land use and water:
an environmental management GRAND challenge

@cjlortie

environmental management challenge case

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Better late than never: a synthesis of strategic land retirement and restoration in California

Christopher J. Lortie, A. Filazzola, R. Kelsey, Abigail K. Hart, H. S. Butterfield

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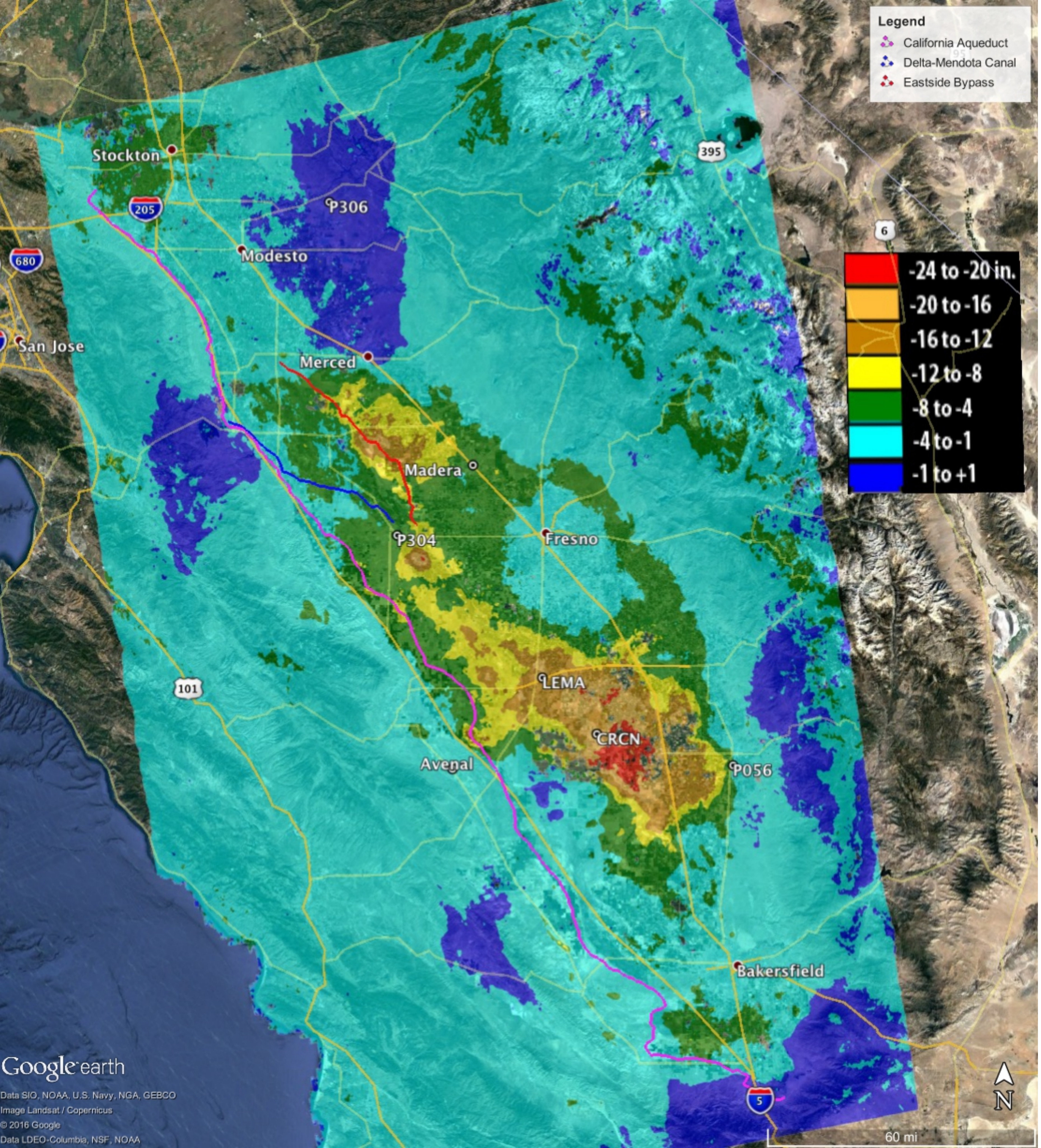
emc2

novelty

agriculture and agricultural lands are changing

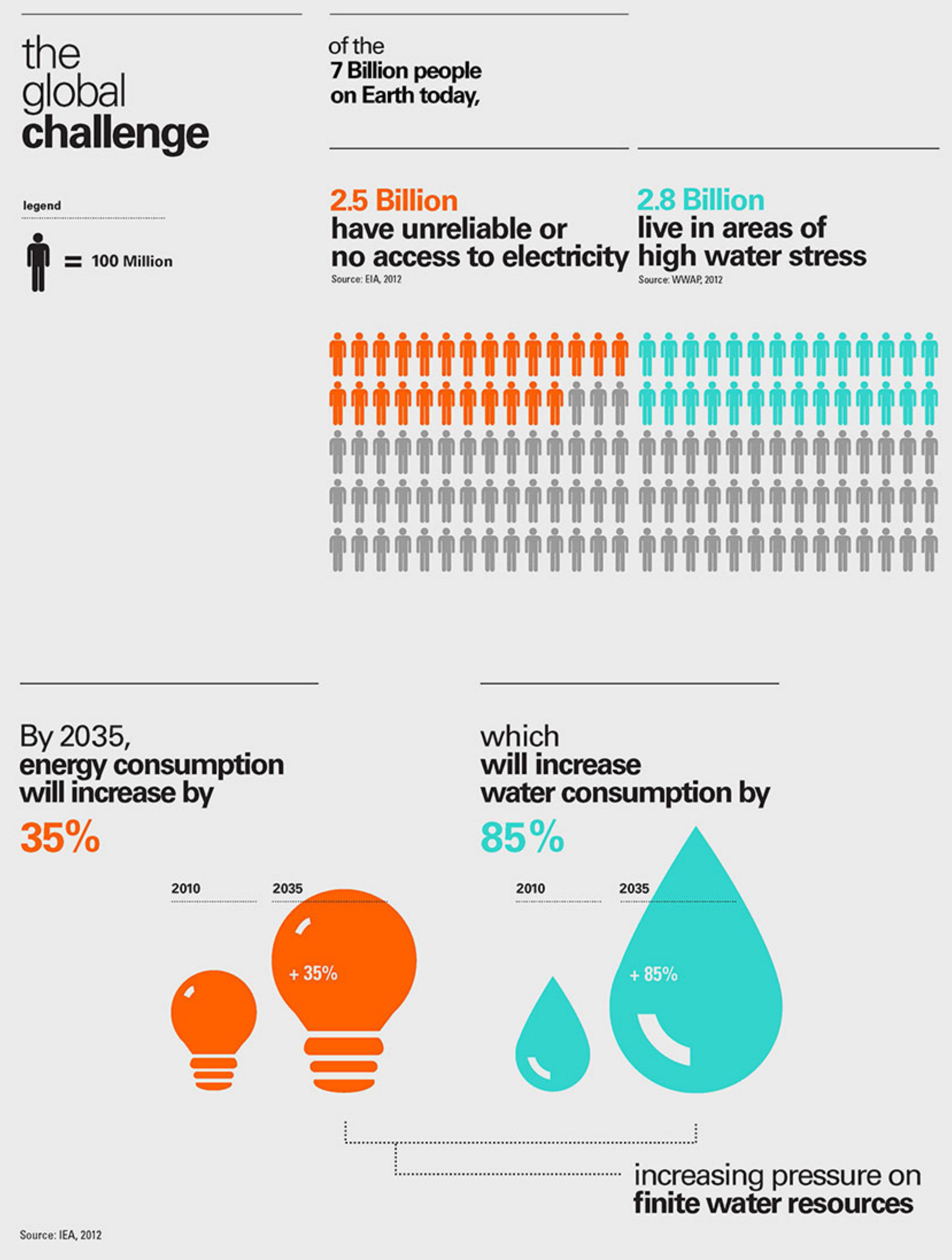
plants and animals important for restoration

no pristine states or benchmarks needed



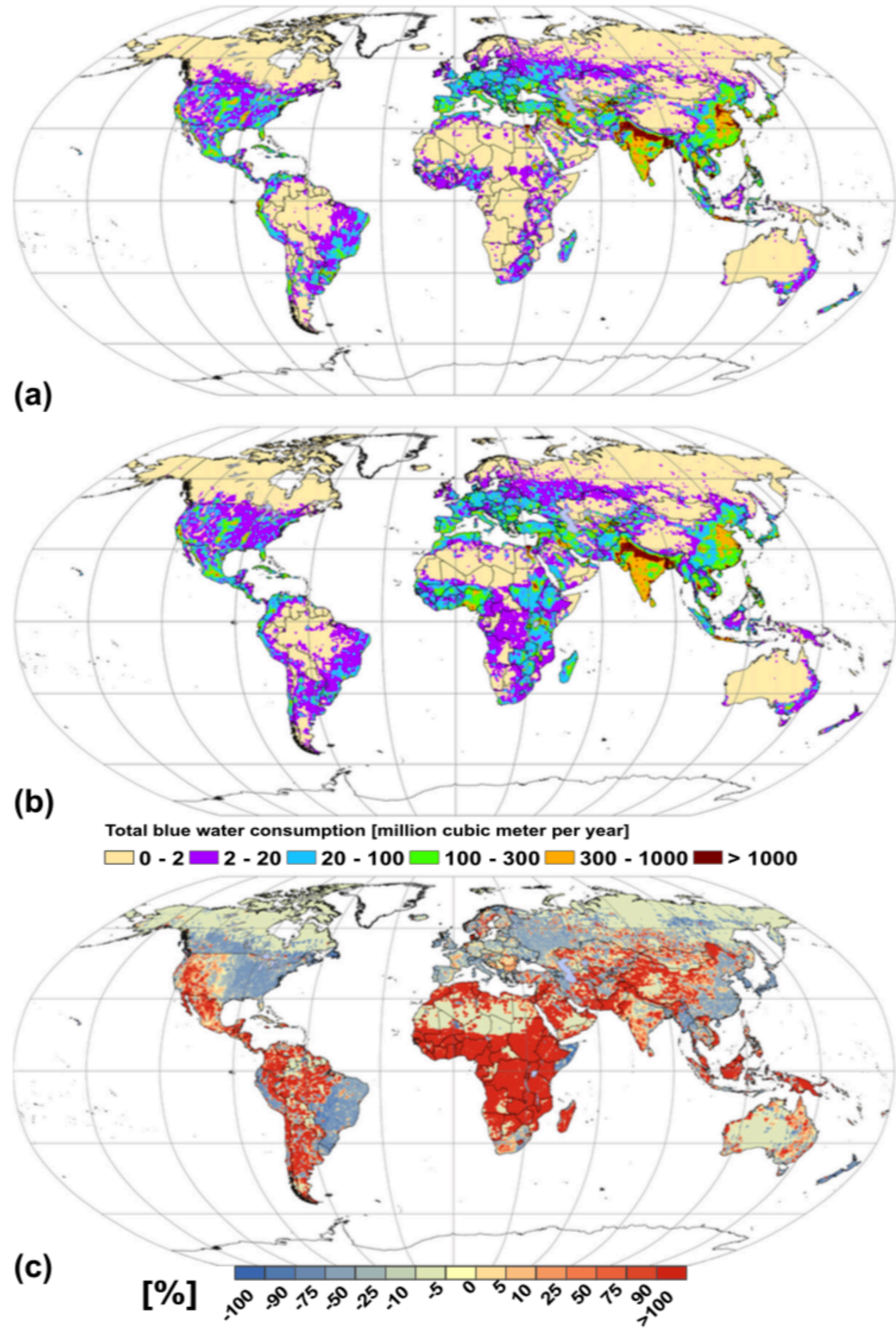
challenges

aquifer depletions > sinking land

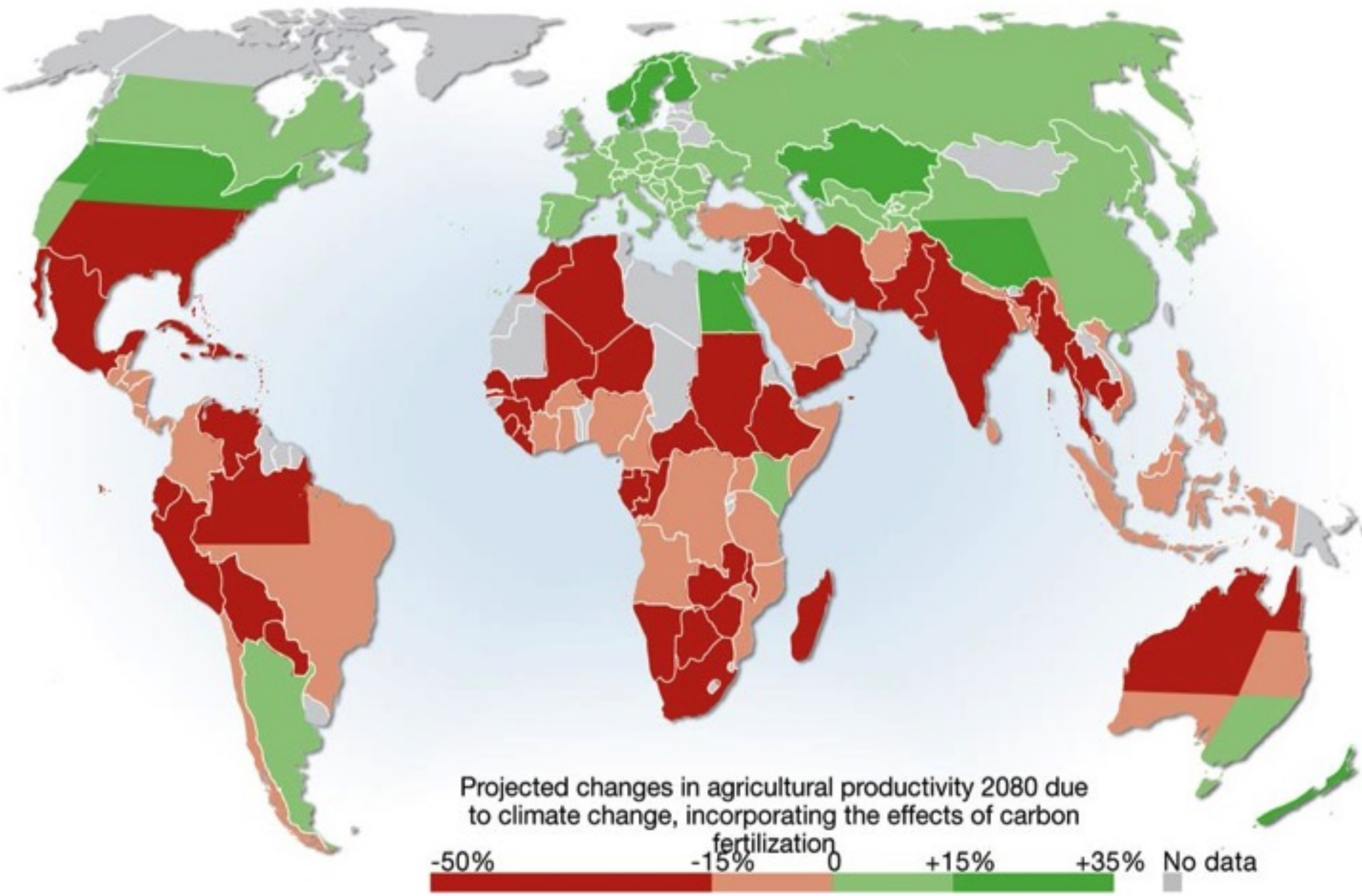


nearly half the global pop faces high water stress

water consumption levels are critical



Projected changes in agricultural productivity 2080 due to climate change,incorporating the effects of carbon fertilization (Ahlenius, 2009)



land & water limiting

methods

https://cjlortie.github.io/Strategic_retired_lands_synthesis/

systematic review

R

habitat models

gbif

evidence mapping

flagship studies to show us the way forward

Table 1. A list of flagship studies that specifically explore habitat assessment and quantification for the SJD.

Q	Title	Year	Species	Tool
1	Optimizing habitat protection using demographic models of population viability	2002	San Joaquin kit fox	Model
1	Optimizing reserve expansion for disjunct populations of San Joaquin kit fox	2004	San Joaquin kit fox	Model
1	Partitioning the effects of an ecosystem engineer: Kangaroo rats control community structure via multiple pathways	2012	Giant kangaroo rat	Trapping
1	Persistence of historical population structure in an endangered species despite near-complete biome conversion in California's SJD	2017	Blunt-nosed leopard lizard	Transects
1	Species distribution models of an endangered rodent offer conflicting measures of habitat quality at multiple scales	2014	Giant kangaroo rat	Trapping
1	Translocating endangered kangaroo rats in the San Joaquin Valley of California: recommendations for future efforts	2013	Tipton kangaroo rats	Review
1	Use of agricultural lands by San Joaquin kit foxes12	2007	San Joaquin kit fox	Telemetry
2	Can Orchards Help Connect Mediterranean Ecosystems? Animal Movement Data Alter Conservation Priorities	2015	Bobcats	Survey
2	Ghost of habitat past: Historic habitat affects the contemporary distribution of giant garter snakes in a modified landscape	2014	Giant garter snake	Survey
2	Habitat restoration and agricultural production under land retirement	2001	None	Simulation model
2	Is there room for all of us? Renewable energy and Xerospermophilus mohavensis	2013	Mohave ground squirrel	Survey
3	A genetic assessment of the recovery units for the Mojave population of the desert tortoise, Gopherus agassizii	2007	Desert tortoise	Survey
3	Agricultural legacies in the great basin alter vegetation cover, composition, and response to precipitation	2006	Plants	Survey
3	Anthropogenic degradation of the southern California desert ecosystem and prospects for natural recovery and restoration	1999	Plants	Review
3	Benefit-cost model for an artificial recharge scenario in the San Joaquin Valley, California	1999	Hydrology	Model
3	Conserving species in fragmented habitats: population dynamics of the flat-tailed horned lizard, Phrynosoma mcallii	2009	Flat-tailed horned lizard	Survey
3	Energy analysis of reclaimed water application for irrigation in arid and semi-arid regions	2016	None	Model
3	Enhancing Quality of Desert Tortoise Habitat: augmenting Native Forage and Cover Plants	2015	Desert tortoise	Restoration
3	Guidelines for the field evaluation of desert tortoise health and disease	2001	Desert tortoise	Monitoring
3	Lack of native species recovery following severe exotic disturbance in southern Californian shrublands	1999	Shrubs	Monitoring
3	Mitigation-driven translocation effects on temperature, condition, growth, and mortality of Mojave desert tortoise (Gopherus agassizii) in the face of solar energy development	2016	Desert tortoise	Monitoring
3	Multiple factors affect a population of Agassiz's desert tortoise (Gopherus agassizii) in the northwestern Mojave Desert	2013	Desert tortoise	Monitoring
3	Perspectives in dryland restoration: approaches for climate change adaptation	2012	Plants	Review
3	Phytolith evidence for the extent and nature of prehistoric Californian grasslands	2013	Plant community	Survey
3	Restoration of Mediterranean ecosystems	1999	Plants	Review
3	Spatially explicit decision support for selecting translocation areas for Mojave desert tortoises	2008	Desert tortoise	Model
3	The SJD of California: ecologically Misunderstood and Overlooked	2011	All	Review
3	Using livestock to manage plant composition: a meta-analysis of grazing in California Mediterranean grasslands	2013	Plant community	Review

Notes: SJD, San Joaquin Desert.

In this synthesis, a flagship study was defined as high-quality instances that directly provided evidence associated with the driving questions that structured this review. Each of these studies highlighted either a specific tool, approach, or proof of concept for restoration, or critical species information. Full citation detail for each provided in the appendices.

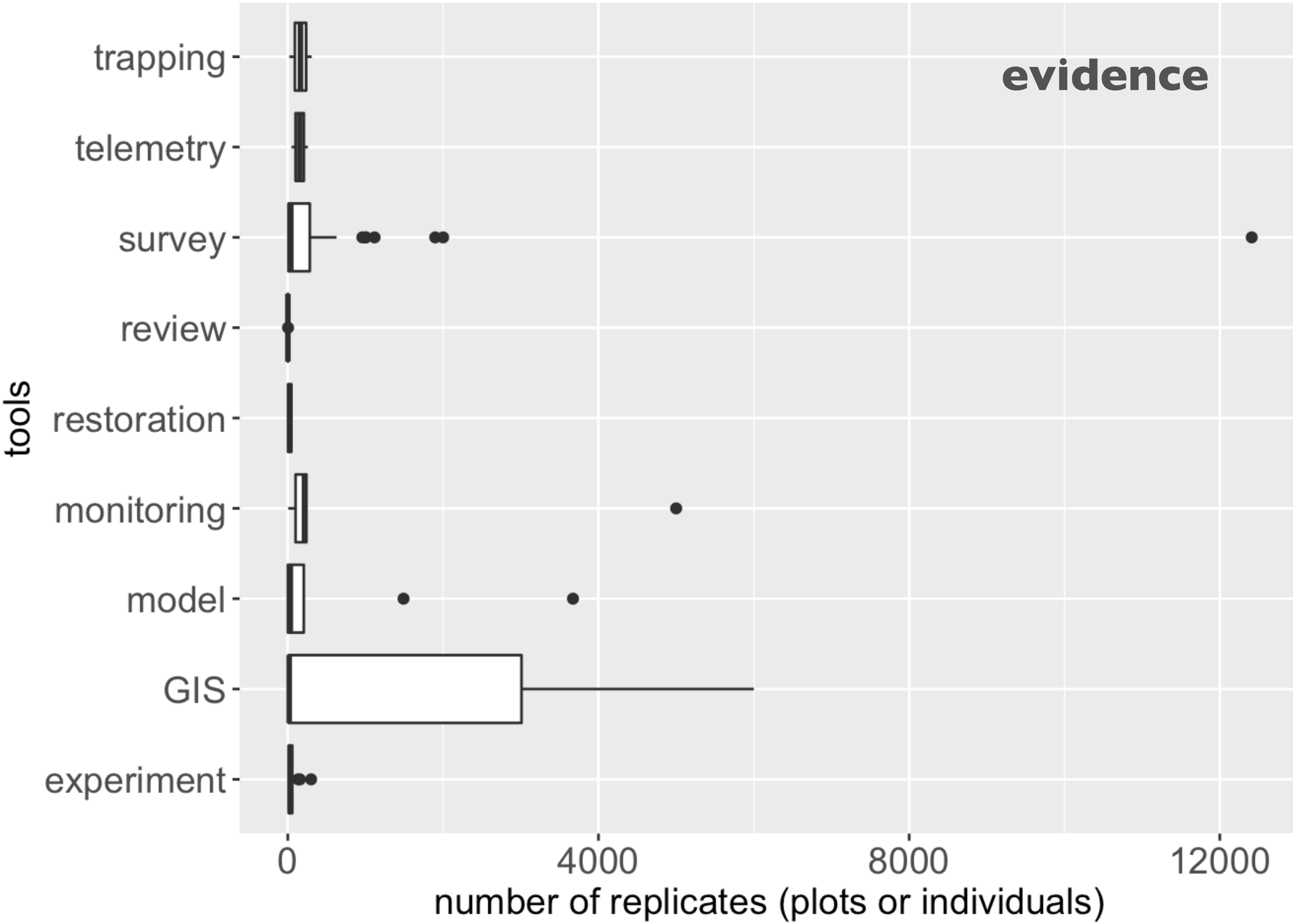
categories of tools

Table 3. A summary of the four major classes of historical habitat assessment tools for desert animal species in agricultural landscapes with three endangered species as focal search terms in this synthesis (i.e., primarily species-centric estimates and methods).

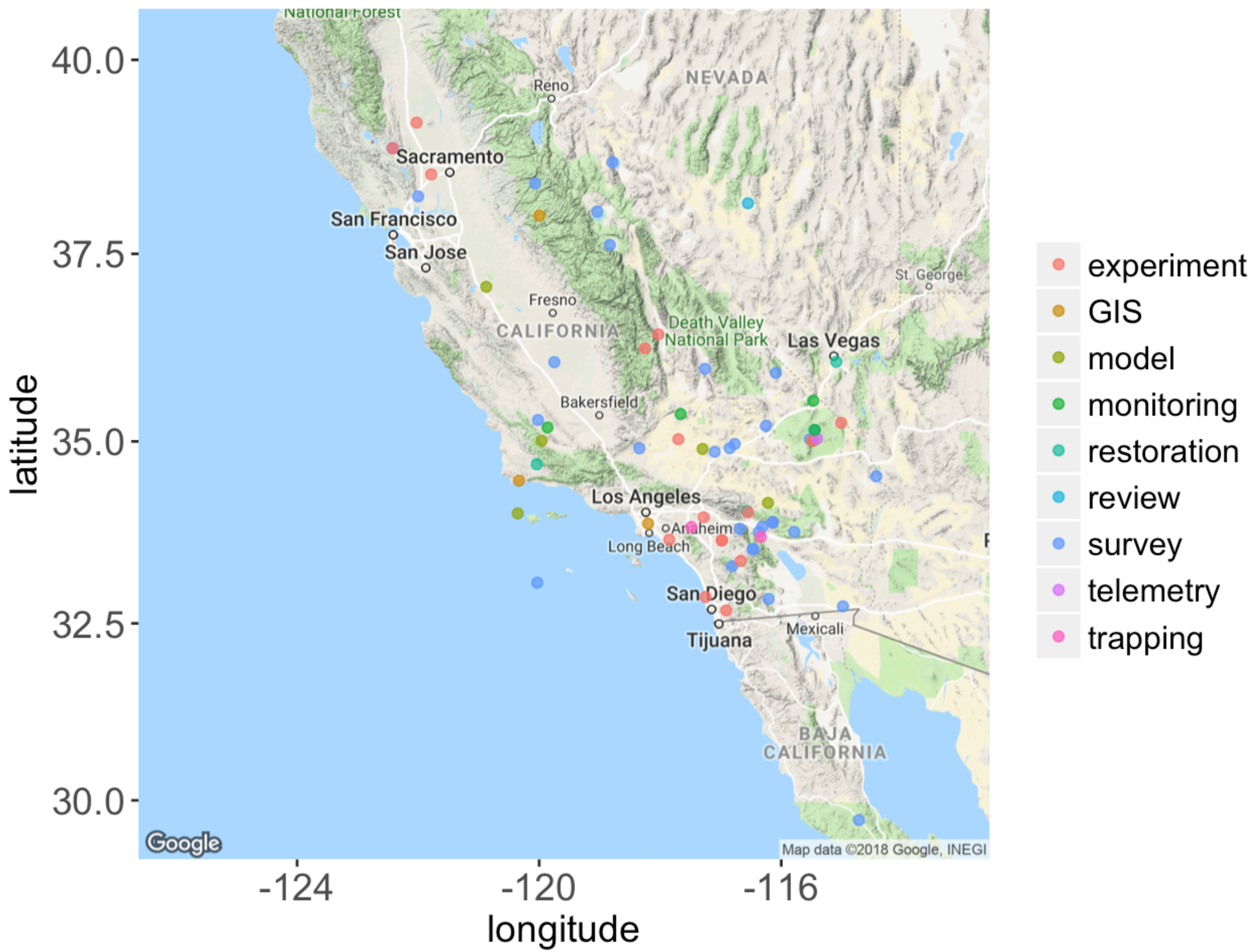
Tool classification	Description	Application
Historic vegetation maps	Regional maps that provided longitudinal data for vegetation relevant to indicator animal species	The habitat requirements typically included vegetation preferences and association patterns. Matching historic vegetation occurrences with animal preferences provided an estimate of likely habitat suitability within a region
Proxy vegetation studies	The ecological function of contemporary vegetation such as orchards or other woody plant species was assessed	Focus on the function of vegetation for indicator animal species including cover, shelter, refuge, or habitat connectivity is examined through occurrence or tracking surveys
Historic range maps	Maps within a region specific to an animal species that delineates reported sightings and/or estimated extents of movement within an area	Maps are used to infer former occupancy and typically assumed that occupancy was an indicator of suitable habitat. Most commonly applied to a region to show the extent that an animal species occupied a region over a specified period of time in the past
Historic survey records	Occurrence data from VertNet or GBIF that provide occurrence data for a given species. Can be refined by time or region	Used for species distribution models such as MaxEnt or other tools to estimate habitat suitability and relative occupancy patterns

Notes: GBIF, Global Biodiversity Information Facility.

Each class was reported at least once in a study listed in the flagship studies (listed in Table 1). Full details described in Results for relevant applications to the San Joaquin kit fox, giant kangaroo rat, and blunt-nosed leopard lizard.



evidence
trapping
telemetry
survey
review
restoration
monitoring
model
GIS
experiment
tools
0
4000
8000
12000
number of replicates (plots or individuals)



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35.0
32.5
30.0
longitude
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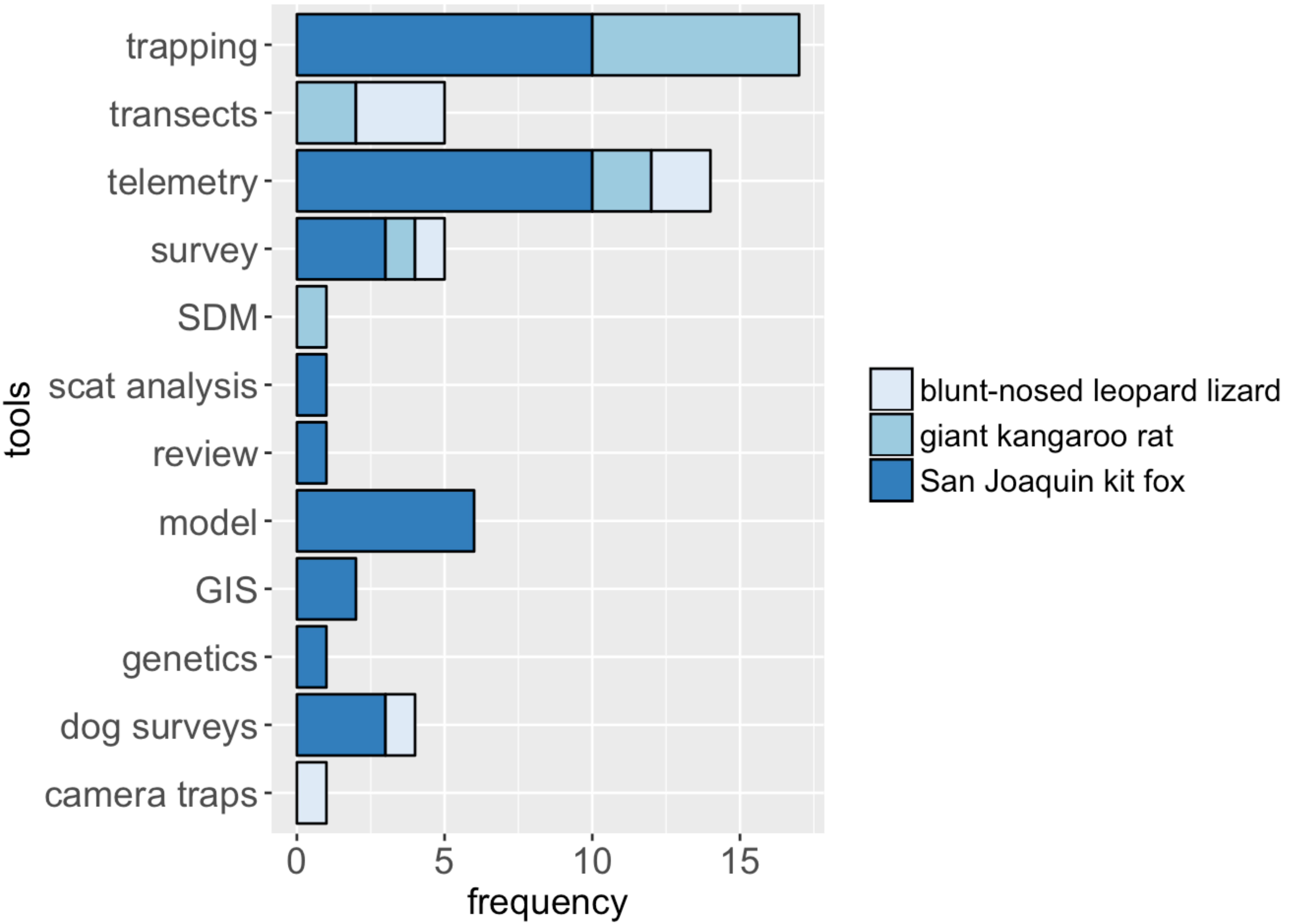
-120
-116
experiment
GIS
model
monitoring
restoration
review
survey
telemetry
trapping
National Forest
NEVADA
Reno
Sacramento
San Francisco
San Jose
St. George
Fresno
CALIFORNIA
Death Valley National Park
Las Vegas
Bakersfield
Los Angeles
Anaheim
Long Beach
San Diego
Tijuana
Mexicali
BAJA CALIFORNIA
Google
Map data ©2018 Google, INEGI



trapping
transects
telemetry
survey
SDM
scat analysis
review
model
GIS
genetics
dog surveys
camera traps
tools
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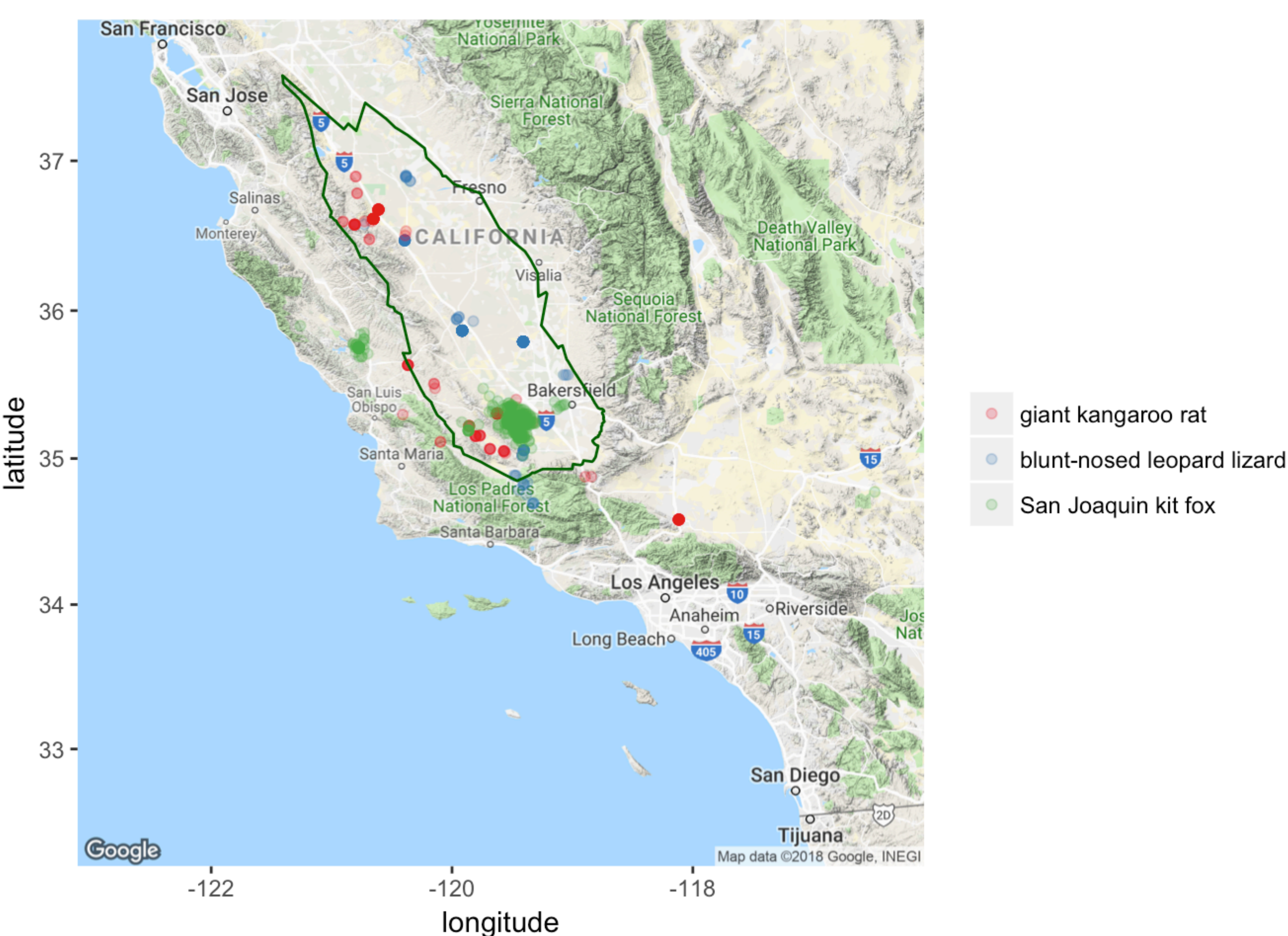
10
15
frequency
blunt-nosed leopard lizard
giant kangaroo rat
San Joaquin kit fox



San Francisco
San Jose
Yosemite National Park
Sierra National Forest
Salinas
Monterey
Fresno
CALIFORNIA
Visalia
Death Valley National Park
Sequoia National Forest
Bakersfield
San Luis Obispo
Santa Maria
Los Padres National Forest
Santa Barbara
Los Angeles
Anaheim
Riverside
Long Beach
San Diego
Tijuana
Google
Map data ©2018 Google, INEGI
37
36
35
34
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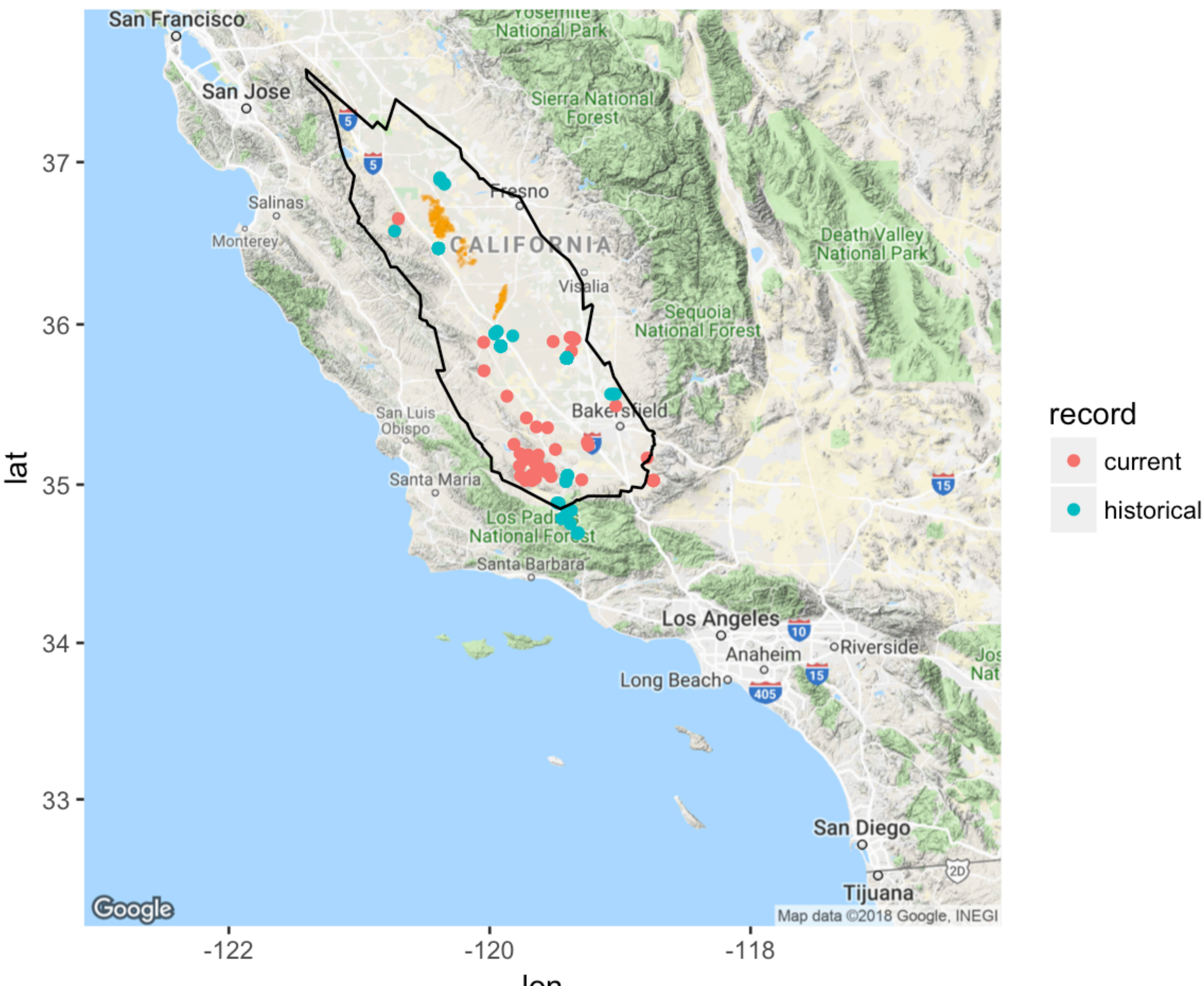
latitude
-122
-120
-118
longitude
giant kangaroo rat
blunt-nosed leopard lizard
San Joaquin kit fox



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San Jose
Sierra National Forest
Fresno
Salinas
Monterey
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Death Valley National Park
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Sequoia National Forest
San Luis Obispo
Bakersfield
Santa Maria
Los Padres National Forest
Santa Barbara
Los Angeles
Anaheim
Riverside
Long Beach
San Diego
Tijuana
Google
Map data ©2018 Google, INEGI
lat
37
36
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34
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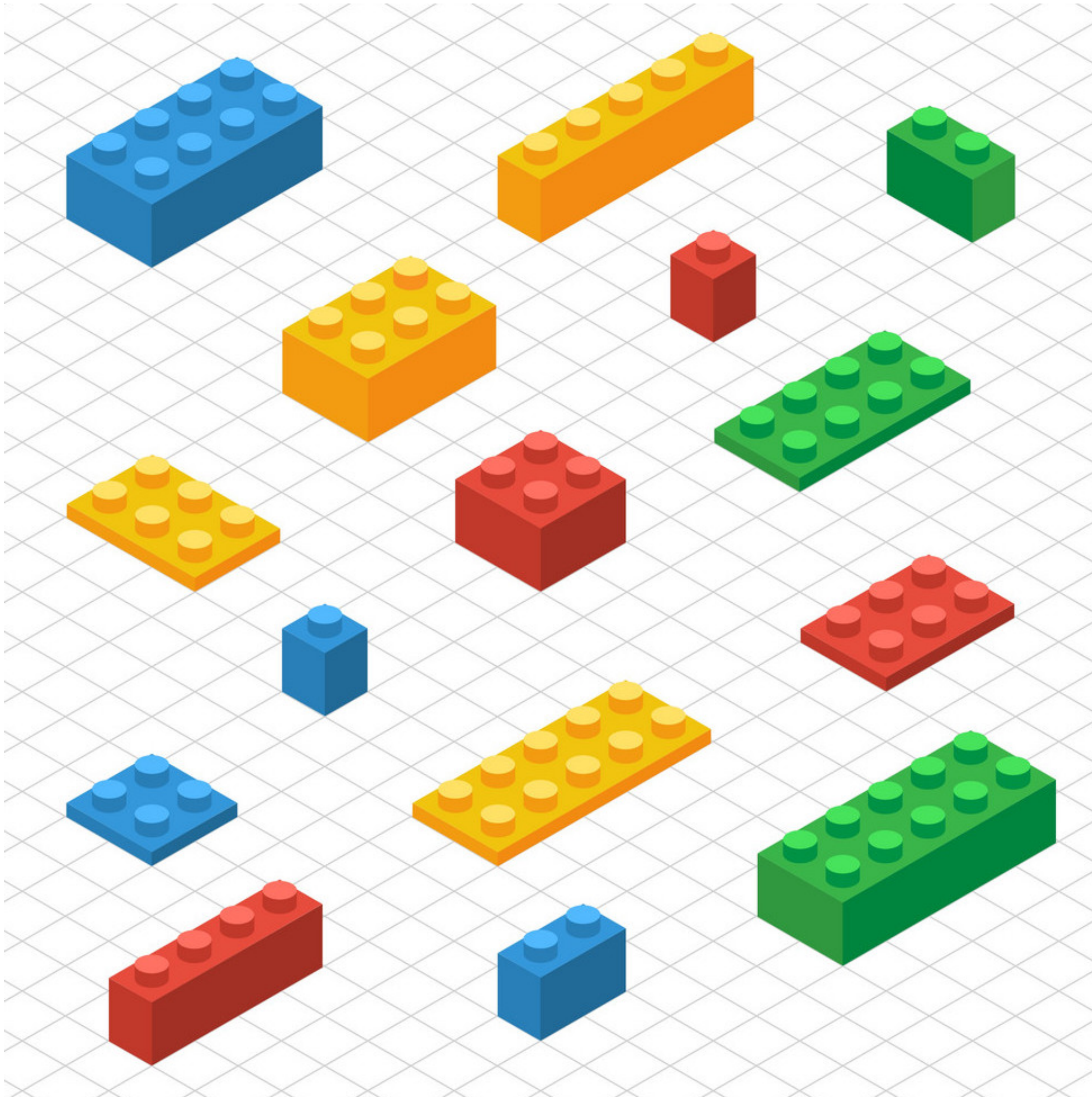
-122
-120
-118
lon
record
current
historical

bio4enviro connection

evidence > species > tools > locations > reuse > big picture

tools



whatever you can use to put the pieces together

implications

water & land always connected

aqua spell +
changes in land use
is the magic we need