

Maine Department of Marine Resources Spring Dive Survey Report



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Table of Contents

| | |
|--|----|
| Executive Summary | 2 |
| Introduction and Background..... | 2 |
| Survey Methodology | 4 |
| Data Collection Parameters: | 4 |
| Survey Effort (2025)..... | 5 |
| Survey Timeline & Evolution | 5 |
| Findings & Trends | 6 |
| Green Sea Urchin Population Trends | 6 |
| Community and Associated Species Shifts | 8 |
| Sea Stars and Sea Cucumbers | 8 |
| Algal Communities | 10 |
| Cancer Crabs and Lobsters | 11 |
| Invasive and Emerging Species | 14 |
| Didemnum vexillum | 14 |
| European Tunicate | 15 |
| Ephemeral Red Algae | 16 |
| Desmarestia..... | 17 |
| Conclusion..... | 18 |
| Acknowledgments..... | 19 |
| References | 19 |
| Appendices..... | 19 |
| Appendix A: Regional Map of Survey Sites (2025) | 19 |
| Appendix B: Trend Summary Tables (Linear Slopes by region and depth stratum)..... | 20 |

Executive Summary

Across Maine’s long-term dive survey (2001-2025), the biggest statewide signal is a broad decline in urchin condition and abundance indicators across most regions and depth strata. Urchin test diameter trends are mixed by area, but many region–stratum combinations show decreasing mean size through time, while several others, such as in some shallower strata, show modest increases. In contrast, urchin biomass displays a very clear pattern that is decreasing in nearly every region and depth stratum. The steepest declines are concentrated in multiple mid-to-late regions and often strongest in deeper strata. Community abundance patterns also point to major ecosystem change: sea star counts are declining across regions, crab counts (Jonah and rock crab) generally trend downward, and lobster abundance is mostly flat-to-decreasing with a few regional exceptions. Sea cucumber abundance shows a long-term decline from the early years of the survey, with a modest uptick in 2025 relative to recent years. This suggests recent improvement, but not a reversal of the broader downward trend.

Algal communities also show a persistent shift in composition over time. Across much of the coast and in most depth strata, canopy cover is declining while crust cover is often increasing; understory trends are mixed, with increases in several regions/strata and decreases in others. Newer data streams add important context: in 2024–2025, the share of filamentous red algae within the understory generally increased across many region–stratum combinations, while *Desmarestia*’s share of the canopy is more variable (increasing in many areas but decreasing in some). Invasive tunicate trajectories diverge: European tunicate (*A. aspersa*) is generally stable-to-decreasing where detected in the short recent record, while Didemnum (*D. vexillum*) shows gradual increases in presence across regions and strata over its longer time series, with “common” status remaining less frequent but also trending upward in several areas. Overall, the survey indicates widespread declines in urchin biomass and several key invertebrate groups alongside long-term shifts in algal structure, underscoring ongoing change in nearshore benthic communities and the value of continued standardized monitoring.

Introduction and Background

The Maine Department of Marine Resources (MEDMR) has conducted the spring dive survey since 2001, collecting data on green sea urchin size, abundance, benthic habitat, basic algal cover, and the presence of invasive species. The inception of this survey was a collaborative effort between industry members, state scientists, policymakers, and university researchers. The survey was designed to provide fisheries-independent data to monitor the status of green sea urchin populations along the Maine coast.

To structure the survey, the Maine coastline was divided into nine regions based on fishing pressure and commercial landings value (see Figure 1). Within each region, 16 survey sites were selected: five sentinel sites chosen at the start of the survey with input from the commercial urchin fishing industry, and 11 random sites determined annually using a random number generator. The selection of random sites ensures broad spatial coverage. Each grid selected is cross-referenced with a substrate background layer in ArcGIS to confirm its suitability for dive surveys, ensuring a hard-bottom habitat conducive to urchin populations.

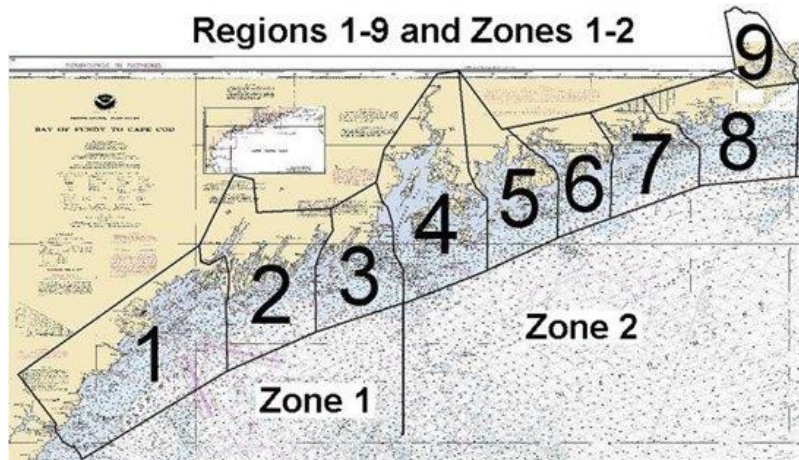


Figure 1: Map of the Maine coastline with the two urchin commercial fishing zones and the nine dive survey regions.

This collaborative survey involves two divers per site: traditionally one MEDMR scientist and one commercial urchin diver. Additionally, MEDMR contracts commercial fishermen with dive-friendly vessels to serve as tenders, many of whom are/were involved with the urchin industry. University researchers played a critical role in shaping the dive survey sampling plan, and data from the survey were used to develop a green sea urchin stock assessment model for the state (Grabowski et al., 2005). The continued involvement of the commercial fishing industry and various researchers has made this survey a successful example of collaborative fisheries monitoring and assessment.

Beyond tracking sea urchin populations, the dive survey has provided valuable insights into broader ecological changes in Gulf of Maine benthic communities. It has documented shifts in urchin distribution, including unexpected population increases in bays and declines along outer headlands. The survey also played a crucial role in identifying major ecological events, such as the decline of sea stars statewide and the presence of wasting disease in 2013. Additionally, MEDMR scientists have tracked changes in algal turfing communities and monitored the spread of the invasive tunicate, *Didemnum vexillum*, which is becoming increasingly prevalent in the Gulf of Maine.

This report summarizes survey activities and observations from the spring field season (May 1 through June 20). The MEDMR dive survey remains a critical tool for monitoring changes in Maine's nearshore marine ecosystems. The extensive dataset gathered over more than two decades provides valuable information on species abundance, habitat conditions, and emerging ecological trends.

Survey Methodology

The MEDMR dive survey follows a structured methodology to ensure consistency and accuracy in data collection. The survey covers nine designated regions along the Maine coast, with each region containing 16 sites: five sentinel sites and 11 randomly selected sites. Sentinel sites were established at the survey's inception based on recommendations from the commercial urchin fishing industry, while random sites are selected each year using a random number generator to ensure broad and unbiased sampling.

Each site is surveyed by a team of two divers who enter the water from a dive tender vessel. From the vessel, a transect bearing is established using a compass heading, providing a fixed line of travel for the dive team (see Figure 2). The divers begin their assessment at the deepest depth stratum (10–15 m) and follow this transect line toward shore, collecting data at three depth ranges: 10–15 m, 5–10 m, and 0–5 m. While traveling along the transect, divers place quadrats at random locations within each depth stratum.



Figure 2: Schematic of two divers following shoreward transect lines from a vessel. Figure generated using AI (ChatGPT/DALL-E).

At every site, each diver randomly places a 1-m² quadrat frame ten times per depth stratum. The quadrat frame is made of ¾-inch PVC pipe and serves as the standardized unit for data collection. Observations are recorded underwater using modified wrist slates with attached data sheets.

Data Collection Parameters:

- **Green Sea Urchins:** All urchins at least 10mm in diameter within each quadrat are counted.
- **Urchin Size Sampling:** Divers collect all urchins from one randomly selected quadrat per depth stratum to measure test diameter before releasing them.
- **Algal Cover:** Algae are classified into three functional groups—encrusting (crust), turfing (understory), and canopy-forming (kelps) and their percent cover is recorded in each quadrat.
 - **Red Algae Cover:** The percentage of the understory composed of ephemeral red algae (% present) is recorded to capture algal types in more detail.
 - **Desmarestia:** The percentage of the canopy composed of *Desmarestia* (% present) is recorded to capture algal types in more detail.

- **Cancer Crabs:** Jonah crabs (*Cancer borealis*) and rock crabs (*Cancer irroratus*) are counted, measured (carapace width, mm), and sexed. Crabs are collected across all depth strata and combined into one sample per site.
- **American Lobsters:** (*Homarus americanus*) are counted in every quadrat.
- **Sea Stars:** (*Asterias sp.*, *Crossaster sp.*, *Solaster sp.*) are counted in every quadrat. Sea stars are collected and measured (longest arm length, mm) only when they occur in the urchin size-sample quadrat.
- **Sea Cucumbers:** (*Cucumaria frondosa*) are counted in every quadrat.
- **Invasive Tunicates:** The presence of two invasive tunicates is recorded in every quadrat: *Didemnum vexillum* (colonial tunicate) and the European sea squirt *Ascidrella aspersa* (solitary tunicate). Each species is scored as “Present” ($\leq 50\%$ cover) or “Common” ($>50\%$ cover).

Survey Effort (2025)

- **Survey window:** May 1 through June 20
- **Regions surveyed:** 9 (all regions)
- **Dives completed:** 139 of 144 planned
- **Missed dives:** 5 missed due to hazardous site conditions

Survey Timeline & Evolution

Since its early years, the MEDMR dive survey has evolved in response to shifting research priorities, funding availability, and observed changes in Maine’s coastal ecosystems.

- **2003–2007:** The survey expanded beyond urchin monitoring to include other key benthic species such as Cancer crabs, lobsters, and sea stars, enhancing understanding of predator–prey dynamics and community structure. Divers began sexing Cancer crabs in 2004 to provide more detailed population data. During this period, the survey also removed the fourth depth stratum and discontinued underwater camera use to simplify methods and improve data consistency.
 - **2010–2012:** Sea cucumbers (*Cucumaria frondosa*) were added to the survey as interest grew in additional commercially valuable echinoderms. Funding reductions in 2012 led to spatial contraction, concentrating survey efforts on regions with the greatest economic importance.
 - **2024–2026:** Multi-year funding supported three consecutive years of full coastwide surveys (2024, 2025, and 2026). During this period, data collection expanded to include additional taxa (e.g., sea squirts and *Desmarestia* algae) to support broader ecosystem monitoring.
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Findings & Trends

Green Sea Urchin Population Trends

Across the time series, urchin test diameter shows a strong depth- and region-dependent pattern (see Figure 3). Several regions show consistent decreases across all depth strata, most notably Regions 2 and 3. In contrast, Regions 8 and 9 stand out as broadly increasing across all three depth strata, with positive slopes in every stratum and generally larger year-to-year increases than many other regions.

A common “split” pattern also shows up in multiple regions: increases in shallow water paired with decreases in deeper strata. Regions 5, 6, and 7 all increase in Depth Stratum 1 but decrease in Depth Strata 2 and 3, suggesting that shallow urchin size structure is shifting larger while deeper urchin size structure are shifting smaller over time (or failing to maintain larger size classes). Region 1 is similar but a bit more mixed, with increases in Depth Strata 1–2 and a decrease in Depth Stratum 3. Overall, the trend summary table suggests that size trends are not uniform statewide; instead, they cluster into a few consistent regional patterns (see Appendix B, Table 1).

Urchin biomass shows a broad coastwide decline across nearly all regions and depth strata, with the most consistent decreases appearing in regions 2–9 for all three strata (see Figure 4). The steepest declines occur in the mid-to-late regions, especially Regions 7 and 8—where biomass drops fastest in the deeper strata (Depth Stratum 3) and is also strongly negative in Stratum 2. Region 6 also stands out for large, consistent declines across all depths. The main exception is Region 1, where biomass is increasing in the shallower strata (Depth Strata 1 and 2) but still decreasing in Depth Stratum 3, suggesting a more localized pattern of recovery in shallow water that is not reflected elsewhere.

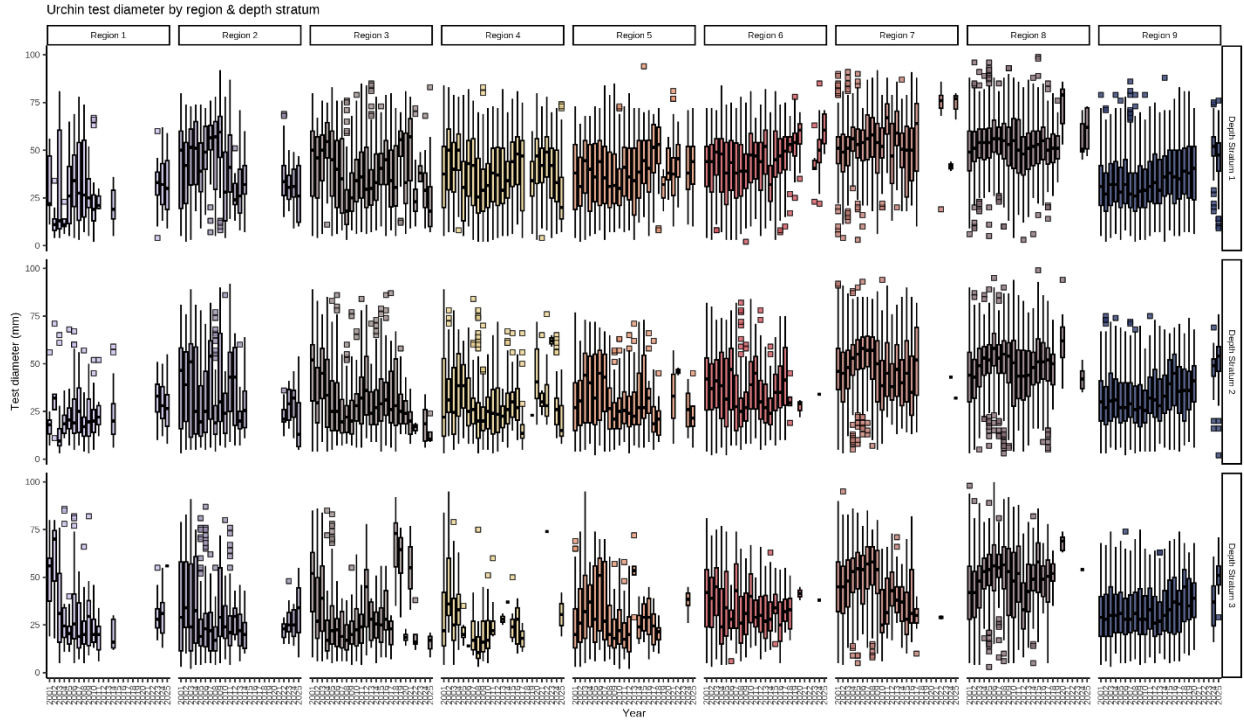


Figure 3: Distribution of green sea urchin test diameters (mm) across survey years, shown separately for each region and depth stratum. Boxplots summarize measured urchins within each year (center line = median; box = interquartile range; whiskers = $1.5 \times \text{IQR}$; points indicate outliers), allowing comparison of size structure through time among regions and across depth strata.

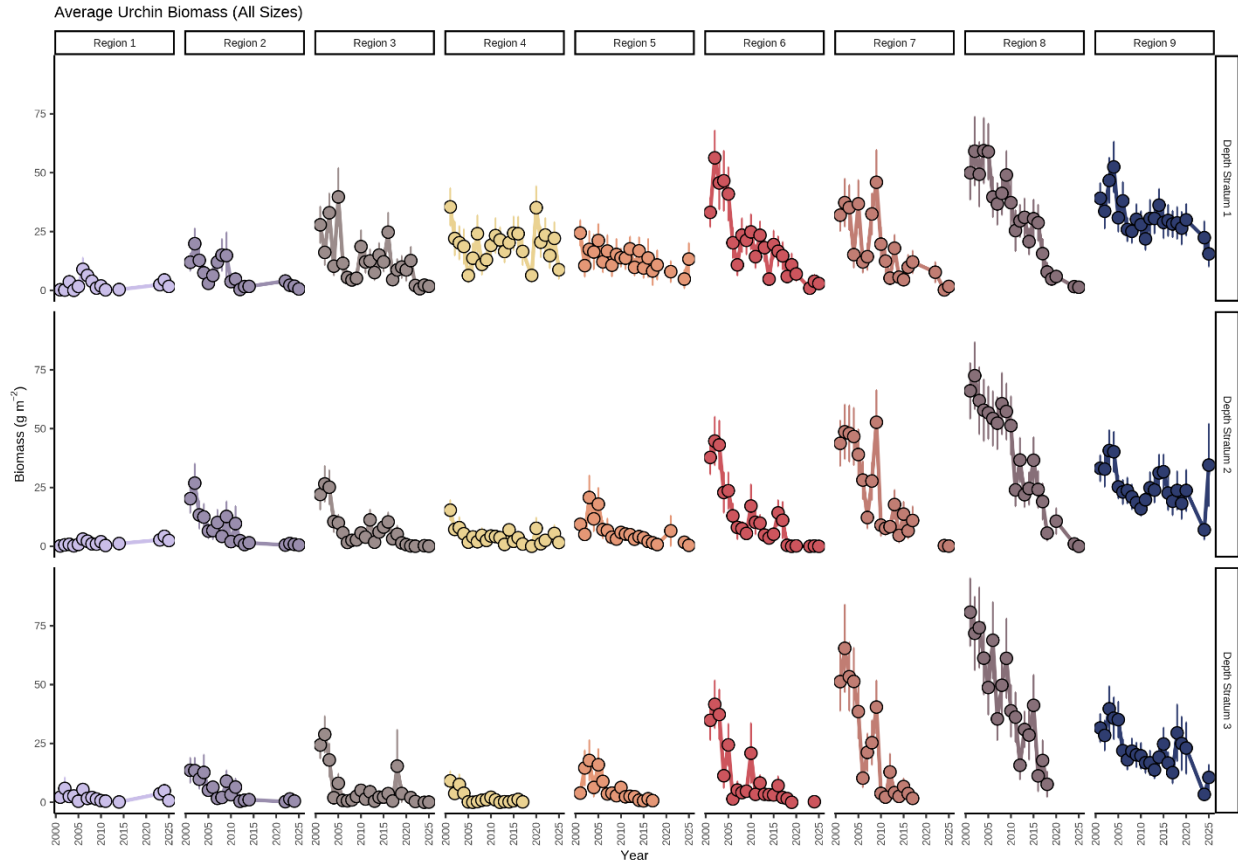


Figure 4: Mean green sea urchin biomass (all sizes; $g\ m^{-2}$) by region and depth stratum, across survey years. Biomass was estimated for each $1\ m^2$ quadrat by converting individual test diameters to wet weight using an allometric length–weight relationship and summing weights within quadrats; points show the regional mean across quadrats and error bars show $\pm 1\ SE$. Region–year estimates were suppressed (not plotted) when site coverage within a depth stratum did not meet minimum sampling thresholds to avoid region-wide values being driven by a small number of sites.

Community and Associated Species Shifts

Sea Stars and Sea Cucumbers

Sea star abundance declined over time in every region, making this the most consistent regional signal across the abundance metrics (see Figure 5). Overall, the pattern points

to a broad, long-term reduction in sea star abundance across the survey footprint rather than a change isolated to a single region.

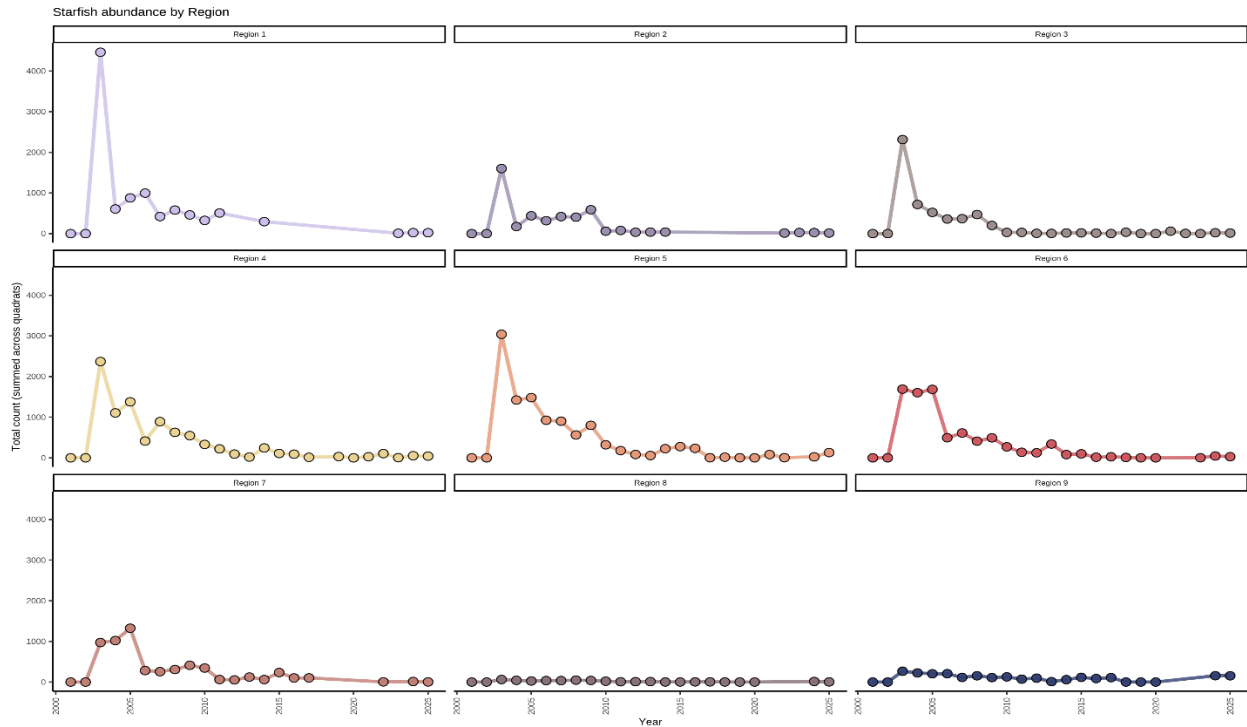


Figure 5: Total Sea star abundance by region through time (all depth strata combined). Each panel shows annual totals summed across all surveyed quadrats within a region.

Sea cucumber abundance trends were mixed but generally positive for 2025 (see Figure 6). Regions 1, 2, 3, 5, 6, 7, and 9 show increasing linear trends, while Regions 4 and 8 show decreasing trends.

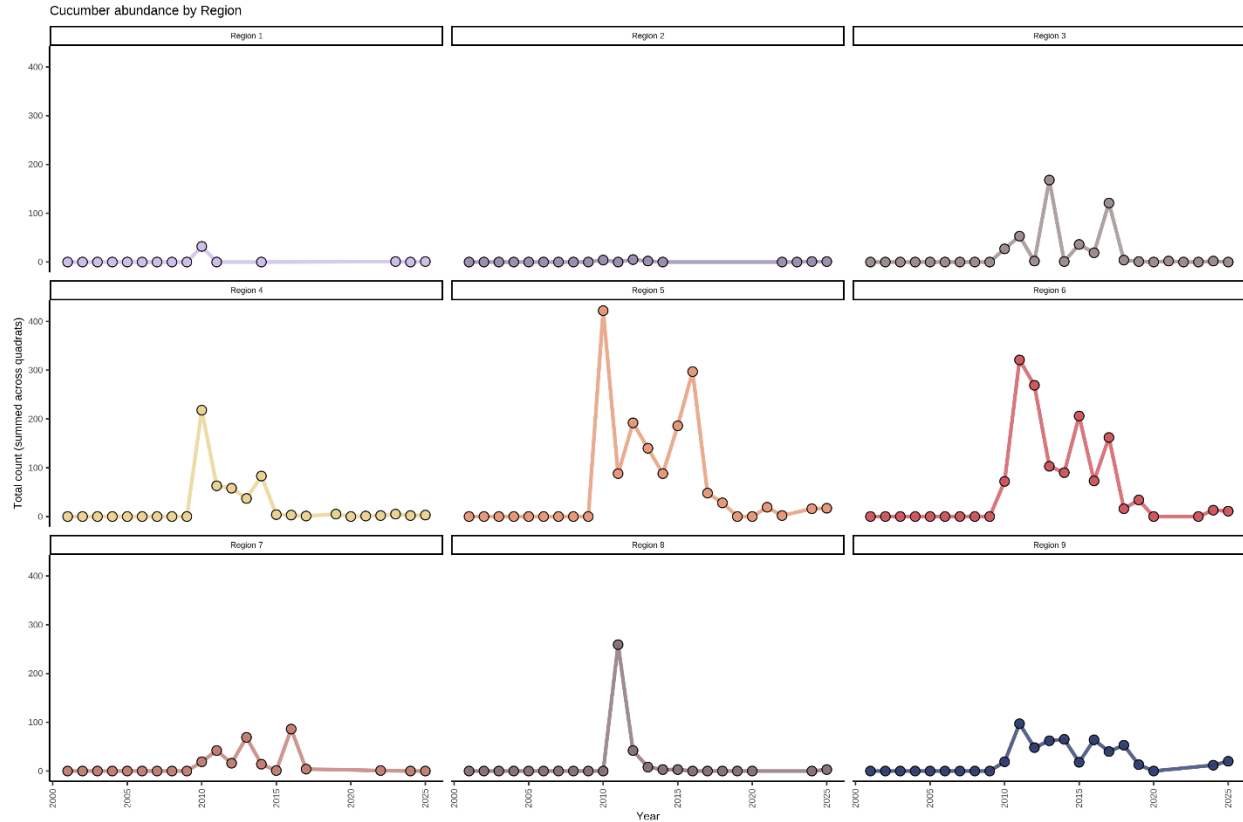


Figure 6: Total Sea cucumber abundance by region through time (all depth strata combined). Annual totals are summed across all surveyed quadrats within each region.

Algal Communities

Across most regions and depth strata, canopy cover shows a consistent long-term decline (see Figure 7). Negative slopes and “Decreasing” classifications dominate, and that pattern is especially clear in deeper water (Depth Stratum 3), where canopy is often low on average and still trending downward in nearly every region (see Appendix B, Table 2). Overall, canopy-forming algae are generally becoming less prevalent through time across much of the survey footprint.

Crust and understory trends are more mixed and appear to vary by region and depth. Crust is often increasing in regions 1–2 and 9, while it decreases in several mid-coast regions across multiple strata, so it is not a uniform statewide signal. Understory more frequently shows stable-to-increasing patterns in several regions and strata but declines in others (notably parts of regions 1–2). Taken together, the broad takeaway is a shift away from canopy cover, with compensating increases in understory and/or crust in some areas, but not consistently everywhere.



Figure 7: Mean algal cover by type (Crust, Understory, and Canopy) through time, shown for each region and depth stratum. Bars represent the average percent cover per 1 m² quadrat, calculated using only quadrats where algal cover was recorded; stacked segments show relative contributions of each algal layer to total algal cover within each region–stratum–year.

Cancer Crabs and Lobsters

Cancer crabs are mostly trending downwards, with Jonah crab declines in regions 1 – 8, only increasing in region 9 (see Figure 8). Rock crabs are also largely declining statewide, with some regions (6, 8 and 9) showing small increases in 2025 (see Figure 9).

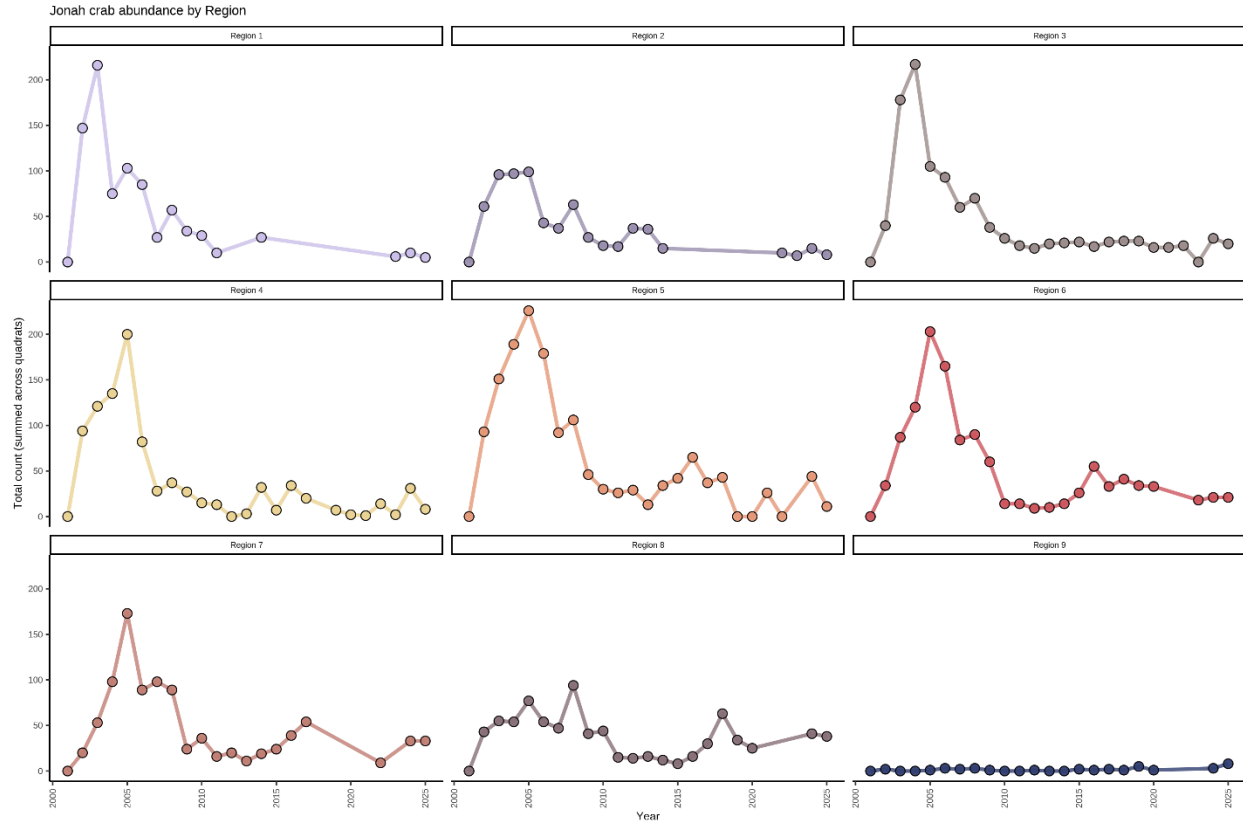


Figure 8: Total Jonah crab abundance by region through time (all depth strata combined). Annual totals are summed across all surveyed quadrats within each region.

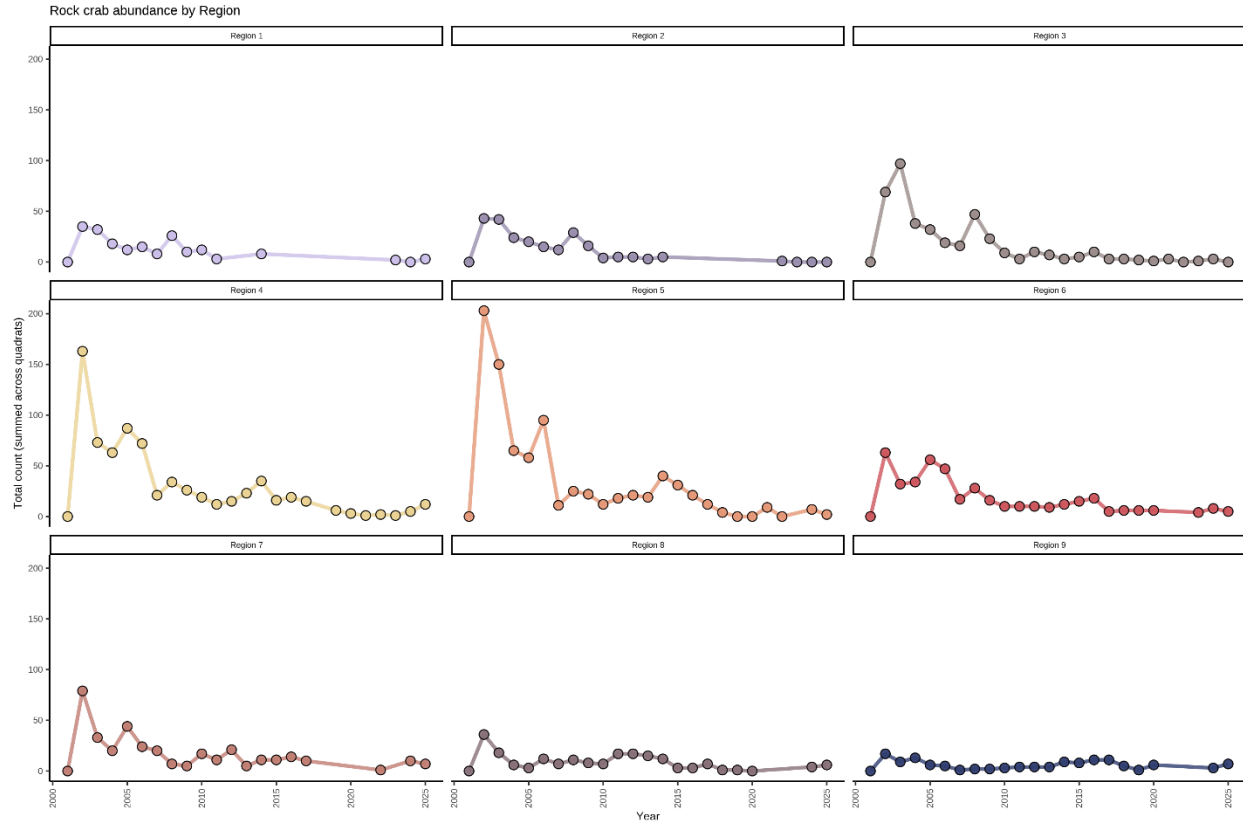


Figure 9: Total rock crab abundance by region through time (all depth strata combined). Annual totals are summed across all surveyed quadrats within each region.

Lobster abundance is a bit more mixed, with regions 4, 5 and 9 showing small increases in abundance while the rest decline (see Figure 10). It is worth noting that while this survey records lobster when seen, we are not surveying their preferred habitat.

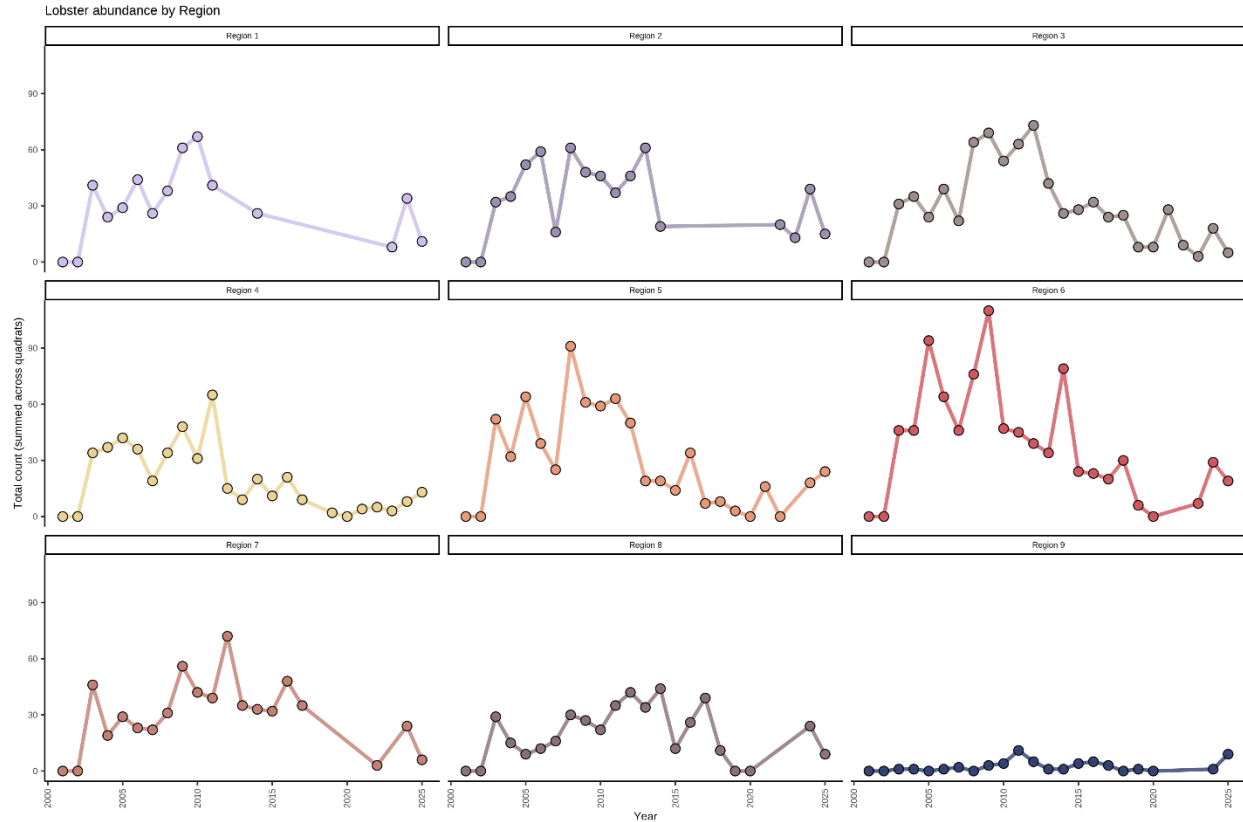


Figure 10: Total lobster abundance by region through time (all depth strata combined). Annual totals are summed across all surveyed quadrats within each region.

Invasive and Emerging Species

Didemnum vexillum

Across the survey, *Didemnum* (*Didemnum vexillum*) shows a consistent, broad increase in occurrence: “any presence” is increasing in every region and depth stratum, with the strongest gains in a few places (notably Region 6 Depth Stratum 2, and multiple strata in regions 1–2) (see Figure 11). In contrast, the “common” category (>50% cover) is generally flat-to-slightly increasing, and in many region–depth combinations it remains stable at (or very near) zero, suggesting that while *Didemnum* is showing up more often across the coast, it is usually present at lower cover levels rather than frequently forming high-coverage infestations—at least over the time period summarized.

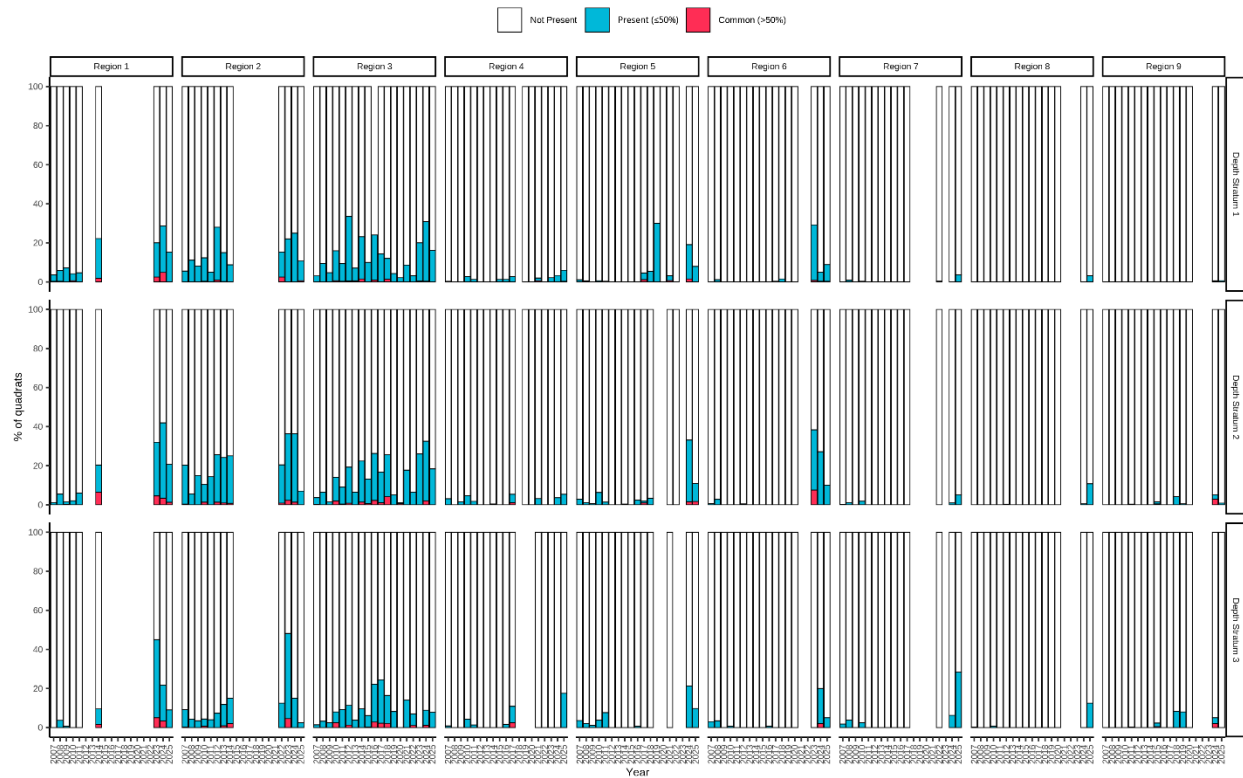


Figure 11: For each region and depth stratum, stacked bars show the percentage of surveyed quadrats classified as Not Present, Present ($\leq 50\%$ cover), or Common ($> 50\%$ cover) for the invasive colonial tunicate *Didemnum vexillum* from 2007 onward.

European Tunicate

Overall, the European tunicate (*Ascidella aspersa*) shows a generally declining footprint from 2024 - 2025 (see Figure 12). “Any presence” decreases in many region–depth combinations, with only a few scattered increases or consistently stable areas.

At the same time, the “common” category ($> 50\%$ cover) is usually flat at or near zero. When it does change, it more often decreases than increases. This suggests that at the sites we monitor, changes are driven more by how often the tunicate is detected than by increases in high-cover infestations.

European tunicate (*A. aspersa*) 2024-2025
 Percent of quadrats by status

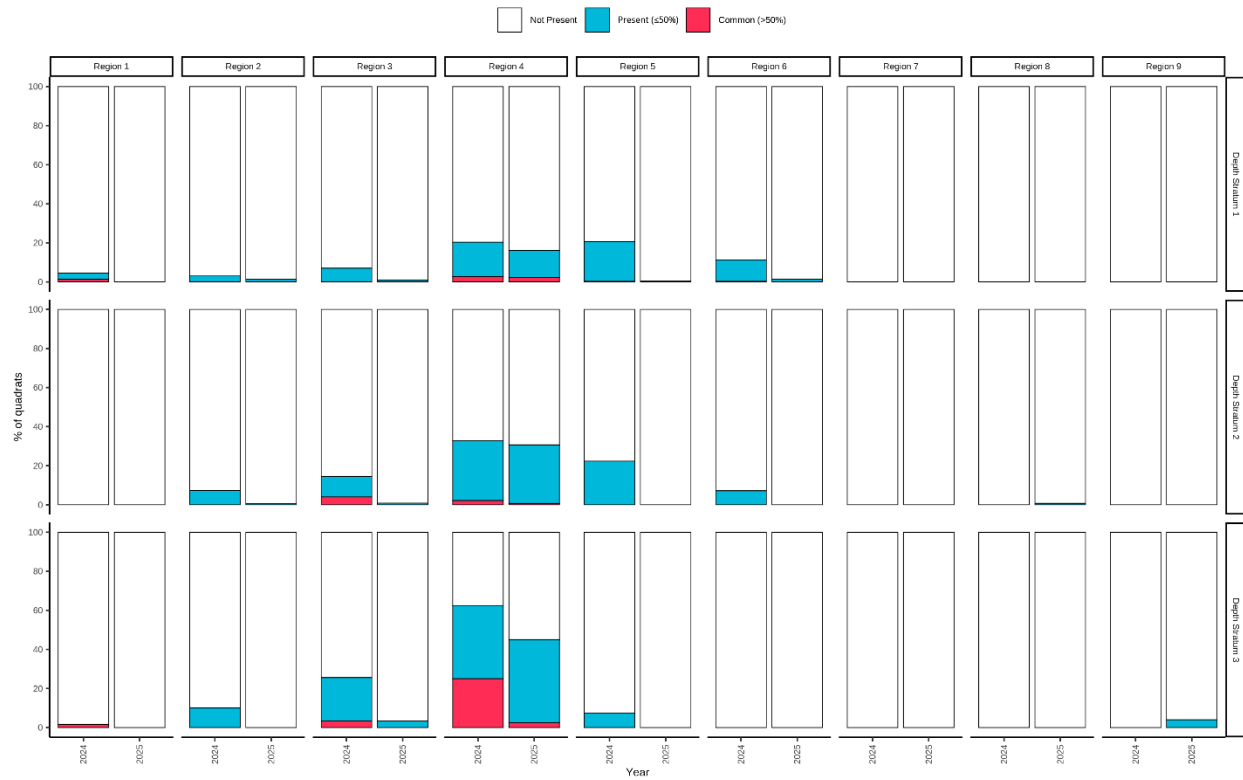


Figure 12: For each region and depth stratum, stacked bars show the percent of surveyed quadrats classified as Not Present, Present ($\leq 50\%$ cover), or Common ($> 50\%$ cover) for the invasive European tunicate, *Asciidiella aspersa*, in 2024–2025.

Ephemeral Red Algae

Across all regions and depth strata red algae generally shows an increasing pattern from 2024 to 2025 (see Figure 13). Nearly every region has positive slopes, suggesting filamentous red algae made up a larger fraction of the understory layer in 2025 than in 2024. The exceptions are region 5, depth strata 2 and 3, and region 9 where the red algae share or the understory is decreasing.

Understory cover split by filamentous red algae (2024–2025)

Bars show mean understory cover split into filamentous red algae vs remaining understory

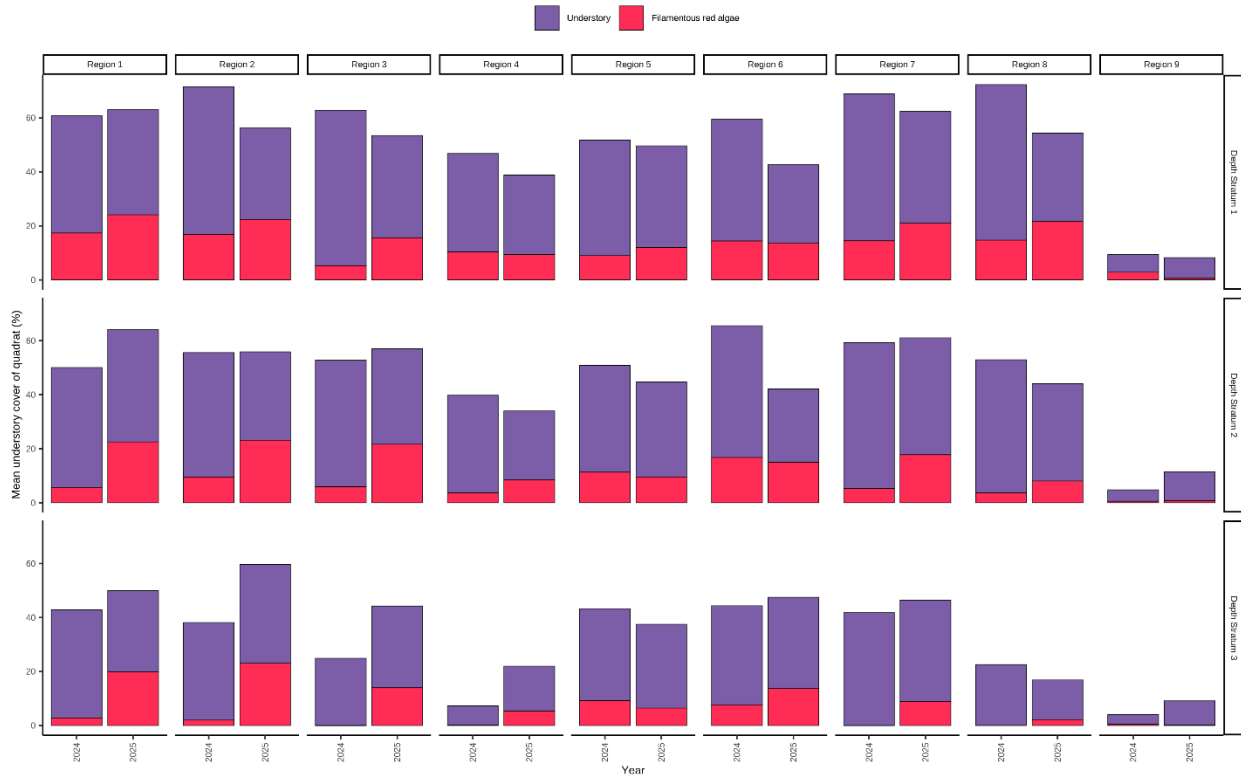


Figure 13: Mean understory cover (%) is shown for each region and depth stratum in 2024–2025, split into the portion attributable to filamentous red algae versus the remaining understory. Red algae values represent the percent of the understory layer comprised of filamentous red algae, converted to absolute quadrat cover for display.

Desmarestia

Desmarestia (share of canopy) shows a more mixed pattern (see Figure 14). Several regions show increases in at least some depth strata (for example, Regions 1, 4, 5, and 6), but there are notable decreases in regions 2, 3, 7, and 8 (most consistently in-Depth Stratum 1, and in some cases Depth Stratum 2 as well). A few region × stratum combinations are stable at zero, which reflects Desmarestia not being observed/recorded in those panels during these first two years rather than evidence of no change.

Canopy cover split by *Desmarestia* (2024–2025)
 Bars show mean canopy cover split into *Desmarestia* vs remaining canopy

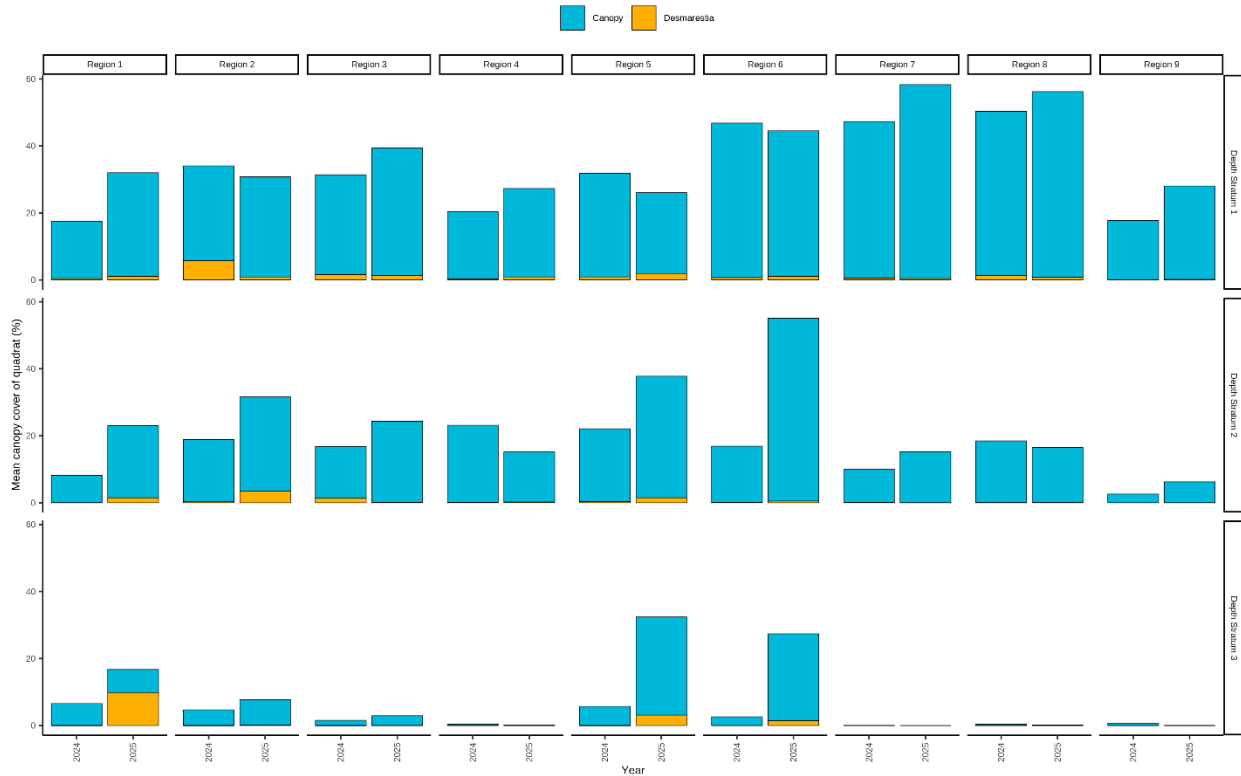


Figure 14: Mean canopy cover (%) is shown for each region and depth stratum in 2024–2025, split into the portion attributable to *Desmarestia* versus the remaining canopy. *Desmarestia* values represent the percent of the canopy layer comprised of *Desmarestia*, converted to absolute quadrat cover for display.

Conclusion

Maine’s long-term, fishery-independent dive survey provides a standardized, coastwide dataset to track nearshore benthic conditions across regions and depth strata since 2001, using repeated quadrat-based observations at sentinel and random sites (with coverage varying by year and stratum, and some newer metrics only available recently). Across the time series, the clearest signal is broadly declining urchin biomass in most region–depth combinations, alongside generally declining or flat-to-decreasing patterns for several associated invertebrate groups. Algal communities also reflect a persistent structural shift, with canopy cover often decreasing and crust cover frequently increasing, and the 2024–2025 additions improving resolution on understory red algae and *Desmarestia* within canopy where collected. Overall, these patterns underscore the value of maintaining (and strengthening where possible) a consistent monitoring program to detect long-term change, compare conditions across space and depth, and document emerging shifts in Maine’s coastal ecosystems.

Acknowledgments

The Maine Department of Marine Resources thanks the commercial urchin divers, vessel tenders, and industry members who continue to support and participate in this long-term monitoring effort. Their expertise and collaboration have been vital to the success of the dive survey since its inception.

References

Grabowski, R. C., Windholz, T., & Chen, Y. (2005). Estimating exploitable stock biomass for the Maine green sea urchin (*Strongylocentrotus droebachiensis*) fishery using a spatial statistics approach. *Fishery Bulletin*, 103(2), 320–330.

Appendices

Appendix A: Regional Map of Survey Sites (2025)

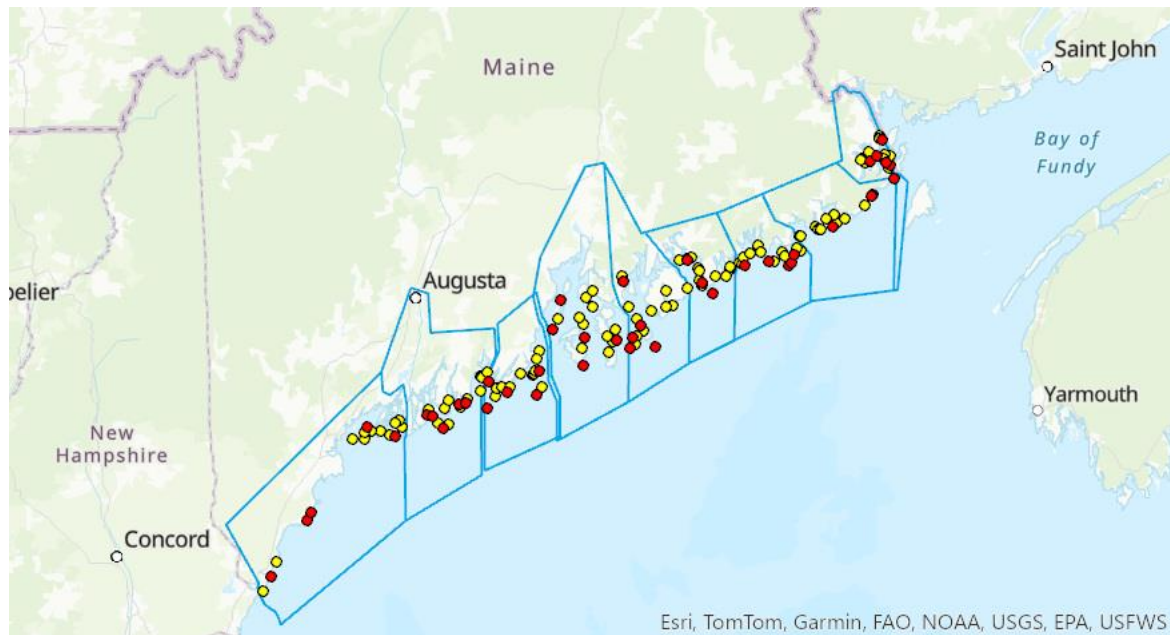


Figure 15: 2025 Dive Survey Sites visited, red circles denote Sentinel Sites and yellow circles denote Random sites.

Appendix B: Trend Summary Tables (Linear Slopes by region and depth stratum)

Table 1: Urchin test diameter trend summary by region and depth stratum. For each region–depth stratum combination, the table reports sample size (number of measured urchins and number of survey years), the fitted linear trend in test diameter through time (slope in mm/year and intercept), and the direction of change (increasing/decreasing/stable), along with the estimated percent change per year relative to the mean diameter for that region–stratum.

| region | zone | n_urchins | n_years | slope | intercept | trend | pct_change_per_year |
|----------|-----------------|-----------|---------|----------|-----------|------------|---------------------|
| Region 1 | Depth Stratum 1 | 479 | 15 | 0.149687 | -270.709 | Increasing | 0.494042 |
| Region 1 | Depth Stratum 2 | 537 | 15 | 0.448939 | -879.667 | Increasing | 1.956821 |
| Region 1 | Depth Stratum 3 | 332 | 15 | -0.3205 | 673.1441 | Decreasing | -1.10323 |
| Region 2 | Depth Stratum 1 | 843 | 18 | -0.51429 | 1074.688 | Decreasing | -1.22796 |
| Region 2 | Depth Stratum 2 | 1134 | 18 | -0.67172 | 1382.262 | Decreasing | -1.93843 |
| Region 2 | Depth Stratum 3 | 840 | 18 | -0.78422 | 1602.822 | Decreasing | -2.68798 |
| Region 3 | Depth Stratum 1 | 2416 | 25 | -0.32681 | 695.8283 | Decreasing | -0.83844 |
| Region 3 | Depth Stratum 2 | 1793 | 24 | -0.57542 | 1188.687 | Decreasing | -1.73662 |
| Region 3 | Depth Stratum 3 | 1059 | 23 | -0.8305 | 1699.241 | Decreasing | -2.53832 |
| Region 4 | Depth Stratum 1 | 3959 | 24 | -0.00362 | 44.82654 | Decreasing | -0.00964 |
| Region 4 | Depth Stratum 2 | 1192 | 24 | -0.2975 | 626.6582 | Decreasing | -1.03056 |
| Region 4 | Depth Stratum 3 | 391 | 18 | -0.52465 | 1079.703 | Decreasing | -1.88424 |
| Region 5 | Depth Stratum 1 | 2582 | 24 | 0.269356 | -503.668 | Increasing | 0.718668 |
| Region 5 | Depth Stratum 2 | 1572 | 22 | -0.45686 | 948.205 | Decreasing | -1.47935 |
| Region 5 | Depth Stratum 3 | 1024 | 19 | -0.50779 | 1047.678 | Decreasing | -1.7553 |
| Region 6 | Depth Stratum 1 | 3448 | 23 | 0.406744 | -774.24 | Increasing | 0.965046 |
| Region 6 | Depth Stratum 2 | 2611 | 20 | -0.39895 | 836.7389 | Decreasing | -1.09448 |
| Region 6 | Depth Stratum 3 | 1688 | 20 | -0.62933 | 1298.247 | Decreasing | -1.73674 |
| Region 7 | Depth Stratum 1 | 1625 | 20 | 0.410355 | -771.028 | Increasing | 0.783157 |
| Region 7 | Depth Stratum 2 | 2273 | 19 | -0.08348 | 215.3116 | Decreasing | -0.17449 |
| Region 7 | Depth Stratum 3 | 1799 | 18 | -0.34115 | 730.6341 | Decreasing | -0.73166 |
| Region 8 | Depth Stratum 1 | 3259 | 22 | 0.024348 | 3.399631 | Increasing | 0.046568 |
| Region 8 | Depth Stratum 2 | 4396 | 20 | 0.191407 | -336.141 | Increasing | 0.398477 |
| Region 8 | Depth Stratum 3 | 3683 | 20 | 0.379739 | -714.636 | Increasing | 0.805243 |
| Region 9 | Depth Stratum 1 | 8511 | 22 | 0.494451 | -959.839 | Increasing | 1.478194 |
| Region 9 | Depth Stratum 2 | 6559 | 22 | 0.460665 | -892.856 | Increasing | 1.433419 |
| Region 9 | Depth Stratum 3 | 5007 | 22 | 0.280701 | -531.653 | Increasing | 0.882765 |

Table 2: Algal cover trend summary by region and depth stratum. Linear trends in mean percent cover for canopy, understory, and crust algae are reported as slope (percentage points per year) with an increasing/decreasing/stable classification, based on quadrats where algal cover was recorded (NA values treated as not recorded rather than zero).

| region | zone | algal_type | n_year s | mean_cover_ove r all | pct_points_per_ye ar | pct_change_per_ye ar | trend |
|--------|------|------------|-------------|----------------------------|-------------------------|-------------------------|-------|
|--------|------|------------|-------------|----------------------------|-------------------------|-------------------------|-------|

| | | | | | | | |
|----------|-----------------|------------|----|----------|----------|----------|------------|
| Region 1 | Depth Stratum 1 | Canopy | 15 | 31.80075 | -0.8013 | -2.51975 | Decreasing |
| Region 1 | Depth Stratum 1 | Crust | 15 | 44.80101 | 0.134401 | 0.299995 | Increasing |
| Region 1 | Depth Stratum 1 | Understory | 15 | 65.06526 | -0.01532 | -0.02355 | Decreasing |
| Region 1 | Depth Stratum 2 | Canopy | 15 | 18.70364 | -0.36377 | -1.94489 | Decreasing |
| Region 1 | Depth Stratum 2 | Crust | 15 | 42.10206 | 0.840366 | 1.996022 | Increasing |
| Region 1 | Depth Stratum 2 | Understory | 15 | 62.8251 | -0.40064 | -0.6377 | Decreasing |
| Region 1 | Depth Stratum 3 | Canopy | 15 | 8.685337 | -0.06176 | -0.71113 | Decreasing |
| Region 1 | Depth Stratum 3 | Crust | 15 | 42.59338 | 0.747073 | 1.753965 | Increasing |
| Region 1 | Depth Stratum 3 | Understory | 15 | 47.20253 | -0.03699 | -0.07837 | Decreasing |
| Region 2 | Depth Stratum 1 | Canopy | 18 | 29.10485 | -0.21747 | -0.74721 | Decreasing |
| Region 2 | Depth Stratum 1 | Crust | 18 | 48.04895 | 0.646282 | 1.34505 | Increasing |
| Region 2 | Depth Stratum 1 | Understory | 18 | 69.48078 | -0.14933 | -0.21492 | Decreasing |
| Region 2 | Depth Stratum 2 | Canopy | 18 | 21.25296 | -0.27564 | -1.29694 | Decreasing |
| Region 2 | Depth Stratum 2 | Crust | 18 | 45.84932 | 0.597515 | 1.303215 | Increasing |
| Region 2 | Depth Stratum 2 | Understory | 18 | 61.73957 | -0.03019 | -0.0489 | Decreasing |
| Region 2 | Depth Stratum 3 | Canopy | 18 | 10.42195 | -0.33905 | -3.25324 | Decreasing |
| Region 2 | Depth Stratum 3 | Crust | 18 | 48.92729 | 0.529996 | 1.083231 | Increasing |
| Region 2 | Depth Stratum 3 | Understory | 18 | 49.47312 | 0.214382 | 0.43333 | Increasing |
| Region 3 | Depth Stratum 1 | Canopy | 25 | 39.83136 | -1.0811 | -2.7142 | Decreasing |
| Region 3 | Depth Stratum 1 | Crust | 25 | 51.19615 | 0.069565 | 0.135878 | Increasing |
| Region 3 | Depth Stratum 1 | Understory | 25 | 63.28495 | 0.318124 | 0.502685 | Increasing |
| Region 3 | Depth Stratum 2 | Canopy | 25 | 24.36051 | -0.37724 | -1.54857 | Decreasing |
| Region 3 | Depth Stratum 2 | Crust | 25 | 44.04653 | -0.26872 | -0.61008 | Decreasing |

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|----------|-----------------|------------|----|----------|----------|----------|------------|
| Region 3 | Depth Stratum 2 | Understory | 25 | 56.79751 | -0.02898 | -0.05103 | Decreasing |
| Region 3 | Depth Stratum 3 | Canopy | 25 | 7.656825 | -0.28502 | -3.72237 | Decreasing |
| Region 3 | Depth Stratum 3 | Crust | 25 | 42.80787 | -0.63498 | -1.48333 | Decreasing |
| Region 3 | Depth Stratum 3 | Understory | 25 | 38.93862 | -0.10479 | -0.26911 | Decreasing |
| Region 4 | Depth Stratum 1 | Canopy | 24 | 33.0689 | -1.17876 | -3.56457 | Decreasing |
| Region 4 | Depth Stratum 1 | Crust | 24 | 52.39299 | 0.229399 | 0.437842 | Increasing |
| Region 4 | Depth Stratum 1 | Understory | 24 | 47.29258 | -0.23973 | -0.5069 | Decreasing |
| Region 4 | Depth Stratum 2 | Canopy | 24 | 20.52435 | -0.09889 | -0.48182 | Decreasing |
| Region 4 | Depth Stratum 2 | Crust | 24 | 44.18263 | -0.3941 | -0.89198 | Decreasing |
| Region 4 | Depth Stratum 2 | Understory | 24 | 44.96984 | 0.001351 | 0.003005 | Increasing |
| Region 4 | Depth Stratum 3 | Canopy | 22 | 1.484346 | -0.15058 | -10.1446 | Decreasing |
| Region 4 | Depth Stratum 3 | Crust | 22 | 30.6567 | -0.98447 | -3.21129 | Decreasing |
| Region 4 | Depth Stratum 3 | Understory | 22 | 28.51998 | -0.14307 | -0.50166 | Decreasing |
| Region 5 | Depth Stratum 1 | Canopy | 24 | 39.4003 | -1.44519 | -3.66798 | Decreasing |
| Region 5 | Depth Stratum 1 | Crust | 24 | 44.38779 | -0.61385 | -1.38292 | Decreasing |
| Region 5 | Depth Stratum 1 | Understory | 24 | 43.56879 | -0.48153 | -1.10522 | Decreasing |
| Region 5 | Depth Stratum 2 | Canopy | 22 | 23.21769 | 0.077452 | 0.33359 | Increasing |
| Region 5 | Depth Stratum 2 | Crust | 22 | 43.51142 | -0.90077 | -2.07019 | Decreasing |
| Region 5 | Depth Stratum 2 | Understory | 22 | 44.22953 | 0.080471 | 0.181939 | Increasing |
| Region 5 | Depth Stratum 3 | Canopy | 21 | 7.380331 | 0.415764 | 5.633409 | Increasing |
| Region 5 | Depth Stratum 3 | Crust | 21 | 45.64943 | -1.23288 | -2.70075 | Decreasing |
| Region 5 | Depth Stratum 3 | Understory | 21 | 34.82787 | 0.87904 | 2.523955 | Increasing |
| Region 6 | Depth Stratum 1 | Canopy | 23 | 54.21173 | -0.82073 | -1.51393 | Decreasing |

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|----------|-----------------|------------|----|----------|----------|----------|------------|
| Region 6 | Depth Stratum 1 | Crust | 23 | 58.77888 | -0.92865 | -1.5799 | Decreasing |
| Region 6 | Depth Stratum 1 | Understory | 23 | 41.75538 | 1.188819 | 2.847105 | Increasing |
| Region 6 | Depth Stratum 2 | Canopy | 23 | 27.34992 | 0.615618 | 2.250895 | Increasing |
| Region 6 | Depth Stratum 2 | Crust | 23 | 61.45115 | -1.16617 | -1.89772 | Decreasing |
| Region 6 | Depth Stratum 2 | Understory | 23 | 43.72053 | 1.465235 | 3.351366 | Increasing |
| Region 6 | Depth Stratum 3 | Canopy | 23 | 5.849829 | 0.441025 | 7.539102 | Increasing |
| Region 6 | Depth Stratum 3 | Crust | 23 | 65.06326 | -1.03589 | -1.59213 | Decreasing |
| Region 6 | Depth Stratum 3 | Understory | 23 | 32.62337 | 1.672723 | 5.127376 | Increasing |
| Region 7 | Depth Stratum 1 | Canopy | 20 | 62.94324 | -1.13751 | -1.80719 | Decreasing |
| Region 7 | Depth Stratum 1 | Crust | 20 | 49.10915 | 0.01717 | 0.034964 | Increasing |
| Region 7 | Depth Stratum 1 | Understory | 20 | 61.13308 | 0.57164 | 0.935075 | Increasing |
| Region 7 | Depth Stratum 2 | Canopy | 20 | 20.03385 | -0.64509 | -3.22002 | Decreasing |
| Region 7 | Depth Stratum 2 | Crust | 20 | 54.40634 | -0.81844 | -1.50432 | Decreasing |
| Region 7 | Depth Stratum 2 | Understory | 20 | 50.7046 | 0.668576 | 1.318571 | Increasing |
| Region 7 | Depth Stratum 3 | Canopy | 20 | 1.804298 | -0.13672 | -7.57759 | Decreasing |
| Region 7 | Depth Stratum 3 | Crust | 20 | 64.40758 | -0.47533 | -0.738 | Decreasing |
| Region 7 | Depth Stratum 3 | Understory | 20 | 31.06977 | 0.934606 | 3.008087 | Increasing |
| Region 8 | Depth Stratum 1 | Canopy | 22 | 59.69312 | -1.11937 | -1.87521 | Decreasing |
| Region 8 | Depth Stratum 1 | Crust | 22 | 50.66731 | -0.30728 | -0.60646 | Decreasing |
| Region 8 | Depth Stratum 1 | Understory | 22 | 60.53118 | 0.220865 | 0.364877 | Increasing |
| Region 8 | Depth Stratum 2 | Canopy | 22 | 23.15944 | -0.73743 | -3.18415 | Decreasing |
| Region 8 | Depth Stratum 2 | Crust | 22 | 58.32989 | -0.67002 | -1.14867 | Decreasing |
| Region 8 | Depth Stratum 2 | Understory | 22 | 40.983 | 0.835593 | 2.038877 | Increasing |

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|----------|-----------------|------------|----|----------|----------|----------|------------|
| Region 8 | Depth Stratum 3 | Canopy | 22 | 4.018939 | -0.20675 | -5.14444 | Decreasing |
| Region 8 | Depth Stratum 3 | Crust | 22 | 60.78532 | -0.55158 | -0.90743 | Decreasing |
| Region 8 | Depth Stratum 3 | Understory | 22 | 21.85393 | 0.348533 | 1.594831 | Increasing |
| Region 9 | Depth Stratum 1 | Canopy | 22 | 16.19703 | -0.12918 | -0.79755 | Decreasing |
| Region 9 | Depth Stratum 1 | Crust | 22 | 35.61917 | 0.136382 | 0.382889 | Increasing |
| Region 9 | Depth Stratum 1 | Understory | 22 | 9.633418 | -0.11317 | -1.17482 | Decreasing |
| Region 9 | Depth Stratum 2 | Canopy | 22 | 3.145726 | -0.1078 | -3.42695 | Decreasing |
| Region 9 | Depth Stratum 2 | Crust | 22 | 33.11676 | 0.094346 | 0.284887 | Increasing |
| Region 9 | Depth Stratum 2 | Understory | 22 | 8.943542 | 0.152918 | 1.70982 | Increasing |
| Region 9 | Depth Stratum 3 | Canopy | 22 | 0.27399 | -0.03575 | -13.047 | Decreasing |
| Region 9 | Depth Stratum 3 | Crust | 22 | 26.77466 | 0.193474 | 0.722601 | Increasing |
| Region 9 | Depth Stratum 3 | Understory | 22 | 7.854024 | 0.197779 | 2.518192 | Increasing |