DOCKETED	
Docket Number:	09-AFC-05C
Project Title:	Abengoa Mojave Compliance
TN #:	232300
Document Title:	COMPLIANCE7-03-00, Mojave Solar Project 2019 Annual Compliance Report (09-AFC-5C) 3
Description:	COMPLIANCE7-03-00, Mojave Solar Project 2019 Annual Compliance Report (09-AFC-5C) part 3
Filer:	Jose Manuel Bravo Romero
Organization:	Mojave Solar Project
Submitter Role:	Applicant
Submission Date:	3/4/2020 9:19:34 AM
Docketed Date:	3/4/2020

Mojave Solar LLC

42134 Harper Lake Road Phone: 760 308 0400
Hinkley, California 92347

SUBMITTED ELECTRONICALLY

Subject:	**09-AFC-5C**
Condition Number:	**Compliance 7**
Description:	**Mojave Solar Project 2019 Annual Compliance Report**
Submittal Number:	**COMPLIANCE7-03-00**
Distribution:	**Keith Winstead, CEC; Kara Harris, US DOE; Dr. Sharma Shankar CDFW; Ray Bransfield, USFWS; Thomas Dietsch, USFWS**

February 27, 2020

Keith Winstead
Compliance Project Manager
California Energy Commission
1516 Ninth Street, MS-2000
Sacramento, CA 95814
keith.winstead@energy.ca.gov

Dear Mr. Winstead,

The attached Mojave Solar Project 2019 Annual Compliance Report (09-AFC-5C) is submitted for your review as part of the ongoing reporting required by the California Energy Commission's Conditions of Certification for the Mojave Solar Project.

Sincerely,

Jose Manuel Bravo Romero
Manager
Compliance, Permitting, Quality and Environment Department
ASI Operations LLC
Mojave Solar Project
42134 Harper Lake Rd
Hinkley, CA 92347
(303) 378-7302
jmanuel.bravo@atlanticayield.com

Attachment: 09-AFC-5C Mojave Solar Project 2019 Annual Compliance Report.

09-AFC-5C Mojave Solar Project
Annual Compliance Report
2019 reporting period

Prepared by:

AS Industrial Operations LLC.

for

Mojave Solar LLC
42134 Harper Lake Road
Hinkley, California 92347

Transition Habitat Conservancy

Abengoa Mojave Solar Project Mitigation Property and Edison Sandlot Transmission Upgrade Mitigation Property 2019 Annual Report

Abengoa Mojave Solar Project Mitigation Property and Edison Sandlot Transmission Upgrade Mitigation Property 2019 Annual Report

Transition Habitat Conservancy
PO Box 720026, Pinon Hills, CA 92372
760 868 5136
Jill Bays
Jill@TransitionHabitat.org

December 2019 Annual Report

In 2017 THC became an Accredited Land Trust by the Land Trust Alliance. This is a national mark of distinction. Accreditation affirms national quality standers are met resulting in sound finances, ethical conduct, responsible governance and lasting stewardship. THC is Authorized to Hold Mitigation Land by the California Department of Fish and Wildlife. This will need to be renewed in 2022.

Exhibit
01 Authorization to Hold Mitigation land by CDFW

The Transition Habitat Conservancy (THC) acquired fee title to 234 acres owned by Solucar Inc., a subsidiary of Abengoa, in August of 2014. This acquisition serves to mitigate for the loss of desert tortoise habitat from the construction of the Abengoa Mojave Solar Project and the transmission upgrades for Edison known as Sandlot. THC manages and monitors the land use of the property in perpetuity in order to detect changes harmful to the habitat values of the property, and to take action when necessary to correct these issues. This mitigation satisfies the following permits:

- **For Mojave Solar: The Abengoa Mojave Solar Project ("AMSP")** in San Bernardino County, California, pursuant to California Energy Commission ("CEC") License Decision CEC-800-2010-008-CMF, dated September 2010 (the "CEC License Decision") (hereinafter "AMSP Requirements")
- **For SCE: Incidental Take Permit No. 2081-2011-055-06 (the "ITP")** issued by the California Department of Fish and Wildlife ("CDFW") for the Special Protection System for the Abengoa Mojave Solar Project ("SPS Project") and Lockhart Substation Project CPUC A.11-05-006, State Clearinghouse Number 2011051041, July 2011 (hereinafter "SPS Upgrade Requirements")

I. THC conducted annual land use monitoring using aerial drone for most of the parcels. THC now has 2 FAA licensed drone pilots which are necessary in order to fly in restricted airspace. Our parcels are all located within the Black Mountain Supersonic Corridor and the Air Force requirements to fly within that space are very restricted. Drone photos are much more revealing as the photos are not obstructed by bushes or vertical features. High resolution photos are reviewed by Land Stewards on computer and details can be seen almost down to the footprint size level. This is very useful when dumped trash is found and photos of the trash can be sent to the clean-up crew including its location so they know where to go and what type of equipment is needed in order to implement cleanup activities.

Below are the ***2019 Monitoring results and reports***

Exhibit

02 2019 Abengoa/Edison Sandlot Monitoring

03 Abengoa Survey Report 2019

II. Tortoise Surveys and Plans

Overview

As part of a long-term effort to assess desert tortoise habitat quality on all Transition Habitat Conservancy (THC) parcels, in the vicinity of Fremont Peak and Harper Lake in San Bernardino County, an initial full-coverage desert tortoise survey of parcel 0490-223-37 (hereafter referred to as the "Abengoa hotspot," or "the hotspot") occurred in Fall 2017. The survey immediately demonstrated the relatively very high density of tortoise sign in the area. The site is dominated by a hill with numerous limestone outcrops, whose upper slopes have creosote, whose lower slopes are dominated by creosote-burrobush, beneath which are flats covered with several species of saltbush (Atriplex).
Upon realizing the high value of the parcel in an area of generally low desert tortoise density, Hardshell Labs and THC began to document the use of the site by tortoises and ravens and to pursue funding to enhance its value to the federally and state listed threatened reptile. Using THC Endowment funds in 2019 and small grants we started searching for tortoise sign and did an initial vegetation enhancement project. We designed the current project, funded by Edison International to thoroughly map the entire hotspot, to assess the use of the area by ravens and to create a plan to address the threat posed to the hotspot tortoises by raven predation on young tortoises.

The significance of the site is due not only to the high density of desert tortoises there but to the fact that this is a functional "island" of high-quality habitat surrounded by much lower density and habitat quality. This, combined with the easy accessibility of the site, and its exposure to frequent raven overflights, makes it an ideal place for further study of the apparent hotspot phenomenon. Further, it affords the opportunity to experiment with methods of predation reduction and habitat quality enhancement.

Desert Tortoise Food Gardens

The award of a grant from Patagonia for the construction, placement and monitoring of rainfall concentrators is a first step into vegetation management. It will allow us to gain experience enhancing availability of high quality food for tortoises. The report from this effort is detailed and summarized in the exhibit.

Exhibits
04 Tortoise hot spot Fremont Kramer CHU
05 Tortoise and Raven management in hotspot (Integrating Desert Tortoise and Raven Studies with Management: A First Step)
06 THC_DTNFG Final Report

III. Annual Restoration Completed

We've been taking a systematic approach to tackling incursions in the Desert Wildlife Management Area by tracing illegal routes from our parcels to their origins on legal routes and attempting to remove these tracks to discourage further trespass and damage to the habitat on our property. Once these incursion sites had been identified, we were left with a map of restoration points along the legal route system. Reports show before and after photos of all of our restoration.

Exhibits:

07 2019 THC Staff Restoration
08 AmeriCorps 2019 Restoration report
09 Ancestral Lands Crew 2019 Restoration Report

IV. Law Enforcement: $24,815 was spent on law enforcement from the OHV Grant. A total of 88 patrols occurred in 2019.

Exhibit
10 Sheriff's reports

V. Financials

THC was able to leverage funding from several sources in addition to SB 34 endowment payout in order to accomplish all of this work in the Fremont Region. Thanks to our AmeriCorps Crew of 8 people for 12 weeks (Grant), our OHV Restoration Grant and close collaborations with CDFW, BLM, Fort Irwin, USFWS, plans are being formulated and implemented to give a general uplift to all lands in the region.

THC had Audited Financial Statements produced by an independent CPA and those are attached. In 2017 our Authorization to Hold Mitigation Lands form CDFW was renewed until 2022, authorization is attached. THC's financial position is strong. THC SB 34 endowment is currently held by NFWF and we expect to get it transferred back to THC in 2021 as is authorized by our CDFW contract when we meet certain criteria which we fully intend to meet.

Exhibits
11 9 2018 THC Tax Return
12 Audited Financial Statements by Independent CPA
13 2019 Endowment Performance

Sincerely Yours,

Jill Bays, President
Transition Habitat Conservancy
760 868 5136
Jill@transitionhabitat.org
Po Box 720026
Pinon Hills, CA 92372

Table of Contents

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Division of Ecosystem Conservation
1416 Ninth Street, Suite 1208
Sacramento, CA 95814
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

March 13, 2017

Jill Bays, President
Transition Habitat Conservancy
P.O. Box 720026
Pinon Hills, California 92372

Dear Ms. Bays

Application for Transition Habitat Conservancy to Hold and Manage Mitigation Lands

On August 15, 2016, the California Department of Fish and Wildlife (CDFW) received your application to hold and manage mitigation lands within CDFW's South Coast and Inland Deserts regions. Pursuant to Government Code section 65967, CDFW has exercised our required due diligence process in reviewing your application and supporting documentation. We are pleased to inform you that your request to hold and manage mitigation lands within CDFW's South Coast and Inland Deserts regions is hereby approved. Please keep this letter of approval until its expiration on March 13, 2022.

If you would like to renew your current approval status, we encourage you to contact CDFW six months prior to March 13, 2022 for updated applications and requirements. Currently, the renewal process requires you to submit application sections: A, B, and I. Application sections C, D, and H, are required only if any information has changed since the approval date. Application sections E, F, and G are not required for renewal.

Please provide a copy of this letter to any project proponent that wishes to seek CDFW approval for your organization to hold and manage mitigation lands as a condition of any permit requiring the transfer interest in real property to mitigate the impact that the project will have on fish and wildlife resources. If you have any questions, please contact Beatriz Rambarran at (916) 651-1279 or beatriz.rambarran@wildlife.ca.gov.

Sincerely,

Richard Macedo
Branch Chief
Department of Fish and Wildlife
Habitat Conservation Planning Branch

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: NW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022335-1NW

Press to GPS

+35.031346, -117.372075, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372075

Latitude: +35.031346

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Tortoise shell.

Monitor: Sam

Photo point ID: (calculated) 049022335-2E

Press to GPS

+35.034956, -117.373432, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.373432

Latitude: +35.034956

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Road, approximately 10 feet wide, with recent vehicle use.

Monitor: Sam

Photo point ID: (calculated) 049022335-3W

Press to GPS

+35.039562, -117.372227, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372037

Latitude: +35.040325

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: SE

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview from corner of parcel.

Monitor: Sam

Photo point ID: (calculated) 049022335-4SE

Press to GPS

+35.040322, -117.372020, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375132

Latitude: +35.040290

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Road labeled BLM route FP5342. Approximately 10 feet wide with recent vehicle use.

Monitor: Sam

Photo point ID: (calculated) 049022337

Press to GPS

+35.040282, -117.375125, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375218

Latitude: +35.040632

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☒ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☒ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Camping and shooting area access road. Approximately 8 feet wide with scattered shooting and other debris in the vicinity.

Monitor: Sam

Photo point ID: (calculated) 049022337-2N

Press to GPS

+35.040563, -117.375284, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375218

Latitude: +35.040632

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Active tortoise burrow showing conservation value of Property.

Monitor: Sam

Photo point ID: (calculated) 049022337-3S

Press to GPS

+35.041239, -117.373592, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.373592

Latitude: +35.041239

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022337-4S

Press to GPS

+35.047379, -117.372108, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372108

Latitude: +35.047379

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022337-5S

Press to GPS

+35.047358, -117.374094, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374094

Latitude: +35.047358

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 6

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☒ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☒ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Alternate access road, approximately eight feet wide with recent use, to the camping and shooting area with various debris scattered in the vicinity.

Monitor: Sam

Photo point ID: (calculated) 049022337-6N

Press to GPS

+35.040751, -117.374946, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374946

Latitude: +35.040751

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022335-5E

Press to GPS

+35.036614, -117.374770, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374770

Latitude: +35.036614

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: barbed wire fence on south side of road. road appears to be access to private land with structures west of the parcel

Monitor: Sam

Photo point ID: (calculated) 049018448-1W

Press to GPS

+35.025785, -117.372121, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372121

Latitude: +35.025785

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: T-post fence line with no road access.

Monitor: Sam

Photo point ID: (calculated) 049018448-2W

Press to GPS

+35.022240, -117.372893, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372893

Latitude: +35.022240

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: NW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049018448-3NW

Press to GPS

+35.020117, -117.372963, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372963

Latitude: +35.020117

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049018448-4N

Press to GPS

+35.018892, -117.374996, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374996

Latitude: +35.018892

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: SW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview from property corner (survey monument).

Monitor: Sam

Photo point ID: (calculated) 049018448-5SW

Press to GPS

+35.031376, -117.372101, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372101

Latitude: +35.031376

Monitoring Survey
Transition Habitat Conservancy
Property: Abengoa
Location: Fremont-Kramer Desert Wildlife Management Area
Date: December 2019

Transition Habitat
CONSERVANCY

Abengoa Annual Monitoring Survey

Contents

Executive Summary

The parcels subject to this monitoring parcel are owned by the Transition Habitat Conservancy and are subject to a Conservation Easement with specific conservation values described in the section "Legal Description of Property and Conservation Values." In order to ensure these specific conservation values are upheld, yearly monitoring is prescribed.

Monitoring Plan: Create aerial drone missions to acquire comprehensive coverage of the parcels. In addition, conduct desert tortoise surveys with a biologist and/or volunteers at our Burrow Blitz event. If any new observations of the following land uses are made, establish new photo points to document.

The parcels were visited several times throughout the year and formal monitoring was completed in November 2019. Other than three designated routes that traverse the parcels, there were no new observed land uses on the property. This report will be reviewed by THC's Land Management Committee.

Property Description Sandlot

Conservation Area Name: *Fremont-Kramer Desert Wildlife Management Area*

Assessor Parcel No: 0490-184-48

Acres: ± 102 acres

Land Owner: Transition Habitat Conservancy

Conservation Easement Grantee: California Department of Fish and Wildlife

Summarized Legal Description: The property is a portion of the W½ of the E½ of Sections 23 and 26, Township 11 North, Range 5 West, San Bernardino Base and Meridian, County of San Bernardino, State of California.

Property Description MSP

Assessor Parcel No(s): 0490-223-35 & 0490-223-37

Acres: 73 ± acres (0490-223-35) and 58 ± acres (0490-223-37)

Total acreage: 132.78 ± acres

Land Owner: Transition Habitat Conservancy

Conservation Easement Grantee: California Department of Fish and Wildlife

Summarized Legal Description: The property is a portion of the W½ of the E½ of Sections 23 and 26, Township 11 North, Range 5 West, San Bernardino Base and Meridian, County of San Bernardino, State of California.

USGS Quadrangle: 1986, 7.5-minute series, Lockhart, California Quadrangle, provisional edition.

Directions to Property: From Kramer Junction, CA, travel east on CA Highway 58 for approximately 13 miles. Turn north and travel on Harper Lake Road for approximately seven miles. Turn west on Hoffman Road and travel for approximately 2.4 miles to reach the east boundary of the property.

Monitor(s): Sam Easley

Date of inspection: November 2019

Season of Inspection: Fall

Legal Description of Property and Conservation Values

Parcel **APN 0490-184-48** is located in the valley surrounding Harper Dry Lake, three miles west of Harper Dry Lake and 19 miles northwest of Barstow, California. The Easement Area rests on the relatively flat bajada draining into Harper Dry Lake. The Easement Area consists of one assessor parcel located within Township 11 North, Range 5 West, San Bernardino Base and Meridian, County of San Bernardino, State of California, and is described as the southeast quarter of Section 23 excepting therefrom the north half of the north half of said southeast quarter, also excepting therefrom the easterly 1,700 feet of the southeast quarter of said Section 23, together with the northeast quarter of Section 26 excepting therefrom the easterly 1,700 feet of said northeast quarter.

The Easement Area is within the Fremont-Kramer Desert Wildlife Management Area and forms a portion of THC's Lockhart Ecological Reserve. The Easement Area conserves critical habitat for the federally threatened desert tortoise and the state-listed Mohave ground squirrel, and also provides protection for special vegetation communities, including shadscale and spinescale scrub. The terrain on the parcel is relatively level with a slight downward gradient to the northeast. The elevation ranges between 2,090 and 2,130 feet above mean sea level.

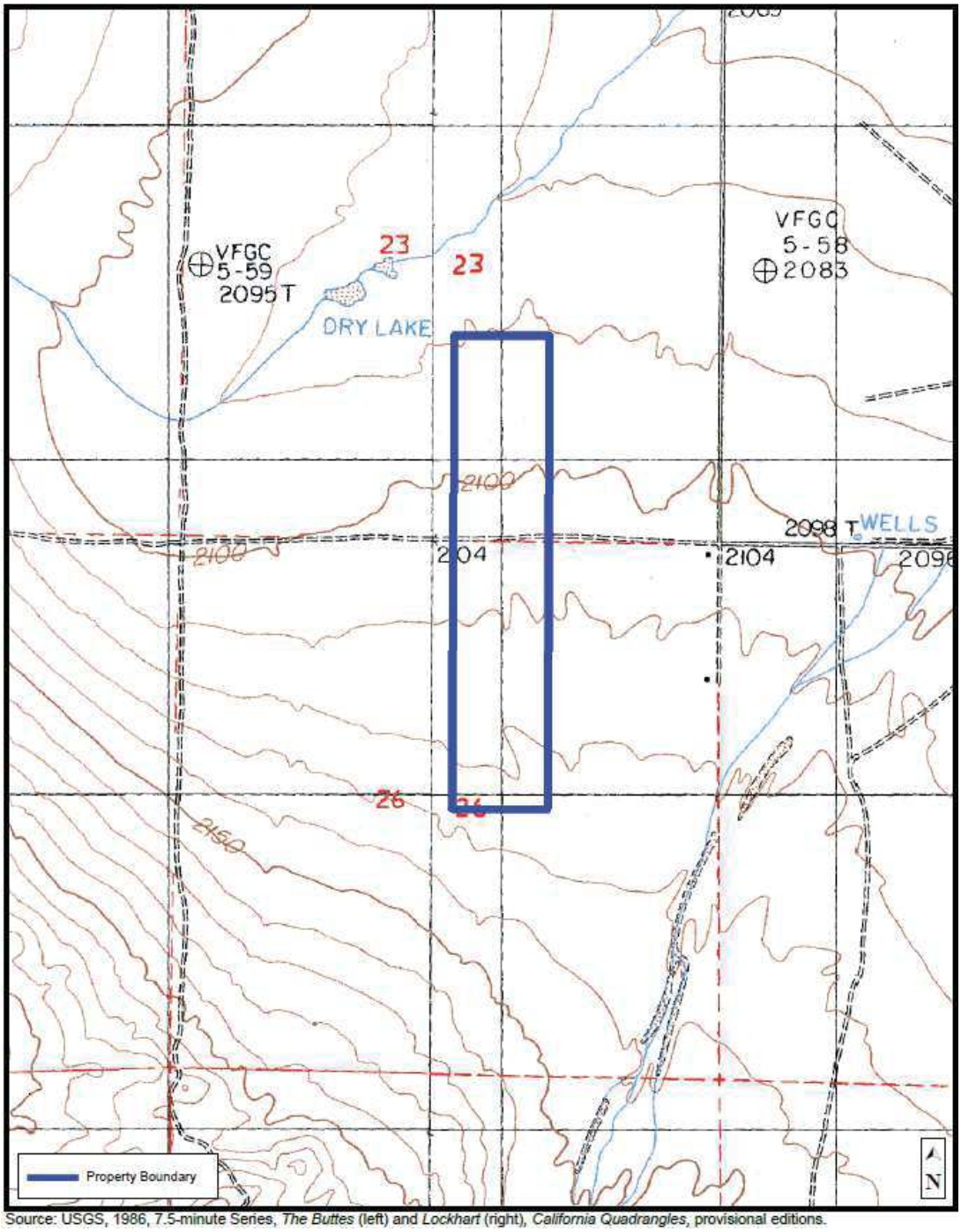
The specific Conservation Values as described in the Conservation Easement are: land being in an unimproved natural condition, with high quality habitat for desert tortoise, Mohave ground squirrel, and containing shadscale scrub intergrading with spinescale scrub.

Parcel (APN 0490-223-35), APN 0490-223-37), These parcels are located in the valley surrounding Harper Dry Lake, three miles west of Harper Dry Lake and 19 miles northwest of Barstow, California. The parcels rest on the relatively flat bajada draining into Harper Dry Lake but contain low hills in its northernmost one-quarter. The two parcels are located within Township 11 North, Range 5 West, San Bernardino Base and Meridian, County of San Bernardino, State of California, and are described as the north half of the north half of the east half of Section 23, excepting therefrom the easterly 1,700 feet, together with the south half of the north half of the east half of Section 23, excepting therefrom the easterly 1,700 feet, together with the north half of the north half of the south half of the east half of Section 23, excepting therefrom the easterly 1,700 feet (APN 0490-223-35) and the east half of the south half of Section 14, excepting therefrom the easterly 1,700 feet (APN 0490-223-37).

The Easement Area is within the Fremont-Kramer Desert Wildlife Management Area and forms a portion of THC's Lockhart Ecological Reserve. The properties conserve critical habitat for the federally threatened desert tortoise and the state-listed Mohave ground squirrel and provide protection for the burrowing owl and other special-status plant and animal species. The terrain of the Easement Area is relatively level in the southern three-quarters and contains low, rocky hills in the northern one-quarter, with an overall downward gradient to the northeast. The elevation ranges between 2,080 and 2,250 feet above mean sea level.

The specific Conservation Values as described in the Conservation Easement are: land being in a natural condition, with high quality habitat for desert tortoise, Mohave ground squirrel, burrowing owl, and other special-status plant and animal species.

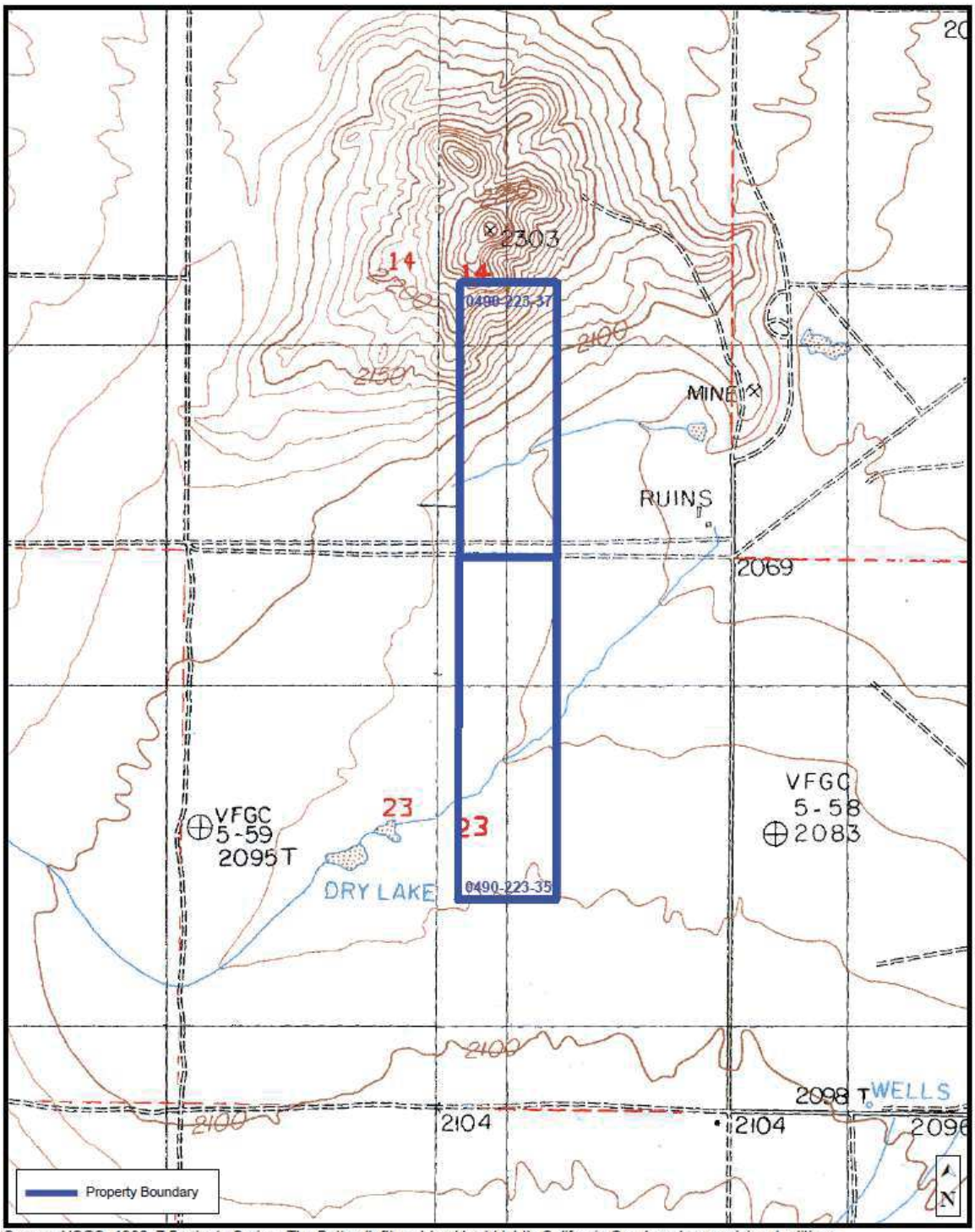
Location Maps



Source: USGS, 1986, 7.5-minute Series, *The Buttes* (left) and *Lockhart* (right), *California Quadrangles*, provisional editions.

FIGURE 1. Aerial view of parcel 0490-184-48

Location Maps



Source: USGS, 1986, 7.5-minute Series, *The Buttes* (left) and *Lockhart* (right), *California Quadrangles*, provisional editions.
Scale: 1 inch = 1/4 mile

FIGURE 2. Aerial view of parcel 0490-223-35 and 0490-223-37

Aerial View

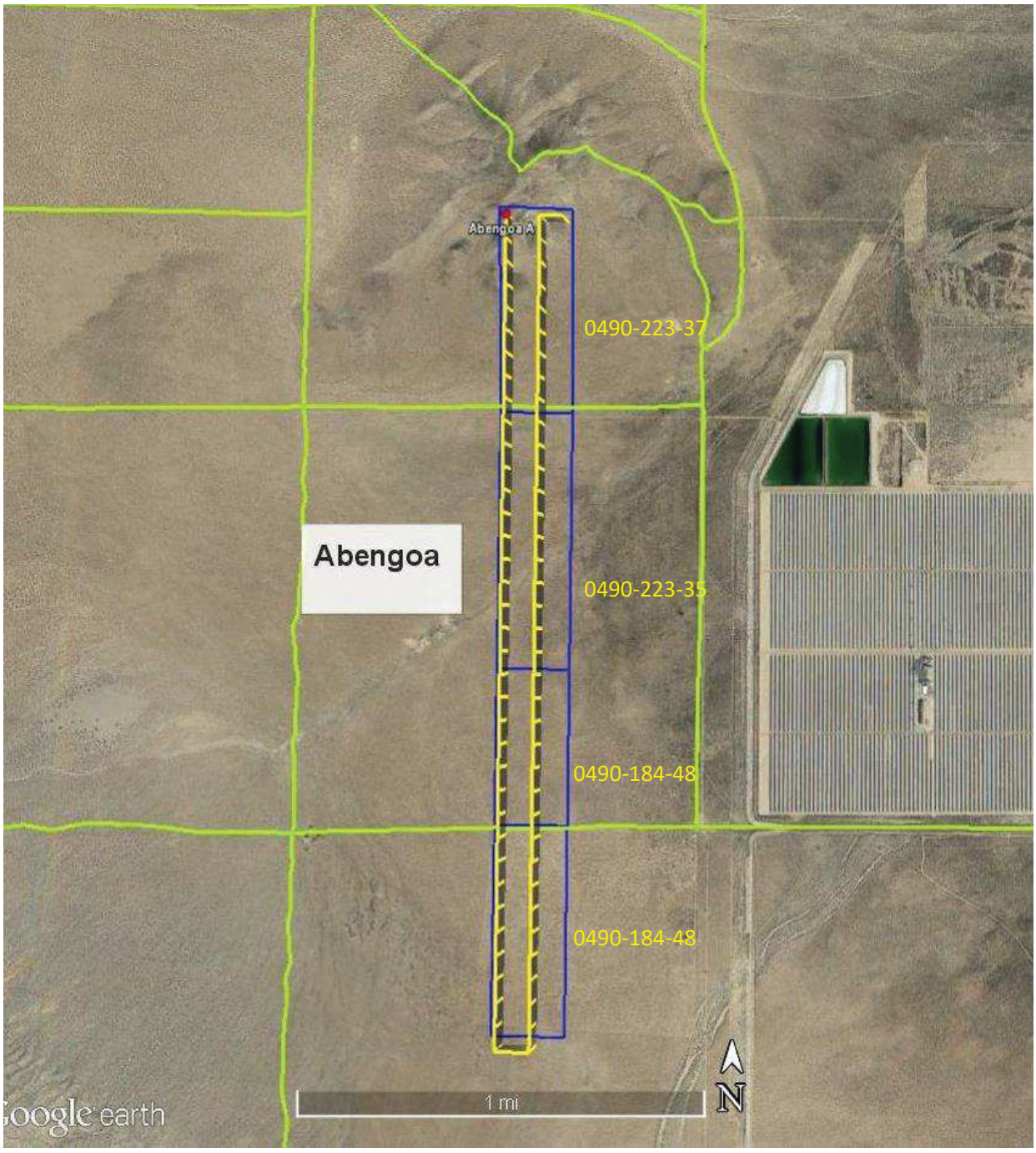


Figure 3. Aerial view of property with corresponding photo points denoted by yellow hash marks. Green lines indicate BLM designated routes

Summary of Site Inspection

Inspection Items	None	Onsite	Nearby
Landscape Alterations	X		
Roads, paved	X		
Dump areas of any kind	X		
Utility lines outside existing locations	X		
Wells and/or other water developments outside existing locations	X		
Structures of any type except fencing		X	X
Mines, shafts, pits			X
Pipelines (water or otherwise) outside existing locations	X		
Billboards	X		
Off-Road Vehicle Use		X	X
Physical Improvements of Any Kind	X		
Grading or excavation	X		
Commercial uses	X		

Summary Land Use Changes Observed

Persistent tracks on an old roadbed along the western boundary of parcel 0490-223-37 but no trespass is observed heading onto the property. No other land uses of note.

Signature Page

Prepared by

Name: Sam Easley | Signature: | Date: 12/5/19

Title: Land Stewardship Specialist

Approved by:

Name: Cody Hanford | Signature: | Date: 12-5-2019

Title: Executive Director

Drone Overview

Figure 4: Overview of drone flight path and photo points with example photos labeled in red

Figure 4: Overview of drone flight path and photo points with example photos labeled in red

Example Photo Overviews

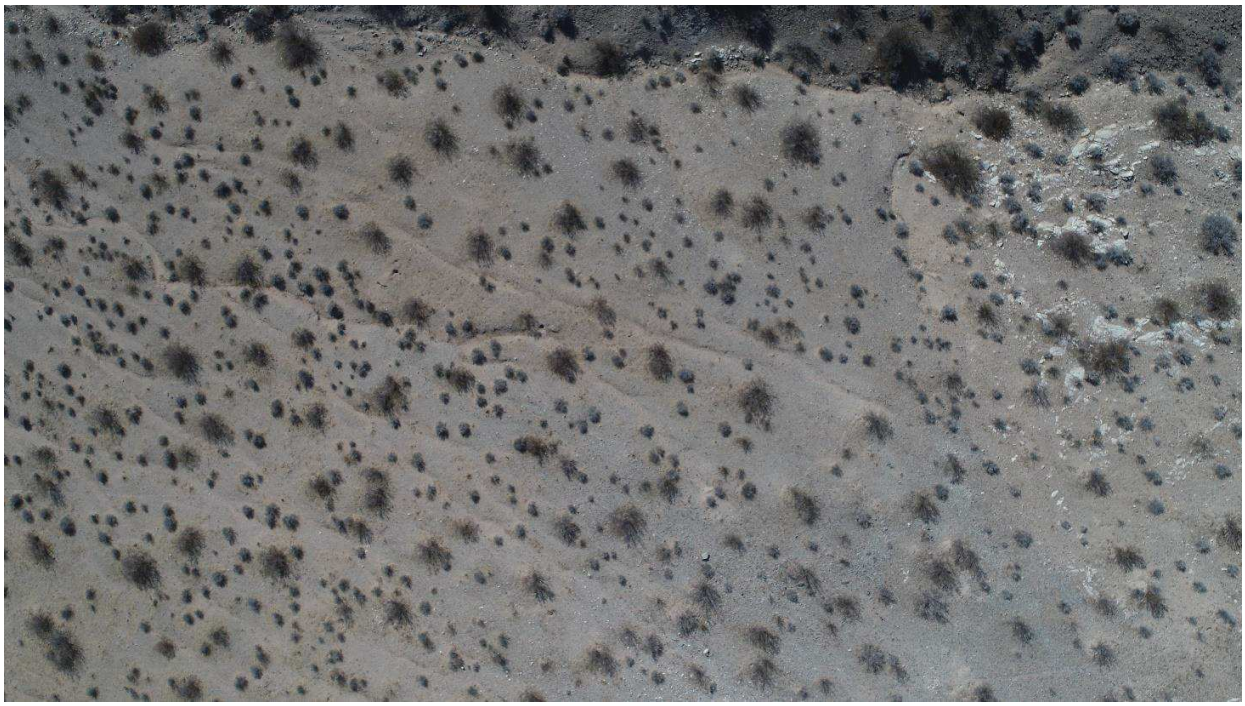


Photo 3A: Rocky hillside wash located near northwestern boundary of parcel 490-223-37

Photo 28A: Denuded area near legal route with faint evidence of past OHV use located near west boundary of parcel 0490-184-48

Photo 7B: Faint abandoned tracks located near southeastern boundary of parcel 0490-184-48

Photo 27B: Wash located near eastern boundary of parcel 0490-223-35

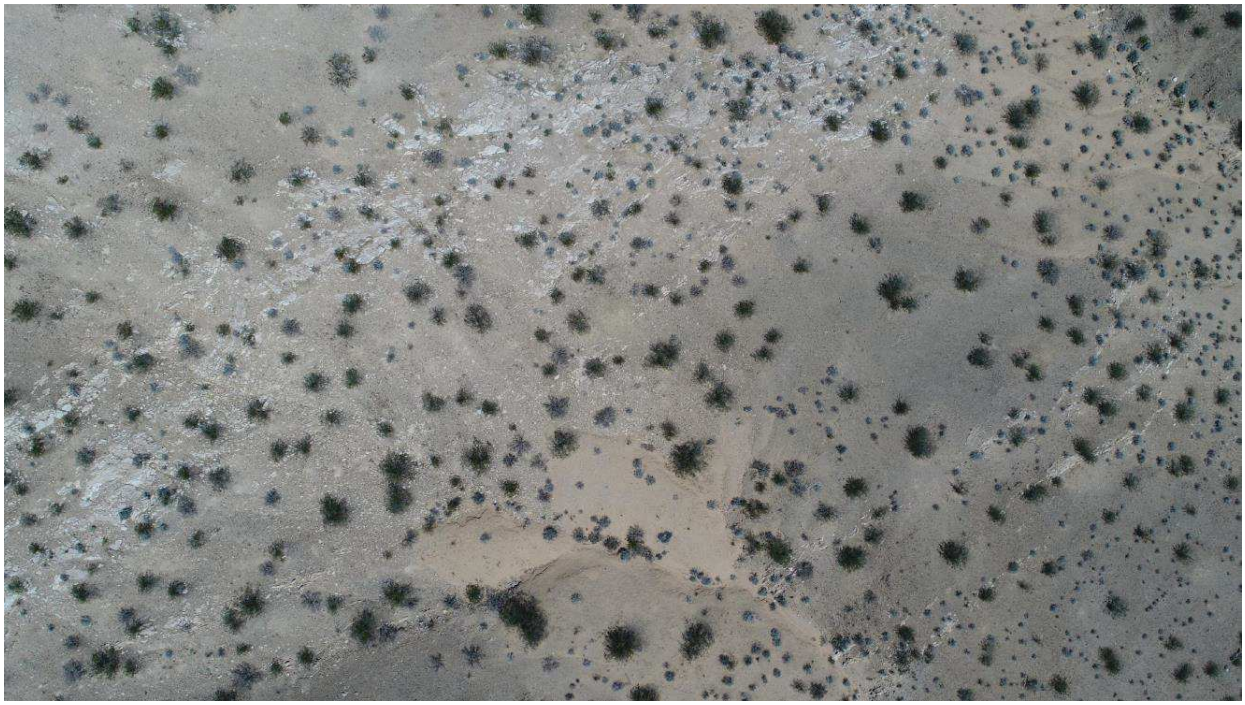


Photo 36B: Known tortoise hotspot located near the northeastern boundary of parcel 0490-223-37

Overview Photo: Looking N of parcel 0490-223-37 and surrounding hillside

Live Tortoise Survey

Figure 5. Live desert tortoise observations on and around the property as of Dec 2019

Tortoise Burrow Survey

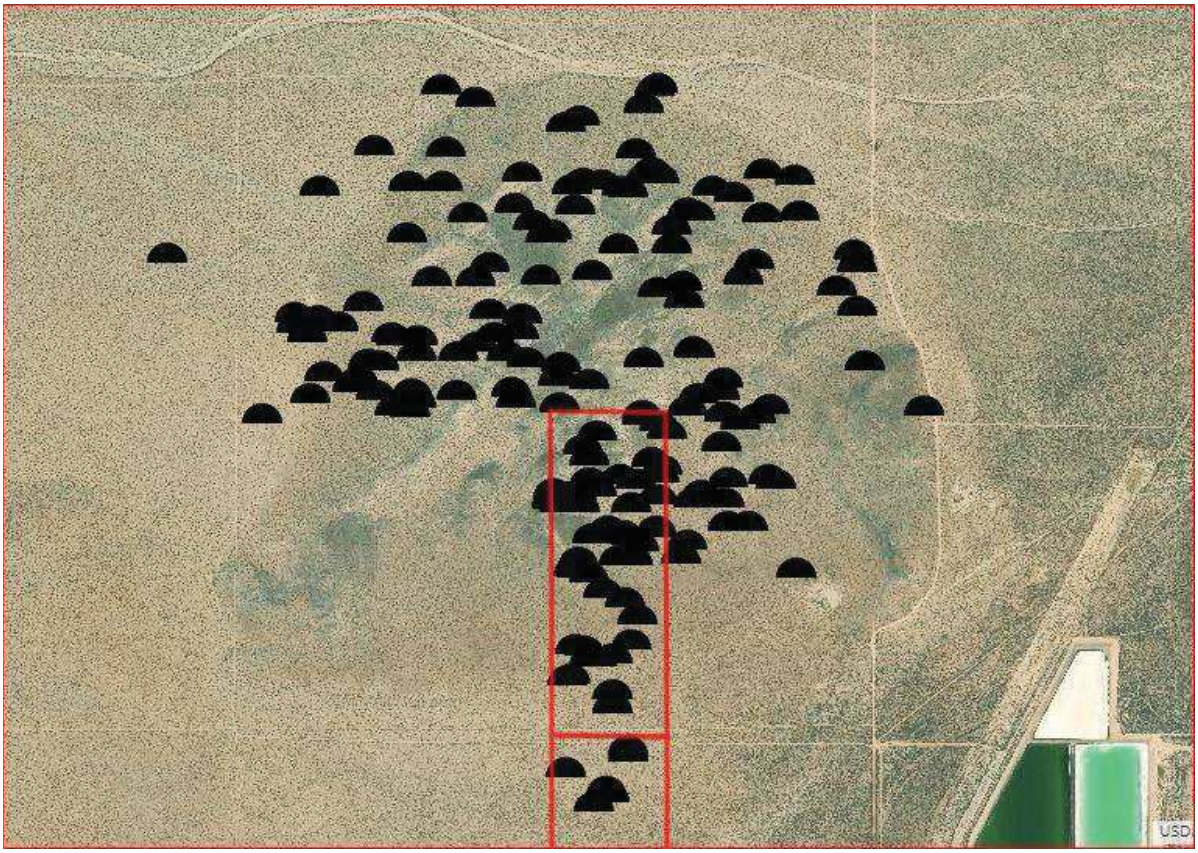


Figure 6. Desert tortoise burrows identified and mapped as of Dec 2019

Photo 1. Juvenile in burrow found October 23, 2019 on parcel 0490-223-37

Photo 2. Adult Female found March 30, 2019 on parcel 0490-223-35

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: NW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022335-1NW

Press to GPS

+35.031346, -117.372075, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372075

Latitude: +35.031346

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Tortoise shell.

Monitor: Sam

Photo point ID: (calculated) 049022335-2E

Press to GPS

+35.034956, -117.373432, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.373432

Latitude: +35.034956

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Road, approximately 10 feet wide, with recent vehicle use.

Monitor: Sam

Photo point ID: (calculated) 049022335-3W

Press to GPS

+35.039562, -117.372227, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372037

Latitude: +35.040325

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: SE

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview from corner of parcel.

Monitor: Sam

Photo point ID: (calculated) 049022335-4SE

Press to GPS

+35.040322, -117.372020, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375132

Latitude: +35.040290

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Road labeled BLM route FP5342. Approximately 10 feet wide with recent vehicle use.

Monitor: Sam

Photo point ID: (calculated) 049022337

Press to GPS

+35.040282, -117.375125, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375218

Latitude: +35.040632

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☒ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☒ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Camping and shooting area access road. Approximately 8 feet wide with scattered shooting and other debris in the vicinity.

Monitor: Sam

Photo point ID: (calculated) 049022337-2N

Press to GPS

+35.040563, -117.375284, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.375218

Latitude: +35.040632

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Active tortoise burrow showing conservation value of Property.

Monitor: Sam

Photo point ID: (calculated) 049022337-3S

Press to GPS

+35.041239, -117.373592, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.373592

Latitude: +35.041239

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022337-4S

Press to GPS

+35.047379, -117.372108, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372108

Latitude: +35.047379

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: S

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022337-5S

Press to GPS

+35.047358, -117.374094, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374094

Latitude: +35.047358

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022337

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 6

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☒ Vehicle use
- ☒ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☒ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: Alternate access road, approximately eight feet wide with recent use, to the camping and shooting area with various debris scattered in the vicinity.

Monitor: Sam

Photo point ID: (calculated) 049022337-6N

Press to GPS

+35.040751, -117.374946, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374946

Latitude: +35.040751

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049022335

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: E

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049022335-5E

Press to GPS

+35.036614, -117.374770, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374770

Latitude: +35.036614

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 1

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☒ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: barbed wire fence on south side of road. road appears to be access to private land with structures west of the parcel

Monitor: Sam

Photo point ID: (calculated) 049018448-1W

Press to GPS

+35.025785, -117.372121, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372121

Latitude: +35.025785

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 2

Direction: W

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☒ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☐ None of the above

Comments: T-post fence line with no road access.

Monitor: Sam

Photo point ID: (calculated) 049018448-2W

Press to GPS

+35.022240, -117.372893, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372893

Latitude: +35.022240

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 3

Direction: NW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049018448-3NW

Press to GPS

+35.020117, -117.372963, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372963

Latitude: +35.020117

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 4

Direction: N

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview.

Monitor: Sam

Photo point ID: (calculated) 049018448-4N

Press to GPS

+35.018892, -117.374996, +5.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.374996

Latitude: +35.018892

TRANSITION HABITAT CONSERVANCY MONITORING FORM

APN: 049018448

Project Area: Lockhart

Date: 9/25/2019

Photopoint: 5

Direction: SW

Baseline/1st picture

New picture

Land use (if none applicable, mark "None of the above)

- ☐ Agricultural activities
- ☐ Fire protection activities
- ☐ Vehicle use
- ☐ Recreational activities
- ☐ Commercial or industrial uses
- ☐ Structures or construction activities
- ☐ Accumulation of trash or debris
- ☐ Non-native species
- ☐ Mining or excavation
- ☐ Surface alteration
- ☐ Cutting or removal of vegetation
- ☐ Alteration or degradation water courses
- ☐ Other (see comments)
- ☒ None of the above

Comments: Overview from property corner (survey monument).

Monitor: Sam

Photo point ID: (calculated) 049018448-5SW

Press to GPS

+35.031376, -117.372101, +10.000000

DO NOT GET GPS COORDINATES IF THEY ARE ALREADY HERE AND CORRECT

iPads use GCS WGS 1984 in Decimal degrees

Press to Insert GPS coordinates

Longitude: -117.372101

Latitude: +35.031376

Results Report: Edison International Grant to Transition Habitat Conservancy
Integrating Desert Tortoise and Raven Studies with Management: A First Step

Tim Shields
Hardshell Labs, Inc.

For Transition Habitat Conservancy

Introduction

As part of a long-term effort to assess desert tortoise habitat quality on all Transition Habitat Conservancy (THC) parcels, in the vicinity of Fremont Peak and Harper Lake in San Bernardino County, an initial full-coverage desert tortoise survey of parcel 0490-223-37 (hereafter referred to as the "Abengoa hotspot," or "the hotspot") occurred in Fall 2017. The survey immediately demonstrated the relatively very high density of tortoise sign in the area. The site (Figure 1) is dominated by a hill with numerous limestone outcrops, whose upper slopes have creosote, whose lower slopes are dominated by creosote-burrobush, beneath which are flats covered with several species of saltbush (Atriplex).

Upon realizing the high value of the parcel in an area of generally low desert tortoise density, Hardshell Labs and THC began to document the use of the site by tortoises and ravens and to pursue funding to enhance its value to the federally and state listed threatened reptile. Using THC general funds and small grants we started searching for tortoise sign and did an initial vegetation enhancement project. We designed the current project, funded by Edison International to thoroughly map the entire hotspot, to assess the use of the area by ravens and to create a plan to address the threat posed to the hotspot tortoises by raven predation on young tortoises.

The significance of the site is due not only to the high density of desert tortoises there but to the fact that this is a functional "island" of high-quality habitat surrounded by much lower density and habitat quality. This, combined with the easy accessibility of the site, and its exposure to frequent raven overflights, makes it an ideal place for further study of the apparent hotspot phenomenon. Further, it affords the opportunity to experiment with methods of predation reduction and habitat quality enhancement.

This report describes the results of field work and includes a first draft of a raven management plan for the site.

Figure 1. Abengoa hotspot habitat, showing hill, viewed from the south, in center of the area.

Results and Discussion

Tortoise Sign Transects

Between September 2018 and June 2019, we surveyed and mapped tortoise sign on the hotspot using 10-meter presence-absence transects. Included in the survey was the mapping of all burrows, carcasses, tracks, courtship rings, the examination of all tortoises encountered, and marking of those tortoises that could be captured, on parcels surrounding the hill. These included two THC parcels, a large BLM tract north of the hill, and an eastern parcel belonging to the solar energy company, Abengoa Solar. Figure 2 shows the land status and area covered during the work.

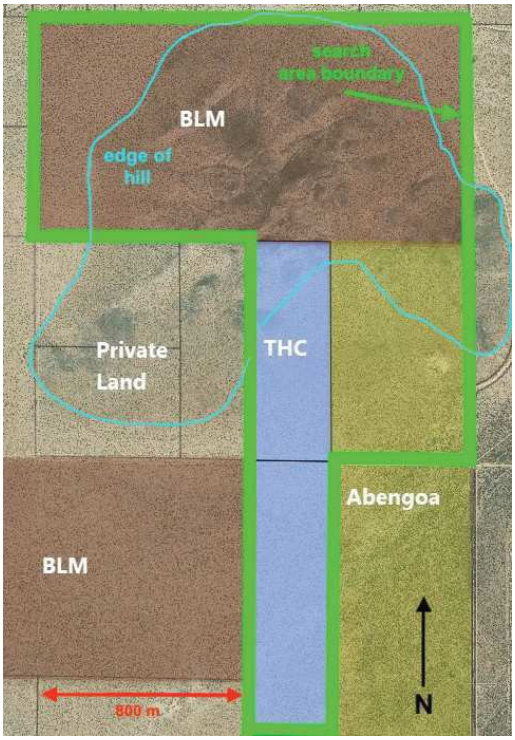


Figure 2. Hotspot land status and DT sign search area boundary

The results of this effort confirmed the high density and favorable demographics of the tortoise population inhabiting the hotspot. Within a roughly one square mile area we found 17 live tortoises, 165 tortoise burrows and 29 carcasses. Of particular note is the proportion of young animals among the ranks of the live tortoises. Given the relative difficulty of finding small tortoises these results indicate that there is good reproduction at the site and integration of younger tortoises into the breeding pool. Of the 17, one was a hatchling, three were juveniles and three were immatures. In addition, shell-wear of adults, an indication of relative age, shows a wide age range and includes several individuals only recently recruited into the pool of breeding individuals.

In addition, the discovery of two raven-pecked carcasses of juvenile tortoises demonstrates that this threat to the tortoise population is a matter if immediate concern. Given the usual quick loss of small tortoise carcasses to scavengers, the fact that two such carcasses have been found suggest that ravens present a threat to the long-term well-being of the population. Prior and concurrent field work on the site has included recording every sighting of ravens and demonstrated that ravens are frequently present flying over and alighting on the site.

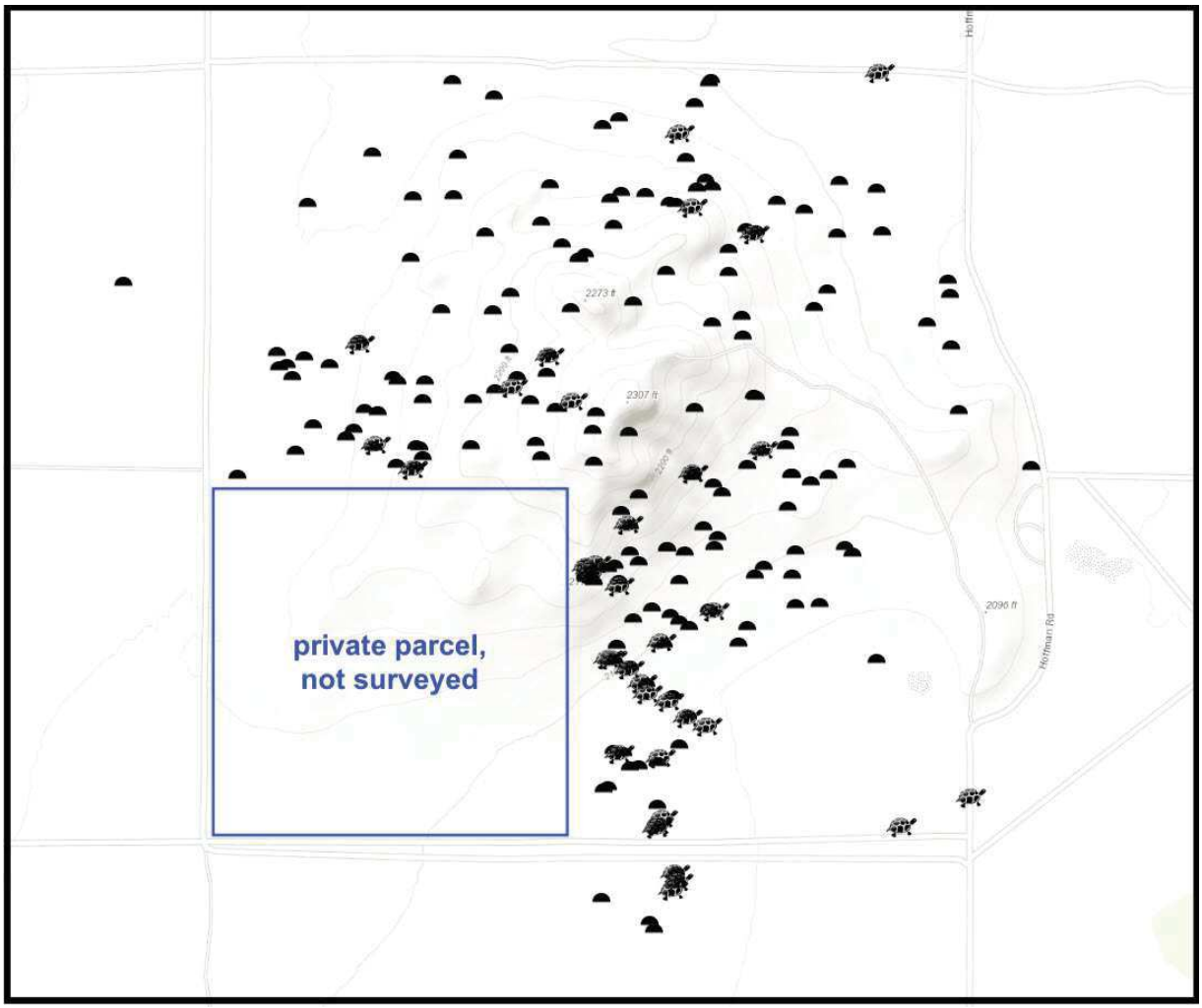


Figure 3. Distribution of tortoise sign on Abengoa hotspot. Pictured are symbols for live tortoises and their burrows. (Note that the privately owned southwest corner parcel was not surveyed.)

Raven Presence Monitoring

On four different days over the course of the project we conducted three one-hour raven searches. Every 15 minutes a 5-minute, 360° binocular sweep was performed from the top of the hill dominating the hotspot. We recorded the estimated position, flight direction and altitude, and behavior of every raven seen or heard, both within the five-minute count period and in the times between them.

The goal was to count raven flights in the vicinity of the hotspot over the course of winter and spring to gain a sense of seasonal patterns of raven presence and to gain familiarity with a possible technique for long-term monitoring. In addition, we recorded all sightings of ravens incidental to other field work. Time spent on the hilltop was valuable in providing a panoramic view of the hotspot and informing design ideas for raven repulsion options.

On every day of dedicated raven counts we saw at least one raven and, in most cases, we saw them in at least two of the three counting periods. Beyond that, our numerous opportunistic observations of ravens at other times, including sightings of ravens on the ground in the hotspot, show that ravens are consistently present. Springtime counts were higher than wintertime counts. This is not surprising, given that the

breeding season for ravens occurs then and entails the full-time occupation of territories that are often empty in the winter. Another factor is that raven nesting coincides with the season of highest activity for tortoises, including the juveniles vulnerable to raven predation.

The sample size of the counts was too low to allow any statistical analysis but the method is simple and, if expanded, could provide usable data for before and after counts when raven control measures are instituted.

Raven nest mapping

We spent 7-person days in intensive searches for raven nests within 7 miles of the hotspot, as a way to supplement the knowledge of raven nest sites in the area and to familiarize ourselves with the pattern and particulars of raven nesting with the zone. Prior work by Hardshell has demonstrated that nesting ravens range widely during nesting season and our goal was to generate a comprehensive map of raven nests within likely foraging distance of the hotspot. Work included:

- searching the southern face of Fremont Peak for cliff and rock outcrop nests
- a careful examination of the Kramer Buttes, a series of large rock outcrops from 1,600 to 4,000 meters from the hotspot
- searching Joshua trees to the northeast of the hotspot that had not yet been surveyed in the course of USFWS funded raven monitoring since 2014 in the Superior-Cronese Critical Habitat Unit (S-C CHU).
- reaching out to operators of solar facilities in the area and asking about raven nesting on their grounds and facilities. This effort grew out of knowledge of repeated raven nesting at the Abengoa Harper Lake solar facility.

We confirmed that the Kramer Buttes had six possible raven nests, we added six Joshua tree nests to the map and learned of at least two nests in solar facilities. This supplemented prior knowledge of high-density raven nesting in a corridor of 500 kV transmission towers owned by LADWP and running about 6 km south of the hotspot.

As part of ongoing raven nest monitoring and egg oiling work in spring 2019 we tracked the use of the nests found during the mapping effort for their use by ravens. In acknowledgment of the value of the hotspot, we received special permission from USFWS to treat (egg oil) nests at Kramer Buttes, in the Fremont-Kramer CHU. We treated all three active nests, with a total of 12 eggs, none of which produced viable offspring. We confirmed that one nest was active on the Abengoa solar site, about 6 km away from the hotspot, and that one may have been active at the NextEra Energy site, about 3 km distant. We were unable to treat these nests due to the length of time needed for Abengoa to receive permission from USFWS and California Energy Commission to treat the nest on their facility. Four raven nests were active on the LADWP towers within the study area. One Joshua Tree nest within the specified radius, previously found during USFWS raven monitoring work, was active and was also oiled, eliminating 5 eggs.

Figure 4 shows the distribution of raven nests within a 7-mile radius of the hotspot, with and additional circle shown centered on Fremont Peak, whose cliffs are likely to harbor raven nests and whose southern and eastern flanks were searched for the study.

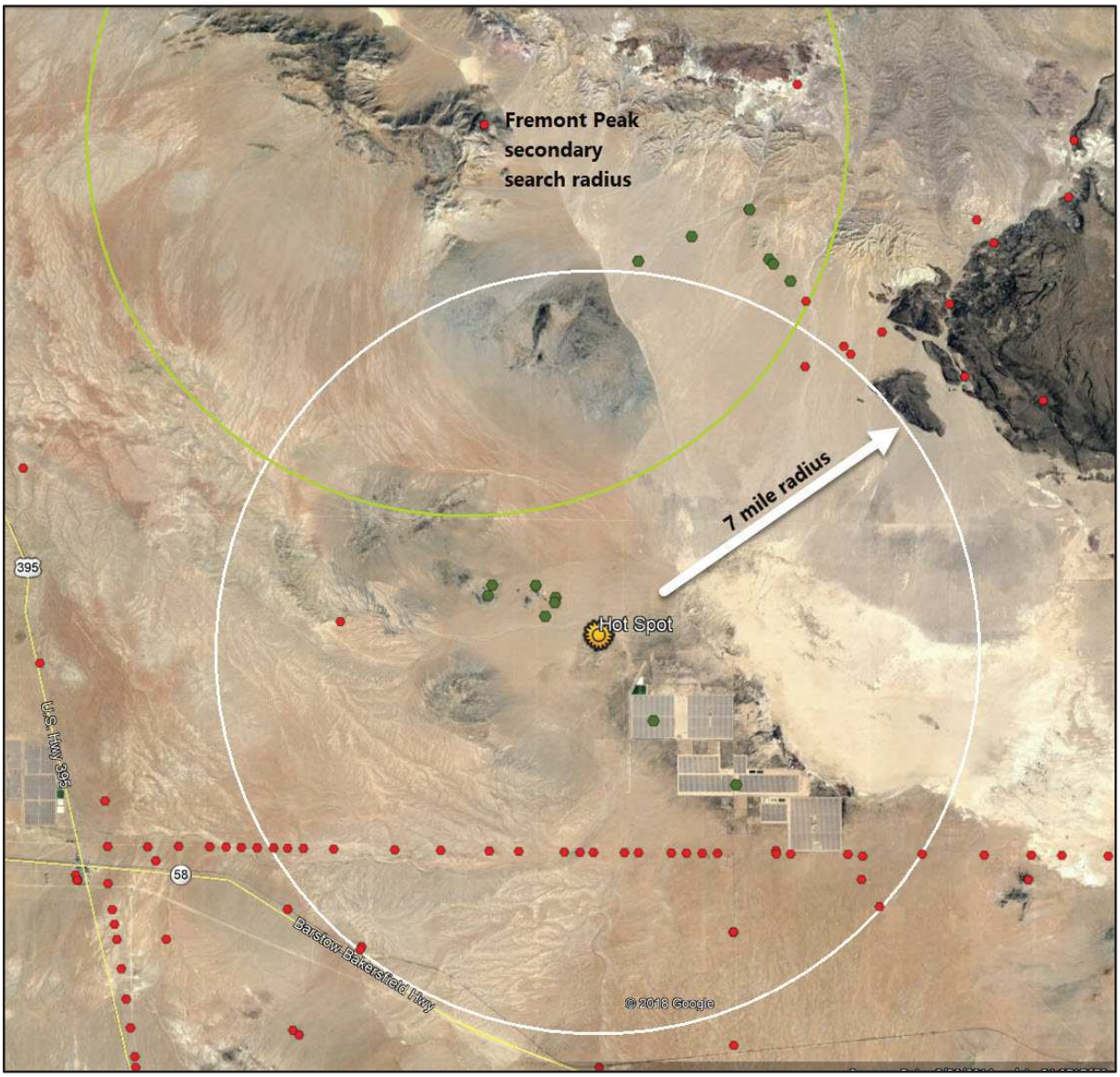


Figure 4. Raven nests in the hotspot vicinity, with search areas indicated. Red nests are previously mapped, while green sites were added during the study.

Proposed Raven Management Plan Draft

What follows is a proposal for active raven management in and around the so-called Abengoa desert tortoise hotspot. This is part of a wider effort to integrate tortoise monitoring with habitat enhancements and active predator management. This plan is primarily based on the results of the above work and on development work on tools and techniques for raven control, in progress by Hardshell on several Department of Defense (DoD) Small Business Innovation Research (SBIR) contracts. Proposed methods fall into three categories: redistribution of ravens; behavior modification; and numbers reduction.

Redistribution: on-site repulsion tools and methods

Prior experimentation with several tools has demonstrated the efficacy of hazing ravens from defined areas. Driving ravens from high value habitat could be achieved through the use of:

- *Lasers*- Hardshell Labs has been experimenting with green light lasers as raven repulsion tools for 5 years. We have demonstrated that ravens are highly sensitive to laser light, including during daytime, and that the effective range of such devices can be over 1,600m (one mile). Ravens have abandoned otherwise attractive sites in response to consistent treatment with lasers. Under a DoD SBIR project we are developing a remotely fired laser (RFL), one that could be monitored off-site via a live video stream or that could be linked with a pattern recognition program, providing autonomous activation of the system and autonomous or semi-autonomous operation. The core of this system is raven recognition software that can discriminate between ravens, natural objects and other species of birds. The current version of the program correctly flags ravens and crows over 90% of the time. Figure 6 shows a possible deployment of three RFLs to render the tortoise hotspot a "no landing zone" for ravens. Keep in mind that a flying raven is no threat to tortoises- it is only the bird on the ground that is a problem.

Figure 5. Ravens fleeing a green light laser. Note the beam striking near the base of the wood power pole. Over 400 ravens were driven into the sky by a laser sweep in this case.

We illustrate a 1,600m (one mile) radius of fire from the top of the highest hill, which coincides neatly with the center of the hotspot. That radius of fire would entirely cover the hotspot and reach well into the lower quality saltbush habitat.

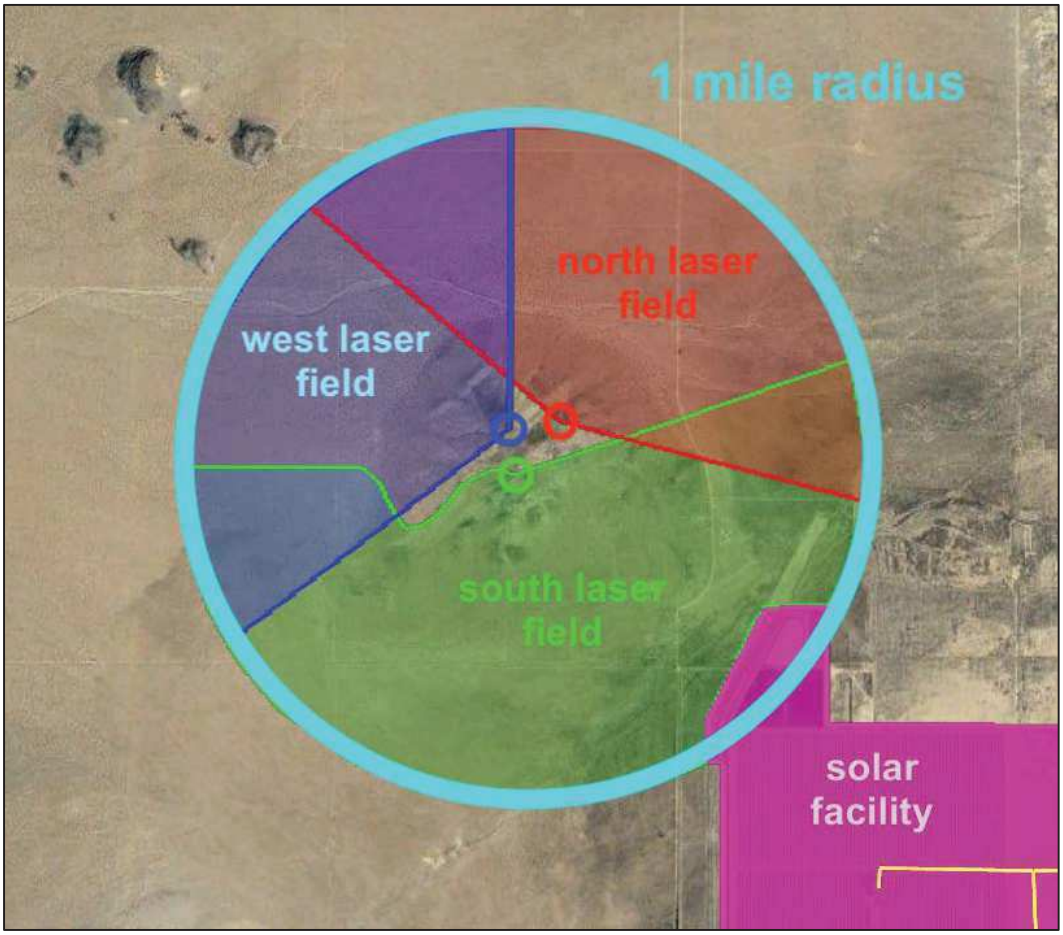


Figure 6. Proposed three laser array for raven repulsion from hotpot

A single laser mounted on a pole on the top of the hill (like the prototype in Figure 7) would do the same but the concern here is that such an obvious emplacement would render the device vulnerable to theft or vandalism. A dirt road passes within 15m of the peak of the hill. The three-laser array presented in the figure above is based on the idea of using small, camouflaged lasers distributed away from high traffic areas but with commanding views of the hotspot. The light blue circle shows the 1-mile radius. The grounds of the solar facility, shown in magenta, would be specifically excluded from the laser treatment footprint.

Figure 7. Prototype laser mounted on pole.

- *Aerial Drones*- Another line of tech development by Hardshell is the use of aerial drones as raven hazing devices. As with the lasers, we have experimented with drones under active control by a human and found them to be highly repulsive to ravens. This includes ravens at high value subsidy sites (a composting facility and pistachio orchards) and those that are incidentally driven from nests on which we have done drone-based remote egg oiling. We are working to automate drone operation for a variety of conservation purposes, including hazing via drones activated in response to the presence of ravens in the area.

Figure 8. Drone's eye view of fleeing ravens.

There are legitimate safety concerns associated with both of the above devices and their deployment will be subject to a lengthy process to receive permission. This is a worthwhile effort, however, because the hotspot would be an ideal testing ground. We have made USFWS and BLM personnel aware of both the hotspot and our work under this contract and anticipate support for the testing necessary to develop hazing options at the Abengoa hotspot.

On-site behavior modification

Changing the tendency of ravens to prey on juvenile tortoises could be achieved through the use of another device: 3D printed models of juvenile desert tortoises, called Techno-tortoises^{TM}. Hardshell Labs is working on an SBIR contract to perfect versions to deliver strong aversive experiences to ravens attacking the devices.

In 2019, as part of a large-scale raven monitoring effort, Hardshell did a series of field experiments with Techno-tortoises^{TM} paired with motion capture cameras in the Fremont-Kramer CHU 40 miles south of the hotspot. We demonstrated that ravens consistently investigated and attacked the models, and that the observed frequency of attack is clearly an existential threat to desert tortoises in the region. The results are still being analyzed but already these conclusions are clear:

- The models are attractive to ravens and they readily investigated and attacked them
- Video records demonstrate that many of the ravens are engaging in normal predatory behavior in their interactions with the models
- The birds, in attacking the models, are physically very vulnerable to aversive experiences delivered through the devices.

Figure 9. Raven attacking Techno-tortoise^{TM} model. (Still from motion capture camera)

We are developing two aversive experience delivery methods:

- Carbachol treated bait version- This is a thin-walled model designed to break realistically under hammering by a raven's beak, exposing a meat bait treated with the emetic compound carbachol, a chemical frequently used in aversive training of predators. Carbachol induces severe, but non-lethal, nausea within minutes of ingestion and has been shown to immediately alter the dietary habits of predators, including ravens, that consume it.
- Methyl anthranilate (MA) spray version- This otherwise harmless chemical is highly irritating to birds and we will equip Techno-tortoises with sensors that will trigger the spray of MA directly in the face of the predator when the model is under attack. In this case we are targeting ravens but, if successful, the model could be modified to address mammalian predation as well.

Carbachol and methyl anthranilate have been used in a variety of cases to alter the menu choices of wild predators. Deploying such devices within the hotspot is a highly targeted method of altering the behavior of exactly those ravens likely to engage in tortoise predation on the site.

Numerical reduction of ravens around the hotspot

Egg oiling is a method to greatly reduce or eliminate the reproductive success of birds whose nests are treated. Treated eggs fail to hatch, but are left undamaged and continue to elicit care from the parents, in most cases, preventing, or at least greatly delaying, re-nesting. In most cases oiling eggs results in entirely eliminating within-year raven reproduction.

In extensive oiling of raven nests in the Superior-Cronese and Fremont-Kramer CHUs, which surround the Abengoa hotspot, we have demonstrated its efficacy in dramatically reducing the number of nestling ravens. This is important because predation by parent ravens as they struggle to feed their rapidly growing nestlings is responsible for the loss of large numbers of hatchling, juvenile and small immature tortoises. The onset

of raven egg hatching is closely coincident with the appearance of the carcasses of predated small tortoises at monitored nests.

Figure 10. Clutch of 5 raven eggs, after oiling with REO equipment (Still from REO device camera)

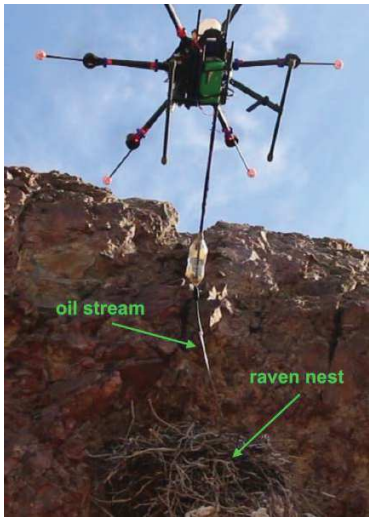


Figure 11. REO drone

Beyond the within-year effects, we have started to see reduction of raven nesting attempts in areas exposed to consistent egg oiling over several years. At two sites of about six square miles each we have recorded a greater than 50% reduction in the number of pairs even attempting to nest. At the Hyundai-Kia Motor Group test track, after four years of treating all on-site nests and three years of 98% elimination of hatching (one nestling produced from 12 nests) the number of nesting pairs has declined from eight in 2016 to three in 2019. In the Spanish Canyon-Alvord Mountain area of the Superior-Cronese CHU, over three years of egg oiling, we recorded a decline from seven nests in 2017, with 5 of those being treated, to three in 2019 (3 of 3 treated). In 2018, a very dry year of greatly reduced raven nesting attempts regionally, two clutches were oiled. Over the three-year span only one nestling survived from the ten treated clutches of eggs, a 97% reduction in hatching.

Thus, in addition to the numerical reduction of ravens produced in an area of intensive nest oiling we may be achieving a long-term repulsion of ravens from such areas. Such an effect promises to lower the labor intensity of the raven control effort over time.

Projected Timeline to Reduce Raven Predation on Desert Tortoises at the Abengoa Hotspot

1) Continue raven counts throughout the period of treatments to numerically assess the treatments' effects on ravens in the vicinity of the hotspot.
2) Oil 100% of raven nests within five miles of the hotspot- This goal is achievable in the 2020 nesting season.
    a. We oiled three nests in the Kramer Buttes in 2019 and are confident that we treated every raven nest there. All nesting pairs used previously discovered nests. We will continue to treat all nests in the Buttes area as part of long-term USFWS administered raven monitoring and egg oiling.
    b. We have received permission from solar site operators, and the regulators overseeing them, to oil any nests found on their facilities to the east and south of the hotspot. There was one confirmed and one possible nest reported in 2019 and we will work with the operators to find and oil all nests in the Abengoa and NextEra sites in 2020. Abengoa

representatives assisted in arranging the necessary permission from USFWS and California Energy Commission regulators. The nests on the Buttes and the solar sites, given their proximity to the hotspot, are the top priority targets for egg oiling.

c. Nesting on LADWP transmission towers 6 km south of the hotspot is well documented and such nests are easy to locate and monitor. We will follow up on a successful trial of tower oiling in 2019 with an emphasis on treating nests on this stretch of towers in 2020. We anticipate that LADWP will permit this activity given their positive response to our 2019 trial of tower nest oiling.
d. The Joshua tree nests in the northeast section of the circle centered on the hotspot will be carefully monitored and all active raven nests there treated. This effort will be part of long-term USFWS administered raven monitoring and egg oiling.

Comprehensive oiling of raven nests in succeeding years should be relatively easy to maintain as knowledge of raven nest sites accumulates and the continued development of the technology of remote egg oiling makes it progressively easier.

3) Conduct a trial run of laser treatment of ravens landing within the hotspot
    a. In late 2019 contact regulators and other interested parties to discuss the deployment of a laser to be used to repel ravens from the hotspot
    b. In 2020, experiment with a hand-held laser to repel ravens attempting to land, or seen landing, within the designated hotspot. Successful tests have already been run at the American Organics composting facility in Oro Grande, and at a pistachio orchard in Inyokern. This would be the first long-term deployment in tortoise habitat.
    c. In 2021, conduct experimental use of a remotely controlled laser in the hotspot. Details of this phase will be contingent on the results of the 2020 work, the approval of land and wildlife managers and other interested parties, and on acquisition of necessary funding. Results of this phase will determine the viability of long-term use of a laser on the site.

4) Deploy Techno-tortoises^{TM} in the hotspot
    a. In 2020, measure attack rates in and around the hotspot on non-aversive models paired with motion capture cameras. Funding administered by USFWS will be pursued. Such models were used in 2019 to measure predation pressure and would be used in a similar manner to gather baseline data in advance of the use of aversive conditioning models.
    b. Continue Techno-tortoise development under the current SBIR Phase 1 and 2 projects, on which Hardshell Labs is a partner. Funding from DoD.
    c. Use the hotspot as a test site for the SBIR Phase 2 field trials of the aversive models of the device.

Conclusions

In the course of this project we accomplished the following:

- A comprehensive coverage of the Abengoa hotspot to map tortoise sign and encounter and mark live desert tortoises on BLM, Abengoa Solar and THC parcels
- Gained much more detailed knowledge of the presence of ravens in the area
    - through dedicated raven search periods
    - by recording observations incidental

    - by comprehensively mapping raven nests within a 7-mile radius of the hotspot including careful searches of the slopes of Fremont Peak, the rock outcrops of the Kramer Buttes and an area of Joshua trees to the northeast. This information was added to that already gathered by USFWS raven nest monitoring projects emphasizing raven use of electrical transmission and distribution towers
    - contacted Abengoa Solar for information on raven nesting on their facility and requesting access to them
    - spoke with employees of the NextEra Energy site and heard that there is at least one raven nest that is regularly active
- Reduced raven reproductive success by treating three nests on the Kramer Buttes and one nest in a Joshua tree northeast of the hotspot. This involved:
    - Informing our USFWS point of contact of the importance of these nests, given their proximity to the hotspot and requesting a special permission to treat these nests in a critical habitat unit within which nests were not broadly treated in 2019
    - Monitoring the use of the nests by ravens and treating them with oil
    - Confirming that none of the 12 eggs oiled eventually hatched

- Worked with agency personnel to inform them of the importance of the hotspot and arranging for future work on the site. This included:
    - Pursuing and receiving a USFWS permit to handle and mark tortoises
    - Keeping current our permit from the USFWS Migratory Bird Treaty Office for egg oiling, under which we will continue yearly nest treatment
    - Receiving permission to oil raven nests at the Kramer Buttes in 2019 and urging making nest treatment in the vicinity of the hotspot a priority for future years
    - Continuing work and pursuing funding, in cooperation with the base biologist at Edwards Air Force Base, for the development of a sophisticated laser system for raven repulsion, with the idea of deploying it at the hotspot as part of field testing
    - Working with BLM personnel to receive permission to continue tortoise sign search on their land north of the Abengoa and THC parcels
    - Confirmed that the hotspot and its environs are outside the bounds of the Air Force Black Mountain Supersonic Corridor

- Worked with landowners to gain access to, and knowledge of, tortoise presence and raven nesting on their land:
    - With Abengoa Solar:
        - to gain access to their parcel within the hotspot for the purpose of conducting tortoise sign search
        - To discuss access to raven nesting on their facilities for treatment of their eggs
    - With BLM to gain access to their parcel within the hotspot for the purpose of conducting tortoise sign search

- Continued development efforts on devices that may be used in future work with raven management:
    - Began work on a SBIR contract to create aversive experience delivery versions of the 3D printed model juvenile tortoises, Techno-tortoises^{TM}
    - Received confirmation that a SBIR project to develop a remotely fired laser will be funded in late 2019

- Received confirmation that a project to experiment with drone-based bird hazing will be funded in fall 2019

The Abengoa hotspot is an exceptionally valuable area for purposes of tortoise conservation. The high population density and its favorable demographics show that this area has a chance for long-term survival. Its proximity to paved roads ensure the low logistical cost of working there. The presence of ravens and their documented predation on juvenile tortoises on the hotspot add urgency to the task of managing the birds for the sake of desert tortoise conservation. THC's leadership and openness to innovative efforts means that we have the opportunity to try methods that would not otherwise be likely.

The support of Edison International has added great resolution to our understanding of desert tortoise and raven ecology on the Abengoa hotspot and given us the chance to make significant progress on active measures to intervene for the good of tortoises. The value of the work is two-fold: there are the benefits that we hope accrue directly to the tortoises occupying the hotspot; perhaps more importantly, the work we do there will establish a template for wider application of the techniques we hatch there. For this we are profoundly indebted.

Acknowledgments

We would like to thank Edison International for funding this effort to advance active positive management of tortoises and ravens. Kathy Holmes did much of the fieldwork. USFWS has been supportive of our endeavors on THC lands and Kerry Holcomb has been particularly helpful in this respect. Jose Romero of Abengoa was very helpful in gaining permission for future oiling of raven nests on solar facilities.

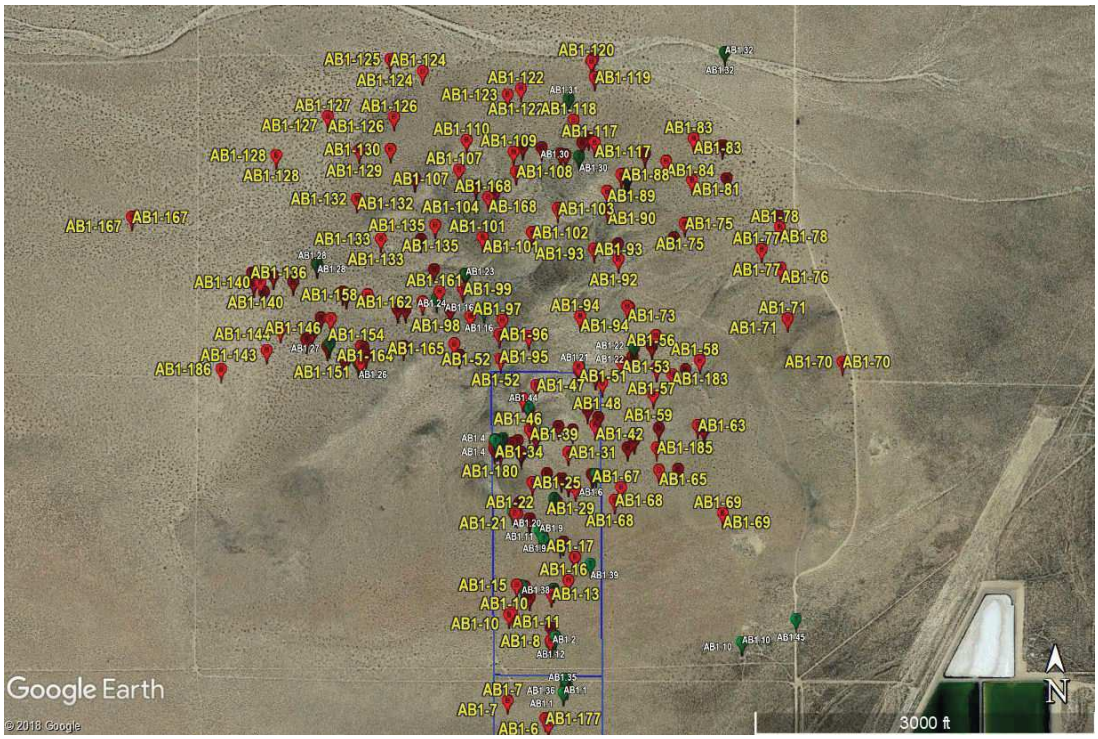


Figure 12. Map of all tortoise burrows identified and categorized during the 2018/2019 field season

Results Report: Edison International Grant to Transition Habitat Conservancy
Integrating Desert Tortoise and Raven Studies with Management: A First Step

Tim Shields
Hardshell Labs, Inc.

For Transition Habitat Conservancy

Introduction

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Upon realizing the high value of the parcel in an area of generally low desert tortoise density, Hardshell Labs and THC began to document the use of the site by tortoises and ravens and to pursue funding to enhance its value to the federally and state listed threatened reptile. Using THC general funds and small grants we started searching for tortoise sign and did an initial vegetation enhancement project. We designed the current project, funded by Edison International to thoroughly map the entire hotspot, to assess the use of the area by ravens and to create a plan to address the threat posed to the hotspot tortoises by raven predation on young tortoises.

The significance of the site is due not only to the high density of desert tortoises there but to the fact that this is a functional "island" of high-quality habitat surrounded by much lower density and habitat quality. This, combined with the easy accessibility of the site, and its exposure to frequent raven overflights, makes it an ideal place for further study of the apparent hotspot phenomenon. Further, it affords the opportunity to experiment with methods of predation reduction and habitat quality enhancement.

This report describes the results of field work and includes a first draft of a raven management plan for the site.

Figure 1. Abengoa hotspot habitat, showing hill, viewed from the south, in center of the area.

Results and Discussion

Tortoise Sign Transects

Between September 2018 and June 2019, we surveyed and mapped tortoise sign on the hotspot using 10-meter presence-absence transects. Included in the survey was the mapping of all burrows, carcasses, tracks, courtship rings, the examination of all tortoises encountered, and marking of those tortoises that could be captured, on parcels surrounding the hill. These included two THC parcels, a large BLM tract north of the hill, and an eastern parcel belonging to the solar energy company, Abengoa Solar. Figure 2 shows the land status and area covered during the work.

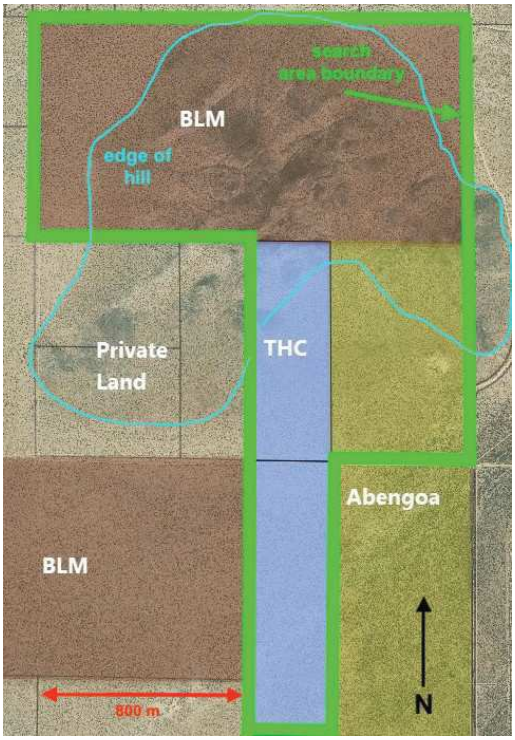

Figure 2. Hotspot land status and DT sign search area boundary

The results of this effort confirmed the high density and favorable demographics of the tortoise population inhabiting the hotspot. Within a roughly one square mile area we found 17 live tortoises, 165 tortoise burrows and 29 carcasses. Of particular note is the proportion of young animals among the ranks of the live tortoises. Given the relative difficulty of finding small tortoises these results indicate that there is good reproduction at the site and integration of younger tortoises into the breeding pool. Of the 17, one was a hatchling, three were juveniles and three were immatures. In addition, shell-wear of adults, an indication of relative age, shows a wide age range and includes several individuals only recently recruited into the pool of breeding individuals.

In addition, the discovery of two raven-pecked carcasses of juvenile tortoises demonstrates that this threat to the tortoise population is a matter if immediate concern. Given the usual quick loss of small tortoise carcasses to scavengers, the fact that two such carcasses have been found suggest that ravens present a threat to the long-term well-being of the population. Prior and concurrent field work on the site has included recording every sighting of ravens and demonstrated that ravens are frequently present flying over and alighting on the site.

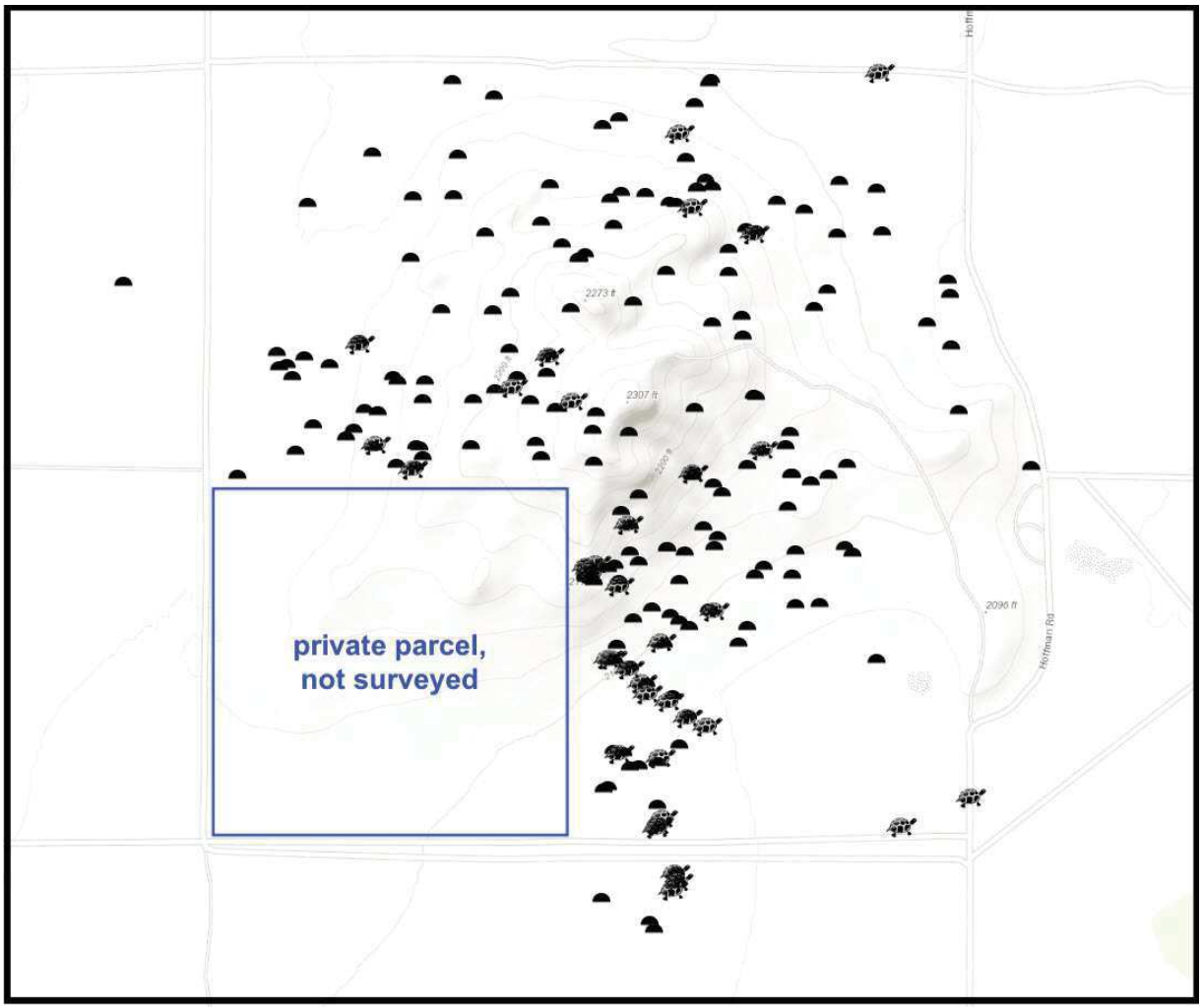

Figure 3. Distribution of tortoise sign on Abengoa hotspot. Pictured are symbols for live tortoises and their burrows. (Note that the privately owned southwest corner parcel was not surveyed.)

Raven Presence Monitoring

On four different days over the course of the project we conducted three one-hour raven searches. Every 15 minutes a 5-minute, 360° binocular sweep was performed from the top of the hill dominating the hotspot. We recorded the estimated position, flight direction and altitude, and behavior of every raven seen or heard, both within the five-minute count period and in the times between them.

The goal was to count raven flights in the vicinity of the hotspot over the course of winter and spring to gain a sense of seasonal patterns of raven presence and to gain familiarity with a possible technique for long-term monitoring. In addition, we recorded all sightings of ravens incidental to other field work. Time spent on the hilltop was valuable in providing a panoramic view of the hotspot and informing design ideas for raven repulsion options.

On every day of dedicated raven counts we saw at least one raven and, in most cases, we saw them in at least two of the three counting periods. Beyond that, our numerous opportunistic observations of ravens at other times, including sightings of ravens on the ground in the hotspot, show that ravens are consistently present. Springtime counts were higher than wintertime counts. This is not surprising, given that the

breeding season for ravens occurs then and entails the full-time occupation of territories that are often empty in the winter. Another factor is that raven nesting coincides with the season of highest activity for tortoises, including the juveniles vulnerable to raven predation.

The sample size of the counts was too low to allow any statistical analysis but the method is simple and, if expanded, could provide usable data for before and after counts when raven control measures are instituted.

Raven nest mapping

We spent 7-person days in intensive searches for raven nests within 7 miles of the hotspot, as a way to supplement the knowledge of raven nest sites in the area and to familiarize ourselves with the pattern and particulars of raven nesting with the zone. Prior work by Hardshell has demonstrated that nesting ravens range widely during nesting season and our goal was to generate a comprehensive map of raven nests within likely foraging distance of the hotspot. Work included:

- searching the southern face of Fremont Peak for cliff and rock outcrop nests
- a careful examination of the Kramer Buttes, a series of large rock outcrops from 1,600 to 4,000 meters from the hotspot
- searching Joshua trees to the northeast of the hotspot that had not yet been surveyed in the course of USFWS funded raven monitoring since 2014 in the Superior-Cronese Critical Habitat Unit (S-C CHU).
- reaching out to operators of solar facilities in the area and asking about raven nesting on their grounds and facilities. This effort grew out of knowledge of repeated raven nesting at the Abengoa Harper Lake solar facility.

We confirmed that the Kramer Buttes had six possible raven nests, we added six Joshua tree nests to the map and learned of at least two nests in solar facilities. This supplemented prior knowledge of high-density raven nesting in a corridor of 500 kV transmission towers owned by LADWP and running about 6 km south of the hotspot.

As part of ongoing raven nest monitoring and egg oiling work in spring 2019 we tracked the use of the nests found during the mapping effort for their use by ravens. In acknowledgment of the value of the hotspot, we received special permission from USFWS to treat (egg oil) nests at Kramer Buttes, in the Fremont-Kramer CHU. We treated all three active nests, with a total of 12 eggs, none of which produced viable offspring. We confirmed that one nest was active on the Abengoa solar site, about 6 km away from the hotspot, and that one may have been active at the NextEra Energy site, about 3 km distant. We were unable to treat these nests due to the length of time needed for Abengoa to receive permission from USFWS and California Energy Commission to treat the nest on their facility. Four raven nests were active on the LADWP towers within the study area. One Joshua Tree nest within the specified radius, previously found during USFWS raven monitoring work, was active and was also oiled, eliminating 5 eggs.

Figure 4 shows the distribution of raven nests within a 7-mile radius of the hotspot, with and additional circle shown centered on Fremont Peak, whose cliffs are likely to harbor raven nests and whose southern and eastern flanks were searched for the study.

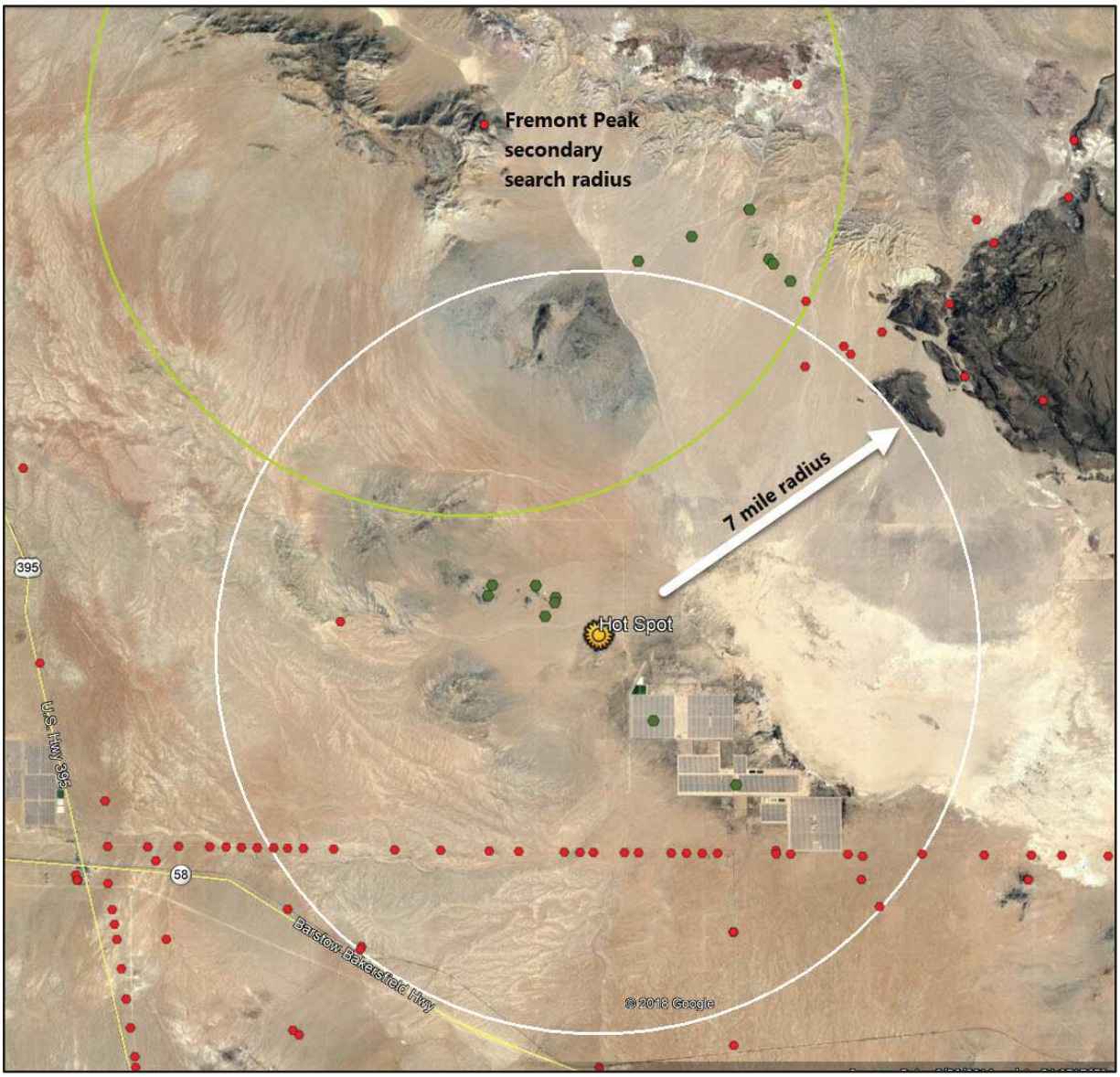

Figure 4. Raven nests in the hotspot vicinity, with search areas indicated. Red nests are previously mapped, while green sites were added during the study.

Proposed Raven Management Plan Draft

What follows is a proposal for active raven management in and around the so-called Abengoa desert tortoise hotspot. This is part of a wider effort to integrate tortoise monitoring with habitat enhancements and active predator management. This plan is primarily based on the results of the above work and on development work on tools and techniques for raven control, in progress by Hardshell on several Department of Defense (DoD) Small Business Innovation Research (SBIR) contracts. Proposed methods fall into three categories: redistribution of ravens; behavior modification; and numbers reduction.

Redistribution: on-site repulsion tools and methods

Prior experimentation with several tools has demonstrated the efficacy of hazing ravens from defined areas. Driving ravens from high value habitat could be achieved through the use of:

- *Lasers*- Hardshell Labs has been experimenting with green light lasers as raven repulsion tools for 5 years. We have demonstrated that ravens are highly sensitive to laser light, including during daytime, and that the effective range of such devices can be over 1,600m (one mile). Ravens have abandoned otherwise attractive sites in response to consistent treatment with lasers. Under a DoD SBIR project we are developing a remotely fired laser (RFL), one that could be monitored off-site via a live video stream or that could be linked with a pattern recognition program, providing autonomous activation of the system and autonomous or semi-autonomous operation. The core of this system is raven recognition software that can discriminate between ravens, natural objects and other species of birds. The current version of the program correctly flags ravens and crows over 90% of the time. Figure 6 shows a possible deployment of three RFLs to render the tortoise hotspot a "no landing zone" for ravens. Keep in mind that a flying raven is no threat to tortoises- it is only the bird on the ground that is a problem.

Figure 5. Ravens fleeing a green light laser. Note the beam striking near the base of the wood power pole. Over 400 ravens were driven into the sky by a laser sweep in this case.

We illustrate a 1,600m (one mile) radius of fire from the top of the highest hill, which coincides neatly with the center of the hotspot. That radius of fire would entirely cover the hotspot and reach well into the lower quality saltbush habitat.

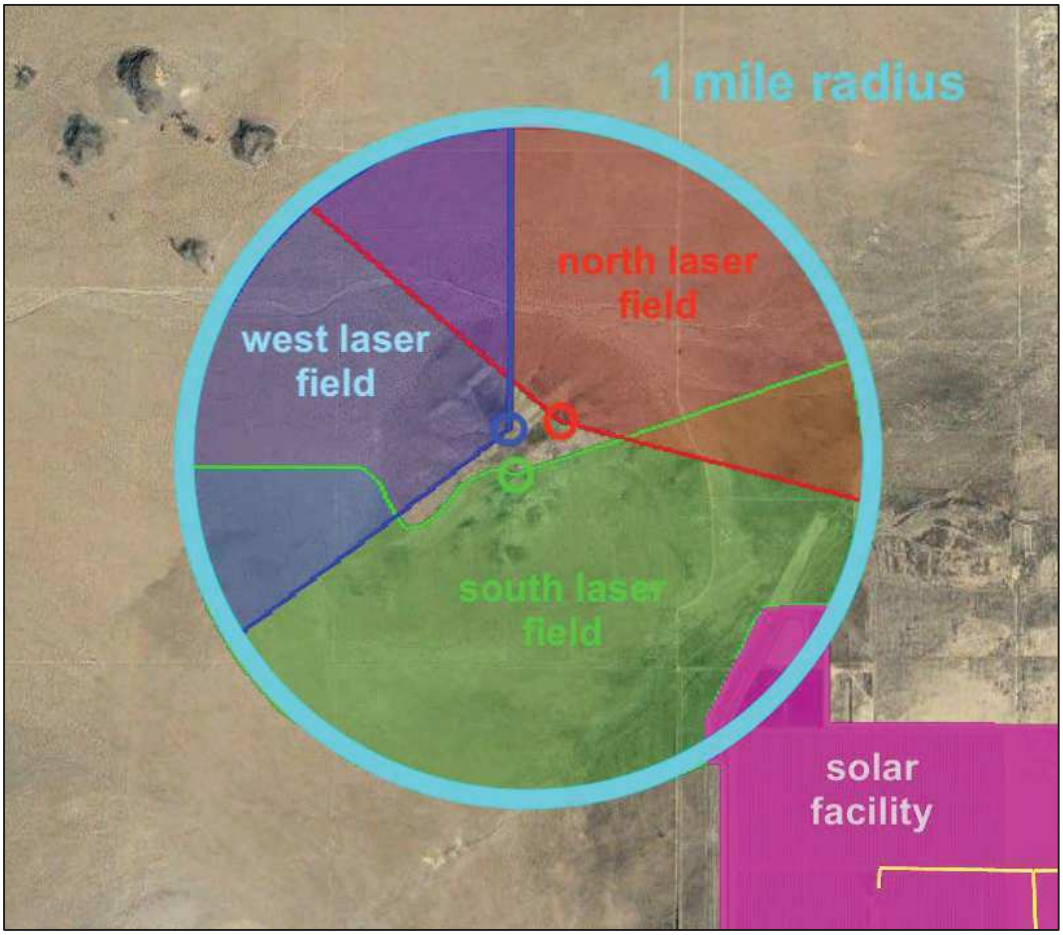

Figure 6. Proposed three laser array for raven repulsion from hotpot

A single laser mounted on a pole on the top of the hill (like the prototype in Figure 7) would do the same but the concern here is that such an obvious emplacement would render the device vulnerable to theft or vandalism. A dirt road passes within 15m of the peak of the hill. The three-laser array presented in the figure above is based on the idea of using small, camouflaged lasers distributed away from high traffic areas but with commanding views of the hotspot. The light blue circle shows the 1-mile radius. The grounds of the solar facility, shown in magenta, would be specifically excluded from the laser treatment footprint.

Figure 7. Prototype laser mounted on pole.

- *Aerial Drones*- Another line of tech development by Hardshell is the use of aerial drones as raven hazing devices. As with the lasers, we have experimented with drones under active control by a human and found them to be highly repulsive to ravens. This includes ravens at high value subsidy sites (a composting facility and pistachio orchards) and those that are incidentally driven from nests on which we have done drone-based remote egg oiling. We are working to automate drone operation for a variety of conservation purposes, including hazing via drones activated in response to the presence of ravens in the area.

Figure 8. Drone's eye view of fleeing ravens.

There are legitimate safety concerns associated with both of the above devices and their deployment will be subject to a lengthy process to receive permission. This is a worthwhile effort, however, because the hotspot would be an ideal testing ground. We have made USFWS and BLM personnel aware of both the hotspot and our work under this contract and anticipate support for the testing necessary to develop hazing options at the Abengoa hotspot.

On-site behavior modification

Changing the tendency of ravens to prey on juvenile tortoises could be achieved through the use of another device: 3D printed models of juvenile desert tortoises, called Techno-tortoises^{TM}. Hardshell Labs is working on an SBIR contract to perfect versions to deliver strong aversive experiences to ravens attacking the devices.

In 2019, as part of a large-scale raven monitoring effort, Hardshell did a series of field experiments with Techno-tortoises^{TM} paired with motion capture cameras in the Fremont-Kramer CHU 40 miles south of the hotspot. We demonstrated that ravens consistently investigated and attacked the models, and that the observed frequency of attack is clearly an existential threat to desert tortoises in the region. The results are still being analyzed but already these conclusions are clear:

- The models are attractive to ravens and they readily investigated and attacked them
- Video records demonstrate that many of the ravens are engaging in normal predatory behavior in their interactions with the models
- The birds, in attacking the models, are physically very vulnerable to aversive experiences delivered through the devices.

Figure 9. Raven attacking Techno-tortoise^{TM} model. (Still from motion capture camera)

We are developing two aversive experience delivery methods:

- Carbachol treated bait version- This is a thin-walled model designed to break realistically under hammering by a raven's beak, exposing a meat bait treated with the emetic compound carbachol, a chemical frequently used in aversive training of predators. Carbachol induces severe, but non-lethal, nausea within minutes of ingestion and has been shown to immediately alter the dietary habits of predators, including ravens, that consume it.
- Methyl anthranilate (MA) spray version- This otherwise harmless chemical is highly irritating to birds and we will equip Techno-tortoises with sensors that will trigger the spray of MA directly in the face of the predator when the model is under attack. In this case we are targeting ravens but, if successful, the model could be modified to address mammalian predation as well.

Carbachol and methyl anthranilate have been used in a variety of cases to alter the menu choices of wild predators. Deploying such devices within the hotspot is a highly targeted method of altering the behavior of exactly those ravens likely to engage in tortoise predation on the site.

Numerical reduction of ravens around the hotspot

Egg oiling is a method to greatly reduce or eliminate the reproductive success of birds whose nests are treated. Treated eggs fail to hatch, but are left undamaged and continue to elicit care from the parents, in most cases, preventing, or at least greatly delaying, re-nesting. In most cases oiling eggs results in entirely eliminating within-year raven reproduction.

In extensive oiling of raven nests in the Superior-Cronese and Fremont-Kramer CHUs, which surround the Abengoa hotspot, we have demonstrated its efficacy in dramatically reducing the number of nestling ravens. This is important because predation by parent ravens as they struggle to feed their rapidly growing nestlings is responsible for the loss of large numbers of hatchling, juvenile and small immature tortoises. The onset

of raven egg hatching is closely coincident with the appearance of the carcasses of predated small tortoises at monitored nests.

Figure 10. Clutch of 5 raven eggs, after oiling with REO equipment (Still from REO device camera)

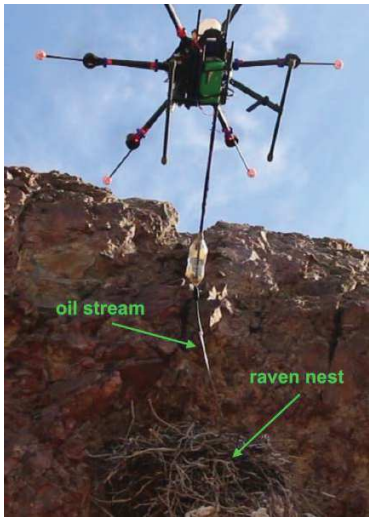

Figure 11. REO drone

Beyond the within-year effects, we have started to see reduction of raven nesting attempts in areas exposed to consistent egg oiling over several years. At two sites of about six square miles each we have recorded a greater than 50% reduction in the number of pairs even attempting to nest. At the Hyundai-Kia Motor Group test track, after four years of treating all on-site nests and three years of 98% elimination of hatching (one nestling produced from 12 nests) the number of nesting pairs has declined from eight in 2016 to three in 2019. In the Spanish Canyon-Alvord Mountain area of the Superior-Cronese CHU, over three years of egg oiling, we recorded a decline from seven nests in 2017, with 5 of those being treated, to three in 2019 (3 of 3 treated). In 2018, a very dry year of greatly reduced raven nesting attempts regionally, two clutches were oiled. Over the three-year span only one nestling survived from the ten treated clutches of eggs, a 97% reduction in hatching.

Thus, in addition to the numerical reduction of ravens produced in an area of intensive nest oiling we may be achieving a long-term repulsion of ravens from such areas. Such an effect promises to lower the labor intensity of the raven control effort over time.

Projected Timeline to Reduce Raven Predation on Desert Tortoises at the Abengoa Hotspot

1) Continue raven counts throughout the period of treatments to numerically assess the treatments' effects on ravens in the vicinity of the hotspot.
2) Oil 100% of raven nests within five miles of the hotspot- This goal is achievable in the 2020 nesting season.
    a. We oiled three nests in the Kramer Buttes in 2019 and are confident that we treated every raven nest there. All nesting pairs used previously discovered nests. We will continue to treat all nests in the Buttes area as part of long-term USFWS administered raven monitoring and egg oiling.
    b. We have received permission from solar site operators, and the regulators overseeing them, to oil any nests found on their facilities to the east and south of the hotspot. There was one confirmed and one possible nest reported in 2019 and we will work with the operators to find and oil all nests in the Abengoa and NextEra sites in 2020. Abengoa

representatives assisted in arranging the necessary permission from USFWS and California Energy Commission regulators. The nests on the Buttes and the solar sites, given their proximity to the hotspot, are the top priority targets for egg oiling.

c. Nesting on LADWP transmission towers 6 km south of the hotspot is well documented and such nests are easy to locate and monitor. We will follow up on a successful trial of tower oiling in 2019 with an emphasis on treating nests on this stretch of towers in 2020. We anticipate that LADWP will permit this activity given their positive response to our 2019 trial of tower nest oiling.
d. The Joshua tree nests in the northeast section of the circle centered on the hotspot will be carefully monitored and all active raven nests there treated. This effort will be part of long-term USFWS administered raven monitoring and egg oiling.

Comprehensive oiling of raven nests in succeeding years should be relatively easy to maintain as knowledge of raven nest sites accumulates and the continued development of the technology of remote egg oiling makes it progressively easier.

3) Conduct a trial run of laser treatment of ravens landing within the hotspot
    a. In late 2019 contact regulators and other interested parties to discuss the deployment of a laser to be used to repel ravens from the hotspot
    b. In 2020, experiment with a hand-held laser to repel ravens attempting to land, or seen landing, within the designated hotspot. Successful tests have already been run at the American Organics composting facility in Oro Grande, and at a pistachio orchard in Inyokern. This would be the first long-term deployment in tortoise habitat.
    c. In 2021, conduct experimental use of a remotely controlled laser in the hotspot. Details of this phase will be contingent on the results of the 2020 work, the approval of land and wildlife managers and other interested parties, and on acquisition of necessary funding. Results of this phase will determine the viability of long-term use of a laser on the site.

4) Deploy Techno-tortoises^{TM} in the hotspot
    a. In 2020, measure attack rates in and around the hotspot on non-aversive models paired with motion capture cameras. Funding administered by USFWS will be pursued. Such models were used in 2019 to measure predation pressure and would be used in a similar manner to gather baseline data in advance of the use of aversive conditioning models.
    b. Continue Techno-tortoise development under the current SBIR Phase 1 and 2 projects, on which Hardshell Labs is a partner. Funding from DoD.
    c. Use the hotspot as a test site for the SBIR Phase 2 field trials of the aversive models of the device.

Conclusions

In the course of this project we accomplished the following:

- A comprehensive coverage of the Abengoa hotspot to map tortoise sign and encounter and mark live desert tortoises on BLM, Abengoa Solar and THC parcels
- Gained much more detailed knowledge of the presence of ravens in the area
    - through dedicated raven search periods
    - by recording observations incidental

    - by comprehensively mapping raven nests within a 7-mile radius of the hotspot including careful searches of the slopes of Fremont Peak, the rock outcrops of the Kramer Buttes and an area of Joshua trees to the northeast. This information was added to that already gathered by USFWS raven nest monitoring projects emphasizing raven use of electrical transmission and distribution towers
    - contacted Abengoa Solar for information on raven nesting on their facility and requesting access to them
    - spoke with employees of the NextEra Energy site and heard that there is at least one raven nest that is regularly active
- Reduced raven reproductive success by treating three nests on the Kramer Buttes and one nest in a Joshua tree northeast of the hotspot. This involved:
    - Informing our USFWS point of contact of the importance of these nests, given their proximity to the hotspot and requesting a special permission to treat these nests in a critical habitat unit within which nests were not broadly treated in 2019
    - Monitoring the use of the nests by ravens and treating them with oil
    - Confirming that none of the 12 eggs oiled eventually hatched

- Worked with agency personnel to inform them of the importance of the hotspot and arranging for future work on the site. This included:
    - Pursuing and receiving a USFWS permit to handle and mark tortoises
    - Keeping current our permit from the USFWS Migratory Bird Treaty Office for egg oiling, under which we will continue yearly nest treatment
    - Receiving permission to oil raven nests at the Kramer Buttes in 2019 and urging making nest treatment in the vicinity of the hotspot a priority for future years
    - Continuing work and pursuing funding, in cooperation with the base biologist at Edwards Air Force Base, for the development of a sophisticated laser system for raven repulsion, with the idea of deploying it at the hotspot as part of field testing
    - Working with BLM personnel to receive permission to continue tortoise sign search on their land north of the Abengoa and THC parcels
    - Confirmed that the hotspot and its environs are outside the bounds of the Air Force Black Mountain Supersonic Corridor

- Worked with landowners to gain access to, and knowledge of, tortoise presence and raven nesting on their land:
    - With Abengoa Solar:
        - to gain access to their parcel within the hotspot for the purpose of conducting tortoise sign search
        - To discuss access to raven nesting on their facilities for treatment of their eggs
    - With BLM to gain access to their parcel within the hotspot for the purpose of conducting tortoise sign search

- Continued development efforts on devices that may be used in future work with raven management:
    - Began work on a SBIR contract to create aversive experience delivery versions of the 3D printed model juvenile tortoises, Techno-tortoises^{TM}
    - Received confirmation that a SBIR project to develop a remotely fired laser will be funded in late 2019

- Received confirmation that a project to experiment with drone-based bird hazing will be funded in fall 2019

The Abengoa hotspot is an exceptionally valuable area for purposes of tortoise conservation. The high population density and its favorable demographics show that this area has a chance for long-term survival. Its proximity to paved roads ensure the low logistical cost of working there. The presence of ravens and their documented predation on juvenile tortoises on the hotspot add urgency to the task of managing the birds for the sake of desert tortoise conservation. THC's leadership and openness to innovative efforts means that we have the opportunity to try methods that would not otherwise be likely.

The support of Edison International has added great resolution to our understanding of desert tortoise and raven ecology on the Abengoa hotspot and given us the chance to make significant progress on active measures to intervene for the good of tortoises. The value of the work is two-fold: there are the benefits that we hope accrue directly to the tortoises occupying the hotspot; perhaps more importantly, the work we do there will establish a template for wider application of the techniques we hatch there. For this we are profoundly indebted.

Acknowledgments

We would like to thank Edison International for funding this effort to advance active positive management of tortoises and ravens. Kathy Holmes did much of the fieldwork. USFWS has been supportive of our endeavors on THC lands and Kerry Holcomb has been particularly helpful in this respect. Jose Romero of Abengoa was very helpful in gaining permission for future oiling of raven nests on solar facilities.

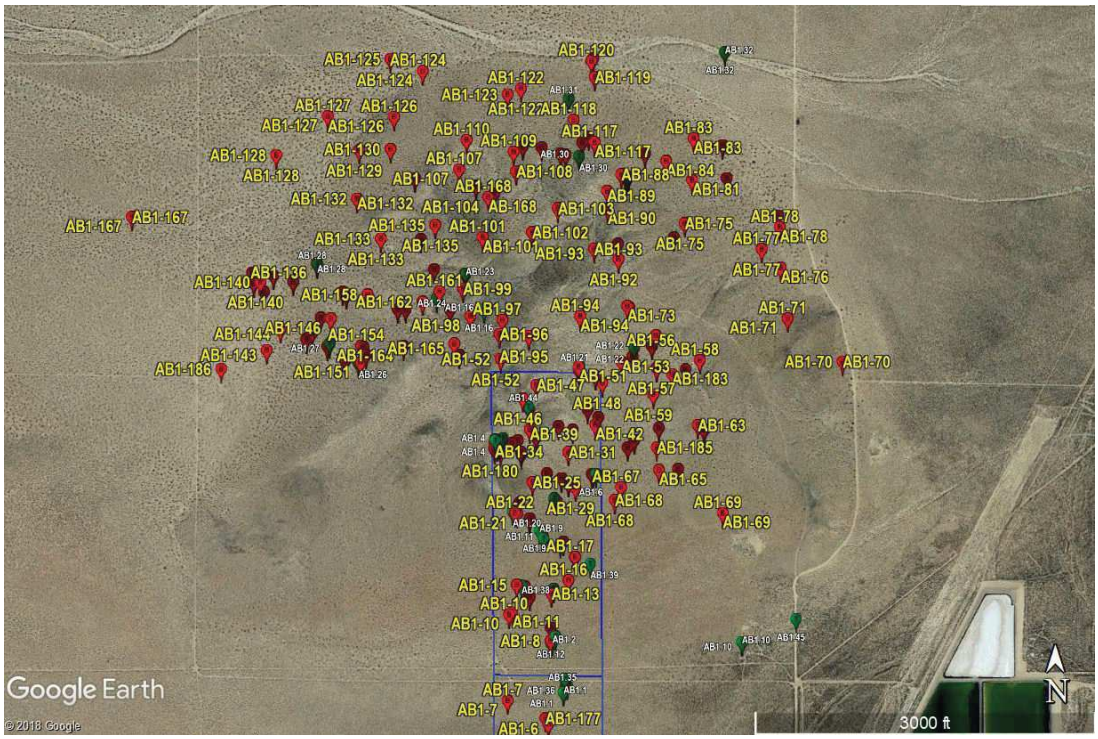

Figure 12. Map of all tortoise burrows identified and categorized during the 2018/2019 field season

Transition Habitat
CONSERVANCY

Desert Tortoise Native Food Gardens: 2018 Final Project Report

Introduction

The decline of Agassiz' desert tortoise, the iconic Mojave Desert reptile, has been well documented and closely observed. Populations have fallen 90-95% in many areas and a wide array of causes identified and argued over as to their relative importance. What is clear is that human activities are largely to blame and that some of the significant threats, such as the spread of respiratory diseases, will be difficult or impossible to control. However, some threats are manageable and this is where effort should be focused. Transition Habitat Conservancy and Hardshell Labs, Inc. have been working together for three years on desert tortoise conservation around Fremont Peak, a west Mojave mountain at the center of a large number of parcels purchased by THC. The work has included assessment of the history and current status of tortoise populations there and planning for active ecological intervention to improve the lot of tortoises there.

The most important result so far has been the discovery of a pair of tortoise population "hotspots" in a setting of land wherein a steep decline of tortoises has occurred over the last 25 years or so. We continue to investigate these hotspots with a view to characterizing them. However, we are also interested in experimenting with active interventions to improve habitat quality and thus survival of tortoises. In was with this in mind that we approached Patagonia for a 2018 grant to develop and apply some of these interventions: specifically vegetation quality and diversity and improved access to water for tortoises.

Role of diverse vegetation in tortoise well-being

Desert tortoises are herbivores and benefit from a diverse range of dietary choices. Among food items a typical west Mojave tortoise might consume in a season are 15 or so species of native annual forbs (wildflowers), several species of native grass and a number of perennials, such as cacti. Diversity allows tortoises access to a full range of nutrients and to fine tune their diet to particular needs, seasonally and individually.

Unfortunately a number of invasive annual plant species have become firmly established in the Mojave and have increased in prevalence over time. Of particular note are *Schismus barbatus* and *Schismus arabicus,* two Mediterranean annual grasses that become dominant, especially in the west Mojave. As their numbers have grown that of native plants has fallen leading to greatly reduced dietary diversity for tortoises. Schismus grasses are relatively poor forage for tortoises, making their prevalence even more problematic.

Role of water in tortoise well-being

In the arid and drought prone Mojave water is the most essential resource for wildlife and its acquisition is a life or death matter. Tortoises have no higher priority and have a wide range of behaviors to maximize the capture of water during rare rainfall events. They know where water is likely to accumulate and move to those places in advance of rainfall to be ready to get what they can while they can. In much of the region sandy soils mean that most of the rainfall that might otherwise be available to tortoises simply drains away. Tortoises actually modify natural features to increase water retention and have been seen to use artificial materials and structures that retain rainfall.

With the above points in mind we examined a number of options for a demonstration of active ecological intervention. Our goal was to provide tangible benefits for tortoises in the short term while gaining valuable experience for long-term use in tortoise conservation. We aimed for low cost, high benefit options.

Ideas for active management of vegetation

- Removal of weeds- Weed removal, via mechanical or chemical means, is beyond the scope of options for the time being. It bears future consideration and could be combined with methods to enhance the growth of native plants

- Fostering of native plants
    - Large scale watering- Large scale watering of tracts of deserts has been tried in the past, notably at the Desert Tortoise Research Natural Area using a large sprinkler system but this is a very water and cash intensive approach to ensuring tortoise access to sufficient high quality forage.
    - Rainfall concentrators- We identified this option as the best one for the project. The idea is to use a water repellent surface to collect water over a relatively large area and concentrate it in a relatively small area, thereby creating a highly watered soil patch. We decided to seed these small high moisture areas with a valuable forage species, the desert dandelion, *Malacothrix glabrata*.

Ideas for active management of water for tortoises

- Active hydration- US Fish and Wildlife Service has approved a number of methods for directly hydrating tortoises after capture: epicoelomic injection; nasal hydration; and waterpan provision. These are labor intensive and depend on capturing and handling tortoises
- Provision of drinking sites- An alternative approach is to provide artificial drinking sites for tortoises that will maximize the availability of water for them during rainfall events. Tortoises have frequently been observed ingesting water collected on impervious surfaces. They modify natural sites to increase water retention and use a wide variety of artificial surfaces as well: road beds; bits of tin roofing; and in the case of one juvenile tortoise a flattened beer can. Tortoises can find such sites and return to them so this approach takes advantage of their natural abilities. Using inexpensive, durable items that retain water is a low risk-high reward approach.
- Provision of green plant matter- The fostering of plant growth is an indirect way of hydrating tortoises via digestive processes.

Given the modest scale of the project we chose to construct 24 sets of rainfall concentrators, dubbed Desert Tortoise Native Food Gardens, and pair them with fired, unglazed clay nursery plates as drinking sites. We wanted to compare results for different watering regimes and devised three treatments for each of the 24 sites.

Methods

Materials:

Drinking Sites: We chose 10 and 12” simple fired clay plates, used as planter bases, from a garden supplier. These readymade items are inexpensive, impervious to water and likely to be durable once placed in tortoise habitat.

Rainfall Concentrators: We used standard 26” wide corrugated fiberglass roofing panels, cut to 48” lengths, as the basis for the units. Pairs of 24” 5/8” rebar were driven through holes drilled in the roofing to anchor the units to the soil. The roofing units were slanted by clipping two 1-gallon paint style cans on the side to be raised.

Rain Gauges: Four standard garden-style rain gauges were used, one pair at each of the two tortoise hot spots under investigation. One was placed to collect ambient rainfall and the other was placed beneath the drip line of one of the concentrators.

Motion Capture Cameras: Four Cuddeback brand game trail motion capture cameras were used, two per hot spot and trained on the concentrators and the resulting plant growth to attempt to record use of the sites by wildlife, particularly desert tortoises.

Implementation: 24 Desert Tortoise Native Food Gardens were installed on THC lands on January 18 and 19th, 2018. Twelve each were built at each of two tortoise “hotspots”, high quality habitat areas with very high relative densities of tortoises. In each hotspot one garden was equipped with a pair of rain gauges, one to measure ambient rainfall and the other positioned to measure the runoff from the concentrator. In addition, two gardens per hotspot were monitored using Cuddeback motion capture cameras. These were chosen to maximize the odds of recording tortoise visits.

Placement: All units were placed in the east to north quadrant relative to large creosote bushes with the drip lines of the concentrators aligned with the canopy edges of the shrubs. Seeds were sown along the drip lines, the point of highest natural density of annual forbs. The northeast position yielded the best protection for the units from the prevailing southwest winds.

In order to measure results and establish a proof-of-concept, each site included three unique water concentrator/seed assemblages and a drinking site dish. The three assemblages included: 1) a concentrator with native seeds that only received available precipitation, 2) a concentrator with native seeds that received a watering supplement to account for the very dry winter, 3) a control site with only native seeds and no concentrator. The order of the three units per garden was randomly assigned. Figure 2 shows the design of the concentrators and the arrangement of a typical set.

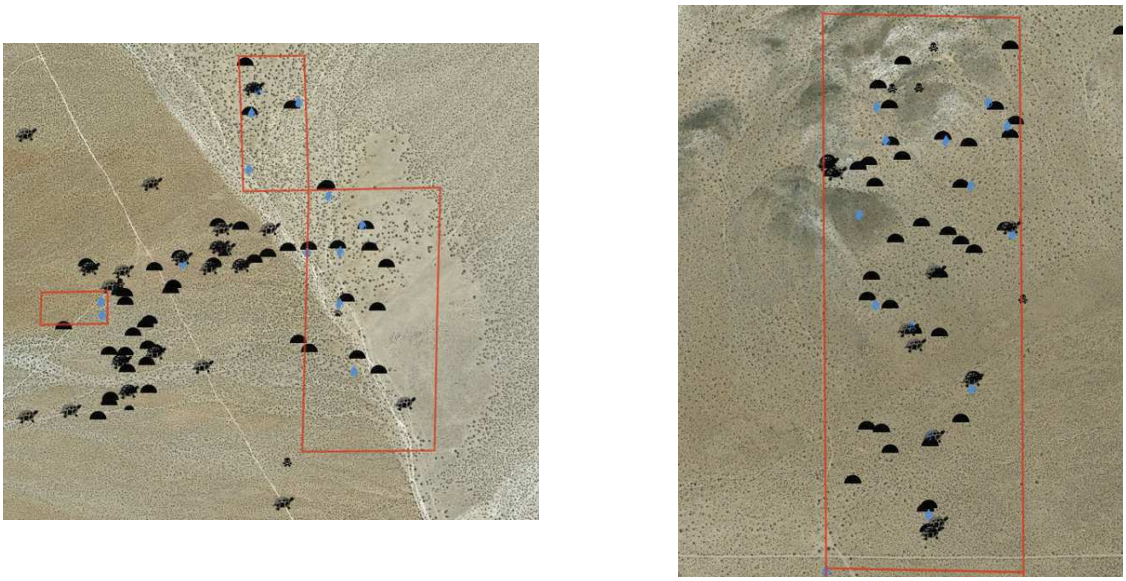

Figure 1. The two desert tortoise hotspot areas. Map shows tortoise burrows and live tortoises in black icons and rainfall collectors denoted by blue water drop shape.

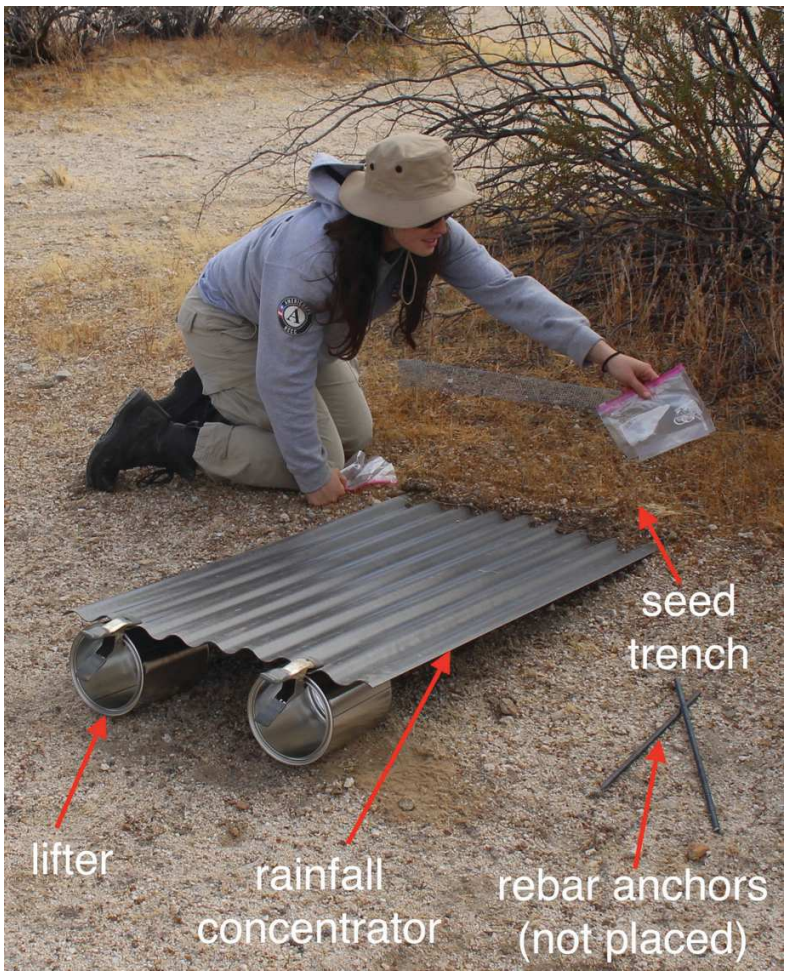

Figure 2. Collector installation. Seeds are being sown and rebar anchors are ready for placement. Note that seed trench is placed at the edge of a creosote mound, even with the canopy's edge.

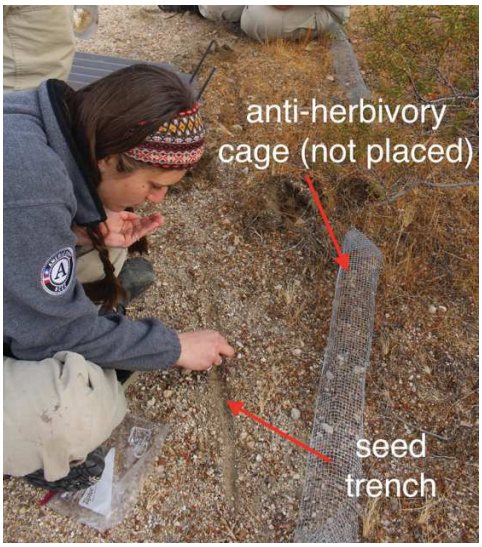

Figure 3. Sowing seeds prior to placement of concentrator

Figure 4. Placement of anti-herbivore cage over seed trench. Cages reduced seed loss to mammalian seed-eaters.

Figure 5. Installation of drinking site. A small rock ramp was placed in each to afford an exit for young tortoises and other small creatures

Notable Changes: Due to a few factors and variables, we opted to change some of details from the original grant proposal. 1) The largest factor was the timing of the grant award. Ideally, this project would have commenced in the summer or early fall to coincide with the desert's typical water cycle and receive any rains that fall in early winter. The grant was funded in late December 2017, so we needed to act quickly to install the gardens and to adjust our plan to compensate for a few critical missed rain events in fall/winter. 2) Another factor was a $1,200 difference in the proposal budget and the grant award. This primarily resulted in the decision to aggregate the Food Garden sites to two unique areas and to forego purchasing seed from an outside source. 3) Third factor was the very dry winter season we had in the West Mojave. This, along with award timing, prompted us to establish water supplemented sites to help generate a variety of possible results/measurables and help establish the proof of concept. We also had to use a small, but immediately available source of local native seeds (desert dandelion) instead of an abundant variety of annuals.
* Please note, this is in no way a grievance about the grant. We are very grateful for the opportunity to try a new concept and to further contribute to desert tortoise recovery. We just want the grantor and other readers to be aware of the variables that altered some of the project implementation details.

Monitoring Regimen: The 24 garden sites were visited at least every two weeks by THC staff, and as soon as possible following the two rain events that occurred between the January installation and April 1st. Site visits consisted of:

- hand-watering the water supplement concentrator to simulate a 1/2" (12 mm) rainfall. These supplemental waterings were continued on a roughly bi-monthly basis until a total of 2.5" (60 mm) was reached. Combined with natural rainfall during the season the natural-plus-supplemental watering equaled an average rainfall season of 5" (120 mm). Hand watering was done to minimize soil disturbance
- checking 4 rain gauges: 2 measuring ambient rainfall and 2 measuring concentrator runoff
- inspection and photography of each native seed assemblage for growth progress.
- counting of the number of sprouts of all plant types and identification of plants to highest level of taxonomic detail possible (young sprouts can be difficult to identify to species)
- the ground cover diameter of a sample of desert dandelion plants was taken for growth comparison purposes
- downloading of camera images
- repair of any units damaged by wind

We removed the Food Garden concentrators at the end of March, at the end of the usual rainy season and just before tortoises typically emerge and engage in foraging activity but continued to monitor plant growth at all 24 garden sites. We performed a final, thorough desert tortoise survey of the two Food Garden areas on April 1st. Motion capture cameras remained in place until May 30.

Results: As stated in the grant proposal, some of the major outcomes will not be measurable for a few years and only after consistent application of the ecological interventions. Our short-term results for the spring of 2018 were:

1) The water concentrators increased available water for seeds at a ratio greater than 10:1. According to our rain gauges, the sites received about 0.5 inches of rainfall on two occasions. The rain gauges (5-inch capacity) placed under the collectors were overflowing after each rain event. This is a proof of concept of the water collection aspect of the project.
2) The germination and growth of the sown desert dandelion seeds was proportional to the amount of water they received. The control units, dependent on ambient rainfall had very poor germination and almost no growth due to the drought conditions that prevailed in the area. The garden units that concentrated available rainfall (approx. 1" for the project duration and 1.5" for the season) were intermediate and those with supplemental watering to simulate average levels of rainfall (5" total) had the highest germination and best growth.
3) Seeds of a variety of annual plant species germinated and grew in response to rainfall concentration and watering. These "volunteers" included *Erodium cicutarium, Erodium texanum, Chaenactis Fremontii, Amsinckia intermedia, Plantago insularis* and an unidentified mustard, likely *Sisymbrium irio*.
4) Invasive grasses, especially *Schismus arabicus*, also benefitted and, over time, came to dominate at many garden sites. This may be the result of differential herbivory, whereby desirable annual plants such as desert dandelions, were eaten by herbivorous species and Schismus left untouched and/or a competitive advantage for Schismus that allows it to outgrow native

5) Desert dandelion sprouts grew well at many of the garden sites but in most cases were eaten before maturing. This indicates their desirability and may also be a by-product of their rarity in this severe drought year. The dandelion growth we fostered at the gardens was the only production of this highly desirable forage species that we observed over most of the hotspots. Tortoises could have consumed the vegetation, but we did not capture any evidence with the motion capture cameras and thus cannot verify.
6) The overall results varied widely among the 24 Food Garden sites. Some grew well, and others had little to no growth. We gathered information on the performance of each site as well as site characteristics (soil type, slope angle and direction). This information will be used to target future placement of rainfall concentrators.
7) Due to the very dry winter, desert spring blooms were sparse, and we were unable to collect seed for next year.
8) We recorded two interactions between tortoises and our artificial drinking sites. In one instance, a motion capture camera recorded a tortoise sitting immediately over a site (Figure 12) during a dry period. We have observed tortoises investigating potential drinking sites in this manner and believe it is likely that this tortoise was assessing the drinking site with this in mind. In the other case, following a rain event we found a nearly drained site and an active adult tortoise nearby (Figure 13). Given the fact that nearby drinking sites had much higher levels of water in them it is likely that the tortoise had ingested water at the site.

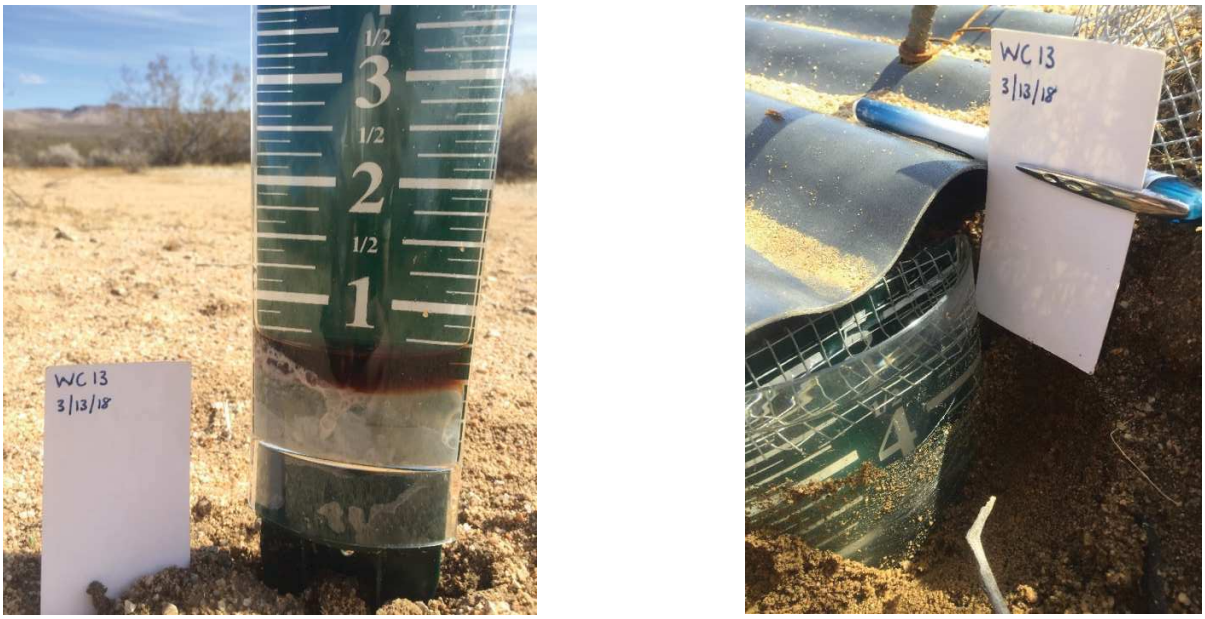

Figure 6. Rain gauges at Collector WC13. Left gauge measures ambient rainfall and shows approximately 0.5” (12mm). Dark layer is oil used to prevent evaporation of rain water. Right gauge measures runoff from concentrator in same storm and is over 5” (125 mm) deep

Figure 7. Desert dandelion sprouts growing beneath anti-herbivore cage.

Figure 8. Cage removed. Note the very dry conditions outside the footprint of the rainfall collector.

Figure 9. Close-up of desert dandelion growth.

Figure 10. Evidence of herbivory. Pen points to cropped desert dandelion stems. Identity of herbivore unknown.

Discussion

Drought is a stress on all desert wildlife, tortoises included. Lack of water retards growth, compromises health and restricts motion. Combined with other stressors and threats it can result, directly and indirectly, in the death of tortoises. Conversely, well-hydrated tortoises can grow, are more resistant to disease and, being more mobile, are able to travel more freely, acquiring the food they need and the mates they desire. Tortoises are expert navigators and seem to have excellent mental maps of their home ranges and the resources contained therein. They have the ability to recognize and return to resource rich patches, seemingly including places found in dry conditions that will serve to collect and retain rainfall.

Our goal is to take advantage of these natural abilities of tortoises and of naturally available rainwater to provide relief from drought stress for the reptiles. Further we want to provide this service at a low cost as this will make the widespread adoption of the measures more likely. The current project is a first step in this direction and intended to not only provide food for tortoises and other herbivores in the short term but, more importantly, serve as a trial run of techniques.

Rainfall concentration redistributes the natural supply of water in the desert. By denying rain to a larger collection area and delivering it to a much smaller recipient area we create an area of soil moisture above that of the surroundings. By taking water from intershrub spaces, areas of sparse annual plant growth, and delivering it to the canopy edges of creosote bushes, the places with the densest annual vegetation, we can bolster the production of food plants of highest value to desert tortoises. In drought years the supply of water fails to reach the threshold necessary to ensure the germination and growth the annual wildflowers on which tortoises depend. Concentrating rainfall raises a patch of soil moisture above the critical minimum. Sowing seeds of desirable food species in the recipient areas we can further amplify the benefit, establishing a food garden of sorts. Tortoises are expert exploiters if patchy resources and we can rely on them to find the gardens.

In this first year of work we:

- acquired material for 48 concentrators and 24 drinking sites, as well as 4 camera traps and 4 rain gauges
- monitored 24 gardens, each with three strips of desert dandelion seeds (one with no supplemental water, one concentrating ambient rainfall and one concentrating ambient water and receiving supplementary water to simulate a normal rainfall year. Monitoring included extensive photography of units and resultant plant growth
- gathered evidence, in a very dry year, of good performance by concentrators and the generation of usable forage for herbivores

- collected evidence of use of a drinking site by one tortoise and the investigation of another by another tortoise
- gained valuable experience in all phases of operation: construction and maintenance of collectors; provision of supplementary water; handling and sowing seeds and fostering growth of an important desert tortoise food; monitoring sites via handheld and motion capture cameras;
- set the stage for adaptive management planning based on first year's results

The good news from year 1 is that we can leverage ambient water to foster desert vegetation. Climate change is affecting duration and consistency of water cycles in the Mojave, and the supplement we supply could help sustain desert tortoises in tougher years.

We intend to make the following changes:

Recommended Next Steps

1) Continue use of Version 1 collectors
2) Assess the environmental characteristics of the best performing gardens from Year 1 and place Year 2 gardens in areas with those features
3) Install larger sites with broader swales to deliver collected water over a greater area. Design Version 2 collectors using lessons learned in Year 1 with an emphasis on simplicity, durability, low profile and low cost
4) Purchase/obtain much more native seed of several species and be ready to install collectors earlier in the season. In 2018 we missed the first big rainstorm. Installation in October will ensure the capture of a full winter's worth of rain
5) Determine the level of supplemental watering needed based on early season rainfall and long-range projections for the late season. We envision commencing watering, if any, in January through March
6) Remove invasive grasses, especially Schismus, and mustard plants (family Brassicaceae), from the gardens early in the growth season (late February-March)
7) Systematic comparison of ambient plant production with the treatments used

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Bureau of Land Management, Barstow Field Office

Figure 11. Two potential beneficiaries. Both observe during the full-coverage site visits in early April. Left image is very young juvenile. Very rare to see in the field.

Figure 12. Desert tortoise investigates drinking site provided by project. Note the edge of the container and markers for rainfall concentrators.

Figure 13. Drained drinking site and nearby desert tortoise seen on 7 April 2018 following a rainfall event. Tortoise likely drank out of container. Note the very dry conditions in the area during a severe drought year.