Rebuilding Coral Reefs:
Insights from Hawaii, Fiji, and Florida

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Abstract
This study examines coral reef management strategies using case studies from Maui, Fiji, and Florida. Through interviews and observations, the investigation explores community-driven initiatives and scientific efforts to conserve coral reefs. In Maui, holistic projects like Pacific Whale Foundation's Mauka to Makai program respond to environmental challenges. In Fiji, organizations like Coral Gardeners and Corals for Conservation employ tailored active restoration methods. Meanwhile, ongoing efforts in Florida underscore the urgency of addressing climate change. These findings emphasize the importance of global collaboration and proactive measures to ensure the resilience of coral reef ecosystems. Digital communication through photography and videography will reveal monitoring plans to combat the local stressors to coral reefs in each region.

Background
In lieu of the announcement of a fourth global bleaching event in April 2024, climate change remains a threat to coral reefs. Using the monitoring and predictions by NOAA's Coral Reef Watch[1] (figure 1), it is evident by the contrast in colors that some locations experience more severe bleaching levels, risk of near complete mortality of over 80% of corals (purple) than less severe alert levels, risk of reef-wide coral bleaching in (red). First in the Atlantic Ocean, between July and August 2023, the waters near the Florida Keys reached above 90°F,[2] alarming coral bleaching alert levels 1 and 2.[3] Meanwhile in the North Pacific, waters around the Hawaiian Islands experienced no stress to watch level (yellow). [4] In the South Pacific, waters around Fiji also experienced no stress warnings. [5]

In addition to distinct effects of rising sea surface temperatures on corals, each locality has unique local stressors. The coral reefs in the Florida Keys face multiple natural and anthropogenic stressors due to tropical storms, hurricanes, and disease outbreaks.[6] For instance, in 2014 through 2019, Stony Coral Loss Tissue Disease swept through the reef.[7] Over the last 40 years, nearly 90% of the coral that had historically dominated the reefs have been lost.[8] Coral bleaching is not unique to Florida; the Main Hawaiian Islands experienced wide-spread coral

[1] *NOAA confirms 4th global coral bleaching event*. (2024, April 15). NOAA. Link.
[2] Einhorn, Catrin and Shao, Elena. "How Hot Is the Sea Off Florida Right Now? Think 90s Fahrenheit." *The New York Times*, 13 December 2023. Link.
[3] NOAA Coral Reef Watch. 2019, updated daily. Florida 5 km Single-Pixel Virtual Station Time Series Graphs, July 17, 2023. College Park, Maryland, USA: NOAA Coral Reef Watch. Data set accessed 2024-06-09 at https://coralreefwatch.noaa.gov/product/vs_single_pixel_exp/florida_keys.php.
[4] NOAA Coral Reef Watch. 2019, updated daily. Polynesia 5 km Regional Virtual Station Time Series Graphs, July 31, 2019. College Park, Maryland, USA: NOAA Coral Reef Watch. Data set accessed 2024-06-09 at https://coralreefwatch.noaa.gov/product/vs/timeseries/polynesia.php#hawaii.
[5] NOAA Coral Reef Watch. 2019, updated daily. Melanesia 5 km Regional Virtual Station Time Series Graphs, July 31, 2019 . College Park, Maryland, USA: NOAA Coral Reef Watch. Data set accessed 2024-06-09 at https://coralreefwatch.noaa.gov/product/vs/timeseries/melanesia.php#fiji.
[6] Economics, T. B. D. (2019). The Economic Contribution of Spending in the Florida Keys National Marine Sanctuary to the Florida Economy.
[7] Becker, C. C., Weber, L., Zgliczynski, B., Sullivan, C., Sandin, S., Muller, E., ... & Apprill, A. (2023). Cruise Report, Executive Summary. Unpublished.
[8] "Restoring Seven Iconic Reefs: A Mission to Recover the Coral Reefs of the Florida Key." *NOAA Fisheries*, 13 December 2023, Link.

bleaching in 2015, including the reefs in Maui.[9] In August 2023, Maui, Hawaii experienced an unprecedented natural disaster, resulting in elevated levels of toxic substances from ash and fire-related debris[10] with potential effects to adjacent waters. On top of this, each region has a distinct population density, 63/km² in Maui, Hawaii[11] in 2018, 1,380/km² in Key West, Florida[12] in 2020, and 162/km² in 2017 in Malolo Island, Fiji[13], resulting in varying levels of human impacts to coral reefs.

How does each location work to combat its environmental stressors? There is no one-size fits all solution in the rebuilding of coral reefs; nevertheless, case studies can be used to learn about efforts to combat the local stressors and applied to reef conservation efforts worldwide.

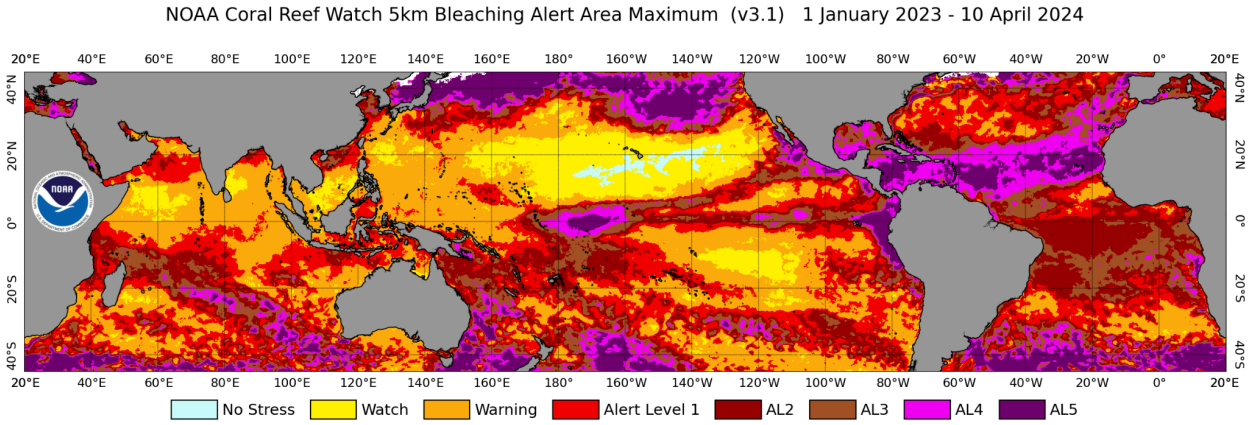

Figure 1: *NOAA Coral Reef Watch 5km Bleaching Alert Area Maximum*[14]

In 2021, the International Coral Reef Society (ICRS) released *Rebuilding Coral Reefs*, a grand decadal challenge that called international, regional, national, and local entities to work together to change the trajectory of coral reefs from heading towards collapse to a trajectory of recovery.[15] If global warming exceeds 1.5 °C, 70-90% of reef corals will be lost; if it exceeds 2°C above pre-industrial temperatures, 99% will be lost.[16] Approaching the middle of the decade mark, there is an opportunity to assess the state of coral reefs based on the framework laid out in the science to policy paper. This project highlights coral reef management strategies regionally through interviews and digital communication to assess the further efforts necessary to rebuild

[9] NOAA Coral Reef Watch (2015). Annual Summaries of Thermal Conditions Related to Coral Bleaching for NCRMP Jurisdictions.
[10] "Lahaina Ash Characterization Testing Show Elevated Levels of Toxic Substances." *State of Hawaii, Department of Health*, 10 December 2023. Link.
[11] Open Data Network. Data for Maui County, HI. Link.
[12] *United States Census Bereau*. Data for Key West City, Florida. Link.
[13] Brinkhoff, Thomas. *City Population*. Data for Malolo (Tikina, Fiji). Link.
[14] *NOAA confirms 4th global coral bleaching event*. (2024, April 15). NOAA. Link.
[15] Knowlton, N., Corcoran, E., Felis, T., de Goeij, J., Grottoli, A., Harding, S., ... & Ferse, S. (2021). Rebuilding coral reefs: a decadal grand challenge.
[16] Hoegh Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I. A., ... & Zhou, G. (2018). Impacts of 1.5 C global warming on natural and human systems.

coral reefs worldwide using the ICRS framework.

Rebuilding Coral Reefs: Three Pillar Approach[17]
To assess the state of coral reefs and future steps in coral conservation in three case studies (Hawaii, Fiji, Florida), this project will refer to the three pillars of action underscored in *Rebuilding Coral Reefs*.

- Pillar one calls for the reduction of global climate change threats by lowering greenhouse gas emissions and increasing carbon sequestration.
- Pillar two describes improvement of local conditions by managing local stressors.
- Pillar three suggests investments in active restoration to enhance recovery of corals. Active restoration involves human intervention (i.e. coral nurseries, outplaning, larval seeding).

Approach

The investigative project will use three case studies (Hawaii, Fiji, Florida) to visually showcase how different communities integrate policies for coral reef management, local solutions, and research investments in their rapid efforts towards coral conservation. Digital communication through photography and videography will reveal monitoring plans to combat the local stressors to coral reefs.

Objectives

1. Narrate the story of *Rebuilding Coral Reefs* in Maui, Fiji, and the Florida Keys from an investigative perspective of a scientist and journalist, using the ICRS's three pillar framework.

[17] Knowlton, N., Corcoran, E., Felis, T., de Goeij, J., Grottoli, A., Harding, S., ... & Ferse, S. (2021). Rebuilding coral reefs: a decadal grand challenge.

2. Investigate the on-going research and community efforts by coral conservationists worldwide from the Pacific Whale Foundation, Coral Gardeners, Corals for Conservation, and NOAA's *Mission: Iconic Reefs* project.
3. Learn Adobe Lightroom and Adobe Premiere Pro to communicate coral conservation in a three-part video series to submit and showcase video/s at scientific conferences.

Methods

1.) Followed and filmed Pacific Whale Foundation's Mauka to Makai project in Maui, Hawaii (April 4-11, 2024) and their land to sea restoration efforts following the August 2023 wildfires. Conducted interviews with the conservation and outreach team.
    a.) Mackenzie Perillo, Conservation Biologist
    b.) Jessica Hunsucker, Conservation and Outreach Coordinator
    c.) Leiana Coloma-Naho'oikaika, Education Specialist
2.) Filmed excursion on the traditional Fijian voyaging boat, the Uti Ni Yalo, and field trip to the invertebrate collections at the University of the South Pacific. Conducted interviews with coral conservationists in Fiji (April 22-26th, 2024).
    a.) Wilson Hazelman, Reef Restoration and Awareness Manager at Coral Gardners
    b.) Laisani Waqaikadovu, Site Manager for Corals for Conservation
3.) Conducted a remote interview with Jennifer Moore (May 30th, 2024), co-lead for NOAA's *Mission: Iconic Reefs* in Florida
4.) Video edited one of the three-part videos, *From the Ashes* to showcase at the capstone symposium (June 11th, 2024)
    a.) Submitted film abstract to Reef Futures 2024 (May 31st, 2024)
5.) Created *Rebuilding Coral Reefs* playlist on Youtube to host stand-alone short documentary videos
6.) Continue video editing future videos and release on the playlist at spaced out times

Summary of Findings

After interviewing six different experts in coral conservation and visiting two of the locations, the local efforts and rapid action to monitor and preserve coral reefs echo throughout Hawaii, Fiji, and Florida. In Maui, restoration of cultural lands and research investments to support large-area imagery dominate the rapid efforts to monitor coral reefs. In Fiji, active restoration efforts by coral nurseries and outplanting are supported by organizations like Coral Gardners and Corals for Conservation. In both locations, Pacific Islanders voice their deep-rooted cultural ties to the sea. In Florida, on-going efforts by NOAA's *Mission: Iconic Reefs* race to restore corals during a time of extreme heat stress. Despite the combined efforts by scientists and communities to actively monitor and restore coral reefs worldwide, there is a call to revisit global management and policy efforts to ensure that global climate change does not undermine the efforts by scientists and communities in rebuilding coral reefs.

From the Ashes- Maui, Hawaii, U.S.A.

Pacific Whale Foundation's (PWF) Mauka to Makai initiative stemmed from the ashes of the

August 2023 wildfires on Maui.[18] The holistic program responds to the devastation by creating a monitoring and restoration response plan using land and sea-based mitigation and monitoring strategies. The program seeks to restore the health of Maui's ʻāina (ocean, land, and air). PWF partners with other ʻāina-based organizations like Hawaii Land Trust and Maui Cultural Lands and supports their efforts by bringing kamaʻāina, visitors, and PWF staff to lend a hand in tending to the land.

Secondary to this, scientists seek to understand the effect of the debris and ashes from the fires on coral reefs. At PWF, a team of scientists monitor Olowalu and Mala Wharf in Maui and conduct bi-weekly fish/invert/benthic cover studies. Conservation biologist Mackenzie Perillo spearheads large-area imaging to gain a baseline survey of the reef. She describes that from her observations following the wildfires, there has not been a massive coral disease outbreak or bleaching event. The cultural ties, community action, and research investments to restore the land and the sea highlight a hopeful story for coral reefs worldwide.

Signals of Resilience- Malolo Island, Fiji
A couple in Fiji both find purpose in their work in coral conservation. Both native to Fiji, they acknowledge their heritage as a Pacific Islander, their relationship with the sea, and the community's dependence on corals. Wilson Hazelman, Reef Restoration and Awareness Manager at Coral Gardeners, defines coral restoration as helping a degraded reef back to health or transforming a once damaged reef back to its original state or better. Wilson's wife, Laisani Waqaikadovu, Site Manager for Corals for Conservation adds that a degraded reef may be overwhelmed with crown-of-thorns sea stars or dominated by algae; it is typically degraded due to human activity.

The two coral conservation organizations in Fiji approach coral conservation with distinct methods for coral nurseries and outplanting. Both organizations express how certain corals demonstrate different growth rates with certain methods for the nurseries and outplant. Coral Gardeners use rope nurseries, the table method, and coral trees[19], while Corals for Conservation uses the table method, A-frames, and fish houses. Corals for Conservation differs by implementing gene bank nurseries for corals, pulling corals that they deem thermo-tolerant from the water to bring to the nursery. Although the success of active restoration may be debated, Wilson expresses that, "... it's about making a difference and trying to make things right… Even though it is an active restoration, I believe that whatever ways that can help should be done because it's better than not doing anything and just letting corals go extinct."

Under Extreme Stress- Florida Keys, Florida, U.S.A.
Although restoring America's Great Barrier Reef may seem like an insurmountable challenge, researchers in Florida race to battle the rapid loss of coral. Through their program, *Mission: Iconic Reefs*, developed in 2020, NOAA and their partners race to restore seven coral reefs in the Florida Keys National Marine Sanctuary.[20] NOAA staff recognize that active restoration of corals

[18] *Mauka to Makai: Maui Fires Monitoring Plan*. Pacific Whale Foundation. Link.
[19] Chauvelot, S., Plourde, C., Thomas, L. "2023 Impact Report." *Coral Gardeners*. Link.
[20] "Restoring Seven Iconic Reefs: A Mission to Recover the Coral Reefs of the Florida Key." *NOAA Fisheries*, 13 December 2023, Link.

in Florida serves as a space for innovation and growth; conservationists predicted the non-linear progress and uphill battle in developing methods for reef restoration.

Jennifer Moore, NOAA Protected Coral Recovery Coordinator and *Mission: Iconic Reefs* co-lead finds hope in the work. She recounts that in July 2023, sea surface temperatures in Florida surmounted to 2-3°C warmer than the seasonal average, sea surface temperatures that were more conducive to the months of August or late September. In combination with intensified solar radiation, researchers did not anticipate the instant mortality of elkhorn and staghorn coral. During this event, corals skipped bleaching and went straight to mortality, the heat appearing to fry the coral's tissue. Historically, hundreds of thousands to millions of elkhorn corals dominated the reefs in the 1980s, and now 37 wild elkhorn corals live on the reef while others reside in aquaria.

She explains that corals in Florida are in a dire state, "Yet, I know that we can't give up because if we do, it is putting the nail in the coffin for coral reefs. Restoration has to continue to happen while we solve the underlying problems like climate change, but if we just wait for climate change to be fixed, there will not be any corals alive to then help populate the reefs. While it is the biggest challenge, it also gives me hope, because I cannot give up and my colleagues are not giving up."

Climate Change is Still a Threat. There is Still Work to Do.

"Neglecting to address climate change would undermine, and ultimately make useless, most attempts to mitigate or otherwise address local threats." [21] Until policymakers, conservationists, and humans tackle the larger issue of climate change, the progress to rebuild coral reefs may taper off and never see the light of day.

For Maui, Fiji, and Florida, pillar 1, reduction of global climate change threats, remains the largest pillar to tackle. Despite the ongoing efforts by coral conservationists in Maui, Fiji, and Florida to improve local conditions for coral reefs by increasing protection and investing in restoration science to enhance recovery and adaptation rates in corals, climate change remains the imminent threat to coral reefs. Further action calls for trailblazers to design, push, and implement nature-based solutions to reduce global climate threats. Reducing greenhouse emissions and increasing carbon sequestration may seem daunting, but doable with commitment, coherence, and innovation.[22]

Deliverable

Rebuilding Coral Reefs highlights coral conservation efforts worldwide through digital communication. A video playlist, *Rebuilding Coral Reefs* is hosted on Youtube. This platform increases accessibility to a general audience and allows people outside of science, especially people unable to visit a coral reef to connect with the environment and learn about the people working to conserve it. Each episode reveals how different communities integrate policies for

[21] Knowlton, N., Corcoran, E., Felis, T., de Goeij, J., Grottoli, A., Harding, S., ... & Ferse, S. (2021). Rebuilding coral reefs: a decadal grand challenge.
[22] *Id.*

coral reef management, local solutions, and research investments. This digital storytelling effort will help connect a broad audience with current coral conservation efforts in hopes to evoke a willingness to preserve the environment.

bit.ly/3VJHdMJ

The playlist hosts the first stand-alone video, *From the Ashes*, to capture reef conservation efforts in Hawaii. Other stand-alone videos will be released at staggered periods in time. Additionally, these videos will also reach policymakers, scientists, and advocates in coral conservation through showcases at conferences like Reef Futures and other film festivals. In each of the stand-alone videos, a hopeful tone highlights ocean optimism[23], as coined by Dr. Nancy Knowlton to inspire the audience to tackle global solutions towards rebuilding coral reefs.

Measurements of Success

Submission of film to conferences and film festivals and future showings
Reef Futures 2024, December 2024
Pacific Whale Foundation 9th Annual Film Festival, June 2025

[23] Knowlton, Nancy. "Ocean optimism: Moving beyond the obituaries in marine conservation." *Annual Review of Marine Science* 13 (2021): 479-499.

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