FROM FIELD TO PORT

A Transportation Network Analysis of Central Valley, California Nut Production

INTRODUCTION

California exports a majority of its almonds, walnuts, and pistachios—foreign sales which dwarf those of all other agricultural products and generate billions of dollars in annual revenue for the state (California Department of Food and Agriculture, 2017). These nut producers, however, are largely located in the state's Central Valley. The farm sector must thus have direct access to an infrastructure that can transport their products to seaports and connect them to their foreign buyers. As demonstrated in 2015 when labor disputes delayed the movement of freight and cost overseas business, the agricultural sector already operates on a fine margin (Young, 2015). Moreover, given current trade turmoil in international markets, which has led nations like China and India to place retaliatory tariffs on U.S. tree nuts, producers are working to minimize costs as much as possible and are considering their options for expanding to new markets (International Nut and Dried Fruit Council, 2019). Decision-makers in California ultimately need to know what local obstacles this industry face as they try to develop their markets and transport products to buyers around the world.

In an effort to begin to understand the supply chain that local farmers must navigate, this project asks**, how reliable is the transportation network on which the almond, walnut, and pistachio producers of California's Central Valley depend to ship their crops to exporters?**

Answering this question requires evaluating driving distances and the accessibility of highway routes connecting different nut crops to the state's major seaports. This network assessment will help clarify how much cropland falls within specific service areas of a port and allow for further extrapolation about the time, costs, and environmental impact of shipping almonds, walnuts, and pistachios overseas.

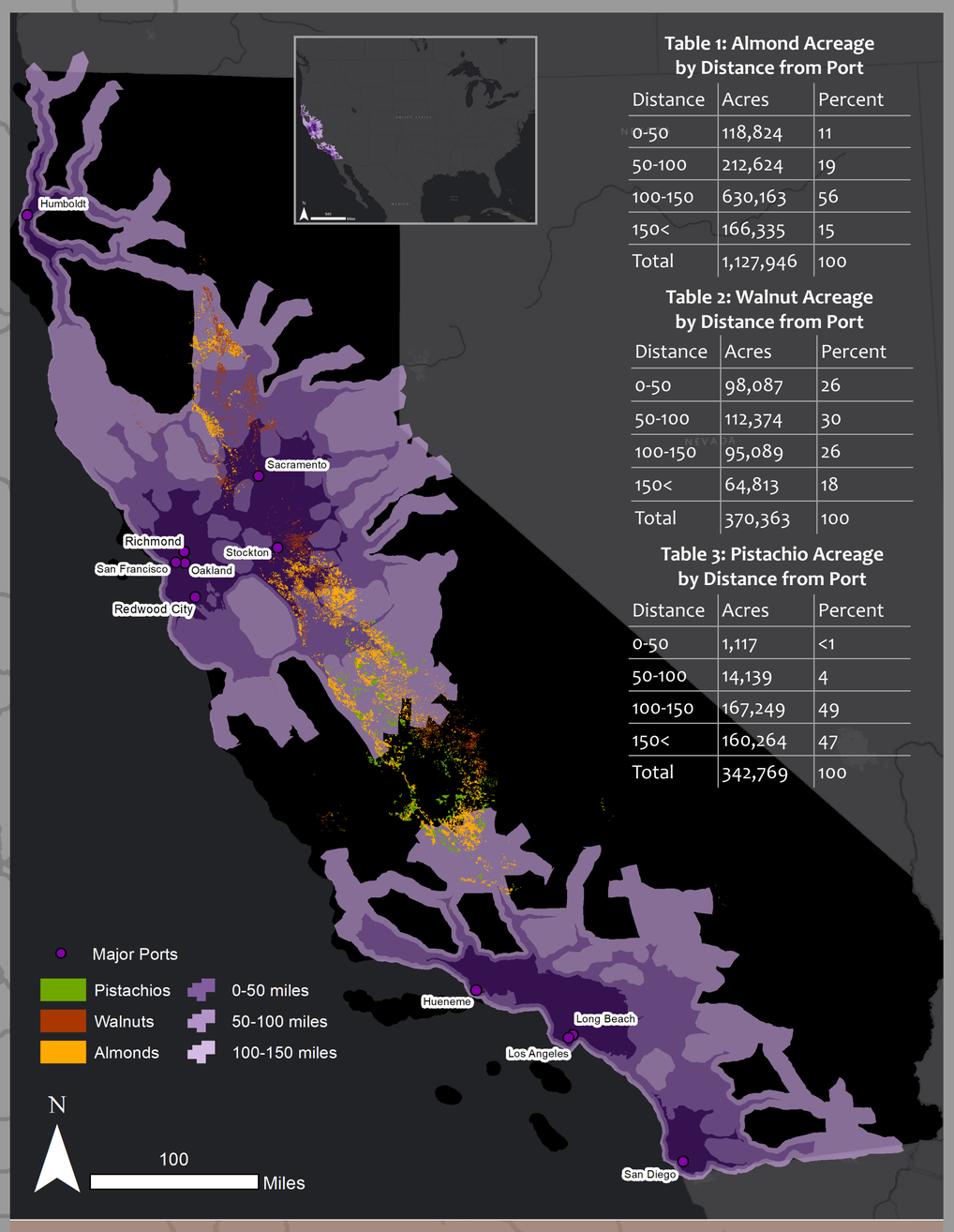

Figure 1: Statewide Seaport Service Areas for Almond, Walnut, & Pistachio Cropping

Table 1: Almond Acreage by Distance from Port

Distance	Acres	Percent
0-50	118,824	11
50-100	212,624	19
100-150	630,163	56
150<	166,335	15
Total	1,127,946	100

Table 2: Walnut Acreage by Distance from Port

Distance	Acres	Percent
0-50	98,087	26
50-100	112,374	30
100-150	95,089	26
150<	64,813	18
Total	370,363	100

Table 3: Pistachio Acreage by Distance from Port

Distance	Acres	Percent
0-50	1,117	<1
50-100	14,139	4
100-150	167,249	49
150<	160,264	47
Total	342,769	100

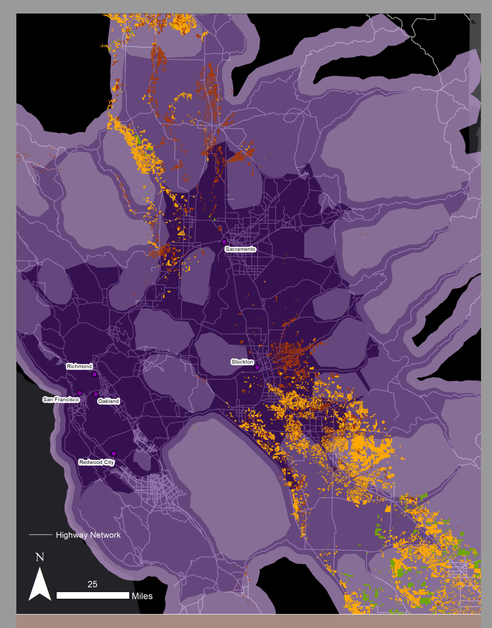

Figure 2: Northern California Seaport Service Areas for Almond, Walnut, & Pistachio Cropping

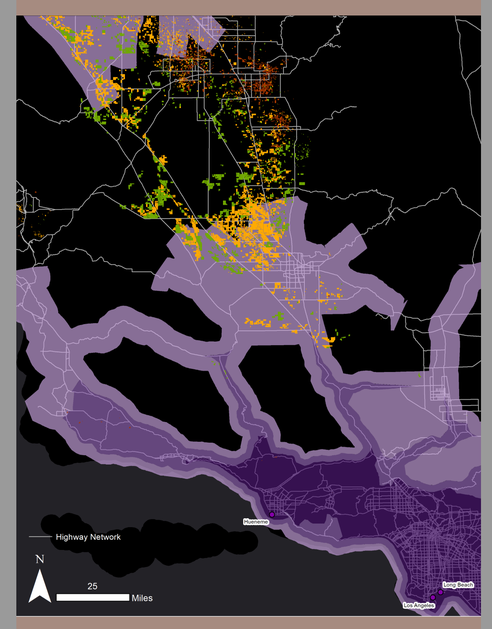

Figure 3: Southern California Seaport Service Areas for Almond, Walnut, & Pistachio Cropping

METHODOLOGY

Using the spatial software ArcMap 10.7.1, the principal investigation of this project focused on the *network analyst* extension to measure driving distances from California's 11 major seaports along truck-accessible highways.

The national highway planning network was first selected for the state of California then applied to create a new network dataset. Next, the port facilities were input to a new service area, which was run on the new network to generate polygon breaks at 50, 100, and 150 miles.

After isolating the almond, walnut, and pistachio polygons from the California cropping data, a spatial join on the intersection of the service area polygons and the cropping polygons combined these results. Summary tools subsequently allowed further analysis to determine what percentage of almond, walnut, and pistachio cropland is served by a port.

The final output, as seen here, features the state's major ports, their combined service areas, the highway planning network, and the statewide distribution of all farmland growing almonds, walnuts, and pistachios.

RESULTS

This spatial analysis demonstrates that pistachio crops must travel significantly further to reach a port. Roughly 96% of pistachio acres are more than 100 miles from a port and about half of those acres are further than 150 miles. In contrast, walnuts have the greatest proportion of acres (56%) which are less than 100 miles from a port. Notably, the smallest proportion of almonds must travel more than 150 miles, yet the state grows so many more almonds than pistachios or walnuts that this crop tops the other two by acreage in each service area. The more centrally located ports also prove more able to serve Central Valley farmers, and ports like San Diego, Humboldt, and even Los Angeles are distinctly removed from nut production.

DISCUSSION

INTERPRETATION: The ports in Sacramento and Stockton, which are connected via deep water channels, have a clear capacity to serve much of the state's almond and walnut production. Oakland, however, is notably a much busier port for agricultural exports, which raises questions as to whether nut crops are traveling further by highway to reach ports with better infrastructure (USDA Agricultural Marketing Service, 2017). Similarly, Los Angeles and Long Beach are two of the busiest agricultural ports in the country, which would suggest a trucking and logistics infrastructure exists that allows a significant portion of farm products to travel from outside these service areas (more than 150 miles). To this point, much of the state's pistachio crops fall in the middle of the Northern and Southern regions. As California prepares to spend millions on projects to mitigate freight congestion, stakeholders should ask which ports can best serve producers and whether opportunities exist to better connect them to exporters (Lamb, 2018).

LIMITATIONS: Nut products need to travel to processing facilities before entering the market. Time and data limitations, however, meant that this project did not include these locations in the analysis. Developing a more detailed spatial overview of the supply chain would thus better serve questions about how nut products are shipped to exporters.

FURTHER ANALYSIS: Considerations like traffic volume, freight lanes, and time/cost calculations per mile could contribute new data points for further visualizing which shipping routes prove most efficient. Moreover, California has begun to aggressively pursue a zero emissions agenda; thus, given the importance of almond, walnut, and pistachio exports, this project opens a path to further study the impact of these industries and how to begin to reduce their emissions (Cart, 2019).

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Projection: NAD83 California Teale Albers (2011)
Data Sources: California Department of Water Resources (2014), California Department of Fish and Game (2014), U.S. Department of Transportation (2019), ESRI (2019)
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