



Channel Islands National Park

Terrestrial Vegetation Monitoring Annual Report - 2020

Natural Resource Report NPS/MEDN/NRR—2023/2558





ON THIS PAGE

California macrophylla on Santa Barbara Island

Photograph by Dirk Rodriguez

ON THE COVER

Sunrise over Santa Barbara Island

Photograph by Dirk Rodriguez

Channel Islands National Park

Terrestrial Vegetation Monitoring Annual Report - 2020

Natural Resource Report NPS/MEDN/NRR—2023/2558

Cameron B. Williams

Channel Islands National Park
1901 Spinnaker Dr.
Ventura, CA 93001

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Executive Summary

This report presents the data collected in 2020 as part of the long-term terrestrial vegetation monitoring program at Channel Islands National Park.

The purpose of this monitoring program is to document long-term trends in the park's vegetation communities. Data are collected from 30-m-long transects using a point-line intercept method. In the past, each transect was sampled annually. However, beginning in 2012 the program began adding randomly located transects to improve the representativeness of the sampling, and transitioned to a rotating panel design. Now only a core subset of the transects are surveyed annually. Non-core transects are assigned to one of four panels, each of which is surveyed once every four years.

Coronavirus disease (COVID-19) caused a global pandemic that prevented field data collection from most of the transects scheduled for 2020. As a result, just 29 of the 127 transects scheduled were visited, distributed as follows: Santa Barbara Island ($n = 18$), Santa Cruz Island ($n = 11$). The small size of this 2020 dataset offers limited comparisons to previous years. The program also planned to install 19 new transects on Santa Rosa and San Miguel islands to complete the probabilistic component of the study design (Tiszler et al. 2016a), but the safety response to COVID-19 did not permit these installations.

Key 2020 results and interpretation:

- For the transects visited at both islands in 2020, a long-term decline in mean absolute cover, measured as the mean number of taxa intersecting each point along a transect, was apparent. Annual rainfall correlated positively with mean absolute cover of vegetation.
- Six vegetation communities were visited at Santa Barbara Island compared to nine at Santa Cruz Island, despite the smaller number of transects surveyed at the latter.
- Mean absolute cover at both islands together averaged 87%, with native plants covering 44% and non-natives covering 39%. Among vegetation communities, mean absolute cover ranged from a high of 137% in a *Lyonothamnus* grove to a low of 32% in a riparian community where few plants were encountered along one transect. Mean absolute cover was higher at Santa Cruz Island (105%) than Santa Barbara Island (77%), and mean absolute native cover followed the same pattern (57% vs 36%).
- For both islands combined, mean richness per transect was 11 taxa. Compared to Santa Barbara Island, Santa Cruz Island supported higher overall mean species richness (14 vs 9 taxa) and higher species evenness (0.70 vs 0.55).
- Santa Cruz Island's higher absolute cover, higher native species cover, higher species richness, and higher species evenness indicate that its vegetation is in better overall condition compared to Santa Barbara Island, and that the rate of recovery after overgrazing is faster at Santa Cruz Island than Santa Barbara Island.



Santa Cruz Island ironwood on Santa Cruz Island (photo by J. Lesage, Santa Barbara Botanic Garden).

Acknowledgments

No one accomplishes their work without assistance from others. This report is a result of the hard work done by the employees at Channel Islands National Park and is just one of the fruits of their labor. Thanks to Supervisory Natural Resource Manager, Annie Little, for organizing the effort that led to this 2020 vegetation monitoring dataset, and to the park's former Botanist, Dirk Rodriguez, for providing instructions and guidance on how to collect the data. GIS Specialist Rocky Rudolph provided valuable technical support. Special appreciation is extended to the Santa Barbara Botanic Garden's Denise Knapp for administrative support and to Stephanie Calloway, Josie Lesage, and Adam Searcy for performing all of the fieldwork associated with the 2020 vegetation monitoring.

Introduction

Channel Islands National Park (CHIS) hosts at least 800 species of vascular plants, including 70 endemics and 14 taxa protected under the Endangered Species Act. This oasis of biodiversity is comprised of five islands—Santa Barbara Island (SBI), Anacapa Island (ANI), Santa Cruz Island (SCI), Santa Rosa Island (SRI), and San Miguel Island (SMI)—located off the coast of southern California (Figure 1). Although at least 13,000 years of Native American habitation influenced the ecology of these islands (Orr 1962; Johnson et al. 2002), the relatively brief tenure of grazers introduced by ranching activities from the mid-1800s through 2015 dramatically altered the trajectory of vegetation in the park today (Rick et al. 2014; McEachern et al. 2016).



Figure 1. Channel Islands National Park (islands outlined in green).

Long-term monitoring is a critical component of environmental science because it is inexpensive compared to the value of the resources it protects and management it guides, and the data can inform interdisciplinary ecological inquiries (Lovett et al. 2007). A formal long-term terrestrial vegetation

monitoring program was initiated at CHIS in 1984 when 54 transects were established across SBI, ANI, and SMI to monitor the dominant island vegetation communities using a point-line intercept method (Halvorson et al. 1988; McEachern 2001). In subsequent years, shrub and tree-based monitoring protocols were added (McEachern 2000). When the park acquired SRI in 1990 and the eastern parts of SCI in 1999 and 2001, an additional 86 and 43 transects were planned, respectively. The remaining portion (western 76%) of SCI is owned and managed by The Nature Conservancy (TNC) and is not included in the park's long-term vegetation monitoring program.

The Mediterranean Coast Network (MEDN) of Inventory and Monitoring (I&M) was created in 2000, when long-term terrestrial vegetation monitoring became one of the network's 15 'Vital Signs' programs (Cameron et al. 2005). Beginning in 2012, improvements to the original monitoring protocol corrected deficiencies to improve the underlying statistical framework. These improvements included installing additional probabilistically selected transects and transitioning from monitoring all transects annually to a rotating panel design in which a core set of transects were visited annually (hereafter, "core" transects), and each of the remaining transects were assigned to one of four panels with each panel set on a four-year rotating schedule (hereafter, "panel" transects). The transition to a design of core and panel transects resulted in a loss of some statistical power to detect interannual variability, but it expanded spatial coverage and provided statistical inference to the islands as a whole. The modified program was then expanded to the two other parks within the MEDN—Santa Monica National Recreation Area and Cabrillo National Monument. See Tiszler et al. (2016a) for a detailed review of changes to the monitoring program.

This report summarizes the terrestrial vegetation monitoring data collected at CHIS in 2020. The cursory analyses and interpretation provided are intended as a brief overview of the program's activities in 2020 rather than a thorough analysis of long-term trends and covariates in the vegetation data. Interpretations are guided primarily by inter-island variation in climate and physiography as well as the history of grazing by introduced animals.

Methods

Monitoring Dates

The seasonality of monitoring can be an important variable that affects the data collected. California’s Mediterranean-type climate is characterized by cool wet winters and warm dry summers, a pattern that drives much of the phenological variation in the state’s vegetation, including at CHIS. The optimal period for terrestrial vegetation monitoring at CHIS is between late February and mid-May. The 2020 field schedule fit within this period (Table 1).

Table 1. Field schedule for vegetation monitoring at Channel Islands National Park in 2020. Counts of transects surveyed by island and by core/panel are included, as are the number of transects for which the shrub density and tree density measurements were implemented.

Island	Dates visited	Total	Core	Panel C	Panel D	Shrub	Tree
Santa Barbara Island	02/20–02/25	18	8	1	9	7	0
Santa Cruz Island	03/03–03/08	11	6	0	5	5	2

Transect Locations

The transects monitored in 2020 consisted of a combination of legacy sites used in the past for early vegetation research, plus a set of modern transects installed specifically to monitor long-term changes in the park’s vegetation. Legacy transects were deliberately placed in areas with intact native vegetation, whereas modern transects were placed using a generalized random tessellation stratified survey design (GRTS; Olsen et al. 2012) to achieve a spatially balanced probabilistic sample that allows inference to each entire island, and the park portion of SCI. A statistically appropriate analysis would need to take into account this difference in placement of legacy (non-random) versus modern (probabilistic) transects. However, for the purposes of summarizing the 2020 data for this annual report, the data are treated as a simple random sample. A total of 29 transects were surveyed, including 14 designated as core transects and 15 as panel (Table 1). Eighteen transects were surveyed at SBI and 11 at SCI (Figures 2–3).

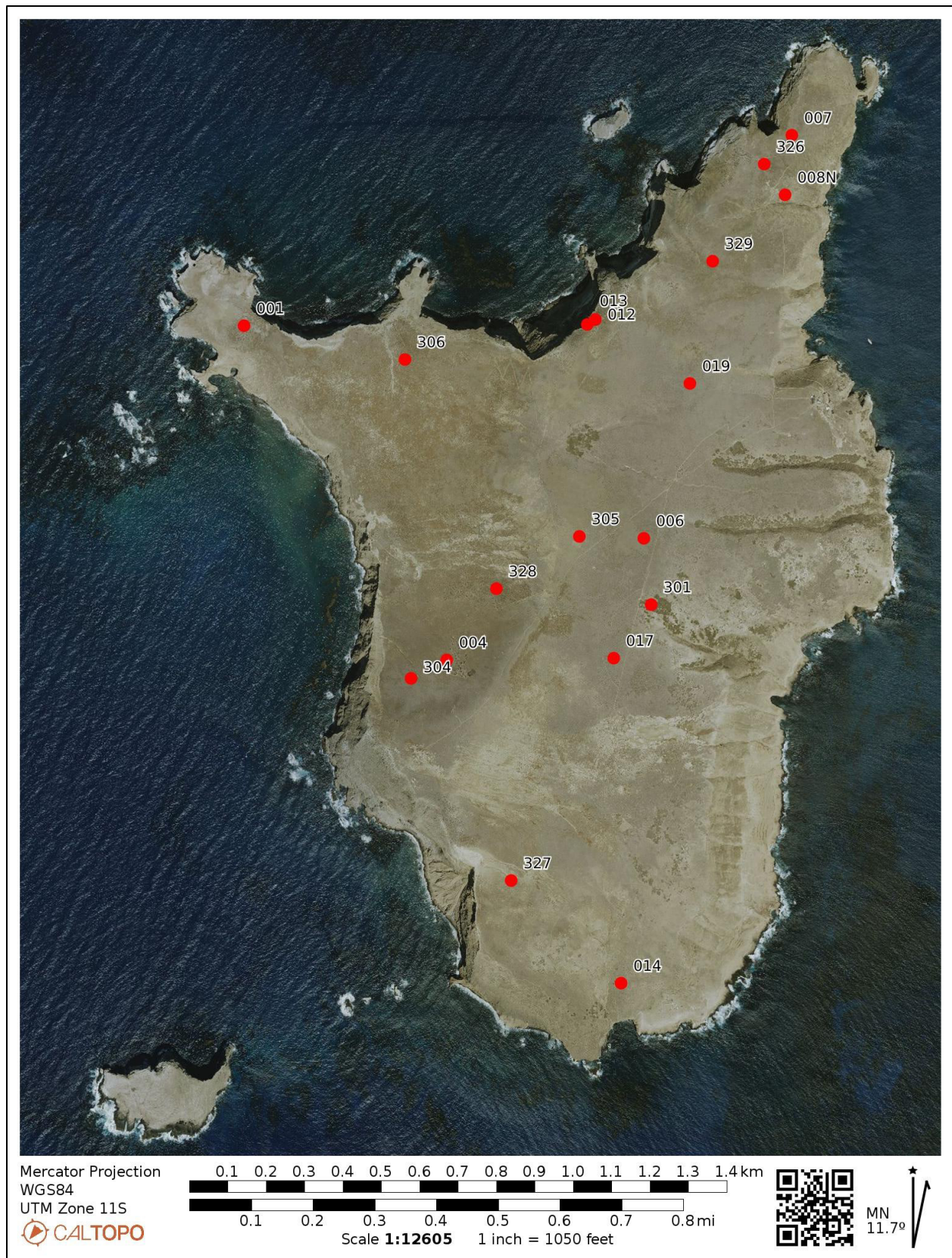


Figure 2. Vegetation monitoring transects on Santa Barbara Island surveyed in 2020.

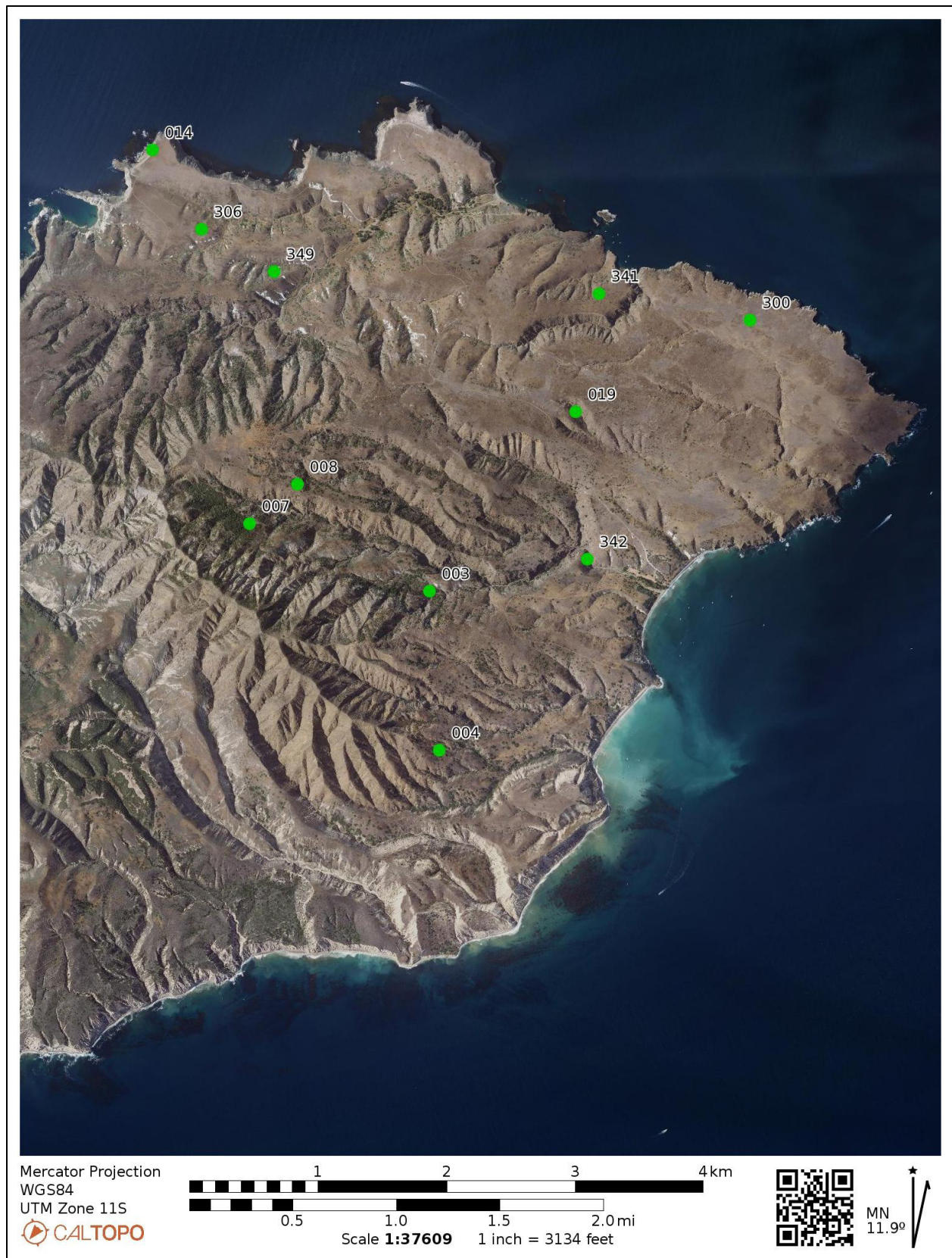


Figure 3. Vegetation monitoring transects on Santa Cruz Island surveyed in 2020.

Field Data Collection

A standard operating procedure (SOP) describing the methods that were used to conduct this vegetation monitoring includes a foliar cover measurement, a species richness count, a shrub density measurement, and a tree density measurement (Tiszler et al. 2016b). Each were referred to as ‘protocols’ in the CHIS legacy vegetation monitoring handbook (Halverson et al. 1988) and in a USGS report on tree and shrub monitoring (McEachern 2000).

For the foliar cover measurement, a meter tape was stretched out between two monument stakes that mark the ends of a transect (Figure 4), and data were recorded every 30 cm along the meter tape using a point-line-intercept method. The data recorded were the plant taxa present at those points (both live and, for perennial species, dead tissue). The height of the tallest vegetation was also recorded at each point. Each transect was 30 m in length and provided 100 points of data, except for three legacy transects at SBI, two of which were 39 m and one 22 m. Differences in transect length were reconciled during the data analysis (see below).

The species richness count captured richness at three different spatial levels: (1) taxa encountered using the point-line intercept method, (2) taxa occurring within a 1-m plot adjacent to the transect line that were not already recorded by the point-line intercept method, and (3) taxa occurring within a 5-m plot adjacent to the transect line that were not already recorded by 1 and 2 above. Importantly, this last spatial level, implemented starting in 2016, represents a departure from the SOP, which described a 10-m wide plot centered on the 30-m point-line intercept transect (Tiszler et al. 2016b).

The density of shrubs, when present, was measured if not recorded in the previous year. A 1-m plot was placed adjacent to the transect line, divided into six 1-m x 5-m sub-plots, and the number of individuals present within each sub-plot was counted (Figure 4). Four developmental classes—seedling, juvenile, live adult, and dead adult—were recorded. Importantly, two departures from the SOP occurred. First, the number of individuals, not the number of stems per shrub, was counted. Second, resprouts were not included as a developmental class. These two departures from the shrub protocol were consistent with past surveys.

In tree-dominated communities, tree density was measured within a 10-m x 30-m plot centered on the 30-m point-line intercept transect with half of the plot on the uphill side of the transect line and the other half on the downhill side (Figure 4). Within the plot, tree species were recorded in five categories: seedlings, juveniles, live adults, dead adults, and basal resprouts. For the live adult class, diameter at breast height was also measured.

Data from the foliar cover measurements and species richness counts were recorded directly into an iPad via FileMaker specifically customized for the MEDN long-term vegetation monitoring program. Data files were then shuttled into a Microsoft Access (version 365; Microsoft Corporation 2021) database maintained by the MEDN I&M data manager. Shrub and tree density measurements were recorded onto paper datasheets and subsequently entered directly into the database.

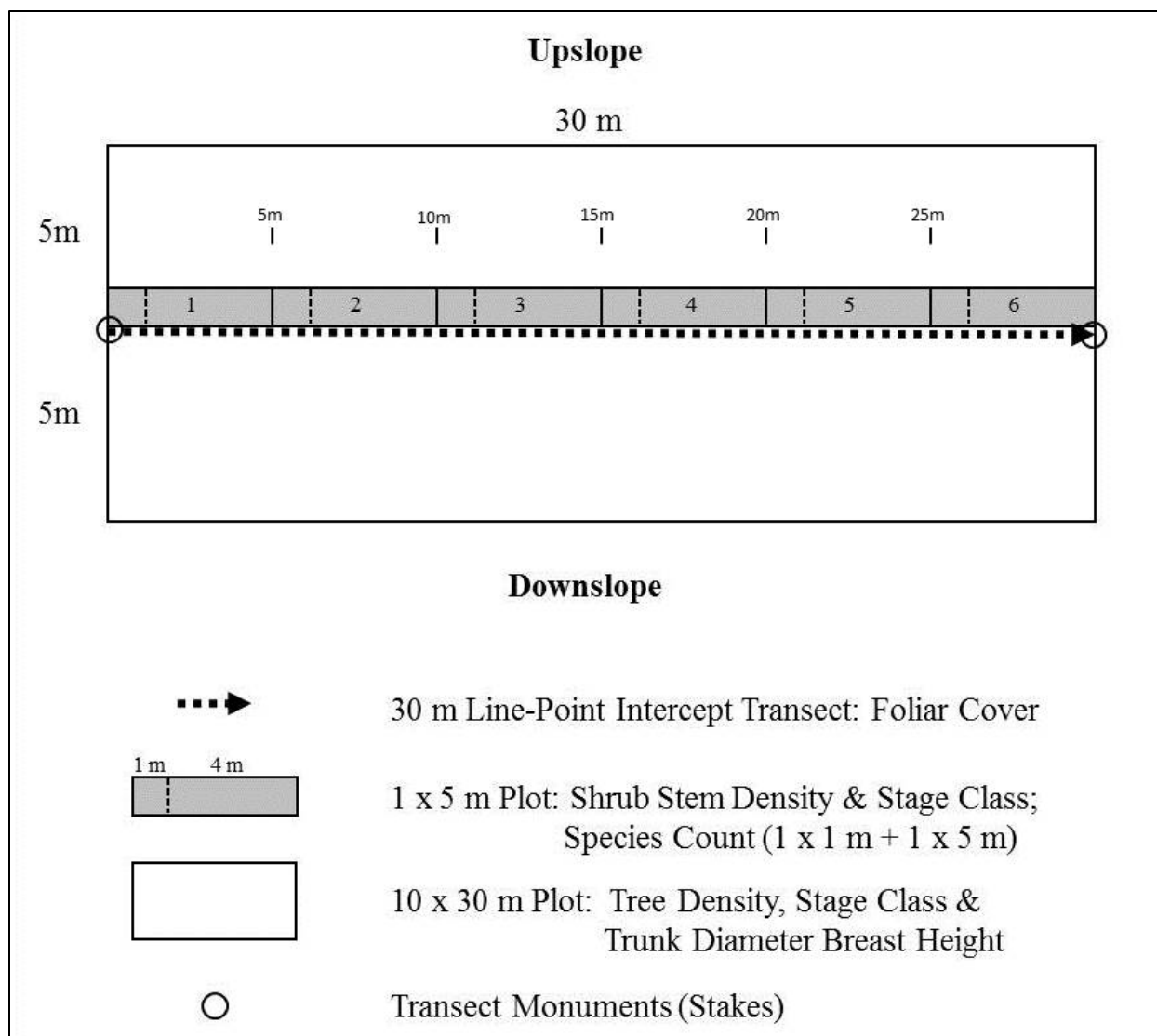


Figure 4. Schematic diagram of a 30-m transect with overlying shrub and tree plots (from Tiszler et al. 2016b).

Precipitation Records

Long-term precipitation records from the park islands are incomplete, so a complete dataset (1957–present) of rainfall was retrieved from Station 168 (Ventura County Watershed Protection District 2022) located near Oxnard, California to represent the timing and relative quantity of rainfall received by the park as a whole (Figure 5). Annual precipitation from Station 168 was based on water years extending from October to September. Additionally, mean annual precipitation for SBI (1980–2004) and SCI (1990–2020) were retrieved from the Western Regional Climate Center (2022).

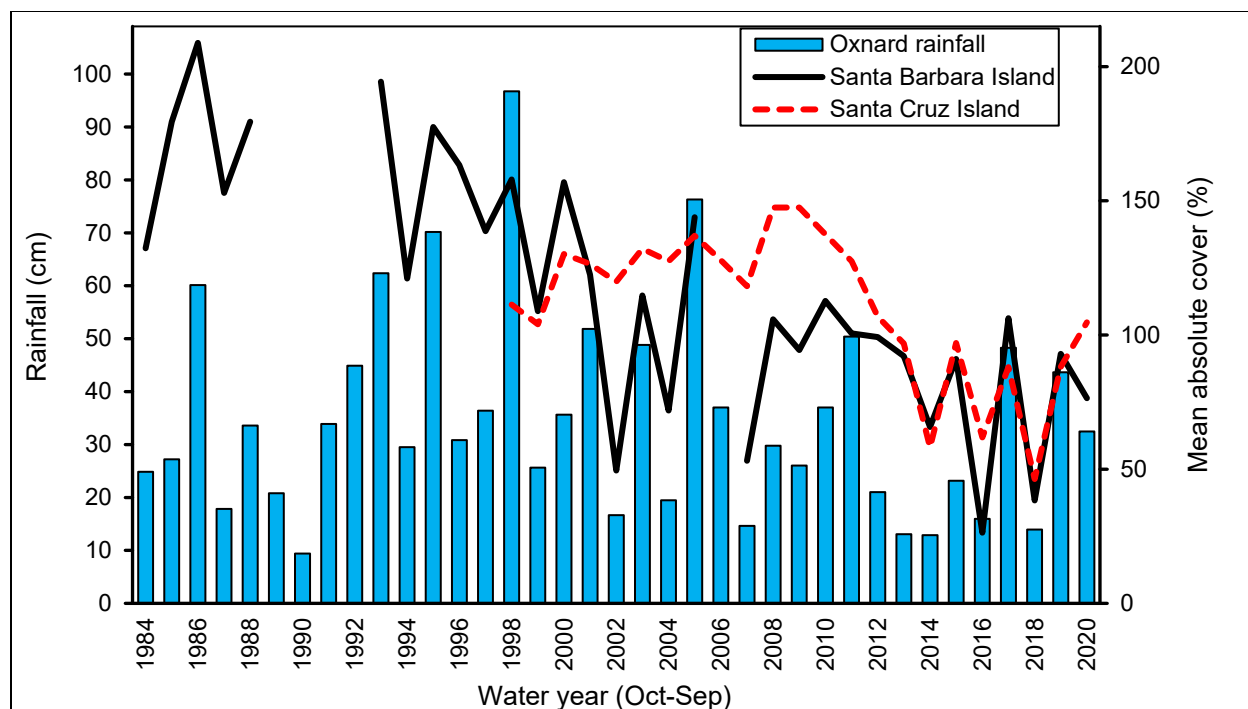


Figure 5. Mean absolute vegetation cover per transect at Santa Barbara Island (18 transects) or Santa Cruz Island (11 transects) since 1984, compared to annual rainfall. Vegetation data were not collected in 1989–1992 or 2006. Rainfall data are from Station 168 (Ventura County Watershed Protection District 2022) near Oxnard, California.

Data Management and Analysis

After field work, all data were quality assured (QA) and quality controlled (QC) by the park botanist. The Microsoft Access database was then queried to extract summaries of the QA and QC data, and the summaries were exported to Microsoft Excel (version 365; Microsoft Corporation 2021) where quantitative community indicators such as foliar cover, species richness, and species evenness were calculated.

To allow cover data collected using the point-line intercept method to be comparable across transects of different length, they were converted to absolute cover by summing across a transect the number of taxa recorded at each point and then dividing that sum by the total number of points. A logarithmic regression model was then used to explore the relationship between precipitation and absolute cover. Absolute total cover, native cover, and perennial cover were compared between SBI and SCI using one-tailed t-tests after confirming that the data were normally distributed via Kolmogorov-Smirnov tests. Relative cover (%) was computed by dividing the components of absolute cover by total absolute cover.

Species richness is defined as the number of species in a given area. I included taxa encountered using the point-line intercept method plus any additional species registered within the 1 x 30 m belt to improve representation of infrequent taxa, since data from point-line intercept transects typically underestimate infrequent species (Dethier et al. 1993). Species evenness, a measure of relative

dominance among species (Smith and Wilson 1999), was represented by Pielou's J (Pielou 1966) for each transect, using

$$J = H' / H'_{max} \quad \text{Equation 1}$$

in which H' is the Shannon index, calculated as

$$H' = - \sum_{i=1}^s P_i \ln P_i \quad \text{Equation 2}$$

(McCune and Grace 2002). In Equation 2, s represents species richness while P_i is the portion of species i to all species within the population or sample. In Equation 1, H'_{max} is the maximum possible value of H' . Pielou's J ranges from 0 to 1 and is highest when all species have equal abundance. Normality of the species richness and species evenness data was confirmed via Kolmogorov-Smirnov tests, after which these diversity indices were compared between SBI and SCI using one-tailed t-tests.

Results and Interpretation

The 2020 CHIS vegetation monitoring dataset is very incomplete due to the COVID-19 safety response and termination of field work. Therefore, the analyses and summaries below offer minimal among-year interpretation. Relationships were drawn between vegetation cover and annual precipitation. Native versus non-native cover and diversity indices were compared among plant communities and between SBI and SCI. Shrub and tree protocols were implemented too infrequently (Table 1) to warrant associated analyses.

Vegetation Cover

The long-term vegetation monitoring data from CHIS has historically portrayed a positive relationship between precipitation and the mean number of ‘hits’ per transect (e.g., Rodriguez 2021), which for a given transect is the sum of the species richness recorded at each point along that transect (Tiszler et al. 2016b). For example, the 2012–2016 California drought, which may have been the driest four years of the previous 1,200 (Dong et al. 2019), manifested as a dip in the mean number of hits per transect during those years (Rodriguez and Williams 2022). A similar pattern emerged when culling the historical data to include only the 29 transects visited in 2020—absolute cover was positively correlated with annual rainfall (Figures 5, 6). This analysis also revealed an apparent long-term decline in absolute cover that was more pronounced at SBI than SCI (Figure 5), but caution is urged in this interpretation because not every transect surveyed in 2020 was surveyed in prior years.

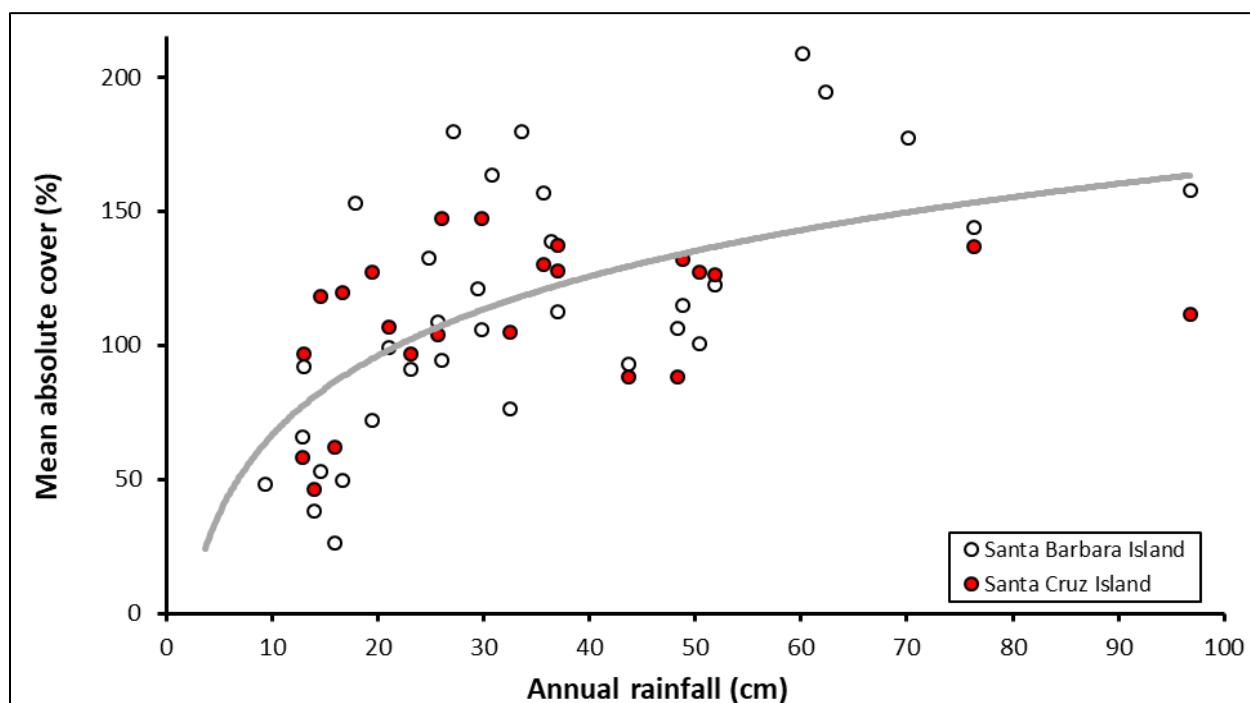


Figure 6. Positive correlation between annual rainfall and mean absolute cover of vegetation at Santa Barbara Island (18 transects spanning 1984–2020) and Santa Cruz Island (11 transects spanning 1998–2020) combined. Data were fit to a logarithmic regression model: $y = 42.663 \ln(x) - 31.722$ ($R^2 = 0.37$). Rainfall data are from Station 168 (Ventura County Watershed Protection District 2022) near Oxnard, CA.

The tallest canopy was 537 cm, formed by a dense grove of *Lyonothamnus* on SCI, whereas the shortest canopy was less than 2 cm tall on a sparsely vegetated transect dominated by *Erodium* sp. in a coastal scrub community at Santa Barbara Island (Table 2). Mean canopy height per transect was much higher at Santa Cruz Island than Santa Barbara Island (146 vs 11 cm), which was expected due to the presence of several tree-dominated transects at SCI and the altogether absence of trees at SBI.

Table 2. Mean canopy heights and counts of transects surveyed within each vegetation community at Santa Barbara Island and Santa Cruz Island in 2020.

Community	Mean canopy height (cm)	Santa Barbara Island	Santa Cruz Island
Boxthorn Scrub	17	2	0
Cactus Scrub	7	1	0
Cactus Scrub	7	1	0
Coastal Bluff Scrub	14	0	1
Coastal Scrub	14	1	2
Coreopsis Scrub	13	2	0
Island Chaparral	211	0	1
<i>Lyonothamnus</i> Grove	537	0	1
Mixed Woodland	256	0	1
Oak Woodland	461	0	1
Riparian	11	0	1
Seablite Scrub	8	4	0
Seacliff Scrub	5	2	0
Shrub Savannah	19	0	1
Valley/Foothill Grassland	18	6	2

Overall plant cover and the cover of native taxa can help evaluate the condition of the park's vegetation communities after years of extensive grazing, as some plant communities increased native plant cover following the removal of introduced herbivores (Willis et al. 2018). The highest absolute cover was in a *Lyonothamnus* grove that supported a mean of 137%, but this community ranked 9th of 14 with only 63% of the cover attributed to native plants (Figure 7). Mixed woodland, island chaparral, riparian, and oak woodland each supported over 80% cover of native plants, whereas seablite scrub and shrub savannah each had 25% or less of native cover. Valley/foothill grassland, the most common community surveyed in 2020, also exhibited relatively little native plant cover at 40%. Santa Cruz Island on average supported significantly higher absolute cover of all plant taxa combined (105% vs 77%; $p = 0.032$) as well as higher native cover (57% vs 36%; $p = 0.026$) (Figure 8). These patterns may be driven by a significant and nearly two-fold higher absolute cover of

perennial plants at SCI compared to SBI (65% vs 15%; $p < 0.001$), and they suggest that SCI could be undergoing a more effective recovery after grazer removal compared to SBI. The fact that SCI receives higher annual precipitation (40 vs 20 cm) than SBI is also likely to play an important role in recovery. For example, the non-native species *Hordeum murinum* (foxtail grass) and *Mesembryanthemum crystallinum* (crystalline iceplant) may switch dominance with the native shrub *Suaeda taxifolia* (woolly seablite) in patterns that are related to climate (Davidson et al. 2019). Other environmental variables influential to vegetation recovery include land-use history, hydrology, geology, and soil types (McEachern et al. 2016; Schoenherr et al. 1999). In particular, SBI's thin, clayey soils may resist community change away from domination by non-native annuals (McEachern et al. 2016).

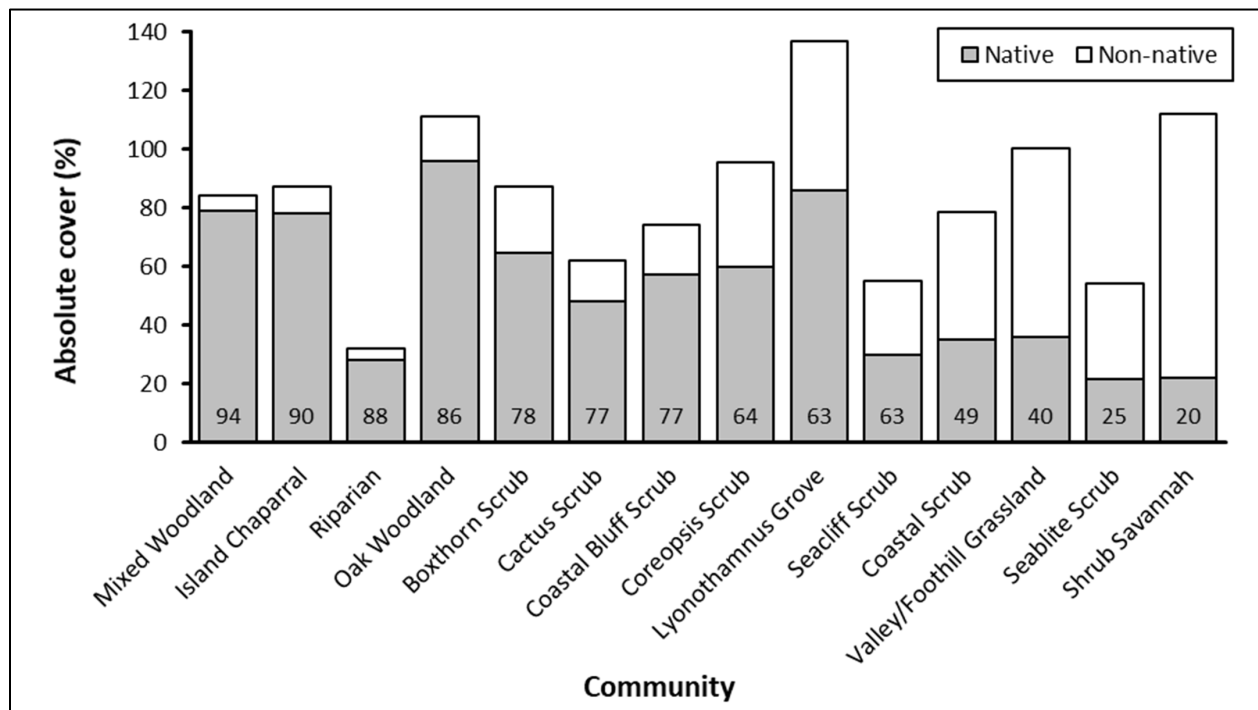


Figure 7. Mean absolute cover of native vs non-native plants by community at Santa Barbara and Santa Cruz Islands in 2020. Communities are ranked by percent native cover, as enumerated in each column.

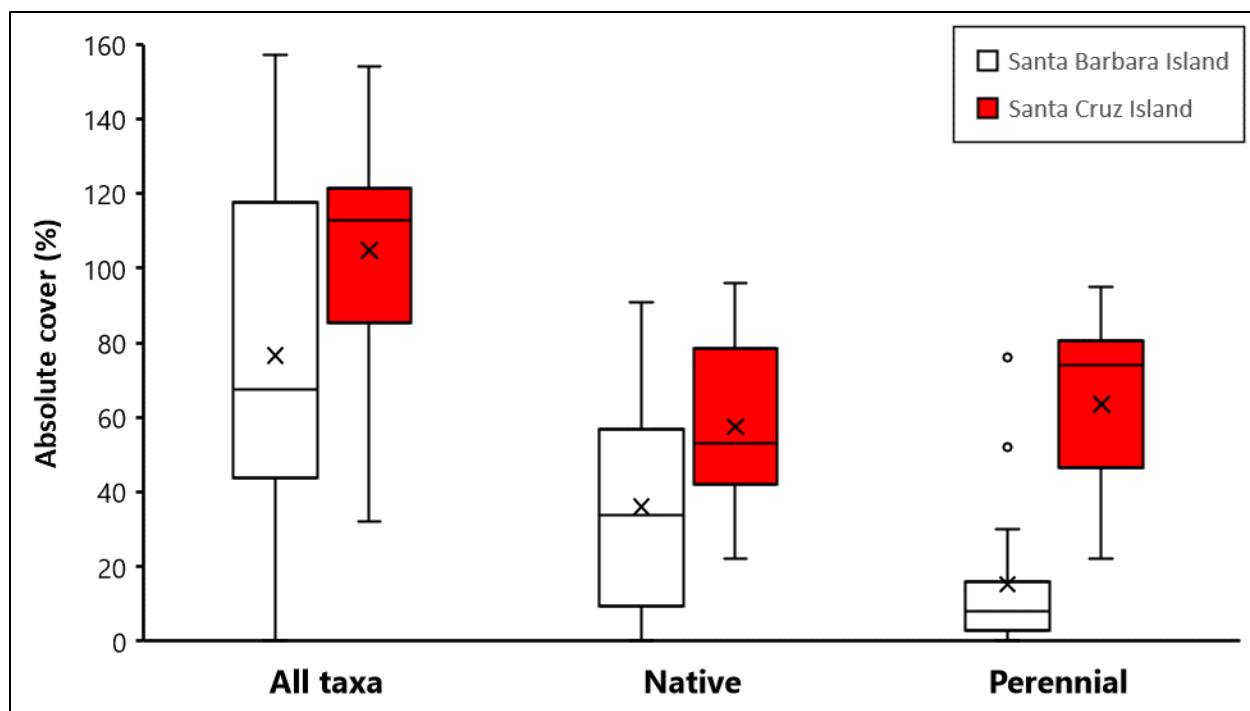


Figure 8. Comparisons of absolute vegetation cover between Santa Barbara Island and Santa Cruz Island in 2020. “x” represents mean. All differences were significant ($p < 0.05$ for each comparison).

Species Richness and Evenness

Species composition exerts a strong influence over susceptibility to invasion by non-native plants (Hooper et al. 2005), and ecosystem productivity is positively correlated with both species richness and species evenness (e.g., Naeem et al. 1994; Wilsey and Potvin 2000). Therefore, diversity indices compared among plant communities can be useful tools in evaluating community and ecosystem recovery after environmental degradation, such as that caused by overgrazing. At CHIS in 2020, the most species-rich plant communities were shrub savanna (18 taxa), boxthorn scrub (17 taxa), and cactus scrub (16 taxa) (Figure 9). Communities supporting the fewest taxa included seablite scrub, seacliff scrub (6 taxa each), and valley/foothill grassland (8 taxa). The highest proportion of native species was found in island chaparral (91%) and mixed woodland (83%), whereas the communities supporting the smallest proportion of native plant richness were seablite scrub (31%) and valley/foothill grassland (38%). The lack of statistical replication for many of these communities constrains interpretation. However, seablite scrub ($n = 4$) and valley/foothill grassland ($n = 8$) had consistently low proportions of absolute cover and native richness, as well as relatively low overall richness. These communities may have been more susceptible to grazing in the past and currently resistant to passive recovery; both communities could benefit from targeted restoration efforts. Island chaparral and mixed woodland ($n = 1$ each) may represent the other end of the spectrum.

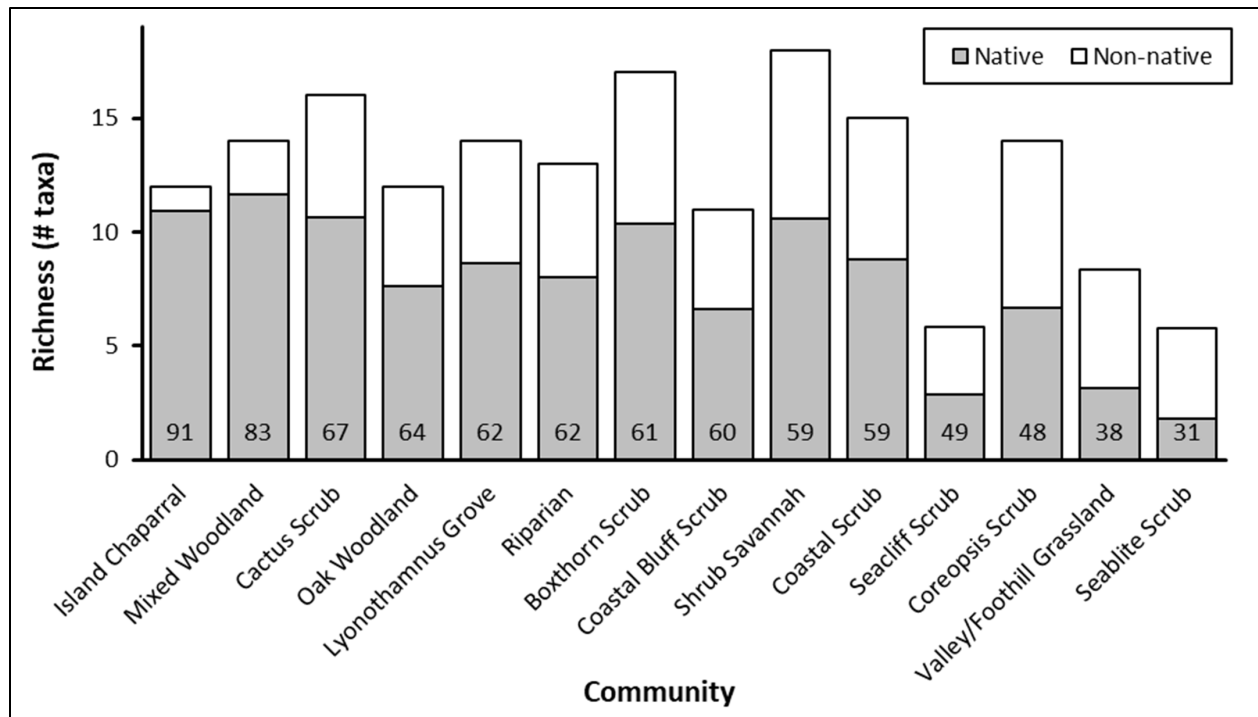


Figure 9. Mean richness of native vs non-native plants by community at Santa Barbara and Santa Cruz Islands in 2020. Communities are ranked by percent richness of natives, as enumerated in each column.

Santa Cruz Island supported significantly higher species richness than SBI (14 vs 9 taxa, $p = 0.044$; Figure 10). Species evenness was also higher at SCI compared SBI (0.70 vs 0.55, $p = 0.034$; Figure 10). High species richness is consistently associated with resistance to invasion by non-native species in part because a range of species responses to environmental disturbance can stabilize ecosystem processes (Hooper et al. 2005). Therefore, SBI may be more susceptible to non-native species invasions compared to SCI. Perhaps exacerbating this susceptibility is SBI's potentially lower rate of productivity as suggested by the island's lower richness and evenness (Figure 10).

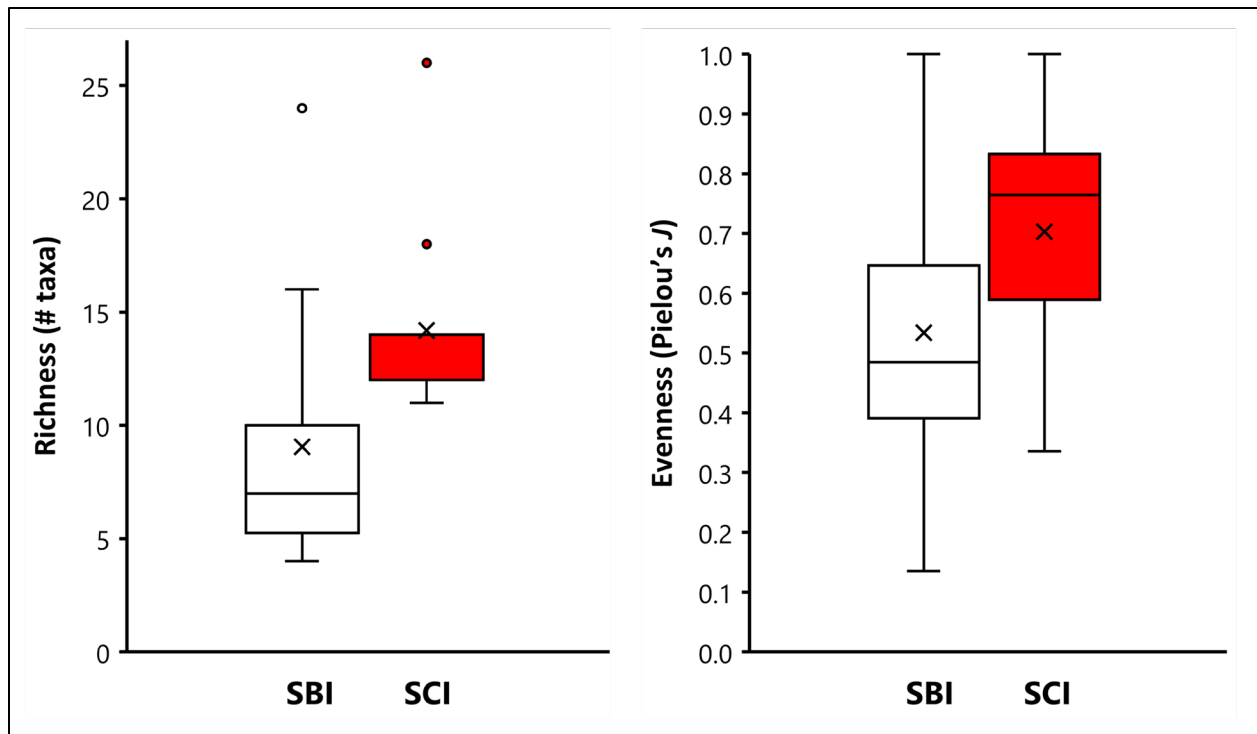


Figure 10. Mean richness (left) and evenness (right) compared between Santa Barbara Island (SBI) and Santa Cruz Island (SCI). “x” represents mean. Both comparisons were significant ($p < 0.05$ for each).

Conclusions

COVID-19 severely limited field visits to long-term vegetation monitoring transects that were scheduled for 2020. Despite this limitation, 29 of the 127 scheduled transects were surveyed, but the dataset's small size inhibits comparisons to previous years. Consistent with historical analyses, vegetation cover continues to be positively correlated with precipitation; severe droughts in the past were visible in the cover data, and future droughts are likely to manifest in a similar manner. Compared to SBI, SCI exhibits: (1) higher absolute cover and (2) higher native species cover, patterns that may be driven by the higher cover of perennial species; (3) higher species richness, and (4) higher species evenness. These results collectively suggest that SCI's ecosystem processes may be more resilient to perturbations such as drought and/or invasions by non-native species. In addition, SCI's higher rate of productivity (as inferred via higher richness and evenness) and higher annual rainfall (Western Regional Climate Center 2022) likely fostered a faster historical rate of recovery after overgrazing compared to SBI; they may also forecast a faster future recovery rate. The seablite scrub community at SBI appears to be slow to recover, as evidenced by low absolute cover, low overall richness, and low proportion of native species. Recovery of this community may greatly benefit from targeted restoration efforts.

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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525