California Statewide Agricultural Land Use Mapping for Informed Decision Making and Temporal Change Assessment

Groundwater Resources Association

Tools For Developing a GSP

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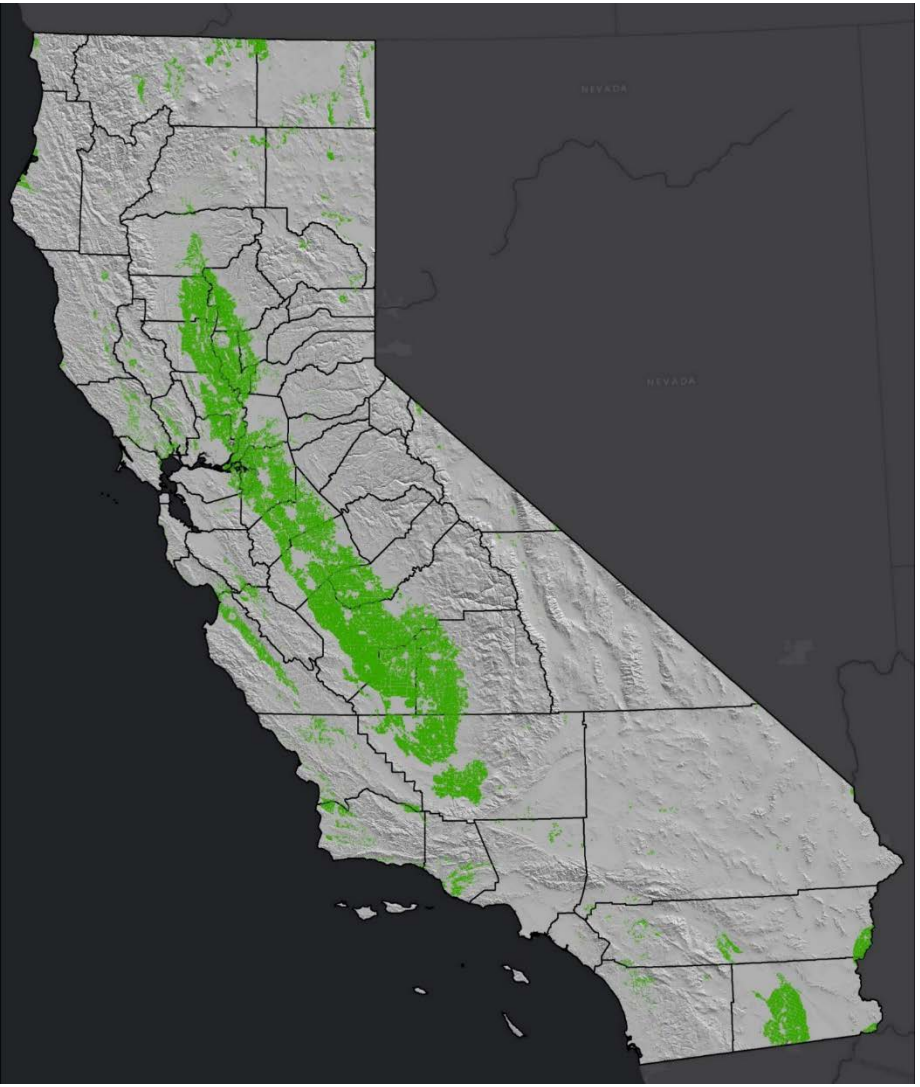
LAND IQ

Presentation Summary

- Publically Available Information
  - DWR Statewide Crop Mapping
- Example Data Resources for GSP Development
  - Retrospective Crop Mapping
  - Irrigation Method Determination
  - Crop Age Determination
  - Consumptive Use Estimates
  - Groundwater Recharge Potential

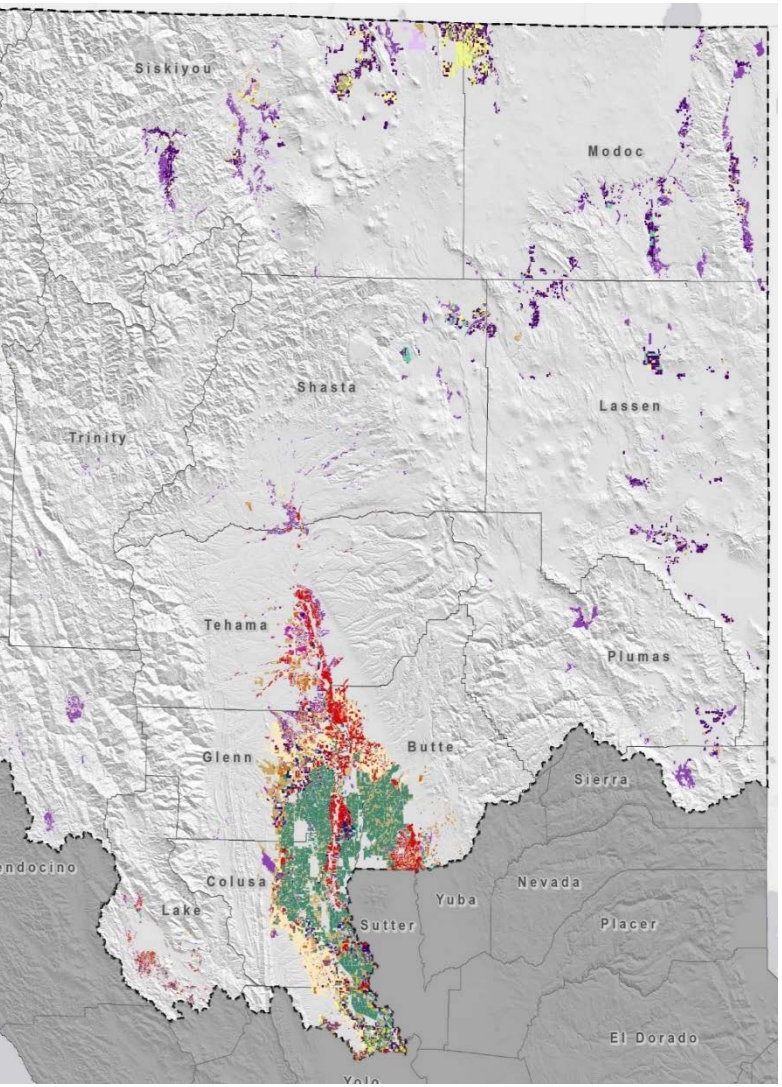
Statewide Land Use

- Proven method developed through R&D and various approaches over the past 10 years
- Publically available statewide land use map products
  - Agriculture
  - Managed wetlands (e.g. state and federal wildlife refuges)
  - Urban areas
  - Major highways
- Historic mapping in San Joaquin Valley, Sacramento Valley, Imperial Valley, AZ, NM, TX, NV – resulted in statewide CA mapping
- Results are accurate crop maps, statistics, used for overall land use change analysis
- Similar legend as past, intermittent DWR land use mapping
- 2014 publically and freely available in June/July timeframe
- 2016 currently being mapped and available in late 2017/early 2018

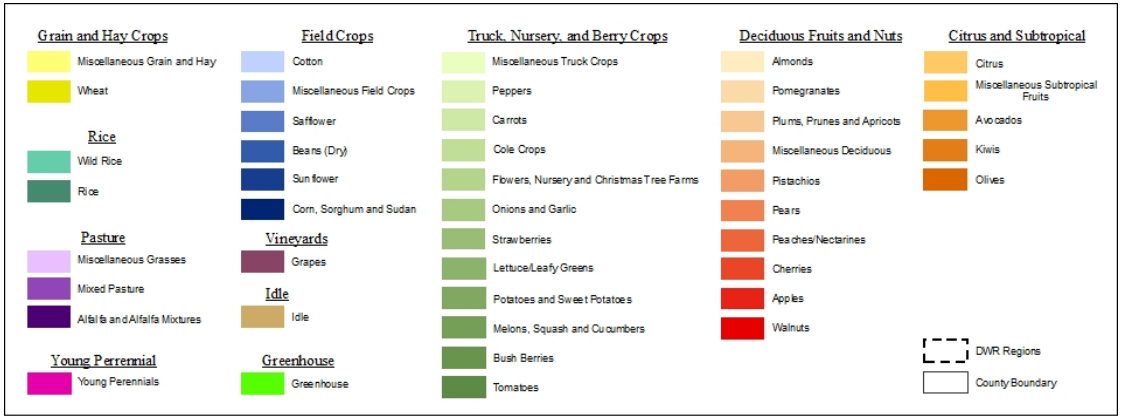


Land Use Classifications

- Over 9 million acres of irrigated land use classified
- 356,180 individually classified polygons
- Minimum field size of 2.0 acres
- Approximately 45 crop legend categories (including managed wetland systems)
- 95% accuracy based on ground-truthed independent validation dataset
- 1,064,294 acres of urban land use



CA - DWR
Northern Region



- Major crops include:
  - Rice, Walnuts, Almonds, Alfalfa, Mixed Pasture, Prunes, Grapes, Olives
  - 2014 Total Irrigated & Fallow Land = 1,492,979

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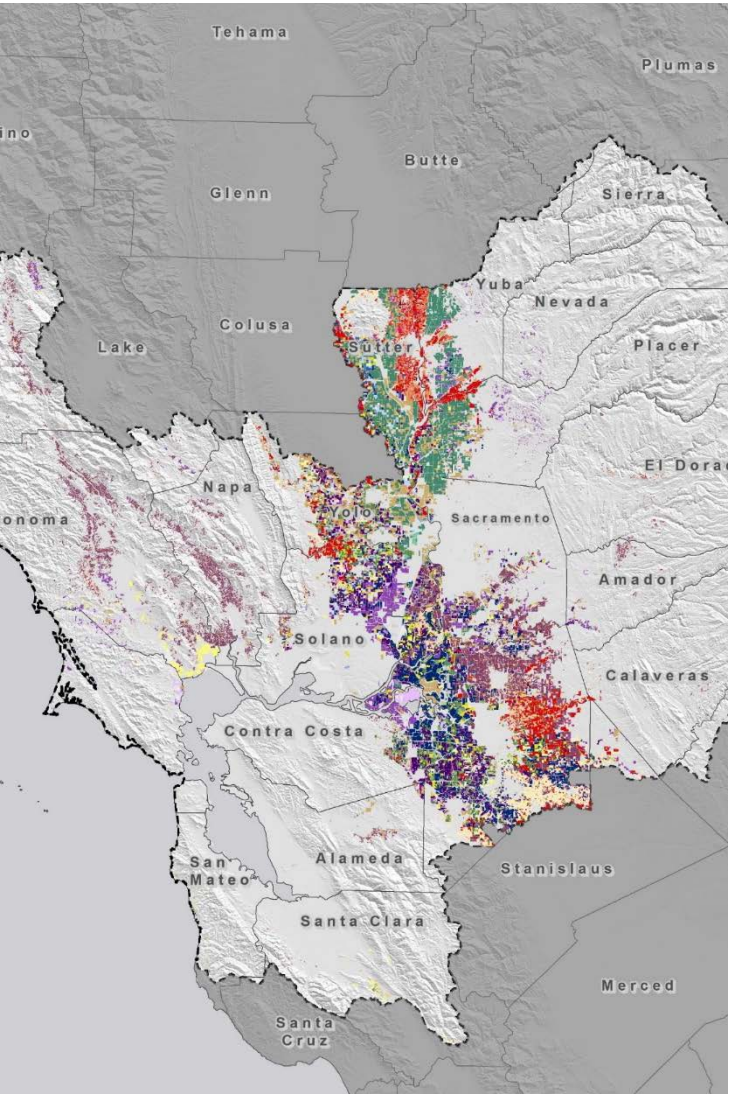
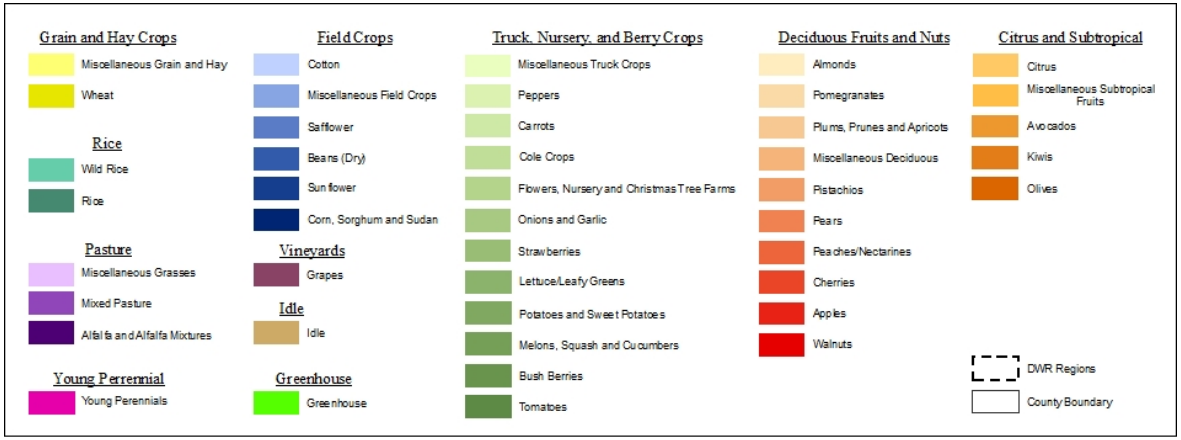


CA - DWR
North Central Region



- Major crops include:
  - Grapes, Almonds, Walnuts, Corn, Alfalfa, Tomatoes, Mixed Pasture, Fallow
  - 2014 Total Irrigated & Fallow Land = 1,664,941 acres

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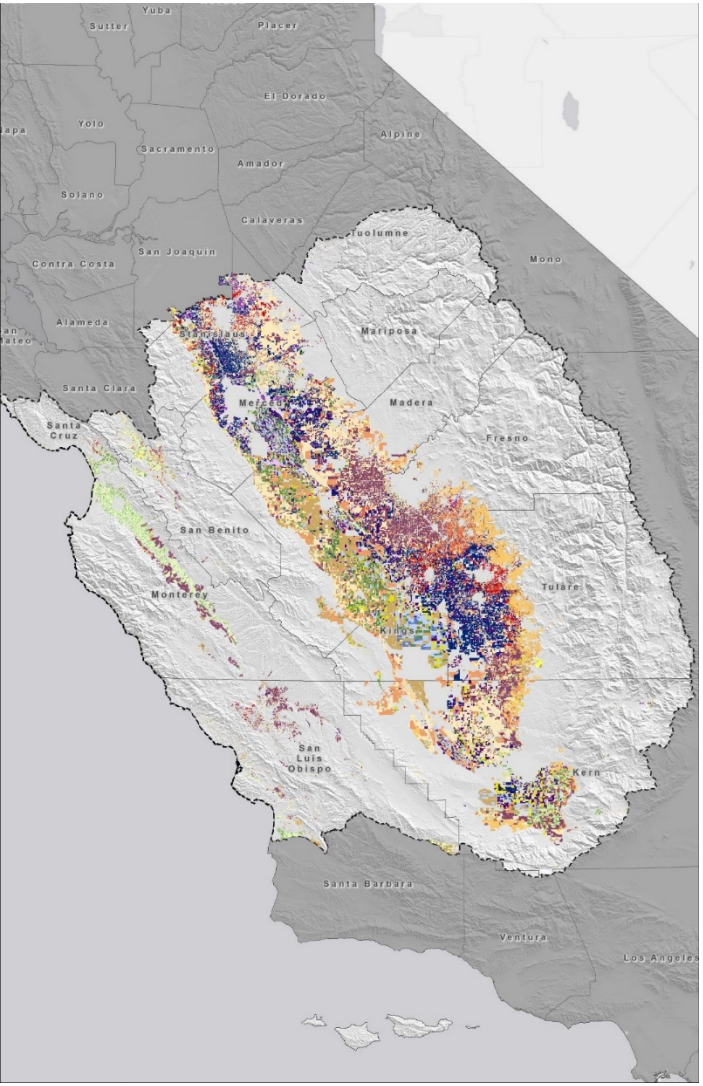
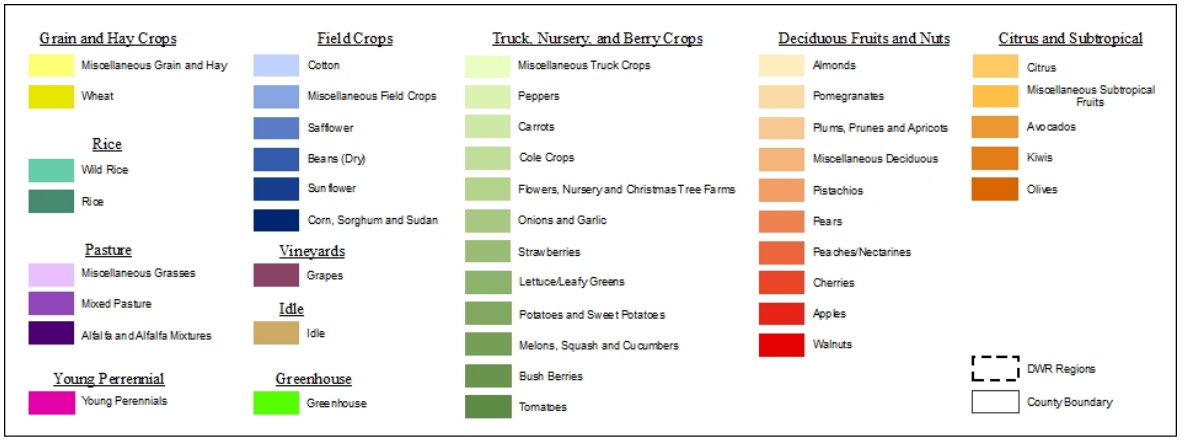


CA – DWR
South Central Region



- Major crops include:
  - Grapes, Almonds, Pistachios, Citrus, Walnuts, Corn, Sorghum, Cotton, Alfalfa, Tomatoes, Wheat, Fallow
  - 2014 Total Irrigated & Fallow Land = 4,829,004 acres

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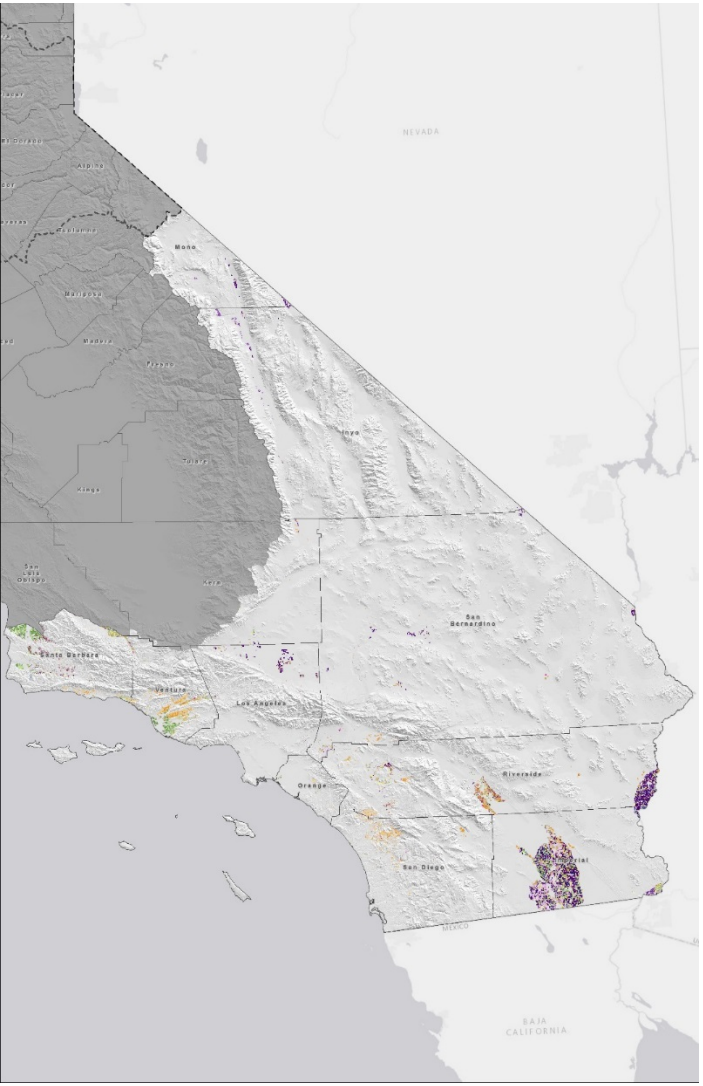
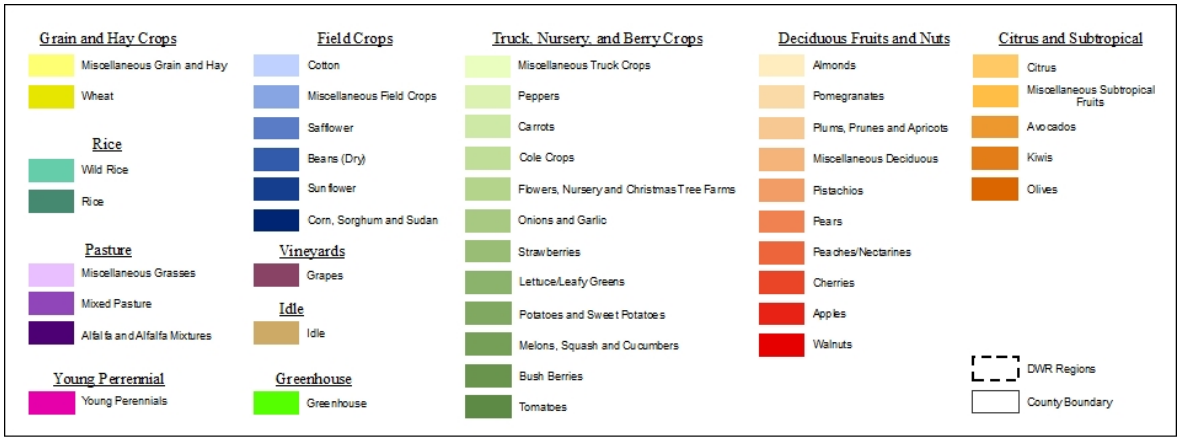
LAND IQ

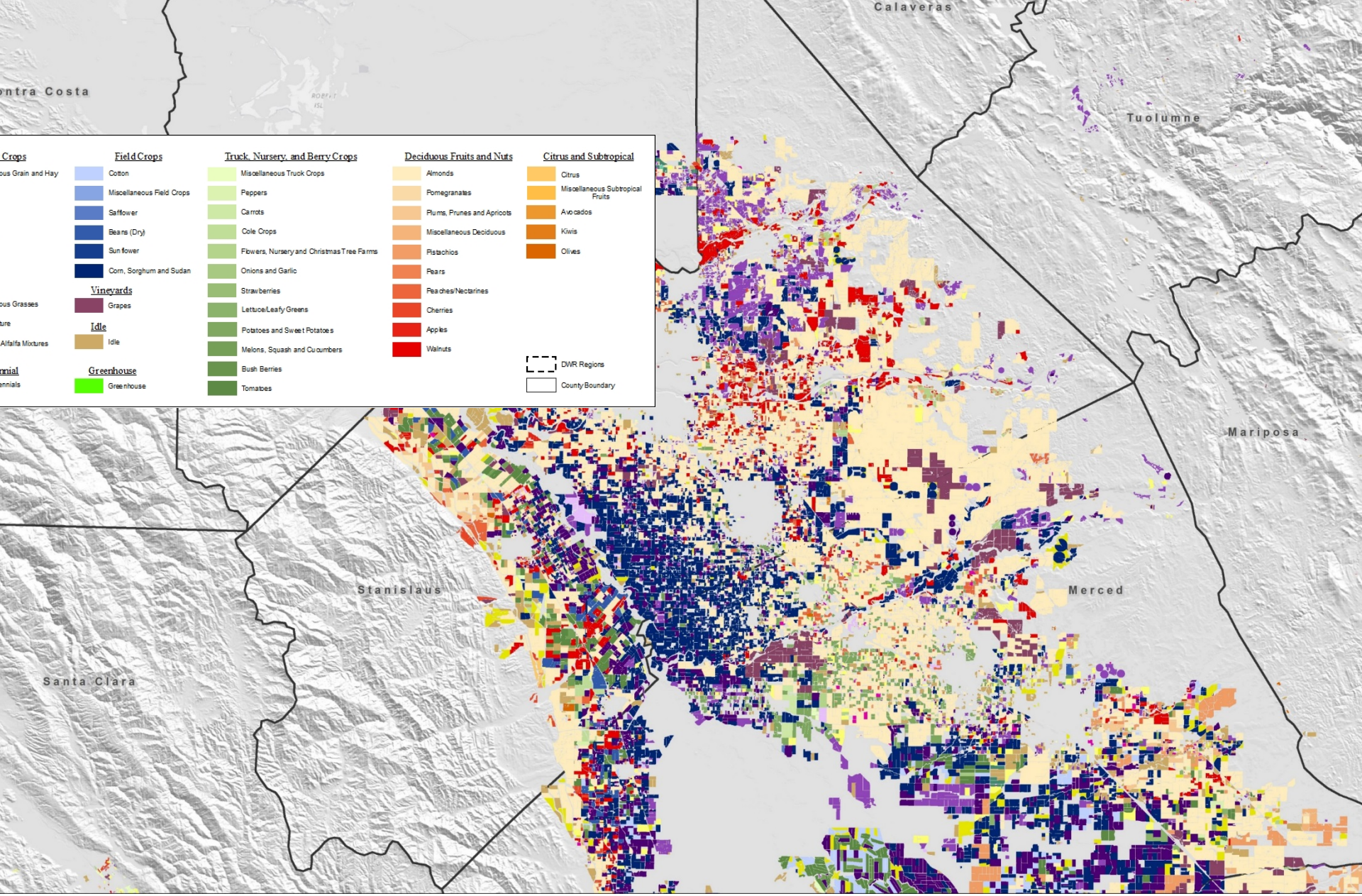


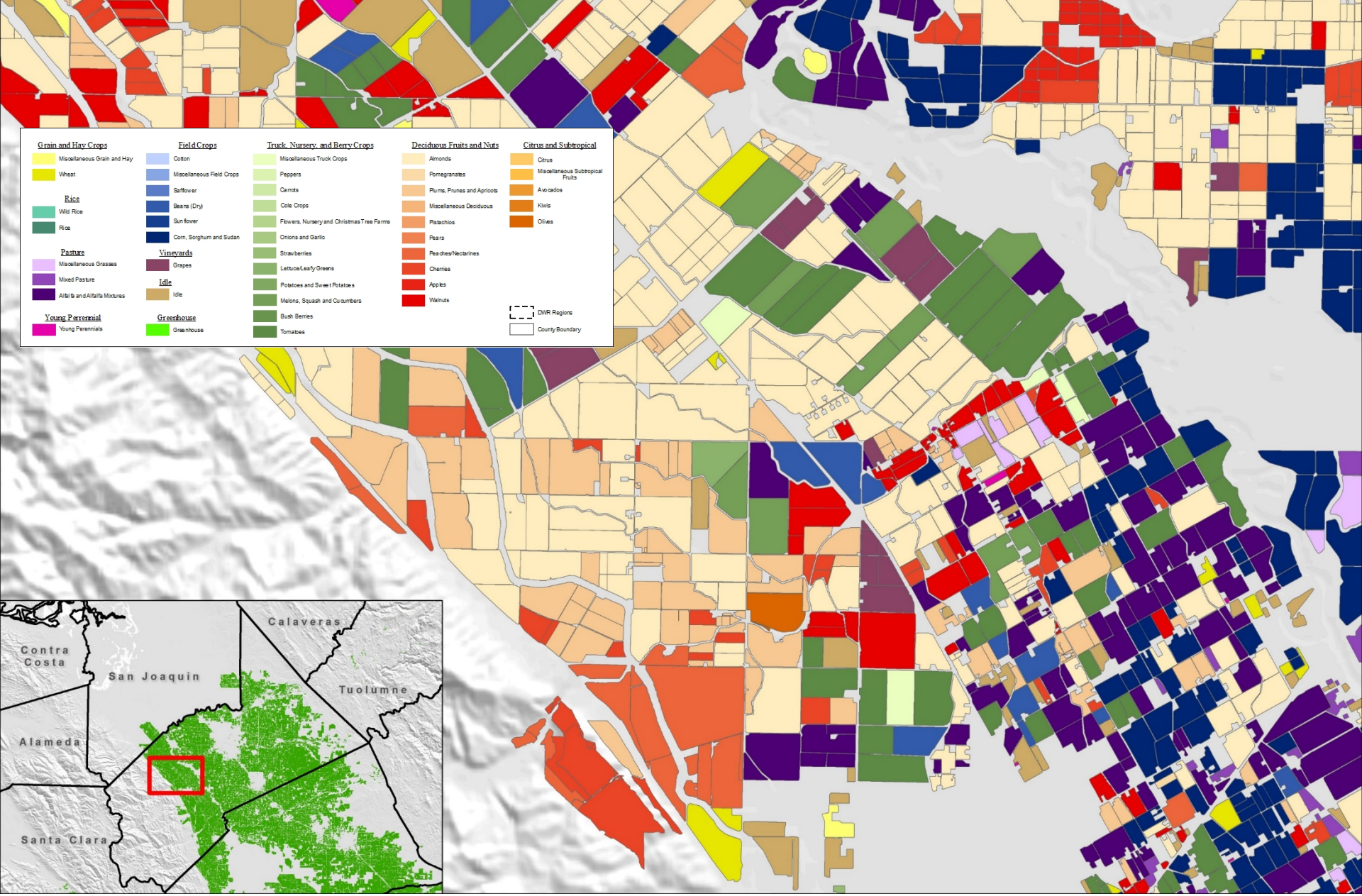
CA – DWR
Southern Region



- Major crops include:
  - Alfalfa, Citrus, Avocados, Cole Crops, Lettuce/Leafy Greens, Carrots, Truck Crops, Strawberries
  - 2014 Total Irrigated & Fallow Land = 949,504 acres

LAND IQ


Calaveras
ontra Costa
Tuolumne
Mariposa
Stanislaus
Merced
Santa Clara
Crops
ous Grain and Hay
ous Grasses
ture
Alfalfa Mixtures
nnial
nnials
Field Crops
Cotton
Miscellaneous Field Crops
Safflower
Beans (Dry)
Sunflower
Corn, Sorghum and Sudan
Vineyards
Grapes
Idle
Idle
Greenhouse
Greenhouse
Truck, Nursery, and Berry Crops
Miscellaneous Truck Crops
Peppers
Carrots
Cole Crops
Flowers, Nursery and Christmas Tree Farms
Onions and Garlic
Strawberries
Lettuce/Leafy Greens
Potatoes and Sweet Potatoes
Melons, Squash and Cucumbers
Bush Berries
Tomatoes
Deciduous Fruits and Nuts
Almonds
Pomegranates
Plums, Prunes and Apricots
Miscellaneous Deciduous
Pistachios
Pears
Peaches/Nectarines
Cherries
Apples
Walnuts
Citrus and Subtropical
Citrus
Miscellaneous Subtropical Fruits
Avocados
Kiwis
Olives
DWR Regions
County Boundary


Grain and Hay Crops
Miscellaneous Grain and Hay
Wheat
Rice
Wild Rice
Rice
Pasture
Miscellaneous Grasses
Mixed Pasture
Alfalfa and Alfalfa Mixtures
Young Perrennial
Young Perennials
Field Crops
Cotton
Miscellaneous Field Crops
Safflower
Beans (Dry)
Sunflower
Corn, Sorghum and Sudan
Vineyards
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Citrus
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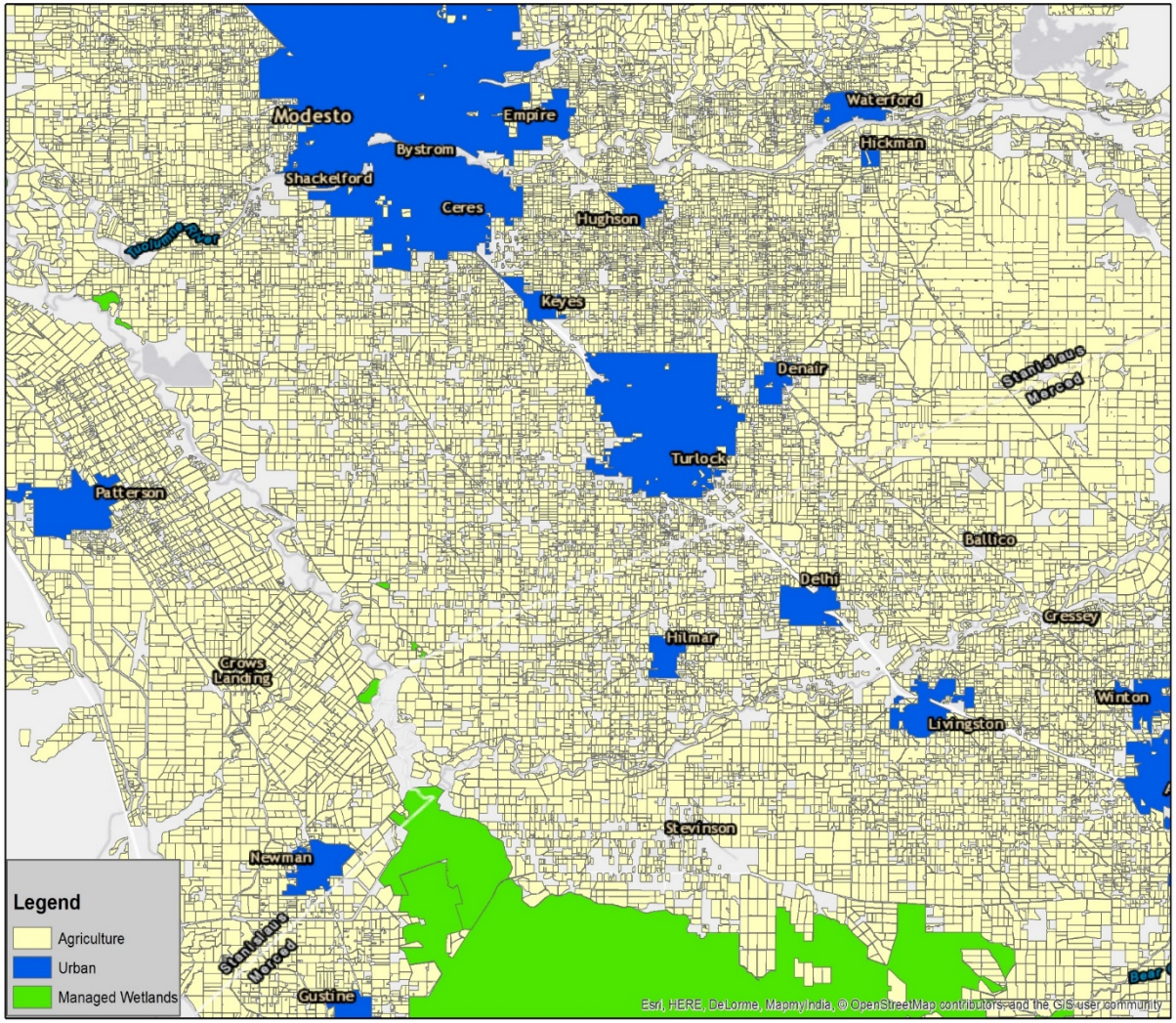
Avocados
Kiwis
Olives
DWR Regions
County Boundary
Calaveras
Contra Costa
San Joaquin
Tuolumne
Alameda
Santa Clara



Managed Wetlands and Urban

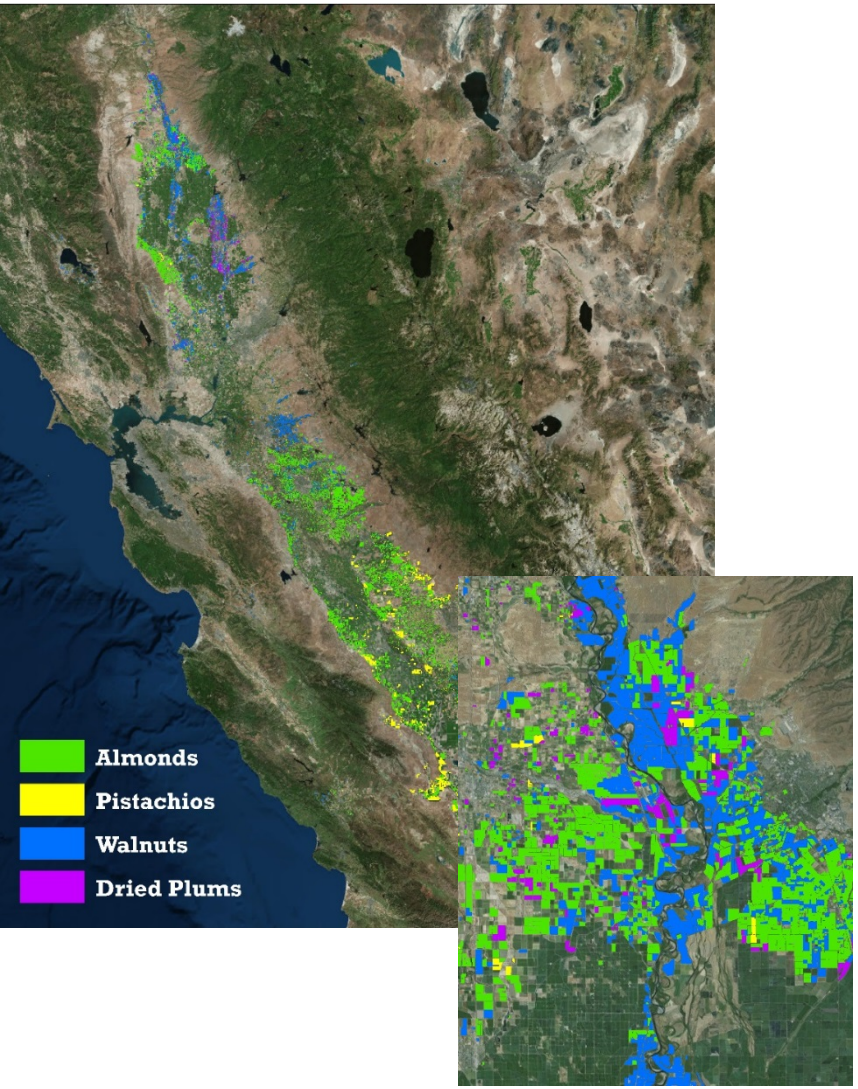
- All managed wetlands (e.g. state and federal wildlife refuges) were classified as to areas receiving water
- Urban classified by land use only

2016 Land Use Preview

- Considerable increase in fallow ground as compared to 2014
- Significant (e.g. 10-15%) change in irrigated area (field) boundaries
- Continued expansion of permanent crops (e.g. almonds, walnuts, pistachios, etc)
- Continued urban expansion as compared to 2014

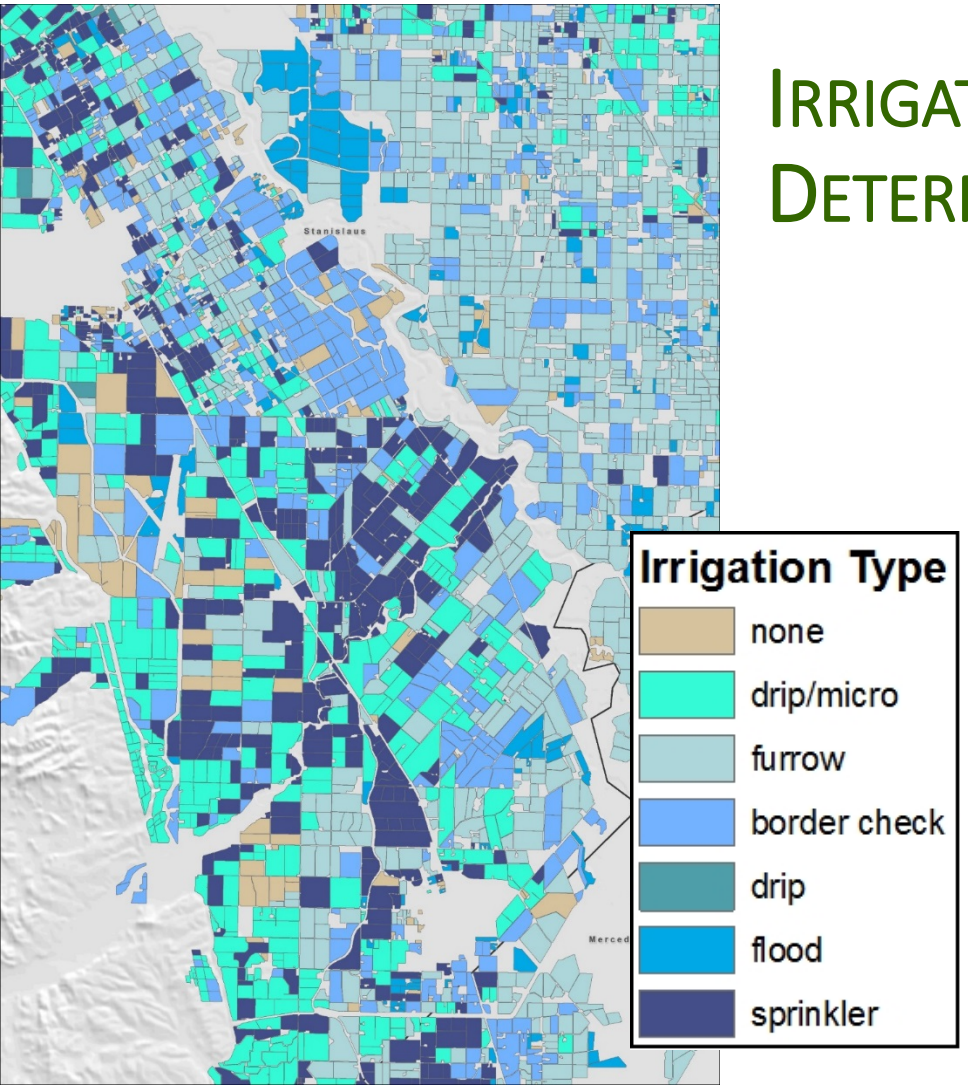
GSA-Specific Crop-Mapping Derived Data

- Example Data Resources for GSP Development
  - Retrospective Crop Mapping
  - Irrigation Method Determination
  - Crop Age Determination
  - Consumptive Use Estimates
  - Groundwater Recharge Potential



Retrospective Crop Mapping

- Use of existing crop mapping algorithms for change analysis moving backwards
- Use of historic ground truthing information back through 2011 and beyond
- Coupling land use sciences with spatial sciences
- Maintaining consistency with 2014 and 2016 datasets

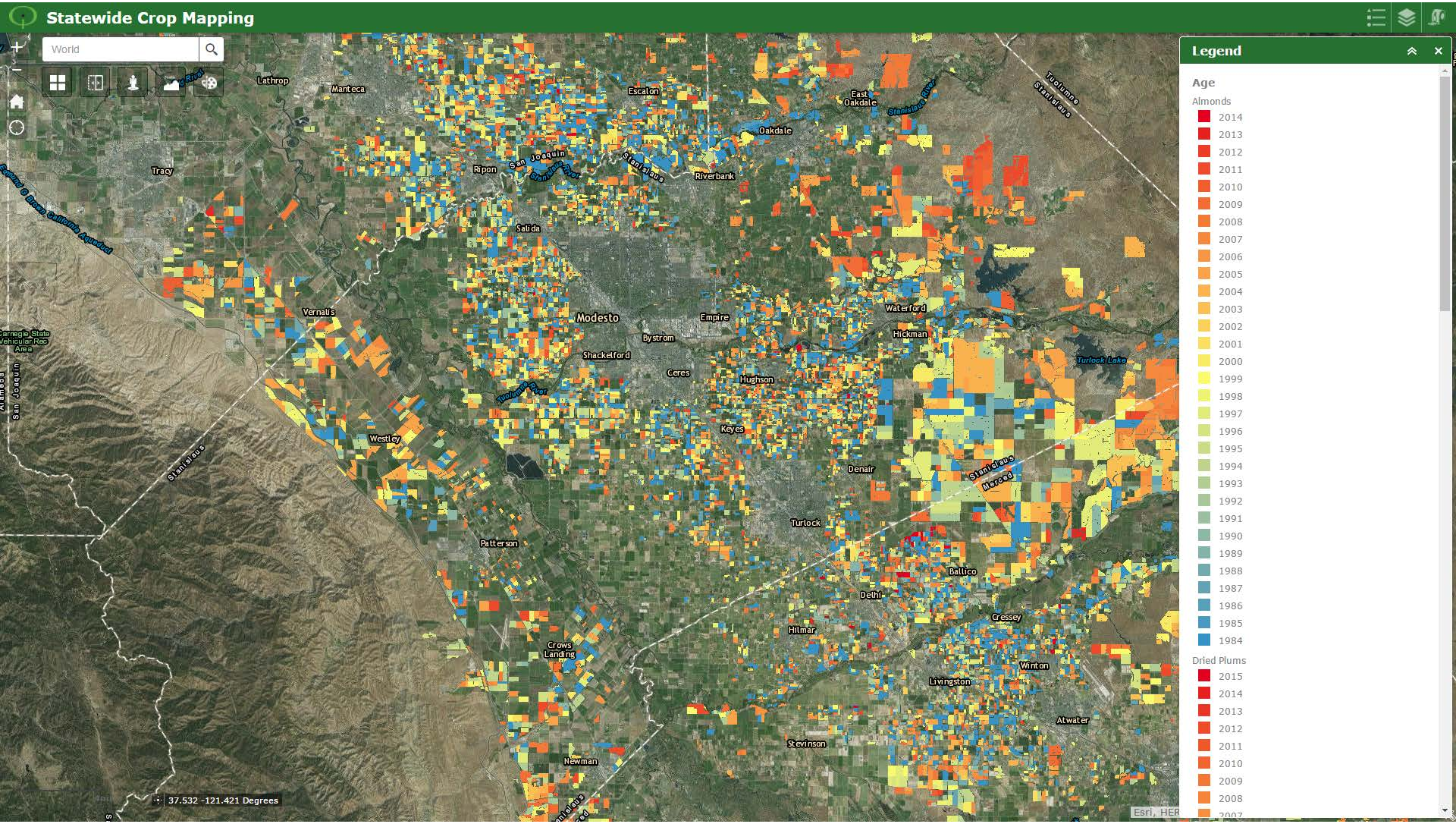


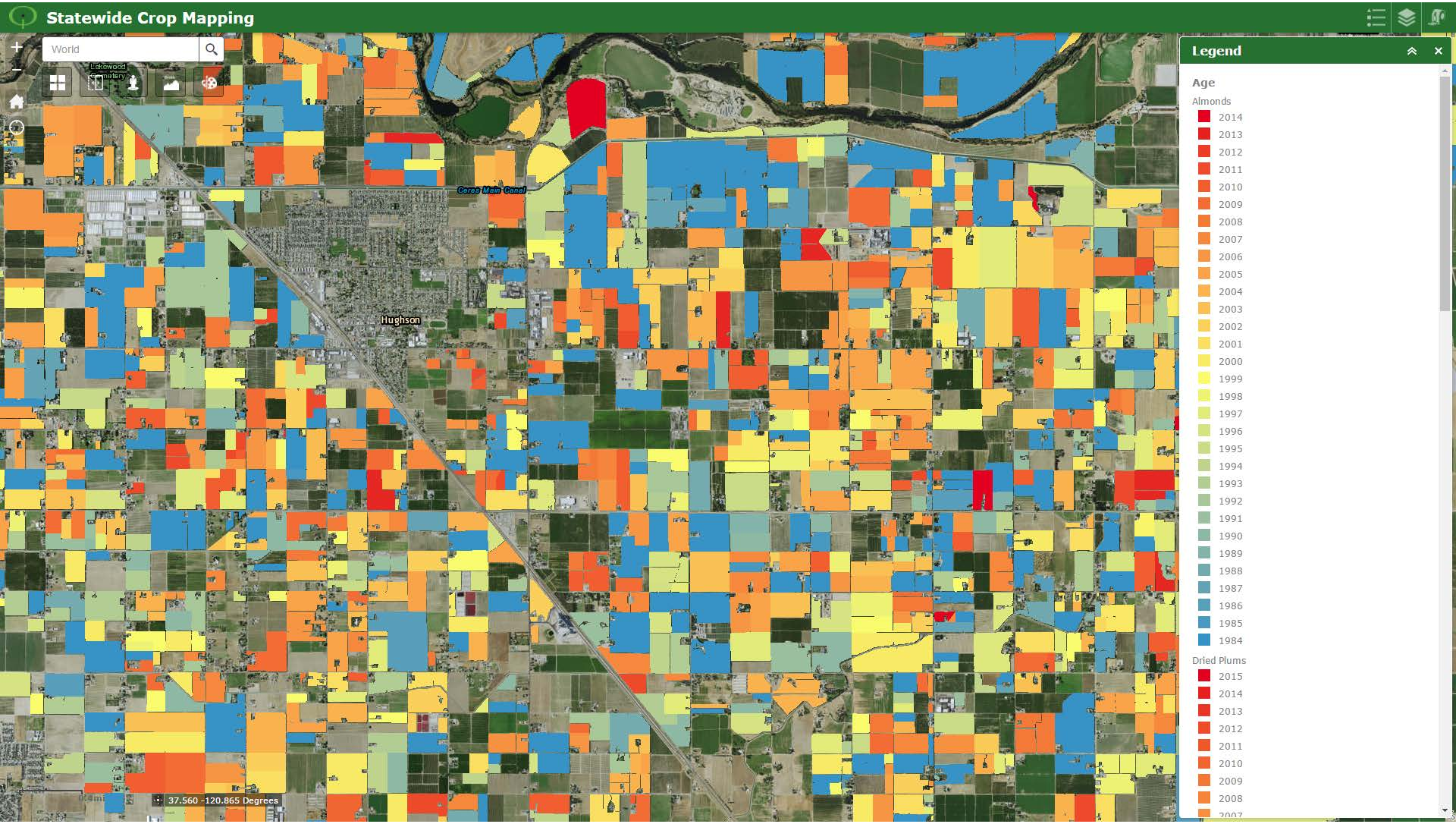
Irrigation Method Determination

- Incorporation of various lines of evidence to create irrigation method distribution
  - Crop type
  - Statewide ground truth results
  - Irrigation district records
  - DWR records
  - Source water supply
  - Agronomic knowledge
  - Known regional differences
  - Temporal differences (e.g. crop age)
  - Topography

Crop Age Determination

- Permanent crops make up over 35% of all irrigated crops in California
- Analyze historic imagery (back to 1984) to determine the planting year
- 90% accurate (+/- 1-2 years)
- Continuing to increase over time
- Represents a “hard water demand” that is expected to increase
- Results in more accurate estimation of evapotranspiration


Statewide Crop Mapping
World
Legend
Age
Almonds
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
1996
1995
1994
1993
1992
1991
1990
1989
1988
1987
1986
1985
1984
Dried Plums
2015
2014
2013
2012
2011
2010
2009
2008
Lathrop
Manteca
Escalon
East Oakdale
Oakdale
Tracy
Ripon
San Joaquin
Stanislaus River
Riverbank
Salida
Vernalis
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Turlock Lake
Tuolumne River
Keyes
Westley
Denair
Stanislaus
Turlock
Patterson
Ballico
Delhi
Cressey
Hilmar
Crows Landing
Winton
Livingston
Atwater
Stevinson
Newman
Merced
37.532 -121.421 Degrees
Esri, HER


Statewide Crop Mapping
World
Lakewood Cemetery
Corcoran Main Canal
Hughson
37.560 -120.865 Degrees
Legend
Age
Almonds
2014
2013
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
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1984
Dried Plums
2015
2014
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2012
2011
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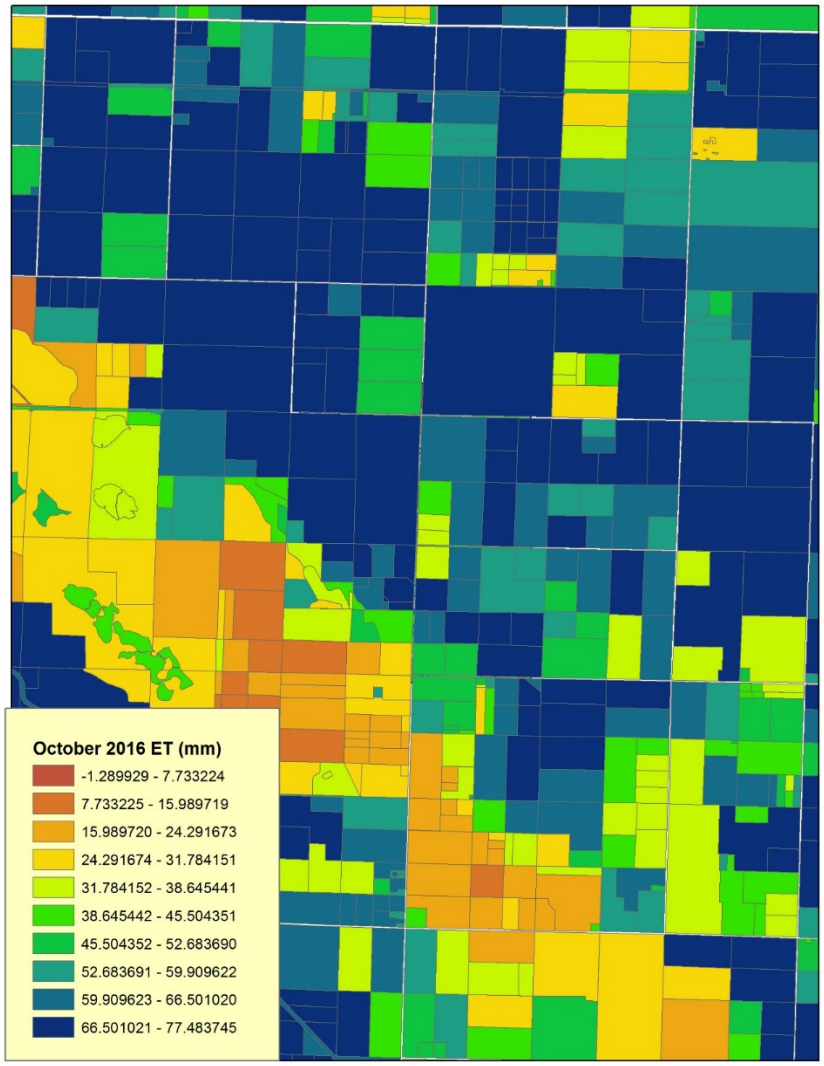
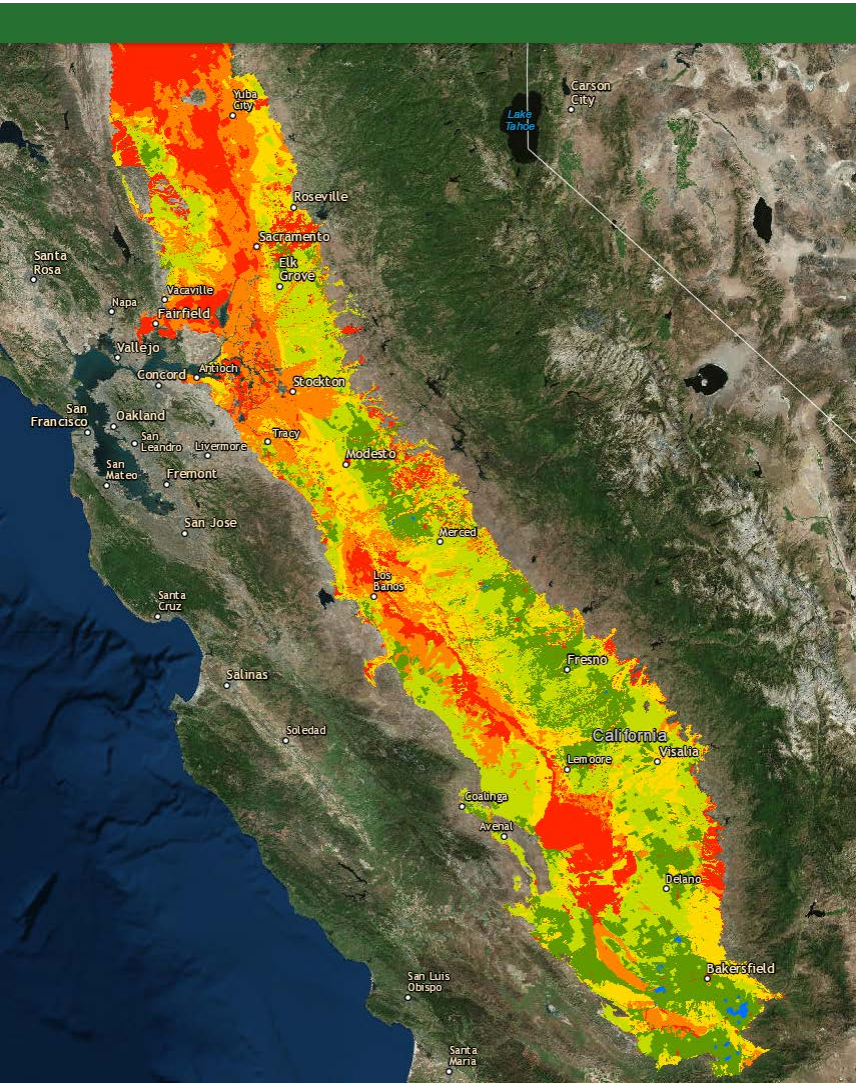
2007



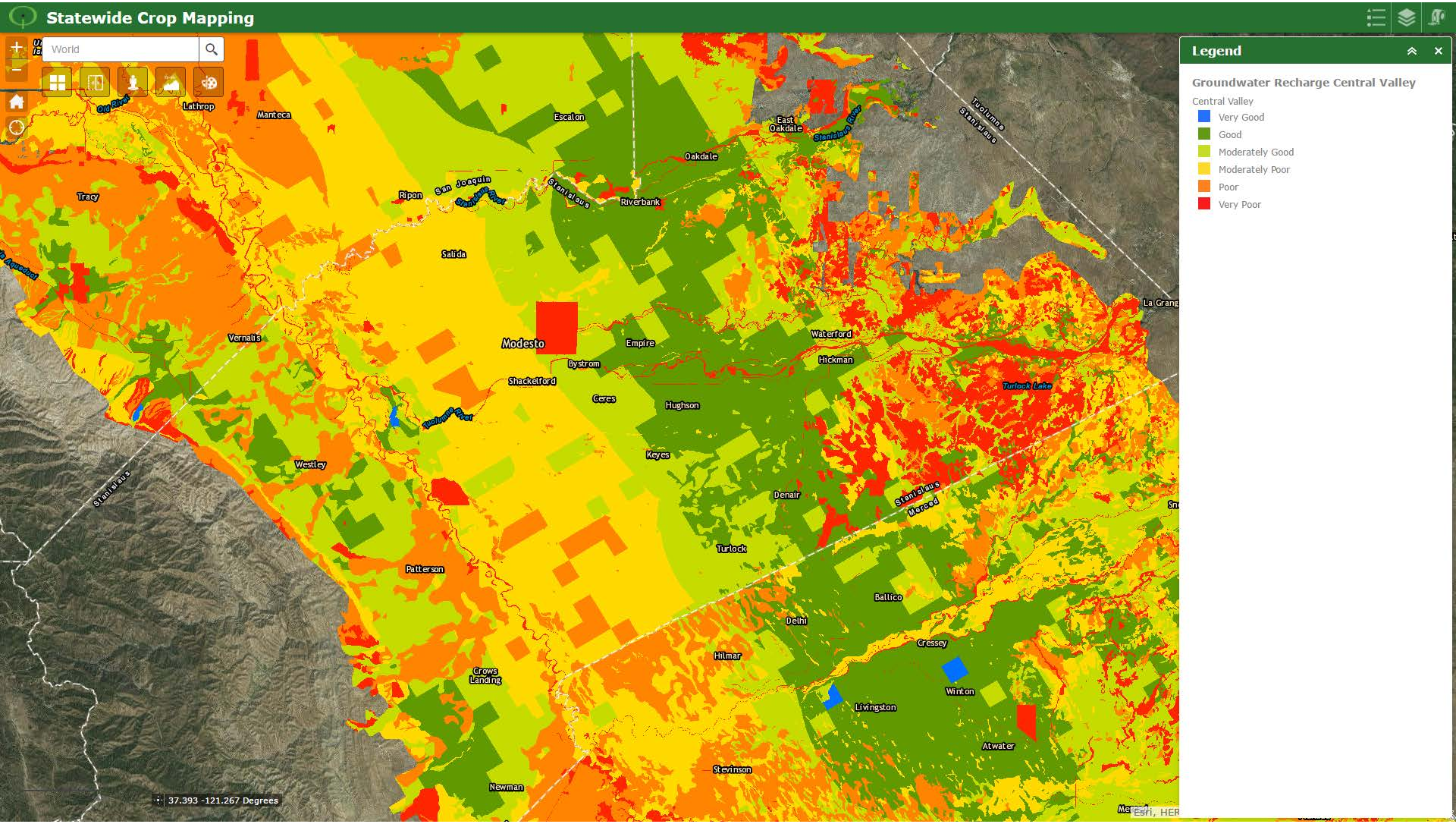
Consumptive Use Determination

- Optimized remotely sensed methodology
- Coupling of crop type with remotely sensed methods to determine evapotranspiration
- Results in higher accuracy than remotely sensed methods alone
- Allows for field by field determination of evapotranspiration
- Incorporation of permanent crop age allows for more accurate estimation of crop consumptive use



GROUNDWATER RECHARGE POTENTIAL

- Data Inputs:
  - Soil Agricultural Groundwater Banking Index (SAGBI)
  - USGS Groundwater Levels
  - Central Valley Hydrologic Model (CVHM)
  - Irrigation District Coverage
  - Hydrology & Points of Diversion
- Results in a Central Valley wide recharge index map combining surface and sub-surface conditions


Statewide Crop Mapping
World
Legend
Groundwater Recharge Central Valley
Central Valley
Very Good
Good
Moderately Good
Moderately Poor
Poor
Very Poor
Lathrop
Manteca
Escalon
East Oakdale
Oakdale
Tuolumne
Stanislaus
Tracy
Ripon
San Joaquin
Stanislaus River
Riverbank
Salida
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Turlock Lake
Tuolumne River
Keyes
Westley
Denair
Merced
Turlock
Patterson
Ballico
Delhi
Cressey
Hilmar
Crows Landing
Winton
Livingston
Atwater
Stevinson
Newman
37.393 -121.267 Degrees
Esri, HER

CONCLUSIONS

- Statewide land use will be publically available from DWR for:
  - 2014 – in June/July 2017
  - 2016 – late 2017/early 2018
- GSA-Specific Derivative Products
  - Retrospective Crop Mapping
  - Irrigation Method
  - Consumptive Use Estimates
  - Crop Age Determination
  - Groundwater Recharge Potential
- Purpose is to provide consistent data resources across all GSAs

ACKNOWLEDGEMENTS

- California Department of Water Resources
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  - Kim Rosmaier, North Central District
  - Luis Avila, South Central District
  - Sergio Fierro, Southern District
- Technical Partners
  - University of California, Davis
  - California Polytechnic State University, San Luis Obispo
  - California State University, Monterey Bay

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California State University MONTEREY BAY

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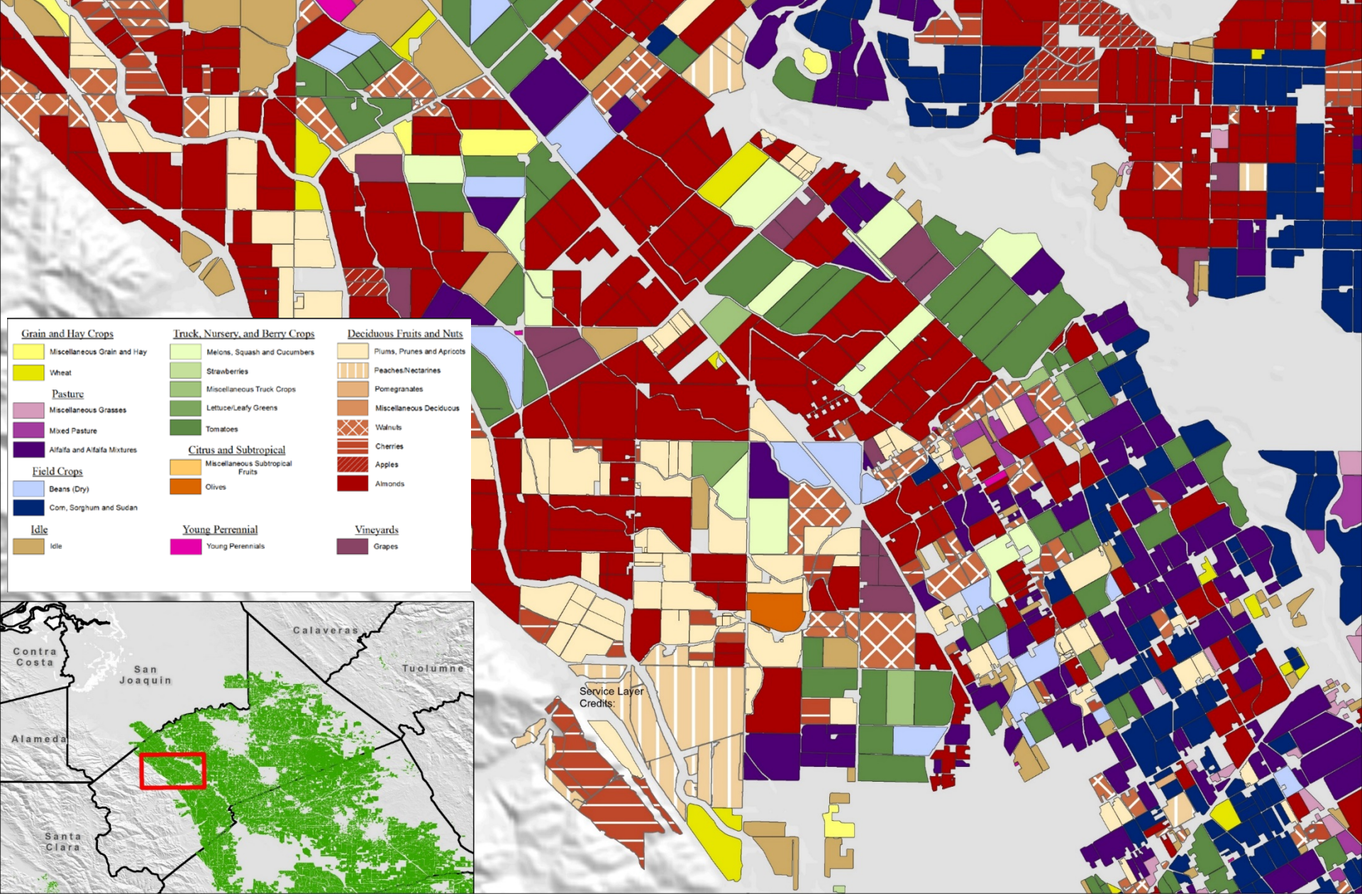
END


Grain and Hay Crops
Miscellaneous Grain and Hay
Wheat
Pasture
Miscellaneous Grasses
Mixed Pasture
Alfalfa and Alfalfa Mixtures
Field Crops
Beans (Dry)
Corn, Sorghum and Sudan
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Truck, Nursery, and Berry Crops
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Citrus and Subtropical
Miscellaneous Subtropical Fruits
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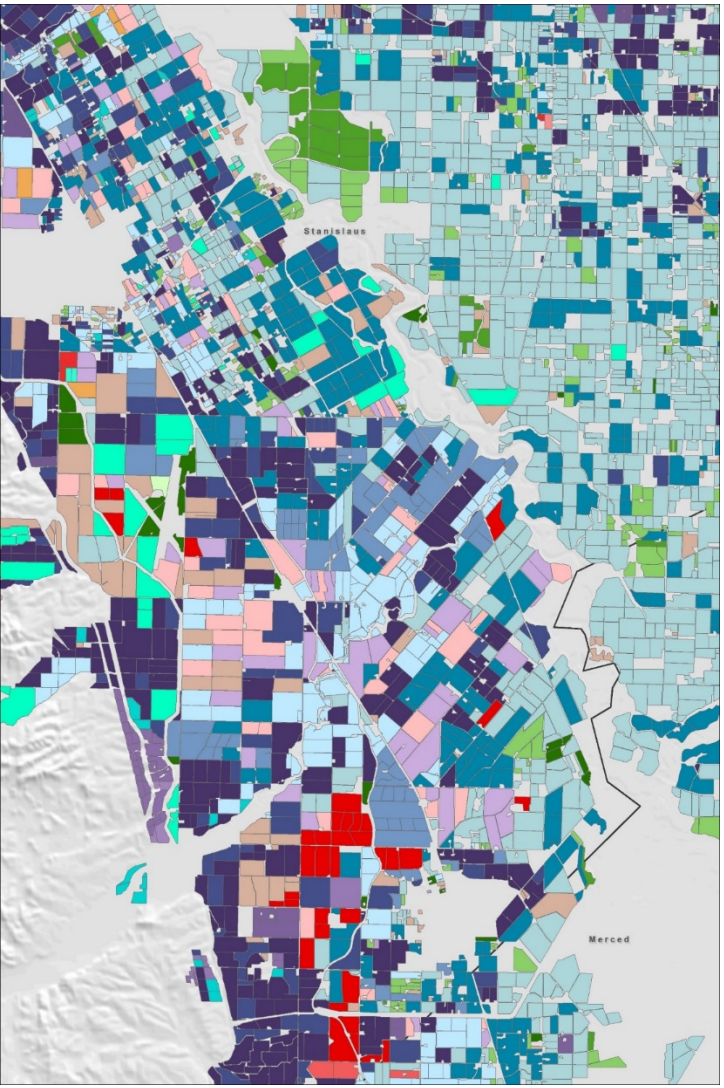
Plums, Prunes and Apricots
Peaches/Nectarines
Pomegranates
Miscellaneous Deciduous
Walnuts
Cherries
Apples
Almonds
Vineyards
Grapes
Contra Costa
San Joaquin
Calaveras
Tuolumne
Alameda
Santa Clara
Service Layer Credits:

Irrigation Method & Crop Type



Flood

- flood, Safflower
- flood, Mixed Pasture
- flood, Miscellaneous Grasses
- flood, Miscellaneous Grain and Hay

Sprinkler

- sprinkler, Walnuts
- sprinkler, Beans (Dry)
- sprinkler, Almonds

Drip

- drip, Strawberries
- drip, Miscellaneous Truck Crops
- drip, Lettuce/Leafy Greens

Drip / Micro

- drip/micro, Tomatoes
- drip/micro, Young Perennials
- drip/micro, Pomegranates
- drip/micro, Pistachios
- drip/micro, Peaches/Nectarines
- drip/micro, Citrus
- drip/micro, Olives
- drip/micro, Grapes
- drip/micro, Miscellaneous Subtropical Fruits
- drip/micro, Miscellaneous Deciduous
- drip/micro, Apples
- drip/micro, Almonds

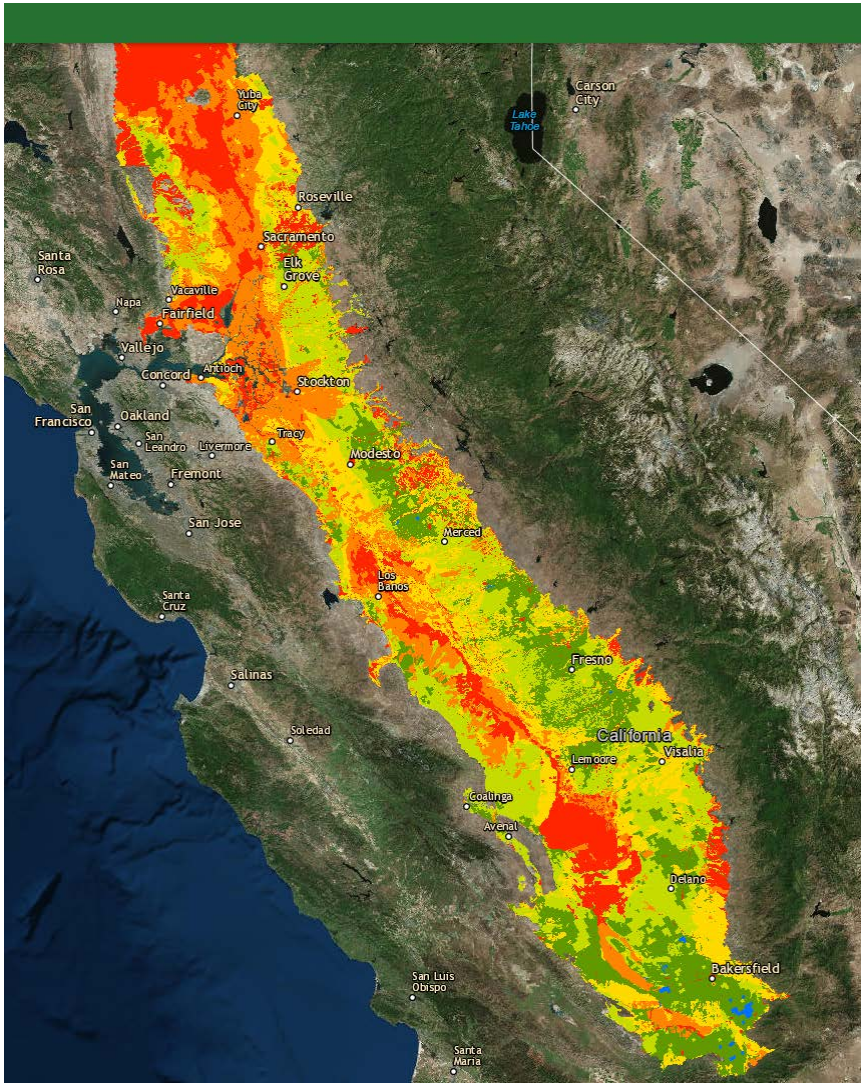
Furrow

- furrow, Tomatoes
- furrow, Potatoes and Sweet Potatoes
- furrow, Peppers
- furrow, Onions and Garlic
- furrow, Cole Crops

Border Check

- border check, Wheat
- border check, Cherries
- border check, Alfalfa and Alfalfa Mixtures

- none, Idle


Yuba City
Carson City
Lake Tahoe
Roseville
Sacramento
Santa Rosa
Elk Grove
Napa
Vacaville
Fairfield
Vallejo
Antioch
Concord
Stockton
San Francisco
Oakland
San Leandro
Livermore
Tracy
Modesto
San Mateo
Fremont
San Jose
Merced
Los Banos
Santa Cruz
Fresno
Salinas
Soledad
California
Visalia
Lemoore
Coalinga
Avenal
Delano
Bakersfield
San Luis Obispo
Santa Maria