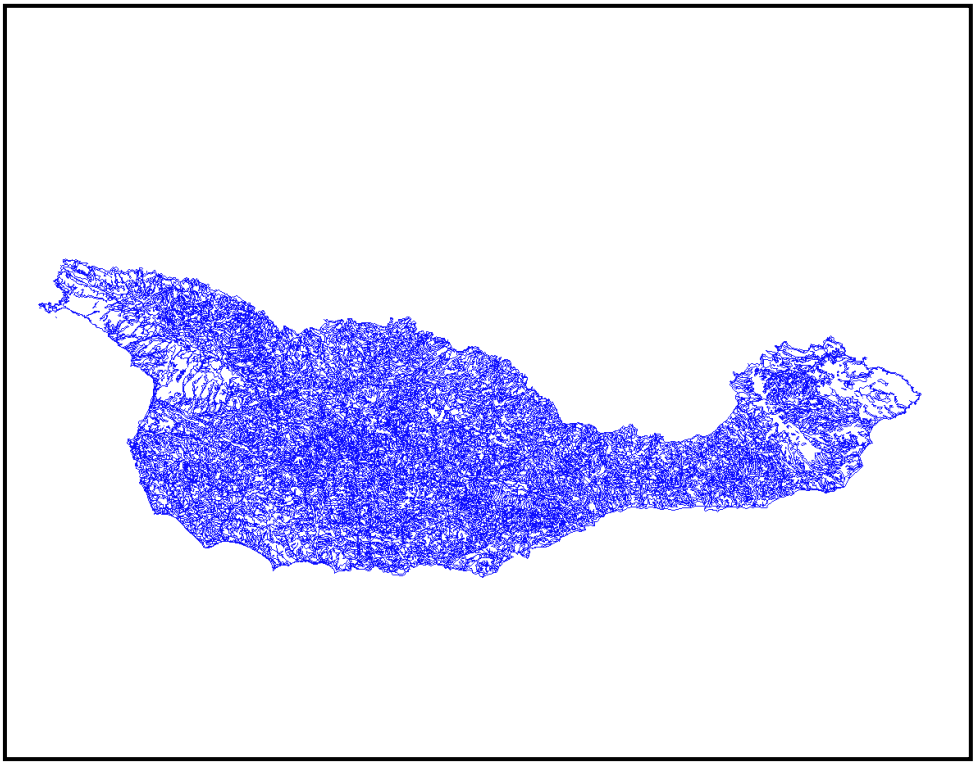
SANTA CRUZ ISLAND PHOTO INTERPRETATION AND MAPPING CLASSIFICATION REPORT



Prepared for The Nature Conservancy

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THE NATURE CONSERVANCY
SANTA CRUZ ISLAND
VEGETATION MAP FINAL REPORT

I. INTRODUCTION

Aerial Information Systems, Inc. (AIS) was contracted by The Nature Conservancy (TNC) to create a vegetation map of Santa Cruz Island (SCI). The study area is approximately 62,000 acres (96 square miles).

Santa Cruz Island is divided between TNC and the National Park Service (NPS). TNC owns and manages the western 76% of the island; the eastern 24% is owned and managed by the NPS.

Santa Cruz is the largest island off the coast of California. Located between Anacapa and Santa Rosa Islands, it lies from 19-25 miles off the adjacent mainland coast between Ventura and Santa Barbara.

The scenic beauty of Santa Cruz is reflected in its many landforms; rugged mountain ranges, the highest peaks on the Channel Islands, deep canyons, a central valley, year-round springs and streams, plus 77 miles of craggy coastline cliffs, giant sea caves, pristine tidepools and expansive beaches. Lying directly on the boundary between cold northern and warm southern waters, this island hosts unique plant, animal, and marine communities representing nearly 1000 miles of coastline (NPS, 2005). Santa Cruz is the most rugged and topographically diverse of the Northern Channel Islands dominated by two longitudinal ridges (the North and South ridges) running in an east-west direction and intervening valley (the Central Valley), which is 12.5 miles long. (Junak, 1995)

During the last 150 years, the composition and distribution of vegetation on Santa Cruz Island has been greatly altered by large numbers of feral grazing animals, cultivation, disturbance, and the introduction of alien plant taxa (Brumbaugh, 1989a, Hochberg et al.,1980, Leishman, 1981.) Only in the last decade has plant life begin to recover since the last grazing activities on the island ceased. Damage from grazing related activities is especially evident on the eastern half of the island, and is also prevalent on the west side, though to a lesser degree.

Since 2006, several thousand feral pigs have been fully eradicated from the island and signs of recovery are already noted in the increased wildflowers this spring (March 2007), including some fairly extensive stands of *Dodecatheon* on the isthmus. Recovery from the animal's rooting damage is already noticeable, especially under the canopies of oaks in grassy settings.

In addition to mapping the floristic composition of the island, AIS has mapped cover density for each of the major plant life forms (conifers, hardwoods and shrubs) associated with the mapped vegetation stand. It is hoped that this will provide a useful recovery-monitoring tool in assessing the increased woody vegetative components since the time grazing-related activities and feral pig damage have stopped.

II. VEGETATION MAPPING

PHOTO INTERPRETATION MAPPING CRITERIA

The AIS photo interpretation (PI) mapping criterion contains a set of decision rules that are used to ensure accuracy and maintain consistency of vegetation attributes including type, densities and fennel component modifier. This criterion assists the user in understanding the characteristics, definition, and context for each vegetation community.

Minimum Mapping Unit - Vegetation Complexing Issues and Inclusions

A general guideline of ½ hectare is used as a minimum polygon size for delineating a visible alliance or vegetation mapping unit. Exceptions to this minimum mapping unit (MMU) do occur, and the following types are mapped down to ¼ hectare:

- Ironwood
- Fremont and black cottonwood
- Big leaf maple stands
- Vernal ponds and seeps
- Giant wildrye
- Saltgrass
- Sea blite-San Miguel island locoweed
- Tejon milk aster
- Bracken fern
- Coastal salt pan vegetation
- Sliver beachbur-beach sand-verbena
- Australian saltbush
- Harding grass
- Water bodies
- Wetlands
- Land use

It is important to note that small inclusions of vegetation communities that may exceed ½ hectare when ecotones and gradations are included are a normal part of any vegetation map. The vegetation boundaries delineated on the digital imagery represent the photo interpreter's estimate at defining the modal break point between two communities, whether at a detailed association level of mapping or at a more general habitat level. When assessing the accuracy of a vegetation polygon, it is important to review the entire polygon for its accuracy, not just a small sample within that unit.

Aggregation

Aggregation of multiple vegetative classes is necessary when vegetation types present within a polygon fall below the resolution of the minimum mapping unit of 0.5 ha. Examples are listed below:

- Like life forms are aggregated together; tree dominated types are aggregated with other tree dominated types, shrub types with other shrub types and herbaceous types with other herbaceous vegetation types.

- If possible, wetland vegetation types generally should not be aggregated with upland types, even if they are in the same life form.

- If a unit that is below minimum mapping resolution is completely surrounded by another vegetation type, the unit is aggregated with the surrounding vegetation.

Density

Density, also referred to as vegetative cover, is a quantitative estimate of plant cover derived from viewing the aerial photography in stereo magnification. For this project, each polygon has 3 different densities that are assigned: conifer, hardwood and shrub. The three densities illustrate what life forms are present and the associated vegetative cover that occurs within a polygon.

Photo interpreters use six categories to define density or vegetative cover:

1 = Greater than 60%
2 = 40-60%
3 = 25-40%
4 = 10-25%
5 = 2-10 %
9 = Not applicable

It is important to note that photo interpreters can only accurately quantify the vegetation that is visible on the aerial photography. Using aerial photography at scales smaller than about 1:12000 (the SCI aerial photography is 1:12000), photo interpreters generally cannot see the amount of vegetation which is obscured by a higher canopy, regardless of its life form; therefore, total vegetative cover may differ from assessments done on the ground by field crews. Understory vegetation that is not visible on the aerial photograph cannot be quantified when assigning the total cover of vegetation for that polygon.

Density Mapping Criteria

The following guidelines are followed when assigning the density to a polygon:

- To determine the density or vegetative cover, photo interpreters assign percentages to the different life forms visible on the aerial photo, including non-vegetated areas. The total percent cover of conifer trees, hardwood trees, shrubs, herbaceous and non-vegetated should add up to 100%. The density percentages are then converted into the appropriate density categories (see above section for these categories).

- Non-vegetated areas are not coded in the database unless they meet the minimum mapping resolution for the study area and can be mapped as a stand-alone polygon. Otherwise, it is assumed that all vegetation polygons contain non-vegetated areas.

- The photo interpreters consider the coverage pattern of the life form before assigning a density code to the polygon. Estimating densities is more straightforward when plants occupying the same strata are evenly distributed throughout the polygon. However, when polygons contain populations of plants that are clumped or occurring only in portions of the polygon, the photo interpreter must also consider the area that is not occupied by plant cover when determining total density. To ensure consistency, it is helpful to count the plants in polygons with clumped and unevenly distributed vegetation and then compare them to similar sized polygons with an even distribution of plant cover.

- Vegetation stature and the scale of the aerial photography determine the visibility of individual plants. Trees are usually visible as individuals, and with larger scale photography, so are shrubs. However, grasses are rarely seen as individual plants, regardless of the scale of the photography.

- In the case of trees and shrubs, the percent cover at a density break is adjusted downward. If the percent cover is at about 25%, the polygon is assigned a density category of sparse (10-25%) instead of dispersed (25-40%).

- Dry grasses tend to be less dense than they appear on the aerial photography. To more accurately depict the densities, the percent cover for dry grasses is adjusted downward. For example, if the percent cover falls at the lower end of a density class, the polygon should be assigned the next density class down. For example, if the percent cover is 25%, the polygon should be assigned a density category of sparse (10-25%) instead of dispersed (25-40%).

- The date that the aerial photography is flown also influences the density assigned to vegetation types, especially for herbaceous dominated vegetation types. Subsequent field verification and accuracy assessments must take into consideration the following factors that can cause apparent discrepancies between the densities evident on the photo and those visible in the field:

    - Seasonality - The density of most herbaceous plants is variable due to their annual growth cycle. Depending on the season the aerial photography was taken, a mapped unit could show a different density on the aerial photographs than is observed during an on-site visit at a different time of the year. Another effect of seasonality is leaf on/off conditions. Photos of forest or woodland areas with leaf on conditions obscure the understory. Photos of leaf off conditions would allow photo interpretation of the understory, but make it difficult to identify the overstory species since there is no foliage present.

    - Annual variability - The environmental conditions at the time of the photography (wet vs. drought years, flooding, etc.) may affect the densities seen during the on-site field visits.

In addition to the above guidelines, AIS established a set of rules to follow when considering the three different densities for conifer, hardwood and shrub components, as well as assigning vegetation codes:

1. For the polygon to be assigned a conifer dominated vegetation code, then the density of the conifer component in the polygon must be greater than 10%, regardless of the density of the hardwoods and/or shrubs.
2. For the polygon to be assigned a hardwood dominated vegetation code, then the density of the hardwood component must be greater than 10%, regardless of the shrub density, while the conifer density must be less than 10%.
3. For the polygon to be assigned a shrub dominated vegetation code, then the density of the shrub component must be greater than 10% and the densities of the hardwoods and the conifers must each be less than 10%.
4. There are a few vegetation types that are an exception to the rule for assigning a shrub dominated vegetation code. These types are coastal bluff scrub mapping unit (3301) and inland bluff scrub mapping unit (3303). In these mapping units, the densities of the conifers and hardwoods must each be below 10% (although they are usually not present in these vegetation types), but the shrub density can also be below 10%.
5. For the polygon to be assigned a landslide code (9410), cliffs-rock outcrops-steep eroded cliffs (9420) or streambeds and flats code (9430), all the densities within the polygon must each be less than 10%. These mapping types are typically very sparse or non-vegetated.
6. For the polygon to be assigned a land use category (e.g. 9100,9200, or 9600) then all of the densities are coded as not applicable even if vegetation is present in an urban context.
7. For a polygon to be coded as water, all the densities are coded as not applicable.

Formation/ Alliance / Association / Mapping Unit Assignments

The assignment of alliances to the vegetation is based on the California Native Plant Society's book titled Manual of California Vegetation, by John O. Sawyer and Todd Keeler-Wolf (1995). Normally, associations must be supported with several surveys taken in the field by collecting either rapid assessment plots or more comprehensive releve plots, and the data then run through a vegetation analysis classifier program such as Two-way Indicator Species Analysis (TWINSPAN). Results from the program are then analyzed and unique floristic communities are then described and placed into a key. The results are variants within the alliance, which may be defined as an association. Associations may be defined by key indicator species, which may not be visible to the photo interpreter.

Mapping units which are more specific than alliance types are derived for vegetation types that could be distinguished on the imagery below the alliance level (sub alliance mapping units) or that cannot be defined in the field into any given alliance (habitats, stands, etc.). Mapping units which are more general than alliance types may be noted as two or more alliances or "superalliances" which commonly co-occur in the study such as coyote brush and willow. Other mapping units may be more habitat derived such as coastal bluff scrub, which may encompass a number of alliances.

The use of formation level mapping units (such as 3000 – depicting chaparral) were used when photo interpreters could not discern species dominance due to a number of factors including small stand size, disturbance, young trees or shrubs not exhibiting typical photo signatures and where species could be identified but not keyed to a finer mapping category.

SANTA CRUZ ISLAND SPECIFIC MAPPING PROTOCOLS AND CRITERIA

To accommodate some of SCI's serious invasive vegetative issues, every effort was made to delineate non-native stands of Harding grass, fennel, Australian saltbush and eucalyptus. In the future, this map will be used as a baseline for mapping an additional fifty or so invasive species, which cannot be detected through photo interpretation efforts alone.

In addition, wetlands were delineated below MMU when visible on the photography, or substantiated with field efforts. Riparian vegetation such as big leaf maple, Fremont cottonwood and black cottonwood trees were also mapped below MMU when plot data supported it. Linear wetlands that were often extremely narrow were also delineated when visible on the photography.

Some vegetation types were mapped based on data from field plots, field reconnaissance or other source material. Several rare plant communities, such as canyon live oak, were derived in part from the Vegetation of Santa Cruz Island map which was produced in 1985 by Richard A. Minnich. The vegetation types that were mapped with the aid of field related or reference data are noted below:

- St. Catherine's lace (ground plot data)
- Canyon live oak (Vegetation of Santa Cruz Island Map, R. Minnich 1985)
- Big Leaf Maple (Flora of Santa Cruz Island, Junak 1995)
- Vernal Pools (USGS rapid assessment plot data)
- Black and Fremont Cottonwood (Flora of Santa Cruz Island, Junak 1995)
- Salt Grass (Flora of Santa Cruz Island, Junak 1995)

Fennel Modifier

Since fennel is one of the most aggressively spreading and invasive plants located on the island, photo interpreters attempted to delineate fennel where it was seen on the aerial photography. The base imagery (IKONOS) yielded little to no reflectance of the fennel, so it was virtually impossible to use this imagery to map the fennel. The aerial photographs were more helpful in mapping the fennel, but since they were taken in November when the fennel was dead, all the photo interpreters could see were large stands of dead stalks. Plot data was also used as a basis and extrapolated in some areas, but the photo interpreters could also identify the larger stands without the aid of plot data. When a polygon was dominated by fennel, it was either assigned the fennel vegetation code (4301) and given a fennel component modifier of 3 (severe), or assigned a vegetation code other than fennel with a fennel component modifier of 3. The fennel component modifier list is below:

1 = Minimal: Generally less than 5% cover of fennel in the polygon. Photo interpreters may or may not be able to detect these small amounts, and ground based information is often necessary in assigning a fennel modifier of 1.
2 = Moderate: Approximately 5-10% cover of fennel over most of the polygon. Polygons with this density are visible on the aerial photography.
3 = Severe: Over 10% cover of fennel is in the polygon. Fennel is often a co-dominant to other herbaceous vegetation.

PROJECT MATERIALS

The following is a list of materials used for the SCI mapping project:

Digital Imagery and Aerial Photography

- IKONOS IMAGERY
  - Digital
  - Scale = meter
  - Available in natural color and color-infrared (CIR)
  - Date of photography = April 2005
- Air Photo USA
  - Digital
  - Scale = meter
  - Natural color
  - Date of photography = summer 2002
- Aerial photographs from I.K. Curtis
  - 158 9x9 diapositives used for mapping
  - Nominal scale = 1:12000
  - Natural color
  - Date of photography = November 2005

There were two sets of digital imagery used for this project. The base imagery for this project is 1-meter resolution satellite imagery from IKONOS, which is available in both natural color and color-infrared, and was taken in April 2005. AIS used both the natural and the CIR imagery from IKONOS for identifying different species. The other set of digital imagery that was used as ancillary data came from Air Photo USA. The digital 1-meter natural color aerial photography was taken in summer of 2002.

Although the base imagery for the final mapping was the IKONOS imagery, there was another set of imagery used for the initial photo interpretation delineations, which were made on frosted mylar sheets that were placed over 9x9 aerial photograph diapositives. Approximately 158 1:12,000 natural color 9x9 aerial photograph diapositives were used to interpret the vegetation on SCI. The aerial photography used for the initial photo interpretation delineations was flown in November 2005. Conditions in November were in mostly leaf on for most of the cold season deciduous species, so it was useful for identifying the deciduous plants. Late season shadowing on the aerial photographs, especially on the north facing slopes, required using the digital imagery for the mapping in the areas that were obscured by shadows on the aerial photographs. The digital imagery, which was flown in spring and summer conditions, was also useful for making breaks in the herbaceous types.

Basemap

The base imagery for this project is the IKONOS imagery, however, the project was divided into separate pieces according to the USGS digital orthophoto quarter quadrangles (DOQQ) that cover the island. This dividing of the island into separate pieces facilitated more than one person working on it at the same time. Upon completion, the DOQQ pieces were joined into one edgematched coverage. This process is discussed in the data conversion section of this report.

Ancillary Data
The ancillary data used by AIS during the SCI project is listed below.

- Vegetation of Santa Cruz Island Map, by Richard Minnich
- Shaded-Relief Map of Santa Cruz Island, by Steve Junak
- A Flora of Santa Cruz Island, by Steve Junak
- Geologic Map of Western Santa Cruz Island, by Thomas Dibblee, Jr.
- Geologic Map of Eastern Santa Cruz Island, by Thomas Dibblee, Jr.
- USGS Releves 2002-2003
- Field observations (2006) from Coleen Cory
- NPS Vegetation transects
- TNC Klinger Vegetation Bird Transects
- NPS Rare Weedy Plants (Polygons and Points)
- SCI Vegetation Map, by Violet Gray
- GIS data from TNC includes:
    - Streams
    - Springs
    - Wet Points
    - Contours
    - Geology
    - Airstrips
    - Place names
    - Shoreline
    - Watershed

PHOTO INTERPRETATION MAPPING PROCEDURES

There are four major tasks associated with the photo interpretation phase of the SCI vegetation mapping project:

- Field reconnaissance
- Photo interpretation of vegetation
- Data conversion (rectification of vegetation delineations)
- Field verification

Both the photo interpreters and the project field ecologist perform the field reconnaissance and verification tasks as a team, while the photo interpreters are solely responsible for the vegetation interpretations and data rectification.

AIS conducted the field reconnaissance, photo interpretation, data conversion efforts and field verification. The TNC ecologists accompanied AIS on both the reconnaissance and verification efforts.

FIELD RECONNAISSANCE

The field reconnaissance visit serves two major functions. First, it allows the photo interpreter to key the signature on the aerial photos to the vegetation on the ground at each site. Second, the photo interpreter becomes familiar with the flora, vegetation communities and local ecology that occur in the study area. Field ecologists that are familiar with the local vegetation and ecology of the study area are present to help the photo interpreter understand these elements and their relationship with the geography of the study area.

AIS performed two field reconnaissance trips to SCI. In July 2006, the AIS Photo Interpreters and the Senior Ecologist from California Department of Fish and Game (Todd Keeler-Wolf) joined the TNC staff (Coleen Cory, Brian Cohen) to visit the entire west side as well as the isthmus (the TNC side of the island). In August 2006, the AIS Photo Interpreters and the Senior Ecologist from California Department of Fish and Game visited the east side of the island, which is the NPS side.

Prior to the field reconnaissance trip, the AIS photo interpreter performs several in-house tasks in order to facilitate a more organized trip. Field routes are planned to accommodate a variety of factors including: maximizing the number of vegetation communities and elevation zones visited, responding to any recommendations of project staff, addressing time constraint considerations, and accessibility. The 9 x 9 aerial prints along the selected routes are prepared with an acetate field overlay. Location features such as trails and place names are drafted onto the overlays to aid in navigation. There were no aerial photograph prints from the November 2005 overflight available, so AIS made hard copies of the aerial photo diapositives in order to use them in the field during the reconnaissance effort.

Each aerial photo is reviewed under a stereoscope to choose several things, including: representative signatures of different vegetation types; geographic variables (% slope, aspect, shape of the slope, elevation); and other abiotic variables noted on the photography. Field check sites and associated notations are drafted onto the field overlays. Multiple sites are chosen to provide alternatives if one or more sites prove inaccessible. The hard copy aerial photograph prints made by AIS, acetate overlays and associated topographic sheets are arranged in packets for the field team.

Field site numbers are annotated directly onto the photo field acetate overlay, thereby correlating the field site to a specific location and photo signature. A field notebook is used to record pertinent information (canopy dominance, understory species present, abiotic features, disturbance history) for each site visited. Color ground photos are taken with a digital camera at selected locations and are later compared to the aerial photographs and the field site notes. Additional field sites include areas encountered in transit between initially selected sites, areas of noteworthy or unusual significance, and other vegetation types the photo interpreter or field ecologist deem important.

A preliminary mapping classification and PI signature key is then developed using information derived from the field reconnaissance and any existing field plot data.

PHOTO INTERPRETATION OF VEGETATION

Photo interpretation is the process of identifying map units based on their photo signature. All land cover features have a photo signature. These signatures are defined by the color, texture, tone and pattern they represent on the aerial photography. By observing the context and extent of the photo signatures associated with specific vegetation types, the photo interpreter is able to identify and delineate boundaries between plant communities or signature units. Environmental factors such as elevation, slope, and aspect also play an important part of the photo interpretation decision-making process.

Each photo is prepared with a 9”x9” frosted mylar overlay for the photo signature delineations. Photo overlays are pin-registered to the photos and project labels are affixed to each overlay identifying the photo number, status of work, and photo interpreter responsible for that task. Study area boundaries are drafted onto each photo overlay, defining the area within the photograph to be interpreted. The study area boundaries are edgematched to adjacent photos to ensure complete coverage.

Additional collateral sources (existing vegetation maps, supplemental imagery, soil data, plot data, etc.) can be of great utility to the photo interpreter. Prior to the PI effort on the photo, this ancillary data is added to the mylar overlay by the photo interpreter in order to document all locations and information within the study area on an aerial photograph. Understanding the relationship between the vegetation units and the environmental context in which they appear is useful in the interpretation process. Familiarity with regional differences also aids interpretation by establishing a context for a specific area.

Using a mirror stereoscope, with a 3X ocular lens, photo signature units are delineated onto the mylar overlays. These initial photo delineations are based on a number of signature characteristics including color, tone, texture, relative height and density. Attribute codes (mapping classification types, densities and fennel component modifiers) are assigned to each polygon and annotated onto the mylar overlay. The vegetation polygons and codes are edgematched to the adjoining photo overlays. Areas of land use are also mapped during the mapping of the vegetation units.

The PI effort is conducted in accordance with the preliminary mapping classification created as a result of the field reconnaissance trips in addition to the criteria for defining each community or alliance. Any questionable photo signatures encountered during this phase of the mapping effort were sent to the TNC Field Ecologist (Coleen Cory). This required her to either use her existing knowledge of the area or go out into the field to the site in question to get an answer.

Mapping Resolution

Photo interpretations were done using aerial photography at a scale of 1:12000 (1" = 1000 feet). Photo interpreters used 3X ocular lenses to enhance line detail to a scale of approximately 1:3000. Viewing the final rectified linework over imagery at scales larger than 1:3000 may show spatial errors, which are beyond the resolution of the input scale at which the interpretation was originally performed.

QUALITY CONTROL OF THE PHOTO INTERPRETATION

A separate quality control step is performed for each photo upon completion of the photo interpretation. The senior photo interpreter reviews each photo for map unit delineation, PI signature code, density codes and fennel modifier accuracy. Each photo overlay is checked for completeness, consistency, and adherence to the mapping criteria and guidelines established by AIS.

FIELD VERIFICATION

The mapping is followed by a final field verification trip designed to confirm that the vegetation units were mapped correctly. Any outstanding photo interpretation related questions are also addressed during the visit. The field verification trip for SCI occurred in March 2007 with the Senior Photo Interpreter from AIS (John Menke) and the TNC Field Ecologist (Coleen Cory).

FINAL QUALITY CONTROL OF THE PHOTO INTERPRETATION

After the field verification effort is complete, the senior photo interpreter corrects inaccurate calls and extrapolates to other possible existing errors of similar photo signature correlates. A final in-house QC is then performed on the aerial photos in the study area.

III. DATA CONVERSION

The following section outlines the data automation procedures required to convert the hand-drafted vegetation map units to a digital format rectified to the DOQQ grid with the IKONOS imagery as the base.

DATA AUTOMATION

Data automation is conducted using Mono Digitizing Stereo Digitizing (MDSD) software. The first step of the procedure involves the creation of control points. Control points are locational points identified both on the IKONOS imagery and the aerial photography that are identified and input into an ARC/INFO point coverage.

The MDSD software used to capture the vegetation linework automatically georeferences the data into real world coordinates. By using the control points generated in the previous step each photo is registered to the IKONOS imagery. Once each photo is georeferenced, the lines are then digitized. The digitized lines are stored in an MDSD outfile format that are then converted to a coverage using ARC/INFO.

DATA RECTIFICATION

The study area is divided into different pieces based on the DOQQ grid. The DOQQ imagery itself is never used; the IKONOS imagery is used instead. The DOQQ grid is only used as a helpful way to divide the project into different pieces so that more than one person can work on it at once.

Coverage linework from each aerial photo is rectified to the IKONOS imagery. The coverage, containing polygons and codes, is checked for open polygons, data registration, and any spatial edgematch problems between photos. Registration quality depends on the accuracy, quantity, and distribution of the control points. Spatial refinement is performed in ARCEDIT sessions using various user-defined tools. Lines depicting boundaries representing minimal ecotones (for example – land use interface, water bodies, life-form interface) are refined.

POLYGON ATTRIBUTE ASSIGNMENT

During the data rectification step, label points are created and coded for each map unit. The vegetation mapping type, conifer density, hardwood density, shrub density and fennel component modifier codes are input for each polygon (see Appendix A for SCI Mapping Classification). Automated quality control measures that AIS created, such as Codecheck and code frequency programs are run to check for code validity.

CODE VERIFICATION AND EDIT PLOT QUALITY CONTROL

A hard copy edit plot of the converted spatial data is produced for each DOQQ and compared to the aerial photo overlays. Each plot is checked for cartographic quality of the arcs defining the polygon features and the accuracy of the label assignments. Line and code corrections are noted directly on the edit plot. All edit plots are edgematched to verify line and code accuracy across the entire project area. Processors conduct interactive ARCEDIT sessions to make the necessary corrections to the coverages.

FINAL QUALITY CONTROL OF THE FINAL VEGETATION MAP

The individual coverages created for each DOQQ are then joined into a single seamless vegetation coverage for the project study area. This final vegetation layer is examined by the senior photo interpreter. Final checks are conducted to test for invalid codes, duplicate labels, missing or extra lines, edgematch problems, verify the registration of linework to the IKONOS base imagery, and to review the distribution of species mapped within the study area.

IV. APPENDICES

APPENDIX A

Santa Cruz Island Final Mapping Classification

Updated March 27, 2007

CLASS

Formation

Mapping Units

Alliance (Code ending in a zero)

Sub Alliance – Potential Associations

1000 – 2000 FORESTS & WOODLANDS

1100 – Temperate Broadleaf Sclerophyll Evergreen Forests
- 1110 – Ironwood Alliance
- 1120 – Eucalyptus Stands Mapping Unit
- 1130 – Island Cherry - (Island Scrub Oak – Toyon)

1200 – Temperate Needleleaf Evergreen Forests
- 1201 – Introduced Pines or Cypress Mapping Unit
- 1210 – Bishop Pine Alliance
  - *1211 – Bishop Pine –(Island Oak) / (Summer Holly – Toyon)*
  - *1212 – Bishop Pine / California Huckleberry – (Summer Holly-Toyon)*
  - *1213 – Bishop Pine / Island Scrub Oak – Island Manzanita*
  - *1214 – Bishop Pine / Island Scrub Oak – (McMinn's Manzanita – Woolly Leaf Manzanita)*
  - *1215 – Bishop Pine – Coast Live Oak / (Island Scrub Oak–Island Manzanita)*

1300 – Temporarily Flooded Cold Season Deciduous Forests
- 1310 – Big Leaf Maple Alliance
- 1320 – Fremont Cottonwood – Black Cottonwood Superalliance

1400 – Cold Season Deciduous Forests

2100 – Xeric Sclerophyll Evergreen Woodlands
- 2110 – Coast Live Oak Alliance
- 2120 – Canyon Live Oak Alliance

2200 – Cold Season Deciduous Woodlands

3000 – SHRUBLANDS

3100 – Temperate Broadleaf Sclerophyll Evergreen Shrublands (Chaparral)
- 3101 – McMinn's Manzanita - (Woolly Leaf Manzanita)
- 3110 – Chamise Alliance

- 3120 – Island Scrub Oak Alliance
  - 3121 – Island Scrub Oak – Island Manzanita (Chamise - Bigpod Ceanothus)
  - 3122 – Island Scrub Oak – Summer Holly
  - 3123 – Island Scrub Oak – Island Ceanothus
  - 3124 – Island Scrub Oak – (Island Manzanita – Chamise–Bigpod Ceanothus) Maritime
  - 3125 – Island Scrub Oak – McMinn's Manzanita – (Woolly Leaf Manzanita – Chamise)
  - 3126 – Island Scrub Oak – Coastal Sage Scrub Transition
- 3130 – Island Manzanita Alliance
- 3140 – Birch-leaf Mountain Mahogany Alliance
- 3150 – Lemonadeberry Alliance

3200– Temperate Microphyllous Evergreen Shrublands

- 3240 – Coyote Brush Alliance
- 3250 – Mulefat Alliance

3300 – Temperate Xeric Mixed Drought-Deciduous Shrublands

- 3301 – Coastal Bluff Scrub Habitat
- 3302 – Australian Saltbush Mapping Unit
- 3303 – Inland Bluff Scrub Habitat
- 3310 – California Sagebrush Alliance
  - *3311 – California Sagebrush Pure Stands*
  - *3312 – California Sagebrush – Santa Cruz Island Buckwheat*
  - *3313 – California Sagebrush – Lemonadeberry*
  - *3314 – California Sagebrush - Coastal Bluff Scrub Transition*
  - *3315 – California Sagebrush – Island Bush Monkeyflower*
  - *3316 – California Sagebrush – Coyote Brush*
- 3320 – Santa Cruz Island Buckwheat Alliance
- 3330 – Saint Catherine's Lace Alliance
- 3340 – Island Bush Monkeyflower - Island Bristleweed – Paintbrush Mapping Unit

3400 – Temporarily Flooded Cold Season Deciduous Shrublands

- 3401 – Mixed Arroyo Willow – Mule Fat Mapping Unit
- 3410 – Arroyo Willow Alliance

4000 – HERBACEOUS

4100 – Saturated Temperate Perennial Graminoids
- 4101 – Bulrush – Cattail Mapping Unit

4200 – Seasonally or Temporarily Flooded Graminoids
- 4201 – Seasonally or Temporarily Flooded Springs, Seeps, Vernal Ponds Mapping Unit

4300 – Tall Temperate Annual Graminoids
- 4301 – Fennel Mapping Unit
- 4310 – California Annual Grasslands Alliance
- 4320 – Giant Wildrye - Creeping Wildrye Superalliance

4400 – Tall Temperate Perennial Graminoids
- 4401 – Coastal Salt Pan Mapping Unit
- 4402 – Needlegrass
- 4410 – Silver Beachbur - Beach Sand-Verbena Alliance
- 4420 – Harding Grass

4600 – Tidally Flooded Grasslands
- 4610 – Saltgrass Alliance

4700 – Tall Temperate Forblands

- 4701 – Sea Blite – San Miguel Island Locoweed
- 4702 – Tejon Milk Aster - (Coastal Goldenbush)
- 4710 – Bracken Fern Alliance

9000 – LAND USE – Sparsely or Unvegetated

9100 – Built-up
9200 – Agriculture
9400 – Sparsely Vegetated or Unvegetated Areas
- 9410 – Landslides
- 9420 – Cliffs – Rock Outcrops – Steep eroded slopes
- 9430 – Stream Beds and Flats

9500 – Water
9600 – Planted trees & shrubs

9999 – Field questions or Unknown

Cover Class Density Values

Density values given for three fields:
- Conifer
- Hardwood
- Shrub

Density Values

1 = >60%
2 = 40-60%
3 = 25-40%
4 = 10-25%
5 = 2-10%
9 = Not Applicable

MODIFIERS

Fennel Component:
- 1 = Minimal – 2-5%
- 2 = Moderate – 5-10%
- 3 = Severe - >10%
- 9 = Not applicable

APPENDIX B

Santa Cruz Island Photo Interpretation Descriptions

Santa Cruz Island Buckwheat - Photo by T. Keeler-Wolf

Note: The mapping units listed in this document are described based on how the photo interpreter mapped the vegetation and are not defined by plot (ground based) related information. They are derived from a combination of field reconnaissance used to train on air photo signatures, and knowledge from TNC and state ecologists.

Mapping types, which are finer than the Alliance Level (overstory dominance vegetation,) are not currently supported as Associations within the mapping classification and should at this time be designated as sub-alliance mapping units. After plot analysis and the development of a floristic classification, the types in the mapping classification should be cross-walked to the floristically defined associations.

Photo signatures are derived from 1:12,000 natural color 9" by 9" diapositives flown in November 2005 in early leaf-change conditions after a higher than normal rainfall season. Other data sets used to further train on signature to ground correlations include a digitally scanned air photo composite flow in summer 2002 and a 1 meter pixel based imagery flown in April of 2005. Aerial photo examples in this document are extracted from the imagery flow in the summer of 2002 and therefore photo signature will not correlate exactly to the November 2005 aerial photography.

1000 – 2000 FORESTS & WOODLANDS

1100 – Temperate Broadleaf Sclerophyll Evergreen Forests

1110 – Ironwood Alliance

Lyonothamnus floribundus Alliance

Mapping Description

Mapped in small to very small stands where *Lyonothamnus floribundus* dominates the hardwood canopy, generally as a sole component. Mapped in patches as small as ¼ acre. In some situations clonal patches, which are up to 20 meters apart, will be aggregated together into one mapping unit or polygon.

Environmental Settings

Mapped almost exclusively on mid to upper north facing, neutral to concave slopes that trend to be steep. Occasionally mapped on lower protected slopes, trending southerly.

Distribution

Found throughout the island, except extreme western and eastern portions. Stands are very common but small in size. Largest stands are in the higher elevation portions of the island.

Photo Interpretation Signature – Mapping Characteristics

Signature varies depending on health of the stand – clonal in appearance; appears not as bright as other hardwood species such as coast live oak. Signature variability in the stand is generally minimal, and the crown shape and size yield a fairly even texture throughout.

1120 – Eucalyptus Stands Mapping Unit

Eucalyptus spp. Stands Mapping Unit

Mapping Description

Mapped as pure stands where *Eucalyptus spp.* (primarily *E. globules*) is the sole component of the canopy layer.

Environmental Settings

Noted primarily in association with land use related features.

Distribution

Several stands noted, primarily in the Central Valley. Largest stands noted west of the UC research headquarters on the western side of the island and adjacent to the NPS headquarters on the eastern portion of the island.

Photo Interpretation Signature – Mapping Characteristics

Color is consistent within the stand and tends to be dull green, somewhat similar to ironwood. Crown size and shape is variable within the stand, unlike ironwood where crown shape and size yield a fairly even texture throughout.

1130 – Island Cherry – (Island Scrub Oak – Toyon)

Prunus ilicifolia subsp*. Lyonii – (Quercus pacifica - Heteromeles arbutifolia)*

Mapping Descriptions

Mapped in sparse settings where *Prunus ilicifolia* subsp. *lyonii* dominates or co-dominates the stand. *Quercus pacifica or Heteromeles arbutifolia* can be important subordinates to the tall shrub layer and can dominate over small areas of the mapped polygon.

Environmental Settings

Noted in steep north trending rocky settings or occasionally in minor draws as a co-dominate with *Quercus pacifica.*

Distribution

Uncommon or rare as mappable stands on major north trending slopes, especially south of the Central Valley.

Photo Interpretation Signature – Mapping Characteristics

Due to its location on steep, shady slopes and the overall sparse distribution of individuals in the stand, it is extremely difficult to discern on the aerial photography. Modeling of slope related features is used to aid in photo interpretation. *Prunus ilicifolia* tends to yield a brighter green signature than various scrub oak species and is usually taller.

1200 – Temperate Needleleaf Evergreen Forests

1201 – Introduced Pines or Cypress Mapping Unit

Introduced *Pinus pinea* or *Cupressus macrocarpa* Mapping Unit

Mapping Descriptions

Mapped in variable settings where either *Pinus pinea* or *Cupressus macrocarpa* dominate the stand as planted trees.

Environmental Settings

Associated with land use related features of historical interest.

Distribution

Uncommon, but small stands noted at Christy Ranch, Prisoners' Harbor, and Delphine's grove.

Photo Interpretation Signature – Mapping Characteristics

Broad spreading crowns are typical of Monterey cypress as noted in the above picture at Delphine's grove.

1210 – Bishop Pine Alliance

Pinus muricata Alliance

Mapped to the alliance level when stands are below about 1 hectare in size or where photo interpreters cannot distinguish the finer levels in the classification. Three large stands make up most of the acreage on the island: the Christy Pines, located east of the Christy Ranch; the Pelican Bay Pines, located between Prisoner's Harbor and Pelican Bay; and the China Harbor Pines, located south of China Harbor along East End Road.

1211 – Bishop Pine – (Island Oak) / (Summer Holly – Toyon)

Pinus muricata – (Quercus pacifica) / (Comarostaphylis diversifolia - Heteromeles arbutifolia)

Mapping Descriptions

Mapped in mesic settings where *Pinus muricata* dominates the conifer layer ranging in cover from an emergent tree layer of about 10% to a dense woodland occasionally up to 60% cover. Understory shrub layer can contain *Comarostaphylis diversifolia, Ceanothus arboreus* or *Heteromeles arbutifolia*. In several stands, *Quercus tomentella* can be a minor component to the overstory layer.

Environmental Settings

Found in more limited areas than xeric pine types, usually on north trending mid to lower concave settings.

Distribution

Most stands are found on north trending slopes of Christy canyon, but limited in extent elsewhere.

Photo Interpretation Signature – Mapping Characteristics

Pines are generally open in this type with shadowing and numerous breaks in the canopy, which yield a black signature. Mature individuals of *Quercus tomentella* are recognizable on the photography as a bright yellow-green large tree in the tall tree layer.

1212 – Bishop Pine / California Huckleberry – (Summer Holly – Toyon)

Pinus muricata / Vaccinium ovatum – (Comarostaphylis diversifolia - Heteromeles arbutifolia)

Mapping Descriptions

Mapped in sub mesic settings where *Pinus muricata* forms a dense component, often with over 80% cover. Understory shrub layer is not visible and *Vaccinium ovatum* is inferred as a diagnostic species in the understory.

Environmental Settings

Found on gentle upper slopes, trending north on neutral to slightly concave settings.

Distribution

Dense pine stands are not well developed and are isolated to the Christy pines stands. Mapped polygons are generally small in size.

Photo Interpretation Signature – Mapping Characteristics

Photo interpreters map to this type when pine stands are nearly closed and understory shrubs are generally not detectable on the aerial photography.

1213 – Bishop Pine / Island Scrub Oak – Island Manzanita

Pinus muricata / Quercus pacifica - Arctostaphylos insularis

Mapping Descriptions:

Mapped in xeric settings where *Pinus muricata* forms an emergent conifer layer of 10-20% cover (Occasionally as a sparse woodland between 20-40% cover) over a sparse to dense shrub layer generally consisting of *Arctostaphylos insularis* and/or *Quercus pacifica.* Other drier chaparral species including *Adenostoma fasciculatum* or *Ceanothus megacarpus* may form a minor component in the driest stands.

Environmental Settings

Found on gentle mid to upper slopes, and the best examples are observed on ridgelines and associated spurs on neutral to slightly convex settings.

Distribution

Common throughout stands west of Pelican Bay and in the Christy stands.

Photo Interpretation Signature – Mapping Characteristics

Sparse pines are difficult to distinguish, especially when small in stature. The pines in this type form at least a 10% crown cover.

1214 – Bishop Pine / Island Scrub Oak – (McMinn's Manzanita – Woolly-Leaf Manzanita)

Pinus muricata / Quercus pacifica – (Arctostaphylos viridissima - Arctostaphylos tomentosa)

Mapping Descriptions

Mapped in xeric settings where *Pinus muricata forms* an emergent conifer layer (occasionally as a sparse woodland with up to 40% cover), generally over a dense shrub layer containing *Quercus pacifica* and *Arctostaphylos viridissima.* Several stands may contain *Arctostaphylos tomentosa*, but are inseparable using the aerial photography.

Environmental Settings

Best examples are on gentle, mid to upper slopes in neutral to slightly convex settings. Occasionally on steeper protected slopes trending southerly.

Distribution

Mapped exclusively in the stands south of China Harbor.

Photo Interpretation Signature – Mapping Characteristics

It is not possible to distinguish *Arctostaphylos* species on the aerial photography, therefore this type is mapped based on modeling the presence of *Arctostaphylos viridissima,* which is the most likely species occurring in the China Harbor stand.

1215 – Bishop Pine – Coast Live Oak / (Island Scrub Oak – Island Manzanita)

Pinus muricata - Quercus agrifolia / (Quercus pacifica - Arctostaphylos insularis)

Mapping Descriptions

Mapped where hardwoods and conifers mix in a variety of settings. Either *Pinus muricata or Quercus agrifolia* can dominate the stand. Both species generally have at least 10% relative cover. Most stands are a woodland containing 10-50% tree cover with an open understory of shrubs and grasses.

Environmental Settings

Found in sub mesic and mesic settings, generally in low slope positions, occasionally adjacent to riparian vegetation in canyon bottoms. Occasionally mapped on gently sloping, north trending areas with a grassy understory.

Distribution

Most polygons are mapped in the pine stands west of Pelican Bay.

Photo Interpretation Signature – Mapping Characteristics

Quercus agrifolia is usually larger crowned and has a slightly brighter green signature than *Quercus pacifica.* In shady canyons it may be difficult to detect *Pinus muricata* where conifer cover is less than 20%.

1300 – Temporarily Flooded Cold Season Deciduous Forests

1310 – Big Leaf Maple Alliance

Acer macrophyllum Alliance

Mapping Descriptions

Mapped where *Acer macrophyllum* dominates the canopy layer. *Salix spp.* can be an understory shrub or tree.

Environmental Settings

Found in steep, narrow, north trending canyons with a significant watershed allowing for seasonal water flow.

Distribution

Mapped strictly based on ground assessments including plots and other surveys and only where visible on the aerial photography.

Photo Interpretation Signature – Mapping Characteristics

Photo interpretation signature not established due to limited aerial extent and rarity.

1320 – Fremont Cottonwood – Black Cottonwood Superalliance

Populus fremontii - Populus balsamifera

Mapping Descriptions

Mapped were *Populus balsamifera* or *Populus fremontii* range from a sparse emergent tree cover to a woodland (approximately 5-40% cover) over either a *salix spp.* understory or in a sparse riverbed setting.

Environmental Settings

Found in narrow canyons where water runs at least seasonally, but more frequently noted in broader flat canyons where water may be locally closer to the surface.

Distribution

Mapped almost exclusively west of the isthmus as small polygons in watersheds occurring both north and south of the Central valley.

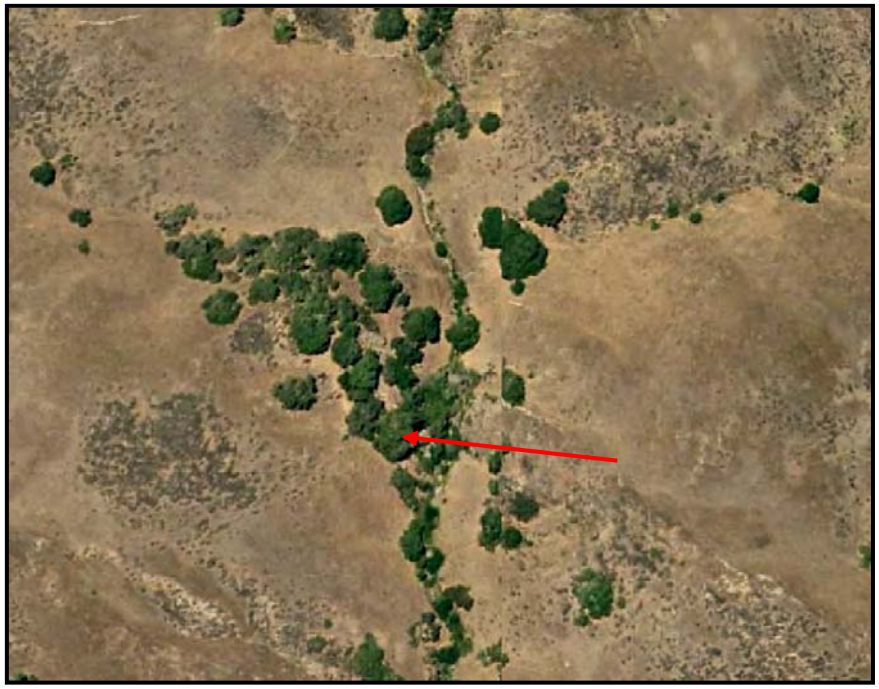
Photo Interpretation Signature – Mapping Characteristics

In addition to the environmental setting, leaf-change conditions in some locations aid the photo interpreter in mapping these two species that have large rounded crowns. Photo interpreters have no environmental or signature correlates to separate out the two species of cottonwood.

2100 – Xeric Sclerophyll Evergreen Woodlands

2110 – Coast Live Oak Alliance

Quercus agrifolia Alliance



Mapping Descriptions

Mapped only to the alliance level where *Quercus agrifolia* dominates the tree layer, usually in woodland settings with 25-60% cover. *Pinus muricata* can be a sparse (under 10% cover) emergent component to the oak canopy in the area west of Pelican Bay. Note that areas with >10% cover of pine would be labeled as type 1215. Settings vary considerably. At times the understory consists of a tall shrub layer of *Quercus pacifica*. Other settings include: oak woodlands over a grassy open understory; oaks in a mesic riparian setting, often with tall chaparral species such as *Ceanothus arboreus* and *Heteromeles arbutifolia;* or dense stands of pure coast live oak, occasionally over 60% cover.

Environmental Settings

Conditions vary from riparian to gently sloping ridgelines and spurs. Rarely noted on steep south trending slopes, but found occasionally on steep concave to neutral north facing slopes.

Distribution

Good representative samples are mapped west of the isthmus, especially in north trending canyons along the entire extent of the North Ridge. Smaller stands are noted in canyons south of the Central Valley.

Photo Interpretation Signature – Mapping Characteristics

Individual trees are large crowned, usually significantly larger than other species of oak. Not separable from the much rarer canyon live oak. *Quercus agrifolia* has a significantly brighter green signature than the drier *Quercus pacifica.* Both species have a well-defined crown. *Quercus agrifolia* also has a significantly brighter green signature than *Lyonothamnus floribundus.*

2120 – Canyon Live Oak Alliance

Quercus chryosolepis Alliance

Mapping Descriptions

Rare type, mapped only to the alliance level where *Quercus chryosolepis* dominates the tree layer over a grassy understory. *Quercus agrifolia* may share dominance in the stand or be nearby in adjacent stands.

Environmental Settings

Found on higher elevation steep upper north trending slopes.

Distribution

Mapped only in small stands along the upper most slopes of the North Ridge. Individuals noted elsewhere are too small to map.

Photo Interpretation Signature – Mapping Characteristics

Not discernable from *Quercus agrifolia*, and stands are too small and rare to derive any photo signature to ground correlation. Mapped based in part on the Vegetation of Santa Cruz Island map compiled by Richard A. Minnich, 1980 and on notes from A Flora of Santa Cruz Island by Steve Junak.

2200 – Cold Season Deciduous Woodlands

3000 SHRUBLANDS

3100 – Temperate Broadleaf Sclerophyll Evergreen Shrublands (Chaparral)

Polygons are mapped to this broad formation category in several situations: Where stands contain multiple co-dominants in which the photo interpreter cannot determine species dominance; where patches are too small to determine species dominance; or in post disturbance settings where individual plants are too young to determine species composition.

3101 – McMinn's Manzanita – (Woolly Leaf Manzanita)

Arctostaphylos viridissima – (Arctostaphylos tomentosa)

Mapping Descriptions

Mapped where *Arctostaphylos viridissima* or *A. tomentosa* dominates the shrub layer usually as a dense cover over 60%. Some disturbed ridgeline populations are mapped in more open settings. *Quercus pacifica* or *Adenostoma fasciculatum* can be a minor component to the stand. Several stands contain a sparse emergent overstory of *Pinus muricata*, generally less than 5% cover.

Environmental Settings

Mapped on gentle upper slopes, spurs and ridgelines.

Distribution

Mapped exclusively in the area between Prisoners' Harbor and China Harbor, mainly on upper slopes along the East End and Navy roads.

Photo Interpretation Signature – Mapping Characteristics

Species of manzanita are not separable using the aerial photography; two of the three species of manzanita, (*Arctostaphylos viridissima* and *A.insularis*) commonly found on the island have been mapped based on location. The third, (*Arctostaphylos tomentosa)* cannot be reliably mapped using location criteria. In general, manzanitas tend to have a well-defined crown edge, yield a smooth texture in dense stands and overall trend greener than oak or chamise on the aerial photography.

3110 – Chamise Alliance

Adenostoma fasciculatum Alliance

Mapping Descriptions

Mapped where *Adenostoma fasciculatum* strongly dominates the chaparral shrub layer in dense settings. Other species, especially *Ceanothus megacarpus* can be a component to the shrub layer. *Adenostoma fasciculatum* is often a component to other chaparral communities, especially the xeric *Quercus pacifica* types.

Environmental Settings

Mapped on extremely xeric, south trending, mid and upper slopes ranging from moderate to steep.

Distribution

As mappable units, these stands are limited in extent. The best stands are noted on slopes north of the Central Valley east of the Main Ranch.

Photo Interpretation Signature – Mapping Characteristics

In a mixed chaparral setting, *Adenostoma fasciculatum* is generally not discernable. Larger pure stands tend to have a less billowy texture than scrub oak, and texture throughout the stand remains fairly consistent. The color of *Adenostoma fasciculatum* trends slightly browner than scrub oak on the imagery.

3120 – Island Scrub Oak Alliance

Quercus pacifica Alliance

Mapped to the alliance level when stands are below about one hectare in size or where photo interpreters cannot distinguish at finer levels in the classification. Also mapped to the alliance level where *Quercus pacifica* is a sole or strong dominant to the shrub layer. Other scrub oak species including *Quercus dumosa* or *Q. parvula* or any cross-breeding variants are not discernable using the aerial photography, nor are they capable of being mapped through environmental modeling of any form and most likely are included in this alliance.

Quercus pacifica is common and widespread throughout the island in a variety of settings.

3121 – Island Scrub Oak – Island Manzanita (Chamise - Bigpod Ceanothus)

Quercus pacifica - Arctostaphylos insularis (Adenostoma fasciculatum - Ceanothus megacarpus)

Mapping Descriptions

Mapped where *Quercus pacifica* usually dominates the chaparral cover. Other chaparral species, especially *Arctostaphylos insularis* may co-dominate or, at times, locally dominate portions of the stand. *Adenostoma fasciculatum* and/or *Ceanothus megacarpus* are often components but generally minor except in the most xeric settings. Several stands mapped in grassy settings, especially in the eastern portion of the island.

Environmental Settings

Noted in xeric to extremely xeric settings on a variety of slopes that trend predominantly south to west.

Distribution

Probably the most widespread of the island scrub oak types. Good representative examples are found on slopes generally south of the South Ridge road and south facing slopes along the North Ridge.

Photo Interpretation Signature – Mapping Characteristics

Signature varies depending on species makeup; scrub oaks generally are a dull green to gray color with a billowy texture; *Ceanothus megacarpus* tends to have a light gray signature and *Arctostaphylos insularis* often yields a green signature with a smoother texture.

3122 – Island Scrub Oak – Summer Holly

Quercus pacifica - Comarostaphylis diversifolia

Mapping Descriptions

Mapped where *Quercus pacifica* dominates the canopy, often as a very tall shrub or small tree. *Comarostaphylis diversifolia* is present generally as a minor cover, also as a tall shrub or small tree. *Heteromeles arbutifolia* and or *Prunus ilicifolia* may also be present in the stand. Stands can be open with canopy gaps. Emergent *Pinus muricata* is occasionally a component in stands, especially at the western edges of the Christy pines. *Quercus agrifolia* or *Q. tomentella* may also be present in draws or coves as a minor hardwood component to this type.

Environmental Settings

Stands appear to take on the presence of a hardwood forest. The most mesic of the scrub oak types, stands are found on steep north trending protected slopes, and are often in cove-like settings.

Distribution

Uncommon type; As mappable stands, limited in distribution mainly to the western third of the island on slopes south of the Canada Christy drainage.

Photo Interpretation Signature – Mapping Characteristics

Difficult to interpret from other mesic chaparral containing no summer holly due to it's steep, shady northerly setting. May not be separable from types where *Ceanothus arborus* is the major co-dominate with *Quercus pacifica.* In Ideal settings, *Comarostaphylis diversifolia* gives off a somewhat bright green signature but not as bright as *Heteromeles arbutifolia* which often appears more of a yellow-green. Photo interpreters relied field plot and reconnaissance data for establishing signatures and environmental correlates.

3123 – Island Scrub Oak – Island Ceanothus

Quercus pacifica - Ceanothus arborus

Mapping Descriptions

Mapped where *Quercus pacifica* dominates or co-dominates the stand with *Ceanothus arborus*, both generally as tall shrubs. *Heteromeles arbutifolia* and or *Prunus ilicifolia* may also be present in the stand. *Quercus agrifolia* can be a sparse emergent hardwood to the stand, especially in canyon bottoms.

Environmental Settings

Mesic scrub oak type found on north trending canyons and upper coves on neutral to concave settings in a variety of positions from lower to upper slopes.

Distribution

Both common and widespread, stands are frequently adjacent to (usually downslope) the more xeric type 3121. This type is more common and better developed on the western side of the island.

Photo Interpretation Signature – Mapping Characteristics

Signature varies considerably depending on species makeup as well as slope characteristics, which influences the shadowing of an area. *Heteromeles arbutifolia* often appears as a tall shrub with a yellow-green color; *Prunus ilicifolia* usually yields a brighter green signature than *Quercus pacifica.* A much more common component, *Ceanothus arborus,* is a tall shrub that typically yields a silver-gray to a light blue color. *Ceanothus arborus* rarely clusters as extensive patches within the stand, so it appears to give a 'salt & pepper' like appearance on the aerial photography. This type often contains openings in the canopy due to tall shrubs falling, which results in variable shrub heights within a polygon. Very similar to type 3122.

3124 – Island Scrub Oak – (Island Manzanita – Chamise – Bigpod Ceanothus) Maritime

Quercus pacifica – (Arctostaphylos insularis - Adenostoma fasciculatum - Ceanothus megacarpus) Maritime

Mapping Descriptions

Mapped where *Quercus pacifica* generally co-dominates the stand with other chaparral species such as *Arctostaphylos insularis*, *Ceanothus megacarpus* or *Adenostoma fasciculatum* in a very low, wind-pruned growth form.

Environmental Settings

Mapped in a variety of slope settings where strong maritime weather pattern predominates most of the year.

Distribution

Mapped exclusively on the southwestern portion of the island extending from the Christy pines west to more protected settings near the coast.

Photo Interpretation Signature – Mapping Characteristics

Signature varies considerably depending on species makeup. It is extremely difficult to differentiate chaparral species in this stunted growth form. Wind pruned plants contain little or no dead stems and therefore all species appear much greener than growth forms occurring away from the maritime influence. *Heteromeles arbutifolia* is generally not as dramatically affected by wind as other species found in this type, so it tends to be slightly taller than the other species.

3125 – Island Scrub Oak – McMinn's Manzanita (Woolly Leaf Manzanita – Chamise)

Quercus pacifica - Arctostaphylos viridissima (Arctostaphylos tomentosa - Adenostoma fasciculatum)

Mapping Descriptions

Mapped where *Quercus pacifica* dominates or co-dominates the chaparral stand generally with *Arctostaphylos viridissima* or *A.tomentosa* (Note manzanita species are not separable using the aerial photography). Other chaparral species such as *Adenostoma fasciculatum* can be a minor component to the stand.

Environmental Settings

Mapped in slightly more mesic settings than stands containing pure *Arctostaphylos viridissima* or *A.tomentosa* generally on gently sloping mid and upper slopes. Stands can be extensive and usually form a dense cover of over 70%.

Distribution

Mapped based on photo signature and regional information regarding the distribution of *Arctostaphylos viridissima.* In general manzanita shrubs tend to have a smooth green signature with a well-defined crown edge. When mixing with the duller green to gray signature of *Quercus pacifica,* this type yields a variable signature pattern, depending on species dominance. Mapped primarily on the isthmus from the mouth of Canada Pomona to the China Harbor Pines.

Photo Interpretation Signature – Mapping Characteristics

Very similar in signature to type 3121 although not as variable since generally only two species co-dominate.

3126 – Island Scrub Oak – Coastal Sage Scrub Transition

Quercus pacifica - Coastal Sage Scrub Transition

Mapping Descriptions

Mapped where *Quercus pacifica* generally dominates the chaparral canopy, usually with a minor component of *Rhus integrifolia.* Coastal sage scrub species (CSS) usually are an important component to this type as an open to dense understory, with *Artemisia californica* the most common species in the CSS layer. Other CSS species such as *Eriogonium arborescens* can be a sparse component to the stand. Annual grasses can be an important component to this type.

Environmental Settings

Mapped in the most xeric settings for this alliance, often interfacing with dry CSS or inland bluff scrub communities. Common on steep south, east and west trending slopes not too far inland from the coast.

Distribution

Good representative stands occur on the southern canyons near the coast and on south facing slopes in the eastern portion of the Central valley. Most stands are within about ½ mile from the coast.

Photo Interpretation Signature – Mapping Characteristics

This type has a unique signature in that it shares characteristics from two major formations (drought-deciduous and sclerophyll shrubs) and varies considerably depending on formation dominance and species makeup. Signatures are typical for dry forms of *Quercus pacifica. Artemisia californica* generally yields a gray signature of varying tones. *Rhus integrifolia* usually contrasts with the associated oak, yielding a brighter green signature.

3130 – Island Manzanita Alliance

Arctostaphylos insularis Alliance

Mapping Descriptions

Mapped where *Arctostaphylos insularis* strongly dominates the stand, usually in very dense settings. *Pinus muricata* can be a sparse emergent to the chaparral canopy.

Environmental Settings

Mapped exclusively on ridgelines and associated spurs, rarely descending downslope.

Distribution

Most polygons are mapped on ridgelines south of the Central Valley, locally in sparser settings with a grassy understory along the spurs off the North Ridge. Replaced by type 3101 in the isthmus area.

Photo Interpretation Signature – Mapping Characteristics

Partially modeled on ridgelines and spurs. In general manzanita shrubs give off a green signature, medium in tone with a smooth texture where cover density is high. Stands commonly occur adjacent to type 3121 on higher ridgelines and spurs.

3140 – Birch-leaf Mountain Mahogany Alliance

Cercocarpus betuloides Alliance

Mapping Descriptions

Mapped where *Cercocarpus betuloides* dominates the stand, generally in sparse to moderate cover. Although it often forms a minor component to chaparral and riparian communities elsewhere, it is only mapped locally where it dominates over areas greater than the MMU.

Environmental Settings

Where mapped, it is found in rocky south trending but rather protected slopes generally fairly close to the canyon bottom.

Distribution

Mappable stands only noted north of Canada del Puerto in the vicinity of Canada del Pino.

Photo Interpretation Signature – Mapping Characteristics

Signature correlates are not well established since distribution as dominant stands is limited. Overall, *Cercocarpus betuloides* has a narrow, poorly defined crown. Color patterns are difficult to ascertain also because of sparse cover in generally steep settings.

3150 – Lemonadeberry Alliance

Rhus integrifolia Alliance

Mapping Descriptions

Generally mapped in grassy open settings; *Rhus integrifolia* dominates the stand in sparse to dense cover. *Artemisia californica* can be a minor component to the coastal sage scrub layer.

Environmental Settings

Usually mapped very near the coast, occasionally on the coastal bluff itself. In the eastern portions of the Central Valley, several stands are noted a fair distance inland. Generally limited to south trending slopes, often steep. Also noted in grassy open settings in gently sloping terrain, especially in the eastern third of the island.

Distribution

Found throughout the island generally within a mile of the coast. Least common on the northern ranges of the island.

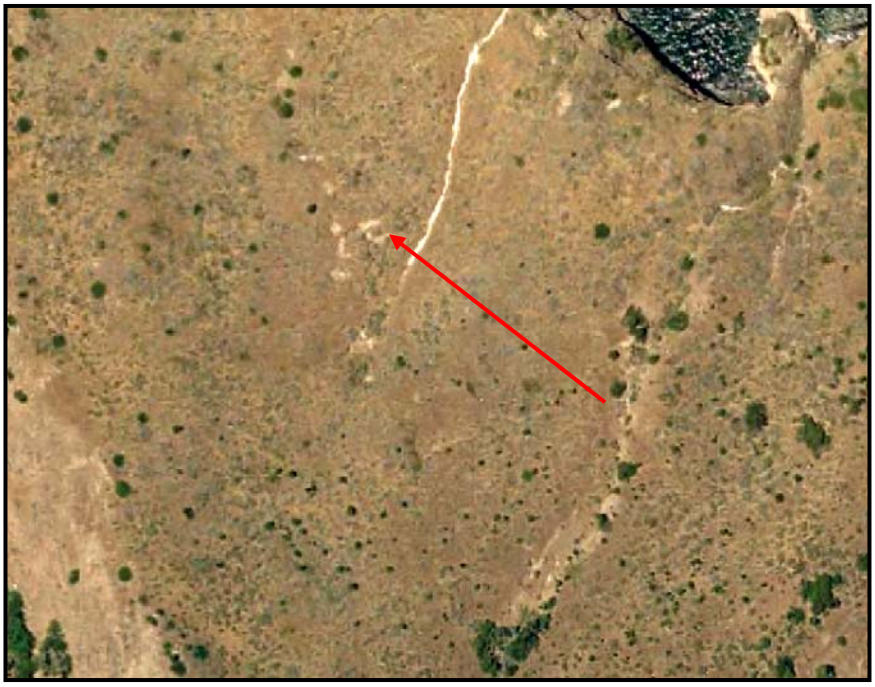
Photo Interpretation Signature – Mapping Characteristics

Similar in signature to manzanita species; green tones vary considerably depending on age of the leaf but are generally darker green than most manzanitas. Location is key in helping distinguish *Rhus integrifolia* from *Arctostaphylos.* Overlap of the two species is generally limited. The open grassy setting is also a key which distinguish it's setting from Arctostaphylos types that are often in dense stands with little herbaceous understory.

3200 – Temperate Microphyllous Evergreen Shrublands

3240 – Coyote Brush Alliance

Baccharis pilularis Alliance



Mapping Descriptions

Generally mapped in open grassy settings where *Baccharis pilularis* dominates the shrub layer in sparse to moderate cover. Stands can occasionally have a dense cover of over 60% especially on gentle north trending slopes in the isthmus region. *Rhus integrifolia* and or *Artemisia californica* can be minor components to the stand in coastal areas. Sparse stands of *Baccharis pilularis* below 5-10% cover in grassy settings are common and are noted as a shrub component in the density cover layer.

Environmental Settings

Mapped on gentle to moderately sloping environments of deep soil on a variety of aspects and slope positions. Also noted on drier riparian fringes of major washes and on old stream terraces just upslope from the active channel.

Distribution

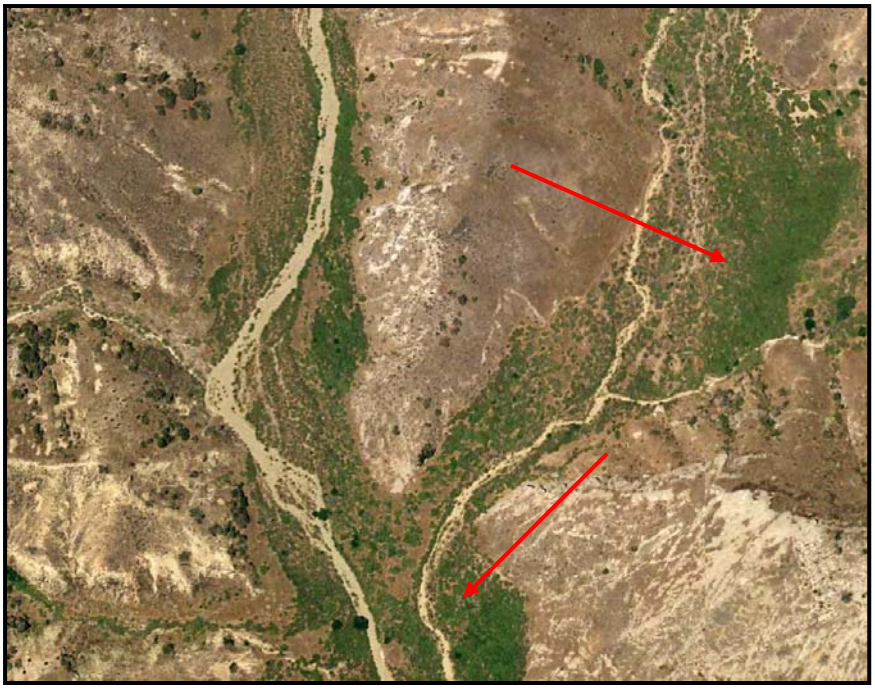
Commonly found on most portions of the island with the exception of the highest and most inland slopes. Good representative stands are found on gentle slopes on the northern third of the island and northern portions of the isthmus and in the vicinity of Campo Del Norte.

Photo Interpretation Signature – Mapping Characteristics

Baccharis generally yields a yellow-green signature that is highly variable in color and tone depending primarily on the health and age of the plant. Individual crowns are poorly defined but in dense stands tend to have a mottled texture. Signature varies considerably, also depending on herbaceous makeup, especially the presence of *foeniculum vulgare,* which tends to make the overall stand darker and less green. In sparse settings, *Baccharis pilularis* is difficult to discern. *Baccharis salicifolia* is generally found in gravely broad well-drained stream channels while *Baccharis pilularis* will often be found in grassy settings on the adjacent terrace.

3250 – Mulefat Alliance

Baccharis salicifolia Alliance



Mapping Descriptions

Mapped where *Baccharis salicifolia* dominates the stand or co-dominates the stand with *Baccharis pilularis*. Willow species, especially *Salix lasiolepis* can be a minor component to wetter stands. Understory herbaceous layer varies considerably.

Environmental Settings

Noted in active sandy or gravelly well-drained flat channels in environments wetter than *Baccharis pilularis* but drier than *Salix lasiolepis*.

Distribution

Fairly common in most major stream channels that are not too narrow. The most extensive stands occur on the west side of the island in the larger south trending drainages from Playa Larga to White Rock.

Photo Interpretation Signature – Mapping Characteristics

Baccharis salicifolia, in pure and extensive stands, gives off a stipple-like texture that varies from brown to green. Textural variability is minimal in the stand, but may increase depending on presence of *Baccharis pilularis* and herbaceous grasses and forbs towards the drier margins of the stand.

3300 – Temperate Xeric Mixed Drought-Deciduous Shrublands

3301 – Coastal Bluff Scrub Habitat

Mapping Descriptions

Mapped based primarily on location where bluff and steep cliffs extend no further than several hundred meters from the shoreline. Vegetation is usually sparse; often in a rocky setting with a sparse herbaceous layer, but overall cover is at least 2-5%. Species dominating or sharing dominance on the bluff may include the following, but is not limited to: *Artemisia californica, Dudleya, Coreopsis gigantean, Encelia californica, Eriophyllum staechadifolium, Leymus condensatus, Rhus integrifolia,* and *Opuntia littoralis*. Further analysis of the plot data may categorize the mapped polygons into floristic types that will be too fine scale to distinguish on the aerial photography. Subsequent modeling efforts based on geologic substrate or slope related characteristics may aid in refining the mapped polygons into a floristic type. Several patches on the bluff itself are mapped to floristic alliances including (*Rhus integrifolia* or *Artemisia californica)* where visible on the imagery.

Environmental Settings

Moderately steep to vertical cliff faces that are generally rocky with minimal soil development characterize most of the coastal bluffs along Santa Cruz Island.

Distribution

Over 90% of the island's coastal fringe end in a steep bluff edge; bluff faces are interrupted generally where larger streams form small sandy beaches at their mouth.

Photo Interpretation Signature – Mapping Characteristics

Most plant species on the bluff are not correlated to an aerial photo signature since they rarely form extensive mappable stands. Portions of the bluff, especially on the northern side of the island are completely obscured by shadow and in several places where slopes are vertical, they are too narrow to map. Air photo signature varies considerably depending on vegetation densities and geology. The signature also depends little on species composition, since most bluff communities contain only a sparse cover of vegetation.

3302 – Australian Saltbush Mapping Unit

Atriplex semibaccata Mapping Unit

Mapping Descriptions

Mapped where *Atriplex semibaccata* is present and has sparse cover, generally with minimal herbaceous understory.

Environmental Settings

Found on alkali flats, eroded sites, and sparsely vegetated blowouts about a mile or less from the coast.

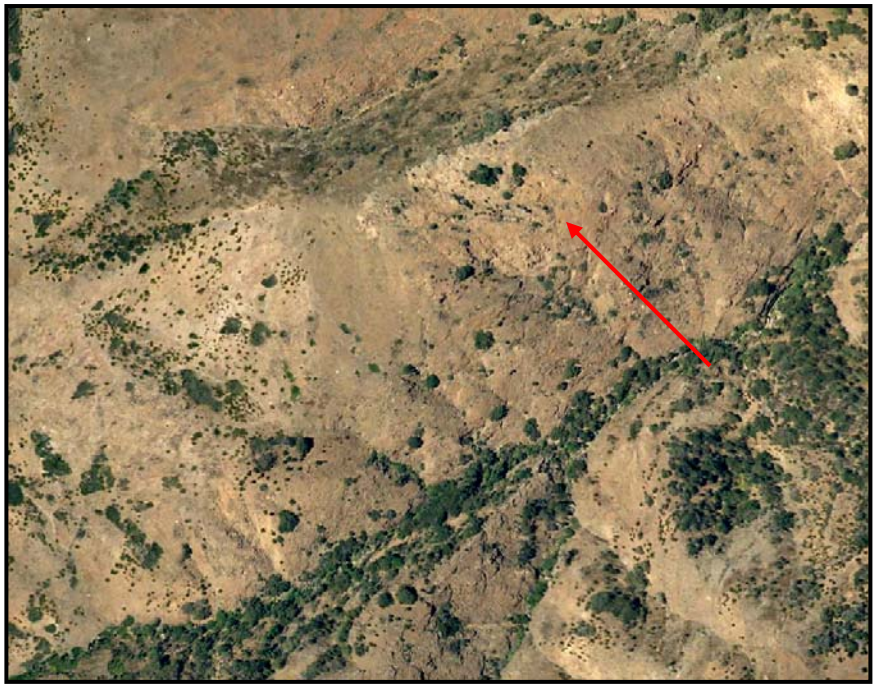
Distribution

Mapped polygons are based on reconnaissance only in several locations south of Christy Ranch and near Cavern Point.

Photo Interpretation Signature – Mapping Characteristics

Stands are too sparse to derive a reliable air photo signature correlation and therefore cannot be comprehensively mapped. Most stands are below MMU.

3303 – Inland Bluff Scrub Habitat



Mapping Descriptions

Mapped based primarily on a combination of vegetative signature, geology, environmental conditions and location. Vegetation is usually too sparse to reliably assign floristic categories to the mapped units; overall cover is at least 2-5%. Settings are usually rocky, often with a sparse herbaceous layer. Small patches of thin soil may develop, especially on narrow shelves or spurs, which may allow for the growth of dense patches of native grasses and forbs. Species dominating or sharing dominance on the bluff may include, but are not limited to *Eriogonum arboresens, E. grande, Hazardia dentosa, H. squarrosa, Gnaphalium bicolor, Lotus argophyllus,* and *L. dendroideus.* Further analysis of the plot data may categorize the mapped polygons into floristic types that will be too fine a scale to distinguish on the aerial photography. Subsequent modeling efforts based on geologic substrate or slope related characteristics may aid in classifying these polygons into floristic types. Denser stands of vegetation in steep rocky environments are occasionally mapped to the Santa Cruz Island Buckwheat Alliance where visible on the aerial photography. Areas that look similar to this type, yet have even less vegetation or none at all are coded into the cliffs- rock outcrops-steep eroded slopes (code 9420).

Environmental Settings

Mapped primarily on steep, rocky inland bluffs, usually more than several hundred meters from the shoreline, especially on south and west facing slopes in all positions ranging from just above the riparian zone up to the ridge tops. Also mapped in disturbance related settings where soil has been stripped off from landslides or grazing, leaving exposed rock that is clearly returning to a vegetative community.

Distribution

Very common especially on the western two thirds of the island but most extensively mapped on sandstone and conglomerates of the Blanca formation and lower tertiary sequence in the southwestern portion between Bowen and Kinton Points. Arbitrary boundaries between the two bluff scrub types (inland & coastal) are occasionally drawn, based primarily on location from the shoreline and, to a lesser extent, on slope related characteristics and vegetation cover related features such as density.

Photo Interpretation Signature – Mapping Characteristics

Most plant species on the bluff are not correlated to an aerial photo signature since they rarely form extensive mappable stands. Portions of the inland bluff trending north, which form nearly vertical exposures, are completely hidden in shadow. Air photo signature varies considerably depending on vegetation densities and geology. The signature depends little on species composition since most bluff communities contain only a sparse cover of vegetation.

3310 – California Sagebrush Alliance

Artemisia californica Alliance

Mapped where *Artemisia californica* dominates the stand in a wide variety of settings from an open sparse shrub layer to a dense cover. Mapped to the alliance level where photo interpreters cannot distinguish at finer levels in the classification or in extremely small patches below approximately one hectare. Most stands mapped within a mile of the coast extending inland into the western portions of the Central Valley and well into Canada Christy. It is less common on well-drained, coarser, grained soils. Several stands, especially in the southern portion of the island west of the isthmus have a significant component of *Salvia mellifera*, however, no signature correlate has been developed for this species off the aerial photography.

3311 – California Sagebrush Pure Stands

Artemisia californica Pure Stands

Mapping Descriptions

Mapped where *Artemisia californica* is a strong dominant, generally over 90% relative cover usually in very dense stands.

Environmental Settings

Mapped on gently sloping terrain on a variety of slope positions.

Distribution

Usually very near the coastal bluff, most stands mapped in the southwest portion of the island. Not frequently mapped.

Photo Interpretation Signature – Mapping Characteristics

Difficult to ascertain if the stand is over 90% *Artemisia californica* in all but the most ideal settings (dense stands with minimal herbaceous signature). Due to this difficulty, many stands which are pure or strongly dominant are probably mapped to the alliance level. *Artemisia californica* shows up in varying tones of gray on the aerial photography and dense stands tend to have a billowy texture. Pure stands have a fairly consistent signature throughout the mapped polygon.

3312 – California Sagebrush – Santa Cruz Island Buckwheat

Artemisia californica - Eriogonum arboresens

Mapping Descriptions

Mapped where *Artemisia californica* dominates or co-dominates the shrub layer with *Eriogonum arboresens* generally in moderately open to very dense settings. At times, *Eriogonum arboresens* can dominate over small areas. Emergent chaparral species can be present in the stand as a minor component.

Environmental Settings

Mapped on steeper settings than most *Artemisia californica* types, generally on south trending mid and upper slopes further inland.

Distribution

The most common type mapped in the California sagebrush alliance; most polygons are mapped on slopes north of the Central Valley and in the southwestern section of the island. This type also represents the most inland expression of the California sagebrush alliance.

Photo Interpretation Signature – Mapping Characteristics

Contrasts between the signature of *Artemisia californica* and *Eriogonum arboresens* are easily discernable on the aerial photography over fairly extensive areas when both species have a significant relative cover. *Eriogonum arboresens* tends to have a small, well-defined crown trending dark brown while *Artemisia californica* shows up in varying tones of gray on the aerial photography. Smaller individuals of both species are extremely difficult to differentiate.

3313 – California Sagebrush – Lemonadeberry

Artemisia californica - Rhus integrifolia

Mapping Descriptions

Mapped where *Artemisia californica* dominates or co-dominates the shrub layer with *Rhus integrifolia* generally in dense settings. *Rhus integrifolia* can locally dominate over small areas.

Environmental Settings

Mapped in a wide variety of slope related settings from gentle to steep, usually trending southerly in fairly exposed, xeric environments.

Distribution

Most polygons mapped fairly close to the shoreline extending inland along Canada Christy and Canada Medio. Stands mapped in the south and above mentioned canyons often transition inland into a mix of *Quercus pacifica*, *Artemisia californica* and *Rhus integrifolia* (type 3126). This type is commonly mapped on the western side of the island.

Photo Interpretation Signature – Mapping Characteristics

Contrasts between the signature of *Artemisia californica* and *Rhus integrifolia* are easily discernable on the aerial photography since the two species are in different floristic formations. *Artemisia californica* shows up in varying tones of gray on the aerial photography with a fairly diffuse crown edge, while *Rhus integrifolia* yields a dark green color of varying tones and a well-defined crown.

3314 – California Sagebrush – Coastal Bluff Scrub Transition

Artemisia californica - Coastal Bluff Scrub Transition

Mapping Descriptions

Mapped in dense stands adjacent to the bluff extending inland several hundred meters where *Artemisia californica* is a co-dominant to strong dominant, usually sharing the canopy with other species occurring on or near the bluff such as *Encelia californica, Leymus condensatus,* or *Eriophyllum stachaedifolium*, to name a few.

Environmental Settings

Mapped in rather mesic settings on variable slope positions, which are not too steep.

Distribution

Common where *Artemisia californica* forms extensive dense stands near and adjacent to the coastal bluff, especially in the southern portion of the island between Bowen Point and Valley Anchorage. Also common upslope from Pozo Beach and Playa Larga.

Photo Interpretation Signature – Mapping Characteristics

Artemisia californica shows up in varying tones of gray on the aerial photography with a fairly diffuse crown edge; in this type, cover is usually dense and overall texture is billowy like. Other species, when important in the canopy, introduce variability in the overall signature. *Leymus condensatus* tends to have a yellow green color and *Encelia californica* is an orange to brown plant, but is very difficult to detect unless common in the stand.

3315 – California Sagebrush – Island Bush Monkeyflower

Artemisia californica - Mimulus flemingii

Mapping Descriptions

Mapped where *Artemisia californica* dominates or co-dominates the stand in moderate to dense cover with one or more of the following occupying a minor to significant component to the shrub layer: *Mimulus flemingii, M.longiflurus, Isocoma menziesii or Castilleja spp.*

Environmental Settings

Noted in very mesic settings in the CSS (coastal sage scrub) zone, usually within about a half a mile from the coastline. Most mapped polygons trend north to east on rather steep lower to middle slopes.

Distribution

Not as common as other *Artemisia californica* types, possibly because of mapping difficulty in distinguishing *Mimulus spp* on the aerial photography.

Photo Interpretation Signature – Mapping Characteristics

Extremely difficult to map due to it's shady setting on steep north slopes and overall difficulty in discerning small shrub species off the aerial photography. Recognizing the presence of *Artemisia californica* as a component to the stand and modeling based on environmental parameters is how photo interpreters map most stands. In most ideal situations where *Mimulus spp.* is an important stand component, a slight reddish color is noted in the overall signature.

3316 – California Sagebrush – Coyote Brush

Artemisia californica - Baccharis pilularis

Mapping Descriptions

Mapped where *Artemisia californica* dominates or co-dominates the stand with *Baccharis pilularis* in open to rather dense settings, usually with a significant annual grass component. *Baccharis pilularis* quite often dominates the stand over small areas, especially where overall shrub cover is sparse.

Environmental Settings

Mapped on gentle slopes in rather mesic environments, usually in somewhat steeper settings than areas of pure *Baccharis pilularis*. Often found above active flood channels where rather steep slopes transition onto the stream terrace.

Distribution

Mixing of the two species is common, but does not occur over very extensive areas; narrow bands of mixing appear to be ecotonal between *Baccharis pilularis* and steeper sloped *Artemisia californica* stands. Most extensive stands are located along the Navy Road on the isthmus.

Photo Interpretation Signature – Mapping Characteristics

Mapping difficulty depends on extent of which the two species mix; over small areas it is difficult to discern off the aerial photography. In larger stands it is easy to recognize the overall gray color of *Artemisia californica* in contrast to the poorly defined crown and yellow green appearance of *Baccharis pilularis.*

3320 – Santa Cruz Island Buckwheat Alliance

Eriogonum arboresens Alliance

Mapping Descriptions

Mapped where *Eriogonum arboresens* dominates the stand as extremely sparse to sparse cover over a rocky or herbaceous understory. Other species common to inland bluff scrub environments may be a component to the stand. Occasionally, shrub cover becomes dense over very small areas in locally favorable settings, which aren't quite as steep or rocky.

Environmental Setting

Generally found on steep to very steep mid to upper south trending slopes, which are usually rocky but not as severe as inland bluff scrub conditions. Often found just upslope from the California Sagebrush – Santa Cruz Island Buckwheat type (type 3312) and adjacent to inland bluff scrub which is normally found in harsher settings.

Distribution

Mapped extensively, especially on the western half of the island in areas near the coast to well inland.

Photo Interpretation Signature – Mapping Characteristics

Eriogonum arboresens has a well-defined crown edge and is generally a dark brown. In most settings it is easily recognizable except where individual plants are extremely small in harsher environments and where overall cover is extremely sparse. Transitions between this type and the inland bluff scrub community (type 3303) is often difficult to discern.

3330 – Saint Catherine's Lace Alliance

Eriogonum grande Alliance

Mapping Descriptions

Mapped where *Eriogonum grande* dominates the low shrub layer in sparse to dense cover over a sparse to dense herbaceous understory.

Environmental Setting

Noted in two distinct settings: on steep south trending slopes where *Eriogonum grande* is a sparse shrub overstory in a rocky setting, and on ridgelines in dense grassy areas where this small shrub can become locally dense. Both settings trend quite xeric.

Distribution

Probably more commonly found than mapped; most stands mapped are in denser settings where *Eriogonum grande* is visible on the aerial photography. Most polygons are mapped on the isthmus on upper slopes and ridges. Sparse populations on steep rocky slopes are most likely lumped into the inland bluff scrub habitat. *Eriogonum grande* is often a component to other mapped types including inland bluff scrub (type 3303) and annual grasses (type 4310).

Photo Interpretation Signature – Mapping Characteristics

Overall signature of this species is confusing as several shrubs and herbaceous species mimic the color, tone and patterning of *Eriogonum grande*. In dense stands, *Eriogonum grande* generally yields a dark brown smooth signature that appears splotchy due to its irregular patterning of density in relation to annual and native grasses. Most stands are mapped close to existing plot and reconnaissance data.

3340 – Island Bush Monkeyflower – Island Bristleweed –Paintbrush Mapping Unit

Mimulus flemingii - Hazardia dentosa - Castilleja spp. Mapping Unit

Mapping Descriptions

Mapped where one or more of the following: *Mimulus flemingii, M.longiflurus, Hazardia dentosa* or *Castilleja spp.* dominate, co-dominate or are a subordinate species in the shrub layer. In many stands, all four species are found as a sparse to moderate cover over a herbaceous understory. Rockier settings generally have more *Hazardia dentosa* in the stand.

Environmental Setting

Mapped throughout the island on northwest, north, northeast and east facing steep slopes in a variety of slope positions from just above the riparian zone to just below many of the ridgelines and spurs. Most stands occur in rocky settings.

Distribution

Extensively mapped throughout all regions of the island from the coastal fringe to mountains far in the interior.

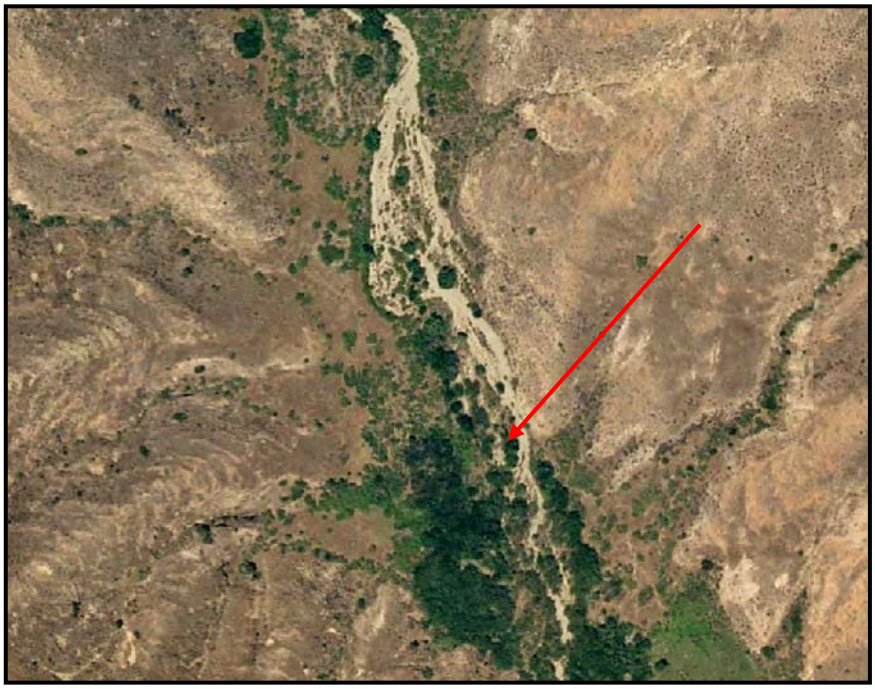
Photo Interpretation Signature – Mapping Characteristics

Like the bluff scrub communities, most plant species in this alliance are not easy to correlate to an air photo signature due to their sparse cover, small stature and steep northerly setting, which is often in shadow. In ideal settings, *Mimulus* tends to give a brown to reddish signature where it strongly dominates in larger stands, individual plants are not discernable; *Hazardia dentosa* tends to be a light blue and individual shrubs are often visible against the relatively dark background. Modeling the slope attributes and rockiness of the area is key in aiding the photo interpreter in interpreting this type.

3400 – Temporarily Flooded Cold Season Deciduous Shrublands

3401 – Mixed Arroyo Willow – Mule Fat Mapping Unit

Mixed *Salix lasiolepis - Baccharis salicifolia* Mapping Unit



Mapping Descriptions

Mapped where *Baccharis salicifolia* or *Salix lasiolepis* either dominates or co-dominates riparian stands of vegetation in moderately dense to dense cover. Drier fringes contain less *Salix lasiolepis* with a minor component of *Baccharis pilularis*. Wetter locations tend to have more *Salix lasiolepis*, possibly with other *Salix* or *Populus* individuals as a minor component to the stand.

Environmental Setting

Found in riparian and riparian fringe areas in streams with a large watershed, allowing for seasonal to perennial flow during most years. Stream channel width varies considerably. Wider systems may contain a zone of pure willow in the wettest portions that transition to coyote brush dominant areas on the higher terraces with *Baccharis salicifolia* occupying intermediate locations.

Distribution

Common in streams, especially streams that drain south of Ridge Road south of the Central Valley. Major watersheds where this type is extensively mapped include: Canada Christy, Laguna Canyon, Willows Canyon and Canada del Puerto. Much more extensively mapped west of the isthmus.

Photo Interpretation Signature – Mapping Characteristics

On the late fall imagery (November 2005) within isolated pockets of cold air drainages, leaves on the willows are starting to change, yielding a yellow to dull green appearance. On less wind-protected sites, *Salix lasiolepis* gives a dull green appearance, probably as a result of late-season stress of the plant leaf. *Baccharis salicifolia* has a much more narrow crown with a non-descript brownish color with a poorly defined crown edge. In drier settings where *Baccharis pilularis* is present signatures trend a bit more yellow-green.

3410 – Arroyo Willow Alliance

Salix lasiolepis Alliance

Mapping Descriptions

Mapped where *Salix lasiolepis* is the sole dominant to the tall shrub or small tree canopy, usually in dense stands. Other willow species in addition to *Populus fremontii* or *P. balsamifera* can form a minor emergent tree layer to the canopy.

Environmental Setting

Found extending several hundred meters below small springs in upper drainages or in streams where water flows most of the year. Stands are rarely found beyond the active flood channel except in saturated conditions.

Distribution

Not as common as the mixed arroyo willow - mule fat type (type 3401), but found in most of the drainages mentioned in that community. Stands are also not as extensive and often form very narrow linear polygons in narrow canyons with large watersheds.

Photo Interpretation Signature – Mapping Characteristics

On the late fall imagery (November 2005) in isolated pockets of cold air drainages, leaves on the willows are starting to change, yielding a yellow to dull green appearance. On less wind-protected sites, *Salix lasiolepis* gives a dull green appearance, probably as a result of late-season stress of the plant leaf. Where stands are fairly extensive, *Salix lasiolepis* crowns form a billowy texture and are fairly consistent throughout the mapped stand.

4000 HERBACEOUS

4100 – Saturated Temperate Perennial Graminoids

Several small polygons at the mouth of larger streams have been mapped to this formation. Photo interpreters cannot discern dominant species since they cover such a small area.

4101 - Bulrush – Cattail Mapping Unit

This is a rare type on Santa Cruz Island. There are small stands noted at Prisoner's Harbor and the mouth of Laguna Canyon.

4200 – Seasonally or Temporarily Flooded Graminoids

4201 – Seasonally or Temporarily Flooded Springs, Seeps, Vernal Ponds Mapping Unit

Mapping Descriptions

Mapped where plants from the sedge or grass families occur in very small stands under ¼ acre in a variety of wetland habitats. *Salix lasiolepis* may occur along some of the fringes of the herbaceous stand while other mapped polygons may include open water.

Environmental Setting

Seasonally flooded wetlands include many of the small seeps and springs at the upper portions of small canyons; however, most of these contain predominantly woody vegetation. Several vernal pools have been mapped where existing imagery shows encroachment of annual grasses.

Distribution

There are only several polygons large enough to map on the aerial photography. One large vernal pool is located on the isthmus near the navy base.

Photo Interpretation Signature – Mapping Characteristics

Signature is a bright green but varies considerably both within the stand and among the mapped polygons. Stand sizes are not large enough to discern species dominance.

4300 – Tall Temperate Annual Graminoids

4301 – Fennel Mapping Unit

Foeniculum vulgare Mapping Unit

Mapping Descriptions

Mapped where *Foeniculum vulgare* dominates the herbaceous layer. Annual grasses including *Avena spp, Bromus spp.* and *Hordeum spp.* can dominate in portions of the mapped polygon. Shrubs, especially *Baccharis pilularis* are often a common overstory component and may be increasing in cover during the past decade.

Environmental Setting

Common invasive plant in a variety of sparse shrub and grassy areas, which is potentially limited only by very steep, rocky environments. *Foeniculum vulgare* often grows in dense stands on gentle slopes in grasslands adjacent to major stream channels.

Distribution

The most extensive fennel stands occur on the isthmus along Navy Road west of Mount Pleasant. Other areas of dense fennel are located west of the UC Field Station, Christy Ranch, Main Ranch Airfield and the hills south of Smugglers' Cove. Dense fennel is occasionally mapped in narrow channels downstream from large ridge top stands; these channels may act as a conduit for further spreading of this invasive weed to grassy areas in the extreme southern portions of the island. Note plot data along San Justiniano Road northeast of Willows Anchorage depicting this species in the southern portion of the island.

Photo Interpretation Signature – Mapping Characteristics

Signature depends highly on overall density of *Foeniculum vulgare*. This species contrasts well against the annual grasses on the November 2005 aerial photography, where the signature is dark gray due to the dead plant stalks noted at that time of year. *Foeniculum vulgare* is not easily seen on either set of digital imagery. Sparse fennel is difficult to discern in dense annual grasses, which has a yellow-brownish color that makes it difficult to differentiate the dark gray signature of the *Foeniculum vulgare*.

4310 – California Annual Grasslands Alliance

Mapping Description

Mapped in generally dense cover where species from the genera *Avena, Bromus, Hordeum, or Lolium* usually dominate. Forbs and other species of annual grass can dominate over smaller areas. Ridgelines, spurs and rockier areas generally have a significant native component of *Nasella*. Woody vegetation is generally well below 10% cover and often includes species such as *Baccharis salicifolia* and *Artemisia californica.*

Environmental Setting

Mapped extensively on deep poorly drained soils in valleys and ridgelines throughout the island in a variety of slope positions.

Distribution

Much more extensively mapped on the eastern third of the island but common throughout except on rocky slopes and ridges.

Photo Interpretation Signature – Mapping Characteristics

Annual grasses vary considerably in signature but cannot be tied to individual species. Signature variability is governed more by the health of the grasses in the stand in addition to other factors, such as presence of fennel or other forb related vegetation. Healthier stands give off more of a yellow color, but most stands that have long since seeded tend to yield a light gray color. Texture is generally smooth but mottling increases with species variability and moisture related factors.

4320 – Giant Wildrye – Creeping Wildrye Superalliance

Leymus condensatus - Elymus glaucus Superalliance

Mapping Description

Mapped where *Leymus condensatus* or *Elymus glaucus* dominate the stand, often with a component of *Artemisia californica* in the shrub layer.

Environmental Setting

Found in moist settings on benches and terraces near the coast, often just above the bluff or on the coastal bluff itself. Also noted on moist terraces above major drainages.

Distribution

Uncommon as mappable stands generally near the coast, usually as a component to the CSS layer. In most areas where wildrye is visible, it is minor component of *Artemisia californica*. Only several polygons have been mapped where this species of grass forms a dominant cover over a mappable area. Largest patches occur between Albert and Valley Anchorages.

Photo Interpretation Signature – Mapping Characteristics

Leymus condensatus is recognizable in dense stands and as a major component to *Artemisia californica* in stands greater than ½ acre in size. The tall grass generally yields a yellowish signature, which varies even within the small size of the stand. Contrast is high against the adjacent dense stands of *Artemisia californica.*

4400 - Tall Temperate Perennial Graminoids

4401 – Coastal Salt Pan Mapping Unit

Mapping Description

Mapped where salt pans are the dominant feature. Sparse amounts of *Distichlis spicata* grow along the edges of the pan in addition to the invasive *Mesembryanthemum crystallinum*. Several unique rare endemics also inhabit the salt pans on Christy Beach several meters south of the lagoon.

Environmental Setting

Mapped behind the main coastal dune where small amounts of water collect and evaporate early in the season, leaving behind a nearly unvegetated salt pan.

Distribution

Extremely small in size and only a few mapped polygons, all well below MMU. Best example is at Christy Beach.

Photo Interpretation Signature – Mapping Characteristics

No aerial photo signature correlates have been developed for the associated species except for *Mesembryanthemum crystallinum,* which gives off a deep reddish brown signature. Overall appearance is dark gray, which may account for the flooding at the time the photography was flown.

4402 – Needlegrass

Achnatherum aridum

It is not possible to separate out a native grass component from annual grasses using the aerial photography. Soil depth and/or slope characteristics are also not consistently reliable as modeling tools that can be used across the island when mapping native grasses. Native grasses can possibly be mapped by ground assessing existing grassland polygons and re-coding or dividing existing mapping units in a subsequent effort.

4410 – Silver Beachbur - Beach Sand - Verbena Alliance

Ambrosia chamissonis - Beach Sand - *Abronia maritime* Alliance

Mapping Description

Mapped on the coastal dune where *Ambrosia chamissonis, Abronia maritima, Cakile maritima*, and *Distichlis spicata* are sparse components to the coastal dune.

Environmental Setting

Mapped on the coastal dune above the approximate mean annual high tide.

Distribution

About twenty polygons exclusively mapped from Christy Beach south along the southern coast to the vicinity of Albert's Anchorage. By far the best example is the dune along Christy Beach from just north of Christy Point extend north for approximately 2 miles.

Photo Interpretation Signature – Mapping Characteristics

Mapped only where vegetation is visible on the sand regardless of how high the sand is adjacent to the intertidal zone. However, vegetation can be visible only in trace amounts. Along some portions of the Christy Beach dune, the signature is yellow from the flowering silver beachbur.

4420 Harding Grass

Phalaris aquatica

Mapping Description

Mapped where *Phalaris aquatica* is a component of annual grasses or where it dominates the stand in dense settings. All patches that are visible on the imagery are mapped, even when below MMU.

Environmental Setting

Introduced invasive; currently within annual grassland types

Distribution

One huge stand mapped in the vicinity of the Campo Grande Airfield on the eastern portion of the island. Small patches have extended beyond that stand, especially to the southeast.

Photo Interpretation Signature – Mapping Characteristics

Dense stands easily recognizable as a uniform yellow signature, which is slightly coarser than the adjacent annual grasses. Where *Phalaris aquatica* is a sparse component to the annuals, it is more difficult to see.

4600 – Tidally Flooded Grasslands

4610 – Saltgrass Alliance

Distichlis spicata Alliance

Mapping Description

Mapped where *Distichlis spicata* is a component of annual grasses or where it dominates the stand in sparse to dense settings.

Environmental Setting

Mapped on upland coastal terraces where it mixes with annual grasses adjacent to the coastal bluff and on the fringes of small coastal lagoons at the mouth of larger streams.

Distribution

Most extensive stands are located where it mixes with annual grasses near the West End Airfield. About 50 polygons mapped, most of them less than five acres in size.

Photo Interpretation Signature – Mapping Characteristics

Extremely difficult to separate from annual grasses on the aerial photography. Photo interpreters use location and setting to model a signature that yields a somewhat more yellow-green signature than just annual grasses. Pure stands adjacent to lagoons are extremely small in size but give off a dark brown signature.

4700 – Tall Temperate Forblands

4701 – Sea Blite – San Miguel Island Locoweed

Sueda taxifolia - Astragalus miguelensis

Mapping Descriptions

Mapped where *Sueda taxifolia* and *Astragalus miguelensis* dominate the stand in sparse to dense cover with little or no annual grasses. *Mesembryanthemum crystallinum* may encroach on the edges of the stand.

Environmental Setting

Mapped in sandy areas along the upper part of the bluff and on the adjacent terrace edge.

Distribution

Only a few polygons mapped, limited to the northeastern third of the island from Potato Harbor to Cavern Point.

Photo Interpretation Signature – Mapping Characteristics

Visible only on the terrace edge adjacent to the coastal bluff where small patches are recognizable on the aerial photography, especially if there is a high component of *Astragalus miguelensis*. The bluish-white tomentose branches contrast well especially against darker soils. Many patches, however, are too small to map. *Mesembryanthemum crystallinum,* an aggressive invasive, often is in the stand and appears a dark brown-red color.

4702 – Tejon Milk Aster – (Coastal Goldenbush)

Stephanomeria cichoriacca – (Isocoma menziesii)

Mapping descriptions

Mapped where *Stephanomeria cichoriacca* dominates or co-dominates the stand in extremely sparse settings. *Isocoma menziesii* may be a component to the shrub layer. Annual grasses are occasionally a component, but are extremely sparse.

Environmental Setting

Found in a variety of slope related settings; mapped only on Santa Cruz Island volcanics where exposed tephra related ash is noted.

Distribution

Mapped stands are small and are limited to the eastern portion of the island.

Photo Interpretation Signature – Mapping Characteristics

Mapped using geologic features noted above; sparse shrub layer is not separable from other coastal scrub related species. Modeling may prove unreliable.

4710 – Bracken Fern Alliance

Pteridium aquilinum Alliance

Mapping descriptions

Mapped where *Pteridium aquilinum* dominates the herb layer in dense stands. Stand edges co-dominate with annual grasses and *Baccharis pilularis* as a sparse shrub overstory along the driest margins.

Environmental Setting

Mesic swales and low areas; possibly in seeps, locally

Distribution

Only several polygons mapped, the best example being Lagunitas Secas near West Peak in the northern portion of the island.

Photo Interpretation Signature – Mapping Characteristics

The Lagunitas Secas stand appears a bright orange to yellow-green, depicting the stressful conditions of *Pteridium aquilinum* in late season condition.

APPENDIX C

Santa Cruz Island Polygon Attribute Table with Field Definitions

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	8	18	F	5
9	PERIMETER	8	18	F	5
17	SCVEG#	4	5	B	-
21	SCVEG-ID	4	5	B	-
25	PI	4	4	N	0
29	DENSITYCON	1	1	I	-
30	DENSITYHARD	1	1	I	-
31	DENSITYSHRUB	1	1	I	-
32	FENNEL	1	1	I	-

F = Floating
B = Binary
N = Numeric
I = Integer

PI: Mapping code for vegetation code, including water and land use
DENSITYCON: Density of conifers in a polygon
DENSITYHARD: Density of hardwoods in a polygon
DENSITYSHRUB: Density of shrubs in a polygon
FENNEL: Fennel modifier
SCVEG-ID: numeric ID for each polygon
SCVEG#: internal record number for ArcInfo

File Specifications

ARC Info Coverage Format
Shape File

Coordinate System Used

NAD27 UTM projection – Meters
Zone 11

APPENDIX D

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