Environmental Stressors Shift Microbial Influence on Sea Star Wasting Disease

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Introduction

- Asteroids (sea stars) are important keystone predators.
- Many species across the Northeast Pacific have died off due to sea star wasting disease (SSWD) since 2013.
- *P. helianthoides* faced a >90% decline in population between 2017-2020.
- Population loss have contributed to the disruption of entire intertidal communities.
- Viral etiology was previously considered, though was found inconsistent.
- Microbial and environmental evaluation reveals an interplay between drastic water temperature changes and microbial composition shifts

The Progression of SSWD

Figure 1. Progression of SSWD in *P. helianthoides* (Sunflower Sea star). (Hakai Institute, 2025)

Regional Population Declines of *P. helianthoides*

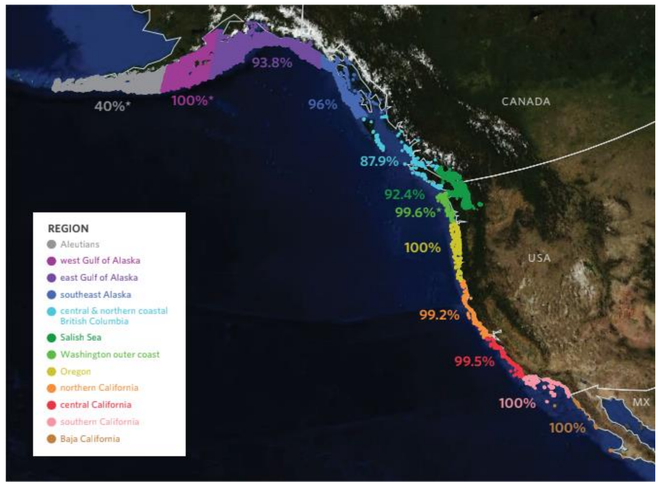

Figure 2. Estimated percent declines in *P. helianthoides* population from 2013-2017. (Heady et al, 2023)

Methods

A literature review was conducted to assess whether environmental stressors and microbial composition shifts create conditions associated with SSWD.

Studies focused on environmental monitoring, microbiological evaluation, and bioinformatics.

38 sources were collected and reviewed to synthesize results., which included analyzing firsthand collected data (primary) and evaluating findings from published literature (secondary)

Results

Temperature and Dissolved Oxygen Availability Affect Lesion Formation

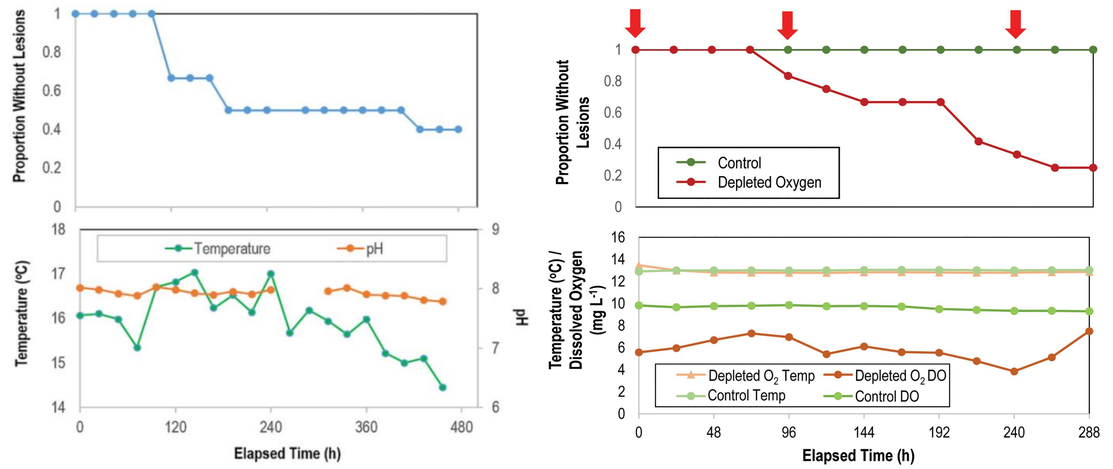

Figure 3. Effects of temperature and dissolved oxygen (DO) availability on lesion formation in sea stars. (Left) Proportions of sea stars without lesions decreased when experiencing drastic temperature fluctuations over a 20 day experiment. (Right) DO deficiency under heightened temperatures increase the proportion of lesions amongst sea stars. (Aquino et al. 2021).

Ocean Warming is Linked to the Nearshore Abundance Collapse of *P. helianthoides*

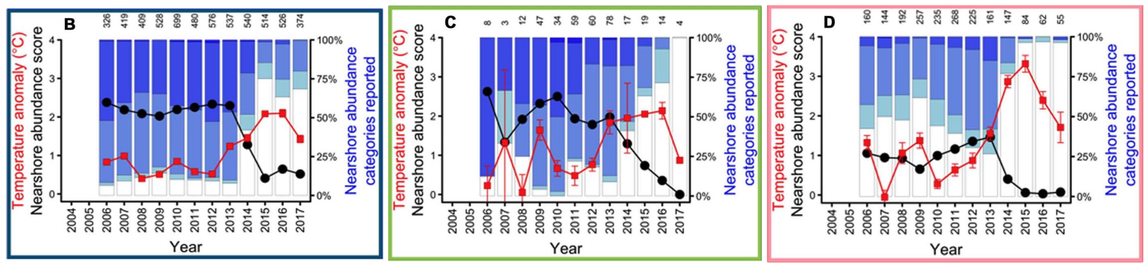

Figure 4. Regional temperature anomalies (red) are associated with declines in nearshore biomass of *P. helianthoides* (black) across Washington (B), Oregon (C), and California (D). Annual proportions of nearshore biomass are represented as categorical abundance scores (blue bars). Across all regions, ocean temperature increased sharply after 2012, coinciding with simultaneous population declines of *P. helianthoides* along nearshore areas. Annual surveying was done between 2004-2017. (Harvell et al. 2019).

Microbial Composition Shifts and *V. pectenicida* Proliferation During SSWD Onset

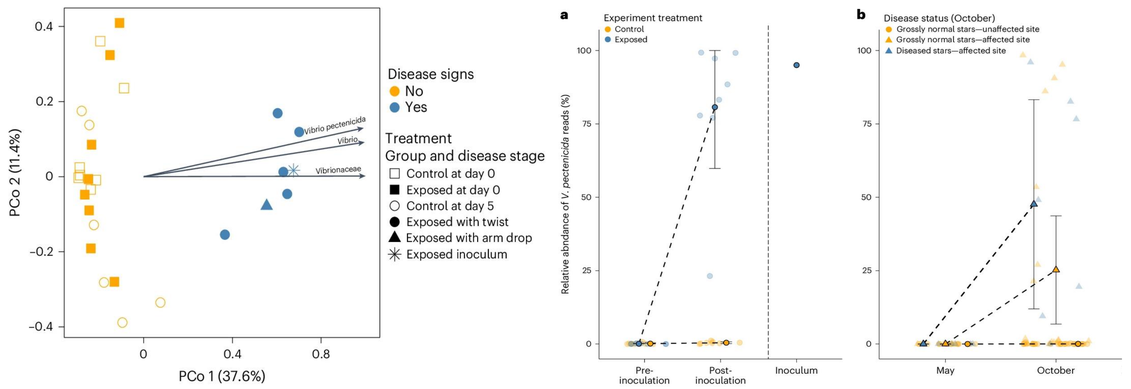

Figure 5. (Left) Principal Coordinate Analysis (PCoA) plot shows microbial composition differences between healthy and diseased sea stars, with vectors showing strong associations of *V. pectenicida* and other *Vibrionaceae* taxa amongst diseased sea stars. (Right) Relative abundance of *V. pectenicida* from coelomic fluid analysis in controlled exposures (a) and during a field SSWD outbreak (b). Diseased stars exhibit higher proliferation of *V. pectenicida*, though grossly normal sites in affected areas shows elevated levels of exposure. No *V. pectenicida* was detected during sample collections in May, when no outbreaks were present. (Prentice et al. 2025).

Conclusion

- Abrupt and significant temperature shifts may destabilize host microbiota and physiology.
- Elevated temperatures provide optimal conditions for heterotrophic bacterial proliferation along the animal-water interface.
- Warming reduce oxygen solubility in water, impairing crucial physiological and immunological processes in sea stars.
- *Vibrio* bacteria are recognized as a barometer for climate change, as shifting conditions favor their growth
- Together, these stressors intensify the pathogenic potential of *V. pectenicida*, contributing to the susceptibility to SSWD.

Thermal Mismatch Between Host and Pathogen

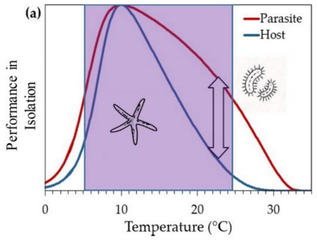

Figure 6. Conceptual illustration of the Thermal Mismatch Hypothesis (TMH), visualizing how warming conditions may provide performance advantages for cold-adapted pathogens. Under heightened temperature conditions, cold-adapted pathogens (e.g. *V. pectenicida*) can outperform their hosts (e.g. sea stars), which may intensify disease susceptibility. (Figure adapted from Rohr et al. 2020).

Future Directions

- Environmental monitoring for upwelling events and temperature shifts
- Identify mechanism(s) behind *V. pectenicida* infection
- Assessing susceptibility amongst other Echinoderms
- Identifying potential resistance traits against SSWD
- Develop treatment plans and recovery goals

Captive Rearing Efforts for *P. helianthoides*

Figure 7. Captive rearing efforts for *P. helianthoides* recovery at UW Friday Harbor Laboratories, led by Jason Hodin. (Heady et al. 2023).

References