UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Hollings Marine Laboratory
331 Fort Johnson Road
Charleston, South Carolina 29412

December 15, 2017

The Honorable Elle Cochran
and Members of the Maui County Council
West Maui Seat
200 S. High Street
Wailuku, Hawaii 96793

Dear Council Member Cochran and Maui County Council Members:

I am writing in response to your request for comments on the science related to coral reefs and the impacts of sunscreens and cosmetics containing oxybenzone.

I am a NOAA scientist working within the National Ocean Service's National Centers for Coastal Ocean Science. I have over 30 years of experience in molecular and cellular biology, biochemistry and pathobiology, which I have applied to aspects of coral health and disease research for the past 20 years. I am also one of the co-authors of a 2016 peer-reviewed article in *Archives of Environmental Contamination and Toxicology* that examined the toxicological effects of oxybenzone on coral larvae, cultured primary coral cells and measured environmental concentrations in coral reef areas in the Caribbean and at multiple sites in Hawaii.

The preponderance of scientific evidence indicates that oxybenzone is toxic to coral and threatens overall coral reef health by:

- inducing coral bleaching;
- harming or killing coral larvae by inducing gross deformities, DNA damage, and bleaching;
- acting as an endocrine disruptor; and
- bioaccumulating in coral tissue.

I have provide the attached summary of the relevant peer-reviewed literature (Appendix A) in support of this conclusion. As you will see, the research documenting the toxicity of oxybenzone on corals is extensive. While additional research may incrementally add to our understanding of its impacts to other coral reef species, additional research on the impacts of oxybenzone should not be a prerequisite to management action.

Sincerely,

Cheryl M. Woodley

Cheryl M. Woodley, PhD
Coral Health & Disease Program and
Coral Disease & Health Consortium

Appendix A: Literature Review

The weight of evidence, built over at least 20 years of research and hundreds of peer-reviewed scientific articles, demonstrates that oxybenzone is toxic to corals and other animals. Oxybenzone [aka, Benzophone-3; (2-hydroxy-4-methoxyphenyl)(phenyl) methanone] is present in aquatic[1,2,3,4], marine[5,6,7,8,9] and coral reef environments[10,11,12,13]. It can convey multiple and different lethal and sub-lethal effects in aquatic taxa as diverse as marine bacteria[14,15], microalgae[16], protozoans[17], cnideria[18], molluscs[19,20], sea urchins[21], crustaceans[22], and fish[23,24,25].

Compounding the problem, oxybenzone becomes more toxic when the exposures occur in sunlight (or artificial light containing UV). Additionally, oxybenzone is also known to act as an endocrine disruptor with non-monotonic dose responses (meaning low doses can have greater endocrine disrupting effects than at higher doses)[26,27,28]. In addition, among these studies are also those that have developed ecological risk assessments (i.e., hazard quotients)[29,30,31] for various receptor species (non-coral) exposed to oxybenzone in aquatic environments.

The first evidence showing that oxybenzone is a threat to coral reefs came in 2008, when Danovaro et al.[32] showed that oxybenzone could induce coral bleaching. Our work[33] provided evidence for more precise toxicity effects using exposure-response profiles and photo-enhanced toxicity characteristics of oxybenzone (i.e., oxybenzone is more toxic in sunlight) in corals and provided insights into the toxicopathology of corals exposed to oxybenzone. Multiple toxicity endpoints were assessed to determine toxicity for coral larvae including gross deformities, DNA damage, and bleaching. Cell mortality in primary coral cell cultures was used in an *in vitro* assay across multiple coral species to assess oxybenzone toxicity and species sensitivities to the compound. Our results showed that gross developmental deformities in coral larvae of differing degrees across all concentrations tested and after 8 h exposure their movements ceased. These gross observations were underscored by subcellular pathologies showing catastrophic tissue lysis and cellular degradation, particularly at the surface of the larvae. The larvae also displayed reduced chlorophyll fluorescence indicative of bleaching at all concentrations tested.

The accumulation of DNA damage underscores the potential threat of oxybenzone to corals and other coral reef organisms. It has implications for potential impacts to larval development, coral recruitment and juvenile survival and on a larger scale implications for impacts to the adult coral's reproductive effort and the fitness of coral populations exposed to oxybenzone now and in the future. Our laboratory studies included concentrations levels of oxybenzone that were in the same range as actual levels measured in coral reef zones in the U.S. Virgin Islands and in the Hawaiian sites on Oahu and Maui.

A follow-on experiment conducted in our laboratory with adult coral (*Fungia* sp.) showed that when exposed to a water accommodated fraction of a popular sunscreen formulation (Fig. 1), the corals exuded large amounts of mucus and lifted epithelial layers of their surface tissues. Analytical chemistry determined that coral tissues do bioaccumulate active sunscreen ingredients (results presented in 2016 at the International Coral Reef Symposium, Honolulu HI).

A new study[34] builds on previous work to provide further information indicating a high bioaccumulative potential for oxybenzone to accumulate into coral tissues and a preliminary risk assessment for coral species exposed to oxybenzone and other sunscreen contaminants. The authors caution of an increased risk during coral spawning seasons and for corals close to aquatic recreational hotspots.

The preponderance of scientific evidence provided by our work and that of many others supports a reasonable conclusion that oxybenzone is a threat to coral and can threaten overall coral reef health. Managing the exposure of corals and other reef organisms is one essential step for reducing this threat on reef ecosystems.

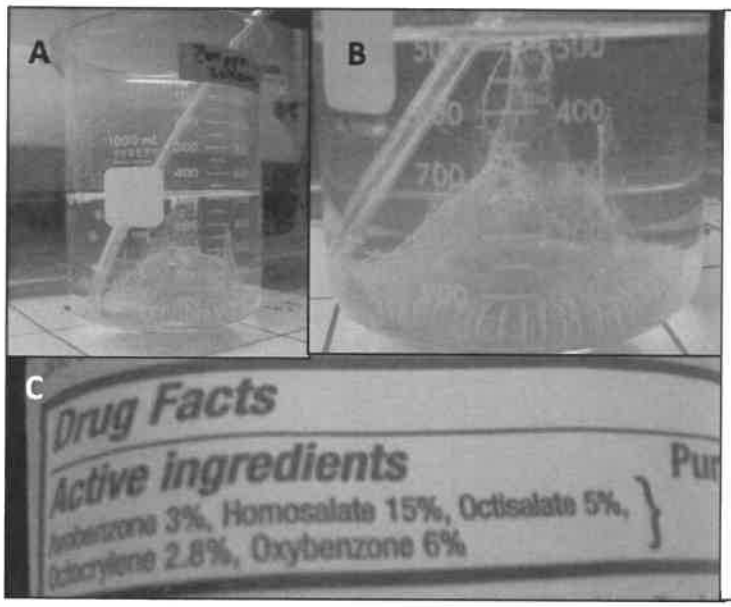

Fig. 1. Exposure-response of *Fungia* coral to commercial sunscreen lotion formulation. This experiment was to evaluate the response of coral to a water-accommodated fraction (WAF) of a commercial sunscreen formulation and to determine the amount of sunscreen components that are taken up into coral tissues. Panels A & B show response of *Fungia* sp. after 23 h exposure to WAF of a commercial sunscreen. Mucus sheets and expansion of surface epithelial tissues in response to sunscreen exposure, a reaction similar to that described by Danovaro et al (2008). Panel C is sunscreen product label of active ingredients in tested formulation. Tissue extracts of exposed corals showed oxybenzone levels could bioaccumulate to 220.7 parts per trillion (ng/L) after 48h exposure.

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