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
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Kick-off Meeting: May 2017
Water and the Central Valley
Central Valley Water Needs
Drought Challenges Water Management for Wetlands, Biodiversity & People
Coordinated Data-Driven Decision Support Optimizes Water Management to Achieve Multiple-Benefits for today and 100 years from now

Where to put water and when to maximize multiple benefits?

**Biological Targets**
- Waterfowl
- Shorebirds
- Giant Garter Snake

**Ecosystem Service Targets**
- Groundwater Recharge
- Freshwater Biodiversity

Groundwater Recharge

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

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

Bird Observations

- **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
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
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

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

215 60m² 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)
Fall flood-up vegetation structure

Tall emergent vegetation (cattails, bulrush)
From Landsat 8
Trained and tested with daily 3m Planet Labs imagery

7/24/2017

7/25/2017

2016 San Luis NWR, Los Banos, Volta
Summer moist soil seed distribution, production

10 yr Distribution, Acreage
Annual 30m Central Valley maps of swamp timothy, watergrass, and smartweed

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/m²

2017 Sacramento
Integration of models for future scenario modeling

Central Valley Future Scenarios

- Flooding probability
- Fallowland probability
- Greenness persistence

Bad Business As Usual
California Dreamin'
Central Valley Dust Bowl
Everyone Equally Miserable

Water Availability (low) Management for Conservation (good)
Integration of models for future scenario modeling

LUCAS (Wilson et al. 2016)

BCM recharge (Flint et al. 2013)

WEAP-CV (Matchett and Fleskes 2017)
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