Potential Extent of Vineyard Development in the Santa Monica Mountain National Recreation Area

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Abstract

The Santa Monica Mountains National Recreation Area (SMMNRA) exists as one of the few large tracts of land in Southern California that provide natural habitat supporting ecological services for both humans and wildlife. Despite conservation efforts, urbanization has already contributed to widespread disturbance throughout the area, and recent trends in the development of vineyards could pose further threats. Additional vineyard development has the potential to severely disturb natural areas, which could result in fragmentation and loss of native species. Our research focuses on the physical and political factors that constrain vineyards. With a better understanding of these constraints, potential locations for further vineyard development can be identified.

Geographic Information Systems (GIS), allow for the organization, manipulation, and spatial representation of data. A literature survey was used to determine physical factors appropriate for vineyard development, and municipal codes were interpreted to determine areas with favorable zoning. Data displaying physical and political constraints were mapped using GIS to represent areas with the potential for vineyard development.

Analysis indicated that unprotected areas in the SMMNRA are at risk of being disturbed by vineyard development. Of the 48, 394 acres in the study site, 62.5% had favorable physical conditions and appropriate zoning for development. A land cover analysis underscored the potential effects of widespread development as 74.5% of native vegetation in the study site was at risk.

Our research seeks to identify areas where vineyard development could potentially occur given current zoning and land use regulations. Identification of vulnerable areas increases environmental awareness and is an important first step in conservation and planning efforts. We anticipate that this research will elucidate the potential degree for future development and serve as an appropriate basis for further research.

INTRODUCTION

Urbanization and land use change have drastically altered land cover along the Southern California coast. The Santa Monica Mountains National Recreation Area (SMMNRA) is one of the remaining large tracts of land in the Los Angeles area that still provide natural habitat for wildlife, as well as various ecosystem services (Swenson, 2000). As an increasing number of private landowners in the SMMNRA begin to explore opportunities for developing hobby vineyards, the consequences on natural ecosystems must be better understood. We attempted to identify potential areas for vineyard development in order to distinguish habitats at risk of disturbance and improve land use policy.

The National Park Service (NPS) manages the SMMNRA, which constitutes recreational, residential, and commercial zones, separating it from many protected areas focused largely on habitat conservation (National Park Service, 2008). Mixed chaparral is the most prevalent type of native vegetation in the SMMNRA, but oak woodlands, coastal sage scrub, savanna, and riparian zones are also common. Additionally, a large portion of land consists of introduced annual grasslands.

Mediterranean regions around the world, including Southern California, are predicted to experience significant biodiversity losses due to changes in climate and land use (Sala, 2000). Furthermore, population growth has a highly positive correlation with the number of threatened animal and plant species in Southern California (Underwood, 2008). Residential, commercial, and agricultural development has put significant pressure on native land cover (Freidin, 2003). These processes, especially in low-lying flat areas characterized by fertile soil and adequate rainfall, have resulted in highly fragmented landscapes with interspersed patches of natural habitat (Underwood, 2009). Conserving native vegetation is vital for the preservation of California's biodiversity. Oak woodlands alone provide critical habitat for more than 60 mammal, 80 amphibian and reptile, and 100 bird species" (Hilty, 2006).

Historically, conservation near urban areas has been difficult due to expensive land prices and high demand for land, as well as a tendency to favor development over protection (Swenson, 2000). Although large tracts of land remain undeveloped, protection within the SMMNRA has proved complicated as nearly half (over 70,000 acres) of the land is privately owned (NPS, 2008). Private development can be difficult to monitor and may violate zoning policies. Additionally, the SMMNRA spans numerous cities and unincorporated areas in Los Angeles County that each use differing zoning ordinances, which further complicates conservation efforts. Despite these obstacles, both government and private conservation agencies have been successful in preserving fragments of natural land cover on a parcel-to-parcel basis (Swenson, 2000). Improved understanding of how development alters landscapes and influences natural processes allows conservationists to prioritize threatened areas for protection and direct future research efforts.

Our research focuses on the identification of current vineyards and potential areas for future vineyard expansion within the unprotected areas of the SMMNRA. Potential vineyard extent was mapped under a "maximum development scenario" using zoning

policies and physical characteristics as constraints, and vegetation types that were at high risk of being displaced or disturbed by development were also identified. Existing vineyards were primarily identified using Google imagery. The extent of maximum development and displaced vegetation are important due to the adverse effects that vineyard development may have on an ecosystem. Displacement of natural vegetation is a direct cause of habitat loss and is disruptive to ecosystem health (Fairbanks, 2004). Development effects include fragmentation and increased edge effects decreases in habitat size and complexity, changes in predominant vegetation types, effects on local hydrology, water pollution, soil erosion, and air pollution (Foley, 2005; Heaton, 2000).

Over two thirds (68%, 32972.16 acres) of our study site lies in unincorporated areas of Los Angeles County. Unincorporated Area in the SMMNRA is made up of two planning zones, the Coastal Zone and the North Area, each with different protected areas. In recreation areas, the Coastal Zone "extends inland to the first major ridgeline paralleling the sea or five miles from the mean high tide line of the sea, whichever is less" (California Coastal Act, 2010).

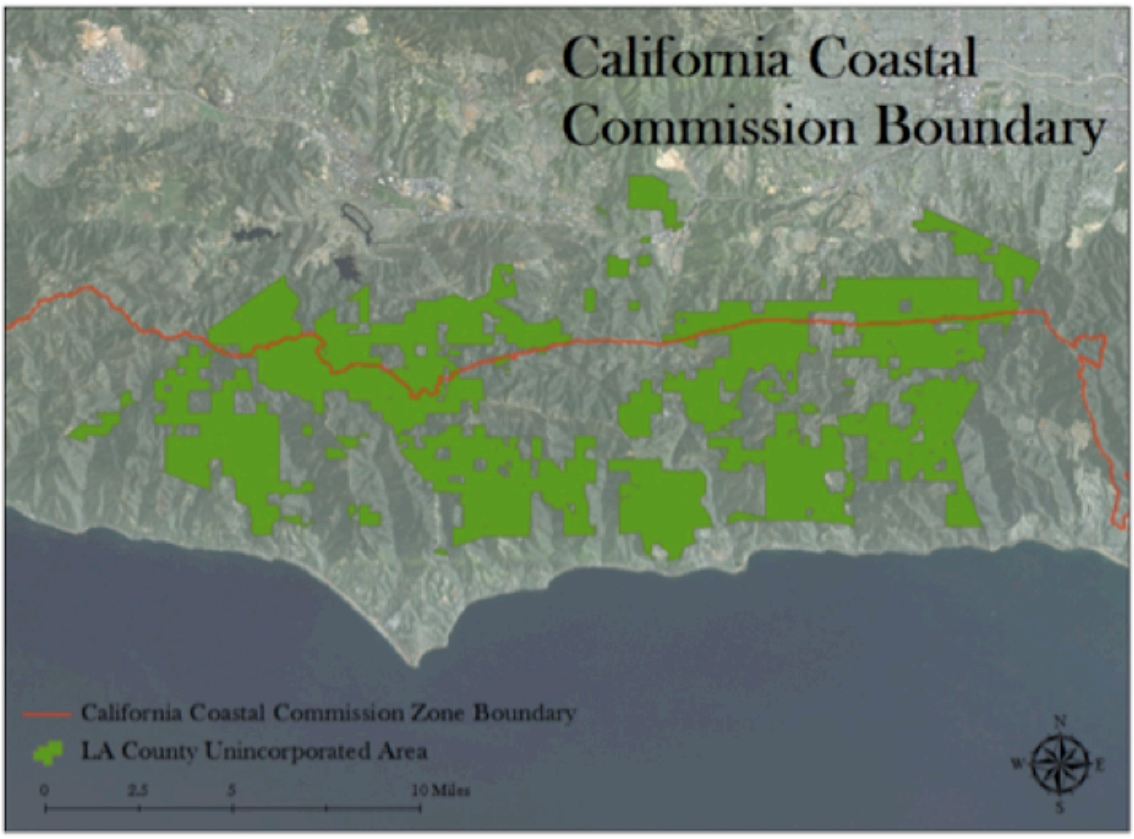

Figure 1: California Coastal Commission Boundary separating the Coastal Zone and the North Area of the study site.

The Coastal Zone sets aside *Significant Environmental Resource Area* (SERA) to be protected from development. Within SERAs are even more highly protected areas set aside under the California Coastal Act as *Environmentally Sensitive Habitat Area* (ESHA). These areas have

been designated as those in which rare natural habitat serves a unique or necessary ecosystem function and are vulnerable to degradation from human activity or development. Such areas include riparian areas, streams, native woodlands, native grasslands/savannas, chaparral, coastal sage scrub, dunes, bluffs, and wetlands (Malibu Local Coastal Land Use Plan, 2002). ESHAs are protected for research and educational purposes, as well as for resource-dependent development.

ESHA buffer zones, which project 100-200 feet from ESHA, are also protected "to serve as transitional habitat and provide distance and physical barriers to human intrusion." Vineyard development in ESHA is prohibited and Malibu's Environmental Review Board must review development within buffer zones 200 feet of ESHA. No more than 25% or 10,000 square feet, whichever is smaller, may be developed in ESHA (Malibu Local Coastal Land Use Plan, 2002).

The North Area, which is located north of the Coastal Zone, sets aside *Significant Ecological Areas* (SEAs) to be protected. SEAs are habitats that are home to "unique, rare, or endangered species, or areas of habitat that are rapidly declining in Los Angeles County" and are in danger of decline due to human disturbance (Santa Monica Mountains North Area Plan). They include "[1]habitats for rare and endangered species… [2]restricted natural communities… [3]habitats restricted in distribution in the County; [4]breeding or nesting grounds; [5]unusual biotic communities; [6]sites with critical wildlife and fish value; and, [7]relatively undisturbed habitat" (LA County General Plan). ESHAs, SEAs are set aside for research, educational purposes, and other resource-dependent activities, rather than for recreation or resource harvest.

Vineyard development within SEAs is allowed, but plans for such development must be reviewed by LA County's Significant Ecological Area Technical Advisory Board (SEATAC), which will suggest mitigation measures in order to minimize impacts on local ecosystems if necessary. Review is on a case-by-case basis and the LA County General Plan allows for the use of different "preservation techniques" depending on various factors such as the value of the resource, site suitability, or the risk of damage due to development (LA County General Plan).

Methodology

Study Site

The study site for this project consisted of the unprotected areas within the SMMNRA that are within Los Angeles County. The SMMNRA as a whole contains roughly 150,000 acres of land and has been established as a National Recreation Area since 1978 (NPS, 2008). The majority of the land within the study site includes unincorporated areas of Los Angeles County. The other areas include the following incorporated cities: Malibu, Westlake Village, Agoura Hills, Calabasas, and Los Angeles.

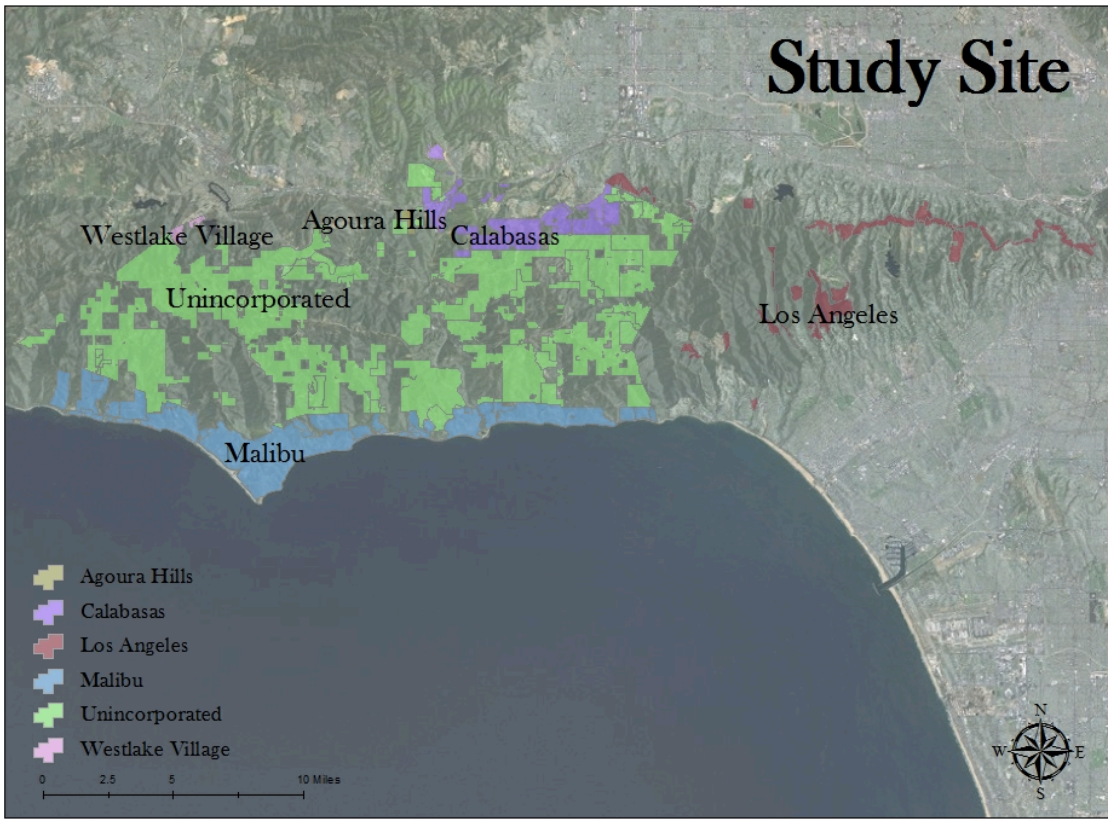

Figure 2: The study site within the unprotected section of the Santa Monica Mountain Recreation Area

The study area was determined using the following three shape files: the Los Angeles County boundary from the LA County GIS Data Portal, the SMMNRA tracts boundary from the National Park Service, and the major and minor roads boundary from the LA County GIS Data Portal. In ArcMap areas within both the SMMNRA and Los Angeles County were selected using the 'Intersect' tool. The protected areas were then removed from the study site using the 'Erase' tool because development within these areas is prohibited by the NPS. Existing roads were classified into three different groups according to size by using the 'Measure' tool, and buffers were applied to each group using the 'Buffer' tool. A 160-foot buffer was applied to the 101 Freeway, a 60-foot buffer to the Pacific Coast Highway, and a 30-foot buffer was applied to all other roads. The roads, as well as their surrounding buffers, were then removed from the study site using the 'Erase' tool. The result of this was then projected using the projected coordinate system 'NAD_1983_StatePlane_California_V_FIPS_0405_Feet'.
This final resulting shapefile included only unprotected areas within the SMMNRA existing in Los Angeles County where roads were not present.

Preparation of Layers

The following obtained layers were all originally clipped to the study site using the 'Intersect' tool and projected in the projected coordinate system 'NAD_1983_StatePlane_California_V_FIPS_0405_Feet' using the 'Project' tool.

SEA.shp
ESHA.shp
SERA.shp
malibu_ESHA.shp

slope.shp
vegetation.shp

agoura_zoning.shp
calabasas_zoning.shp
la_city_zoning.shp
la_unincorporated_zoning.shp
malibu_zoning.shp
westlake_zoning.shp

All of the data used in this analysis or represented in these maps comes from one of these original layers or from a modified version of these layers.

Maximum Development Scenario

In order to determine the potential sites for vineyard development, this study considered the main physical and zoning constraints that impede vineyard development. A maximum development scenario was mapped that took into account physical constraints, including the presence of bodies of water, rock outcrop, beach sand, and steep slopes and zoning constraints, including zoning regulations and locations of SERA and SEA in LA Unincorporated Areas and ESHA in Malibu. These factors were considered because they would either make development unfeasible or prohibited by law.

Physical Constraints

Because roads were removed in the derivation of the study site, they did not need to be considered as a physical constraint.

Areas within the study site that contained rocky outcrops, beach sand, or bodies of water were removed because development in these areas would be unlikely. Land cover shape files from 2007 were obtained from the NPS and selected by attribute to depict all areas primarily composed of rock, sand or water. Areas within the study site that contained rocky outcrop, sand, or bodies of water were removed using the 'Erase' tool.

Slopes greater than 1:3 (33 percent) were excluded from the study site because steep slopes are more difficult, costly, and hazardous to develop on. Development on slopes greater than 33 percent was determined to be improbable for two reasons. First, the City of Malibu's zoning code prohibits development on slopes greater than 33 percent due to its difficult and disruptive nature, so it is likely that development on slopes greater than 33 percent in other areas would also be improbable. Second, the literature suggests that

development on slopes greater than 15 percent is unlikely because these slopes can be dangerous to operate equipment on and is quick to erode (Kurtural, 2002). In order to provide a conservative value 33 percent, not 15 percent, was chosen as the cutoff value. Slope raster files were obtained from the USGS National Elevation Dataset. The slope was classified as a percentage using the 'Surface Analysis' tool, and the resulting raster file was converted to a shape file using the 'Raster to Polygon' tool. Areas within the study site that exceeded a 33 percent slope were reclassified as 'not permitted' despite zoning in the area.

After applying these physical constraints, the study site was classified into the following two categories: favorable area and unfavorable area for development.

Zoning Constraints

After survey by physical constraints, favorable areas were analyzed using zoning constraints. The constraints considered were the zoning regulations that are enforced by the different governing bodies within the study area. These included the Los Angeles County Department of Planning for the unincorporated areas and the planning departments of the City of Malibu, the City of Westlake Village, the City of Agoura Hills, the City of Calabasas, and the City of Los Angeles for the incorporated cities. To define accurate zoning constraints within the study site, we interpreted the municipal code for each area. To ensure accurate interpretation, we also contacted the planning departments of Los Angeles County and each of the incorporated cities. A summary of zoning constraints can be found in the Appendix (Table A-1).

Zoning shape files for the unincorporated areas of Los Angeles County were obtained from the LA County GIS Data Portal. Zoning shape files for the incorporated cities were obtained directly from their respective planning departments. The City of Agoura Hills did not have zoning shape files for use, so these shape files were digitized in ArcMap from existing maps in Portable Document Format.

In addition to zoning type, SERA and SEA were also taken into account in the LA County unincorporated areas. Both of these shape files were obtained from the LA County GIS Data Portal. Because ESHA SERA and non-ESHA SERA have different barriers to development, the SERA shape file was sorted by attribute to create two separate shape files: one representing ESHA and one representing the remaining SERA including Significant Woodlands and Savannas, Significant Watersheds, and Watersheds. Using the 'Buffer' tool, a 200-foot buffer was placed around all ESHA. The ESHA buffer, SERA not containing ESHA, and SEA shape files were then combined using the 'Union' tool to create a shape file representing areas that required either ERB or SEA-TAC approval for development.

ESHA was also taken into account in the City of Malibu. ESHA shape files were obtained from the City of Malibu's Department of Planning. A 200-foot buffer was placed around all ESHA using the 'Buffer' tool.

Maximum Development Scenario – Calculations

We determined the Maximum Development percentages in our Results Section with the following calculations:

- (1) % of study site with favorable physical constraints = acreage with favorable constraints total acreage in study site

- (2) % of favorable area with development potential = acreage with potential due to zoning total favorable acreage

Equations (1) and (2) hold within each city and Unincorporated Area, as well for the entire study site.

We determined the Maximum Development percentages in our Discussion Section with the following calculations:

- (3) % of study site with development potential by city = acreage with potential total acreage in study site

- (4) % of study site with no development potential = 1– total acreage with potentialtotal acreage in study site

- (5) % of developable Unincorporated Area (or Malibu) requiring ERB or SEATAC review = acreage with potential in SERA or SEA (only SERA in Malibu)total developable acreage of Unincorporated Area (or Malibu)

- (6) % of developable Unincorporated Area requiring Accessory Use Permit = acreage with potential requiring Accessory Use Permittotal developable acreage in Unincorporated Area

Equation (6) holds for Unincorporated Area, Malibu, and Calabasas.

Corresponding tables found in the Appendix (tables A-7 through A-9).

Vegetation at Risk

Land cover analysis was completed to determine what vegetation types were most at risk under the maximum development scenario. The vegetation at risk map was the result of two intersected shape files. From our resulting maximum development scenario map, the areas not permitted for development by zoning, the areas with slopes greater than 33 percent, and the areas with unsuitable land cover, including rock, beach sand, and water, were removed using the 'Erase' tool. This resulted in a new layer where both physical and

zoning constraints permitted vineyard development. Shape files depicting the location of different types of vegetation were obtained from an NPS survey in 2007. Vegetation type was generally classified by affiliation. However, in order to more accurately depict the location of oak woodland, the "riparian woodland" and the "upland tree" classes were both reclassified to depict vegetation type in more detail. The resulting reclassification contained a total of 16 vegetation classes:

Agriculture
CA Bay
CA Sycamore
CA Walnut
Chaparral
Coastal Sage Scrub
Coast Live Oak
Disturbed
Exotic/Invasive
Prairie/Meadow
Mulefat
Sycamore-Live Oak
Valley Oak
Valley Oak-Live Oak
White Alder
Willow

Using the 'Intersect' tool, the two described layers were overlaid, and the area of each vegetation class was calculated.

After calculating areas in ArcMap, the data were analyzed in Excel. Only classes representing native vegetation were considered at risk because these vegetation types are important for maintaining biodiversity in the SMMNRA. Analysis did not include Agoura Hills because there were no areas in Agoura Hills that were deemed developable.

The percentage of each native vegetation type at risk in the study site was computed via a ratio between area at risk and total area classified within the study site. For this portion of analysis, the areas of the four unique classes of oak were summed and represented as one class called oak.

Subsequently, the percentage of total native vegetation at risk within each city or unincorporated area was computed via a ratio between total area of native vegetation at risk within each city and total area of native vegetation classified within each city.

To gain a better understanding of the type of native vegetation at risk, the total area of each native vegetation type in each city or unincorporated area was calculated. The percentage of each native vegetation type at risk in each city or unincorporated area was then calculated using a ratio between area at risk and total area classified in each city or unincorporated area.

Existing Vineyards

Public documentation recording locations of vineyards and visual surveys of imagery in Google Earth were used to find and map the areas where vineyards already existed. The surveyed vineyards included large commercial vineyards, as well as small hobby vineyards. These vineyards were then digitized into polygons in Google Earth and converted to shape files.

In ArcMap, unique vineyards were classified using a parcel boundary shapefile from the LA County GIS Data Portal. Vineyard polygons found in the same parcel or in parcels under the same ownership were combined using the 'Dissolve' tool. The area of each of these dissolved polygons was then calculated in acres using the 'Calculate Geometry' tool. The dissolved polygons were then converted to points using the 'Polygon to Point' tool to accurately determine the number of unique vineyards existing in the SMMNRA.

After the locations of vineyards in the study site were mapped, the vineyard shape file was overlaid on the "maximum development scenario" map and the land cover map for analysis.

Results

Maximum Development

Of the total area of our study site, 73.8% (35,726.49 acres) is characterized by favorable constraints, i.e. land with a slope of less than 33% or land not covered by rock, water, or beach sand. Of the total study site, 62.5% (30,237.88 acres) has the potential for vineyard development (figure 3).

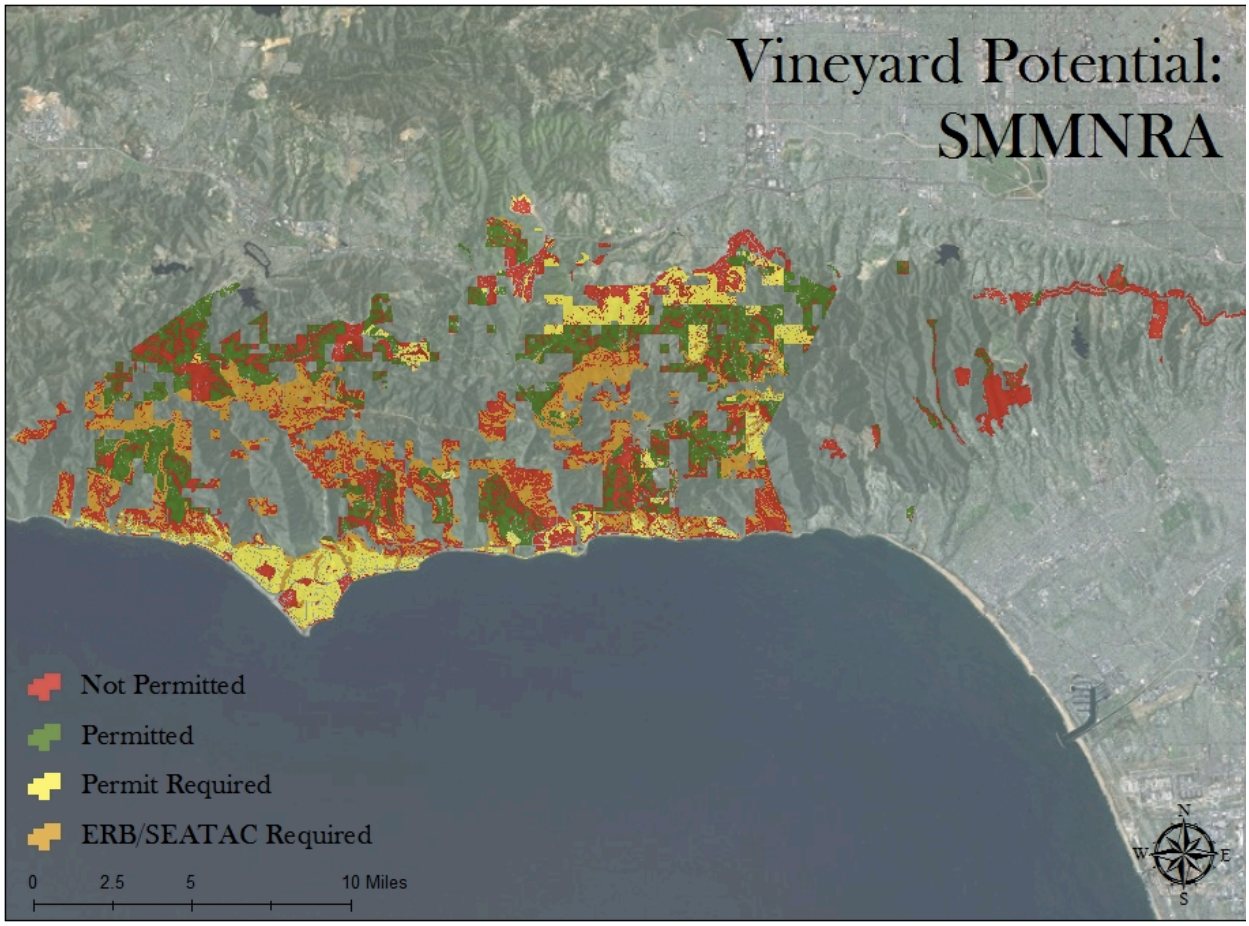

Figure 3: extent of vineyard potential in SMMNRA

Figures A-5 – A-10 display developable area for vineyards under a worst-case scenario within each city. 22,391 acres occur in Unincorporated Areas of LA County, 5,478 acres in Malibu, 1,806.3 acres in Calabasas, 399.1 acres in the City of LA, and 163.5 acres in Westlake Village. There is no potential for development in Agoura Hills due to unfavorable zoning constraints. Figure 4 compares the acreage of potential vineyard expansion under a worst-case scenario.

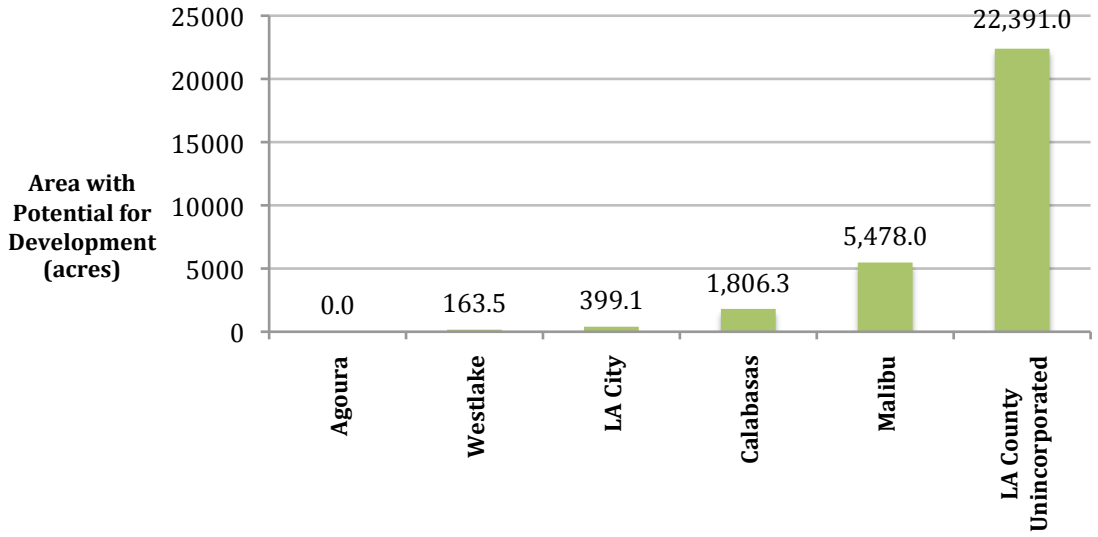

Figure 4: Potential vineyard development per zoning area in acres

As specified earlier, the city of Malibu and Unincorporated Area in LA County have special regulations regarding development in protected areas. Unincorporated Area with favorable conditions for viticulture total 24,099.9 acres. Within these areas, 93.3% has the potential for vineyard development. 6,200.6 acres in Malibu have favorable physical constraints for viticulture and within this, 88.3% has the capacity for vineyard development.

Vegetation at Risk

The percentage of total native vegetation threatened by potential vineyard development over the entire study site of the SMMNRA is shown in Figure 5. Vegetation classified as Prairie/Meadow is most threatened by development with 75% of total Prairie/Meadow area found within the study site being at risk. California Bay is the least threatened with 41% of its coverage at risk. Remaining vegetation types including Oak, California Sycamore, Coastal Sage Scrub, Chaparral, Mulefat, Willow and California Walnut are all at 49% or above risk of potential development. It is important to note for later discussion that all Oak species, which includes Coast Live Oak, Live Oak, Sycamore-Live Oak and Valley Oak, and Valley Oak-Live Oak, are at a 65% risk for displacement by development.

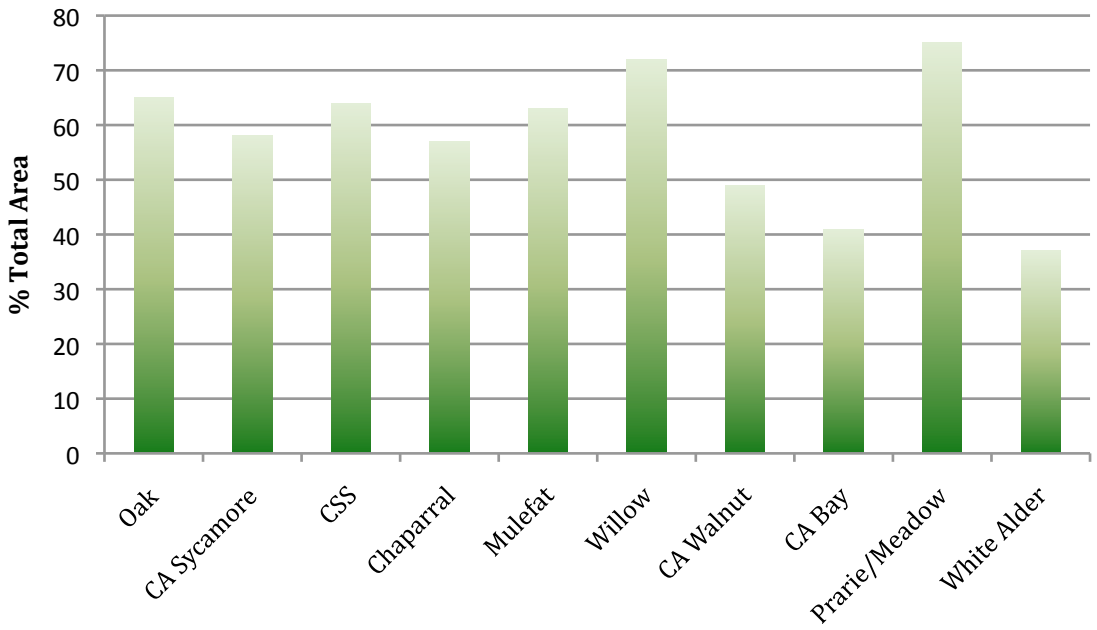

Figure 5: Native vegetation at risk in the SMMNRA

The percentage of total native vegetation within each city of the study site threatened by potential development is displayed in Figure 6. Westlake Village has 93% of its native vegetation at risk, while the City of Los Angeles has only 15% of its native vegetation at risk. Malibu, Calabasas and Los Angeles County are at a 46% risk or higher.

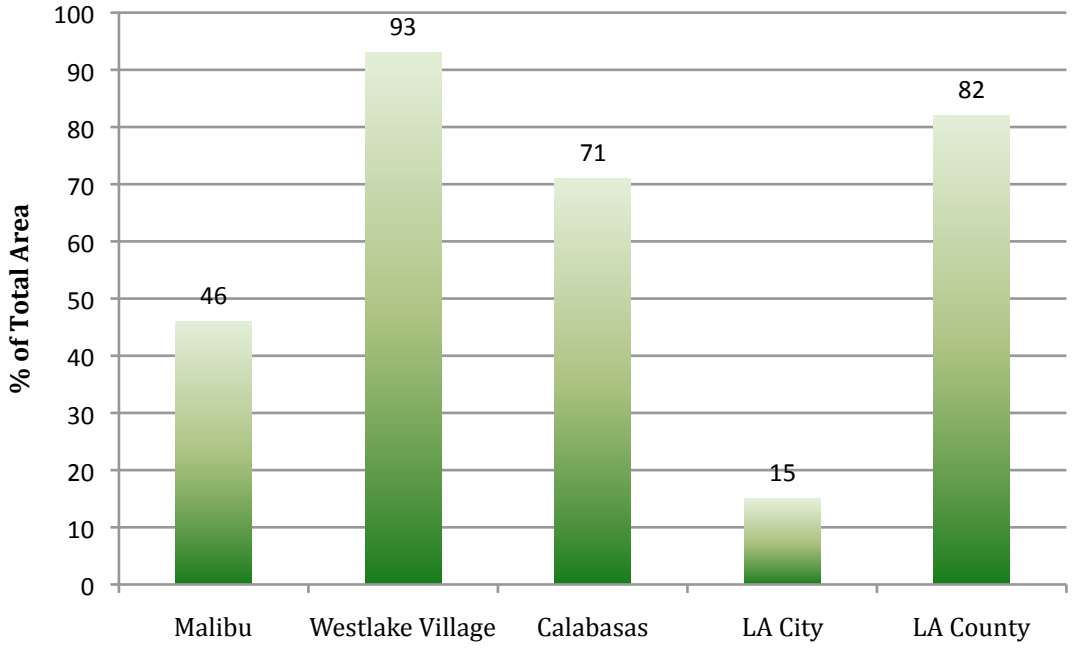

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Figure 6: Percent of total native vegetation at risk in each city

Figures 7-11 (below) compare each city's acreage (bar graphs) of native vegetation against their risk of displacement by development (on the left vertical axis) and measured the percentage (line graph) of area per type at risk within each city compared to each the total coverage throughout the study site of the vegetation type (on the right vertical axis). All bar graphs are displayed in log scale for a better visualization of the wide range in different vegetation areas throughout each city. Tables A-2 through A-6 in the appendix contain data extracted from the produced maps, also in the appendix (figures A-11 – A-15) and reinforce the exact areas and percentages displayed in figures 7 through 11.

The figures show that Chaparral is the largest area at risk in each city with an overall of 13,306 acres at risk. Mulefat is the smallest area at risk with only 6.5 acres endangered. Mulefat is not classified in Westlake and excluded in the graphs for Malibu and Los Angeles City due to areas on the order of one hundredth of an acre.

In Malibu and the City of Los Angeles, the vegetation type with the largest percentage of its coverage at risk is the California Sycamore. 81% is threatened in Malibu and 63% is threatened in the City of Los Angeles. In Westlake Village the Coast Live Oak is all (100%) at risk for displacement due to vineyard development, and in Calabasas, Mulefat is 100% threatened. Valley Oak in Los Angeles County the Valley Oak is 95% in danger.

Figures 7 through 11 show the individual vegetation types amongst the various cities in our study site. It is important to not only acknowledge that all Oak is at a total of 65% risk of displacement within the study site as shown in Figure 5, but to identify Westlake as having the largest percentage of Oak threatened by vineyard development, with 100% at risk, and the City of Los Angeles as the smallest percentage of Oak threatened by vineyard development, with 5% at risk. This will be revisited in later discussion.

Native vegetation that is identified consistently across all cities includes: Coastal Sage Scrub, Coast Live Oak and Chaparral. Thus, 18,597 acres of common native vegetation types among the 5 cities is threatened by development. Recall from Figure 5 that 57% (13,306 acres) of Chaparral is at risk and that Coastal Sage Scrub has 64% (3,475 acres) of its total land coverage at risk throughout the study site. Coast Live Oak is included in previous risk calculations encompassing all Oak species. However this particular Oak species can be singled out from the total Oak calculations because of its commonality among the 5 cities. The subspecies of Coast Live Oak has 66% of its total acreage at risk to development.

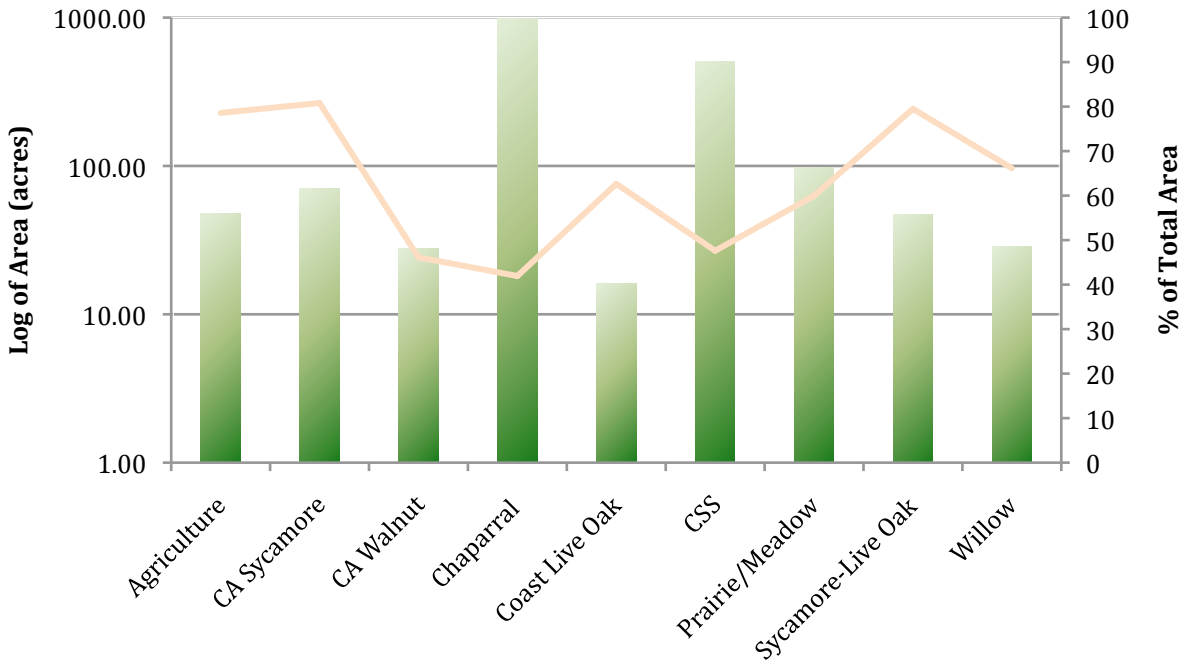

Figure 7: Native vegetation at risk in Malibu

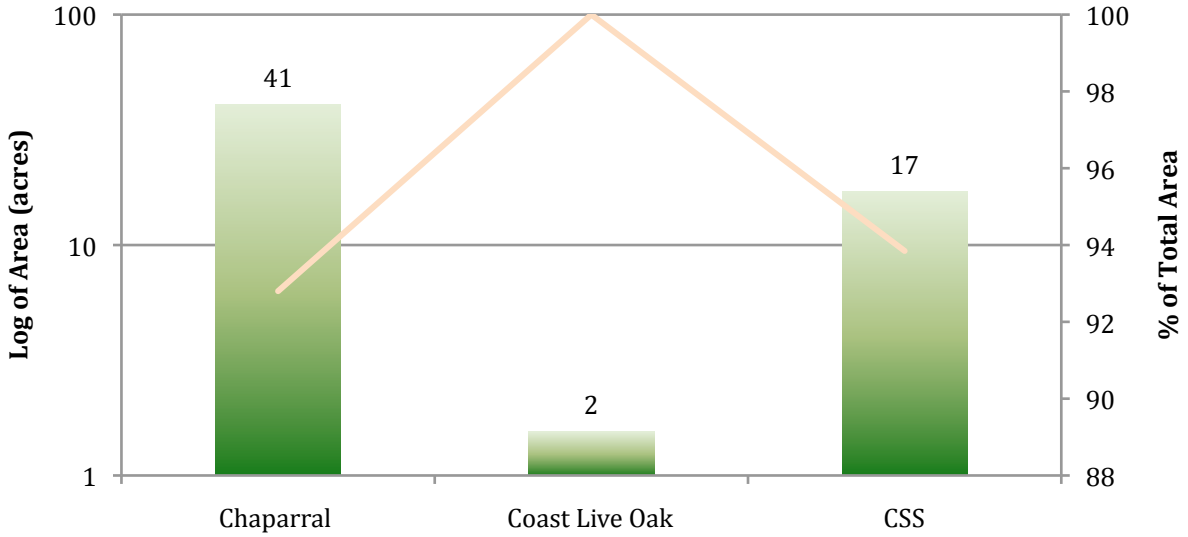

Figure 8: Native vegetation risk in Westlake Village

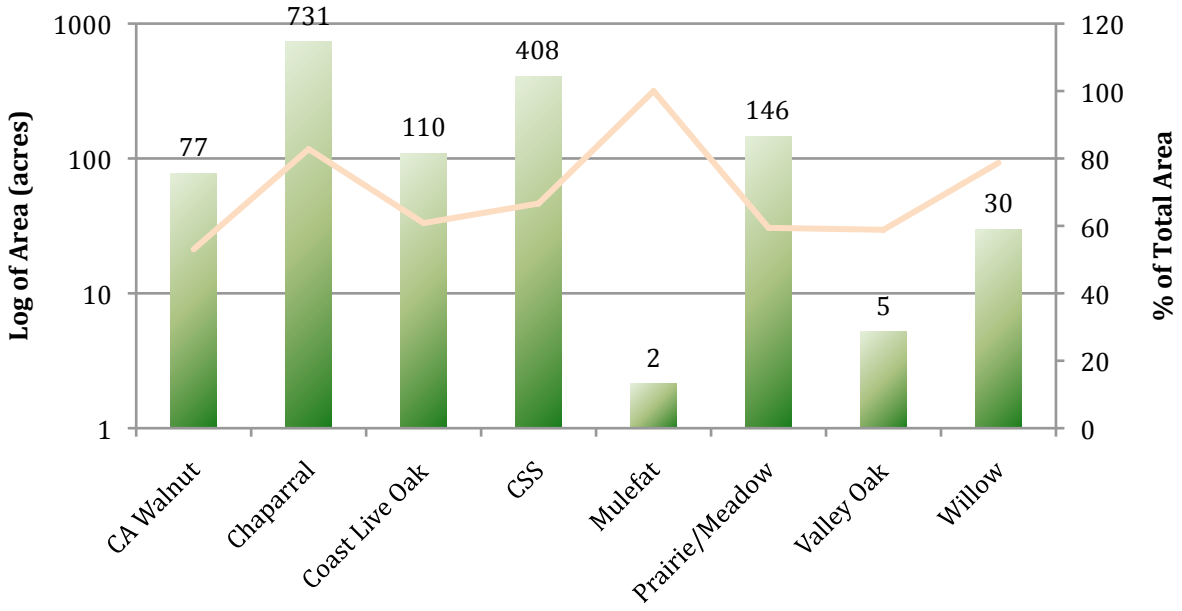

Figure 9: Native vegetation at risk in Calabasas

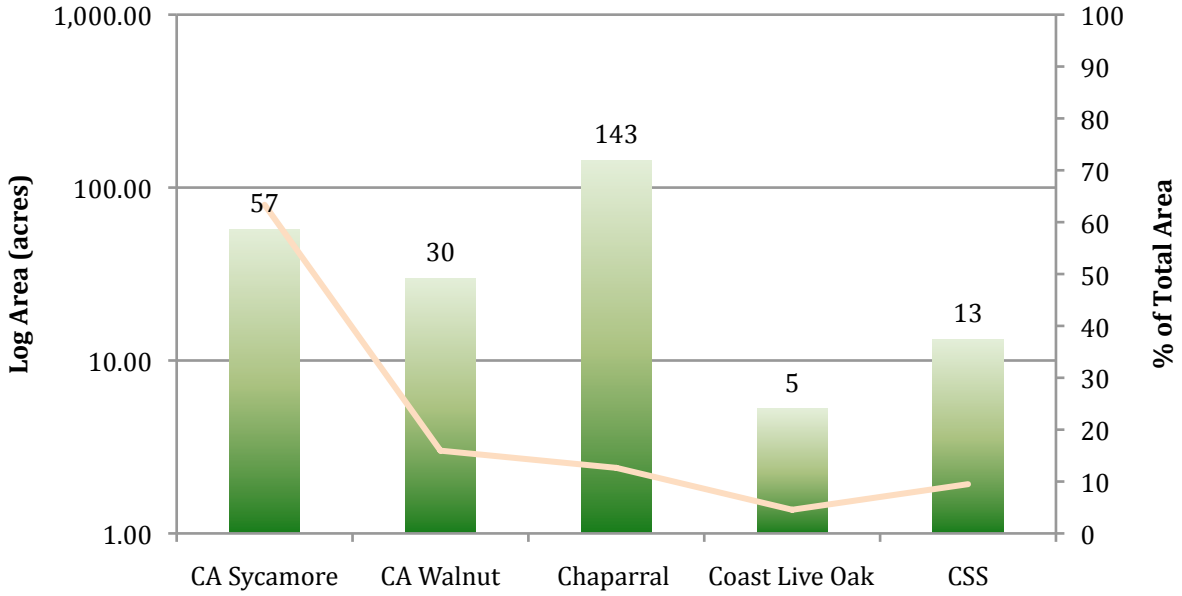

Figure 10: Native vegetation at risk in Los Angeles

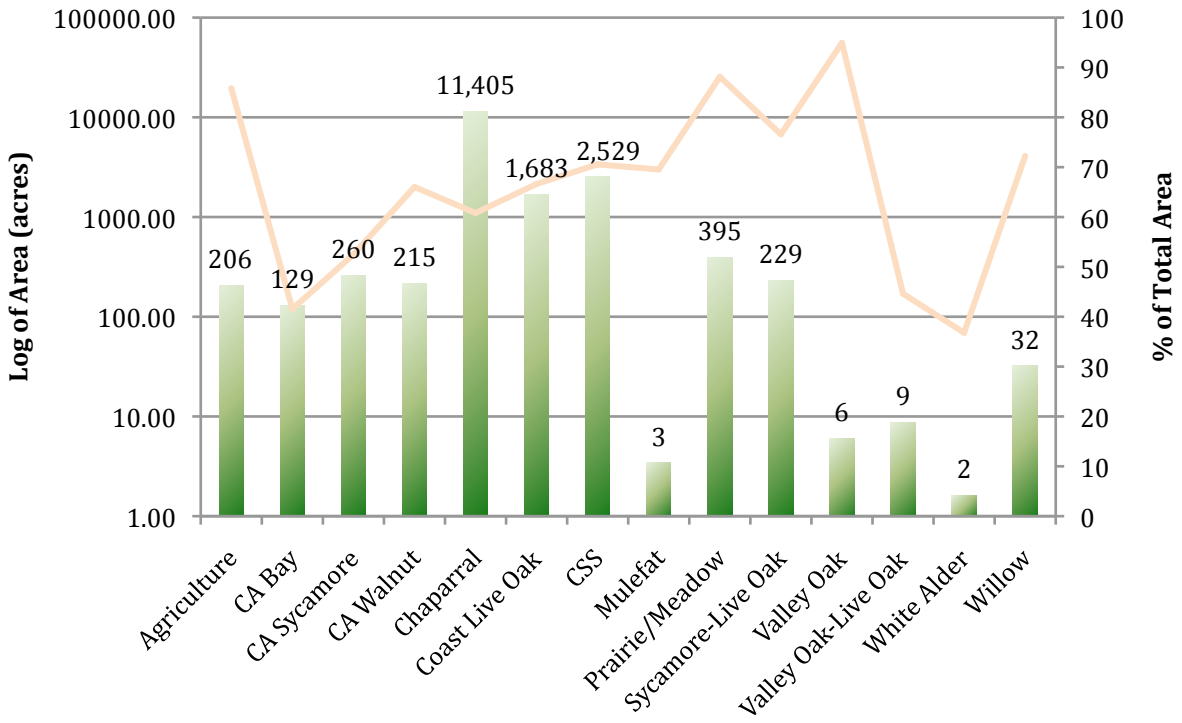

Figure 11: Native vegetation at is in unincorporated Los Angeles County

Current Vineyards

Using public documentation and Google map imagery, a total of 38 vineyards were identified (Figure 12). The total area of these vineyards extended across 165 acres of the study site. The majority of these vineyards, 36 out of 38, were located in either Malibu or the unincorporated areas of Los Angeles County. One vineyard was identified in LA City, and one vineyard was identified in Calabasas.

The overlay of existing vineyards on the "maximum development scenario" showed that 35 of the existing vineyards were located in areas with zoning codes permitting vineyard development. The vineyard in LA City, a part of the vineyard in Calabasas, and a part of one large vineyard in the unincorporated area were located in areas with zoning codes that do not permit vineyard development. 31 of the vineyards were located in areas where the slope never exceeds 33%. Furthermore, the overlay of existing vineyards on the land cover map showed that 33 of the 38 vineyards were located in areas either completely or partially designated as "disturbed." The size and specific details of the vineyards, such as the zone they are found in are listed in the appendix (tables A-10 and A-11).

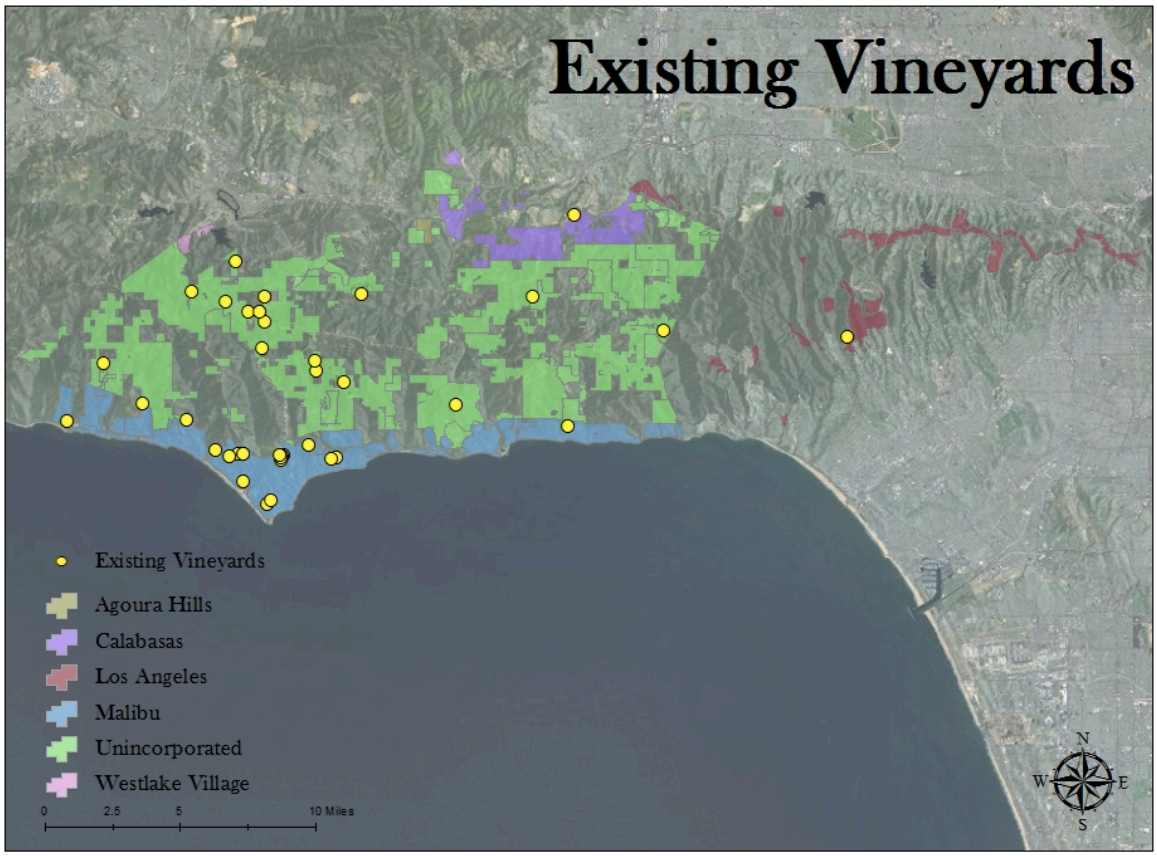

Figure 12: Existing extent of vineyards in the SMMNRA

Discussion

Maximum Development

Of our total study area about 62.5% has the potential for vineyard development. Figure 13 shows the portion of undevelopable land and developable land by zoning area. Most of the area within our study site with potential for vineyard development occurs in Unincorporated Areas of LA County, about 46.3%. 11.3% occurs in Malibu, 3.7% in Calabasas, 0.8% in the City of LA, and only 0.3% in Westlake Village. In addition, zoning policies within Agoura Hills do not permit the development of vineyards anywhere within its jurisdiction.

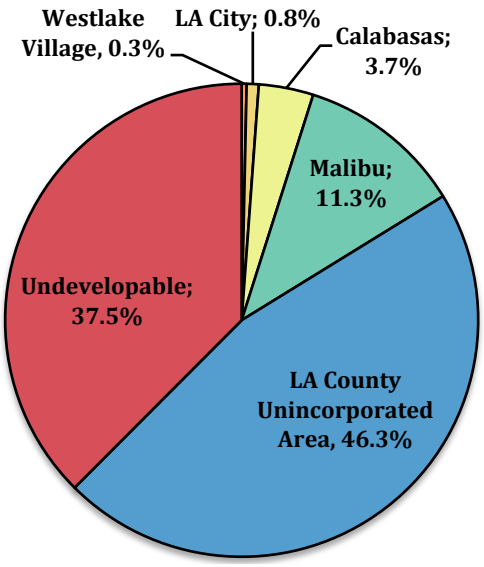

Figure 13: Potential vineyard development in SMMNRA divided amongst cities within the study site

Unincorporated areas have the highest capacity for vineyard development due to several factors. By nature, the unincorporated areas have looser zoning regulations than cities. In addition, LA County's unincorporated areas consist of less land covered by impermeable surfaces such as paved roads and buildings as well as more land area characterized by shallow slopes and other physical characteristics favorable to vineyard growth (Rundel, 2011).

Unincorporated Areas lie within the North Area and Coastal Zone, while Malibu lies in solely in the Coastal Zone. While vineyard expansion is possible in these areas, the LA County General Plan and the Malibu Local Coastal Land Use Plan may make development significantly more difficult. Within developable areas in Unincorporated Area, 36.4% (8,139.3 acres) lie in either SEA or SERA (figure. 14). Any potential development within these areas would require prior review by SEATAC or ERB respectively.

6.2% (1,381.8) of developable land in our study site lies in areas where vineyard development is permitted as an accessory use. In a conditional use permit is required prior to development. As a note, 100% of developable area in Calabasas requires a conditional use permit for vineyard development.

Within developable areas in the Malibu Costal Zone, 42.2% (2,312.97 acres) lie within ESHA (figure 15). As such, any development plan would require revision and approval by the ERB before moving forward. Areas of Malibu lying in ESHA with favorable physical constraints were regarded as developable.

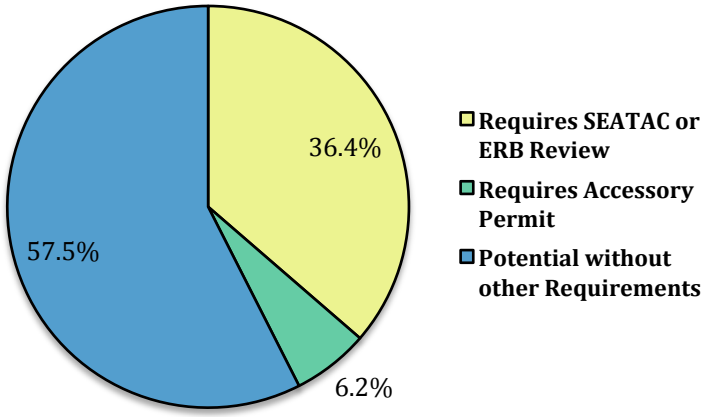

Figure 14: Potential vineyard development in Unincorporated area of LA County

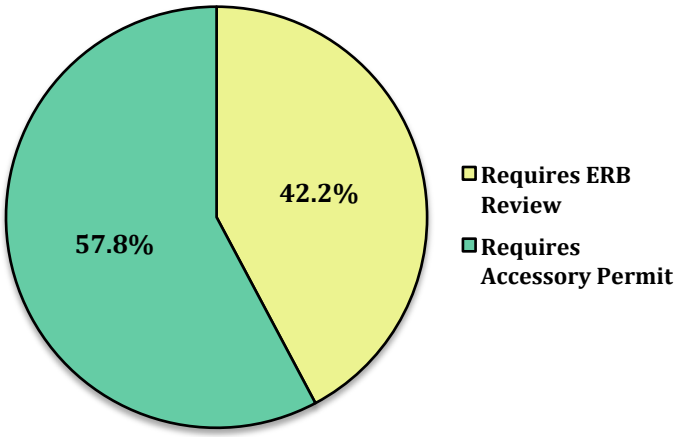

Figure 15: Potential vineyard development in Malibu

Native Vegetation at Risk

As a Mediterranean ecosystem, the SMMNRA is prone to loss in species density as a result of human activity. In addition, when analyzing the threat posed by vineyard development, one must realize that the SMMNRA is among just 1.2% of Mediterranean type ecosystems existing across the globe as a biodiversity hotspot (Vogiatzakis, 2006). Therefore, as a region that is inherently at risk to human disturbance and is home to an ecosystem type that is rare worldwide, any disturbance to native vegetation should addressed and mitigated. Visualizing the total percentage of vegetation at risk in our study site seen in figure 5, along with the total vegetation at risk within each of the 5 cities in the SMMNRA seen in figure 6**,** allows us to develop the big picture of how vineyard development, could potentially disturb the native environment.

Two major concerns within the study site are habitat fragmentation and the high risk of Oak displacement due to development. Within semiarid Mediterranean ecosystems, habitat fragmentation has increased sharply in the last century (Alados, 2004). Applying this to our results shows a high risk factor for native vegetation in the case of vineyard

development. Habitat fragmentation is likely to be a consequence of such development. Habitat fragmentation is explained as a disruption in dispersion and expansion of native vegetation populations creating smaller areas of native vegetation that become less viable to sustain the original population (Alados, 2004). Four types of native vegetation at risk of habitat fragmentation are Chaparral, Coast Live Oak (Oaks in general as well) and Coastal Sage Scrub. Chaparral, Coast Live Oak and Coastal Sage Scrub occur in every city as observed in the study site. These sets of vegetation that expand across 5 of the 6 cities within the study site should be preserved similarly to limit fragmentation.

Chaparral has the largest area at risk across the SMMNRA study site. This is important to identify because Chaparral, as well as Coastal Sage Scrub, is relatively delicate and can reestablish only over long periods of time (Soulé, 2011). In addition, large mammals and Chaparral-dependent rodents living in the SMMNRA prefer to use natural habitat over urban areas, leading fragmentation to have a significant effect on their ability to move across landscapes in search of food, find mates, and space to live (Freidin, 2003; Sauvajot, 1998). Such barriers to mobility reduce accessibility to essential resources and can reduce the reproductive capacity and overall genetic diversity in the region.

Oak is threatened by potential vineyard development due to a general trend in the favorable soils Oak resides on that also allow for successful grape production. This poses a problem as the role of Oaks is that of a keystone species in semi-arid Mediterranean ecosystems (Heaton, 2000). As a keystone species, Oaks have an important role in providing structure within the Mediterranean ecosystem (Manning, 2006). An ecosystem has the potential to degrade without its keystone species, which poses a problem because more than half of Oaks residing in the SMMNRA threatened by potential vineyard development. 100% of Oak at threat in Westlake Village and an overall of 66% of Coast Live Oak found among all cities are at risk in our study site. In the future, analysis on native vegetation should focus on impacts posed by vineyard development. Future research could monitor where vineyard expansion occurs to determine what areas are converted from oak to vineyard.

The vegetation types with a high percentage of risk for displacement compared to its total area within each city in the SMMNRA should be emphasized because vineyard development poses an increased threat for said vegetation types. These values inform individuals of the native vegetation residing within the city and the native vegetation that should be conserved within the city. It is interesting to note that California Sycamore is a risk in both Malibu and Los Angeles City. A key species in riparian ecosystems, the California Sycamore particularly important for conservation efforts. Oak is also at a 95% and above risk within Westlake Village and unincorporated area in Los Angeles County. These vegetation types are of high risk and are crucial in the preservation of ecosystems.

Unincorporated area in Los Angeles County has 82% of its total native vegetation at risk from development, while the City of Los Angeles has only 15% at risk (figure 6). Unincorporated areas have a high percentage of threat from development, which should be of concern to SEATAC or ERB. The high percentage correlates with much of the unincorporated land allowing for development. Because a large percentage of native

vegetation occurs in either SEAs or SERAs in the unincorporated areas, it is likely that our values overestimate the amount of native vegetation at risk. The small percentage in Los Angeles can be due partly because not much of the land cover in the city is incorporated into the study site and a majority of the land has been developed on prior to the 2007 vegetation data used in our analysis. Such data shows which city's native vegetation has the greatest risk of being displaced by vineyard development versus which city's native vegetation has the least risk of displacement. It should be noted that disturbed vegetation and exotic or invasive vegetation are not included in any of Figures 5-11, but are included in Tables A-2 through A-6. These two vegetation types are simply included because zoning laws permit vineyard development on such land coverage. Therefore these two types of vegetation should be acknowledged alongside native vegetation at risk in order to have a holistic understanding of the types of vegetation could be displaced by vineyards. Since 30 of the 38 vineyards currently residing in the SMMNRA are developed on disturbed vegetation, the disturbed vegetation category cannot be ignored. Instead it should be recognized as part of the study site, and used to understand the total threat posed by vineyard development.

Current Vineyard Extent

Although the SMMNRA contains a large area with the potential for vineyard development, the current extent is minimal. Most of the existing vineyards are small and exist as accessory uses to structures such as residences. The fact that it is difficult to identify the majority of current vineyards due to their relatively small size and lack of public documentation leads us to conclude that most of these vineyards are probably "hobby vineyards." Due to the small size of these vineyards, it is very possible that not all of the vineyards in the SMMNRA were identifiable via satellite imagery.

The overlay of the vineyard layer and the "maximum development scenario" highlighted some interesting conclusions. The two vineyards occurring in LA City and Calabasas were either entirely or partially located in areas where zoning codes prohibited vineyard development. The inappropriate development of vineyards in these areas is probably due to an incomplete understanding of zoning codes by landowners and developers. In LA City and Calabasas vineyards are not prominent; therefore, residents are likely unaware of zoning that prohibits development. In contrast, vineyards appearing in Malibu and the unincorporated areas, where viticulture is more prominent, followed appropriate zoning with the exception of one large vineyard that was partially developed in ESHA.

Of the 38 vineyards, 31 vineyards were located in areas where the slope never exceeded 33%. Although the remaining seven vineyards generally avoided steeper slopes, each of these vineyards had small areas built on slopes exceeding 33%. Development on steeper slopes can probably be attributed to the relative size of these vineyards. The majority of vineyards in the study site were small with areas less than one acre. In comparison, the vineyards located in areas with steeper slopes all had areas larger than one acre. Two of the vineyards were significantly larger with areas of 91 and 30 acres. Smaller vineyards are constrained by steep slopes due to physical and economic factors. Although larger

vineyards generally avoided steeper slopes, increased experience and higher capital probably allowed for development in areas that were normally avoided due to steep slopes.

In terms of existing vegetation that may be replaced by vineyards, it is important to note that the majority of vineyards are present in "disturbed vegetation" zones, which largely consist of residential areas. Therefore, it is likely that these vineyards are not independently causing habitat distress, as they are built in areas that have already been developed in some fashion. However, further development in disturbed areas could result in the fragmentation of the already limited amount of vegetation in such areas.

Conclusion

Using physical constraints and zoning policy data, we concluded that 62.5% of the current unprotected area of the SMMNRA has the possibility of being developed for vineyard use. If vineyard construction continues, native vegetation types located in areas with the potential for development could be at risk. In order to maintain native habitat, areas in danger of development should be carefully studied and development policy should reflect the use of practices that minimize habitat degradation. The use of satellite imagery and public parcel data resulted in the identification of 38 vineyards. Most of these were small, non-commercial vineyards residing in developed areas and operating as an accessory use.

To the authors' knowledge, such a study has not been performed. As such, our research can be used as a preliminary study, or a proof-of-concept for future research. The areas at risk of further development have been identified, and the next challenge lies in determining what can be done to preserve them. Land use planners can use our research to minimize development impacts, and conservationists can employ our research to focus protection efforts on areas that are at risk. Furthermore, with the identification of vineyards in the area, surveys may be carried out to better understand the vineyard culture in the SMMNRA, as well as to share information to ensure vineyards are managed sustainably.

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Appendix

Table A-1: Relevant Zoning Policy Summary

City	Zoning Code	Vineyard Restriction
Agoura Hills	RV: Residential-Very Low Density District (9222.1)	Permitted
LA City	A1: Agriculture Zone (12.05)	Permitted
	A2: Agricultural Zone (12.06)	Permitted
	RA: Suburban Zone (12.07)	Permitted
	PF: Public Facilities Zone (12.04.09)	Permitted
Malibu	RR: Rural Residential District (17.08)	Conditional Use Permit
	SF: Single Family Density Residential District (17.10)	Conditional Use Permit
	MF: Multiple Family Residential District (17.12)	Conditional Use Permit
Westlake Village	N/A	No Restriction*
Unincorporated Area	R-1 Single Family Residence Zone (22.20.100)	Conditional Use Permit
	R-2 Two Family Residence Zone (22.20.200)	Conditional Use Permit
	R-3 Limited Multiple Residence Zone (22.20.290)	Conditional Use Permit
	R-4 Unlimited Residence Zone (22.20.370)	Conditional Use Permit
	R-A Residential Agricultural Zone (22.20.410)	Permitted
	RPD Residential Planned Development Zone (22.20.460)	Conditional Use Permit
	A-1 Light Agricultural Zone (22.24.070)	Permitted
	A-2 Heavy Agricultural Zone (22.24.120)	Permitted
	A-2H Heavy Agricultural Zone Including Hog Ranches (22.24.200)	Permitted
	C-H Commercial Highway Zone (22.28.050)	Conditional Use Permit
	C-1 Restricted Business Zone (22.28.080)	Permitted
	C-2 Neighborhood Commercial Zone (22.28.130)	Permitted
	C-3 Unlimited Commercial Zone (22.28.180)	Permitted
	C-M Commercial Manufacturing Zone (22.28.230)	Permitted
	C-R Commercial Recreation Zone (22.28.290)	Permitted
	CPD Commercial Planned Development Zone (22.28.340)	Permitted
	M-1 Light Manufacturing Zone (22.32.040)	Permitted
	D-2 Desert Mountain Zone (22.32.090)	Permitted
	M-1 1/2 Restricted Heavy Manufacturing Zone (22.32.100)	Permitted
	MPD Manufacturing-Industrial Planned Development Zone (22.32.150)	Permitted
	M-2 Heavy Manufacturing Zone & M-4 Unlimited Manufacturing Zone (22.32.160)	Permitted
	M-3 Unclassified Zone (22.32.220)	Permitted
	M-2 1/2 Aircraft, Heavy Industrial Zone (22.32.270)	Conditional Use Permit
	B-2 Corner Buffer Zone (22.32.370)	Permitted

	SR-D Scientific Research and Development Zone (22.40.350)	Permitted
	O-S Open Space Zone (22.40.410)	Permitted
	A-C Arts and Crafts Zone (22.40.480)	Conditional Use Permit
	MXD Mixed Use Development Zone (22.40.520)	Permitted
Calabasas	RR: Rural Residential District (17.11.010)	Conditional Use Permit
	HM: Hillside/Mountainous District (17.11.010)	Conditional Use Permit
	OS: Open Space District (17.11.010)	Conditional Use Permit

* Westlake Village Municipal Code does not address vineyards because they are considered a form of landscaping.

Table A-2: Extent and Risk of Vegetation Classes in Malibu

Land Cover Classification	Area at Risk (acres)	Total Area (acres)	Percent Total Area at Risk
Agriculture	47.97	61.05	79
CA Sycamore	70.36	87.07	81
CA Walnut	27.77	60.20	46
Chaparral	985.39	2349.60	42
Coast Live Oak	16.06	25.64	63
Coastal Sage Scrub	507.94	1066.86	48
Disturbed	3500.81	4732.40	74
Exotic/Invasive	133.43	214.84	62
Prairie/Meadow	98.07	163.56	60
Sycamore-Live Oak	47.20	59.37	79
Willow	28.85	43.60	66
Native Vegetation Sum	1781.63	3855.91	46

Table A-3: Extent and risk of Vegetation Classes in Westlake Village

Land Cover Classification	Area at Risk (acres)	Total Area (acres)	Percent of Total Area at Risk
Chaparral	40.93	44.10	93
Coast Live Oak	1.55	1.55	100
Coastal Sage Scrub	17.08	18.20	94
Disturbed	103.97	114.34	91
Native Vegetation Sum	59.56	63.85	93

Table A-4: Extent and Risk of Vegetation Classes in Calabasas

Land Cover Classification	Area at Risk (acres)	Total Area (acres)	Percent of Total Area at Risk
CA Walnut	76.97	145.05	53

Chaparral	731.48	883.64	83
Coast Live Oak	109.69	180.31	61
Coastal Sage Scrub	407.92	612.11	67
Disturbed	271.17	1324.02	20
Exotic/Invasive	24.79	37.31	66
Mulefat	2.13	2.13	100
Prairie/Meadow	146.03	245.77	59
Valley Oak	5.18	8.79	59
Willow	29.90	37.99	79
Native Vegetation Sum	1509.29	2115.80	71

Table A-5: Extent and Risk of Vegetation Classes in Los Angeles

Land Cover Classification	Area at Risk (acres)	Total Area (acres)	Percent of Total Area at Risk
CA Sycamore	57.22	90.34	63
CA Walnut	29.73	186.36	16
Chaparral	143.05	1131.90	13
Coast Live Oak	5.25	115.15	5
Coastal Sage Scrub	13.17	138.72	9
Disturbed	136.68	1666.93	8
Exotic/Invasive	13.85	127.20	11
Native Vegetation Sum	235.25	1523.75	15

Table A-6: Extent and Risk of Vegetation Classes in Unincorporated area of Los Angeles County

Land Cover Classification	Area at Risk (acres)	Total Area (acres)	Percent of Total Area at Risk
Agriculture	206.33	240.34	86
CA Bay	128.70	309.75	42
CA Sycamore	259.79	494.92	52
CA Walnut	215.15	325.85	66
Chaparral	11405.10	18754.70	61
Coast Live Oak	1682.77	2525.28	67
Coastal Sage Scrub	2529.32	3585.03	71
Disturbed	5163.38	6063.43	85
Exotic/Invasive	124.25	184.75	67
Mulefat	3.42	4.92	70
Prairie/Meadow	394.54	447.73	88
Sycamore-Live Oak	229.22	299.30	77
Valley Oak	6.05	6.37	95
Valley Oak-Live Oak	8.74	19.58	45

White Alder	1.61	4.38	37
Willow	32.08	44.38	72
Native Vegetation Sum	22059.86	26822.20	82

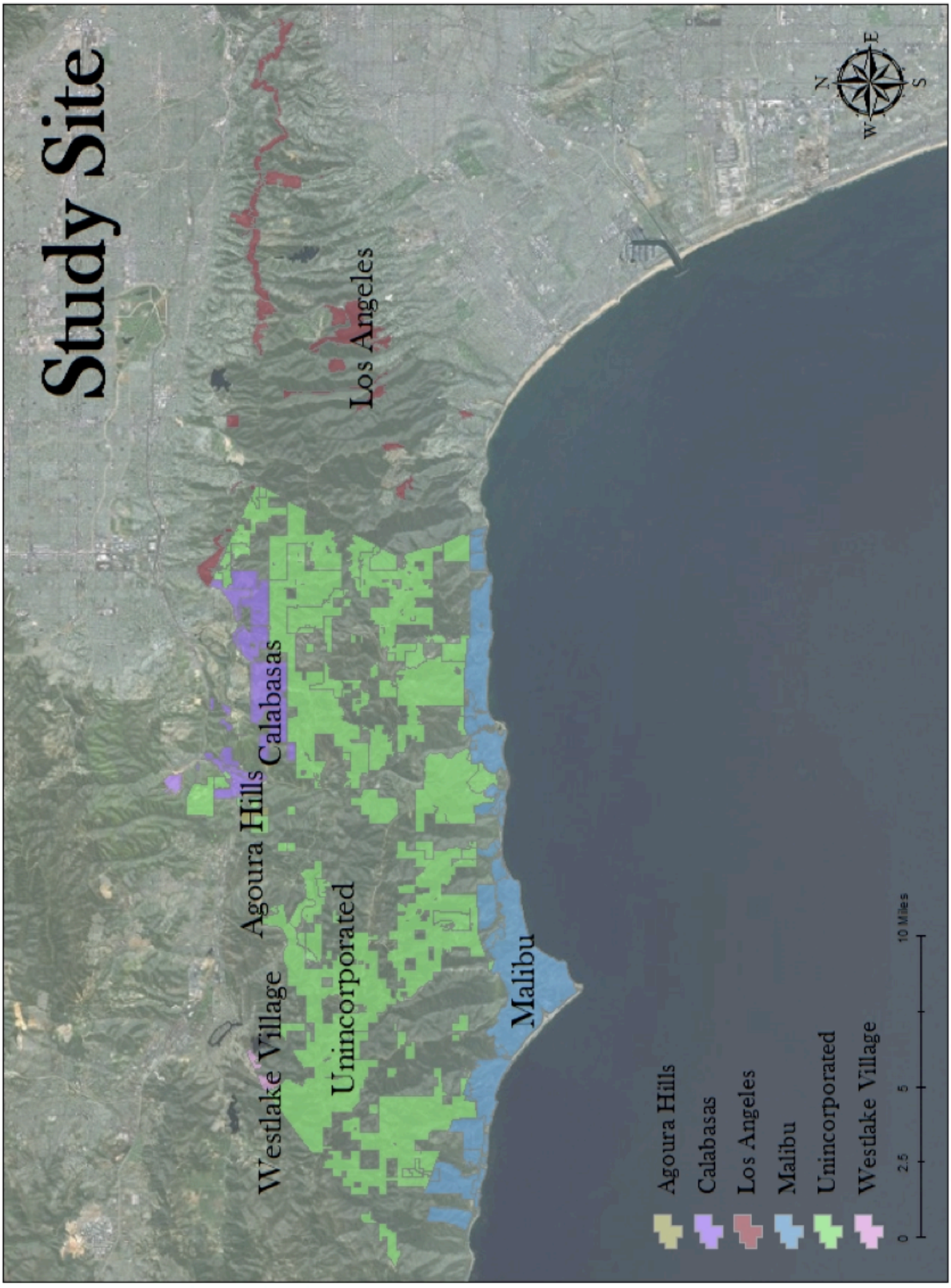


Figure A-1: Study Site within SMMNRA

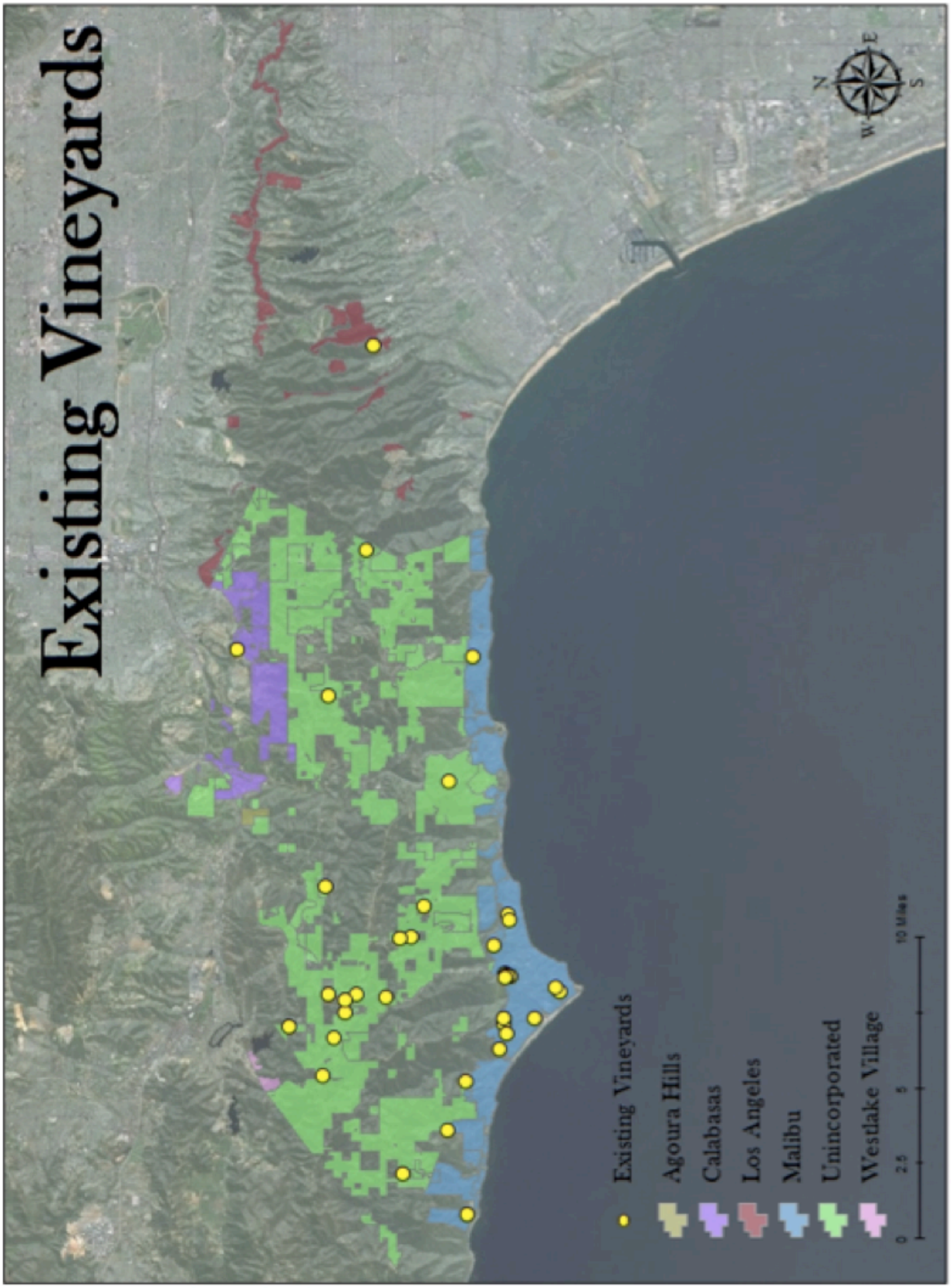


Figure A-2: Existing Vineyards within Study Site

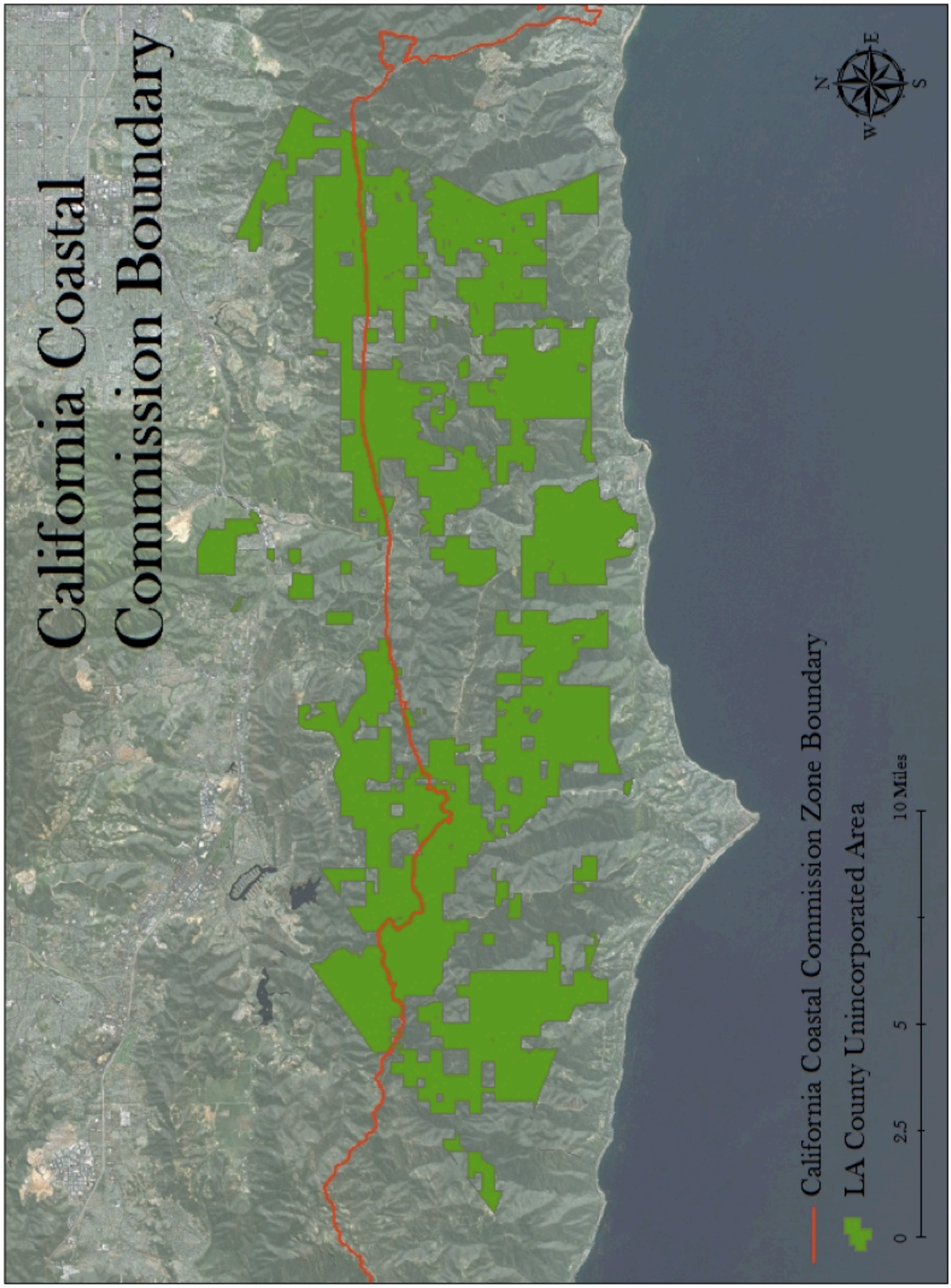


Figure A-3: California Coastal Commission Boundary in Study Site

Figure A-4: Maximum Development Potential within Study Site

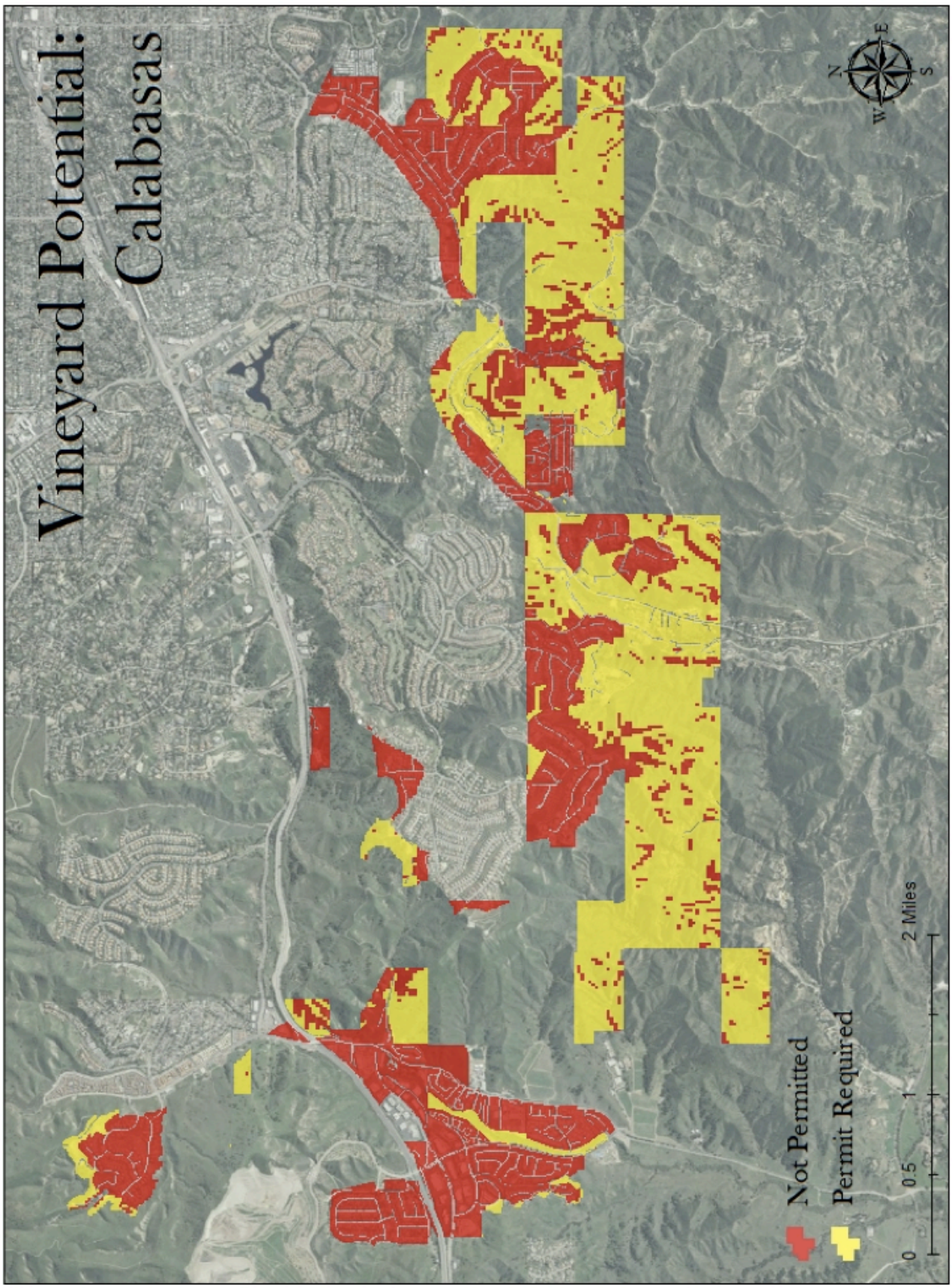
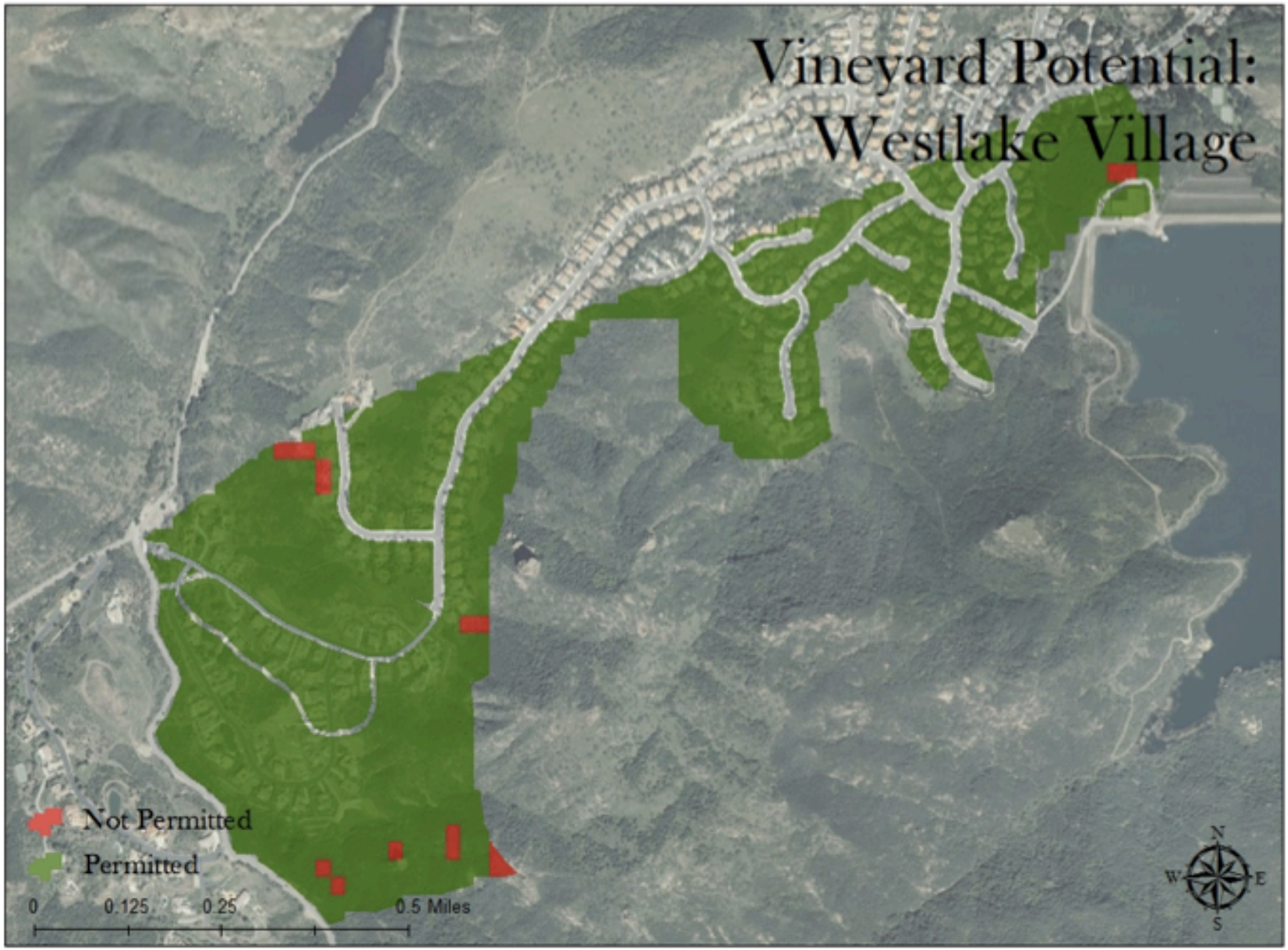


Figure A-5: Potential Development within Calabasas

Figure A-6: Potential Development within Agoura Hills


Vineyard Potential:
Westlake Village
Not Permitted
Permitted
0
0.125
0.25
0.5 Miles
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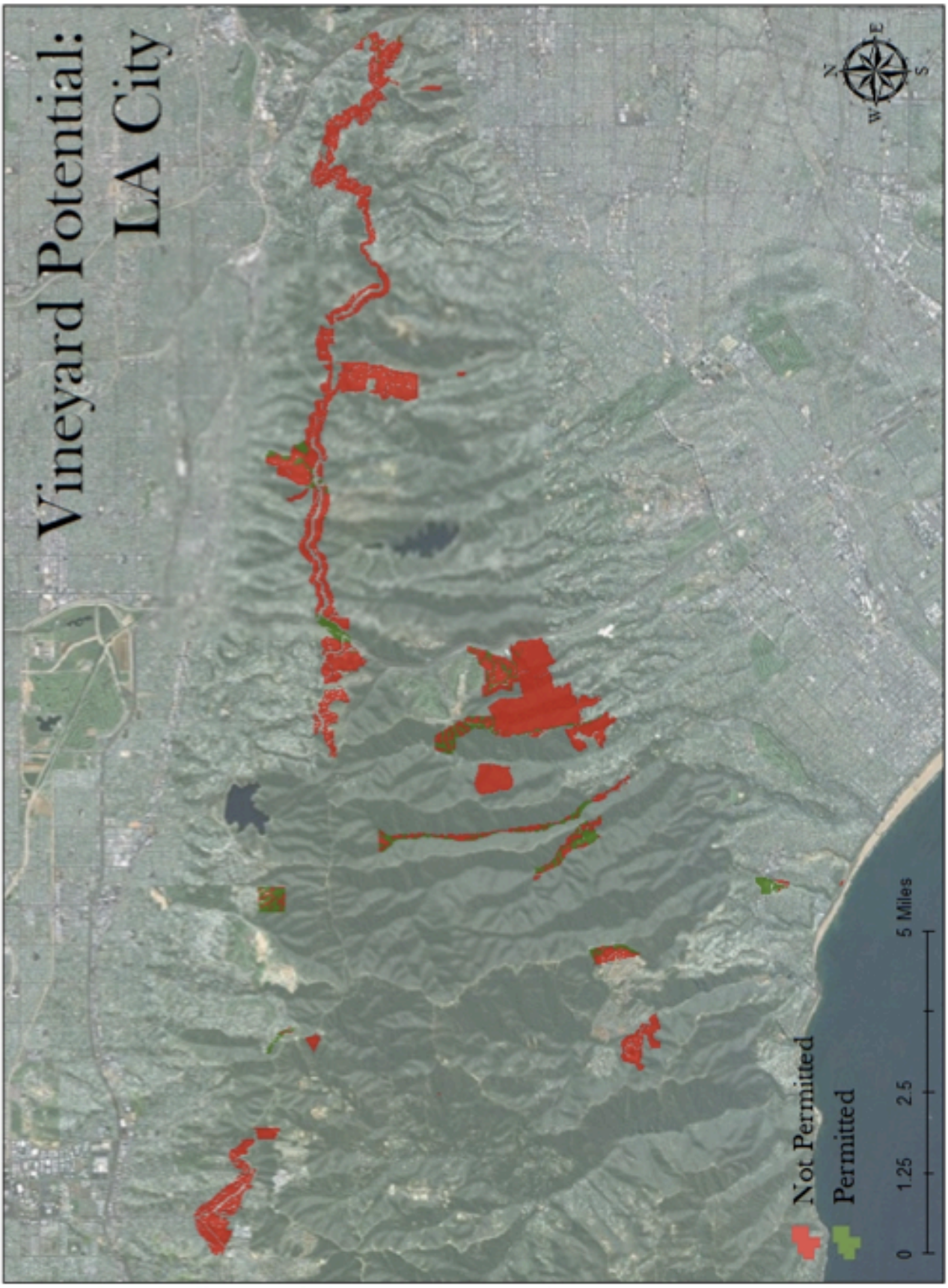
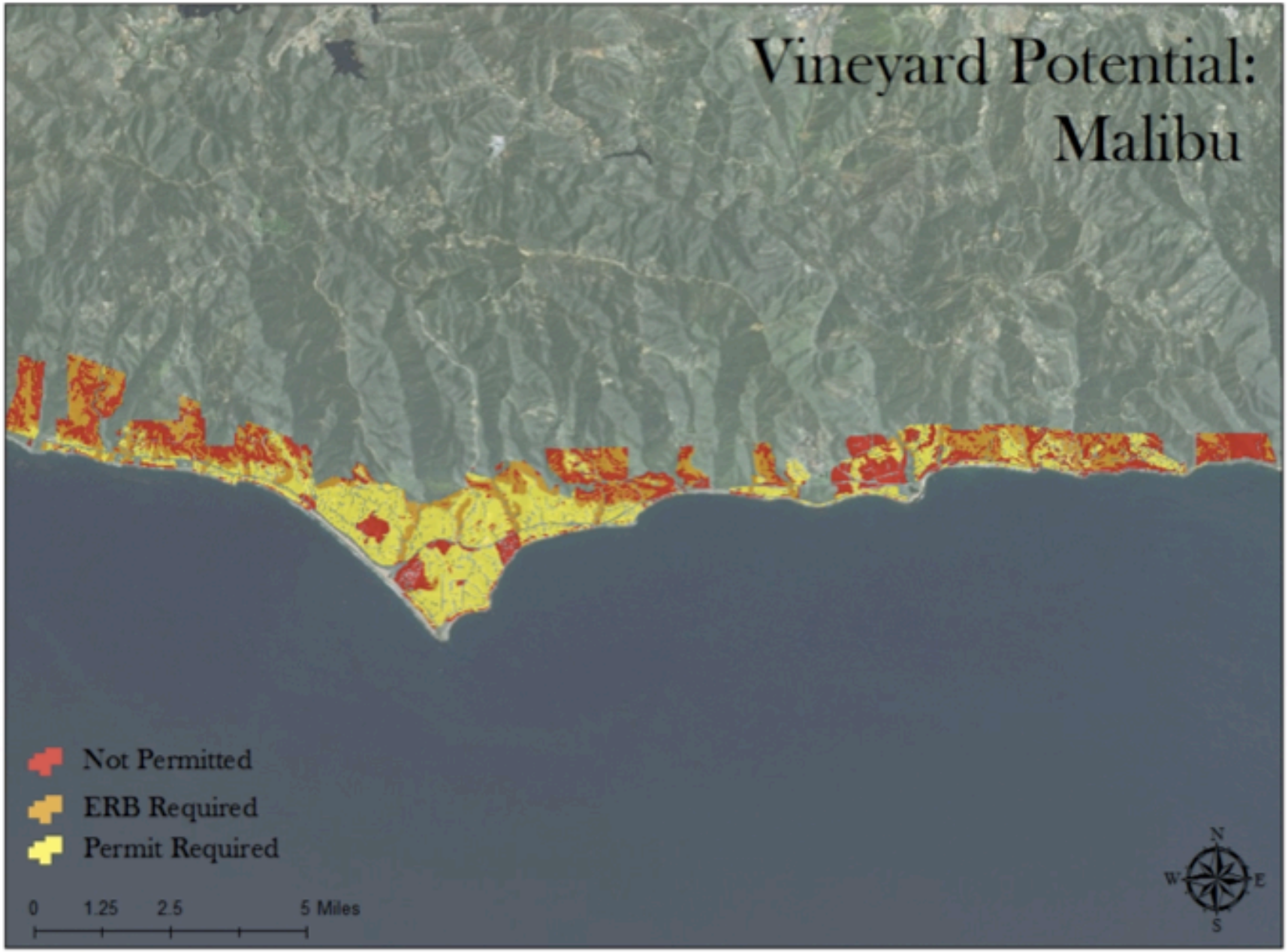


Figure A-8: Potential Development in Los Angeles

Figure A-9: Potential Development in Malibu



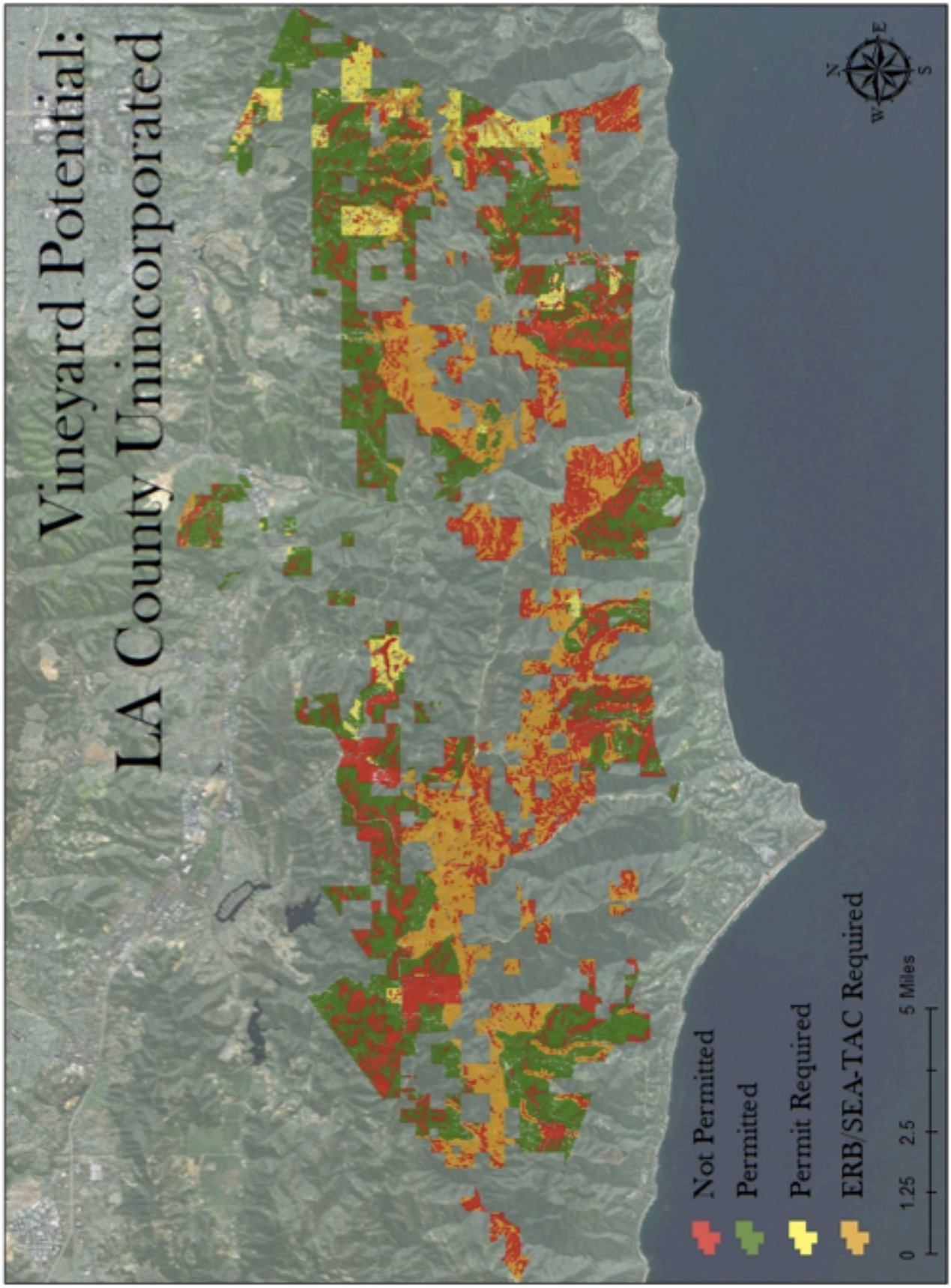


Figure A-10: Potential Development in Unincorporated Los Angeles County

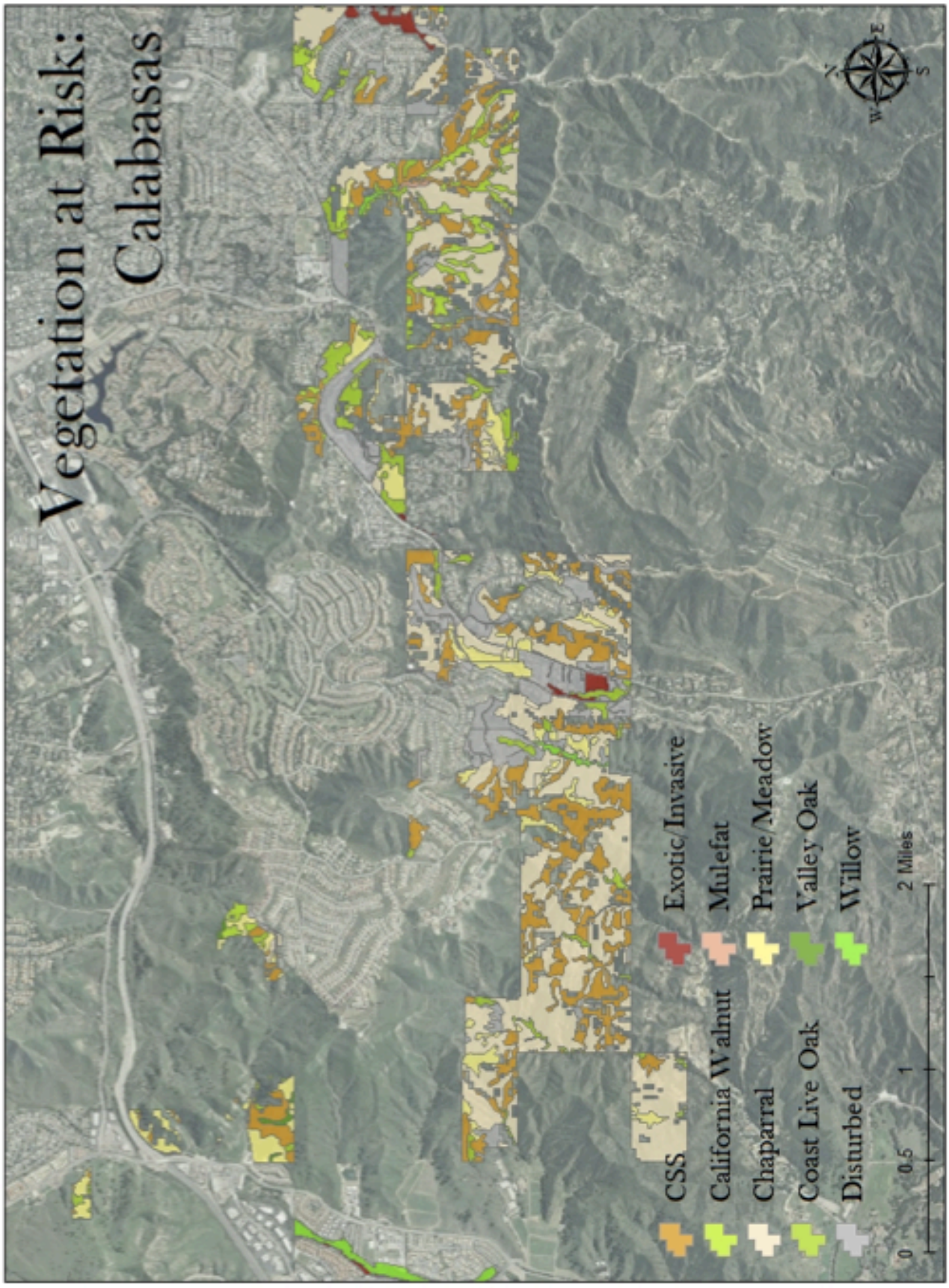


Figure A-11: Vegetation at Risk from Development in Calabasas

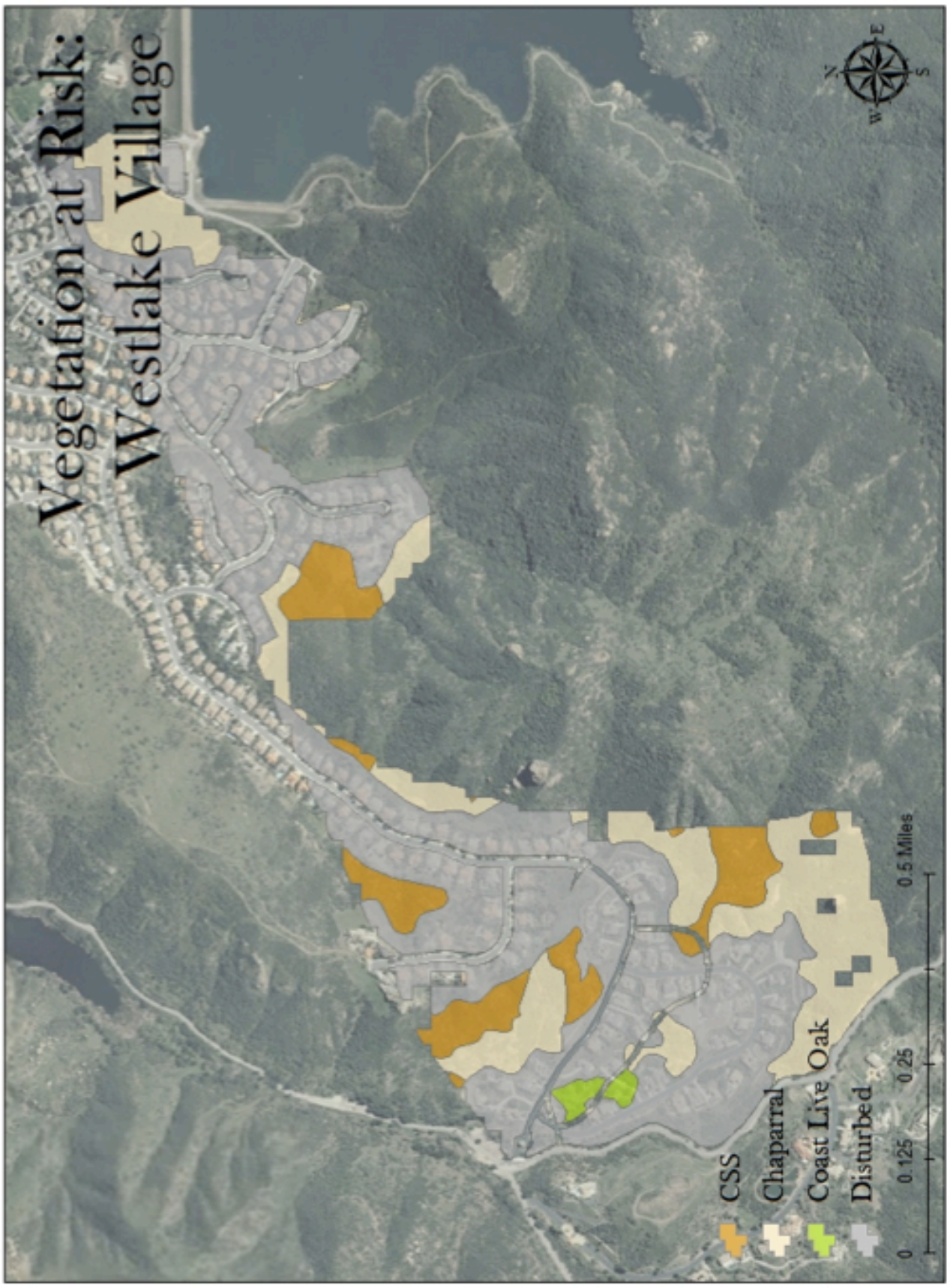


Figure A-12: Vegetation at Risk from Development in Westlake Village

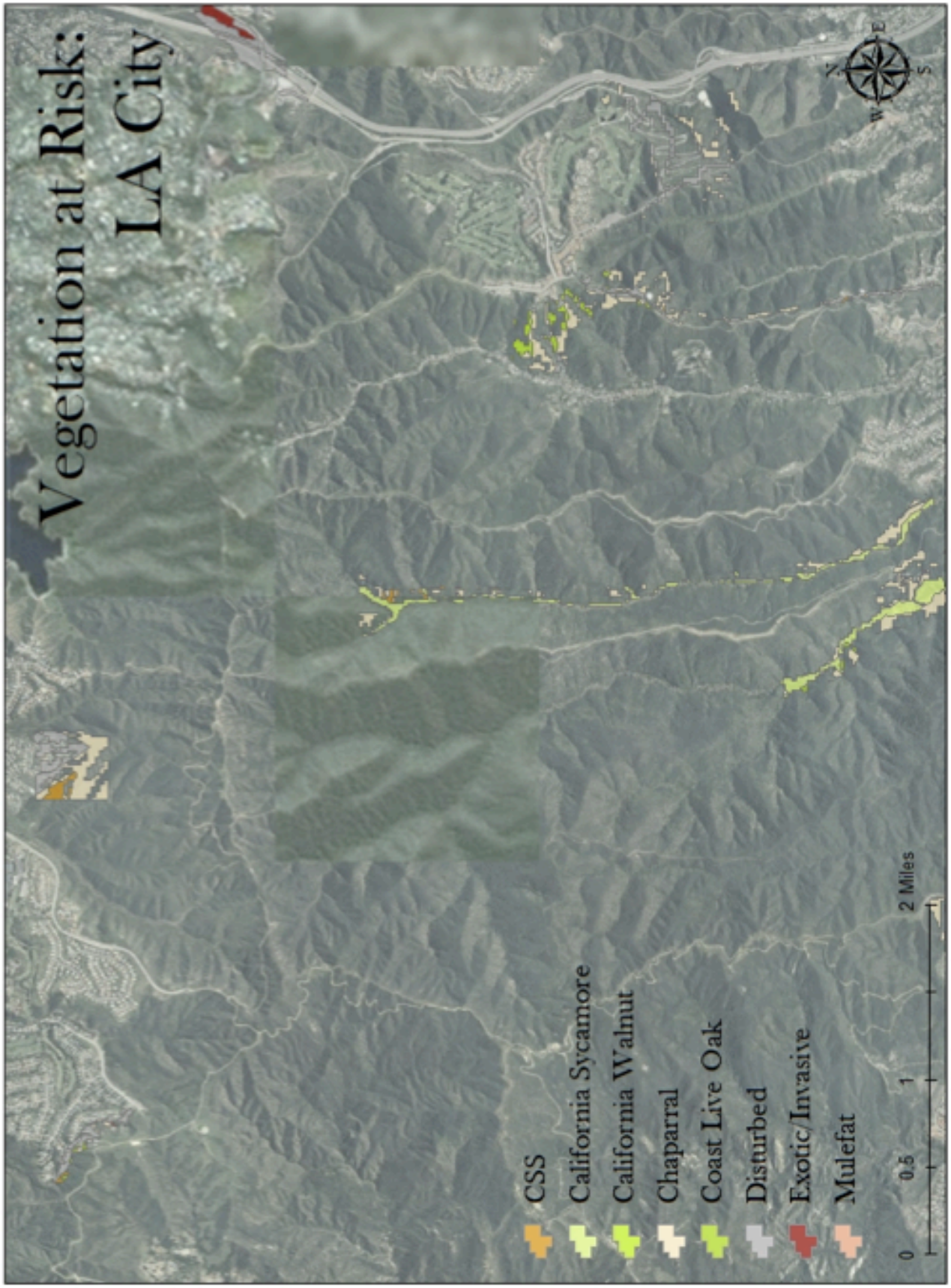


Figure A-13: Vegetation at Risk from Development in Los Angeles

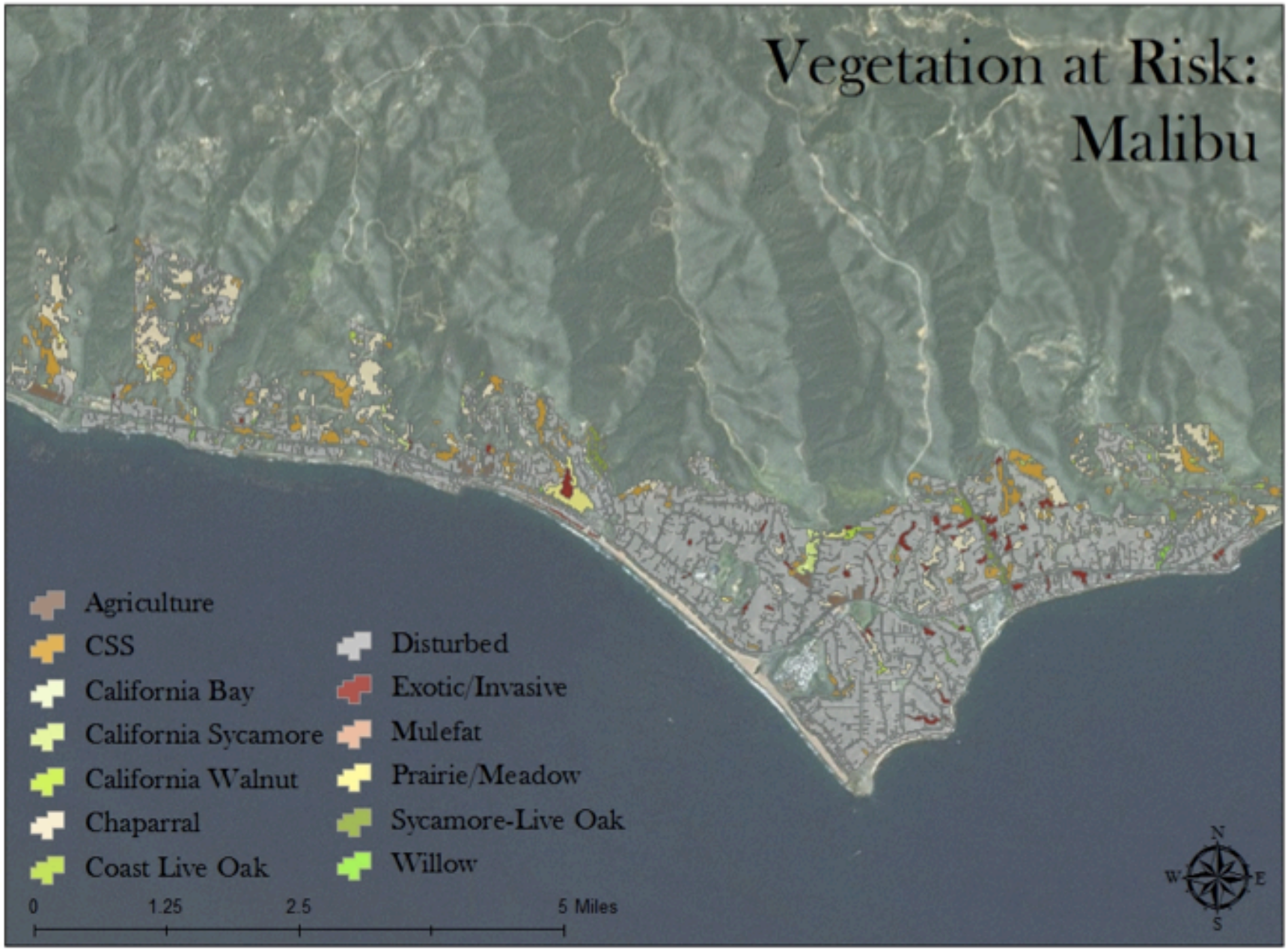


Figure A-14: Vegetation at Risk from Development in Malibu

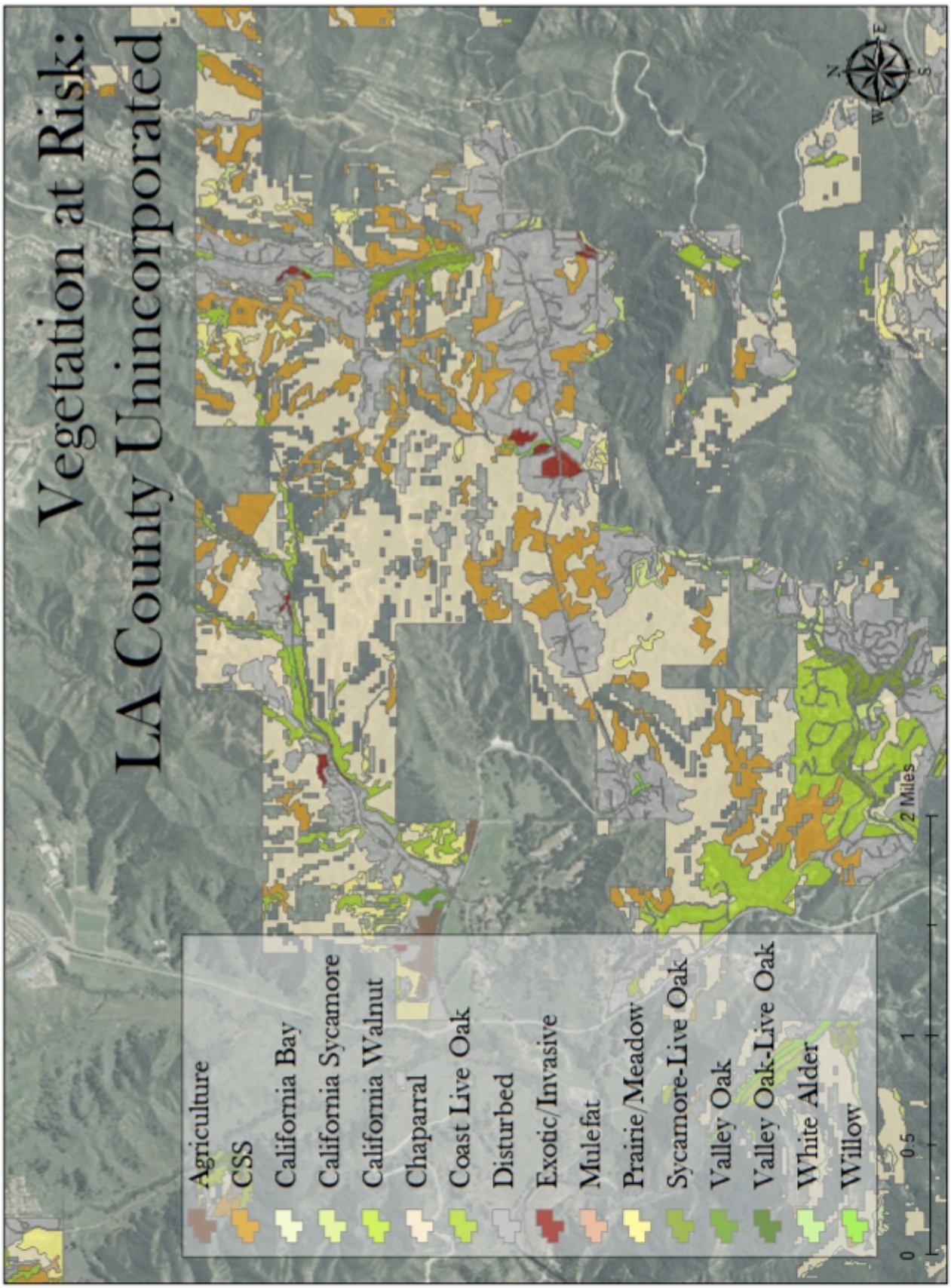


Figure A-15: Vegetation at Risk from Development in Unincorporated Los Angeles County

Table A-7: Total Study Site - Potential Vineyard Development

City	Total Area (acres)	Favorable Constraints (acres)	Favorable: Potential (acres)	% Potential of Favorable	% Potential of Total Study Site	% Potential of City
Agoura	148.26	0	0	0	0	0
LA City	3263.08	2287.49	399.05	0.174	0.008	0.122
Calabasas	3446.93	3064.93	1806.31	0.589	0.037	0.524
Malibu	8397.01	6200.64	5477.99	0.883	0.113	0.652
LA County Unincorporated	32972.16	24009.90	22391	0.933	0.463	0.679
Westlake	166.64	163.53	163.53	1.000	0.003	0.981
Undevelopable					0.375	
Total Study Site	48394.08	35726.49	30237.88	0.846	0.625	0.625

Table A-8: LA County Unincorporated Area (UA) - Potential Vineyard Development, Protected Areas

Total Area in UA (acres)	Favorable (acres)	Potential (acre)	% Potential of Favorable	Potential req. ERB or SEATAC (acre)	% Potential of UA req. ERB or SEATAC	Potential req. Permit (acre)	% Potential of UA req. Permit	Potential: No req.	% Potential of UA with No req.
32972.16	24009.9	22391	0.933	8139.29	0.364	1381.83	0.062	12869.88	0.575

Table A-9: Malibu - Potential Vineyard Development, Protected Areas

Total Area in Malibu (acres)	Favorable (acres)	Potential (acre)	% Potential of Favorable	Potential req. ERB (acre)	% Potential of Malibu req. ERB	Potential req. Permit (acre)	% Potential of Malibu req. Permit
8379.01	6200.64	5477.99	0.883	2312.97	0.422	3165.02	0.578

Table A-10: Size of Vineyards

Vineyard	Area (acres)	Vineyard	Area (acres)
1	0.22	**20**	1.52
2	0.65	**21**	1.47
3	2.81	**22**	0.16
4	3.59	**23**	1.32
5	0.59	**24**	0.44
6	90.55	**25**	0.58
7	0.15	**26**	0.95
8	0.87	**27**	0.26
9	1.59	**28**	0.50
10	30.59	**29**	1.77
11	0.10	**30**	1.28
12	0.77	**31**	0.63
13	6.61	**32**	0.65
14	1.19	**33**	0.61
15	1.00	**34**	0.11
16	1.11	**35**	1.66
17	0.91	**36**	0.97
18	2.00	**37**	4.15
19	0.10	**38**	0.74

Table A-11: Individual Vineyard Breakdown

Vineyard	City	Zoning	Vegetation	Comments
1	Malibu	Permit Required	Disturbed	
2	Unincp	ERB/SEATAC Required & Permitted	Disturbed	
3	Malibu	ERB Required & Permit Required	Disturbed	
4	Unincp	Permitted	Agriculture & Distrubed	Slope in some areas is greater than 33%. Size is 3.6 acres.
5	Malibu	ERB Required & Permit Required	Disturbed	
6	Unincp	Permitted	Agriculture & Distrubed	Slope in some areas is greater than 33%. However, most of site is less than 33% and vineyard avoids the steep slope just to the north. Vineyard is very large.

				Largest identified (91 acres).
7	Malibu	Permit Required	Disturbed	
8	Unincp	ERB/SEATAC Required	Sycarmore-Live Oak	Woodland surrounds vineyard (maybe illegally cleared)
9	Malibu	Permit Required	Disturbed	
10	Unincp	Not Permitted (ESHA) & ERB/SEATAC Required	Coast Live Oak & Agriculture	ESHA & SERA/SEA due to high presence of Coast Live Oak. Second largest vineyard identified (30 acres). One area where slope exceeds 33%. Even though its in protected area, vineyard mostly avoids native vegetation.
11	Unincp	ERB/SEATAC Required	Disturbed	
12	Unincp	Permitted	Disturbed	
13	Unincp	ERB/SEATC Required	Chapparal (but largely cleared)	Some slopes greater than 33%, but most of vineyard in areas with slope less than 33%. Vineyard is large (6 acres).
14	Unincp	ERB/SEATAC Required	Disturbed	
15	Unincp	ERB/SEATAC Required	Disturbed	
16	LA City	Not Permitted (RE)	Disturbed	LA City Planner stated only AG and RA zoning areas would be allowed to grow vineyards.
17	Unincp	Permitted	Disturbed & Chapparal	
18	Malibu	Permit Required	Disturbed	Vineyard on larger side (2 acres). Some areas where slope is greater than 33%.
19	Calabasas	Permit Required & Not Permitted	Disturbed & CSS	Extends from OS into Residential Area
20	Unincp	ERB/SEATAC Required	Disturbed	
21	Unincp	ERB/SEATAC Required	Disturbed	

22	Unincp	Permit Required	Disturbed	
23	Unincp	ERB/SEATAC Required	Disturbed	
24	Malibu	ERB Required	Disturbed	
25	Malibu	Permit Required	Disturbed	
26	Unincp	ERB/SEATAC Required	Disturbed	
27	Malibu	Permit Required	Disturbed	
28	Malibu	ERB Required	Disturbed	
29	Malibu	Permit Required &ERB Required	Disturbed	
30	Malibu	Permit Required &ERB Required	Disturbed	
31	Malibu	Permit Required	Disturbed	
32	Malibu	Permit Required	Disturbed	
33	Malibu	Permit Required	Disturbed	
34	Malibu	Permit Required	Disturbed	
35	Unincp	Permitted	Distrubed	
36	Unincp	Permitted	Chapparal & CSS	Small portion in area with slope greater than 33%. Vineyard is 1 acre.
37	Unincp	ERB/SEATAC Required	Chapparal (areas cleard)	Small portion in area with slope greater than 33%. Vineyard is relatively large (4 acres).
38	Malibu	Permit Required	Disturbed	