Decision Model for Controlling Buffelgrass Invasion in an Urban-Wildland Interface

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Problem Statement

Buffelgrass (*Pennisetum ciliare*), a fire-prone African bunchgrass, is spreading rapidly across the increasingly urbanized, desert landscapes of southern and central Arizona.

Ongoing are:

- escalating fire risks in what was long considered a fireproof (and maintenance-free) desert landscape
- transformation of unique Sonoran desert landscape with potential impacts on property
- impacts on prominent national parks and conservation initiatives
- increased mitigation requirements to protect threatened and endangered species

A History of Buffelgrass Introduction

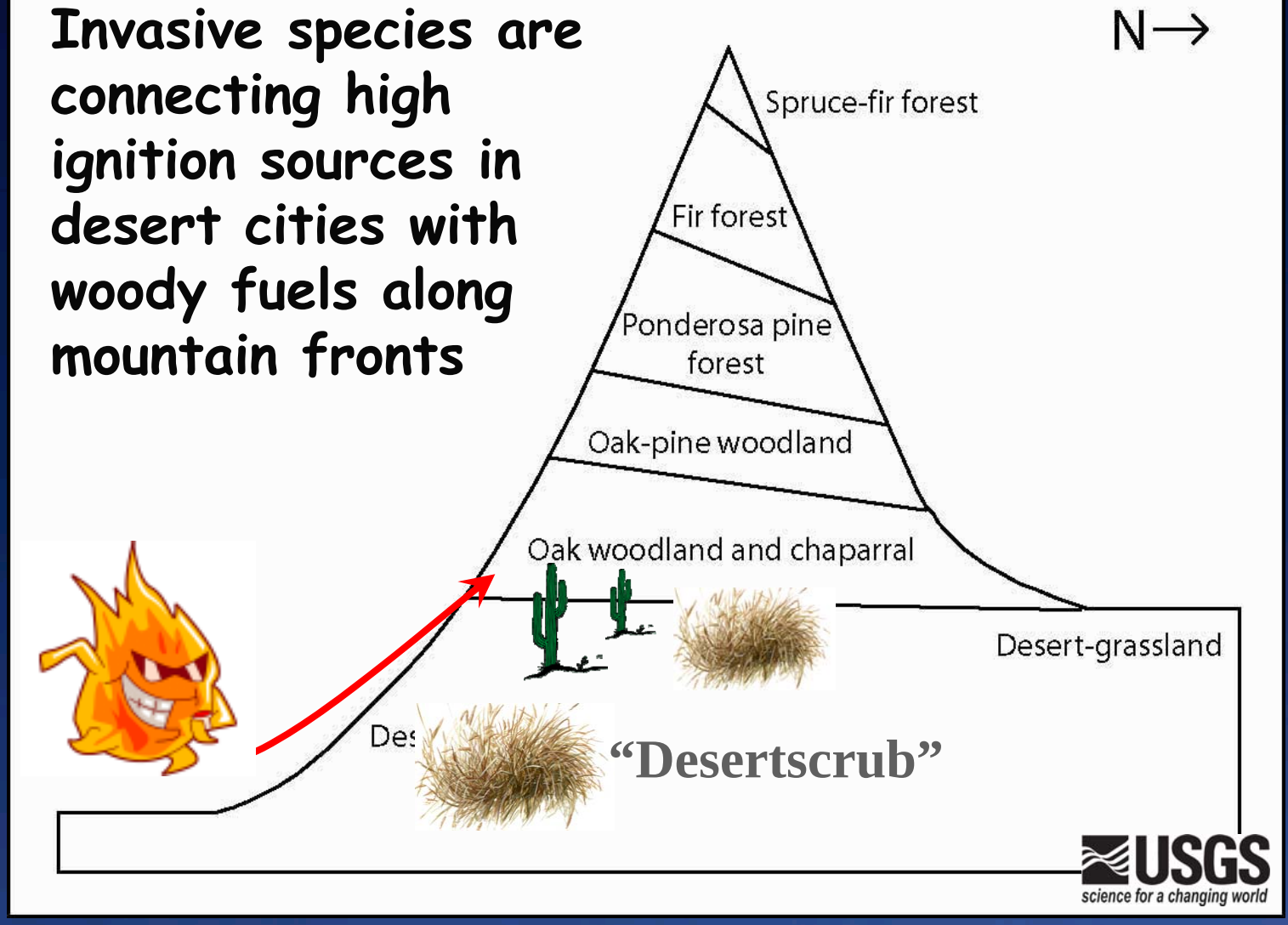
1940's	SCS reintroduces T-4464 from Kenya's Turkana Desert into South Texas, where it becomes "wonder grass"
1940's	SCS plants it at Plant Materials Center in Tucson
1958	USDA & UA range scientists convince Mexican gov't to convert millions of acres in Sonora to "zacate bufel"
1970's	discovery of sexual clone jumpstarts aggressive breeding by USDA-ARS & Texas Ag. Res. Station at Texas A&M
1973-1974	Planted at Caterpillar Company's Proving Grounds
1979	Planted at Tucson Plant Materials Center
1982-1986	Planted at Santa Rita Exp. Range
1985-1995	USDA-ARS uses to reclaim abandoned farmland in S. AZ
2002-2005	USDA-ARS Crop Germplasm Unit/Texas A&M develop & release "Frio", now planted in Cananea, Sonora

Gaps in vegetation reduce fire risk

Thin photosynthetic epidermal layers are not fire resistant

Increased risk of forest fire

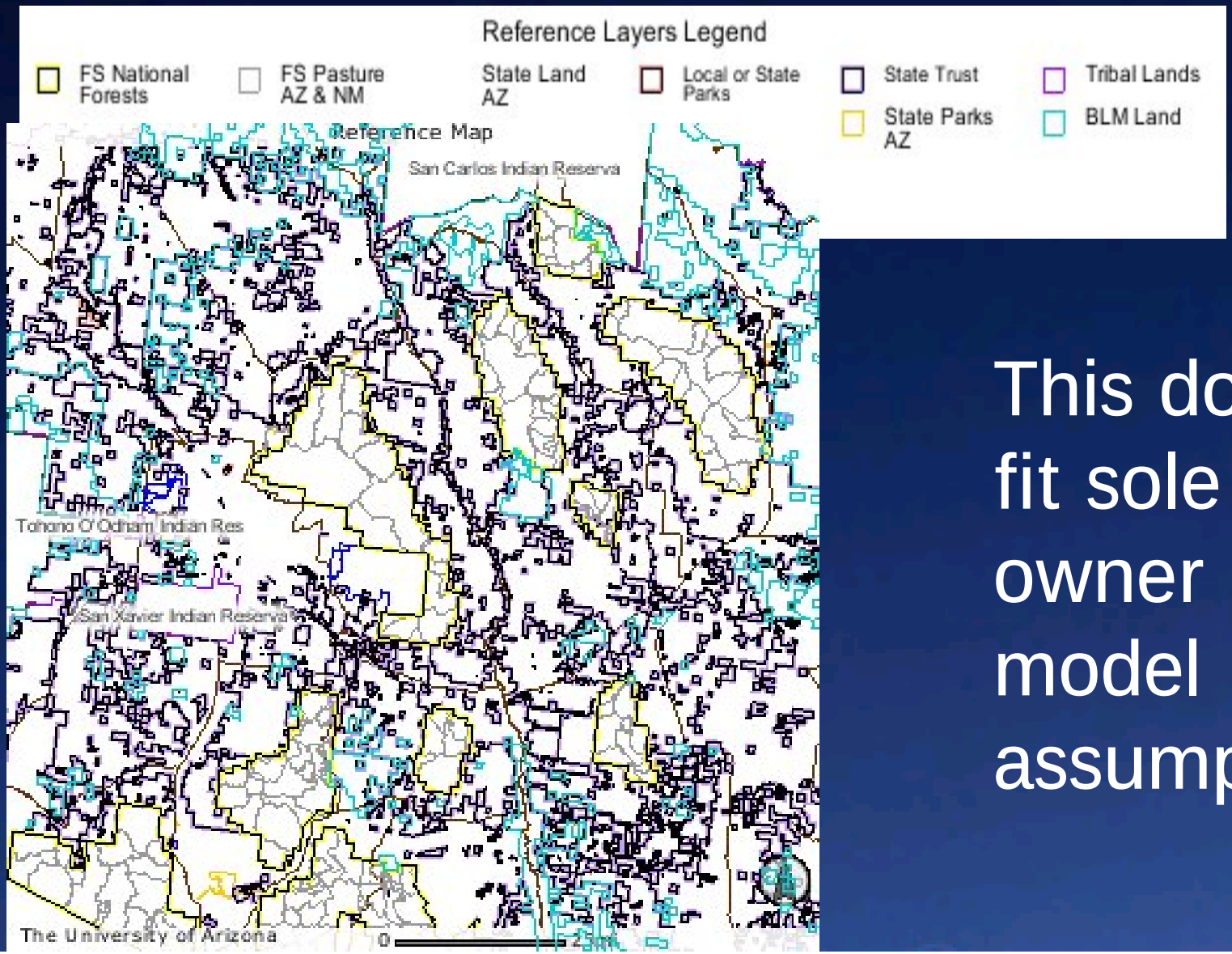
Invasive species are connecting high ignition sources in desert cities with woody fuels along mountain fronts



Sole Owner, Optimal Control Framework Inadequate

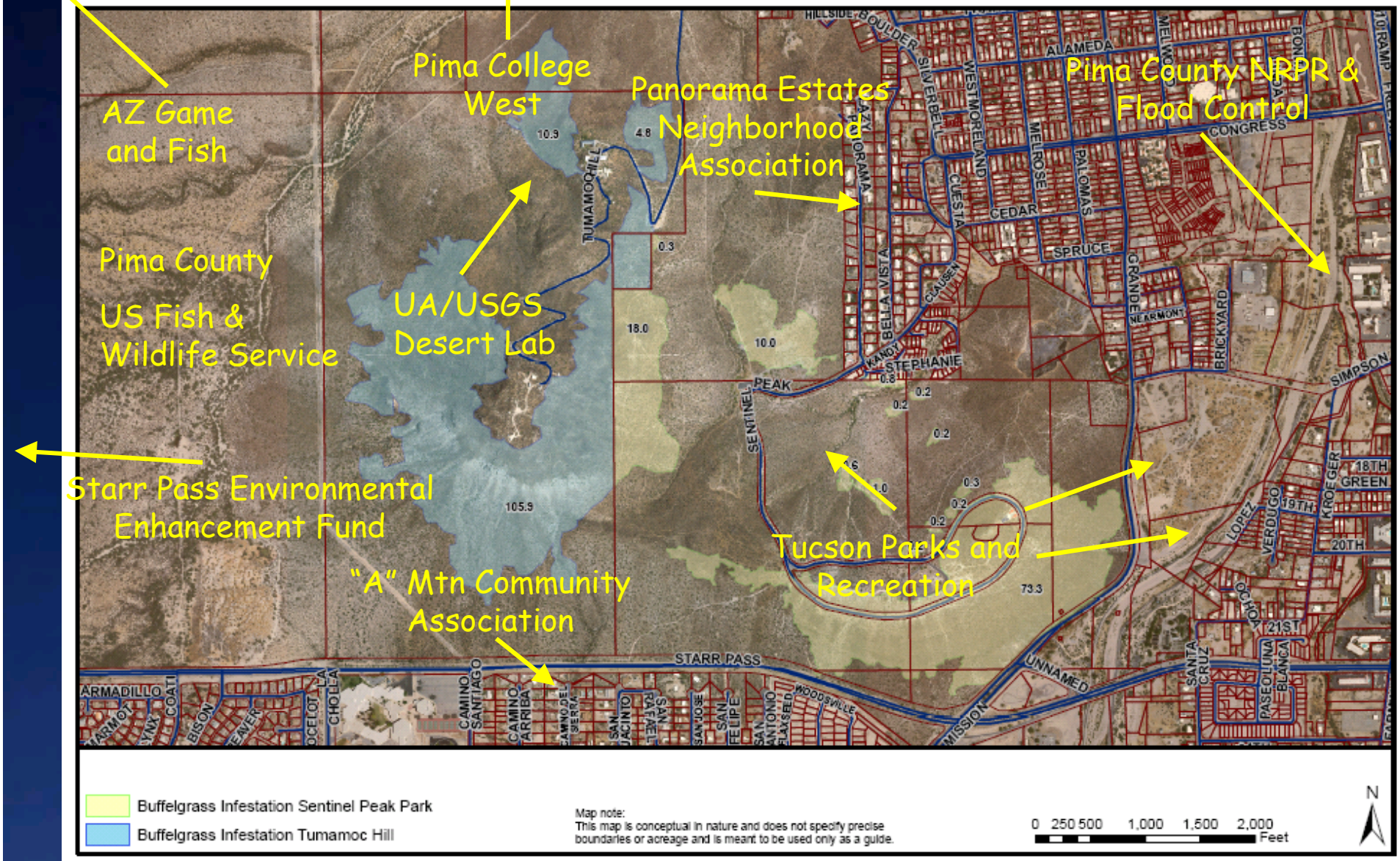
- Multiple land management jurisdictions
- Public and private entities
- Local, state, and federal land management entities
- Entities have different objective functions
- Buffelgrass control is a “weakest-link” public good

Jurisdictional Fragmentation in Eastern Pima County



This doesn't fit sole owner model assumptions

Buffelgrass Eradication Effort, Tumamoc Hill and 'A' Mountain 8/06



Alternative Approach

- Use spatial dynamic programming
- Explicitly account for jurisdictional fragmentation
- Explicitly account for “weakest-link” public good problem
- Allow for uncoordinated and coordinated management
- Use Analytical Hierarchy Process (AHP) to provide user-friendly specification of dynamic programming problem

Project Activities

- Develop and calibrate buffelgrass spread model
- Develop potential damage surfaces
- Develop treatment cost surfaces
- Develop static cost-effectiveness maps (damage reduction per $ spent)

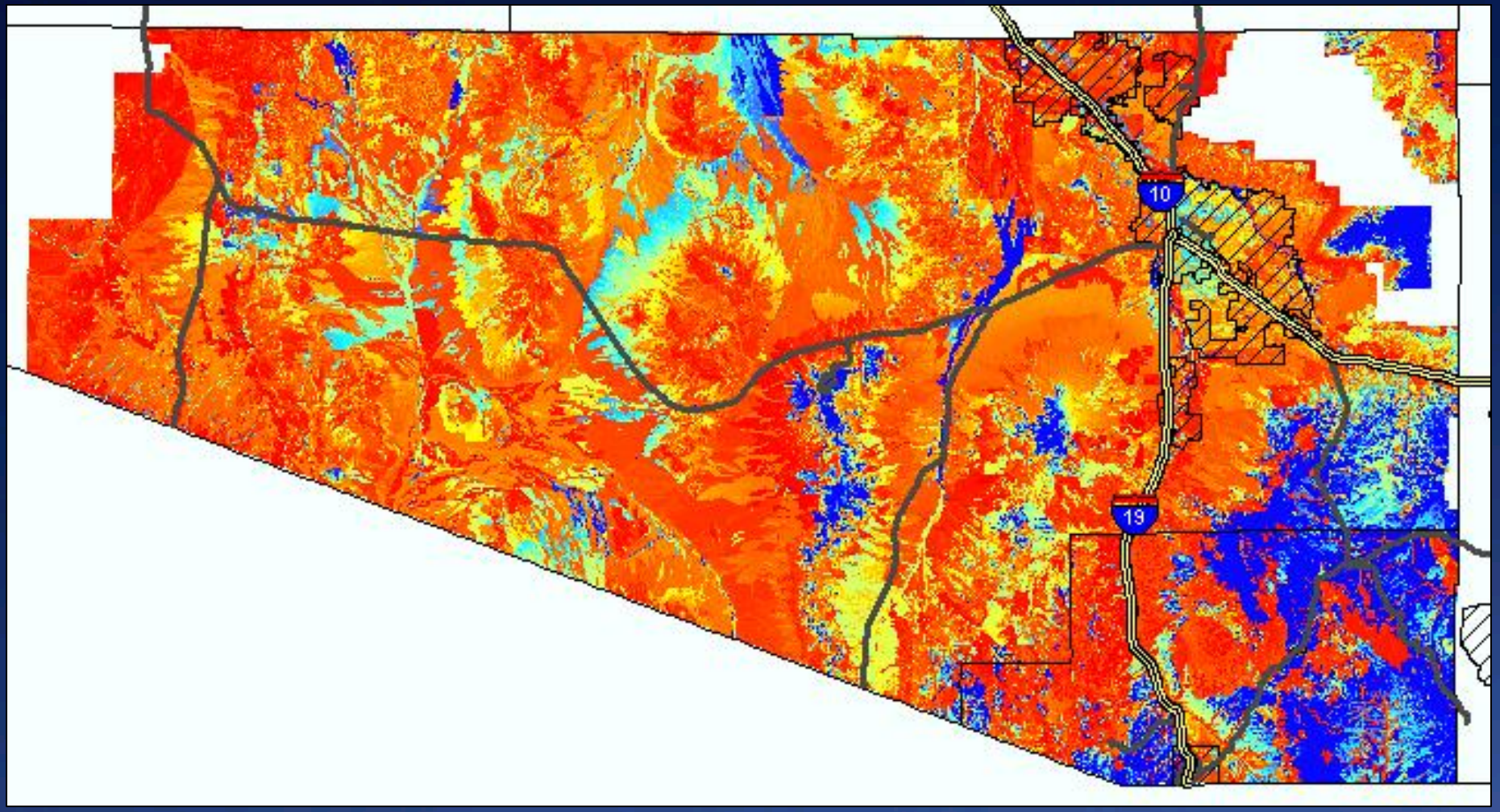
Modeling Buffelgrass Spread

- Little pre-existing characterization of spread model or model parameters
- Model calibrated to replicate historical aerial photos and more recent monitoring data

Modeling Buffelgrass Spread

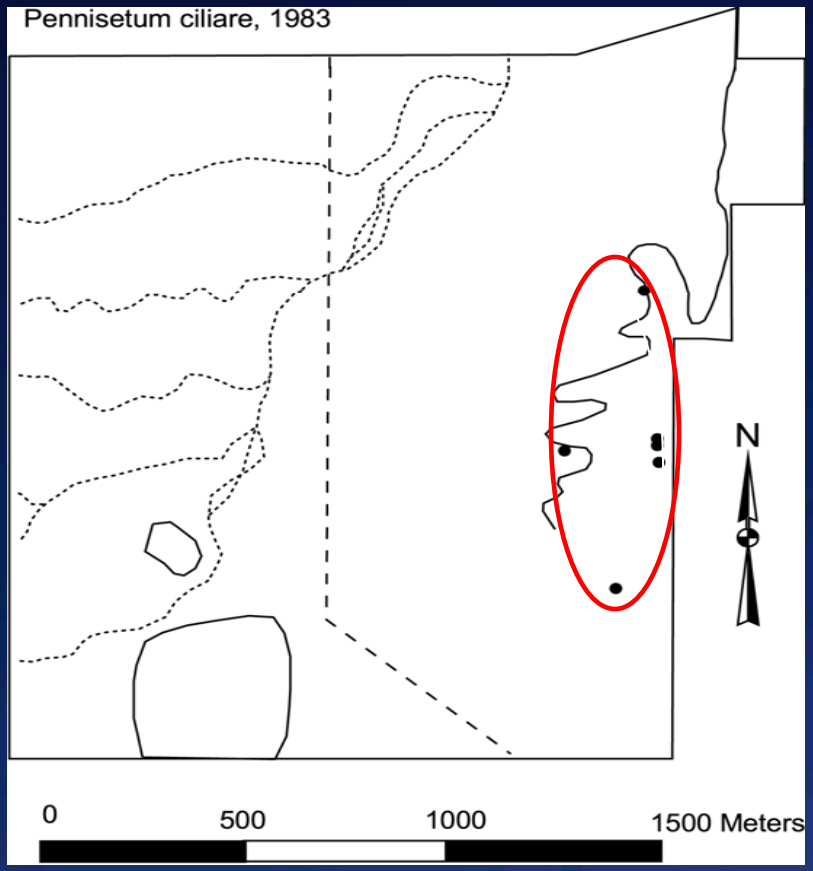
- Dispersal modeled using a negative exponential dispersal kernel
- Dispersal characterized as short-distance front and longer-distance dispersal of “satellite” patches
- Spread depends on suitability (soils, climate)
- Spread faster along roadways and disturbed areas

Potential buffelgrass distribution in Pima and Santa Cruz Counties

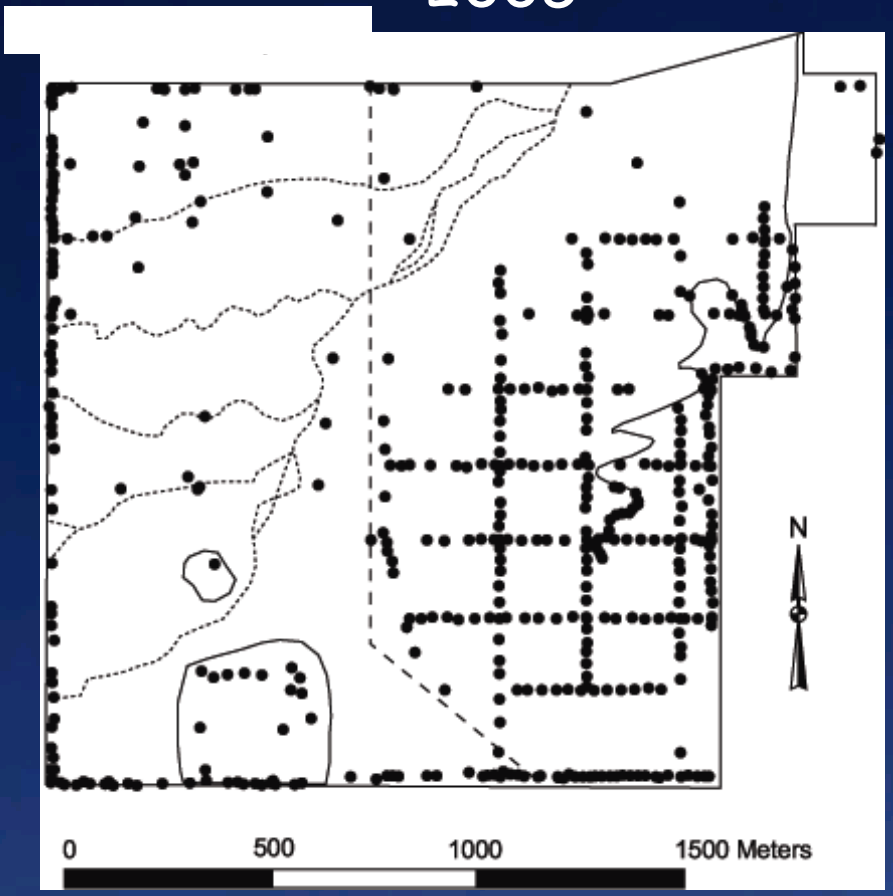


Increase in buffelgrass on Tumamoc Hill

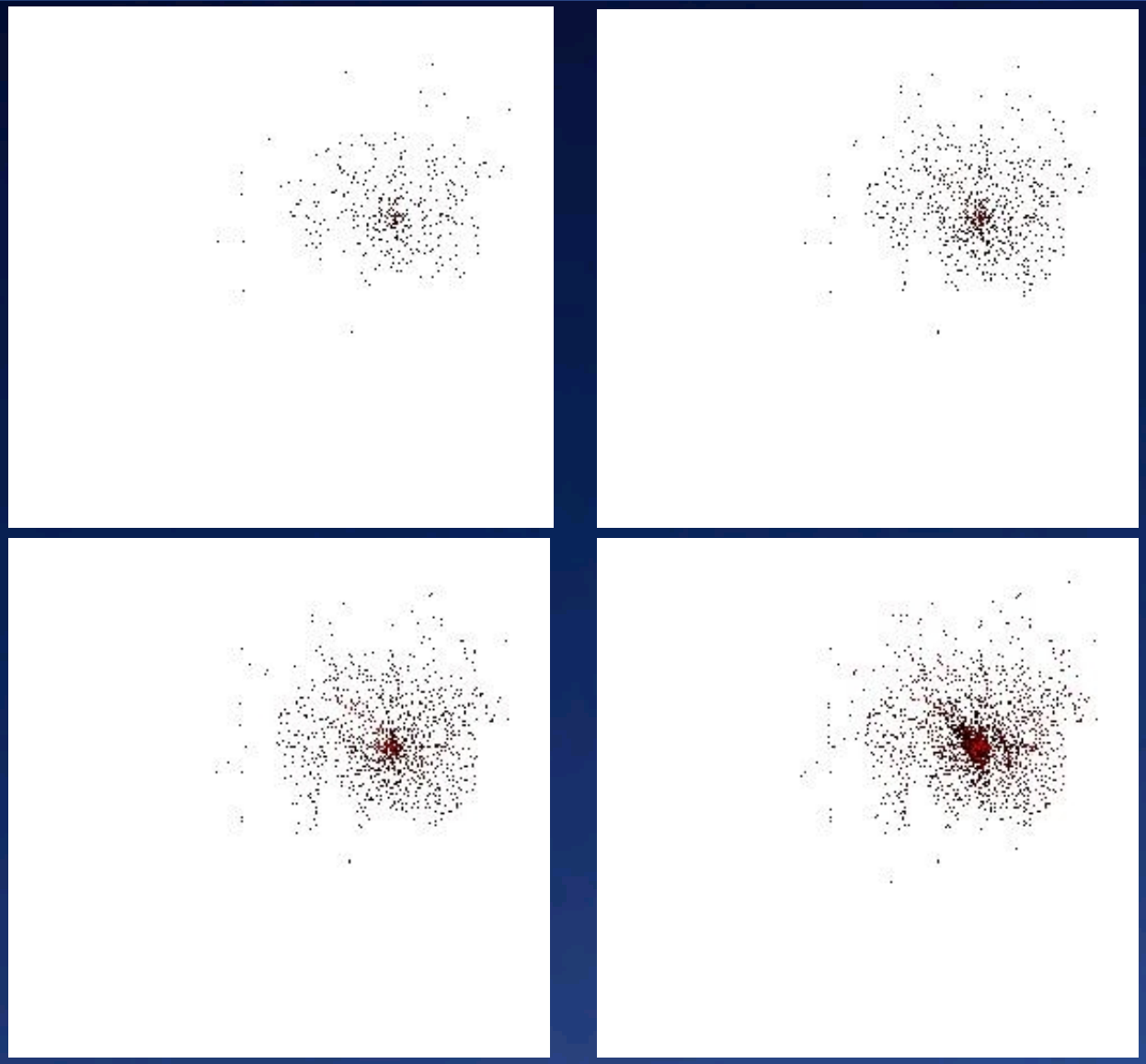
1983



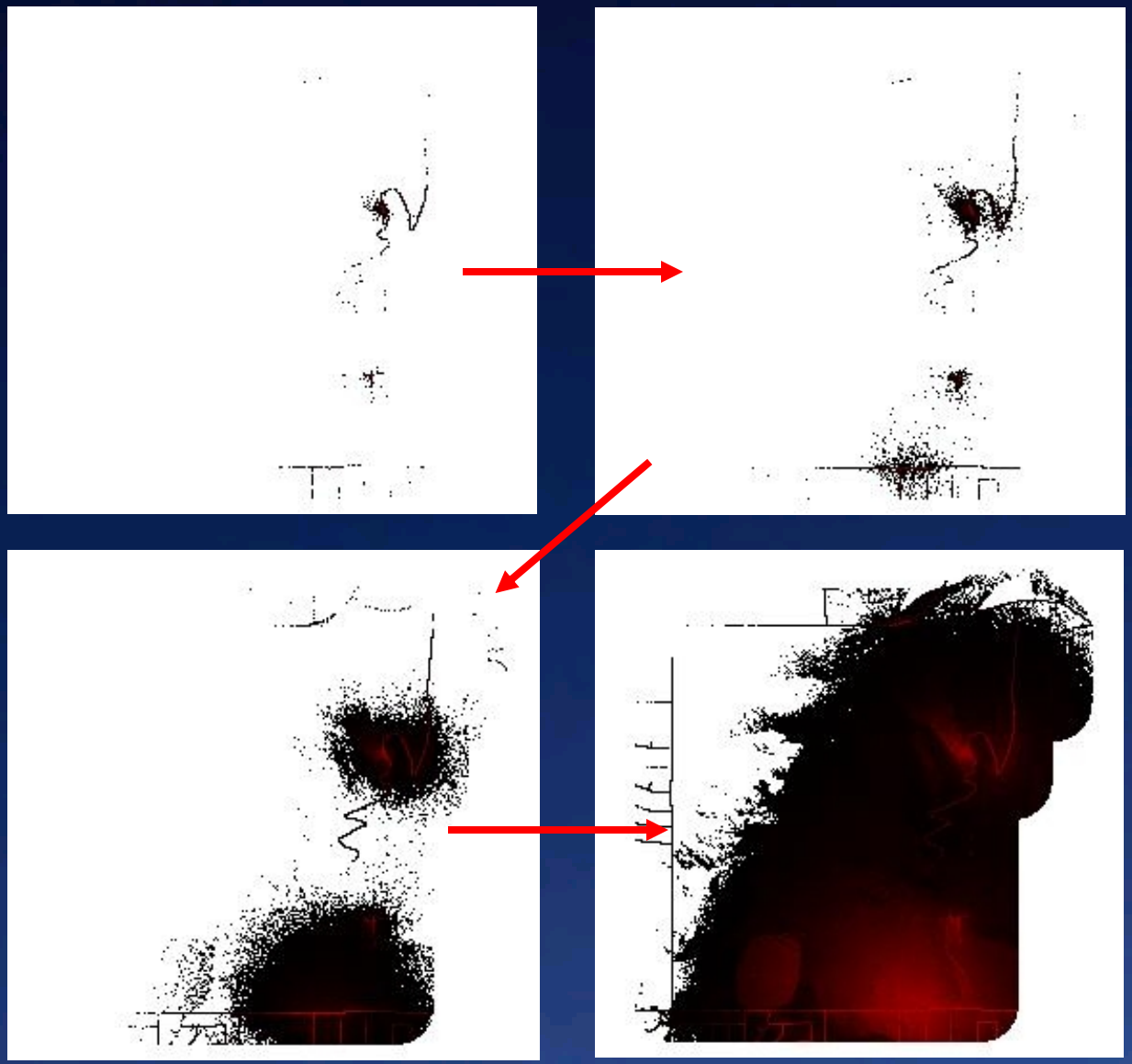
2005



Modeling Spread without Road Effect

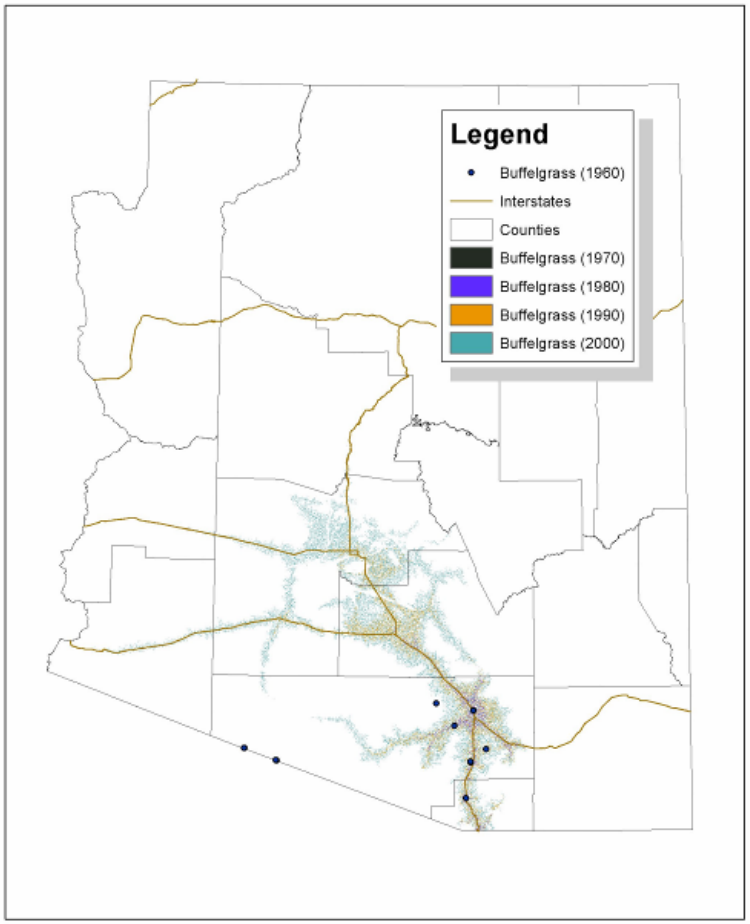


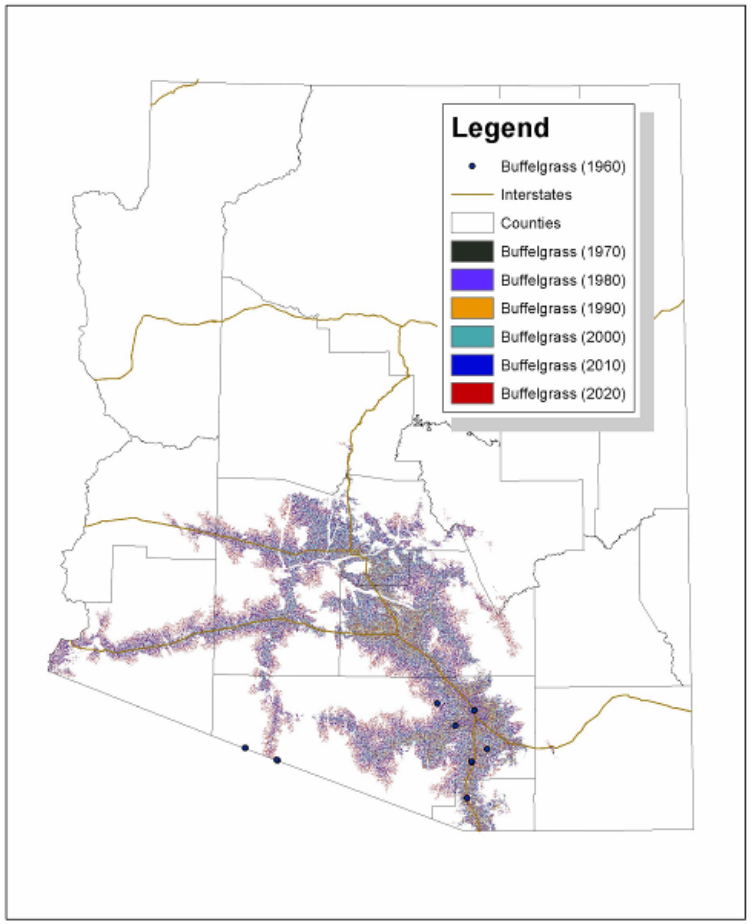
Simulated Spread on Tumamoc Hill



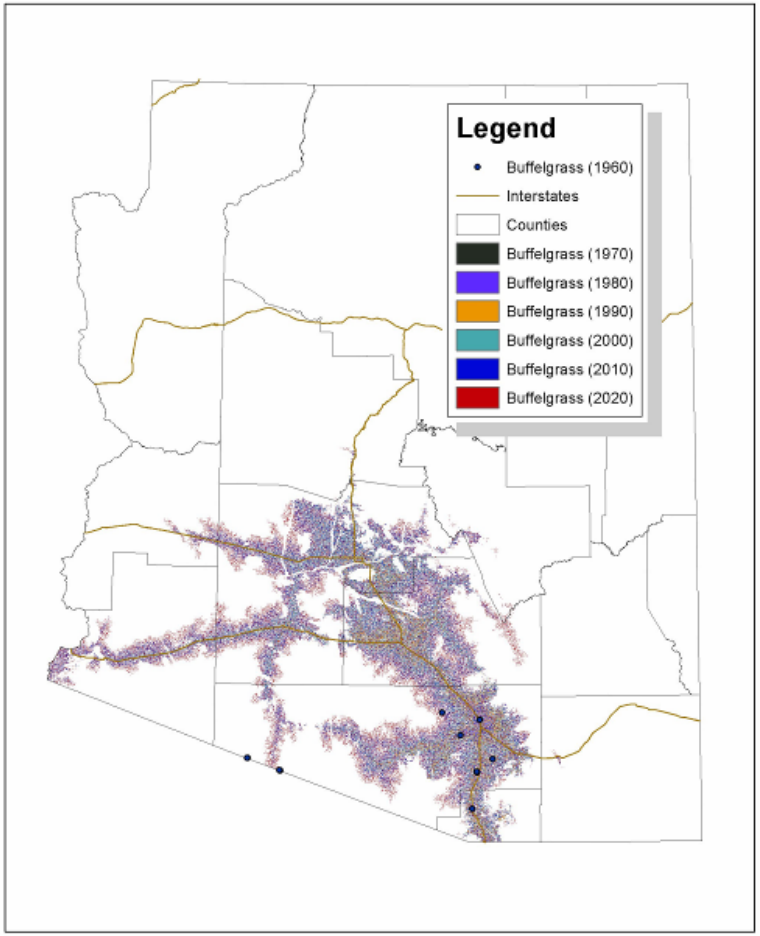
Road effect included

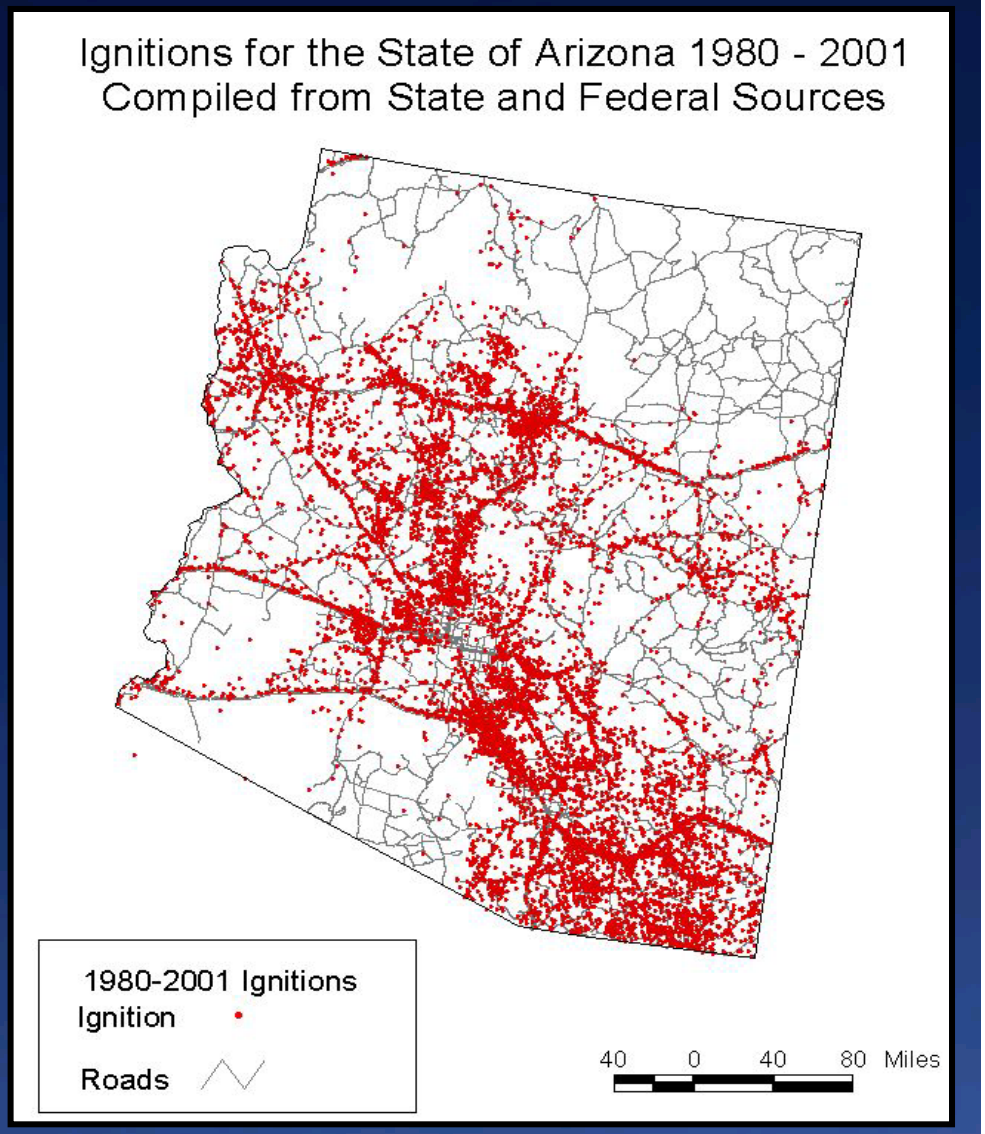
Projected Spread, 2000-2020



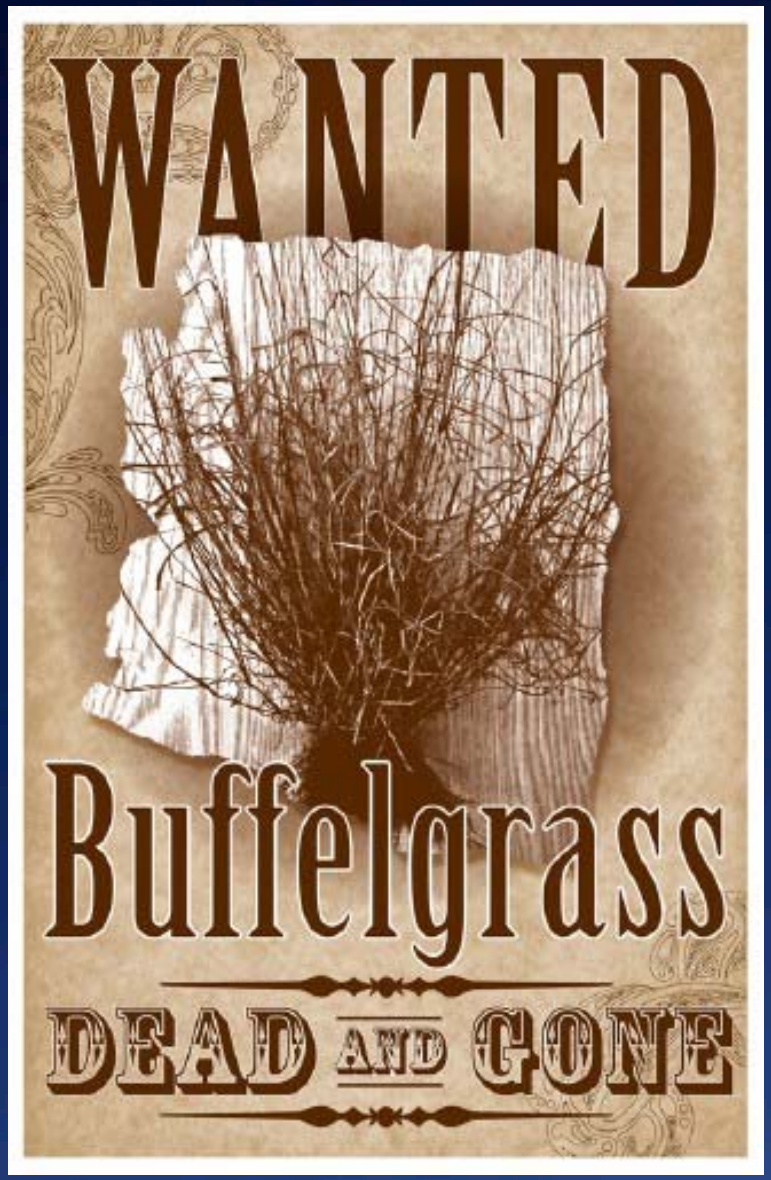


Projected Population & Fire Risk





Media Coverage



Interviews of Land Managers

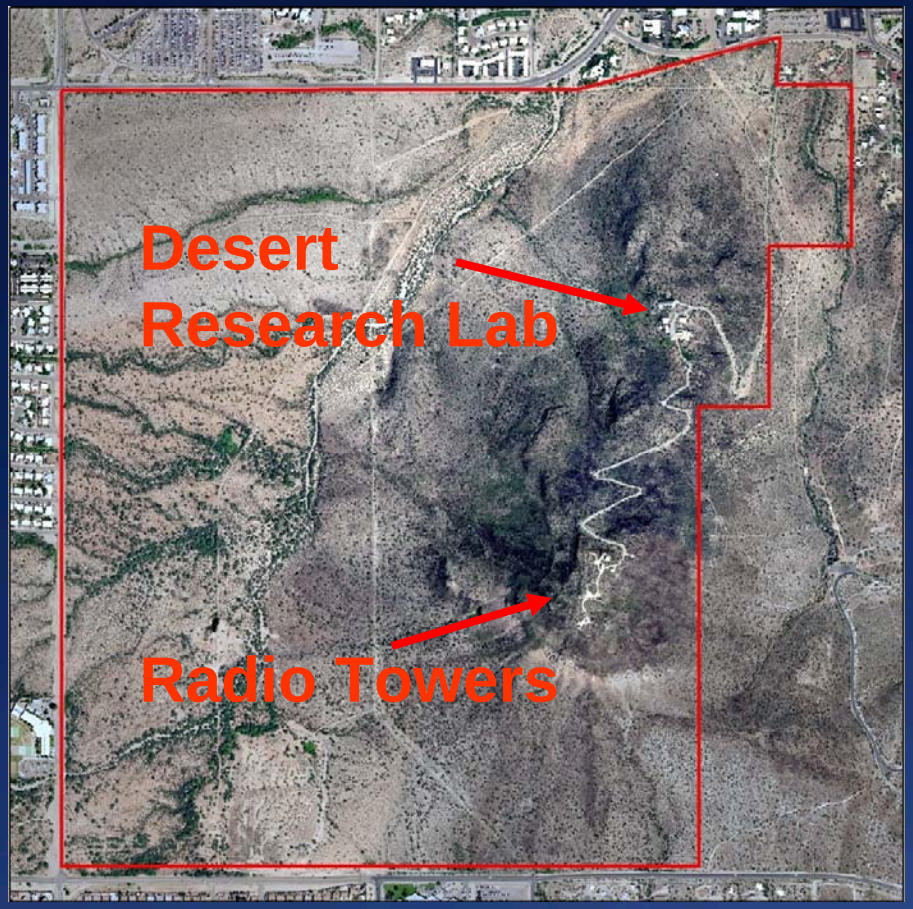
PIMA ASSOCIATION OF GOVERNMENTS
177 N. CHURCH AVE.
SUITE 405
TUCSON, ARIZONA 85701
(520) 792-1093 FAX: (520) 620-6981

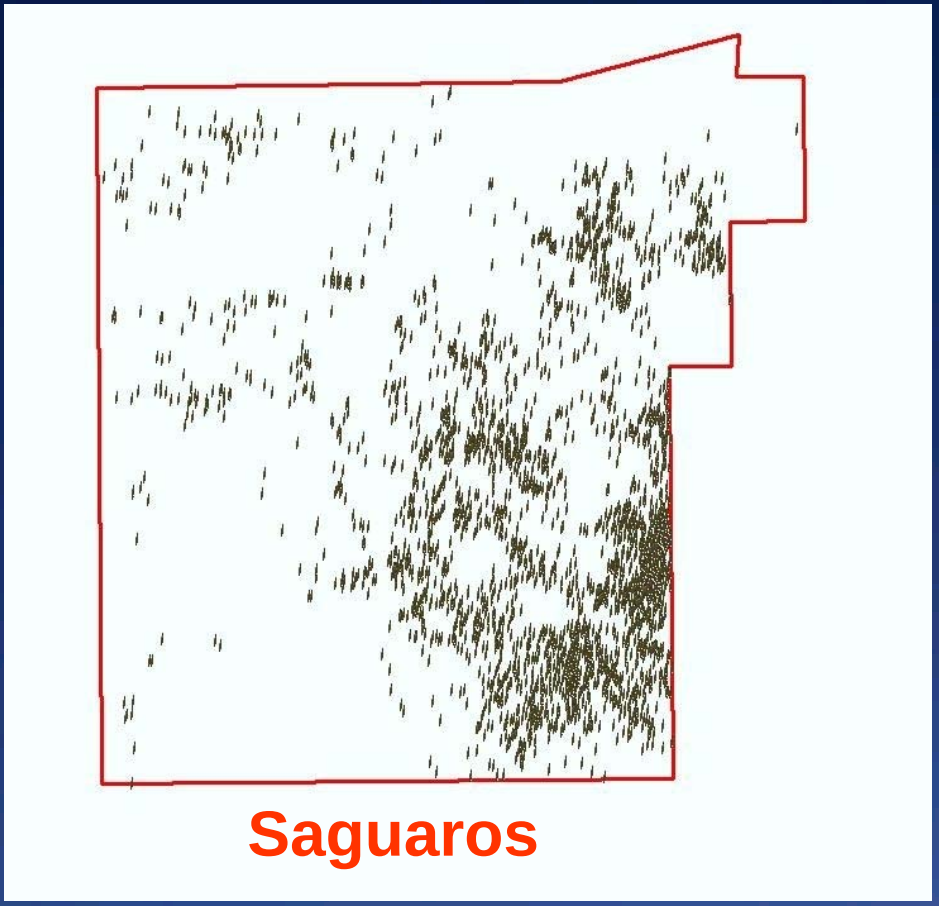
Buffelgrass Summit draws more than 120 people to address growing concern of plant species invasion

Ongoing data / information collection

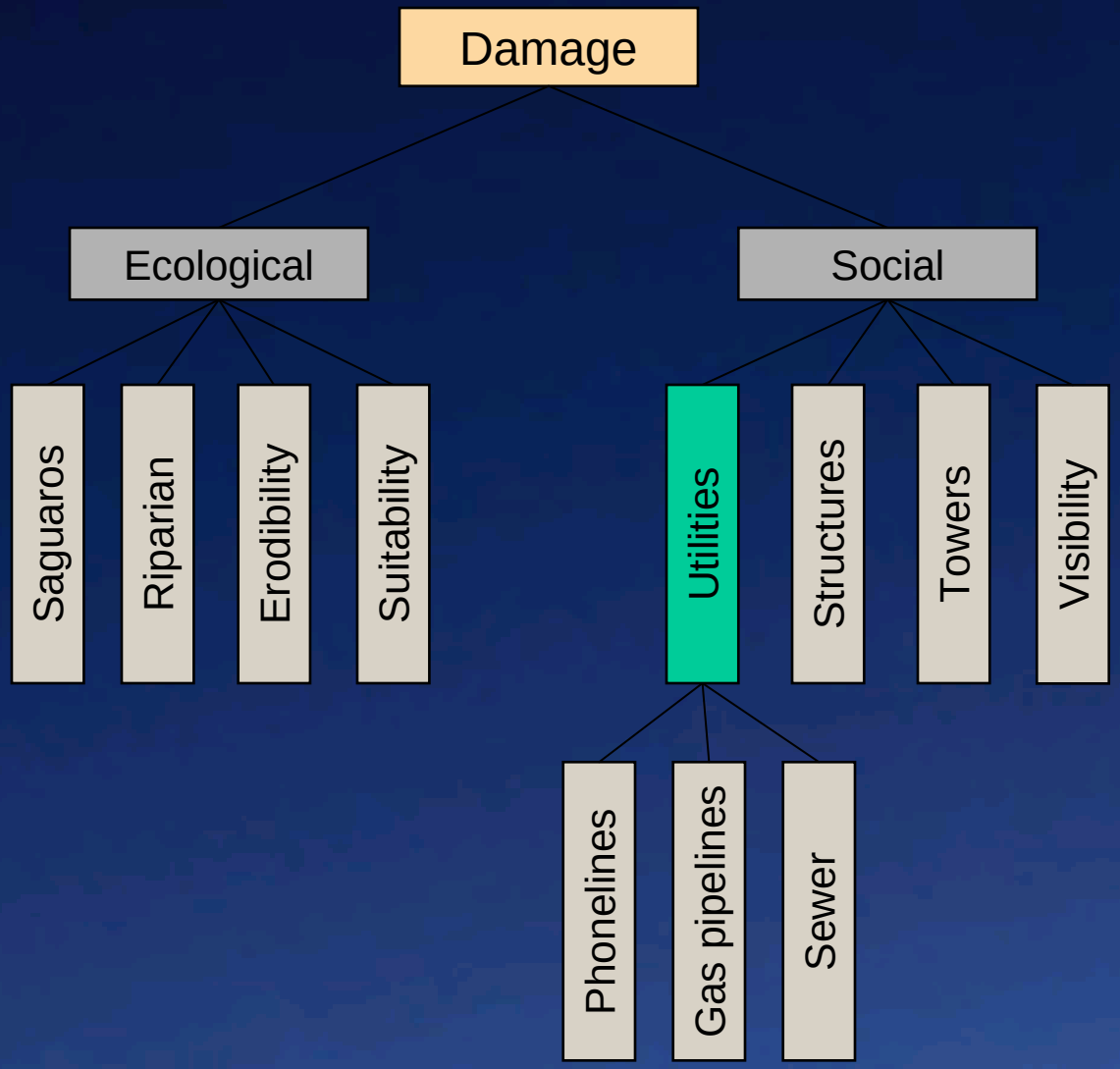
- Agency damage / risk reduction objectives
- Agency constraints
- Developing treatment cost functions

Tumamoc Hill Application



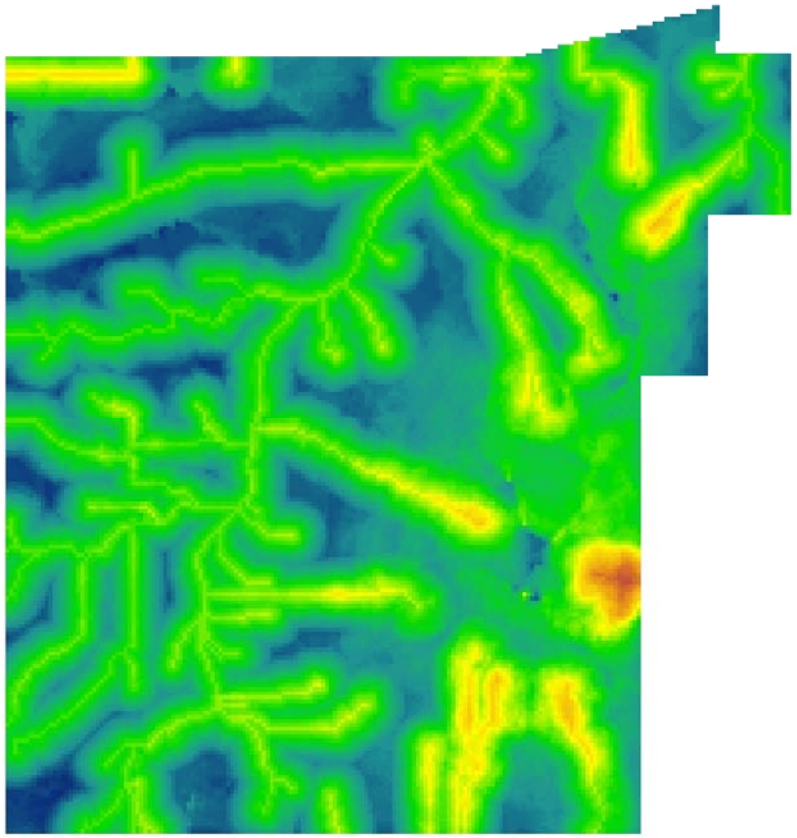


Potential Risk Measures

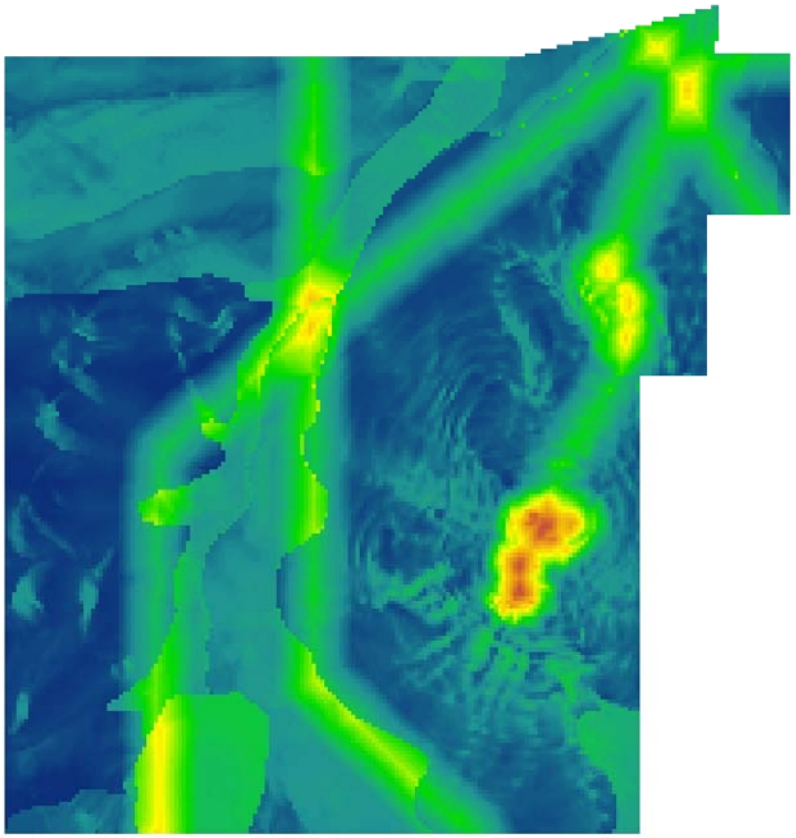


Potential Damage Surfaces

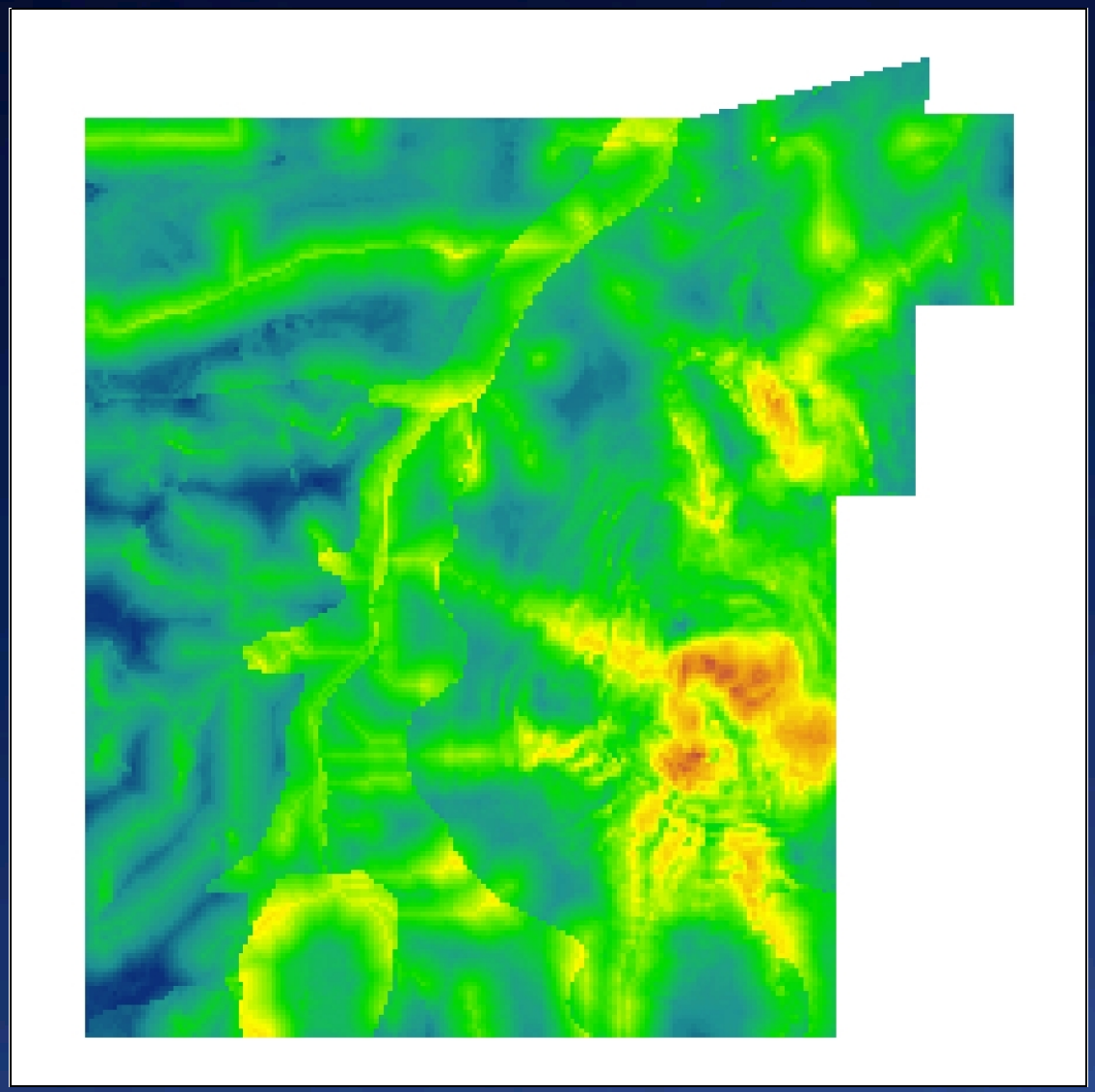
Saguaros



Infrastructure

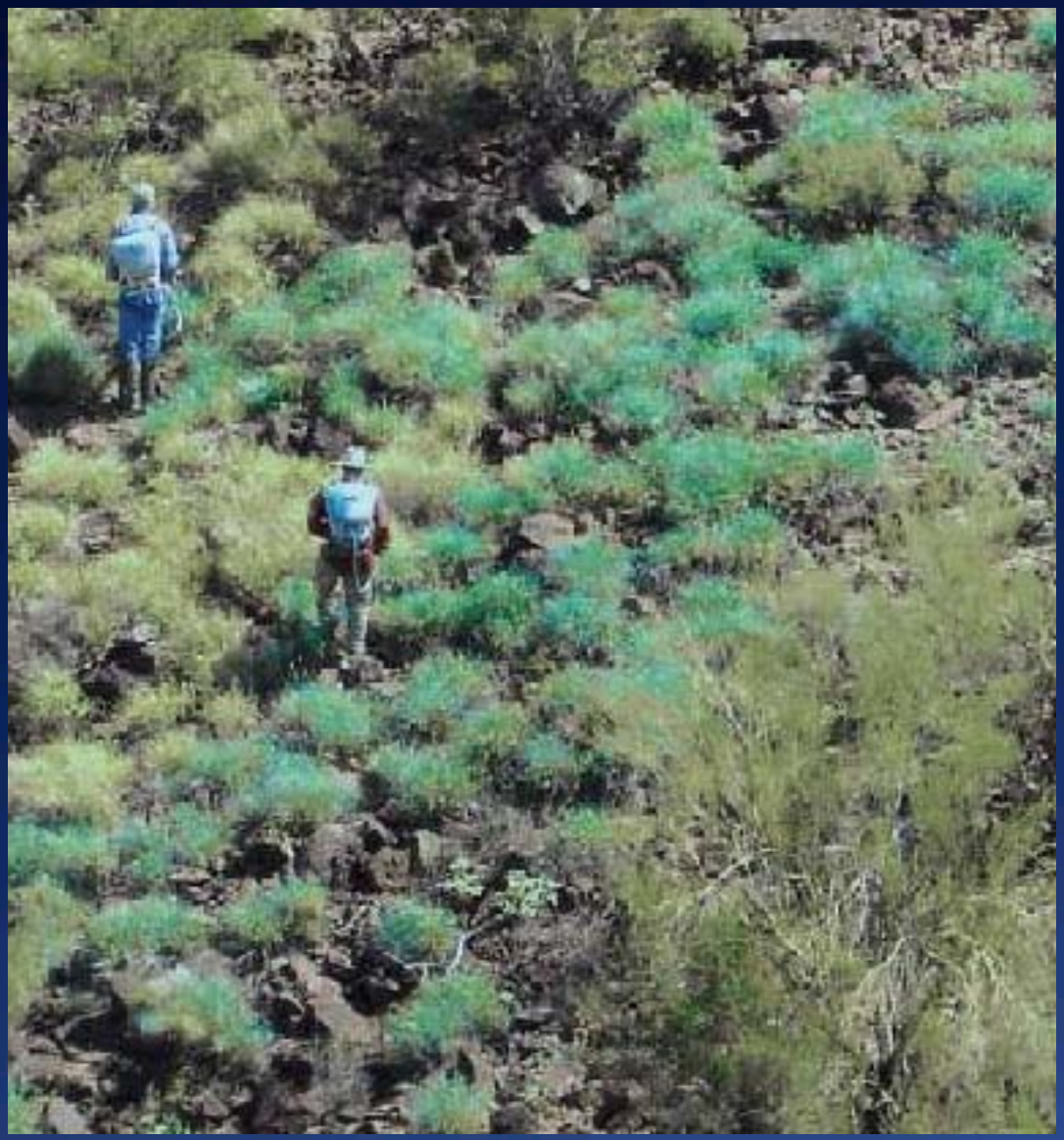


Weighted Potential Damage



Equal weighting to saguaros and infrastructure

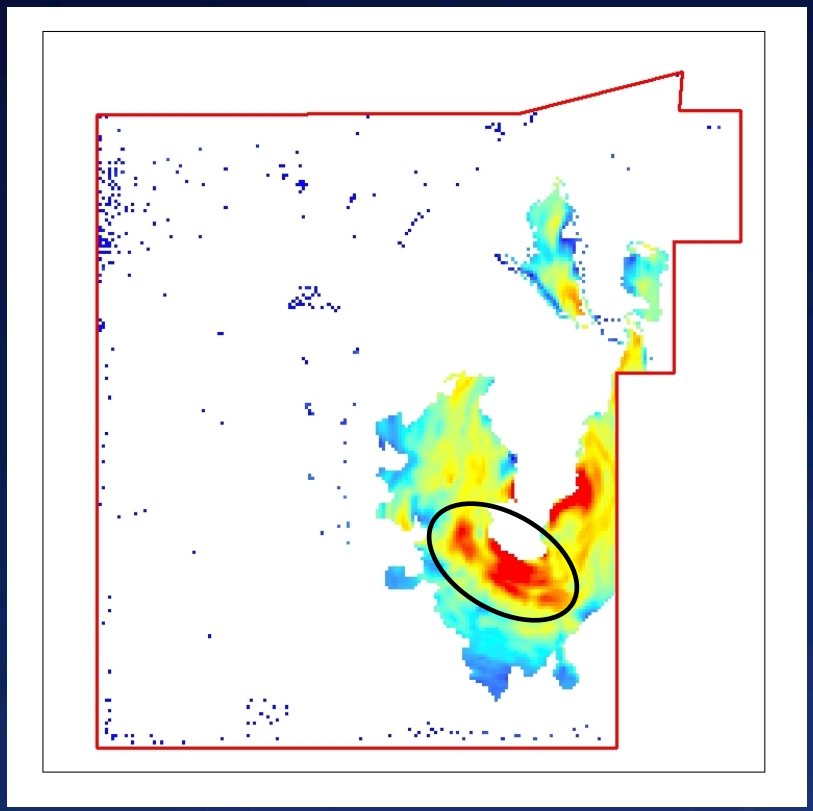
Backpack Spraying with Glyphosate



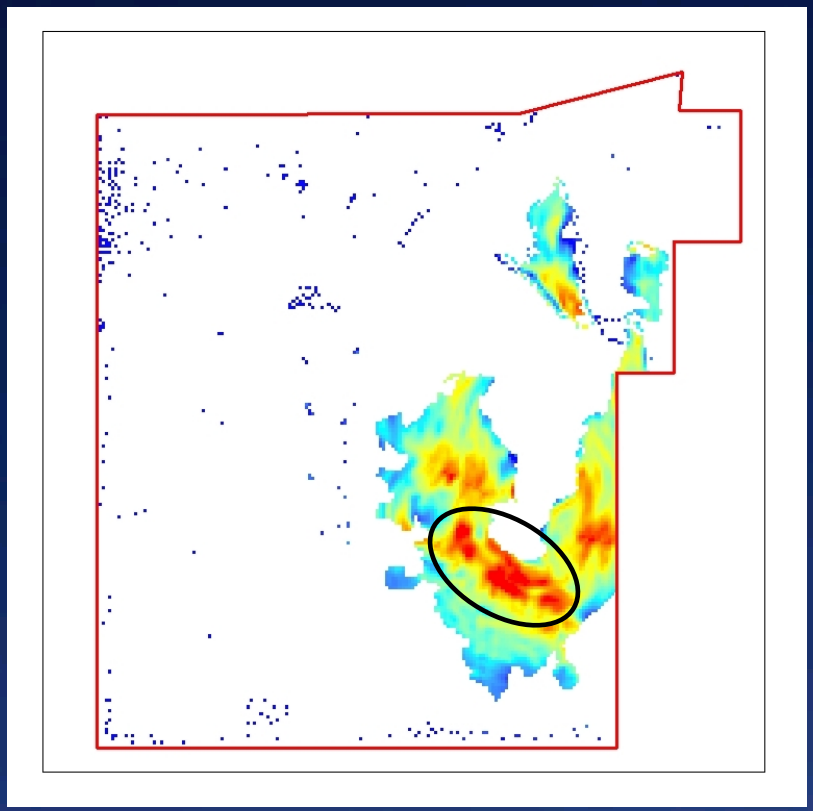
Costs have ranged from <$100 / acre along roads to >$850 / acre on steeper slopes and more remote areas

Static Treatment Cost-Effectiveness

Infrastructure



Ecological

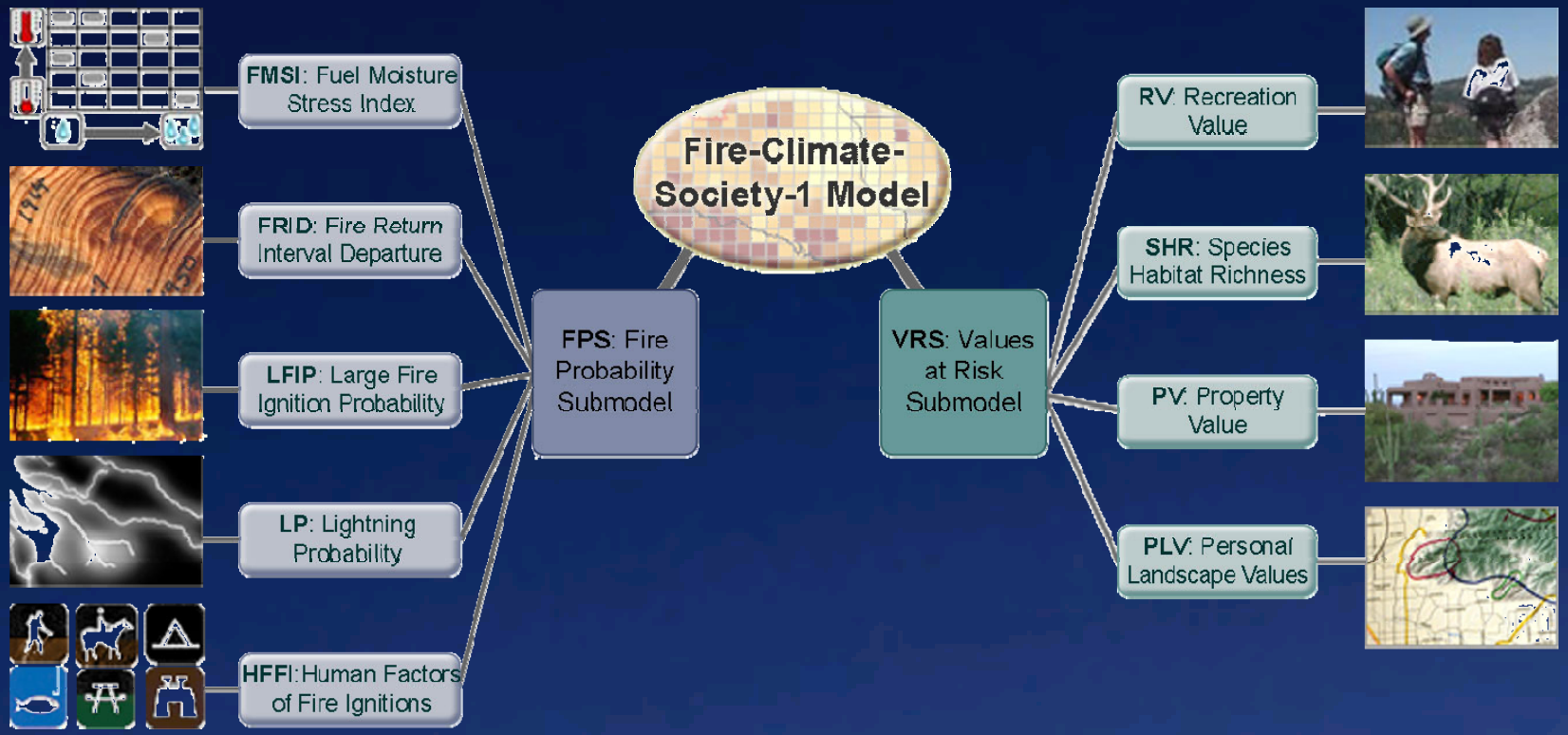


Reduction in damage index per $ of treatment

Next Steps

- Multi-objective dynamic programming model simulations
- Compare optimal solutions with “rules of thumb”
- Extend model to multiple players
- Expansion of geographic area for simulations
- AHP Model development

Example: FCS-1 Model



Example: FCS-1 Model