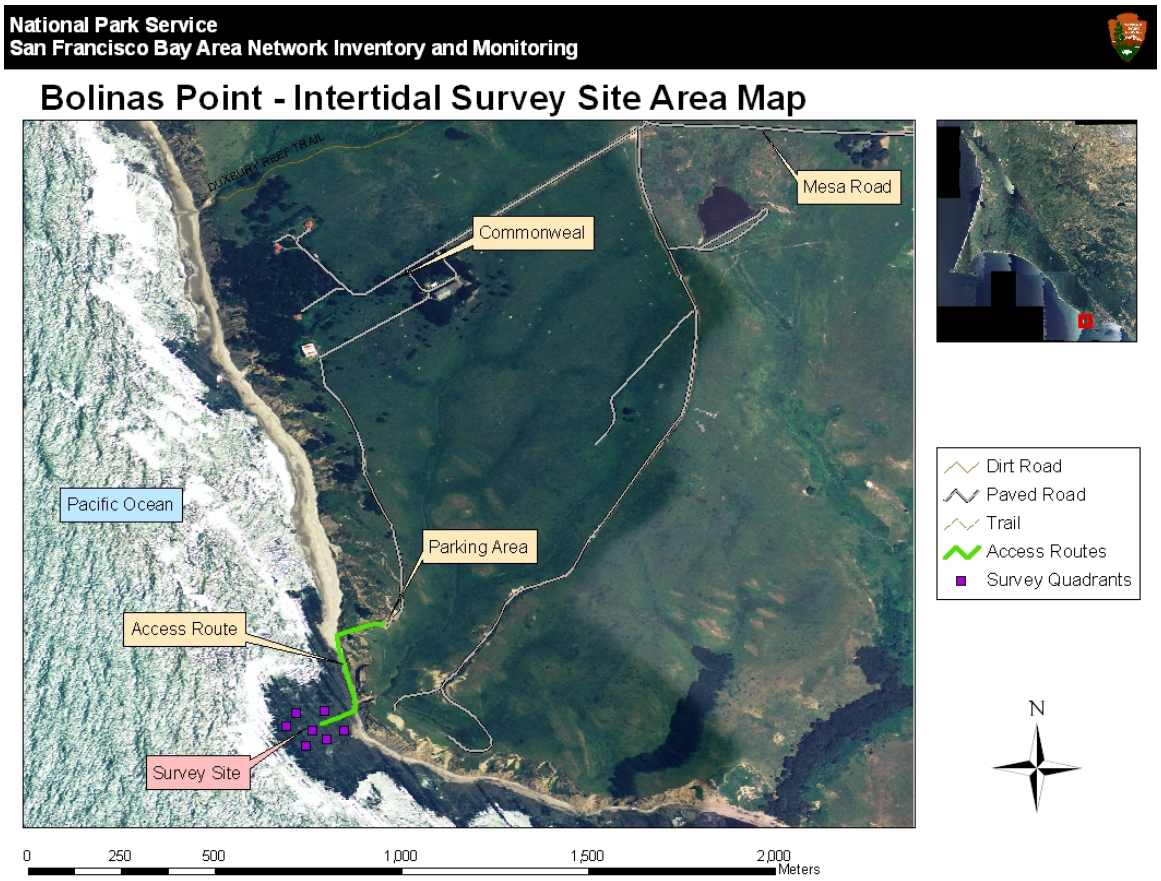


Figure SOP 18.3. Site map and access of Bolinas Point, Point Reyes National Seashore.

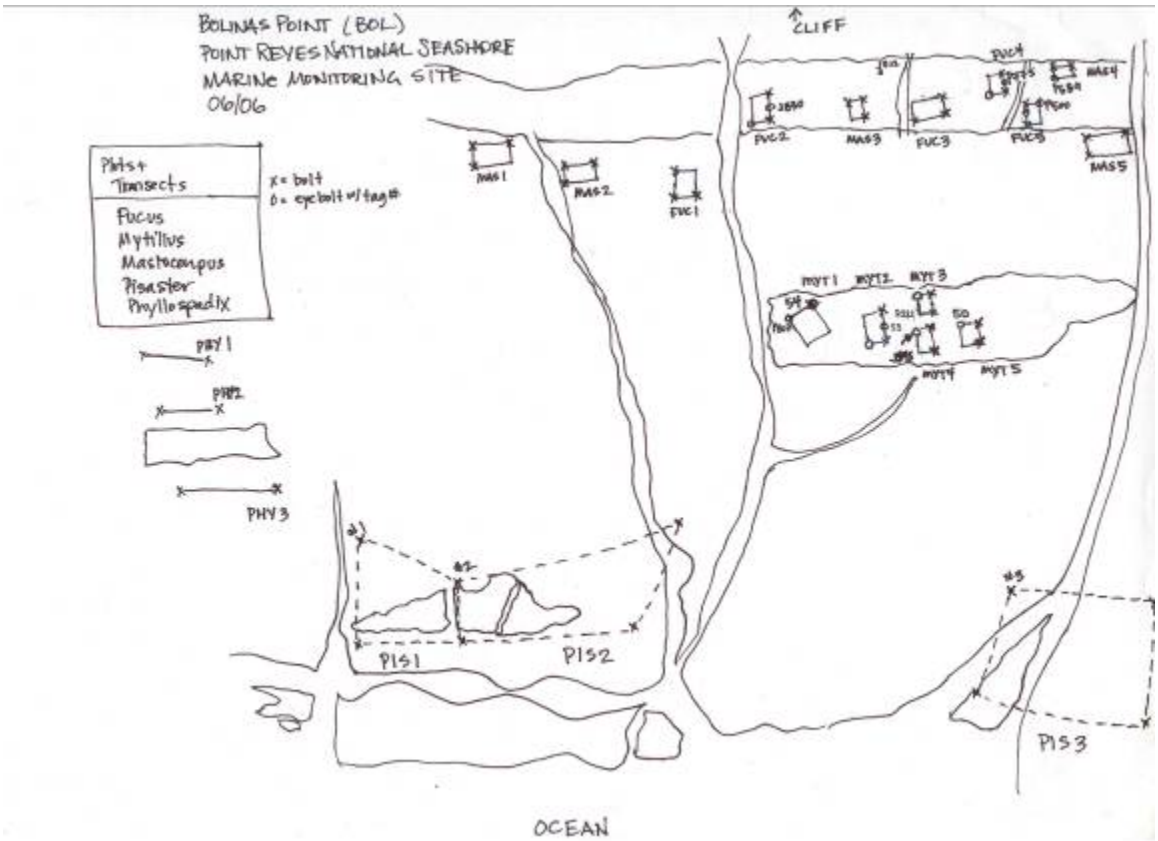


Figure SOP 18.4. Sketch of sample sites at Bolinas Point, Point Reyes National Seashore.

Table SOP 18.2. Bolinas Point monitoring locations (UTM coordinates, NAD83 datum, zone 10)
ND = no data.

Quadrat/ Feature	Established	X coord.	Y coord.
PHY1	2005	523838	4195254
PHY2	2005	523836	4195247
PHY3	2005	ND	ND
PIS1-1	2005	523841	4195177
PIS1-2	2005	523837	4195176
PIS1/2-1	2005	523837	4195162
PIS1/2-2	2005	523838	4195163
PIS2-1	2005	523847	5195143
PIS2-2	2005	523858	4195149
PIS3-1	2005	523869	4195114
PIS3-2	2005	523872	4195115
PIS3-3	2005	523866	4195125
PIS3-4	2005	523860	4195128
FUC1	2005	523885	4195148
FUC2	2005	523892	4195155
FUC3	2005	523901	4195146
FUC4	2005	523903	4195135
FUC5	2005	523904	4195133
MYT1	2005	523870	4195146
MYT2	2005	523872	4195143

Quadrat/ Feature	Established	X coord.	Y coord.
MYT3	2005	523876	4195138
MYT4	2005	523877	4195140
MYT5	2005	523879	4195141
MAS1	2005	ND	ND
MAS2	2005	ND	ND
MAS3	2005	523897	4195151
MAS4	2005	523904	4195129
MAS5	2005	523905	4195126

Alcatraz, San Francisco County, California, Golden Gate National Recreation Area

Location: The monitoring site at Alcatraz is located on the SW corner of the island. Midpoint geographic coordinates: 37°49'30"N , 122°25'19W (Figures SOP 18.5-6).

Directions: Alcatraz is only accessible by boat. The NPS concession serving the island is Hornblower Cruises operating from Pier 33 in San Francisco. The study site is accessed by walking east from the main docks along the Agave Trail. Follow trail approximately .3 mi to a hairpin turn where trail turns into stairs. Climb over railing and continue walking along water. Plots are located on the exposed rock outcrop approximately 25 m beyond the trail fence.

Establishment: Monitoring at this site was initiated with the assistance of Dan Richards, Channel Islands National Park in 1989.

Elevation/Location: The location of monitoring points (quadrats, seastar transects, and photo panorama points) were documented using GPS (Trimble GeoExplorer III) and post-processed to improve accuracy (Table SOP 18.1). Elevations surveyed by Tucker and Assoc., on Feb. 2003. Elevations of quadrats are of numbered brass plot tags. Interplot measurements are provided in Table SOP 18.2.

Plot/Transect Information: The site originally had 15 plots (5 *Fucus*, 5 barnacle, and 5 *Mastocarpus*). One plot was covered by a slide in 2005 leaving 14 plots which are currently being sampled. There are two sea star transects (Figure 18.6).

History: At GOGA, a rocky intertidal monitoring program was established initially in 1989 at Alcatraz Island and Slide Ranch with assistance from Dan Richards, Channel Island National Park. For sites established in 1989, the field sampling protocol was based on a rocky intertidal monitoring program created and implemented by Channel Islands National Park (Richards and Davis 1988). Fifteen permanently established photoquadrat plots (50 x 75 cm) were placed in mid- and high-intertidal sites and targeted typical assemblages of the area (e.g, *Fucus, Endocladia*, or *Mastocarpus*). There are two seastar transects (Fong 2009).

Benchmarks: Two National Geodetic Survey benchmarks are located on the island (PID- HT3019 and HT3015). HT3019, the closest to the intertidal site, is associated with the Alcatraz lighthouse on the parade ground. Geographic coordinates are latitude 37° 49' 34.41831" longitude 122° 25' 19.66380". Elevation is 62 ft (NAVD 88).

Geology/Landform: The south side of the island contains a sheer rock wall that terminates on a narrow rock reef about 10-15 m wide. Geology of the monitoring site consists primarily of a bedrock reef of sandstone and greywacke shale of the Franciscan complex with slide debris from upper slopes (Blake et al. 2000, NPS 2009). The reef is interfingered with surge channels of coarse gravel and cobble materials. This narrow intertidal reef extends only for a short distance (about 200 m) and represents the major rocky intertidal habitat for the island. The rock wall is heavily used during the spring and summer by nesting birds, generally cormorants. This rocky intertidal area is nearby a regional dredged material disposal site that overlaps into waters managed by the Park.

Cooperation: The monitoring site is maintained by GOGA. Current point-of-contact- Darren Fong, GOGA Aquatic Ecologist, 415-331-8716.

Land Ownership: U.S. government (GOGA)

USGS Quadrangle: San Francisco North Quadrangle (7.5 minute)

Period of Record: 1989 to present

Table SOP 18.3. Alcatraz Island monitoring locations and elevations (UTM coordinates, NAD83 zone 10N).

Quadrat/ Feature	X Coord.	Y Coord.	Elevation (ft, NAVD88)	Quadrat Slope
220	550911.1	4186558.7	4.7	sloped
221	550903.8	4186559.7	4.6	flat
222	550897.8	4186559.1	4.6	flat
223	550893.5	4186560.7	4.6	flat
224	550894.3	4186557.8	4.9	sloped
225	550904.8	4186561.6	3.9	flat
226	550899.2	4186555.6	1.8	sloped
227	550892.5	4186560.3	4.7	flat
228	550889.4	4186557.8	2.7	sloped
229	550873.3	4186563.7	3.0	sloped
230	550882.5	4186561.6	3.8	flat
231	550883.3	4186555.6	4.0	flat
232 (&photopan)	550877.8	4186564.3	4.6	sloped
233	550875.4	4186561.3	4.6	sloped
234	550873.8	4186558.2	4.4	sloped
Seastar Bolt (west)	550887.8	4186557.2	3.3	
Seastar Bolt (east)	550901.1	4186556.5	N.D.	
Seastar Surge Channel (landward)	550826.0	4186601.1	0.8	
Seastar Surge Channel (seaward)	550822.2	4186593.7	0.3	
PhotoPan-PSCO#4	550877.9	4186559.4	N.D.	

N.D.= no data

Table SOP 18.4. Alcatraz Interplot Measurements

From Plot#	To Plot#	Distance (m)	Azimuth	To Plot#	Distance (m)	Azimuth
220	225	6.1	280	0	0.0	0
221	225	1.3	5	226	7.7	210
222	226	5.1	160	224	3.6	225
223	224	2.1	155	0	0.0	0
224	222	3.6	45	223	2.1	335
225	220	6.1	100	221	1.3	185
226	221	7.7	30	222	5.1	340
227	228	5.3	213	223	0.5	65
228	227	5.3	33	231	2.1	240
229	233	2.4	105	234	5.2	150
230	231	5.8	145	232	6.9	270
231	228	2.1	60	230	5.8	325
232	230	6.9	90	233	0.7	240
233	232	0.7	60	234	4.1	175
234	229	5.2	330	233	4.1	355

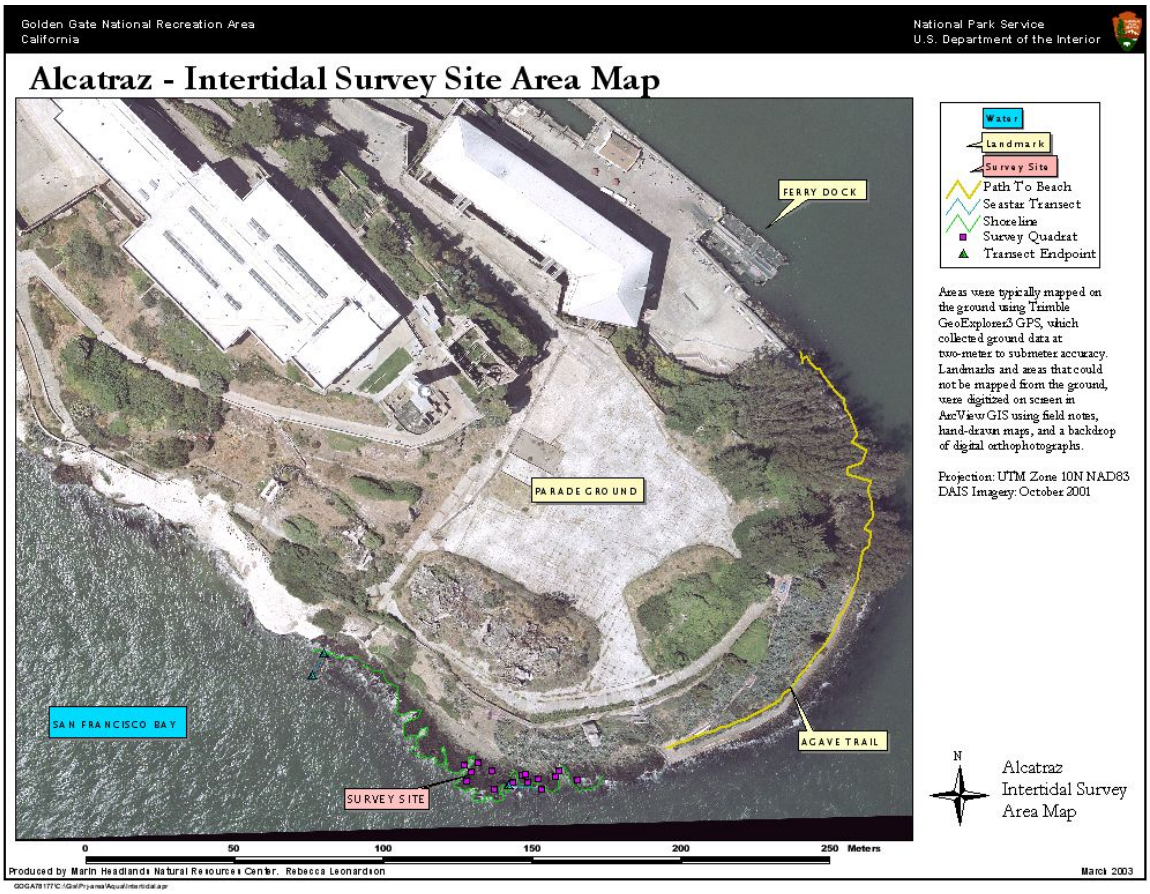


Figure SOP 18.5. Site map and access of Alcatraz, Golden Gate National Recreation Area.

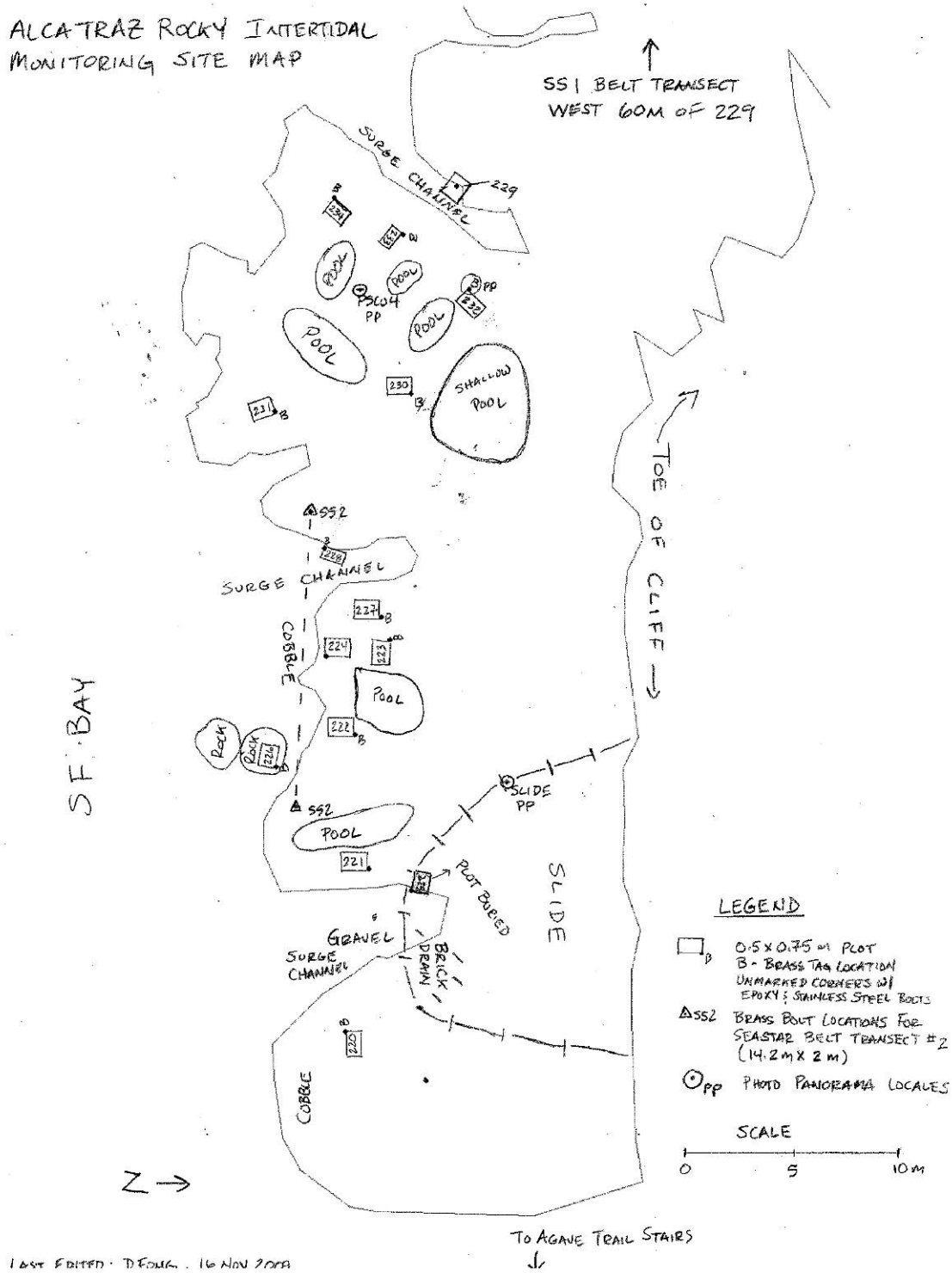


Figure SOP 18.6. Sketch of sample sites on Alcatraz, Golden Gate National Recreation Area.

Point Bonita, Marin County, California, Golden Gate National Recreation Area
Location: The monitoring site at Point Bonita is located in Bonita Cove near the existing Lighthouse and abandoned Coast Guard wharf. Midpoint geographic coordinates: 37°49'8.78895" N 122°31'45.67979" W (Figures SOP 18.7–9).

Directions: From Highway 101 just north of the Golden Gate bridge, exit at the Alexander Ave exit. Head east 300 yards towards Sausalito, turn left and take the Fort Barry tunnel/Bunker Road into the Marin Headlands. Follow Bunker Road west until the Rodeo Lake intersection, turn left onto Field Road. Follow signs to Point Bonita Lighthouse. Park at the Lighthouse trailhead parking. Proceed on foot towards the Lighthouse. Follow dirt path to monitoring site as shown on Figure SOP 18.8.

Establishment: The original monitoring site was established by a consultant, Natalie Cosentino, on June 12–13, 1998 (Cosentino 1998). The MARINe monitoring plots were established by PISCO/MARINe in July 2006.

Elevation/Location: The location of monitoring points (quadrats, seastar transects, and photo panorama points) were documented using GPS (Trimble GeoExplorer III) and post-processed to improve accuracy (Table SOP 18.3). Interplot measurements are provided in Figure SOP 18.7.

Plot/Transect Information: The site contains 10 NPS plots established in 1998, 15 MARINe plots and two seastar transects (Figure 18.9).

History: From 1998 to 2005, monitoring site was sampled twice yearly during the summer and winter. Sample procedures include point contact (0.3x0.5 m) of quadrats and belt transects for seastars. General site photographs and quadrat photos were also taken. Motile invertebrate surveys were also conducted within the same quadrats using a smaller frame (0.25x 0.25 m). Because of time and personnel constraints, motile invertebrate surveys were conducted less frequently (Cosentino 1998). From 2006 to present, the monitoring site is sampled once a year during the summer at three targeted assemblages using photoquadrats, seastar belt transects, motile invertebrates, and site photographs. One 1998-era plot was incorporated into the new plots (Q304→ Endo#3). In addition, quadrat photographs are also obtained of pre-2006 plots.

Benchmarks: One nearby benchmark is present that was used to establish elevations of existing monitoring plots and transects. The point is a NOAA Nat. Ocean Survey Benchmark – a 3" Brass cap Stamped 4609D 1979. The monument is set in concrete headwall at tide level in the vicinity of Point Bonita Lighthouse. Benchmark elevation established by Federal Highways Administration surveyor (February 25, 2009).

NAD_83(CORS96)(EPOCH:2002.0000)
37° 49' 10.88576" 0.011(m)
122° 31' 45.22756" 0.021(m)
3.324(m) +/-0.02m [Elevation in NAVD88 (Computed using GEOID03)]

Geology/Landform: The Point Bonita monitoring site contains a mixture of bedrock bench intermixed with small boulder fields generated by the eroding headlands. The adjacent upslope

geology consists of Cretaceous-Jurassic-Fransican complex (greywacke and greenstone) and is reflected in the nature of the boulders themselves.

Cooperation: The monitoring site is maintained by GOGA. Current point-of-contact- Darren Fong, GOGA Aquatic Ecologist, 415-331-8716. There is also a NOAA monitoring program located on the rocky peninsula with the old Coast Guard wharf (LIMPETs). They are currently counting abundance of ochre seastars and anemones. NOAA point-of-contact- Jan Roletto, Gulf of the Farallones NMS research coordinator, 415-561-6627

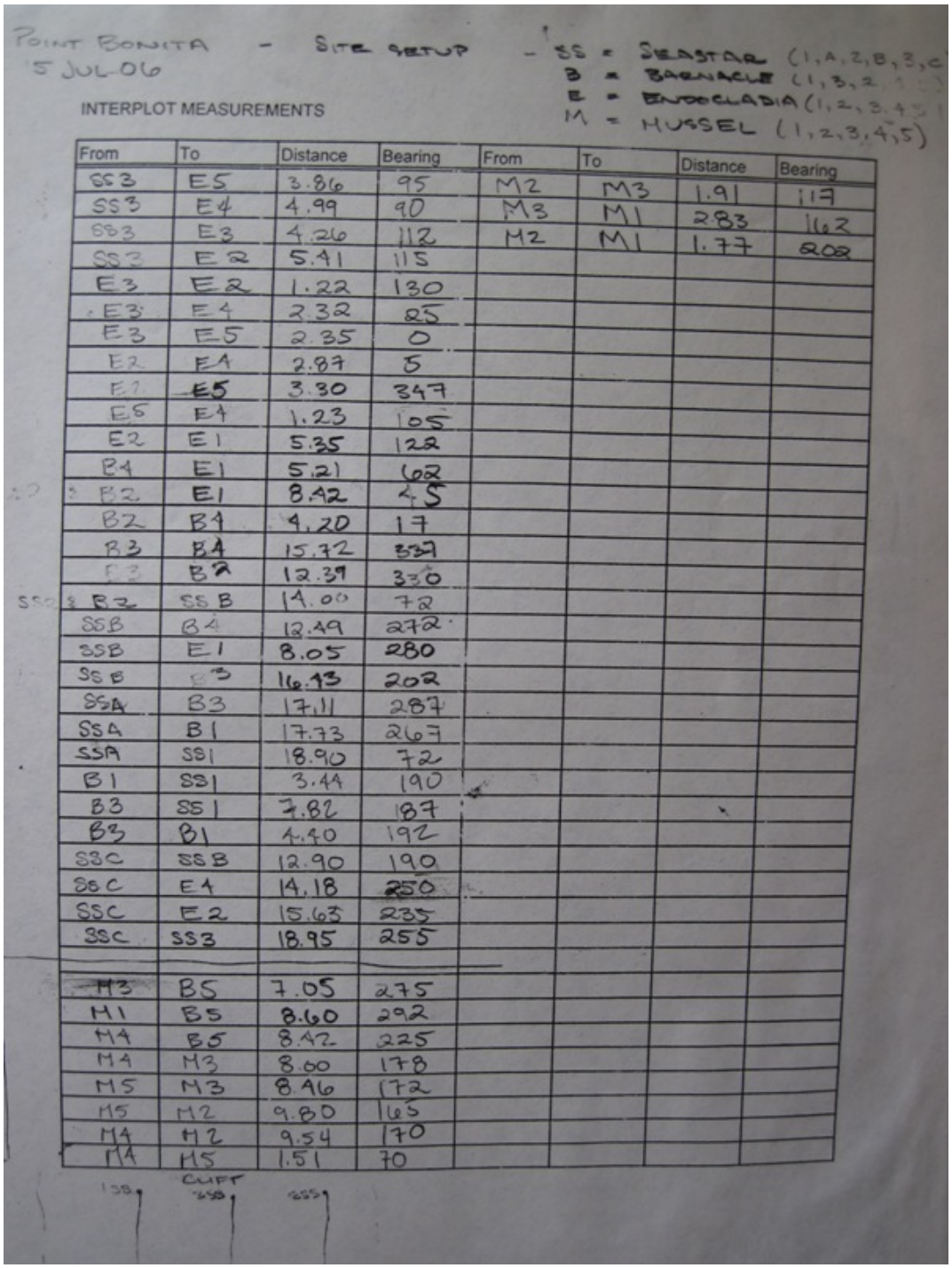
Land Ownership: U.S. government (GOGA)

USGS Quadrangle: Point Bonita (7.5 minute)

Period of Record: October 22, 1998 to present

Table SOP 18.5. Point Bonita monitoring locations and elevations (UTM coordinates, NAD83 zone 10N).

Quadrat/ Feature	Established	X coord.	Y coord.	Elevation (ft, NAVD88)
301	1998	541421.806	541421.806	1.74
302	1998	541417.325	541417.325	2.31
303	1998	541412.012	541412.012	4.91
304	1998	541414.975	541414.975	3.75
305	1998	541413.597	541413.597	3.64
306	1998	541441.774	541441.774	4.46
307	1998	541437.951	541437.951	2.95
308	1998	541441.499	541441.499	2.08
309	1998	541441.966	541441.966	0.73
311	1998	541443.848	541443.848	1.50
B1	2006	541410.200	4185791.907	5.51
B2	2006	541407.769	4185817.700	6.68
B3	2006	541410.696	4185794.172	5.08
B4	2006	541412.284	4185819.308	5.49
B5	2006	541445.235	4185886.652	5.69
E1	2006	541417.842	4185820.254	2.86
E2	2006	541413.783	4185820.032	3.79
E3 (304)	1998	541412.707	4185820.258	3.59
E4	2006	541414.907	4185821.274	2.61
E5	2006	541411.925	4185823.749	2.21
M1	2006	541452.350	4185880.001	5.17
m2	2006	541453.677	4185881.783	5.08
M3	2006	541452.026	4185884.329	4.85
M4	2006	541452.222	4185892.512	4.56
M5	2006	541454.122	4185891.127	4.89
SSTAR1-landward	1998			7.86
SSTAR 1-seaward	1998	541427.564	4185791.907	0.94
SSTAR 2-landward	1998	541411.272	4185804.677	6.68
SSTAR 2-seaward	1998	541423.719	4185805.975	-2.47
SSTAR 3-landward	1998	541408.267	4185825.167	6.11
SSTAR 3-seaward	1998	541427.566	4185825.231	-1.02



POINT BONITA - SITE SETUP
5 JUL-06

SS = SEASTAR (1,A,2,B,3,C)
B = BARNACLE (1,3,2)
E = ENDOCLADIA (1,2,3,4,5)
M = MUSSEL (1,2,3,4,5)

INTERPLOT MEASUREMENTS

From	To	Distance	Bearing	From	To	Distance	Bearing
SS3	E5	3.86	95	M2	M3	1.91	117
SS3	E4	4.99	90	M3	M1	2.83	162
SS3	E3	4.26	112	M2	M1	1.77	202
SS3	E2	5.41	115				
E3	E2	1.22	130				
E3	E4	2.32	25				
E3	E5	2.35	0				
E2	E4	2.87	5				
E2	E5	3.30	347				
E5	E4	1.23	105				
E2	E1	5.35	122				
B4	E1	5.21	62				
B2	E1	8.42	45				
B2	B4	4.20	17				
B3	B4	15.72	337				
B3	B2	12.39	330				
B2	SSB	14.00	72				
SSB	B4	12.49	272				
SSB	E1	8.05	280				
SSB	B3	16.43	202				
SSA	B3	17.11	287				
SSA	B1	17.73	267				
SSA	SS1	18.90	72				
B1	SS1	3.44	190				
B3	SS1	7.82	187				
B3	B1	4.40	192				
SSC	SSB	12.90	190				
SSC	E4	14.18	250				
SSC	E2	15.63	235				
SSC	SS3	18.95	255				
M3	B5	7.05	275				
M1	B5	8.60	292				
M4	B5	8.42	225				
M4	M3	8.00	178				
M5	M3	8.46	172				
M5	M2	9.80	165				
M4	M2	9.54	170				
M4	M5	1.51	70				

CUFF

Figure SOP 18.7. Point Bonita interplot measurements.

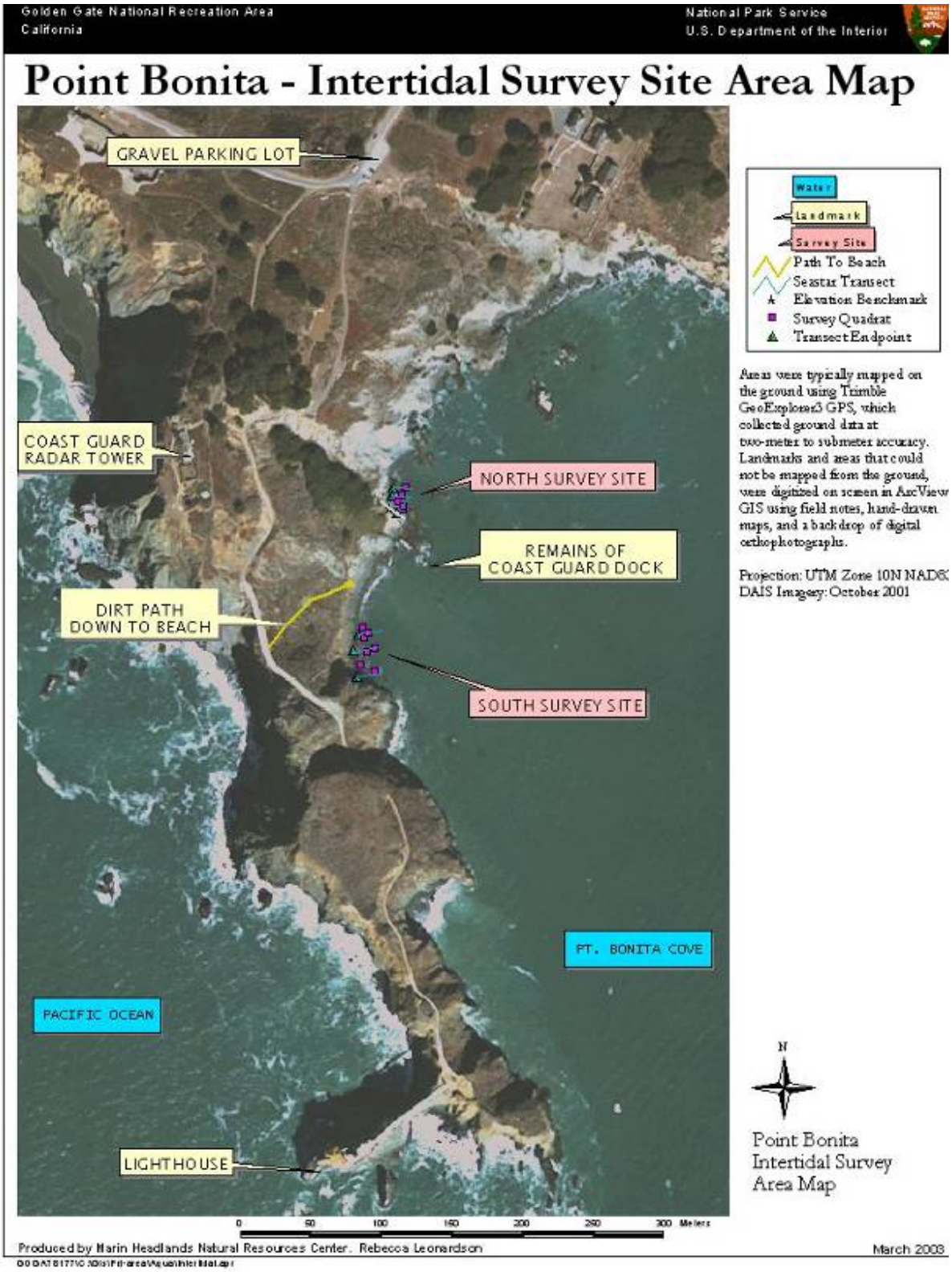


Figure SOP 18.8. Site map and access to Point Bonita, Golden Gate National Recreation Area.

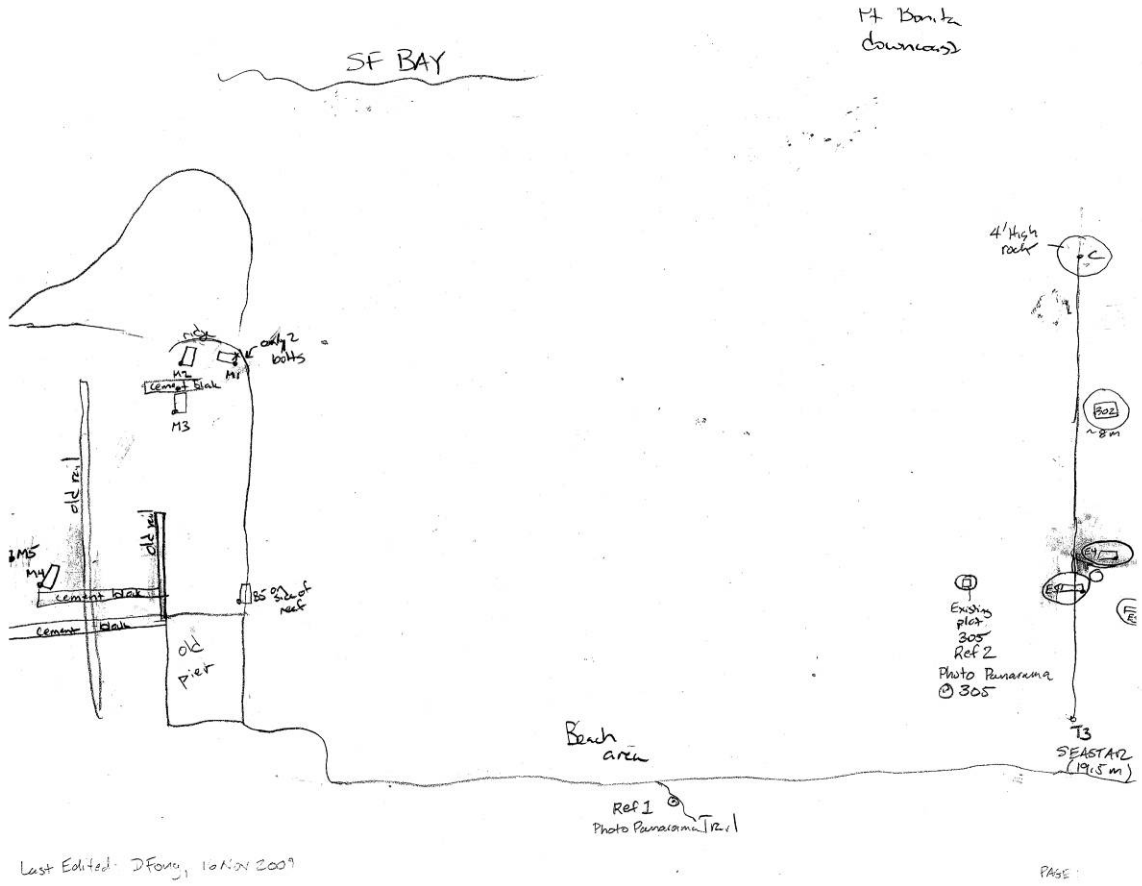


Figure SOP 18.9. Sketch of plot locations at Point Bonita, Golden Gate National Recreation Area.

Slide Ranch, Marin County, California, Golden Gate National Recreation Area

Location: (Figures SOP 18.10 - 13). The monitoring site at Point Bonita is located 1.5 mi S of Stinson Beach off of Highway 1. The plots are on the cobble beach below Slide Ranch. Midpoint geographic coordinates: 37°52’26.62576” N 122°36’3.40054” W.

Directions: From Highway 101 just north of the Golden Gate bridge, exit onto Highway 1 (Stinson Beach/Mt. Tamalpias). Continue on Highway 1 through Stinson Beach until seeing the sign for Slide Ranch (Figures SOP 18.10 and 11) on the left. Park in the upper parking lot and walk into the group of buildings making up the Slide Ranch educational facilities. The beach is accessed by trail extending from the end of the drive.

Figure SOP 18.10. Map to Slide Ranch.

Establishment: The original monitoring site was established by Dan Richards of Channel Islands National Park. The MARINe monitoring plots were established by PISCO/MARINe in 2006.

Elevation/Location: The location of monitoring points (quadrats, seastar transects, and photo panorama points) were documented using GPS (Trimble GeoExplorer III) and post-processed to improve accuracy (Table SOP 18.4). Interplot measurements are provided in Tables SOP 18.5 and Figure SOP 18.12.

Plot/Transect Information: The site includes 10 NPS plots established in 1989 and 20 MARINe plots. There are three seastar transects and three surfgrass transects (Figure 18.13).

History: At GOGA, a rocky intertidal monitoring program was established initially in 1989 at Alcatraz Island and Slide Ranch with assistance from Dan Richards, Channel Island National Park. For sites established in 1989, the field sampling protocol was based on a rocky intertidal monitoring program created and implemented by Channel Islands National Park (Richards and Davis 1988).

Permanently established photoquadrat plots (50 x 75 cm) were placed in mid- and high-intertidal sites and targeted typical assemblages of the area (e.g, *Fucus, Endocladia*, or *Mastocarpus*). From 2001, motile invertebrate surveys were also conducted within the same quadrats using a smaller frame (0.25x 0.25 m). Because of time and personnel constraints, motile invertebrate surveys were conducted less frequently. New quadrats and transects were established in 1995 by NOAA Gulf of the Farallones National Marine Sanctuary (Consentino and Chess 1997). Data for Slide Ranch was summarized by Cosentino and Chess (1997). In 2006, additional permanent photoquadrats (50 x 75 cm) were placed in targeted assemblages by MARINe staff. Three 1989-era plots were incorporated into the new plots (Q209→ Pelv#5, Q217→ Endo#3, Q215→ Endo#4). From 2006 to present, the monitoring site is sampled once a year during the summer at four targeted assemblages using photoquadrats, seastar belt transects, surfgrass transects, motile invertebrates, and site photographs. In addition, quadrat photographs are also obtained of pre-2006 plots.

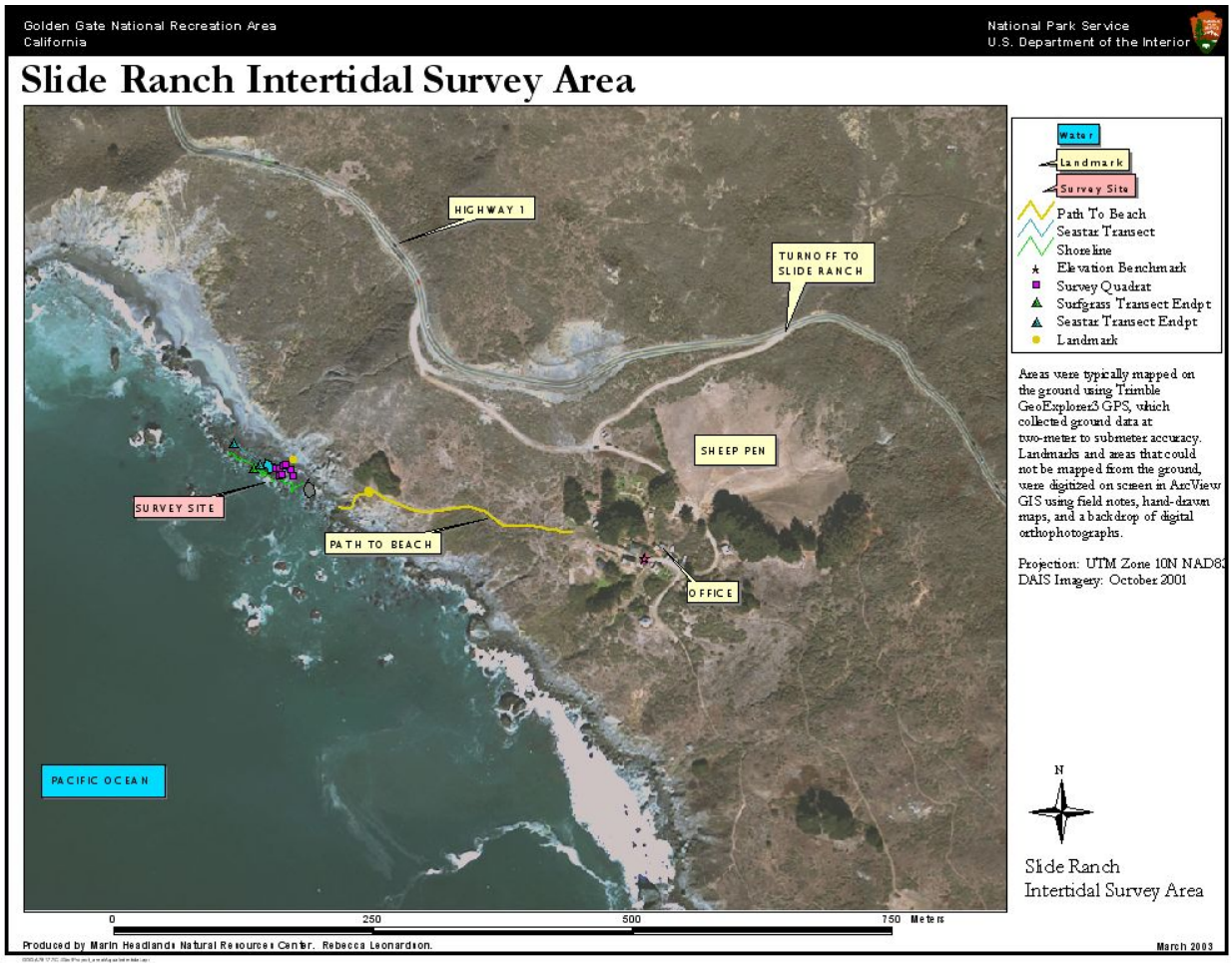


Figure SOP 18.11. Site map and access to Slide Ranch, Golden Gate National Recreation Area.

Benchmarks: NA

Geology/Landform: The Slide Ranch monitoring site contains a mixture of small boulder fields and mixed hard-soft substrates. The adjacent upslope geology consists of Quaternary-Holocene-landslide deposits.

Cooperation: The monitoring site is maintained by GOGA. Current point-of-contact- Darren Fong, GOGA Aquatic Ecologist, 415-331-8716.

Land Ownership: U.S. government (GOGA)

USGS Quadrangle: (7.5 minute)

Period of Record: 1989 to present.

Table SOP 18.6. Slide Ranch monitoring locations and elevations (UTM coordinates, NAD83 zone 10N).

Quadrat/ Feature	Established	X coord.	Y coord.	Elevation (ft, NAVD88)
205	1989	535126.547	4191910.000	4.74
206	1989	535126.148	4191909.121	4.73
207	1989	535128.713	4191902.755	2.80
208	1989	535112.568	4191910.599	3.22
209	1989	535115.402	4191910.168	5.71
215	1989	535117.920	4191904.121	3.47
216	1989	535116.063	4191903.092	4.16
217	1989	535116.369	4191904.440	3.83
218	1989	535119.564	4191912.946	3.60
219	1989	535121.913	4191913.236	4.44
CHT1	2006	535069.119	4191939.146	7.02
CHT2	2006	535068.459	4191941.278	6.72

Table SOP 18.6. Slide Ranch monitoring locations and elevations (UTM coordinates, NAD83 zone 10N).

Quadrat/ Feature	Established	X coord.	Y coord.	Elevation (ft, NAVD88)
CHT3	2006	535083.171	4191928.613	8.47
CHT4	2006	535099.318	4191929.640	8.34
CHT5	2006	535116.894	4191913.146	3.17
END1	2006	535092.095	4191928.206	1.47
END2	2006	535096.879	4191924.337	4.57
END3 (217)	1989	535114.780	4191907.565	2.92
END4 (215)	1989	535117.542	4191906.593	2.86
END5	2006	535121.056	4191901.714	-0.03
MYT1	2006	535059.756	4191929.118	6.52
MYT2	2006	535066.507	4191927.081	7.55
MYT3	2006	535067.737	4191926.233	7.96
MYT4	2006	535073.763	4191926.309	8.32
MYT5	2006	535082.976	4191925.886	6.62
PEL1	2006	535070.994	4191944.733	5.42
PEL2	2006	535072.193	4191941.046	5.42
PEL3	2006	535076.786	4191930.101	4.56
PEL4	2006	535116.220	4191908.719	5.27
PEL5 (209)	1989	535115.493	4191908.931	
REF1	2006	535068.309	4191931.572	
SSTR1-landward	2005	535125.373	4191909.805	4.74

Table SOP 18.6. Slide Ranch monitoring locations and elevations (UTM coordinates, NAD83 zone 10N).

Quadrat/ Feature	Established	X coord.	Y coord.	Elevation (ft, NAVD88)
SSTR1-seaward	2005	535114.610	4191899.176	-0.03
SSTR2-landward	2006	535121.916	4191913.275	1.37
SSTR2-seaward	2006	535108.519	4191904.813	0.97
SSTR3-south	1989	535097.750	4191913.929	-0.53
SSTR3-north	1989	535085.910	4191922.535	-1.21
SURF1N	2001	535077.539	4191918.904	0.95
SURF1S	2001	535096.005	4191901.712	-1.28
SURF2N	2001	535114.287	4191900.498	2.46
SURF2S	2001	535118.653	4191892.328	-2.23

Table SOP 18.7. Slide Ranch interplot measurements (MARINe plots, 1989+).

From Plot#	To Plot#	Distance (m)	Azimuth	To Plot#	Distance (m)	Azimuth
217	218	8.7	60	216	1.8	160
206*	207	6.3	153	209	10.2	290
207	217	12.6	283	215	10.2	284
216	215	1.8	58	217	1.8	340
215	216	1.8	238	219	9.9	28
208	209	3.0	110			
209	206	10.2	110	208	3.0	290
218	217	8.7	240	219	2.6	88
219	205	6.1	130	218	2.6	268
205*	219	6.1	310			

Note: *Quadrats 205 and 206 are adjacent on the same rock

INTERPLOT MEASUREMENTS

site: SLIDE RANCH date: 6/28/06

From	To	Distance m	Bearing	From	To	Distance	Bearing
MYT1	MYT2	4.97	75	PEL5	END4	5.92	140
MYT1	MYT3	6.59	80	END3	END4	2.45	155
MYT1	REF1	8.25	35	END3	END5	6.78	100
MYT2	REF1	5.36	5	END4	END5	4.62	115
MYT3	REF1	5.60	345	#216	END5	5.10	95
MYT4	REF1	8.32	295				
MYT4	PEL3	7.67	355				
MYT3	PEL3	9.68	30				
MYT2	PEL3	10.49	10				
MYT2	MYT4	7.47	75				
MYT3	MYT4	5.84	80				
MYT4	MYT5	8.90	70				
MYT4	CHT3	10.26	60				
PEL3	CHT3.	10.68	100				
PEL3	MYT5	10.99	125				
REF1	PEL2	10.30	5				
REF1	PEL1	13.33	360				
REF1	CHT2	10.55	340				
REF1	CHT1	9.82	337				
PEL3	CHT1	11.35	295				
PEL3	CHT2	11.39	310				
PEL2	CHT2	4.48	257				
PEL2	CHT1	5.23	255				
PEL1	CHT2	4.03	220				
PEL1	PEL2	3.79	140				
END2	END1	5.73	275				
CHT4	END1	7.64	230				
CHT4	END2	5.90	185				
END1	CHT3	7.83	255				
END2	CHT3	13.04	270				
END2	MYT5	13.70	255				
CHT4	CHT3	15.08	245				
PEL4	CHT5	3.67	15				
PEL5	CHT5	4.74	10				
PEL5	PEL4	1.58	350				
PEL4	END3	5.86	160				
PEL4	END4	6.97	135				

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Figure SOP 18.12. Slide Ranch Interplot Measurements (MARINe plots, 2006+).

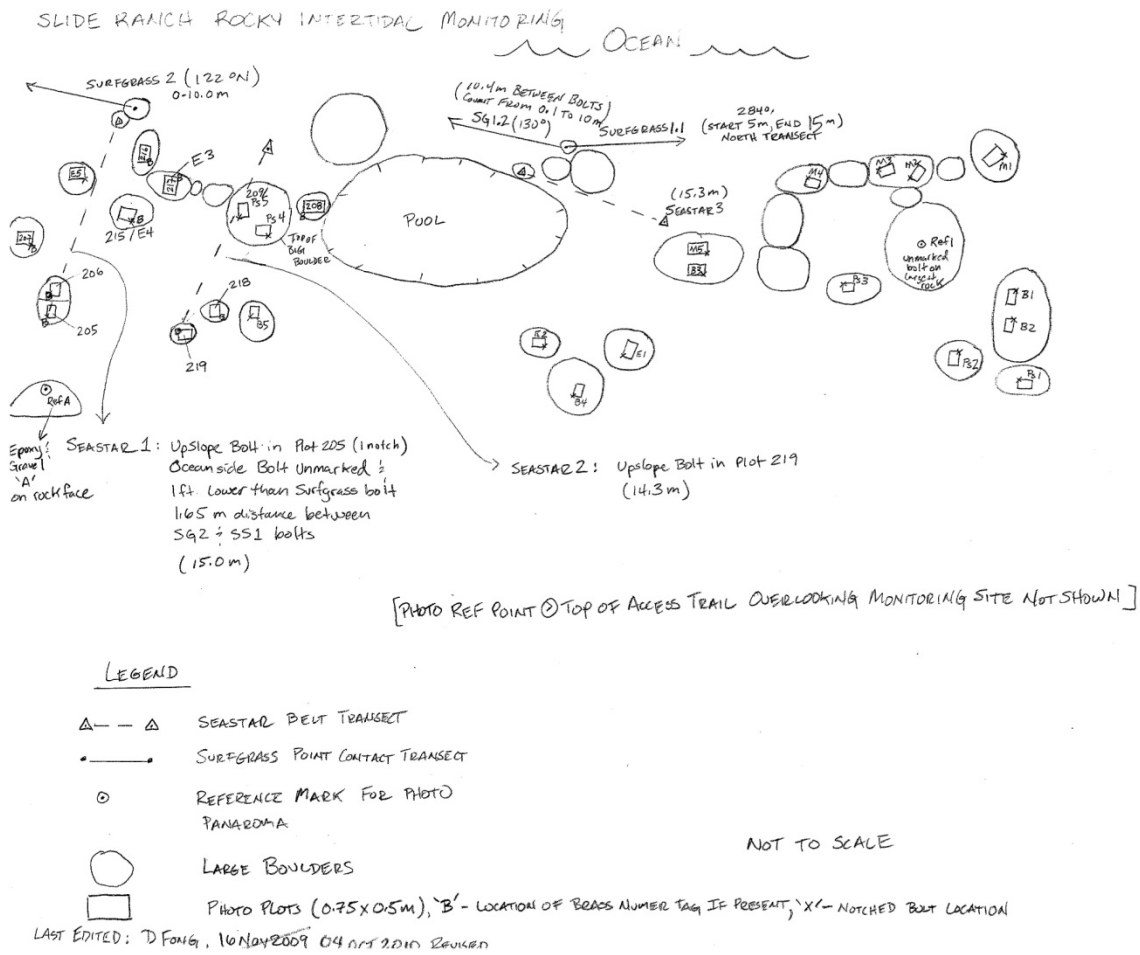

Figure SOP 18.13. Sketch of plot locations at Slide Ranch, Golden Gate National Recreation Area.

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