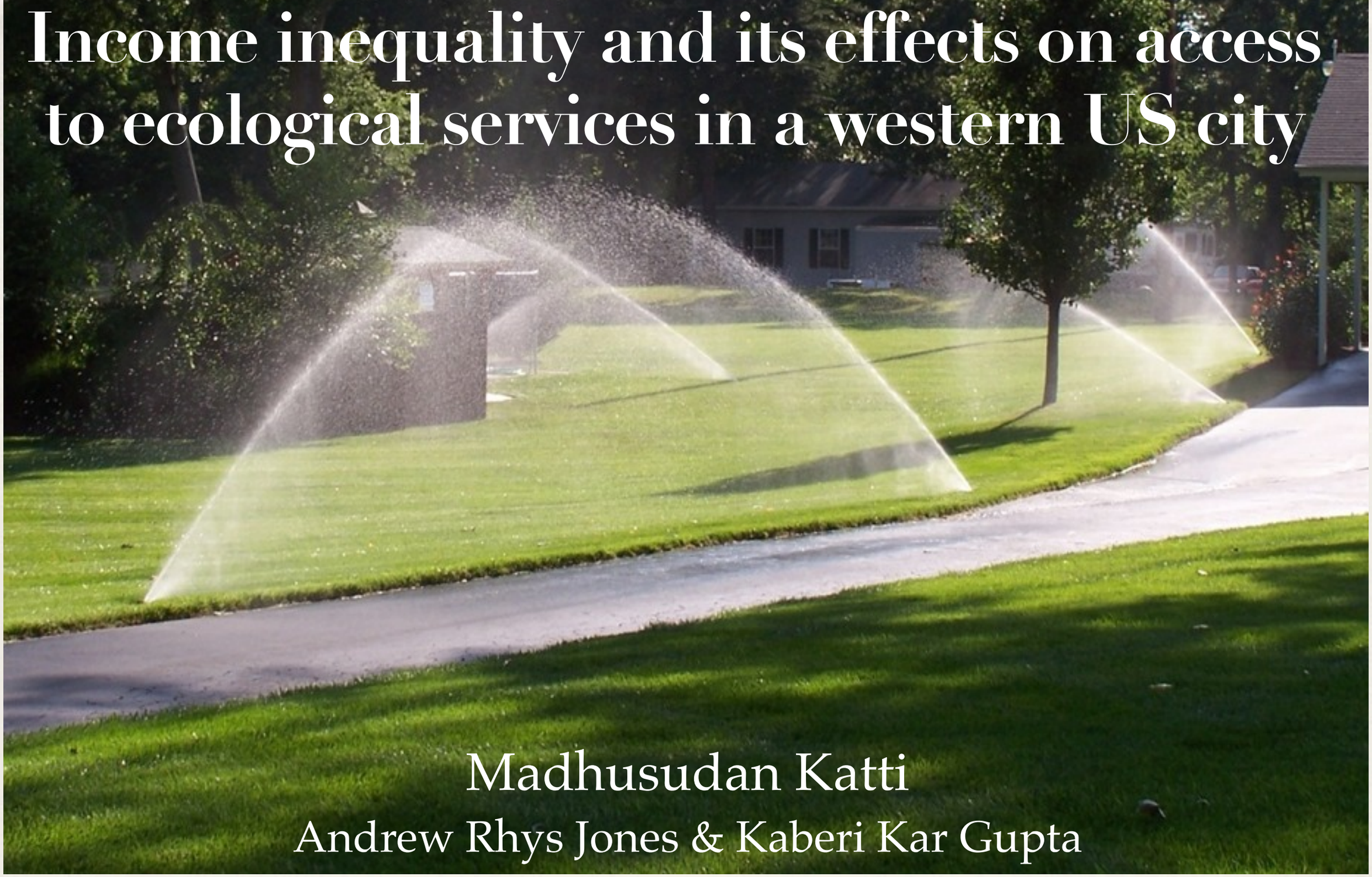
Income inequality and its effects on access to ecological services in a western US city



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International Geographical Congress 2012
Köln, Germany, August 23, 2012

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Urban Long-Term Research Area
Fresno And Clovis Ecosocial Study

Water: a key resource & ecosystem service in any urban Social-Ecological System

What drives water consumption?

- Sococioeconomic status is positively correlated with levels of resource consumption
  - at individual/household scale as well as larger social units
- As both a good and a service, water is usually priced at a low rate in industrialized and post-industrial countries
  - as it is deemed essential to human survival;
  - and therefore, often priced for delivery of service rather than for the resource itself

What drives water consumption?

- Household consumption of water is shaped & constrained by
  - home design (*age of house, irrigation technology*)
  - residential landscape design (*type of plants, yard layout*)
  - status honor gained by conspicuous consumption of resources
  - ***or,*** by decreased consumption through newer technology and design that may be linked to greater environmental awareness

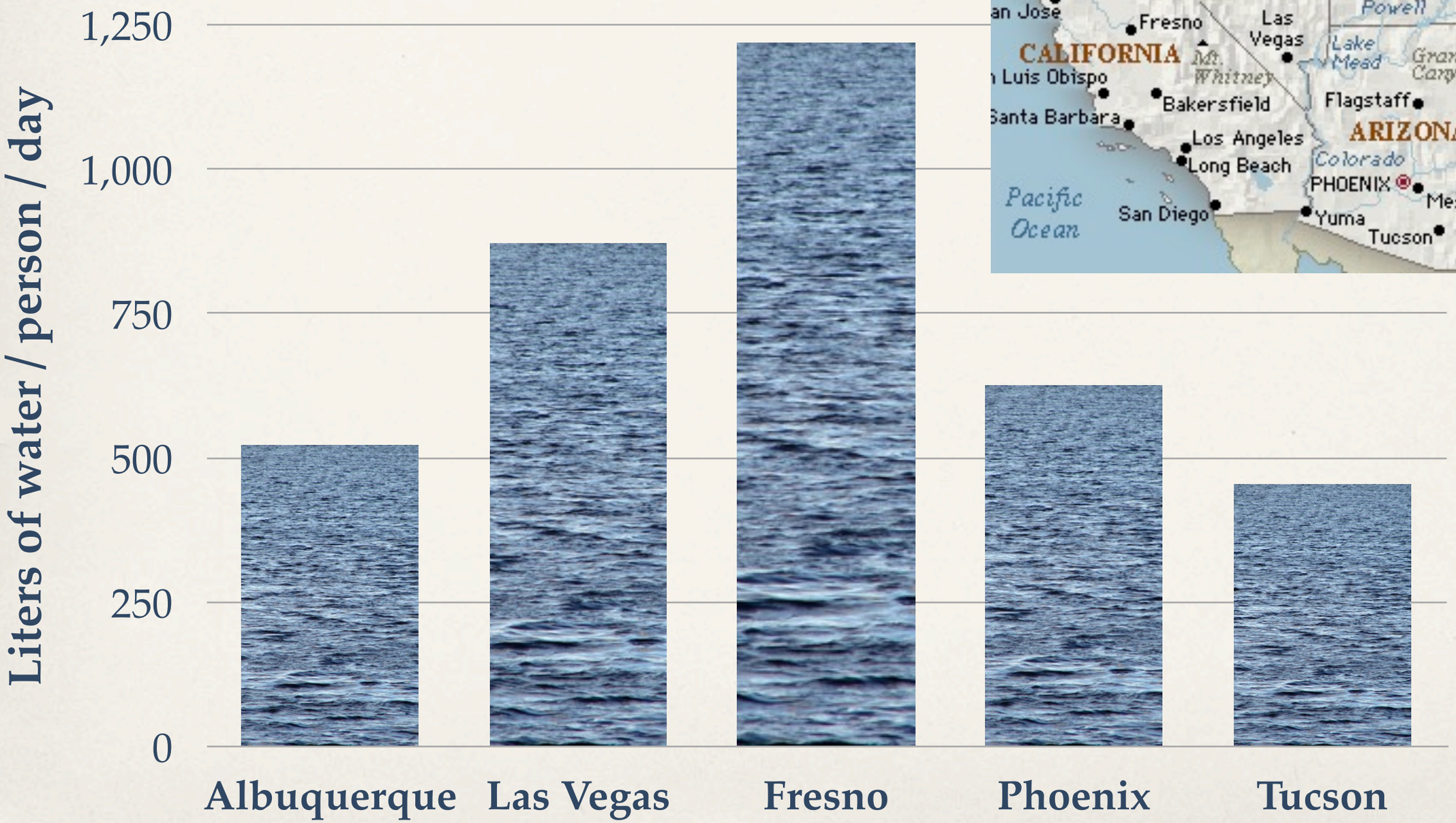
Water pricing as a regulatory tool?

- Water pricing may reduce water consumption under certain conditions
  - but most municipal water departments avoid water pricing policies that could encourage conservation
- The cost of water is negligible for budgetary decision making in most households - particularly true in the US

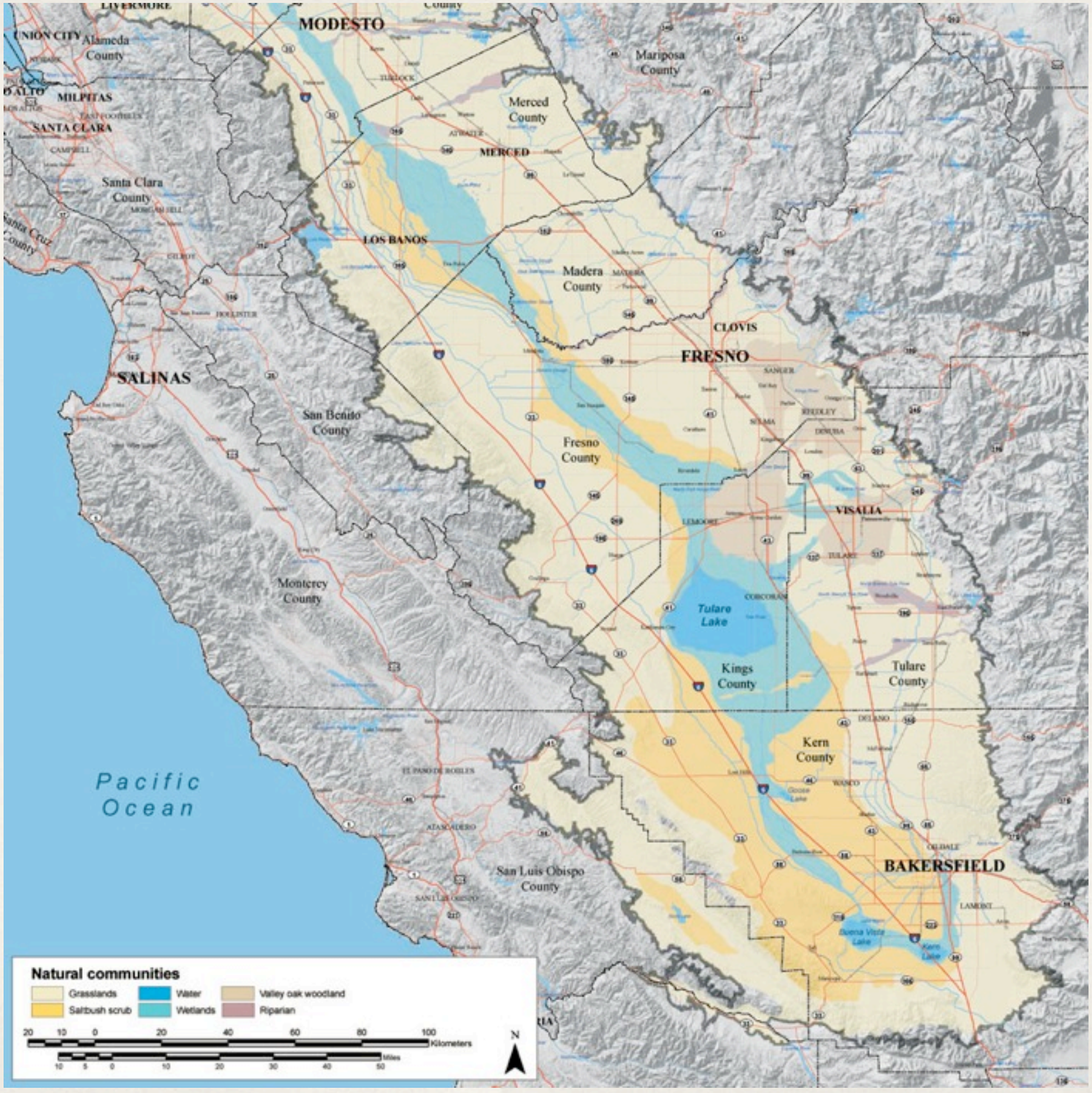
Consequences of human water consumption for urban biodiversity

- Patterns of water use by humans shape the urban landscape
- Water availability, irrigation technologies, and human preferences determine urban plant diversity
  - plant diversity is more directly driven by human actions
- Water availability, plant diversity & cover, landscape structure and heterogeneity drive animal diversity
  - birds freely choose to inhabit/abandon urban habitats,
  - therefore they are good indicators of biodiversity outcomes

How much water do we use in the Cadillac Desert?



San Joaquin Valley “natural” communities

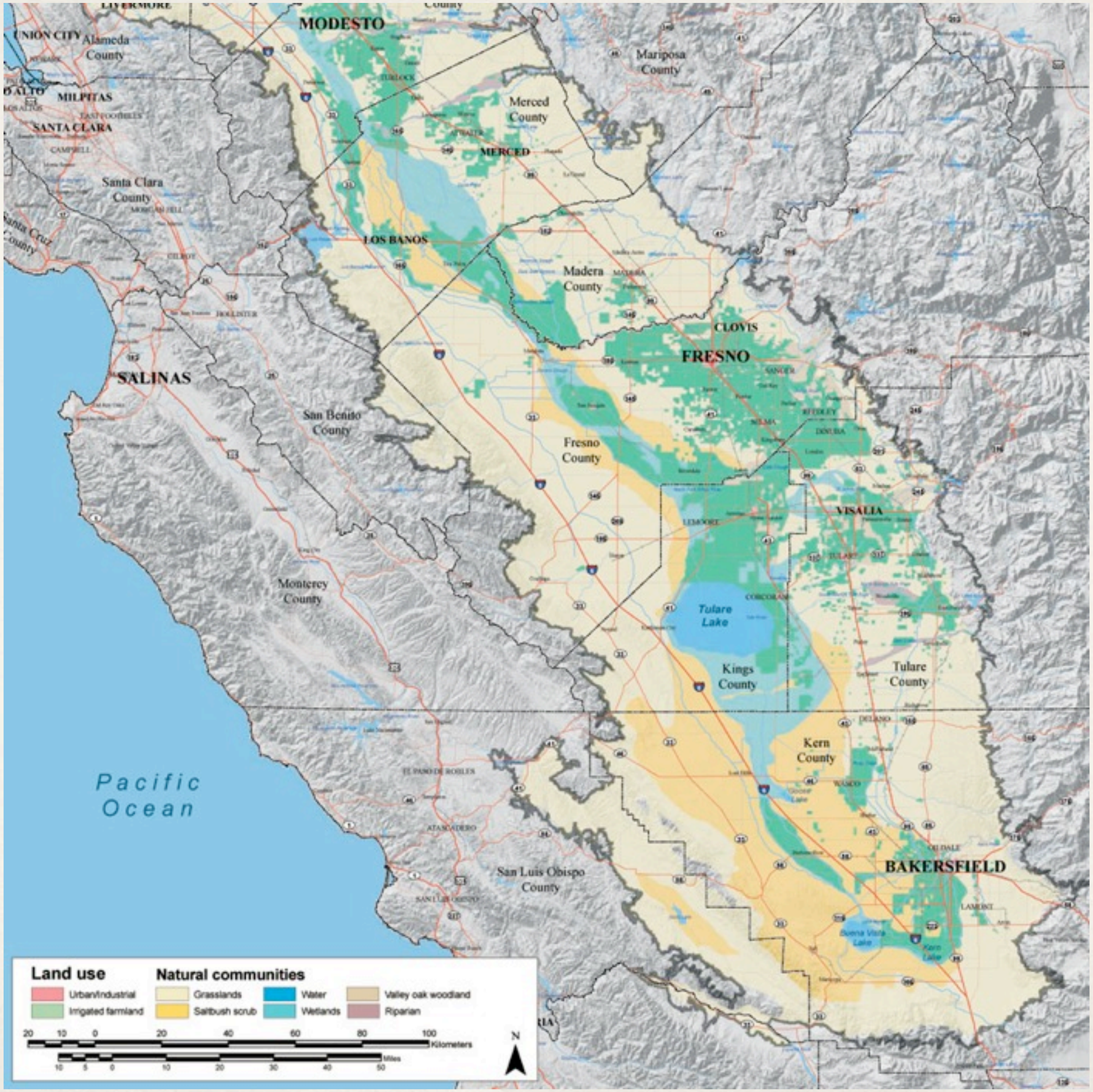


Maps produced by the Endangered Species Recovery Program (ESRP)

San Joaquin Valley: 1885

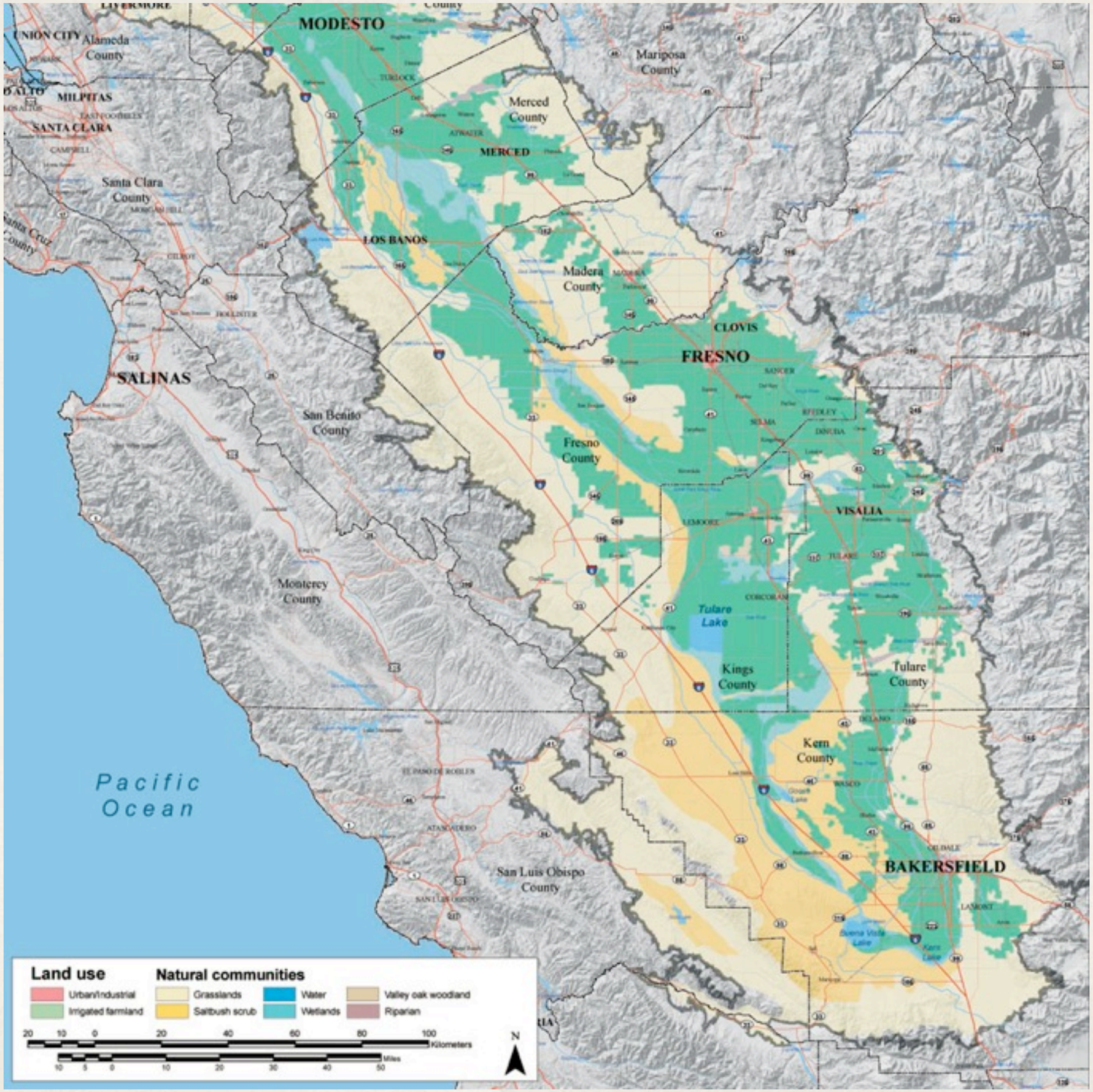
Maps produced by the Endangered Species Recovery Program (ESRP)

San Joaquin Valley: 1912



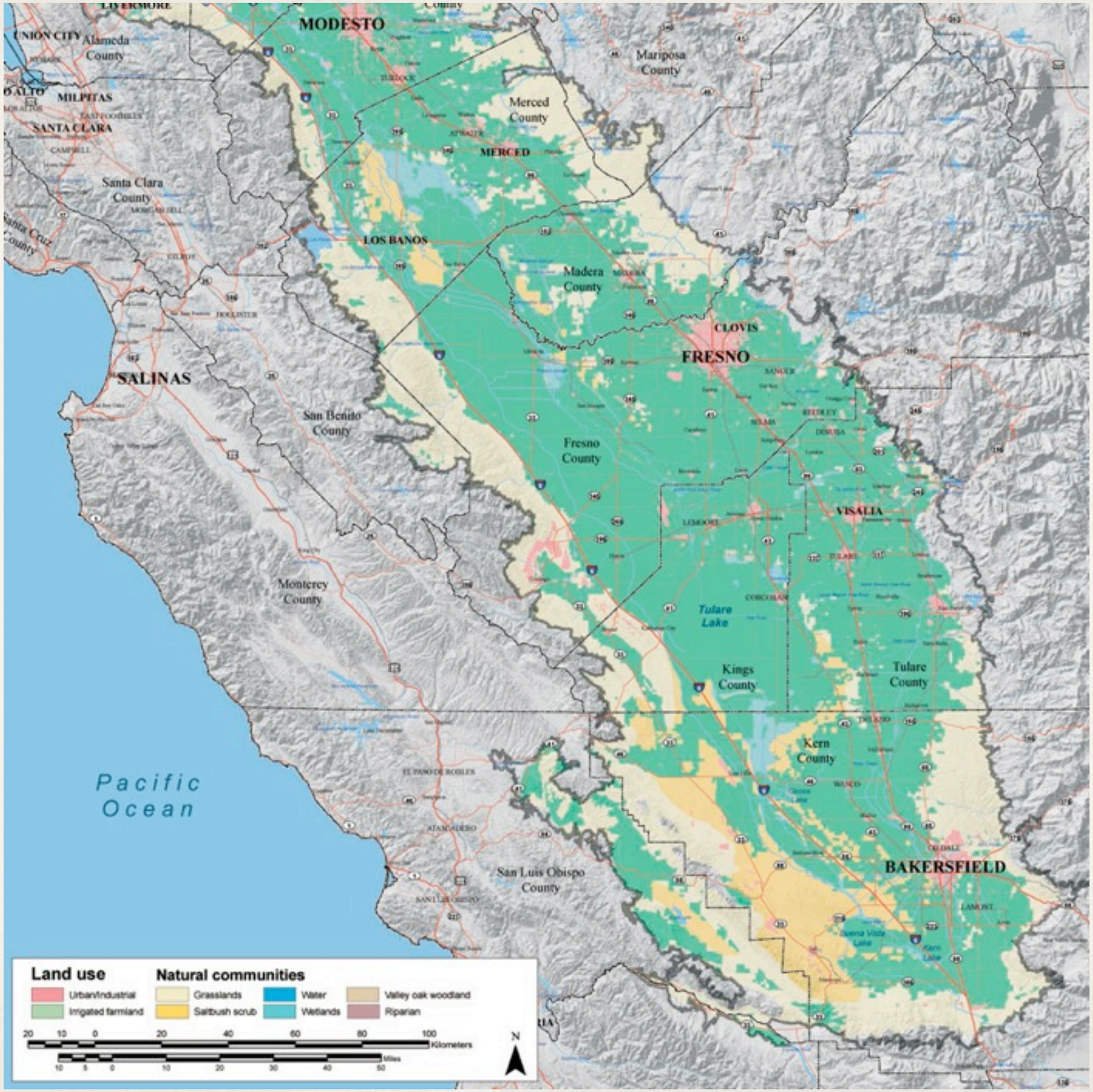
Maps produced by the Endangered Species Recovery Program (ESRP)

San Joaquin Valley: 1945



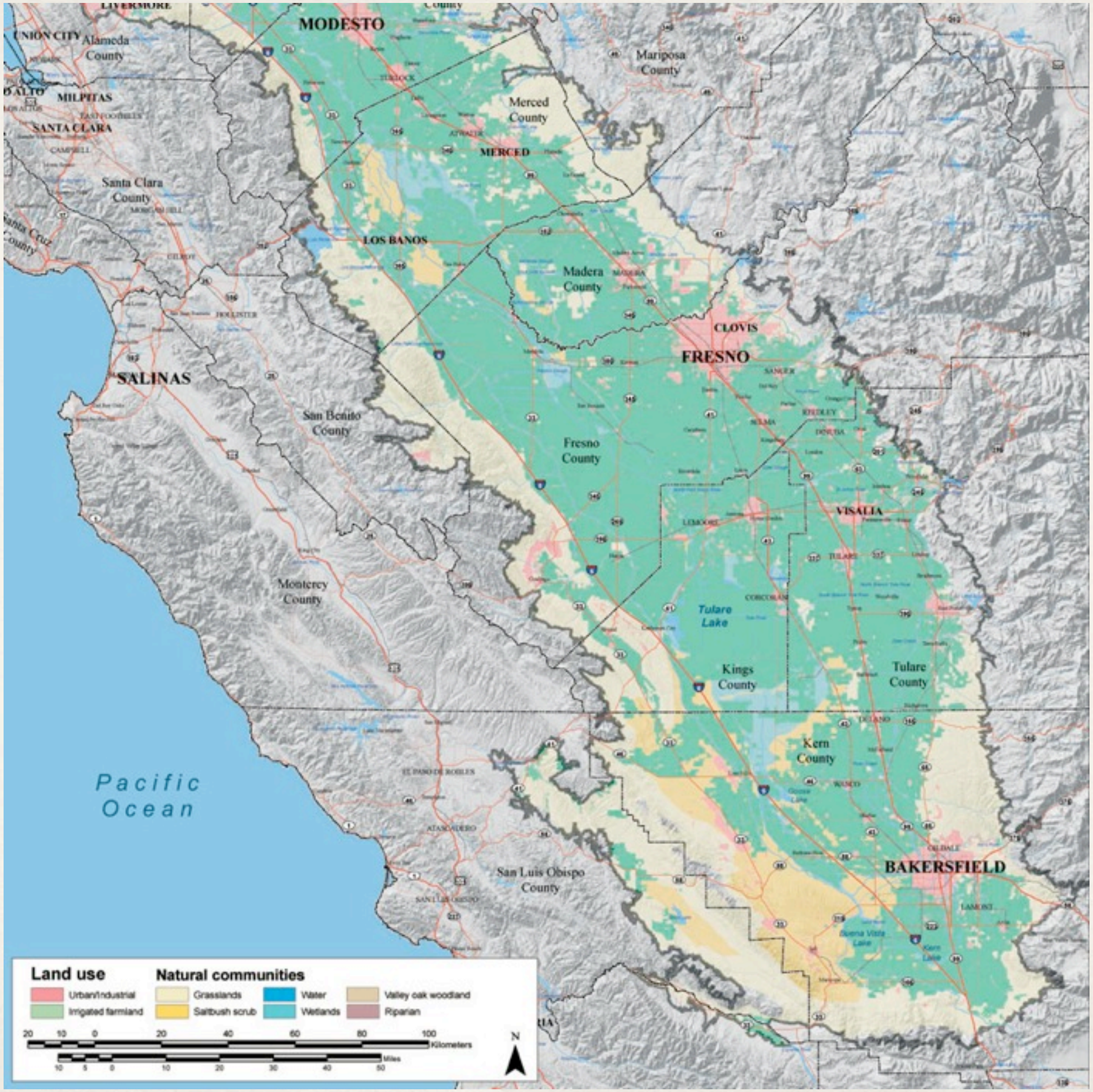
Maps produced by the Endangered Species Recovery Program (ESRP)

San Joaquin Valley: 1977



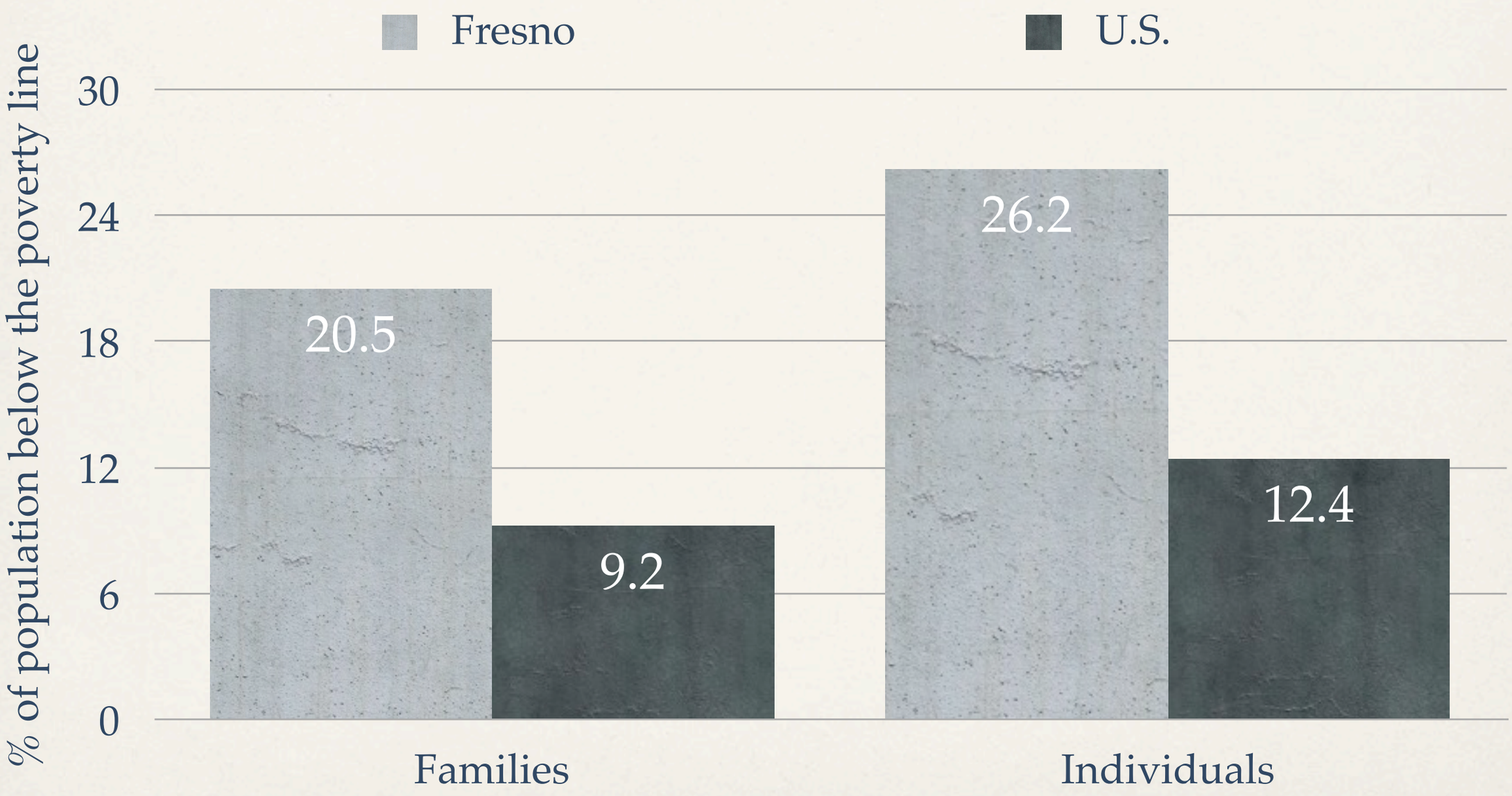
Maps produced by the Endangered Species Recovery Program (ESRP)

San Joaquin Valley: 2000



Maps produced by the Endangered Species Recovery Program (ESRP)

Poverty in Fresno



Household Water Use in Fresno

- Currently, 51% of city water supply is used residentially
  - 70% of residential water use is for landscape irrigation
- No meters: water bill is at a flat monthly rate
  - Neighboring Clovis has metered water since 1910
  - Fresno rejected metering in early 1990s referendum
- Meters are now running in parts of the city; target date for full implementation of metering: 2013 (*we hope...*)

Experimental opportunity

- The onset of metering in Fresno gives us a “found experiment”

- Clovis provides a “control” as an adjacent city with similar socioeconomics /demographics but >100 yrs of metering

- We have an opportunity to examine the socioecological dynamics of water use in a ***Before-After-Control-Impact (BACI)*** design.

- Currently in the *Before* phase, establishing baseline data

Urban Long-Term Research Area Fresno And Clovis Ecosocial Study

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External Drivers

Socioeconomic / Political Factors

Ecological Factors

Q5

Institutional

Water use policies, land use decisions, metering

Biotic Structure

Animal Diversity

Q4

Q1

Disturbance Regimes

Long-term Press

Global Climate Change

Short-term Pulses

Water use and availability

Q2

Land Use Land Cover / Plant Diversity

Individual

Civic-mindedness, identity, socioeconomic status

Q3

Ecosystem Function

water cycles and dynamics

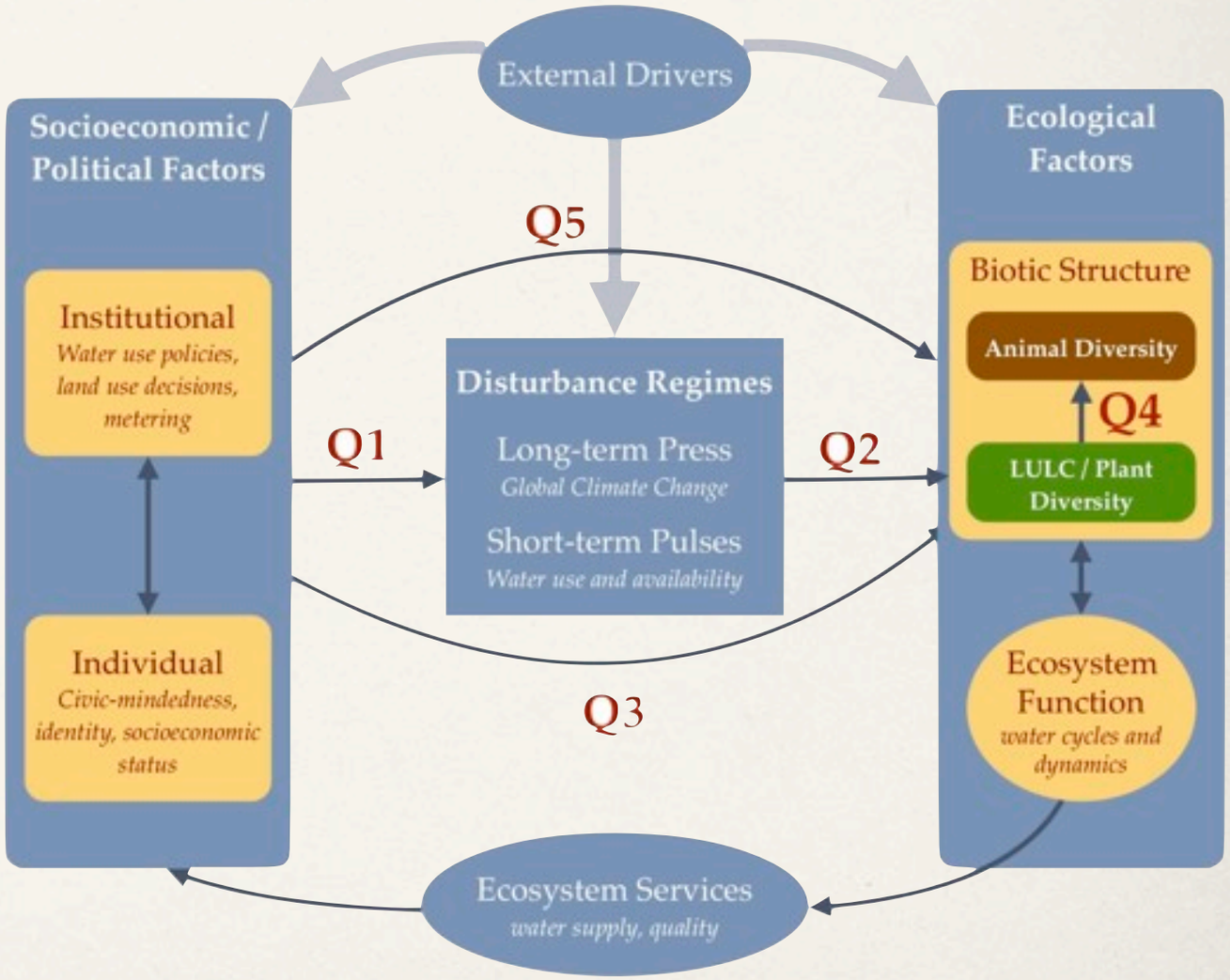
Ecosystem Services

water supply, quality

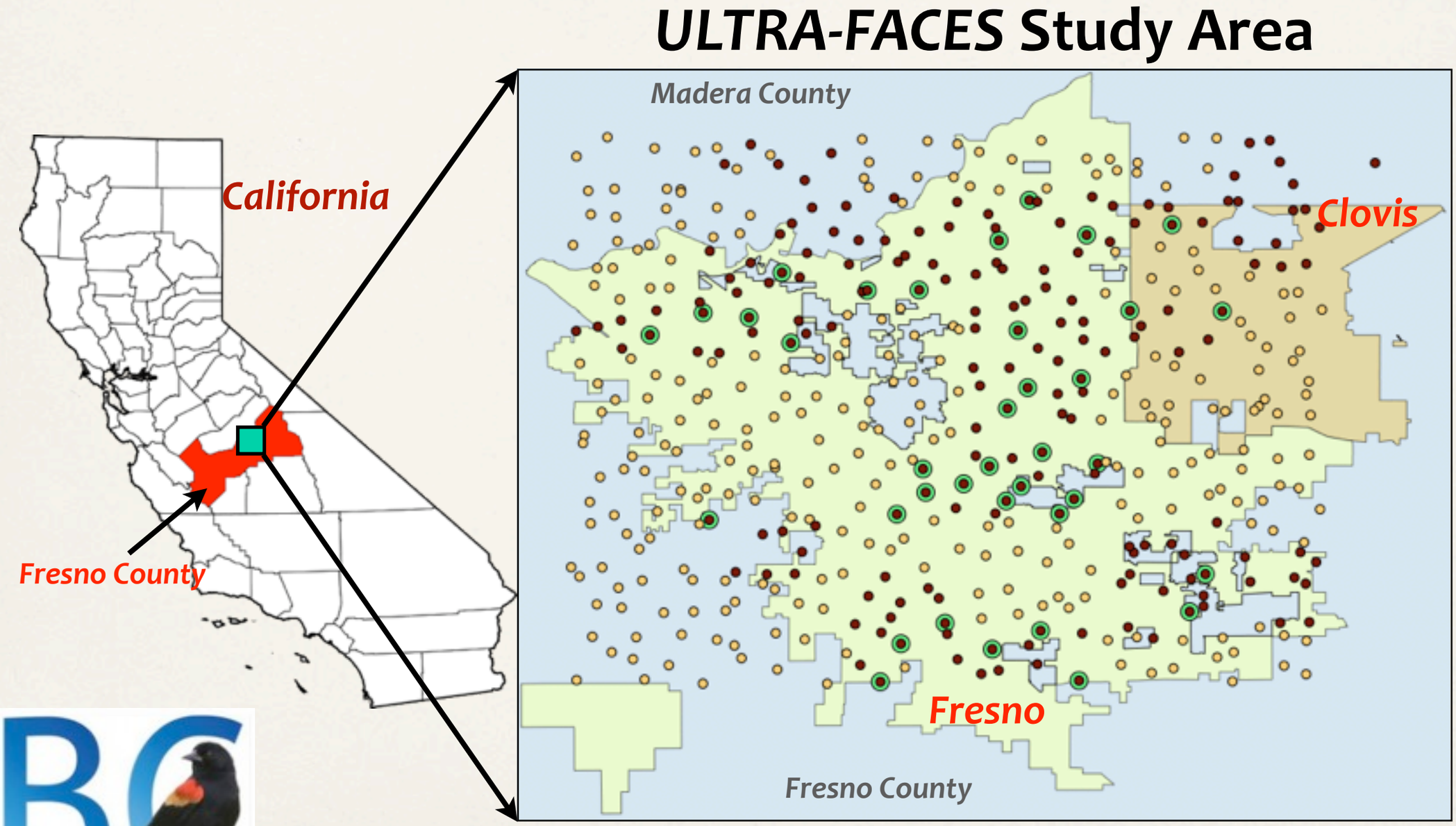
Source for model: Integrative Science for Society and Environment: A Strategic Research Initiative

Main Research Questions

1. How are institutions of governance & individual decisions related to water use & availability in an urban SES?
2. How is water use & availability related to residential landscaping (land-use/land-cover) & plant diversity?
3. How are institutional & individual factors related to land cover & plant diversity at broader scales?
4. How does land use & plant diversity affect bird diversity in cities?
5. More broadly, how do the dynamic interactions & feedback between institutional/individual actors and an ecosystem service (water) affect ecological outcomes (i.e., plant & bird diversity)?



Study Area & Sampling Design
Fresno Clovis Metropolitan Area



How the social might affect the ecological

Wealth

Home value (Zestimate)
% Popn. below poverty line
Also: Pop. Den; % Hispanic

Irrigation

Visual score on scale 0-4

Vegetation cover

% canopy
% grass
% building
% impervious
Tree species richness

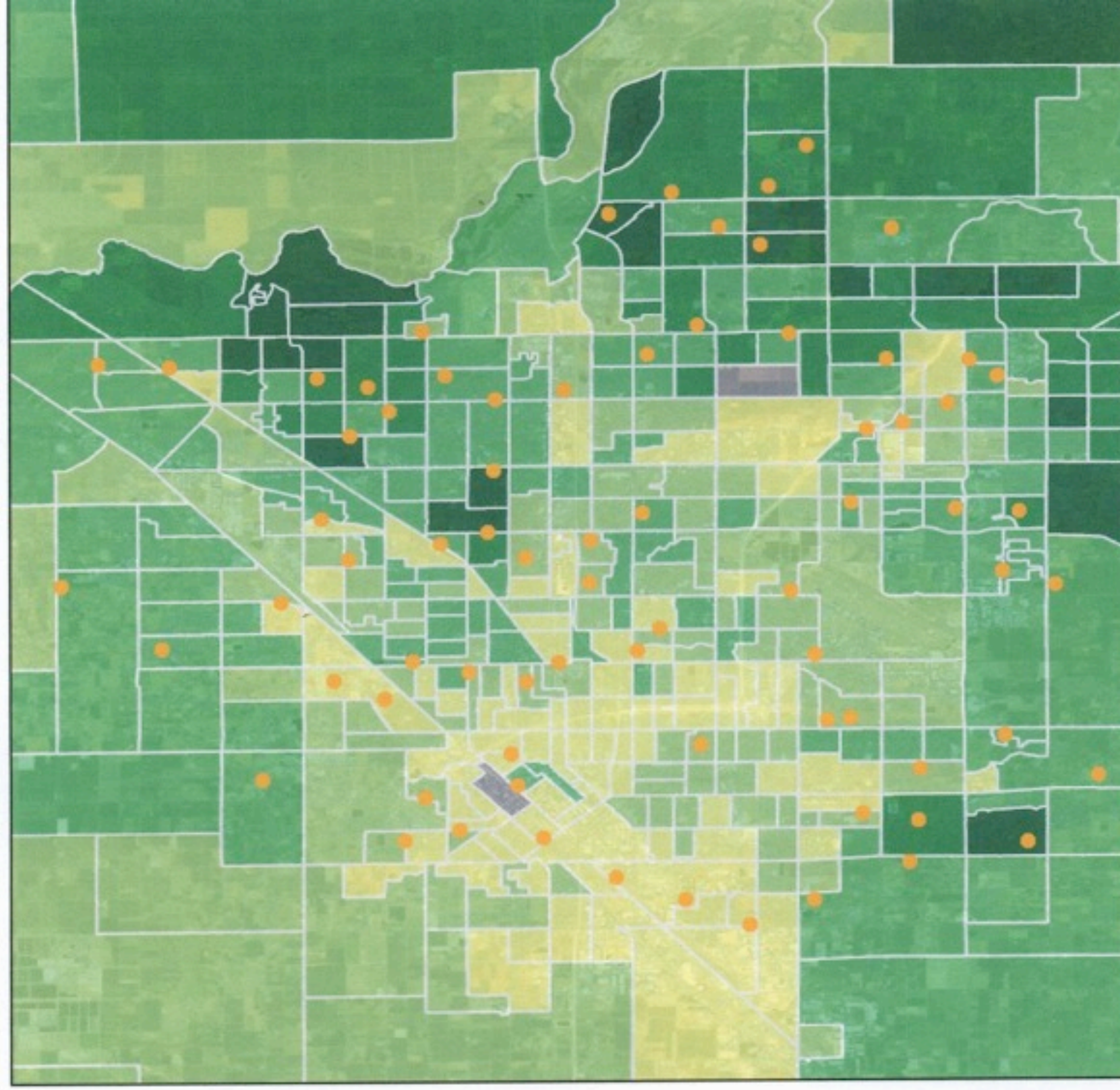
Birds

Bird species richness
Bird functional groups

Vegetation

- Subsample of FBC sites
- Sites chosen to represent wealth gradient across FCMA
- Survey of trees, ground and canopy cover, irrigation level, conducted spring 2011
- Socioeconomic, demographic variables from US Census
- Property value Zestimate from zillow.com

Reid 2011. MS Thesis.



Multivariate drivers of tree species richness

Relative performance of alternative models with **human (socioeconomic/demographic/ behavioral)** and **ecological (cover, biotic/abiotic)** variables to predict tree species richness. 3 Models with ΔAICc < 7 are shown (*per: Burnham et al 2011*).

Model	No. Param	AICc	ΔAICc	R^2
Zestimate, % Impervious, % Grass, Zestimate*% Impervious, Zestimate*% Grass	5	262.71	3.53	0.489
Zestimate, % Impervious, % Grass, Pop. Density, Zestimate*% Impervious, Zestimate*% Grass, % Impervious*Pop. Density	***7***	***259.18***	***0***	***0.585***
Zestimate, %Impervious, % Grass, Pop. Density, **Irrigation Rate**, Zestimate*Impervious, Zestimate*% Grass, Impervious*Pop. Density, **Irrigation Rate***Grass	9	262.61	3.43	0.614

Reid 2011. MS Thesis.

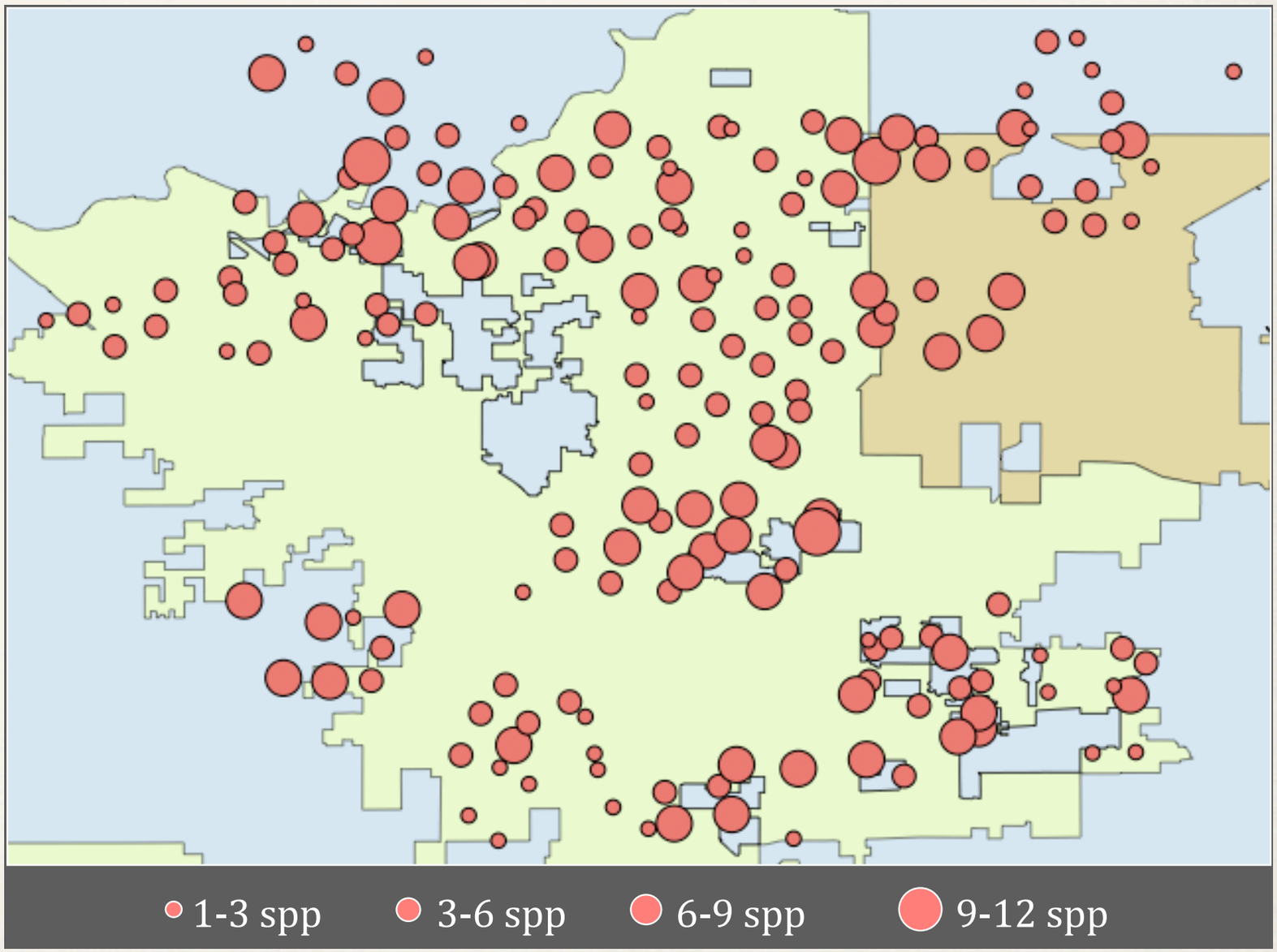
Multivariate drivers of tree diversity

- Tree species richness
  - decreases with greater impervious ground cover
  - increases with neighborhood home property values
  - *increases with amount of yard irrigation*
  - increases with ethnic diversity? (measured as % Hispanic)

Reid 2011. MS Thesis.

Bird Species Richness

- In 2008
- 186 points surveyed by 30 volunteers
- 68 bird species recorded
- 3,263 total birds
- Average species richness per site **5.13 ± 0.16 SE**



Schleder 2010. MS Thesis.

Multivariate drivers of bird species richness

Relative performance of alternative models with **human (socioeconomic/demographic/ behavioral)** and **ecological (cover, biotic/abiotic)** variables to predict bird species richness. Models with ΔAICc < 7 are shown (*per: Burnham et al 2011*).

Model	No. Param	AICc	ΔAICc	R^2
% Bldg, (% Poverty*Irrigation)	2	156.85	3.26	0.293
% Bldg, (% Poverty*%Grass), (% Poverty*Irrigation)	3	154.32	0.73	0.383
% Bldg, (% Poverty*%Grass), (% Poverty*Grass Height), (% Poverty*Irrigation)	***4***	***153.59***	***0***	***0.438***
% Grass, % Bldg, (% Poverty*%Grass), (% Poverty*Grass Height), (% Poverty*Irrigation)	5	154.54	0.95	0.46
% Grass, % Bldg, Grass Height, (% Poverty*%Grass), (% Poverty*Grass Height), (% Poverty*Irrigation)	6	156.07	2.48	0.49

Schleder 2010. MS Thesis.

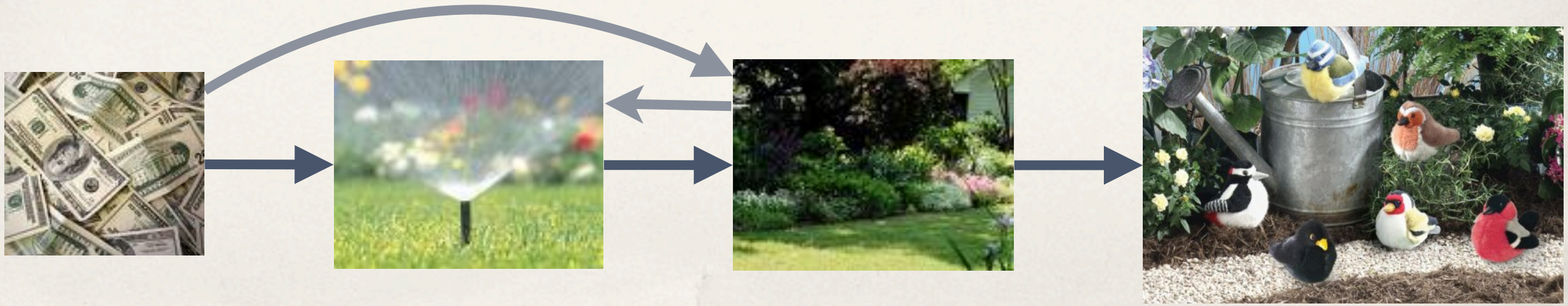
Multivariate drivers of bird diversity

- Bird species diversity
  - decreases with impervious ground cover - % buildings
  - increases with % grass cover and grass height
  - increases with amount of yard irrigation
  - decreases with neighborhood poverty - % population below poverty line

Schleder 2010. MS Thesis.

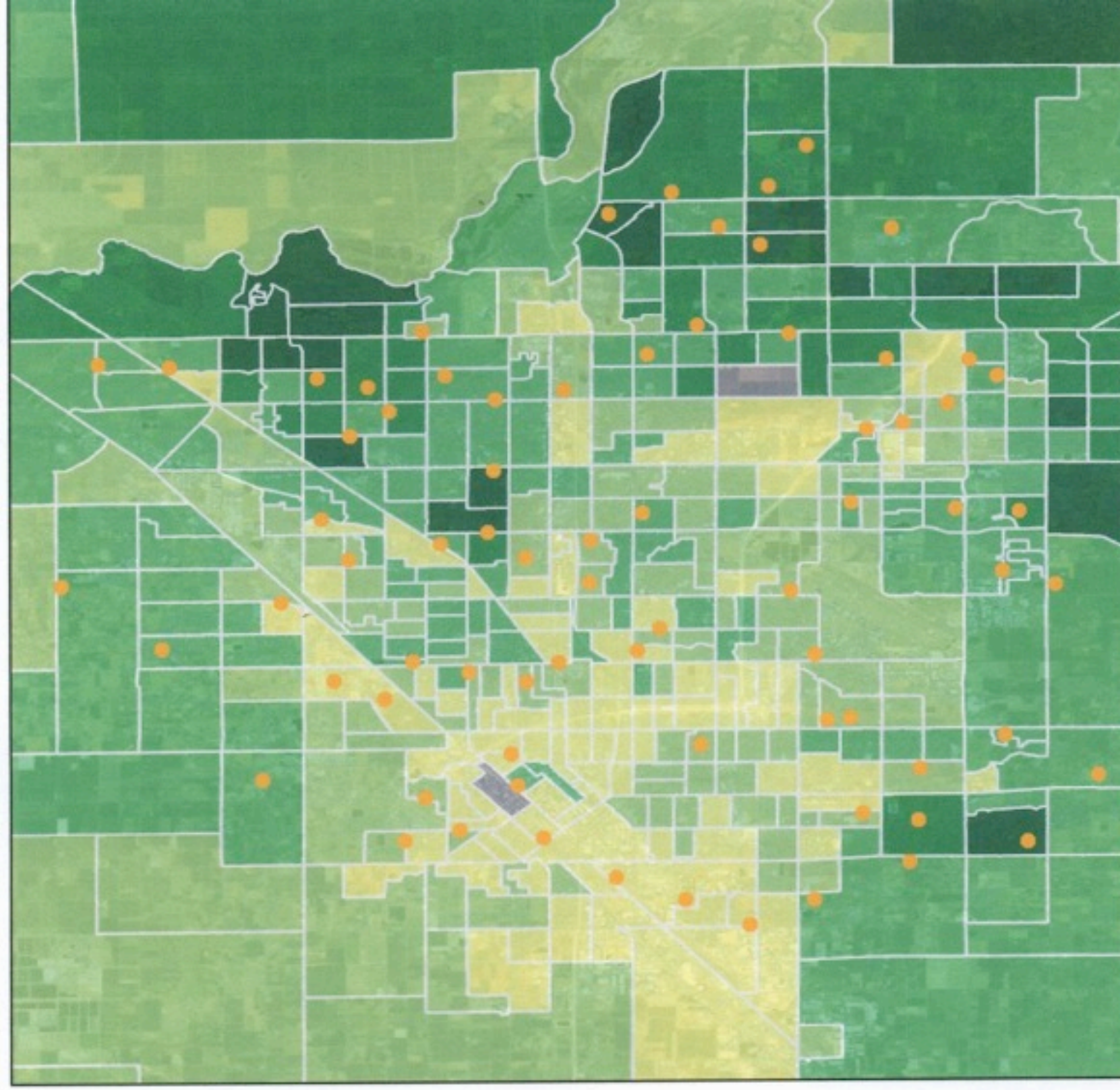
Wealth, irrigation, & urban biodiversity
Social effects on the ecological box

- Residential irrigation increased significantly with wealth.
- **Species richness:** Multivariate results indicate that socioeconomic variables and irrigation have strong positive effects on both tree and bird species richness in combination with habitat cover variables.
- **Avian guilds:** Wealth and irrigation also strongly affect avian guild richness, with insectivores particularly sensitive to irrigation, disappearing from poorly irrigated areas.



Other pathways being studied

- Social survey of individual households (*led by Andrew Jones anjones@csufresno.edu*)
- Site visits to homes (*by Hank Delcore hdelcore@csufresno.edu*)
- Focus group and individual interviews of institutional actors (*under way*)
- Land Use Land Cover (LULC) analysis (*preliminary*)



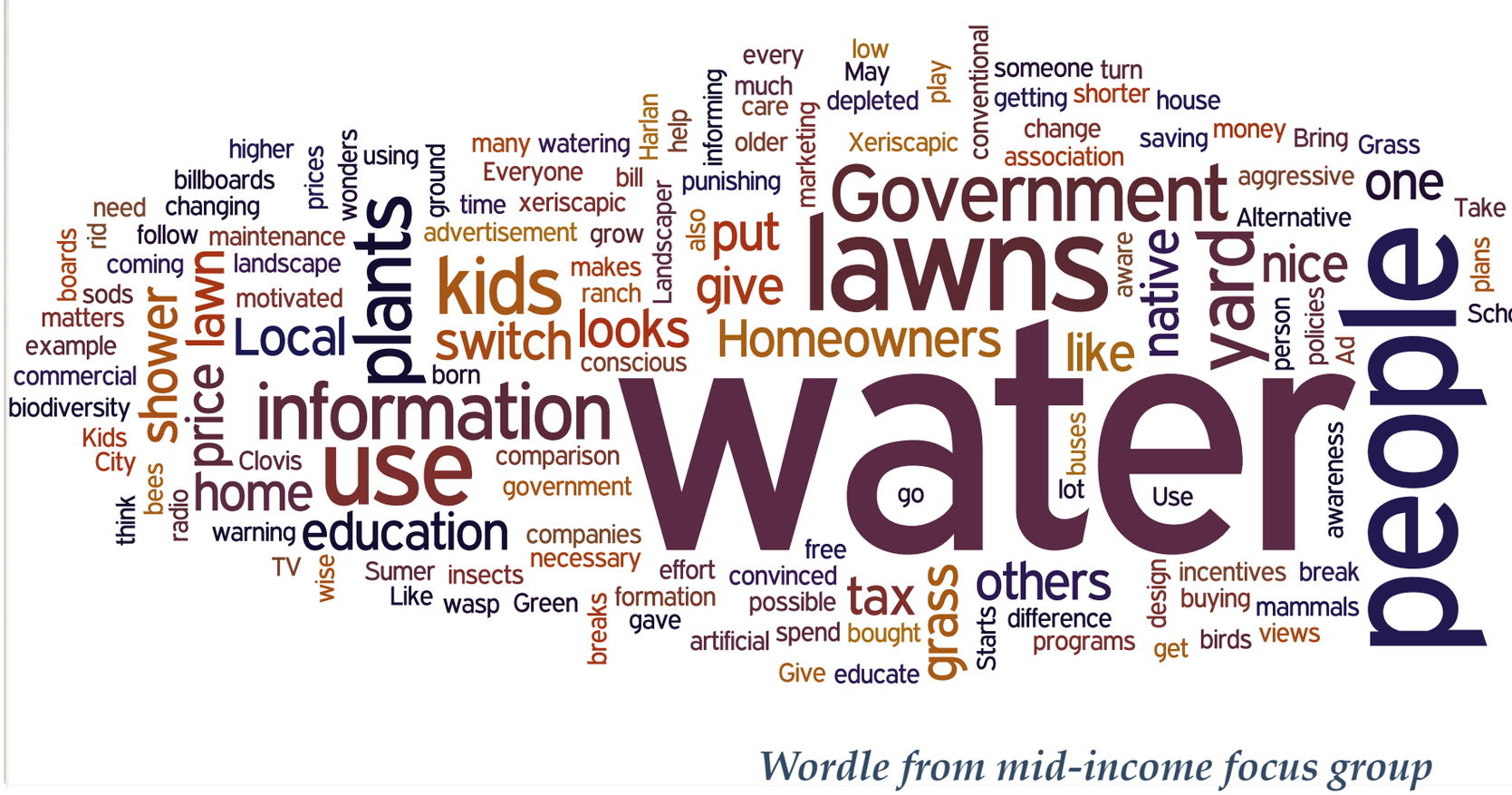
ULTRA-Ex Social Study
Sampling Sites Distribution
(Total 74 sites)
and
2010 Median Household Income

Cultural inertia in water use

Perceptions of ecology in the social box

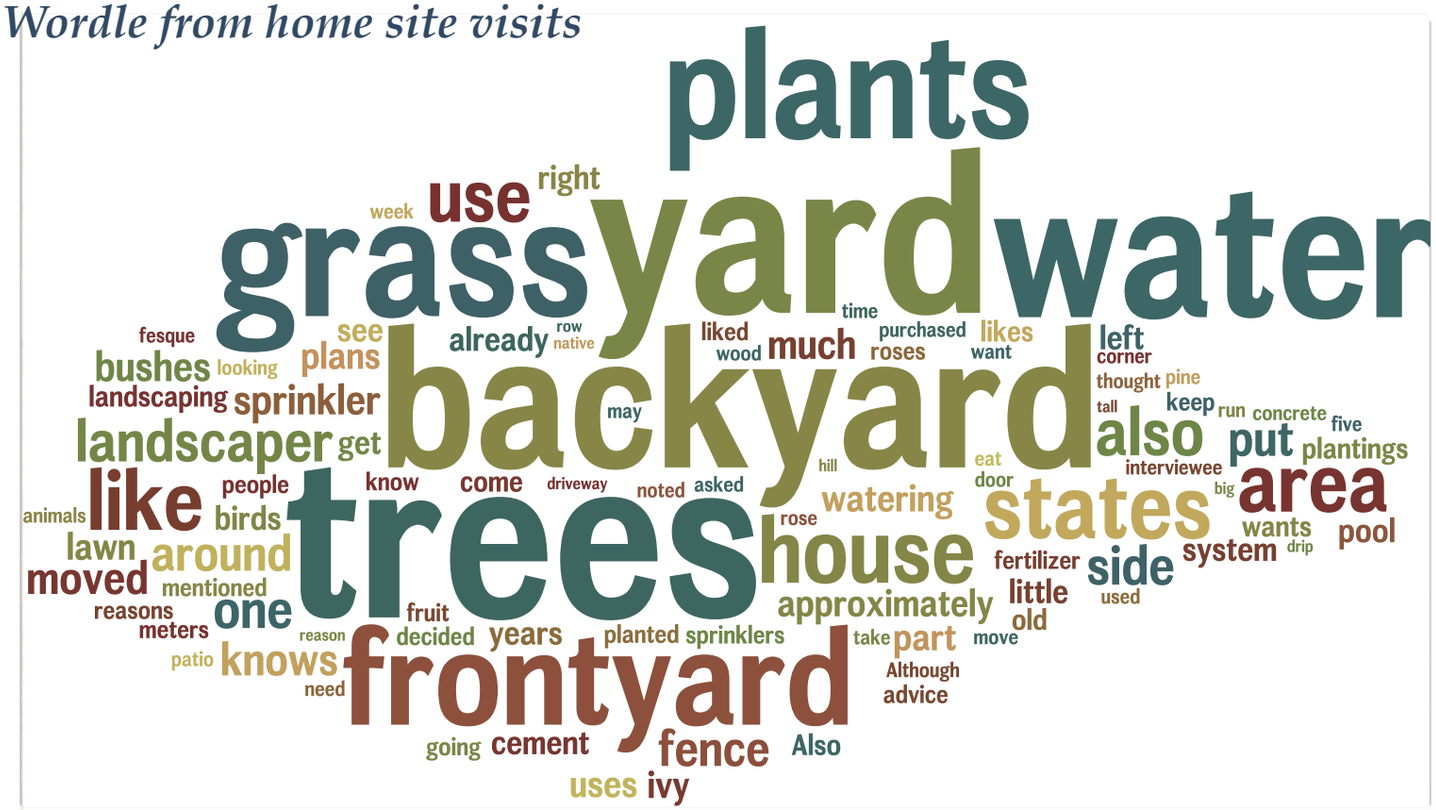
- Mail surveys and site visits found:
  - 85.8% self-reported compliance with municipal codes for watering lawns, but
  - 76% underestimated the amount of water used outdoors; 61% estimate it at <40% of their household water use
- Planting and landscaping decisions, and water use influenced by
  - educational attainment, income, landscaping companies
  - family members, neighbors
- **Cultural inertia:** 62.7% say they have tried to reduce water use for environmental reasons, but ***only <25% have actually planted water-saving species or removed thirsty ones from their yards!***

Thinking about water & landscapes in our yards…



Wordle from mid-income focus group

Wordle from home site visits



"I always thought of myself as conservation-minded, but I don't think looking back in retrospect that my choices for the valley have reflected that image of myself… I try to conserve water when I can but I think my choices have not been so great."

- Homeowner

It takes a village to study the city...

- *Paying the bills*:
  - National Science Foundation & U.S. Forest Service (ULTRA-Ex Award # 0949036)
  - CSU Fresno: Provost, College of Science and Mathematics, Division of Graduate Studies
  - Robert and Norma Craig Foundation
  - Fresno Audubon Society
- City of Fresno, City of Clovis, Fresno County
- Citizen Scientists of the Fresno Bird Count!
- *FBC coordination*: Kaberi Kar Gupta, Jenny Phillips, Pedro Garcia, Amy Krisch
- *Database*: Xiaoming Yang
- *Data entry*: Amer Naik, Rhiannon Perry
- Tucson Bird Count, NiJeL.org

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