

• The Effects of Oxybenzone • on Growth and Development of Hawaiian Coral Reefs

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AP Research STEM



Introduction & Background

Reef Importance:

- ❖ 830,000 species affected
- ❖ 10% reef populations are unbleached in the Caribbean ocean
- ❖ 6.1 million workers are dependent on reefs
- ❖ Shore barrier



Figure 1. A healthy coral reef

Starting in Hawaii

Sunscreen Crisis

- ❖ “Relating to Water Population” bill begins in January of 2021

Banning of Sunscreen

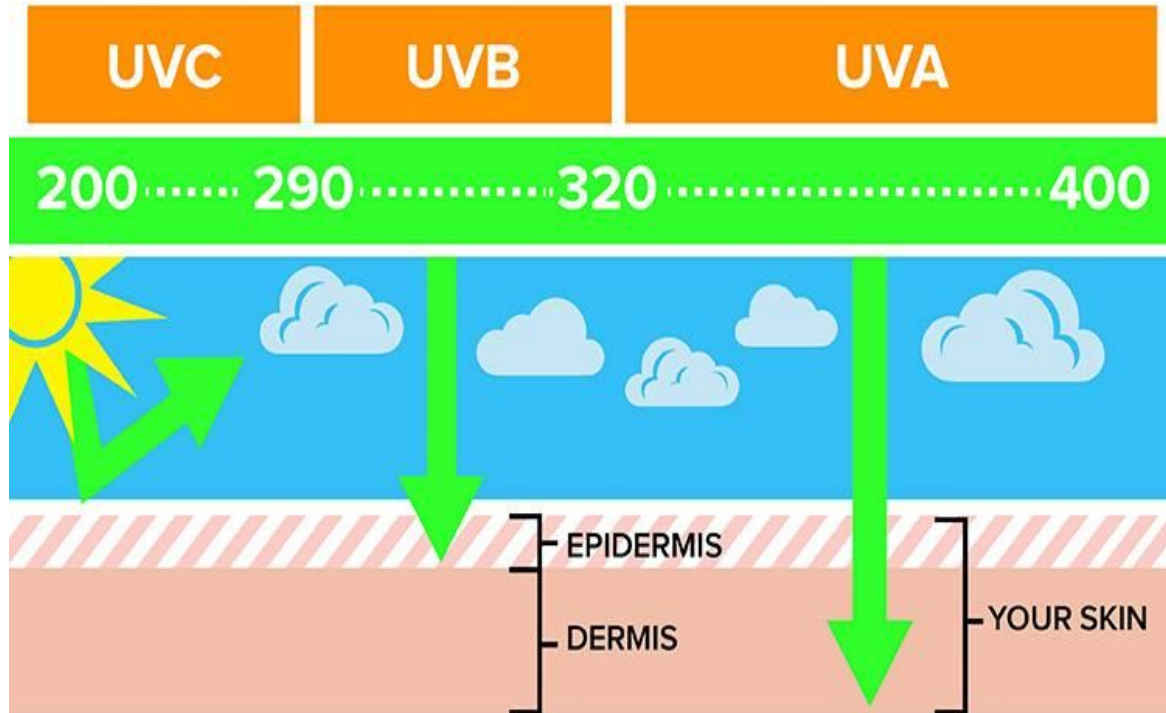
- ❖ Hawaii’s ban on Oxybenzone

How?

- ❖ Raw Elements Sunscreen
- ❖ Hawaii supplies sunscreen

Sunscreen

UV TYPE & SKIN PENETRATION



- ❖ Oxybenzone enters epidermis to protect
- UV rays hit epidermis and damage

Figure 2. Types of UV radiation and sunscreen protection with the different ways they penetrate skin

Bleaching Factors

- ❖ Factors involved in bleaching:
 - Pollution/environmental factors
 - warming of the water temperatures
 - overfishing

- ❖ Sunscreen Bleaching:
 - 25% of sunscreens wash off in the water when applied



Figure 3. A bleached coral reef

How Bleaching Occurs?

- ❖ Sunscreens block sunlight
- ❖ Sunscreens coat coral
- ❖ Dinoflagellates
 - outer shell
 - photosynthesis
- ❖ Symbiotic relationship with Zooxanthellae
 - Pigmentation

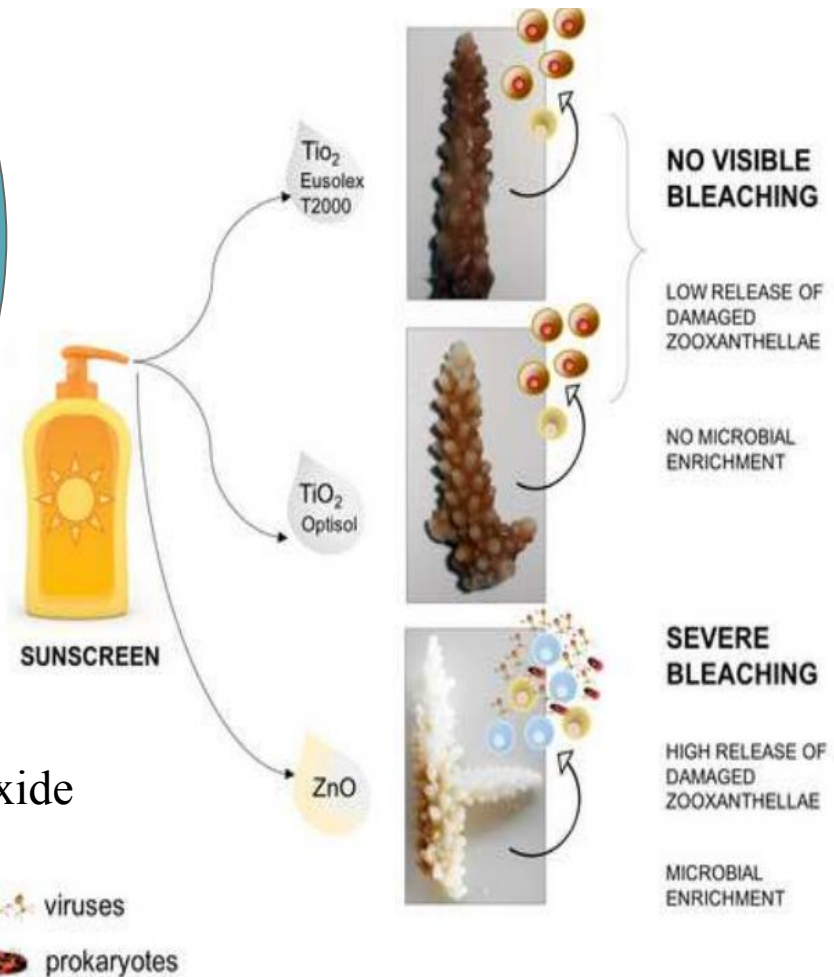


Figure 4. Coral damage Titanium Dioxide and Zinc Oxide

Causes of Bleaching

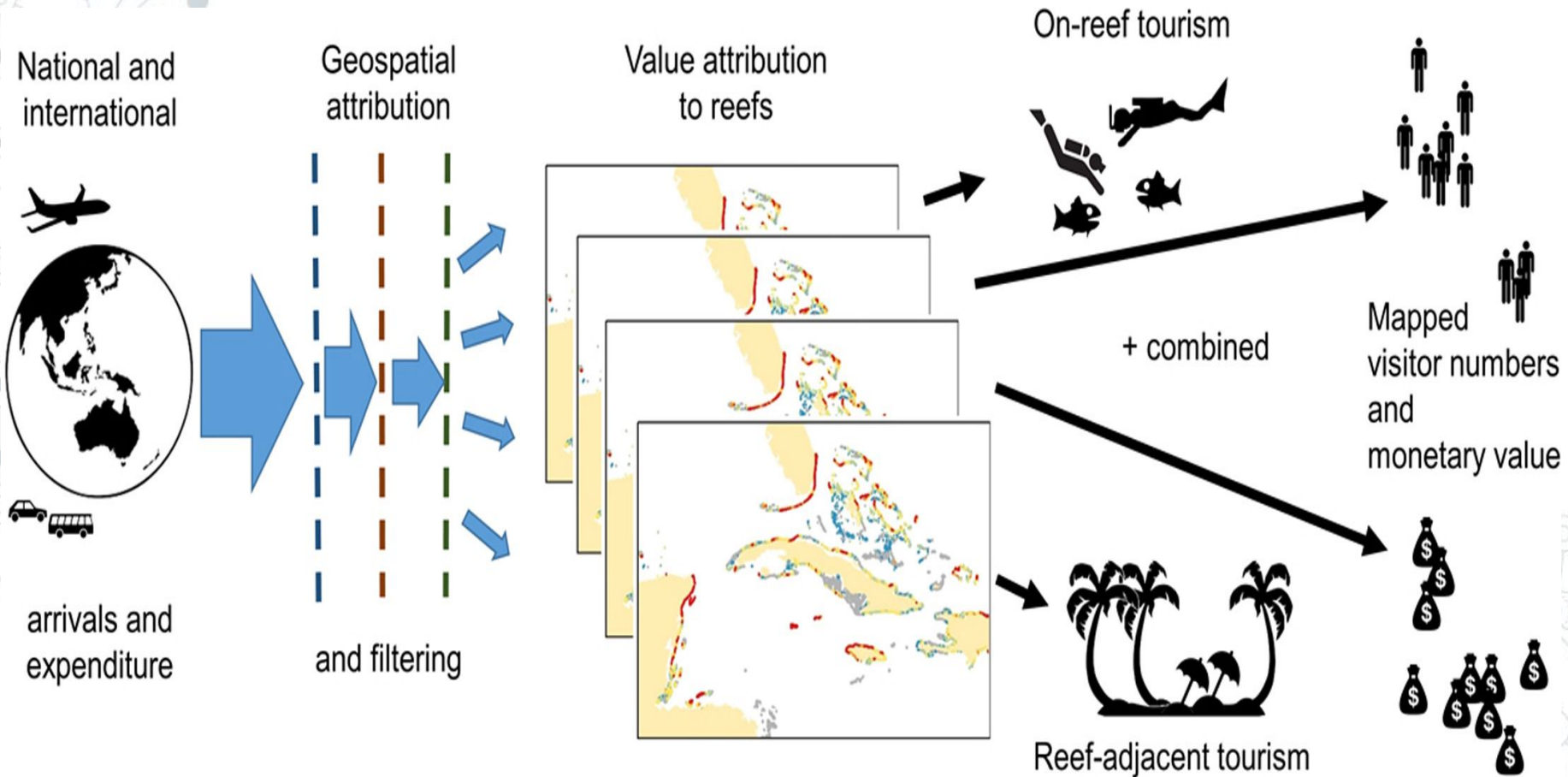


Figure 5. Impact of coral bleaching on society

Formation of Coral

- ❖ Corals form in warm, shallow climates
- ❖ Create calcium skeleton off of ocean floor
- Skeletal endocrine disruptor

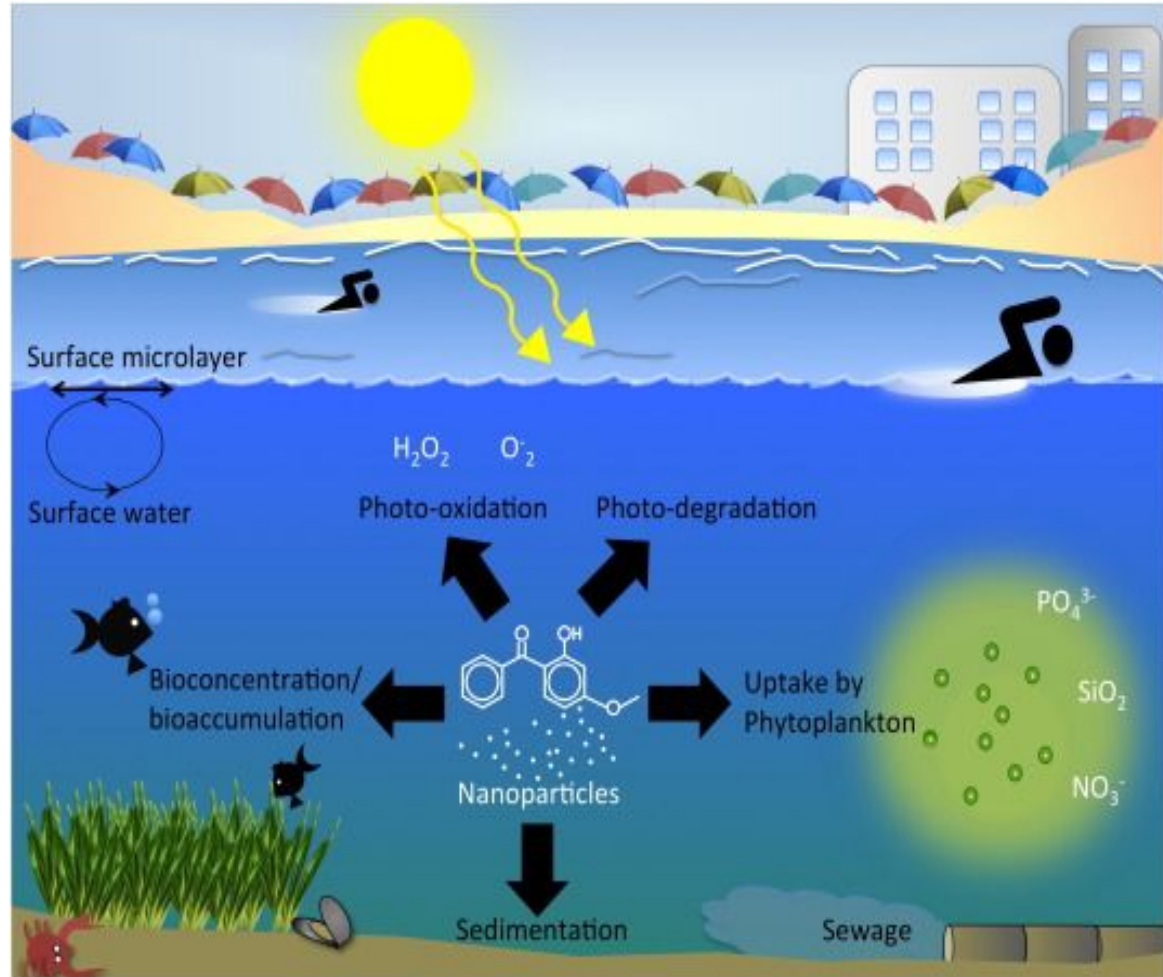


Figure 6. The entrance of toxins into the aquatic ecosystem



Purpose

Investigate the effects of Oxybenzone
on the growth and development of
Hawaiian coral reefs



Research Question

What are the effects of Oxybenzone on growth and development of Hawaiian coral reefs?



Hypothesis

Alternative

Oxybenzone in sunscreen products decreases the regeneration of coral reefs over time.

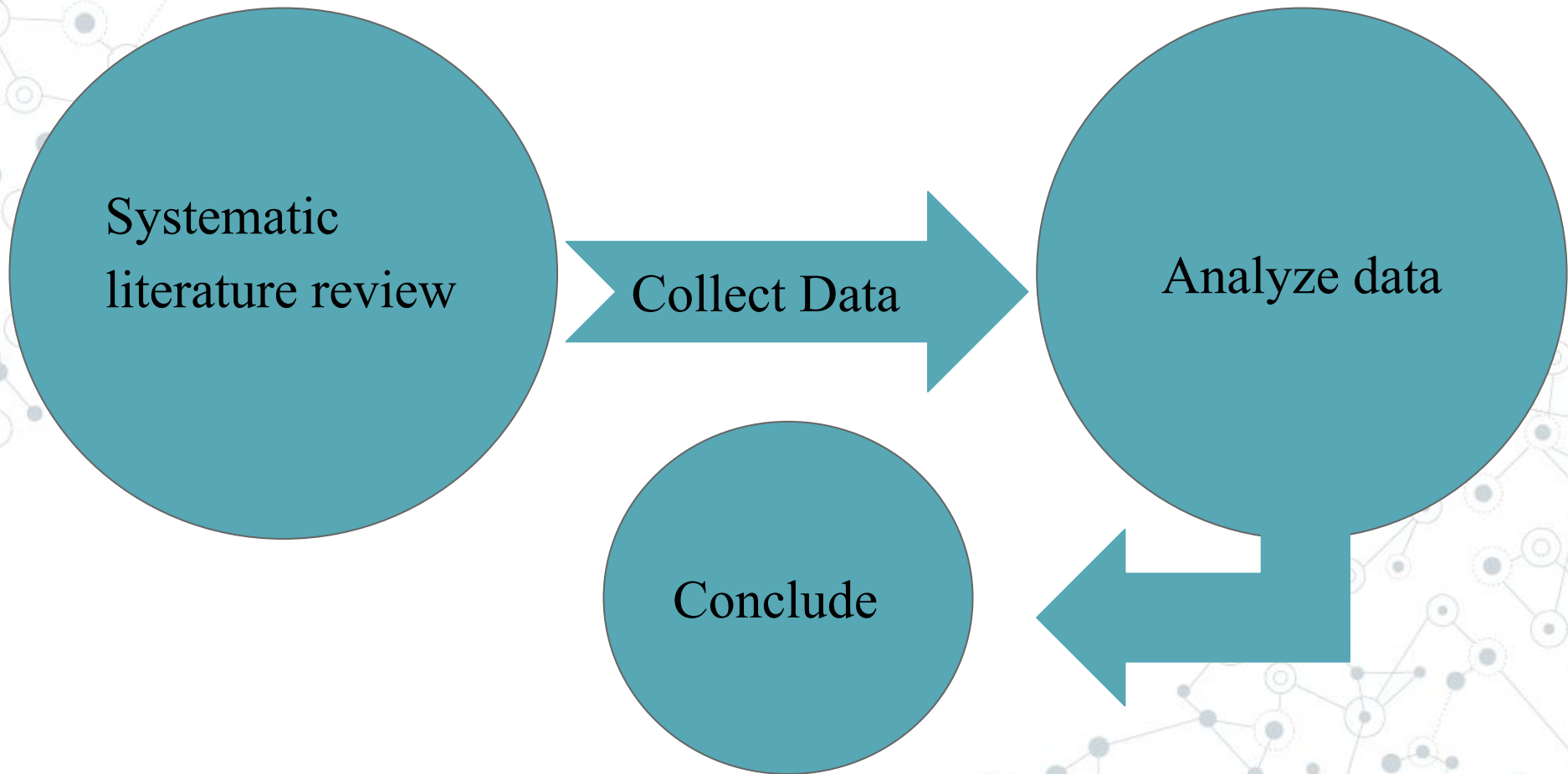
Null

Oxybenzone in sunscreen products does not affect the regeneration of coral reefs over time.

A decorative background featuring a network diagram of interconnected nodes and lines, primarily located in the top-left and bottom-right corners. The nodes are represented by circles of varying sizes and colors (grey, blue, white), connected by thin lines. Some nodes have concentric circles, suggesting a hierarchical or layered structure.

Methods

Systematic Literature Review



Research Papers


- ❖ Gathered from
 - Springer
 - PLOS ONE
 - Cross Mark
 - Environmental International
 - Environmental Health Perspectives
 - Elsevier

- ❖ Key words
 - Oxybenzone
 - Coral Reefs
 - Bleaching
 - Sunscreen

- ❖ Range of data
 - 2006-2019

Data Extraction

- ❖ Data on cell mortality causing bleaching
- ❖ Graph-Google Sheets and Excel
- ❖ Data analysis-conducted t test
 - p- values

A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid grey, some hollow white) connected by thin grey lines. The nodes are arranged in a complex, interconnected pattern.

Results

A decorative network diagram in the bottom-right corner, similar to the one in the top-left, with nodes of varying sizes and colors connected by thin lines.

Reef Bleaching and Coastal Tourism

Countries with coastal tourism	Coastal Tourism Percentage
Egypt	44
Indonesia	29
Mexico	27
Thailand	34
Australia	24
China	13
Philippines	30
USA (Hawaii)	58
Japan	10
USA (Florida)	11

Spalding, M., Burke, L., Wood, S. A., Ashpole, J., Hutchison, J., & Ermgassen, P. (2017). Mapping the global value and distribution of coral reef tourism.

Marine Policy, 82,104-113. doi:10.1016/j.marpol.2017.05.014.

Table 1. Coastal tourism percentages in reef containing countries

Lethal Contamination of Oxybenzone

Table 2. At LC50 ppb, calicoblast cells begin to die with Oxybenzone exposure

Coral Species	OB -LC50 (ug/L)
Indo-Pacific species	
<i>Stylophora pistillata</i> (light)	42
<i>Stylophora pistillata</i> (dark)	671
<i>Pocillopora damicornis</i>	8
Caribbean-Atlantic Species	
<i>Acropora cervicornis</i>	9
<i>Montastrea annularis</i>	74
<i>Montastrea cavernosa</i>	52
<i>Porites asteoides</i>	340
<i>Porites divaricata</i>	36

Downs, C. A., Kramarsky- Winter, E., Segal, R., Fauth, J., Knutson, S., Bronstein, O., Ciner, F. R., Jeger, R., et al. (2015). Toxicological 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. *Archives of Environmental Contamination and Toxicology*, 70, 265-288, doi:10.1007/s00244-015-0227-7.

Mortality Rates With Oxybenzone

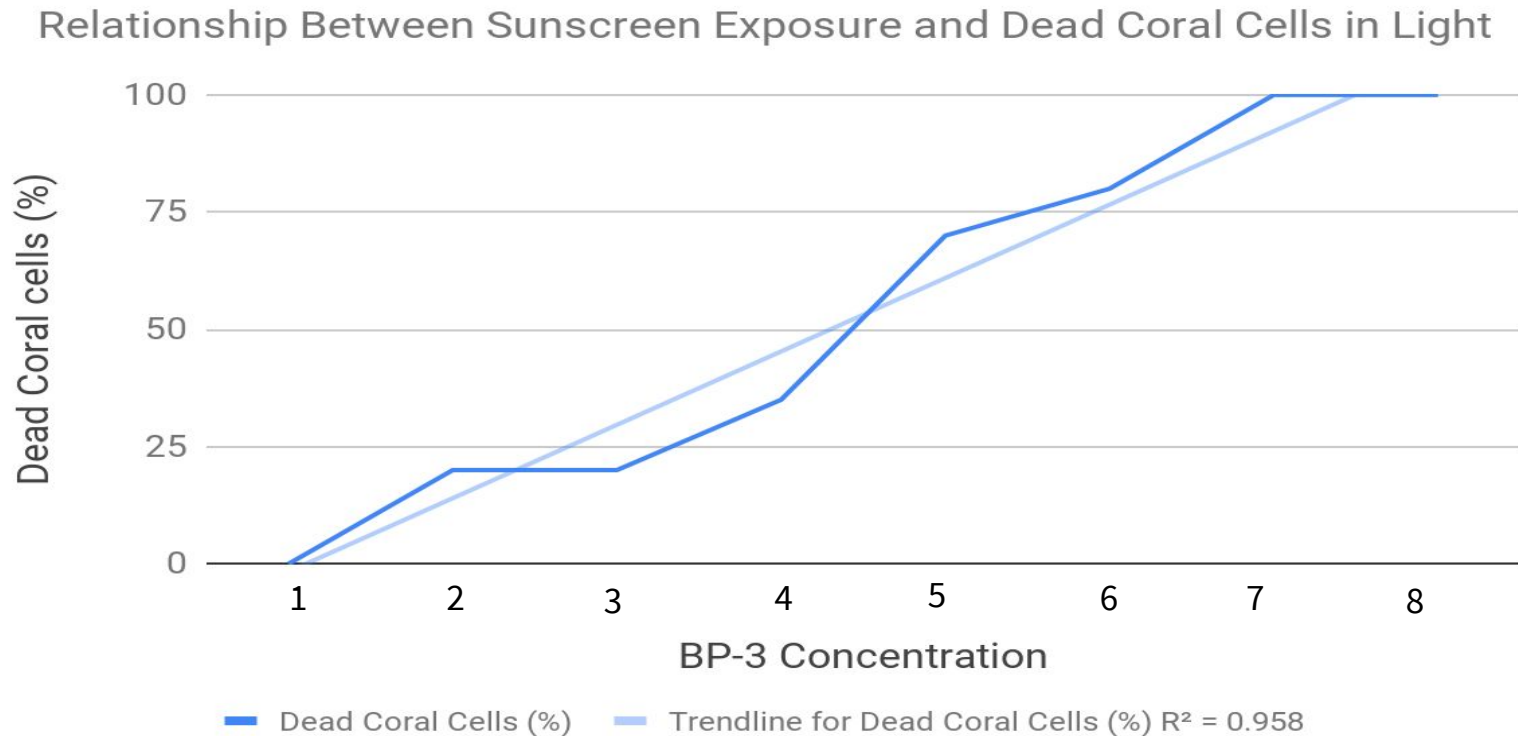


Figure 7. Mortality rates of coral after exposure to Oxybenzone concentrations

- ❖ Comparison of concentration: 0.0061
- ❖ Comparison of dead cells (%): 0.0933

A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid grey, some hollow white) connected by thin grey lines. The nodes are arranged in a complex, interconnected pattern.

Discussion

A decorative network diagram in the bottom-right corner, similar to the one in the top-left, with nodes of different sizes and colors connected by thin lines.



Analysis

- ❖ High tourism yields bleaching
- ❖ Mortality rates increase with Oxybenzone
 - Oxybenzone lethal to coral

A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid grey, some hollow white) connected by thin grey lines, forming a complex web structure.

Conclusion

A decorative network diagram in the bottom-right corner, similar to the one in the top-left, with nodes and connecting lines.

Conclusion

- ❖ Oxybenzone is affecting the coral population in the Hawaiian reefs
 - Oxybenzone concentrations detrimental to coral life
 - Oxybenzone breaks down coral
- ❖ Reject null and accept alternative hypothesis



Limitations

- ❖ Small number of similar data able to be compared
- ❖ Newer topic of discussion
- ❖ Hawaii specifically looked at compared to world scale
- ❖ Other issues in ecosystem that bleach coral

A decorative network diagram in the top-left corner, consisting of various sized nodes (some solid grey, some hollow white) connected by thin grey lines. The nodes are arranged in a complex, interconnected pattern that tapers towards the right.

Further Work

A decorative network diagram in the bottom-right corner, similar to the one in the top-left, featuring nodes of different sizes and styles connected by thin lines, forming a complex web-like structure.

The Future of Coral Reefs

- ❖ Oxybenzone sunscreens used
- ❖ Reefs continue to bleach
- ❖ By 2021, bill will limit sunscreens in Hawaii
 - Oxybenzone ban
- ❖ Use non toxic sunscreens
 - Titanium Dioxide alternative to Oxybenzone

Acknowledgements

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