El Dorado County
West Slope Agricultural Development Feasibility Assessment

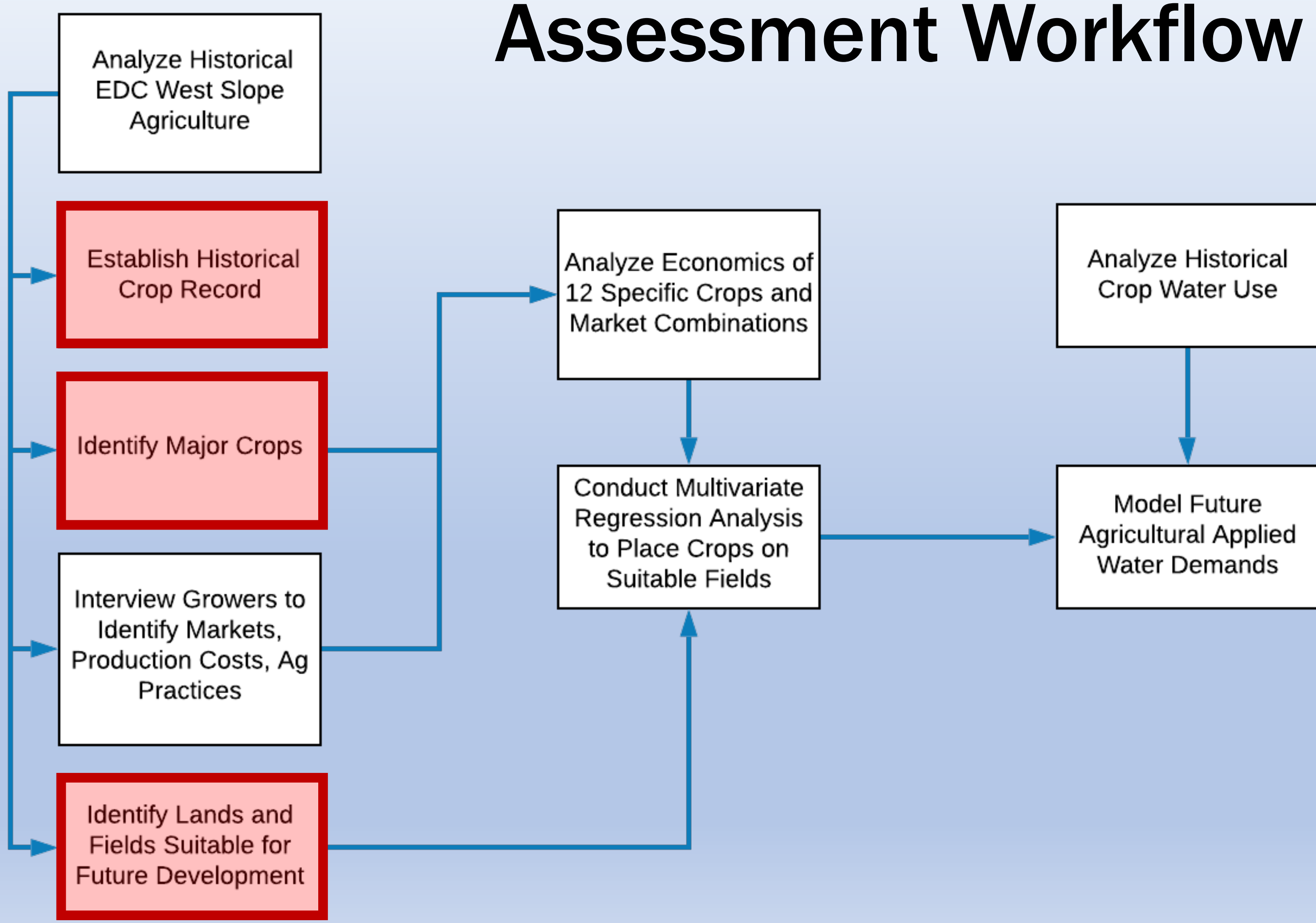
Project Summary Presentation to the

El Dorado County Agricultural Commission

Board of Supervisors Meeting Room

November 13, 2019, 6:00 p.m.
Placerville, CA

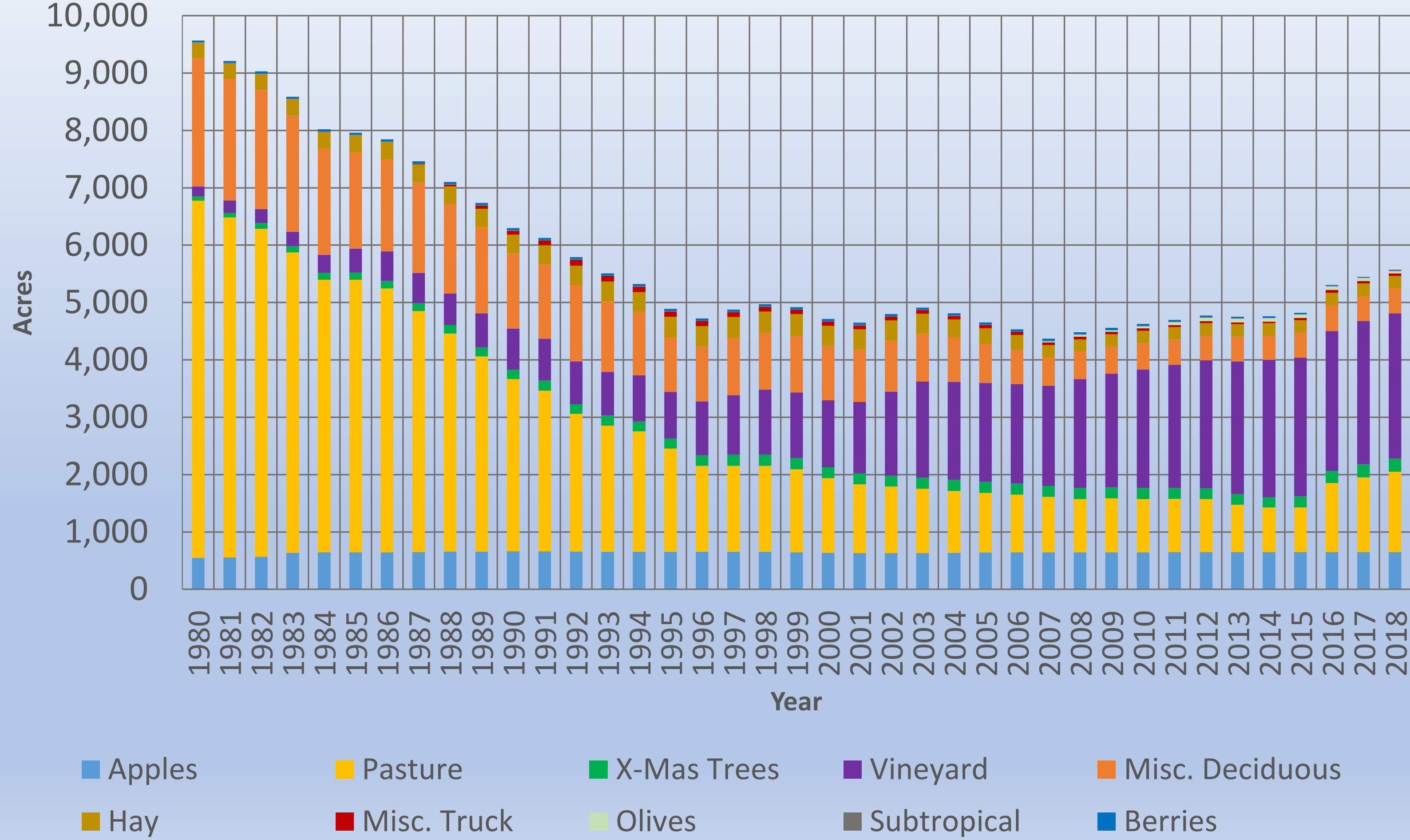
Ag Development Feasibility Assessment Workflow



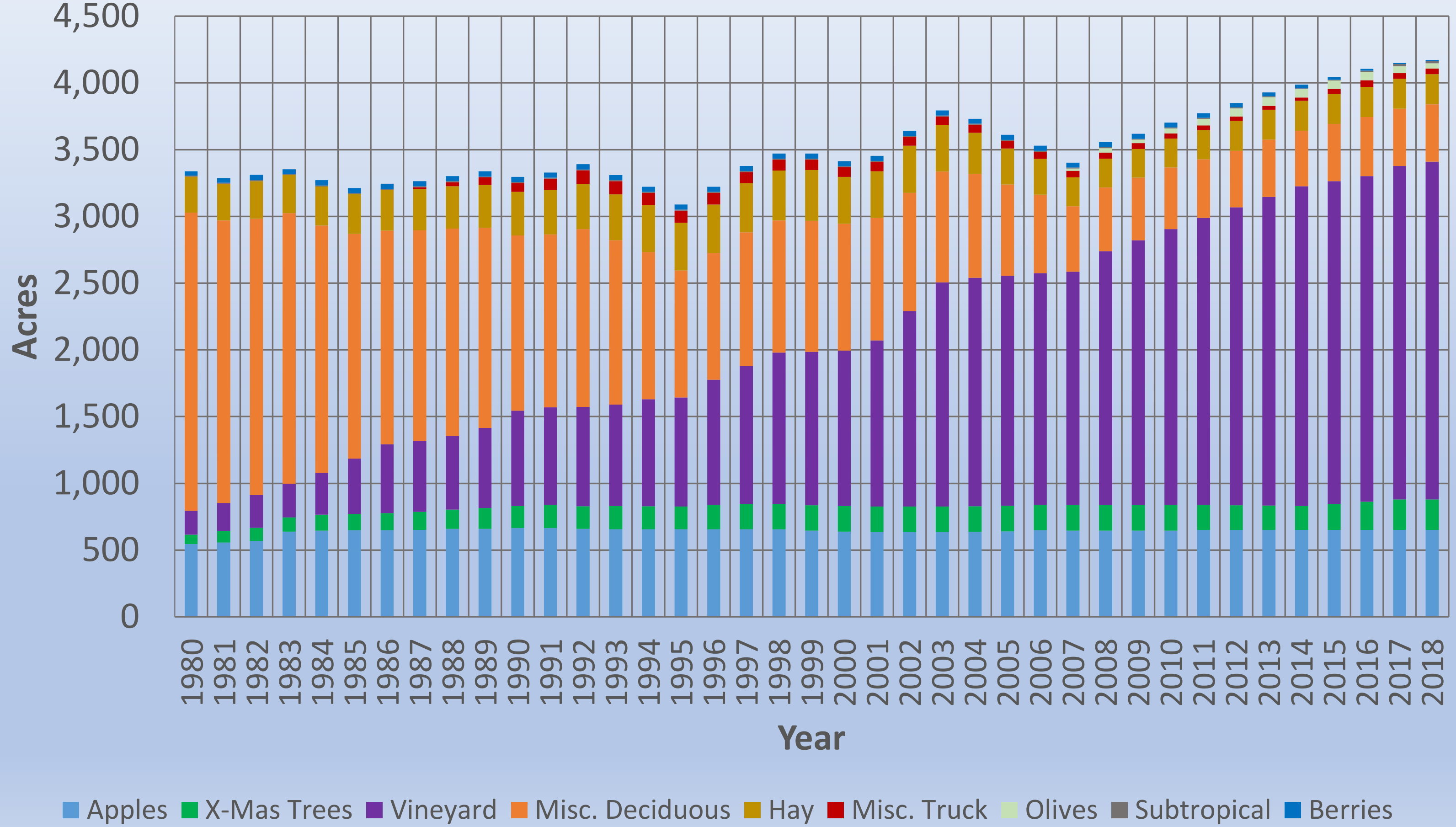
Historical Crop Record: Data Sources & Years Available

- Annual Ag Commissioner Reports and National Agricultural Statistics Service (NASS) – 1980-2016
- DWR Land Use Survey - 2009
- Land IQ Crop Surveys – 2014, 2016-2018
- Pesticide Use Reports (PUR) – 2014-2016
- NASS Cropland Data Layer

Reconciled Historical Cropping Record



Reconciled Historical Cropping Record (without Pasture)



Major Crops

- Five selected major crops are:
  1) Vineyard (wine grapes)
  2) Apples
  3) Miscellaneous Deciduous (includes nectarines, peaches, pears, walnuts and others)
  4) Pasture
  5) Christmas Trees
- These five crops account for 93% of the total existing West Slope cropped area (2016)

Land Suitability Analysis: Objective and Approach

- Objective
  - Identify West Slope lands with physical and other characteristics suitable for expansion of irrigated agriculture
- Three-Step Screening/Selection Approach
  1. Develop database of potential fields meeting basic eligibility criteria (>1 acre size, <4,000'elev, <15% slope)
  2. "Coarse" screening to identify fields meeting common (not crop-specific) suitability factors
  3. "Fine" screening to identify fields meeting crop-specific suitability factors

“Coarse” Screening Factors/Criteria

Characteristic	Criterion
Land Ownership	Private
Land Use Designation and Zoning	Appropriate for Agricultural Development per EDC General Plan
Elevation	4,000 feet above mean sea level or lower
Average Slope	15 degrees or less
Slope Variability (STD)	5 degrees or less
Land Capability Classification	6 or less
ParcelField Acreage	1 acre or greater
Perimeter/Area Ratio	1,050 or less

"Coarse" Screening Results

Number of ParcelFields	4,564
Total Acres	48,430
Average Acres per ParcelField	10.6

"Fine" (Crop-Specific) Screening Factors

- Analyze *existing* irrigated fields to define suitable characteristics for potential *future* irrigated fields

- Selected fine screening factors
  - Lower Elevation (feet)
  - Upper Elevation (feet)
  - Average Slope (degrees)
  - Slope Variability (degrees)

“Fine” (Crop-Specific) Screening Factors/Criteria

- Screening factors generally defined by 5th and 95th percentiles of existing ag fields

Crop	Lower Elevation (feet)	Upper Elevation (feet)	Average Slope (degrees)	Slope Variability (degrees)
Apples	450*	3,200	11	4.1
Miscellaneous Deciduous	450*	2,700	12	4.4
Pasture	450*	2,500	8	3.3
Vineyard	450*	2,900	14	4.6
X-mas Trees	450*	3,400	14	4.1

* 450 feet above sea level is the approximate lowest elevation on the West Slope

Factors in ParcelField Database

Current Factors

- Ownership
- General Plan land use designation and zoning
- Elevation (max and min)
- Average slope
- Slope variability (STD)
- Size (1 ac min)
- Land capability classification
- Shape (P/A ratio)

Factors for Future Refinement

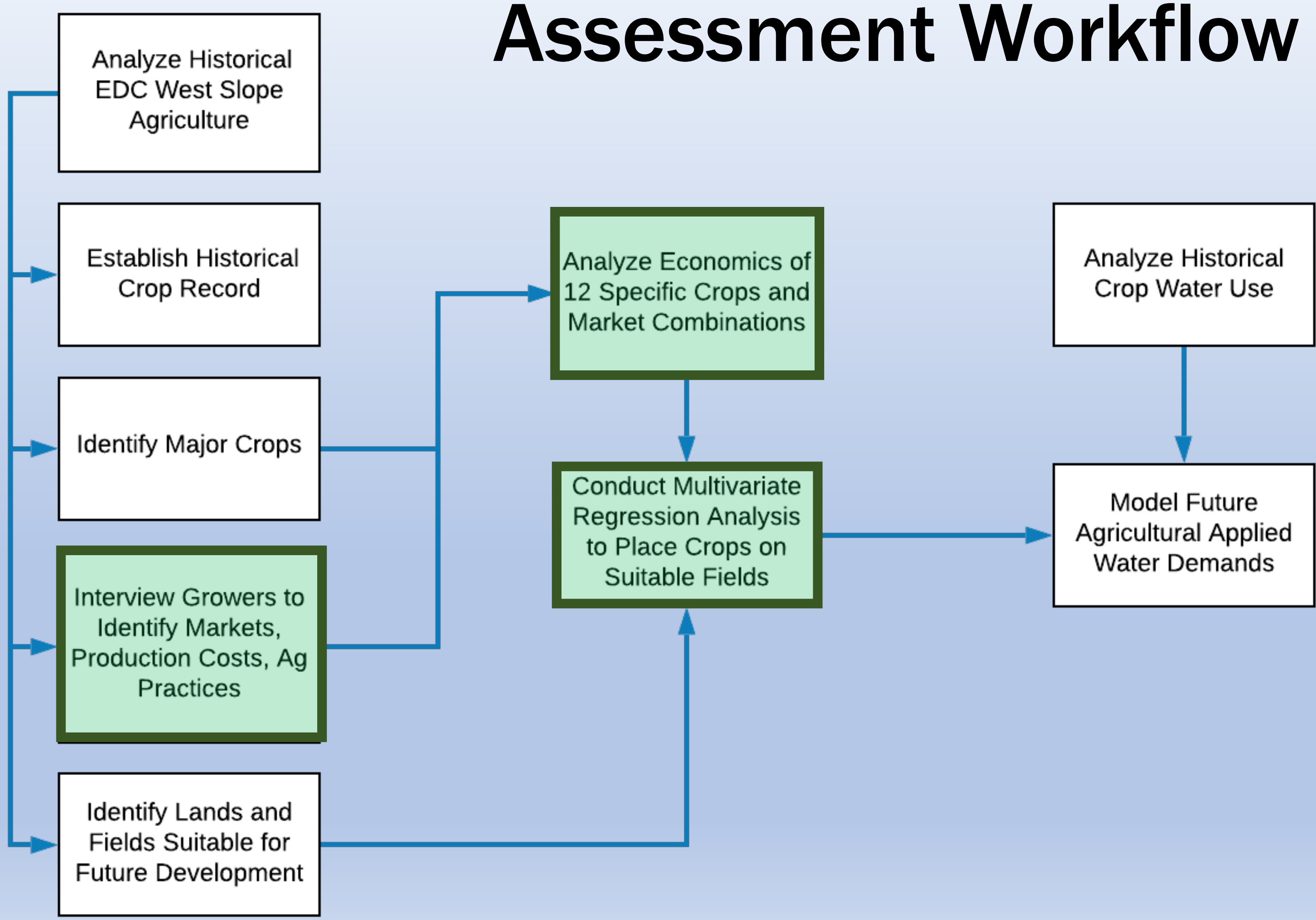
- Exposure (aspect)
- Existing land use/cover
- Oak Woodland designation
- In/out of surface water purveyor area
- Proximity to closest:
  - Primary road
  - Secondary road
  - Existing irrigated field
- Crop on closest irrigated field

ParcelField "Fine" (Crop-Specific) Screening Results

Crop	ParcelField Count	Total Acres
Apples	2,579	27,707
Miscellaneous Deciduous	3,356	37,915
Pasture	1,174	14,281
Vineyard	3,936	42,620
X-mas Trees	879	7,996

- Substantial overlap exists because many ParcelFields are suitable for multiple crops
- Discrete results (overlap accounted for):
  - 4,277 ParcelFields
  - 45,231 total acres
  - Average 10.6 acres/ParcelField

Ag Development Feasibility Assessment Workflow



Economic Analysis
Objective and Approach

- Objective
  - Establish the value of water in crop production under current market conditions, and how it would change with expansion of irrigated agriculture
- Approach
  - Quantify production costs, returns, and markets for current and alternative EDC crops
  - Develop economic model to assess the value of water as EDC production expands, and optimally allocate land that is identified to be suitable for irrigated agriculture (DE analysis)

Grower Interviews

- Conducted 13 interviews between April 1 and April 19, 2019
  - 2 cow-calf rangeland operations
  - 1 specialty livestock farm
  - 2 Christmas tree farms
  - 4 wine grape growers
  - 1 small mixed vegetable operation
  - 3 diversified apple/berry/fruit operations
- Interview topics included:
  - Business practices, production, costs, and markets
  - Irrigation management practices and costs
  - Discussion of EDC factors that could encourage or limit future agricultural development

EDC Crops for Economic Analysis

- Expanded total crops from 5 major crops and 2 alternatives to 9 major crops and 3 alternatives

Initial Major Crops
Apples
Pasture
Grapes
Misc. Deciduous
X-Mas Trees
Alt 1 (TBD)
Alt 2 (TBD)

Revised Major Crops	Market Type	Current Acres
Apples	DTC (Apple Hill)	587
Apples	Specialty Wholesale	65
Pasture	DTC (Specialty Meat)	813
Pasture	Wholesale	813
Grapes	DTC (Wine)	1,519
Grapes	Wholesale (Export)	1,012
Misc. Deciduous	DTC (Peaches)	229
Misc. Deciduous	Wholesale (Walnuts)	200
X-Mas Trees	DTC (You-Cut)	227
(Alt) Berries	DTC (Farmers Markets)	9
(Alt) Small Veg	DTC (Specialty Markets)	41
(Alt) Mandarins	Wholesale	56

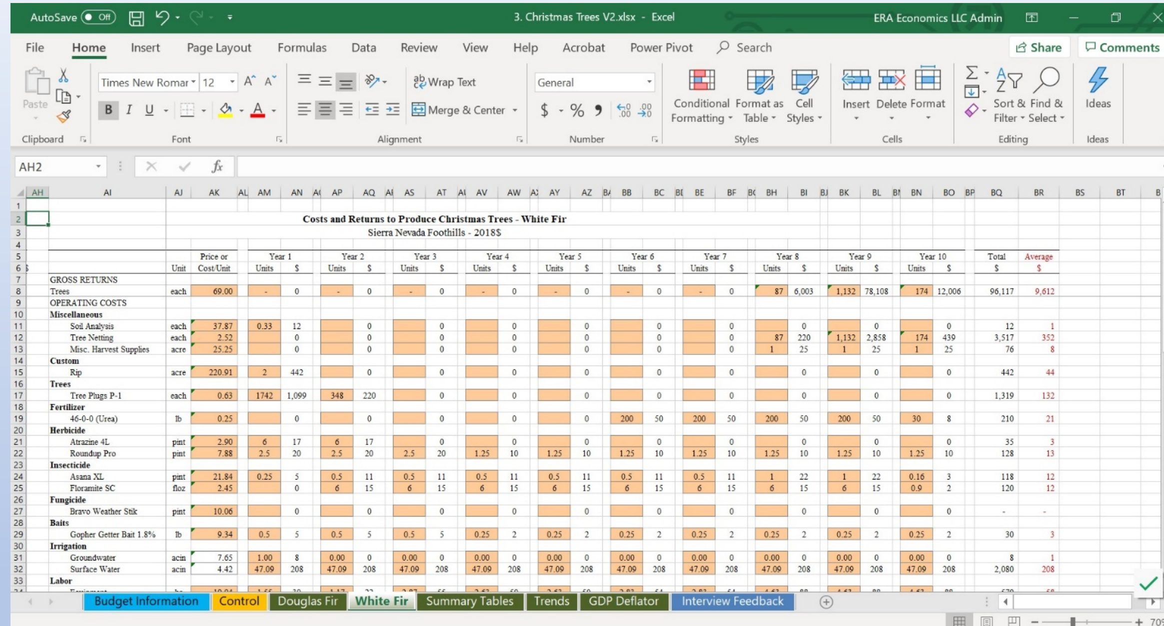
EDC Crop Markets Overview

Crop	Market Type	Market Supply	Market Demand
Apples	**DTC**	EDC	Greater Sacramento Area[1]
Apples	**Specialty Wholesale**	California + U.S.	U.S. + Export
Pasture	**DTC**	EDC	Greater Sacramento Area
Pasture	**Wholesale**	U.S.	U.S.
Grapes	**DTC**	EDC	Greater Sacramento Area
Grapes	**Wholesale**	Portions of Crush Districts: 10, 8, and 7	U.S. + Export (mid-priced wines)
Misc. Deciduous	**DTC**	EDC	Greater Sacramento Area
Misc. Deciduous	**Wholesale**	California	U.S. + Export
X-Mas Trees	**DTC**	Greater Sacramento Area	Greater Sacramento Area
(Alt) Berries	**DTC**	EDC	Greater Sacramento Area
(Alt) Small Vegetable	**DTC**	EDC	Greater Sacramento Area
(Alt) Mandarins	**Wholesale**	California	U.S.

1. Includes Sacramento Area, EDC, Reno, and SF Bay Area

EDC Crop Markets, Costs, and Returns

- Each crop is characterized by:
  - Itemized operating costs
  - Itemized capital costs



Costs and Returns to Produce Christmas Trees - White Fir
Sierra Nevada Foothills - 2018$

	Unit	Price or Cost/Unit	Year 1 Units	Year 1 $	Year 2 Units	Year 2 $	Year 3 Units	Year 3 $	Year 4 Units	Year 4 $	Year 5 Units	Year 5 $
GROSS RETURNS												
Trees	each	69.00	-	0	-	0	-	0	-	0	-	0
OPERATING COSTS												
Miscellaneous												
Soil Analysis	each	37.87	0.33	12		0		0		0		0
Tree Netting	each	2.52		0		0		0		0		0
Misc. Harvest Supplies	acre	25.25		0		0		0		0		0
Custom												
Rip	acre	220.91	2	442		0		0		0		0
Trees												
Tree Plugs P-1	each	0.63	1742	1,099	348	220		0		0		0
Fertilizer												
46-0-0 (Urea)	lb	0.25		0		0		0		0		0
Herbicide												
Atrazine 4L	pint	2.90	6	17	6	17		0		0		0
Roundup Pro	pint	7.88	2.5	20	2.5	20	2.5	20	1.25	10	1.25	10
Insecticide												
Asana XL	pint	21.84	0.25	5	0.5	11	0.5	11	0.5	11	0.5	11
Floramite SC	floz	2.45		0	6	15	6	15	6	15	6	15
Fungicide												
Bravo Weather Stik	pint	10.06		0		0		0		0		0
Baits												
Gopher Getter Bait 1.8%	lb	9.34	0.5	5	0.5	5	0.5	5	0.25	2	0.25	2
Irrigation												
Groundwater	acin	7.65	1.00	8	0.00	0	0.00	0	0.00	0	0.00	0
Surface Water	acin	4.42	47.09	208	47.09	208	47.09	208	47.09	208	47.09	208
Labor												

	Year 6 Units	Year 6 $	Year 7 Units	Year 7 $	Year 8 Units	Year 8 $	Year 9 Units	Year 9 $	Year 10 Units	Year 10 $	Total $	Average $
GROSS RETURNS												
Trees	-	0	-	0	87	6,003	1,132	78,108	174	12,006	96,117	9,612
OPERATING COSTS												
Miscellaneous												
Soil Analysis		0		0		0		0		0	12	1
Tree Netting		0		0	87	220	1,132	2,858	174	439	3,517	352
Misc. Harvest Supplies		0		0	1	25	1	25	1	25	76	8
Custom												
Rip		0		0		0		0		0	442	44
Trees												
Tree Plugs P-1		0		0		0		0		0	1,319	132
Fertilizer												
46-0-0 (Urea)	200	50	200	50	200	50	200	50	30	8	210	21
Herbicide												
Atrazine 4L		0		0		0		0		0	35	3
Roundup Pro	1.25	10	1.25	10	1.25	10	1.25	10	1.25	10	128	13
Insecticide												
Asana XL	0.5	11	0.5	11	1	22	1	22	0.16	3	118	12
Floramite SC	6	15	6	15	6	15	6	15	0.9	2	120	12
Fungicide												
Bravo Weather Stik		0		0		0		0		0	-	-
Baits												
Gopher Getter Bait 1.8%	0.25	2	0.25	2	0.25	2	0.25	2	0.25	2	30	3
Irrigation												
Groundwater	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	8	1
Surface Water	47.09	208	47.09	208	47.09	208	47.09	208	47.09	208	2,080	208
Labor												

  - Full cost of “unpriced” inputs (owner-operator time, return to management, return to risk)
  - Developed as series of crop budget models tailored to EDC conditions

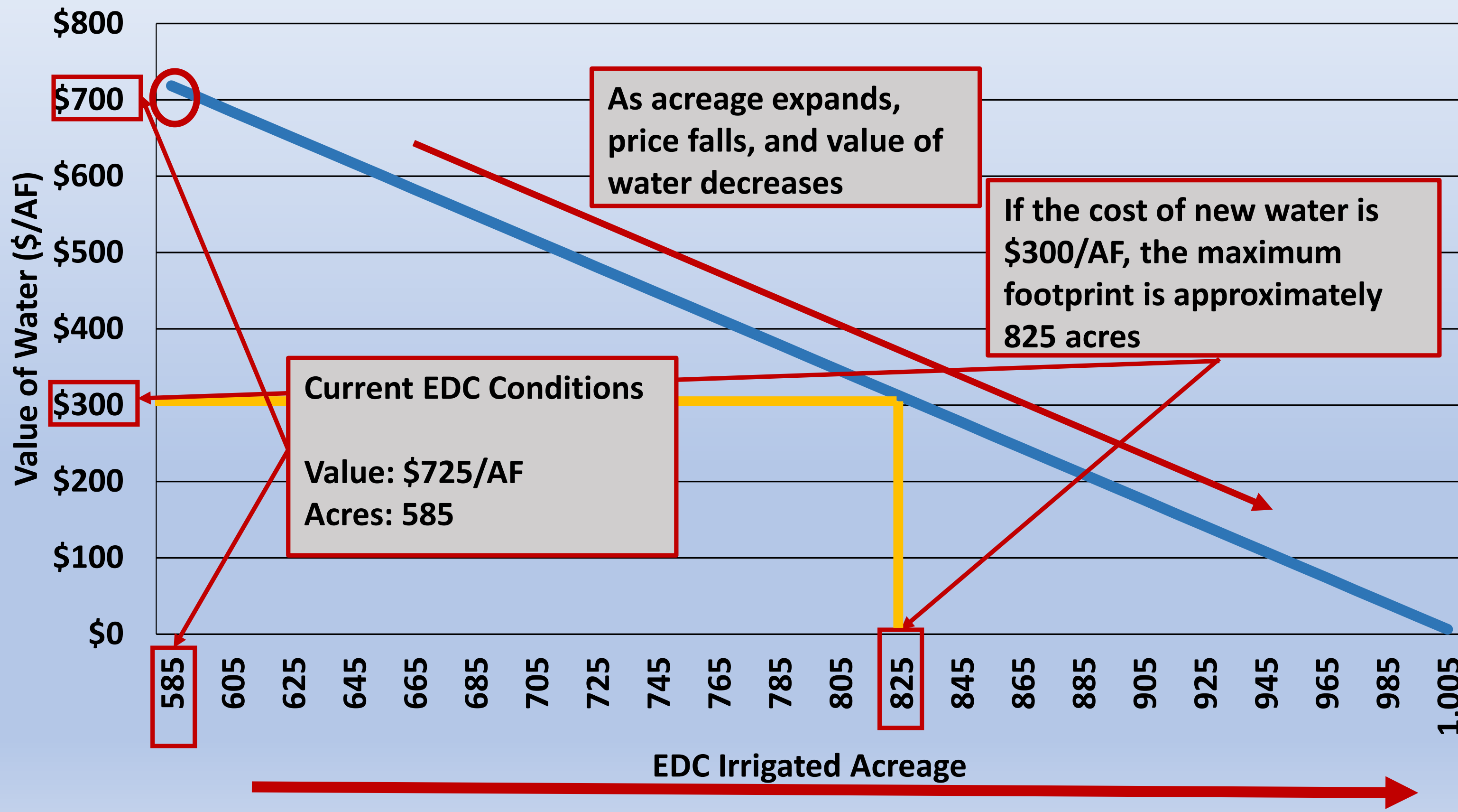
Example: Direct to Consumer Apples

- Example shows example of increasing supply of EDC apples for DTC market

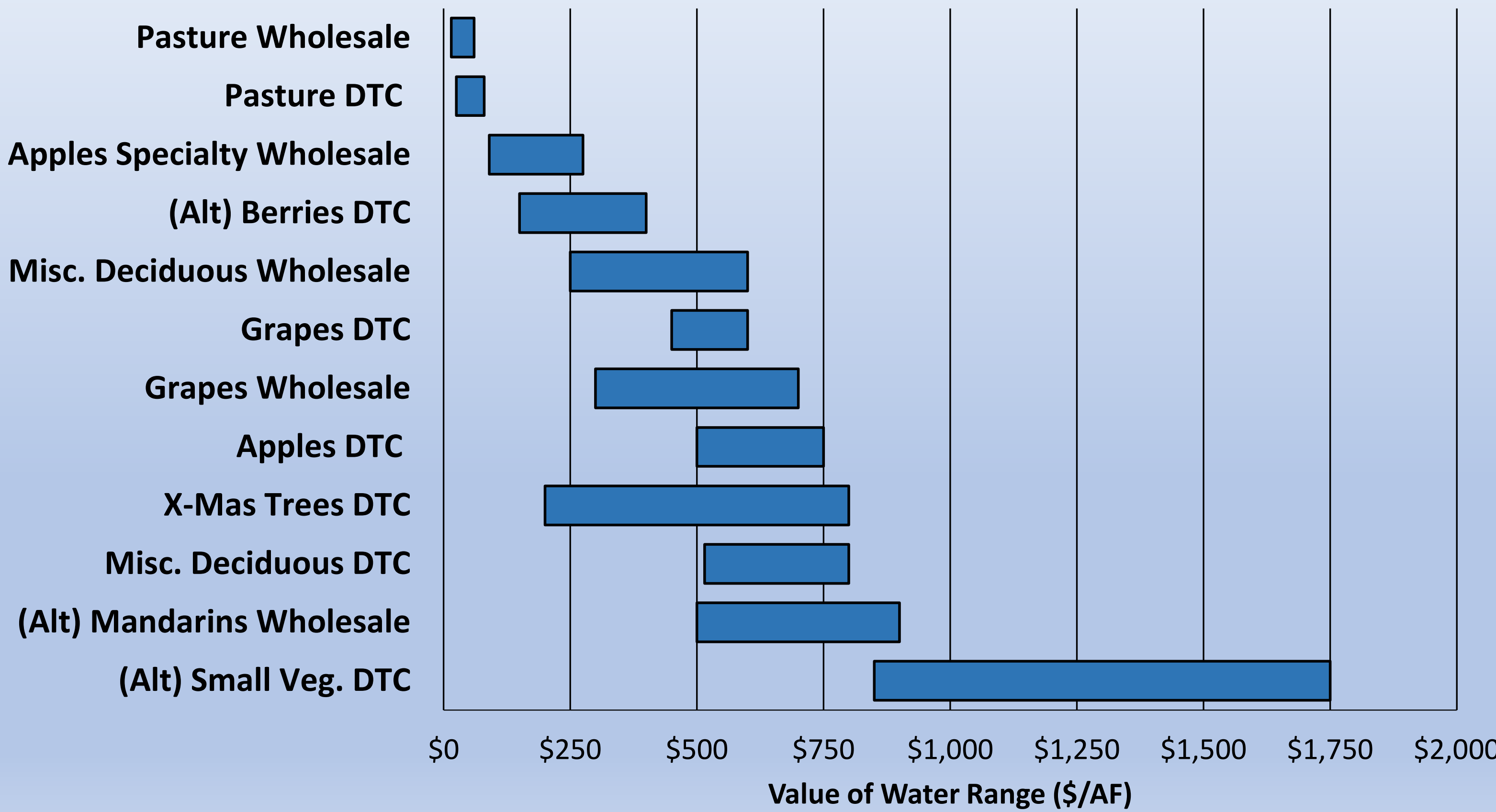
- Supply expands and puts downward pressure on price, net returns fall, which causes the value of water to decrease

- Increasing consumer demand puts upward pressure on price, net returns rise, which causes the value of water to increase

Direct to Consumer Apples Water Value Example



Value of Water Range Estimates (Range)



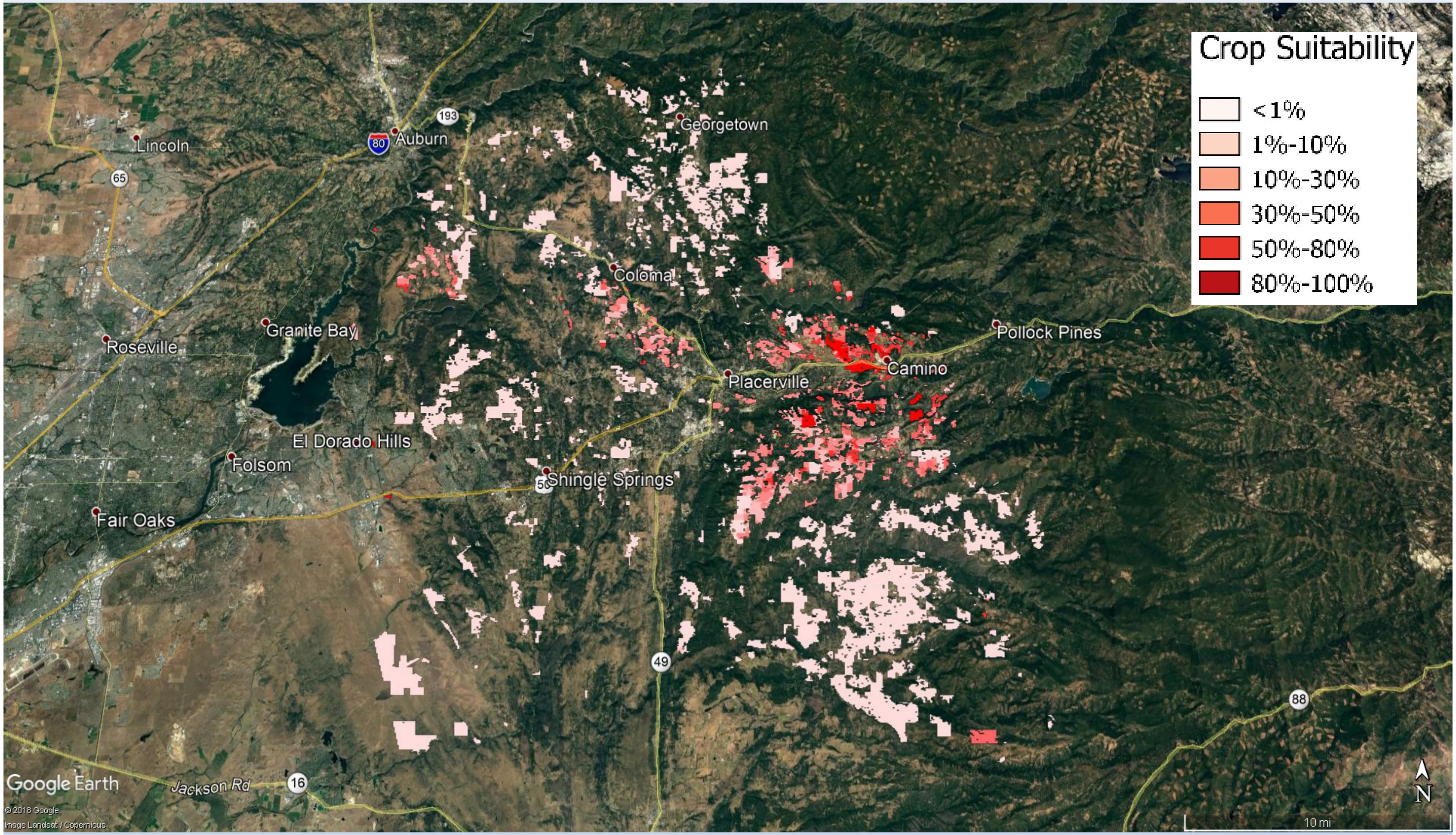
Crop Placement

- Multivariate regression analysis calculates the probability of each crop type based on potentially developable ParcelFields characteristics
  - Maximum of 45,231 acres based on coarse screening criteria
- Economic analysis determines how the value of water changes as production expands, and the maximum economically developable footprint
  - Maximum economic footprint depends on the cost of water and new land development
- Crops are “placed” based on land suitability and consistent with market conditions

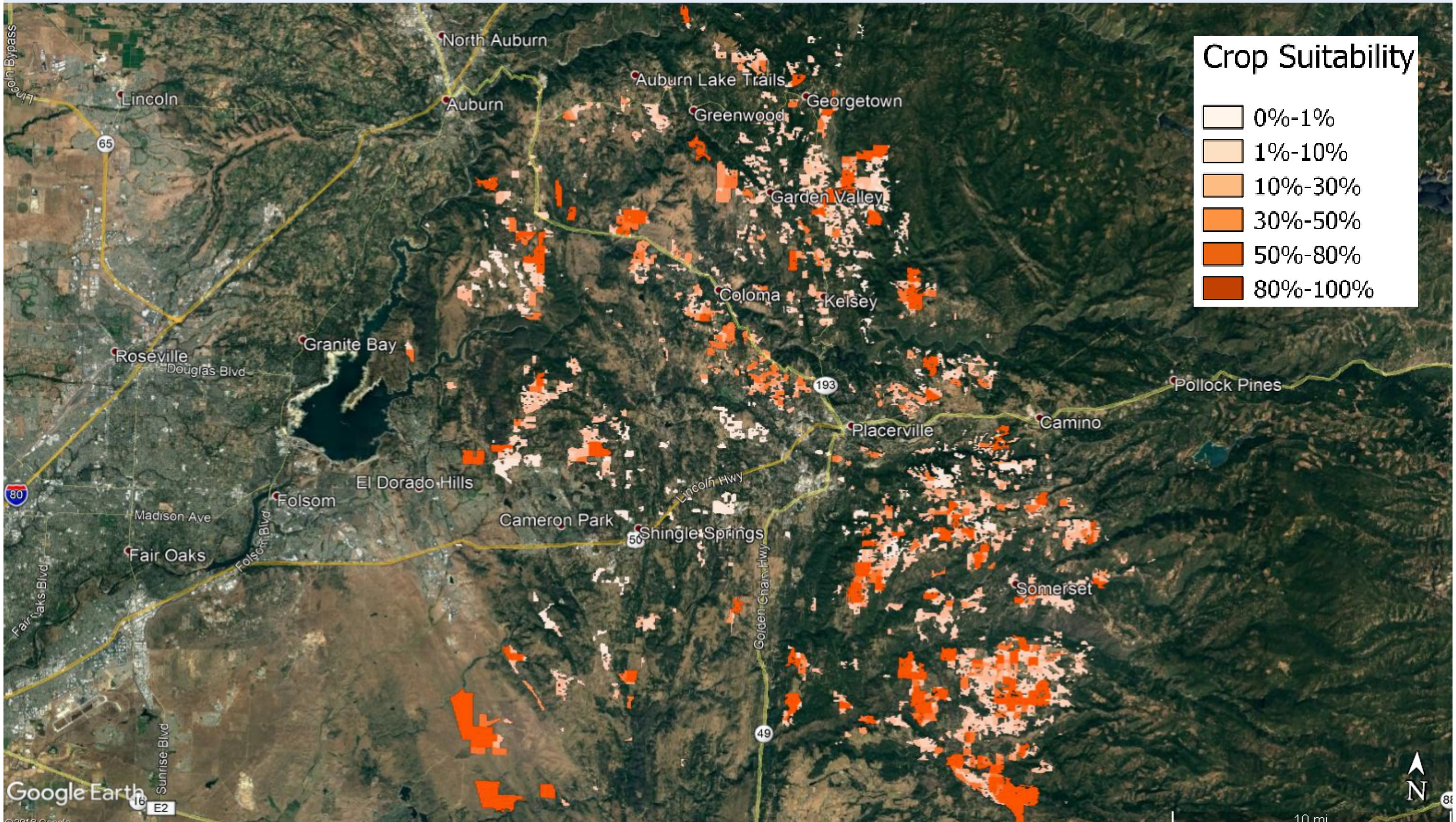
Multivariate Regression Analysis

Model Variable	Notes/Overview
Crop	**Major Crops: Apples, Pasture, Grapes, Misc. Deciduous, and X-Mas Trees[1]**
Parcel Acreage	Field size, measured in acres
Perimeter/Area Ratio	Measurement of how "regular" the field is shaped
Mean Field Elevation	Elevation of the field in feet
Mean Field Slope	Average slope of the field in degrees
Slope Variability	Variability of the field, measured as the standard deviation of the slope
Mean Aspect Direction	Northern or Southern exposure of the field
Land Capability Index	Land Capability Classification of the field
ETo Zone	Climate Evapotranspiration zone (spatial variable)
WRDMP Demand Unit	Water planning zones used in WRDMP (spatial variable)
Proximity to Major Road	Proximity (miles) to nearest road, up to 5 miles away

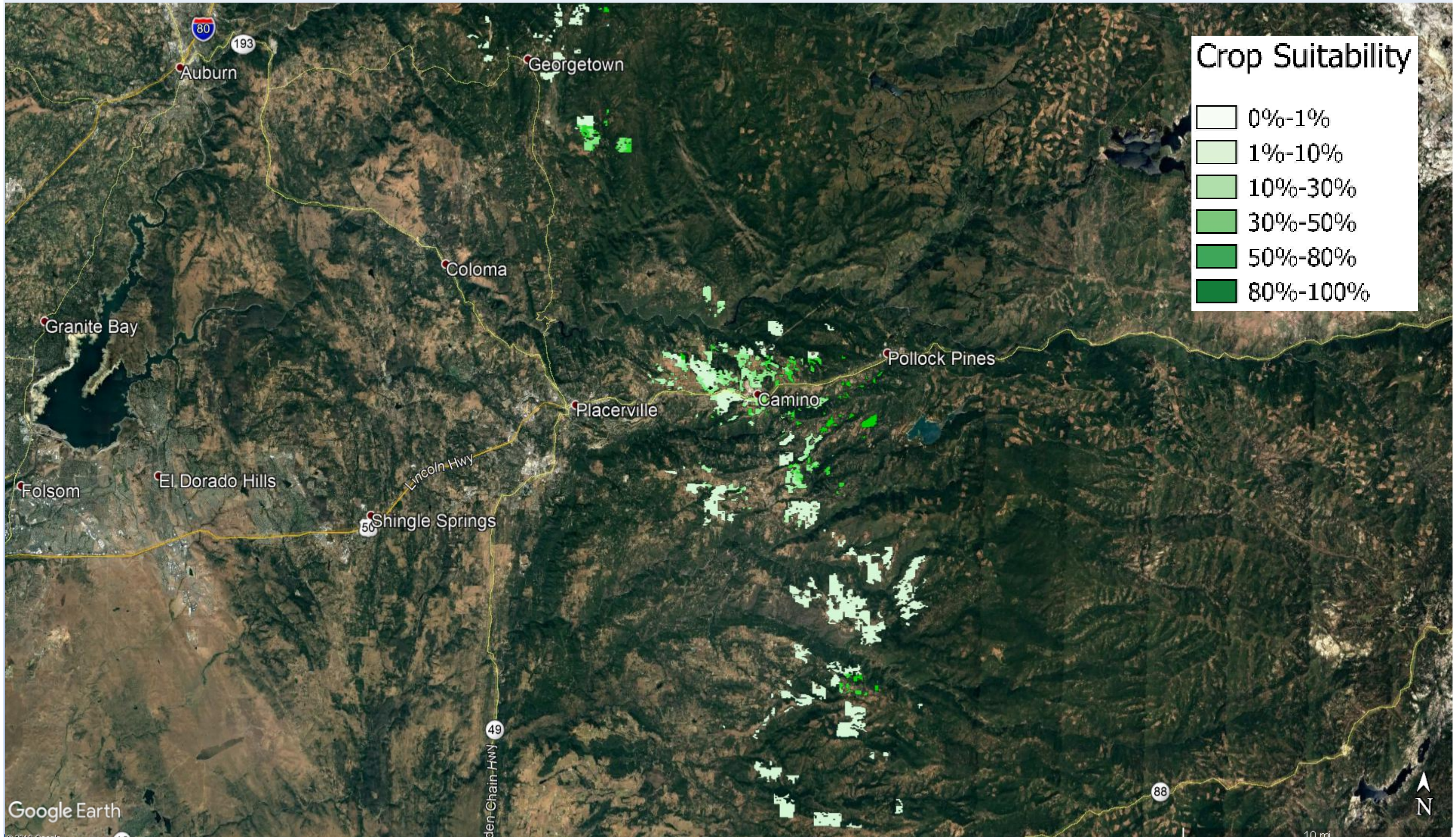
Apple Crop Map



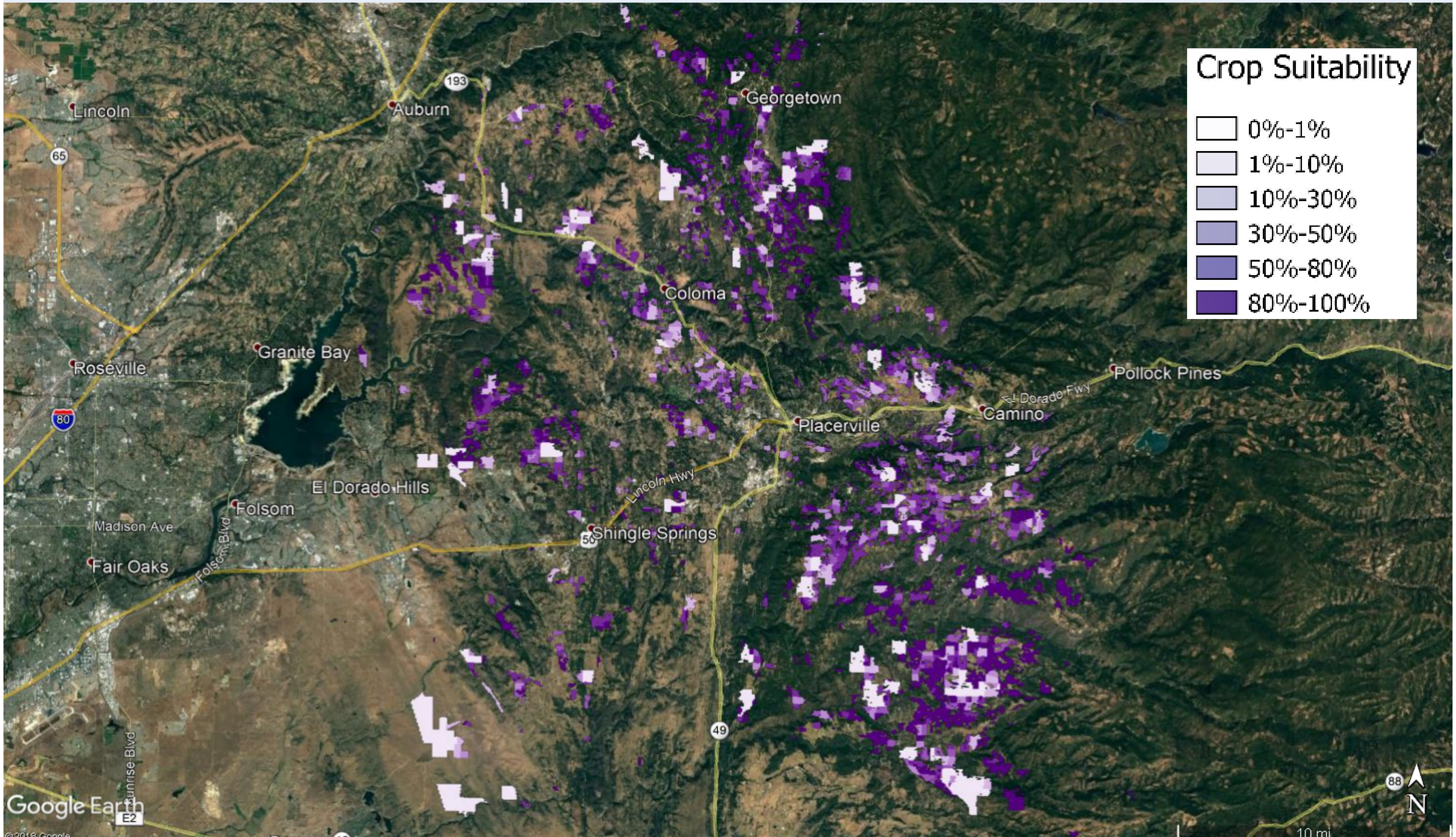
Other Deciduous Crop Map



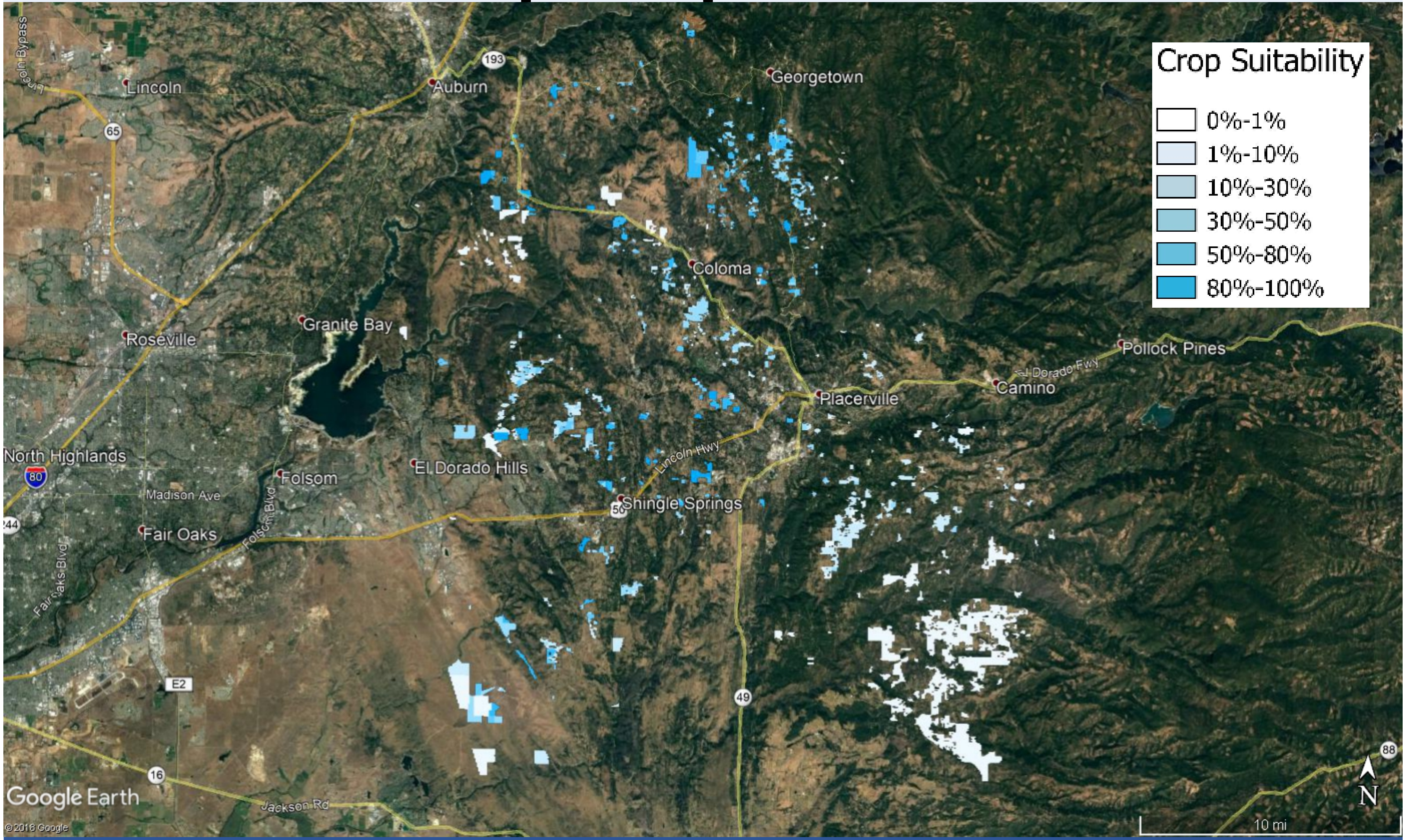
Xmas Trees Crop Map



Vineyards Crop Map



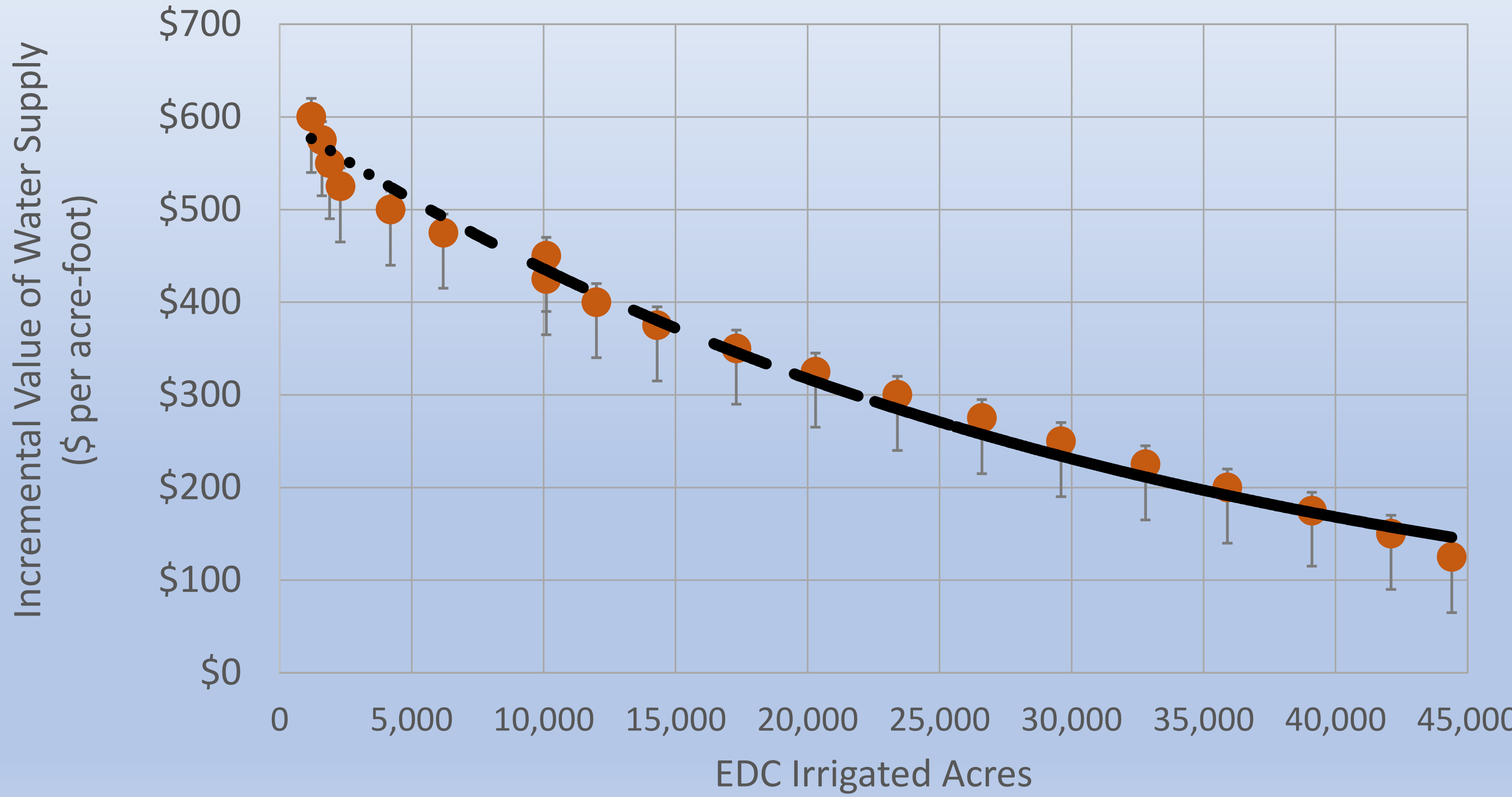
Pasture Crop Map



Economic Analysis

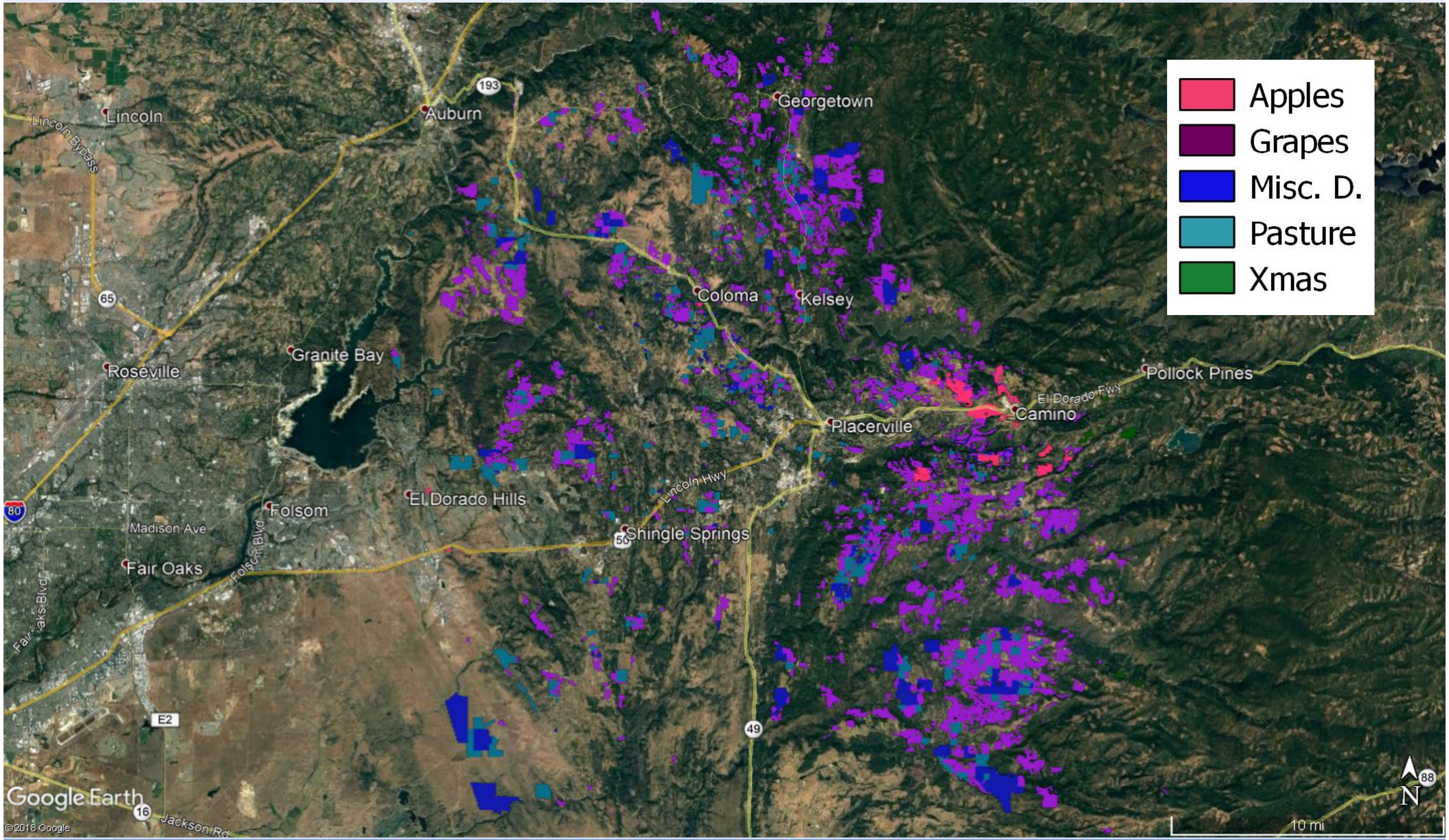
- Economic analysis of each crop and market is used to determine the value of water
- The value of water changes as the potentially developable ParcelFields footprint expands
  - The mix of crops (over 12 crop-market combinations) changes as the footprint expands
- The economically feasible footprint depends on the cost of developing new land and water supply

Economic Analysis: EDC Land



Note: error bars show +15/-35% range

Initial Crop Placement

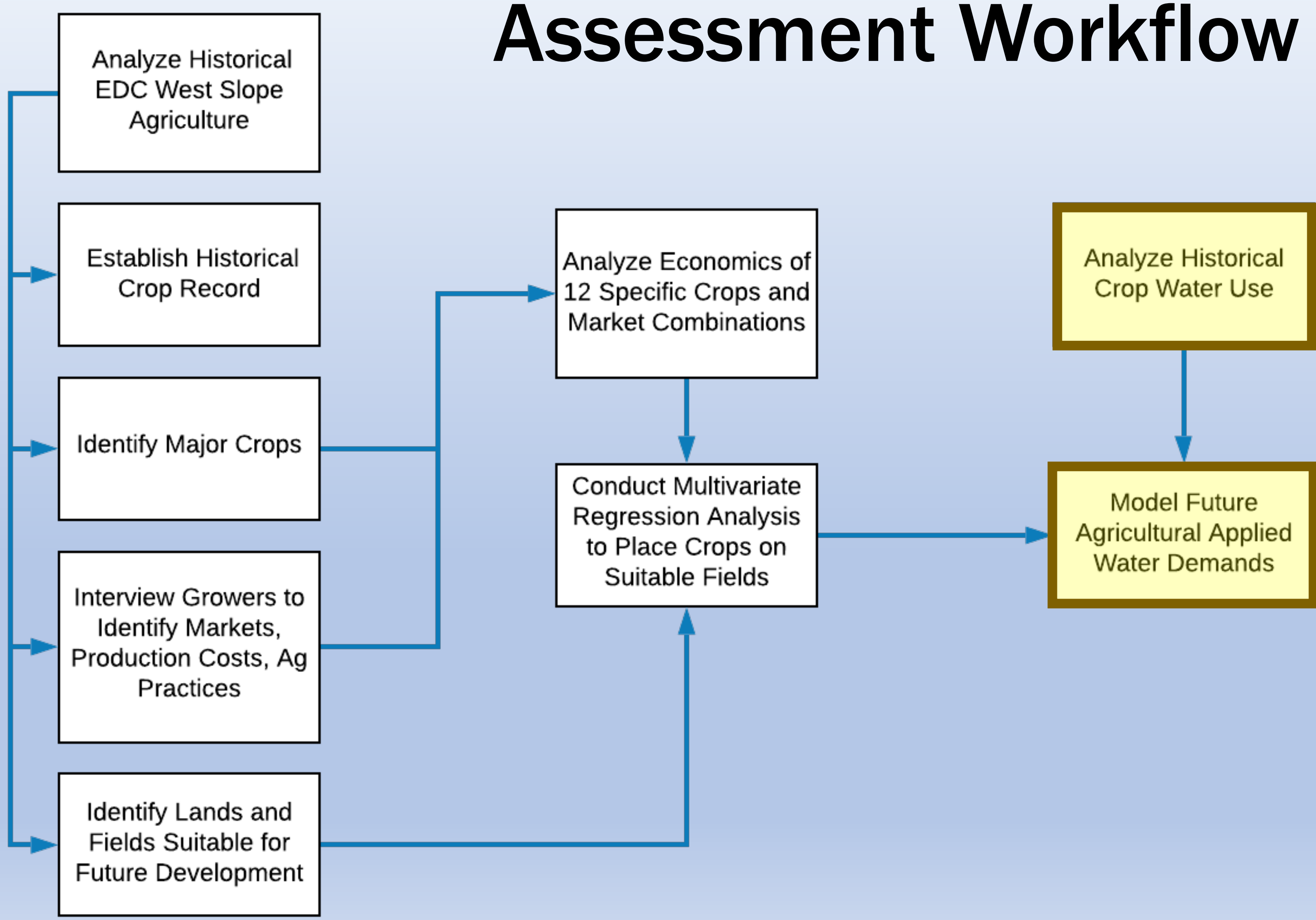


Maximum Developable Footprint

	Apples	Vineyard	Pasture	Misc. Deciduous	Xmas Trees	Total
Current Irrigated Acreage	650	2,530	1,625	535	225	**5,565**
Maximum Potentially Developable Acres	1,030	24,270	8,170	7,275	280	**41,025**
Total	**1,680**	**26,800**	**9,795**	**7,810**	**505**	**46,590**

- Crops are aggregated from 12 crop-market combinations into 5 major crop types
- Land, water, other development costs are not factored into maximum footprint calculation
- Initial maximum footprint sensitivity analysis
  - 34,500 – 41,000 acres

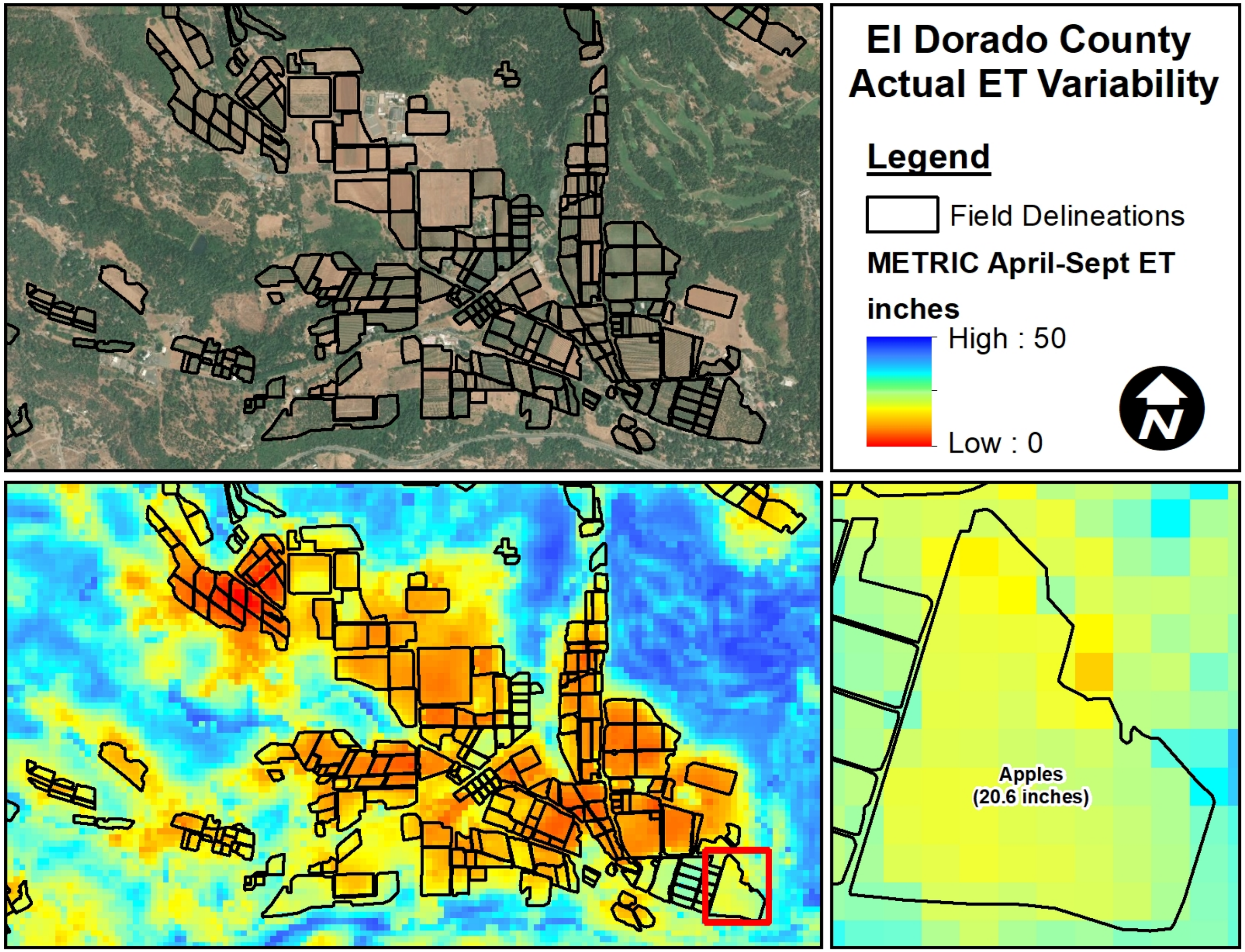
Ag Development Feasibility Assessment Workflow



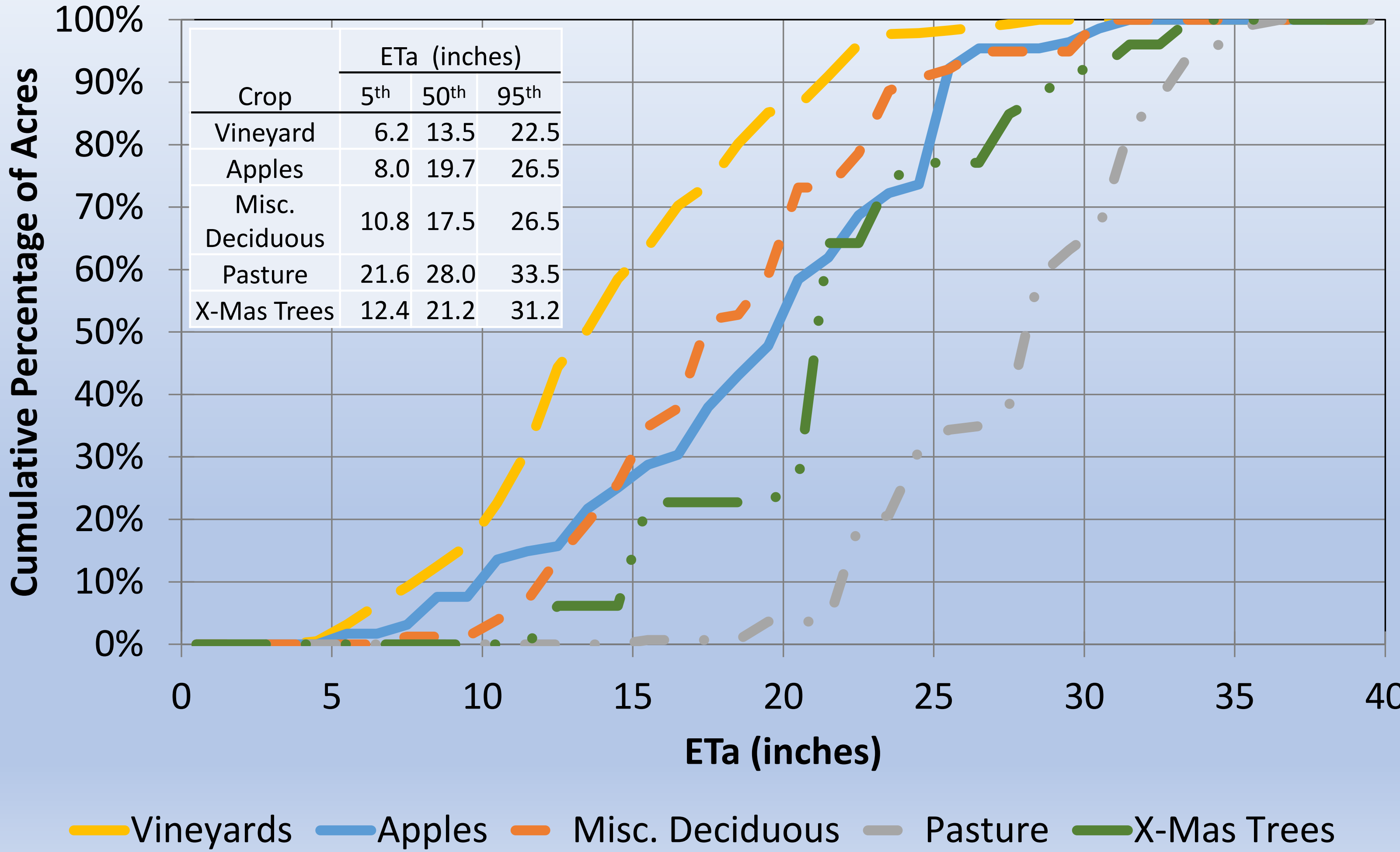
Current Crop ET Estimated by METRIC Remote Sensing Energy Balance Model

- Adapted by Dr. Richard Allen (Univ. of Idaho) from the SEBAL model developed by Dr. Wim Bastiaanssen (Netherlands)
- Application developed for calendar year 2017
  - Aligned with LandIQ crop maps
  - Cloud-free Landsat images available from 3/2/17 to 10/4/17, inclusive (9 images total)
- METRIC and SEBAL models well validated
  - Generally ±5% compared to other documented ET sources (e.g., lysimeter, eddy covariance, surface renewal, water balance, other)

2017 METRIC Seasonal ET by Field – Sample

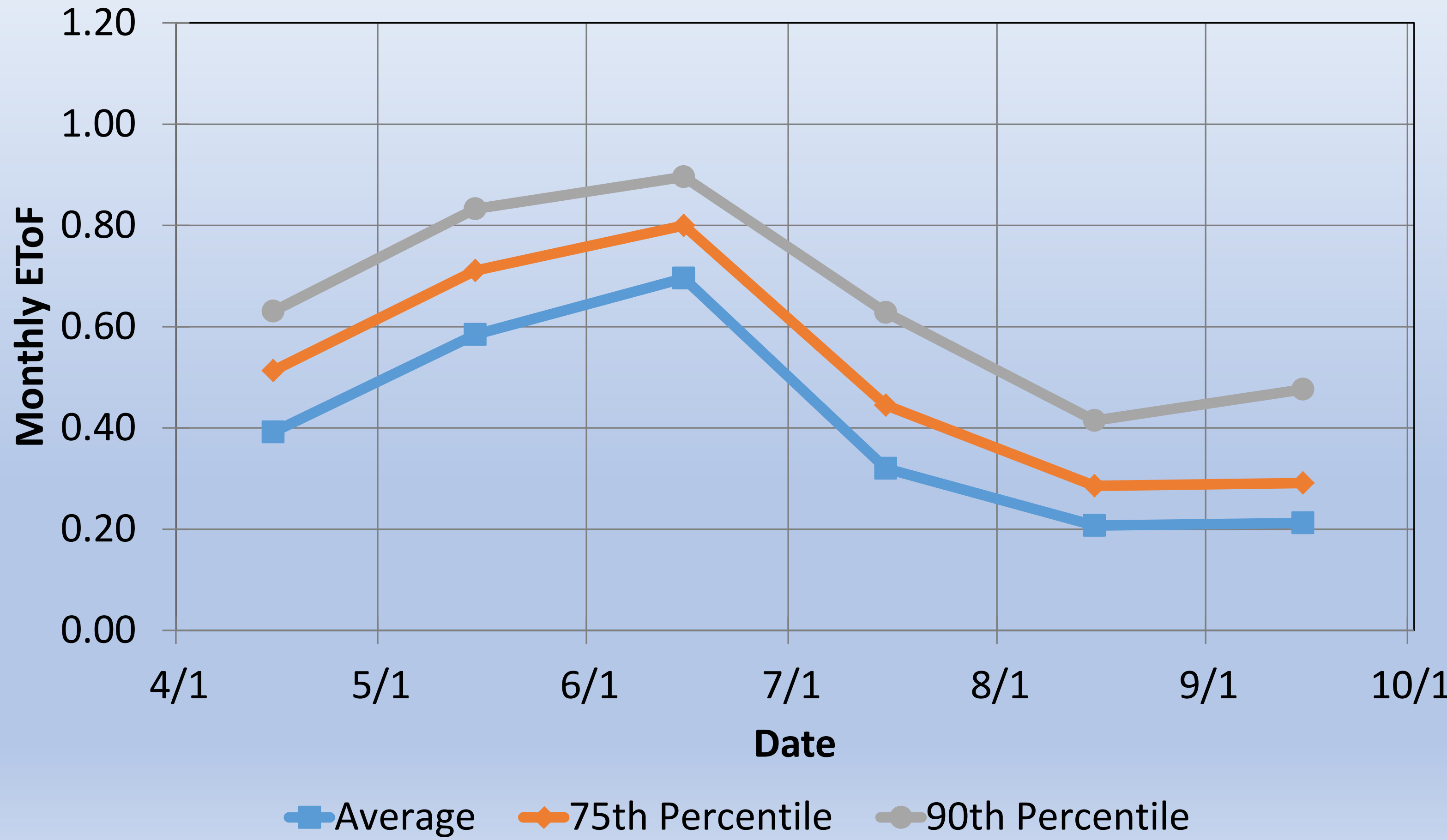


ETa Distribution (April – September 2017)



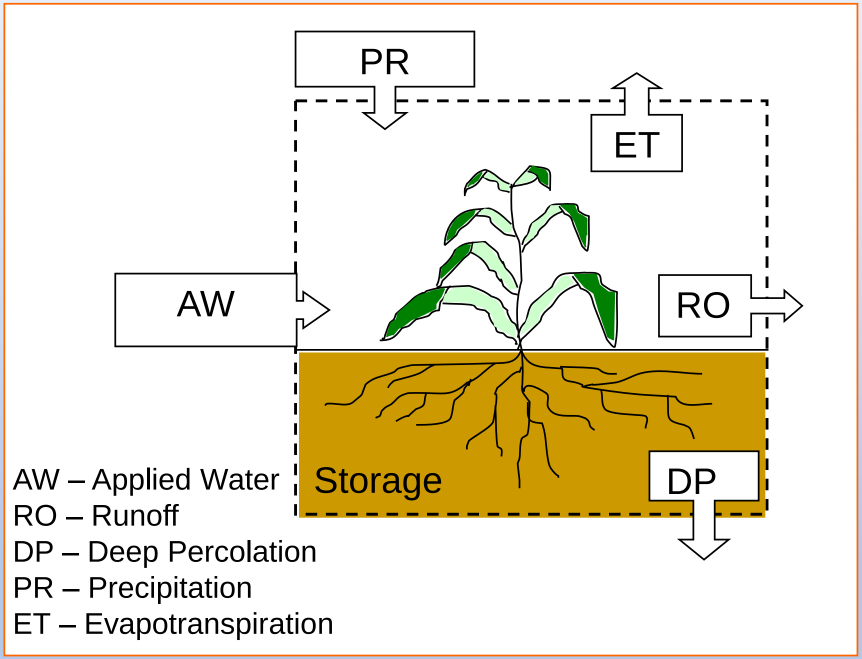
Crop	ETa (inches) 5th	50th	95th
Vineyard	6.2	13.5	22.5
Apples	8.0	19.7	26.5
Misc. Deciduous	10.8	17.5	26.5
Pasture	21.6	28.0	33.5
X-Mas Trees	12.4	21.2	31.2

Crop Coefficients (EToF) Vineyard



Crop Applied Water Model

- Used DWR's IDC Model
  - Surface layer module of DWR's Integrated Water Flow Model (IWFM)
- 1998–2017 period of analysis
- Calculates daily root zone water balance for each model element (94 crop-soil-climate zone combinations)
- Accounts for ET from applied water and from precipitation separately



Applied Water Model Scenarios

Model Run	Cropping	Crop ET Rate	Climate
1	Existing	Existing (50th percentile)	Historical
2	Future	Existing (50th percentile)	Historical
3	Future	Future (75th percentile)	Historical
4	Future	Future (75th percentile)	CT2040
5	Future	Future (75th percentile)	CT2055
6	Future	Future (75th percentile)	HD2040
7	Future	Future (75th percentile)	HD2055
8	Future	Future (75th percentile)	WW2055
9	Future	Future (75th percentile)	WW2055

Notes

50th percentile assumes future crops would have the same average ET rates as current crops

75th percentile assumes future crops would have ET rates above the average of current crops

CT = central tendency climate

HD = hotter, dryer climate

WW = warmer, wetter climate

Applied Water Model Results

Model Run	Cropping	Crop ET Rate	Climate	Cropped Area (acres)	Avg. Applied Water Volume (AF)	Avg. Applied Water Depth (AF/acre)
1	Existing	50^{th} percentile	Historical	5,572	6,188	1.1
2	Future	50^{th} percentile	Historical	46,597	46,759	1.0
3	Future	75^{th} percentile	Historical	46,597	60,439	1.3
4	Future	75^{th} percentile	CT2040	46,597	67,962	1.5
5	Future	75^{th} percentile	CT2055	46,597	72,790	1.6
6	Future	75^{th} percentile	HD2040	46,597	72,875	1.6
7	Future	75^{th} percentile	HD2055	46,597	78,441	1.7
8	Future	75^{th} percentile	WW2040	46,597	63,917	1.4
9	Future	75^{th} percentile	WW2055	46,597	64,588	1.4

Notes

50th percentile assumes future crops would have the same average ET rates as current crops

75th percentile assumes future crops would have ET rates above the average of current crops

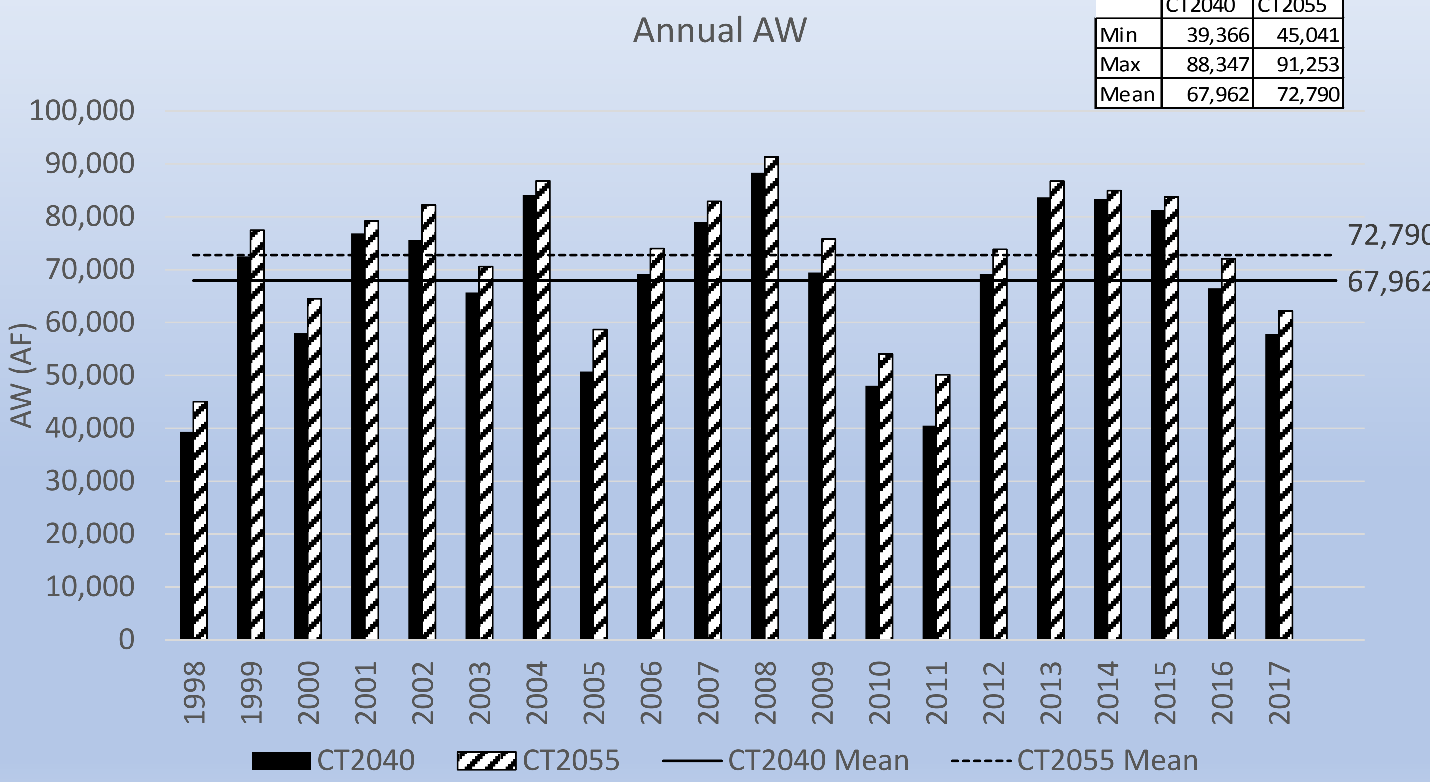
CT = central tendency climate

HD = hotter, dryer climate

WW = warmer, wetter climate

Sample Ag Demands: Avg. AW by Year (Runs 4 and 5)

	CT2040	CT2055
Min	39,366	45,041
Max	88,347	91,253
Mean	67,962	72,790



Thank You!