Marine invasive species in Hawai‘i: pathways, pests, and policies

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STOP THE SILENT INVASION
COORDINATING GROUP ON ALIEN PEST SPECIES

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University of Hawai‘i at Mānoa

Value of Hawaii's reefs & losses avoided through healthy reefs

- Invaluable **cultural connections**
- 2013 NOAA meta-analysis quantifying the value of Hawaii's reefs (subsistence, recreational, commercial fisheries, tourism, etc.): **$1.74M annually**
- 2019 USGS study: Hawaii reefs provide **$836M in averted damages** to property and economic activity
- **With a 1-meter loss in reef height** (e.g. via sea level rise + heat + ocean acidification + coral death/loss of recruitment) **damages projected at $1.3B** to property and economic activity

Top left: lūheʻe, octopus fishing lure (Smithsonian image). Right and bottom: recent economic valuation and damage aversion studies of U.S. reefs, including in Hawaii.

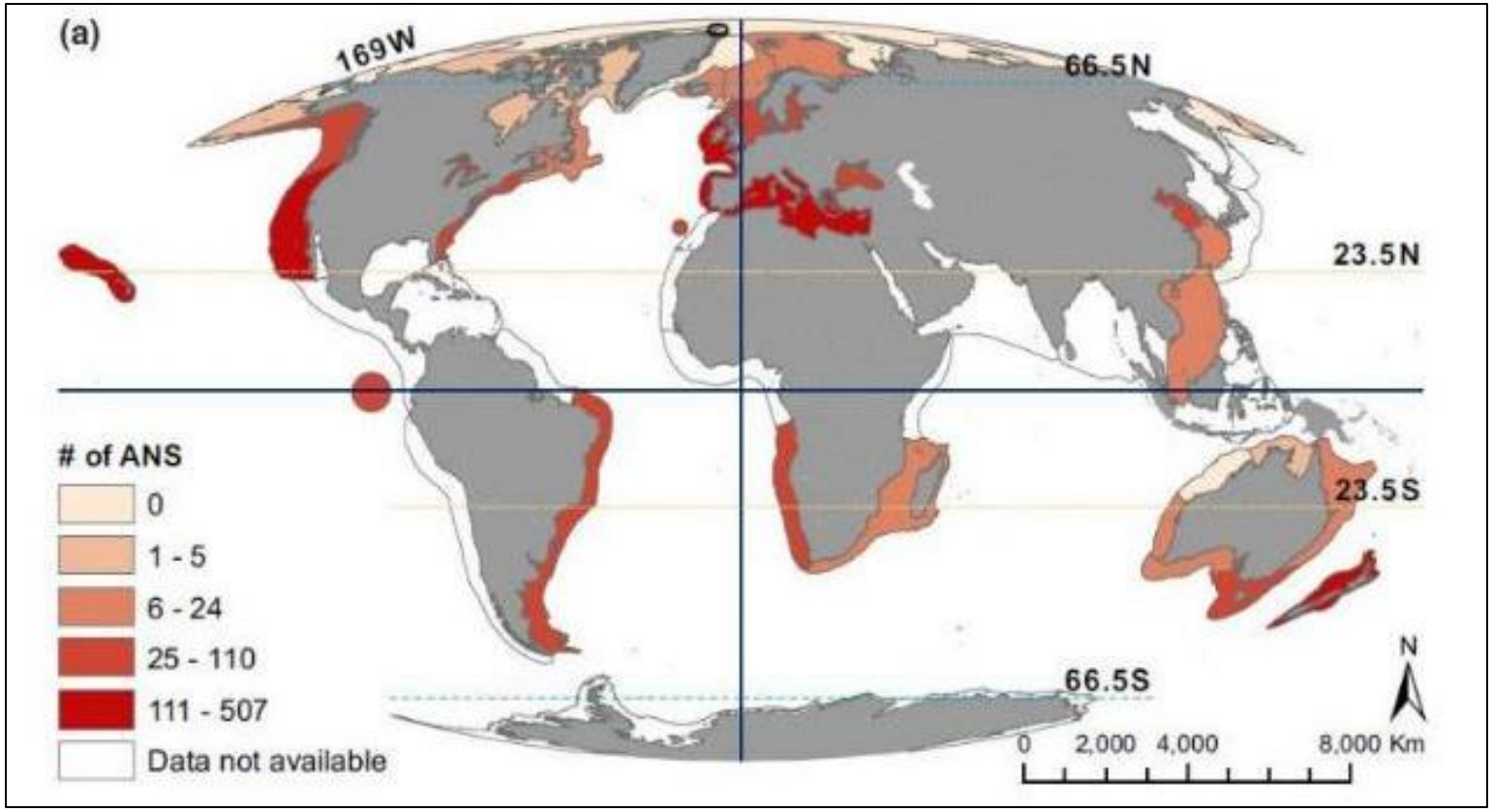
Confluence of climate change and invasive species

- Invasive species are the greatest driver of native biodiversity loss (extinctions) on islands
- Invasive species degrade the resilience of reefs, mangroves, and forests—critical natural infrastructure
  - They weaken, smother, crowd out, or kill native marine life, including keystone species; cause phase shifts
  - Some can alter nutrient cycles, increase turbidity, and concentrate toxins
  - Reduce the ability to buffer and protect shorelines
- Must address invasive species to meet climate adaptation goals

Brain coral in the Florida Keys killed by Stony Coral Tissue Loss Disease. Photos by Ilsa B. Kuffner)

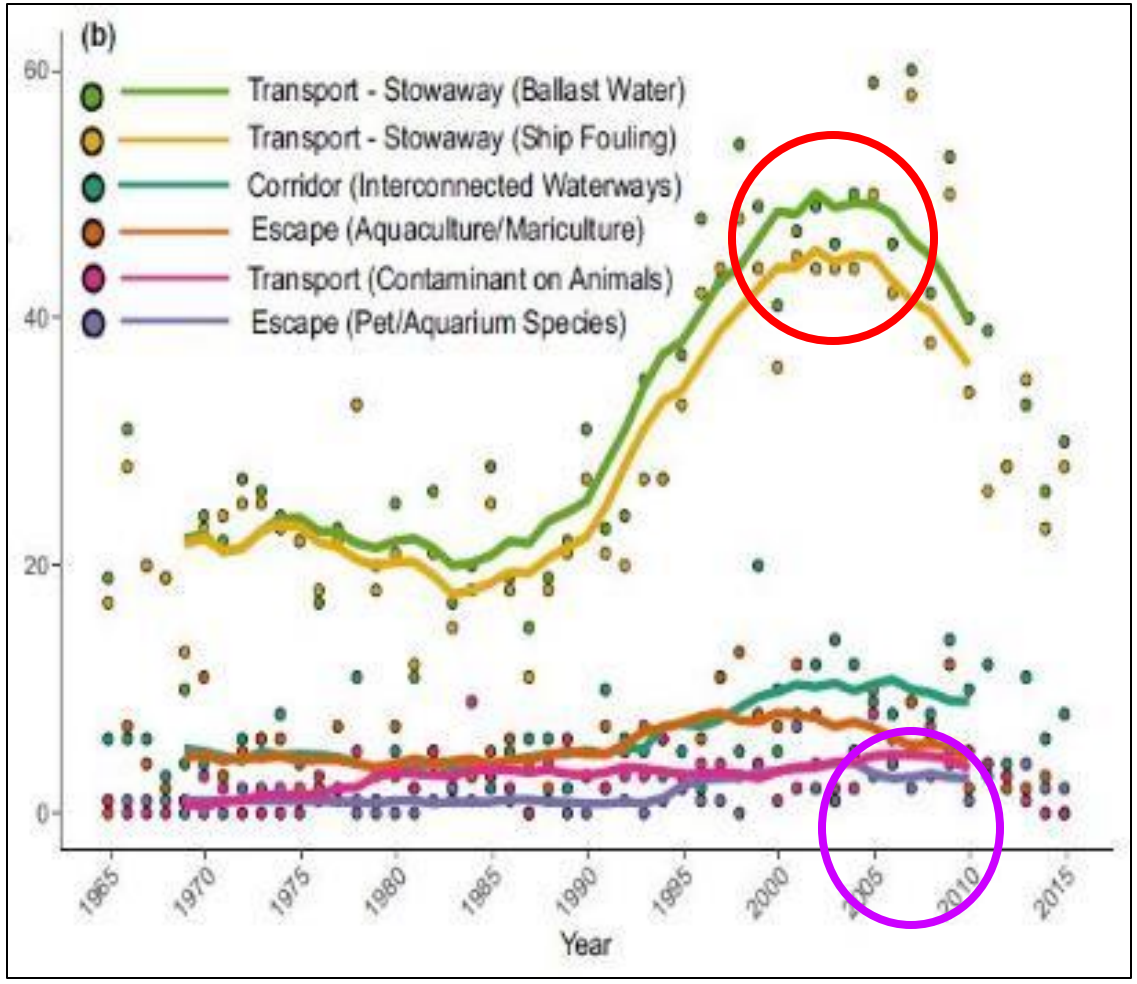
Global detections of introduced freshwater, estuarine, and marine species

There is an **increase in aquatic non-native species** (Bailey et al. 2020)



Records of primary detections of aquatic non-native species (ANS) between 1965 and 2015 in each of 49 coastal marine, estuarine, and freshwater ecosystems. (image from Bailey et al., 2020)

Marine invasive species pathways

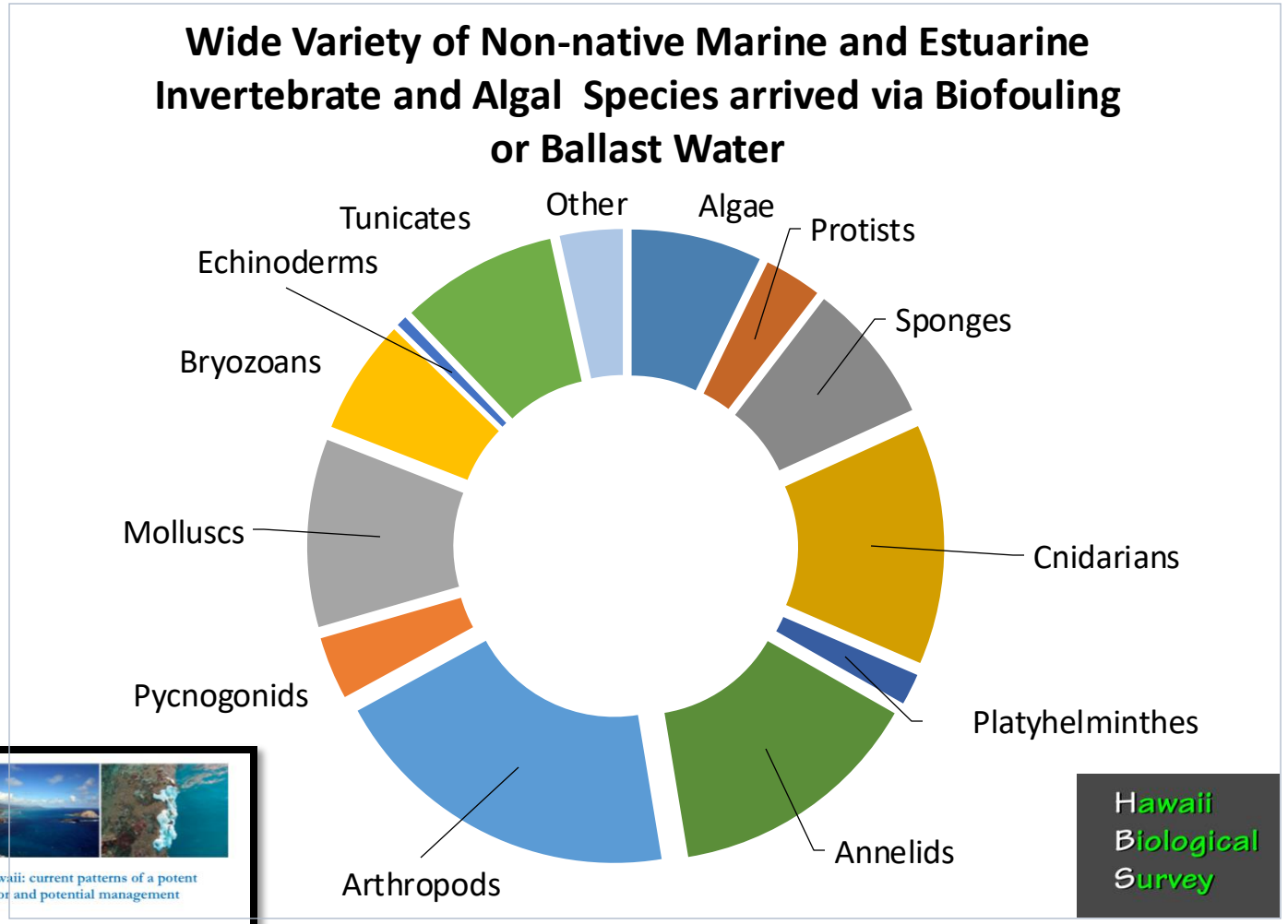


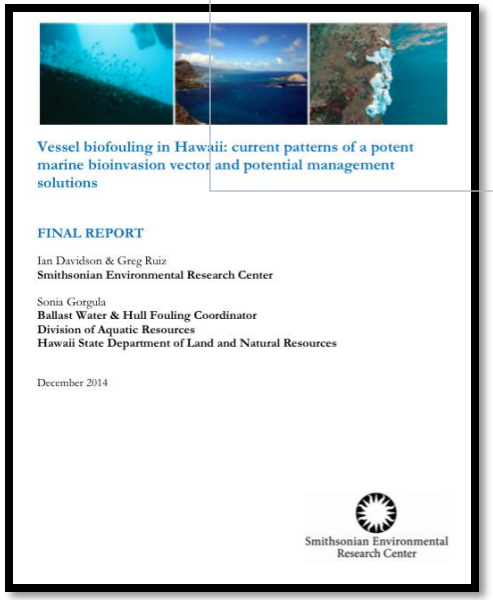
- Vessel ballast water
- Vessel biofouling
- Aquaculture/Mariculture escape
- Contaminant or hitchhike on other species
- Escaped or released aquarium pets

Chronology of primary detection events of ANS across 49 marine, estuarine, and freshwater ecosystems during 1965–2015 […] the number of primary detection events of ANS by pathway, for the top six pathways (96% of records). Bailey et al., 2020

In Hawai‘i, the top vectors are vessel biofouling and ballast water

- 78% (346 of 463) non-native invertebrate and algal species arrived via biofouling or ballast water
- Hawai‘i has 463 non-native and cryptogenic (of unknown origin) marine and estuarine species—the highest in the U.S.
- Native ranges are **global; vessels are the primary vector**




Vessel biofouling in Hawaii: current patterns of a potent marine bioinvasion vector and potential management solutions

FINAL REPORT

Ian Davidson & Greg Ruiz
Smithsonian Environmental Research Center

Sonia Gorgula
Ballast Water & Hull Fouling Coordinator
Division of Aquatic Resources
Hawaii State Department of Land and Natural Resources

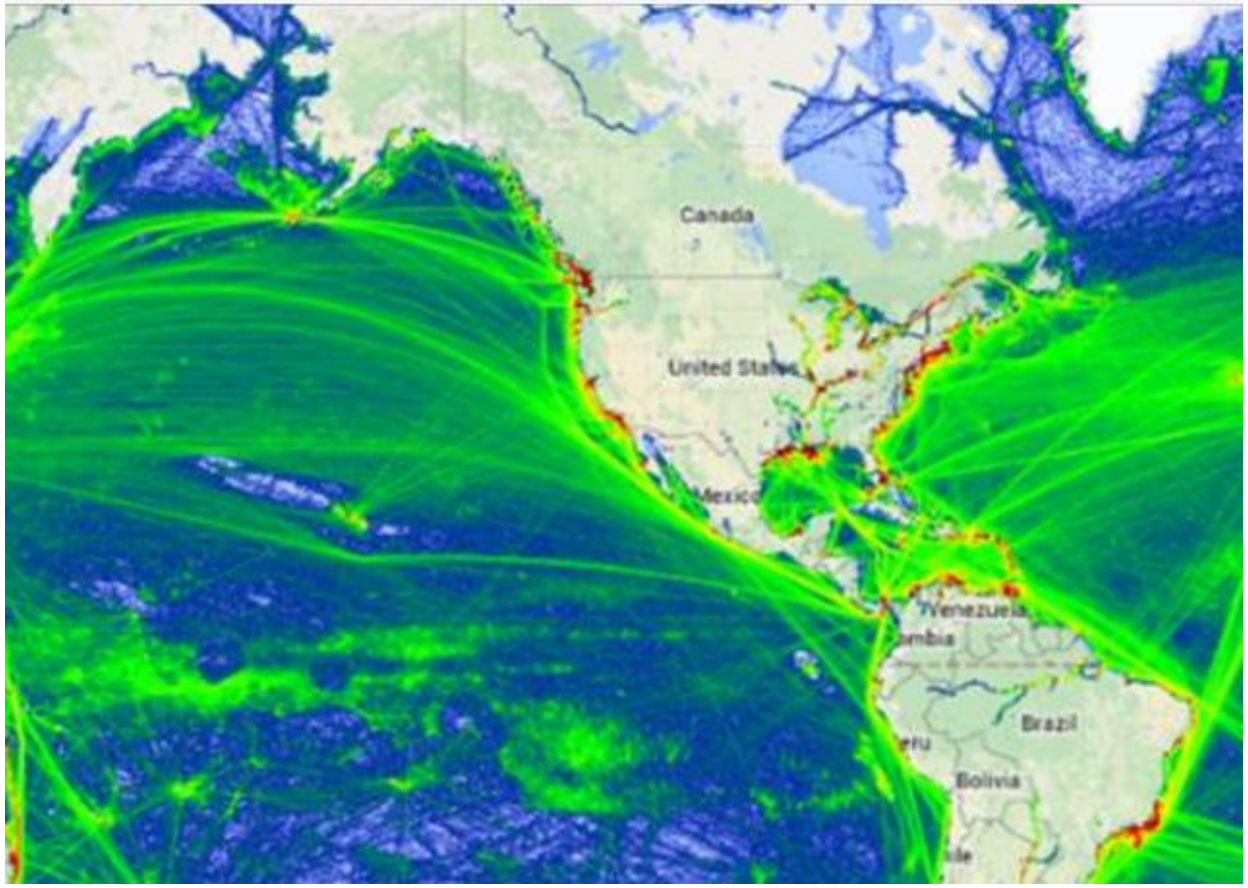
December 2014

Smithsonian Environmental Research Center

Carlton & Eldredge, 2009; Davidson & Ruiz, 2014; Zabin et al., 2016)

Pathway: vessels (ballast water & biofouling), marine invasive species, and climate change

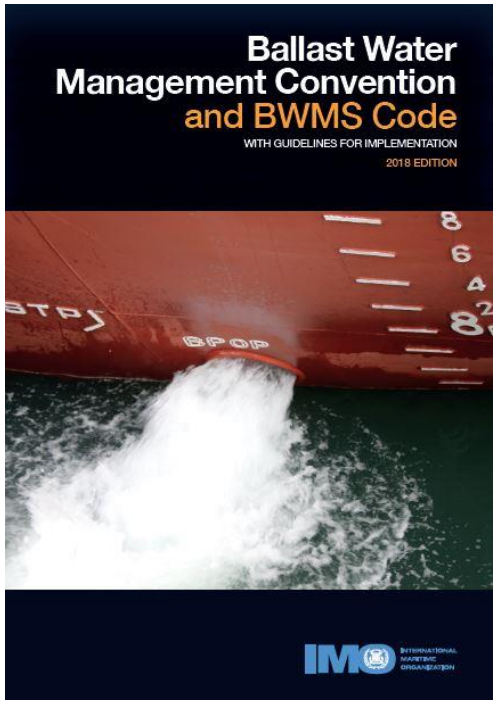
- Global maritime traffic is projected to increase by 240 – 1,209% by 2050 and yield a **3- to 20-fold increase in global marine species invasion risk**
- **Shipping growth will have a far greater effect on marine invasions** than climate-driven environmental changes (both bullets Sardain 2019)
- **25% of emerging alien species results from new source pools**, largely due to changing climate + geopolitics (Seebens 2018)



One year of vessel traffic in 2017. From: www.marinetraffic.com

Prevention policies: vessel ballast water

- International (IMO) regulations, federal regulations (33 CFR subchapter O), HI state regulations (in effect but soon to be preempted by federal regs)
- Ballast water management systems (BWMS)
- U.S. has BWMS testing protocol & performance standards



Prevention policies: vessel biofilms and biofouling

- The growth of marine species on the hull and niche areas, incl. water pipes and “sea chests”.
- Despite anti-fouling paint (which usually contains copper & zinc) or coatings, **biofilm (the bacterial slime-layer)** begins to grow within days and allowing larger **biofouling** species to colonize.
- Unlike ballast water, there are **no binding international regulations**
- 33 CFR 151.2050 (remove fouling organisms from vessel’s hull, piping, and tanks), **but no federal testing/approval for in-water cleaning & capture tech** and regulatory framework

Case study: ballast water and biofouling/biofilm pose a risk for transmitting Stony Coral Tissue Loss Disease—SCTLD

- Disease first observed in South Florida in 2014, **now in 28 Caribbean countries (not yet in HI / Pacific)**
- Affects 30+ coral species. Once **infected, coral colonies die within weeks to months**. Up to **90% loss** of living coral in some areas.
- Still **not isolated and identified**
- **UV ballast water management systems only 50% effective** at mitigating SCTLD in ballast water
- Can **remain pathogenic in sediments,** be spread by moving sediments, re-emerge to infect next generation
- Biofilms/fouling are potential reservoirs
- Some Pacific corals are susceptible (in publication)

SCTLD killing a coral colony in Florida. See location dashboard: https://www.agrra.org/coral-disease-outbreak/

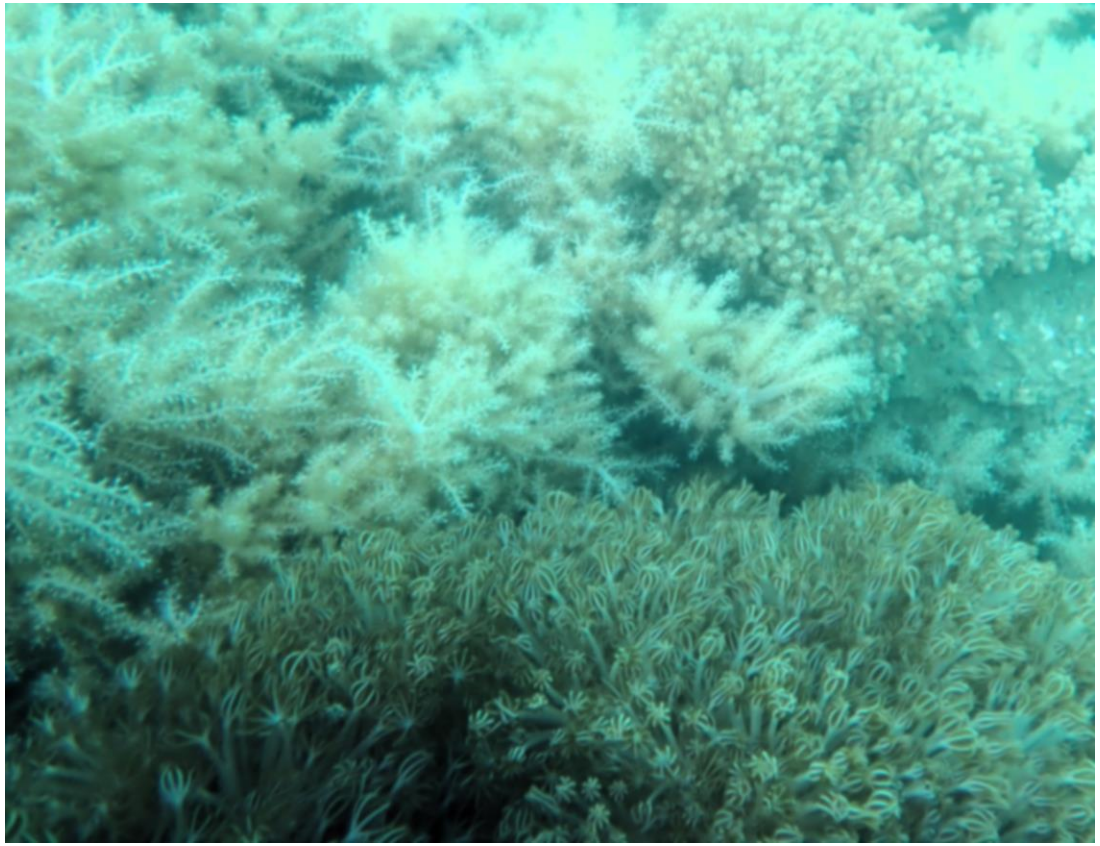
Case study: Stony Coral Tissue Loss Disease—SCTLD…is Hawaii at risk?

- 2014 - 2022 there were **84 arrivals** in Hawaii of vessels coming from a SCTLD-affected area
- At least 9 of these vessels are known to have discharged ballast water in Hawaii, meaning that there were **millions of tons of ballast water discharged**
- Vessels continue to arrive in Hawaii from the SCTLD-affected region
- Hawaii has **yet to adopt protective regulations** for vessels arriving from the affected region.

AGRRA SCTLD dashboard, red are positive for SCTLD, green negative, small red dots are ports. https://www.agrra.org/coral-disease-outbreak/

Pathway: aquarium release and outplanting

- Marine aquarium ownership is increasing globally, the U.S. is the largest consumer
- Release of aquarium pets may occur if owners aren't aware of the possible harm, if they don't have re-homing or amnesty turn-in options, or if they just don't care
- Illegal "outplanting" of aquarium species may also occur so the population may be used to harvest and sell
- In Hawaii, the vast majority of marine aquarium species (and animals in general) are illegal to import and possess, but we are seeing issues



Pulse coral (*Unomia stolonifera)* and Kenyan tree coral (*Capnella cf spicata),* non-native soft corals invading Pearl Harbor, Hawaii. These are two of the six species of popular (but restricted) aquarium species released in Pearl Harbor.

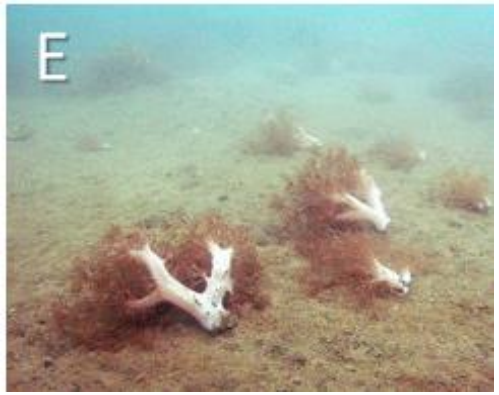
Case study: pulse coral (*Unomia stolonifera*)

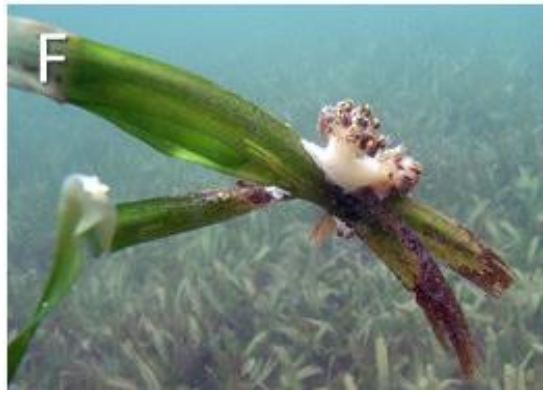
- Despite being illegal to import/possess, pulse coral was found to be present in Pearl Harbor over approx. 80 acres.
- Forms dense colonies overgrowing coral, attached to hard bottom, or in loose rubble, with 50-80% coverage. Smothers coral and reduces fish and invertebrate populations
- Native to the western Indo-Pacific (Indonesia).
- Hobbyists introduced and illegally outplanted in Venezuela; and illegally imported, possessed and released in Hawaii

Pulse coral in Pearl Harbor, the first record of this species in U.S. (and state) waters. Photo: U.S. Navy, The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.

Pulse coral (*Unomia stolonifera*)

- Can multiply and spread via fragmentation, budding, runners, and sexual reproduction (HI assessing sexual reproduction capacity)
- **Fragments drift with seafloor current and can reattach to the bottom** or to other drifting items (example in image F from Venezuela)
- Although not currently believed to be the case in HI, if populations are allowed to spread to areas where they are close to vessel hulls, **they may be able to attach and spread via biofouling**
- We have a goal of **eradication through adaptive management** (e.g. learn as you go)



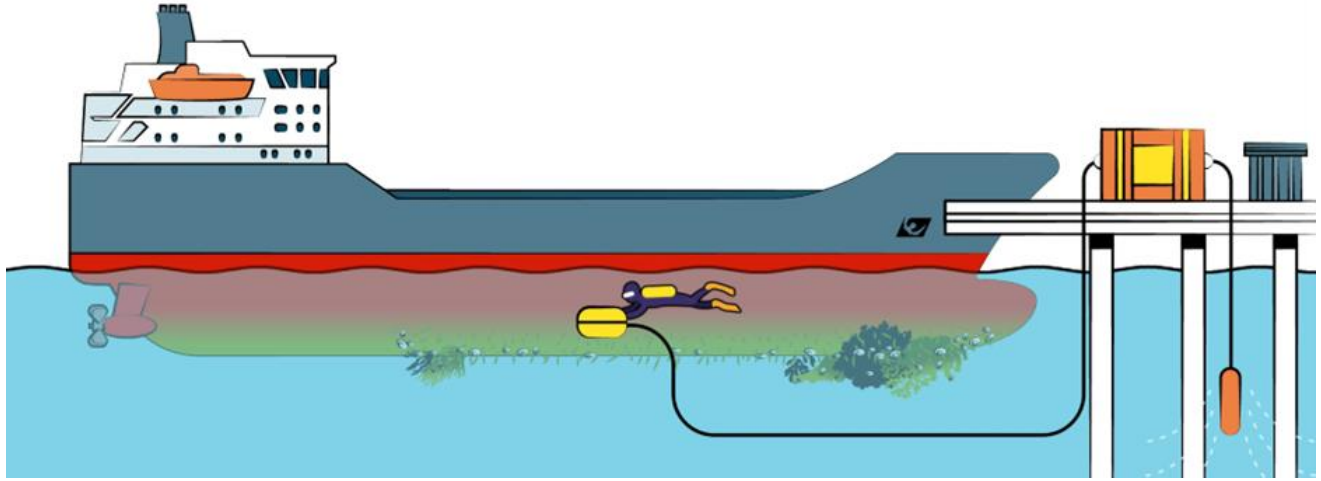


Top: *Unomia stolonifera* (formerly known as *Xenia elongata*) was recently redescribed based partly on the **presence of polyps along the stalk**. Fragments drift (E) and can re-attach (F). Photo D: Reefbuilders; photos E, F: Ruiz-Allais et al 2021

Policy & programmatic opportunities: vessel pathway

- Consider reviewing and enacting local laws related to ballast water and biofouling, including no discharge for all vessels arriving from SCTLD-affected port within the last 5 ports
- In the U.S., there is a new federal law (VIDA) that, when fully enacted will preempt state (and territorial) ballast and biofouling regulations. VIDA Petition/Application opportunity to review any standards of performance, regulation, or policy if there exists new information that could reasonably result in a change to the standard of performance, regulation, or policy
- Need monitoring & control tools

Right: In-water cleaning with capture graphic. https://www.cgaps.org/aquatic-invasive-species/



Policy & programmatic opportunities: marine aquarium release & outplanting pathway

- Review and enact or update local import/possession/sale laws regarding popular marine aquarium species
- NOTE: review and pursue mirroring of local laws in DOD installation regulations.
- Provide opportunities to surrender illegal pets & provide outreach
- Need monitoring & control tools

New Hawaii campaign, "Don't Let it Loose Hawaii" launched October 28, 2024. Logo by Hannah Chang for open use/modification by other jurisdictions upon request to CGAPS.

Mahalo!

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- National Park Service
- U.S. Fish & Wildlife Service

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