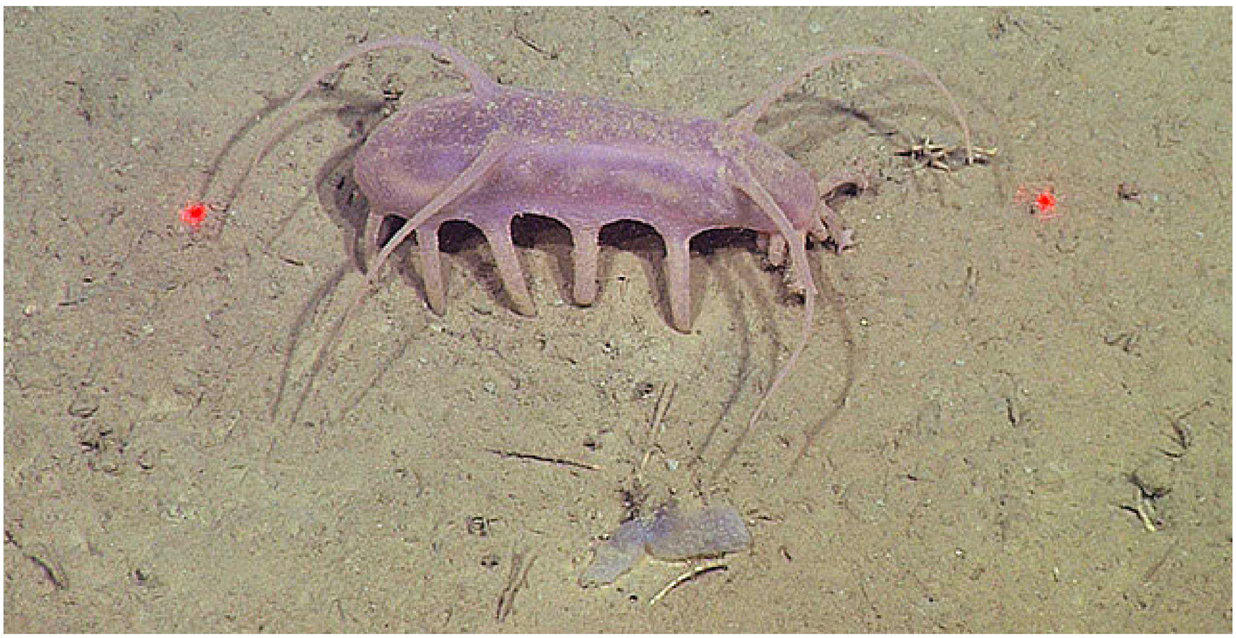
Deep-sea animal communities can change dramatically and erratically over time

April 8 2020, by Kim Fulton-Bennett



Sea pigs are a type of deep-sea sea cucumber whose populations may increase after large pulses of food sink to the deep seafloor. The gelatinous material at the bottom of the image (probably part of a pyrosome) is one example of the kinds of food in these pulses. The red dots are about 29 centimeters apart and are used to estimate the sizes of objects in the image. Credit: MBARI

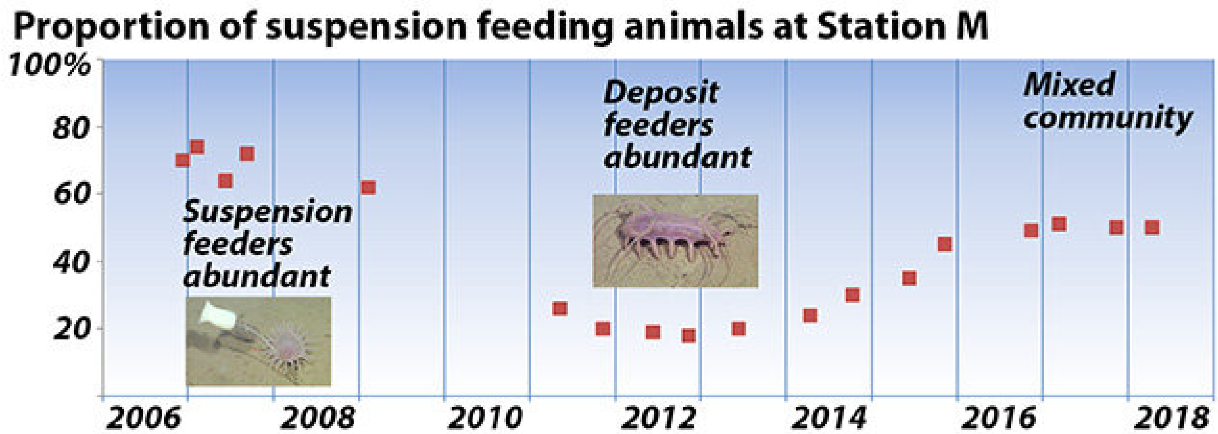
A 30-year study off the California coast has revealed dramatic fluctuations in deep-sea animal communities. Despite decades of research, scientists are still not sure what drives these changes. These findings are described in a recent paper by former MBARI researcher Linda Kuhnz and other MBARI scientists.

This paper and 15 others will be published in a special issue of Deep-Sea Research in summer 2020. The issue focuses on research at Station M, a deep-sea study site about 220 kilometers (137 miles) west of the Central California coast and 4,000 meters (13,100 feet) below the surface.

MBARI marine ecologist Ken Smith has led research efforts at Station M for three decades, using every conceivable oceanographic tool—seafloor cameras, landers, core samplers, sediment traps, and a variety of underwater robots.

Between 2006 and 2018, Smith and his team used MBARI's remotely operated vehicles (ROVs) Tiburon and Doc Ricketts to conduct 18 video surveys of the seafloor at Station M. These surveys add to a record of survey photography at Station M that extends back to 1989.

After each survey, Kuhnz identified every animal visible in the video and entered this information into MBARI's vast VARS (Video Annotation Reference System) database. All told, Kuhnz entered about 120,000 observations and documented over 400 different types of animals. The result was the most detailed, long-term record of change in a deep-sea animal community ever compiled.

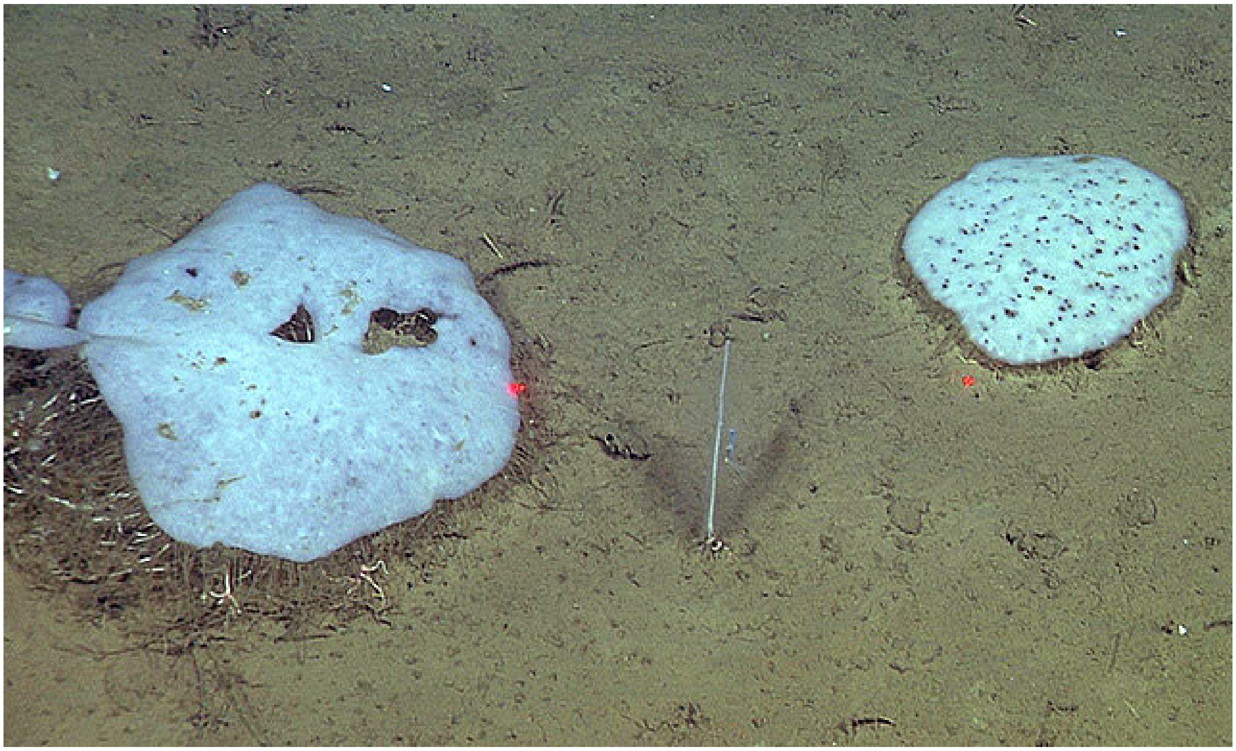


This graph shows how animal communities at Station M went from being dominated by suspension feeders such as sponges, to being dominated by deposit feeders such as sea cucumbers. Credit: Kim Fulton-Bennett/MBARI

Analyzing these data, the researchers discovered huge variations in the numbers and types of animals over time. For example, the average density of animals seen in the surveys varied by a factor of 100, from one animal in 17 square meters (in September 2007) to 6.5 animals in one square meter (in November 2012). The types of animals on the seafloor also changed, with sponges dominating in the early surveys, then sea cucumbers becoming dominant, followed by a mix of the two.

Drilling into the data, the researchers noticed that these changes involved more than just sponges and sea cucumbers. From 2006 to 2009, most of the animals seen on the seafloor at Station M were relatively immobile creatures that consume particles or organisms in the surrounding seawater. These included sponges, anemones, tunicates, and sea pens.

Around 2011, however, these "suspension feeders" started to become less numerous, and were partially replaced by mobile animals such as sea cucumbers, brittle stars, and worms, which eat food from the surface of the muddy seafloor. Between 2011 and 2014, the populations of such "deposit feeders" increased rapidly, eventually accounting for up to 90 percent of all the animals on the seafloor.

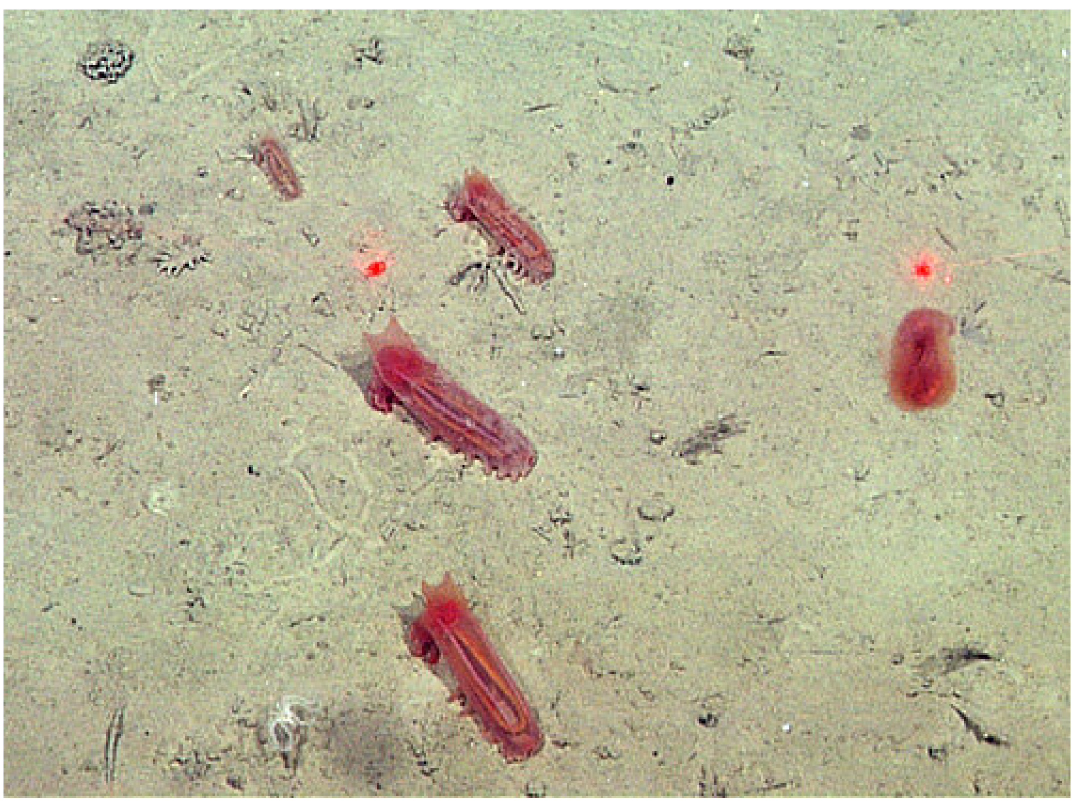


This photograph shows two sponges and a sea pen on the seafloor at Station M. Such relatively immobile suspension feeders dominated the animal community at Station M during the early years of this study. Credit: MBARI

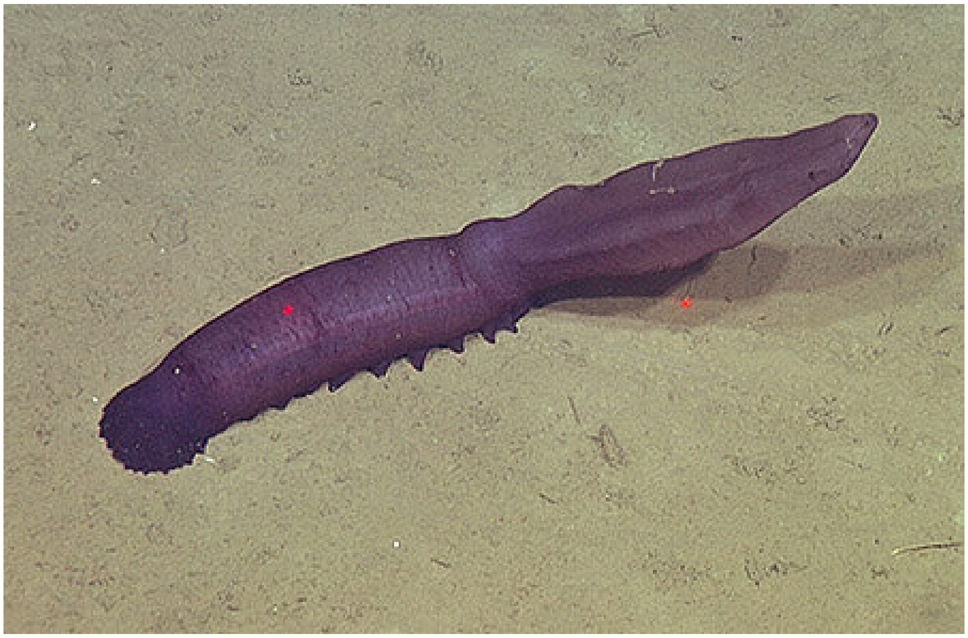
After 2014, however, the number of deposit feeders decreased and the number of suspension feeders increased, until the two groups were almost evenly mixed. This mixed community of both deposit and suspension feeders was similar to the animal communities that Smith and his colleagues observed during their early research at Station M in the early 1990s.

Kuhnz and her co-authors looked for possible links between changes in animal community at Station M and changes in the amount of food reaching the seafloor. The primary source of food for most deep-sea animals is organic detritus that sinks down from the sunlit surface layers into the depths of the ocean. This includes dead or dying algae, shed skins and feces from animals, and occasionally entire animals.

Previous studies by Smith and others showed that, for periods of years, or even decades, very little of this food reached the seafloor at Station M, so animals on the seafloor had very little to eat. But every now and then, algae and and/or animals such as salps became extremely abundant near the sea surface. When these organisms died en-masse, their sinking bodies reached the seafloor quickly and provided a feast for deep-sea animals.



Sea cucumbers such as these (in the genus Peniagone) became much more common at Station M after 2011. The red dots are about 29 centimeters apart and are used to estimate the sizes of objects in the image. Credit: MBARI



Although populations of some sea cucumbers at Station M varied dramatically over time, populations of other sea cucumbers, such Psychropotes longicauda, remained relatively stable. Credit: MBARI

But Kuhnz' paper suggests that it's not just the amount of food, but also the type of food that causes changes in deep-sea animal communities. For example, as the researchers point out, "The conspicuous, sustained drop in abundance of sponges, tunicates, sea pens, and other filter/suspension feeders after the heavy salp detritus influx in 2011 may suggest that large amounts of gelatinous material smother or otherwise inhibit these animals."

Similarly, some sea cucumbers benefit more than others from these abyssal feasts. For example, sea pigs (Scotoplanes globosa) appear to eat a wide variety of detritus, and can rapidly take advantage of the fresh material arriving at the seafloor. Other sea cucumbers, such as the large, purple Psychropotes longicauda, seem to prefer older detritus that has been partially decomposed by bacteria. Perhaps because of their differing dietary preferences, populations of sea pigs waxed and waned while populations of Psychropotes sea cucumbers remained relatively consistent throughout the study.

Kuhnz and her fellow authors point out that the erratic and fundamental community changes they observed in this study show how much scientists still have to learn about life in the deep sea. Their findings also show that one-time surveys of deep-sea animals are unlikely to capture the diversity and dynamic changes in these communities over time. This highlights the importance of long-term time-series data and the challenges faced by researchers trying to understand "baseline conditions" in deep-sea areas under consideration for industrial development or deep-sea mining.

More information: Linda A. Kuhnz et al. Benthic megafauna assemblage change over three decades in the abyss: Variations from species to functional groups, *Deep Sea Research Part II: Topical Studies in Oceanography* (2020). DOI: 10.1016/j.dsr2.2020.104761

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