Application of integrated inventory to the study of urban ecosystem: an extensive 200-site field survey of the Central Arizona-Phoenix LTER

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Introduction & Methodology

- We asked the question: *'What are the ecological conditions associated with the range of current land uses across metropolitan Phoenix and how do these conditions vary in space and with time?'*
- To answer this question we adopted a whole system approach, using a random sampling design to conduct an extensive field survey and integrated inventory of a number of key variables.
- A tessellation-stratified sampling design consisting of a 4km x 4 km grid was overlaid on the study area (6387 km^2). One sample point was randomly located in each grid cell within the developed urban core; outside this area every third grid cell was sampled (n=206 sites).
- Field plots were 30m x 30m square and were surveyed exactly where they fell – unless access was not possible (12 such cases) when they were moved to the nearest available point with same characteristics (possible at all but 2 sites), giving a total sample of 204 sites.
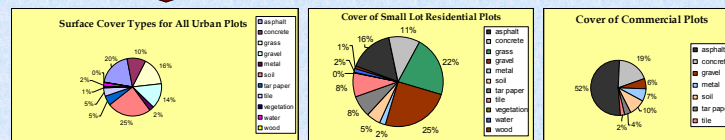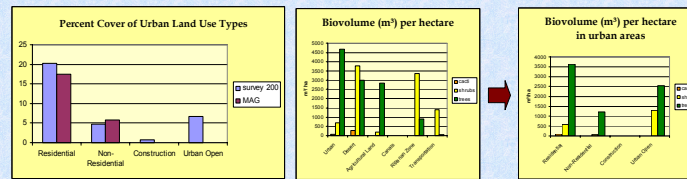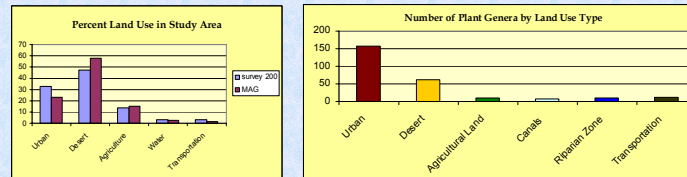
Main variables inventoried:

Land use & surface cover types (e.g.lawn, concrete, asphalt, bare soil, tile roof)
- *Vegetation diversity* (id to genera), biovolume & condition **(see Stiles & Scheiner poster)**
- *Soil:* Soil cores for determination of major nutrient content, pH, bulk density & texture
- *Soil fauna/flora:* Samples taken for assay of prokaryote, mycorrhizal activity/diversity **(see the Cousins & Stutz poster)** & pollen id.
- *Micro-meteorology:* measured while on site.
- *Decomposition study* (place *Encelia farinosa* litter bags & wood for recovery after 12 months).
- *Insect diversity:* 3 sweep net samples taken from representative shrubs & trees on the plot **(see the Rango et al poster)**
- *Documentary Photos:* From plot center in four cardinal directions and one 'synoptic' view
- *Bird survey:* Point count of all species for 15 minutes within 3 hours of sunrise, from plot center, 4 times per year. **See the Shochat & Katti poster.**
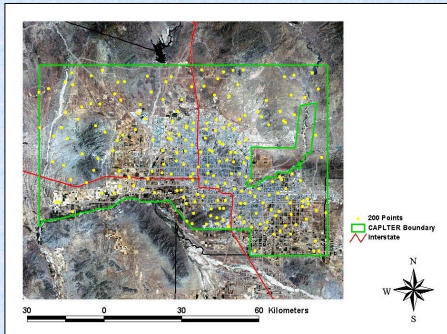
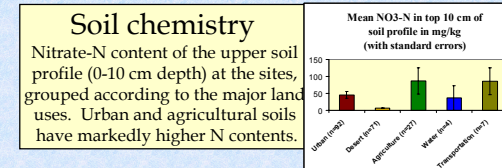Survey sample points and study area boundary
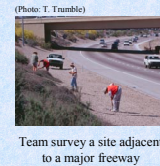
Legend: 200 Points; CAPLTER Boundary; Interstate

Additional Applications of the Survey Data

In addition to answering our basic question, the survey is also intended to:
- be repeated every 5 years as part of long-term monitoring
- help scale up findings from site-specific studies to the entire study area
- provide a framework of common study sites for multi-investigator studies
- allow comparison of basic site variables between CAP and BES (Baltimore)
- generate ground-truth data with which to calibrate remotely sensed imagery
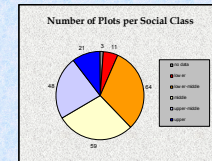- produce data for use in whole system modeling

Examples of desert, agricultural, residential, and downtown urban field sites.

(Photo: T. Trumble)

Team survey a site adjacent to a major freeway

Percent Land Use in Study Area (survey 200 / MAG) — Urban, Desert, Agriculture, Water, Transportation

Number of Plant Genera by Land Use Type — Urban, Desert, Agricultural Land, Canals, Riparian Zone, Transportation

Percent Cover of Urban Land Use Types (survey 200 / MAG) — Residential, Non-Residential, Construction, Urban Open

Biovolume (m³) per hectare (cacti / shrubs / trees)

Biovolume (m³) per hectare in urban areas (cacti / shrubs / trees)

Surface Cover Types for All Urban Plots — asphalt, concrete, grass, gravel, metal, soil, tar paper, tile, vegetation, water, wood

Cover of Small Lot Residential Plots

Cover of Commercial Plots

Soil chemistry

Nitrate-N content of the upper soil profile (0-10 cm depth) at the sites, grouped according to the major land uses. Urban and agricultural soils have markedly higher N contents.

Mean NO3-N in top 10 cm of soil profile in mg/kg (with standard errors) — Urban (n=9), Desert (n=71), Agriculture (n=2), Water (n=4), Transportation (n=7)

(Photo: T. Trumble)

Taking a soil core sample at one of the urban sites.

Number of Plots per Social Class — no data, low er, low er-middle, middle, upper-middle, upper

Example of an interdisciplinary study using the survey data

Socioeconomic Status of Neighborhoods in the Phoenix Metropolitan Area, 1990
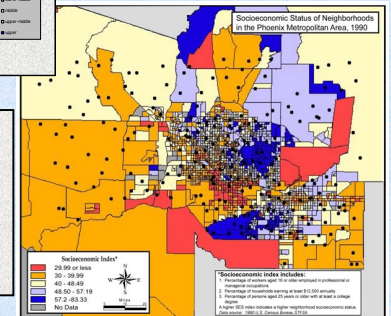
Outline for the analysis of the relationship between vegetation and socio-demographic indicators.
Vegetation measures will include:
- species diversity (native versus exotic)
- cover of major vegetation types
- biovolume
Socio-demographic indicators will include:
- socio-economic index (see map)
- race/ethnicity
- household type indicators

Socioeconomic Index: 29.99 or less; 30 - 39.99; 40 - 48.49; 48.50 - 57.19; 57.2 -83.33; No Data

Development of an 'urban-ness' index

The proposed method uses a number of key components as equal contributors to the index. Another possibility is to create sub-indices that are constructs of

Proposed Components	Variable	Units
1. Human population	Population density	People per km^2
2. Location in city	Distance from urban center	Kilometers (inverse)
3. Structural modification (horizontal component)	Impervious surface cover	Fraction of 1 or %
4. Structural modification (vertical component)	Height of tallest building	Meters
5. Human activity	Measure of traffic activity (MAG)	Vehicles per hour
6. Recent development activity	Number of housing completions	Number in last 2? years
7. Length of occupation	Time since 1st development	Years
8. Modification of native vegetation	Number of native species (n)	1/n

Two Hypothetical Examples	*Business area near downtown Phoenix*	*Large lot residential in West Valley*
Component	**Rank Score**	**Rank Score**
1. Human population	3	2
2. Location in city	5	2
3. Structural modification (horizontal component)	5	3
4. Structural modification (vertical component)	5	1
5. Human activity	5	2
6. Recent development activity	3	3
7. Length of occupation	5	2
8. Modification of native vegetation	5	3
Average Score:	**4.5**	**2.3**
Total Score:	**36**	**18**