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Natural Resource Stewardship and Science

Rocky Intertidal Monitoring

2019–2020 Results from Redwood National and State Parks

Natural Resource Report NPS/KLMN/NRR—2023/2608



ON THE COVER
The intertidal community at Damnation Creek, Redwood National and State Parks.
Photograph by Karah Ammann

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Natural Resource Report NPS/KLMN/NRR—2023/2608

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Executive Summary

This report presents the results of the monitoring surveys done in 2019 and 2020 of the rocky intertidal community at three sites within the Redwood National and State Parks (RNSP) in Del Norte County, California. These sites are part of MARINe (Multi-Agency Rocky Intertidal Network), a regional intertidal monitoring network sponsored by the Bureau of Ocean Energy Management (BOEM), with additional funding and support from local and state governments, universities, and private organizations (see www.marine.ucsc.edu). Funding for annual monitoring in RNSP is provided by the National Park Service (NPS) Klamath Network (KLMN) through a cooperative agreement with the University of California at Santa Cruz (UCSC). Field sampling is accomplished through a collaborative effort between UCSC and RNSP staff. The 2019 and 2020 field crews each consisted of 4 UCSC biologists and three RNSP staff members.

This monitoring program, adapted from MARINe protocols, was designed to identify and follow temporal trends in populations of the common and/or ecologically important organisms in the rocky intertidal community at three index sites within the RNSP. To accomplish this, sites are sampled once a year, and data are collected from permanent plots established to monitor changes in sessile invertebrates, algae, and the ochre sea star (*Pisaster ochraceus*), and from permanent transects to monitor surfgrass (*Phyllospadix* spp.) and sea palm (*Postelsia palmaeformis*). These data are utilized to determine annual status of the community and archived for future use to explore broader spatial and temporal trends. All of the monitored populations varied to some degree over the course of 2019–2020.

The KLMN rocky intertidal monitoring program ("RNSP rocky intertidal monitoring program" in previous reports; Amman et al. 2022), which started in RNSP in 2004, continues to progress successfully. The procedures for data collection, data management, data analysis, and reporting are regularly assessed and have undergone some revisions based on the evolution of the monitoring program (Ammann and Raimondi 2008; protocol revision in progress [Eric Dinger, National Park Service ecologist, pers. comm., Jan 23, 2023]). As such, this year's report follows on Amman et al. (2022) which introduced new reporting. Amman et al. (2022) and this report include broader scale biodiversity data collected through Coastal Biodiversity Survey protocol. These biodiversity data are sampled at 2 of the 3 sites every sampling period. This report differs from earlier annual reports in shifting from a full summary report, with in-depth analysis, to an administrative data summary report that does not contain in-depth analyses. Subsequent reports will follow this format. This report also reports on optional MARINe protocol data we collected that are not part of the KLMN rocky intertidal protocol (e.g., mussel sizes and sea palm measurements). Some of these optional data measurements may be discontinued in future years. More comprehensive trend analyses of the data are available in the program's 5-year trend reports, the first of which included data through 2013 (Ammann et al. 2017) and the consecutive trend paper through 2018 (Lohse et al. in press).

Acknowledgments

We thank the 2019–2020 field crew for their hard work and dedication to the project: Laura Anderson, David Lohse and Nathan Fletcher. We also appreciate the field assistance from Redwood National and State Parks staff, including David Anderson, Terry Hines, Kyle Max, Heather Brown, Kelly Breen, Teresa King, and numerous seasonal staff and volunteers. Rani Gaddam from UCSC, Allison Snyder, Sonya Daw, Alice Chung-MacCoubrey, and Jeri Stoller from the Klamath Network have provided editorial, technical, and data assistance. Dr. Pete Raimondi (UCSC) is the Principal Investigator for the cooperative agreement and field work at Redwood National and State Parks.

Introduction

Among the many concerns of resource managers is the ability to detect and mitigate the effects of anthropogenic events, like oil spills and climate change, which can alter the structure of natural communities. An important tool needed to accomplish this is long-term monitoring programs that establish baseline data and follow changes over time (Davis 2005). Such programs provide important information needed to distinguish natural changes in community structure from those caused by severe episodic (like disease) or anthropogenic events. As such, a consortium of monitoring programs has been established for rocky intertidal habitats, including protocols used in Redwood National and State Parks (RNSP) as part of the Klamath Inventory and Monitoring Network (KLMN) vital signs monitoring programs.

The Bureau of Ocean Energy Management (BOEM), part of the U.S. Department of Interior, and the Partnership for the Interdisciplinary Studies of Coastal Oceans (PISCO) have been working in concert with a number of academic and government organizations to monitor intertidal zones along the western coast of North America, from Alaska to California. Community Structure Surveys of the rocky intertidal zone have been conducted by PISCO and members of Multi-Agency Rocky Intertidal Network (MARINe), a monitoring consortium including over 20 coastwide agencies. Several other coastal national parks, including Cabrillo National Monument, Golden Gate National Recreation Area, Point Reyes National Seashore, and Channel Islands National Park, have intertidal monitoring programs to establish baseline datasets of their marine resources and to follow changes in these resources (Davis and Halvorson 1996; Davis 2005). Because such monitoring allows changes to be tracked within and between communities over yearly time scales, it provides critical information needed to make informed management decisions. Further, understanding these patterns is necessary for detecting changes resulting from disturbances such as oil spills or global climate change.

The Community Structure Surveys were initiated in the early 1980s to determine abundance and distributional patterns of intertidal species along the southern California coast (Ambrose et al. 1992). Since then, sites have been added in central and northern California, Oregon, Washington, and Alaska. The Klamath Network has adapted the protocols used in these surveys (Engle 2005, updated to Engle et al. 2022) to monitor the intertidal communities within RNSP (Ammann and Raimondi 2008). This facilitates comparisons between the RNSP sites and those elsewhere along the coast.

The specific monitoring objectives of the KLMN rocky intertidal monitoring program ("RNSP rocky intertidal monitoring program" in previous reports; Amman et al. 2022) conducted at RNSP, include the following:

- Monitor the temporal dynamics of target invertebrate, algal, and surfgrass species at accessible, representative, and historically sampled rocky intertidal sites at Redwood National and State Parks that can feasibly be monitored with the Klamath Inventory and Monitoring Network's intertidal monitoring budget ($30k/y) with the goal to 1) evaluate potential impacts of visitor use or other park-specific activities, and 2) provide monitoring information to help assess level of impacts and changes outside normal limits of variation due

to oil spills, nonpoint source pollution, or other anthropogenic stressors that may come from outside the parks.

- Determine status through time of morphology, disease/condition, and other key parameters describing population status (e.g., size, structure) of the selected intertidal organisms.
- Integrate with and contribute to a monitoring network spanning a broad geographic region in order to evaluate trends at multiple scales, from parkwide to regionwide.
- Detect and document invasions, changes in species ranges, the spread of diseases, and the rates and scales of processes affecting the structure and function of rocky intertidal populations and communities to better understand normal limits of variation.

The specific measurement and analysis objectives of the program are as follows:

- Provide a photographic record of sessile invertebrates and algae using fixed plots (photoplots) as reference.
- Determine the abundance (percent cover) of organisms within select fixed plots (interchangeably called photoplots or photoquadrats).
- Within fixed plots, determine the abundance of sea stars.
- Determine surfgrass abundance by measuring cover along fixed point-intercept transects.
- Identify changes that are inconsistent with the established baseline conditions, whether they are park-specific or broader in scale, and whether there are potential management actions needed to mitigate them.
- Prepare annual summary reports and 5-year, peer reviewed trend analysis reports showing data relevance following National Park Service reporting guidelines. Reports will display any major (>50%) changes in the abundance of target taxa between sampling intervals as a highlight for potential management actions.
- Under optional MARINe protocols that we will implement variously from year to year, additional measurement objectives include:
    - Measure sea palms using similar methods to surfgrass abundance. This is an optional MARINe parameter and was implemented at RNSP in 2014.
    - Measure mussel sizes and bed/patch thickness using an optional MARINe protocol implemented in 2011.
- Under protocol revisions currently in preparation, the additional measurement objectives are to quantify species distribution and abundance across sites using biodiversity surveys conducted by a team of taxonomic experts and are implemented in this study period.

The KLMN rocky intertidal monitoring program uses a park-based design with judgment selected sites that integrates with a long-term, spatially extensive program. The national parks are promoting the importance of marine resources by establishing long-term monitoring programs supported by the public and the scientific community. This effort will translate into a greater appreciation of these resources and an awareness of the importance of maintaining them for future generations. See www.eeb.ucsc.edu/pacificrockyintertidal for more information.

This annual report documents the results of data collected in 2019–2020 for the KLMN rocky intertidal monitoring program at RNSP (Ammann and Raimondi 2008). It also documents data collected as part of MARINe optional measurements (methods used in short-term studies by the larger monitoring consortium), plus community biodiversity data collected as investigations into protocol additions and revisions.

Study Area

Three rocky intertidal sites are monitored within RNSP: Enderts Beach, Damnation Creek, and False Klamath Cove (Figure 1). These index sites are approximately 5 km apart and span the nearly 20 km of rocky intertidal habitat present in RNSP. The sites are all located in an Area of Special Biological Significance (Redwood National Park ASBS).

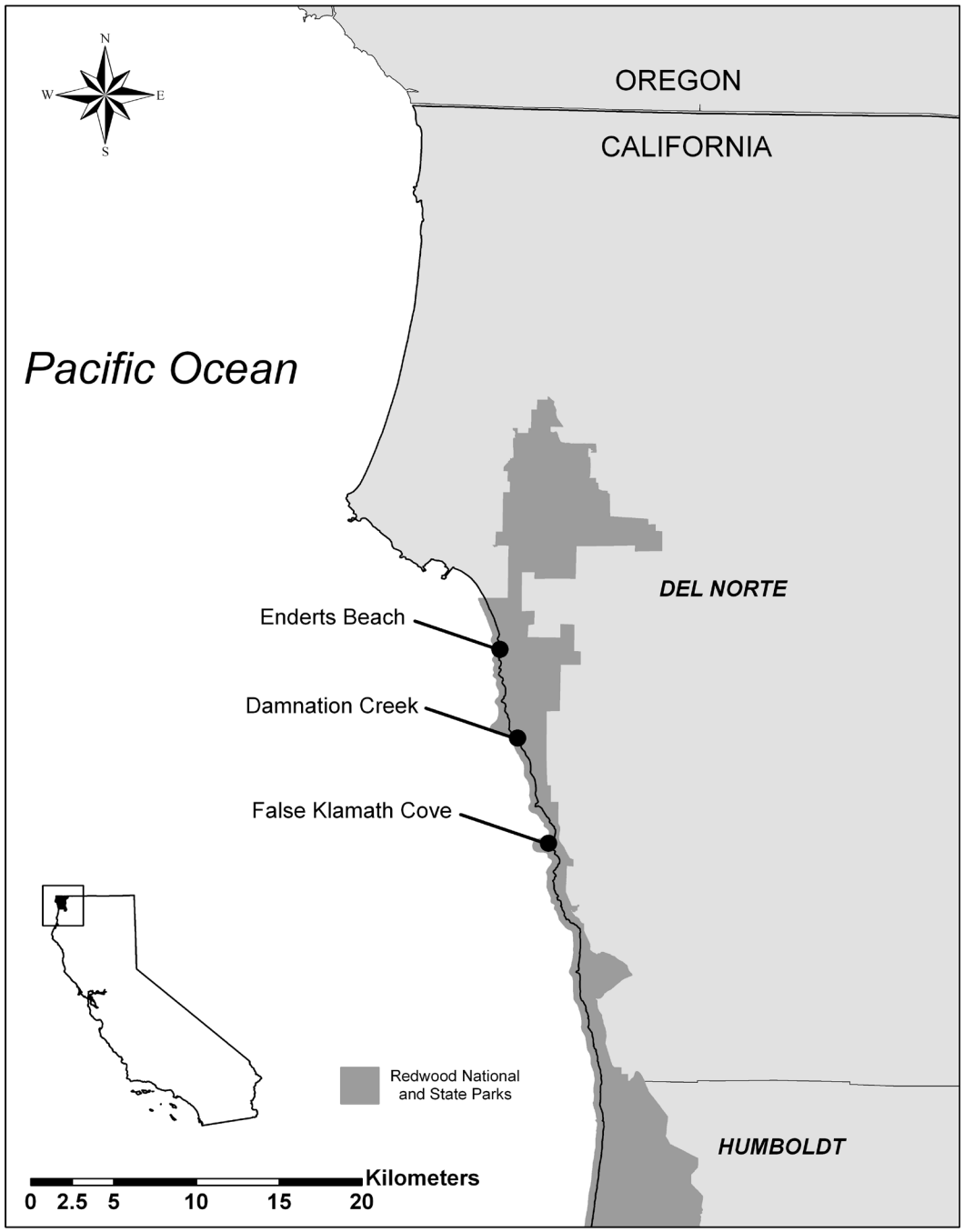


Figure 1. Map of northern California showing the locations of the study sites sampled in the spring and fall of each year within Redwood National and State Parks.

Enderts Beach, located at the southern end of Crescent Beach, is at the northern edge of RNSP. The site consists of a large, gently sloping bench (approximately 100 m wide) and a series of three smaller benches separated by surge channels, a few scattered boulders, and cobble beds. Rocky intertidal monitoring occurs on the three smaller benches. Public visitation is relatively low due to obstructed access through a cave. Enderts Beach is dominated by consolidated bedrock (greywacke mudstone/sandstone with calcite intrusions), and the area surrounding the site comprises a mixture of consolidated bedrock, boulder fields, and sandy beach. The primary coastal orientation of this site is west.

Damnation Creek is 5 km south of Enderts Beach and 6.5 km north of False Klamath Cove. It is an extensive rocky bench cut by channels, with a few large sedentary boulders at its seaward edge. To access this site, a 45-minute steep hike is required, and then Damnation Creek must be crossed. This site receives very low visitation by hikers. Damnation Creek is dominated by a mixture of consolidated bedrock, boulders, and cobble beach. The area surrounding the site comprises a mixture of consolidated bedrock, boulder fields, and cobble beach. The primary coastal orientation of this site is south/southwest. Although the site is near the mouth of Damnation Creek, most of the monitoring plots are established far enough away from the creek's outflow to avoid direct freshwater input. The exception to this is a series of mussel plots established within the path of the creek's outflow.

False Klamath Cove is located just south of Wilson Creek, about 8 km north of the Klamath River. This site has variable substrata ranging from coarse sand to large boulders. There is potential for temporal variation in sand scour and boulder movement. The intertidal study site is peninsula-like with the ocean to the north and south and a sea stack (approximately 75 m tall and 100 m wide) at the west end. The primary coastal orientation of this site is west. The peninsula stretches approximately 250 m long with a width of approximately 100 m. The site consists of a gently sloping field of boulders and small benches dominated by a mixture of consolidated bedrock, boulder fields, and cobble beach, and the area surrounding the site comprises a mixture of consolidated bedrock, boulder fields, and sandy beach. The vast majority of the sampling takes place on variously sized boulders.

Methods

Community Structure Surveys

Sample Design

The methods used for monitoring algal and invertebrate species in RNSP during the 2019–2020 monitoring years, and since monitoring began in 2004, are based on protocols developed by MARINe (marine.ucsc.edu). Protocols are explained in detail in Ammann and Raimondi (2008). In brief, the abundance of ecologically important organisms is measured in discrete, fixed plots that have been established in targeted assemblages. Using fixed plots allows the dynamics of species to be monitored with reasonable sampling effort and provides greater statistical power to detect changes over time but limits the statistical inference. Smaller (50 × 75 cm) plots are used to monitor sessile (or relatively nonmotile) algae and invertebrates. Larger, irregular plots are used to sample more mobile species. Transects (10 m) are used to sample surfgrass and sea palm. Data collection and reporting for 2019–2020 also include parameters measured as part of short-term MARINe monitoring (https://marine.ucsc.edu/methods/index.html) but that are not required by the KLMN protocol.

Field Log

Field logs were kept to provide a record of general observations made during the surveys at the monitoring sites. Recorded observations included weather conditions, participants, changes to or deviations from the protocols, and any unique or unusual occurrences. Physical and weather-related conditions were collected initially upon reaching the site, as were counts of birds, marine mammals, and humans. These data included tidal information, temperature, wind, levels of rain, sand scour, plant wrack, dead animals, and trash.

Photoplots

At each site, photoplots (50 × 75 cm) were used to record changes in abundance (measured as percent cover) of conspicuous, abundant, and ecologically important species, including mussels (*Mytilus californianus*), barnacles (*Chthamalus dalli/Balanus glandula*), and three species of algae: turfweed (*Endocladia muricata*), dwarf rockweed (*Pelvetiopsis limitata*), and rockweed (*Fucus gardneri*) (Figure 2).

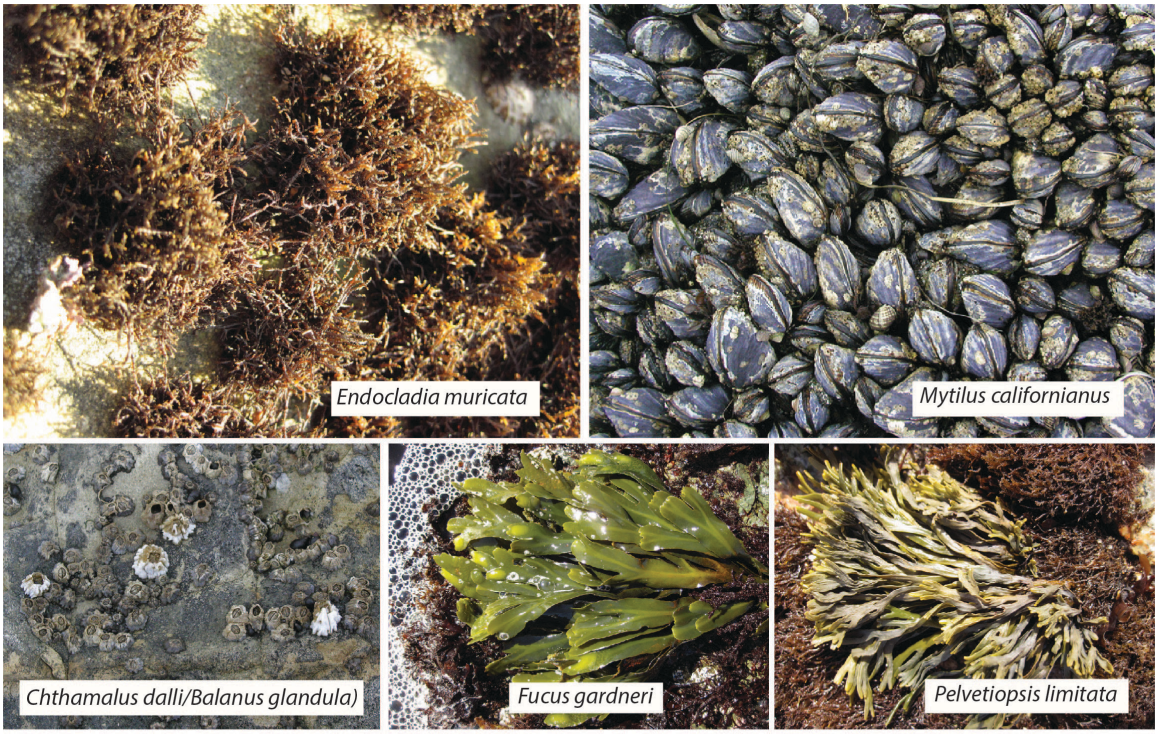


Figure 2. Photographs depicting the 5 target species sampled in permanent photoplots in Redwood National and State Parks.

Five photoplots were established for each species (Table 1), and the location of each plot was chosen to maximize the abundance of the targeted species. Because the rockweed (*Fucus*) was not abundant at Enderts Beach, and dwarf rockweed (*Pelvetiopsis*) was not abundant at Damnation Creek, no plots were set up to monitor these species at those sites. At Damnation Creek, 5 additional mussel plots were established in the outflow of Damnation Creek, where salinity is often much lower than in the other mussel plots (Cox and McGary 2006). At low tide the salinity of the water surrounding the mussel plots near Damnation Creek has been recorded to be as low as 22 ppt (parts per thousand) compared to the average ocean salinity between 32 and 35 ppt.

Table 1. Summary of species monitored in photoplots at Redwood National and State Park sites, including number of replicate plots.

	Mussels	**Barnacles**	**Rockweeds/Sessile algae species**		
Site	***Mytilus* spp.**	***Chthamalus/ Balanus***	***Pelvetiopsis limitata***	***Endocladia muricata***	***Fucus gardneri***
Enderts Beach	5 plots	5 plots	5 plots	5 plots	–
Damnation Creek	10 plots*	5 plots	–	5 plots	5 plots
False Klamath Cove	5 plots	5 plots	5 plots	5 plots	5 plots

* Five mussel plots are located away from creek outflow and five plots are located near the outflow of Damnation Creek.

The photoplots were marked by three permanent bolts and were photographed using a digital camera mounted on a PVC photo-framer. The abundances (percent cover) of all sessile species in the photoplots were determined using a rectangular grid of 100 uniformly spaced points. This grid was placed over the plot and the taxon under each point was identified. In 2014 a new layering Standard Operating Procedure (SOP) was implemented, based on MARINe, that allowed more than 1 taxon to be recorded per point whenever multiple layers were present. Apple iPads were used to record these data in the field. Due to COVID-19 global pandemic travel restrictions and a reduced crew in 2020, False Klamath Cove photoplots were photographed in the field but lab scored using an AI image analysis program. These results are not within the scope of the protocol, are not verified, and not included in the report.

Sea Stars

Irregularly-shaped, large (greater than 1 × 10 m) permanent plots were used to monitor the size and abundance of the ochre sea star. Three plots were monitored at Damnation Creek and False Klamath Cove, and 2 plots were sampled at Enderts Beach. These plots varied in size and were established in areas where sea stars were abundant (preferably >20 individuals per plot) and were thus not intended to quantify the overall density of sea stars at the site. Each ochre sea star encountered was counted and measured. Other rarer sea stars, such as the bat star (*Patiria miniata*), giant sea star (*Pisaster giganteus*), sunflower star (*Pycnopodia helianthoides*), six-armed star (*Leptastarias hexactis*), and leather sea star (*Dermasterias imbricata*), were also counted when encountered. *Katharina tunicata*, the leather or Katy chiton, was also monitored in these plots. Since the onset of Sea Star Wasting Syndrome (SSWS) in 2013, monitoring groups, including the KLMN rocky intertidal team, have been recording the disease category of each sea star noted. More information and detailed sampling protocols for tracking SSWS can be found at seastarwasting.org.

Surfgrass and Sea Palm Abundance

To measure the abundance (percent cover) of surfgrass (*Phyllospadix scouleri/torreyi*), 2 permanent line transects were established at Damnation Creek. Note that surfgrass is not abundant at the other sites. Each transect was 10 m long and was sampled by noting the species under each 10 cm mark. Thickness of the surfgrass bed was measured every meter along the transects.

Starting in 2014 at False Klamath Cove, 2 permanent line transects, each 6 meters long, were established to measure the abundance (counts) of sea palm (*Postelsia palmaeformis*). Note that sea palms are not present at the other sites. Each transect line was divided into 1 m segments, and numbers of *Postelsia* were recorded in 1 × 1 m segments along both sides of the line. However, due to certain wave conditions and specific habitat requirements it may not be possible to sample the transects during every field survey. For example, *Postelsia* is found only in very wave exposed habitats, and therefore may not have been counted during every survey trip. This measurement is an optional MARINe parameter and may be discontinued if time limitations make it necessary to prioritize other species.

Mussel Measurement

Starting in 2011, mussel (*Mytilus californianu*s) sizes and bed/patch thickness were measured within each mussel photoplot. Ten length measurements (more if the mussel bed is multilayered) and 5

mussel bed/patch depth measurements were recorded in each plot. When combined with measures of mussel spatial cover and density (number of individuals per m^2), these measurements can provide estimates of site-wide mussel biomass. This procedure is an optional MARINe parameter and may be discontinued if time limitations make it necessary to prioritize metrics.

Sea Surface Temperature

Sea surface temperature was measured at each site using small TidbiT temperature data loggers (Onset Computer Corporation). These units were attached to the rock below the mussel zone, and set to record temperatures every 15 minutes. The units were changed out during each site visit, downloaded, and then reset for use again. Sea surface temperature was calculated only from those times of the day when the probe was underwater.

Coastal Biodiversity Surveys

Sample Design

Layered upon the above-described Community Structure Surveys are the additional goals of documenting species richness and changes in the distribution of species within and among sites over time. Coastal Biodiversity Surveys, designed to capture information about the rocky intertidal community as a whole (rather than targeted species), are used to address these goals. These surveys are much more intensive and require a high-level of expertise and consistency in the identification of marine organisms.

We trialed Coastal Biodiversity Surveys for the first time in 2017. For 2019 and 2020, we followed the proposed schedule of conducting them at 2 of the 3 RNSP sites each year with a rotating schedule that allows for each site to be sampled twice every 3 years. These surveys are conducted along a series of parallel transect lines permanently established from the high to low intertidal zone at each site (see Figure 3). For this report, the trialed methods have been adapted from a published protocol (https://marine.ucsc.edu/biodiversityprotocol.pdf) available from the MARINe website (https://marine.ucsc.edu/methods/biodiversity-methods.html). We present a simplified summary of the methods.

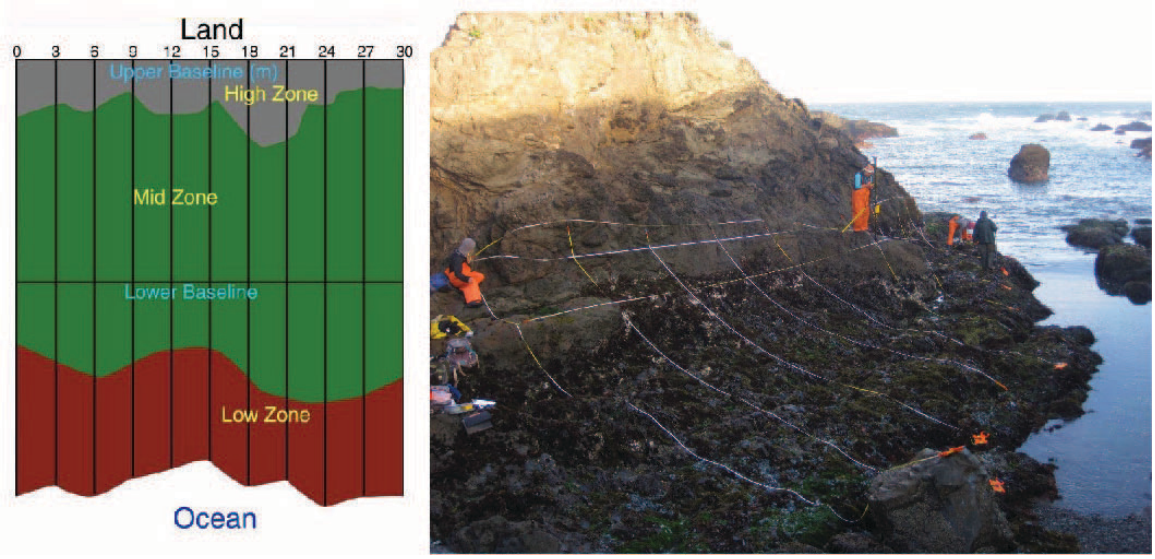


Figure 3. Example diagram of biodiversity grid set up (left) and photograph of grid set up (right). Baselines on the figure refer to monumented reference lines.

Point Contact Surveys

Point contact surveys are used to estimate the abundance and diversity of sessile intertidal taxa (algae and invertebrates). Each transect is sampled using the point intercept method to record the taxa found directly underneath approximately 100 points on each transect. Point contact data are recorded in the field directly with handheld tablet computers (i.e., Apple iPad mini) into a specially designed application created by DiveNav, Inc.

As part of the forthcoming protocol revisions, two variations of this method were used at RNSP sites: 1) first point only, and 2) full point. The first point method only records the identity of the topmost taxa visible under each point. In contrast, the full point method identifies the first three taxa under each point. Thus, if there are multiple taxa under a point, such as when there is layering or epibionts on hosts, more than one taxa are recorded per point. In addition, if fewer than three taxa are recorded under a point, then data are collected on the identity of the next one or two taxa closest to that point. Both variations of point contact surveys have been used on an alternate schedule so that each site is sampled with full points every three years and first point every three years. In 2019, Enderts was sampled first point and Damnation Creek was full point; in 2020 False Klamath Cove had a full point survey and Damnation Creek had a first point survey. The purpose of alternating the methods is to maximize the data collected and reduce sampling time. The full point surveys require a full day more of field time. Comparisons of data from the two methods are part of protocol revisions currently in progress and are not included here. Sampling trips include days with optimal low tides as well as days with less optimal tides (thus fewer workable hours), so rotating the point contact methods at sites each year is a way to optimize our sampling efforts.

Quadrat Sampling

Quadrat sampling is used to estimate the density of mobile invertebrates. Quadrat sampling consists of recording the abundance of all mobile invertebrate species within 0.5 × 0.5 m quadrats randomly

placed within each of the three biological intertidal zones (high, mid, and low) along each transect (Figure 4). Three quadrats are sampled along each transect, for a total of 33 quadrats per site.

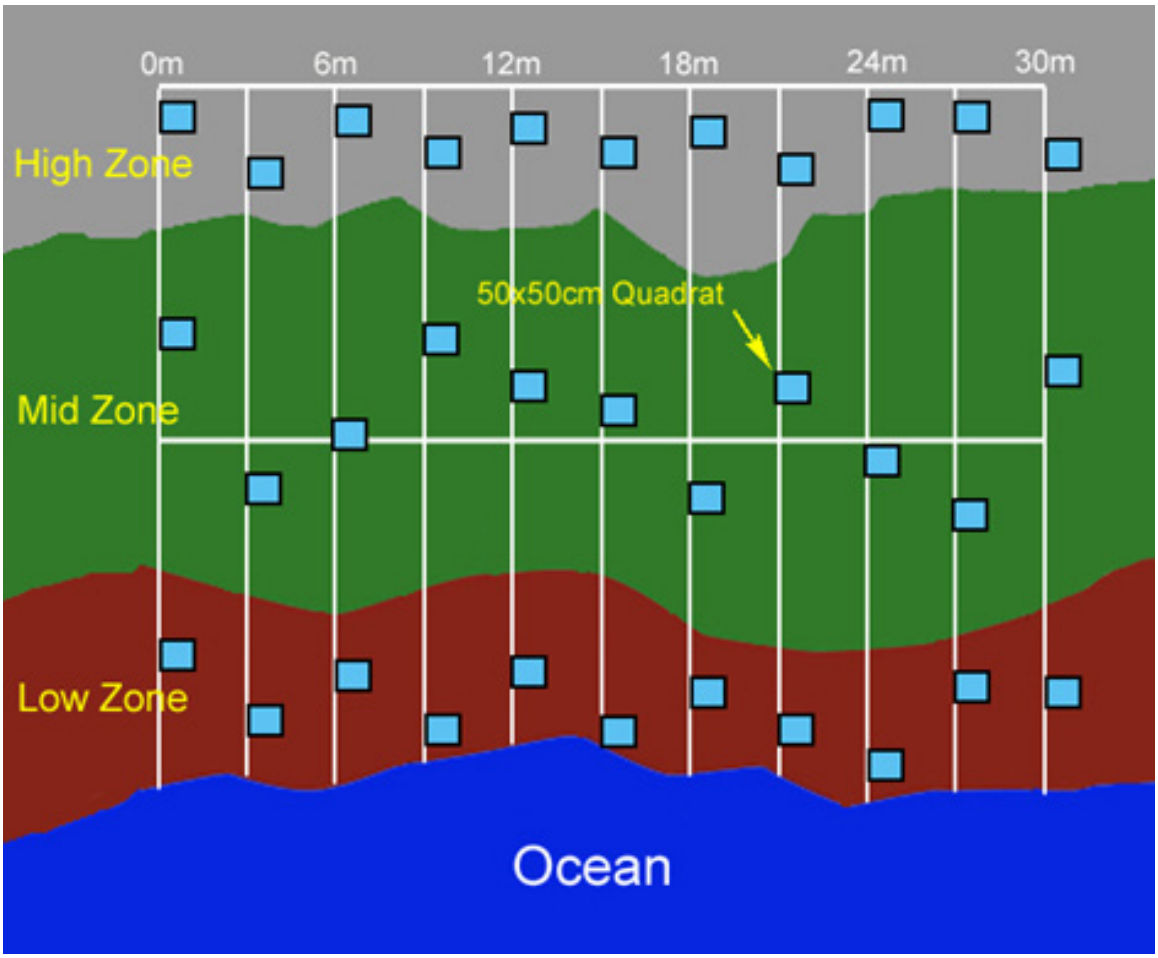


Figure 4. Example schematic diagram of mobile invertebrate quadrat sampling (blue squares) along biodiversity transect lines.

Swath Transects

Swath transects are used to estimate the density of sea stars, abalone, and other large mobile invertebrates. Swath sampling consists of recording the number of large invertebrates in a 2 m wide band centered over each transect. The location (to the nearest 0.5 m along the transect), number, and species names are recorded.

Topography Surveys

Topography surveys are used to create a 3D topographical representation of each survey area. Using a rotating laser level and a stadia rod, heights are measured along each transect at locations where there are major changes in elevation. These data are then converted to heights relative to mean sea level (MSL) by also measuring the height of a reference bolt whose elevation has been measured using a Trimble differential GPS unit. This survey is only performed once per site.

Data Collection and Entry

The intertidal sites at RNSP were sampled annually in the spring/summer when tides were sufficiently low to permit sampling. The surveys occur in May or June. All data for this report were collected between May 19th and 23rd, 2019 (SU19) and June 5th and 8th, 2020 (SU20) (Table 2). Each site required one full low tide sequence to conduct the long-term monitoring survey and one to two days for each biodiversity survey. Surveys required a team of three to six experienced intertidal field biologists with two to four extra field biologists and/or volunteers assisting. The summer 2019 crew consisted of four UC Santa Cruz (UCSC) biologists (Nathan Fletcher, Karah Ammann, David Lohse and Laura Anderson) with three alternating RNSP crewmembers (Kyle Max, Heather Brown, Kelley Breen, Teresa King, Zoe Varner. Gilian Allen, and Desiree Otillio). Due to COVID-19 global pandemic travel restrictions, the summer 2020 crew consisted of three UCSC biologists (Karah Ammann, Laura Anderson and Nathan Fletcher), a UCSC volunteer Caleen Fletcher with two to three RNSP crewmembers (alternating Kyle Max, Kelley Breen, Heather Brown and Carolynn Aguayo)

Table 2. Sampling locations and dates for rocky intertidal monitoring at Redwood National and State Parks, 2019–2020.

Site	Site Code	Latitude [1]	Longitude [1]	Summer 2019	Summer 2020
False Klamath Cove	FKC	41.59476	124.10643	19 May	5 June
Damnation Creek	DMN	41.65249	124.12784	20 & 23 May	7–8 June
Enderts Beach	END	41.69000	124.14257	21 May	6 June

[1] Site coordinates are in decimal degrees, NAD83 datum (source Bureau of Land Management).

After completing each survey, researchers reviewed the data forms for missing or incorrectly recorded data. Once complete, the data from field logs, photoplots, sea star plots, and surfgrass transects were entered into the MARINe Data Management System (MDMS), a system that provides uniform data information storage and retrieval for all MARINe institutions. Detailed information about QA/QC procedures for data collection, verification, and validation can be found in the protocol narrative and SOP #14 Data Management (Ammann and Raimondi 2008).

Data Analysis

Basic summary statistics were used to examine variations in abundance for the key species found in the photoplots (e.g., barnacles [*Chthamulus*, *Balanus*, etc.], mussels [*Mytilis* spp.], and rockweed species [e.g., *Pelvetiopsis limitata*]) and in the line transects (e.g., surfgrass [*Phyllospadix* spp.]). Mean percent cover values are presented for each site (based on pooled values for all plots in each zone) in summer sampling periods. This report covers two years of data; any analysis of trends should be based on a longer time series (greater than five years). Trend graphs are available at https://marine.ucsc.edu/sites/index.html.

Results

Raw data used to create this report are available upon request through MARINe or the National Park Service. Please contact the authors with requests.

Community Structure Surveys

Field Log

Species List and Conditions

The general observations of conditions for each survey are presented in Table 3.

Table 3. Field conditions for sampling trips in 2019 and 2020 at 3 intertidal sites within Redwood National and State Parks. Tide level is relative to Mean Lower Low Water. NS = not sampled due to trail closures.

Site ID [1]	Season Code [2]	Start Time	End Time	Low Tide Level (ft)	Low Tide Time	Swell Surge [3]	Wind [3]	Rain [3]	Recent Rain [3]	Sediment Level [3]	Scour [3]	Rock Movement [3]	Plant Wrack [3]	Drift Wood [3]	Shell Debris [3]	Dead Animals [3]	Trash [3]
END	SU19	5:30	10:30	−1.3	8:18	H	M	H	H	L	L	L	L	L	L	0	L
END	SU20	5:30	10:45	−2.0	6:55	M	L	0	0	L	L	L	L	L	L	0	0
DMN	SU19	7:00	10:45	−0.6	9:50	M	M	0	0	M	L	L	L	M	L	0	L
DMN	SU20	5:30	11:30	−1.7	8:30	L	L	0	0	L	L	L	L	L	L	0	L
FKC	SU19	4:50	9:00	−1.5	6:53	M	L	0	M	L	L	L	L	L	L	0	0
FKC	SU20	5:30	10:00	−2.0	6:55	L	L	0	M	M	L	M	L	L	L	0	0

[1] Site ID = END = Enderts Beach; DMN = Damnation Creek; FKC = False Klamath Cove.

[2] Season Code = SU19 = summer 2019 (May 19–23, 2019); SU20 = summer 2020 (June 5–June 8, 2020).

[3] Condition levels: 0 = zero; L = relatively few or low levels; M = Medium or moderate levels, H = High or severe levels.

Shorebirds and Mammals Species Lists

The only marine mammal seen at the sites during the 2019 and 2020 sampling surveys was an occasional harbor seal swimming offshore. Summaries of the common shorebirds observed during the RNSP surveys are presented in Table 4. These data represent the greatest number of each species observed at any one time on or near the sampled reef. They are not intended as census data, but rather as field observations. A list of additional bird species that were noted nearby or flying over the sampling sites at one or more occasions during 2019–2020 follows.

Table 4. Common shorebirds observed at Redwood National and State Parks monitoring sites during intertidal sampling trips in 2019–2020 (maximum seen at any one time).

Site ID [1]	Season [2]	Cormorant (*Phalacrocorax* spp.)	Gull (*Larus* spp.)	Oystercatcher (*Haematopus bachmani*)	Small Shorebirds (various species)
END	SU19	0	1	0	0
END	SU20	0	1	2	0
DMN	SU19	0	0	2	0
DMN	SU20	0	0	11	0
FKC	SU19	0	2	2	0
FKC	SU20	0	2	1	0
Totals	**n/a**	**0**	**6**	**18**	**0**

[1] END = Enderts Beach; DMN = Damnation Creek; FKC = False Klamath Cove.

[2] SU19 = summer 2019 (May 26–27, 2019); SU18 = summer 2018 (May 28–June 2, 2018).

Additional non-shorebird species (common name [scientific name]) observed at Redwood National and State Parks intertidal sites during 2019–2020 sampling follow:

- American Crow (*Corvus brachyrhynchos*)
- American Robin (*Turdus migratorius*)
- Bald Eagle (*Haliaeetus leucocephalus*)
- Barn swallow (*Hirundo rustica*)
- Brandt's Cormorant (*Phalacrocorax penicillatus*)
- Chestnut-backed Chickadee (*Poecile rufescens*)
- Common Murre (*Uria aalge*)
- Common Raven (*Corvus corax*)
- Double-crested Cormorant (*Phalacrocorax auritus*)
- Eurasian collared Dove (*Streptopelia decaocto*)
- Great Blue Heron (*Ardea Herodias*)

- Golden-crowned Kinglet (*Regulus satrapa*)
- Loons (*Gavia* spp.)
- Orange-crowned Warbler (*Leiothlypis celata*)
- Osprey (*Pandion haliaetus*)
- Pacific-slope flycatcher (*Empidonax difficilis*)
- Pacific Wren (*Troglodytes pacificus*)
- Peregrine Falcon (*Falco peregrinus*)
- Pelagic Cormorant (*Phalacrocorax pelagicus*)
- Pigeon Guillemot (*Cepphus columba*)
- Swainson's Thrush (*Catharus ustulatus*)
- Song Sparrow (*Melospiza melodia*)
- Turkey Vulture (*Cathartes aura*)
- Western Gull (*Larus occidentalis*)

Photoplots

Abundance (percent cover) of species found in the five types of photoplots are presented in Figures 5–14 and will be discussed in detail below. The figures include the top five most abundant taxa within the photoplots. Note that the following summaries are from only two years of observation and, as such, are not intended to represent an analysis of any long-term changes. Graphs with the data can be created with the interactive map and graphing tool at https://marine.ucsc.edu/explore-the-data/index.html and can be recreated in various configurations.

Barnacle (*Chthamalus dalli* and *Balanus glandula*) Photoplots

Barnacles represented the dominant species in all of these plots during 2019 and 2020 (Figures 5 and 6), with the exception of plots at Enderts Beach in 2019 when mussel cover mildly exceeded barnacle cover. Cover of barnacles increased at Enderts Beach in 2020 but remained below 50%. The barnacle cover exceeded >50% for the other sites.

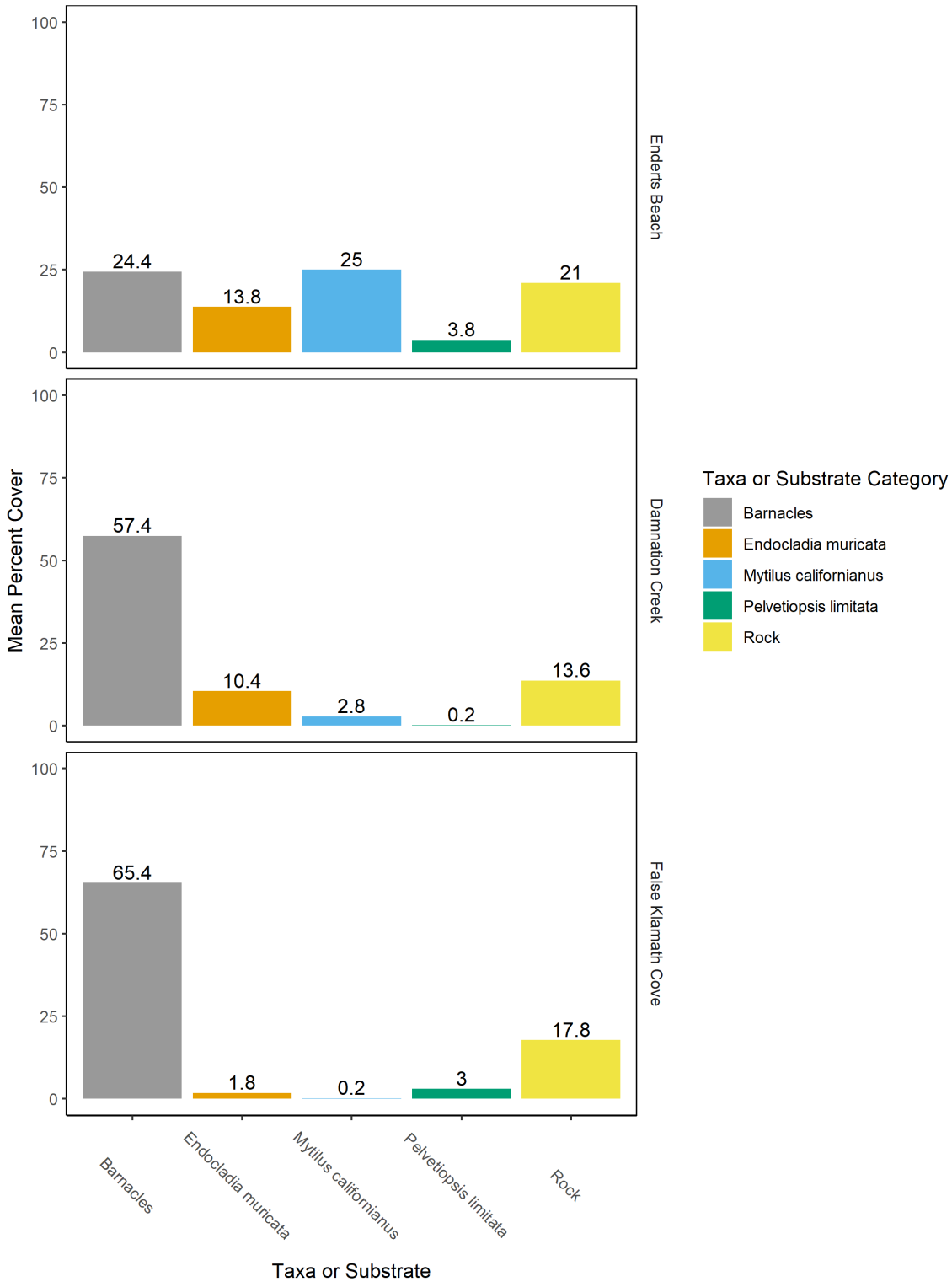


Figure 5. Mean percent cover of the most common taxa or substrate in the barnacle (*Balanus/Chthamalus*) photoplots during 2019 surveys at Redwood National and State Parks.

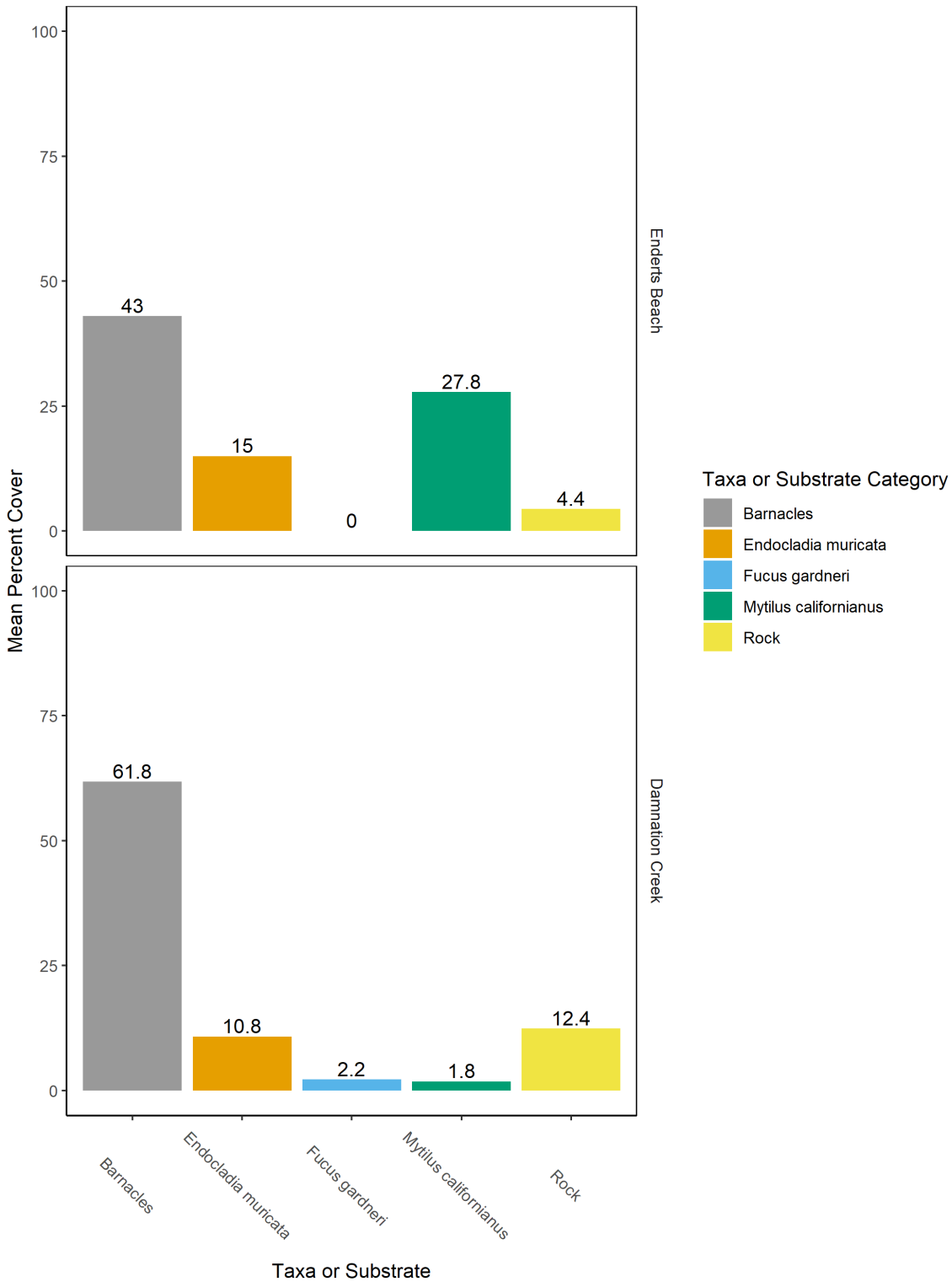


Figure 6. Mean percent cover of the most common taxa or substrate in the barnacle (*Balanus/Chthamalus*) photoplots during 2020 surveys at Redwood National and State Parks. False Klamath Cove plots were not field scored in 2020.

Turfweed *(Endocladia muricata)* Photoplots

At all sites during both 2019 and 2020 surveys, turfweed (*Endocladia muricata*) represented the most dominant cover in these plots (Figures 7 and 8). At Enderts Beach the cover of Endocladia in the plots decreased nearly 10% from 2019 to 2020, while cover at Damnation Creek saw a small increase (<5%) between surveys.

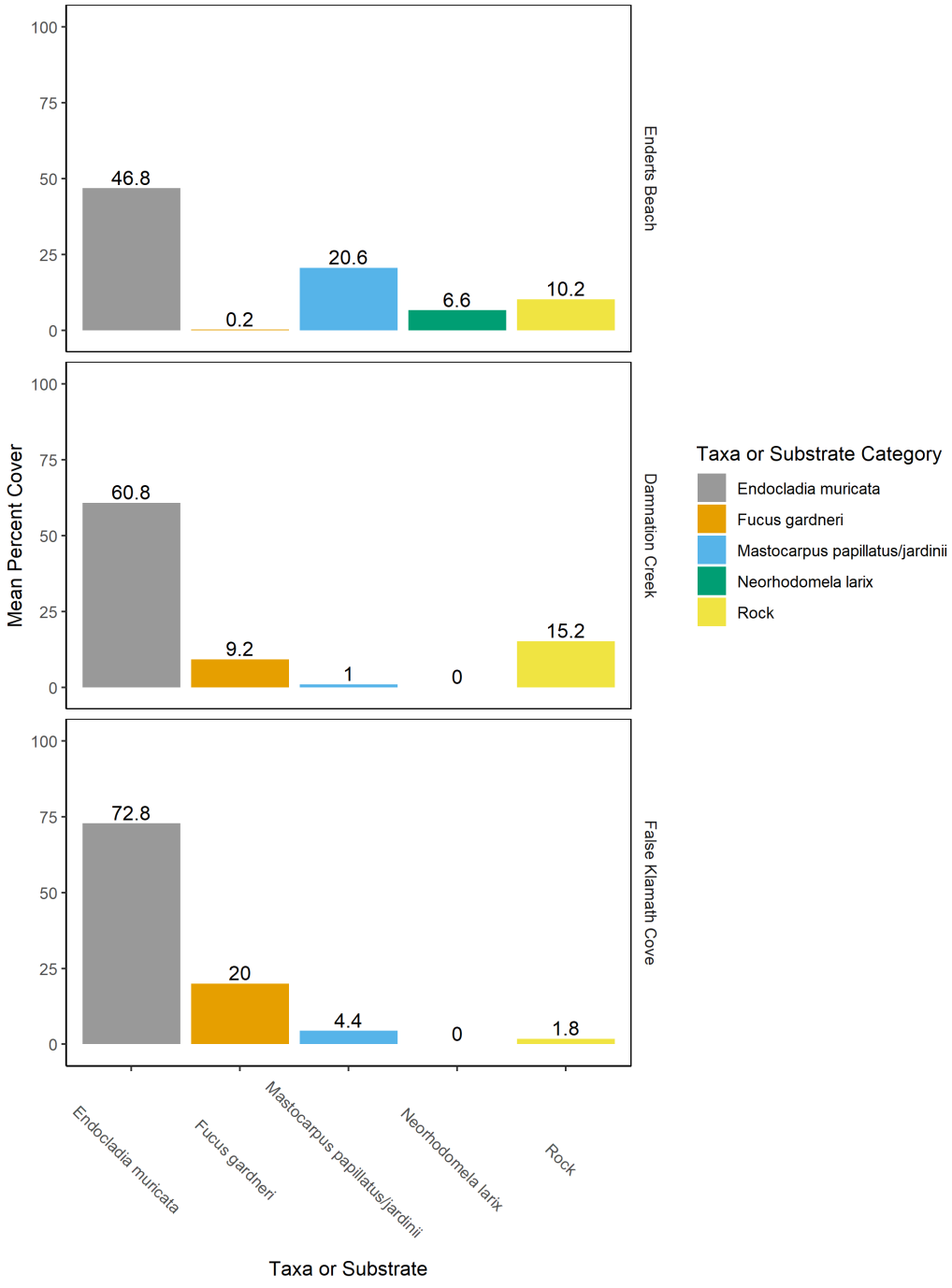


Figure 7. Mean percent cover of the most common taxa or substrate in turfweed (*Endocladia muricata*) photoplots during 2019 surveys at Redwood National and State Parks.

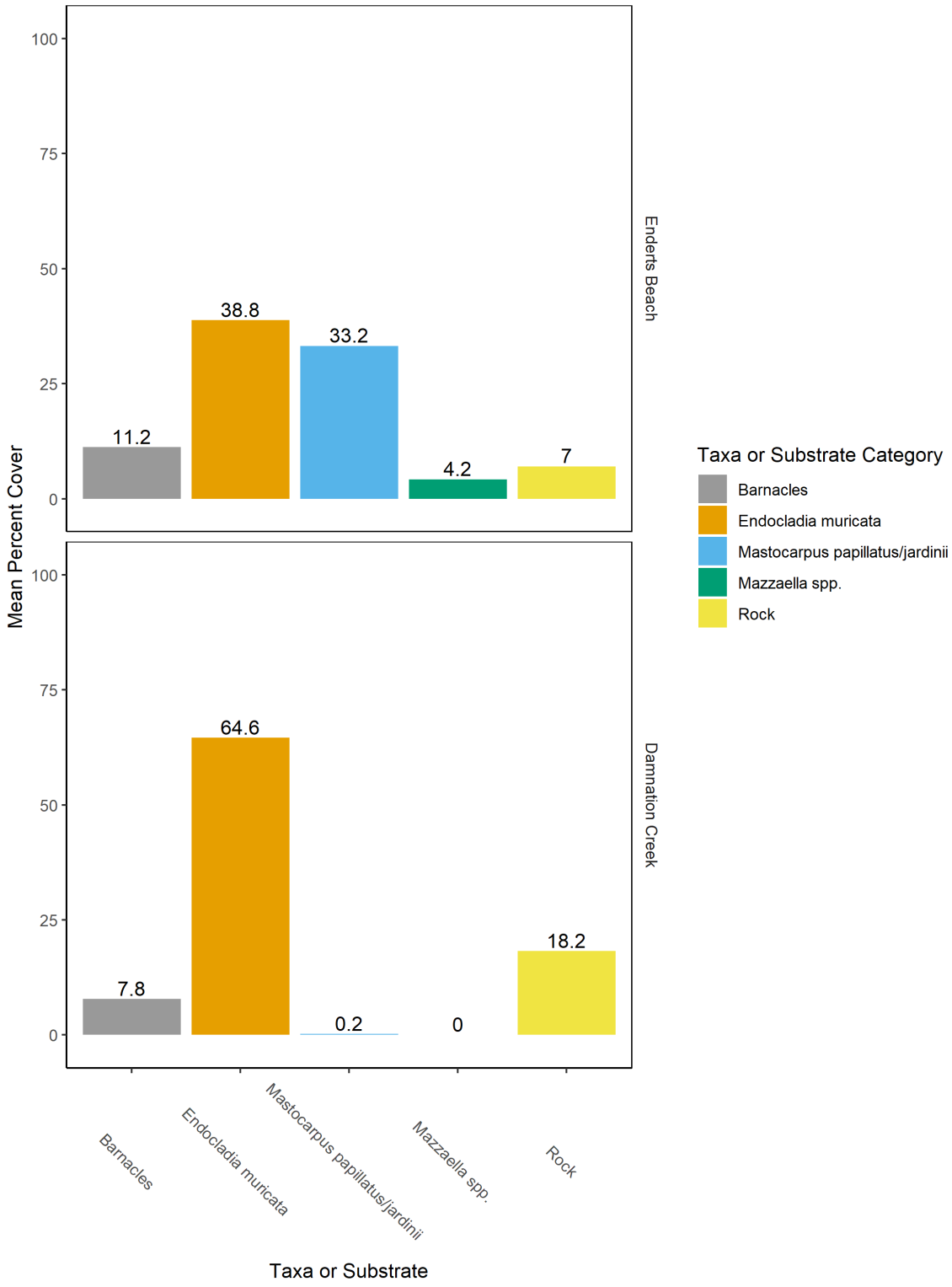


Figure 8. Mean percent cover of the most common taxa or substrate in turfweed (*Endocladia muricata*) photoplots during 2020 surveys at Redwood National and State Parks. False Klamath Cove plots were not field scored in 2020.

Rockweed *(Fucus gardneri)* and Dwarf Rockweed *(Pelvetiopsis limitata)* Photoplots

In both sets of rockweed plots the dominant species was also the targeted species. Specifically, cover of *Fucus gardneri* was >80% in plots at False Klamath Cove and Damnation Creek during both 2019 and 2020 surveys (Figures 9 and 10). *Pelvetiopsis limitata* was around 70% within the plots at Enderts Beach during 2019 and 2020 (Figures 11 and 12), while False Klamath Cove had lower (~50%) cover in 2019 (Figure 11).

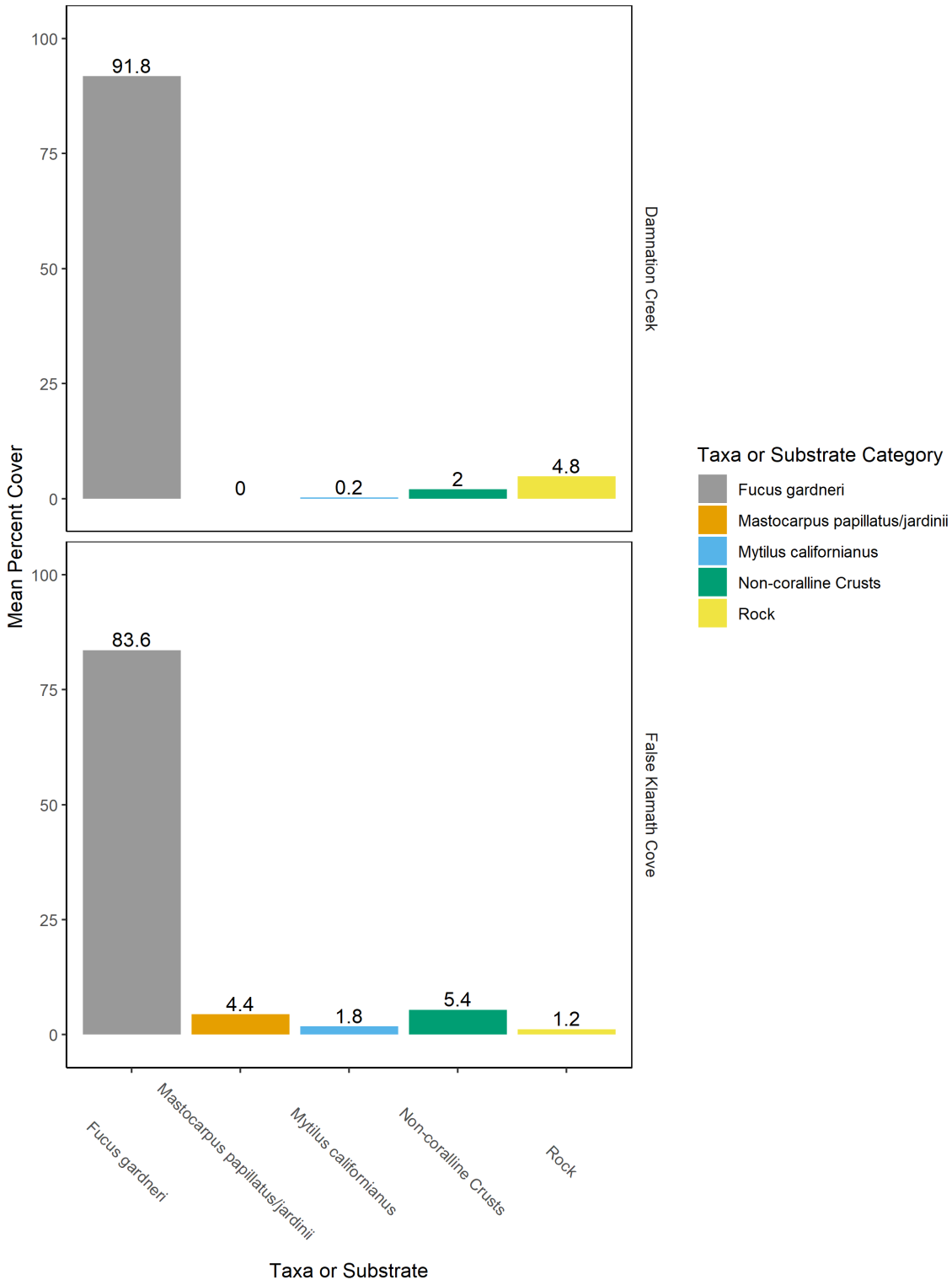


Figure 9. Mean percent cover of the most common taxa or substrate in the rockweed (*Fucus gardneri*) photoplots during 2019 surveys at Redwood National and State Parks.

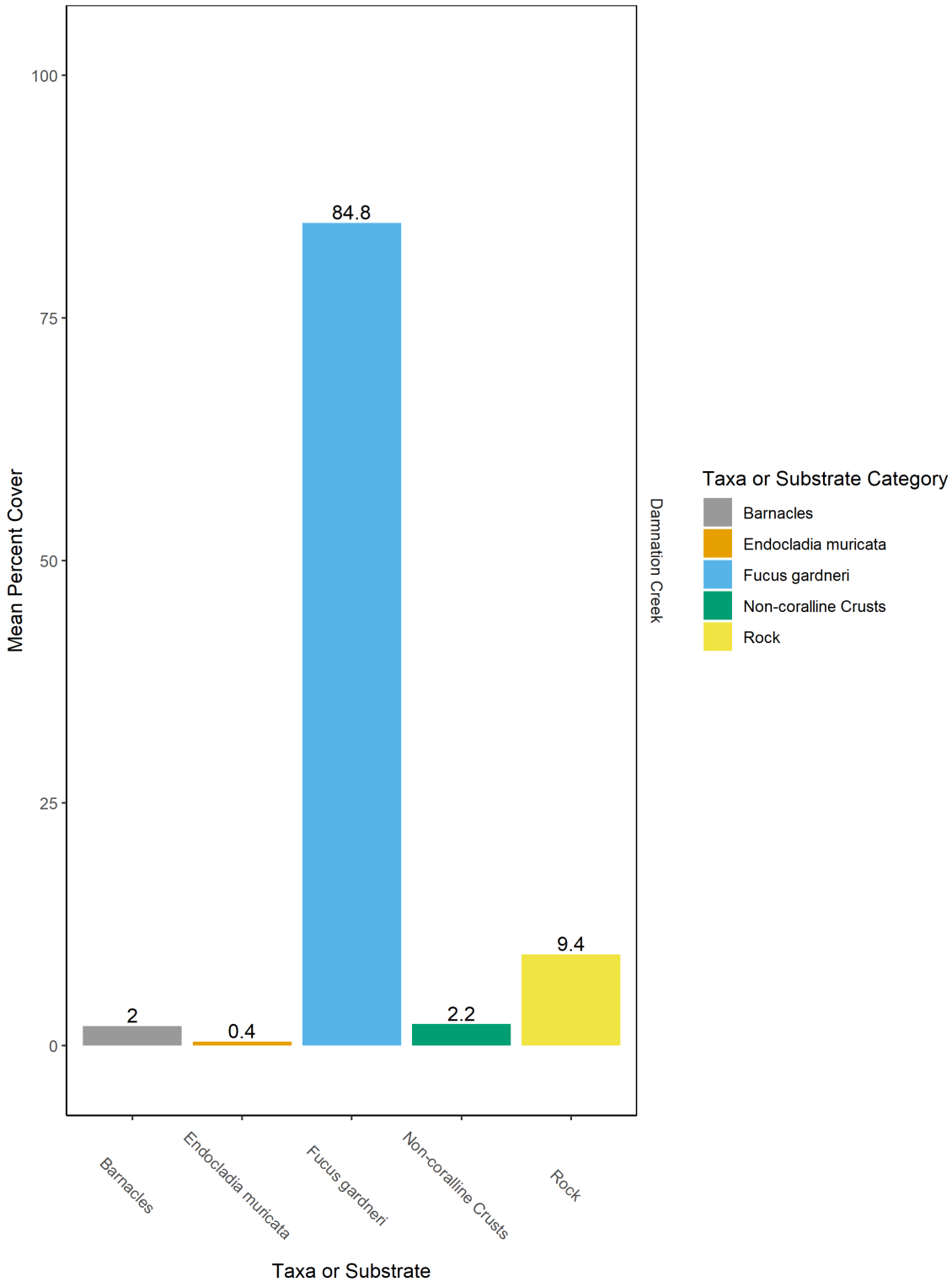


Figure 10. Mean percent cover of the most common taxa or substrate in the rockweed (*Fucus gardneri*) photoplots during 2020 surveys at Redwood National and State Parks. False Klamath Cove plots were not field scored in 2020.

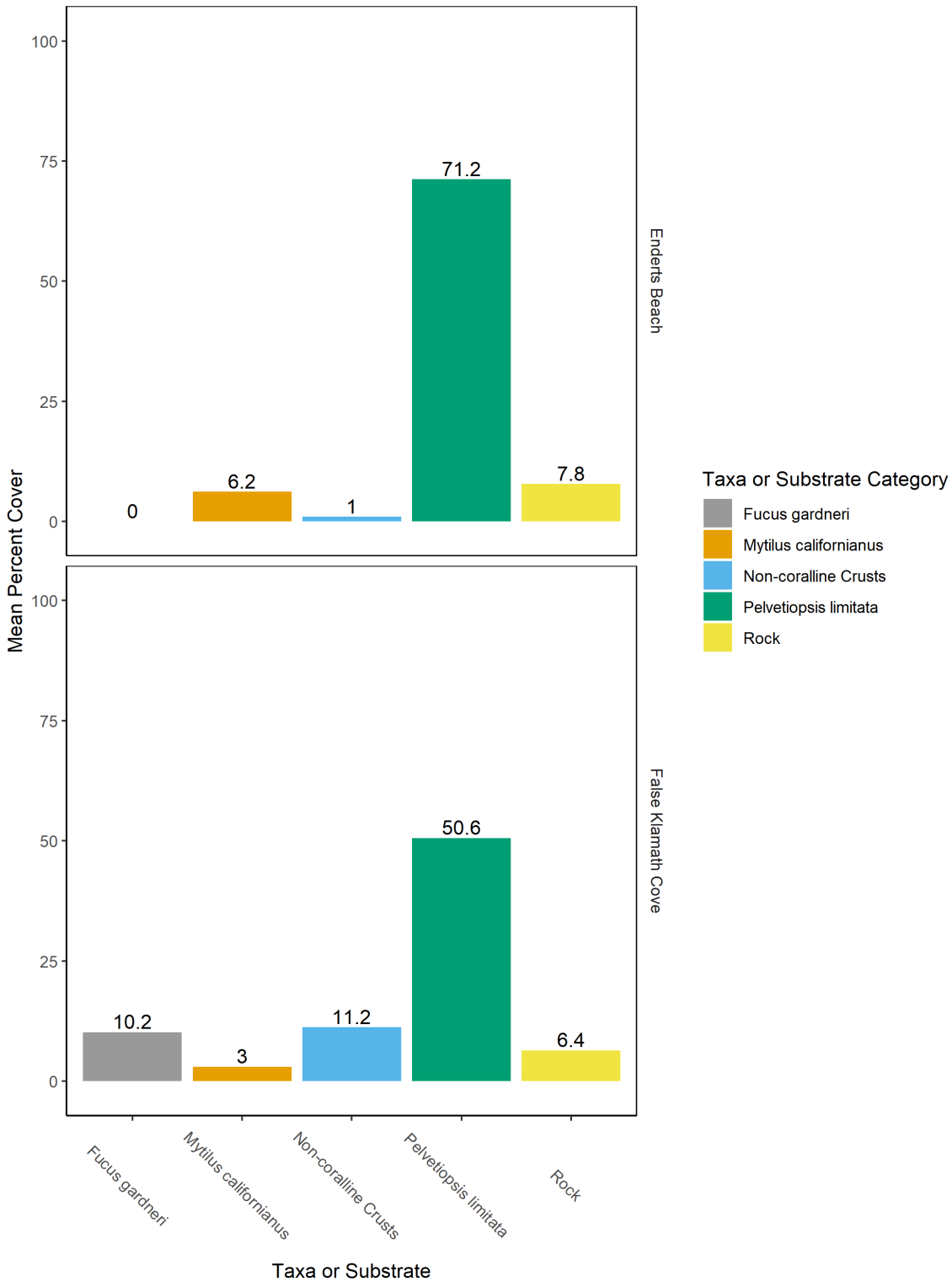


Figure 11. Mean percent cover of the most common taxa or substrate in dwarf rockweed (*Pelvetiopsis limitata)* photoplots during 2019 surveys at Redwood National and State Parks.

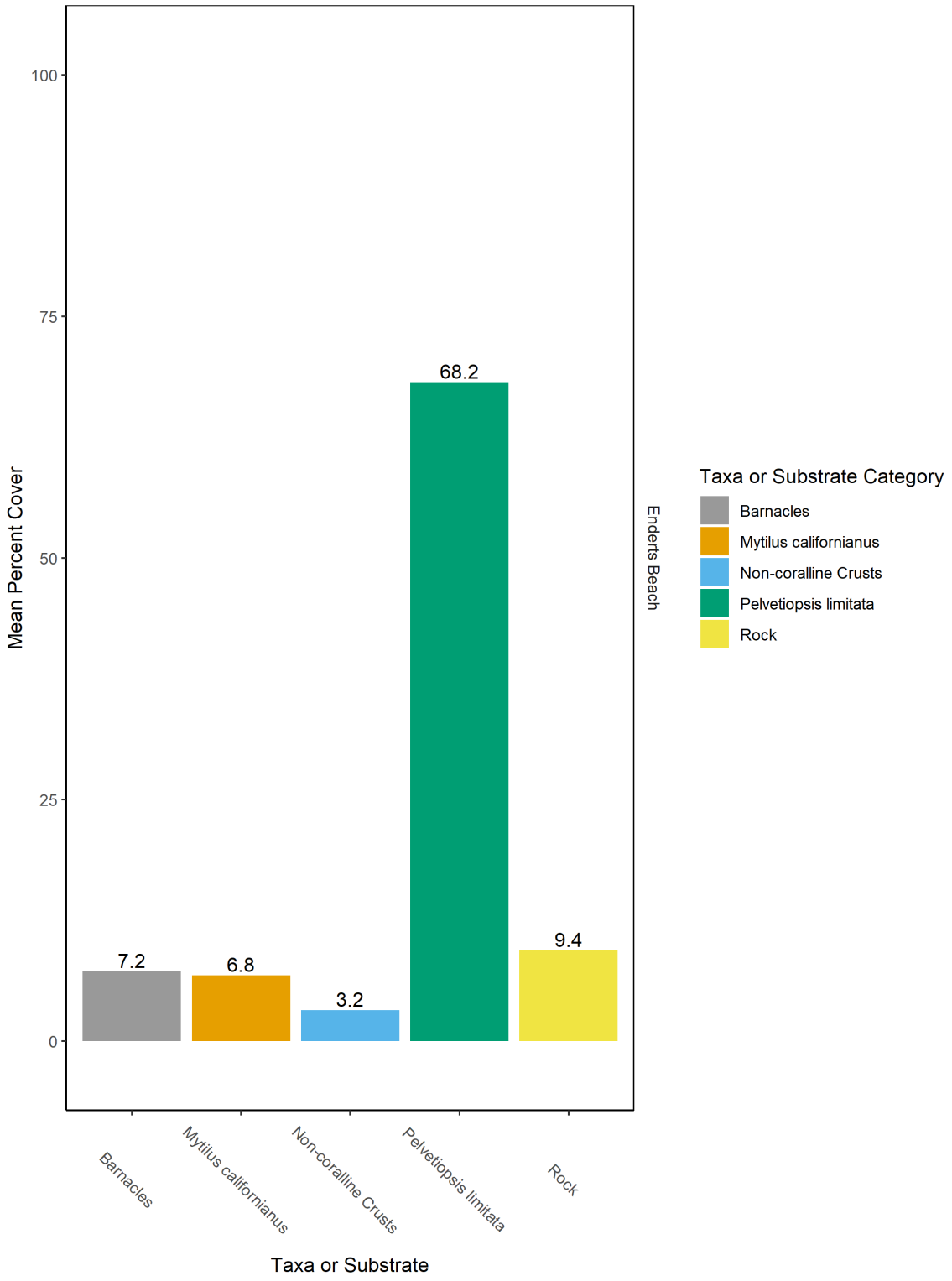


Figure 12. Mean percent cover of the most common taxa in dwarf rockweed (*Pelvetiopsis limitata*) photoplots during 2020 surveys at Redwood National and State Parks. False Klamath Cove plots were not field scored in 2020.

Mussel (*Mytilus californianus*) Photoplots

Overall, mussel (*Mytilus californianus*) cover in plots at Damnation Creek was high (>95%) during 2019 (Figure 13) and 2020 (Figure 14). Mussel cover at Enderts was also high (~90%) in 2020 (Figure 14), while mussel cover at Enderts Beach and False Klamath Cove was moderately high in 2019 (~80%) (Figure 13).

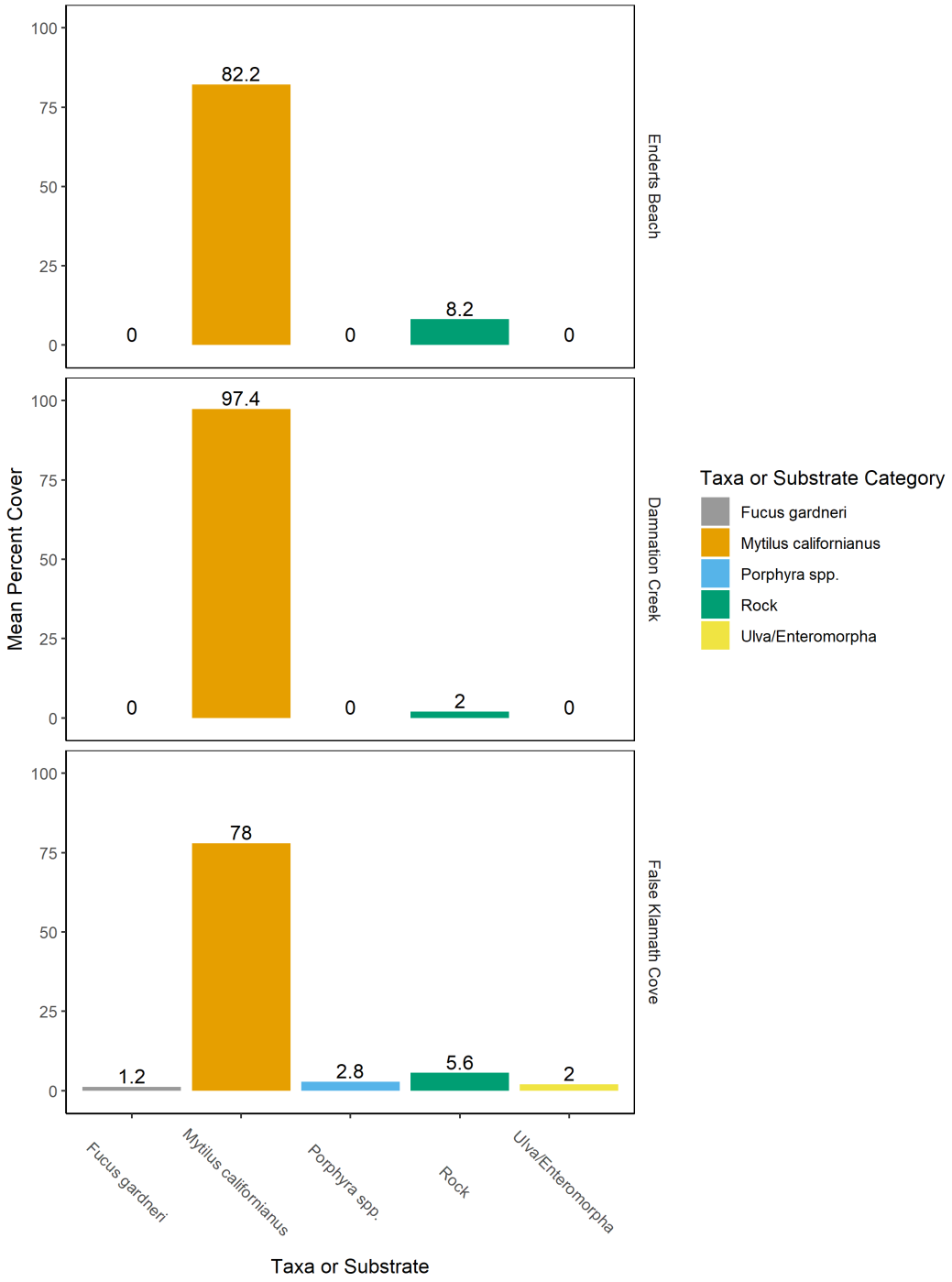


Figure 13. Mean percent cover of the most common taxa or substrate in mussel (*Mytilus californianus*) photoplots during 2019 surveys at Redwood National and State Parks.

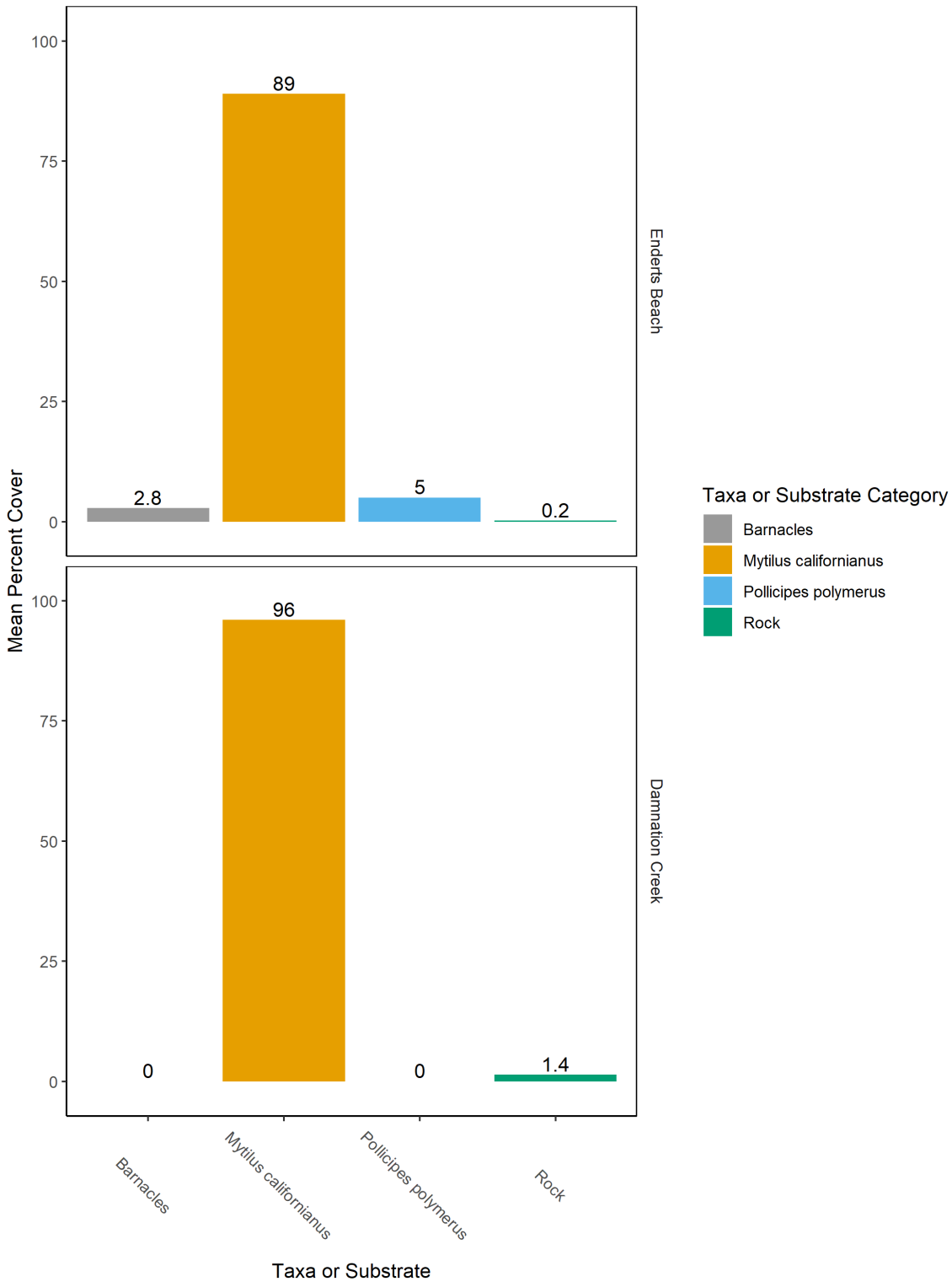


Figure 14. Mean percent cover of the most common taxa or substrate in mussel (*Mytilus californianus*) photoplots during 2020 surveys at Redwood National and State Parks. False Klamath Cove plots were not field scored in 2020.

Sea Star Plots

Because the size of the sea star plots varied among the sites, sea star abundances should not be compared across sites. At both Enderts Beach and False Klamath Cove, the majority of the ochre sea stars (*Pisaster ochraceus*) were ≤40 mm (Figure 15). This was due to a large increase in the number of small (<20 mm) individuals within the past few years, which suggests a recent recruitment event had occurred. Damnation Creek had far fewer sea stars than the other sites, with a greater proportion of larger individuals.

The size structure of the ochre sea star populations differed among the three sites (Figure 15). The range of sizes was greatest at Enderts Beach in 2020, and the size structure of *Pisaster* was skewed toward smaller individuals at Enderts Beach and False Klamath Cove. Mean size was similar between survey periods for each site but differed between sites (Table 5). Hundreds of individuals <20 mm were observed in plots at False Klamath Cove and Enderts Beach. In contrast, at Damnation Creek, fewer than five individuals measuring ≤20 mm were observed in the plots in 2019 and 2020 though overall numbers increased in all size categories in Damnation Creek plots from 2019 to 2020 with an overall quadrupling of ochre sea star abundance.

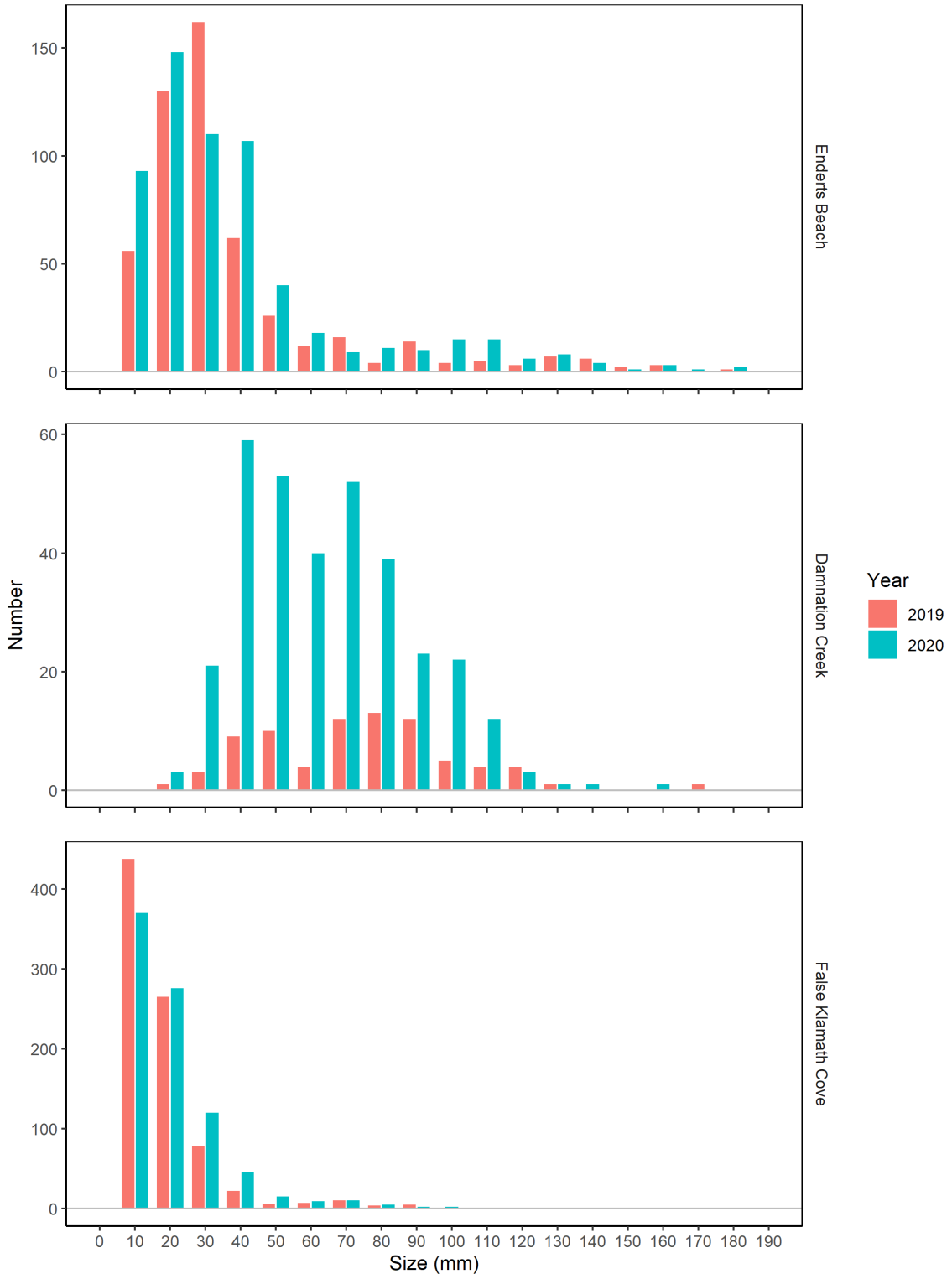


Figure 15. Size distributions of ochre sea stars (*Pisaster ochraceus*) at three sites within the Redwood National and State Parks during the summer sampling period in 2019 and 2020. Note different scale on y-axis.

Table 5. Number of total individuals (n) sampled and mean size for ochre sea stars (*Pisaster ochraceus*) at three sites within the Redwood National and State Parks during the summer sampling period in 2019(SU19) and 2020 (SU20).

Site	Season	n	Mean Size (mm)
Enderts Beach	SU19	513	37.5
Enderts Beach	SU20	601	39.2
Damnation Creek	SU19	79	74.6
Damnation Creek	SU20	330	64.4
False Klamath Cove	SU19	835	17.5
False Klamath Cove	SU20	854	20.1

Mussel Measurements

Size distributions of the mussels (*Mytilus californianus*) within the plots at Enderts Beach, Damnation Creek, and False Klamath Cove for 2019 and 2020 summer surveys are shown in Figure 16. In 2019, the range of mussel sizes was similar at all three sites, but the overall size structure was slightly skewed toward the smaller size classes at False Klamath Cove compared to the other two sites. At both Enderts Beach and Damnation Creek the number of individuals in the smaller size classes was slightly higher in 2020 than in 2019, while at Enderts Beach it was the number of large individuals that had increased in 2020. At all three sites, but especially at Damnation Creek, the thickness of the mussel bed was much greater than the average mussel length (Table 6), suggesting that the mussel beds at all three sites were multilayered (i.e., the visible surface layer hides additional layers of mussels below them).

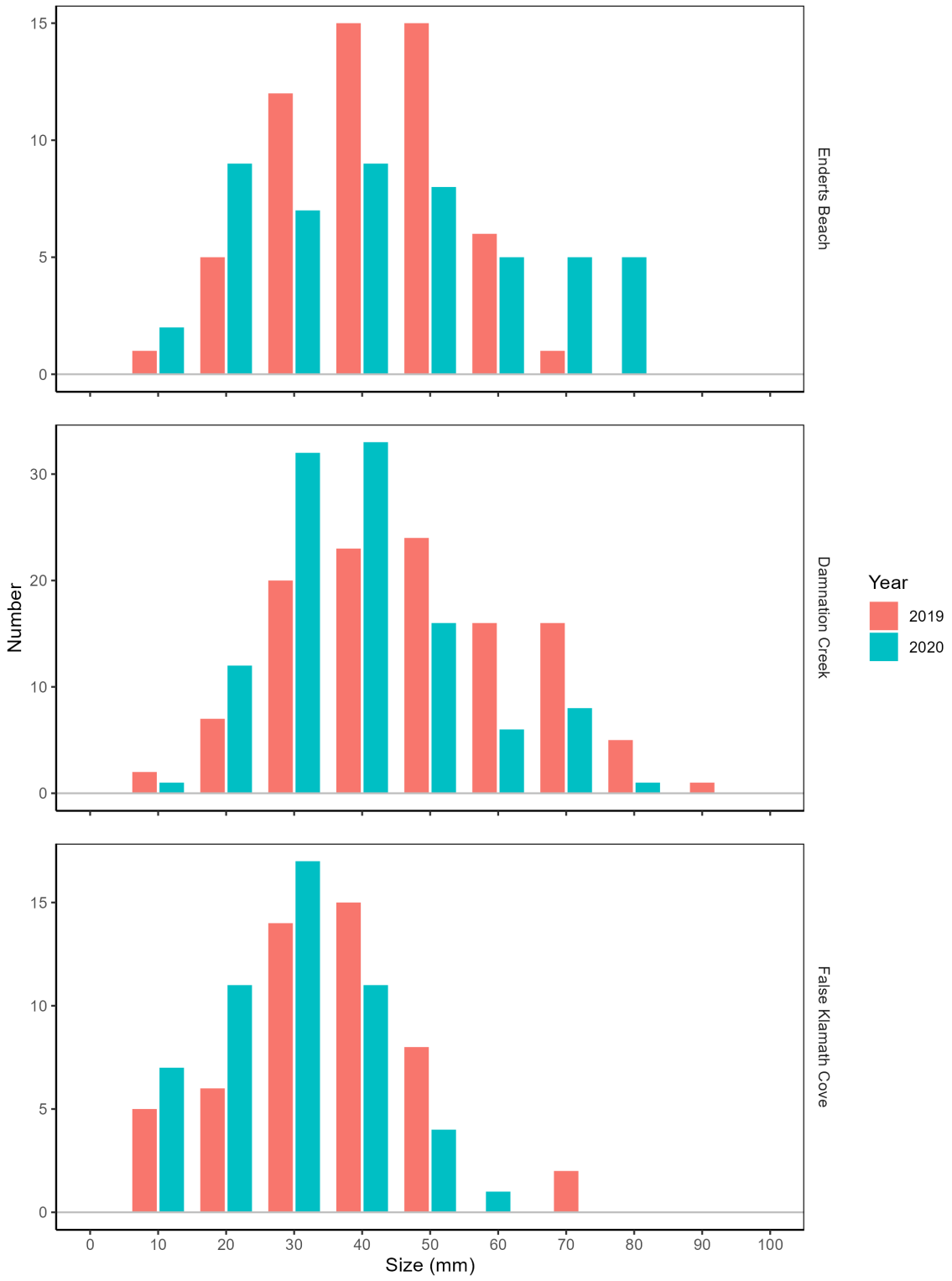


Figure 16. Size distributions of mussels (*Mytilus californianus*) at three sites within the Redwood National and State Parks during the summer sampling period in 2019 and 2020.

Table 6. Mean bed depth, individual length, and ratio of depth to length for mussels (*Mytilus californianus*) at three sites within the Redwood National and State Parks during the summer sampling period in 2019 (SU19) and 2020 (SU20). n= total number of thickness measurements.

Site	Season	n	Mean Bed Depth (mm)	Mean Individual Length (mm)	Depth/Length
Enderts Beach	SU19	25	70	40.9	1.71
Enderts Beach	SU20	25	111.6	44.4	2.51
Damnation Creek	SU19	25	104.4	42.6	2.45
Damnation Creek	SU20	25	112	35.5	3.15
False Klamath Cove	SU19	25	59.2	34.6	1.71
False Klamath Cove	SU20	25	57.6	29.4	1.96

Surfgrass and Sea Palm Transects

During the 2019 summer survey, surfgrass (*Phyllospadix scouleri/torreyi*) was not sampled due to swell levels. In 2020, transect 1 had 86% surfgrass cover and transect 2 had 89% cover. During the 2019 and 2020 summer survey, sea palm (*Postelsia palmaeformis*) counts at False Klamath Cove were zero individuals for transect 1 and 1,345 and 852 individuals, respectively, for transect 2.

Sea Surface Temperature

During 2019–2020, sea surface temperature ranged from lows of 8.2º C to highs of 17.3º C (Figure 17). There was little temperature variation among the three sites. The temperature logger was missing from False Klamath Cove in 2019.

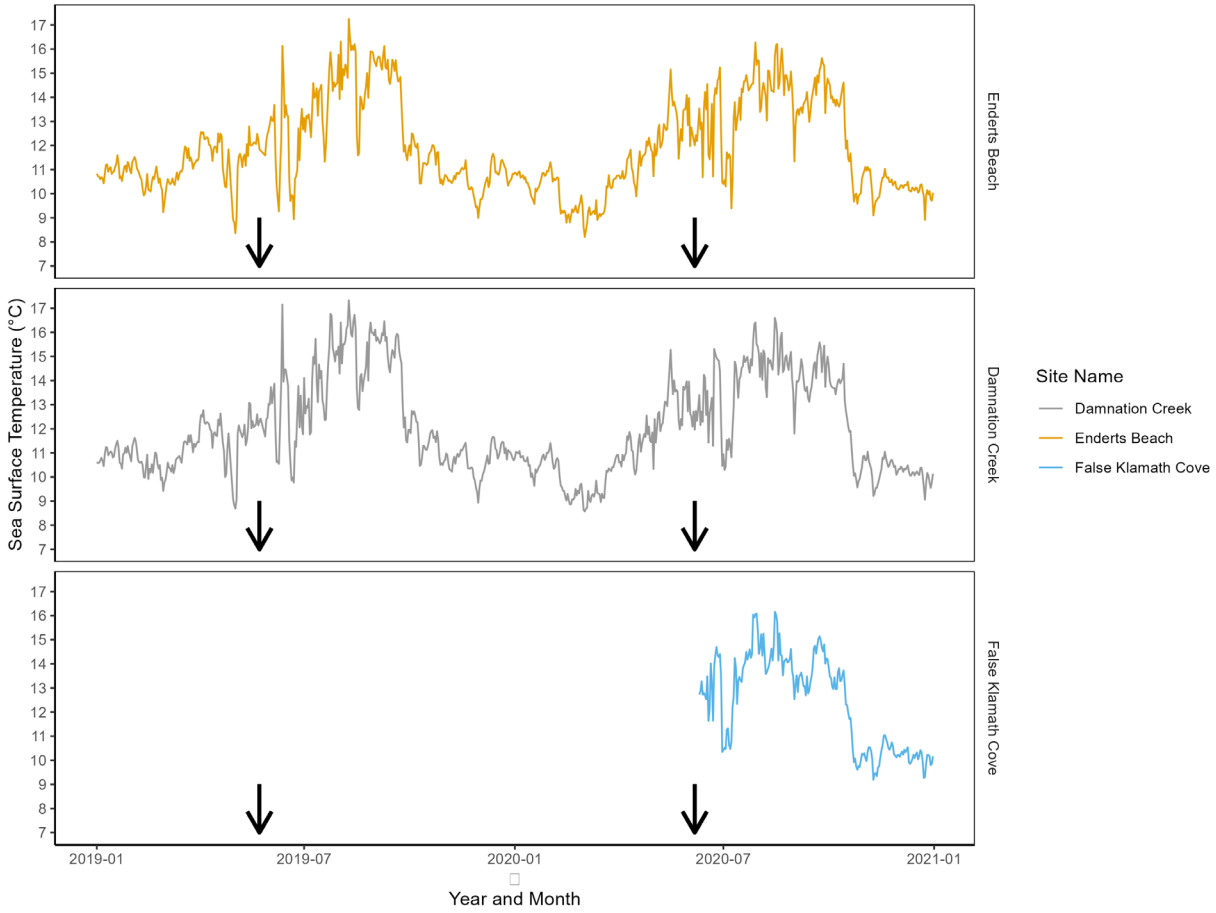


Figure 17. Sea surface temperatures from three Redwood National and State Parks sites in 2019–2020. Arrows denote the two periods when the community structure surveys were performed. Continuous temperature data collected with Onset TidbiT brand temperature loggers. Gaps indicate missing data: either the logger's batteries failed or the logger was missing upon the site visit.

Coastal Biodiversity Surveys

In 2020, biodiversity surveys were conducted at False Klamath Cove and Damnation Creek using the full point and first point protocols, respectively (see Methods section for details). In 2019, they were conducted at Damnation Creek and Enderts Beach using the full point and first point protocols, respectively.

Point Contact Surveys and Quadrat Sampling

The percent cover for each of the most common species (>1%) and substrate type observed during the point contact surveys is shown in Figures 18–20.

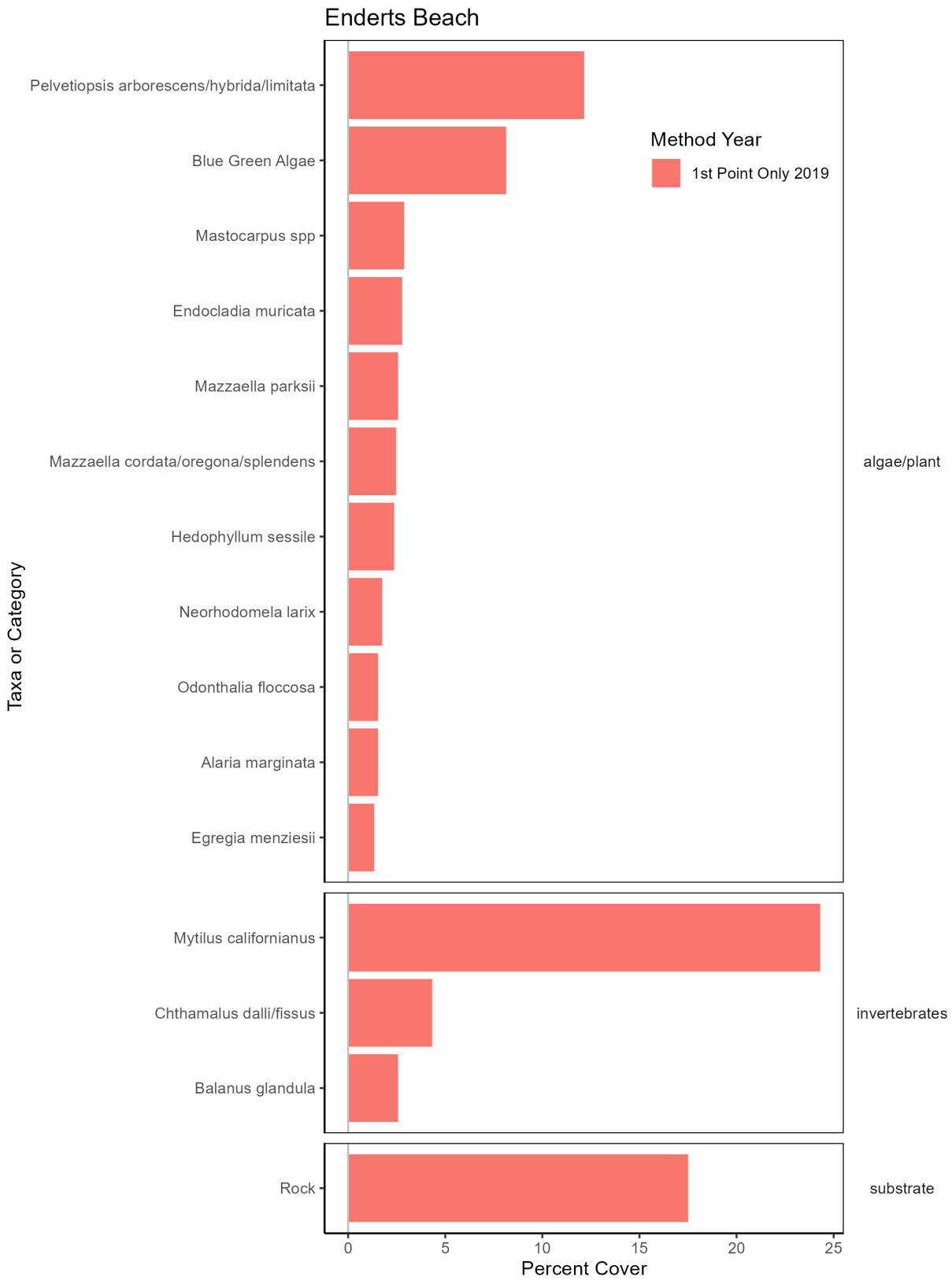


Figure 18. Percent cover of the most common taxa and substrate recorded during biodiversity surveys at Enderts Beach in 2019.

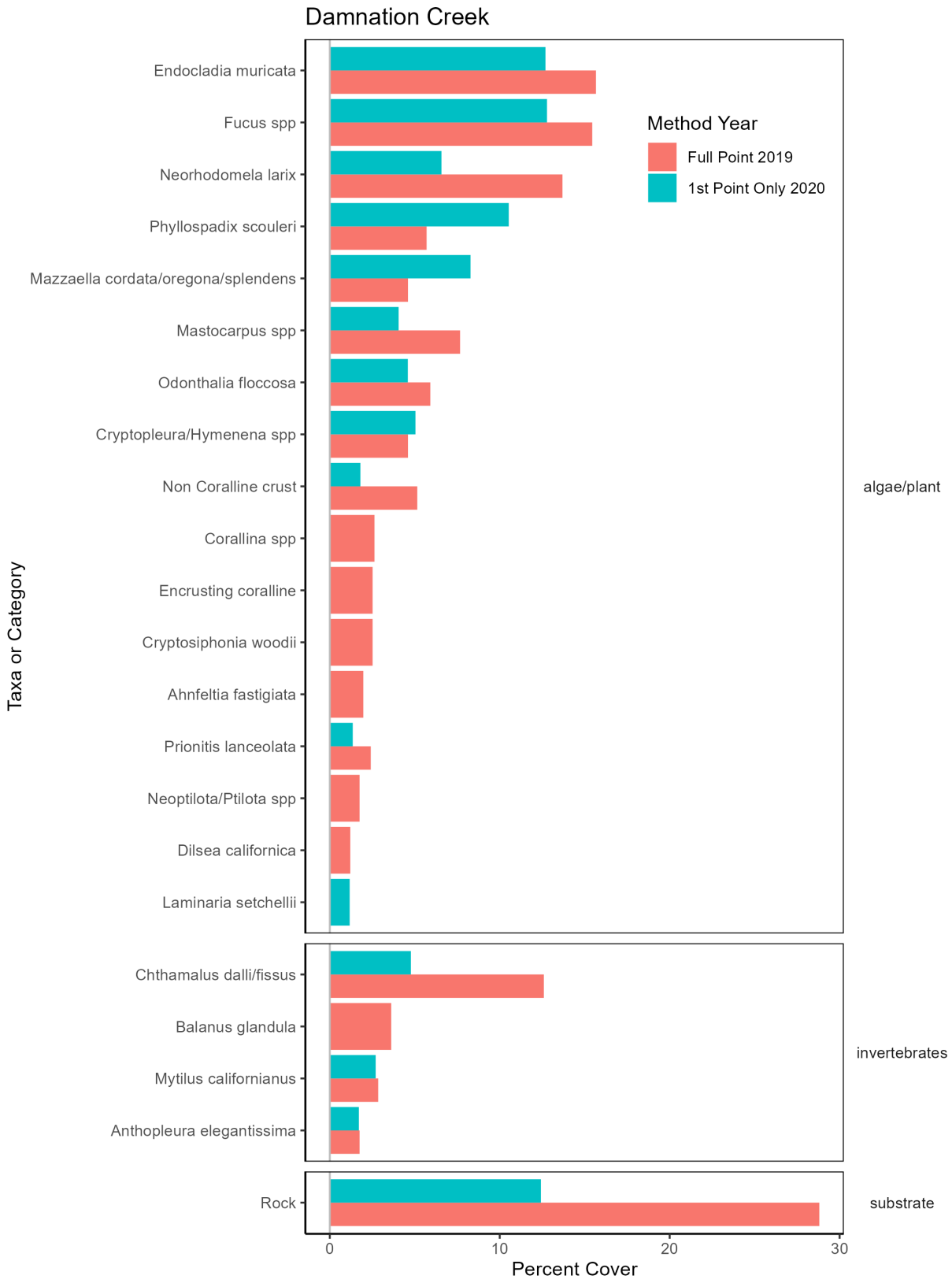


Figure 19. Percent cover of the most common taxa and substrate recorded during biodiversity surveys at Damnation Creek in 2019 and 2020.

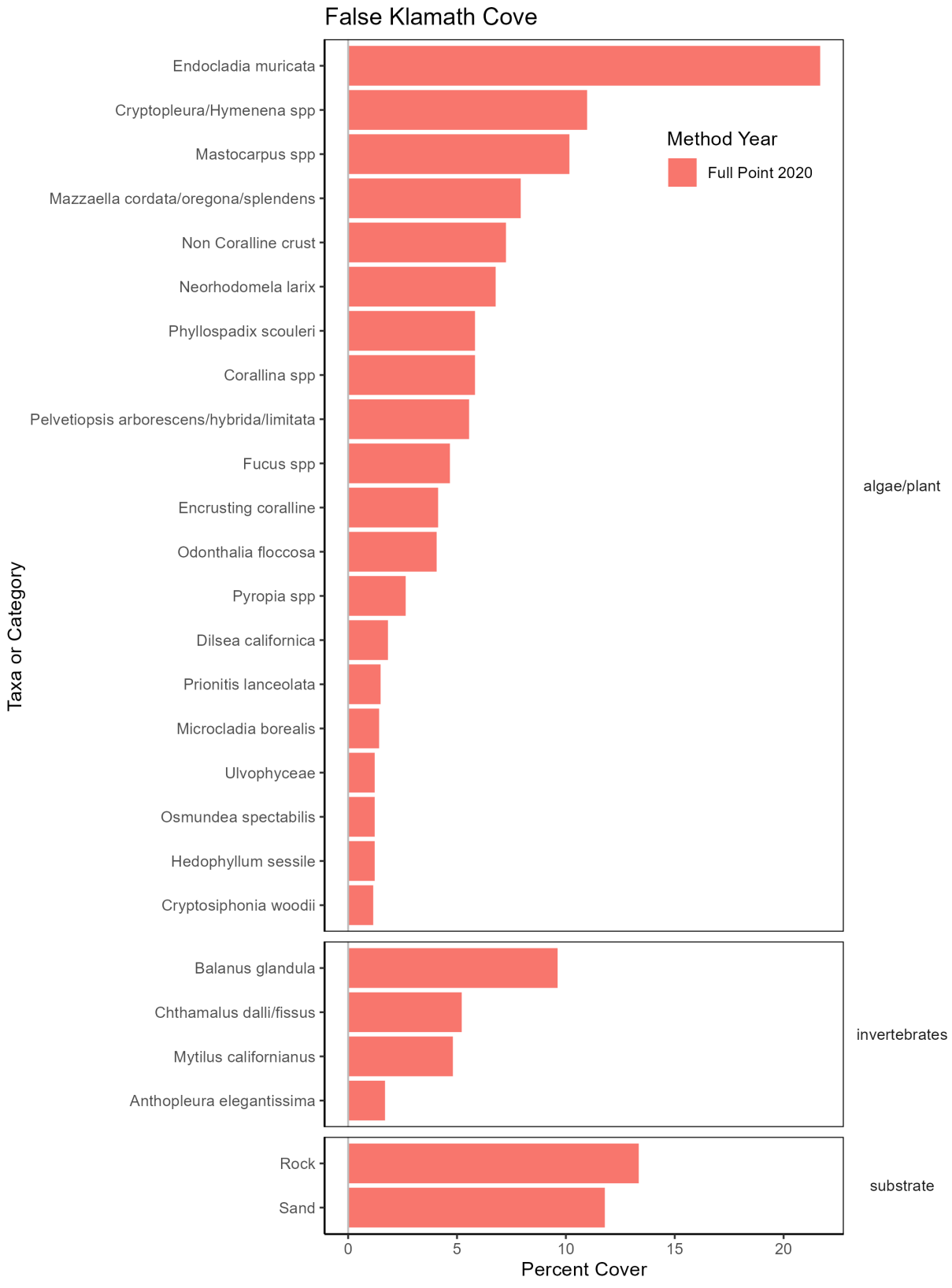


Figure 20. Percent cover of the most common taxa and substrate recorded during biodiversity surveys at False Klamath Cove in 2020.

The total number of taxa found using the full point protocol ranged from 70 to 82, while the first point survey at Enderts Beach found 57 and Damnation Creek found 69 (see Appendix for full list). At all three sites, rock was the most common underlying category. While common taxa varied among sites, they included the mussel (*Mytilus californianus*), the algae *Endocladia, Pelvetiopsis*, *Mastocarpus*, and the barnacle *Chthamalus* spp. (Figures 18–20). The densities of mobile invertebrate species observed during the quadrat surveys are shown in Figures 21–23. The most common mobile invertebrates found at the sites were the snail *Littorina* spp, and various limpets in the genus *Lottia* (Figures 21–23).

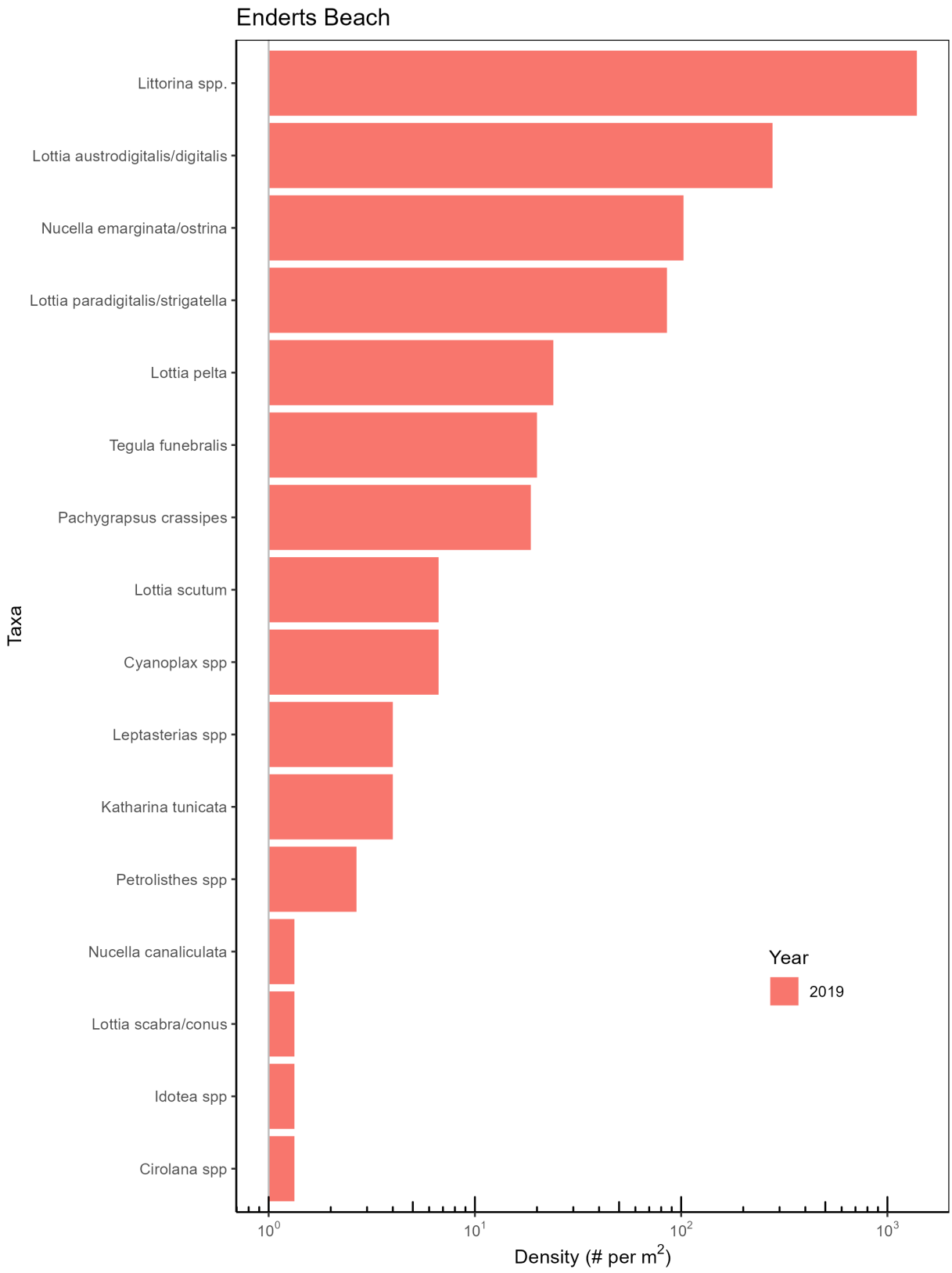


Figure 21. Density of the most common mobile taxa recorded during biodiversity surveys at Enderts Beach in 2019. Note log scale x-axis.

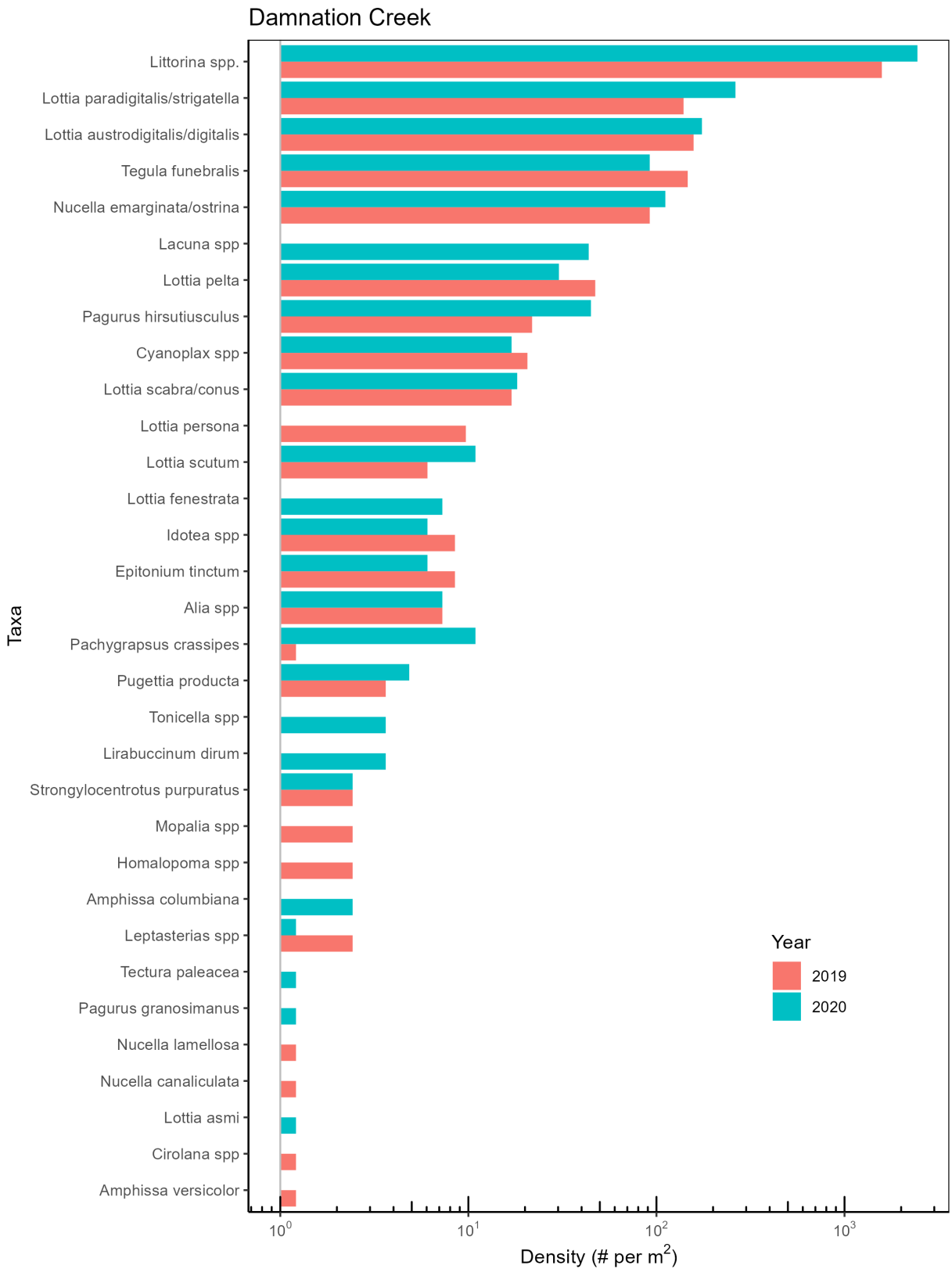


Figure 22. Density of the most common mobile taxa recorded during biodiversity surveys at Damnation Creek in 2019 and 2020. Note log scale x-axis.

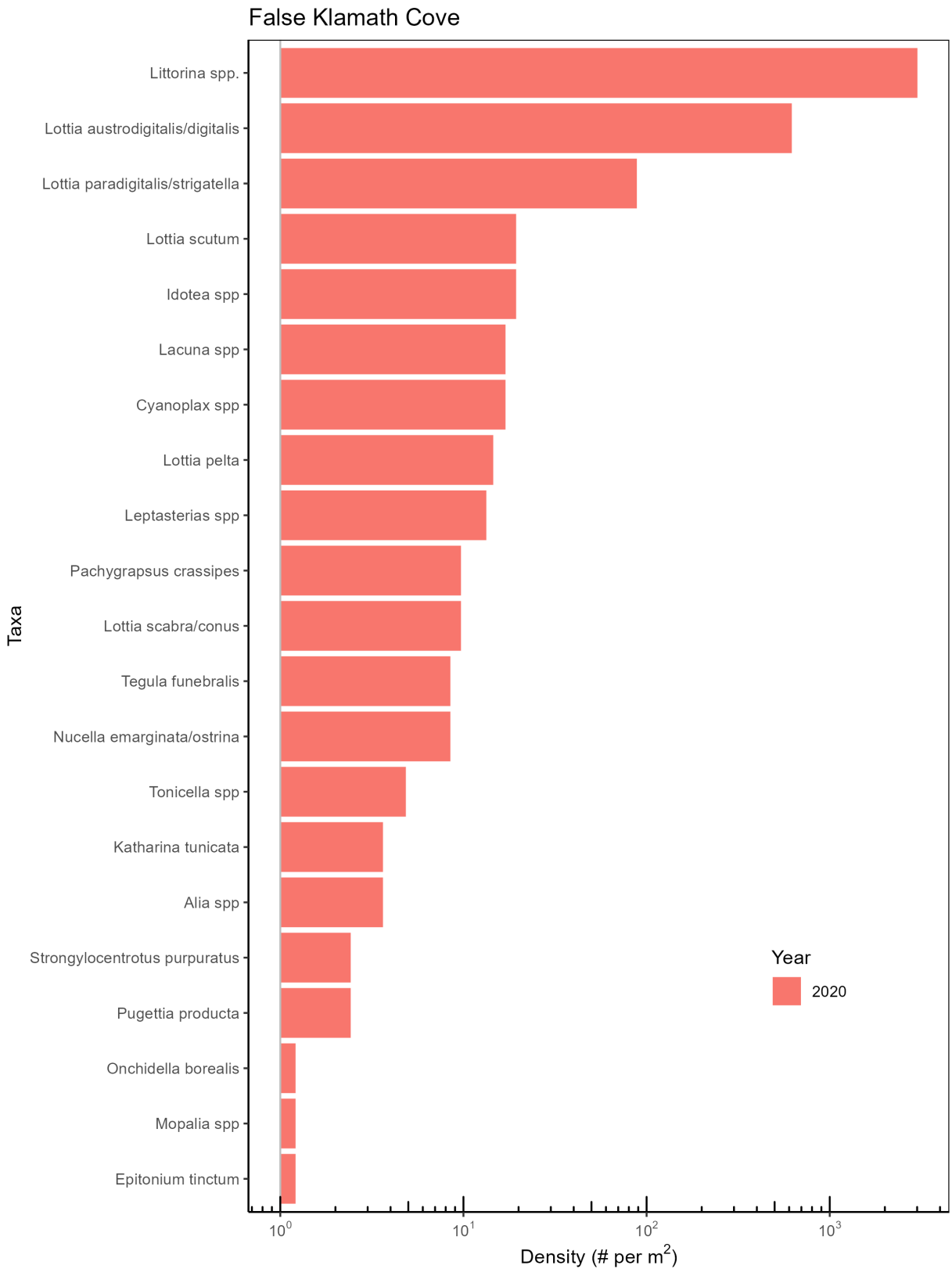


Figure 23. Density of the most common mobile taxa recorded during biodiversity surveys at False Klamath Cove in 2020. Note log scale x-axis.

Swath Transects

Very few sea stars were found during the swath surveys at all sites; densities of *Pisaster ochraceus* (ochre sea star) ranged from a low of 0.42 per m^2 at Damnation Creek (2019), to a high of 0.90 and 1.3 per m^2 at Enderts Beach (2019) and False Klamath Cove (2020), respectively. *Henricia* spp. (blood star), *Patiria miniata* (bat star–at False Klamath Cove in 2020 only) and *Dermasterias imbricata* (leather star) were also observed on swaths at very low densities.

All Taxa Recorded

A complete list of presence/absence data for all taxa found during the Redwood National and State Parks biodiversity surveys between 2019 and 2020 can be seen in the Appendix.

Biodiversity point contact, quadrat, and swath data are available at www.pacificrockyintertidal.org.

Conclusion

A primary objective of the KLMN rocky intertidal monitoring program at RNSP is to track changes in the structure of the intertidal community over time. To accomplish this, data on the distribution, abundance, and sizes of species found at several sites within RNSP have been collected since 2004.

This report covers the sampling during 2019 and 2020 and coincides with a protocol review and revision process. Key elements incorporated into this protocol and report since 2017 are 1) discontinuing the winter sampling period, 2) removing fixed mobile invertebrate plots, and 3) incorporating community biodiversity sampling. These revisions were trialed in 2017/18 (Ammann et al. 2022) and continue to be part of the current data collection. Sampling was successful for all elements retained from the prior protocol and revisions were added to the upcoming revised protocol. A final change is annual reporting in a data series format, which serves as a timely release of data, but precludes in-depth analysis of the data. A trends report covering 2004 to 2013 is available and provides more in-depth analysis for that time period (Ammann et al. 2017). A publication that covers trends from 2004 to 2018 is in press (Lohse et al. in press).

All data collected at RNSP through the KLMN rocky intertidal monitoring program contribute to a larger dataset for the MARINe network. This long-term monitoring can detect deviations from baseline conditions, such as disturbance or long-term changes (e.g., climate change). For RNSP and other members of the MARINe network, current trends and syntheses can be found on their website (https://marinedb.ucsc.edu/interactive/intertidalmap.html) This website provides access to interactive data from the long-term intertidal monitoring as well as the coastal biodiversity program. Data summaries are also available for both survey methods under the site info pages of the website (https://marine.ucsc.edu/sites/index.html).

The ongoing inventory and monitoring program of the KLMN rocky intertidal community at RNSP continues to generate data vital to our understanding of the dynamics of rocky intertidal communities along the western coastline of North America. These findings will inform managers and policymakers and facilitate marine conservation through public outreach.

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Appendix: Species List

Table A1. Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The "X" in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Snails	*Alia* spp.	–	X	X	X
	Amphissa columbiana	–	X	–	–
	Amphissa versicolor	–	–	X	–
	Epitonium tinctum	–	X	X	X
	Lacuna spp.	–	X	–	X
	Lirabuccinum dirum	–	X	–	–
	Littorina keenae	X	X	X	X
	Lirularia spp./*Margarites* spp.	–	–	X	–
	Littorina spp.	X	X	X	X
	Nucella canaliculata	X	–	X	–
	Nucella emarginata/ostrina	X	X	X	X
	Nucella lamellosa	–	–	X	–
	Tegula funebralis	X	X	X	X
Chitons	*Cyanoplax* spp.	X	X	X	X
	Katharina tunicata	X	–	–	X
	Mopalia spp.	–	–	X	X

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The “X” in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Chitons (continued)	*Tonicella lineata/lokii*	–	X	–	X
Sea Slugs	*Hermissenda crassicornis*	–	–	–	X
	Onchidella borealis	–	–	–	X
Bivalves	*Mytilus californianus*	X	X	X	X
	Mytilus trossulus/edulis/galloprovincialis	X	–	X	–
Limpets	*Lottia asmi*	–	X	–	–
	Lottia austrodigitalis/digitalis	X	X	X	X
	Lottia fenestrata	–	X	–	–
	Lottia paradigitalis/strigatella	X	X	X	X
	Lottia pelta	X	X	X	X
	Lottia persona	–	–	X	–
	Lottia scabra/conus	X	X	X	X
	Lottia scutum	X	X	X	X
	Small limpet	X	X	X	X
	Tectura paleacea	–	X	–	–
Crustaceans (crabs)	*Pachygrapsus crassipes*	X	X	X	X
	Pagurus granosimanus	–	X	–	–
	Pagurus hirsutiusculus	–	X	X	–

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The "X" in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Crustaceans (crabs) (continued)	*Pugettia producta*	X	–	–	–
	Petrolisthes spp	X	–	–	–
	Cirolana spp.	X	–	X	–
Crustaceans (barnacles)	*Balanus glandula*	X	X	X	X
	Chthamalus dalli/fissus	X	X	X	X
	Pollicipes polymerus	X	X	X	X
	Semibalanus cariosus	X	X	X	X
Worms	*Chone minuta*	–	–	–	X
	Phragmatopoma spp./*Sabellaria* spp.	X	X	X	X
Echinoderms (sea stars)	*Dermasterias imbricata*	–	X	–	–
	Henricia spp.	–	X	–	–
	Leptasterias hexactis	X	X	X	X
	Pisaster ochraceus	X	X	X	X
Echinoderms (sea urchins)	*Strongylocentrotus purpuratus*	–	X	X	X
Porifera (sponges)	*Halichondria* spp.	X	–	–	X
	Haliclona spp.	–	–	X	–
Urochordota (tunicate)	*Eurystomella bilabiata*	–	–	–	X

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The "X" in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Cnidaria (sea anemone)	*Anthopleura elegantissima*	X	X	X	X
	Anthopleura xanthogrammica	X	X	X	X
Cyanobacteria	*Callothrix;* blue green algae	X	–	–	X
Seagrass	*Phyllospadix scouleri*	X	X	X	X
Microalgae	Colonial diatom	–	X	–	X
	Diatom	X	–	X	X
Brown Algae	*Alaria marginata*	X	–	–	X
	Desmarestia ligulata	–	X	–	X
	Egregia menziesii	X	X	X	X
	Endarachne spp./*Petalonia* spp./ *Phaeostrophion* spp.	–	–	X	X
	Fucus spp.	X	X	X	X
	Laminaria setchellii	–	X	–	X
	Laminaria sinclairii	–	–	–	X
	Pelvetiopsis spp.	X	X	X	X
	Saccharina sessilis	X	–	–	X
Green Algae	*Cladophora columbiana*	X	X	X	X
	Ulothrix spp.	–	–	X	–
	Ulva spp./*Kornmannia* spp./ *Monostroma* spp.	X	–	X	X

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The “X” in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Red Algae	*Ahnfeltia fastigiata*	–	X	X	X
	Ahnfeltiopsis linearis	–	–	–	X
	Callithamnion pikeanum	X	X	–	X
	Centroceras spp./*Ceramium* spp./ *Polysiphonia* spp.	–	X	X	X
	Constantinea simplex	–	–	–	X
	Cryptopleura spp./ *Hymenena* spp.	X	X	X	X
	Cryptosiphonia woodii	X	X	X	X
	Dilsea californica	X	X	X	X
	Endocladia muricata	X	X	X	X
	Farlowia spp./*Pikea* spp.	–	–	X	X
	Gelidium coulteri	–	X	X	X
	Gloiopeltis furcata	–	–	X	X
	Halymenia/Schizymenia spp	X	–	X	X
	Mastocarpus spp.	X	X	X	X
	Mazzaella cordata/splendens/oregona	X	X	X	X
	Mazzaella parksii	X	–	–	–
	Microcladia borealis	X	X	X	X
	Neoptilota spp./*Ptilota* spp.	–	X	X	X

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The “X” in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Red Algae (continued)	*Neorhodomela larix*	X	X	X	X
	Neorhodomela oregona	X	X	–	–
	Odonthalia floccosa	X	X	X	X
	Osmundea spectabilis	–	X	X	X
	Plocamium pacificum	–	–	–	X
	Plocamium violaceum	X	X	X	X
	Polyneura latissima	–	X	–	–
	Polysiphonia spp.	–	–	–	X
	Prionitis linearis	–	–	X	X
	Prionitis lanceolata	–	X	X	X
	Prionitis sternbergii	–	X	–	–
	Pterosiphonia bipinnata	X	X	–	X
	Pterosiphonia dendroidea/pennata	–	–	X	–
	Pyropia spp.	X	–	X	X
Red Algae (red crusts)	*Petrocelis*	X	X	X	X
	Ralfsiaceae	X	X	X	X
	Other red crust	X	X	X	X

Table A1 (continued). Presence and absence of all taxa found at Redwood National and State Parks sites during 2019 and 2020 biodiversity surveys. The “X” in the table below indicates species present.

		First Point Only Survey		Full Point Survey	
Category	**Taxa**	**Enderts Beach 2019**	**Damnation Creek 2020**	**Damnation Creek 2019**	**False Klamath Cove 2020**
Red Algae (red corallines)	*Bossiella* spp.	–	–	–	X
	Calliarthron spp.	–	–	X	–
	Corallina spp.	X	X	X	X
	Crustose corallines	X	X	X	X
Substrate	Rock	X	X	X	X
	Sand	–	X	X	X
Total taxa	**n/a**	**57**	**69**	**70**	**82**

The Department of the Interior protects and manages the nation’s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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