What's Lurking in O'ahu, HI Harbors?: Marine Bioinvasions in the 21st Century

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Introduction

Hawaiian marine ecosystems are highly susceptible to invasion by non-native species due to biogeographical isolation, lack of natural predators, extensive harbor and port habitats, and a year-round growing season [3]. It is estimated that over 460 introduced (333) and cryptogenic (130) species are established in Hawai'i's marine waters [2], arriving primarily through ship vectors (biofouling, solid ballast, and ballast water) [2, 3, 5]. Introduced species have the potential to impact biodiversity, ecosystem function, and ecosystem services. Early detection is important in preventing the establishment of non-native species, for once an alien species is established the cost and effort to remove them increases drastically over time (and may be unfeasible for most marine species) [4]. The objectives of this study were to 1) monitor O'ahu harbors' biofouling community, 2) compare results to previous harbor biofouling studies, and 3) determine if new species have established including possible Japanese species arriving on marine debris following the 2011 Japanese tsunami.

Study Sites

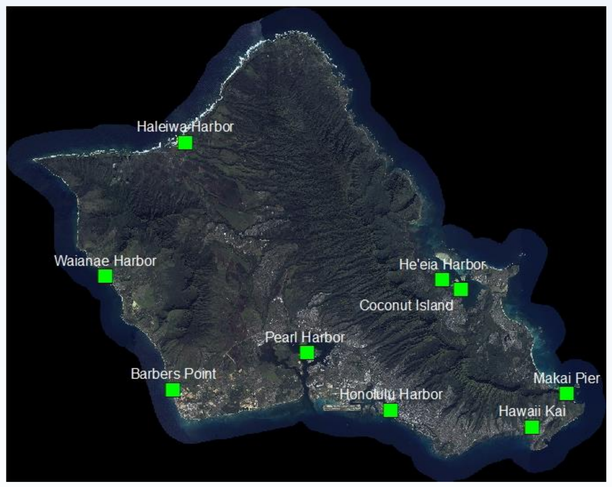

Figure 1: Settlement panel deployment locations

Materials and Methods

(Photo: Left: Settlement panel ready to be deployed, Right: Settlement panel retrieval)

- Ten PVC panels (~13 cm^2) were deployed at eleven sites within nine harbors and piers around Oahu
- Deployment depth: one meter below the mean low water line
- Time frame: three months from September to December 2015
- Salinity and temperature depth profiles were taken during deployment and retrieval for each site
- Panel retrieval: all organisms were sorted into general taxonomic groups
- Specimens were vouchered for taxonomic identification and genetic analysis

(Photo: Top left: Biofouling on a settlement panel, Bottom left: Scraping biofouling off a panel to be sorted, Right: Biologist sorting species by taxon)

Results

- Over 1,000 organisms were collected, resulting in 126 positively identified species
- 53 species (42%) were known introduced species
- 73 species (58%) were:
- 27 native species
- 13 cryptogenic species
- 32 species of unknown biogeographical status in Hawaii (presumably native)
- 1 species establishment unknown (EU: non-natives with unknown continued presence and reproduction [1])

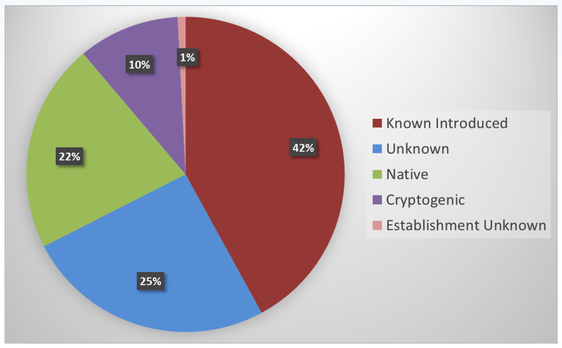

Figure 2: Species composition in O'ahu Harbors

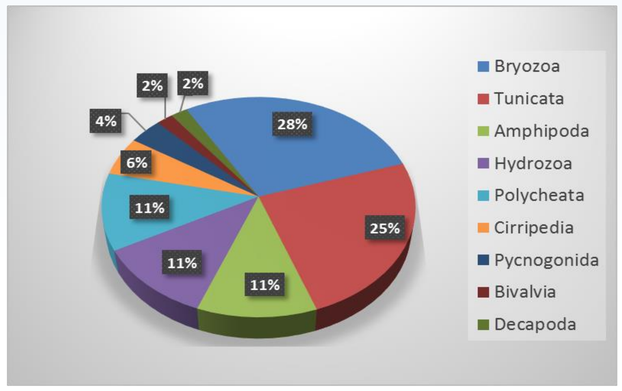

Figure 3: Introduced Species by Taxa

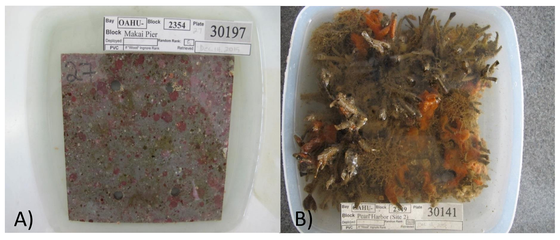

Figure 4: Settlement plates from A) Makai Pier and B) Pearl Harbor: representing the least and most introduced species found, respectively.

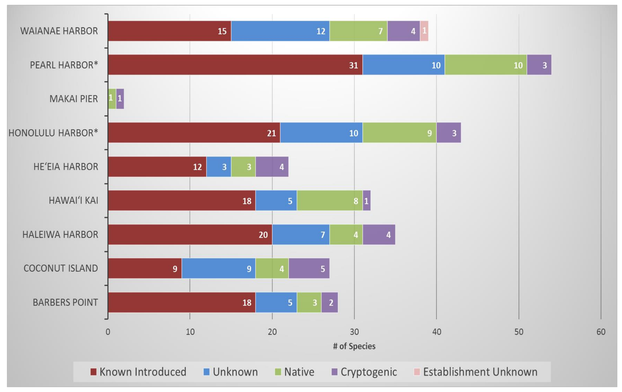

Figure 5: Known Introduced Species per Study Site (*indicates that two sites were sampled at these harbors)

Literature Cited

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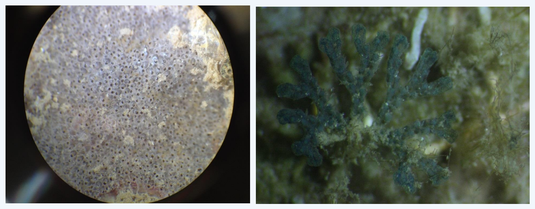
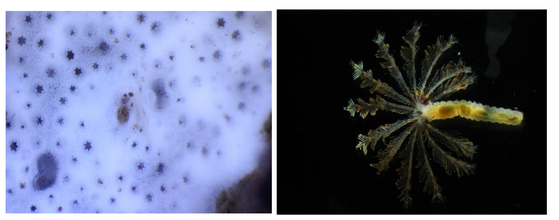
Conclusions



(Photo: Individual species under a microscope: *Cellooraria sp,* (left) and *Viridentual dentata* (right))

- This survey established a baseline for future harbor monitoring and created an up-to-date comprehensive database for marine invasive species on O'ahu
- As expected, commercial and military ports had more introduced fouling organisms than small piers and boat harbors
- One new non-native species was found in this study which had not been previously recorded from Hawai'i, the amphipod *Autonoe seurati*, probably introduced by ships from the Indo-West Pacific
- The North American bryozoan *Celleporaria brunnea* was found in Haleiwa Harbor and Honolulu Harbor in this study
- It was previously documented in 1999 on a barge being towed from California to Hawai'i but was not considered to be established [1]. It was then found in fouling communities during the 2006 SERC Hawai'i surveys
- No new Japanese biofouling species were detected in the surveys

- **Next Steps**:
- Analyze the Next Generation Sequencing data (DNA analysis technique) and cross reference with taxonomic species lists
- Continue building a barcode database of Hawai'i's biofouling species
- Develop a risk assessment model to identify potential threats to Hawaiian nearshore habitats
- Assess changes in community composition over time, as well as movement of established introduced species into other harbors or neighboring islands, and connectivity to foreign ports



(Photo: Individual species under a microscope: an unidentified tunicate (left) and an annelid of the suborder Sabellida (right))