



Channel Islands National Park

Vegetation Classification and Mapping Project Report



National Park Service crew sampling vegetation on Santa Rosa Island, Channel Islands National Park.
NPS

Channel Islands National Park: Vegetation classification and mapping project report

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Abstract

In 2012, Channel Islands National Park (CHIS), with support and funding from the National Park Service's (NPS) National Vegetation Mapping Inventory (VMI) Program, initiated new vegetation classifications and maps for four northern Channel Islands—Anacapa Island (ANI), Santa Rosa Island (SRI), Santa Cruz Island (SCI), and San Miguel Island (SMI). The project was conducted in two distinct phases. Phase 1 consisted of a mapping and classification effort for ANI, SRI, and SMI. Phase 2 mapped and classified the vegetation for SCI alone. Initial site visits and reconnaissance were conducted jointly by AIS and NPS, followed by NPS-led field data collection efforts. Data collection for the photo interpretation and for the basis of the vegetation classification continued for more than two years, resulting in the completion of over 1,600 field plots and rapid field assessments. For both Phases 1 and 2, map polygons were delineated from photo interpretation of 2012 and 2017 (respectively) aerial color imagery (six-inch resolution) using heads-up digitizing. In total, Phase 1 generated 13,767 polygons that were delineated across 84 different mapping units and Phase 2 generated 13,901 polygons that were delineated across 52 different mapping units. Once draft maps were completed, accuracy assessments were completed to ensure polygons were mapped accurately. The accuracy assessment analysis revealed some discrepancies; however, further review yielded no change to the original field identifications. For Phases 1 and 2 combined, analysis of the field data resulted in 58 plant alliances and 114 associations. SRI supported the highest number of vegetation types despite being the second largest Channel Island, whereas the largest island, SCI, ranked second. However, SCI had the most shrub-dominated vegetation types, whereas SRI had the most herb-dominated types. Six alliances/associations were shared among all four islands, 17 were shared by three islands, 39 were shared by two islands, and another 39 were unique to individual islands.

Executive Summary

In 2012, Channel Islands National Park (CHIS), with support and funding from the National Park Service's (NPS) National Vegetation Mapping Inventory (VMI)¹ Program, initiated new vegetation classifications and maps for four northern Channel Islands—Anacapa Island (ANI), Santa Rosa Island (SRI), Santa Cruz Island (SCI), and San Miguel Island (SMI). The fifth northern island within the park, Santa Barbara Island (SBI), was not included in the project for reasons discussed below.

Although the four northern Channel Islands included in the project share a similar bioregional environment, the work was conducted in two distinct phases. Phase 1 consisted of a mapping and classification effort for ANI, SRI, and SMI. Phase 2 mapped and classified the vegetation for SCI alone. Prior to the beginning of the project in 2012, and in consultation with the NPS VMI, it was originally decided that SCI and SBI would be excluded from the project for three reasons: (1) vegetation classifications and maps had been completed for both islands within the previous 10 years, (2) the cost of including both islands, especially SCI, would have exceeded the project budget allocation, and (3) specific to SCI, 76% of that island is owned and managed by The Nature Conservancy (TNC).

However, as the mapping and classification effort for ANI, SRI, and SMI neared completion, TNC began a mapping and classification effort for their portion of SCI. By 2016, TNC realized that their funds were insufficient to complete the mapping efforts. They also realized that including the NPS-owned part of SCI would result in a higher quality map because some plant communities were better represented on the NPS-managed part of the island. In addition, TNC wanted to create a map that would meet NPS VMI standards, but they were not familiar with those standards. Therefore, TNC broached the idea of collaboration with CHIS to complete their classification and mapping effort. Following approval from NPS VMI, Phase 2 was initiated with CHIS assistance. This assistance included providing input on modifying the standard field methods used to collect vegetation classification, sharing accuracy assessment (AA) data to take better advantage of the use of a small helicopter to move from site to site, assisting with field reconnaissance trips with the photo interpreters, conducting the AA of the SCI map, and incorporating the results into the final report.

Although SBI was not included in this project, the field data collected for that island in 2010 was incorporated into a California Native Plant Society (CNPS) vegetation classification effort for all eight Channel Islands. That classification effort was not part of this project, but it did utilize the project's field data in the final vegetation classification.

Key collaborators for Phase 1 included Aerial Information Systems (AIS), CNPS, Santa Barbara Botanic Garden (SBBG), and NPS. For Phase 2, AIS, CNPS, and NPS remained as key collaborators, but the role of SBBG diminished, while TNC played a major role in the mapping effort for SCI. Photo interpretation and polygon delineation of the vegetation maps were overseen by AIS for both

¹ The NPS Vegetation Mapping Inventory (VMI) was formerly known as the USGS-NPS Vegetation Mapping Program but underwent a name change. The program is referred to as NPS VMI throughout this report.

phases. The vegetation classification effort was led by CNPS for all four islands with initial assistance by NPS, while SBBG provided taxonomic expertise and served as the repository for the plant specimens collected. Staff at CHIS coordinated the overall efforts and also collected field data for the vegetation classification and the photo interpretation for ANI, SRI, and SMI. Field data collecting efforts for SCI were led by TNC for both the vegetation classification and the AA.

For Phase 1 (ANI, SRI, SMI), a formal initiation meeting took place in January 2012, when goals and timelines were outlined for all interested parties and collaborators. That spring, initial site visits and reconnaissance were conducted jointly by AIS and NPS, followed by NPS-led field data collection efforts. Data collection for the photo interpretation and for the basis of the vegetation classification continued for more than two years, resulting in the completion of over 1,600 field plots and rapid field assessments. Plot data were collected from both random and subjective locations while rapid field assessments were directed by AIS. An interim vegetation classification was then completed by NPS staff, followed by a preliminary field key generated by CNPS. This key was tested by CHIS field staff that provided feedback to CNPS prior to the development of the final field key in 2013.

Phase 1 map polygons were delineated from photo interpretation of 2012 aerial color imagery (six-inch resolution) using heads-up digitizing. Where interpretation of photo signatures was obscured by shadows or other anomalies, field visits resolved the vegetation types. Although the majority of the delineation was confined to the standard minimum mapping unit of 0.5 ha, some island vegetation types affected by ranching-era grazing led to fragmented plant communities, in which case areas less than 0.5 ha were delineated when ample contrast from the surrounding plant communities occurred. Mapping units smaller than the standard minimum were also delineated for island-unique vegetation communities such as stands of ironwood and island oak. In total, 13,767 polygons were delineated across 84 different mapping units. The mean area among all terrestrial mapping units was 1.84 ha. Separated by island, SRI had 11,231 polygons with a mean area of 1.91 ha. For SMI and ANI, these values were 2,148 polygons with 1.74 ha, and 388 polygons with 0.70 ha, respectively. Exotic trees and shrubs, sparsely to non-vegetated areas, and water bodies encompassed 193 polygons with a mean area of 3.68 ha.

After completion of the draft maps for Phase 1, field data supporting an AA were collected from SRI and SMI. Over 920 plots or stand rapid assessments were completed during this effort, yielding overall accuracies of 88.0% for SRI and 84.9% for SMI (with Kappa coefficient correction, 83.6% and 82.5%, respectively). Of the 42 mapped types on SRI, 14 were below 80% user's accuracy and 16 were below 80% producer's accuracy, whereas of the 23 mapped types on SMI, six were below both 80% user's accuracy and 80% producer's accuracy. The majority of the vegetation types below 80% accuracy were herbaceous classes where cover of the dominants likely varied among years. An AA was not attempted for ANI because access to the middle and west islets was constrained somewhat by ocean conditions and substantially by closures that protect California Brown Pelican (*Pelecanus occidentalis* ssp. *californicus*) nesting activities January through August, a range that encompasses the phenologically appropriate timing for vegetation surveys. Conducting an AA that is outside of a phenologically appropriate window would have biased the results away from annual

species and yielded lower confidence. Fortunately, the relatively small sizes of each islet allowed field crews to visit nearly all of the community types that were safe to access.

For Phase 2 (SCI), a formal initiation meeting did not take place because TNC had already begun the vegetation mapping project prior to CHIS involvement and because the collaborators responsible for Phase 1 needed to perform their work. Polygon delineation and map creation was managed by AIS, and the vegetation classification was generated by CNPS using data collected from SCI in combination with ANI, SRI, and SMI. The Nature Conservancy managed the data collection for both the vegetation classification and AA. The NPS role was to support any protocol modifications, assist field reconnaissance, conduct the AA, and document the efforts as part of the overall project report.

Polygon delineation for Phase 2 was identical to the methodology for Phase 1, except that it was based on aerial color imagery obtained in 2017 rather than 2012. The minimum mapping unit was 0.5 ha and included smaller delineations for stands of unique or rare island communities. In total, 13,901 polygons were delineated across 52 different mapping units, excluding units within the littoral zone. The mean size of all terrestrial mapping units for SCI was 1.78 ha, and the largest and smallest terrestrial mapping units were 263 ha and <0.001 ha, respectively.

The AA for Phase 2 did not rely on ground-truthed field visits. Instead, an experienced island botanist used the vegetation field key from a helicopter to determine the plant community type for each AA point. Multiple high-resolution photographs were taken of each plot area, which were subsequently reviewed if a discrepancy in the classification occurred. Although the AA analysis revealed some discrepancies, further review yielded no change to the original field identifications.

For Phases 1 and 2 combined, analysis of the field data resulted in 58 plant alliances and 114 associations. Surprisingly, SRI supported the highest number of vegetation types despite being the second largest Channel Island, whereas the largest island SCI ranked second. However, SCI had the most shrub-dominated vegetation types, whereas SRI had the most herb-dominated types. This latter result may be a consequence of the more recent removal of ranched animals from SRI. Six alliances/associations were shared among all four islands, 17 were shared by three islands, 39 were shared by two islands, and 39 were each unique to one island. Plant communities ranged from Torrey pine and oak woodland to chaparral and annual or perennial grassland. Shrubland and grassland were the most dominant communities in terms of the number of vegetation types they encompassed and areas they covered.

Products generated from the CHIS vegetation mapping effort that are available in this document include:

- Summary of methods and results
- Dichotomous vegetation community field key
- Description of mapping protocols and vegetation map classes
- Descriptions of vegetation alliances and associations

- Samples of completed field forms

Products generated from the mapping project that are available elsewhere include:

- Geodatabase containing map polygons and attributes
- Photographs of classification plots, reconnaissance observation points, and AA points in both hard copy and digital versions
- All field data collected for the above
- Hard copies of the vegetation maps
- Metadata for all digital products

This report describes the effort involved with producing a vegetation classification with associated maps for the four northern Channel Islands. The results of this effort will be of interest to government and non-government agencies, researchers, and CHIS staff.

List of Acronyms and Abbreviations

AA: accuracy assessment

AIS: Aerial Information Systems

ANI: Anacapa Island

CDFW: California Department of Fish and Wildlife

CHIS: Channel Islands National Park

CNPS: California Native Plant Society

ESRI: Environmental Systems Research Institute

FGDC: Federal Geographic Data Committee

GIS: geographic information system

GPS: global positioning system

GRTS: generalized random tessellation stratified (sampling design)

I&M: Inventory and Monitoring

IVC: International Vegetation Classification

MMU: minimum mapping unit

MRT: Mountains Restoration Trust

NPS: National Park Service

NVCS: National Vegetation Classification Standard

QA/QC: quality assurance / quality control

RA: rapid assessment

SBBG: Santa Barbara Botanic Garden

SBI: Santa Barbara Island

SCI: Santa Cruz Island

SMI: San Miguel Island

SRI: Santa Rosa Island

TNC: The Nature Conservancy

VMI: Vegetation Mapping Inventory

USGS: United States Geological Survey

UTM: Universal Transverse Mercator

WCS: Wildlands Conservation Science

Acknowledgments

A project of this scope depends on the work of numerous individuals and groups, and its completion would not have been possible without their help and support. Thousands of hours were spent in the field and office providing logistical support, guidance, and training; poring over aerial images, while drawing countless polygons; discerning subtle differences between vegetation types; scrutinizing hand-written datasheets; entering innumerable small datasets; and proofing, organizing, interpreting, synthesizing, and classifying data. From this massive effort emerged a complete, comprehensive, and scientifically credible overview of the vegetation communities at Channel Islands National Park. This information will be of high value to government and non-government agencies, scientists and researchers, and most of all to the park itself and those responsible for its care and management. We gratefully thank the following agencies, organizations, and people for their contributions that made this product possible: Aerial Information Systems (Arin Glass, Debbie Johnson, Ed Reyes); the California Native Plant Society (Jennifer Buck-Diaz, Julie Evens, Kendra Sikes); the California Department of Fish and Wildlife (Todd Keeler-Wolf); Channel Islands National Park (Rocky Rudolph, Ken Niessen, Nicole Sawbey, Clark Cowan, Lena Lee); Mountains Restoration Trust (Debbie Sharpton, Sangeet Khalsa, Justina Fedorchuk, Tim Handley); NatureServe (Marion Reed); the Santa Barbara Botanic Garden (Robert Muller, Denise Knapp, Steve Junak); The Nature Conservancy (Jennifer Baker, Brian Cohen, David Dewey, John Knapp, Scott Morrison, Eamon O'Byrne, Amy Parks, John Randall, and Daniel Yesland); and the United States Geological Survey (Kathryn McEachern). This project was made possible through the support from the National Park Service Inventory and Monitoring Division.

Introduction

The National Vegetation Mapping Inventory (VMI) Program began in 1994 with the primary objective of implementing and standardizing inventory and monitoring (I&M) programs throughout the National Park Service (NPS). Currently, 32 NPS I&M networks encompass parks across the U.S. The program oversees 12 basic inventories that are used to compile existing information, acquire new information, and establish a baseline of natural resource data in more than 270 national parks. Additional funding for the program was provided by the Natural Resource Challenge in 2000 and 2002.

The long-term goals of the [NPS I&M Program](#) are to:

- Inventory the natural resources under NPS stewardship to determine their nature and status.
- Monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments.
- Establish natural resource inventory and monitoring as a standard practice throughout the National Park System that transcends traditional program, activity, and funding boundaries.
- Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making.
- Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

To help fulfill these goals, an initiative was funded by [NPS](#) in cooperation with the United States Geological Survey (USGS) ² to [classify, describe, and map detailed vegetation communities](#) in more than 280 national park units across the U.S. The main goal of this nation-wide vegetation classification and mapping effort is to “produce high-quality, standardized maps and associated data sets of vegetation and other land-cover occurring within parks” (NPS 2012). Under this effort most national parks in the western U.S. have completed vegetation classifications and vegetation maps for the lands they administer. [According to NPS VMI](#), inventories of the vegetation resources will help park managers maintain plant biodiversity; better understand wildlife habitat; and manage challenges such as exotic species, insect outbreaks and diseases, and wildland fires.

The NPS VMI requires parks to adhere to established procedures so that the classification and maps produced are compatible with other agencies and organizations. As part of this goal, the inventory uses the National Vegetation Classification Standard (NVCS) for all vegetation classifications and has adopted standard operating procedures that meet Federal Geographic Data Committee (FGDC) standards. Scientists with NPS VMI, The Nature Conservancy (TNC), and Environmental Systems Research Institute, Inc. (ESRI) developed procedures for classifying and mapping vegetation and for

² The NPS Vegetation Mapping Inventory (VMI) was formerly known as the USGS-NPS Vegetation Mapping Program but underwent a name change. The program is referred to as NPS VMI throughout this report.

completing accuracy assessments (ESRI et al. 1994; TNC & ESRI 1994a, 1994b; TNC 1996; NatureServe 2004; Lea & Curtis 2010). Products of the NPS VMI Program meet FGDC standards for vegetation classification and metadata and national standards for spatial accuracy and data transfer (FGDC 1998, 2008; USGS 1999a, 1999b).

Channel Islands National Park (CHIS) consists of five islands—Santa Barbara Island (SBI), Anacapa Island (ANI), Santa Cruz Island (SCI), Santa Rosa Island (SRI), and San Miguel Island (SMI)—off the coast of southern California (Figure 1) and is host to at least 800 species of vascular plants comprising vegetation communities that span forests, woodlands, chaparral, scrub, and grassland. Plant communities that occupy the northern four islands were the focus of this project; SBI was not emphasized because vegetation mapping and classification efforts had recently been completed (Rodriguez et al. 2010). The project occurred in two phases: Phase 1 encompassed ANI, SRI, and SMI, while Phase 2 was dedicated to SCI in a collaborative effort with TNC. This report describes the production of vegetation maps and associated classifications for the four northern Channel Islands and is the product of collaboration with Aerial Information Systems (AIS), the California Native Plant Society (CNPS), the California Department of Fish and Wildlife (CDFW), CHIS, Mountains Restoration Trust (MRT), NatureServe, the Santa Barbara Botanic Garden (SBBG), TNC, and USGS.



Figure 1. Map featuring the five islands that comprise Channel Islands National Park (CHIS).
NPS

Phase 1: Anacapa Island, Santa Rosa Island, San Miguel Island

Phase 1 Classification and Mapping Overview

As part of the national program to describe and map the vegetation communities contained within all the 280 national park units, CHIS was tasked in 2011 with developing a vegetation classification and vegetation map to VMI standards for three of the five islands contained within the park—ANI, SRI, and SMI. As part of those standards, the vegetation classification would adhere to the NVCS hierarchy and be based on analysis of data collected from both relevé plots and rapid assessment surveys. From the vegetation classification, a plant community key would be developed. The vegetation classification would also form the basis of an initial draft vegetation map and then a final map. Map polygons would be delineated to the alliance or association level depending on the community scale the mappers could discern from the aerial photos and other ancillary imagery and data. Following completion of the draft map, an assessment would ascertain the overall accuracy of the map and the individual plant communities. Based on the results of the accuracy assessment (AA), adjustments would be made to the draft map from which a final map would arise. The goal of the project was to achieve an overall map accuracy of at least 80% (ESRI et al. 1994). In addition to a final vegetation map (digital and hard copy), vegetation classification, and vegetation field key, other products would include a PLOTS database containing data collected for both the vegetation classification and AA, a written description of the vegetation communities identified from the vegetation classification, a project description report, and a report documenting the incorporation of the island communities into the international ecological classification standard.

After internal discussion, an overall framework was envisioned with the project consisting of seven components: (1) planning and scoping, (2) aerial imagery acquisition, (3) field data collection for both the vegetation classification and AA, (4) a vegetation classification, (5) photo interpretation and polygon delineation, (6) AA, and (7) project completion and presentation. Potential collaborators were also identified and approached to determine interest in participating in the project.

At its inception, the project was anticipated to span from 2012 through 2016. This end date was revised to 2020 following the addition of Santa Cruz Island (SCI), which constituted a separate phase; Phase 1 encompassed ANI, SRI, and SMI, whereas Phase 2 consisted solely of SCI. With the addition of SCI, nearly all of the products—a vegetation classification with community descriptions and a field key to the vegetation communities—were updated to include the SCI data. The SCI field classification data and AA data were also incorporated into the PLOTS database. However, vegetation communities that were unique to SCI were not incorporated into NatureServe's International Ecological Classification Standard because funding was insufficient to revise and update that report.

Phase 1 Partners

In 2011, CHIS submitted a proposal to generate new vegetation classifications and vegetation maps for ANI, SRI, and SMI, with a project start date in 2012. Upon funding approval, CHIS initiated

contact with potential collaborators, including AIS, CDFW, CNPS, MRT, NatureServe, and SBBG, each of which had extensive experience with the vegetation mapping process, familiarity with the NVCS and its taxonomic hierarchy, and/or intimate knowledge of the unique plant communities present on the islands. Collaborators and the expertise they contributed are listed alphabetically below.

AIS: Aerial Information Systems is a minority- and woman-owned business with extensive experience applying geographic information systems (GIS) to environmental planning. Photo interpretation is a core component of AIS, which collaborated with the other two parks in the Mediterranean Network—Santa Monica National Recreation Area and Cabrillo National Monument—on their vegetation mapping projects. The role of AIS was creation of the vegetation maps for each of the three islands via photo interpretation of 2012 aerial imagery.

CDFW: The California Department of Fish and Wildlife (formerly the California Department of Fish and Game) is a department under the state’s Natural Resources Agency. Its mandate is to manage and protect the state’s fish, wildlife, plant, and native habitats. As part of its conservation program, it has led or assisted with vegetation mapping efforts throughout the state. For this project, CDFW provided input on the interpretation of classification data, assisted with field reconnaissance of the island plant communities, and provided general vegetation mapping guidance.

CHIS: Channel Islands National Park oversaw the general management of the project, including establishing and prioritizing the budget, hiring field crews, sampling vegetation, entering data, coordinating logistics, conducting the accuracy assessment, and writing the final report.

CNPS: The California Native Plant Society is a volunteer-driven organization dedicated to the preservation of the state’s native plant communities and rare plants. Through their Vegetation Science Program CNPS has worked with other National Parks, the U.S. Forest Service, Bureau of Land Management, California state agencies, and private organizations to classify and map vegetation communities throughout California. The dual role of CNPS was to oversee the training of the field crews who collected the data and to generate the final vegetation classification, field key to vegetation communities, and descriptions of the vegetation types.

NatureServe: This organization leverages science, data, and technology to guide biodiversity conservation and stewardship. One of NatureServe’s specialties is the cataloging of global ecosystems and placing them within the hierarchy of the International Vegetation Classification (IVC) system. The NVCS, used as the basis of the CHIS vegetation classification, is a jurisdictional subset of the IVC. NatureServe was and continues to be involved in the development of the NVCS and was tasked with placing the park’s plant communities within the global framework of the IVC.

SBBG: The Santa Barbara Botanic Garden is dedicated to conserving native plants and habitats for the health and well-being of our planet. Its curators and scientists have conducted plant surveys and research on all of the Channel Islands and brought extensive knowledge of plant communities and rare plants at CHIS. The Clifton Smith Herbarium at SBBG was the designated repository for all plant specimens curated for this project, and its staff assisted with data collection and plant identification.

USGS: Staff from the U.S. Geological Survey stationed at the CHIS field office provided assistance with planning, scoping, and technical support throughout the project.

Phase 1 Timeline

In January 2012, a planning and scoping meeting included representatives from the above-listed collaborators and other interested parties. Collaborators with prior mapping experience provided input and guidance, and a project framework was developed along with an overarching timeline (Table 1). Individual tasks were assigned to each collaborator with anticipated completion dates. Since the development of a vegetation map involves many moving parts, completion dates were general in nature to accommodate unforeseen issues (e.g., poor weather) with the potential to delay planned operations. Specific tasks for Phase 1 are listed chronologically below.

Table 1. Phase 1 overarching timeline.

Task	2012	2013	2014	2015	2016
Planning and scoping	X	–	–	–	–
Aerial imagery acquisition	X	–	–	–	–
Data collection training	X	–	–	–	–
Field data collection	X	X	X	–	–
Plant community key development	–	X	X	–	–
Photo interpretation/polygon delineation	–	X	X	X	–
Vegetation classification	–	X	X	–	–
Accuracy assessment	–	–	–	X	–
Vegetation community descriptions	–	–	–	X	–
Individual reports and products	–	–	–	–	X

“X” indicates the year in which a given task was completed or scheduled for completion.

2012: Planning and scoping meeting was held. Field crews were hired to collect vegetation classification data. CNPS provided the initial training on data collecting methods. Stratified random points were generated in GIS for all three islands. Field crews began collecting data in the spring, starting on SRI. Previously collected data from the park’s long-term monitoring program, previous mapping efforts, and other ancillary information were aggregated and provided to both AIS and CNPS. By summer, enough field data were collected that an initial vegetation classification was constructed by CHIS staff. Aerial imagery was obtained in October after which AIS began polygon delineation on SRI.

2013: CNPS provided training on field data collection methods. Field data collection continued on SRI and began on SMI and ANI. Polygon delineation continued on SRI and began on SMI. Field verification trips were conducted for SRI and SMI. An interim vegetation classification was constructed based on additional field data by CNPS, which also produced a draft key to vegetation communities. Differences between the initial and interim vegetation classification necessitated

changes in map drafting, so AIS paused polygon delineation for SRI and SMI and then resumed after the final vegetation classification was produced.

2014: Field data collection was completed, the vegetation community key was refined, and a final vegetation classification was produced. Additional field verification trips were conducted on SRI and SMI. Initial field reconnaissance by AIS was conducted on ANI. CNPS finalized the vegetation community key and produced a final classification. Polygon delineation by AIS continued for SRI and SMI. A draft vegetation map was produced for ANI.

2015: Draft maps were completed for SRI and SMI. Random accuracy assessment points were generated for SRI and SMI using a generalized random tessellation stratified (GRTS) design (Stevens & Olsen 2003, 2004) and following NPS guidelines (Lea and Curtis 2010). A crew was hired to collect field data for the AA.

2016: Data were collected for the AA, and an AA was conducted that calculated user and producer accuracy percentages. The draft maps were refined based on AA results and final maps were generated. CNPS and AIS completed individual reports for their contributions. NatureServe integrated the vegetation communities identified from the field data into the National Vegetation Classification.

Phase 2: Santa Cruz Island

Phase 2 Overview and Partners

In late 2015 as Phase 1 neared completion, TNC approached CHIS to request assistance with completing a vegetation classification and map for SCI. Although it is the largest island within the park boundary, SCI was not included in the original project because of budget limitations and because a vegetation classification and map were completed for the island in 2007. However, an AA was not completed for the 2007 map, and importantly SCI's vegetation communities began to change significantly with the removal of feral pigs in the same year. Therefore, TNC supported the production of an updated vegetation map and associated classification for the entire island and funded 100% of the field data collection for a vegetation classification and approximately 75% of the associated map. The high costs forecasted to generate the remaining products—a vegetation classification, key to communities, and AA—were creatively reduced by planning to use a light helicopter to access remote relevé points that were randomly located across SCI's rugged landscape. This reduced-cost plan was then proposed by CHIS and TNC to the Washington Office of the I&M program which approved the funding.

Phase 2 collaborators were slightly different than Phase 1. The initial collaborators included CDFW, TNC, USGS, and Wildlands Conservation Science (WCS). Having already started the project, TNC took the lead while CHIS assisted, and AIS joined late in 2016. In addition to the collaborators (AIS, CDFW, CNPS, MRT, NS, SBBG) listed for Phase 1 above, the expertise that TNC and WCS provided for Phase 2 is detailed below.

TNC: The Nature Conservancy owns and manages 76% of SCI. Founded in 1951, TNC is currently a global organization with more than 1 million members, and its mission to conserve the lands and waters on which all life depends. As the majority landowner of SCI since 1978, TNC has collaborated with CHIS to achieve many conservation efforts, including the culling of invasive Eucalyptus trees, the removal feral pigs, and the recovery of island foxes.

WCS: Wildlands Conservation Science is a small business with wide-ranging work experience on the Channel Islands that includes surveys for weeds and rare plants as well as removal of invasive species. They have extensive expertise using helicopters for biological field work. The primary role of WCS was to collect field data used in the vegetation classification and to conduct the field portion of the AA.

Phase 2 Timeline

The addition of Phase 2 to the vegetation mapping project occurred in late 2015 and early 2016, after collaborations were forged with TNC and WCS. Data collection, derivation of the classification and keys to vegetation communities, the AA, and nearly all of the report writing occurred between 2017 and 2019 (Table 2). As the project approached completion in 2019, CHIS botanist Dirk Rodriguez retired. The new botanist Cameron Williams finalized the project and reporting thereafter. Specific tasks for Phase 2 are listed chronologically below.

Table 2. Phase 2 overarching timeline.

Task	2015–2016	2017	2018	2019	2020
Planning and scoping	X	–	–	–	–
Methods-testing and reconnaissance	–	X	–	–	–
Field data collection	–	X	–	–	–
Aerial imagery acquisition	–	X	–	–	–
Photo interpretation/polygon delineation	–	X	X	–	–
Plant community key revision	–	–	X	–	–
Vegetation classification revision	–	–	X	–	–
Accuracy assessment	–	–	–	X	–
Community description revision	–	–	–	X	–
Individual reports and products	–	–	–	X	X

“X” indicates the year in which a given task was completed or scheduled for completion.

2015–2016: Towards the end of 2015, TNC approached CHIS with a request to provide funding and assistance for a new vegetation classification and map for SCI. Staff from CHIS and TNC participated in a conference call with Karl Brown and Tammy Cook from NPS’s Natural Resource Stewardship and Science Biological Resources Management Division, to discuss their interest in helping to fund the SCI mapping project. The project received tentative approval. A formal proposal was submitted for funding in 2016 after which the project was approved and funded.

2017: In January 2017, staff from CHIS and TNC field-tested methods for data collection to facilitate rapid data acquisition. The goal was to shift emphasis from traditional on-the-ground field work toward aerial data collection via helicopter in order to minimize travel costs. In February, CHIS assisted AIS with reconnaissance of the island prior to the initiation of polygon delineation. In March, field teams began collecting data for the new SCI vegetation classification. In May, new aerial imagery was acquired for the northern Channel Islands, and the images were used for polygon delineation of the SCI map.

2018: Polygon delineation continued for the SCI map while CNPS completed a revised vegetation classification that incorporated the SCI data. A revised field key that included the SCI vegetation types was also drafted. A draft SCI vegetation map was completed by AIS in the fall.

2019: In early 2019, random points for the AA were assigned to the draft map of vegetation communities, excluding the littoral zone, other water mapping units, and cultivated areas, using VMI guidelines and standards (Lea and Curtis 2010). In April from a helicopter, the AA points were identified using the field key to vegetation communities and simultaneously photographed in high resolution. A GIS database containing the field identifications was delivered to CHIS and analyzed for discrepancies between the field identifications and the mapped polygon designations. Discrepancies unexplainable as data entry errors and difficult-to-identify vegetation types were further reviewed in conjunction with the high-resolution photographs to confirm or overturn the field

identifications. The AA results were updated with any changes and a final contingency table was produced. CNPS submitted revised versions of the vegetation classification report, vegetation description report, and field key to vegetation communities as well as a final vegetation classification database to CHIS.

2020: AIS produced a final vegetation map and mapping report for SCI. The vegetation map field data were migrated over to the PLOTS database. All associated reports, photographs, and completed maps were submitted to the national VMI office.

Project Area

Ownership and Geography

President Jimmy Carter established CHIS in 1980 (Public Law 96-199), subsuming Channel Islands National Monument—which comprised only SBI and ANI—into a national park consisting of five islands (Figure 2). Ownership and management of SCI are split 76% and 24% between TNC and CHIS, respectively. The Department of Defense owns SMI, but this island is administered by CHIS under an agreement with the U.S. Navy. The legislation enabling CHIS made note of the special fragility and sensitivity of the resources contained within the park’s boundary and mandated “an inventory of all terrestrial and marine resources, indicating their population dynamics, and probable trends...”. Subsequently, CHIS was one of four prototype parks that were selected to develop “robust and sustainable” inventory and monitoring efforts of the natural resources contained within each park.

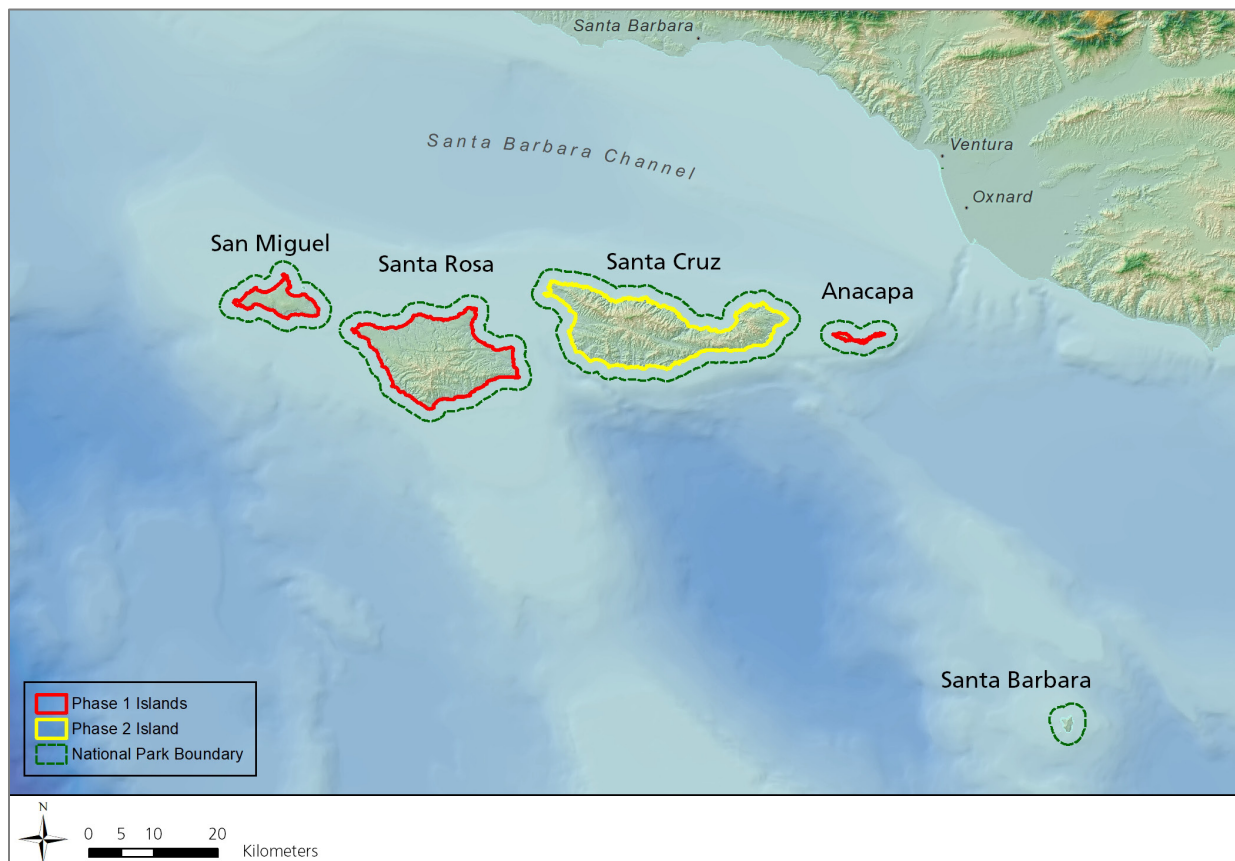


Figure 2. The components of Channel Islands National Park included in Phase 1 (red; ANI, SRI, SMI) versus Phase 2 (yellow; SCI). Santa Barbara Island was not featured in this vegetation mapping project.
NPS

Located within the southern California bight, the five islands included within CHIS are part of an eight-island archipelago. The east–west-trending chain of four islands paralleling the mainland coast

is the focus of this vegetation mapping project. During the Pleistocene epoch, these northern Channel Islands were connected into a single larger unit known as Santa Roseae. In contrast, the four southern Channel Islands, which include SBI, San Clemente Island, Santa Catalina Island, and San Nicolas Island, are spatially distant from each other and remained separated during the Pleistocene epoch.

Climate

The region has a Mediterranean-type climate characterized by cool, wet winters and warm, dry summers. Island climate is greatly influenced by the marine environment that provides milder summer temperatures and higher humidity compared to inland areas. December to March offer the coolest temperatures, whereas July to October are the warmest. Average temperatures are 11.7–15.0°C in January and 16.7–21.1°C in July (Davidson et al. 2019). Freezing is rare. Coastal fog can be present year-round but peaks May to June upon the formation of a strong inversion layer. Even with the marine environment’s moderating effect, anthropogenic climate shifts are causing detectable environmental changes such as a higher mean annual temperature of 1.4°C relative to the 1950–2010 average, with the greatest increase occurring in spring (Gonzalez 2020).

Interannual rainfall on the Channel Islands is highly variable, but most falls between November and April with January and February typically being the wettest (Davidson et al. 2019). Similar precipitation patterns occur across most of California as large pulses of rain are delivered via a few large storm events rather than being more evenly distributed through time. Historically, collection of island weather data has been inconsistent, so generating island-specific trends or determining long-term patterns engenders large uncertainties. In addition, rainfall amounts can vary greatly among islands and even within an individual island. Therefore, island managers and researchers routinely supplement island precipitation data with that from the mainland. Data from mainland weather stations in Ventura and Oxnard (e.g., Station 168; Ventura County Watershed Protection District) correlate well with island weather data resulting in fairly reliable datasets. From 1971 to 2000, mean annual rainfall for the islands within the park boundary was 41 cm (Gonzalez 2020).

Ecology

The vegetation of CHIS is a combination of native and non-native species, and each island hosts a unique flora and set of communities that reflect local geology, topography, and land-use history. Island vegetation was shaped to varying degrees by prehistoric grazers such as mammoths (*Mammuthus columbi*) and pygmy mammoths (*Mammuthus exilis*) and by at least 13,000 years of Native American habitation (Orr 1962; Johnson et al. 2002). Accounts of island plant communities prior to European contact are scarce, but the most extensive communities on the islands were likely shrub and tree-dominated (Rick et al. 2014). However, the introduction of non-native animals such as cattle, sheep, pigs, deer, and elk through ranching activities from the mid-1800s through 2011 dramatically altered the trajectory of the park’s vegetation (Rick et al. 2014; McEachern et al. 2016). The dominant modern island plant communities include scrub, island chaparral, valley and foothill grassland, woodland and forest, and wetlands (Junak et al. 2007). Unsurprisingly, larger islands tend to support a larger number of plant species and vegetation types (Junak 2008).

Approximately 25% of the plant species present on the islands are non-native (Ratay et al. 2014) and were likely introduced during ranching activities (McEachern et al. 2016). Non-native plants are present in varying degrees within every plant community, and in some cases, they are dominant enough to define the vegetation type (e.g., *Avena barbata*–*Avena fatua* Semi-natural Association). However, due to their isolation from the mainland, the islands are also home to a relatively large proportion of endemic taxa (Schoenherr et al. 2003), defined here as plants that are native and restricted to the Channel Islands. Of the four islands, SCI hosts the highest number of endemic taxa, whereas SMI has the fewest (Table 3).

Vegetation surveys repeated over time at CHIS indicate that native plant communities are recovering following the removal of introduced herbivores (Summers et al. 2018; Thomson et al. 2022; Starcevich et al. in press), but recovery is uneven and hindered by drought that appears to have impacted SBI and ANI more than the larger islands (Rodriguez 2021; Rodriguez & Williams 2022, Williams 2023). In many places, a century or more of grazing has fragmented native plant communities into small patches surrounded by annual grasses, a patchwork that influences vegetation mapping.

Table 3. Number of vascular plant taxa known to occur at each of the northern four Channel Islands. Data from Ratay et al. (2014), excluding extirpated taxa.

Island	Richness of Vascular Plant Taxa			
	Native	Non-native	Endemic	Total
Anacapa	192	76	22	268
Santa Cruz	486	174	45	660
Santa Rosa	400	118	42	518
San Miguel	213	79	18	292

Geology

The northern Channel Islands are considered a westward extension of the Santa Monica Mountains, which are part of the Transverse Ranges (Crouch 1979; Vedder & Howell 1980). Subduction of the Pacific Plate beneath the North American Plate buckled and uplifted the Earth’s crust, yielding a northwest–southeast-oriented set of mountain ranges off the coast of what is now San Diego (Schoenherr et al. 2003). Over about 10 million years, the subduction zone shifted into a transform fault to generate the San Andreas fault system, which initiated a northwestward migration of these mountain ranges. Approximately 20 million years ago, the western edge of their supporting platform became anchored to the North American Plate, initiating a 90° clockwise rotation of the ranges that re-oriented them into the modern east–west-trending Transverse Ranges, including the ridgeline composing the Santa Monica Mountains and northern Channel Islands (Crouch & Suppe 1993; McEachern et al. 2016).

Northwestward migration and rotation of the platform caused crustal thinning that encouraged volcanic eruptions (Weigand & Savage 2002). The erupted material, including lava flows, covered

much of the area comprising the northern Channel Islands and the western Santa Monica Mountains. Today, volcanic formations make up a substantial portion of the islands' geology, especially ANI, which is almost entirely volcanic rock. Many Channel Islands also contain significant components of sedimentary rock formed from ocean-deposited mainland sediments, eroded volcanic materials, and vast quantities of calcareous organisms. Subsequent uplift and sea-level fluctuations incorporated large shale and sandstone deposits into the parent material from which the current vegetation grows. Caliche—a calcium-rich soil cemented together by the precipitation of calcium carbonate in semi-arid environments—is also common on several islands. Although sea level minima during the Pleistocene epoch exposed land bridges joining the four northern Channel Islands, there is no evidence to suggest that these or the southern islands were connected to the mainland (Schoenherr et al. 2003).

Island-specific Natural History

Anacapa Island

The smallest of the four islands in the project area, ANI is composed of three islets informally named East, Middle, and West that together encompass an area of about 283 ha. These islets are volcanic outcrops overlain by sedimentary deposits (Davidson et al. 2019) and bounded by steep, rocky cliff faces around their perimeters. West ANI hosts the highest peak at 283 m elevation along a dominating ridgeline that extends the length of nearly the entire islet, the north slope of which is cut by a few deep drainages. East and Middle ANI are mostly high plateaus turning into spine ridges at one (East ANI) or both ends (Middle ANI).

Native Americans used ANI as early as about 5,000 years ago, but none of the islets contain convincing evidence of permanent settlement (Rick 2006). East ANI was partly graded by the Coast Guard prior to the construction of several buildings and a lighthouse by the U.S. Lighthouse Service in 1932 at its east end. This is the most heavily visited of the three islets and has regularly scheduled boat runs during the spring, summer, and fall when as many as 100 people may be present on the small islet at one time. Sheep grazing on Middle ANI decimated its vegetation in the first half of the 1900s, whereas West ANI was less grazed (Davidson et al. 2019). To protect seabirds, Middle and West ANI are closed to the public year-round and to NPS staff during the breeding season.

On East and Middle ANI, native plant communities are small and patchy, except on the perimeter steep slopes and cliffs that provided refuge during lighthouse and grazing activities. Weedy, non-native species appear to be spreading on these islets, especially during droughts, and some native species such as purple needlegrass and Coast dudleya (*Dudleya caespitosa*) are in decline. Surviving native plant communities feature giant coreopsis and island tarweed (*Deinandra clementina*). On East ANI, perennial iceplant (*Malephora crocea*) invaded large areas that recent and ongoing restoration efforts are attempting to mitigate, which may be aiding colonization by its invasive relative crystalline ice-plant (*Mesembryanthemum crystallinum*). West ANI's dominating east–west ridge has a significant effect on the island's vegetation. The south side's steep escarpment features desiccated exposures with loose and erosive soils, whereas the north side's sloped plain is interrupted by humid canyons that receive relatively low solar radiation. South slope communities feature California bush sunflower (*Encelia californica*), Santa Cruz Island buckwheat (*Eriogonum*

arborescens), and California sagebrush with scattered prickly pear (*Opuntia littoralis/oricola*). The north side supports a mix of shrub communities dominated by California sagebrush, giant coreopsis, and goldenbush. Coast live oak (*Quercus agrifolia*), island oak (*Q. tomentella*), and island cherry (*Prunus ilicifolia* ssp. *lyonii*) occur in two of the north-side drainages. Arroyo willow (*Salix lasiolepis*) is also present near the terminus of a north-side drainage.

Santa Cruz Island

The largest of the Channel Islands, SCI has an area of 24,686 ha, with topography that is more rugged than the other islands of the archipelago. The main body of the island is dissected by the east–west-trending Santa Cruz Island Fault that forms a central valley flanked by substantial ridges to the north and south. Devil’s Peak, on the north ridge, is 753 m tall, representing the highest elevation of all eight Channel Islands. Compared to the other northern islands, SCI has the most variability in topography and climate, resulting in high plant diversity (Davidson et al. 2019).

The vegetation of SCI was influenced by Native American habitation extending to at least 8,700 years ago (Glassow et al. 2009). Similar to the other islands, however, ranching activities that commenced in the mid-1800s upset the island’s ecological balance, especially after the introduction of sheep and pigs (Davidson et al. 2019). Introduced annual grasses, as well as the cultivated trees eucalyptus, fig (*Ficus carica*), olive (*Olea europaea*), and English walnut (*Juglans regia*), spread across the island (Junak et al. 1995). The ecological imbalance wrought by ranching activities encouraged prickly pear cactus to overtake as much as 40% of the grazable land, so the insect cochineal scale (*Dactylopius coccus*) was introduced as a biological control (Goeden et al. 1967), but it later spread to other islands. In 2006, the last of the introduced grazers were removed, allowing unhindered recovery of the entire island’s native plant communities to begin.

The topography of SCI divides the island into four ecological zones that underly the distribution of plant communities: (1) slopes, flats, and canyons on the north side of the island, (2) south-facing interior slopes and canyons above the island’s central valley, (3) north-facing interior slopes and canyons on the south side of the island’s central valley, and (4) south-facing slopes, flats, and canyons on the south side (Junak et al. 1995). Plant communities are further influenced by geologic substrate types that include metamorphic and granitic basement rocks, volcanics, sedimentary deposits, and Quaternary alluvium, terrace deposits, and landslides. Overlaying these ecological zones and substrates, 16 vegetation types encompass dunes, grassland, scrub, chaparral, woodland, conifer forest, and coastal and freshwater wetlands (Junak et al. 1995). The history of community vegetation descriptions for SCI has been the subject of study since the eight upland communities and two wetland types were initially defined (Philbrick & Haller 1977) and later modified as new classifications emerged (Holland 1986; Junak et al. 1995).

Santa Rosa Island

The second largest of the northern Channel Islands, SRI encompasses just over 21,500 ha. The island is roughly bisected by an east–west-trending ridge generated by a transform fault that runs through the island’s long axis (Schumann et al. 2014). Most major drainages flow north or south from this ridge, which hosts SRI’s highest peak at 484 m elevation. On the north side, drainages originating

from the interior slopes cut oceanward through Pleistocene marine terrace deposits of sandstone, shales, colluvium, and alluvium that overlie sedimentary and metamorphic rock formations (Davidson et al. 2019). Gradients are gentler and longer on the north than the south side of the island. The perimeter of the island is defined by sandy beaches or steep unstable slopes.

Although at least 13,000 years of Native American habitation influenced the ecology of SRI (Orr 1962; Johnson et al. 2002), the relatively brief tenure of non-native grazers introduced by ranching activities from the mid-1800s through 2011 dramatically altered the trajectory of the island's vegetation (Rick et al. 2014; McEachern et al. 2016). The geology of SRI supports few stable and steep volcanic slopes that were known on other islands to serve as refugia to native plants, and consequently almost all parts of SRI were subject to the pressures of introduced grazers. Canyons that did serve as native plant refugia appear to be recovering well after grazer removal (Thomson et al. 2022).

Slopes on the south side of SRI are dominated by coastal sage scrub and grassland with occasional small arborescent stands of island scrub oak (*Quercus pacifica*) and individual toyon (*Heteromeles arbutifolia*). Coyote brush (*Baccharis pilularis* ssp. *consanguinea*) scrub is more common on the mesic parts of the island, especially on the north side and on slopes bordering riparian areas. Woodlands comprised of Torrey pine (*Pinus torreyana* ssp. *insularis*), bishop pine (*Pinus muricata*), and mixed oak are concentrated in the northeast. Island chaparral is also concentrated in the northeast, with smaller stands occurring on the east end and south side of the island. Observations of exposed basal burls in areas adjacent to but not currently occupied by island chaparral suggest that this community may have been more extensive prior to ranching activities. Annual and perennial grasslands cover more area than any other single vegetation type. While the majority of the grassland is composed of non-native annual grasses such as wild oat (*Avena fatua*) and ripgut grass (*Bromus diandrus*), significant areas are dominated by native bunch grasses. Large expanses of grassland are studded with coyote brush, perhaps indicating active recolonization by woody shrubs. Purple needlegrass (*Stipa pulchra*) covers substantial areas and is the most common native bunchgrass, whereas foothill needlegrass (*Stipa lepida*) and nodding needlegrass (*Stipa cernua*) tend to mingle with shrub-dominated communities and line roadsides. Highly disturbed vernal pools are sparse on SRI and were mapped where identifiable. Caliche scrub is especially common on the western extent of the island, where subshrubs emerging from caliche soil form the dominant canopy. Here, low-growing golden bush (*Isocoma menziesii*) and California sagebrush (*Artemisia californica*) are interspersed with other short perennials such as blue-eyed grass (*Sisyrinchium bellum*) and San Miguel Island locoweed (*Astragalus miguelensis*), with small annuals like shining peppergrass (*Lepidium nitidum* var. *nitidum*), scarlet pimpernel (*Lysimachia arvensis*), and bur-clover (*Medicago polymorpha*) growing between.

San Miguel Island

With an area of about 3770 ha, SMI is the third largest island in the project area. The island has a relatively low profile with two similarly sized and centrally located hills, the highest of which is San Miguel Hill at 253 m elevation. Located 44 km off the Santa Barbara coast, SMI is fully exposed to the powerful winds that sweep persistently southward around Point Conception, delivering cool,

moist air and copious summer fog. Standing water is perennially present within at least one drainage, but the island supports no perennial streams despite high fog interception.

San Miguel Island was grazed by mammoths in the Pleistocene (Schoenherr et al. 2003) and occupied by Native Americans continuously for at least the last 8,000 years (Erlandson et al. 2009), but the intensive grazing by introduced livestock brought the most consequential ecological changes to the island (Davidson et al. 2019). Aerial photographs taken in 1929 after at least eight decades of sheep grazing (McEachern et al. 2016) reveal expansive areas of eolian erosion where the vegetation had been almost completely consumed. After sheep removal in the 1970s, areas of bare ground that were eroding began to stabilize via revegetation that included ingrowth of cryptobiotic soil crusts (Zellman 2014). However, even with the recovery, some shrub species have been extirpated, as evidenced by the presence of exposed basal burls of species that no longer live on the island.

Today's vegetation is mainly a mix of coastal shrubland and grassland. Goldenbush, California sagebrush, coyote brush, silverbush lupine (*Lupinus albifrons*), and giant coreopsis (*Leptosyne gigantea*) are the dominant shrubs, the composition of which ranges from intermixed to monodominant stands. The most common grasses include *Bromus diandrus*, wild oats (*Avena fatua/barbata*), and purple needlegrass. Wall barley (*Hordeum murinum*), creeping wild rye (*Elymus triticoides*), red brome (*Bromus madritensis* ssp. *rubens*), and meadow barley (*Hordeum brachyantherum*) are also frequent. Caliche scrub on SMI is characterized by widely scattered, low-growing goldenbush and California sagebrush interspersed with blue-eyed grass, seaside daisy (*Erigeron glaucus*), sickle grass (*Parapholis incurva*), and meadow barley. Larger statured vegetation is rare on SMI, but arroyo willow occupies at least two drainages, and a small, planted grove of the non-native California fan palm (*Washingtonia filifera*) grows in Cuyler Harbor.

Historical Information

Historical information from previous monitoring and mapping efforts were evaluated for their utility in this vegetation mapping project. Available data included long-term annual vegetation monitoring for all park islands, vegetation maps for each of the four northern Channel Islands, and a vegetation classification for SCI. Using standard methodology for evaluating the utility of existing datasets for vegetation mapping (The Nature Conservancy 1996), we determined that the historical data classified as Category III, meaning that the “data can be used for vegetation classification and characterization of a vegetation type within the park, but not for mapping or analysis because the sample is not adequately geo-referenced, contains inadequate detail in the vegetation information, and/or may not represent existing vegetation at the sample location”. Due to several deficiencies and constraints outlined below, the VMI considered these data valid for planning sampling activities, guiding data collection, describing vegetation communities, writing reports, and aiding aerial photo interpretation.

Prior Monitoring Data

Long-term vegetation monitoring at CHIS began in 1984 on SBI, ANI, and SMI, in 1993 on SRI, and in 1997 on SCI (Tiszler et al. 2016). Data encompassed all dominant island plant communities and were reviewed for accuracy by the park botanist. Deficiencies in the monitoring data included (1) the difference in the methodology employed, as vegetation monitoring was based on a line-point intercept method whereas vegetation mapping relies on plots; and (2) the subjective placement of some of the monitoring locations. Thus, the historical monitoring data from CHIS were ultimately used to inform the initial vegetation classification and to aid the photo interpreters with acquiring signatures that defined the communities.

Prior Vegetation Maps

Although repeat vegetation mapping was identified as a specific operational goal for the vegetation monitoring program at CHIS (Halvorson et al. 1988; McEachern 2001), a lack of funding led to researcher-generated maps that employed inconsistent methodologies among islands. A few maps were generated for each of the four northern Channel Islands prior to 1991. On SCI, the most recent mapping project was completed in 2009 (Cohen et al. 2009). Information from these previous efforts was constrained by the accuracy of coordinates for plot locations and by the age of the data since ecological change occurred in the interim. Therefore, similar in utility to the monitoring data, the historical mapping data informed the initial classification and aided photo interpretation. In addition, the relevé plot locations surveyed in 2002–2003 (McEachern & Chess 2004) for the 2009 map (Cohen et al. 2009) were also surveyed for the vegetation map and classification presented here. A brief history of the vegetation maps generated between 1855 and 2009 is outlined below for each of the northern four Channel Islands.

Anacapa Island

Only one historical vegetation map was produced for ANI (Figure 3; Hochberg et al. 1979). The map was based on 1:24,000 color infrared photography, map units were spot-checked in the field, and taxonomic treatment was described by seasoned experts by listing the major species (McEachern

2001). Seven broad plant community types emerged from the effort. One vegetation type—coastal bluff—was mapped as having a coreopsis phase and a sea-cliff phase.

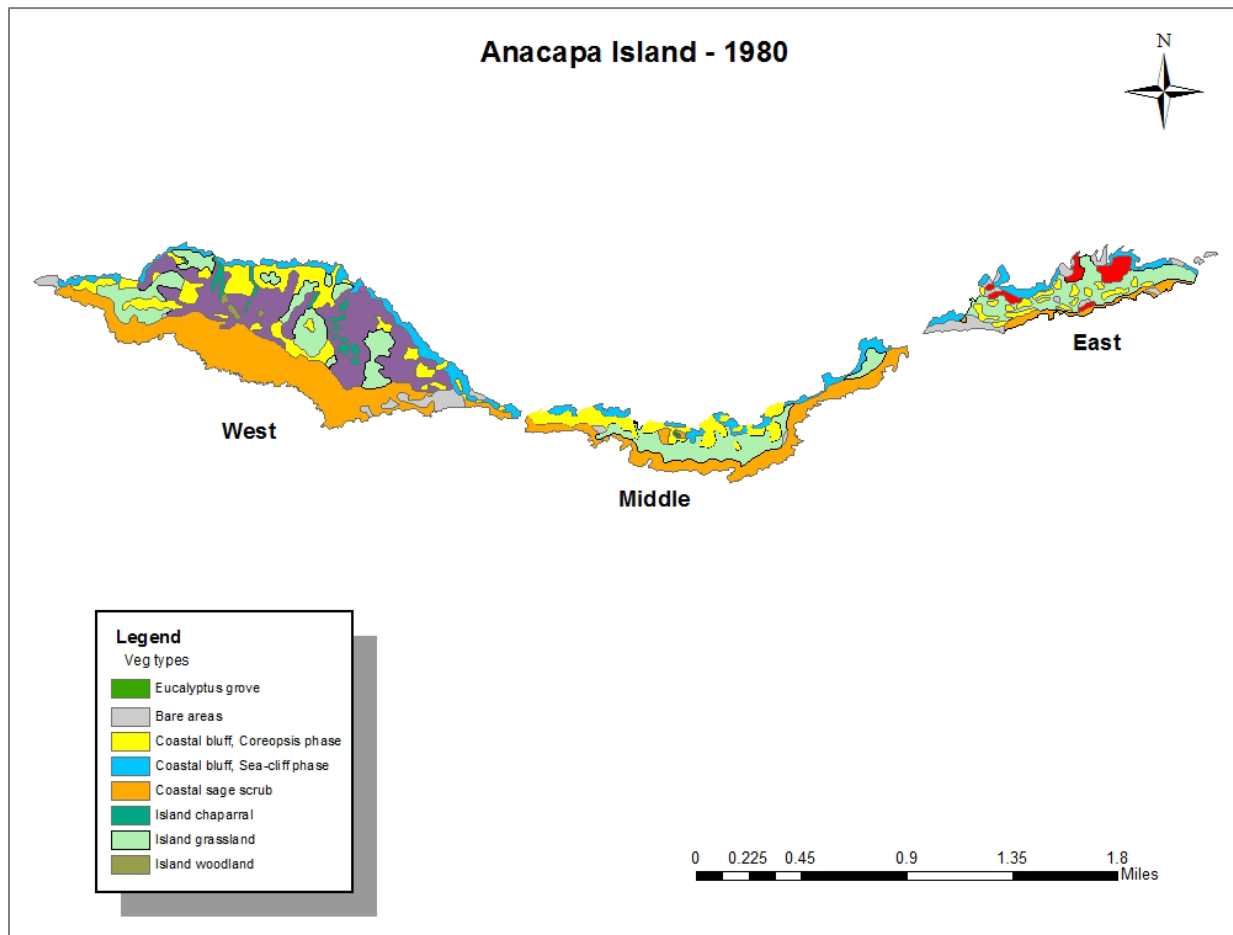


Figure 3. Vegetation map of Anacapa Island, redrawn from Hochberg et al. (1979).

NPS

Santa Cruz Island

Several historical vegetation maps were produced for SCI. Partial maps by Johnson in 1855 and 1859, which feature ocean terraces at the island's east and northeast, were putatively appended by S. Forni in 1874–1875 (Figure 4). General documentation is available describing the technical methods used by the U.S. Coast Survey in producing their maps, but the specifics of how Johnson and Forni generated their maps are missing. Based on prior accounts of large swaths of SCI being heavily covered by shrubs and trees (Junak et al. 1995), the Forni addition shows considerable change as extensive areas on the terraces and gentler slopes were converted to grassland by the time it was produced. This reduction in vegetation is attributable to heavy sheep grazing (Davidson et al. 2019).

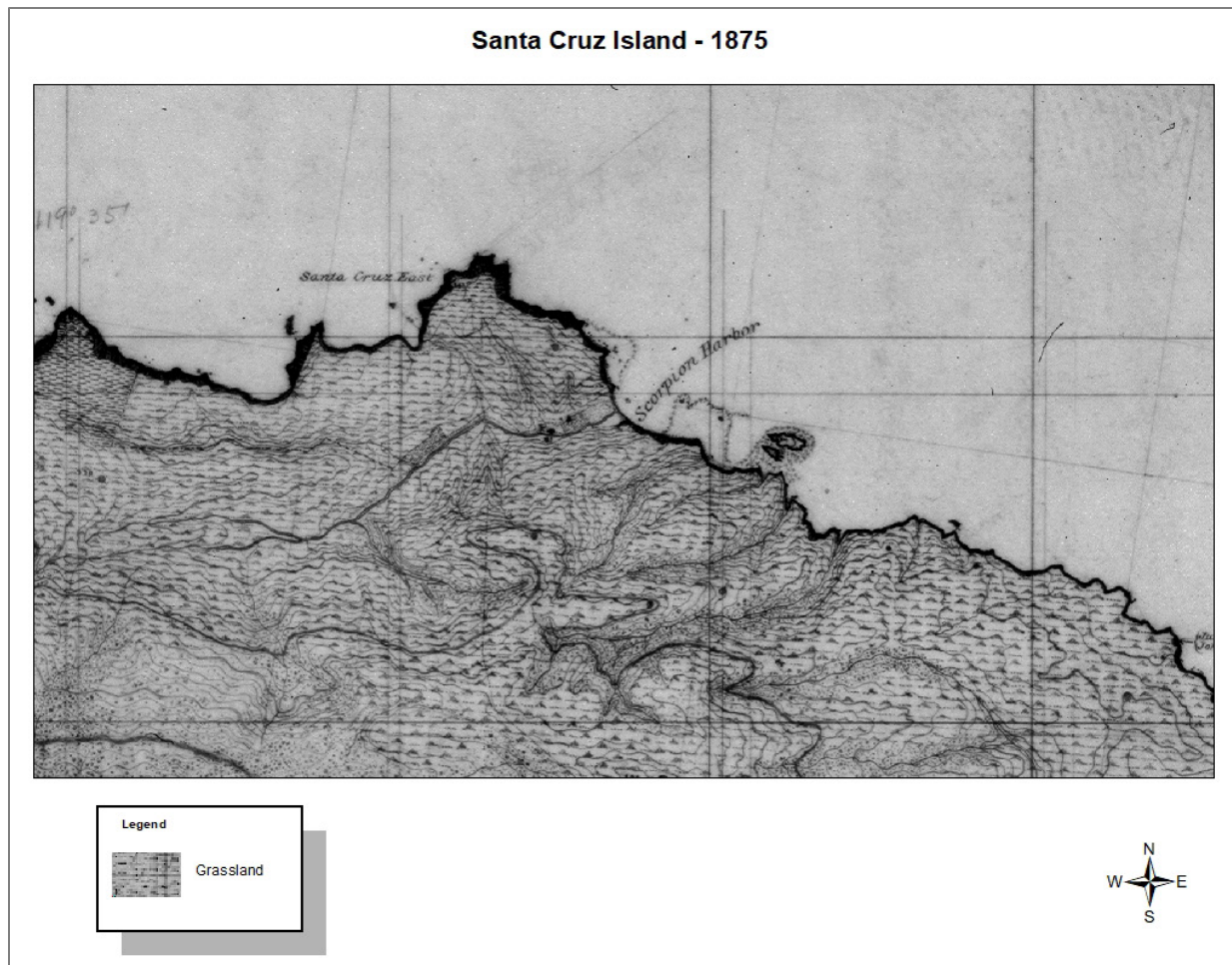


Figure 4. Partial vegetation map of Santa Cruz Island produced by S. Forni in 1875. In the absence of a legend, modern symbology was applied to represent grassland.

NPS

After the Forni and Johnson maps, SCI did not see a mapping effort for more than 100 years. Then, from 1:24,000 scale color infrared aerial photography captured in 1970, floristic and physiognomic features were interpreted using a minimum polygon differentiation threshold of 20% (Minnich 1980). Vegetation types and plant signatures were verified via field photographs and/or visits. The map product shows that grasslands continued to occupy extensive areas of the island (Figure 5).

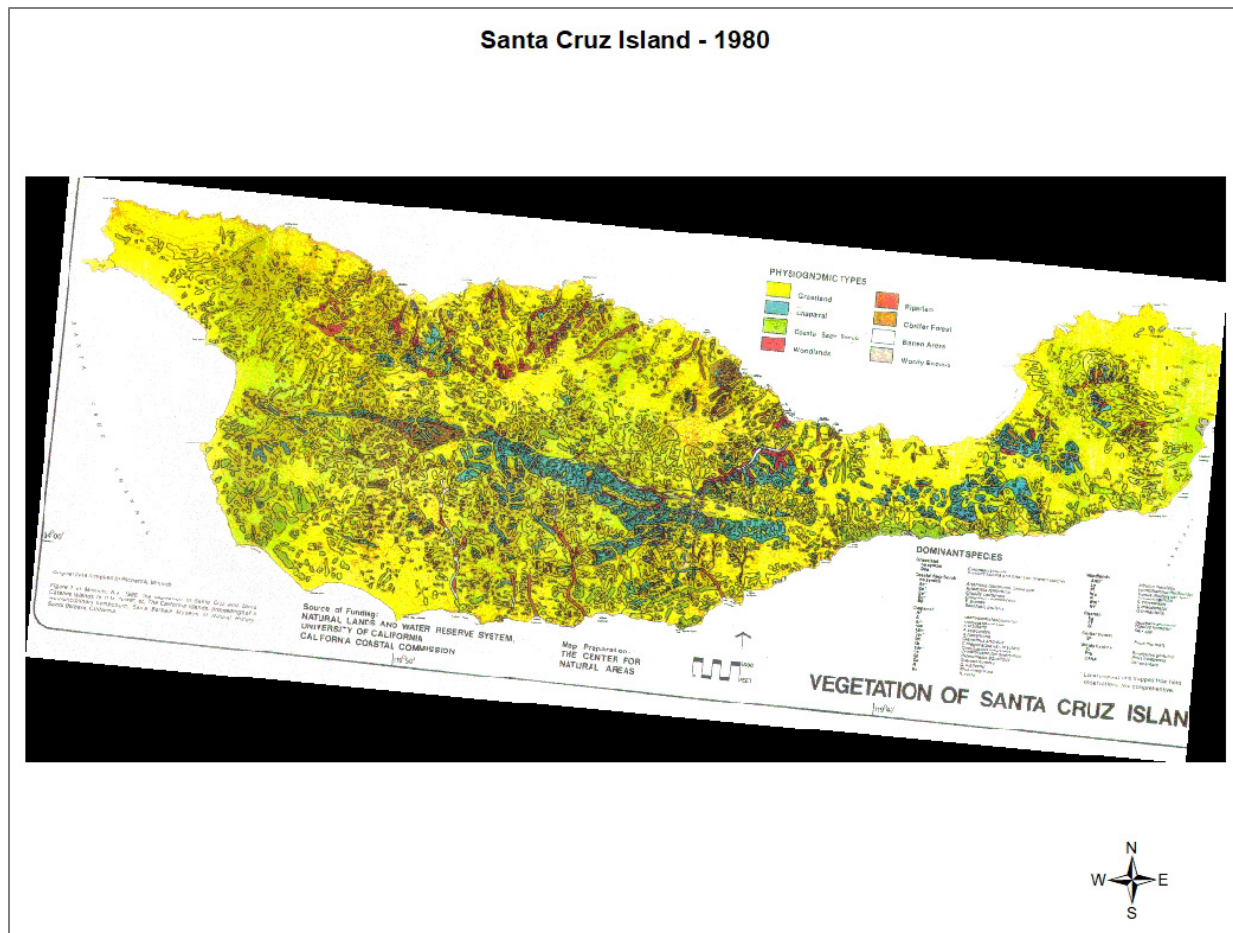


Figure 5. Vegetation map of Santa Cruz Island produced by Minnich (1980). In the absence of a digitally ortho-rectified version, a photo of the original map rather than a re-drawn version is shown.

NPS

The next vegetation map for SCI used July 1984 infrared and true-color aerial imagery at a 1:24,000 scale (Jones et al. 1993). Polygon delineation was completed by Pacific Western Aerial Surveys, and multiple site visits cross-checked mapping rules and vegetation distribution. The originally hand-drawn map was later digitized into a GIS layer in order to cross-tabulate vegetation types with other environmental variables. Based on the Philbrick and Haller (1977) classification, the aerial imagery's tone, texture, and context were used to distinguish 11 vegetation types, including coastal bluff, barren, coastal sage scrub, pines, island oaks, oaks, chaparral, island ironwoods, riparian, woody exotics, and grassland. Notably, vegetation types featuring shrubs and trees usually occurred in stands covering <1.5 ha and were surrounded by grasses. In the aerial imagery, chaparral-dominating scrub oak was difficult to distinguish from other oak classes, and coastal bluff vegetation was likely underestimated due to cliff steepness and shadows. The map produced by Jones et al. (1993) and another that coupled 1991 color infrared aerial photographs with 1993 Landsat thematic mapper imagery (Cobb & Mertes 1999) are not shown here.

In 2004, NPS used 2-ft digital aerial imagery to delineate polygons based on vegetation types at the formation and/or sub-formation level, yielding eight vegetation types and nine map classes (NPS 2004). Over 90% of the area was covered by medium tall grassland, deciduous shrubland, evergreen shrubland, and evergreen woodland; the remaining area was dominated by forbs, evergreen forest, deciduous woodland, deciduous forest (Figure 6).

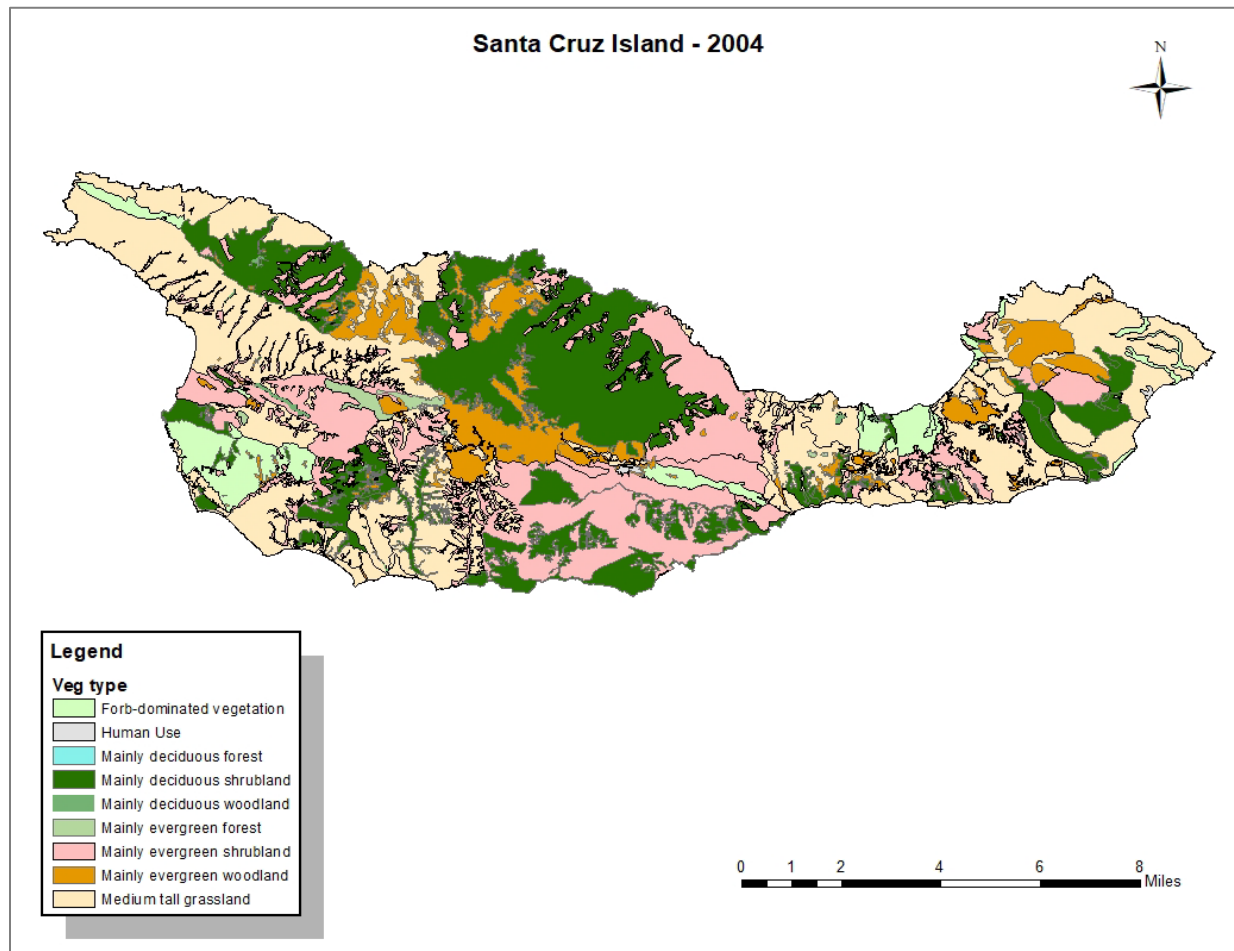


Figure 6. Vegetation map of Santa Cruz Island produced by the National Park Service (2004).

NPS

In 2002–2003, USGS surveyed 362 relevé plots with intent to generate a new vegetation classification for SCI (McEachern & Chess 2004). Sampling points were stratified by watershed, and then weighted toward those placed in northwestern SCI’s steep drainages to compensate for the lower sampling rate there. Although a vegetation map was not generated from this classification, these data were used as the foundation for a new vegetation classification, map, and database for SCI (Cohen et al. 2009). For map creation, TNC contracted with AIS to develop a vegetation spatial database of the entire island. The minimum mapping unit was 0.5 ha, and the polygon delineation was from 1:12,000 natural color aerial imagery captured in 2005. This effort adhered to the Sawyer alliance-association classification developed for California which is consistent with the NVCS and

[illegible]

NPS

The first known mapping effort for SRI was conducted in 1872 by S. Forni as part of a survey of the Santa Barbara Channel by what was then the U.S. Coast Survey. Little is known about the methodology used to construct the map, but it indicates that grasses were the dominant plant cover in terms of spatial extent and that cacti were also more abundant than at present. The next known mapping effort of SRI employed polygon delineation on true color aerial photographs from 1988, and the classification was based on data from 173 relevé plots (Clark et al. 1990). Field botanists

completed an AA but without formal documentation. The map featured 15 vegetation types and a few ancillary non-vegetation types (Figure 8). Non-native annual grassland dominated the landscape, while other vegetation types with substantial cover included coastal sage scrub, island chaparral, and lupine scrub. Notably, *Baccharis* scrub occurred in only a few small locations.

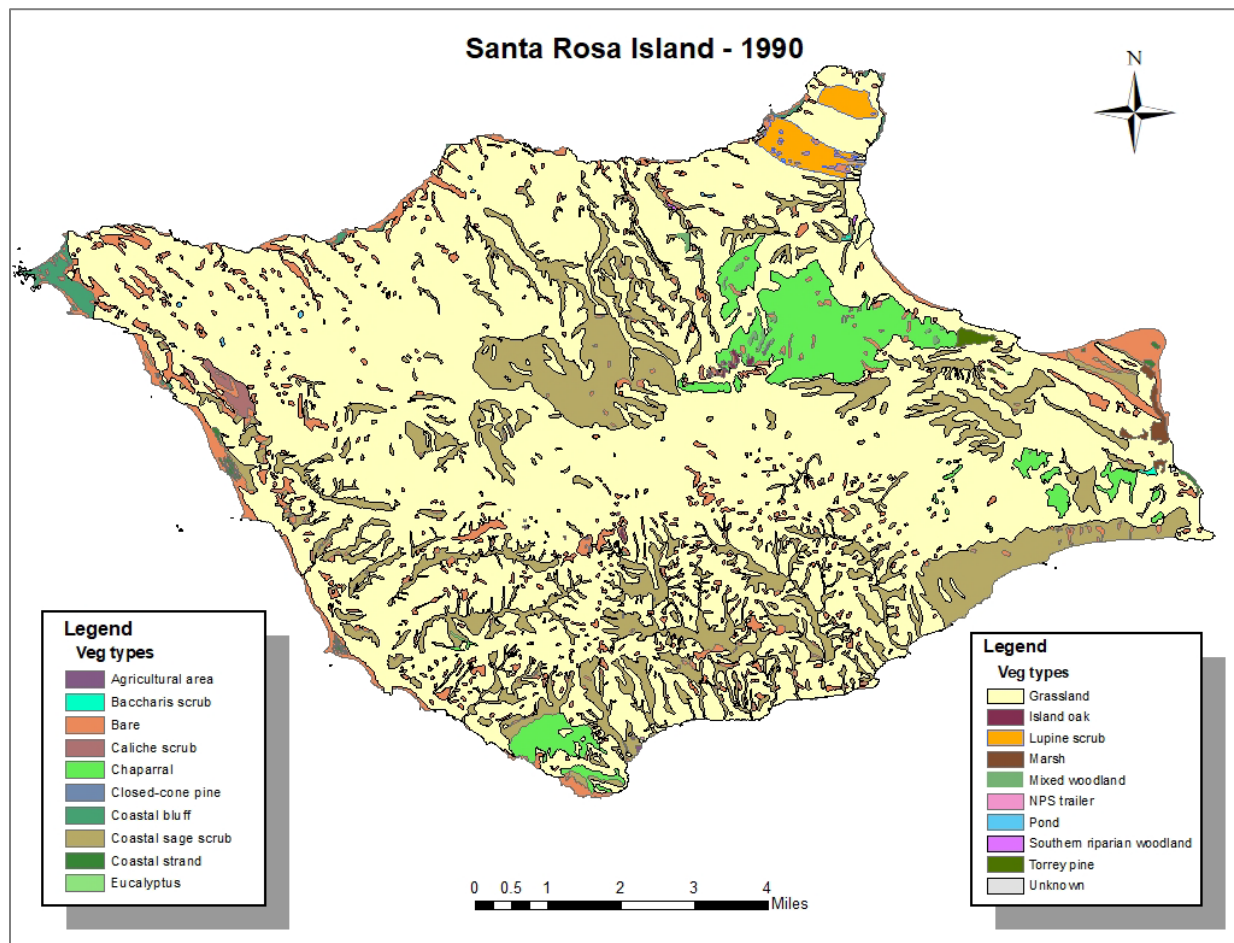


Figure 8. Vegetation map of Santa Rosa Island, redrawn from Clark et al. (1990).

NPS

San Miguel Island

The first known vegetation map of SMI was based on May 1978 color infrared aerial imagery at a scale of 1:6,000 and supported by field surveys and transect sampling to verify community types (Hochberg et al. 1979). The resulting classification produced seven plant associations and ten map classes (Figure 9) informed by an evaluation of vegetation communities for SCI that was produced a few years prior (Philbrick and Haller 1977). The associations were based either on the dominant vegetation or the presence of persistent woody remnants of shrub species such as buckthorn (*Rhamnus*) or California-lilac (*Ceanothus*) that indicated a historical cover of chaparral. Grassland and goldenbush scrub were the most common vegetation types in this 1979 map.

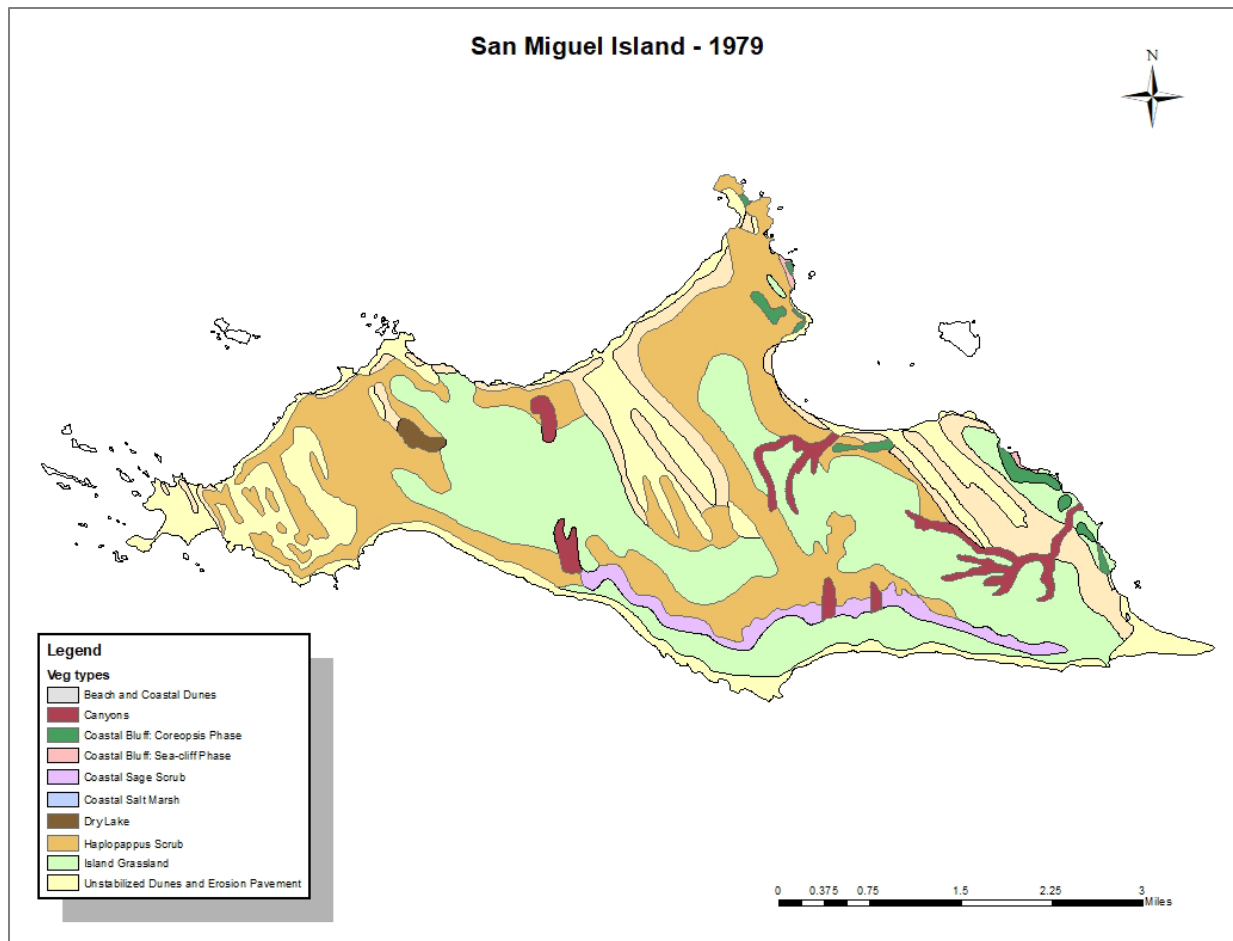


Figure 9. Vegetation map of San Miguel Island, redrawn from Hochberg et al. (1979).

NPS

Another vegetation classification for SMI was generated a few years later based on approximately 86 randomly placed relevé plots that yielded ten vegetation classes and utilized distinct phases as classification types (Lenihan 1983; Figure 10). For example, *Carpobrotus-Pennisetum* had a grass phase, a forb phase, and a shrub phase; the *Coreopsis-Dudleya* type had forb and shrub phases; and grasslands were included an *Avena-Malva* type and a *Bromus-Calystegia* type, each with grass and forb phases. As with the previously generated map (Hochberg et al. 1979), types dominated or co-dominated by grasses and goldenbush scrub were the largest vegetation classes in terms of spatial extent.

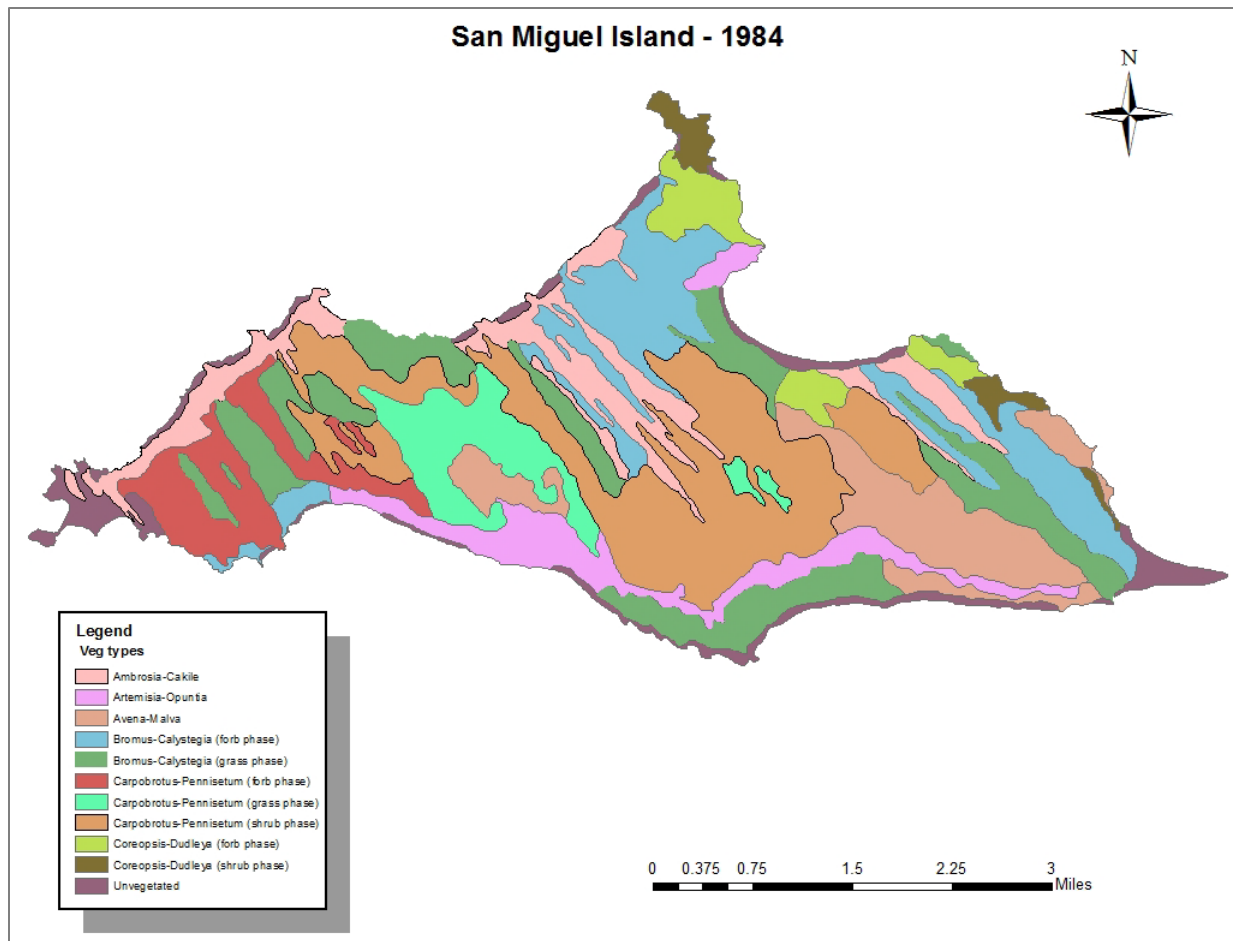


Figure 10. Vegetation map of San Miguel Island, redrawn from Lenihan (1983).

NPS

Two subsequent vegetation maps of SMI were produced. The map generated by Hochberg et al. (1979) was refined using digital scanning methods but without additional site visits (Halvorson 1991; Figure 11). Another map was produced in 1994 but scant documentation and metadata constrain its interpretive potential (Figure 11). These two maps display seven to ten fairly broad vegetation types, including different phases of the same plant community. Collectively, the time range over which these maps were generated captured the disappearance of a prominent sandspit at the east end of SMI between 1991 and 1994. This physiographical change may represent interior soil stabilization via recovery of the island's plant communities after intensive sheep grazing was terminated in the 1970s.

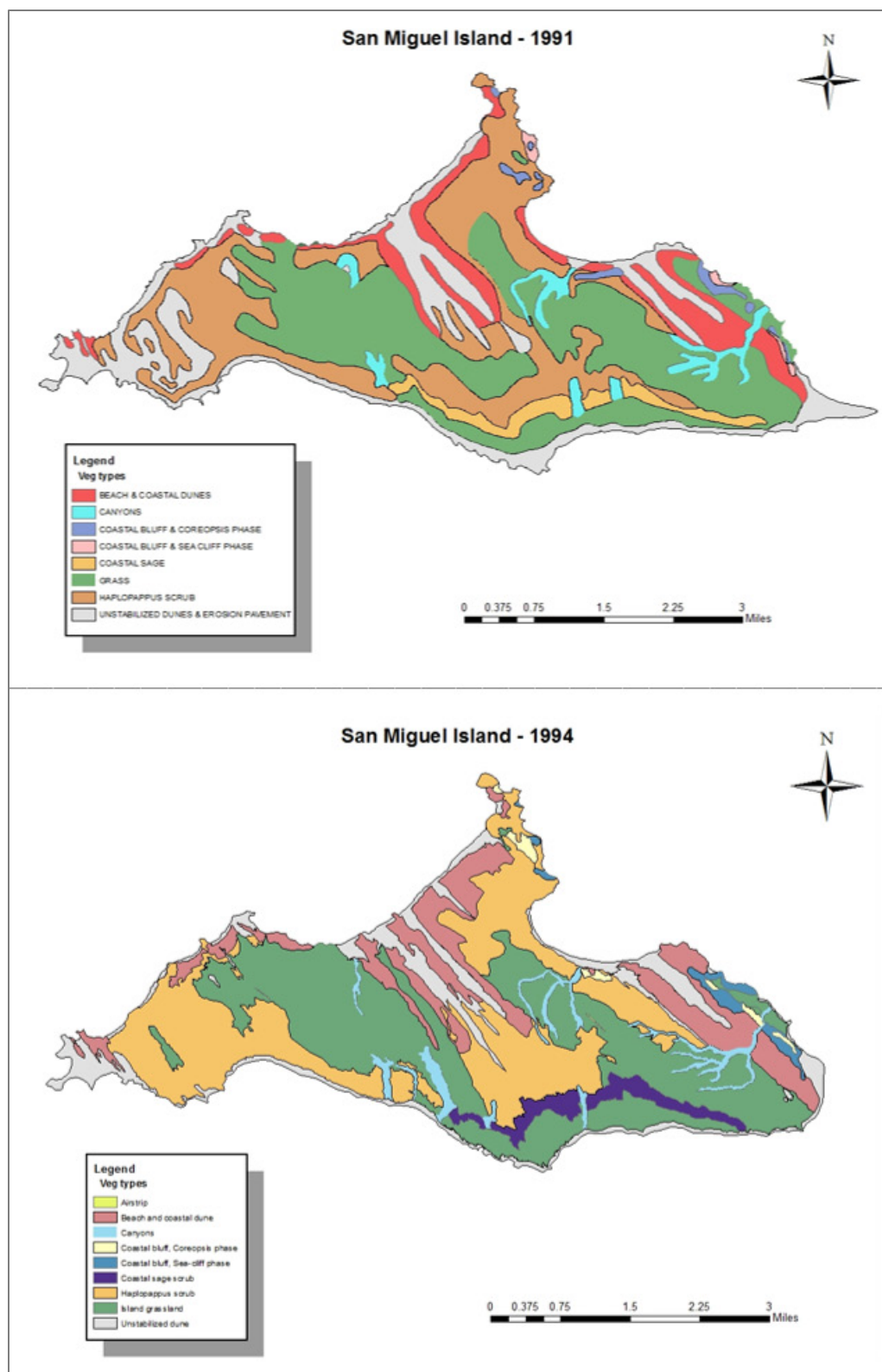


Figure 11. Vegetation maps of San Miguel Island, redrawn from Halvorson (1991) and from anonymous (1994). Note the disappearance of a sandspit at the east end of the island.

NPS

Site Selection

Data collection sites were selected either randomly or subjectively. Most of the random points were generated in ArcGIS using a procedure stratified by proportion of watershed area. Subjective sites were selected by field teams when opportunistically encountering unusual or rare plant communities, or by AIS photo interpreters when areas containing vegetation signatures were difficult to identify from the aerial imagery.

For ANI, SRI, and SMI, a GRTS sampling design (Stevens & Olsen 2003, 2004) was implemented to allocate sample sites. The sampling universe consisted of all land above mean tide, excluding slopes $>35^\circ$ as a safety precaution, developed areas, and cultivated land. All roads and trails were excluded with a 5 m buffer to minimize ruderal effects to the vegetation composition within each site. Due to the fairly moderate terrain over most of the included landscape, a travel cost factor was not used to eliminate sites from the samples.

Anacapa Island (East, Middle, West)

Ten, 15, and 20 points were randomly located across the landscapes of East, Middle, and West, respectively (Figures 12, 13, 14). Stratification was not attempted due to the relatively small sizes of each islet combined with the lack of substantial watersheds. Irregular and infrequent transportation to Middle and West imparted uncertainty in the ability to perform field surveys and AAs. This logistical constraint triggered a 2013 review of the survey sites, the outcome of which supported surveying all accessible vegetation types on the three islets. The primary advantage of this approach was to omit the need to conduct an AA if at least most of the accessible sites could be surveyed. Indeed, by October 2016, nearly all accessible, mapped polygons were surveyed, and classifiable information on the species present within each polygon was obtained. Ultimately, a total of 152 sites were surveyed across the three islets.

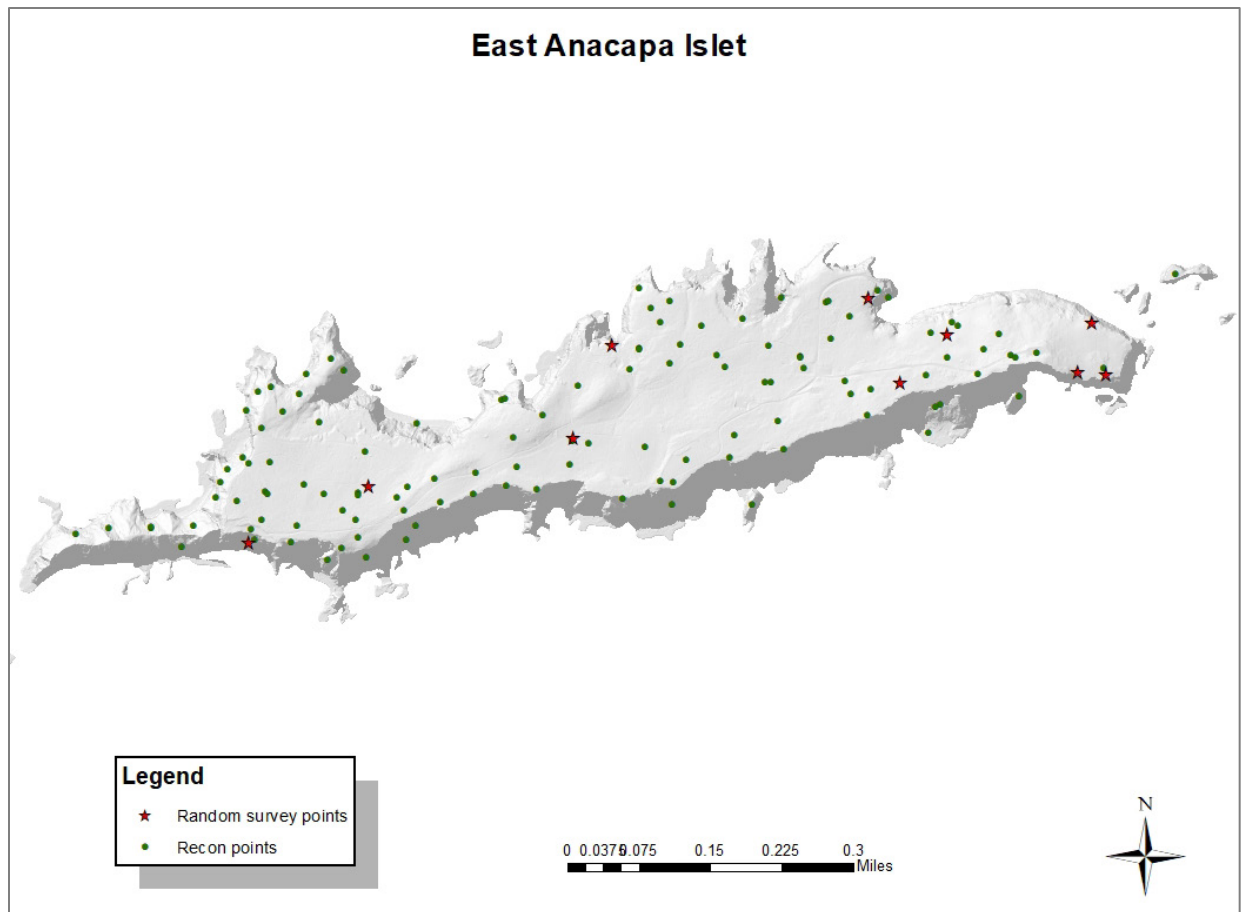


Figure 12. Randomly selected survey points and reconnaissance locations on East Anacapa Islet.
NPS

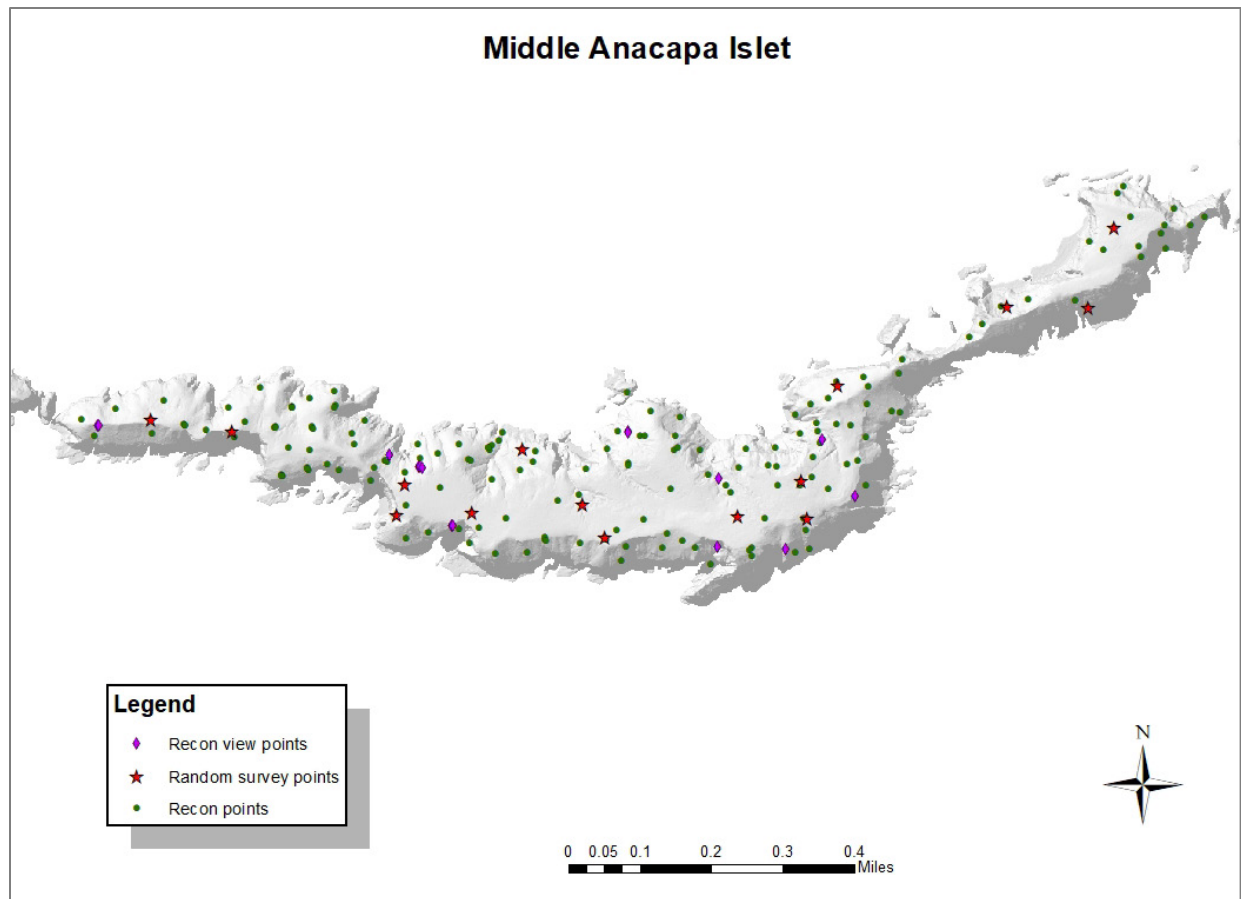


Figure 13. Randomly selected survey points and reconnaissance locations on Middle Anacapa Islet.
NPS

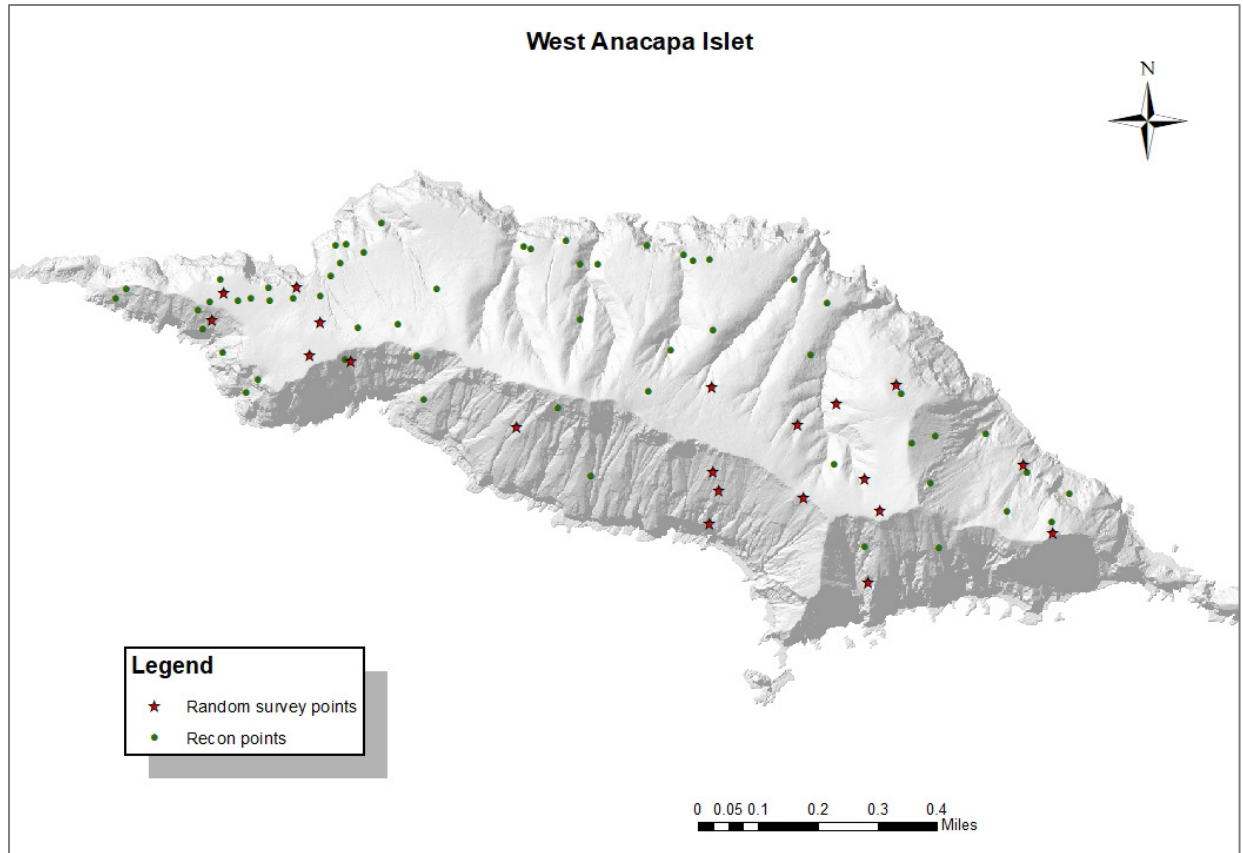


Figure 14. Randomly selected survey points and reconnaissance locations on West Anacapa Islet.
NPS

Santa Cruz Island

A total of 430 points were allocated to SCI (Figure 15), 405 of which were repeats of relevé plot locations originally surveyed in 2002–2003 (McEachern & Chess 2004) for the vegetation classification and mapping project that was based on 2005 aerial imagery (Cohen et al. 2009). The original random points were proportionally stratified by the areas of major watersheds, except that the higher personnel costs associated with travel over steeper terrain yielded an allocation of points at half the density over the rugged terrain of northwestern SCI. The classification presented here compensated for this discrepancy by allocating an additional 25 randomly selected sites to the northwest.

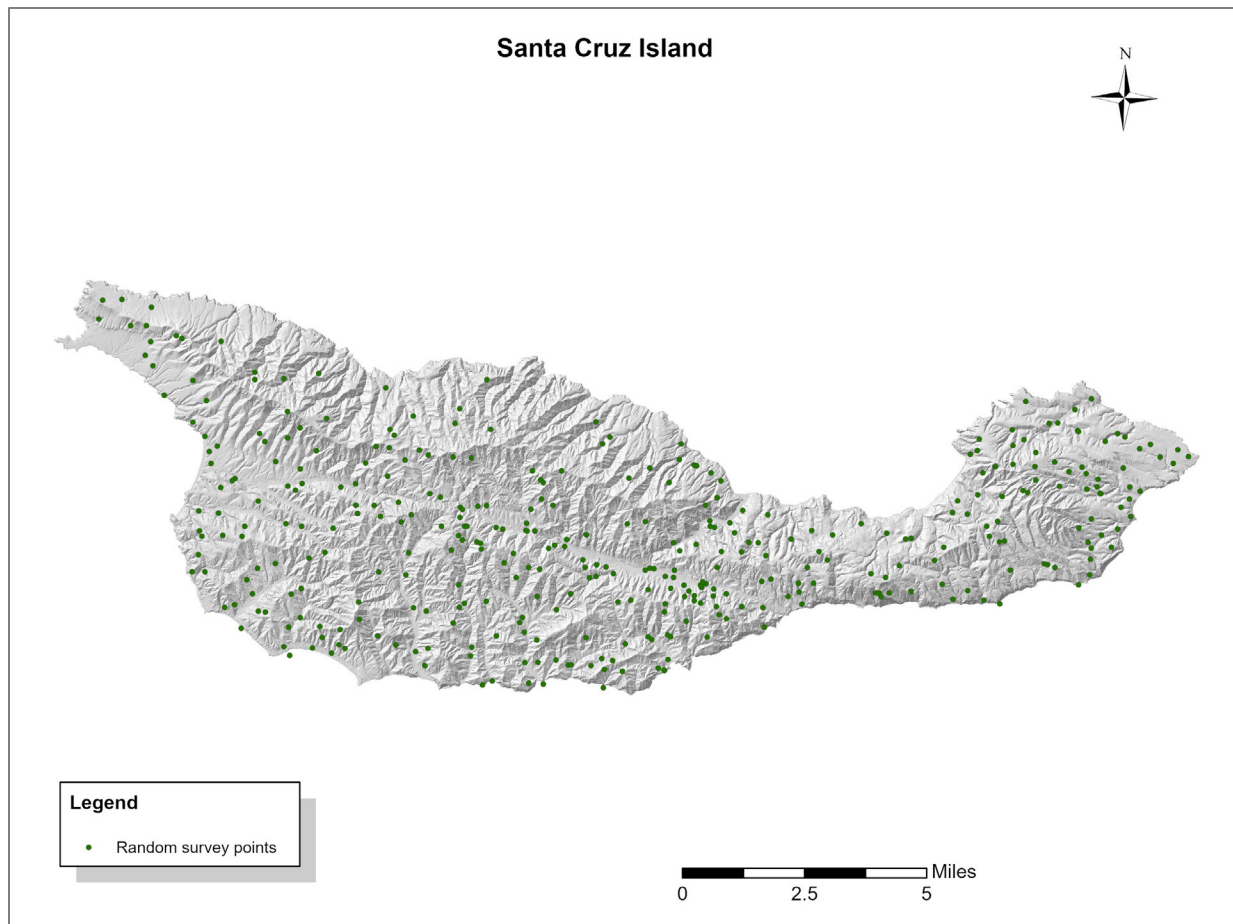


Figure 15. Randomly selected survey point locations on Santa Cruz Island.

NPS

Santa Rosa Island

A random selection of 500 points, stratified by watershed with equal probability assigned, was distributed across SRI (Figure 16). An additional 30 points were allocated to riparian areas, which can be underrepresented due to their tendency toward linearity. A subjective selection of 594 points was added to capture unusual and rare communities and to aid photo interpretation. The total number of surveyed sites on SRI was 1124.

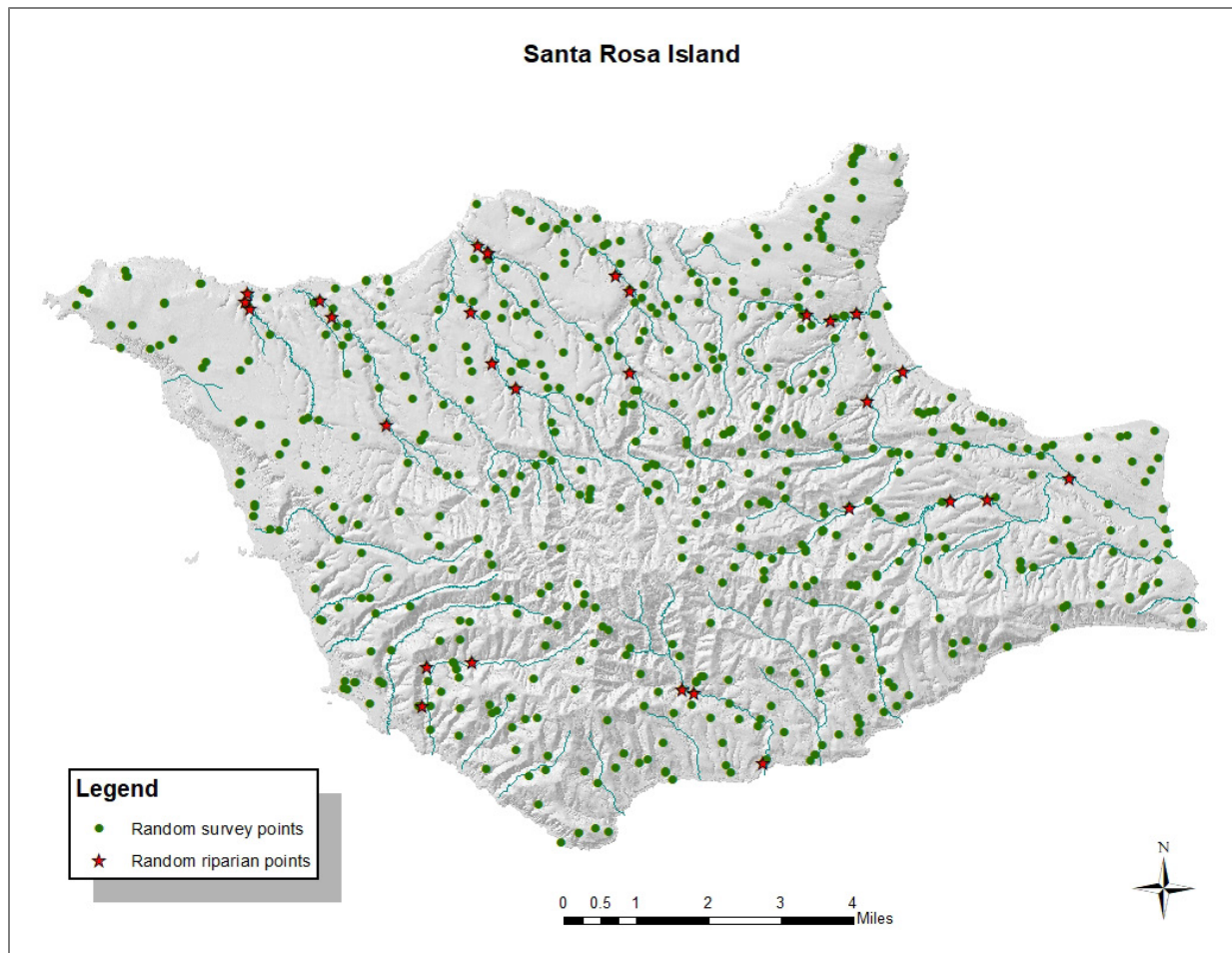


Figure 16. Randomly selected survey point locations on Santa Rosa Island, including 500 initial points plus an additional 30 targeting riparian areas.

NPS

San Miguel Island

A random selection of 125 points was distributed across the SMI landscape (Figure 17). Points were stratified by watershed, with a slightly higher proportion of points (1.25:1.00) assigned in the Willow Canyon watershed to capture the higher complexity in community composition there. Similar to SRI, a subjective selection of 203 points was added to capture unusual and rare communities and to aid photo interpretation. The total number of surveyed sites on SMI was 328.

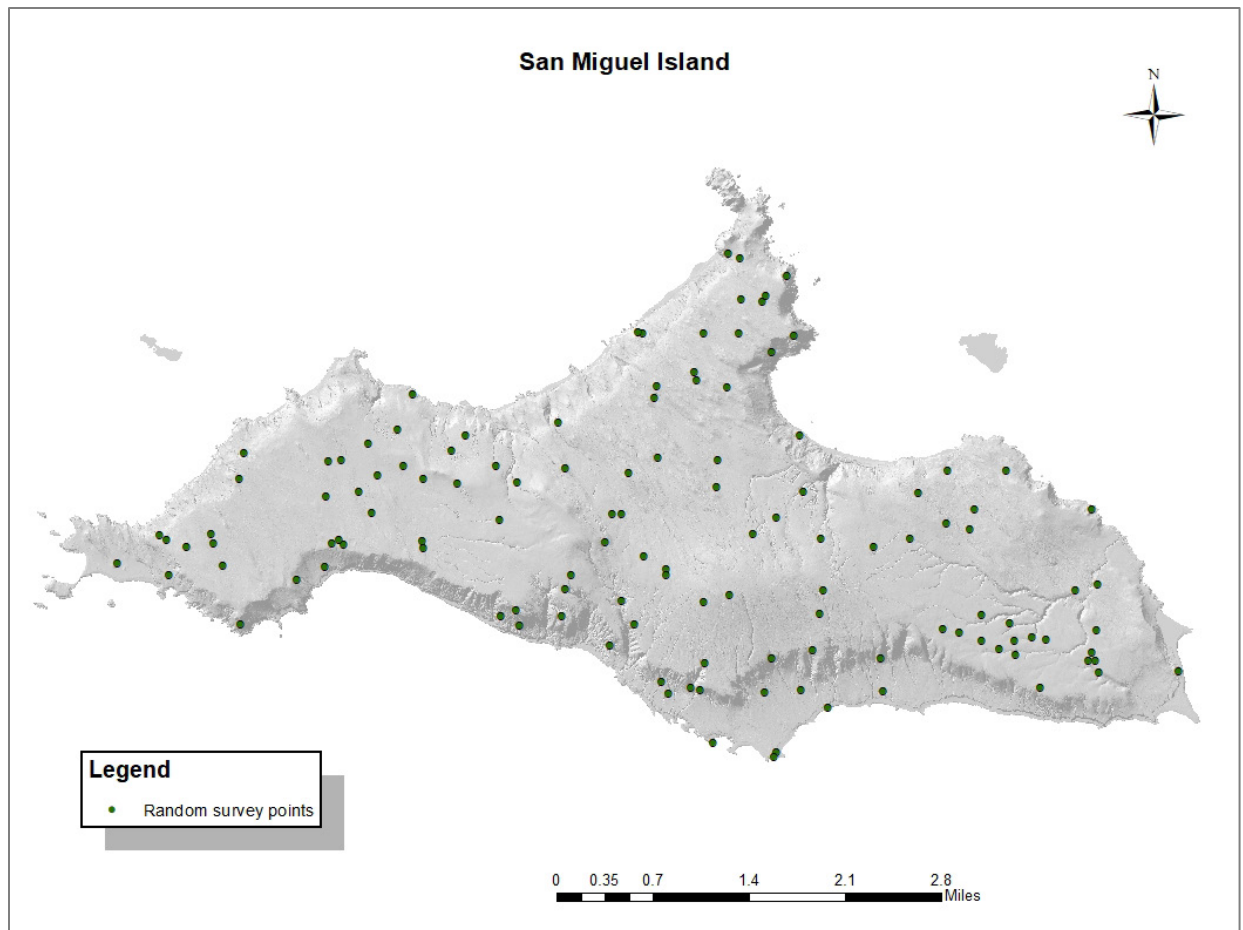


Figure 17. Randomly selected survey point locations on San Miguel Island.

NPS

Classification Data Collection and Management

Limitations inherent within the historical vegetation datasets motivated additional data collection to generate an up-to-date vegetation classification. Field methods followed national standards developed by the VMI program. Data were derived from relevé plot data, rapid assessment (RA) data, and point observation data. Three types of surveys were employed: relevé (plot-based) surveys, full RAs, or abbreviated RAs. Relevé surveys were confined within the boundaries of the plot sampled and generated a complete list of species present, whereas RAs surveyed entire stands or polygons and noted only the 20 most common plants present. Full RAs recorded physical attributes such as aspect and slope, whereas abbreviated RAs did not.

Phase 1 Data Collection

Several island visits occurred within the project timeline. Initial visits were attended by CNPS, CDFG, AIS, and CHIS personnel. For training visits, only CNPS ecologists and CHIS personnel were present. Subsequent field reconnaissance was conducted by AIS (Reyes et al. 2018, 2020) and the CHIS botanist. The purpose of these different trips was to familiarize project collaborators with the island plant communities, clarify mapping signatures from the aerial imagery, identify unique or rare island communities for mapping, and test the vegetation field key during its development. An example of a field reconnaissance form is available in this report's [supplemental materials in DataStore](#).

Data for the vegetation classification was collected by a pair of two-person field crews working year-round. All crew members had extensive experience with southern California plants, and at least one member of each crew possessed extensive knowledge of vegetation communities and plant species of the Channel Islands. Field methods followed the Relevé Protocol (CNPS 2000) with minor modifications. Crews were trained on SRI by CNPS in June 2012 and January 2013 to ensure consistency and orient new field crew members. As part of the training, data were collected from actual random point locations.

The logistics required to transport crews to island field sites were complex and costly. To minimize costs, crews typically lodged on an island for one week while collecting data each day, and classification data were collected year-round from 2012 to the end of 2013. While these strategies increased time-efficiency for the field crews, they also imparted the effect of seasonal changes in plant cover into the data, an effect that was exacerbated by the 2011–2016 drought that affected southern California. This effect was ameliorated by field crew familiarity with vegetation communities and plant species of southern California and the Channel Islands.

All randomly generated points and subjective opportunistic sites received relevé surveys or full RAs. Subjective survey sites directed by photo interpreters as a signature check recorded only the dominant species and spatial data (i.e., abbreviated RA). Photographs featuring the vegetation surveyed were taken at all sites.

Crews used hand-held Garmin GPS (Global Positioning System) units to navigate to each random point location where a relevé plot was installed to capture the dominant community physiognomy. The random point served as the southwest corner of the plot. However, a new GPS point was recorded if the plot was shifted to avoid anomalies such as ecotones or non-representative vegetation, a process that ensured each sampled community was homogenous in composition and structural integrity. Data were collected from relevé plots, and plot sizes were determined by community physiognomy. The ideal plot sizes for the three physiognomic types—tree-dominated, shrub-dominated, and herbaceous communities—were 1000 m², 400 m², and 100 m², respectively. Plot dimensions were also standardized (Table 4) but could be adjusted to better fit a given stand. For example, the length and width of a standard tree-dominated plot could be adjusted to 100 m x 10 m to better capture a narrowly linear riparian community while maintaining the overall area of 1000 m². In some cases, a standard plot was such a poor match to a community that the plot area was reduced below the recommend area by the field crew. In other cases, crews sampled the entirety of an oddly shaped stand. Plot dimensions and any deviations from the standard protocol were recorded. Plot boundaries were outlined by meter tapes unless the entire stand was assessed.

Table 4. Plot sizes used for vegetation sampling at Anacapa Island, Santa Rosa Island, and San Miguel Island.

Vegetation Class	Area (m2)	Plot Dimensions (m)
Forest and Woodland	1000	50 x 20
Shrubland	400	40 x 10 or 20 x 20
Herbaceous	100	10 x 10

After the plot boundaries were established, the stand vegetation was assessed. Data collected included island, location in Universal Transverse Mercator (UTM), plot size, substrate/surface cover, soil type, species present, percent cover for the species present, strata height and cover, slope, topography, and aspect (Table 5). Plants were identified to species when possible, or to genus if not. Uncertainty in field identification warranted specimen collection to achieve higher taxonomic resolution, and most specimens were discarded after identification. The vegetation community representing each stand was then assigned to the alliance or association level. In addition, once a draft vegetation key was written, it was used by the field crew to identify the vegetation type as a way to elucidate discrepancies in the key. Photos were taken in the four cardinal directions from the southwest corner, and an additional photograph was taken diagonally across the plot. Crews recorded general observations, the plot's representativeness of the stand, indications of site disturbance, and other information of interest. Any discrepancies, including alternate identifications of the community and terrain features that impeded photography from the plot's southwest corner, were recorded on the plot data sheets, which can be found in this report's [supplemental materials in DataStore](#).

Table 5. Data fields on relevé and rapid assessment data sheets.

Plot Data Type	Components
Metadata	Plot #, plot type, date, island, surveyor names, GPS unit, datum, utm coordinates, utm zone, bearing from left axis of southwest corner, camera type, photo numbers, stand size, plot size, plot shape.
Environmental	Aspect, slope, position in watershed, terrain form, geology type, soil texture, mesic type, percent surface cover, presence of bioturbation, evidence of fire, ungulate scat present.
Vegetation data	DBH class (trees), life stage (shrubs), herbaceous height category, category percent cover (non-vascular, vascular, tree, shrub, herbaceous), height class (tree, shrub, herbaceous), percent cover by species, list of unusual or rare species.
Ancillary information	Description of stand, list of adjacent plant communities, plant phenology (tree, shrub, herbaceous), assessed alliance/association, items of other interest.

Phase 2 Data Collection

The vegetation classification analysis for SCI relied on two separate sets of plant community data. The first dataset was collected from 2002 to 2003 for a vegetation classification and mapping project (McEachern & Chess 2004) that was ultimately published by Cohen et al. (2009). The second dataset was initiated in 2015 in support of the present mapping project. This more recent dataset consisted of revisits to the 2002–2003 sites, as well as an additional 25 randomly selected sites located in the northeast section of the island.

2002–2003 Data Collection (McEachern & Chess 2004)

Although the initial site points were randomly located, adjustments were made to ensure each relevé plot was placed within the nearest homogenous stand. Each plot was marked with a short aluminum stake at the northwest corner and topographically aligned with the long axis perpendicular to the slope. The remaining three corners were temporarily maintained by aluminum poles so that the whole plot could be outlined with a meter tape. The position of the initial plot corner was recorded in UTM coordinates using a Garmin GPS hand-held unit. Data collection methods conformed to the NVCS to ensure compatibility with regional and national scales. The collected data included photographs as well as physiographic and community variables (Table 6). Prior to each sampling season, field crews collected data from training plots together with experienced team leaders to maintain consistency of data collection throughout the study.

Table 6. Data collected from relevé plots in 2002–2003 by McEachern (2004).

Plot Data Type	Components
Plot location and identification	Surveyor names, date, UTM coordinates.
Photographs	Minimum 4 photos per plot
Stand description	Stand type (from Junak et al. 1995), approximate size of stand sampled, adjacent community types, distance to nearest edge.
Physical environment	Slope, aspect, shape, elevation, topographic position, landform, soil depth to bedrock
Disturbance	Presence/absence of pig rooting, trailing, scat, root exposure
Substrate cover	Cover class of substrate
Stratum data	Total vegetation cover by cover class within ground, shrub, tree height classes
Species data	Cover class by species, phenology, associated species within the stand (outside the plot)

2015–2019 Mapping Effort

In April and May of 2015, WCS, under contract with TNC, captured geo-referenced, high-resolution photographs of the common and unique island plant communities. These photographs were taken via helicopter at altitudes from 1.5 m to 304 m above the canopy level. The approximately 55,000 images were then provided to the photo interpreters to conduct the signature acquisition and analysis. Following funding approval from NPS to complete the SCI map, a team of photo interpreters from AIS and ecologists from the CDFW and TNC participated in two field reconnaissance visits in February and May 2016. These trips familiarized the team AIS with SCI’s vegetation, as this knowledge helped AIS compile information that would assist in developing key signatures for the different vegetation types when viewed from the aerial imagery.

Field work for the vegetation classification was conducted in April and May 2017. A helicopter ferried field crews among sites to reduce travel time and personnel costs. Given the frequently dense and tall physiognomy of SCI’s vegetation, the time taken to lay out each plot was reduced by marking only two adjacent sides which required the surveyor to visually delineate the rest. The veracity of this modified methodology was verified on SCI in January 2017. The type of data collected for SCI was essentially the same as for ANI, SRI, and SMI, but three differences are notable. First, data collected for SCI used a single standard plot area of 400 m² (40 x 10 m or 20 x 20 m) for each of the three major vegetation types instead of a different plot area for each. Second, the 400 m² plot area was optimized based on a pilot study of community composition sampling that explored nested plot sizes in the major scrub vegetation types—chaparral, coastal sage scrub/coastal bluff scrub—on SCI (McEachern & Chess 2004). Third, the 2002–2003 data differed in how percent cover and abundance were estimated, so some data adjustments were required (Sikes et al. 2018).

Data Management

At the end of each day, data sheets were reviewed by field crews for potential errors or missing information. Any corrections or changes were accompanied by explanations noted on the same datasheet. Collections of plant species undetermined in the field were identified using a dichotomous

key (Junak et al. 1995; Baldwin et al. 2012). After each island trip, all data sheets were entered into a Microsoft® Access database in which the data underwent a thorough QA/QC process and taxon nomenclature followed Baldwin et al. (2012). These data were then used as the basis for a vegetation classification.

Vegetation Classification

Vegetation in California can be classified at the national level and the state level. The NVCS equally emphasizes physiognomy and floristics to provide a standardized, scientifically credible vegetation classification for North America (USNVC 2022). The default state standard (Sawyer et al. 2009) relies on a mainly floristic approach, particularly for the lower classification levels, but adheres to the nomenclature of the NVCS. The classification for this project was developed in collaboration by CHIS, CNPS, and CDFW to fit within both the state framework of Sawyer et al. (2009) and the NVCS. Below is a summary of the analysis of the vegetation types on the four northern Channel Islands. Comprehensive descriptions can be found in Sikes et al. (2018).

National Vegetation Classification Standard (NVCS)

Beginning in the 1990s, a number of government agencies and non-government organizations recognized the need to create a standardized, scientifically credible vegetation classification for North America. In 1997, the first vegetation standard was adopted by the FGDC, and in 1999, a Memorandum of Understanding was formalized between the Ecological Society of America, TNC, NatureServe, USGS, the U.S. Forest Service, and FGDC to develop and maintain the NVCS (USNVC 2022). In 2016 a second version of the initial vegetation standard was released under the NVCS. All vegetation classifications and maps produced under the VMI program, including this mapping project, adhere to the NVCS.

The NVCS uses an eight-level natural vegetation hierarchy (Table 7). The upper three levels emphasize physiognomic features in an ecological context while the middle three rely on dominant and diagnostic growth forms and compositional similarity. The lower two layers—alliance and association—are based on diagnostic and/or dominant species and compositional similarity that reflects local and regional environmental factors (USNVC 2022).

Table 7. Eight-level hierarchy used in the National Vegetation Classification (USNVC 2022).

Hierarchy Level		Criteria	Example
Upper: Physiognomy plays a predominant role.	L1 – Class	Broad combinations of general dominant growth forms adapted to basic temperature (energy budget), moisture and/or substrate or aquatic conditions.	1. Forest and Woodland
	L2 – Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental positions, or that reflect overriding substrate or aquatic conditions.	1.B.1. Warm Temperate Forest and Woodland
	L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates and hydrologic conditions.	1.B.1.Nc. California Forest and Woodland

Table 7 (continued). Eight-level hierarchy used in the National Vegetation Classification (USNVC 2022).

Hierarchy Level		Criteria	Example
Middle: Both floristics and physiognomy play a significant role.	L4 – Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	M009. California Forest and Woodland
	L5 – Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	California Forest and Woodland Macrogroup
	L6 – Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographical differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	California Broadleaf Forest and Woodland Group
Lower: Floristics plays a predominant role.	L7 – Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors and disturbance regimes.	<i>Quercus tomentella</i> - <i>Lyonothamnus floribundus</i> California Islands Woodland Alliance
	L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic, climate, substrates, hydrology, and disturbance regimes.	<i>Quercus tomentella</i> Association

California State Classification Standard

Due to its large size, plant diversity, and varied topography, California contains a large number of vegetation types (Sawyer et al. 2009). However, a history of developing different classification systems led to inconsistencies that impeded communication among land management agencies and organizations. To address the situation, CNPS in partnership with CDFW developed a comprehensive and consistent framework to classify California’s plant communities, and a committee was assembled in 1991 to oversee this effort. The result was a unified, coherent, and all-encompassing structure for classifying the State’s vegetation (Sawyer & Keeler-Wolf 1995; Sawyer et al. 2009) that adhered to the NVCS, enabling California’s vegetation types to be placed within the national hierarchy. The alliances and associations arising from the analysis of the ANI, SCI, SRI, and SMI communities were placed within the hierarchies of Sawyer et al. (2009) and the NVCS, a process that resulted in descriptions of novel vegetation communities and associated classification updates.

Data Analysis

The vegetation classification analysis occurred over four iterations: one initial analysis, two interim analyses, and one final analysis. The initial analysis and the first interim analysis were conducted by NPS personnel at CHIS, whereas the final two analyses were overseen by CNPS. All four resulting classifications were generated using hierarchical agglomerative cluster analyses. See Sikes et al. (2018) for a full portrayal of the data analyses that generated the classifications.

Prior to conducting the analyses, adjustments to the dataset were necessary to account for variation in taxonomic resolution and sampling methodology. First, several taxonomic issues were clarified across the entire dataset by aggregating taxa based on morphological or ecological similarities. Second, the SCI data contained cover values that were estimated differently than the other islands. The CNPS methodology for collecting data on ANI, SRI, and SMI used cover values for individuals and aggregates of plants that incorporated a porosity component, whereas complete canopy cover was assumed for individuals and aggregates of plants at SCI. Therefore, a correction factor had to be applied to the SCI cover values to render them consistent with the ANI, SMI, and SRI datasets. Third, methodological differences in measuring abundance of individual species by height class and overall height strata were similarly reconciled. Finally, nomenclature that shifted over time was addressed via a crosswalk that updated the taxon names applied to SCI.

The data fed into the analyses were derived from either relevé fixed-plots or rapid assessment stand-based surveys, and included species' percent covers, vegetation structure, and physical site characteristics such as slope, aspect, topography, and soil type. Each successive classification included more data. The first classification analysis used data from only 174 field samples from SRI. The second interim classification, produced in June 2013, was based on 580 samples from SRI. In 2015, the final classification featured 315 taxa and 1831 samples from all project islands including 372 surveys from SCI.

All multivariate analyses were performed using PC-ORD Version 5.33 (McCune & Mefford 2006). Samples with outlying Sørensen distances of greater than three standard deviations from the mean, which consisted of seven samples and one species (*Bromus diandrus*), were removed before running the final classification. To increase the probability that the cluster analysis would arrive at a coherent hierarchy, species that occurred in fewer than seven samples were removed to further reduce noise in the dataset. The dataset was then transformed to a modified Braun-Blanquet scale in which species' cover values were categorized into seven different cover classes <1%, 1–5%, 5–15%, 15–25%, 25–50%, 50–75%, >75%. Finally, hierarchical agglomerative clustering using a Sørensen distance matrix, a flexible beta of -0.25, and group linkage method (McCune & Grace 2002) was used to generate a dendrogram representing hierarchical groupings of the vegetation communities.

Indicator species analysis was used to assign each species a group membership at all hierarchical levels within the dendrogram, and the statistical significance of each indicator species was evaluated using a Monte Carlo test of significance with 1,000 randomizations (Dufrêne & Legendre 1997). Additional indicator species analyses were conducted using two to 40+ groups. A *p*-value cutoff of

0.05 was used to identify the number of indicator species for each analysis, and an average p -value was assigned to each group. Community classifications with the highest number of significant indicator species and the lowest group p -values were selected for further evaluation. The groupings that best met the above criteria contained eight and 21 groups. These groupings were used to help determine where the plot data were placed into the overall classification based on the species that grouped together well in the cluster analysis.

After each iteration of the classification analyses, meetings via conference call were held to discuss the results and make adjustments to better fit the field observations, to determine whether new or island-unique plant communities were valid, and to better integrate the classification within the larger NVCS framework. This latter task was overseen by NatureServe (in conjunction with CNPS), which began reviewing the classification in 2016. Following their review, nine alliances and 26 new associations were accepted into the NVCS with descriptions. An additional 24 associations were accepted without descriptions. All will be considered provisional with acceptance pending peer review of the classification.

Classification Results

The final classification included 56 alliances and 111 associations across the four northern Channel Islands (Table 8). Some alliances were sampled on just one island whereas others were found on a majority of the islands. Of the associations, 34 were not included in the Manual of California Vegetation (Sawyer et al. 2009), and 17 are putatively considered unique to the Channel Islands due to one of the characteristic species being island-endemic. However, 14 of these new associations have provisional status due to their small sample sizes. Some plot data could not be assigned to the alliance or association level and were subsequently placed at the group level. These alliances and associations nest within the NVCS hierarchy (NatureServe 2017; Table 9).

Table 8. Final vegetation classification consistent with the Manual of California Vegetation (Sawyer et al. 2009).

Life form	Alliance	Association
Tree	<i>Pinus muricata</i> – <i>Pinus radiata</i>	<i>Pinus muricata</i> / <i>Arctostaphylos</i> spp.
	<i>Pinus muricata</i> - <i>Pinus radiata</i>	<i>Pinus muricata</i> / <i>Comarostaphylos diversifolia</i> ssp. <i>planifolia</i>
	<i>Pinus torreyana</i>	<i>Pinus torreyana</i> ssp. <i>insularis</i>
	<i>Populus trichocarpa</i>	<i>Populus trichocarpa</i> / <i>Salix lasiolepis</i>
	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i>
	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i> – <i>Quercus tomentella</i> / (<i>Prunus ilicifolia</i> ssp. <i>lyonii</i>)
	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i> / <i>Arctostaphylos</i> (<i>insularis</i>)
	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i> / <i>Quercus pacifica</i>
	<i>Quercus tomentella</i> – <i>Lyonothamnus Floribundus</i>	<i>Lyonothamnus floribundus</i>
	<i>Quercus tomentella</i> – <i>Lyonothamnus Floribundus</i>	<i>Quercus tomentella</i>
Shrub	<i>Acmispon glaber</i> – <i>Lupinus albifrons</i>	<i>Lupinus albifrons</i> coastal
	<i>Adenostoma fasciculatum</i>	<i>Adenostoma fasciculatum</i> Southern maritime
	<i>Adenostoma fasciculatum</i>	<i>Adenostoma fasciculatum</i> var. <i>prostratum</i> – (<i>Quercus pacifica</i>)
	<i>Adenostoma fasciculatum</i>	<i>Adenostoma fasciculatum</i> var. <i>prostratum</i> – <i>Salvia brandegeei</i> / <i>Selaginella bigelovii</i>
	<i>Arctostaphylos</i> (<i>crustacea</i> , <i>tomentosa</i>)	–
	<i>Arctostaphylos</i> (<i>crustacea</i> , <i>tomentosa</i>)	<i>Arctostaphylos confertiflora</i>
	<i>Arctostaphylos</i> (<i>crustacea</i> , <i>tomentosa</i>)	<i>Arctostaphylos crustacea</i>

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify some Alliances to the Association level.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 8 (continued). Final vegetation classification consistent with the Manual of California Vegetation (Sawyer et al. 2009).

Life form	Alliance	Association
Shrub (cont.)	<i>Arctostaphylos (crustacea, tomentosa)</i>	<i>Arctostaphylos insularis</i>
	<i>Artemisia californica</i>	–
	<i>Artemisia californica</i>	<i>Artemisia californica</i>
	<i>Artemisia californica</i>	<i>Artemisia californica</i> – <i>Opuntia littoralis</i>
	<i>Artemisia californica</i>	<i>Artemisia californica</i> – <i>Peritoma arborea</i>
	<i>Artemisia californica</i>	<i>Artemisia californica</i> – <i>Salvia brandegeei</i>
	<i>Artemisia californica</i>	<i>Artemisia californica</i> / <i>Bromus carinatus</i>
	<i>Artemisia californica</i>	<i>Artemisia californica</i> / <i>Stipa (pulchra)</i>
	<i>Baccharis pilularis</i>	–
	<i>Baccharis pilularis</i>	<i>Baccharis pilularis</i>
	<i>Baccharis pilularis</i>	<i>Baccharis pilularis</i> – <i>Artemisia californica</i>
	<i>Baccharis pilularis</i>	<i>Baccharis pilularis</i> / Annual Grass – Herb
	<i>Baccharis pilularis</i>	<i>Baccharis pilularis</i> / (<i>Stipa pulchra</i> – <i>Elymus glaucus</i> – <i>Bromus carinatus</i>)
	<i>Baccharis salicifolia</i>	<i>Baccharis salicifolia</i>
	<i>Ceanothus megacarpus</i>	<i>Ceanothus megacarpus</i> var <i>insularis</i>
	<i>Cercocarpus betuloides</i>	–
	<i>Cercocarpus betuloides</i>	<i>Cercocarpus betuloides</i> var <i>blancheae</i>
	<i>Deinandra clementina</i> – <i>Eriogonum giganteum</i>	<i>Deinandra clementina</i>
	<i>Encelia californica</i> – <i>Eriogonum cinereum</i>	<i>Encelia californica</i> – <i>Eriogonum arborescens</i>
	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> var. <i>grande</i>	–
	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> var. <i>grande</i>	<i>Artemisia californica</i> - <i>Eriogonum arborescens</i>
	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> var. <i>grande</i>	–
	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> var. <i>grande</i>	<i>Eriogonum grande</i> var. <i>grande</i>
	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> var. <i>grande</i>	<i>Eriogonum grande</i> var. <i>rubescens</i>
	<i>Isocoma menziesii</i>	–
	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i>
	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i> – <i>Acmispon dendroideus</i>

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Table 8 (continued). Final vegetation classification consistent with the Manual of California Vegetation (Sawyer et al. 2009).

Life form	Alliance	Association
Shrub (cont.)	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i> – <i>Artemisia californica</i>
	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i> – <i>Lupinus albifrons</i>
	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i> / (<i>Astragalus miguelensis</i> – <i>Extriplex californica</i>)
	<i>Isocoma menziesii</i>	<i>Isocoma menziesii</i> / <i>Dudleya greenei</i>
	<i>Lepidospartum squamatum</i>	<i>Lepidospartum squamatum</i> – <i>Baccharis salicifolia</i>
	<i>Leptosyne gigantea</i>	<i>Leptosyne gigantea</i> – (<i>Lycium californicum</i> - <i>Opuntia</i> spp.)
	<i>Leptosyne gigantea</i>	<i>Leptosyne gigantea</i> – <i>Acemisson dendroideus</i>
	<i>Leptosyne gigantea</i>	<i>Leptosyne gigantea</i> / (<i>Dudleya greenei</i>)
	<i>Lupinus arboreus</i>	–
	<i>Lycium californicum</i>	<i>Lycium californicum</i>
	<i>Mimulus aurantiacus</i>	<i>Mimulus parviflorus</i>
	<i>Opuntia littoralis</i> – <i>Opuntia oricola</i> – <i>Cylindropuntia prolifera</i>	<i>Cylindropuntia</i> – Mixed coastal scrub
	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i>	<i>Heteromeles arbutifolia</i>
	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i>	<i>Heteromeles arbutifolia</i> – <i>Artemisia californica</i> – <i>Rhus integrifolia</i> – (<i>Salvia brandegeei</i>)
	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i>	<i>Prunus ilicifolia</i> ssp. <i>lyonii</i>
	<i>Quercus dumosa</i> – <i>Quercus pacifica</i>	–
	<i>Quercus dumosa</i> – <i>Quercus pacifica</i>	<i>Quercus pacifica</i>
	<i>Quercus dumosa</i> – <i>Quercus pacifica</i>	<i>Quercus pacifica</i> – (<i>Arctostaphylos insularis</i> – <i>Ceanothus megacarpus</i> var. <i>insularis</i>)
	<i>Quercus dumosa</i> – <i>Quercus pacifica</i>	<i>Quercus pacifica</i> – <i>Rhus integrifolia</i>
	<i>Quercus dumosa</i> – <i>Quercus pacifica</i>	<i>Quercus pacifica</i> / grass
	<i>Rhus integrifolia</i>	<i>Rhus integrifolia</i>
	<i>Rhus integrifolia</i>	<i>Rhus integrifolia</i> – <i>Artemisia californica</i>
	<i>Salix lasiolepis</i>	<i>Salix lasiolepis</i>
	<i>Salix lasiolepis</i>	<i>Salix lasiolepis</i> – <i>Baccharis salicifolia</i>
	<i>Salvia mellifera</i>	<i>Salvia mellifera</i> – <i>Opuntia littoralis</i> – <i>Rhus integrifolia</i>
Herb	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i>	<i>Ambrosia chamissonis</i> – <i>Abronia maritima</i> – <i>Cakile maritima</i>
	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i>	<i>Ambrosia chamissonis</i> – <i>Malacothrix incana</i> – <i>Carpobrotus chilensis</i> – <i>Poa douglasii</i>

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Table 8 (continued). Final vegetation classification consistent with the Manual of California Vegetation (Sawyer et al. 2009).

Life form	Alliance	Association
Herb (cont.)	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i>	<i>Calystegia macrostegia</i> – <i>Erigeron glaucus</i> – <i>Malacothrix incana</i> ^A
	<i>Amsinckia (menziesii, tessellate)</i> – <i>Phacelia</i> spp.	<i>Amsinckia (intermedia, menziesii)</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Atriplex semibaccata</i> – <i>Hordeum (murinum)</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Avena barbata</i> – <i>Avena fatua</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Brachypodium distachyon</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Bromus diandrus</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Bromus diandrus</i> – <i>Avena</i> spp.
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Bromus hordeaceus</i> – <i>Erodium botrys</i>
	<i>Avena</i> spp. – <i>Bromus</i> spp.	<i>Hypochaeris glabra</i> – <i>Festuca (bromoides)</i>
	<i>Brassica nigra</i> and other mustards	<i>Brassica nigra</i>
	<i>Bromus carinatus</i> – <i>Elymus glaucus</i>	<i>Bromus carinatus</i>
	<i>Bromus carinatus</i> – <i>Elymus glaucus</i>	<i>Pteridium aquilinum</i> - Grass
	<i>Carex (pansa, praegracilis)</i>	–
	<i>Carex (pansa, praegracilis)</i>	<i>Carex pansa</i>
	<i>Carex (pansa, praegracilis)</i>	<i>Carex praegracilis</i>
	<i>Conium maculatum</i> – <i>Foeniculum vulgare</i>	<i>Foeniculum vulgare</i>
	<i>Corethrogyne filaginifolia</i> – <i>Eriogonum (elongatum, nudum)</i>	<i>Corethrogyne filaginifolia</i>
	<i>Cressa truxillensis</i> – <i>Distichlis spicata</i>	<i>Cressa truxillensis</i>
	<i>Cynodon dactylon</i> – <i>Crypsis</i> spp. – <i>Paspalum</i> spp.	<i>Cynodon dactylon</i>
	<i>Distichlis spicata</i>	–
	<i>Distichlis spicata</i>	<i>Distichlis spicata</i>
	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> – (<i>Baccharis glutinosa</i> – <i>Equisetum hyemale</i>)
	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> – annual grasses
	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> – <i>Elymus triticoides</i>
	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> – <i>Frankenia salina</i> – <i>Jaumea carnosa</i>
	<i>Dudleya greenei</i> – <i>Dudleya</i> spp. Succulent Scrub	<i>Dudleya greenei</i>
	<i>Elymus cinereus</i> – <i>Elymus triticoides</i>	<i>Elymus triticoides</i>
	<i>Elymus cinereus</i> – <i>Elymus triticoides</i>	<i>Elymus triticoides</i> – <i>Bromus</i> spp. – <i>Avena</i> spp.

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Table 8 (continued). Final vegetation classification consistent with the Manual of California Vegetation (Sawyer et al. 2009).

Life form	Alliance	Association
Herb (cont.)	<i>Elymus condensatus</i>	<i>Elymus condensatus</i>
	<i>Eschscholzia (californica) – Lupinus (nanus)</i>	<i>Eschscholzia californica</i>
	<i>Festuca perennis</i>	<i>Festuca perennis</i>
	<i>Frankenia salina</i>	<i>Frankenia salina – Distichlis spicata</i>
	<i>Frankenia salina</i>	<i>Frankenia salina – Extriplex californica</i>
	<i>Frankenia salina</i>	<i>Suaeda taxifolia – Hordeum murinum</i>
	<i>Grindelia (camporum, stricta)</i>	<i>Grindelia camporum</i>
	<i>Hordeum brachyantherum</i>	<i>Hordeum brachyantherum</i>
	<i>Juncus (effusus, patens)</i>	<i>Juncus phaeocephalus</i>
	<i>Juncus balticus – Juncus mexicanus</i>	<i>Juncus balticus – (Juncus mexicanus)</i>
	<i>Lasthenia californica – Plantago erecta – Festuca microstachys</i>	<i>Lasthenia californica – Extriplex californica</i>
	<i>Lasthenia fremontii – Distichlis spicata</i>	<i>Spergularia macrotheca – Hordeum (murinum)</i>
	<i>Mesembryanthemum</i> spp. – <i>Carpobrotus</i> spp.	<i>Carpobrotus</i> spp. – <i>Mesembryanthemum crystallinum</i>
	<i>Mesembryanthemum</i> spp. – <i>Carpobrotus</i> spp.	<i>Mesembryanthemum crystallinum – Malva parviflora – Hordeum murinum</i>
	<i>Salicornia pacifica (Salicornia depressa)</i>	<i>Salicornia pacifica – Distichlis spicata</i>
	<i>Stipa</i> spp. – <i>Melica</i> spp.	–
	<i>Stipa</i> spp. – <i>Melica</i> spp.	<i>Stipa pulchra</i>
	<i>Stipa</i> spp. – <i>Melica</i> spp.	<i>Stipa pulchra – Avena</i> spp. – <i>Bromus</i> spp.
	<i>Stipa</i> spp. – <i>Melica</i> spp.	<i>Stipa pulchra – Corethrogyne filaginifolia</i>
	<i>Stipa</i> spp. – <i>Melica</i> spp.	<i>Stipa pulchra – Festuca perennis – (Trifolium spp)</i> ^A
	<i>Typha (angustifolia, domingensis, latifolia)</i>	<i>Typha domingensis</i>
Sparse	<i>Dudleya cymosa – Dudleya lanceolata – Lichen/Moss Sparse</i>	<i>Dudleya (blochmaniae</i> ssp. <i>insularis, gnoma)</i> – Sparse Herb
	<i>Dudleya cymosa – Dudleya lanceolata – Lichen/Moss Sparse</i>	Lichen gravel – Bedrock Nonvascular Sparse
	Sparsely vegetated drainage channels & seeps	Sparsely vegetated drainage channels & seeps

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify some Alliances to the Association level.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9. List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
1. Forest & Woodland	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G195. Californian Broadleaf Forest & Woodland	<i>Quercus tomentella</i> – <i>Lyonothamnus floribundus</i> Alliance	<i>Lyonothamnus floribundus</i> Association (provisional)
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G195. Californian Broadleaf Forest & Woodland	<i>Quercus tomentella</i> – <i>Lyonothamnus floribundus</i> Alliance	<i>Quercus tomentella</i> Association
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G195. Californian Broadleaf Forest & Woodland	<i>Quercus agrifolia</i> Alliance	<i>Quercus agrifolia</i> Association
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G195. Californian Broadleaf Forest & Woodland	<i>Quercus agrifolia</i> Alliance	<i>Quercus agrifolia</i> – <i>Quercus tomentella</i> / (<i>Prunus ilicifolia</i> ssp. <i>lyonii</i>) Association (provisional)
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G195. Californian Broadleaf Forest & Woodland	<i>Quercus agrifolia</i> Alliance	<i>Quercus agrifolia</i> / <i>Quercus pacifica</i> Association
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G198. Californian Conifer Forest & Woodland	<i>Pinus muricata</i> – <i>Pinus radiata</i> Alliance	<i>Pinus muricata</i> / <i>Arctostaphylos</i> spp. Association
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G198. Californian Conifer Forest & Woodland	<i>Pinus muricata</i> – <i>Pinus radiata</i> Alliance	<i>Pinus muricata</i> / <i>Comarostaphylis diversifolia</i> ssp. <i>planifolia</i> Association (provisional)
	1.B. Temperate & Boreal Forest & Woodland	1.B.1. Warm Temperate Forest & Woodland	1.B.1.Nc. Californian Forest & Woodland	M009. Californian Forest & Woodland	G198. Californian Conifer Forest & Woodland	<i>Pinus torreyana</i> Alliance	<i>Pinus torreyana</i> ssp. <i>insularis</i> Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
1. Forest & Woodland (cont.)	1.B. Temperate & Boreal Forest & Woodland	1.B.3. Temperate Flooded & Swamp Forest	1.B.3.Nd. Western North American Interior Flooded Forest	M036. Interior Warm & Cool Desert Riparian Forest	G797. Western Interior Riparian Forest & Woodland	<i>Salix laevigata</i> Alliance	<i>Salix laevigata</i> Association
2. Shrub & Herb Vegetation	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G257. Californian Xeric Chaparral	<i>Adenostoma fasciculatum</i> Alliance	<i>Adenostoma fasciculatum</i> var. <i>prostratum</i> – (<i>Quercus pacifica</i>) Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G257. Californian Xeric Chaparral	<i>Adenostoma fasciculatum</i> Alliance	<i>Adenostoma fasciculatum</i> var. <i>prostratum</i> – <i>Salvia brandegeei</i> / <i>Selaginella bigelovii</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G257. Californian Xeric Chaparral	<i>Ceanothus megacarpus</i> Alliance	<i>Ceanothus megacarpus</i> var. <i>insularis</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Arctostaphylos (crustacea, tomentosa)</i> Alliance	<i>Arctostaphylos confertiflora</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Arctostaphylos (crustacea, tomentosa)</i> Alliance	<i>Arctostaphylos crustacea</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Arctostaphylos (crustacea, tomentosa)</i> Alliance	<i>Arctostaphylos insularis</i> Association ^A
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Quercus dumosa</i> – <i>Quercus pacifica</i> Alliance	<i>Quercus pacifica</i> Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Quercus dumosa</i> – <i>Quercus pacifica</i> Alliance	<i>Quercus pacifica</i> – (<i>Arctostaphylos insularis</i> – <i>Ceanothus megacarpus</i> var. <i>insularis</i>) Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Quercus dumosa</i> – <i>Quercus pacifica</i> Alliance	<i>Quercus pacifica</i> – <i>Heteromeles arbutifolia</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Quercus dumosa</i> – <i>Quercus pacifica</i> Alliance	<i>Quercus pacifica</i> / grass Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Rhus integrifolia</i> Alliance	<i>Rhus integrifolia</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G258. Californian Maritime Chaparral	<i>Rhus integrifolia</i> Alliance	<i>Rhus integrifolia</i> – <i>Artemisia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G261. Californian Mesic & Pre-montane Chaparral	<i>Cercocarpus betuloides</i> Alliance	<i>Cercocarpus betuloides</i> var. <i>blancheae</i> Association (provisional) ^A
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G261. Californian Mesic & Pre-montane Chaparral	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i> Alliance	<i>Heteromeles arbutifolia</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G261. Californian Mesic & Pre-montane Chaparral	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i> Alliance	<i>Heteromeles arbutifolia</i> – <i>Artemisia californica</i> – <i>Rhus integrifolia</i> – (<i>Salvia brandegeei</i>) Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M043. Californian Chaparral	G261. Californian Mesic & Pre-montane Chaparral	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i> Alliance	<i>Prunus ilicifolia</i> ssp. <i>lyonii</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> – <i>Eriogonum arborescens</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> – <i>Peritoma arborea</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> – <i>Salvia brandegeei</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> / <i>Bromus carinatus</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Artemisia californica</i> Alliance	<i>Artemisia californica</i> / <i>Stipa (pulchra)</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Encelia californica</i> – <i>Eriogonum cinereum</i> Alliance	<i>Encelia californica</i> – <i>Eriogonum arborescens</i> Association (provisional)

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G264. Central & Southern Californian Coastal Sage Scrub	<i>Salvia mellifera</i> Alliance	<i>Salvia mellifera</i> – <i>Artemisia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G662. Californian North Coastal & Mesic Scrub	<i>Baccharis pilularis</i> Alliance	<i>Baccharis pilularis</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G662. Californian North Coastal & Mesic Scrub	<i>Baccharis pilularis</i> Alliance	<i>Baccharis pilularis</i> – <i>Artemisia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G662. Californian North Coastal & Mesic Scrub	<i>Baccharis pilularis</i> Alliance	<i>Baccharis pilularis</i> / Annual Grass – Herb Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G662. Californian North Coastal & Mesic Scrub	<i>Baccharis pilularis</i> Alliance	<i>Baccharis pilularis</i> / (<i>Stipa pulchra</i> – <i>Elymus glaucus</i> – <i>Bromus carinatus</i>) Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G782. Californian Coastal-Foothill Seral Scrub	<i>Acmispon glaber</i> – <i>Lupinus albifrons</i> Alliance	<i>Lupinus albifrons</i> coastal Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M044. Californian Coastal Scrub	G782. Californian Coastal-Foothill Seral Scrub	<i>Mimulus aurantiacus</i> Alliance	<i>Mimulus aurantiacus</i> var. <i>parviflorus</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Corethrogyne filaginifolia</i> – <i>Eriogonum (elongatum, nudum)</i> Alliance	<i>Corethrogyne filaginifolia</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Elymus condensatus</i> Alliance	<i>Elymus condensatus</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Stipa</i> spp. – <i>Melica</i> spp. Alliance	<i>Stipa pulchra</i> Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Stipa</i> spp. – <i>Melica</i> spp. Alliance	<i>Stipa pulchra</i> – <i>Avena</i> spp. – <i>Bromus</i> spp. Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Stipa</i> spp. – <i>Melica</i> spp. Alliance	<i>Stipa pulchra</i> – <i>Corethrogyne filaginifolia</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G496. Californian Perennial Grassland	<i>Stipa</i> spp. – <i>Melica</i> spp. Alliance	<i>Stipa pulchra</i> – <i>Festuca perennis</i> – (<i>Trifolium</i> spp.) Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G766. Californian Annual Grassland & Forb Meadow	<i>Eschscholzia (californica)</i> – <i>Lupinus (nanus)</i> Alliance	<i>Eschscholzia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M045. Californian Annual & Perennial Grassland	G766. Californian Annual Grassland & Forb Meadow	<i>Lasthenia californica</i> – <i>Plantago erecta</i> – <i>Festuca microstachys</i> Alliance	<i>Lasthenia californica</i> – <i>Extriplex californica</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Atriplex semibaccata</i> – <i>Hordeum (murinum)</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Avena barbata</i> – <i>Avena fatua</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Brachypodium distachyon</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Bromus diandrus</i> Semi-natural Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Bromus diandrus</i> – <i>Avena</i> spp. Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Bromus hordeaceus</i> – <i>Erodium botrys</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Avena</i> spp. – <i>Bromus</i> spp. Semi-natural Alliance	<i>Hypochaeris glabra</i> – <i>Festuca (bromoides)</i> Semi-natural Association ^A
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Brassica nigra</i> and other <i>mustards</i> Semi-natural Alliance	<i>Brassica nigra</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Conium maculatum</i> – <i>Foeniculum vulgare</i> Semi-natural Alliance	<i>Foeniculum vulgare</i> Semi-natural Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.1. Mediterranean Scrub & Grassland	2.B.1.Na. Californian Scrub & Grassland	M046. Californian Ruderal Grassland, Meadow & Scrub	G497. Californian Ruderal Grassland, Meadow & Scrub	<i>Festuca perennis</i> Semi-natural Alliance	<i>Festuca perennis</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.2. Temperate Grassland & Shrubland	2.B.2.Na. Western North American Grassland & Shrubland	M050. Southern Vancouverian Lowland Grassland & Shrubland	G488. Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie	<i>Bromus carinatus</i> – <i>Elymus glaucus</i> Alliance	<i>Bromus carinatus</i> Association (provisional)
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.2. Temperate Grassland & Shrubland	2.B.2.Na. Western North American Grassland & Shrubland	M050. Southern Vancouverian Lowland Grassland & Shrubland	G488. Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie	<i>Bromus carinatus</i> – <i>Elymus glaucus</i> Alliance	<i>Pteridium aquilinum</i> – Grass Association (provisional)

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i> Alliance	<i>Ambrosia chamissonis</i> – <i>Abronia maritima</i> – <i>Cakile maritima</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i> Alliance	<i>Ambrosia chamissonis</i> – <i>Malacothrix incana</i> – <i>Carpobrotus chilensis</i> – <i>Poa douglasii</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i> Alliance	<i>Calystegia macrostegia</i> – <i>Erigeron glaucus</i> – <i>Malacothrix incana</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> – <i>Acmispon dendroideus</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> – <i>Artemisia californica</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> – <i>Lupinus albifrons</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> / (<i>Astragalus miguelensis</i> – <i>Extriplex californica</i>) Association

Associations denoted with “–” indicate a lack of suitable information in the plant community data to identify to the Association level.

N/A indicates an alliance that contains no associations.

^A Associations that either contain island-endemic taxa or were not otherwise known on the mainland or California islands at the time of project completion.

Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Isocoma menziesii</i> Alliance	<i>Isocoma menziesii</i> / <i>Dudleya greenei</i> Association
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M059. Pacific Coastal Beach & Dune	G663. Californian Coastal Beach & Dune	<i>Lupinus arboreus</i> Alliance	–
	2.B. Temperate & Boreal Grassland & Shrubland	2.B.4. Temperate to Polar Scrub & Herb Coastal Vegetation	2.B.4.Nb. Pacific North American Coastal Scrub & Herb Vegetation	M511. North Pacific Coastal Ruderal Grassland & Shrubland	G647. North Pacific Maritime Coastal Ruderal Dune	<i>Mesembryanthemum</i> spp. – <i>Carpobrotus</i> spp. Alliance	<i>Carpobrotus</i> spp. – <i>Mesembryanthemum crystallinum</i> Semi-natural Association
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G517. Vancouverian Freshwater Wet Meadow & Marsh	<i>Carex (pansa, praegracilis)</i> Alliance (provisional)	<i>Carex (pansa, praegracilis)</i> Association (provisional)
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G517. Vancouverian Freshwater Wet Meadow & Marsh	<i>Hordeum brachyantherum</i> Alliance	<i>Hordeum brachyantherum</i> Association
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G517. Vancouverian Freshwater Wet Meadow & Marsh	<i>Juncus (effusus, patens)</i> Alliance	<i>Juncus phaeocephalus</i> Association (provisional)
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G517. Vancouverian Freshwater Wet Meadow & Marsh	<i>Juncus balticus</i> – <i>Juncus mexicanus</i> Alliance	<i>Juncus balticus</i> – (<i>Juncus mexicanus</i>) Association

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G517. Vancouverian Freshwater Wet Meadow & Marsh	Sparsely vegetated drainage channels & seeps Mapping Unit	N/A
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M073. Vancouverian Lowland Marsh, Wet Meadow & Shrubland	G525. Temperate Pacific Freshwater Wet Mudflat	<i>Grindelia (camporum, stricta)</i> Alliance	<i>Grindelia camporum</i> Association
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M074. Western North American Vernal Pool	G530. Californian Vernal Pool	<i>Cressa truxillensis</i> – <i>Distichlis spicata</i> Alliance	<i>Cressa truxillensis</i> Association (provisional)
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M074. Western North American Vernal Pool	G530. Californian Vernal Pool	<i>Lasthenia fremontii</i> – <i>Distichlis spicata</i> Alliance	<i>Spergularia macrotheca</i> – <i>Hordeum (murinum)</i> Association
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M301. Western North American Ruderal Marsh, Wet Meadow & Shrubland	G524. Western North American Ruderal Marsh, Wet Meadow & Shrubland	Dammed pond Mapping Unit	N/A
	2.C. Shrub & Herb Wetland	2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland	2.C.4.Nb. Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland	M888. Arid West Interior Freshwater Marsh	G531. Arid West Interior Freshwater Marsh	<i>Typha (angustifolia, domingensis, latifolia)</i> Alliance	<i>Typha domingensis</i> Association
	2.C. Shrub & Herb Wetland	Marsh, Wet Meadow & Shrubland	2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque	M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland	G533. North American Warm Desert Riparian Low Bosque & Shrubland	<i>Baccharis salicifolia</i> Alliance	<i>Baccharis salicifolia</i> Association

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.C. Shrub & Herb Wetland	Marsh, Wet Meadow & Shrubland	2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque	M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland	G533. North American Warm Desert Riparian Low Bosque & Shrubland	<i>Salix lasiolepis</i> Alliance	<i>Salix lasiolepis</i> Association
	2.C. Shrub & Herb Wetland	Marsh, Wet Meadow & Shrubland	2.C.4.Nc. Southwestern North American Warm Desert Freshwater Marsh & Bosque	M076. Warm Desert Lowland Freshwater Marsh, Wet Meadow & Shrubland	G533. North American Warm Desert Riparian Low Bosque & Shrubland	<i>Salix lasiolepis</i> Alliance	<i>Salix lasiolepis</i> – <i>Baccharis salicifolia</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nc. Temperate & Boreal Pacific Coastal Salt Marsh	M081. North American Pacific Coastal Salt Marsh	G499. Temperate Pacific Salt Marsh	<i>Salicornia pacifica</i> (<i>Salicornia depressa</i>) Alliance	<i>Salicornia pacifica</i> – <i>Distichlis spicata</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Distichlis spicata</i> Alliance	<i>Distichlis spicata</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Distichlis spicata</i> Alliance	<i>Distichlis spicata</i> – (<i>Baccharis glutinosa</i> – <i>Equisetum hyemale</i>) Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Distichlis spicata</i> Alliance	<i>Distichlis spicata</i> – annual grasses Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Distichlis spicata</i> Alliance	<i>Distichlis spicata</i> – <i>Elymus triticoides</i> Association

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
2. Shrub & Herb Vegetation (cont.)	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Distichlis spicata</i> Alliance	<i>Distichlis spicata</i> – <i>Frankenia salina</i> – <i>Jaumea carnosa</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Elymus cinereus</i> – <i>Elymus triticoides</i> Alliance	<i>Elymus triticoides</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Elymus cinereus</i> – <i>Elymus triticoides</i> Alliance	<i>Elymus triticoides</i> – <i>Bromus</i> spp. – <i>Avena</i> spp. Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Frankenia salina</i> Alliance	<i>Frankenia salina</i> – <i>Distichlis spicata</i> Association
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Frankenia salina</i> Alliance	<i>Frankenia salina</i> – <i>Extriplex californica</i> Association (provisional)
	2.C. Shrub & Herb Wetland	2.C.5. Salt Marsh	2.C.5.Nd. North American Western Interior Brackish Marsh, Playa. & Shrubland	M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G538. North American Desert Alkaline-Saline Marsh & Playa	<i>Frankenia salina</i> Alliance	<i>Suaeda taxifolia</i> – <i>Hordeum murinum</i> Association
3. Desert & Semi-Desert	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Deinandra clementina</i> – <i>Eriogonum giganteum</i> Alliance	<i>Deinandra clementina</i> Association (provisional)

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
3. Desert & Semi-Desert (cont.)	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Dudleya greenei</i> – <i>Dudleya</i> spp. Succulent Scrub Alliance	<i>Dudleya greenei</i> Association (provisional)
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> Alliance	<i>Eriogonum arborescens</i> Association
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> Alliance	<i>Eriogonum arborescens</i> – <i>Hazardia detonsa</i> Association
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> Alliance	<i>Eriogonum grande</i> var. <i>grande</i> Association
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> Alliance	<i>Eriogonum grande</i> var. <i>rubescens</i> Association (provisional)
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Leptosyne gigantea</i> Alliance	<i>Leptosyne gigantea</i> – <i>Acmispon dendroideus</i> Association (provisional)
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Leptosyne gigantea</i> Alliance	<i>Leptosyne gigantea</i> / (<i>Dudleya greenei</i>) Association
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Lycium californicum</i> Alliance	<i>Lycium californicum</i> Association (provisional)
	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M088. Mojave-Sonoran Semi-Desert Scrub	G298. Baja Semi-Desert Coastal Succulent Scrub	<i>Opuntia littoralis</i> – <i>Opuntia oricola</i> – <i>Cylindropuntia prolifera</i> Alliance	<i>Cylindropuntia prolifera</i> – Mixed Coastal Scrub Association (provisional)

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Table 9 (continued). List of vegetation alliances and associations of the four northern Channel Islands, nested within the NVCS hierarchy.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association
3. Desert & Semi-Desert (cont.)	3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland	3.A.2. Warm Desert & Semi-Desert Scrub & Grassland	3.A.2.Na. North American Warm Desert Scrub & Grassland	M512. North American Warm Desert Ruderal Scrub & Grassland	G677. North American Warm Desert Ruderal Grassland	<i>Cynodon dactylon</i> – <i>Crypsis</i> spp. – <i>Paspalum</i> spp. Moist Semi-natural Alliance ^A	<i>Cynodon dactylon</i> Semi-natural Association
6. Open Rock Vegetation	6.B. Temperate & Boreal Open Rock Vegetation	6.B.1. Temperate & Boreal Cliff, Scree & Other Rock Vegetation	6.B.1.Nb. Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation	M887. Western North American Cliff, Scree & Rock Vegetation	G563. Californian Cliff, Scree & Rock Vegetation	<i>Dudleya cymosa</i> – <i>Dudleya lanceolata</i> – Lichen/Moss Sparse Alliance ^A	<i>Dudleya (blochmaniae</i> ssp. <i>insularis</i> , <i>gnoma</i>) – Sparse Herb Association (provisional)

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Plant Community Descriptions

A summary of the vegetation community types occurring on the northern four Channel Islands is provided in this section, organized by dominant growth form (tree, shrub, herb), then by group, and finally alphabetically by alliance. A complete overview of these community types along with detailed local, environmental, and vegetation descriptions is based on the plot and rapid assessment data obtained during this project and can be found in Sikes et al. (2018). Global descriptions are available in NatureServe (2017), where the vegetation types are placed within national and international frameworks. In some cases, the names of the alliances and/or associations in the local descriptions are inconsistent with the global descriptions, in which case the differences are noted in the detailed local community descriptions (Sikes et al. 2018). The summaries below are grouped into three broad physiognomic types: tree-dominated communities, shrub-dominated communities, and herb-dominated communities.

A few discrepancies occurred when describing the plant communities. First, the same vegetation type may be named differently on the SCI vegetation map versus the maps of ANI, SRI, and SMI due to changes in the naming convention that occurred between the time the maps were generated for Phase 1 and Phase 2. For example, SCI has a vegetation type mapped as the Central California Coast & Island Manzanita Shrubland Alliance, but this same type on SRI is mapped as the *Arctostaphylos (crustacea, tomentosa)* Central Coast and Island Alliance. However, the map codes are consistent; for the example given above, both vegetation types have the same map code 21230. Second, a few mapped vegetation types do not have community descriptions because they were missed during the field data collection effort. Two examples of this discrepancy are the *Opuntia littoralis* Alliance and the *Atriplex lentiformis* Alliance. Third, occasionally an alliance is described but the vegetation type was mapped to the association level, a type of mismatch that occurred primarily on SMI.

Tree-dominated Communities (Upland)

Stands of broadleaf and conifer-dominated tree communities occurred on the northern four Channel Islands, but they were not extensive. Excluding the deeper drainages of West ANI and a planted *Eucalyptus* stand on Middle ANI, tree-dominated communities were present on only SCI and SRI where they were represented by five alliances and nine associations.

Californian Broadleaf Forest and Woodland

Two of the alliances in this group were identified by the dominance or co-dominance of three oak species. Oaks (*Quercus* spp.) comprised the largest spatial extent of the broadleaf tree communities on the islands, with coast live oak (*Quercus agrifolia*) being the most common arborescent oak species. The largest and most abundant stands occurred on SCI. Four associations underpinned the *Quercus agrifolia* alliance, and two of these were provisional. This species did not typically form pure stands and usually occurred mixed with other arborescent species such as island oak (*Quercus tomentella*), or shrub species such as toyon (*Heteromeles arbutifolia*) and *Prunus ilicifolia* ssp. *lyonii*. *Quercus agrifolia* occurred only on SCI and SRI and was well sampled on both. The species favored drainage bottoms and lower slopes where the understory tended to be sparsely vegetated, and the litter layer was quite thick. The other oak species, *Quercus tomentella*, that defined one of the

alliances is endemic to the Channel Islands, occurring on SCI, SRI, ANI and Guadalupe Island off coast of Baja, Mexico. On SRI, *Quercus tomentella* occurred in nearly pure stands, sometimes with a thick litter layer. The third oak species, island scrub oak (*Quercus pacifica*), is also endemic to the northern Channel Islands. On SCI, it was the dominant species in many areas along the island's north coast and the north-facing slopes of the interior. Depending on exposure to wind, *Quercus pacifica* can grow as a tree or shrub, the latter of which can dominate or co-dominate in shrub communities by virtue of its highly clonal habit.

The other upland broadleaf tree species present on the islands were Northern Channel Island's ironwood (*Lyonothamnus floribundus* ssp. *aspleniifolius*) and big-leaf maple (*Acer macrophyllum*), represented by dominance or co-dominance in two alliances and two nested associations.

Lyonothamnus floribundus ssp. *aspleniifolius* is endemic to the islands and was most common on SCI's north-facing mesic slopes and less common in drainages of SRI. *Lyonothamnus floribundus* ssp. *aspleniifolius* occurred mixed with other tree and shrub species and was found in nearly pure groves by virtue to its highly clonal habit on more mesic northerly slopes where it contributed to a substantial litter layer. The species tended to have a depauperate understory, although this has changed rapidly in recent years following the removal of non-native grazers/browsers from the islands. Even though *Lyonothamnus floribundus* ssp. *aspleniifolius* and *Quercus tomentella* were grouped under the same alliance, they rarely, if ever, co-occurred.

Acer macrophyllum occurred on SCI and on the mainland. On SCI, stands typically occupied shady, mesic drainage bottoms. *Acer macrophyllum* stands were not sampled during field data collection, so the community was not represented in the vegetation classification. However, big-leaf maple is noted below because 17 stands were identified by the photo-interpreters and mapped as the *Acer macrophyllum* Forest Alliance.

- *Acer macrophyllum* Forest Alliance
- *Quercus agrifolia* Alliance
 - *Quercus agrifolia* Association
 - *Quercus agrifolia* – *Quercus tomentella* / *Prunus ilicifolia* ssp. *lyonii* Association
 - *Quercus agrifolia* / *Arctostaphylos (insularis)* Association
 - *Quercus agrifolia* / *Quercus pacifica* Association
- *Quercus tomentella* – *Lyonothamnus* Alliance
 - *Lyonothamnus floribundus* Association
 - *Quercus tomentella* Association

Californian Conifer Forest and Woodland

This group was represented by two alliances and three associations that featured the only two conifer species naturally occurring on the islands—Bishop pine (*Pinus muricata*) and Island Torrey pine (*P. torreyana* ssp. *insularis*). Here, the *Pinus muricata* – *Pinus radiata* Alliance formed an open tree

canopy with an open to intermittent shrub understory. It was positioned primarily on upper slopes, although it occasionally grew on lower slopes and in canyons at predominantly north-facing, cooler aspects. *Pinus muricata* was present on both SCI and SRI but was much more extensive on SCI. On SRI, young *Pinus muricata* were browsed and trampled by elk and deer until their removal in 2011, which relieved a major ecological pressure that had threatened the continued existence of those stands.

Island Torrey pine (*Pinus torreyana* ssp. *insularis*) is endemic to SRI. Its closest relative, Torrey pine (*Pinus torreyana* ssp. *torreyana*), is restricted to coastal slopes on the mainland near San Diego, California. The *Pinus torreyana* Alliance formed an open to intermittent tree canopy with a sparse to open shrub understory. It was found directly above the ocean along marine terraces and coastal bluffs including steep uplifted slopes primarily with northern aspects. On SRI, stands were restricted to moderate slopes in the northeast section overlooking Becher's Bay, although scattered individuals were located elsewhere on the island. At present, island Torrey pine is in the process of re-establishing after elk and deer were removed.

- *Pinus muricata* – *Pinus radiata* Alliance
 - *Pinus muricata* / *Arctostaphylos* spp. Association
 - *Pinus muricata* / *Comarostaphylis diversifolia* spp. *planifolia* Association
- *Pinus torreyana* Alliance
 - *Pinus torreyana* ssp. *insularis* Association

North Pacific Lowland Riparian Forest and Woodland

Black cottonwood (*Populus trichocarpa*) was the dominant species in the alliance and association that comprised this group on the islands. The species occurred on both SCI and SRI but only conformed the vegetation type on the former where it grew in wet riparian areas and alluvial terraces. The community was characterized by an open tree canopy with a scattered shrub understory. The alliance does occur on the mainland, but due to its limited distribution on the islands, the community was poorly sampled. The most commonly associated species were mule fat (*Baccharis salicifolia*), arroyo willow (*Salix lasiolepis*), *Lupinus albifrons*, and purple false brome (*Brachypodium distachyon*).

- *Populus trichocarpa* Alliance
 - *Populus trichocarpa* / *Salix lasiolepis* Association

Shrub-dominated Communities

Baja Semi-desert Coastal Succulent Scrub

On the northern Channel Islands, this group consisted of six alliances and ten nested associations, with one of the alliances and its nested association being provisional. The *Eriogonum arborescens* – *Eriogonum grande* Alliance and its four nested associations included the largest of the alliances under this group both in terms of the number of stands (4,440) and their spatial extent. The vast majority of these stands occurred on SCI whereas ANI, SRI, and SMI together harbored just 37

stands, with most of these on ANI, the smallest island. On SCI, *Eriogonum arborescens* was vastly more dominant than buckwheat (*Eriogonum grande*) while the opposite pattern was found on SMI, whereas an approximately even balance between the two species occurred on ANI and SRI. However, *Eriogonum arborescens* has been increasing on SRI following the removal of introduced herbivores.

The remaining five alliances and their nested associations were less common. The *Deinandra clementina* – *Eriogonum giganteum* Alliance and the *Deinandra clementina* Association occurred only on ANI, although they are also known from Santa Barbara Island, San Nicolas Island, and San Clemente Island. The association was considered provisional due to the low sample size within and beyond the project area. Both *Deinandra clementina* and *Eriogonum giganteum* are endemic to the California Channel Islands. Only one mapped stand of this vegetation type was encountered on Middle ANI.

Within the project area, the *Dudleya greenei* – *Dudleya* spp. Succulent Scrub Alliance and its association were recorded only on SMI. However, unsampled stands may also occur on SCI, other California and Mexican islands, and the mainland. The association's diagnostic species, Greene's dudleya (*Dudleya greenei*), is endemic to the northern Channel Islands but may represent a complex of closely related species. Two stands of this alliance were mapped on ANI, and six stands of its association were mapped on SMI.

The *Leptosyne gigantea* Alliance was sampled just once on ANI. Of its two nested associations, the *Leptosyne gigantea* – *Acmispon dendroideus* Association was sampled only nine times on SMI whereas the *Leptosyne gigantea* / (*Dudleya greenei*) Association was sampled 27 times on ANI, SCI, and SMI. The stands of *Leptosyne gigantea*, which were all mapped along SCI's northern coastal bluffs, were classified as *Leptosyne gigantea* Coastal Bluff Shrubland Alliance.

The *Lycium californicum* Alliance and its eponymous association was sampled just once on SRI. The alliance was considered provisional due to its small sample size, but stands are also known to occur on Santa Barbara Island, San Nicolas Island, and the mainland. Two stands of the association were mapped, with one occurring on ANI and the other on SMI.

The *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Alliance and its association was also poorly sampled within the project area, with just one sample on SRI. However, this vegetation community also occurs on the southern Channel Islands and the mainland. The two diagnostic prickly-pear species (*Opuntia* spp.) were historically more common on SCI and SRI where the stands were extensive enough to appear on S. Forni's 1872 map of SRI. While the historical abundance of *Opuntia* spp. may have benefited from grazers that targeted other plants, the introduction of a cochineal scale (*Dactylopius* sp.) control on SCI in the early 1960s eventually spread to ANI and SRI and reduced the abundance of *Opuntia* on all three islands. Ten stands of the *Cylindropuntia prolifera* – Mixed Coastal Scrub Association were mapped on SCI, SRI, and SMI.

- *Deinandra clementina* – *Eriogonum giganteum* Alliance
 - *Deinandra clementina* Association (provisional)

- *Dudleya greenei* – *Dudleya* spp. Succulent Scrub Alliance
 - *Dudleya greenei* Association (provisional)
- *Eriogonum arborescens* – *Eriogonum grande* Alliance
 - *Eriogonum arborescens* Association
 - *Eriogonum arborescens* – *Hazardia detonsa* Association
 - *Eriogonum grande* var. *grande* Association
 - *Eriogonum grande* var. *rubescens* Association (provisional)
- *Leptosyne gigantea* Alliance
 - *Leptosyne gigantea* – *Acmispon dendroideus* Association (provisional)
 - *Leptosyne gigantea* / (*Dudleya greenei*) Association
- *Lycium californicum* Alliance
 - *Lycium californicum* Association (provisional)
- *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Alliance
 - *Cylindropuntia prolifera* – Mixed Coastal Scrub Association (provisional)

Californian Coastal Beach and Dune

This group was represented by three alliances containing nine associations. The *Abronia latifolia* – *Ambrosia chamissonis* Alliance had three associations occurring only on SMI. The two associations featuring beach bur-sage (*Ambrosia chamissonis*) were found on sandy soils along the coast, whereas the association featuring morning glory (*Calystegia macrostegia*) was found along the coast and interior on the west and northwest part of the island. Some stands were identified only to the alliance level and were mapped along the coasts of SCI, SRI, and SMI. The *Isocoma menziesii* Alliance also occurred on SCI, SRI, and SMI but was best represented on SRI and SMI. *Isocoma menziesii* stands on SCI were identified only to the alliance level, and these occurred on coastal flats and bluffs at the west and east ends of the island. On SRI, stands were found mostly along the coast, although they also occurred inland on calcium carbonate soils at the island's west end. *Isocoma menziesii* stands on SMI were both coastal and interior with the *Isocoma menziesii* / *Dudleya greenei* Association being unique to this island. The *Lupinus arboreus* Alliance was only found on SRI, with most stands occurring near Carrington Point in the northeast and two locations at the south side's interior.

- *Abronia latifolia* – *Ambrosia chamissonis* Alliance
 - *Ambrosia chamissonis* – *Abronia maritima* – *Cakile maritima* Association
 - *Ambrosia chamissonis* – *Malacothrix incana* – *Carpobrotus chilensis* – *Poa douglasii* Association
 - *Calystegia macrostegia* – *Erigeron glaucus* – *Malacothrix incana* Association
- *Isocoma menziesii* Alliance

- *Isocoma menziesii* Association
- *Isocoma menziesii* – *Acmispon dendroideus* Association
- *Isocoma menziesii* – *Artemisia californica* Association
- *Isocoma menziesii* – *Lupinus albifrons* Association
- *Isocoma menziesii* / (*Astragalus miguelensis* – *Extiplex californica*) Association
- *Isocoma menziesii* / *Dudleya greenei* Association
- *Lupinus arboreus* Alliance

Californian Coastal-Foothill Seral Scrub

The *Acmispon glaber* – *Lupinus albifrons* Alliance was represented by the *Lupinus albifrons* coastal Association which occurred on SRI and SMI. The characteristic shrub, *Lupinus albifrons*, can be relatively short lived, and its cover fluctuates temporally from open to dense. Between individual shrubs grew a well-developed herbaceous layer consisting of annual grasses, forbs, or subshrubs. The species preferred the sandy soils of stabilized dunes, and the largest stands on SRI occurred at the extreme northeast part of the island with smaller stands elsewhere. On SMI, *Lupinus albifrons* was common and well distributed. The most commonly associated shrub species were *Baccharis pilularis* ssp. *consanguinea* and *Isocoma menziesii*, and the most common herb associate was *Bromus diandrus*.

The *Mimulus aurantiacus* Alliance is unique to the Channel Islands where it occurred on SCI and SRI but was more common on the latter. On SCI, the stands were dominated by southern bush monkeyflower (*Mimulus aurantiacus* var. *pubescens*) rather than island bush monkeyflower (*Mimulus aurantiacus* var. *parviflorus*), although the latter did occur on SCI as well. The shrub and herbaceous layers for these stands were typically open and found on more mesic slopes. Other shrubs such as *Baccharis pilularis* ssp. *consanguinea*, *Heteromeles arbutifolia*, *Artemisia californica*, and *Quercus pacifica* usually occurred at low densities. Herbaceous associates sometimes included *Avena* spp., California-aster (*Corethrogyne filaginifolia*), dune bent grass (*Agrostis pallens*), California fuchsia (*Epilobium canum*), *Bromus diandrus*, and round-fruited sedge (*Carex globosa*).

- *Acmispon glaber* – *Lupinus albifrons* Alliance
 - *Lupinus albifrons* coastal Association
- *Mimulus aurantiacus* Alliance
 - *Mimulus aurantiacus* var. *parviflorus* Association (provisional)

Californian Maritime Chaparral

Although these three alliances also occur on the mainland, many of the shrub species that define the associations were island endemics. The shrub species dominating these alliances—manzanita (*Arctostaphylos* spp.), *Quercus pacifica*, and lemonade berry (*Rhus integrifolia*)—co-occurred in varying amounts or formed pure stands.

Stands classified under the *Arctostaphylos (crustacea, tomentosa)* Alliance were found on SRI and SCI. On SRI, the largest stands occurred in the northeast with smaller stands at the southeast end and at the southern tip of the island. Stands dominated by Santa Rosa Island manzanita (*Arctostaphylos confertiflora*) were heavily impacted by the long duration of non-native herbivores. Complete removal of these herbivores in 2011 is allowing a recovery at present, although the trails left behind by these large herbivores still cut through the stands of Santa Rosa Island manzanita. Maritime chaparral stands on SCI were also degraded by the presence of non-native herbivores such as sheep, cattle, and feral pigs, but the majority of those animals were eliminated by the mid-1980s. At present, many of SCI's stands have recovered substantially enough to display dense thickets. These communities occurred on a variety of slopes, aspects and substrates.

The *Quercus dumosa* – *Quercus pacifica* Alliance features *Quercus pacifica* that can form open to closed canopies with typically little understory except for the provisional *Quercus pacifica* / grass association. The growth form of *Quercus pacifica* can be prostrate to mounding to arborescent, the latter of which occurred in more sheltered locations. Intense herbivore pressure may have facilitated the *Quercus pacifica* / grass Association; browsing of the *Quercus pacifica* may have opened up these stands to invasion by annual grasses, resulting in a woodland-like appearance. With time, other shrubs may invade the open understory to create a more typical island shrubland.

The *Rhus integrifolia* Alliance was somewhat different than those featuring *Arctostaphylos* and *Quercus*. Although this alliance usually occurred with *Artemisia californica*, it was also present in maritime chaparral stands dominated by *Quercus* and *Arctostaphylos*, albeit at typically low cover. The relatively high concentration of stands on the south sides of SCI and SRI suggest that the *Rhus integrifolia* Alliance may prefer relatively dry island conditions. This Alliance did not occur on the other islands.

- *Arctostaphylos (crustacea, tomentosa)* Alliance
 - *Arctostaphylos confertiflora* Association
 - *Arctostaphylos crustacea* Association
 - *Arctostaphylos insularis* Association
- *Quercus dumosa* – *Quercus pacifica* Alliance
 - *Quercus pacifica* Association
 - *Quercus pacifica* – (*Arctostaphylos insularis* – *Ceanothus megacarpus* var. *insularis*) Association
 - *Quercus pacifica* – *Rhus integrifolia* Association
 - *Quercus pacifica* / grass Association (provisional)
- *Rhus integrifolia* Alliance
 - *Rhus integrifolia* Association
 - *Rhus integrifolia* – *Artemisia californica* Association (provisional)

Californian Mesic and Pre-montane Chaparral

The stands that make up this group were found on ANI, SCI, and SRI, but none of the alliances or associations were common to all three islands. Stands comprising the *Cercocarpus betuloides* Alliance were found exclusively on SCI where it occurred on a variety of slope positions but preferred northwest-facing slopes. The most common associated species were *Quercus pacifica*, *Prunus ilicifolia* ssp. *lyonii*, and *Mimulus aurantiacus* var. *pubescens*. The hybrid tree species MacDonald's oak (*Quercus x macdonaldii*) was also occasionally present at low cover.

The *Heteromeles arbutifolia* Association occurred on both SCI and SRI and was categorized as provisional due to the small sample size. The *Heteromeles arbutifolia* – *Artemisia californica* Association was only found on SRI. The *Prunus ilicifolia* ssp. *lyonii* Association was found on West ANI and SCI, and it occurred on all slope positions including drainage bottoms. Common associated species with this association were *Artemisia californica*, *Baccharis pilularis* ssp. *consanguinea*, and Brandegee's sage (*Salvia brandegeei*) the latter of which occurred only on SRI. The most common herbaceous species was *Bromus diandrus* which occurred in about half of the plots.

- *Cercocarpus betuloides* Alliance
 - *Cercocarpus betuloides* var. *blancheae* Association (provisional)
- *Prunus ilicifolia* – *Heteromeles arbutifolia* – *Ceanothus spinosus* Alliance
 - *Heteromeles arbutifolia* Association (provisional)
 - *Heteromeles arbutifolia* – *Artemisia californica* Association
 - *Prunus ilicifolia* ssp. *lyonii* Association

Californian North Coastal and Mesic Scrub

Most of the plots under the *Baccharis pilularis* Alliance fit into four associations. Three of the associations were found on SCI, SRI, and SMI, whereas the fourth occurred on ANI and SRI. The characteristic species, *Baccharis pilularis* ssp. *consanguinea*, usually occurred on more mesic north-facing slopes and in drainages. The associations were well sampled on the islands with the *Baccharis pilularis* / (*Stipa pulchra* – *Elymus glaucus* – *Bromus carinatus*) Association being the most common. Associated shrubs included *Artemisia californica*, *Isocoma menziesii*, *Lupinus albifrons*, and *Acmispon dendroideus*. A wide range of common herbaceous species were associated, including *Avena* spp., *Bromus diandrus*, soft chess (*Bromus hordeaceus*), California brome (*Bromus carinatus*), *Corethrogyne filaginifolia*, and *Stipa pulchra*.

The *Ceanothus thyrsiflorus* Alliance was represented by the *Ceanothus arboreus* Association. The community was sampled only on SCI, although it was known in the past to occur on SRI. The discrepancy was due to the short life span of fiddleleaf ceanothus (*Ceanothus arboreus*) which on SRI occur as even-aged high-cover stands that can disappear completely over just 1–3 years. The species was mapped from the 2012 aerial imagery, but although *Ceanothus arboreus* individuals were present in plots when they were eventually visited, their cover was insufficient to classify as *Ceanothus arboreus* Association. For SCI, other common shrub species present in stands included island manzanita (*Arctostaphylos insularis*), *Eriogonum arborescens*, and island hazardia (*Hazardia*

detonsa). These shrub species did not occur with *Ceanothus arboreus* on SRI. *Bromus diandrus* was the most common associated herbaceous species followed by goldback fern (*Pentagramma triangularis*), American wild carrot (*Daucus pusillus*), and small-flower catchfly (*Silene gallica*).

- *Baccharis pilularis* Alliance
 - *Baccharis pilularis* Association
 - *Baccharis pilularis* – *Artemisia californica* Association
 - *Baccharis pilularis* / (*Stipa pulchra* – *Elymus glaucus* – *Bromus carinatus*) Association
 - *Baccharis pilularis* / Annual grass – herb Association
- *Ceanothus thyrsiflorus* Alliance
 - *Ceanothus arboreus* Association

Californian Xeric Chaparral

The *Adenostoma fasciculatum* Alliance consists of three associations with numerous endemics. The *Adenostoma fasciculatum* Southern Maritime Association was originally described from the mainland, and on SCI encountered just three times. On SCI, this association typically occurs between mid-slope and ridge-top positions where it formed open to moderately dense stands. The other two associations featured prostrate chamise (*Adenostoma fasciculatum* var. *prostratum*), which exhibits a prostrate and mounding physiognomy and is known only from SRI and Baja California. These associations were browsed heavily by deer and elk whose persistent trails at present still dissect many stands. Two associated shrubs, *Quercus pacifica* and *Salvia brandegeei*, are island endemics, and additional shrub associates included *Heteromeles arbutifolia* and *Mimulus aurantiacus* var. *parviflorus*. The herbaceous species Bigelow's spike-moss (*Selaginella bigelovii*) and *Carex globosa* were present in just under half of the stands.

The *Ceanothus megacarpus* Alliance was present on SCI and SRI. The featured species island ceanothus (*Ceanothus megacarpus* var. *insularis*) formed distinctive stands only on SCI where it was found on south and northwest aspects in the island's center. Where present on SRI, the species was uncommon to rare and usually associated with *Adenostoma fasciculatum* var. *prostratum*. This difference in communities between SCI and SRI could be explained by heavy browsing by deer on SRI. On SCI, the stands supported an open to intermittent shrub layer and an open understory. Commonly associated species included *Mimulus aurantiacus* var. *pubescens*, island buckwheat (*Eriogonum grande* var. *grande*), and island broom (*Acmispon dendroideus* var. *dendroideus*). *Ceanothus megacarpus* var. *insularis* is endemic to SCI and SRI.

- *Adenostoma fasciculatum* Alliance
 - *Adenostoma fasciculatum* Southern Maritime Association
 - *Adenostoma fasciculatum* var. *prostratum* – (*Quercus pacifica*) Association

- *Adenostoma fasciculatum* var. *prostratum* – *Salvia brandegeei* / *Selaginella bigelovii* Association (provisional)
- *Ceanothus megacarpus* Alliance
 - *Ceanothus megacarpus* var. *insularis* Association

Central and Southern Californian Coastal Sage Scrub

The *Artemisia californica* Alliance and associations contained some of the most common vegetation types within the project area along with a few that were somewhat rare. Three of the associations were sampled on at least three islands, and three were found on one island each. Two associations are newly described. The cover of the characteristic species *Artemisia californica* was variable, with the more open stands supporting greater cover of herbs in the understory. The stands occurred on a variety of substrates, slopes, and aspects but tended to be more common on south aspects. The *Artemisia californica* Alliance on ANI was sampled just once, whereas on SCI, SRI, and SMI the alliance was sampled 96 times. In addition to the codominant species, shrub associates included *Baccharis pilularis* ssp. *consanguinea*, *Isocoma menziesii*, *Rhus integrifolia*, *Acmispon dendroideus*, and *Lupinus albifrons*. Common herbaceous associates included *Avena* spp., foxtail chess (*Bromus madritensis*), *Bromus diandrus*, Australian saltbush (*Atriplex semibaccata*), and island morning glory (*Calystegia macrostegia* ssp. *macrostegia*).

In contrast, the *Encelia californica* – *Eriogonum cinereum* Alliance was more restricted. Within the project area, this alliance was represented by the *Encelia californica* – *Eriogonum arborescens* Association and was sampled only on Middle and West ANI. However, large and dense stands of *Encelia californica* were noted on the south side of SCI during field reconnaissance, so the alliance likely occurred there. The alliance also occurs on the California mainland where it is represented by a different association without the characteristic co-dominant *Eriogonum arborescens* that is a northern Channel Islands endemic. *Encelia californica* is drought deciduous, so shrub cover in these stands varied from open to moderately dense depending on season. *Encelia californica* appeared to prefer dry conditions and well drained soils on fairly steep slopes. Similar to SCI, stands on ANI occurred on south-facing aspects and on ridgetops. Other species commonly present in *Encelia californica* stands included *Artemisia californica*, *Rhus integrifolia*, and *Opuntia oricola*. Coast dudleya (*Dudleya caespitosa*) was the most common herbaceous species present. Other less common herbs included *Selaginella bigelovii*, crystalline iceplant (*Mesembryanthemum crystallinum*), and chilicothe (*Marah macrocarpus*).

Stands of the *Salvia mellifera* Association have been sampled on Santa Catalina Island, but within the project area this association was sampled in just one plot, which was located on SCI's south side. In this stand, the shrub layer was intermittent with a sparse herbaceous understory. Black sage (*Salvia mellifera*) was the dominant shrub species with *Rhus integrifolia* and *Artemisia californica* occurring at lower cover. Other shrub species such as Plummer's baccharis (*Baccharis plummerae* ssp. *plummerae*) were sparse. Associated herbaceous species included San Diego needle grass (*Stipa diegoensis*), coffee fern (*Pellaea andromedifolia*), and bedstraw (*Galium* sp.).

- *Artemisia californica* Alliance
 - *Artemisia californica* Association
 - *Artemisia californica* – *Opuntia littoralis* Association (provisional)
 - *Artemisia californica* – *Peritoma arborea* Association
 - *Artemisia californica* – *Salvia brandegeei*
 - *Artemisia californica* – *Salvia mellifera* Association
 - *Artemisia californica* / *Stipa (pulchra)* Association
- *Encelia californica* – *Eriogonum cinereum*
 - *Encelia californica* – *Eriogonum arborescens* Association (provisional)
- *Salvia mellifera* Alliance
 - *Salvia mellifera* – *Opuntia littoralis* – *Rhus integrifolia* Association

North American Warm Desert Riparian Low Bosque and Shrubland

This group on the northern Channel Islands is comprised of two alliances and three nested associations. However, for the most part, only the alliance levels were mapped. The *Baccharis salicifolia* Association and the *Salix lasiolepis* Association occurred only on SCI, whereas the *Salix lasiolepis* – *Baccharis salicifolia* Association was present on SCI, SRI, and SMI. Both alliances contained characteristic species commonly found in canyon bottoms and riparian areas whether or not surface water was present.

Stands representing the *Baccharis salicifolia* Alliance were mapped 114 times on SCI. A total of 255 stands were mapped as either the *Salix lasiolepis* Alliance or the *Salix lasiolepis* Association with the vast majority (243) occurring on SCI, whereas only four stands of this alliance were mapped on SMI. The *Salix lasiolepis* – *Baccharis salicifolia* Association was sampled on SCI but not mapped. *Salix lasiolepis* has expanded since the removal of cattle on SRI.

- *Baccharis salicifolia* Alliance
 - *Baccharis salicifolia* Association
- *Salix lasiolepis* Alliance
 - *Salix lasiolepis* Association
 - *Salix lasiolepis* – *Baccharis salicifolia* Association

Herbaceous Communities

Arid West Interior Freshwater Marsh

The *Typha (angustifolia, domingensis, latifolia)* Alliance contained just one association. This vegetation type was found only in wetlands and consequently occurred on SCI, SRI, and SMI, each of which harbors brackish and/or freshwater riparian areas. A total of 44 stands were mapped. The association was found at the mouths of three drainages on different parts of SCI, in riparian areas on

the southeast side of SRI which supported the highest number of stands, and in one drainage on SMI. Only southern cattail (*Typha domingensis*), the characteristic species of the association, occurred on the northern Channel Islands where it expanded rapidly on SRI following the removal of cattle in 1998.

- *Typha (angustifolia, domingensis, latifolia)* Alliance
 - *Typha domingensis* Association

Californian Annual Grassland and Forb Meadow

This small group was represented by just two alliances and two associations. Stands were few in number but occurred close to the shore (within 362 m) on all islands in the project area. The *Eschscholzia (californica) – Lupinus (nanus)* Alliance, here represented by the *Eschscholzia californica* Association, was identified by one stand on SMI where it was not mapped. The association is also known from the California mainland. The *Lasthenia californica – Extriplex californica* Association was found on ANI and SRI just four times with all stands occurring along the coast. Due to this small sample size, the association was given provisional designation.

- *Eschscholzia (californica) – Lupinus (nana)* Alliance
 - *Eschscholzia californica* Association
- *Lasthenia californica – Plantago erecta – Festuca microstachys* Alliance
 - *Lasthenia californica – Extriplex californica* Association (provisional)

Californian Cliff, Scree, and Rock Vegetation

This group contained one alliance with two nested associations in the project area, and only a few stands were sampled on SCI and SRI. Although this alliance and its two associations were seldom sampled, 1793 polygons were mapped to the group level with 365 occurring on SCI and 1428 across ANI, SRI, and SMI. The stands were characterized by very low plant cover with abundant bare soil and rock, contrasting greatly with the surrounding denser vegetation. When present, the shrubs *Isocoma menziesii* and *Artemisia californica* occurred in small amounts, at very low cover, and consisted of small and stunted individuals due to low site productivity. The *Dudleya (blochmaniae* spp. *insularis, gnoma*) – Sparse Herb Association was comprised of species endemic to the northern Channel Islands, and considered provisional because it was sampled only twice on SRI. Both stands were located in the eastern portion of the island. The Lichen Gravel – Bedrock Non-vascular Sparse Association was sampled seven times on SCI and SRI, where it typically occupied ridgetops or coastal bluffs with rocky soils and low plant cover. This association is also known from Pinnacles National Monument in northern California.

- *Dudleya cymosa – Dudleya lanceolata – Lichen/Moss Sparse* Alliance
 - *Dudleya (blochmaniae* spp. *insularis, gnoma*) – Sparse Herb Association (provisional)
 - Lichen Gravel – Bedrock Non-vascular Sparse Association

Californian Perennial Grassland

Three alliances and six associations comprised this group. The *Corethrogyne filaginifolia* – *Eriogonum* (*elongatum*, *nudum*) Alliance, represented by the *Corethrogyne filaginifolia* Association, was found only on SRI where it occurred primarily on ridgetops and upper slopes. Stand cover was typically open, and the substrate was often rocky. Ground cover consisted of small amounts of litter as well as lichens and cryptogamic soil crusts. The sample size was relatively low, but the alliance is also known to occur on the mainland. Of the relatively large number of associated species, most common were *Bromus diandrus*, sandcarpet (*Cardionema ramosissimum*), longbeak stork's bill (*Erodium botrys*), featherweed (*Gamochaeta ustulata*), smooth cat's ear (*Hypochaeris glabra*), miniature lupine (*Lupinus bicolor*), dot-seed plantain (*Plantago erecta*), *Silene gallica*, and *Stipa pulchra*. The two shrub species *Baccharis pilularis* ssp. *consanguinea* and *Acmispon dendroideus* were sometimes present at low cover.

The *Elymus condensatus* Alliance occurred just once on each of ANI and SMI, but it is also known from Santa Catalina Island and the California mainland. Giant wild-rye (*Elymus condensatus*) was also found on SRI and SCI, and its spatial extent was large enough to delineate eight stands on SCI. The two stands sampled on ANI and SMI were in mesic areas with northern aspects and co-occurred with *Isocoma menziesii*. Other associated shrubs included *Rhus integrifolia*, *Baccharis pilularis* ssp. *consanguinea*, *Leptosyne gigantea*, and golden yarrow (*Eriophyllum confertiflorum* var. *confertiflorum*). Associated herbs included little California melica (*Melica imperfecta*), *Marah macrocarpus*, and nettle-leaf goosefoot (*Chenopodium murale*).

Two of the associations within the *Stipa* spp. – *Melica* spp. Alliance were well represented within the project area. The *Stipa pulchra* Association and the *Stipa pulchra* – *Avena* spp. – *Bromus* spp. Association occurred on all four islands, and both were well captured with 100 and 105 samples, respectively. The other two associations occurred on just one island each but were fairly well sampled with 29 samples for the *Stipa pulchra* – *Corethrogyne filaginifolia* Association and 14 for the *Stipa pulchra* – *Festuca perennis* – (*Trifolium* spp.) Association. One sample could only be classified to the Alliance level. Stands adhering to this alliance were characterized by low to high cover of *Stipa*. Although stands were dominated by herbaceous species, the shrubs *Baccharis pilularis* ssp. *consanguinea* and *Artemisia californica* occurred at low densities in some stands. Tree cover was absent. In contrast to the mainland, stands dominated by *Stipa* occupied fairly substantial areas on all four islands, with a total of 8914 mapped acres. Stands were sampled on various slopes, flats, and aspects, and on SRI the alliance occupied extensive areas on the northern terraces. Other associated species included *Atriplex semibaccata*, *Avena* spp., *Bromus diandrus*, *Dichelostemma capitatum*, and *Corethrogyne filaginifolia*.

- *Corethrogyne filaginifolia* – *Eriogonum* (*elongatum*, *nudum*) Alliance
 - *Corethrogyne filaginifolia* Association (provisional)
- *Elymus condensatus* Alliance
 - *Elymus condensatus* Association
- *Stipa* spp. – *Melica* spp. Alliance

- *Stipa pulchra* Association
- *Stipa pulchra* – *Avena* spp. – *Bromus* spp. Association
- *Stipa pulchra* – *Corethrogyne filaginifolia* Association
- *Stipa pulchra* – *Festuca perennis* – (*Trifolium* spp.) Association

Californian Ruderal Grassland, Meadow, and Scrub

This group exhibited the largest spatial extent within the project area and was particularly common on SRI. It was comprised of four alliances and ten associations, each featuring short herbaceous species with open to dense cover. The presence of this group on the islands is likely the product of more than 100 years of grazing because the characteristic species are not native to the islands or the continental U.S. Most of the associations were sampled on all slopes and aspects. On SCI it was more common on the east and west rather than the central portion of the island. Many of the characteristic species were annuals whose cover fluctuates annually depending on the timing and amount of rainfall.

The species that characterized the *Avena* spp. – *Bromus* spp. Semi-natural Alliance and its associations were non-native and primarily graminoids, the exceptions being *Atriplex semibaccata*, *Erodium botrys*, and *Hypochaeris glabra*. The alliance occurred at coastal and interior positions and on various slopes and aspects. Substrates were variable but tended to be deep, and shrubs were present but widely scattered. Several of the associations such as the *Avena barbata* – *Avena fatua* Semi-natural Association and the two *Bromus diandrus* associations occupied large areas, particularly on SCI, SRI, and SMI. Some of the characteristic species for these association were also significant components of other associations such as the *Baccharis pilularis* / Annual grass – herb Association.

The *Atriplex semibaccata* – *Hordeum (murinum)* Semi-natural Association was sampled on SCI, SRI, and SMI. On SRI the association was represented by 17 plots, whereas SCI and SMI hosted only two plots each. It occurred on both slopes and flats but had an affinity for west-facing aspects. Although this association was newly described for this project, it likely occurs on the mainland and other islands beyond the project area. Other species that commonly co-occurred in the *Atriplex semibaccata* – *Hordeum murinum* Association were *Avena* spp., *Bromus hordeaceus*, *Bromus diandrus*, and *Medicago polymorpha*. The shrub species *Baccharis pilularis* was sometimes present at low cover.

The *Avena barbata* – *Avena fatua* Association occurred on various slope positions but favored south-facing aspects. The two characteristic species were dominant or co-dominant with each other in the stands, which were open to dense. The association was well sampled on SCI and SRI, whereas only two plots were sampled on SMI and none on ANI. *Bromus diandrus* was the most common associated species but at relatively low cover. Other species included *Atriplex semibaccata*, *Bromus hordeaceus*, *Medicago polymorpha*, *Stipa pulchra*, and *Hordeum murinum*, but only the latter co-occurred at a greater than 50% frequency.

Brachypodium distachyon stands occurred only on SCI, although the species is also present on SRI. The featured species is an aggressive weed native to southern Europe. It was first collected on SCI in 1991 and spread rapidly thereafter. The association was sampled only six times, but it has also been recorded from Santa Catalina Island and the mainland.

Stands of the *Bromus diandrus* Semi-natural Association occurred on all four of the islands and is also present on the mainland. It was best represented from SRI where it was sampled 62 times. Stands were found on various slope positions and flats, and across all aspects. Cover was open to very dense and varied annually depending on winter rainfall. Widely scattered shrubs such as *Baccharis pilularis* also occurred in some of the stands. Non-native associates included *Avena* spp., *Bromus hordeaceus*, and *Hordeum murinum* whereas native associates were less common and included common fiddleneck (*Amsinckia intermedia*), blue dicks (*Dichelostemma capitatum*), and *Stipa pulchra*.

The *Bromus diandrus* – *Avena* spp. Semi-natural Association was similar to the *Bromus diandrus* Semi-natural Association with many of the same co-occurring species, the main difference being that *Avena* was a co-dominant. Stands were most common on SRI, but the association was also present on SCI and SMI. Like the *Bromus diandrus* Semi-natural Association, stands occurred on a variety of slope positions and aspects. Associated taxa included *Atriplex semibaccata*, *Baccharis pilularis*, *Medicago polymorpha*, and *Stipa pulchra*.

The *Bromus hordeaceus* – *Erodium botrys* Semi-natural Association and the *Hypochaeris glabra* – *Festuca* Semi-natural Association were poorly sampled. The former occurred only on SCI and SRI, whereas the latter occurred only on SCI. The eponymous species are annuals and their cover varied annually depending on rainfall.

The *Brassica nigra* and Other Mustards Semi-natural Alliance was represented by the *Brassica nigra* Semi-natural Association and occurred only on SCI, although black mustard (*Brassica nigra*) was present on other islands in the project area. Only one sample was taken from SCI, but the Alliance has also been found on San Clemente Island and the California mainland. Cover and abundance of the characteristic species varied annually depending on environmental factors such as winter precipitation. With adequate winter rainfall the species grew much taller (over 1 m) than species with which it co-occurred. Additional associates included *Bromus diandrus*, *Bromus madritensis*, tocalote (*Centaurea melitensis*), *Medicago polymorpha*, and pinpoint clover (*Trifolium gracilentum*), each with relatively low cover.

The *Conium maculatum* – *Foeniculum vulgare* Semi-natural Herbaceous Alliance was sampled only on SCI. Although sampled just seven times, the alliance was mapped as occupying over 471 acres on the island. Both characteristic species were present on SCI, but only fennel (*Foeniculum vulgare*) occurred in the sampled plots. Stands occurred on the isthmus, in the Central valley, and at the west end of the island. Attempts at controlling *Foeniculum vulgare* through burning, uprooting of smaller plants, and the application of herbicides yielded some success at increasing the cover of native shrubs, according to monitoring data. Associated shrub species included *Artemisia californica*,

Ceanothus arboreus, *Baccharis pilularis* spp. *consanguinea*, *Quercus pacifica*, and *Rhus integrifolia*. Commonly associated herbaceous species were *Avena* spp., *Bromus diandrus*, *Bromus hordeaceus*, *Calystegia macrostegia* spp. *macrostegia*, and *Medicago polymorpha*.

The *Festuca perennis* Semi-natural Herbaceous Alliance was sampled only nine times on SCI. Stands occupied a variety of slope positions but were located primarily on northeast aspects. Cover was open to dense, and like most annual species its cover varied annually depending on environmental factors. Associated native shrubs were present in some stands at less than 20% relative cover and included *Artemisia californica*, *Baccharis pilularis* ssp. *consanguinea*, red-flowered buckwheat (*Eriogonum grande* var. *rubescens*), and *Isocoma menziesii*. Common co-occurring herbs were *Avena*, *Bromus diandrus*, *Medicago polymorpha*, common sow thistle (*Sonchus oleraceus*), and *Stipa pulchra*.

- *Avena* spp. – *Bromus* spp. Semi-natural Alliance
 - *Atriplex semibaccata* – *Hordeum (murinum)* Semi-natural Association
 - *Avena barbata* – *Avena fatua* Semi-natural Association
 - *Brachypodium distachyon* Semi-natural Association
 - *Bromus diandrus* Semi-natural Association
 - *Bromus diandrus* – *Avena* spp. Semi-natural Association
 - *Bromus hordeaceus* – *Erodium botrys* Semi-natural Association
 - *Hypochaeris glabra* – *Festuca (bromoides)* Semi-natural Association
- *Brassica nigra* and Other Mustards Semi-natural Alliance
 - *Brassica nigra* Semi-natural Association
- *Conium maculatum* – *Foeniculum vulgare* Semi-natural Alliance
 - *Foeniculum vulgare* Semi-natural Association
- *Festuca perennis* Semi-natural Alliance
 - *Festuca perennis* Semi-natural Association

Californian Vernal Pool

The Californian Vernal Pool group consisted of two alliances each with one nested association. The *Cressa truxillensis* Association is not known from the mainland, was sampled only once on SRI's east end, and was therefore considered provisional. The *Lasthenia fremontii* – *Distichlis spicata* Alliance and *Spergularia macrotheca* – *Hordeum (murinum)* association consisted of 19 stands on SRI that were scattered, small, and mapped only to the alliance level.

- *Cressa truxillensis* – *Distichlis spicata* Alliance
 - *Cressa truxillensis* Association (provisional)
- *Lasthenia fremontii* – *Distichlis spicata* Alliance

- *Spergularia macrotheca* – *Hordeum (murinum)* Association

North American Desert Alkaline-Saline Marsh & Playa Group

This group was represented by three alliances with ten associations. *Distichlis spicata*, *Elymus triticoides*, and alkali heath (*Frankenia salina*) were the diagnostic species for all three alliances and nine of the associations. This vegetation type was found in alkaline and saline soils.

Stands of the *Distichlis spicata* Alliance and its associations were present on all four islands and mapped primarily to the alliance level. The majority occurred on SRI, with SCI and SMI having approximately the same number of mapped stands. *Distichlis spicata* stands on SCI were primarily confined to coastal areas whereas SMI supported both coastal and inland stands. Anacapa Island contained the fewest occurrences with all on Middle. Most of the stands on SRI were located in drainage bottoms, on coastal terraces, and on coastal flats. Occasionally, *Distichlis spicata* was overtopped by associated species which likely skewed ocular estimates of cover and contributed to the alliance being undermapped.

The *Elymus cinereus* – *Elymus triticoides* Alliance and its two nested associations had the second highest number of stands and the second largest spatial extent. However, stands were sampled and mapped only on SRI due to their absence from ANI, SCI, and SMI. The *Frankenia salina* Alliance and two of its nested associations featured *Frankenia salina*, whereas a third association featured *Suaeda taxifolia* and *Hordeum murinum* as the diagnostic species. Stands with *Frankenia salina* occurred in just 11 mapped stands on ANI, SCI, and SRI. Stands with *Suaeda taxifolia* were even more rare; only three stands were encountered on the west end of SCI.

- *Distichlis spicata* Alliance
 - *Distichlis spicata* Association
 - *Distichlis spicata* – (*Baccharis glutinosa* – *Equisetum hyemale*) Association
 - *Distichlis spicata* – annual grasses Association
 - *Distichlis spicata* – *Elymus triticoides* Association
 - *Distichlis spicata* – *Frankenia salina* – *Jaumea carnosa* Association
- *Elymus cinereus* – *Elymus triticoides* Alliance
 - *Elymus triticoides* Association
 - *Elymus triticoides* – *Bromus* spp. – *Avena* spp. Association
- *Frankenia salina* Alliance
 - *Frankenia salina* – *Distichlis spicata* Association
 - *Frankenia salina* – *Extriplex californica* Association (provisional)
 - *Suaeda taxifolia* – *Hordeum* Association

North American Warm Desert Ruderal Grassland

This group was represented by just one alliance and one association. Of the three diagnostic species in the *Cynodon dactylon* – *Crypsis* spp. – *Paspalum* spp. Moist Semi-natural Alliance, only *Cynodon dactylon* occurred in sufficient cover to be mapped on the northern Channel Islands. *Crypsis* did not occur in the project area, and *Paspalum* occurred infrequently on SCI. Three sampled sites of the *Cynodon dactylon* Semi-natural Association were located in mesic sites and drainage bottoms on the south side of SRI. The species is often confused with the native grass *Distichlis spicata* which is far more common, and therefore this association may be more common than reported. Although sampled, stands representing this alliance and association were not mapped because occupied areas were smaller than the MMU size.

- *Cynodon dactylon* – *Crypsis* spp. – *Paspalum* spp. Moist Semi-natural Alliance
 - *Cynodon dactylon* Semi-natural Association

Southern Vancouverian Shrub and Herbaceous Bald, Bluff, and Prairie

This group was represented by one alliance containing two provisional associations that were found on separate islands. The *Bromus carinatus* Association was found on SRI and consisted of five mapped stands with two near the coastline and three inland. The *Pteridium aquilinum* – Grass Association was found nine times on SCI where it occurred in two spatial clusters of five and four stands. Neither association is known to occur on the mainland, and both were considered provisional due to the limited number of sampled stands.

- *Bromus carinatus* – *Elymus glaucus* Alliance
 - *Bromus carinatus* Association (provisional)
 - *Pteridium aquilinum* – Grass Association (provisional)

Temperate Pacific Freshwater Wet Mudflat

This group was represented by just one alliance containing one association. Neither the *Grindelia* (*camporum*, *stricta*) Alliance nor the *Grindelia camporum* Association were well represented, with only one stand identified to the alliance level and nine to association. All occurred on ANI. The alliance-level stand was found only on West ANI whereas the nine stands of the *Grindelia camporum* Association occurred on all three islets.

- *Grindelia* (*camporum*, *stricta*) Alliance
 - *Grindelia camporum* Association

Temperate Pacific Salt Marsh

This group was sampled only three times on SCI and SRI. The alliance requires a specific topographic profile rare on the northern Channel Islands—low-elevation, broad plains at the mouths of prominent drainages, where salt marshes form. The diagnostic species representing the alliance and association were salt tolerant, which allowed them to survive in coastal wetlands that were flooded and drained by ocean tides. The community was found at the western extent of SCI, whereas on SRI it was found in the east around the mouth of the Old Ranch drainage. Because this alliance

was poorly sampled and spatially limited, it was only mapped only on SCI at the group level. Associated species included *Bromus diandrus*, salt grass (*Distichlis spicata*), and *Frankenia salina*. The namesake species for the alliance and association, pickleweed (*Salicornia pacifica*), also occurred on ANI and SMI, but it was not mapped as a community type on those islands.

- *Salicornia pacifica* (*Salicornia depressa*) Alliance
 - *Salicornia pacifica* – *Distichlis spicata* Association

Vancouverian Freshwater Wet Meadow and Marsh

This group was comprised of four alliances each with one nested association, and one mapping unit. The *Carex* (*pansa*, *praegracilis*) Association and the *Hordeum brachyantherum* Association occurred on SRI and SMI, whereas the associations featuring rush (*Juncus*) were found separately on one island each. The *Juncus phaeocephalus* Association was found only on SRI in freshwater riparian habitat. The *Juncus balticus* – (*Juncus mexicanus*) Association was found only on SMI. One alliance and two associations were provisionally designated because their sample sizes were low, and they are not known from the mainland. The Sparsely vegetated drainage channels and seeps Mapping Unit occurred on ANI, SCI, and SRI.

- *Carex* (*pansa*, *praegracilis*) Alliance (provisional)
 - *Carex* (*pansa*, *praegracilis*) Association (provisional)
- *Hordeum brachyantherum* Alliance
 - *Hordeum brachyantherum* Association
- *Juncus* (*effusus*, *patens*) Alliance
 - *Juncus phaeocephalus* Association (provisional)
- *Juncus balticus* – *Juncus mexicanus* Alliance
 - *Juncus balticus* – (*Juncus mexicanus*) Association
- Sparsely vegetated drainage channels and seeps Mapping Unit

Accuracy Assessment

An AA evaluates how well the mapped vegetation types and the vegetation types in the field agree. The methodology used in this AA followed standard techniques widely used in error analysis of vegetation mapping (Lea & Curtis 2010).

General Approach

A random selection of vegetation types identified in the field was compared against the vegetation types identified by photo interpreters. For each island separately, these pairs of data were used to assemble a contingency table, in which rows were photo interpreter identifications and columns were field identifications. Agreeing identifications cumulated along a diagonal in each island's table. Counts of identifications that agreed versus disagreed, along with the areas of each vegetation type, were then used to compute the following four key metrics that each portray a type of accuracy:

1. Overall accuracy is the probability that a random point in the target area is classified correctly by the map.
2. User's accuracy is defined as the probability that a location mapped as a certain vegetation type correctly reflects that vegetation type in the field and is useful to a map's target audience.
3. Producer's accuracy is defined as the probability that a vegetation type in the field was correctly mapped as that vegetation type by the photo interpreters. It informs map makers how well the analysis of aerial imagery reflects vegetation types on the ground. These three measures of accuracy are expressed as percentages, ranging from 0% (poorest agreement) to 100% (best agreement).
4. The kappa coefficient is another measure of overall accuracy that additionally takes into account the possibility of the agreement occurring by chance. Kappa is also expressed as a percentage, with 0% representing random mapping and 100% reflecting perfect agreement.

Equations for computing these estimates of accuracy can be found in Lea & Curtis (2010) and are appropriate only if sites are selected at random. A map can have a high producer's accuracy combined with a low user's accuracy or vice versa, but an ideal map will have both a high producer's accuracy and high user's accuracy, as well as at least 80% overall accuracy for each map produced (ESRI et al. 1994). Under NPS guidelines, the recommended number of AA points per vegetation type is 0.6 samples/ha. The NPS I&M program further constrains sample size by a maximum of 30 samples for abundant vegetation types and a minimum of five samples for rare types (Table 10), constraints that balance statistical standards against the costs associated with obtaining AA field data. Abundance versus rarity is defined by area rather than number of polygons, with abundant types occupying greater than 50 ha and rare types less than 8.33 ha (Lea & Curtis 2010). A vegetation type with high producer but low user accuracy usually indicates that the type is undermapped—that is, more common on the ground than it is represented on the map. Conversely, a vegetation type with low producer and high user accuracy usually indicates that the type is overmapped.

Table 10. Standard sample size allocations.

Map class area (ha)	Observation points (count)
> 50	30
8.33–50	0.6 per ha
< 8.33	5

Site Selection

Accuracy assessment sites for all four islands within the project area were selected using a GRTS sampling design (Stevens & Olsen 2003, 2004), stratified by the mapped vegetation type. An oversample of points was also drawn for each vegetation type to provide contingencies in case points were inaccessible and to prevent overlap of AA plots, the latter of which was normally restricted to vegetation types that contained few small polygons. For ANI, SRI, and SMI, nine mapping units were excluded from the sample pool because they did not contribute to the understanding of natural vegetation communities. These units included (mapping unit numbers):

1. Littoral mapping unit (91100)
2. Beach sand mapping unit (91120)
3. Sand mapping unit (91400)
4. Mudflat mapping unit (91500)
5. Exotic trees and shrubs mapping unit (93000)
6. Water mapping unit (98000)
7. Dammed pond mapping unit (98010)
8. Urban/disturbed mapping unit (99000)
9. Sparsely vegetated drainage & seeps mapping unit (71110)

Although AA sites were selected for ANI, the AA was ultimately abandoned. As described above, transportation access to Middle and West ANI is irregular and infrequent due to California Brown Pelican nesting activities. In addition, much of West consists of slopes $>40^\circ$ which were deemed too steep to access safely. To assess feasibility for conducting the analysis, an AA point draw for all of ANI was overlaid onto a digital elevation model with the unsafe slopes highlighted. This analysis revealed that 26% of the 273 total AA points on ANI fell on slopes that were unsafe (Table 11). On West, 61% of the 110 points were unsafe (Figure 18). These percentages fell unequally across ANI's vegetation types. For example, 12 of the 22 vegetation types (54%) contained AA points on slopes $>40^\circ$, and the *Encelia californica* – *Eriogonum arborescens* Association had the most AA points (22 of 30) on unsafe slopes. Of the total 388 polygons for ANI, 173 contained inaccessible AA points. However, approximately 90% of the remaining (accessible) polygons and 14 of the 22 vegetation types in the point draw had been visited prior to the AA, either during data collection in support of the vegetation classification or to answer vegetation questions posed by the photo interpreters. On East and Middle, all accessible polygons were surveyed, and nearly all were surveyed on West.

While statistically valid AA points on about half of the vegetation types in the AA draw could have been obtained, the impediment to accessing a substantial number of AA points would have undermined the overall accuracy for ANI. Thus, due to the combination of limited transportation to Middle and West ANI, a high proportion of AA points on unsafe slopes, and decent previous survey coverage for more than half of the vegetation types, field data for an AA of ANI were not collected.

Table 11. Counts of accuracy assessment points on Anacapa Island by vegetation type and accessibility.

Group, Alliance, or Association	# Points Inaccessible	# Points Total	% Points Inaccessible
<i>Artemisia californica</i> / <i>Stipa (pulchra)</i> Association	0	5	0
<i>Avena barbata</i> – <i>Avena fatua</i> Semi-natural Association	0	46	0
<i>Baccharis pilularis</i> – <i>Artemisia californica</i> Association	0	47	0
Californian Maritime Chaparral Group	0	3	0
<i>Deinandra clementina</i> – <i>Eriogonum giganteum</i> Alliance	0	5	0
<i>Distichlis spicata</i> Alliance	0	3	0
<i>Frankenia salina</i> – <i>Extriplex californica</i> Association	0	3	0
<i>Grindelia (camporum, stricta)</i> Alliance	0	10	0
<i>Isocoma menziesii</i> Alliance	0	4	0
<i>Stipa</i> spp. – <i>Melica</i> spp. Alliance	0	7	0
<i>Cylindropuntia prolifera</i> – Mixed Coastal Scrub Association	1	5	20
<i>Rhus integrifolia</i> Alliance	1	5	20
<i>Eriogonum arborescens</i> Association	2	5	40
<i>Eriogonum grande</i> var. <i>grande</i> Association	2	5	40
<i>Prunus ilicifolia</i> ssp. <i>lyonii</i> Association	2	5	40
<i>Artemisia californica</i> Association	4	6	67
<i>Atriplex lentiformis</i> Alliance	4	5	80
<i>Leptosyne gigantea</i> / (<i>Dudleya greenei</i>) Association	5	19	26
<i>Carpobrotus</i> spp. – <i>Mesembryanthemum crystallinum</i> Association	7	11	64
<i>Artemisia californica</i> – <i>Eriogonum arborescens</i> Association	9	26	35
California Cliff, Scree and Rock Vegetation Group	12	18	67
<i>Encelia californica</i> – <i>Eriogonum arborescens</i> Association	22	30	73
Total	71	273	26

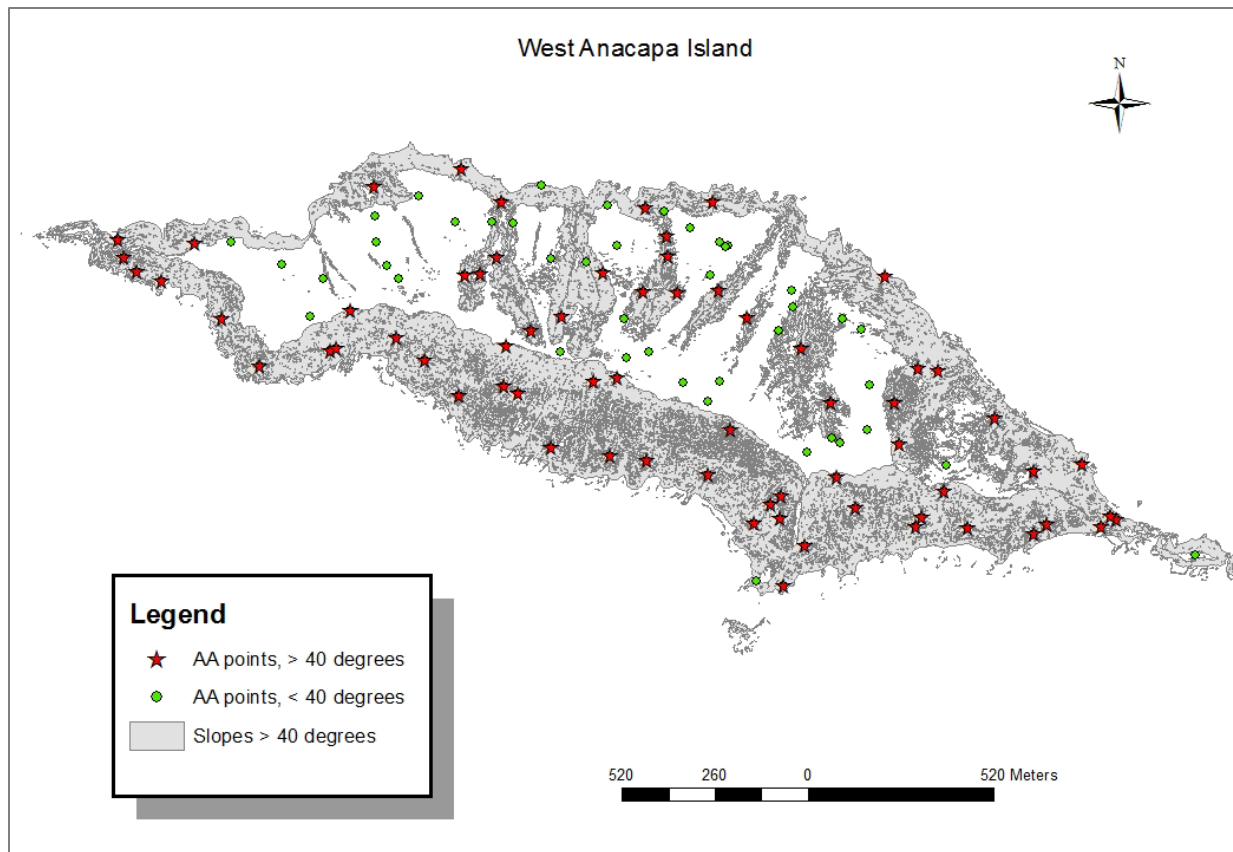


Figure 18. Accuracy assessment points assigned to West Anacapa Island, partitioned by accessibility based on slope angle.

NPS

For SCI, 54 of the 838 AA points fell within Bald Eagle (*Haliaeetus leucocephalus*) flight restriction zones (Figure 19) which were excluded for reasons described below in the subsection “Field Data Collection”. These were replaced by 51 overdraw points resulting in the assessment of 835 plots. Of these, 129 of the smaller plots each received an assessment of the entire polygon, in which case a note was recorded. Six mapping units were excluded from the SCI sample draw because they did not contribute to the understanding of natural vegetation communities. These exclusions were (mapping unit numbers):

1. Anthropogenic areas (99100)
2. Beach and Sand mapping unit (91120)
3. Littoral mapping unit (91100)
4. Planted Trees and Shrubs mapping unit (93000)
5. Urban/disturbed mapping unit (99000)
6. Water body mapping unit (98000)

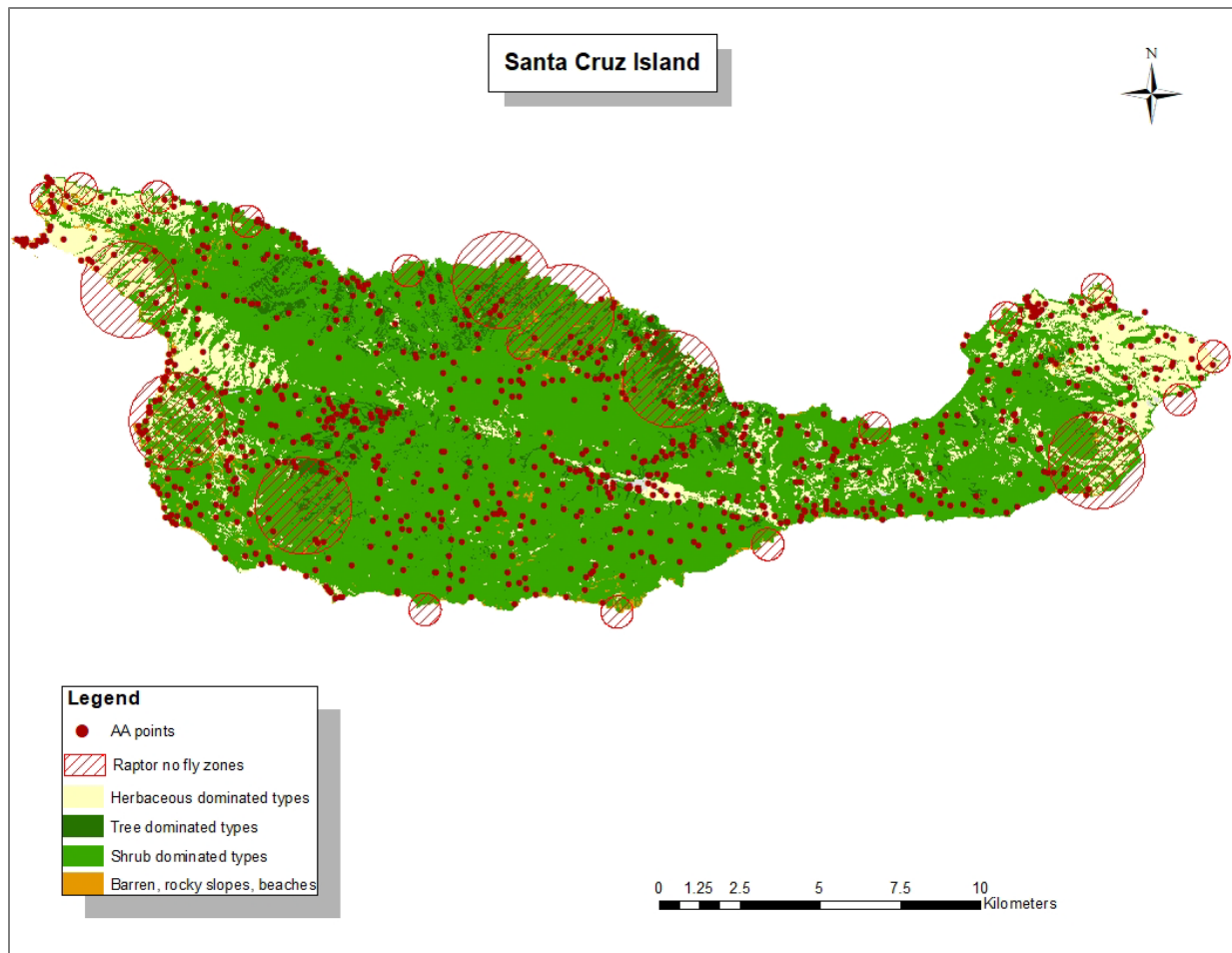


Figure 19. Accuracy assessment points assigned to Santa Cruz Island, overlaid onto coarse land cover types and including flight restriction zones.

NPS

The total area of unsampled mapping units for SCI was 24,733 ha, the vast majority of which was 24,683 ha of the littoral mapping unit comprised primarily of ocean. Of the 46 alliances, associations, and mapping units that remained for the AA, nine of the vegetation types were tree-dominated, 21 were shrub-dominated, and 16 were herb-dominated.

Santa Rosa Island and SMI hosted a total of 84 mapped types, but only 76 were sampled for the AA. The unsampled mapping units encompassed 23,570 ha, of which 23,281 ha was the littoral mapping unit. The 76 mapping units sampled included 35 alliances, 35 associations, two groups, and one division. Most of the sampled vegetation classes were shrub- or grass-dominated. Six hundred eighty-nine AA sample points were assigned to SRI (Figure 20) and 390 to SMI (Figure 21), with an additional 809 points allocated as overdraw.

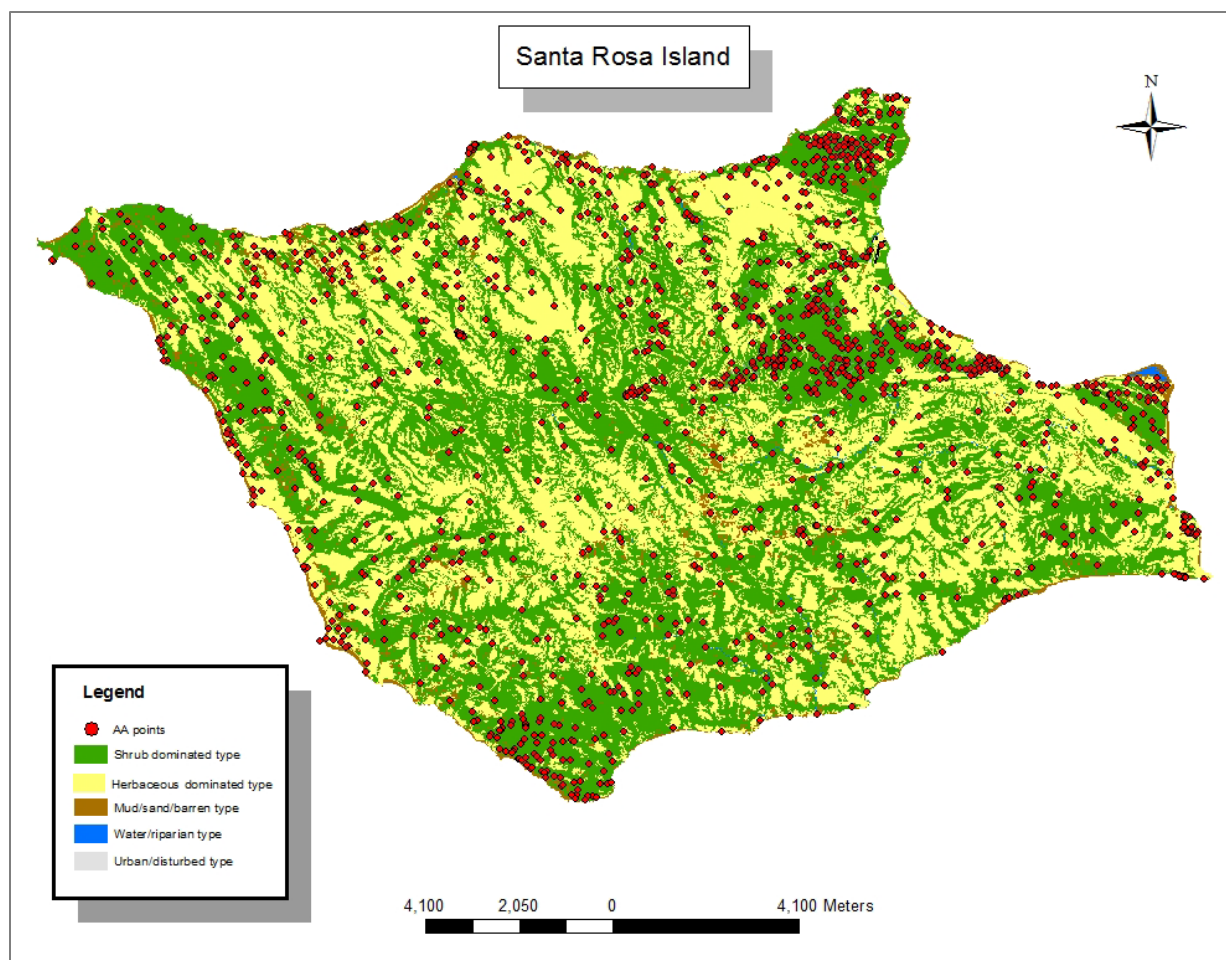


Figure 20. Accuracy assessment points assigned to Santa Rosa Island, overlaid onto coarse land cover types.

NPS

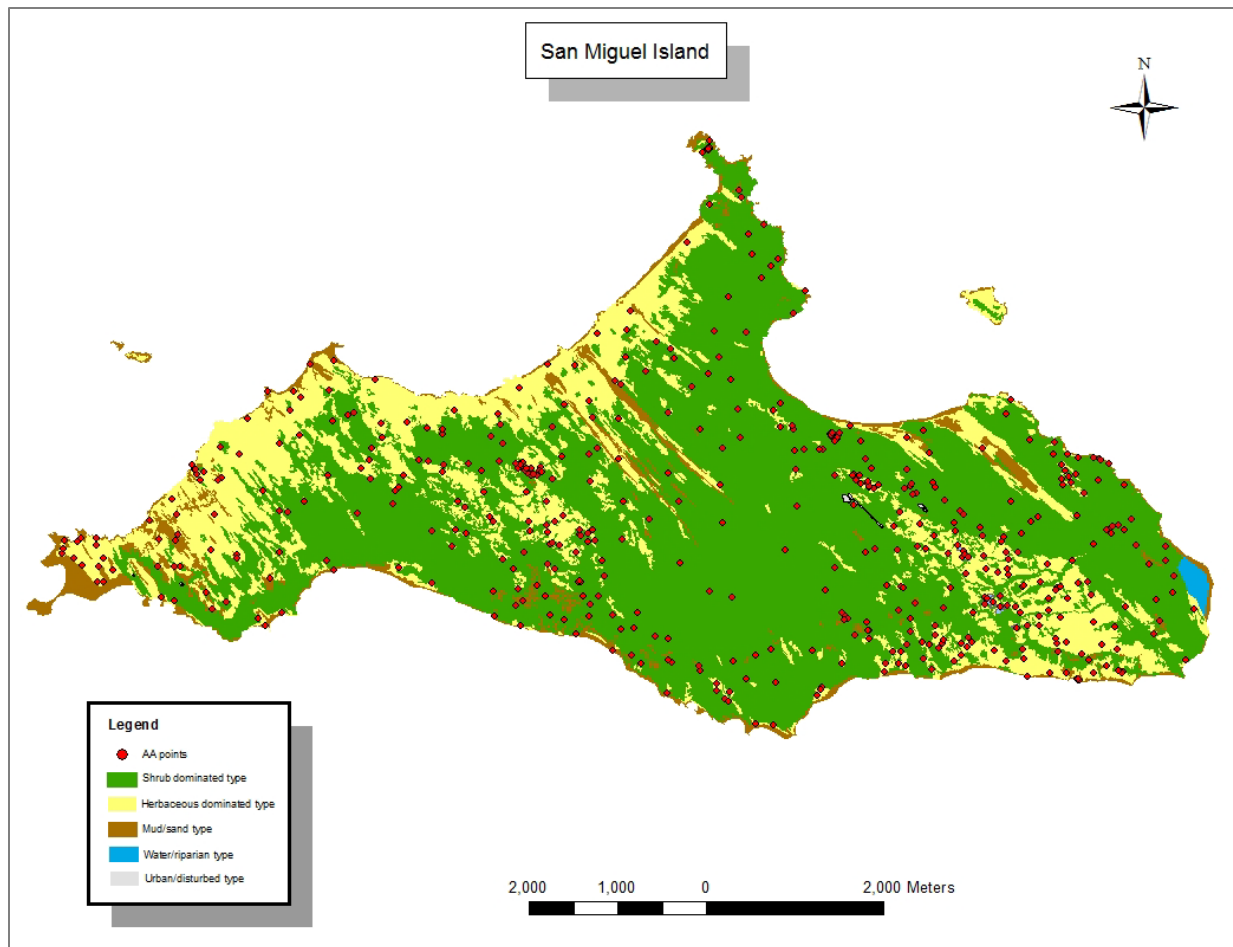


Figure 21. Accuracy assessment points assigned to San Miguel Island, overlaid onto coarse land cover types.

NPS

Field Data Collection

Field data for the AA was collected differently for SCI than for SRI and SMI. Visits to SCI's AA points occurred in April 2019, and the field data collection employed a non-standard aerial technique. For each AA point, field crew in a helicopter hovering over the AA point assessed and classified the vegetation type with the use of the vegetation field key developed by CNPS. The field identification and accompanying notes were entered into iPads using the software package Collector. Field identifications were based on 0.5 ha plots unless an entire stand was assessed, in which case additional notes were recorded. During the aerial evaluation, high-resolution photographs were taken for each plot or stand. These 26,754 photographs served as documentation of the site conditions in place of recording plot data (e.g., percent cover) onto paper datasheets, and were also used to reconcile discrepancies in vegetation type between the field identification and photo interpretation. Discrepancies were afforded a second and rarely a third perspective to arrive at the best possible determination.

For SRI and SMI, field data were collected from February to August 2016. Navigation to the AA points was facilitated by iPads loaded with AA locations and polygon boundaries, Garmin GPS units, and printed aerial images. The field crew typically installed a default circular plot at each AA location, but plots were reshaped or relocated according to a decision tree (Lea & Curtis 2010) if the point fell near a polygon boundary or was small (e.g., in a fragmented vegetation community). In rare instances due to safety or other concerns, an entire stand would be assessed. The recorded data included descriptions of location and environment, habitat and vegetation, and vegetation type identified using a CNPS key to vegetation communities. If evidence suggested that the vegetation had changed since the 2012 aerial imagery, or if the species composition matched two vegetation types, a secondary vegetation type was recorded.

To minimize errors introduced by patches of vegetation spanning ecotones (i.e., the zone of transition between two vegetation types) or by communities with small areas and, minor deviations from standard protocol were required for these two islands. For any AA of a vegetation map, an AA point that falls within an ecotone may capture only one of the two vegetation types, and vegetation types with polygons smaller than the standard MMU of 0.5 ha may be underrepresented because they are typically subsumed into the larger surrounding vegetation types. The solution is typically to use a circular plot of 0.5 ha as the basis for determining a vegetation type, and a buffer is applied to the inside of each polygon boundary to prevent AA points from falling on an ecotone. Under NPS guidelines, the formula for determining the buffer distance is:

$$\text{buffer distance} = \sqrt{R^2 + M^2 + F^2}$$

In this equation, R is the radius distance of the observation area, M is the expected maximum positional error distance in the map, and F is the expected field positioning (GPS) error distance. For a 0.5 ha polygon, $R = 40$ m, $M = 15$ m, and $F = 12$ m (90th percentile), which gives a buffer distance of 44 m. However, problems arose when applying this buffer to the delineated polygons at SRI and SMI. Due to the intensive grazing history of these islands, many native plant communities were reduced to small patches or confined to steep coastal bluffs. Therefore, applying the 44-m buffer to the delineated polygons excluded many small native community polygons from the GRTS draw because the buffer either consumed the entire polygon area or concentrated the points into the remaining polygon center. Repeating the draw using reduced buffers of 5–10 m failed to fix the problem, and removing the buffer altogether meant that a portion of a plot could fall into the adjacent polygon. We therefore used rectangular plots with the AA point assigned to any of the four plot corners, which provided enough flexibility to ensure each plot was placed wholly within a single community type. Another complication with small polygon sizes was the inability to fit 0.5 ha plots within polygons less than 0.5 ha. Our solution was to allow for smaller plot sizes to be used, or to evaluate the entire stand.

Of the 1059 points allocated to the two islands, 922 were successfully visited, including 641 on SRI and 281 on SMI. The discrepancy was primarily attributed to close-proximity points and polygons that were too small to accommodate multiple plots, and secondarily because of safety. All data collected were entered into a Microsoft® Access database with the data proofed prior and after entry.

Nomenclature and QA/QC protocols adhered to those used in the vegetation classification. Digital photographs were also taken as described above in the section Classification Data Collection and Processing. These digital images are archived at CHIS.

Contingency Table Analysis

Accuracy assessment analyses were performed separately for SCI, SRI, and SMI. For each island, QA/QC data were entered into a 2x2 matrix constructed in Microsoft® Excel, with rows representing vegetation types identified by the photo interpreters and columns representing vegetation types identified by field crew. The unit of replication was the polygon, so cells of the matrix were populated with counts of photo interpreter identifications or field crew identifications for every polygon included in the AA. A vegetation type agreed upon by the photo interpreters and field crews indicated that the AA point was correct; these values formed the diagonal in each island's matrix. Disagreements were initially considered incorrect; these values populated the remaining cells of the matrix. The completed matrices represented the draft contingency tables used to compute the preliminary accuracies, and these tables were shared with the photo interpreters (AIS) and CNPS for review.

Following the AIS and CNPS reviews, representatives from each met with CHIS primarily to discuss the disagreements in vegetation types identified by the photo interpreters versus field crew. Two categories of disagreement emerged: (1) clerical mistakes, including data entry errors, location errors, keying errors, incorrect field determinations (i.e., datasheet species list did not match vegetation type), and inclusions of multiple vegetation types within larger polygons; and (2) legitimate disagreements in the identification. Clerical mistakes were corrected, when possible, but data points associated with irreconcilable clerical mistakes were dropped from the analysis. Legitimate disagreements were sometimes caused by wide seasonal or annual variation in cover values typically associated with annual species, in which case the incorrect designation was changed to correct. These revised contingency tables were reviewed by AIS and CNPS, and potential solutions for addressing vegetation types with accuracies lower than 50% were discussed. Potential solutions included aggregating upward to a lower resolution level in the hierarchy, re-coding the mapping units for vegetation types with consistently high proportions of disagreements and splitting polygons that may have been comprised of two or more vegetation types. In most cases, these solutions were not applied, and the remaining legitimate disagreements were retained in the final contingency tables used to compute the final accuracies. These contingency tables are available in this report's [supplemental materials in DataStore](#).

Final Accuracies

Overall map accuracies for SRI and SMI exceeded the program recommendation of 80%, but SCI's Kappa-corrected accuracy of 76% did not (Table 12). Although no requirement demands that individual vegetation types achieve the 80% threshold, comparing among islands the proportions of vegetation types that do is informative. Of the types on SRI and SMI, 52% and 48%, respectively, yielded low accuracies compared to 74% on SCI despite having a high proportion of vegetation types (35 of 47) below 80% user's and/or producer's accuracies.

Table 12. Overall accuracies by island.

Island	Overall Accuracy	95% Confidence Interval	Kappa Correction	95% Confidence Interval
Santa Cruz	77.7%	71.7%–83.7%	75.8%	73.2%–78.3%
Santa Rosa	87.0%	83.2%–90.8%	82.1%	79.6%–84.6%
San Miguel	84.0%	78.4%–89.5%	82.8%	79.3%–86.3%

Santa Cruz Island supported 47 vegetation types (Table 13). Of these, 12 types generated both producer's and user's accuracies above 80%, and 12 types failed to meet both. Twelve vegetation types returned user's or producer's accuracies below 80%. Eleven types had high producer's accuracies but low user's accuracies, whereas 12 had high user's accuracies but low producer's accuracies. All but one tree-dominated community scored high for both user and producer accuracies, whereas shrub and herb-dominated communities yielded variable accuracies. Some example sources of error included misidentification of the diagnostic species *Lasthenia fremontii* vs. *Lasthenia californica/gracilis*, missing types in the key to vegetation or the electronic platform's drop-down menu, types that were identified for the first time during the AA, and a raptor exclusion zone that prevented helicopter access to the *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Shrubland Alliance. The analysis for each SCI vegetation type can be found in the final contingency tables, which are available in this report's [supplemental materials in DataStore](#).

Table 13. Accuracies by vegetation type on Santa Cruz Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
11110	<i>Quercus tomentella</i> – <i>Lyonothamnus floribundus</i> California Islands Woodland Alliance	23.6%	100%	15	0
11111	<i>Lyonothamnus floribundus</i> Association (provisional)	100%	90.0%	30	3
11120	<i>Quercus agrifolia</i> Woodland Alliance	97.2%	73.3%	30	8
11130	<i>Quercus chrysolepis</i> Woodland Alliance	100%	25.0%	4	3
11210	<i>Pinus muricata</i> – <i>Pinus radiata</i> Woodland Alliance	66.1%	96.7%	30	1
12110	<i>Eucalyptus</i> spp. – <i>Ailanthus altissima</i> – <i>Robinia pseudoacacia</i> Semi-Natural Alliance	100%	100%	12	0
13110	<i>Populus trichocarpa</i> Forest Alliance	100%	100%	5	0
13120	<i>Acer macrophyllum</i> Forest Alliance	100%	80.0%	5	1

^A Due to a raptor exclusion zone, the lone *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Shrubland Alliance polygon could not be accessed for the accuracy assessment.

^B This was not one of the original mapping units but was identified as a type in the AA.

^C Dropped from the AA.

Table 13 (continued). Accuracies by vegetation type on Santa Cruz Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
21110	<i>Adenostoma fasciculatum</i> Shrubland Alliance	100%	33.3%	6	4
21120	<i>Ceanothus megacarpus</i> Shrubland Alliance	18.0%	96.7%	30	1
21210	<i>Quercus dumosa</i> – <i>Quercus pacifica</i> Chaparral Alliance	100%	56.7%	30	13
21220	<i>Rhus integrifolia</i> Coastal Bluff Shrubland Alliance	50.6%	93.3%	30	2
21230	<i>Arctostaphylos (crustacea, tomentosa)</i> Central Coast & Island Shrubland Alliance	96.9%	96.7%	30	1
21240	<i>Leptosyne gigantea</i> Coastal Bluff Shrubland Alliance	60.1%	76.2%	21	5
21260	<i>Opuntia littoralis</i> – <i>Opuntia oricola</i> – <i>Cylindropuntia prolifera</i> Shrubland Alliance ^A	–	–	–	–
21310	<i>Prunus ilicifolia</i> – <i>Heteromeles arbutifolia</i> – <i>Ceanothus spinosus</i> Mesic Chaparral Alliance	20.5%	83.3%	30	5
21320	<i>Cercocarpus betuloides</i> Shrubland Alliance	5.5%	46.7%	14	16
21500	Baja Semi-Desert Coastal Succulent Scrub Group	100%	100%	1	0
22110	<i>Artemisia californica</i> Shrubland Alliance	26.9%	86.7%	30	4
22120	<i>Mimulus aurantiacus</i> Shrubland Alliance	61.8%	100%	5	0
22130	<i>Encelia californica</i> – <i>Eriogonum cinereum</i> Shrubland Alliance	76.0%	93.3%	30	2
22150	<i>Salvia mellifera</i> Shrubland Alliance	5.1%	60.0%	5	2
22210	<i>Isocoma menziesii</i> Shrubland Alliance	74.8%	56.7%	30	13
22230	<i>Eriogonum arborescens</i> – <i>Eriogonum grande</i> Scrub Alliance	99.1%	76.7%	30	7
31130	<i>Lasthenia californica</i> - <i>Plantago erecta</i> - <i>Festuca microstachys</i> Herbaceous Alliance ^B	0.0%	0.0%	–	–
31220	<i>Elymus condensatus</i> Coastal Grassland Alliance	100%	100%	4	0
31240	<i>Stipa</i> spp. – <i>Melica</i> spp. Grassland Alliance	61.3%	93.3%	30	2
31262	<i>Pteridium aquilinum</i> – Grass Association (provisional)	100%	80.0%	5	1
32100	Californian Grassland & Meadow Mapping Unit	93.4%	96.7%	30	1

^A Due to a raptor exclusion zone, the lone *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Shrubland Alliance polygon could not be accessed for the accuracy assessment.

^B This was not one of the original mapping units but was identified as a type in the AA.

^C Dropped from the AA.

Table 13 (continued). Accuracies by vegetation type on Santa Cruz Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
32160	<i>Conium maculatum</i> – <i>Foeniculum vulgare</i> Semi-natural Alliance	81.2%	75.9%	22	7
32170	<i>Atriplex semibaccata</i> – <i>Hordeum (murinum)</i> Semi-natural Association	100%	16.7%	6	5
41130	<i>Mesembryanthemum</i> spp. - <i>Carpobrotus</i> spp. Semi-natural Herbaceous Alliance ^B	0.0%	0.0%	–	–
41150	<i>Baccharis pilularis</i> Shrubland Alliance	94.8%	62.2%	29	11
41170	<i>Ceanothus thyrsiflorus</i> Shrubland Alliance	27.5%	93.3%	30	2
41210	<i>Abronia latifolia</i> – <i>Ambrosia chamissonis</i> Herbaceous Alliance	62.8%	63.6%	11	4
52100	Californian Vernal Pool Group	100%	7.1%	14	13
52110	<i>Lasthenia fremontii</i> – <i>Distichlis spicata</i> Herbaceous Alliance	0.0%	0.0%	2	2
53110	<i>Lepidospartum squamatum</i> Shrubland Alliance	0.0%	0.0%	2	2
54110	<i>Phalaris aquatica</i> – <i>Phalaris arundinacea</i> Semi-natural Alliance	100%	93.8%	16	1
55110	<i>Baccharis salicifolia</i> Shrubland Alliance	43.0%	63.3%	19	11
55130	<i>Salix lasiolepis</i> Shrubland Alliance	100%	86.7%	30	4
55220	<i>Typha (angustifolia, domingensis, latifolia)</i> Western Herbaceous Emergent Alliance	100%	100%	3	0
62110	<i>Atriplex lentiformis</i> Shrubland Alliance	7.1%	100%	1	0
62120	<i>Frankenia salina</i> Herbaceous Alliance	0.0%	0.0%	3	3
63100	Temperate Pacific Salt Marsh Group	0.0%	0.0%	1	1
63120	<i>Distichlis spicata</i> Alkaline Flats Alliance	100%	6.3%	16	15
71100	Californian Cliff, Scree & Rock Vegetation Group	100%	64.3%	28	10
71110	Sparsely vegetated drainage channels & seeps Mapping Unit	52.8%	100%	5	0
96000	Standing Dead Trees Mapping Unit ^C	–	–	–	–

^A Due to a raptor exclusion zone, the lone *Opuntia littoralis* – *Opuntia oricola* – *Cylindropuntia prolifera* Shrubland Alliance polygon could not be accessed for the accuracy assessment.

^B This was not one of the original mapping units but was identified as a type in the AA.

^C Dropped from the AA.

Santa Rosa Island supported 42 vegetation types (Table 14). Of these, 21 types generated both producer's and user's accuracies above 80%, whereas ten types failed to meet both. Eleven vegetation types returned user's or producer's accuracy below 80%. Five types had high producer's accuracies but low user's accuracies, while six had high user's accuracies but low producer's accuracies. Vegetation types with either a low producer's or user's accuracy were comprised solely

of shrub and herb-dominated communities, whereas all the tree-dominated communities generated both high producer's and user's accuracies. All of the original vegetation types were retained, although three vegetation types— *Leptosyne gigantea* Alliance, California Coastal-Foothill Seral Scrub Group, and Californian North Coastal & Mesic Scrub Group—were separated from delineated polygons based on the AA data. The analysis for each vegetation type can be found in the final contingency tables, which are available in this report's [supplemental materials in DataStore](#).

Table 14. Accuracies by vegetation type on Santa Rosa Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
11111	<i>Lyonothamnus floribundus</i> Association (provisional)	100%	100%	6	0
11113	<i>Quercus tomentella</i> Association	91.9%	100%	13	0
11120	<i>Quercus agrifolia</i> Woodland Alliance	100%	83.3%	12	2
11210	<i>Pinus muricata</i> - <i>Pinus radiata</i> Woodland Alliance	100%	100%	5	0
11220	<i>Pinus torreyana</i> Woodland Alliance	100%	100%	15	0
21110	<i>Adenostoma fasciculatum</i> Shrubland Alliance	95.1%	100%	30	0
21210	<i>Quercus dumosa</i> - <i>Quercus pacifica</i> Chaparral Alliance	98.6%	93.3%	30	2
21220	<i>Rhus integrifolia</i> Coastal Bluff Alliance	74.3%	93.3%	30	2
21230	<i>Arctostaphylos (crustacea, tomentosa)</i> Central Coast and Island Alliance	86.7%	82.1%	28	5
21240	<i>Leptosyne gigantea</i> Alliance ^A	0.0%	0.0%	—	-
21260	<i>Opuntia littoralis</i> - <i>Opuntia oricola</i> - <i>Opuntia prolifera</i> Shrubland Alliance	100%	100%	2	0
21310	<i>Prunus ilicifolia</i> - <i>Heteromeles arbutifolia</i> - <i>Ceanothus spinosus</i> Mesic Chaparral Alliance	97.9%	83.3%	30	5
22110	<i>Artemisia californica</i> Alliance	95.8%	100%	30	0
22120	<i>Mimulus aurantiacus</i> Shrubland Alliance	70.2%	55.6%	9	4
22160	<i>Acmispon glaber</i> - <i>Lupinus albifrons</i> Shrubland Alliance	84.6%	86.2%	29	4
22200	California Coastal-Foothill Seral Scrub Group ^A	0.0%	0.0%	—	—
22210	<i>Isocoma menziesii</i> Shrubland Alliance	99.1%	70.0%	30	9
22230	<i>Eriogonum arborescens</i> - <i>Eriogonum grande</i> Scrub Alliance	10.9%	100%	4	0
31130	<i>Lasthenia californica</i> - <i>Plantago erecta</i> - <i>Festuca microstachys</i> Herbaceous Alliance	53.0%	100%	1	0

^A This was not one of the original mapping units but was identified as a type in the AA.

Table 14 (continued). Accuracies by vegetation type on Santa Rosa Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
31200	Californian Native Perennial Grassland Group	100%	61.5%	26	10
31210	<i>Corethrogyne filaginifolia</i> - <i>Eriogonum (elongatum, nudum)</i> Herbaceous Alliance	3.5%	100%	5	0
31240	<i>Stipa</i> spp. - <i>Melica</i> spp. Grassland Alliance	98.8%	86.7%	30	4
31260	<i>Bromus carinatus</i> - <i>Elymus glaucus</i> Herbaceous Alliance	29.4%	33.3%	6	4
32100	Californian Grassland & Meadow Mapping Unit	88.4%	76.7%	30	7
32170	<i>Atriplex semibaccata</i> - <i>Hordeum (murinum)</i> Semi-natural Association	64.3%	86.7%	30	4
41100	Californian North Coastal & Mesic Scrub Group ^A	0.0%	0.0%	–	–
41110	<i>Lupinus arboreus</i> Dune Scrub Alliance	34.2%	55.2%	29	13
41130	<i>Mesembryanthemum</i> spp. - <i>Carpobrotus</i> spp. Semi-natural Herbaceous Alliance	19.9%	60.0%	5	2
41150	<i>Baccharis pilularis</i> Shrubland Alliance	98.9%	96.7%	30	1
41210	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous Alliance	68.9%	93.3%	30	2
41220	<i>Carex (pansa, praegracilis)</i> Herbaceous Alliance (provisional)	9.7%	60.0%	5	2
51120	<i>Hordeum brachyantherum</i> Herbaceous Alliance	100%	100%	1	0
51140	<i>Juncus (effusus, patens)</i> Herbaceous Alliance	100%	50.0%	2	1
52100	<i>Lasthenia fremontii</i> - <i>Distichlis spicata</i> Herbaceous Alliance	100%	100%	5	0
52150	<i>Cressa truxillensis</i> - <i>Distichlis spicata</i> Herbaceous Alliance	100%	100%	1	0
55130	<i>Salix lasiolepis</i> Shrubland Alliance	100%	100%	5	0
55220	<i>Typha (angustifolia, domingensis, latifolia)</i> Western Herbaceous Emergent Alliance	100%	100%	15	0
61110	<i>Elymus cinereus</i> - <i>Elymus triticoides</i> Herbaceous Alliance	33.8%	40.0%	30	18
62120	<i>Frankenia salina</i> Herbaceous Alliance	100%	50.0%	4	2
62121	<i>Suaeda taxifolia</i> - <i>Hordeum murinum</i> Association	100%	100%	5	0
63120	<i>Distichlis spicata</i> Alkaline Flats Alliance	37.0%	76.7%	30	7
71100	Californian Cliff, Scree & Rock Vegetation Group	92.0%	89.7%	29	3

^A This was not one of the original mapping units but was identified as a type in the AA.

San Miguel Island supported 23 vegetation types (Table 15). Of these, 12 types generated both producer's and user's accuracies above 80%, whereas only one type failed to meet both. Ten vegetation types returned user's or producer's accuracies below 80%. Five types had high producer's accuracies but low user's accuracies, and five had high user's accuracies but low producer's accuracies. All vegetation types were retained. In some cases, a vegetation type, even though it yielded low accuracy, was retained because the diagnostic species for the type was endemic or near endemic to the islands and was deemed ecologically important. In other cases, the park was interested in tracking vegetation types composed primarily of nonnative species, or mapping grass-dominated communities to a finer scale than normal. These latter cases were motivated by the fact that the northern Channel Islands support more extensive communities of native perennial grasses than other southern California parks. The analysis for SMI's individual vegetation types can be found in the final contingency tables, which are available in this report's [supplemental materials in DataStore](#).

Table 15. Accuracies by vegetation type on San Miguel Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
21240	<i>Leptosyne gigantea</i> Alliance	98.9%	86.7%	30	4
21251	<i>Lycium californicum</i> Association (provisional)	100%	100%	1	0
21261	<i>Opuntia littoralis</i> – Mixed Coastal Scrub Association	100%	100%	4	0
22110	<i>Artemisia californica</i> Alliance	62.4%	96.7%	30	1
22160	<i>Acmispon glaber</i> – <i>Lupinus albifrons</i> Shrubland Alliance	7.4%	96.7%	30	1
22200	California Coastal and Foothill Seral Group	100%	83.3%	6	1
22210	<i>Isocoma menziesii</i> Shrubland Alliance	93.1%	86.2%	29	4
22230	<i>Eriogonum arborescens</i> - <i>Eriogonum grande</i> Alliance	100%	80.0%	5	1
31221	<i>Elymus condensatus</i> Association	100%	100%	1	0
431240	<i>Stipa</i> spp. - <i>Melica</i> spp. Grassland Alliance	96.7%	96.6%	29	1
32100	Californian Grassland & Meadow Mapping Unit	92.8%	70.0%	30	9
32170	<i>Atriplex semibaccata</i> - <i>Hordeum (murinum)</i> Semi-natural Association	100%	66.7%	3	1
41131	<i>Carpobrotus</i> spp. - <i>Mesembryanthemum crystallinum</i> Semi-natural Association	34.2%	81.3%	16	3
41150	<i>Baccharis pilularis</i> Alliance	100%	96.6%	29	1
41210	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous Alliance	100%	69.2%	26	8
41221	<i>Carex (pansa, praegracilis)</i> Association (provisional)	100%	33.3%	3	2

Table 15 (continued). Accuracies by vegetation type on San Miguel Island.

Map Unit #	Map Unit Name	Producer's Accuracy	User's Accuracy	# of AA Points	# Incorrect
51121	<i>Hordeum brachyantherum</i> Association	100%	100%	3	0
51131	<i>Juncus balticus</i> - (<i>Juncus mexicanus</i>) Association	14.0%	100%	3	0
55131	<i>Salix lasiolepis</i> Association	100%	100%	4	0
55221	<i>Typha domingensis</i> Association	100%	100%	2	0
63120	<i>Distichlis spicata</i> Alliance	47.6%	50.0%	30	15
71100	CA Cliff, Scree & Rock Vegetation Group	49.0%	100%	26	0
71121	<i>Dudleya greenei</i> Alliance (provisional)	100%	40.0%	5	3

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