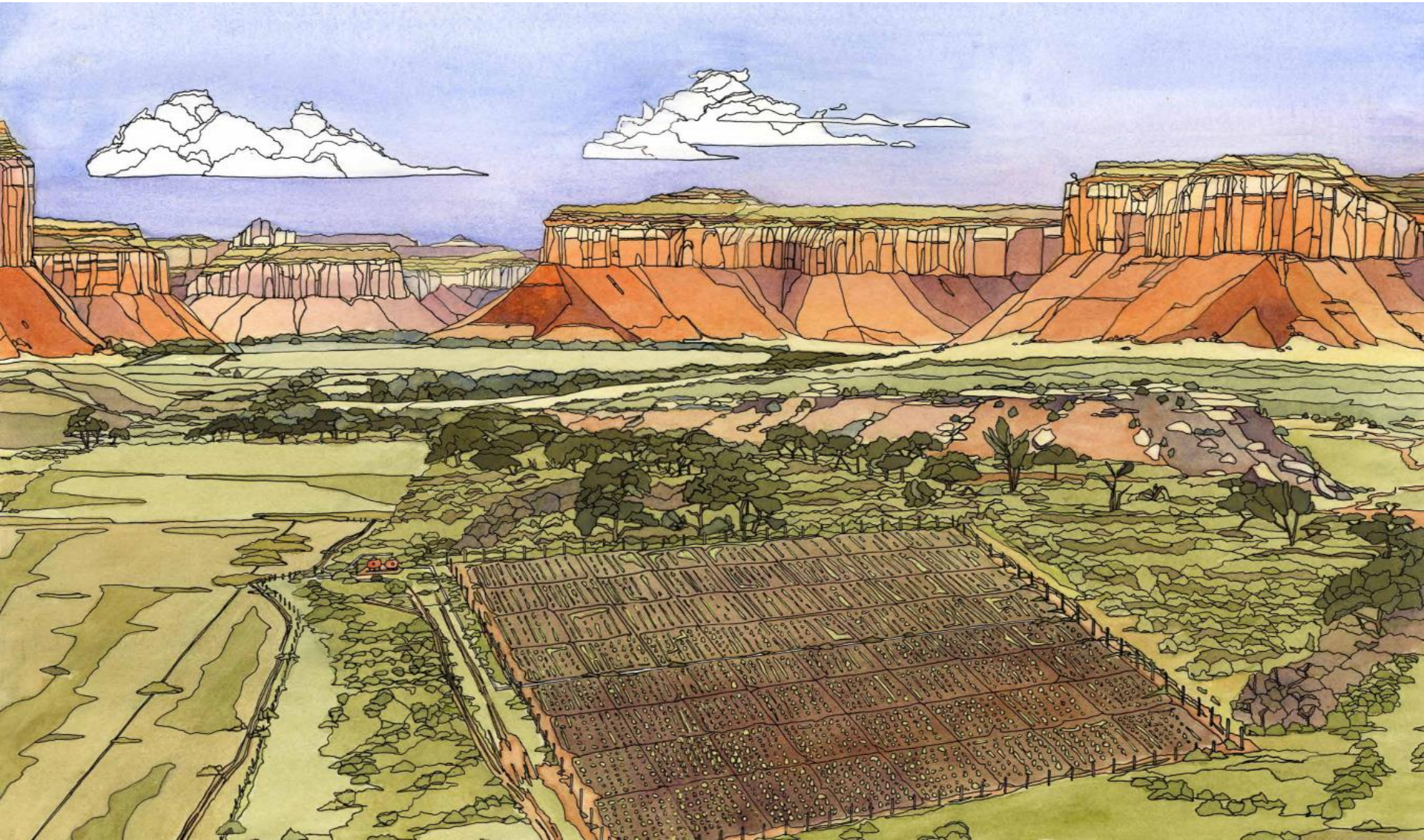


Developing Pollinator-Dependent Plant Materials For Use In A Growing Restoration Economy

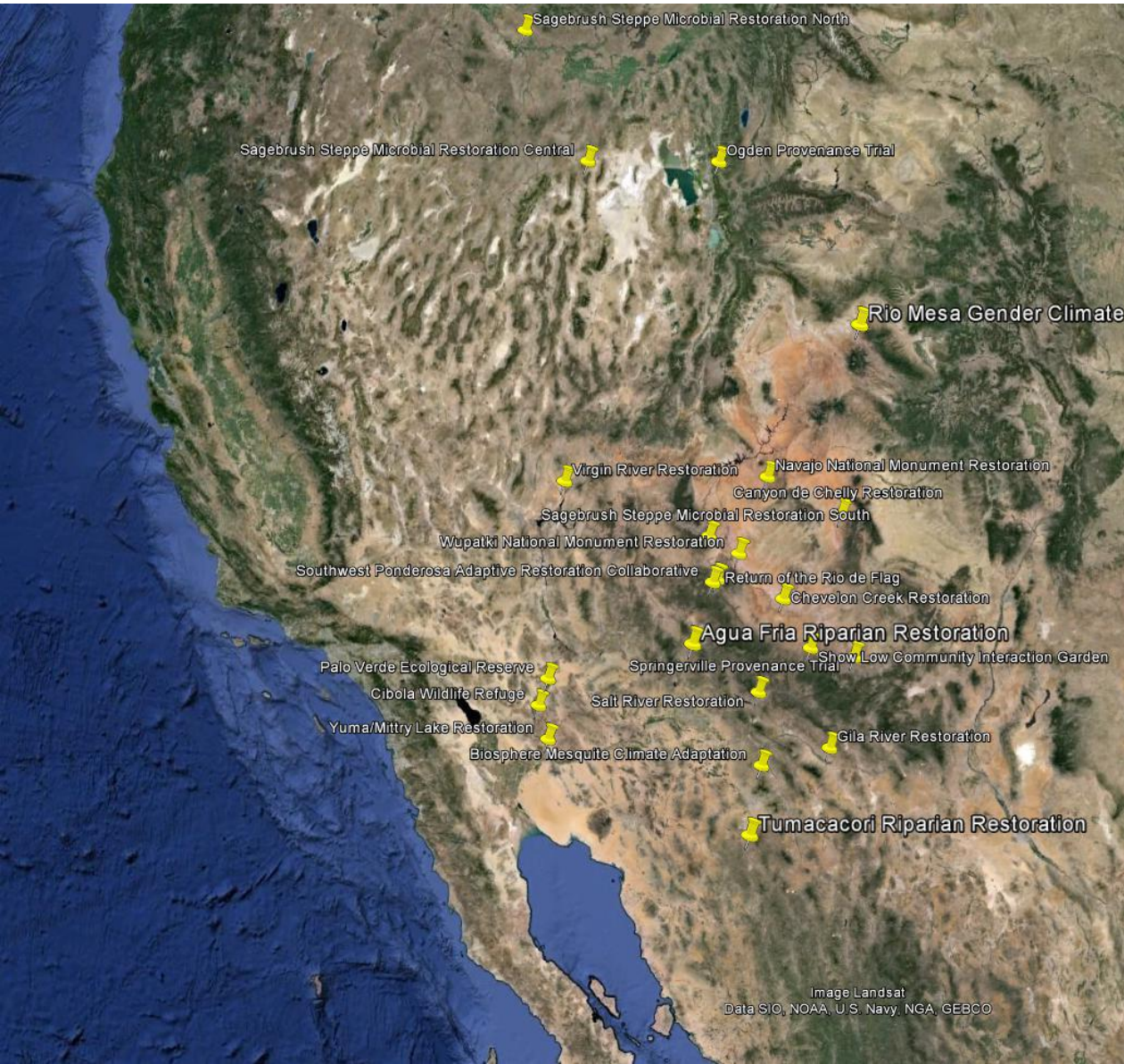
NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry, and Natural Sciences

Kevin Grady, Karen Haubensak, Clare Aslan
Chris Updike, Zach Ventrella





Genetics-based Restoration Network



Species Currently Tested:

Populus fremontii

Populus angustifolia

Salix gooddingii

Salix exigua

Acer negundo

Fraxinus velutina

Prosopis velutina

Pinus ponderosa

Artemisia tridentata

Elymus elymoides

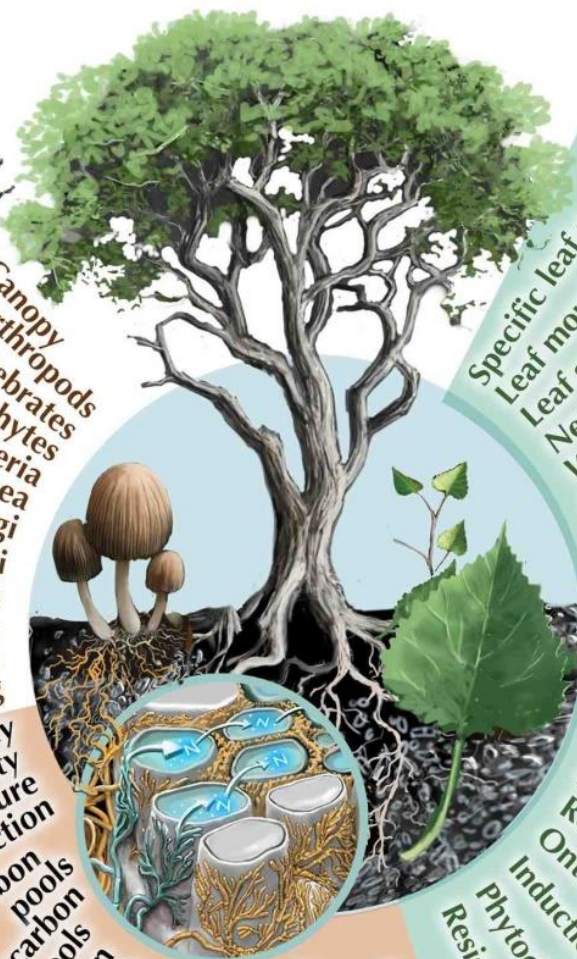
Achnatherum hymenoides

COMMUNITY

Canopy arthropods
aquatic macroinvertebrates
Twig endophytes
Soil bacteria
Ammonia oxidizing archaea
Decomposer fungi
Mycorrhizal fungi
Understory plants
Community structure
Interaction networks
Avian nesting

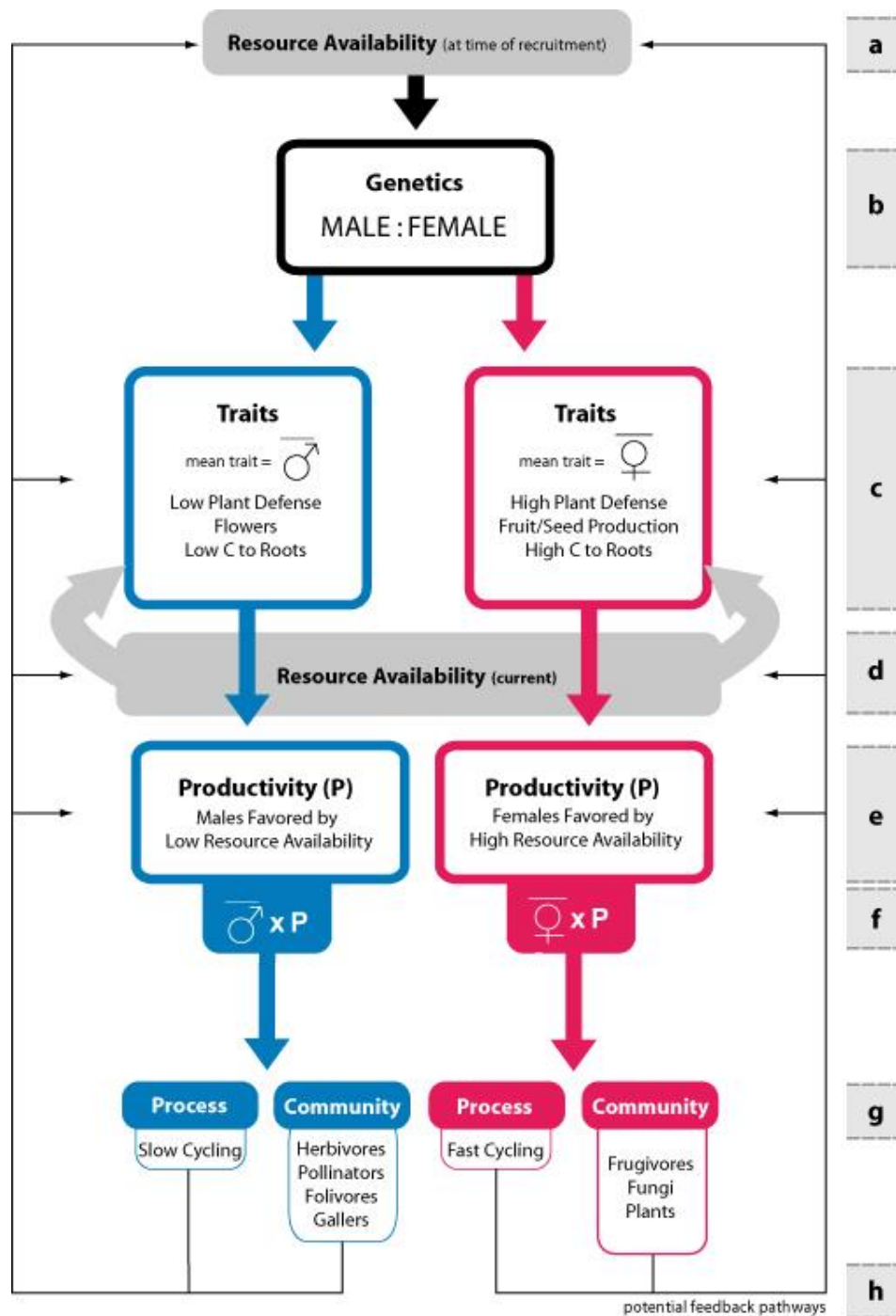
ECOSYSTEM

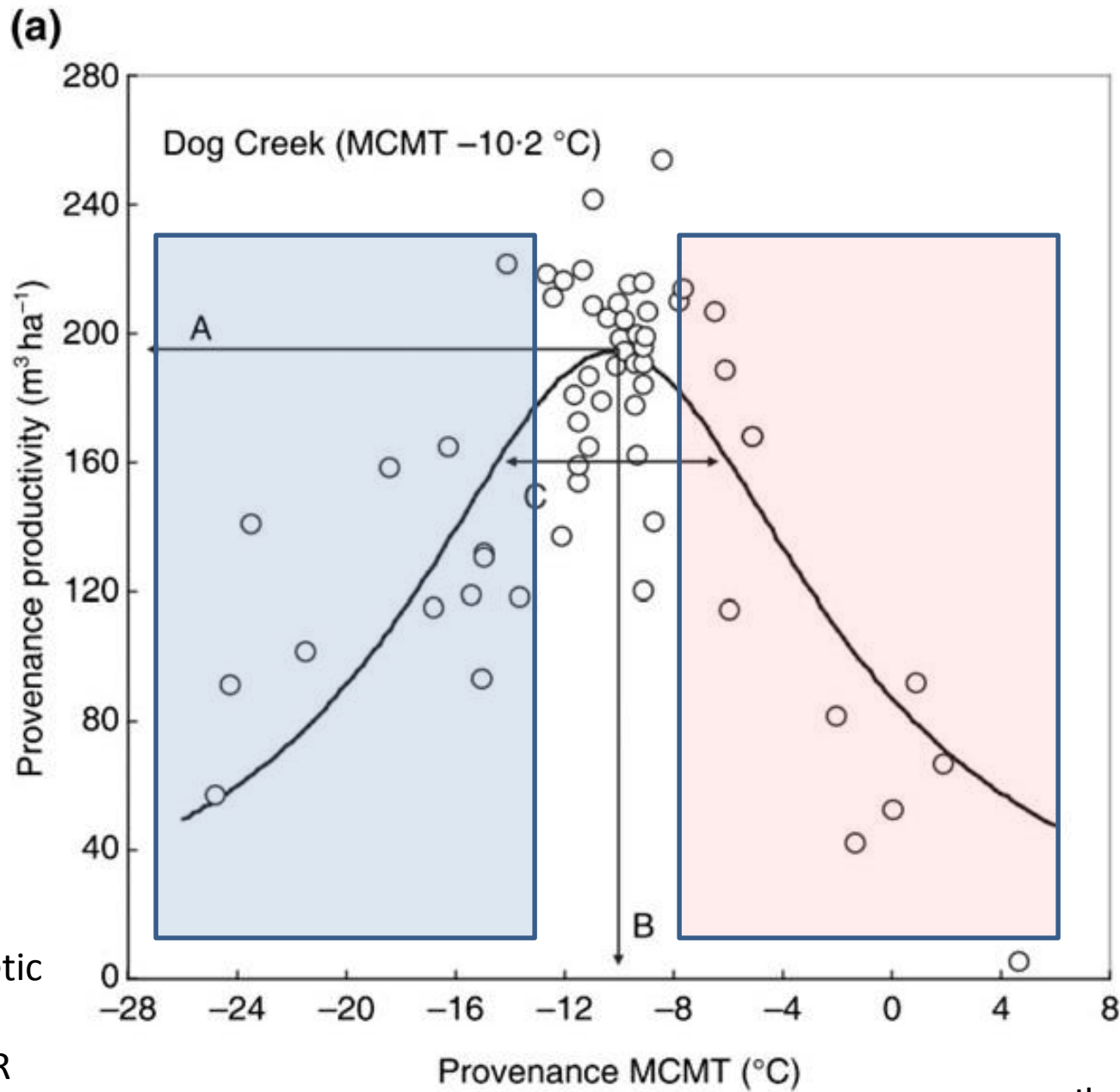
Biodiversity
Stability
Trophic structure
Net primary production
Aboveground carbon pools
Belowground carbon pools
Litter production
Litter quality
Decomposition
Nutrient cycling
Carbon cycling
Soil development
Nitrogen mineralization
Soil nitrification
Soil nitrification
Terrestrial-aquatic linkages



INDIVIDUAL / POPULATION

Specific leaf area
Leaf morphology
Leaf gas exchange
Net photosynthetic rate
Water use efficiency
Phenology
Architecture
Bark thickness
Frost tolerance
Heat tolerance
Drought tolerance
Sink-source relationships
Growth
Survival
Reproduction
Ontogeny of maturation
Induction of defenses
Resistance to pests & pathogens
Phytochemistry



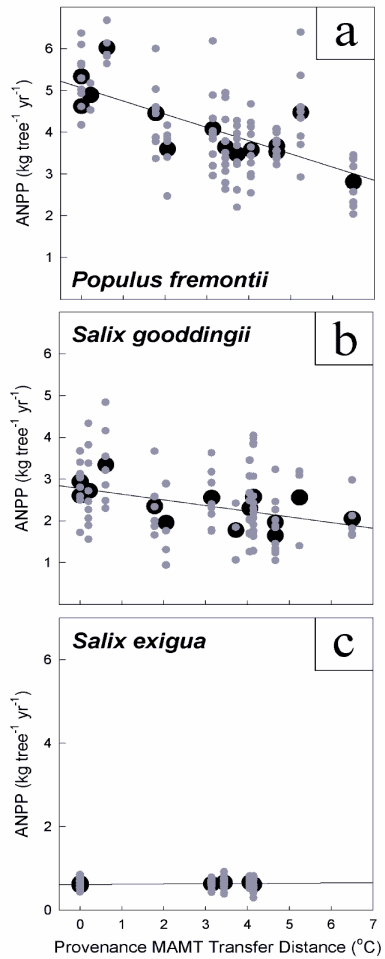


RED:
Traits of
Tomorrow

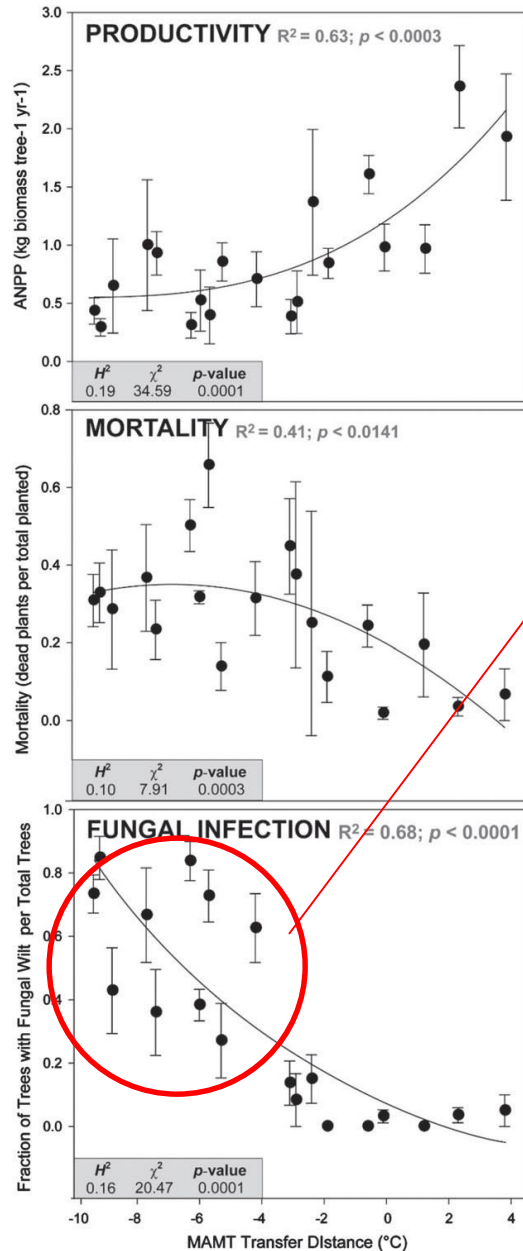
BLUE:
Traits Lost
(local genetic
Extinction)
PLUS THEIR
COMMUNITIES

Ikeda et al. 2014,
J. Functional Eco.

Local adaptation varies among species



Assisted Migration Recommendations

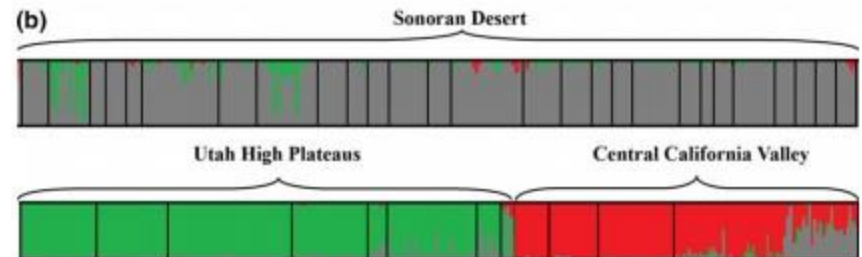
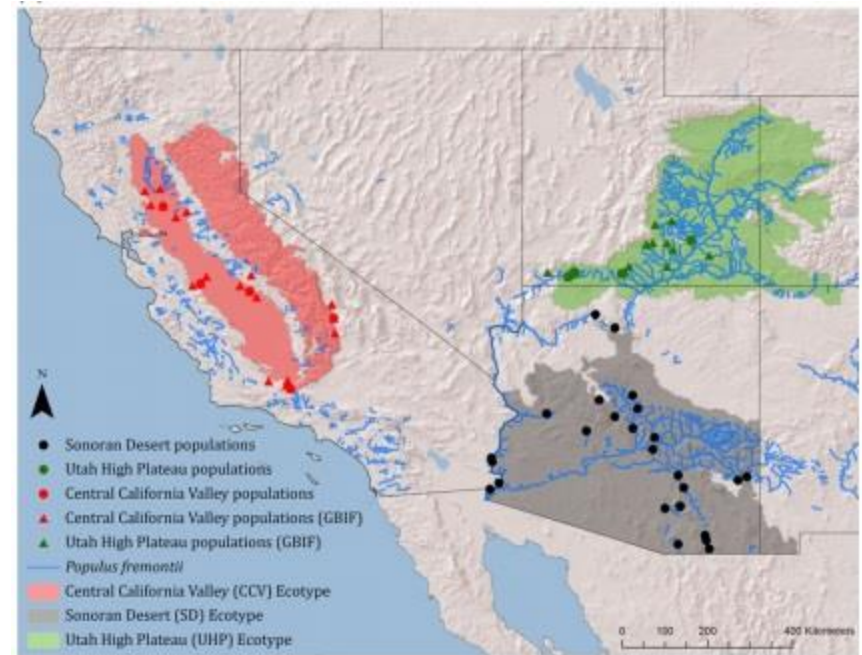


> 3 C transfer

Grady et al. 2015,
Restoration Eco.

Ecoregions defined by genetics AND
COMMUNITIES

Ikeda et al. 2016, GCB



Upcoming Provenance Trials

LOCAL ABIOTIC ADAPTATION

LOCAL BIOTIC ADAPTATION

Asclepias subverticillata

Astragalus lonchocarpus

Brickellia californica

Dieteria canescens

Erigeron divergens

Eriogonum racemosum

Gutierrezia sarothrae

Heterotheca villosa

Linum lewisii

Oenothera pallida

Penstemon strictus

Purshia mexicana

Ratibida columnifera

Sphaeralcea parvifolia

Thelesperma megapotamicum



Provenance Trial Design

**21 Populations Per Species
+ Cultivars**

**Family Line Replication
(9 families – replicated 4 times per site)**

FLAGSTAFF – 7000'

FARMINGTON – 5,500'

RIO MESA – 4,500'

CAMP VERDE – 3,500'

ADDITIONAL DROUGHT
MICROBIAL INOCULATION



Hypothesis Testing

Current Local Maladaptation

Reduced Fitness and Growth

Changes in C Allocation Patterns: Low Defense, Low Floral Rewards

Changes in Communities of Associates Insects (Pollinators, Herbivores, Soil Organisms)

Pollination Limitation (Reduces Fitness)

Future Local Maladaptation

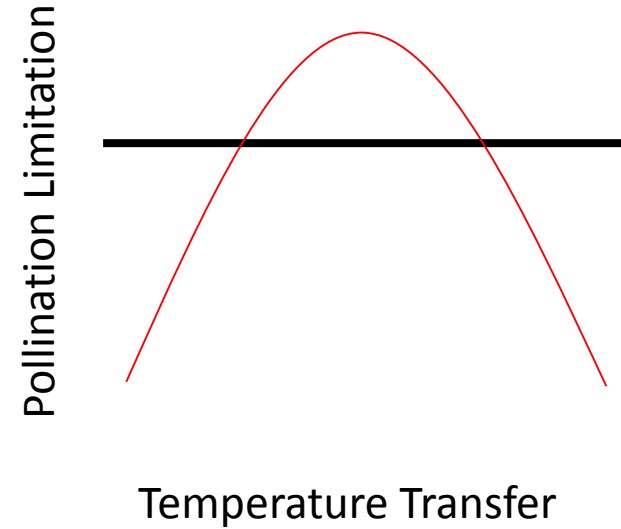
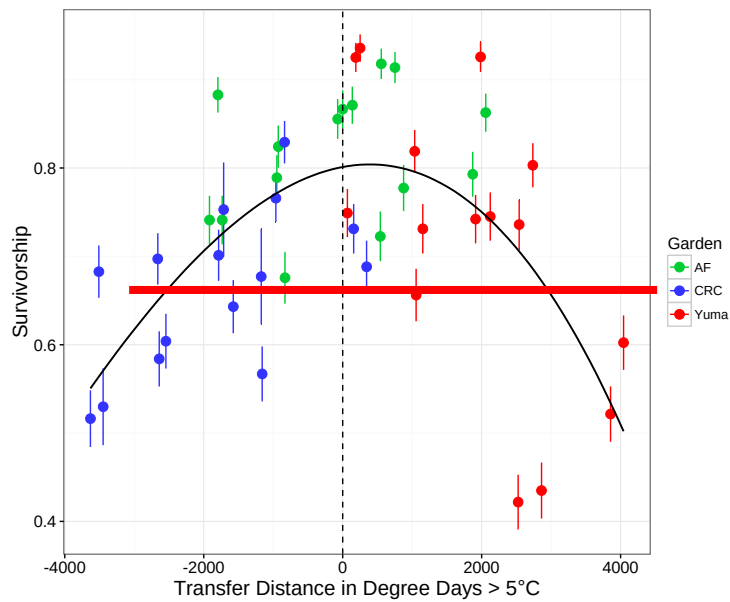
Asynchronous Phenology (PLUS ALL OF THE ABOVE)

Assisted Migration

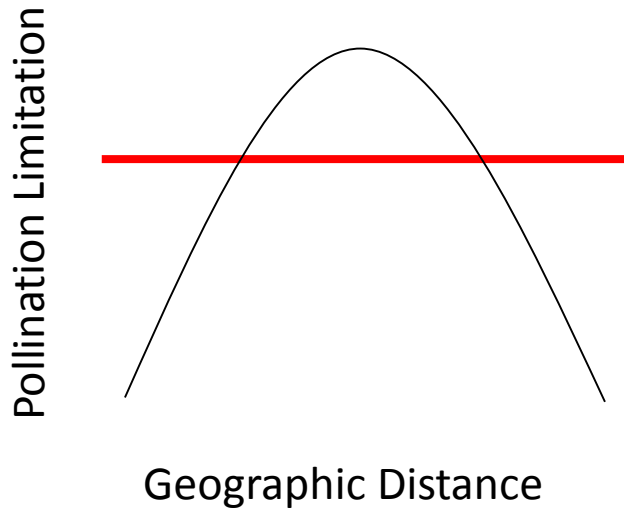
Maintain Fitness

Transfers Too Far Result in: Asynchrony / Local Biotic and Abiotic Maladaptation

ALL THE ABOVE VARY BY PLANT SPECIES



PLANT SPECIES A
 PLANT REQUIRES TRANSFER FOR CC
 POLLINATOR – NO VARIATION BY TEMP
 POLLINATOR – HIGH VAR BY DISTANCE
 = NEED TO TRANSFER FOR PLANTS – BUT
 NOT FAR (distance)



PLANT SPECIES B
 PLANT NO TRANSFER NEEDED
 POLLINATORS IMPACTED BY CC
 POLLINATOR – NO DISTANCE ISSUE
 = TRANSFER NOT NEEDED FOR PLANTS BUT
 NEEDED FOR INSECTS



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