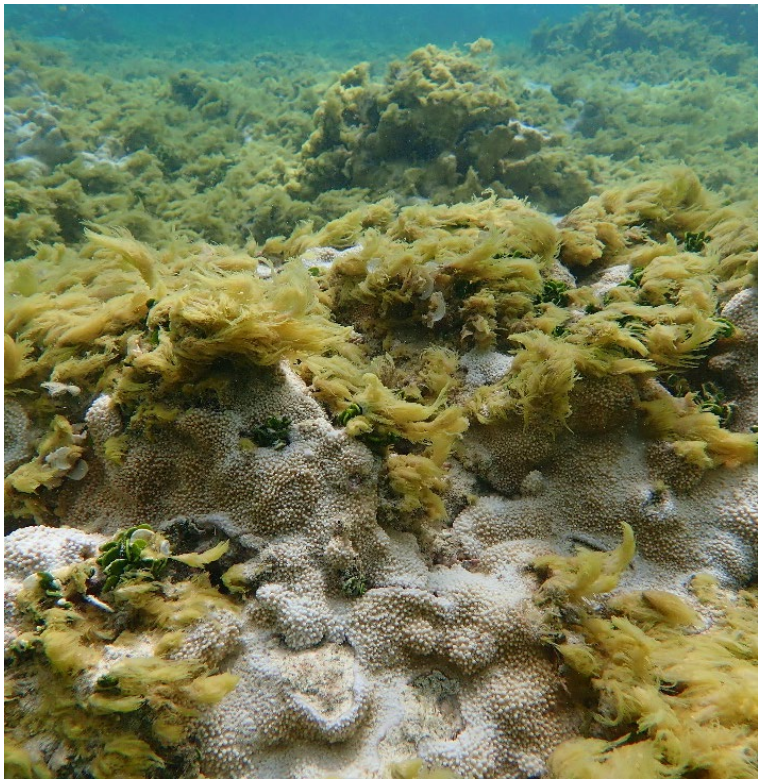
Investigation of Algal Bloom Near Kaiona Beach Park, Waimānalo, Oʻahu



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FIELD REPORT

Background

On May 30, 2022, the Hawai'i Department of Land and Natural Resources (DLNR) began receiving reports from community members of white, cloudy run-off near Kaiona Beach Park near Waimānalo, O'ahu. Community members were concerned the runoff was causing algal blooms which were smothering and killing corals. This run-off was believed by the community to be coming from several large houses on the waterfront. From the public reports, it was unclear what species of algae were over growing the corals and to what extent. It was also unclear if the algal blooms were a result of the reported run-off, from another source, or were of natural origins.

Algal outbreaks are a great concern for coral reefs in Hawai'i and coral reefs world wide. In the 1970s, invasive algae covered 50 to 100% of some Kāne'ohe Bay reefs (Stimson, 2015). A survey of the main Hawaiian islands found the top five most common invasive algae species were *Acanhopora spicifera, Avrainvillea amadelpha, Gracilaria salicornia, Hypnea musciformis,* and *Kappaphycus spp.* (Smith et al., 2002). These invasive species threaten the coral reef ecosystems of Hawaii by smothering and killing coral species which build the structure in which reef fish and invertebrates survive (Friedlander et al., 2005).

The site of concern is near Kaiona Beach Park, a highly trafficked area of Waimānalo beach. In this area, the reef structure contains patchy areas of live coral, dead coral heads, and pavement-style hard substrate intermixed between sandy patches. In August 2017, Nichols and Marko (2019) reported 15.9% coral cover with *M. capitata* as the most abundant genus in this area.

Methods

On June 2, 2022, the DAR AIS Program performed a site inspection at Kaiona Beach Park to determine (1) the species causing the outbreak, (2) what spatial extent the outbreak was occurring, and (3) if land-based nutrients are the cause to the outbreak. AIS members, spaced approximately 10 m apart, swam in a standard grid pattern over the area believed to be the most affected by the algae. Every 10 m, AIS members took a GPS waypoint and recorded the percent coral cover, dominant coral species, percent algal cover, dominant algae species, and any other notes for that point within a 1 m diameter. This procedure allowed the team to survey over 75,000 m^2 of near-shore reef and collect 342 data points.

Results

In line with prior research, the most common coral species identified during the survey was *M. capitata*. For the surveyed area, the average coral cover was 13.9%. At nearly 1/3 of the points surveyed, no coral was present. Average algal cover (including cyanobacteria) was 22.0%. A mixture of native, as well as non-native algal species were present. *Chrysocystis fragilis* was the dominant algal species at 49% of points surveyed. *Lyngbya majuscula* was also present at many of the points surveyed. It was found most densely in the first 100 meters near shore where then *C. fragilis* became more prevalent (Figure 1). Only 5% of points surveyed contained no algae or cyanobacteria. A mixture of native, as well as non-native algal species, are known to be present. The most common native algae species present were *Halimeda discoidea* and *Padina sp.* (Figure 2).

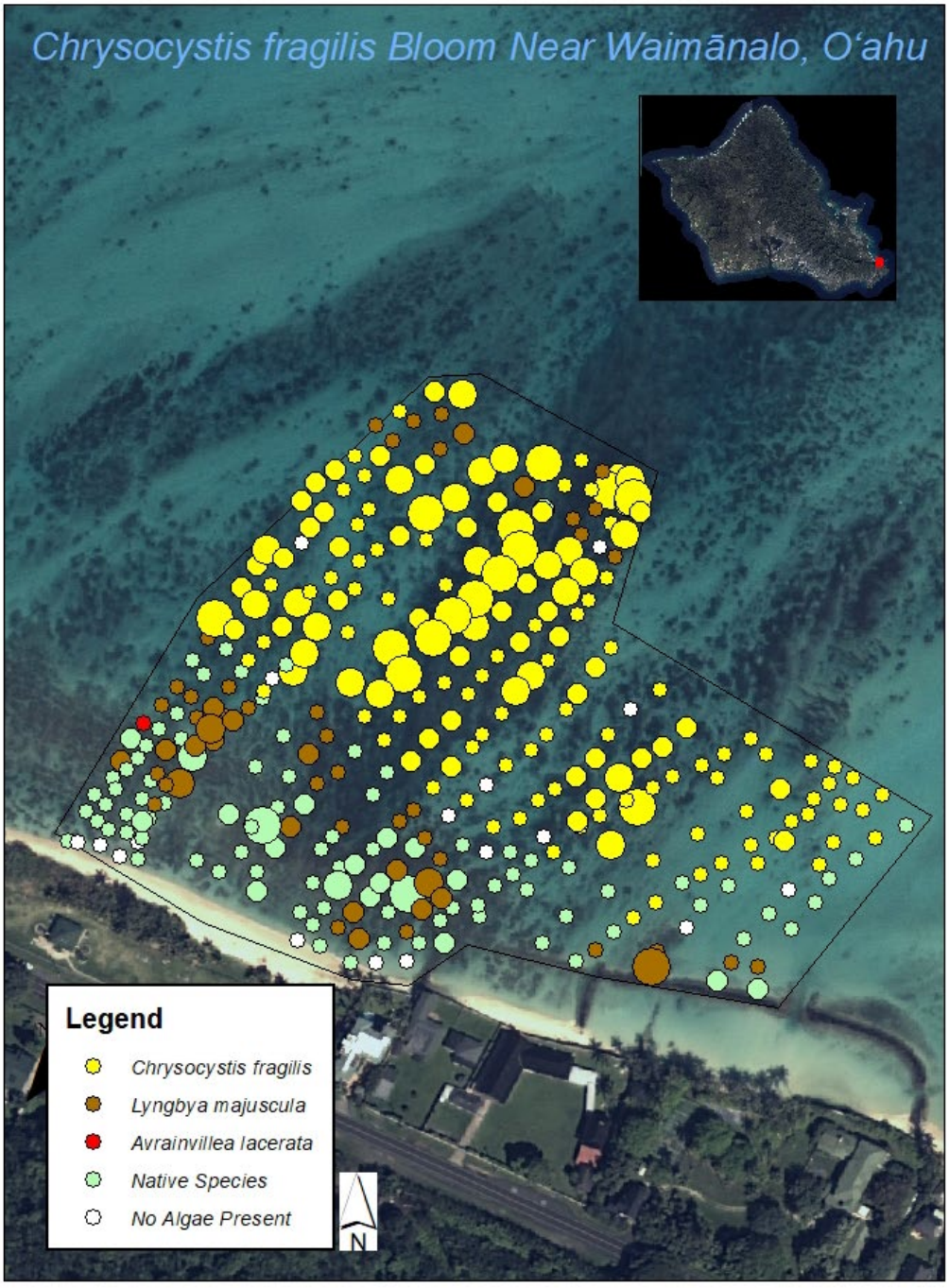

Figure 1. A map of surveyed points with the dominate algal species present at each point. Point sizes represent relative percent coverage at each point.

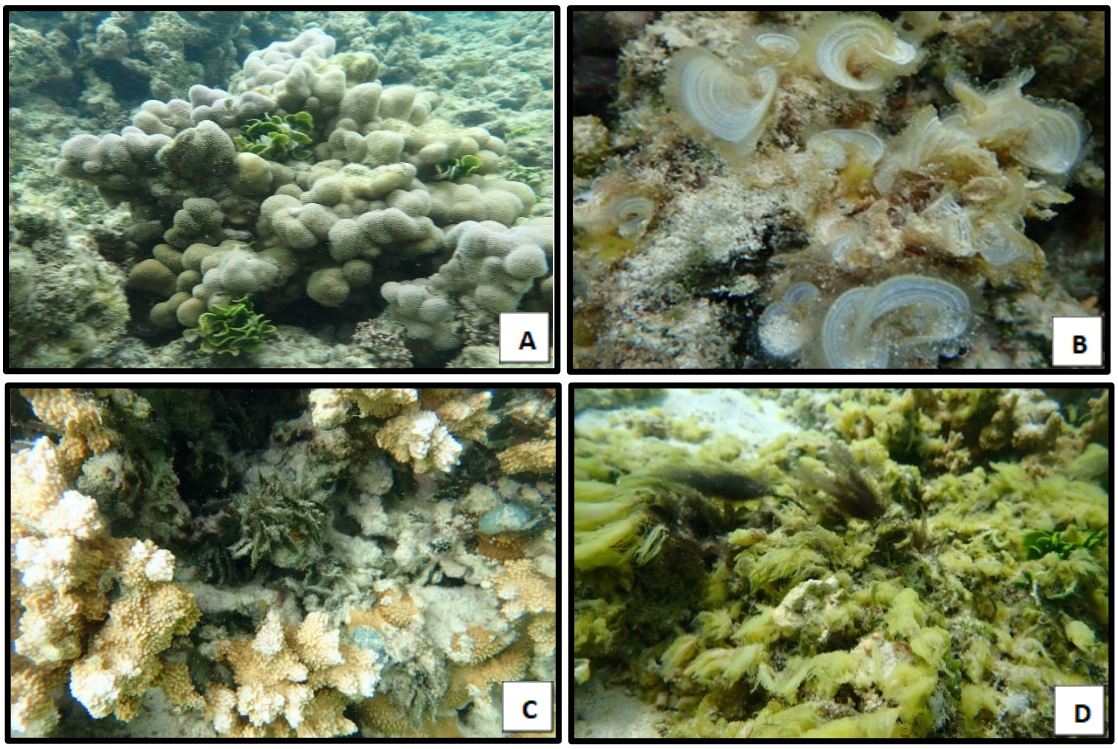

Figure 2. A) Native green alga, *Halimeda discoidea* growing within a *Porites evermanni* colony. B) Native *Padina sp.* C) Invasive *Avrainvillea lacerata* growing in between *Montipora capitata*. D) Small patches of *Lyngbya majuscula*, the darker, courser hair-like cyanobacteria surrounded by *Chrysocystis fragilis*, the yellow/green algae.

Although there were many native and non-native algae species competing with corals, as well as the cyanobacteria *Lyngbya majuscula,* it was determined that the likely species causing concern to community members is a brown alga, *Chrysocystis fragilis*, also known as Golden Threads (Figure 2,3). Beginning approximately 100 m offshore, *C. fragilis* was found in dense mats covering up to 90% of benthic habitat (Figure 1,3). It was observed to be actively smothering corals although most corals appeared to still be healthy.

Figure 3. Dense mats of *Chrysocystis fragilis* overgrowing *Montipera capitata* near Kaiona Beach Park, Waimānalo.

Discussion

After reviewing the data, there does not appear to be a clear point source for nutrients which would be causing this outbreak of algae and cyanobacteria. *Chrysocystis fragilis* is widespread in the surveyed area and although it seemed to be concentrated in one section of the reef surveyed, this may be due to the fact that there is simply more hard substrate in that particular location. The AIS Program observed that *C. fragilis* prefers hard substrate and is less common on sandy bottoms. It is possible that nutrients are being carried out to the reef via submarine groundwater discharge (SGD)(Garrison et al., 2003; Knee et al., 2010). The amount of freshwater and nutrients that can enter the reef from underground may be significant if the benthos is porous (Oberdorfer & Buddemeier, 1986). Agriculture and urbanization have had a significant increase on the nutrient concentrations found in the aquifers on O'ahu. Sources of terrestrial nutrient enrichment include excess flow out of sewer systems, septic tank leakage, and fertilizers. However, it would be difficult to prove that any land-based source of nutrients is responsible for this particular outbreak. Also, some blooms of *C. fragilis* are linked more closely to water temperatures, not nutrient levels (Schaffelke et al. 2004; Sparrow & Heimann 2007).

Chrysocystis fragilis is a common species across the Pacific where it forms fragile colonies (Lobban et al., 1995). There was an unusually large bloom on the Great Barrier Reef of Australia in 2003 and 2004, which negatively impacted live corals and coral settlement (Schaffelke et al. 2004). In Hawai'i, it is often observed in the summer months when wave action is minimal (Dollar & Grigg, 2004). Due to the fragility of *C. fragilis*, "the slightest water action" can easily break off new algal growth (Dollar et al. 2004). In July 2002, an outbreak was recorded in Maui where aggregations peaked at 26% of benthic cover, but due to the short nature of the study it was unclear if the outbreak ultimately caused coral mortality (Dollar & Grigg, 2004). At the site of the current outbreak in Waimānalo, there is very little wave action due to the outer reef blocking most wave action from reaching the shore. This may be in part as to why the outbreak has been able to grow to such a large scale.

Through the AIS Program's observations, it was clear that the algae were competing with live corals and actively smothering them (Figure 3). Unfortunately, it will be difficult to determine the overall impact on corals because there is no recent baseline data that a post-outbreak survey could be compared to.

While performing the survey, the AIS Program encountered three individuals who were aware of the algae and were grateful DAR was investigating the situation. One individual noted that there have been algae blooms similar to this previously. However, those blooms went away whereas this bloom does not appear to be decreasing and seems more widespread than before. The individuals also reported instances of illegal fishing and illegal boat anchoring near shore, which the team observed had damaged corals.

AIS members also observed the invasive algae *A. lacerata*, although not in large numbers. *A. lacerata* is a highly disruptive species as it competes with native coral and algae species, and has the potential to transform sandy near-shore benthic habitat to mud-flats by trapping sediments and holding them more so than native species (Veazey et al., 2019). Veazey et al. (2009) also found that the area is more than 75% suitable habitat for continued *A. lacerata* invasion, as determined by the author's model.

Conclusions

The outbreak appears to be naturally occurring and has precedent in the State. The algae will likely be dislodged eventually through wave action. It is unclear if land-based nutrients are responsible for *C. fragilis* growth, as this has not been previously shown and prior outbreaks have occurred in oligotrophic areas. Generally, eutrophication in a reef system can be harmful to coral species by promoting the rapid growth of algae species. These events should be limited, when possible, as other algae species are known to have had caused significant damage to Hawai'i's coral species.

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