Progress report on MSRP project "Interpreting changes in community structure in marine reserves in light of spatial and temporal patterns of settlement"

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The primary **objective** of this proposal was to understand the spatial and temporal patterns of recruitment of commercially and ecologically important fishes and invertebrates in relation to the system of reserves in the Channel Islands and Santa Barbara channel mainland, and to identify the potential oceanographic causes of these patterns.

The primary **motivation** of this work is that an understanding of the spatial and temporal patterns of recruitment into and around marine reserves as well as knowledge of potential oceanographic causes of the patterns provides an essential context to interpreting any observed changes to populations inside and outside reserves as well as any potential regional and local effects of reserves on recruitment.

Major accomplishments:

- Settlement of invertebrates and fishes was monitored regionally at 14 locations from 2007-2009 (Fig. 1)
- A finer spatial scale array of collectors ('local-scale') was embedded in the regional array and monitored biweekly for fishes (originally proposed) and for invertebrates (added) during 2008-2009 (Fig 2).
- Oceanographic instrumentation was deployed throughout the project as part of the PISCO program. Additional temperature loggers were deployed on the 'local-scale' array during the period of collections.
- Methods for visual identification of urchins, crabs and other invertebrate species were developed.
- The project involved one postdoc, one Masters student and 5 undergraduates, in addition to the PI. The invertebrate settlement data will be analyzed and written for a Masters degree in the Ecology, Evolution and Marine Biology department at UCSB. The undergraduate students presented results from this work at the Annual Undergraduate Research Symposium at UCSB (May 2010).
- Two papers have been published that included fish settlement data from 2008 (partially funded by this grant). We anticipate a minimum of three additional papers to be submitted on results from the local scale array (fish, urchins and crabs/other invertebrates).
- Data were used in the successful five-year review of the Channel Islands MPA network and presented to the Fish and Game commission during that process (2008).

Major Results to date:

- Spatial and temporal variation: In general, variation among collectors within a site was low for both fishes and invertebrates. Site variation and regional variation (East vs. Central vs. West or Island vs. Mainland) was significant for many species groupings as was interannual and seasonal variation.

- Relative to the existing longer-term time series of fish settlement beginning in 2000, the period of this study (2007-2009) was generally characterized by low settlement for kelp bass, and moderate settlement for the KGB rockfish group (Kelp, Gopher, Black and Yellow and Copper Rockfishes). As in other years, OYT rockfishes (Olive and Yellowtail Rockfishes) did not settle abundantly in the SB Channel area and Cabezon settled in low abundance and equally among sites and years (Fig. 3).
- Spatial patterns of fish settlement in this study were similar to those observed since 2000. Settlement of the fish groups measured here tends to be highest along the north shores of the Channel islands (relative to the South shores and Mainland coast) and at the central sites (relative to the Eastern and Western sites) (Fig. 3)
- Average invertebrate settlement was greater in 2009 than 2007-2008 (Fig. 4. note different y-axis scales). In particular, mean settlement of both urchin species was approximately 4x greater in 2009 than 2007 or 2008 while crabs, while scallops and mussels ranged from 2 to 10x greater.
- Analysis of the 'local-scale' array for crabs showed that over two years (2008 and 2009) settlement of Cancrids (*Cancer* spp) was greater than the other crab groups and occurred earlier in the spring (Fig. 5). Settlement of *Pugettia* spp (kelp crabs) and Shore crabs (including *Hemigrapsus* spp and *Pachygrapsus* spp) occurred throughout the spring and summer. In 2008 settlement of *Cancer* spp. and *Pugettia* spp. appeared to be inversely related. This pattern was less apparent in 2009 when settlement was highly variable. All crab groups had higher settlement in the Western locations in the Channel Islands, an area characterized by colder water.

Relevance to MPA effectiveness:

With current initiatives in California and world wide aimed at protecting marine biodiversity in networks of marine protected areas there is an increased need to understand the effectiveness of MPAs in allowing exploited species to recover, the mechanisms and timeframes by which recovery happens and also their potential role in terms of acting as source populations.

This is typically done by comparing inside and outside reserves and by looking at changes in populations over time. Recovery of exploited populations in marine reserves can happen through growth of individuals, immigration (e.g. seasonal movements of adults) and/or recruitment of new individuals. Thus, predicting whether exploited species will actually "recover" in reserves and the time frame of changes requires an understanding of how patterns of settlement and recruitment vary in space and time.

In 2003, a network of marine protected areas was designated in the Northern Channel Islands. In 2008, these reserves and the associated monitoring programs underwent a mandatory, five-year review, conducted by the California Fish and Game Commission. Even after only five years, there were indications that populations had increased inside of many of the MPAs. Our research program (PISCO) is largely responsible for monitoring the populations and communities throughout the reserve network. Data from this project (MSRP) were used, at that time, to qualitatively interpret the spatial patterns of population responses (e.g. which reserves showed greatest change). With a longer time series of recruitment and a thorough understanding of spatial recruitment patterns, we are now anticipating the magnitude of response in the various regions of the network in preparation for the 10-year review. Further, this project has brought the issue of

recruitment monitoring to the forefront in the development of MPA monitoring plans for the newly created Marine Life Protection Act MPA networks.

This study has provided a baseline for developing predictions about where specific taxa will recover in reserves. For example, we now know that recruitment of most species is significantly lower on the mainland coast relative to the Channel Islands. Thus, we cannot expect new mainland MPAs (e.g. MLPA MPAs) to respond to protection as quickly as reserves in the Channel Islands.

Papers partially supported by this work:

Caselle, J.E., B.P. Kinlan, and R.R. Warner. 2010. Temporal and spatial scales of influence on nearshore fish settlement in the Southern California bight. Bulletin of Marine Science. 86:355-385

Caselle, J.E., M.H. Carr, D.P. Malone, J.R. Wilson, and D. E. Wendt. In press. Predictability of settlement of nearshore rockfishes (genus *Sebastes*) in central and southern California using simple proxies of ocean conditions. CalCOFI reports.

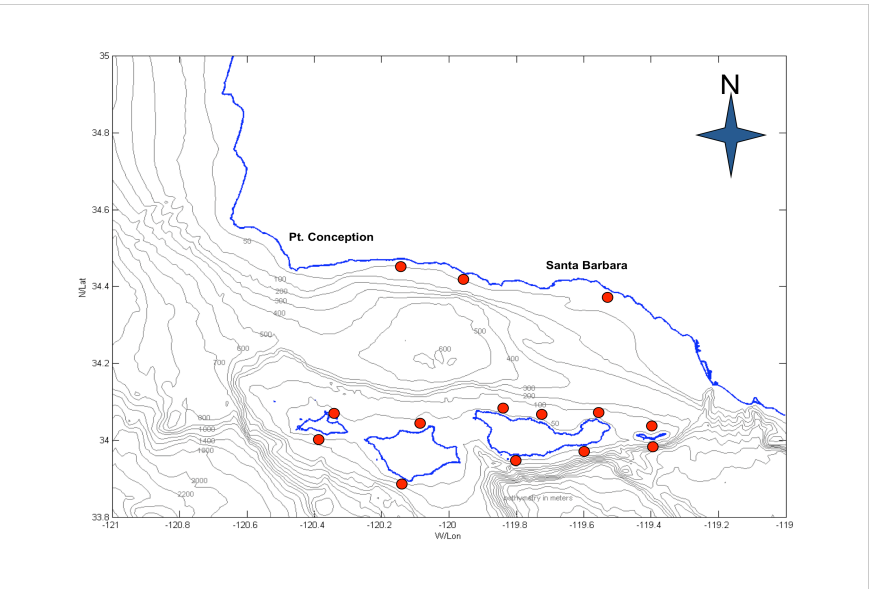

Fig 1. Locations of the regional array of settlement collectors. We monitored fish settlement at these locations from 2007 - 2009 and invertebrate settlement at a subset of these locations in 2007-2008.

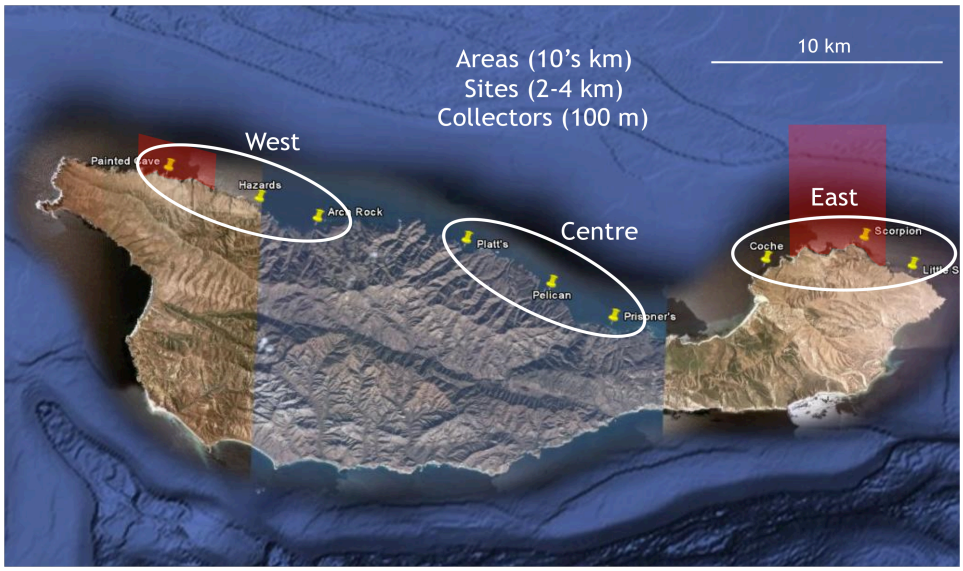

Fig. 2. Locations of the 'local-scale' array on the North shore of Santa Cruz Island. Areas are defined as East, Center and West. At each Site (yellow point), we deployed 3 replicate Collectors of each type (SMURFs, brushes and tuffies) on separate mooring lines approximately 100m from one another.

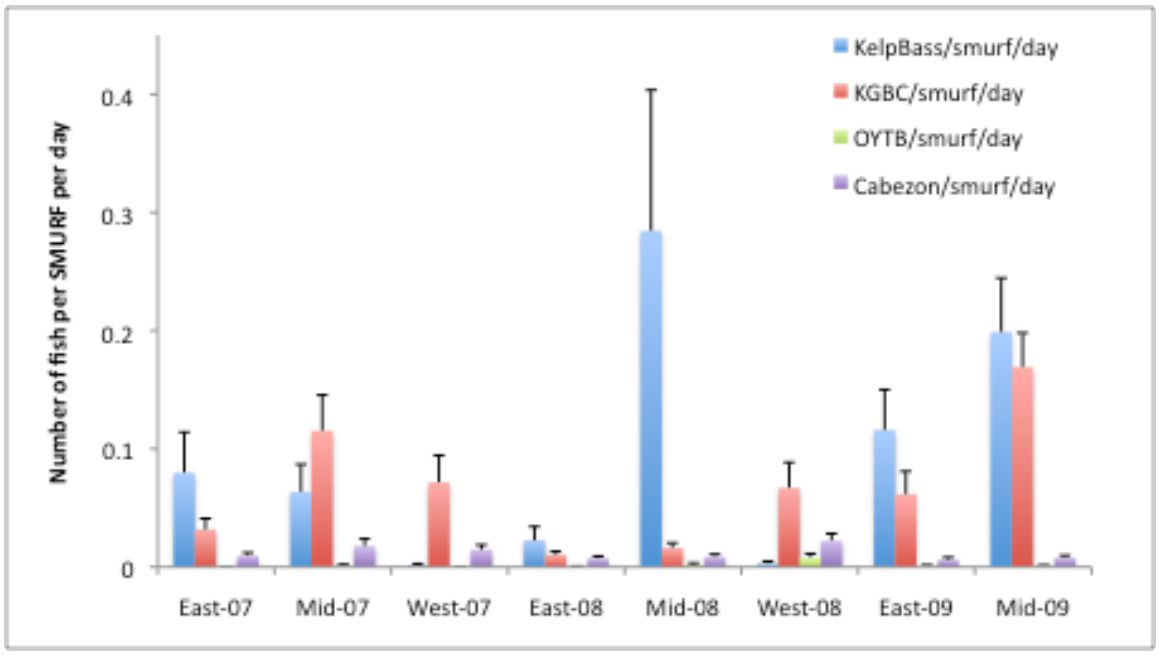

Figure 3. Fish settlement (mean number of fish per smurf per day + 1 SE) for Kelp Bass, KGBC (Kelp, Gopher, Black and Yellow and Copper Rockfishes), OYT (Olive and Yellowtail Rockfishes) and Cabezon. The Santa Barbara Channel and Channel Islands is broken down by region (East, Middle and West) and each year-region is presented.

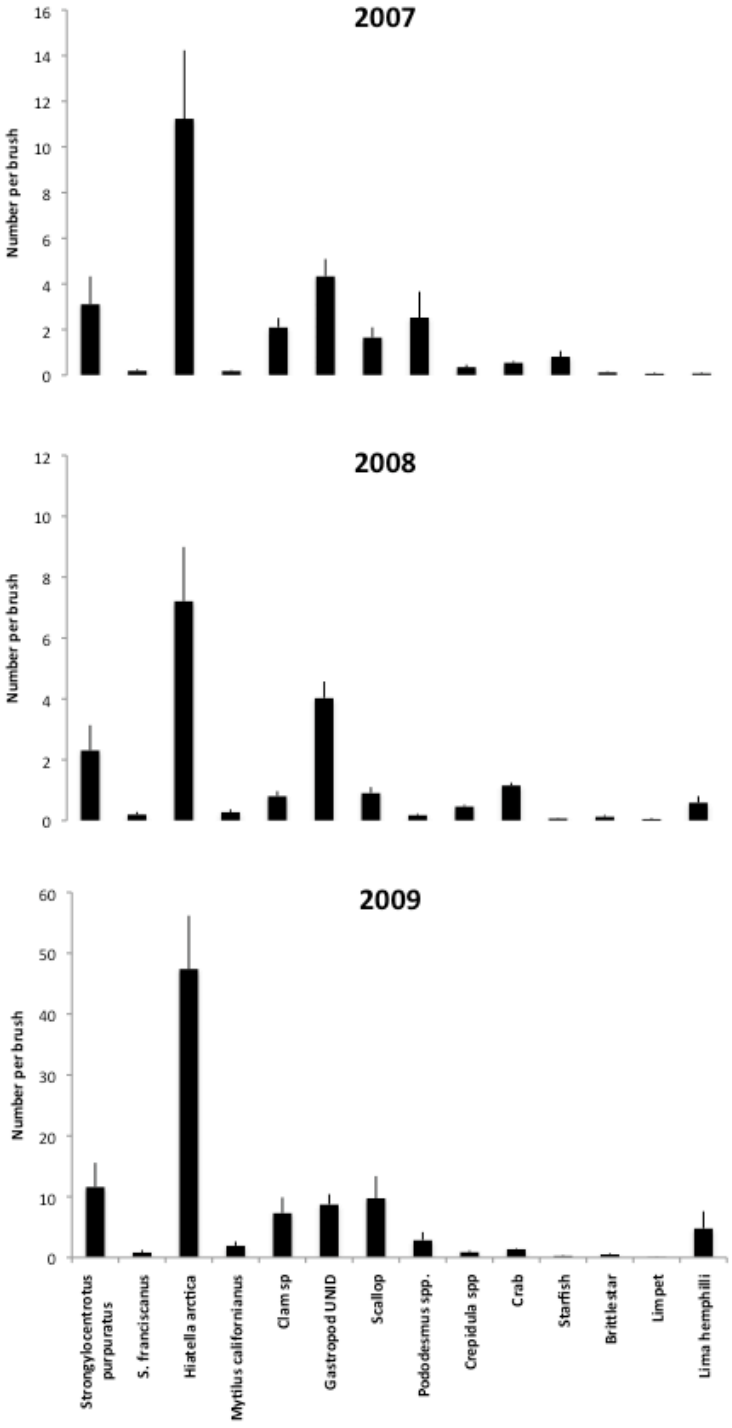

Fig. 4. Invertebrate settlement (number per brush-collector) for 2007, 2008 and 2009. Data are mean number of organisms per brush for all sites (e.g. the regional array) and all time periods (+ 1 SE). Species names, genus names or common name groupings are given.

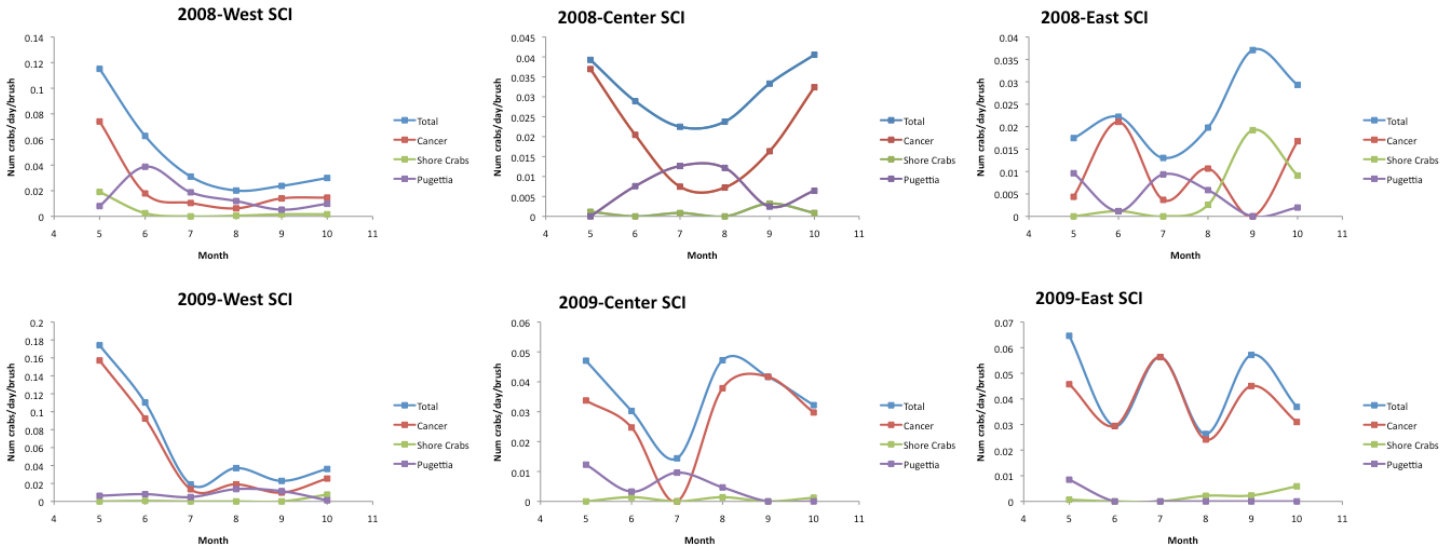

Fig. 5. Time series of crab settlement (monthly mean number per day per brush) from the local scale array. West, Center and East are regions as shown in Fig. 2. Groups are *Cancer* spp (red), Shore crabs (*Hemigrapsus* spp and *Pachygrapus* spp) and *Pugettia* spp. Note different y-axis scales.