Mapping the Distribution of Maritime Chaparral Species in the Monterey Bay Area

Prepared for the U. S. Fish and Wildlife Service, Ventura Fish and Wildlife Office

Eric Van Dyke and Karen Holl
April 26, 2003

Introduction

Central maritime chaparral is an uncommon vegetation type that is present in patches at locations scattered throughout the Monterey Bay region. Maritime chaparral stands are dominated by one or more *Arctostaphylos* taxa, including several subspecies of burl forming *A. tomentosa* (woollyleaf, shaggy-barked, or brittleleaf manzanita) and four locally endemic, non-burl forming species that were the primary focus of this study: *A. hookeri* ssp. *hookeri* (Hooker's manzanita), *A. pajaroensis* (Pajaro manzanita), *A. montereyensis* (Monterey or Toro manzanita), and *A. pumila* (sandmat manzanita). At some locations, stand dominance is shared with *Adenostoma fasciculatum*. Several State and Federally listed species are associated with central maritime chaparral, including *Chorizanthe pungens* var. *pungens*, *Cordylanthus rigidus* ssp. *littoralis*, and *Piperia yadonii*.

Our understanding of the distribution of Monterey Bay maritime chaparral and its endemic shrubs is largely due to the work of Jim Griffin in the 1970s (Griffin 1978).

The occurrence of maritime chaparral is typically associated with dry, well-drained soils or exposed upland locations. Several species present in maritime chaparral, including *Dendromecon rigida*, *Pickeringia montana*, and *Quercus wislizenii*, are typical of much drier inland habitats. Two Monterey Bay endemic shrubs, *Arctostaphylos pajaroensis* in the Prunedale region and *A. pumila* at former Fort Ord and the nearby Monterey Airport area, are almost entirely restricted to ancient dune sands. In the Prunedale sandhills, discrete chaparral patches occur within a matrix of coast live oak woodland. The Monterey Bay area's largest maritime chaparral expanses are found on rolling sandhills at central and southwestern Fort Ord. At more inland locations, from eastern Fort Ord through Toro Park and the Pine Canyon area, scattered individuals and occasional patches of the uncommon endemic *A. montereyensis* occur on heavier soils within expanses of *Adenostoma* chaparral and shrubland. *Arctostaphylos hookeri* ssp. *hookeri*, another uncommon Monterey Bay area endemic, inhabits a variety of coastal chaparral habitats—from exposed sandstone crags in the Prunedale area to heavy clay soils in the closed-cone conifer forest understory of the Del Monte Forest.

Maritime chaparral is threatened by fragmentation due to agricultural and residential development, poor recruitment resulting from wildfire suppression, successional transition to oak woodland or closed-cone conifer forest, and invasion by exotic species such as *Carpobrotus edulis*, *Cortaderia jubata*, *Eucalyptus globulus*, and *Genista monspessulana*.

The objective of this project was to map the boundaries of central maritime chaparral patches in the Monterey Bay area and to compile abundance data for the region's endemic *Arctostaphylos* species. Presence data for *Ceanothus cuneatus* var. *rigidus* and

Ericameria fasciculata, two maritime chaparral-associated local endemics, were also compiled as encountered. The four *Arctostaphylos* species and *Ericameria fasciculata* are considered rare, threatened, or endangered (List 1B) by the California Native Plant Society; *Ceanothus cuneatus* var. *rigidus* is on the CNPS watch list (List 4).

High-resolution aerial imagery was interpreted to map the distribution of chaparral patches. A limited set of field surveys, using Griffin's sampling techniques to facilitate comparison with earlier studies, were undertaken as ground truth for the image interpretation process and to develop abundance estimates for the six target species. The results of this survey are available as a set of ArcView GIS layers on the accompanying CD.

Methods

Maritime Chaparral Mapping

Griffin's original 1978 distribution map of Monterey Bay area endemic shrubs was located in the files at Hastings Reserve. We scanned and georectified this map to serve as our starting point for mapping the region's maritime chaparral stands (Figure 1).

The extent of maritime chaparral was determined through aerial image interpretation techniques. A variety of flight dates and types of aerial imagery were reviewed to determine which was most suitable for distinguishing chaparral habitat. After color enhancement of the selected photographs to emphasize habitat distinctions, we performed systematic searches in the vicinity of each of Griffin's designated chaparral "localities". Additional sites that were identified as maritime chaparral by local experts or from voucher specimens were also searched.

Identified chaparral patches were re-located and digitized directly from high-resolution digital ortho images to ArcView polygon shapefiles. This methodology assured consistent spatial accuracy and a common timeframe. All Monterey County localities, with the exception of a relatively small area south of Gibson Canyon, were digitized from Monterey County's December 1999 0.6 m/pixel panchromatic DOQs (HAW 1999). Digitizing of the Santa Cruz County localities at Buena Vista and Calabasas was completed using Monterey County's May 2001 0.6 m/pixel color infrared DOQs (HAW 2001). Coverage for southern Gibson Canyon, which is not yet available from Monterey County's digital ortho series, was from 1993 U. S. Geological Survey 1.0 m/pixel panchromatic DOQs (NAPP 1996). Heads-up digitizing was performed at a standard scale of 1:4000, yielding chaparral polygons with approximately 10 m spatial accuracy and a minimum mapping unit of approximately 2500 m^2 (although a number of smaller polygons that could be clearly identified were also included).

Interpretation of aerial imagery is effective where textural differences between habitat types are visually distinctive. Boundaries between maritime chaparral patches and adjacent woodland, grassland, and developed areas are typically abrupt and were readily identified on our imagery. The project's two contributors independently digitized several test patches at widely distributed locations to assess the level of inconsistency of interpretation; the resulting chaparral acreage was nearly identical in all cases.

In areas of transition from chaparral to other habitat types, the visual threshold was approximately 50% shrub cover. Therefore predominately woodland or grassland

regions where chaparral associated shrubs were present could not be identified in this study. Chaparral and sage scrub habitats were occasionally visually ambiguous. Inspection of color or color infrared imagery usually resolved these interpretation questions, although field visits were occasionally required. A paved road was always considered to be the boundary of a chaparral patch, as were cleared areas wider than approximately 20 m. Unpaved roads and paths were generally included within chaparral polygons, as were areas of disturbance, bare ground, and fragments of other habitat types provided they were smaller than the minimum mapping unit.

The chaparral polygons delineated by our mapping methodology correspond closely to the *Woollyleaf manzanita series* defined in the California Native Plant Society's Manual of California Vegetation (Sawyer and Keeler-Wolf 1995), i.e. a continuous canopy dominated by manzanita and other broad-leaved evergreen shrubs that occurs on upland bluffs, dunes, mesas, outcrops, slopes, and terraces.

Figure 2 shows an example of digitized chaparral polygons over the ortho imagery.

Distribution and Dominance of Endemic Shrubs

The presence and estimated density of endemic *Arctostaphylos* species, *Ceanothus cuneatus* var. *rigidus*, and *Ericameria fasciculata* in or near the mapped chaparral stands were determined from targeted field surveys and through a review of the California Natural Diversity Database (CNDDB 2002), voucher records at the Pacific Grove Museum of Natural History herbarium, and through interviews with local experts. Only voucher records collected since 1977 (subsequent to Griffin's field work) were included.

Field visits were made to parklands and protected conservation lands and other readily accessible sites where maritime chaparral was present. Ten meter by ten meter square sampling plots were selected in undisturbed portions of the chaparral and dominance of the six target species was estimated according to the Braun-Blanquet minimal-area relevé method (Mueller-Dombois and Ellenberg 1974, Griffin 1978, Van Dyke et al. 2001). Occurrences of the six target species that were observed outside of these sampling plots, and an estimate of their relative density, were also recorded. Estimated species abundance at former Fort Ord was obtained by scanning, georectifying, and digitizing published distribution maps (USACE/Jones & Stokes 1992).

Results and Discussion

Maritime Chaparral Mapping

Interpretation of high-resolution imagery allowed us to identify and digitize about 17,600 acres of chaparral throughout the study area (Table 1; Figure 3). The resulting dataset, which comprises 654 polygons, is included in the accompanying data CD as the ArcView shapefile "chaparral.shp". (The contents of the CD are listed in Appendix 1.)

The chaparral that we mapped consists of three distinct habitat types:

- *Maritime chaparral.* Central maritime chaparral is dominated by *Arctostaphylos* species, typically one or more varieties of *A. tomentosa* in combination with one or more local endemic *Arctostaphylos* species. *Adenostoma fasciculatum* is frequently present, but rarely dominant. Maritime chaparral occurs as discrete patches within a matrix of *Quercus agrifolia* or closed-cone conifer forest. The

largest expanses of maritime chaparral are on the coastal sand flats and interior sandstone uplands of former Fort Ord; scattered remnants of similar habitat occur nearby in the vicinity of Monterey Airport. Smaller expanses are present on the ridges above Gibson Canyon in the Palo Corona region. Fragmented maritime chaparral is widespread on ridgelines and upper slopes of the Prunedale sandhills. Occasional small patches occur in the vicinity of Jacks Peak and in the Del Monte Forest as well as at Buena Vista and Calabasas in southern Santa Cruz County.

- *Inland chaparral with occasional maritime chaparral-associated endemic shrubs.* Chaparral in the Toro Park/Pine Canyon area is dominated by *Adenostoma fasciculatum*, but includes scattered individuals and moderate-density stands of *Arctostaphylos tomentosa* and *A. montereyensis*. Although not true maritime chaparral, this habitat type was digitized and incorporated in our survey because of the presence of *A. montereyensis* and other maritime chaparral-associated endemic species, including scattered *Ceanothus cuneatus* var. *rigidus* and occasional *Ericameria fasciculata.*

- *Closed-cone conifer forest understory with maritime chaparral-associated endemic shrubs*. The target species *Arctostaphylos hookeri* ssp. *hookeri* is present at low densities at a number of locations throughout the Del Monte Forest. *Ceanothus cuneatus* var. *rigidus* and *Ericameria fasciculata* are also occasional in this forest understory. Unfortunately, it was not possible to accurately interpret and digitize this habitat type from aerial imagery. Although understory habitats were not included in our survey, the few acres of true maritime chaparral (with minimal forest canopy) that remain in the vicinity of S. F. B. Morse Preserve were included.

Table 2 lists the number of chaparral patches, the mean patch size, and the acreage of the largest patch at each of the eight localities. Table 3 lists the major public and protected lands within each locality and the chaparral acreage that they contain.

Distribution and Dominance of Endemic Shrubs

Estimates of percent cover for the six target species obtained during field visits and from vouchers are collected as point features in the shapefile "species.shp". The theme table for this dataset contains three types of records: in the table's *Type* field, our field sampling plots are labeled *plot*, individual occurrences that we observed in the field (outside of the plots) are labeled *occur*, and species locations obtained from vouchers and CNDDB records are labeled *voucher*. A percent cover value for each species present in a plot, or for the single species present at an occurrence or voucher location, is represented by a symbol in the appropriate field (*ArcHoo*, *ArcMon*, *ArcPaj*, *ArcPum*, *CeaCun*, or *EriFas*). These symbols correspond to Braun-Blanquet cover-abundance values: 'r' = 1 individual, '+' = few individuals, '1' = 1-5% cover, '2' = 5-25% cover, '3' = 25-50% cover, '4' = 50-75% cover, and '5' = 75-100% cover. Figure 4 shows the locations of sampling plots, individual occurrences, and voucher records.

A mapping of estimated extent and density for each target species is provided in the six shapefiles "arcHoo.shp", "arcMon.shp", "arcPaj.shp", "arcPum.shp", "ceaCun.shp", and "eriFas.shp". These polygons were interpolated from the point features in "species.shp", from interviews with local experts, and from published USACE/Jones &

Stokes (1992) distribution maps of former Fort Ord. Each extent polygon was assigned a species density consistent with the USACE/Jones & Stokes scheme (*low* = "one to tens of shrubs per acre", *medium* = "tens to hundreds of shrubs per acre", and *high* = "hundreds to thousands of shrubs per acre"). Although Braun-Blanquet values were not directly comparable to these density ranges (percent cover rather than number of shrubs), we converted our estimates as follows: 'r' and '+' to *low* (i.e. one or two plants per 10×10 m plot), '1' and '2' to *medium* (i.e. between two and 40 plants per plot), and '3', '4', and '5' to *high* (i.e. 40 or more plants per plot).

Species distribution and density maps for the six target species are shown in Figures 5 through 10. Because the target shrubs frequently occur in mixed habitat adjoining chaparral patches, these distribution maps may incorporate additional area not mapped as maritime chaparral in Figure 3. Note that these maps should be treated with caution; they constitute educated estimates based on limited field data, oral descriptions, and published data collected through somewhat varied methodologies.

Arctostaphylos hookeri* ssp. *hookeri

A. hookeri ssp. *hookeri* has the widest distribution of the four endemic *Arctostaphylos* species, although it is generally a minor constituent in chaparral patches dominated by other species, particularly varieties of *A. tomentosa*. An exception is along ridgelines and sandstone plateaus in the Prunedale area, where *A. hookeri* is often the dominant in low-growing (< 0.5 m) mixed chaparral. This is typical habitat for Federally endangered *Piperia yadonii*. Small, nearly pure patches of *A. hookeri* were also noted in the Calabasas and Buena Vista regions at sites that appear to be recovering after mechanical clearing. *A. hookeri* is present at low to moderate densities within a mixture of chaparral and coastal scrub species across eastern central Fort Ord, although less frequently in the *A. pumila* dominated dune sands to the west and the *A. montereyensis* dominated sandstone uplands to the east. A. hookeri is also present on ridgelines above Gibson Canyon.

In the Del Monte Forest, *A. hookeri* is scattered widely at low densities in the closed cone conifer understory; it is particularly evident along paths and in clearings. Abundance of this species is gradually decreasing under the closing forest canopy (V. Yadon, pers. comm.) At the few small patches of true maritime chaparral in the vicinity of S. F. B. Morse Preserve, *A. hookeri* is abundant and occasionally dominant. As in the Prunedale area, this low-growing mixed chaparral is habitat for *Piperia yadonii*.

The only Monterey Bay area chaparral location where *A. hookeri* is completely absent is the relatively inland Toro Park/Pine Canyon region.

Arctostaphylos montereyensis

A. montereyensis is restricted to sandstone uplands at eastern Fort Ord, hillsides in the Toro Park/Pine Canyon region, and a few small patches near Boots Road and Laureles Grade—plus occasional individuals and small patches on old dune sands at southwestern Fort Ord and near Monterey Airport. Densities are low throughout most of this range; the highest density stands are on the eastern Fort Ord ridges, where *A. montereyensis* is intermixed with *A. tomentosa* and is locally dominant. Chaparral in the Toro Park region southeast of Fort Ord is dominated by *Adenostoma fasciculatum*, scattered with

individuals or small patches of mixed *A. tomentosa* and *A. montereyensis*. The southern extent of *A. montereyensis* in the Pine Canyon and San Benancio/Corral de Tierra region has not yet been clearly determined.

Arctostaphylos pajaroensis

A. pajaroensis is restricted to the Prunedale sandhills, where it intermixes with *A. tomentosa* ssp. *crustacea* and *A. hookeri* ssp. *hookeri*. Tall, dense, and frequently nearly pure stands cover the deeper soils on slopes, while lower growing stands on sandstone ridges and plateaus are mixed with—and often dominated by—*A. hookeri*. Because of the varied topography in the Prunedale sandhills and intensive development in the area, patches dominated by *A. pajaroensis* are small and fragmented and generally restricted to uplands, separated from one another by oak woodlands and agricultural and residential uses. Historical aerial photographs indicate that these stands are decreasing in size due to invasion by oak woodlands and exotic eucalyptus forests (E. Van Dyke, unpublished). Disturbed *A. pajaroensis* chaparral is aggressively invaded by *Cortaderia jubata.*

Herbarium specimens from the 1930s indicate that *A. pajaroensis* was formerly present in the Calabasas area in southern Santa Cruz County, but we were unable to relocate it in the region's remaining chaparral patches.

A very small number of *A. pajaroensis* or *A. pajaroensis*/*A. montereyensis* hybrids have been reported at widely separated locations on former Fort Ord—the possibility that these constituted a new taxon was briefly considered but subsequently dismissed (V. T. Parker, pers. comm.). Possibly these individuals are the result of intentional planting, perhaps as habitat restoration for game (V. Yadon, pers. comm.).

Arctostaphylos pumila

A. pumila occurs at moderate to high densities in broad, low growing stands intermixed with coastal scrub species on the sands of northern, central, and southwestern Fort Ord. Smaller degraded remnants of similar habitat are present at the Monterey Airport. We also encountered a very few individuals in uplands at nearby Jacks Peak.

Griffin (1978) reported *A. pumila* in *Cupressus goveniana* understory near Gibson Canyon, but we did not observe this species during a brief visit to the site. Historic vouchers indicate that *A. pumila* was also formerly found at several Monterey Peninsula coastal sites near Pacific Grove, Asilomar, and Carmel. We did not attempt to relocate these non-chaparral occurrences.

Ceanothus cuneatus* var. *rigidus

C. cuneatus var. *rigidus* is present at all of the Monterey Bay area chaparral localities, but densities reach moderate levels only at eastern and central Ford Ord. Only a few widely scattered and frequently senescent individuals are encountered at most other locations. This short-lived, early successional species favors gaps in the chaparral canopy or scrublands and disturbed areas adjacent to chaparral stands. Fire suppression is the likely cause of a significant decrease in abundance of the species, at least in the Prunedale area (Van Dyke et al. 2001). *C. cuneatus* var. *rigidus* is often an indicator of likely habitat for Federally threatened *Chorizanthe pungens* var. *pungens.*

Ericameria fasciculata

E. fasciculata is endemic to the Monterey Bay area. The distribution and habitat preferences of this species appear to be similar to *C. cuneatus* var. *rigidus* within this restricted range. Densities are uniformly low; only on the sandstone ridges of eastern Fort Ord and at two widely separated locations in the Prunedale hills did we encounter more than one or two individuals at a single site. In nearly every case, the few plants that we encountered during field surveys were at localities previously known to local experts or that matched reported voucher records.

Proposed Additional Studies

The survey area should be extended to encompass the full extent of *Arctostaphylos hookeri* ssp. *hookeri*, which is reported to occur in small patches near the coast south of Point Lobos. The distribution of *Ceanothus cuneatus* var. *rigidus* also likely extends south of Point Lobos as well as inland on the Sierra de Salinas.

Two distinct chaparral associations are present throughout the Prunedale sandhills, a tall, dense canopy dominated by *A. pajaroensis* and a low, open heath dominated by *A. hookeri* ssp. *hookeri* and *Adenostoma fasciculatum*. It would be helpful to map and quantify these distinct vegetation types. Identification of these two associations is not possible using standard aerial imagery, but may be feasible with advanced techniques such as hyperspectral imaging.

Several subspecies in the *Arctostaphylos tomentosa/crustacea* complex are endemic to the Monterey Bay region. It would be valuable to map the distribution and densities of these taxa.

Finally, it would be useful to extend the study area north of Santa Cruz to encompass the sandhills and "chalks" habitats of *Arctostaphylos glutinosa*, *A. nummularia* var. *sensitiva,* and *A. silvicola*.

Acknowledgments

Thanks to Sus Danner, Bruce Delgado, Alison Graff, Grey Hayes, Jane Holte, Charles McClain, Ed Mercurio, Tom Parker, Mark Stromberg, Mike Vasey, and Vern Yadon—and to Jim Griffin for his pioneering work.

Literature Cited

CNDDB. 2003. Natural diversity database (January 2, 2003 version). California Department of Fish and Game, Sacramento CA.

Griffin, J. R. 1978. Maritime chaparral and endemic shrubs of the Monterey Bay region, California. Madroño 25:65-112.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, N.Y.

Sawyer, J. and T. Keeler-Wolf. 1995. A manual of California vegetation. CNPS Press, Sacramento CA.

USACE/Jones & Stokes Associates. 1992. Flora and fauna baseline study of Fort Ord, California. U.S. Army Corps of Engineers, Sacramento, CA.

Van Dyke, E., K. D. Holl, and J. R. Griffin. 2001. Maritime chaparral community transition in the absence of fire. Madroño 48:221-229.

Table 1. Monterey Bay area chaparral acreage.

Locality	Habitat type	Target species	Chaparral acres
Calabasas/ Buena Vista	maritime chaparral	*A. hookeri* ssp. *hookeri* *C. cuneatus* var. *rigidus*	54
Prunedale	maritime chaparral	*A. hookeri* ssp. *hookeri* *A. pajaroensis* *C. cuneatus* var. *rigidus* *E. fasciculata*	2794
Fort Ord	maritime chaparral	*A. hookeri* ssp. *hookeri* *A. montereyensis* *A. pajaroensis* *A. pumila* *C. cuneatus* var. *rigidus* *E. fasciculata*	11,036
Monterey Airport	maritime chaparral	*A. hookeri* ssp. *hookeri* *A. montereyensis* *A. pumila* *C. cuneatus* var. *rigidus* *E. fasciculata*	25
Jacks Peak	maritime chaparral	*A. hookeri* ssp. *hookeri* *A. pumila* *C. cuneatus* var. *rigidus*	152
Del Monte Forest	forest understory maritime chaparral	*A. hookeri* ssp. *hookeri* *C. cuneatus* var. *rigidus* *E. fasciculata*	10[(1)]
Palo Corona/ Gibson Canyon	maritime chaparral	A. hookeri ssp. hookeri *C. cuneatus* var. *rigidus*	1078
(total maritime chaparral)			15,149
Toro Park/ Pine Canyon	inland chaparral	*A. montereyensis* *C. cuneatus* var. *rigidus* *E. fasciculata*	2429
(total chaparral)			17,579

[(1)]Maritime chaparral patches excluding forest understory.

Table 2. Chaparral patch size.

Locality	Number of patches	Mean patch size (acres)	Largest patch (acres)
Calabasas/ Buena Vista	37	1.5	10
Prunedale	195	14	213
Fort Ord	280	39	6813
Monterey Airport	23	1.1	6
Jacks Peak	28	5	27
Del Monte Forest	8	1.2	5[(1)]
Palo Corona/ Gibson Canyon	54	20	225
(maritime chaparral)	625	24	6813
Toro Park/ Pine Canyon	29	84	1629[(2)]
(all chaparral)	654	27	6813

[(1)]Maritime chaparral patches excluding forest understory.
[(2)]Inland chaparral.

Table 3. Chaparral on public and protected lands.

Name	Owner	Locality	Chaparral acres
Buena Vista property (proposed)	Trust for Public Land	Calabasas/Buena Vista	17
Lewis Road Landfill (closed)	Salinas Valley Solid Waste Authority	Prunedale	39
Elkhorn Watershed Protected Lands	Elkhorn Slough Foundation/Nature Conservancy	Prunedale	245
Freeway 101 Alignment (abandoned)	CalTrans	Prunedale	75
Manzanita County Park	Monterey County Parks	Prunedale	228
UC Natural Reserve	University of California	Fort Ord	244
Fort Ord Public Lands	BLM	Fort Ord	1986[(1)]
Laguna Seca County Park	Monterey County Parks	Fort Ord	13
Monterey Airport	Monterey Peninsula Airport District	Monterey Airport	19
Jacks Peak County Park	Monterey County Parks	Jacks Peak	8
S. F. B. Morse Preserve	Del Monte Forest Foundation	Del Monte Forest	0.5[(2)]
Palo Corona/Point Lobos Ranch	Big Sur Land Trust	Palo Corona/Gibson Canyon	567
Lobos Ranch/Marks Addition/Garrapata	California State Parks	Palo Corona/Gibson Canyon	161
Toro County Park	Monterey County Parks	Toro Park/Pine Canyon	1889[(3)]
(total public/protected lands)			5495

[(1)]Will increase substantially after additional lands are cleared of unexploded ordnance and transferred to the Bureau of Land Management.
[(2)]Maritime chaparral patches excluding forest understory.
[(3)]Inland chaparral.

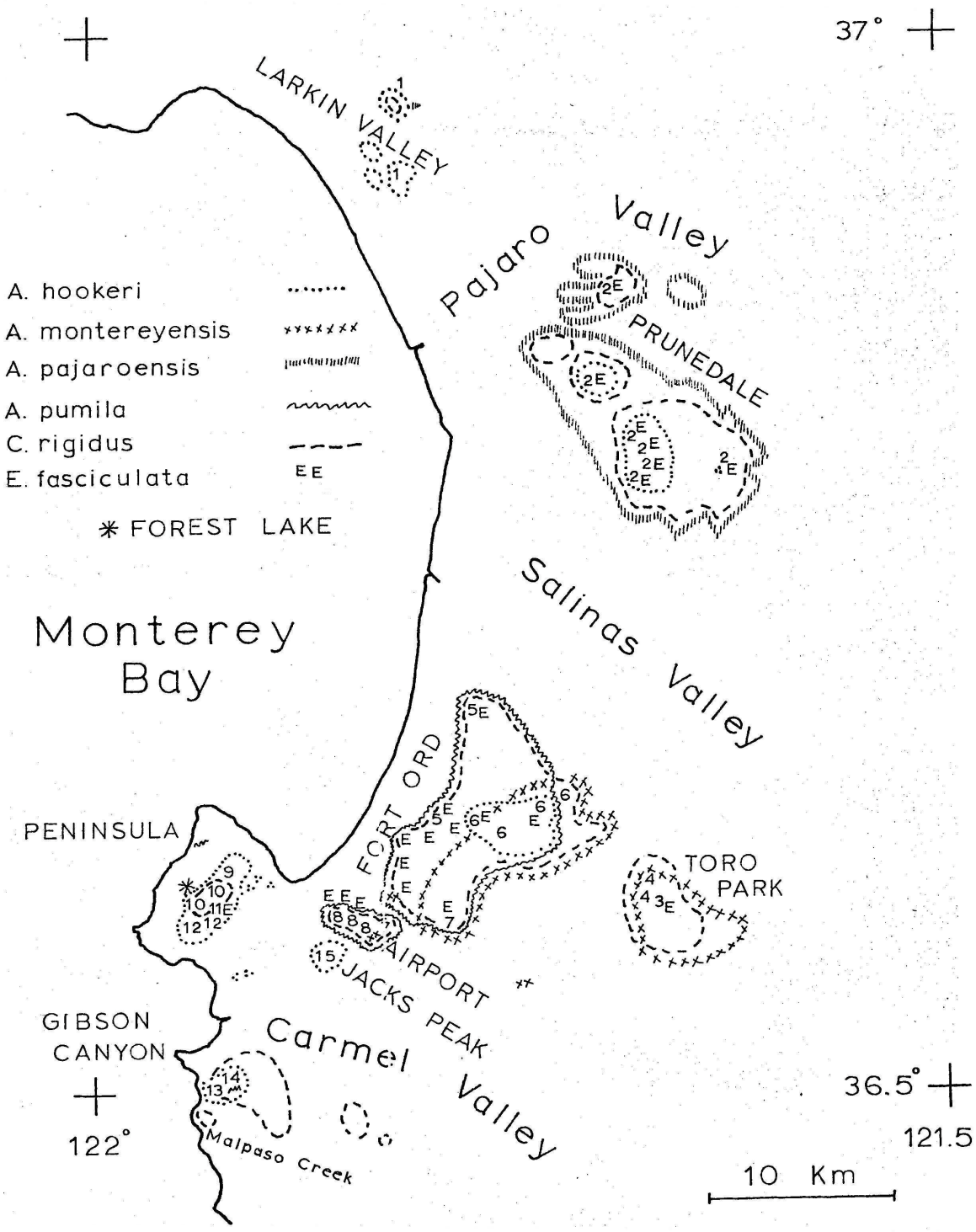

Figure 1. Maritime chaparral shrub distribution from Griffin (1978).

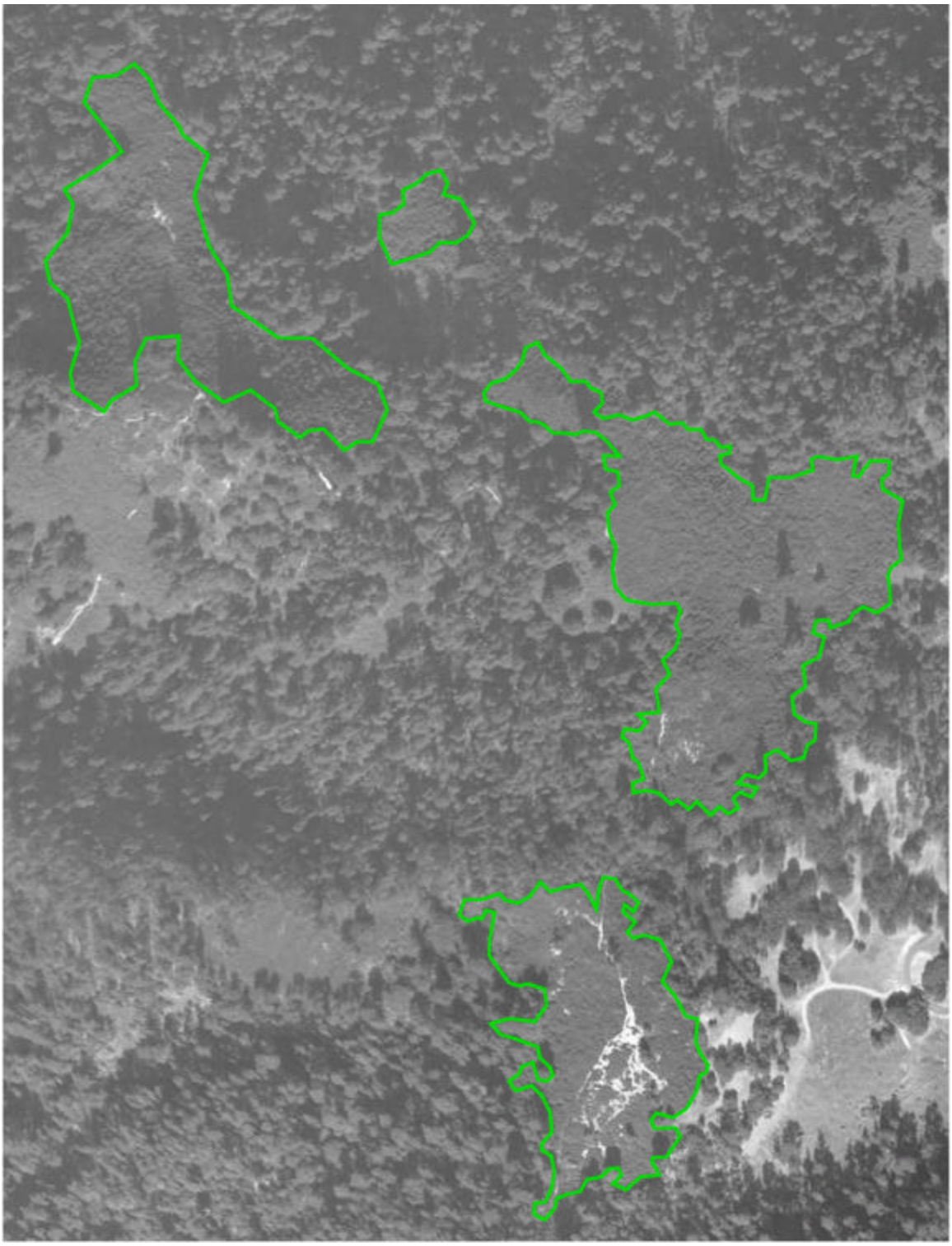

Figure 2. Digitized chaparral polygons near Jacks Peak County Park.

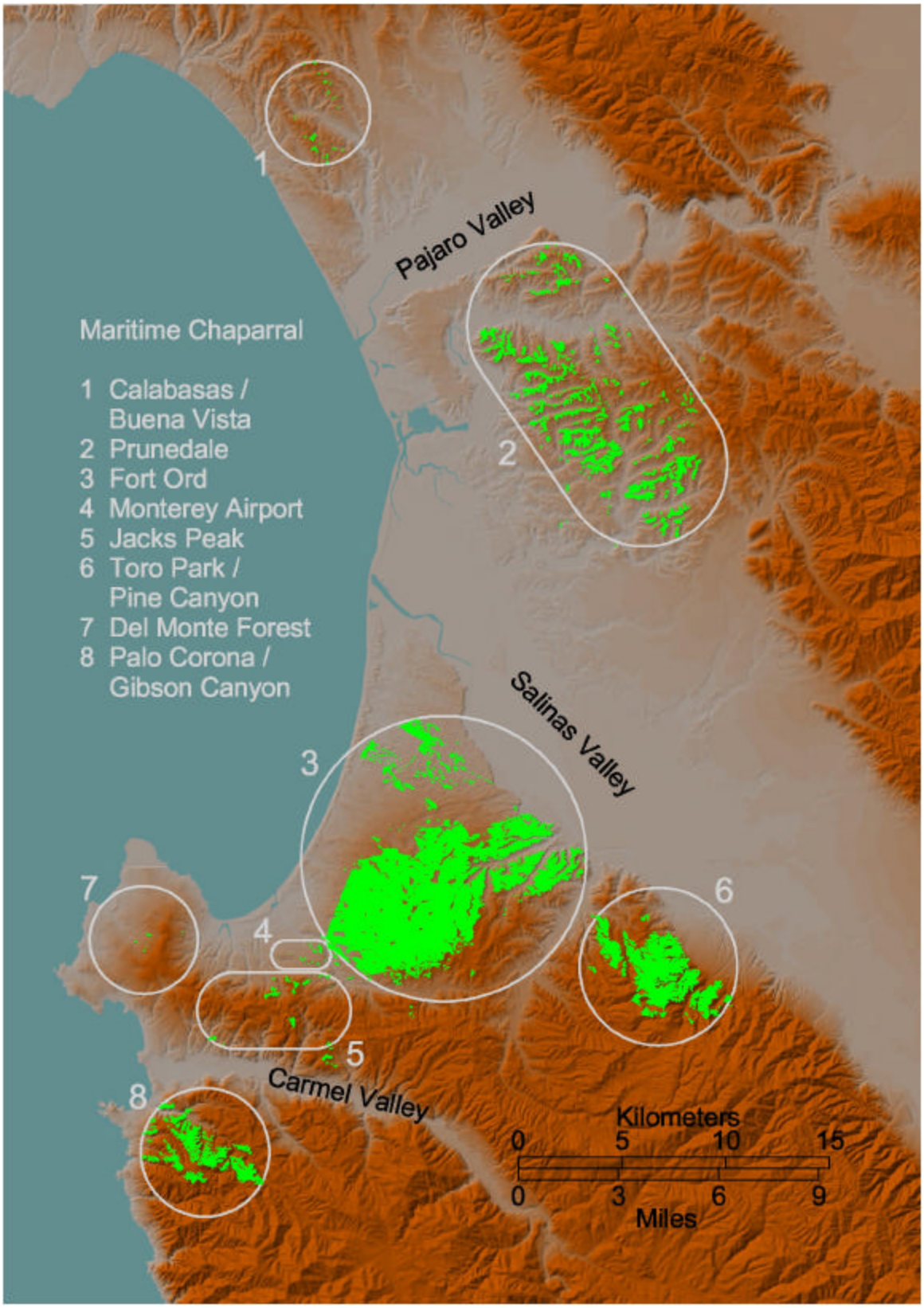

Figure 3. Maritime chaparral in the Monterey Bay area.

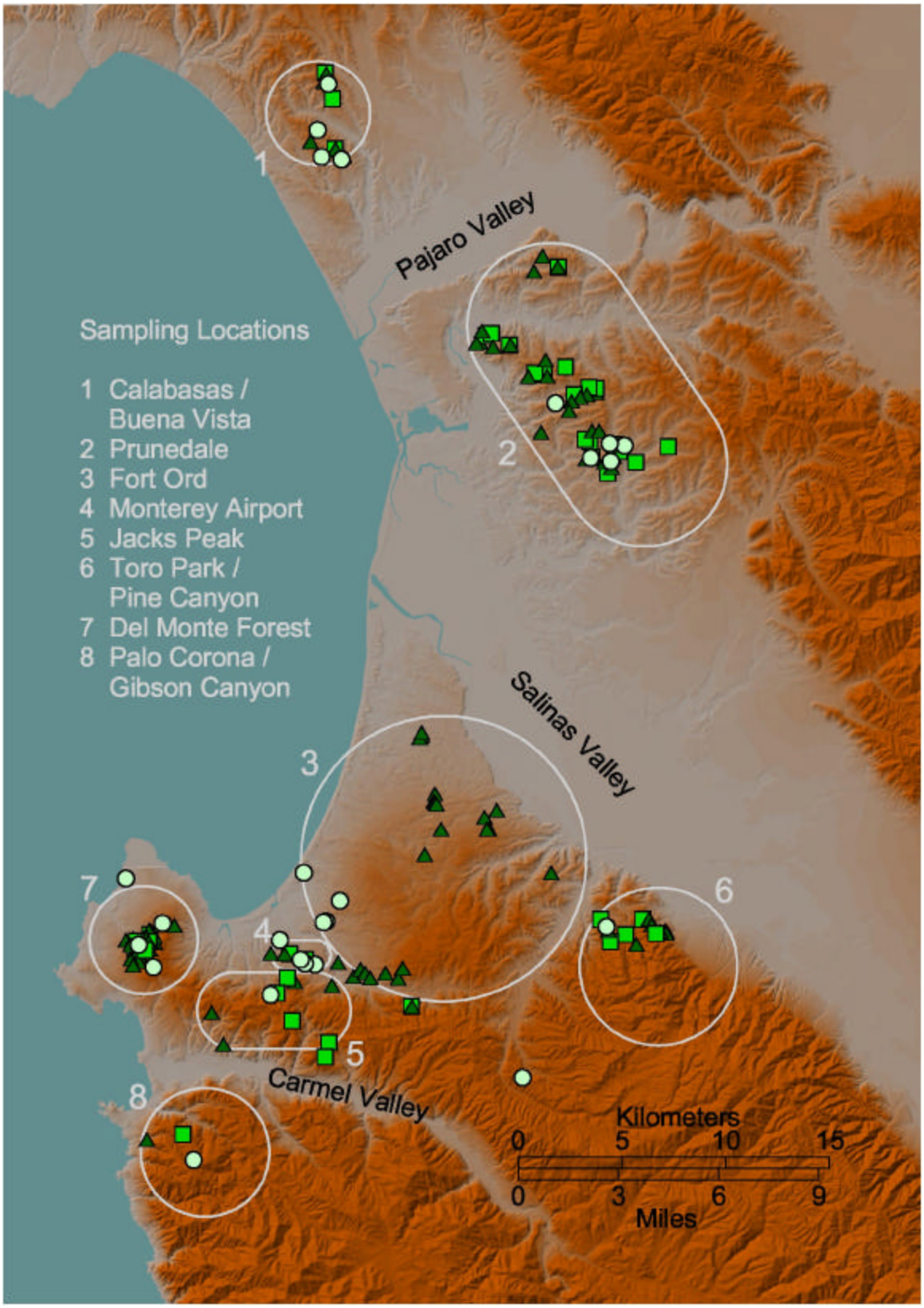

Figure 4. Maritime chaparral sampling locations. Squares represent sampling plots, triangles represent single species occurrences, and circles represent voucher specimens.

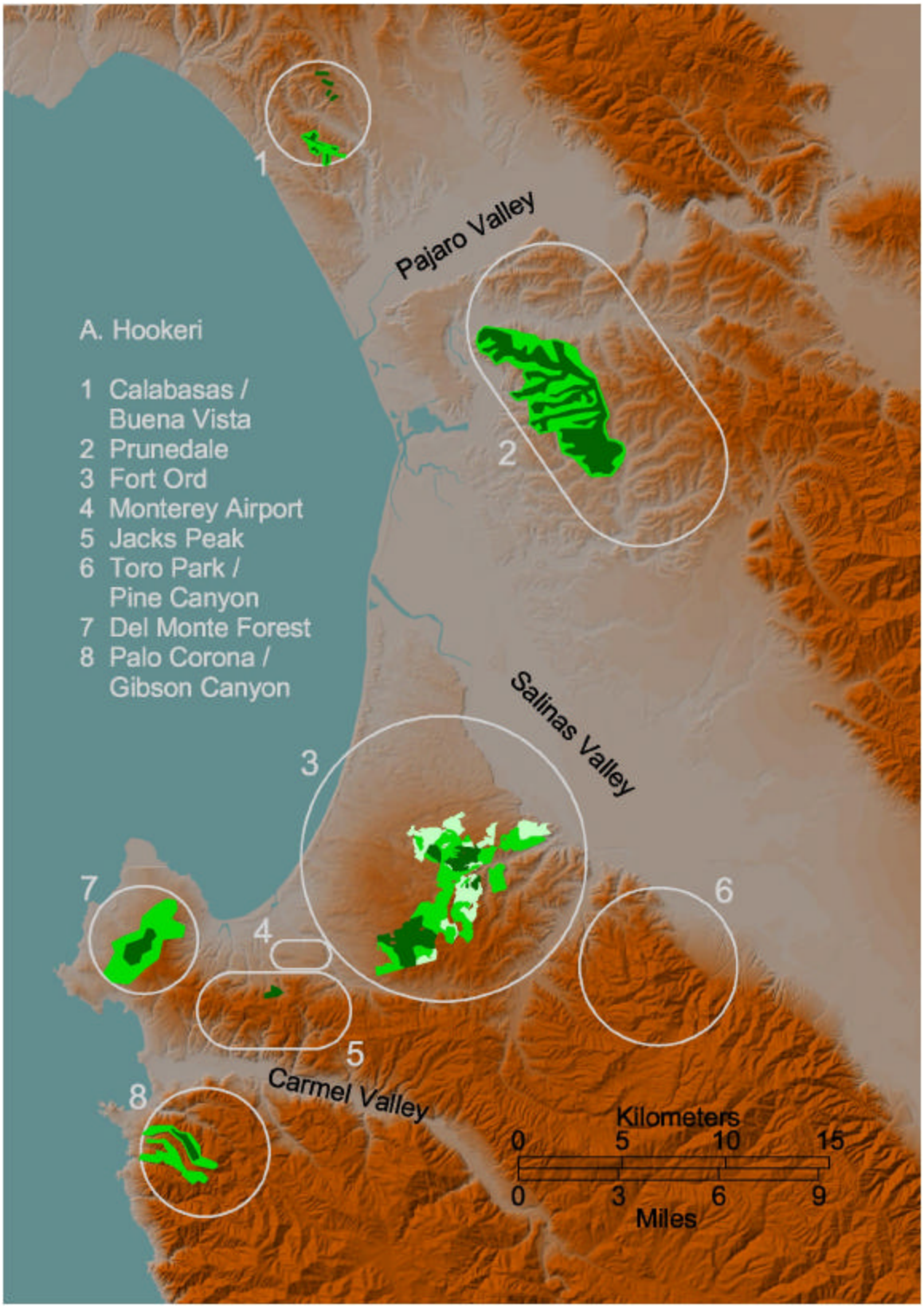

Figure 5. Estimated distribution of *A. hookeri* ssp. *hookeri*. Darker shades of green represent higher densities.

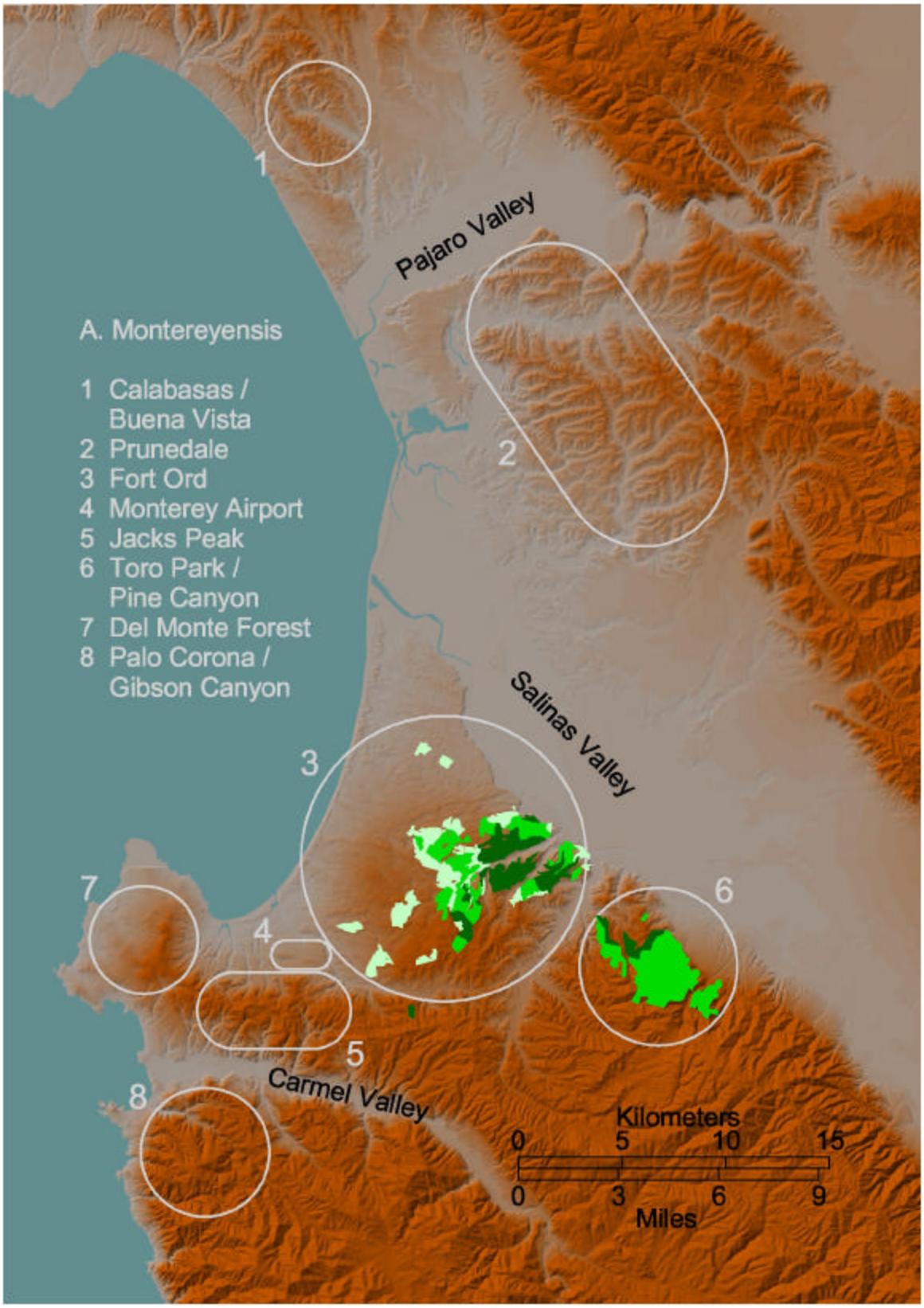

Figure 6. Estimated distribution of *A. montereyensis*. Darker shades of green represent higher densities.

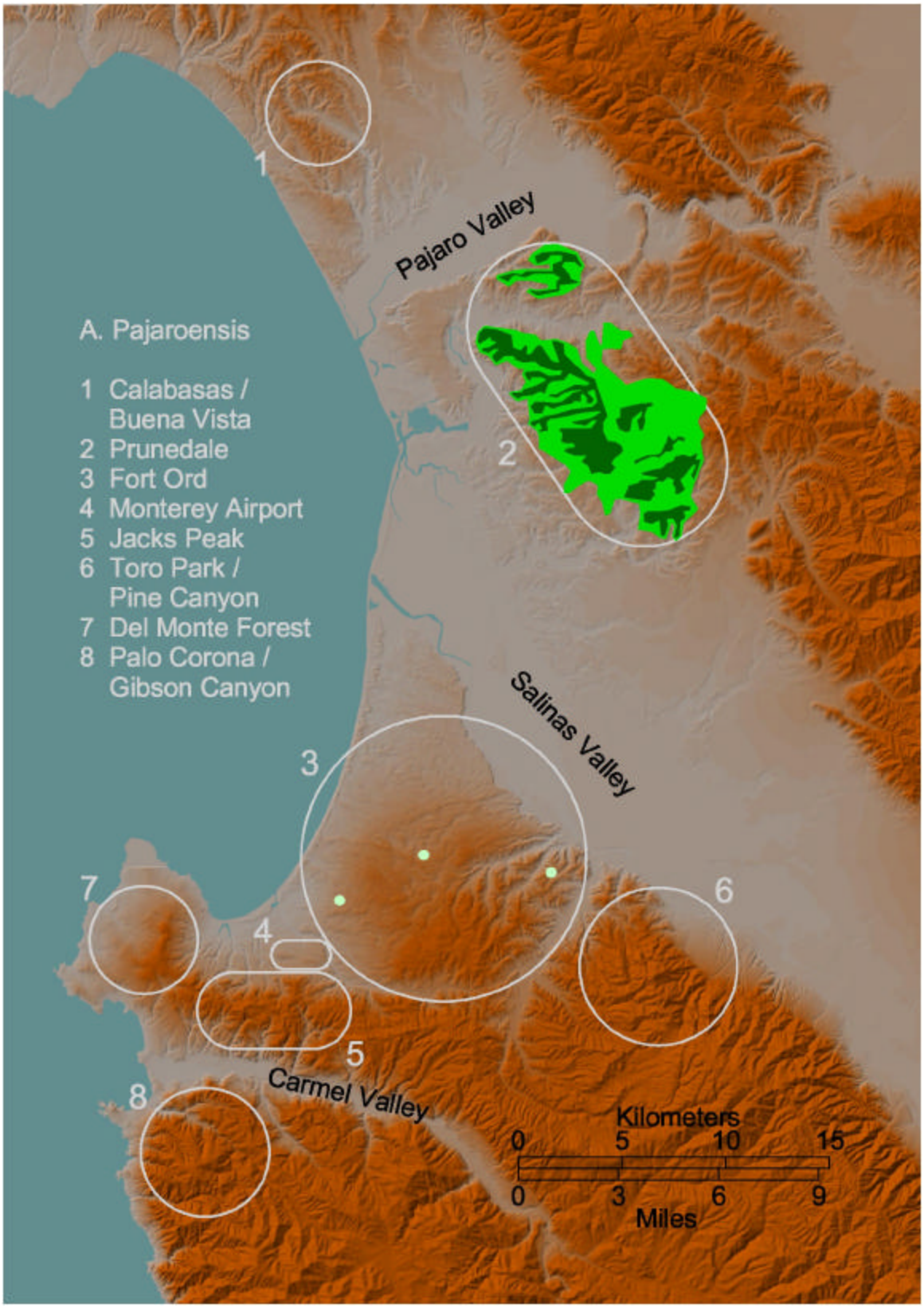

Figure 7. Estimated distribution of *A. pajaroensis*. Darker shades of green represent higher densities.

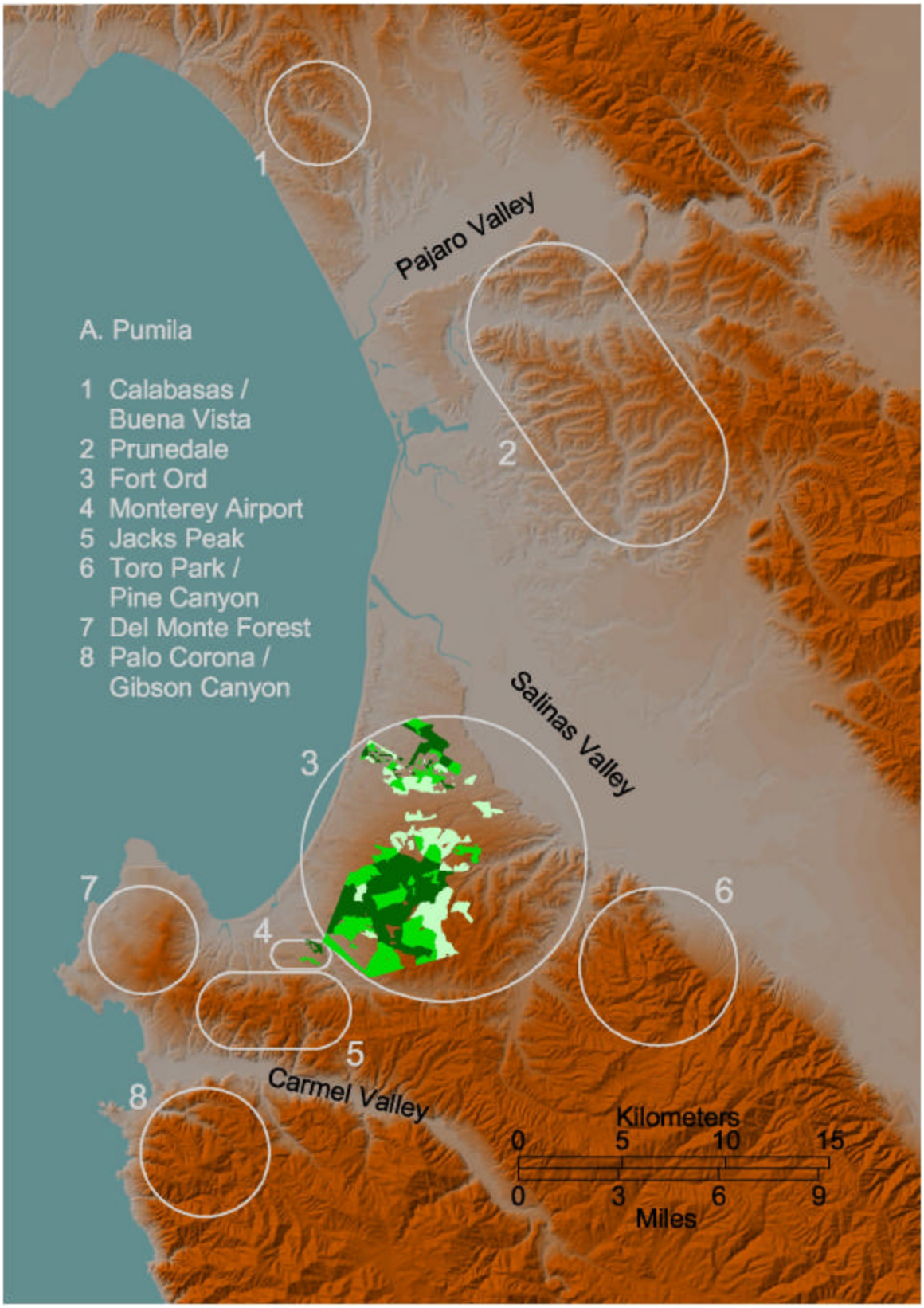

Figure 8. Estimated distribution of *A. pumila*. Darker shades of green represent higher densities.

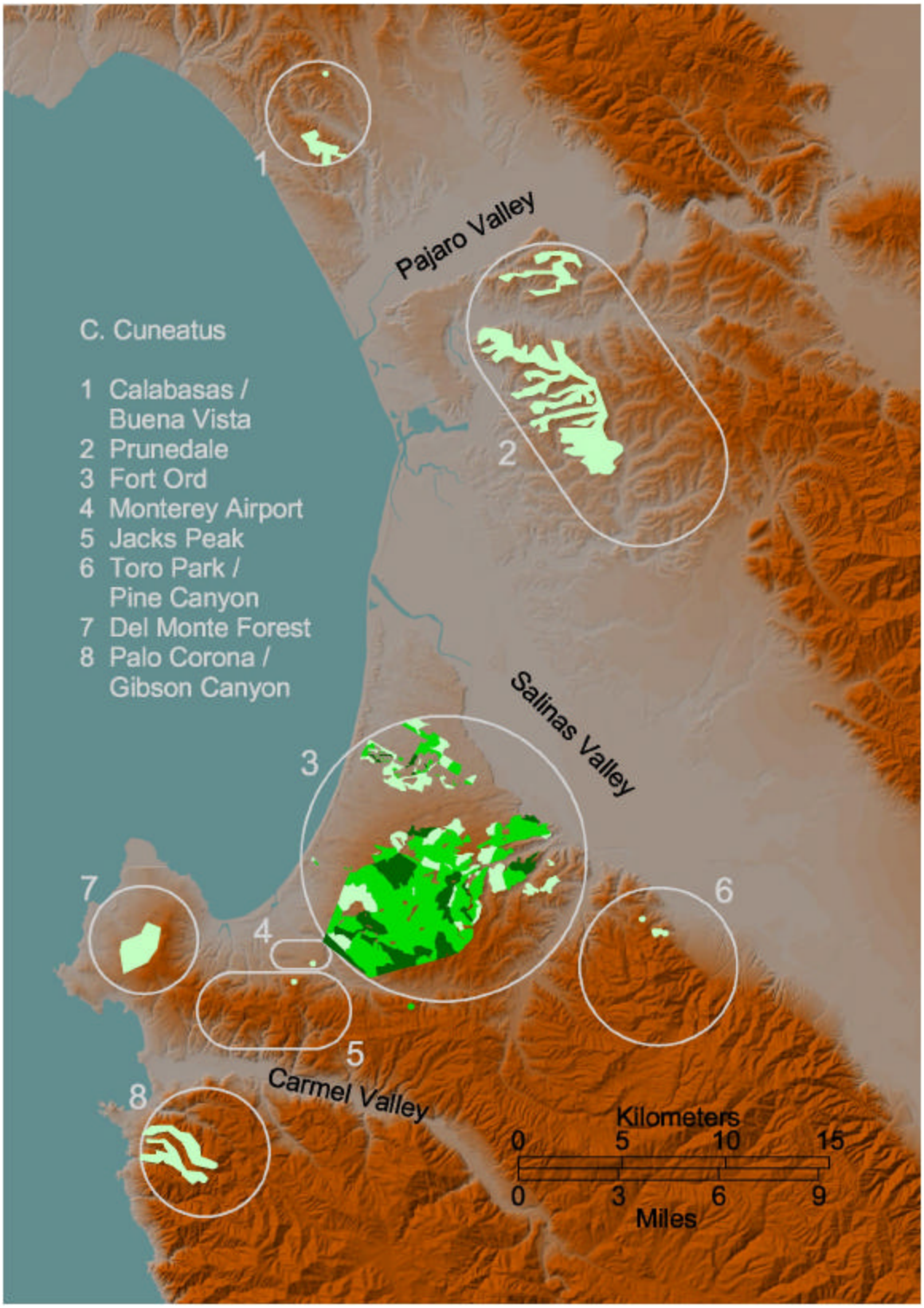

Figure 9. Estimated distribution of *C. cuneatus* var. *rigidus*. Darker shades of green represent higher densities.

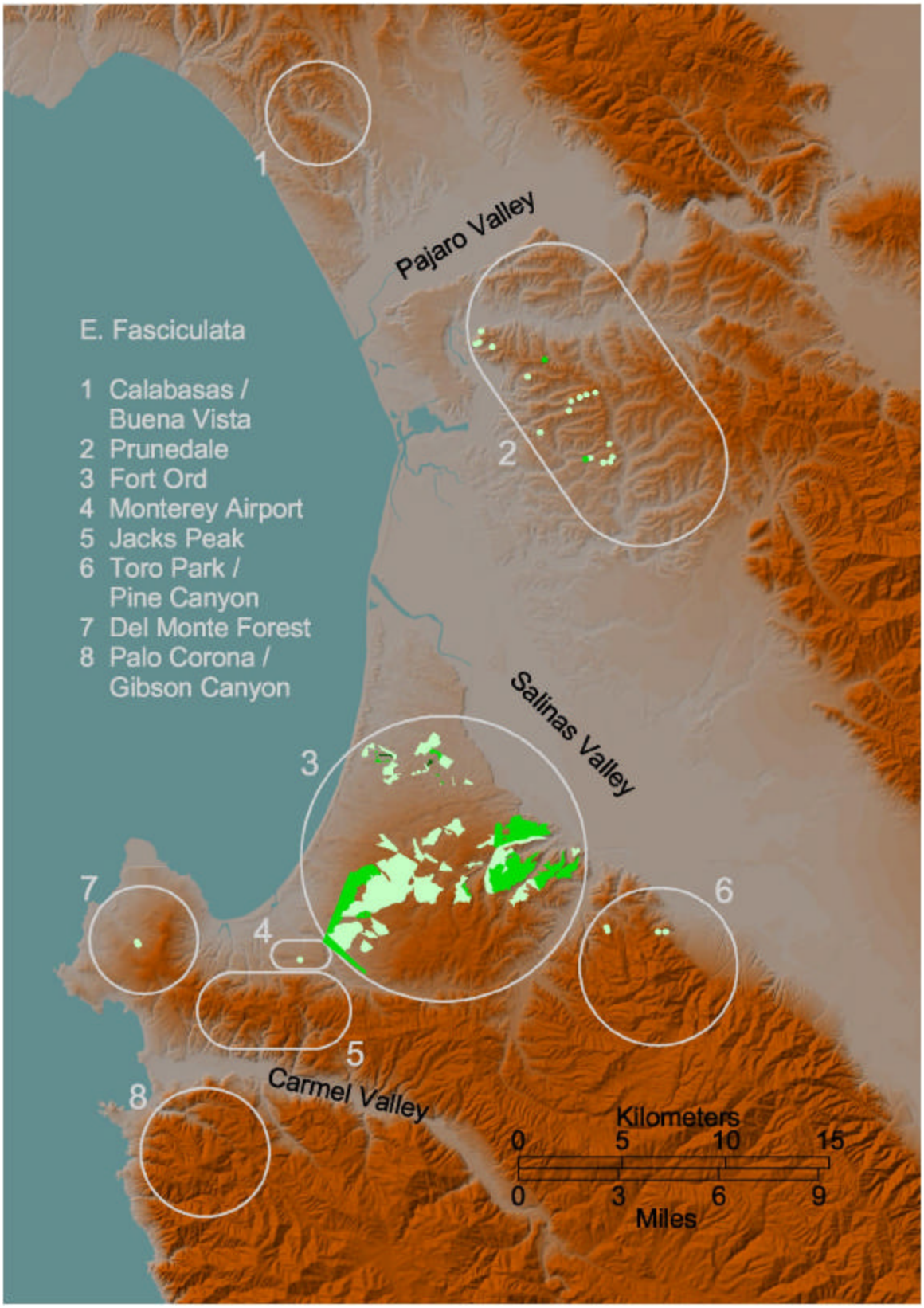

Figure 10. Estimated distribution of *E. fasciculata.* Darker shades of green represent higher densities.

Appendix 1. ArcView GIS shapefiles and legend files on the accompanying CD.

Coordinate System: Universal Transverse Mercator, Zone 10N, Meters.
Datum: WGS84.

Directory\File	Contents
\digitize\chaparral.shp	Maritime chaparral patch boundaries [polygon]
\digitize\css.shp	Selected coastal sage scrub patch boundaries (resolution of ambiguous interpretation) [polygon]
\digitize\species.shp	Field sampling locations and species percent cover estimates [point]
\digitize\species.avl	Legend for display of all records in "species.shp"
\digitize\arcHoo.avl	Legend for display of *A. hookeri* ssp. *hookeri* records in "species.shp"
\digitize\arcMon.avl	Legend for display of *A. montereyensis* records in "species.shp"
\digitize\arcPaj.avl	Legend for display of *A. pajaroensis* records in "species.shp"
\digitize\arcPum.avl	Legend for display of *A. pumila* records in "species.shp"
\digitize\ceaCun.avl	Legend for display of *C. cuneatus* var. *rigidus* records in "species.shp"
\digitize\eriFas.avl	Legend for display of *E. fasciculata* records in "species.shp"
\digitize\protected.shp	Boundaries of public and protected lands [polygon]
\estimate\arcHoo.shp	Estimated density of *A. hookeri* ssp. *hookeri* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\arcMon.shp	Estimated density of *A. montereyensis* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\arcPaj.shp	Estimated density of *A. pajaroensis* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\arcPum.shp	Estimated density of *A. pumila* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\ceaCun.shp	Estimated density of *C. cuneatus* var. *rigidus* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\eriFas.shp	Estimated density of *E. fasciculata* [polygon] Incorporates USACE/Jones & Stokes (1992) mapping
\estimate\density.avl	Legend for display of density estimates in "arcHoo.shp", "arcMon.shp", "arcPaj.shp", "arcPum.shp", "ceaCun.shp", and "eriFas.shp"