The Role of Eelgrass Beds As Fish and Invertebrate Habitat

2009 ~ 2010 Final Report

Santa Barbara Channelkeeper

Introduction

This report provides a detailed description of survey work performed in 2008 and 2009 at eelgrass beds around three of the California Channel Islands and also includes information collected in 2009 on beds located along the southern Santa Barbara County coastline.

Our goal was to map and assess the importance of eelgrass beds as essential habitat for fishes and major invertebrates at locations around the Northern Channel Islands and along the mainland coast. Evidence from around the world suggests that seagrass beds provide critical nursery habitat and as primary producers are a very important part of the ecosystem.

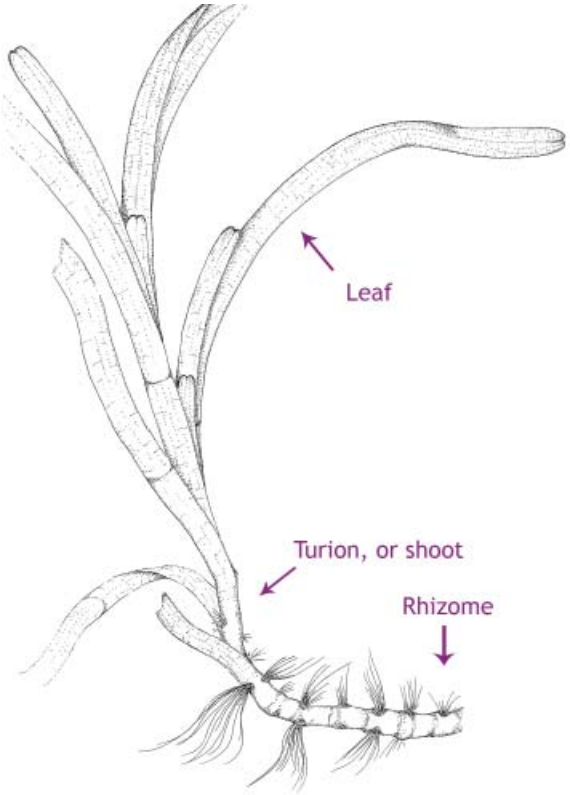
Seagrasses are marine flowering plants that form underwater patches or meadows much like wild grasses do on land, and can be among the most productive communities on earth (Hillman et al. 1989, Duarte and Chiscano 1999). They are ecologically significant for increasing primary production, supporting complex food webs, recycling nutrients, and stabilizing sediments (den Hartog 1970, Fonseca et al 1990, Larkum et al. 2006). Seagrasses form important coastal habitats by providing food and shelter for numerous fishes and invertebrate species, and providing habitat complexity (den Hartog 1970, Fonseca et al 1990).

In California, there are two genera of seagrasses which have radically different habitat requirements. The most well-known grass is the surfgrass *Phyllospadix*, which grows on wave-swept rocky shores and shallow subtidal reefs. This brilliant green grass may be exposed at low tide and sometimes appears to be growing up through the sand, but its rhizomes must be attached to hard substrate.

Eelgrass (*Zostera sp*) is found world-wide in temperate zones in soft-bottom habitats within sheltered bays and estuaries. In California, this includes Humboldt Bay, Tomales Bay, San Francisco Bay, Morro Bay, Newport Bay, and San Diego Bay, where it occurs from the low inter-tidal zone to depths of about 6 meters. The eelgrass beds that we surveyed at the Channel Islands and along the outer mainland coast of Southern California are unique because they are growing outside of this bay environment. Recently, genetic studies have differentiated between the eelgrass growing inside bays (the cosmopolitan *Z. marina*) and that growing along the outer coast and at the islands (*Z. pacifica*) (Coyer et al. 2008). *Z. marina* has a narrower blade, and there are several locations outside of our study area where both species co-occur (San Clemente and Santa Catalina Islands).

Eelgrass beds are recognized by state and federal statutes as both highly valuable and sensitive habitats. Eelgrass has been designated as Essential Fish Habitat (EFH) for various fish species managed under the Magnuson-Stevens Fishery Conservation Management Act, and has been listed as a Habitat Area of Particular Concern, identifying it as rare, especially vulnerable to human impacts, particularly important ecologically, and/or located in environmentally stressed areas. In California, species diversity in eelgrass beds can be nearly twice as high as on nearby sandy intertidal and subtidal habitats (Engle et al. 1995), and eelgrass beds are nurseries for many common and commercially important fishes (Jackson et al. 2001), including rockfish (Sebastes sp.), surfperch and kelp bass (Hoffman 1986, Engle et al 1995).

Like kelp reefs, healthy eelgrass beds may provide essential habitat for settlement and reproduction of spawning stock inside marine reserves and both habitat and food for harvestable species outside reserves. And, like kelp beds, eelgrass may also serve as an important nursery ground for both fished and unfished species (Heck et al. 2003, Pondella et al. 2006).



The major beds at the Channel Islands (which occur at 20 locations at 6 of the 8 islands) have already been located in the mid-1990's, but not all of these eelgrass habitats were completely mapped (Engle et al. 1998, Engle and Miller 2005, Altstatt 2005). There has been no comprehensive identification and mapping of mainland open-coast eelgrass habitats. While some of these deeper-water beds are known from industry-related activities (such as permit-related surveys for offshore oil and gas development, pipeline abandonment or dredging projects), this information has not been entirely ground-truthed (Santa Barbara Channelkeeper 2008).

Biology

Eelgrass leaves grow from a horizontal rhizome with rootlets that lay just below the sediment surface. The leaves emerge through a sheath, forming a turion, or shoot. During the spring, some vegetative shoots may morph into reproductive shoots, which are recognizable by being much taller with a narrow erect stem. The reproductive structures are called inflorescences and branch out from the stem, with new inflorescences growing from the elongating tip (see photo). In mid-summer, reproductive beds can double in height to near 2 meters tall. Plants produce both male and female flowers, although they are typically not open at the same time, thus reducing the chance of self-fertilization. Anthers loaded with pollen float away from male flowers and are borne on the currents until encountering a female flower. A seed pod, or spathe, may contain up to14 developing seeds, depending upon fertilization success. The mature seeds fall to the seafloor when disturbed by water motion. The inflorescences degrade and break away from the rhizomes when reproduction has slowed, usually coinciding with warm water in the late summer. However, we have observed some beds producing seeds or flowering late into the winter.

World-wide, recruitment due to seed dispersal is low, and most eelgrass beds spread from vegetative growth (Oleson and Sand-Jensen 1994). However, in some areas with long winters, *Z. marina* acts as an annual species, with heavy flowering and beds re-growing each spring from seeds produced the previous fall. At the Channel Islands and along the mainland, *Z. pacifica* is a perennial species. There is a great deal of variability in flower and seed production and seedling recruitment on both spatial and temporal scales. We have found that most beds begin to flower by April, with seeds produced throughout the summer (Altstatt, personal observation).

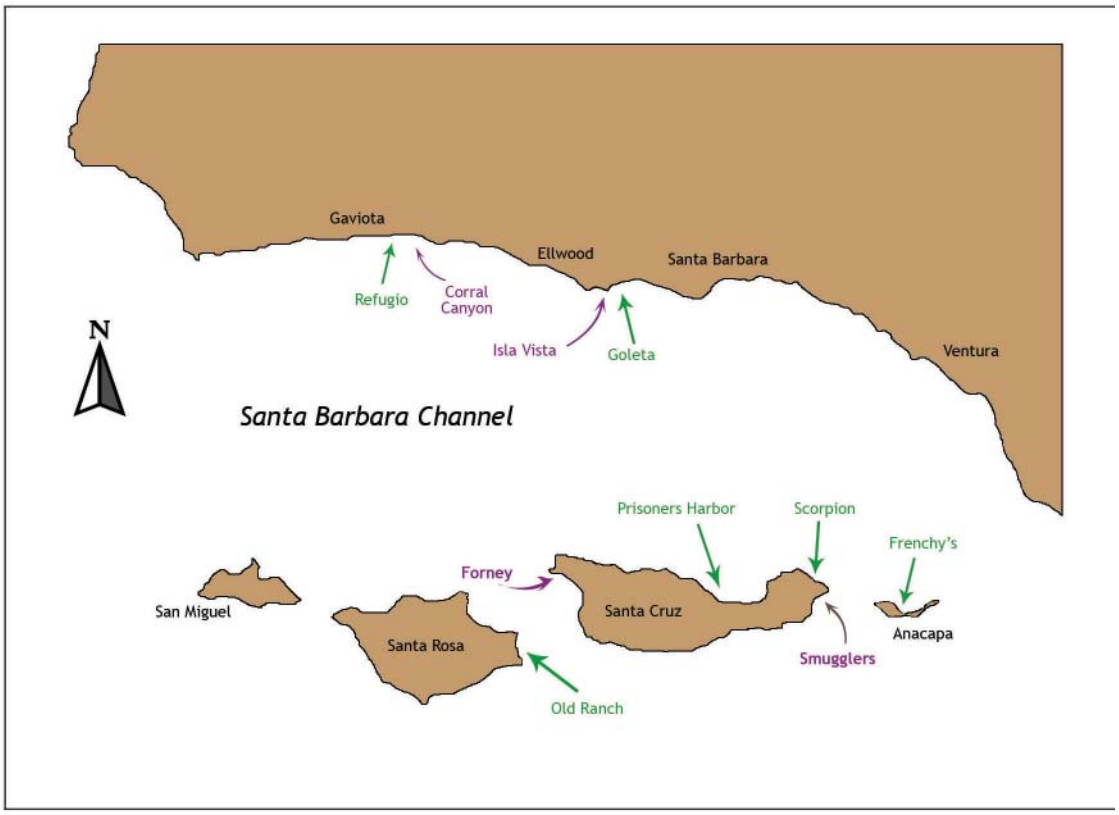
Threats

In Southern California, eelgrass has been severely impacted by increased turbidity, dredging, construction and pollution within its habitat of shallow bays and coastal lagoons (Merkel 1991). Compared to eelgrass along the mainland, beds at the mostly uninhabited Channel Islands face few impacts. However, threats to these island beds include not only natural occurrences, such as storms, heavy surf and sediment movement, but also pollution and disturbances from visiting boats. The Channel Islands are a popular boating destination, both for pleasure and commercial interests, and the sheltered coves where eelgrass grows are desirable anchorages, so cumulative impacts from dragging and pulling anchors can be significant. Boating traffic is heaviest in the eastern Channel, closest to Santa Barbara, Ventura and Channel Islands Harbors, and the three eelgrass beds in this region are located in popular anchorages (Smugglers Cove, Scorpion Anchorage and Prisoners Harbor). Damage from anchors and moorings is most evident in these locations (Altstatt, personal observation). This report provides information about the precise location and extent as well as maps for the prominent island eelgrass beds so that boaters will be able to best choose an anchoring location, and so that divers and others may visit and enjoy the beauty and biodiversity that the beds provide.

Project Goals and Objectives

Santa Barbara Channelkeeper studied all four of the major eelgrass beds around Santa Cruz Island, in addition to a site each at Anacapa and Santa Rosa Islands, for a total of six sites. Two of the beds (at Old Ranch and Scorpion) are within no-take Marine Reserves, one bed (at Frenchy's Cove) straddles a Marine Conservation Area and a Marine Reserve, and the other three (Smugglers, Prisoners Harbor and Forney Cove) are unprotected from fishing.

We collected information at these six islands beds during the 2008 and 2009 field seasons. The majority of the information was gathered during a series of three multi-day cruises aboard the CINMS R/V Shearwater, which was granted to Santa Barbara Channelkeeper for this specific purpose in August 2008, and in June and October 2009. The focus of these cruises was on collecting eelgrass mapping and monitoring information around the islands using a larger number of volunteers and divers than the Channelkeeper vessel could accommodate.



Location of ten eelgrass beds at the islands and along the mainland targeted by Channelkeeper for focused monitoring and mapping during 2008-2009. Six green arrows denote proposed sites; four additional sites are in purple.

In addition to collecting data on the location and extent of these beds, we also conducted seasonal quantitative surveys of adult and juvenile fish and large macro-invertebrates. As several of the beds are within or adjacent to marine reserves, our project will aid future evaluations of the effectiveness of existing Channel Islands Marine Protected Areas while also highlighting currently unrestricted areas with high biodiversity value that merit protection.

During the same period, we worked at four locations along the mainland. We collected mapping information at Goleta, Isla Vista, Corral Canyon and Refugio, and conducted quantitative fish and invertebrate surveys at Goleta and Corral. The Goleta bed is adjacent to the proposed Campus Point State Marine Reserve.

Research divers from the Marine Science Institute at UC Santa Barbara (UCSB), UC Los Angeles, the California Coastal Commission, Channel Islands National Marine Sanctuary (CINMS), Channel Islands National Park (CINP), Commercial Fishermen of Santa Barbara, Inc. and Tenera Environmental assisted us. Additionally, students and volunteers from the community joined us each day to provide topside support.

In total, Channelkeeper surveyed four mainland beds and six island beds (Table 1). Work at these ten locations took place throughout 2008 and 2009, and a schedule of both mapping and surveys by site can be found in Table 2.

Mapping

A common tool used by resource managers and consultants for mapping eelgrass beds in shallow bays and estuaries is side-scan or single beam sonar, which can be deployed from a small boat with a minimum number of people. Even so, this information needs to be ground-truthed by SCUBA for each new location to be sure that the imagery is of eelgrass and not other submerged aquatic vegetation. Thereafter, these data must be processed to produce maps.

For this study, we used divers on SCUBA who collected observations and metadata while they traced the edges of the beds, and then made informed decisions about where to conduct the quantitative surveys. Our techniques were as follows. A diver team entered the water, with one diver towing a surface float that supported a water-resistant Global Positioning System (GPS). A GPS-equipped kayaker at the surface followed the towed buoy and divers. The team worked together to locate and track both the inner and outer edges of the bed, which in some cases were not always well-defined. In locations where visibility was poor, the second diver would scout ahead and communicate back to the diver towing the GPS which direction to swim. The WAAS-enabled GPS was set to log a position data point every three seconds. The diver team also took field notes on depth, density and other observations every few minutes throughout the dive, in order to annotate the maps later. The downside of using this technique is that divers are limited by bottom time. Larger beds require more dives and sometimes, return visits to the site. Additionally, depending on the visibility, there are some limitations to inferring whether or not an eelgrass bed is truly solid from edge to edge, or whether it is patchy. After spending a lot of time conducting these underwater surveys, we feel confident that our notes and metadata for each site along with the maps we produced present an accurate characterization of each eelgrass bed. On average, it took three hours underwater to collect the data presented in each map. Some of the smaller beds were mapped in two dives (Forney Cove) while the largest took six dives or more (Old Ranch and Prisoners). The resulting GPS track for each bed was later downloaded, processed and saved as a text file. This information was used by GIS staff at CINP and CINMS to create shape files overlaying aerial photographs of the islands.

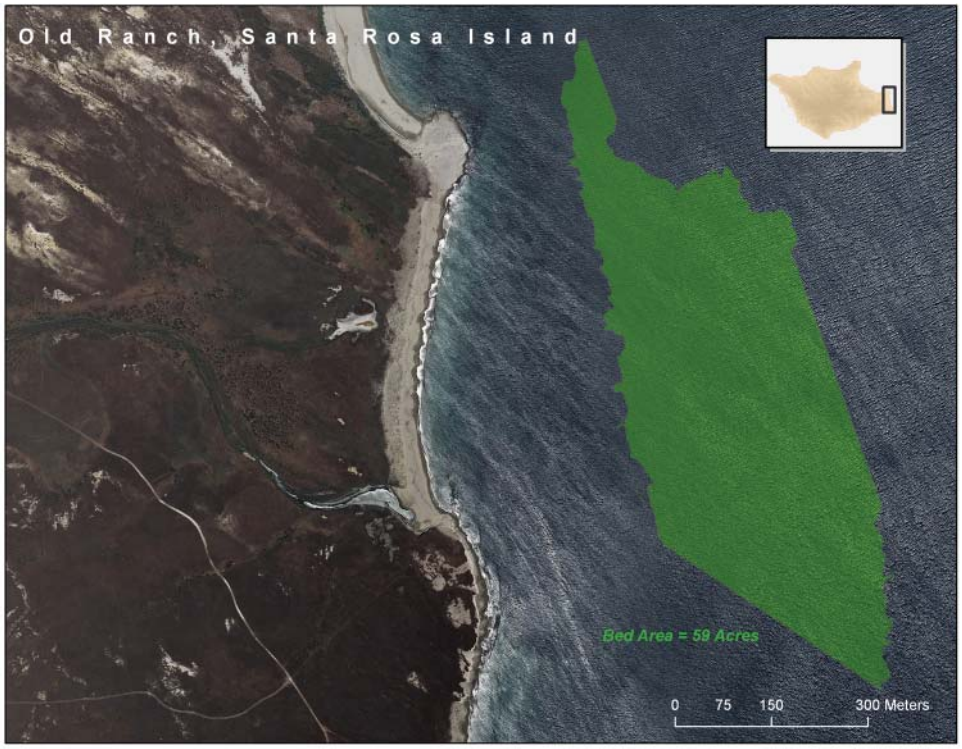
Island beds

Santa Rosa Island

Old Ranch

Eelgrass has been reported at three main locations off Santa Rosa Island: Bechers Bay, Johnsons' Lee and Old Ranch, a site that was discovered during one of the 1995 Channel Islands Research Program cruises.

Old Ranch is located off the eastern end of Santa Rosa Island, within the Skunk Point State Marine Reserve. The bed extends from Oat Point south to near Lagoon Cove. The bed is named after Old Ranch Canyon, which drains nearby. For this study, we chose not to sample at Bechers Bay or Johnsons' Lee, where patchy eelgrass can be found mixed in with low lying reef and kelp. The visibility is often very poor in Bechers Bay and it would have been difficult to find places to lay multiple transects solely within eelgrass habitat.



Mapping Old Ranch took six dives: five in August 2008, and one in October 2009. We found this bed to be the largest, at 59 acres. The eelgrass is in a large uniform meadow that is up to 300 meters wide and 800 meters long. The sediment is white sand and the grass grows from about 35-50 feet deep. The current can be very strong here, especially at the deep edge of the bed, which is more than 600 meters offshore. In October 2009, we experienced currents on the bottom too strong to swim against and our sampling was aborted after one dive.

Santa Cruz Island

Forney Cove

The westernmost bed offshore of Santa Cruz Island is in Forney Cove. Forney is a small remote cove that is protected from the predominant westerly swell, and is visited by occasional fishermen and pleasure boaters. The bottom is mostly sandy

but there is low-lying reef in shallow water on either side of the cove, with a thin kelp bed and understory algae. In some areas there is a thin layer of sand over the reef. We were not planning to sample this site, but as our field work at Old Ranch was aborted due to poor sea conditions in October 2009, we performed two dives at Forney instead.

Mapping Forney took two dives. Some of the eelgrass is growing around and between the patch reefs, but there is a small bed in slightly deeper waters (at 20 feet) and patches extend out to 30 feet. The eelgrass covers approximate 3.3 acres.

With the exception of Forney Cove, there has been no eelgrass reported along the south side of Santa Cruz Island, which is exposed with little shelter from waves and swell from the west or south. The north side is steep, exposed to waves and swell, and the western anchorages are small and do not allow for a stable soft bottom environment.

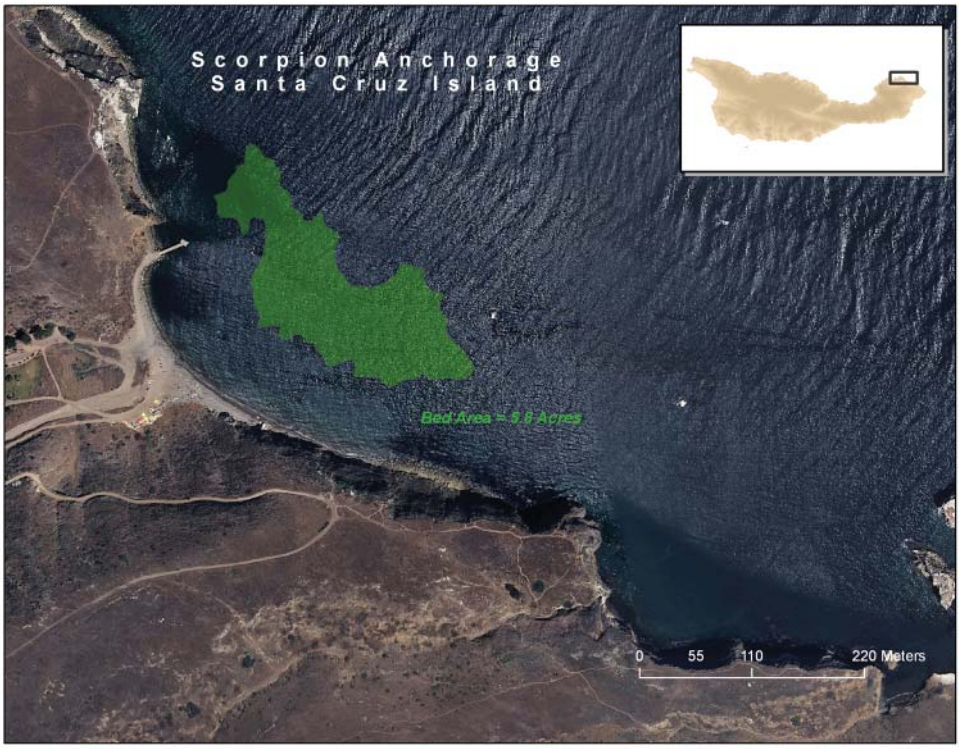
Prisoners Harbor

Prisoners Harbor is perhaps the most sheltered location on the island, tucked inside a large bight midway along the island on the north side. The NPS maintains a pier and mooring can in shallow water (about 17 feet). This location is popular with pleasure boats, especially northwest of the pier, where the eelgrass is quite thick. Holes in the grass from anchoring are evident in this area. In the surveys in the 1990s, it was thought that a separate bed lay 2 km to the east at Canada del Agua. During our mapping study, we swam this stretch of coastline and documented that a solid band of eelgrass extends the entire distance, and that there is just one large bed. This bed is fairly well-defined on both the shallow and deep edges.

Mapping the entire bed took seven dives. The entire bed is 43 acres and extends for 2 km. The eelgrass grows in water as shallow as 14 feet, comes within 20 feet of the pier and also grows out to 30 feet, although it is less dense at this depth. The narrowest part of the bed is off the mouth of Canada del Puerto, where periodic heavy rains create a torrent of muddy water and debris that is swept out of the canyon onto the seafloor, gouging out a channel. Inshore of the eelgrass along the Prisoners lagoon, kelp seasonally recruits to cobbles.

Scorpion Anchorage

The next bed to the east is in Scorpion. Scorpion is the 'front yard' of the main visitor center at Santa Cruz Island where the majority of Park visitors come ashore. Most come via Island Packers, the concessionaire to the park, but private boats will often anchor here or tuck in behind Scorpion Rock to the east. In addition, NPS boats visit several times a week, and two mooring cans are maintained in 25 feet for this purpose. Storms in December 1997 caused extreme flooding in Scorpion Canyon, sending sediment and debris offshore into the eelgrass bed. Diver observations confirmed that the bed was reduced in size by up to 30%, although no mapping was done at the time (J. Engle and D. Richards, personal communication).



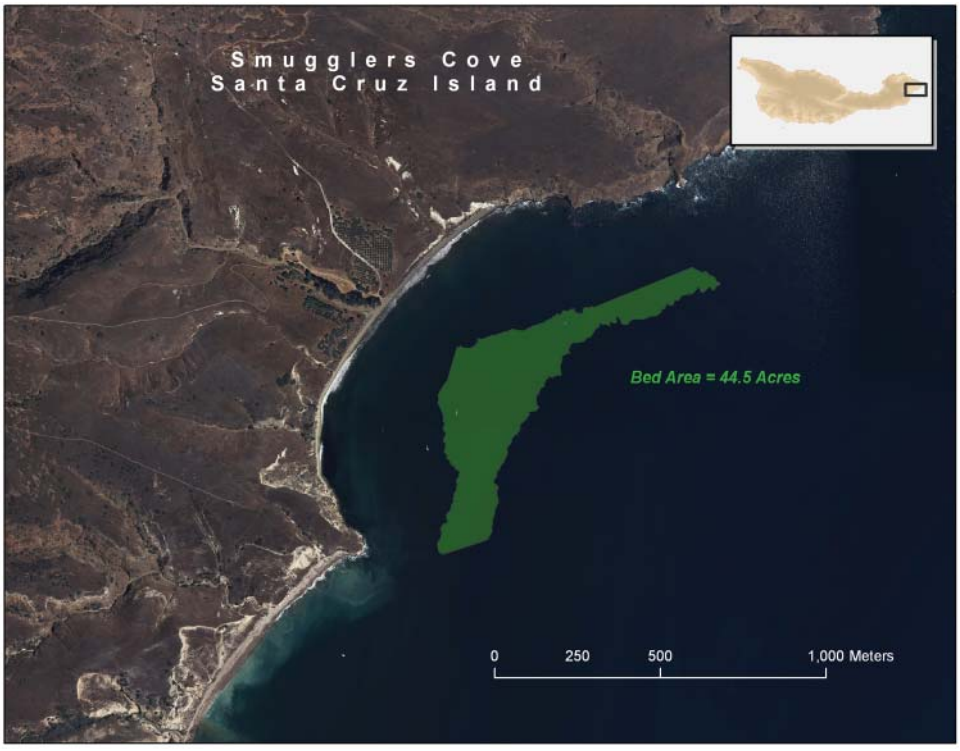
Mapping Scorpion took four dives. The bed is 5.8 acres

in size. This bed is comprised of dense islands of grass 5-30 meters across and separated by sand channels of the same distance or more. Some of these “holes" may have been caused by damage from anchoring, or from mooring chains before NPS adapted their system to decrease disturbance to the seafloor. Our 30-meter transects often ran across bare sand, even though there was eelgrass all around. The area between the two mooring cans supports the largest island. There is not a distinct edge to the bed; rather there are scattered clumps that diminish in size with distance away from the center.

Smugglers Cove

Smugglers is located on the eastern end of the island, inside a wide embayment sheltered from prevailing northwest swell and wind. The bay is exposed to extended south swells which are common during the summer and fall months.

This is the deepest bed at Santa Cruz, with grass growing from 37-55 feet. The Coast Guard mooring can buoy is near the offshore edge of the grass in 50 feet of water. This area is probably the most popular anchorage at the island. During the summer or on holidays, it is not uncommon to have thirty boats anchored here, with more farther to the south at Yellowbanks. Many boats try to tuck in shallow and may avoid anchoring in the eelgrass if they are shallower than 35 feet. The visibility at Smugglers can be quite poor if there is a south swell, which re-suspends fine silt and sand up into the bottom 2 meters of the water column. We have had to abort dives here even on days when surface conditions look good as ‘white-out’ conditions make working near the seafloor impossible.



Mapping this bed took six dives. The bed is 44.5 acres, making it the largest at Santa Cruz Island. The bed is uniformly dense, with fairly distinct inshore and offshore boundaries.

Anacapa Island

Frenchy’s Cove

Historically, there was eelgrass in several locations

around Anacapa Island, but the largest bed was at Frenchy's Cove, West Anacapa in 20-40 feet of water. All the Anacapa beds disappeared in the late 1980s due to overgrazing by the white urchin *Lytechinus anamesus* following an extraordinary post-El Nino recruitment event (Engle et al. 1995). The Channel Islands Research Program established a long-term monitoring site at Frenchy's Cove in 1991 to monitor for eelgrass recruitment, although none was ever detected. In 2003, Santa Barbara Channelkeeper (along with assistance from agency and research partners) established a restoration site on the border of the Seasonal Pelican Closure in the western part of the cove (Altstatt, 2005). During monitoring following the restoration effort, divers noticed that eelgrass was also becoming established down-current across the cove. The eelgrass now straddles the boundary between the State Marine Conservation Area to the west and the State Marine Reserve to the east. Inshore at about 20 feet, the sand turns to gravel, cobble and shell hash, which appears to limit the inshore distribution of the grass. In deeper water, the parchment tube worm *Chaetopterous* has been common to abundant here, building 'reefs' of tubes at or just under the sediment surface. Offshore to the east, there is a rocky outcrop in 60-75 feet, which is at least 100 meters off-shore of the eelgrass bed.

In favorable years, there is seasonal recruitment of giant kelp and other brown algae onto worm tubes, pebbles and cobble, but this algae rarely persists year-round. In 2003, the brittlestar *Ophiothrix spiculata* appeared in very high numbers (1,300 per m2) in as shallow as 25 feet. After nearly a year of carpeting the bottom, their high numbers vanished as quickly as they appeared, but scattered individuals may still be found around worm tubes in deeper waters. Frenchy's Cove is the most protected cove at Anacapa Island, offering moderate protection from northwest winds and swell. Although the anchorage is not as secure as those at Santa Cruz, occasionally pleasure boats use the cove for a lunch stop or overnight stay.

Mapping this bed took two dives. The bed is 2.9 acres, making it the smallest of all in our the study, but as the bed became established only recently from 2003 plantings, it will most likely continue to grow rapidly. The eelgrass is spreading both from seed dispersal and from extension of rhizomes. Because of this, the grass forms patches of a few shoots to islands greater than 100 square meters. We expect that over the next several years, the islands will coalesce and the bed will become more solid, as it once was in this location. The map shows the two high density areas of grass, with the restoration site to the west, although scattered patches are growing in between these locations.

Mainland Beds

Santa Barbara Channelkeeper collected information at four mainland locations: Goleta, Isla Vista, Corral Canyon and Refugio. For this study, numerous scouting dives were performed at each site in order to determine the best place to begin mapping and monitoring. We were familiar with the Goleta bed as we have periodically monitored shoot density and other parameters there over the last five years, but we had not worked in areas to the west. The location, depth and estimated size of beds can be found in Table 1.

Goleta

The Goleta Beach bed has been in place for decades and is most dense to the east of the public pier at the Goleta Beach County Park. Thinner patches are scattered to the west of the sewer outfall pipes that parallel the pier. The sediment in this area can be very silty as the mouth of the Goleta Slough watershed is just east of the pier, and visibility is often poor, especially during flood control management and dredging activities within the Slough and periodic beach nourishment along the shoreline.

From our surveys, the Goleta bed is by far the largest along the mainland, at an estimated 38 acres, with most of the bed found in depths of 20-25 feet. This does not include the scattered patches found to the west of the sewage outfall pipes or shallow areas near the Slough mouth, as these areas are harder to quantify and are more vulnerable to shifting sediments.

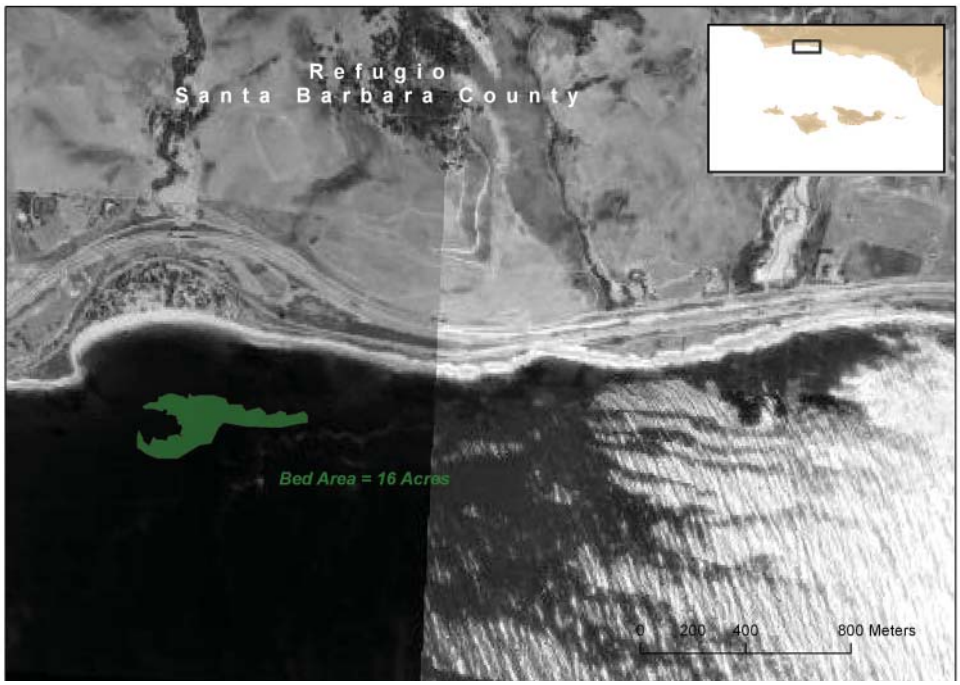
Isla Vista

The Isla Vista bed was located offshore of the kelp and rocky reefs to the south of the UCSB campus lagoon, near Campus Point, in depths of 40-45 feet. Although reportedly stable for 25 years, the bed was not found during our dives and is believed to have been buried in sand during an unusually large storm event in December 2007. A few shoots remain and a monitoring site was established at this location for future surveys. This discovery has changed the way we think about the long-term stability of beds, and is a reminder of the degree by which physical conditions may affect them.

Refugio

The eelgrass can be accessed by swimming out straight offshore from the beach at Refugio State Park. There are grass patches in between fingers of rocky reef, and a thin band runs along the offshore kelp bed. During our visits to Refugio, the visibility was sometimes poor and, although we collected mapping and observational data, our quantitative survey efforts took place one mile to the east at Corral Canyon,

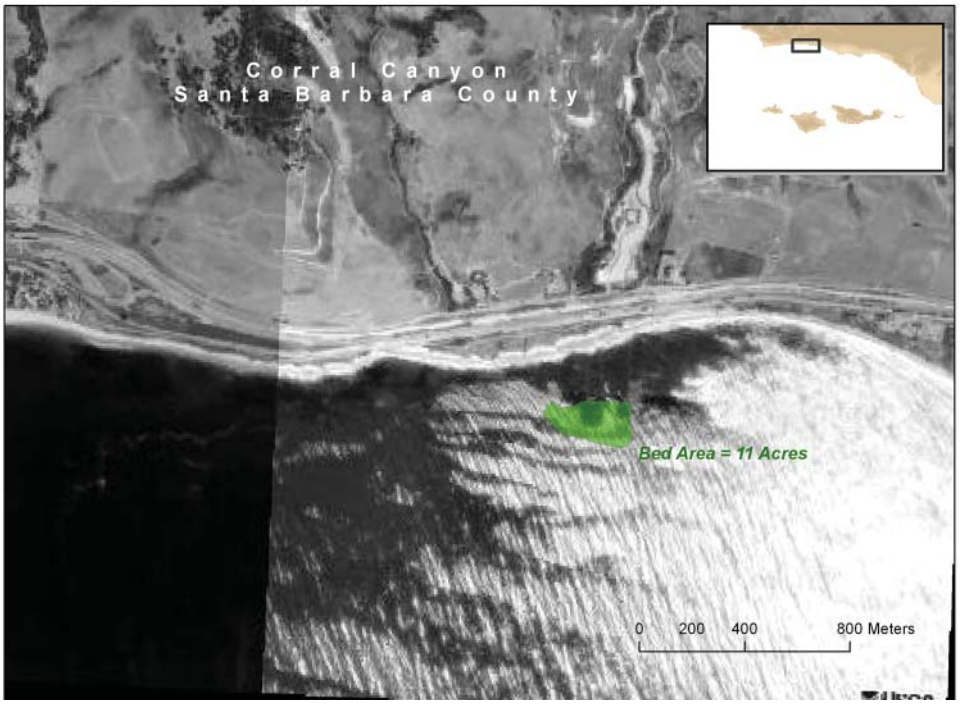
where a solid bed exists and where the visibility was better. The “industry standard” minimum water visibility for counting fish transects is 10 feet, which is often hard to find at coastal sites. Past reports from sport divers indicated an area of thick grass right off the point, but we did not come across a large meadow in this area during our surveys.



We mapped this 16-acre bed in three dives. There are occasional patches beyond this area extending towards both the east and west which are outside of the bed contour.

Corral Canyon

The Corral Canyon bed, located one mile to the east of Refugio, spans roughly a quarter-mile of coastline, with a solid bed in the middle and with scattered patches continuing both to the east and to the west. This bed is offshore of the mouth of Las Flores Canyon, upstream of which is sited Exxon’s Las Flores Oil and Gas Processing Facility. A series of pipelines coming from the offshore oil rigs run ashore here and bisect the eelgrass bed. Over the past 25 years, numerous biological surveys have taken place here in preparation for pipeline construction and abandonment. This area is also known to local surfers as “Lorraines.”



We mapped this bed in two dives, and the calculated size is 11 acres. Although we did not swim the entire distance, it is possible that scattered grass extends all the way between Corral Canyon and Refugio.

Survey Methods

We collected information at each bed on eelgrass shoot density, fish and major invertebrate abundance and diversity along quantitative transects. This information was augmented by observations made during survey and mapping dives.

Shoot Density

Shoot density was measured at each bed by counting the number of shoots (turions) within 0.25 m^2 quadrats placed at regular intervals along a transect (in most cases shared with the fish transects). In some areas where the beds were not continuous, or if more than 30% of the transect fell across bare sand, additional quadrats were haphazardly placed in the nearest eelgrass and counted. We monitored for flowering shoots at all beds during the June 2009 sampling.

Fish and Band Transects

Diver teams deployed a 30 m tape through the eelgrass bed, with the lead diver counting and estimating sizes for all swimming (epibenthic) fishes within the transect corridor. Fish were scored within a three-dimensional corridor 30 m long by 2 m wide, with the vertical component extending from the substrate to the top of the eelgrass bed plus 1 m above the bed (for a total of 2 meters). The second diver followed along counting sedentary fishes and major invertebrates along the bottom (benthic portion) of the transect swath. No infaunal or invasive sampling was done. Multiple stratified random transects were completed by one or more diver pairs during each dive, providing numerous surveys throughout a given eelgrass bed. The total number of transects completed at each site depended upon the size of the bed, the number of divers, and ocean conditions. Three to four 30-meter transects could be sampled by each diver team during a typical dive. Additionally, divers recorded observations on species seen outside of the transect corridor. Roving Diver Fish Counts were performed as time allowed.

Results

During the twelve days of cruises aboard the CINMS R/V Shearwater, between four and seven divers participated each day, collecting shoot density data in 865 quadrats, conducting 200 quantitative fish transects and counting motile invertebrates in 133 band transects. A total 156 individual dives were performed during these three collaborative cruises. In addition to working at the Channel Islands, we collected transect and quadrat data at coastal sites (Goleta, Corral Canyon) during the summer of 2009. The total number of transects and quadrats counted for each island site during each survey are shown in Table 3. In general, sites that were sampled the least (Prisoners in August 2008, Old Ranch in October 2009) had the

fewest number of fish and invertebrates.

Common Invertebrates

Invertebrates scored within transects during our surveys included snails, clams, anemones, crabs, and sea stars. A complete list with densities is given in Table 4. The number of species encountered within transects along with the most common species can be seen in Table 5. The most common animals encountered included the highly motile Sand Star Astropecten, the herbivorous Wavy Top Snail Megastrea and the scavenger Kellet's Whelk Kelletia. There were two species of large clam that were sometimes lumped together, the Geoduck and the Horse Neck Clam.

Frenchy's Cove

The number of species found within bands ranged from four to 16. The most common species was the wavy top snail, ranging from 1.5 to 16 per transect. These large herbivorous snails are the chief invertebrate grazer on eelgrass, but they did not seem to be evenly distributed. Rather, divers would encounter clumps of them congregating in a particular area, perhaps in response to a local disturbance (Altstatt, personal observation). Sand stars were also common. The predatory cone snail was found on the eelgrass blades or on the sand within the bed.

Smugglers Cove

The most common animal in transects was the kellet's whelk, up to three times more than at other sites. We do not know what they were feeding on, but it is possible that they were attracted to galley scraps discarded by anchored boaters. There were also wavy top snails, though at 10% of the density at Frenchy's.

Scorpion Anchorage

The most common animals here were sand stars and clams. We noticed the red cucumber Pachythyone (a small cucumber occasionally found in very high densities on rocky reefs around Santa Cruz and Santa Rosa Islands) in August 2008 but not at later dates.

Prisoners Harbor

By far the most common animals found in band transects here were clams, with the highest density of any site. More species than at any other site were found here in June 2009, when the blackeye goby was also common with four fish per transect.

Forney Cove

Bat stars were the most common species found here, second only in density to Old Ranch.

Old Ranch

In August 2008, 13 species were encountered here, making this site the richest second only to Frenchy's. The October 2009 sampling was too limited by poor conditions to be much of a comparison. By far the most common animal was the bat star, followed by kelp crabs. Three additional species of crab were also well-represented here: red rock, brown rock and slender, all cooler water species.

Goleta

The three most commonly encountered animals at Goleta were all crabs: slender, globe and red rock crabs. We did not find any herbivorous snails here.

Corral Canyon

There were twice as many species here (10) than at Goleta, but curiously the only overlap was with the stalked tunicate (Table 6). The most common animals encountered in transects were sheep crabs, short-spined stars and kellet's whelks.

The total number of species found at each site varied throughout the sampling period, with no clear pattern evident. The greatest number of species found were at Frenchy's in October 2009 (16), followed by Old Ranch in August 2008 (13) and Prisoners in June 2009 (12). Understandably, the fewest species were found at sites with only limited sampling: Old Ranch Oct 2009 (2) and Prisoners August 2008 (3). There were more cooler water species found at western sites. For example, rock and kelp crabs were found at Old Ranch and along the mainland but not at warmer eastern Santa Cruz or Anacapa. Bat stars were common at Forney, Old Ranch, and Refugio, but not at the other sites. The small red sea cucumber Pachythyone was also observed in high numbers at Old Ranch, but only one time at Scorpion.

Common Fish

Fish surveys revealed variation within and between beds, and between seasons. Many of the fish observed within eelgrass beds are commonly found over reefs or within kelpbeds in Southern California. These include kelp bass, senoritas and black surfperch. Some fish prefer soft-bottom habitat, and these include bat rays, sand dabs, lavender sculpins and the orange-throat pike blenny (seen only at Frenchy's Cove, Anacapa Island).

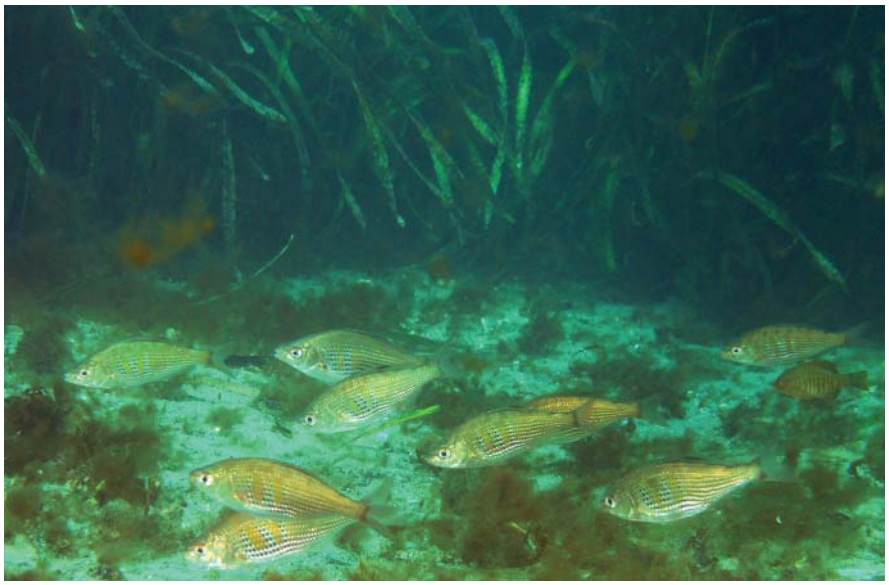
Table 6 shows the fish that were observed by divers at each island site. This information was gathered through a combination of quantitative fish transects, roving diver fish counts and other observations at each site. The five most commonly encountered fish were senoritas (93% of the site visits), black perch and kelp bass (86%) and white and pile perch (71%). The most abundant fish counted were shiner perch, which reached means of 10 fish per transect at Prisoners and 55 at Old Ranch in fall 2009. The greatest number of kelp bass, black surfperch and senorita of any site were found at Frenchy's Cove. However, shiner perch were never observed there or at Scorpion.

Table 7 shows the fish that were observed by divers at each mainland site. This information was gathered through a combination of quantitative fish transects, roving diver fish counts and other observations at each site. The fish common to each site were black perch, rainbow perch and white perch. Refugio had the richest assemblage although no quantitative fish transects were done because water clarity was not sufficient during visits to perform survey dives. Again, the most abundant fish counted were shiner perch, which reached means of 17 fish per transect at Goleta and 55 at Corral Canyon.

Overall, the most common assemblage of fish found in eelgrass beds was the perches, with seven species represented. Perch are live-bearers and are found along the west coast of North America from Alaska to Baja. These fish are known to inhabit shallow water that is heavily structured, such as around pilings and eelgrass beds. They can be found in loose schools or aggregations, and some species like the shiner perch exhibit seasonal onshore-offshore movements. Young feed mainly on copepods, while adults eat various small crustaceans, mollusks, and algae. We did not observe any grazing on eelgrass by perches. Black and white perch were usually found picking and winnowing along the edges of eelgrass patches.

Shiner perch were by far the most common fish with numbers of over 50 per transect at two sites. Schools of small shiners would drift in and out of the transect corridor. Larger individuals were either

found solitary or in pairs (males become very dark) doing mating displays. White perch were by far the most common at the mainland sites, especially Goleta, with an average of four fish per transect. Black perch were most common at Frenchy's Cove with four fish per transect, while all other sites had around one. Striped and rainbow perch, which are colder-water species, were never observed at Anacapa Island.



Kelp bass

The kelp bass *Paralabrax clathratus*, also known as the Calico bass, is a very popular and important sport fish in Southern California. Fish must be greater than 12 inches to be landed. Overall, there were more legal-sized kelpbass in the reserves than outside (Figure 1). More large kelp bass were found at Scorpion, Frenchy's, and Old Ranch than elsewhere, with the greatest number found at Scorpion in October 2009. Diver observations from this survey noted schools of large bass in motion across the entire area. This phenomenon has also been noted in previous years during the late fall around Frenchy's. There were no small or legal bass found at Forney Cove, Goleta or Corral Canyon; the few fish seen at these sites were in the medium size category. Very few bass of any size were found at Forney Cove or Corral Canyon, with none at Goleta.

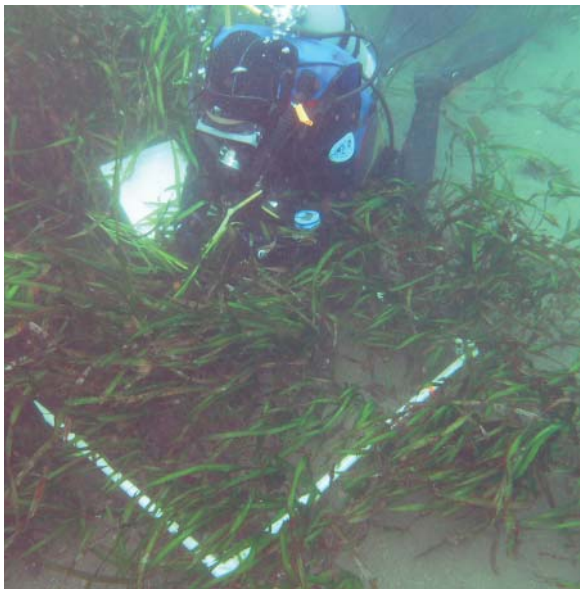
Young of the Year Recruits

The timing when many fish recruits appear depends on current patterns and water temperature. Young fish of any species are especially skittish and often missed during transects. Kelp bass recruits, or young of the year (YOY) were only seen in October 2009, while giant kelpfish YOYs were seen at all sites in August 2008, and then only at Frenchy's in June and at Prisoners in October 2009 (Figure 2). There is a major difference between these fish in that the Giant kelpfish are known to breed throughout the year. The only rockfish recruits observed during the study were at Corral and Refugio in July 2009 and at Scorpion in October 2009. In previous surveys not within the timeframe of this project, we also observed YOY senoritas and several species of perch. Boccacio juveniles, although not small enough to be con-

sidered YOYs, were encountered at Old Ranch and at Corral. Boccacio rockfish were once common and are now a highly regulated species of concern.

Shoot Density

Shoot density is given in Table 7. At the four sites where monitoring occurred in both June and October 2009, shoot density was higher in the summer than in the fall, with significant differences at Smugglers and Scorpion (Figure 3). This is consistent with observations that beds thin out in the fall and winter or after the plants have extended energy into reproductive effort. The highest shoot density in June 2009 was at Scorpion, with a mean of 34.5, followed by Prisoners with a mean of 23.7. The remainder of the beds ranged from between 5.9 to 15.4 shoots per quadrat. At the mainland, shoot density was similar between Goleta and Corral (8.7 and 7.8, respectively), which was the lowest found at any site (Figure 4).



As with other plants, growth (and number of new leaves or shoots) is linked to light levels and nutrients. Also, sprouting of seedlings can dramatically increase the density. For our study, new seedlings were not uniformly common and only adult (i.e. wider) shoots were considered for density estimates. Shoot density can also vary from year to year, as can be seen from Scorpion and Prisoners, where monitoring occurred in August 2008. These levels were roughly two-thirds lower than in 2009, while Frenchy's and Old Ranch densities were about the same. Not too much should be inferred from this, however, as the sampling seasons were all different (2008 was in late August, 2009 was in mid-June and early October). Previous work (Engle et al. 1998) found that shoot density could differ by depth level within a bed. Although we did not test this exclusively, we did sample at multiple locations throughout the beds and found no noticeable differences with depth.

We did find an across-site difference in density within the Prisoners bed. This bed was much larger than expected in that it extends all the way to Canada del Agua, a distance of nearly 2 km. We counted shoots at both ends of the bed, and found that the eelgrass is two to three times as dense near the pier as at the eastern end. At the beginning of this study, it was thought that separate beds grew at Prisoners and Canada del Agua. Eventually, we found that the two sites are actually the west and east ends of one continuous bed. During June 2009, separate transects were counted at four sub-sites within what became known as the large Prisoners bed. West Prisoners was just west of the pier. East Prisoners was off the mouth of Canada del Puerto, and there was no significant difference between the mean numbers of shoots in these locations, which were about 400 meters apart. Canada del Agua is the eastern edge of the larger bed, and we sampled two sub-sites here - near a large

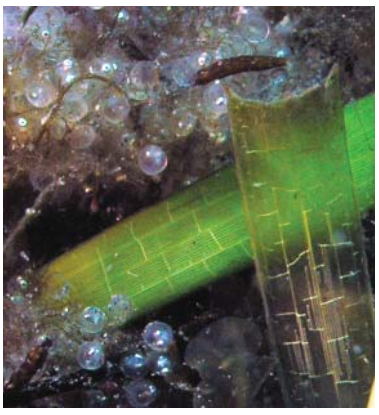
rock slide at the edge of the bed, and just west of a long rock dyke that forms a sub-tidal reef bisecting the bed. These sites were also about 400 meters apart. There was a significant difference between sites in the number of shoots at this eastern end of the bed.

Compared to density estimates from surveys during the mid 1990s, our measurements were very similar and Scorpion was again found to have the highest density (28 – 34 in 1995-97). Once beds have become established they may exist in a stable state until a major disturbance event occurs, whether as flooding and sedimentation from a record rainfall or a boom in the population of sea urchins.

The number of flowering shoots was also recorded (Figure 5, Table 8). Since the majority of beds began to produce reproductive shoots in late spring, only the data for June 2009 are discussed here. At this time the plants were still showing all the stages of flowering. By August the seeds were being released, and by October the reproductive shoots had been excised and were mostly gone from the drift. The greatest numbers of flowers were observed at Corral and Goleta, with more than twice as many flowering shoots at Corral (2.5) than at Goleta (1.2) or at any of the islands sites. It should be noted that surveys in these two beds took place in late July, nearly two months later than at the islands sites. However, once developing, the individual reproductive shoots seem to persist for several months throughout the summer, so we feel fairly confident that the shoots we observed in late July would have been in place in June. At the islands, flowering shoot density ranged from 0.25 (East Canada del Agua) to a high of 1.6 (West Canada del Agua) per quad. In general, the number of reproductive shoots paired with the density of turions. There were more at east than west Prisoners, but with a lot of variation. There were more at west than at east Canada del Agua. From Scorpion east to Smuggler and Frenchy's, there was a decreasing number of flowering shoots. An interesting note was made at East Canada del Agua in January 2009, during a mapping dive, when a number of immature reproductive shoots were observed. There was no obvious explanation for why these plants were six months out of synch with surrounding areas. A similar observation was made outside of this study at Goleta in 2005, where plants were observed to be flowering in December. A separate observation in 2007 at this same bed found that all flowering shoots had been dropped from the plants by the first week of September, coinciding with a week-long period of very warm water. Thus, the timing of at least the cessation of reproduction may be strongly affected by water temperature and variable from year to year.

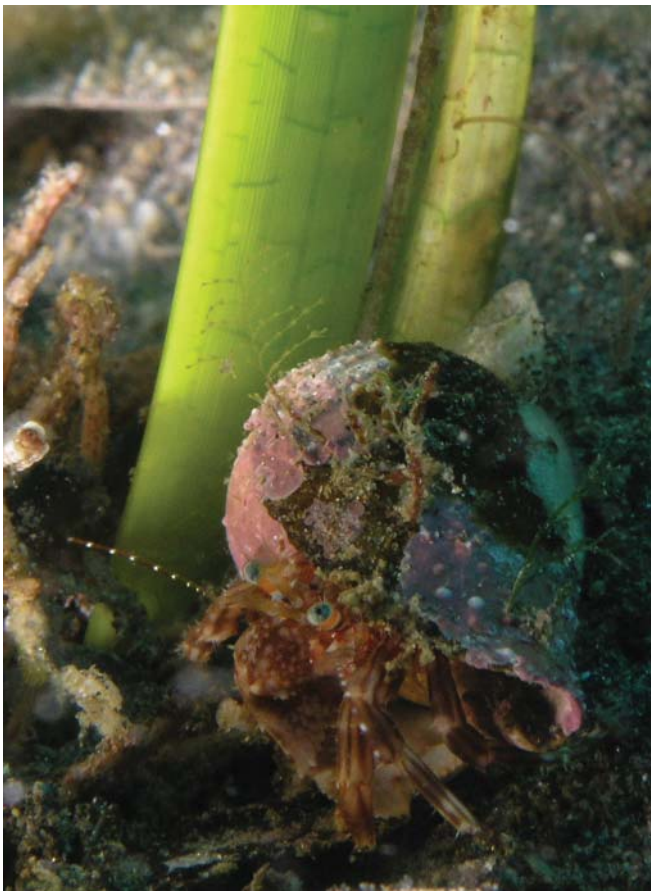
Discussion and Conclusions

We planned to sample our sites in early summer and fall, in order to examine the seasonality of different fishes, and to capture recruitment if possible. Diving conditions are usually best during the fall, and we did have poor conditions at the mainland sites (strong winds and low visibility) during the spring and summer, which limited our surveys in those locations. Many of the fish encountered are highly motile and may migrate on and offshore seasonally. Also, some species are found on rocky reefs and may travel back and forth from adjacent reefs to eelgrass beds on a regular basis, so the distance from adjoining reefs may affect the abundance within the eelgrass bed. Sheephead were observed only once over the eelgrass at Frenchy's, although they are present on a deep rocky reef about 100 meters offshore off the eelgrass bed. Some species formed schools that would move through. This included the herbivorous opaleye, which was observed heavily grazing patches at Scorpion and Frenchy's. Blacksmith, a very common aggregating fish at the islands, were almost never encountered over the eelgrass beds but could be seen in huge numbers at nearby rocky habitat. Topsmelt, jack mackerel and sardines are schooling mid-water fish that could form very dense schools but were disturbed by diver presence and did not often fall within the transect corridor. Of interest was the observation prior to this study that in the month of April in two consecutive years, topsmelt spawned in the restored eelgrass bed at Frenchy's. We might have missed this and other spawning events by sampling later in June.



Differences between the mainland beds also include exposure to prevailing westerly swells (Goleta is more protected) and the occasional south swell (affecting Refugio but not Corral or Goleta due to shadowing from the Channel Islands). The amount of terrestrial input through creek mouths could also be a factor. The Goleta Slough watershed is far greater and more extensively developed than either Refugio or Las Flores. Goleta Beach also experiences periodic beach nourishment and dredging activities upstream in the Slough, which can mix very fine sediments into the water column and on occasion bury the eelgrass in mud (as seen

at Goleta in 2006). However, shoot densities were similar when we sampled in 2009.



Depth at which eelgrass is found depends upon prevailing exposure and water clarity. The shallowest site was at Prisoners, which had the best protection from long-period swell, but also frequently had poor visibility due to the silty sediment. These two conditions both allow and require that the grass grow as shallow as possible in order to get enough sunlight. The two beds open to southerly swells, Old Ranch and Smugglers, were growing in the deepest water, but visibility at these two sites was generally quite good due in part to the coarser sediment found there. Even during periods of heavy south swell, the visibility could be quite good throughout most of the water column due to the currents that set up during swells, with the visibility near the bottom lowered by suspension of particles, which would sometimes settle out in between waves. The two largest beds at Santa Cruz Island, Prisoners and Smugglers are similar in size (43 and 44.5 acres) but differ in exposure, depth, shape and extent of coastline covered. Although we did not measure the length of grass blades during this study, there is a noticeable difference between shallow beds (longer) and deeper beds (shorter) (Engle et al. 1998). Even though the eelgrass at Prisoners grows into very shallow water, it rarely experiences the long-period wave energy that the bed at Smugglers does.

We attempted to schedule our surveys during calm conditions, but found that we could not predict water clarity based upon sea conditions. For example, during visits to Refugio, conditions were not good enough to quantitatively count fishes, although mapping could be accomplished, and on days when only mapping was scheduled, the conditions turned out to be very good. The distance from Santa Barbara Harbor (about 23 miles) precluded us from making many return trips on the chance of finding better conditions. We regret not finding good enough working conditions to perform the surveys at Refugio, because from our observations during mapping, this site had more species of fish (14) than found at Corral (13) and Goleta (5). Also, our notes recorded very large numbers of bat stars in this bed. One unusual find at Corral Canyon that stands out was a single Belcher's Chorus Shell, a large whelk usually found on mudflats, and not seen at any of the other sites.

The most critical factor that affected fish counts was water clarity. Quantitative counts could not be done if the visibility was under 10 feet. Occasionally, observations were done at the edge of this cutoff and consequently there were a reduced number of fish observed (Prisoners in August 2008, Goleta 2009). At Old Ranch

in October 2009, the visibility was excellent but the current on the bottom was so strong that although divers attempted a normal survey, few transects and quadrats were completed. Another factor that might affect the overall number of fish recorded was how many transects were performed and how many dives were done at each site. More transects would give a better estimate of the number of fish present. However, we had to balance this need with collecting other types of data and visiting other sites.

Bed size and uniformity could also affect the diversity and abundance of fish observed. Some fish such as Black surfperch appeared to congregate and feed around patch edges, using the eelgrass as protective cover. This was particularly noticeable at Scorpion and Frenchy's, where the beds are composed of smaller patches. Larger beds, such as at Smugglers and Old Ranch, had fewer of these fish, or else they were more evenly distributed throughout the bed. Similarly, lavender sculpins were also observed mostly on the edges of patches and never at Smugglers or Old Ranch. Conversely, shiner perch were found at uniform beds (Prisoners, Smugglers, and Old Ranch) and not at the very patchy island sites. Bed fragmentation might not be accompanied by loss in species richness until a certain threshold is reached (Reed and Hovel 2006), but there is not a clear trend in our data either way.

Higher numbers of large kelp bass were found at Frenchy's, Scorpion and Old Ranch than elsewhere, suggesting that perhaps the no-take marine reserves are working for this species. Whether or not more and/or larger species are found within the boundary of a reserve depends on the sampling season, the natural history of the target animal and its habitat requirements. For example, lobsters move into shallow water during the warm summer and fall months, and when winter swells arrive, they move offshore into deeper areas through the spring. We have observed lobsters in the eelgrass at Frenchy's and Smugglers only during warmer water, even though we have dove in these locations throughout the year. There is extensive trapping for lobsters and rock crabs around the islands and along the mainland, and with time we may be able to detect changes in their abundances as well. Crabs also move on and offshore seasonally and depending on the sampling and fishing season, we might miss changes unless surveys were designed with this in mind. Knowing the natural history of the target animal helps create a successful sampling regime. This study was done to provide an overall look at multiple sites throughout three of the Channel Islands and along the mainland coast of Southern Santa Barbara County to help elucidate the importance of eelgrass habitat and to help establish a baseline of monitoring data that may be continued in the future.

Acknowledgements

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List of Tables and Figures

Table 1. List of names, coordinates and sizes for all mapped beds.

Bed Name	Location	Position	Depth (m)	Size		Reserve
				Acres	*Hectares*	
Frenchy's	Anacapa Is	34 00.502 N 119 24.658 W	7-10	2.9	1.2	Anacapa Island State Marine Conservation Area
Smugglers	Santa Cruz Is.	34 00.991 N 119 32.328 W	11-15	44.5	18.0	
Scorpion	Santa Cruz Is.	34 02.981 N 119 33.273 W	4-11	5.8	2.4	Scorpion State Marine Reserve
Prisoners	Santa Cruz Is.	34 01.424 N 119 41.231 W	4-11	43	17.4	
Forney	Santa Cruz Is.	34 03.333 N 119 55.120 W	5-10	3.3	1.3	
Old Ranch	Santa Rosa Is.	33 57.901 N 119 58.481 W	11-15	59	23.9	Skunk Point Marine Reserve
Goleta	Mainland coast	34 24.655 N 119 49.404 W	6-9	38	15.4	
Isla Vista	Mainland coast	34 24.055 N 119 51.162 W	13	0	0	Campus Point State Marine Reserve
Corral	Mainland coast	34 27.625 N 120 02.640 W	8-12	11	4.5	
Refugio	Mainland coast	34 27.532 N 120 04.248 W	8-12	16	6.5	

Table 2. Schedule of site visits and activities (surveys (S) or mapping (M)) for each eelgrass bed.

Date	Frenchy's	Smugglers	Scorpion	Prisoners	Forney	Old Ranch	Goleta	Corral	Refugio	Isla Vista
7/29/2008									M	
7/31/2008				M						
8/13/2008									M	
8/14/2008										M
8/26/2008			S, M	S, M						
8/27/2008						S				
8/28/2008	S									
8/29/2008						S, M				
9/10/2008		S								
9/11/2008			S	S						
9/17/2008	S									
10/15/2008	S									
11/25/2008			M							
11/28/2008				M						
1/13/2009				M						
1/16/2009							M			
1/29/2009								M		
2/24/2009				M						
5/20/2009		M								
6/4/2009	S		S							
6/15/2009				S						
6/16/2009			S	S						
6/17/2009	S, M									
6/18/2009		S, M								
7/29/2009	S									
7/21/2009							S			
7/24/2009	S									
8/26/2009								S, M		
10/5/2009			S	S						
10/6/2009					S, M	S, M				
10/7/2009	S, M									
10/8/2009		S, M								

Summary of 2008-9 Santa Barbara Channelkeeper Island Eelgrass surveys
Work performed aboard the R/V Shearwater

			# Individual Dives	Fish Transect	Band Transect	Quadrat
Summer	**Site**	**Date**				
	Scorpion	August 26, 2008	6	5	0	75
	Prisoners	August 26, 2008	6	3	3	45
	Frenchys	August 28, 2009	20	4	4	60
	Old Ranch	August 29, 2008	29	25	21	80
	Total:		61	37	28	260
Summer	**Site**	**Date**				
	Old Ranch	*no data*	*	*	*	*
	Forney	*no data*	*	*	*	*
	Prisoners	June 16 2009	9	18	10	52
	Canada Agua	June 15 2009	6	12	8	100
	Scorpion	June 16 2009	6	15	8	48
	Smugglers	June 18 2009	10	22	12	41
	Frenchys	*no data*	*	*	*	*
	East of Frenchy's	June 17 2009	16	24	12	120
		Total:	47	91	50	361
Fall	**Site**	**Date**				
	Old Ranch	Oct 6 2009	4	3	3	10
	Forney	Oct 6 2009	8	7	7	28
	Prisoners	Oct 5 2009	10	24	15	57
	Canada Agua	*no data*	*	*	*	*
	Scorpion	Oct 5 2009	5	9	8	39
	Smugglers	Oct 8 2009	12	15	10	47
	Frenchy's	Oct 7 2009	9	14	12	63
	East Frenchy's	*no data*	*	*	*	*
		Total:	48	72	55	244
		Grand Total For 2008-9:	**156**	**200**	**133**	**865**

Band Transects are 30m x 2m and are scored for invertebrates and algae.
Fish Transects are 30m x 2m x 2m.
Quadrats are 1/4 m2 and are scored for number of eelgrass shoots (turions), flowering shoots and seedlings.

Table 4. Complete list of species encountered during band transects (means and SE) on CINMS R/V Shearwater survey trips August 2008, June 2009 and October 2009, and mainland surveys July 2009.

	Frenchy's						Smugglers				Scorpion						Prisoners						Forney		Old Ranch				Goleta		Corral	
	Aug08		Jun09		Oct09		Jun09		Oct09		Aug08		Jun09		Oct09		Aug08		Jun09		Oct09		Oct09		Aug08		Oct09		Jul09		Jul09	
SPECIES	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Bat star	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	3.00	2.04	5.14	1.70	0.00	0.00	0.00	0.00	0.00	0.00
Black eye goby	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.22	2.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brown rock crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Bubble snail	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chorus shell	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Cone snail	0.00	0.00	0.00	0.00	9.45	3.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.27	0.15	0.75	0.48	0.00	0.00	0.33	0.33	0.13	0.13	0.00	0.00
Geoduck clam	0.00	0.00	1.58	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	1.75	0.00	0.00	0.00	0.00	1.78	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Gilded top snail	0.00	0.00	0.00	0.00	0.18	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Globe crab	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.18	0.00	0.00
Halibut	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hermit crab larg claw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horse neck clam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.09	0.00	0.00	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Ida's miter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kellet's whelk	0.25	0.25	0.00	0.00	1.14	0.66	0.92	0.38	3.09	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.27
Kelp crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.33	0.00	0.00	0.00	0.00	0.25	0.16
Leather star	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Moon snail	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.10	0.10	0.17	0.17	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octopus	0.25	0.25	0.00	0.00	0.09	0.09	0.08	0.08	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pisaster recruit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red rock crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.64	0.18	0.00	0.00	0.38	0.26	0.00	0.00
Sand anemnome	0.00	0.00	0.00	0.00	2.64	1.25	0.00	0.00	0.09	0.09	0.00	0.00	0.13	0.13	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Sand star	5.00	1.68	10.83	1.98	2.32	1.00	0.58	0.29	0.45	0.28	1.08	0.45	1.00	0.42	2.10	0.50	0.17	0.17	0.39	0.14	0.27	0.12	0.00	0.00	0.41	0.17	0.00	0.00	0.00	0.00	0.25	0.25
Sea cucumber	1.50	0.65	0.00	0.00	1.05	0.36	0.00	0.00	0.09	0.09	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.29	0.00	0.00	0.25	0.25	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Red cucumber	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25	0.00	0.00	0.00	0.00
Sea hare	0.00	0.00	1.33	1.02	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.50	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Sea pen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Sea urchin, purple	0.00	0.00	0.00	0.00	3.45	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea urchin, red	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea urchin, white	0.50	0.50	0.00	0.00	0.50	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sheep crab	0.25	0.25	0.00	0.00	0.18	0.12	0.00	0.00	0.09	0.09	0.42	0.19	0.38	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.26
Short-spined star	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.37
Slender crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.14	0.00	0.00	1.00	0.33	0.00	0.00
Stalked tunicate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13	0.25	0.16
Sunflower star	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tube anenome	0.00	0.00	0.00	0.00	2.20	0.89	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	1.30	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unid clam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	1.40	0.93	6.17	3.22	1.67	1.19	1.47	1.19	0.00	0.00	1.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00
Unid crab	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unid flatfish	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unid snail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wavy-top snail	9.50	4.11	1.50	0.53	16.09	3.40	0.42	0.15	1.27	0.63	0.25	0.18	0.25	0.16	0.20	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 5. Complete list of fish species from diver observation and data collected at island eelgrass beds during Santa Barbara Channelkeeper cruises aboard the CINMS R/V Shearwater

Fish Species	Late Summer 2008				Summer 2009				Fall 2009					
	OR	PRIS	SCOR	FREN	PRIS	SCOR	SMUG	FREN	OR	FOR	PRIS	SCOR	SMUG	FREN
Angel shark					*							*	*	
Bat ray	*		*	*				*	*		*	*		*
Black eye goby	*			*	*	*		*						*
Black perch	*		*	*	*	*	*	*		*	*	*	*	*
Blacksmith			*	*										
Boccacio juv	*													
Cabezon	*													
CO turbot				*									*	*
Giant kelpfish	*	*	*	*	*	*		*			*			
Giant kelpfish YOY	*	*	*	*				*			*			
Halfmoon			*	*				*						
Halibut			*		*									
Horn shark									*				*	*
Jack mackerel	*			*			*				*	*	*	*
Kelp bass	*	*	*	*	*	*	*	*			*	*	*	*
Kelp bass YOY											*		*	
Kelp perch					*					*				
Kelp perch YOY					*									
Kelp rockfish						*								
Lavender sculpin			*	*	*			*		*		*		
Ocean white fish				*								*		
Opaleye			*	*				*			*	*		
Painted greenlng							*							
Pike blenny														*
Pile perch	*	*	*	*		*	*			*	*	*	*	
Pipefish					*									
Rainbow perch	*		*		*		*			*	*		*	
Rockfish YOY												*		
Rock wrasse			*	*										
Rubberlip perch						*					*			
Sanddab	*				*	*								*
Sarcastic fringehead	*							*						
Sardines	*										*			
Sargo					*		*							
Scorpionfish				*										
Senorita	*	*	*	*	*	*	*	*		*	*	*	*	*
Shiner surfperch	*	*			*		*		*		*			
Shovelnose guitarfish								*						
Striped perch			*								*			
Thornback ray	*	*								*				
Topsmelt			*	*		*								
Tubesnouts	*				*				*	*				
Walleye perch					*						*			
White perch		*	*		*	*	*	*		*	*	*	*	
Total Number species:	18	8	17	18	18	11	10	13	4	9	17	12	11	10

OR = Old Ranch SRI FOR = Forney SCI PRIS = Prisoners SCI SCOR= Scorpion SCI SMUG = Smugglers SCI FREN = Frenchys ANA

Table 6. Complete list of fish species from diver observations at mainland eelgrass beds Summer 2009

		Summer 2009		
SPECIES		Goleta	Corral	Refugio
Angel shark				x
Bat ray			x	x
Black perch		x	x	x
Bocaccio juv			x	
Giant kelpfish			x	x
Giant Seabass		*		
Kelp bass			x	x
Kelp perch			x	
Lavender sculpin				x
Pile perch			x	
Pipefish		*		x
Rainbow perch		x	x	x
Rockfish YOY			x	x
Sand dab		x	x	
Senorita		*	x	x
Shiner surfperch		x		x
Shovelnose Guitarfish				x
Tubesnouts			x	x
White perch		x	x	x
White Seabass		*		

Total Number species:	**5**	**13**	**14**

* observed in prior years

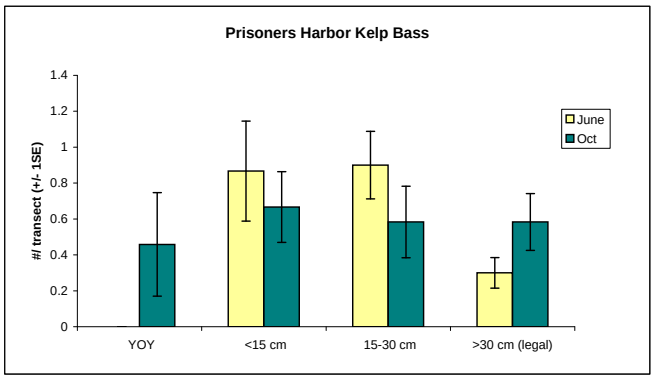
Table 7. Eelgrass shoot density. Data are mean number of shoots (turions) in a 1/4 m^2 quadrat.

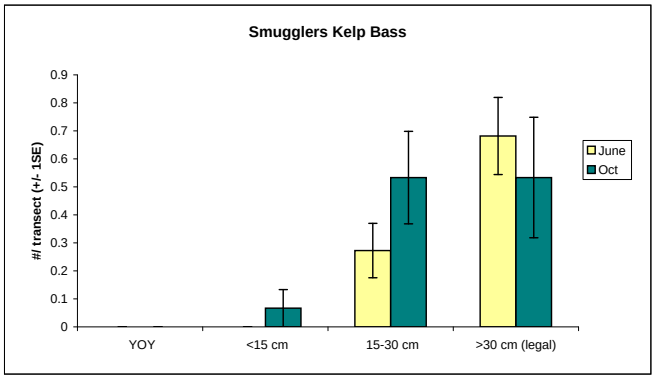
Sampling Period	Frenchy's		Smugglers		Scorpion		East Agua		West Agua		Prisoners		Forney		Old Ranch		Goleta		Corral	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
August 2008	11.2	2.2	*nd*	~	19.7	1.2	*nd*	~	*nd*	~	15.1	0.7	*nd*	~	14.0	0.5	*nd*	~	*nd*	~
June 2009	11.5	2.0	15.4	0.6	34.5	1.8	8.5	0.6	12.8	1.0	23.8	1.5	*nd*	~	*nd*	~	8.7	0.7	7.8	0.5
October 2009	9.8	0.9	12.2	0.5	27.6	1.3	*nd*	~	*nd*	~	22.7	1.3	10.8	0.8	16.0	1.2	*nd*	~	*nd*	~

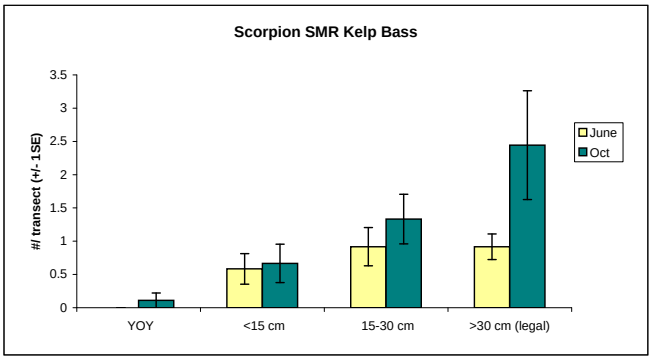
Table 8. Eelgrass flowering shoot density. Data are mean number of reproductive shoots in a 1/4 m^2 quadrat.

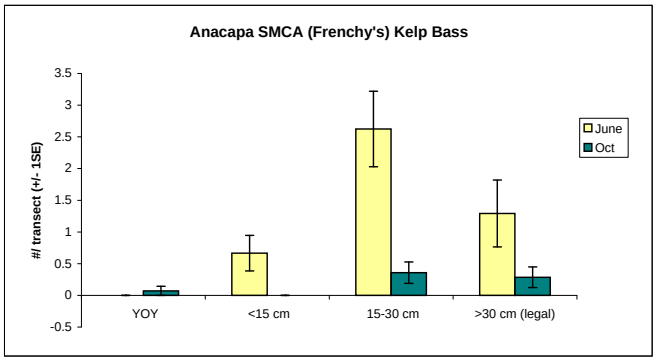
Sampling Period	Frenchy's		Smugglers		Scorpion		East Agua		West Agua		Prisoners		Goleta		Corral	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
June - July 2009	0.29	0.12	0.54	0.16	0.80	0.41	0.21	0.09	1.16	0.26	0.38	0.20	1.21	0.17	2.48	0.22

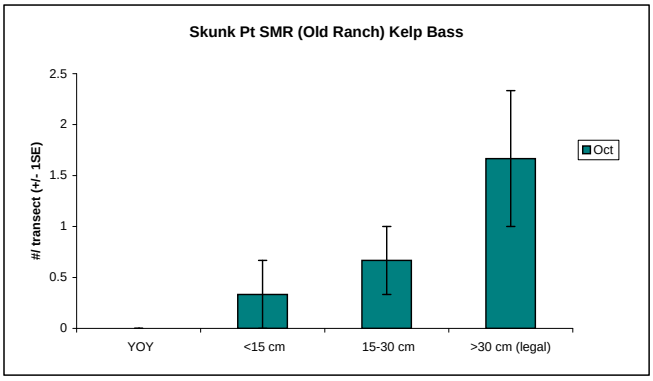
Figure 1. Distribution of kelp bass in four size categories at all sites sampled in 2009

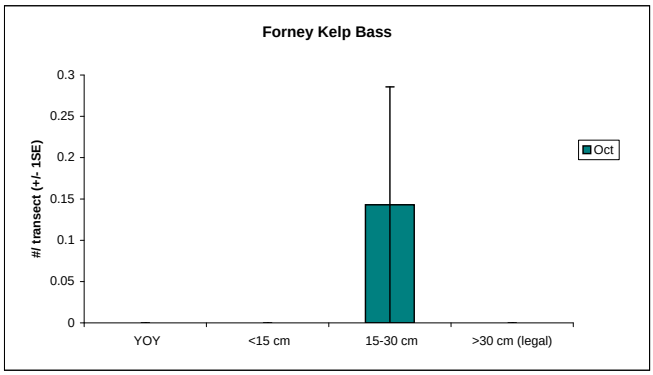


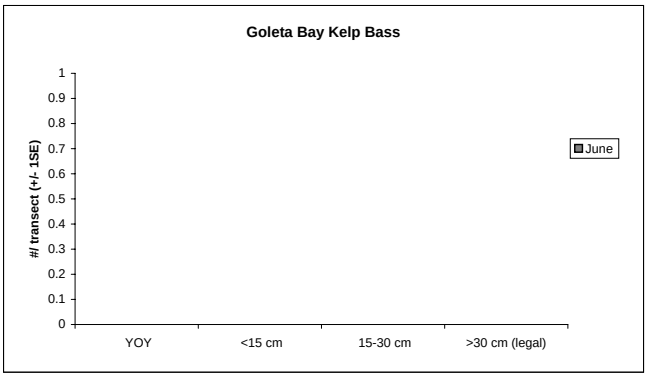












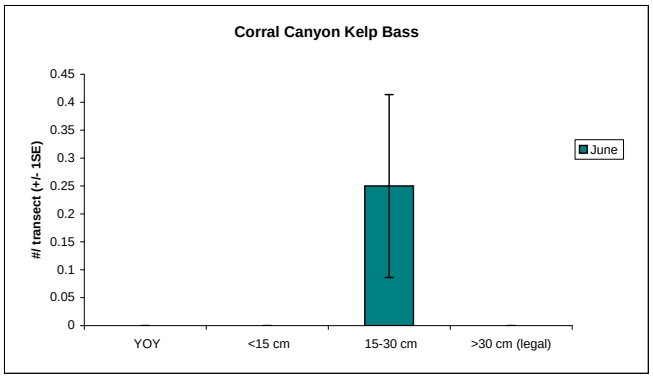


Figure 2. Young of the Year fish recruits at sites sampled in October 2009

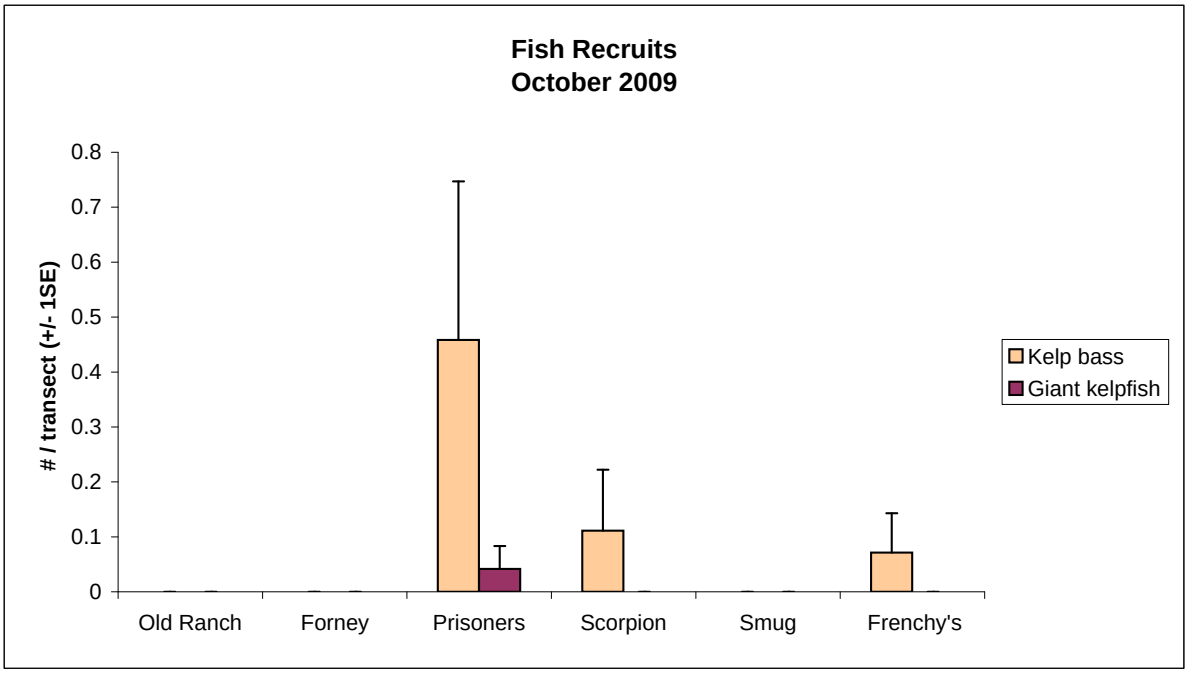


Figure 3. Shoot density at four island sites that were sampled in two seasons in 2009

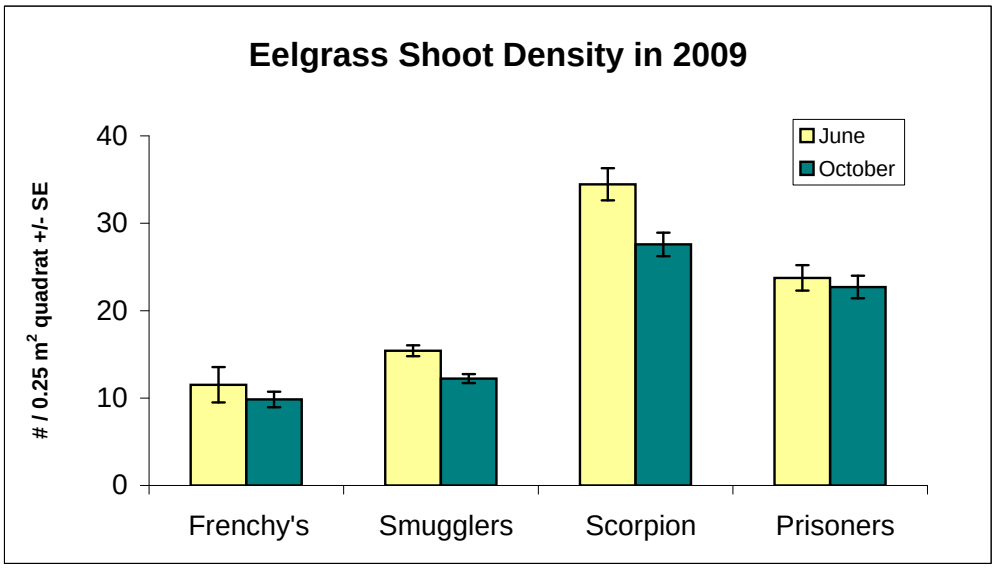


Figure 4. Shoot density at all sites in Summer 2009

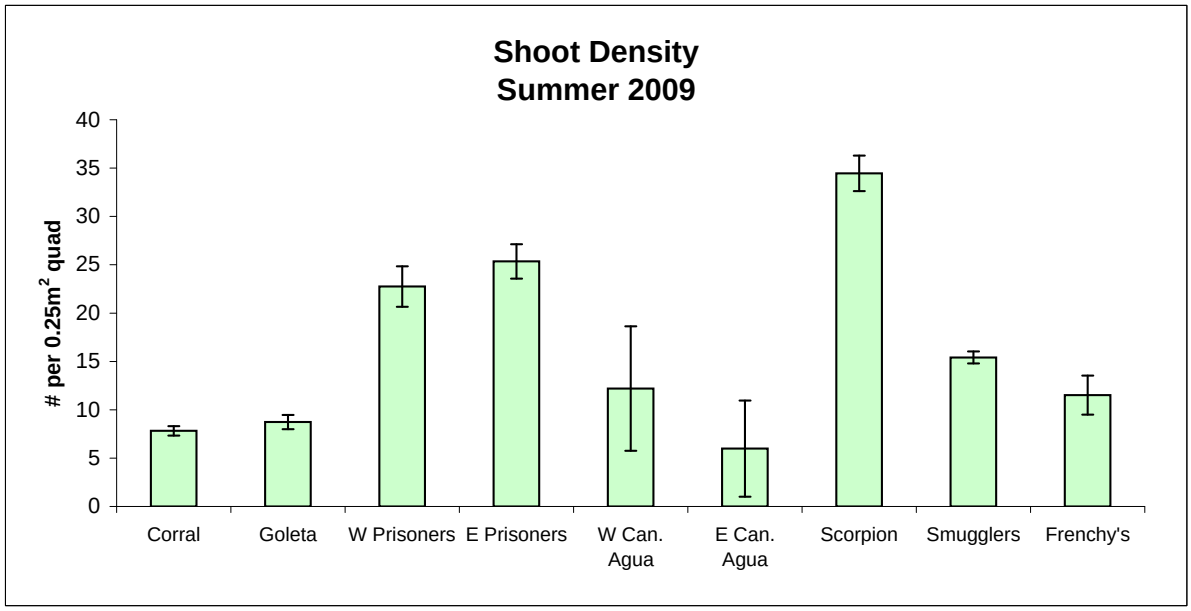


Figure 5. Density of flowering shoots at all sites in Summer 2009