Angeles, Paua Marine Research Group, NOAA, and TBF. Physical and chemical surveys have been less extensive but have been conducted by groups of researchers from UC Davis, TBF, UCLA, Cal State Northridge, and Cal State Monterrey. Monitoring program priorities developed by the working group included indicators that were part of existing monitoring programs such as fish community data, kelp cover, and invertebrate indicator species. Additional potential research questions and studies are identified in the data gaps subsection at the end of the chapter. Some of the identified challenges for this habitat by the working group were making sure some of the indicators did not have overlap in the monitoring data feeding into them and discussions about the potential to merge several indicators into a future index that has not yet been developed. Climate vulnerability was informed by the Climate Change Vulnerability Assessment conducted by SMBNEP in 2016 (Grubbs et al. 2016).

Indicators

Utilizing indicators helps track changes in the environment, and consistently collecting data on these indicators over time allows for long-term trends in habitat condition to be evaluated. The rocky reef habitat includes 12 indicators across four categories which will be used to detect changes in the environment (Table 6.1). Indicators will be monitored using a variety of programs and studies identified in the subsection below. Where possible, indicators are reflective of quantitative measurements at specific geospatial scales.

Table 4.1. Indicators for rocky reef habitats in the Santa Monica Bay region.

Indicator Category	Rocky Reef Indicators
Habitat Extent	Area of Rocky Reef Habitats
Ecological Condition	Kelp Canopy Coverage / Urchin Barren Extent
	Invertebrate Indicator Species
	Rocky Reef Fish Production
	Invasive Indicator Species
Stressors	Fishing Pressure
	Anthropogenic Discharges and Runoff
	Landslides and Sedimentation (Landscape Modification)
	Turbidity / Light Penetration
Climate Change Vulnerability	Water Temperature Change
	Increased Storminess
	Invertebrate Recruitment

Monitoring Program and Current Studies

This section of the report contains details on specific monitoring program implementation components that will be used to evaluate trends in the indicators over time. Information is provided on monitoring programs, responsible parties, and frequency of data collection.

For habitat extent, this indicator will be evaluated by tracking area of hard substrata by depth and category (e.g., deep reef, kelp beds, artificial reefs including outfall pipes, surfgrass, rock, etc.). Various geospatial layers can be used to inform this indicator, including those of Pondella et al. 2015 and Claisse et al. 2012 and armoring matrices surrounding and including outfall pipes (such as those of LASAN Hyperion Water Treatment Plant). Multispectral aerial imagery may also serve to inform this indicator or others below. Perhaps equally important is the three-dimensional structure of rocky reef habitat. A metric of vertical complexity needs to be developed for this habitat. Some measure of rugosity is possible, but side-scan sonar or some other recent technology may be well suited to capture this information for habitat extent.

For the other three categories of indicators, i.e., ecological condition, stressors, and climate change vulnerability, details on implementation strategies and monitoring program elements can be found in Tables 4.2, 4.3, and 4.4, respectively.

While VRG is conducting large-scale biological and side-scan monitoring, there are still geographic data gaps that need to be filled to be comprehensive across all rocky subtidal reef habitats. There are also categories of habitat type that are largely data gaps such as deep reef systems, artificial reefs, or areas with surfgrass. Additionally, note that monitoring programs that do not have a formal plan associated with them or are largely associated with opportunistic filling of data gaps state “opportunistic surveys / research” or “no current programs” in the tables below as they may not currently be funded programs.

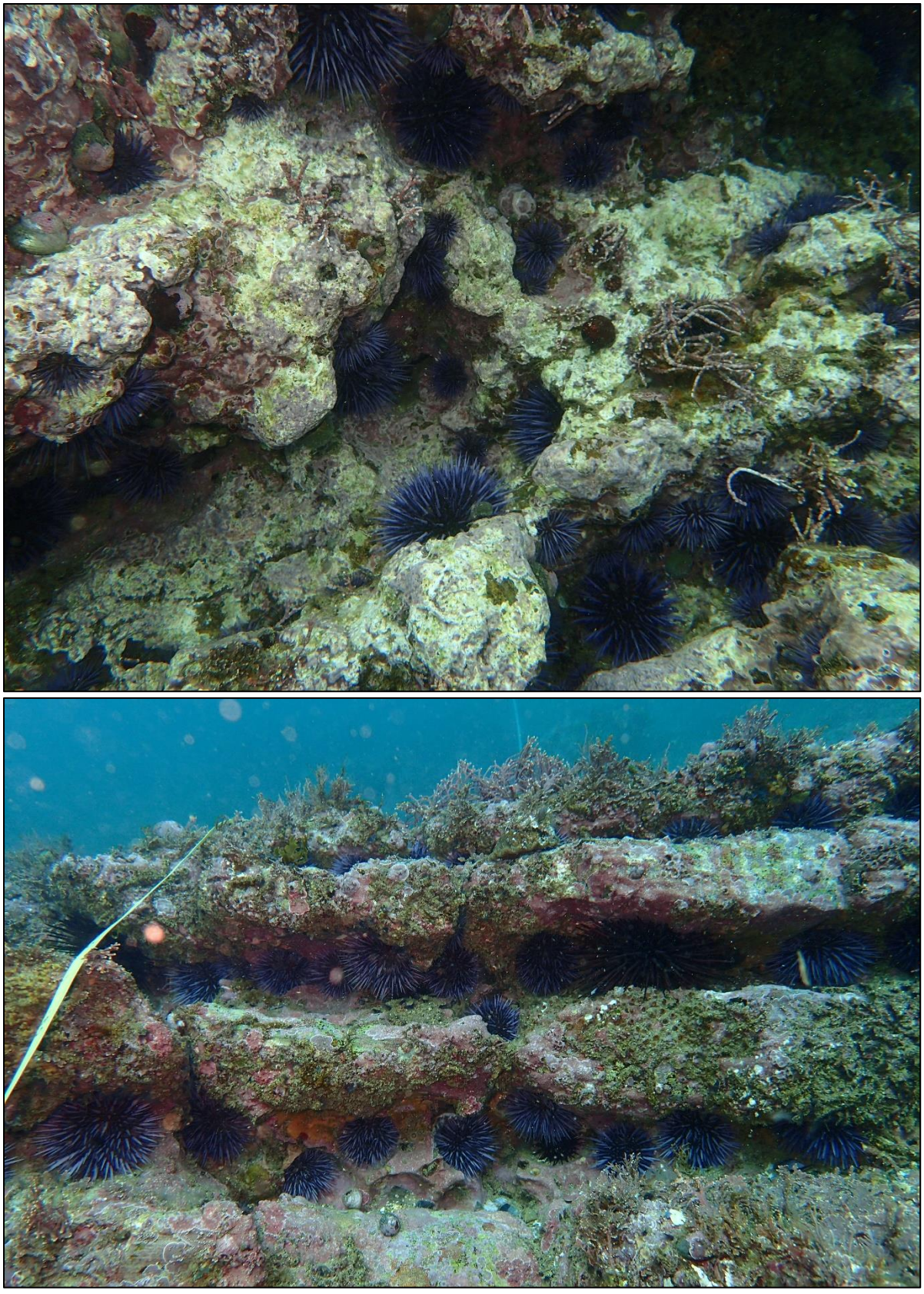

Figure 4-1. Rocky reef habitat as urchin barrens (pre-restoration) (credit: TBF).

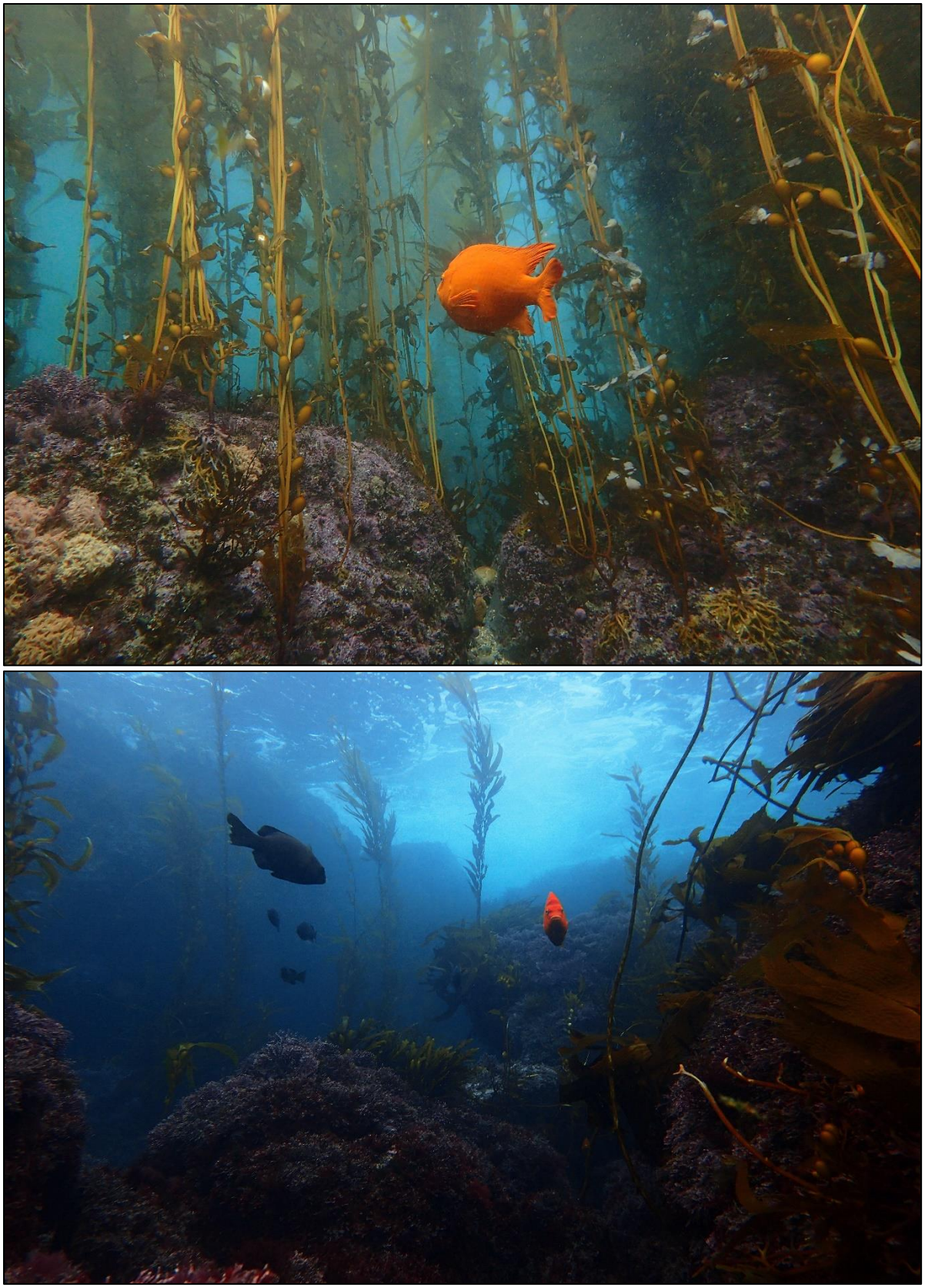

Figure 4-2. Rocky reef habitat as kelp forest with high diversity (credit: TBF).

Table 4.2. Ecological Condition Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Kelp Canopy Coverage / Urchin Barren Extent	Kelp aerial coverage	Central Region Kelp Survey Consortium aerial visual surveys (Ventura to Mexico); satellite data from NASA as LandSat data or other satellites; Dr. Kyle Cavanaugh at UCLA conducts periodic drone surveys and analyzes Planet (satellite) data	Quarterly for aerial surveys; opportunistic research for satellite data and drone surveys
	Percent of rocky reef by urchin density threshold	TBF pre- and post-data from kelp restoration areas off the PV Peninsula	Data collected in response to restoration efforts; analyzed and summarized annually
	Kelp density and understory macroalgae	TBF pre- and post-data from kelp restoration areas off the PV Peninsula; VRG surveys of several sites off PV Peninsula	Data collected in response to restoration efforts; analyzed and summarized annually; VRG annually
Invertebrate Indicator species	Spiny lobster densities	CDFW fishing data; CRANE surveys conducted by VRG; MPA data by VRG in Malibu	CRANE annually
	Sea stars and important commercial invertebrates	California Department of Fish and Wildlife fishing data; CRANE surveys conducted by VRG; MPA data by VRG in Malibu	CRANE annually
Rocky Reef Fish Production	Fish Production	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually
	Diversity and biomass index sensitive to fishing	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually
Invasive Indicator Species	Density and distribution of invasive algae and invertebrates	CRANE surveys by VRG and others; MPA data by VRG in Malibu; several location data gaps	CRANE annually

Table 4.3. Stressor Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Fishing Pressure Index	Index of fishing pressure	Commercial Passenger Fishing Vessel logs by CDFW; aerial surveys conducted by LightHawk and TBF	Opportunistic quarterly surveys; unknowns due to COVID and funding; CDFW frequency unknown
Anthropogenic Discharges and Runoff	Plume probability mapping	Remote sensing data (satellite)	Opportunistic surveys / research
	Runoff pollutants and point-source discharge	No current programs	No current programs
Landslides and Sedimentation (Landscape Modification)	Maps of landslide events and vulnerability assessment	Possible remote sensing data (Planet satellite)	Opportunistic surveys / research
	Direct burial, scour, etc.	Possible remote sensing data (Planet satellite)	Opportunistic surveys / research
	Water velocities and patterns	Some historical data from ADCPs along PV Peninsula	Opportunistic surveys / research
Turbidity / Light Penetration	Light penetration / depth	Some historical data may be available from one site location (Marguerite) by UC Davis	No current programs
	Tracking HAB events	No current programs	No current programs
	Chlorophyll	Remote sensing data (satellite)	Opportunistic surveys / research

Table 4.4. Climate Vulnerability Metrics and Monitoring Program Details.

Indicator	Monitoring Metric / Parameter	Monitoring Data Program / Responsible Party	Frequency
Water Temperature Change	Temperature	SCCOOS SM Pier data; National Weather Service offshore station data	SCCOOS – hourly, when available; NWS daily
		TBF and UC Davis HOBO-loggers collecting temperature data (15-minute interval) and miniDOT data on abalone sites (10-minute interval)	TBF data opportunistically for four-month periods
		CTD by CLA-EMD	Annually
		UC Davis miniCTD deployed historically at Marguerite for approximately two years	Historical data
Increased Storminess	Wave energy	Bottom-mounted pressure sensors (Seabird Wave and Tide Gauges and Open Wave Height Loggers) from UC Davis (historical study); buoy data from NOAA and Scripps Institution of Oceanography	Historical data for UC Davis study (periodically 2016-2019); real time data from NOAA/Scripps
Invertebrate Recruitment (OA)	pCO_2, dissolved oxygen, pH	LACSD has a single location offshore annual dataset (pCO_2, pH; see pelagic chapter); TBF deploys miniDOT data on abalone sites (10-minute interval)	LACSD – one site annually (not on a reef); TBF data opportunistically for four-month periods
	Benthic invertebrate composition and size class	CRANE surveys by VRG and others; MPA data by VRG in Malibu	CRANE annually

Data Sharing and Reporting

Rocky reef monitoring data will be compiled and analyzed approximately every five years associated with production of the SMBNEP SotB Report and led by the NEP's Technical Advisory Committee. The SotB Report will be made publicly available via website. Data will be consolidated and used to develop the SotB condition and trend graphics and will be represented visually when possible. Detailed information on data quality control, quality assurance, database management, and analysis will be available in the next update of SMBNEP's Quality Assurance Program Plan, scheduled for review in 2021. Data will be stored on TBF's servers with summaries available to the public upon request. When possible, data will be incorporated into public databases or data sharing portals.

Data Gaps and Future Studies

Habitat extent data for rocky reefs are present for some categories of habitats (e.g., maps of urchin barrens versus kelp forests) and limited in others (e.g., surfgrass areas). Additionally, an important metric for habitat extent that still needs development is a metric of vertical complexity using sonar or another method.

Many of the major outstanding data gaps that remain for the rocky reef habitat include limited geographic scope of many of the biological and physical indicators. Geographic ranges for existing data have been focused around the PV Peninsula and limited in places such as Malibu. Expansion of existing standardized protocols such as CRANE surveys into new geographic regions in the Bay is recommended. Additional geographic limitations include categories of habitat such as deep reefs, artificial reefs, and surfgrass habitats. Some data collection at the Hyperion outfall pipes (1-mile and 5-mile) is being conducted by LASAN, but it has not been translated into the indicators listed above. Additionally, little quantitative information associated with landslides is known or tracked impacting rocky reef systems.

Data gaps identified in the 2015 SotB Report included recommendations for further development of the rocky reef fish index, commercially important and other invertebrate data analyses, and other biological response variables. Several CMP rocky reef indicators are either not fully developed or do not have identified monitoring programs (e.g., anthropogenic discharges, landslides and sedimentation, and turbidity / light penetration). Additionally, the invertebrate recruitment indicator categorized in the "climate vulnerability" category needs further development. Table 4.5 summarizes priority data gaps identified for the rocky reefs habitat; types of data gaps; potential sources of funding at the federal, state, and local levels for filling these data gaps; and cross-references to relevant actions and potential funding sources identified in the 2019 CCMP Finance Plan (also provided in Table 9.3 of Chapter 9).

Next steps for this habitat type include continuing to prioritize and fill data gaps listed above and in Tables 4.2-4.5, especially the categories that are “no current programs” and require more information, as well as additional new studies that could further support the evaluation of the key indices for this habitat. Note that Tables 4.2-4.4 may look complete, but still may have spatial or metric data gaps. Future studies that are recommended include expansion of data sets identified for priority indicators in the tables above and use of additional monitoring methods or research tools. Examples include drone surveys for high resolution kelp cover, fishery stock models for Santa Monica Bay, ROV-AUV surveys, or data for deep reefs and other sites. There is an expressed interest for better tracking for stormwater plumes, coastal landslides, and spatially increased water quality data. Specific efforts should also prioritize water quality to better characterize the inputs of wildfires. Additionally, several indicators in the tables above could be supported by analysis of targeted satellite data from NASA over time.

Table 4.5. Rocky Reef Habitat – Summary of Data Gaps and Potential Funding Sources.

Indicator Category	Rocky Reef Habitat Data Gaps	Data Gap Type	Potential Funding Source(s)
Habitat Extent	ROV, sonar, and other surveys for characterization of deep reefs, surfgrass habitats, and other sites	Special study (new data acquisition, new methods/tools development)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
	Metric for vertical complexity	Special study (new methods/tools)	Prop. 50 and others (2019 CCMP Finance Plan Action #37)
Ecological Condition	Expansion of existing CRANE surveys into new geographic regions in the Bay	Index component	Unknown
Stressor	Fishing Pressure Index	Index development; Index component	Prop. 50, others
	Point source discharge and runoff pollutant loading and plume mapping	Single metric; Special study (existing data, new methods/tools development)	Unknown
	Landslide event mapping and vulnerability assessment	Single metric; Special study (existing data)	Unknown
	HAB tracking with remote sensing	Single metric; Special study (new methods/tools development)	OPC, NOAA, MERHAB program (2019 CCMP Finance Plan Action #35)
Climate Vulnerability	Impacts of acidification on benthic invertebrate mortality	Special study (existing data)	Sea Grant, OPC, SCC, others (2019 CCMP Finance Plan Action #36)

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