

Nudibranch range shift

A species of nudibranch sea slug is expanding its range northward along the California coast in response to warming ocean conditions.



A nudibranch sea slug, *Phidiana hiltoni* (*P. hiltoni*), has been expanding its range farther north along the California coast. During periods of warm ocean conditions, most often linked with El Niño events, some marine species temporarily shift northward but then move back to their original location when cool conditions return. *P. hiltoni* has been moving northward since the mid-1970s, and has remained at the new northern locations where it has been observed.



Phidiana hiltoni is a soft-bodied nudibranch living in shallow water rocky habitat.

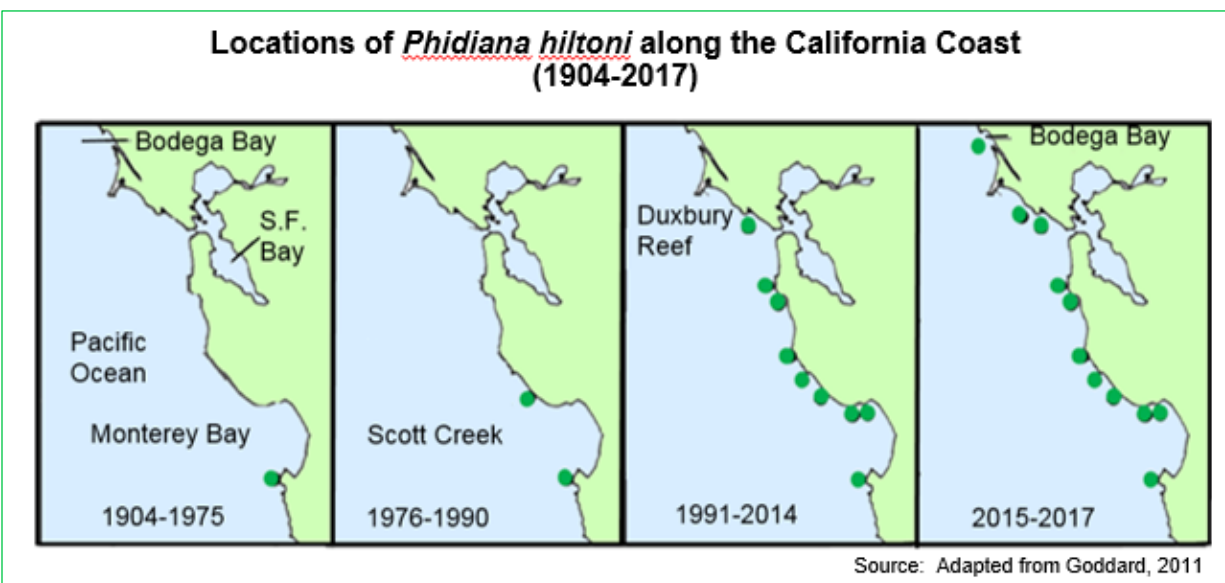
Photo: Jeffrey Goddard

California's coastal ocean temperatures have warmed over the past century. With water temperatures steadily increasing, recently settled southern marine species are more likely to remain in their expanded northern ranges. Changes in the ranges of small, short-lived marine organisms such as nudibranchs may seem inconsequential. However, their habitats overlap with commercially important organisms, including abalone, crab and lingcod. The introduction of organisms into new territories can have negative impacts on resident species, similar to those caused by invasive species.

What does the indicator show?

Historical surveys of nudibranch populations along the California coast show that *P. hiltoni* has extended its range northward by 210 kilometer (km) since the mid-1970s. The maps below show locations where *P. hiltoni* had been observed (green circles) during four different periods, starting in 1904.

Until 1975, *P. hiltoni*'s most northern location was on the Monterey Peninsula. Beginning in the late 1970s, its range expanded north across Monterey Bay to Scott Creek. By 1992, it had spread another 110 km up the coast into the San Francisco Bay Area as far north as Duxbury Reef in Marin County. By 2015, it had reached Bodega Bay.





Unusually warm waters occurred in the Pacific Ocean in 2014-2015. This “marine heat wave” affected the entire west coast of North America. While marine heat waves have occurred in the past, the magnitude and duration of the warming during this time period was unprecedented for the region. Fish and other marine organisms shifted their distributions farther north to cooler waters.

Warm ocean temperatures can cause poleward shifts in ocean currents that transport nudibranchs in larval form northward along the coast. All told, 23 nudibranch species were found at new northernmost locations during the recent marine heat wave. Among these was *P. hiltoni*. After inhabiting Duxbury Reef for 13 years, this nudibranch was found for the first time in Bodega Bay in 2015. It continues to be found at this new northernmost location. Interestingly, while strong El Nino warming events occurred during the century-long observation period, it was only after the 1990s that *P. hiltoni* appeared in the San Francisco Bay Area.

Why is this indicator important?

When species occupy new habitats, they can disrupt predator-prey relationships, compete for food and other resources, and cause other disruptions to the ecosystem. Population declines in other nudibranch species have occurred at Duxbury Reef, where high densities of *P. hiltoni* have been observed. These declines appear to have resulted from *P. hiltoni* preying on resident nudibranchs and competing for common prey species. Scientists suggest *P. hiltoni* may be disrupting food webs and altering species composition along the California coast where its populations are dense.

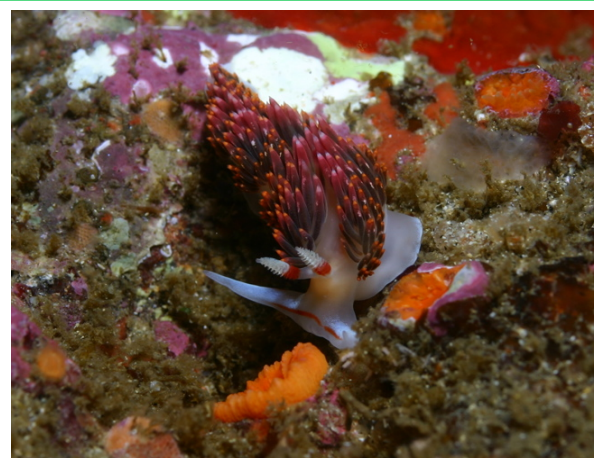


Photo: NOAA/Monterey Bay Aquarium Research Institute

Marine animals live in habitats defined by certain physical conditions, such as temperature and salinity. As ocean temperatures warm, range shifts can provide important insights into how species are responding to climate change. *P. hiltoni* remains the best documented example of an apparent permanent northern range shift among Pacific Coast nudibranchs. This species’ response to ocean warming may foretell larger ecological changes that may already have been set in motion by climate change.

For more information about this and other climate change indicators, visit:

<https://oehha.ca.gov/climate-change/report/2018-report-indicators-climate-change-california>

