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# REEF-SAFE UV CREAMS FOR MARINE CONSERVATION

UV SUNSCREEN

***FRIEND OF THE SEA® - WORLD SUSTAINABILITY ORGANIZATION***
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# REEF-SAFE UV CREAMS FOR MARINE CONSERVATION

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Since their invention in 1936, Ultraviolet creams (UV) have undeniably saved countless lives globally, with regular use preventing the development of cancers, precancers, and melanoma. However, despite UV creams' health benefits to humans, recent research into UV creams' potential impact on the ocean environment has provoked significant fear among marine scientists globally [1].

After a generation of naïve neglect, the curious concern and subsequent study of marine ecologist Cinzia Corinaldesi estimated that an incomprehensible 20,000 tons of UV cream are leaked by seaside tourists in the Northern Mediterranean every year [2], leading to a further study by Dr. Craig Downs, who estimated that up to 14,000 tons of UV cream contaminate coral reef systems annually. The landmark studies sparked worldwide efforts to further understand how the colossal amount of UV creams interact with marine biota and the potential magnitude of impact in the ocean.

UV creams are frequently leaked into the ocean during recreational activities by running off the skin, or through wastewater flows after showers or excretion. Although wastewater treatment facilities can filter most toxins, the compounds commonly found in UV creams tend to pass through. As UV creams are leaked into wastewater streams, their presence tends to stretch far beyond the immediate point of use. Since research efforts began, contaminating UV creams have been found in wastewater in Brazil, Switzerland, Korea, China, Thailand, the Philippines, and the US [3]. The exponential rise in tourism and, most notably, coastal tourism has dramatically exacerbated the extent of UV cream leakage in the ocean. The UV creams have also been progressively strengthened to boost their cancer-preventing properties and subsequently increased their ecotoxicity over time.

**1.** Tovar-Sánchez, Antonio (2019) 'Massive coastal tourism influx to the Mediterranean Sea: The environmental risk of sunscreensv

**2.** Corinaldesi C, (2001). Sunscreens and marine pollution: an experimental study on sunscreen product effects on the coastal marine environment. Thesis, University of Ancona, Ancona, Italy

**3.** Kwon, Ba Reum (2021) 'Occurrence of major organic UV filters in the aquatic environment and their endocrine disruption potentials: A mini-review.'

## COMPOSITION OF CONVENTIONAL UV CREAMS

Most UV creams are made up of physical or chemical ultraviolet filters manufactured to absorb or reflect harmful, cancer-inducing radiation from the sun. Chemical UV filters are designed to be absorbed by the skin, where they absorb and expel UV radiation. Physical UV filters are designed to reflect the sun's rays; however, most leave a thick, white pasty layer on the skin, making chemical UV creams the more popular choice for most consumers.

Unfortunately, the most damaging compounds are those found in chemical UV creams, notably oxybenzone, sulisobenzone, octinoxate, and octocrylene, the most common being oxybenzone, found in over 80% of skincare products [4]. Studies assessing the impacts of UV creams found that over half of the compounds in chemical UV creams available on the market are ecotoxic in marine organisms, as the compounds are easily dissolved in water and are infamously known as 'forever chemicals' due to their inability to biodegrade.

Physical UV filters are commonly made up of Zinc oxide or Titanium dioxide, which are considered relatively environmentally friendlier compared to chemical UV creams, as they are less prone to be ingested by marine organisms. However, the recent development of physical filters, particularly ones that use 'nano-sized' minerals, has also been seen to be harmful to marine organisms, especially coral reefs [5]. Nonetheless, marine scientists, conservation organizations, and governmental authorities, including the Food and Drug Administration in the US [6], have encouraged the usage of physical UV creams instead of the more ecotoxic chemical UV creams.

## IMPACTS ON MARINE ECOSYSTEMS

***Coral Bleaching***

Coral bleaching occurs typically under significant changes in light, temperature, or nutrients that provoke the disappearance of essential symbiotic algae that corals depend on, ultimately leading to coral starvation and death. Coral bleaching has been heavily attributed to climate change-induced rises in sea surface water temperature; however, researchers assessing the impacts of UV creams, in particular Oxybenzone, have found it heavily reduces corals' natural resilience to bleaching [7]. As a result, many scientists now worry that a heavy presence of UV creams in coral environments may provoke bleaching under even more minor variations in light, temperature, or nutrients and could accelerate the rate of global coral bleaching. Concerningly, almost all research assessing UV creams' impacts on coral has been

**4.** Zhong, Xin (2019) 'The toxicological effects of oxybenzone, an active ingredient in suncream personal care products, on prokaryotic alga Arthrospira sp. and eukaryotic alga Chlorella sp.'

**5.** Bom, S. (2019) 'A step forward on sustainability in the cosmetics industry: A review.'

**6.** Ouchene, Lydia (2019) 'Hawaii and Other Jurisdictions Ban Oxybenzone or Octinoxate Sunscreens Based on the Confirmed Adverse Environmental Effects of Sunscreen Ingredients on Aquatic Environments.'

**7.** Downs, C.A (2014) 'Toxicological effects of the sunscreen UV filter, benzophenone-2, on planulae and in vitro cells of the coral.'

conducted in laboratory settings, leaving the real-world consequences largely ambiguous.

Coral reefs remain a crucial life-supporting system in the oceans, providing heavily healthy habitats and fostering symbiotic harmony for up to a million fish species [8]. However, it is now estimated that around 40% of coral reefs globally have been exposed and contaminated by UV creams [9], potentially deteriorating the lifespans of the already endangered and heavily bleached systems and accelerating their demise.

### *Reproductive and organ disruption*

In more general studies attempting to decipher the potential adverse effects of chemical UV creams on marine organisms, researchers widely documented disturbing interruptions to reproductive health, significant organ disruption, and growth stunting in many fish species [10]. Hermaphroditism or intersex, which can significantly reduce the reproductive capability of fish, has been seen in clown fish, parrot fish, moray eels, gobies, medkas, and wrasse, with estrogen production and sperm availability limited in zebrafish and bonnethead sharks, respectively [11]. The adverse reproductive effects on fish species come as great concern to marine conservationists as UV creams may have the opportunity to severely disrupt fish populations, which can lead to devastating cascading impacts on marine biodiversity [12].

### *Plankton diatoms*

UV creams have also been documented to stunt the cell growth in planktonic diatoms [13], the most common type of plankton representing an essential ecosystem component supporting global oxygen production, marine food webs, and deep-sea carbon sequestration. Moreover, planktonic diatoms populations are already facing projected declines due to ocean acidification, where the additional stressor induced by UV cream contamination may accelerate their disappearance, with disproportionate impacts on the global oxygen and carbon cycle.

Sea urchins

Sea urchins are especially sensitive to contamination by UV creams, reducing their resilience to other environmental stressors and representing a significant threat to the species' survival. A study isolating the impacts of Oxybenzone on sea urchins found that there were physical anomalies in 100% of the sea urchin samples exposed to harmful UV creams [14]. Sea urchins are vitally important for maintaining ecosystem balance in coral reef systems, where their absence would further deteriorate the precarious state of coral reefs.

**8.** Schneider, Samantha L (2019) 'Review of environmental effects of oxybenzone and other sunscreen active ingredients.'

**9.** ICRI briefing (2018) Impacts of sunscreens on corals, ;IMPACTS OF SUNSCREENS ON CORAL REEFS FUNDED WITH THE SUPPORT OF THE GOVERNMENT OF SWEDEN AND THE FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITE.'

**10.** Fagervold, S K (2019) Occurrence and Environmental Distribution of 5 UV Filters During the Summer Season in Different Water Bodies

**11.** Schneider (2014) 'Review of environmental effects of oxybenzone and other sunscreen active ingredients

**12.** Shaun Mccoshum (2016) 'Direct and indirect effects of sunscreen exposure for reef biota.'

**13.** Zhong, Xin (2019) 'The toxicological effects of oxybenzone, an active ingredient in suncream personal care products, on prokaryotic alga Arthrospira sp. and eukaryotic alga Chlorella sp.'

**14.** Corinaldesi C (2017). 'Sunscreen products impair the early developmental stages of the sea urchin.'

***Terrestrial ecosystems***

The Chemicals in UV creams have regularly been found in Dolphins in Brazil, Cormorants in Switzerland, and Birds in Spain [15], which is a worrying signal that the adverse effects of UV cream leakage have also crossed into terrestrial landscapes, a field of research that has so far been neglected.

The compounds in UV creams are highly harmful on their own; however, as they remain in the ocean environment effectively forever, they are susceptible to the processes of bioaccumulation and biomagnification, which progressively magnify their adverse impacts indefinitely.

Bioaccumulation occurs when organisms consume chemicals faster than they can be disposed of, increasing their internal concentration and subsequent ecotoxicity over time. Bioaccumulation is an alarming phenomenon as even in areas that enjoy the relatively low presence of UV creams, the process permits even the smallest number of compounds to accumulate in marine organisms, eventually reaching harmful levels and ultimately leading to the myriad of adverse impacts mentioned above [16].

Biomagnification occurs as the chemicals are moved up the food chain as one species eats another, magnifying the magnitude of exposure to organisms at all trophic levels [17]. Species higher in the food chain include many of which ultimately end up on our plates, such as Mussels, Clams, Fish [18], Crabs [19], Shrimps, Prawns, and Squid [20], which implies UV creams as not merely an issue of environmental concern but also human health.

## THE GLOBAL RESPONSE

The environmental impacts onset by UV creams has led to interventions globally to ameliorate the ongoing impacts and to prevent further damage.

Hawaii initiated one of the first large-scale interventions when it banned harmful chemicals found in UV creams in 2018, including oxybenzone and octinoxate, closely followed by the country of Palau, which has prohibited the sale and use of up to 11 chemicals and compounds found in UV creams, being the first country in the world to do so [21].

**15.** Tovar-Sánchez, Antonio (2019) 'Massive coastal tourism influx to the Mediterranean Sea: The environmental risk of sunscreens.'

**16.** Vita, N. A. 'Parameters for assessing the aquatic environmental impact of cosmetic products.'

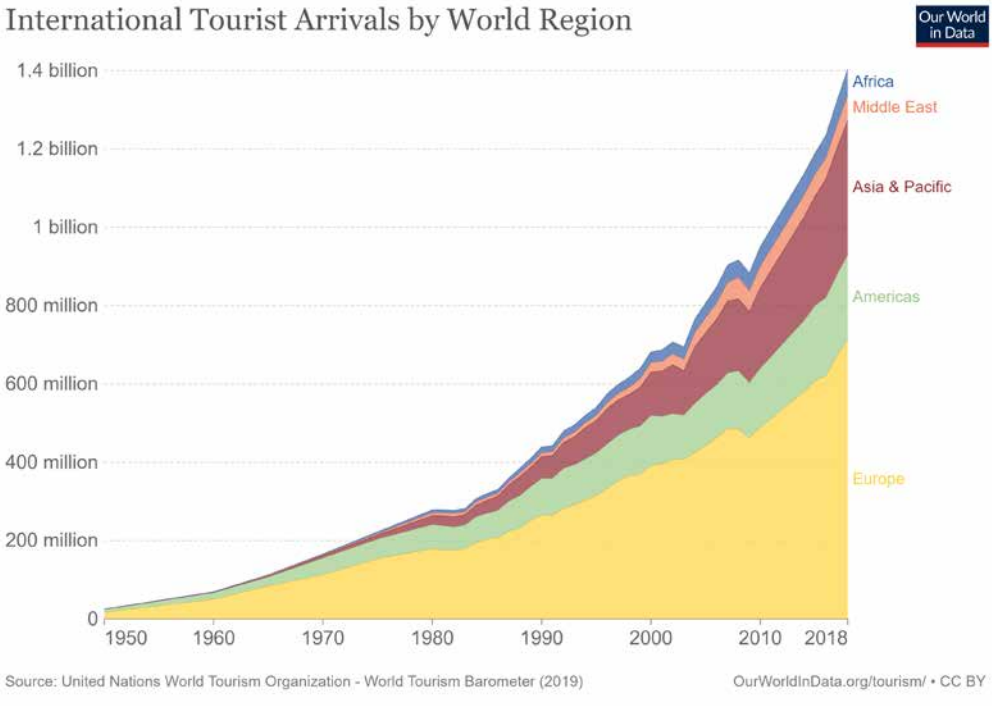
**17.** Fagervold, S K (2019) 'Occurrence and Environmental Distribution of 5 UV Filters During the Summer Season in Different Water Bodies.'

**18.** Bachelot, M. (2012). 'Organic UV filter concentrations in marine mussels from French coastal regions.'

**19.** Molins-Delgado (2018) 'Occurrence of organic UV filters and metabolites in lebranche mullet.'

**20.** Paredes, E (2014) 'Ecotoxicological evaluation of four UV filters using marine organisms from different trophic levels.'

**21.** Ouchene, Lydia (2019) 'Hawaii and Other Jurisdictions Ban Oxybenzone or Octinoxate Sunscreens Based on the Confirmed Adverse Environmental Effects of Sunscreen Ingredients on Aquatic Environments.'





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In 2021, marine national parks in Thailand, heavily inundated with tourists throughout the year, banned coral-harming UV creams containing the ecotoxic compound Oxybenzone, stating that 'they heavily damage reefs, coral larvae and provoke coral bleaching.' Violators have been faced with fines of up to USD 3000. Similar legal proceedings are taking place in Aruba and Bonaire [22].

A waterpark in Mexico is currently engaged in a campaign where visitors are encouraged to trade their environmentally harmful UV creams for chemical-free, biodegradable ones, successfully exchanging 100,000 UV creams a year. The US environmental protection agency has also taken the step to officially declare Oxybenzone as an environmentally endangering contaminant [23].

## CONCLUDING REMARKS

The impacts of UV creams on ocean environments are empirical and widely documented, and greater collective efforts that go beyond the few current interventions are vital to protect and conserve marine ecosystems and biodiversity. Although the evidence is clear, incumbent research remains riddled with ambiguities and knowledge gaps since most tests have been conducted in laboratory settings. Moreover, existing studies have only assessed the effects of the chemicals in isolation, and many scientists have demanded research into the impacts of compounded chemicals that would permit an accurate understanding of the actual damage of UV creams, as most contain up to 20 different compounds [24]. Despite oxybenzone and octinoxate being the most heavily documented compounds in the literature owing to their devastating impacts on marine organisms, other prevalent compounds found in UV creams, Octyl Methoxycinnamate, Octocrylene, and Octyl Salicylate, have also been reported to cause similar adverse effects, and are also prone to the process of bioaccumulation and biomagnification.

Though we can accurately predict general locations of significant UV cream contamination by isolating coastal, lake, and river tourism areas, worryingly, the potential spread of UV cream leakage may be more profound than presently understood. For example, UV creams have been found almost a kilometer from Japan's coast. In a more extreme case, they have even been detected in the Artic, thousands of kilometers from tourist beaches [25]. Furthermore, despite the general acknowledgment of the short-term impacts of UV creams in marine environments [26] [27], the processes of bioaccumulation and biomagnification have undermined efforts to understand their effects in the long run, as the processes allow compounds to remain in the environment for virtually indefinite periods [28] and, consequently, there are fears that current models predicting the number of UV creams in the oceans only provide a modest estimation.

**22.** Tovar-Sánchez, Antonio (2019) 'Massive coastal tourism influx to the Mediterranean Sea: The environmental risk of sunscreens'.

**23.** Blitz J.B (2008) 'Possible environmental effects of sunscreen run-off'.

**24.** ICRI briefing (2018) Impacts of sunscreens on corals, ;IMPACTS OF SUNSCREENS ON CORAL REEFS FUNDED WITH THE SUPPORT OF THE GOVERNMENT OF SWEDEN AND THE FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITE'.

**25.** Schneider, Samantha L (2019) 'Review of environmental effects of oxybenzone and other sunscreen active ingredients

**26.** Labille, Jérôme (2019) 'Assessing Sunscreen Lifecycle to Minimize Environmental Risk Posed by Nanoparticulate UV-Filters-A Review for Safer-by-Design Products'

**27.** Vita, N. A. (2018) Parameters for assessing the aquatic environmental impact of cosmetic products

**28.** Kwon, Ba Reum (2021) 'Occurrence of major organic UV filters in the aquatic environment and their endocrine disruption potentials: A mini-review'.

# FRIEND OF THE SEA CERTIFIED UV CREAMS FOR HEALTHY OCEANS

Fortunately, there has been encouraging progress in developing environmentally friendlier UV creams. Chemical UV creams that do not contain oxybenzone, octocrylene, and octinoxate and physical UV creams with large enough particles that mitigate marine organism ingestion have already had profound impacts in alleviating potential damage. Friend of the Sea has set out to identify, collaborate and support UV cream manufacturers that abide by proven reef-safe requirements by introducing the Friend of the Sea UV cream certification. The Friend of the Sea UV cream certification aims to bring critical attention to the issue and raise the voices of UV cream manufacturers actively engaged in marine conservation. UV creams certified by Friend of the Sea ensure the utmost respect and consideration through science-based approaches applied in their design.

Currently, Nagua, Nidaria Technology Ltd, Tropenzorg B.V, and Taio Care have successfully been awarded the Friend of the Sea certification.

**Friend of the Sea certified UV cream products need to satisfy the following:**

- Significantly reduced run-off into the water, longer water resistance, and durability,
- In the case of chemical UV creams, to avoid using the chemicals, Ethylhexyl-Methoxycinnamate, Benzophenone-3, Avobenz one, Octisalate, Octocrylene; Homosalate, Butylparaben, and Methylbenzylidene Camphor.
- In the case of physical UV creams, particles must be sufficiently large to prevent pollutive dispersion into the marine ecosystem.
- The ingredients prove to be biodegradable.


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