SAND BEACH AND COASTAL LAGOON MONITORING HANDBOOK

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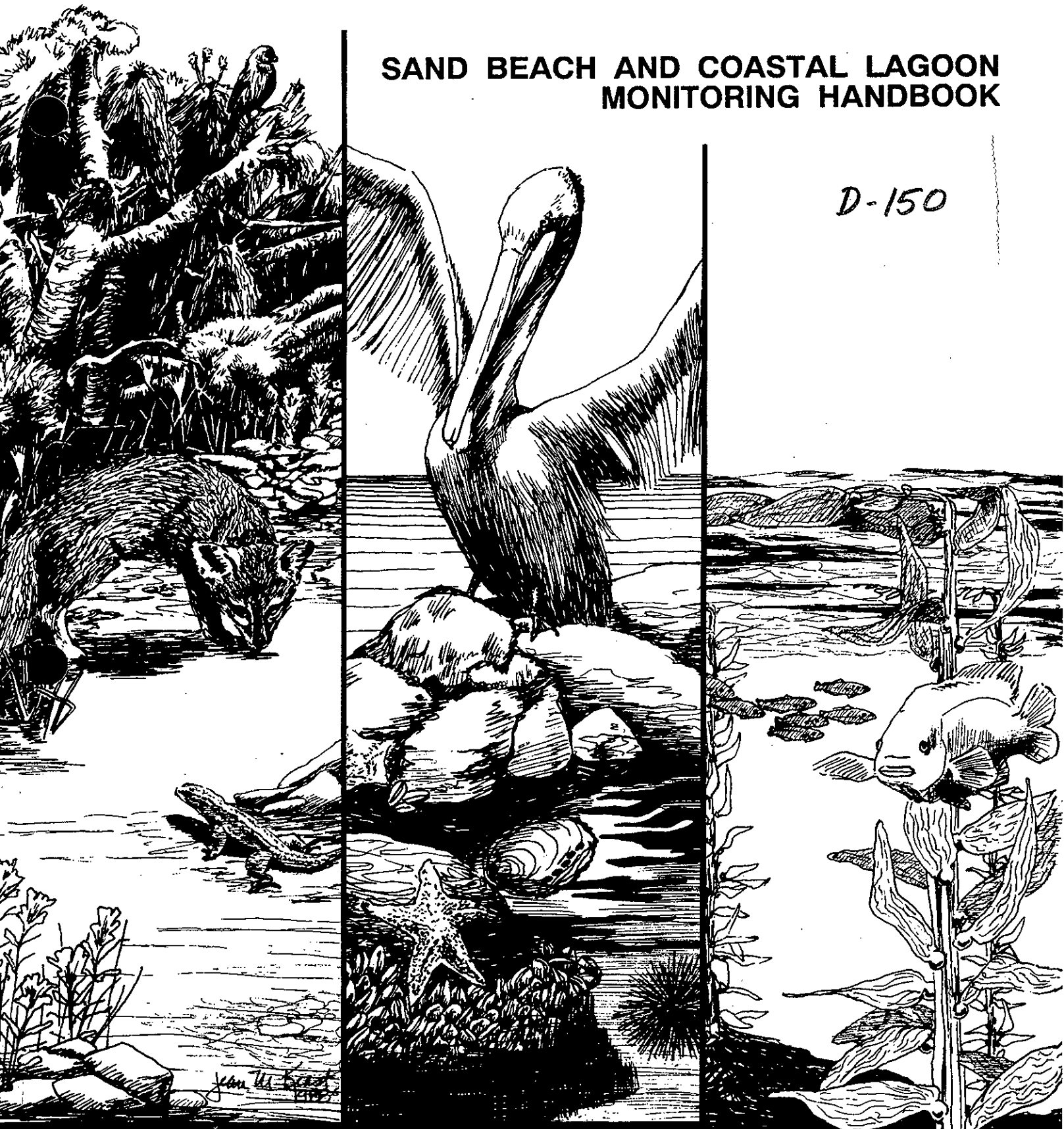

Channel Islands National Park

National Park Service
U.S. Department of the Interior

SAND BEACH and COASTAL LAGOON MONITORING HANDBOOK

CHANNEL ISLANDS NATIONAL PARK
CALIFORNIA

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INTRODUCTION

Sand beaches are a major component of the intertidal region of Santa Rosa Island, making up approximately 30 kilometers of the island's shoreline. A wide variety of exposures and types of beaches occur on the island, including northwest facing beaches, sheltered beaches with eastern exposures and beaches with south and southwest exposures. Many of the beach exposures found on Santa Rosa Island do not occur on the California mainland.

Sandy beaches are characterized by the absence of attached plants and a mobile fauna. Many sand beach species migrate with tidal cycles, and are adapted to burrow rapidly to maintain position in the constantly shifting sands. The zonation and distribution of sand beach macrofauna species and the physical features of the beach (Figure 1) change dramatically with tide and swell regimes. In contrast, the majority of the inhabitants of rocky intertidal habitats maintain position by strong attachments to rocks, resulting in distinct zonation patterns associated with intertidal height.

The sand beach is an important interface between land and sea and is utilized by a variety of nonresident species for feeding, resting, and breeding. Many bird species, including shorebirds, gulls, and terrestrial birds, feed upon the drift feeding, filter feeding and secondary consumer macrofauna of the sand beach community. Snowy Plovers breed in numbers on the beaches of both Santa Rosa and San Miguel Islands and are very sensitive to disturbance by man and predators during the spring and summer breeding season. Beaches provide important haulout and rookery areas for pinnipeds. On Santa Rosa Island, both endemic island foxes and feral pigs forage on the beaches.

Beach macrofauna communities are well adapted to natural disturbances such as changes in beach morphology. The sand beach community is sensitive to large scale changes, such as El Niño events, which affect many of the marine resources of Channel Island National Park. Chronic and acute pollution from shipping, oil production and mainland sources have the potential to cause major disturbance to the balance of the sand beach community and the organisms which utilize it.

Overgrazing by large numbers of cattle, pigs, deer, horses and elk has led to severe erosion and enhanced sediment delivery to island beaches. The beaches of Santa Rosa Island may shrink as a consequence of decreases in erosion and sediment supply, once large herbivores are removed and revegetation occurs on the island. Long term monitoring will describe changes in the beach community associated with sediment dynamics.

Coastal wetlands in California are generally small, discrete and relatively recent in origin (Zedler 1982). The wetlands of eastern Santa Rosa Island should be considered coastal lagoons due to the lack of regular tidal flushing and free exchange with the ocean. The coastal lagoon system found on the eastern end of Santa Rosa Island currently consists of three separate lagoons with different physical characteristics and is the sole example of that habitat in the Northern Channel Islands. The lagoons are generally isolated from ocean by a sand beach berm and water levels are typically maintained above sea level by occasional ocean overwash events.

The lagoons harbor unique fauna and flora including salt tolerant invertebrates and fish, seagrass and algae. The majority of lagoon macrofauna and flora occur transiently but in high abundances at times, providing a vital food source for avifauna. Shorebirds, waterfowl, raptors and terrestrial bird species utilize the lagoons in many ways: as feeding grounds during migration, overwintering areas, hunting areas and resident habitat. Numbers of snowy plovers nest in the lagoon area and adjacent beaches during breeding season and utilize the area during migration. A variety of mammals including island foxes, skunks and feral pigs utilize the lagoon area. In addition, the lagoon sediments contain valuable presettlement paleoecological information in the form of fossil pollen and plant macrofossils and may hold a record of unprecedented length for a Southern California wetland.

Rainstorm and swell events can potentially cause extreme disturbance, and bring rapid and lasting changes to the lagoons. If the berm barrier is broken by flooding or large waves, the lagoons may drain completely, washing the fauna out to sea or leaving them exposed. In the course of a single tidal cycle, ocean overwash into a lagoon may increase the volume of water by orders of magnitude, change the salinity and temperature of the water, and introduce marine fish and other organisms.

Erosion due to overgrazing has probably significantly increased the sedimentation rate in the lagoons of Santa Rosa Island and may lead to premature filling of the lagoon basin and loss of the lagoons. Catastrophic sedimentation is of particular concern in wet or unusual flood years until revegetation occurs in the lagoon watershed area.

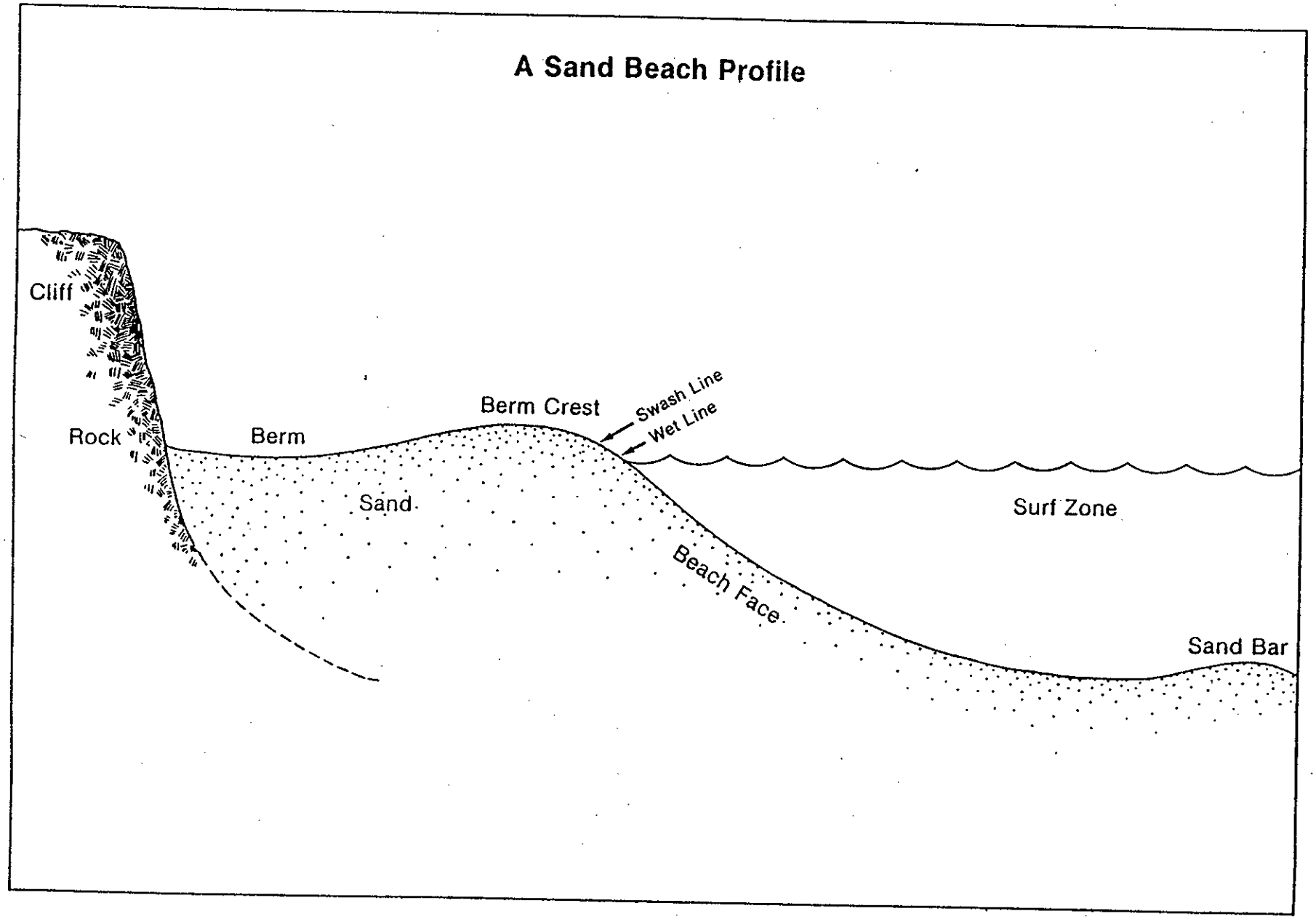


Figure 1 Sand Beach Profile

MONITORING DESIGN CONSIDERATIONS

SPECIES SELECTION

Sand beach macrofauna depend almost entirely upon exogenous sources of carbon as relatively little primary production occurs on the beach itself. The two main sources of primary production available to the sand beach communities of Channel Islands National Park are:

1) the drift algae from nearshore kelp forests and algal beds

2) the production of inshore and offshore phytoplankton.

The metabolism of the beach community is closely linked with kelp forest and macroalgal communities, and with oceanographic conditions including upwelling events and currents which control planktonic productivity. The dichotomy of resource inputs available to the sand beach results in two distinct groups of primary consumers. First, the drift macrophyte consumers, e.g. amphipods and flies, which inhabit the upper beach and come down to the mid and lower beach to feed; and second, the filter feeders, e.g. sand crabs and clams, which feed on phytoplankton, zooplankton and suspended particulates. Scavengers and other secondary consumers, such as beetles and isopods, feed upon carrion, and other wrack that is deposited on beaches and prey upon the primary consumers.

The selection of taxa for sand beach monitoring was designed to provide representation of the two types of primary consumers and the other ecological roles found in the sand beach communities of Santa Rosa Island. Species were selected to represent the trophic levels, feeding types and various reproductive strategies in the beach macrofauna community. Specific beach macrofauna were selected after macrofauna inventories were completed at a variety of beach types. The design study of lagoon macrofauna and dynamics resulted in a qualitative approach to lagoon monitoring which involves both avifauna and lagoon infauna.

The organisms selected for monitoring sand beach communities occurred commonly on the beaches of Santa Rosa Island. The sand crab, *Emerita analoga*, the isopod *Excirolana chiltoni* and the beachhoppers, *Meglaorchestia* were selected as indicator species. Macrophyte debris, primarily algal wrack, was selected for monitoring on sand beaches. In addition, on more protected sand beaches, the spiny sand crab, *Blepharipoda occidentalis*, the Pismo clam, *Tivela stultorum* and the purple olive snail, *Olivella biplicata*

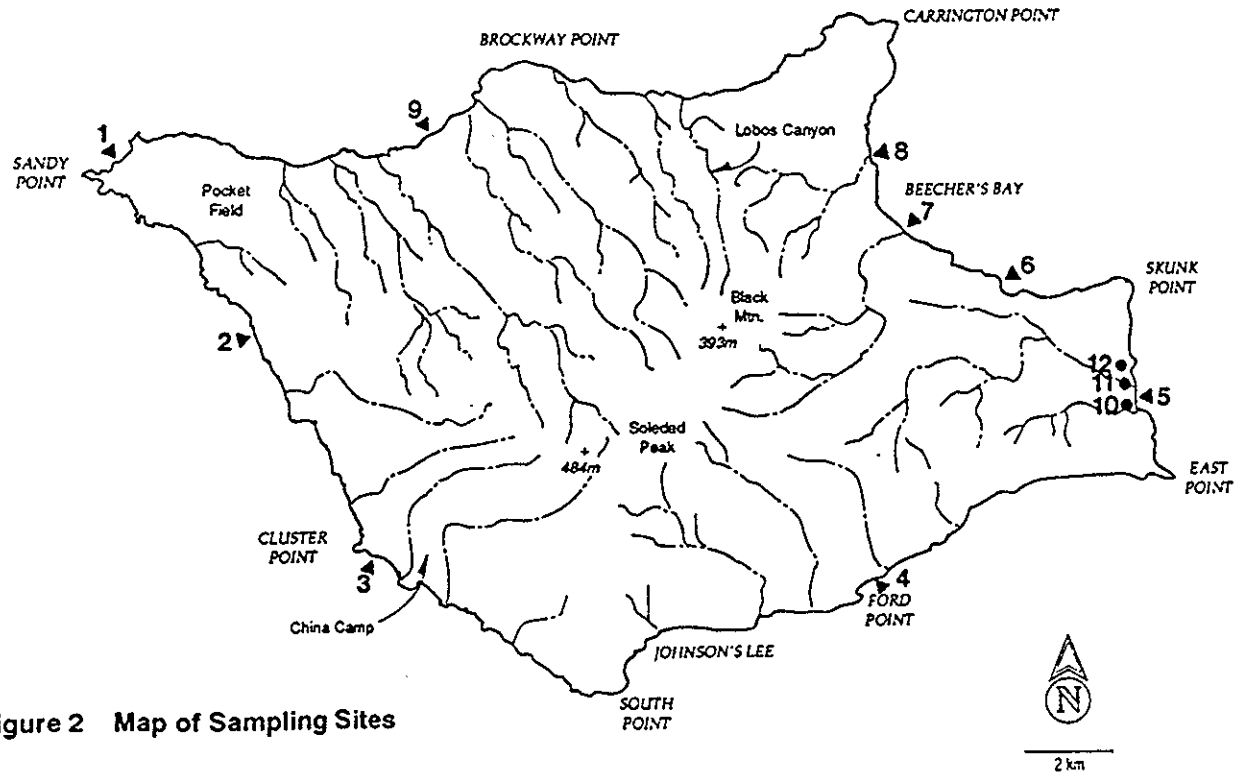


Figure 2 Map of Sampling Sites

were selected as indicator organisms. Shorebird occurrence and abundances will be monitored at selected sites. Snowy plover breeding surveys will be conducted on Santa Rosa Island as part of the existing seabird monitoring program.

At the lagoons, the distribution and numbers of avifauna including: waterfowl, shorebirds and raptors will be monitored. The ephemeral nature of the lagoon macrofauna, the physical dynamics of the habitat and the difficulty of interpreting the results of sampling a highly variable volume of water indicated the use of a qualitative approach. A species checklist will be used to monitor nonavian lagoon macrofauna. A list of macrofauna species that have been found in the lagoons include: the arrow goby, *Clevelandia ios*, top smelt *Atherinops affinis*, spionid worms *Polydora*, shore crabs, *Pachygrapsus crassipes* and *Hemigrapsus oregonensis*, waterboatmen, *Trichocorixa reticulata*, brine flies, *Ephydra millbrae*. Tiger beetles *(Cincindela)* and shore bugs (Saldidae) may be seasonally abundant on the mud and sand flats. Measurement of the physical conditions of the three lagoons including the water temperature, salinity, secchi depth, and relative water levels will compose the remainder of the long term monitoring program in the lagoon habitat.

SITE SELECTION

Sand beaches are found on every exposure of Santa Rosa Island and range from high to low wave energy. The physical properties of beaches including slope, grain size, permeability, cusping, and stability vary dramatically with both temporal and geographic differences in exposure and wave energy. Nine beach sites were selected to represent the extensive range of exposures and types of beaches found on Santa Rosa Island (Table 1, Figure 2). Appendix A contains maps giving more detailed locations of each site.

Three lagoons occur on the east end of the island (Figure 2, Table 1, Appendix A). Each of the lagoons has distinct hydrology. At the Old Ranch House Canyon lagoon, five permanant stations will be monitored using physical measurements and faunal diversity surveys. Two stations will be monitored similarly at Old Ranch Canyon and Oak Point lagoons. See Appendix A for locations of the sampling stations.

SAMPLING TECHNIQUES

A variety of sampling techniques are needed to monitor the population dynamics of beach and lagoon organisms (Table 1, 2). The mobility and burrowing habits of most sand beach macrofauna requires that

Table 1 Beach & Lagoon Monitoring Sites & Monitoring Activities

BEACHES

	Site Information					Monitoring Activities							
Location	Code	Site#	Macro-phyte Wrack	Upper Beach Trans.	Wash Zone Trans.	Subtidal Trans.	Band Trans.	Trench Trans.	Mark. Recap	Sup. Sample	Size Freq.	Phy. Meas.	Bird Census
Sandy Pt.	SRISP	1	3	5	5					1	1/sp	1	1
Bee Rock West	SRIBR	2	3	5	5					1	1/sp	1	1
China Camp	SRICC	3	3	5	5					1	1/sp	1	1
Ford Pt.	SRIFP	4	3	5	5					1	1/sp	1	1
Abalone Rocks	SRIAR	5	3	5	5					1	1/sp	1	1
Southeast Anch.	SRISE	6	3	5	5	5	5-10	5-10	1	1	1/sp	1	1
Water Canyon	SRIWC	7	3	5	5					1	1/sp	1	1
Becher's Pier	SRIBB	8	3	5	5					1	1/sp	1	1
Soledad West	SRISW	9	3	5	5					1	1/sp	1	1

LAGOONS

Location	Code	Site#	# Stations	Bird Census	Physical Measurements	Species List
Old Ranch House Cyn	SRIORH	10	5	1	1	3/stat.
Old Ranch Cyn.	SRIOR	11	2	1	1	3/stat.
Oat Pt.	SRIOP	12	2	1	1	3/stat.

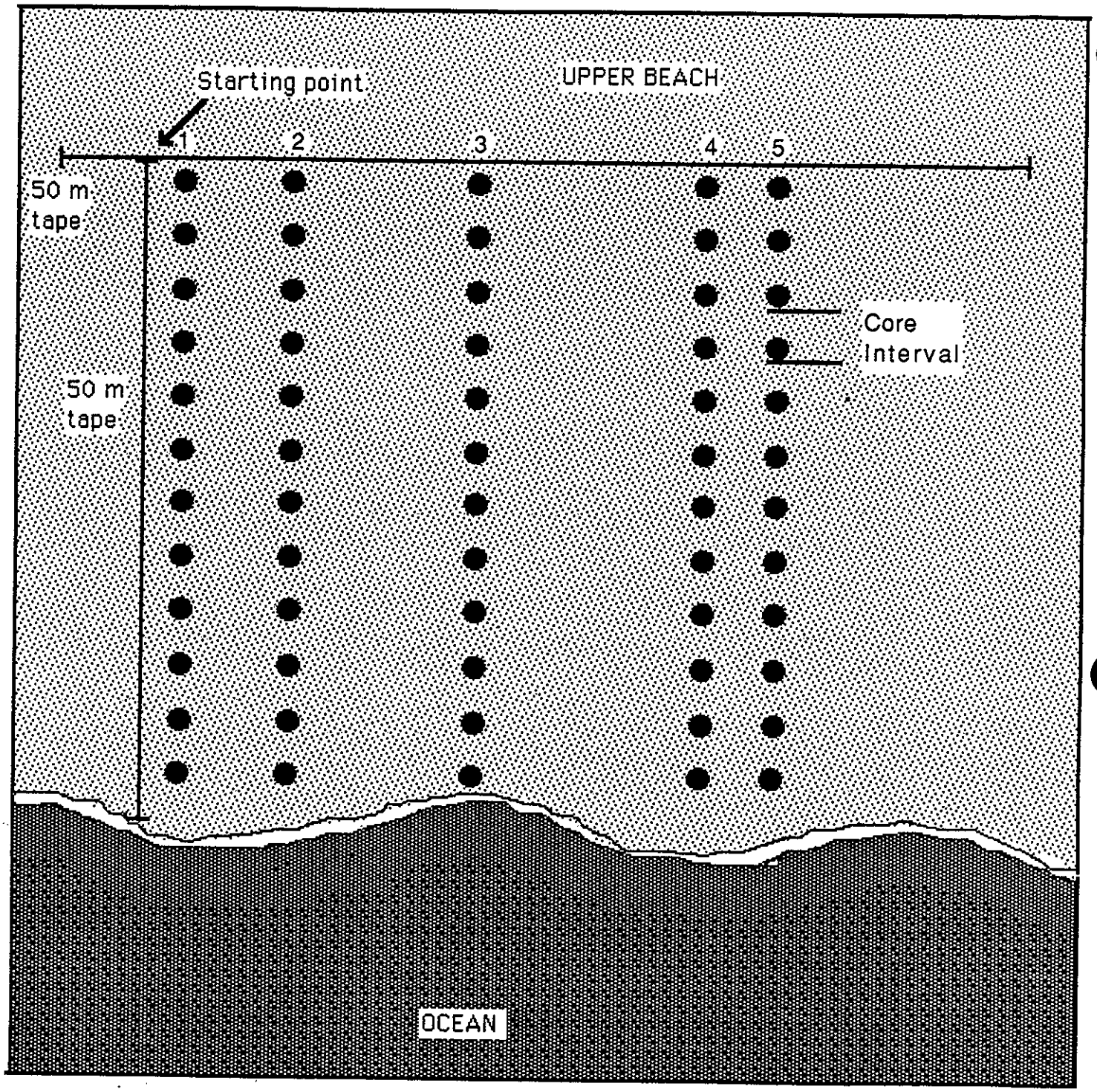
the organisms be physically captured and separated from the sand for measurement of abundance and population characteristics. Unlike the rocky intertidal or other more stable habitats, returning to a permanent sampling plot on a sand beach will not yield comparable results over time. The ability of many sand beach macrofauna to avoid sampling devices, particularly in the wash zone, requires quick reproducible techniques and the inclusion of buffer areas in sampling protocols.

Vertical format transects (Figure 3) of various types were selected for sampling the beaches in order to accommodate the daily and seasonally shifting intertidal zonation of mobile macrofauna species. To allow comparisons between different beaches of various widths and samples taken on single beaches in different swell and tidal conditions all faunal abundance measures will be converted to the abundance of vertical meter wide strips (Brown and McLachlan 1990). The width of the intertidal zone and the length of the beach will be measured to allow density estimates if needed. Subtidal band transects will be used sample rare and clumped organisms at some protected sites. For selected macrofauna, measurements of size frequency distributions will be used to monitor population age and size structure and reproductive characteristics. That procedure will provide estimates of growth and mortality rates and allow the identification and monitoring of recruitment cohorts. Supplemental sampling of selected indicator species will be used to provide additional information on reproductive characteristics of the populations.

The accuracy and precision of sampling techniques selected for long term monitoring programs need to be transmitted through many generations of observers without degradation (Davis 1988). Sampling techniques should provide values that are relatively free of variation between observers and minimally impact populations of indicator organisms and their habitats.

Table 2 Sampling Technique Summary for Sand Beach and Lagoon Monitoring

Technique	Sample Size	Target Species
Clam Gun Transects	varies	*Megalorchestia, Emerita, Excirolana, Olivella* and associated sp.
Band Transects	1x100m	*Tivela*, associated species
Trench Transects	0.25x20m	*Tivela, Blepharipoda*
Point Contact Transects	100 pts	Macrophyte wrack
Supplemental Sampling	100-500/species	*Emerita*
Mark Recapture Sampling	varies	*Tivela*
Size Frequency Distributions	Varies by species	*Emerita, Blepharipoda, Tivela, Olivella*
Species Checklist	Varies	Lagoon Species
Physical Conditions		N/A
Avifauna Census		Shorebirds, Seabirds, Raptors, Terrestrial birds



$$\text{Number of organisms per meter} = \text{Number caught in transect} * \frac{(\text{Core interval m} * 1\text{ m})}{(\text{Core area m2})}$$

Figure 3 Vertical Transect Format

MONITORING PROTOCOL

A summary of the techniques to be employed at each monitoring location is given in Table 1. A summary of monitoring techniques, sample sizes and target species is given in Table 2. A summary of population parameters measured by the monitoring program is shown by species or taxon in Appendix B.

The majority of beach monitoring activities will be conducted once annually in early August during a period of daylight falling tides. Shallow subtidal monitoring requires very calm conditions and should be conducted in the late summer or early fall. The lagoon monitoring should be conducted quarterly. Low intertidal beach monitoring will be conducted during low tides in the spring and fall coincident with rocky intertidal monitoring on Santa Rosa Island. Mark and recapture sampling will be conducted four times in the summer months.

When scheduling trips, allow one day per site to conduct the monitoring. Transportation time to sites on Santa Rosa Island should be accounted for in planning the monitoring schedule. It may be possible to collect data and animals from two adjacent sites and hold the animals for processing at the second site or at Becher's Pier or Jolla Vieja beach that same day.

Blank data forms for recording data obtained from each sampling method are provided in Appendix E. Photocopies of data forms from this handbook may be produced on regular or waterproof paper for use in the field.

Personal gear for investigators conducting sand beach monitoring should include the following:

Hiking boots or shoes	Notebook
Day pack	Field guides
Radio	Sunscreen
Booties or old sneakers	Camera
Swim trunks or shorts	Binoculars
Hat or visor	Old towels
Sunglasses	Food and drink
Watch cap	First aid kit
Wetsuit	Flashlight
Windbreaker	Vest

Immediately after arriving at a beach, the investigators should conduct a bird census. The sequence of sampling procedures then depends on the tide conditions and number of available personnel. A working sequence could be: macrophyte wrack transects, wash zone transects, supplemental sampling, physical measurements and upper beach transects when the tide will be falling for 2-3 hours after your arrival. If you must wait for the tide start falling, conduct the upper beach transects first. If the tide will be coming in soon, conduct the wash zone and supplemental sampling first. When two teams of investigators are available, the upper beach and macrophyte wrack procedures may be conducted by one team while the wash zone transects and supplemental sampling are conducted by the second team. Processing of quantitative upper beach and wash zone samples may then occur simultaneously. Size frequency distribution measurement of *Emerita analoga* should be conducted after the quantitative sample is processed.

TRANSECT SAMPLING

Four types of vertical transect sampling will be conducted for the sand beach monitoring program including clam gun transects, subtidal band transects, trench transects and point contact transects. Each technique is described in detail in the following sections.

Clam Gun Transects

Sampling with clam gun transects will be conducted in two areas of the beach, the wash zone, and the upper beach at most locations. At some sites, low intertidal transects and shallow subtidal transects will be used to sample slow moving organisms such as *Olivella* and *Tivela*.

Upper Beach Transects

Purpose:
To estimate the abundance of beachhoppers (*Megalorchestia*) and associated species on the upper beach.

Equipment:
Megalorchestia data sheet
Aluminum clam gun
Pencil
Mesh bags (fine mesh 2mm)
Plastic bucket
MgCl solution (10 %)
50m tape
Random number list

Personnel:
Two persons

Conditions:
Sampling must be conducted during the daytime preferably in the full sun on a medium height tide as the target species are most active in the evening.

Sites:
Soledad North, Sandy Point, Bee Rock West, China Camp, Ford Point, Abalone Rocks, Water Canyon, Becher's Pier, Southeast Anchorage.

Time Required:
1 hour

Methods:
Data sheets are numbered with 5 random numbers from 1-50 with at least 5 meters between numbers to avoid overlap and disturbance of active animals. The numbers indicate starting points for each transect. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

Locate the middle of the main beach section at the site. Conduct a quick visual reconnaissance and locate the nearest area of amphipod burrows and measure the vertical distance between the highest and lowest extent of hopper burrows and the distance to the reference point. Stretch a 50m tape parallel to the water above the highest visible burrows and then use the random numbers on the data sheet to locate the starting point of each transect. The transect should start above the highest visible burrows and extend down the beach to below the lower edge of the hopper beds. Measure the distance to be covered by the transect. To sample, take a 10cm deep core every 0.25, 0.5 or 1.0 meter (see Figure 3) along the transect and place the core in the numbered mesh bag for that transect. If you hit drift kelp, try to cut through it with the clam gun to sample the sand below. This may not always be possible, you may also sample the nearest adjacent area of clear sand or move the kelp aside, if it is a small clump. When the transect is complete, record the spacing and the number of cores taken in each transect. The same spacing and number of cores should be used in each transect at any one site. Tightly close the drawstring top of the mesh bag and then fold it over onto itself and tie it. Repeat for the next 4 transects. When all transects are completed rinse the sand through the mesh of the closed bags in the surf zone, retaining the animals. Submerge the portion of the bag containing animals into MgCl solution for 10 or more minutes to subdue the animals. Count the number of amphipods and associated species found in each transect and record. Identify the associated species to taxon (Order: family), if possible. Rinse the animals in sea water to clear anesthetic and return them to upper beach under damp kelp wrack.

If the schedule requires holding the animals for several hours or overnight prior to processing, the animals should be preserved or chilled into a quiescent state. This procedure will eliminate the loss of animals from predation during the holding period.

Best results will be obtained when relatively high numbers (50 individuals) of beachhoppers are collected in each transect. Spacing for cores should reflect that goal, although some beaches have low abundances of upper beach macrofauna. It may be helpful to run a preliminary transect and count at those sites. Sites with relatively narrow beaches such as Water Canyon, Becher's Pier, Southeast Anchorage, Ford Point and Abalone Rocks should be sampled with 0.25 to 0.5 meter spacing. Sites with wide beaches and high wrack deposition such as Soledad North, and Sandy Point may be adequately sampled with core spacing of 1.0 meter or more. China Camp and Bee Rock West are relatively wide beaches but may require spacing of 0.5 meters or less as upper beach macrofauna are relatively sparse.

Wash Zone Transects

Purpose:
To estimate the abundance of sand crab and isopod species populations on a beach including: *Emerita*, *Excirolana* and associated species.

Materials:
1 clam gun
1 50 meter tape
1 100 meter tape
1 random number list
5 fine mesh bags (mesh 2mm)
1 meter stick
1 Emerita abundance data sheet
5 calibrated sieve buckets (#4, 8, 18, 28, 38)
2 buckets (3-5 gallon)

Personnel:
2 observers in shorts and booties.

Conditions:
A falling tide is best. Low swell and wind conditions are ideal.

Sites:
Soledad North, Sandy Point, China Camp, Bee Rock West, Ford Point, Abalone Rocks, Water Canyon, Becher's Pier, S.E. Anchorage.

Time required:

With 2 observers, two hours should be allowed to collect and process samples. Samples from beaches with coarser sediments, such as Water Canyon, will take 0.5 hour longer to process.

Methods:

Data sheets are numbered with 5 random numbers from 1-100 with at least 5 meters between numbers to avoid overlap and disturbance of active animals. The numbers indicate starting points for each transect. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

Locate the approximate middle of the beach section for the site and then locate aggregations of crabs in and above the wash zone. It may be necessary to dig and toss a vertical series of shovelfulls of sand to determine the upper extent of sand crab aggregations. In the wash zone area where crabs are visible, stretch the 100m tape parallel to the shore just above the highest extent of crab occurrence. Use the random numbers on the data sheet to establish the locations of the starting marks for each of five vertical transects along your 100 meter tape. To obtain the best results choose the core spacing such that 100 or more crabs are collected in each transect. It may be helpful to run a practice transect and count before collecting the samples. Core spacing of 0.5 meter will be adequate for most of the sites under most conditions. At very high crab densities and wide bands of aggregated crabs, a spacing of 1.0 meter may be more practical.

Starting at the tape and continuing into the water (0.5 meter depth) one observer should quickly take cores to a depth of 10cm at the appropriate intervals (Figure 3). Each core will be placed in the labeled mesh bag held by the second observer who follows closely down the beach and keeps track of the number of cores taken in the transect. Sampling should occur quickly to avoid disturbance and loss of active animals from the sampling area hence, it is best to calibrate the required spacing of the cores with the observer's foot size or a meter stick. Place all of the cores in the mesh bag labeled for the particular transect. Record the number of cores you took in each of the transects and the spacing of your cores. It is best to take the same number of cores and use the same spacing in each transect. Measure and record the vertical intertidal distance sampled by the transects using the 50 meter tape. Rinse as much of the sand as possible from each of the mesh bags in the surf zone once all of the transects are complete. If coarse sediments remain in the bag, separate the animals from the sediments by stirring and quickly decanting the animals off with seawater between two buckets and into the marked mesh bag.

To process the quantitative sample, stack the five sieve buckets in descending order so that the largest number is the top bucket. Put the sediment free contents of a single mesh bag (one transect sample) into the top bucket and rinse it down with seawater gently rotating the stack of buckets. The crabs will crawl down through the stack until they can not fit through the holes. Once the crabs appear to be sorted to a uniform size check the sizes of the smaller animals by placing them in a hole until the smallest crab you can find does not fall through a hole. Once each bucket is sorted to size you should count the number of ovigerous and non-ovigerous sand crabs and megalopa and record those numbers for each bucket. In addition, count the numbers of *Excirolana*, *Exosphaeroma*, *Nephtys*, *Euzonus*, *Olivella*, *Blepharipoda* and *Tivela* you find in each transect sample. Process all five transect samples in the same manner. Retain the *Emerita*, *Blepharipoda* and *Tivela* for population size frequency distributions and return the rest of the organisms to the beach.

Lower Beach and Subtidal Transects

Purpose:

To estimate the abundance of *Olivella* and associated species populations in the low sandy intertidal zone.

Materials:

1 aluminum clam gun
2 50 meter tapes
1 random number list
5 fine mesh bags, labeled 1-5
1 meter stick
1 Olivella abundance data sheet
2 buckets

Personnel:

2 observers in shorts and booties.

Conditions:

The sampling may be easily conducted on a low tide (< 0.0 ft) in low swell conditions if possible. If conducted on a higher tide the observers may wish to wear masks and wetsuits.

Sites:

S.E. Anchorage.

Time Required:
1.5 hours

Methods:
Data sheets are numbered with 5 random numbers from 1-50 with at least 5 meters between numbers to avoid overlap. The numbers indicate starting points for each transect. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

A quick reconnaissance of the area should be conducted to locate the zone where *Olivella* occur. Once the general area is located, measure the distance between the highest and lowest extent of *Olivella*. A 50m tape should be stretched parallel to water above the highest extent of the animals. Five starting points for transects should be selected along the tape using the random numbers on the data sheet. The locations of the transect starting points may be marked with the labeled mesh bags or with marks in the sand. Cores should be taken with the clam gun to a depth of 10cm and placed in a labeled mesh bag. Uniform core spacing should be planned to obtain 30 or more animals per transect. A practice transect and count may be useful in deciding on the spacing of cores for the sampling. Take cores (Figure 3) every 0.25m to 0.5m from just above the highest area of occurrence to just below the lowest zone of occurrence. Place all of the cores in the mesh bag marked for the particular transect. Record the number of cores you took in each and the length of the transects and the spacing of the cores. It is best to take the same number of cores and use the same spacing in each transect. Rinse as much of the sand as possible from each of the mesh bags in the surf zone once all of the transects are complete.

Ennumerate the organisms in each bag by species and record on the data sheet. Retain the *Olivella*, *Blepharipoda* and *Tivela* for measurement of size frequency distributions. Make a sketch indicating the area sampled.

Band Transects

Purpose:
To determine the distribution and abundance of subtidal *Tivela* populations and associated species.

Site:
SE Anchorage

Materials:
Dive compass
Data slate
Pencils
1 meter pvc pipe rods (2-4)
Random number table
Vertical stakes (5)
2 100 meter tapes

Personnel:
3 people equipped for free diving or SCUBA

Conditions:
Medium tide needed. This procedure should not be attempted unless the swell is small (.5m) and the visibility is good (5m).

Site:
S.E. Anchorage

Time required:
2 hours

Methods:
Data sheets are numbered with 3-5 random numbers from 1-100 with at least 15 meters between numbers to avoid overlap. The numbers indicate starting points for each transect set of four. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

Locate the permanent reference marker on the cliff backing the beach. From that point, stretch a 100 meter tape parallel to shore above the highest wash. Select a starting point along the tape for the first transect using the random numbers. Mark the top of the first transect with a vertical pipe or stake driven into the sand. Repeat the procedure for the next two four transects.

Two observers should suit up and take the slate and pencil, 100m tape and meter pipe sections down the beach to the water from the first transect starting point. One person will act as the beach anchor for the meter tape. The divers should line up to the first mark, take a compass heading on a line of site perpendicular to the shore and proceed into ~0.75 meter of water and swim out 100 meters in a straight line perpendicular to the beach face. One diver should carry the tape letting it unwind behind him, the second diver should swim 2 meters away on a parallel course. Using the one meter pipe as a reference, the divers count all of the siphons, exposed clams and associated species observed in the 1 x 100 meter area swum. On reaching the 100 meter mark, clams and observations should be recorded for

each divers' transect. The divers should swim parallel to the beach in opposite directions for ~2m away from their last transect and swim to the beach on the opposite compass course. All clam siphons, exposed clams, and associated species should be counted and recorded for the 1 x 100 meter area of the return swim.

Repeat the above procedure for two to four additional sets of four 100 meter swims starting at each the randomly chosen beach locations. An additional pair of divers may be employed to sample simultaneously, they should be started on a different transect start point and have their own meter tape and compasses. Upon completion of all sets of transects, transcribe the data from the slates onto a *Tivela* subtidal siphon count data sheet.

In the preceding technique, each diver samples two 1 x 100 meter band areas at each randomly selected location. The pair of divers sample a total of four 1 x 100 meter bands or 400 square meters at each starting location. When three transect starting points are sampled in the preceding manner, a total of twelve 1 x 100 meter areas are sampled. Depending upon available time and manpower, additional transects may be conducted.

Point Contact Transects

Purpose:
To determine the percent cover, composition and average depth of macrophyte wrack on selected beaches.

Equipment:
2 100 meter tapes w/stakes
1 meter stick
Random number list
1 macrophyte wrack data sheet
1 pencil

Personnel:
Two observers

Conditions:
A falling tide (~3.0 feet) during a neap tide series

Sites:
Sandy Point, China Camp, Ford Point, Abalone Rocks, Water Canyon, Bee Rock West, Soledad North and Southeast Anchorage.

Time Required:
1.0 hours

Methods:
Data sheets are numbered with 3 random numbers from 1-100 with at least 5 meters between numbers to avoid overlap. The numbers indicate starting points for each transect. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

Locate the approximate midpoint of the beach section. Describe landward boundary on data sheet. Measure the distance from the landward boundary to the highest wrack, the berm crest, the zone of maximum wrack deposition, the saturation line, and the lowest recently deposited wrack. Using the random numbers on the data sheet select three starting points for your transects along a tape stretched parallel to the water in the upper most zone of the beach below the lowest vegetation.

At the starting point for your first transect, stretch the second meter tape perpendicular to the shore from the landward boundary towards the water. Each transect should consist of 100 points. The spacing of sampling points is a function of the width of the beach to be sampled. Recommendations for approximate spacing of sampling points follow: Soledad (0.5m) Sandy Point (0.5m), Water Cyn (0.25m), Becher's Pier (0.25m), Bee Rock West (0.5m) China Camp (1.0m), Ford Point (0.25m), Abalone Rocks (0.25m), and Southeast Anchorage (0.25m).

Starting at the top of the tape examine the beach under the first point. The sampling points should be dimensionless (use the size of the tape mark ~2mm). Record the presence of each type of wrack up to three species and the order of dominance, the overall depth of wrack (2cm minimum), and the presence of tar at each point on the transect. If no wrack or tar is present at a point, record the substrate as sand or rock. Continue down the transect recording data from each point until you reach 100 points. All three transects should be the same length and contain the same number of sampled points.

Trench Transects

Purpose:
To determine the distribution, abundance and size frequency distribution of certain low intertidal beach macrofauna including: *Tivela stultorum* and *Blepharipoda occidentalis*.

Equipment:
Data sheets or slate
100 meter tape
50 meter tape
Pencil
2 square shovels (0.25m wide)
Calipers
Meshbags (10, numbered 1-10)
Random number list

Personnel:
2-3 people in booties and shorts

Conditions:
A minus tide of -0.5 or lower and low swell conditions.

Sites:
S.E. Anchorage, Becher's, Ab Rocks

Time Required:
3 hours

Methods:
Data sheets are numbered with 10 random numbers from 1-100 with at least 5 meters between numbers to avoid overlap. The numbers indicate starting points for each transect. Random numbers are generated with a Pascal program and should be included in the sampling equipment.

At Southeast Anchorage, proceed southeast from the small pocket beach at the foot of the gully until you reach the third beach section from the gully. Locate the permanent reference point on the cliff backing the beach. From that point, stretch the 100 meter tape parallel to the shoreline on the lower beach just above the highest sand crab aggregations. Using the random numbers on the data sheet, locate the starting point for the first transect on the 100 meter tape. Mark that point with the labeled mesh bag or with a mark in the sand. Repeat for the next four to nine transects. You should start your trenches approximately at the bottom of the upper band of sand crabs and trench from there down to the lowest intertidal area that you can reasonably work. Record the vertical distance to covered by each trench. When possible, all transects should be equal in length. Start the trench at the selected intertidal height directly down the beach from the randomly selected starting mark. With the square shovel, dig a uniform, continuous trench that is one shovel width (0.25m) wide and ~ 0.25 m deep from the starting point to the low intertidal. Toss the sand from the trench out and to the side of the trench. The second person sorts through the sand collecting macrofauna, placing all organisms in a mesh bag labeled with the trench #. Repeat the above procedure for each of the additional 4-9 trenches as time and the tide allow.

When the trenches are completed, the contents of each mesh bag should be identified, enumerated, and recorded on the data sheets. All *Tivela* should be checked for marks. Record the number of marked and unmarked clams. All *Blepharipoda* should be sexed and the reproductive condition of females recorded. All animals should be retained for determination of size frequency distributions. When measurements are completed, all animals should be returned to the sandy intertidal habitat. Individual *Tivela* should be placed in the sand to a depth which covers most of the shell and with the hinge ligament facing up and the hinge facing the ocean. Collect and remove empty clam shells on the beach from the gulley to the end of the last beach section. Record the number of marked empty shells.

MARK AND RECAPTURE SAMPLING

Purpose:
To obtain estimates of the population size of Pismo clams, *Tivela stultorum*, at selected sites on Santa Rosa Island using a multiple mark recapture technique. Population size estimates may be made from subtidal or intertidal samples of clams. Methods for collection of subtidal clams are described below. Intertidal estimates may be made using clams collected and marked in trench transect sampling described in an earlier section of this handbook. Marking protocols are the same for both subtidal and intertidal procedures.

Equipment needed:
goody bags
hacksaw blade
abalone iron (optional)
data sheets
copy of marking code information

Personnel needed:
2-3 people equipped for skin or scuba diving

Conditions:
A medium to high tide is best. The swell should be small (0.5m) and the visibility good (5m).

Site:
Southeast Anchorage

Methods:

To avoid problems with mortality associated with long term mark-recapture studies, each year will be treated separately. A unique mark code will be used for each year such that the number of marked clams will not cummulate across years, only across samples in a single year. Collections of clams will be made 4 times each year. The first sample of the year should be collected in June, subsequent samples should be collected in July, August and September if possible. No estimates of population size will be possible for the first sample of each year, although a rough estimate of overwintering success may be made from the number of recaptured clams that were marked in the previous year.

The multiple mark recapture technique requires that the entire area be searched systematically with uniform effort. The assumptions of the multiple mark recapture procedure include: marked animals are randomly redistributed throughout the population, no marks or tags are lost or become unrecognizable, marked and unmarked animals have the same suspectability to capture, no immigration of animals to population, and mortalitiy or emmigration of animals occurs similarly for both marked and unmarked individuals (see Krebs 1989 for further details).

The divers should arrange to each search specific areas of the site for clams and collect all clams and empty shells in their area. The abalone iron may be useful in removing the clams from the sand. After the area has been searched and clams collected, the clams should be taken to the beach.

Each clam should be checked for marks on the shell. Prior to 1991, two types of marks were used on native clams:

1) a unique mark code of hacksaw grooves cut at a right angle to the apex of the umbo and

2) a single horizontal hacksaw groove cut across the apex of the umbo (see Figure 4).

Small clams transplanted to the site in October of 1989 were marked with a notch on the valve edges. Subtidal transplants were notched on the edges of the valve adjacent to the hinge ligament and intertidal transplants were notched on the opposite edges of the valve. The notch marks on transplanted clams have been overgrown by normal shell growth and occur some distance from the valve edges.

Record the number of clams with: 1) current year marks (r), 2) previous year marks (u), 3) transplant marks (u) and, 4) no marks in the sample (u).

Retain all clams for measurement of shell length to determine a size frequency distribution for the sample (see following section). Note the mark status of each clam during the size frequency measurements. Record the numbers of marked and unmarked empty shells collected in the sample.

All unmarked clams greater than 70mm should be marked in the area of the umbo using the hacksaw blade. The suggested marks to use in each year of sampling and a diagram showing the correct orientation for division of the clam into 4 distinct areas for marking are given in Appendix F and Figure 4. The grooves cut in the shell with the hacksaw blade should be approximately 2mm deep and 10mm long. All clams with marks from previous years should be remarked so they are marked with the current year's mark. Record the number of newly marked and remarked clams which will be returned to the site (x). Once all clams are counted, measured and marked, the divers should return to the area of collection and redistribute the clams. Each clam should be dug into the sand with the hinge up and the umbo facing away from shore.

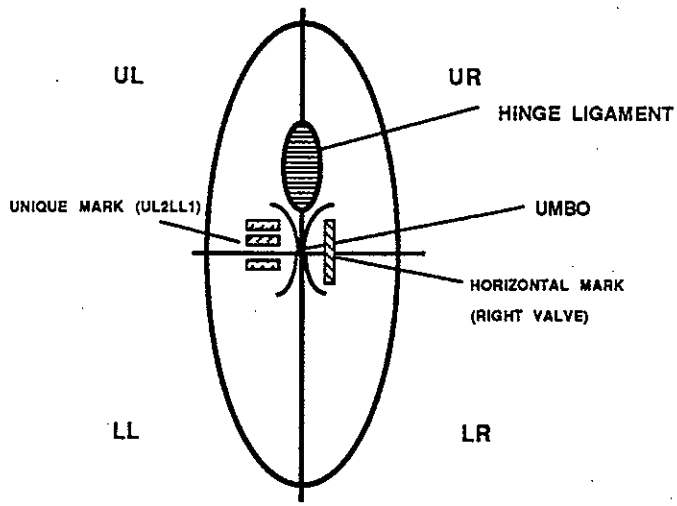


Figure 4 Markings used on *Tivela stultorum*

SUPPLEMENTAL SAMPLING

Purpose:

To collect a sample of reproductive sand crabs to supplement the crabs already collected with the quantitative clam gun sampling for determination of size frequency distribution and reproductive condition of sand crab populations.

Materials:

Shovel
Bucket
Mesh bags (large and fine mesh)

Personnel:

Two persons wearing shorts

Conditions:

A falling tide and moderate surf are best.

Sites:

Sandy Point, China Camp, Ford Point, Abalone Rocks, Water Canyon, S.E. Anchorage, Becher's Pier, Bee Rock West, and Soledad North.

Time required:

0.5 hour

Methods:

Locate aggregations of sand crabs in the wash zone of the beach. Walk the beach at the wetline or higher and examine the aggregations of sand crabs for patches of larger crabs. It is important to avoid disturbing the aggregations in the wash zone. Once a patch of larger animals has been located, wait until the last wave has receded and one investigator should quickly dig shovelfuls of sand from the area placing them in the coarse mesh bag held by the second person. The sand should be rinsed through the bag retaining the crabs. This process should be repeated until 200 or more larger crabs have been collected. If aggregations of small animals are present scoop a few shovelfuls of sand from those aggregations into a fine mesh bag and rinse the sand out retaining the crabs. All of the crabs should be combined in labeled fine mesh bag, rinsed again in seawater and retained in a plastic bucket with an empty mesh bag in the bottom to provide a space from the water which is shed from the bag of crabs. To avoid mortality, do not submerge sand crabs in seawater in a bucket for any length of time. A second seawater rinsed mesh bag should be placed over the sample. Crabs may be kept alive in this manner for several hours or overnight in cool conditions until the sample can be conveniently processed and measured. The preceding treatment may be particularly useful at sites with steep or difficult access or late in the day, when it may be expedient to carry the sample of crabs out and process them later at a site with easier access or in better light conditions. Quantitative sand crab samples may be packed similarly and held for later processing when access or the schedule requires.

SIZE FREQUENCY DATA

Purpose:

To determine size frequency distributions for several species of beach macrofauna. Size frequency distributions are measured for several sand beach species after the animals have been collected for abundance estimates. Size frequency distributions for *Emerita* and *Olivella* will be measured using an sieve sorter (Wenner et al. 1974). Individual measurements with vernier calipers will be used to measure size frequency distributions of *Tivela* and *Blepharipoda*.

Materials:

2 vernier calipers, stainless steel, 220mm
5 colanders, plastic
Mesh bags, small and large mesh sizes
Waterproof data sheets, one per species
Pencils
24 calibrated sieve buckets (#4-#50)
3 buckets, plastic
1 towel
Data sheet
Pencil

Personnel:

2-3 persons

Sites:

All stations

Time Required:

Varies depending on sample size and measurement technique. Allow 1 to 1.5 hour for sorter measurement, and 0.5 to 0.75 hour for caliper measurement of other species.

Methods:

Measurements of the maximum shell length of *Tivela stultorum* and the maximum carapace length of *Blepharipoda occidentalis* will be taken with calipers to the nearest millimeter and recorded on appropriate data sheets. The carapace length of large *Emerita* (Sieve # 50 or greater) will also be measured with calipers to the nearest mm (Figure 5). Sex and reproductive condition (ovigerous/nonovigerous female crabs) will be noted for the two crab species

(Figure 6). All *Tivela* should be checked for identifying marks at the umbo or on the valve and growth measurements taken where possible. All animals should be returned to the point of collection.

Size frequency distributions of samples of *Emerita* and *Olivella* will be measured with a graded series of bucket sieves. A calibration for the sorter allows the conversion of sieve numbers to carapace length or shell length in mm for each species (see Appendix D). Place the sieve set up securely in a sheltered area above the wave wash. The numbers should be descending from top to bottom of the series with the smallest number (4) at the bottom of the stack.

For *Emerita*, the sample to be measured from any one site will consist of a combination of the five bags of crabs collected and counted during the quantitative sampling and a single bag of larger opportunistically collected crabs. If the sample is relatively free of gravel and coarse sediment, it may be emptied into the top bucket of the stack. If there is a lot of gravel and sediments present, the sample should be decanted with seawater to separate the animals from the gravel. Once the sample is in the sorter, a couple of buckets of seawater should be poured into the top of the sorter and the sorter gently agitated by rotating several of the top sieves. Examine the top sieve for crabs, any crabs which do not fall through the holes in the largest of the sieves must be measured with calipers, checked for the presence of eggs and recorded on the data sheet. The crabs should just sit in the holes, anterior end up. Do not push crabs through the holes just set them gently, posterior end first, in the hole to see if they fall through to the next sieve. Frequent pouring of fresh seawater into the stack will assist the sorting of the crabs by size. On the next sieve down the stack, check to see if the crabs are all setting in holes and appear of similar size. Check the 5-10 smallest crabs in each sorter bucket for fit. Count, sex, and check reproductive condition on all crabs in that bucket. Record the data from each sieve bucket on the space provided on the data sheet. When large numbers of crabs are present in a sieve bucket, you may determine the sex for a subsample of crabs and count the rest, recording the size of the subsample and the total number of crabs on the appropriate spaces on the data sheet. The numbers of male and female crabs can be calculated later from the subsample results. Do not determine sex on crabs smaller than sieve bucket #14, just count the animals and record their number in the total crabs column.

For *Olivella* samples, the mechanics of the procedure are very similar to that described above for *Emerita*. The sample to be sorted consists of the contents of the mesh bags from the three to five quadrats sampled for estimating abundance of *Olivella*. The snails are much less active and will require more manipulation to determine sizes with the sorter sieves. No reproductive information will be collected for *Olivella*, only counts of size frequency in the sieves. Animals should be returned to the low intertidal when the sample is processed and the data recorded.

Organisms sampled:

Genus	Sample Sizes	Measurement
Tivela	5-100	Max. shell length (mm)
Olivella	100	Max. shell length (mm)
Blepharipoda	5-100	Max. carapace length (mm) (sex, reproductive condition)
Emerita	500-2000	Max. carapace length (mm) (sex, reproductive condition)

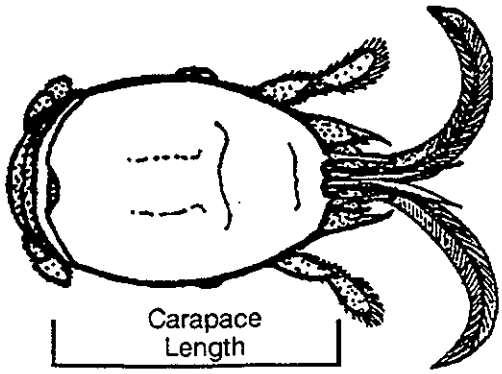
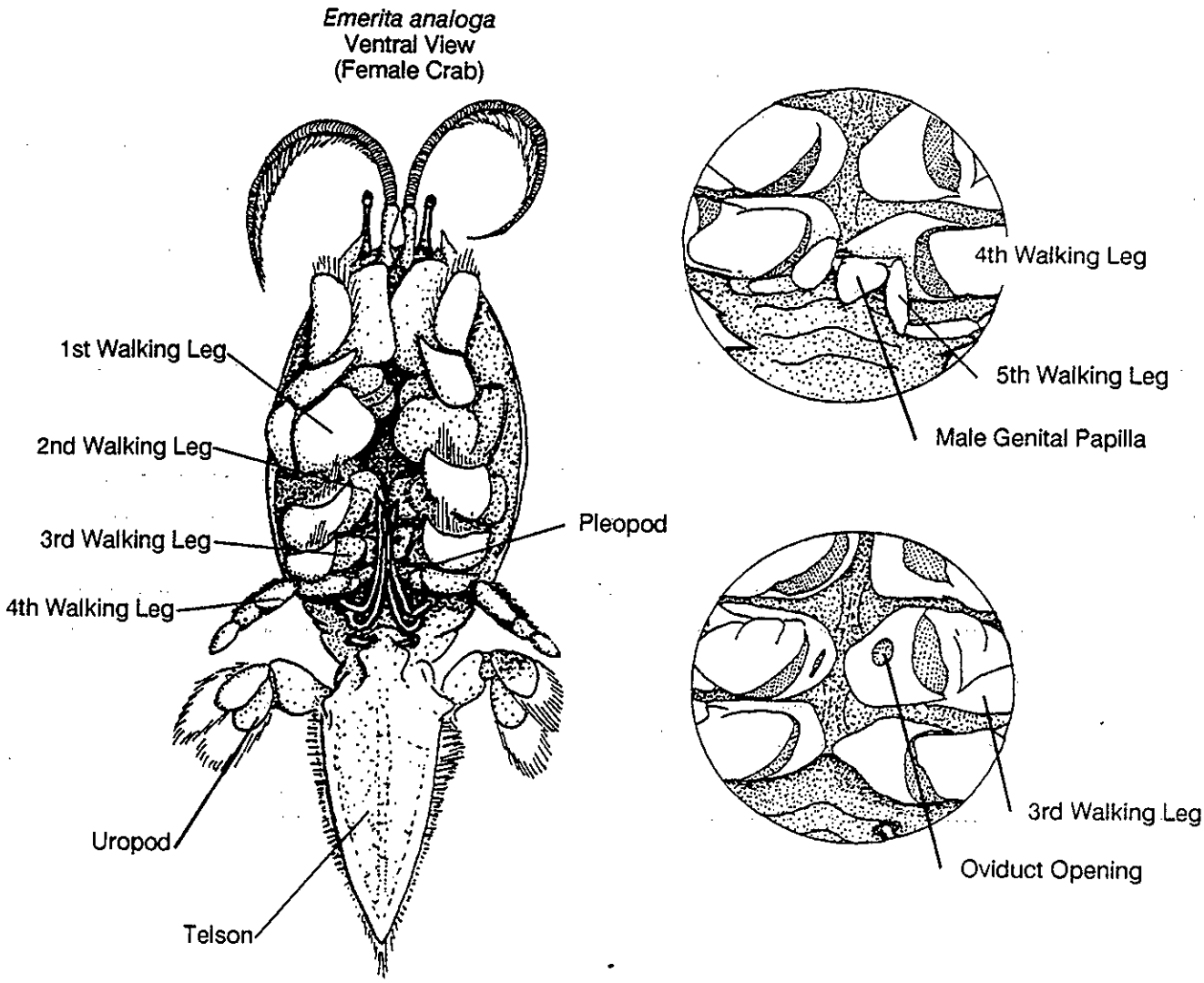


Figure 5 Carapace Length Measurement



	Size	Pleopods	Oviduct Openings	Genital Papillae
Megalopa	to 6mm	Plumose	-	-
Males	to 16mm	-	-	Present
Females	to 36mm	Present	Present	-

Figure 6 Sex Determination in *Emerita analoga*

SPECIES CHECKLIST

Purpose:

To compile species presence/absence and relative abundance data for the three lagoons. A variety of sampling techniques may be employed. Sampling methods may include aquatic dip nets, beach seine, clam gun cores and visual inspection by trained observers.

Personnel:

2-3 observers, waders or wetsuits may be needed for seines

Materials:

Long-handled aquatic dip net
Beach seine
Clam gun
Insect net
1 mm mesh sieve
1 white enamel pan
Buckets
Hand lens
Vials with ethanol
Whirlpak bags
Labels and pencil
Data sheets

Sites:

All stations at the three lagoons (see Appendix A). All Stations are marked with metal survey stakes except Station 1 at Old Ranch House Canyon Lagoon. It is located 50m from the Rocky Bank on the Eastern edge.

Time Required:

~1 hour per lagoon, small lagoons may take less time and the large lagoon at Abalone Rocks may take more time

Methods:

The relative abundance of all species present at the lagoons is estimated. A species list is compiled from sampling with clam gun cores, dip nets, insect nets and visual observation at each of the stations where physical measurements are taken. For each location observed and for each type of sampling employed, record relative abundance per square meter of each species on a scale of 0-6 as follows:

0 = absent
1 = one individual present
2 = 2-10 individuals present
3 = 11-100 individuals present
4 = 101-1000 individuals present
5 = 1001-10000 individuals present
6 = 10001-100000 individuals

Prior to disturbing the area around each station, visual estimates of the percent cover, condition, attachment and average plant size (length in cm) of *Ruppia* and other aquatic plants and algae (*Enteromorpha*) should be made. The presence and relative abundance of *Macrocystis* and *Phyllospadix* wrack should be noted for each station. Other debris and probable origin should be noted e.g. carcasses of marine mammals, seabirds or terrestrial livestock. Visual observations of water and sediment surfaces should be made around each station prior to sampling. The presence and estimated abundance per square meter of insects including brine files and tiger beetles should be recorded.

Three standard samples should be collected with a long-handled aquatic net at each station. The water column should be sampled by using standard 1 meter sweeps of the net at 1-2 meters from shore. This process should be repeated 2 more times over different areas of water which were not disturbed by the previous sweeps. After each sweep, the contents of the net bag should then be concentrated in the bottom of the net and dumped into a shallow white enamel pan for identification and abundance estimates of lagoon species. Small fish and a variety of aquatic insects and invertebrates may be captured with this method.

Identify all specimens to species (see Table 1), preserve a few of any unidentifiable organisms in carefully labeled vials for later identification.

The bottom surface of the lagoons may be sampled in a similar manner using three standard 1 meter sweep samples along the bottom of the lagoon at each station then observing each sample in a shallow white enamel pan. Identify and estimate the abundance of all organisms. A few specimens of each unidentifiable organism may be preserved in labeled vials for later identification.

Three standard core samples should be taken with the clam gun at Station 1 at the Old Ranch House Canyon Lagoon. Core samples are sieved through a 1 mm size sieve to retain macrofauna. To obtain a core sample, insert the clam gun to a depth of 20 cm, place your thumb over the hole in the top and carefully pull the clam gun and enclosed core from the sediments. Hold the clam gun and core over the 1 mm sieve and remove your thumb from the hole in the top to extrude the core onto the sieve. Gently wash the fine sediments out of the sieve, retaining coarse sediments and macrofauna.

NOTE: If the core drops out of the clam gun prematurely during removal, you should put your hand under the gun as soon as possible to support the core. It may be helpful to practice taking a few cores before conducting the sampling.

All organisms should be identified to species and their relative abundances should be estimated. A few specimens of any unidentifiable organisms should be preserved in labeled vials for future identification.

Seine sampling is an optional technique to be used when fish are apparently present and conditions allow. It should be noted that this type of sampling is fairly disruptive and can result in fish mortality and sediment disturbance. Seine sampling is best conducted in the creeks and in the main basin of the Abalone Rocks lagoon, and in the Old Ranch Canyon lagoon. Two to three observers are needed in shorts, wetsuits, or waders. The net should be unrolled and straightened out away from the sampling locations to minimize disturbance. The net should be oriented with the bag section following, the floats at the surface of the water and the weights at the bottom of the lagoon. A sampling area is chosen ahead of time e.g. a distance along a creek or across a basin. Each observer should take a pole end and one of the observers should carry the bulk of the net until the water is entered. Upon entering the water the net should be extended across the sampling area with one observer holding a pole one each end and the weights at the bottom of the lagoon. The observers should then start walking in parallel along the sampling area, dragging the net with them, keeping the net as extended as possible. At the end of the sampling area, one observer should stop and climb up the bank while the other swings rapidly around in an arc towards the same bank to catch escaping fish. The net should be dragged carefully onto the bank or sand. Fish and crabs should be identified to species and relative abundance estimates should be made for each species.

AVIFAUNA CENSUS

Purpose:

To census the birds utilizing selected sand beaches and the coastal lagoons of Santa Rosa Island.

Equipment:

Bird data sheets and Bird field guide
Field notebook and Pencil
Binoculars

Personnel:

One to two observers trained in the identification of birds. Observers should be dressed in drab colors.

Conditions:

Strong winds, rain and heavy fog may make bird counts very difficult. Conducting the census early in the day is probably ideal for both wind and lighting on Santa Rosa Island.

Sites:

All beach and lagoon sites.

Time Required:

0.5 hour per location

Methods:

Beaches

The observer(s) should approach the census site carefully to minimize disturbance. Observations should commence at one end of the beach if possible and observer should walk slowly down the beach recording the species and numbers sighted. Keep track of birds to avoid double counts. Record behavioral notes particularly feeding behavior of birds. On wide beaches two observers will be better able to cover the area and should walk at the same pace on the upper and mid beach. Record the time of the census and the sky and wind conditions.

Lagoons

The lagoons should each be approached slowly and carefully to avoid flushing the birds early (particularly ducks). The observers should walk around each of the lagoons recording the number and species of birds present in the census area which is defined as the water, mudpans and banks of the lagoons. Be aware that birds may flush from one lagoon to another during the census. It is important to keep track of group size and the direction of flight. Each of the three lagoons should be treated as a separate site and a separate data sheet should be used to record census data. Record observations on behavior and feeding. Record the time of the census and the sky and wind conditions.

NOTE: If data were recorded in a field notebook, record all data on bird data sheets for each site at the end of the day.

PHYSICAL MEASUREMENTS

Purpose:
To monitor physical factors which could be related to habitat conditions and suitability and to population dynamics of indicator species. Most measurements will be taken in conjunction with biological samples.

Equipment:
1 thermometer (celsius)
1 refractometer
1 pipette with bulb
Lens tissue
1 secchi disc and line
2 meter sticks
1 level (24 inch)
1 2 meter wood pole (net handle)
1 50 meter tape
1 line with fishing weight
Lagoon or beach physical data sheets
Pencil

Personnel:
Two observers

Sites:
All beach sites and lagoon stations.

Time Required:
At the beach sites, ~ 10 minutes is needed. At the lagoon stations, ~ 15 minutes is needed for each station.

Methods:
The following measurements will be taken and recorded upon the appropriate data sheets:

Water temperature
A plastic shielded thermometer with a Celsius scale should be used. The thermometer should be held in the water to be measured for 40 seconds and then read quickly upon removal from the water. Shield the thermometer from the wind while reading the scale.

At sand beach sites, one measurement should be made in the surf zone at a depth of 0.5m.

At lagoon stations, one measurement should be made at each of two depths (surface and 5 or 10cm) at each of the stations.

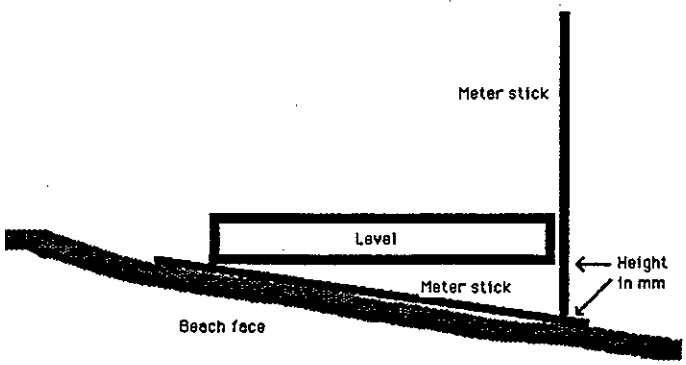


Figure 7 Beach Slope Measurement

Salinity
The Reichert temperature compensated refractometer should be used. A clean eye dropper should be used to collect water from the appropriate location and depth. Avoid collecting sediments or debris with the water which will cause error in the reading. The drop of water should be placed on the clean glass surface of the refractometer, then the plastic scale should be lowered onto the drop. The observer should then look through the eyepiece while holding the instrument level and read the right hand scale at the boundary between the dark and light fields. The reading will be in parts per thousand (0/00).

At the beach sites including the beach adjacent to the lagoons, one determination should be made in the surf zone (0.5m). Do not take the refractometer into the surf.

At the lagoon stations, one measurement should be made at each of two depths (surface and 5cm). If the stream is present at the Old Ranch Canyon lagoon, additional surface measurements should be taken upstream at 10 meter intervals until fresh water is reached or the streambed is dry. Once fresh water is reached, the observer should take measurements downstream at shorter intervals to determine the point of transition between fresh and saline water. The distance in meters from station 2 to the point where fresh water is reached should be recorded.

Secchi depth
The secchi disk should be attached to the end of the long aquatic net and extended out ~1 meter over the water lying directly out from the station. The disk should be lowered until it is no longer visible or hits the bottom of the lagoon. The depth at which the disk disappears from view or touches the bottom should be recorded to the nearest cm. Check the secchi depth by raising and lowering the disk three times. A meter stick may be used to determine the amount of line left out of the water and then subtracted from the total line length to obtain secchi depth. The depth of the water should also be determined with a meter stick and recorded. At the lagoon stations, one determination of secchi depth should be made at each of the permanent stations.

Beach slope
The slope of the beach face is determined by using a level and two meter sticks. The determination should be made at the wet line (Figure 1). One meter stick should be laid perpendicular to the shoreline and the level placed upon it. The seaward end level should be raised until the bubble centers between the crosshairs. The second meter stick should be used to measure the distance that the level was raised to center the bubble (Figure 7). That distance and the length of the level will be used to calculate the slope of the beach (**arc tan rise/run = slope in degrees**).

At beach sites, three determinations of slope should be made along the wet line.

Water levels
Stage gages have been installed for the determination of relative water levels at the three lagoons (see Appendix A).

One reading should be made at each stage gage.

Photos
Photographs of each beach site should be taken at the time of monitoring to aid in description of long term changes in beach morphology and sediment dynamics. Aerial photos of the lagoons and beaches should be taken at five year intervals in conjunction with the vegetation mapping photo series and more often if financially feasible particularly for the lagoons.

DATA MANAGEMENT

Data input, analysis, and reporting is different for each of the sampling protocols described in the previous section. Therefore, data management is discussed by sampling method used to collect the data. Detailed instructions on data entry and use of computer programs for data analysis follow.

Data management files will be in dBase III Plus and Lotus 123. For summarizing the data and generating reports, the statistical software package, SPSS/PC is used to translate the data files created by dBase III to SPSS files. SPSS programs are then used to summarize data. Lotus 123 files are used to store certain size frequency distribution files and generate histograms and to store mark and recapture data.

TRANSECT SAMPLING

Separate files will be created for each year and transect type as named in Table 3. Once all data are entered and verified, backup copies should be made, and no more editing done to the file. The following example is for clam gun transects (TCGXX.DBF). A blank file called F:\BEACH\ TCGLK.DBF is used to facilitate data entry. Another file called BTALL.DBF is created by appending appropriate years to it. This file is then used by BTCALC.PRO to create a summary table of means and standard deviations by species and location and saves the results to a file called BTALL.RSL.

dBASE FILE STRUCTURE

dBase III Plus file structure for transect files is as follows:

FIELD	FIELD NAME	TYPE	WIDTH
1	Location	Numeric	2
2	Year	Numeric	2
3	Species	Numeric	5
4	Type	Numeric	2
5	Transect	Numeric	2
6	Spacing	Numeric	4
7	Length	Numeric	4
8	Count	Numeric	4
9	Ovigerous	Numeric	4
10	Box 38	Numeric	4
11	Box 28	Numeric	4
12	Box 18	Numeric	4
13	Box 8	Numeric	4
14	Box 4	Numeric	4
15	Megalopa	Numeric	4

Table 3 Filenames for dBase III, Lotus 123, and SPSS data analysis programs (supply last two digits of year at xx)

Technique	dBase III file	SPSS program	Lotus 123 file
Transects			
Clam gun	btxx.dbf	btcalc.pro	
Trench	btxx.dbf	btcalc.pro	
Band	btxx.dbf	btcalc.pro	
Point contact	bpcxx.dbf	bpccalc.pro	
Mark-recapture			mrtivxx.wks
Size Frequency			
in mm	bsizexx.dbf	bsfcalc.pro	
sieves			
Emerita	easumxx.dbf		easizexx.wks
Olivella			obsizexx.wks
Species list	lslxx.dbf	none	
Avifauna census	bbirdxx.dbf	none	
Physical data	bphxx.dbf	none	

Field 1 is the location or site code number (see Table 1)

Field 2 is the last two digits of the year sampled

Field 3 is the species code number (see Appendix C)

Field 4 is the type of transect (1 = clam gun, 2 = trench, 3 = band)

Field 5 is the number of the transect sampled

Field 6 is the number of cores per meter (0.5, 1, 2, 4, use 0 for trench and band transects data)

Field 7 is the length of the transect in meters

Field 8 is the total number of individuals found on the transect

Field 9 is the total number of ovigerous individuals found on the transect (decapod crustacea only)

Fields 10-14 are the number of individuals found in the respective size fractions in each transect (*Emerita* transects only)

Field 15 is the total number of megalopa found in each transect (*Emerita* transects only)

The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file. Data files are named as follows: for 1990 BT90.DBF and so forth.

Creating A New Data File

Use the following procedure to create a new transect file once you are in dBase III:

.use F:\beach\btblk.dbf (to access blank file)
.copy to F:\beach\btxx.dbf
(copies the blank file to the new year file you are creating, supply year at xx)

Entering Data and Updating Files

After the new file is established, begin entering data. The order of the species on the data sheets is the same as that in the file, so data entry should go smoothly. To enter information and data, proceed in the following manner after entering dBase III:

.use F:\beach\btxx.dbf
(accesses file)
.replace all loc with
(you enter location code here)
.replace all year with
(enter two digits for year here
.1
(takes you to first record for data entry go to any record number by typing the number at the dot prompt)
.browse
(most efficient command for data entry)

Now move to the other columns and begin entering data.

To modify the file for the second and subsequent stations, use the following commands:

.use F:\beach\btxx.dbf
(accesses file)
.append from F:\beach\btblk.dbf
(appends blank records for one station to the file)

Once the blank records have been appended, fill in the information for the year and location in the following way:

.x
(type in the record number where you wish to start)
.replace next y loc with __
(replaces blank station with the number of the station you are working on)
.x
(returns to record # where you started)
.replace next y year with __
(adds year designation to year field)
.x
(back to where you started)
.browse
(into edit mode to begin data entry)

Do not worry initially if the locations are not in sequence. After entering data for all the locations, the file may be sorted in several ways. For example, to sort by location:

.use F:\beach\btxx.dbf
.sort to F:beach\(file name.ext) by loc
.close all

You may then delete the old file

.erase F:\beach\btgxx.dbf

and rename the sorted file to the old filename:

.rename F:\beach\(file name.ext) to F:\beach\btxx.dbf

Two important final points: remember to press Control-End to save changes you make in browse and to type in "Close all" before proceeding to work on another file or exiting dBase III plus.

Preparation for Data Analysis

Transect files for each transect type from several years may be appended together prior to analysis with SPSS. For any one type of transect, select the years to be included in the analysis, copy the first year file to a new filename and append the other files to the new file. For example, to summarize information on clam gun transects for years 1990-1995, files TCG90.DBF, TCG91.DBF, TCG92.DBF, TCG93.DBF, TCG94.DBF, and TCG95.DBF would be compiled into the large file called TCGALL.DBF in the following manner:

.use F:\beach\btall.dbf
(accesses dBase III file)
.zap
(deletes and packs all records in that file)
.append from F:\beach\bt90.dbf
(appends 1990 data to tcgall.dbf)
.append from F:\beach\bt91.dbf
(appends 1991 data to btall.dbf)
.append from F:\beach\bt92.dbf
(appends 1992 data to tcgall.dbf)
and so on .... to **bt95.dbf**

.close all
(closes **btgall.dbf**)

Use these commands to modify TCGALL.DBF any way you wish.

SPSS Data Analysis and Reports

SPSS is used to analyze data catalogued in dBase III. In order to do this, the dBase file must be converted to a form that SPSS can understand using the SPSS translate utility. For example, to translate the large file tcgall.dbf to SPSS, do the following at the SPSS prompt:

SPSSPC:translate from='F:\beach\btall.dbf'

For large files, this may take some time, so be patient. Once this has finished, proceed with commands for analysis. The program {BTCALC.PRO} is used to translate and calculate mean counts for clam gun transect species by size and reproductive type and is listed in Appendix H. When {BTCALC.PRO} is run it saves the results to the file F:\BEACH\BT.RSL. This is a text file and is best edited using a word processor. To convert it to WordPerfect, use the Text In/Text Out feature, Control-F3 and select option 3. Edit and add titles, page numbers, and a cover page if desired.

If {BTCALC.PRO} already contains a translate statement (as it does in the example in Appendix H), execute the program by doing the following at the SPSSPC prompt:

SPSSPC:include F:\beach\btcalc.pro

This step translates and performs the calculations indicated by the program without having to enter the review feature of SPSS, blocking and running.

In order to avoid repeating the time consuming translation step, you can save translated files to SPSS system files, directly accessible by SPSS with the GET command. Do the following at the SPSS prompt to save the translated dBase file to an SPSS system file:

SPSSPC:save outfile='F:\beach\btallyr.sys'

If analysis is required for only one station, species or year, one may selectively analyze these categories using the "Process if" or "Select if" commands. For example, to compute means for Location 4 only, insert the following command before the "means tables" command:

process if (loc=4)

POINT CONTACT TRANSECTS

Separate data files are created for each year called BPCXX.DBF (XX=year). Once all data are entered and checked, backup copies should be made and no more editing should be executed on the file. BPCBLANK.DBF is a blank structure file used to facilitate data entry. BPCALL is created by appending appropriate years to it. This file is then used by BPCCALC.PRO which creates a summary table of means and standard deviations by species, location and date.

dBASE FILE STRUCTURE

The dBase III Plus structure for Point Contact Transects is as follows:

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	Species	Numeric	6
4	Transect	Numeric	2
5	Spacing	Numeric	2
6	Length	Numeric	4
7	Count	Numeric	4

Field 1 is the location code number (Table 1)

Field 2 is the last two digits of the year sampled

Field 3 is the species or substrate code number (see Appendix C)

Field 4 is the point spacing

Field 5 is the length of the transect in meters

Field 6 is the transect number

Field 7 is the number of points containing the species in the transect

The dBase files are stored on the file server in the F:\BEACH directory and are backed up on floppy disks.

Creating A New Data File

Use the following procedure to create a new BPC file after entering dBase III Plus:

.use F:\beach\bpcblank.dbf
(opens the blank structure file)
.copy to F:\beach\bpcxx.dbf
(copies the structure to the file for the current year, supply year at xx)
.close all

Entering Data and Updating Files

Once the new file is created, begin entering data. To enter data proceed in the following manner after entering dBase III Plus:

.use F:\beach\bpcxx.dbf
(accesses file)
.replace all loc with __
(enter location code here)
.replace all year with __
(enter last two digits of year here)
.1
(takes you to record 1)
.browse
(most efficient command for data entry)

Now, move to the species, transect and count columns and begin entering data.

To modify the file for second and subsequent locations, issue the following commands:

.use F:\beach\bpc.dbf
(accesses file)
.append from F:\beach\bpcblank.dbf
(appends blank records to the file)

Once the blank records are appended, fill in the informantion for the year and location in the following way:

.x
(at x type in the record number where you wish to begin)
.replace next y loc with __
(replaces blank locations with the number of the station that you wish to enter data for)
.x
(returns to record number where you started)
.replace next y year with __
(replaces blank years with the current year)
.x
(back to starting point)
.browse
(into edit mode for data entry)

Do not be concerned initially if the locations are not in sequence. After entering data for all locations, the file may be sorted in several ways. For example, to sort by station:

.use F:\beach\bpcxx.dbf
.sort to F:\beach\{filename.ext} by loc
.close all

You may then delete the old file:

.erase F:\beach\bpcxx.dbf

and rename the sorted file to the old filename:

.rename F:\beach\{filename.ext} to F:\beach\bpcxx.dbf

Finally, remember to press Control-End to save changes made in browse and to type in close all before starting to work on another file or exiting dBase III Plus.

Preparation for Data Analysis

BPC files from several years may be appended together prior to analysis with SPSS. Select the years to be included in you analysis, copy the first year file to a new file name of your choosing and appendy the other files to the new file. For example, to summarize information for years 1990 through 1992, you would compile files BPC90.DBF, BPC91.DBF and BPC92.DBF into a large file called BPCALL.DBF in the following manner:

.use F:\beach\bpc90.dbf
.copy to F:\beach\bpcall.dbf
.close all
.use F:\beach\bpcall.dbf
.append from F:\beach\bpc91.dbf
.append from F:\beach\bpc92.dbf
.close all

SPSS Data Analysis and Reports

SPSS is used to analyze data catalogued in dBase III. In order to do this, the dBase file must be converted to a form that SPSS can understand using the SPSS translate utility. For example, to translate the large file bpcall.dbf to SPSS, do the following at the SPSS prompt:

SPSSPC:translate from='F:\beach\bpcall.dbf'

For large files, this may take some time, so be patient. Once this has finished, proceed with commands for analysis. The program {BPCCALC.PRO} is used to translate and calculate mean counts for point contact transect species and is listed in Appendix H. When {BPCCALC.PRO} is run it saves the results to the file F:\BEACH\BPC.RSL. This is a text file and is best edited using a word processor. To convert it to WordPerfect, use the Text In/Text Out feature, Control-F3 and select option 3. Edit and add titles, page numbers, and a cover page if desired.

If BPCCALC.PRO already contains a translate statement (as it does in the example in Appendix H), execute the program by doing the following at the SPSSPC prompt:

SPSSPC:include F:\beach\bpccalc.pro

This step translates and performs the calculations indicated by the program without having to enter the review feature of SPSS, blocking and running.

In order to avoid the time consuming translation step, you can save translated files to SPSS system files, directly accessible by SPSS with the GET command. Do the following at the SPSS prompt to save the translated dBase file to an SPSS system file:

SPSSPC:save outfile='F:\beach\bpcallyr.sys'

If analysis is required for only one station, species or year, one may selectively analyze these categories using the "Process if" or "Select if" commands. For example, to compute means for Location 4 only, insert the following command before the "means tables" command:

process if (loc=4)

MARK AND RECAPTURE DATA

Enter the data from each sample in a Lotus 123 spreadsheet. The blank file MRTIVBLK.WKS can be copied and renamed for each year. The file name should be MRTIVXX.WKS, replace xx with the last two digits of the year of the sample. The format for the worksheet is given in Appendix F. For each sample, enter the location, date and the following data:

u = the number of unmarked clams and clams with previous year or transplant marks caught in sample

x = the number of clams newly marked or remarked and returned in current sample

r = the number of recaptured clams marked with the current year's mark

m = the total number of clams marked with the current year's mark in the population at time of sampling

(sum of x's from preceding samples)

u+r= number of clams caught
(marked + unmarked)

The spreadsheet will then be used to calculate sums of r, m, m(u+r) and make estimates of population size using the following formulas.

Petersen formula: $m(u+r)/r$

Population size =

$$\frac{\text{\# marked clams (marked + unmarked caught)}}{\text{number of recaptured marked clams in sample}}$$

Schnabel formula: $\sum[m(u+r)]/\sum r$

Population size =

$$\frac{\sum\text{[\# marked clams (marked + unmarked caught)]}}{\sum\text{ number of recaptured marked clams in sample}}$$

Confidence limits may be calculated for the population size estimates from the following formulas. See Appendix F for table of confidence limit values for numbers of recaptures based on the Poisson distribution.

Petersen:

Upper Confidence Limit =

$$\left[\frac{m(u+r)}{\text{lower confidence limit value for } r+1}\right] - 1$$

Lower Confidence Limit =

$$\left[\frac{m(u+r)}{\text{upper confidence limit value for } r+1}\right] - 1$$

Schnabel:

Upper Confidence Limit =

$$\frac{\sum[m(u+r)]}{\text{lower confidence limit value for } \sum r}$$

Lower Confidence Limit =

$$\frac{\sum[m(u+r)]}{\text{upper confidence limit value for } \sum r}$$

SIZE FREQUENCY DATA

Size frequency data from *Tivela* and *Blepharipoda* samples will be entered into dBase III files for analysis in SPSS. Size frequency data from *Emerita* and *Olivella* populations will be entered into Lotus 123 files for analysis.

dBASE FILE STRUCTURE

dBase III Plus file structure for size frequency data is as follows:

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	Date	Numeric	4
4	Species	Numeric	5
5	Size	Numeric	2
6	Sex	Numeric	2
7	Reprod	Numeric	2

Field 1 is the location or site code number (see Table 1)

Field 2 is the year sampled

Field 3 is the date sampled

Field 4 is the species code number (see Appendix C)

Field 5 is the size measurement in mm

Field 6 is the sex of the individual (0 = undetermined, 1 = male, 2 = female)

Field 7 is the reproductive state of the individual (0 = undetermined, 1 = ovigerous, 2 = non-ovigerous)

Fields 6 and 7 apply to crabs only, for all clam data enter zeros. The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file.

Creating a New Data File

Enter dBase III, at the dot prompt type the following commands:

.use F:\beach\bsizeblk.dbf
(accesses blank file)
.copy to F:\beach\bsizexx.dbf
(copies the blank file to the new year file you are creating, supply year at xx)
.close all

Entering Data and Updating Files

After the new file is established, begin entering data. Use the following commands:

.use F:\beach\bsizexx.dbf
(accesses file)
.set carry on
(turns on carry mode. Data is copied from the prior record to a new record when using browse)
.go bottom
(positions at bottom of file)
.browse
(allows data entry and edit)

Enter the first measurement, sex and reproductive condition and the species code, location code and year. Position the cursor at the size mm column and press the down arrow. When asked whether you want to enter new records, answer yes. Each time the down arrow is pressed, all the data in the prior record is copied. Re-enter the size mm, sex and reproductive condition data even though it might be the same when entering crab data. For clams, just reenter the size mm data. Repeat this for the data for each species, remembering to change the species code for each new species you enter data for. For any species for which there is no data (n=0), you must enter a zero for the size mm for every station where the species did not occur. Otherwise, the histogram program (SPSS) will stop at the first species for which there is no data. Repeat for each site, changing the location code for each new site.

When finished entering data, leave the last record in the file with all zeros, so that the starting place is clearly indicated for the next session of data entry. Remove that record from the file when all data for the year is entered.

When editing of a particular data file is complete, close the file with the following commands:

Press Ctrl End
(exits and saves file)
.close all
(closes all data bases)

Other dBase III Commands

The above commands are used to enter new data into the data base files. To find and edit a specific record, use the locate command. For example, to edit the records for *Blepharipoda* at Abalone Rocks Beach, type the following commands:

.locate for location = xx .and. species = xxxxxx

SPSS Data Analysis and Reports

With the size frequency data, one year of data will be analyzed at a time. Using SPSS, select the location for histogram results. To generate a report using the size frequency data, run SPSS\PC+ from the menu and select size frequencies.

To create an SPSS system file, enter the following commands at the SPSSPC prompt:

SPSSPC:translate from = 'F:\beach\bsize90.dbf'
(converts dBase III file to SPSS active file)
SPSSPC:save outfile = 'F:\beach\bsizeyr.sys'
(saves active file to an SPSS system file)

Once the system file has been created there is no need to issue the above commands again.

Using one year of data at a time, select one location (site) and run the BSFCALC.PRO (size frequency histogram program) to generate a report of histograms for all the size frequency species at that site. For example:

SPSSPC:get file = 'F:\beach\bsizeyr.sys'
(retrieves system file)
SPSSPC:select if (location = xx)
(selects cases for location xx)
SPSSPC:include bsfcalc.pro
(generates a frequency table with all statistics for the location xx for all species)

See Appendix H for program.

Press the space bar once each time the "MORE" query appears in the upper right hand corner of the screen.

To generate another histogram report for a different location, enter the commands starting with the "get file" statement as above.

Each time the BFSCALC.PRO is run, the results in SREPORT.RSL will be erased. Print the results before running bfscalc.pro again.

When the program run is complete, the SPSSPC: prompt will appear. Type **finish** to exit out of SPSS. Print the report using DOS while in the F:\BEACH directory. Use the DOS print command as follows:

F:\beach\print sreport.rsl

To edit with a word processer, copy the file to the WordPerfect directory.

LOTUS FILE STRUCTURE

Size frequency data for *Emerita* and *Olivella* is already in the form of a frequency distribution due to the use of a sorter to process samples. Data should be entered into a spreadsheet format. Blank files called EASIZEBLK.WKS and OBSIZEBLK.WKS will be used to copy structure to a file for data entry. Open the blank file of the appropriate type and rename it for the year of data you wish to enter e.g. EASIZE90.LOT. For each location, copy the location name and year down for rows. Then begin entering data in the appropriate columns from smallest to largest crab or snail sizes. Save the file when finished entering data. A size frequency histogram may be then be generated using the graph function of Lotus 123. The file for *Olivella biplicata* will contain only size data. The file for *Emerita analoga* will contain size, sex and reproductive condition data. Example spreadsheets for *Emerita* are provided in Appendix G. Calibrations to be used to convert sieve bucket size to shell length or carapace length in mm are provided in Appendix D.

Summary Statistics

For the *Emerita* data, the following summary statistics should be obtained from the data or spreadsheet:

female size at maturity - smallest size at which 50% of the crabs are ovigerous

5th and 95th percentile sizes of ovigerous crabs - multiply the total number of ovigerous crabs by 0.05 to find the nth crab, then count ovigerous crabs up from the bottom (5th percentile) or down from the top (95th percentile) of the size distribution to the size where the nth crab occurs

largest male size - the size of the largest male crab

%ovigerous - #ovigerous crabs divided by the total number of female crabs at or above the size of the smallest ovigerous crab *100).

Example data and resultant summary statistics are given in Appendix G. A summary table should be constructed for each year containing the summary statistics for all locations using the form in Appendix G. Convert the sieve bucket number values to carapace length in mm by using the calibration for *Emerita analoga* in Appendix D.

Those summary data should be entered in to a database file called EASUMXX.DBF.

dBASE FILE STRUCTURE

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	MMS	Numeric	4
4	5th%ile	Numeric	4
5	95%ile	Numeric	4
6	%ovig	Numeric	4
7	Male	Numeric	4

Field 1 is the location or site code number (see Table 1)

Field 2 is the year sampled

Field 3 is the minimum size at maturity of female crabs in mm.

Field 4 is the 5th percentile size of ovigerous crabs in mm.

Field 5 is the 95th percentile size of ovigerous crabs in mm.

Field 6 is the percentage of ovigerous crabs

Field 7 is the size of the largest male crab in mm.

The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file.

Creating A New Data File

To create a new data file, you can copy the structure of a blank data file to the new one and then start appending data. Use the following procedure to create a new file after entering dBase III Plus:

.use F:\beach\eablank.dbf
(opens the blank structure file)
.copy to F:\beach\easumxx.dbf
(copies the structure to the file for the current year, supply year at xx)
.close all

Entering Data and Updating Files

Once the new file is created, begin entering data. To enter data proceed in the following manner after entering dBase III Plus:

.use F:\beach\easumxx.dbf
(accesses file)
.1
(takes you to record 1)
.browse
(most efficient command for data entry)

Enter the location and year in the appropriate columns. Now, move to the crab summary statistic columns and begin entering data for that location. Move to the next record to enter data for the next location. Continue until data from all locations are entered.

Finally, remember to press Control-End to save changes made in browse and to type in close all before starting to work on another file or exiting dBase III Plus.

Data Analysis and Reports

No protocols have been developed for data analysis.

SPECIES LISTS

dBASE FILE STRUCTURE

dBase III Plus file structure for species list data is as follows:

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	Date	Numeric	6
4	Station	Numeric	2
5	Species	Numeric	5
6	Replicate	Numeric	2
7	Relative Abundance	Numeric	4

Field 1 is the location or site code number (see Table 1)

Field 2 is the year sampled

Field 3 is the date sampled

Field 4 is the station number

Field 5 is the species code number (see Appendix C)

Field 6 is the replicate number

Field 7 is the code for estimated abundance in the sample (see methods)

The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file.

Creating A New Data File

To create a new data file, you can copy the structure of a blank data file to the new one and then start appending data. Use the following procedure to create a new file after entering dBase III Plus:

.use F:\beach\lslblank.dbf
(opens the blank structure file)
.copy to F:\beach\lslxx.dbf
(copies the structure to the file for the current year, supply year at xx)
.close all

Entering Data and Updating Files

Once the new file is created, begin entering data. To enter data proceed in the following manner after entering dBase III Plus:

.use F:\beach\lslxx.dbf
(accesses file)
.replace all loc with __
(enter location code here)
.replace all year with __
(enter last two digits of year here)
.1
(takes you to record 1)
.replace all date with __
(enter the julian day code here)
.1
.replace all station with __
(enter the station code here)
.1
.browse
(most efficient command for data entry)

Now, move to the species, replicate and estimated abundance columns and begin entering data.

To modify the file for second and subsequent locations, issue the following commands:

.use F:\beach\lsl.dbf
(accesses file)
.append from F:\beach\lslblank.dbf
(appends blank records to the file)

Once the blank records are appended, fill in the information for the year and location in the following way:

.x
(at x type in the record number where you wish to begin)
.replace next y loc with __
(replaces blank locations with the number of the location that you wish to enter data for)
.x
(returns to record number where you started)
.replace next y year with __
(replaces blank years with the current year)
.x
. replace next y date with
.x
.replace next y station with
.x
(back to starting point)
.browse
(into edit mode for data entry)

Finally, remember to press Control-End to save changes made in browse and to type in close all before starting to work on another file or exiting dBase III Plus.

Data Analysis and Reports

No protocols have been developed for data analysis.

AVIFAUNA CENSUS DATA

dBASE FILE STRUCTURE

dBase III Plus file structure for avifauna data is as follows:

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	Date	Numeric	4
4	Habitat	Numeric	2
5	Species	Numeric	5
6	Count	Numeric	4

Field 1 is the location or site code number

Field 2 is the year sampled

Field 3 is the date sampled

Field 4 is the type of habitat censused, 1 = beach, 2 = lagoon

Field 5 is the species code number (see Appendix C)

Field 6 is the number of individuals found in the census

The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file.

Creating A New Data File

To enter dBase III, at the dot prompt type the following commands:

.use F:\beach\bbirdblk.dbf
(accesses blank file)
.copy to F:\beach\bbird90.dbf
(copies the blank file to the new year file you are creating, supply year at 90)
.close all

Entering Data and Updating Files

After the new file is established, begin entering data. Use the following commands:

.use F:\beach\bbird90.dbf
(accesses file)
.replace all loc with __
.replace all year with __
.1
.replace all date with __
(enter julian day code)
.1
.replace all habitat with __
(enter habitat code)
.1
.browse
(allows data entry and editing)

Now move to the species and count columns and begin entering census data.

To modify the file for second and subsequent locations, issue the following commands:

.use F:\beach\bbird90.dbf
.append from F:\beach\bbirdblk.dbf

Once the blank records have been appended, fill in the information for the year and location in the following way:

.x
(type in beginning record number)
.replace next y loc with __
.x
.replace next y year with __
.x
.replace next y date with __
.x
.replace next y habitat with __
.browse

Go to the species and count columns and start entering data for numbers and species.

Two important final points: remember to press Control-End to save changes you make in browse and to type in "Close all" before proceeding to work on another file or exiting dBase III plus.

Data Analysis and Reports

No protocols for analysis of bird data have been developed.

PHYSICAL MEASUREMENTS

dBASE FILE STRUCTURE

dBase III Plus file structure for physical data is as follows:

Field	Field Name	Type	Width
1	Location	Numeric	2
2	Year	Numeric	2
3	Date	Numeric	4
4	Station	Numeric	2
5	Habitat	Numeric	2
6	Type	Numeric	2
7	Measurement	Numeric	4

Field 1 is the location or site code number

Field 2 is the year sampled

Field 3 is the date sampled

Field 4 is the station sampled (for lagoon sites only, for all beach sites station = 0)

Field 5 is the type of habitat measured (1 = beach, 2 = lagoon)

Field 6 is a code number denoting the measurement type (1 = water temperature, 2 = salinity, 3 = relative water level, 4 = secchi depth, 5 = beach slope)

Field 7 is the measurement result

The dBase III files are stored on the file server under the F:\BEACH directory and on floppy disks. Each year of data is entered in a file.

Creating A New Data File

To create a new data file, you can copy the structure of a blank data file to the new one and then start appending data. Use the following procedure to create a new file after entering dBase III Plus:

.use F:\beach\bphblank.dbf
(opens the blank structure file)
.copy to F:\beach\bphxx.dbf
(copies the structure to the file for the current year, supply year at xx)
.close all

Entering Data and Updating Files

Once the new file is created, begin entering data. To enter data proceed in the following manner after entering dBase III Plus:

.use F:\beach\bphxx.dbf
(accesses file)
.replace all loc with __
(enter location code here)
.replace all year with __
(enter last two digits of year here)
.1
(takes you to record 1)
.replace all date with __
(enter julian day code)
.1
.browse
(most efficient command for data entry)

Now, move to the station, type, habitat, and measurement columns and begin entering data.

To modify the file for second and subsequent locations, issue the following commands:

.use F:\beach\bph.dbf
(accesses file)
.append from F:\beach\bphblank.dbf
(appends blank records to the file)

Once the blank records are appended, fill in the information for the year and location in the following way:

.x
(at x type in the record number where you wish to begin)
.replace next y loc with __
(replaces blank locations with the number of the station that you wish to enter data for)
.x
(returns to record number where you started)
.replace next y year with __
(replaces blank years with the current year)
.x
.replace next y date with __
.x
(back to starting point)
.browse
(into edit mode for data entry)

Finally, remember to press Control-End to save changes made in browse and to type in close all before starting to work on another file or exiting dBase III Plus.

Data Analysis and Reports

No protocols have been developed for data analysis.

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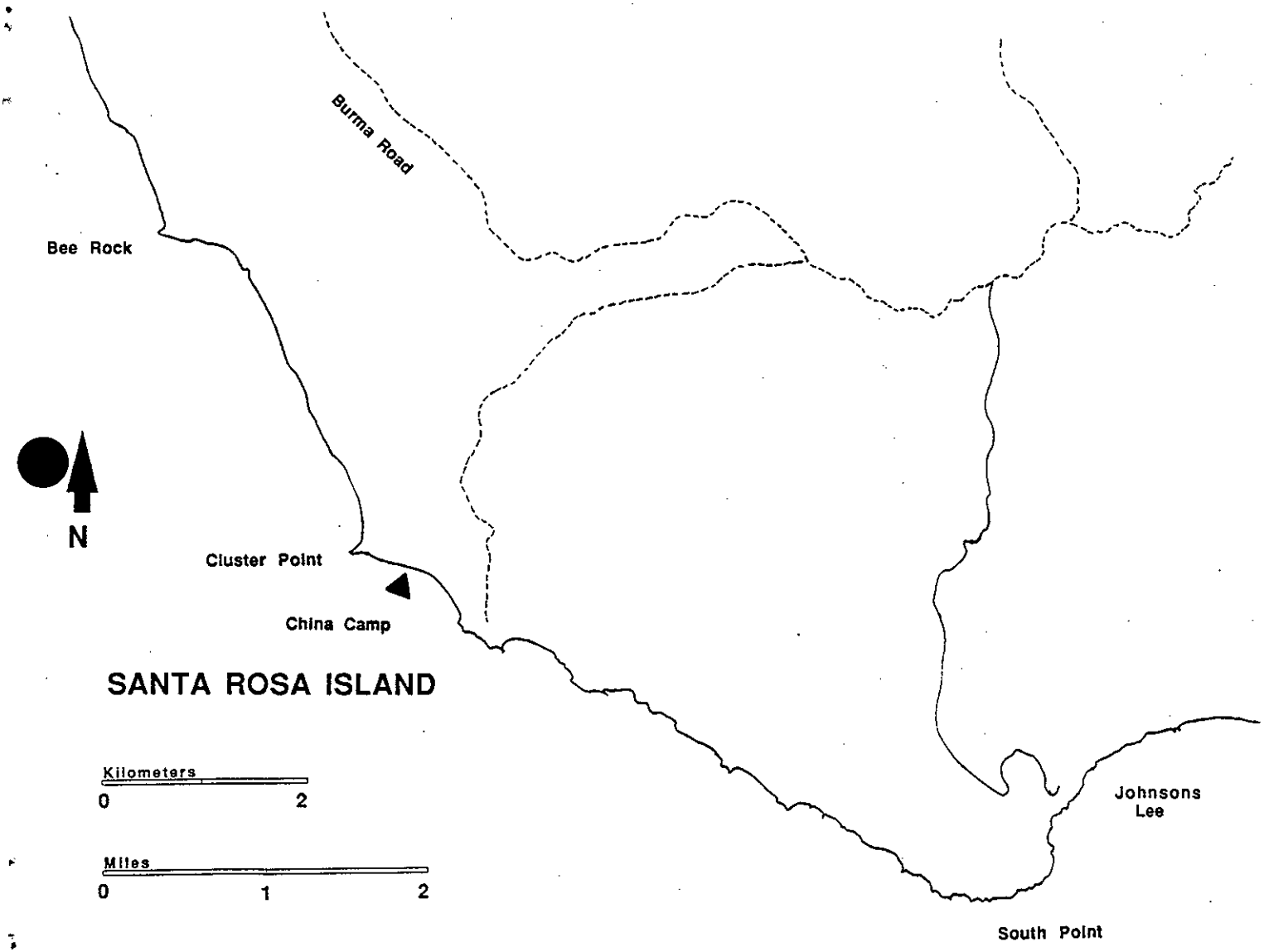
Davis, G.E. 1988. Kelp forest monitoring handbook. Channel Islands National Park. National Park Service, Ventura, Calif. 34 p.

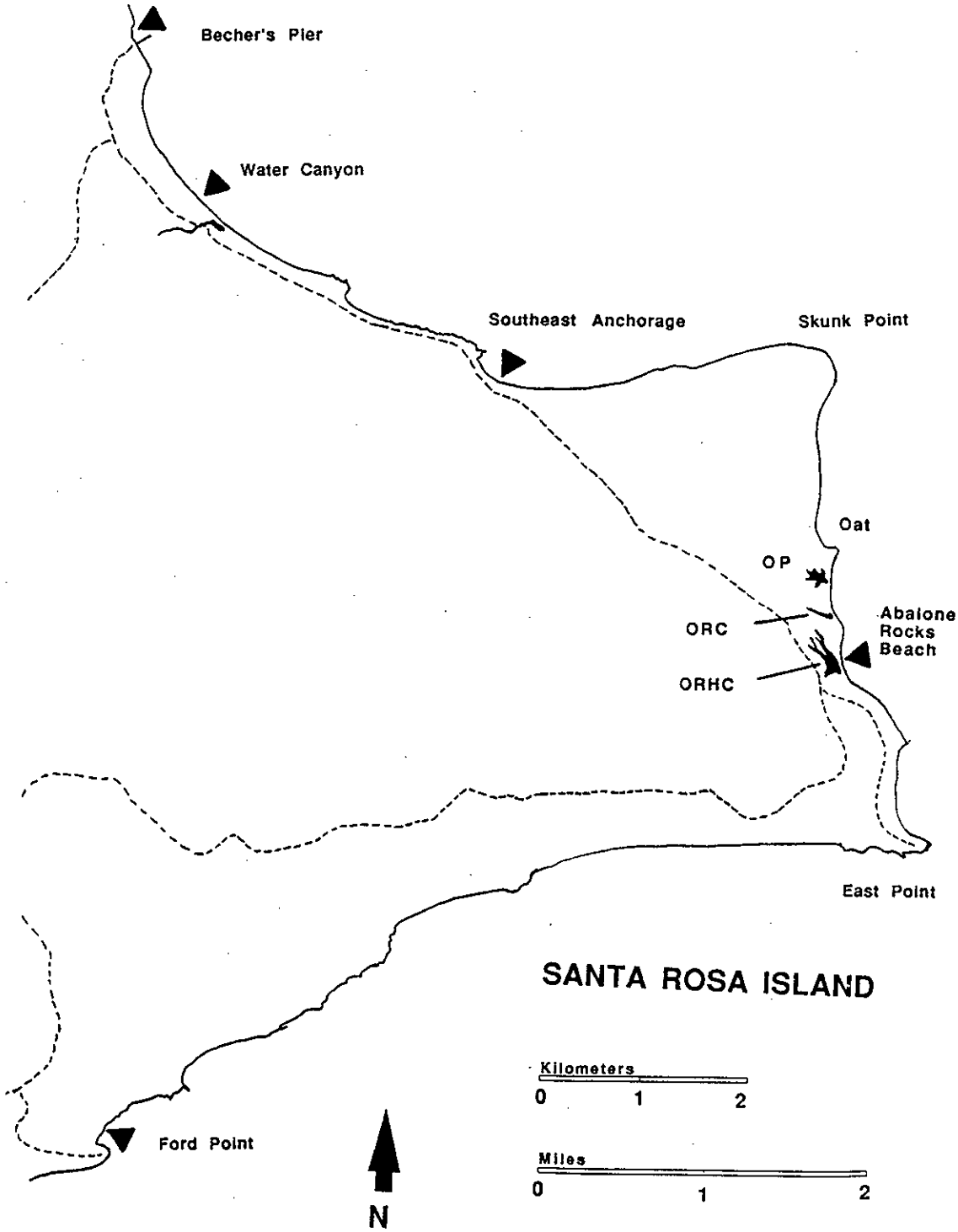
Krebs, C.J. 1989. Ecological Methodology. Harper and Row, Publishers, New York. 654p.

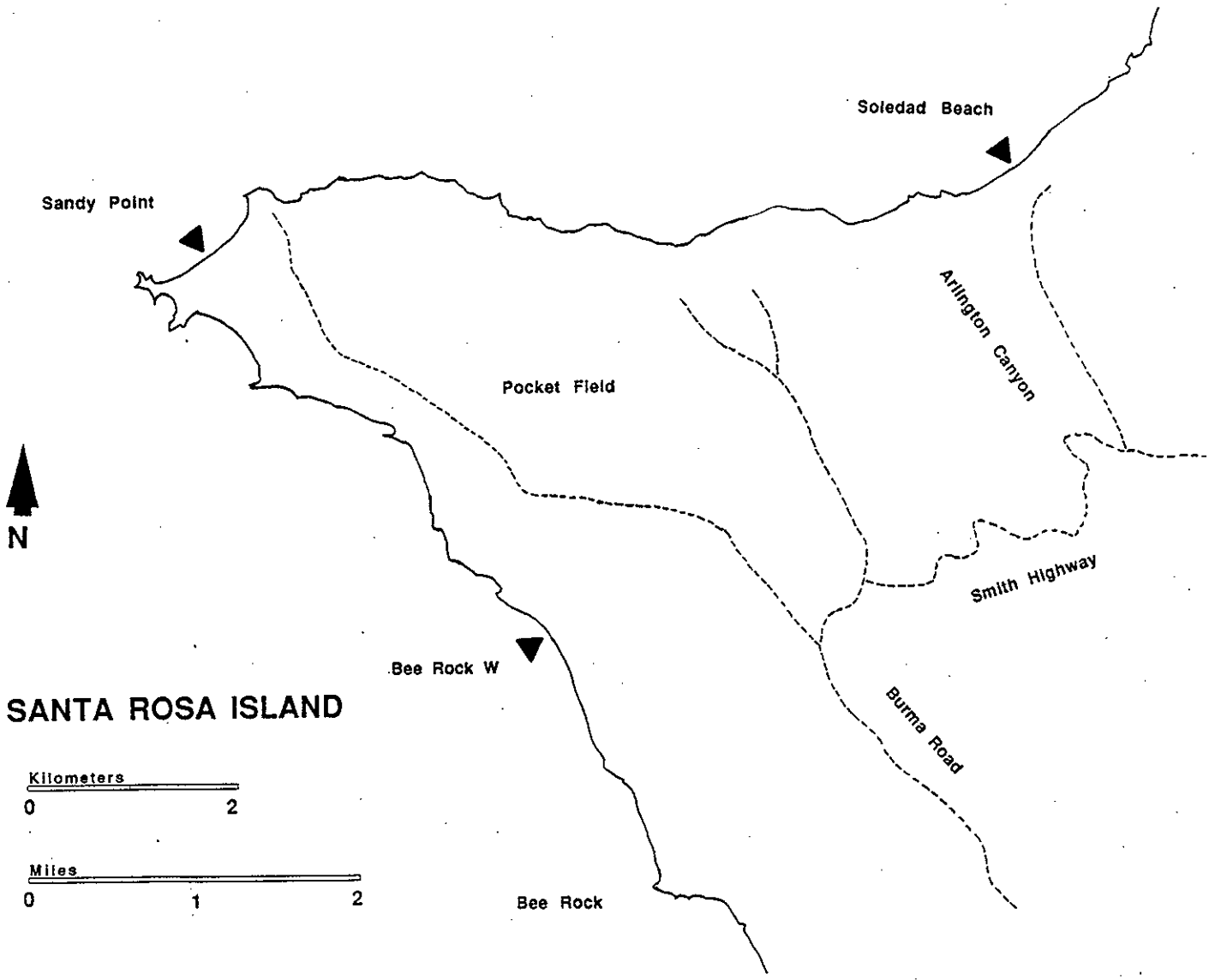
Wenner, A.M., C. Fusaro and A. Oaten 1974. Size at onset of sexual maturity and growth rate in crustacean populations. Can. J. Zool. 52: 1095-1106.

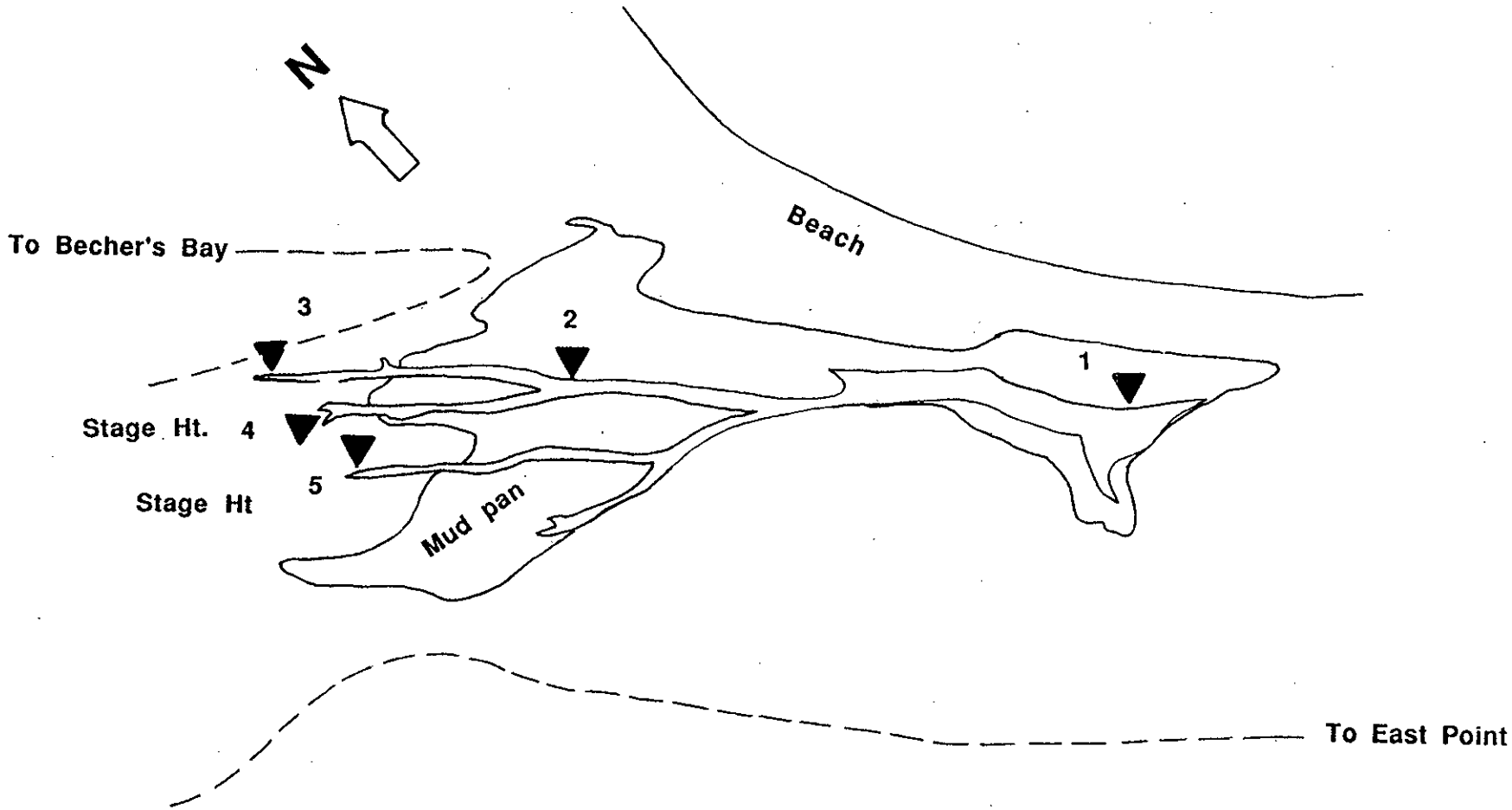
Zedler, J.B. 1982. The ecology of southern California salt marshes: a community profile. U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C. FWS/OBS-81/54. 110pp.

APPENDIX A. Sampling Locations

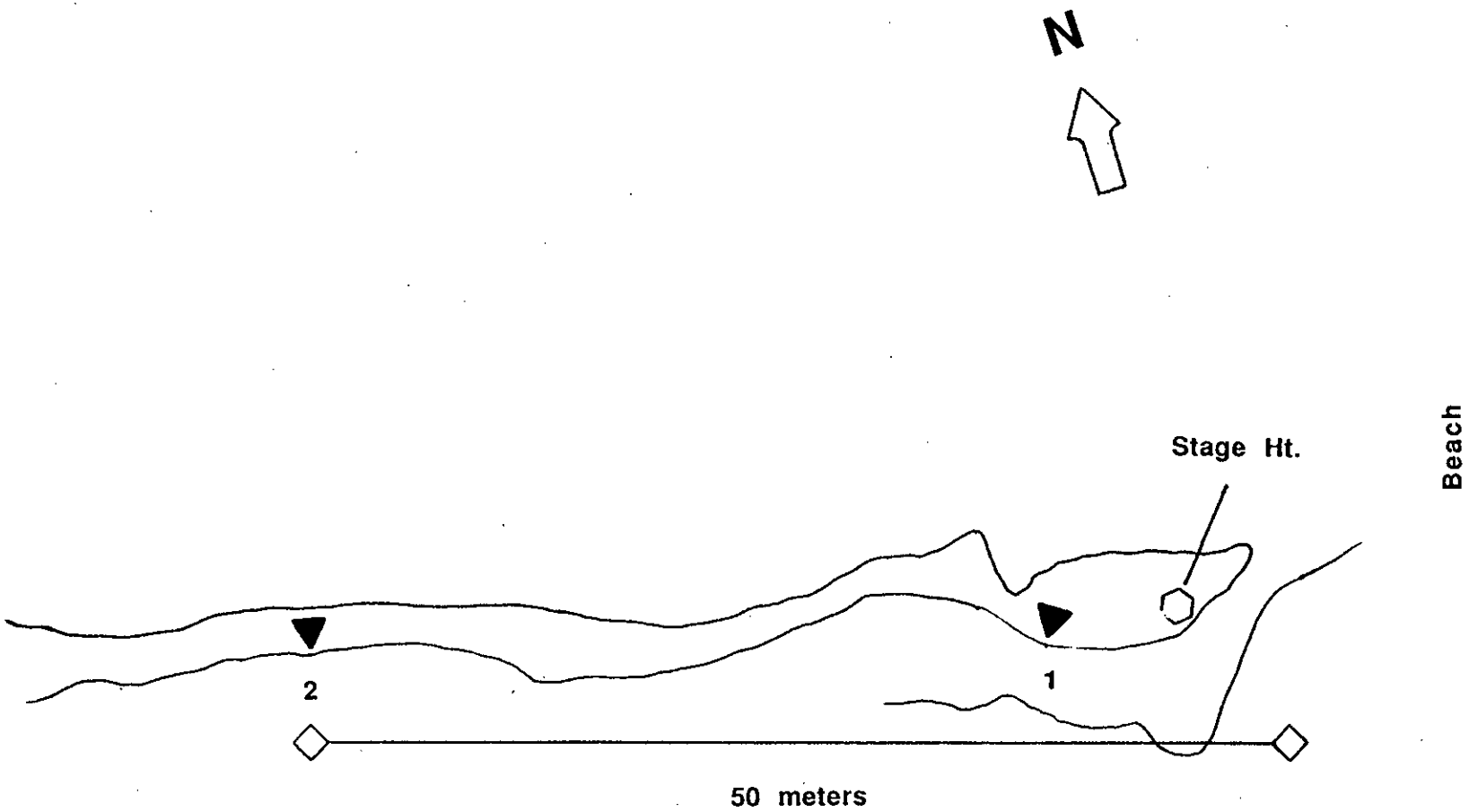



Becher's Pier
Water Canyon
Southeast Anchorage
Skunk Point
Oat
OP
ORC
ORHC
Abalone Rocks Beach
East Point
SANTA ROSA ISLAND
Kilometers
0 1 2
Miles
0 1 2
Ford Point
N

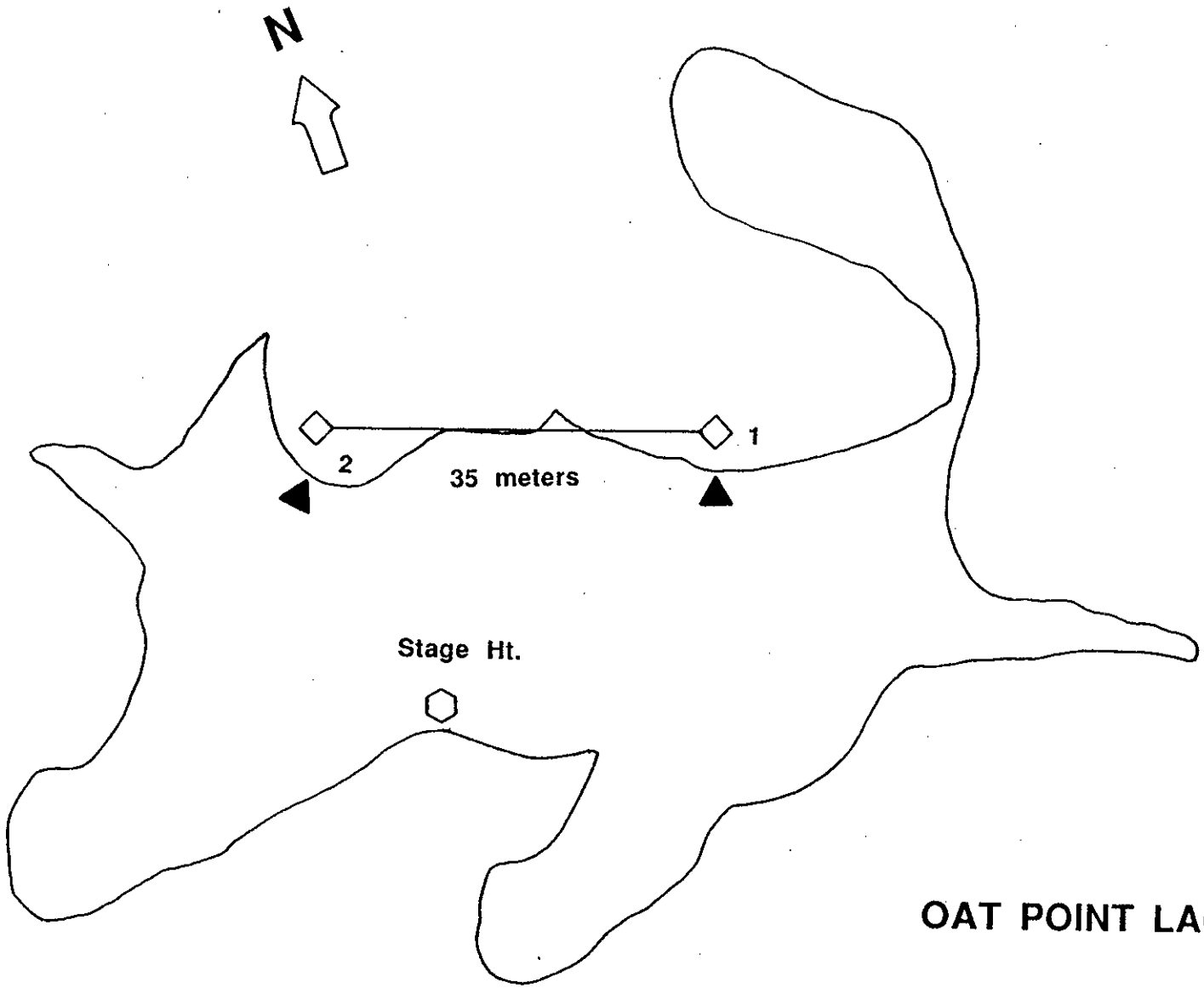

Soledad Beach
Sandy Point
Arlington Canyon
Pocket Field
N
Smith Highway
Bee Rock W
SANTA ROSA ISLAND
Burma Road
Kilometers
0
2
Miles
0
1
2
Bee Rock



OLD RANCH HOUSE CANYON LAGOON



OLD RANCH CANYON LAGOON



OAT POINT LAGOON

APPENDIX B.
Summary of beach and lagoon population parameters monitored in Channel Islands National Park

TAXON	SAMPLING FREQUENCY	LOCATIONS	ABUNDANCE	SIZE/AGE STRUCT	REPROD EFFORT	RECRUIT RATE	GROWTH	MORT RATE
Birds								
Various species	quarterly	3	count	no	no	no	no	no
	annual	9	count	no	no	no	no	no
Fishes								
Arrow goby *Clevelandia ios*	quarterly	3	relative	no	no	no	no	no
Top smelt *Atherinops affinis*	quarterly	3	relative	no	no	no	no	no
Invertebrates								
Polychaete worm *Nephtys californicus*	annual	9	density	no	no	no	no	no
Polychaete worm *Euzonus mucronata*	annual	9	density	no	no	no	no	no
Polychaete worm *Polydora cornuta*	quarterly	2	relative	no	no	no	no	no
Purple olive snail *Olivella biplicata*	annual	1	density	yes	no	no	no	no
Pismo clam *Tivela stultorum*	annual	1	density	yes	no	yes	yes	no
Beachhopper *Megalorchestia sp.*	annual	9	density	no	no	no	no	no
Misc. Amphipods *Gammaridea*	annual	9	density	no	no	no	no	no

TAXON	SAMPLING FREQUENCY	LOCATIONS	ABUNDANCE	SIZE/AGE STRUCT	REPROD EFFORT	RECRUIT RATE	GROWTH	MORT RATE
Isopod *Excirolana chiltoni*	annual	9	density	no	no	no	no	no
Isopod *Exosphaeroma inornata*	annual	9	density	no	no	no	no	no2
Isopod *Alloniscus perconvexus*	annual	9	density	no	no	no	no	no
Beach mysid *Archeomysis grebnitzkii*	annual	9	density	no	no	no	no	no
Common sand crab *Emerita analoga*	annual	9	density	yes	yes	yes	yes	no
Spiny sand crab *Blepharipoda occidentalis*	annual	9	density	yes	yes	yes	yes	no
Water boatman *Trichocorixa reticulata*	quarterly	3	relative	no	no	no	no	no
Shore bug Saldidae sp.	quarterly	3	relative	no	no	no	no	no
Brine fly *Ephydra millbrae*	quarterly	3	relative	no	no	no	no	no
Tiger beetle *Cincindela sp.*	quarterly	3	relative	no	no	no	no	no
Misc. Carabid beetles	annual	9	density	no	no	no	no	no
Pictured Rove Beetle *Thinopinus pictus*	annual	9	density	no	no	no	no	no
Misc. Rove Beetles Staphylinidae	annual	9	density	no	no	no	no	no

TAXON	SAMPLING FREQUENCY	LOCATIONS	ABUNDANCE	SIZE/AGE STRUCT	REPROD EFFORT	RECRUIT RATE	GROWTH	MORT RATE
Misc. other Beetles	annual	9	density	no	no	no	no	no
Algae and plants								
Macrophyte Wrack by species/type	annual	9	%cover	no	no	no	no	no
Widgeon grass *Ruppia maritima*	quarterly	3	%cover	aver. size	no	no	no	no

APPENDIX C. Beach and Lagoon: Species Codes and Checklist

CODE	TECHNIQUE	SPECIES
1000	PC	Green Algae
1001	PC	Misc. Green Algae
2000	PC	Brown Algae
2001	PC	Misc. Brown Algae
2010	PC	*Macrocystis pyrifera*
2012	PC	*Egregia*
3000	PC	Red Algae
3001	PC	Misc. Red Algae
4000	PC	Plants
4002	PC	*Phyllospadix*
4003	PC	Terrestrial plants
7000		Annelida, Polychaeta
7004	T	*Euzonus sp.*
7005	T	*Nephtys californiensus*
7006	T	*Glycera sp.*
7007	SL	*Polydora cornuta*
7008	T	*Lumbrinereis zonata*
7009	T	Misc. polychaetes
8000		Arthropoda
8002	T	*Megalorchestia sp.*
8003	T	other gammarid amphipods
8004	T	*Excirolana chiltoni*
8005	T	*Exosphaeroma ornata*
8006	T	*Alloniscus perconvexus*
8007	T	*Archeomysis grebnitzkii*
8008	SL	*Callianassa sp.*
8009	T,S	*Emerita analoga*
8010	T,TT	*Blepharipoda occidentalis*
8011	T,TT	*Lepidopa californica*
8012	B	*Cancer gracilis*
8013	SL	*Pachygrapsus crassipes*
8014	SL	*Hemigrapsus oregonensis*
8015	SL	*Trichocorixa reticulata*
8016	SL	Saldidae sp.
8017	SL	*Ephydra millbrae*
8018	SL	*Cincindela sp.*
8019	T	misc. Carabidae
8020	T	*Thinopinus pictus*
8021	T	misc. Staphylinidae
8022	T	misc. Curculionidae
9000		Mollusca

CODE	TECHNIQUE	SPECIES
9012	T	*Olivella biplicata*
9013	TT,B,R	*Tivela stultorum*
13000	T	misc. invertebrates
13001	T	*Paranemertes californica*
14000		Fishes
14028	SL	*Atherinops affinis*
14029	T	*Leuresthes tenuis*
14030	SL	*Clevelandia ios*
14031	SL	misc fish
15000		Substrates
15002	PC	Rock
15004	PC	Sand
15005	PC	Tar
15006	PC	Carrion
15007	PC	Anthrop. Debris
16000		Birds
16001	VC	Common Loon
16002	VC	Arctic Loon
16003	VC	Red-throated Loon
16004	VC	Western/Clark's Grebe
16005	VC	Horned Grebe
16006	VC	Eared Grebe
16007	VC	Pied-billed Grebe
16008	VC	Brown Pelican
16009	VC	Double Crested Cormorant
16010	VC	Brandt's Cormorant
16011	VC	Pelagic Cormorant
16012	VC	Great Blue Heron
16013	VC	Black-crowned Night Heron
16014	VC	Snowy Egret
16015	VC	Cattle Egret
16016	VC	Great Egret
16017	VC	Green-backed Heron
16018	VC	Brant
16019	VC	Mallard
16020	VC	Green-winged Teal
16021	VC	American Widgeon
16022	VC	Northern Pintail
16023	VC	Northern Shoveller
16024	VC	Blue-winged Teal

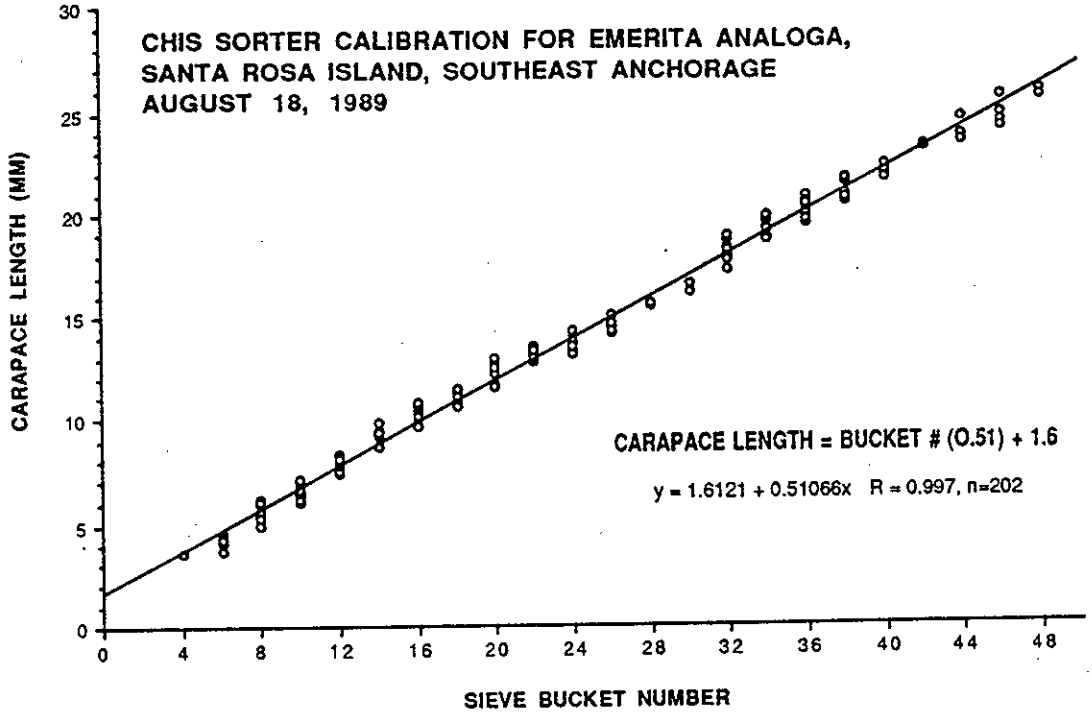
CODE	TECHNIQUE	SPECIES
16025	VC	Cinnamon Teal
16026	VC	Ruddy Duck
16027	VC	Ring-necked Duck
16028	VC	Lesser Scaup
16029	VC	Surf Scoter
16030	VC	Bufflehead
16031	VC	Red-breasted Merganser
16032	VC	Sora
16033	VC	American Coot
16034	VC	misc. Rails
16035	VC	Black Oystercatcher
16036	VC	Snowy Plover
16037	VC	Semipalmated Plover
16038	VC	Killdeer
16039	VC	Black-bellied Plover
16040	VC	Lesser Golden Plover
16041	VC	Marbled Godwit
16042	VC	Whimbrel
16043	VC	Long-billed Curlew
16044	VC	Willet
16045	VC	Greater Yellowlegs
16046	VC	Lesser Yellowlegs
16047	VC	Spotted Sandpiper
16048	VC	Wandering Tattler
16049	VC	Wilson's Phalarope
16050	VC	Red-necked Phalarope
16051	VC	Red Phalarope
16052	VC	Short-billed Dowitcher
16053	VC	Long-billed Dowitcher
16054	VC	Common Snipe
16055	VC	Ruddy Turnstone
16056	VC	Black Turnstone
16057	VC	Surfbird
16058	VC	Red Knot
16059	VC	Dunlin
16060	VC	Sanderling
16061	VC	Western Sandpiper
16062	VC	Eastern Sandpiper
16063	VC	Baird's Sandpiper
16064	VC	Pectoral Sandpiper
16065	VC	Heerman's Gull
16066	VC	Bonaparte's Gull
16067	VC	Ring-billed Gull
16068	VC	Mew Gull
16069	VC	Herring Gull
16070	VC	California Gull
16071	VC	Thayer's Gull
16072	VC	Western Gull

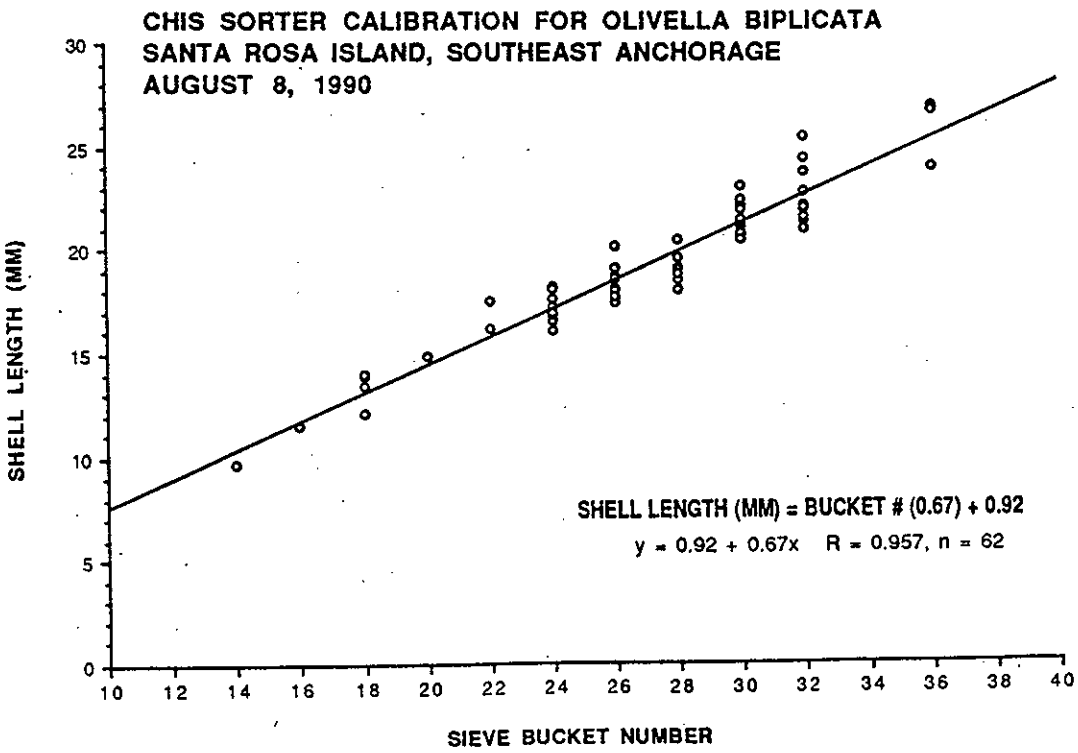
CODE	TECHNIQUE	SPECIES
16073	VC	Glaucous-winged Gull
16074	VC	Black-legged Kittiwake
16075	VC	Sabine's Gull
16076	VC	Common Tern
16077	VC	Arctic Tern
16078	VC	Forster's Tern
16079	VC	Elegant Tern
16080	VC	Royal Tern
16081	VC	Peregrine Falcon
16082	VC	Osprey
16083	VC	Bald Eagle
16084	VC	Red-tailed Hawk
16085	VC	American Kestrel
16086	VC	Belted Kingfisher

TECHNIQUE

PC -	Point Contact Transect
T -	Clam Gun Transects
TT -	Trench Transects
S -	Supplemental Sampling
B -	Band Transects
R -	Mark Recapture
SL -	Species List
VC -	Visual Census

APPENDIX D. Calibration Curves





Megalorchestia Abundance Data Form

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____ Beach Slope_____
Time of High Tide_____ Beach Width_____
Beach Backing_____ Sky_____

Transect	1	2	3	4	5	6	7	8	9	10
Length (m)										
# of cores										
cores/m										
# amphipods										
amphipod/m										
other species										
Alloniscus										
beetles										
staphylinids										
Thinopinus										
other sp.										
flies										

NOTES: Describe type of burrows, wrack, activity of organisms and sketch the bed locations relative to base point

Emerita Size Frequency Data Sheet

Site_____ Date_____ Time_____

Investigators_____ Beach Slope_____

Water Temp._____ Swell Height_____ Wind_____

Box #	New Eggs	Eyespot Eggs	Grey Eggs	Just Drop.	Total Ovig.	Non-Ovig.	Total Females	Males	Total Crabs	Notes/ Megalopa
60										
58										
56										
54										
52										
50										
48										
46										
44										
42										
40										
38										
36										
34										
32										
30										
28										
26										
24										
22										
20										
18										
16										
14										
12										
10										
8										
6										
4										
Totals										
caliper										
meas.										

Emerita Abundance

Site_____ Date_____ Time_____

Investigators_____ Core/m (80 cm^2 x 10 cm)_____

Water Temp._____ Beach Slope_____

Swell Height_____ Wind_____ Intertidal Width_____

Transect #	1	2	3	4	5	mean	st dv
# cores							
size (box #)							
# 38+total							
# 38+ovig							
# 28+total							
# 28+ovig							
# 18+total							
# 18+ovig							
# 8+total							
# 8+ovig							
# 4+total							
# megalopa							
# ovig. crabs							
# nonovig.							
total crabs							
crabs + meg.							
crabs/meter							
other spec. #							
Excirolana							
Olivella							
Euzonus							
Nephtys							
Blepharipoda							

Olivella biplicata Abundance Data Form

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____ Beach Slope_____
Time of Low Tide_____ Beach Width_____
Core Spacing (cores/m)_____

Transect	1	2	3	4	5	6	7	8	9	10
Length (m)										
# of cores										
# snails										
other species										
Tivela										
Emerita										
Blepharipoda										
Polychaetes										

Olivella Size Frequency Data Sheet

Site_____ Date_____ Time_____

Investigators_____ Beach Slope_____

Water Temp._____ Swell Height_____ Wind_____

Box #	Number of Snails	Notes
44		
42		
40		
38		
36		
34		
32		
30		
28		
26		
24		
22		
20		
18		
16		
14		
12		
10		
8		
6		
4		
Totals		

Blepharipoda Abundance and Size Frequency Distribution Data Form

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____ Beach Slope_____
Swell Height_____ Time of Low Tide_____

Trench #	1	2	3	4	5	6	7	8	9	10
Length (m)										
width(m)										
m^2 sampled										
# crabs										
size (mm)										
Males										
Ovig. females										
Nonovig fem										

Macrophyte Wrack Transect Data Form

Island_____ Site_____ Date_____

Observer_____ Data Recorder_____ Time_____

Tide_____ Swell Ht._____ Wind Speed_____

Zone Width_____ Point Spacing_____ # Points_____

Transect #						Transect #						
Point 001	Comp.	Ht.	Point 051	Comp.	Ht.	Point 001	Comp.	Ht.	Point 051	Comp.	Ht.	Key to Codes
002			052			002			052			M= Macrocystis
003			053			003			053			P=Phyllospadix
004			054			004			054			E= Egregia
005			055			005			055			B=brown algae
006			056			006			056			R=red algae
007			057			007			057			G=green algae
008			058			008			058			A=unid'd algae
009			059			009			059			T=tar
010			060			010			060			Tr=terrestrial
011			061			011			061			D= anthrop debris
012			062			012			062			C= carrion
013			063			013			063			
014			064			014			064			
015			065			015			065			
016			066			016			066			
017			067			017			067			
018			068			018			068			
019			069			019			069			
020			070			020			070			
021			071			021			071			
022			072			022			072			
023			073			023			073			
024			074			024			074			
025			075			025			075			
026			076			026			076			
027			077			027			077			
028			078			028			078			
029			079			029			079			
030			080			030			080			
031			081			031			081			
032			082			032			082			
033			083			033			083			
034			084			034			084			
035			085			035			085			
036			086			036			086			
037			087			037			087			
038			088			038			088			
039			089			039			089			
040			090			040			090			
041			091			041			091			
042			092			042			092			
043			093			043			093			
044			094			044			094			
045			095			045			095			
046			096			046			096			
047			097			047			097			
048			098			048			098			
049			099			049			099			
050			100			050			100			
			101						101			

Tivela abundance and size frequency data sheet

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____ Beach Slope_____
Swell Height_____ Time of Low Tide_____

Trench #	1	2	3	4	5	6	7	8	9	10
Random #										
Length (m)										
Width(m)										
m^2 sampled										
Total clams caught										
# unmarked clams										
size (mm)										
# marked clams										
size (mm)*										
*Note the mark type:										
NH-Native horizontal										
NU-Native unique										
IT- Intertidal xplant										
ST-Subtidal xplant										
# clams marked and										
returned to intertidal										
Other species #										

Tivela subtidal abundance and size frequency data sheet

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____ Visibility_____

DIVER NAME					TOTALS
AREA					
Total clams caught (u + r)					
# Unmarked + prev year clams(u)					
# Recaptured marked clams (r)					
# Clams newly marked/retrn'd(x)					
Search Time (minutes)					
Clams per hour					

Unmarked clams or clams marked in previous year: (shell length, type of mark applied, old mark type)

Length (mm)	Mark *	Length (mm)	Mark *	Length (mm)	Mark *	Length (mm)	Mark *	

Recaptured clams with present year's mark: (shell length and type of mark)

Length (mm)	Mark *	Length (mm)	Mark *	Length (mm)	Mark *	Length (mm)	Mark *	

*Marks to be used by year: 1991 UL1, 1992 UL2, 1993 UL3, 1994 LL1, 1995 LL2, 1996 LL3, 1997 UR1, 1998 UR2, 1999 UR3, 2000 LR1, 2001 LR2, 2002 LR3

Subtidal band transect data sheet
Tivela and associated species

Site_____ Date_____
Investigators_____ Time_____
Water Temp_____Visibility_____ SwellHeight_____

Transect #	1				2			
Random #								
100 m. seg. #	1	2	3	4	5	6	7	8
# clam siphons								
Associated sp.								

Transect #	3				4			
Random #								
100 m. seg. #	1	2	3	4	5	6	7	8
# clam siphons								
Associated sp.								

Transect #	5				6			
Random #								
100 m. seg. #	1	2	3	4	5	6	7	8
# clam siphons								
Associated sp.								

Site:	Date: / /	Time: :
Wind:	Temp.:	Sky:
Investigator:		
Common Loon		
Arctic Loon		
Red-throated Loon		
W./Clark's Grebe		
Horned Grebe		
Eared Grebe		
Pied-billed Grebe		
Brown Pelican		
Double-crested Corm.		
Brandt's Cormorant		
Pelagic Cormorant		
Great Blue Heron		
Brant		
Mallard		
Green-winged Teal		
American Wigeon		
Northern Pintail		
Northern Shoveller		
Blue-winged Teal		
Cinnamon Teal		
Ruddy Duck		
Ring-necked Duck		
Lesser Scaup		
Surf Scoter		
Bufflehead		
Red-br. Merganser		
Sora		
American Coot		
Black Oystercatcher		
Snowy Plover- B		
Semipalmated Plover		
Killdeer- B		
Black-bellied Plover		
Lesser Golden-Plover		
Marbled Godwit		
Whimbrel		
Long-billed Curlew		
Willet		
Greater Yellowlegs		
Lesser Yellowlegs		
Spotted Sandpiper		
Wandering Tattler		
Wilson's Phalarope		
Red-necked Phalarope		
Red Phalarope		

Short-billed Dowitcher
Long-billed Dowitcher
Common Snipe
Ruddy Turnstone
Black Turnstone
Surfbird
Red Knot
Dunlin
Sanderling
Western Sandpiper
Least Sandpiper
Baird's Sandpiper
Pectoral Sandpiper
Heermann's Gull
Bonaparte's Gull
Ring-billed Gull
Mew Gull
Herring Gull
California Gull
Thayer's Gull
Western Gull
Glaucous-winged Gull
Black-legged Kittiwake
Sabine's Gull
Common Tern
Arctic Tern
Forster's Tern
Elegant Tern
Royal Tern
Red-tailed Hawk- B
American Kestrel- B
Mourning Dove- B
Belted Kingfisher
Black Phoebe- B
W. Flycatcher- B
Horned Lark- B
Barn Swallow- B
Common Raven- B
House Wren
Bewick's Wren- B
Marsh Wren
Loggerhead Shrike- B
Northern Mockingbird
Water Pipit
European Starling- B
Orange-cr. Warbler- B
Song Sparrow- B
Chipping Sparrow- B
W. Meadowlark- B
House Finch- B

Lagoon Species List and Abundance Data Form

Site_____ Date_____Time_____

Investigators_____ Station Number_____

	Sample Type_____ Est. abundance per m^2			Sample Type_____ Est. abundance per m^2		
Replicate #	1	2	3	1	2	3
Species						
Trichocorixa reticulata						
Ephydra sp.						
Atherinops affinis						
Polydora sp. (polychaete)						

Abund. est.: 0=absent, 1=1, 2= 2-10, 3= 11-100, 4= 101-1000, 5= 1001-10000, 6= 10001+

	Sample Type_____ Est. abundance per m^2			Sample Type_____ Est. abundance per m^2		
Replicate #	1	2	3	1	2	3
Species						
Trichocorixa reticulata						
Ephydra sp.						
Atherinops affinis						
Clevelandia ios						

Aquatic Plant/Algae

Species	estimated %cover	height
Ruppia maritima		

Lagoon shores, water surface

Species	Location	estimated abundance per m^2
Saldid bugs		
Cincindela		
Staphylinidae		
Ephydra sp.		

Seine catch

Length of tow

Species	Number caught

CHANNEL ISLANDS NATIONAL PARK
SAND BEACH MONITORING PHYSICAL MEASUREMENTS AND ACTIVITY LOG

DATE:_____ LOCATION_____
OBSERVERS_____

PHYSICAL MEASUREMENTS

TIME (24 HR)_____WIND SPEED AND DIRECTION_____

WAVE HEIGHT AND DIRECTION_____CLOUD COVER_____

WATER TEMPERATURE_____BEACH SLOPE_____
_____

MONITORING ACTIVITIES

TECHNIQUE NUMBER OF SAMPLES COMPLETED AND OBSERVERS

CLAM GUN TRANSECTS
UPPER BEACH_____
(5)
WASH ZONE_____
(5)
LOWER BEACH_____
(5)

TRENCH TRANSECTS_____
(5-10 0.25x20meter)

POINT CONTACT TRANSECTS_____
(3 x 100 points)

BAND TRANSECTS_____
(12 1 x 100 meter)

SIZE FREQUENCY_____
(list species)

PHYSICAL MEASUREMENTS_____

BIRD CENSUS_____

SPECIES LIST_____

PHOTOS TAKEN_____

Lagoon Physical Measurements Data Form

Island_____Sites_____Date_____
Time of Sampling_____ Investigators_____

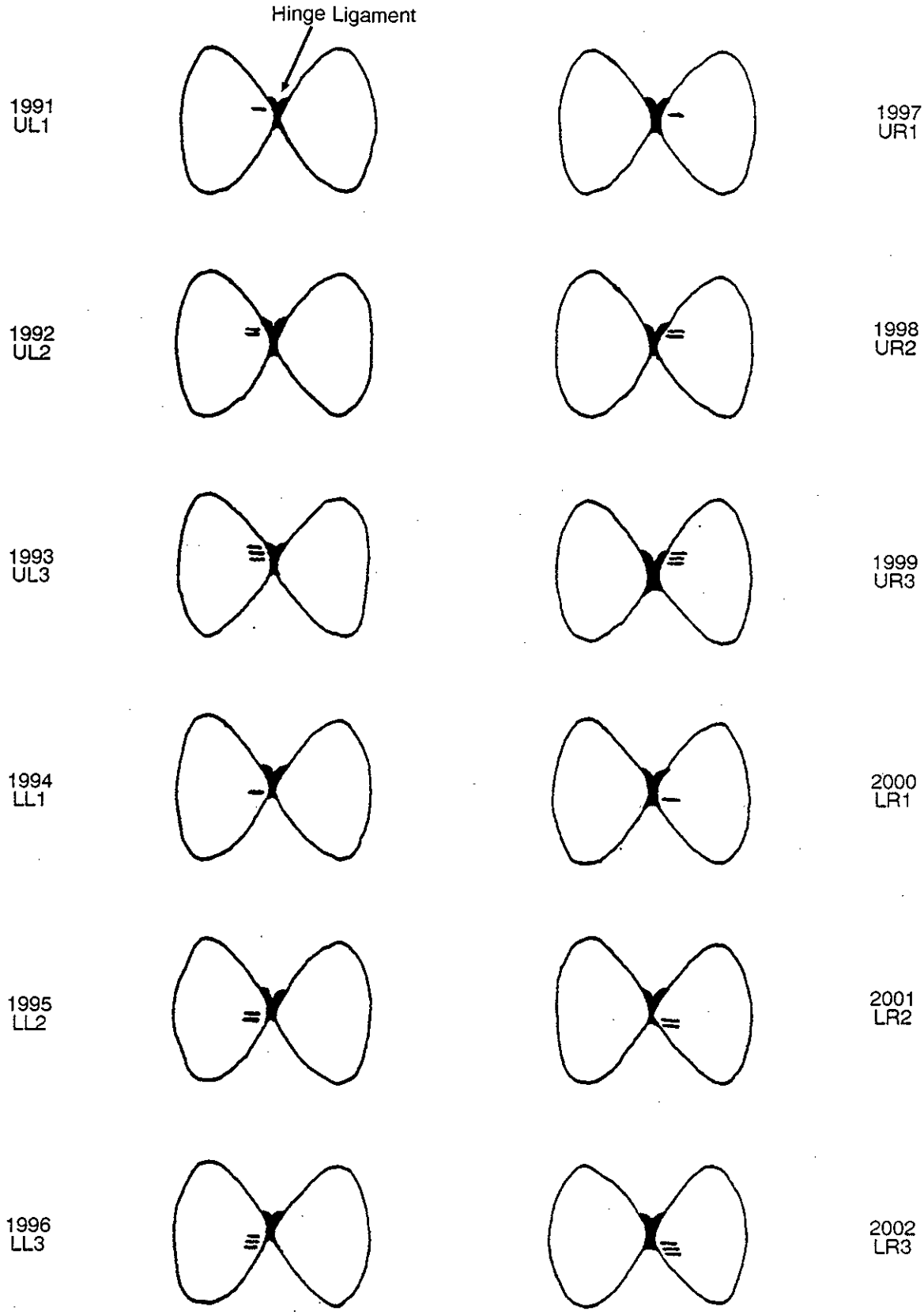
Site Station	Water Depth	Secchi Depth	Sample Depths	Temp .C	Salinity 0/00	Notes/ Flow etc.
SRIORH 1 =old1A						
2 =old1C						
3 =old1E						
4 =old2						
5 =old3						
SRIOR 1						
2						
SRIOP 1						
2						

Relative Water Levels:
SRIORH
Station 4 gauge_____Station 5 gauge_____Ref Rock_____
SRIOR
Gauge on east bank_____
(near beach)
SRIOP Gauge on east bank_____

Notes: (include distance in meters to freshwater for SRIOR)

APPENDIX F. Example spreadsheet for *Tivela stultorum* mark recapture data.

SITE	DATE	# UNMARKED (u)	# RECAPTURES (r)	#CAUGHT (u + r)	# MARKED & RETURNED (x)	TOTAL MARKED (m)	m(u + r)	Σ m(u + r)	Σ (r)	PETERSON P1=m(u+r)/r	SCHNABEL P2=Σm(u+r)/Σr
SRISE	19-Jan-89	6	0	6	6	0	0	0	0		
SRISE	16-Feb-89	10	0	10	10	6	60	60	0		
SRISE	3-Apr-89	9	1	10	6	16	160	220	1	160	220
SRISE	22-May-89	1	0	1	0	22	22	242	1		242
SRISE	21-Jun-89	9	0	9	6	22	198	440	1		440
SRISE	19-Jul-89	104	2	106	104	28	2968	3408	3	1484	1136
SRISE	21-Jul-89	6	0	6	2	132	792	4200	3		1400
SRISE	18-Aug-89	3	0	3	2	134	402	4602	3		1534
SRISE	15-Sep-89	22	13	35	22	136	4760	9362	16	366	585
SRISE	17-Sep-89	84	5	89	84	158	14062	23424	21	2812	1115
SRISE	8-Oct-90	12	1	13	0	242	3146	26570	22	3146	1208
SRISE	4-Apr-90	9	0	9	0	242	2178	28748	22		1308
SRISE	8-Aug-90	5	2	7	0	242	1694	30442	24	847	1268



APPENDIX F. Suggested Marks for *Tivela* Mark-Recapture Sampling

APPENDIX F. Mark recapture confidence limits from Poisson Distribution

	95%		99%			95%		99%	
x	Lower	Upper	Lower	Upper	x	Lower	Upper	Lower	Upper
0	0	3.285	0	4.771	51	37.67	66.76	34.18	71.56
1	0.051	5.323	0.010	6.914	52	38.16	66.76	35.20	73.20
2	0.355	6.686	0.149	8.727	53	39.76	68.10	36.54	73.62
3	0.818	8.102	0.436	10.473	54	40.94	69.62	36.54	75.16
4	1.366	9.598	0.823	12.347	55	40.94	71.09	37.82	76.61
5	1.970	11.177	1.279	13.793	56	41.75	71.28	38.94	77.15
6	2.613	12.817	1.785	15.277	57	43.45	72.66	38.94	78.71
7	3.285	13.765	2.330	16.801	58	44.26	74.22	40.37	80.06
8	3.285	14.921	2.906	18.362	59	44.26	75.49	41.39	80.65
9	4.460	16.768	3.507	19.462	60	45.28	75.78	41.39	82.21
10	5.323	17.633	4.130	20.676	61	47.02	77.16	42.85	83.56
11	5.323	19.050	4.771	22.042	62	47.69	78.73	43.91	84.12
12	6.686	20.335	4.771	23.765	63	47.69	79.98	43.91	85.65
13	6.686	21.364	5.829	24.925	64	48.74	80.25	45.26	87.12
14	8.102	22.945	6.668	25.992	65	50.42	81.61	46.50	87.55
15	8.102	23.762	6.914	27.718	66	51.29	83.14	46.50	89.05
16	9.598	25.400	7.756	28.852	67	51.29	84.57	47.62	90.72
17	9.598	26.306	8.727	29.900	68	52.15	84.67	49.13	90.96
18	11.177	27.735	8.727	31.839	69	53.72	86.01	49.13	92.42
19	11.177	28.966	10.009	32.547	70	54.99	87.48	49.96	94.34
20	12.817	30.017	10.473	34.183	71	54.99	89.23	51.78	94.35
21	12.817	31.675	11.242	35.204	72	55.51	89.23	51.78	95.76
22	13.765	32.277	12.347	36.544	73	56.99	90.37	52.28	97.42
23	14.921	34.048	12.347	37.819	74	58.72	91.78	54.03	98.36
24	14.921	34.665	13.793	38.939	75	58.72	93.48	54.74	99.09
25	16.768	36.030	13.793	40.373	76	58.84	94.23	54.74	100.61
26	16.77	37.67	15.28	41.39	77	60.24	94.70	56.14	102.16
27	17.63	38.16	15.28	42.85	78	61.90	96.06	57.61	102.42
28	19.05	39.76	16.80	43.91	79	62.81	97.54	57.61	103.84
29	19.05	40.94	16.80	45.26	80	62.81	99.17	58.35	105.66
30	20.33	41.75	18.36	46.50	81	63.49	99.17	60.39	106.12
31	21.36	43.45	18.36	47.62	82	64.95	100.32	60.39	107.10
32	21.36	44.26	19.46	49.13	83	66.76	101.71	60.59	108.61
33	22.94	45.28	20.28	49.96	84	66.76	103.31	62.13	110.16
34	23.76	47.02	20.68	51.78	85	66.76	104.40	63.63	110.37
35	23.76	47.69	22.04	52.28	86	68.10	104.58	63.63	111.78
36	25.40	48.74	22.04	54.03	87	69.62	105.90	64.26	113.45
37	26.31	50.42	23.76	54.74	88	71.09	107.32	65.96	114.33
38	26.31	51.29	23.76	56.14	89	71.09	109.11	66.81	114.99
39	27.73	52.15	24.92	57.61	90	71.28	109.61	66.81	116.44
40	28.97	53.72	25.83	58.35	91	72.66	110.11	67.92	118.33
41	28.97	54.99	25.99	60.39	92	74.22	111.44	69.83	118.33
42	30.02	55.51	27.72	60.59	93	75.49	112.87	69.83	119.59
43	31.67	56.99	27.72	62.13	94	75.49	114.84	70.05	121.09
44	31.67	58.72	28.85	63.63	95	75.78	114.84	71.56	122.69
45	32.28	58.84	29.90	64.26	96	77.16	115.60	73.20	122.78
46	34.05	60.24	29.90	65.96	97	78.73	116.93	73.20	124.16
47	34.66	61.90	31.84	66.81	98	79.98	118.35	73.62	125.70
48	34.66	62.81	31.84	67.92	99	79.98	120.36	75.16	127.07
49	36.03	63.49	32.55	69.83	100	80.25	120.36	76.61	127.31
50	37.67	64.95	34.18	70.05					

Emerita Size Frequency Data Sheet

Site Sandy Point Beach Date 8/7/90 Time 1400

Investigators J. Dugan, D. Hubbard Beach Slope 5.4cm / 61cm

Water Temp. 20°C Swell Height 0.5m Wind 5 kts

Box #	New Eggs	Eyespot Eggs	Grey Eggs	Just Drop.	Total Ovig.	Non-Ovig.	Total Females	Males	Total Crabs	Notes/ Megalopa
60										
58										
56										
54										
52										
50										
48										
46										
44										
42										
40		2			2		2			
38										
36		2			2		2			
34	8	2			10		10			
32	9	6	1	1	17	2	19			
30	14	8	1		23	2	25			
28	38	21		1	60	2	62			
26	38	23	2	1	64	6	70			
24	21	3	6	1	31	3	34			
22	7	3			10	2	12			
20	1	4			5	1	6			
18	30	4			34	73	107	6		
16	20	5		1	26	228	254	46		
14	2				2	108	110	10		
12						105	105	35	140	Sexed 20 crabs
10									367	unsexed
8									66	
6									10	8 → mg.
4										
totals	188	83	10	5	286	532	818	97	1358	8 n=1366
caliper										
meas.										

APPENDIX G. Example spreadsheet for *Emerita analoga* population structures using data from Sandy Point.

SITE	DATE	SIEVE #	# OVIG	# NONOVIG	# MALE	# UNSEXED	# MEGALOPA	TOTAL CRABS
SRISP	7-Aug-90	4	0	0	0	0	0	0
SRISP	7-Aug-90	6	0	0	0	10	8	18
SRISP	7-Aug-90	8	0	0	0	66	0	66
SRISP	7-Aug-90	10	0	0	0	367	0	367
SRISP	7-Aug-90	12	0	105	35	0	0	140
SRISP	7-Aug-90	14	2	108	10	0	0	120
SRISP	7-Aug-90	16	26	228	46	0	0	300
SRISP	7-Aug-90	18	34	73	6	0	0	113
SRISP	7-Aug-90	20	5	1	0	0	0	6
SRISP	7-Aug-90	22	10	2	0	0	0	12
SRISP	7-Aug-90	24	31	3	0	0	0	34
SRISP	7-Aug-90	26	64	6	0	0	0	70
SRISP	7-Aug-90	28	60	2	0	0	0	62
SRISP	7-Aug-90	30	23	2	0	0	0	25
SRISP	7-Aug-90	32	17	2	0	0	0	19
SRISP	7-Aug-90	34	10	0	0	0	0	10
SRISP	7-Aug-90	36	2	0	0	0	0	2
SRISP	7-Aug-90	38	0	0	0	0	0	0
SRISP	7-Aug-90	40	2	0	0	0	0	2
SRISP	7-Aug-90	42	0	0	0	0	0	0
SRISP	7-Aug-90	44	0	0	0	0	0	0
SRISP	7-Aug-90	46	0	0	0	0	0	0
SRISP	7-Aug-90	48	0	0	0	0	0	0
SRISP	7-Aug-90	50	0	0	0	0	0	0
SRISP	7-Aug-90	52	0	0	0	0	0	0
SRISP	7-Aug-90	54	0	0	0	0	0	0
SRISP	7-Aug-90	56	0	0	0	0	0	0
SRISP	7-Aug-90	58	0	0	0	0	0	0
SRISP	7-Aug-90	60	0	0	0	0	0	0

APPENDIX G.

Example of summary statistics for *Emerita analoga* population structures using data from Sandy Point.

SITE	DATE	SIZE AT MATURITY OF FEMALE CRABS	95TH%ILE SIZE OF OVIG. CRABS	5TH%ILE SIZE OF OVIG. CRABS	LARGEST MALE CRAB	PERCENT OVIGEROUS
SRISP	07AUG90					40.1
SIEVE #		20	32	16	18	
MM CL		11.8	17.9	9.8	10.8	

APPENDIX H. Data Conversion Programs

btcalc.pro

October 15, 1990
Modified by J. Dugan

Notes: Use this program when running SPSS to access and translate the transect database file called btxx.dbf from dBase III. This program assigns species lable to the codes found in the dBase file. It also performs calculations on the number of organisms per meter based on the spacing of cores. Last, it calculates the mean number of organisms per meter for the SPSS summary report.

```
translate from='f:\beach\btall.dbf'/map.
set beep=off.
value labels/species
        7004    'Euzonus'
        7005    'Nephtys californiensus'
        7006    'Glycera sp'
        7009    'other Polychaeta'
        8002    'Megalorchestia sp'
        8003    'other gammaridean amphipods'
        8004    'Excirolana chiltoni'
        8005    'Exosphaeroma ornata'
        8006    'Alloniscus perconvexus'
        8007    'Archeomysis grebnitzkii'
        8009    'Emerita analoga'
        8010    'Blepharipoda occidentalis'
        8011    'Lepidopa californica'
        8012    'Cancer gracilis'
        8019    'Carabidae beetles'
        8020    'Thinopinus pictus'
        8021    'other Staphylinidae'
        8022    'Curculionidae'
        9012    'Olivella biplicata'
        9013    'Tivela stultorum'
        13001   'Paranemertes californica'.
value labels/loc
        1       'SRI SANDY POINT'
        2       'SRI BEE ROCK WEST'
        3       'SRI CHINA CAMP'.
        4       'SRI FORD POINT'
        5       'SRI ABALONE ROCKS'
        6       'SRI SOUTHEAST ANCHORAGE'
        7       'SRI WATER CANYON'
        8       'SRI BECHERS PIER'
        9       'SRI SOLEDAD WEST'.
set listing= 'bt.rsl'/length=59/width=79.
set listing='spss.lis'.
set listing='bt.rsl'/length=59/width=79/eject=on.
process if (type=1).
compute permeter=count*1.
if (spacing = .5) permeter = count*250.
if (spacing = 1)  permeter = count*125.
if (spacing = 2)  permeter = count*62.5.
if (spacing = 4)  permeter = count*31.3.
means tables = permeter by species by loc.
```

```
process if (species=8009).
compute permeter=ovigerous*1.
if (spacing = .5) permeter = ovigerous*250.
if (spacing = 1)  permeter = ovigerous*125.
if (spacing = 2)  permeter = ovigerous*62.5.
if (spacing = 4)  permeter = ovigerous*31.3.
means tables = permeter by species by ovigerous by loc.
process if (species=8009).
compute permeter=box38*1.
if (spacing = .5) permeter = box38*250.
if (spacing = 1)  permeter = box38*125.
if (spacing = 2)  permeter = box38*62.5.
if (spacing = 4)  permeter = box38*31.3.
means tables = permeter by species by box38 by loc.
process if (species=8009).
compute permeter=box28*1.
if (spacing = .5) permeter = box28*250.
if (spacing = 1)  permeter = box28*125.
if (spacing = 2)  permeter = box28*62.5.
if (spacing = 4)  permeter = box28*31.3.
means tables = permeter by species by box28 by loc.
process if (species=8009).
compute permeter=box18*1.
if (spacing = .5) permeter = box18*250.
if (spacing = 1)  permeter = box18*125.
if (spacing = 2)  permeter = box18*62.5.
if (spacing = 4)  permeter = box18*31.3.
means tables = permeter by species by box18 by loc.
process if (species=8009).
compute permeter=box8*1.
if (spacing = .5) permeter = box8*250.
if (spacing = 1)  permeter = box8*125.
if (spacing = 2)  permeter = box8*62.5.
if (spacing = 4)  permeter = box8*31.3.
means tables = permeter by species by box8 by loc.
process if (species=8009).
compute permeter=box4*1.
if (spacing = .5) permeter = box4*250.
if (spacing = 1)  permeter = box4*125.
if (spacing = 2)  permeter = box4*62.5.
if (spacing = 4)  permeter = box4*31.3.
means tables = permeter by species by box4 by loc.
process if (species=8009).
compute permeter=megalopa*1.
if (spacing = .5) permeter = megalopa*250.
if (spacing = 1)  permeter = megalopa*125.
if (spacing = 2)  permeter = megalopa*62.5.
if (spacing = 4)  permeter = megalopa*31.3.
means tables = permeter by species by megalopa by loc.
process if (species=8010).
compute permeter=ovigerous*1.
if (spacing = .5) permeter = ovigerous*250.
if (spacing = 1)  permeter = ovigerous*125.
if (spacing = 2)  permeter = ovigerous*62.5.
```

```
if (spacing = 4)  permeter = ovigerous*31.3.
means tables = permeter by species by ovigerous by loc.
process if (type=2).
compute permeter= count*constant.
if (spacing=0) permeter = count*4.
means tables = permeter by species by loc.
process if (type=2).
compute permeter=ovigerous*4
if (spacing=0) permeter = ovigerous*4.
means tables = permeter by species by ovigerous by loc.
process if (type=3).
compute kount=count/100.
means tables = kount by species by loc.
```

bpcalc.pro

October 15, 1990
J. Dugan

Notes: Use this program when running SPSS to access and translate the point contact transect database file called bpcxx.dbf from dBase III. This program assigns species and location labels to the codes found in the dBase file. It also performs a percent cover calculation based on the number of points sampled. Last, it performs a calculation of mean percent cover for point contact transect species for the SPSS summary report.

```
translate from='f:\beach\bpcall.dbf'/map.
set beep=off.
value labels/species
        1001   'misc green algae'
        2001   'misc brown algae'
        2010   'Macrocystis pyrifera'
        2012   'Egregia'
        3001   'misc red algae'
        4000   'plants'
        4002   'Phyllospadix'
        4003   'terr vegetation'
        15002  'rock'
        15004  'sand'
        15005  'tar'
        15006  'carrion'
        15007  'anthro debris'.
value labels/loc
        1      'SRI SANDY POINT'
        2      'SRI BEE ROCK WEST'
        3      'SRI CHINA CAMP'
        4      'SRI FORD POINT'
        5      'SRI ABALONE ROCKS'
        6      'SRI SOUTHEAST ANCHORAGE'
        7      'SRI WATER CANYON'
        8      'SRI BECHERS PIER'
        9      'SRI SOLEDAD WEST'.

compute pctcover = count/100*100.
set listing= 'bpc.rsl'/length=59/width=79.
set listing='spss.lis'.
set listing='bpc.rsl'/length=59/width=79/eject=on.
means tables = pctcover by species by loc.
```

bsfcalc.pro

October 15, 1990
J. Dugan

Notes: Use this program when running SPSS to generate size frequency histograms for all species at the selected location.

```
set listing = 'bsfrep.pro'/length=56/width=79.
set listing = 'spss.lis'/length=56/width=79.
set listing = 'bsfrep.pro'/length=56/width=79/eject=on.

process if (species=8010).
list/cases = to 1.
process if (species=8010).
frequencies var = size_mm
/format = notable
/stats = all
/hist = percent = increment (2).

process if (sex=1).
list/cases = to 1.
process if (sex=1).
frequencies var = size_mm
/format = notable
/stats = all
/hist = percent = increment (2).

process if (sex=2).
list/cases = to 1.
process if (sex=2).
frequencies var = size_mm
/format = notable
/stats = all
/hist = percent = increment (2).

process if (reprod=2).
list/cases = to 1.
process if (reprod=2).
frequencies var = size_mm
/format = notable
/stats = all
/hist = percent = increment (2).

process if (species=9013).
list/cases = to 1.
process if (species=9013).
frequencies var = size_mm
/format = notable
/stats = all
/hist = percent = increment (2).
```