OCEANWATCH

SPOTLIGHT Marine Biodiversity Loss: Epidemic Wipes Out Majority of Sunflower Sea Stars

Shutterstock, Greg Amptman | *A sunflower sea star sitting on a cold water coral formations.*

ocean wise®

AUTHORS Amber Dearden, Aroha Miller **REVIEWERS** Jessica Schultz, Fiona Francis

PUBLISHED August 2021

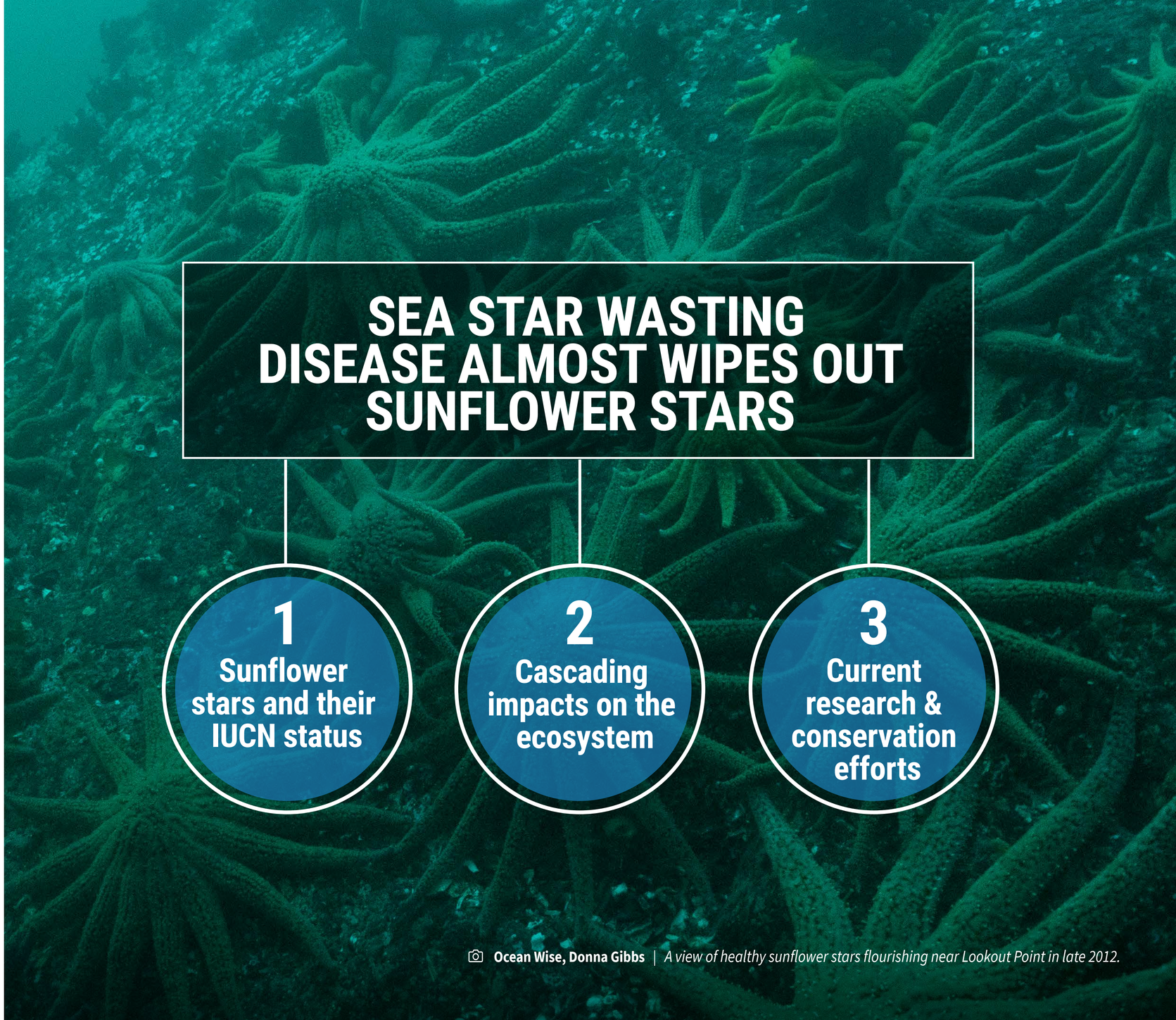
Overview

In 2013, Sea Star Wasting Disease (SSWD) swept the coast of the Pacific Northwest, devastating sea star populations along the entire region from Alaska to Mexico. SSWD is the largest marine wildlife mortality event on record and it impacted over 20 sea star species.[1] These impacts have trickled down through the food web, affecting entire ecosystems, and influencing biodiversity along the coast.

The sunflower sea star (*Pycnopodia helianthoides*) was one particularly hard hit species with huge losses of between 99-100% in some populations.[2,3] As a result, through a huge international assessment effort, sunflower stars are now listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN).[4]

Although SSWD has been intensively studied in the past decade, there are many research gaps, and the disease continues to impact many sea star populations. Climate change and other threats also play a role in the recovery of sea stars, making it difficult for them to rebound or even survive in some areas. For example, in some areas in their southern range, sunflower stars have completely disappeared and might not ever return.[4]

This spotlight report will look at SSWD and its impacts on sunflower stars, including data contributed to IUCN by Ocean Wise researchers, links between climate change and sunflower star recovery, as well as current conservation efforts for the species. A list of things you can do to reduce your impact on the marine environment and encourage recovery of sunflower stars is located at the end of this report.



Ocean Wise, Donna Gibbs | *A view of healthy sunflower stars flourishing near Lookout Point in late 2012.*

Marine Diseases

Globally, marine biodiversity is decreasing at an unprecedented rate. Biodiversity loss has far-reaching implications and can lead to trophic cascades and ecosystems shifts; loss of ecosystem services; negative impacts on food provisioning, livelihoods, and economies; and direct impacts on human health.[5] Marine biodiversity loss can be caused by numerous stressors include climate change, overfishing, habitat destruction, and pollution. However, a major, often overlooked cause is marine disease. Marine diseases have impacted species around the world from coral reefs[6] to North American urchin populations,[7] and many marine diseases are exacerbated by other stressors such as climate change.[2] With so many co-occurring threats, the addition of disease can magnify the effects on a species.

Beginning in 2013, Sea Star Wasting Disease (SSWD) began to devastate the populations of at least 20 species of sea stars,[4] causing large populations of these animals to vanish in a matter of weeks. SSWD is characterised by white lesions and tissue decay, causing sea stars to melt away, sometimes in just a few days. The exact cause is still unknown, but there are likely multiple factors at play and outbreaks of the diseased are still occurring to this day. SSWD had particularly catastrophic effects on sunflower stars, killing 99-100% of some populations.[2]

Sunflower Stars

Sunflower stars live up to 37 years, grow up to 1 m across and have as many as 24 arms by the time they reach maturity.[4,8] They are one of the largest and fastest moving sea stars in the world, travelling up to 1 m per minute.[8] Sunflower stars are most commonly found at a depth of 25 m, but can be found at depths up to 455 m.[4] They are often seen along rocky intertidal[i] habitats at low tide, and their range spans from Alaska, United States, down to Baja California, Mexico.

Sunflower stars were once a common sight in the subtidal waters of the Pacific Northwest[ii]. SSWD wiped out most of the global population of sunflower stars – approximately 5.75 billion individuals – along more than 3000 km of coastline.[4] It is not yet clear whether recovery of this species is possible or if sunflower stars will once again become a common sight in these waters.

[i] Intertidal – the area between the low and high tide margins.
[ii] Pacific Northwest - the region of western North America, including western Canada, bounded by the Pacific Ocean.

Ocean Wise, Donna Gibbs | *A healthy sunflower star.*

Spotlight 1

Sunflower Stars and IUCN Listing

In 2013, multiple outbreaks of SSWD were observed by researchers across the Pacific Northwest. For the IUCN report, researchers collated and gathered thirty-one datasets from 60 institutions spanning the entire Pacific Northwest coastline, including contributions from four countries, and five First Nations. With support from Python Systems Corp. and long-running citizen science surveys, Ocean Wise scientists contributed the longest temporal dataset, with over 50 years of data on sunflower stars collected along the B.C. coast[iii]. In Atl'ka7tsem/Howe Sound specifically, Ocean Wise researchers compared sea star abundance at 20 sites before and after the 2013 outbreak to document the population-level impacts of SSWS in B.C. waters.[3] Sunflower star abundance between the two periods declined an average of 89% across all analysed study sites. This research also contributed to knowledge about sunflower star declines to inform the IUCN[iv] assessment.

Since SSWD was first observed, the global sunflower star population has declined by more than 90% and is still declining in some regions.[9] This highly significant decline alone qualified it as Critically Endangered under the IUCN criteria (Table 1).

The IUCN's Red List for Threatened Species was established in 1964 and has since become the global authority in establishing the extinction risk of species. There are seven main designations with varying risk of extinction (Table 1). By listing a species on the Red List, it helps to inform conservation and policy decisions to protect the species most at risk.

Table 1. The 2001 IUCN Red List categories and criteria. Sunflower stars are Critically Endangered, just one step behind being listed as Extinct in the Wild.

LISTING	RATIONAL
Extinct	All individuals from the taxon are known to be dead. There are no surviving individuals.
Extinct in the Wild	The only remaining individuals from the taxon are in captivity, cultivation or as a naturalized population.
Critically Endangered	The taxon faces an extremely high risk of extinction in the wild.
Endangered	The taxon faces a very high risk of extinction in the wild.
Vulnerable	The taxon faces a high risk of extinction in the wild.
Near Threatened	The taxon is close to qualifying for oris likely to qualify for a threatened category in the near future.
Least Concerned	The taxa are widespread and abundant.
Data Deficient	There is insufficient data to be able to assign a category.
Not Evaluated	The taxon has not yet been evaluated against the criteria.

Ocean Wise, Donna Gibbs | *The tubefeet of a sunflower star.*

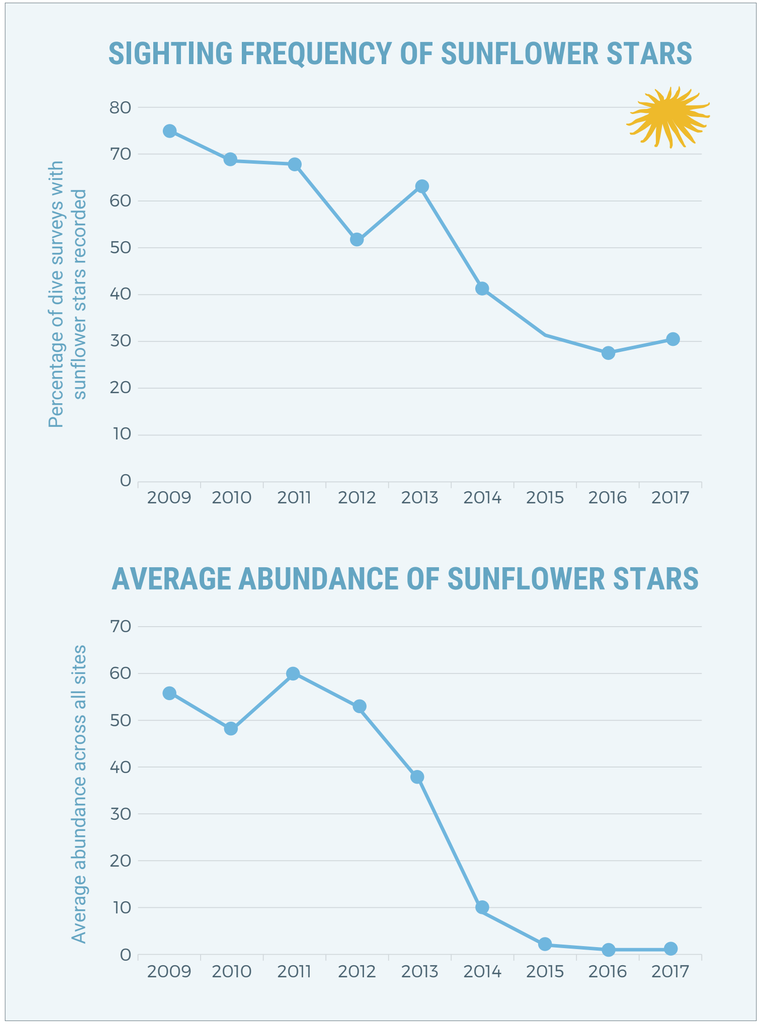


Figure 1. The change in sighting frequency of sunflower stars between 2009-2017 (top panel) and average abundance of sunflower stars (bottom panel). SSWD was first observed in 2013. Data taken from the Pacific Marine Life Surveys Database of opportunistic SCUBA-based observations (adapted from Ocean Watch BC Coast 2018 Report).

[iii] Credit must be given to Donna and Charlie Gibbs for the careful curation of this extraordinarily long data set and generous donation of their time and knowledge in doing this work.
[iv] IUCN - IUCN Red List of Threatened Species

Spotlight 2

Cascading Impacts of SSWD

As with all of Earth's natural systems, the relationships between species and habitats are complex and interconnected. As a result, it is no surprise that SSWD has had far reaching impacts on species other than just sea stars.

Sea stars are voracious predators and often play a role in keeping the numbers of invertebrate species that they eat under control. They are mostly carnivorous,[v] eating a wide range of prey including sea urchins, fish, bivalves, crustaceans, and gastropods. In fact, for sunflower stars, sea urchins make up anywhere from about 20–98% of their diet.[10]

The decline of sunflower stars has coincided with vast increases in some of these prey species, such as green sea urchins (*Strongylocentrotus droeba*chiensis). In some areas of B.C., medium sized urchins increased in abundance more than three-fold when sunflower stars declined.[10] Locally, in Howe Sound, green sea urchins increased almost four-fold following the mortality of sunflower stars (Figure 2).

Sea urchins feed on kelp, and in areas when urchins populations explode, such as areas where sunflower sea stars have disappeared, they graze away the kelp completely, leaving behind a vast rocky wasteland. This result is called urchin barrens.[6]

Kelp forests are important breeding grounds and nurseries for many fish and invertebrate species, such as rockfish, herring, crabs and prawns, as well as sea otters. They also have a promising role in countering the impacts of climate change. They are able to sequester carbon, and act as an ocean acidification buffer.

With this important habitat vanishing due to numerous different stressors, we are seeing decreases in biodiversity and changes to community structure throughout the surrounding ecosystem. With SSWD causing devastating losses in sunflower star numbers that can result in the explosion of green sea urchin populations, protecting and restoring sunflower stars is crucial in helping to conserve kelp habitat.

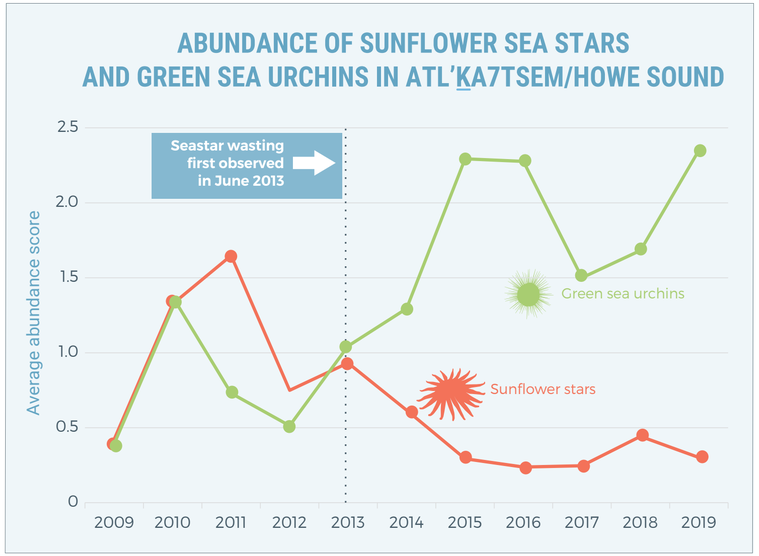
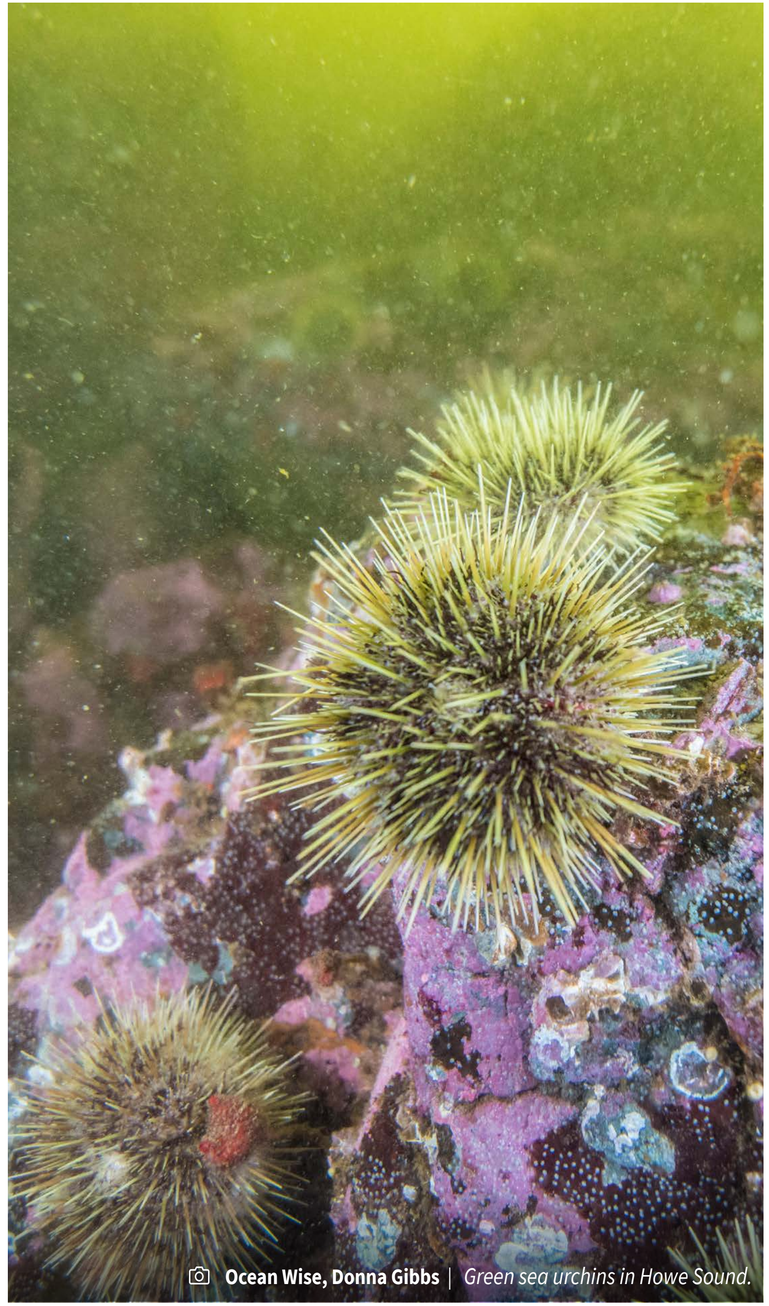


Figure 2. Observed impacts of SSWD, from the outbreak in 2013 until 2019. The inverse relationship between sunflower stars and green sea urchins demonstrates the ecosystem impacts – as we lose sunflower stars, green sea urchin populations boom (Adapted from Schultz 2020, in Ocean Watch Átl'ka7tsem/Txwnéwu7ts/Howe Sound 2020 Report).



Ocean Wise, Donna Gibbs | *Green sea urchins in Howe Sound.*

[v] Carnivorous – the primary dietary intake comes from eating other animals.

Spotlight 3

Recovery Potential and Conservation Efforts

Research and conservation efforts are underway to help protect and preserve sunflower stars. Efforts are being led by researchers from many institutes in Canada, the USA, and Mexico and includes captive breeding programs, research into the genetic connectivity of remaining sunflower stars, and ongoing monitoring of remaining populations.

Surprisingly, despite the recent rise in sunflower star research, we know very little about their basic biology. This greatly limits our ability to design effective protection measures. For example, we don't know how big sunflower stars need to be to reproduce or at what time of year their spawning events occur. This kind of information is critical for informing captive breeding efforts and for understanding if the individuals remaining in wild populations are large enough to reproduce and sustain a population.

Currently a collaborative study between Oregon State University and several other institutes, including Fisheries and Oceans Canada, is trying to answer some of these questions by monitoring the reproductive activity of sunflower stars in Washington, British Columbia, and Alaska. This research will be completed in 2022/2023 with the hope that the data collected in British Columbia can be combined with other Canadian datasets, such as observations from long-term Fisheries and Oceans Canada surveys to help develop protection measures in Canada for sunflower stars through recommendations to the Committee on the Status of Endangered Wildlife in Canada (COSWEIC) and eventually the Species At Risk Act (SARA).

Ocean Wise, Donna Gibbs | *A healthy sunflower star.*

Ocean Wise, Lee Newman | *Sunflower star showing signs of SSWD, with the body turning gelatinous and disappearing.*

Ocean Wise, Donna Gibbs | *A sunflower sea star affected by SSWD.*

Ocean Wise, Donna Gibbs | *Signs of severe SSWD on sunflower stars, Cates Bay c. 2013.*

Conclusion

Marine diseases are increasing in frequency and severity, along with the many threats brought about by human activities in the ocean. Climate change plays a role in exacerbating the impacts of marine diseases and is impacting marine biodiversity and taking away from essential ecosystem services provided by the ocean.

The recent SSWD outbreak has demonstrated the devastating consequences marine diseases can have on species, and their ripple effects throughout local ecosystems. Research and conservation efforts are ongoing to increase our understanding of the basic biology of sunflower stars, in the hopes that we can secure the survival of this species.

While we rely on the many dedicated researchers to learn more to save this species, we can all still play a part in lessening our environmental impact and helping to reduce climate change. Read on to learn what you can do. See Resources for further reading on the topic.

Ocean Wise, Neil Fisher | *Barkley Sounds with healthy amounts of kelp and sea otter activity, signs of a healthy ecosystem c. 2013.*

What can you do?

Individual and Organization Actions

- ❑ Actions to mitigate climate change will promote sunflower star recovery and decrease the probability of other wildlife disease outbreaks in the future. A more comprehensive list of possible actions to take can be found in the article **The path to zero carbon municipalities** (OWHS 2020).

Government Actions and Policy

- ❑ Financially support ongoing research projects and assess the need for additional research. Support further studies specifically on the cause(s) of SSWD.
- ❑ Support and fund researchers and conservationists in Canada and the USA to continue to work on a sunflower star recovery and monitoring strategy.
- ❑ Support and fund researchers and conservationists to protect and restore important kelp forests around the globe.

Resources

- ❑ A resource with links to discover more about SSWD, including maps, data, news and information, and identification guides; Sea Star Wasting Syndrome | MARINe (ucsc.edu)
- ❑ For a detailed look at the sunflower sea star and its current status and impacts from SSWD, see the IUCN listing; Pycnopodia helianthoides (Sunflower Seastar) (iucnredlist.org)

Cite this report as: Dearden A. Miller A. 2021. Ocean Watch Spotlight. Marine biodiversity loss: Epidemic wipes out majority of sunflower sea stars. 9 pages Ocean Wise Conservation Association, Vancouver, Canada.
ISBN: 978-1-7776644-3-5

References

1. Hewson, I. et al. Densovirus associated with sea-star wasting disease and mass mortality. *Proc. Natl. Acad. Sci. U. S. A.* **111**, 17278 – 83 (2014).

2. Harvell, C. D. *et al*. Disease epidemic and a marine heat wave are associated with the continental-scale collapse of a pivotal predator (Pycnopodia helianthoides). *Sci. Adv.* **5**, eaau7042 (2019).

3. Schultz, J. A., Cloutier, R. N. & Côté, I. M. Evidence for a trophic cascade on rocky reefs following sea star mass mortality in British Columbia. *PeerJ* (2016) doi:10.7717/peerj.1980.

4. Gravem, S. A. *et al. Pycnopodia helianthoides. The IUCN Red List of Threatened Species 2020.* https://dx.doi.org/10.2305/IUCN.UK.2020-%0A3.RLTS.T178290276A178341498.en (2020).

5. Roe, D. Biodiversity loss—more than an environmental emergency. *Lancelet Planet. Heal.* **3**, 287–289 (2019).

6. Alvarez-Filip, L., Dulvy, N. K., Gill, J. A., Côté, I. M. & Watkinson, A. R. Flattening of Caribbean coral reefs: region-wide declines in architectural complexity. *Proc. R. Soc. B Biol. Sci.* **276**, 3019–3025 (2009).

7. Feehan, C. & Scheibling, R. Effects of sea urchin disease on coastal marine ecosystems. *Mar. Biol.* **161**, 1467–1485 (2014).

8. Gravem, S. A. *et al. Pycnopodia helianthoides (amended version of 2020 assessment). IUCN Redlist of Threatened Species.* https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T178290276A197818455.en (2021).

9. Aquarium of the Pacific. Sunflower Sea Star Pycnopodia helianthoides. *Aquarium of the Pacific Online Learning Center* https://www.aquariumofpacific.org/onlinelearningcenter/species/sunflower_sea_star#:~:text=Primarily carnivorous%2C P.,and occasionally sponges and algae (2021).

10. Burt, J. M. *et al.* Sudden collapse of a mesopredator reveals its complementary role in mediating rocky reef regime shifts. *Proc. R. Soc. B Biol. Sci.* **285**, (2018).

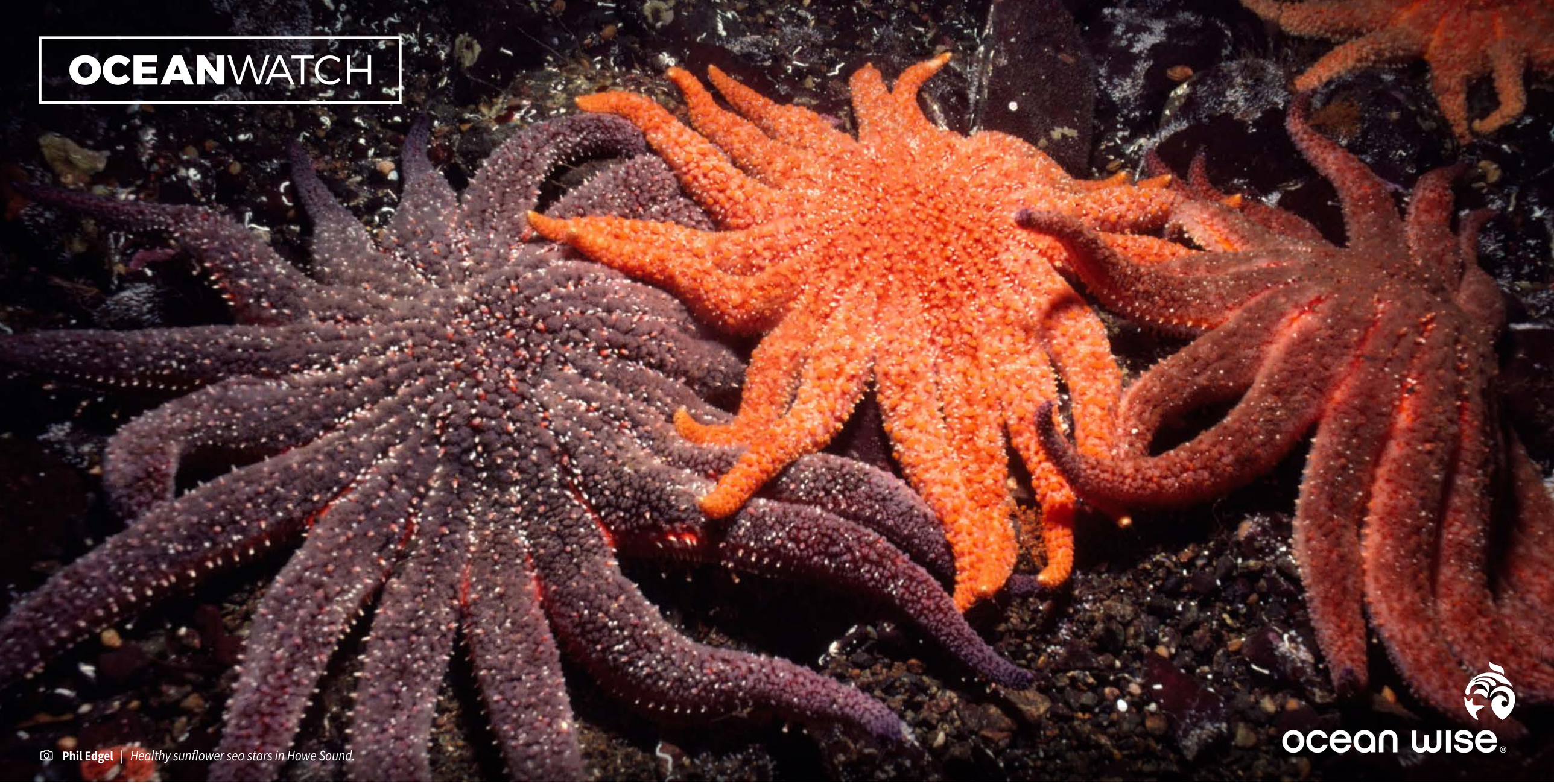
This project was undertaken with financial support from

sitka foundation

North Family FOUNDATION

Shutterstock, Greg Amptman | *A sunflower sea star sitting on a cold water coral formations.*

OCEANWATCH



Phil Edgel | *Healthy sunflower sea stars in Howe Sound.*

ocean wise®

Ocean Wise Conservation Association, P.O. Box 3232 Vancouver, BC, V6B 3X8