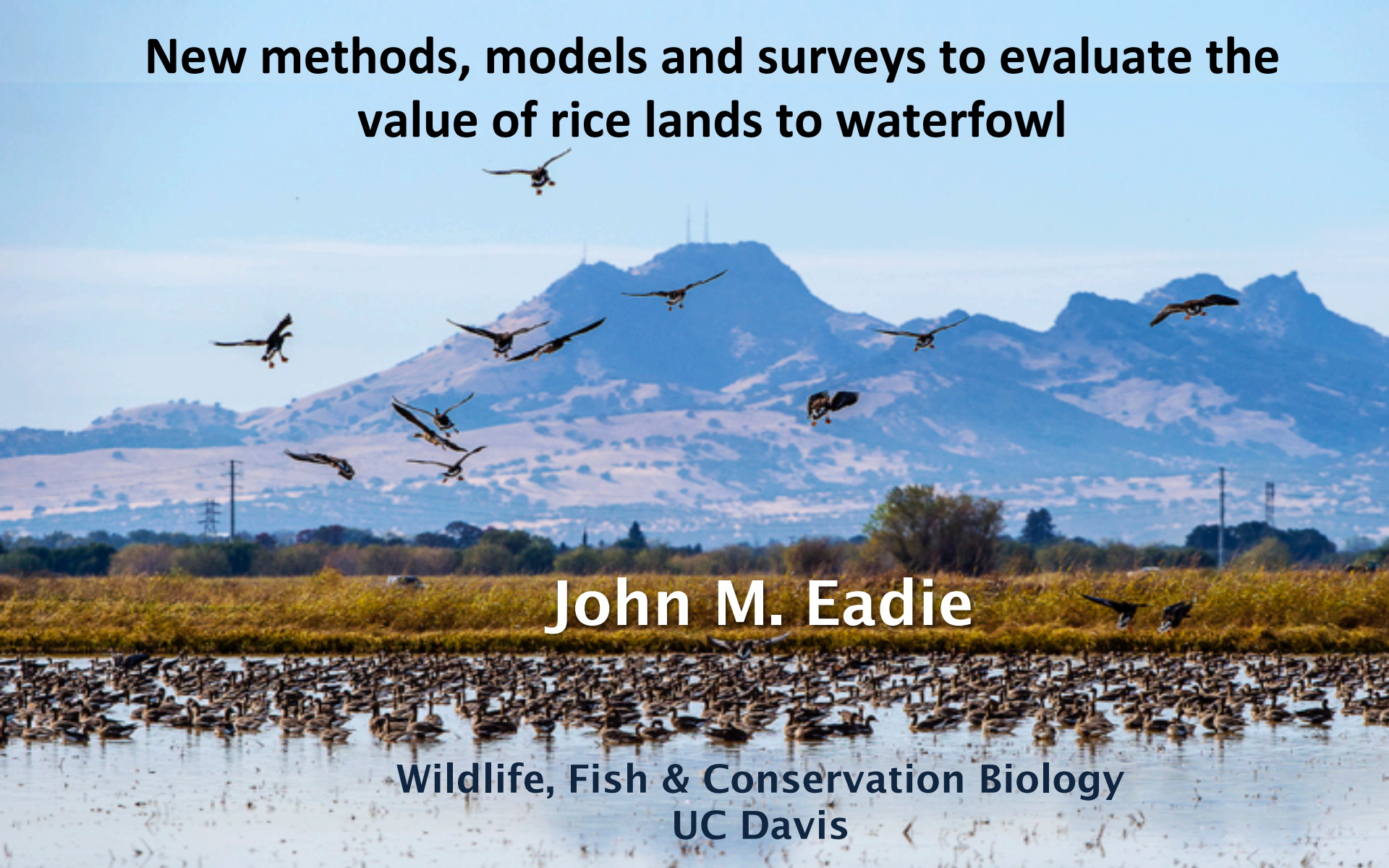
New methods, models and surveys to evaluate the value of rice lands to waterfowl



John M. Eadie

Wildlife, Fish & Conservation Biology
UC Davis

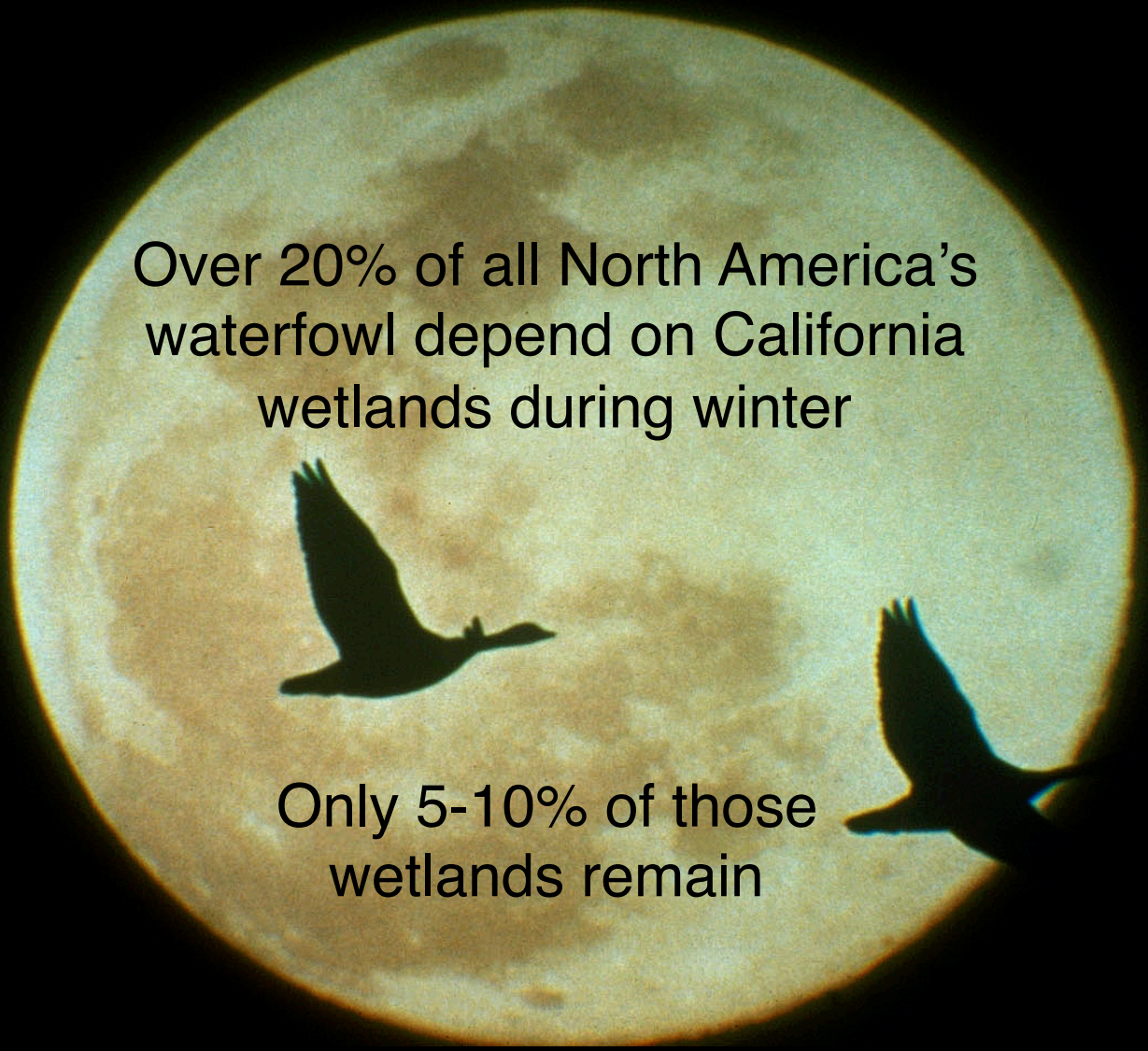
The importance of the Central Valley to migratory waterfowl

- 20% of North America's migratory waterfowl
- 60% of Pacific Flyway population
- 4–7 million birds annually

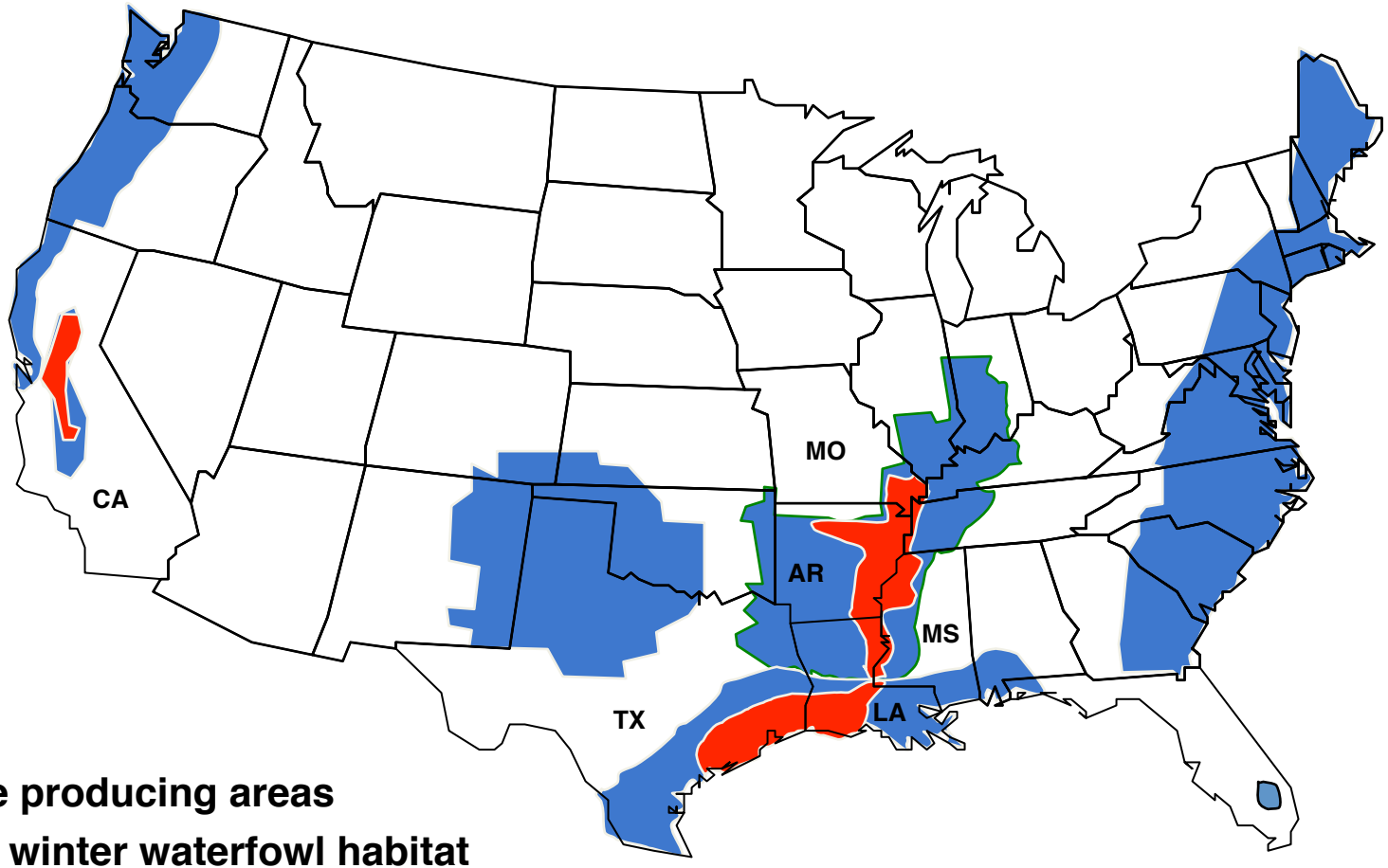
Wetlands of the Central Valley provide habitat for many other birds

350,000 SHOREBIRDS

> 700,000 SONGBIRDS


Over 20% of all North America's waterfowl depend on California wetlands during winter
Only 5-10% of those wetlands remain

Rice & Waterfowl



Rice producing areas

Key winter waterfowl habitat

Rice & Waterfowl

30 – 40 million kg waste grain

Feed 4 – 5 million birds for 150 days

What’s good for the grower is good for the goose

Central Valley Joint Venture

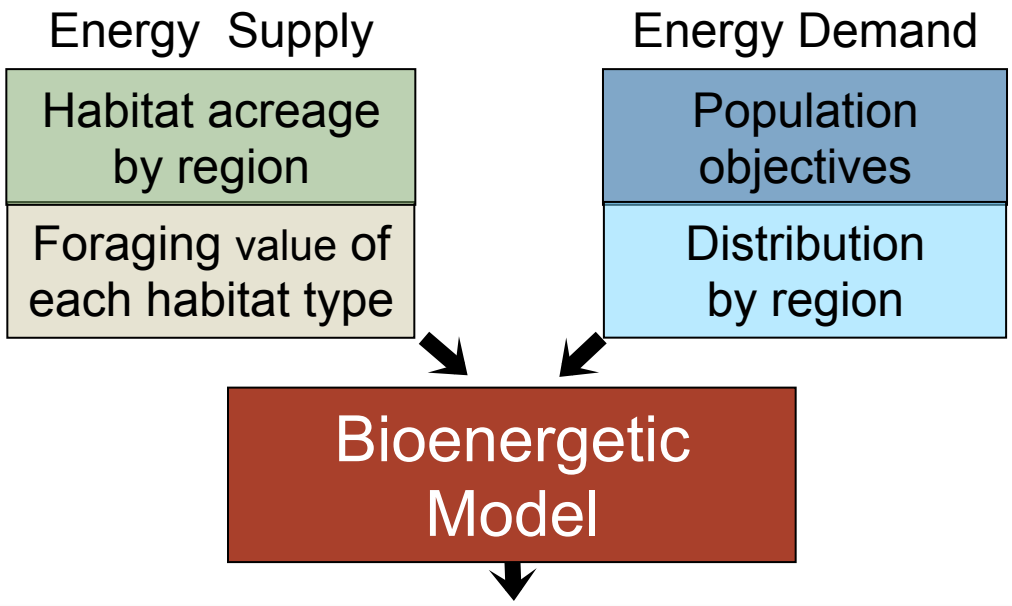
- How much habitat is needed to support current waterfowl populations?
- What types of habitats are needed to meet these objectives?
- Where in the Central Valley are these habitats needed?

Energy demands of waterfowl in winter

- Goal: to determine amount of foraging habitat needed to meet energy demands of desired waterfowl populations

Non-breeding region planning models

Duck energy days (DED) or
Duck use days (DUD)



$$\text{Acres needed} = \frac{\text{Number of Birds} * \text{Energy / bird}}{\text{Energy available / acre}}$$

Truemet – population energy demand (blue) vs. food supply (red)

CVJV at NAWMP goals

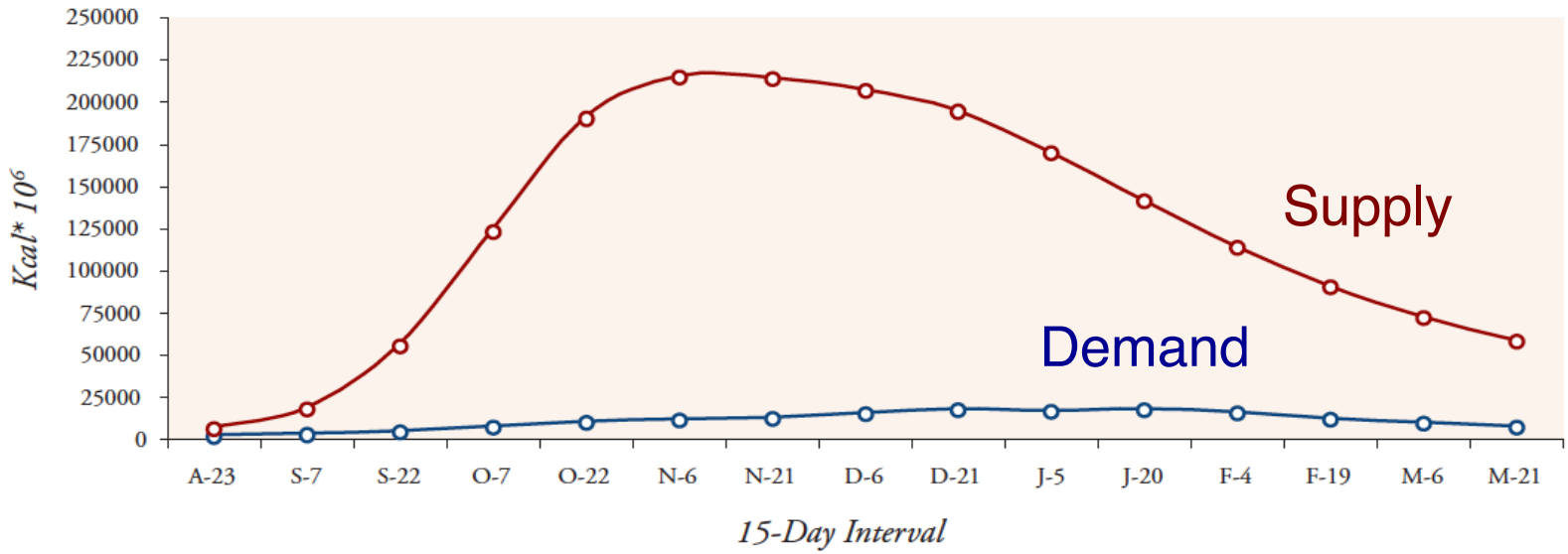


Figure 4-10. Population energy demand (blue) vs. food energy supply (red) for ducks in the Central Valley when duck populations are at NAWMP goals.

CVJV 2006 Implementation Plan

Drought & Ducks

- Less water for wetlands (public & private)
- Reduced rice flooding
- Less habitat, less food
- Greater concentration of birds & more disease

- Less water for summer habitat and broods
- Reduced support

Managing food, water and the environment

- Every wildlife conservation issue in California comes down to water
- Agriculture, urban, fish & endangered species (in-stream), wetland (out-of-stream) species
- How do we manage and plan for all these needs?
- Planning and decision support tools (wildlife management has fallen behind)

Spatially-explicit Waterbird Agent-based Modeling Program (SWAMP)

Matt Miller, Kevin Ringelman, Jeff Schank

DELTA WATERFOWL

Dennis G. Raveling
Endowed Waterfowl Chair
UCDAVIS
UNIVERSITY OF CALIFORNIA

SWAMP

Spatially-explicit Waterbird Agent-based Modeling Program

A decision tool for water, wetlands and waterbirds

- Spatially-explicit agent-based modeling program
- Evaluate behavior, resource use and resource needs for several million birds in Central Valley
- Evaluate effects of changes in land use, water allocations, agricultural practices on ability to sustain a desired population of waterbirds (and other wetland dependent wildlife)

SWAMP Agent-based Model

- Model 1.5 million birds, and their food, as individual agents (15 min time steps for 180 days) in Butte Basin
- Use established bioenergetic & physiological relationships
- Spatially-explicit (GIS) landscapes (rice, managed wetlands, refuges)
- Influence of water and land management on amount and distribution of each habitat type
- Influence of amount and distribution of each habitat type on energy budgets and sustainable populations

Scenarios

- Status quo (no drought)
- Dry-severe climate (drought) & expansive urbanization (all scenarios except baseline)
- **Wetland restoration goals met / not met**
- **Winter-flooded rice / rice idled (up to 80%)**

Scenario overview

Scenario	Climate	Urbanization	Wetland Restoration	Rice
1	Historical	Current	Current	Current
2	Dry-severe (GFDL A2)	Expansive	Restoration goals met	Current
3	Dry-severe (GFDL A2)	Expansive	**No restoration**	Current
4	Dry-severe (GFDL A2)	Expansive	Restoration goals met	**Rice Idled**
5	Dry-severe (GFDL A2)	Expansive	**No restoration**	**Rice Idled**

Water and Habitat Modeling

Joe Fleskes, Elliott Matchett USGS & David Purkey SEI

- Identified fine-scale hydrological units (HUs) within CVJV basins characterizing waterbird habitat conservation goals, water supplies and demands, and management of water supplies and drainage
- Used WEAP (Water Evaluation And Planning model) to translate land and water resources output from the scenario modeling tool (WEAP-CVwh) into habitat areas supported by projected water supplies

WEAP (Water Evaluation And Planning)

- Water supplies, demands, and delivery in part of Butte Basin, CA
- WEAP represents these as a system of links and nodes
- **Links**: water transmission to demand sites (green arrows), rivers (blue arrows), diversions (orange arrows).
- **Nodes**: surface storage reservoirs (green triangles), catchments (green circles), streamflow requirements (purple circles with crosshairs), streamflow gages (blue circles with arrows).

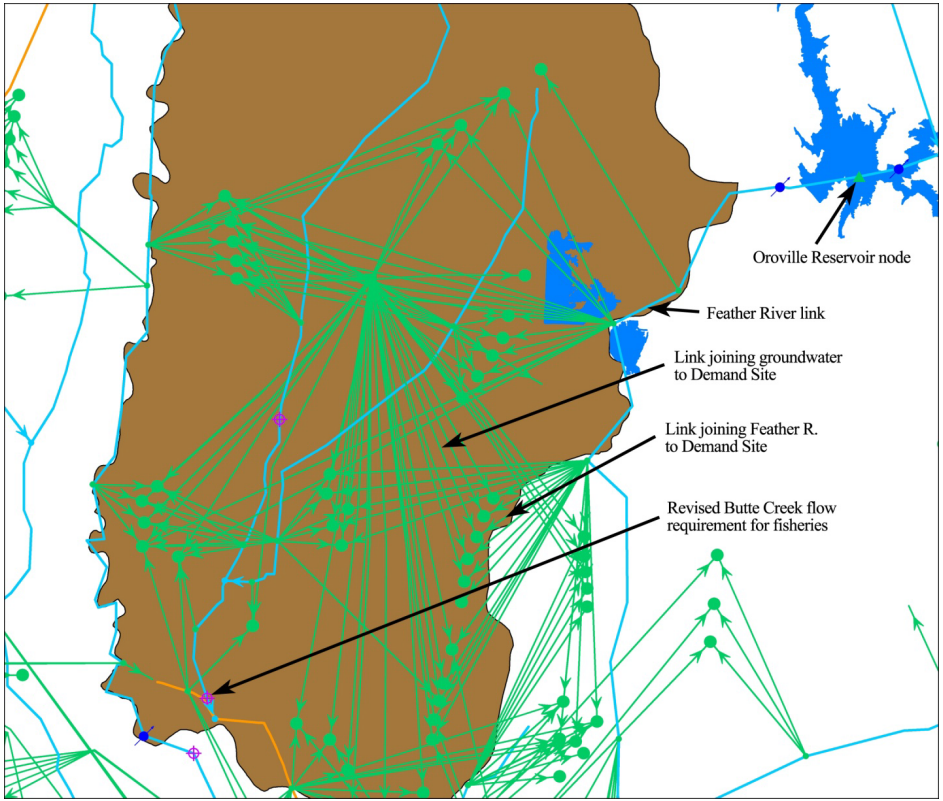
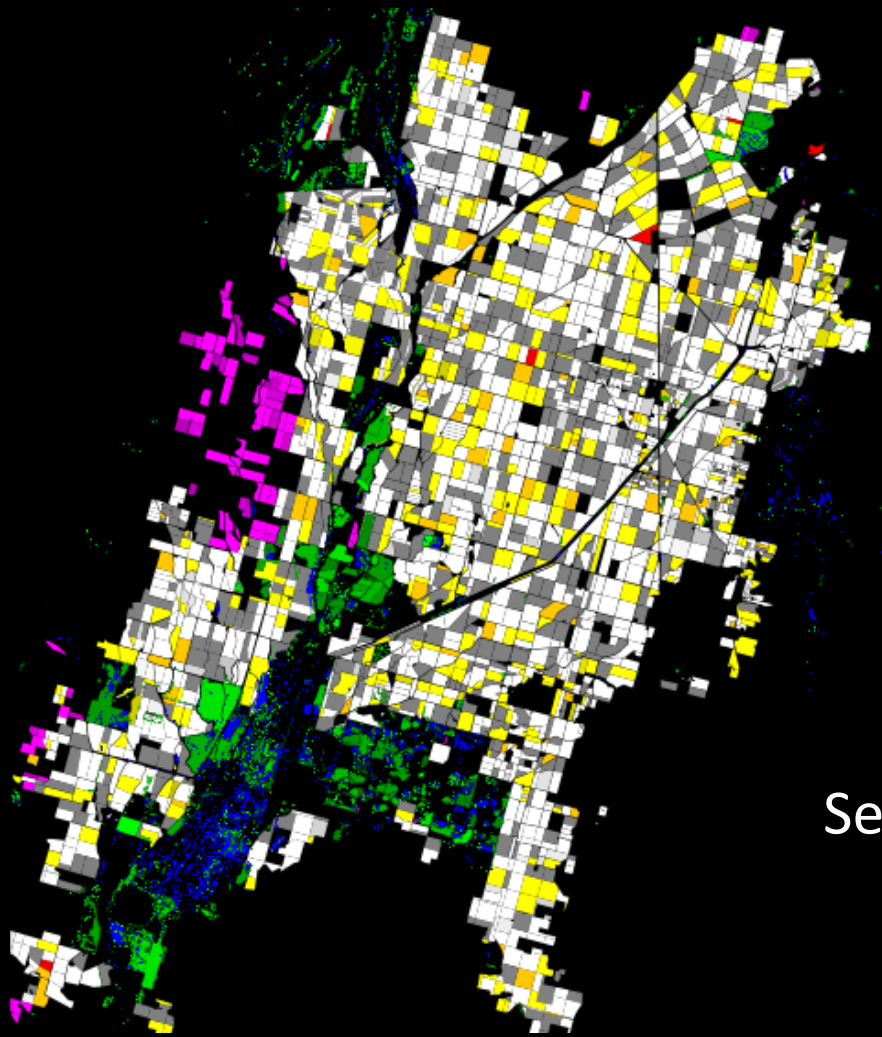


Image Landsat
14.05 mi

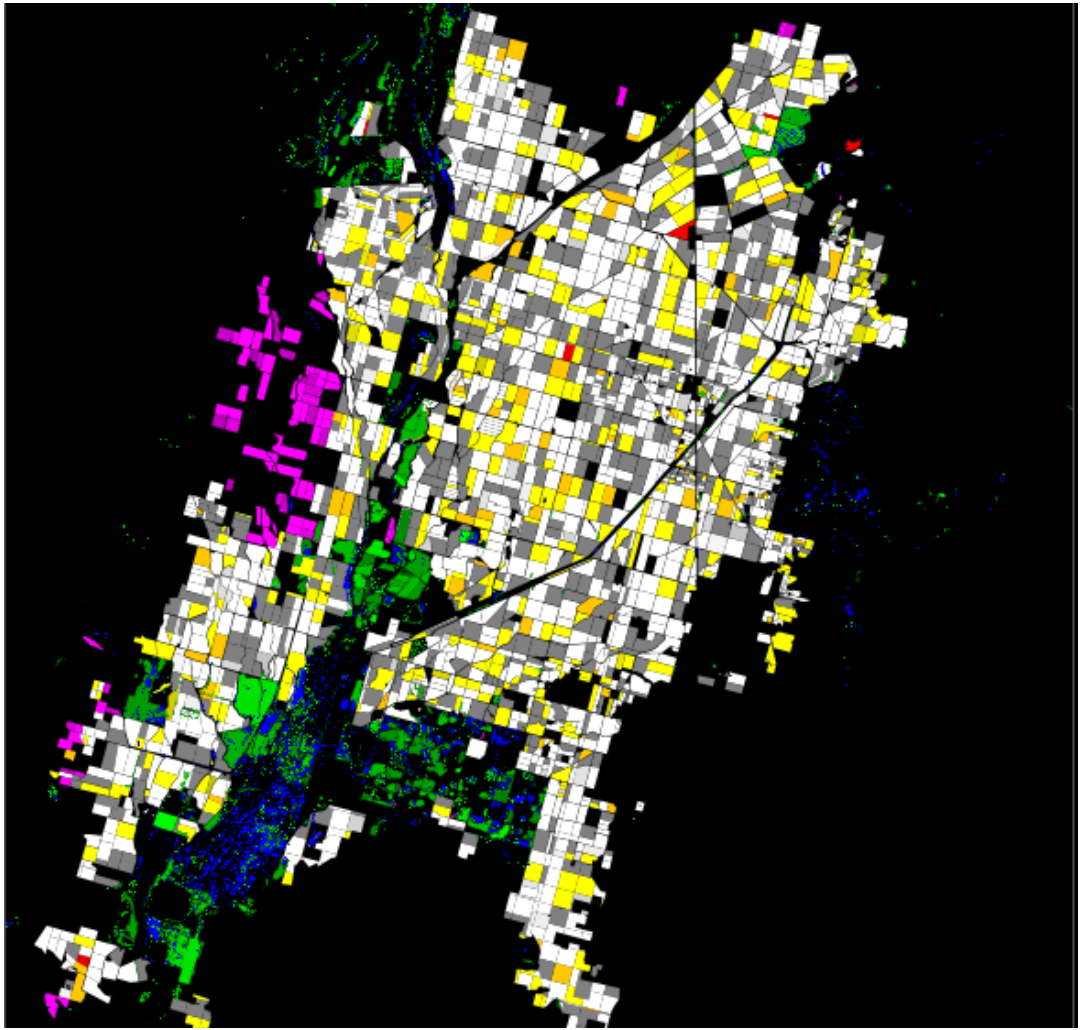


HABITATS

- Winter flooded rice
- Urban/non-habitat
- Corn
- Seasonal wetlands
- Semi-permanent wetlands

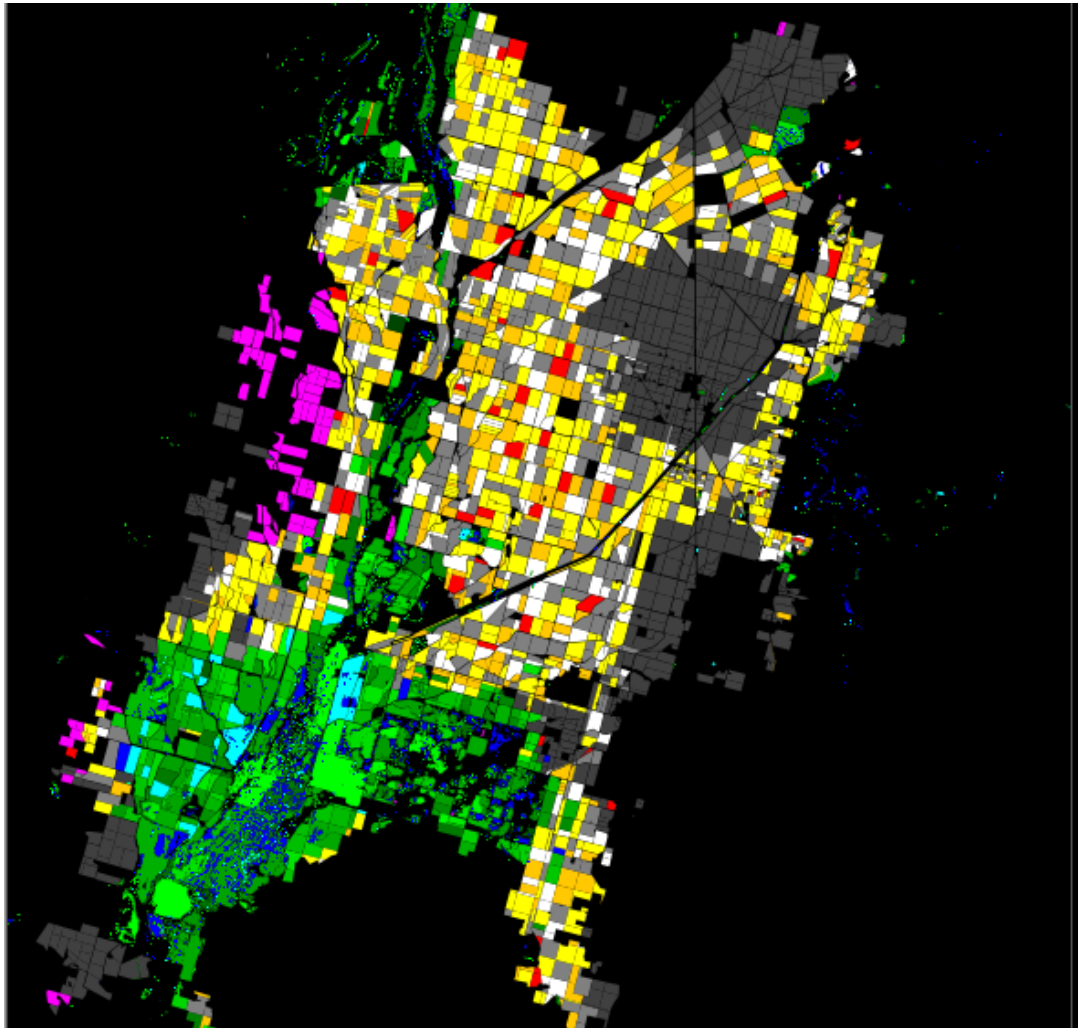
Scenario 1 (Baseline)

- Current climate
- Current urbanization
- Current wetland restoration
- Current winter flooding of rice



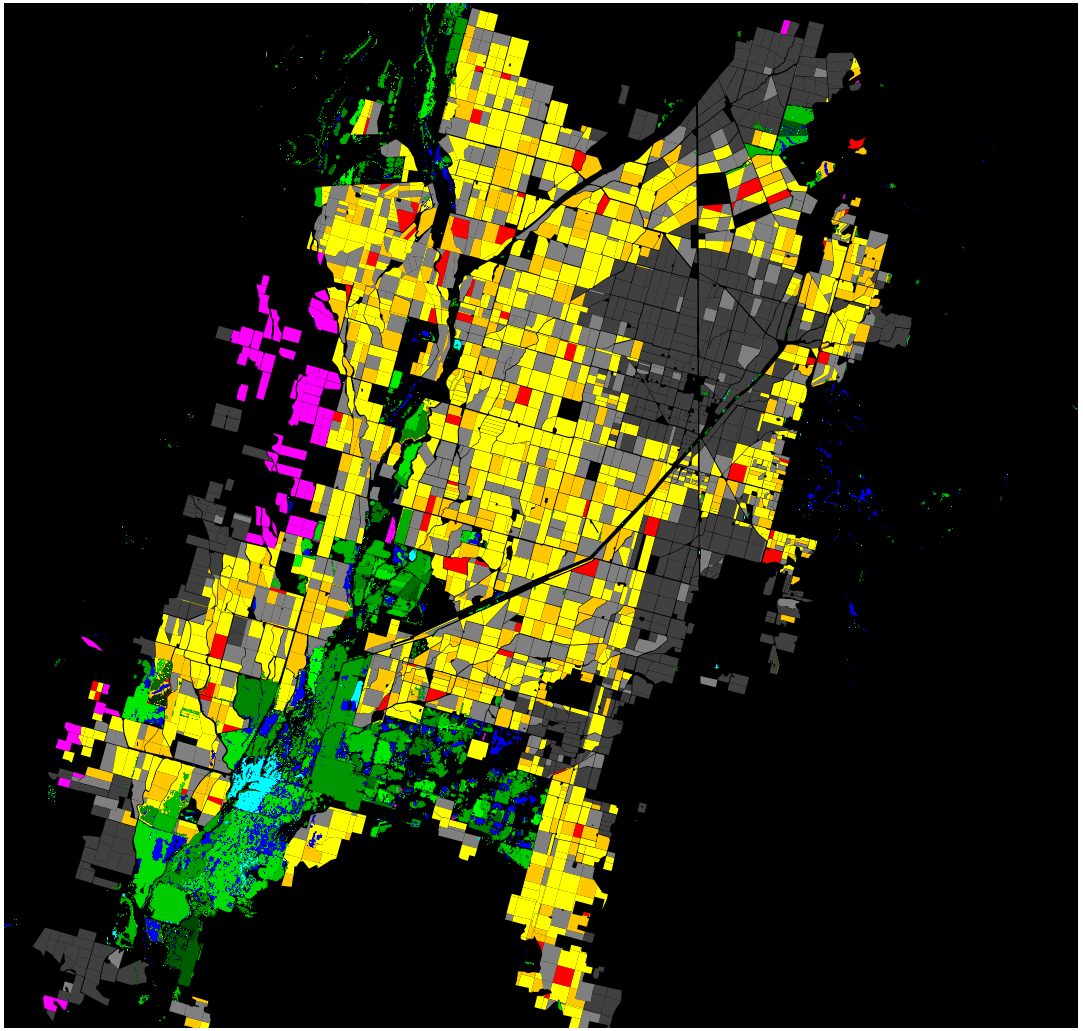
Scenario 2

- Dry-severe climate
- Expansive urbanization
- Wetland restoration goals met
- Current winter flooding of rice



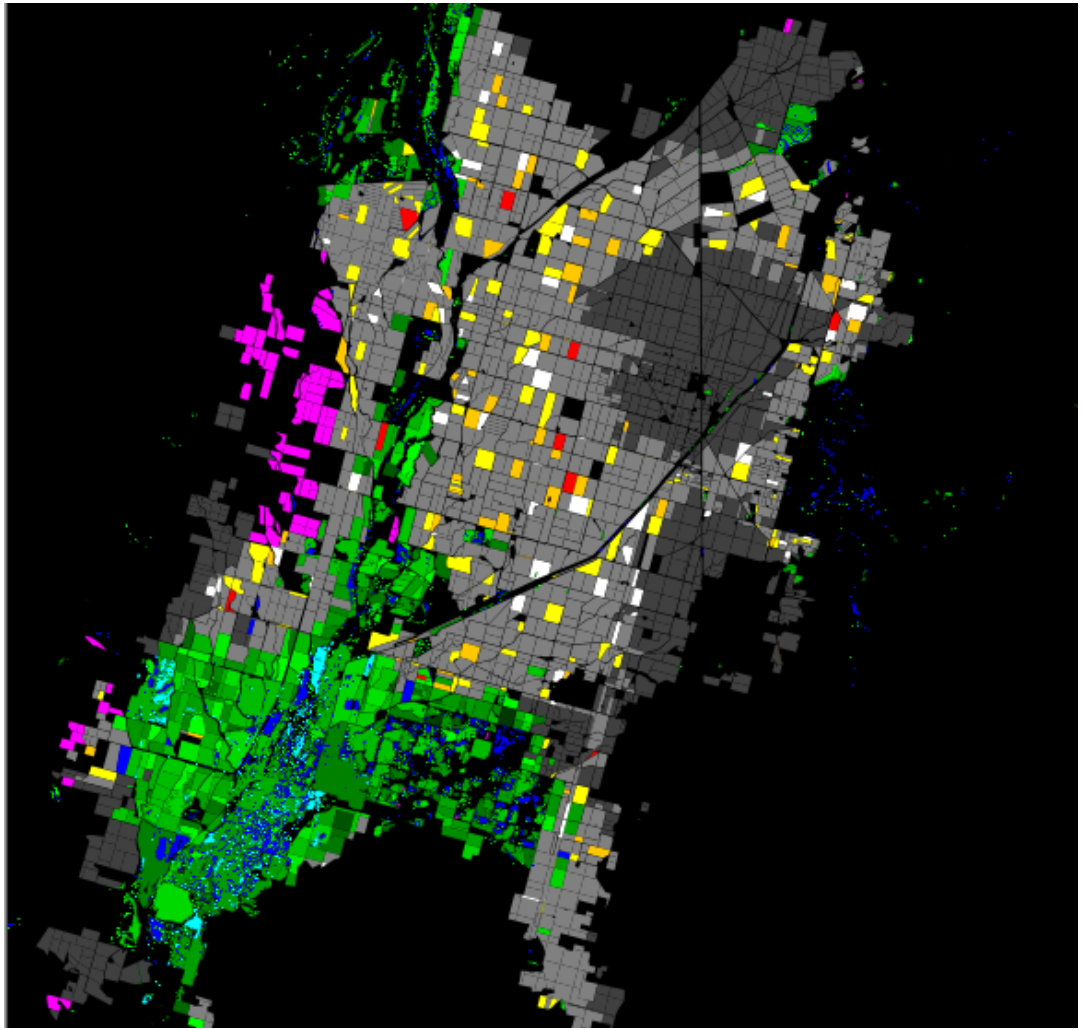
Scenario 3

- Dry-severe climate
- Expansive urbanization
- Wetland restoration goals NOT met
- Current winter flooding of rice



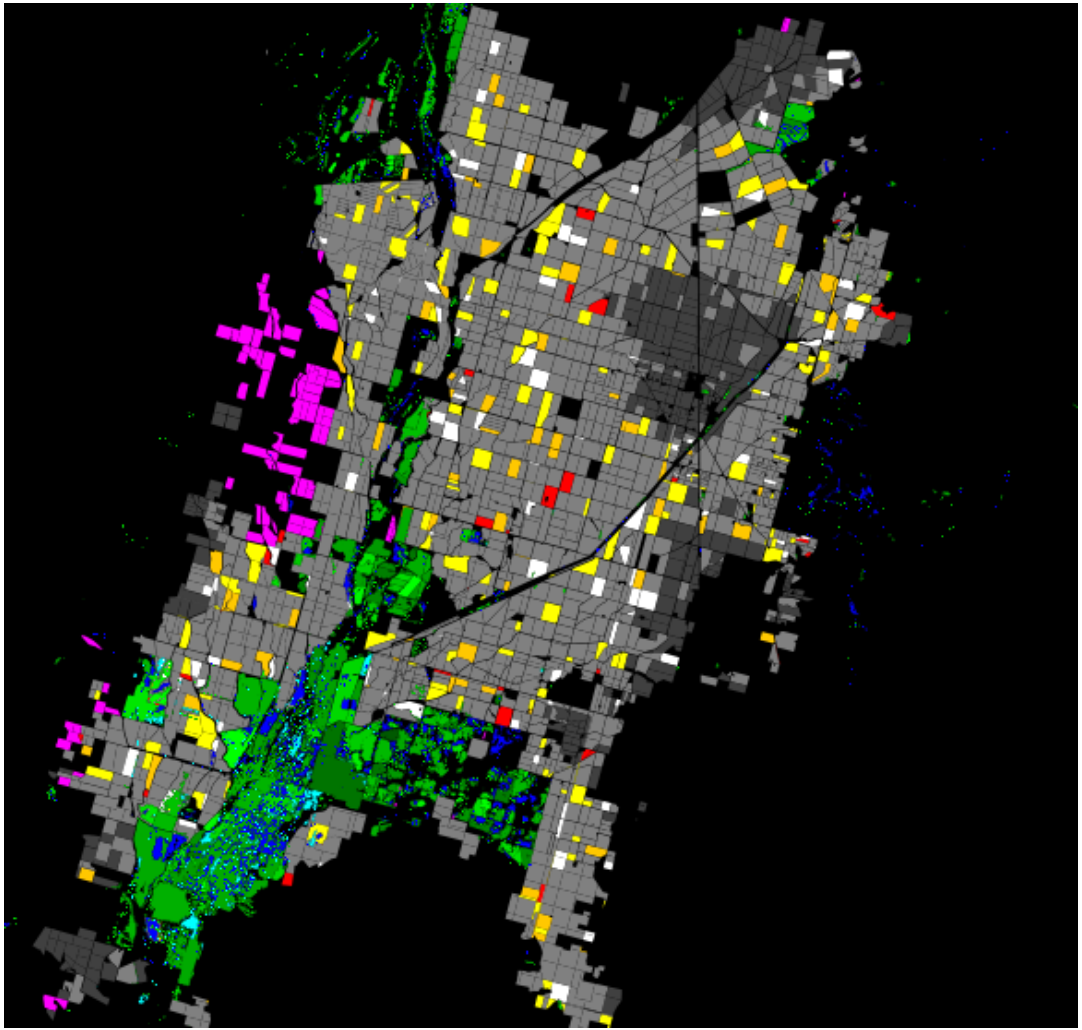
Scenario 4

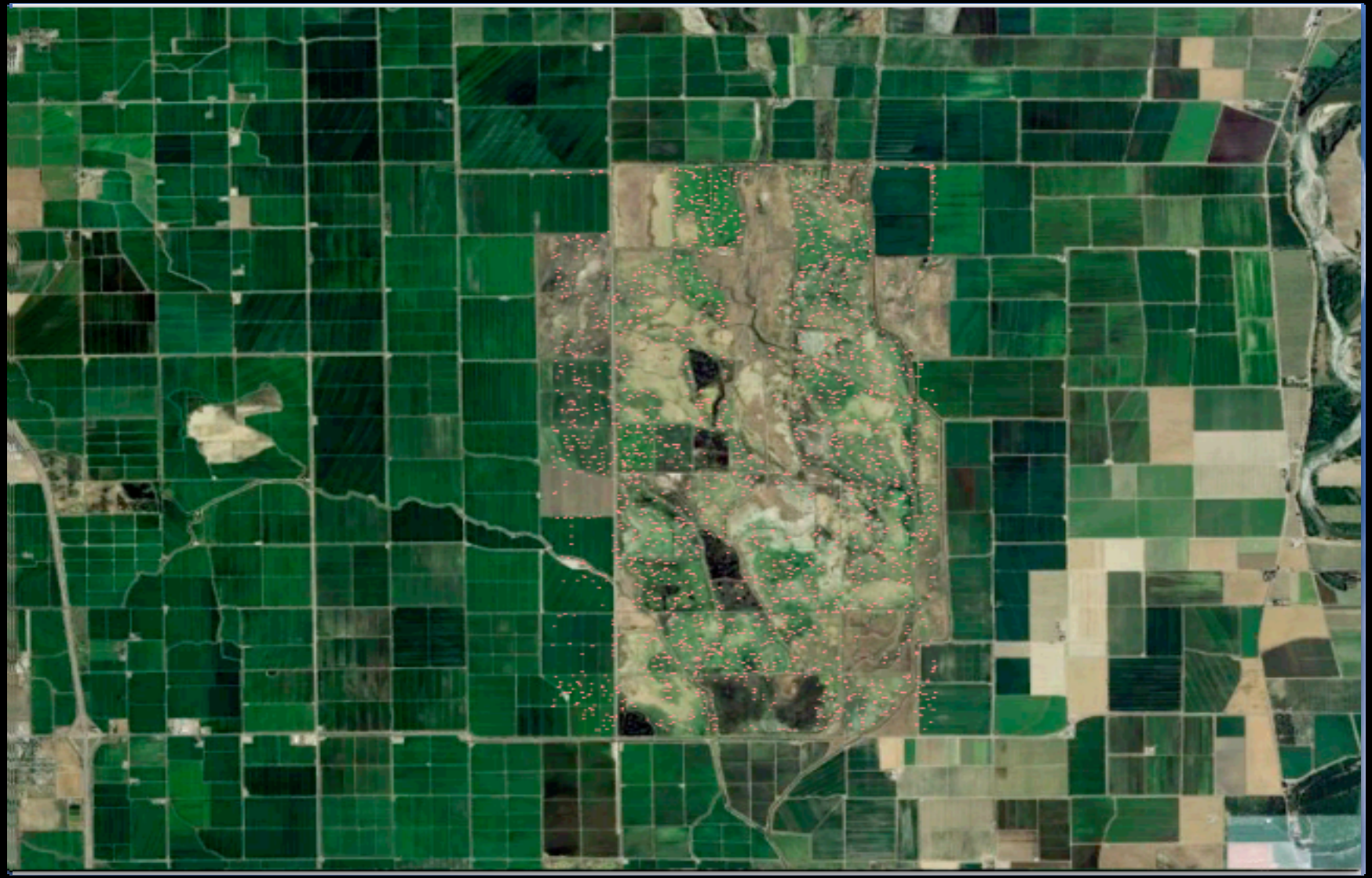
- Dry-severe climate
- Expansive urbanization
- Wetland restoration goals met
- Idling of rice

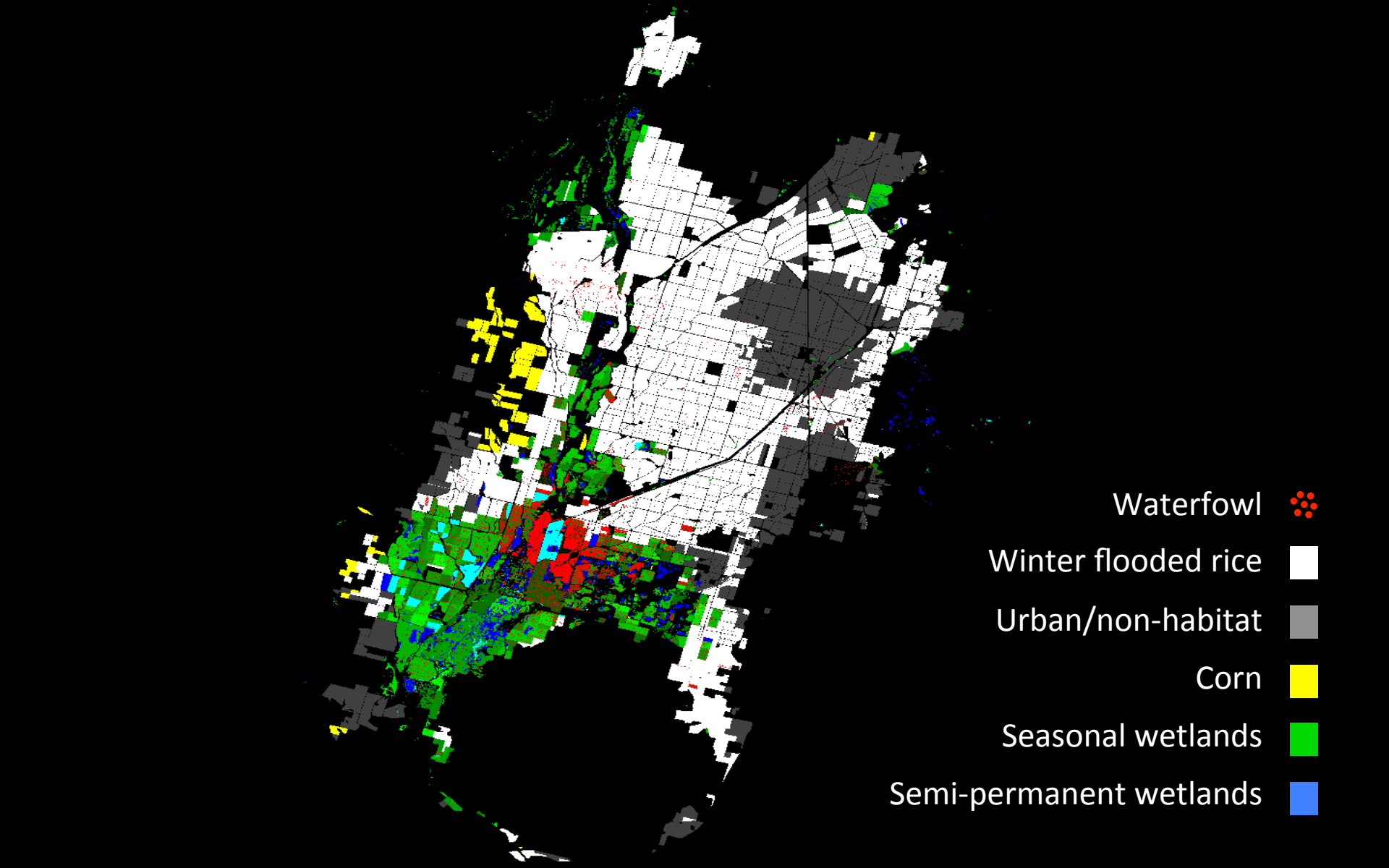


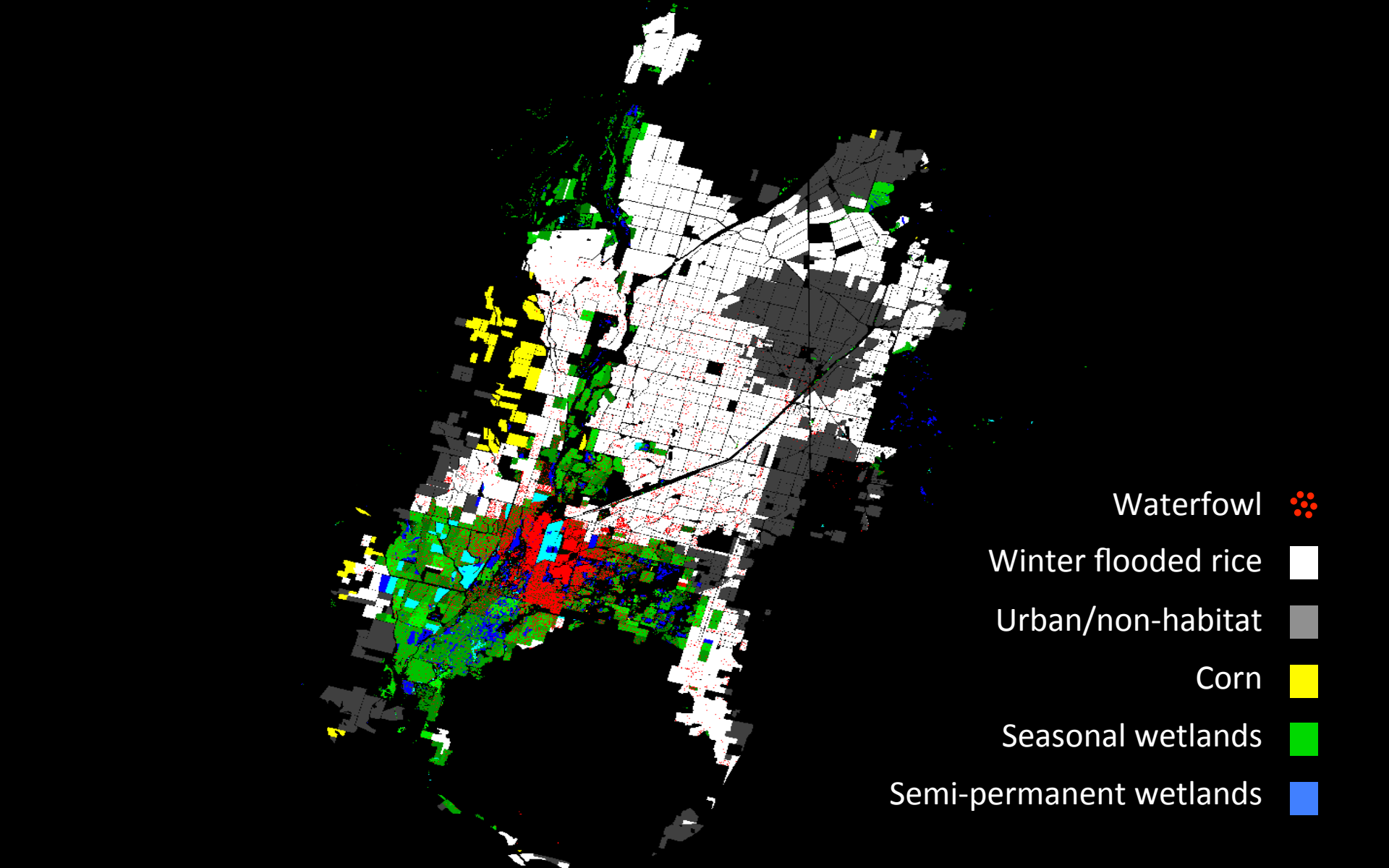
Scenario 5

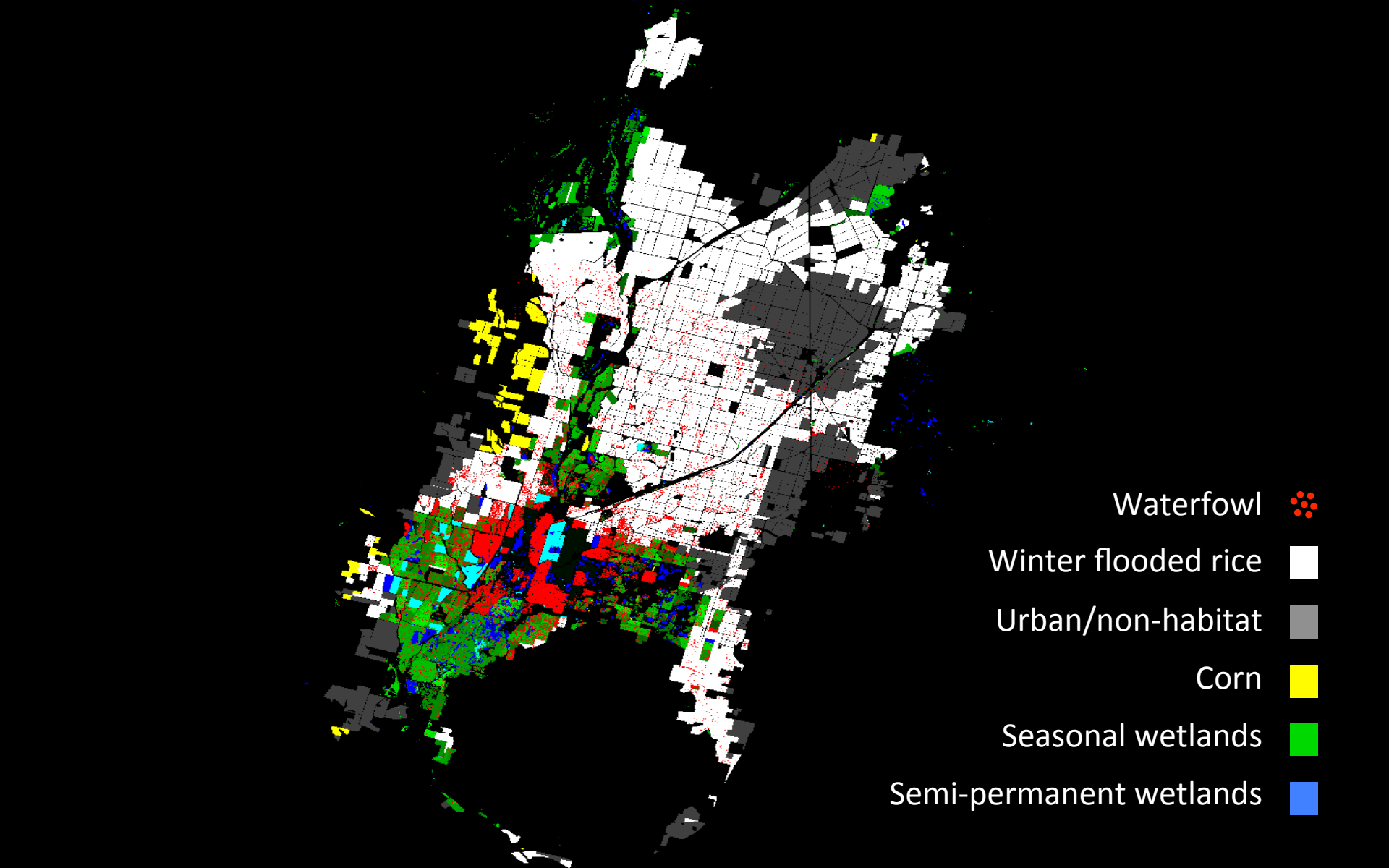
- Dry-severe climate
- Expansive urbanization
- Wetland restoration goals **NOT** met
- Idling of rice

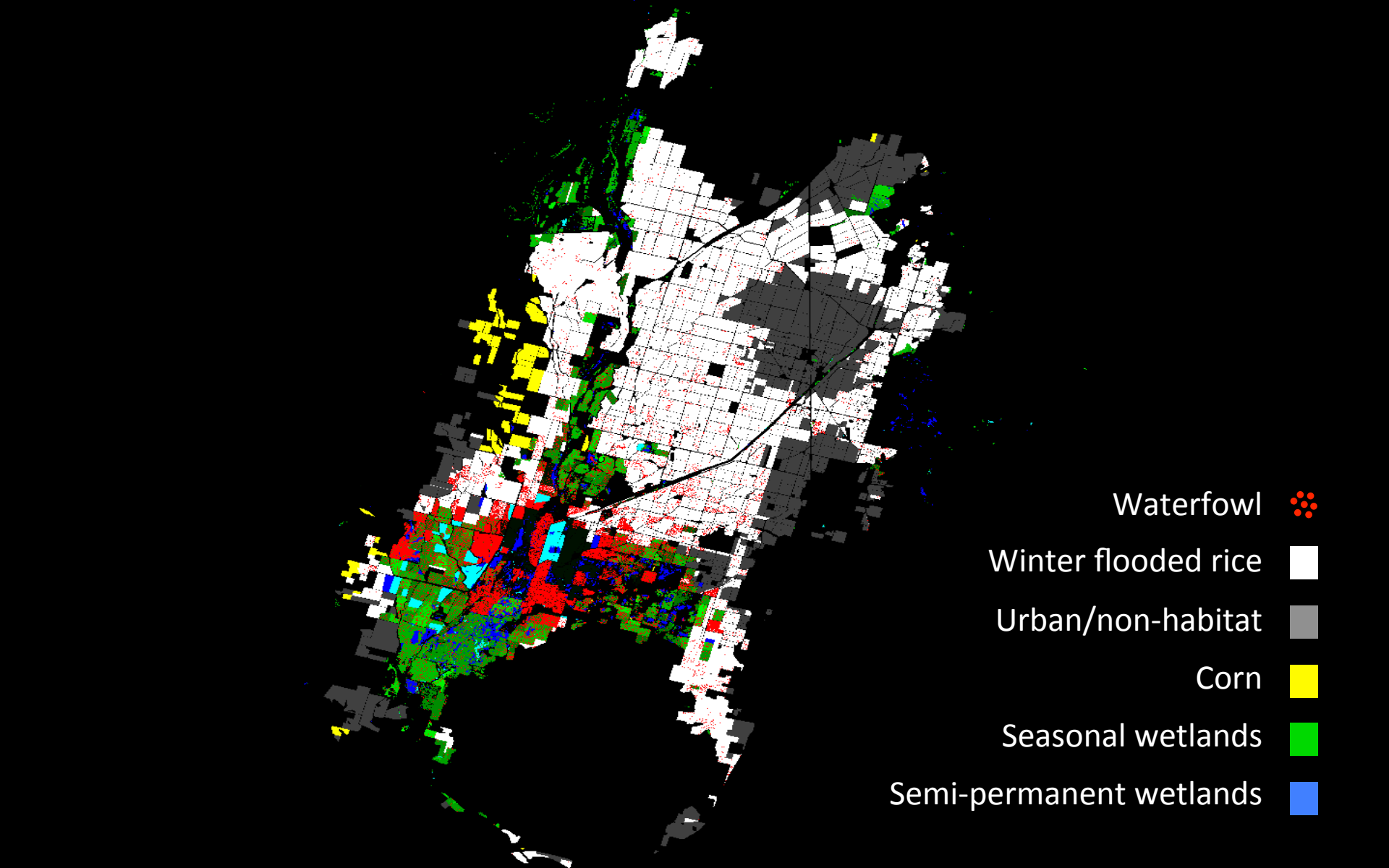




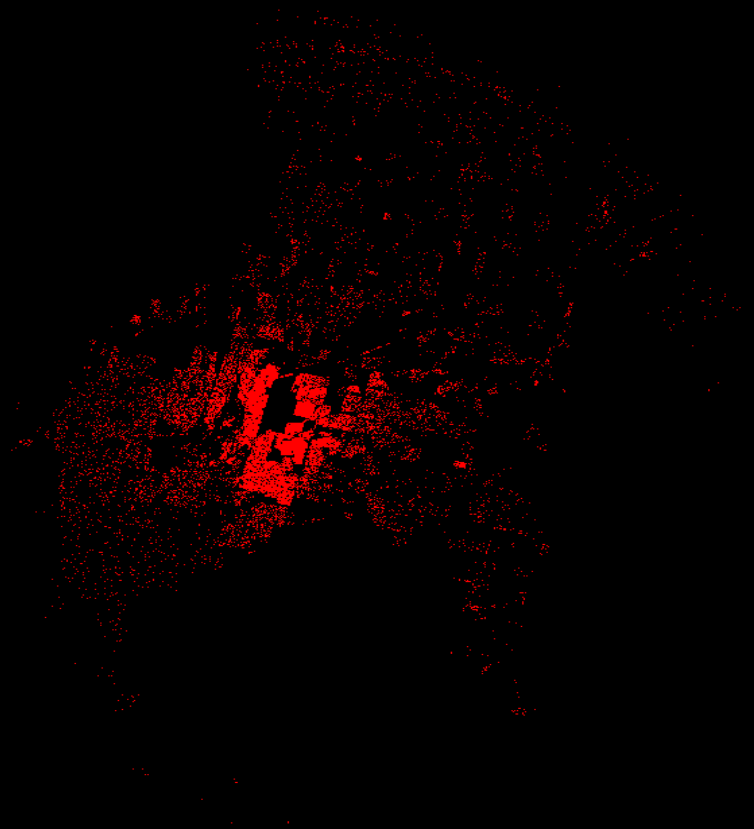

Waterfowl
Winter flooded rice
Urban/non-habitat
Corn
Seasonal wetlands
Semi-permanent wetlands

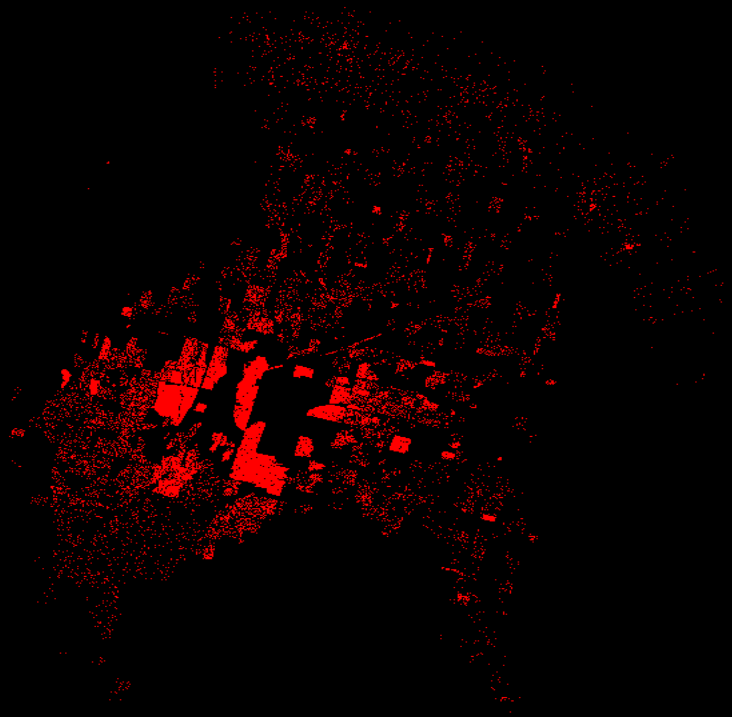

Waterfowl
Winter flooded rice
Urban/non-habitat
Corn
Seasonal wetlands
Semi-permanent wetlands

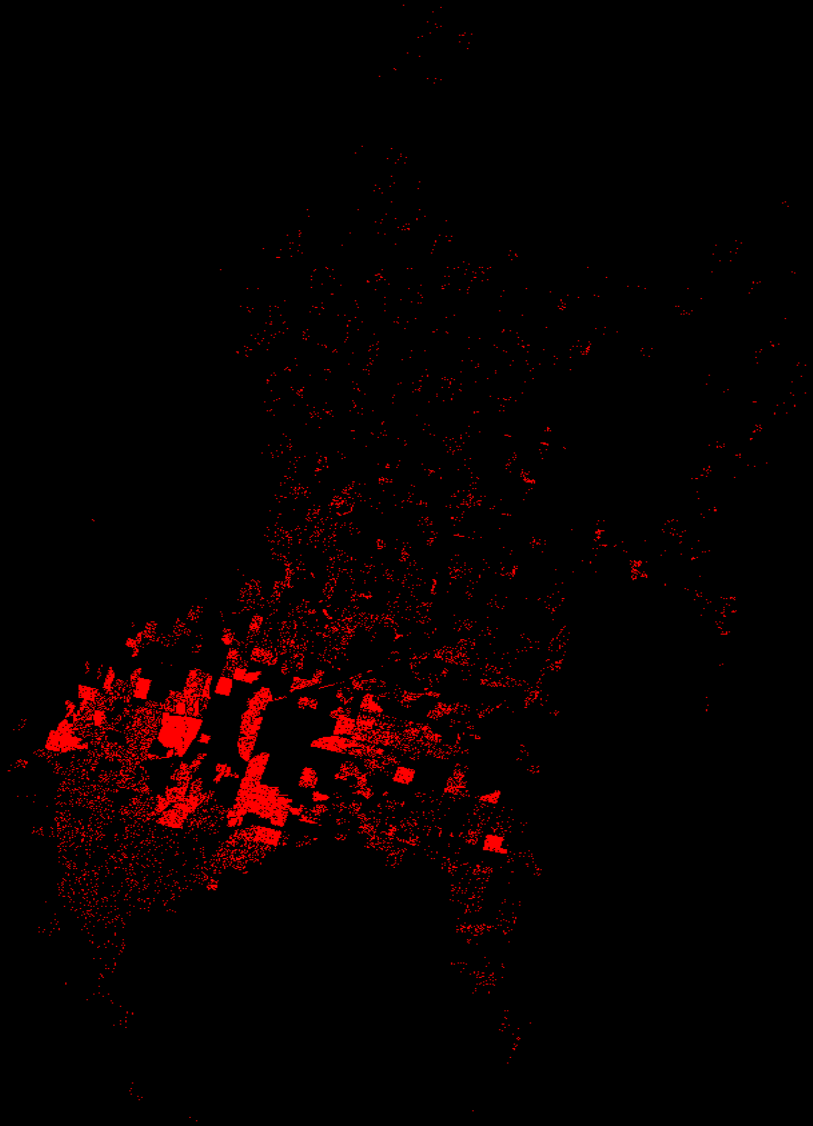

Waterfowl
Winter flooded rice
Urban/non-habitat
Corn
Seasonal wetlands
Semi-permanent wetlands

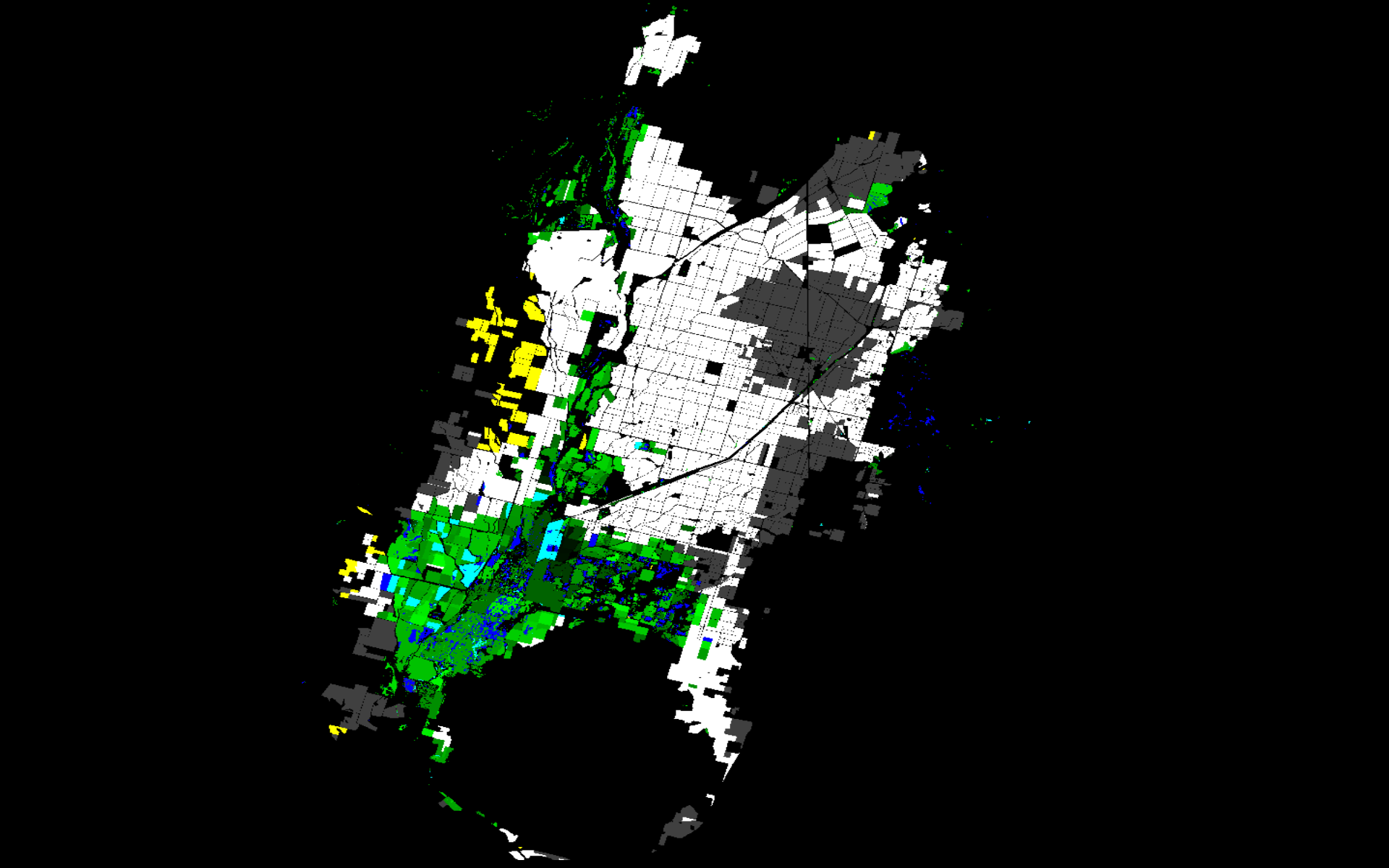

Waterfowl
Winter flooded rice
Urban/non-habitat
Corn
Seasonal wetlands
Semi-permanent wetlands

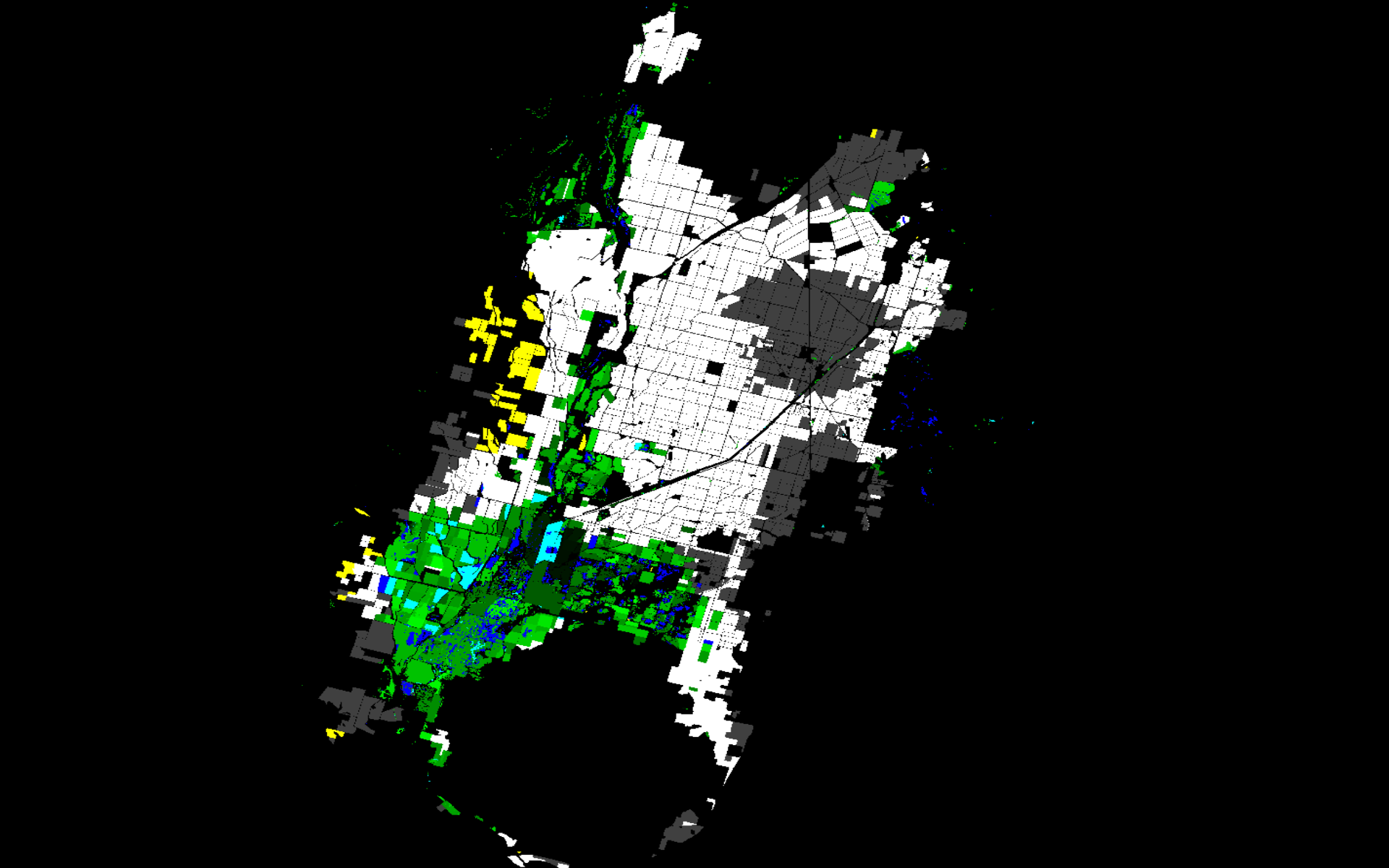
Waterfowl distribution

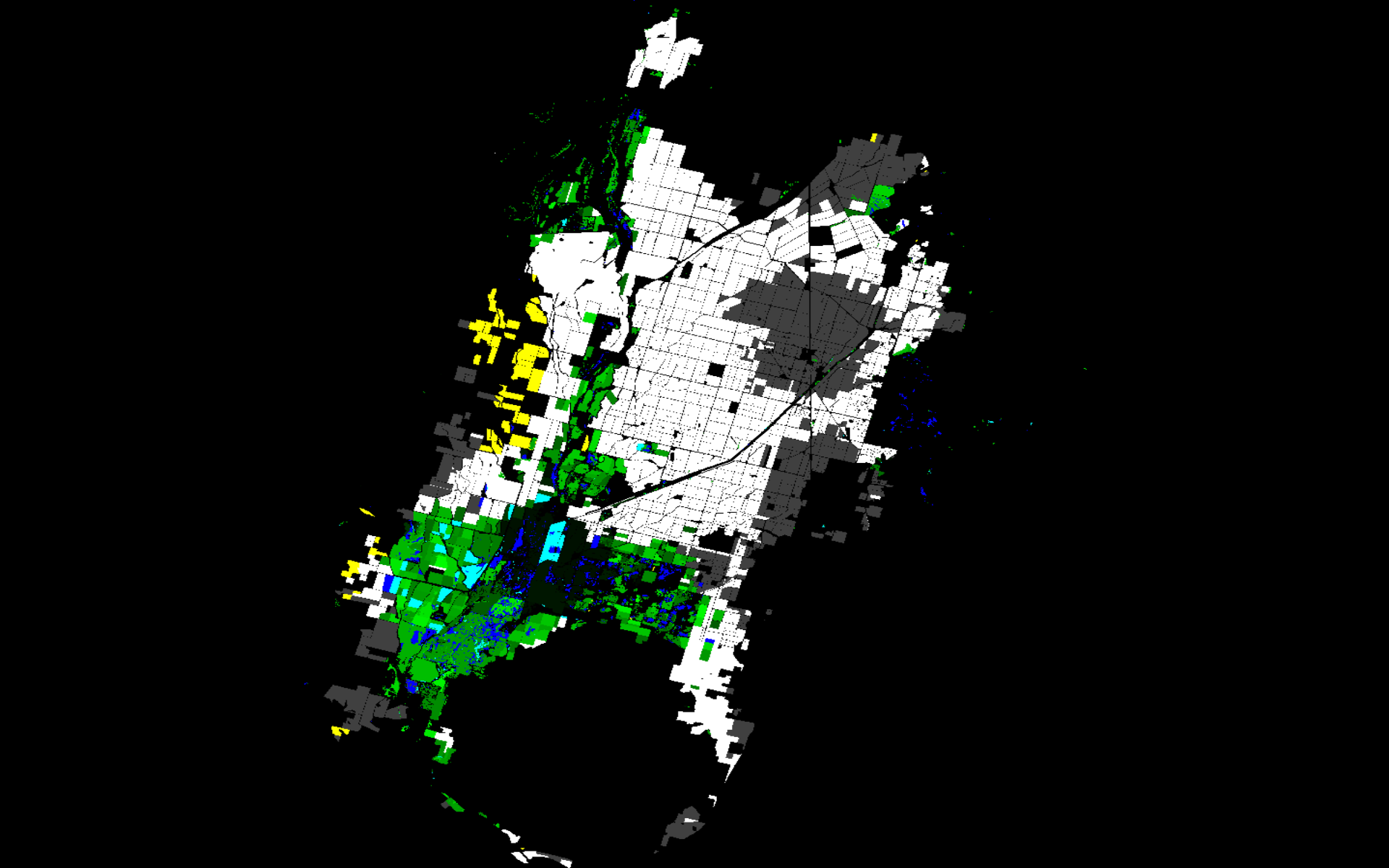




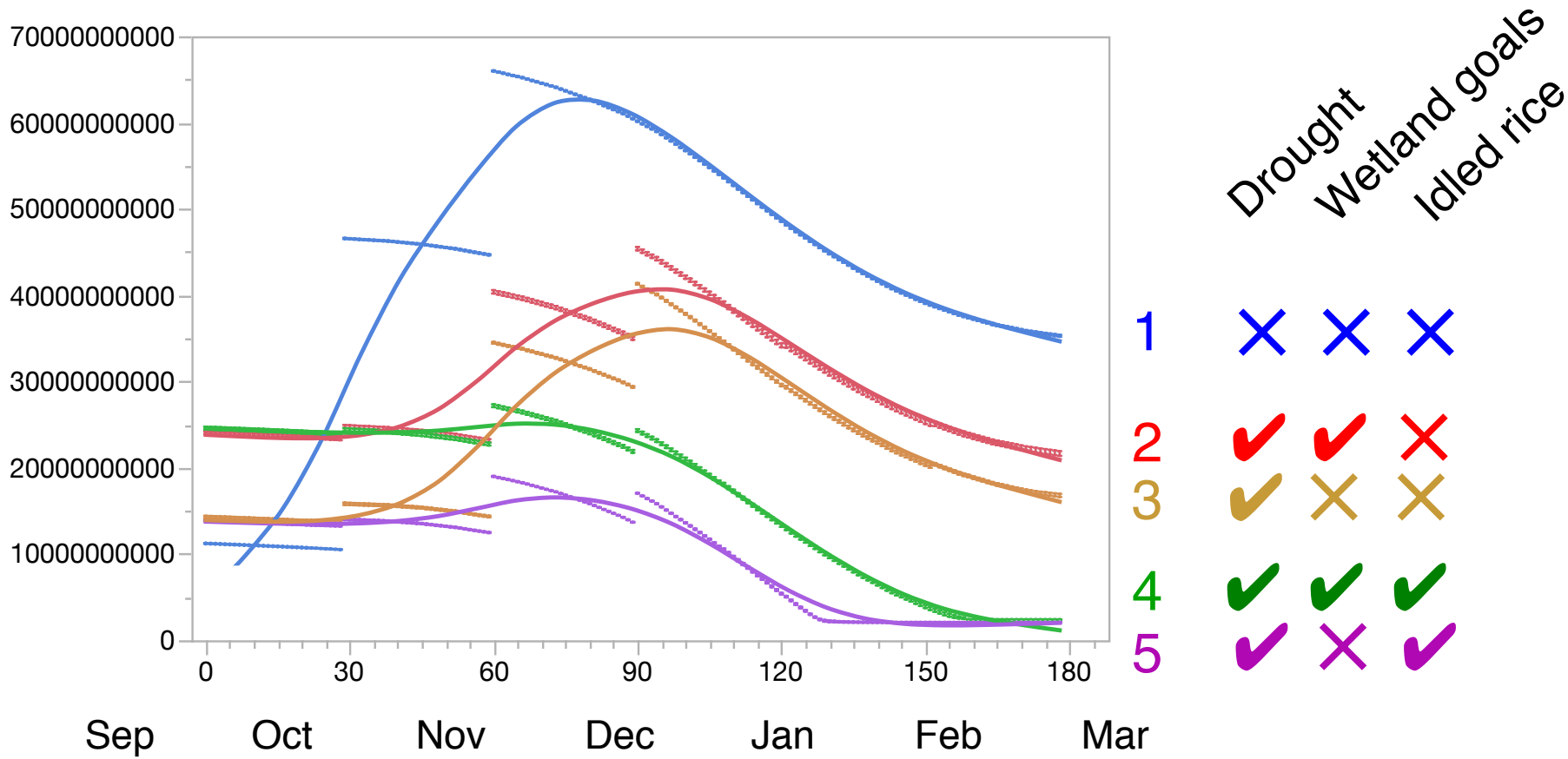




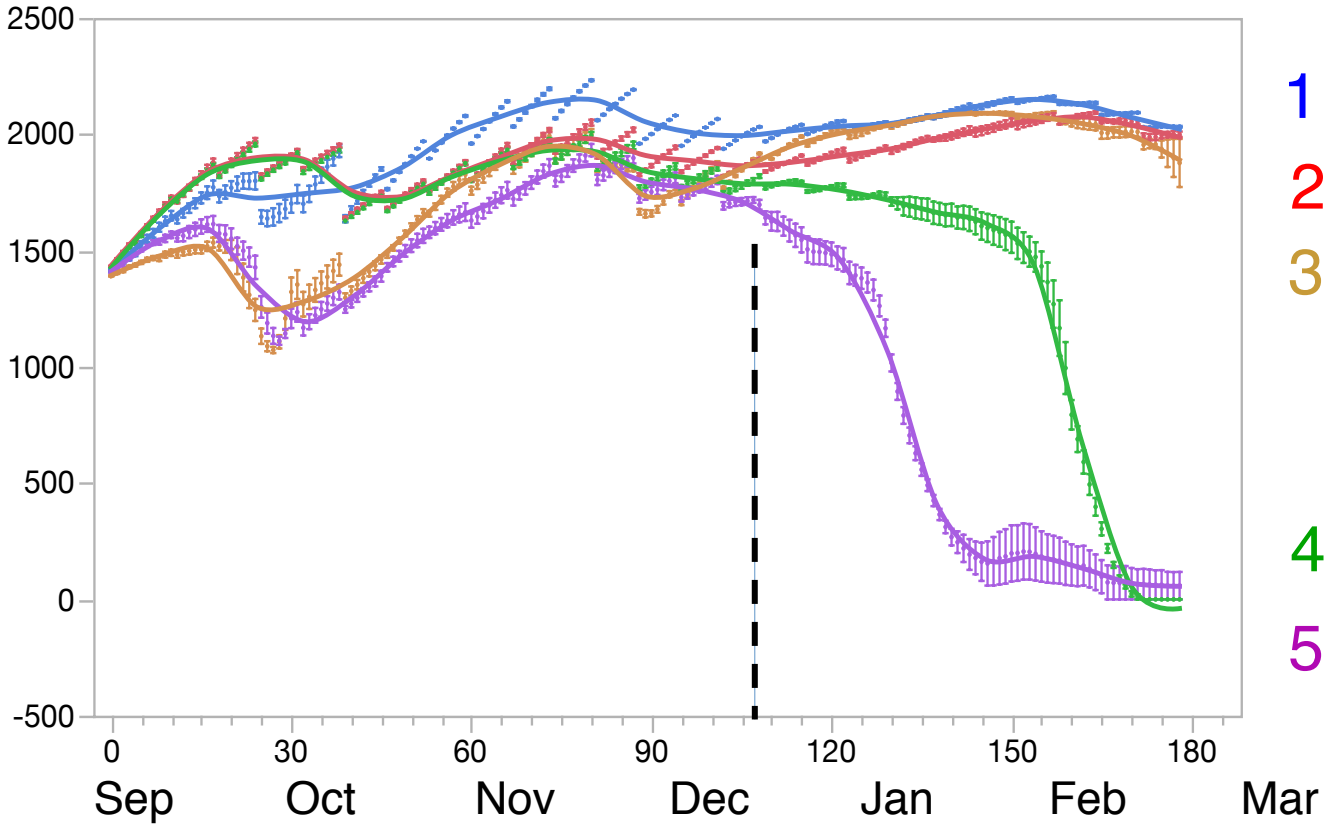




Food (energy) Availability

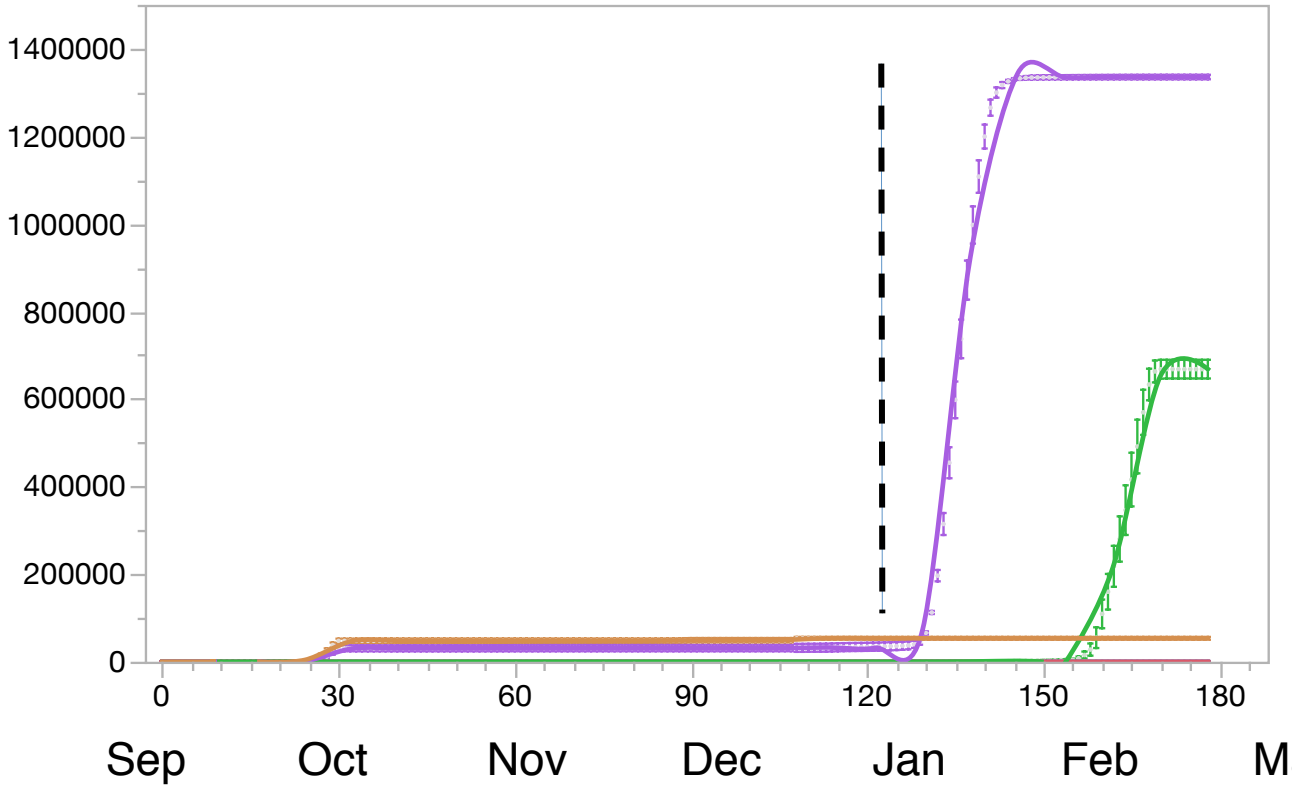


Fat Reserves



	Drought	Wetland goals	Idled rice
1	✗	✗	✗
2	✔	✔	✗
3	✔	✗	✗
4	✔	✔	✔
5	✔	✗	✔

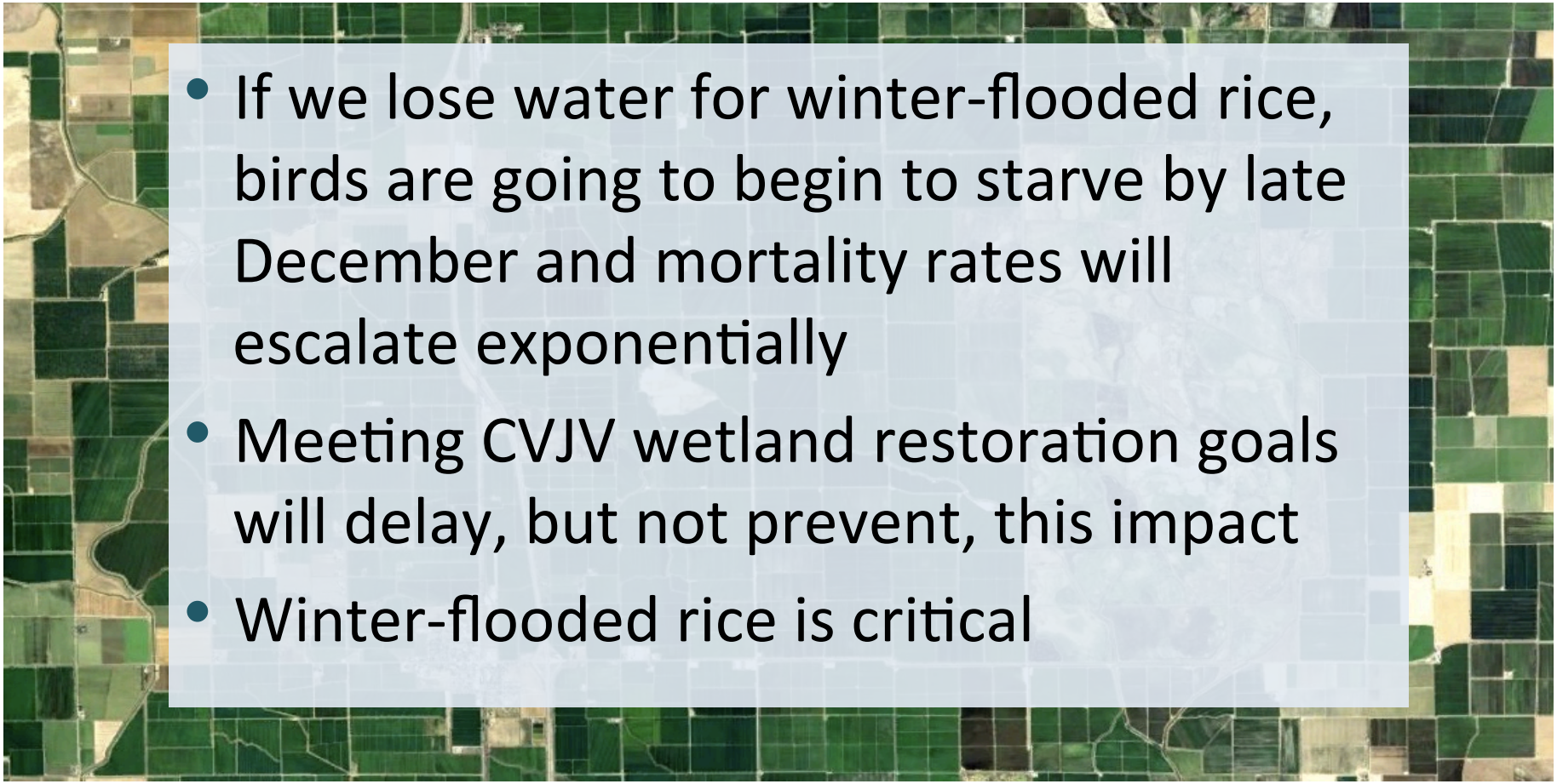
Total Mortality



	Drought	Wetland goals	Idled rice
5	✔	✕	✔
4	✔	✔	✔
3	✔	✕	✕
2	✔	✔	✕
1	✕	✕	✕

Bio-energetic Modeling

Spatially-explicit Waterbird Agent-based Modeling Program (SWAMP)



- If we lose water for winter-flooded rice, birds are going to begin to starve by late December and mortality rates will escalate exponentially
- Meeting CVJV wetland restoration goals will delay, but not prevent, this impact
- Winter-flooded rice is critical

The Value of the SWAMP Model

- Anticipate (and quantify) predicted outcomes of drought and water & land-use policies
- Provides multiple measures of bird condition and demography
- Allows scenario planning (what if)
- Facilitates management in a spatially-explicit framework (not just how much, but where)

The state of the State from a duck's eye view

- 2011-13 - winter-flooded rice and grain corn accounted for 41% and 21% of all duck food supplies.
- Thus, 62% of all duck food energy in the Central Valley is derived from agricultural sources.
- Fundamentally, the bottom line is simple: as agriculture goes, so go waterfowl.

Post-harvest Practices

- One of greatest areas of uncertainty centers on post-harvest practices other than winter-flooding, or on post-harvest practices that precede winter-flooding.
- CVJV's assumptions about the post-harvest treatment of rice and corn fields that are <u>not</u> flooded are over 25 years old, and are based on the Joint Venture's 1989 implementation plan

Four critical information needs

1. Understand current post-harvest practices used by rice growers and grain corn growers and the acreage subjected to each
2. Estimates of the current food/energy value provided under each of these treatment types
3. Projection of future changes in these practices
4. Evaluation (through bioenergetic modeling) of the impact of current and future post-harvest practices on waterfowl energy supplies and sustainability

A New Study

1. Identify the post-harvest practices now used by California rice growers (e.g. disking, chopping, etc.)
2. Estimate the percent of all harvested rice fields in each of these post-harvest practice categories
3. Sample the availability of waste-rice in each post-harvest treatment category
4. Interview landowners about what post-harvest practices they are likely to use in the long-term, and the likelihood that they will winter-flood

A New Study

5. Define the post-harvest practices now used by California grain corn growers, estimate the percent of all grain corn fields that fall into these categories, and sample the availability of waste corn in each category
6. Model the effects of possible trends in post-harvest practices on waterfowl

4 Phases

- **Phase I** – identify and define the post-harvest practices currently used by California rice growers and grain corn growers
  - Conduct a survey of locations/landowners providing a representative sample of rice and corn fields in different regions of the CVJV
  - Michael Stevens

4 Phases

- **Phase II** – landowner survey, mail-in survey
  - Site visits with landowners/growers, or telephone and written contacts with managers and landowners
  - Comprehensive effort to ensure broad participation and to cover as many regions within the CVJV as possible

4 Phases

- **Phase III** – sampling to estimate availability of waste grain in rice fields post harvest.
  - This component of the project would be undertaken by a MS graduate student working at UC Davis

4 Phases

- **Phase IV** – bioenergetic modeling to evaluate the effect of changes in rice lands and postharvest practices on food availability and carrying capacity for wintering waterfowl
  - TRUEMET and SWAMP models

Timeline

	Jan–July 2016	Aug–Dec 2016	Jan–July 2017	Aug–Dec 2017	Jan–July 2018
Phase I. Survey of current postharvest practices					
Phase II. Survey of future postharvest practices					
Phase III. Field Sampling of waste grain					
Phase IV. Bioenergetic Modeling					

Thanks!

A Mutual Benefit?

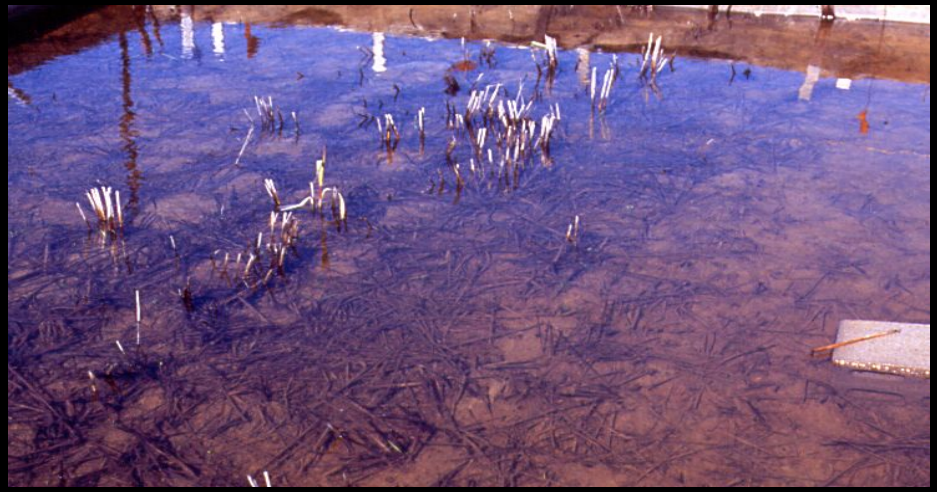
Large numbers of foraging ducks might help shred and decompose rice straw

Effects of waterfowl on straw decomposition

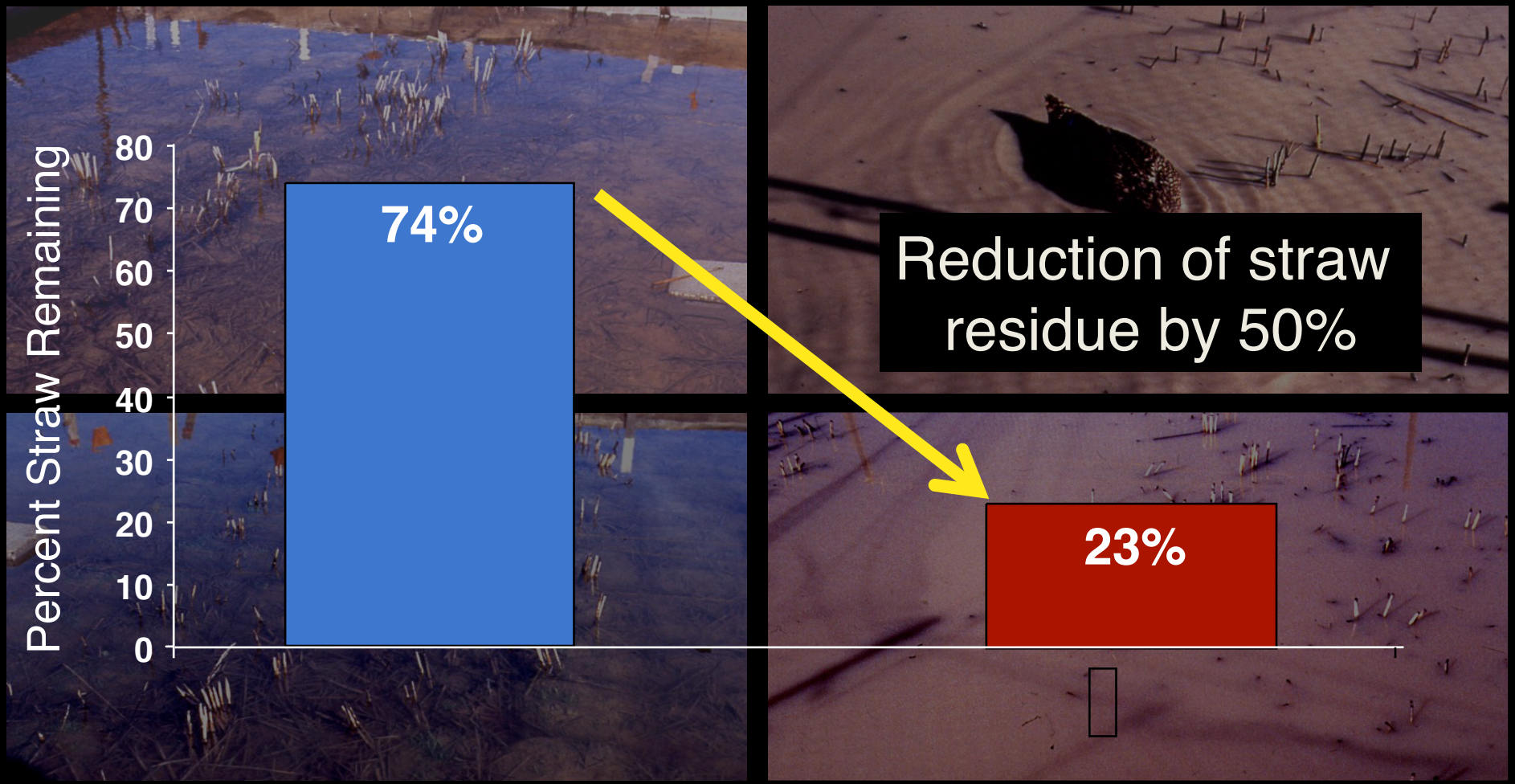
Ducks

No Ducks

No Ducks

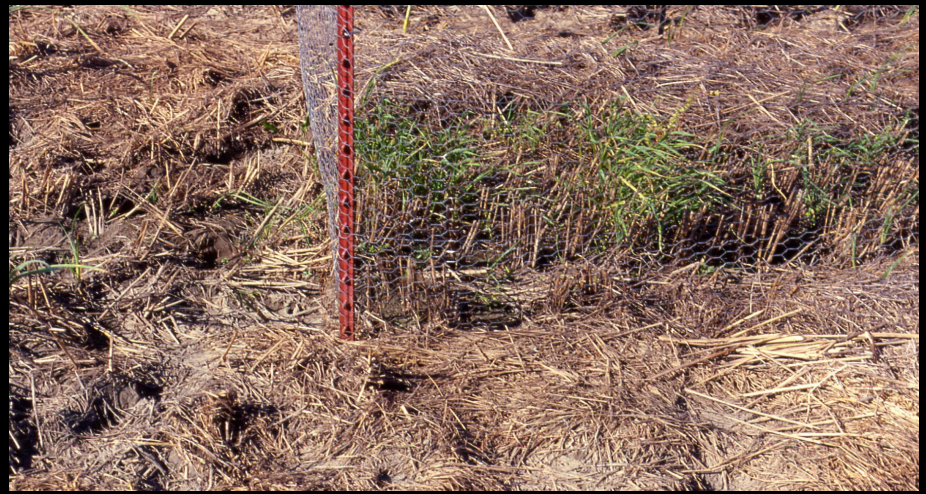


Ducks


No Ducks
Ducks
Percent Straw Remaining
80
70
60
50
40
30
20
10
0
74%
23%
Reduction of straw residue by 50%

Reduction of straw residue by > 25%

Reduction of weed biomass by > 50%



No Ducks

Ducks

Flooded rice fields…

- Provide winter habitat for waterfowl
- Waterfowl, in turn, help:

a) Increase straw decomposition

b) Reduce weed seeds

c) Reduce insect pests