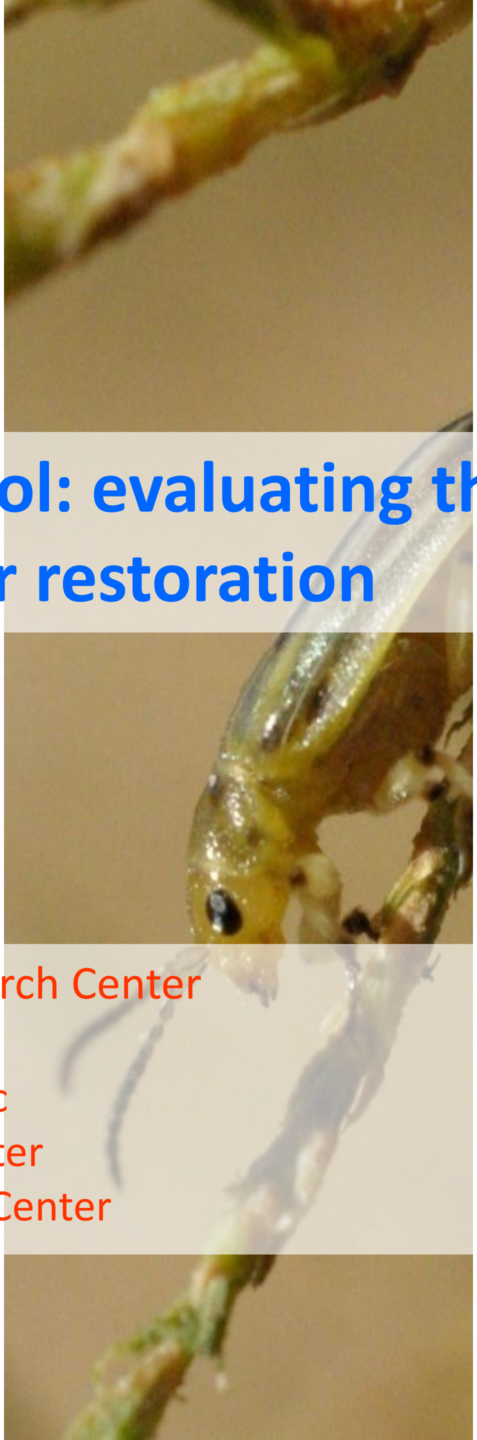
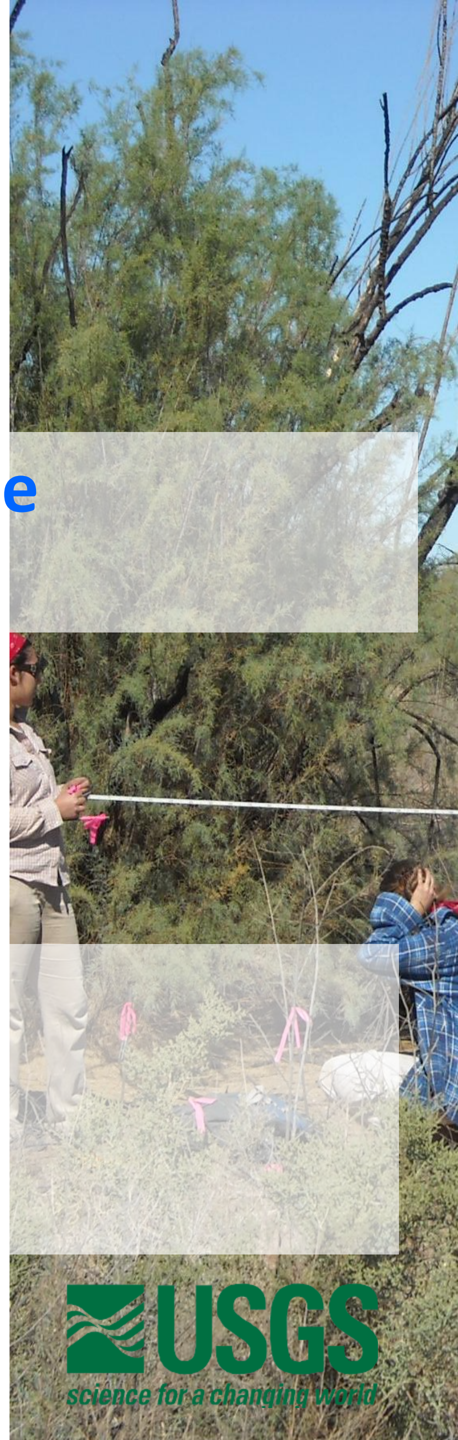


Tamarisk and biological control: evaluating the interactions and preparing for restoration

Steven Ostoja - USGS, Western Ecological Research Center

Heather Bateman – Arizona State Univ. Polytechnic
Patrick Shathroth – USGS, Fort Collins Science Center
Matt Brooks - USGS, Western Ecological Research Center

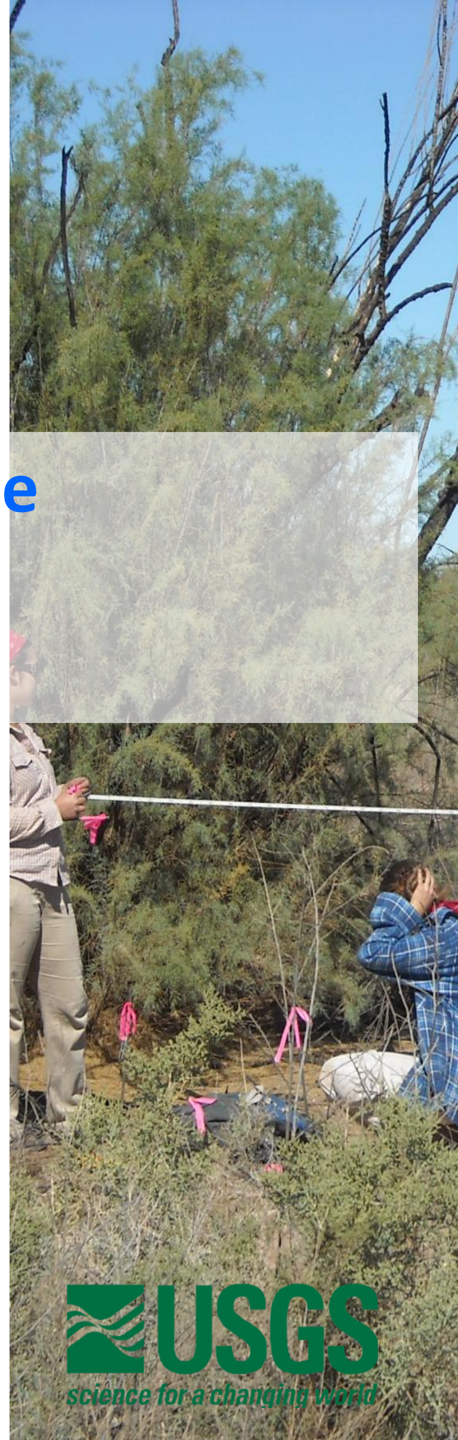
ASU

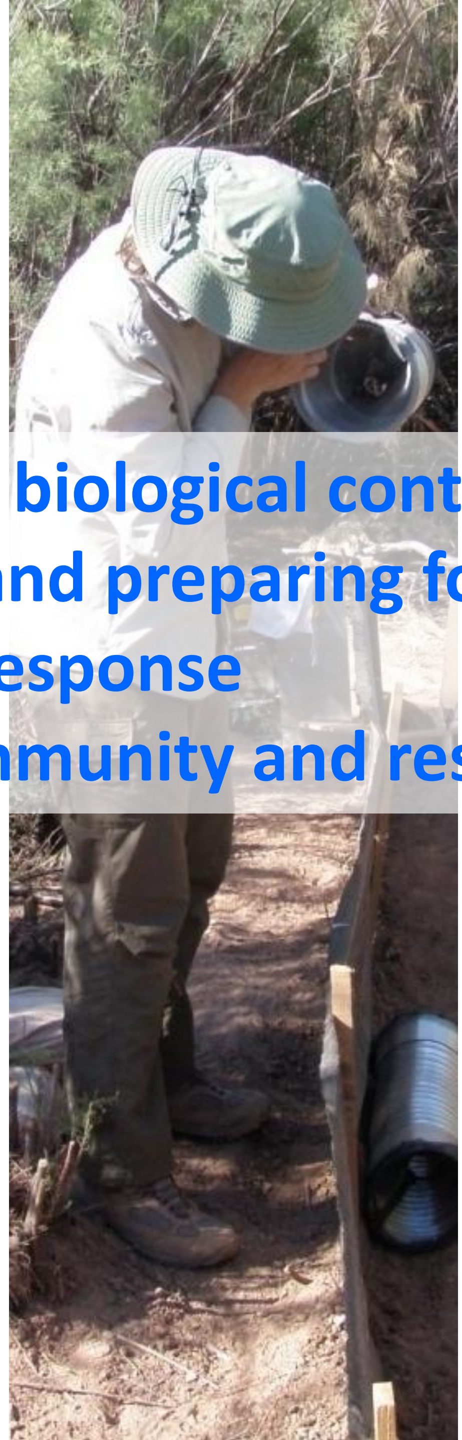
USGS
science for a changing world

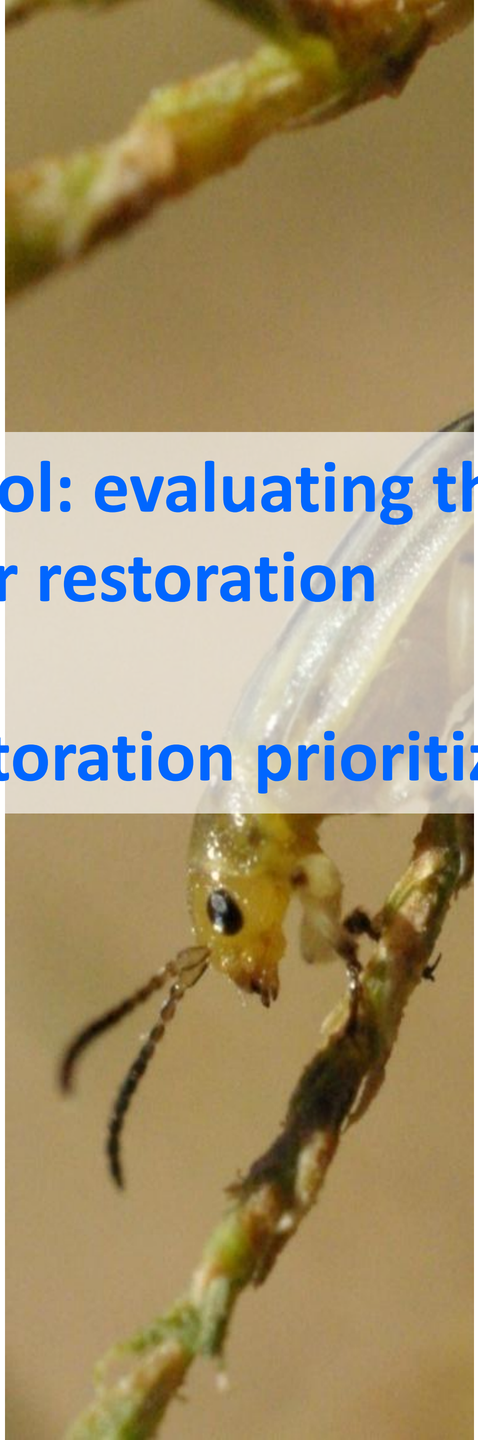
Tamarisk and biological control: evaluating the interactions and preparing for restoration

i. Wildlife response







Tamarisk and biological control: evaluating the interactions and preparing for restoration

i. Wildlife response

ii. Plant community and restoration prioritization

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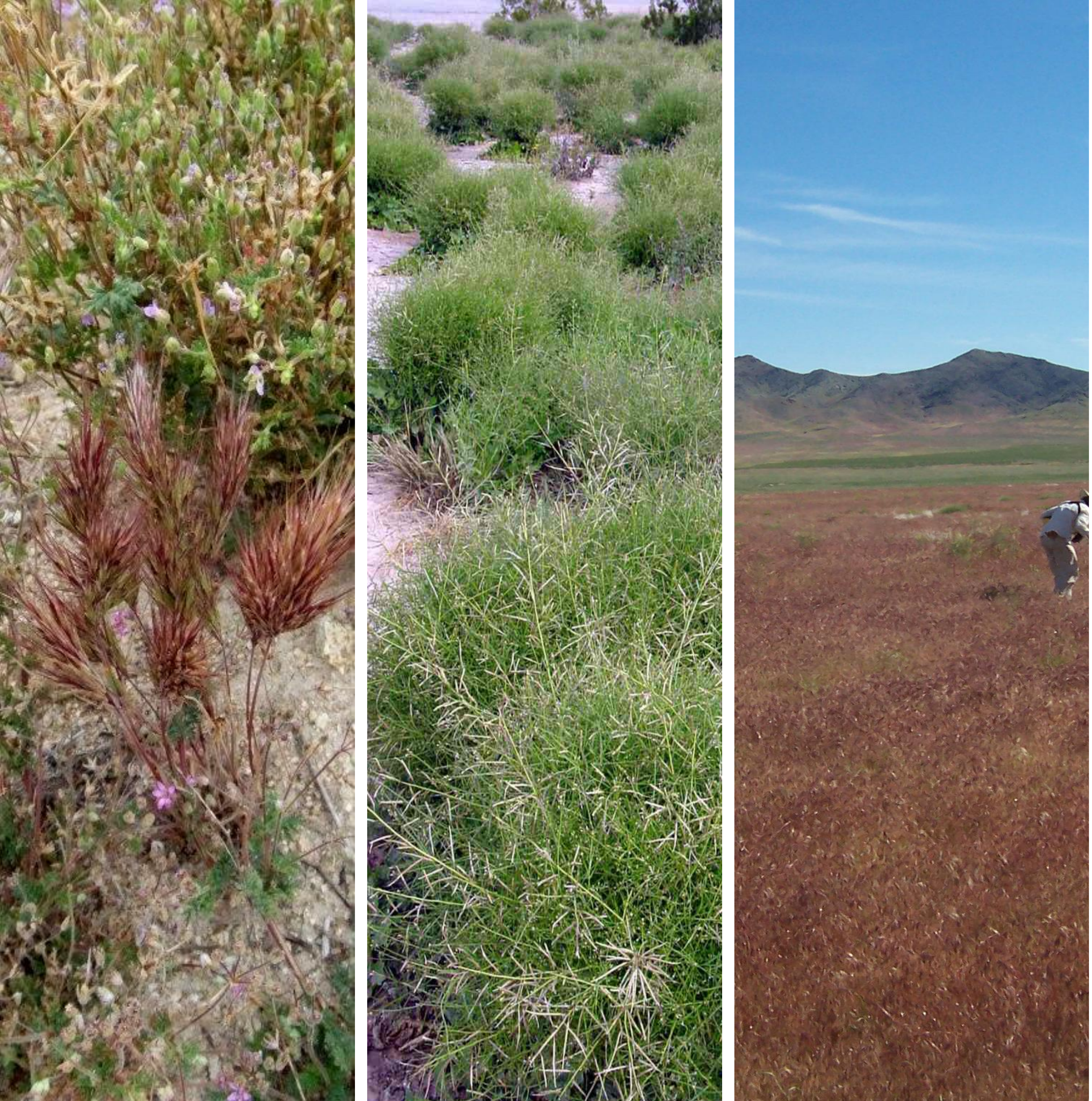
Tamarisk invasion and system conversion

Species Invasions

Among one of the greatest threats to global environmental change.

D'Antonio & Vitousek 1992

Species Invasions

In the US the cost from invasive species ca. $120 billon with over 100 million acres affected.

Pimentel et al. 2005

Species Invasions

Invasions influence multiple levels of ecological organization including compromised ecosystem processes to community and population effects.

Brooks et al. 2004

Systems Perspective

Invasion… conversion…

Altered soil chemistry and biology

Local reduction of native plant species diversity

Altered soil chemistry and biology

Changed native wildlife abundance and diversity

Local reduction of native plant species diversity

Altered soil chemistry and biology

Control and restoration difficult and costly

Changed native wildlife abundance and diversity

Local reduction of native plant species diversity

Altered soil chemistry and biology

Reponses of biological control unknown

Control and restoration difficult and costly

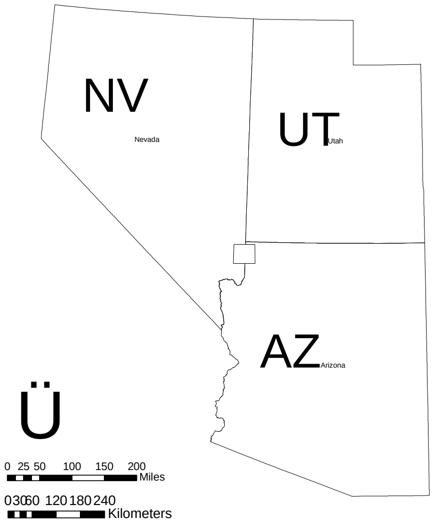
Changed native wildlife abundance and diversity

Local reduction of native plant species diversity

Altered soil chemistry and biology


Species Management and Control

tamarisk leaf beetle
Chrysomelidae
Diorhabda spp.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Miles
0 30 60 120 180 240
Kilometers


1 June 2010


20 June 2010
M. Kuehn

Unprecedented Natural Experiment

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Biological Control

Researchers have documented unanticipated consequences caused by the introduction of an insect biocontrol agent on higher trophic-levels.

Pearson et al. 2005

Biological Control

Omnivorous deer mice (*Peromyscus maniculatus*) had greater overwinter survival because of subsidies from the insect agent.

Pearson and Callaway 2006, 2008

Biological Control

Increased numbers of *P. maniculatus* caused greater seed predation on native plants and mice populations had greater incidences of hanta virus.

Pearson and Callaway 2006, 2008

Biological control of *Tamarix* and the effects on riparian ecosystems in the western U.S.

I. Background

Tamarix (saltcedar, tamarisk) is a riparian shrub or small tree that has spread extensively since its introduction near the San Francisco, California, area circa 1854. By 1900, it was established in several western states. *Tamarix* species began to spread on western rivers at the same time as the major rivers were dammed and diverted for agricultural and municipal use. *Tamarix* are drought- and salt-tolerant and are therefore better adapted than native trees to the conditions prevailing on these altered rivers. During the mid-to-late 1900s, they were commonly perceived as problem plants that used large amounts of water, out-competed native trees, and provided poor wildlife habitat. Accordingly, local, state, and federal agencies have undertaken considerable efforts to eradicate tamarisk and restore riparian habitats to pre-invasion status.

Traditional eradication methods for *Tamarix*, including herbicide treatments, are now considered undesirable because they are costly and have unintended impacts on native species. In recent years, several specialist herbivore species (beetles) in the genus *Diorhabda* have been field released in western U.S. river systems to achieve biological control of *Tamarix*. These beetles can cause substantial defoliation and may eventually cause mortality of *Tamarix*, paving the way for changes to plant community composition and structure, with consequent effects on wildlife populations and ecosystem processes (such as wildfire, hydrological dynamics, and sediment dynamics). The beetle is spreading rapidly in the Upper Colorado River watershed, is well established in parts of Texas, New Mexico, Wyoming, Utah, and Nevada, and is expected to colonize the Lower Colorado River system in the future. A rapid loss of *Tamarix* will cause cascading effects on riparian communities, the severity of which will depend on the type of plant successions and the speed with which such plants colonize post-beetle habitats.

Release of the beetle was not accompanied by a coordinated monitoring program to document its spread and effectiveness. Current knowledge is incomplete and is based on individual, short-term research projects. The beetle has spread much more rapidly than was originally predicted. There is concern about this rapid spread, how the beetle affects wildlife habitat, and where it will go next. Therefore, development of a scientifically sound, interdisciplinary set of research and monitoring activities focused on determining the effects of *Tamarix* beetles on riparian ecosystems is critical to help inform managers in the region about conservation of wildlife species and habitat, as well as management alternatives such as restoration and rehabilitation.

Restoration, or returning a disturbed ecosystem to some previous state—in this case, repopulating native riparian zones with cottonwood and willow trees—may not be a realistic goal on many altered rivers due to changes in flow regimes and salinization of the aquifers and soils. Increasing the vegetation cover and productivity of a disturbed ecosystem so that it may still provide wildlife habitat, erosion control, or recreational services through rehabilitation is often a more realistic goal. Because simply replacing *Tamarix* with native species following defoliation might not be the most feasible course of action at a given site, managers are seeking a scientific basis to guide their choices for ensuring functional wildlife and ecosystem habitats as the *Tamarix–Diorhabda* interactions proceed on western rivers.

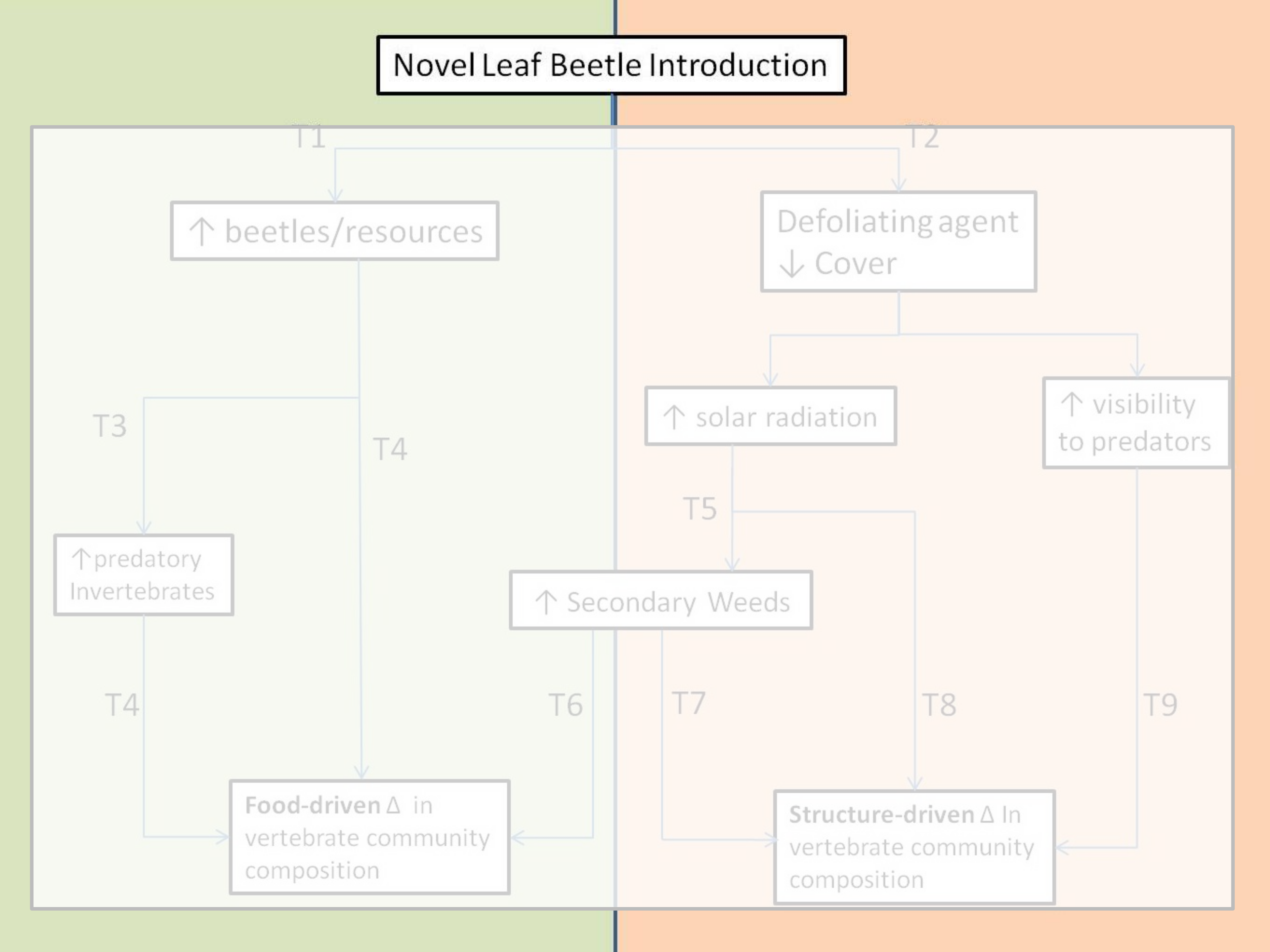
USGS scientists are recognized leaders in research that supports management of *Tamarix*-dominated ecosystems in western North America, including the plant's distribution abundance, and water use; wildlife habitat values; sediment flux; and the restoration of native vegetation following *Tamarix* defoliation. Past efforts and published studies provide a strong foundation for understanding the best approaches for addressing key questions associated with biological control of saltcedar. USGS scientists are also involved in several ongoing studies that directly address questions related to biocontrol of *Tamarix*. Thus they are well positioned to lead research and monitoring efforts tied to the biological control of *Tamarix*, trophic linkages, and ecosystem processes.

A unified approach to long-term monitoring of *Tamarix–Diorhabda* interactions is sorely needed, as we are at the beginning of a process that could have profound impacts on western U.S. riparian habitats for decades to come. This white paper briefly articulates the key research questions with direct management implications associated with *Tamarix*-beetle interactions. We also highlight ongoing and recent activities of the USGS science team and propose future work USGS could undertake associated with the biological control of *Tamarix* in the western U.S.

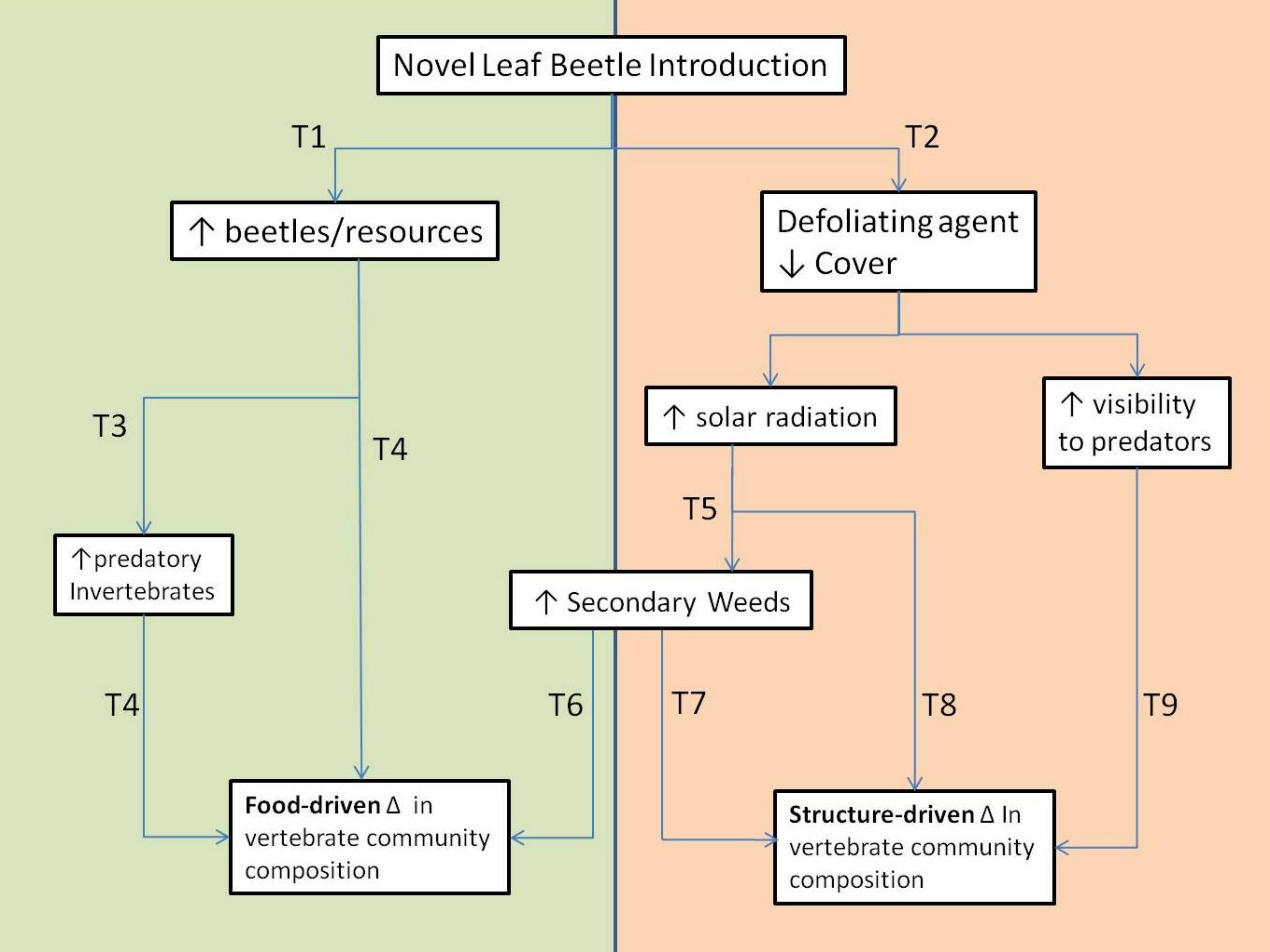
Research Objectives

Evaluate small vertebrate communities among mixed vs. monotypic *Tamarix* stands to understand potential impacts of biocontrol

- What is the pattern of herpetofauna community in mixed-native and exotic habitat
- What is the pattern of small mammal community in mixed-native and exotic habitat
    - Arthropod community



Novel Leaf Beetle Introduction
T1
T2
↑ beetles/resources
Defoliating agent
↓ Cover
↑ solar radiation
↑ visibility
to predators
T3
T4
T5
↑predatory
Invertebrates
↑ Secondary Weeds
T4
T6
T7
T8
T9
Food-driven Δ in
vertebrate community
composition
Structure-driven Δ In
vertebrate community
composition



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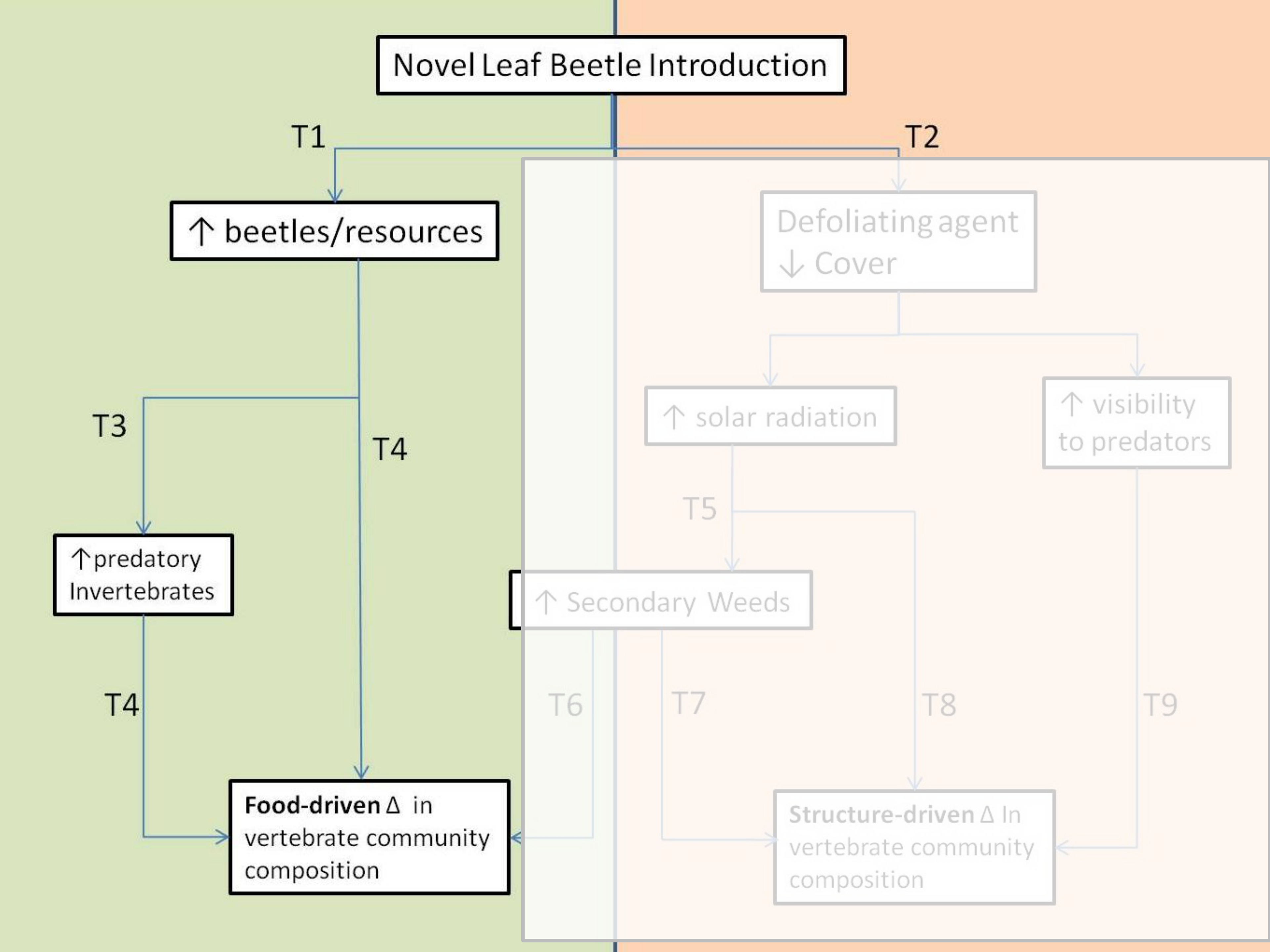
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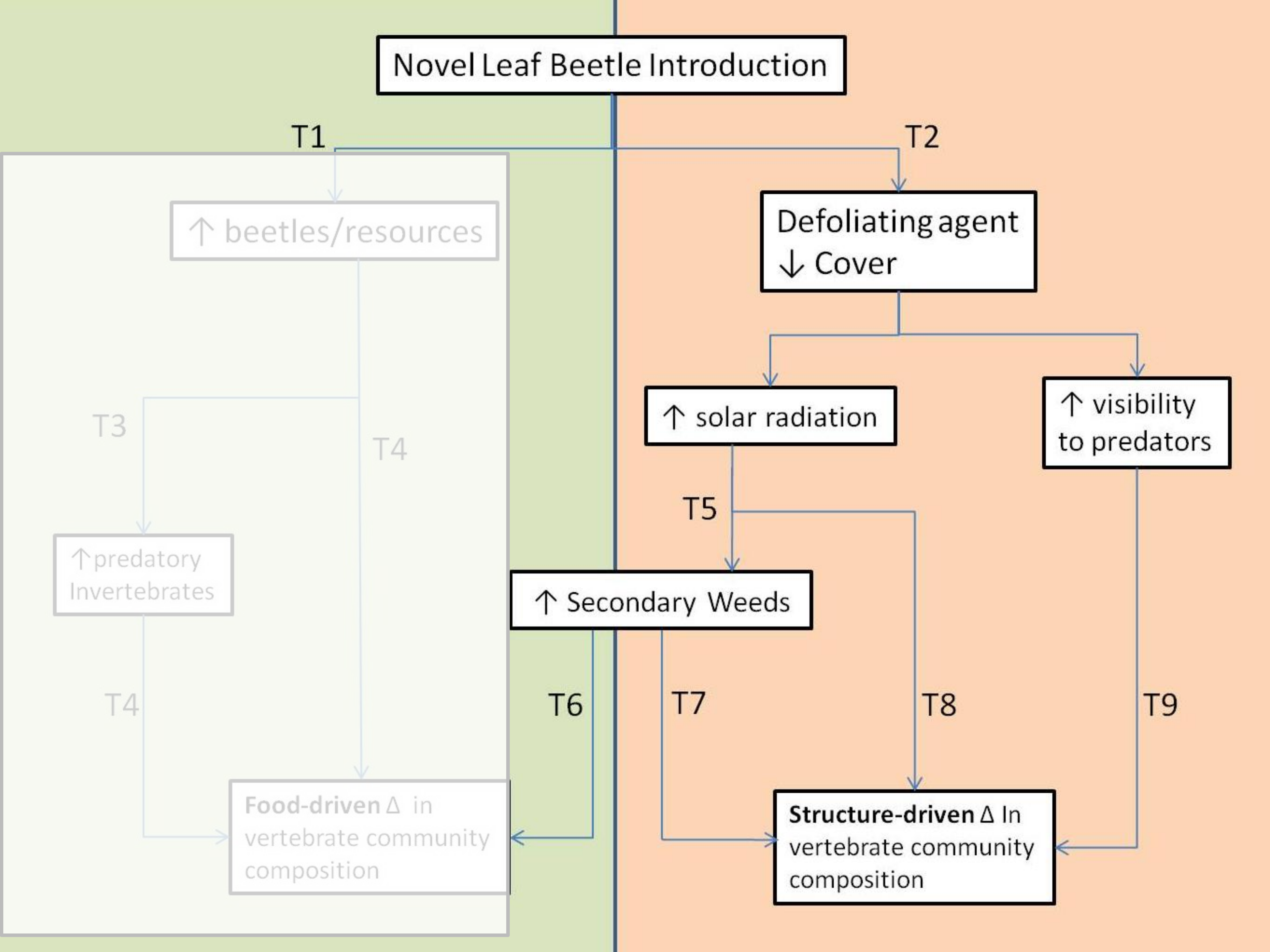
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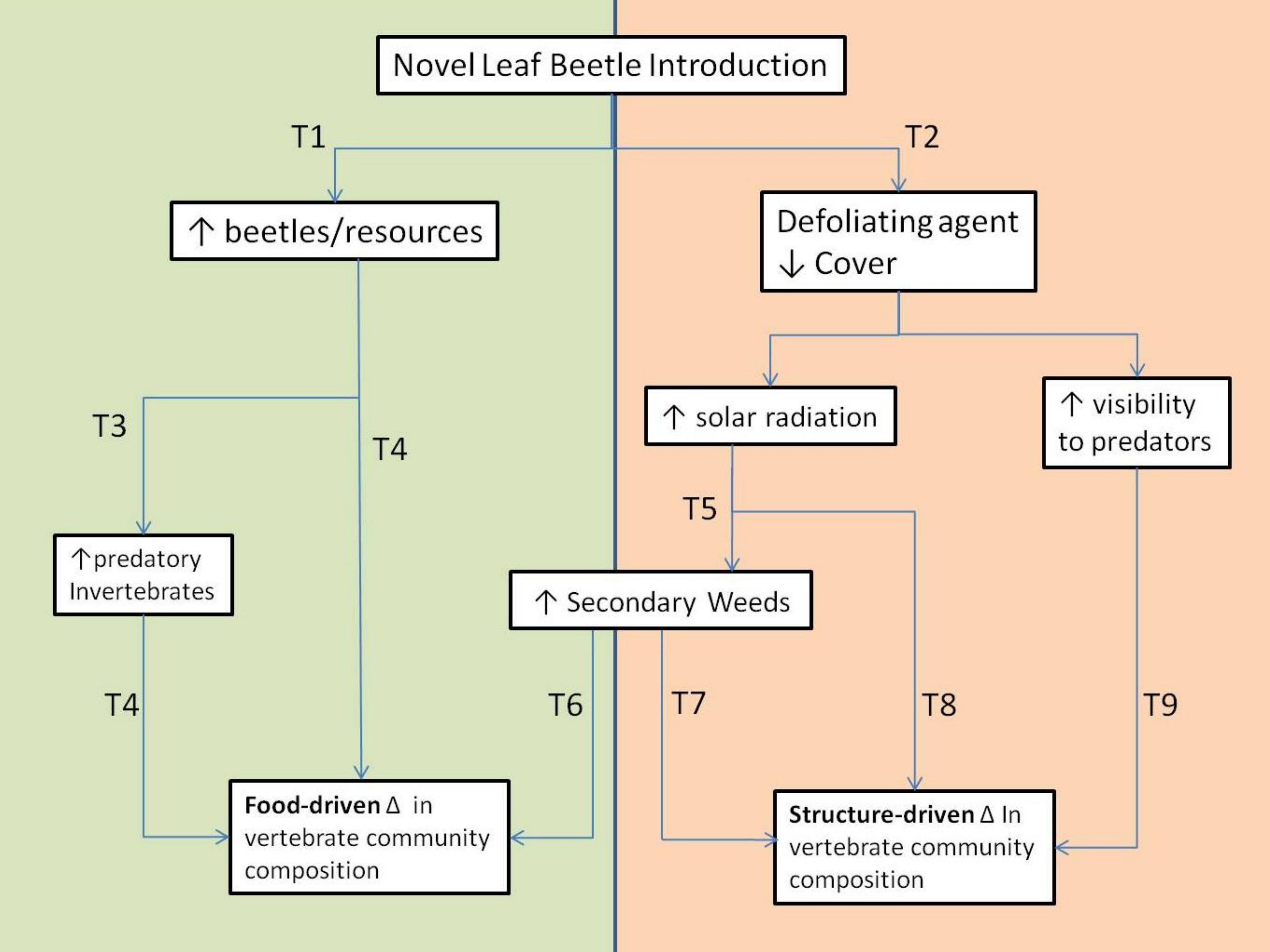
↑ visibility to predators
T5
↑predatory Invertebrates
↑ Secondary Weeds
T4
T6
T7
T8
T9
Food-driven Δ in vertebrate community composition
Structure-driven Δ In vertebrate community composition



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T6
T7
T8
T9
Food-driven Δ in
vertebrate community
composition
Structure-driven Δ In
vertebrate community
composition

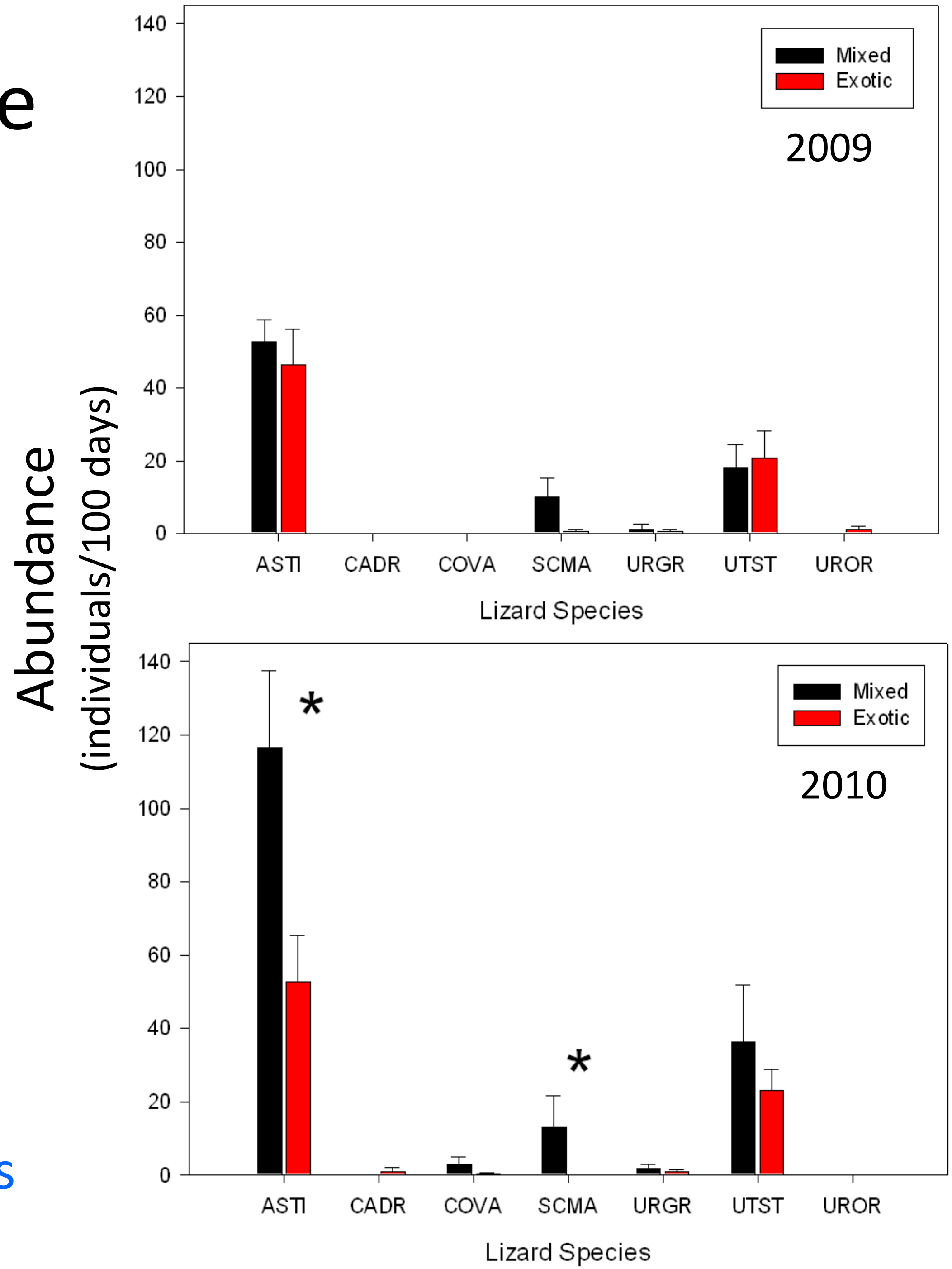



Pre Beetle Patterns

Methods - Lizards

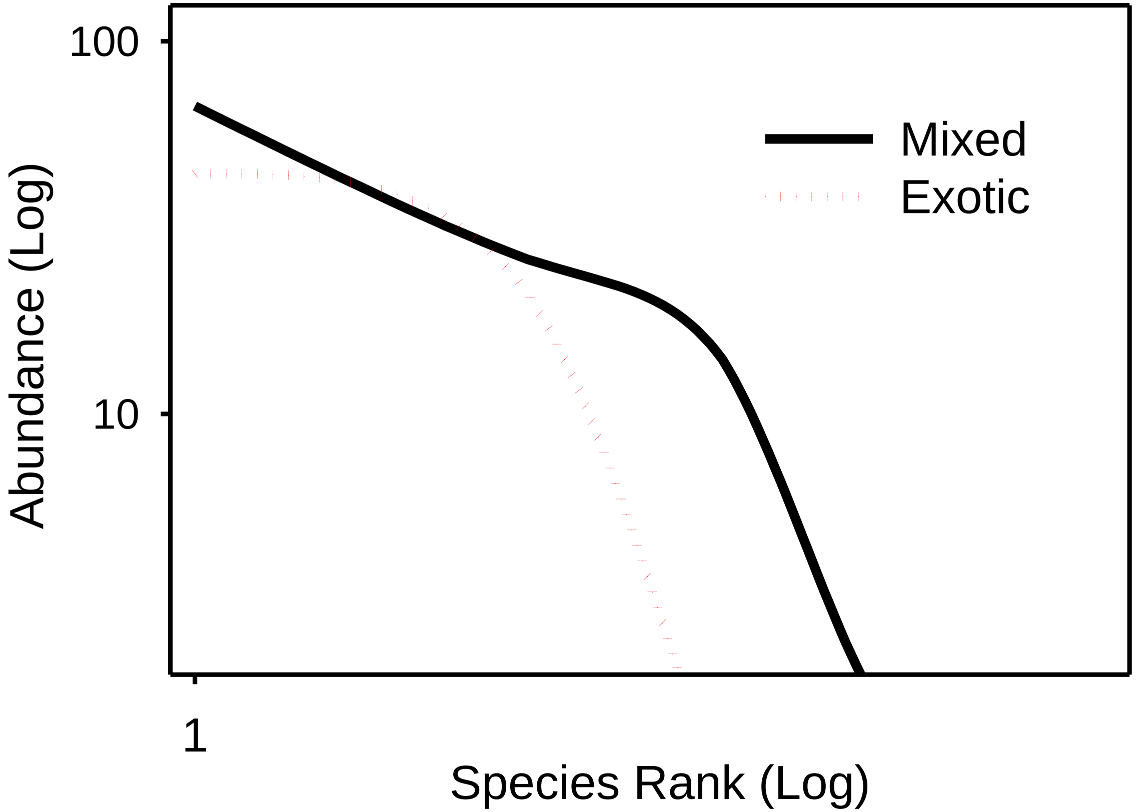
- Live trapping methods
- 18 sites – 10 monotypic exotic and 8 mixed-native
- 7 species of lizards
- 424 trap days in 2009, 358 trap days in 2010
- 329 unique lizards in 2009, 336 unique lizards in 2010

Lizard Abundance



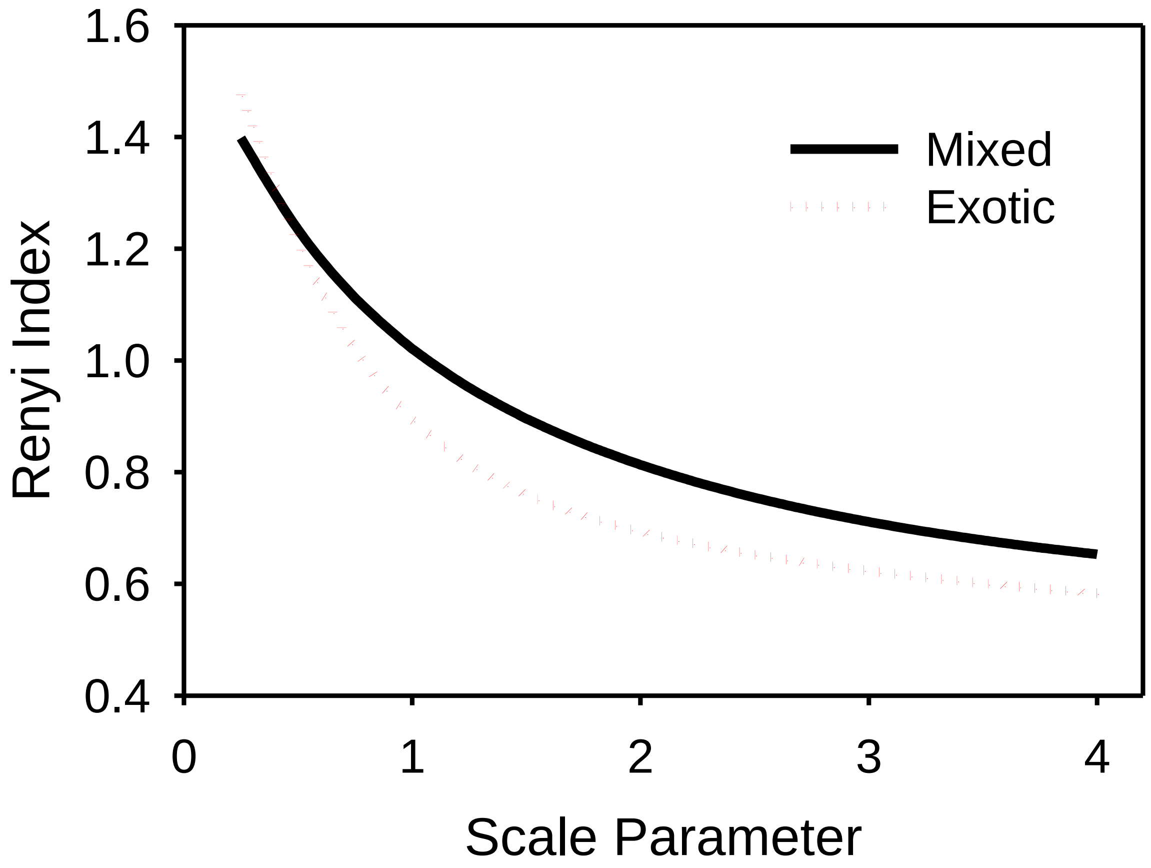
- Two species abundances differ among habitat types

Lizard Abundance



- Pattern driven by ASTI
- Less common species negatively influenced by exotic

Lizard Diversity



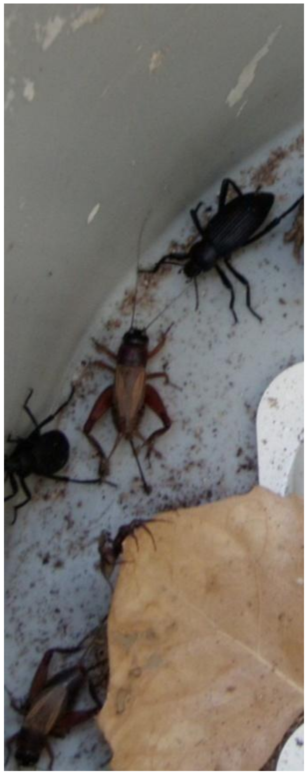
- Species richness greatest in exotic, but
- Diversity is slightly greater in mixed

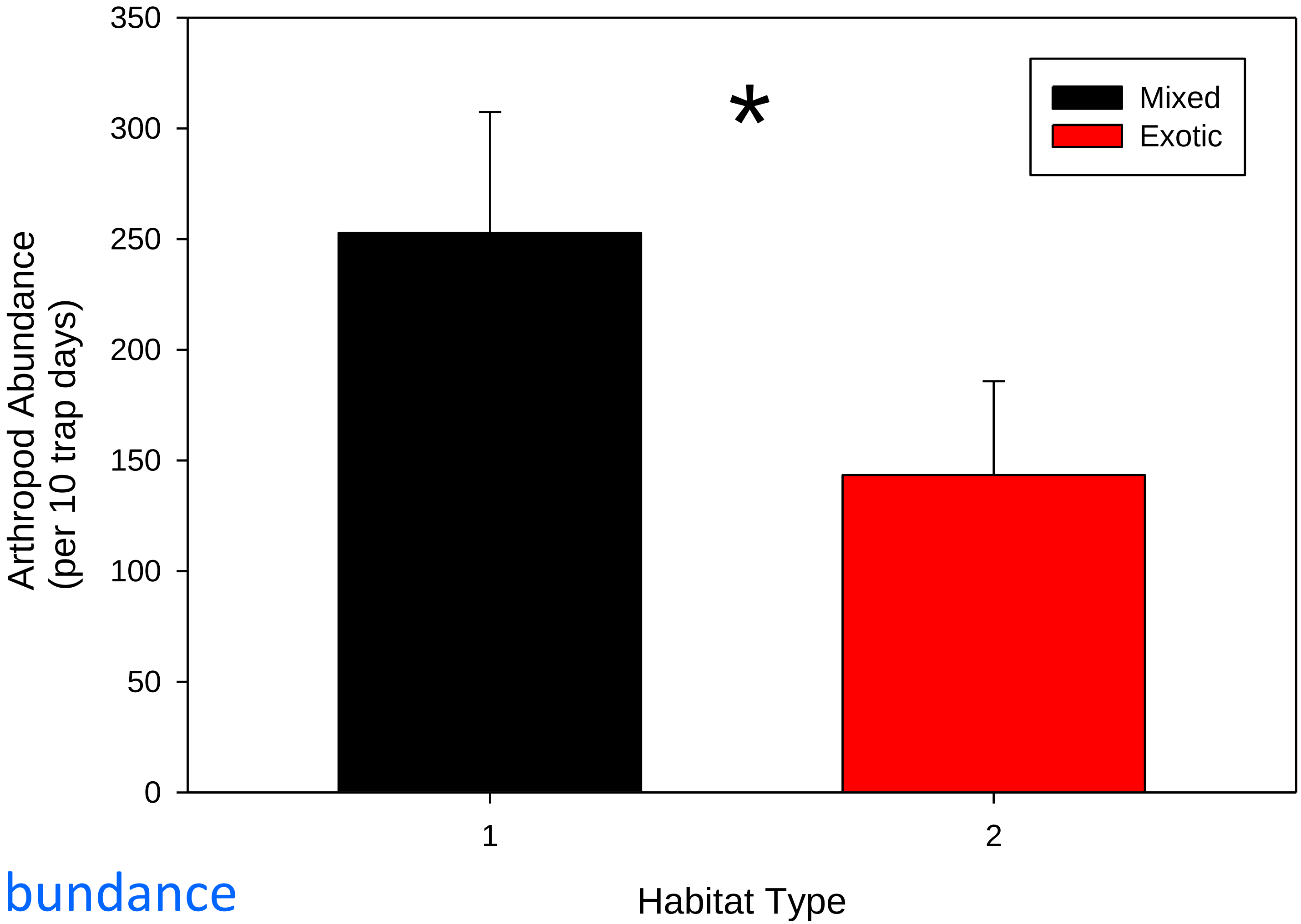
Methods - Arthropods




- Live trapping in pitfalls
- 18 sites – 10 monotypic exotic and 8 mixed-native
- 18 Orders
- 424 trap days in 2009, 358 trap days in 2010

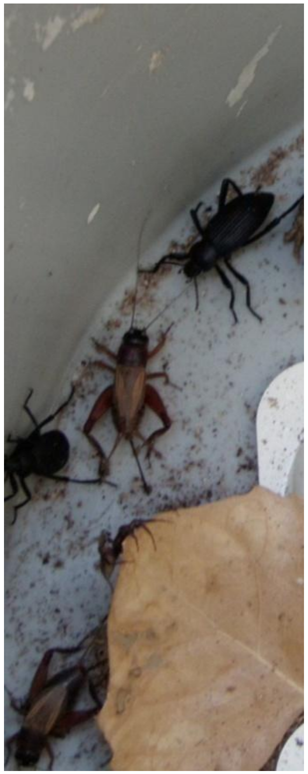
Arthropod Abundance

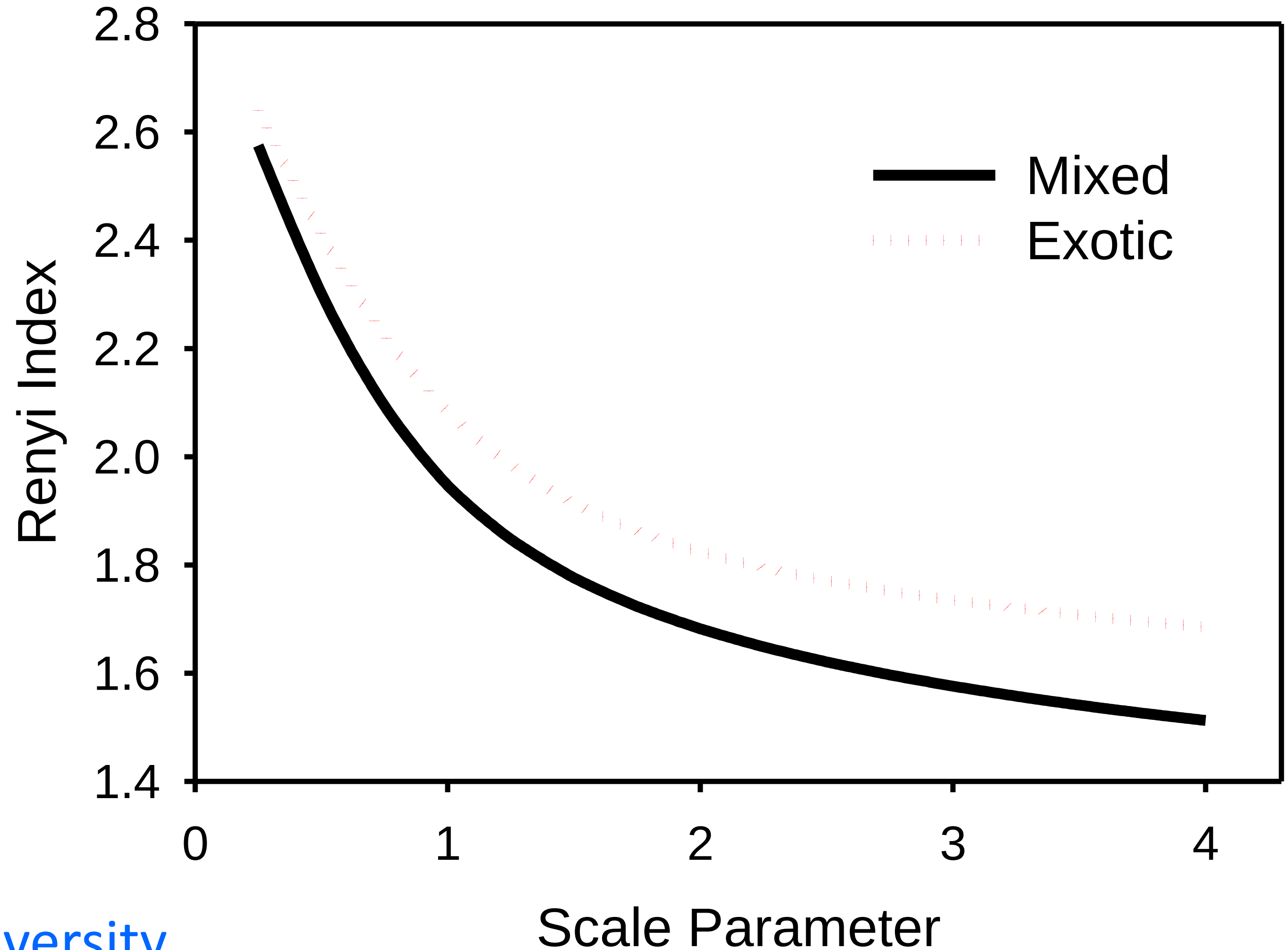




- Arthropod abundance greater in mixed habitats

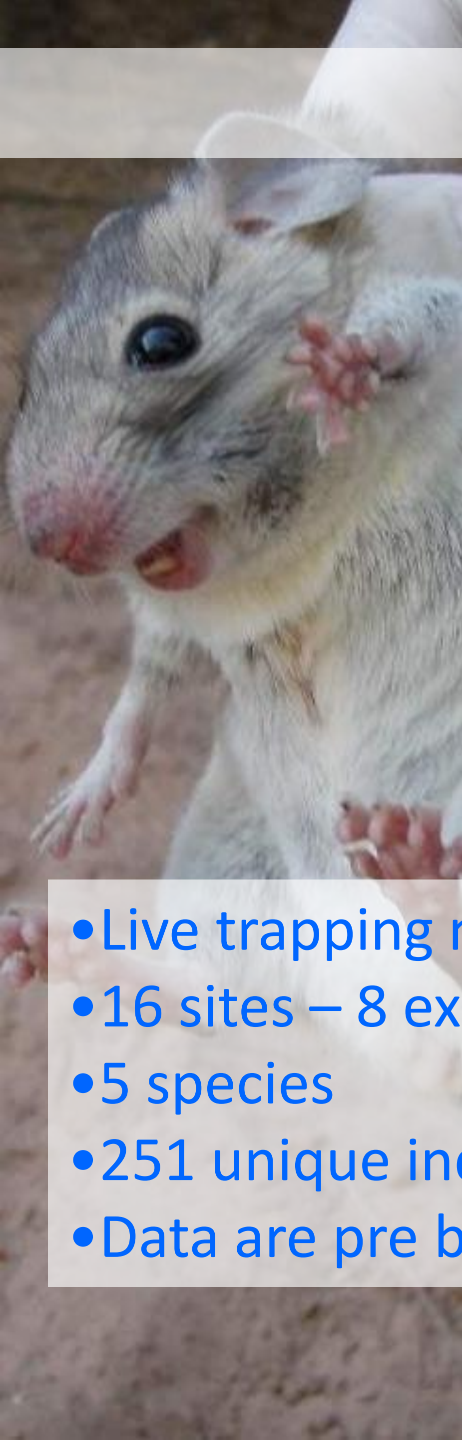
Arthropod Diversity

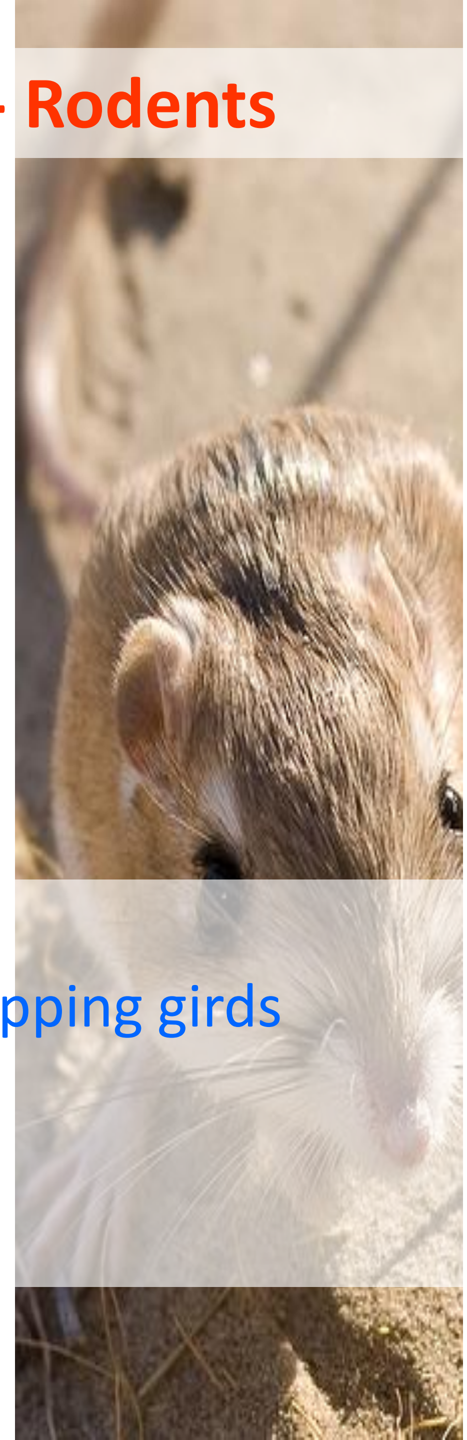




- Arthropod diversity lower in mixed habitats

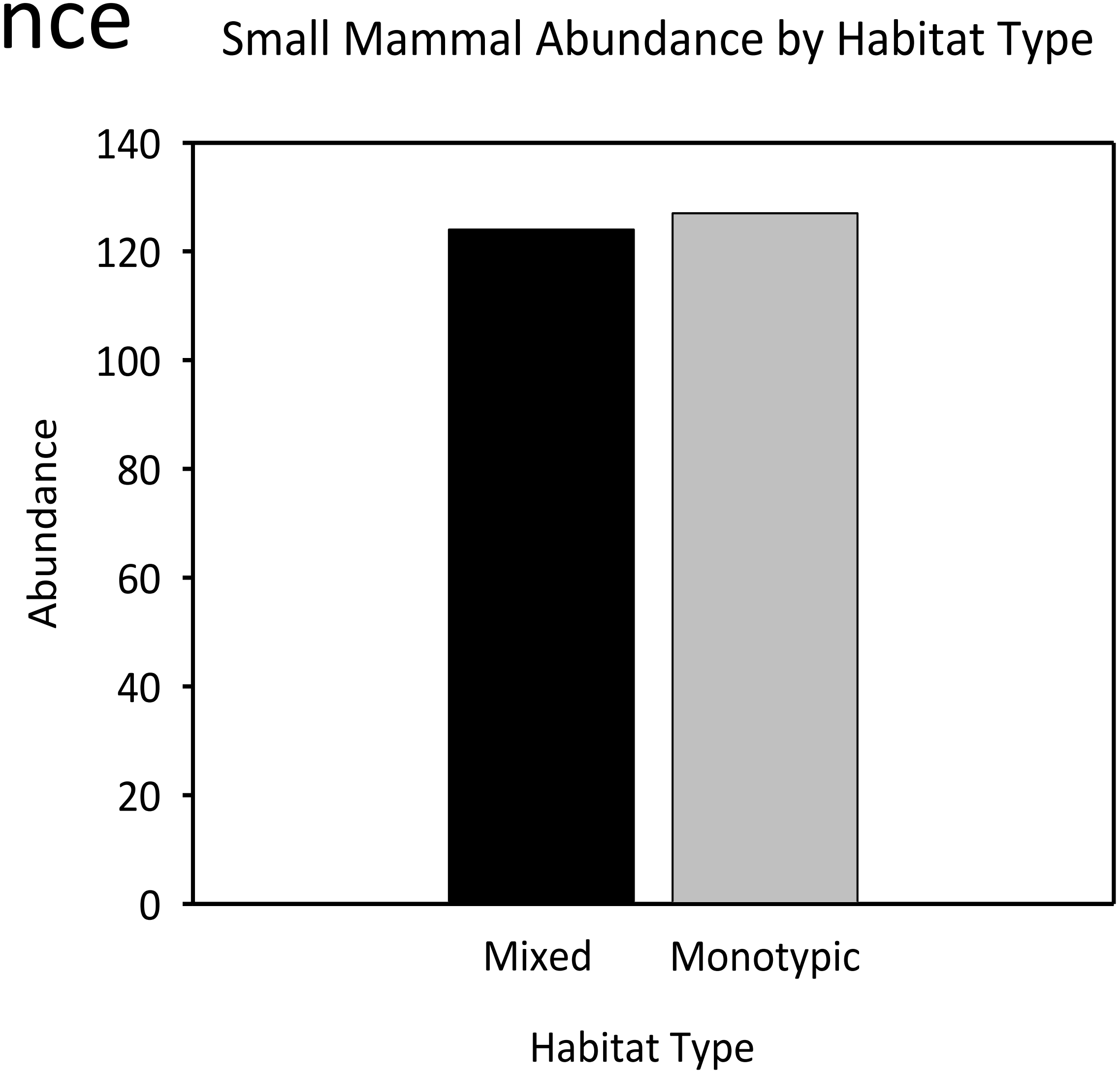
Methods - Rodents





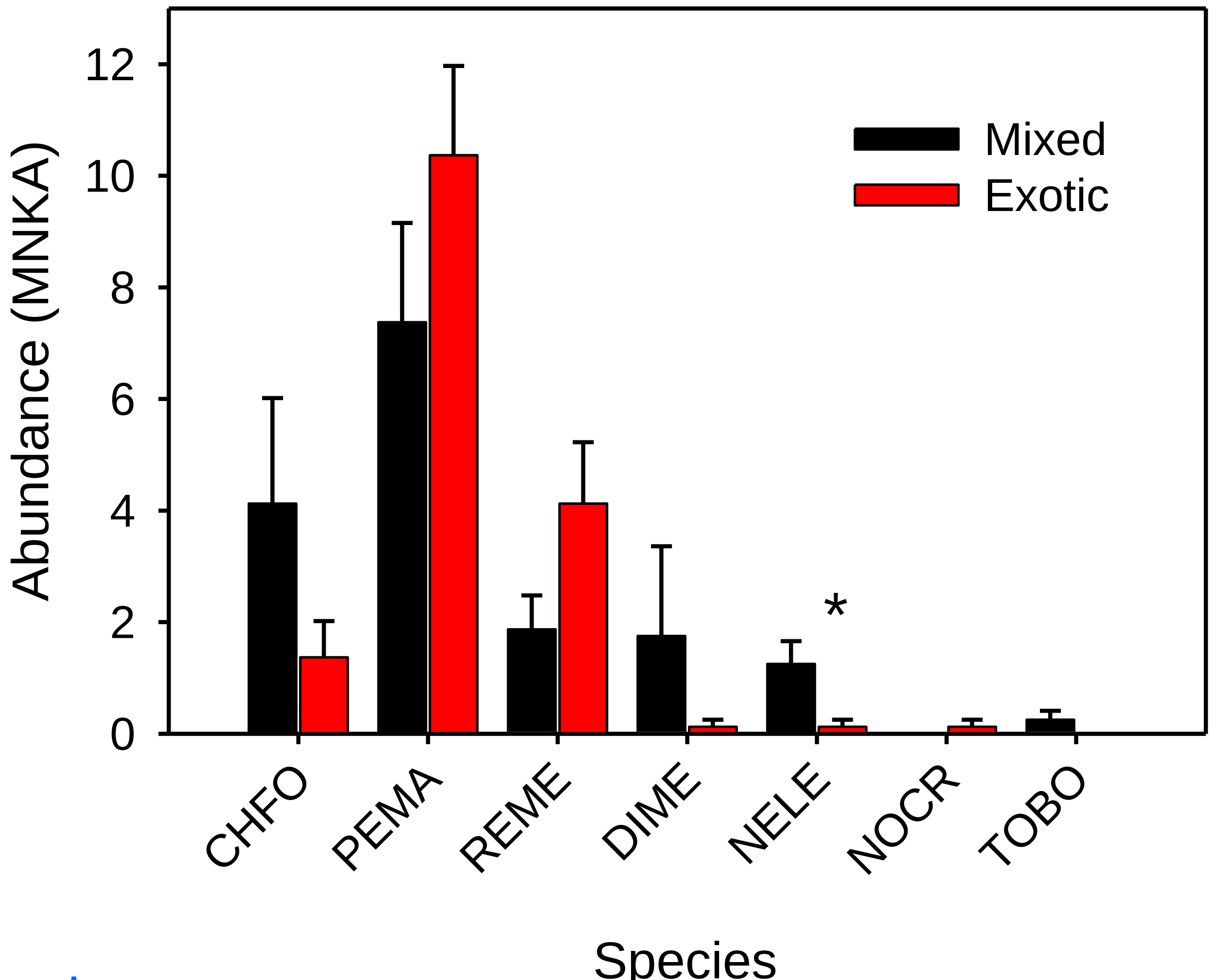

- Live trapping methods
- 16 sites – 8 exotic and 8 mixed trapping girds
- 5 species
- 251 unique individuals
- Data are pre beetle in 2010

Rodent Abundance



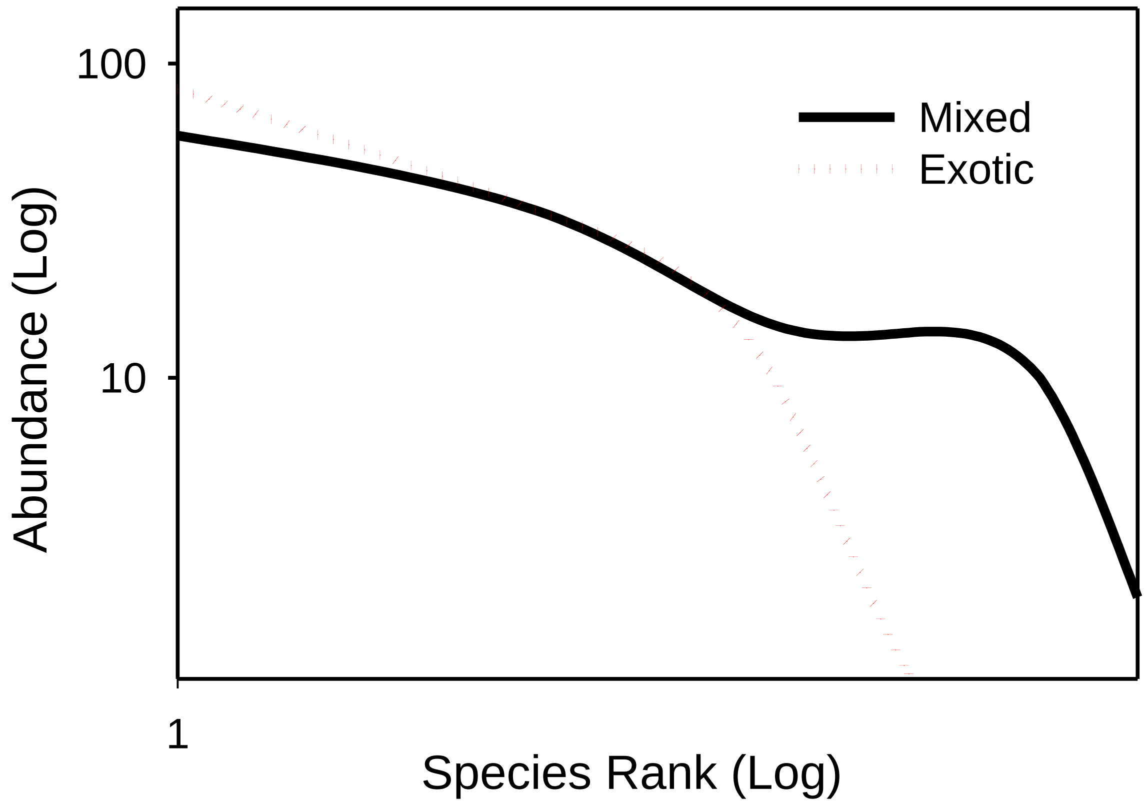
- Similar overall abundance

Rodent Abundance



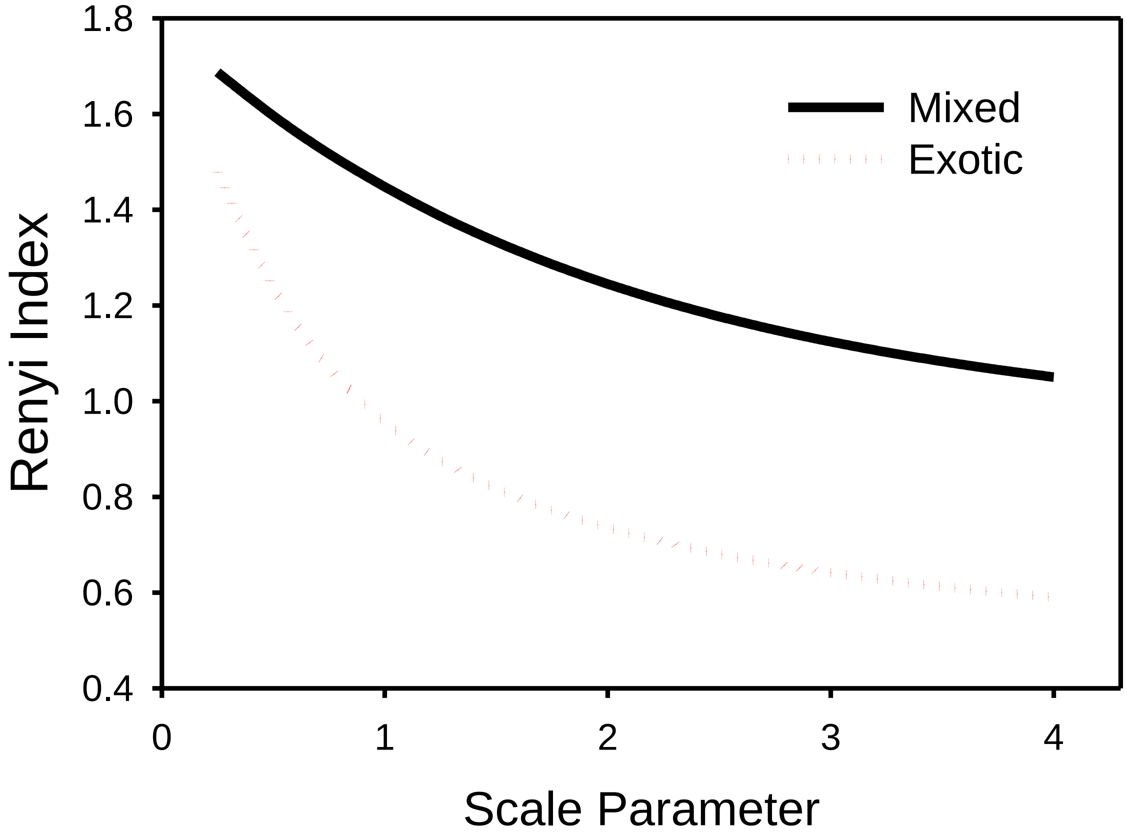
- Species abundances differ by habitat

Rodent Abundance



- Pattern driven by PEMA
- Less common species negatively influenced by exotic

Rodent Diversity



- Significantly greater species diversity in mixed habitat

Project Summary

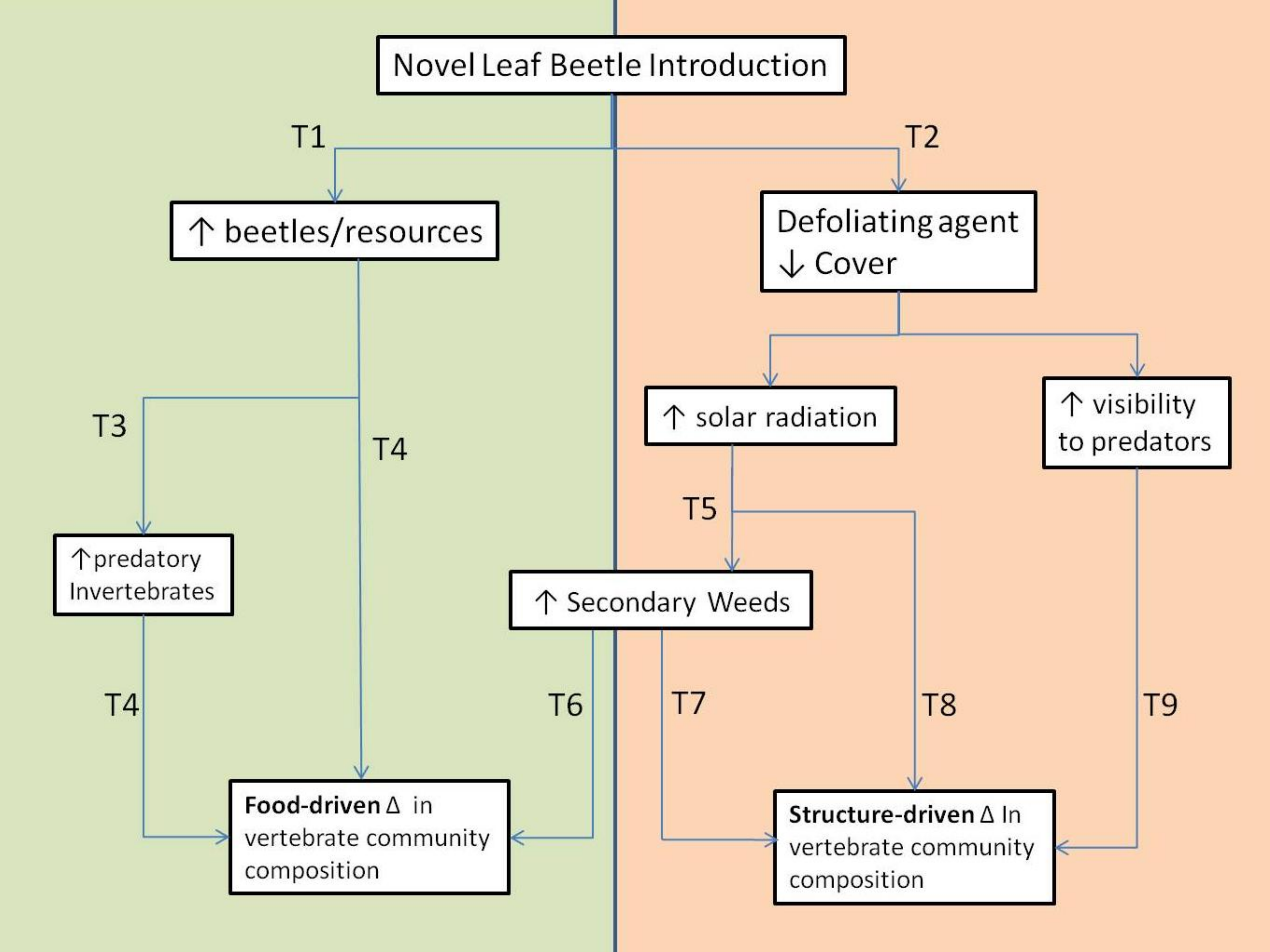
Evaluate small vertebrate communities among mixed vs. monotypic *Tamarix* stands to understand potential impacts of biocontrol

- Rodent and lizard abundances are similar in mixed and exotic habitats, driven by generalist species
- Species-specific responses: desert wood rats and desert spiny lizards more abundant in mixed habitat
- Rodent and lizard diversity is greater in mixed habitat
- Less common species appear to be negatively influenced with by *Tamarix* dominance

Implications

Predictions for post-beetle habitats

- Insectivorous species may increase in abundance from biocontrol agent
  - Feeding trials confirm beetle as food
- Species-specific responses: desert woodrats and desert spiny lizards more abundant in mixed habitat
  - Related to habitat features of mixed sites
- Wildlife species are one component of a comprehensive monitoring scheme to address multiple management goals



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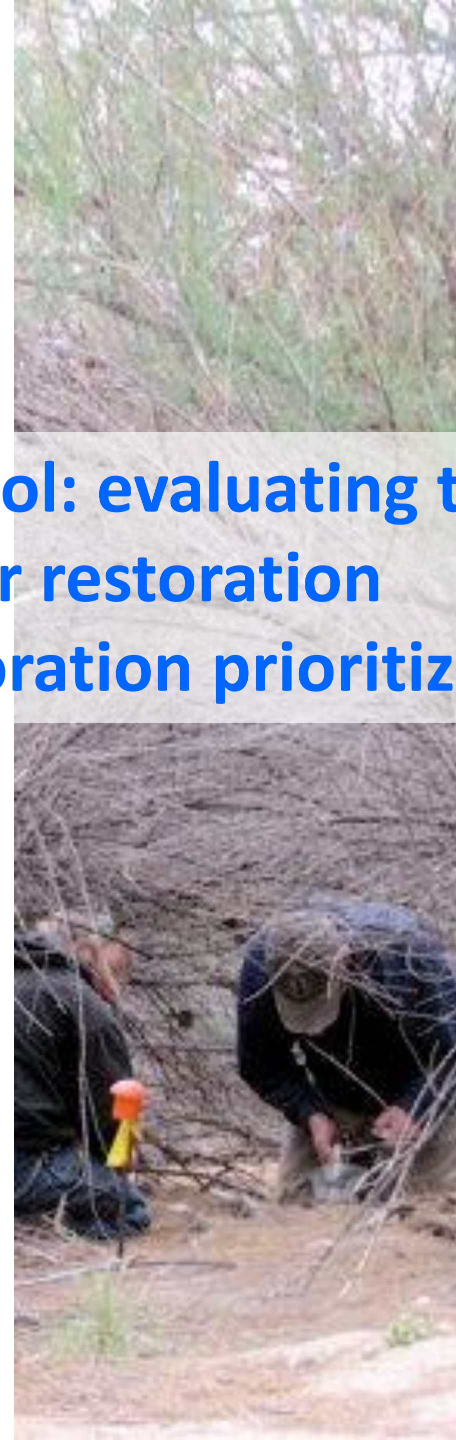
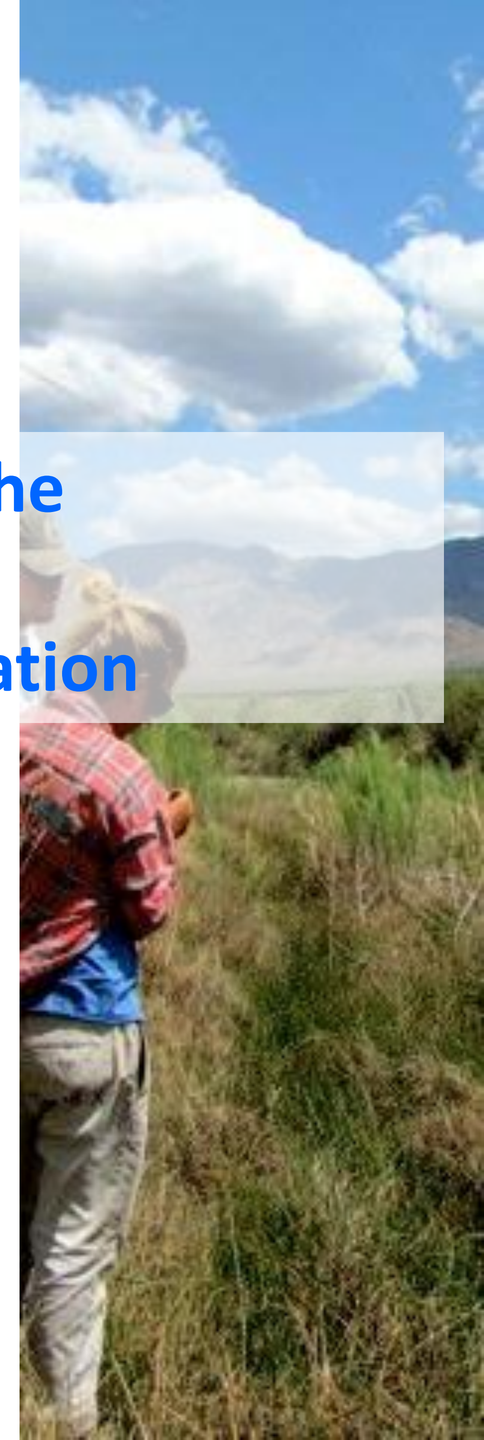
Tamarisk and biological control: evaluating the interactions and preparing for restoration
ii. Plant community and restoration prioritization





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Secondary Weeds

Secondary Weeds

Secondary Weeds

Native Plant Establishment

Plant Community & Defoliation

Plant Community & Defoliation

Seed Bank
Soil Chemistry

Plant Community & Defoliation

Seed Bank Soil Chemistry

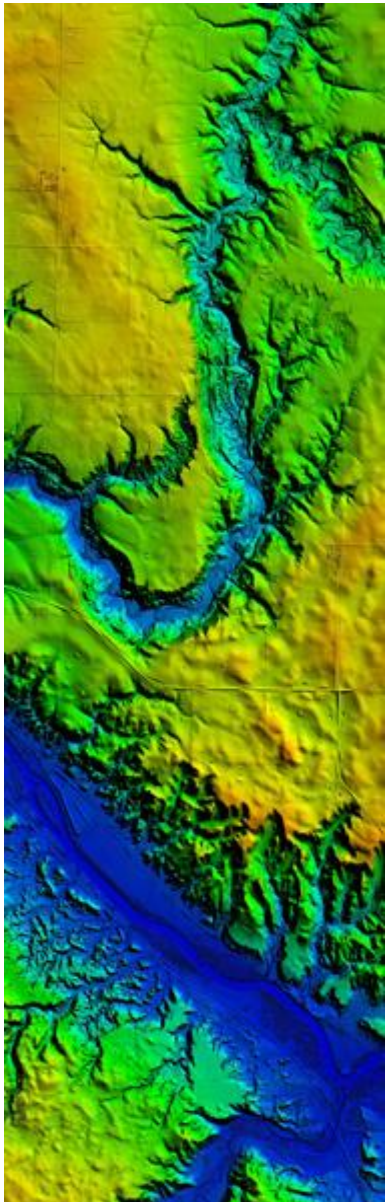
Topographic Mapping

Plant Community & Defoliation

Seed Bank Soil Chemistry

Topographic Mapping

Remote Sensing

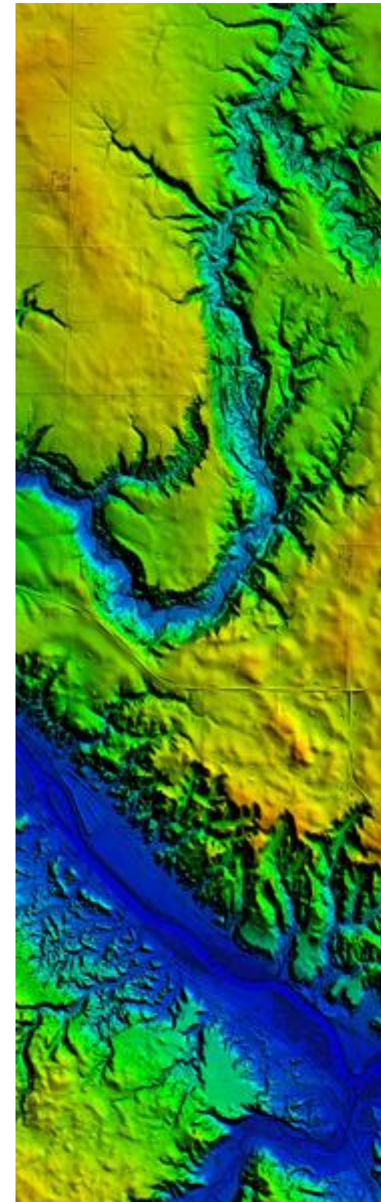


Plant Community & Defoliation

Seed Bank Soil Chemistry

Topographic Mapping

Remote Sensing



24 cross channel transects

24 cross channel transects (< 500 m)

> 500 plots

24 cross channel transects

> 500 plots

> 2000 seed pool and soil chemistry samples

24 cross channel transects

> 500 plots

> 2000 seed pool and
soil chemistry samples

Targeted and detailed mapping

24 cross channel transects

> 500 plots

> 2000 seed pool and soil chemistry samples

Targeted and detailed mapping

LiDar imagery

24 cross channel transects

> 500 plots

> 2000 seed pool and
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Targeted and detailed mapping

LiDar imagery

Seasonal monitoring defoliation patterns

24 cross channel transects

>500 plots

> 2000 seed pool and
soil chemistry samples

Targeted and detailed mapping

LiDar imagery

Seasonal monitoring defoliation patterns

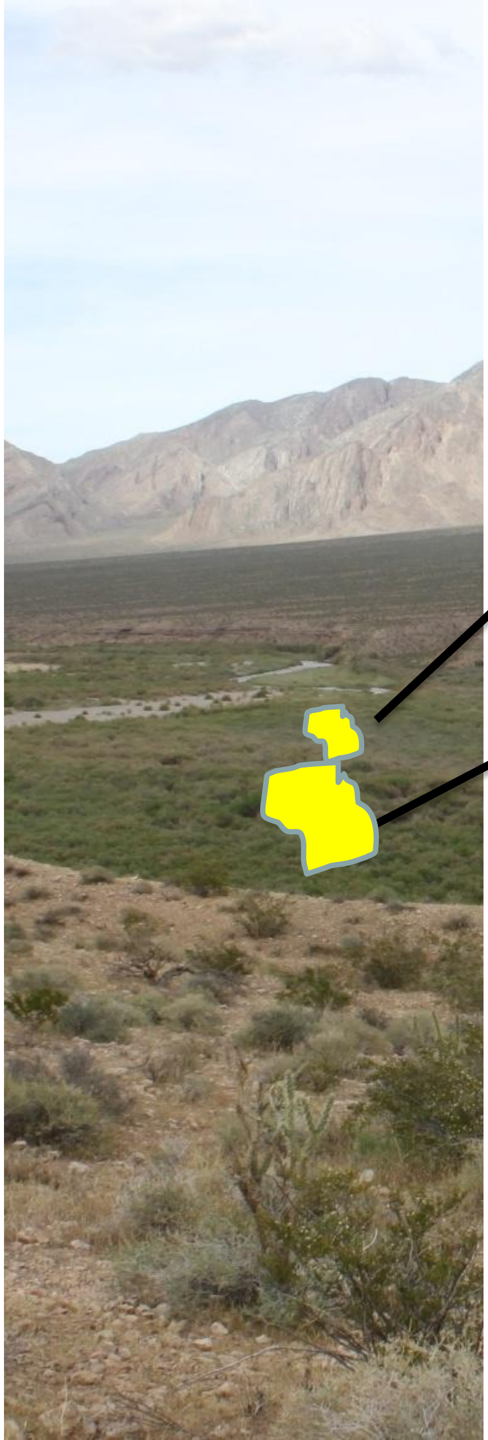
Repeat sampling with pre beetle data

Comprehensive Biophysical Sampling and Surveying

Native Plant Recruitment

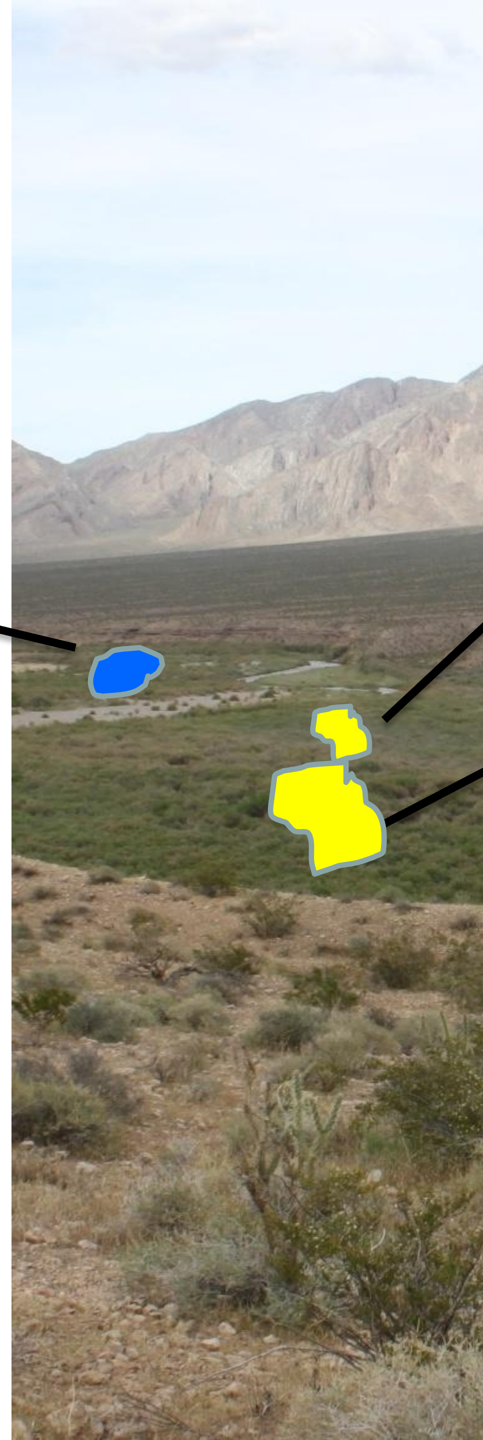
Native Plant Recruitment

Secondary Weeds



Restoration Sites

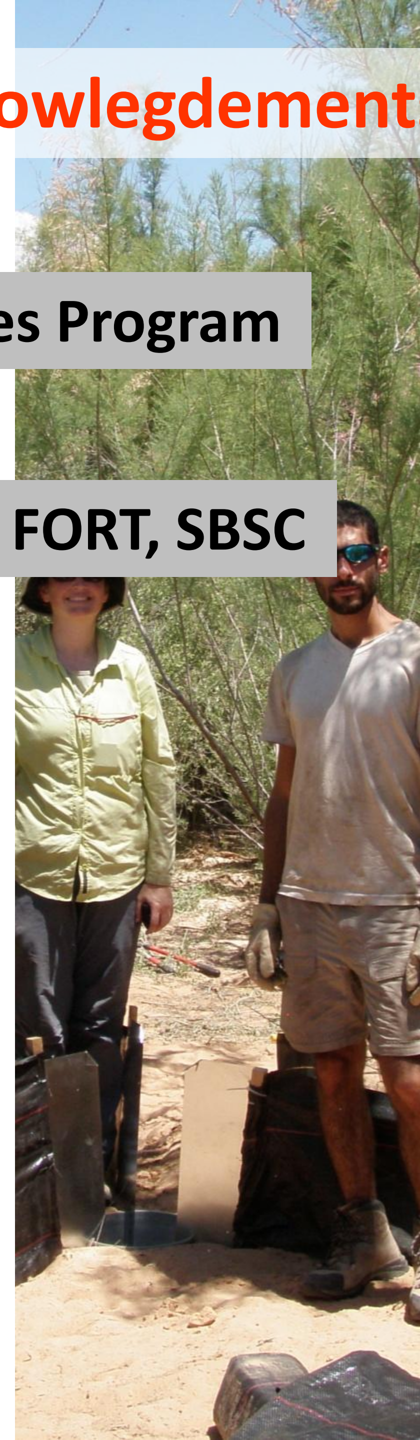
No Action Needed



Restoration Sites

Funding and Acknowlegdements






USGS National Invasive Species Program

USGS Science Centers: WERC, FORT, SBSC

ASU Polytechnic