- Environment: not just the birds and the bees
- Ecosystem services in urban areas
- Using ecological principles in design and management
- Urban areas consistent with their surrounding ecosystems

Nancy B. Grimm
Arizona State University

Central Arizona – Phoenix Long-Term Ecological Research

GLOBAL INSTITUTE of SUSTAINABILITY

ECOSYSTEM SERVICES: we depend upon ecosystems for much of what makes any environment “livable”

- Providing goods (fresh water, food, fiber)
- Regulating conditions (climate, water quality)
- Benefits to well-being (aesthetic, recreation, sense of place)
- Supporting (nutrient cycles, energy production, etc.)

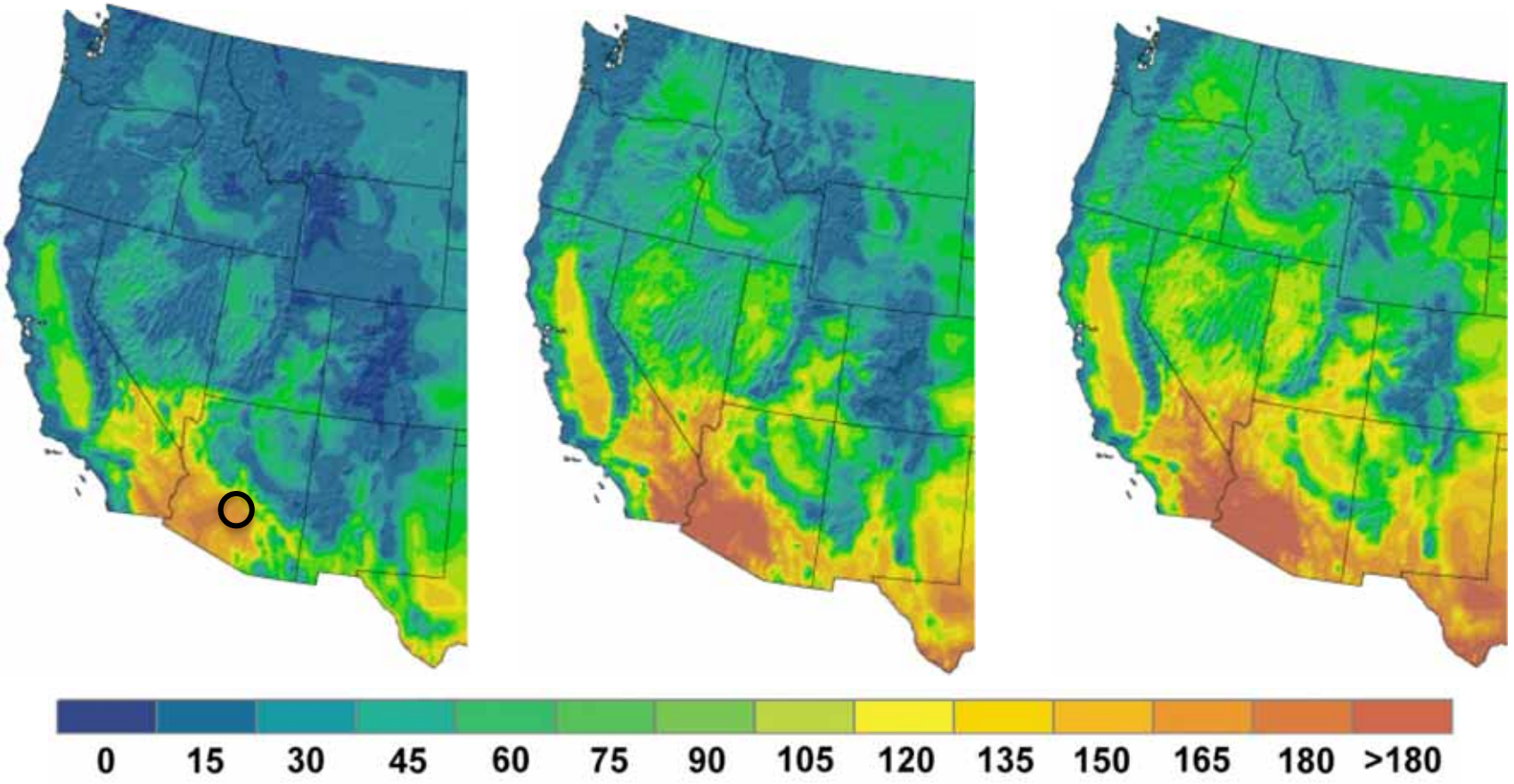
There are always tradeoffs among services; we cannot maximally extract benefit from ecosystems without compromising something else – here and now, or in a different place at a different time.

Days Above 90°F

1961-1979
Observed

2080-2099
Lower emissions scenario

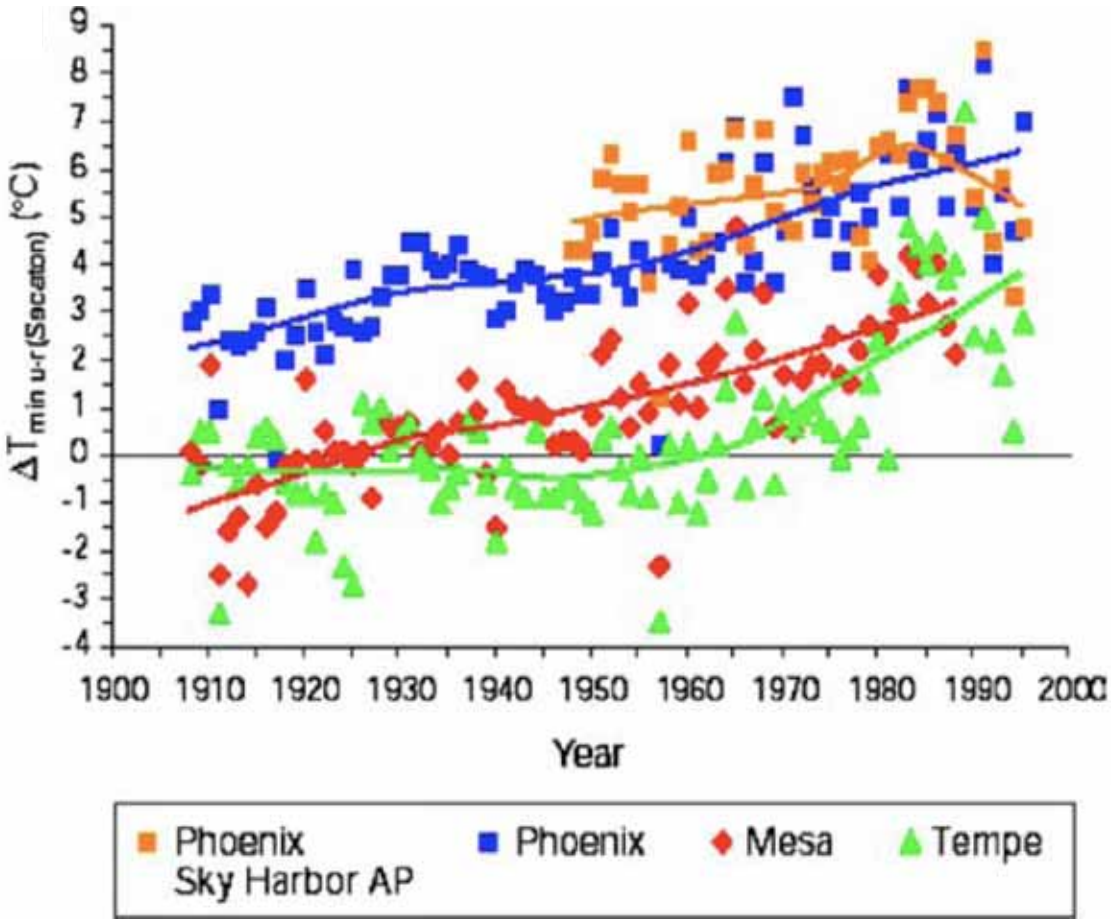
2080-2099
Higher emissions scenario



The average number of days when the maximum temperature has exceeded or is projected to exceed 90ºF by end of century. Much of the southern United States is projected to have more than twice as many days above 90ºF by the end of this century.

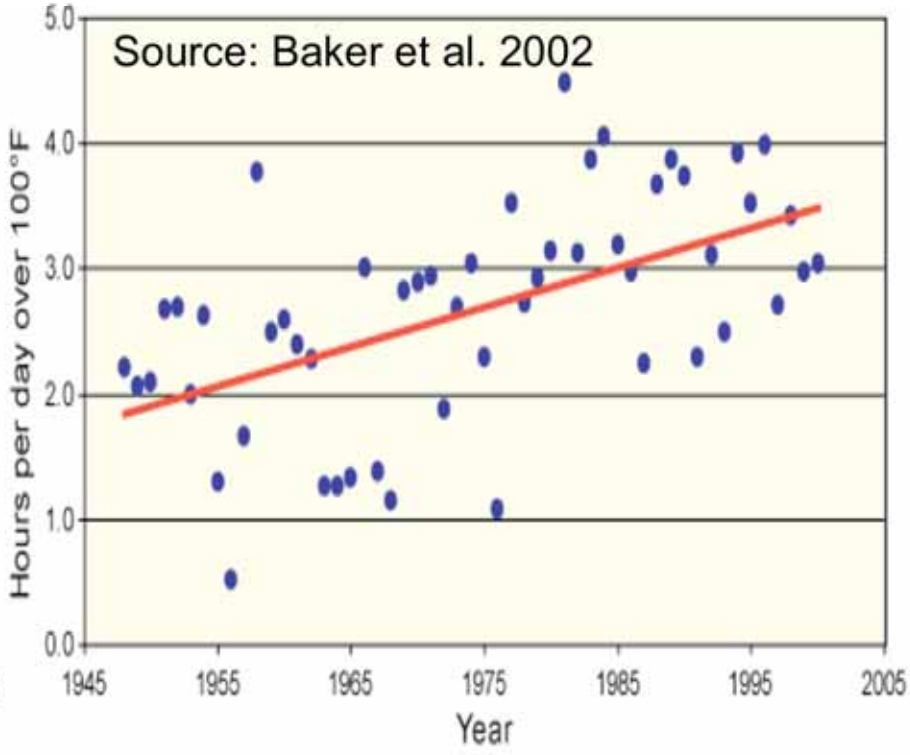
Source: *Global climate change impacts in the United States, 2009.*

Local temperature is increasing faster



Mean minimum temperature has increased as much as 5°C over the past century.

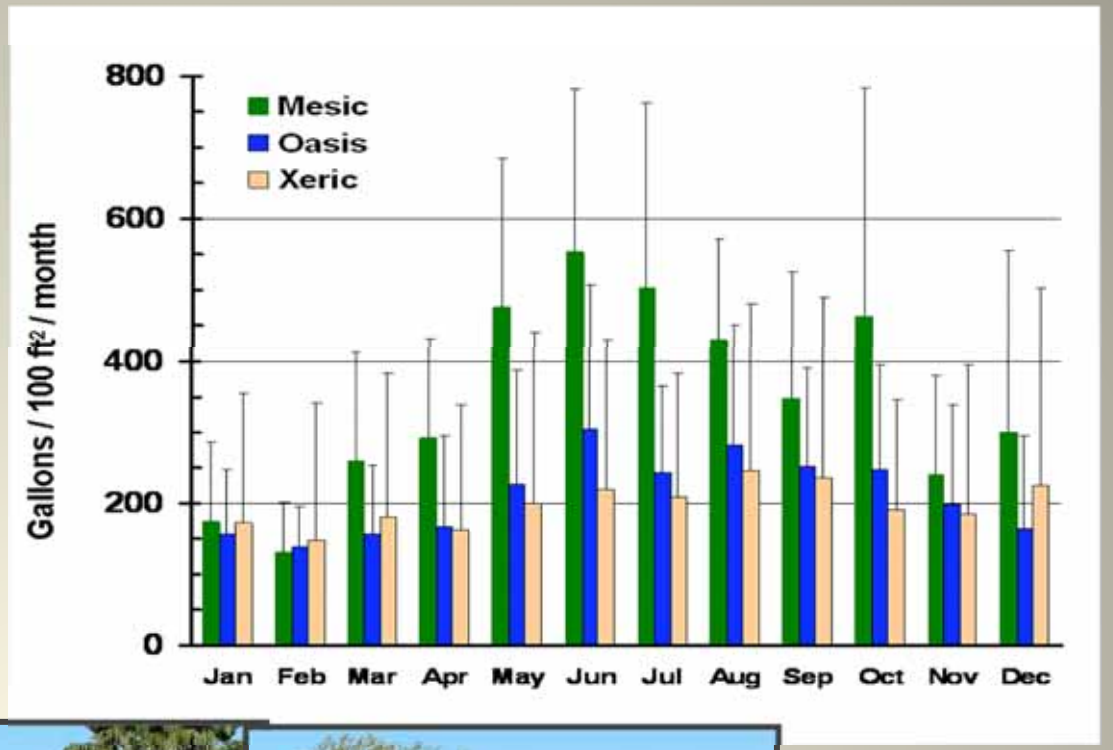
This compares to <1°C increase in mean temperature regionally.



The average number of hours per summer day in Phoenix that the temperature was over 100°F has doubled over the past 50 years, mostly as a result of the urban heat island effect.

ECOSYSTEM SERVICES

Tradeoffs in water provisioning, climate modulation, energy costs

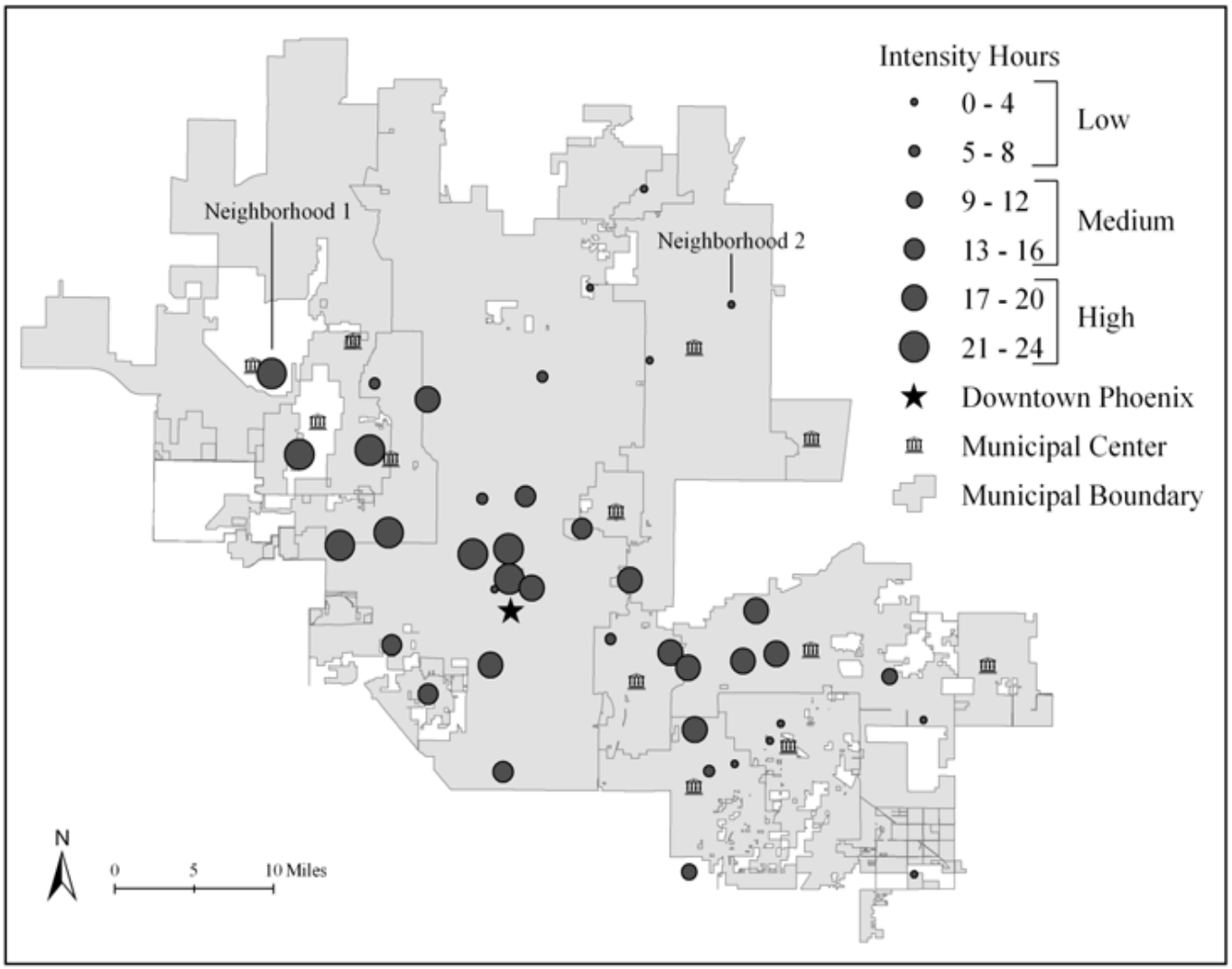


High to Low Water Use

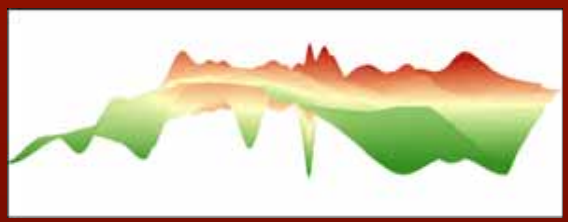
42.7°C 44.1°C 45.7°C

Mid-afternoon house exterior temperature (n=6 per landscape type, June 16 2007, p<0.05)

Hours of Exposure to Extreme Heat by Neighborhood July 15-19, 2005



- Range: 24
- Mean: 12.6
- SD: 7.9
- N = 40



Central Arizona – Phoenix Long-Term Ecological Research

Darren Ruddell et al., 2009

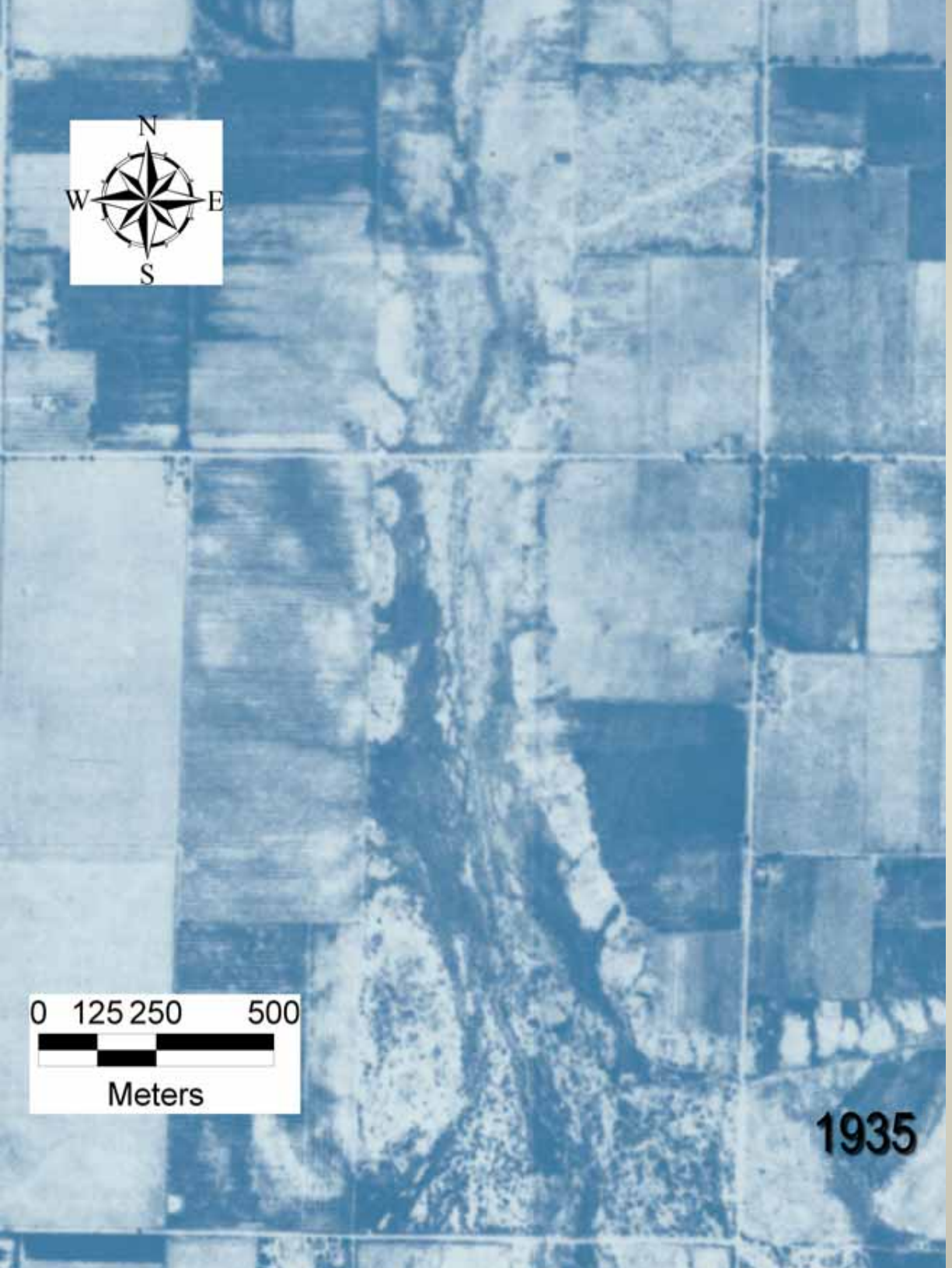
Demographic Characteristics by Exposure Intensity Class

US Census	Low	Medium	High	
N Neighborhoods	15	10	15	
Size				
Population per sq mi	3,569	3,757	7,550	*
Income				
Household income	$71,903	$62,669	$38,621	*
Ethnicity				
% minority	20.7	25.9	44.7	*
Age				
% ages 65 and over	9.8	20.4	17.5	*

Darren Ruddell et al., 2009

Wealth→ plant abundance & diversity→ cooler microclimates→ reduced exposure risk

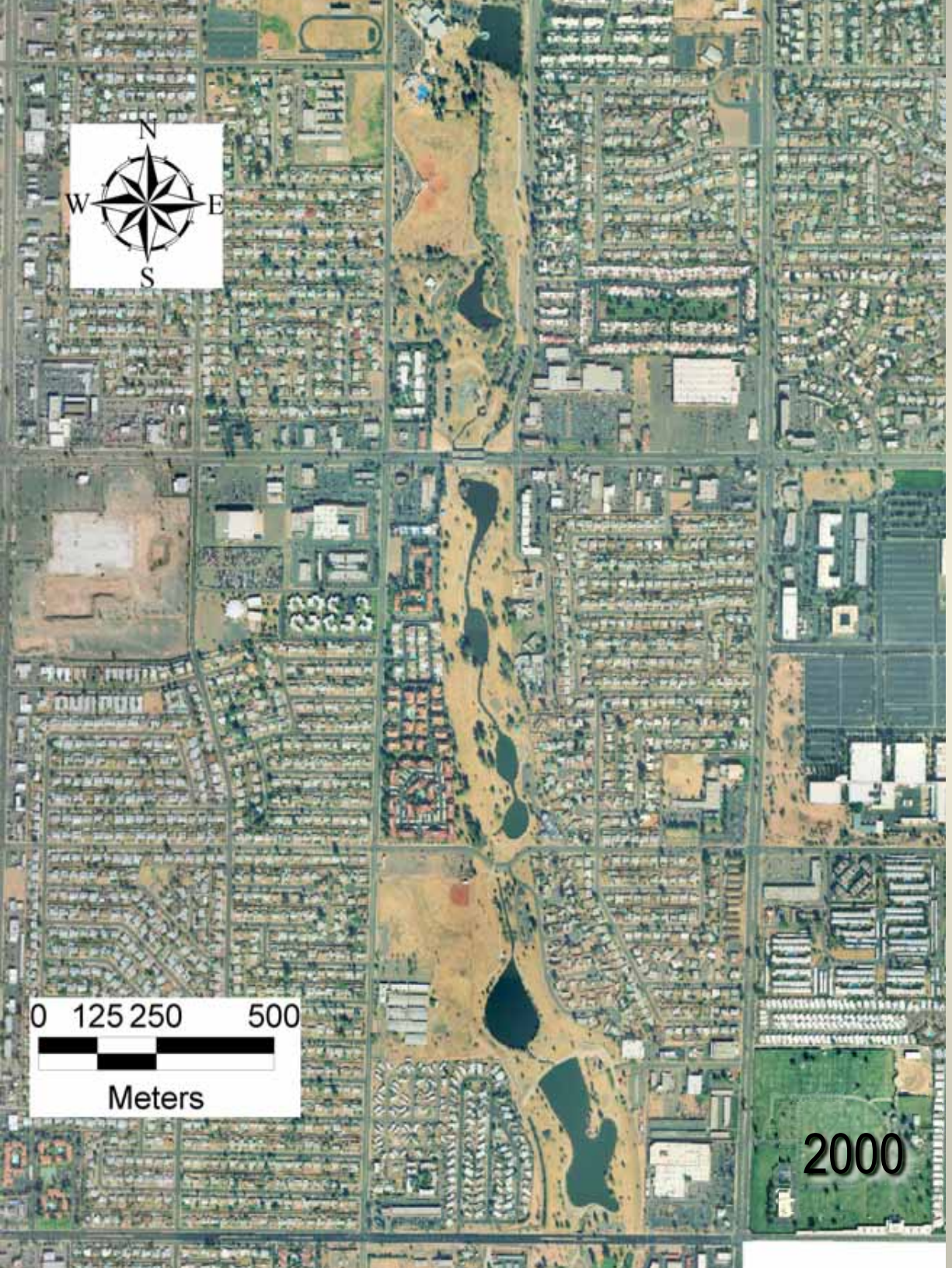
Tradeoffs: water use



Indian Bend Wash: reach-scale geomorphic and hydrologic changes

- Pre-development: agricultural landscape, very sparse housing
- Geomorphology: ephemeral stream, broad, flood-created channel
- Vegetation: sparse mesquite trees, low shrubs, open areas
- Natural tributary channels evident upstream
- 1950's: beginning of rapid urbanization

From Roach et al. 2008, BioScience

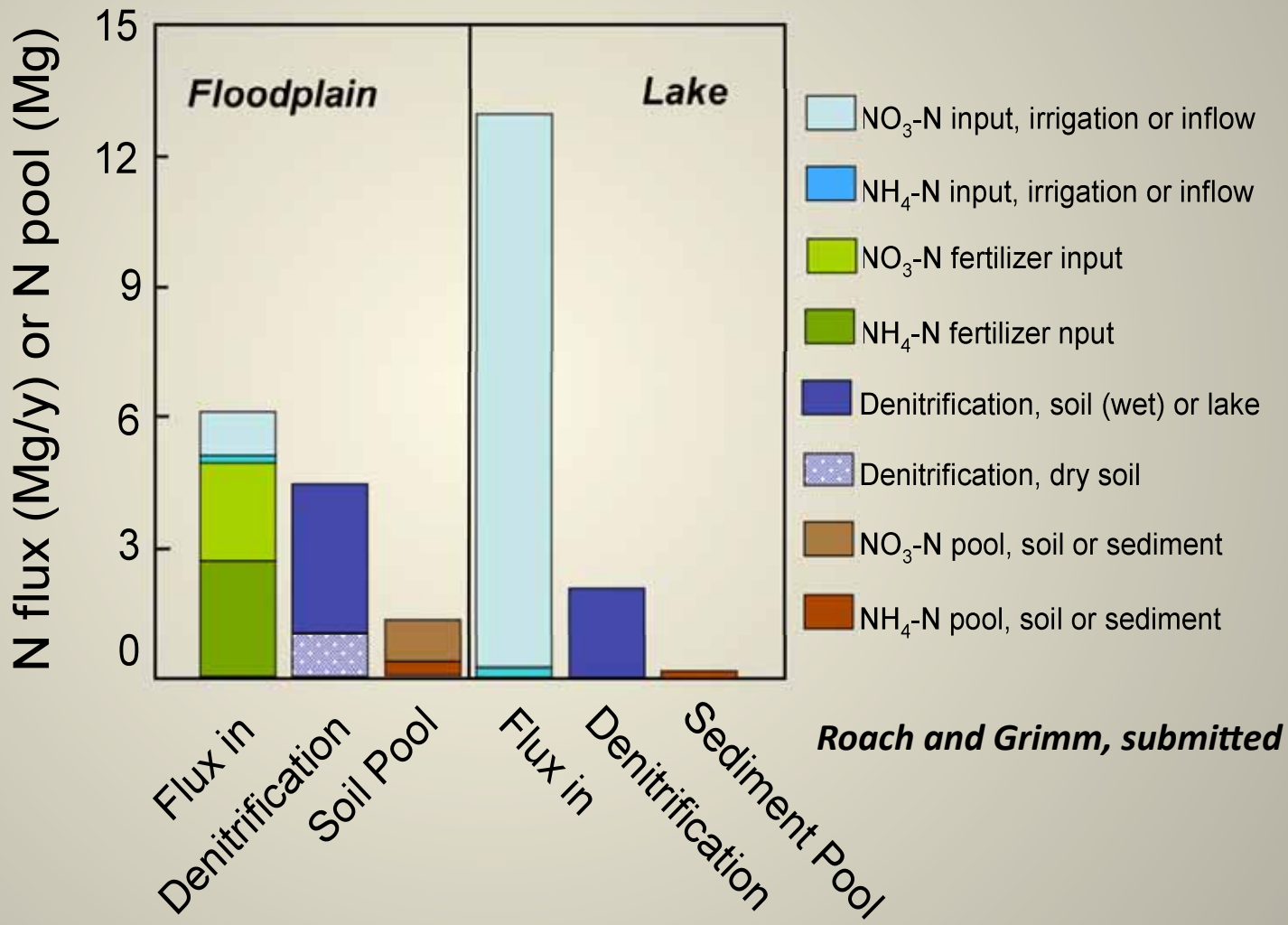


Indian Bend Wash: reach-scale geomorphic and hydrologic changes

- Flooding→design options for "managing" floods, protecting life & property
- Floodway supports the natural flooding regime with minor economic consequences
- Recreational ecosystem services
- Are floodplains and lakes effective in removing nitrogen?

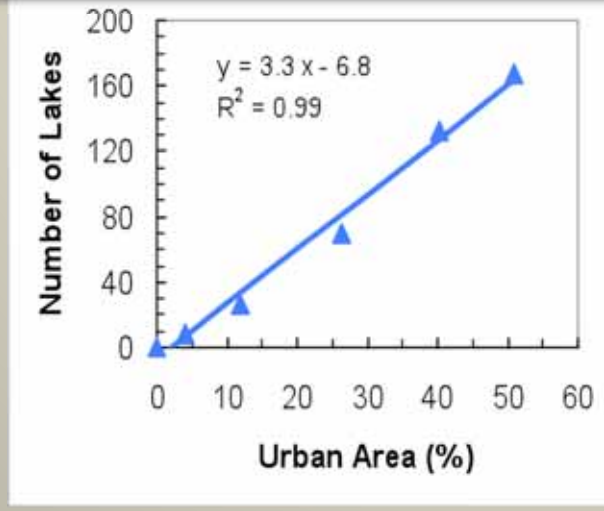
From Roach et al. 2008, BioScience

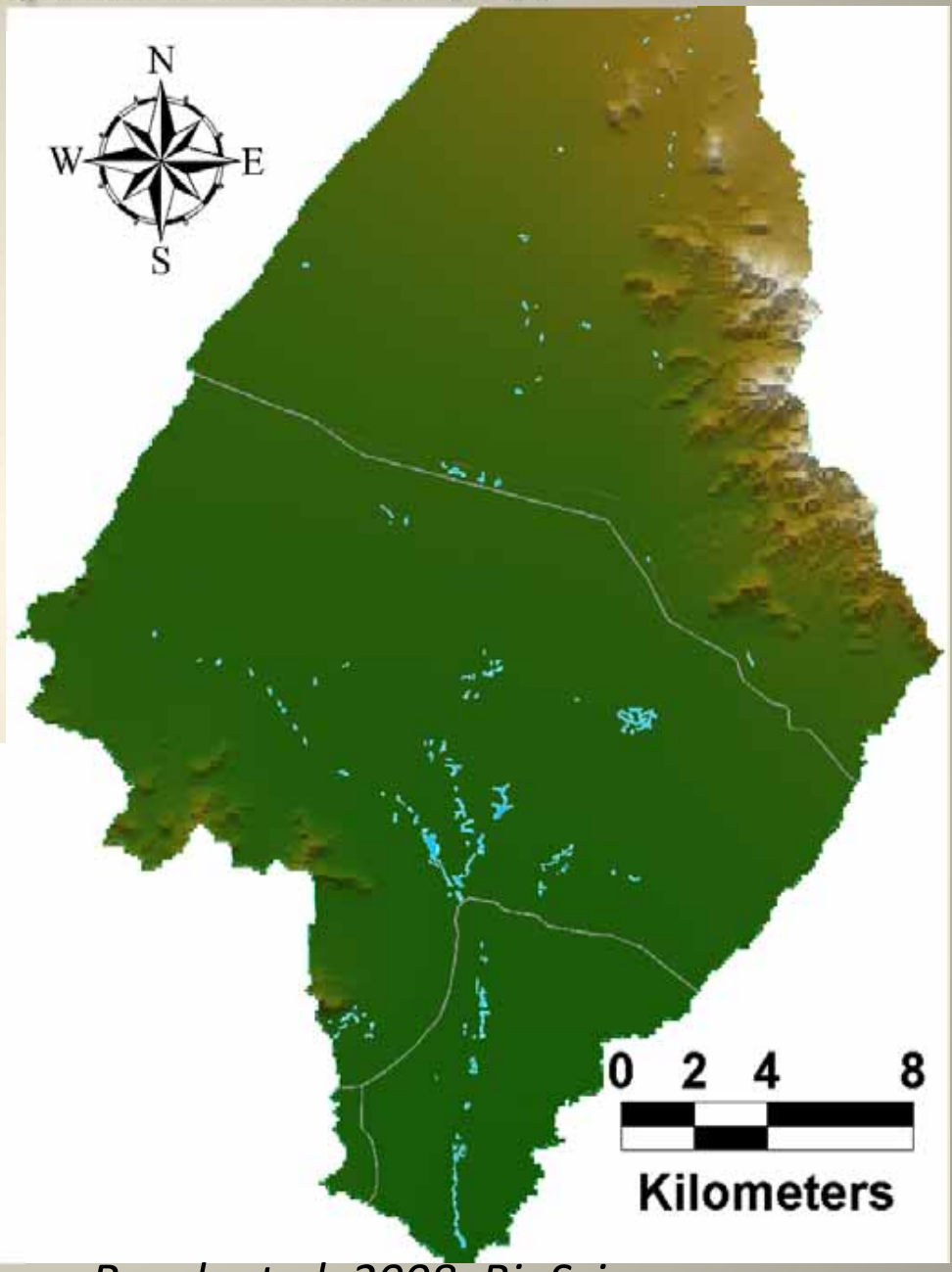
Are these new urban water features effective in nitrogen removal?



Roach and Grimm, submitted

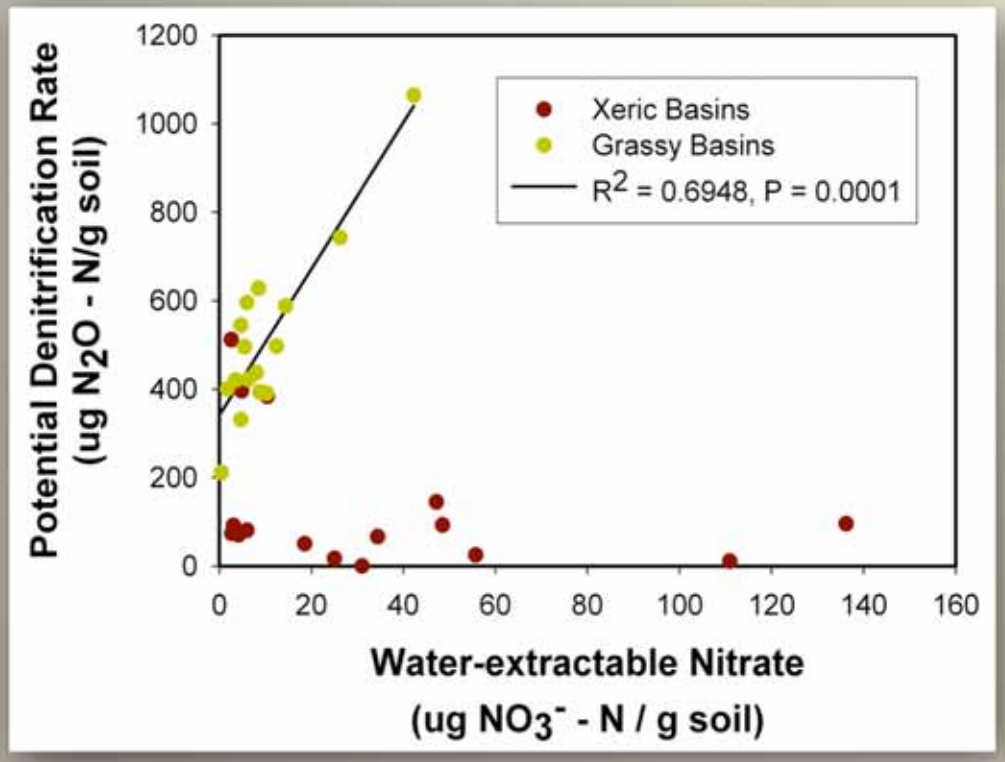
Creation of lakes: 160 in IBW (shown), >1000 in Phoenix metro (vs. 0 in 1900) *(Larson & Grimm, in prep)*





Roach et al. 2008, BioScience

Retention basins are another water feature with high potential denitrification



Larson, dissertation

NAS Forum on Urban Sustainability, Sept 2009

- In urban landscapes: designed ecosystems replace 'natural' aquatic ecosystems

- How can we improve or maximize the delivery of ecosystem services by streams using management, restoration, or design?
- What tradeoffs exist and how to manage?

Iterative Conceptual Framework Linking Social and Biophysical Sciences via Ecosystem Services