Rocky Intertidal Resources Monitoring Handbook, Cabrillo National Monument, Point Loma, San Diego, California

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U.S. GEOLOGICAL SURVEY

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1. Introduction

Long-term monitoring of biological resources and public use in rocky intertidal habitats at Cabrillo National Monument was initiated in 1990 in order to assess dynamic ecological conditions with respect to impacts from public visitation and other human activities in the San Diego metropolitan area. Public access to the monument's intertidal zone is restricted to a single point on the western coast of Point Loma approximately 800 m north of the tip of the peninsula (Figs. 1 & 2). From this point, visitors can explore about 1 km of open ocean shoreline without crossing deep channels that extend to the base of steep cliffs, or moving around the southern tip of the Point into San Diego Bay. This situation creates an apparent gradient of public use extending from the access location downcoast to the Point. The resource monitoring stations were stratified into 3 areas along this presumed human use gradient, with each area encompassing roughly 330 m of shoreline (Fig. 2). Each of the survey locations, designated Area I, Area II, and Area III (Figs. 1 & 2), have been monitored semi-annually (Spring and Fall) for the past 6 yr. Two sites north of the Monument, Navy North and South (Fig. 1), have been monitored in 1995 using the same techniques. A separate manual has been developed for the Navy sites. Continued monitoring of all 5 sites in future years is highly recommended. Biological surveys at these locations provide quantitative seasonal data for index species in fixed plots or transects, and qualitative inventory data for other plants and animals whenever possible. In addition, Cabrillo National Monument personnel collect data on prevailing sea/weather conditions and abundances of birds and visitors at the Monument sites whenever possible during daytime low tide periods.

This handbook provides guidelines and specifies procedures for monitoring target species assemblages at Area I, Area II And Area III rocky intertidal sites at the Cabrillo National Monument, Point Loma, San Diego. The handbook will help survey teams prepare for surveys, locate the permanent study plots and standardize sampling procedures for future surveys at these sites, either for continued seasonal monitoring or for impact prevention or assessment studies should the need arise. Visitor and bird census methods and survey data management techniques also are described.

2. Survey Background and Planning

This section provides background information about the survey sites, target species, and fixed plots. Survey planning activities are discussed, including scheduling, personnel, and logistical considerations. The guidelines are based on practical experience with intertidal monitoring surveys and field conditions encountered at the Cabrillo National Monument sites since 1990. The guidelines should not be applied rigidly because each survey has its particular circumstances (e.g., weather conditions, number and experience of samplers). Individual judgments will always be necessary in conducting field surveys. It is important to maintain flexibility because unforeseen situations may require last-minute modifications to sampling plans.

2.1 Survey sites

The 3 survey sites (Area I, Area II, Area III) are located on the southernmost outer coast of Point Loma (Figs. 1 & 2). These, approximately equal-sized sites (~330 m long each) are contiguous, extending downcoast along the cliff-backed rocky intertidal shore from the sole beach entry point (Area I) to the southern tip of the peninsula at the Lighthouse (Area III). Access to all 3 sites is via a short trail from the visitor parking lot, located immediately north of the old Navy dolphin training facilities. To get to the parking lot, drive south along Cabrillo Memorial Drive (Route 209), turn right just before reaching the kiosk for the Cabrillo National Monument visitor center, head down the steep road which curves past the lighthouse, and turn left into the parking lot just past the fenced-in Navy compound. Directions for getting to the sites and brief descriptions of physical conditions at the survey locations are as follows:

Area I

From the visitor parking lot, take the path leading upcoast to the cliff edge. Follow the edge of the cliff to the left (south) and walk down to the intertidal through an area of irregularly-sloping bedrock. Area I extends from ~220 m north to ~110 m south of the access point (Figs. 2 & 3). The northern portion of Area I is backed by fractured low cliffs with small caves and pockets of cobble and boulders. Goose barnacle plots and half of the owl limpet plots are located on the steeply sloping base of the sandstone cliffs. The offshore area is composed of pools, surge channels, scattered boulders and gently sloping rock reefs extending 20 to 40 m from the cliffs. Fixed survey spots are scattered throughout this region, with plots on the raised, mostly granitic boulders and transects on the flat sedimentary reefs. The southern part of the site is in a cove backed by a high cliff and beach. Several transects are located at the north end of this cove (out from the visitor access point), but no monitoring plots are located within the cove. The downcoast boundary of Area I is the south end of the cove.

Area II

Follow the same directions given above to reach Area I, then hike south along the shore approximately 110 m to the northern edge of Area II (Figs. 2 & 4). The hike to Area II takes about 10 min from the parking lot, and is best done when the tide level is <1 m above MLLW (in order to avoid getting wet above the waist). Area II extends downcoast approximately 330 m from the boundary of Area I, with the central portion located offshore from the old Navy dolphin training compound. The northern section of Area II has sloping rock slabs and low-relief reefs, mixed with various-sized boulder/bedrock outcrops. The central and southern parts of the site are backed by an irregular low sandstone cliff with caves and pockets of boulders and cobbles. The lower intertidal zone extends more than 50 m offshore in Area II, encompassing extensive pools and flat reefs topped with occasional boulders. Fixed survey spots are scattered throughout the site, with goose barnacle and half the owl limpet plots on cliff walls or bases, other plots on boulders, and transects on low-relief bedrock. The southern boundary of Area II is offshore from the Radio Tower.

Area III

Follow the same directions given above to reach Area II, then continue south approximately 330 m to the northern end of Area III (Figs. 2, 5-6). The hike to Area III takes 15-20 min from the parking lot, and also is best done when the tide level is <1 m above MLLW. The site extends another 330 m from the northern edge south to the tip of Point Loma, including a

prominent line of boulders that extend offshore southwest of the lighthouse. The site is backed by large riprap boulders and a low cliff. Except for the south end boulders, the offshore portion of Area III has extensive, broad, (>70 m) flat reefs with shallow pools and small rocks. The transects for monitoring algal turf, surf grass and boa kelp are located in the northern part of the site. Permanent plots for monitoring goose barnacles are located on granitic riprap boulders placed along the cliff base to reduce erosion. Two acorn barnacle plots are located on a platform in the middle of the site, and one owl limpet plot is located nearby on a bedrock shelf at the base of a cliff point. All of the other permanent plots are located on the line of boulders at the south end of the site (Fig. 6).

2.2 Target species assemblages

Key species and broader taxonomic categories surveyed at the Cabrillo National Monument rocky intertidal sites are listed in Table 1. The same 13 target taxa are monitored at each location. Grouped according to survey method, they are as follows:

- Photoplots: acorn, thatched, and goose barnacles, rockweed, and mussels
- Circular plots: owl limpets
- Line transects: boa kelp, sargassum weed, algal turf, surf grass, and anemones
- Timed search: abalone and sea stars

2.3 Fixed plots and transects

Table 1 summarizes the sampling techniques and number of plots and transects for each key species at the 3 monitoring sites. The plots and transects have been monitored semi-annually since 1990. There are 5 replicates for each photoplot species, except for goose barnacles which have 6 because monitoring was changed from 3 band transects to 6 photoplots (2 per transect) in 1995. Owl limpet plots have 6 replicates, 3 on cliff bases and 3 on boulders, except for Area III which has 5 on boulders and 1 on the only cliff base habitat available. There are 2 replicates for each line-intercept species.

The relatively permanent fixed plots and transects were established at the Monument sites in Spring 1990. The 4 corners of each rectangular photoplot (except for goose barnacles) are marked with ~5 cm diameter blobs of green epoxy. Photoplot numbers are located at the upper left corner of each plot on a brass tag or etched into the epoxy. Stainless steel or silicone bronze bolts (3/8 in) fixed into the bedrock with epoxy were used to mark the corners of goose barnacle photoplots, center of circular owl limpet plots, and start, middle and end, of all transects. Some of the hexagonal bolt heads are marked (using a band saw or hack saw) with notches on the bolt head edge or with grooves across the bolt head top to identify the plot or transect number. Bolt head number codes based on notch and groove combinations are illustrated in Table 2. For plots with notched bolts, the number bolt is located in the upper left corner of each photoplot (with a blank bolt on the other corners), at the center of each circular plot, and at the start (north end) of each transect. Transect center bolts are blank; end bolts are marked "X". Two types of codes are used to identify plots (see Table 2 & Figs. 3-6). Alphanumeric codes indicate which key species and replicate number is targeted, with the number of bolt notches representing the replicate number. Unique 1-3 digit numeric plot/transect codes were imprinted on the original brass tags (most of which now are missing or unreadable), and continue to be used, especially on bolt-less plots and when shooting plot photographs. Measurements (distance and bearing) taken from the number corner or bolt of each plot/transect to one or more other number corners or bolts are used

for mapping the sites (Tables 3-5; Form 1), locating hard to find plots/transects, and as standard photo or video reference viewpoints.

2.4 Survey scheduling

The sites are sampled semi-annually, in Spring and Fall. Allow 1 day per site, working during the lowest tide ± 2-3 hr (4-5 hr total time/sample). The sampling period can be scheduled tentatively months in advance by checking the appropriate San Diego tide table booklet, calendar, or computer program. If possible, survey the sites during the lowest ("spring tide") daylight tide conditions in the months of March/April and October/November. At these times, the best low tides will occur in the afternoons. Generally, there are 5 to 7 workable days within each optimum tidal series. When planning the sampling schedule, remember to take into account factors such as:

- advance arrangements for all participants (transportation, lodging, etc.)
- the time of low tide with respect to sunset (to allow time to complete the site)
- the extra time (at low water) needed to hike to Area III (15-20 min each way)
- some days may not be workable due to rain, wind, or heavy swells.
- 1-2 days at the end of each tidal series should be reserved as "fall-back" days, in case a site survey must be rescheduled.

2.5 Personnel

The number of people needed to sample a site depends on level of experience. Four experienced people can sample a site adequately during 1 good low tide period of 4-5 hr; however 6 people, with at least 3 experienced, is recommended. Then it is possible to have 3 teams of 2. Each team should consist of at least 1 sampler who is familiar with that task's techniques and a recorder, who may or may not be experienced. In general there should be separate teams for the plot photographs, owl limpet measurements, and transect scoring. Other tasks to split among the teams include plot/transect location, cleaning/repair of all markers, site reconnaissance, timed search for abalone and sea stars, and video overview (optional).

2.6 Logistics

An outline of tasks to be accomplished prior to, during, and after the field sampling is provided in Table 3. Equipment and materials needed for the monitoring should be stored in 1 location so that they can be assembled efficiently prior to each survey trip. It is important to use the Equipment Checklist (Form 1) to be sure nothing is forgotten. Expendable items such as film, batteries, and videotape need to be purchased in advance. Film and batteries can be purchased in bulk and stored in a refrigerator. Spares should be included in case something does not work or gets dropped into a tidepool. Rechargeable batteries should be freshly charged. Load and test camera, strobe, and camcorder to be sure they are working properly. Photocopy required data sheets from originals at the back of the handbook (see Form 1 for recommended number of copies). Required data forms include Field Logs (Form 3), Photo Logs (Form 4), Owl Limpet Measurements (Form 5), Line-Transect Scores (Form 6), Abalone/Sea Star Counts (Form 7), and People/Bird Census Sheets (Form 8). Bring a supply of sharpened #2 pencils. Remind the data recorders to print legibly and darkly so that the completed data sheets can be photocopied.

Usually each person carries a backpack or bucket loaded with sampling and personal gear. Five or more rectangular quadrat frames can bundled together with bungee cords or Velcro straps for ease of carrying. Samplers should be prepared for all possible weather conditions (especially sun and wind) and should dress accordingly. Listen to the marine weather and surf reports for current sea conditions. Rubber boots may be worn; however, rugged neopreme booties or old sports shoes work quite well and are easier to walk in when filled with sea water. A spare change of clothing can be useful. Foam gardening pads provide comfort for kneeling during owl limpet measurements. Food, water, a hat, sunglasses, and sunscreen are all recommended.

Transportation time should be planned to arrive at the site anywhere from 2-3 hr before low tide. This includes driving, gear organizing, and hiking time. Allow extra time on the first day for initial equipment setup and orientation of survey participants.

Much of the work should be done as the tide is going out. Generally the tide will be in the mid to late-afternoon, thus approaching darkness will limit work during the rising tide. The target species are best sampled during an out-going tide in this order:

1) High intertidal: goose barnacles, owl limpets, rockweed
2) Mid intertidal: acorn and thatched barnacles, mussels, turf, anemones
3) Low intertidal: sargassum weed, surf grass, boa kelp, abalone, sea stars

3. Survey Methods

3.1 Site reconnaissance

During each survey it is important to observe and record the general physical and biological conditions at the site. These observations, along with any photo and video overviews, provide valuable perspective on site dynamics which assist in the interpretation of data from the fixed plots and transects. Often it is most practical to do at least part of the site reconnaissance upon first arrival (assuming a descending tide) because many of these observations can be done before the tide is low enough for performing other tasks. Additional notes can be added later during the monitoring, or even afterwards, when more time is available to organize thoughts.

Site reconnaissance notes are recorded on the Field Log (Form 3). Physical conditions to be noted include weather conditions (cloud cover, wind speed and direction, air temperature), sea conditions (wave height and direction, surge, water temperature), substrate changes (sand/gravel burial or scouring, overturned boulders, landslides, etc.), presence and distribution of oil/tar, and other unusual occurrences such as floating debris or pollutants. Biological features that should be recorded include obvious changes (or lack thereof) in target and other species distribution, abundance, recruitment, and appearance (size, color, behavior, epiphytes, etc.). The behavior of birds and people is of interest. Signs of disturbance by visitors may be evident.

3.2 Video overview (optional)

Videotape overviews, along with still photographs, document the general physical and biological characteristics of a survey site. They also record plot and transect conditions within the context of the entire site. If desired, they can be used to monitor large-scale temporal changes in biological assemblages. Audio tracks on the videotape allow site reconnaissance observations to be recorded along with the video images.

A videotape record of each survey site should be made during the initial survey and anytime an obvious change or impact has occurred. If time and personnel permit, video overviews can also be done during routine monitoring surveys. The video operator uses a portable camcorder protected by a splashproof housing to document the nature of conditions at each site through visual recordings on 8 mm tape accompanied by observational narration. Video views range from distant overviews of general habitat features to close-ups of individual species. Important conditions to document on video include the following: all survey plots and transects, sand influence (beach level, scour or smothering effects), health of organisms (bleached plants, dead barnacles, etc.), interesting concentrations of species, recruitment events, extent of ephemeral algae, oil/tar presence and extent, evidence of people use and/or pollution, and any unusual phenomena.

3.2.1 Video procedures

Video procedures for each site consist of the following:

- a broad overview of the entire site if possible from a high cliff vantage point
- a beach level overview of all plots and surrounding habitats from fixed points
- beach level closer views of interesting phenomena

The video documentation can be accomplished by a single experienced person (who knows how to use the equipment, the layout of the study site, and what to document visually and through narration). However, the process becomes most efficient if an assistant is available, because that person can carry supplies (batteries, tapes, maps, etc.), keep track of the sequence of video views, and look out for waves that may splash the video operator and camcorder. The time it takes to do a video survey depends on the spatial extent and complexity of the study site, and the thoroughness of the site documentation. Preliminary reconnaissance prior to actual videotaping is needed to evaluate conditions at the site and organize points to emphasize visually and verbally. This may take 30-60 min and can be done as the tide recedes. The video survey typically takes 1-2 hr around the time of low tide. This includes about 30-60 min of actual videotaping and 30-60 min of other activities, including set-up at each view point, movement between view points, and changing batteries or tapes. Thus the entire video survey operation at one site takes approximately 1.5 to 3 hrs to complete.

Prior to each video survey, the equipment should be assembled and tested. Video camcorders can be finicky (especially Hi-8). Charge all batteries, clean the video head (if necessary), and make a test recording. Review the camcorder operation, the site-specific video plan, and the results of any previous video surveys (so you know what conditions and possible resource changes to look for). At the site, as the tide recedes, locate and mark all plots with bright materials (PVC frames for photoplots, flagging for owl limpet plots, and meter tapes for irregular plots and transects). Conduct an observational reconnaissance of the entire study site -- plots, species, etc. Plan the order (and sometimes modified locations) of video views based on sea conditions, tide levels, and sun position. Organize thoughts for narration during videotaping. Set up camcorder and record a title sequence listing study site and survey date. Also at this time, or at the start of the first overview sequence, verbally record the study site, date, video operator, current time, time and height of low tide, weather conditions, and other pertinent information.

Generally the cliff overview (if present) will be the first video sequence recorded. It puts the entire study site in perspective and documents large-scale changes (e.g., variations in sand levels). Best results are obtained when the tide is fairly low and the plots and reference bolts have been marked conspicuously. Establish a fixed view point, which may be marked or simply described. Use standardized operating procedures and verbal descriptions (see guidelines below). If possible, always start facing upcoast, then use wide-angle view to pan downcoast along the most offshore exposed portion of intertidal first. Reverse the pan for the next closer inshore view. Continue this procedure until the entire shore has been documented. During these video pans, zoom in on key reef areas or survey plots where appropriate, but do not overuse the zoom. All pan and zoom movements should be made slowly.

Beach level overviews are used to put the individual permanent plots or transects into perspective with surrounding assemblages. Record a video sequence from each designated vantage point. At most reference points, plan to do a circular pan (360°) beginning with the most upcoast view. Start with wide angle of more distant habitats on the first pan. If necessary, do a second circular pan of the closest habitats. At any time you can zoom in and describe particular marked plots or other interesting phenomena. It is not necessary to show great detail for each photoplot because the still photos cover that. If particular plots are not covered by video sequences from the marked vantage points, then each plot or group of plots should be videotaped from a standard unmarked view point, usually from about 3 m away with the sun at your back. For each transect not covered by sequences from the marked vantage points, stand about 3 m away from the center bolt (with sun at back), then pan slowly along the meter tape from the start bolt to the end bolt. For irregular plots, choose a central vantage point about 3 m off the plot (with sun at back if possible), then pan along farthest view of plot (starting upcoast and inshore if possible). Reverse the pan for next closer view and continue until the whole plot has been covered.

Close view video sequences of interesting intertidal phenomena not necessarily associated with the survey plots may be recorded if time permits. These need not be done from fixed vantage points, nor do they have to be taped during each succeeding survey at a particular site. If they are important enough to be repeatedly documented, then vantage points should be marked or described for standardization.

3.2.2 Guidelines for best video results

Camcorder guidelines

These guidelines are for Sony, Nikon, or Ricoh Hi-8 camcorders. Read the manual and know how to operate the camera properly to obtain the best quality video and sound recordings. Camcorders can be sensitive to jarring. Carry in a padded case whenever possible. Check the camera housing lens periodically for salt spray outside (especially on windy days) or fogging inside. These conditions will cause blurred images. If necessary, clean the lens with fresh water or lens cleaner, then wipe dry with lens paper. Insert several small desiccant packs inside the splashproof housing to remove moisture.

Hi-8 tape cassettes provide the highest resolution; however, they are more expensive than regular 8 mm tapes, cannot be played back on standard 8 mm camcorders, and require a special monitor to take advantage of the increased resolution. If the drawbacks of Hi-8 tapes present a problem, regular 8 mm tapes can be used and still provide good quality. 60 min cassettes are

preferred, but 120 min tapes also work well. Take 2 fully-charged heavy duty camcorder batteries to ensure up to 1 hr of taping. These batteries never give as much time as expected (especially with lots of zooming), and older batteries do not hold a charge well. Use the video head cleaner tape periodically, especially if the recorded image becomes jittery. Plan to clean the head before each series of intertidal video surveys.

Leave the time display on the video for all recording. This provides a fixed visual record on the tape for later reference. This is especially important if tapes are played on a VCR with a different type of counter than that used when the video log was transcribed. It would be preferable to record both date and time, but most camcorders allow only one or the other.

Video guidelines

Tape a title sequence (with the site name and date on a piece of paper) at the start of each video survey and at the beginning of each new tape. Try to videotape at the lowest tide and best light conditions (closest to midday). Unfortunately, many of the good low tides occur in the late afternoon when the sun is low in the sky directly offshore. Best results are obtained under these conditions by keeping the sun behind you as much as possible and by aiming the camera down to reduce the amount of bright sky in view. This helps to minimize under-exposure of shaded reef areas (silhouette effects).

Hold camera as steady as possible, especially when zoomed in. Remain fixed on still shots for several seconds -- longer than seems sufficient while filming. Pan very slowly. You need to consciously slow down any movements. Slow motion pans work much better than walking while taping. Note that your eye (not looking through the eyepiece) generally can see more detail (bolts, tags, etc.) than shows up on the video, especially when contrast is low. On the other hand, videotapes played back on a color monitor appear much better than what you see through the black and white eyepiece monitor. Sometimes, when looking through the small eyepiece, it is difficult to tell if the camera is aimed correctly at low contrast subjects.

Narration guidelines

It is not easy to videotape intertidal areas and verbally describe them at the same time. Therefore, it is important to explore the survey site before taping in order to plan what to emphasize and how to describe it. Remember to set the microphone switch to the wind setting. Talk loudly when it is windy or there is noisy surf. At the start and end of each site video (and each tape) and periodically throughout the tape, verbally identify the site, date, time, narrator, and any other pertinent information. Wait several seconds after starting a new tape before talking to be sure what is said will be recorded.

Describe the vantage point at the start of each video sequence. Use standard descriptors for view directions, plot locations, etc. For example, be clear about using "view from" and "view of" when describing a scene. Compass directions may be confusing because local shores can be quite irregular. Instead use "upcoast", "downcoast", "inshore", and "offshore" to describe plot locations and views. Consult the site map before starting each video sequence so that correct plot numbers will be included in the commentary.

3.3 Photoplot surveys

To survey photoquadrats, first locate them using information from the site map, interplot measurement table, and plot print photographs. Clean the corner markers and note their condition, especially whether repairs are needed. Place a temporary 50 X 75 cm PVC quadrat frame over each plot to mark it for easy relocation, or tie red flagging on bolts . Next, check the camera and strobe (film and batteries loaded?) and assemble the quadrapod apparatus, which holds the camera and strobe directly above each photoplot (Fig. 7). Carry the quadrapod to each plot, replace the temporary PVC frame with the quadrapod so that the photo identification tag is in the upper left corner, adjust the 3 photo identification rings so that each plot number digit appears to the right of each ring, and photograph the plot twice, bracketing for best exposure.

Tide conditions dictate the order in which the quadrats are sampled. If the tide is receding, sample the highest plots, then work down the beach as lower plots are exposed. If the tide is around the low, begin with the downshore plots first. The photographer's assistant must re-position the photo identification tag with the correct plot number each time the frame is placed over a new plot. The assistant also records pertinent information such as photo number, plot number, and exposure on the Photo Log (Form 4). It can be difficult to identify certain species when looking at the slides back in the lab, so it is advisable to jot down (or sketch) a few notes about species composition, cover, unusual or occasional species, etc. while at the plot. After all plot photos are taken, any spare frames left on the roll are used for more general overview shots, or of those species that are not directly targeted by photos (e.g., surf grass, boa kelp, owl limpets).

The procedures described here are for a generic 35 mm, single lens reflex camera, with a 28 mm lens. Other cameras may be used, but the details of setup and alignment will be slightly different. Use a strobe mounted to the camera to fill in shadows, even in bright sunlight. Read the user manuals for both camera and strobe. Most cameras synchronize focal plane shutters with strobes at a 1/125 second shutter speed. Use that shutter speed with 100 ASA Ektachrome color slide film and aperture settings of f 11and f 16. This film, at these settings, provides the broad range of image densities required to interpret the photographs in the laboratory. Certainly other films and settings will work, but the recommended settings have proven effective for recording intertidal plots over a wide range of conditions for more than 10 years.

Check all camera gear before leaving for field sampling, while you have no tide-driven time constraints. Use a protective case for the camera, cable shutter release, strobe, film, and spare batteries. Also include lens paper and cleaner, or a chamois skin, a smudge-proof marking pen (sharpie) for marking exposed film rolls, and a lens cap. Bundle the quadrapod components with bungee cords for convenient carrying.

Camera Setup

Load the camera in accordance with the manufacturer's instructions. Check camera and strobe batteries to assure full charges. Having to wait for a slow strobe to recharge, or having to replace a camera battery, during a rapidly rising tide is annoying, and leads to haste-induced errors.

Quadrapod setup

At the field site, assemble the quadrapod apparatus (Fig. 7). Make sure the PVC rods are securely attached and the frames are parallel by placing the plot frame on a flat surface and pressing firmly on the camera frame fittings. Mount the camera and strobe using a quick release camera mount and the camera's hot shoe. Attach the cable shutter release. Check frame alignment and camera focus by looking through the viewfinder. Adjust the frame as necessary by pressing on the quadrapod fittings. Set the focus at about 0.8 m; you should be able to clearly read the frame number indicator. Set the shutter speed to 1/125 second and the aperture to f 11. Turn on the strobe.

Photographing the plots

Select the plot to be photographed. Set the plot number indicator rings on the quadrapod plot frame so that the plot numbers are immediately to the right of the rings. Place the quadrapod plot frame over the plot with the plot indicator tag in the upper left corner of the frame. Check frame alignment and focus through the view finder; adjust as necessary. Trip the shutter, check to assure that the strobe discharged, record the plot number and camera settings on the Photo Log (Form 4). If the strobe failed, check the equipment and re-take the picture, recording the failure on the Photo Log. Set the lens aperture at f 16 and repeat the process. Move to the next plot and repeat the process until all plots at the site have been recorded.

3.4 Circular plot surveys

Two persons work best for surveying the owl limpet plots: 1 experienced person to identify and measure the limpets, and an assistant to record the data. First locate the plots, using information from the site maps, the interplot measurement chart, and the plot print photos. Clean the markers and note their condition, particularly whether repairs are needed. This is important since there is only one bolt per plot. Tie bright surveyor's flagging to each bolt for ease of relocation. To survey each plot, attach a 1 m length of line (or meter tape) to the center bolt and swing around in an arc, carefully searching all cracks and crevices for *Lottia*. Be aware that the limpets may be covered with barnacles, algae, etc., and can even be confused with chitons. Owl limpets found within that arc (including those touched by the 1 m mark) are measured with calipers to the nearest millimeter, then marked with a yellow forestry crayon to avoid duplicate scoring. However, limpets <15 mm are not scored because it is difficult to distinguish tiny *Lottia* from other species of limpets. Measurements are recorded on the Owl Limpet Data Sheet by a helper (Form 5). If the limpet cannot be measured in place (due to crevices or other irregularities), estimate its size and note this on the data sheet. Never remove limpets from the rock. Observations including obvious scars from missing limpets and any evidence of predation also should be included on the data sheet.

3.5 Line intercept transect surveys

Two persons are most efficient for surveying the point-intercept transects, 1 experienced person to identify the organisms located along the tape edge, and an assistant to record the data. First locate the transects, using information from the site maps, the interplot measurement chart, and the transect print photos. Care must be taken not to disturb the positions of plants along the transect path when searching for bolts. Clean the markers and note their condition, particularly whether repairs are needed. Tie bright surveyor's flagging to each bolt for ease of transect relocation. Once the tide is low enough, run a meter tape (again with care) the length of the

transect, starting from the notched bolt. Watch for approaching surges that might disturb the position of the tape or the plants around it. If possible, survey the entire transect during a period when the tape and plants are undisturbed. To score the line-intercept transects, the sampler walks along each transact, calling out whatever taxon falls directly beneath the tape edge. The line cover estimates are rounded off to the nearest centimeter, thus 1000 separate segments are scored for each 10 m transect. It may appear as if the scoring would be extremely tedious; however, in practice, relatively few taxa make up most of the line-intercept cover. Up to 8 taxonomic categories are called out by the scorer and then recorded onto the Line-Transect Data Sheet by an assistant (Form 6). Typical scoring may proceed as follows: "bare substrate 0-46 cm, surf grass 46-321 cm, boa kelp 321-378 cm, etc." General observations, such as key species condition (e.g., color and length) and sand cover (if any) are all important to note.

3.6 Timed searches

Around the time of low tide, 1 person should spend 30 min (or 2 persons 15 min each) searching crevices and pools along the low intertidal zone haphazardly throughout the site for possible occurrences of black abalone (*Haliotis cracherodii)* or ochre sea stars (*Pisaster ochraceus*). In addition, record other related species, including green (*H. fulgens)* and pink (*H. corrugata*) abalone and bat (*Asterina miniata*), blue knobby (*Pisaster giganteus*), and fragile (*Astrometis sertulifera)* stars. Plan to get wet at least to thigh level as you kneel to look under boulders and ledges. Use a waterproof flashlight if necessary to see into dark areas. Turn over occasional rocks and look for juveniles. Record the number and size (cm) of any abalone or sea stars found. For abalone, measure greatest shell length. For sea stars, measure from the middle of the central disk to the tip of the longest ray. Record results on the Abalone/Sea Star Data Sheet (form 7). Note the presence and condition of any abalone shells seen. Other interesting species observations can be recorded on the Field Log and species inventory list (optional).

3.7 Visitor and bird census

Unlike all other sampling which takes place twice per year, the number of people and birds should be recorded (to the extent possible) each day that the low tide falls between 1000-1600 hrs (PST) and is <15 cm above mean lower low water (MLLW). About 120 days meet these conditions during the year. This sampling can be conducted by Cabrillo National Monument staff or volunteers as part of their routine patrols of the shore during low tides when visitors are most likely to be present. The number of people and birds within Areas I, II, and III should be counted within 30 min of the low tide by walking along the shore through the 3 areas. The observer must be familar with the site boundaries (see map in Fig. 2). The observer also must be able to recognize different birds, preferably to species, but at least to 3 ecological categories: wading birds, shore birds, and sea birds. Wading birds include herons and egrets. Shore birds include plovers, willets, tattlers, godwits, whimbrels, turnstones, and sanderlings. Sea birds include gulls, cormorants, and pelicans. People and bird counts plus data on weather and sea conditions are recorded on the People and Bird Census Sheet (Form 8). It is important to fill in the data for all categories on the form. Also, use #2 pencils and print legibly and darkly so completed data sheets can be interpreted correctly and photocopied. The tick marks for people and bird counts should be summed up for each category to eliminate ambiguity (e.g., does "11" represent 2 tick marks or the number 11?). Because the people/bird surveys are done on many days, they also represent a good opportunity to observe changes in intertidal life, disturbances

(e.g., storms), human impacts, behavior of people or birds, etc. These observations should be recorded on the back of the data sheets.

3.8 Data management

After returning from sampling, the data sheets should be organized and checked for completeness and legibility. Field notes should be written up (if not done so already) while thoughts are fresh. It is important to make a list of plot markers that need repairs and to note any ideas for increasing the efficiency of sampling. Data sheets along with field notes are filed into notebooks under each site and sampling period. The film is sent off to be processed. When the slides return, mark them individually with site name, date, species and plot number. Organize the slides by site, target species, and sequential plot number into notebooks filed within plastic slide-holder sleeves to await scoring.

For scoring, each slide is projected onto a white board that is marked with a grid of 100 evenly-spaced points. Single taxa beneath each of the 100 points are identified and recorded within the proper category on the Point-Intercept Score Sheet (9 categories, Form 9). Photoplot and all other numerical data are then entered into a computer spreadsheet file and saved for later analysis.

Table 1. Index Taxa and Monitoring Techniques at Cabrillo National Monument Sites. Values in parentheses indicate the number of replicate plots emphasizing those particular species.

Technique/Taxa	Dimensions	Number Per Area	Total Sample
Photoplot	50 X 75 cm	21	63
Acorn Barnacle			
Chthamalus spp.			
Pink Thatched Barnacle		(5)	
Tetraclita rubescens			
Rockweed		(5)	
Pelvetia fastigiata			
California Mussel		(5)	
Mytilus californianus			
Goose Barnacle		(6)	
Pollicipes polymerus			
Other Plants			
Other Animals			
Tar			
Bare Substrate			
Circular Plot	1 m radius	6	18
Owl Limpet			
Lottia gigantea			
Line Transect	10 m	6	18
Boa Kelp		(2)	
Egregia menziesii			
Sargassum Weed			
Sargassum muticum			
Red Algal Turf		(2)	
Corallina spp. et al.			
Surf Grass		(2)	
Phyllospadix spp.			
Aggregating Anemone			
Anthopleura elegantissima			
Other Biota			
Tar			
Bare Substrate			
Timed Search	30 person-minutes	1	3
Black Abalone			
Haliotis cracherodii			
Ochre Sea Star			
Pisaster ochraceus			

Table 2. Rocky Intertidal Survey Plots and Plot Identification Codes.

Plot Type/	Plot	Photo/Tag Code		
Key Species	Code	Area I	Area II	Area III
Photoplot				
Barnacles	B1	286	247	3
	B2	299	248	16
	B3	294	256	29
	B4	292	259	30
	B5	293	260	20
Rockweed	Pe1	291	249	9
(Pelvetia)	Pe2	290	251	10
	Pe3	295	252	28
	Pe4	288	258	27
	Pe5	287	265	25
Mussel	M1	298	245	24
	M2	297	246	15
	M3	296	253	14
	M4	289	254	17
	M5	285	255	12
Goose Barnacle	Po1	276N		269N
(Pollicipes)	Po2	276S	275C	269S
	Po3	281N	274N	196C
	Po4	281S	274S	
	Po5	278N		23N
	Po6		273S	
Circular Plot				
Owl Limpet	L1	280	239	13
	L2	284	243	26
	L3	283	240	21
	L4	282	242	17
	L5	279	266	18
	L6	277	241	11
Line Transect				
Red Algal Turf	T1	237	244	1
	T2	210	270	8
Surf Grass	G3	238	267	7
	G4	211	271	5
Feather Boa Kelp	K5	236	268	2
	K6	212	272	4

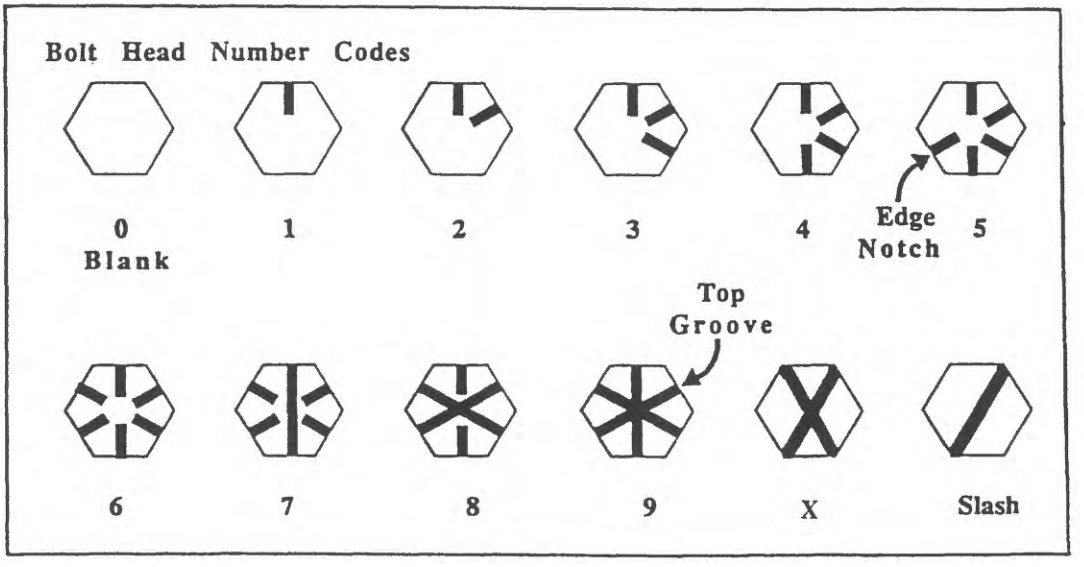


Table 3. Rocky Intertidal Survey Tasks

Prior to surveys
-Organize and test survey gear (see equipment checklist)
-Purchase supplies (film, batteries, videotape)
-Photocopy forms and notes (see equipment checklist)
-Review field procedures and notes from previous surveys

During Surveys
-Site reconnaissance
    Evaluate site and complete General Information Sheet
    Note observed site conditions
    Species list (optional)
    Video overview (optional)
-Clean and repair plot markers

-Photoplot surveys (21 plots at each of 3 sites)
    Acorn/Thatched Barnacle Plots (5)
    Rockweed Plots (5)
    Mussel Plots (5)
    Goose Barnacle Plots (6)

-Circular Plots (6 plots at each of 3 sites)
    Owl Limpet counts and shell length measurements within 2 m diameter plots

-Line Transects (6 transects at each of 3 sites)
    Red Algal Turf (2)
    Surf Grass (2)
    Boa Kelp (2)

-Timed Search (30 minutes at each of 3 sites)
    Abundance and size of abalone and sea stars

-People/Bird Census (within 30 min of low tide at each of 3 sites)

After Surveys
-Write up field notes
-Organize and check data sheets for completeness and legibility
-Process film
-Label slides, organize by site and target species
-Score slides
-Copy videotape to VHS format
-Data entry, display and analysis

Table 4. CABR I Rocky Intertidal Interplot Measurements.

FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)
210C	277	15.90	45	237N	238N	10.10	190	279	281S	9.30	310	291	280	13.50	85
210C	282	10.20	290	237N	238S	19.20	170	279	287	15.00	285	291	284	5.90	190
				237N	276N	17.50	145	280	276S	10.45	330	291	290	6.50	130
210N	210S	9.80	130					280	284	14.70	240	291	294	19.40	310
210N	211N	17.60	100	237S	237N	10.05	350	280	290	7.90	220	291	297	22.40	320
210N	211S	24.10	120	237S	238C	5.38	210	280	291	13.50	265	291	299	19.45	360
210N	277	17.30	70	237S	238N	4.30	275								
210N	279	12.50	50	237S	238S	9.40	190	281N	281S	9.90	180	292	285	13.30	310
210N	282	6.00	270	237S	276N	9.60	110	281N	283	15.80	250	292	288	3.78	90
210N	287	12.45	330	237S	299	5.85	190	281N	287	12.42	205	292	295	13.55	5
								281N	Po3	0.25	DOW				
210S	210N	9.80	310	238C	237S	5.38	30					293	282	9.55	180
				238C	238N	4.99	345	281S	278N	6.03	160	293	287	10.30	90
211C	211N	5.95	345	238C	286	~9.1	360	281S	279	9.30	130	293	288	7.68	360
211C	212S	6.28	225	238C	299	2.63	120	281S	281N	9.90	360				
								281S	287	7.30	255	294	291	19.40	130
211N	210N	17.60	280	238N	236N	13.60	265	281S	Po4	0.90	315	294	296	14.20	225
211N	211C	5.95	165	238N	236S	16.96	240					294	297	3.28	360
211N	211S	10.00	160	238N	237C	5.97	40	282	210C	10.20	110				
211N	212N	11.20	255	238N	237N	10.10	10	282	210N	6.00	90	295	282	27.47	175
211N	212S	10.60	180	238N	237S	4.30	95	282	212N	14.80	120	295	283	8.95	145
211N	277	8.99	10	238N	238C	4.99	165	282	212S	24.80	120	295	285	14.95	270
211N	278S	7.50	35	238N	238S	10.08	160	282	287	10.70	360	295	288	11.20	180
				238N	276N	13.60	105	282	293	9.55	360	295	289	26.55	290
211S	210N	24.10	300	238N	299	7.20	155	282	295	27.47	355	295	290	7.00	5
211S	211N	10.00	340									295	292	13.55	185
211S	212C	9.18	275	238S	236C	16.79	280	283	281N	15.80	70				
211S	212N	14.80	285	238S	236N	18.94	290	283	287	9.85	125	296	284	21.05	100
211S	212S	5.80	255	238S	236S	16.33	265	283	288	5.82	215	296	289	7.60	180
211S	277	18.80	340	238S	237N	19.20	350	283	295	8.95	325	296	294	14.20	45
				238S	237S	9.40	10								
212C	211S	9.18	95	238S	238N	10.08	340	284	280	14.70	60	297	291	22.40	140
212C	212N	6.29	310	238S	276N	10.70	55	284	285	13.55	215	297	294	3.28	180
				238S	276S	13.60	110	284	289	20.50	265	297	298	0.80	360
212N	211N	11.20	75	238S	299	3.55	10	284	290	7.27	90				
212N	211S	14.80	105					284	291	5.90	10	298	236N	13.50	355
212N	212C	6.29	130	276N	237N	17.50	325	284	296	21.05	280	298	236S	3.76	360
212N	212S	10.19	135	276N	237S	9.60	290					298	286	23.76	60
212N	277	15.80	50	276N	238N	13.60	285	285	284	13.55	35	298	297	0.80	180
212N	282	14.80	300	276N	238S	10.70	235	285	289	14.60	295	298	299	18.65	80
				276N	276S	10.17	165	285	292	13.30	130	298	REF	5.78	20
212S	211C	6.28	45	276N	299	9.05	260	285	295	14.95	90				
212S	211N	10.60	360	276N	Po1							299	237S	5.85	10
212S	211S	5.80	75					286	236N	15.74	275	299	238C	2.63	300
212S	212N	10.19	315	276S	238S	13.60	290	286	238C	~9.1	180	299	238N	7.20	335
212S	277	19.10	360	276S	276N	10.17	345	286	298	23.76	240	299	238S	3.55	190
212S	282	24.80	300	276S	280	10.45	150	286	299	10.73	180	299	276N	9.05	80
				276S	299	14.70	305					299	276S	14.70	125
236C	236N	5.03	355	276S	Po2			287	210N	12.45	150	299	286	10.73	360
236C	238S	16.79	100					287	279	15.00	105	299	291	19.45	180
				277	210C	15.90	225	287	281N	12.42	25	299	298	18.65	260
236N	236C	5.03	175	277	210N	17.30	250	287	281S	7.30	75				
236N	236S	9.90	175	277	211N	8.99	190	287	282	10.70	180	REF	236N	8.27	350
236N	238N	13.60	85	277	211S	18.80	160	287	283	9.85	305	REF	236S	2.70	225
236N	238S	18.94	110	277	212N	15.80	230	287	293	10.30	270	REF	298	5.78	200
236N	286	15.74	95	277	212S	19.10	180								
236N	298	13.5	175	277	278	3.10	335	288	283	5.82	35	#TAG	236N	2.34	210
236N	REF	8.27	170	277	279	8.08	300	288	292	3.78	270				
236N	#TAG	2.34	30	277	Po6	0.76	25	288	293	7.68	180	Po1	276N		
								288	295	11.20	360	Po1	Po2		
236S	236N	9.90	355	278N	277	3.10	155					Po2	Po1		
236S	238N	16.96	60	278N	279	6.00	275	289	284	20.50	85	Po2	276S		
236S	238S	16.33	85	278N	281S	6.03	340	289	285	14.60	115	Po3	Po4	8.89	~175
236S	298	3.76	180	278N	Po5	0.27	55	289	295	26.55	110	Po3	281N	0.25	UP
236S	REF	2.70	45					289	296	7.60	360	Po4	281S	0.9	135
				278S	211N	7.50	215					Po4	Po3	8.89	~355
237C	238N	5.97	220					290	280	7.90	40	Po5	Po6	2.87	155
237C	237N	5.02	350	279	210N	12.50	230	290	284	7.27	270	Po5	278N	0.27	235
237N	237C	5.02	170	279	277	8.08	120	290	291	6.50	310	Po6	277	0.76	205
237N	237S	10.05	170	279	278N	6.00	95	290	295	7.00	185	Po6	Po5	2.87	335

Table 5. CABR II Rocky Intertidal Interplot Measurements.

FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)	FROM	TO	DIST (m)	BEAR (Mag)
239	244C	6.90	55	251	246	11.91	260	268C	267N	6.05	360	272C	241	24.83	150
239	244N	12.95	15	251	249	3.25	45					272C	271C	8.41	135
239	244S	6.91	60	251	252	9.54	135	268N	239	15	130	272C	271N	5.71	105
239	248	29.10	190					268N	267N	1.95	90	272C	271S	11.93	155
239	267N	14.80	340	252	243	10.10	130	268N	268C	5.12	165	272C	272N	5.61	340
239	267S	5.20	290	252	251	9.54	315	268N	268S	10.1	165				
239	268N	15.00	310	252	275N	19.08	45					272N	241	30.31	155
239	268S	8.08	275	252	275S	12.89	55	268S	239	8.08	95	272N	255	22.38	25
239	275N	34.07	150					268S	267N	10.88	350	272N	270N	16.24	105
				253	246	23.57	360	268S	267S	3.36	75	272N	271C	13.63	145
240	254	25.69	320	253	254	6.29	180	268S	268N	10.1	345	272N	271N	9.58	135
240	255	26.20	290	253	275S	27.71	50					272N	271S	17.46	155
240	256	12.65	180					270C	241	16.64	190	272N	272C	5.61	160
				254	240	25.69	140	270C	256	17.28	60	272N	272S	10.46	160
241	270C	16.64	10	254	253	6.29	360	270C	258	21.56	90				
241	270N	21.70	360	254	255	19.65	250	270C	270N	5.44	345	272S	241	20.10	150
241	270S	12.90	45					270C	271C	9.36	260	272S	271C	4.55	105
241	271C	16.83	335	255	240	26.20	110	270C	271N	10.40	295	272S	271N	5.54	45
241	271N	21.70	345	255	254	19.65	70	270C	271S	11.16	240	272S	271S	7.17	150
241	271S	12.95	320	255	270N	26.29	210					272S	272N	10.46	340
241	272C	24.83	330	255	271N	26.70	185	270N	241	21.70	180				
241	272N	30.31	335	255	272N	22.38	205	270N	255	26.29	390	273N	260	23.88	270
241	272S	20.10	330					270N	256	17.20	90	273N	274S	14.75	340
				256	240	12.65	360	270N	258	23.76	105	273N	Po5	2.52	~250
242	256	21.27	260	256	242	21.27	80	270N	270C	5.44	165				
242	259	11.40	220	256	270C	17.28	240	270N	270S	10.11	150	273S	260	25.96	295
242	266	10.21	155	256	270N	17.20	270	270N	271C	10.05	230	273S	Po6	1.61	~290
242	274N	7.63	180	256	270S	17.98	225	270N	271N	8.19	270				
								270N	271S	13.60	215	274N	242	7.63	360
243	252	10.10	310	258	259	5.69	110	270N	272N	16.24	285	274N	259	12.00	290
243	275S	12.40	355	258	270C	21.56	270					274N	265	10.60	270
				258	270N	23.76	285	270S	241	12.90	225	274N	266	2.80	180
244C	239	6.90	235	258	270S	19.98	260	270S	256	17.98	45	274N	Po3	Same p	
244C	239	9.09	205					270S	258	19.98	80				
				259	242	11.40	40	270S	270N	10.11	330	274S	260	13.90	270
244N	239	12.95	195	259	258	5.69	290	270S	271C	11.67	285	274S	266	7.10	NA
244N	244C	5.01	165	259	265	5.29	140	270S	271N	14.20	310	274S	273N	14.75	160
244N	244S	9.77	160	259	266	12.45	100	270S	271S	11.62	260	274S	Po4	0.89	305
244N	267N	12.00	290	259	274N	12.00	110								
								271C	241	16.83	155	275N	239	34.07	330
244S	239	6.91	240	260	265	10.75	10	271C	270C	9.36	80	275N	252	19.08	225
244S	244N	9.77	340	260	273N	23.88	90	271C	270N	10.05	50	275N	Po1	3.08	~220
244S	267S	10.97	265	260	273S	25.96	115	271C	270S	11.67	105				
				260	274S	13.90	90	271C	271N	5.12	355	275S	243	12.40	175
245	246	9.08	160					271C	272C	8.41	315	275S	252	12.89	235
245	247	9.09	145	265	259	5.29	320	271C	272N	13.63	325	275S	253	27.71	230
245	248	11.85	135	265	260	10.75	190	271C	272S	4.55	285	275S	Po2	5.57	345
				265	274N	10.60	90								
246	245	9.08	340					271N	241	21.70	165	Po1	275N	3.08	~40
246	247	3.00	90	266	242	10.21	335	271N	255	26.70	5	Po1	Po2	1.26	140
246	251	11.91	80	266	259	12.45	280	271N	270C	10.40	115				
246	253	23.57	180	266	274N	2.80	360	271N	270N	8.19	90	Po2	Po1	1.26	320
				266	274S	7.1	NA	271N	270S	14.20	130	Po2	275S	5.57	165
247	245	9.09	325					271N	271C	5.12	175				
247	246	3.00	270	267C	268N	4.93	315	271N	271S	9.70	180	Po3	274N	Same p	
247	248	5.71	90					271N	272C	5.71	285	Po3	Po4	8.84	~170
				267N	239	14.80	160	271N	272N	9.58	315				
248	239	29.10	10	267N	244N	12.00	110	271N	272S	5.54	225	Po4	274S	0.89	125
248	245	11.85	315	267N	267C	4.97	160					Po4	Po3	8.84	~350
248	247	5.71	270	267N	267S	10.65	155	271S	241	12.95	140				
248	249	6.55	180	267N	268N	1.95	270	271S	270C	11.16	60	Po5	273N	2.52	~70
				267N	268S	10.88	170	271S	270N	13.60	35	Po5	Po6	5.02	~150
249	248	6.55	360					271S	270S	11.62	80				
249	251	3.25	225	267S	239	5.20	110	271S	271N	9.70	360	Po6	273S	1.61	~110
249	252	11.44	145	267S	244S	10.97	85	271S	272C	11.93	335	Po6	Po5	5.02	~330
				267S	267N	10.65	335	271S	272N	17.46	335				
				267S	268S	3.36	255	271S	272S	7.17	330				

Table 6. CABR III Rocky Intertidal Interplot Measurements.

FROM	TO	DIST (m)	BEAR (Mag.)	FROM	TO	DIST (m)	BEAR (Mag.)	FROM	TO	DIST (m)	BEAR (Mag.)	FROM	TO	DIST (m)	BEAR (Mag.)
01C	01N	4.93	335	05S	01C	12.25	310	14	15	2.90	360	29	09	7.35	90
01C	05N	8.22	75	05S	01N	16.92	320	14	18	2.10	180	29	23S	33.75	360
01C	05S	12.25	130	05S	01S	7.88	300					29	27	8.10	180
01C	07N	20.21	55	05S	02N	18.80	230	15	14	2.90	180	29	30	1.95	225
				05S	05N	10.07	340	15	19	1.50	315				
01N	01C	4.93	155	05S	07N	20.22	20					30	26	17.73	160
01N	01S	10.06	140	05S	07S	12.03	5	16	03	1.55	345	30	27	6.60	160
01N	02N	22.60	180	05S	Beach	49.61	70	16	23	30.60	70	30	28	6.25	250
01N	05N	10.51	90	05S	Outmk	36.60	160	16	32	30.6	75	30	29	1.95	45
01N	05S	16.92	140												
01N	07N	20.45	75	07C	07N	5	45	17	12	1.70	135	269N	Beach	46.50	360
								17	18	5.80	360	269N	Inmk	49.10	240
01S	01N	10.06	320	07N	01C	20.21	235					269N	Po1	1.30	140
01S	02N	15.90	200	07N	01N	20.45	255	18	14	2.10	360				
01S	05N	8.85	40	07N	01S	21.45	220	18	17	5.80	180	269S	Inmk	54.5	250
01S	05S	7.88	120	07N	05N	12.64	225					269S	22N	20.40	180
01S	07N	21.45	40	07N	05S	20.22	200	19	15	1.50	135				
				07N	07C	5.00	225	19	20	1.82	360	Beach	05N	48.43	260
02N	01N	22.60	360	07N	07S	9.87	225					Beach	05S	49.61	250
02N	01S	15.90	20	07N	08N	33.65	130	20	19	1.82	180	Beach	07N	38.72	275
02N	02S	9.60	150	07N	Beach	38.72	95	20	21	1.60	360	Beach	07S	46.30	260
02N	04N	19.20	180									Beach	08C	30.19	205
02N	05S	18.80	50	07S	05N	2.79	220	21	20	1.60	180	Beach	08N	26.65	220
02N	Outmk	33.35	180	07S	05S	12.03	185	21	24	0.74	360	Beach	08S	34.14	200
				07S	07N	9.87	45					Beach	269N	46.50	180
02S	02N	9.60	330	07S	Beach	46.30	80	22N	269S	20.40	360	Beach	Inmk	44.90	135
02S	04N	9.29	160												
02S	04S	19.85	225	08C	08N	4.95	345	22S	13	7.80	200	Inmk	08C	14.74	20
02S	Outmk	24.70	120	08C	Beach	30.19	25					Inmk	08N	19.05	20
				08C	Inmk	14.74	200	23	16	30.6	255	Inmk	08S	10.95	45
03	13	37.10	315					23	3	30.75	250	Inmk	269	49.10	60
03	16	1.55	165	08N	05N	36.45	340					Inmk	269S	54.50	70
03	23	30.75	70	08N	07N	33.65	310	23N	13	59.80	340	Inmk	Beach	44.90	315
				08N	08C	4.95	165	23N	16	30.60	250	Inmk	Outmk	26.30	225
04C	04N	5.01	350	08N	08S	9.97	165								
04C	04S	-	180	08N	Beach	26.60	68	23S	29	33.75	180	Outmk	02N	33.35	360
				08N	Beach	26.65	40					Outmk	02S	24.70	300
04N	02N	19.20	360	08N	Inmk	19.05	200	24	21	0.74	180	Outmk	04N	16.55	340
04N	02S	9.29	340					24	25	3.00	360	Outmk	04S	16.84	225
04N	04C	5.01	170	08S	08N	9.97	345					Outmk	05S	36.60	340
04N	04S	10.74	170	08S	Beach	34.14	20	25	24	3.00	180	Outmk	Inmk	26.30	45
04N	Outmk	16.55	160	08S	Inmk	10.95	225	25	26	5.80	360				
								25	27	16.40	345	Po1	269N	1.30	320
04S	02S	19.85	45	09	10	3.60	90					Po1	Po2	8.25	140
04S	04C	-	360	09	27	7.80	225	26	25	5.80	180				
04S	04N	10.74	350	09	29	7.35	270	26	27	12.20	350	Po2	Po1	8.25	320
04S	Outmk	16.84	45					26	28	11.65	360	Po2	Po3	23.80	125
				10	09	3.60	270	26	30	17.73	340				
05C	05N	5.03	340									Po3	Po2	23.80	305
				11	12	1.70	340	27	09	7.80	45	Po3	Po4	3.82	125
05N	01C	8.22	255					27	25	16.40	165				
05N	01N	10.51	270	12	11	1.70	160	27	26	12.20	170	Po4	Po3	3.82	305
05N	01S	8.85	220	12	17	1.70	315	27	28	2.30	245	Po4	Po5	68.62	110
05N	05C	5.03	160					27	29	8.10	360				
05N	05S	10.07	160	13	03	37.10	135	27	30	6.60	340	Po5	Po4	68.62	290
05N	07N	12.64	45	13	22S	7.80	20					Po5	Po6	1.72	170
05N	07S	2.79	40	13	23N	59.80	160	28	26	11.65	180				
05N	08N	36.45	160					28	27	2.30	65	Po6	Po5	1.72	350
05N	Beach	48.43	80					28	30	6.25	70				

FIGURES

Fig. 1. Point Loma Rocky Intertidal Monitoring Sites.

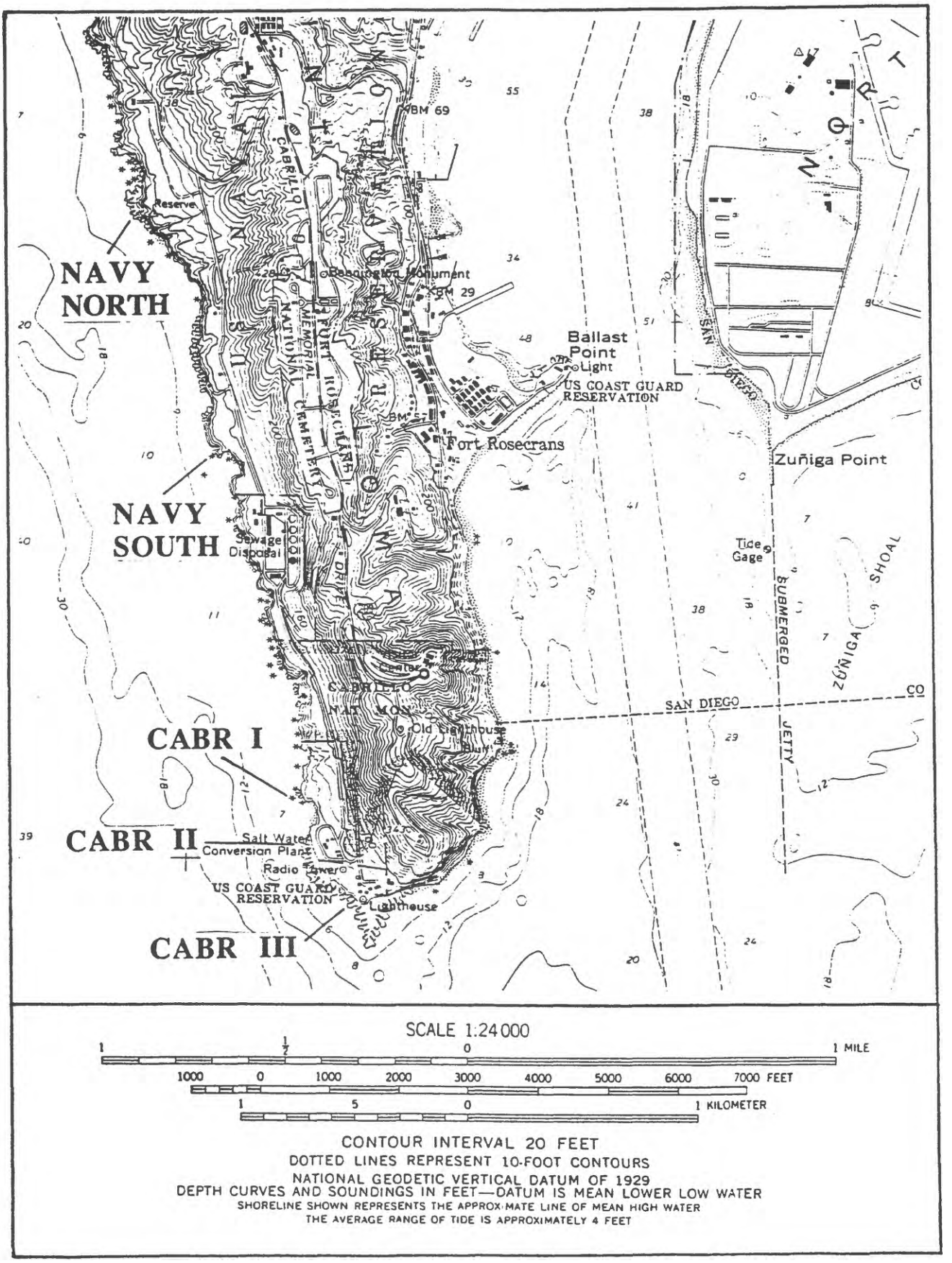


Figure 2. Intertidal Visitor Use and Ecological Monitoring Areas in Cabrillo NM.

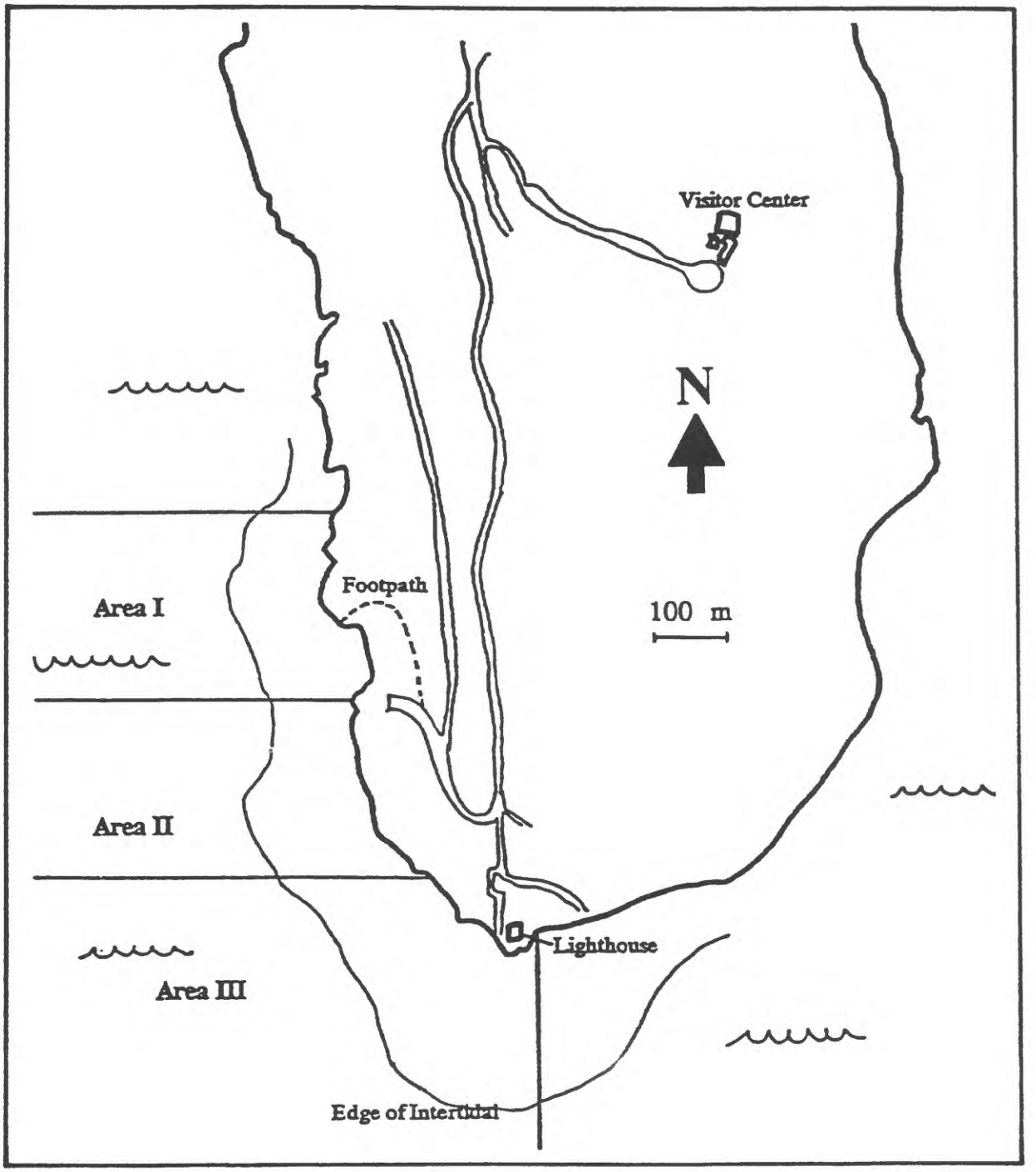


Fig. 3. Cabrillo National Monument Area I Map.

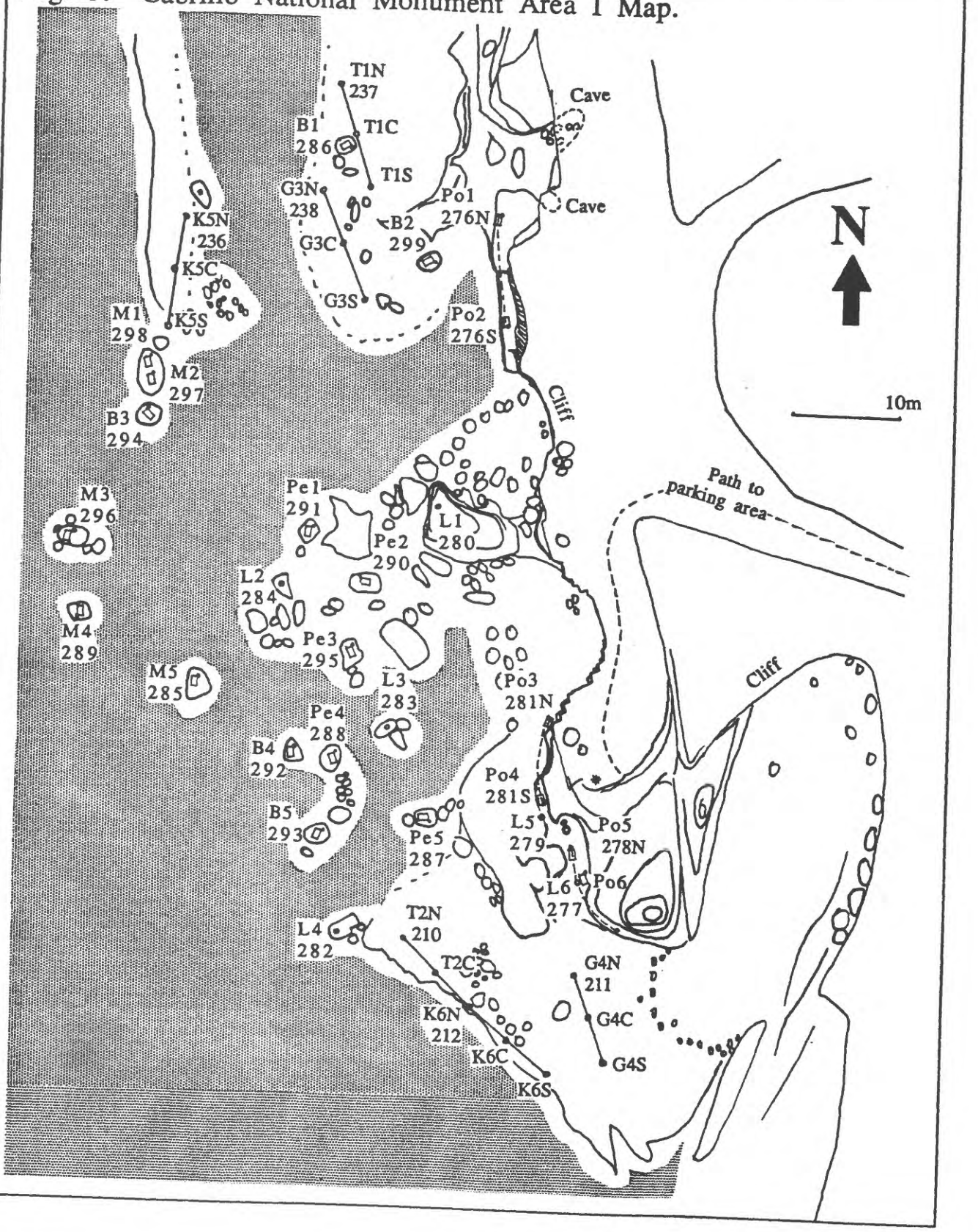


Fig. 4. Cabrillo National Monument Area II Map.

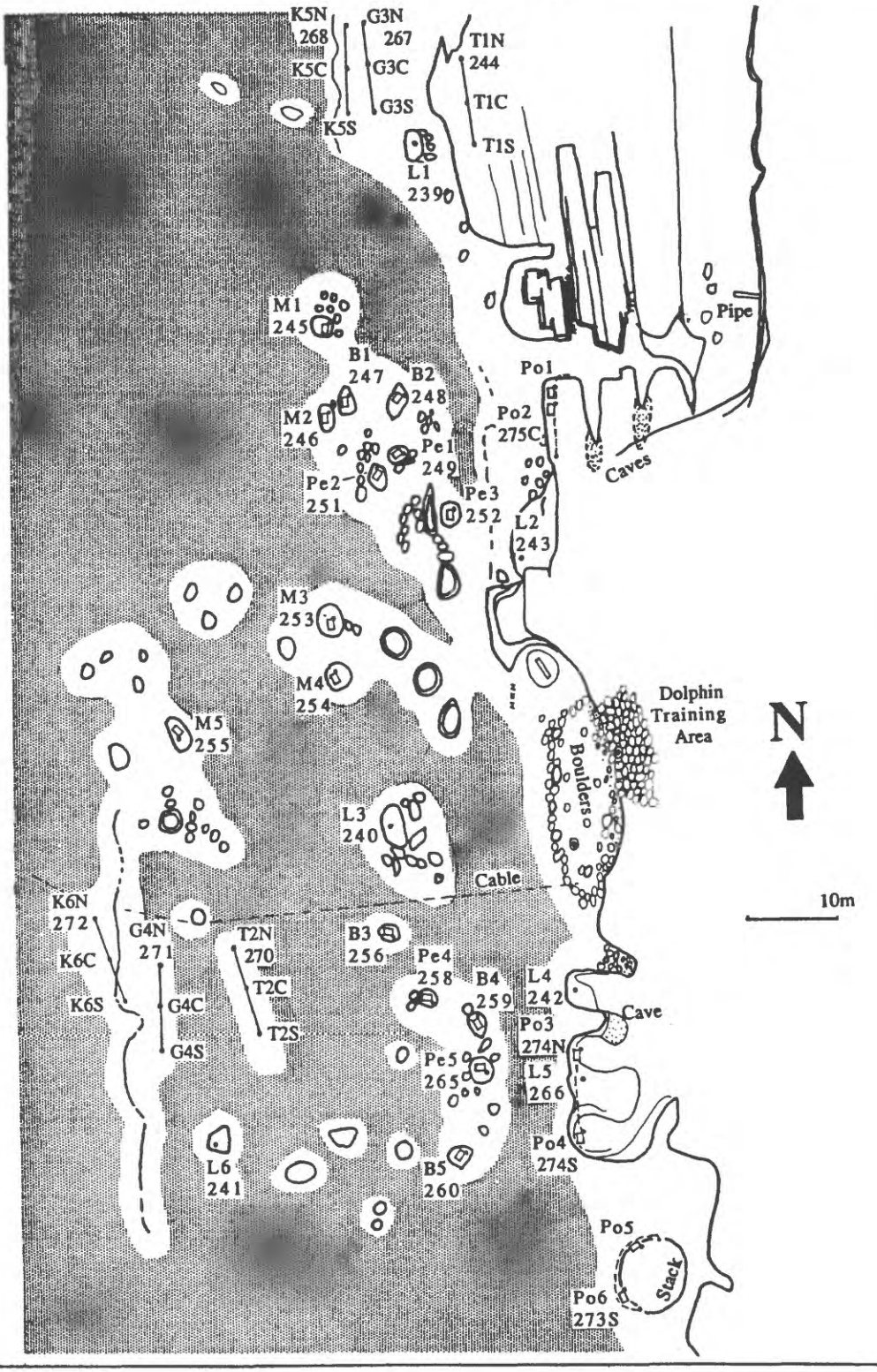


Fig. 5. Cabrillo National Monument Area III North Map.

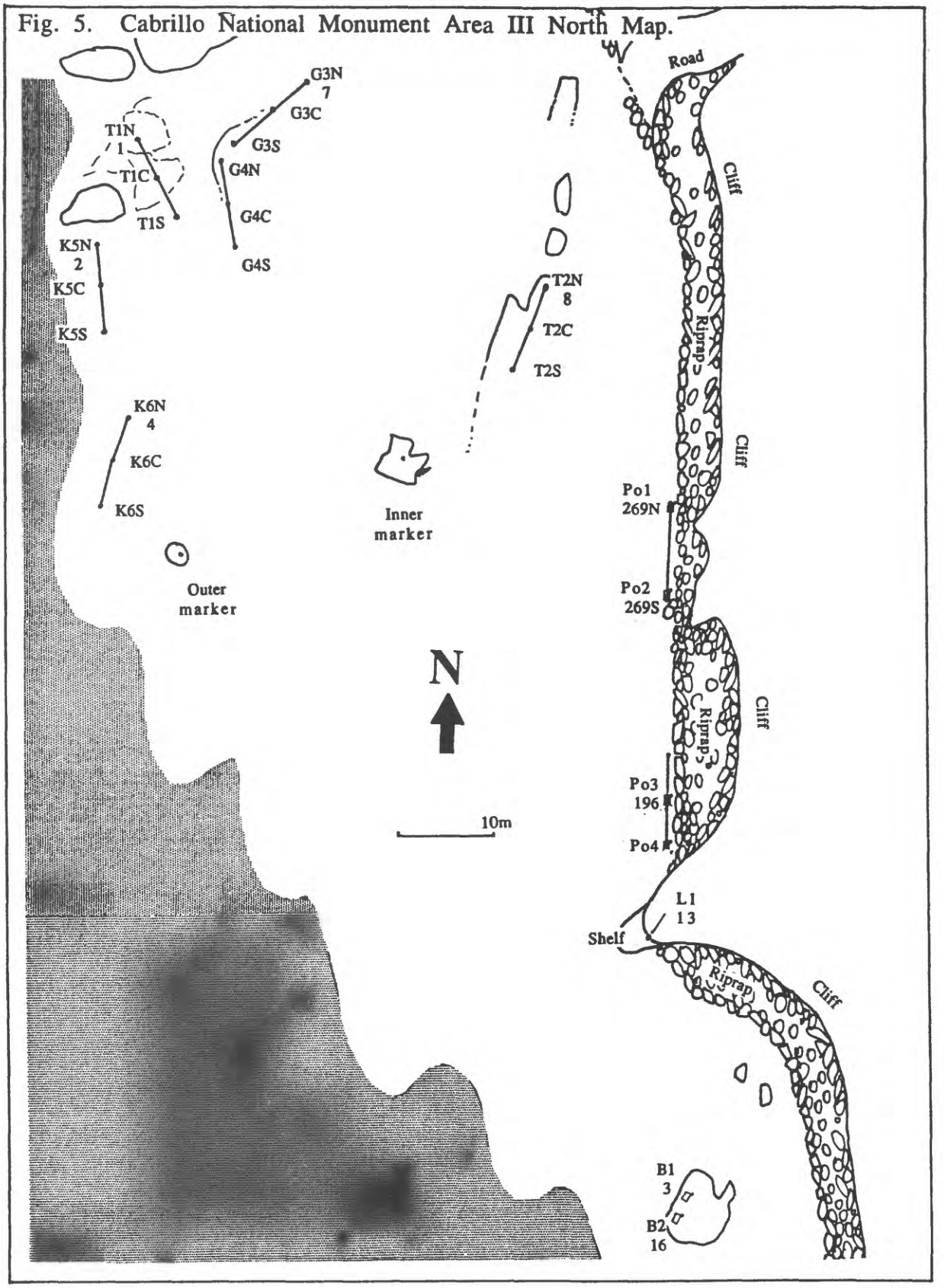


Fig. 6. Cabrillo National Monument Area III South Map.

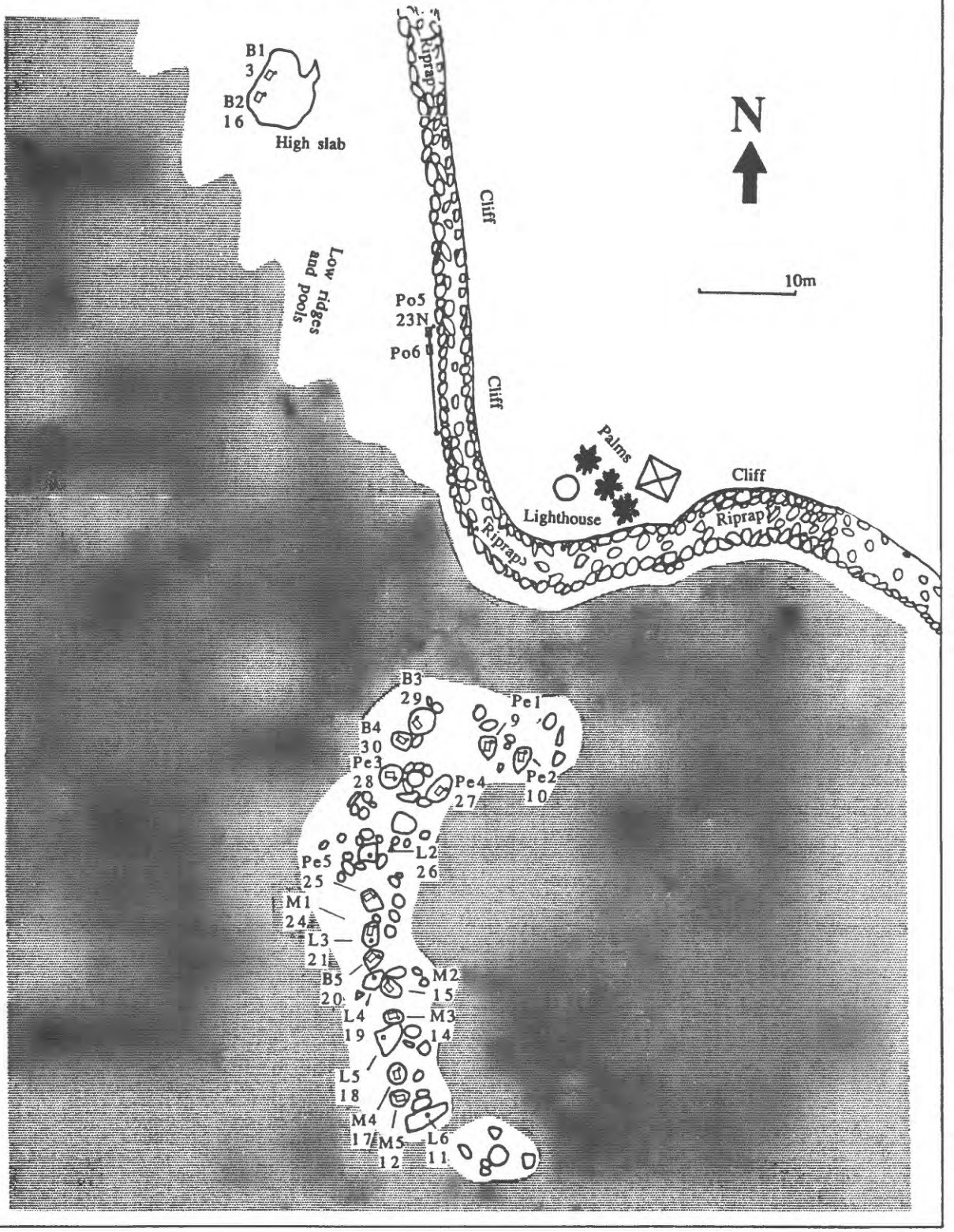
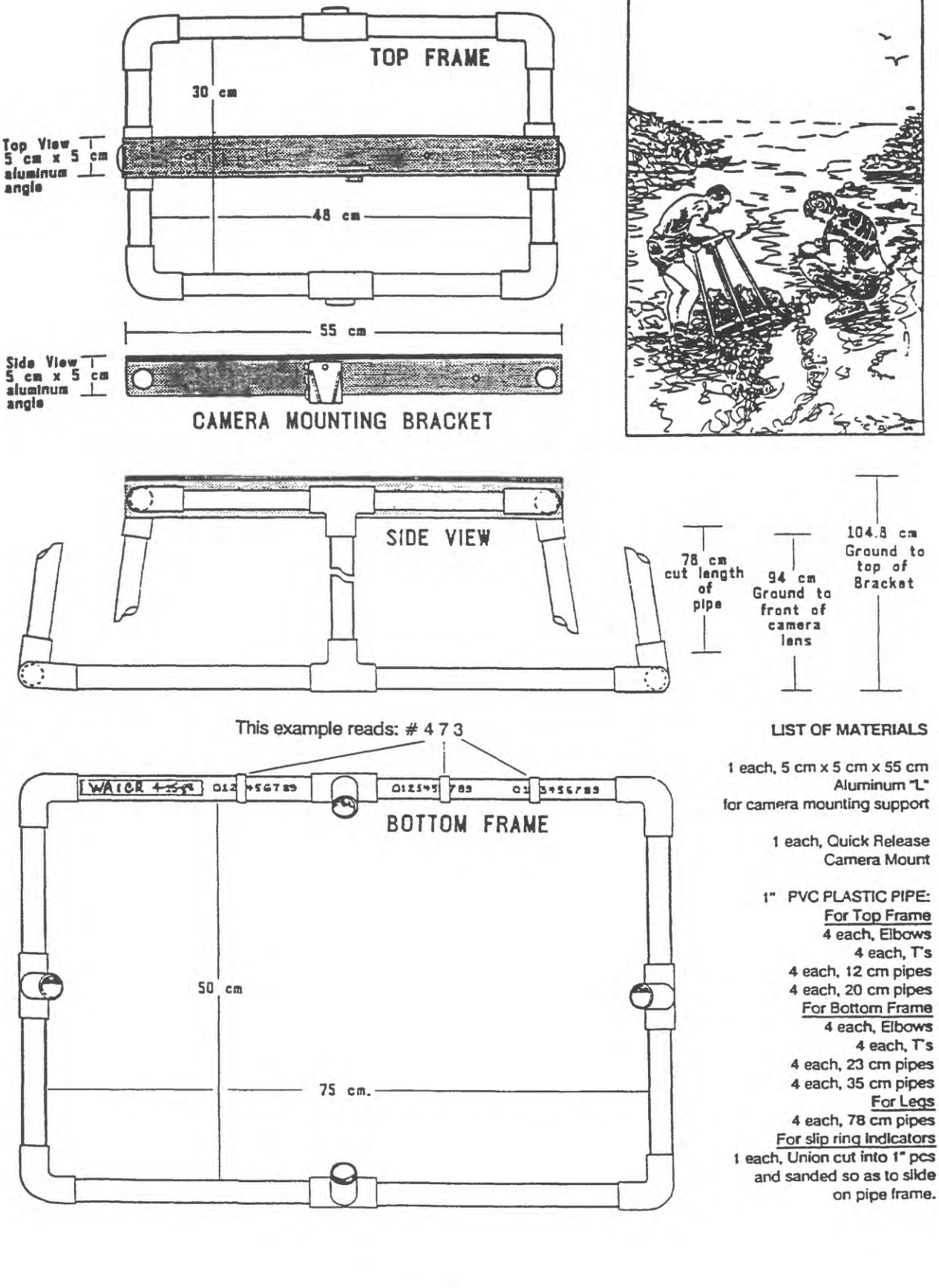


Figure 7. Photoplot Quadropod Apparatus



LIST OF MATERIALS

1 each, 5 cm x 5 cm x 55 cm
Aluminum "L"
for camera mounting support

1 each, Quick Release
Camera Mount

1" PVC PLASTIC PIPE:

For Top Frame
4 each, Elbows
4 each, T's
4 each, 12 cm pipes
4 each, 20 cm pipes

For Bottom Frame
4 each, Elbows
4 each, T's
4 each, 23 cm pipes
4 each, 35 cm pipes

For Legs
4 each, 78 cm pipes

For slip ring indicators
1 each, Union cut into 1" pcs
and sanded so as to slide
on pipe frame.

Form 1. Rocky Intertidal Interplot Measurements.

From	To	Distance	Bearing		From	To	Distance	Bearing		From	To	Distance	Bearing

Form 2. Rocky Intertidal Survey Gear

In NOTEBOOK/CLIPBOARDS

Documents

	Driver's licenses (carry on person)
	CFG collecting permit (if collecting)
	Intertidal Survey Handbooks (2)

Site Information

	Site Maps in plastic sleeves (3 sets)
	Interplot Measurements in plastic sleeves (3 sets)
	Field Notes from previous surveys (1 copy)
	Print Photos of all plots/transects (1 set)
	Clear Plastic Sheet Protectors (3 extra)

Data Forms

	Field Log Forms (10)
	Photo Log Forms (10 dbl sided)
	Owl Limpet Forms (10 dbl sided)
	Line Transect Forms (15 dbl sided)
	Abalone/Sea Star Forms (5)
	Bird/People Census Forms (5)

Other

	#2 Pencils, sharpened (10)
	Grease Pencil for notes on map overlays (1)
	Tide Table (1)
	Notepaper, (1 spare pad)
	Large Rubber Bands for holding notes (5)

In BACKPACK or TOOLBOX

	Waterproof Compasses (2)
	Bright Flagging Tape (2 rolls)
	Small Waterproof Flashlight w/batteries (1)
	Duct Tape (1 roll)
	Cable Ties for repairs (a few in assorted sizes)
	Waterproof Thermometer (1)
	Splashzone Epoxy in 2 small tubs (1 set of A&B)
	Replacement Bolts, assorted lengths (10)
	Bungee Cords or Velcro Straps (4)
	Screwdrivers: normal and phillips (1 each)
	Plastic Bags for specimen collection (optional)
	Small Plastic Specimen Vials (optional)
	Metric Calipers for measuring limpets (3)
	Yellow Crayons for marking limpets (5)
	1 m Lines or Tapes for limpet plots (3)
	Wire Brushes/ Knives to clean markers (3 each)

OTHER ITEMS

	PVC Photo Quadrapod Apparatus (1)
	PVC Quadrats for marking plots (5-15)
	Meter Tapes: 30 m for marking transects (6) 60 or 100 m for measurements (1)
	Backpacks/Buckets to hold loose items (several)
	Aluminum Clipboards (4)
	Foam kneeling pads (3)
	First Aid Kit (1)
	Portable Drill, Bits, Batteries or Fuel (optional)
	Rock Hammer (optional)
	Bright Flag Sticks to mark plots (optional)
	Orange cones (optional)
	Species Identification Books (optional)

In CAMERA CASE

	Camera and Lens (1) (*tested*)
	Strobe (1) (*tested*) and synch. cord
	Batteries for strobe (plus spare)
	Color Slide Film: 36 exposure, 100 ASA, Ektachrome or equivalent (3??? rolls)
	Lens Cap, Paper, and Cleaning Fluid (1 each)
	Waterproof Marking Pen (1)
	Bolt for camera/quadrapod mount (1 spare)
	Crescent Wrench for camera mount (1)
	Camera and Strobe manuals (1 each)

In VIDEO CASE (optional)

	Video Camcorder in Plastic Housing (1) (*tested*)
	Hi or Reg 8 mm 1 hr videotapes (1 plus 1 spare)
	Video Battery Packs (2 heavy duty) (*charged*)
	Lens Paper and Cleaning Fluid (1 each)
	Desiccant Packs (3 small)
	Head-Cleaning Cassette (1)
	Small Towel (1)
	Video Camcorder Manual (1)
	Camcorder Date/Time Disk Battery (1 spare)
	Headphone to check sound (1)

PERSONAL GEAR

	Intertidal Shoes, Boots, or Booties
	Windbreaker and Foul Weather Gear
	Spare Dry Clothing
	Hat, Sunglasses, and Sunscreen
	Snack Food and Drink
	Daypack
	Wetsuit, Kneepads, Gloves (optional)

Form 3: ROCKY INTERTIDAL MONITORING FIELD LOG

Date: _____ **Time:** _____ **Page:** _____ **of** _____
Study Site: _____
Participants: _____
Recorder: _____
Temperature: Air_____**°C Water**_____**°C Tide Level (ft)**_____
Wind: Speed (kt)_____ **Direction**_____ **Cloud Cover**_____**%**
Wave Height (ft)_____ **Surge (light, moderate, heavy)**_____

Field Log (General account of intertidal work, including observations and sketches):

Form 4: ROCKY INTERTIDAL MONITORING PHOTO LOG

Date: _____ **Page:** _____ **of** _____
Area: _____ **Film Roll #:** _____
Photographer: _____
Recorder: _____

Photo #	Study Site	Quadrat #	Shutter Speed	F/Stop	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					

Form 5: ROCKY INTERTIDAL OWL LIMPET MEASUREMENTS

Date: ________________ **Page:** _____ **of** _____

Study Site: ____

Recorder: ________________________ **Measurer** ________________________

Plot #	Length (mm)	Tag #	Plot #	Length (mm)	Tag #	Plot #	Length (mm)	Tag #

Form 6. ROCKY INTERTIDAL MONITORING LINE-INTERCEPT TRANSECT

Location: _____ **Transect #:**_____ **Date:**_____
Recorder: _____ **Reader:**_____
Cover:_____ **Distance Along Transect (cm):**_____

Boa Kelp **Total:**_____
*Egregia sp.*_____

Sargassum Weed **Total:**_____
Sargassum _____

Red Algal Turf **Total:**_____
Corallina sp., et al. _____

Surf Grass **Total:**_____
Phyllospadix sp. _____

Aggregating Anemone **Total:**_____
Anthopleura elegantissima _____

Other Biota **Total:**_____

Tar **Total:**_____

Bare Substrate **Total:**_____

Comments: _____

Form 7. ROCKY INTERTIDAL ABALONE/SEA STAR COUNTS

Date: ___________ **Time:** _____ **Site:** _________________ **Recorder:** ________

SPECIES	**#**	***Size** (cm)	**Notes** (shells, condition, location, etc...)
Black Abalone			
Green Abalone			
Pink Abalone			
Ochre Sea Star			
Blue Sea Star			
Bat Star			
Fragile Star			
Other________			

Date: ___________ **Time:** _____ **Site:** _________________ **Recorder:** ________

SPECIES	**#**	***Size** (cm)	**Notes** (shells, condition, location, etc...)
Black Abalone			
Green Abalone			
Pink Abalone			
Ochre Sea Star			
Blue Sea Star			
Bat Star			
Fragile Star			
Other________			

Date: ___________ **Time:** _____ **Site:** _________________ **Recorder:** ________

SPECIES	**#**	***Size** (cm)	**Notes** (shells, condition, location, etc...)
Black Abalone			
Green Abalone			
Pink Abalone			
Ochre Sea Star			
Blue Sea Star			
Bat Star			
Fragile Star			
Other________			

*For abalone, measure greatest shell length. For sea stars, measure from center of disk to tip of longest ray.

Form 8. ROCKY INTERTIDAL PEOPLE AND BIRD CENSUS

Date: _____ **Time:** _____ **Page #:** _____
Study Site: _____
Observer: _____
Temperature: Air_____ **°C Water**_____ **°C Wave height: (ft)**_____
Wind: Speed (kt)_____ **Direction**_____ **Cloud Cover:** _____
Low Tide Level: (ft)_____ **at** _____ **(time)**

	AREA III	AREA II	AREA I
People			
Wading Birds Great Blue Heron			
Great Egret			
Snowy Egret			
Other			
Shore Birds Black-bellied Plover			
Willet			
Wandering Tattler			
Spotted Godwit			
Whimbrel			
Ruddy Turnstone			
Sanderling			
Other			
Gulls Western			
California			
Heermann's			
Mew			
Ring-billed			
Other			

Form 9. ROCKY INTERTIDAL MONITORING PHOTO POINT INTERCEPT FORM

Site _____ Survey Date _____

Scored by _____ Score Date _____

BARNACLE PLOT #					
Total Points					
Acorn Barnacle					
Thatched Barnacle					
Rockweed					
California Mussel					
Goose Barnacle					
Other Plant					
Other Animal					
Bare Substrate					
Tar					

ROCKWEED PLOT #					
Total Points					
Acorn Barnacle					
Thatched Barnacle					
Rockweed					
California Mussel					
Goose Barnacle					
Other Plant					
Other Animal					
Bare Substrate					
Tar					

MUSSEL PLOT #					
Total Points					
Acorn Barnacle					
Thatched Barnacle					
Rockweed					
California Mussel					
Goose Barnacle					
Other Plant					
Other Animal					
Bare Substrate					
Tar					

POLLICIPES PLOT #						
Total Points						
Acorn Barnacle						
Thatched Barnacle						
Rockweed						
California Mussel						
Goose Barnacle						
Other Plant						
Other Animal						
Bare Substrate						
Tar						

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