



An Analysis of Ulvoid Blooms in New Haven Harbor

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Abstract

Ulvoid blooms are harmful algal blooms found worldwide, including a recurring bloom in New Haven Harbor. This study examines the species identification and distribution of samples from the genus *Ulva* in New Haven Harbor. The chloroplast encoded *rbcl* gene and nuclear internal transcribed spacer region were sequenced. From the current data, six different species were found throughout the harbor. Morphological characteristics of the identified species confirmed the difficulty and inaccuracy of identifying species without the use of molecular methods.

Introduction

Background: Green tides are algal blooms of varying species, primarily in the genus *Ulva* (Yi et al. 2011), of which there are 127 currently accepted different species. Blooms can be harmful due to the release of sulfide, which poisons other fauna (Yi et al. 2011) and are thought to be caused by eutrophication (Nelson et al. 2003b). Different species of *Ulva* are difficult to identify based on their morphology alone due to their simple characteristics and plasticity (Loughnane et al. 2008). *Ulva* comes in two general forms, tubular and blade. Recent studies have used molecular methods to examine species identification (O'Kelly et al. 2010).

Objectives:

- To determine species composition of Ulvoid blooms found in New Haven Harbor
- To examine distribution patterns of the species throughout the harbor to test the hypothesis that there is one clonal species within the recurring bloom

Methods

Collect Samples around New Haven Harbor (Fig. 1 and 2)

Press in herbarium for morphology Preserve in freezer and silica for DNA extraction

Extract DNA and isolate regions

Run PCR on *rbcl* gene Run PCR on Internal Transcribed Spacer region

Analysis

Sequencing done at Yale Sequencing Facility Phylogenetic tree for species identification



Fig. 1 *Ulva* spp. attached to rock



Fig. 2 Ulvoid bloom containing *Ulva* spp.

Results

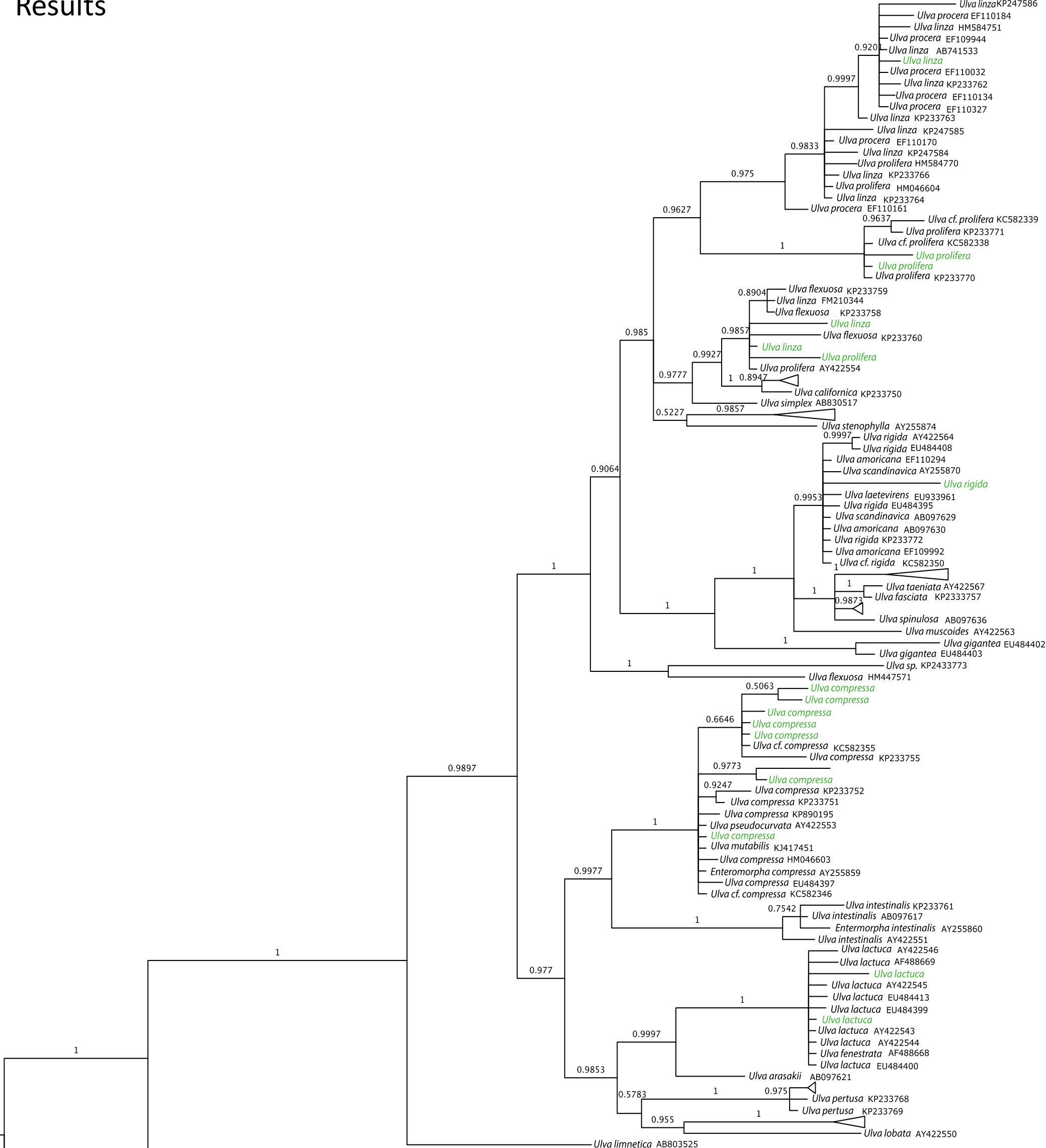


Fig. 3 Phylogenetic tree of *rbcl* data from Bayesian analysis. Numbers above branches indicate posterior probabilities. Samples from this study are highlighted in green

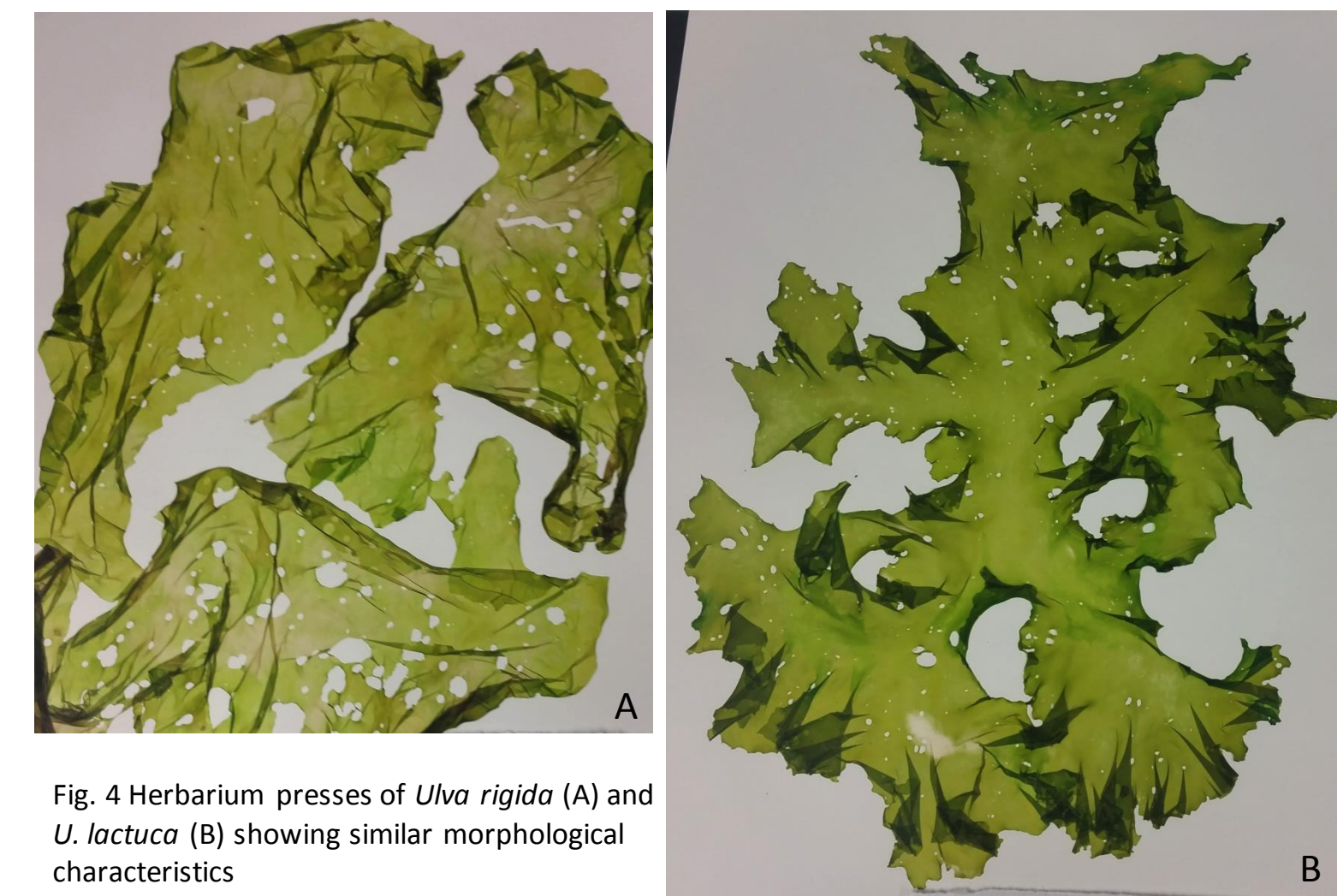


Fig. 4 Herbarium presses of *Ulva rigida* (A) and *Ulva lactuca* (B) showing similar morphological characteristics



Fig. 5 Herbarium presses of *U. compressa* as large blades (A), as small blades (B) and in tubular form (C), showing morphological variation across one species

- Six species currently identified in the harbor: *U. compressa*, *U. lactuca*, *U. rigida*, *U. linza*, *U. torta*, and *U. prolifera* through phylogenetic inference (Fig. 3)
- Morphological characteristics were similar across species (Fig. 4)
- U. compressa* has both tubular and blade morphologies (Fig. 5)
- U. compressa* and *U. prolifera* were most widely distributed throughout the harbor (Fig. 6)

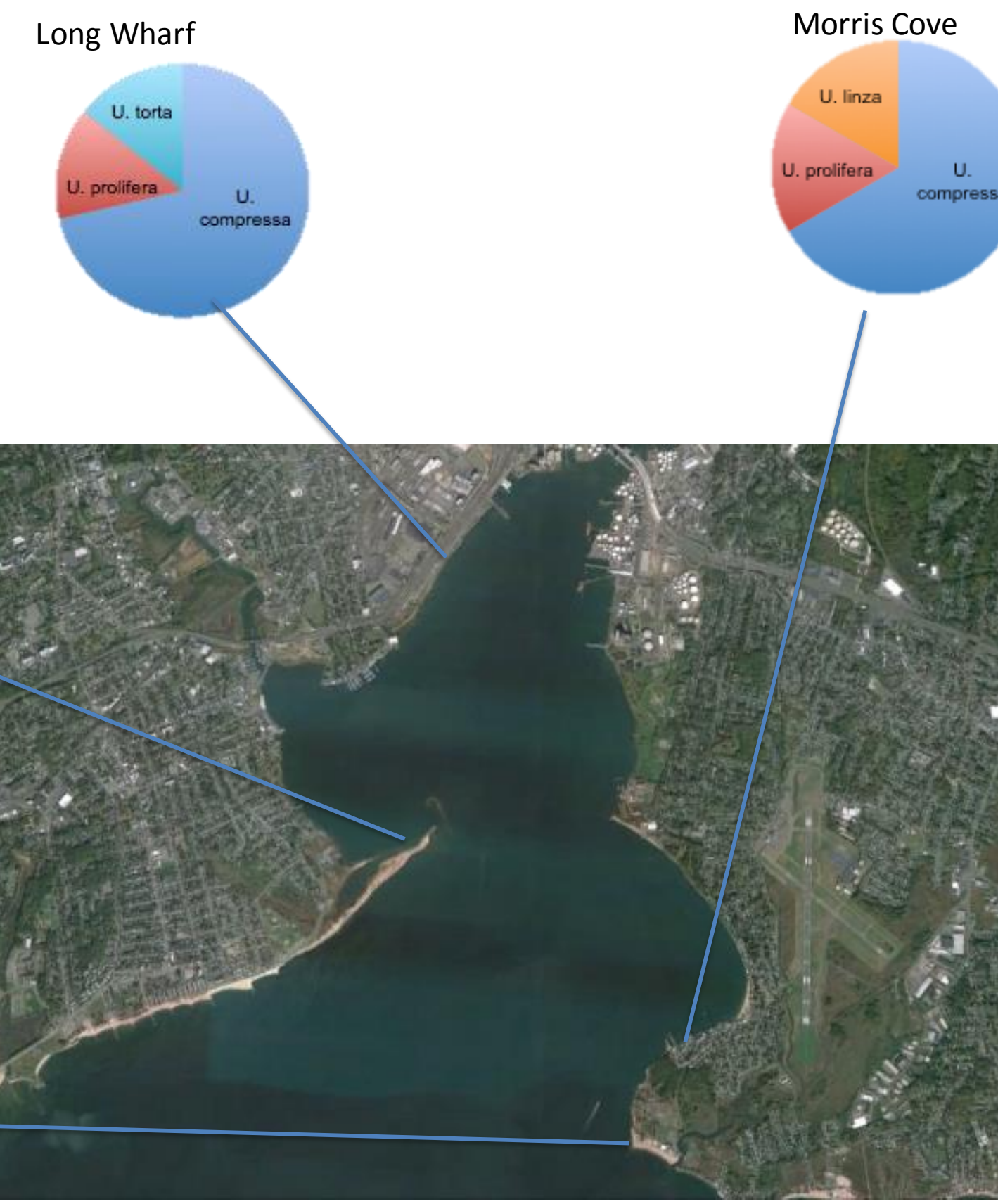


Fig. 6 Sampling locations with corresponding pie charts indicating relative species abundance found at each site

Discussion

- This is the first study to use molecular methods to determine species composition of Ulvoid blooms in the New Haven Harbor
- There is not one clonal species spanning across the bloom; six species were identified with multiple species at each site, contrary to most algal blooms (Hallegraeff G, 2010).
- Morphological characteristics of *Ulva* are not sufficient for species identification and may be misleading. *U. lactuca*, *U. rigida*, and *U. compressa* all display features of having a large blade with angular edges. *U. lactuca* and *U. rigida* both display fenestrations throughout the blade.
- Some species of *Ulva* may be present in both tubular and blade morphologies. *U. compressa* displayed both morphologies.
- Distribution of *U. compressa* and *U. prolifera* span across all sampling locations in the harbor, and *U. compressa* was most abundant at sampling locations. *U. compressa* was also most abundant at bloom sites in a similar study done in Rhode Island (Guidon et al. 2013), where *U. rigida* and *U. lactuca* were also present; this was the only diversity found in Rhode Island. Both this and the present study show diversity that contrasts the assumption that algal blooms are made up of one clonal species.
- There is diversity present within the Ulvoid bloom across New Haven Harbor

Next Steps

In collaboration with Nathan Lanning

- Identify species from biomass quadrat samples; determine if these match up with species currently identified
- Identify species correlated with copper content; determine if there is one species that contains a higher copper content as compared to other species

References

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