

First records of *Anemonia manjano* (Carlgren 1900) in the Hawaiian Islands and the aquarium hobby as an increasingly important pathway for marine invasive species.

Holly Bolick

holly@bishopmuseum.org

Bishop Museum <https://orcid.org/0009-0002-1554-3481>

Jesse Boord

Division of Aquatic Resources

Marie Ferguson

Joint Base Pearl Harbor-Hickam

Julia Hartl

University of Hawai'i at Mānoa Hawai'i Institute of Marine Biology; University of Hawai'i at Manoa
Hawaii Institute of Marine Biology

Kiana Lee

Bishop Museum

Elizabeth Monaghan

Division of Aquatic Resources

Nicole Olmsted

Joint Base Pearl Harbor-Hickam

Research Article

Keywords: invasive species, *Anemonia manjano*, soft-bodied cnidarians, aquarium trade, marine invertebrates

Posted Date: September 1st, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10631956/v1>

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Abstract

Anemonia manjano (Carlgren 1900), or the “majano anemone”, has been found for the first time in Hawaiian waters at two locations on the island of O‘ahu. The initial detection occurred in June 2020 on an open patch reef in Kāne‘ohe Bay. A detection of a second population occurred in February 2023 along the shoreline of an estuarine lagoon within Pearl Harbor. Rapid spatial expansion of both populations in distinctly different habitats among a variety of substrate types has prompted the need for immediate monitoring, eradication, and control efforts. The population in Kāne‘ohe Bay appears to have originated from nonnative stony corals that were introduced to the reef via outplanting or aquarium release. The majano anemone is commonly seen as a prolific and hardy pest species in hobbyist aquariums. Hawaii has seen a significant increase in reported marine introductions linked to the aquarium hobby over the past decade, highlighting the importance of addressing it as a vector of marine invasive species.

Introduction

The Hawaiian Islands have a long, documented history of marine species introductions (Coles et al. 1999). Most of these introductions lead to establishments (Carlton & Eldredge 2009), some of which have become detrimental to Hawai‘i’s delicate marine ecosystem (Bolick & Coles 2007). The majority of the recently documented introduced marine invertebrates in Hawai‘i originated from suspected aquarium releases (Bolick & Lee 2023).

Over the past decade, introduced soft-bodied cnidarians have been the most problematic, establishing and spreading at alarming rates, making response and mitigation challenging. This is not unique to Hawai‘i. Several newly documented cnidarian outbreaks have been devastating coral reefs around the world (Work et al. 2018; Ruiz-Allais et al. 2021; Toledo-Rodriguez et al. 2025).

In 2020, the pink-tipped anemone, *Anemonia manjano*, was first sighted in Hawaiian waters. It was growing amongst a patch of non-native *Montipora foliosa* corals in Kāne‘ohe Bay off the island of O‘ahu that were suspected to have been intentionally outplanted. In 2023, a second sighting of the anemone occurred on O‘ahu along the shoreline of Ford Island in Pearl Harbor. No previous records of the species—whose known native range is the Indian Ocean—exist for the Hawaiian Islands.

In its known geographic range, *A. manjano* has been observed overgrowing scleractinian corals (Tkachenko & Britayev 2016). In Vietnam, *A. manjano* has been reported outcompeting stony corals by using nematocysts in their tentacles to kill coral polyps (Tkachenko 2023). *A. manjano* is also known to be a popular species in the aquarium trade due to its beautiful colors and heartiness, but it can quickly become a nuisance by outcompeting and smothering stony corals in aquarium tanks making it difficult to control (Puts 2022).

A. manjano is also known as a prolific species within the marine aquarium hobby, often appearing in tanks as secretive hitchhikers on live rocks or corals due to its ability to hide deep within the reef structure (Patoka et al. 2020; Puts 2023). Similarly, *A. manjano* appears to have been accidentally

introduced to Kāneʻohe Bay as a stowaway on nonnative stony coral that likely originated from a private marine aquarium.

Both sightings in Hawaiʻi consisted of multiple clusters of individuals at different developmental stages, from half-dollar-sized adults to nearly microscopic recruits, indicative of established, reproducing populations. The distance between the two locations suggests two separate introduction events. The increased footprint of both populations over a short period of time, along with the observed overgrowth of native benthic fauna, and a lack of natural predators in this region (DAR pers. obs. 2026) suggests that *A. manjano* is a highly invasive species in Hawaii needing immediate attention. The likelihood of aquarium release and intentional outplanting as the method of introduction of this species in Hawaiian waters highlights the need to address the aquarium trade as a growing pathway for marine invasive species in the wild.

General Information About *A. manjano*

A. manjano (Anthozoa, Hexacorallia, Actiniaria, Actiniidae) was described from specimens collected in the late 1800s from a reef off northwestern Zanzibar (Carlgren 1900). The known native range of *A. manjano* is the western Indian Ocean (Carlgren 1900) though the species has also been reported as present in Southeast India (Vani Ganapathy & Malathi 2023) and Vietnam (Tkachenko & Britayev, 2016) and as a nonnative in the Philippines (Vallejo et al. 2019).

The species name “manjano” derives from the Swahili word for tumeric and yellow, referring to the body color of the anemone (Carlgren 1900). No holotype was designated, and the syntypes used in his description are housed at Zoologisches Museum Hamburg and the Biologiska museet vid Lunds universitet (Rodrigues et al. 2025).

The taxonomic name has not undergone any revisions since its original description; however, there have been some discrepancies which cause confusion. One of the common names for the manjano anemone drops the ‘n’, calling it the “majano anemone”. Misspellings of the scientific name that similarly drop the ‘n’ (*Anemonia majano*) also occur. This species is also commonly referred to as the “pink-tipped anemone” based on the pink tips of the tentacles (Fig. 1).

Relatively little is known about this species regarding its reproduction modes and timing, rate of growth, age and size at sexual maturity, and lifespan. There is no scientific documentation on sexual or asexual reproduction of *A. manjano* in nature. More work is needed to better understand the life history of this species *in situ*. However, based on observations of the anemone in captivity by aquarium hobbyists as well as reproduction strategies of other closely related species of anemone (*Aiptasia* and *Bolceroides*), it is likely capable of both sexual and asexual reproduction.

Regarding habitat preferences, *A. manjano* is not picky and has been observed occupying sand, coral rubble and both dead and living colonies of corals (Tkachenko & Britayev 2016). In Hawaiʻi, *A. manjano* has also been observed growing on multiple surfaces including, but not limited to, mangrove roots,

floating wood debris, live stony corals, dead coral rubble, coralline algae, and cinder blocks. While the depth range is also undocumented in nature, it was observed in Hawaiian waters at depths between 0.5 to 7.6 meters.

A. manjano demonstrates several dispersal mechanisms in both natural and captive environments. It is able to detach from the substrate and maneuver or “walk” to a new area. Captive *A. manjano* at the Waikiki Aquarium have been observed moving as fast as a foot in four hours (A. Burke pers. comm. 2024). The anemone can spread through pedal laceration and “hitchhike” on rocks, corals, organisms, ship hulls, or floating debris (Patoka et al. 2020).

Detection of *A. manjano* in Hawaiʻi

A. manjano was recorded at two distinct sites on the island of Oʻahu between June 2020 and February 2023 (Fig. 2).

First report: Kāneʻohe Bay (Reef 8):

In June 2020, *A. manjano* was first detected at Reef 8 in Kāneʻohe Bay (Oʻahu) co-occurring with non-native *Montipora foliosa* colonies suspected to have been intentionally outplanted earlier that year. The initial individual polyps were removed along with the non-native montiporids, additional polyps observed on *Montipora capitata* were smothered using Z-SPAR A-788 epoxy on October 23, 2020. Follow-up surveys on January 12 and July 30, 2021, reported one and two individuals, respectively, which were also smothered. Samples of the anemone collected on July 29, 2020, and deposited at Bishop Museum for taxonomic confirmation and genetic analysis. At this time, the population size was minimal.

Continued monitoring of the reef by Division of Aquatic Resources (DAR) Aquatic Invasive Species (AIS) Team in 2024 confirmed the renewed presence of *A. manjano*, which had undergone rapid spatial expansion. A visual survey of Reef 8 on October 24, 2024, delineated an invasion polygon later mapped by structure-from-motion photogrammetry on April 25, 2025. Surveys on January 30, 2026 confirmed additional spread from 217 square meters to over 1100 square meters (Fig. 3). *A. manjano* was found on multiple substrates, including live colonies of native stony corals *M. capitata*, *Porites compressa*, and *Pocillopora damicornis*, as well as crustose coralline algae, coral skeleton, and reef pavement (Fig. 4). Collections from July 29, 2020, and April 25, 2025, were vouchered to the Bishop Museum (Table 1). Years of persistent detections despite removal efforts, the anemone's presence on multiple substrate types, and the discovery of individuals at various developmental stages indicated a robust, reproducing population requiring immediate intervention.

Second Report: Pearl Harbor (Ford Island):

On February 24, 2023, a second population of *A. manjano* was reported by a civilian biologist along the shoreline of Ford Island in Joint Base Pearl Harbor-Hickam (JBPHH). The anemone was discovered in shallow water attached to mangrove roots and floating driftwood along the western shoreline but only a handful of individuals were observed in the area (N. Treneman, pers. obs. 2023; Fig. 5).

A shoreline survey of *A. manjano* conducted by the Department of the Navy (DON) on October 26, 2023 confirmed a high-density population located within the area initially observed. *A. manjano* was documented in the shallow intertidal zone along approximately 52 meters of the Ford Island shoreline (an area measuring approximately 150 square meters). No significant changes were observed during follow-up shoreline surveys conducted on December 14, 2023 and January 10, 2024; however, one new, small cluster of *A. manjano* was observed at the southern end of the current known distribution area. The population present confirmed from initial shoreline surveys prompted additional voucher collections to the Bishop Museum (Table 1).

Results from regular shoreline surveys conducted between October 2023 and January 2026 confirmed an established and expanding *A. manjano* population within an area of approximately 2,989 square meters (0.74 acres) along the western end of Ford Island (Fig. 6). As indicated on the map, not only did the footprint of the infestation zone increase over time, but also the number and density of clusters detected in each survey. The red zone represents the highest density and is the location of the initial discovery site of the anemone in Pearl Harbor. The orange (medium density) and yellow (low density) show the expanding footprint.

The first in-water survey was conducted in February 2026 and the report revealed an *A. manjano* distribution extent of approximately 2.92 acres, in varying densities within the survey site (Fig. 7) at depths of roughly 18 to 25 feet (5.5 to 7.6 meters). *A. manjano* was generally absent from sand areas unless hard substrate was present for attachment.

Survey summary

Survey efforts differed between the two locations due to variations in site accessibility, permitting requirements, and available personnel. In Kāneʻohe Bay, repeated surveys of the entire infestation area were conducted because the site was readily accessible and could be incorporated into regularly scheduled monitoring activities. In contrast, survey efforts at Pearl Harbor were constrained by access restrictions and permitting requirements, limiting assessments primarily to shoreline surveys until February 2026. Despite these differences in survey methodology and effort, both populations exhibited similar rates of expansion—increasing approximately sixfold within less than one year. Consequently, both populations were classified as invasive infestations requiring immediate management intervention. The Pearl Harbor infestation occupies approximately 3 acres within a largely enclosed estuarine system, while the Kāneʻohe Bay population occurs on an open reef and currently covers a smaller area of approximately 0.5 acres.

Voucher sample and genetic info

Voucher specimens from both sites were submitted to the Bishop Museum (Table 1). Data for museum voucher specimens is freely accessible through the Global Biodiversity Information Facility (GBIF) portal <https://www.gbif.org/dataset/50743314-a455-4f64-b5d5-8a4e816aeec6>.

Table 1

List of the *A. manjano* specimens vouchered at the Bishop Museum Invertebrate Zoology Collection.

Catalog Number	Locality	Habitat notes	Depth	Collector	Date Collected
BPBM-D2606	Kāneʻohe Bay, Reef 8	in non native corals	3m	Kim Fuller	29 July 2020
BPBM-D2607	Kāneʻohe Bay, Reef 8	in non native corals	3m	Kim Fuller	29 July 2020
BPBM-D2619	Kāneʻohe Bay, Reef 8	in non-native corals	3m	Kim Fuller	29 July 2020
BPBM-D2989	Pearl Harbor, Ford Island	on wood block	0.5m	N. Treneman	24 February 2023
BPBM-D3034	Pearl Harbor, Ford Island	in coral rubble	1-2m	H. Adams	11 January 2024
BPBM-D3704	Kāneʻohe Bay, Reef 8	in coral rubble	3m	J. Boord	25 April 2025
BPBM-D3711	Kāneʻohe Bay, Reef 8	non-native coral site	1-5m	C. Ratum, K. Gonzalez	25 April 2025
BPBM-D3795	Waikiki Aquarium	aquarium tank	N/A	K. Lee	05 August 2025

The initial visual identification of the anemone from Kāneʻohe Bay was done by Josh Maxwell of the Waikiki Aquarium. The initial visual identification of the anemone in Pearl Harbor was done by Nancy Treneman and Jim Carlton. All morphological identifications were confirmed by Invertebrate Zoology staff at Bishop Museum. Tissue samples taken from each voucher specimen were submitted to the Hawaiʻi Institute of Marine Biology (HIMB) for sequencing.

Morphological identifications were genetically confirmed by Jules Hartl at HIMB using tissue samples from Bishop Museum voucher specimens. Barcode sequences were generated for a 400-base-pair region of the genome using primer pairs designed to amplify anthozoan DNA (Anth-28S). After processing sequences with Geneious Prime 2025.1.2 software, consensus sequences were deposited in the National Center for Biotechnology Information (NCBI) BioSample database (Pearl Harbor: SAMN55909282; Kāneʻohe Bay: SAMN55909276 and SAMN55909157).

Pathway Considerations

In Kāneʻohe Bay, *A. manjano* originally co-occurred exclusively with non-native *Montipora foliosa*, a commonly traded ornamental coral species. The close spatial association of these corals and anemones within a small patch reef strongly indicates a localized aquarium release or a deliberate out-planting event.

In contrast, Pearl Harbor detections occurred without stony coral co-occurrence and in a partially brackish, mangrove-fringe habitat, consistent with multiple vectors (e.g., aquarium release, hull/float-raft fouling). The two Oāhu records—separate in both oceanographic setting and introduction history—likely represent independent introduction events rather than rapid spread from a single source.

Conclusion

In Hawaiʻi, *A. manjano* has been introduced at two distinct locations and has successfully established across different habitat types. Despite the use of similar treatment methods at both sites, access and permitting constraints have delayed mitigation efforts, potentially reducing the feasibility and effectiveness of eradication and containment. The rapid expansion of this species, its ability to overgrow and displace stony corals, and the risk of spread to nearby reef systems underscore the importance of a timely management response. Prompt implementation of control and eradication measures, coupled with efforts to prevent future introductions of *A. manjano* and other aquarium-associated species, will be critical to minimizing ecological impacts and limiting further spread.

The global extent of actinarian introductions and their potential to alter the native biodiversity long-term are poorly understood and largely understudied (Gimenez & Brante 2021). However, case studies have shown actinarian species rapidly expanding following introduction to a new area (Patris et al. 2019) and changing local assemblages in ways that can be economically detrimental (Molinet et al. 2023).

Over the past decade, the aquarium hobby has been the suspected vector for several highly invasive octocoral species in the Caribbean which have caused significant damage to reef, algal, and seagrass meadow habitats in the region (Ruiz-Allais et al. 2021; Toledo-Rodriguez et al. 2025 a, b). In Hawaiʻi, several nonnative species—including at least one highly invasive octocoral species—detected in Pearl Harbor are believed to have come from at least two separate aquarium releases (Bolick & Lee 2023). While ship traffic has historically been largely responsible for marine introductions in most regions (Bailey et al. 2020), including Hawaii (Carlton & Eldredge 2009), the aquarium trade is emerging as an important pathway for marine invasive species.

There are an estimated 6.7 million marine aquarium hobbyists globally with the United States as the largest importer of marine animals for the aquarium hobby (Watson et al. 2023). Global ownership and the resulting movement of marine animals it will produce are expected to increase greatly throughout this century, estimated to reach upwards of 45 million hobbyists by 2100 (Watson et al. 2023). Recent cases such as *A. manjano* and other aquarium hobby-related introductions in Hawaiʻi and the Caribbean highlight the need for increasing vigilance, fostering public awareness about the impacts of aquarium introductions, and increasing capacity nationwide to accept unwanted aquarium organisms, and of upmost importance, the need to address the role of aquarium associated pathways and pathway focused prevention and rapid response nationwide.

Declarations

We confirm that this manuscript is original, is not currently under consideration by any other journal, and has not been published previously.

Funding and Competing Interests

We declare that no funds, grants, or other support were received to assist with the preparation of this manuscript. The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the conceptual content design. Taxonomic and biological information was contributed by Kiana Lee and Holly Bolick. Genetic information was contributed by Julia Hartl. Field data collection and visualization for surveys and distribution maps were contributed by Jesse Boord, Elizabeth Monaghan, Nicole Olmsted, and Marie Ferguson. The first draft of the manuscript was written by Holly Bolick and Kiana Lee and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

Nancy Treneman for the collection of anemone samples (with images) and for alerting Division of Aquatic Resources (DAR) of the initial sighting in Pearl Harbor. Jim Carlton for the taxonomic identification of the Pearl Harbor sample. Anthony Burke for providing information about the anemone in aquaria and for providing specimens for vouchering at Bishop Museum. Josh Maxwell for the initial identification of the anemone. Kim Fuller, Kate Gonzalez and the DAR Aquatic Invasive Species Team for their detection and survey efforts to record the spread in Kāneʻohe Bay. Gabby Kawelo and Hiʻilei Kawelo for initial non-native coral detection in Kāneʻohe Bay. Heeia National Estuarine Research Reserve System staff for help and support with the anemone response efforts. The ToBo lab at HIMB for genetic confirmation of the anemone. Samantha Palhano Azevedo Alves, Jessica Idle, Rachel Nordschow, Alexander Bauer, and the entire University of Hawaiʻi, Pacific Cooperative Studies Unit, Joint Base Pearl Harbor-Hickam Field Team for conducting monthly shoreline monitoring surveys and creating maps to document the spread along Ford Island. Hawaii Invasive Octocoral Working Group for their continued efforts to collaborate, monitor, and address marine invasive species in Hawaiian waters.

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Figures



Figure 1

Image of live *Anemonia manjano* collected from Kāneʻohe Bay, Oʻahu: Bishop Museum specimen D3034
(Photo credit: Noel Kenny)

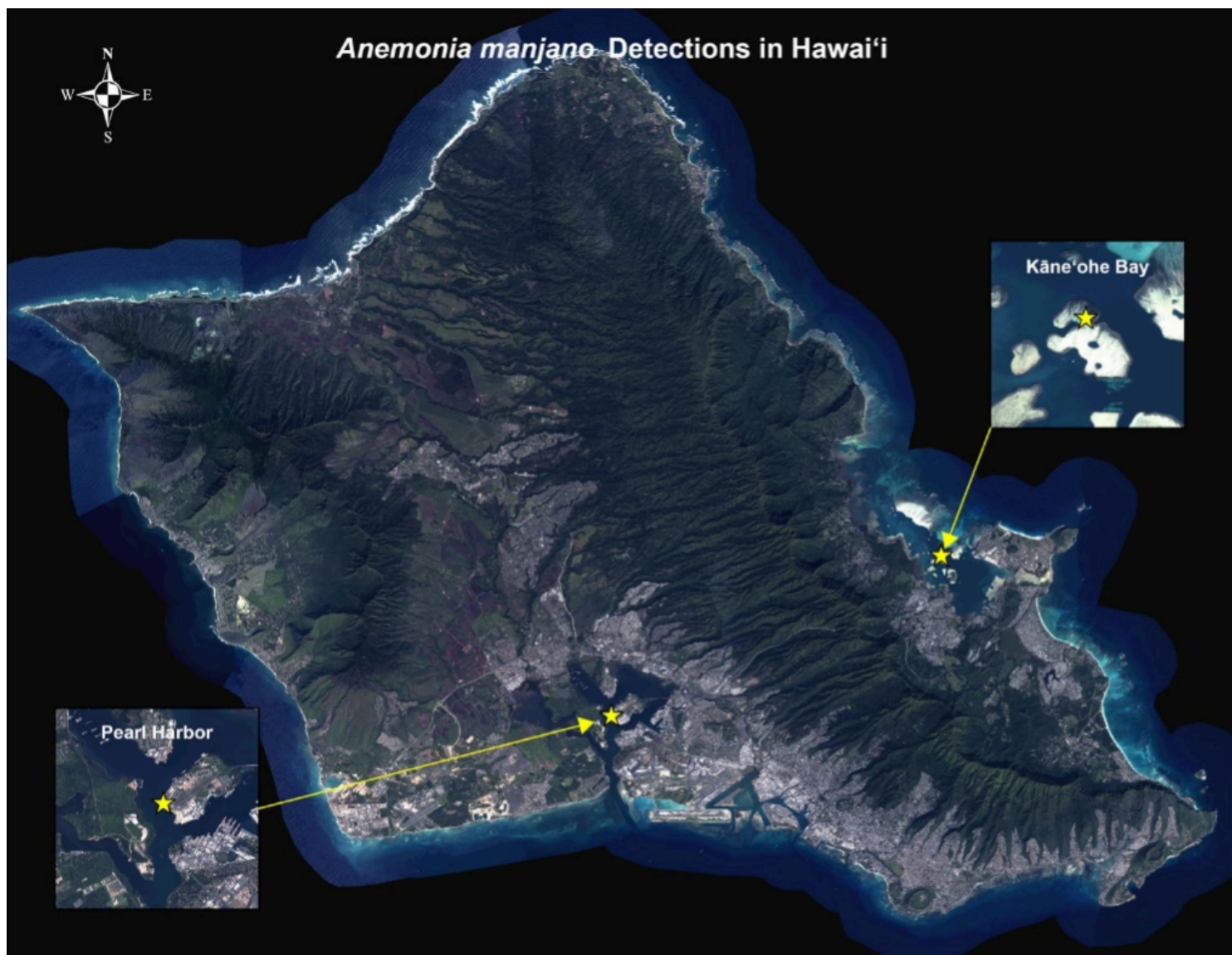


Figure 2

Locations of *Anemonia manjano* detections on the island of Oʻahu, Hawaiʻi. The species was recorded at two distinct sites: Reef 8 in Kāneʻohe Bay and along the shoreline of Ford Island in Pearl Harbor. Insets show detailed views of each detection location. Raster map image (originally JPG) created in ArcGIS Pro (ESRI Inc.)

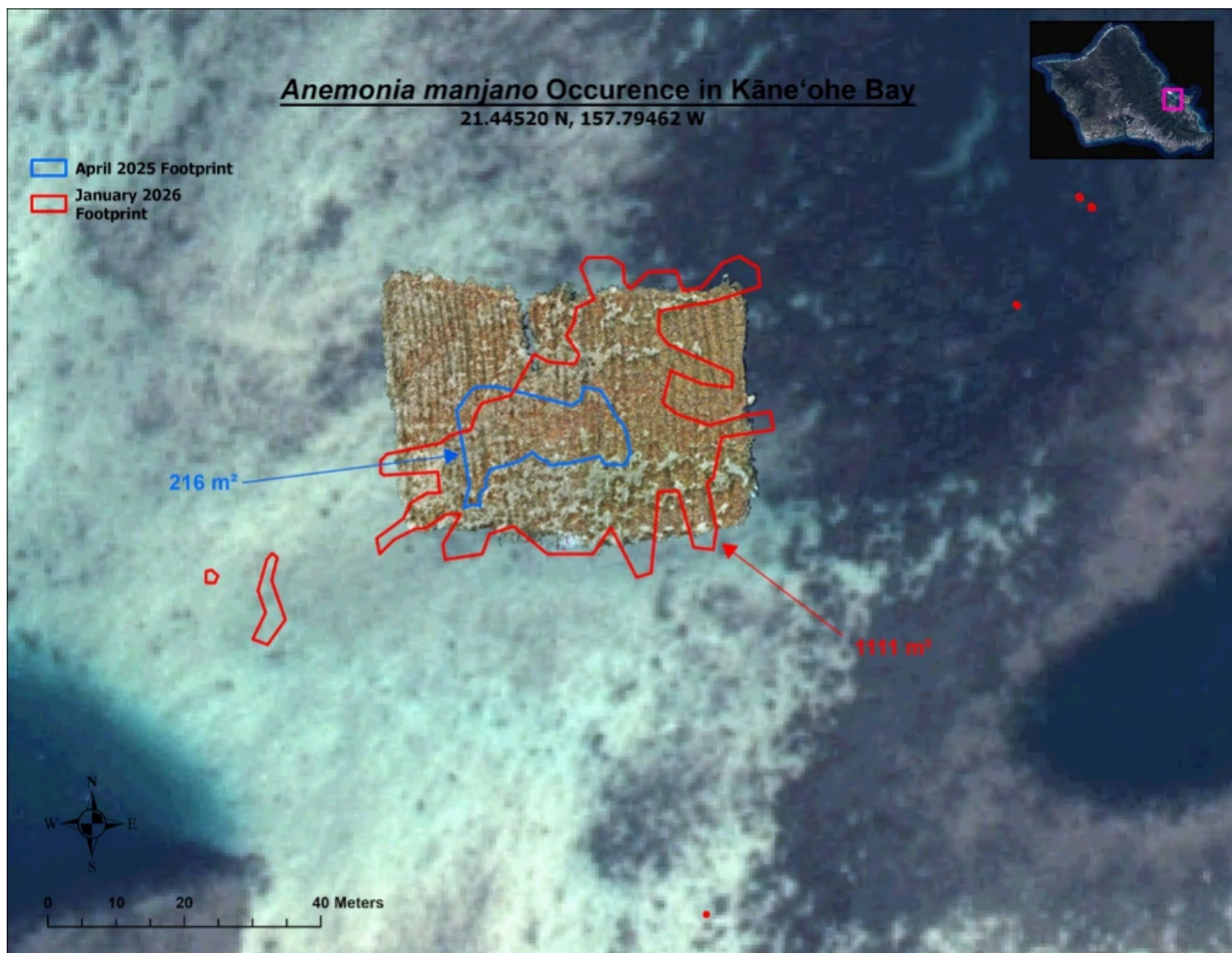


Figure 3

Spatial extent of the *Anemonia manjano* infestation at Reef 8 in Kāneʻohe Bay, Oʻahu. The initial mapped footprint from April 2025 (blue polygon) is compared to the expanded footprint from January 2026 (red polygon), illustrating rapid spatial growth. Additional small satellite detections are shown outside the main infestation area. Basemap imagery derived from structure-from-motion photogrammetry to exhibit coral cover. Raster map image (originally JPG) created in ArcGIS Pro (ESRI Inc.)

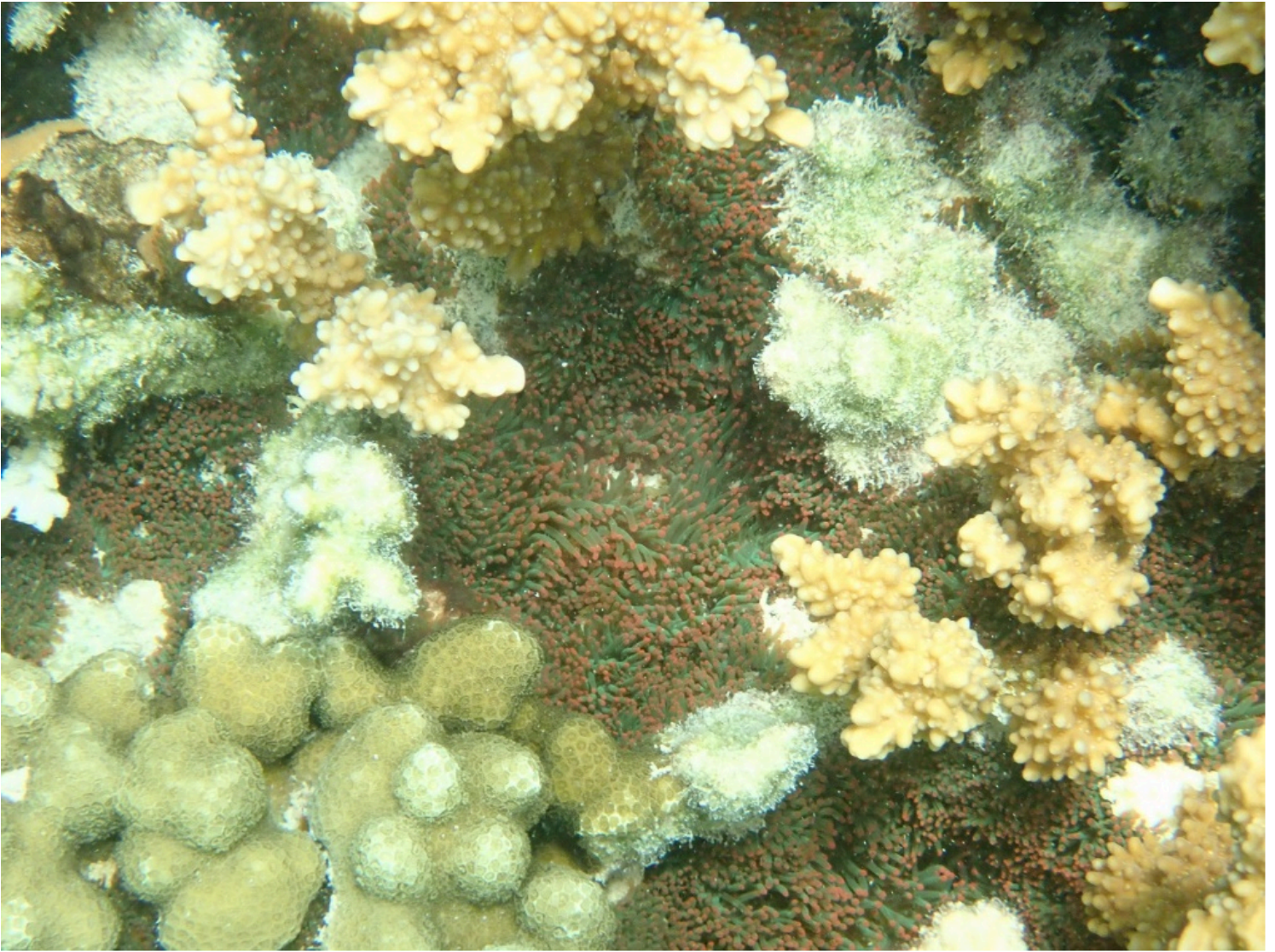


Figure 4

Image of *A. manjano* growing on native *Montipora* and *Porites* corals in Kāneʻohe Bay (Photo Credit: DAR AIS)



Figure 5

Image of *A. manjano* attached to a mangrove root in Pearl Harbor (Photo Credit: Nancy Treneman)

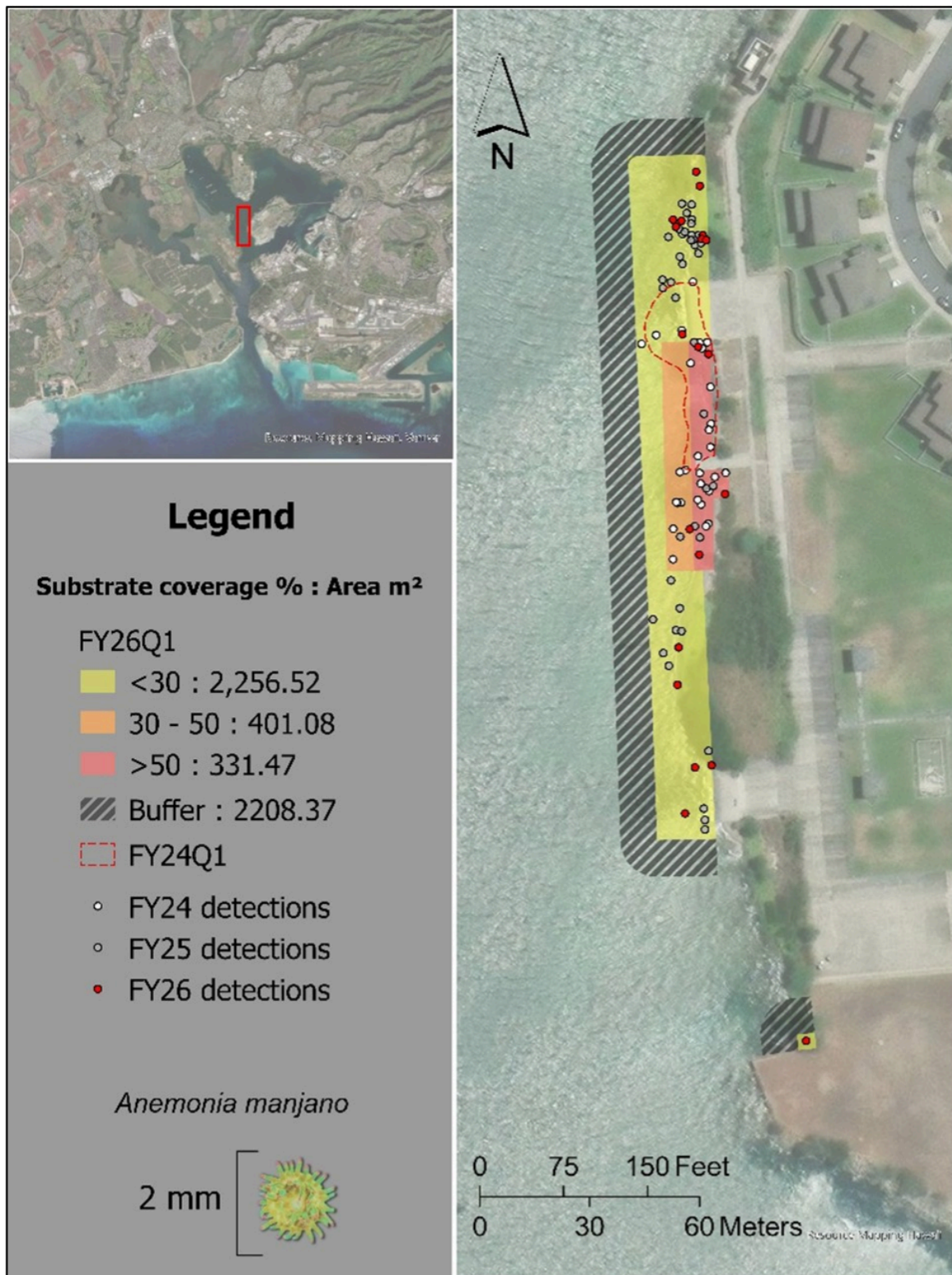


Figure 6

A. manjano distribution extent results from DON shoreline surveys on Ford Island, JBPHH, as of January 2026. New individuals or clusters identified during surveys are symbolized by circles, with colors representing fiscal year (FY) of discovery. *A. manjano* coverage is categorized as > 50% (red), 30-50% (orange), and < 30% (yellow). A 10-m buffer (dashed line) is included as an area of potential *A. manjano*

presence. The *A. manjano* distribution from initial surveys (October 2023 to January 2024) is denoted by the red-dashed line. Raster map image (originally JPG) created in ArcGIS Pro (ESRI Inc.)



Figure 7

A. manjano distribution extent results from DON in-water surveys on Ford Island, JBPHH, conducted in February 2026. An *A. manjano* distribution extent of approximately 2.92 acres, of varying density, was

observed. *A. manjano* density coverage is categorized as high (67.1 - 100% [red]), moderate (34.1 - 67% [orange]), and low (0.1 - 34% [yellow]). Raster map image (originally JPG) created in ArcGIS Pro (ESRI Inc.)