



SONOMA **VEG** MAP

SONOMA COUNTY VEGETATION & HABITAT MAPPING PROGRAM

High-Quality Data for Planning, Conservation and Resource Management



Overview

1. Meeting purpose and introduce project team (Tom - 2 minutes)
2. About the program (Tom - 12 min.)
 - Goals
 - Products and adaptive scope
 - Uses
3. Introduction to Remote Sensing and Mapping Advisory Committee (Mark - 5 min.)
4. Technical approach to mapping (Mark - 15 min.)
5. Getting involved and providing input (Tom - 10 min.)
6. Questions and discussion (All - 15 min.)



Aerial Photo



Medium-scale vegetation map



Appropriate Use:

Good inventory for area the size of **half the county**
(1:100,000 scale or higher)



Fine-scale vegetation map



Good inventory for **individual properties**
(1:5,000 scale or higher)

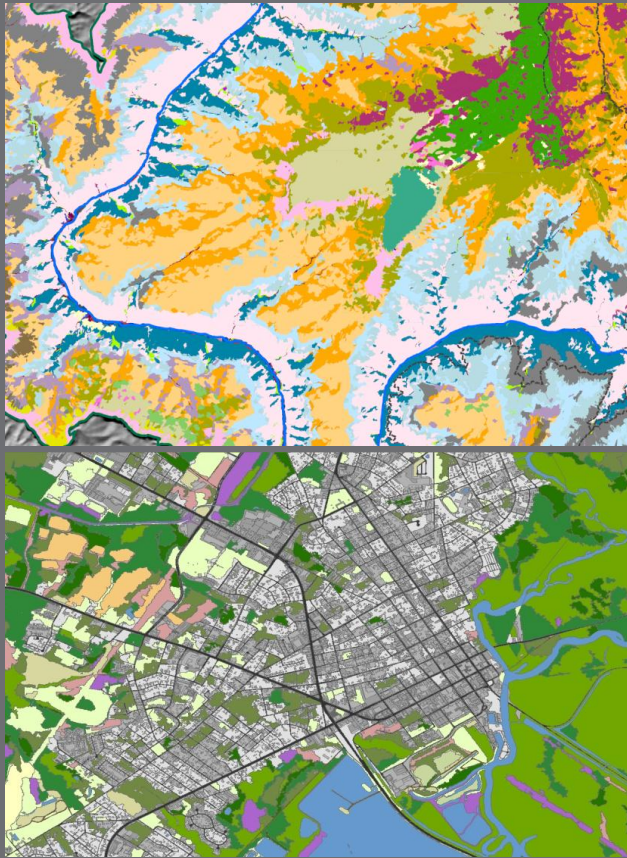


About the Program

“Program” not “project”? “Program” = sustained effort to collaborate with other groups to create, maintain, and analyze high-quality, fine-scale vegetation and habitat data for Sonoma County.

Goals

- Support and enhance local planning through high-quality data
- Support and implement key resource inventory and mapping action items from the County General Plan, the District’s acquisition and strategic plans, the Sonoma County Biodiversity Action Plan, the Sonoma County Climate Action Plan, RCD watershed plans, and others
- Contribute to efforts to generate natural resource data and capture expert knowledge
- Enhance the many ways the community is already engaged as “citizen scientists”
- *What’s missing?*



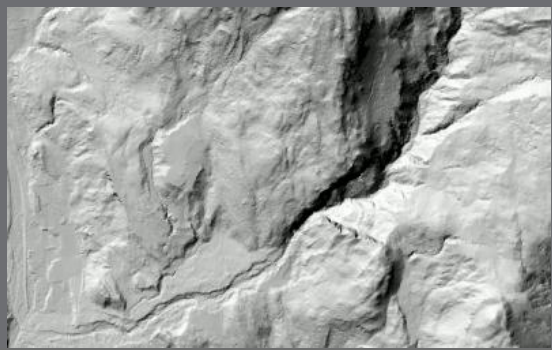
Funded Product

Fine-scale digital map of the county's vegetation types and their geographic distribution: The "base map"

- ~45 vegetation types
- Manual of California Vegetation classification system
- 1-acre minimum mapping unit
- Based on April 2011 aerial photography, 6-inch per pixel
- Delivery in 2015
- Cost: \$392K
- **Additional options**



Additional Options



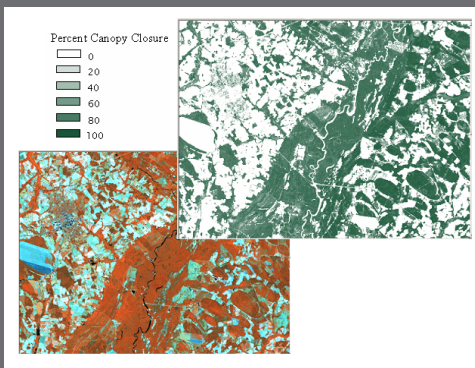
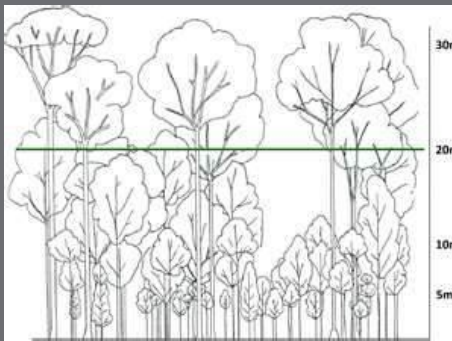
- LIDAR Acquisition Option (~\$800K)
 - Countywide LIDAR collect (competitive bid)
 - Increase vegetation and habitat map accuracy
 - Allow for more automated and accurate forest structure mapping
 - Allow for better biomass estimates and carbon inventories

Other uses: hydrologic modeling, slope/visibility analyses, infrastructure planning, and more...



Additional Options

- Forest Structure Option (\$52K)
 - Adds tree size and canopy closure
 - Enhances habitat assessment uses of map
 - Enhances map's usability for fuels and fire
 - Necessary for accurate biomass estimates and estimates of carbon sequestration



Other uses: habitat mapping, fire/fuel models, water quality analysis, carbon sequestration analysis, and more...

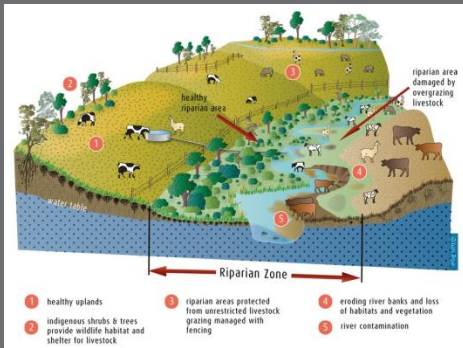


Additional Options

➤ Enhanced Classification Option (\$75K)

- Provides increased classification detail in certain geographies or within certain classes
- For example, riparian areas could be mapped using a more detailed classification than other areas

Other uses: land use planning, flood control planning/ channel management, climate change response planning, and more...



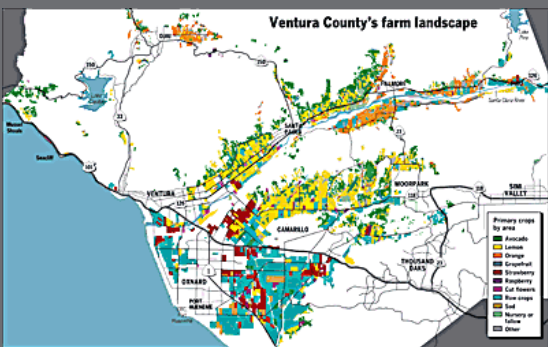


Additional Options

➤ Agriculture Detail Option (\$50K)

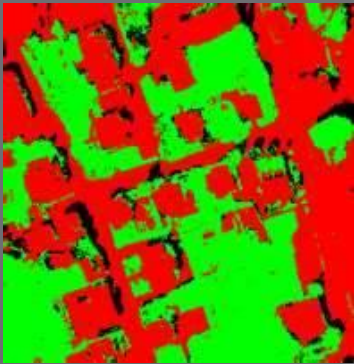
- Base map class “Agriculture” mapped in more detail
- Row crops, vineyards, tree crops mapped separately

Other uses: change detection in cover types, food production assessment, economic analyses, Environmental Impact Assessments, and more...





Additional Options



➤ Pervious/Impervious Surface Option (\$79K)

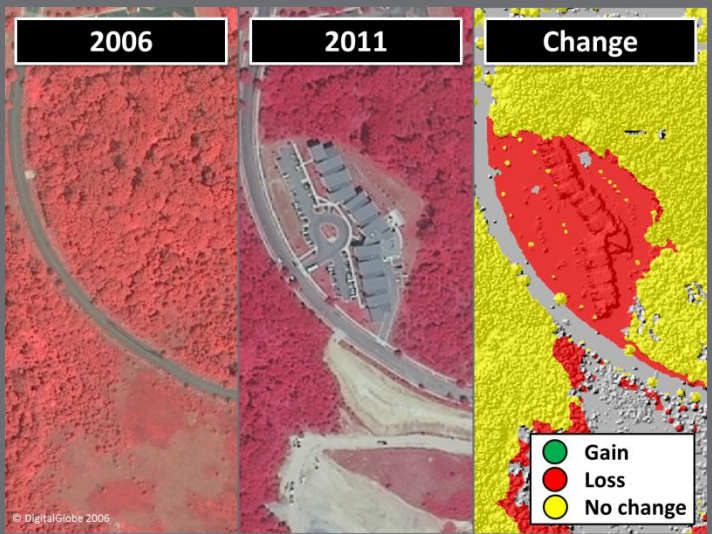
- Divides the “urban” base map class into “urban impervious” and “urban pervious”
- Useful for stormwater/TMDL modeling
- LIDAR data will improve the automation and accuracy of pervious/impervious mapping

Other uses: groundwater recharge modeling, land use planning Environmental Impact Assessments, and more...



Additional Options

- Change Detection Option (\$ TBD)
 - Provide the District and its partners with a protocol for mapping vegetation and habitat change across the county every three years





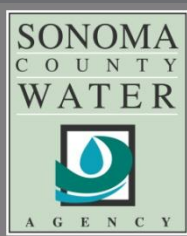
Options ↔ Adaptive Approach



- Adapt scope to:
 - Respond to funder and end user needs
 - Incorporate stakeholder and expert input
- Example: Addition of up front classification field work
 - Made possible by in-kind contribution by CDFW Biogeographic Division (covers significant portion of the overall cost)



Adaptive Approach



- Example:
- Growing list of partners:
 - California Department of Fish and Wildlife
 - Sonoma County Water Agency
 - Sonoma Land Trust
 - Environmental Systems Research Institute (ESRI)
 - University of California, Berkeley





Multiple Uses for Multiple Entities

Forests

Woodlands

Range

Riparian

**High-
resolution
topography**

Wetlands

**Impervious
surfaces**

**Above-ground
biomass**

Rare habitats

- Fire/fuels modeling and management (Fire agencies)
- Watershed planning (RCDs)
- Climate change response planning (Pepperwood Preserve, NBCAI, CPC)
- Land use planning (County/City planning departments)
- Hydrologic modeling (Water Agency, NOAA, Transportation, RCDs)
- Flood forecasting and stormwater modeling (Water Agency, PRMD, and Cities)
- Land and habitat conservation planning (RCDs, District, SLT)
- Wildlife corridor modeling (UC Cooperative Extension, District, PRMD)
- Natural resource management (UCCE)
- Public works infrastructure planning (Transportation departments)
- Habitat mitigation assessment (County/City planning and infrastructure depts.)
- Carbon/biomass inventory (Climate Protection Campaign)



- **Topics to Cover in 20 Minutes**
 1. **Introduction to the Vegetation Mapping and Remote Sensing Advisory Committee**
 2. **Mapping team introduction**
 3. **Overview of mapping approach and methods**



Sonoma County Vegetation and Habitat Mapping Program

Desired Result: “To make the best vegetation map that anyone has ever made”.

- Todd Keeler-Wolf, California Department of Fish & Game



1. Vegetation Mapping and Remote Sensing Advisory Committee

Committee Member	Affiliation
Dr. Matthew "Mateo" Clark	Sonoma State University
Charles Convis	ESRI
Michael Fitzgibbon	PRBO Conservation Science
Karen Gaffney	Open Space District
Kass Green	Kass Green & Associates
Dr. Todd Keeler-Wolf	CA Department of Fish & Game
Dr. Maggi Kelly	U.C. Berkeley
Jennifer Michaud	Prunuske Chatam, Inc.
John Nickerson	Climate Action Reserve
Carlos Ramirez	USDA Forest Service
Tom Robinson	Open Space District
Mark Rosenberg	Cal Fire
Joan Schwan	Prunuske Chatam, Inc.
Mark Tukman	Tukman Geospatial LLC



Purpose of the Advisory Committee

- Provide expert technical advice to the District to support development of an accurate and timely fine-scale vegetation and habitat map for Sonoma County.
- Serve as ambassadors for the project.



Committee Roles and Responsibilities

The Committee will provide expert advice on:

- Vegetation classification scheme and rules
- Field sampling design methods
- Field data capture methods
- Object oriented image classification
- Image classification/interpretation and use of LIDAR imagery
- Accuracy assessment



Advisory Committee Member:

Dr. Matthew “Mateo” Clark

Company/Organization/Role: Associate Professor,
Sonoma State University

Sonoma County Project Role(s): Vegetation and
Remote Sensing Advisory Committee

Expertise/Experience:

Remote sensing of land cover and forest properties;
multispectral, hyperspectral,
LIDAR and SAR; GIS analysis and modeling;

Landscape ecology and conservation



Mateo Clark



Advisory Committee Member: Charles Convis

Company/Organization/Role: Conservation Program Coordinator, ESRI

Sonoma County Project Role(s): Vegetation Mapping and Remote Sensing Advisory Committee

Expertise/Experience: Involved in vegetation mapping programs with CNPS and NPS. Upcoming *Conservation Planning* textbook. Expertise in web-based mapping and cartography for conservation (<http://www.conservationgis.org> & <http://ecp.maps.arcgis.com>).



Charles Convis



Advisory Committee Member: Karen Gaffney

Company/Organization/Role: Manager, Conservation Planning Program, Sonoma County Agricultural Preservation & Open Space District

Sonoma County Project Role(s): Program Manager, Technical Input, Funding Strategy

Expertise/Experience: Ecology, Riparian Ecosystems, Invasive Plants, Ecological Restoration, Watershed Assessment & Planning, Regional Integrated Planning



Karen Gaffney



Advisory Committee Member: Michael Fitzgibbon

Company/Organization/Role: Chief Technology Officer, PRBO Conservation Science

Sonoma County Project Role(s): Veg. Mapping and Remote Sensing Committee

Expertise/Experience: Web application development to deliver extensive geographic & database content at PRBO (CADDC). Core product development and custom application design and implementation at GIS software companies (ESRI, Autodesk, Geogroup).



Michael Fitzgibbon



Advisory Committee Member: Kass Green

Company/Organization/Role: President, Kass Green & Associates, subcontractor to Tukman Geospatial

Sonoma County Project Role(s): Vegetation Mapping and Remote Sensing Committee, Mapping Team, Program Development

Expertise/Experience: Remote sensing methods development, program management, accuracy assessment. Recent high resolution vegetation mapping projects: Grand Canyon Nat'l Park, Nat'l parks of Hawaii and American Samoa, benthic habitats of Texas, Horry County, S.C.



Kass Green



Advisory Committee Member: Dr. Todd Keeler-Wolf

Company/Organization/Role: Todd Keeler-Wolf, Senior Vegetation Ecologist, Vegetation Classification and Mapping Program, Biogeographic Data Branch, California Department of Fish and Wildlife

Sonoma County Project Role(s): Vegetation and Remote Sensing Advisory Committee

Expertise/Experience: Dr. Keeler-Wolf is an expert in classification and mapping of California vegetation, leads the vegetation program in CDFW, and has developed detailed vegetation maps and data driven classification systems for large areas of California. These products are used in various ways for resource and conservation assessment.



Advisory Committee Member: Dr. Maggi Kelly

Company/Organization/Role: Professor, UC Berkeley, Geospatial Innovation Facility

Sonoma County Project Role(s): Vegetation Mapping and Remote Sensing Committee

Expertise/Experience: Remote sensing, GIS, vegetation mapping, webGIS, environmental monitoring, participatory GIS. Director of the UC Berkeley Geospatial Innovation Facility (GIF).



Maggi Kelly

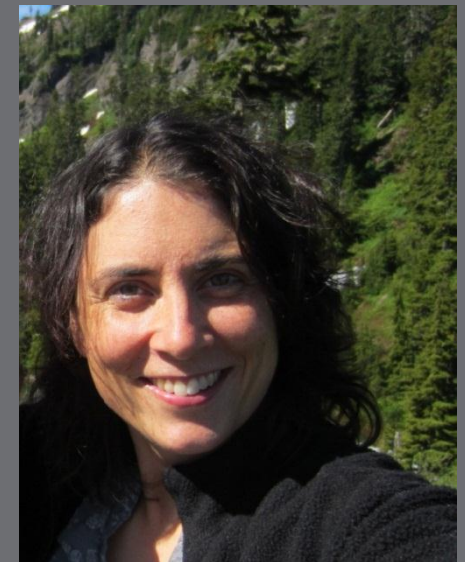


Advisory Committee Member: Jennifer Michaud

Company/Organization/Role: Wildlife Biologist,
Prunuske Chatham, Inc.

Sonoma County Project Role(s): Vegetation Mapping
and Remote Sensing Advisory Committee, local fish and
wildlife expertise

Expertise/Experience: Sonoma County-focused native
fish and wildlife research, monitoring, and restoration;
habitat assessment and management planning for
parks, including Taylor Mtn. and Sonoma Mtn., and for
watershed stewardship programs



Jennifer Michaud



Advisory Committee Member: John Nickerson

Company/Organization/Role: Director of Forestry Mexico Project, Climate Action Reserve and Senior Researcher/Project Developer with Spatial Informatics Group.

Sonoma County Project Role(s): Vegetation Mapping and Remote Sensing Committee

Expertise/Experience: Managed the stakeholder work group that developed the policies for the California compliance protocol and principal author of the same protocol now adopted by the State of California. Expertise in vegetation mapping, forest inventory, growth and yield analysis, forest valuation, carbon assessments, and landscape planning. Develops analytical tools to support inventory and carbon analysis. Currently working with an international stakeholder working group to identify policies for the develop of a forest carbon protocol in Mexico.



John Nickerson



Advisory Committee Member: Carlos Ramirez

Company/Organization/Role: Vegetation Mapping and Inventory Group Leader, USDA Forest Service Region 5 Remote Sensing Laboratory

Sonoma County Project Role(s): Vegetation and Remote Sensing Advisory Committee

Expertise/Experience: Coordinates the cooperative vegetation mapping and monitoring program between the USDA Forest Service and CAL FIRE. Expertise in vegetation mapping, forest inventory, remote sensing, and GIS.



Advisory Committee Member: Tom Robinson

Company/Organization/Role: Conservation Planner, SCAPOSD

Sonoma County Project Role(s): Project Manager

Expertise/Experience: Prioritization methods for open space acquisition and management; landscape ecology and GIS applications; analysis and mapping for local conservation and recreation plans.



Tom Robinson



Advisory Committee Member: Mark Rosenberg

Company/Organization/Role: Research Program Specialist, California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP), Sacramento CA.

Sonoma County Project Role(s): Vegetation and Remote Sensing Advisory Committee

Expertise/Experience: Coordinates the cooperative vegetation mapping and monitoring program between CAL FIRE and the USDA Forest Service. Expertise in vegetation mapping, forest inventory, remote sensing, GIS, habitat modeling and fire behavior. Develops analytical tools in support of forest and rangeland assessments, pre-fire planning, and renewable energy development.



Advisory Committee Member: Joan Schwan

Company/Organization/Role: Vegetation Ecologist, Prunuske Chatham, Inc.

Sonoma County Project Role(s): Vegetation Mapping and Remote Sensing Advisory Committee, classification development, identification of key vegetation types, landowner contacts, field work

Expertise/Experience: Sonoma County-focused native plant research, monitoring, and restoration; vegetation mapping and management planning for parks, including Taylor Mtn. and Sonoma Mtn., and for watershed stewardship programs



Joan Schwan

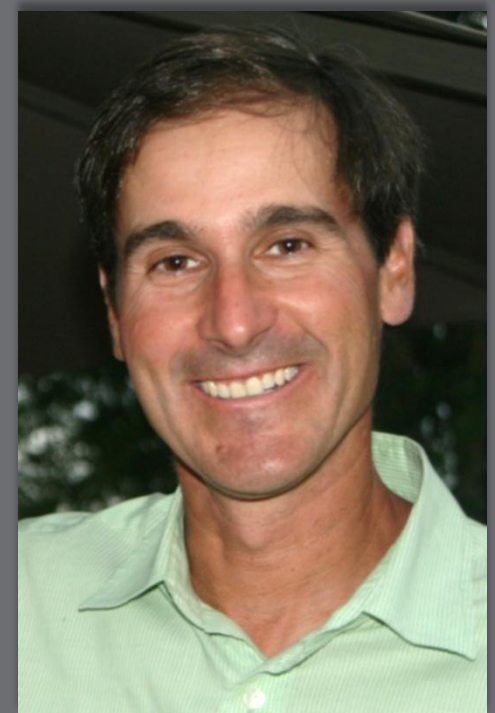


Advisory Committee Member: Mark Tukman

Company/Organization/Role: Principal,
Tukman Geospatial LLC

Sonoma County Project Role(s): Mapping
Team Manager, Technical Lead, Veg. Mapping
and Remote Sensing Committee

Expertise/Experience: Vegetation Mapping
and GIS. Large vegetation mapping projects
including Grand Canyon National Park,
numerous CA National Forests, and Horry
County, SC.



Mark Tukman



2. Mapping Team Introduction

Tukman Geospatial

- Started in 2004 Santa Rosa
- Team-based approach to projects
- Large area vegetation mapping project across the west
- GIS and Remote Sensing expertise
- Bring the latest mapping technology to our projects
- Vegetation mapping for many types of end-users



Mapping Team Introduction

- **Kass Green and Associates**
 - 25 years experience with remote sensing and vegetation mapping and research
 - Directions magazine recently deemed Ms. Green a “rock star of remote sensing”
- **Prunuske Chatham Inc.**
 - Environmental consulting firm based in Sebastopol
 - Years of experience working with the county’s ecosystems and agencies
- **Buena Vista Services LLC**
 - Forestry consulting firm founded in 2003
 - Principal Gene Forsburg brings great expertise in Sonoma County forest inventory and GIS mapping for public and private sector clients



3. Approach and Methods

- The Base Vegetation & Habitat Map is currently funded
- Addition Options will expand the detail and usefulness of the map – funding for these will be determined during the first year
- The work completed in the first year will create a foundation for the end product whether that end product is a complex classification with many Options funded, or the Base Vegetation and Habitat Map



Methods Overview – The Big Picture Tools

- Digital imagery and other geospatial data sets
- Computer algorithms that help us predict vegetation type based on the imagery and other data sets
- Field work
- Manual photo interpretation



How it Works

- Using imagery and other information to map vegetation is effective because
 - a high correlation often exists between variation in the imagery and other data, and
 - variation in the vegetation to be mapped
- Usually, when the landscape varies, the spectral response of the imagery and the classes of the other data also vary correspondingly.



Vegetation Mapping Requires

- Understanding variation on the ground as expressed in the *classification scheme*,
- Understanding variation in the imagery and other data,
- Linking variation in the imagery and other data to variation in the vegetation on the ground, and
- Exploiting those linkages to create vegetation and habitat maps.



1. Sonoma County Classification Schemes

- We will develop *Classification Schemes* to characterize the vegetation of Sonoma County.
 - Lifeform Classification, 20 or so classes
 - Final Mapping Classification – at least 45 classes
- The schemes will be developed to meet the needs of the County and will
 - Consist of both labels and rules (definitions) that are
 - Mutually exclusive
 - Totally exhaustive
 - Hierarchical
 - Include a minimum mapping unit



Lifeform Classes

- Coarse classification akin to cover type
- Classes include conifer forest, deciduous hardwood, chaparral shrub, grassland, agriculture, built up



Upland Grasses and Forbs



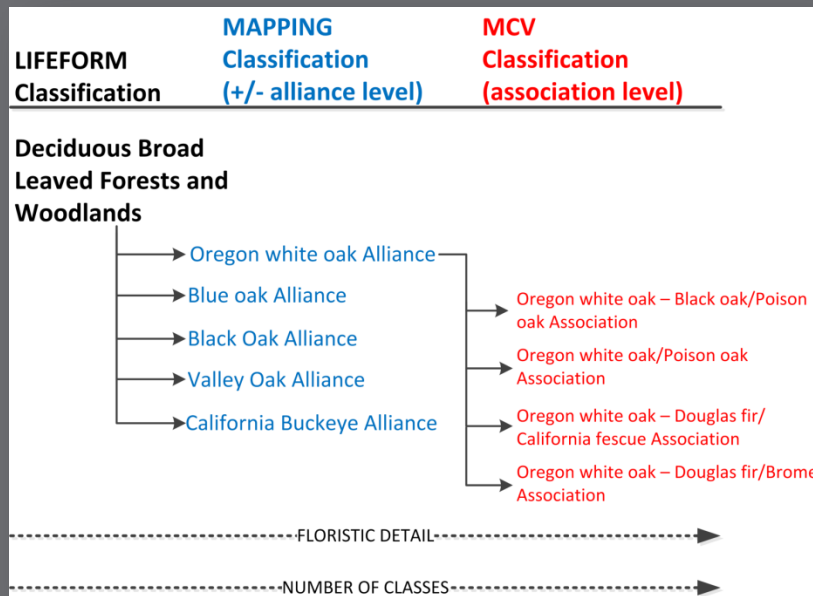
Deciduous Broad-Leaved Forests and Woodlands



Conifer Forests and Woodlands



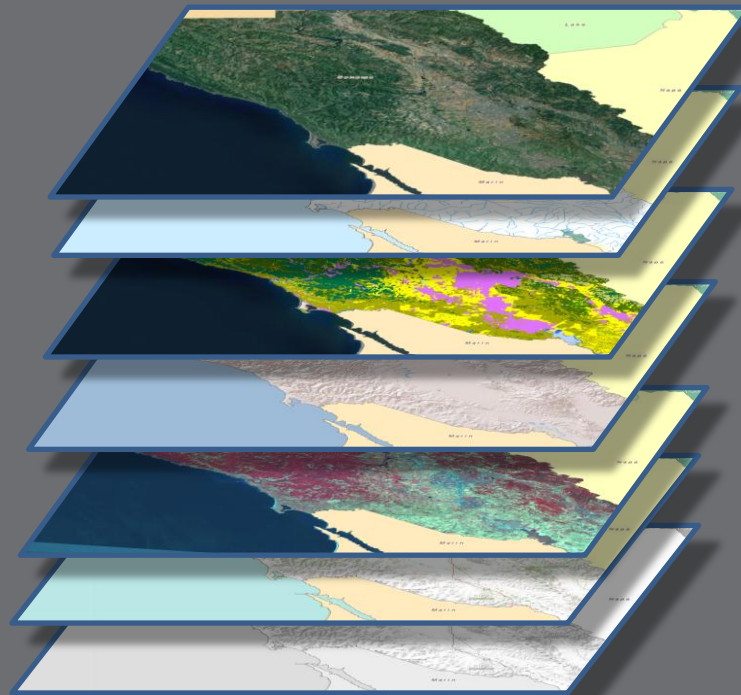
Final Mapping Classification



- Much more floristically detailed than lifeform; at least 45 map classes
- Fundraising efforts and stakeholder input over the next year will determine the final detail of classes, number of classes, types of classes, etc.



2. Acquire Imagery & Other Data



*High resolution
imagery*

Hydrology

*Historical Land Use
Maps*

Sun Illumination

Landsat Imagery

*Digital Elevation
Models*

Etc.



Imagery

- 2011 4-Band Imagery
NIR, R, G, B Bands
- 6-inch Resolution
- Some 3-inch areas in
Santa Rosa & Windsor
- Details and how to
access on the blog
<http://sonomavegmap.org/blog/>





3. Field Work

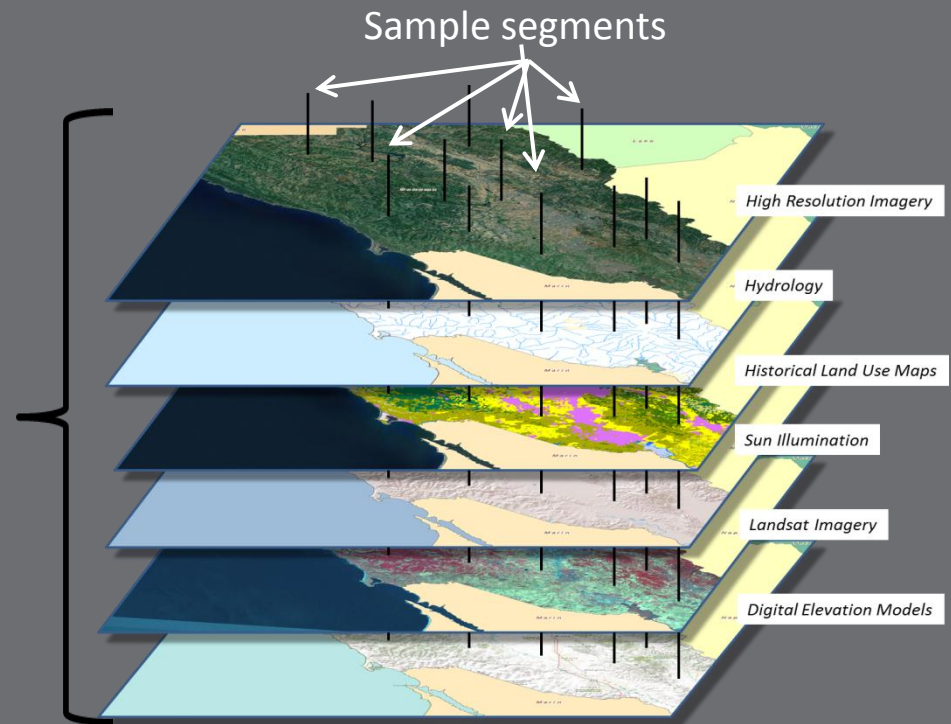


- Provides mapping team with an understanding of vegetation patterns on the ground
- Results in plot data that is used to “train” automated classifiers
- “Calibrates” mapping team’s eyes so that we can relate image signatures in the office to vegetation types on the ground



4. Creating Linkages

- Field samples are combined with imagery and other data layers and analyzed with computer software.
- The analysis produces rules for each vegetation type.
- The rules are then applied across the non-sampled areas.





5. Editing and Expert Review

- Manual editing required for acceptable map accuracy
- Editing is based on field work and photointerpretation
- After editing, final draft maps submitted to local vegetation experts for review
- Review will result in final round of map editing/modeling

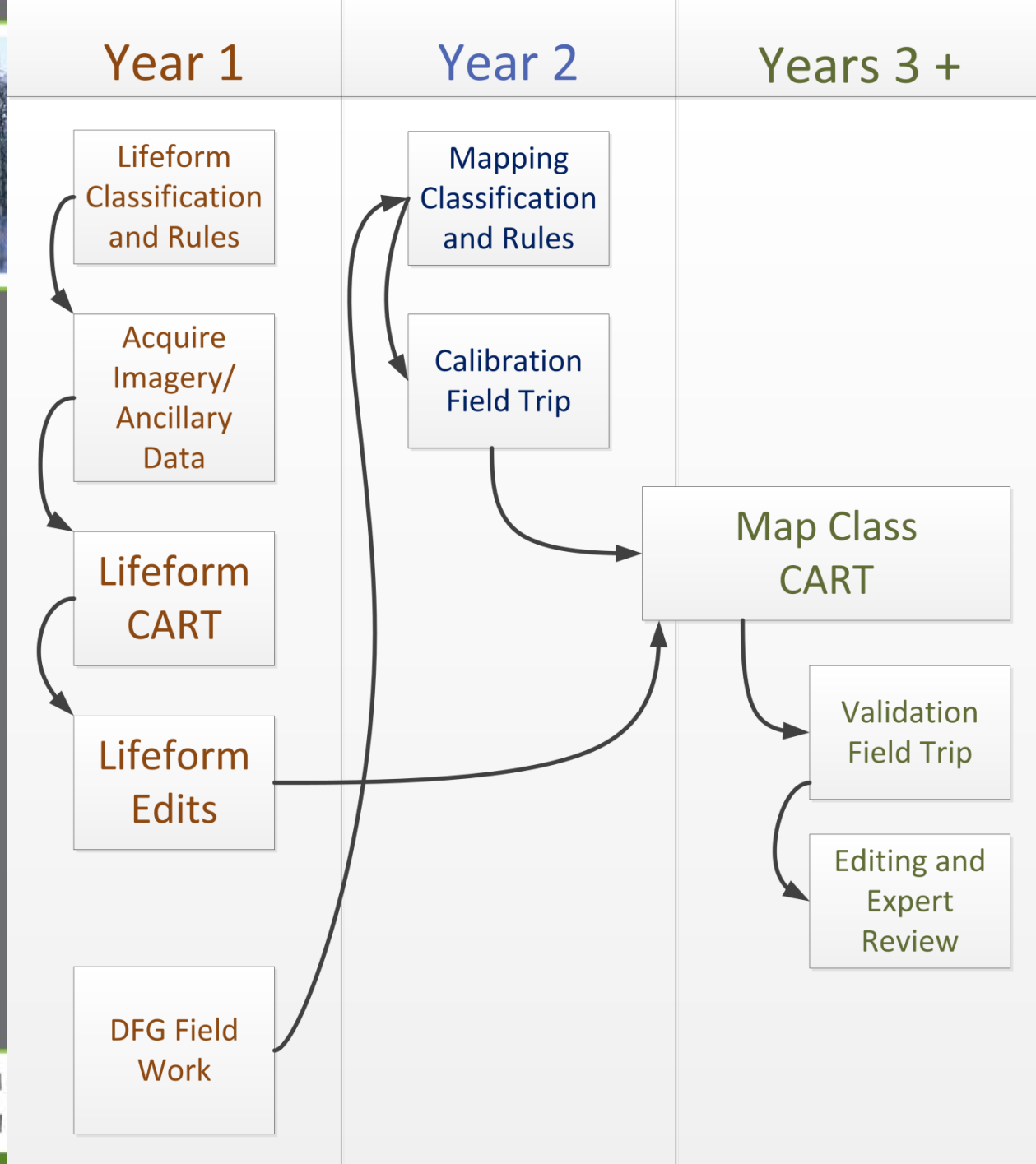


Final Products

- Classification Products
 - Lifeform classification and rules
 - Mapping classification and rules
- Map Products
 - ESRI Geodatabase with vegetation feature class
 - Spatial data linked to the NVCS Hierarchy via relationship class



Work Flow





Generalized Schedule

ID	Task Name	Start	Finish	2012					2013												2014											
				Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Technical Workplan Development	8/15/2012	1/15/2013	█																												
2	Fundraising	8/15/2012	11/15/2013	█																												
3	MCV Field Work - DFG	3/15/2013	11/15/2013						█																							
4	Lifeform Mapping	1/15/2013	11/15/2013						█																							
5	Map Options Chosen, Classification Finalized	11/15/2013	11/15/2013													◆																
6	Mapping Field Work – Tukman Team	12/2/2013	9/1/2014													█																
7	Mapping to Funded Level of Detail	9/15/2014	12/15/2015																									█				

Map Options Chosen, Mapping Classification Established



Interest in any of these areas?

End Uses

Calculations and Analysis, planning and implementation

Funding

Base map or options

Vegetation Ecology, Botany, and Habitats

Vegetation class descriptions, sources of information, accessible field sites

Public Engagement

Education, citizen science, raising awareness, photography, crowd-sourcing technology

Getting Involved

Contact Tom Robinson at

tom.robinson@sonoma-county.org



Committees and Groups

Funding Partners/ End User s

- Funding and end user needs drive scope toward new data and greater specificity

Vegetation Mapping and Remote Sensing Advisory Group

- Expert-level guidance on mapping and remote sensing aspects ensures quality and efficiency
- Access to cutting-edge technology solutions

Local Ecology and Botany Group

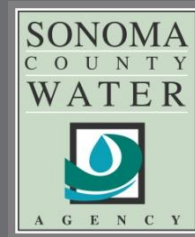
- Provides data and information on veg class descriptions to ensure a localized map
- Advise on community engagement (e.g., citizen science, education)

All Stakeholders

- Collect data points and contribute supporting material
- Implement and engage in education opportunities



Thank you to the program's supporters



Read our blog at www.sonomavegmap.com

Contact: Tom Robinson | tom.robinson@sonoma-county.org

Mark Tukman | mark@tukmangeospatial.com