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Before and After Sea Star Wasting Disease: Subtidal Sunflower Star (Pycnopodia helianthoides) observations in the central US Strait of Juan de Fuca

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Introduction

From the rocky intertidal to subtidal plains, sea stars are important marine invertebrates that can profoundly affect the ecosystems they inhabit. Beginning in 2013, a sea star wasting disease (SSWD) epidemic led to the largest sea star die-off event seen on the Northeastern Pacific coast (1). Among the species of sea stars affected was the sunflower star (*Pycnopodia helianthoides*). Before SSWD, sunflower stars were the most abundant subtidal sea star species. Since the epidemic, studies have reported massive declines in sunflower star populations and even local extinctions (2). Currently, the sunflower star is under review for listing under the ESA and was placed on the ICUN Red List of Threatened Species in December 2020. Assessing the effects of SSWD on sea star populations requires having data before and after the onset of SSWD, therefore long-term monitoring surveys are the best sources to analyze the historical context needed to track the status of sunflower stars.

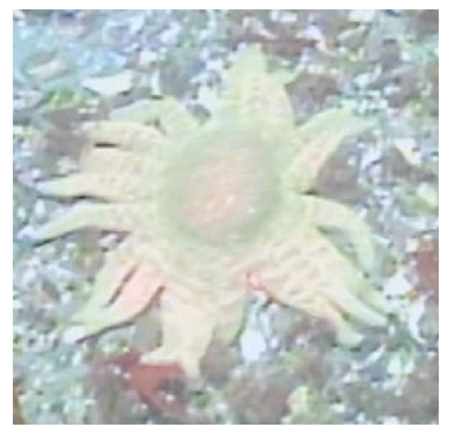
Methods

Figure 1: Map of study area in the central US Strait of Juan de Fuca

We assessed sunflower star abundance using towed underwater videography along 50 km of the central U.S. Strait of Juan de Fuca, located in NW Washington State (figure 1). Annual surveys were completed between 2010 and 2017 and again in 2020, allowing us to compare between pre- and post-epidemic years. The study repeated transects along ~40 km of seafloor, from the shallow subtidal to -15 m (Mean Lower Low Water). During video review, each second of video (corresponding to 1 m nominal width) was classified for the presence of sunflower stars (figure 2). Video surveys offer a lower resolution than other survey types, therefore absence of stars could not be confirmed. Inconspicuous sea stars were likely missed in the classification of video, including juvenile stars, individuals under 10 cm in diameter, and stars obstructed by rocks and vegetation.

Figure 2: Screenshots from videography showing sunflower stars

Results



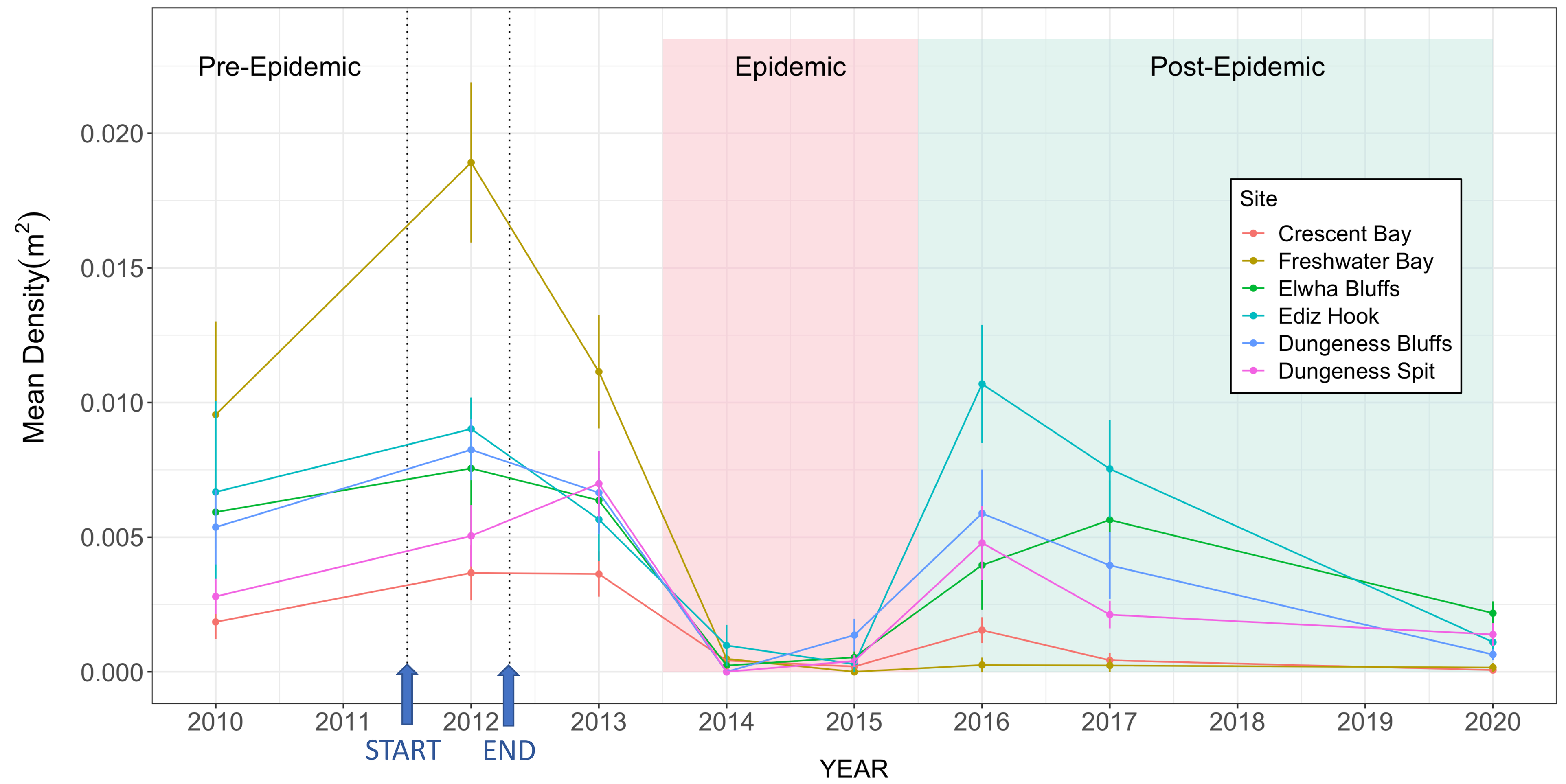


Figure 3. Site mean density (m²) with standard error bars, per year. Blue arrows on x-axis indicate start and end of the Elwha dam removal.

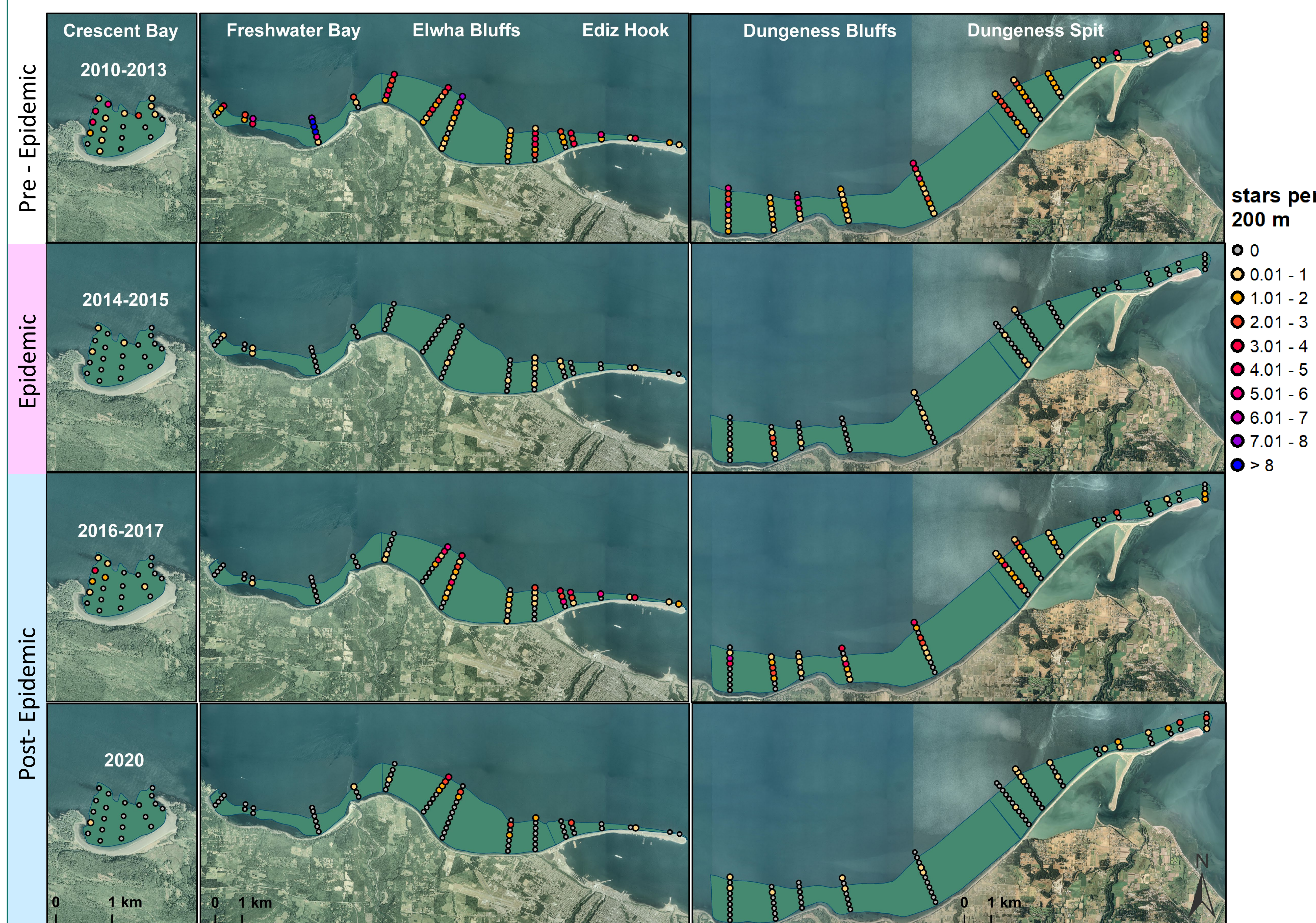


Figure 4. Map of sunflower star abundance per 200 m section of transect.

Results and Discussion

Pre-Epidemic: Sunflower stars were common and widespread, appearing in every site and across depths (figure 4). Densities were similar among sites and years, with the exception of Freshwater Bay, which showed a higher density in 2012 than 2010 and 2013 (figure 3).

Epidemic: A drastic decline in densities occurred in 2014 and 2015. Individuals were observed across all sites at low abundance and variable depths.

Post-Epidemic: 2016 and 2017 surveys showed the start of a rebound back toward pre-epidemic years in the four easternmost sites. Within those sites, sunflower stars were once again observed across most depths, with fewer observations on the shallow end of transects (figure 4).

In 2020, the most recent surveys showed extremely low densities, similar to the epidemic period. A single individual was observed at the Crescent Bay and Freshwater Bay sites. In the other four sites, the remaining individuals occurred more frequently at the deeper end of transects.

Regional Comparisons: Timing of the onset of SSWD varied among regions (3). We observed a massive decline in sunflower star abundance after the first observation of wasting occurred in June 2013, in Washington state, similar to observations along the California coast. In contrast to many other locations, sunflower abundance in this site experienced an unprecedented rebound from 2016-2017, followed by a return to low, epidemic-level densities in 2020. The 2020 decline could reflect additional mortality caused by persistent SSWD or other factors.

Ecological Significance: Like many sea stars, sunflower stars are important predators within nearshore ecosystems. Their top-down predatory control over sea urchin populations is especially crucial in macroalgal habitats where sea otters and other urchin predators are absent (4,5,6). The effects of sunflower star population declines due to the sea star wasting epidemic have been observed in other locations where sunflower stars have become locally extinct or have experienced little recovery (2,5). Sunflower stars remain in this area, but the variability in abundance in the post-epidemic surveys warrant the continuation of surveys. The substantial shift in abundance that we observed raises important questions like how this change in a keystone species has cascaded through the nearshore community and if there are any signs of pre-epidemic level recovery.

References

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