



Fallowed Area Mapping for Drought Impact Reporting and Decision Making

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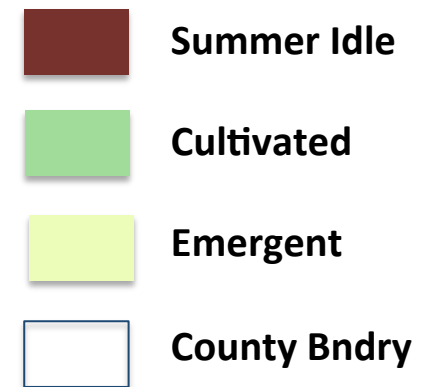
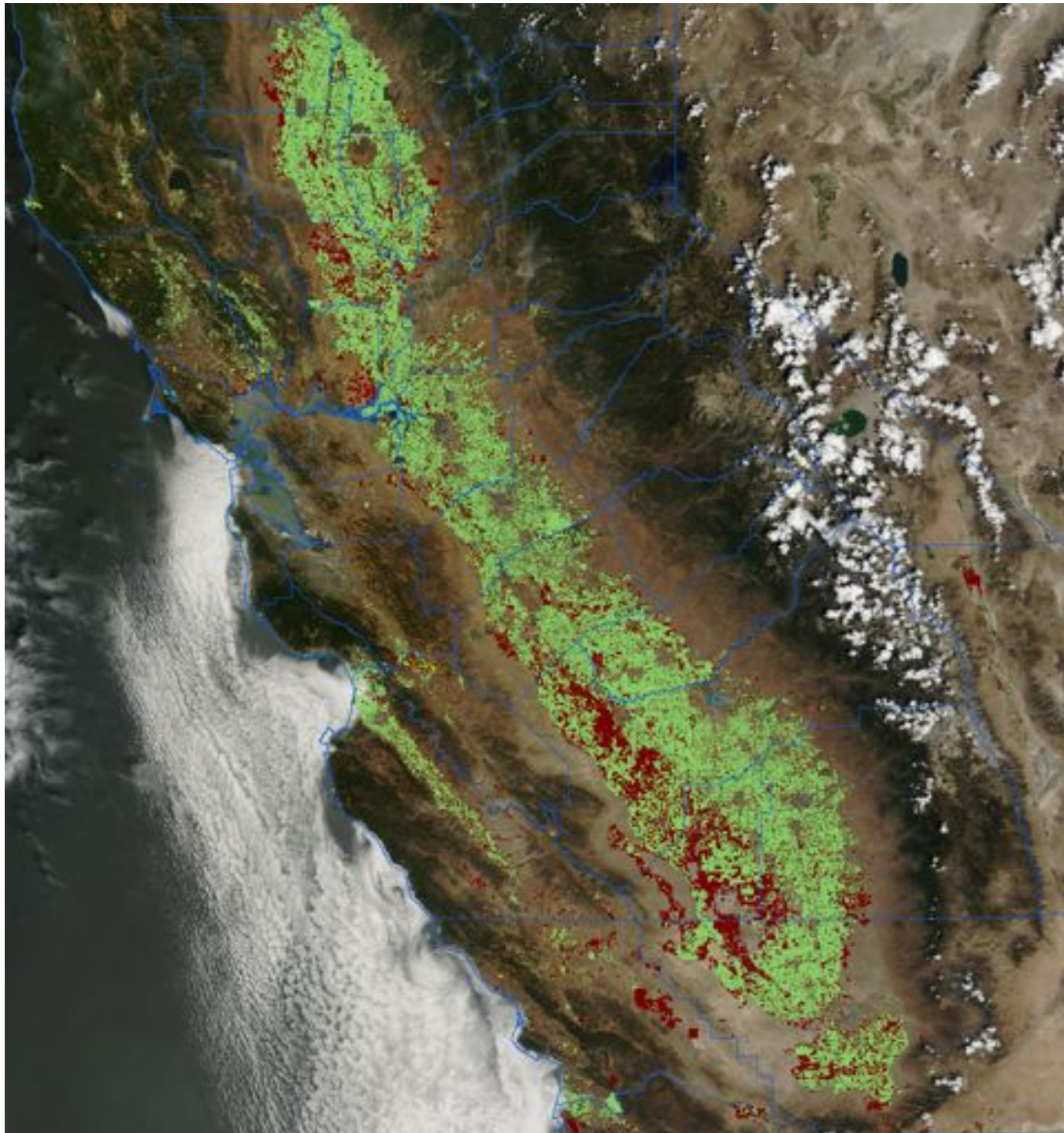
Forrest Melton, Lee Johnson, Carolyn Rosevelt, NASA ARC-CREST / CSU Monterey Bay

Rama Nemani, NASA Ames Research Center

Jeanine Jones, California Department of Water Resources

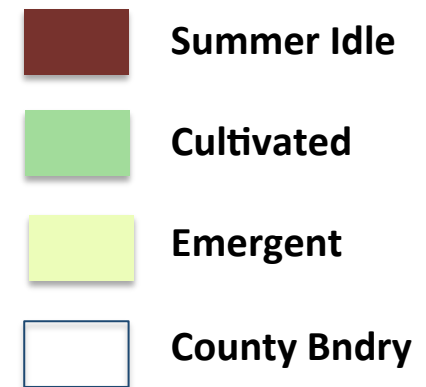
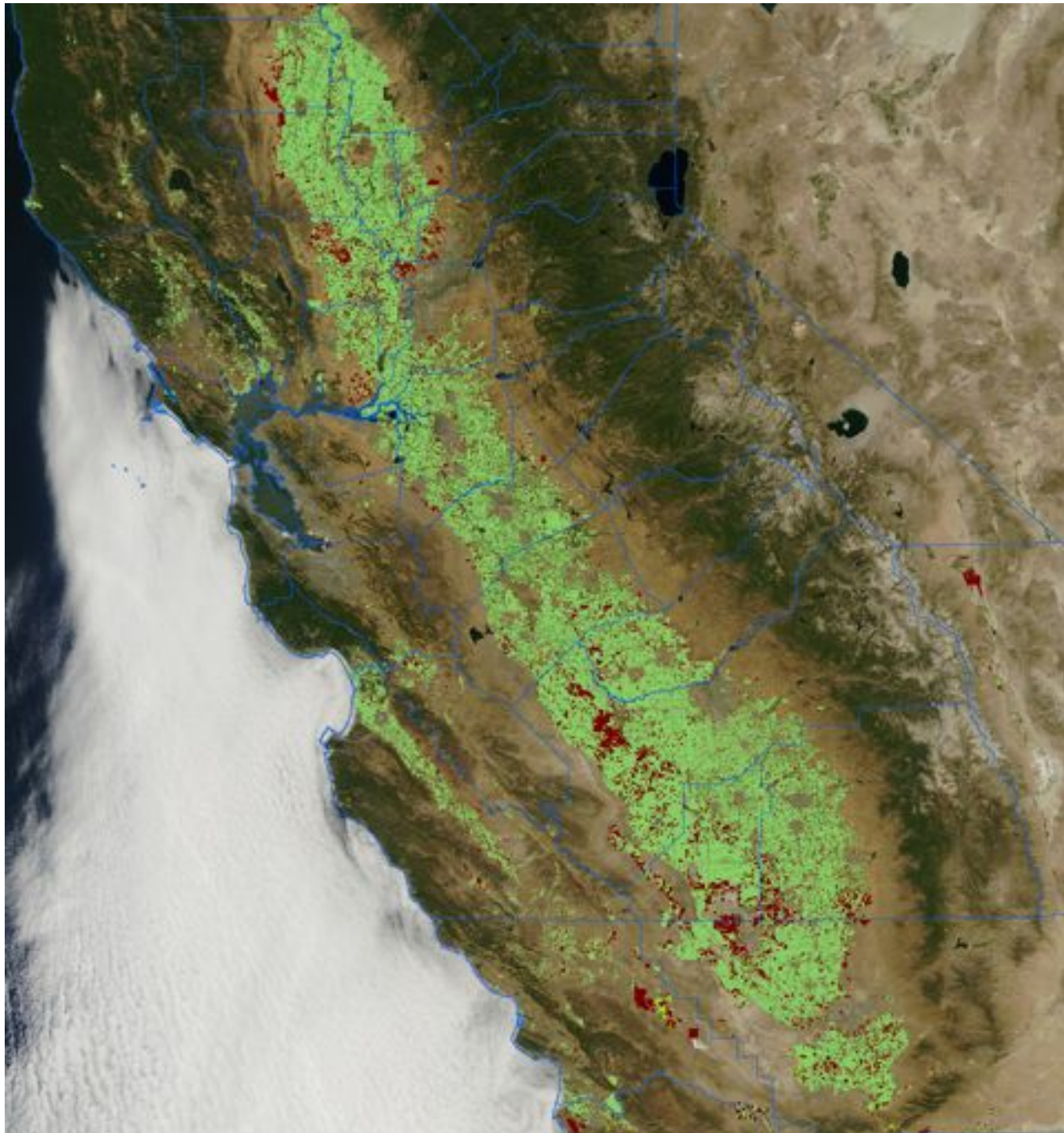
Support from NASA Applied Sciences Program and NIDIS

July 27, 2014
Central Valley
Summer
Conditions
(June 1 – July 27)

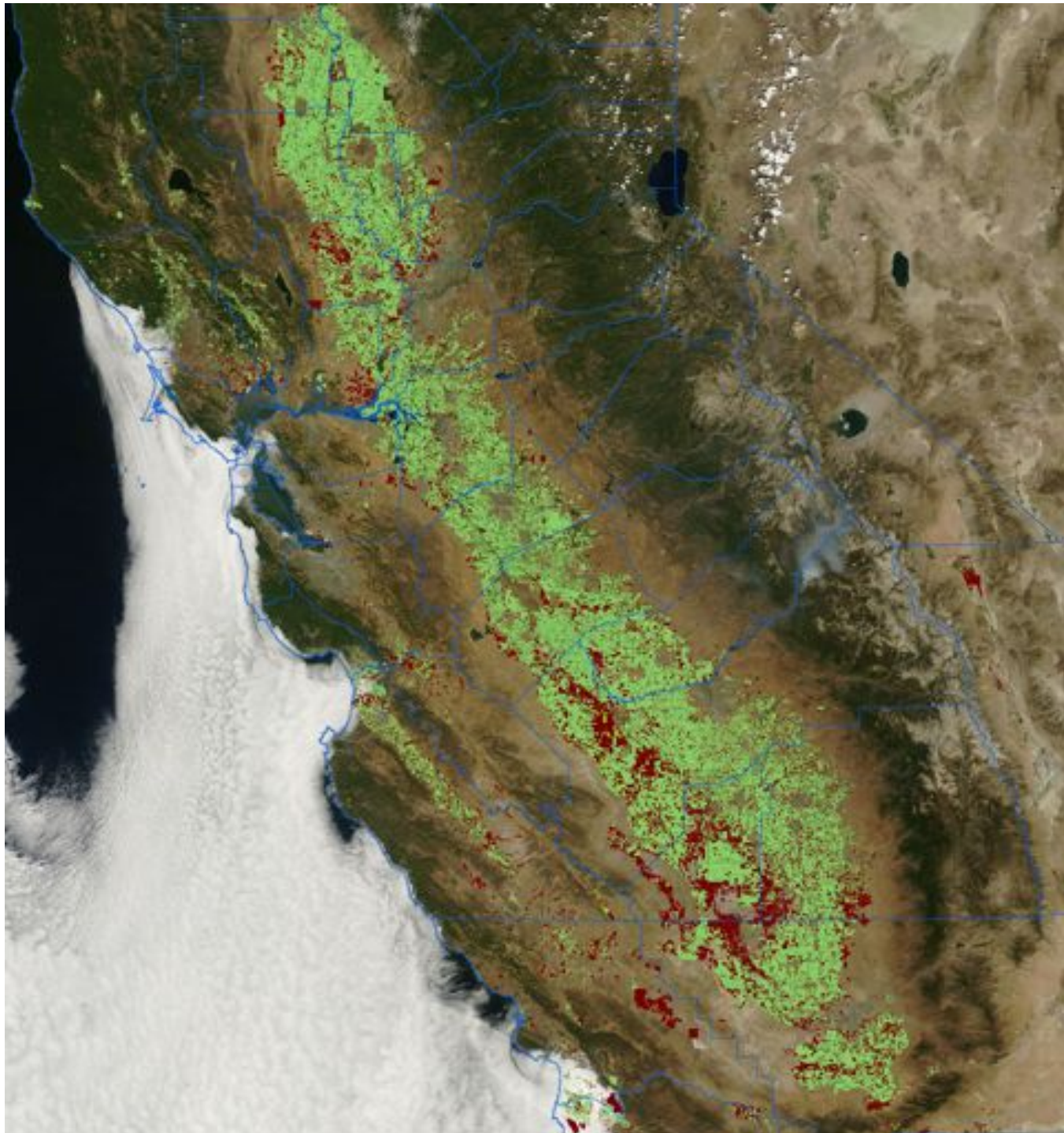


Data source: NASA /
CSU Monterey Bay.
Map derived from
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Aqua satellites.
Satellite observations
for ~200,000 fields
obtained every 8
days.

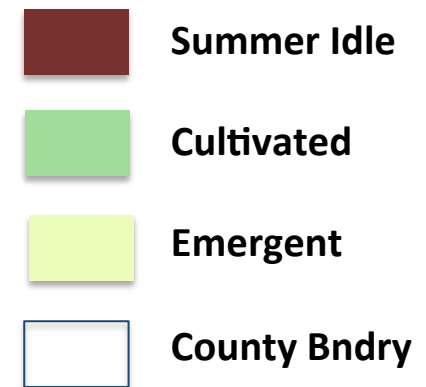
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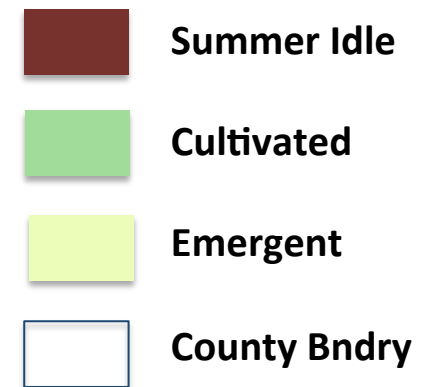
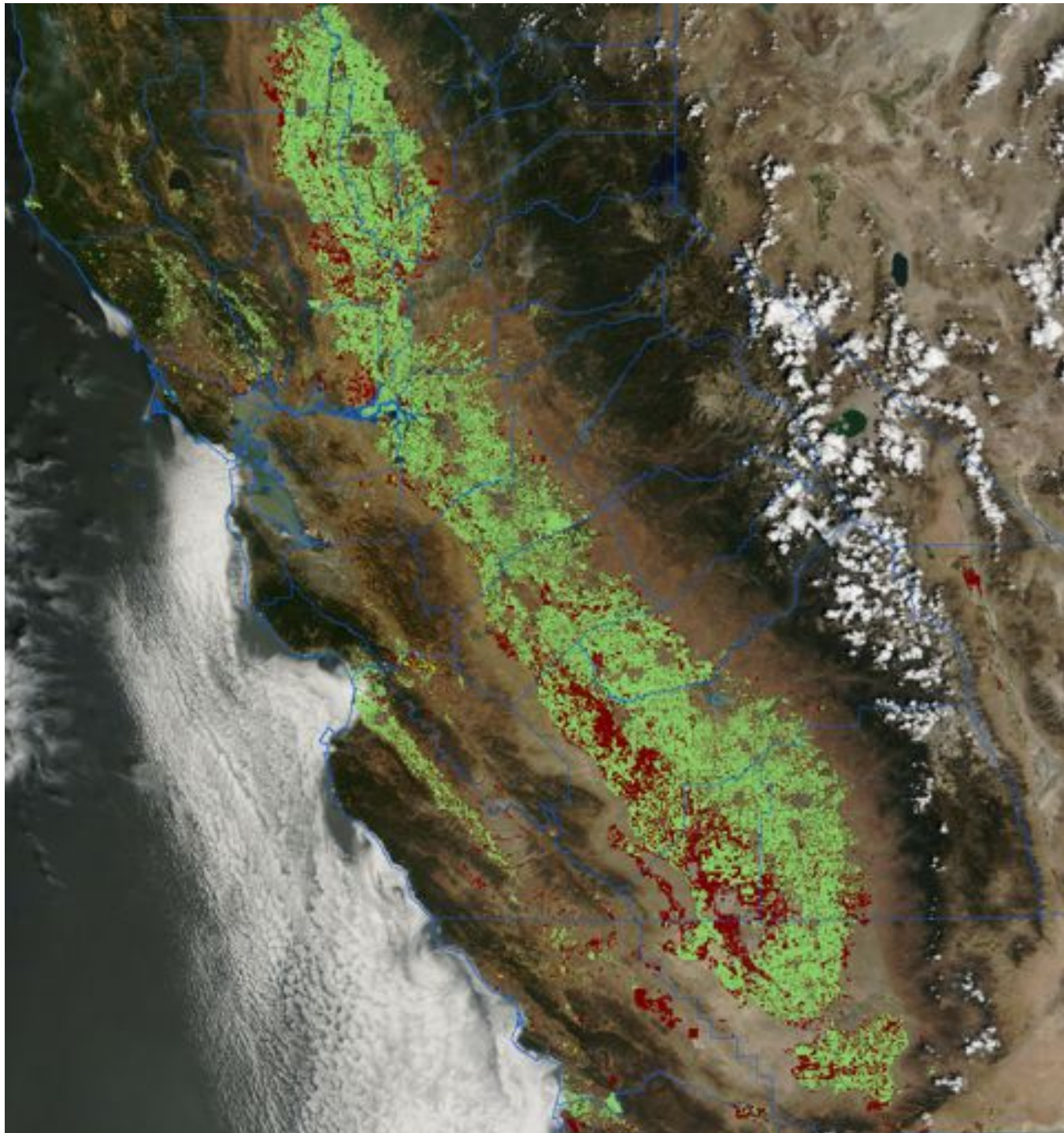


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Central Valley
Summer
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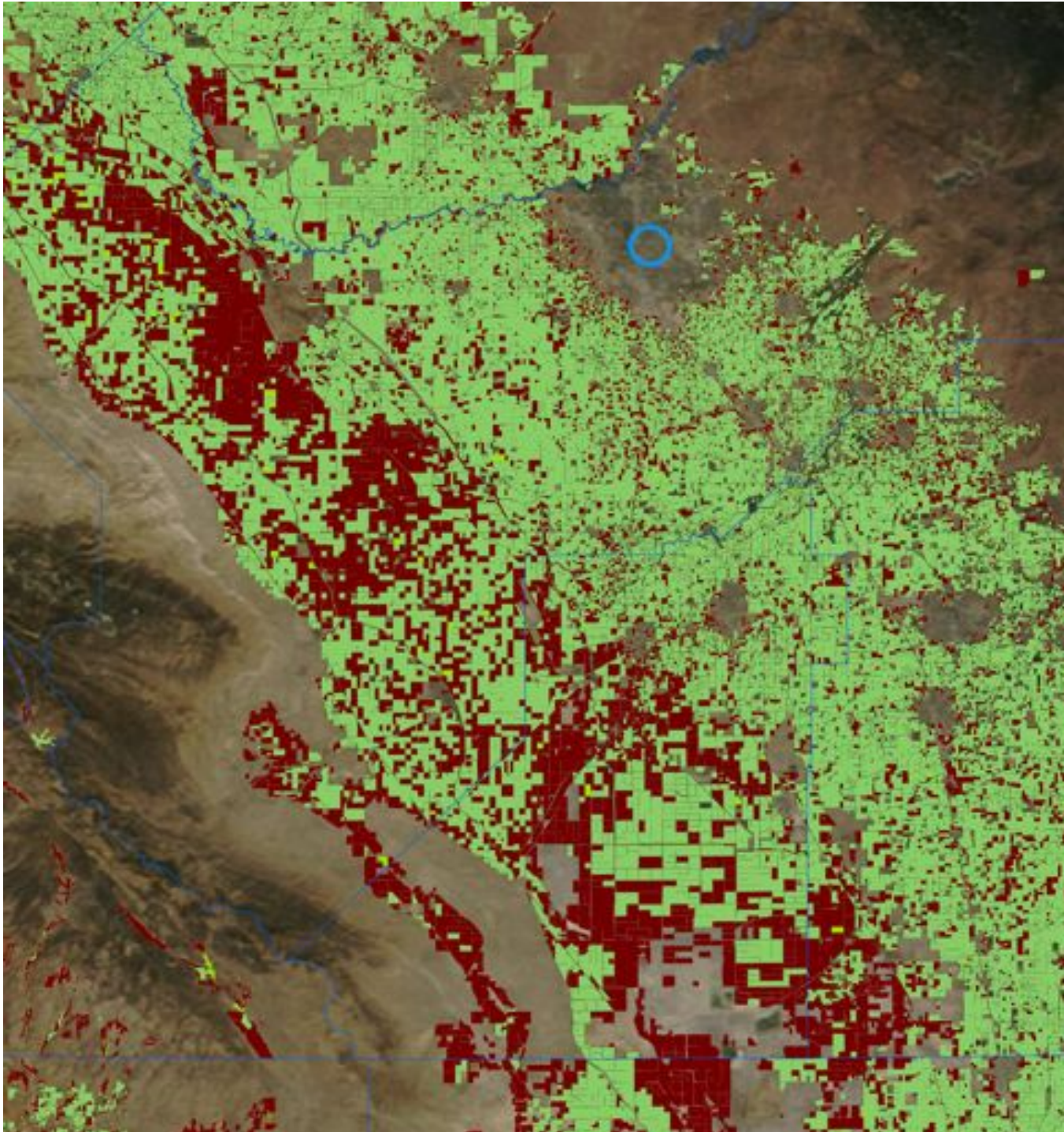


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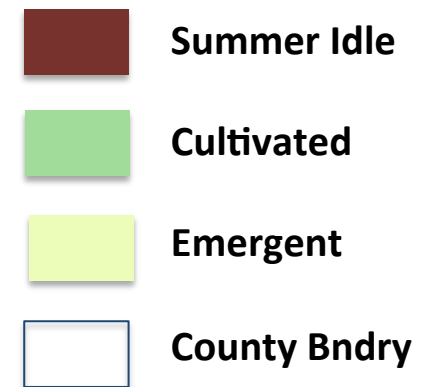
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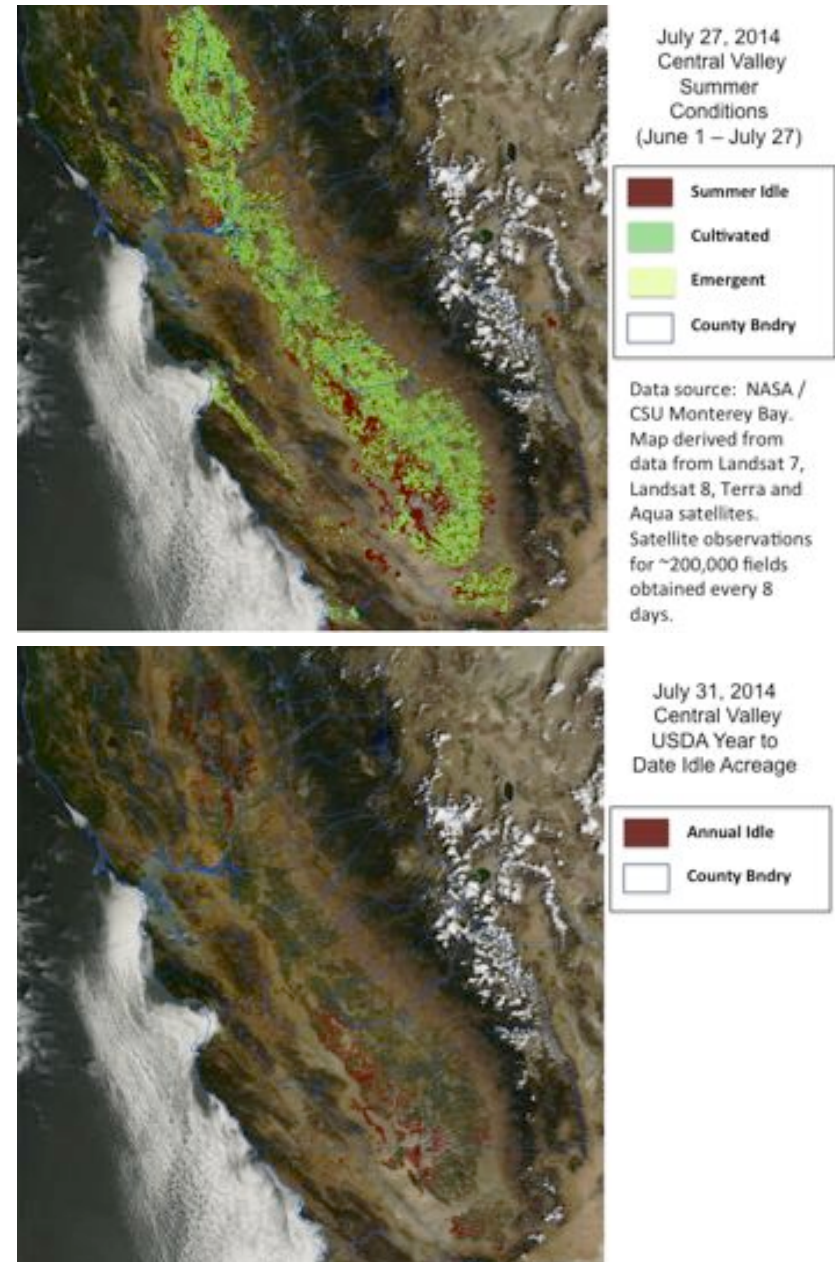
July 27, 2014
San Joaquin Valley
Summer Conditions
(June 1 – July 27)



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Overview

- Collaborative, interagency effort between USGS, USDA, NASA / CSU Monterey Bay, and CA DWR
- Successfully demonstrated capability for within season mapping of idle acreage.
- Monthly estimates generated by the project team for March – July, 2014 and delivered to DWR within two weeks of end of month. Mapping will continue through September.
- Overall accuracy has been approx. +/- 15% or better in all months.



National Integrated Drought Information System (NIDIS) Regional Drought Early Warning Systems



Drought Impacts on Land Following

- **Background:** Mapping of fallowed areas during drought identified as a research priority for NIDIS by CA Department of Water Resources (CDWR)
- **Information needed:** Product similar to 'idle lands' class in NASS crop data layer for California, but on a monthly basis during growing season(s)
- **Project objective:** apply satellite data to provide information that will allow CDWR and other stakeholders to identify extent of, or change from historical conditions in, fallowed acreage due to water shortage



Drought Impacts on Land Fallowing

- **Decisions supported:**
 - State proclamations of emergency pursuant to the California Emergency Services Act and allocation of drought relief funding
 - State priorities for providing assistance with and processing of local water transfer requests
 - State concurrence in county-level requests for USDA drought disaster designations
- **Limitations of previously available information:**
 - USDA NASS Cropland data layer (CDL) considered confidential and market sensitive during the growing season
 - Fallowed acreage reports from other sources do not follow standard definitions or data collection methods → often generate conflicting estimates

Satellite Data



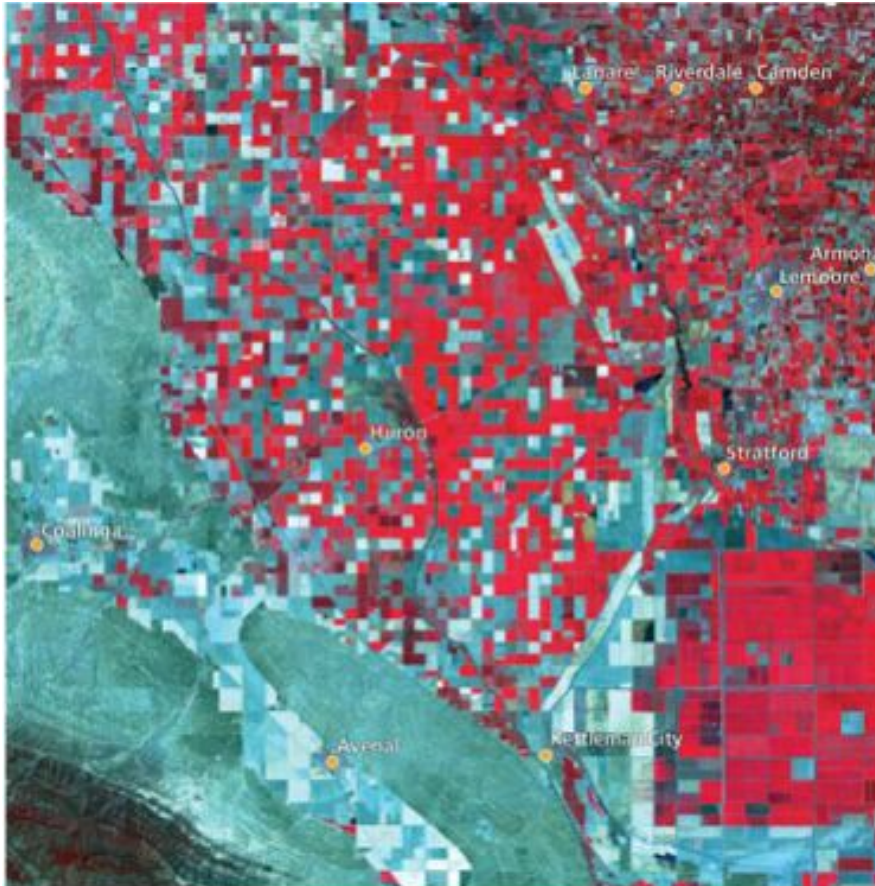
Landsat (TM / ETM+ / OLI)
30m / 0.25 acres
Overpass every 8-16 days



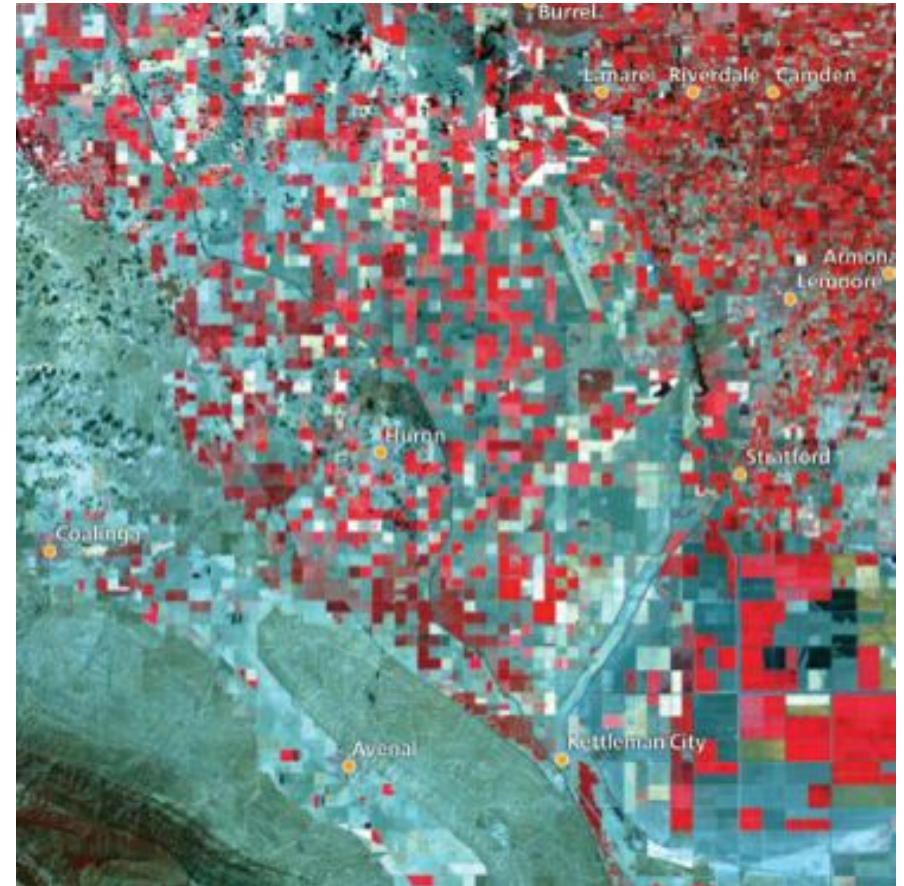
Terra / Aqua (MODIS)
250m / 15.5 acre
Daily overpass



The Landsat View



2007

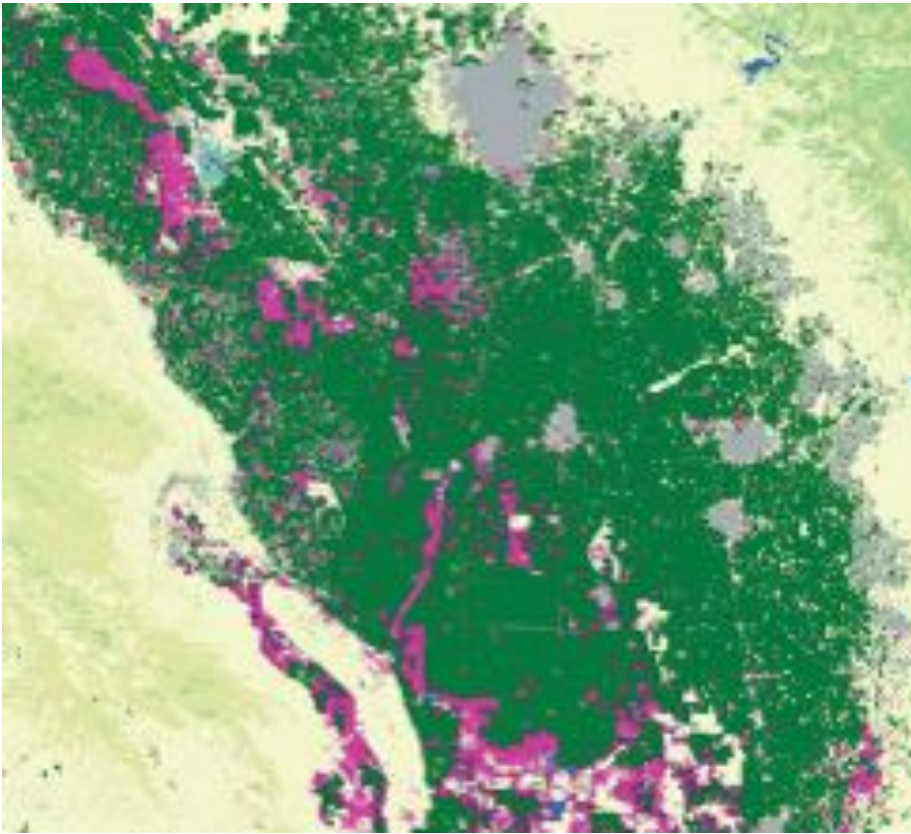


2009

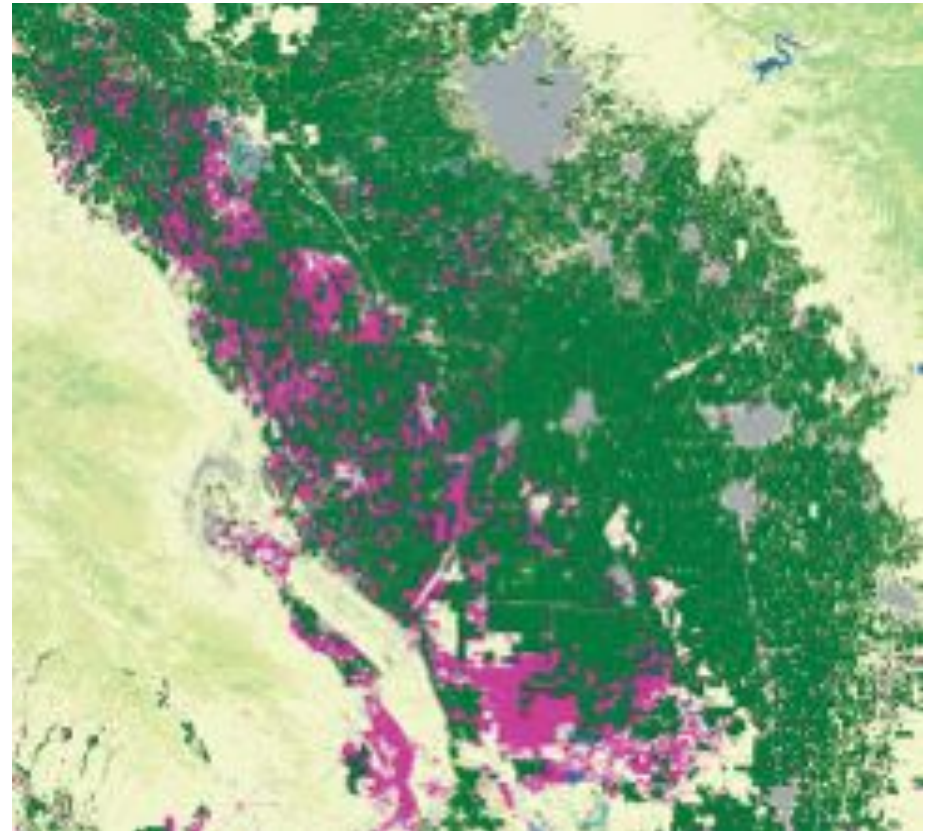
From: **California's Drought of 2007-2009: An Overview**

California Department of Water Resources, 2010

USDA NASS Fallowed Land Mapping



2007



2009

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Stakeholder Requirements

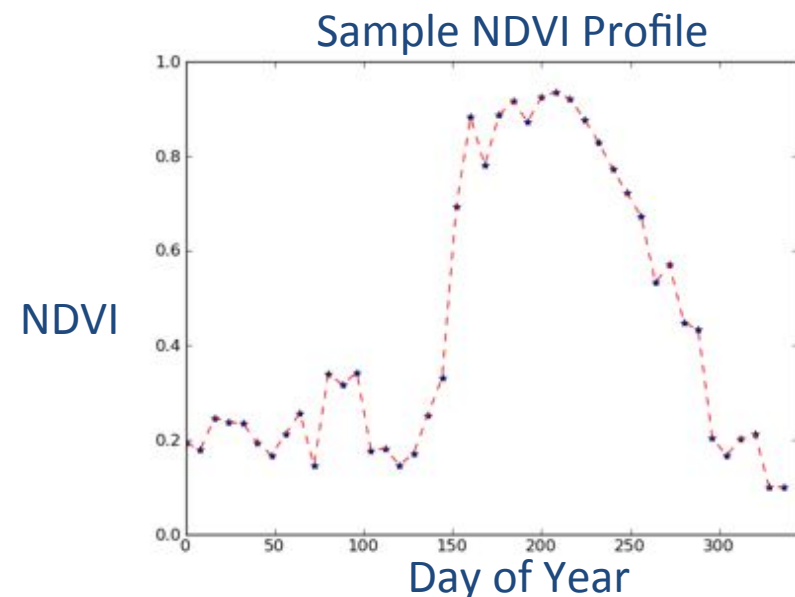
- **Monthly tabular acreage summaries by county for April - September**
- **Latency of no more than two weeks**
- **Uncertainty as high as +/- 25% is acceptable**
- **Historical figures / baseline estimates required for context**

Approach

- **Within-season estimates for June, August, September from USDA NASS using CDL infrastructure**
 - USDA Farm Service Agency (FSA) data used in training decision tree algorithms for each year
- **Early-season estimates for March – May developed by NASA Ames Research Center**
 - Decision tree algorithms applied to timeseries of satellite data
 - Classification accounts for field conditions during reference period

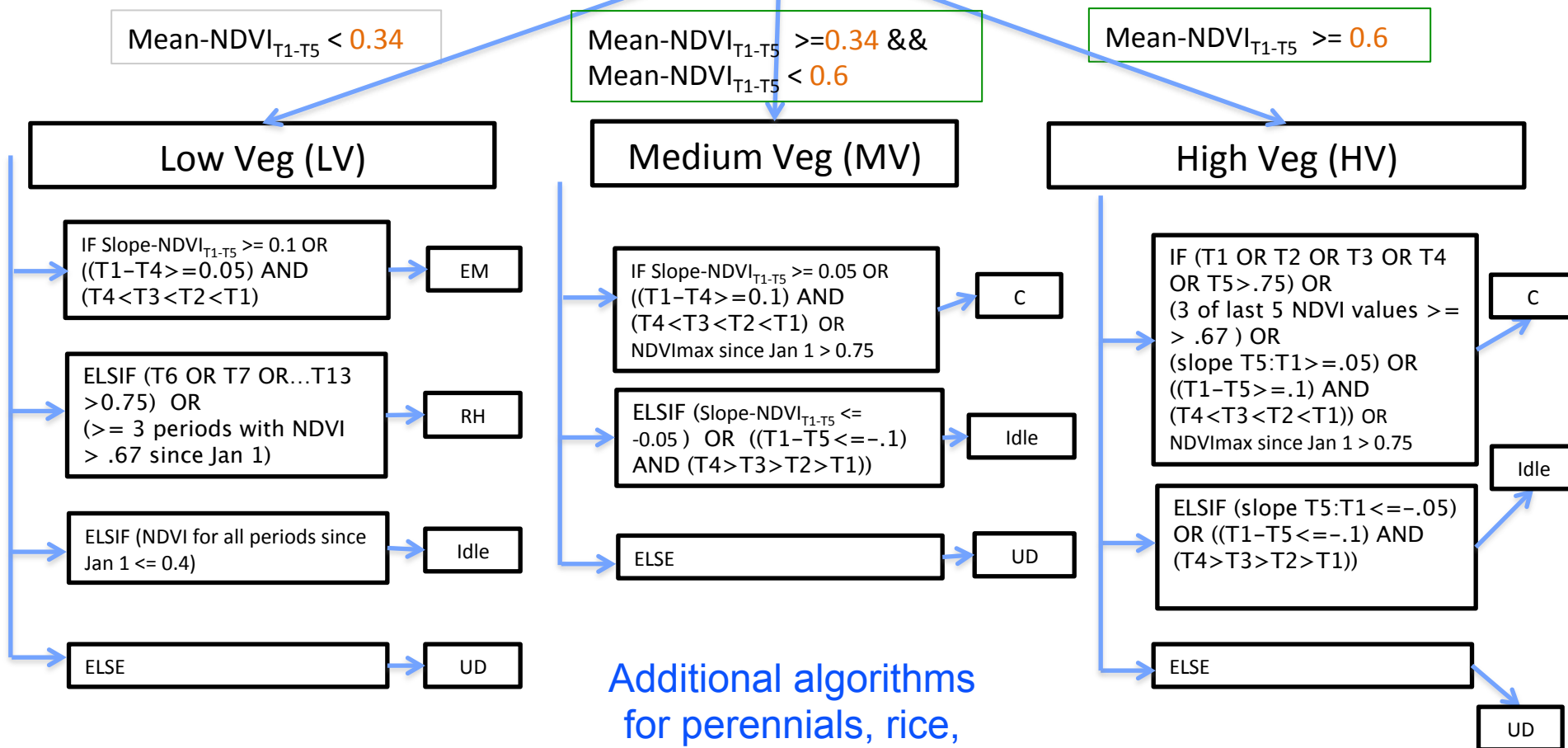
Early Season Mapping of Fallowed Area (March – June): *Approach*

- Normalized Difference Vegetation Index (NDVI) composites for California generated from timeseries of 8-day composites from Landsat 5/7/8 (30m / 0.25 acres) + MODIS (250m / 15.5 acres)
- Using field boundary shapefiles from County Ag Commissioner offices, extracted NDVI profiles (field averages) for every field in the Central Valley
- Calculated max, min, slope, monthly means, etc., every 8-days
- 2011 used as the reference period
- Rapid development and testing utilizes Landsat and MODIS repositories on NASA Earth Exchange



Decision Tree Algorithm Example

Monthly Classification
T1 = most recent, T5 = 32 days prior



Field Survey Transects:

California Central Valley

April-June, 2012; Sept-Oct, 2012; Mar-June, 2013

Mar – Oct, 2014



Survey transects, from April-May and May-June 2012. ~1000 fields total.
March – Sept, 2014, 500-670 fields surveyed monthly



Early Season Algorithm Accuracy Assessment

	March '14		April '14		May '14		June '14		July '14	
	Crop	Idle	Crop	Idle	Crop	Idle	Crop	Idle	Crop	Idle
Producer's Accuracy	91%	92%	94%	86%	82%	96%	94%	88%	95%	84%
User's Accuracy	89%	93%	89%	92%	96%	84%	96%	81%	95%	84%
Overall % Correct	91%		91%		89%		93%		92%	

- Accuracy statistics derived from comparisons against field survey data collected in 2014 at 670 field sites
- Statistics focus on crop/non-crop classification
- Majority of discrepancies explained by issues with young perennials (vineyards, orchards), transitional fields, and field boundary errors

Idle Acreage Summary

Central Valley, Total Idle Acreage, Summary to Date (updated July 27)		
Year	Summer Idle (idle since June 1)	Annual Idle (year to date)
2014	1,706,038	1,068,957
2013	1,621,174	777,510
2011	1,013,233	203,838
2014 - 2011	692,805	865,119

Notes:

- Summer Idle: No crop detected since June 1
- Annual Idle: No crop detected since January 1
- “2014-2011” is the difference in idle acreage between 2014 and 2011
- Data source: NASA Ames Research Center / CSU Monterey Bay
- Accuracy for the estimates from NASA is +/- 16%, based on comparisons with monthly field observations collected across the Central Valley from April-July, 2014.
- Data provided for current year (2014), previous year (2013), and most recent year with average or above average precip during winter (2011)

Central Valley Summer Acreage Summary (2014 vs 2011)

	2014 Summer to Date (June 1 - July 27)					2011 Summer to Date (June 1 - July 27)			
COUNTY	Cropped	Emerg.	Idle	Total		Cropped	Emerg.	Idle	Total
ALAMEDA	3,328	740	7,081	11,149		8,670	322	2,157	11,149
AMADOR	4,804	0	739	5,543		5,453	0	90	5,543
BUTTE	214,077	1,228	19,051	234,357		227,087	410	6,860	234,357
CALAVERAS	2,102	29	1,000	3,132		2,336	65	732	3,132
COLUSA	263,270	1,037	45,053	309,359		282,430	433	26,496	309,359
CONTRA COSTA	32,519	389	2,847	35,754		33,258	86	2,411	35,754
EL DORADO	322	0	0	322		322	0	0	322
FRESNO	791,407	7,500	392,159	1,191,065		971,564	7,311	212,190	1,191,065
GLENN	1,907	0	2,394	4,301		2,808	0	1,493	4,301
KERN	654,626	5,263	321,641	981,531		763,262	20,145	198,123	981,531
KINGS	307,844	1,634	241,849	551,326		443,196	5,640	102,491	551,326
MADERA	291,113	297	53,228	344,639		302,448	1,272	40,919	344,639
MARIPOSA	174	0	391	564		564	0	0	564
MERCED	362,296	3,371	105,032	470,699		422,975	1,331	46,393	470,699
PLACER	19,825	360	17,265	37,450		22,110	57	15,283	37,450
SACRAMENTO	130,341	415	34,262	165,018		135,812	272	28,934	165,018
SAN JOAQUIN	411,427	1,981	69,483	482,891		436,455	114	46,321	482,891
SOLANO	121,864	190	42,603	164,656		132,655	790	31,211	164,656
STANISLAUS	288,975	1,699	41,683	332,357		307,061	151	25,145	332,357
SUTTER	224,761	1,312	33,236	259,309		239,770	87	19,453	259,309
TEHAMA*	7,756	0	2,920	10,675		7,933	0	2,742	10,675
TULARE	518,937	2,208	154,344	675,489		546,319	3,370	125,799	675,489
YOLO	235,379	2,406	104,427	342,212		274,372	1,120	66,720	342,212
YUBA	81,492	0	13,350	94,842		83,502	70	11,270	94,842
Total Acres	4,970,545	32,058	1,706,038	6,708,642		5,652,362	43,047	1,013,233	6,708,642

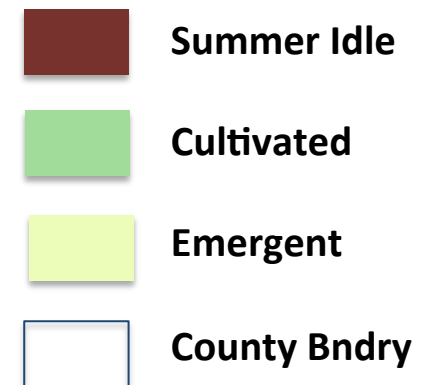
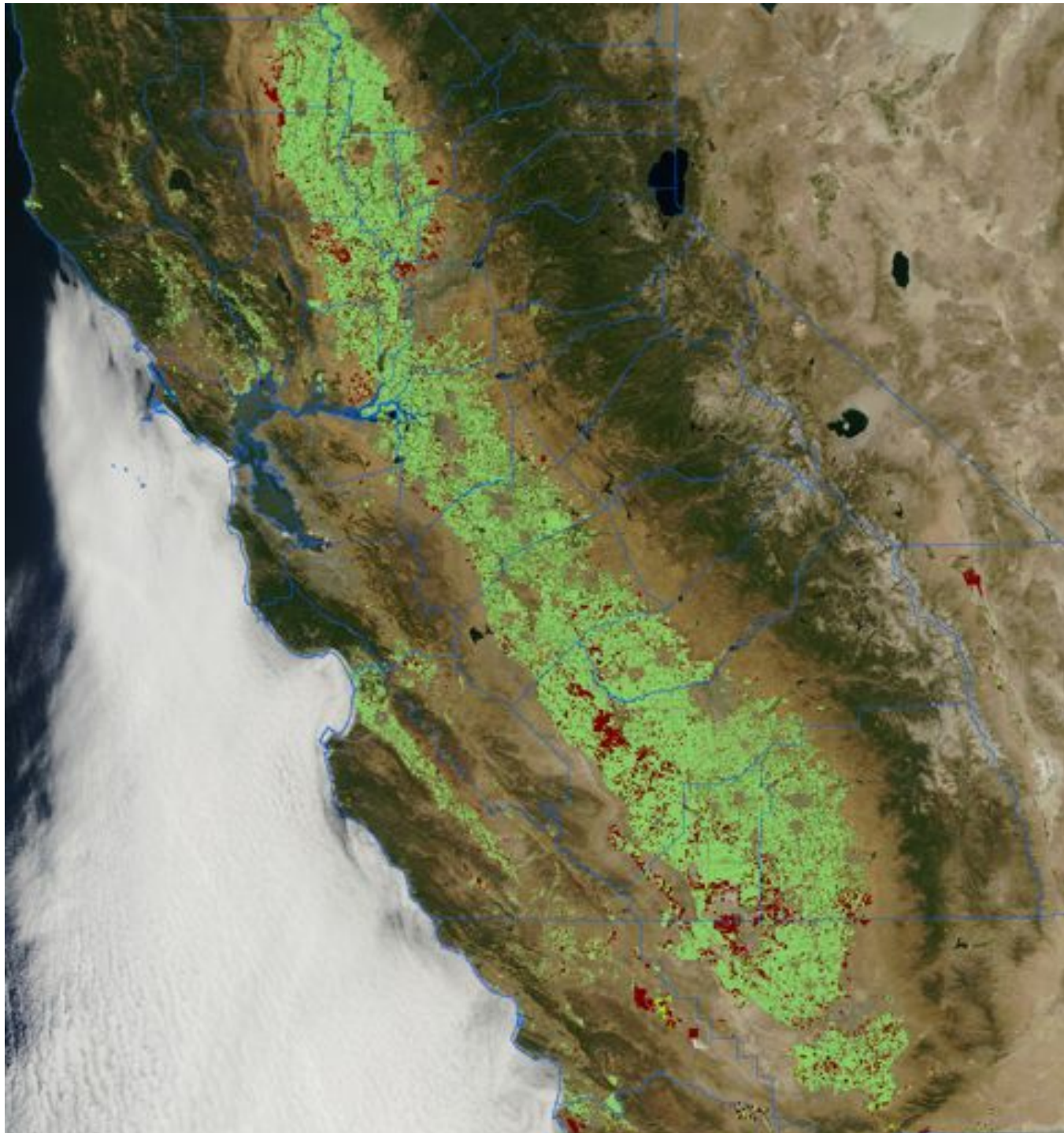
* Data only available for southern Tehama County at this time. Estimate for Tehama County will be revised.

Central Valley Summer Idle Acreage by Crop Type (June 1 - July 27)

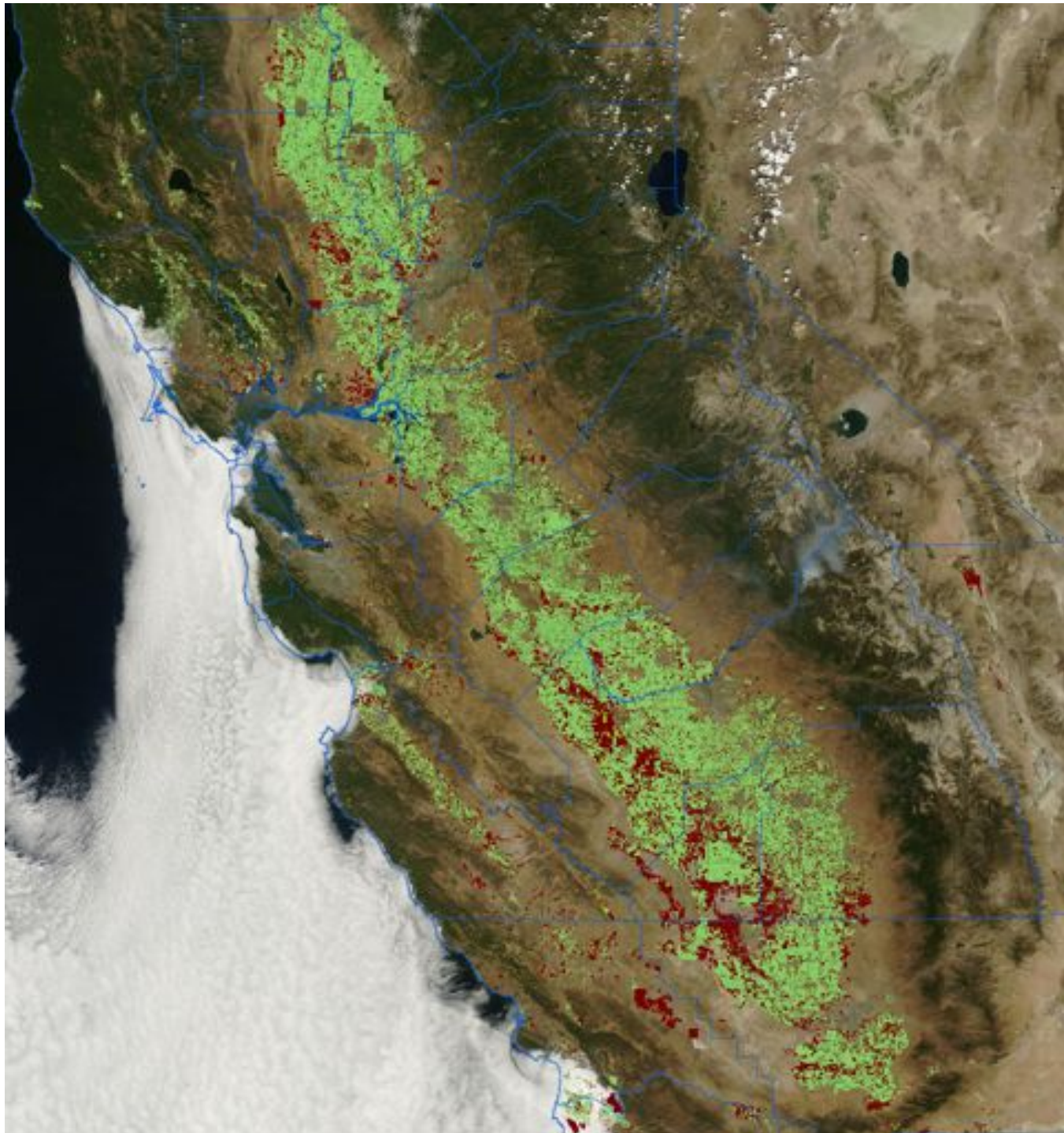
2014					
Commmmodity	Cropped	Emergent	Idle	Total Acres	2014 - 2011 Idle
Total, All Crops	4,970,545	32,058	1,706,038	6,708,641	692,805
MISC CROP, UNCULT. IN 2013	164,827	7,070	468,225	640,122	169,836
COTTON	267,434	4,089	144,858	416,381	108,079
ALFALFA	528,320	1,432	116,588	646,340	79,885
RICE	519,029	2,134	70,378	591,541	56,589
TOMATO PROCESS	122,886	2,541	57,106	182,532	47,799
WHEAT	174,556	287	276,919	451,763	30,378
BARLEY	32,588	229	56,469	89,287	24,024
CORN/WHEAT/OAT FOR FODDER	258,404	1,501	86,829	346,734	35,049
OTHER HAY/NON ALFALFA	38,800	840	26,553	66,193	14,018
SAFFLOWER	27,202	1,033	18,583	46,818	12,400
OATS	25,126	412	32,203	57,741	11,163
GRAPE, WINE	153,055	504	15,422	168,981	10,724
GRAPE, RAISIN	106,319	44	12,476	118,839	10,250
CARROT	13,371	588	20,798	34,758	9,156
CORN	72,121	374	16,968	89,463	8,678
DBL CROP WINWHT/CORN	52,632		10,928	63,560	6,858
GRAPE WINE	49,071	3	6,178	55,253	5,382
GARLIC	7,650	241	7,889	15,780	5,263
CANTALOUPE	7,435	241	6,576	14,251	4,323
POMEGRANATE	27,110	101	6,406	33,617	3,930
***	***	***	***	***	***

Idle acreage by crop type for summer 2014, and the difference between 2014 and 2011 summer idle acreage for the top 20 crop types by idle acreage. Data for additional crops available. (Crop type for each field is based on 2013 data, and data for annual vegetable crops should be combined for public reporting of data).

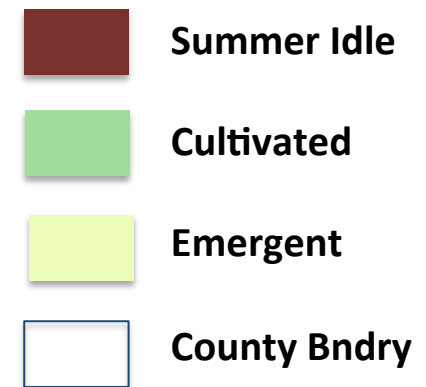
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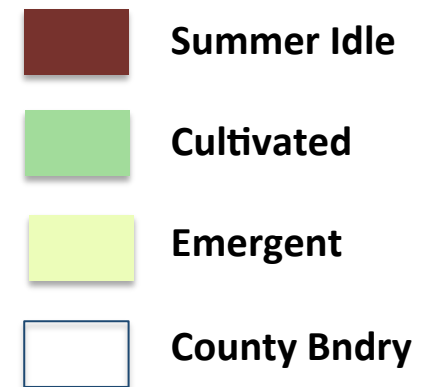
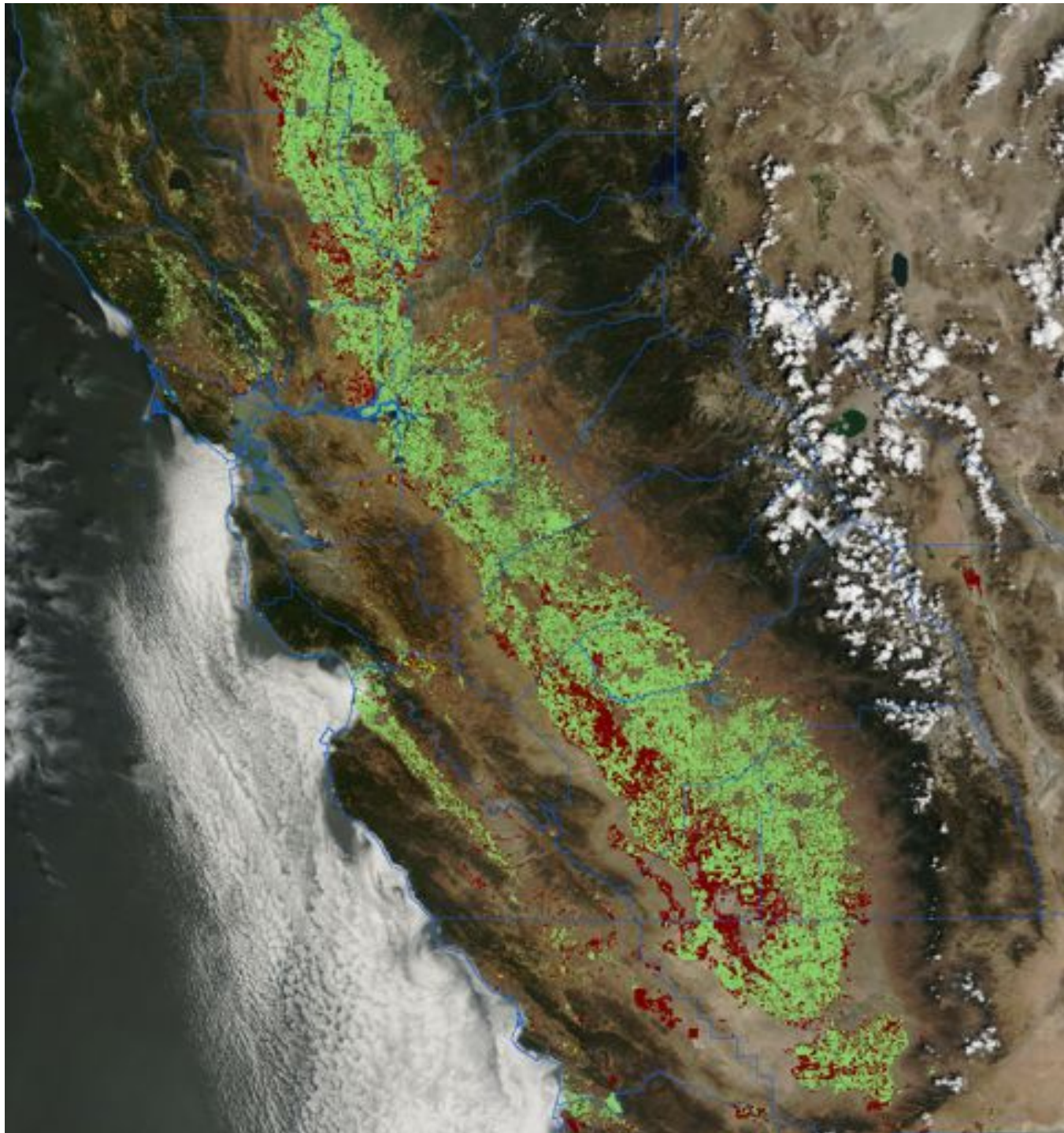


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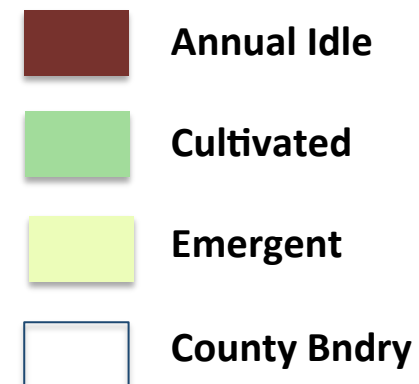
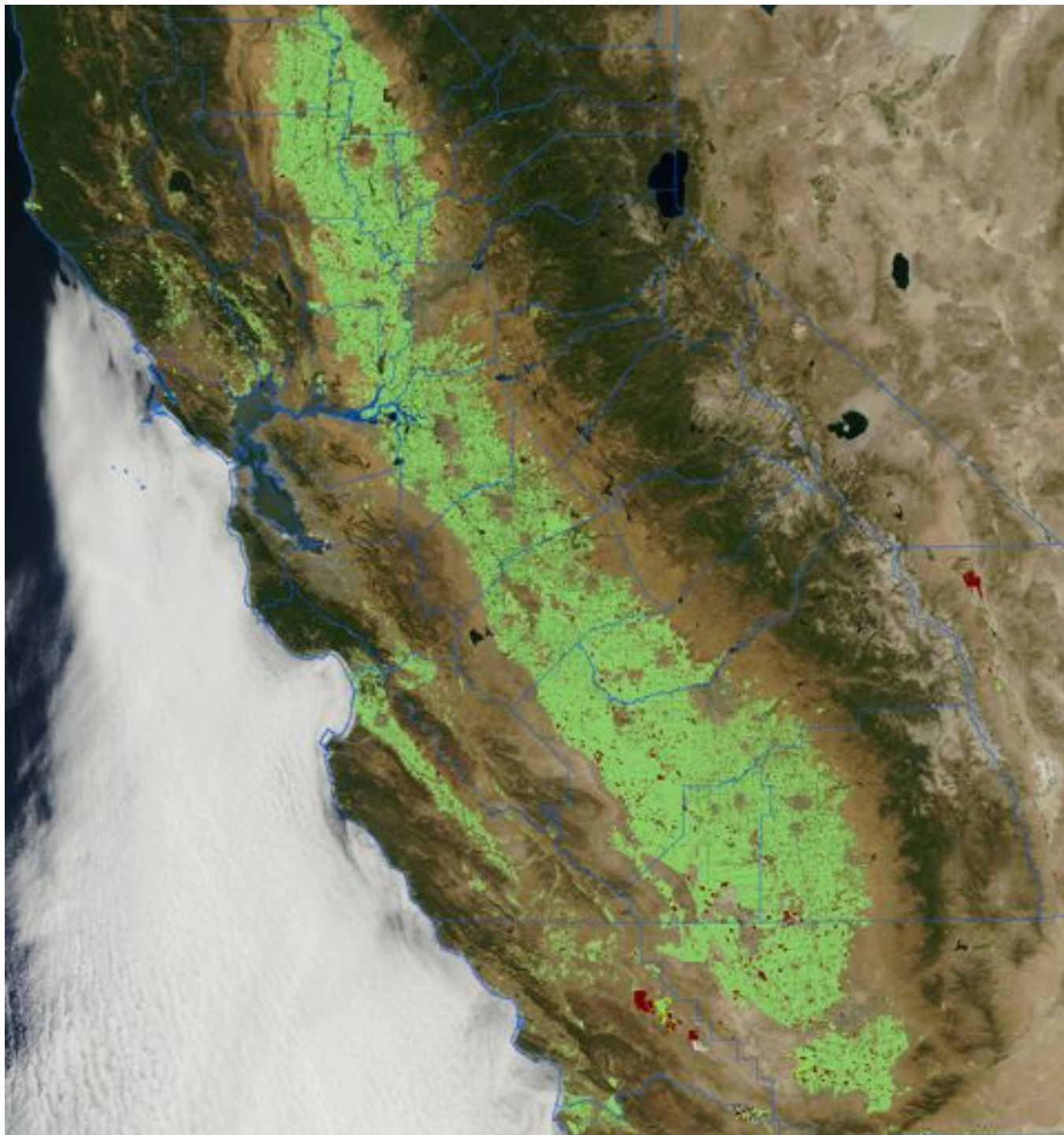
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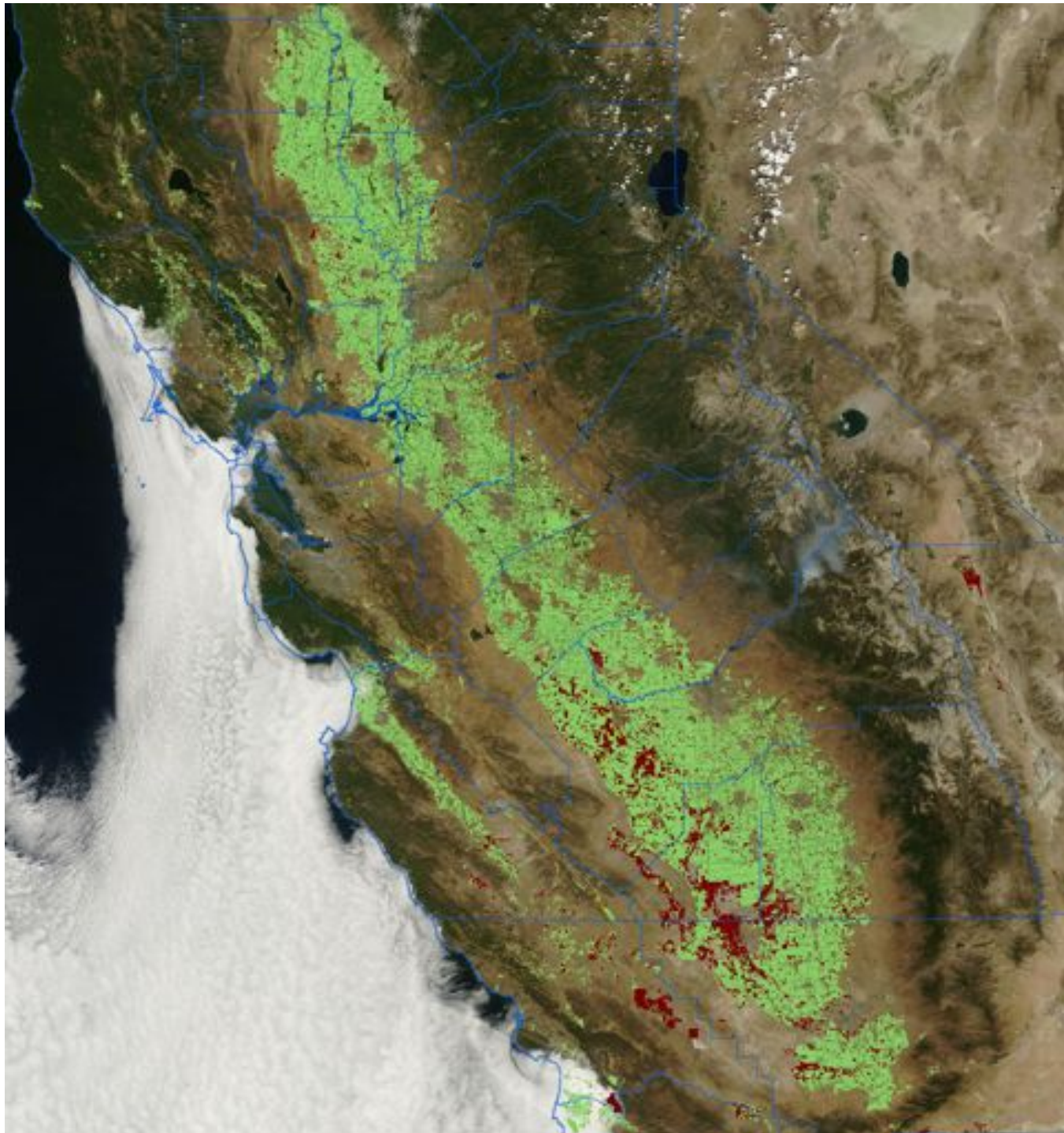


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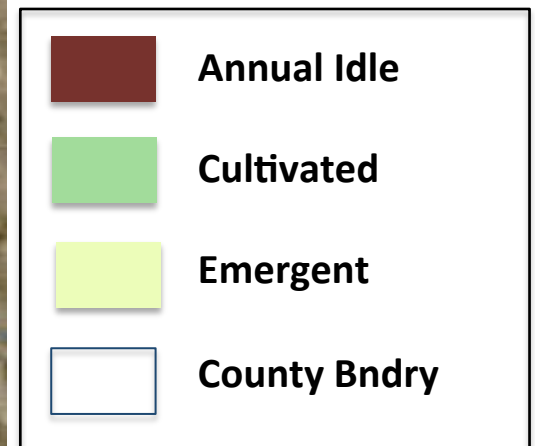
July 27, 2011
Year to Date
Conditions
Central Valley



Data source: USDA
NASS. Map derived
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and DMC satellites.
Pixel-based
classification for
entire state.

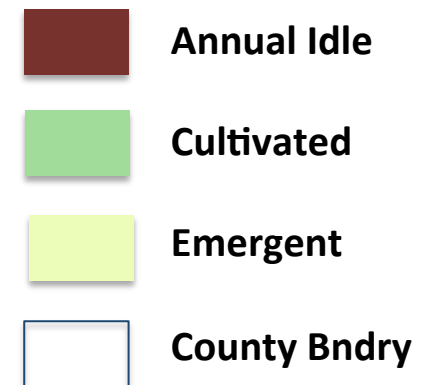
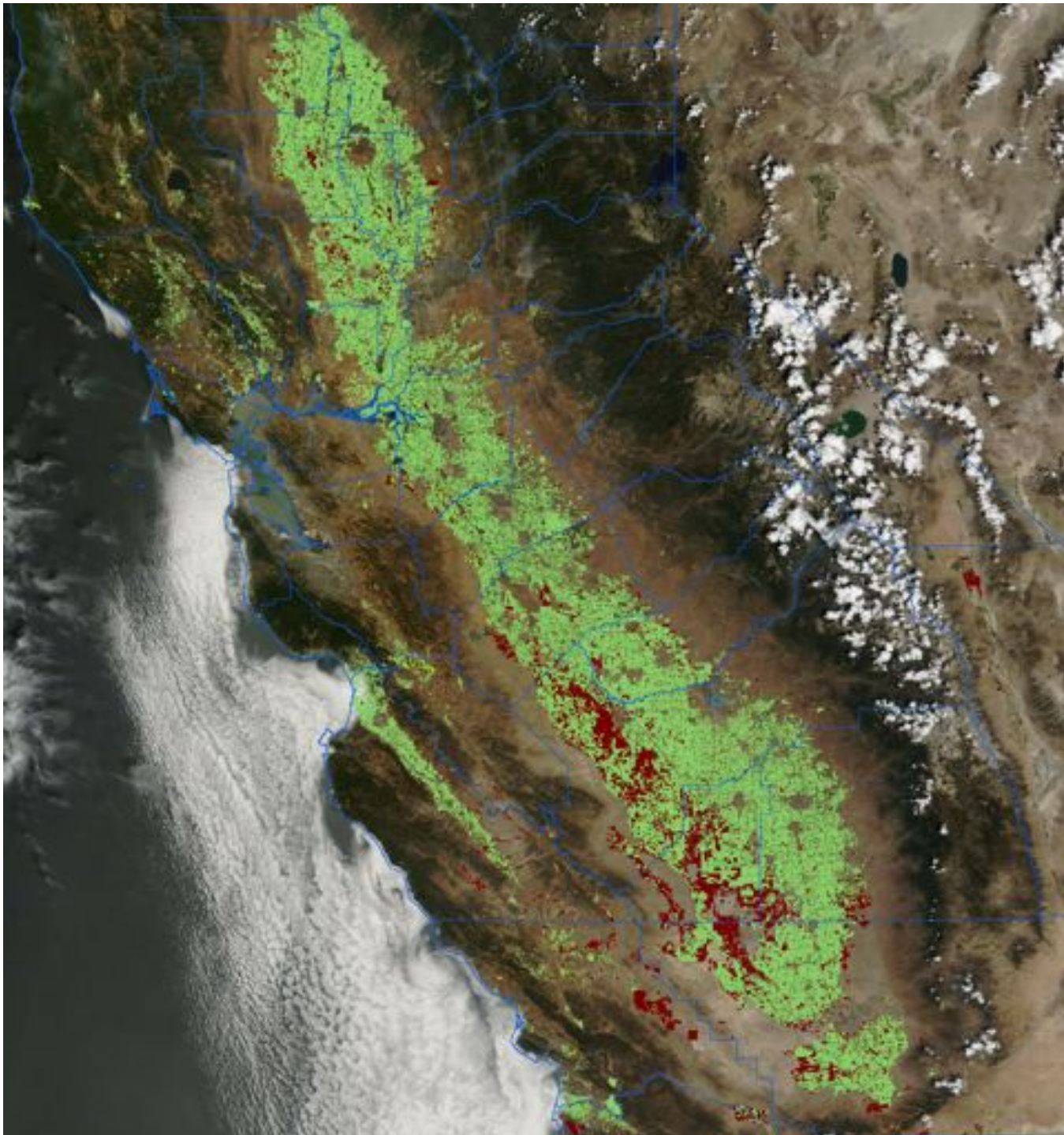


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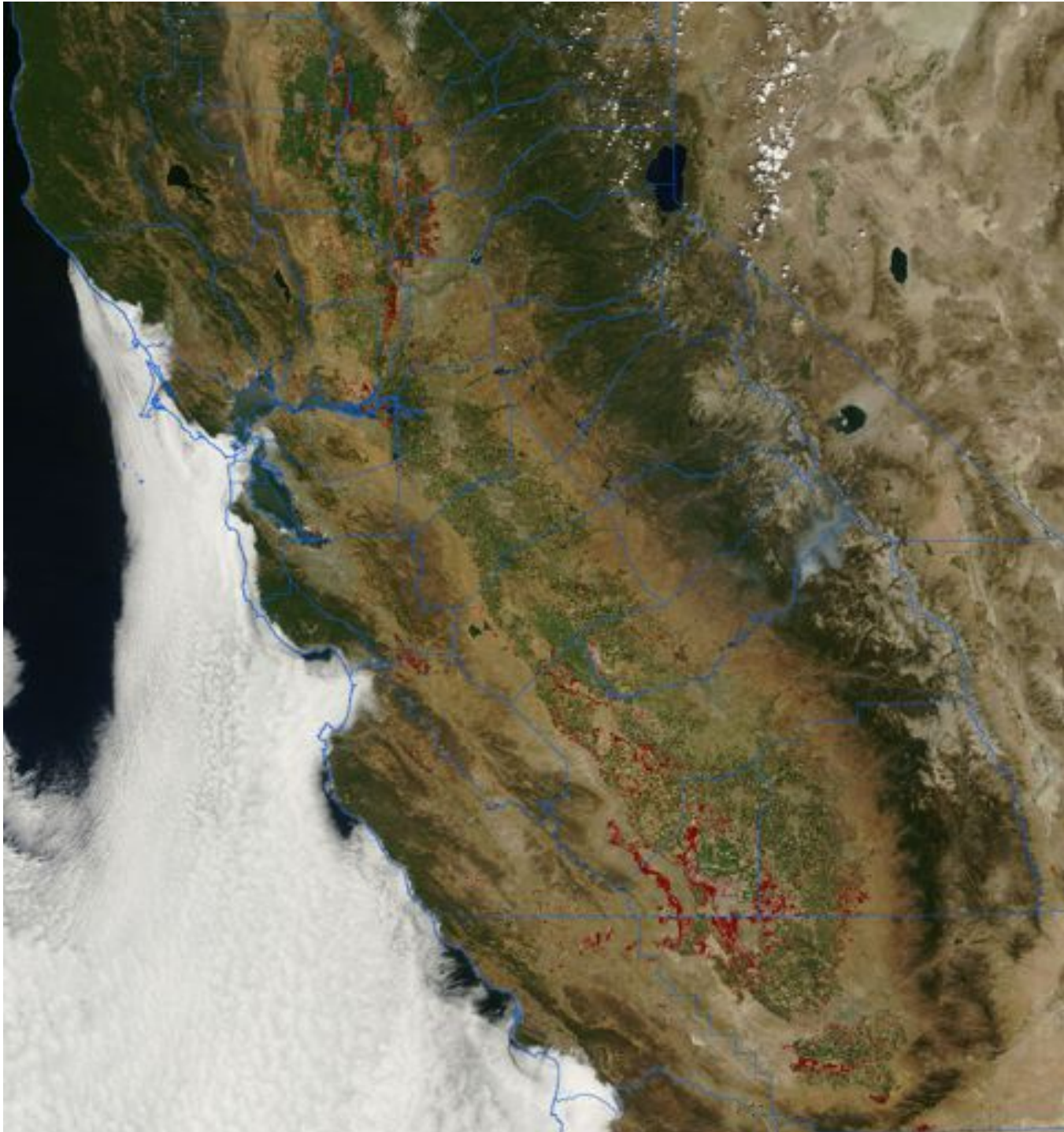


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Annual Idle from USDA NASS

- Annual idle for USDA = idle since ~April 1st, which is the date of the first satellite images used each year in USDA nationwide mapping for U.S.
- Spatial patterns in idle acreage and total annual idle acreage estimates (940,000 acres) similar to NASA/CSUMB acreage estimates and maps

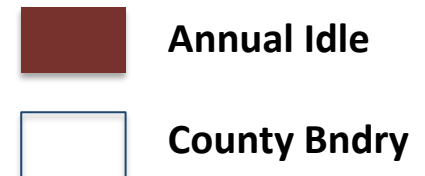
July 31, 2013
Central Valley
USDA Year to
Date Idle Acreage



-  Annual Idle
-  County Bndry

Data source: USDA
NASS. Map derived
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July 31, 2014
Central Valley
USDA Year to
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Transition Strategy

- **USDA NASS mapping will be supported by NASS as part of the Cropland Data Layer program**
- **Evaluating options for March – June estimates**
 - **Option 1: Algorithms / processing workflows to be transferred to CDWR and/or public cloud**
 - **Option 2: Implemented on EROS Enterprise Science Processing Architecture (ESPA)**
- **The ESPA Framework has been created to support Terrestrial Monitoring applications at USGS/EROS**
- **The EROS/Enterprise Science Processing Architecture is designed to enable science users to bring their algorithms to the archive to better and more quickly serve their needs**



Questions?

