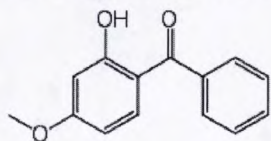


# Oxybenzone



## Chemical Identity

**Chemical Abstract Service (CAS) Registry Number:** 131-57-7

**Molecular Weight (MW)** – 228.25

**United Nations Global Harmonized System (GHS) – Hazard Statements:** H413 – May cause long lasting harmful effects to aquatic life [Hazardous to the aquatic environment, long-term hazard]

**IUPAC Name:** (2-hydroxy-4-methoxyphenyl)-phenylmethanone

**Trade Names/Supplier:** AEC Benzophenone-3 (A & E Connock (Perfumery & Cosmetics) Ltd.); CSS-II Sun Screening Agent (Spec-Chem Industry Inc.); Custom B-3 (Custom Ingredients, Inc.); Escalol 567 (Ashland Inc.); Eusolex 4360 (Merck KGaA /EMD Chemicals); Eusolex 4360 (EMD Performance Materials Corp.); EUSORB 228 (Aceto Corporation); Jeescree Benzophenone 3 (Jeen International Corporation; Neo Heliopan BB (Symrise); OriStar BP3 (Orient Stars LLC); Protaphenone-3 (Protameen Chemicals); Uvasorb MET/C (3V Sigma USA Inc.); Uvinul M 40 (BASF Corporation); UVSOB 350 (LC United Chemical Corp.).

**FDA Voluntary Cosmetic Registration Program (VCRP):** Use as of 01/2015 = 912

**Use Level:** Up to 6.0% in Sunscreens in the United States; Up to 10% in other countries.

**Reported Product Categories:** Aftershave Lotions; Baby Shampoos; Basecoats and Undercoats; Bath Capsules; Bath Oils, Tablets, and Salts; Bath Preparations, Misc.; Bath Soaps and Detergents; Blushers (All types); Body and Hand Preparations (Excluding Shaving Preparations); Bubble Baths; Cleansing Products (Cold Creams, Cleansing Lotions, Liquids and Pads); Colognes and Toilet Waters; Eye Lotions; Eye Makeup Preparations, Misc.; Eye Shadows; Eyebrow Pencils; Eyeliners; Face Powders; Face and Neck Preparations (Excluding Shaving Preparations); Feminine Hygiene Deodorants; Foot Powders and Sprays; Foundations; Fragrance Preparations, Misc.; Hair Coloring Preparations, Misc.; Hair Conditioners; Hair Dyes and Colors (All Types Requiring Caution Statements and Patch Tests); Hair Preparations (Non-coloring), Misc.; Hair Shampoos (Coloring); Hair Sprays (Aerosol Fixatives); Hair Wave Sets; Indoor Tanning Preparations; Lipsticks; Makeup Bases; Makeup Preparations (Not eye), Misc.; Manicuring Preparations, Misc.; Moisturizing Preparations; Nail Creams and Lotions; Nail Polish and Enamel Removers; Nail Polish and Enamels; Night Skin Care Preparations; Perfumes; Personal Cleanliness Products, Misc.; Shampoos (Non-coloring); Shaving

RECEIVED AT IEM MEETING ON 11/13/17

from Joe DiNardo

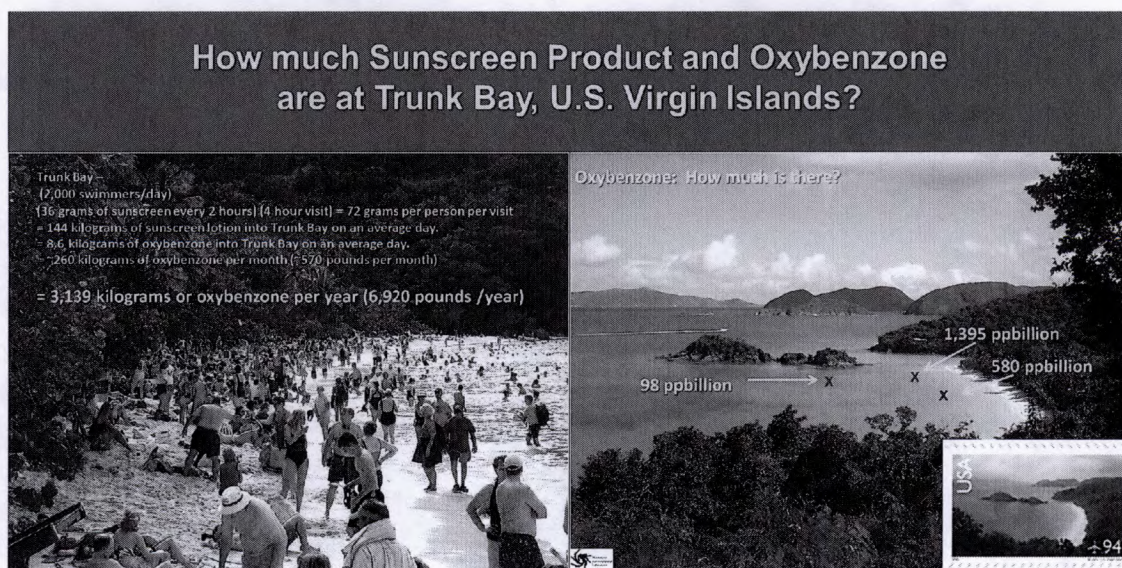
Preparations, Misc.; Skin Care Preparations, Misc.; Skin Fresheners; Suntan Gels, Creams, and Liquids; Suntan Preparations, Misc.; Tonics, Dressings, and Other Hair Grooming Aids

## Oxybenzone Contamination in the Environment and the Public

Oxybenzone is a ubiquitous environmental contaminant – it is found in streams, rivers, lakes, and in marine environments from the Arctic Circle (Barrow, Alaska) to the beaches and coral reefs along the equator<sup>1,2,3,4</sup>. It is considered an environmental hazard in many locations<sup>5</sup>. It is found in very high concentrations in swimming pools and hot tubs<sup>6</sup> and even in our drinking water (municipal treated and desalinated sources)<sup>7,8</sup>. Swimmers directly contaminate water sources, but point and non-point sewage and treated waste-water effluent discharges are the largest source of contamination.

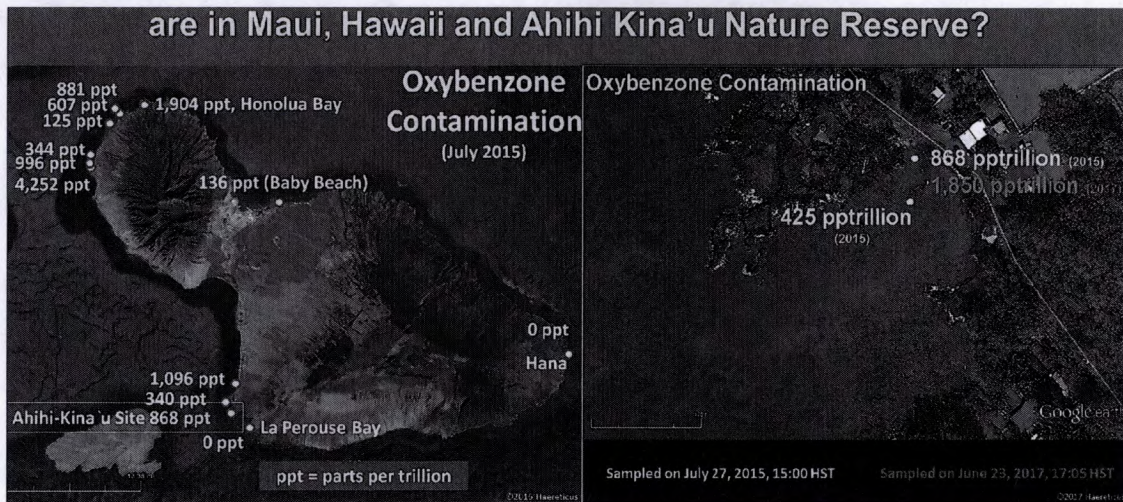
Oxybenzone can be absorbed directly through the skin, either from application of sunscreen product onto the skin, or by absorption from swimming in either swimming pools or along beaches<sup>9,10,11</sup>. Oxybenzone in a commercial sunscreen formulation can transfer from the lotion or spray into the body, and be detected in urine within 30 minutes to several hours of application<sup>12,13</sup>. Oxybenzone body-contamination is widely prevalent in the general human population, with some nationalities having higher levels than others<sup>14</sup>. One study found that 96.8% of participants' urine was contaminated with oxybenzone, indicating the almost-universal prevalence of exposure in the human population<sup>15,16</sup>. Oxybenzone can contaminate semen<sup>17</sup>, placenta and breast milk of marine mammals and humans<sup>18,19,20,21</sup>. Oxybenzone can both bioaccumulate, and can be biomagnified<sup>22</sup>. Oxybenzone has been found in bird eggs, fish, coral, humans, and other marine mammals<sup>23,24,25</sup>.

Oxybenzone is found in many aquatic environments. It is found in parts per trillion concentrations off the coast of Barrow, Alaska, U.S.A, to parts per billion on coral reefs in the Caribbean, Pacific, and Red Sea<sup>1-4</sup>. One of the highest concentrations measured in the marine environment was in Trunk Bay in the U.S. Virgin Islands National Park, in St. John Island, U.S. Virgin Islands. This beach can get between 2,000 to 5,000 people in a day.



In Hawaii, on the island of Maui, the oxybenzone contamination of the west coast is extensive. Honolulu Bay on the northern end of Maui saw 1.9 parts per billion oxybenzone. In the Ahihi Kina'u Nature Reserve, oxybenzone levels are increasing from 2015-2017. The near-shore reef and corals in the Fish Cove area is highly degraded.

How much Sunscreen Product and Oxybenzone Pollution



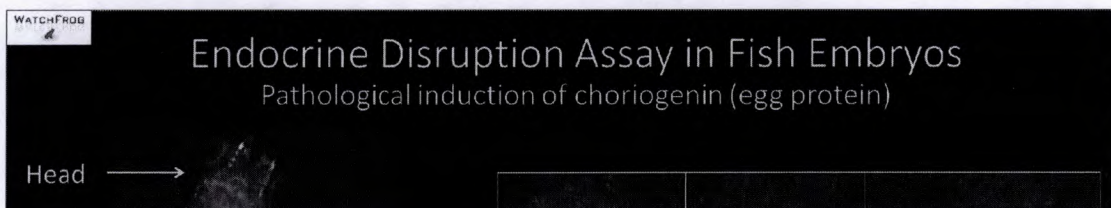
## Oxybenzone Ecotoxicology

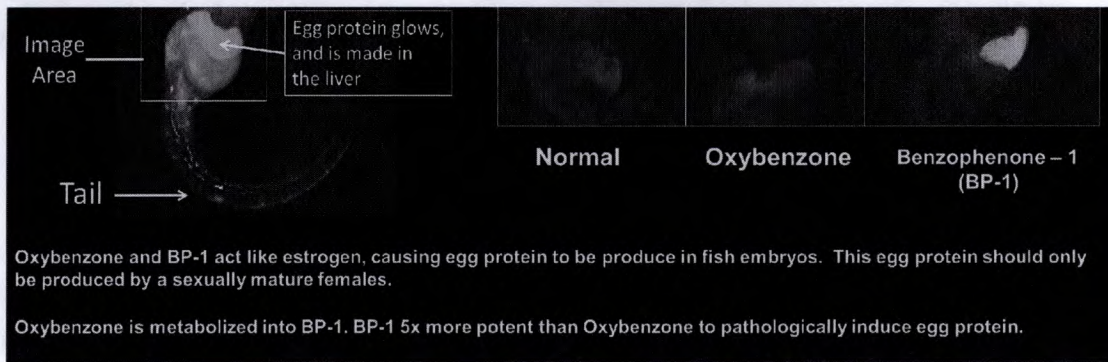
Oxybenzone and many of its metabolites are documented mutagens, especially when exposed to sunlight<sup>26,27,28,29,30</sup>. They can cause genotoxicity either from induction of photo-oxidative stress or adduction to DNA directly through bio-activation by cytochrome P450 enzymes<sup>31,32,33</sup>. Oxybenzone and other benzophenones can induce pro-carcinogenic activities by inducing cell proliferation in cancer cells lines that are receptive to estrogenic compounds<sup>34,35,36</sup>. Recent studies have also documented that oxybenzone increases metastasis potential (cellular proliferation and migration) via a non-estrogenic mechanism<sup>37,38</sup>.

Oxybenzone is a photo-toxicant, especially in the presence of ultraviolet light. This means that the greater the light intensity, especially in the UV and near-UV spectrum, new forms of toxicity manifest, and usually in a dose-dependent manner of both oxybenzone and light.

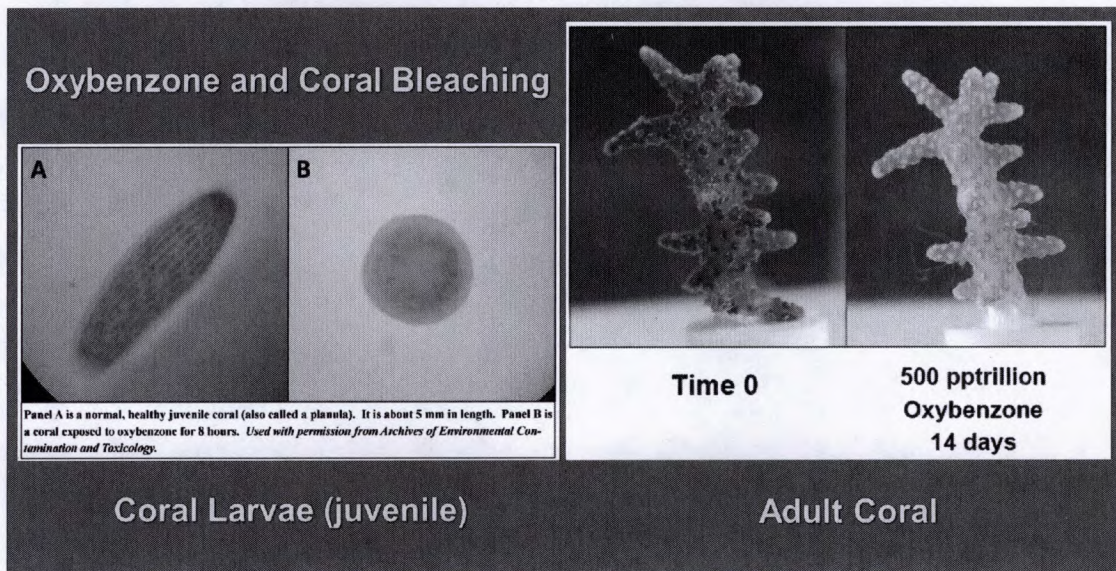
In mammals, especially humans, oxybenzone has been shown to induce photo-allergic contact dermatitis in 16%-25% of the population<sup>39,40,41</sup>. Oxybenzone causes toxicity to sperm development and sperm viability, reduced prostate weight in mature males, and reduced uterine weight in juvenile females<sup>42,43</sup>. In rodents, it reduced fecundity and induced idiopathic sudden death in lactating mothers<sup>44</sup>. Several recent studies have shown a strong association between urinary and seminal oxybenzone concentrations and increased reproductive diseases and reduced fecundity<sup>45,46</sup>. There is a building body of evidence of the estrogenic and anti-androgenic endocrine disrupting mechanisms of oxybenzone in mammals<sup>47,48</sup>. One study indicated an increased occurrence of endometriosis in women exposed to concentrations of oxybenzone, while another study showed a positive association with uterine leiomyoma<sup>49,50</sup>. Oxybenzone has also been associated with altered timing of breast development in girls<sup>51</sup>.

Oxybenzone is a notorious estrogenic endocrine disruptor, causing male fish to become feminized and inducing egg protein production in males and juveniles<sup>52,53,54</sup>. Oxybenzone causes a reduction in the number of eggs a female fish will produce<sup>55,56,57</sup>. In fish, oxybenzone is metabolized into benzophenone-1, a much more potent estrogenic disruptor<sup>58</sup>. Oxybenzone will also cause radical behavioral changes in fish, causing them to lose "territorial" behavior<sup>59</sup>.

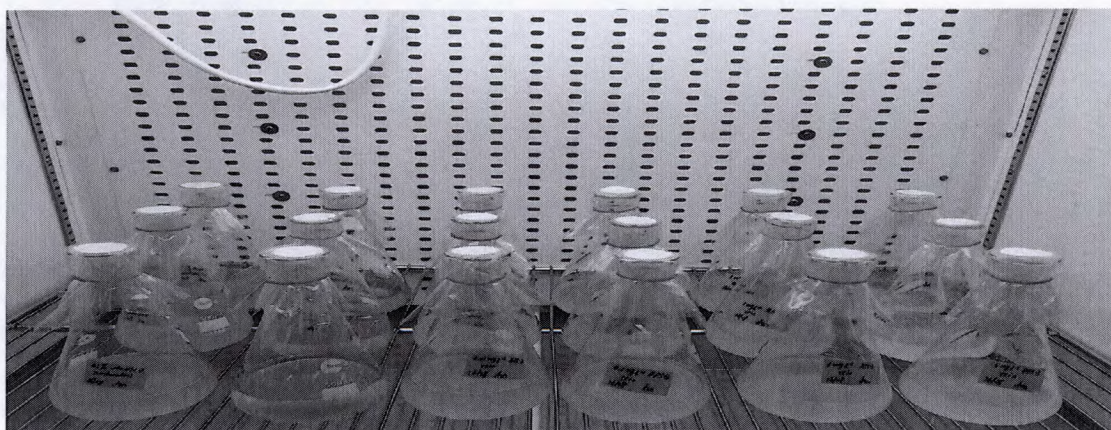




Oxybenzone can have devastating effects on invertebrates, especially on juvenile developmental stages<sup>4</sup>. In coral, it can cause coral bleaching, DNA damage, planula deformity, mortality, and skeletal endocrine disruption<sup>4</sup>. For coral planula, gross toxicological effects were seen as low as 6.5 ppbillion in a 24-hour period, and cellular effects were seen as low as 72 pptillion in a 4-hour period. In bivalves, growth inhibition occurred around 2-3 ppmillion<sup>[1]</sup>. In shrimp larvae, growth inhibition was seen around 421 ppbillion<sup>49</sup>.

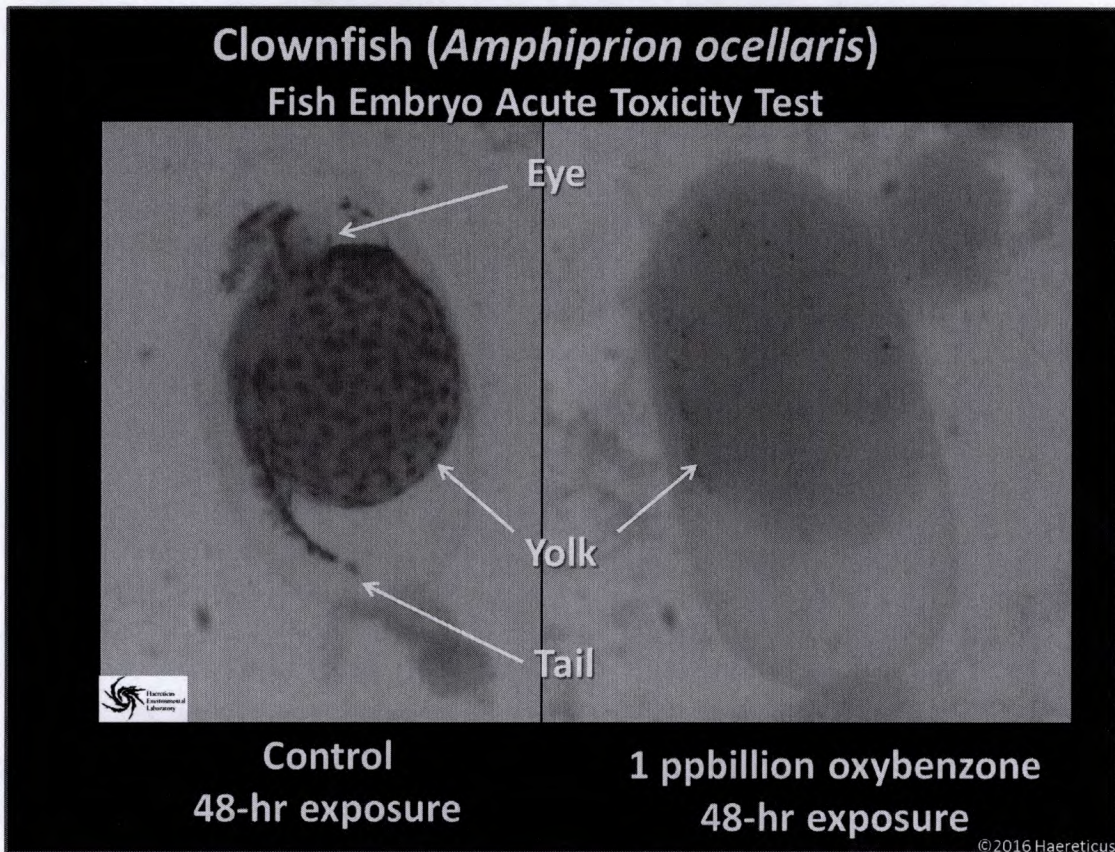


Oxybenzone is even toxic to microalgae, such as *Isochrysis galbana*, at levels comparable to coral, such as 4 ppbillion<sup>49</sup>. A study in 2017 examined the toxicity on mortality, cell growth, and photosynthetic pigments of two important algal species, *Chlamydomonas reinhardtii* and *Microcystis aeruginosa*<sup>1</sup>. Changes in the amount of chlorophyll in these algae occurred in response to oxybenzone concentrations as low as 10 parts per trillion. This toxic response to oxybenzone suggests that the autotrophic level of the food web in marine and aquatic systems could be severely challenged.



Control	0.01	0.1	100	1,000	5,000
$\mu\text{g L}^{-1}$ (parts per billion) Oxybenzone					

Oxybenzone can cause developmental deformities and diseases. In coral, it causes severe deformities in larvae, expanding the mouth (oral pore) more than 10x its normal size, exposing the yolk. In fish embryo, depending on the concentration, it can cause deformities in the eye, heart, and spine, and even severely lethal changes where no development occurs at all.



Humans can also exhibit developmental pathologies, especially fetal-development diseases associated with prenatal exposure to oxybenzone<sup>1,2</sup>. Hirschsprung's disease, a development abnormality thought to afflict every 1 in 3,000 births, has been linked to maternal exposure to oxybenzone, by interfering with the migration neural crest cells during embryonic development<sup>3</sup>. Environmentally relevant concentrations of oxybenzone induced a number of cellular pathologies to brain cells, especially neurons in the developing fetus and infant<sup>4,5</sup>.

**Emerging Science regarding Oxybenzone: a human-health warning.**

Oxybenzone can contaminate hot-tubs and swimming pools with concentrations in the parts per billion<sup>5</sup>. If these pools use chlorine or bromine as a disinfectant, the oxybenzone undergoes a chemical reaction and can become "chlorinated" or "brominated" – meaning a chlorine or bromine is conjugated to the oxybenzone, changing its chemical structure and chemistry<sup>1,2</sup>. Very recent studies show that the chlorinated forms of oxybenzone are significantly more toxic than normal oxybenzone, acting as significant DNA damage agents<sup>57,58,3</sup>. A by-product of this oxybenzone chlorination is chloroform<sup>4</sup>.

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## Are Your Products Safe?

We've come up with a list of chemicals and attributes in personal care products (e.g., sunscreen lotions and sprays) that are found in a number of different aquatic and marine ecosystems that can have a detrimental effect on their existence. We call this list of chemicals and physical-attributes the "HEL LIST." [See the list here](#)

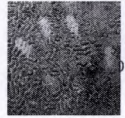
## Help Save The Reefs!

We need YOUR assistance ... so do the coral reefs of the world and the wildlife that depend on them. Your donation in support of our work to better conserve and restore threatened environmental habitats and resources is very much appreciated.

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World Economic Forum and Sunscreen Pollution

🕒 October 2, 2017



Disney Star Promotes Conservation in Hawaii

🕒 August 24, 2017

