STATEWIDE TREECROP MAPPING OF DRIED PLUMS

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INTRODUCTION

As part of a joint project by the Almond Board of California (ABC), the California Walnut Board (CWB), the California Pistachio Research Board (CPRB), and the California Dried Plum Board (CDPB), Land IQ was contracted to map the four respective tree crops on an orchard by orchard basis. This work established an accurate and comprehensive base layer for each tree crop throughout the state of California for the 2014 cropping year. Accuracies are in excess of 95 percent for all tree crops. Young orchards (<3-4 years depending on tree type) are classified separately and acreages estimated based on distribution determined through ground truthing efforts.

This report documents the dried plum results for the state of California as a requirement for research funds. Age estimation on an orchard by orchard basis was determined for almonds, walnuts, and pistachios through additional remote sensing analysis. Dried plum age analysis was not a part of this initial effort, however may be completed at the request of the CDPB. Applications of these base layer mapping results are numerous. Examples include: biomass estimations, regulatory support including Irrigated Lands Regulatory Program (ILRP) and Sustainable Groundwater Management Act (SGMA), crop production estimates, market analyses, crop forecasts, various spatial analyses, environmental impacts, etc.

OBJECTIVE

The primary objective of this project was to produce a statewide spatial database of dried plums with accuracies exceeding 95% (on an acreage basis) using remote sensing, statistical, and temporal analysis methods. This database provides timely, consistent, and comprehensive information on the location, extent, and acreage of dried plum orchards throughout the state of California for a baseline year of 2014. The approach utilized to produce this baseline database lay the groundwork for less intensive updating of the spatial database in subsequent years.

SUMMARY

Accurate and current information on constantly changing acreage and location of crops is critical for environmental, market, and production applications. Growers and commodity groups need to understand the impacts of land use, crop location, crop change, acreage, tree age and best management practices on environmental attributes and impacts such as water quality, air quality, disease, and/or pest vectors. Conversely, environmental factors, such as climate change and sensitive habitats, increasingly influence how much and where these crops are grown. For these purposes, as well as many others, a spatial mapping base layer is integral for effective decision-making and other applications.

In response to this need for information, this project was undertaken to develop an accurate spatial database of almonds, walnuts, pistachios, and dried plums for the 2014 growing season throughout the state of California. Results indicate that accuracies exceeding 95% have been achieved in a timely and cost-effective manner using our remote sensing crop mapping methodology in combination with agronomic knowledge, ground truth data, and an overall comprehensive orchard-by-orchard approach.

For the purposes of this report for the CDPB, the result is a consistent and comprehensive database of the dried plum crop for 2014. This has not been achieved by previous efforts that relied on grower surveys or staggered mapping of regional and/or individual county areas.

Significantly, this project paves the way for cost-effective updates of the inventory over time using focused remote sensing change analysis methods. Recommendations are that a now more simplistic update of the database occur on an annual or every 1-2 year basis. Updates will identify changes in the dried plum crop acreages and locations. In addition, the acreage of tree and vine crops (currently classified as young tree and vine) younger than 3-4 years will be distinguished more thoroughly and current estimates by crop type refined. Ultimately, this will allow for the accurate identification of both mature (older than 3-4 years) and young (less than 3-4 years) trees.

APPROACH

Data specifically developed, enhanced, or used by Land IQ for the mapping project included:

- Integration of agronomic/crop production knowledge
- Detailed ground truth information
- Analysis of multiple image resources

This analysis was conducted at the field scale (Figure 1). Individual fields (not parcels, but rather homogeneous crop types representing true irrigated area) for permanent crops statewide (Figure 2) were used so that each independent management unit could be analyzed independently and assigned to a crop class. The result represents the true irrigated area and not legal or other, less detailed boundaries that may be available elsewhere.

Ground truth data was collected during the 2014 growing season in the field for use in the mapping analysis and also to provide an independent dataset for accuracy comparisons (Figure 3). Approximately 8-12% of all irrigated land in the state was collected. Ground truth data collected during 2012 and 2015 were also integrated into the analysis.

In addition, field data collected in 2012 was verified against the 2014 imagery and used as additional ground truth where needed to fill gaps. The ground truth data was divided randomly into training versus validation data sets. The validation sites were set aside to assess the accuracy of the resulting mapping product.

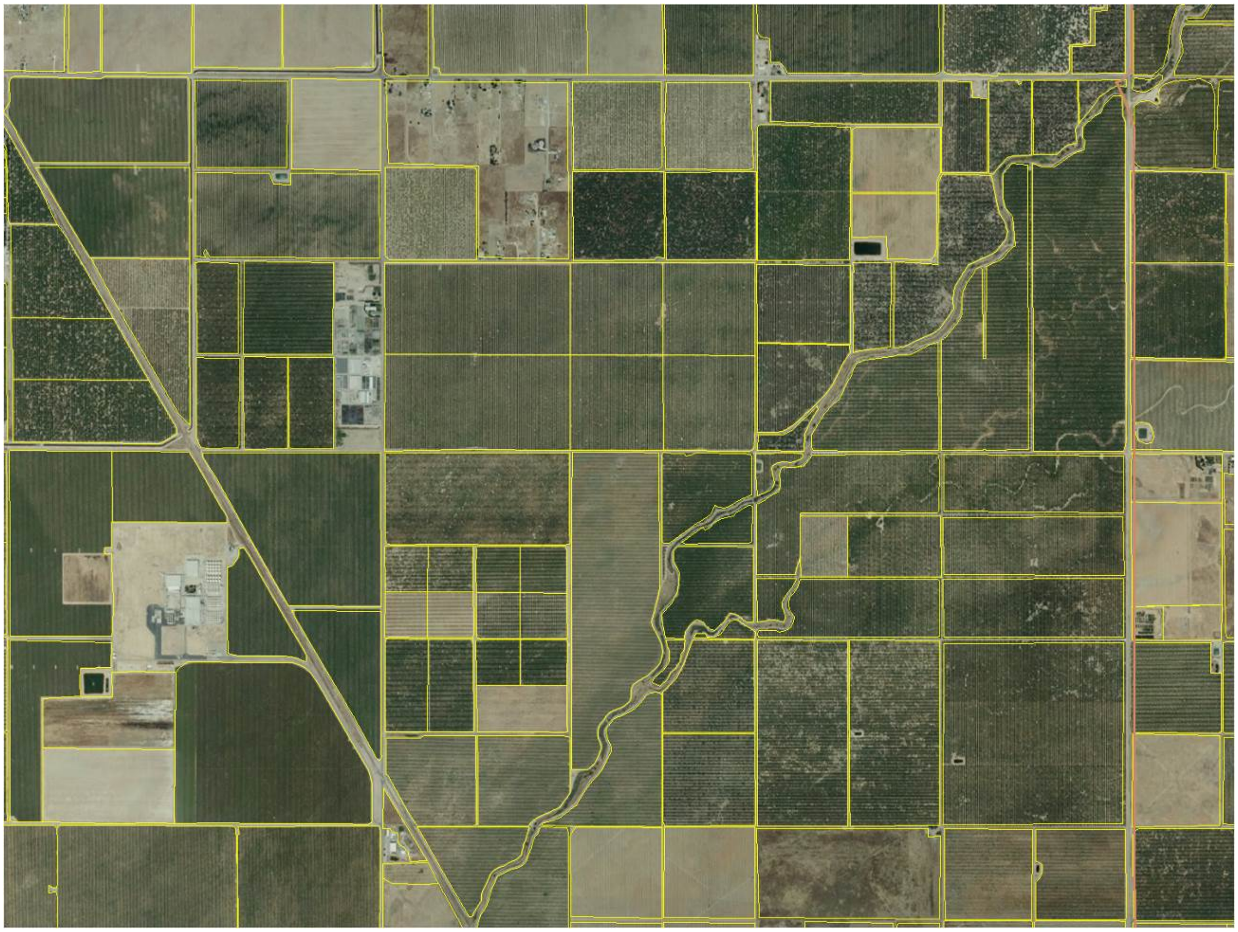

Figure 1. Example of field boundaries.

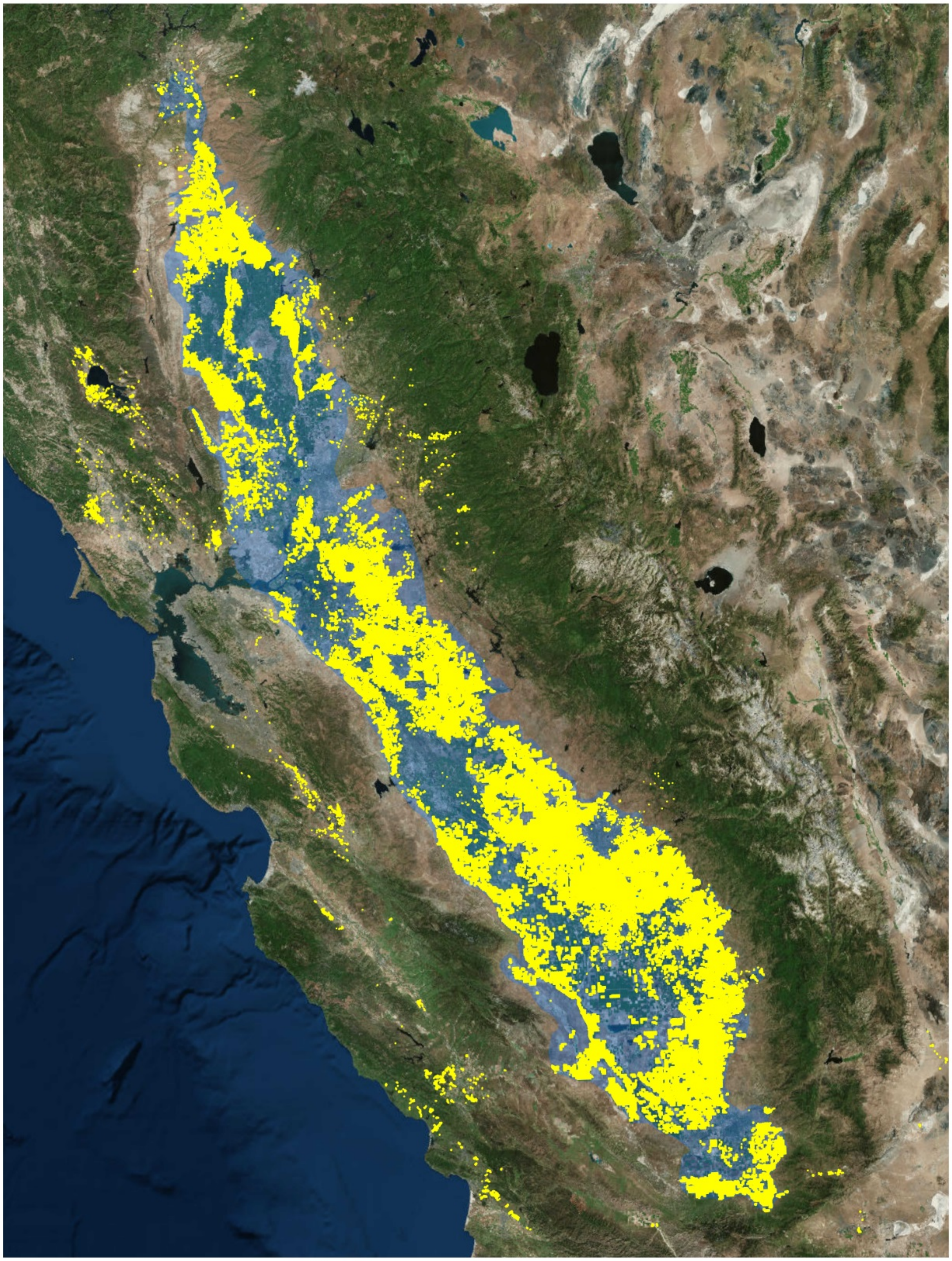

Figure 2. Example of permanent crop fields for the entire state.

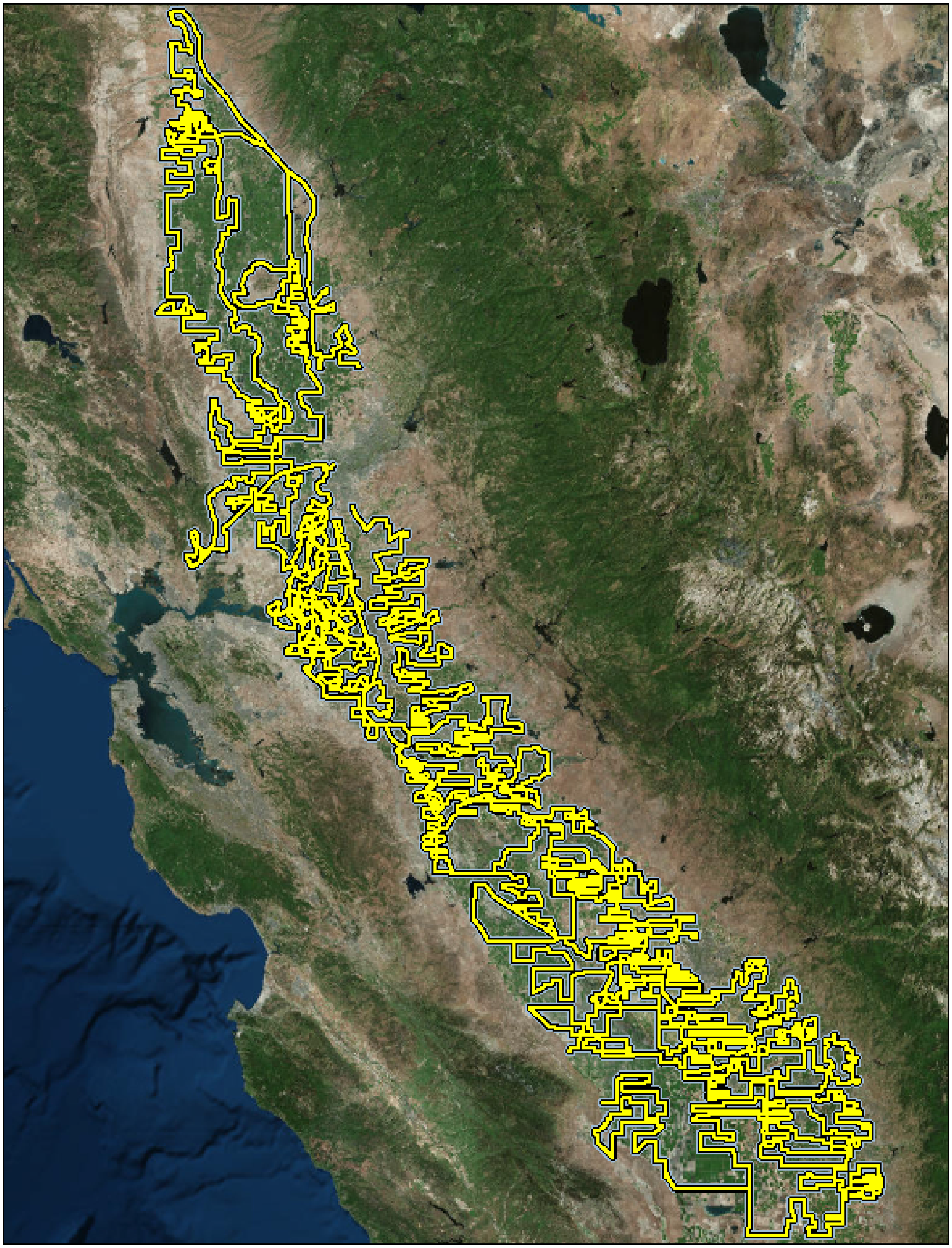

Figure 3. Example of Central Valley ground truth data collection route map.

Counties mapped include the following:

- Butte
- Calaveras
- Colusa
- Contra Costa
- Fresno
- Glenn
- Kern
- Kings
- Lake
- Madera
- Merced
- Placer
- Sacramento
- San Joaquin
- San Luis Obispo
- Shasta
- Solano
- Stanislaus
- Sutter
- Tehama
- Tulare
- Yolo
- Yuba

The remotely sensed crop mapping methodology utilized for this project involved analysis of multiple image sources that encompass a range of spectral characteristics, spatial resolutions, and temporal representation of the crops of interest. These methods were derived from and guided by our understanding of agricultural systems, landscape processes, production systems, and crop phenology.

Multiple sources of imagery were assembled to serve as input, to the remote sensing classification process. As a result of this process, each field was assigned a crop class label. As a quality check, fields with low classification probabilities were inspected and evaluated against the 2014 high resolution imagery. When an error was identified, based on trained expert photo-interpretation, the class label was corrected.

Although not conducted for dried plums at this time, an automated process was developed and implemented for age analysis to evaluate imagery from multiple years to determine when each field was initially planted (as far back as 1984). By subtracting the planting date from the 2014 baseline map date, an estimated age will be assigned to each field analyzed.

RESULTS AND APPLICATIONS

Classification of almonds, walnuts, pistachios, and dried plums was conducted jointly and has been completed for the 2014 growing year. Only results for dried plums are presented here. Completion of this dataset occurred during the third quarter of 2015. It is expected that updates to this dataset for future years can be completed within the same growing year or early during the first quarter of the following year. For example, 2016 update mapping results should be expected by around December of 2016.

There were 51,906 acres of dried plums older than 2-3 years mapped on an orchard by orchard basis in 2014. An additional 1,000-2,000 acres are estimated to be contained within the current young orchard category. This amounts to a total of approximately 53,000 to 54,000 acres of dried plums in the state. The mapping accuracy for dried plums was 95.2 percent. It should be noted that this accuracy represents correctly identifying an individual orchard (regardless of size). Generally, smaller orchards (<5 acres) were more difficult to classify correctly and prediction of larger orchards was more accurate. Therefore, on an acreage basis, the actual accuracy is somewhat higher than the reported 95.2%.

Now that the statewide mapping is complete, spatial results can be developed and shown in a variety of different ways (Figures 4, 5, and 6) through either GIS or web mapping applications.

Applications of these base layer mapping results are numerous. Examples include:

- Water use estimations and analyses – Understanding true irrigated acreage removes or greatly reduces variability of erroneous estimates. When acreage is accurately known, including location and age, estimating crop consumptive use with both empirical and remotely sensed methods can be conducted with more certainty and less error.
- Regulatory support including Irrigated Lands Regulatory Program (ILRP) and Sustainable Groundwater Management Act (SGMA) – It is critical that common base data are used during regulatory compliance and monitoring. These base layer data offer an opportunity for unification of land use classification throughout the Central Valley.
- Biomass estimations – Although age analysis for dried plums was not conducted, it can be completed fairly easily. The resultant data classifies each individual orchard into an age category and a correlation to biomass accumulation can be conducted.
- Proximity analyses – A variety of proximity analyses can be conducted comparing the base layer crop distribution to other publically available data resources. These may include other crop types, hydrologic systems, watersheds, sensitive environments, etc.
- Crop production estimates – Different regions of the state are known to have different yield potentials. With a unique base layer dataset comprised over the entire Central Valley for one year, a more accurate crop production estimate can be forecasted.
- Market analyses – Age determination, location, crop density, and comparison to soil type, available water resources, etc. are all key information that can be used to better determine potential crop volume as well as
- Other spatial and trend analyses – These analyses could include location change evaluations, tree density analysis, vegetative cover analysis, irrigation method relationships, etc.

- Environmental impact analyses – These analyses could include impacts of climate change, chilling hour analyses, pest infestations/management, etc.

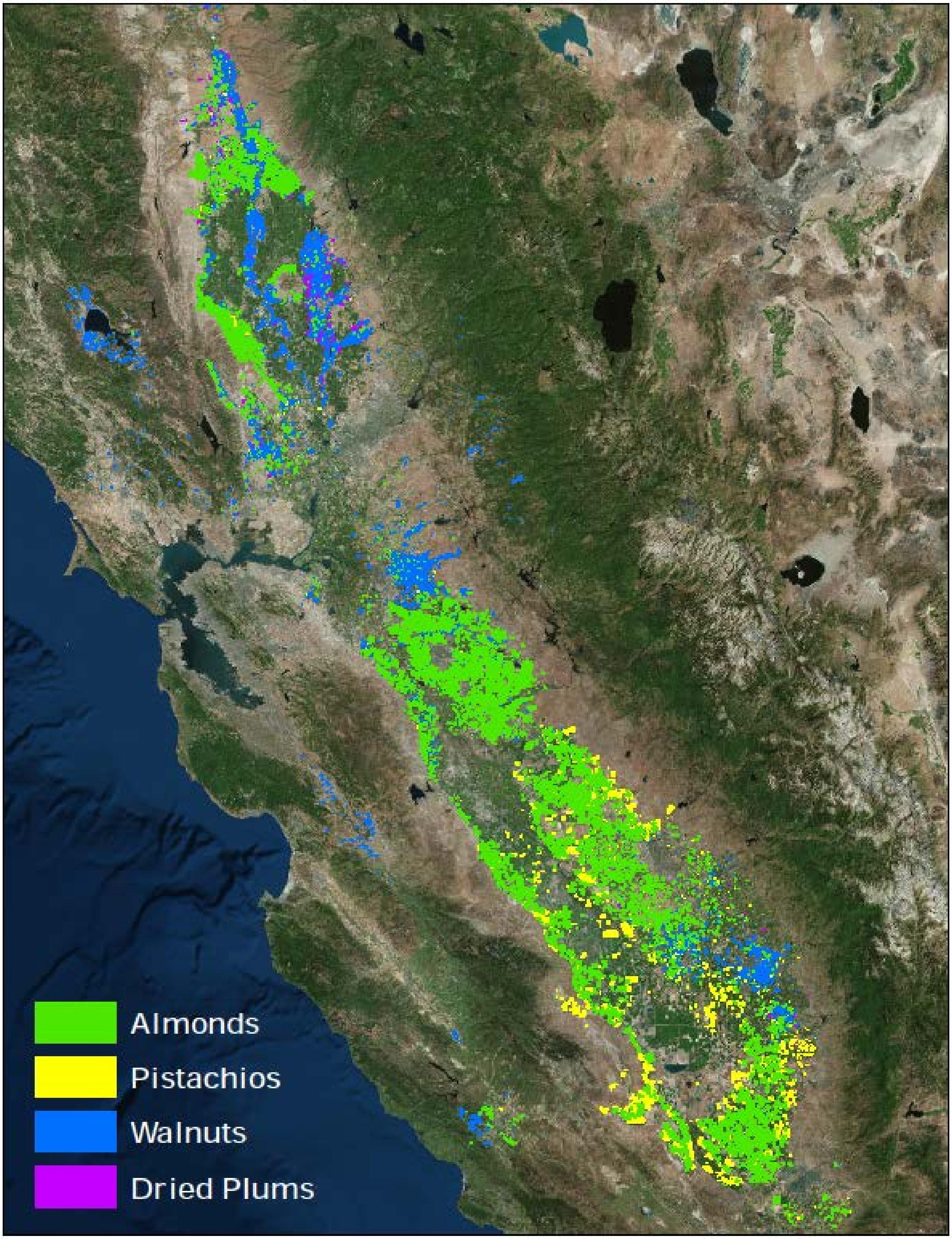

Figure 4. Statewide spatial distribution of almonds, walnuts, pistachios, and dried plums.

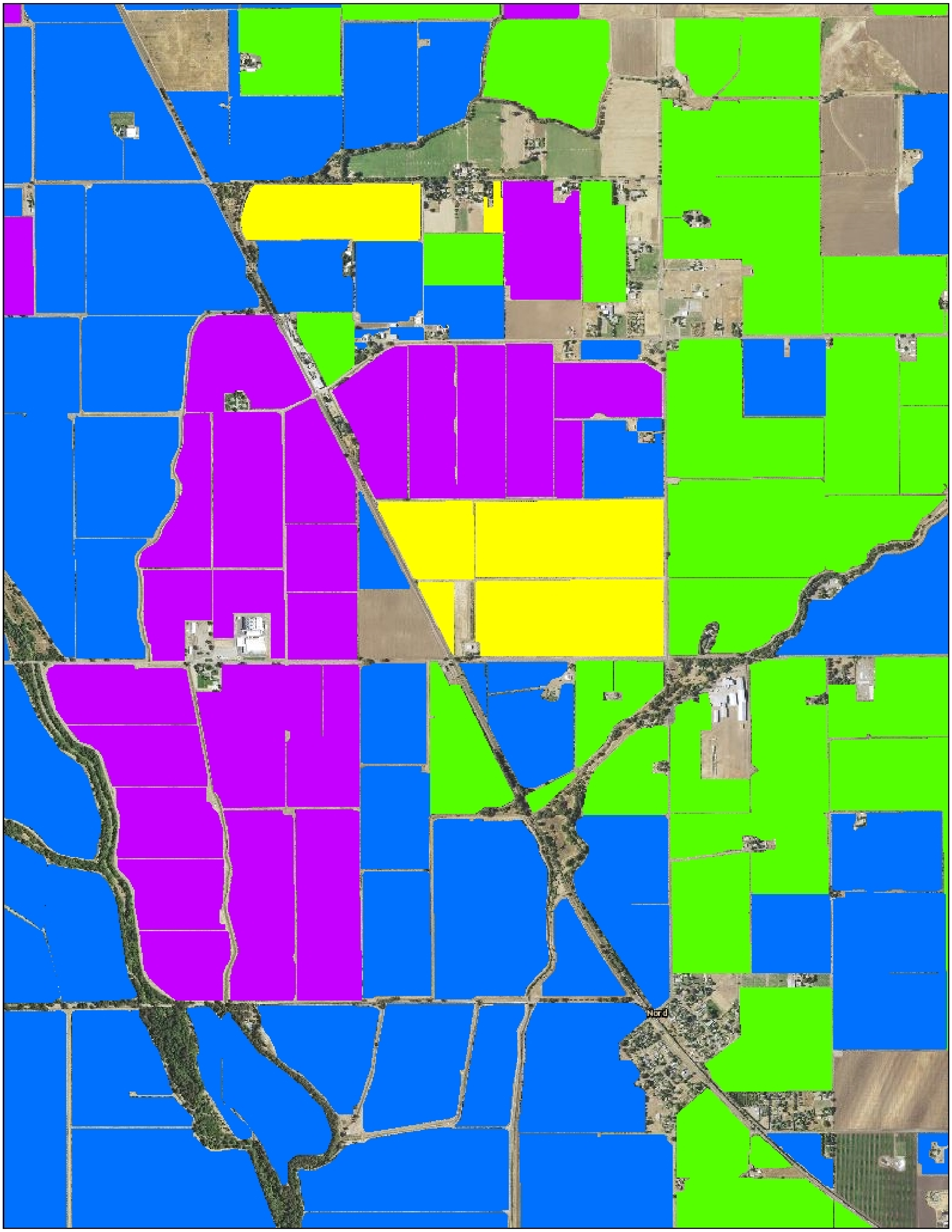

Figure 5. Example of individual mapped orchards for all four tree crops (almonds=green, walnuts=blue, pistachios=yellow, dried plums=purple)

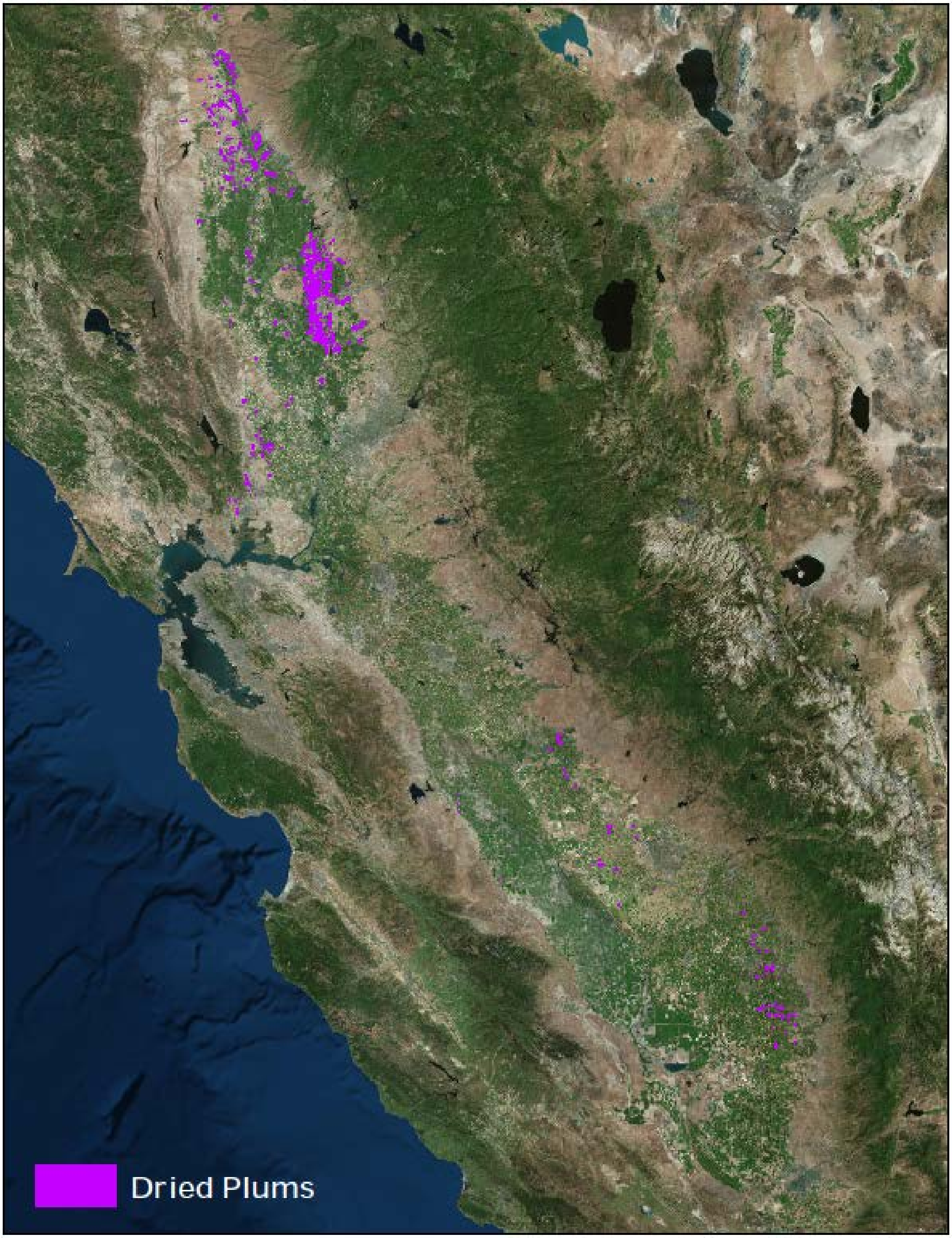

Figure 6. Statewide spatial distribution of dried plums.