Rocky Intertidal Monitoring Program at Cabrillo National Monument

2020 Annual Report

Natural Resource Data Series NPS/MEDN/NRDS—2021/1338
ON THE COVER

Lottia gigantea at Cabrillo National Monument.

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December 2021

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado
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Abstract

The rocky intertidal zone at Cabrillo National Monument is a valued and rare natural resource in southern California. It has been monitored since 1990, and was incorporated into the “Vital Signs” monitoring program of the Mediterranean Coast Inventory and Monitoring Network in 2011. Target species are monitored using core MARINe protocols (Engle 2008), which consist of: (1) circular plots to monitor the size and abundance of *Lottia gigantea*, (2) permanently marked photo-plots to monitor percent cover of sessile invertebrates and rockweed (*Chthamalus/Balanus, Tetraclita, Mytilus, Pollicipes* and *Silvetia*), (3) line transects to assess percent cover of dominant algae and seagrass (red algal turf, *Egregia* and *Phyllospadix*), and (4) timed searches to record presence of rare species (*Pisaster* spp. and *Haliotis* spp.). These surveys are conducted across three Zones at Cabrillo National Monument, which encompass a gradient of human use; Zone I receives the highest visitation, and Zone III has been closed to visitation since 1997. Equal sampling effort is allotted to each Zone. Data collected are assessed annually. This report provides a brief summary of findings from 1990–2020 and reflects on the current status of target species. While *Lottia gigantea* density in circular plots is relatively stable, mean size of individuals has decreased over time. Assessment of photo-plot data reveal a recent decline in *Silvetia* and increase in *Tetraclita* cover in their respective plots. Furthermore, line transects targeting red algae have shifted from dominant articulated coralline cover to non-coralline red algal cover. During timed searches in Fall 2020, no *Pisaster* species were located, but four adult *Haliotis fulgens* were found in Zone III. Collectively, these results reveal no anomalous events in the current study year or sudden departures from reported findings in 2019.

Acknowledgments

Funding and data management for this project were provided by the Mediterranean Coast Inventory and Monitoring Network (MEDN). This work was completed with the help of many community and scientist volunteers.
Introduction

Cabrillo National Monument (CABR) is a unit of the National Park System located at the tip of Point Loma in San Diego, CA. Despite its small size (0.65 terrestrial km²), CABR attracts nearly one million visitors each year, 380,000 of which visited the coastal area of the park in 2020 (estimated using infrared trail counters deployed 2010–2020). Since three sides of the park are surrounded by water, and the fourth abuts a Navy base, the park acts as an “urban island”, providing habitat for unique algal, plant, and animal species in an area of increasing development and urbanization. Further, the 1 km stretch of rocky intertidal zone is regarded as the best conserved rocky intertidal shoreline in mainland southern California. Due to its value as both a habitat refuge and public resource, it is critical to monitor changes in basal species composition in the rocky intertidal at CABR.

To understand flux in natural ecosystems, Gary Davis and Jack Engle began the Cabrillo Rocky Intertidal Monitoring Program (CRIMP) in 1990 with the goals of: (1) establishing limits of variation, (2) determining present health, and (3) diagnosing abnormal conditions in natural ecosystems to inform conservation and resources management decisions (Davis et al. 1994, Davis 1983). In the first five years of data collection (1990–1995), 7 of the 13 focal taxa declined or disappeared from the study area (Engle and Davis 2000). These findings spurred management decisions such as the closure of Zone III to visitors in 1996, creation of the Tidepool Protection, Education and Restoration volunteer docent Program (TPERP) in 1997, founding of the Multi-Agency Rocky Intertidal Network (MARINe), and establishment of the Cabrillo State Marine Reserve as part of the California Marine Life Protection Act (MLPA) in 1999. As a result of these successes, the National Park Service established a service-wide Inventory and Monitoring (I&M) Program to provide scientific information on ecosystem health. In 2011, the Cabrillo Rocky Intertidal Monitoring Program was formally incorporated as a “Vital Sign” in the Mediterranean Coast Network (MEDN) of the I&M Program.

The purpose of this annual report is to provide data summaries for the years 1990–2021, note deviations from sampling protocols, and highlight recent developments in the research program at Cabrillo National Monument. While the ongoing COVID-19 pandemic posed significant challenges to long-term monitoring program efforts, all sampling activities were completed in 2020–2021. New developments to the program include the creation of a new plot guide, updates to GIS layers, replacement and/or repair of plot markers, and installation of two TidbiT (Onset corp.) temperature loggers in Zones I (May 2020) and III (February 2021). There were also two small sailboat groundings in Zone III in fall 2020. These groundings did not result in noticeable damage to the study areas. A significant 40 ft trawler grounding occurred in Zone I in May 2021. The grounding resulted in a multi-agency rescue mission, federal investigation, c.1-acre diesel fuel sheen spanning Zones I and II, major debris piles necessitating intensive cleanup and damage assessment operations. Long-term monitoring plots were not in the major wreckage area, but Zones I and II were likely exposed to diesel fuel and light disturbance from wreckage. Surveys conducted post-grounding will be included in the 2021 report.
Methods

Study Area
The study area at Cabrillo National Monument (San Diego, CA, USA) consists of c. 1 km of shoreline comprised of gently sloping sandstone benches with metavolcanic boulders scattered at the base of sandstone cliffs. This area is subdivided into three zones (I, II, and III; Figure 1), which represent a gradient in human visitation. The single public access point to the tidepool area is in the middle of Zone I. Since it is the most accessible, this area receives the most visitation. Access to zone II requires visitors to amble through a boulder field, so it receives fewer visitors. Zone III has been closed to visitors since November 1996.

![Map of Cabrillo National Monument](image)

**Figure 1.** Map of the intertidal of Cabrillo National Monument, in San Diego, CA. The three zones of the park represent different levels of human visitation: Zone I is high use, Zone II is intermediate use, Zone III has been closed to all visitors since 1996.
Approach and Sampling Design
The complete sampling protocol was conducted twice per year, in the spring and fall, of 1990–2016. In 2017, photoplot, transect, and timed search methods were reduced to annual surveys (Raimondi et al. 2018), while circular Lottia plots continued to be monitored twice annually. Fall surveys were completed December 13th–17th, 2020, and spring Lottia surveys were completed March 24th–26th, 2021. While a summary of methodology is presented in this report, CRIMP adheres to the core MARINe protocol (Engle 2008). All computations and data visualization were done in RStudio (Firke 2021, Garnier 2018, Harrell and Dupont 2021, R Core Team 2021, Robinson et al. 2021, Wickham et al. 2019, Wickham and Bryan 2019), and data are available upon request from MARINe or MEDN.


Request data: https://marine.ucsc.edu/explore-the-data/contact/index.html

Circular Lottia Plots
To collect data on the size-frequency, abundance and density of owl limpets (Lottia gigantea), pre-measured pieces of line were used to delineate circular plots of 1 m radius around fixed bolts (N ≥ 6 per zone). All owl limpets in each plot greater than or equal to 15 mm in shell length were counted and measured. Smaller individuals were not counted or measured, as they are difficult to correctly identify.

Photoplots
Rectangular photo-plots were established to document percent cover of four target taxa: (1) California mussels (Mytilus californianus), (2) acorn/thatched barnacles (Chthamalus spp./Balanus glandula and Tetraclita rubescens), (3) goose barnacles (Pollicipes polymerus), and (4) rockweed (Silvetia compressa) (N ≥ 5 per zone). Plots were photographed during sampling events. Additionally, plots were field scored using a 50 cm x 75 cm PVC quadrat strung to create a grid of 100 evenly spaced points, under which the type of cover was identified and recorded on paper to yield percent cover. When field scoring was not possible, digital photos were scored by overlaying a similar grid with image processing software. Prior to 1996, three line transects per zone targeting Pollicipes polymerus were monitored. In 1996, each line transect was converted into two photo-plots, yielding six photo-plots per zone.

Line Transects
Line transects (10 m) were established to yield percent cover of three target taxa: (1) red algal turf, (2) surfgrass (Phyllospadix spp.), and (3) boa kelp (Egregia menziesii). Two transects were established per target taxa in each zone, for a total of 18 transects (see Results section). The type of cover under each 10 cm “point” along the line was recorded, yielding 100 points for percent cover calculations.

Timed Searches
In each zone, a 30 person-minute timed search was conducted to look for abalone (Haliotis cracherodii and other species) and sea stars (Pisaster ochraceus and other species) in habitat that is
commonly inhabited by those animals. All abalone or sea stars encountered were identified, measured, and recorded.
Results

Circular Lottia Plots
Most Lottia size-frequency, density and mean size measurements are near their grand, or overall, (1990–2020) mean values. Size-frequency data indicate that the largest individuals are consistently found in Zone II, while a high density of mid-sized individuals are found in Zones I and III (Figure 2). This trend is also indicated by the lower average density in Zone II than Zones I and III (Figure 3). While Zone II has the lowest overall density of individuals, it has the highest overall mean size of individuals. Individuals in Zones I and III have lower overall mean sizes (Figure 4). Mean size across all zones decreased between 1990 and 2010 and has shown some recovery between 2010 and 2020.

Figure 2. Heatmap of owl limpet (Lottia gigantea) size-frequency distribution at (A) Zone I, (B) Zone II, and (C) Zone III from 2015–2020. Counts are averages across seasons and plots. Zone II contains the largest individuals, while Zones I and III contain the highest densities of individuals.
Figure 3. Time series of *Lottia gigantea* density at (A) Zone I, (B) Zone II, and (C) Zone III. Values presented are mean density (count/m²) ± SE, summarized across seasons and plots within each zone. Dashed lines represent grand mean density for each zone. In 2020, *Lottia* density in Zones I and III were similar to the grand mean, while density for Zone II remains lower than the grand mean.

Figure 4. Time series of *Lottia gigantea* size at (A) Zone I, (B) Zone II, and (C) Zone III. Values presented are mean size (mm) ± SE, summarized across seasons and plots within each zone. Dashed lines represent grand mean density for each zone. Across all zones, mean size decreased from 1990–2010, and some brief recoveries have occurred between 2010 and 2020, particularly in Zones II and III.
The percent cover of most target species are dynamic over time, and 2020 mean values were similar to overall mean values over the study period (1990–2020) (Figure 5). *Chthamalus/Balanus* barnacles were slightly lower than their grand mean values, but not lower than minima observed during the study period. *Mytilus* percent cover continues to be much lower than their abundances in the 1990s, however values from 2020 are not a severe departure from observations in the past decade. The abundance of *Silvetia* had slowly declined across all zones between 2005 and 2015, but increased across all zones in 2020. Finally, *Tetraclita* has been steadily increasing since 2015, and this finding is consistent across all zones.
Figure 5. Time series of target species abundance in photo-plots across (A) Zone I, (B) Zone II, and (C) Zone III from 1990–2020. Values presented are mean percent cover ± SE, summarized across seasons and plots within each zone (N ≥ 5 for each point). Dashed horizontal lines represent grand mean cover for each zone. Note that y-axis scales vary across plot rows. Present values for *Chthamalus/Balanus*, *Pollicipes* and *Silvetia* are nearby their respective grand means. Present values for *Mytilus* are below values in the 1990s, while *Tetraclita* cover is higher than the grand mean value.
Line Transects
Line transect data are highly variable in part due to low sample size (N = 2 transects per target species in each zone), but two trends merit investigation (Figure 6). First, along the Zone III transects targeting red algal turf, there has been an increase in other red algae accompanied by a decrease in articulated coralline algae. Second, along transects targeting *Egregia*, abundance remained below grand means in 2020, following a noted decline around 2016.
Figure 6. Time series of target species abundance in line transects across (A) Zone I, (B) Zone II, and (C) Zone III from 1990–2020. Values are mean annual percent cover summarized across seasons and plots within each zone (N ≥ 2 per point). Dashed lines represent grand mean cover for each zone. Note that y-axis scales vary across plot rows. Due to low replication and a dynamic system, abundance is highly variable over time.
**Timed Search**

While no target species were found, it is notable that four adult *Haliotis fulgens* (green abalone, a U.S. National Marine Fisheries species of concern), were found near the *Silvetia* plots in Zone III during Fall 2020 surveys at Cabrillo National Monument (Table 1).

**Table 1.** Timed search data collected in Zone I-III in Fall 2020. All green abalone (*Haliotis fulgens*) were adults in Zone III.

<table>
<thead>
<tr>
<th>Target and adjacent species</th>
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<td><em>Patiria miniata</em></td>
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<td><em>Pisaster</em> spp. *</td>
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<tr>
<td><em>Strongylocentrotus</em> spp.</td>
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<tr>
<td><em>Haliotis corrugate</em></td>
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<tr>
<td><em>Haliotis cracherodii</em> *</td>
<td>0</td>
</tr>
<tr>
<td><em>Haliotis fulgens</em></td>
<td>4</td>
</tr>
</tbody>
</table>

* Species targeted in time searches, also shown shaded in gray.
Literature Cited


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NPS 342/177953, December 2021