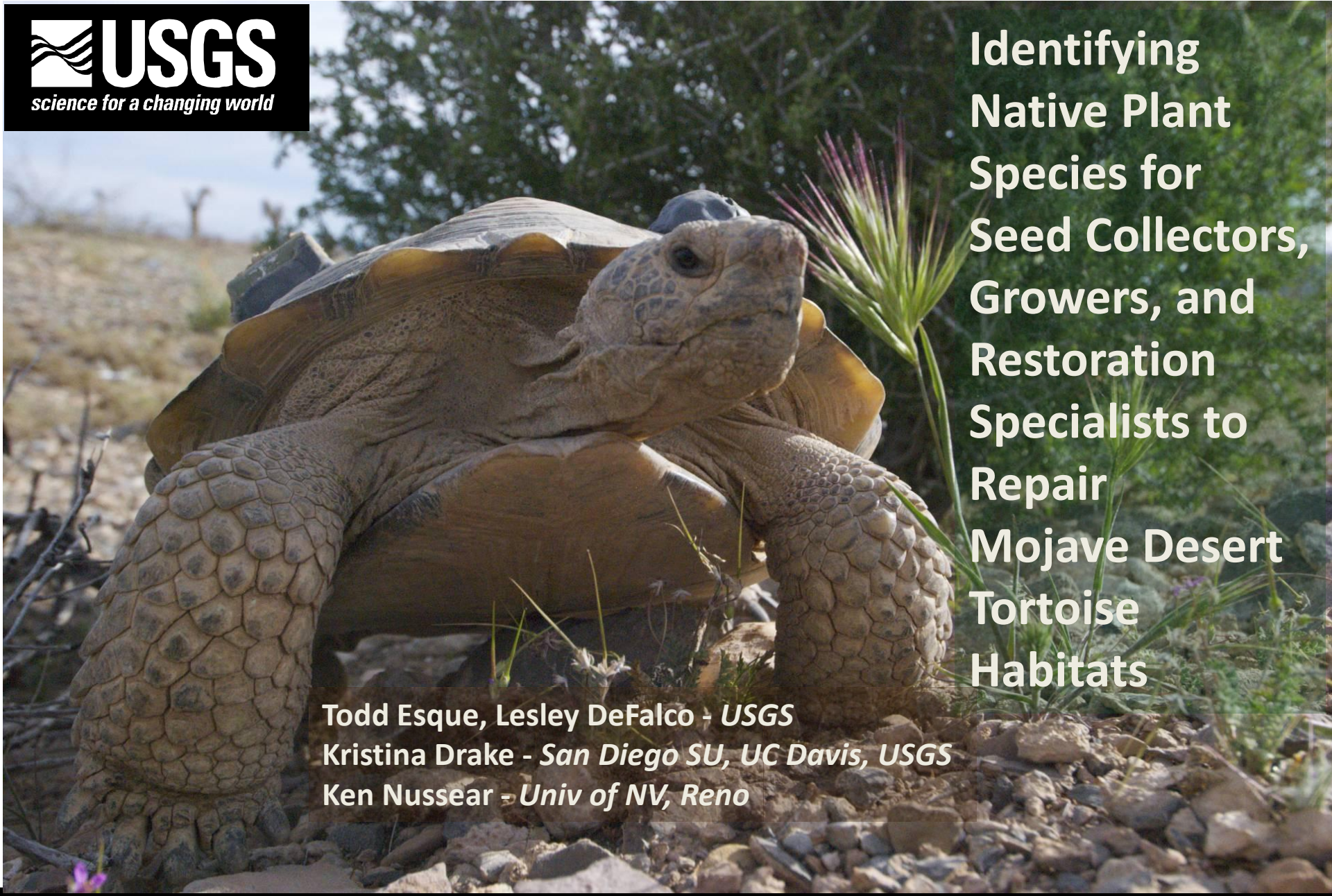

Identifying Native Plant Species for Seed Collectors, Growers, and Restoration Specialists to Repair Mojave Desert Tortoise Habitats

Todd Esque, Lesley DeFalco - *USGS*
Kristina Drake - *San Diego SU, UC Davis, USGS*
Ken Nussear - *Univ of NV, Reno*

Society for Ecological Restoration / Southwest Chapter Conference
9 November 2016, Springs Preserve, Las Vegas, NV

USGS
science for a changing world

Integrating Habitat Restoration with Species Recovery

In The Mojave Desert

Todd Esque, Lesley DeFalco - *USGS*
Kristina Drake - *San Diego SU, UC Davis, USGS*
Ken Nussear - *Univ of NV, Reno*

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Coyote Springs Investments, LLC
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Nevada Depart of Wildlife
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Mojave Science & Cultural Center
Rancho Santa Ana Botanical Garden
Joshua Tree Genome Project
Utah Division of Wildlife Resources
USDA – Shrub Sciences Lab
USDA - Natural Resource Conservation Service
Clark County, Nevada

A Collaboration of Management, Research, and Implementation

Mojave Desert Background

- After the wettest period on record (1978-1983)
- Surge in Mediterranean grasses, and fires

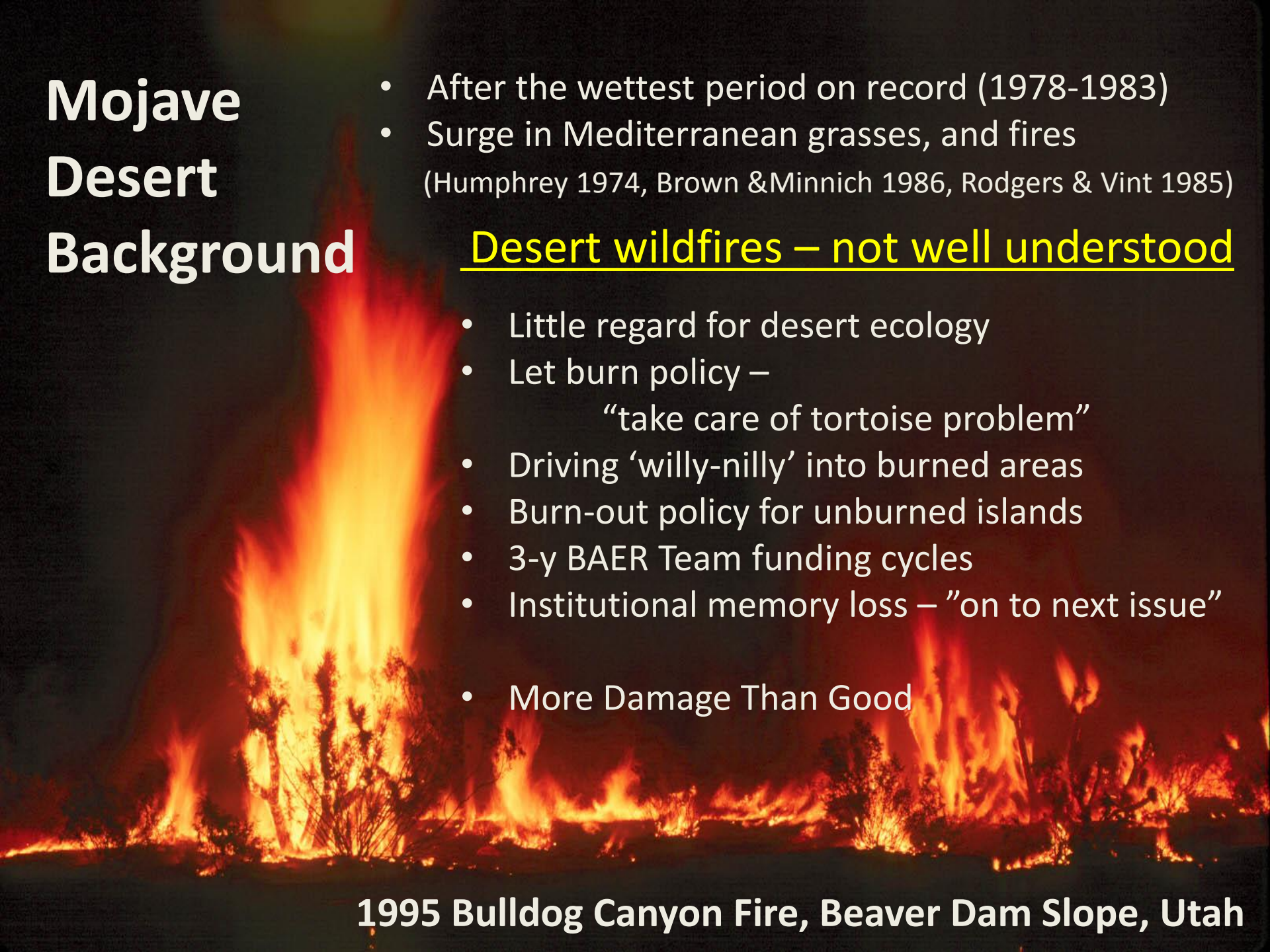
(Humphrey 1974, Brown &Minnich 1986, Rodgers & Vint 1985)

Desert wildfires – not well understood

- Little regard for desert ecology
- Let burn policy –

  "take care of tortoise problem"
- Driving 'willy-nilly' into burned areas
- Burn-out policy for unburned islands
- 3-y BAER Team funding cycles
- Institutional memory loss – "on to next issue"

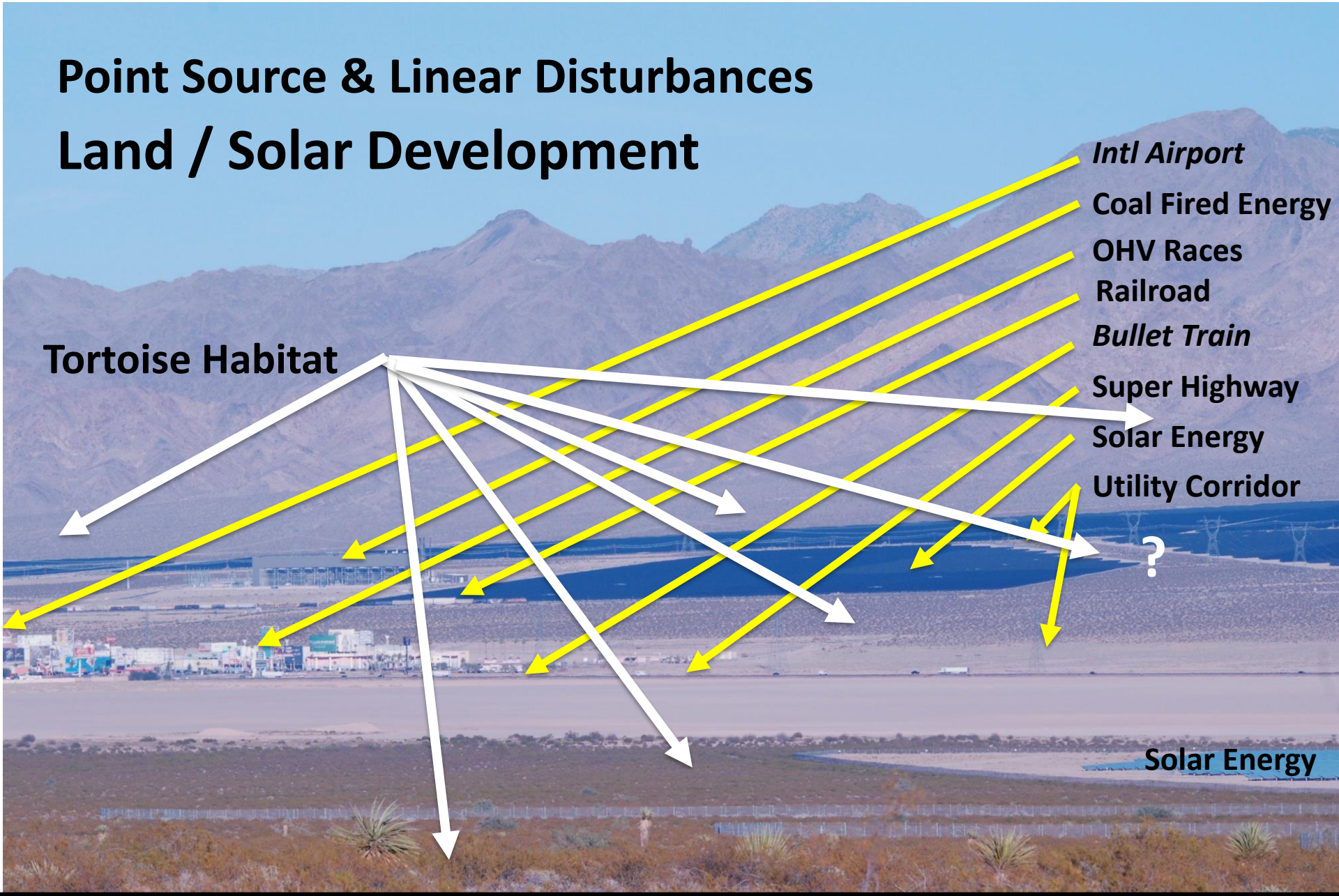
- More Damage Than Good



1995 Bulldog Canyon Fire, Beaver Dam Slope, Utah

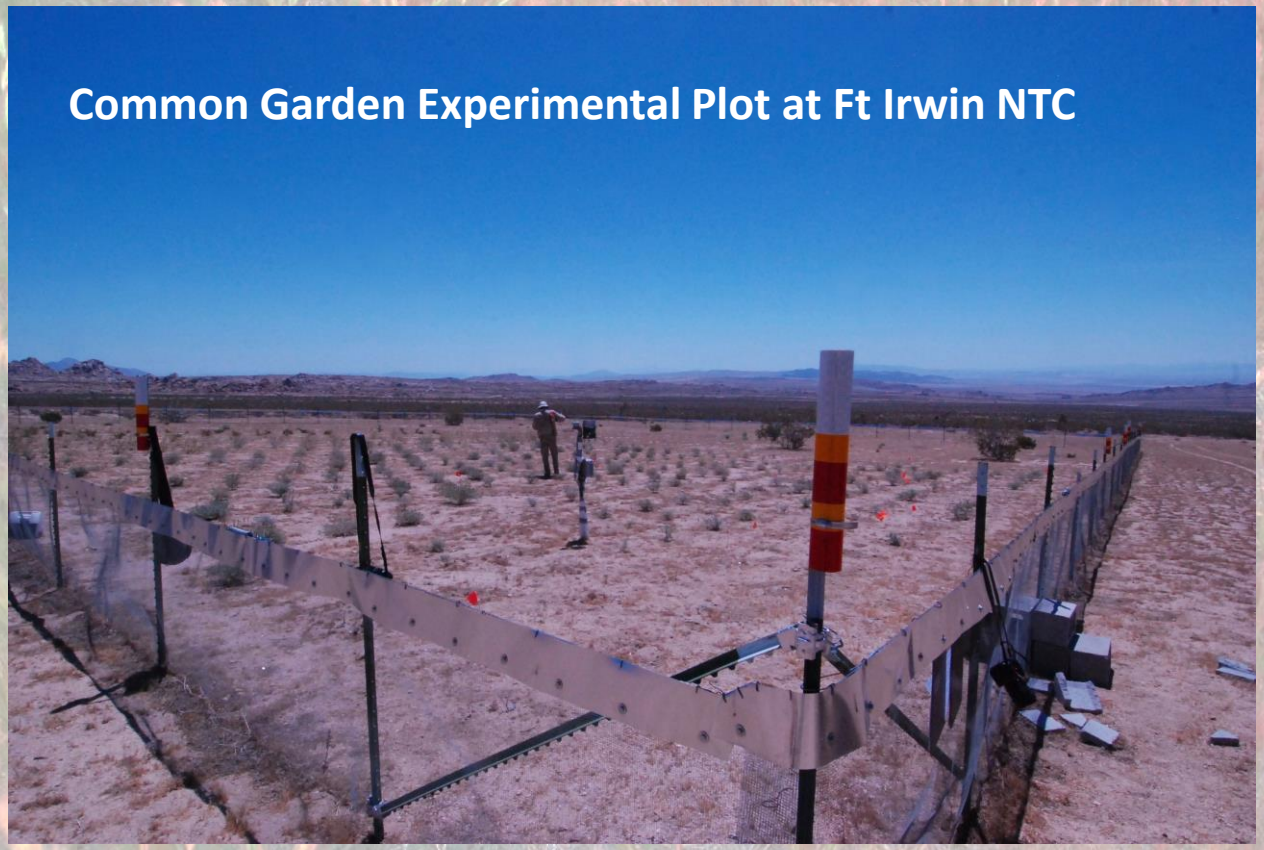

Firefighting Issues
Easily Resolved
(Duck et al 1997)
Many
Fire Effects Issues
Resolved
(Minnich et al, Allen et al. , DeFalco et al.,
Brooks et al., Esque et al., Abella et al., Grey et al.,
Van Linn et al., Shryock et al.)
MOST
Desert Landscape Restoration
Issues UNRESOLVED
1995 Bulldog Canyon Fire, Beaver Dam Slope, Utah

This wildlife corridor has been developed substantially in the past 30 y


Point Source & Linear Disturbances
Land / Solar Development
Intl Airport
Coal Fired Energy
OHV Races
Railroad
Bullet Train
Super Highway
Solar Energy
Utility Corridor
?
Tortoise Habitat
Solar Energy

Grassy desertification
Pakoon Basin, Grand Canyon-Parashant Natl Mon

USGS / BLM / FWS / NRCS
Restoration Research Programs
respond to information needs for natural resource management, techniques, and materials



USGS / BLM / FWS Restoration Research Program

Identify Provisional Seed Zones / Plant Materials Transfer Zones – Mojave Desert-Useful Scale (Shryock et al. 2015,2016)

Test Materials across a Common Garden Network: Physiology, Genetics, Morphology, Phenology, Plant Performance (Custer et al. *In Prep*)

Identify Relevant Species for Seed Collectors, Seed Growers, Restoration Specialists

Improve Habitat Toward the Recovery Threatened Desert Tortoise

Identify Food Species

considering tortoise nutrition & health wherever possible

Identify most commonly used cover species

Determine known history of propagation and restoration techniques and successes for each species

Identify Plant Species for Food

Desert Tortoises use diversity of plants when available

Grasses – alone – are not good diets, esp. not *Bromus* *(Drake et al. 2016)*

Potassium Excretion Potential Hypothesis (Oftedal et al.)
vs.
Integrated Resource Acquisition Hypothesis (Tracy et al.)

The Value of Different Diets - Diet Manipulation Experiment

Brome

Vulpia

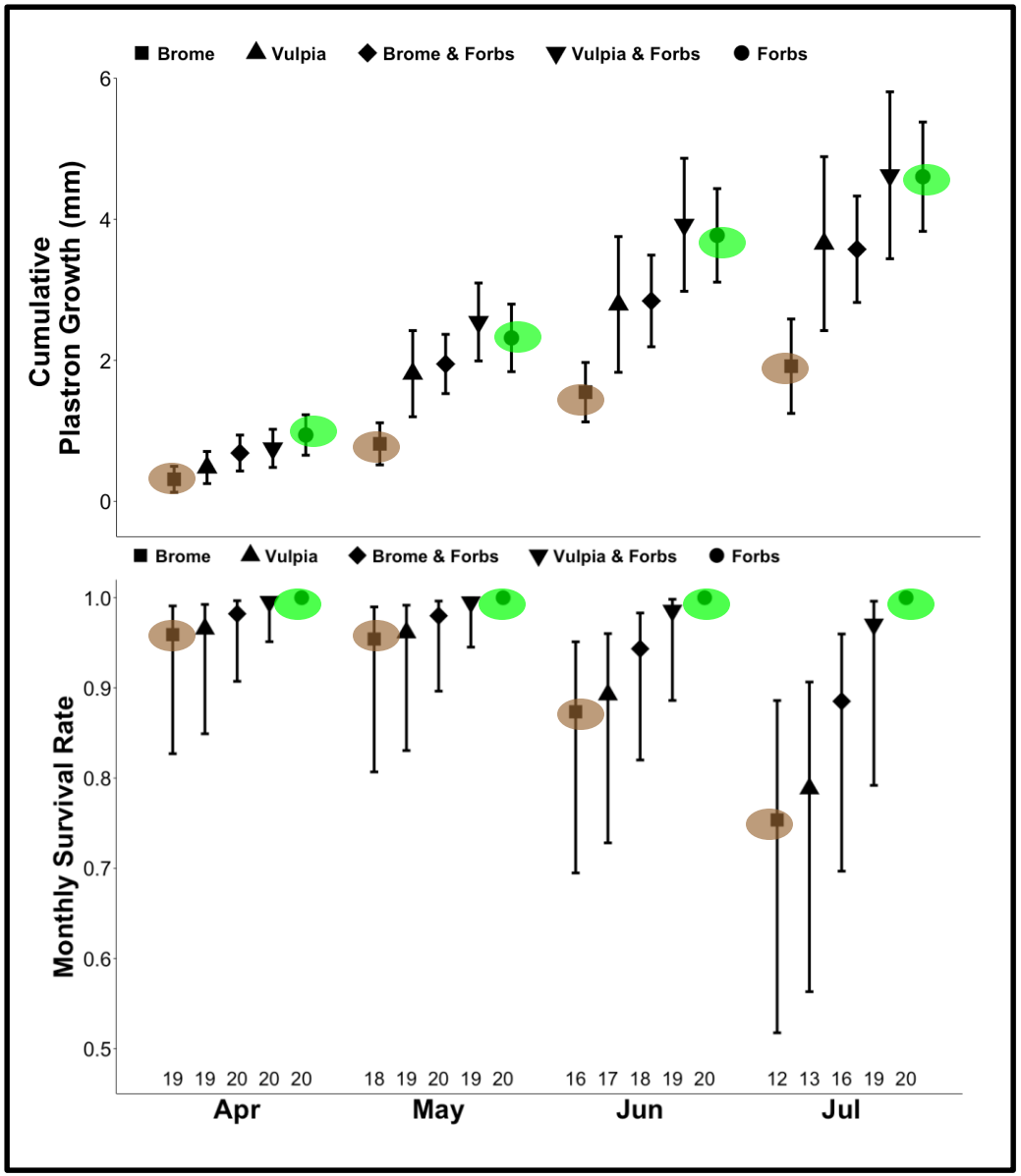
Native Forbs

Dietary Treatments

1. **Non-native Grass** -*Bromus rubens*
2. **Native Grass** -*Vulpia octoflora*
3. **Native Forbs** – 4 Species*
4. **Non-native Grass & Native Forbs**
5. **Native Grass & Native Forbs**

**Cammisonia claviformis*, *Eschultzia californica*, *Malacothrix californica*, and *Plantago ovata*
Brown-eyed evening primrose, California poppy, Desert dandelion, Indian wheat

Diet Study



Drake et al. 2016

Invasive Mediterranean Grasses

Red Brome – *Bromus rubens*

Table 1. Studies that document plant species in the diets of Mojave desert tortoises. For method, OBS=foraging observations, FA=analysis of tortoise feces, and BC= bite counts.

Study	Years	Site	Method	Sample
1	1973	Hinkley, San Bernardino Co., CA	OBS	N = 1 (+ anecdotal)
2	1973-75	Lower Grand Canyon, Mohave Co., AZ	FA	N = 66 fecal pellets
2	1973-75	Beaver Dam Wash, Washington Co., UT	FA	N= 30 fecal pellets
3	1975	Arden Study Area, Clark Co., NV	OBS	N = 100 observations
4	1976-78	Beaver Dam Slope, Washington Co, UT	OBS	N = 26 observations
5	1978	Joshua Tree NP, San Bernardino Co, CA	OBS	N = 15 observations
6	1979	Desert Tortoise Natural Area, Kern Co., CA	OBS	N = 39 observations
7	1980	Ivanpah Valley, San Bernardino Co., CA	OBS	N = 3 observations
7	1981	Ivanpah Valley, San Bernardino Co., CA	OBS	N = 59 observations
7	1980-81	Ivanpah Valley, San Bernardino Co., CA	FA	N = 409 fecal pellets
8	1989-92	City Creek Site, Washington Co., UT	BC	N = 119,198 bites / 29 tortoises
8	1990-92	Littlefield Site, Mohave Co., AZ	BC	N = 33,805 bites / 26 tortoises
9	1992	Desert Tortoise Natural Area, Kern Co., CA	BC	N = 34,243 bites / 18 tortoises
10	1992-93	Ivanpah Vy, San Bernardino Co., CA	BC*	N = 27,715 bites / 20 tortoises
11	1994	City Creek Site, Washington Co., UT	BC	N = 27,842 bites / 5 tortoises

[1]Luckenbach (1982); [2]Hansen et al. (1976); [3]Burge & Bradley (1976); [4]Hohman & Ohmart (1980); [5]Barrow (1979); [6]Bickett (1980); [7]Medica et al. (1981); [8]Esque (1994); [9]Jennings (1993, 2015); [10]Avery (1998); [11]DeFalco (1995). *Bite counts in Avery (1998) were pooled by annual and perennial species and so could not be separated by species in bite count compilation shown in Table 2.

25 Priority Diet Species for Desert Tortoise (>200 Total)
Part 1 – Native Diet Species ≥ 1% of # Bites

Habit	Species	# Sites	# Bites	%Use $_{all}$	%Use$_{native}$
AF	Cryptantha micrantha	4	14,564	6.9	13.3
AF	*Stephanomeria exigua*	3	12,083	5.7	11.0
AF	*Acmispon brachycarpus (Lotus humistratus)*	2	10,512	4.9	9.6
AF	*Plantago ovata*	5	7,070	3.3	6.4
AF	*Descurainia pinnata*	4	5,654	2.7	5.1
AF	*Lotus plebieus*	2	4,316	2.0	3.9
PG	*Stipa (Oryzopsis* or *Achnatherum) hymenoides*	5	3,971	1.9	3.6
PF	Mirabilis laevis var villosa (=M. bigelovii)	1	3,820	1.8	3.5
PF	*Euphorbia albomarginata*	4	3,801	1.8	3.5
AF	*Lepidium lasiocarpum*	3	3,241	1.5	2.9
PF	*Astragalus layneae*	2	2,902	1.4	2.6
AF	*Cryptantha nevadensis*	3	2,568	1.2	2.3
PG	*Hilaria (=Pleuraphis rigida)*	6	2,515	1.2	2.3
Shr	*Krameria erecta (=K. parvifolia)*	3	2,371	1.1	2.2
AG	*Festuca (=Vulpia) octoflora*	4	2,226	1.0	2.0
PF	*Androstephium breviflorum*	1	2,188	1.0	2.0
PF	*Muhlenbergia porteri*	2	2,136	1.0	1.9
	17 Spp				

25 Priority Diet Species for Desert Tortoise
Part 2 – Native Diet Species <1% of # Bites

8 spp Additional due to exceptional characteristics

Habit	Species	# Sites	# Bites	%Use	$\%Use_{native}$
AF	*Plantago patagonica*	3	1,969	0.9	1.8
AF	*Astragalus didymocarpus*	2	1,623	0.8	1.5
AF	*Cryptantha virginensis*	1	593	0.3	0.5
Cac	*Opuntia basilaris*	3	567	0.3	0.5
AF	*Cryptantha circumscissa*	2	561	0.3	0.5
AF	*Cryptantha pterocarya*	3	412	0.2	0.4
PF/Shrub	*Sphaeralcea ambigua*	4	437	0.2	0.4
AF	*Cryptantha angustifolia*	4	61	<0.1	0.1
AF/PF	*Oenothera/Camissonia* spp.	--	--	--	--

Part 3 – Non-native Diet Species

Habit	Species	# Sites	# Bites	%Use $_{all}$	%Use $_{native}$
AF	*Erodium cicutarium*	8	30,139	14.2	n/a
AG	*Bromus madritensis ssp. rubens*	9	27,238	12.8	n/a
AG	*Schismus barbatus*	5	22,517	10.6	n/a
AG	*Bromus tectorum*	2	7,037	3.3	n/a
AG	*Bromus* sp.	3	341	0.2	n/a
AF	*Salsola iberica*	1	86	0.0	n/a

Impacts From Wildfires in Southern Nevada

- **Loss of perennial plants**
- **Shifts in vegetation** (Native -> Invasive Grasses)

July 2005 (Courtesy N. Sikula)

Tortoise Movement into Burned Habitat

Drake et al. 2015
Journal of Wildlife Management

Habit	Species	Total Use	% Use	Site Freq.
W-	*Larrea tridentata*	1,659	43.1	8
W-	*Ambrosia dumosa*	889	23.1	8
W-	*Yucca schidigera*	185	4.8	6
W-	*Lycium andersonii*	173	4.5	8
W+	*Ambrosia (=Hymenoclea) salsola*	138	3.6	5
W-	*Ephedra nevadensis*	132	3.4	6
PF+/W+	*Sphaeralcea ambigua*	123	3.2	6
W-	*Yucca brevifolia*	120	3.1	4
W-	*Atriplex hymenolytra*	53	1.4	2
W-	*Krameria grayi*	53	1.4	5
W-	*Ephedra sp.*	44	1.1	1

11 spp + 40 other spp.

20 of them fire decreasers

Acmispon / Lotus) spp.

Five species

Seed germinability information is lacking for most *Acmispon/Lotus* spp *Acmospon rigidus* seeds

germinated at 15 °C

initial germinability of 59%

long-term cold storage at 4 °C or -15 °

consistent germinability for up to 7 years of storage (Kay et al. 1988)

greater abundances recorded in burned than unburned areas in the northeast Mojave Desert (L. DeFalco, unpubl. Data)

may be a suitable species to include in native mixes for seeding tortoise habitat but remains to be tested.

Conclusions

Process was technically simple,
but logistically challenging

Results are not rules or ordered prioritization,
but should be used to generate
informed discussion/decisions

Applications need to be site specific

Pollinators and other species must be included
in discussions about ‘seed menus’ for restoration

Stay tuned as we use desert tortoises as biological probes to evaluate restoration efficacy in the future….

Rocket Tortoise by Kristina Drake

Restoration

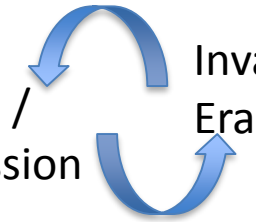
Biological Interactions
granivory & herbivory / facilitation

Seeding & Outplanting

Vegetation Re-Growth
Cryptogamic Communities/
Mycorrhizae communities

Soil Chemistry & Texture

Climate and Weather Patterns



Wildfire /
Suppression

Invasive Species
Eradication / Mitigation

Species Recovery

Distributions & Demographics
Habitat / Population Connectivity
Genetics / Health / Epidemiology

Habitat Characteristics
Food and Nutrition

Conservation Agreements
habitat conservation

Repatriation