Long-term monitoring of Texas Tortoises at Palo Alto Battlefield National Historical Park

Jane E. Carlson, Ph.D.,

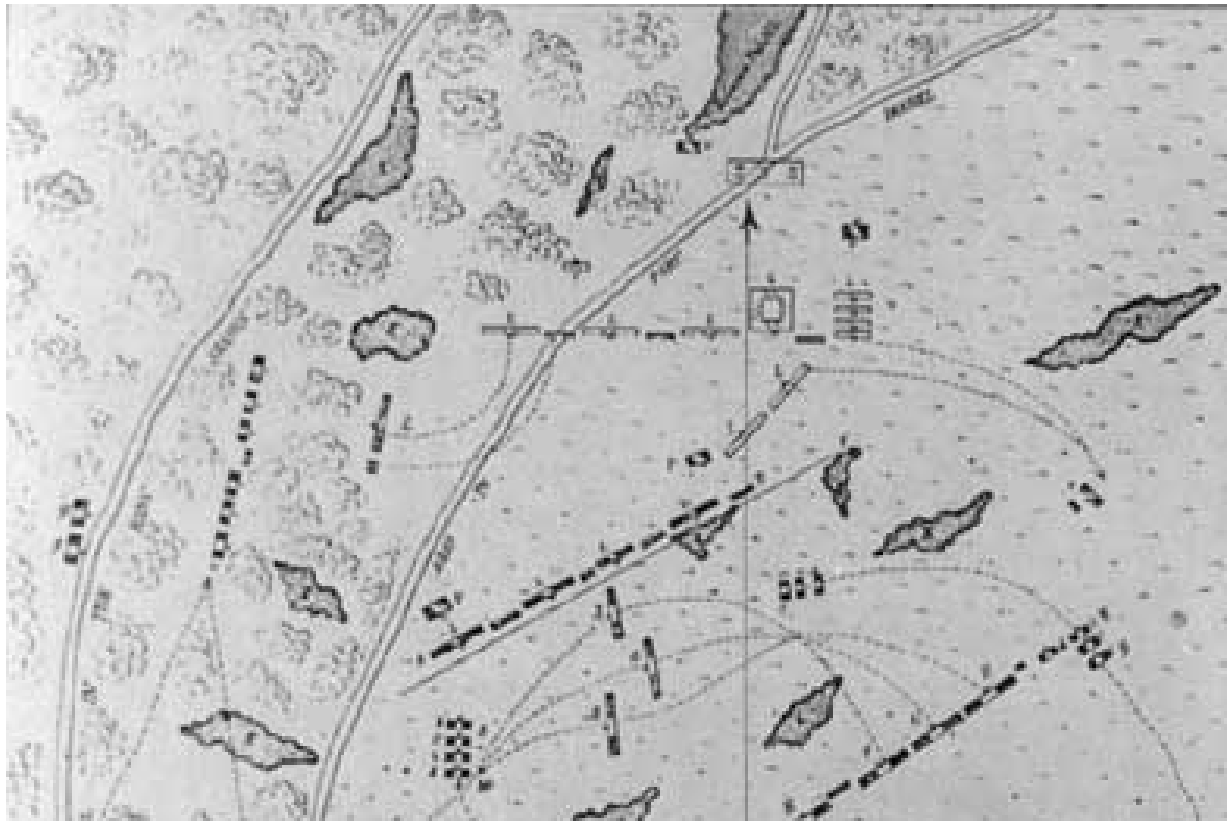
Ecologist at the Gulf Coast I&M Network

Texas Tortoise Working Group
Spring 2025

Partners, network staff, and other contributors
UGA: Kurt Buhlmann, Tracey Tuberville, and Heather Gaya

I&M, PAAL and more: Jeff Bracewell, Martha Segura, Bob Woodman, Whitney Granger, Billy Finney, Fabi Speyrer, Drew Davis, Lee Bragg, and Rolando







[Portion of Ramsey's 1850 map](#) from May 1846 battle







National Park Service Management Objectives for Palo Alto Battlefield

- **Highest priority is to maintain the historic landscape and viewshed of the 1846 battle** within the 520 ha (1,285 ac) property of expansive grassland dominated by cordgrass and woody uplands at its perimeter.



National Park Service Management Objectives for Palo Alto Battlefield

- **Highest priority is to maintain the historic landscape and viewshed of the 1846 battle** within the 520 ha (1,285 ac) property of expansive grassland dominated by cordgrass and woody uplands at its perimeter.
- Maintaining the battlefield as a **cultural landscape generally aligns with natural ecological** landscape. Over 100 ha of woody uplands where tortoises are known or expected to occur
- **Texas tortoises** were selected in 2006 for long-term study by NPS I&M. Over 350 tortoises marked so far during annual surveys in a mark-recapture study. Through their work in the park, I&M draws attention to tortoises, plants, and other wildlife

Management Challenges and Actions at Palo Alto Battlefield NHP



1934



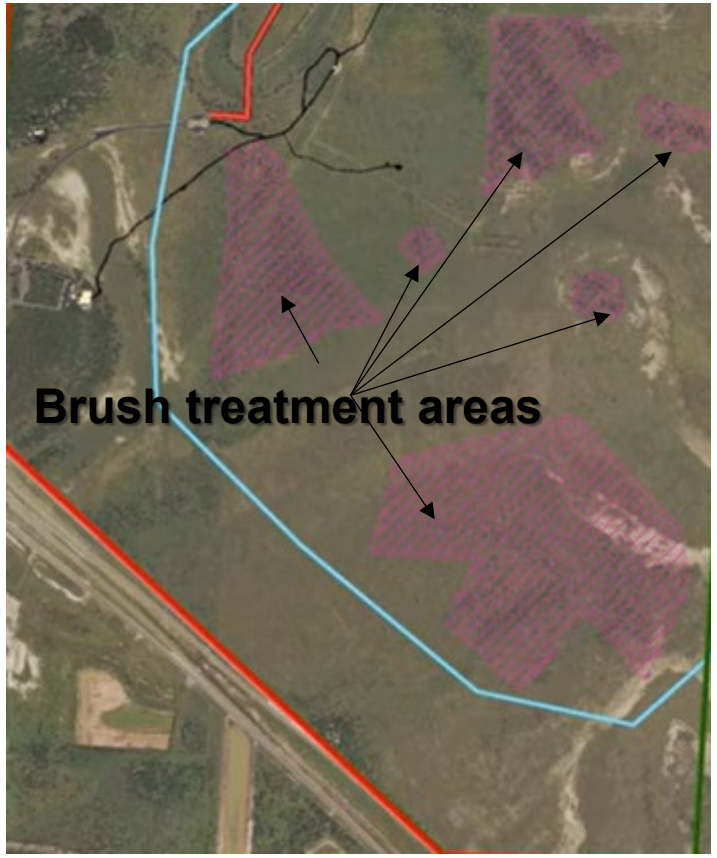
1977 (similar in 1995)



2023

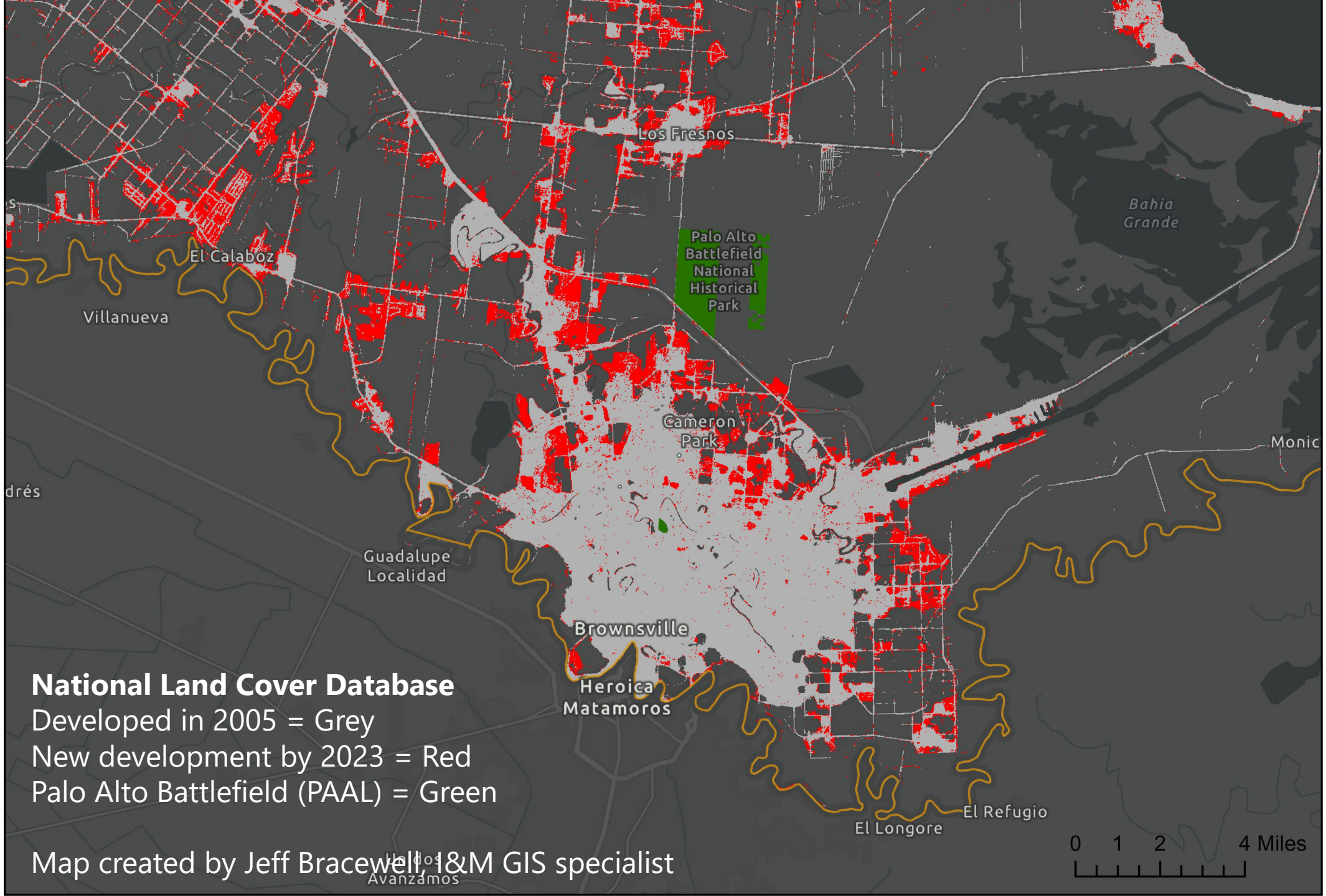
Management Challenges and Actions at Palo Alto Battlefield NHP

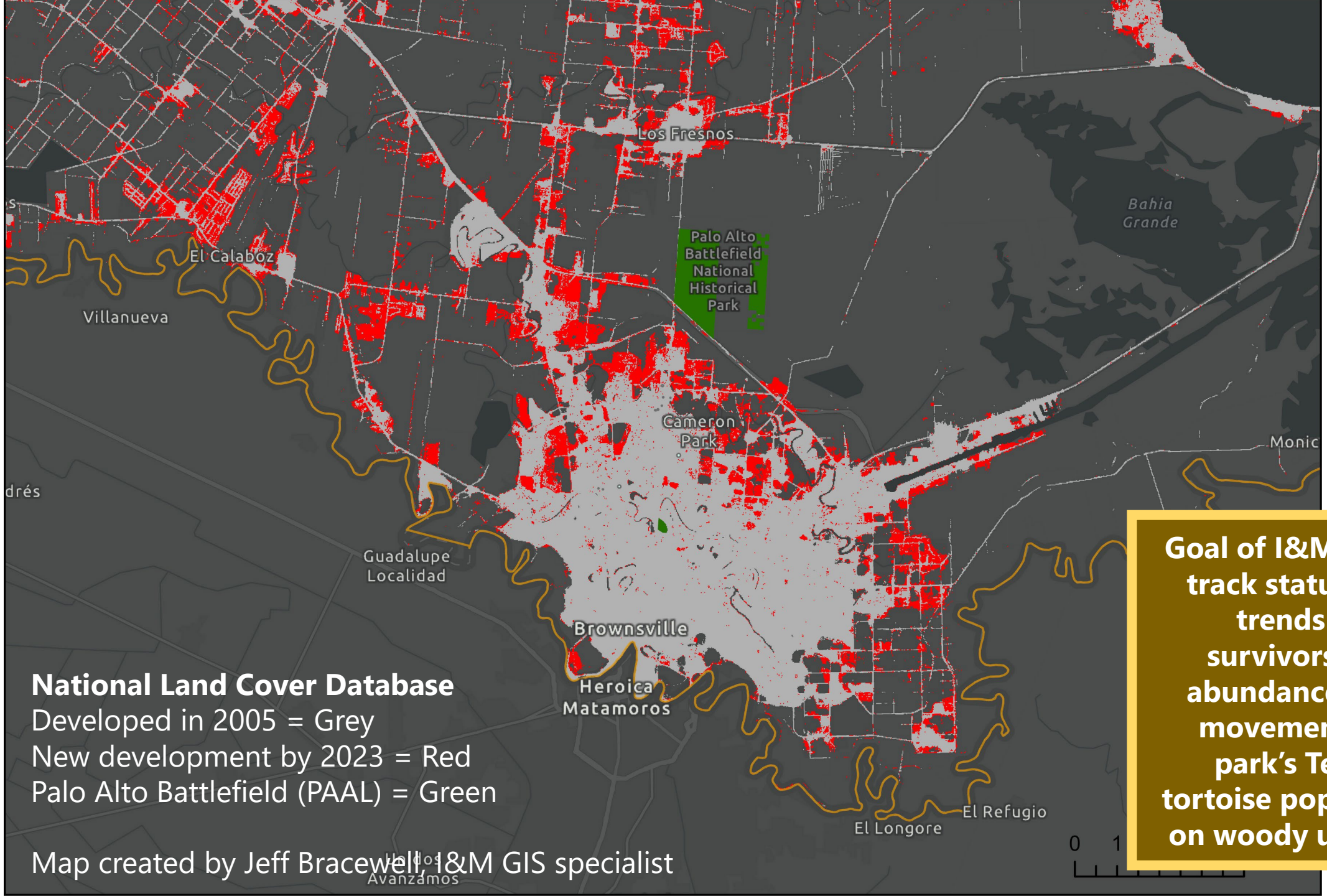






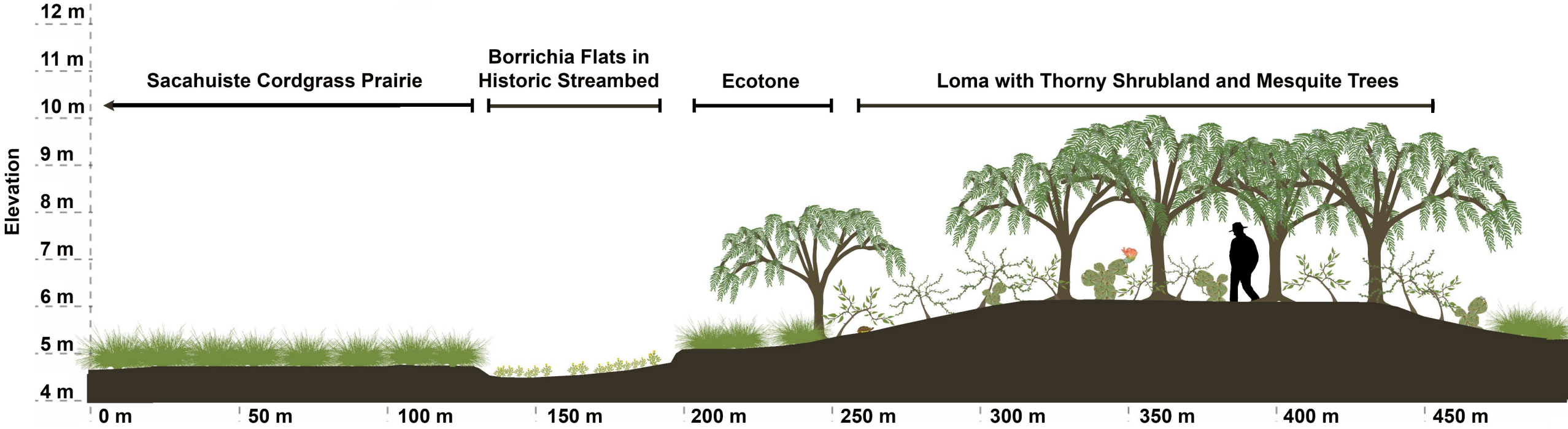
- 2014-2016 cultural landscape restoration with USFWS
- Archeology surveys from 2005-2012, clearing to ground surface in 200 x 200 m blocks in a patchwork design
- Cordgrass plantings in 2014, 2020 and 2023
- Tortoise fence added along southern boundary in 2015
- Waif tortoises generally accepted without quarantine


Los Fresnos
Bahia Grande
Palo Alto Battlefield National Historical Park
El Calaboz
Villanueva
Cameron Park
Guadalupe Localidad
Brownsville
Heroica Matamoros
El Refugio
El Longore
Monic
drés
0 1 2 4 Miles
National Land Cover Database
Developed in 2005 = Grey
New development by 2023 = Red
Palo Alto Battlefield (PAAL) = Green
Map created by Jeff Bracewell, I&M GIS specialist

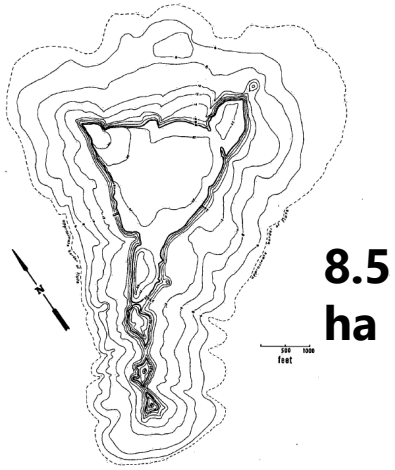

Los Fresnos
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drés
0
1
National Land Cover Database
Developed in 2005 = Grey
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Palo Alto Battlefield (PAAL) = Green
Map created by Jeff Bracewell, I&M GIS specialist
Goal of I&M study: track status and trends in survivorship, abundance, and movements in park's Texas tortoise population on woody uplands

Defining Lomas at Palo Alto Battlefield

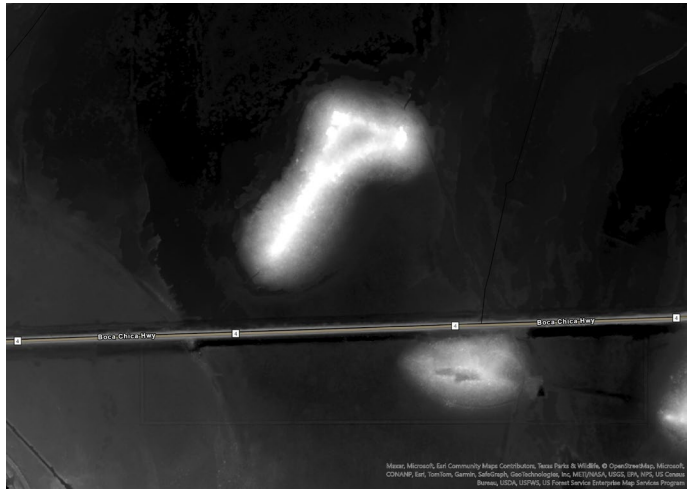
- Park lomas are levees of silty clay loam soils formed from historical river meanders, which differs from wind-deposited dune clay lomas near the coast
- Natural loma vegetation is thornscrub, which occurs on true levee soils (Laredo silty clay loam) and mid-elevation transitional soils in the park (Chargo silty clay, Laredo silty clay loam saline)

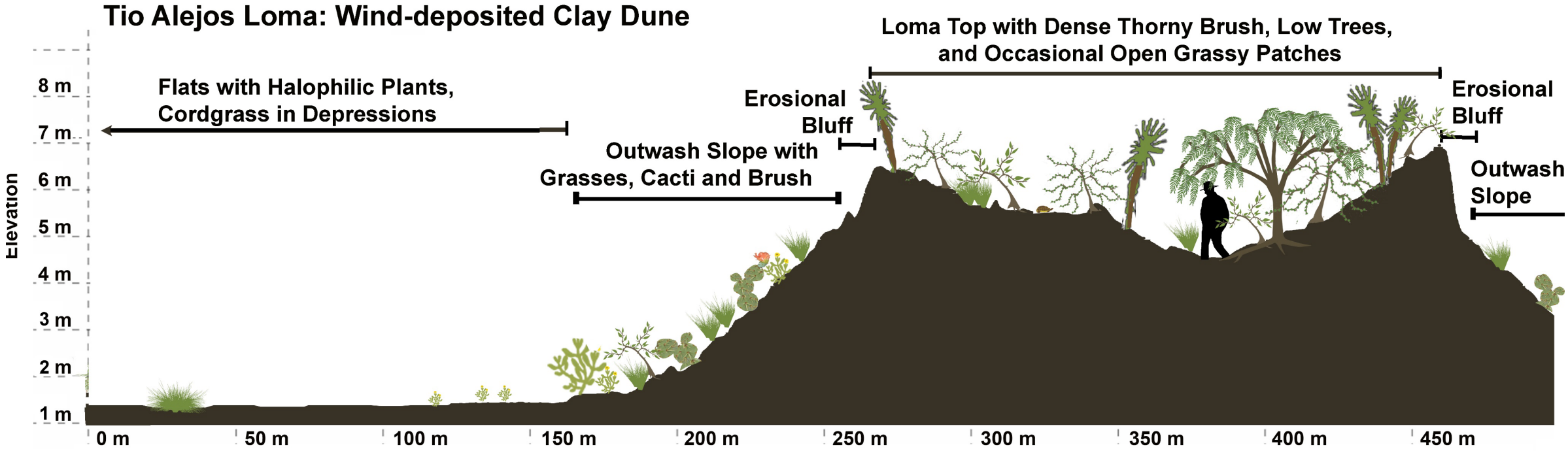


Coastal Loma: Tio Alejos, Auffenberg and Weaver (1969)

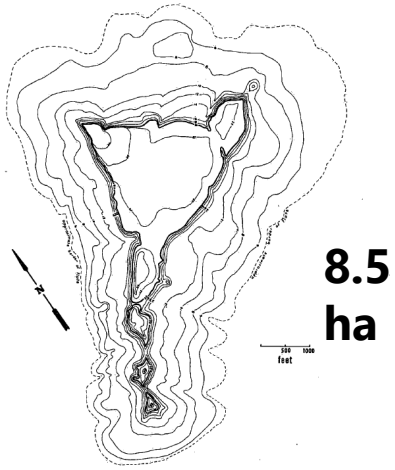




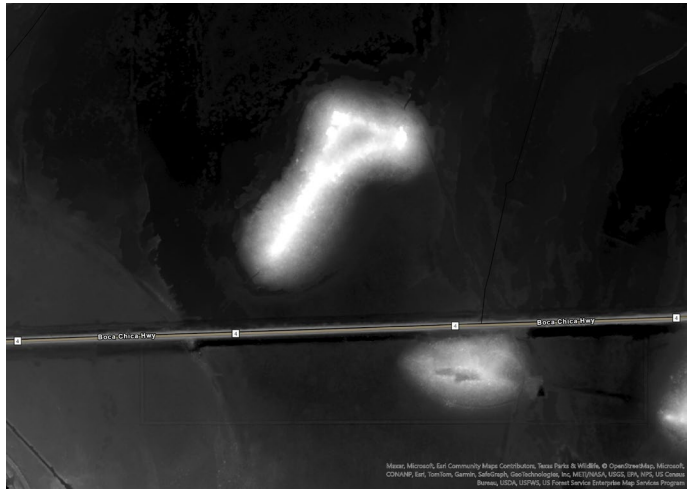


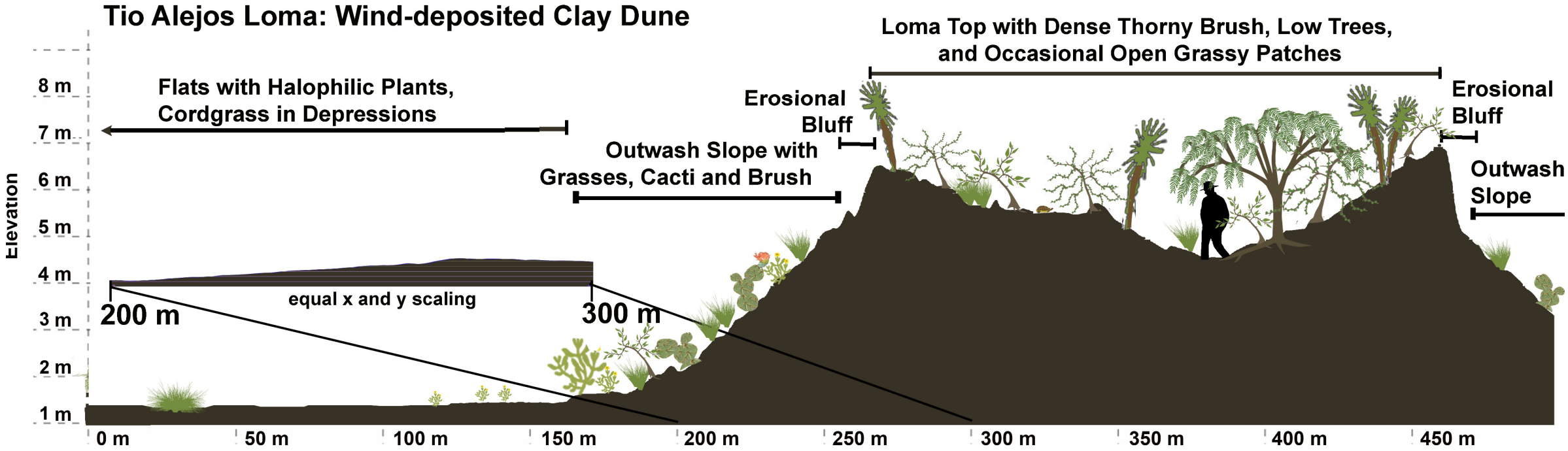


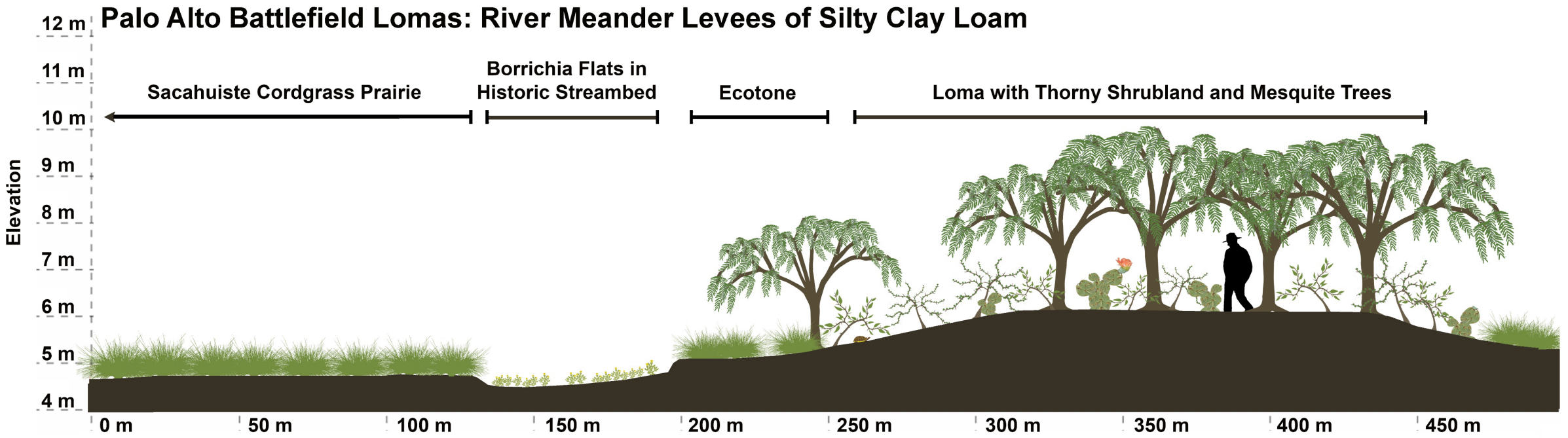
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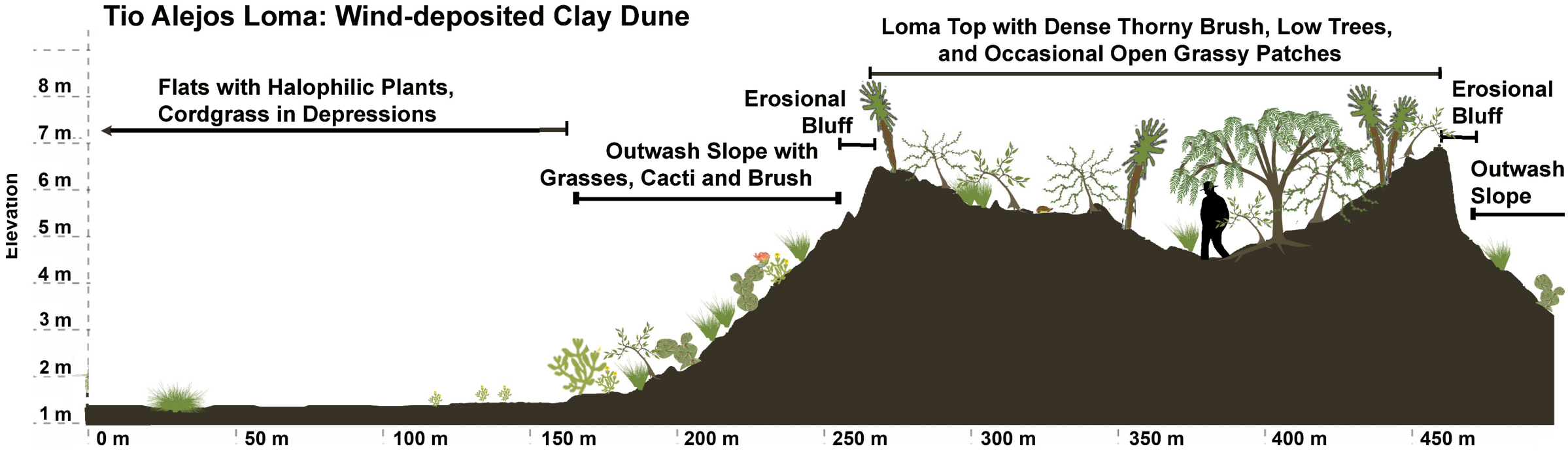






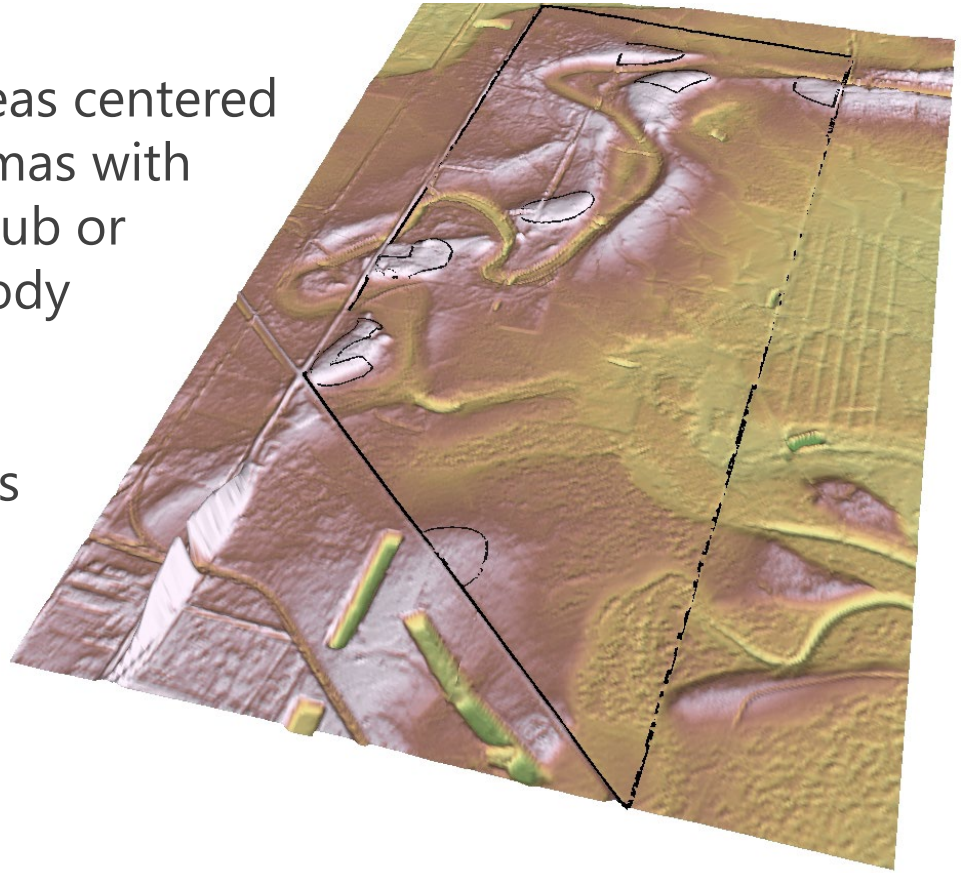


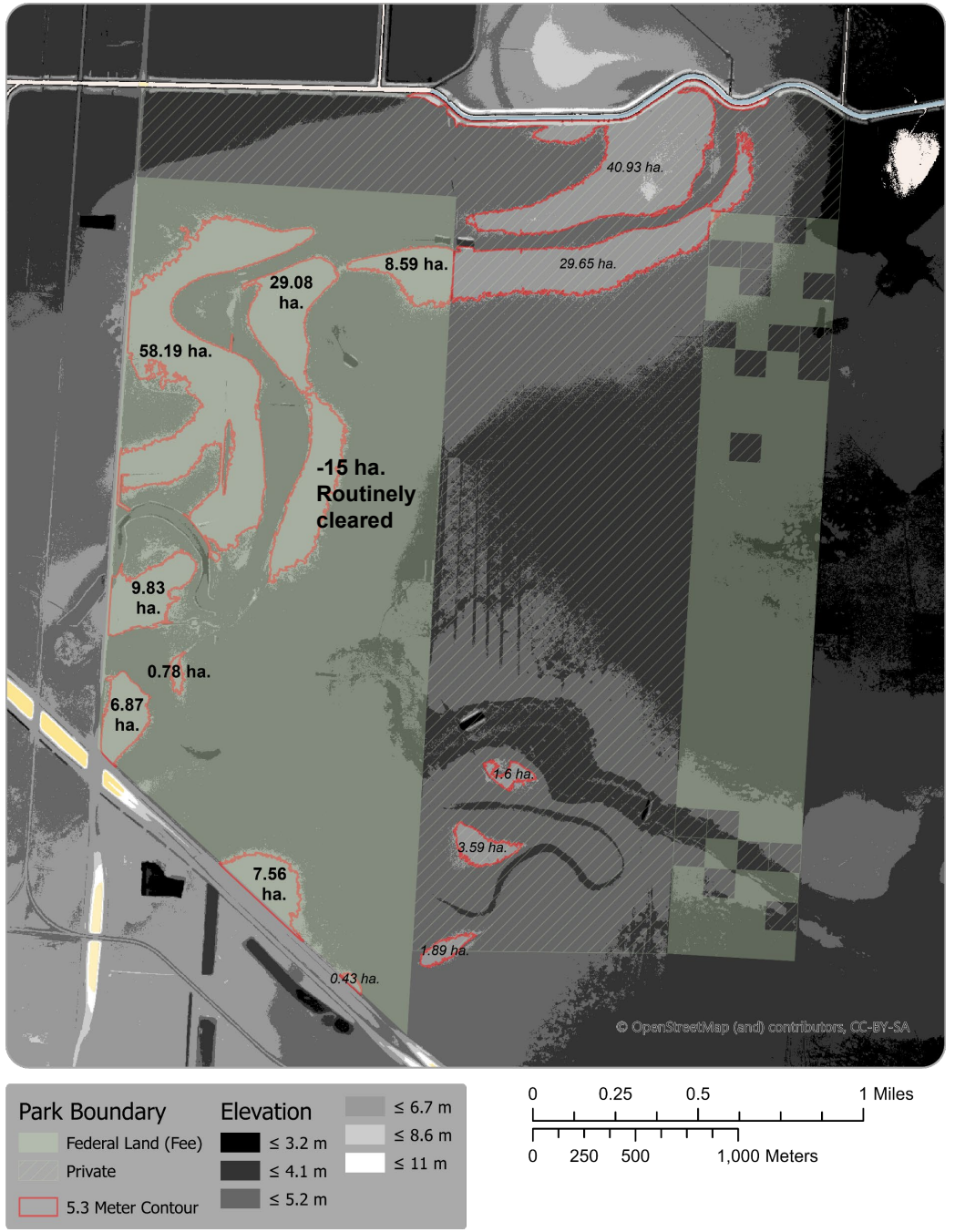

Palo Alto Battlefield Lomas: River Meander Levees of Silty Clay Loam
Elevation
12 m
11 m
10 m
9 m
8 m
7 m
6 m
5 m
4 m
Sacahuiste Cordgrass Prairie
Borrichia Flats in Historic Streambed
Ecotone
Loma with Thorny Shrubland and Mesquite Trees
0 m
50 m
100 m
150 m
200 m
250 m
300 m
350 m
400 m
450 m


Tio Alejos Loma: Wind-deposited Clay Dune
Elevation
8 m
7 m
6 m
5 m
4 m
3 m
2 m
1 m
Flats with Halophilic Plants, Cordgrass in Depressions
Outwash Slope with Grasses, Cacti and Brush
Erosional Bluff
Loma Top with Dense Thorny Brush, Low Trees, and Occasional Open Grassy Patches
Erosional Bluff
Outwash Slope
0 m
50 m
100 m
150 m
200 m
250 m
300 m
350 m
400 m
450 m

Defining Lomas at Palo Alto Battlefield

- Lomas defined using 5.3 meter contour, capturing thornscrub, mesquital and mixed prairie savanna ecotones
- I&M survey areas centered on peaks of lomas with native thornscrub or recovering woody vegetation
- Routine surveys cover 28 ha of 106 ha of similar habitat on park



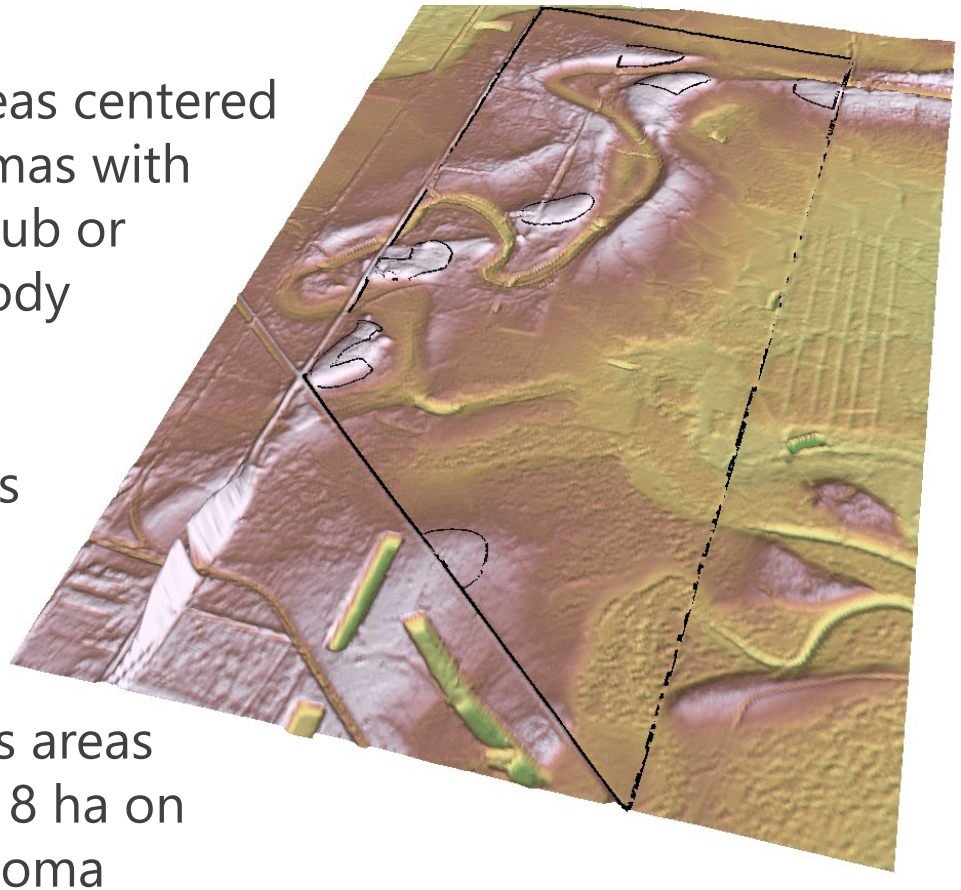


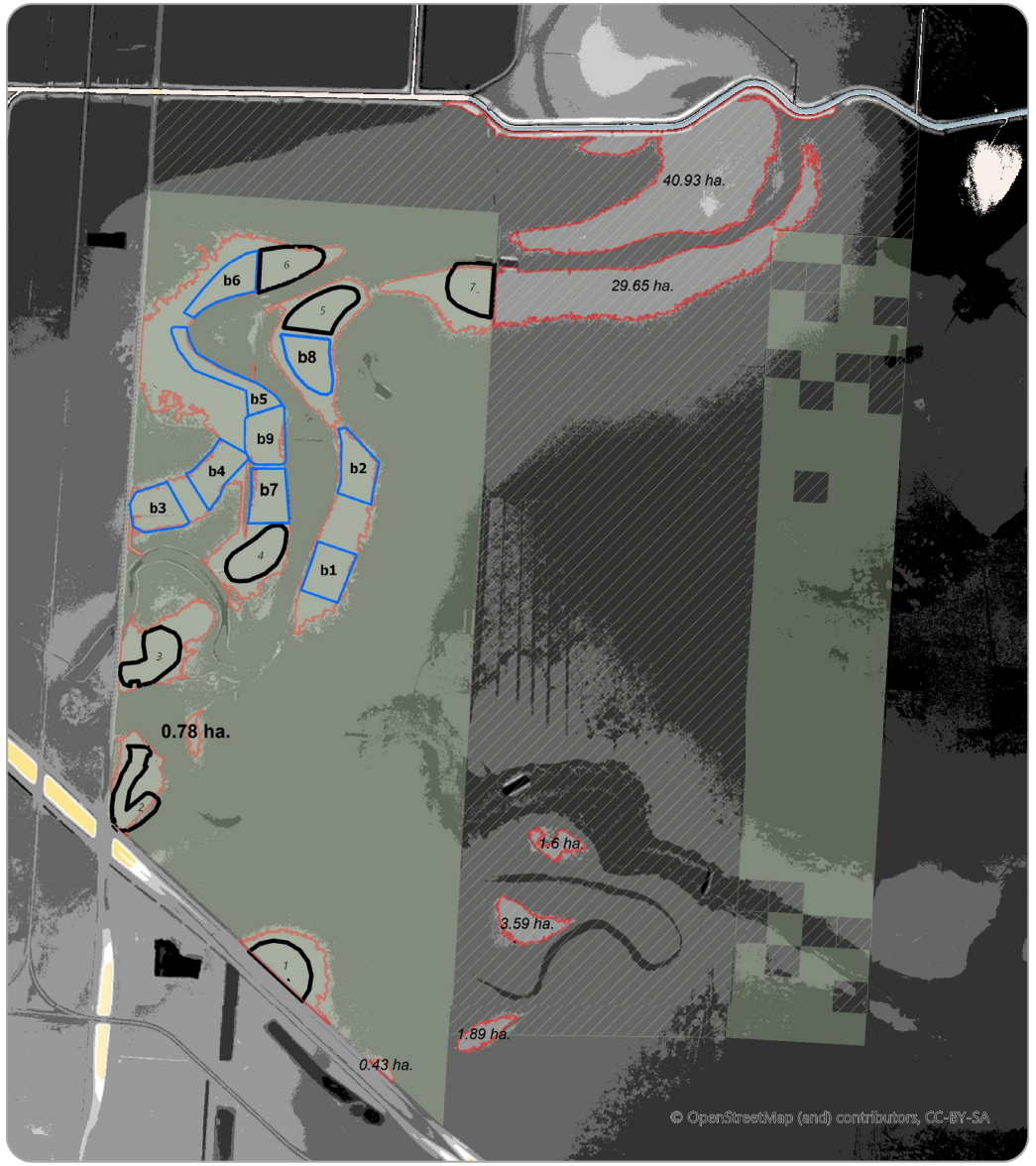
Defining Lomas at Palo Alto Battlefield

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- Routine surveys cover 28 ha of 106 ha of similar habitat on park. Bonus areas add 28 ha plus 8 ha on brush-cleared loma







Spring 2025 Status of 17-year Project

- **28 events since 2008, 7 repeat sample trips, 357 tortoises marked**
  - 19 hatchlings too small to mark
  - 63 dead tortoise, 23 of those marked
- **Annual reports** Emailed to park and NPS-only online since 2016; *publicly available web article or report in 2023 and 2024*
- **Analysis of survivorship and trends in abundance**: spring 2014 to fall 2024
- **Analysis of movements:** marks and recaptures from 2008 to 2024, excluding newly marked individuals in 2023 and 2024





What have we learned so far

- Movements
- Survivorship and trends in abundance
- Vegetation change











Movement Results: Tortoises as homebodies and nomads

"These tortoises are therefore primarily nomadic, and maintain restricted activity ranges for only a few days between successive greater or lesser secondary movements"

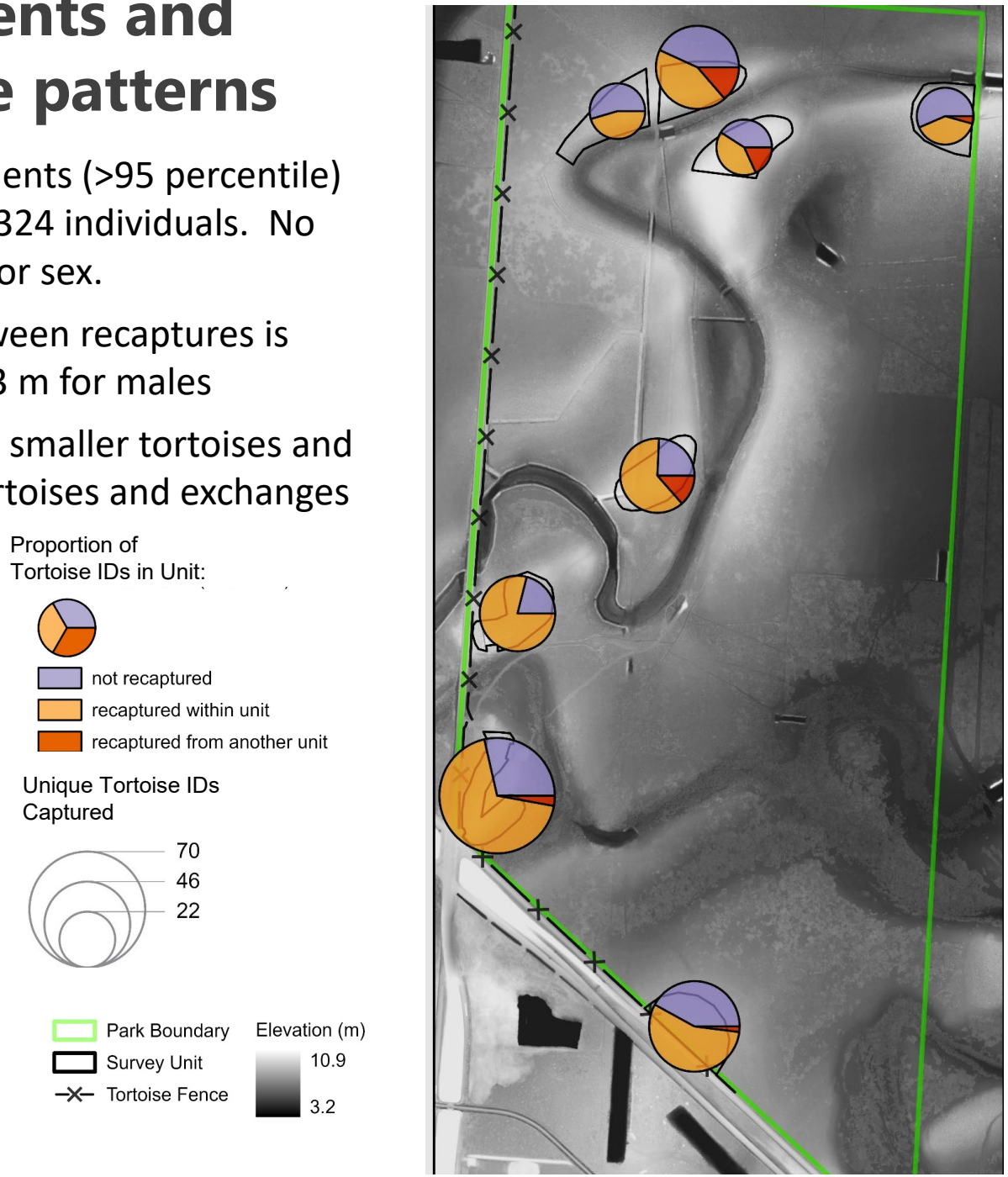
Auffenberg and Weaver 1969

Rose and Judd 2014 disagreed

At PAAL, **37% of all marked tortoises have been captured only once**; 56% have been recaptured in same unit; 7% recaptured in a different unit.

Movements and Recapture patterns

- Long distance movements (>95 percentile) recorded for 13% of all 324 individuals. No tendencies in direction or sex.
- Median distance between recaptures is 39 m for females and 63 m for males
- Northern lomas have smaller tortoises and more once-captured tortoises and exchanges



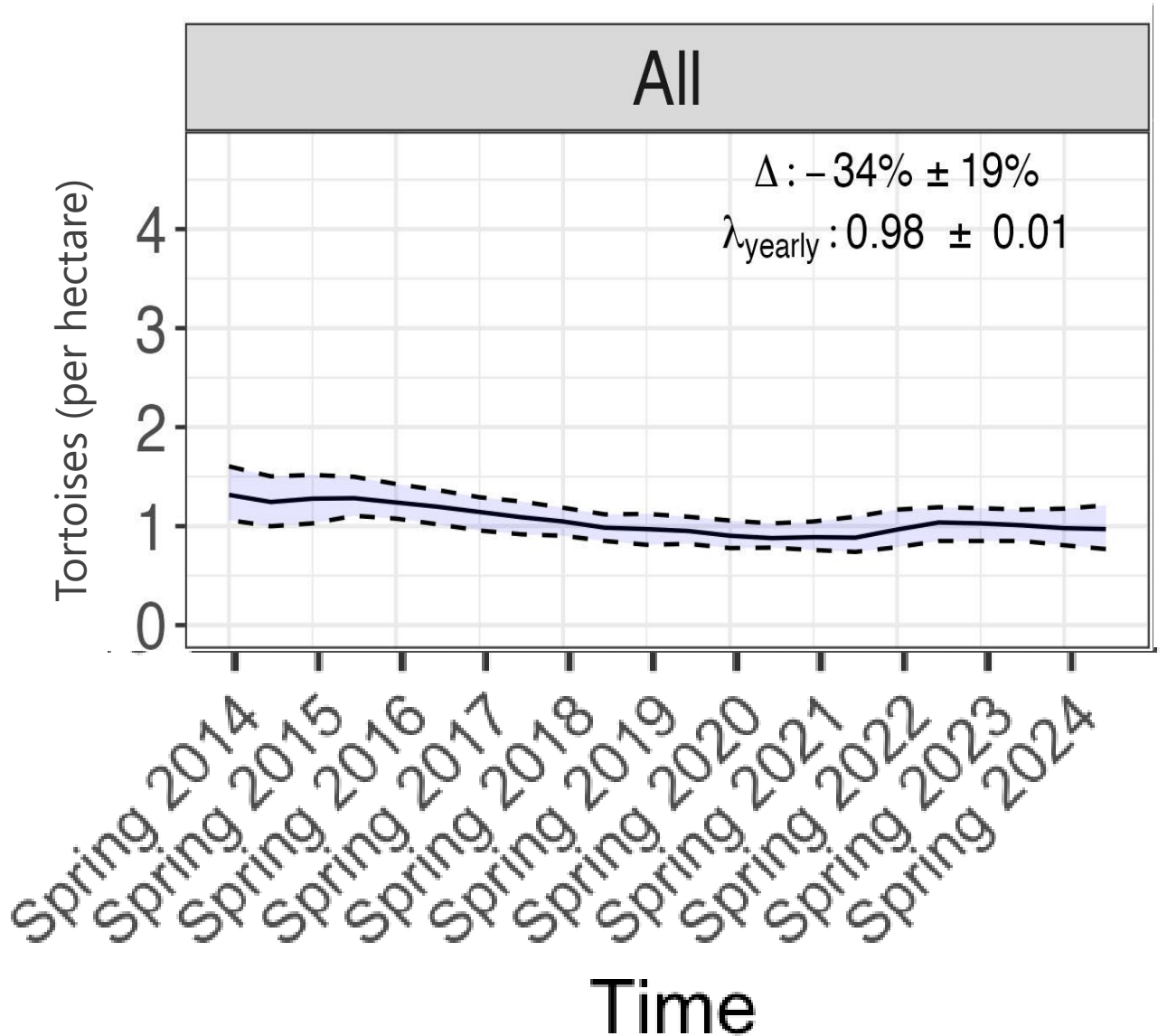
Trend Analysis and Survivorship Results

Bayesian mark-recapture spatial model results
Tuberville et al. in revision

- Annual survivorship is high (87%), but abundance within 28 ha study area has declined over time period from
120 in 2014 **to 90** in 2024

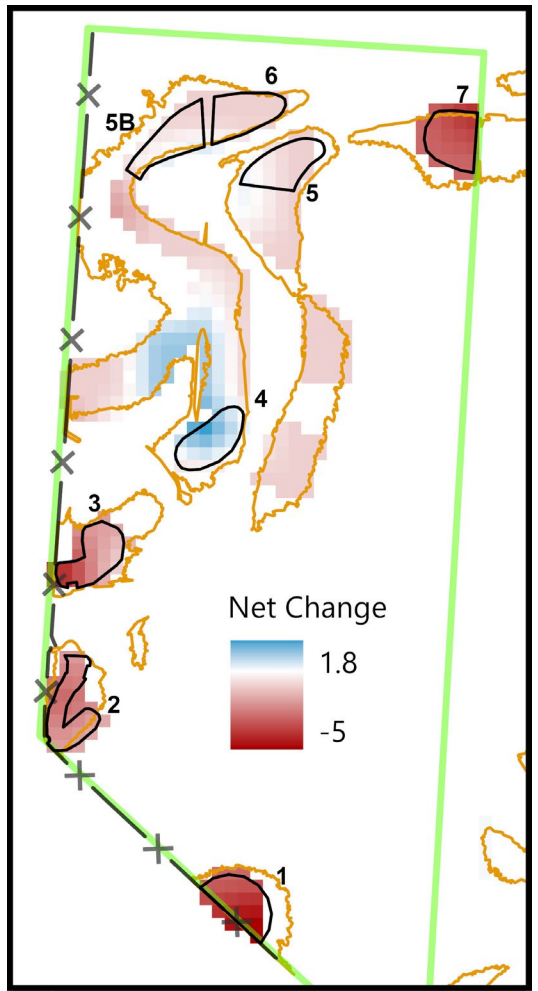
- When estimate includes bonus areas, decline is not significant from **236** in 2014 **to 220** in 2024

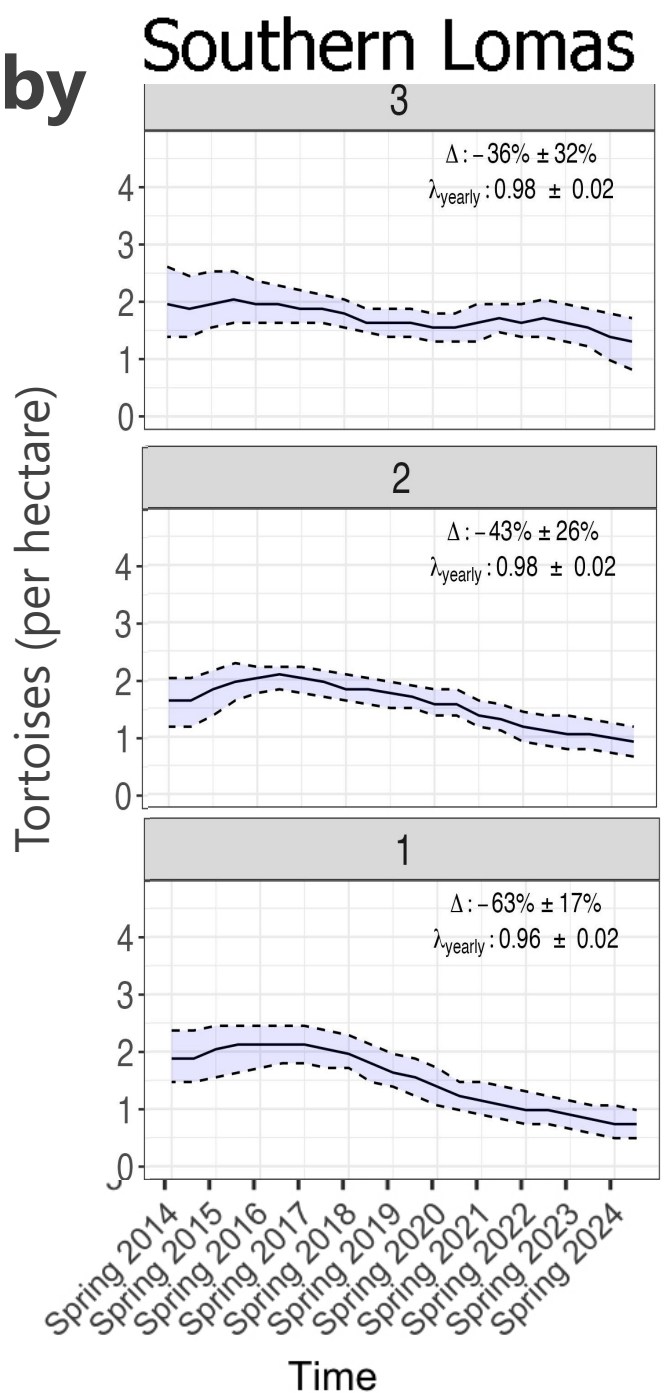
- New spatial model results shown here not yet incorporating covariates such as event-level Vegetation greenness Index (EVI or NDVI) and categorical estimate of Guinea grass invasion

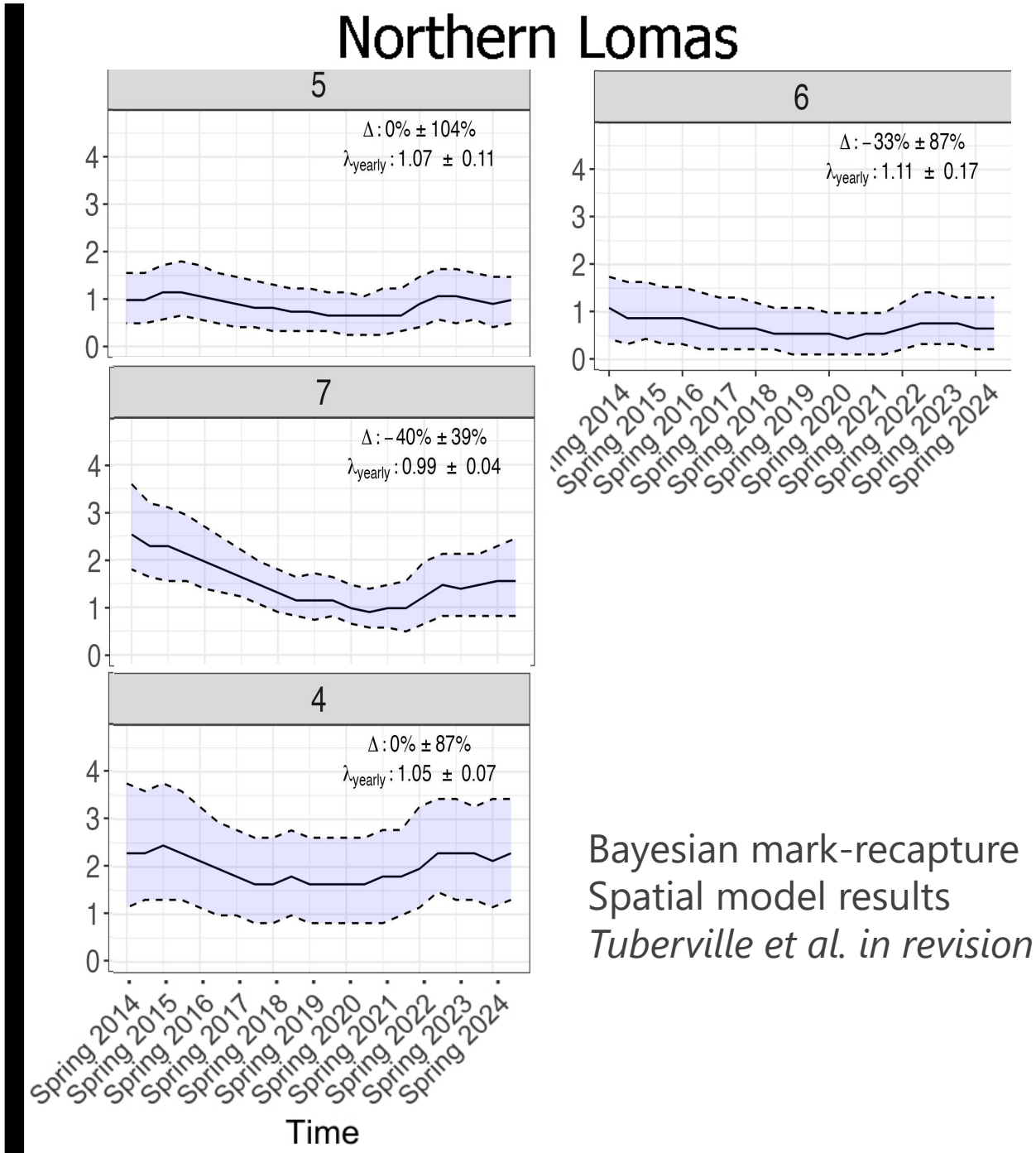


Trend Analysis by Survey Unit

Overall change including bonus areas



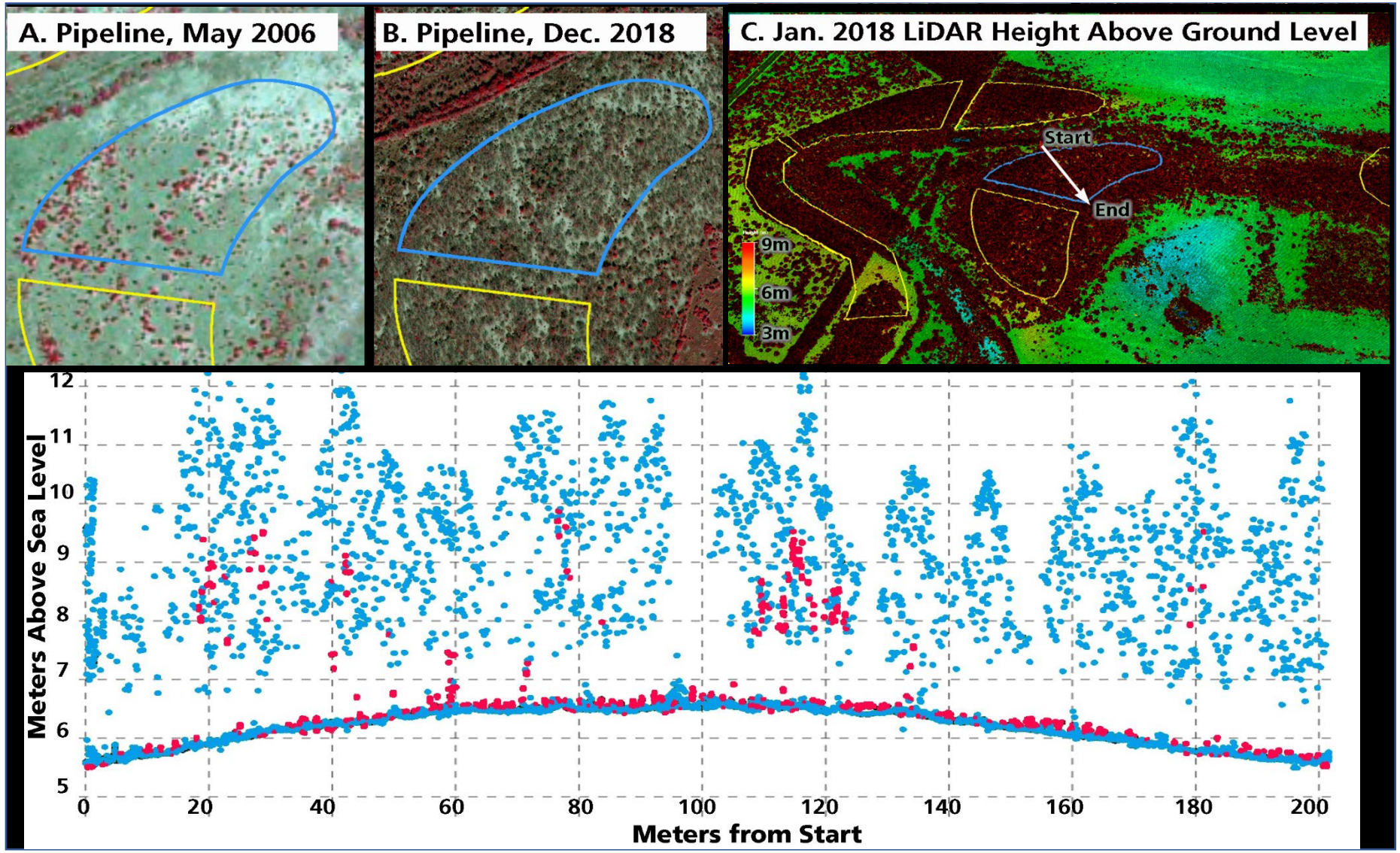




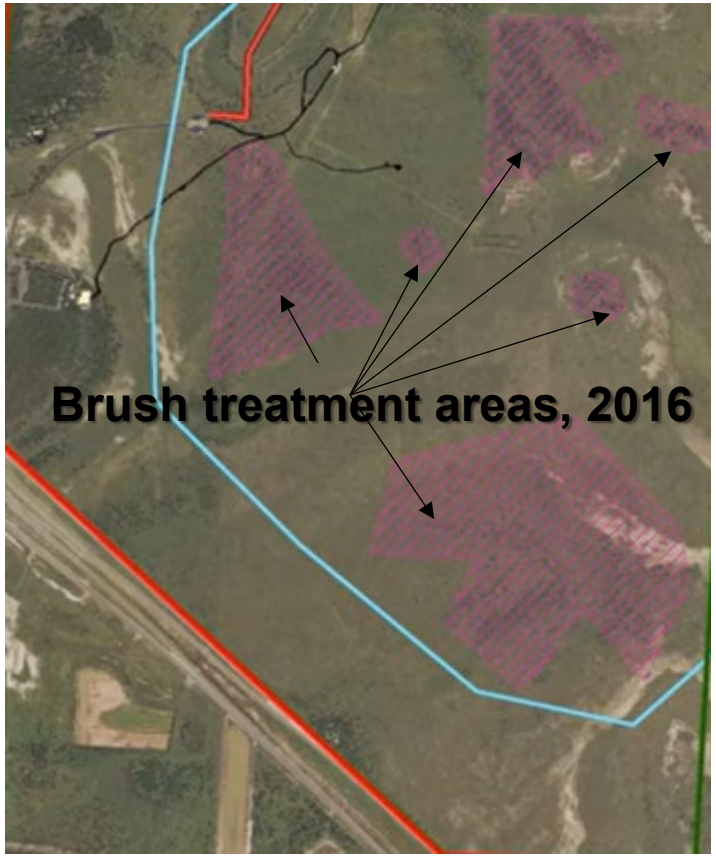
Bayesian mark-recapture Spatial model results
Tuberville et al. in revision

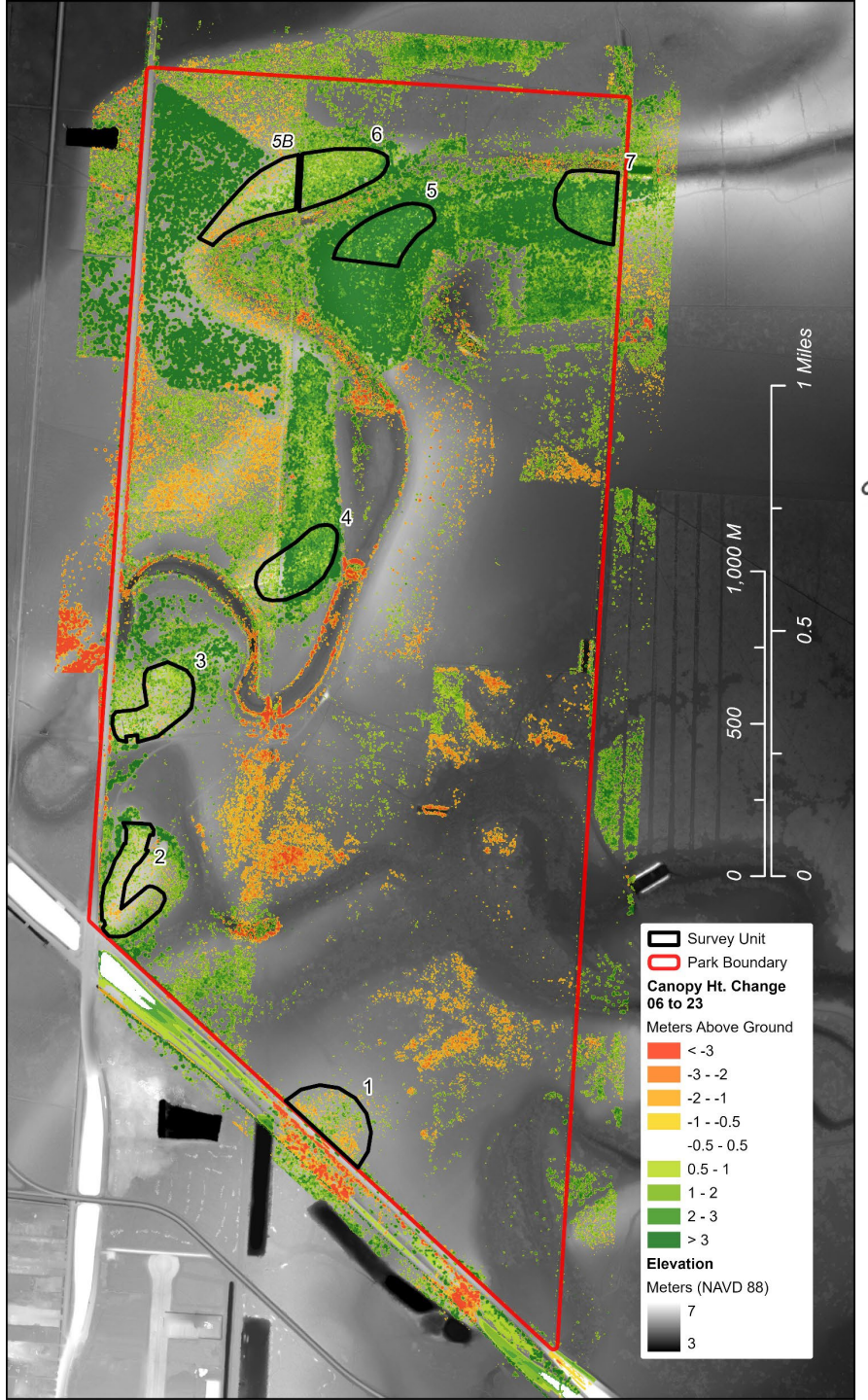
Vegetation Structure has Changed Differently in Northern and Southern Parts of the Park

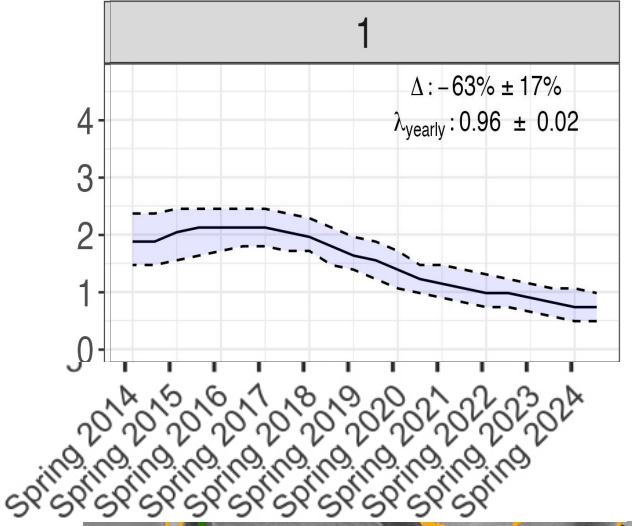
In the North, change is primarily from post- agricultural regrowth

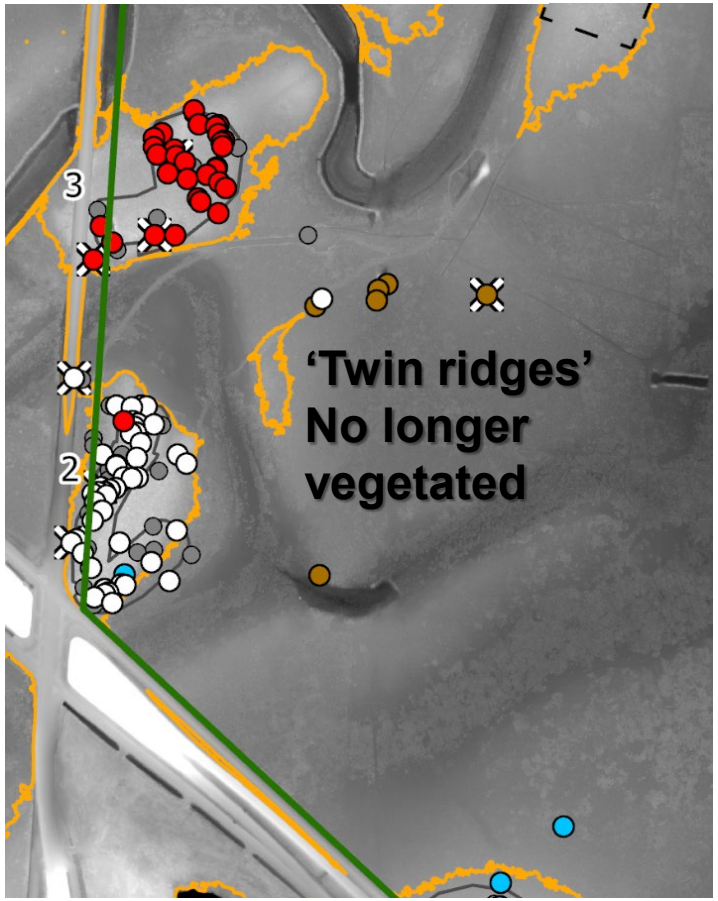


In the South, change is primarily from brush clearing in the historic battlefield



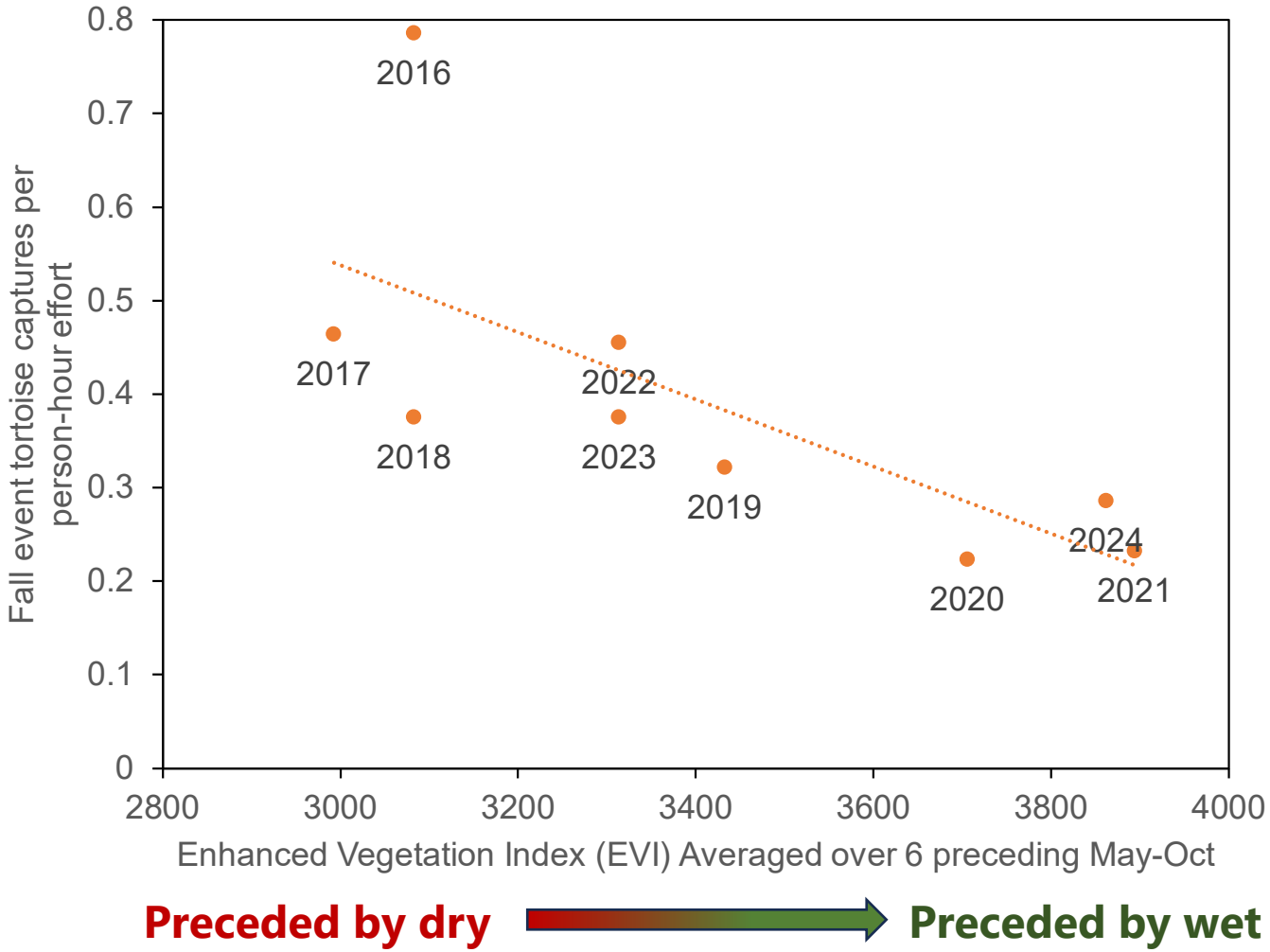


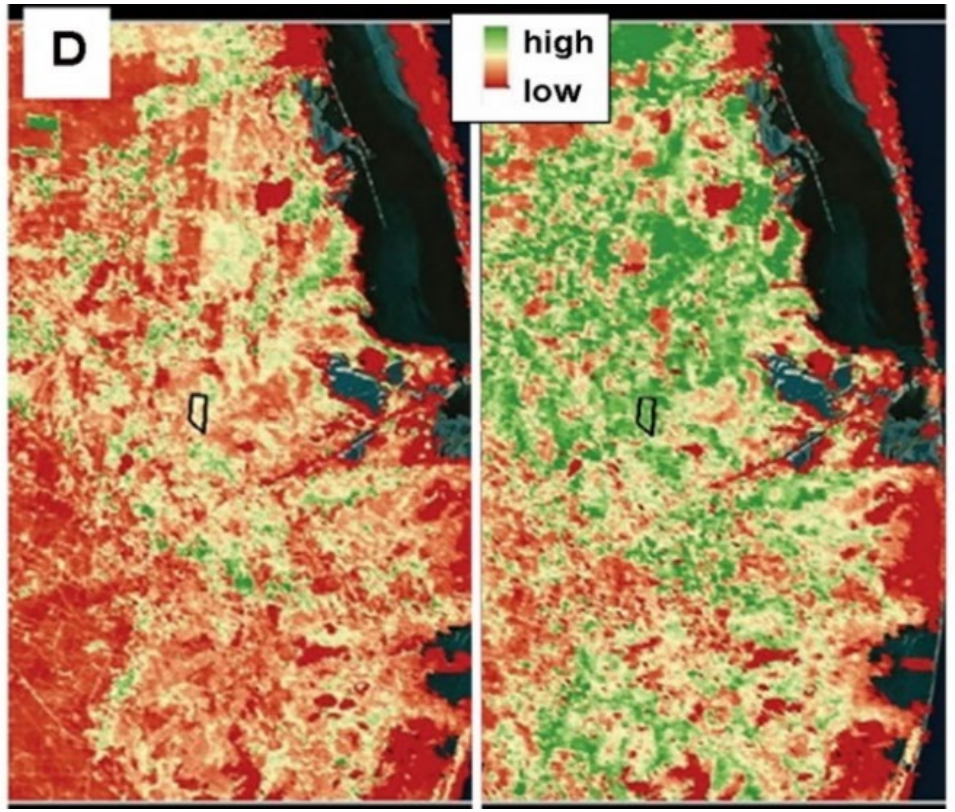




Drought Condition in the Weeks and Months Preceding Surveys

Dense vegetation makes it hard to see tortoises; tortoise behaviors likely change as well





2018-dry year **2020-wet year**

Enhanced Vegetation Index Rasters
For Brownsville area

Guinea Grass Invasion

Major invasion since 2015 in two units; less so in remaining six



April 2015



November 2022

This may help explain the declines in Southside and Northeast Boundary

Conclusions from 17 years at Palo Alto Battlefield and Next Steps

- We have expanded our concept of where park tortoises likely occur and how they move around. **They do interface with management actions,** using ecotones and crossing prairies

- Context of **recent and historic land use** may help explain spatial patterns in abundances, but not the whole story



Conclusions from 17 years at Palo Alto Battlefield and Next Steps

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- Context of **recent and historic land use** may help explain spatial patterns in abundances, but not the whole story

- **Guinea grass management** is elevated to higher priority based on apparent tortoise impacts.

- Park plans to use **fire for brush control** and to reduce invasive grasses; need outside help to understand risks

- Need help from genetics and disease work to better inform the park on its **waif tortoise** handling practices, weighing the costs and benefits



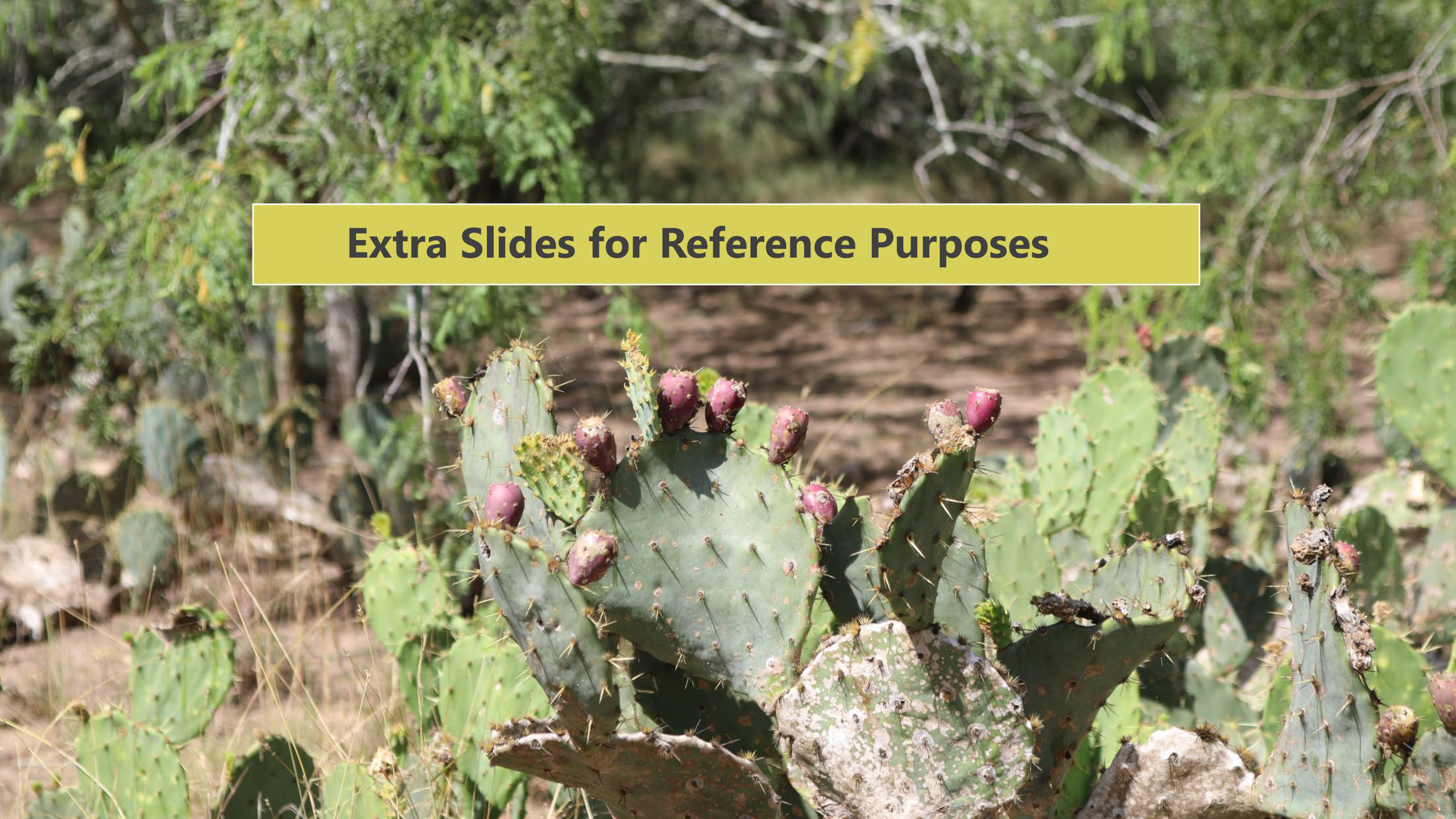
Thank you!







Time for questions and follow up topics

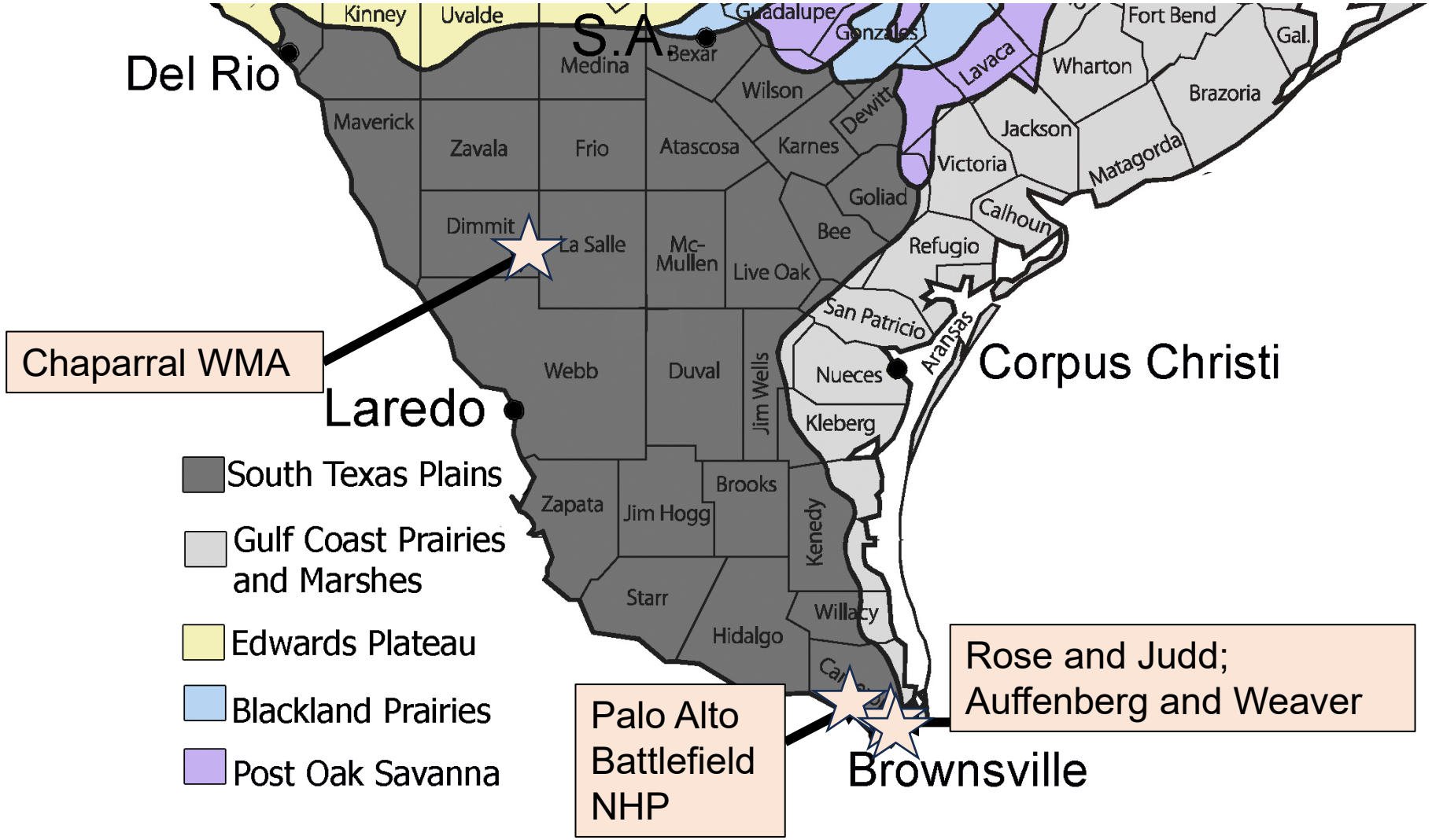


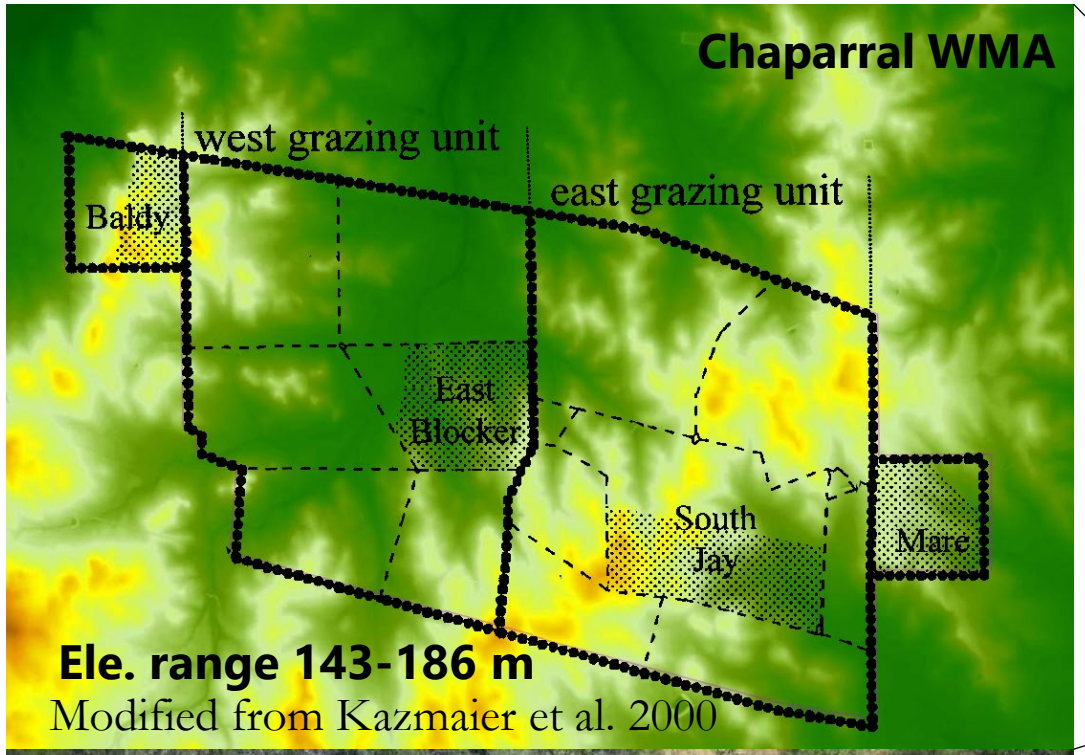
Extra Slides for Reference Purposes

Where do we fit in with other long-term Texas tortoise studies?

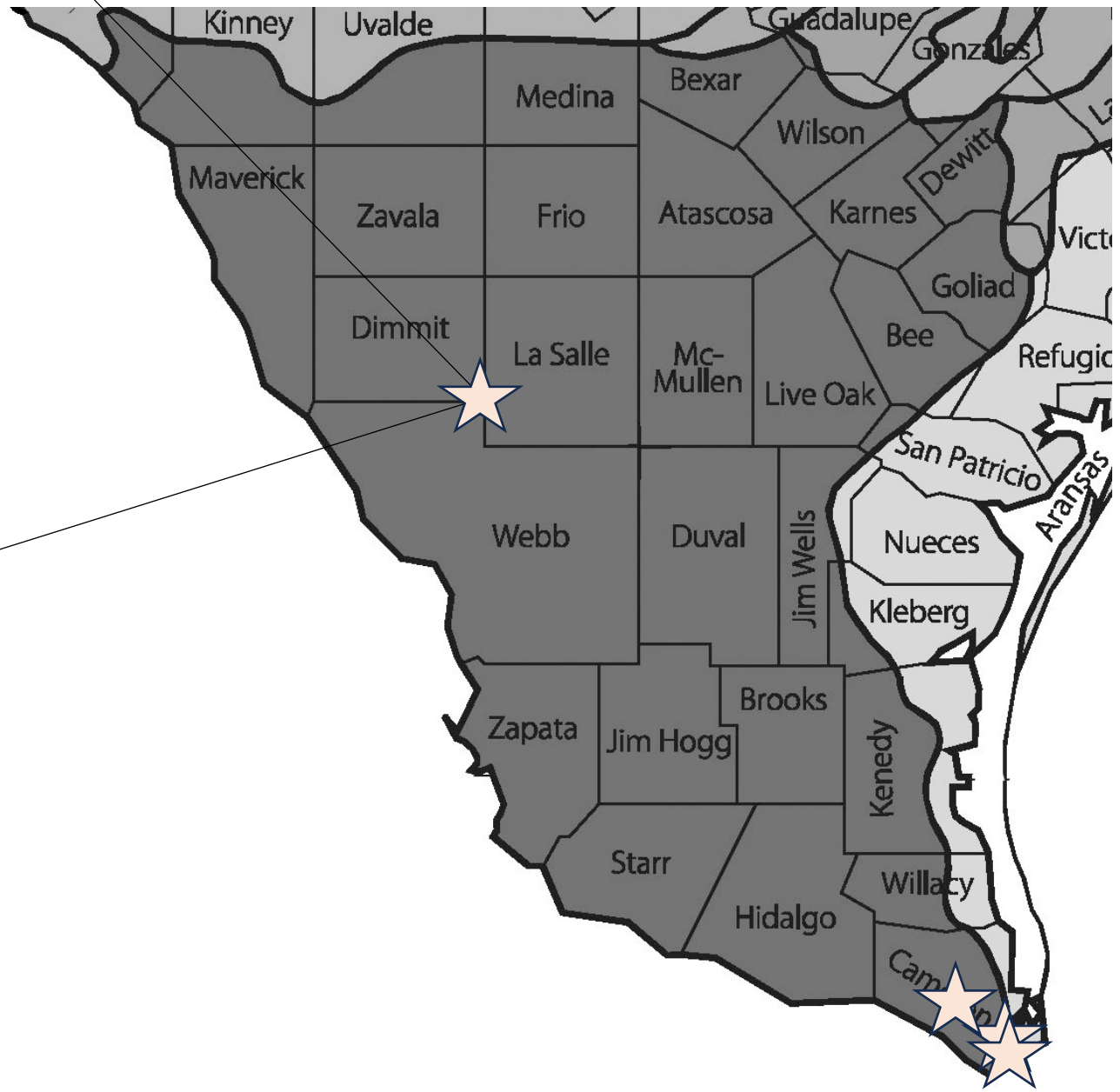
Between isolated lomas in coastal prairie to open brushland expanses in the plains

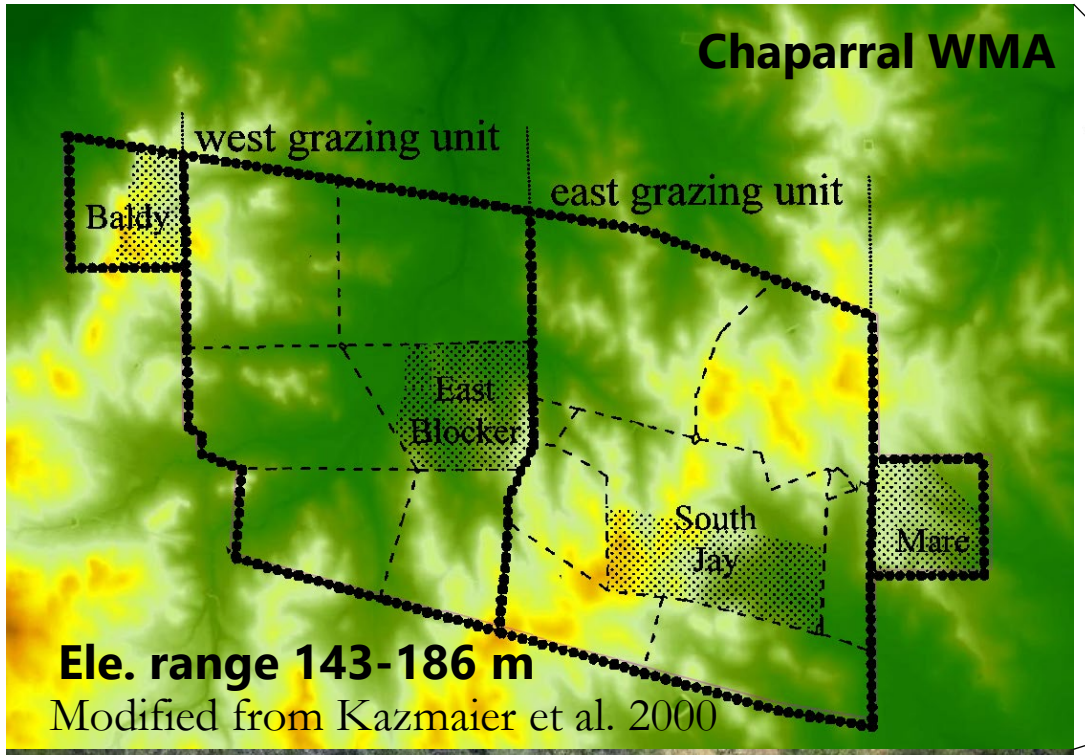
Texas Level III Ecoregions




Chaparral WMA
west grazing unit
east grazing unit
Baldy
East Blocker
South Jay
Mare
Ele. range 143-186 m
Modified from Kazmaier et al. 2000

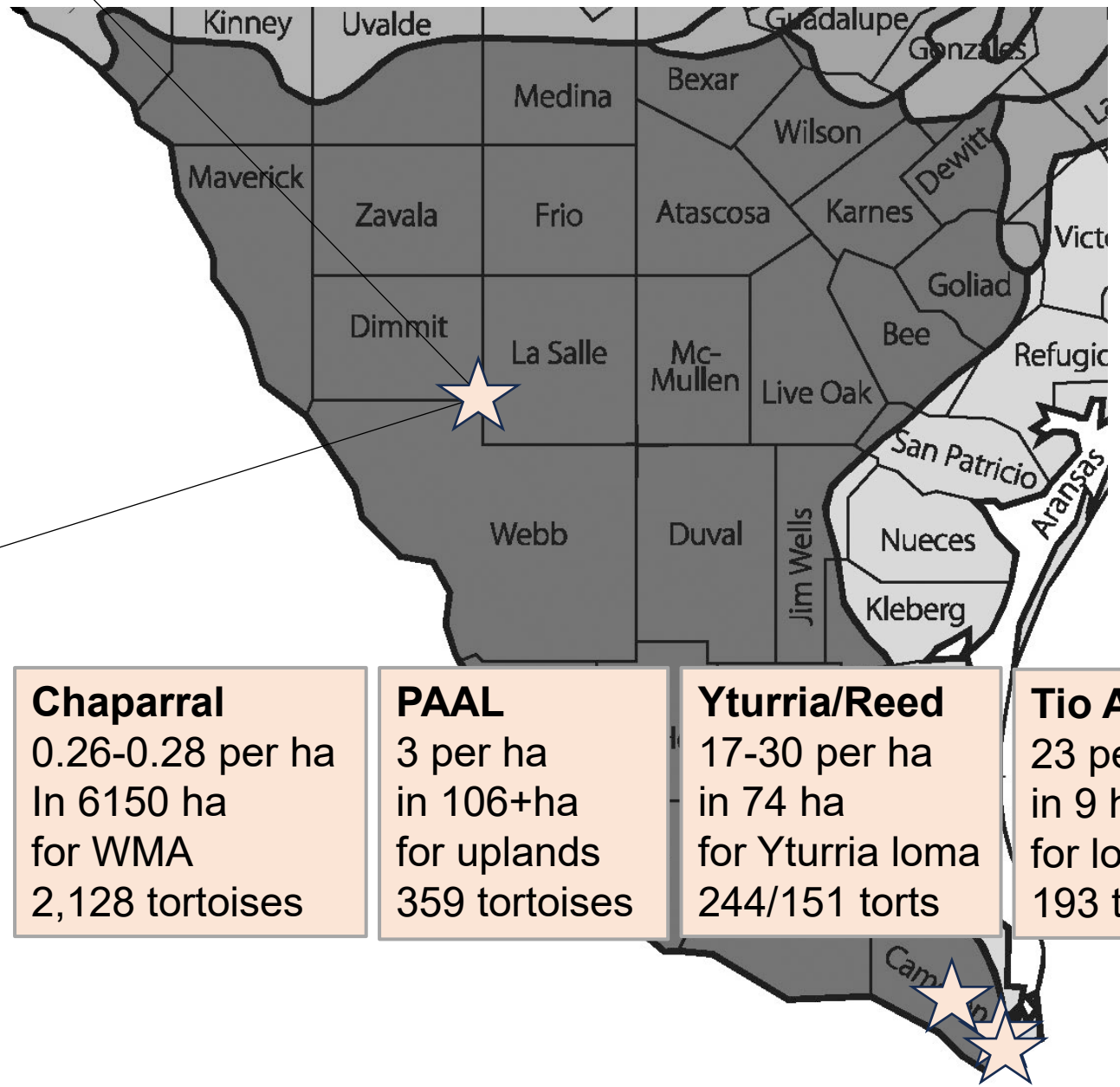



Kinney
Uvalde
Medina
Bexar
Guadalupe
Gonzales
Wilson
Dewitt
Maverick
Zavala
Frio
Atascosa
Karnes
Goliad
Bee
Refugio
Dimmit
La Salle
Mc-Mullen
Live Oak
San Patricio
Aransas
Webb
Duval
Jim Wells
Nueces
Kleberg
Zapata
Jim Hogg
Brooks
Kenedy
Starr
Hidalgo
Willacy





Population density estimates



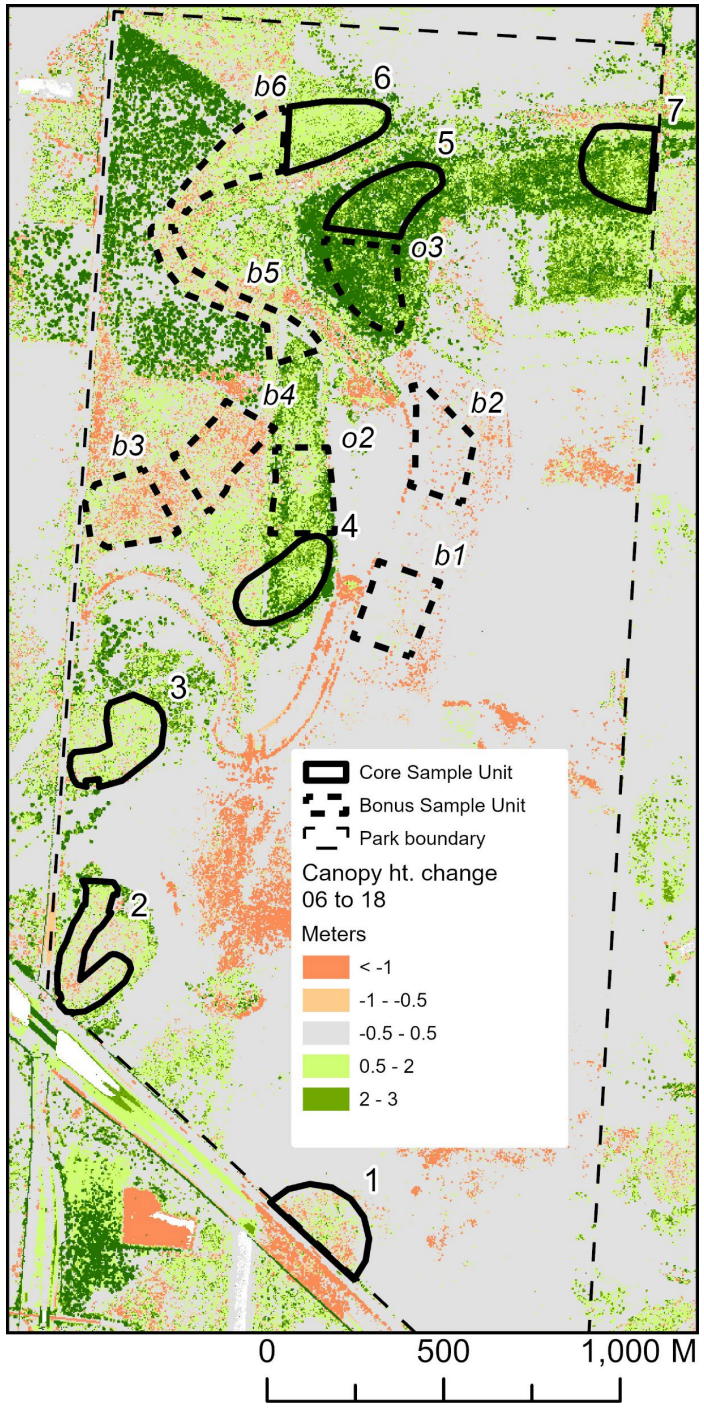
Chaparral
0.26-0.28 per ha
In 6150 ha
for WMA
2,128 tortoises

PAAL
3 per ha
in 106+ha
for uplands
359 tortoises

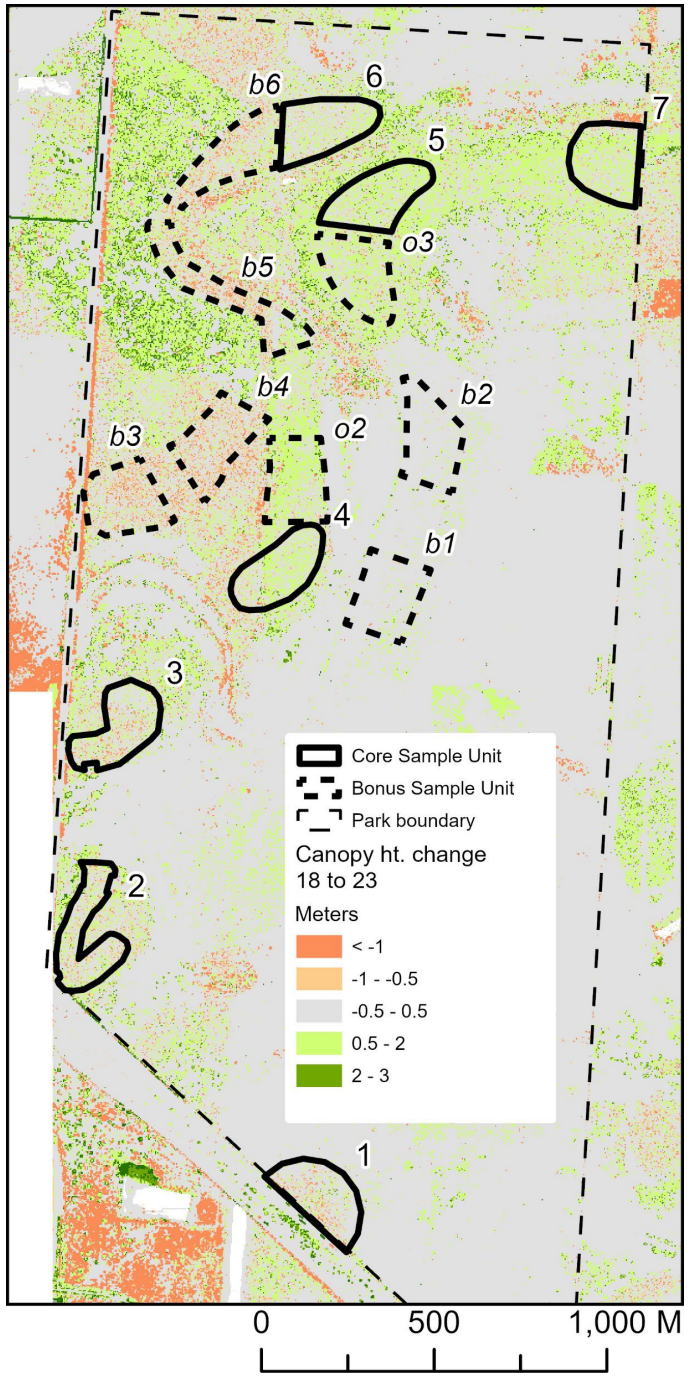
Yturria/Reed
17-30 per ha
in 74 ha
for Yturria loma
244/151 torts

Tio Alejos
23 per ha
in 9 ha
for loma
193 torts

Change from
2006 to 2018
in maximum
vegetation height



Change from
2018 to 2023
in maximum
vegetation height



Lidar and Imagery: Landcover

NAIP – 1m



Hexagon – 15cm



Lidar and Imagery: Landcover

NAIP – 1m

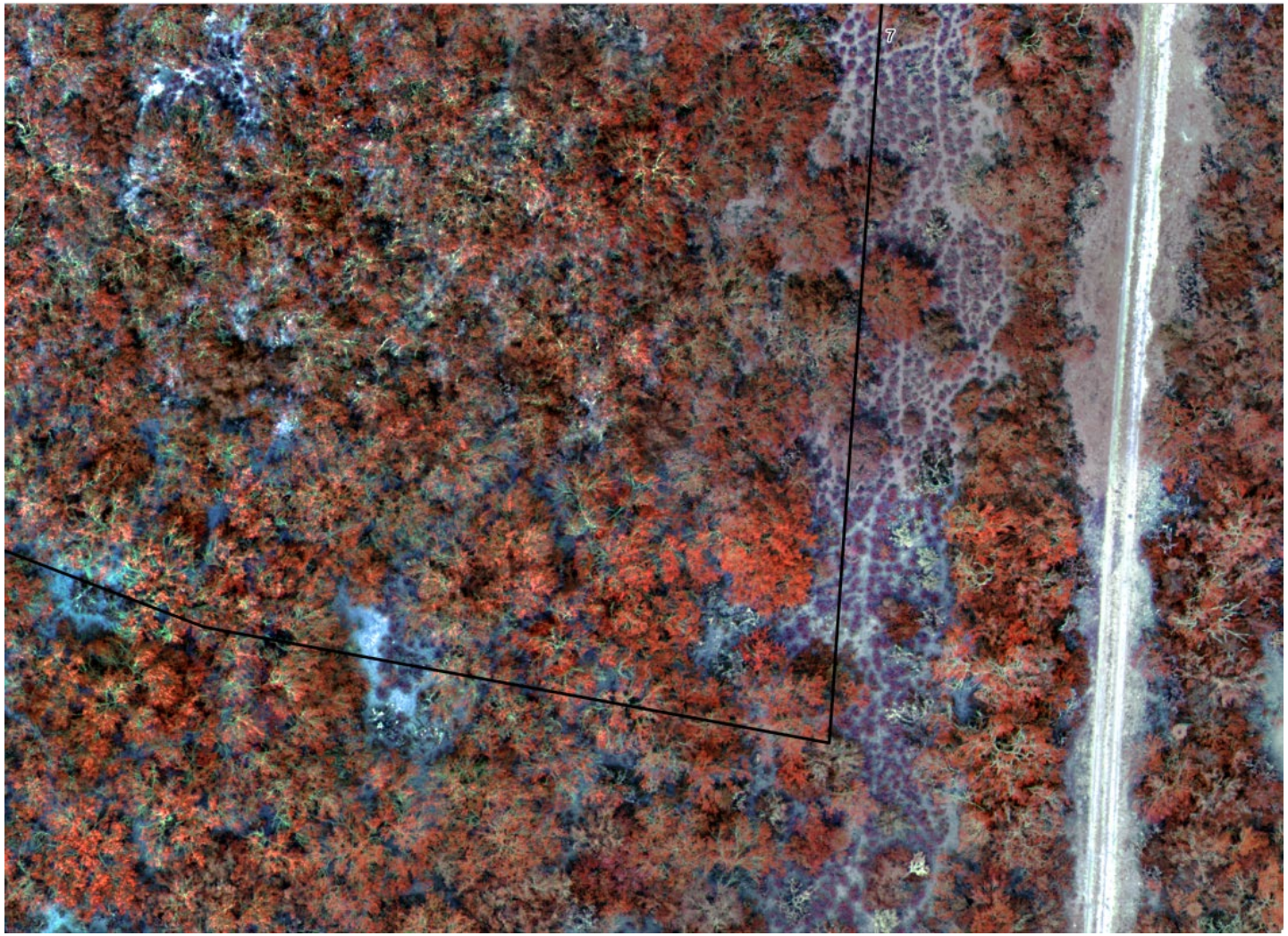


Hexagon – 15cm



USGS science for a changing world

Multispectral – 4cm





1934



1962



1977



1989 (plowed)



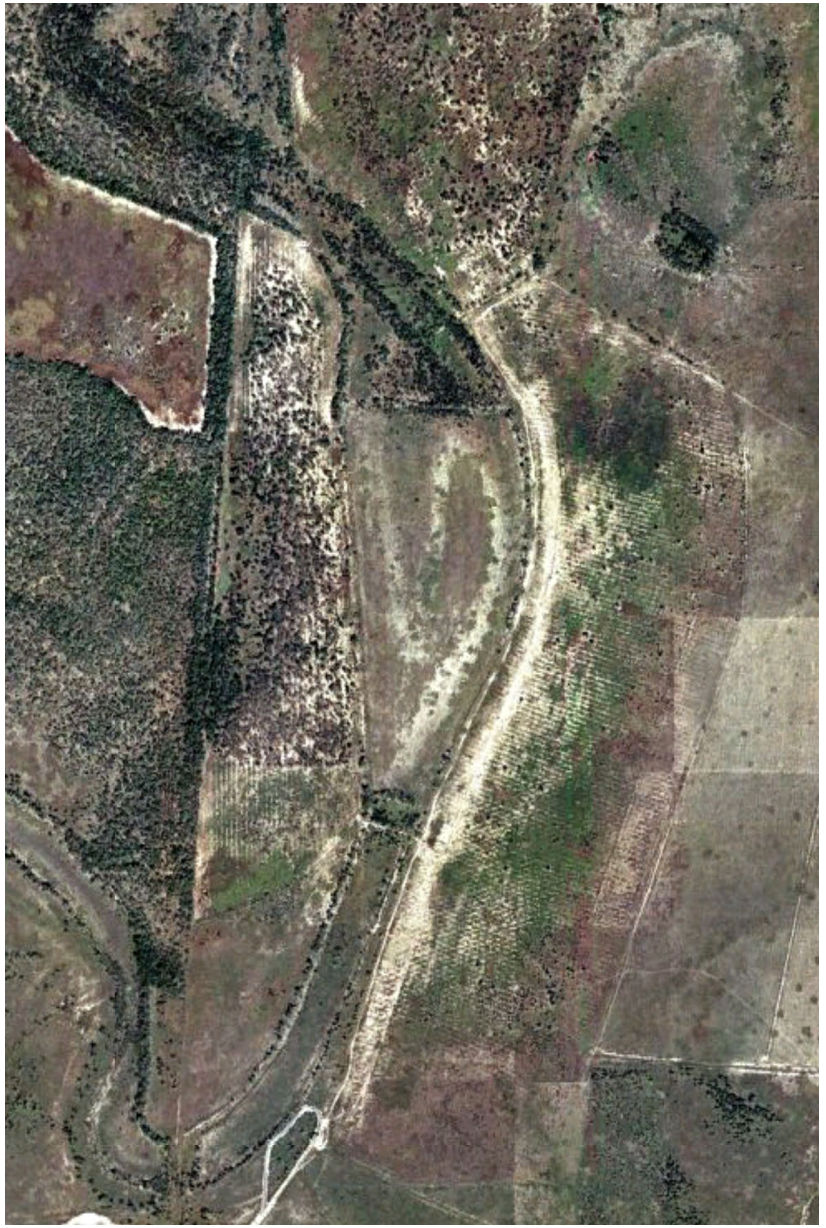
1995 (plowed)



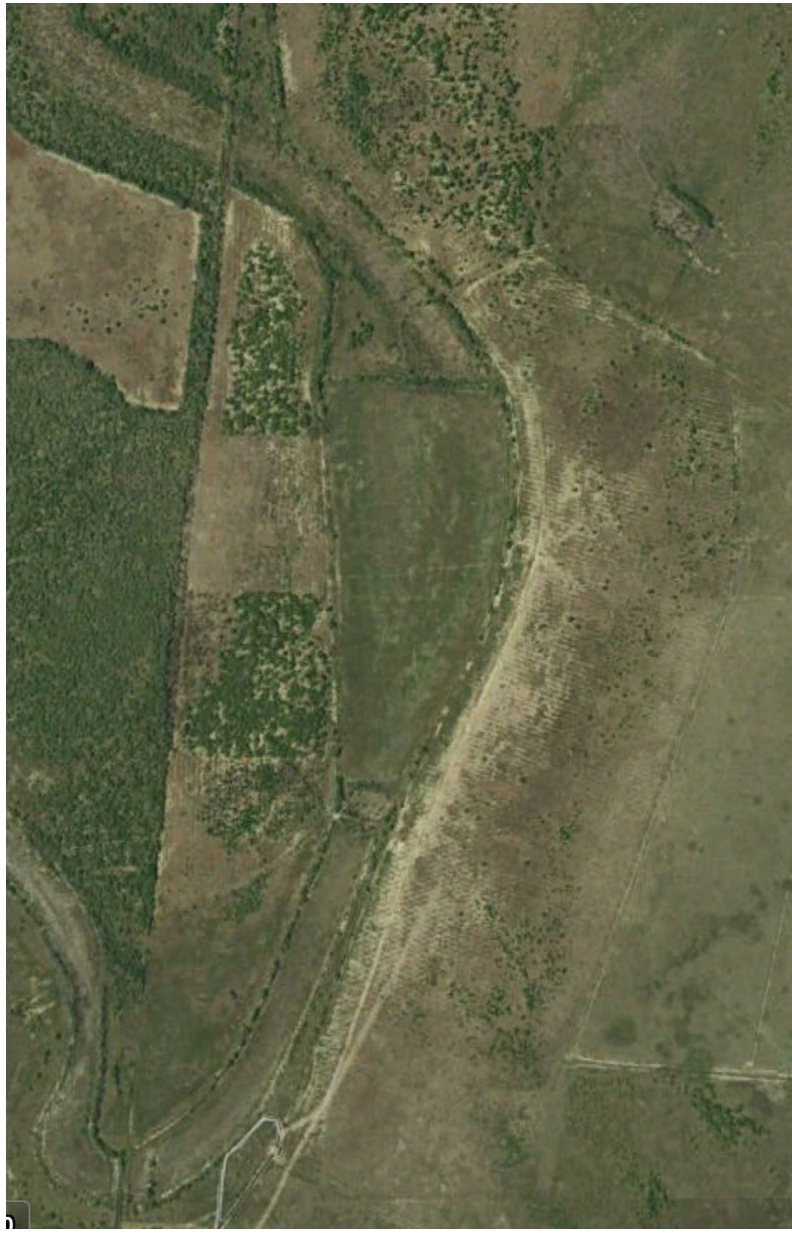
2002 (regrowth)



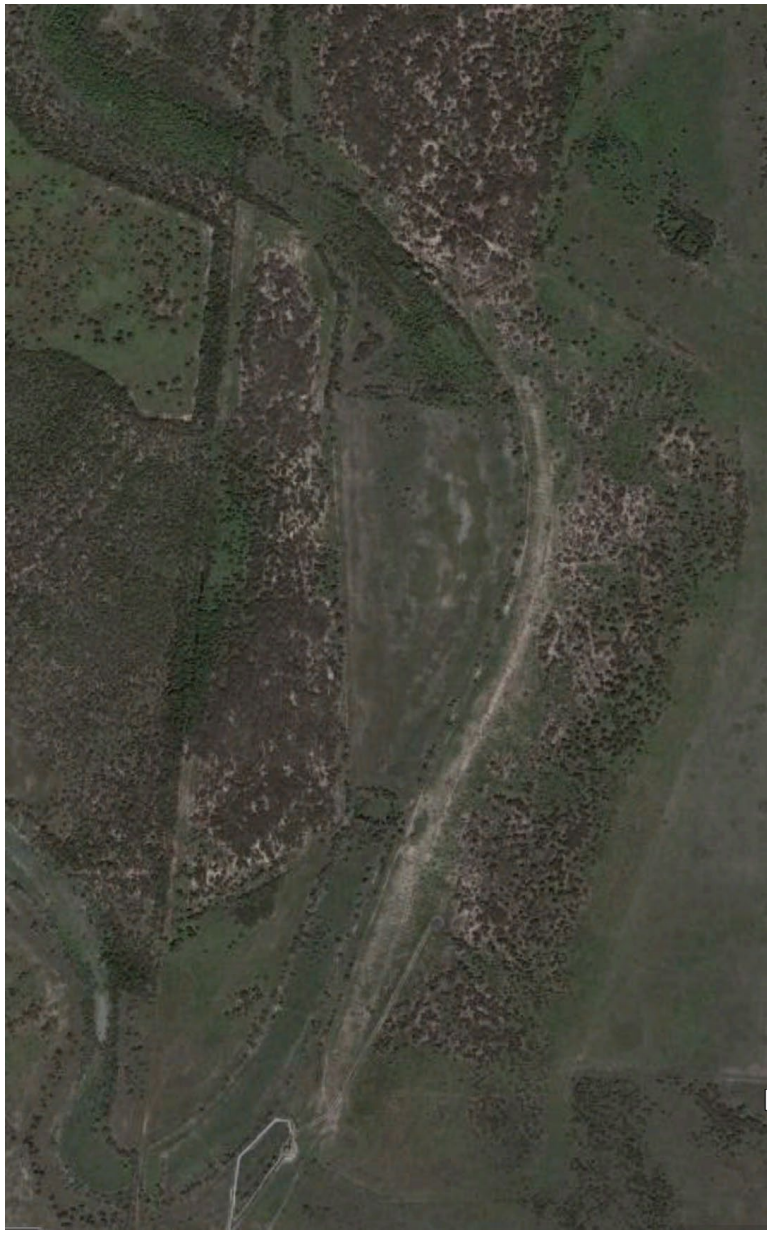
2005 (archeology)



2006 (more archeology)



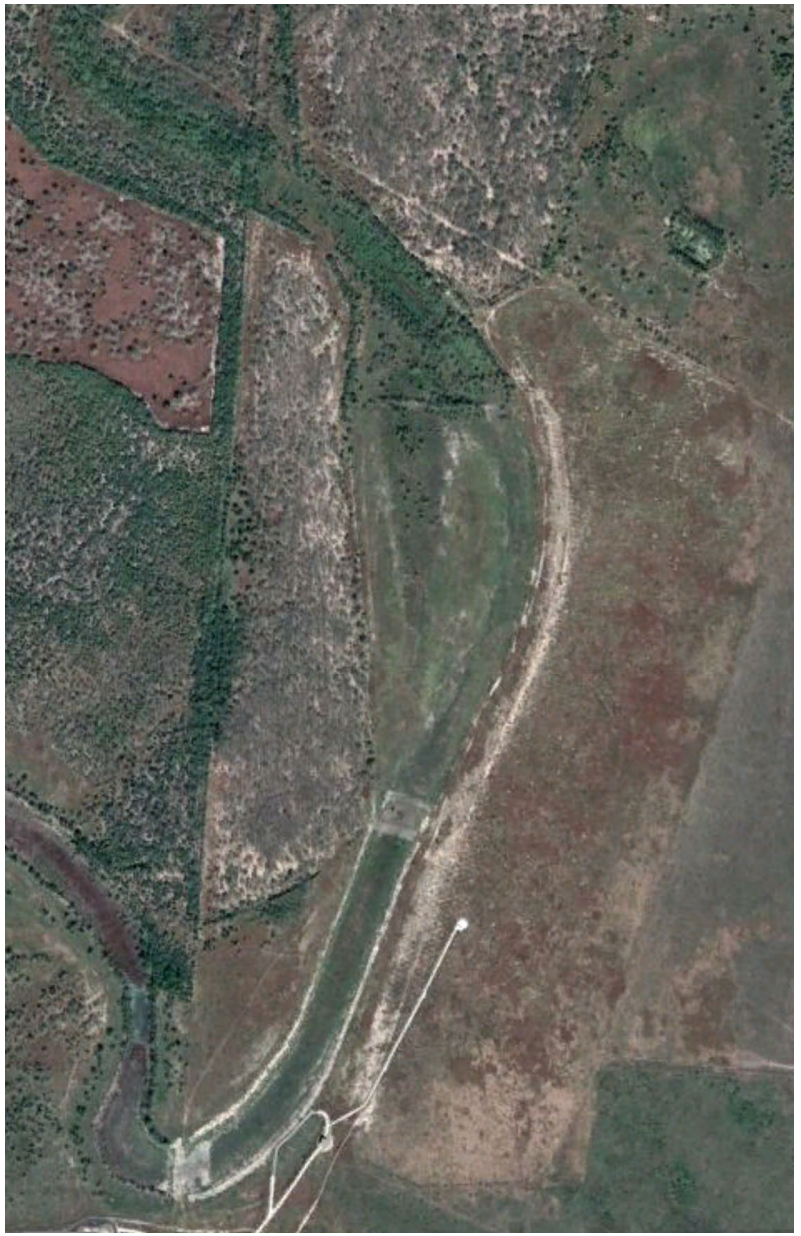
2008 (more archeology into 2012)



2014 (regrowth)



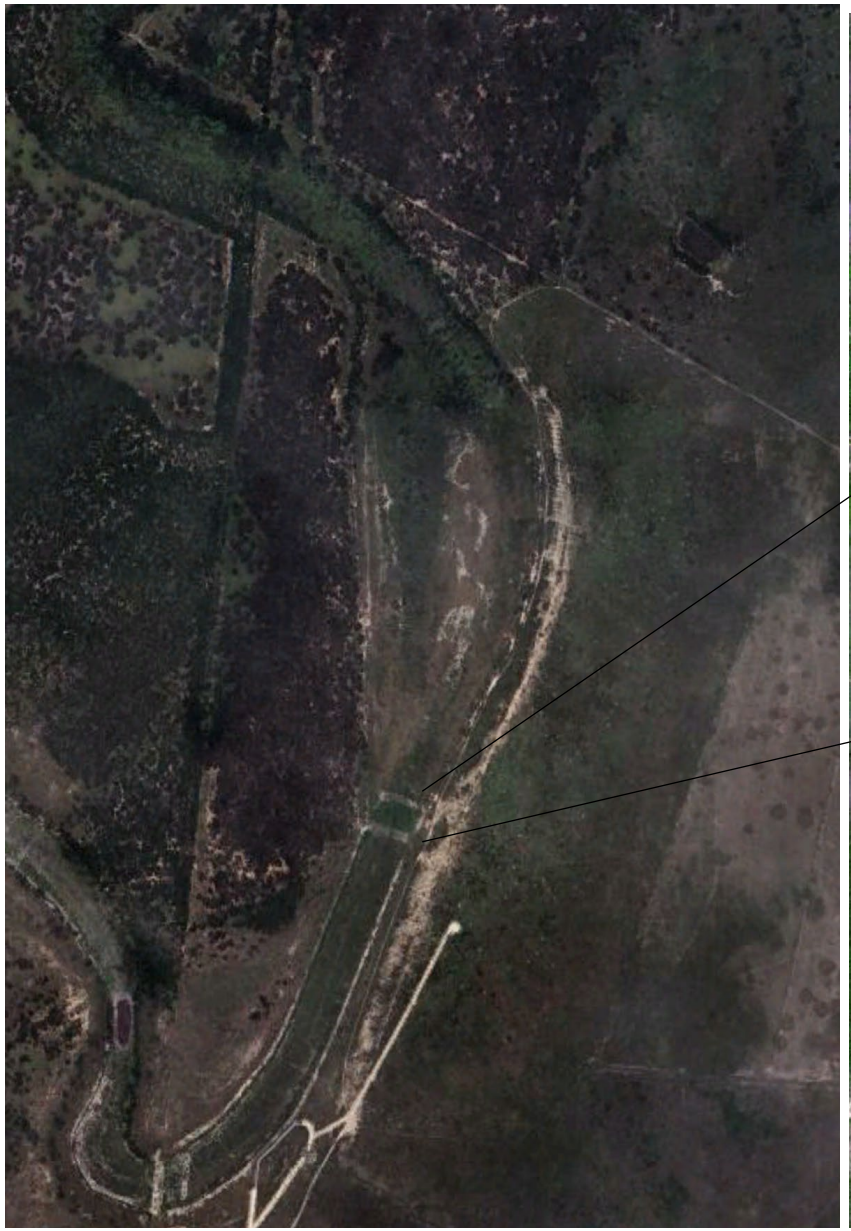
2016 (cleared)



2018 (regrowth)



2020



2023



2024