Effects of predation by parrotfishes on Caribbean corals within and outside of a marine reserve
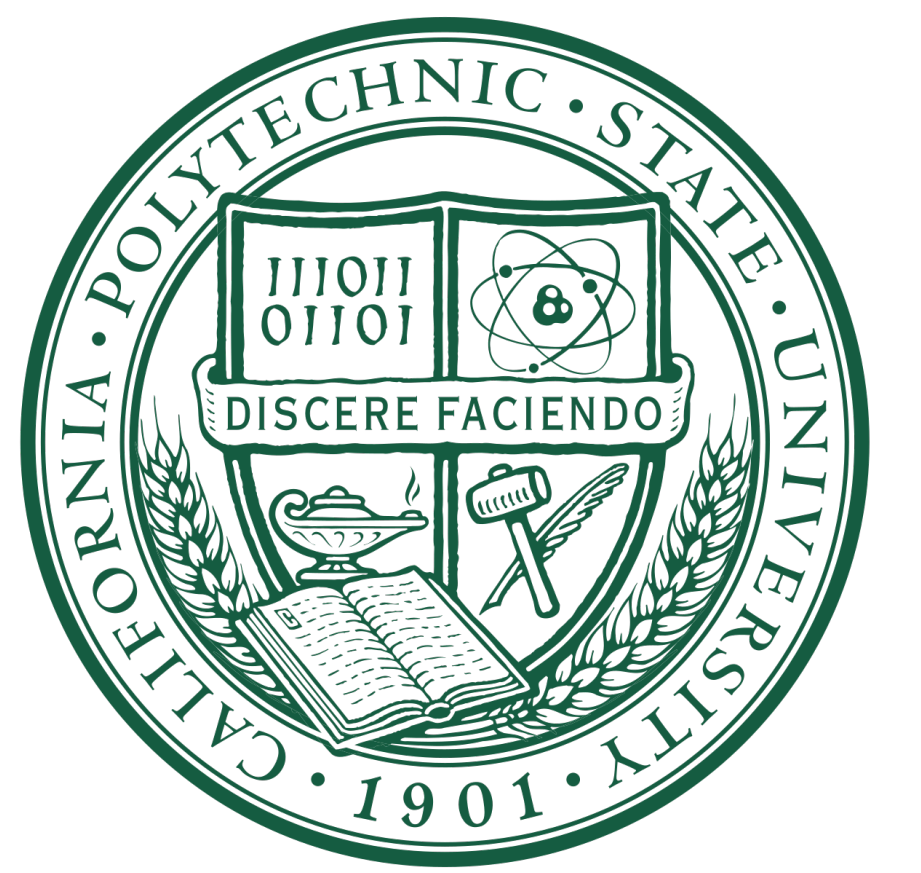
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INTRODUCTION

Parrotfishes (*Scaridae*) indirectly benefit corals by grazing algae, thereby reducing coral-algae competition. However, some species occasionally feed on live coral (aka "corallivory"), which can lead to partial colony mortality.
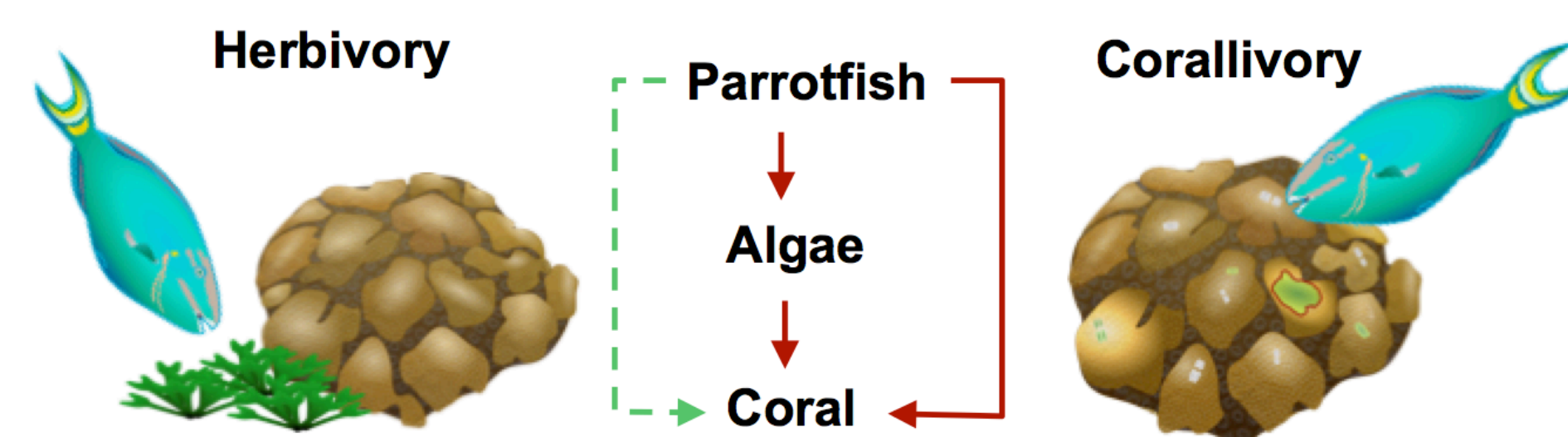
Parrotfishes feed on multiple coral species, but preferentially target threatened *Orbicella annularis*[1,2]. There is increasing concern that parrotfish predation may contribute to substantial long-term declines in *O. annularis*[3,4].

OBJECTIVE

Quantify *O. annularis* healing rates from parrotfishes bite scars based on traits of individual scars, lobes, colonies and sites in St. Croix, US Virgin Islands.

METHODS

- In July, 2018 we tagged 10-15 *O. annularis* with fresh scars per site at 4 sites. We photographed scars every 3-7 days for 1 month. We calculated scar surface area (cm^2) in Image J.
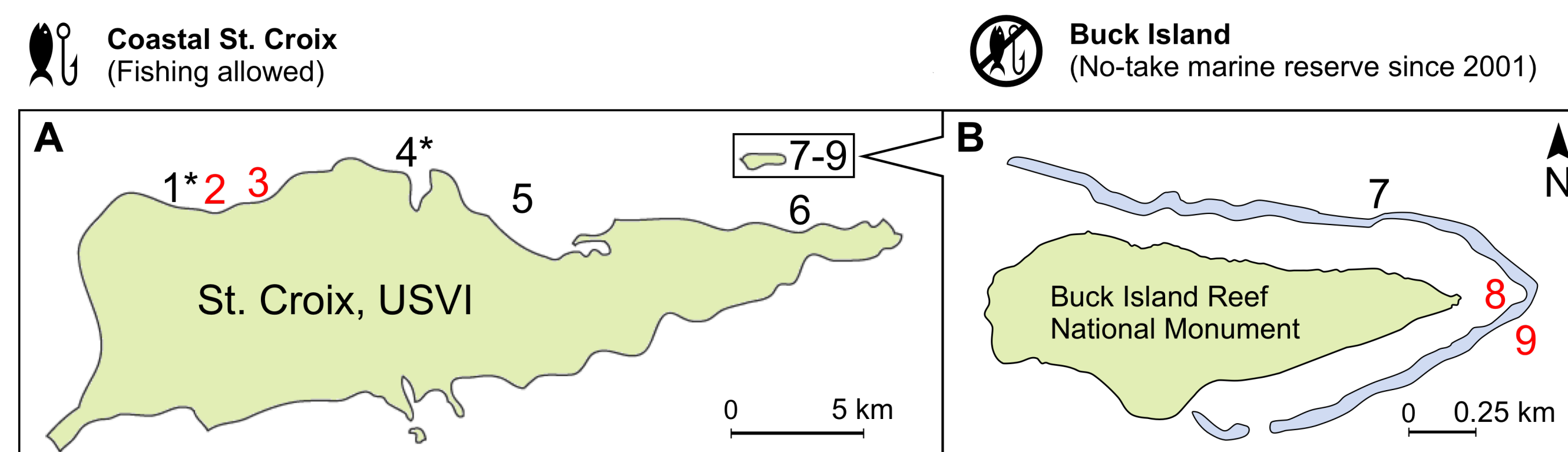

Fig. 1. Study sites on St. Croix, USVI, with the four sites where we surveyed coral scar healing highlighted in red.

- We used a mixed effects model[5] of natural log (ln) of healing rates (cm^2/day) in response to ln of initial scar size (cm^2), lobe area (cm^2), distance between scars (cm), scar density (n scars/lobe), colony depth (m) and status (marine reserve, fished).
- Using AICc[6], we determined the best predictive variables from all models with a Δ AICc <2 (including parameters w/ p-values >0.05).
- We conducted a k-means clustering[7] of scar area over time. We compared parameters to our clusters to see which best explained the four patterns of healing trajectories in our data.

RESULTS

- The best predictive variables of scar healing rate were ln of initial scar area* (Fig. 2), lobe area* (Fig. 4), distance between scars, scar density, and site status (*indicates p-value<0.05*).
- The model had a marginal R^2 of 0.685, i.e. these fixed effects explain 68.5% of the variance in scar healing rate.
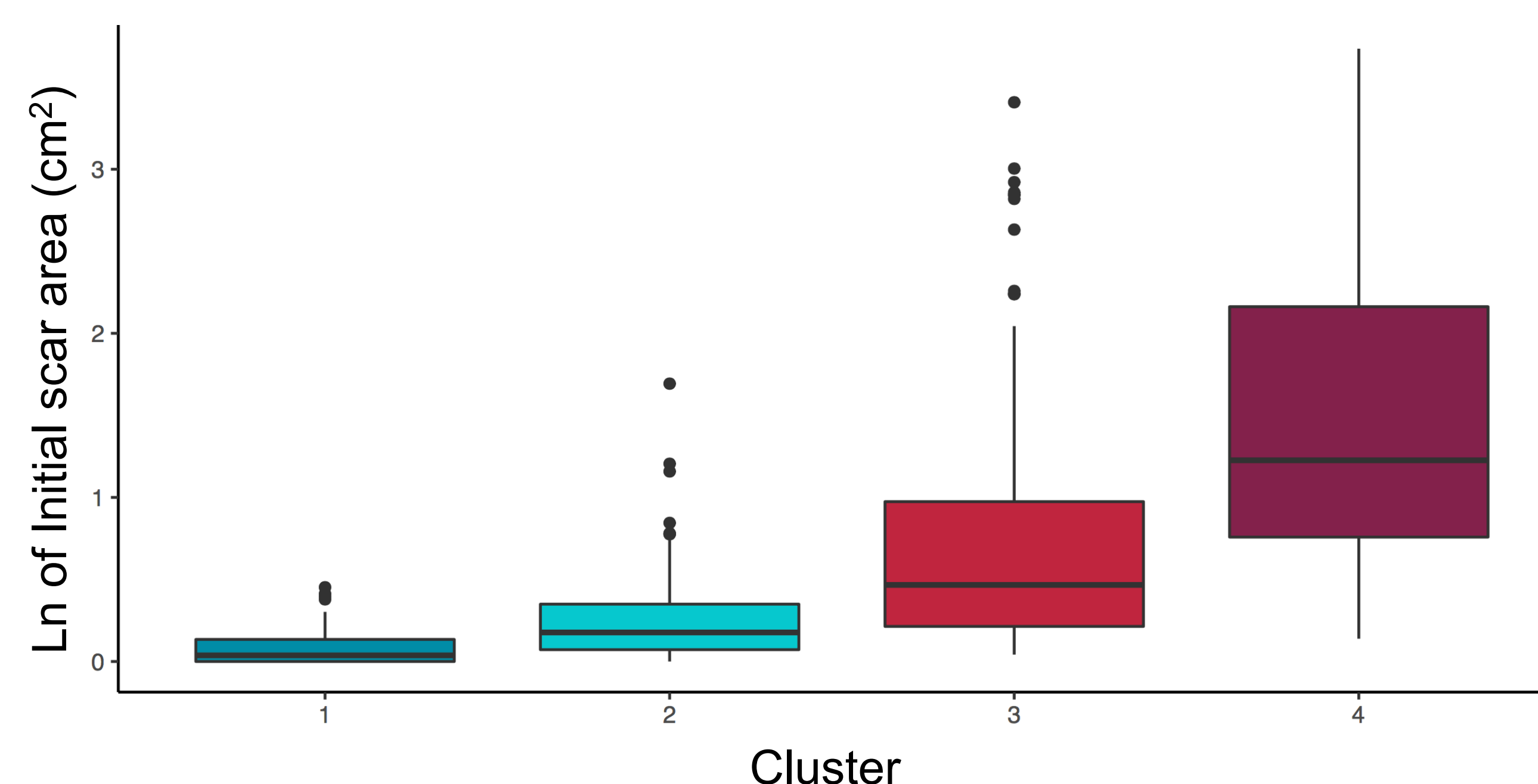

Fig. 2. Ln of Initial scar area (cm^2) by the 4 k-means clusters of scar healing trajectories. Whiskers are 1.5 * IQR, outliers are plotted as individual points. *Scars clustered as follows: 1) healed in ~10 days, 2) healed in ~30 days, 3) some healing, 4) minimal to no healing.*

➔ **Take away:** After accounting for other fixed effects, for every 1cm^2 increase in initial scar area, healing rate decreased by 0.041cm^2/day (t-value$_{(80)}$=12.65, p-value<0.001).
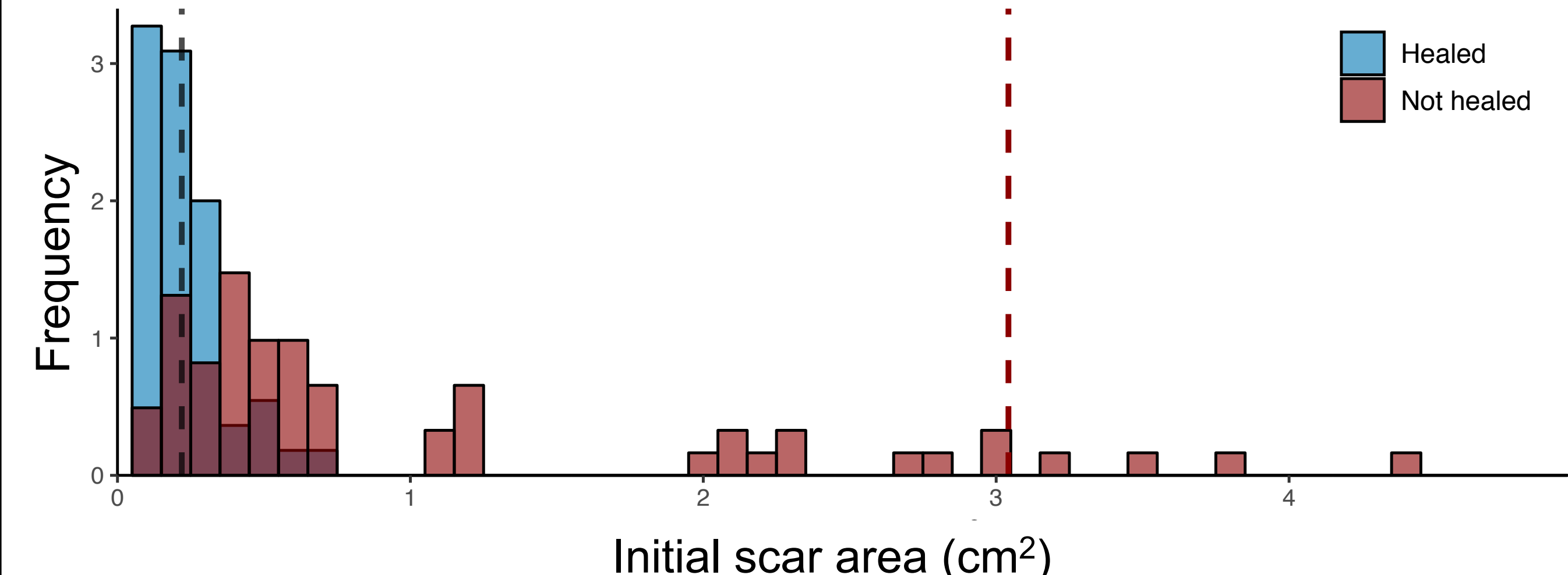

Fig. 3. Initial scar area (cm^2) by healing status after 1 month. Lines indicate mean area by healing status. The x-axis is cropped at 5 cm^2, the max unhealed scar area was 40.87 cm^2.

➔ **Take away:** The max. initial area of healed scars was 0.72 cm^2, indicating that there is a threshold size beyond which scars did not heal over 1 month. There is overlap in size of scars that did and did not heal, indicating that other variables influence healing of scars within an initial area <0.72 cm^2.
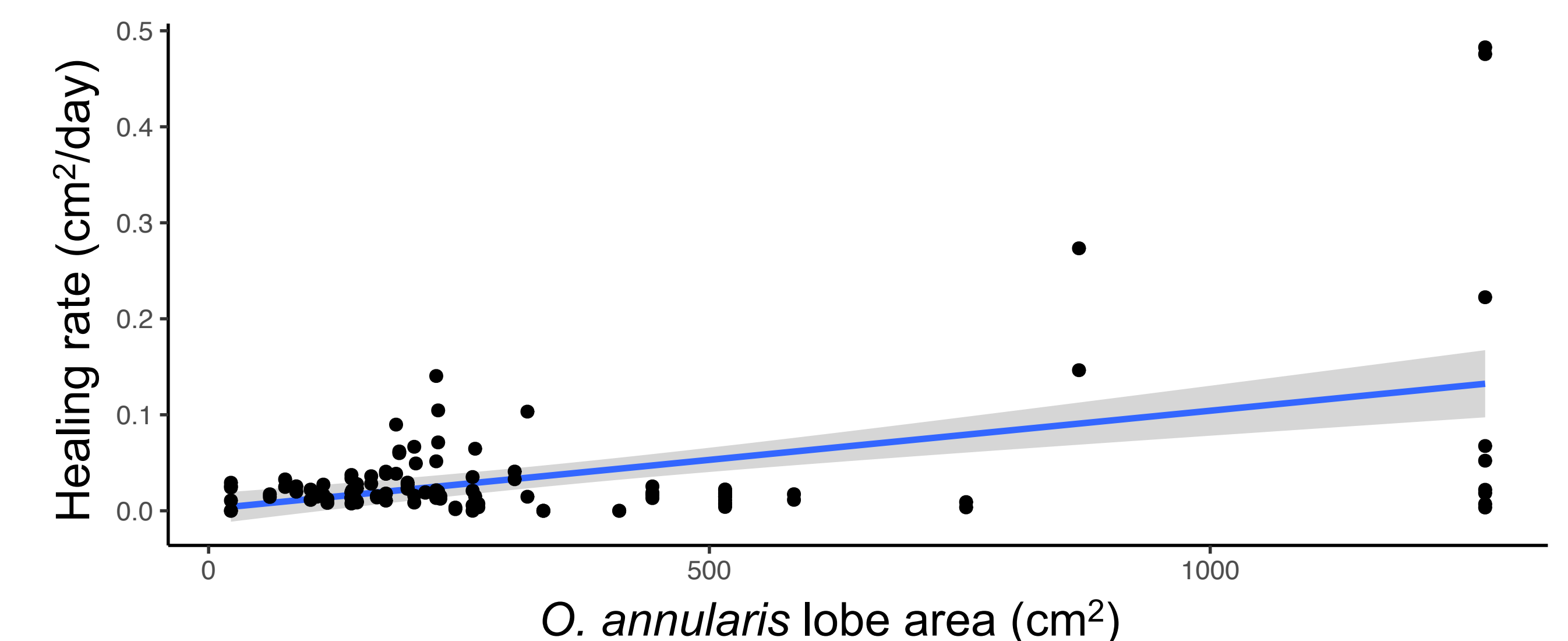

Fig. 4. Healing rate (cm^2/day) in response to lobe area (cm^2). Line of best fit is shown in blue, with SE in gray.

➔ **Take away:** For every 1 cm^2 increase in the lobe area, scar healing rate increased by 0.005 cm^2/day per day (t$_{(9)}$=3.601, p-value=0.0048). The distance between scars, scar density and site status (marine reserve, fished) were relevant predictors in the model, but not significant.

FUTURE DIRECTIONS

- At each of our 9 study sites (Fig. 1), we surveyed the standing stock bite scars on all coral species. With these data, we will estimate differences in scar area and density in response to site-level variation in coral cover, other benthic cover and parrotfish assemblages.
- We will integrate data from these standing stock surveys with our current model to estimate long-term tissue loss from this standing stock of scars, and how site-level parameters influence *O. annularis* tissue loss.

⬇ *Algae,* ⬆ *Coral,* ⬆ *Parrotfish*

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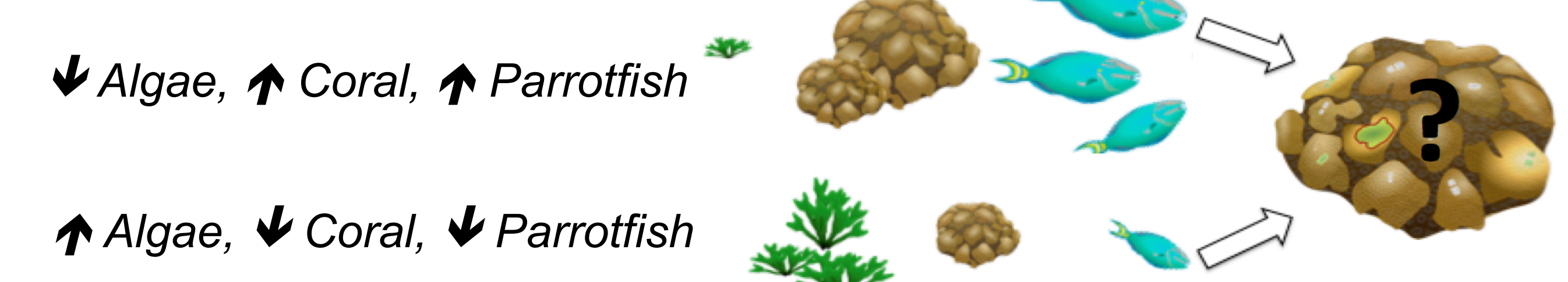
➔ **Take away:** This research will help us understand how natural and human-driven variation in Caribbean coral reef communities alters the impact of parrotfish predation on corals.

ACKNOWLEDGEMENTS

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