

Effects of Fire on San Clemente Bell’s Sparrow Presence and Density

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Introduction

Loss of habitat by feral herbivores on San Clemente Island (SCI), California led to severe population reduction of the endemic Bell’s sparrow (*Artemisospiza belli clementae*). The San Clemente Bell’s sparrow was listed as Threatened by the USFWS in 1977 under the ESA.

After removal of feral grazers by 1992, recovering native vegetation developed into more varied shrub communities across the island, with a delayed but related expansion of the sparrow population into these recently established habitats. In 2020 the USFWS proposed delisting (USFWS 2021).

Prior to shrub regeneration, fire rarely occurred in areas where the Bell’s sparrows were found, but fires from US Navy military training operations now occur at a greater frequency and larger scale in sparrow-occupied areas, potentially affecting long-term population persistence.

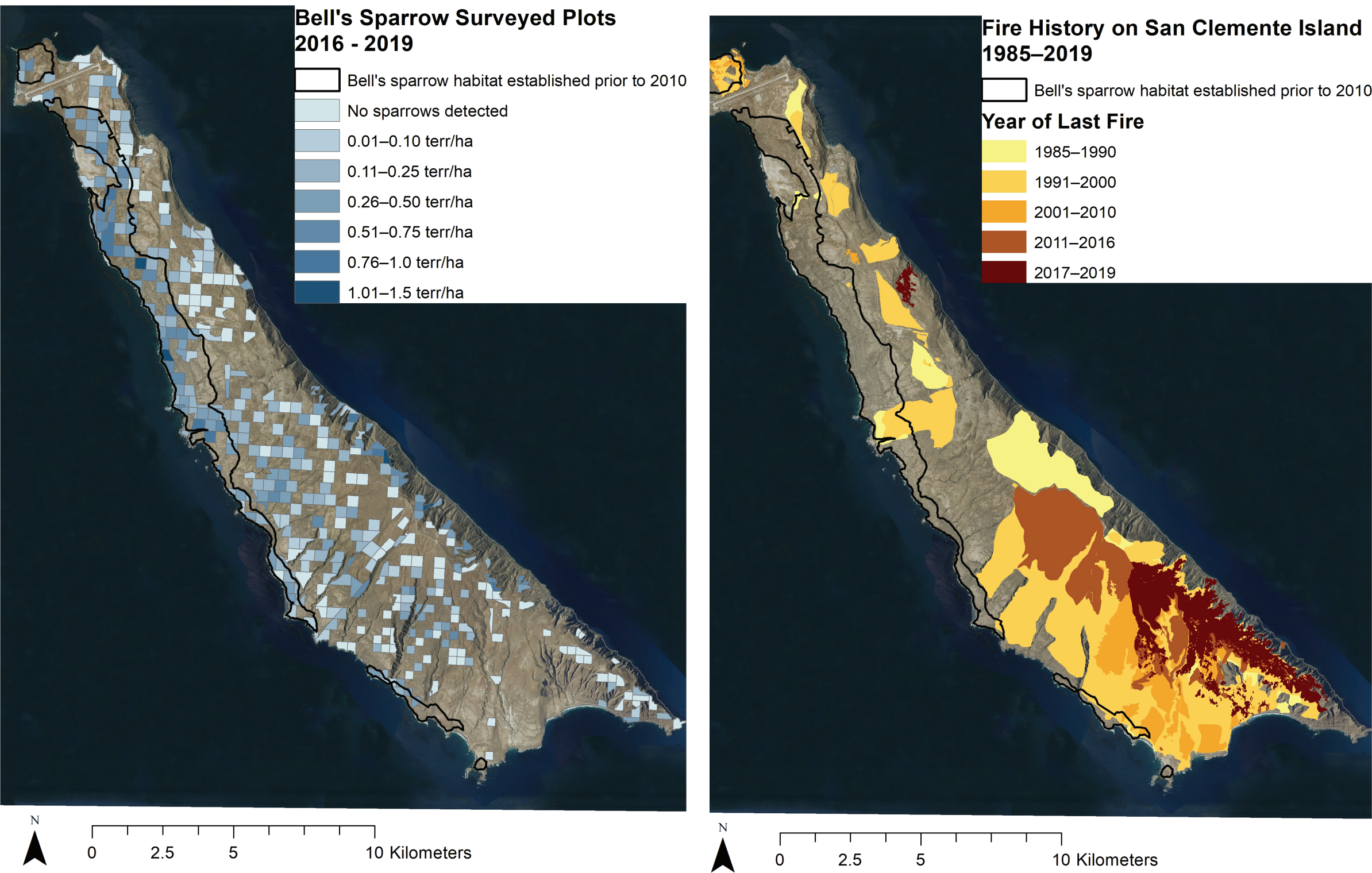
The US Navy, which owns SCI, is currently revising their fire management plan. To inform their development of strategies that will support Bell’s sparrow conservation post-delisting, I conducted post-hoc analyses of fire history and Bell’s sparrow territories to ask:

- Does fire affect Bell’s sparrow presence and density compared to areas with no known fire history?
- Are long-term effects visible in current Bell’s sparrow distribution?



San Clemente Bell’s sparrows foraging after a recent fire.

Methods



Sparrow Data:

- Bell’s sparrow annual surveys from 2013 to 2020 estimated the number of territories per sample plot (Bart et al. 2002, Meiman et al. 2019).
- Survey plots were randomly selected, stratified by habitat, and independent of known fire history.

Models:

I modeled Bell’s sparrow presence and density using zero-inflated negative binomial models, comparing models with fire variables to a no-fire base model that included habitat in the presence part of the model, and habitat + year of survey in the density part.

- I considered model fit for 3 fire variables:
- Fire history (fire history occurred within the previous 40 years, 1/0).
 - Years since last fire (continuous variable).
 - Fire occurred in the previous year (1/0).

Fire History:

- I overlaid the fire perimeters mapped from 1985 to 2019 (Wolf et al. 2012, IWS) onto sparrow plots.
- I determined the most recent fire that burned ≥ 2 ha of the survey plots, the approximate size of a large sparrow territory.
- I assigned a reference category of >40 years if no recorded fires occurred after 1985.

Results

Models that included fire variables for both density and presence had more support than the model without fire variables (Table 1).

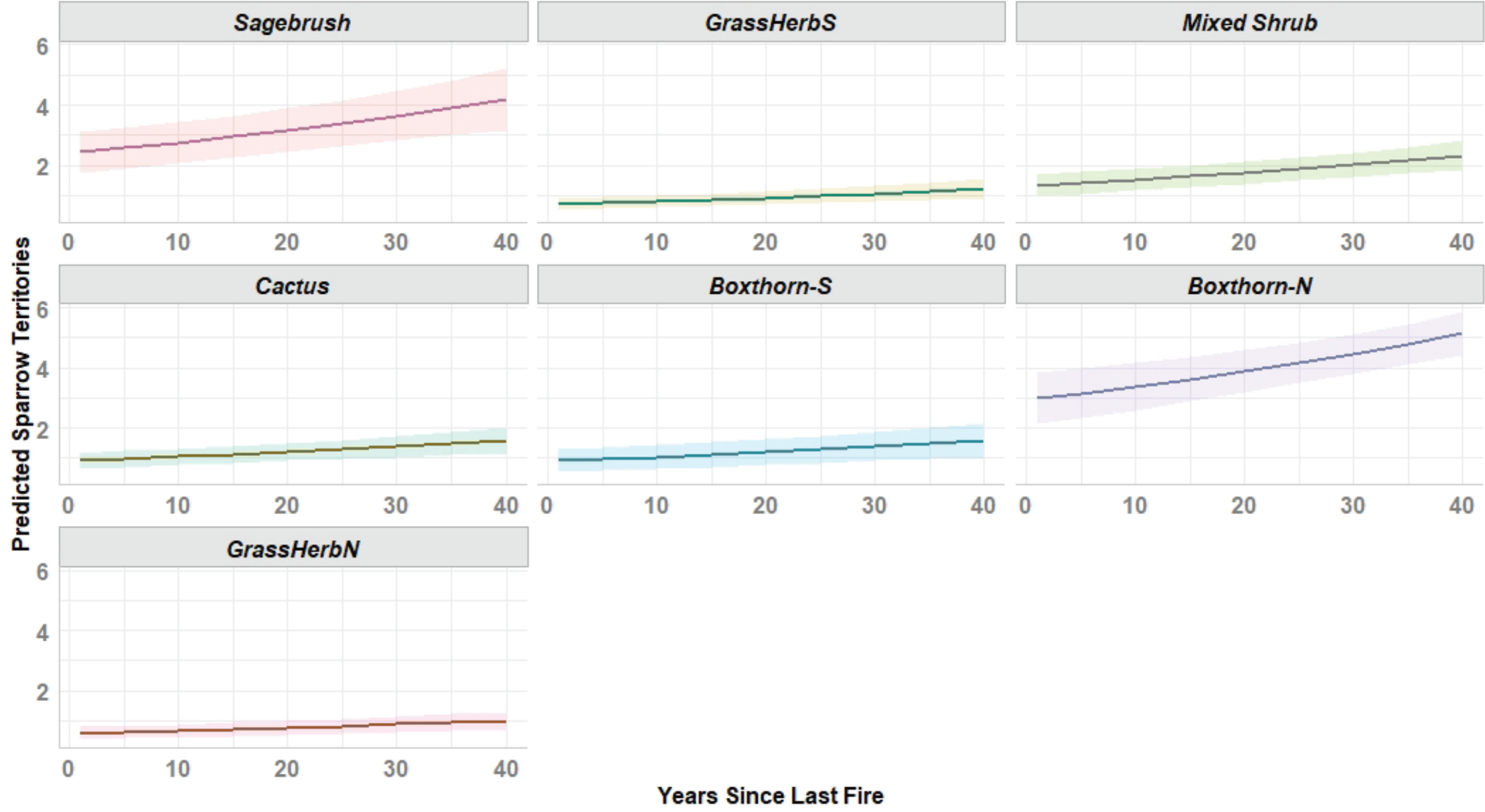
- Fire reduced the probability of sparrow presence.
- Sparrow density increased with increased years since last fire.

Table 1. Ranking of Top Models:			
PRESENCE		DENSITY	ΔAIC_c
Year 1 Post-Fire (1/0)	Years Since Last Fire		0
Fire History (1/0)	Years Since Last Fire		1.2
Years Since Last Fire	Years Since Last Fire		2.6
no fire variable	Years Since Last Fire		4.8
Fire History (1/0)	Fire History (1/0)		9.2
Base Model (no fire variables)			14.3

Effect Size Predictions:
The top model predicted that the odds that there would be no sparrows in the plot increased by a factor of 14.4 in plots that burned within the previous year compared to other plots, while holding all other variables constant.

The alternative top model predicted that the odds that there would be no sparrows in the plot increased by a factor of 4.4 in plots that burned <40 years previously.

In plots where sparrows were present, the top model predicted there would be 42% fewer sparrows in the first year following the fire, 34% fewer sparrows at 10 years post-fire, and 25% fewer sparrows at 20 years post fire, compared to plots with no known fire history during the previous 40 years.



Habitat-specific number of Bell’s sparrows by years since last fire, predicted by the top-ranked model for an average-sized plot (12.4 ha).

Summary

Results suggest that fire reduces San Clemente Bell’s sparrow presence and density compared to similar habitat with no known fire history, and differences in densities persist for decades after fire.

Bell’s sparrows use shrub communities that continue to develop on SCI despite occasional fires. Nonetheless, fires still affect sparrow distribution. Although the majority of the sparrow population is not subject to regular or repeated fire, fire prevention and control measures prioritizing shrub habitats would reduce impacts of fire and continue to conserve the sparrow population.



Sparrow territory in 2015, 6 years post-fire. Same territory in 2022, 1 year post-fire.

Literature Cited

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