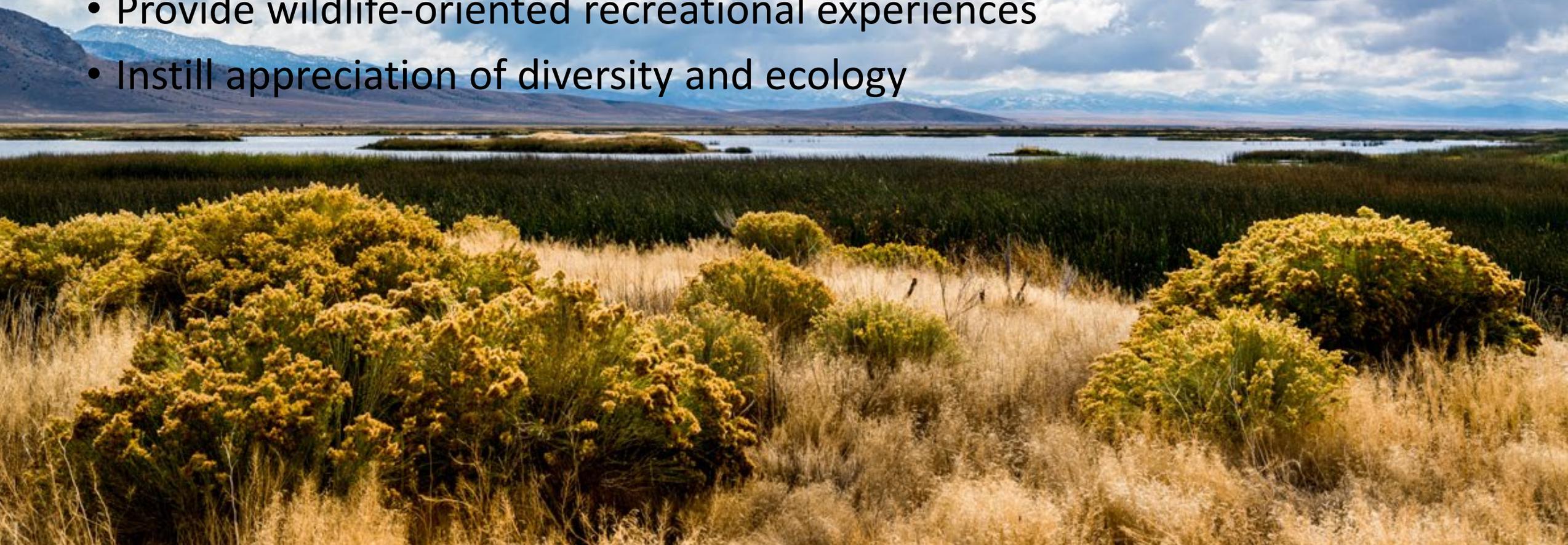


Conservation of rare plants in National Wildlife Refuge wetlands in the Pacific Southwest

Kara Moore-O'Leary
Refuges Inventory & Monitoring
National Wildlife Refuge System
U.S. Fish and Wildlife Service

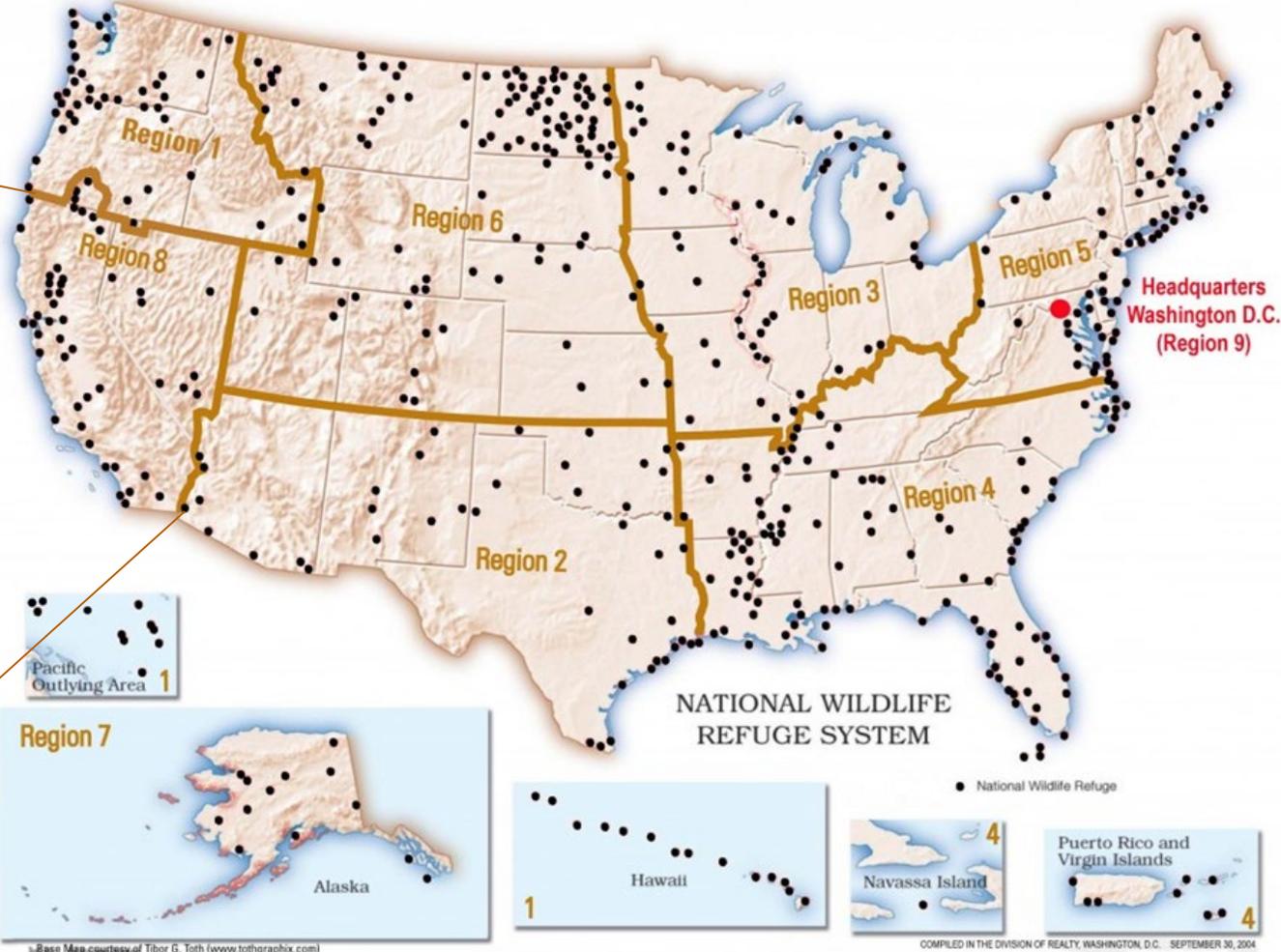
National Wildlife Refuge System

- Conserve a diversity of organisms and their habitats, including T&E species
- Perpetuate a network of habitats for migratory species
- Conserve unique, rare, declining, or significant ecosystems
- Provide wildlife-oriented recreational experiences
- Instill appreciation of diversity and ecology



National Wildlife Refuges


U.S. Fish & Wildlife Service
 Region 8 - Pacific Southwest Region
 California, Nevada and the Klamath Basin
National Wildlife Refuges & Wildlife Management Areas



Base Map courtesy of Tibor G. Toth (www.tothgraphix.com)

COMPILED IN THE DIVISION OF REALTY, WASHINGTON, D.C. SEPTEMBER 30, 2004

Pacific Southwest Refuges conserve wetland diversity



- Spring-fed marsh
- Desert spring outflows
- Managed marsh
- Riparian wetlands and floodplains
- Seasonal wetlands
- Vernal pools
- Wet meadows
- Alkali wet meadows
- Desert wash
- Desert seeps
- Coastal dune ponds
- Estuaries
- Salt marsh
- Tidal marsh
- Tidal sloughs

Threatened plants	Endangered plants
9	20

Vernal pools and alkali meadow complexes

Sacramento National Wildlife Refuge Complex

8 additional T&E vernal pool species at San Diego, San Francisco Bay, and San Luis National Wildlife Refuge Complexes



Photo: Chris Winchell

Hoover's spurge
Euphorbia hooveri



Photo: Reagan O'Leary

Hairy orcuttgrass
Orcuttia pilosa



Photo: Charles Russell

Palmate-bracted bird's beak
Chloropyron palmatum



Photo: Joe Silveira

Estuarian wetlands

San Diego National Wildlife Refuge Complex



Photo: Bonney Nickel



Photo: USFWS



Photo: Lindsey Whittaker

Salt marsh bird's beak, *Cordylanthus maritimus maritimus*

Coastal dune ponds

Guadalupe-Nipomo Dunes NWR

Re-introduced to restored or created wetland habitat



Photo: CNPS

Gambel's water cress
Nasturtium gambelii



Photo: Mark Skinner

La Graciosa thistle
Cirsium loncholepis



Photo: Dunes Center

Marsh Sandwort
Arenaria paludicola



Photo: Dunes Center

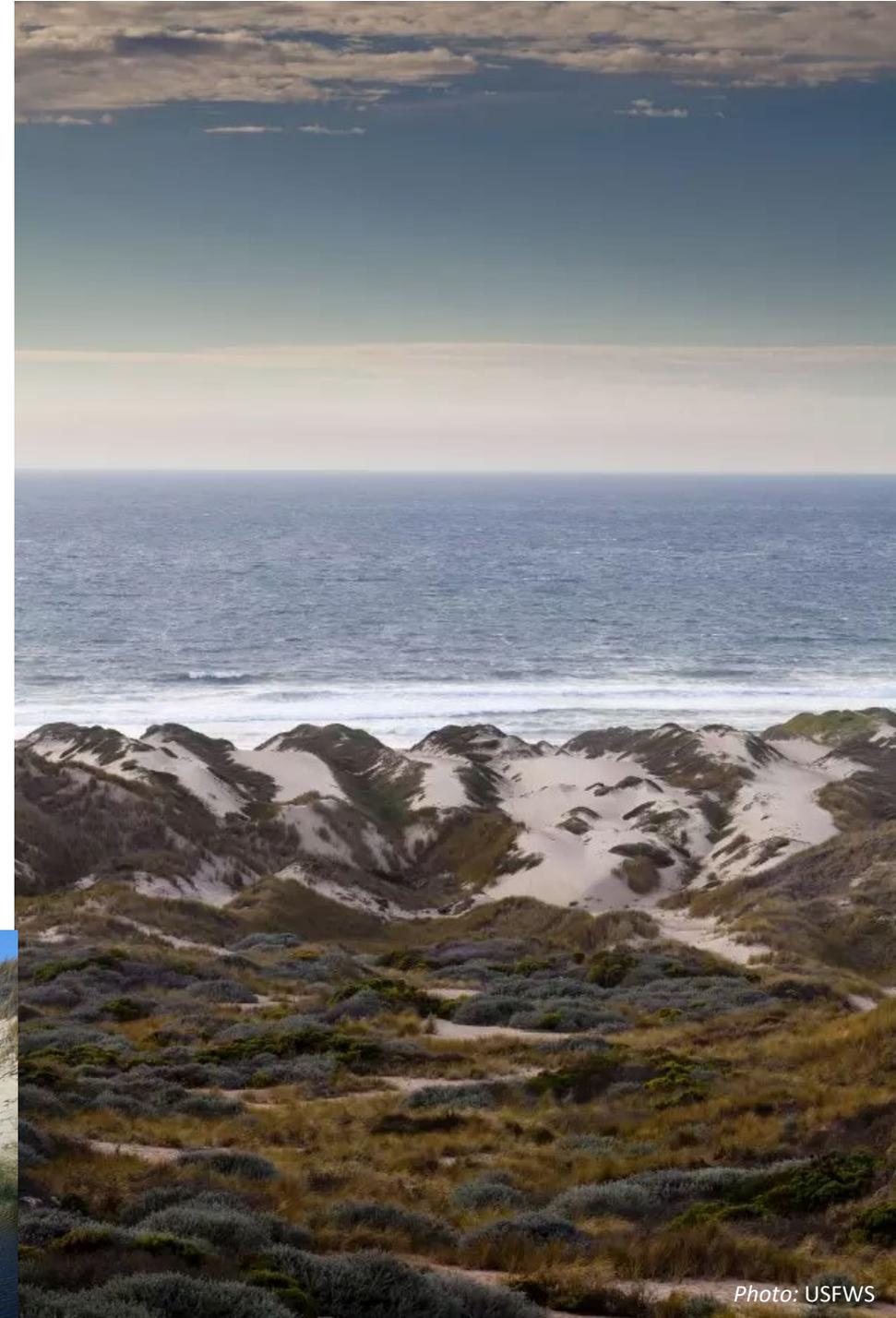


Photo: USFWS

Spring-fed desert wetlands

Ash Meadows National Wildlife Refuge Complex



Desert seeps



Alkali wet meadows



Spring outflows, floodplains, marshes

At least 20 endemic animal species

9 endemic plant species

1 federally endangered plants, 6 threatened

Conserving springs, spring-fed ecosystems, and spring-dependent species in the Amargosa Valley & Carson Slough of Nevada



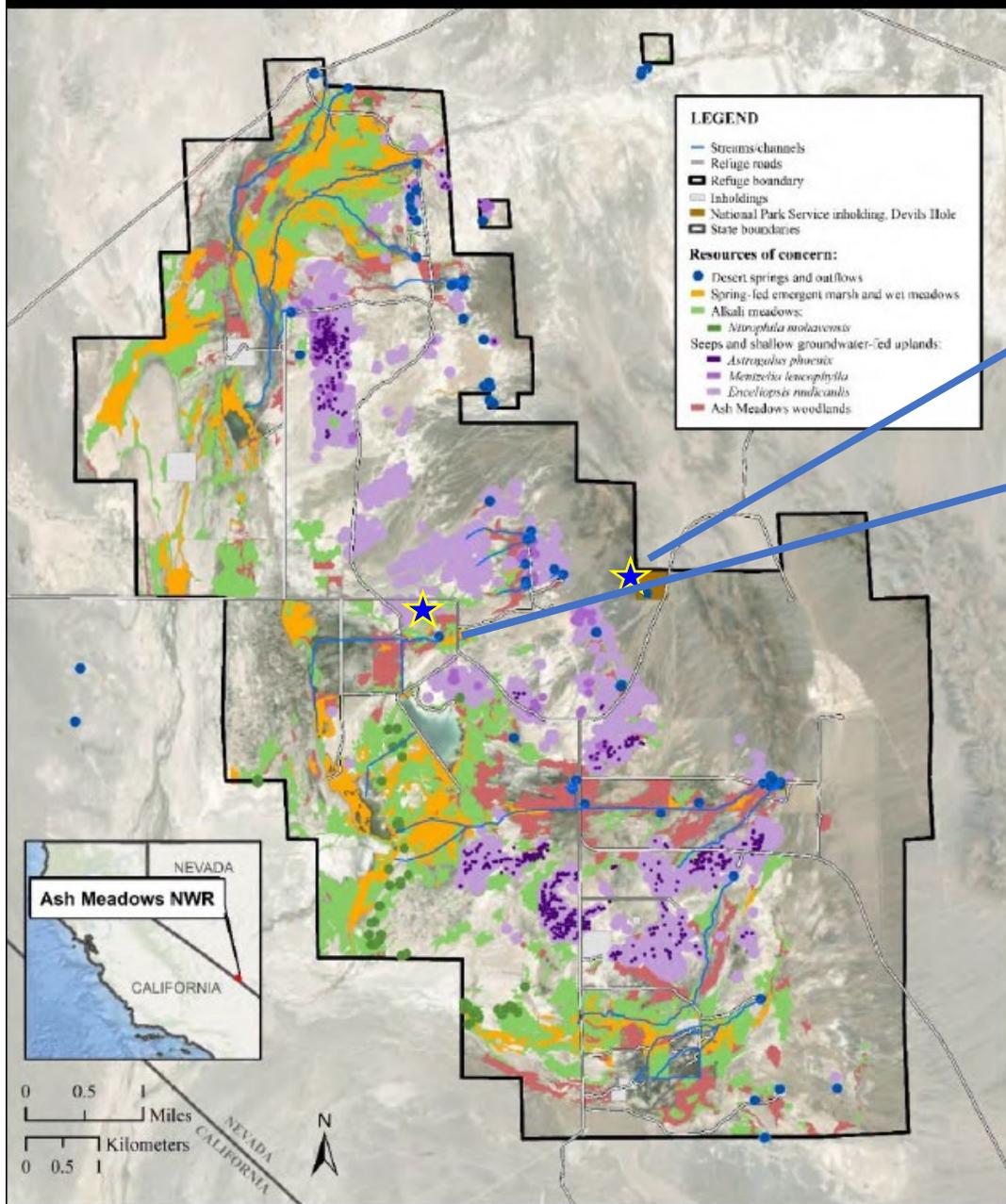
Photo: USFWS



Photo: AroundtheBendFriends.com



Ash Meadows NWR Resources of Concern



- ~ 20 desert spring and seep complexes

Devils hole – enhanced application of the ESA

Crystal spring – largest volume spring, greatest influence on Amargosa niterwort

Collective discharge ~ 17,000 acre-feet per year
90% from 7 major springs

Crystal Spring Pool

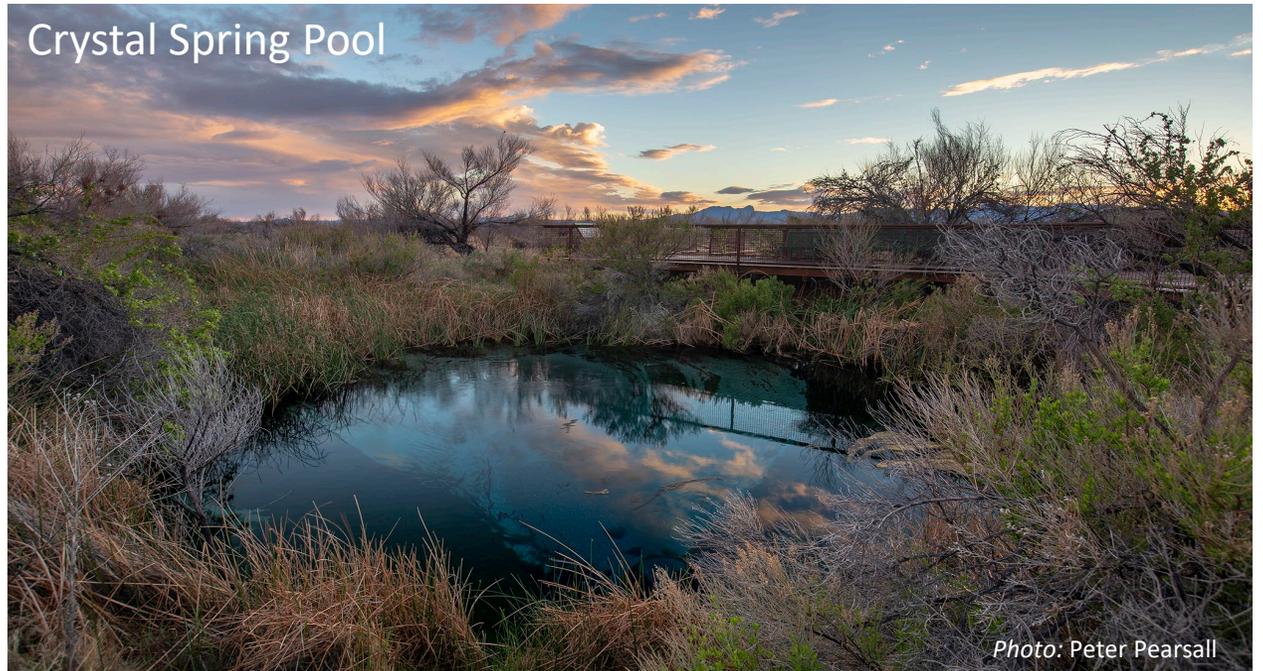


Photo: Peter Pearsall

Map projection: NAD 83 UTM Zone 11. Data Sources: Bio-West, 2011. Refuge approved acquisition boundaries from U.S. Fish & Wildlife Service cadastral dataset, current to March 2019; resources of concern data from refuge; basemap is Esri World Imagery.

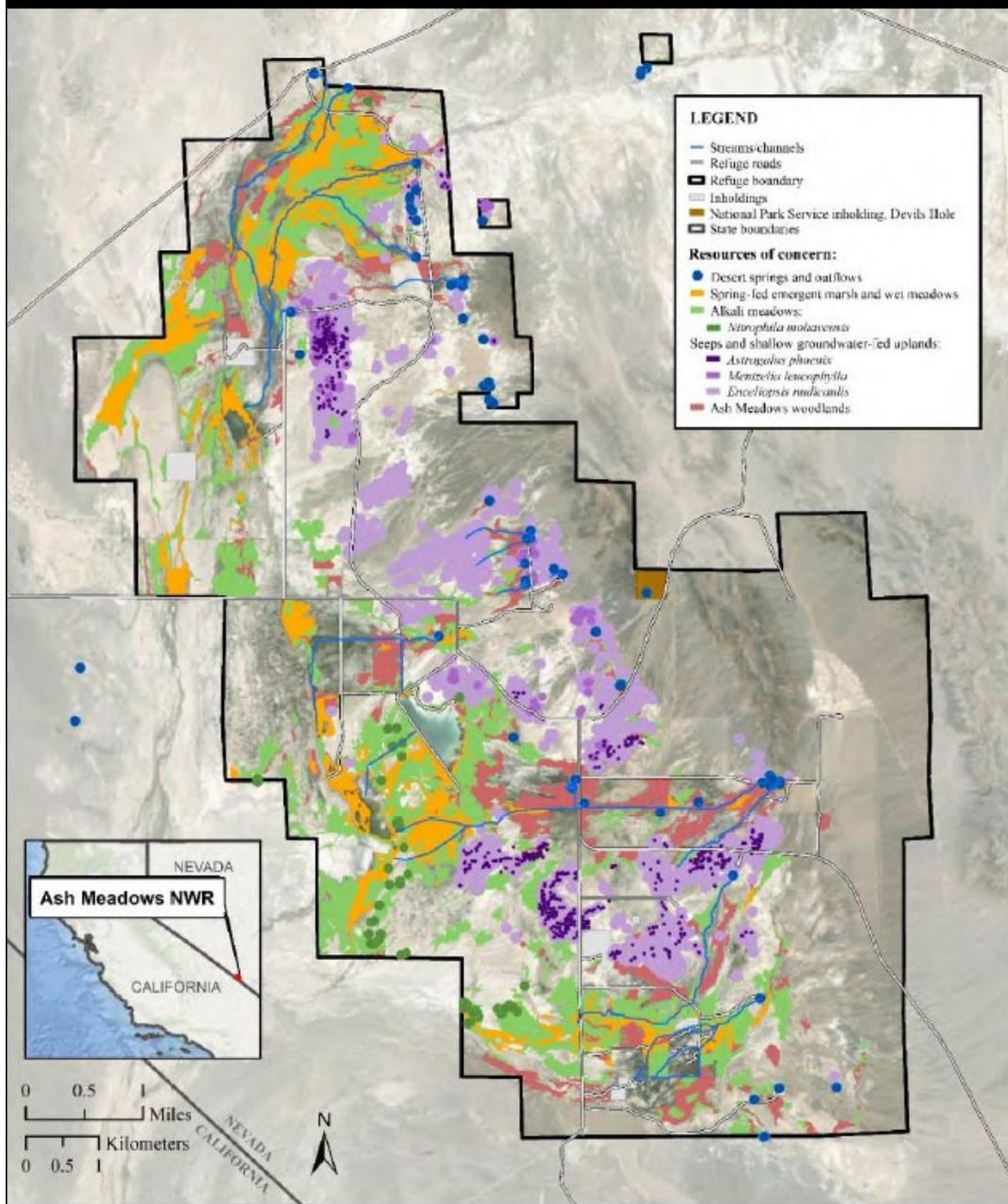
Devils Hole, groundwater conservation, and the ESA

Devils hole pupfish
Cyprinodon diabolis

Cappaert v. United States landmark Supreme Court ruling protecting groundwater for conservation



Ash Meadows NWR Resources of Concern

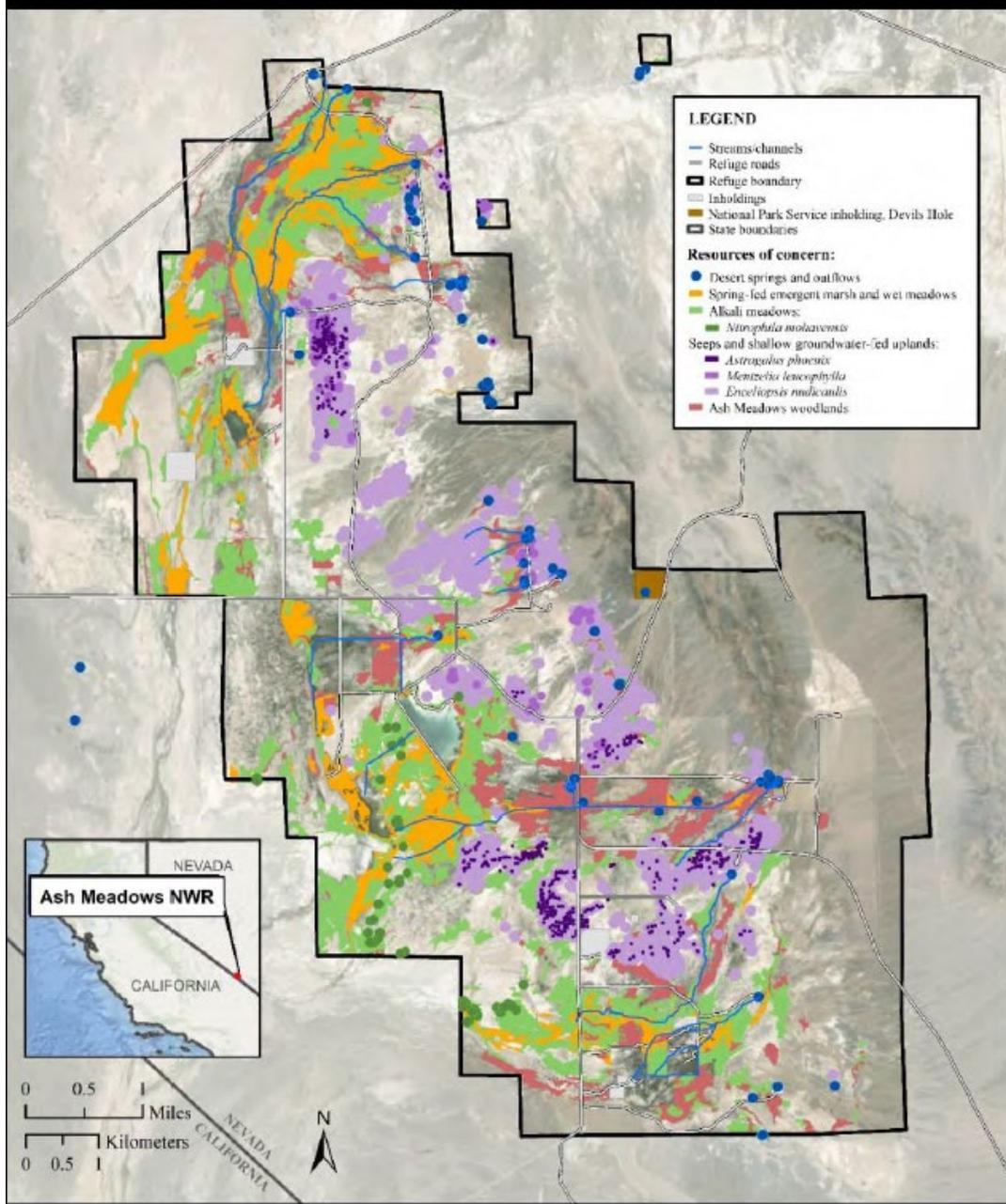


Nine plants endemic to Ash Meadows and Carson Slough



Photos: Peter Pearsall, Karen Tanner, Kara Moore-O'Leary

Ash Meadows NWR Resources of Concern



Majority federally protected



Photos: Peter Pearsall, Karen Tanner, Kara Moore-O'Leary

Crystal spring

2800 gallons of “fossil water” per minute:

- Feeds vast, yet highly altered outwash plain of alkali wetland ecosystems
- Harbors endangered Ash Meadows pupfish, Amargosa niterwort, state listed plants, and secretive marshbirds
- Distribute invasive aquatic organisms like sunfish, bullfrogs, crayfish
- Is bound by an archaic landscape of water control structures



Ash Meadows
Amargosa pupfish, Photo:
Darren Olsen





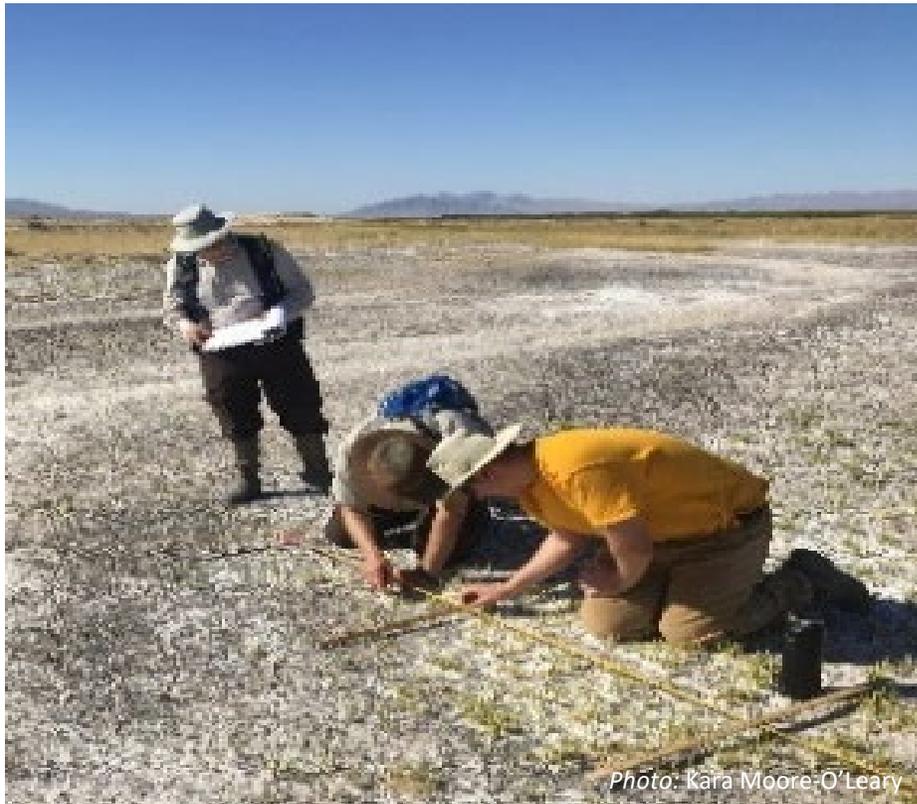
Amargosa
niterwort

Nitrophila mohavensis, Amaranthaceae



High salinity and alkalinity, salt encrusted
Diminutive
Federally listed in 1985 as endangered

Refuge annual surveys track trends in abundance and prevalence of herbivory



Designed to complement BLM survey design in California



Sharp decline at a survey site in 2015



Photos: Peter Pearsall

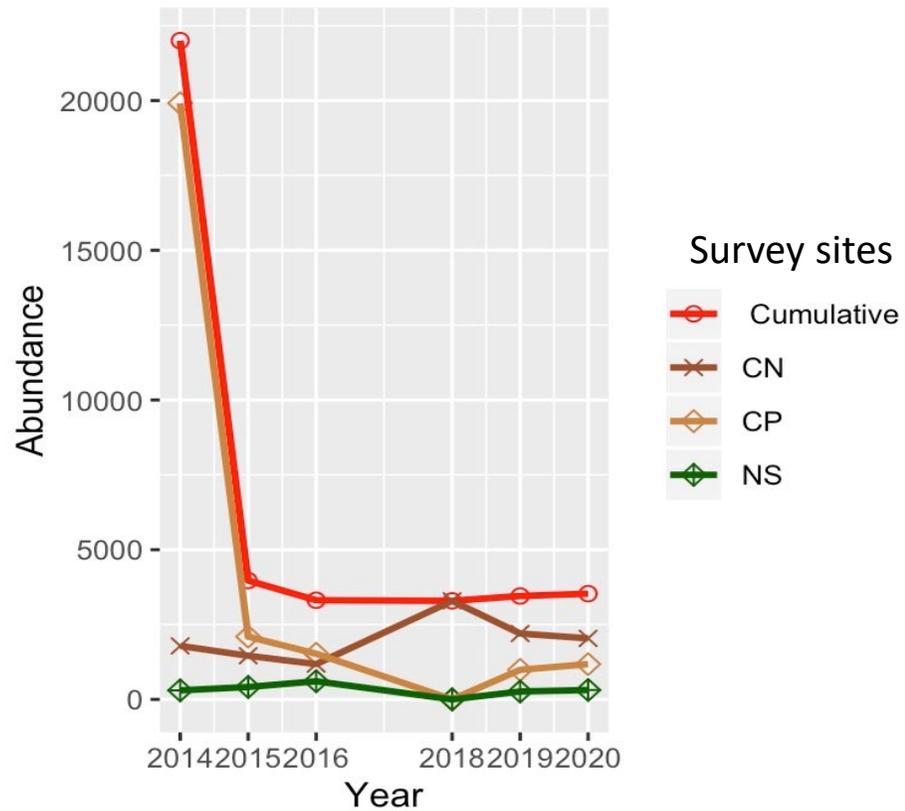
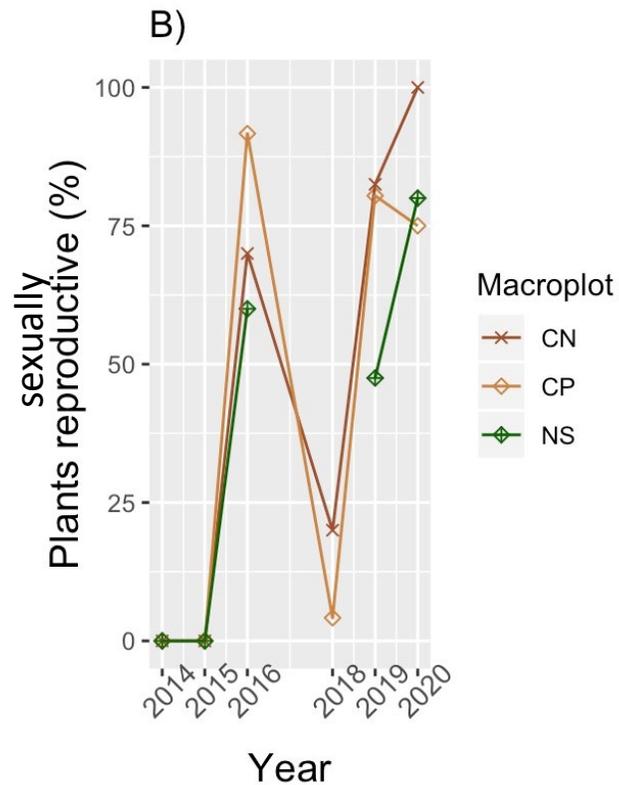


Photo: Karen Tanner

Variable reproduction & low genetic diversity



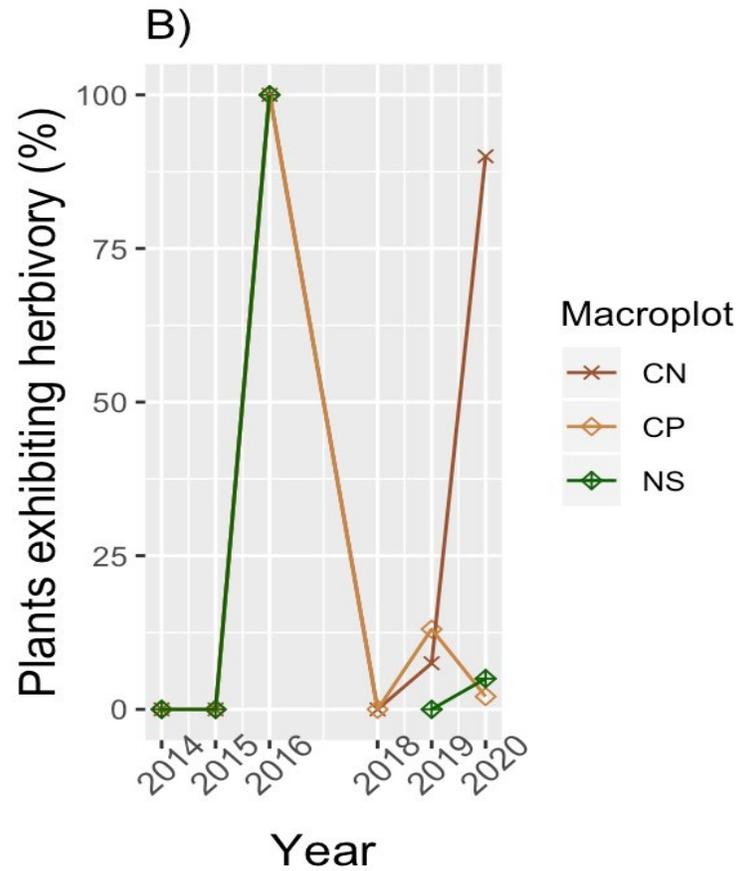
Sexual reproduction episodic in Ash Meadows surveys 2014-2022

Microsatellite loci survey showed multiple genotypes within patches of ramets (Martin et al. 2013)

Localities comprised of their own genotypes suggesting limited genetic exchange (Martin et al. 2013)

Sexual reproduction drops with salinity, but competition relegates it to saline microsites in which it is predominantly clonal (DeFalco et al. 2017)

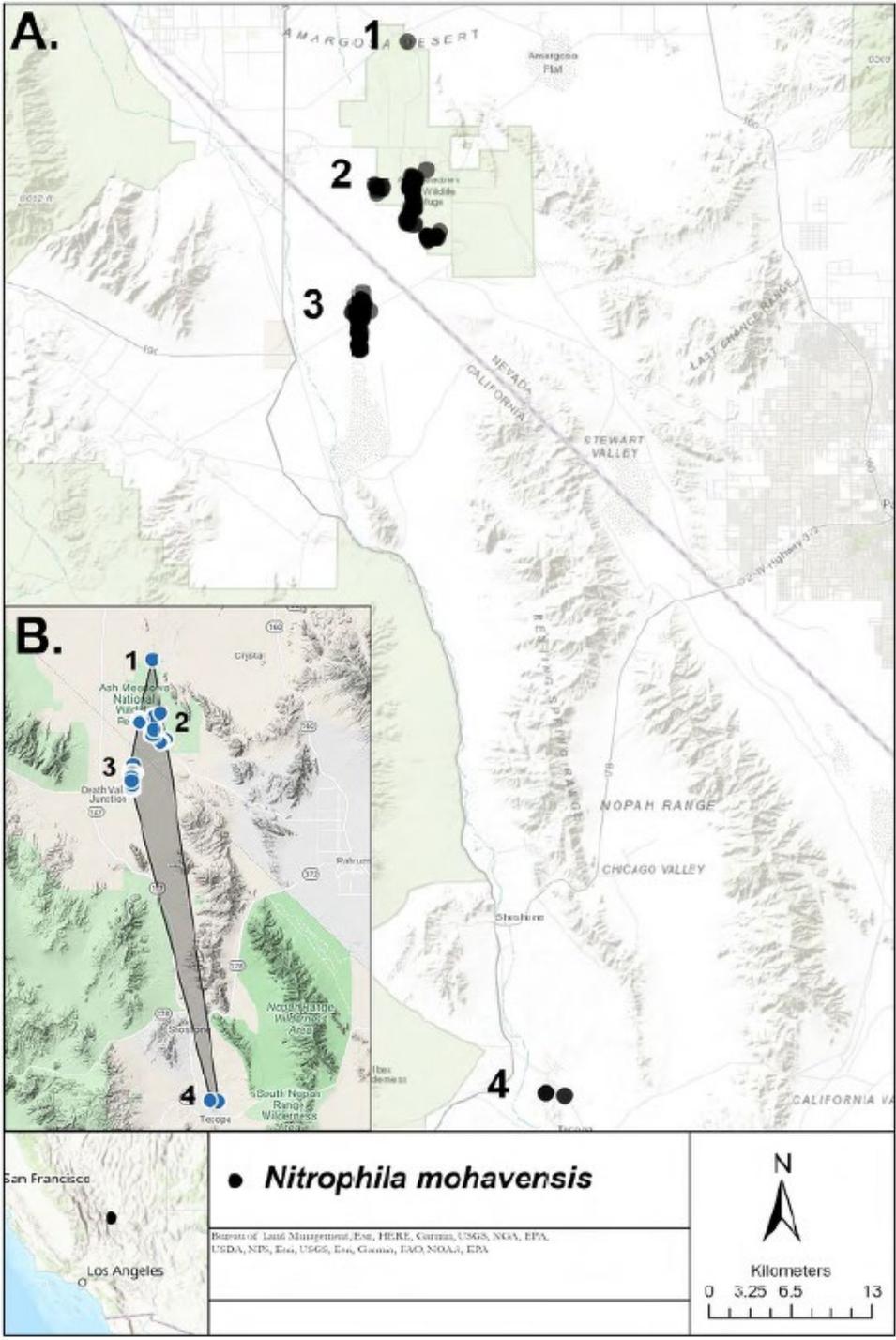
Episodic herbivory reduces fitness in some years



Threats to *Amargosa niterwort*

- Limited genetic diversity
- Constraints on sexual reproduction
- Localized flooding or drying events
- Herbivory
- Vulnerability to habitat alteration





Range crosses state boundaries and agency jurisdictions

Table 1. Known locations for Amargosa niterwort in California and Nevada. Global population estimates are from 2009 to 2017 (USFWS 2020), extent of occurrence was calculated as a part of this study.

Population	State	Site Name	Land Ownership	Global Population Estimate	Extent of occurrence (km ²)
1	NV	Soda Spring	AMNRW	3,993	~5m ²
2	NV	Ash Meadows NWR	AMNRW	54,299	16.02
3	CA	Lower Carson Slough	BLM	176,886	3.44
4	CA	Tecopa Hot Springs	BLM/Private	470	0.04
Total Global Estimation				235,648	19.5

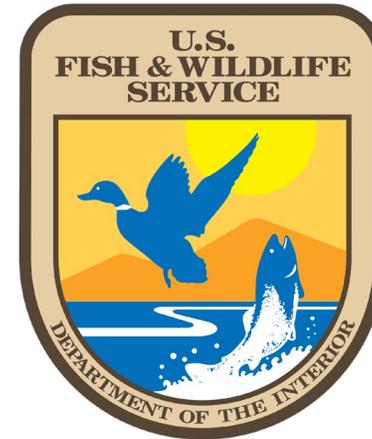
Fraga, Miller, De Groot, Lee, Lund, and Moore-O'Leary. 2021. California Fish and Wildlife Special CESA Issue: 78-95.

Amargosa niterwort working group, est. 2018

Track population-wide changes

Identify population threats and
potential responses

Share opportunities and resources



Potential restoration of Crystal Spring system

Actions being considered to protect and enhance Amargosa niterwort include:

- Population inventory
- Research on translocation and propagation
- Increased environmental monitoring
- Protection of unaffected subpopulations



Photo: Peter Pearsall



Photo: Naomi Fraga

Conclusions

- Refuges provide opportunities for multi-benefit conservation of ecosystems, wildlife, and rare plants
- Survey data can be used to identify management strategies and shape priorities
- Cross-organizational collaboration can enhance ecosystem restoration and recovery efforts



Gratitude

- Refuge managers: Corey Lee, Michael Bower, Kevin DesRoberts
- Survey collaborators: Karen Tanner, Alice Miller, Michael Reeves, Therese Burns, Kaylene Keller, Laurie Simons and many others
- Amargosa niterwort working group: Naomi Fraga, Christina Lund, Alice Miller, Vance Imhoff, Leslie DeFalco and others
- Mentorship and inspiration: Bruce Pavlik and Erin Espeland
- Desert and plant photographers! Particularly Peter Pearsall and Naomi Fraga

