Thank you for signing in early

The webinar will begin promptly at
12:00 pm ET, 9:00 am PT

SERDP
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ESTCP

SERDP and ESTCP Webinar Series

The webinar will begin promptly at 12:00 pm ET, 9:00 am PT

- You have two options for accessing the webinar
  1. Listen to the broadcast audio if your computer is equipped with speakers
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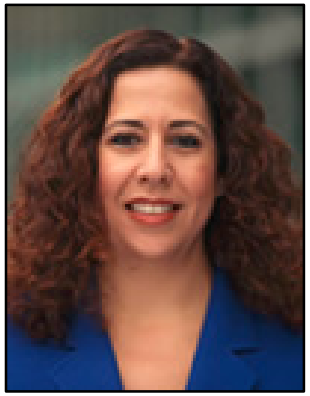
     Required conference ID: 6102000
- For any question or issues, please email serdp-estcp@noblis.org or call 571-372-6565

Award Winning Projects
Resource Conservation and Resiliency

February 23, 2017

Welcome and Introductions

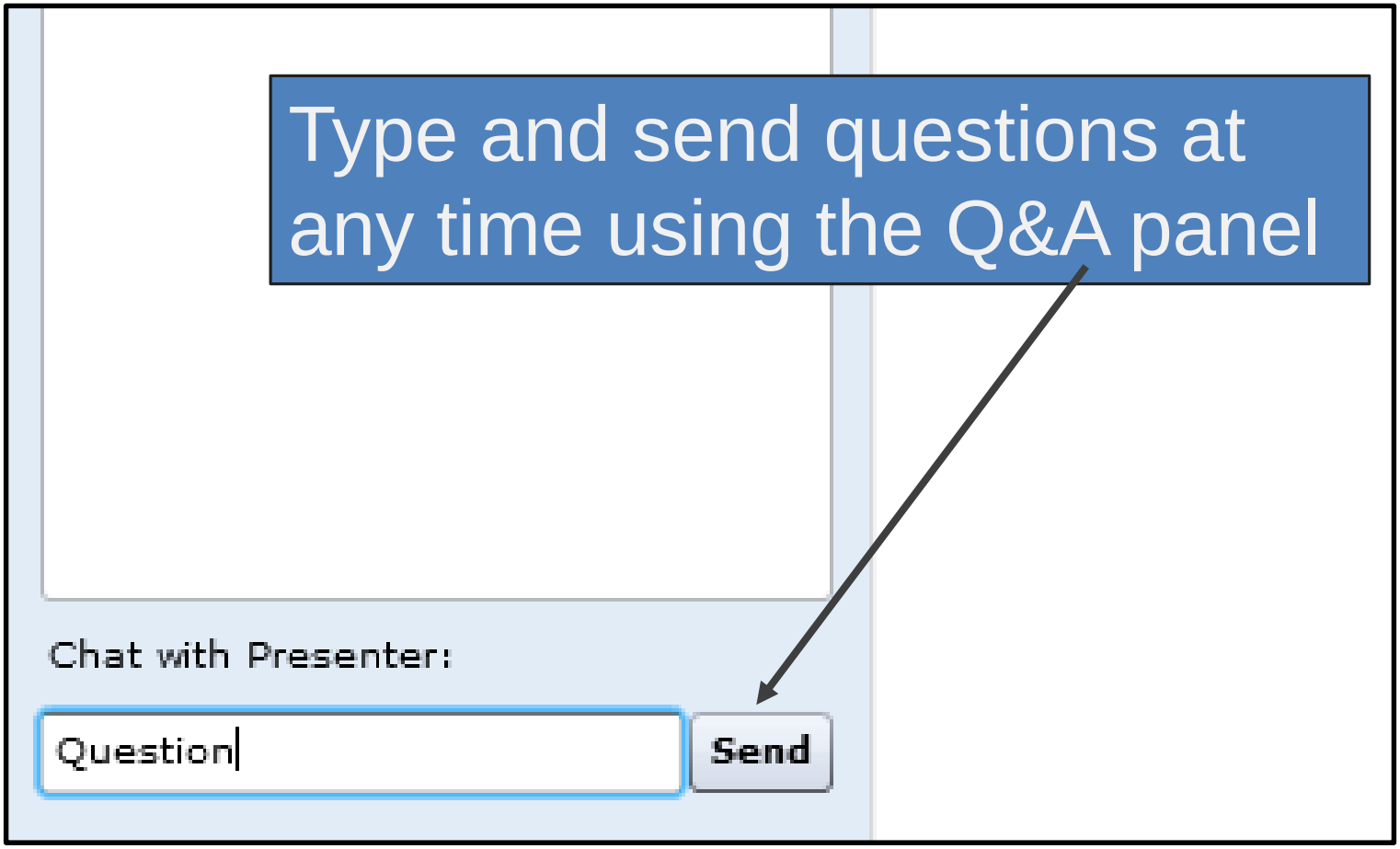


Rula A. Deeb, Ph.D.
Webinar Coordinator

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Rula Deeb, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. Kurt Preston, SERDP and ESTCP
- **Hydroecology of Intermittent and Ephemeral Streams: Will Landscape Connectivity Sustain Aquatic Organisms in a Changing Climate?** (50 minutes + Q&A)
  Dr. Julian Olden, University of Washington
- **Final Q&A session**

How to Ask Questions



In Case of Technical Difficulties

- Delays in the broadcast audio
  - Click the mute/connect button
  - Wait 3-5 seconds
  - Click the mute/connect button again
  - If delays continue, call into the conference line
    - Call into the conference line: 303-248-0285
    - Required conference ID: 6102000
- Submit a question using the chat box

SERDP and ESTCP Overview

Kurt Preston, Ph.D.
Resource Conservation and Resiliency Program Manager

SERDP DOD • EPA • DOE | ESTCP

SERDP

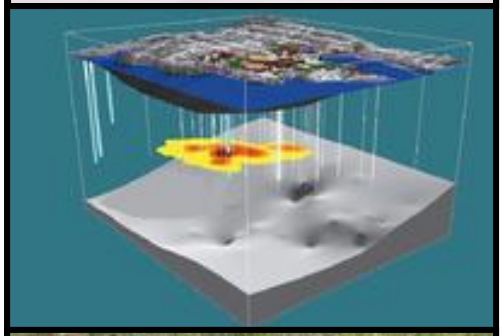
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

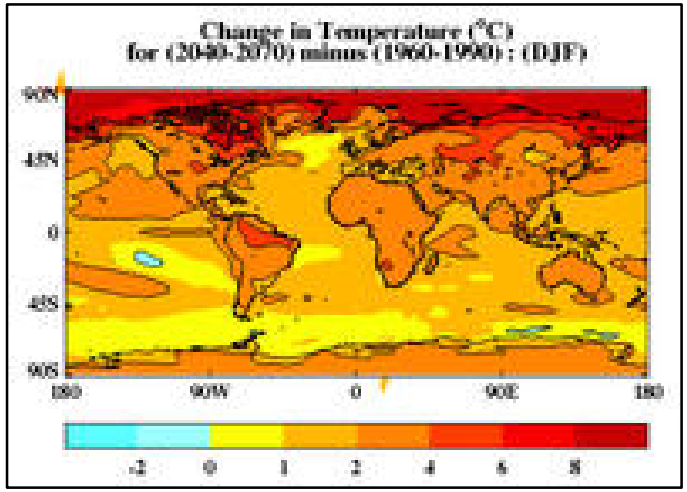
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms



Resource Conservation and Resiliency

- Natural resources
  - Ecological forestry
  - Arid lands ecology and management
  - Cold regions ecology and management
  - Pacific island ecology and management
  - Coastal and estuarine ecology and management
  - Living marine resources ecology and management
  - Species ecology and management
  - Watershed processes and management
- Climate change
  - Vulnerability and impact assessment
  - Adaptation science
  - Land use and carbon management
- Air quality
  - Fugitive dust
  - Fire emissions



SERDP and ESTCP Webinar Series

Date	Topic
March 9, 2017	**Award Winning Projects** Environmental Restoration
March 23, 2017	Monitoring and Risk Assessment of Environmental Risks Posed by Munitions Constituents in Aquatic Systems
April 6, 2017	1,4-Dioxane Impacts and Innovative Cleanup Technologies at DoD Contaminated Sites
April 20, 2017	Solutions for Installations' Participation in Energy Markets
May 4, 2017	Novel Coatings Systems for Use as High Performance Chemical Resistant Power Topcoats

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

SERDP DOD • EPA • DOE | ESTCP

SERDP • ESTCP SYMPOSIUM

2017 | Enhancing DoD's Mission Effectiveness

A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

- November 28 - November 30, 2017
- Washington Hilton Hotel
  1919 Connecticut Avenue, NW
  Washington, DC 20009

Registration information available soon

Hydroecology of Intermittent and Ephemeral Streams: Will Landscape Connectivity Sustain Aquatic Organisms in a Changing Climate?

Julian D. Olden, Ph.D.
University of Washington

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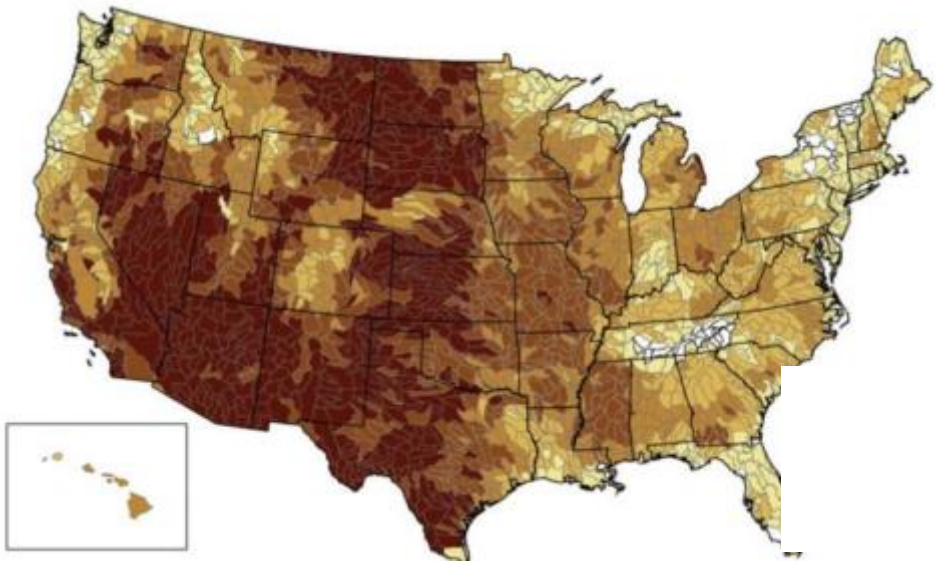
Agenda

- Explore patterns of hydrology and habitat connectivity in dryland streams
- Examine the landscape genetics of amphibian and insect species with contrasting life-history requirements
- Investigate whether species traits provide a currency for multispecies inference in ecology
- Illustrate the challenges and opportunities for aquatic habitat management to conserve amphibians in a changing climate

Motivation

- Enhance our understanding of how intermittent and ephemeral streams in the southwestern United States provide critical habitat and population connectivity for aquatic species, and explore whether these ecological functions will be maintained in a changing climate



Nadeau & Rains (2007)

% Intermittent streams

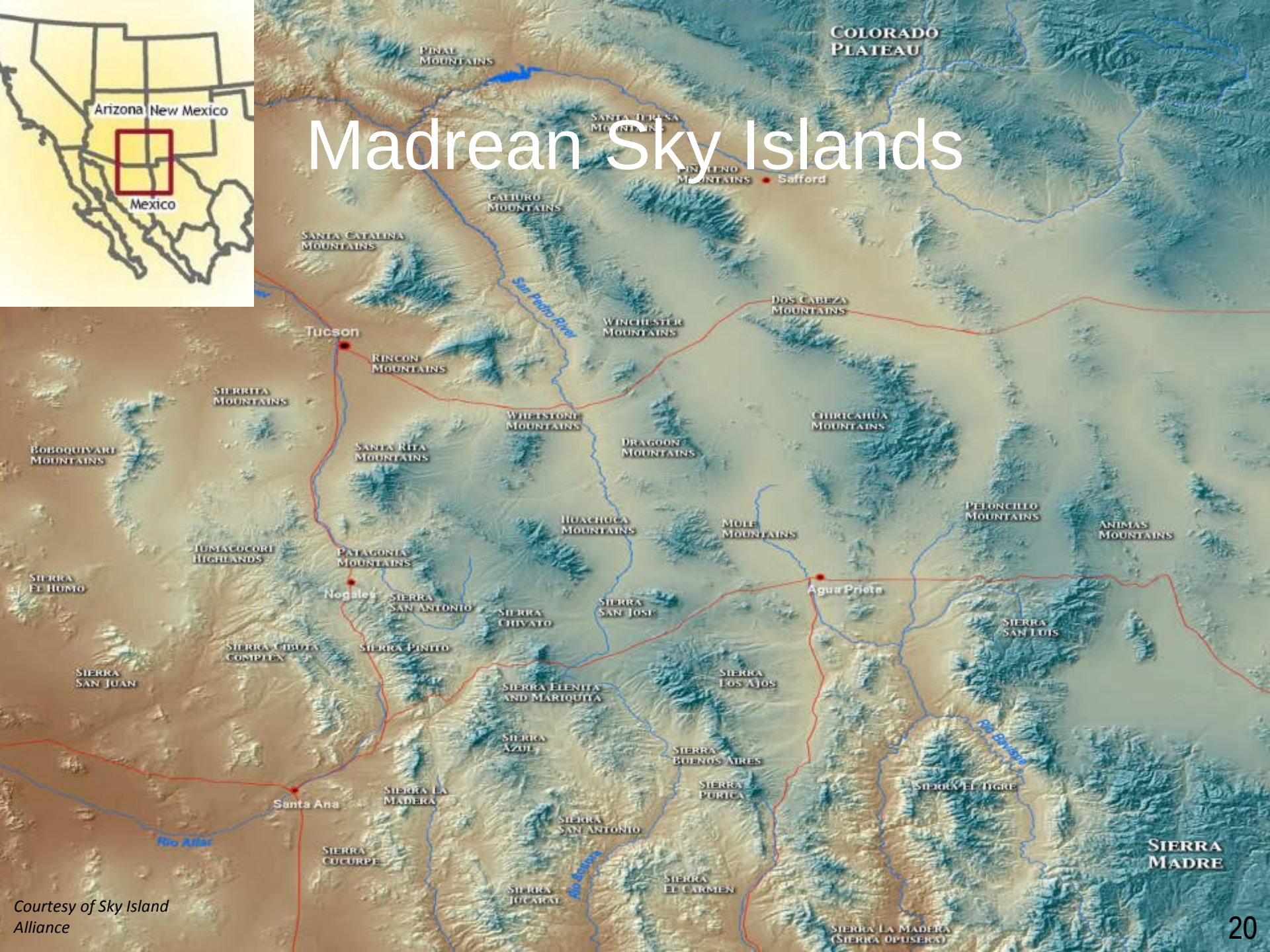
0 50 100

When the River Runs Dry

- Stream drying occurs at multiple spatiotemporal scales
- The prevalence of dryland rivers may increase in response to altered land-use, greater human water use, and climate change
- Stream drying causes the loss of longitudinal connectivity for aquatic biota

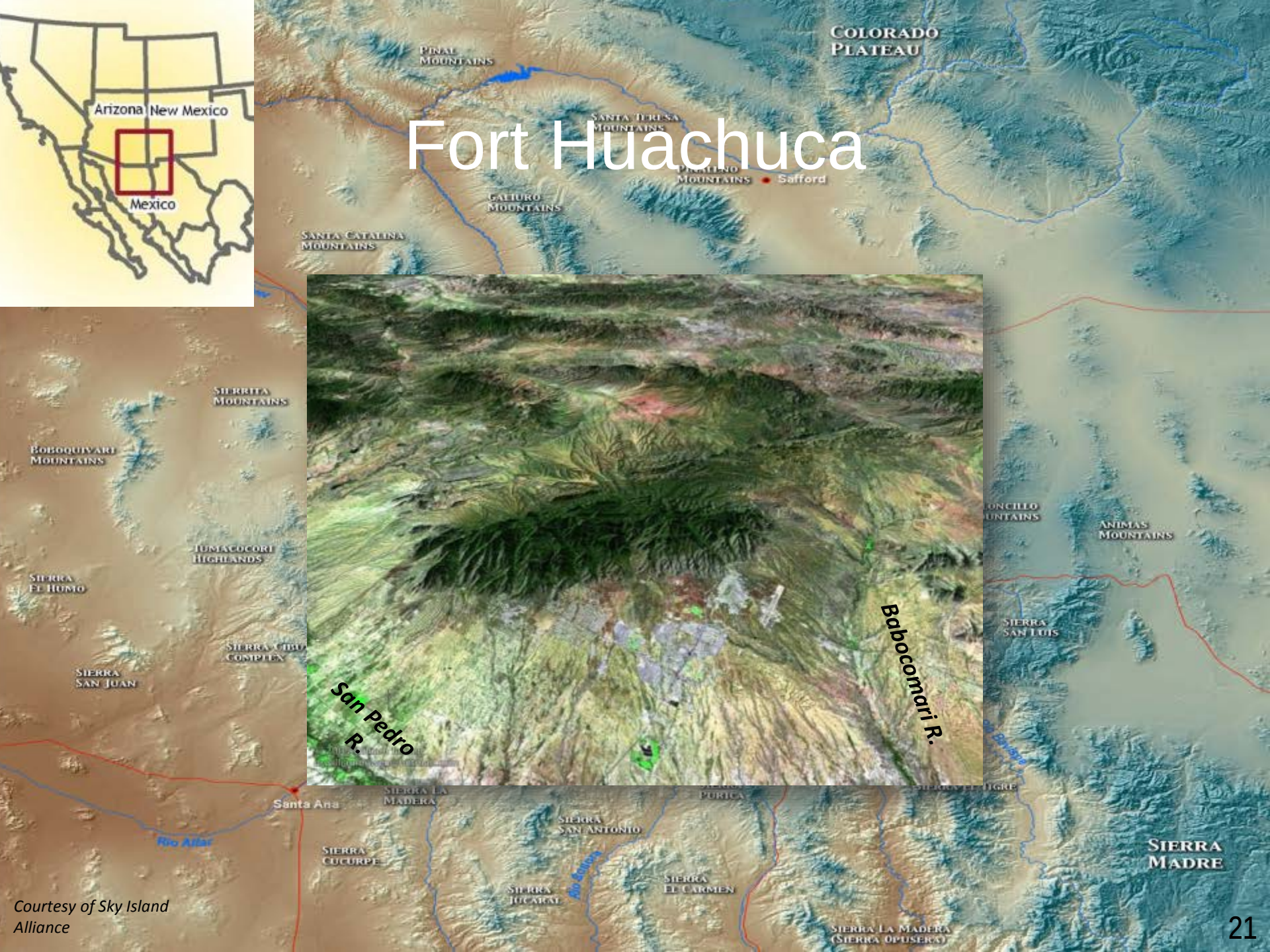
Brown Canyon, Huachuca Mts, AZ

Madrean Sky Islands



Courtesy of Sky Island Alliance

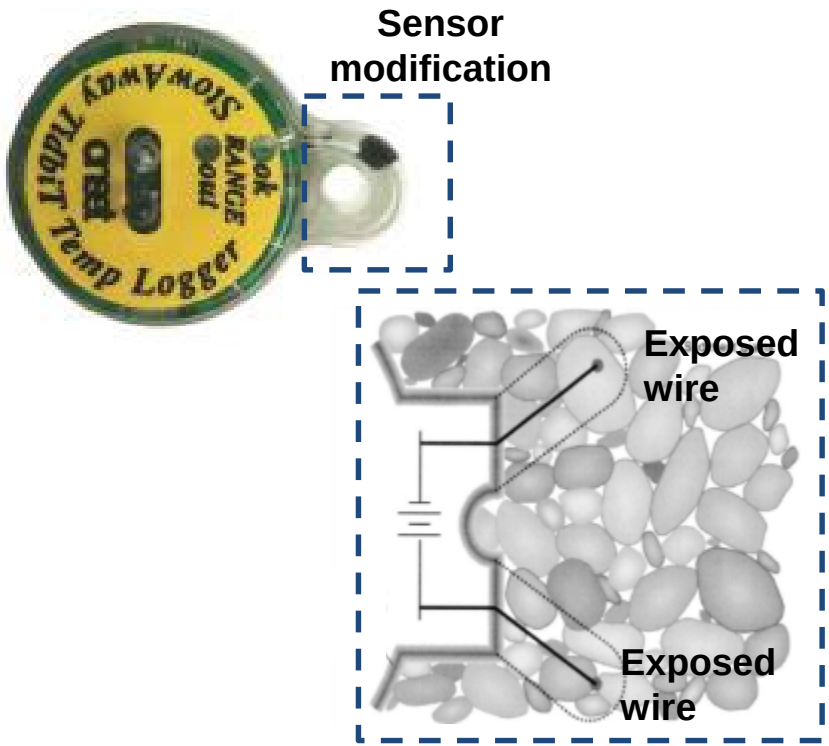
Fort Huachuca

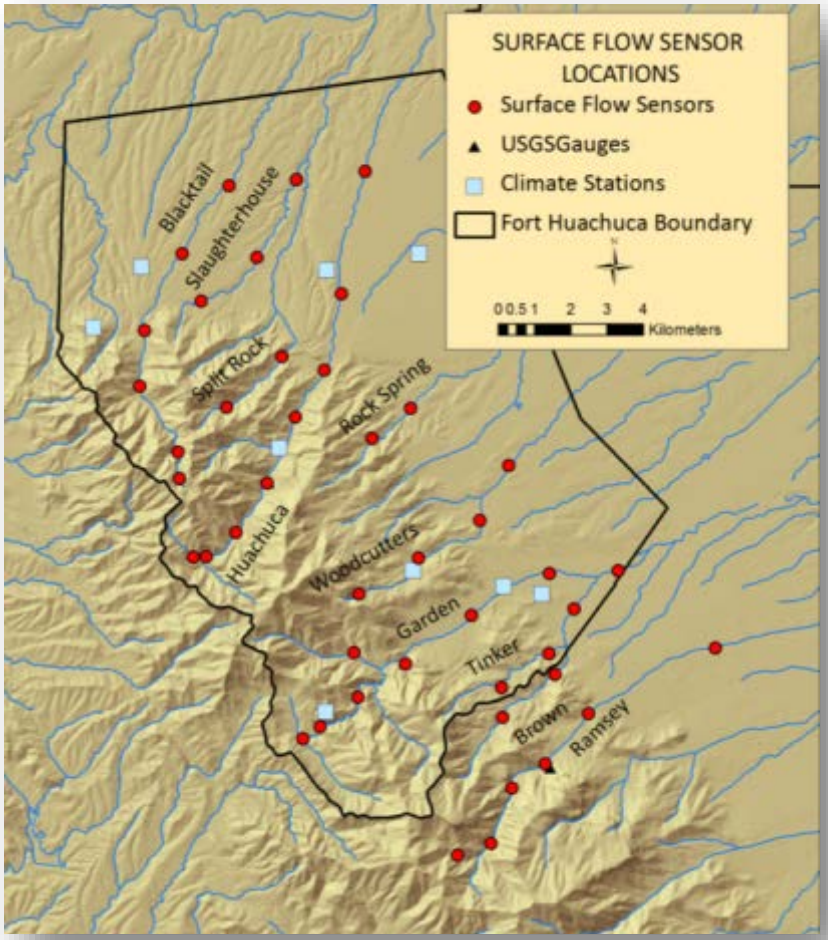


Courtesy of Sky Island Alliance

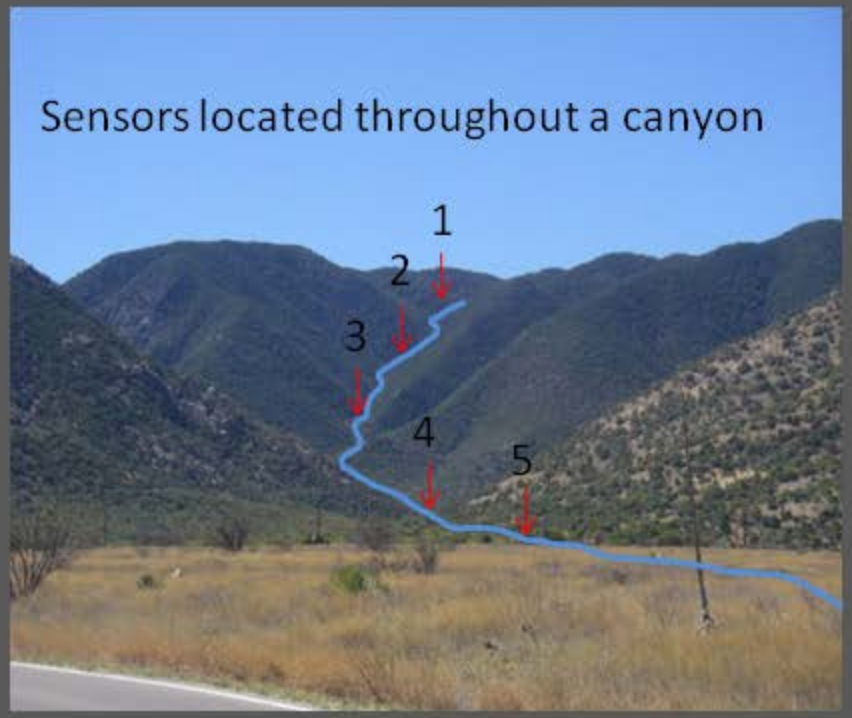
Huachuca Mountains

Riverscape Monitoring Efforts to Track Flow Intermittence





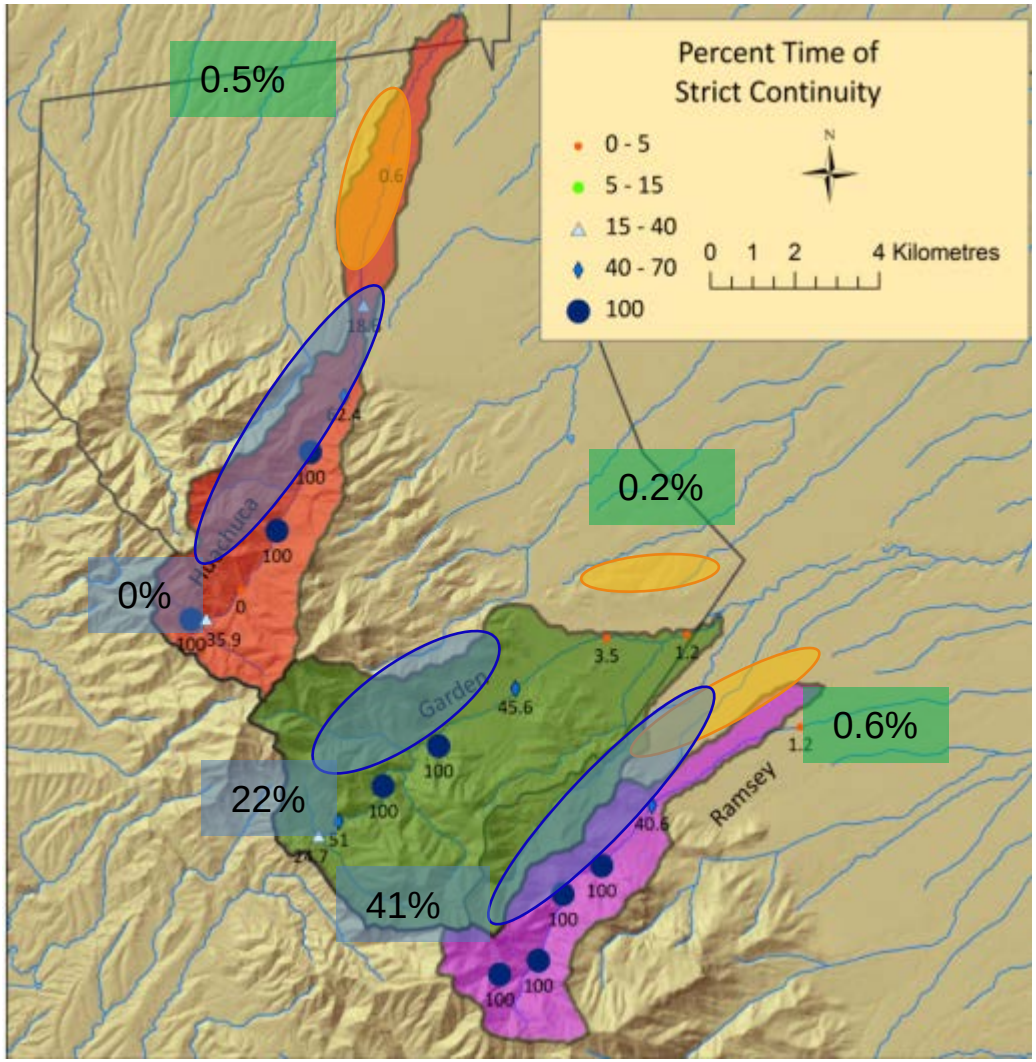
Jaeger, KL. and J.D. Olden. 2012. Electrical resistance sensor arrays as a means to quantify longitudinal connectivity of rivers. *River Research and Applications* 28: 1843-1852.



Housing leashed to adjacent tree

Continuity of Flow

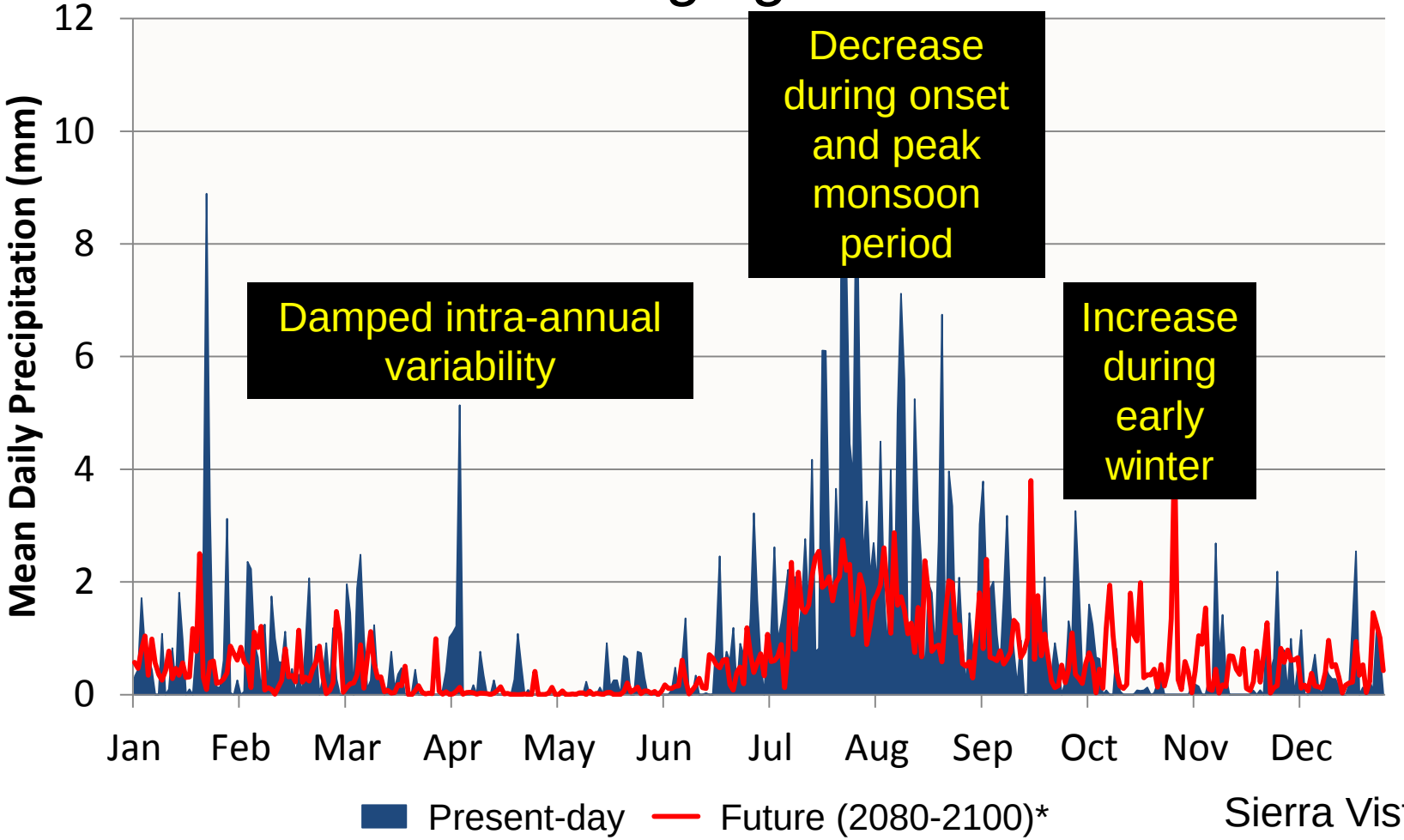
- Continuity of flow over time varied from perennial (100%) to intermittent (5-70%) to ephemeral (<5%)
- The mountain front was moderately connected
- Alluvial plain showed little longitudinal connectivity



Jaeger and Olden (2012, River Research and Applications)

Dryland Streams

Face Changing Climates

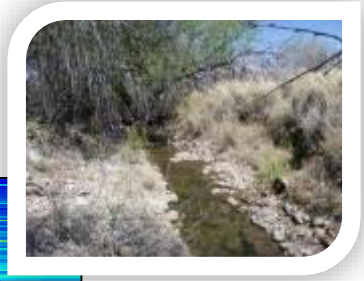


Sierra Vista, AZ

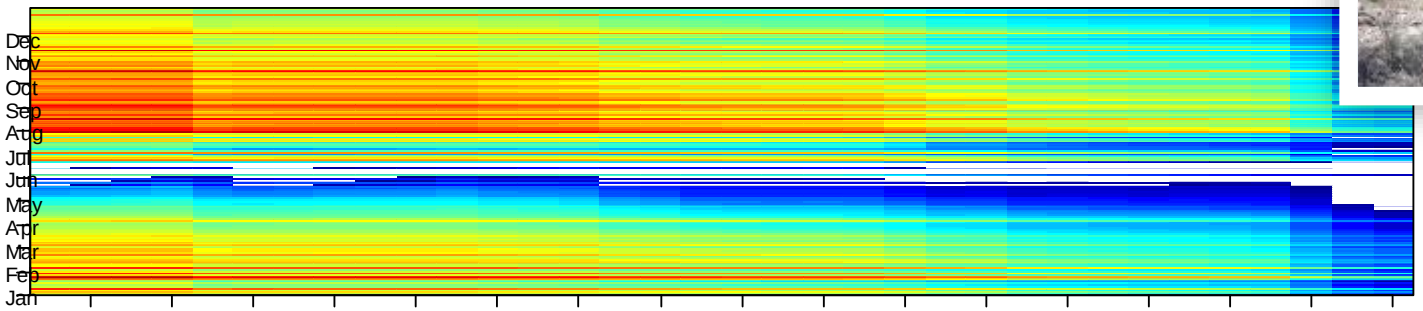
* GFDL CM2.1 GCM, A2 greenhouse-gas emissions scenario, spatially downscaled daily time-step

Dryland Streams

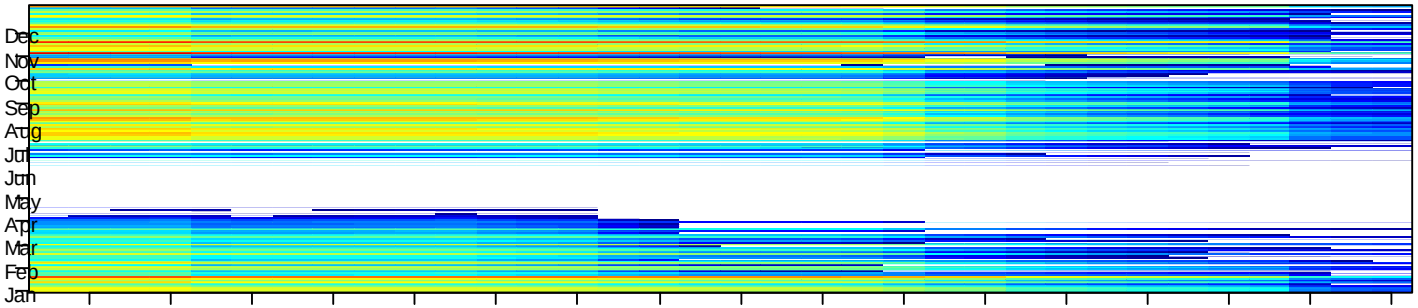
Will Become More Intermittent and Fragmented



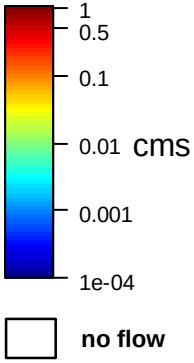
Present Day, Garden Canyon



Projected Future (2080-2100)



Mean daily flow



Upstream ***Downstream***

Species Exhibit Life-History and Dispersal Characteristics that are Adapted to Water Permanence

Abedus herberti
(giant water bug)

Mesocapnia arizonensis
(stonefly)

Boreonectes aequinoctialis
(diving beetle)

Hyla arenicolor
(canyon treefrog)

Anaxyrus punctatus
(red-spotted toad)

Spea multiplicata
(Mexican spadefoot)

perennial

intermittent

ephemeral

Species Exhibit Life-History and Dispersal Characteristics that are Adapted to Water Permanence

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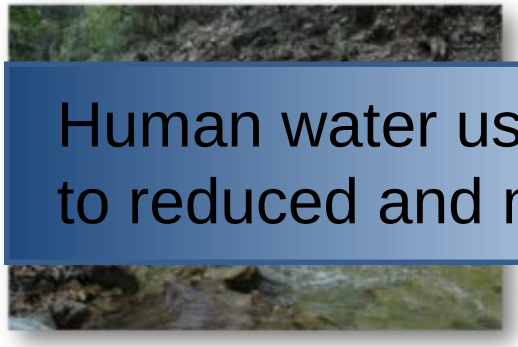


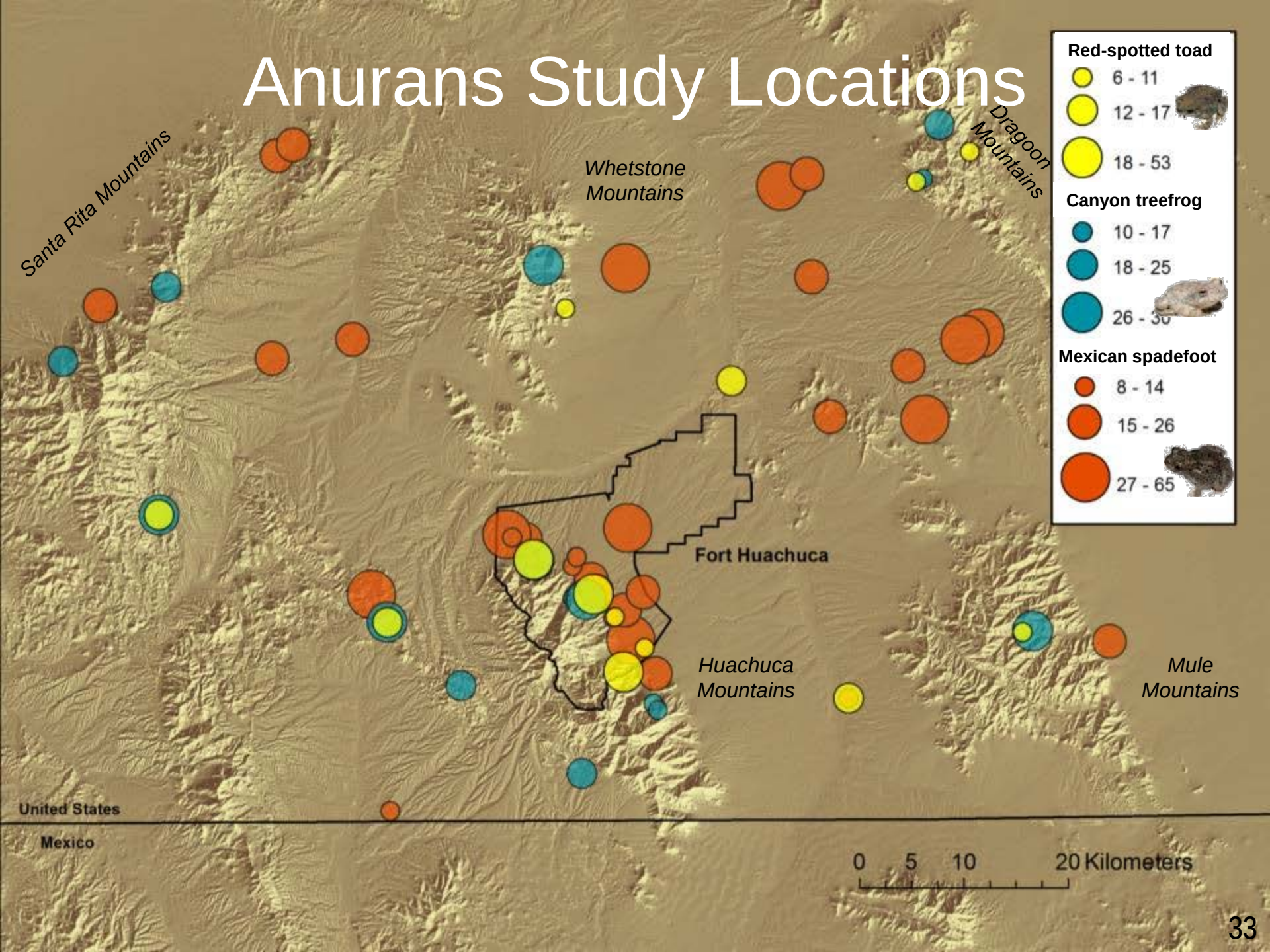
Human water use and further climate change will lead to reduced and more fragmented aquatic habitats

perennial

intermittent

ephemeral

Anurans Study Locations



Predictions

Canyon treefrog

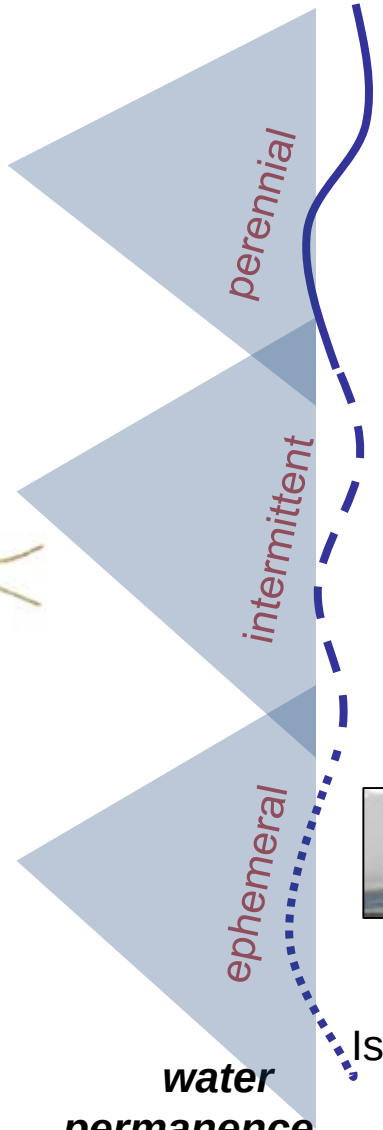
Abedus

Red-spotted toad

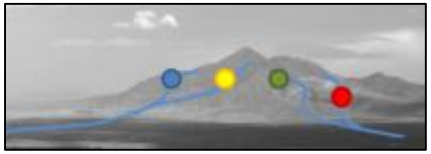
Mesocapnia

Boreonectes

Mexican spadefoot

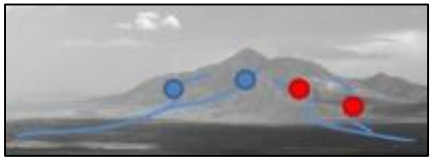


Distinct groups



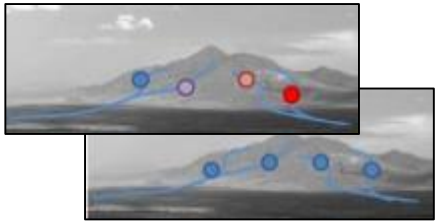
Significant barriers to migration result in genetically distinct populations

Dendritic (river) networks



Higher connectivity along networks (rivers and streams)

Panmixia



No significant barriers to movement detectable

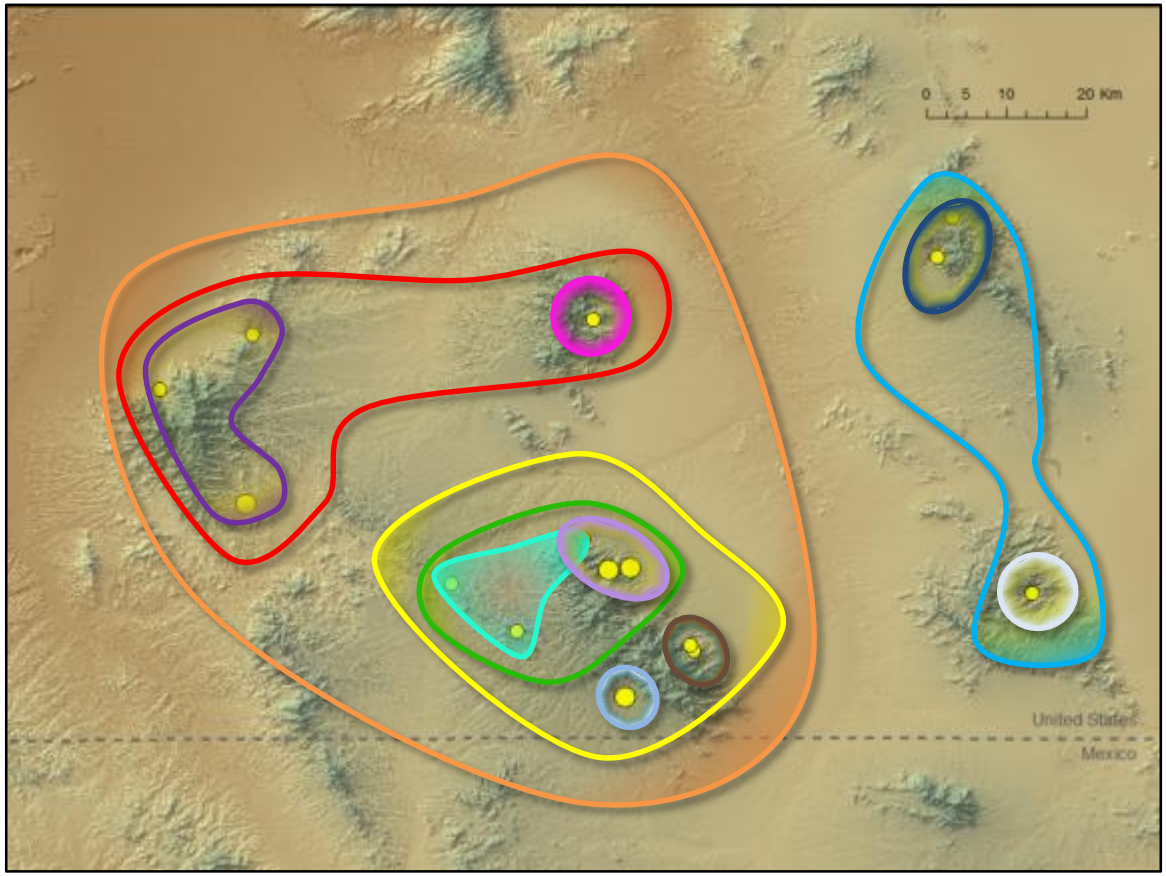
Isolation-by-distance

Genetic differentiation increases with geographic distance

Canyon Treefrog

Canyon Treefrog

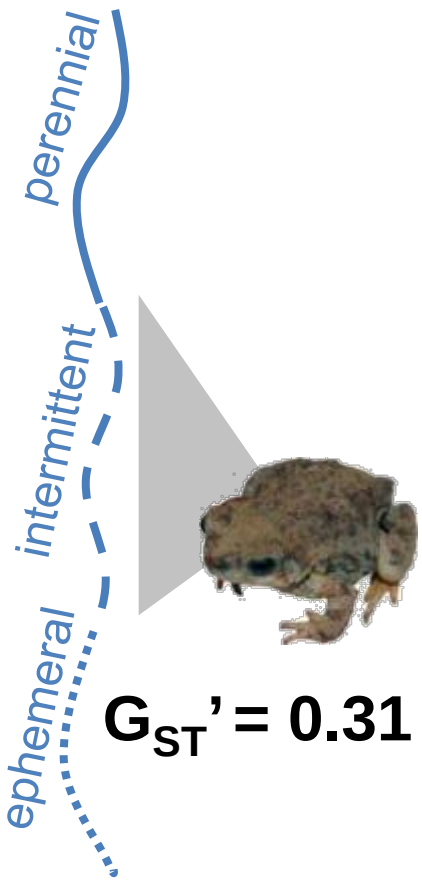
$G_{ST}' = 0.57$



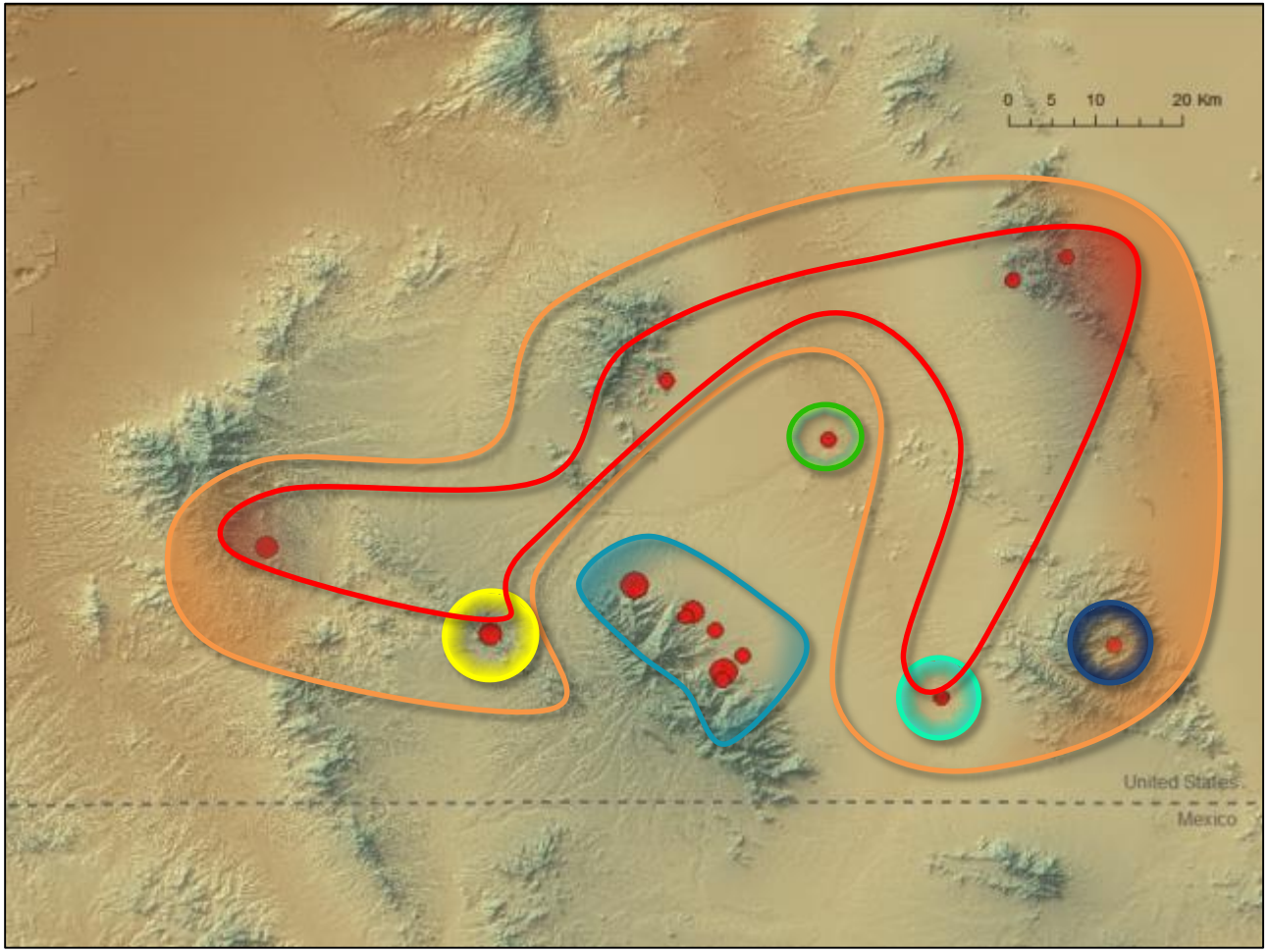
Mims, M.C., Phillipsen, I., Kirk, E., Lytle, D.A. and J.D. Olden. 2015. Ecological strategies predict associations between aquatic and genetic connectivity for dryland amphibians. *Ecology 96: 1371-1382.*

Red-Spotted Toad

Red-Spotted Toad

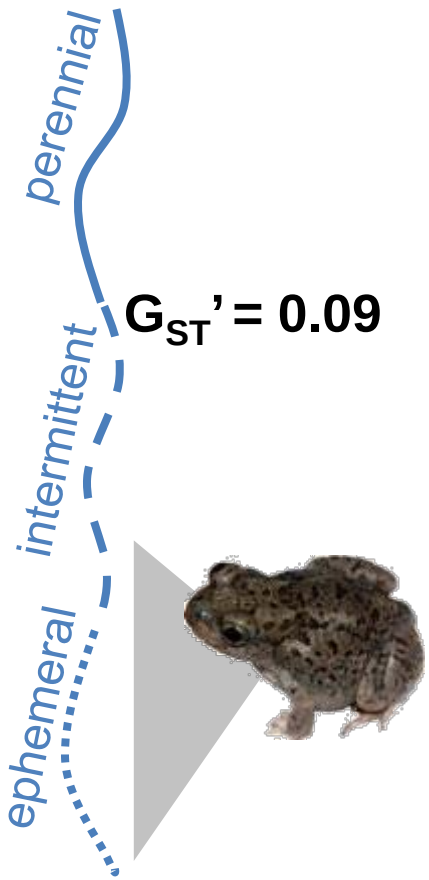


$G_{ST}' = 0.31$

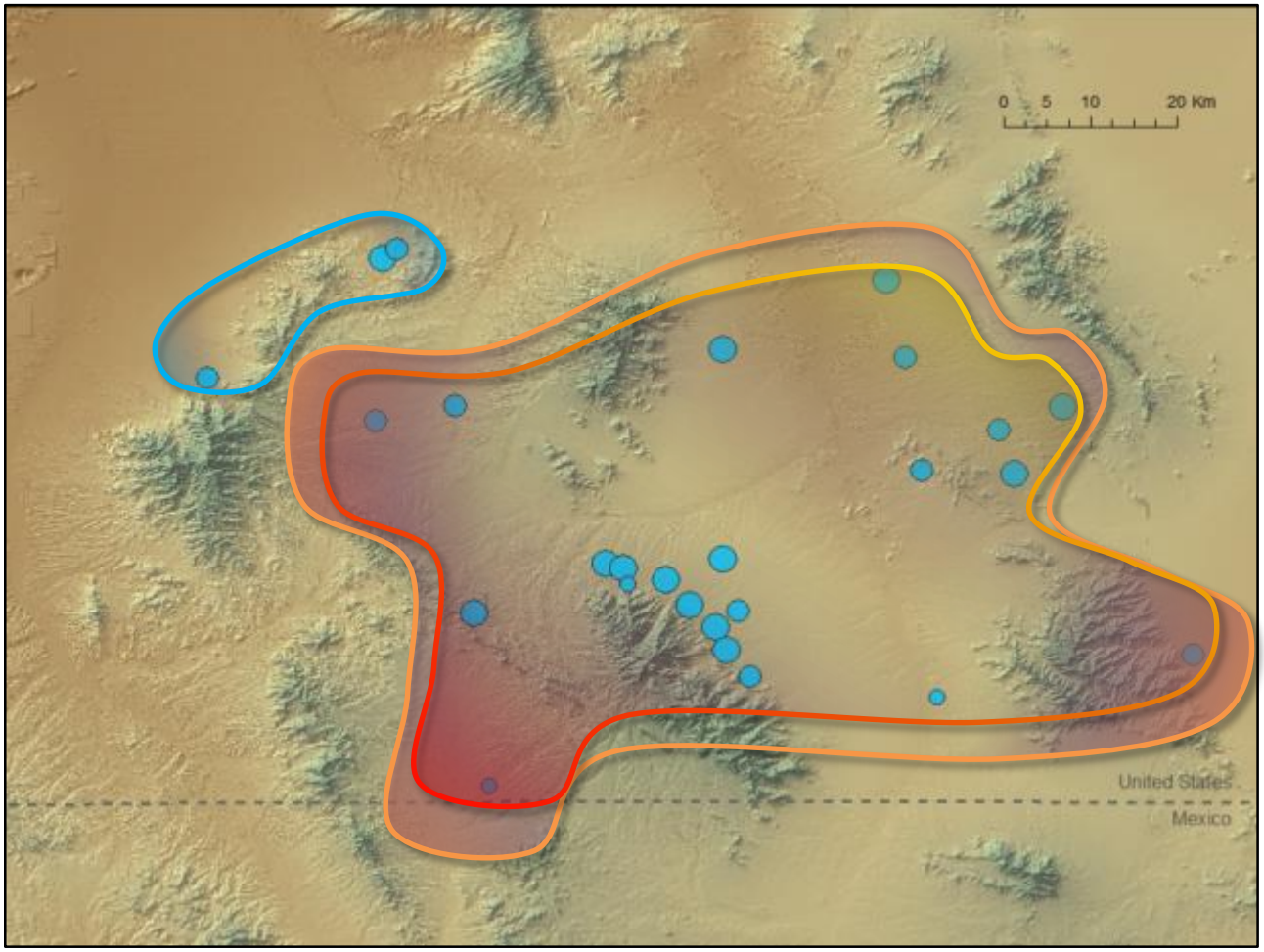


Mexican Spadefoot

Mexican Spadefoot



$G_{ST}' = 0.09$



Predictions, Revisited

Canyon treefrog

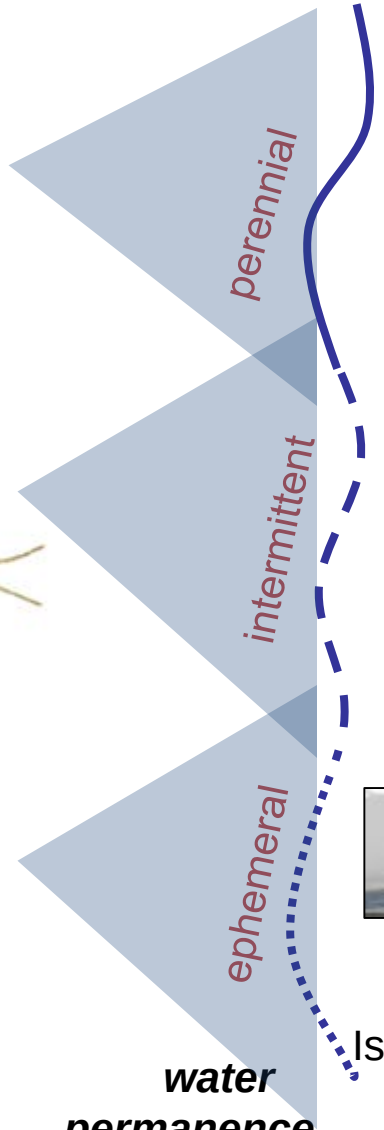
Abedus

Red-spotted toad

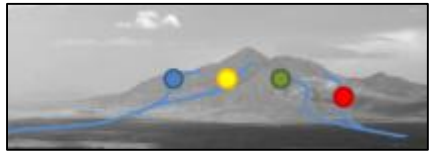
Mesocapnia

Boreonectes

Mexican spadefoot



Distinct groups



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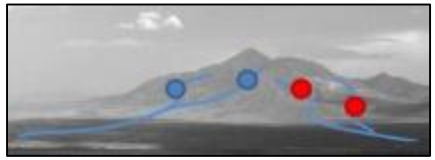
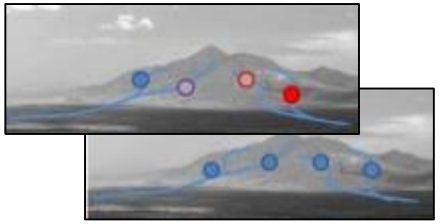
Dendritic (river) networks



Higher connectivity along networks (rivers and streams)

Panmixia



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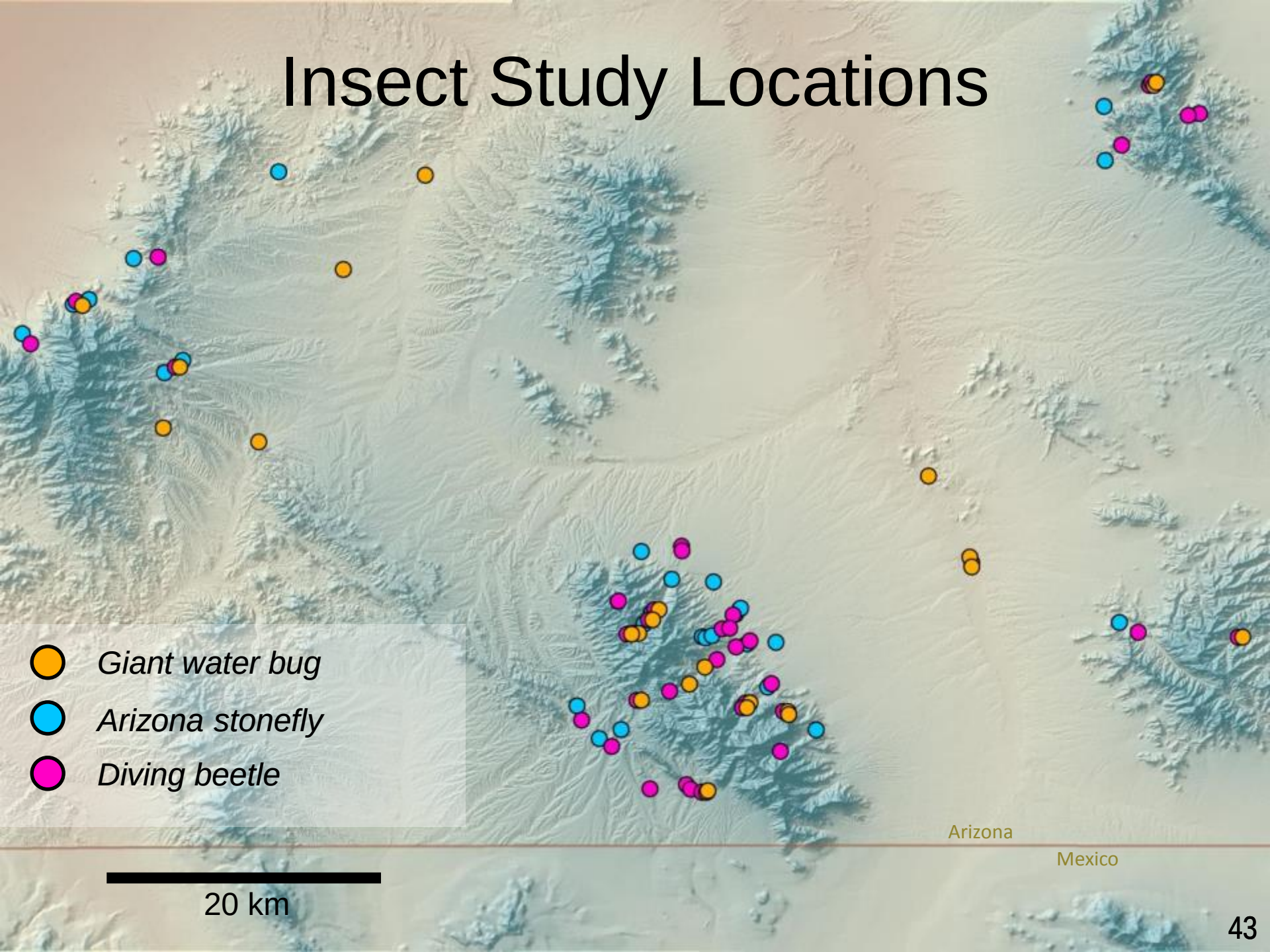
Insect Study Locations

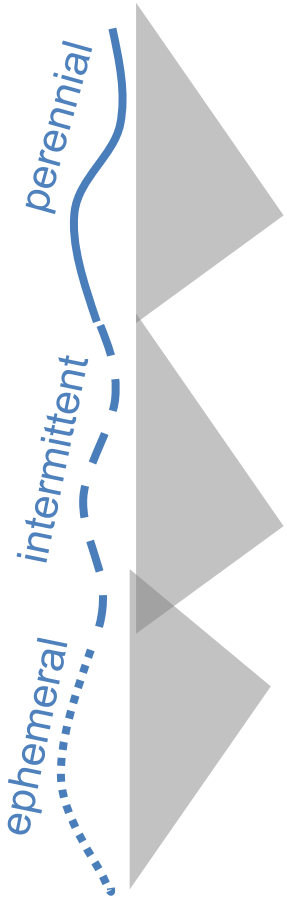


The Giant Water Bug (*Abedus herberti*)

Arizona Stonefly (*Mesocapnia arizonensis*)

Diving beetle
(*Boreonectes aequinoctialis*)

Water Dependency is a Key Trait Defining Population Structure in Dryland Environments



Abedus

$G_{ST}' = 0.36$

Canyon treefrog

$G_{ST}' = 0.57$

Mesocapnia

$G_{ST}' = 0.35$

Red-spotted toad

$G_{ST}' = 0.31$

Boreonectes

$G_{ST}' = 0.01$

Mexican spadefoot

$G_{ST}' = 0.09$

Phillipsen, I., Kirk, E., Bogan, M.T., Mims, M.C., Olden, J.D., and D.A. Lytle. 2015. *Molecular Ecology* 24: 54-69

What Factors Influence the Connectedness of Populations?

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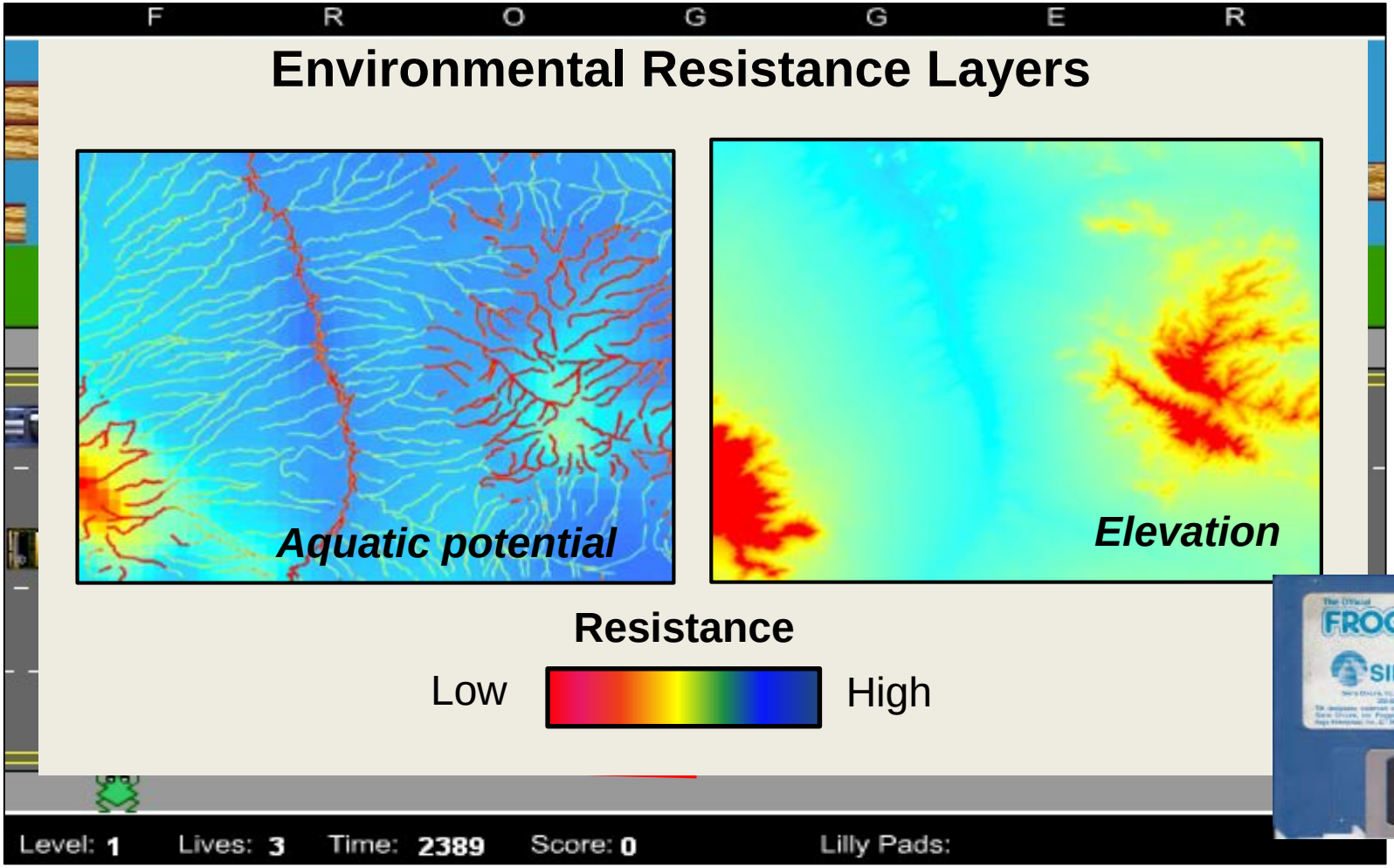
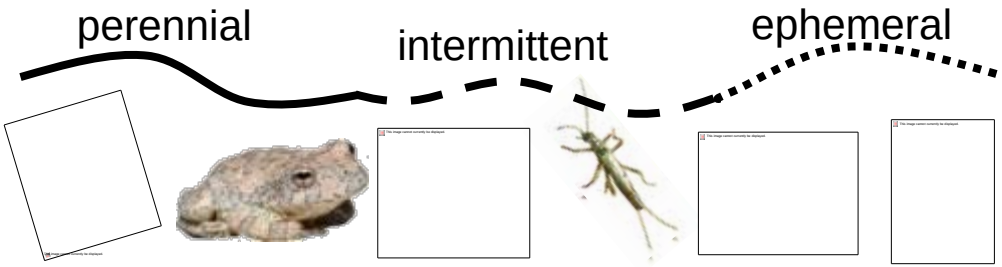
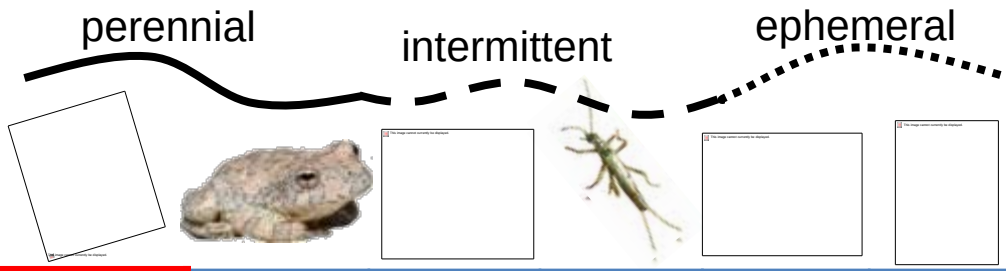


What Factors Influence the Connectedness of Populations?



Model	Landscape drivers						
Isolated populations	None: local processes	X	X				
Terrestrial	Land cover, canopy cover	X	X				
Aquatic	Rivers, ponds, precipitation	X	X	X	X		
Topography	Slope			X	X	X	X
Isolation-by-distance	Distance				X	X	X
Panmixia	None: very high connectivity					X	X

What Factors Influence the Connectedness of Populations?



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Aquatic	Rivers, ponds, precipitation	X	X	X	X		
Topography	Slope			X	X	X	X
Isolation-by-distance	Distance				X	X	X
Panmixia	None: very high connectivity					X	X

Management and Conservation Implications

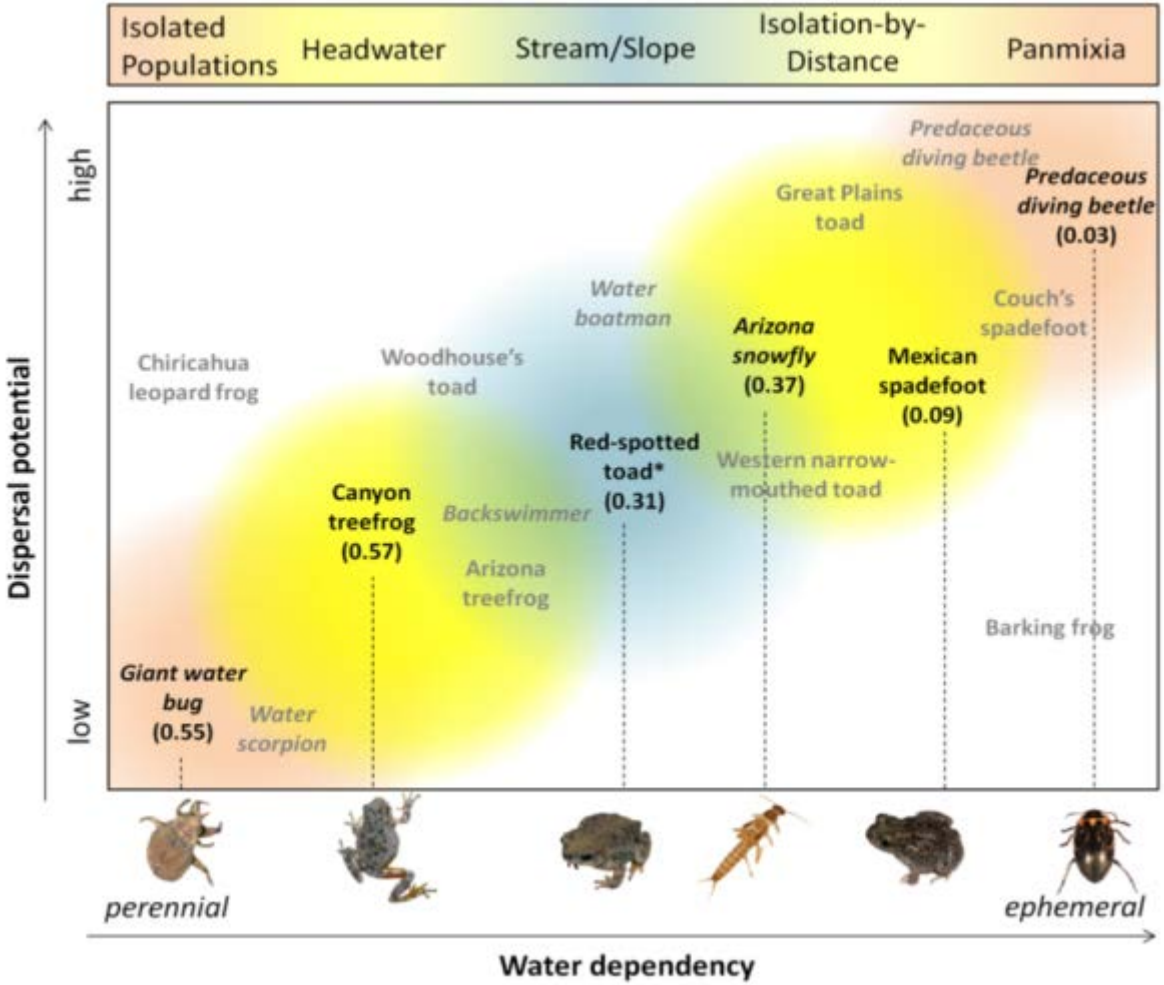
- Evidence that life-history strategies (water dependency, dispersal) predict both population structure and landscape drivers of genetic connectivity
- Transitions from perennial to intermittent habitats will result in local extinctions of aquatic specialists (i.e., canyon tree frog, giant water bug)
- Increased intermittent habitat might be beneficial for some species (red-spotted toad, AZ stonefly), allowing populations to expand into new areas. However, increasing ephemeral habitats may limit genetic flow

Management and Conservation Implications

- Traits-based inference may help inform conservation efforts where single-species genetic studies are not possible

Management and Conservation Implications

- Identify and prioritize populations, minimize local threats
- Implement meta-population management, identify source populations, maintain and restore corridors
- Manage for population structure and genetic diversity at regional scales



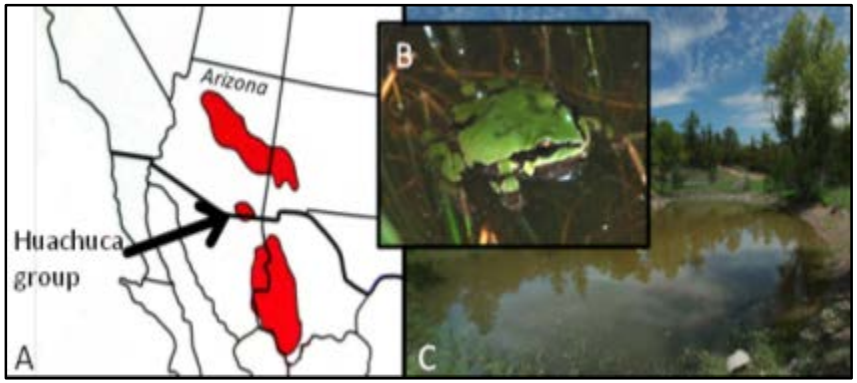
Mims, M.C., Hartfield Kirk, E., Lytle, D.A. and J.D. Olden. In review. *Conservation Genetics.*

Q&A Session 1

SERDP DOD • EPA • DOE | ESTCP

Conservation of a Distinct Population Segment of the Arizona Treefrog

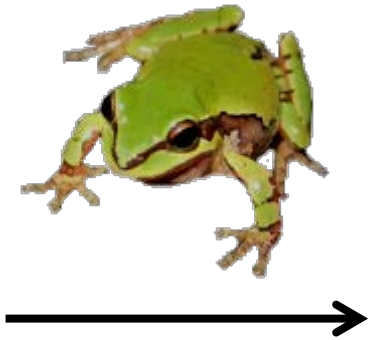
- The Huachuca group is of special conservation concern
- Landscape genetics indicates that the group operates as a metapopulation of connected habitat patches



Mims, M.C., Hauser, L., Goldberg, C.S. and J.D. Olden. 2016. *PLoS One* 11(8): e0160655

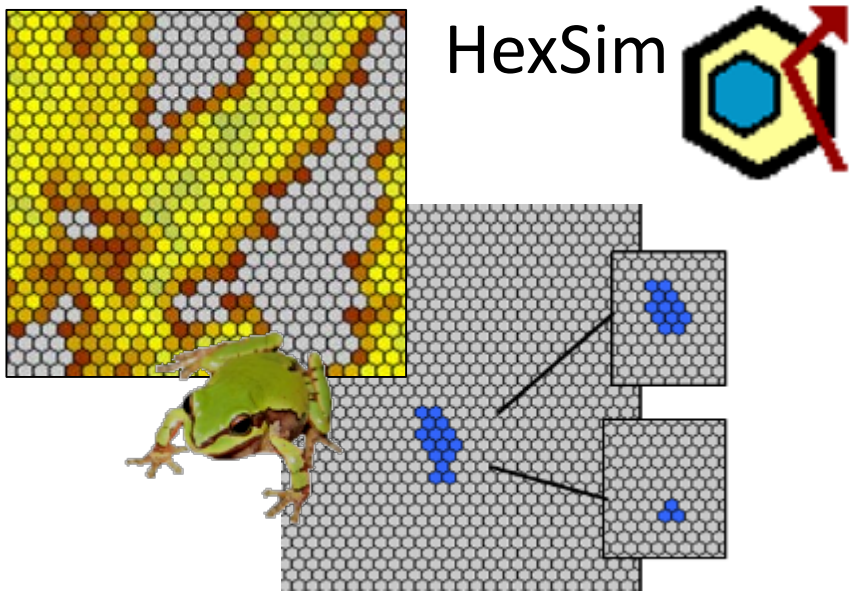
What are the Implications of Aquatic Habitat Loss for Arizona Treefrog?

- Evaluate the response of Arizona treefrog to human-induced reductions in breeding habitat and recruitment success using individual-based modeling and simulations

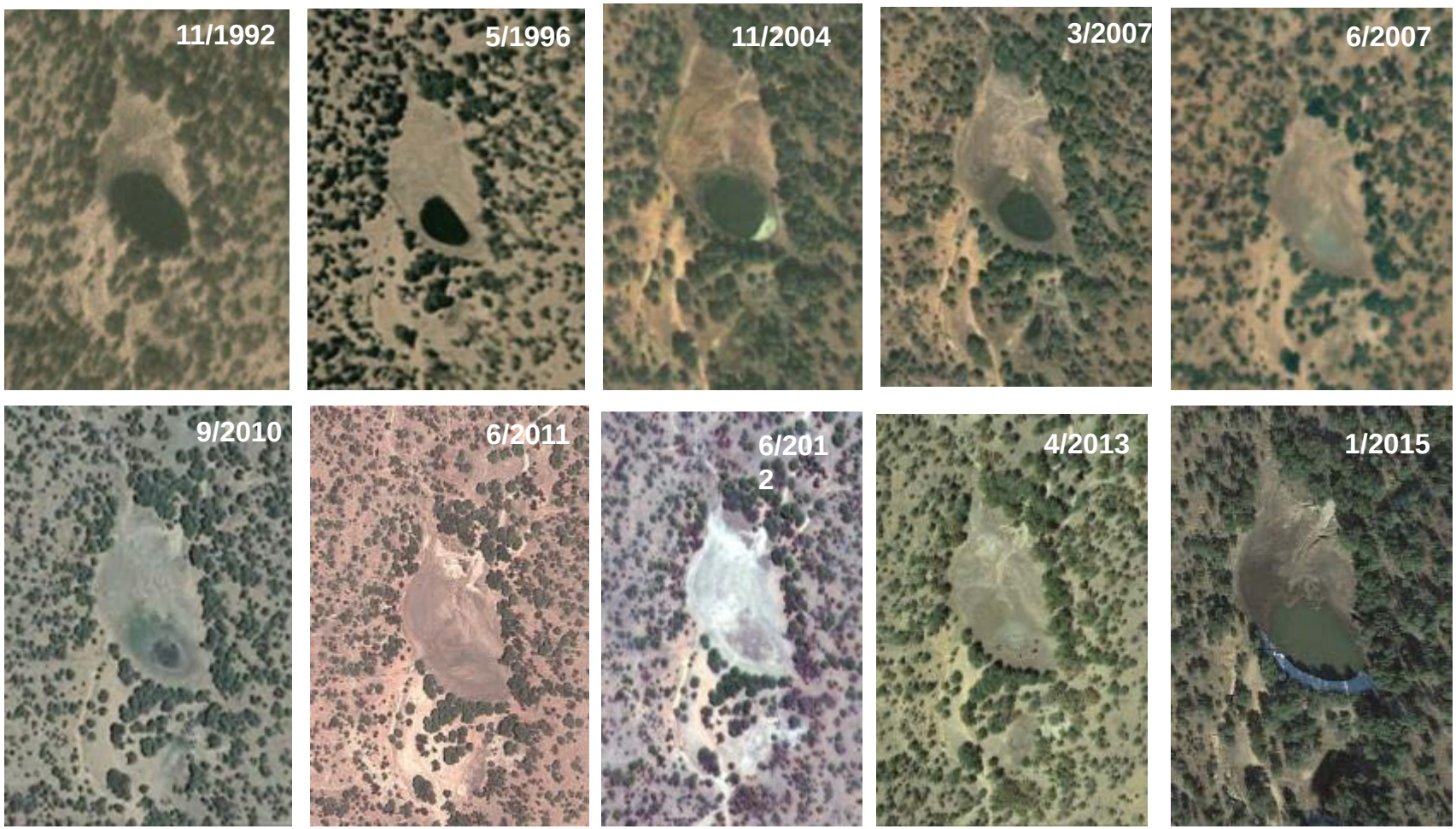


A Model Simulation Approach

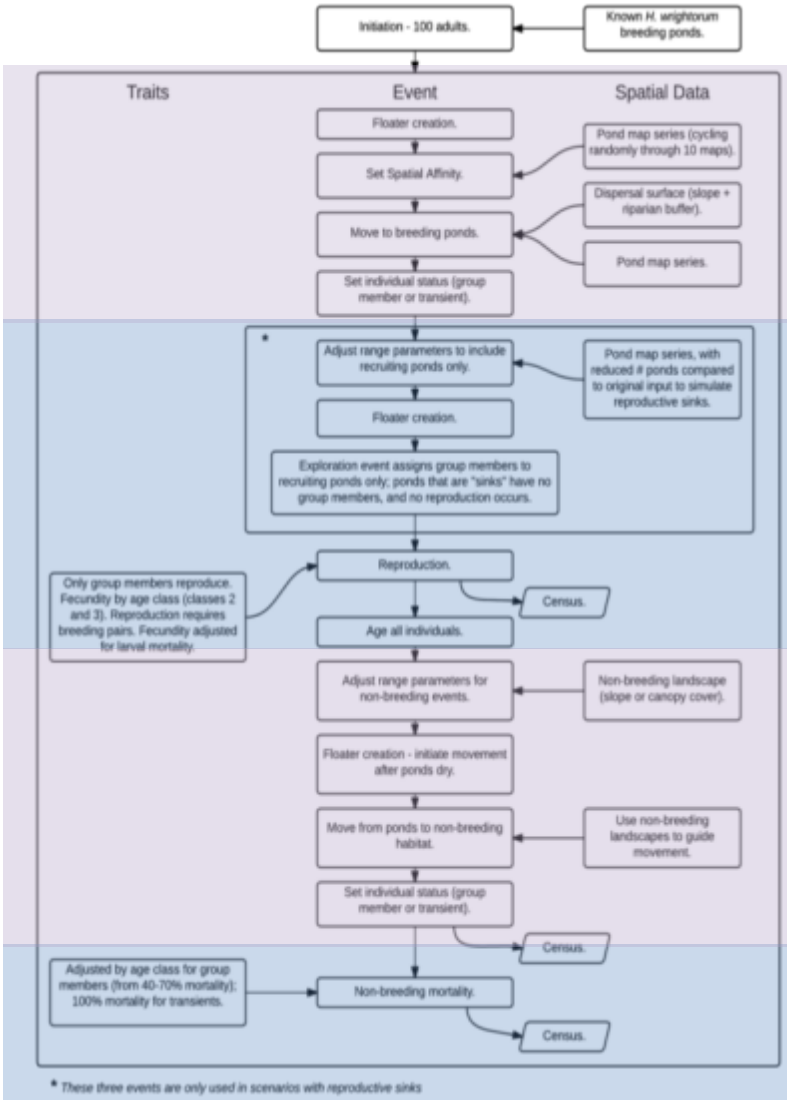
- Explore a range of responses to an environmental stressor, particularly when experimental or observational approaches are not feasible
- HexSim simulation platform is:
  - Individual-based
  - Spatially explicit
  - Life history/demographic inputs



Used Historical Satellite Images to Estimate Pond Hydroperiod

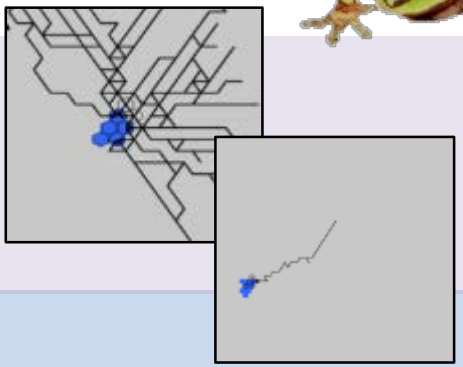


The Model



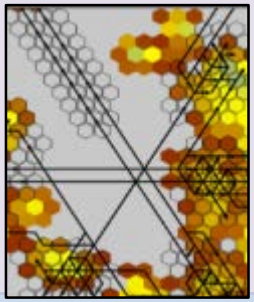
Initialization

Move to ponds



Reproduction and metamorphosis

Overwinter and growth



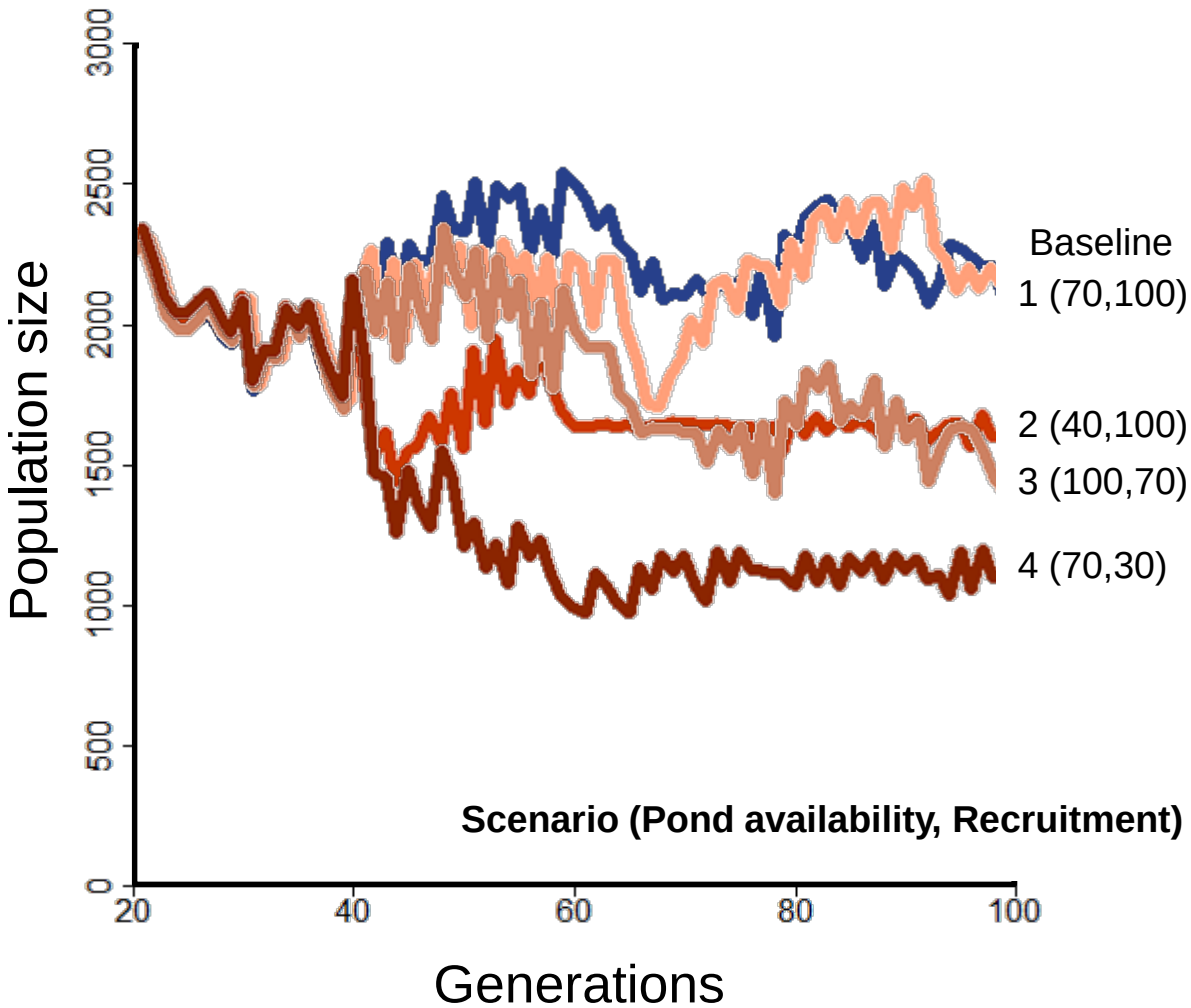
Mortality

Exploring Plausible Scenarios of Changes in Breeding Pond Availability and Recruitment

Scenarios

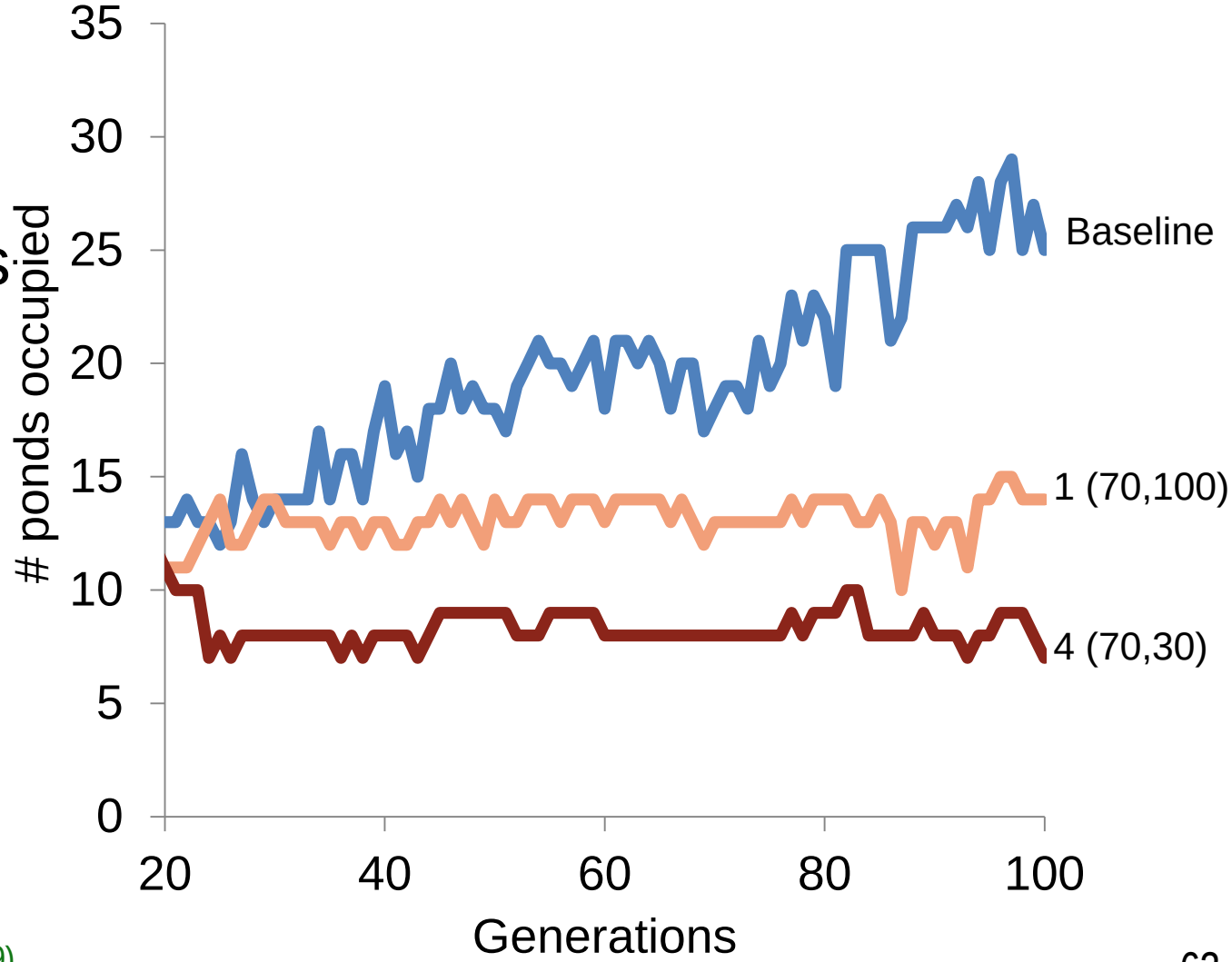
	Baseline	**Drying**			
		1	2	3	4
Breeding pond availability	100%	70%	40%	100%	70%
Recruitment success	100%	100%	100%	70%	30%

Drought Conditions Threaten Treefrog Populations

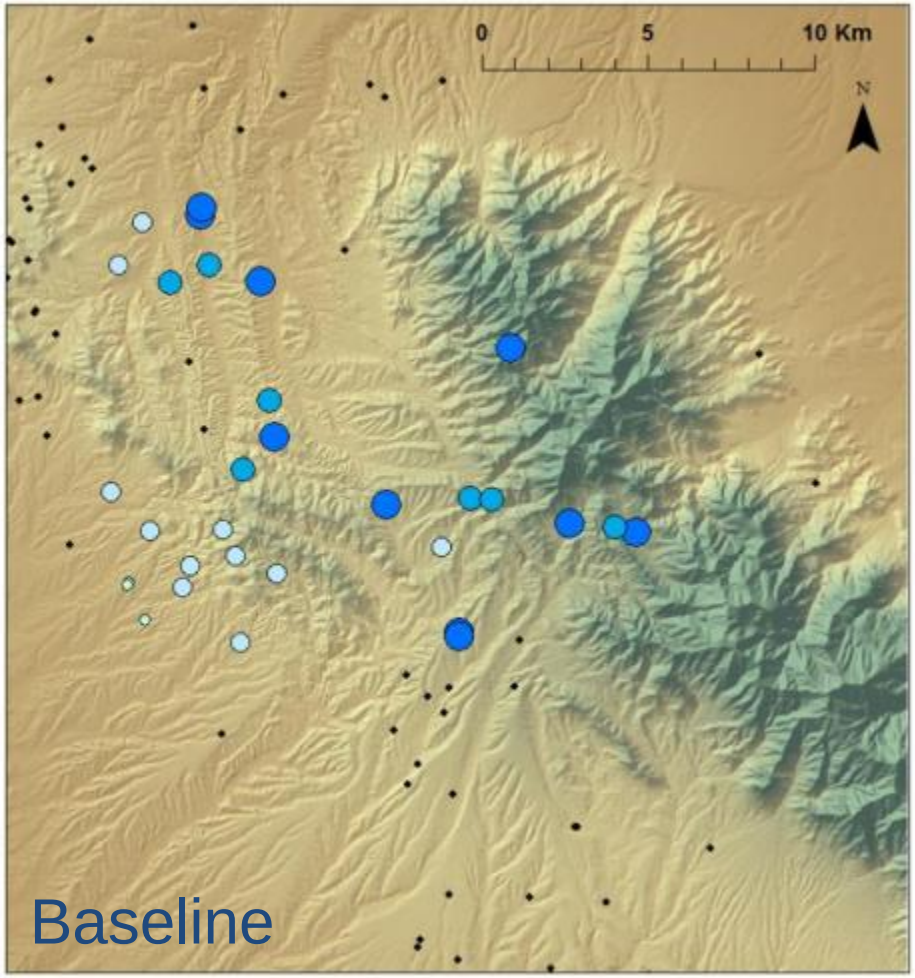


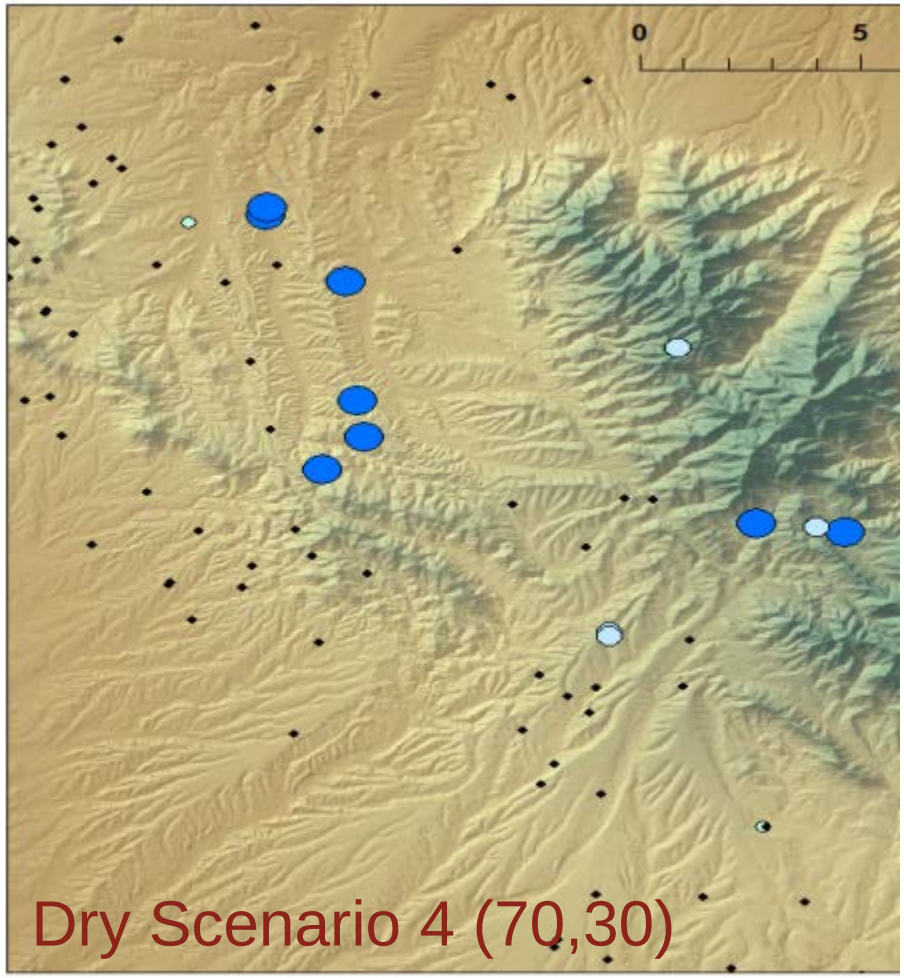
Drought Conditions Threaten Treefrog Populations

- Few Arizona treefrog populations remain after prolonged drought
- Occupy 50% less ponds



Remaining Ponds Occupied by AZ Treefrog





% time occupied for 100 generations represented by symbol size and intensity of blue shading. Ponds never occupied are shown as black points

Consequences of Population Isolation

- Fewer available ponds may lead to the following
  - Greater competition
  - Disease risk (e.g., chytrid fungus)
  - Higher risk of predation (e.g., bullfrogs)

Yellow-legged frog die-off due to *Bd* in California

Juvenile bullfrogs in stock pond in Arizona

Rapid Habitat Loss

- Critical pond habitat can be lost due to wildfire and debris flow after flooding

July 11 flood in Miller Canyon

Monument Fire, *Photo credit: Fort Huachuca Fire Department*

- Monument Fire
  - June 2011
  - 123 km^2 burned
  - Major floods and debris flows in July/August 2011

Management Options

- Manage pond breeding habitats
- Control of invasive bullfrog predators
- Maintain connectivity between populations

Conclusions

- Landscape genetics help inform conservation planning and resource allocation for dryland species
- Traits-based inference may help inform conservation efforts where single-species genetic studies are not possible
- Climate-induced habitat loss and decreased connectivity may threaten the persistence of perennial-water specialists, such as the Arizona treefrog

Acknowledgments

- Dr. David Lytle, Oregon State University

For additional information, please visit:

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Infrastructure-Resiliency/Vulnerability-and-Impact-Assessment/RC-1724

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Q&A Session 2

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