Wild vs. Restored: Evaluating Ecological Function in *Acropora cervicornis* Reefs of Bonaire

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Introduction

- *Acropora cervicornis* (staghorn coral) was once a defining reef-builder in the Caribbean, but populations have crashed by >80–90% since the 1980s from disease, storms, and warming (1, 9, 11).
- The loss of this branching coral reduces the structural habitat that supports fish biomass, diversity, and the ecological function of reefs (2, 4, 5).
- To counter these declines, restoration efforts fragment wild colonies, grow them in nurseries, and outplant them back onto the reef, aiming to rebuild coral cover and structural fish habitat (6, 8).
- Researchers often measure recovery with coral cover, habitat complexity, and fish community metrics, but the question remains: *can restored patches function like wild ones, and how long does it take?* (5, 6, 10, 3).

Figure 1: *Acropora Cervicornis*

Research Objectives

1. Evaluating coral cover and fish communities across wild and restored *A. cervicornis* patches of varying ages.
2. Evaluate ecological resemblance by testing whether older restored patches begin to resemble wild patches in coral cover, fish biomass, and species richness.
3. Link coral and fish dynamics by examining how coral cover and habitat complexity influence fish biomass and community composition.

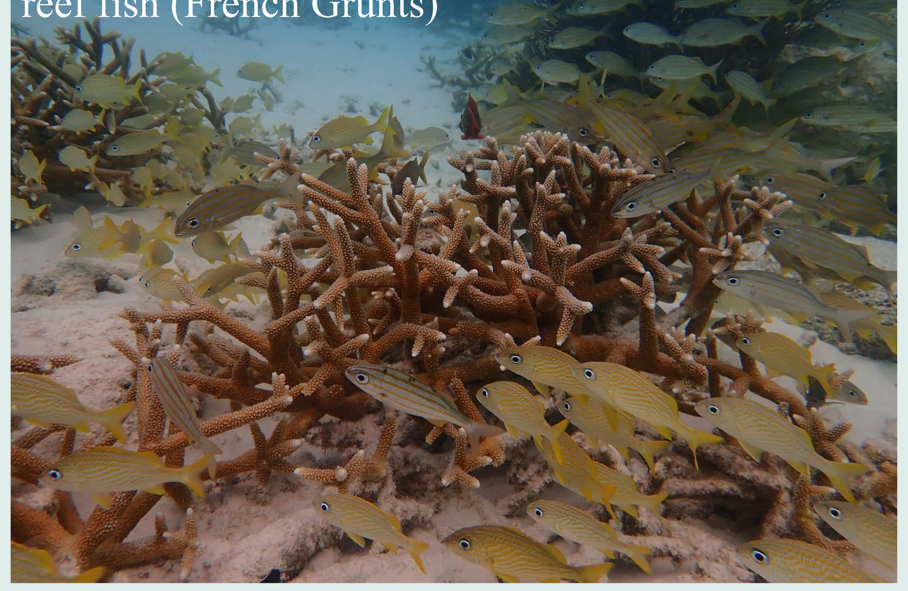

Figure 2: *Acropora cervicornis* reef thriving with reef fish (French Grunts)

Methods

Study Sites
- Location: Bonaire, Caribbean Netherlands (20 sites)
- Figure 3
- Focal coral species: *Acropora Cervicornis* - Figure 1
  - Restored: 8 sites from ages 0-12 years
  - Wild: 12 sites (longstanding)

Field Survey Methods
- At each patch:
  - Laid a 30 m transect with photos taken every 1 m (30 total)
  - Counted, identified and estimated the size of fish in patch
  - Coral branch heights measured every 2 m (16 total)
  - Used GPS to capture the spatial layout of the patches.

Data Analysis
- Standardized fish biomass (g/m transect)
- Calculated mean *A. cervicornis* cover per site
- Compared wild vs. restored patches across ages
- Tested relationships using linear models (R)

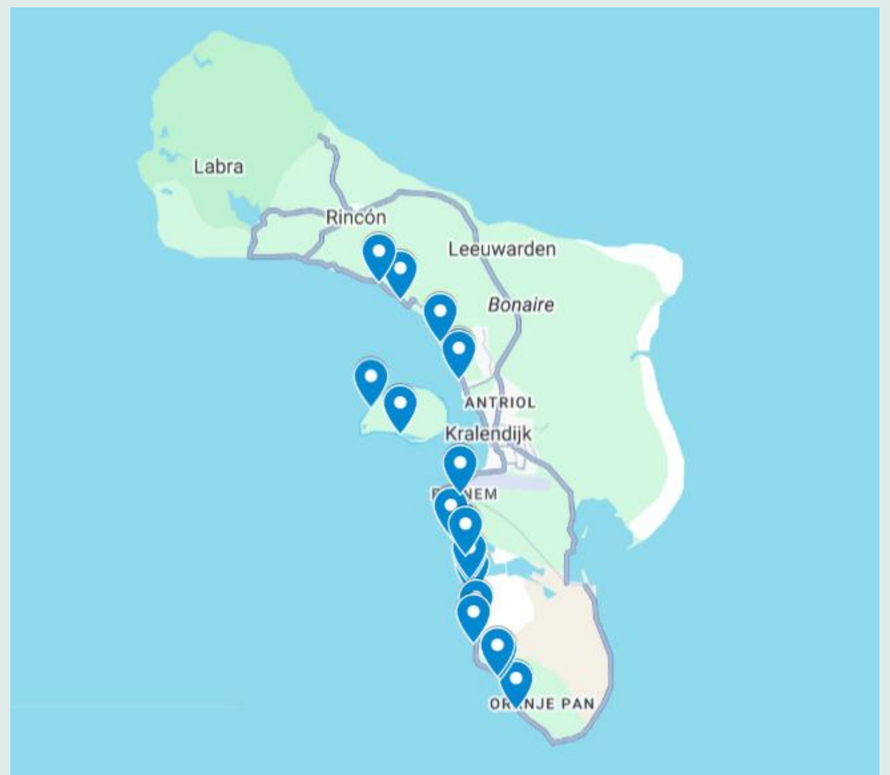

Figure 3: Map of the island of Bonaire

Results

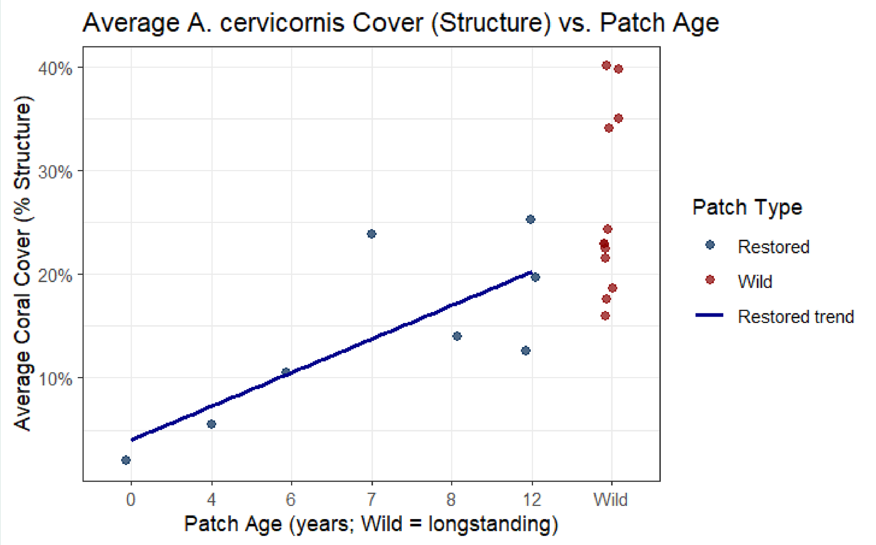

Figure 4: Average *A. cervicornis* cover (% structure) vs. patch age.

Older restored patches had higher *A. cervicornis* cover and the association was statistically significant (simple linear regression, p = 0.033) There is a significant relationship between *A. cervicornis* cover and patch age
- Each point represents one site mean.

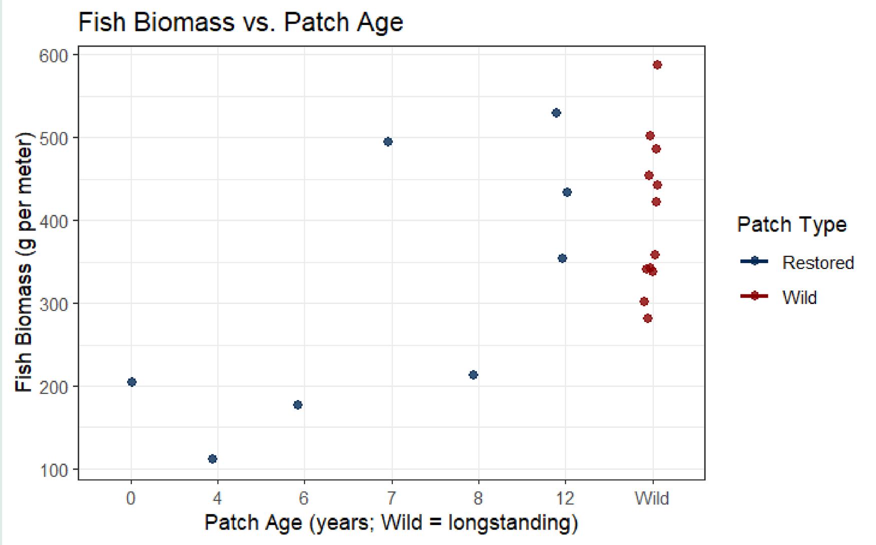

Figure 5: Fish biomass (g per meter) vs. patch age.

Within restored patches, biomass rose with age but was only marginally significant (simple linear regression , $p = 0.063$). Wild sites had slightly lower average biomass compared to 12-year restored sites, but the difference was not significant ($t = 0.60$, $p = 0.589$; Wilcoxon $p = 0.516$).
- Each point represents one site mean.

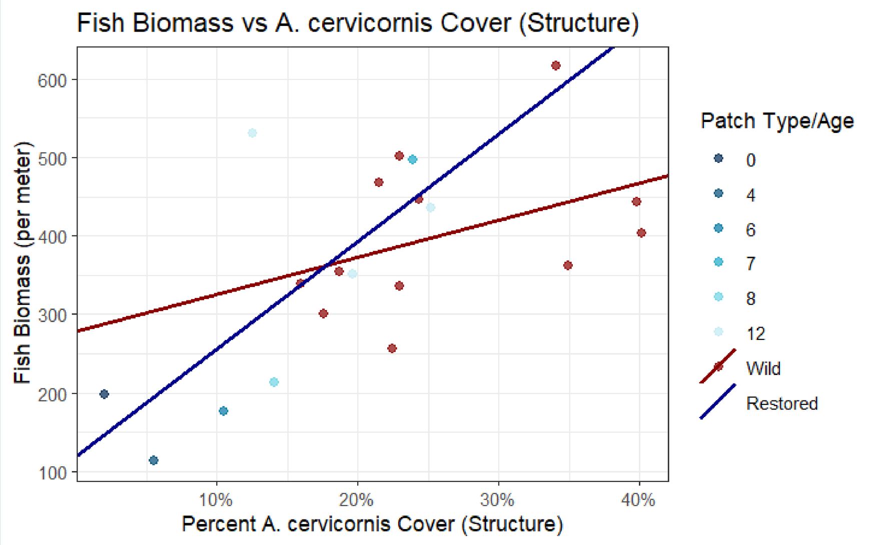

Figure 6: Fish biomass ($g \cdot m^{-1}$) vs. *A. cervicornis* cover (% Structure).

In restored patches, fish biomass increased significantly with *A. cervicornis* cover ($p = 0.047$). In wild patches, the relationship was positive but not significant ($p = 0.185$). An interaction test indicated that slopes did not differ significantly between patch types ($p = 0.157$).
- Each point represents one site mean.

Discussion

- Fish biomass increases with patch age. Older restored sites support higher biomass, suggesting functional recovery over time.
- Coral cover growth in restored *A. cervicornis* patches is variable and slower.
- Fish biomass is wild patches is not strongly related to coral cover, possibly due to long-established structural complexity and mature habitat features (2, 4).
- Restored patches show how structural recovery directly enhances habitat value.
- Results support that *A. cervicornis* restoration enhances ecological function even before full coral recovery (5, 10, 6).
- Findings emphasize that structure and rugosity, not just coral % cover, may drive fish community patterns (2, 4).

Figure 7: Image of 7-year-old restored site 'Pink Beach'

Figure 8: Image of wild site '1000 steps'

Follow up Questions:

- Why doesn't coral cover predict fish biomass in wild patches?
- Do structural traits (branching, rugosity) explain fish patterns better than cover?
- What limits coral cover recovery in restored patches despite biomass gains?
- How do fish community composition and trophic roles shift with patch age?

Figure 9: Image of a <1 year old restored site 'Petris Pillar'

Figure 10: Image of 12-year-old restored site 'Toris Reef'

Acknowledgements

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References