

California natural and working LANDs carbon model, version 2 (CALAND v2)

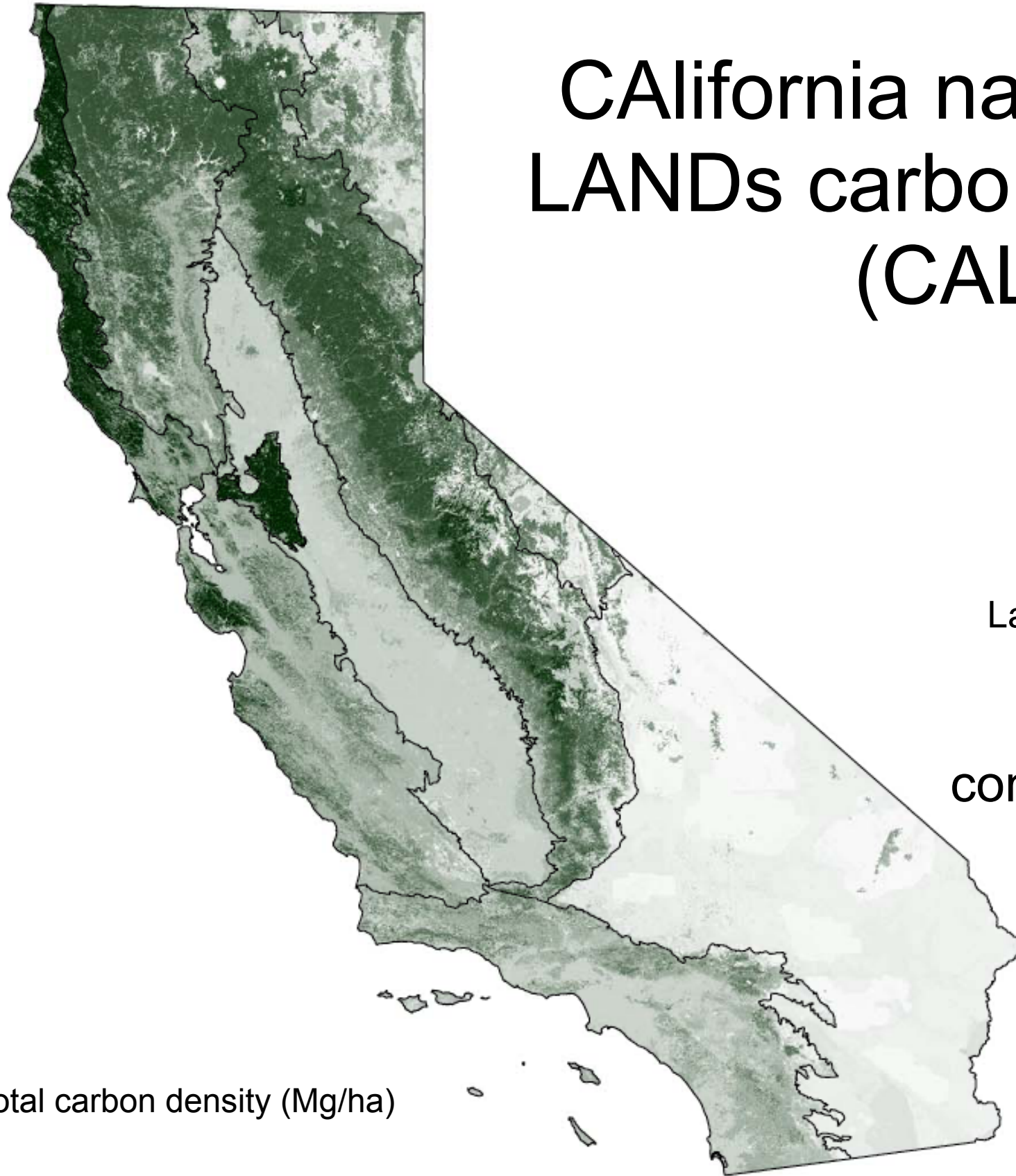
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With feedback and
contributions from many people

Public Workshop on
Proposed NWL Implementation Plan
13 Oct 2017

Total carbon density (Mg/ha)



Overview

- Purpose
- Summary response to feedback
- Model description
 - Updates from version 1
 - Plans for version 3
- Additional management practices
- Take home messages

CALAND

- Database carbon accounting model (excel, R)
 - Annual carbon stock and flow - conserves carbon
 - **Purpose: quantify and compare the changes in landscape carbon and associated GHG due to different management options in the context of the entire CA landscape**
- Initial carbon and land use/cover state (2010)
- Parameters/values for carbon dynamics
- Scenarios: annual area and mortality rates

Key Features

- Observation-based
- All CA land (plus seagrass)
- Spatially explicit practices and effects
- Compare disparate practices in one system
- Evaluate individual practices
- Evaluate aggregate effects of multiple practices

Summary of improvements

- Spatial land cover distribution
 - From 45 to 940 land categories
 - Version 3: BAU land cover change derived from CA Fourth Assessment projections (driven by FMMP land use data)
- Landscape greenhouse gas budget
 - CO₂, Black carbon, Methane
- Management (currently 16 practices)
 - Plus forest slash utilization pathway
 - Diagnostics for per area management effects
 - Exploring additional management practices

Summary of improvements

- Potential climate effects
 - Version 3: CA Fourth Assessment projections (vegetation and fire severity)
- Wildfire
 - Version 3: CA Fourth Assessment projections
 - Spatial area and severity
 - Potential to link managed area to fire severity

Data

- **Initial carbon density:**
 - Vegetation:
 - CARB forest and other land database (Aug 2016) (except urban)
 - Urban: Bjorkman et al. 2015
 - Soil: NRCS gSSURGO (2016) (except rangelands)
 - Grassland/Savanna/Woodland soil: Silver et al. 2010

Data

- **Initial land cover:**
 - CARB forest and other land inventory database (Aug 2016)
 - Landfire remote sensing, 2010
- **Ownership:** CALFIRE-FRAP, USFS, CCED 2015
- **Region (new in version 2):**
 - Bailey's ecological subregions of CA (USFS, CAL FIRE aggregation)
 - Legal Delta (DWR), plus the Suisun marsh (based on gSSURGO soil C and the Central_Valley region)

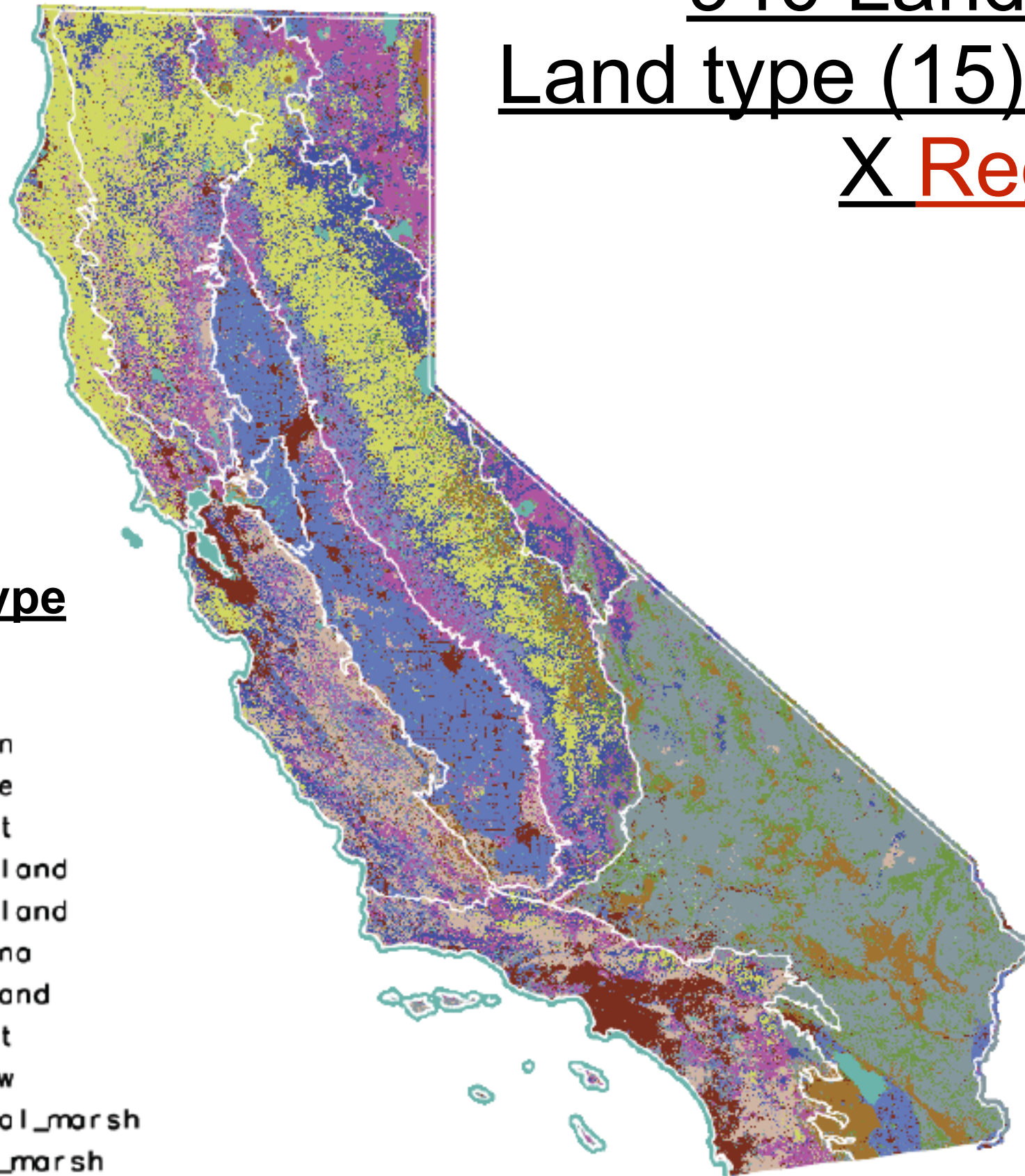
Data

- **Wildfire:** CAL FIRE
 - **Planned:** Spatially explicit wildfire area and severity from CA Fourth Assessment
- **Forest management:** Robards and Nickerson 2013; USFS personal communication 2016; Stewart and Nakamura 2012; CAL FIRE VTP EIR
- **Parameters/values for carbon dynamics:**
 - Academic literature and agency reports

940 Land categories:
Land type (15) X Ownership (9)
X Region (9)

2010

Land type



Region (white lines)

Central_Coast

Central_Valley

Delta

Deserts

Eastside

Klamath

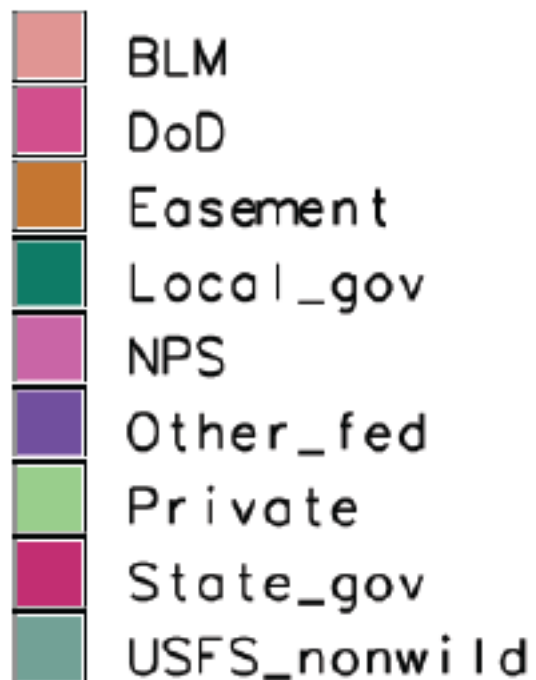
North_Coast

Sierra_Cascades

South_Coast

940 Land categories:
Land type (15) X Ownership (9)
X Region (9)

Ownership



Region (white lines)

Central_Coast

Central_Valley

Delta

Deserts

Eastside

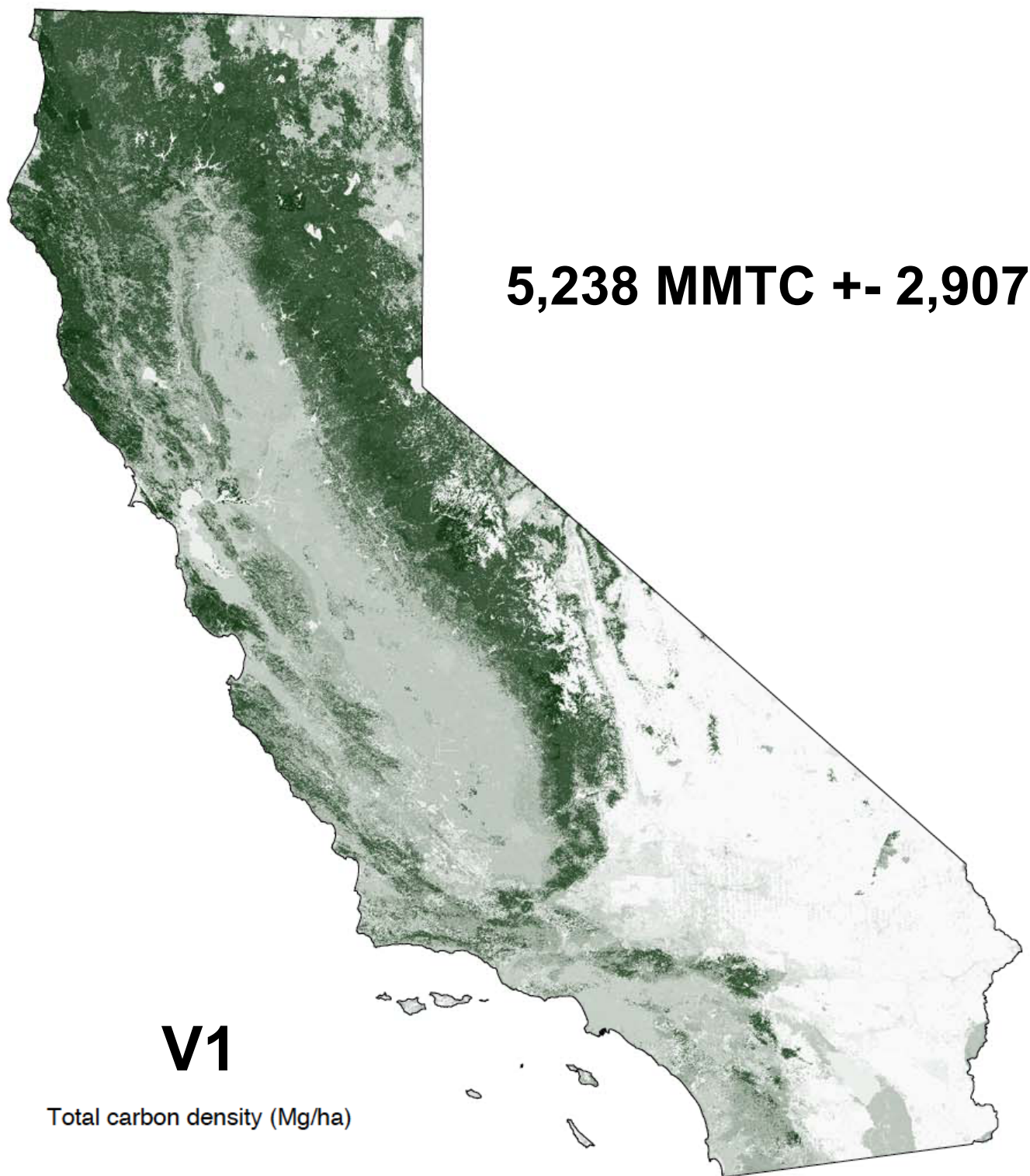
Klamath

North_Coast

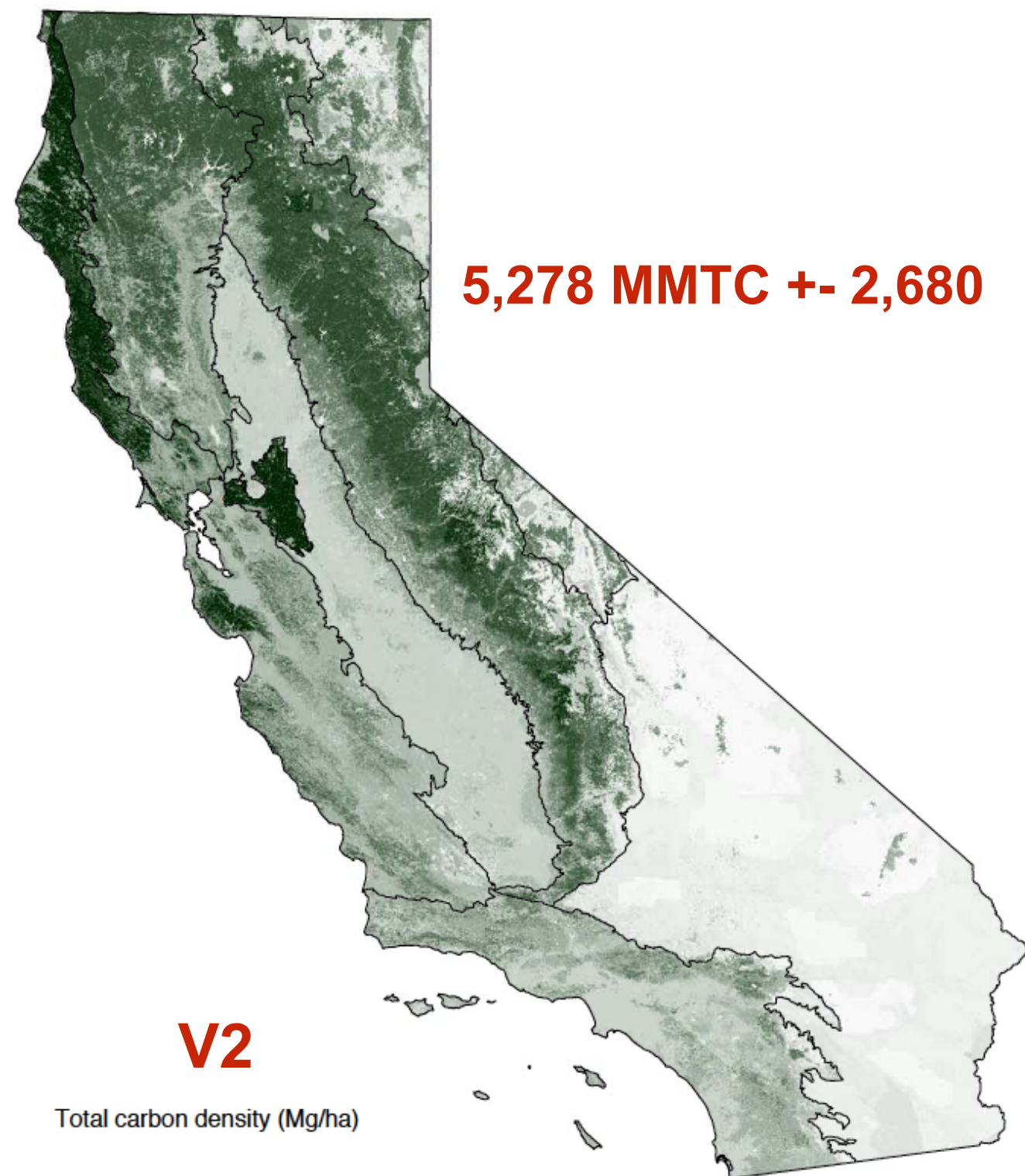
Sierra_Cascades

South_Coast

2010 total carbon density (MgC/ha)

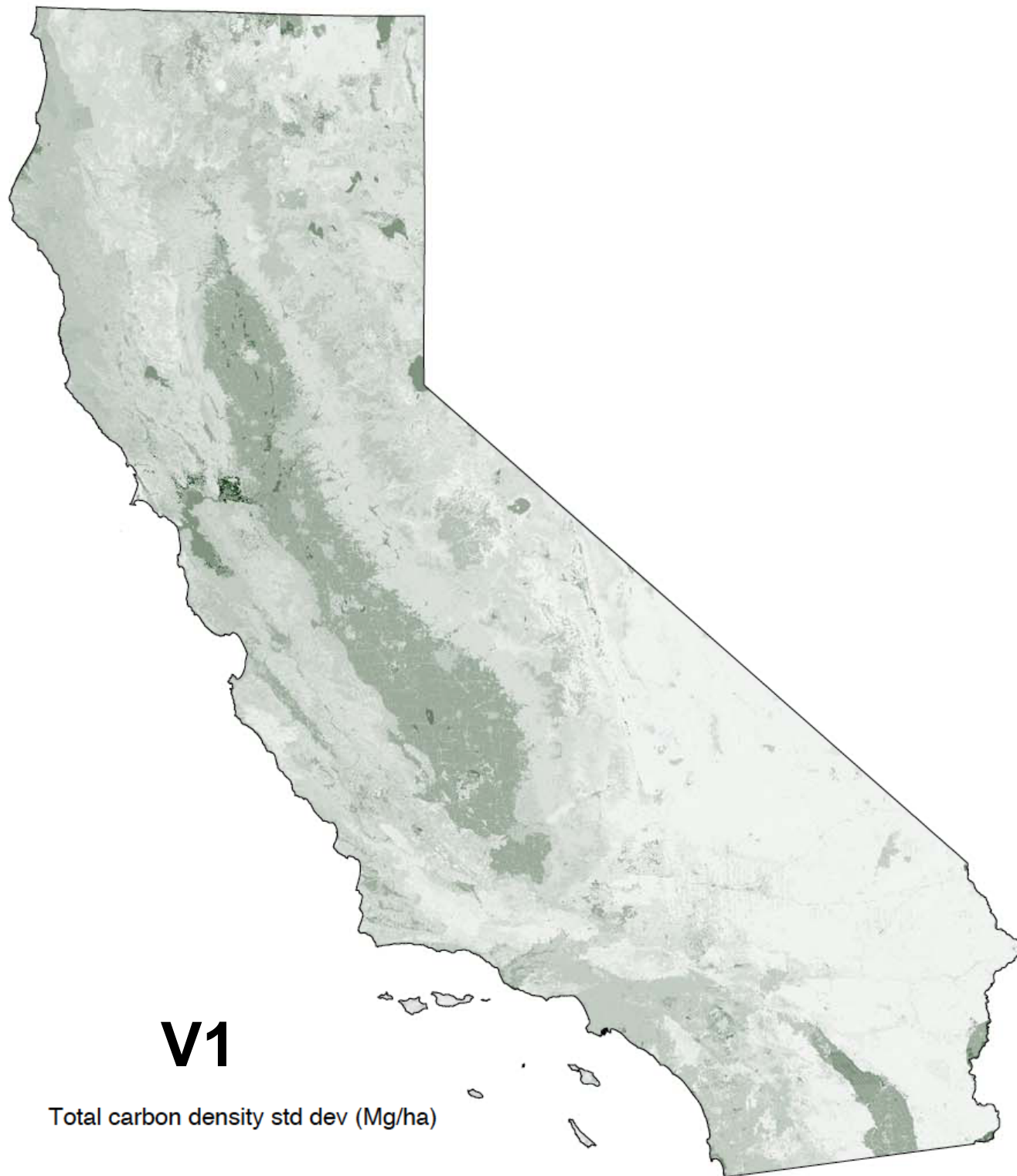


Mean ranges from 3 to 927
MgC/ha

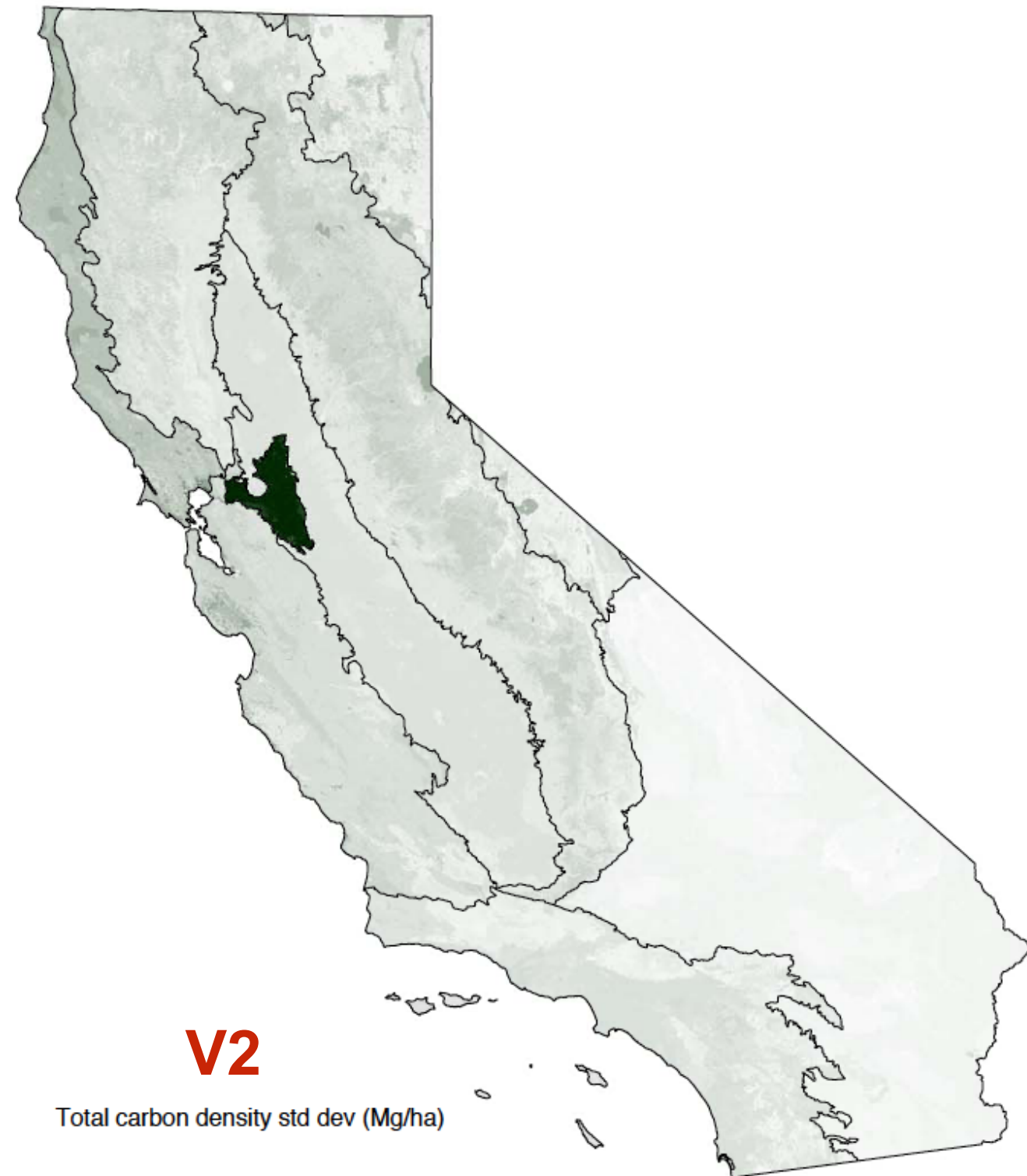


Mean ranges from 0 to 1952
MgC/ha

2010 total carbon density SD (MgC/ha)

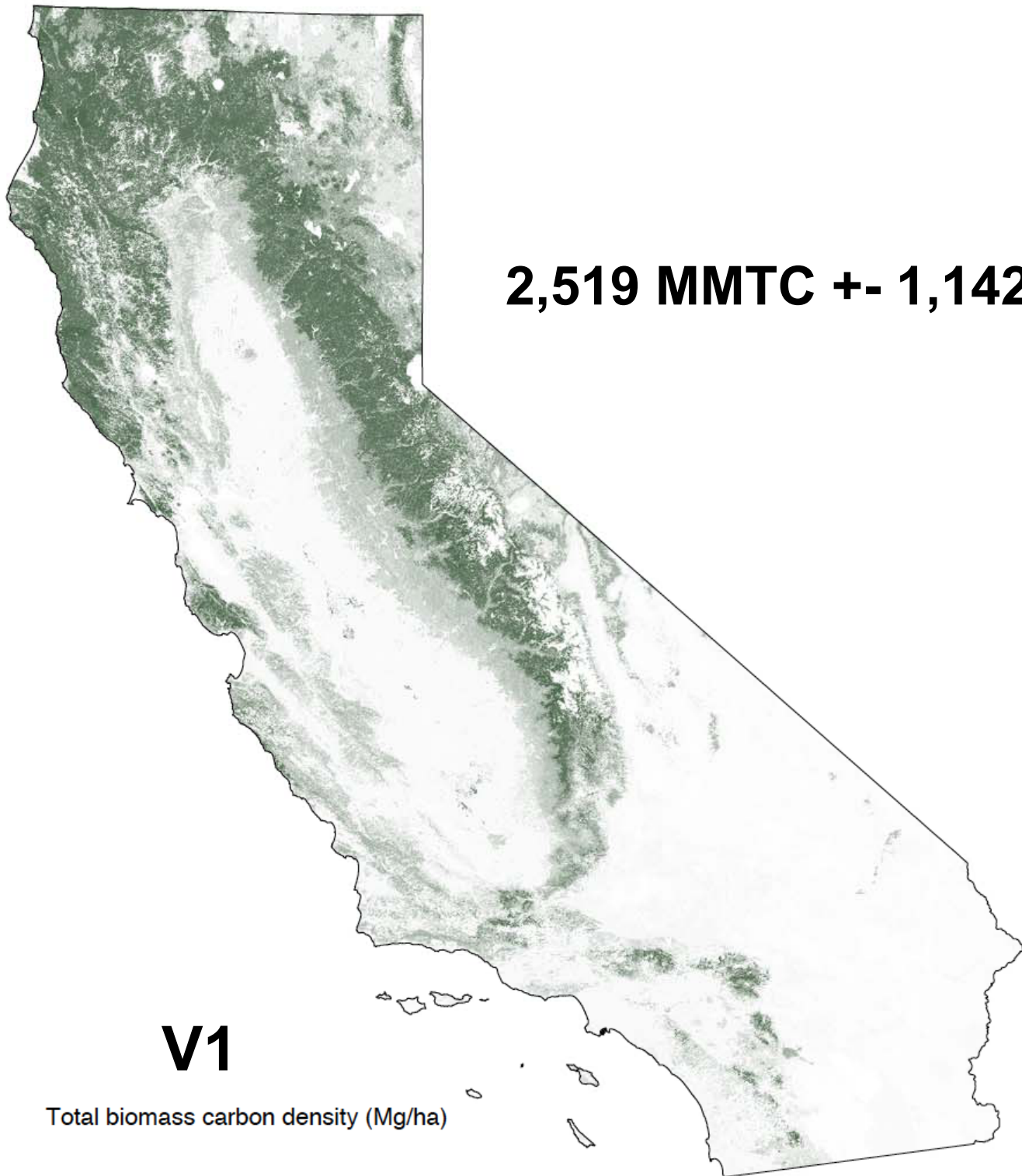


Std Dev ranges from 14 to 1013
MgC/ha

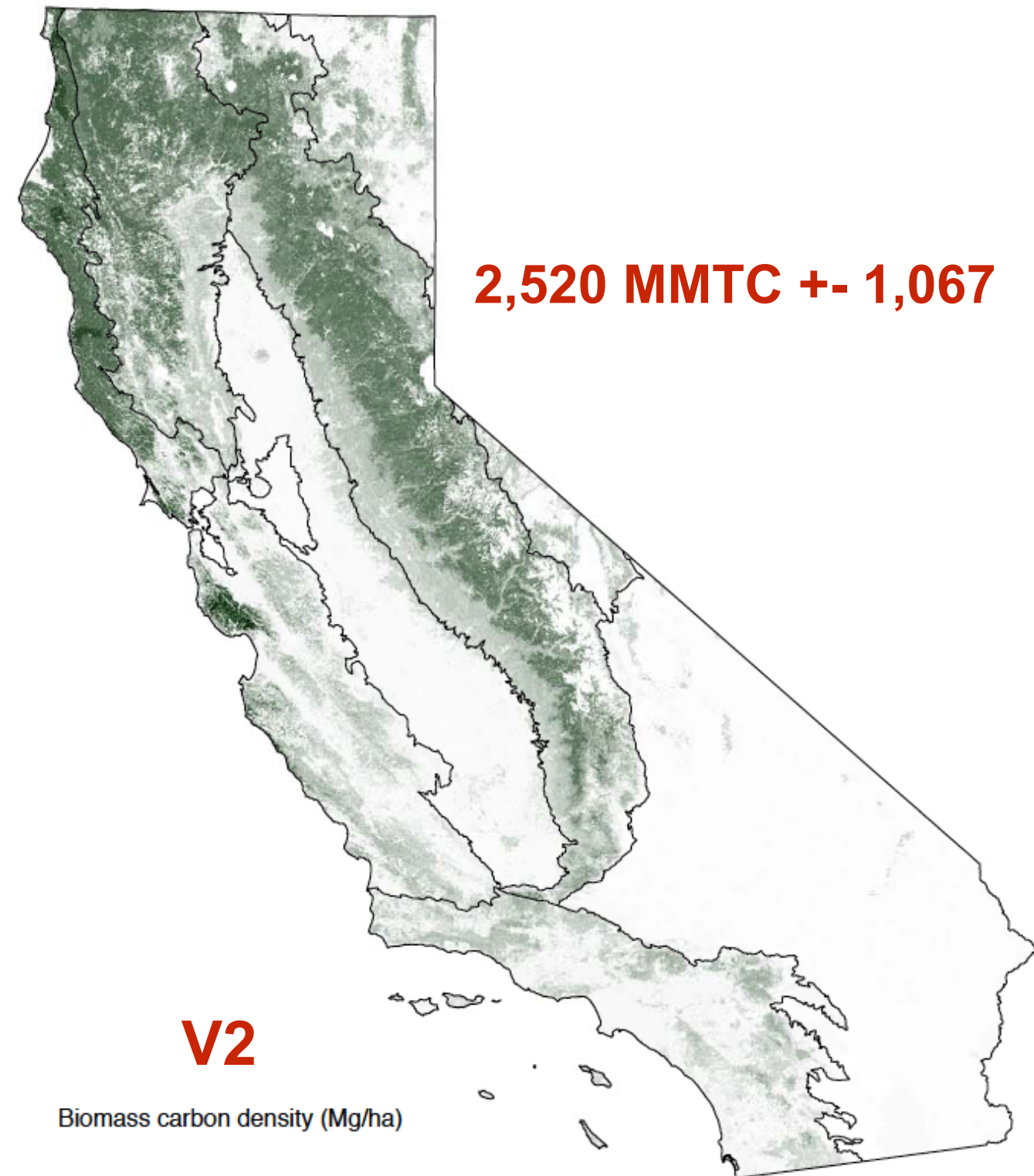


Std Dev ranges from 0 to 1150
MgC/ha

2010 biomass carbon density (MgC/ha)



Mean ranges from 0 to 238
MgC/ha

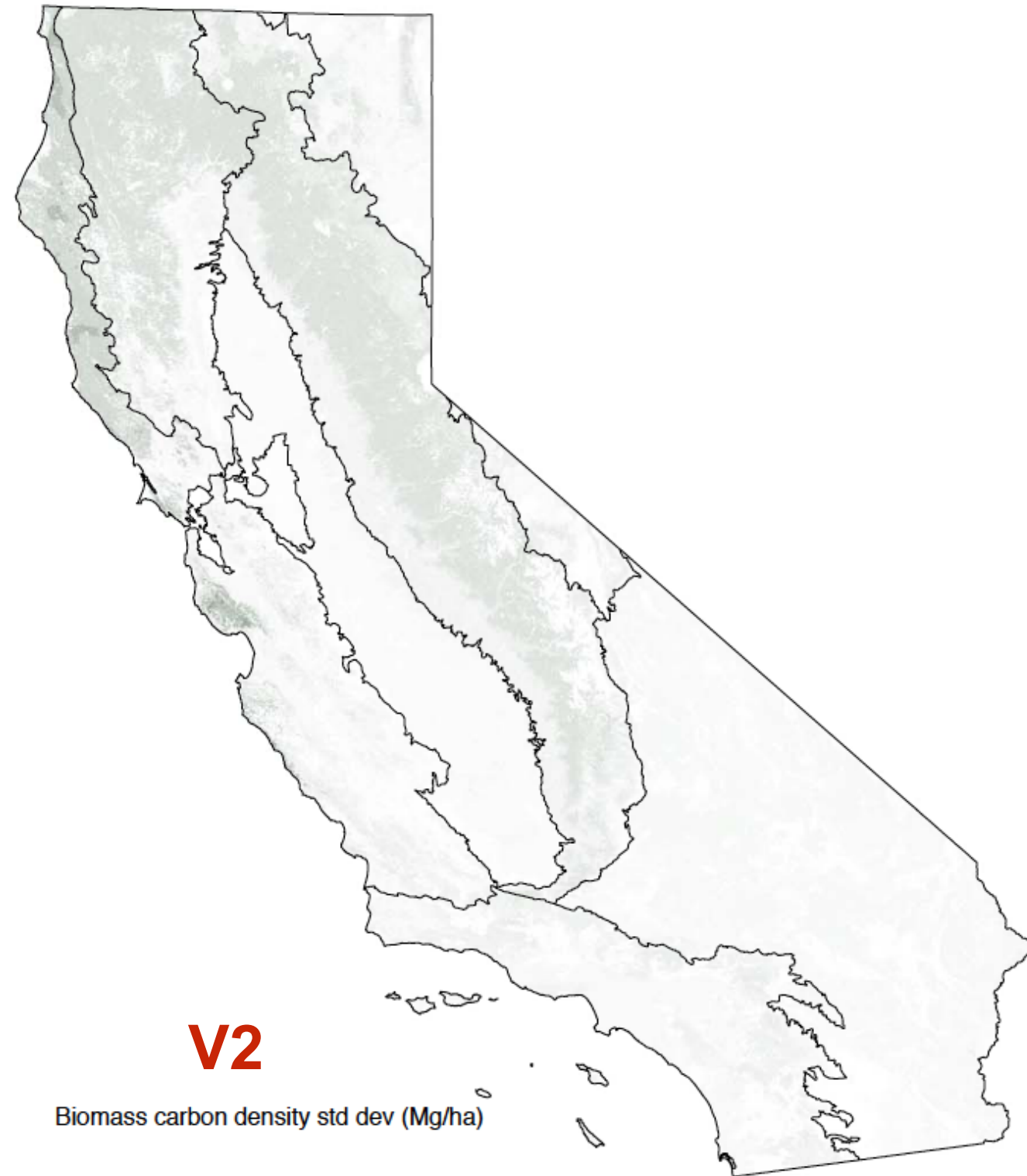


Mean ranges from 0 to 396
MgC/ha

2010 biomass carbon density SD (MgC/ha)

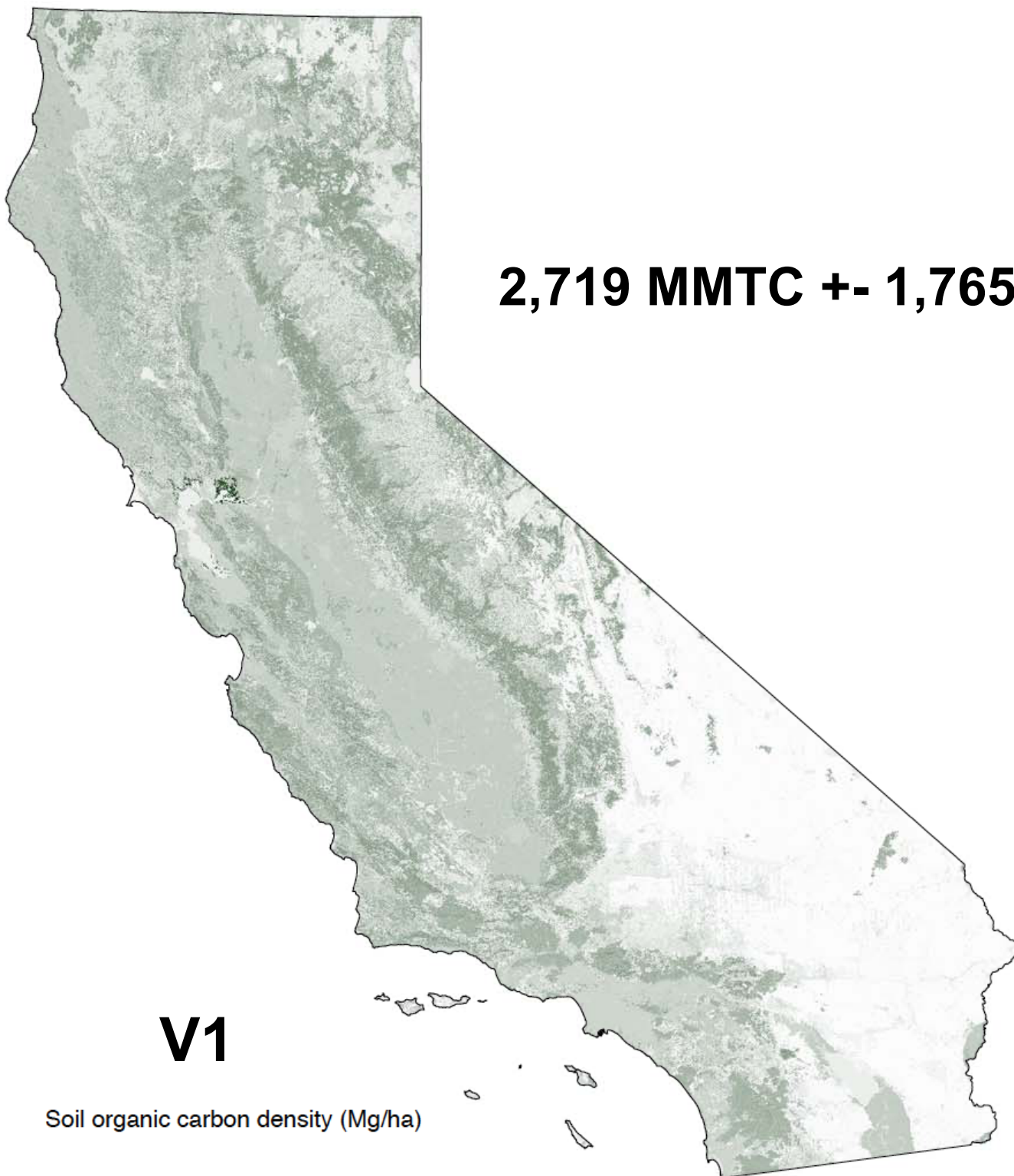


Std Dev ranges from 0 to 72
MgC/ha

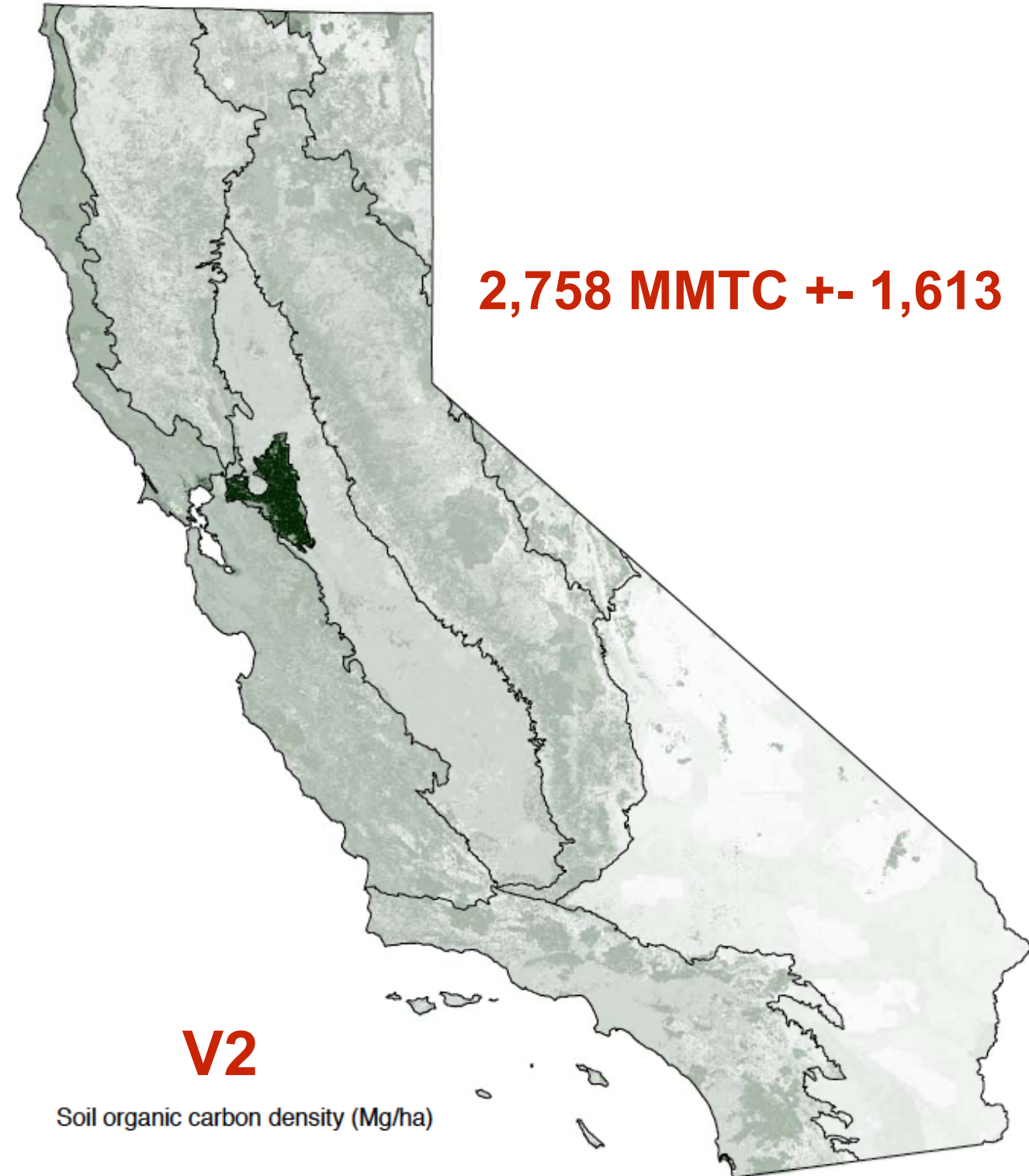


Std Dev ranges from 1 to 134
MgC/ha

2010 organic soil carbon density (MgC/ha)



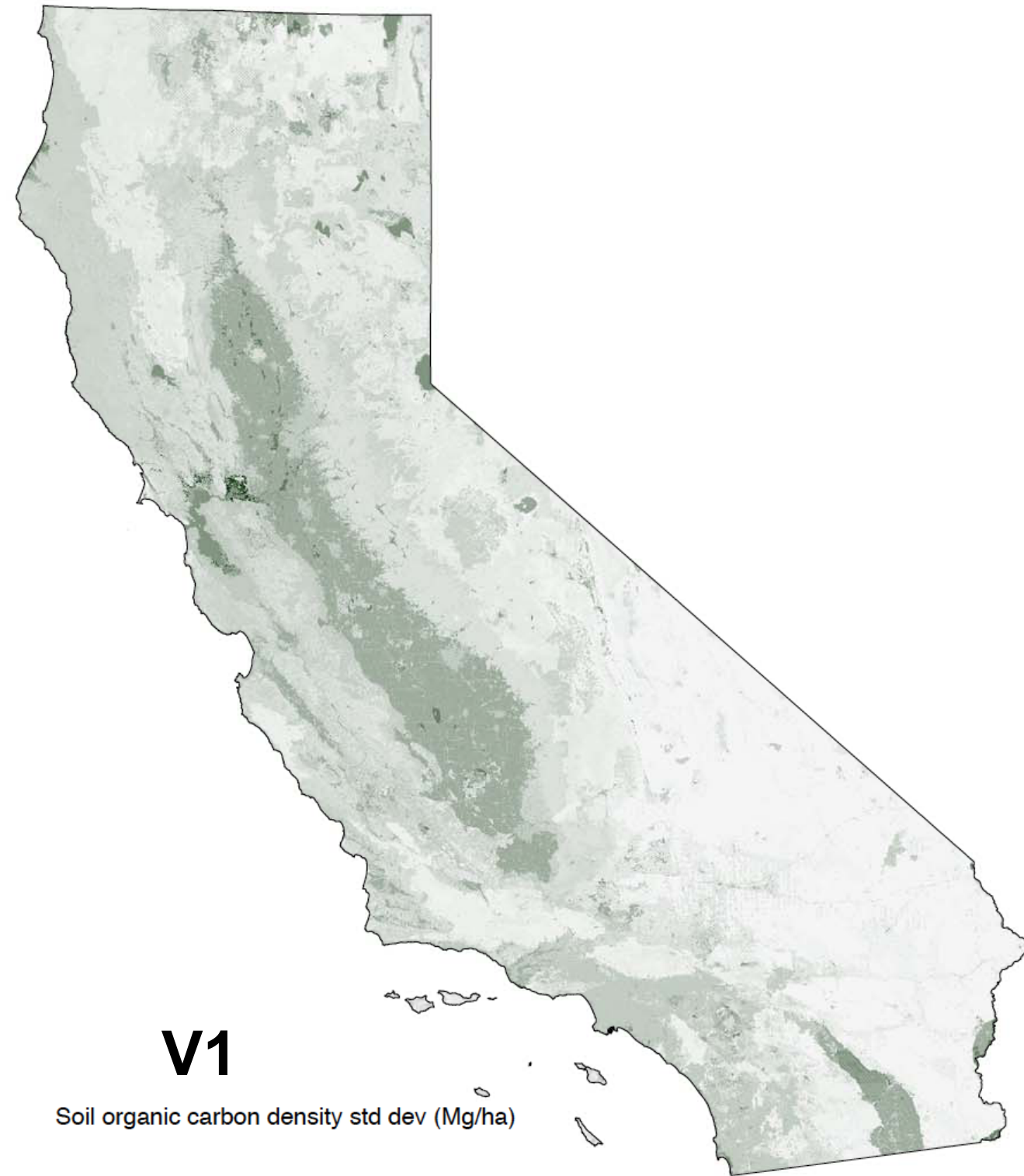
Mean ranges from 3 to 921
MgC/ha



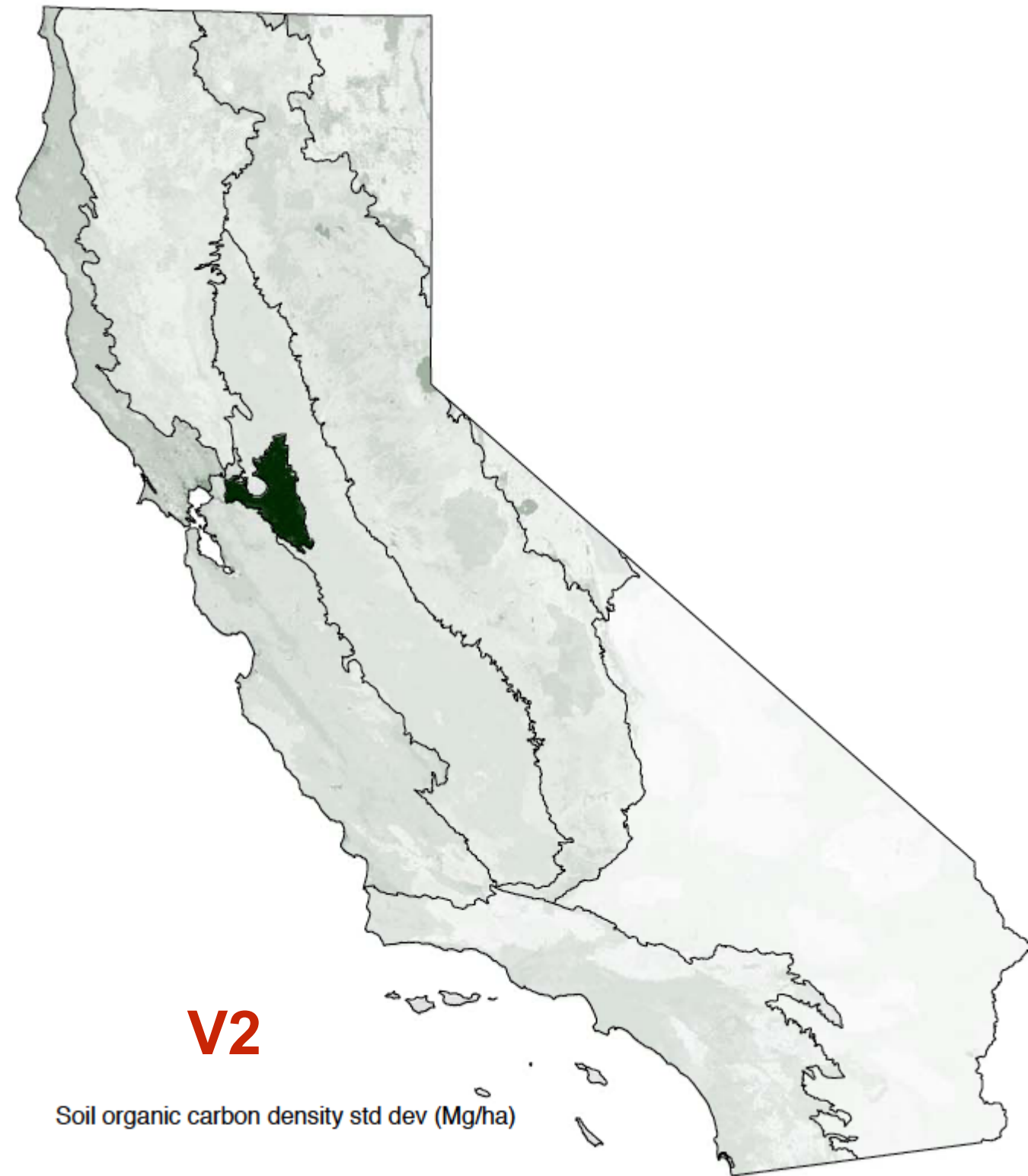
Mean ranges from 0 to 1946
MgC/ha

17

2010 organic soil carbon density SD (MgC/ha)



Std Dev ranges from 14 to 1013
MgC/ha



Std Dev ranges from 3 to 1150
MgC/ha

Model Processes

- **Ecosystem carbon accumulation/loss:**

- with management adjustments and prescribed mortality

- **Management:**

- Forest:

- clearcut
- partial-cut/thinning
- fuel reduction/thinning
- understory treatment
- prescribed burn
- slash utilization

- Cultivated:

- soil conservation
- cover-crop/no-till

- Urban:

- removal of dead material
- fraction of urban forest

- Grassland/Savanna/Woodland:

- compost amendment; 10-yr and 30-yr repeat frequency

Model Processes

- **Land use/cover change:**
 - Historical BAU
 - CARB-Landfire 2001-2010
 - **Planned:** land use driven
 - Restoration (persistent):
 - Coastal marsh, Fresh marsh
 - Meadow, Seagrass
 - Land protection: reduced urban growth rate
 - Forest area expansion (persistent)
- **Wildfire:**
 - Annual area
 - No land type change
 - **Planned:** spatially explicit
- **Wood products:**
 - C gain from:
 - management
 - ag/urban conversion
 - Landfill wood product decay

Potential management practices

- Improved forest management
- Cultivated management
- Rangeland management
- Conversion of agricultural land to non-agricultural vegetation
- Oak woodland restoration
- Natural fire regimes

C-based GHG budget (new in version 2)

- **CO₂**

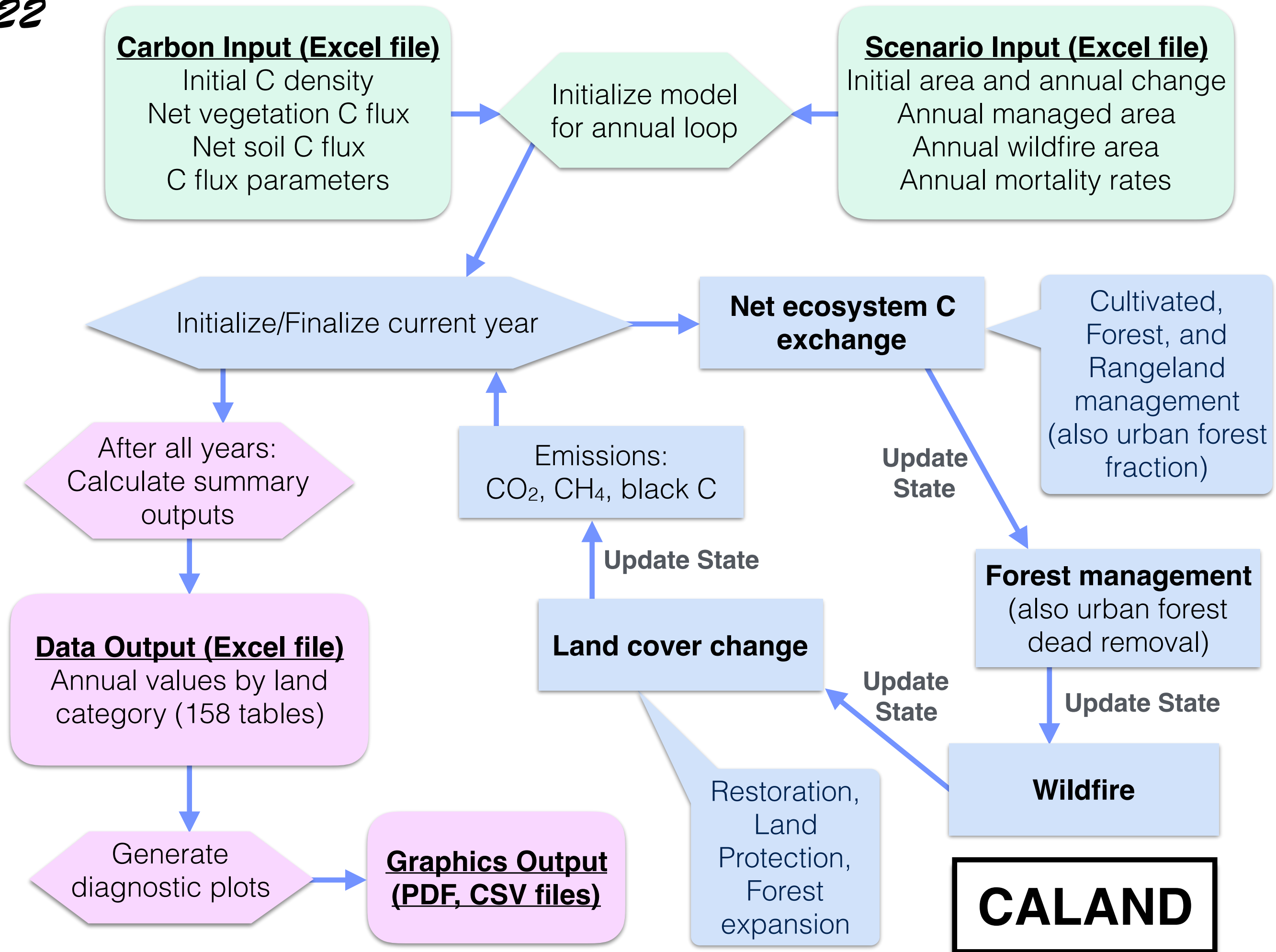
- Net vegetation C uptake
- Net soil C exchange
- Land cover change emissions
- Wildfire, prescribed burn, slash burn, bioenergy
- Forest management
- Wood products

- **Methane**

- Wildfire
- Prescribed burn
- Slash burn
- Bioenergy
- Wood products
- Fresh_marsh

- **Black Carbon**

- Wildfire
- Prescribed burn
- Slash burn
- Bioenergy



CALAND non-zero carbon pools, by land type

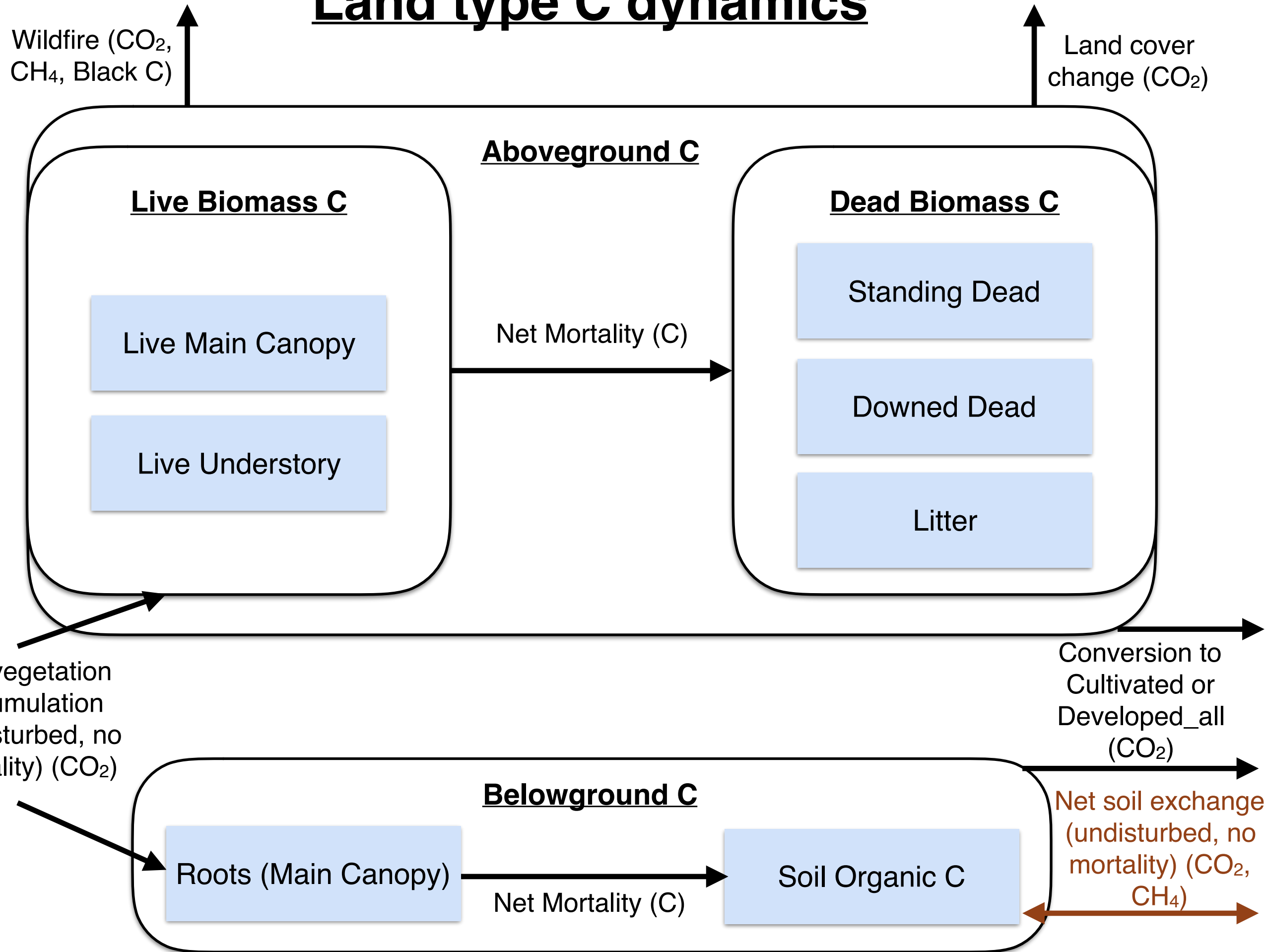
<u>Land type</u>	<u>Main, above</u>	<u>Main, below</u>	<u>Under- story</u>	<u>Standing dead</u>	<u>Downed dead</u>	<u>Litter</u>	<u>Soil</u>
Water							Y
Ice							Y
Barren	Y	Y					Y
Sparse	Y	Y					Y
Desert	Y	Y	Y	Y	Y	Y	Y
Shrubland	Y	Y	Y	Y	Y	Y	Y
Grassland	Y	Y	Y	Y	Y	Y	Y
Savanna	Y	Y	Y	Y	Y	Y	Y
Woodland	Y	Y	Y	Y	Y	Y	Y
Forest	Y	Y	Y	Y	Y	Y	Y
Meadow	Y	Y	Y	Y	Y	Y	Y
Coastal_marsh	Y						Y
Fresh_marsh							Y
Cultivated	Y						Y
Developed_all	Y						Y
Seagrass							Y

Mean annual C accumulation, by land type (MgC/ha)

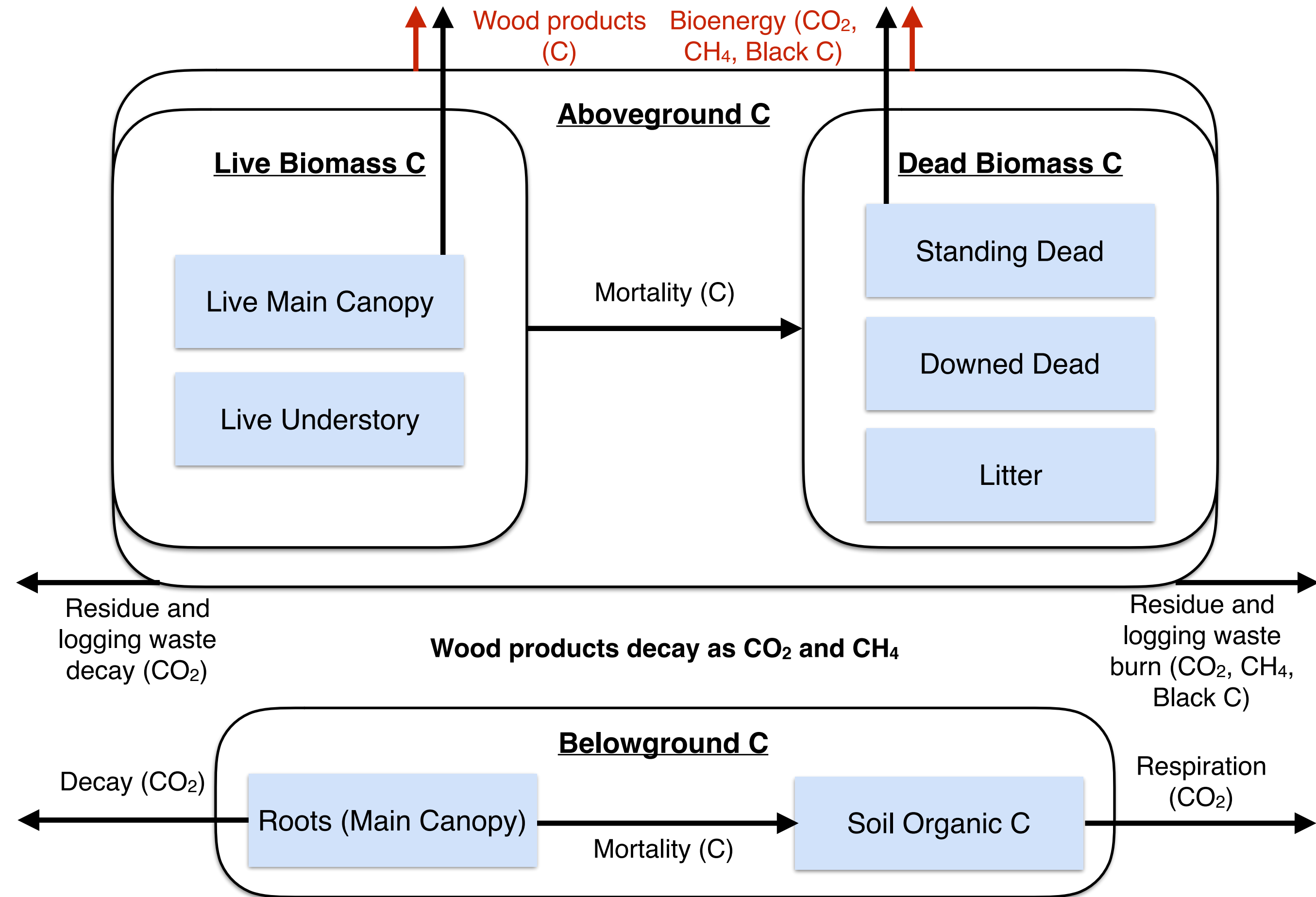
<u>Land Category</u>	<u>Vegetation</u>	<u>Vegetation, managed</u>	<u>Soil (Delta)</u>	<u>Soil (Delta), managed</u>
Desert			0.76	
Shrubland	0.93		0.28	
Grassland			-2.22	-2.09
Savanna	3.67		-2.69	-2.53
Woodland	3.67		-2.69	-2.53
<u>Forest, Private</u>	<u>2.10</u>	<u>2.10</u>	0.71	1.27
<u>Forest, Other</u>	<u>1.40</u>	<u>1.68</u>	0.71	1.27
<u>Forest, USFS non-wild</u>	<u>1.37</u>	<u>1.64</u>	0.71	1.27
Meadow			0.95	
Coastal_marsh			1.44	
Fresh_marsh			3.37	
Cultivated			0.31 (-2.18)	0.8 (-1.7)
Developed_All	0.93	scales with urban forest fraction		
Seagrass (Ocean)			0.43	

- Water, Ice, Barren, Sparse have no C accumulation
- Forest vegetation values are region-specific

Land type C dynamics



Forest management C dynamics



Data limitations

- Savanna/Woodland woody understory and C dynamics
- Root carbon for urban and cultivated
- Annual vs. perennial (woody) crops
 - Woody crop carbon dynamics
- Spatially explicit BAU managed private forest area
- **Planned:** Climate/atmosphere effects on:
 - ecosystem carbon accumulation
 - wildfire area and severity
- **Planned:** Spatially explicit BAU wildfire area and severity

Plans for Version 3

- Updated baseline **land cover change**
 - Use CA Fourth Assessment data
 - This is land use driven change only!
- **Climate effects** on vegetation/soil accumulation
 - Use CA Fourth Assessment data
- Updated **wildfire** input data and implementation
 - Use CA Fourth Assessment data
- Additional **management practices**

Additional practices require data

- Cultivated, Rangeland
 - Soil conservation
 - Soil C accumulation, area
 - Land cover change (requires development)
 - New land type, area
 - Limited duration of benefits
- Forest
 - 21 parameters, area
 - Slash utilization pathway

Forest Management Parameterization: Fuel Reduction practice

<u>Parameter</u>	<u>USFS nonwild</u>
Above Main Canopy (tree) harvested (fraction)	0.20
Standing Dead (tree) harvested (fraction)	0.20
Harvested to Wood Products (fraction)	0.20
Harvested to Energy (fraction)	0.75
Harvested to Sawmill decay (fraction)	0.01
Harvested to Slash (fraction)	0.05
Understory to Slash (fraction)	0.7
Downed Dead to Slash (fraction)	0.42
Litter to Slash (fraction)	0.42
Slash to Energy (fraction)	0
Slash to Wood Products (fraction)	0
Slash to Burn (fraction)	0.25
Slash to Decay (fraction)	0.75
Soil to Atmosphere (fraction)	0.13
Understory to Downed Dead (fraction)	0.3
Above Main Canopy to Standing Dead (fraction)	0
Below Main (root) to Atmosphere (fraction)	0.03
Below Main (root) to Soil (fraction)	0.19
Vegetation C Uptake adjustment (scalar)	1.2
Mortality adjustment (scalar)	0.56
Soil C Uptake adjustment (scalar)	1.79

Take home messages

- **There are three main sources of uncertainty in absolute C budget estimates from CALAND:**
 - **Ecosystem C exchange rates (quantified)**
 - **Initial carbon density (quantified)**
 - **Land cover distribution and change (not quantified)**
 - **Need time series analysis of land use and land cover**
 - **“Permanent” land cover change due to disturbance?**
 - **Woody vs. grass rangeland understory?**
- **CALAND provides robust estimates of the C and C-GHG effects of individual or multiple practices with respect to BAU**
- **Results depend on the land type areas and the extent of managed area**
- **CALAND is a comprehensive landscape carbon accounting tool!**