

CURRENT SCIENCE

The decline of the world's coral reefs is a serious concern, with scientists largely agreeing that global warming, ocean acidification, and invasive disease species are among top, driving factors.^{1,2,3} Yet while some recent, misinformed policy actions might indicate otherwise, the science is clear: no validated, replicated evidence shows a correlation between oxybenzone, a popular UV filter and valuable public health protector, and coral decline.

The "Hawaii ban" is primarily based on two shaky toxicity studies on coral that have not corroborated or reproduced in a real-world environment.^{4,5} Both studies have serious methodological flaws:

- They use coral samples, juvenile coral, and isolated coral cell culture methods. None of these methods are indicative of true environmental conditions.
- They use unrealistically high exposure concentrations
- Sample size, replicates, and analytical methods described are poor

Because of these methodological flaws, they cannot be used for policy making.

A third research group (He, et al) recently published toxicity studies and estimated a medium environmental risk for the two ingredients based on conservative exposure endpoints.

Only four studies have been published in peer-review scientific journals that assess coral toxicity of the UV filters oxybenzone and octinoxate.^{4,5,6} Despite widespread media coverage of these studies claiming that they show how oxybenzone and octinoxate are killing coral, a closer examination of the results demonstrates several flaws and an overall lack of support

for the position that the sunscreen causes coral mortality in the environment:

- These studies do not reflect conditions in a reef ecosystem, where a sunscreen would be rapidly dispersed and diluted.
- Each one of the studies use concentrations of UV filters (parts per million) much higher than what has typically been found in the marine environment (parts per trillion).
- Only the He, et al paper directly tested toxicity of octinoxate.

Typical environmental risk assessments are done using model organisms that are routinely raised in a lab setting, because they tolerate lab culture and can be used to assess potential toxicants. Coral, however, are extremely sensitive organisms, with various symbionts and holobionts (algae and microorganisms that are critical to their growth and survival).

- Coral rely on other reef-dwelling animals to maintain the overall reef health and ecology.
- Taking coral out of the complex reef environment creates stress that makes them immediately vulnerable; they are simply not good laboratory model organisms.
- Each study makes the incorrect assumption that sunscreen ingredient exposure comes via two ways: directly from people engaged in recreational water activities or from wastewater treatment.
- UV filters are used in numerous products, including plastics, packaging, color-fast fabrics, etc.
- No one has yet determined where the UV filters found in the environment originate.
- Plants and some marine organisms make benzophenone compounds naturally.

¹ National Academy of Sciences, Nov. 2018, <https://www8.nationalacademies.org/pa/projectview.aspx?key=dels-osb-17-01#collapseC>

² National Oceanic and Atmospheric Administration's (NOAA), Coral Reef Conservation Program, Coral Threats; Available at: <https://coralreef.noaa.gov/issues/welcome.html>

³ National Academy of Sciences, Nov. 2018, <https://www8.nationalacademies.org/pa/projectview.aspx?key=dels-osb-17-01#collapseC>

⁴ Downs, et al. 2016 Toxicopathological Effects of the Sunscreen UV Filter, Oxybenzone (Benzophenone-3), on Coral Planulae and Cultured Primary Cells and Its Environmental Contamination in Hawaii and the U.S. Virgin Islands. Arch Environ Contam Toxicol 70: 265-288.

⁵ Danovaro, et al. 2008 Sunscreens cause coral bleaching by promoting viral infections. Environ Health Perspectives 116(4):441-7.

⁶ He, et al. 2019. Comparative toxicities of four benzophenone ultraviolet filters to two life stages of two coral species. Science of the Total Environment 651: 2391-2399. He, et al. 2019. Toxicological effects of two organic ultraviolet filters and a related commercial sunscreen product in adult corals. Environmental Pollution 245: 462-4

The coral reef scientific community is unanimous in the conclusion that increased sea temperatures, as a result of global climate change, is the single most important factor in coral survival.

An International Coral Reef Initiative report states: "There is a lack of firm evidence of widespread negative impacts at reef community and/or ecosystem level. The evidence available may not properly reflect conditions on the reef, where pollutants may rapidly disperse and be diluted. Concentrations of UV filters used in experimental work have generally been higher than those likely to be encountered in the reef environment, although no study has assessed the levels of these chemicals in the tissues of long-lived species."⁷

- According to the U.S. National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program, coral reefs are impacted by an increasing array of hazards – primarily from global climate change, ocean acidification, and unsustainable fishing practices.⁸
- This year, the foremost researchers on coral published a seminal paper in *Science* analyzing coral bleaching records at 100 globally distributed reef locations from 1980 to 2016, linking the bleaching events to increased sea temperatures.
- There is no scientific evidence that under realistic conditions, sunscreen ingredients are a relevant source for coral bleaching. In fact:
 - Hawaiian researchers from the Hawai'i Institute of Marine Biology at the University of Hawai'i, Kane'ohe have shown that local conditions do not contribute to coral bleaching events⁹
 - The Australian government found the majority of coral bleaching occurs where there is low to no human interaction and that coral is healthiest in tourist or high traffic areas.

FUTURE SCIENTIFIC STUDIES

KEY WEST-AREA WATER QUALITY STUDY

The aim of this study is to provide information that will allow City Officials in Key West to assess the relative impact of factors that could contribute to the degradation of local coral reef communities. Deliverables include:

- 1) a summary of literature on factors that are known or suspected to contribute to coral decline and their relative magnitude of impact;
- 2) a summary of reported detections of sunscreen ingredients around Key West and other coastal waters;
- 3) a screening evaluation of local anthropogenic factors (e.g., agriculture, WWTP, tourism, shipping traffic) in context with their proximity to coral and associated bathymetry and ocean currents;
- 4) a relative ranking of factors that may be contributing to degradation of coral in marine waters around Key West; and
- 5) triage-oriented recommendations for next steps.

Estimated completion date: April/May 2019

WASH-OFF STUDY

Developing a laboratory model to evaluate the release of target compounds from skin products into seawater under simulated swimming conditions. This study will help determine the level of exposure to the marine environment from sunscreen use.

Estimated completion date: Q3 2019

CORAL TOXICITY STUDY

Regulatory agencies use Environmental Risk Assessments (ERA) to characterize the nature and magnitude of health risks to ecological receptors (e.g., coral) from chemical contaminants and other stressors that may be present in the environment. Risk assessments predict the probability, nature, and magnitude of the adverse health effects that may occur. Oftentimes, key data points are not available, and a risk assessor must make assumptions and estimates to calculate the potential risk. While we have several reliable monitoring studies on which we can base exposure models, we are missing reliable toxicity datapoints. We are proposing to run chronic and acute toxicity assays to calculate a more accurate ERA.

⁷ Wood, Elizabeth, 2018 Marine Conservation Consultant, UK. Impacts of Sunscreen on Coral Reefs, International Coral Reef Initiative

⁸ National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Conservation Program, Coral Threats; Available at: <https://coralreef.noaa.gov/issues/welcome.html>

⁹ Rodgers et al. Patterns of bleaching and mortality following widespread warming events in 2014 and 2015 at the Hanauma Bay Nature Preserve, Hawai'i. PeerJ, 2017;5:e3355; DOI 10.7717/peerj.3355; available at https://peerj.com/articles/3355/?utm_source=TrendMD&utm_campaign=PeerJ_TrendMD_0&utm_medium=TrendMD