Integrating Real-Time Remote-Sensing and Ecological Forecasting into Decision-Support for Water and Wetland Management in the Central Valley of California: Optimizing Across Multiple Benefits

NASA Ecological Forecasting and Biodiversity Team Meeting
April 24 – 26, 2018

Matthew Reiter (Point Blue) and Kristin Byrd (USGS)

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Conservation science for a healthy planet.

USGS science for a changing world

The Nature Conservancy

U.S. Fish & Wildlife Service

CA LCC

Southwest Climate Science Center

NASA

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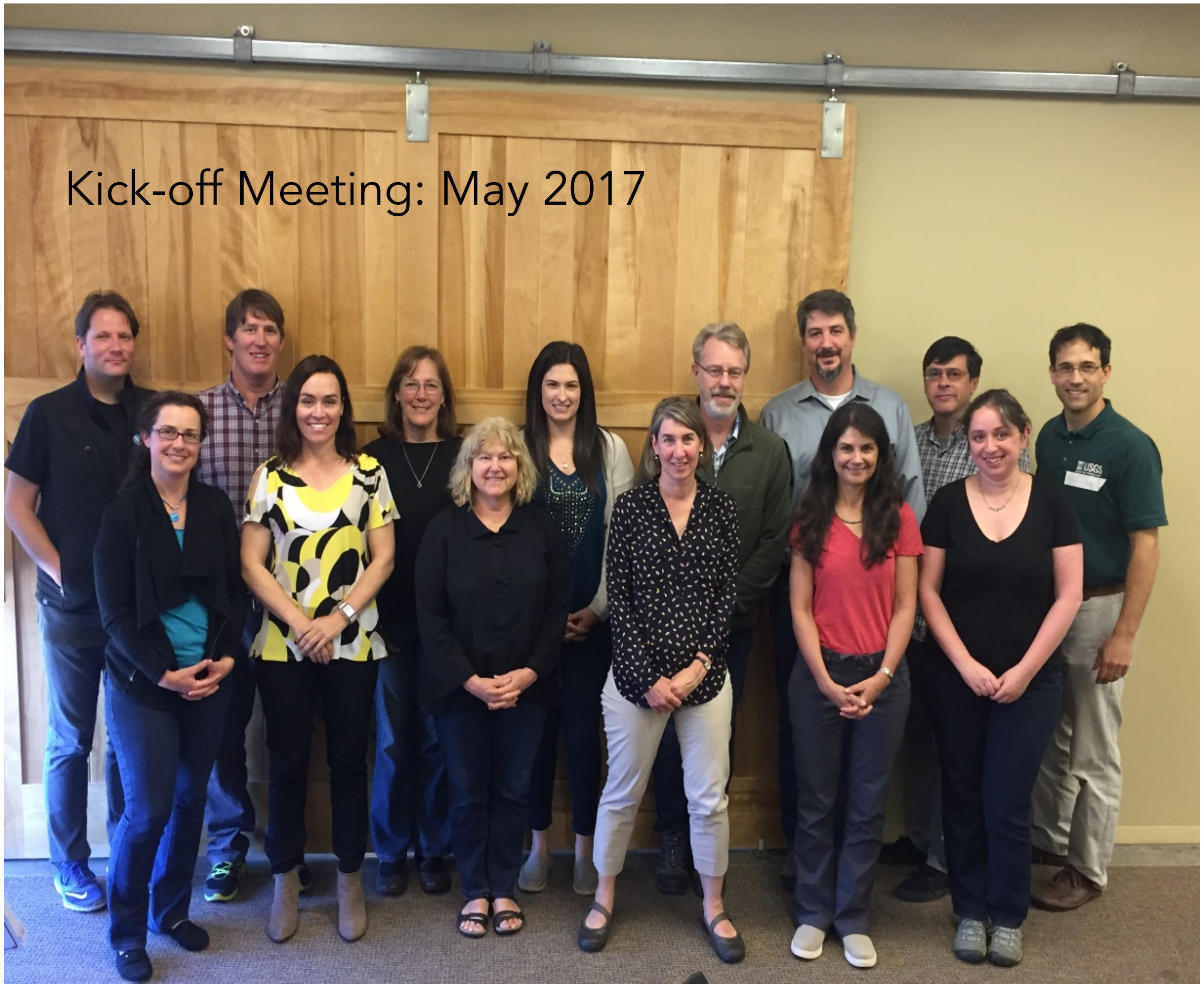

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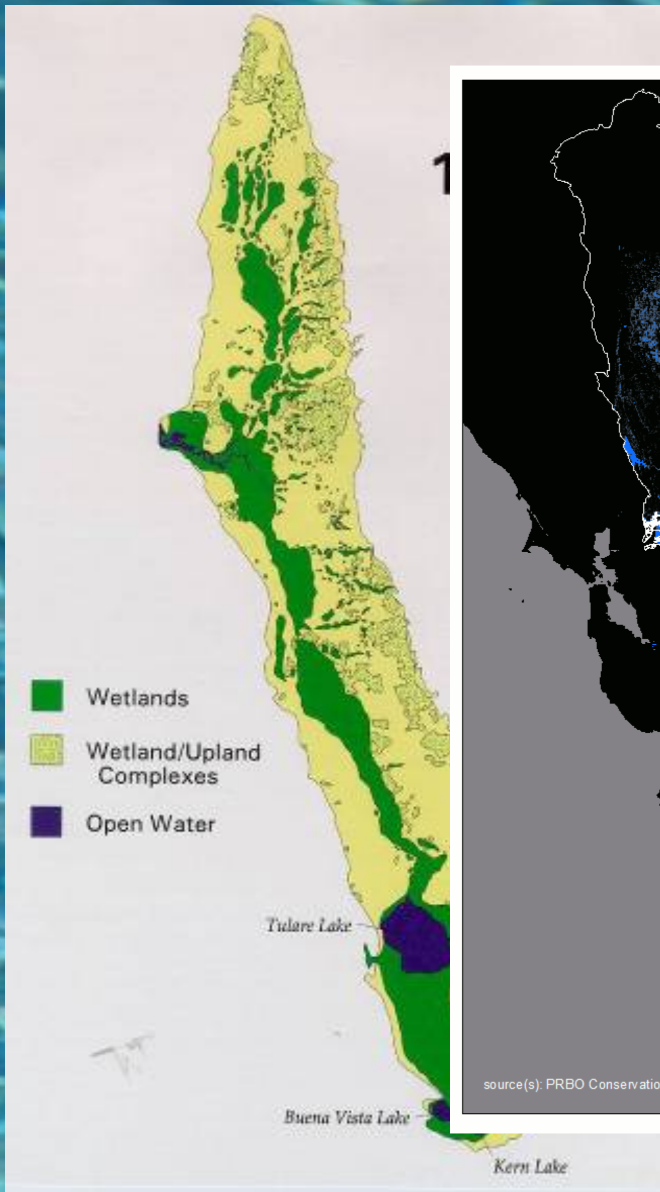
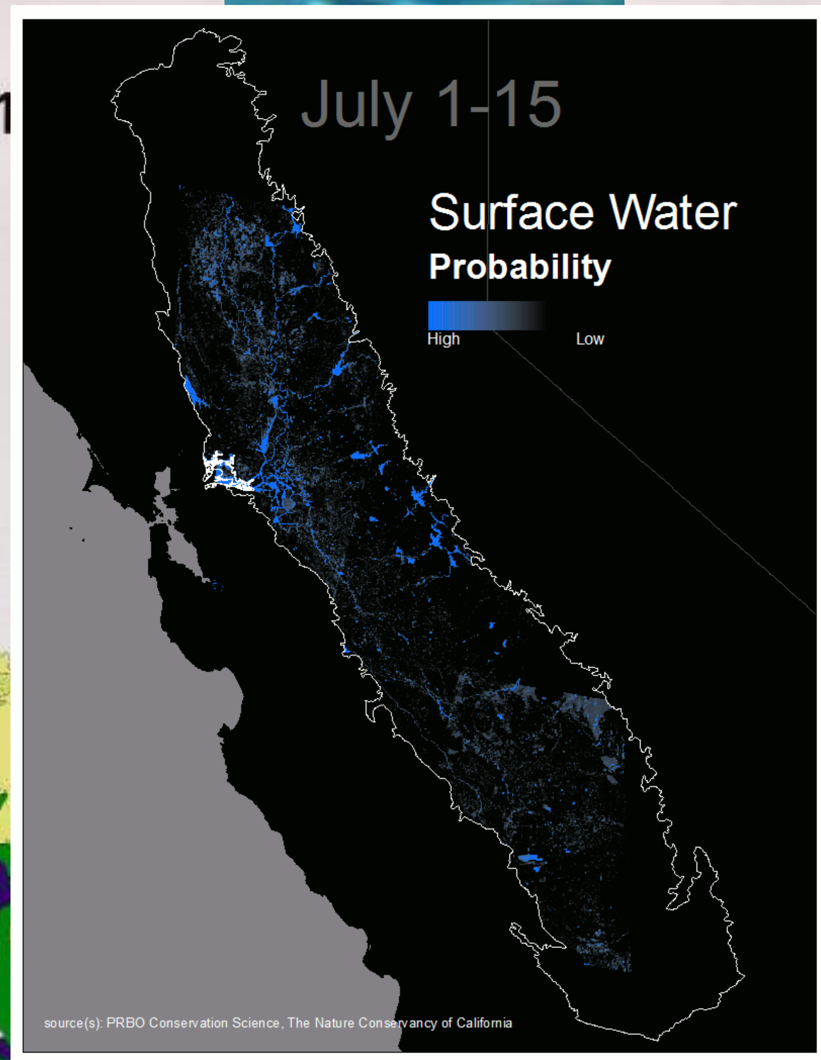
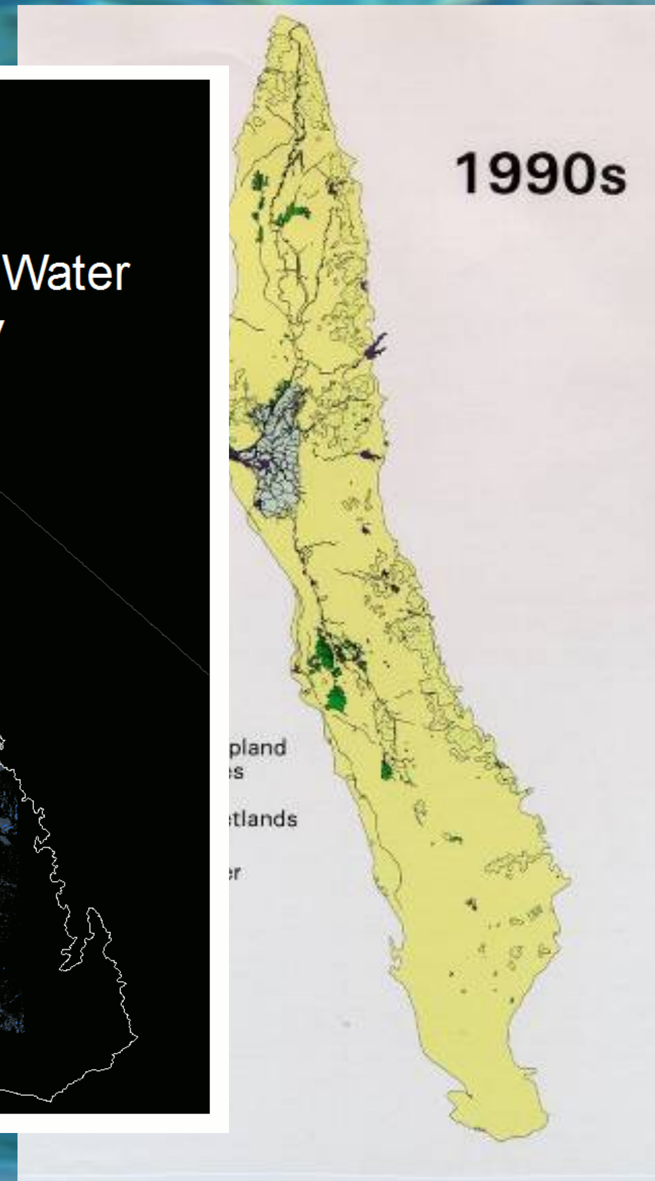
Water and the Central Valley







Central Valley Water Needs

Drought Challenges Water Management for Wetlands, Biodiversity & People

Where to put water and when to maximize multiple benefits?

Biological Targets
Waterfowl
Shorebirds
Giant Garter Snake

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Ecosystem Service Targets
Groundwater Recharge
Freshwater Biodiversity

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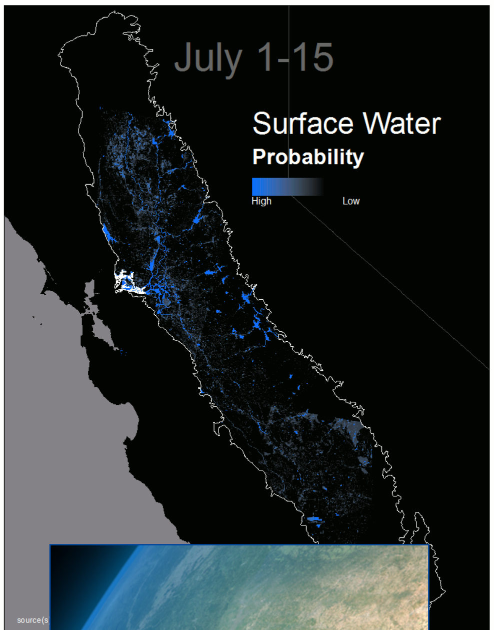

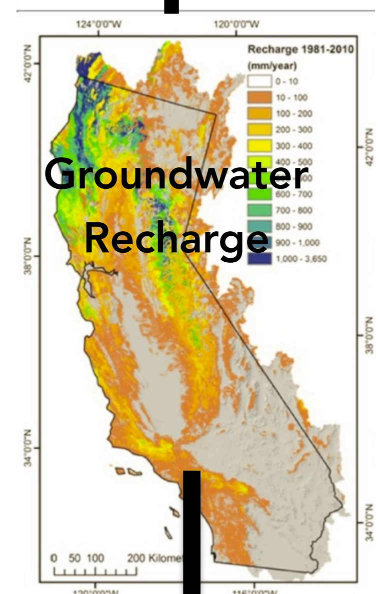

Coordinated Data-Driven Decision Support Optimizes Water Management to Achieve Multiple-Benefits for today and 100 years from now

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Objectives

1. **Multi-annual within-year forecasts** of wetland habitats, the distribution of wetland and open water dependent species, and groundwater recharge.
2. **Generate long-term projections (50-100 years) of flooded cropland and wetland habitat** in order to forecast wetland and open water dependent species, and groundwater recharge under multiple scenarios.
3. **Prioritize and strategically create an integrated network of wetland habitat on the landscape as part of large-scale coordinated conservation** to optimize focal wetland-dependent species and habitats, biodiversity, and groundwater recharge in the Central Valley both in the near-term (within year) and over the long-term (50-100 years).

YEAR 1 – Key Accomplishments

- Confirm/Refine Decision Making Need
- Initial decision support framework (“Water Tracker”)
- Gather ecological target data and identify key drivers
- Develop covariate data using remote sensing
- Integration of models for future scenario modeling

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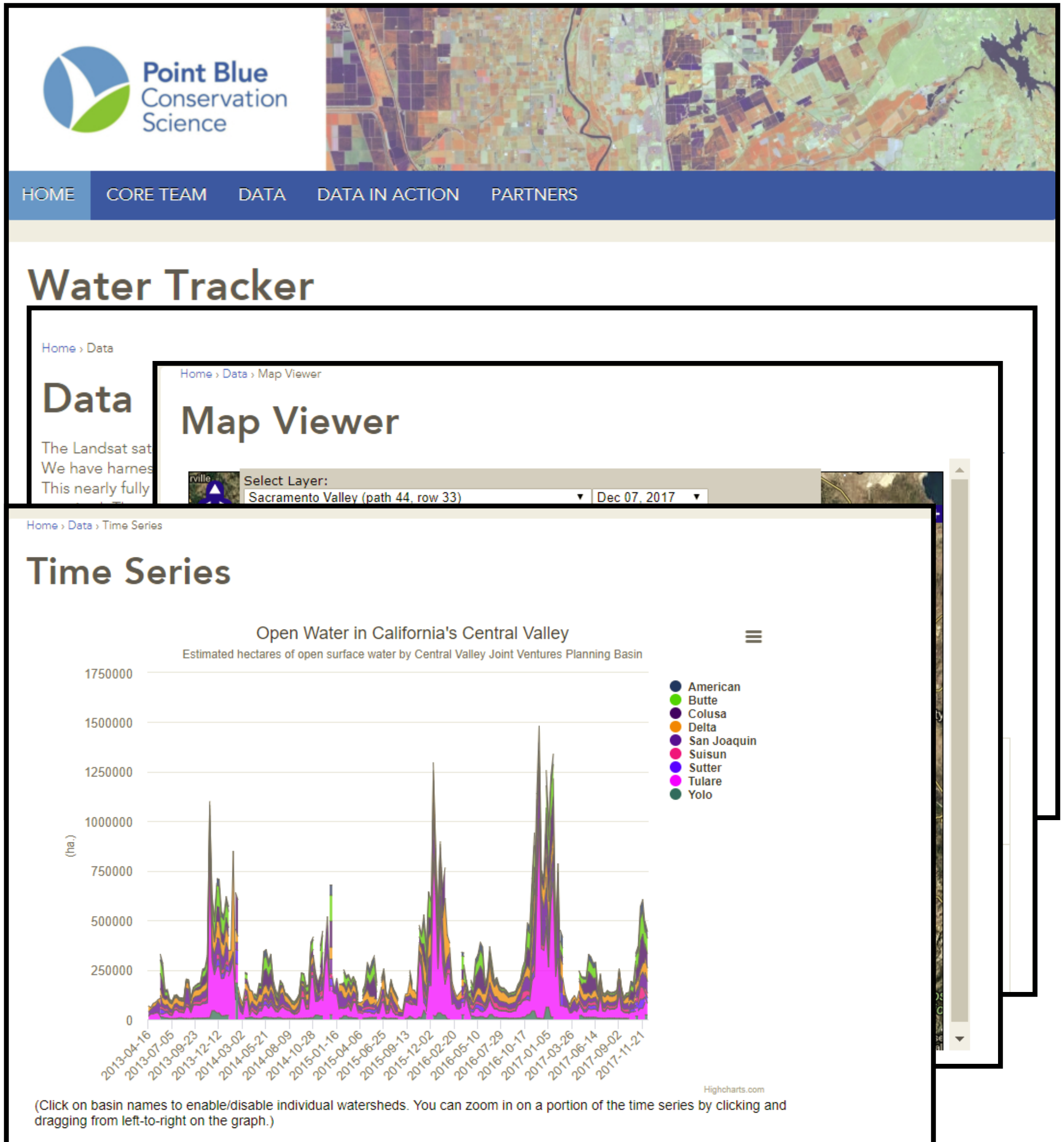
Confirm/Refine Decision Making Need

- TNC and USFWS representatives on the project team
- 6 stakeholder engagement workshops to clarify near-term and long-term decision making needs (50 individuals)
- **Decision:** Where to put water and when to have multiple-benefits? – Dynamic Conservation
- Identified key drivers of decisions

Near-Term (within year)	Long-Term (50-100 years)
Water allocation	Water availability and variability
Post-harvest crop management	Conversion to non-compatible crops
Wetland and crop productivity	Restoration progress
Decision Timing: March, July, January	**Decision Timing:** Variable
Stakeholders: TNC – BirdReturns; USFWS – annual management plans	**Stakeholders:** Central Valley Joint Venture – restoration TNC/USFWS – opportunity maps

Initial decision support framework



Distribution of open water and flooded wetlands and agriculture every 16-days

Collaboration of Point Blue, TNC, USFWS, and USGS

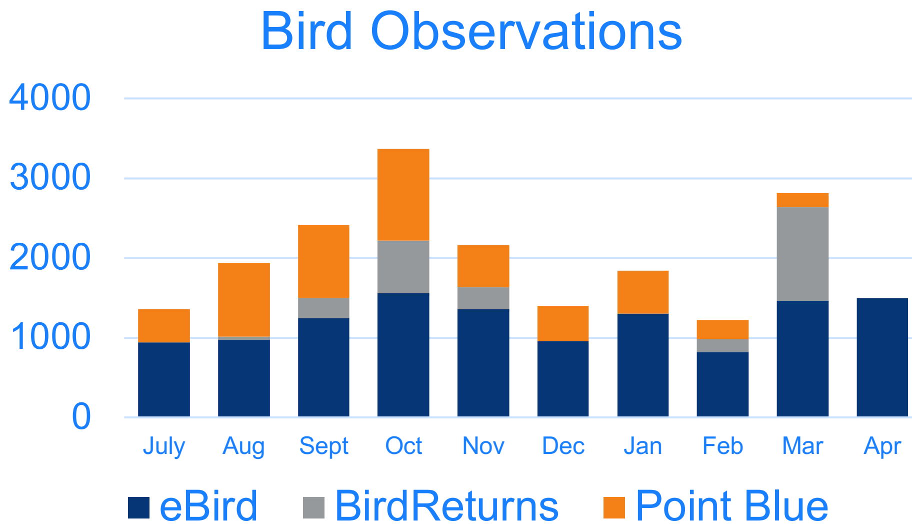
Freely available spatial data on open water for download

Map-based display

Time series of selected regions and cover types

www.pointblue.org/watertracker

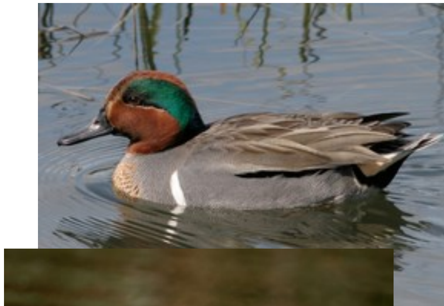
Gather data and assess key drivers

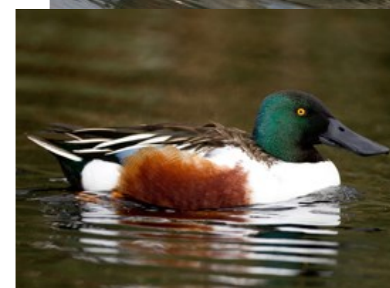


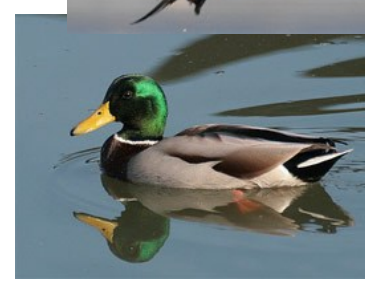
eBird (14,594) – all habitats
7.5% observations in flooded habitat

Point Blue (5,329) – wetlands, agriculture
79% in flooded habitat

TNC Bird Returns (2,544) – rice
80% in flooded habitat







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Gather data and assess key drivers

Giant Garter Snake

- Rice canals and wetlands provide marsh-like habitat during snakes' active period (late March – early October)

- Repeat visit, transect occupancy data since 2003

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Water drives intra- and inter-annual dynamics of habitat quality, variability and persistence….and habitat features are defined by phenology, season and management.

Develop covariate data using remote sensing

Product	Sensor	Dates	Species Models
Monthly surface water, flooded cropland and wetland	Landsat	2000 - 2018	Waterfowl, Shorebirds, Snakes
Fall flood-up vegetation structure	Landsat	2013 - 2017	Waterfowl, Shorebirds, Snakes
Summer peak moist soil seed plant distribution	Landsat	2007 - 2017	Waterfowl
Summer peak moist soil seed relative greenness and seed yield	Landsat	2007 - 2017	Waterfowl
Inter-annual wetland greenness stability, variance	Landsat	2001 - 2017	Waterfowl
Summer peak crop wet biomass (corn, rice, alfalfa)	Landsat	2013 - 2017	Waterfowl, Snakes
Annual fallow cropland	MODIS/Landsat	2001 - 2017	Waterfowl, Shorebirds, Snakes

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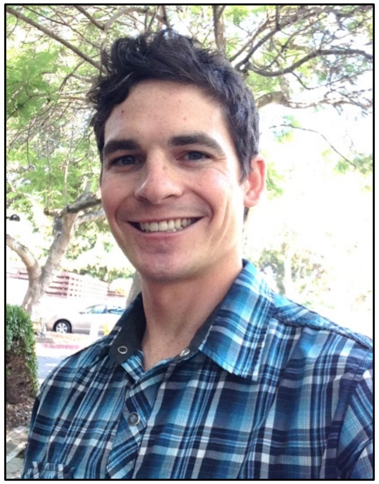
Summer 2017 field surveys

215 60m^2 plots surveyed

345 swamp timothy samples

4 USFWS refuges, 3 CA Wildlife Areas, 1 duck club



Austen Lorenz, remote sensing analyst (left), James Anderson, NAGT intern (right)

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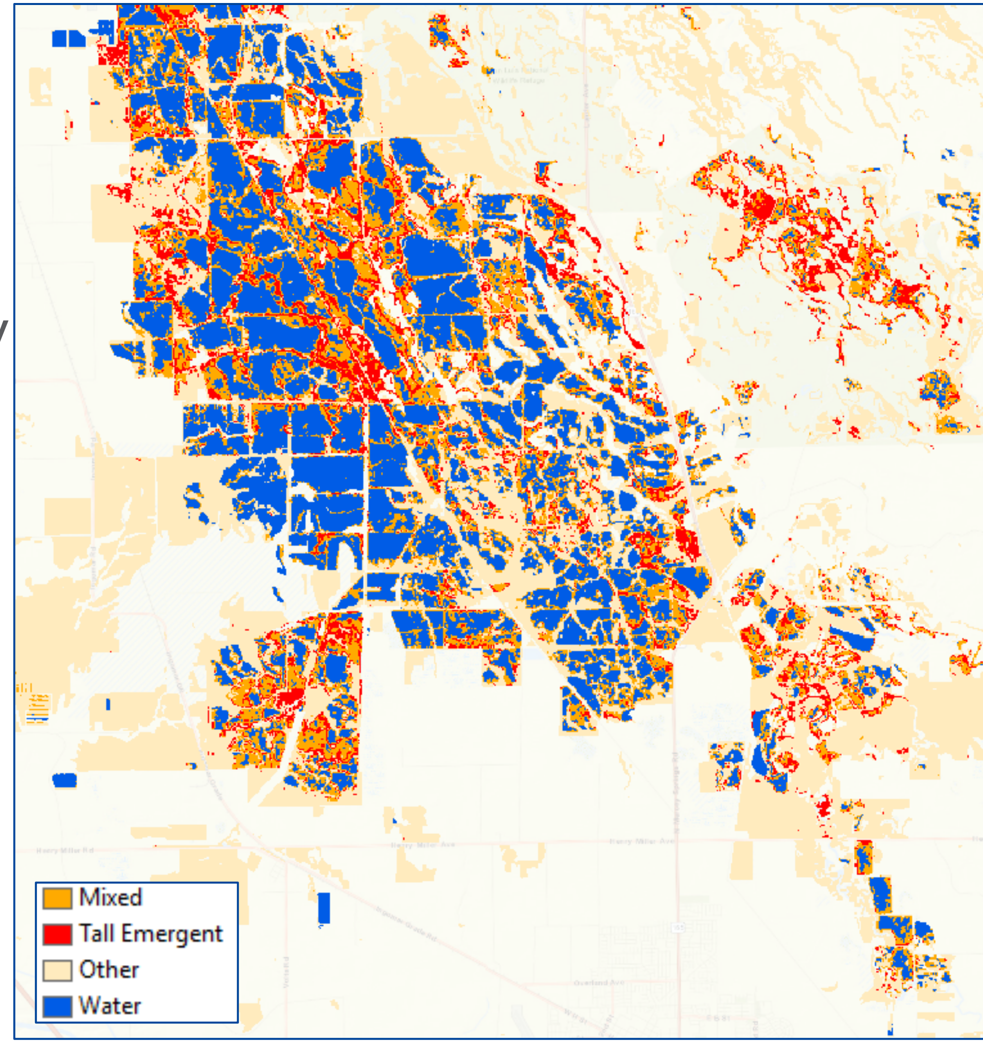
Fall flood-up vegetation structure

Tall emergent vegetation (cattails, bulrush)

From Landsat 8

Trained and tested with daily 3m Planet Labs imagery



2016 San Luis NWR, Los Banos, Volta

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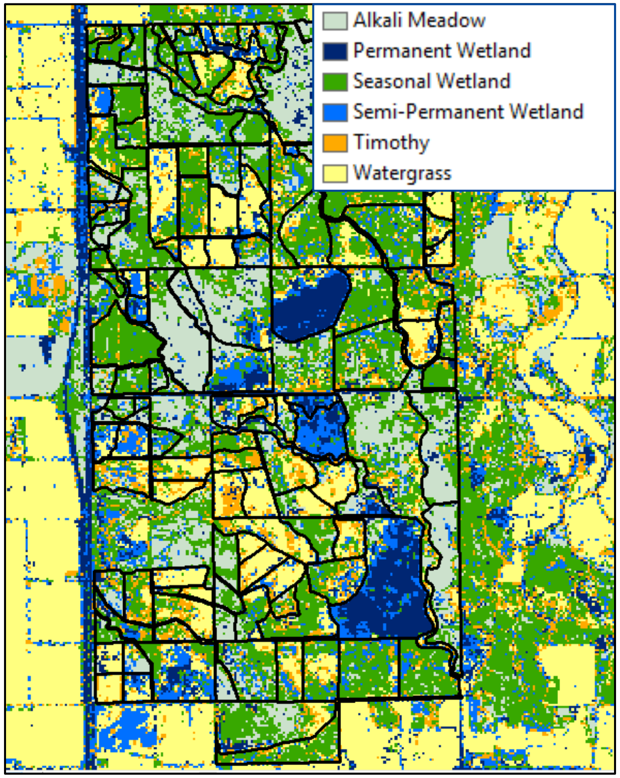
Summer moist soil seed distribution, production

10 yr Distribution, Acreage

Annual 30m Central Valley maps of swamp timothy, watergrass, and smartweed



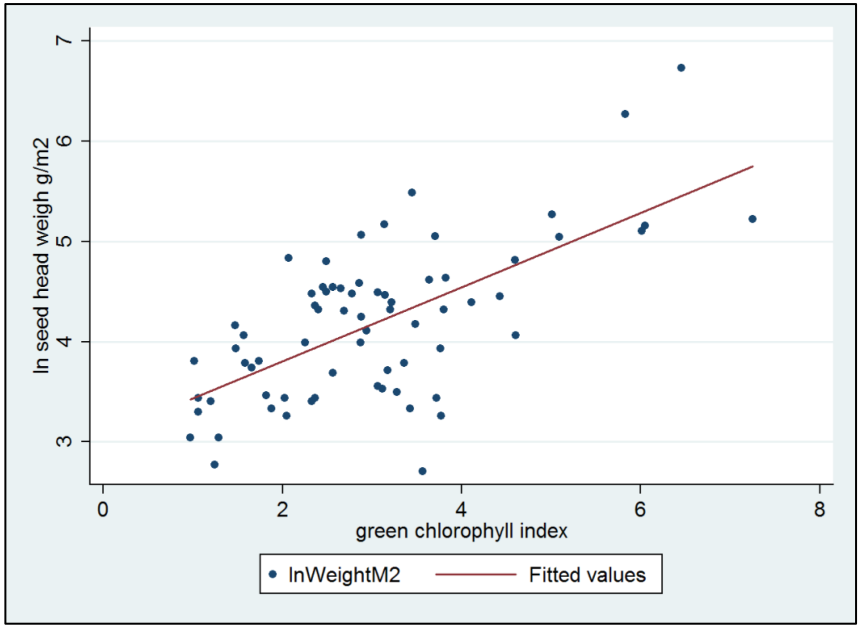
2017 Sacramento

Seed production (swamp timothy)

Regression of weight ~ GI + R/G

GI: green chlorophyll index, R/G: red/green simple ratio index

N=68; R^2 = 0.50; RMSE = 82 g/m^2

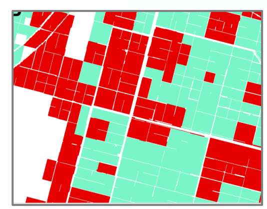


Integration of models for future scenario modeling

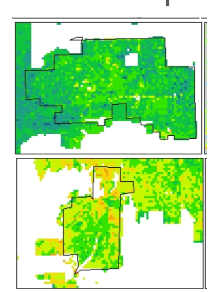
Central Valley Future Scenarios

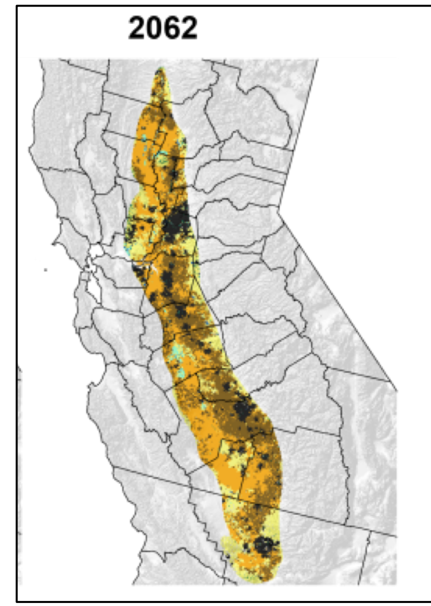
Flooding probability

Fallowland probability



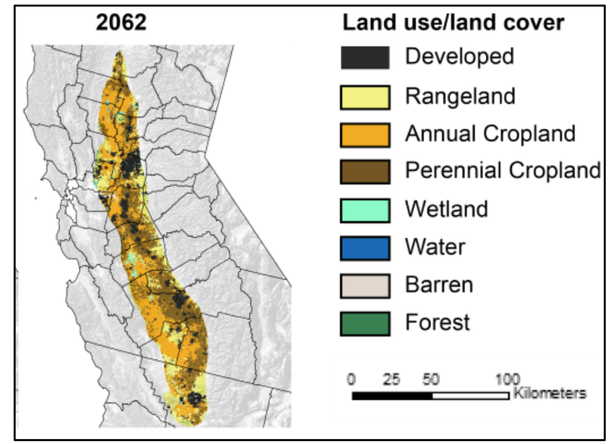
Greenness persistence

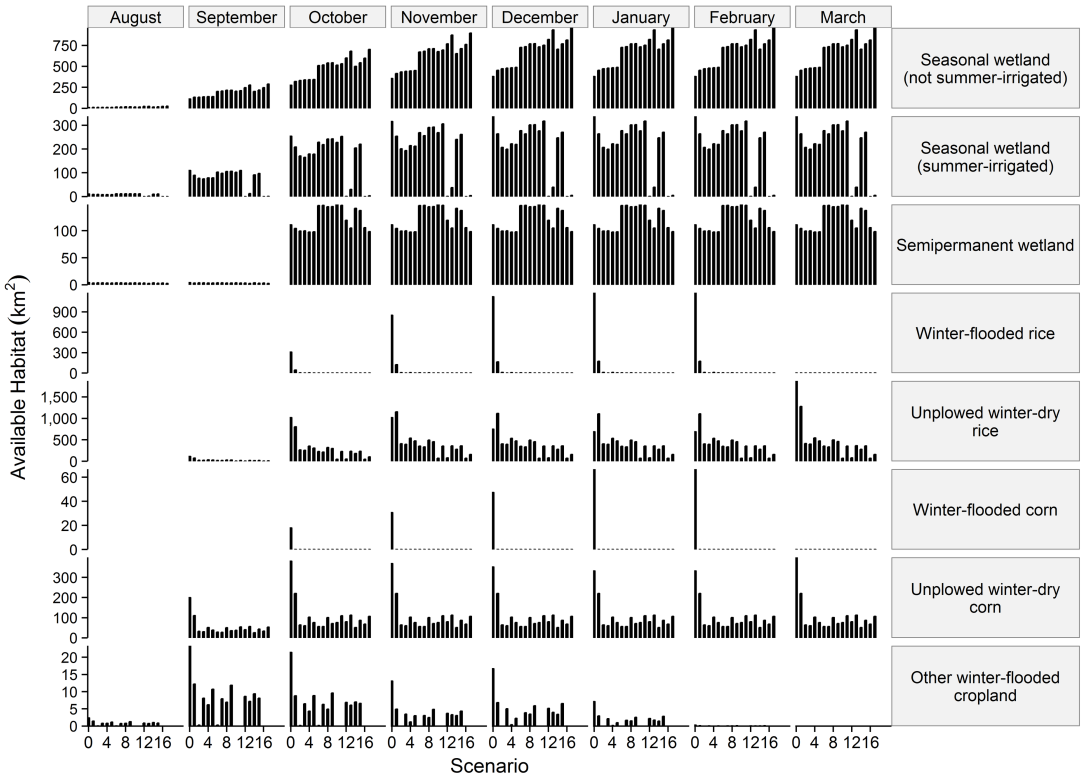




Integration of models for future scenario modeling

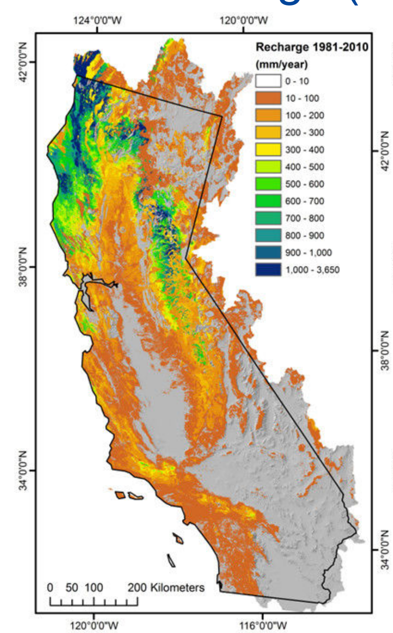
LUCAS (Wilson et al. 2016)





WEAP-CV (Matchett and Fleskes 2017)

BCM recharge (Flint et al. 2013)



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Next Steps

- Complete distribution models for all ecological and **ecosystem services targets**
- Complete **within year forecast models** for ecological and ecosystem services targets
- Complete **100 year Central Valley-wide forecasts** of the availability of essential drivers of ecological and ecosystem targets for multi-scenarios
- **Identify high priority sites** for habitat creation and ecosystem services
- **Make data products available** through an enhanced online system
- **Continued outreach to decision-making stakeholders** to ensure that data products are meeting needs