Drone-Based Land Management

Integrating drone technology into habitat monitoring at the Tejon Ranch Conservancy

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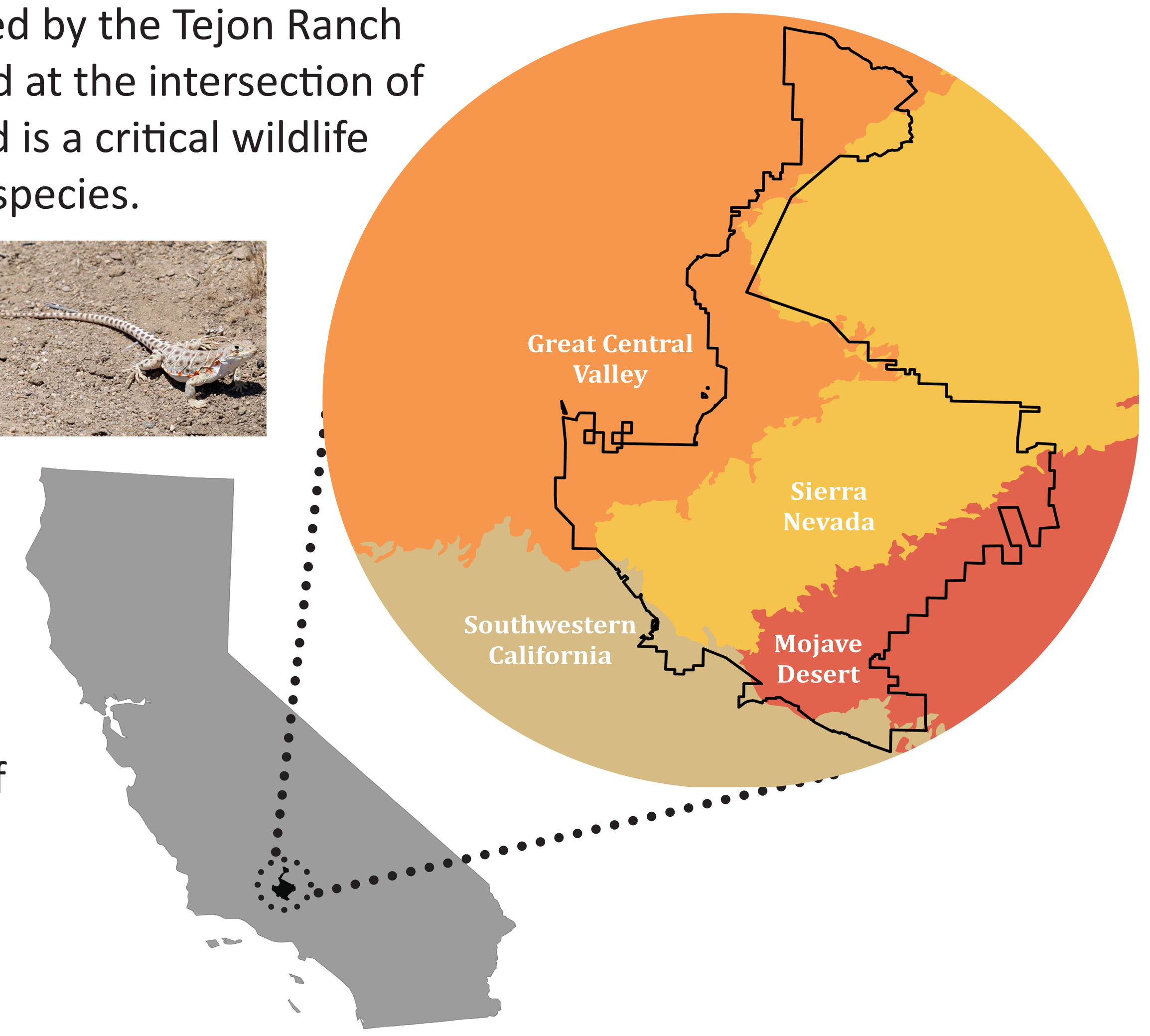
Introduction

The Tejon Ranch Conservancy helps manage over 100,000 acres of conservation easements owned by the Tejon Ranch Company. The property is located at the intersection of four major ecological regions and is a critical wildlife corridor for several endangered species.

Endangered species of Tejon Ranch (left to right): California Condor, Bakersfield Cactus, and Blunt-nose leopard lizard



The Conservancy is responsible for monitoring the conservation easements, but has limited management resources. This research assesses how the use of drones would help the Conservancy expand their habitat monitoring activities using drone-acquired images.

Case Study: Tamarisk (*Tamarix spp.*)

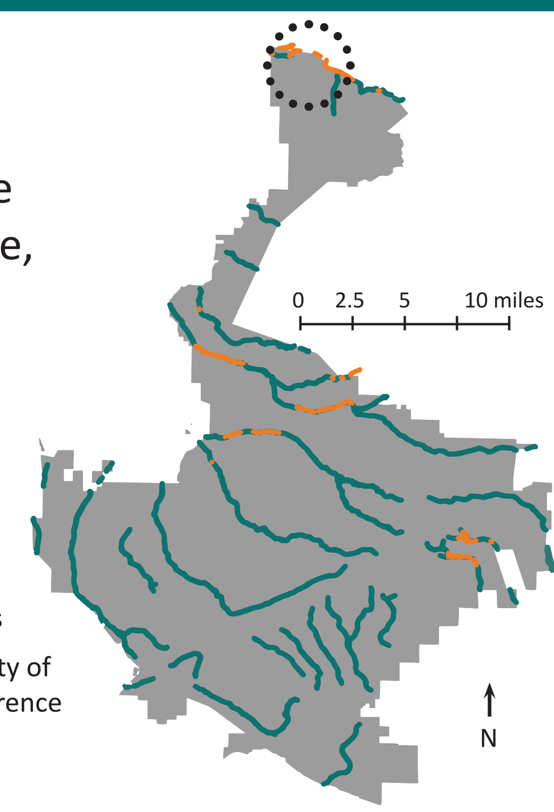
The Conservancy is concerned about the impacts of the invasive, riparian weed tamarisk because it has been sighted in high densities on the property. Tamarisk can dramatically alter the landscape, making it unsuitable for native plants and animals. The following drone flights and analyses are focused on identifying this plant, demonstrating a proof of concept for the types of monitoring of which drones are capable.

Objectives

- Identify locations that are susceptible to tamarisk invasion for test flights
- Complete flights and analyze images
- Determine financial feasibility of drone monitoring

Identify flight locations

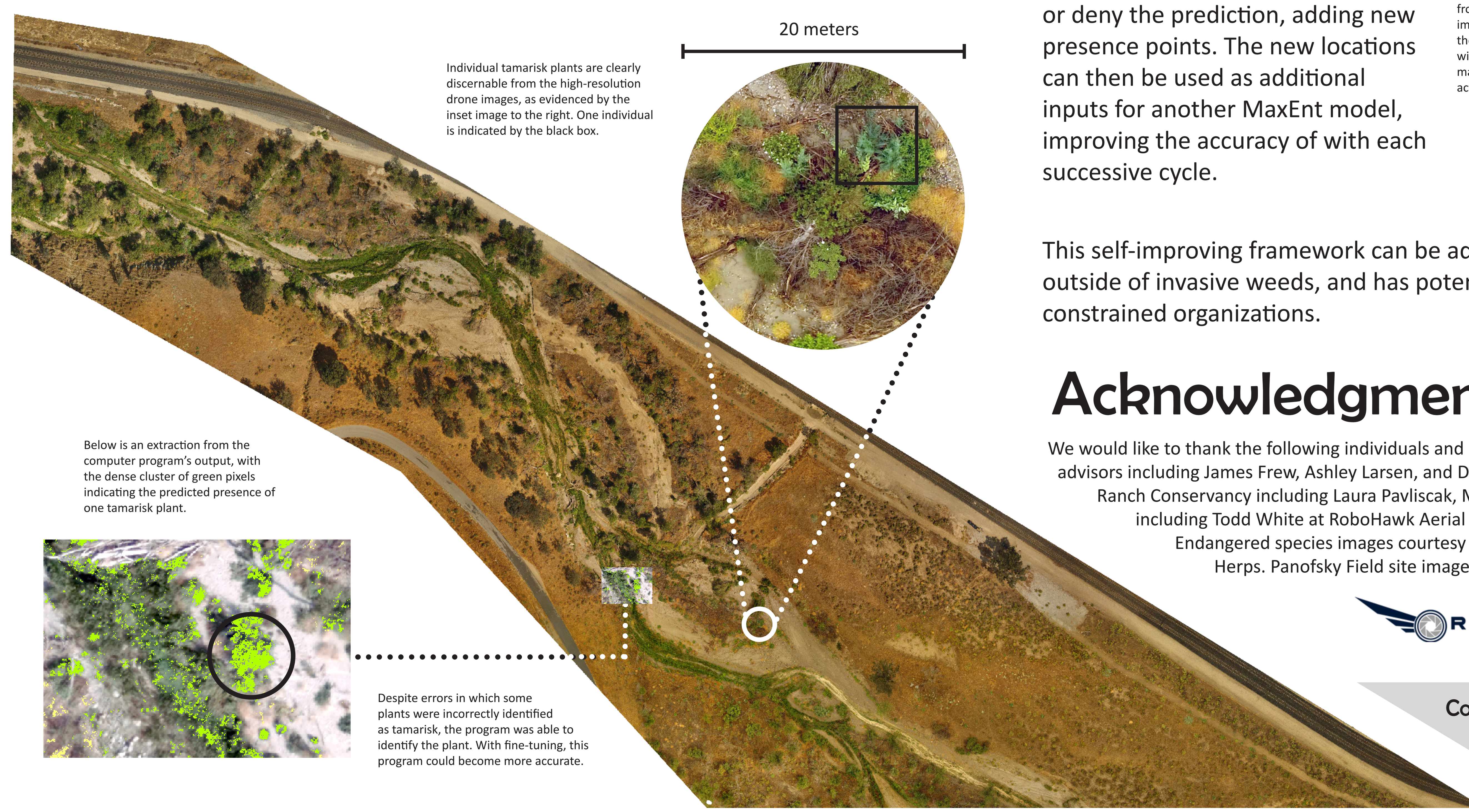
Due to the sheer size of Tejon Ranch, it was impractical to fly over the entire property. Therefore, MaxEnt, a species distribution computer program, was used to identify areas with high risk of tamarisk invasion.



Inputs to the model included known locations of tamarisk and environmental variables such as slope, precipitation, and temperature. One of the vulnerable sites was Caliente Creek, where a 20-acre site called Panofsky Field was selected to conduct test flights.

Conduct flights

On-the-ground surveys were conducted before test flights to identify different plant species in Panofsky Field. Signs were placed next to target plants and were used to confirm individual species from the drone images. The image below is an aerial view of Panofsky Field. It was assembled from over 1000 individual images taken from 120 feet. Tamarisk was visually discernable through the drone images, and an automated computer program was also able to identify tamarisk from the images.



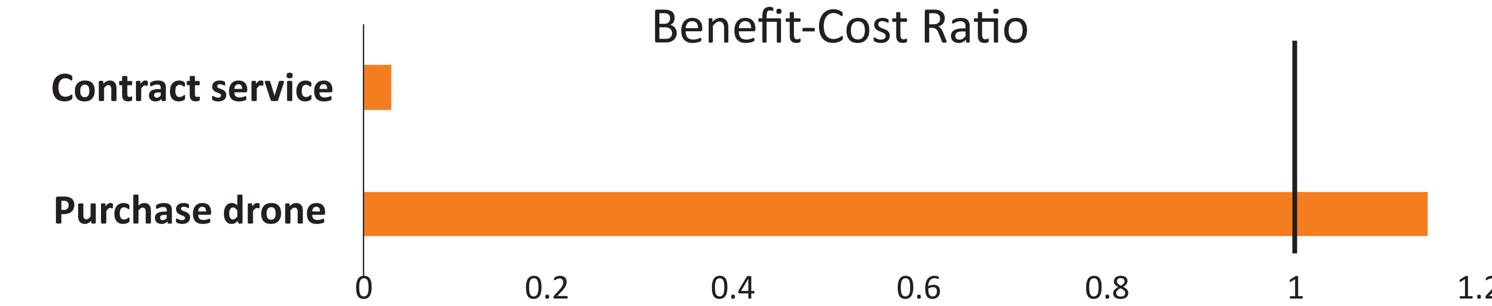
Individual tamarisk plants are clearly discernable from the high-resolution drone images, as evidenced by the inset image to the right. One individual is indicated by the black box.

Below is an extraction from the computer program's output, with the dense cluster of green pixels indicating the predicted presence of one tamarisk plant.

Despite errors in which some plants were incorrectly identified as tamarisk, the program was able to identify the plant. With fine-tuning, this program could become more accurate.

Financial feasibility

Once it was confirmed that drones can identify tamarisk and thus expand habitat monitoring for the Conservancy, a cost-benefit analysis was conducted for two drone-based options: (1) purchasing and operating a drone, and (2) contracting an independent drone service.

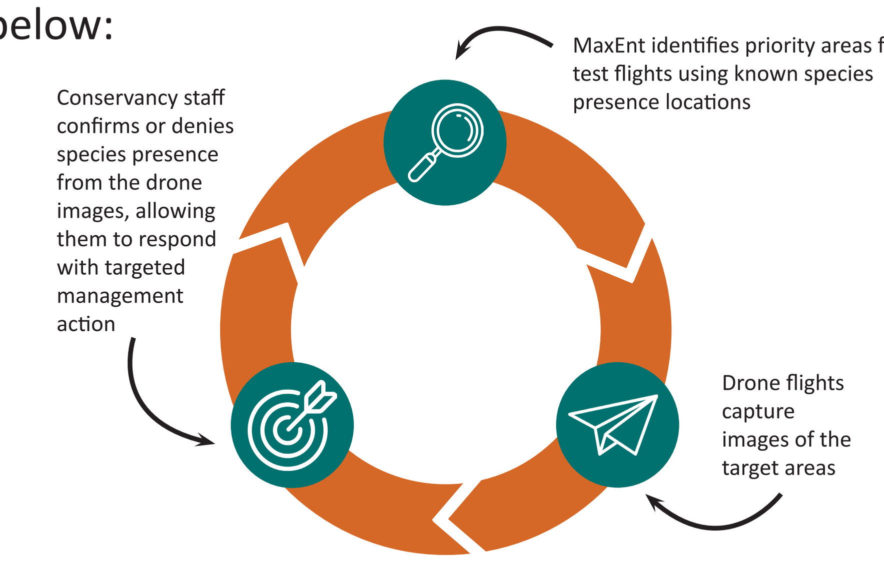


The results are displayed above as a ratio of the total benefits of implementation over the total cost. The drone purchase (Option 2) is the more favorable option because the ratio is greater than 1, meaning that benefits outweigh costs.

Conclusion & Recommendation

The combination of drone technology and predictive computer programs like MaxEnt provides a useful set of tools to expand the Conservancy's habitat monitoring capabilities without incurring a severe financial burden. The advantage of this framework is demonstrated below:

The images from the flights confirm or deny the prediction, adding new presence points. The new locations can then be used as additional inputs for another MaxEnt model, improving the accuracy of with each successive cycle.



This self-improving framework can be adapted to evaluate conservation interests outside of invasive weeds, and has potential applications for similarly resource-constrained organizations.

Acknowledgments

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Contact Information

If you are interested in learning more about our project, please visit our team website: www.tejon-ranch-drones.weebly.com.