Oregon Ocean Science Trust - Grant Report, Oregon nearshore science and monitoring research

Oregon Department of Fish and Wildlife, Marine Resources Program

December 30, 2025

Executive Summary:

Climate Impacts on Nearshore Ecosystems

- Prolonged marine heatwaves (2014–2017) and subsequent El Niño conditions caused major disruptions to Oregon's rocky reef ecosystems, including kelp loss, abalone decline, sea star collapse, and persistent high densities of purple sea urchins.

ODFW Long-Term Monitoring & New Methods

- Leveraging decades of datasets for sea urchins and abalones, ODFW tested new video-based survey techniques and collaborated with commercial and scientific divers to improve species detection and size measurement while maintaining continuity with historical methods.

Key Findings

- Abalone populations remain critically low; sea urchin densities are high with no recent recruitment pulses; and sea star populations show significant shifts post-SSWS outbreak. Video methods were less efficient for size data but useful for species enumeration.

Management & Conservation Actions

- Recommendations include adopting advanced technologies for monitoring, expanding conservation measures for abalones and sea stars, and considering strategies of reducing grazing pressure to restore kelp habitats. Updated datasets and new partnerships will inform future research and policy.

Introduction:

Recent climate-related changes in nearshore ocean conditions along the west coast of North America have caused broad-scale impacts to rocky shore habitats and communities along the southern Oregon coast (Rogers-Bennett & Catton, 2019; Smale, 2020; Kroeker & Sanford, 2021). Anomalously high seawater temperatures during the coastwide marine heatwave (2014–2017) were followed by warm El Niño conditions (2018–2020; Nielsen et al., 2020; Piatt et al., 2020). This prolonged warming has had lasting consequences for the composition and complexity of trophic links within Oregon's kelp beds and rocky reef ecosystems. These disruptions are substantial and include: 1) declines in the spatial cover of bull kelp (*Nereocystis luetkeana*) and understory seaweeds (Hamilton et al., 2020; 2021), 2) dramatic increases in purple sea urchin densities (Groth 2023), 3) starvation and mortality of abalones (Groth and Groth 2023), and 4) coastwide collapse of sunflower sea stars (*Pycnopodia helianthoides*) (Gravem et al., 2020;; Heady et al., 2022).

While oceanography, kelp beds, and marine fishes have various monitoring programs, datasets for invertebrates in Oregon's nearshore are rare and Oregon Department of Fish and Wildlife (ODFW) maintain the longest and most robust. ODFW long-term datasets for subtidal sea urchins and abalones, date back to 1991 and 1964, respectively. Together, these datasets provide the only quantitative insights into shifts in abundance for these important nearshore organisms and fishery targets. ODFW datasets from sea urchins and abalones have been used in several peer-reviewed publications (e.g., Groth, 2023; Hamilton, 2020, etc.), grey literature (Hamilton, et al., etc.), major new networks (Sherriff, 2021; Benitez, 2021; etc.), and in management actions (Rumrill et al., 2025; Groth et al., 2023; etc.).

Due to a lack of longstanding subtidal ecological monitoring programs or directed fisheries, sea stars are not well surveyed; however, there is need for understanding current and past changes in their populations. Sea star wasting syndrome (SSWS) devastated Oregon sea star populations in 2014. We analyzed video data from older sea urchin surveys (2010-2023) to describe changes by species before and after the 2014 event.

A challenge of a long-term dataset is keeping methods similar despite changes in technology, policy, resources and contracting. In this project, we tested new methods, working with contracted commercial sea urchin divers and scientific divers from Oregon Coast Aquarium (OCAq), who in turn subcontracted academic divers from Oregon State University (OSU) and Oregon Institute of Marine Biology (OIMB). We modified methods to suit these divers and replicated surveys in the same fashion as prior ODFW datapoints.

Methods

Surveys

Sites

- We completed sea urchin, sea star, and abalone abundance surveys using akin methods across all major ports (Depoe Bay, Charleston, Port Orford, Gold Beach), while experimenting with new technologies (Figure 1).

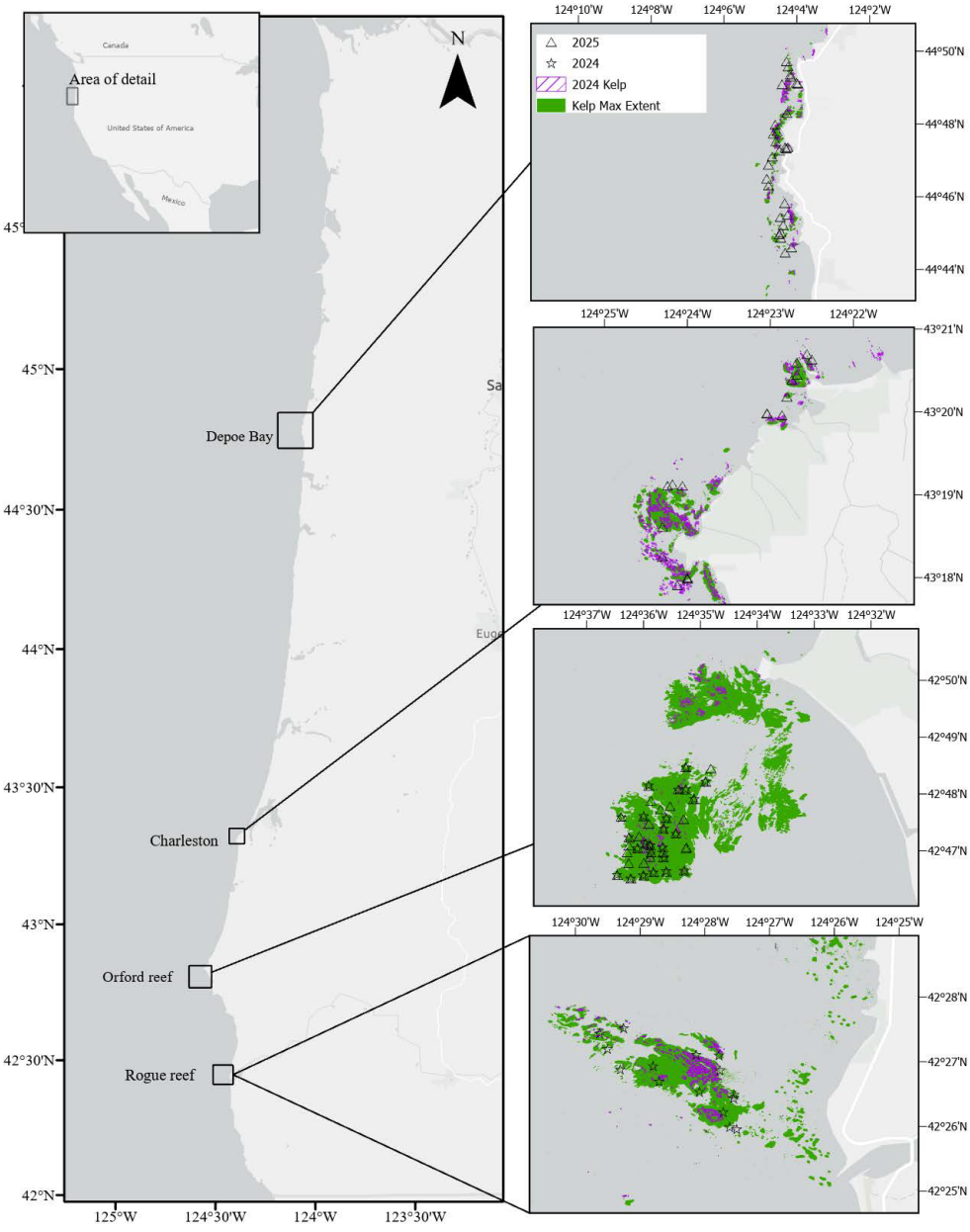


Figure 1. Subtidal belt transect sites and kelp canopy (2024 study and maximum extents (from historical) for OOST grant at Oregon nearshore sites, 2024-2025.

- In total, 166 subtidal belt transects along the Oregon coast were surveyed (Table1).

Table 1. Number of subtidal belt transects by port in Oregon for OOST grant 2024-2025.

PORT	2024	2025
CHARLESTON		21
DEPOE BAY		34
GOLD BEACH	15	
PORT ORFORD	56	40
GRAND TOTAL	**71**	**95**

Abundance counts

- We adapted two different methodologies to measure abundance of species, working with commercial sea urchin divers (Figure 2A) and scientific divers (Figure 2B). In both, several species were enumerated according to long standing methods (Groth 2023). Briefly, divers counted and speciated key invertebrate species along a 30*2 meter transect following a tape at revisited index sites (Figure 2C and 2D).
- For each transect we enumerated and speciated all sea urchins, abalone, and selected sea stars. Using transect videos from surveys, three independent reviewers enumerated and speciated all sea stars.





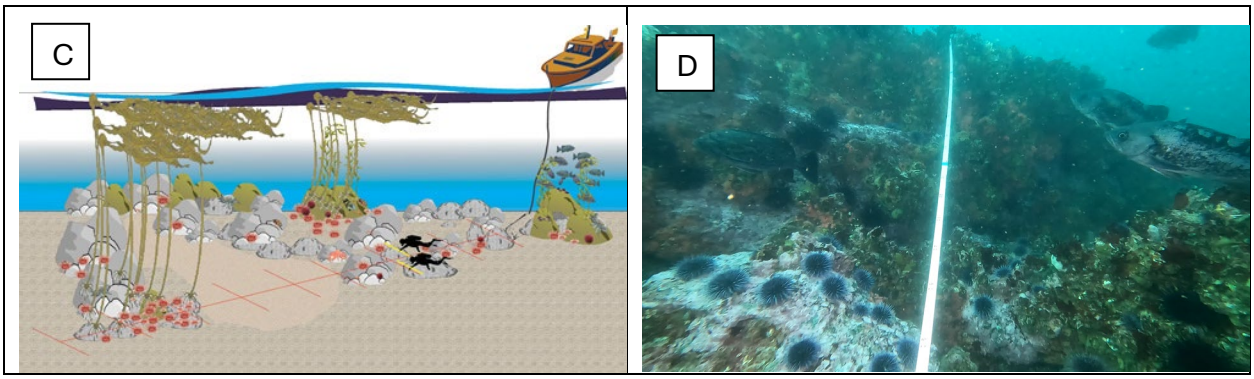
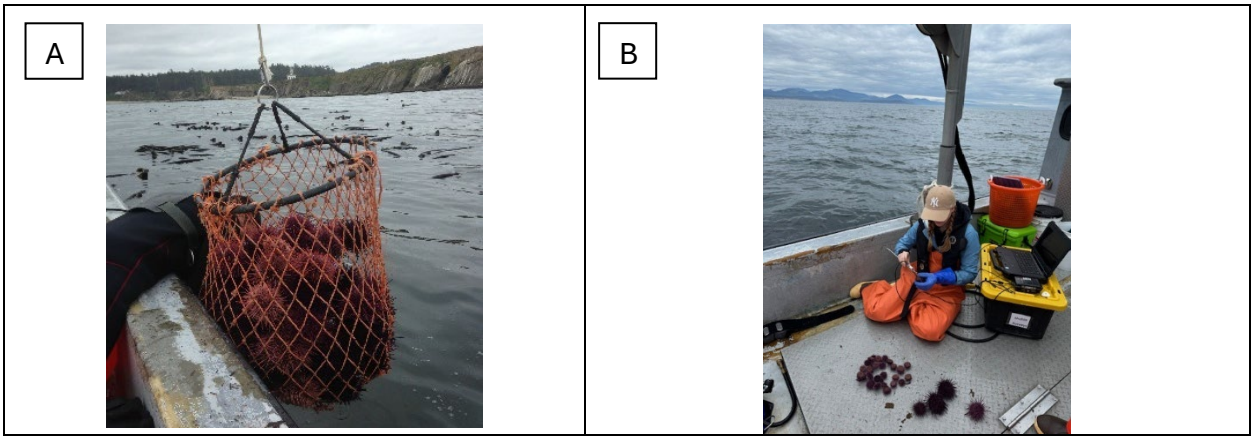


Figure 2. Sea urchin surveys: A) commercial sea urchin diver at Redfish Rocks Marine Reserve, OR, b) OSU/OCAq divers at Depoe Bay, OR, C) Illustration of methodology for subtidal belt transects, d) Underwater photograph of diver following a transect tape on a rocky reef with sea urchins and rockfish.

Sea urchin measurements

- We adapted methods to measure sea urchins for both scientific divers and commercial divers. We took advantage of commercial divers' collection skills and scientific divers' careful camera work when considering adaptations to methodology.
- In 2024, commercial sea urchin divers collected sea urchins (Figure 3A), then measured topside by ODFW staff (Figure 3B). For 2025, scientific divers first calibrated laser/caliper measures (Figure 3C), then reviewed video to compare to 10cm laser pair for approximate measures (Figure 3D).



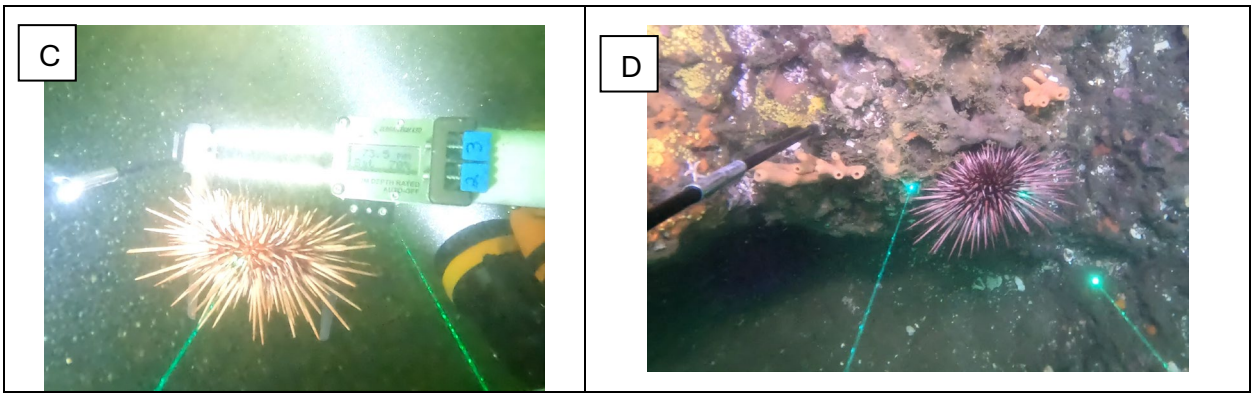


Figure 3. Sea urchin measurement photographs: A) commercial sea urchin diver collecting sample for ODFW topside measurement, B) red sea urchins being measured topside by ODFW staff, C) underwater caliper measurement, D) red sea urchin measured using 10cm wide parallel laser pair.

- We measured 9,968 sea urchins using caliper and video measure methods (Table 2).

Table 2. Number of sea urchins by species and method measured in Oregon for OOST, 2024-2025.

Year (method)	***Species***	
	Red sea urchin	**Purple sea urchin**
2024 (caliper)	3935	3495
2025 (video)	1361	1177
Grand Total	**5296**	**4672**

Sea star video review

- ODFW video reviewers analyzed 1,090 subtidal belt transect videos (2010-2025) to speciate and enumerate sea stars for enhanced understanding of SSWS effects and current condition.

Aligning methods

- We performed replicates of surveys using our past methods and new video methods at two sites (Charleston and Orford Reef) (Table 3), for use in evaluation of methods continuity.

Table 3. Number of subtidal transects used as replicates in comparing methodologies by area, year, and diver type, 2023-2025.

Area	*Year*	*Diver type*	*# of transects*	*# of transects comparable abundance data*	*# of transects with comparable size distribution*	*Num of sea urchins compared red | purple*
Charleston	2023	Scientific diver	26	21	19	379 | 944
	2025	Scientific diver	26	21	19	568 | 759
Orford Reef	2024	Commercial diver	26	26	4	242 | 156
	2025	Scientific diver	40	26	4	163 | 73

Results

Key findings

- Video methods: We experimented with new video methods to adapt technology in long-term datasets, specifically measuring test diameters of sea urchins. We found that video techniques consumed more time than past methods and may have coarse value in describing sea urchin size distributions.
- Abundance surveys methods: We found that use of scientific divers facilitated communication, reduced dive times, and improved safety. We found detection of sea urchins in scientific diver surveys to be higher, especially for small sea urchins.
- Sea urchin densities: Sea urchin densities remained high. While some natural mortality appears to have occurred, densities of purple sea urchins have remained high (Figure 4). We have noted some natural mortality of both species of sea urchins; however, have not carefully analyzed those aspects of the data.

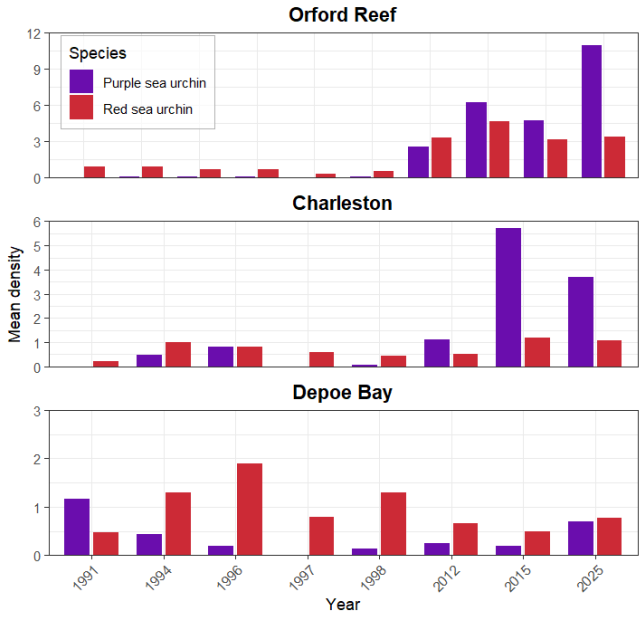


Figure 4. Histogram of densities for purple and red sea urchin (#/m^2) at project areas in Oregon, 1991-2025.

- Sea urchin recruitment: Size distribution data from 2024-2025 surveys DID NOT show major pulses of new recruitment for red sea urchins (Figure 5) or purple sea urchins (Figure 6). After the 2014-15 warm water event we detected a major episodic recruitment for both species, which is extremely rare in the long-term dataset (only detected once before in 1995).

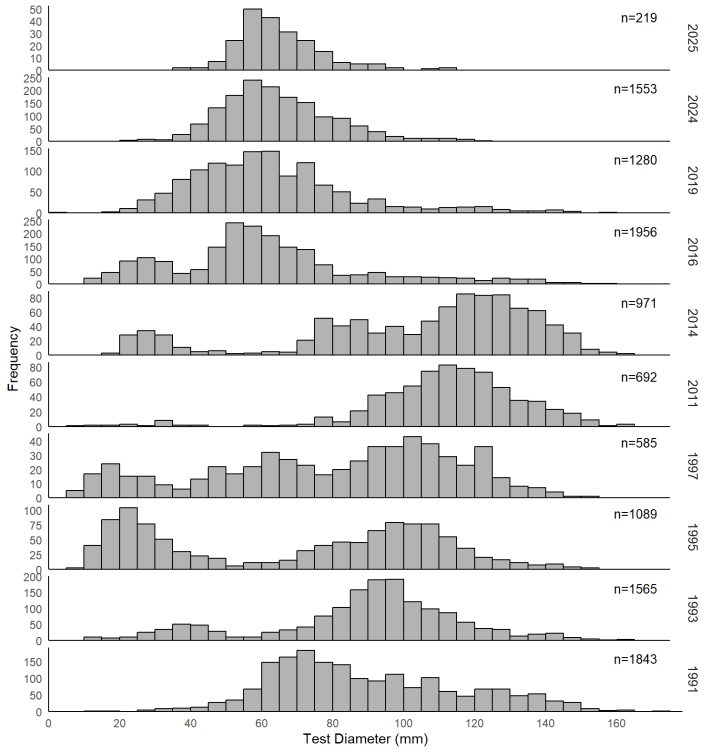


Figure 5. Histograms of red sea urchin (Mesocentrotus franciscanus) test diameter size distribution (5mm bins) at Orford Reef, OR, 1991-2025

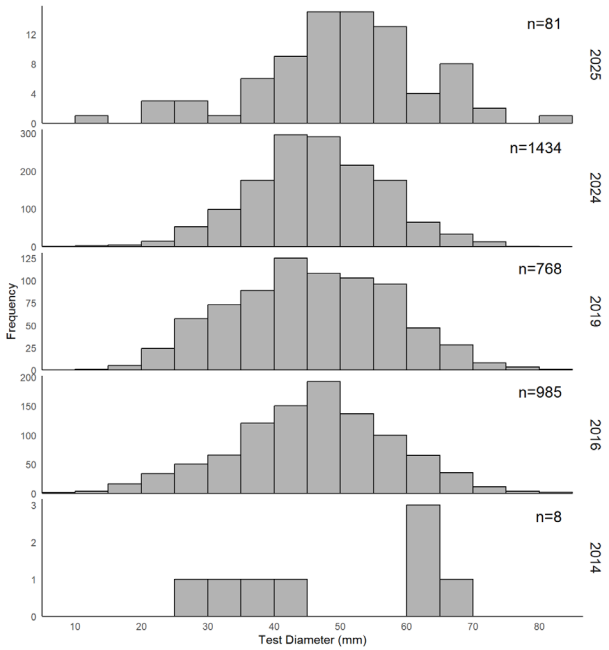


Figure 6. Histograms of purple sea urchin (Strongylocentrotus purpuratus) test diameter size distribution (5mm bins) at Orford Reef, OR, 2014-2025. Note: so few purple sea urchins were detected in surveys prior to 2014, no measurements were taken.

- Abalone: We continued to find a decline in abalone populations. Both red and flat abalone were extremely rarely found, including in former strongholds such as Nellies Cove, near Port Orford (Table 4).

Table 4. Surveyed area, then sea urchin and abalone counts, by species, by year, at Nellies Cove, OR, 2015-2025.

Year	surveyed area (m^2)	sea urchins		abalones		
		purple	red	flat	pinto	red
2015	1140	2938	1738	14	0	27
2019	660	9855	1333	1	9	10
2024	600	5298	910	2	0	4

- Sea stars: We collected new data on sea star abundances before and after SSWS (2014) for the years 2010-2025 across much of Oregon's rocky subtidal nearshore. Using video review time afforded with OOST funds, we found clear winners and losers among sea star populations after the 2014 SSWS event (Figure 7, A-F).

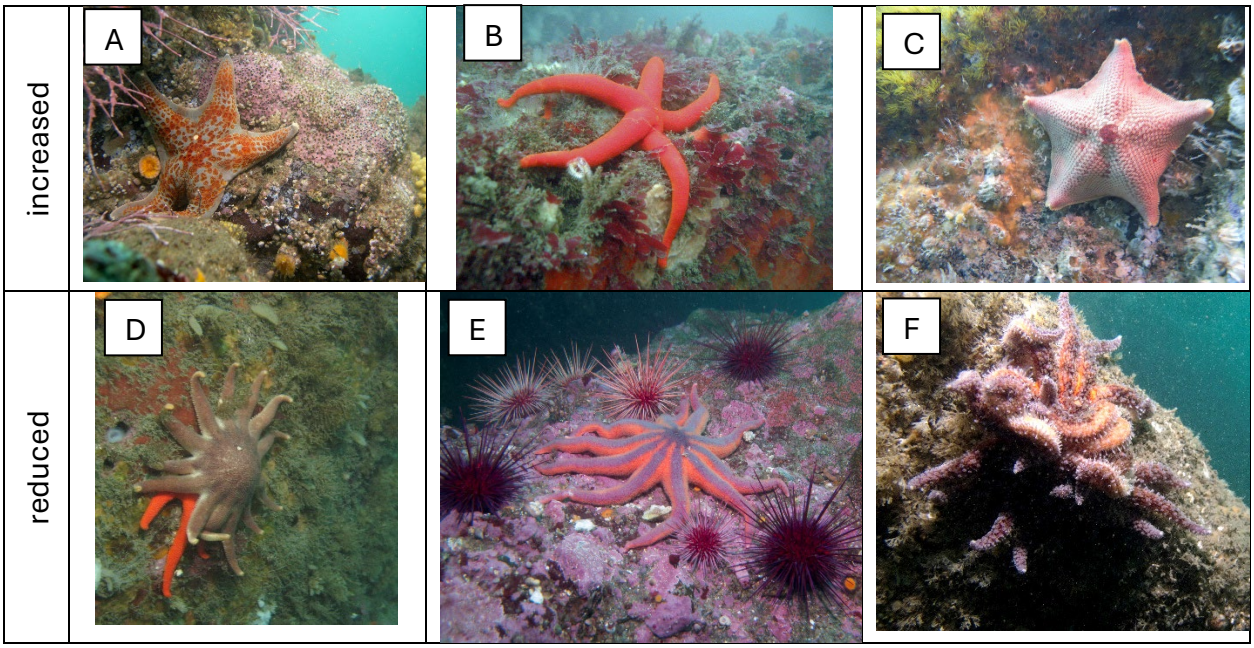


Figure 7. Sea stars found to have increased or decreased after 2014 SSWS event, A) Leather star (Dermasterias imbricata), B) Blood star (Henricia leviuscula), C) Bat star (Patiria miniata), D) Morning sun star (Solaster dawsoni), eating a blood star, E) Striped sun star (Solaster stimpsoni), F) Sunflower star (Pycnopodia helianthoides) succumbing to SSWS (2014)).

Key recommendations

- Video methods: We recommend *in situ* collection of sea urchins, or consideration of new technologies around developing sea urchin size distributions (i.e. stereo video, artificial intelligence, etc.) for improvement in time investment and accuracy.
- Abundance surveys: We found that scientific divers improved safety, detection, and communication. OCAq is well suited for this work and were able to work with major

Oregon universities to bring new divers into the work. This brought new people into the area of nearshore conservation issues and expanded opportunities for collaboration.

- Sea urchin densities: We used these data and field observations to consider a proposal in February 2025 to the Oregon Fish and Wildlife Commission (OFWC) to allow citizens to cull (smash) sea urchins in selected study areas, where "kelp oases" can be attempted. In addition, we've worked to liberalize limitations for recreational (e.g., purple sea urchin limit increased, 2025), commercial (e.g., elimination of quotas), and Tribal (e.g., modified agreements to increase take in intertidal) (Rumrill, et al. 2025).
- Abalone: Based on ODFW staff recommendation from surveys in this data series, OFWC has closed fisheries for all species of abalone common to Oregon. Fisheries have closed for red abalone recently (Groth et al., 2023) and flat abalone historically (Corbett and Groth, 2009). ODFW has restrained scientific take and permitted sea urchin culling in former abalone strongholds. ODFW has developed a conservation and fishery management plan for red abalone (Smith et al., 2023). We plan to continue a strong conservation stance for abalones, given their high sensitivity to kelp abundance, competition, and fishing. Results from this survey strengthen our stance on conservation.
- Sea stars: We recommend increased awareness and conservation around large, soft-bodied sea stars, including, but not limited to sunflower stars (*Pycnopodia helianthoides*). OFWC recently changed regulations (2021), restricting the take of sea stars recreationally. New research, developed under this grant, will allow consideration of more specific and appropriate constraints. This work will help fill a needed gap in the paucity of current, published research regarding Oregon's subtidal sea star populations.

Positive outcomes

- Datasets for sea urchins and abalones have been updated. Sea star data was created. These datasets represent Oregon's key long-term understanding of these species, and are expected to inform studies for years to come. Both datasets are expected to become available soon with new publications.
- New successful partnerships with OCAq, OSU, OIMB, creates new collaborations and investments in Oregon's nearshore communities.
- PI Steve Rumrill gave a public talk at HMSC "Science on tap" titled "Shifting Nearshore conditions: Consequences for Oregon's marine species of greatest conservation need" on November 13, 2024. https://www.youtube.com/watch?v=_4yAMv1dkAo&t=1043s

Next steps

- Current and former sea urchin fishery managers (Kendall Smith and Scott Groth) are evaluating continuity of long-term datasets. We hope to complete a scientific manuscript in coming months describing how the work under this grant can properly be assimilated into older and future datasets.
- We aim to describe changes in sea star abundance before and after SSWS in a scientific manuscript. In addition, we may examine nearshore invertebrate communities more holistically, connecting the species quantified in this grant with ongoing fish and habitat work.

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