# Climate, heatwaves, nearshore ecosystems and the sunflower sea star



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Figure 1

## Sarah Traiger, Biologist at the U.S. Geological Survey, in this wide-ranging analysis, examines climate, heatwaves, nearshore ecosystems, and the plight of the sunflower sea star

The sunflower sea star is a wide-ranging and important species in the nearshore ecosystem.

At the nexus of the ocean and the land lies the nearshore ecosystem, which includes the intertidal, an area exposed during low tides and submerged during high tides. Intertidal species in the intertidal are adapted to extreme environmental variability of temperatures, waves, and salinity. Species' tolerance to desiccation determines the elevation within the intertidal they occupy.

Biological interactions also determine the presence and abundance of species. Predators like sea stars and competition for space can influence the numbers of barnacles and mussels.

As ocean and air temperatures continue to rise with climate change and marine heatwaves become more common (Frolicher et al. 2018), intertidal species are being impacted as they may have limited vertical space to move in response to sea level rise, and many species are already living at the edge of their physiological tolerances for high temperatures.

The sunflower sea star (*Pycnopodia helianthoides*) is one of the largest sea stars in the world, with an arm span of up to 1 m. Although sunflower sea stars can live as deep as 435 m, they are most common in water less than 25 m deep. They are found in kelp forests, sandy and rocky habitats, and eelgrass meadows along the west coast of North America.

Sunflower sea stars are opportunistic and flexible predators that consume what is most available, including sea urchins, mussels, clams, and dead animals. Because of their size, broad range of habitats, and historically high abundance, they can strongly affect nearshore ecosystems (Burt et al., 2018).

However, like many other marine organisms, they are affected by long- term changes in their physical environment associated with climate change and episodic events such as marine heatwaves and disease.

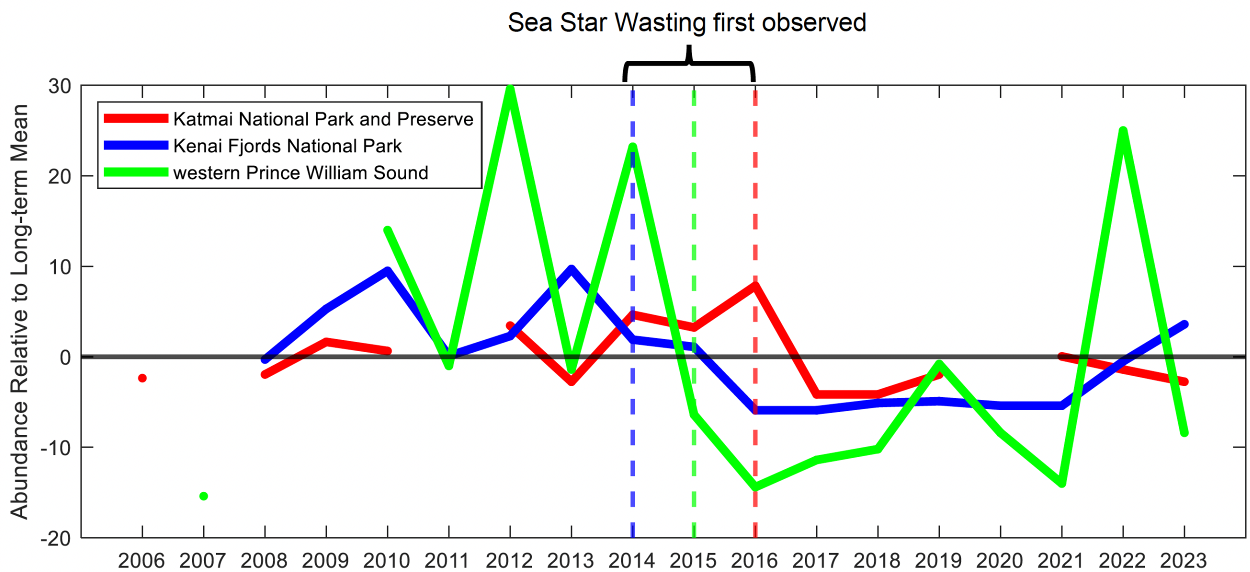


Figure 2

## Abundance of sunflower sea stars reduced

Sea star numbers declined markedly along the Pacific coast of North America over the last decade. The primary driver of the decline appears to be the sea star wasting epidemic, which started in 2013 in California and Oregon and spread along the coast, reaching parts of Alaska in 2014 (Konar et al. 2019).

Sea stars with wasting syndrome develop lesions, their arms twist and detach, and their bodies disintegrate. The cause or causes of the outbreak are still unknown but may be related to environmental stressors such as increased ocean temperature, freshwater input, and changes in the microbial community.

At least 20 sea star species were affected during the 2013-2017 outbreak (Hewson et al. 2014), and many species have not recovered in some areas, although disease observations are now less common. The most severely affected species was the sunflower sea star, which declined by 67-94% in the Gulf of Alaska and disappeared almost entirely from much of its southern range.

The National Marine Fisheries Service determined that the species meets the definition of threatened under the Endangered Species Act, and on March 16, 2023, published a proposed rule to list the species as such. The outbreak in Alaska coincided with the Pacific Marine Heatwave, which had significant effects on Gulf of Alaska biological communities (Suryan et al. 2021).

## Sunflower sea stars and other organisms

Monitoring sunflower sea stars and other organisms in the intertidal gives us a perspective on their population dynamics and community shifts.

Although sunflower sea stars are more common, and individuals are larger in the subtidal, small individuals are also found in the intertidal (Fig. 1). As part of Gulf Watch Alaska nearshore monitoring, we conduct intertidal surveys at numerous sites across the northern Gulf of Alaska.

Surveys provide insights into changes to nearshore ecosystems in light of unanticipated perturbations such as sea star wasting and the Pacific Marine Heatwave. Cause and effect are rarely obvious as biological communities, and their interactions with their environment are extremely complex. However, our study design and broad spatial and temporal coverage allow us to disentangle the likely drivers of observed changes (Coletti et al. 2016).

Before the epidemic, sunflower sea stars were most common at the Gulf Watch study sites in western Prince William Sound (Fig. 2). Sunflower sea stars declined sharply in several regions across the Gulf of Alaska after the start of the epidemic.

Although high abundances have been observed in western Prince William Sound post-epidemic, sunflower sea stars do not appear to have fully recovered from the significant declines, and abundance remains below the long-term mean at most sites (U.S. Geological Survey & National Park Service 2022).

The decline in sea stars, in combination with the heatwave, appeared to benefit mussels (Traiger et al., 2022). Mussels are key prey for several sea star species in Alaska, including the sunflower sea star. With the release of predation pressure due to declines in sea stars and the newly available bare space with declines in rockweed and other seaweeds due to the heatwave (Weitzman et al. 2021), mussels increased in many locations in the Gulf of Alaska (Fig. 3).

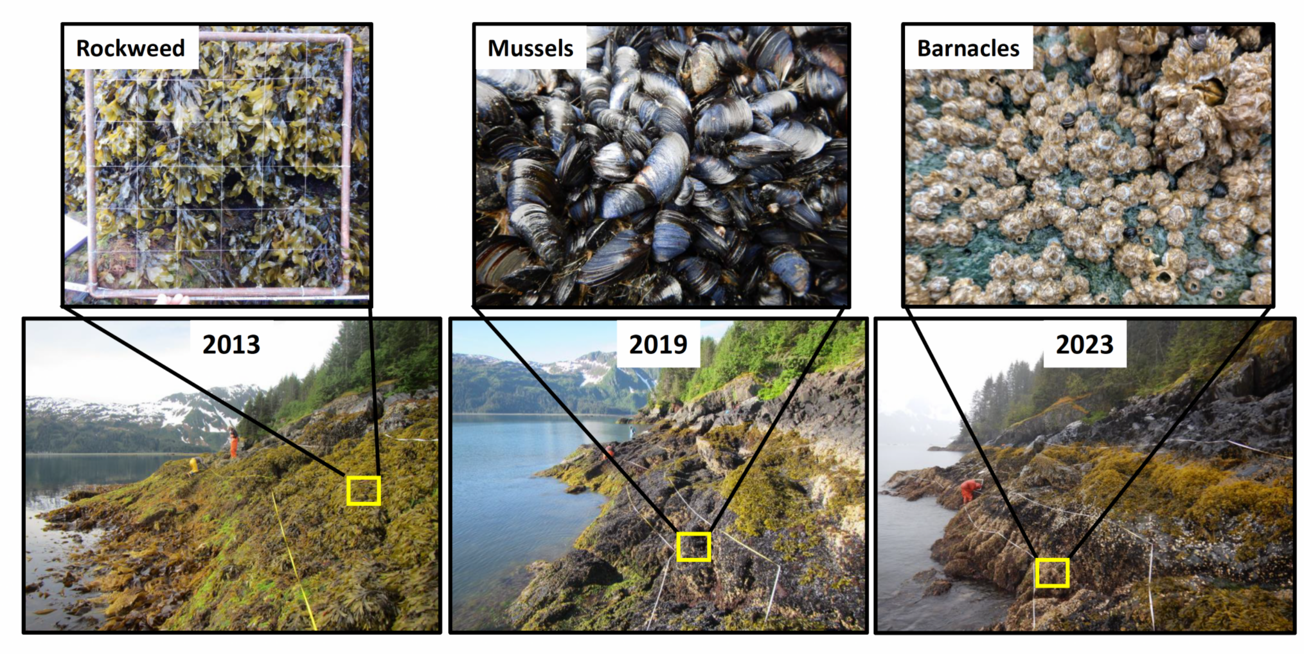


Figure 3

Continued monitoring enables us to track the potential recovery of sunflower sea stars and the responses of species like mussels and determine how these changes affect species higher on the food chain.

### References

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