California Essential Habitat Connectivity Project

Natural Landscape Blocks to be Connected (Action Step 3.3)

Revised 1 June 2009

Trying to address issues raised by the TAG review, and considering some new data inputs, we developed a second iteration of Natural Landscape Blocks that we believe is a major improvement over previous attempts. There are a few final decisions to be made, but we think we are almost there.

First, we examined different combinations of input layers to try to generate a solid foundation that would not be so heavily determined by GAP status as the previous version. We also explored ways to apply model modifiers (e.g., biodiversity hotspots data) without overriding the core themes that pertain explicitly to relative ecological condition rather than biological value.

The new maps were built using the following general steps:

- Step 1: Create a gradient map of "naturalness" for the state based on human landscape alterations (agriculture, urban, roads) on a scale of 0 to 30.
- Step 2. Reduce the naturalness score (by 1 or 2 points) for areas having strongly altered fire regimes (a strong indicator of changes in ecosystem structure and function).
- Step 3. Increase the score (varying by ecoregion) in areas of known high biological value, such as biological hotspots, Essential Habitat areas, or important wetlands.
- Step 4. Determine appropriate score thresholds (and block sizes) to delineate landscape blocks for each ecoregion.
- Step 5. Eliminate small blocks, cluster close together blocks, and dissolve "donut holes" within blocks.

These steps are detailed below.

STEP 1. The new models rely primarily on a "naturalness" score calculated by equally weighting three parameters – Percent Agriculture (rangelands not included as agriculture), Percent Road Density, and Housing Density. Substituting housing density for impervious surface (used in earlier maps) better delineated the wildland-urban interface. Each of these parameters was ranked from 1 (lowest naturalness) to 10 (highest naturalness) based on the detailed descriptions below:

Percent Agriculture

Source: NLCD, Land Cover, raster, 2001, 30m.

Agricultural lands – Cultivated Crops. Reclassed (class 82 to 1, all others to 0). Resampled from 30 to 100m, projected, and calculated focal mean to determine percent land cover in cultivated crops over 5-km2 circular moving window.

Classified into 10 classes with natural breaks (10 = lowest % agriculture, 1 = highest % agriculture).

Road Density

Source: ESRI StreetMapNA Major roads data (9.3, 2008) for US, 1:100,000. Road density – Line density of ESRI Street Map major roads (primary limited access or interstate, primary US and state highway (FCC A1's – A2's); secondary state and county (FCC A3's) over 1300m radius (5 km2). Classified into 10 classes with natural breaks (10 = lowest road density, 1 = highest road density).

Housing Density

Source: California Department of Forestry and Fire Protection Development Footprint 05_1 (05_1, 2005.) 1:100,000. raster 30m.

Housing density – densclass10

1 NONE
2 LESS THAN 1 UNIT PER 160 ACRES (< 4 / Sq. mi.)
3 1 UNIT PER 160 ACRES TO 1 UNIT PER 40 ACRES (4 - 16 / Sq mi)
4 1 UNIT PER 40 ACRES TO 1 UNIT PER 20 ACRES (16 - 32 / Sq mi)
5 1 UNIT PER 20 ACRES TO 1 UNIT PER 10 ACRES (32 - 64 / Sq mi)
6 1 UNIT PER 10 ACRES TO 1 UNIT PER 5 ACRES (64 - 128 / Sq mi)
7 1 UNIT PER 5 ACRES TO 1 UNIT PER 1 ACRE (128 - 640 / Sq mi)
8 1 UNIT PER 1 ACRE TO 2 UNITS PER ACRE (640 - 1280 / Sq mi)*
9 2 UNITS PER 1 ACRE TO 5 UNITS PER ACRE (1280 - 3200 / Sq mi)
10 GREATER THAN OR EQUAL TO 5 UNITS PER ACRE (≥ 3200 / Sq mi).

Resampled from 30 to 100m, projected, and calculated focal mean density class over 5-km2 circle moving window. Classified into 10 classes with natural breaks (10 = lowest mean density class, 1 = highest mean density class).

Adding these three scores gave scores across the state from 13 to 30, with 30 being the most natural areas (i.e., the areas least affected by development, roads, and agriculture).

STEP 2. The naturalness score from Step 1 was reduced for areas suspected to be strongly altered in ecological structure and function, using FRAP Condition Class (departure from natural fire regime) modified for GAP 1 lands.

Condition Class

Source: California Department of Forestry and Fire Protection Fire Regime and Condition Class. (03_2, 2003). Condition class – CON_CLASS

1= Fire regime within or near historical range. Risk of key ecosystem component loss low.
2 = Fire regime moderately altered from historical range. Risk of key ecosystem component loss moderate.
3 = Fire regime significantly altered from historical range. Risk of key ecosystem component loss high.
9 = None Assigned (non-wildlands)

Any cell with GAP = 1, was re-assigned a condition class 1. Results were reclassified (1 and 9 to 0, 2 to 1, and 3 to 2). Data were resampled from 30 to 100m, reprojected, and calculated using focal mean condition class over 5-km2 circular moving window.

Scores from Step 2 were then modified by subtracting 0, 1, or 2 points based on condition class:

0 = lowest mean condition class (less altered)
-1 = middle condition class
-2 = highest condition class (most altered).

Therefore, it was possible for locations scoring a 30 for naturalness in Step 1 to be demoted by a poor condition class (due to deviation from the natural fire regime).

STEP 3. Increased score for known areas of high biological value (HBV), such as biodiversity hotspots, important wetlands, or Essential Habitat areas for listed species. The size of score increase varies by ecoregion (see Step 4).

Data Layers

Essential or critical habitat; wetland/vernal pool; hotspot for amphibians, reptiles, mammals, or plants (as defined by CDFG maps of Rarity-Weighted Richness Indices for these taxa).

- Vernal Pools and Wetlands:
  - Central Valley Vernal Pool Complexes, DFG, 1998
  - California Central Valley Wetlands and Riparian GIS, DFG, 1997
  - Placer County Vernal Pool Resource Inventory, DFG, 2000
  - South Coast Ranges Vernal Pools, DFG, 2003
  - California Wetlands, USFWS, 2006
  - Wetland Reserve Program Lands, if available
- Rarity-Weighted Richness Index, CDFG, 2003
- Essential Habitat identified by USFWS for Federally listed species. (Essential Habitat includes geographic areas essential to a species' conservation, including those areas that may be excluded from designated Critical Habitat for economic or other reasons, such as coverage in long-term conservation agreements.)

These features were overlaid and converted to a 100-m grid. Areas <1 km from major roads were excluded from this score upgrade because they are likely to be ecologically degraded and less likely to support HBV resources than areas farther from roads, and because this increased landscape discrimination within otherwise large areas with HBV resources.

STEP 4. We generated maps using different score thresholds and evaluated which scores appeared to best delineate landscape blocks in each ecoregion. In general, very high scores (28-30) appear to create the most defensible landscape blocks (see discussion and maps below). More developed ecoregions appear to require slightly lower thresholds to discriminate blocks than more intact ecoregions. In two ecoregions where a single

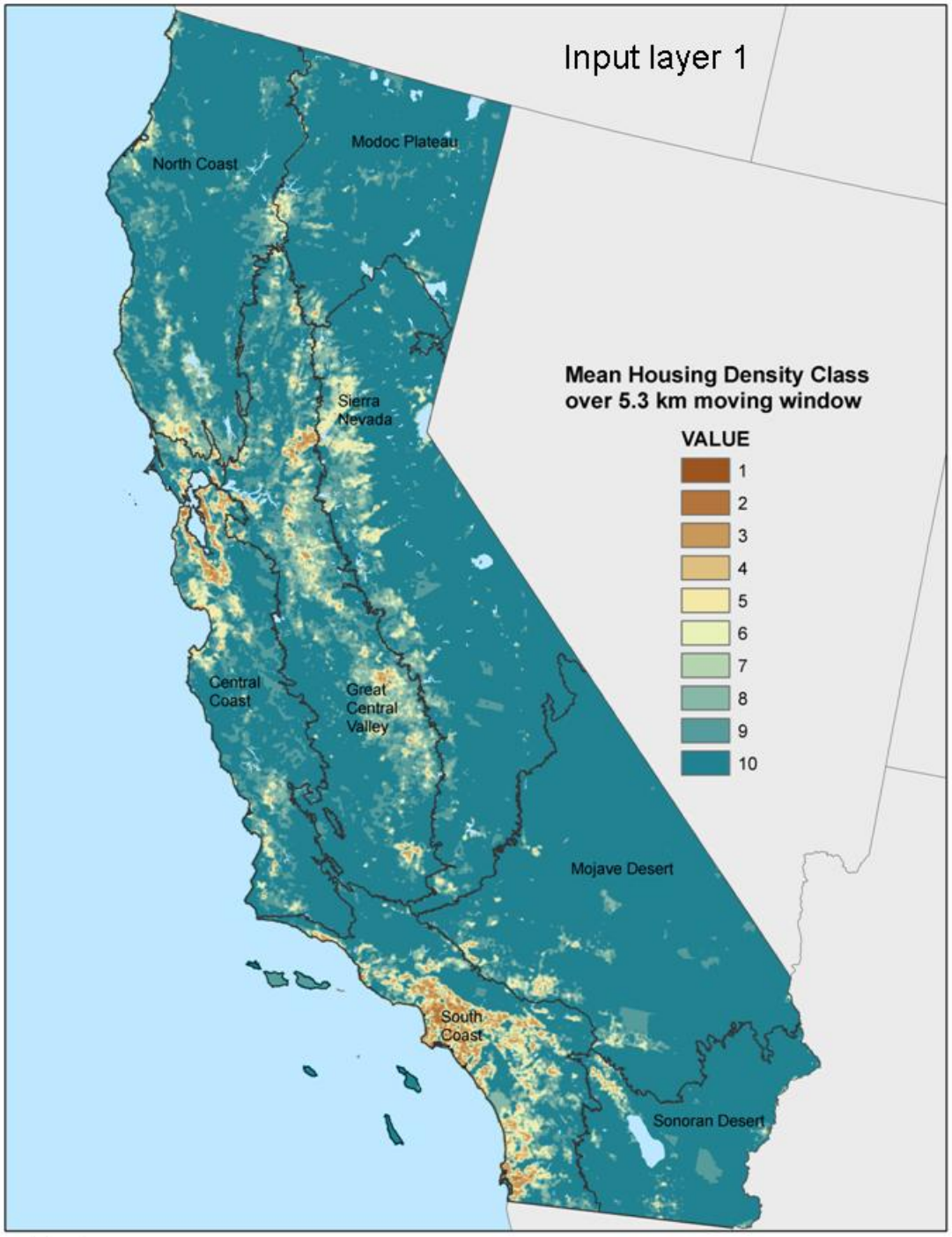
threshold did not seem appropriate (Central Coast and Northern Sierra Nevada), we subdivided them to apply slightly different thresholds in different subregions.

The Mojave and Sonoran Desert Ecoregions have huge areas that score 30 and tend to coalesce into one or a few huge blocks with little discrimination. We therefore applied the highest (least inclusive) threshold, including only areas that scored 30 and are in GAP1 protection status or in an HBV area, to discriminate landscape blocks there. For the North Coast and more intact counties of the Central Coast and Northern Sierra Nevada, we used an intermediate threshold of 30 or 29 and in an HBV area while in the remaining areas we applied the lowest (most inclusive) threshold of 29 or 28 and in an HBV area.

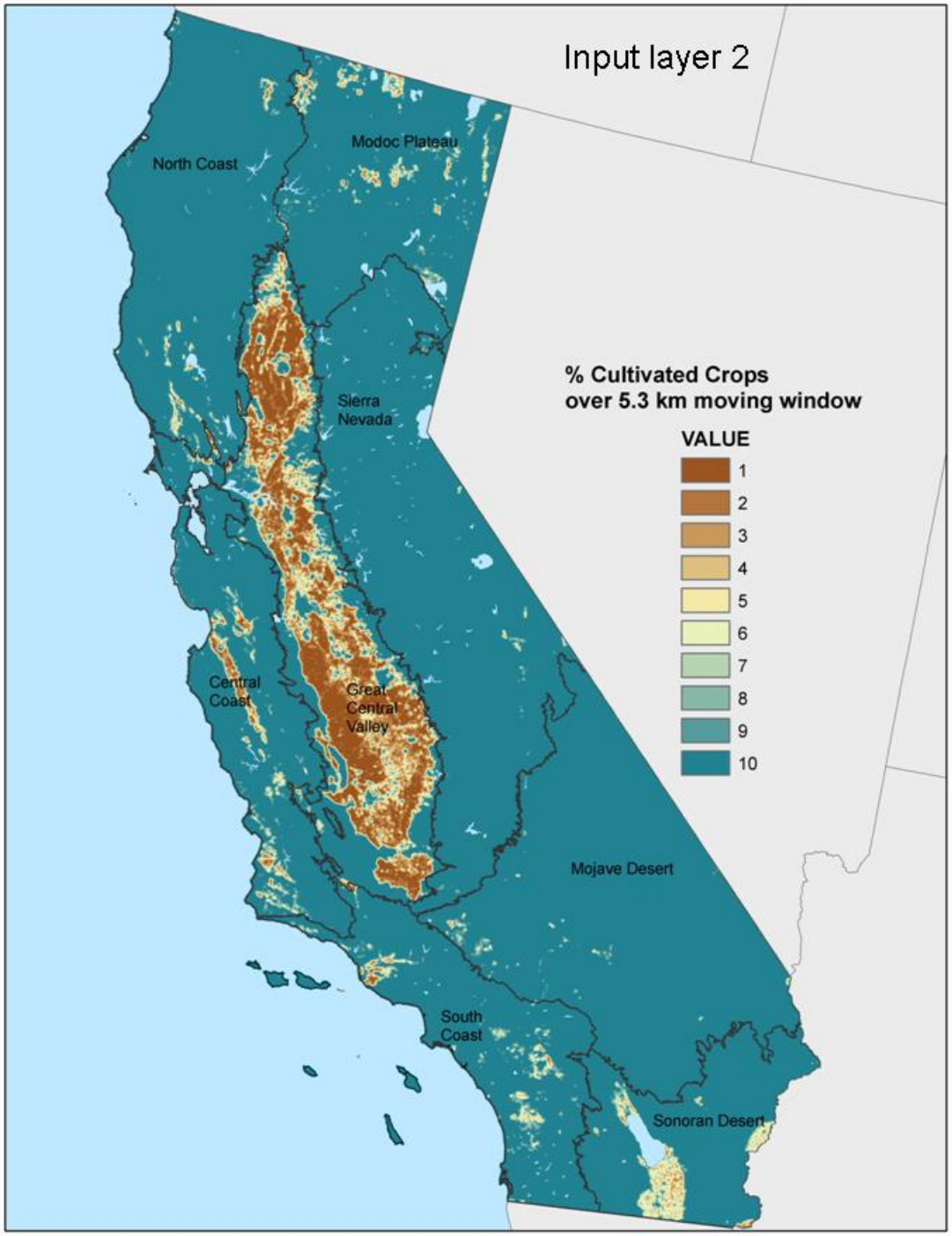
STEP 5. We eliminated blocks < 2,000 acres as being too small to be useful for this statewide map. Remaining blocks within 1 km of one another were aggregated. Holes within blocks were dissolved to form cohesive units.

Maps for Review

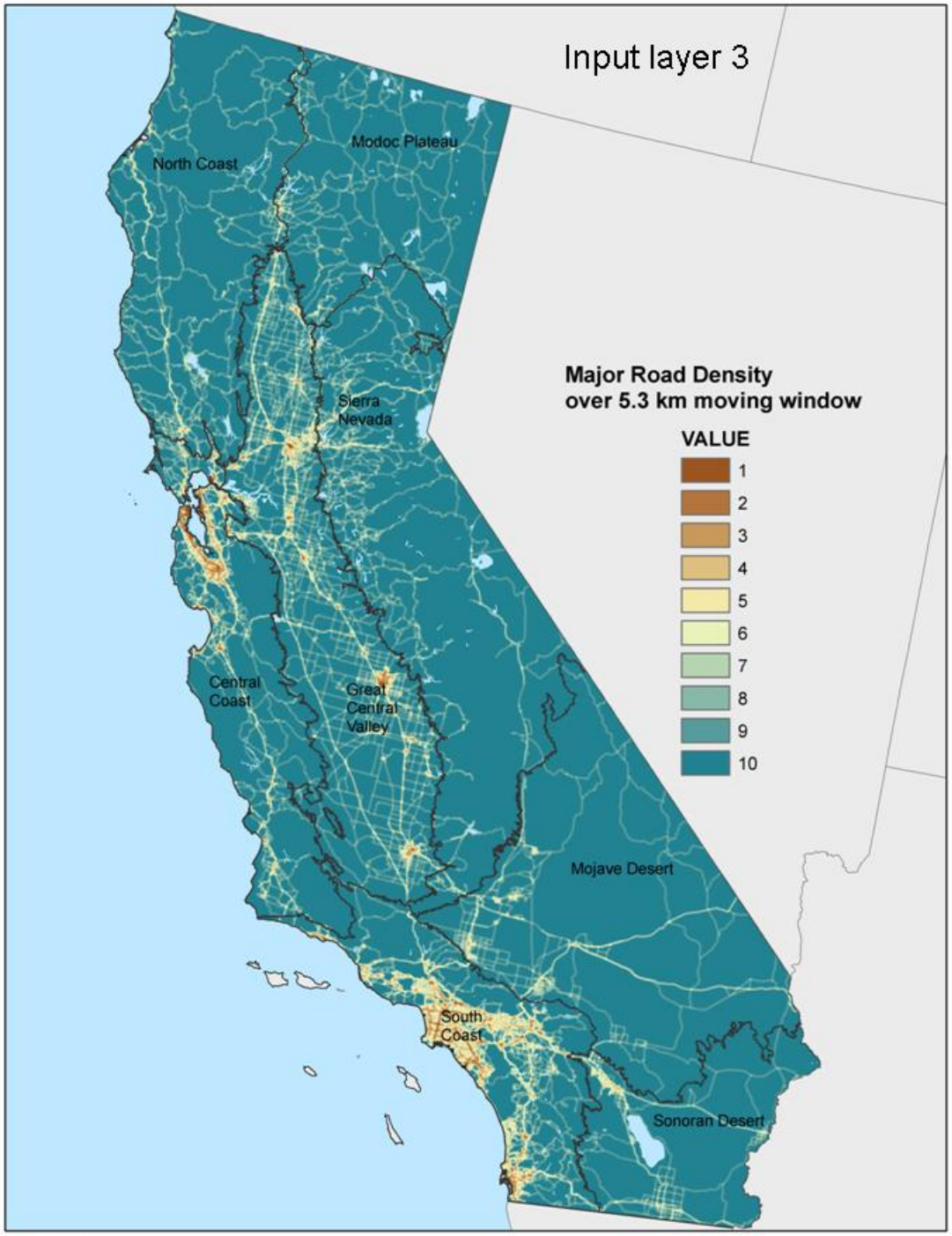
We provide maps below for your review. These illustrate what we currently think is approaching the most defensible block delineation yet, but this is open to discussion.


Input layer 1
Modoc Plateau
North Coast
Sierra Nevada
Mean Housing Density Class over 5.3 km moving window
VALUE
1
2
3
4
5
6
7
8
9
10
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert

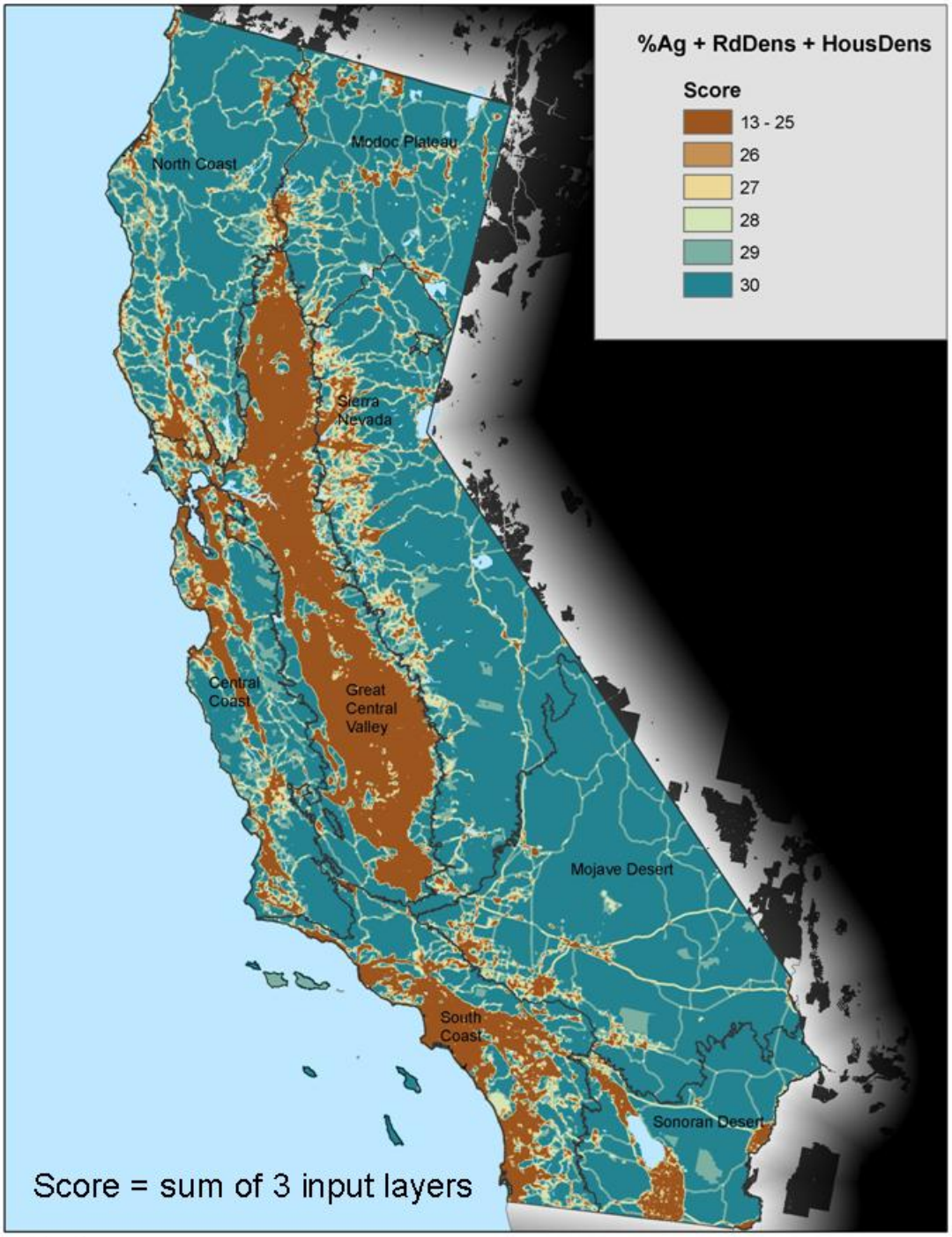
Map 1


Input layer 2
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
% Cultivated Crops
over 5.3 km moving window
VALUE
1
2
3
4
5
6
7
8
9
10

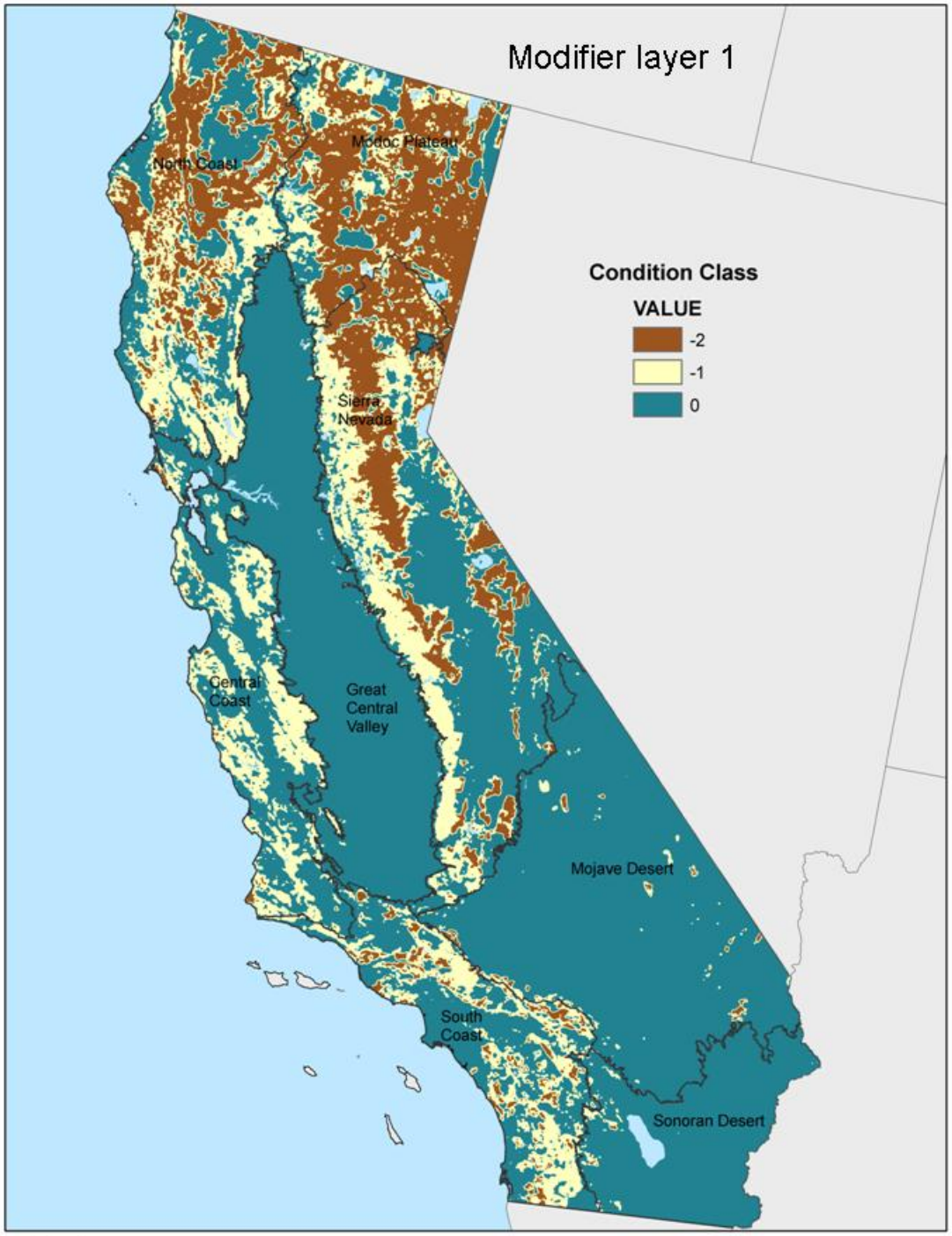
Map 2


Input layer 3
Major Road Density
over 5.3 km moving window
VALUE
1
2
3
4
5
6
7
8
9
10
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert

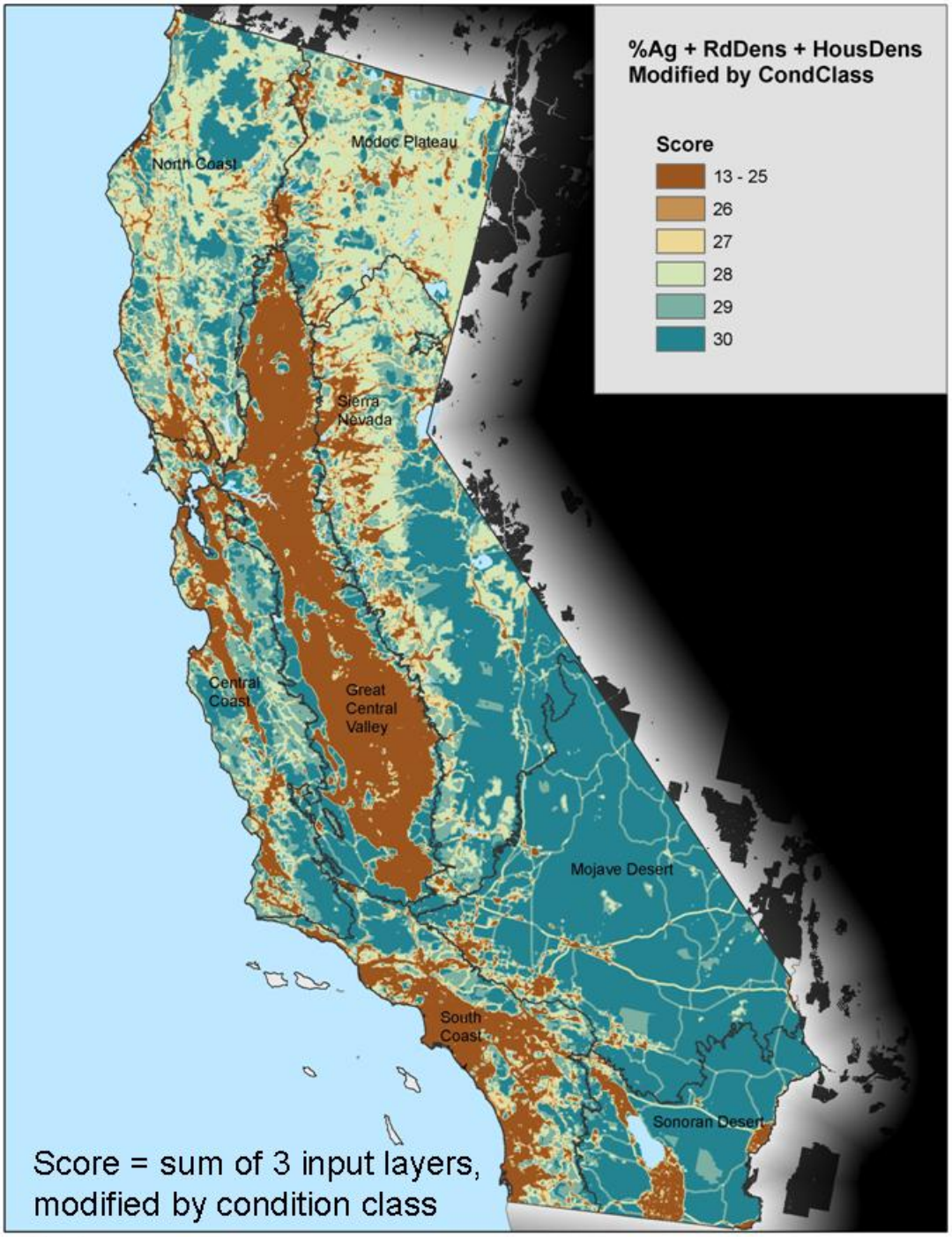
Map 3


%Ag + RdDens + HousDens
Score
13 - 25
26
27
28
29
30
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Score = sum of 3 input layers

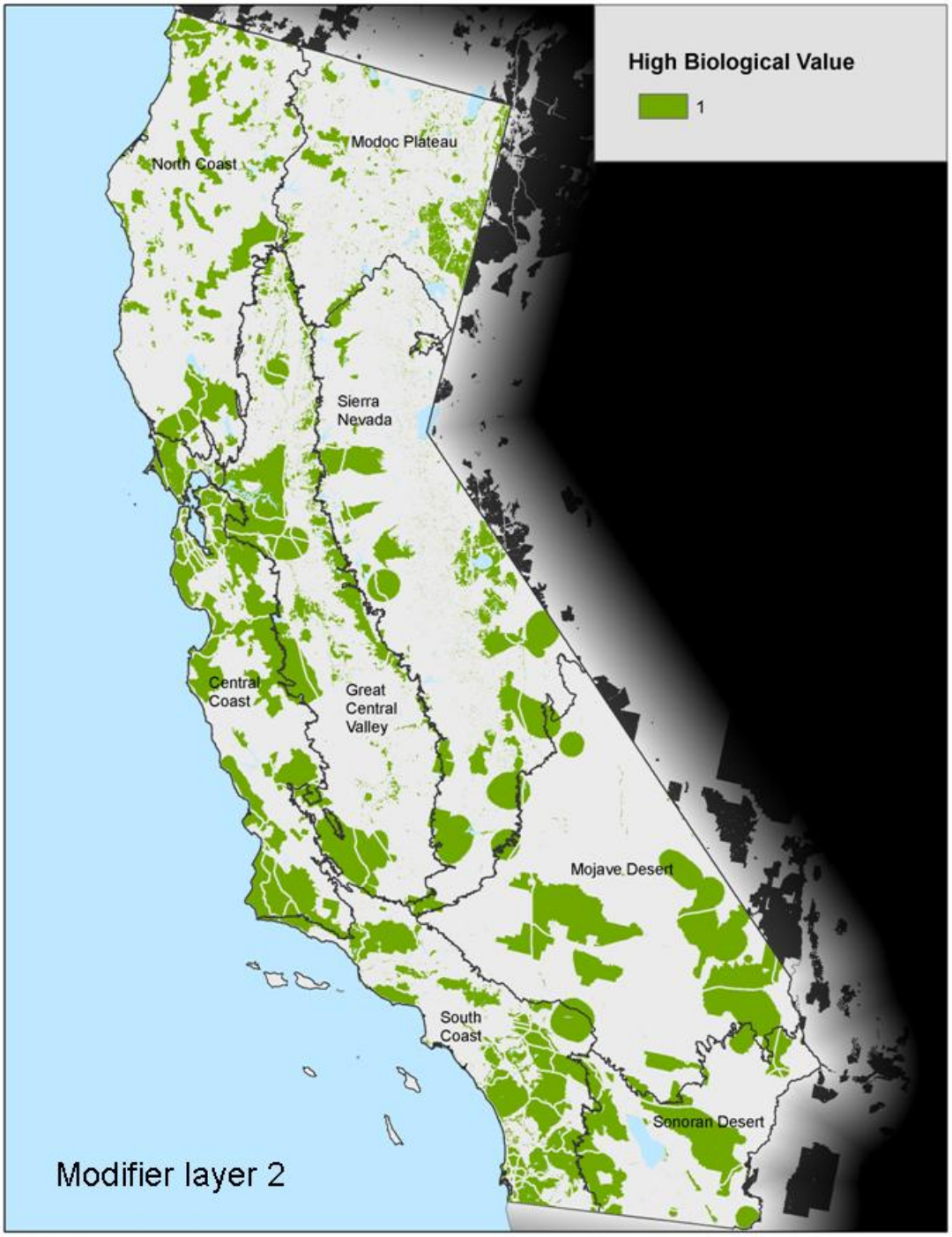
Map 4


Modifier layer 1
Condition Class
VALUE
-2
-1
0
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert

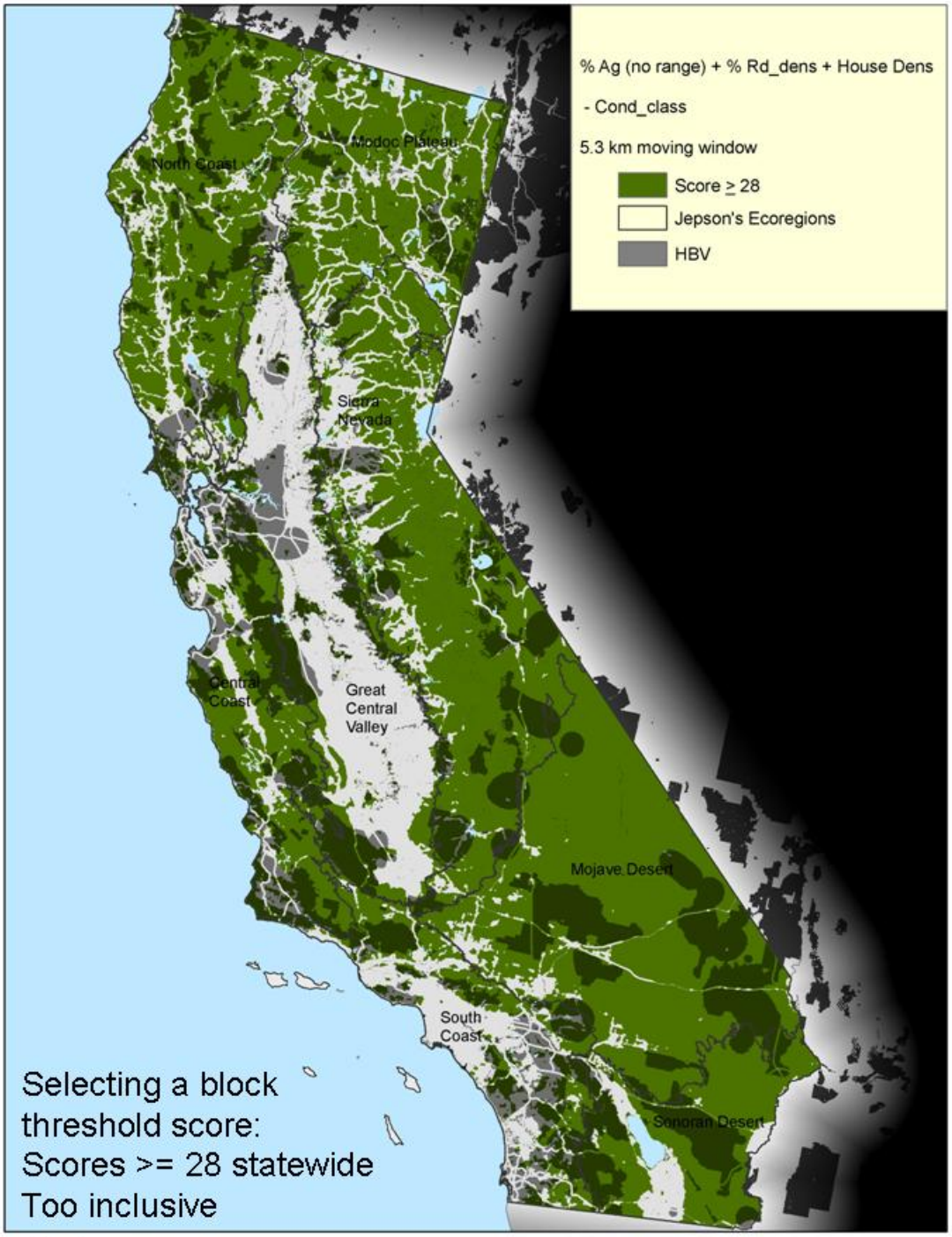
Map 5


%Ag + RdDens + HousDens
Modified by CondClass
Score
13 - 25
26
27
28
29
30
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Score = sum of 3 input layers, modified by condition class

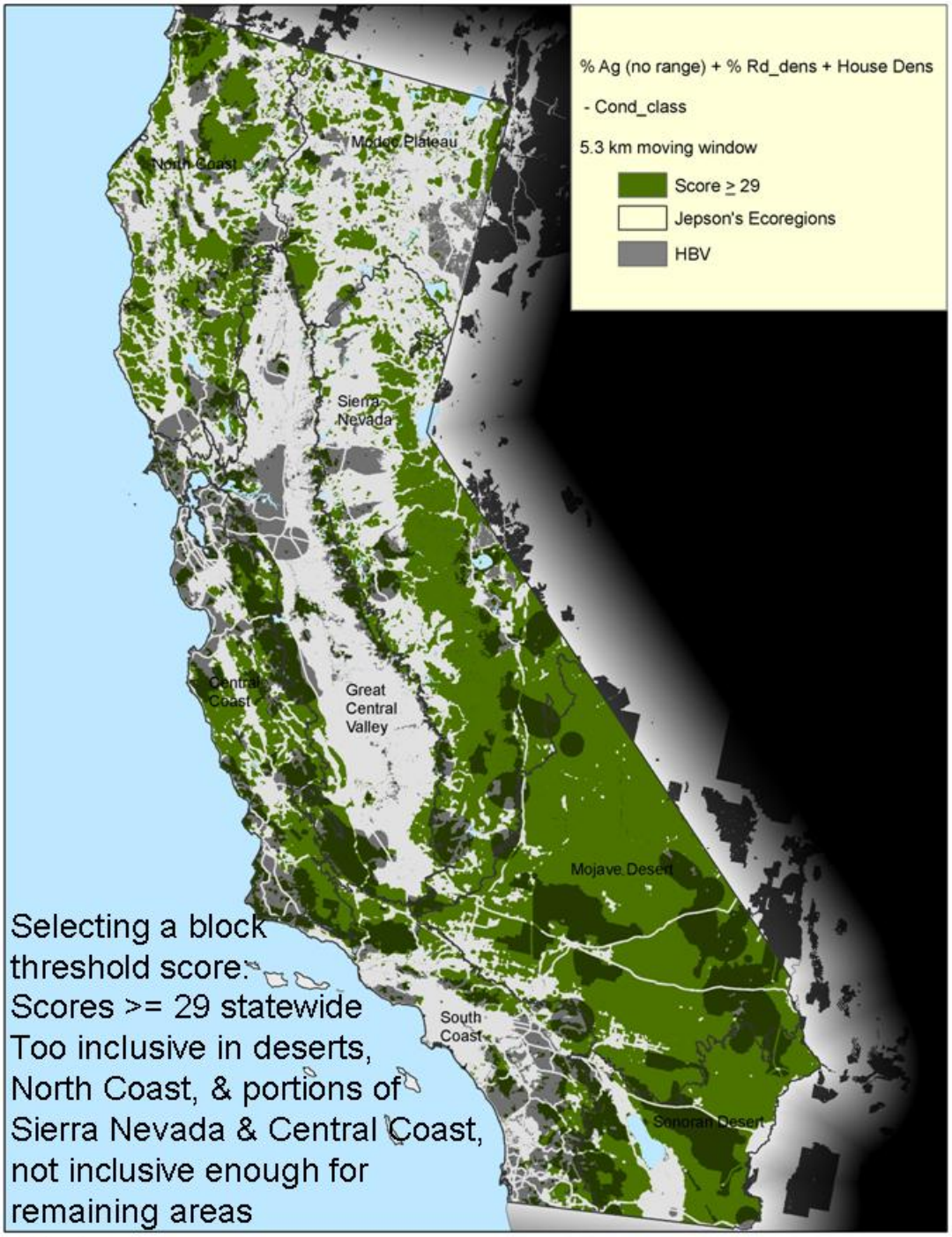
Map 6


High Biological Value
1
Modoc Plateau
North Coast
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Modifier layer 2

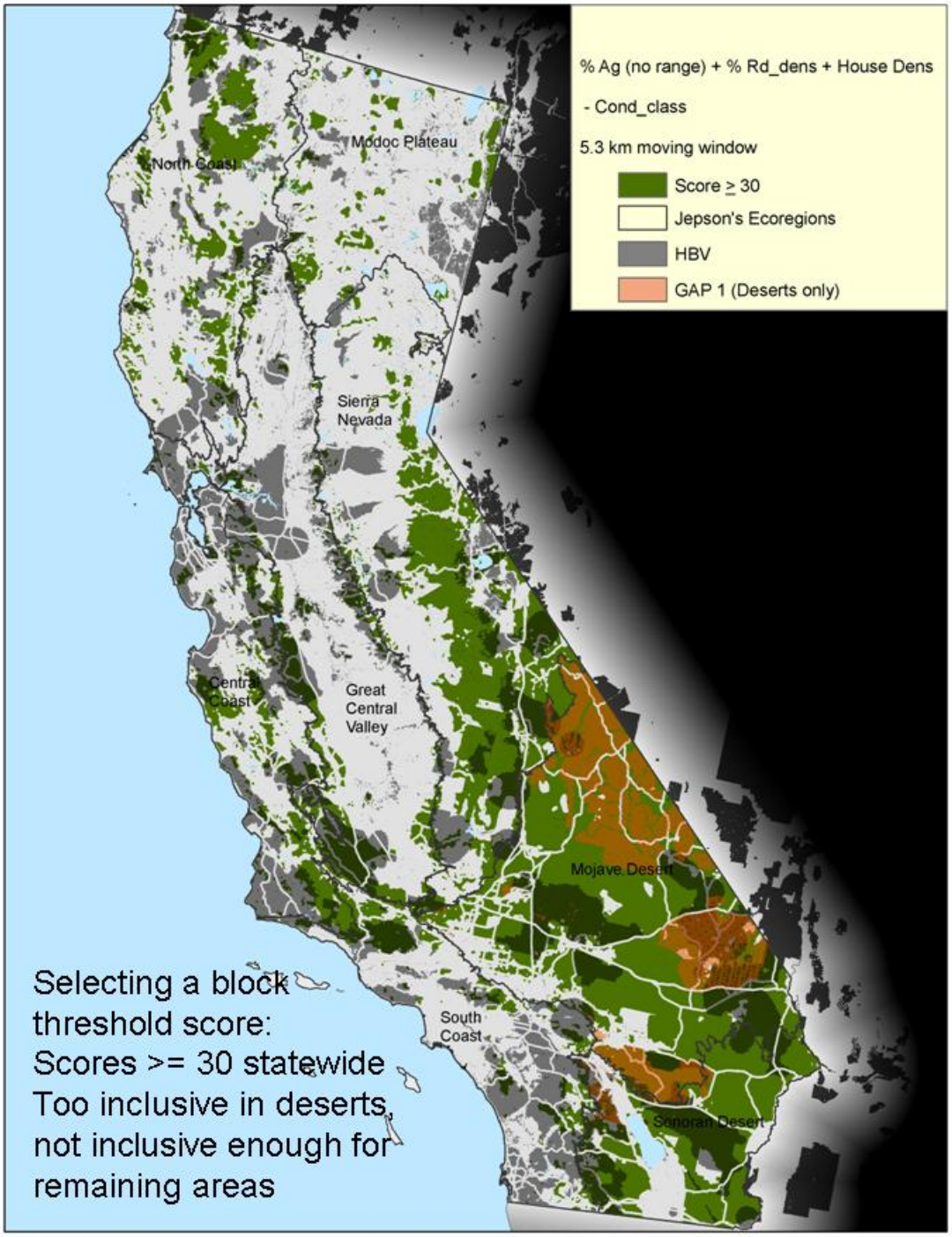
Map 7


% Ag (no range) + % Rd_dens + House Dens
- Cond_class
5.3 km moving window
Score ≥ 28
Jepson's Ecoregions
HBV
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Selecting a block threshold score:
Scores >= 28 statewide
Too inclusive

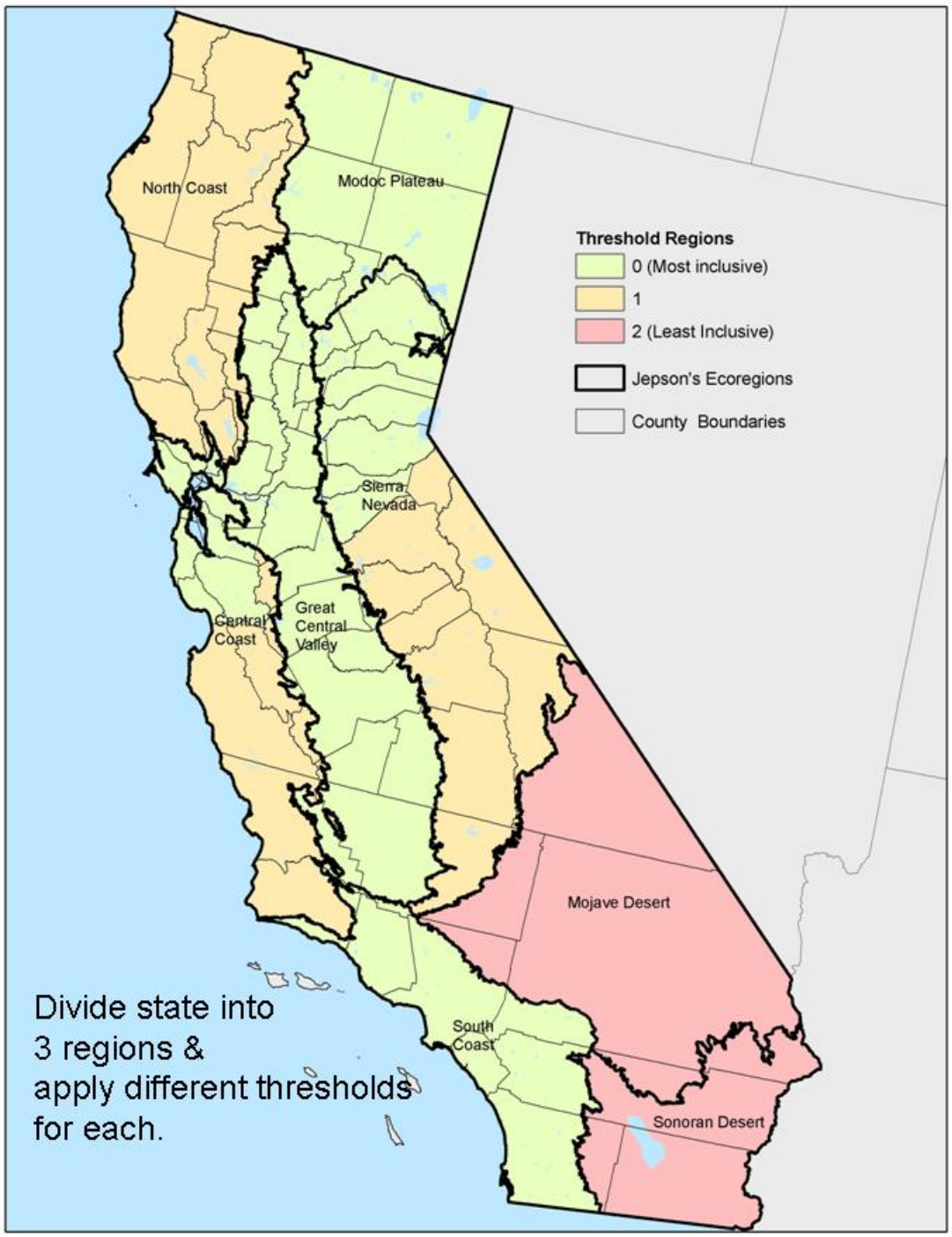
Map 8


% Ag (no range) + % Rd_dens + House Dens
- Cond_class
5.3 km moving window
Score ≥ 29
Jepson's Ecoregions
HBV
Modoc Plateau
North Coast
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Selecting a block threshold score:
Scores >= 29 statewide
Too inclusive in deserts, North Coast, & portions of Sierra Nevada & Central Coast, not inclusive enough for remaining areas

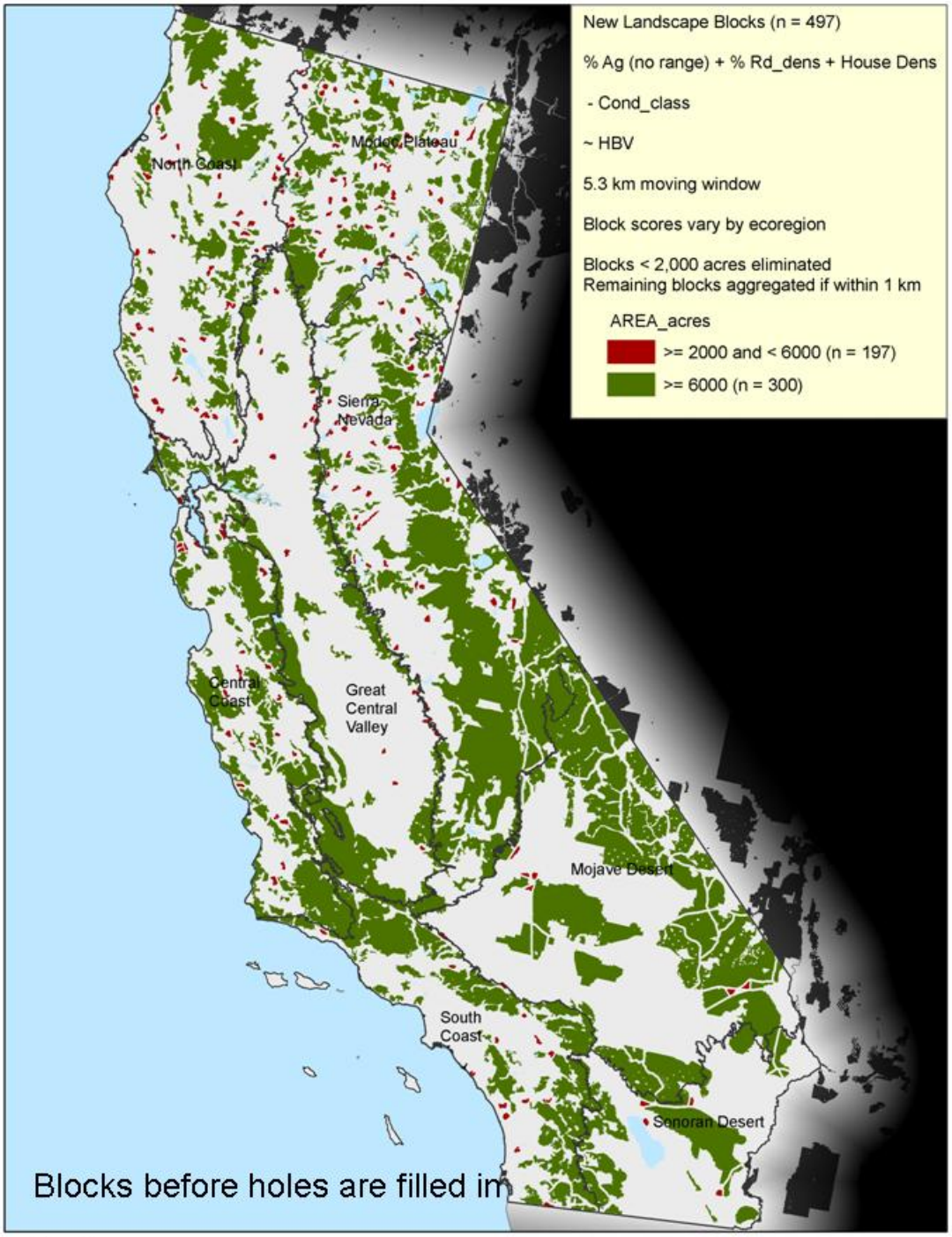
Map 9


% Ag (no range) + % Rd_dens + House Dens
- Cond_class
5.3 km moving window
Score ≥ 30
Jepson's Ecoregions
HBV
GAP 1 (Deserts only)
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Selecting a block threshold score:
Scores >= 30 statewide
Too inclusive in deserts, not inclusive enough for remaining areas

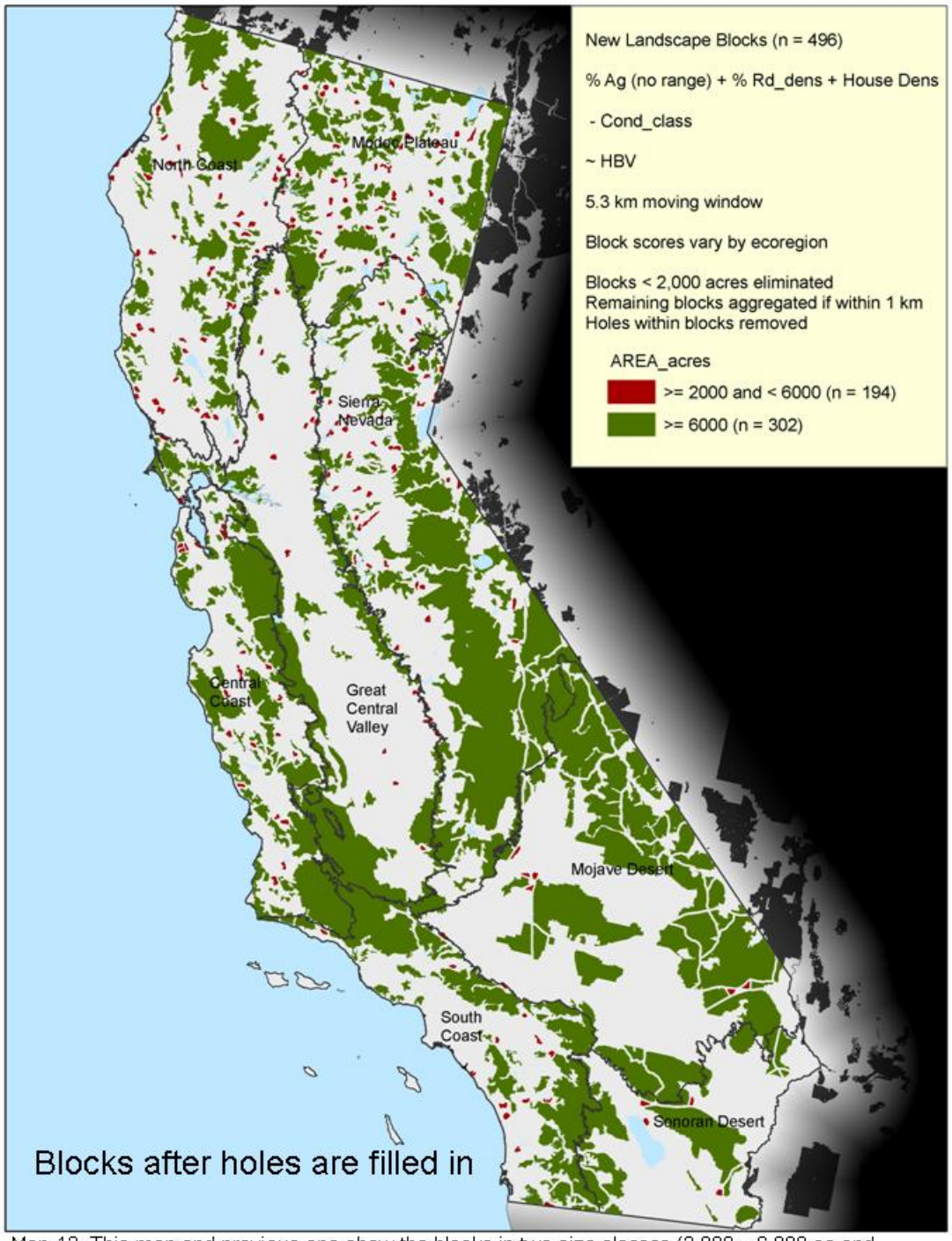
Map 10



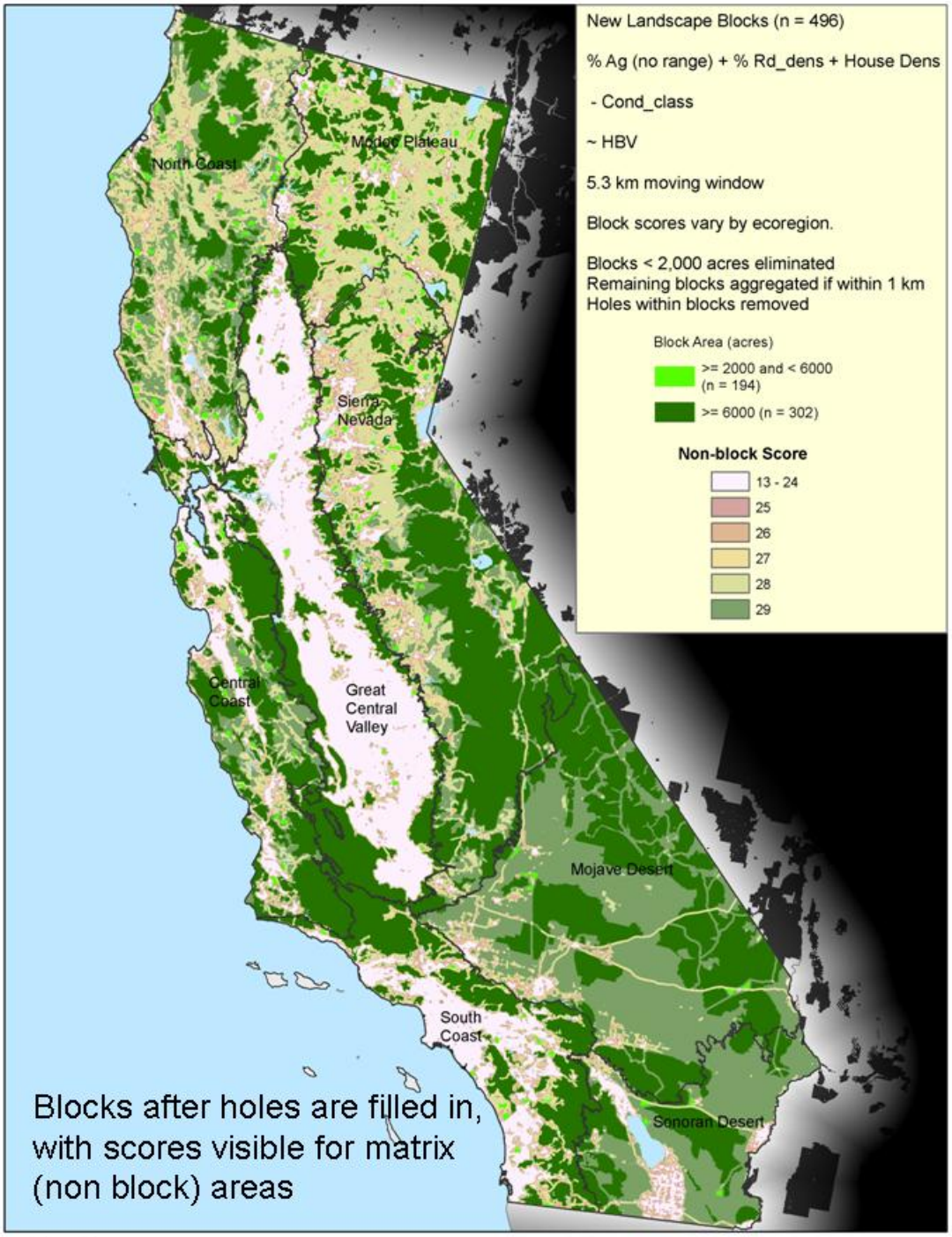
Map 11. Desert ecoregions use highest (least inclusive) threshold of 30 and within an area of GAP1 protection status or HBV, the North Coast and more intact counties of the Central Coast and northern Sierra Nevada use intermediate threshold of 30 or 29 within an HBV area, and the remaining areas use lowest (most inclusive) threshold of 29 or 28 within an HBV area.


New Landscape Blocks (n = 497)
% Ag (no range) + % Rd_dens + House Dens
- Cond_class
~ HBV
5.3 km moving window
Block scores vary by ecoregion
Blocks < 2,000 acres eliminated
Remaining blocks aggregated if within 1 km
AREA_acres
>= 2000 and < 6000 (n = 197)
>= 6000 (n = 300)
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Blocks before holes are filled in

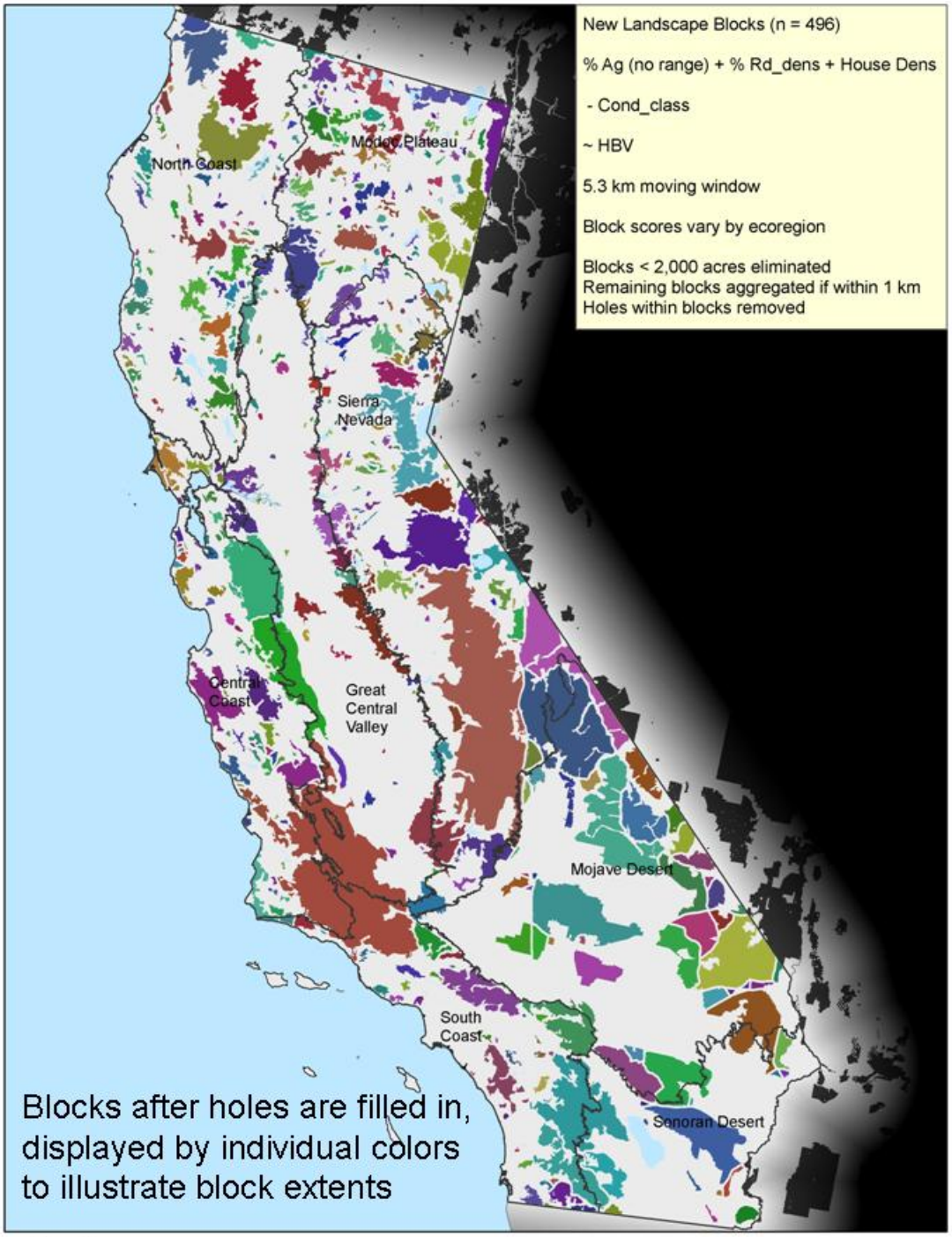
Map 12



Map 13. This map and previous one show the blocks in two size classes (2,000 – 6,000 ac and > 6,000 ac). Note that size thresholds can also vary by ecoregion. We think that blocks > 6,000 ac should be included, perhaps supplemented by blocks of 2,000-6000 in some ecoregions.


New Landscape Blocks (n = 496)
% Ag (no range) + % Rd_dens + House Dens
- Cond_class
~ HBV
5.3 km moving window
Block scores vary by ecoregion.
Blocks < 2,000 acres eliminated
Remaining blocks aggregated if within 1 km
Holes within blocks removed
Block Area (acres)
>= 2000 and < 6000 (n = 194)
>= 6000 (n = 302)
Non-block Score
13 - 24
25
26
27
28
29
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Blocks after holes are filled in, with scores visible for matrix (non block) areas

Map 14


New Landscape Blocks (n = 496)
% Ag (no range) + % Rd_dens + House Dens
- Cond_class
~ HBV
5.3 km moving window
Block scores vary by ecoregion
Blocks < 2,000 acres eliminated
Remaining blocks aggregated if within 1 km
Holes within blocks removed
North Coast
Modoc Plateau
Sierra Nevada
Central Coast
Great Central Valley
Mojave Desert
South Coast
Sonoran Desert
Blocks after holes are filled in, displayed by individual colors to illustrate block extents

Map 15

California Essential Habitat Connectivity project

I. Rules for drawing sticks (Draft 2 Jun 2009)

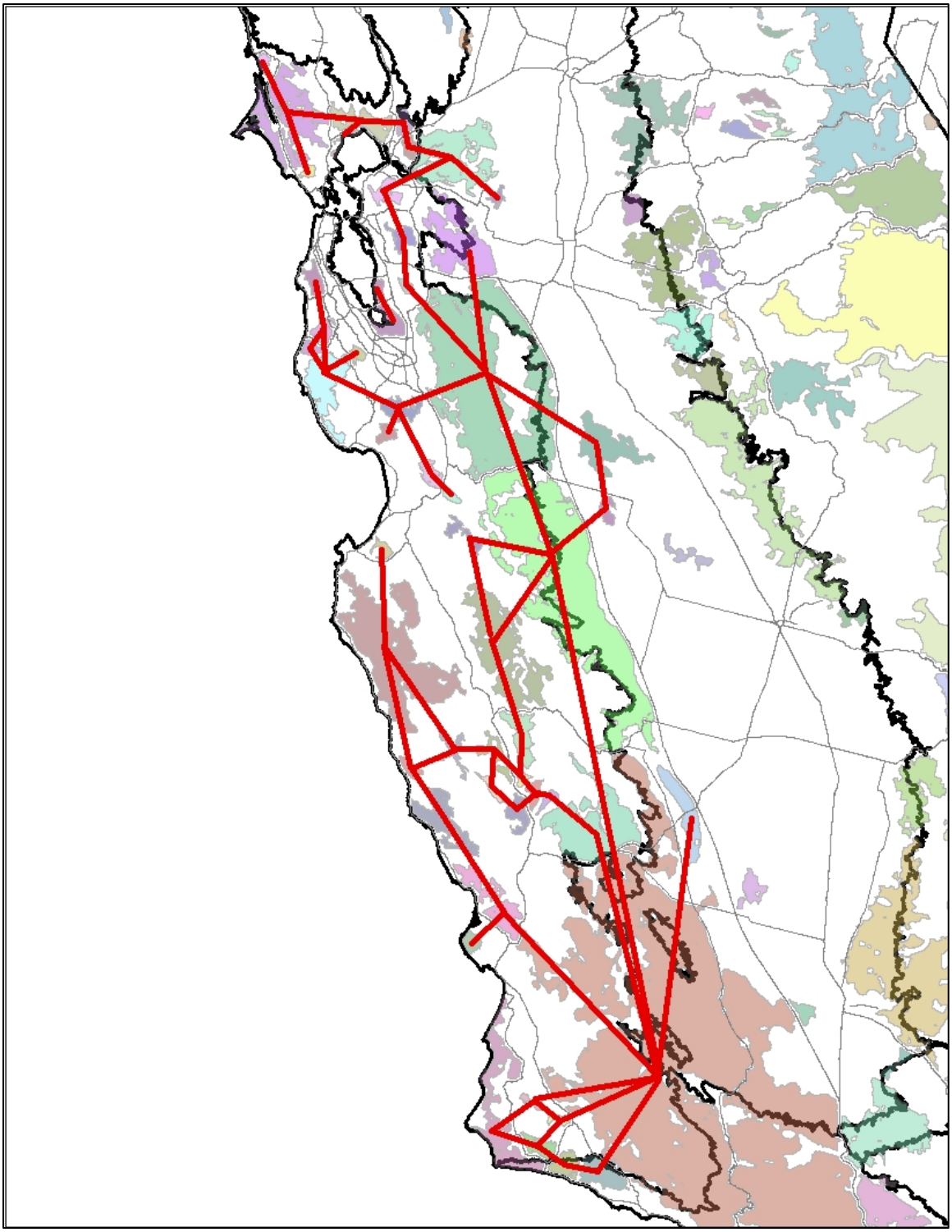
1. Sticks represent a linkage between two landscape blocks, or the need for such a linkage. Sticks are drawn to connect the centroids of landscape blocks. The location of a stick does *not* indicate the location of the linkage; it is simply a conceptual placeholder indicating which landscape blocks should be connected.
2. No stick can represent a linkage that would have to cross > 1 km of open water.
3. No stick can represent a linkage that would have to cross > 1.5 km of urban land. (Recall that the stick does not represent the location of the linkage. Thus, a *stick* may cross >1.5 km of urban land or > 1 km of water if it is feasible for the *linkage* to avoid crossing a lot of urban land or water.)
4. Connect each landscape block to its nearest neighbor (where nearness is defined edge to edge).
5. Connect each landscape block to its second nearest neighbor if the 2nd neighbor is < 15 km away (edge to edge).
6. A group of 2 or more landscape blocks connected by sticks is called a *constellation*.
7. After all constellations have been created by the above rules: Starting with the smallest constellation, connect each constellation to its nearest neighboring constellation (if it isn't already connected). As before, if the connection would have to cross > 1 km of open water or > 1.5 km of urban land, the constellation would remain isolated. See Map 16 for a draft example of how these rules might look when applied to the Central Coast ecoregion.

II. Rules for removing sticks

1. When two landscape blocks or constellations are connected by two or more sticks or chains of sticks, remove any involved stick that represents a markedly inferior linkage. "Inferior" is defined as a linkage that would have to cross at least twice as much distance in urban land use as the relatively "best" linkage, or that would be constrained by existing urbanization to a width less than half the width of the "best" linkage. Retain redundant connections where they both represent linkages of roughly equal quality.

III. Rules for differentiating two types of sticks

1. Use a unique line type to represent a linkage in a situation where the facing edges of two landscape blocks are in public ownership and the only barrier is a road, canal, railroad, or another thin, linear barrier or filter. In these cases, connectivity will be addressed by prescriptions for a variety of crossing structures along the linear barrier. Least-cost modeling will not be needed in these situations.



Map 16: Sample Map with "Sticks" delineating potential Landscape Block connections based on above outlined rule set.